Subsurface Exploration and Geotechnical Engineering Study

Proposed Sitcum Waterway Terminal

Port of Tacoma, Washington

November, 1982

J-1042-02

HART CROWSER & associates inc.
GEOTECHNICAL CONSULTANTS

APPENDIX A
FIELD EXPLORATIONS

The field exploration program completed for this study consisted of a total of 10 hollow-stem auger borings. Seven borings, designated S-1 through S-7, were advanced on land. Three borings, designated OS-1 through OS-3, were completed offshore. These explorations were completed in general accordance with our April 22, 1982 proposal letter.

The purpose of the onland borings was to explore the conditions of the slag fill placed in the previous site development for TOTE operations and evaluate the nature of the underlying natural soils encountered in the vicinity of the proposed rear crane rail in order to evluate slope stability, alternative crane rail foundation types and potential settlement of the completed structure. The offshore borings, accomplished at the Pierhead Line during this study and our previous site study ("Soil and Foundation Engineering Study Proposed Terminal Development, Sitcum Waterway, Port of Tacoma, Washington" dated April 4, 1978) provided boring explorations with a spacing on the order of 300 feet to delineate subsurface conditions along the waterside of the completed pier structure. The approximate locations of the various explorations accomplished for this study, together with the locations of explorations completed for the previous site study, are shown on Figure 1, Site and Exploration Plan. Detailed interpretative logs of the subsurface conditions disclosed at the 1982 exploration locations are included in this Appendix as Figures A-1 through A-10.

The offshore borings, OS-1 through OS-3, were accomplished using hollow-stem auger techniques by Tom Campbell, Inc. of Lynnwood, Washington, under subcontract to Hart-Crowser & Associates, Inc. These borings were advanced utilizing a barge-mounted modified Mobile B-40 drill rig using 3-3/8 inch ID hollow auger. Borings OS-1 through OS-3 were advanced to depths ranging between 65 feet and 32 feet below mudline or 120.5 to 132 feet below the deck of the barge. The offshore borings were advanced to near the depth limit of the equipment utilized. Borings S-1 through S-7 were drilled onshore by FLD Industries of Edmonds, Washington, under subcontract to Hart-Crowser & Associates using a truck-mounted CME 75 drill rig with 3-3/4 inch ID hollow auger. These borings were advanced to depths ranging from 78.5 to 119 feet below the ground surface.

Locations of the onshore borings were determined by hand taping methods from horizontal survey control points set by Port of Tacoma survey crews. An optical reference system consisting of a series of range stakes installed by the Port of Tacoma survey crew was used to locate the offshore borings. Elevation control of the offshore borings was accomplished using tide gauges established by the Port of Tacoma survey crews. The elevation of the onshore borings was determined by interpolation from topographic data furnished by the Port of Tacoma. The locations and elevations should be considered accurate to the degree implied by the method used.

Representative soil samples were obtained at 2.5 foot and 5 foot intervals, in zones of particular interest. Representative disturbed samples of the predominantely granular soils were obtained using the Standard Penetration Test (SPT) procedure in general accordance with the procedure described in ASTM D 1586. The SPT procedure consists of driving a standard 2-inch outside diameter split-barrel sampling tube a distance of 18 inches, using a 140 pounds hammer free-falling 30 inches. The resistance to sampler penetration is recorded in

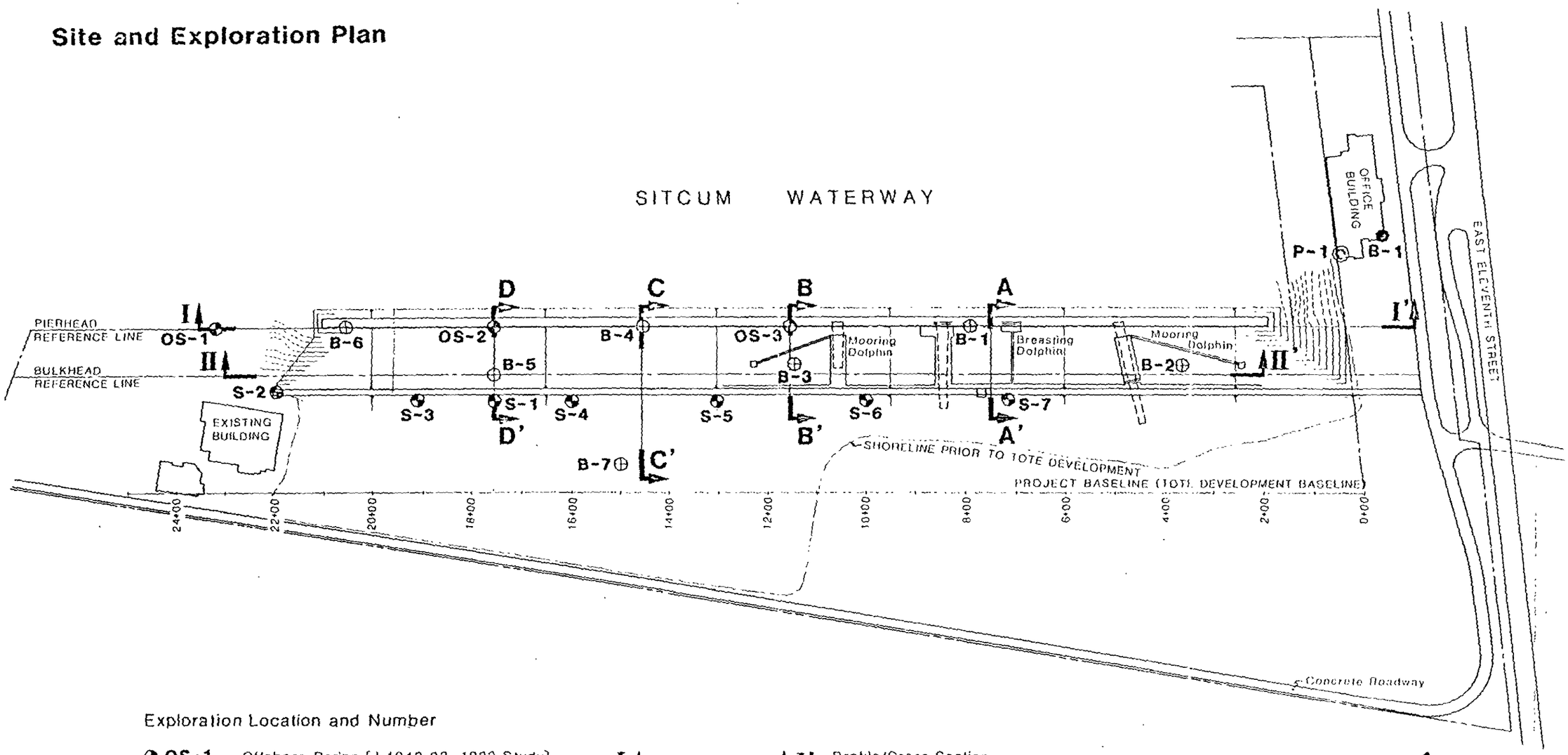
three six-inch intervals. The number of blows required to drive the split-barrel sampler the final 12 inches is referred to as the Standard Penetration Resistance or N value. This N value is used to classify the samples into relative density categories. The Standard Penetration Resistance for each sample has been plotted on the boring logs at their respective sample elevation.

If the high penetration resistance encountered in very dense materials precluded driving the total 18-inch sample interval, the penetration resistance for the partial penetration is entered on the logs as follows: if the total penetration is greater than six inches and less than 18 inches, then the noted N value is the sum of the number of blows completed after the first six inches of penetration, over the number of inches driven in excess of the first six inches. For example, a blow count series of 12 for 6 inches, 30 for 6 inches, and 50 for 3 inches would be reported as 80/9 inches; while a blow count series of 30 for 6 inches, and 50 for 4 inches would be reported as 50/4 inches. In the case where total penetration is less than 6 inches, the total number of blows and penetration is indicated.

Although the site soils are predominantly granular in nature, a few Shelby tube samples of the siltier zones were obtained. Generally, poor sample recovery was noted for this sampling method. This sampling method consists of hydraulically pushing three-inch diameter seamless thin wall, steel tube samplers into the siltier soils at the desired depth. This sampling method substantially reduces the degree of sample disturbance, as compared to driven SPT samples. Shelby tube samples were sealed in the field. Representative samples of the materials recovered within the split-barrel sampler were classified and placed in water-tight jars. All samples were transported to the Seattle laboratory of Hart-Crowser & Associates for further classification and testing.

The borings were continuously observed and soil conditions were logged by Messrs. Scott Wright, Bruce McDonald and Jon Sondergaard, all engineering geologists with Hart-Crowser & Associates. The soil stratification was generalized from drilling observations and the samples recovered from the explorations. The material changes indicated on the boring logs are often gradational in nature, and subsurface conditons may vary at locations other than where the explorations were completed.

Site and Exploration Plan



Exploration Location and Number

- OS-1 Offshore Boring (J-1042-02, 1982 Study)
- S-1 Land Boring (J-1042-02, 1982 Study)
- B-1 Boring (J-581, April, 1978 Study)
- B-1 Boring (J-995, Port of Tacoma Office Building, 1981 Study)
- P-1 Dutch Cone Probe (J-995, Port of Tacoma Office Building, 1981 Study)

I — I' Profile/Cross Section Location and Designation

PROJECT NORTH

0 200 400
Scale in Feet

J-1042-02

APPENDIX B
LABORATORY TESTING PROGRAM

A laboratory testing program was performed for this study to evaluate the basic index and geotechnical engineering properties of the site soils. Laboratory tests were performed on both disturbed and relatively undisturbed samples. The laboratory tests performed and the procedures followed are outlined below.

Visual Classification

All soil samples recovered in the explorations were visually classified in the field and then transported to the laboratory where the classifications were verified in a relatively controlled environment. Classifications were made in general accordance with the Unified Soil Classification System presented in Table B-1. Visual classifications included soil consistency or density, color, moisture content, major soil type and the modifying fractions in the sample. The classifications of selected samples were checked by performing grain size analyses on the samples.

Moisture Content Determinations

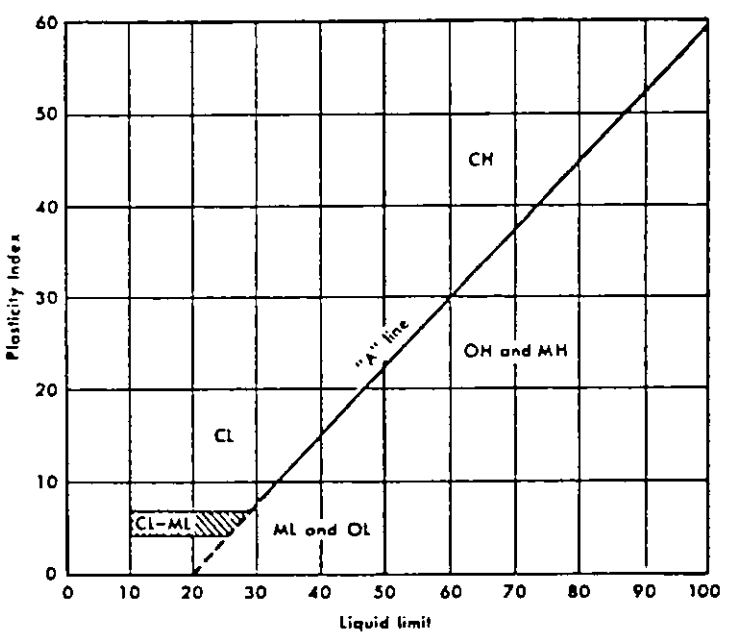
Moisture contents were determined for each samples recovered in the explorations in general accordance with ASTM D 2216071 as soon as possible following their arrival in our Seattle laboratory. The results of these tests are shown adjacent to each soil sample on the Boring Logs, Figure A-1 through A-10. In addition, the moisture contents of samples subjected to other testing have been determined and are presented along with the various test results which follow in this appendix.

Grain Size Analysis

Grain size analyses were performed on representative samples in general accordance with test procedures described in ASTM D 422063. The wet sieve analysis method was used for most samples and determines the size distribution greater than the U.S. No. 200 mesh sieve size. The size distribution for particles less than the No. 200 mesh sieve was determined by the hydrometer method for a selected number of samples. The results of the tests are presented as curves in Figures B-1 through B-13, plotting percent finer by weight versus grain size. Each curve is identified as to boring and sample number with a complete written description presented in tabular form at the bottom of the figure. Samples subjected to grain size analyses are identified on the boring logs.

Table B-1 Unified Soil Classification System

Major divisions			Group symbols	Typical names	Laboratory classification criteria	
Coarse-grained soils (More than half of material is larger than No. 200 sieve size) 0.08 mm	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 per cent ..... GW, GP, SW, SP; More than 12 per cent ..... GM, GC, SM, SC; 5 to 12 per cent ..... Borderline cases requiring dual symbols**	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW
		Gravels with fines (Appreciable amount of fines)	GM* d	Silty gravels, gravel-sand-silt mixtures		Atterburg limits below "A" line or P.I. less than 4 — Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
			GM* u			
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterburg limits above "A" line with P.I. greater than 7
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW
		Sands with fines (Appreciable amount of fines)	SM* d	Silty sands, sand-silt mixtures		Atterburg limits below "A" line or P.I. less than 4 — Limits plotting in hatched zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
			SM* u			
			SC	Clayey sands, sand-clay mixtures		Atterburg limits above "A" line with P.I. greater than 7
Fine-grained soils (More than half of material is smaller than No. 200 sieve) 0.08 mm	Silts and clays (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
			OL	Organic silts and organic silty clays of low plasticity		
	Silts and clays (Liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
			CH	Inorganic clays of high plasticity, fat clays		
			OH	Organic clays of medium to high plasticity, organic silts		
	Highly organic soils		Pt	Peat and other highly organic soils		



Plasticity Chart

*Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits, suffix d used when LL is 28 or less and the P.I. is 6 or less; the suffix u used when LL is greater than 28.

**Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder.

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Boring Log OS-1

SOIL INTERPRETATION

Approximate Station 23+15

Approximate Mudline Elevation in Feet -30 (MLLW)

Loose, saturated black, slightly sandy, clayey SILT

With scattered wood fragments

Grades more sandy to fine sandy SILT

(-37)

Loose, saturated, gray, slightly silty to silty, fine to medium SAND

Wood fragments, 2 to 3 inch lenses of sandy SILT

(-46)

Loose, saturated, gray, slightly silty, fine SAND

Medium dense, silty

Medium dense, silty

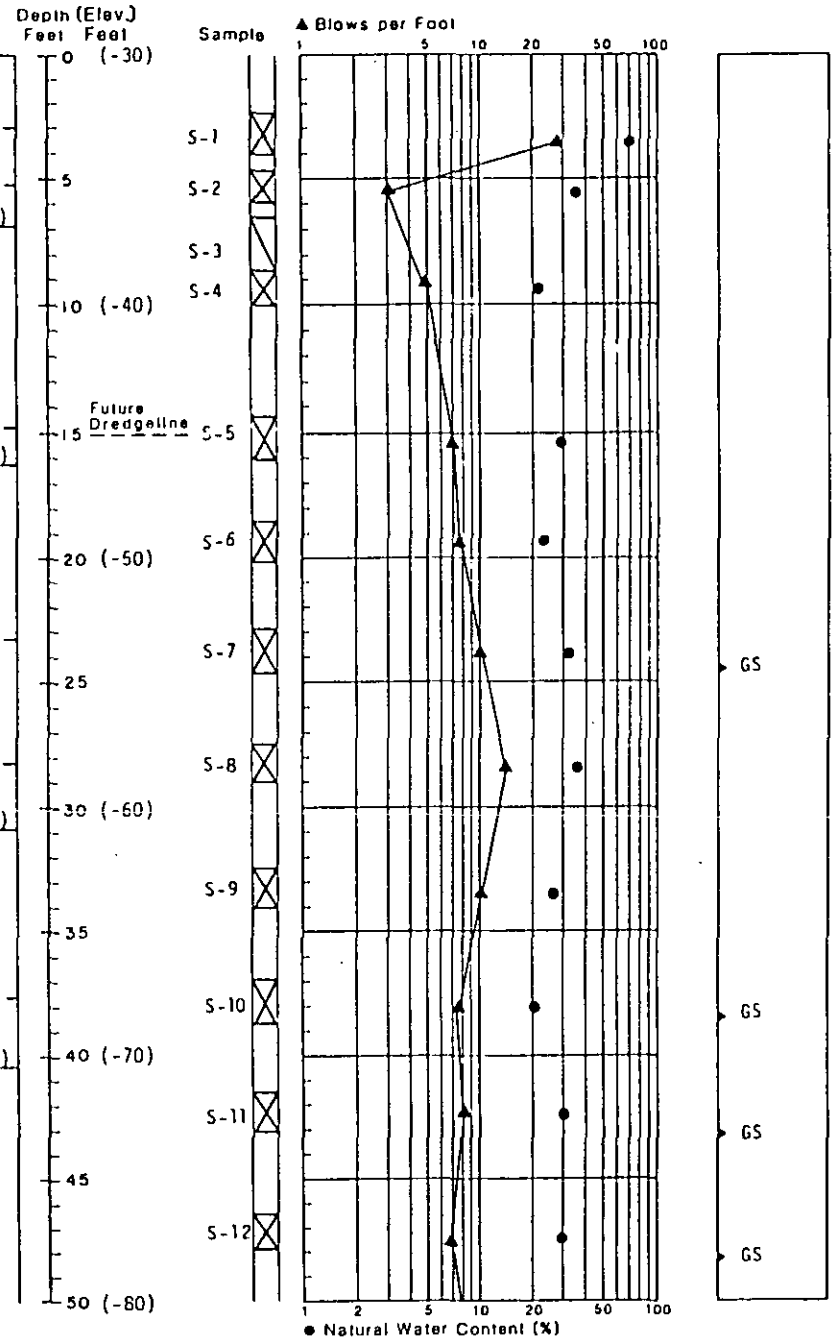
(-61)

Loose to medium dense, saturated, gray, fine to medium SAND.

Slightly silty, shell fragments

(-70)

Medium stiff to stiff, saturated, gray, sandy SILT



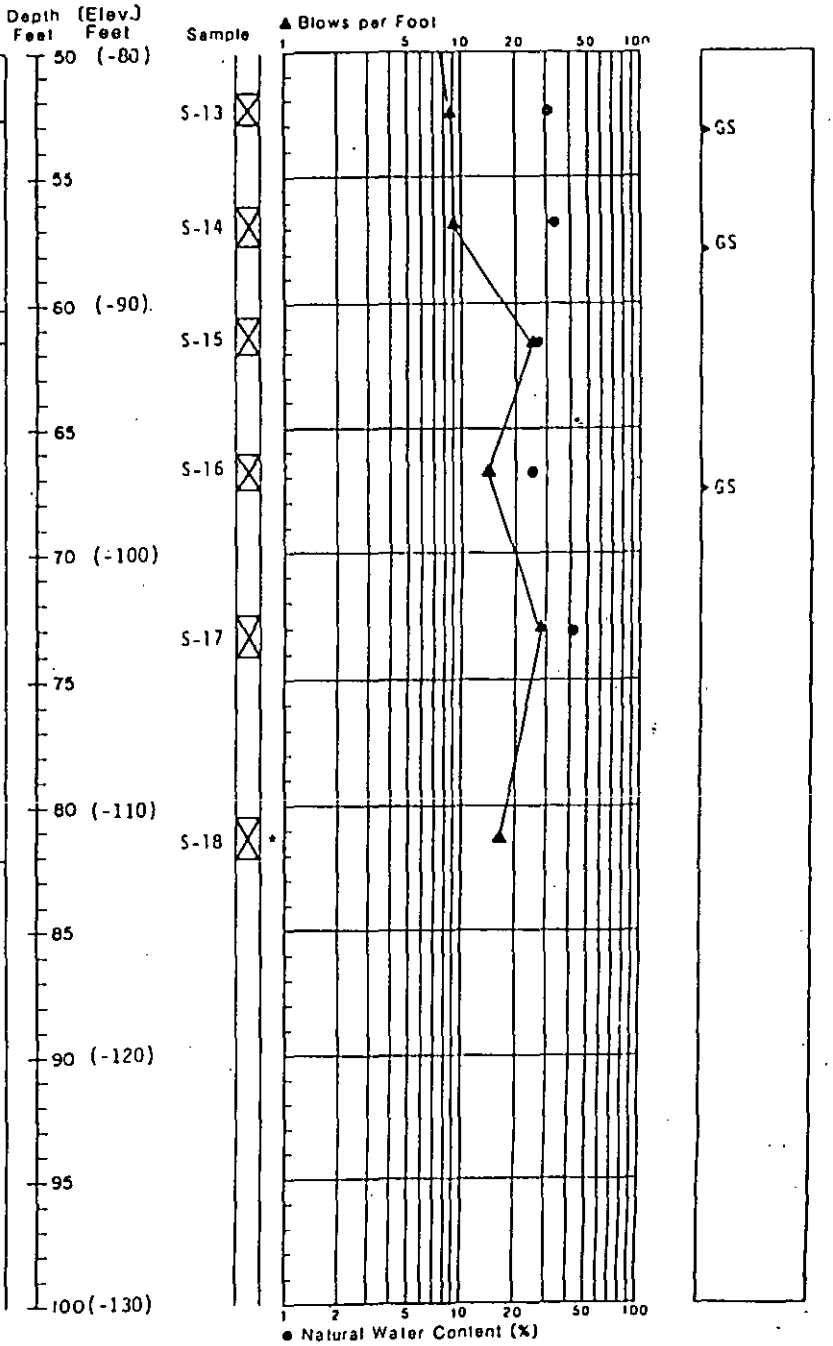
SOIL INTERPRETATION

Medium stiff to stiff, saturated, gray, sandy SILT.
Grades to silty, fine SAND to fine sandy SILT.

Stiff to very stiff, saturated, gray, fine sandy SILT
Occasional shell fragments

(-112)

Bottom of Boring at 82 feet below mudline.
Boring completed 5/4/82.



STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

LABORATORY TESTS

Groundwater Level

Bentonite Seal
2/4/81
Water Level (Date)
ATD At Time of Drilling
Observation Well Tip or Slotted Section

Sampling

2" O.D. Split Spoon Sample
3" O.D. Shelby Tube Sample
Cutting Sample
* No Sample Recovery

Laboratory Tests

GS Grain Size Analysis
CN Consolidation Test
K Permeability Test
DS Direct Shear
QU Unconfined Compression, tsf
TV Torvane, tsf
PP Pocket Penetrometer, tsf
TUU Triaxial Unconsolidated Undrained
TCU Triaxial Consolidated Undrained
TCD Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level, if indicated, is for the date specified and may vary with the time of year.

J-1042-02 August 1982
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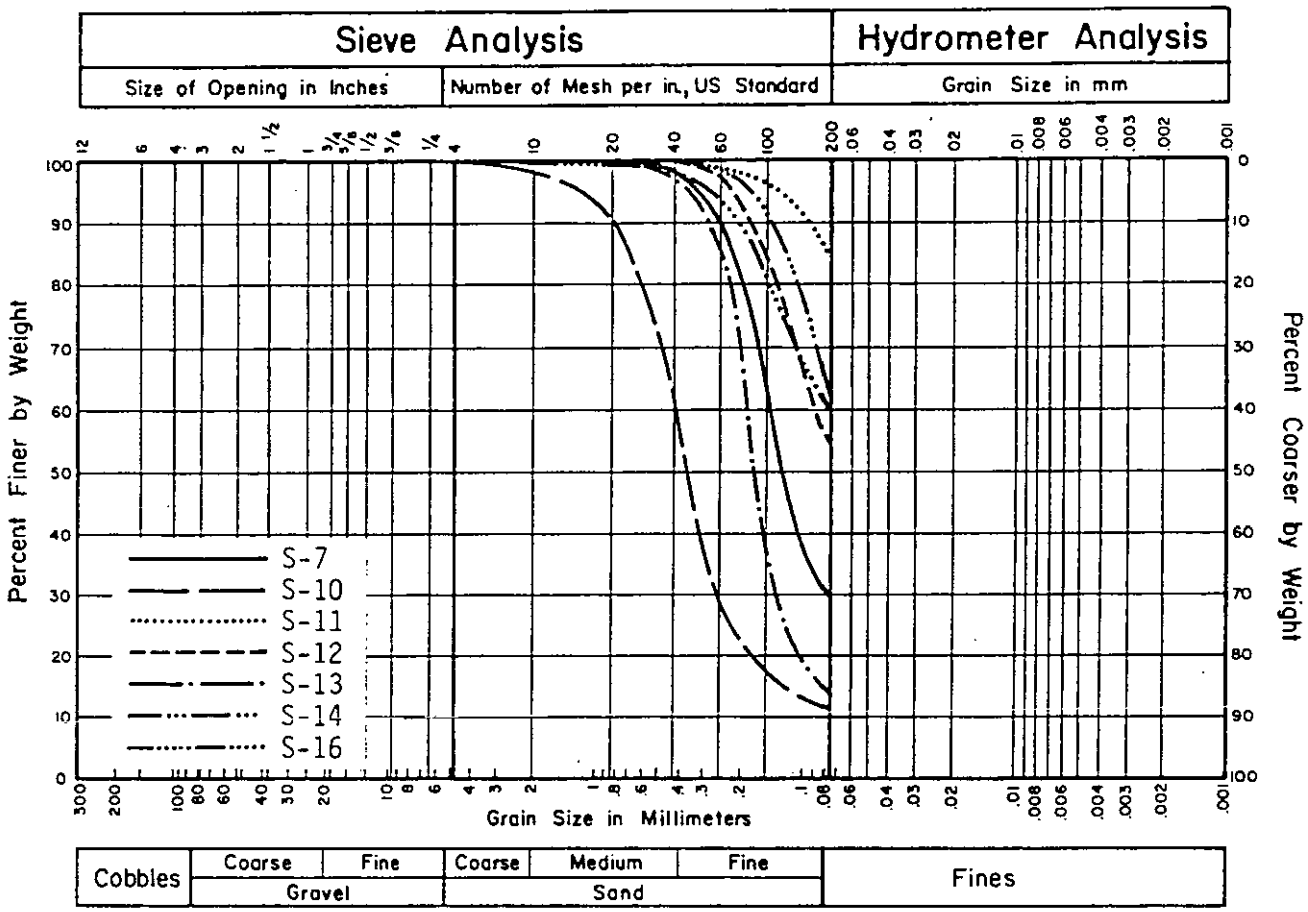
Figure A-8

Grain Size Classification

Boring OS-1



Sample	Depth-ft	U.S.C.	Classification	Nat. W.C. %	Atterberg Limits LL	PL	PI
S-7	23.5 - 24.5	SM	Very silty, fine SAND	30			
S-10	37.5 - 39.0	SM-SW	Slightly silty, medium to fine SAND	24			
S-11	41.5 - 43.0	ML	Sandy SILT	38			
S-12	46.5 - 48.0	ML	Very fine sandy SILT	33			
S-13	51.5 - 53.0	SM	Silty, fine SAND	28			
S-14	56.0 - 57.5	ML	Very sandy SILT	32			
S-16	66.0 - 67.5	ML	Very sandy SILT	27			

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Figure B-8

Boring Log OS-2

SOIL INTERPRETATION

Approximate Station 17+50
Approximate Mudline Elevation In Feet -42 (MLLW)

Loose, saturated, black, slag GRAVEL (FILL), increasing clayey SILT content with depth.

(-48)

Very loose to medium dense, saturated, gray, fine to medium SAND mixed with slag GRAVEL.

Silty

(-57)

Loose to medium dense, saturated, gray, silty, fine to medium SAND.

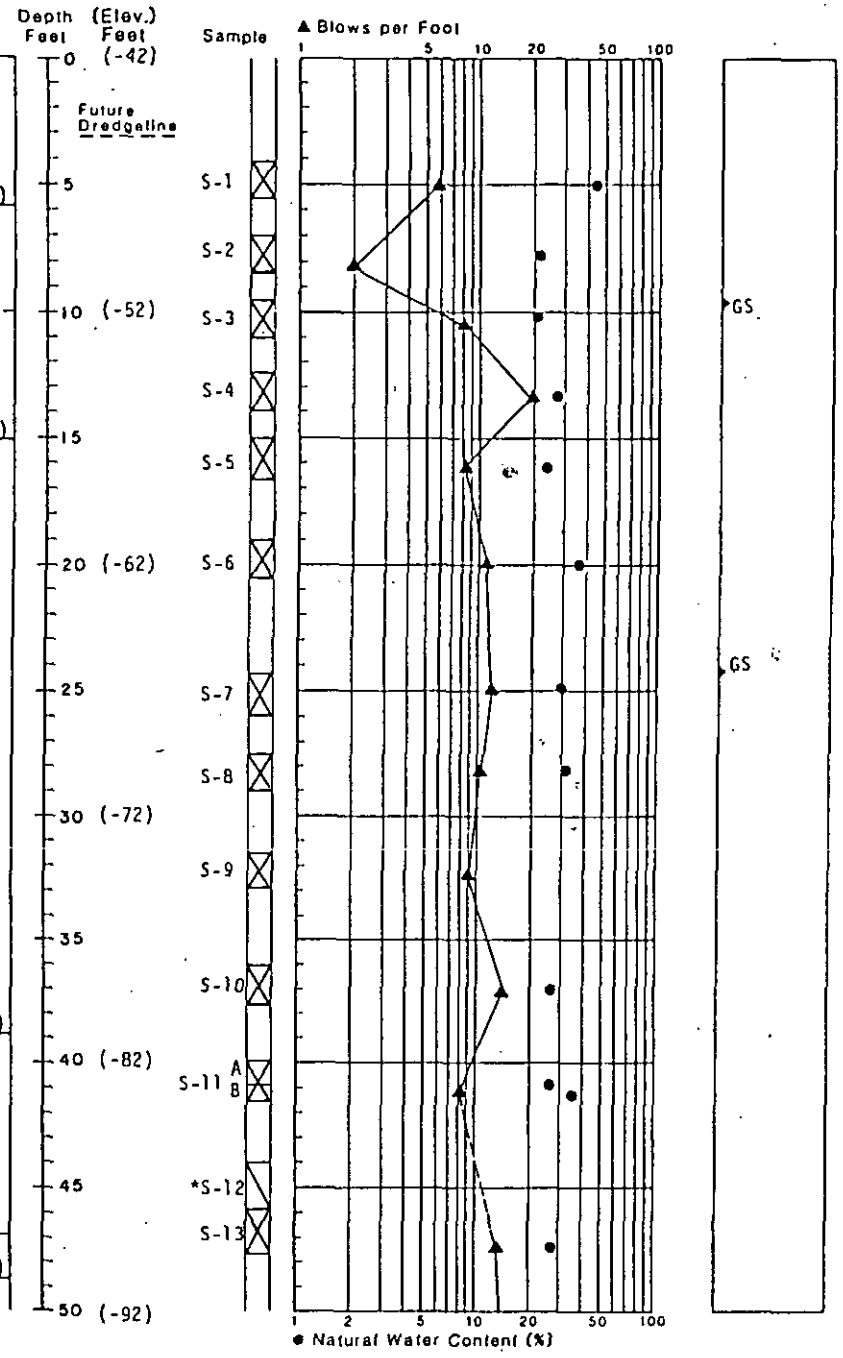
(-81)

Loose to medium dense, saturated, gray, fine to medium SAND with 1/2 inch to 2 inch sandy, clayey SILT interbeds

Grades to silty, fine SAND with clayey SILT interbeds

(-91)

Stiff, saturated, gray, fine sandy SILT



SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE

(140 pound weight, 30 inch drop)

LABORATORY TESTS

Stiff, saturated, gray, fine sandy SILT.

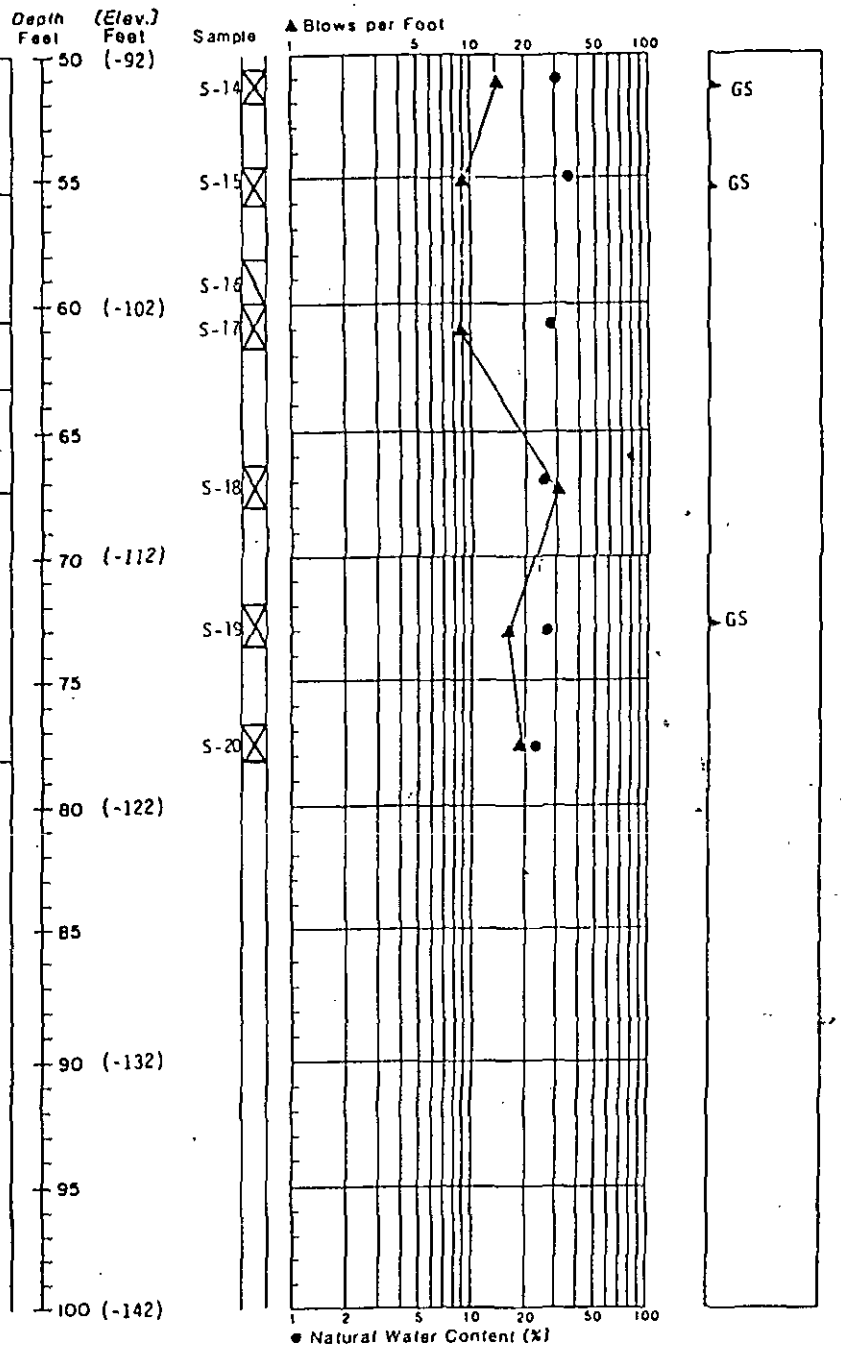
- Blocky structure
- Occasional shell fragments

Stiff to very stiff, saturated, gray, fine sandy SILT

- 1 inch lenses of fine to medium SAND

(-120)

Bottom of Borehole at 78 feet below mudline. Completed 5/8/82.



Groundwater Level

- Bentonite Seal
- 2/4/81 ▽ Water Level (Date)
- ATD At Time of Drilling
- Observation Well Tip or Slotted Section

Sampling

- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Cutting Sample
- ★ No Sample Recovery

Laboratory Tests

GS	Grain Size Analysis	TUU	Triaxial Unconsolidated Undrained
CN	Consolidation Test	TCU	Triaxial Consolidated Undrained
K	Permeability Test	TCD	Triaxial Consolidated Drained
DS	Direct Shear		
OU	Unconfined Compression, tsf		
TV	Torvane, tsf		
PP	Pocket Penetrometer, tsf		

Water Content (%)

Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

Notes

1. Soil descriptions are interpretive and actual changes may be gradual
2. Water Level, if indicated, is for the date specified and may vary with the time of year.

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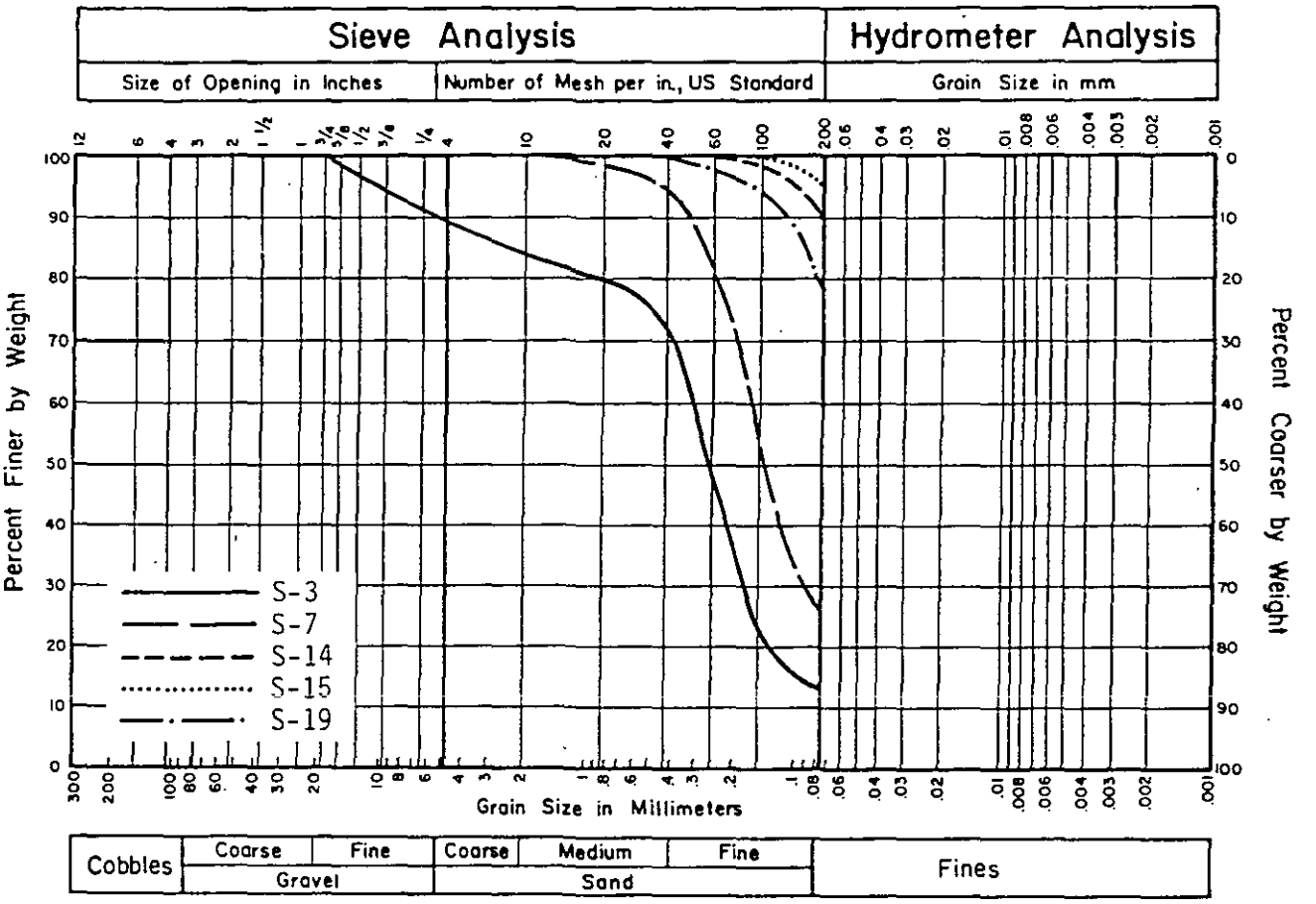
Figure A-9

BC

Grain Size Classification

Boring OS-2



Sample	Depth-ft	U.S.C.	Classification	Nat. W.C. %	Atterberg Limits LL	PL	PI
S-3	9.5 - 11.0	SM	Slightly gravelly, silty, medium to fine SAND	21			
S-7	24.5 - 26.0	SM	Silty, medium to fine SAND	32			
S-14	50.5 - 52.0	ML	Slightly sandy SILT	31			
S-15	54.5 - 56.0	ML	SILT with trace of sand	33			
S-19	72.0 - 73.5	ML	Sandy SILT	31			

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Figure B-9

Boring Log OS-3

SOIL INTERPRETATION

Approximate Station 11+50
Approximate Mudline Elevation in Feet -45 (MLLW)

Medium dense, saturated, black, slag GRAVEL (FILL), increasing SAND and clayey SILT content with depth.

(-51)

Loose to medium dense, saturated, gray, fine to medium SAND

Medium dense, slightly silty

Medium dense, silty, occasional wood fragments

Silty, fine SAND interbeds

(-67)

Medium dense to dense, saturated, gray, silty, fine SAND with thin SAND lenses

Grades to silty, fine to medium SAND

(-86)

Medium dense, saturated, gray, fine to medium SAND

(-91)

Dense, saturated, gray, silty, fine to medium SAND.

Depth Feet | (Elev.) Feet Future Dredgeline

0 (-45)
5
10 (-55)
15
20 (-65)
25
30 (-75)
35
40 (-85)
45
50 (-95)

Sample: S-1, S-2, S-3, S-4, S-5, S-6, S-7, S-8, S-9, S-10, S-11, S-12

STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

▲ Blows per Foot: 1, 5, 10, 20, 50, 100

● Natural Water Content (%): 1, 2, 5, 10, 20, 50, 100

LABORATORY TESTS: GS, GS, GS, GS

SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE

(140 pound weight, 30 inch drop)

LABORATORY TESTS

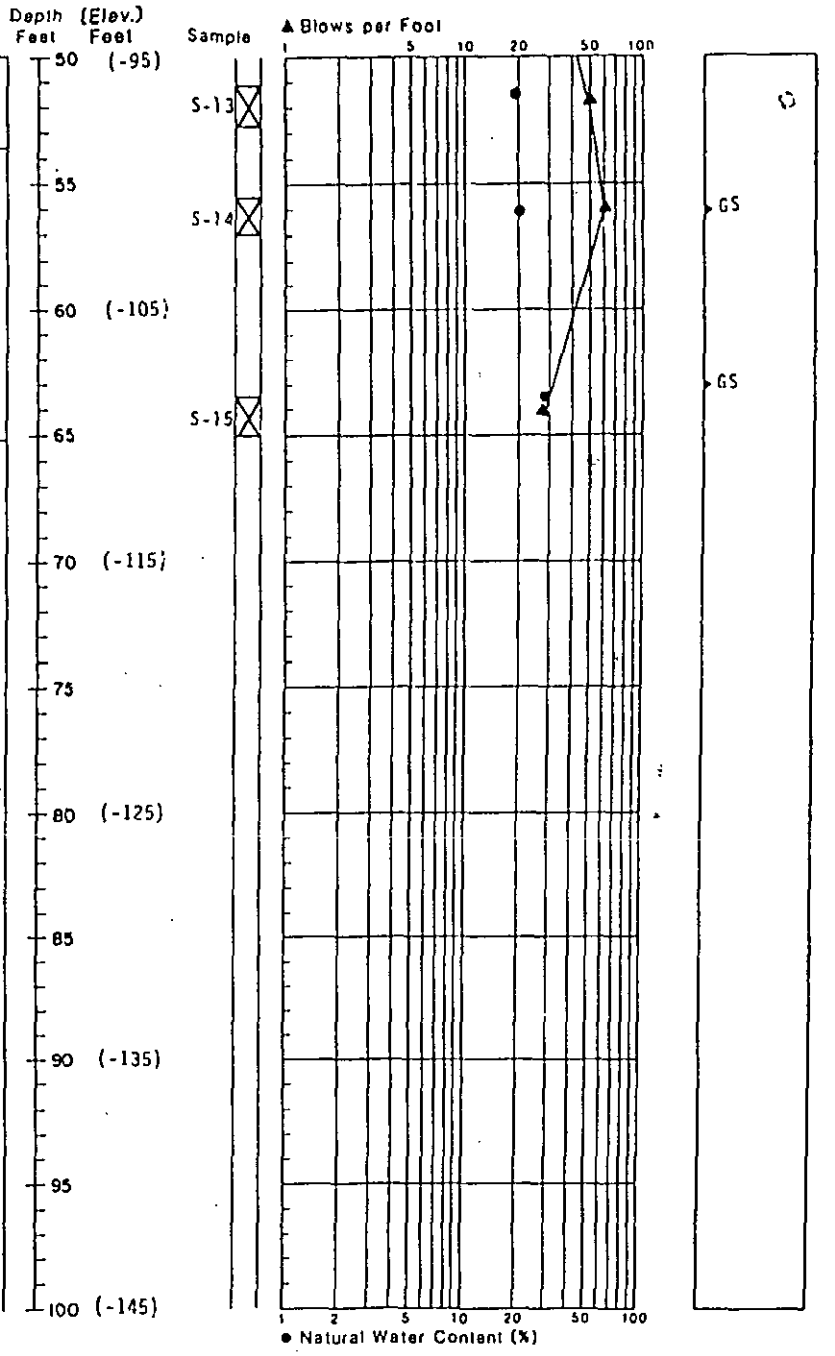
Dense, saturated, gray, silty, fine to medium SAND.

(-98.5)

Medium dense, to very dense, saturated, gray, silty fine SAND to fine sandy SILT.

(-110)

Bottom of Borehole at 65 feet below mudline. Completed 5/6/82.



Groundwater Level

Bentonite Seal

2/4/81

Water Level (Date) At Time of Drilling

ATD

Observation Well Tip or Slotted Section

Sampling

2" O.D. Split Spoon Sample

3" O.D. Shelby Tube Sample

Cutting Sample

* No Sample Recovery

Laboratory Tests

GS Grain Size Analysis

CN Consolidation Test

K Permeability Test

DS Direct Shear

QU Unconfined Compression, tsf

TV Torvane, tsf

PP Pocket Penetrometer, tsf

TUU Triaxial Unconsolidated Undrained

TCU Triaxial Consolidated Undrained

TCD Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level, if indicated, is for the date specified and may vary with the time of year.

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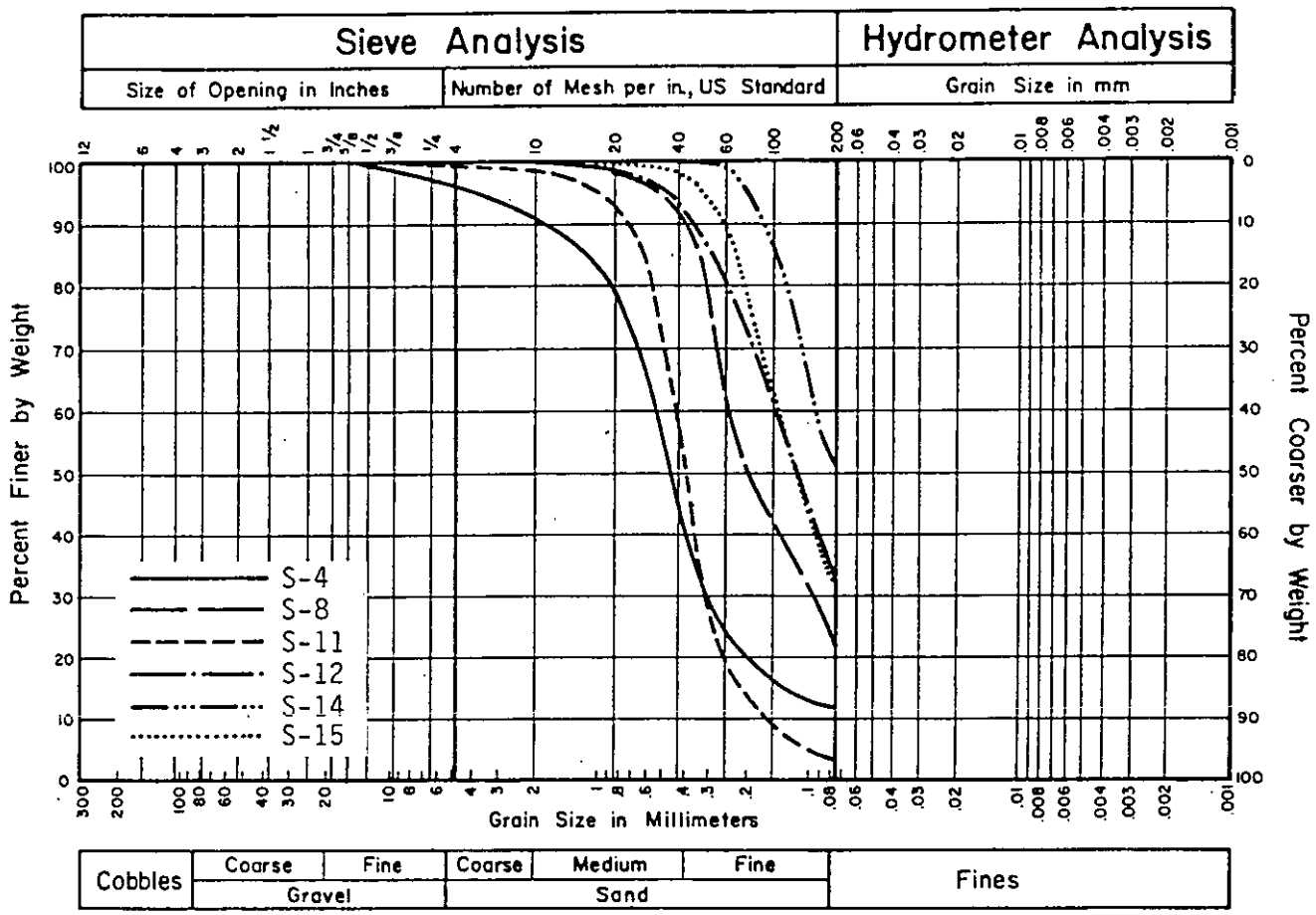
Figure A-10

Grain Size Classification

Boring OS-3



Sample	Depth-ft	U.S.C.	Classification	Nat W.C. %	Atterberg Limits LL	PL	PI
S-4	9.0 - 10.5	SM	Silty SAND	23			
S-8	28.0 - 29.5	SM	Silty, medium to fine SAND	23			
S-11	42.0 - 43.5	SP	Medium to fine SAND	23			
S-12	46.5 - 48.0	SM	Very silty, medium to fine SAND	25			
S-14	55.5 - 57.0	ML - SM	Very sand SILT to very silty SAND	25			
S-15	63.5 - 65.0	SM	Very silty, fine SAND	23			

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Figure B-10

Boring Log S-1

SOIL
INTERPRETATION

Approximate Station 17+50
Approximate Ground Surface Elevation in Feet +18 (MLLW)

Asphalt and Crushed GRAVEL Surfacing

Medium dense, moist, black, slightly sandy, fine to coarse slag GRAVEL (FILL).

Loose, saturated below 16 feet.

(-9)

Medium dense to dense, saturated, gray, silty, fine to medium SAND with occasional wood and shell fragments.

(-14)

Dense, saturated, gray, fine to medium SAND.

Grades to fine SAND.

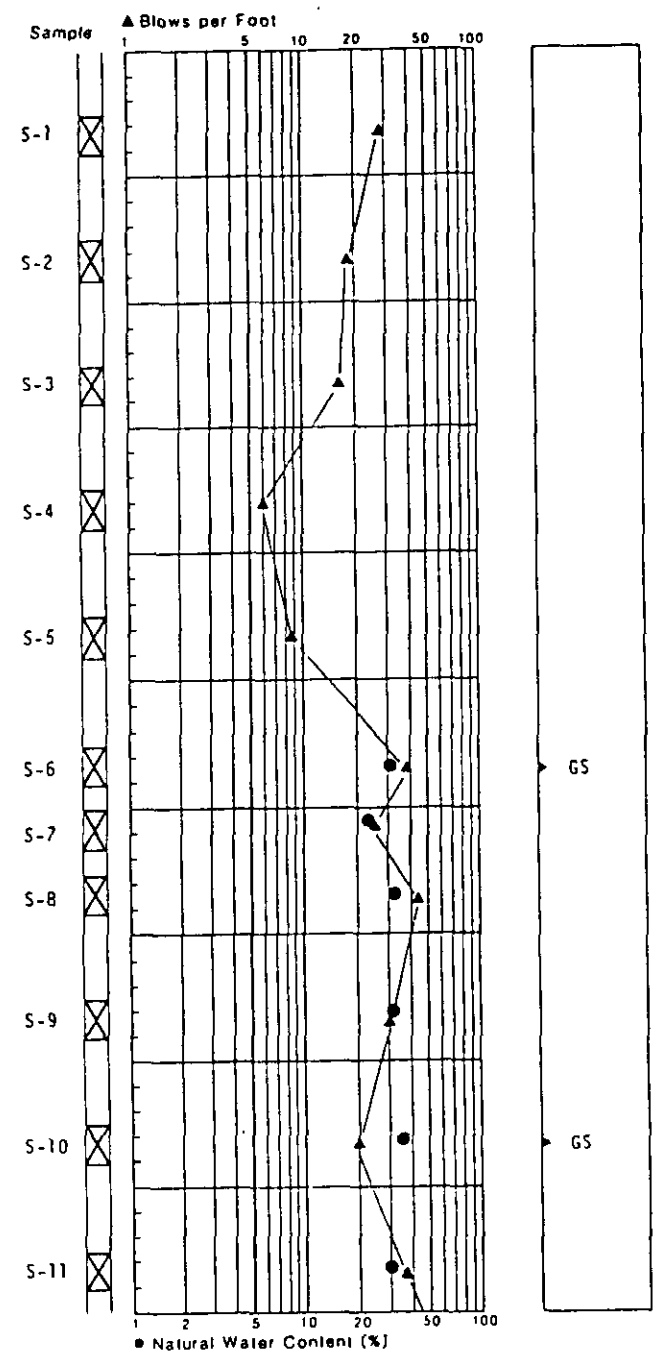
(-23)

Medium dense, saturated, gray, silty, fine SAND to fine sandy SILT.

(-28)

Dense, saturated, gray, fine SAND.

(-32)



SOIL INTERPRETATION

Very dense, saturated, gray, fine SAND, trace of organics.

(-39)

Medium dense, saturated, gray, silty, fine to medium SAND.

Trace wood fragments

(-47)

Medium dense to dense, saturated, gray, silty, fine SAND

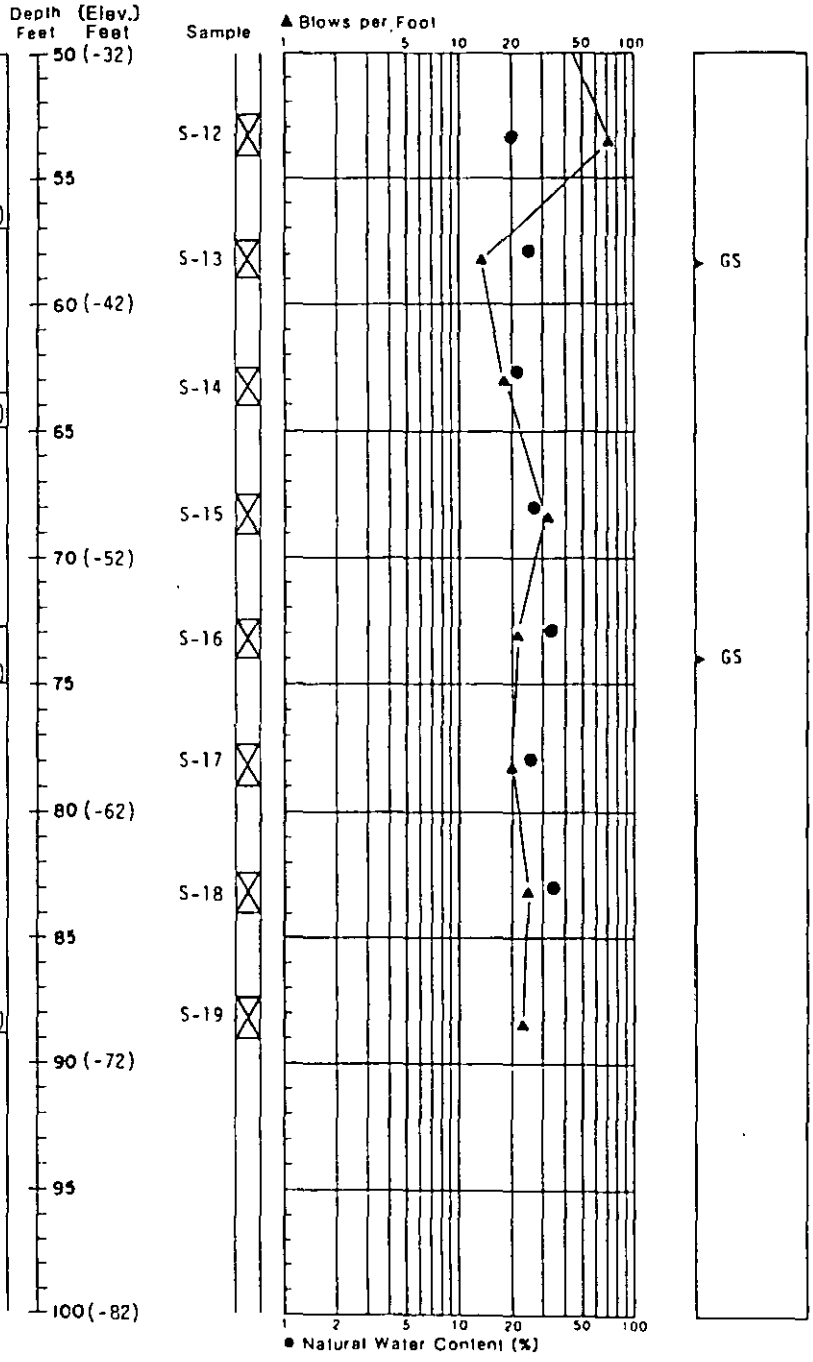
Wood fragments

(-57)

Medium dense, saturated, gray, fine SAND.

(-71)

Bottom of boring at 89 Feet.
Completed 5/20/82.



STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

LABORATORY TESTS

Groundwater Level

Bentonite Seal

2/4/81

Water Level (Date)

ATD At Time of Drilling

Observation Well Tip or Slotted Section

Sampling

2" O.D. Split Spoon Sample

3" O.D. Shelby Tube Sample

Cutting Sample

* No Sample Recovery

Laboratory Tests

GS Grain Size Analysis

CN Consolidation Test

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DS Direct Shear

QU Unconfined Compression, tsf

TV Torvane tsf

PP Pocket Penetrometer, tsf

TUU Triaxial Unconsolidated Undrained

TCU Triaxial Consolidated Undrained

TCD Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual
2. Water Level if indicated is for the date specified and may vary with the time of year

J-1042-02 August 1982

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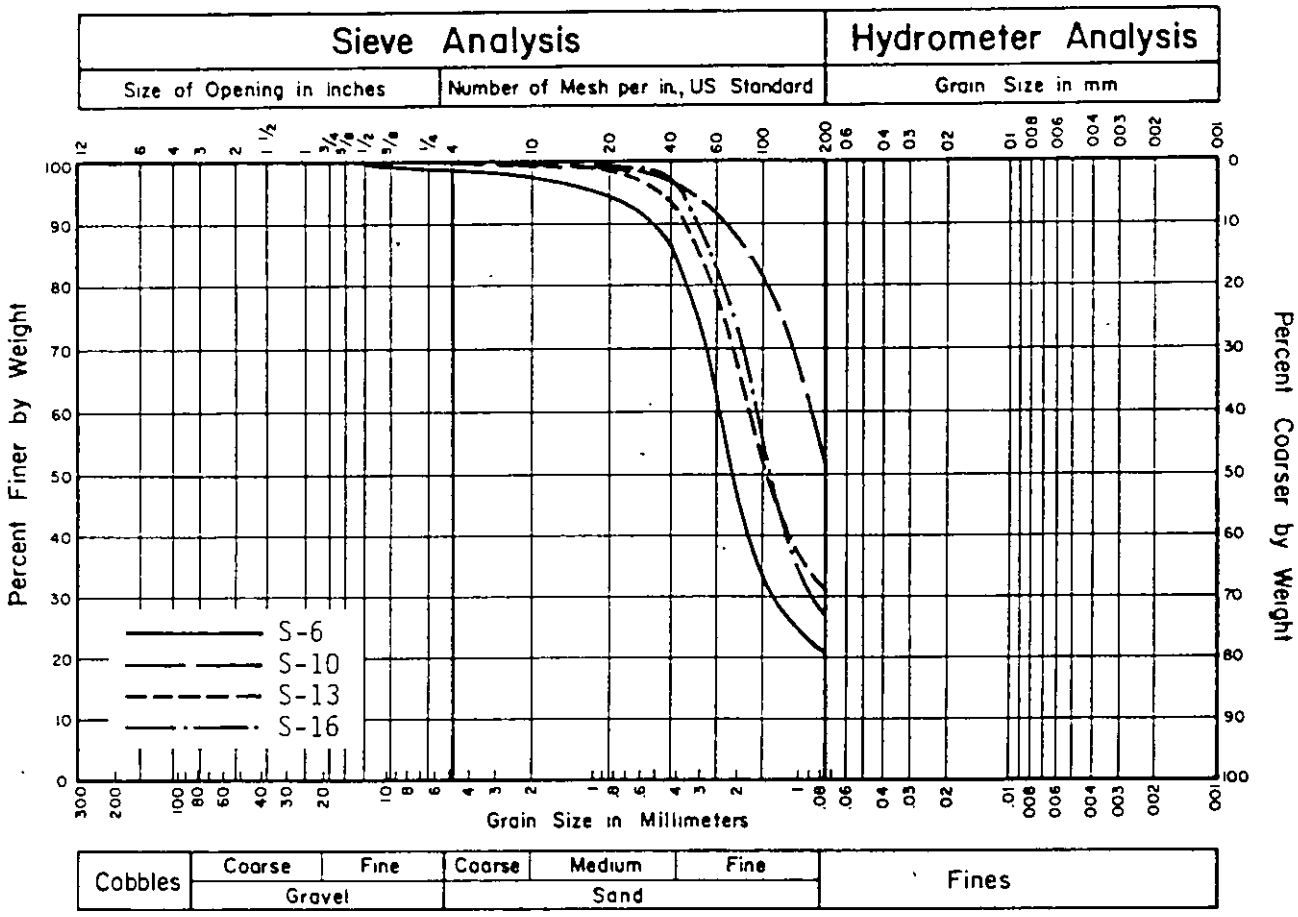
Figure A-1

Grain Size Classification

Boring S-1



Sample	Depth-ft	U.S.C.	Classification	Nat WC %	Atterberg Limits LL	PL	PI
S-6	27.5 - 29.0	SM	Silty, medium to fine SAND	31			
S-10	42.5 - 44.0	ML	Very sandy SILT	37			
S-13	57.5 - 59.0	SM	Very silty, medium to fine SAND	26			
S-16	72.5 - 74.0	SM	Silty, fine SAND	28			

J-1042-02 October 1982
HART-CROWSER & associates inc.
Figure B-1

Boring Log S-2

SOIL INTERPRETATION

Approximate Station 22+00
Approximate Ground Surface Elevation in Feet +18 (MLLW)

Loose to medium dense, moist, brown, silty SAND with occasional gravel, metal and wood fragments. (FILL).

Saturated, brown and black.

(+7.5)

Loose, saturated, black, silty, fine SAND.

Grades to fine sandy SILT.

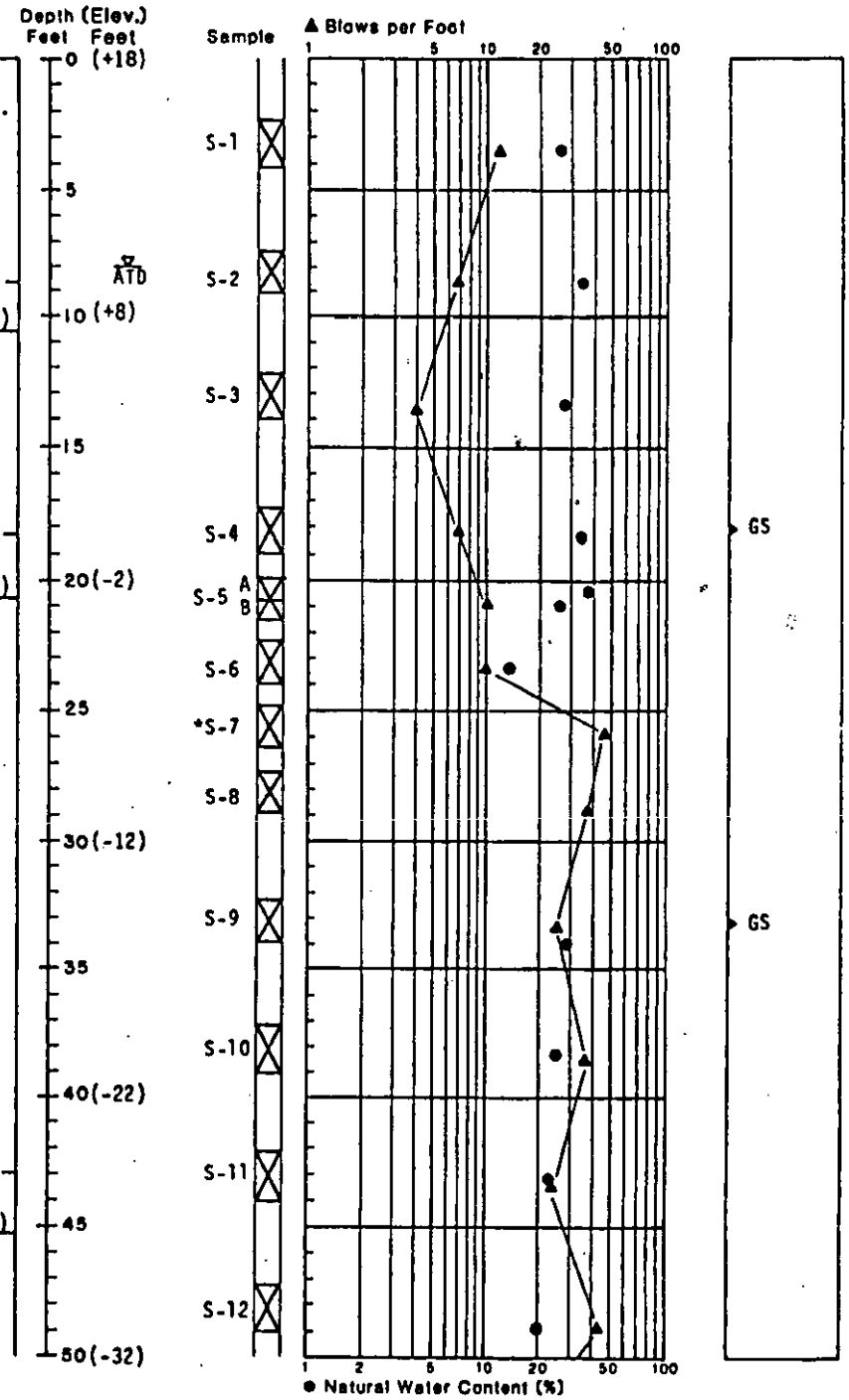
(-3)

Medium dense to dense, saturated, gray, fine to medium SAND.

Silty, trace shell fragments.

(-27)

Medium dense to dense, saturated, gray, slightly silty to silty, fine SAND.



SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE

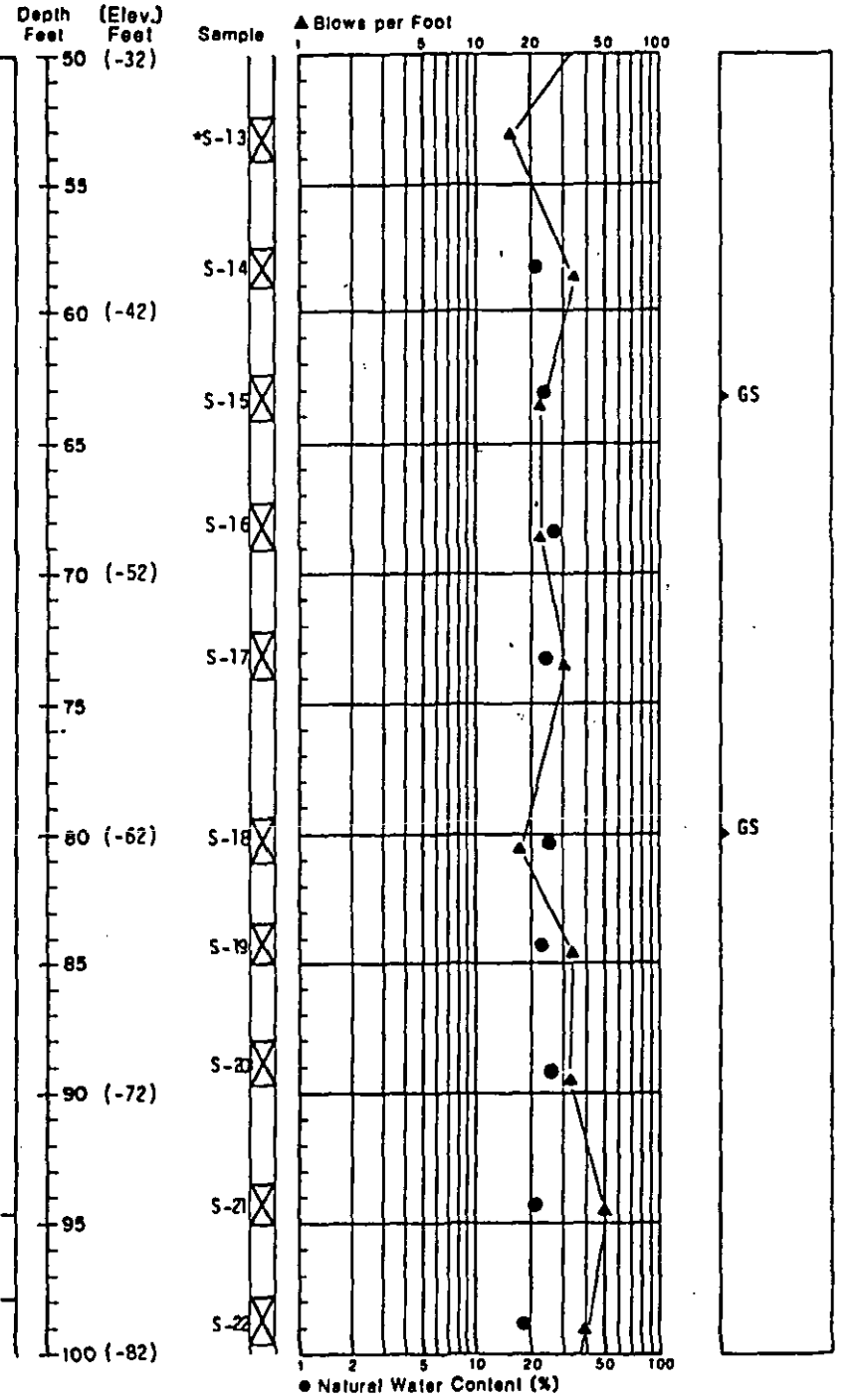
(140 pound weight, 30 inch drop)

LABORATORY TESTS

Medium dense to dense, saturated, gray, slightly silty to silty, fine SAND.

Very dense

Thin SILT interbeds



SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

LABORATORY TESTS

Medium dense to dense, saturated, gray, slightly silty to silty, fine SAND.

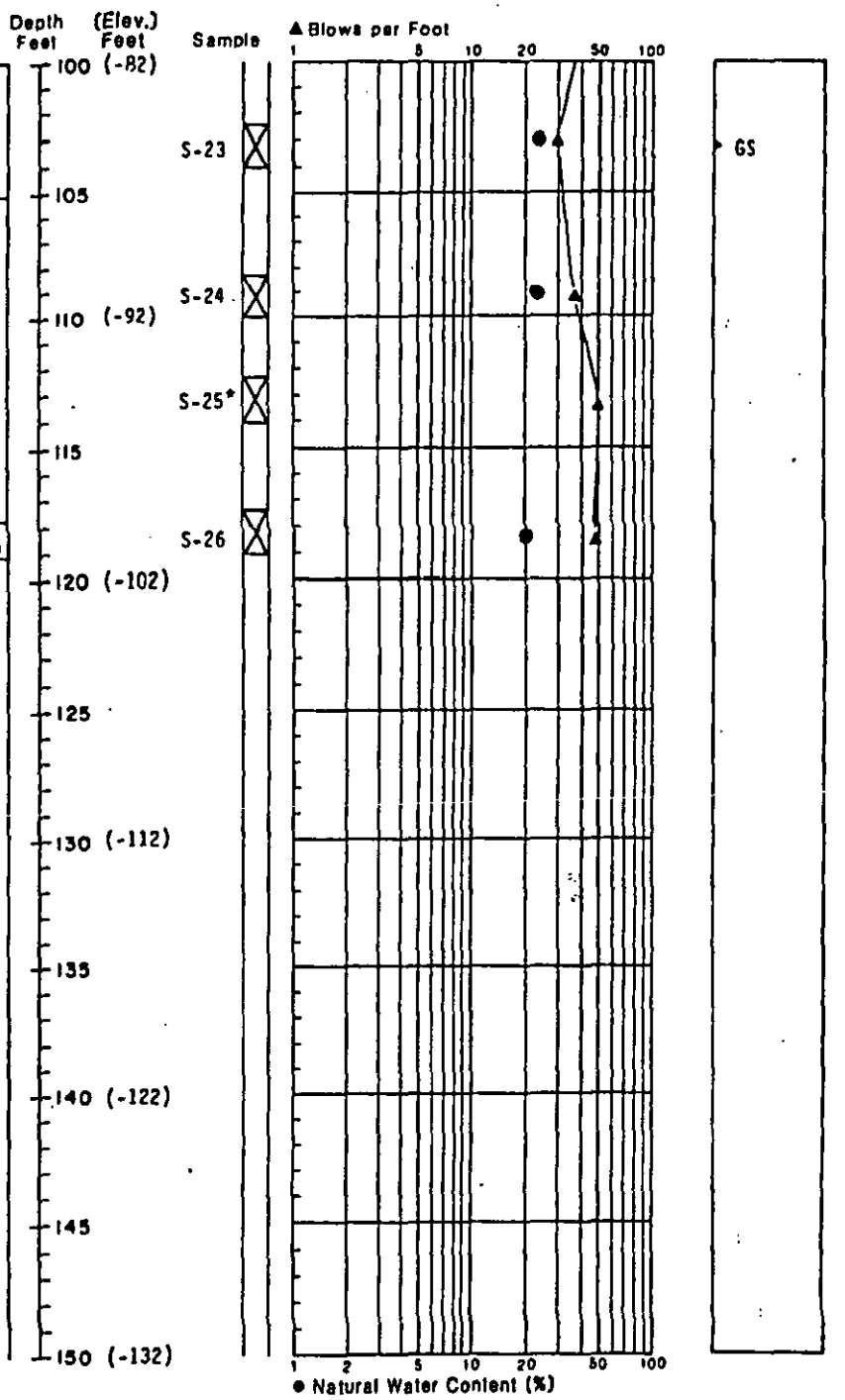
(-87)

Dense, saturated, gray, fine to medium SAND.

Thin SILT lenses

(-101)

Bottom of Boring at 119 feet.
Completed 5/12/82.



Groundwater Level

Bentonite Seal

2/4/83

ATD Water Level (Date) At Time of Drilling

Observation Well Tip or Slotted Section

Sampling

2" O.D. Split Spoon Sample

3" O.D. Shelby Tube Sample

Cutting Sample

* No Sample Recovery

Laboratory Tests

GS Grain Size Analysis
CN Consolidation Test
K Permeability Test
DS Direct Shear
OU Unconfined Compression, tsf
TV Torvane, tsf
PP Pocket Penetrometer, tsf
TUU Triaxial Unconsolidated Undrained
TCU Triaxial Consolidated Undrained
TCD Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

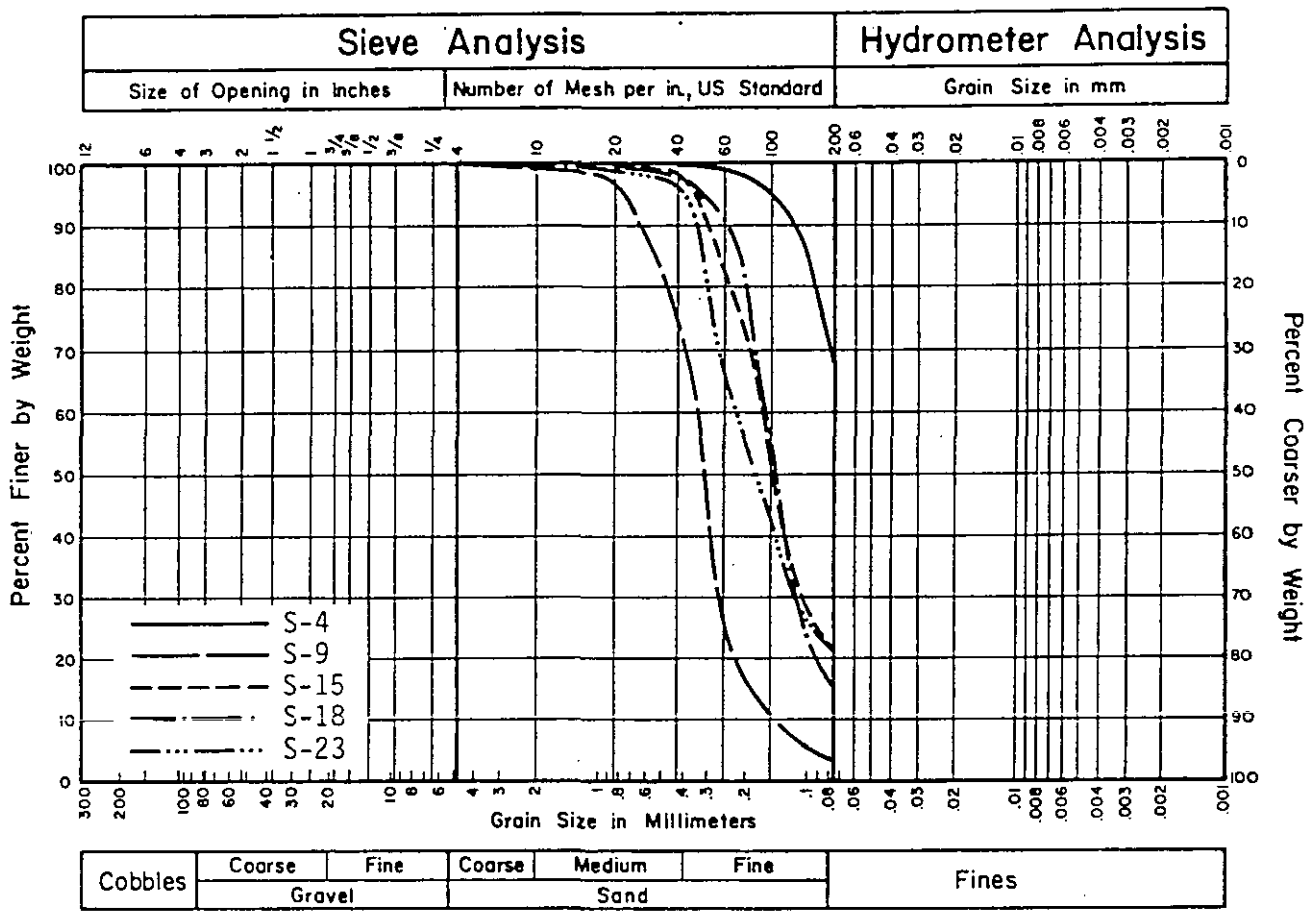
Notes

1. Soil descriptions are interpretive and actual changes may be gradual
2. Water Level, if indicated, is for the date specified and may vary with the time of year.

J-1042-02 August 1982
HART-CROWSER & associates inc.
Figure A-2

Grain Size Classification

Boring S-2



Sample	Depth-ft	U.S.C.	Classification	Nat W.C. %	Atterberg Limits LL	PL	PI
S-4	17.5 - 19.0	ML	Very sandy SILT	33			
S-9	32.5 - 34.0	SP	Medium to fine SAND	29			
S-15	62.5 - 64.0	SM	Silty, fine SAND	26			
S-18	79.5 81.0 -	SM	Silty, fine SAND	29			
S-23	102.5 - 104.0	SM	Silty, fine SAND	26			

J-1042-02 October 1982
HART-CROWSER & associates inc.
Figure B-2

Boring Log S-3

SOIL INTERPRETATION

Approximate Station 19+10
Approximate Ground Surface Elevation in Feet +18 (MLLW)

Asphalt and Crushed GRAVEL surfacing

Loose, moist, brown SAND (FILL). (+15)

Medium dense, moist, black, sandy slag GRAVEL (FILL).

Saturated below 19 feet.

Loose

(-8)

Dense, saturated, gray, silty, fine to medium SAND.

Grades to slightly silty, fine to medium SAND.

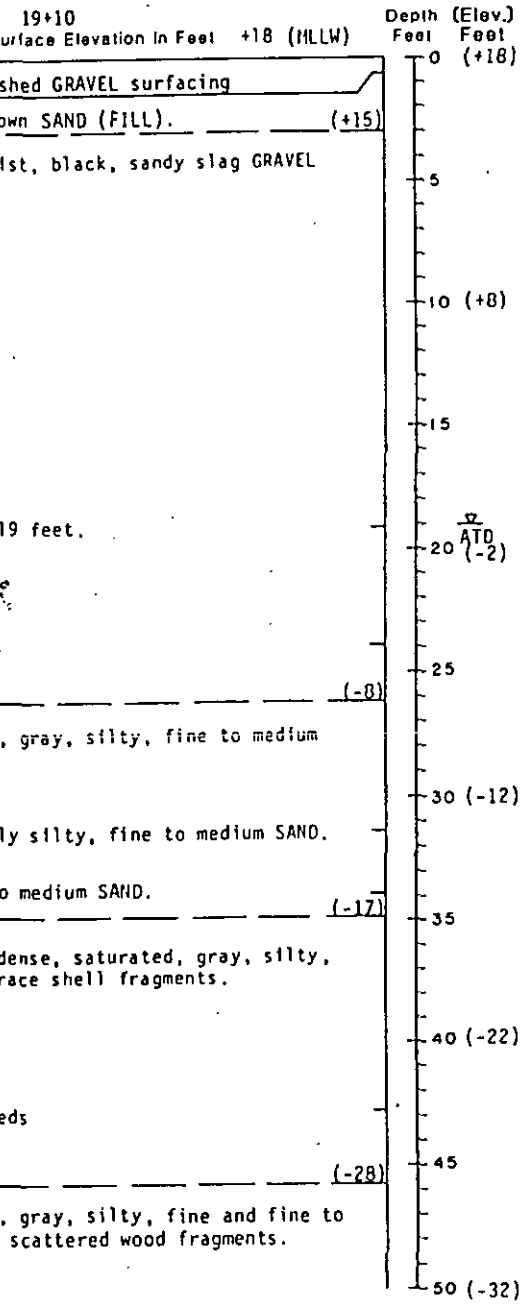
Grades to fine to medium SAND. (-17)

Medium dense to dense, saturated, gray, silty, fine SAND with trace shell fragments.

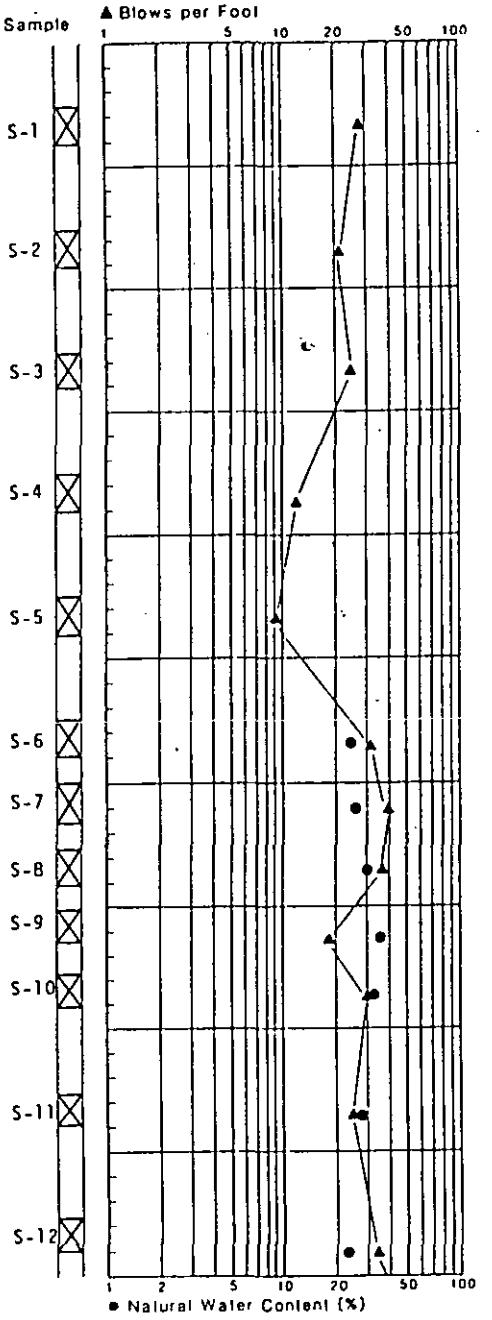
Fine SAND interbeds

(-28)

Dense, saturated, gray, silty, fine and fine to medium SAND with scattered wood fragments.



STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)



LABORATORY TESTS

SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE

(140 pound weight, 30 inch drop)

LABORATORY TESTS

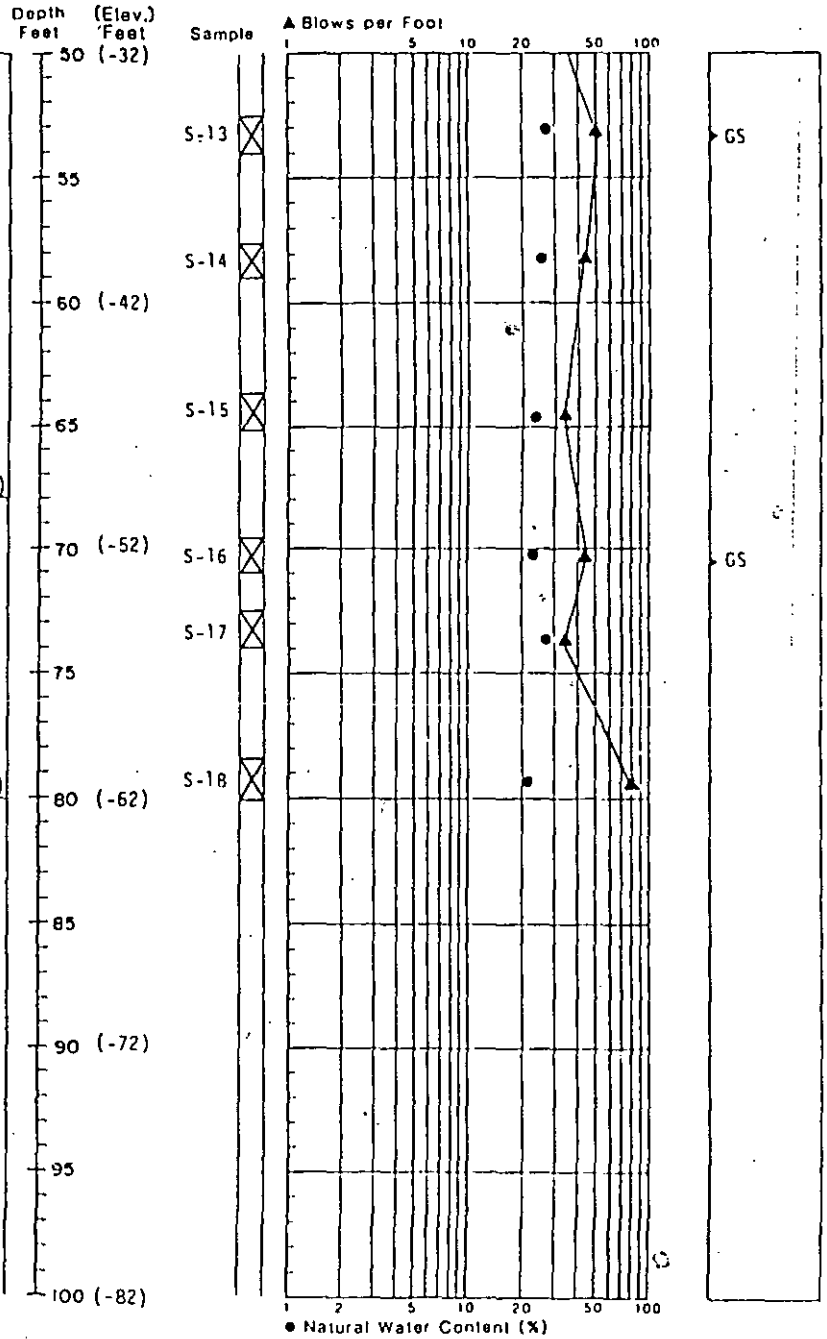
Dense, saturated, gray, silty, fine and fine to medium SAND with scattered wood fragments.

(-50)

Dense, saturated, gray, slightly silty, fine SAND with SILT interbeds

(-62)

Bottom of boring at 80 feet.
Completed 5/14/82.



Groundwater Level

Bentonite Seal

2/4/81

Water Level (Date) At Time of Drilling

ATD

Observation Well Tip or Slotted Section

Sampling

2" O.D. Split Spoon Sample

3" O.D. Shelby Tube Sample

Cutting Sample

* No Sample Recovery

Laboratory Tests

GS Grain Size Analysis

CN Consolidation Test

K Permeability Test

DS Direct Shear

QU Unconfined Compression, tsf

TV Torvane, tsf

PP Pocket Penetrometer, tsf

TUU Triaxial Unconsolidated Undrained

TCU Triaxial Consolidated Undrained

TCD Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual
2. Water Level, if indicated, is for the date specified and may vary with the time of year

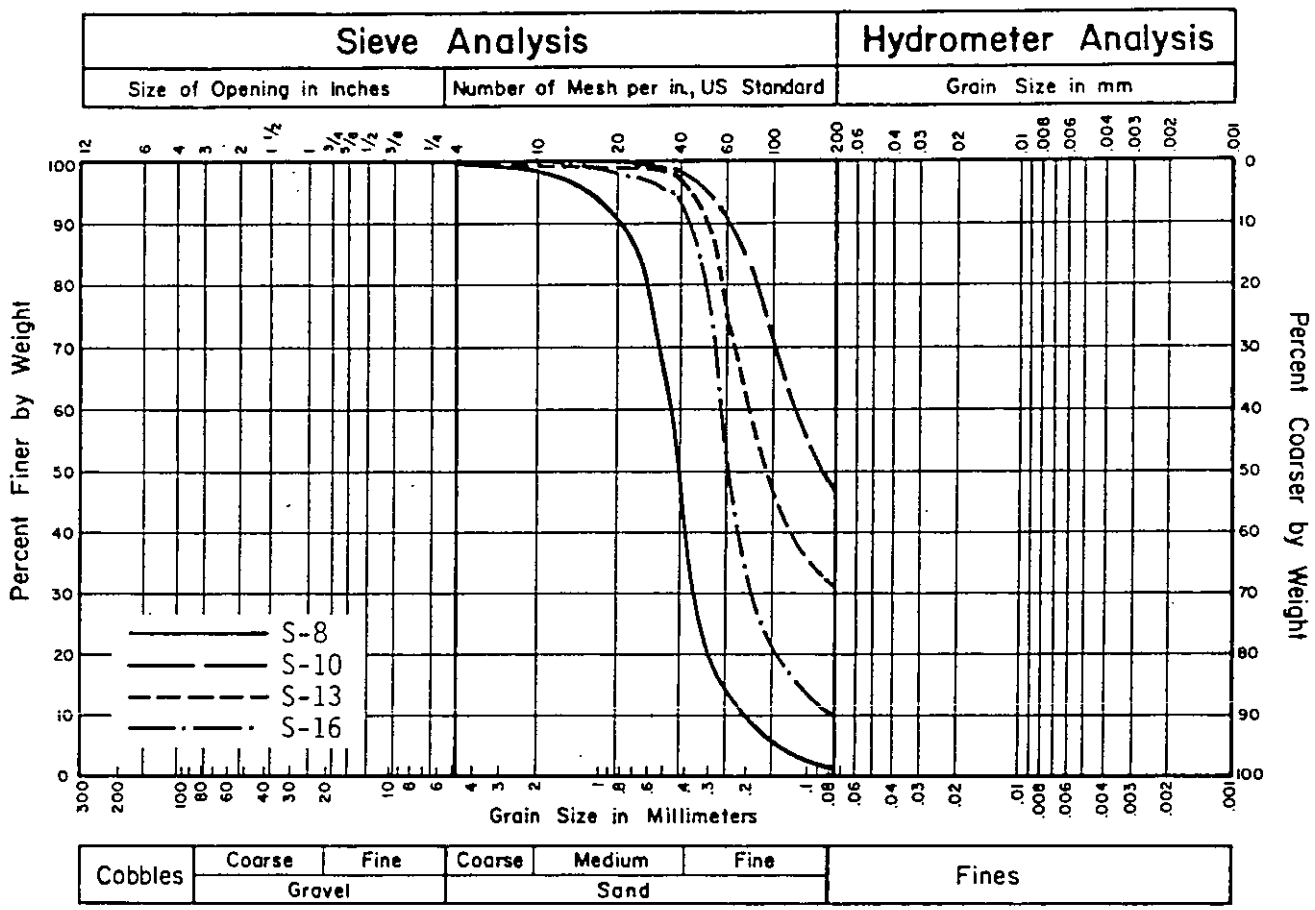
J-1042-02 August 1982

HART-CROWSER & associates Inc.

Figure A-3

Grain Size Classification

Boring S-3



Sample	Depth-ft	U.S.C.	Classification	Nat. W.C. %	Atterberg Limits LL	PL	PI
S-8	32.5 - 34.0	SP	Fine to medium SAND	26			
S-10	37.5 - 39.0	SM	Very silty, fine SAND	31			
S-13	52.5 - 54.0	SM	Very silty, fine SAND	27			
S-16	69.5 - 71.0	SM - SP	Slightly silty, fine SAND	24			

J-1042-02 October 1982
HART-CROWSER & associates inc.
Figure B-3

Boring Log S-4

SOIL INTERPRETATION

Approximate Station 16+00
Approximate Ground Surface Elevation in Feet +18 (MLLW)

Asphalt and Crushed GRAVEL surfacing

Dense, damp, brown, fine to medium SAND (FILL).

(+14)

Medium dense, moist, black, slag GRAVEL (FILL)

Saturated, sandy

Sandy (-10.5)

Interbedded, medium dense, saturated, brown-green silty, fine to medium SAND and stiff, saturated, brown-green SILT.
Trace wood fragments and shells (-14)

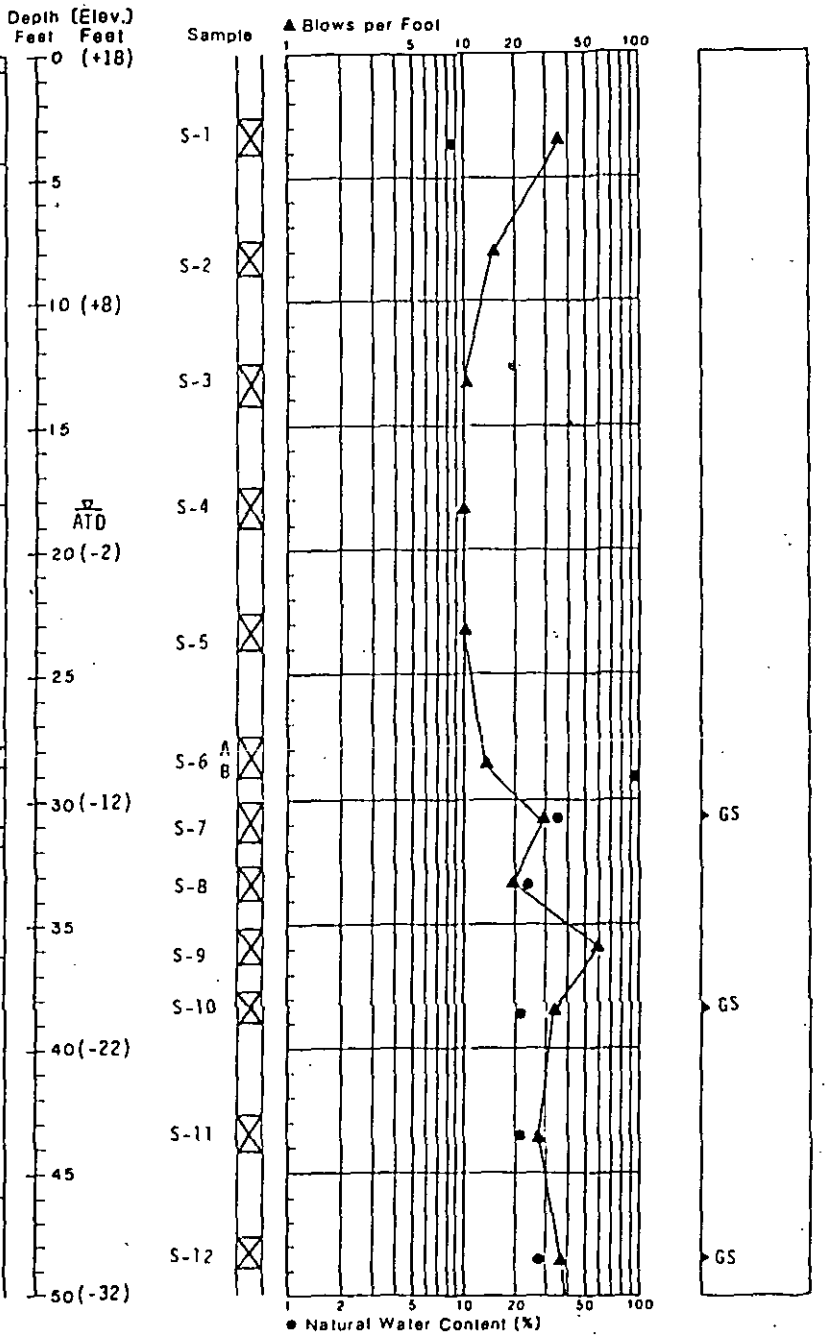
Occasional SILT interbeds and shell fragments.

(-18)

Medium dense to dense, saturated, gray, slightly silty, fine to medium SAND.

(-28)

Dense, saturated, gray, silty, fine to medium SAND.



SOIL INTERPRETATION

Dense, saturated, gray, silty, fine to medium SAND.

Silt interbeds and wood fragments

(-42)

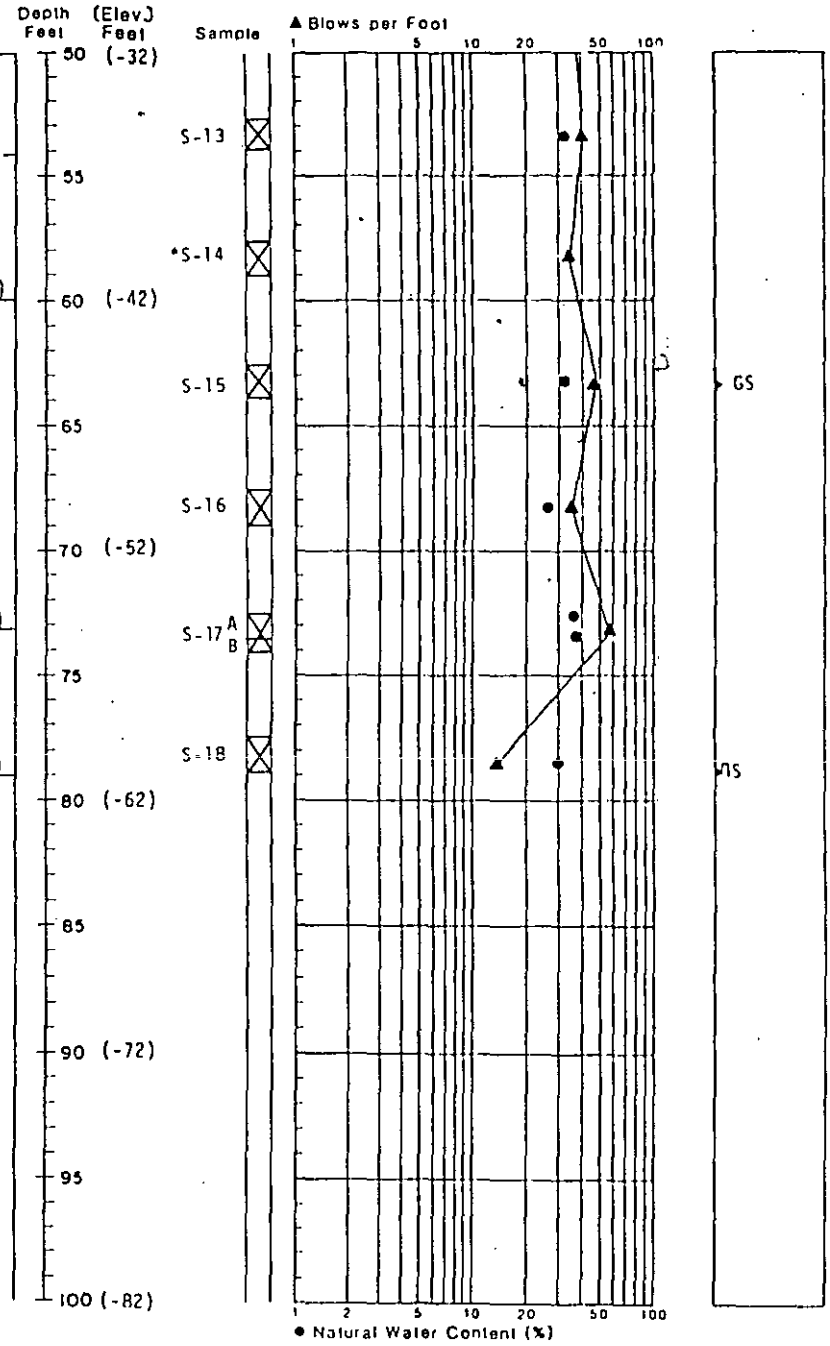
Dense, saturated, gray, slightly silty, fine to medium SAND.

(-55)

Stiff to hard, saturated, brown, fine sandy SILT.

(-61)

Bottom of boring at 79 feet.
Completed 5/17/82



STANDARD PENETRATION RESISTANCE
(140 pound weight, 30 inch drop)

LABORATORY TESTS

Groundwater Level

Bentonite Seal

2/14/81
Water Level (Date)
ATD At Time of Drilling

Observation Well Tip or Slotted Section

Sampling

2" O.D. Split Spoon Sample

3" O.D. Shelby Tube Sample

Cutting Sample

* No Sample Recovery

Laboratory Tests

*GS Grain Size Analysis
CN Consolidation Test
K Permeability Test
DS Direct Shear
QU Unconfined Compression, tsf
TV Torvane, tsf
*PP Pocket Penetrometer, tsf
TUU Triaxial Unconsolidated Undrained
TCU Triaxial Consolidated Undrained
TCD Triaxial Consolidated Drained

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

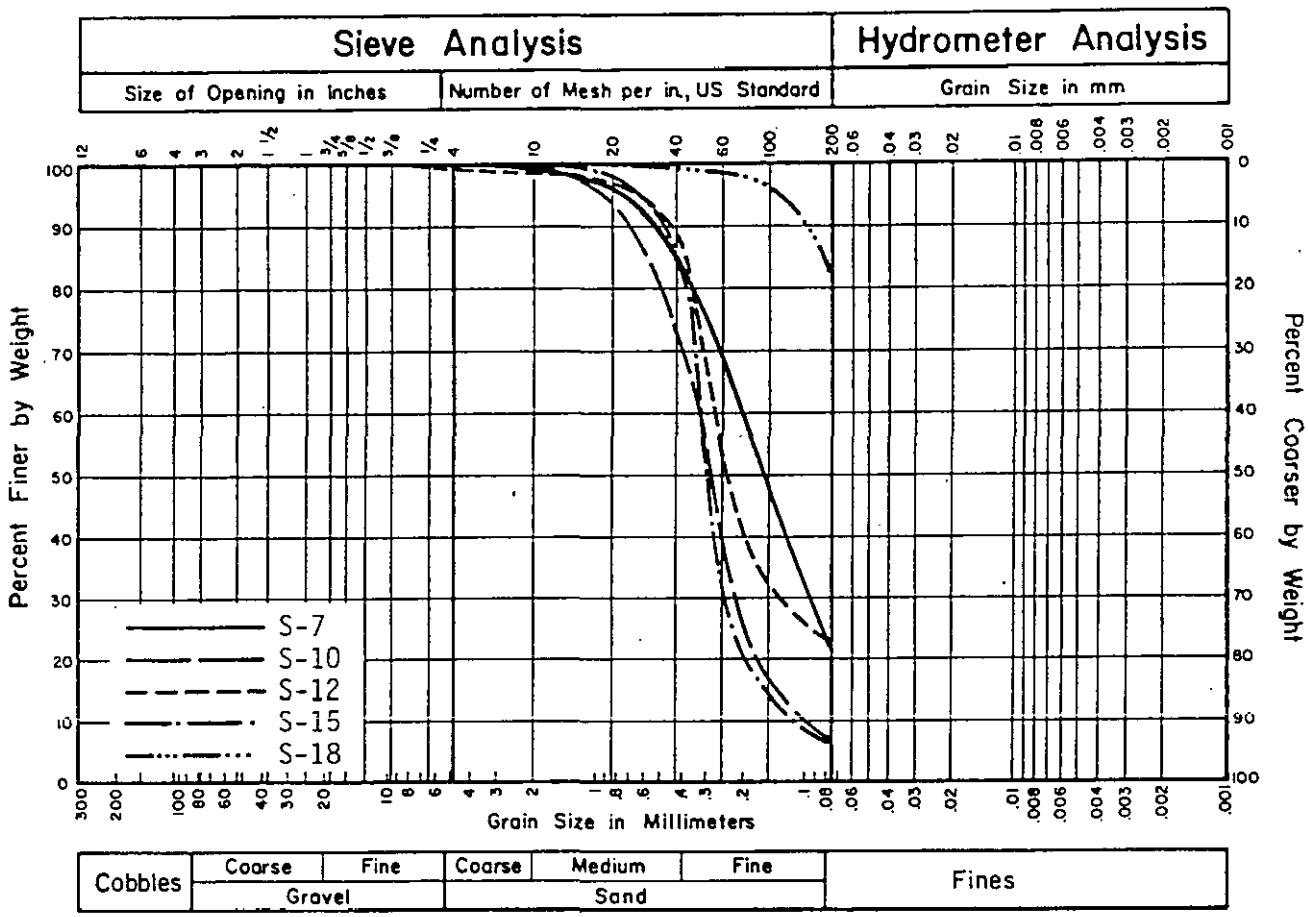
Notes

1. Soil descriptions are interpretive and actual changes may be gradual
2. Water Level, if indicated, is for the date specified and may vary with the time of year

J-1042-02 August 1982
HART-CROWSER & associates Inc.
Figure A-4

Grain Size Classification

Boring S-4



Sample	Depth-ft	U.S.C.	Classification	Nat. W.C. %	Atterberg Limits LL	PL	PI
S-7	30.0 - 31.5	SM	Silty, medium to fine SAND	27			
S-10	37.5 - 39.0	SM - SP	Slightly silty, medium to fine SAND	23			
S-12	47.5 - 49.0	SM	Silty, medium to fine SAND	37			
S-15	62.5 - 64.0	SM - SP	Slightly silty, medium to fine SAND	31			
S-18	77.5 - 79.0	ML	Sandy SILT	28			

J-1042-02 October 1982

HART-CROWSER & associates inc.

Figure B-4

Boring Log S-5

SOIL INTERPRETATION

Approximate Station 13+00

Approximate Ground Surface Elevation in Feet +18 (MLLW)

Asphalt and Crushed GRAVEL surfacing

Medium dense, moist, brown, slightly silty, gravelly SAND (FILL).

(+13)

Loose, moist, black, slag GRAVEL (FILL).

Saturated below 18 feet, sandy

Sandy below 23 feet

(-12.5)

Dense, saturated, gray, silty, fine to medium SAND.

(-22)

Interbedded, dense, saturated, gray, silty, fine to medium SAND, with stiff, saturated, brown, clayey SILT.

(-31)

Depth Feet / (Elev.) Feet: 0 (+18), 5, 10 (+8), 15, ATD, 20 (-2), 25, 30 (-12), 35, 40 (-22), 45, 50 (-32)

Sample: S-1, S-2, S-3, S-4, S-5, S-6, S-7, S-8, S-9, S-10, S-11 A B, S-13, * S-12, S-14, S-15

STANDARD PENETRATION RESISTANCE

(140 pound weight, 30 inch drop)

▲ Blows per Foot (1, 5, 10, 20, 50, 100)

● Natural Water Content (%) (1, 2, 5, 10, 20, 50, 100)

LABORATORY TESTS

GS

GS

GS

SOIL INTERPRETATION

STANDARD PENETRATION RESISTANCE

(140 pound weight, 30 inch drop)

LABORATORY TESTS

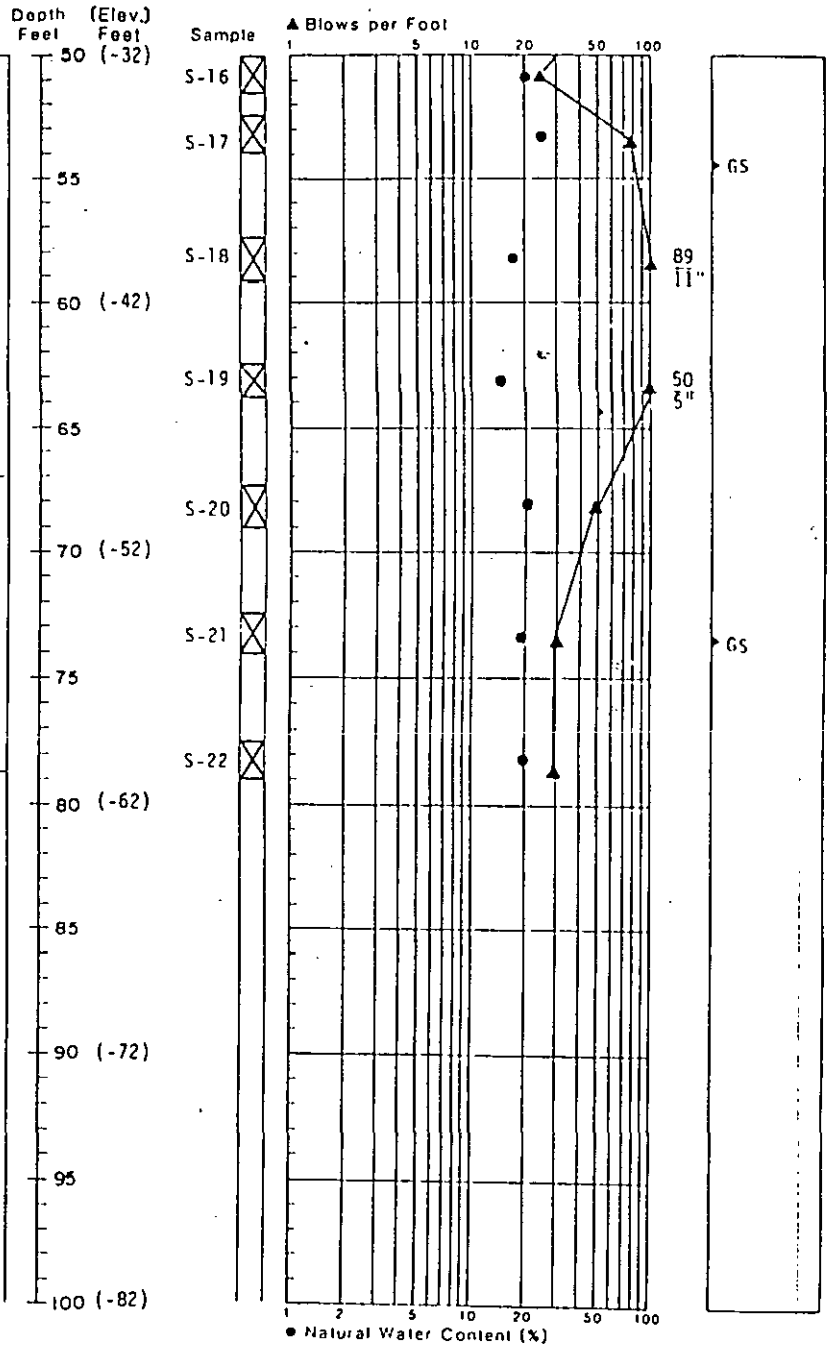
Medium dense to very dense, saturated, gray, slightly silty, fine to medium SAND.

(-49)

Medium dense to dense, silty, fine to medium SAND.

(-61)

Bottom of boring at 79 feet.
Completed 5/11/82.



Groundwater Level

Bentonite Seal

2/14/81

ATD Water Level (Date) At Time of Drilling

Observation Well Tip or Slotted Section

Sampling

- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Cutting Sample
- * No Sample Recovery

Laboratory Tests

GS	Grain Size Analysis	TUU	Triaxial Unconsolidated Undrained
CN	Consolidation Test	TCU	Triaxial Consolidated Undrained
K	Permeability Test	TCD	Triaxial Consolidated Drained
DS	Direct Shear		
QU	Unconfined Compression, tsf		
TV	Torvane, tsf		
PP	Pocket Penetrometer, tsf		

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

Notes

1. Soil descriptions are interpretive and actual changes may be gradual
2. Water Level, if indicated, is for the date specified and may vary with the time of year

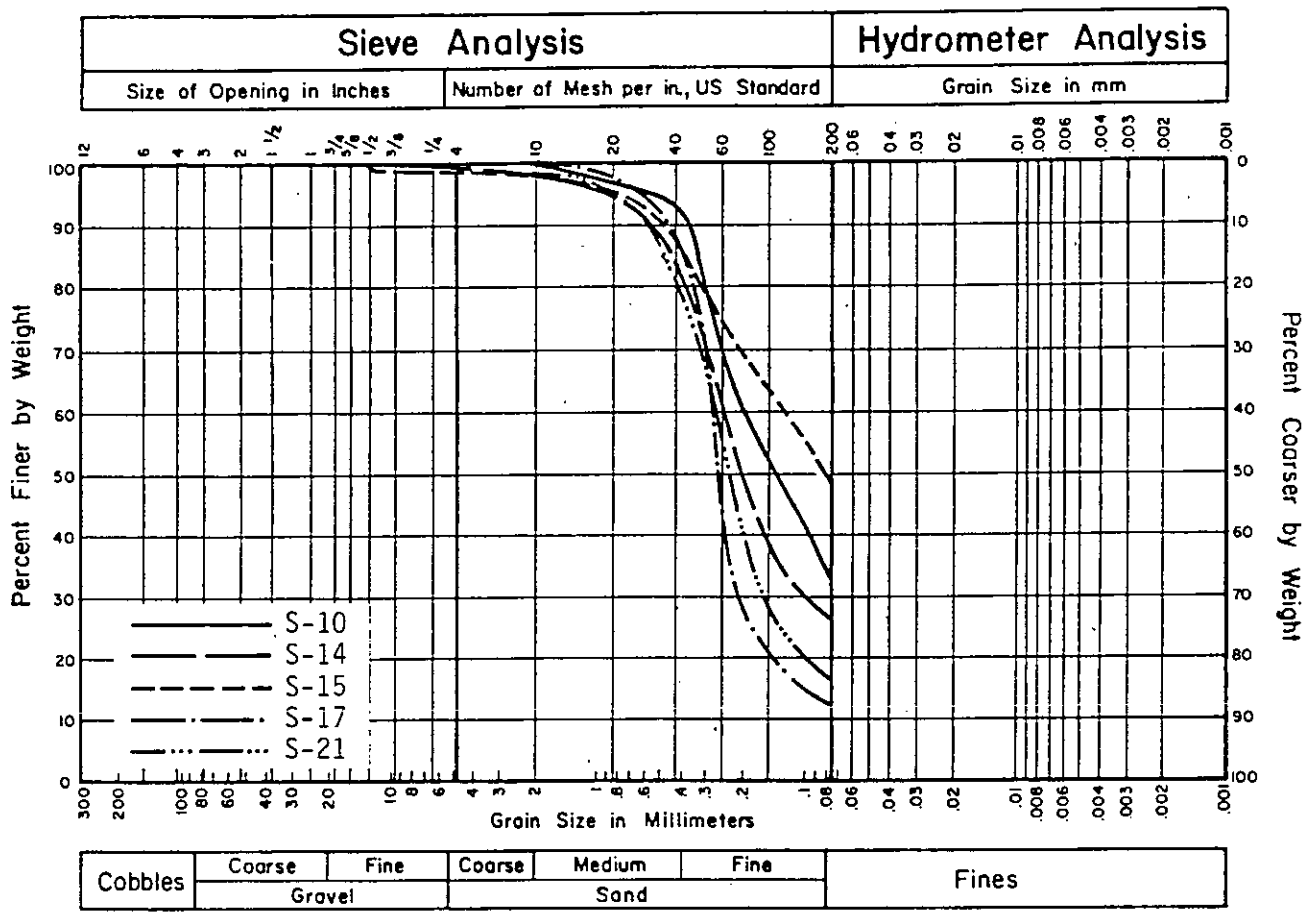
J-1042-02 August 1982

HART-CROWSER & associates Inc.

Figure A-5

Grain Size Classification

Boring S-5



Sample	Depth-ft	U.S.C.	Classification	Nat. W.C. %	Atterberg Limits LL	PL	PI
S-10	37.5 - 39.0	SM	Very silty, medium to fine SAND	24			
S-14	44.6 - 44.8	SM	Silty, medium to fine SAND with slag and wood fragments	25			
S-15	47.5 - 49.0		Very silty, medium to fine SAND	20			
S-17	52.5 - 54.0	SM	Slightly silty, medium to fine SAND	23			
S-21	72.5 - 74.0	SM	Silty, fine to medium SAND	28			

J-1042-02 October 1982

HART-CROWSER & associates inc.

Figure B-5

Boring Log S-6

SOIL INTERPRETATION

Approximate Station 10+00

Approximate Ground Surface Elevation in Feet +18 (MLLW)

Asphalt and Crushed GRAVEL surfacing

Medium dense to dense, moist, mixed brown SAND and black, slag GRAVEL (FILL).

(+8)

Loose, saturated, black, sandy, fine to coarse slag GRAVEL (FILL).

Slightly sandy

Slightly sandy

(-8)

Medium stiff, saturated, brown, silty SAND to fine sandy SILT, with scattered organics, roots and shell fragments.

(-12)

Medium dense, saturated, gray, slightly silty, fine to medium SAND.

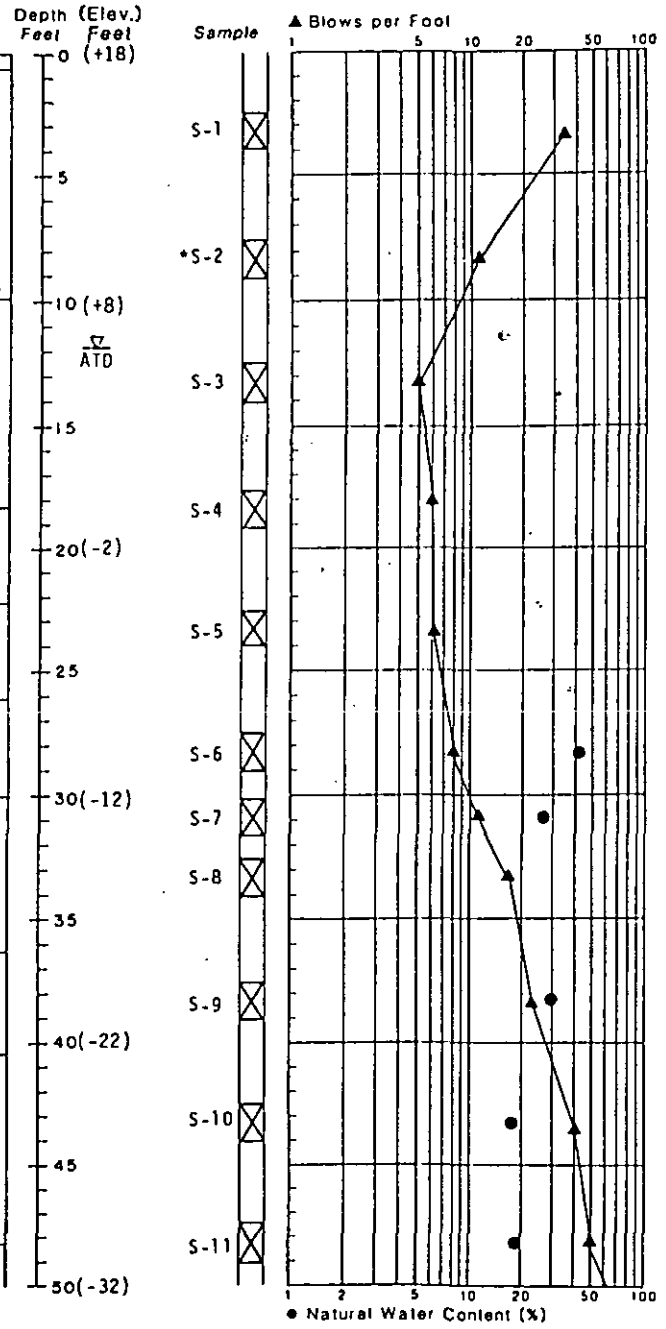
(-18)

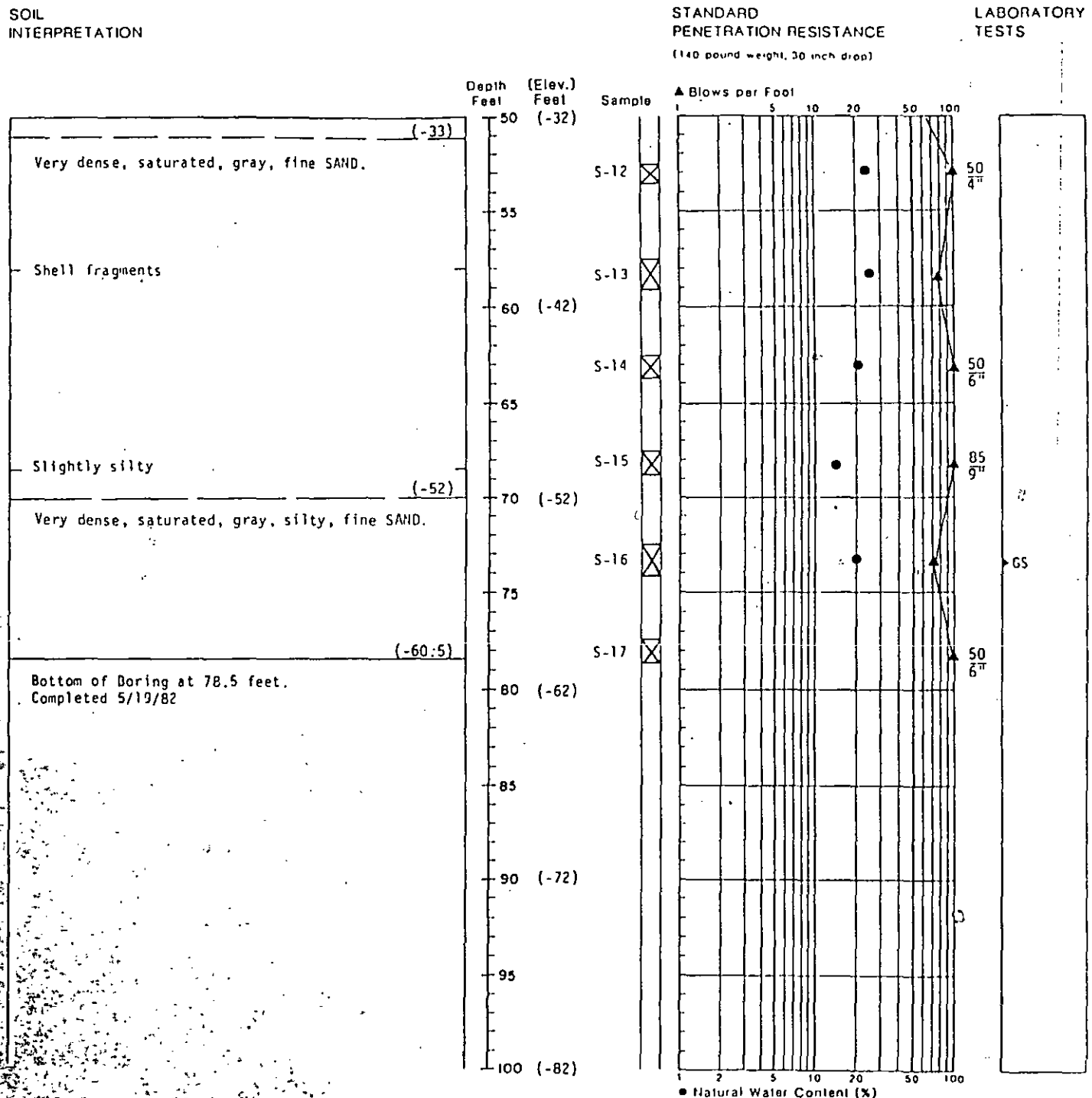
Medium dense, saturated, gray, fine sandy SILT.

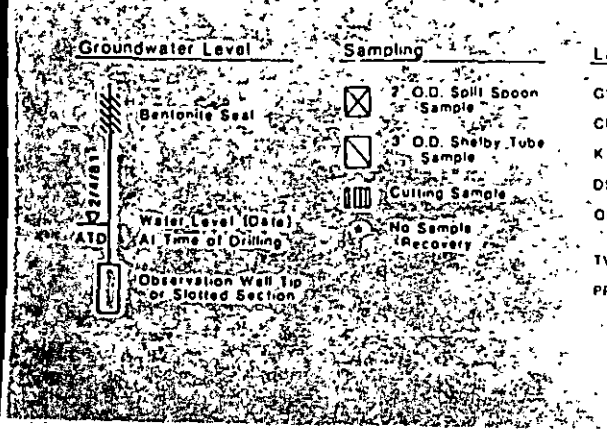
(-22)

Dense, saturated, gray, fine to medium SAND with silty, fine SAND interbeds.

Grades to silty, fine to medium SAND.







Laboratory Tests

GS	Grain Size Analysis	TUU	Triaxial Unconsolidated Undrained
CN	Consolidation Test	TCU	Triaxial Consolidated Undrained
K	Permeability Test	TCD	Triaxial Consolidated Drained
DS	Direct Shear		
QU	Unconfined Compression, tsf		
TV	Torvane, tsf		
PP	Pocket Penetrometer, tsf		

Water Content (%)

Plastic Limit ⊢—●—⊣ Liquid Limit
Natural Water Content

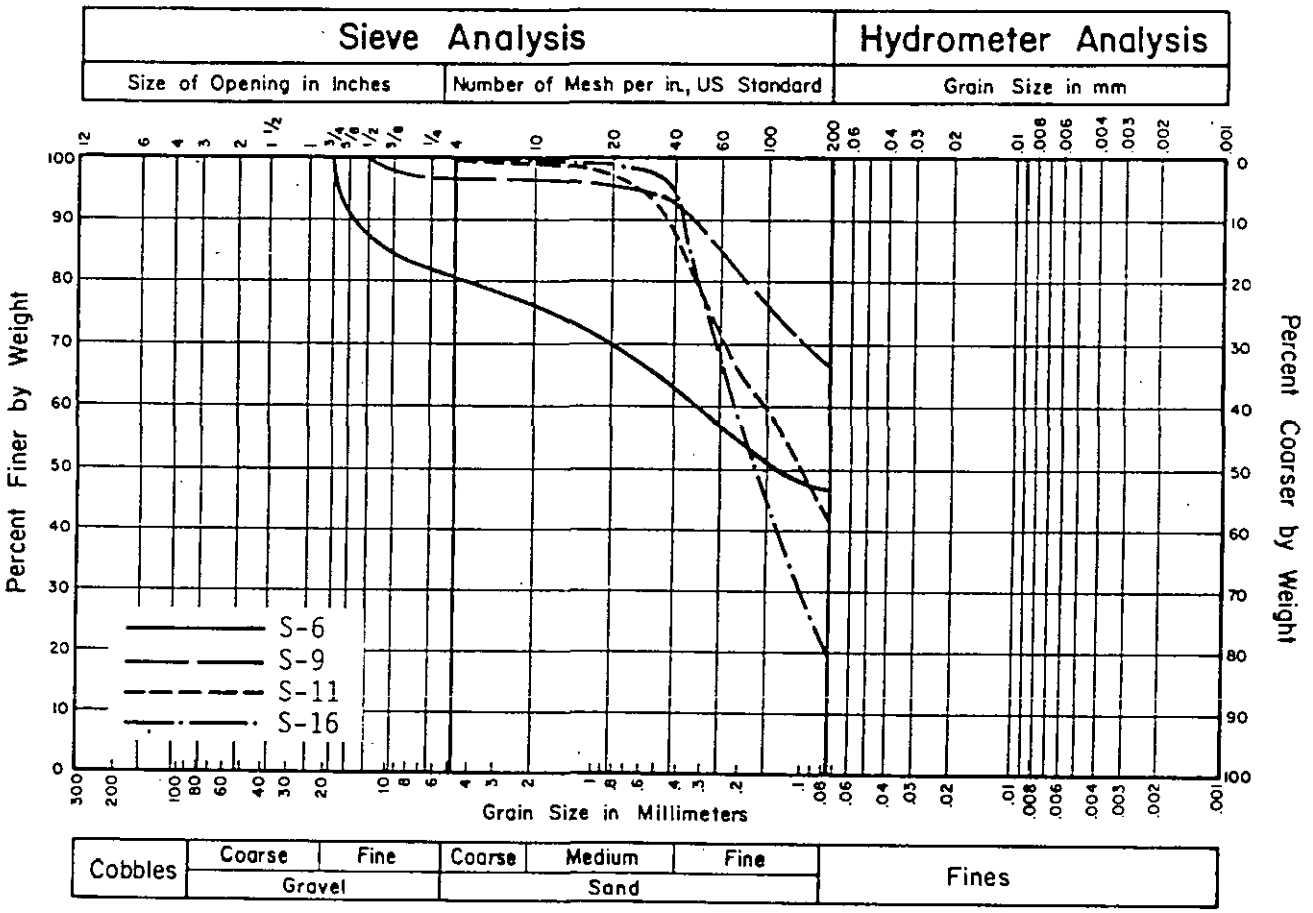
Notes

1. Soil descriptions are interpretive and actual changes may be gradual
2. Water Level, if indicated, is for the date specified and may vary with the time of year

J-1042-02 August 1982
HART-CROWSER & associates Inc
Figure A-6

Grain Size Classification

Boring S-6



Sample	Depth-ft	U.S.C.	Classification	Nat W.C. %	Atterberg Limits LL	PL	PI
S-6	27.5 - 29.0	SM	Gravelly, very silty SAND	35			
S-9	37.5 - 39.0	ML	Very sandy SILT	25			
S-11	47.5 - 49.0	SM	Very silty, medium to fine SAND	19			
S-16	72.5 - 74.0	SM	Silty, fine SAND	22			

J-1042-02 October 1982
HART-CROWSER & associates inc.
Figure B-6

Boring Log S-7

SOIL INTERPRETATION

Approximate Station 7+15
Approximate Ground Surface Elevation in Feet +18 (MLLW)

Asphalt and Crushed GRAVEL surfacing

Dense, moist, brown, fine to medium SAND with occasional SILT inclusion and shell fragments (FILL). (+13)

Loose, moist, black, slag GRAVEL (FILL)

- Sandy
- Saturated below 10 feet

(-9)

Stiff, saturated, brown, fine sandy SILT with shell fragments.

- Clayey

(-18)

Loose, saturated, gray, fine to medium SAND.

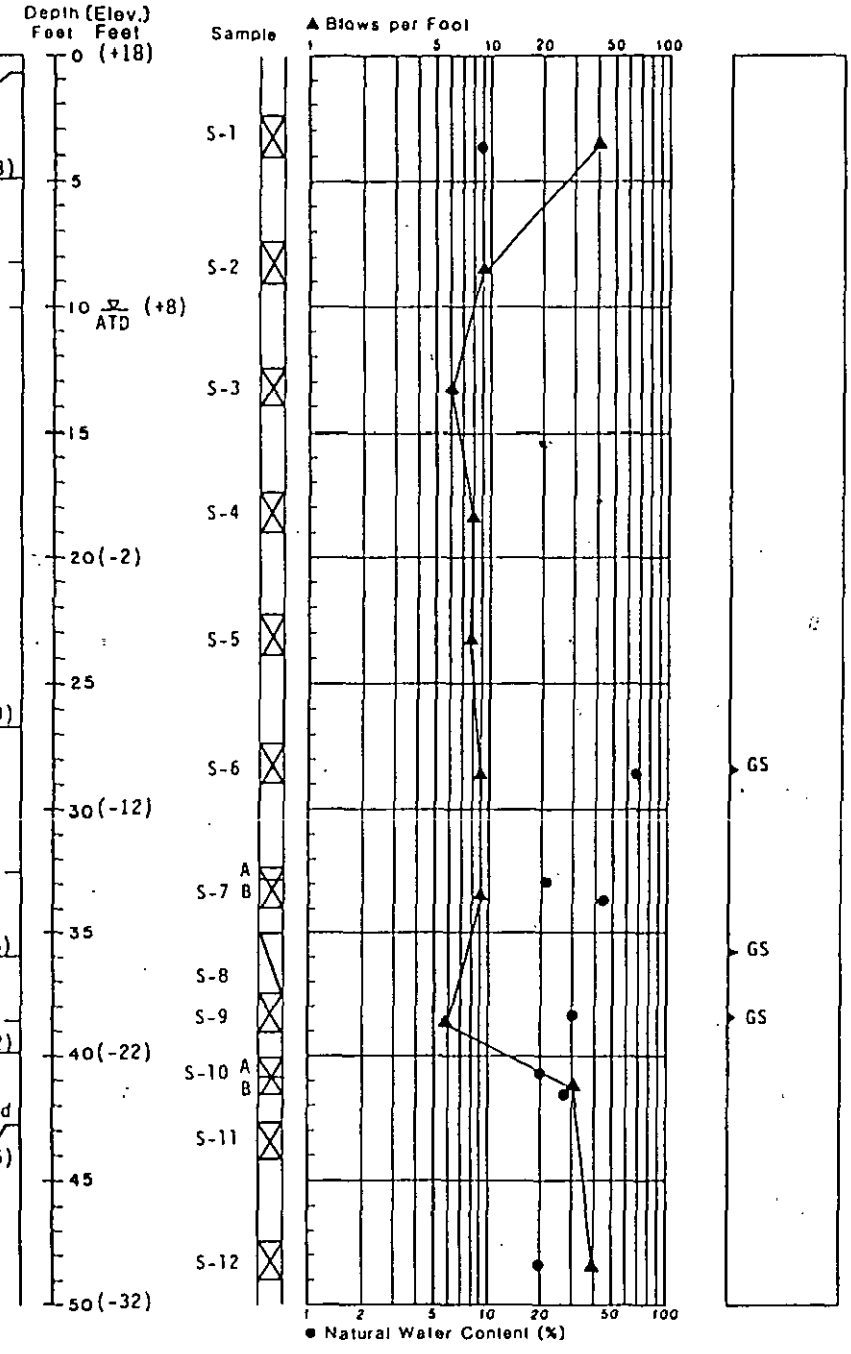
- Slightly silty

(-22)

Interbedded, medium stiff to stiff, saturated, brown, fine sandy SILT and medium dense, saturated gray, fine to medium SAND and silty, fine SAND.

(-25)

Medium dense to dense, saturated, gray, slightly silty to silty, fine and fine to medium SAND.



SOIL INTERPRETATION

Medium dense to dense, saturated, gray, slightly silty to silty, fine and fine to medium SAND.

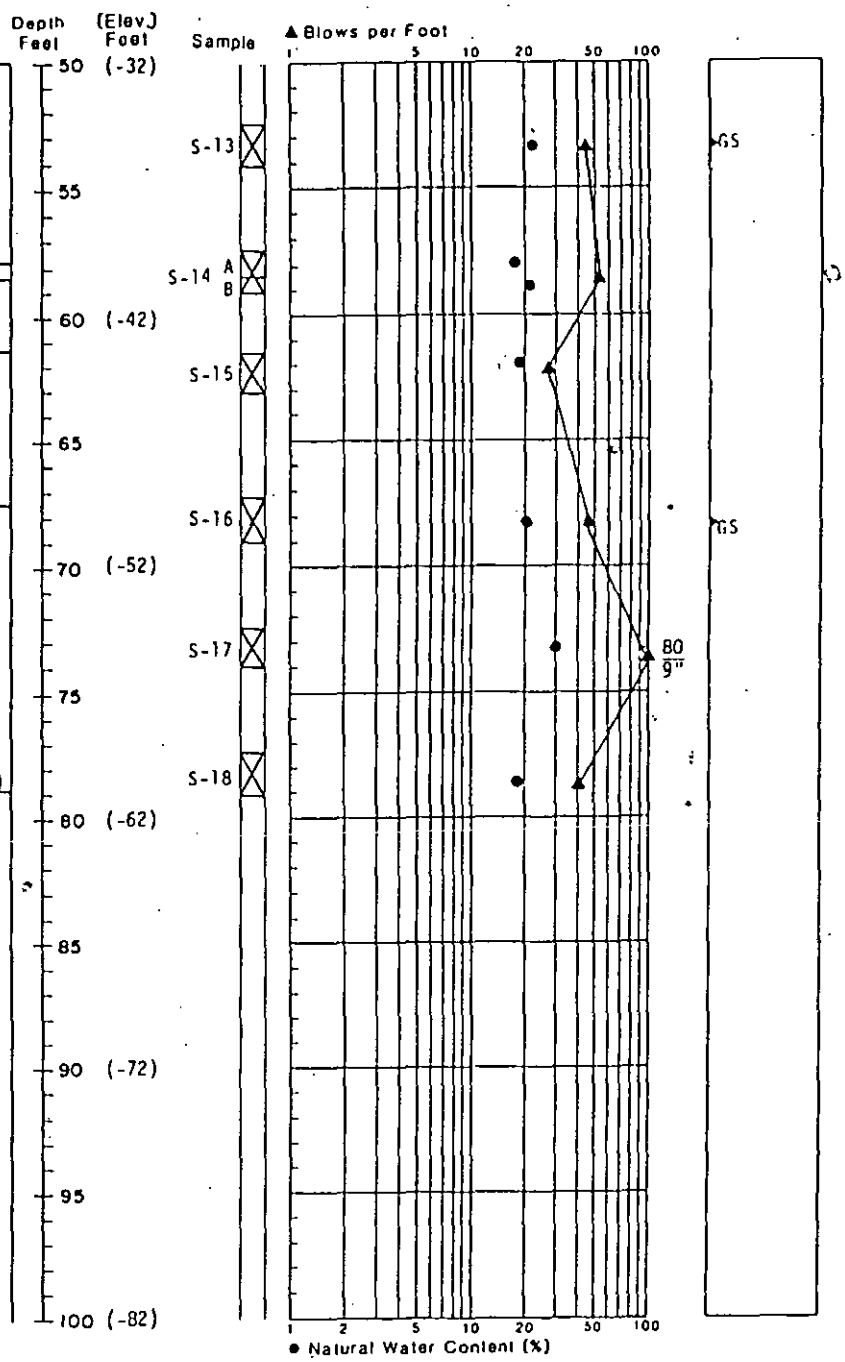
Very stiff SILT lenses and shell fragments (-40.5)

Dense to very dense, saturated, gray, slightly silty, fine to medium SAND.
Trace shell fragments

Trace shell fragments

(-61)

Bottom of boring at 79 feet.
Completed 5/13/82.



Groundwater Level

Bentonite Seal

2/14/81
ATD Water Level (Date) At Time of Drilling

Observation Well Tip or Slotted Section

Sampling

2" O.D. Split Spoon Sample

3" O.D. Shelby Tube Sample

Cutting Sample

★ No Sample Recovery

Laboratory Tests

GS	Grain Size Analysis	TUU	Triaxial Unconsolidated Undrained
CN	Consolidation Test	TCU	Triaxial Consolidated Undrained
K	Permeability Test	TCD	Triaxial Consolidated Drained
DS	Direct Shear		
OU	Unconfined Compression, tsf		
TV	Torvane, tsf		
PP	Pocket Penetrometer, tsf		

Water Content (%)

Plastic Limit — Natural Water Content — Liquid Limit

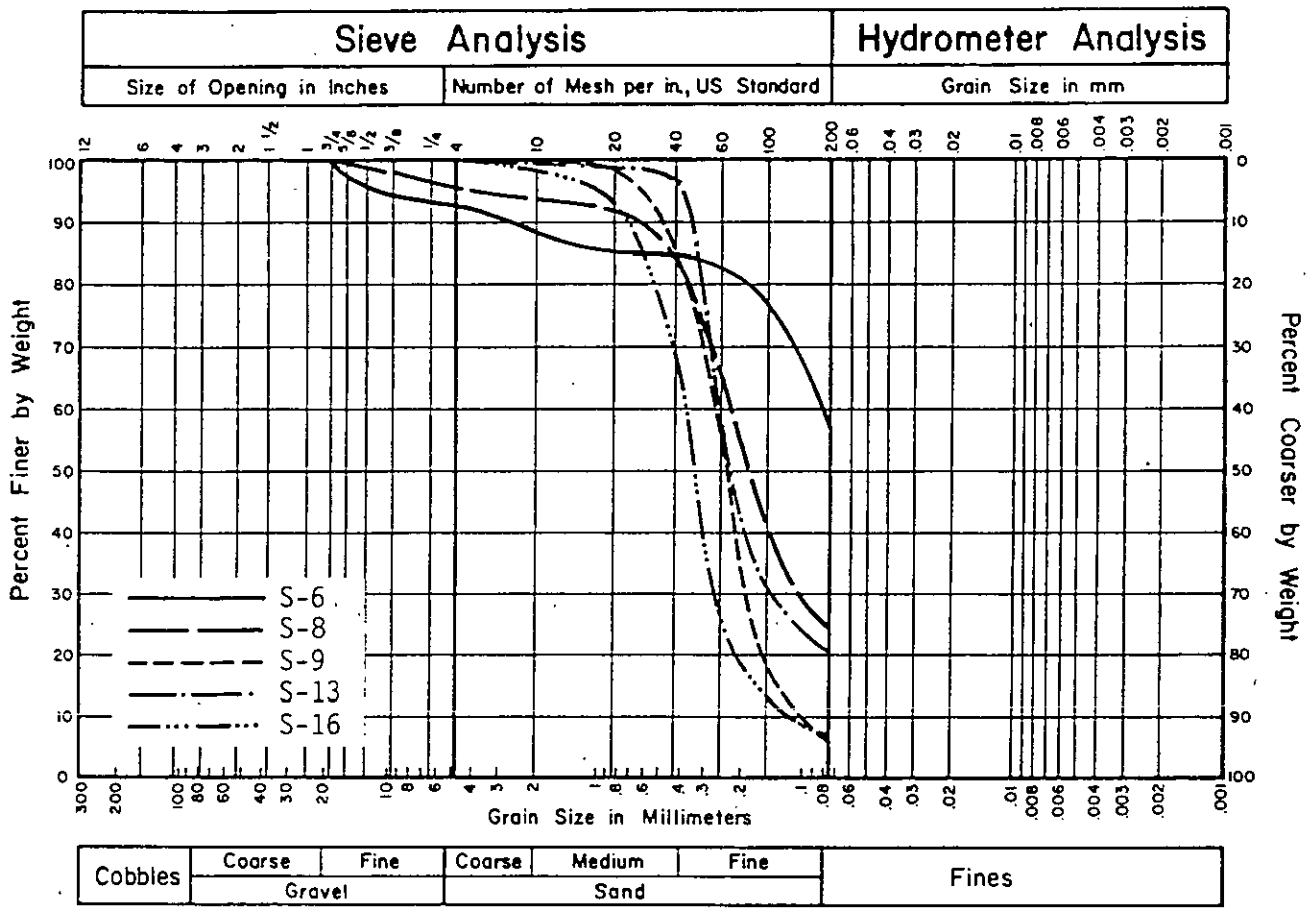
Notes

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level, if indicated, is for the date specified and may vary with the time of year.

1042-02 August 1982
HART-CROWSER & associates Inc.
Figure A-7

Grain Size Classification

Boring S-7



Sample	Depth-ft	U.S.C.	Classification	Nat. W.C. %	Atterberg Limits LL	PL	PI
S-6	27.5 - 29.0	ML	Slightly gravelly, very sandy SILT	36			
S-8	34.6 - 34.8	SM	Silty, medium to fine SAND with slag and wood fragments	22			
S-9	37.5 - 39.0	SM - SP	Slightly silty, medium to fine SAND	30			
S-13	52.5 - 54.0	SM	Silty, fine SAND	23			
S-16	72.5 - 74.0	SM - SP	Slightly silty, medium to fine SAND	24			

J-1042-02 October 1982

HART-CROWSER & associates inc.

Figure B-7