GEOTECHNICAL STUDY (PART I OF II)
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

SHINER MOSELEY AND ASSOCIATES, INC.
CORPUS CHRISTI, TEXAS

Report No. 0602-1316
Part I of II
August 13, 2002

Shiner Moseley and Associates, Inc.
555 N. Carancahua, Suite 1650
Corpus Christi, Texas 78478

Attention: Mr. Dan Heilman, P.E.

Geotechnical Study (Part I of II)
Gulf Shoreline Stabilization Project
Rockefeller Refuge
Cameron Parish, Louisiana

Introduction

Fugro South, Inc. is pleased to present this first report of our geotechnical study for the above-referenced project. Mr. Dan Heilman, P.E., with Shiner Moseley and Associates, Inc. (SMA), requested this study during a telephone conversation with Mr. David W. Duhon of Fugro South, Inc., on March 20, 2002. Mr. Neil McLellan, P.E., with SMA, authorized this study verbally and via memorandum e-mailed to Mr. Duhon on May 29, 2002. We performed this study in general accordance with our Proposal No. 0602-1316, dated March 25, 2002.

This first report is being issued at the request of the client to aid with the conceptual designs of various shoreline stabilization structures. The major design concept included and discussed in this report is allowable soil bearing capacity, followed by construction considerations. Upon determination by others of the stabilization concepts deemed most likely feasible, we will be supplied with the selected design alternatives in order to perform our consolidation and settlement analyses. The results of our analyses will then be presented in a subsequent report.

Project Description. We understand that due to extensive coastal erosion over the past several years, the Louisiana Department of Natural Resources, along with the Rockefeller Wildlife Refuge, is planning to construct a shoreline stabilization structure from Joseph's Bayou westward about 10 miles to the west boundary of the Rockefeller Refuge along the existing shoreline. The project site is essentially located in the southeast corner of Cameron Parish, Louisiana, which is bordered to the south by the Gulf of Mexico. A *Site Vicinity Map* is provided on Plate 1 of this report. The stabilization project may consist of, but not be limited to, constructing a rock breakwater or installing Geotubes. SMA has requested that Fugro South, Inc. provide geotechnical recommendations to aid in the beach stabilization project.

Purposes and Scope of Work. The purposes of our geotechnical study were to: 1) explore subsurface soil conditions along the shoreline, as well as, sample soils along the seafloor; and 2) provide geotechnical recommendations to guide others in the design and construction of potential stabilization structures. Our scope of work included the following:

- drilling and sampling twenty soil borings to explore subsurface soil conditions along the shoreline and obtain soil samples for laboratory testing;
- performing laboratory tests on select soil samples obtained in the field to assess pertinent geotechnical engineering properties;
- obtaining grab (surface) samples across the seafloor profile at the same shoreline locations as the borings. At each borehole location, 5 samples were obtained. The samples were collected at distances of about 0-, 250-, 500-, 1250-, and 2000-ft seaward from the shoreline. All samples have been analyzed for grain-size distribution;
- analyzing the field and laboratory data to develop recommendations to guide others in the design and construction of the potential stabilization structures along the project site shoreline; and
- preparing a two part geotechnical report summarizing our findings (the main aspect of Part I to be bearing capacity and the main aspect of Part II to be settlement).

Environmental assessment, compliance with State and Federal Regulatory requirements, assessment of potential migration, hydrology studies, and/or environmental analyses were beyond the scope of this study. A geological fault study was also beyond the scope of this study.

Applicability of Report. The explorations and analyses for this study, as well as the conclusions and recommendations contained in this report, were selected or developed based on our understanding of the project as described previously and in later sections of this report. If there are differences in location or design features as we understand them, or if the locations or design features change, we should be authorized to review the changes and, if necessary, to modify our conclusions and recommendations. The observations, conclusions, and recommendations presented in this report may not apply to locations not explored by our borings or areas outside the project boundaries.

We have prepared this part I report exclusively for Shiner Moseley and Associates, Inc. to guide in the conceptual design of the shoreline protection alternatives associated with this project. We have conducted this study using the standard level of care and diligence normally practiced by recognized engineering firms now performing similar services under similar circumstances. We intend for this report, including all illustrations, to be used in its entirety. This report should be made available to prospective contractors for information only and not as a warranty of subsurface conditions.

Field Exploration

Our field activities are discussed in this section. We have included discussions relative to drilling & sampling methods for borings, sampling methods for seafloor grab samples, water depth observations, and borehole sealing.

General. Fugro South, Inc. explored subsurface soil conditions at the project site between the dates of June 17, 2002 and July 11, 2002 by drilling and sampling 20 exploratory soil borings and obtaining 100 seafloor samples. The locations of the borings and grab samples are shown on the *Plan of Borings* on Plate 2 of this report. Borings B-1, B-4, B-6, B-8, B-10, B-12, B-14, B-16, and B-19 were drilled to a penetration of approximately 50 ft below existing shoreline grade. Borings B-2, B-5, B-7, B-9, B-11, B-13, B-15, B-17, and B-20 were drilled to a penetration of approximately 25 ft below shoreline grade. Borings B-3 and B-18 were drilled to a depth of about 100 ft below shoreline grade. It should be noted that the spacing between borings is approximately 2,500 ft. Representatives of John E. Chance Land Surveyors staked the borehole locations requested by SMA prior to our arrival onsite. Locations that could not be accessed were offset and the final boring coordinates and elevations are provided in the following table. The coordinates and water-depth readings at the time of sampling for the seafloor grab-samples are provided on Plate 2 at the end of this report. The vertical datum is NAVD88.

BORING NO.	TRANSECT	LATITUDE	LONGITUDE	ELEVATION, FT
B-1	50+00	29°41’16.36193”	92°54’00.78323”	0.35
B-2	75+00	29°41’05.12261”	92°53’35.46969”	1.25
B-3	100+00	29°40’54.78499”	92°53’09.82675”	-0.20
B-4	125+00	29°40’43.45767”	92°52’44.56051”	-0.30
B-5	150+00	29°40’33.10483”	92°52’18.88296”	3.18
B-6	175+00	29°40’20.99154”	92°51’54.00504”	0.58
B-7	200+00	29°40’10.50906”	92°51’28.44306”	0.73
B-8	225+00	29°40’00.83905”	92°51’02.16568”	0.48
B-9	250+00	29°39’53.23203”	92°50’35.10695”	3.82
B-10	275+00	29°39’41.91963”	92°50’09.58169”	-0.43

BORING NO.	TRANSECT	LATITUDE	LONGITUDE	ELEVATION, FT
B-11	300+00	29°39’31.33668”	92°49’44.22550”	3.42
B-12	325+00	29°39’20.26543”	92°49’18.93079”	1.45
B-13	350+00	29°39’08.22383”	92°48’53.97874”	3.91
B-14	375+00	29°38’56.34158”	92°48’29.19304”	-1.09
B-15	400+00	29°38’46.34746”	92°48’03.09055”	3.93
B-16	425+00	29°38’37.40932”	92°47’36.70858”	0.22
B-17	450+00	29°38’24.67592”	92°47’12.24649”	4.60
B-18	475+00	29°38’12.94223”	92°46’47.22920”	1.47
B-19	500+00	29°38’01.91021”	92°46’22.05040”	0.50
B-20	525+00	29°37’57.77359”	92°45’52.68994”	1.97

Borehole Drilling & Sampling Methods. Due to the nature of the marshy surface conditions along the coast, the borings were drilled with a buggy-mounted drill rig using wet-rotary drilling techniques. We generally sampled the soil at about 2-ft intervals in the upper 16 ft and at 5-ft intervals thereafter to the completion depths of the boreholes. Detailed descriptions of the soils encountered in the borings drilled for this study are presented on the boring logs on Plates 3 through 22. A key identifying the terms and symbols used on the boring logs is presented on Plates 23a and 23b.

Undisturbed samples of the cohesive soils within about the upper 16 ft were generally taken using a liner sampler. The liner samples were advanced a distance of about 24 inches using the weight of the drill string. Undisturbed samples of the cohesive soils below a depth of approximately 16 ft were obtained by hydraulically pushing a 3-inch diameter, thin-walled tube sampler a distance of about 24 inches. Our field procedure for cohesive soil sampling was conducted in general accordance with the *Standard Practice for Thin-Walled Tube Sampling of Soils* (ASTM D 1587). We obtained field estimates of the undrained shear strength of the recovered cohesive soil samples using either a Torvane or pocket penetrometer. Where applicable, the field estimates from the hand penetrometer were modified for stiff to very stiff, overconsolidated, natural, cohesive soils (Pleistocene), as described on Plate 23b. Portions of each recovered soil sample were placed into plastic bags or rigid plastic tubes for transportation to our laboratory for further testing.

Granular soil samples were obtained in general accordance with the *Standard Method for Penetration Test and Split-Barrel Sampling of Soils* (ASTM D 1586). Granular soil samples were obtained using the Standard Penetration Test (SPT) as described on Plate 23b. Our geotechnical technician recorded the hammer blows for each sampling interval. The SPT N-value described on Plate 23b is recorded on the boring logs. The soil samples obtained from the split-barrel sampler were visually classified and placed in plastic bags for transportation to our laboratory.

Seafloor Grab Sampling. At each borehole location along the beach, 5 seafloor grab samples were obtained in a perpendicular direction seaward from the shoreline. The samples were collected at distances of about 0-, 250-, 500-, 1250-, and 2000-ft. Each sample was analyzed for grain-size distribution. The coordinates and water-depth readings at the time of sampling for the seafloor grab-samples are provided on Plate 2 at the end of this report.

Water Depth Observations. As stated earlier, borings along the shoreline were drilled with a buggy-mounted drill rig using wet-rotary drilling methods. Due to the low surface elevation of the coastline and the fact that wet-rotary drilling methods had to be utilized for sampling, water depth readings within the exploratory boreholes could not be obtained. However, we were able to measure the water depth at each seafloor grab-sample location. The water level was measured from the water surface to the existing mudline. We have provided a discussion relating to the water depths measured during our sampling operations later in the *General Site Conditions* section of this report.

Borehole Sealing. Each boring was sealed with cement-bentonite grout from the bottom up using a tremie pipe upon completion. When the grout returned to the surface, we removed the tremie pipe and topped off the boreholes by pouring grout from the surface. Our field procedure for borehole completion was conducted in general accordance with the regulations of the Louisiana Department of Transportation and Development (LADOTD), the Office of Public Works (OPW), and the Department of Environmental Quality (DEQ).

Laboratory Testing

The laboratory-testing program for this study was directed primarily toward evaluating the classification properties and undrained shear strength of the coastal subsurface soils along the area of Louisiana shoreline previously discussed. We also measured the compressibility characteristics of the subsurface soils by performing eleven (11) incrementally-loaded consolidation tests on selected samples. Particle size analyses or grain size curves developed from our sieve analyses on select samples of fine material recovered during our drilling activities are presented on Plates A-1 through A-10 in Appendix A of this report. Grain size curves developed from our sieve analyses performed on each seafloor grab-sample are presented on Plates B-1 through B-20 in Appendix B of this report (five (5) grain size distribution curves are presented on each plate). Our laboratory tests were performed in general accordance with the appropriate standards as tabulated at the end of this section.

Classification Tests. The classification tests included tests for natural moisture content, liquid and plastic limits (collectively termed Atterberg Limits), material finer than the No. 200 sieve, grain size distribution for material finer than the No. 200 sieve, and unit weight (dry density). These tests aid in classifying the soils, and are used to correlate the results of other tests performed on samples taken from different borings and/or different depths. The results of these classification tests are presented on the boring logs on Plates 3 through 22.

Undrained Shear Strength Tests. We measured the undrained shear strength of select undisturbed samples of cohesive soils by performing either miniature vane shear tests or unconsolidated-undrained triaxial compression strength tests. Natural moisture contents were determined as a routine portion of the miniature vane and compressive strength tests. Unit weights (dry densities) were determined by procedures outlined in the unconfined compression strength test method. The results of the undrained shear strength tests are presented on the boring logs on Plates 3 through 22.

Compressibility Characteristics. We measured the compressibility characteristics of the subsurface soils by performing eleven (11) incrementally-loaded consolidation tests. Due to the very soft consistency of the upper clays, we were unable to perform any consolidation tests on materials representative of the upper 20 ft at this site. We performed each test with a rebound-reload cycle near the samples estimated preconsolidation pressure. Natural moisture contents, Atterberg Limits, and dry unit weights were determined as routine portions of the consolidation tests. Consolidation test results will be presented as plots of effective vertical pressure versus strain in the second part of this study. Furthermore, the consolidation test results will be utilized for our settlement analyses to be presented in the second part of this study.

Summary of Laboratory Tests. The following table gives the types and number of laboratory tests as well as the standard test methods performed for this study.

Type of Test	Number of Tests	Test Designation
Moisture Content	63	ASTM D 2216
Atterberg Limits	31	ASTM D 4318
Material Finer than No. 200 Sieve	7	ASTM D 1140
Particle Size Analysis (Hydrometer)	110	ASTM D 422
Unit Weight (Dry Density)	32	ASTM D 2166
Unconsolidated-Undrained Triaxial Compression	12	ASTM D 2850
Miniature Vane Shear Test	43	ASTM D 4648

Type of Test	Number of Tests	Test Designation
Incremental Consolidation Test	11	ASTM D 2435

General Site Conditions

The interpreted site and subsurface conditions based upon our field exploration and laboratory testing are discussed in this section. This section also includes a discussion of the water depth conditions encountered along the shoreline during our field exploration activities.

Site Description. The project site is generally composed of the southern portion of Rockefeller Refuge located in Cameron Parish, Louisiana from Joseph's Bayou westward along the beach approximately 10 miles to the western boundary of the refuge. Surface conditions along the coast essentially consist of very soft, highly organic topsoil and easily erodible shell fragments, which compose the beach and grassy marshland. See Plate 2 for an aerial view of the project site.

General Subsurface Conditions. We evaluated subsurface conditions along the shoreline by reviewing the logs of our soil borings and evaluating the results of laboratory tests presented on the boring logs. Generally, the subsurface soil conditions encountered in our soil borings consist of approximately 0 to 5 ft of shell and shell fragments composing the surface of the beach underlain by 35 to 40 ft of Recent clay deposits overlying natural clay of Pleistocene age encountered to a depth of at least 100 ft below the existing shoreline, the maximum depth explored for this study. A *Generalized Subsurface Profile* is provided on Plate 24. The following table provides a general summary of the subsurface conditions encountered during this study.

Stratum	Soil Description	Average Depth
I	Shell with Shell Fragments	Beach Surface, 0 to 5 ft
II	CLAY (Recent)	5 ft to about 40 ft
III	CLAY with Silt and Sand (Pleistocene)	40 ft to at least 100 ft

Stratum I consists of shell and fragmented shell that was observed in the borings performed on the beach from the beach surface to an average depth of about 5 ft below grade. Tests performed on selected samples indicate materials finer than the No. 200 sieve range from about 1 to 6 percent. The measured blow counts (N-values) from the Standard Penetration Test range from 5 to 13 blows per foot in this stratum. These blow counts indicate a loose to medium-dense consistency. Borings that were offset off the beach surface do not show the Stratum I material.

The measured undrained shear strength of the Stratum II Recent cohesive soils typically ranges from approximately 80 psf (very soft) to 450 psf (soft). Undrained shear strengths as low as 60 psf were measured on several samples. Furthermore, it should be noted that relatively high values of water content and Atterberg Limits (Liquid Limit, Plastic Limit, and Plasticity Index) indicated in the Stratum II soils to a penetration of about 35 ft below shoreline grade are likely a result of organics within the recovered soil samples. The water content of the upper clay soils is very close to its Liquid Limit, which means that the upper clays have a consistency of a thick drilling mud.

The measured undrained shear strength in the Stratum III Pleistocene cohesive soils generally ranges from approximately 1000 psf (stiff) to 2,000 psf (very stiff). Appreciable amounts of silt and sand were encountered throughout Stratum III intermixed with the predominantly clay material.

It should be noted that we have reviewed existing soil data from previous Fugro South, Inc. reports 0600-1340 (Northwest Route Access Road, Pecos Prospect, Pecan Island Field) and 0600-1373 (Well and Bridge Locations, Pecos Upthrown Project, Pecan Island, Louisiana), which were in the same general area of this project in South Louisiana to the east in Vermilion Parish. Subsurface conditions are such that the approximate depth, classification, and consistency of the upper clay soils are similar to the conditions discovered for this project. Additional information relating to the subsurface conditions encountered in the borings drilled for this project is presented on the boring logs on Plates 3 through 22 at the end of this report. A key identifying the terms and symbols used on the boring logs is presented on Plates 23a and 23b.

Approximate Seafloor Water Depth. As previously indicated, we measured the water depth from the water surface to the mudline at each of our seafloor grab-sample locations. The water depth observations indicated that the water level at or near the shoreline, corresponding to the first seafloor sample obtained nearest the coast at each boring location, was approximately 5 ft at the time of sampling. This is due to the fact that there is not a gradual slope starting at grade and progressing to a lower depth into the gulf. At the shoreline along the beach, there is a vertical drop of about 5 ft starting at the coast then gradually deepening with distance away from the shore. Generally, progressing in a southerly direction the recorded water depths increase to an approximate depth of 11 ft at the final grab-sample locations, which are located about 2000 ft seaward of the shore. The depth readings corresponding to each grab-sample location are presented on the *Plan of Borings* on Plate 2. It should be noted that the reported water levels are approximate and do not consider any variations in depth associated with tidal fluctuations and/or the variability of the mudline (seafloor) across the site.

Variations in Subsurface Conditions. Our interpretations of soil and water depth conditions, as described in this report, are based on data obtained from our field observations, seafloor sampling, soil borings, and laboratory tests. ***It is possible that undisclosed variations in soil or water depth conditions, the lateral extent and depth of the various strata, especially the Stratum I shell, and the position of the mudline exist across the site.*** Please note that the borings were spread about 2,500 ft apart, therefore, localized variations between boring locations are likely. We recommend careful observations be performed during any construction to verify our interpretations. The information regarding subsurface conditions presented in this report should be made available to prospective contractors for information only, and not as a warranty of subsurface and/or water depth conditions.

Shoreline Protection

We understand the stabilization project may consist of, but not be limited to, constructing a rock breakwater or installing Geotubes to help protect the beach (coastline) from erosion. If alternate methods are to be considered, we will provide our construction recommendations for those alternates in the second part of this study. The following subsections are provided to aid SMA with their conceptual designs.

Rock Breakwater. We understand that a rock breakwater may be considered to protect the coastline from erosion due to wave action. As explained, we have not been provided with the anticipated configuration or size and type of rock to be used for the structure. However, we have assumed that the material will have a minimum nominal size of 6 to 8 inches. The material should be angular and not rounded to allow for interlocking of the material. We expect the rock will be placed using a crane and barge. A detailed slope stability analysis was beyond our scope of work for this project. Once a preliminary design of the desired structure is available, slope as well as base stability of the breakwater, if selected, should be analyzed. Due to the presence of very soft clays to a depth of about 30 ft to 40 ft, base failure will likely govern the height of the structure. Hydraulic stability of the breakwater must be analyzed.

An effective unit weight of 60 to 70 pcf should be used for any portion of the rock breakwater below the waterline. The total unit weight of the rock should be used for the portion of the breakwater above the water surface or on the existing shoreline. A total unit weight of 135 pcf is typical for rock fill. In addition, the weight of the rock would cause the aggregate to “push” into the soft clays encountered in our borings, causing a loss of material. Because of these considerations, it may be necessary to place a geofabric such as Mirafi 500X, or equivalent, below the base of any rock breakwater to act as a separator between the soft clays and the rock aggregate. Also, a geogrid, such as Tensar BX 1100, should be considered between the geofabric and the rock breakwater to promote lateral load transfer and uniform stress distribution thereby reducing the potential for localized bearing capacity failures along the base of the structure. We recommend that the geotextile manufacturer be consulted for specifications on the type of material and placement techniques to be used for this particular application. The breakwater structure should be sized or configured to limit applied pressures at the soft clay mudline to less than the allowable bearing capacity discussed in the *Allowable Bearing Pressure* section.

A proper monitoring and maintenance schedule should be prepared to insure that the rock breakwater maintains its design configuration, and is providing the erosion protection for which it was originally intended.

Geotubes. Geotubes are relatively large diameter cylindrical synthetic tubes that can be filled with dredge materials. The geotubes will act as a stable shoreline protection system protecting the shoreline from erosion.

The geotubes should be sized or configured to limit applied pressures at the soft clay mudline to less than the allowable bearing capacity discussed in the following section.

Allowable Bearing Pressure. The allowable bearing capacity depends primarily on the undrained shear strength of the foundation soils. We recommend an average allowable bearing pressure of **250 psf** be utilized for the design of shoreline protection structures placed on land that bear in the upper Recent natural, clay soil deposits encountered in our exploratory borings. The allowable bearing pressure reported above includes a factor of safety of 2 with respect to shear failure of the foundation soils. However, for this application, and due to the fact that a localized failure of the protection structures on the shore may not be considered catastrophic, a lower value (1.5) may be acceptable for design. Due to the fact that mudline soils in the Gulf may possess lower localized values of undrained shear strength, the allowable bearing capacity utilized for the design of structures placed in the water should be verified through further exploration. We anticipate that at localized areas along the shore and along the seafloor, the allowable bearing capacity may be 30 percent lower than the average value reported above.

Settlement. Estimation of settlement for the very soft clays encountered at this site will be difficult. In addition, consolidation tests could not be performed on the very soft clay samples generally representative of the upper 20 ft of material. Therefore, our settlement estimates will be based on judgment, past experience, and the consolidation settlement analyses. Results of these analyses will be presented in the second part of this study once we have been provided with the size and configuration of the breakwater. Due to the presence of very soft clays to a considerable depth, very large consolidation and creep settlement over a long period of time should be expected at this site. Differential settlement along and across the breakwater is also likely due to variations in the strength and compressibility of the upper clays.

Construction Considerations

The following sections provide additional comments relative to lateral soil displacement due to material placement, construction equipment, construction sequence, a field test section, and construction monitoring.

Lateral Soil Displacement. The upper soils encountered in the exploratory borings consisted primarily of very soft clays. These clays extend from the existing shoreline (mudline) to a depth of about 40 ft. It is possible that a lateral soil displacement (mudwave) could be created in these upper soils when soil or rock is dropped on them. It is difficult to determine the magnitude of a lateral soil displacement. The lateral extent of the displacement will depend on the height from which the construction material is dropped. *Reducing the height from which the materials are dropped into the water will help to reduce the extent of lateral displacement*. In our opinion, it would be prudent to gently place the rock on the prepared subgrade (after the geofabric and geogrid are installed) as opposed to dropping the rock.

Construction Equipment. Any construction equipment used on the beach should be carefully selected and should impart very low bearing pressure on the subgrade soils. Remolding of the soils and continued operation of the construction equipment may further reduce the bearing capacity of the soils. Construction equipment may sink in the very soft clays at this site unless it is supported by mats or other properly prepared subgrade. It should be noted that the allowable bearing capacity given in this report is an average across the site and localized areas have as much as 30 percent lower bearing capacity.

Construction Sequence. We recommend that the sequence of the breakwater construction be such that the entire breakwater is constructed in relatively uniform lifts. Significant (more that about 0.5 ft) differences in height during construction should be avoided to reduce the potential for slope/base failures.

Field Test Section. We strongly recommend that consideration be given to constructing a field test section. The very soft clays at this site are prone to create a mudwave, which will be very difficult to contain or remediate. Construction of a test section will give valuable information on whether the breakwater can be constructed to its intended height, settlement and creep of the soils, and will aid in developing construction sequence and techniques.

Construction Monitoring. We recommend that a geotechnical engineer, or qualified representative, be present on-site to observe the construction of shoreline protection structures. On-site observations may aid in recognizing and reconciling any unanticipated soil or groundwater condition and to check that design recommendations are appropriate and properly implemented during construction. During the construction phases, we can provide construction surveillance to: (1) observe compliance with the design concepts, specifications, and recommendations; and (2) observe subsurface conditions during construction.

* * *

The following illustrations and appendices are attached and complete this report:

	Plate
Site Vicinity Map	1
Plan of Borings	2
Logs of Borings	3 thru 22
Terms and Symbols Used on Logs	23a and 23b
Generalized Subsurface Profile	24
Appendix A	
Grain Size Curves (Boring Samples)	A-1 thru A-10
Appendix B	
Grain Size Curves (Seafloor Samples)	B-1 thru B-20

Closing

We appreciate the opportunity to be of continued service to Shiner Moseley and Associates, Inc, and look forward to working with you again in the near future. Please call us if you have any questions or comments concerning this part of the study or when we may be of further assistance.

Sincerely,

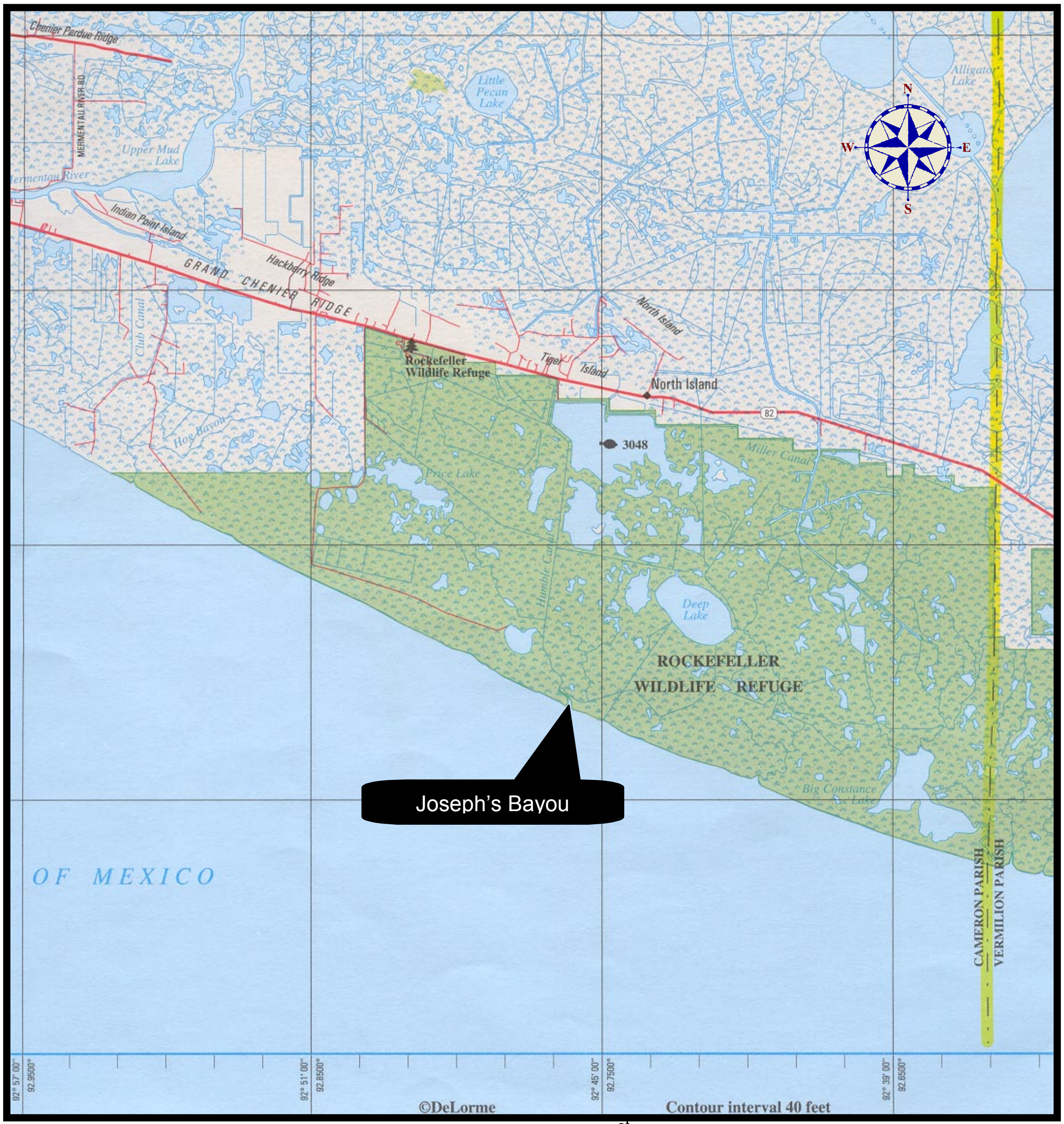
FUGRO SOUTH, INC.

Don Dugas, III, P.E.
Project Engineer

G. Rai Mehdiratta, Ph.D., P.E.
Vice President

Copies Submitted: Addressee (5)

DDIII\GRM
K:\DATA\REPORTS\2002\0602-1316 Shiner Moseley - Rockefeller\0602-1316 R1 SM-Rockefeller Refuge.doc



Reference: Louisiana Atlas & Gazetteer, 1st Edition, DeLorme, 1998.

SITE VICINITY MAP

Not-to-Scale

BARATARIA LCA R2-22

BARATARIA LCA R2-22
BORING SAMPLES AND GRAB SAMPLES

Louisiana DNR Rockerfeller Refuge
Gulf Shoreline Stabilization
Cameron Parish, Louisiana

FUGRO SOUTH

GEODETIC DATUM: NAD 1983
PROJECTION: LOUISIANA SOUTH
GRID UNITS: US SURVEY FEET

FEET SCALE 0 2,000 4000'

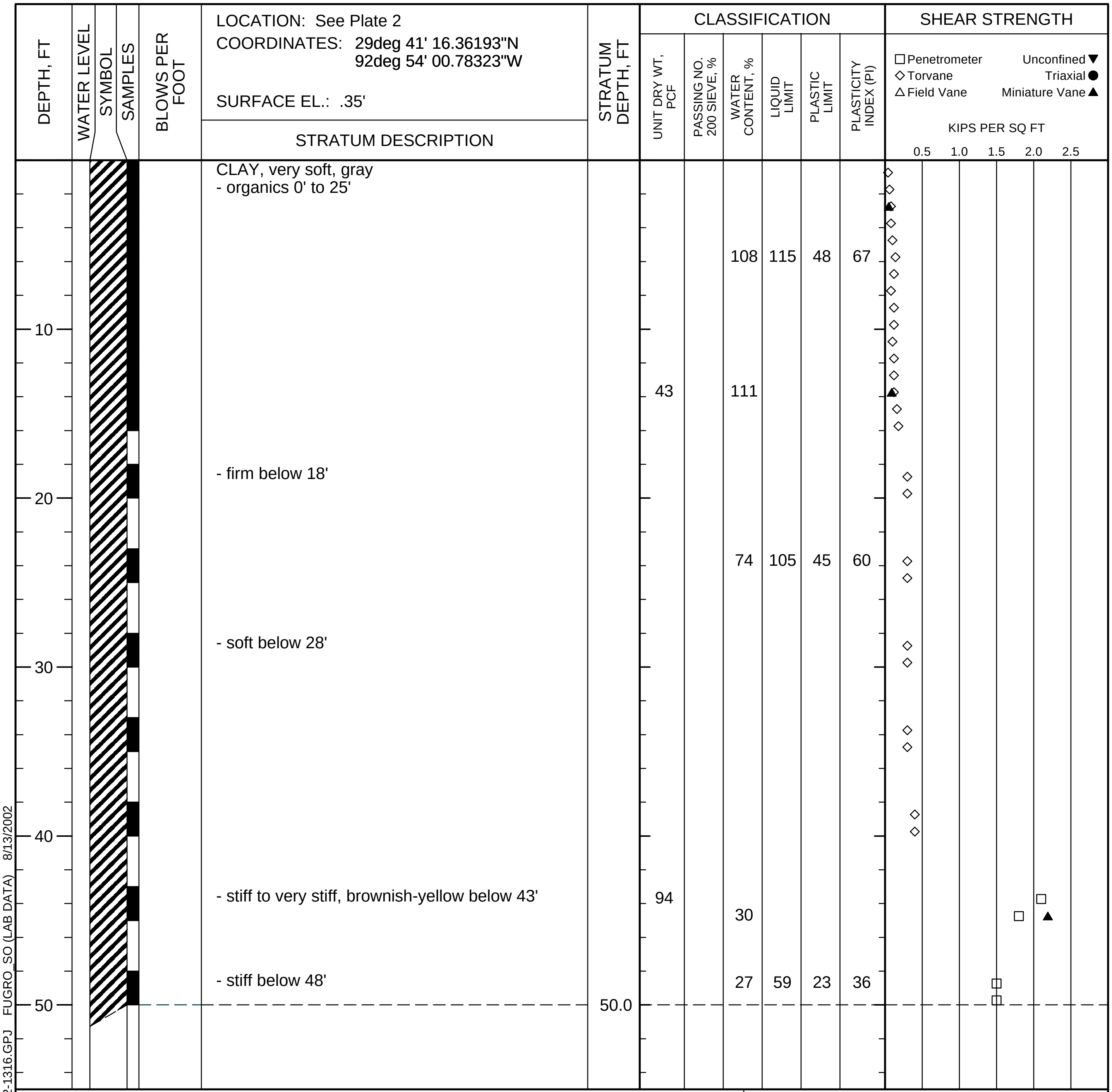
Issue No.	Date	Description	Inter	Drwn	Chkd	Aprv
1	7/30/02	FIRST ISSUE	DR	MJS	RMJ	RMJ

Job No.: 02-5141
Dwgfile: L:\025141\REPORT\MAPS\025141_1.DWG

PLATE 2

LOCATION: See Plate 2
COORDINATES: 29deg 41' 16.36193"N
92deg 54' 00.78323"W

SURFACE EL.: .35'



STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
CLAY, very soft, gray - organics 0' to 25'							
				108	115	48	67
		43		111			
- firm below 18'							
				74	105	45	60
- soft below 28'							
- stiff to very stiff, brownish-yellow below 43'		94					
				30			
- stiff below 48'				27	59	23	36
	50.0						

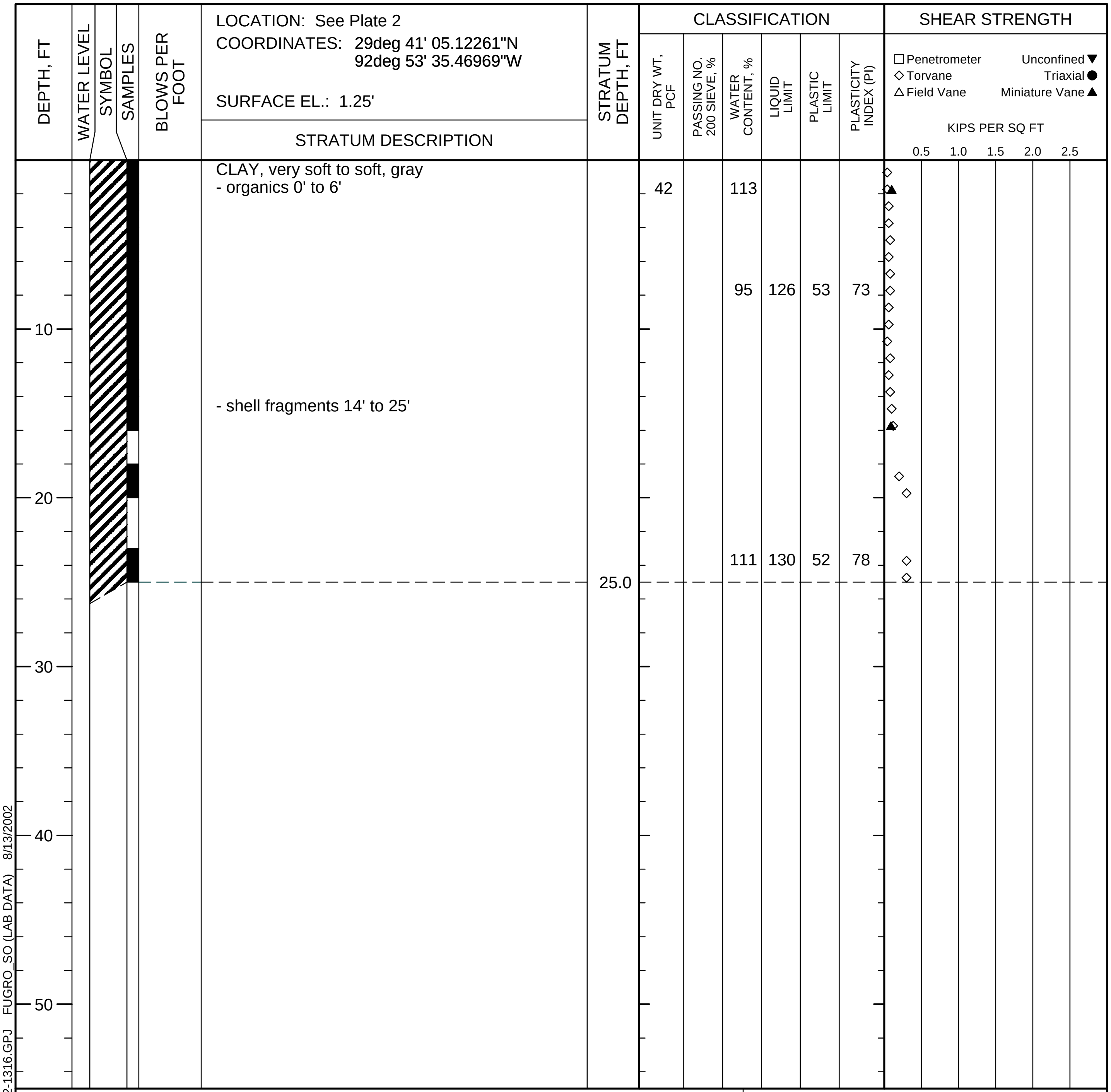
NOTES:
1. Terms and symbols defined on Plate 23a and 23b.

DATE: June 19, 2002
TOTAL DEPTH: 50.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 50'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

C:\CDBURN~1\LAKECH~1\0602-1316.GPJ FUGRO_SO (LAB DATA) 8/13/2002

LOG OF BORING NO. B-1
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

LOCATION: See Plate 2
COORDINATES: 29deg 41' 05.12261"N
92deg 53' 35.46969"W
SURFACE EL.: 1.25'



STRATUM DESCRIPTION

CLAY, very soft to soft, gray
- organics 0' to 6'
- shell fragments 14' to 25'

25.0

CLASSIFICATION

UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
42		113			
		95	126	53	73
		111	130	52	78

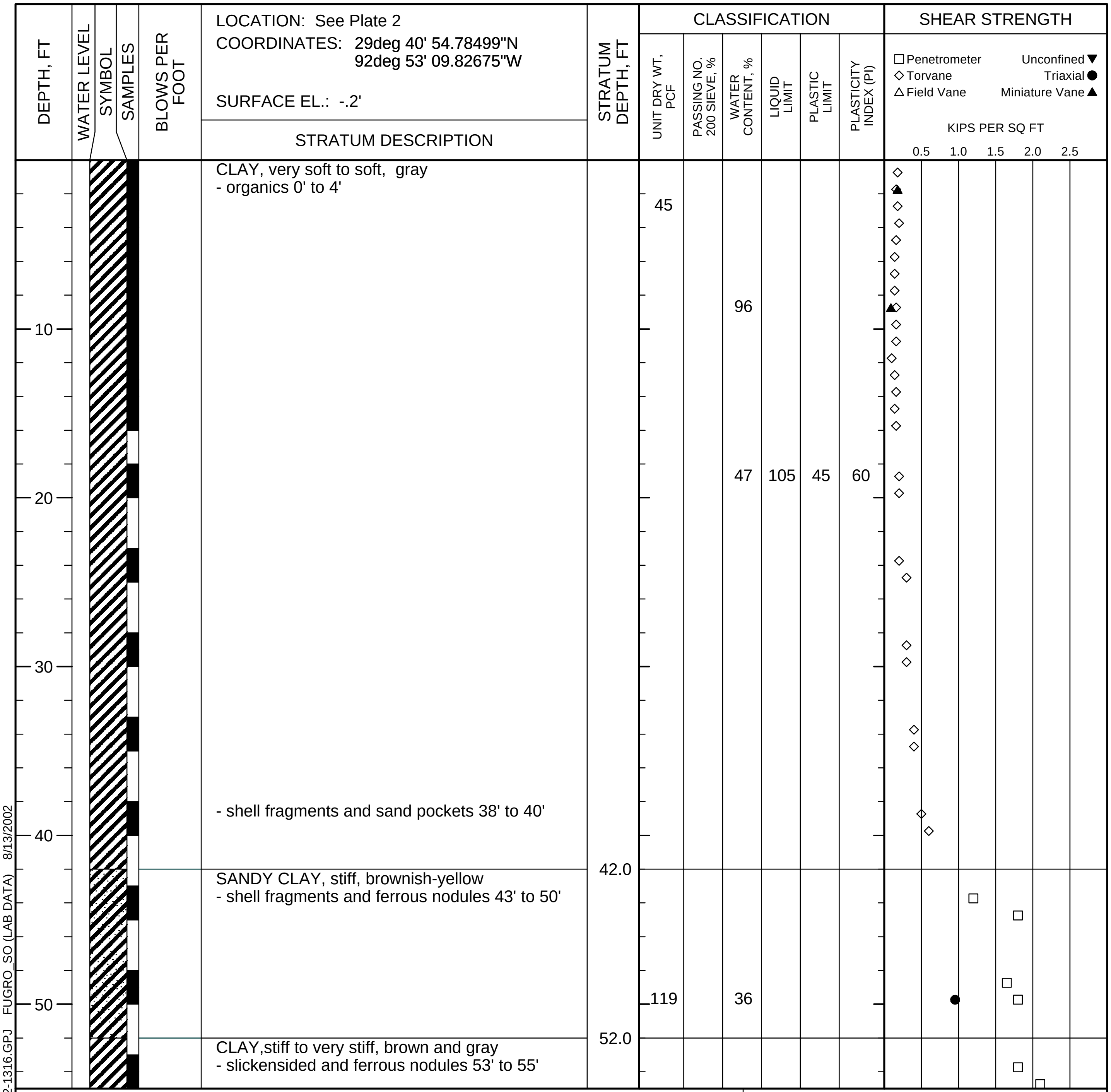
NOTES:
1. Terms and symbols defined on Plate 23a and 23b.

DATE: June 19, 2002
TOTAL DEPTH: 25.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 25'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

C:\CDBURN~1\LAKECH~1\0602-1316.GPJ FUGRO_SO (LAB DATA) 8/13/2002

LOG OF BORING NO. B-2
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

LOCATION: See Plate 2
COORDINATES: 29deg 40' 54.78499"N
92deg 53' 09.82675"W
SURFACE EL.: -.2'



STRATUM DESCRIPTION	STRATUM DEPTH, FT
CLAY, very soft to soft, gray - organics 0' to 4' - shell fragments and sand pockets 38' to 40'	
SANDY CLAY, stiff, brownish-yellow - shell fragments and ferrous nodules 43' to 50'	42.0
CLAY,stiff to very stiff, brown and gray - slickensided and ferrous nodules 53' to 55'	52.0

UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
45					
		96			
		47	105	45	60
119		36			

NOTES:

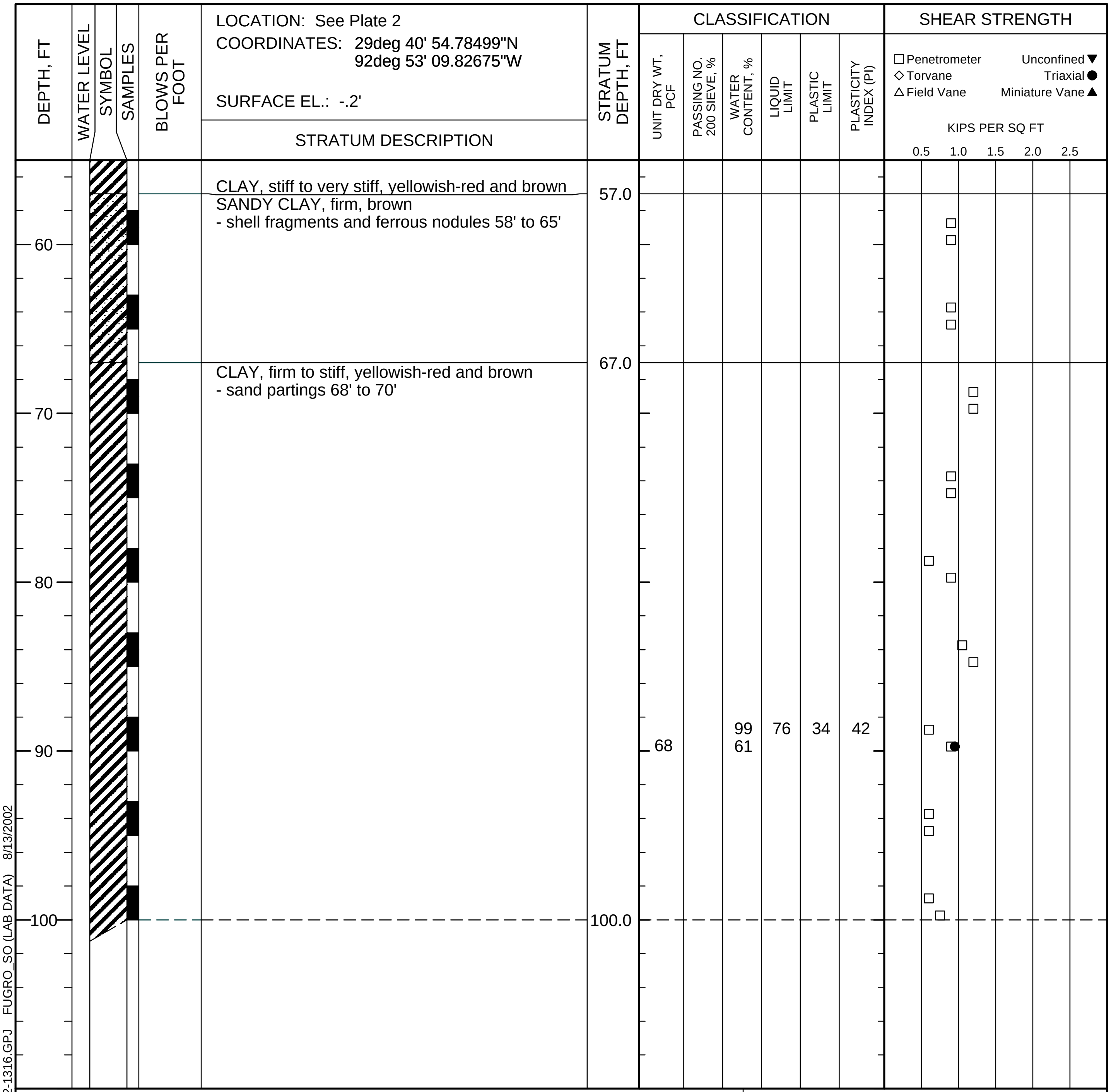
1. Terms and symbols defined on Plate 23a and 23b.

DATE: June 19, 2002
TOTAL DEPTH: 100.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 100'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

LOG OF BORING NO. B-3
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

Report No. 0602-1316

LOCATION: See Plate 2
COORDINATES: 29deg 40' 54.78499"N
92deg 53' 09.82675"W
SURFACE EL.: -.2'



STRATUM DESCRIPTION	STRATUM DEPTH, FT
CLAY, stiff to very stiff, yellowish-red and brown	57.0
SANDY CLAY, firm, brown - shell fragments and ferrous nodules 58' to 65'	67.0
CLAY, firm to stiff, yellowish-red and brown - sand partings 68' to 70'	100.0

UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
		99	76	34	42
68		61			

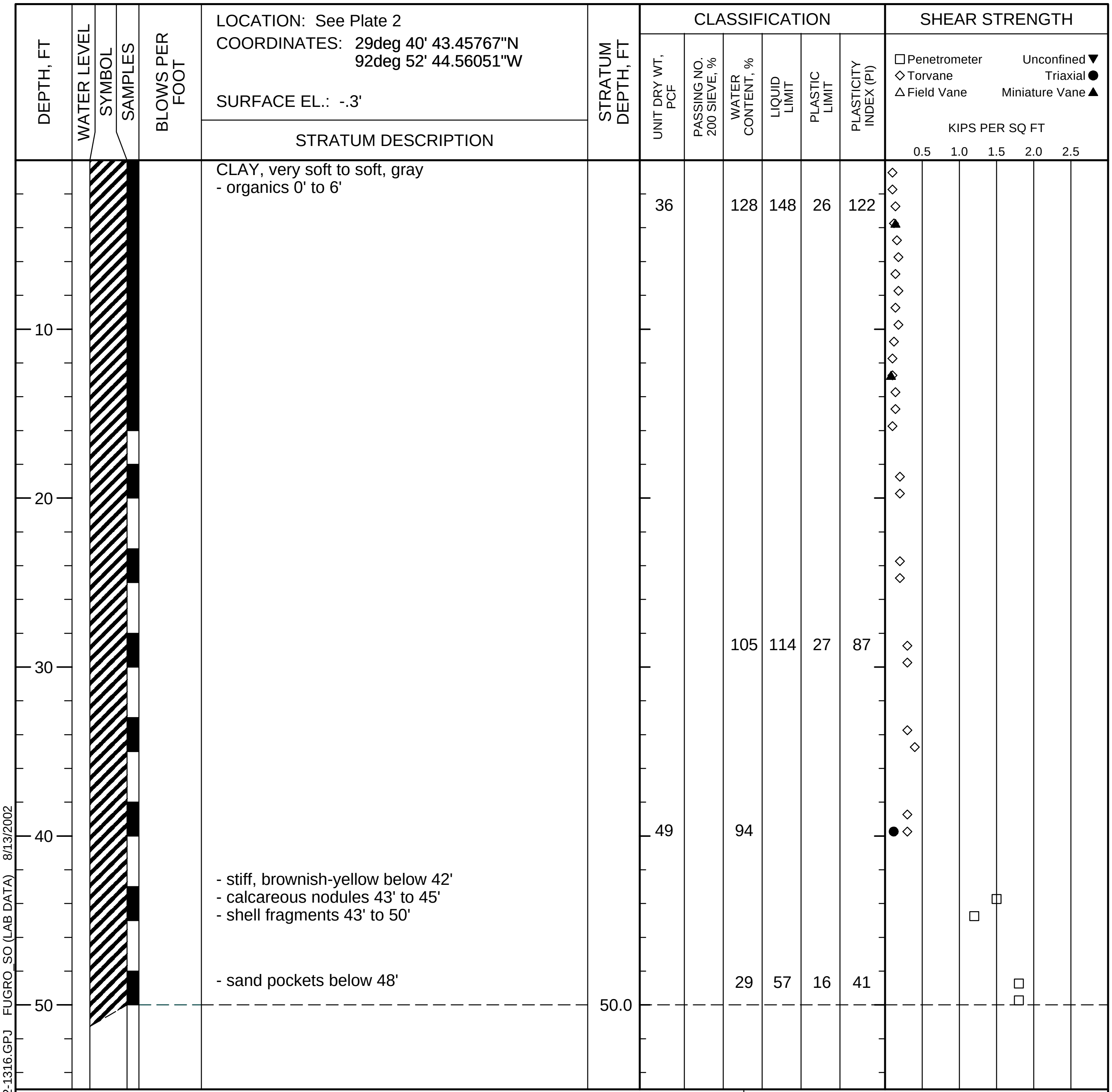
NOTES:
1. Terms and symbols defined on Plate 23a and 23b.

DATE: June 19, 2002
TOTAL DEPTH: 100.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 100'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

LOG OF BORING NO. B-3

GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

LOCATION: See Plate 2
COORDINATES: 29deg 40' 43.45767"N
92deg 52' 44.56051"W
SURFACE EL.: -.3'



STRATUM DESCRIPTION	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
CLAY, very soft to soft, gray - organics 0' to 6'	36		128	148	26	122
			105	114	27	87
	49		94			
- stiff, brownish-yellow below 42' - calcareous nodules 43' to 45' - shell fragments 43' to 50'						
- sand pockets below 48'			29	57	16	41

NOTES:

1. Terms and symbols defined on Plate 23a and 23b.

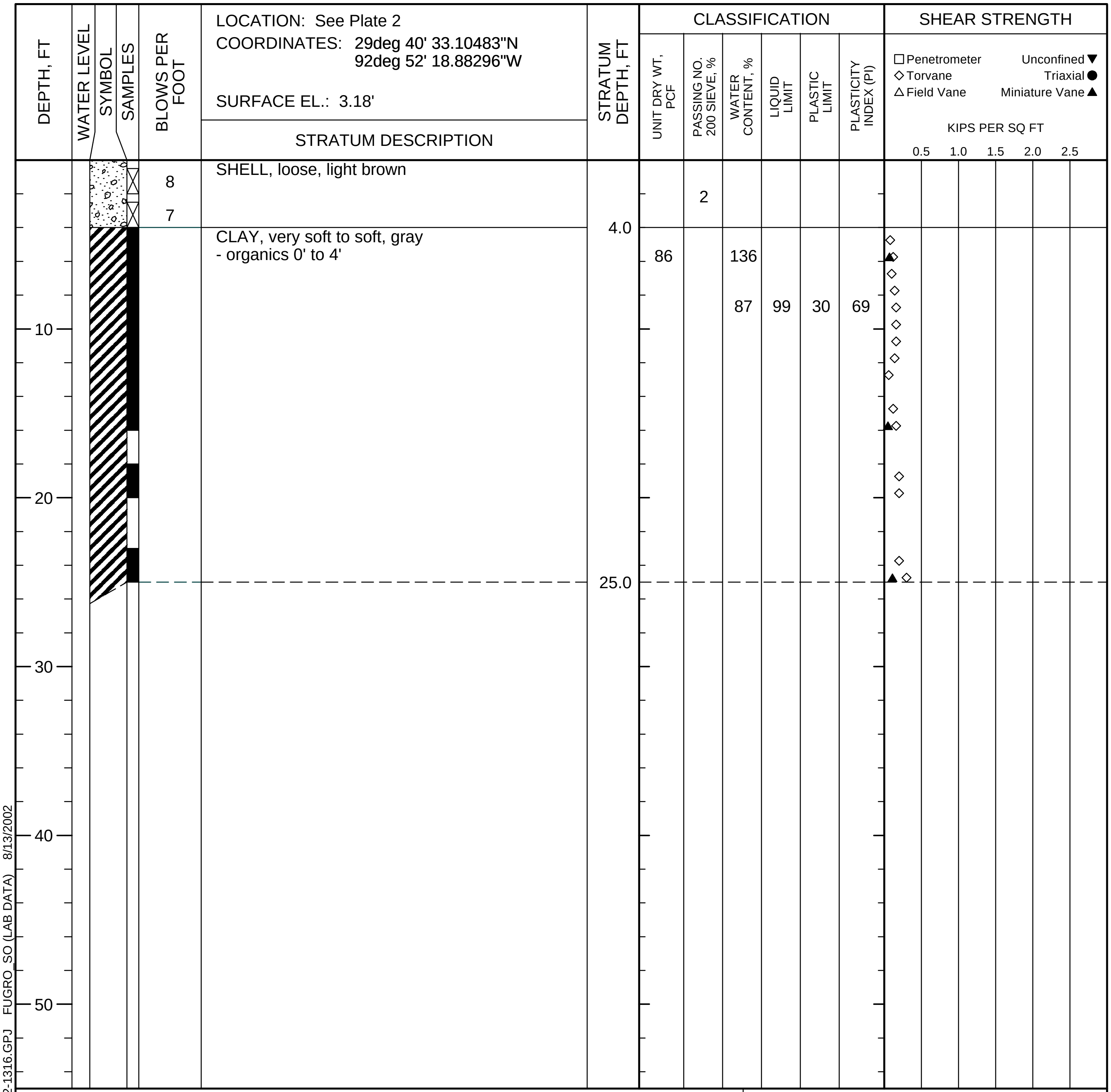
DATE: June 21, 2002
TOTAL DEPTH: 50.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 50'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

LOG OF BORING NO. B-4

GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

Report No. 0602-1316

LOCATION: See Plate 2
COORDINATES: 29deg 40' 33.10483"N
92deg 52' 18.88296"W
SURFACE EL.: 3.18'



BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
8 7	SHELL, loose, light brown			2				
	CLAY, very soft to soft, gray - organics 0' to 4'	4.0	86		136			
					87	99	30	69
		25.0						

NOTES:
1. Terms and symbols defined on Plate 23a and 23b.

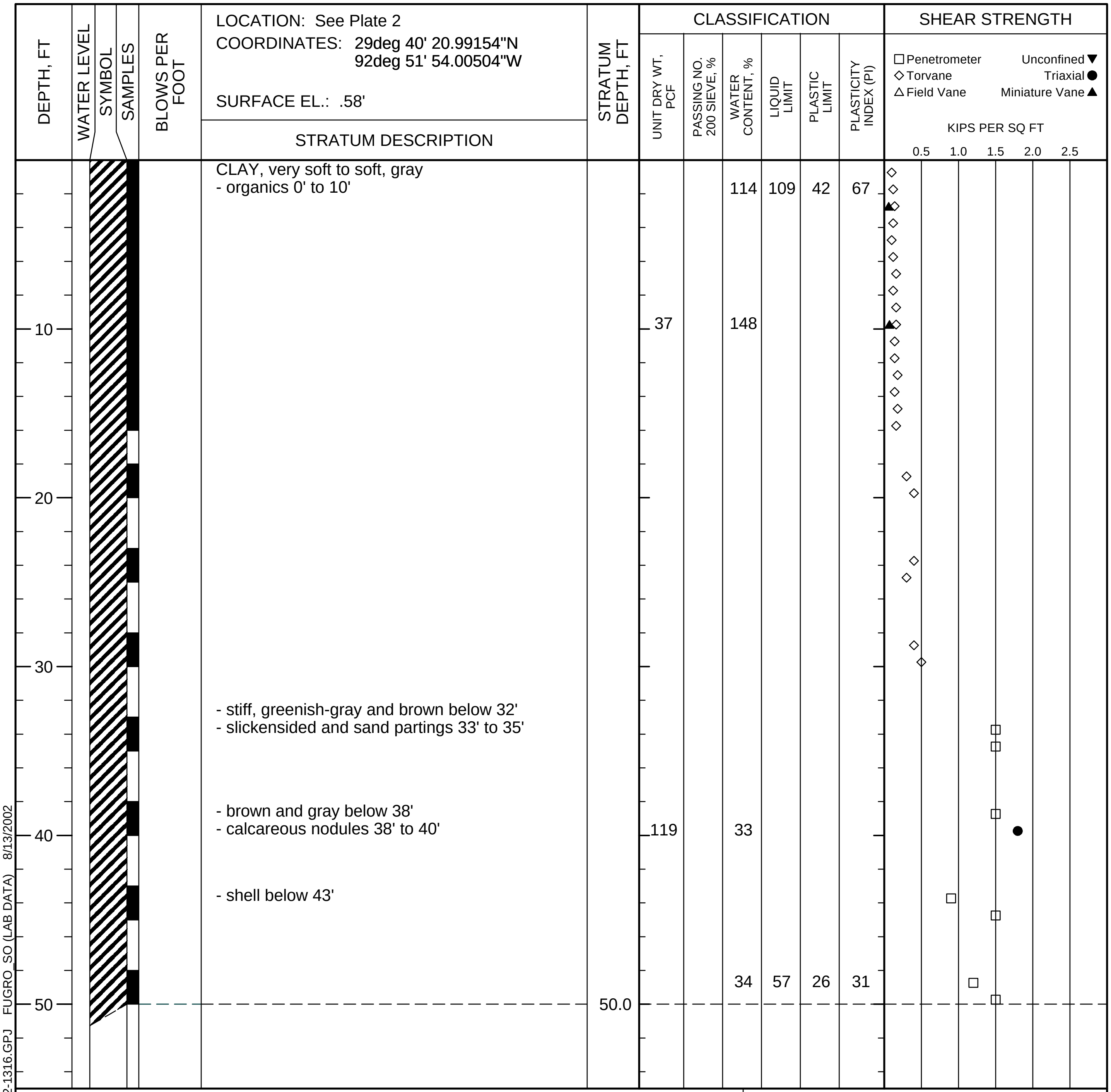
DATE: June 21, 2002
TOTAL DEPTH: 25.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 25'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

C:\CDBURN~1\LAKECH~1\0602-1316.GPJ FUGRO_SO (LAB DATA) 8/13/2002

LOG OF BORING NO. B-5
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

LOCATION: See Plate 2
COORDINATES: 29deg 40' 20.99154"N
92deg 51' 54.00504"W

SURFACE EL.: .58'



STRATUM DESCRIPTION

CLAY, very soft to soft, gray
- organics 0' to 10'
- stiff, greenish-gray and brown below 32'
- slickensided and sand partings 33' to 35'
- brown and gray below 38'
- calcareous nodules 38' to 40'
- shell below 43'

STRATUM DEPTH, FT: 50.0

UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
		114	109	42	67
37		148			
119		33			
		34	57	26	31

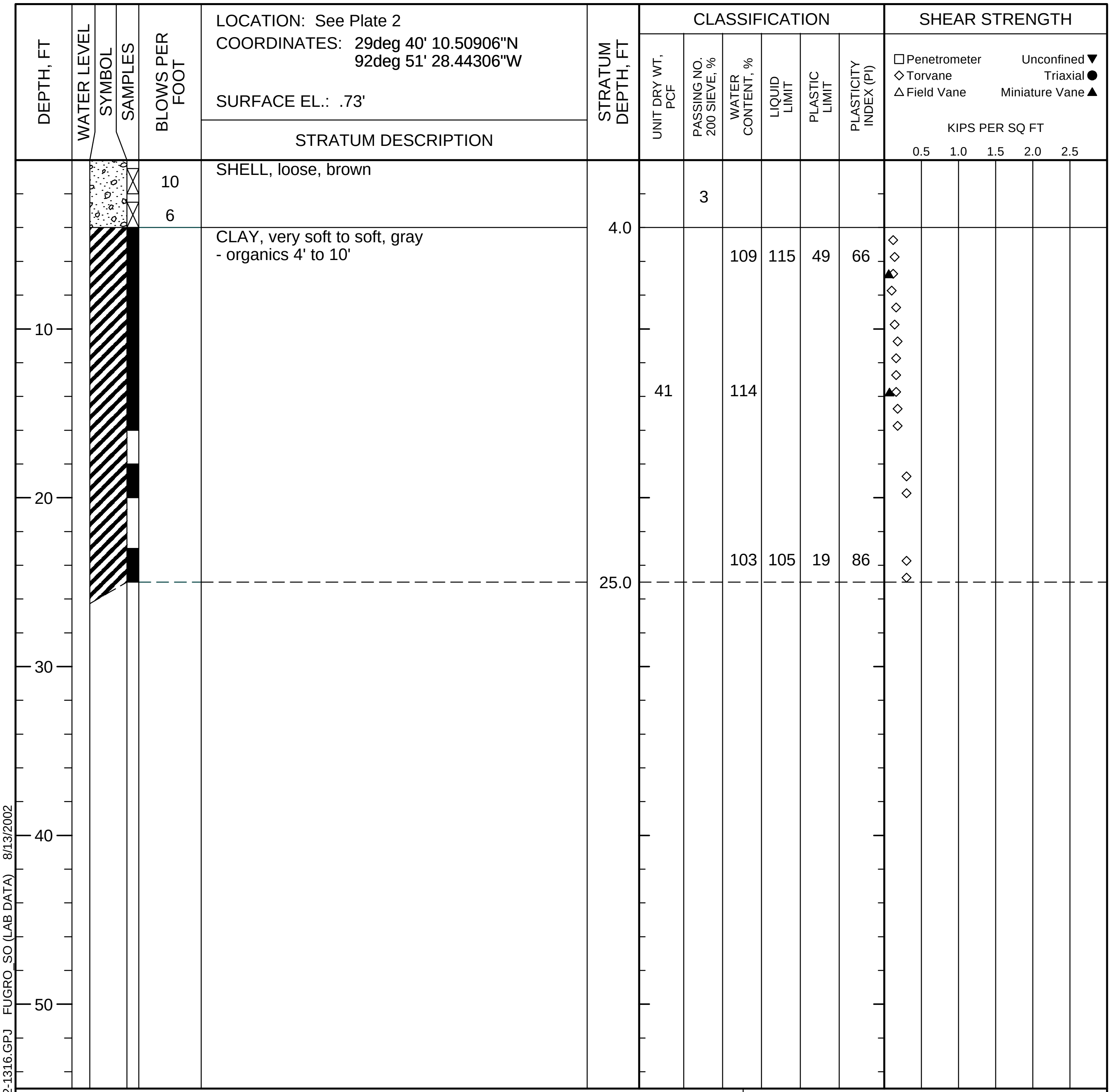
NOTES:
1. Terms and symbols defined on Plate 23a and 23b.

DATE: June 21, 2002
TOTAL DEPTH: 50.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 50'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

C:\CDBURN~1\LAKECH~1\0602-1316.GPJ FUGRO_SO (LAB DATA) 8/13/2002

LOG OF BORING NO. B-6
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

Report No. 0602-1316



LOCATION: See Plate 2
COORDINATES: 29deg 40' 10.50906"N
92deg 51' 28.44306"W

SURFACE EL.: .73'

BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
10	SHELL, loose, brown							
6				3				
	CLAY, very soft to soft, gray - organics 4' to 10'	4.0			109	115	49	66
			41		114			
					103	105	19	86
		25.0						

NOTES:

1. Terms and symbols defined on Plate 23a and 23b.

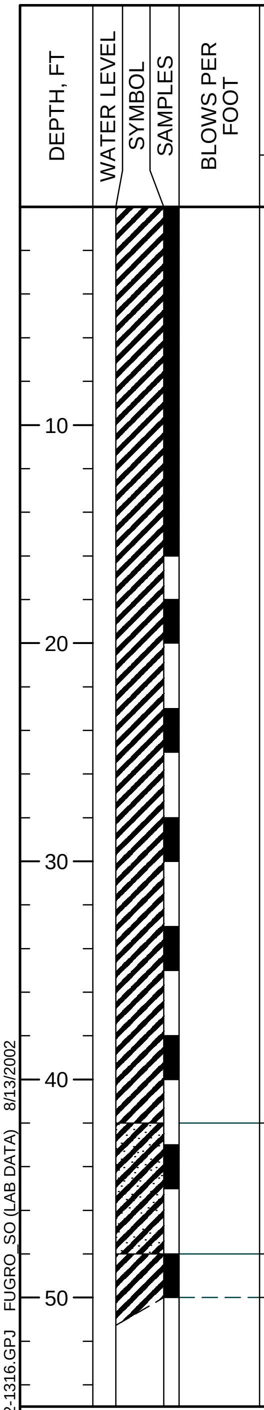
DATE: June 21, 2002
TOTAL DEPTH: 25.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 25'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

C:\CDBURN~1\LAKECH~1\0602-1316.GPJ FUGRO_SO (LAB DATA) 8/13/2002

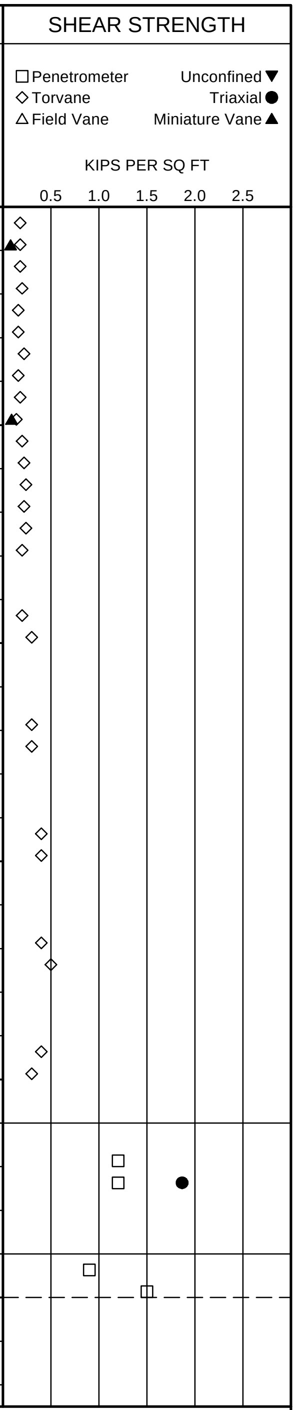
LOG OF BORING NO. B-7
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

LOCATION: See Plate 2
COORDINATES: 29deg 40' 00.8305"N
92deg 51' 02.16568"W

SURFACE EL.: .48'



STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
CLAY, very soft to soft, gray - organics 0' to 11'		44		100			
					126	26	100
SANDY CLAY, stiff, gray	42.0	99		25			
CLAY, firm to stiff, brownish-yellow and gray - calcareous nodules below 48'	48.0			32	56	15	41
	50.0						

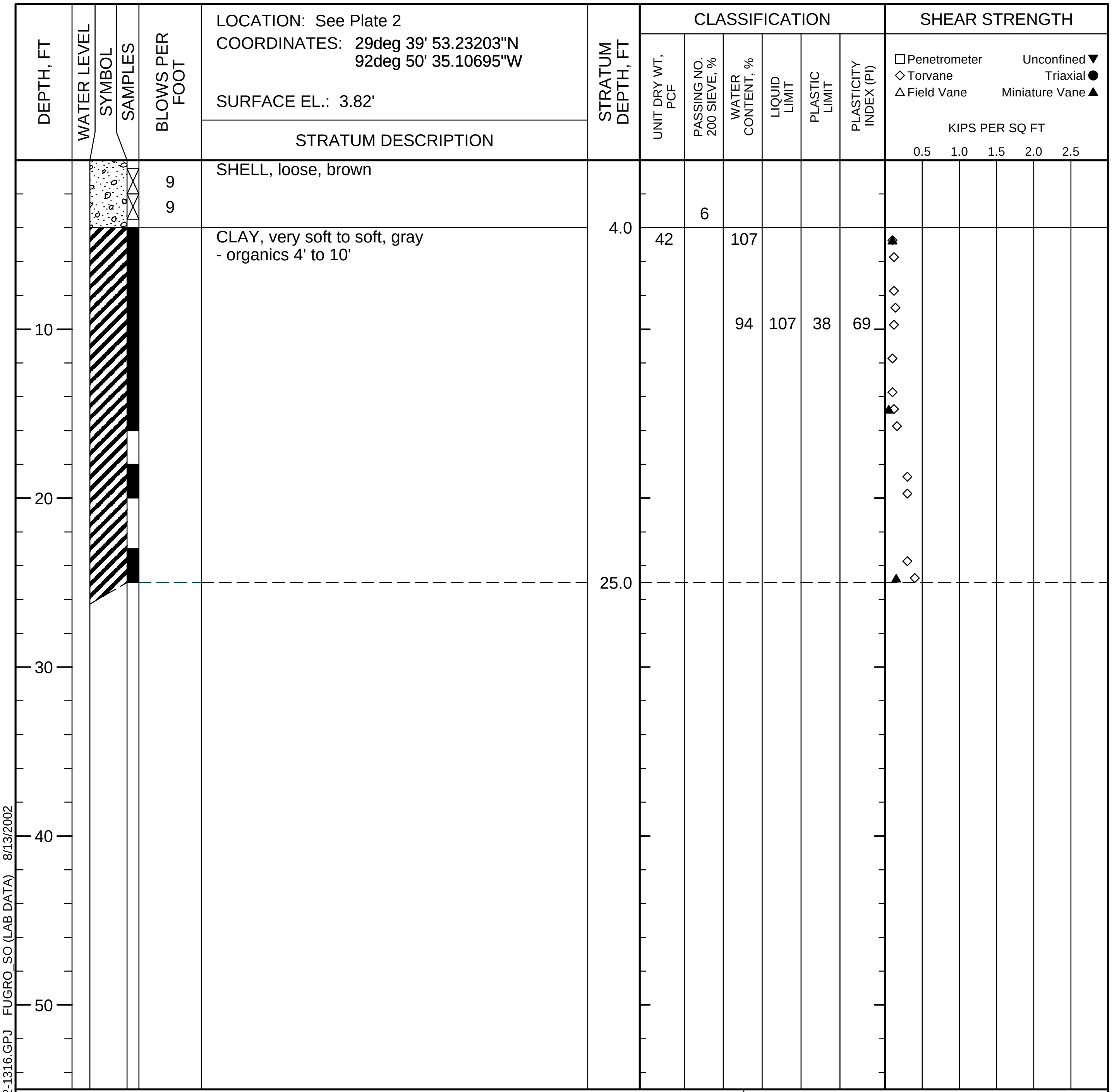


NOTES:
1. Terms and symbols defined on Plate 23a and 23b.

DATE: June 21, 2002
TOTAL DEPTH: 50.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 50'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

LOG OF BORING NO. B-8
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

LOCATION: See Plate 2
COORDINATES: 29deg 39' 53.23203"N
92deg 50' 35.10695"W
SURFACE EL.: 3.82'



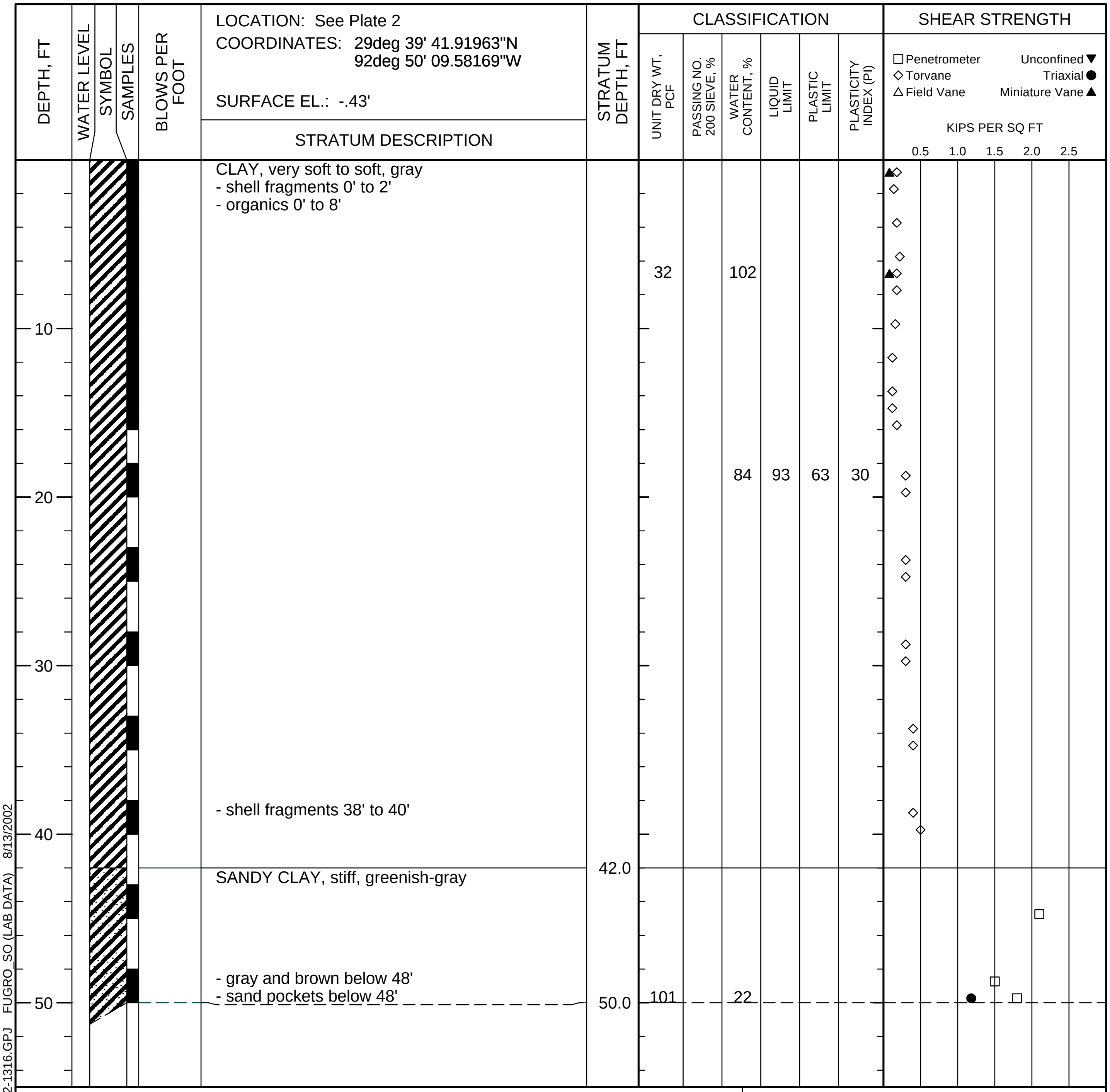
BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
9 9	SHELL, loose, brown			6				
	CLAY, very soft to soft, gray - organics 4' to 10'	4.0	42		107			
					94	107	38	69
		25.0						

NOTES:
1. Terms and symbols defined on Plate 23a and 23b.

DATE: June 22, 2002
TOTAL DEPTH: 50.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 50'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

LOG OF BORING NO. B-9
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

LOCATION: See Plate 2
COORDINATES: 29deg 39' 41.91963"N
92deg 50' 09.58169"W
SURFACE EL.: -.43'



STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
CLAY, very soft to soft, gray - shell fragments 0' to 2' - organics 0' to 8'							
		32		102			
				84	93	63	30
- shell fragments 38' to 40'							
SANDY CLAY, stiff, greenish-gray	42.0						
- gray and brown below 48' - sand pockets below 48'	50.0	101		22			

NOTES:

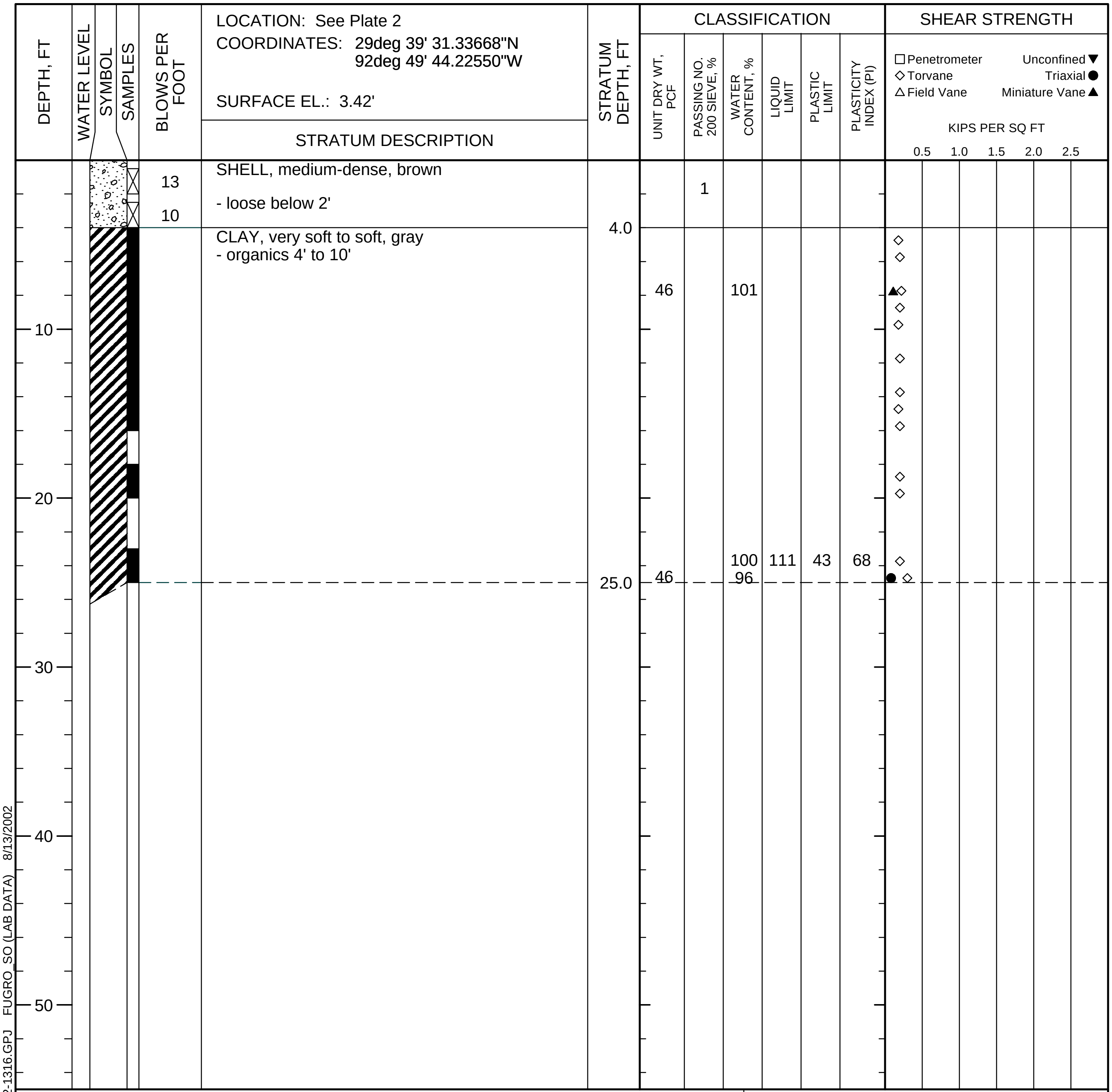
1. Terms and symbols defined on Plate 23a and 23b.

DATE: June 22, 2002
TOTAL DEPTH: 50.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 50'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

LOG OF BORING NO. B-10
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

Report No. 0602-1316

LOCATION: See Plate 2
COORDINATES: 29deg 39' 31.33668"N
92deg 49' 44.22550"W
SURFACE EL.: 3.42'



BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
13	SHELL, medium-dense, brown			1				
10	- loose below 2'	4.0						
	CLAY, very soft to soft, gray - organics 4' to 10'							
			46		101			
					100	111	43	68
		25.0	46		96			

NOTES:
1. Terms and symbols defined on Plate 23a and 23b.

DATE: June 22, 2002
TOTAL DEPTH: 25.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 25'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

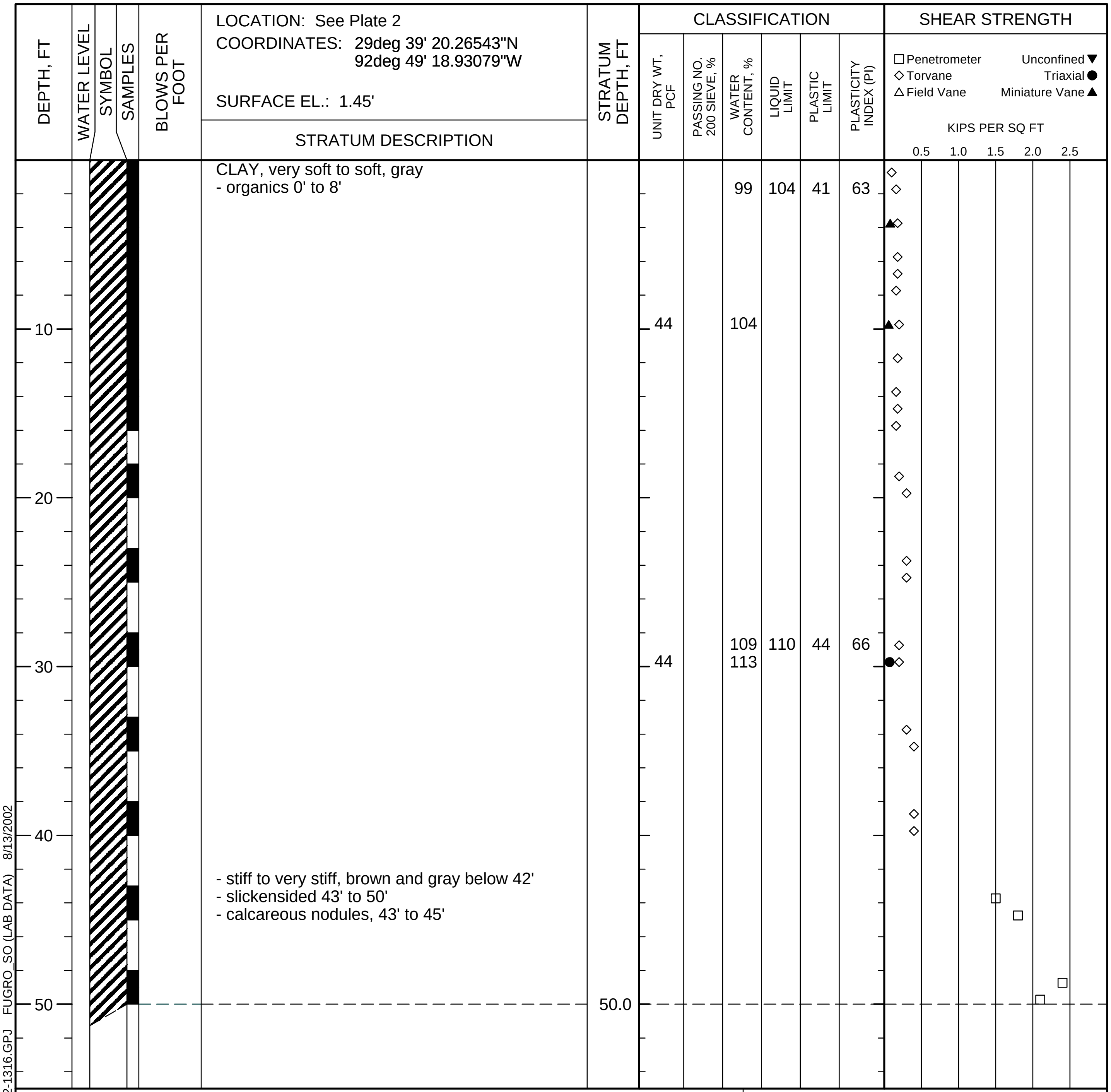
C:\CDBURN~1\LAKECH~1\0602-1316.GPJ FUGRO_SO (LAB DATA) 8/13/2002

LOG OF BORING NO. B-11
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

Report No. 0602-1316

LOCATION: See Plate 2
COORDINATES: 29deg 39' 20.26543"N
92deg 49' 18.93079"W

SURFACE EL.: 1.45'



CLAY, very soft to soft, gray
- organics 0' to 8'
- stiff to very stiff, brown and gray below 42'
- slickensided 43' to 50'
- calcareous nodules, 43' to 45'

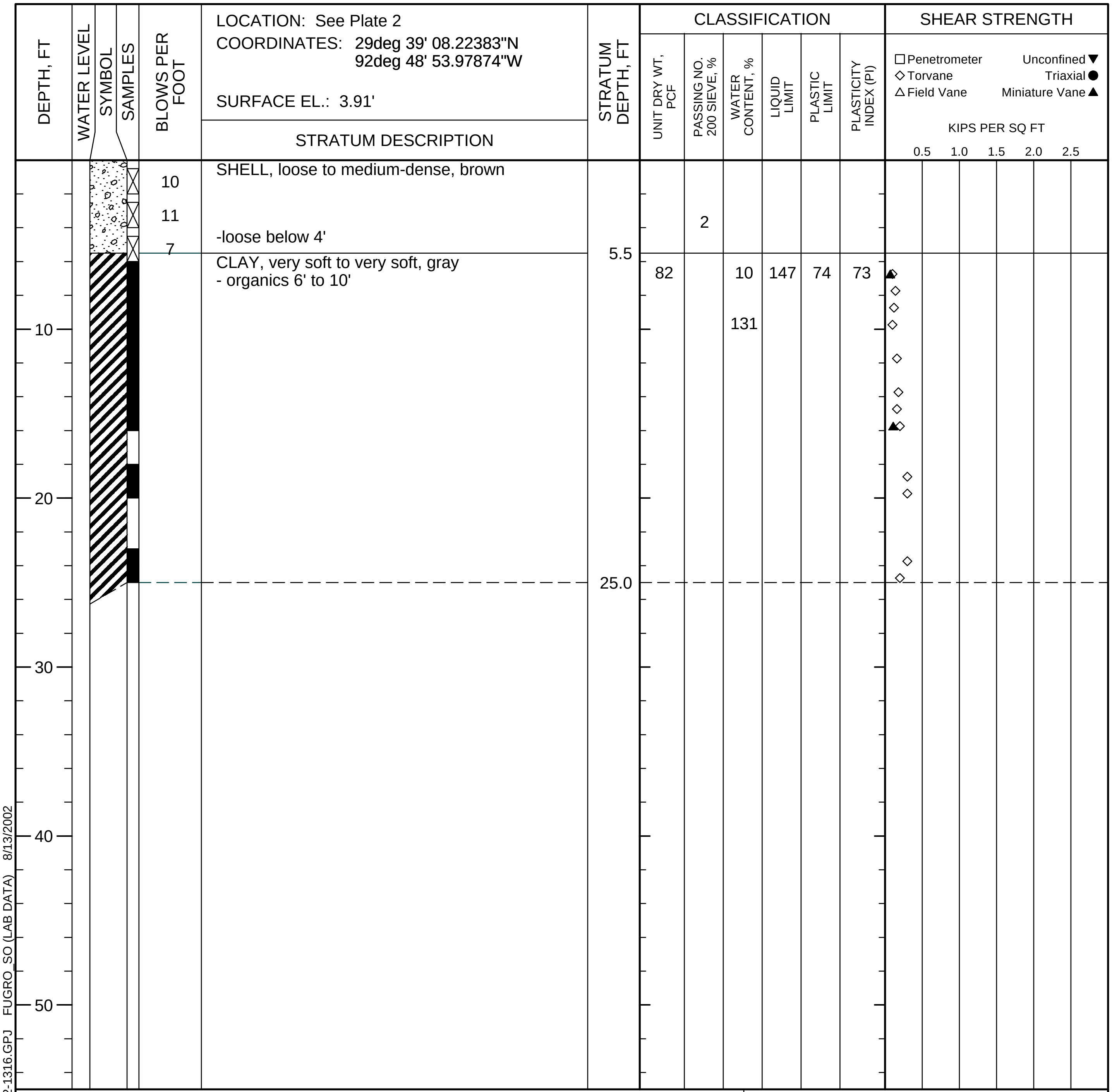
UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
		99	104	41	63
44		104			
		109	110	44	66
44		113			

NOTES:
1. Terms and symbols defined on Plate 23a and 23b.

DATE: June 23, 2002
TOTAL DEPTH: 50.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 50'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

LOG OF BORING NO. B-12
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

LOCATION: See Plate 2
COORDINATES: 29deg 39' 08.22383"N
92deg 48' 53.97874"W
SURFACE EL.: 3.91'



BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
10	SHELL, loose to medium-dense, brown							
11				2				
7	-loose below 4'	5.5						
	CLAY, very soft to very soft, gray - organics 6' to 10'		82		10	147	74	73
					131			
		25.0						

NOTES:

1. Terms and symbols defined on Plate 23a and 23b.

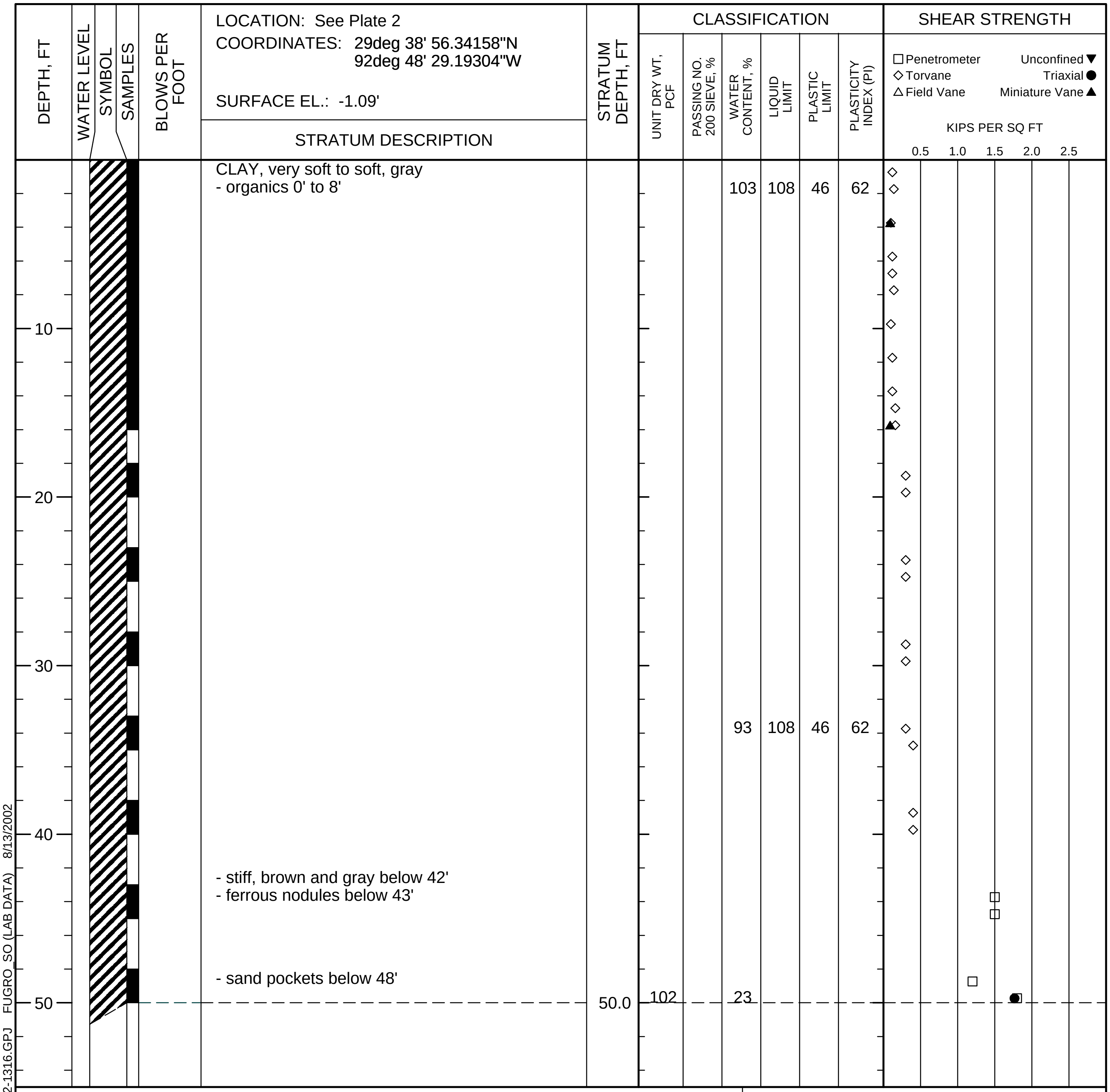
DATE: June 23, 2002
TOTAL DEPTH: 25.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 25'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

LOG OF BORING NO. B-13

GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

LOCATION: See Plate 2
COORDINATES: 29deg 38' 56.34158"N
92deg 48' 29.19304"W

SURFACE EL.: -1.09'



STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
CLAY, very soft to soft, gray - organics 0' to 8'				103	108	46	62
				93	108	46	62
- stiff, brown and gray below 42' - ferrous nodules below 43'							
- sand pockets below 48'	50.0	102		23			

NOTES:
1. Terms and symbols defined on Plate 23a and 23b.

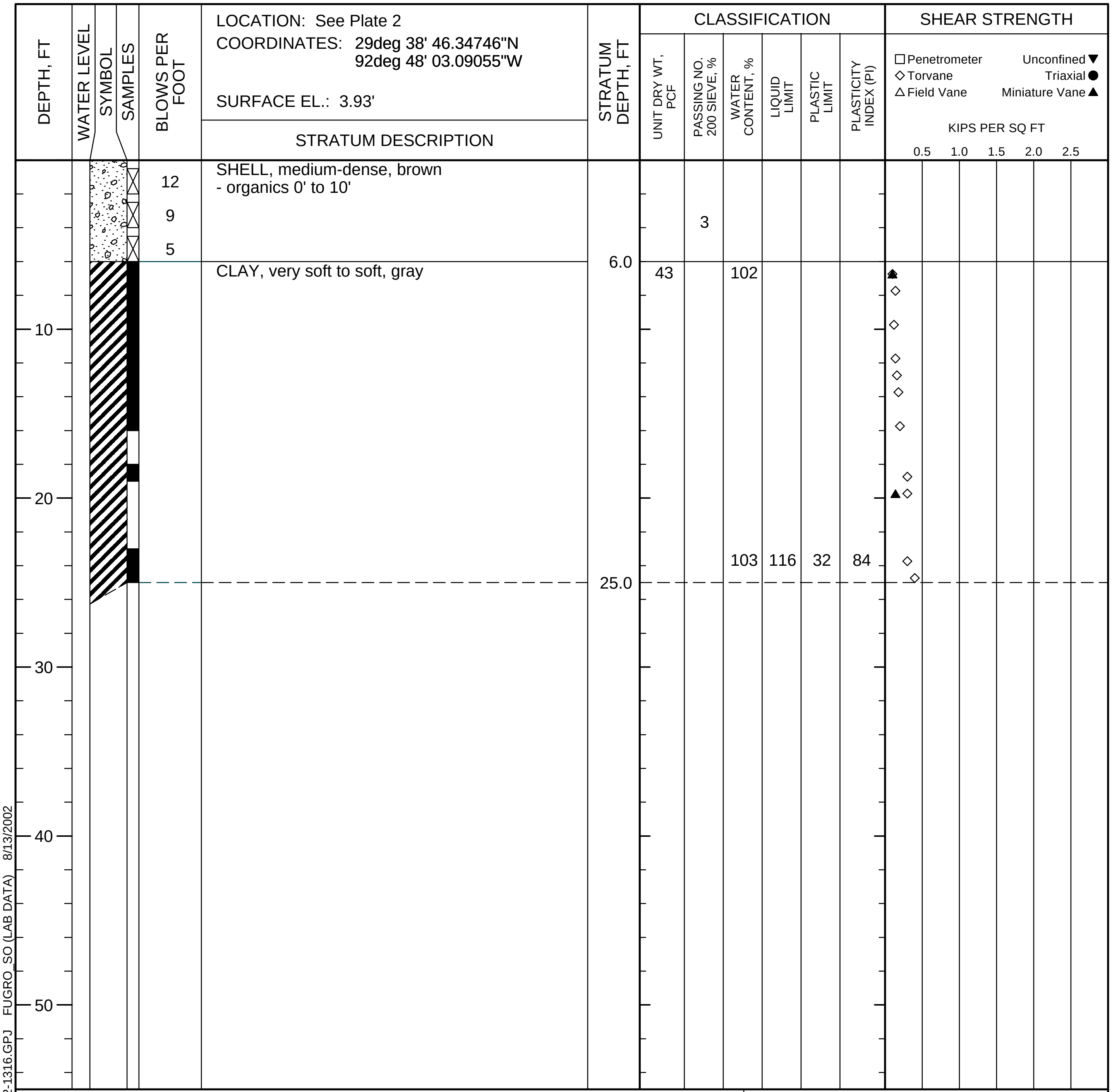
DATE: June 24, 2002
TOTAL DEPTH: 50.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 50'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

C:\CDBURN~1\LAKECH~1\0602-1316.GPJ FUGRO_SO (LAB DATA) 8/13/2002

LOG OF BORING NO. B-14
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

LOCATION: See Plate 2
COORDINATES: 29deg 38' 46.34746"N
92deg 48' 03.09055"W
SURFACE EL.: 3.93'

DEPTH, FT	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
	12 9 5	SHELL, medium-dense, brown - organics 0' to 10'			3				
		CLAY, very soft to soft, gray	6.0	43		102			
						103	116	32	84
			25.0						



C:\CDBURN~1\LAKECH~1\0602-1316.GPJ FUGRO_SO (LAB DATA) 8/13/2002

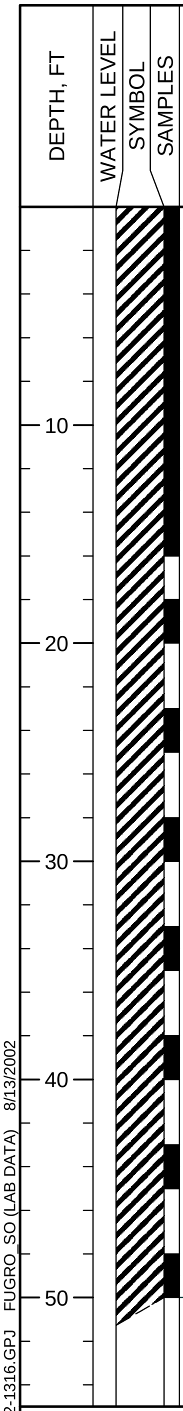
NOTES:
1. Terms and symbols defined on Plate 23a and 23b.

DATE: June 24, 2002
TOTAL DEPTH: 25.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 25'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

LOG OF BORING NO. B-15
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

LOCATION: See Plate 2
COORDINATES: 29deg 38' 37.40932"N
92deg 47' 36.70858"W

SURFACE EL.: .22'



BLOWS PER FOOT

STRATUM DESCRIPTION

CLAY, very soft to soft, gray
- organics 0' to10'

- stiff to very stiff, brownish-yellow and gray below 42'
- slickensided and ferrous nodules 43' to 45'

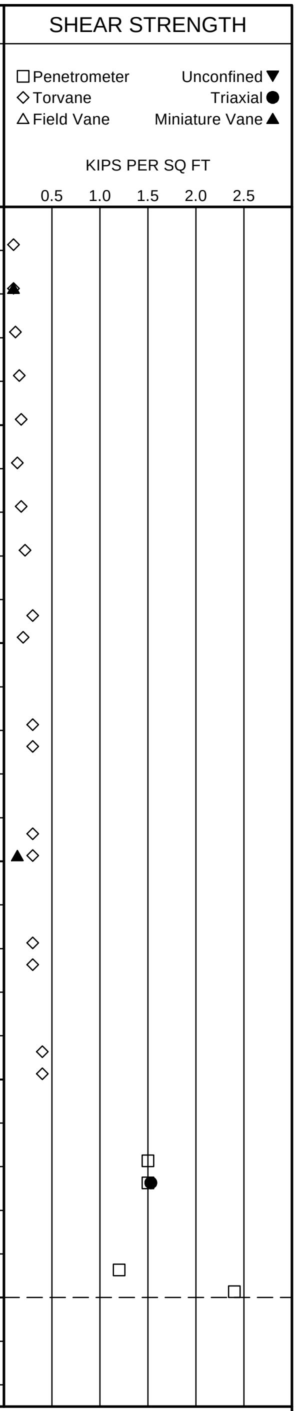
- shell fragments below 48'

STRATUM DEPTH, FT: 50.0

CLASSIFICATION

UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
42		100			
		114	131	51	80
		93	105	41	64
100		24			

SHEAR STRENGTH

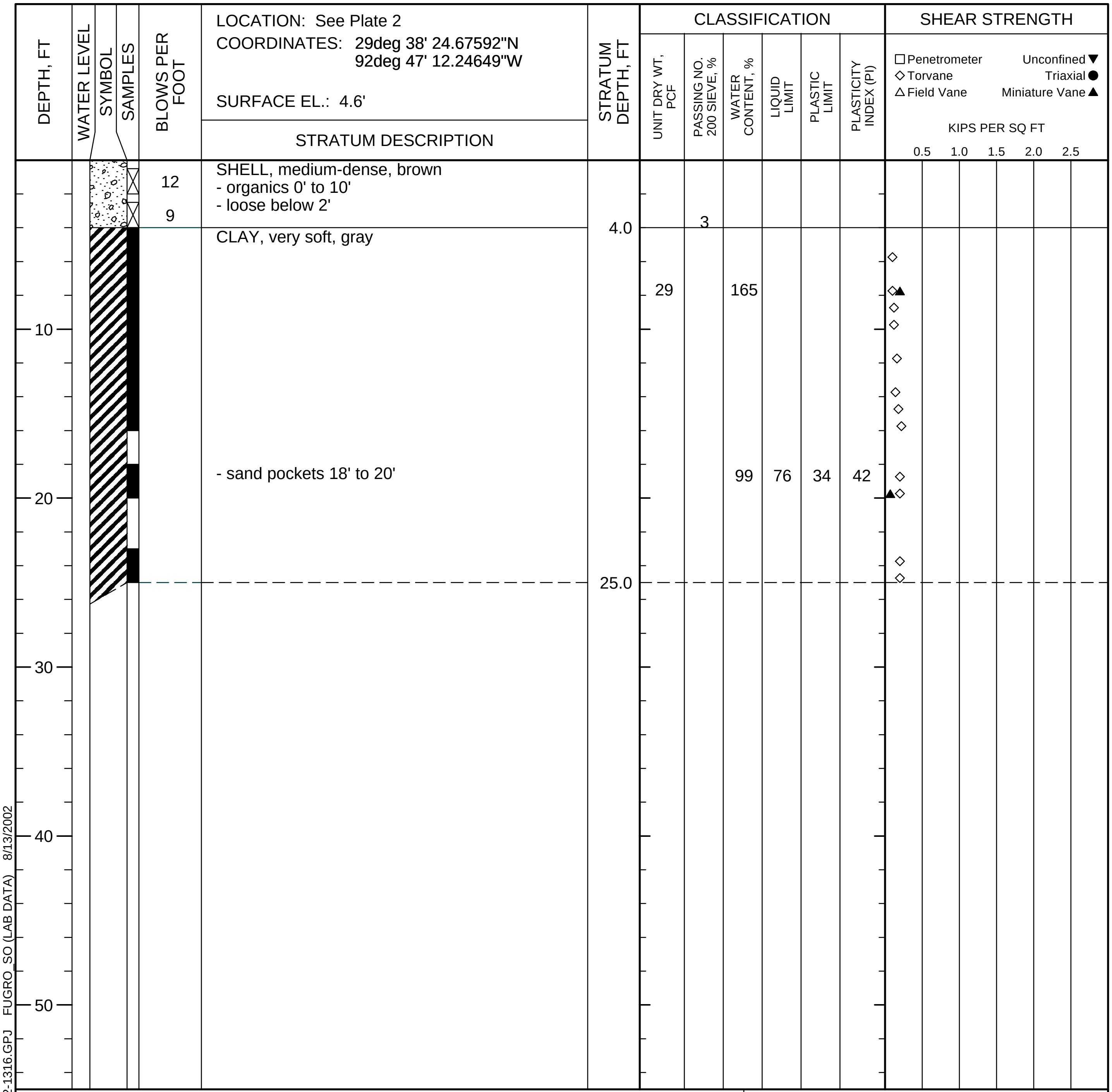


NOTES:
1. Terms and symbols defined on Plate 23a and 23b.

DATE: June 24, 2002
TOTAL DEPTH: 50.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 50'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

LOG OF BORING NO. B-16
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

LOCATION: See Plate 2
COORDINATES: 29deg 38' 24.67592"N
92deg 47' 12.24649"W
SURFACE EL.: 4.6'



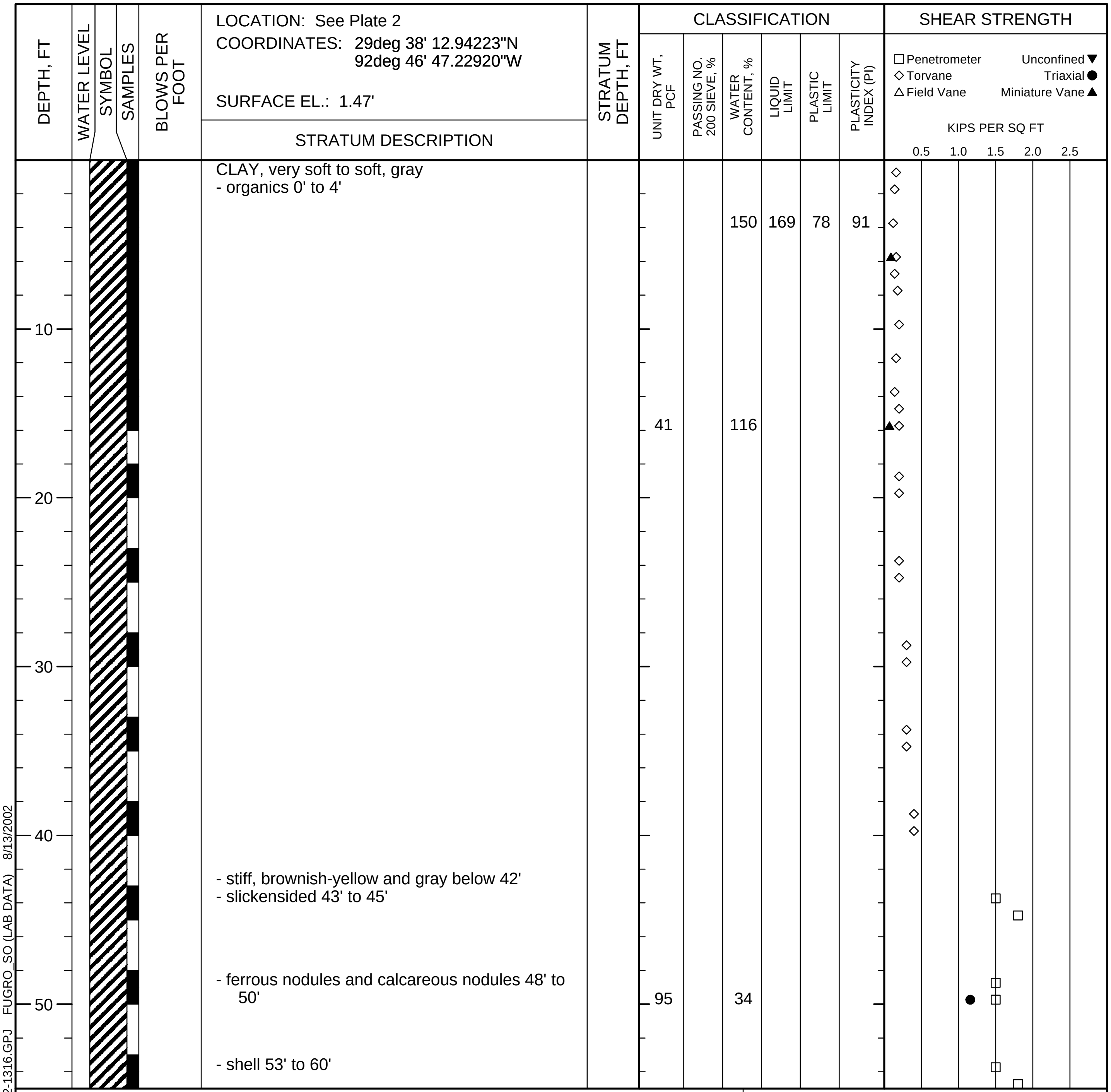
BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
12 9	SHELL, medium-dense, brown - organics 0' to 10' - loose below 2'			3				
	CLAY, very soft, gray	4.0	29		165			
	- sand pockets 18' to 20'				99	76	34	42
		25.0						

NOTES:
1. Terms and symbols defined on Plate 23a and 23b.

DATE: June 26, 2002
TOTAL DEPTH: 25.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 25'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

LOG OF BORING NO. B-17
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

LOCATION: See Plate 2
COORDINATES: 29deg 38' 12.94223"N
92deg 46' 47.22920"W
SURFACE EL.: 1.47'



STRATUM DESCRIPTION

CLAY, very soft to soft, gray
- organics 0' to 4'
- stiff, brownish-yellow and gray below 42'
- slickensided 43' to 45'
- ferrous nodules and calcareous nodules 48' to 50'
- shell 53' to 60'

UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
		150	169	78	91
41		116			
95		34			

NOTES:
1. Terms and symbols defined on Plate 23a and 23b.

DATE: June 26, 2002
TOTAL DEPTH: 100.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 100'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

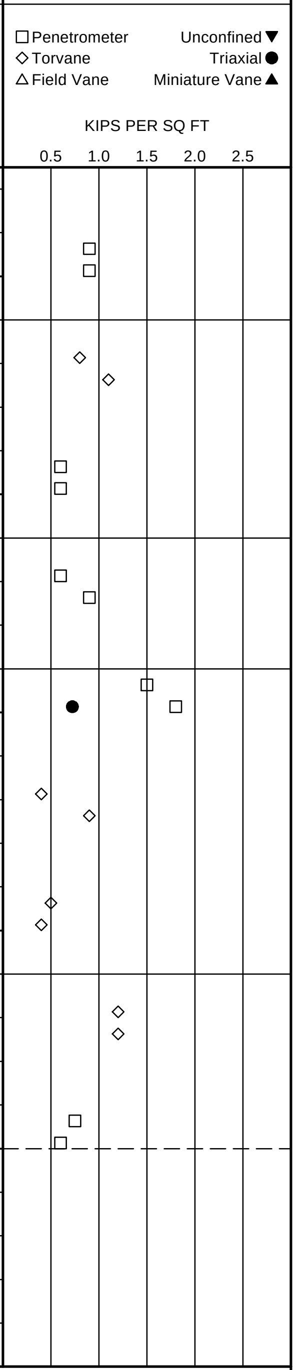
LOG OF BORING NO. B-18
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

PLATE 20a

LOCATION: See Plate 2
COORDINATES: 29deg 38' 12.94223"N
92deg 46' 47.22920"W
SURFACE EL.: 1.47'

DEPTH, FT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
	CLAY, firm, brownish-yellow and gray							
60								
	SANDY CLAY, firm, gray - ferrous nodules 63' to 65' - dark gray and gray below 68' - organics 68' to 70'	62.0						
70								
	CLAY, firm, gray - silt partings 73' to 75'	72.0						
	SILTY CLAY, firm to stiff, brown - silt pockets 78' to 90'	78.0						
80			101		28			
	- soft to firm below 83'							
90								
	CLAY, stiff, gray - firm below 98'	92.0						
100		100.0						

SHEAR STRENGTH



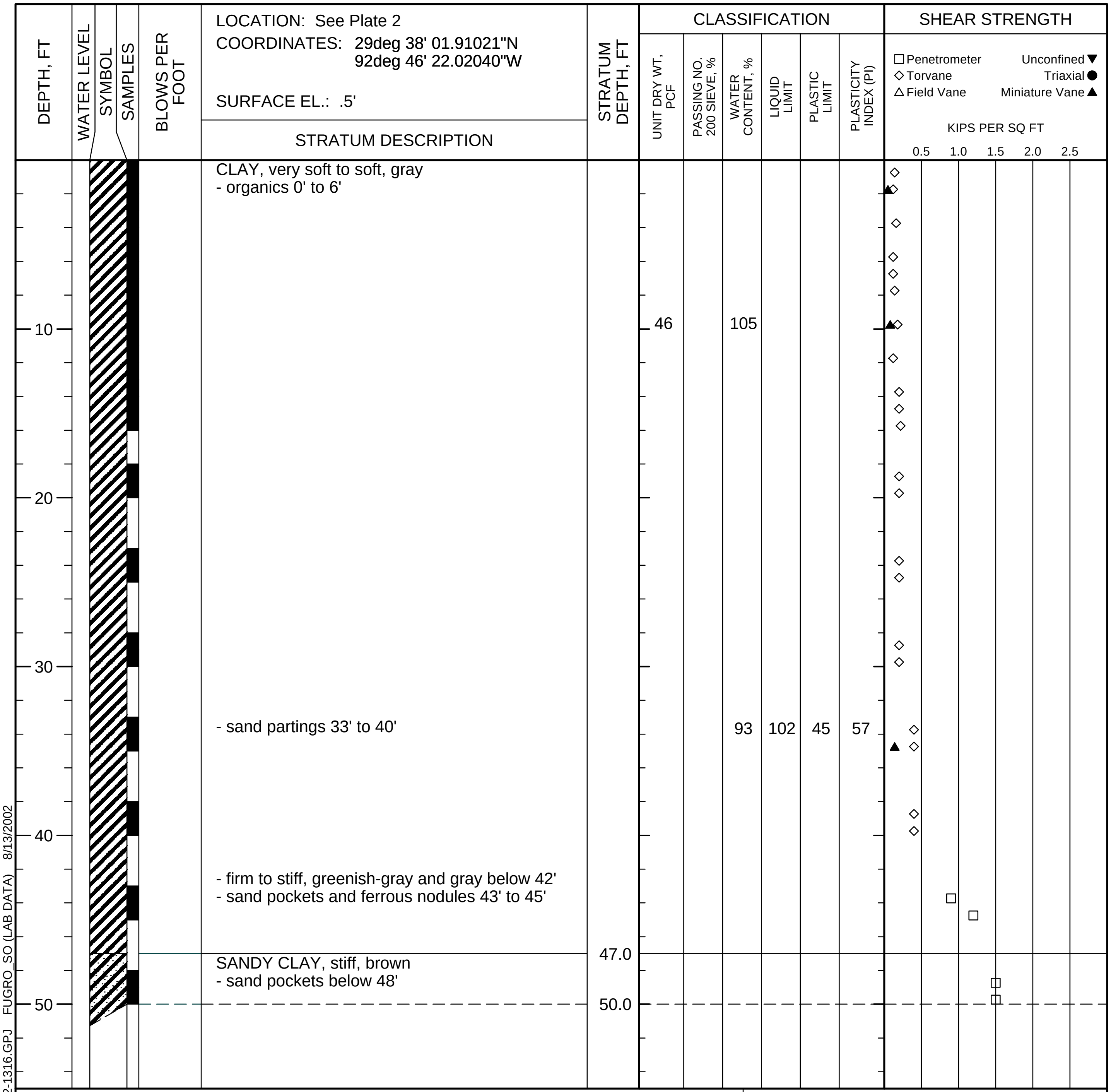
NOTES:
1. Terms and symbols defined on Plate 23a and 23b.

DATE: June 26, 2002
TOTAL DEPTH: 100.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 100'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

C:\CDBURN~1\LAKECH~1\0602-1316.GPJ FUGRO_SO (LAB DATA) 8/13/2002

LOG OF BORING NO. B-18
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

LOCATION: See Plate 2
COORDINATES: 29deg 38' 01.91021"N
92deg 46' 22.02040"W
SURFACE EL.: .5'



STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
CLAY, very soft to soft, gray - organics 0' to 6'							
		46		105			
- sand partings 33' to 40'				93	102	45	57
- firm to stiff, greenish-gray and gray below 42' - sand pockets and ferrous nodules 43' to 45'							
SANDY CLAY, stiff, brown - sand pockets below 48'	47.0						
	50.0						

NOTES:
1. Terms and symbols defined on Plate 23a and 23b.

DATE: June 26, 2002
TOTAL DEPTH: 50.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 50'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

C:\CDBURN~1\LAKECH~1\0602-1316.GPJ FUGRO_SO (LAB DATA) 8/13/2002

LOG OF BORING NO. B-19
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

LOCATION: See Plate 2
COORDINATES: 29deg 37' 57.77359"N
92deg 45' 52.68994"W

SURFACE EL.: 1.97'

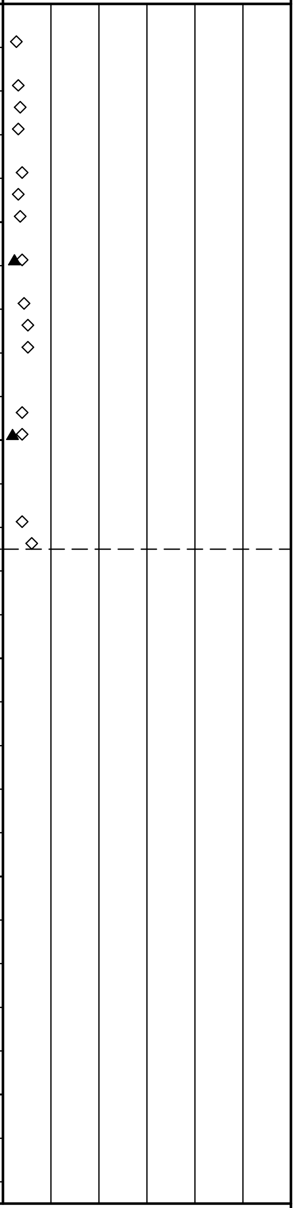
STRATUM DESCRIPTION

CLAY, very soft to soft, brown and gray
- organics 0' to 10'
- shell fragments 0' to 2'
- gray below 4'

STRATUM DEPTH, FT: 25.0

UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
		126	69	27	42
37		129			
		125	127	21	106

SHEAR STRENGTH



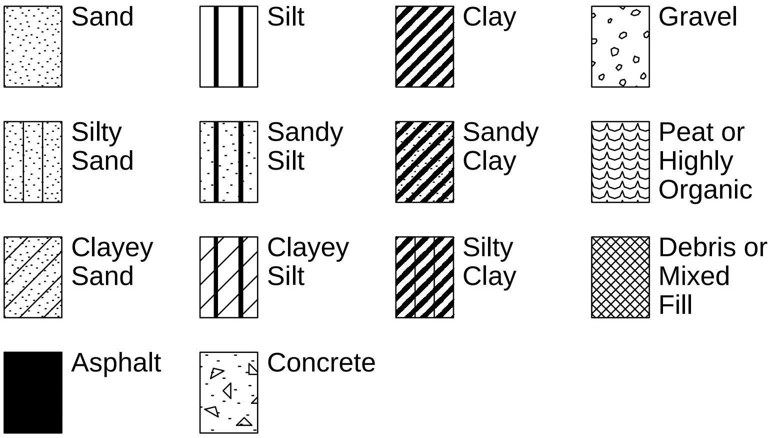
DEPTH, FT: 10, 20, 30, 40, 50

NOTES:
1. Terms and symbols defined on Plate 23a and 23b.

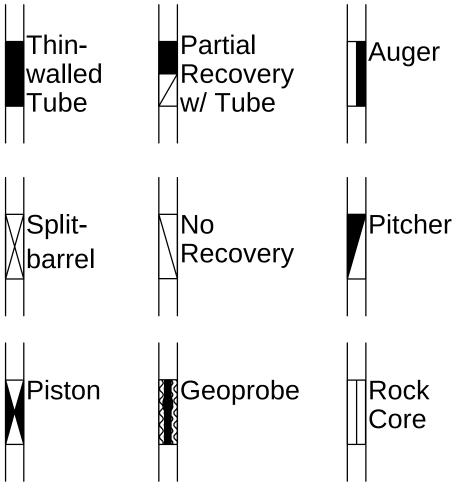
DATE: June 26, 2002
TOTAL DEPTH: 25.0'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: 0' to 25'
BACKFILL: Cement-Bentonite Grout
LOGGER: J. PHIPPS

LOG OF BORING NO. B-20
GULF SHORELINE STABILIZATION PROJECT
ROCKEFELLER REFUGE
CAMERON PARISH, LOUISIANA

SOIL TYPES



SAMPLER TYPES



SOIL GRAIN SIZE

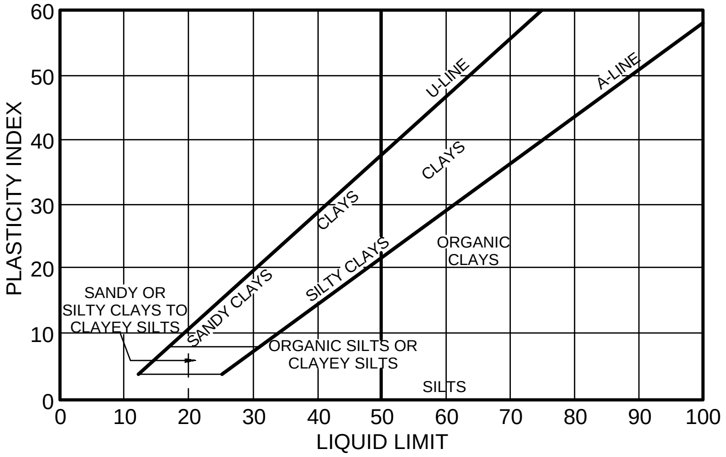
U.S. Standard Sieve

6" 3" 3/4" 4 10 40 200

Boulders	Cobbles	Gravel		Sand			Silt	Clay
		Coarse	Fine	Coarse	Medium	Fine		

152 76.2 19.1 4.76 2.00 0.420 0.074 0.002 (mm)

PLASTICITY CHART



SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil type.
Interlayered	Soil sample composed of alternating layers of different soil type.
Intermixed	Soil sample composed of pockets of different soil type and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of carbonate.
Carbonate	Having more than 50% carbonate content.

TERMS AND SYMBOLS USED ON BORING LOGS

SOIL CLASSIFICATION (1 of 2)

STANDARD PENETRATION TEST (SPT)

A 2-in.-OD, 1-3/8-ID split spoon sampler is driven 1.5 ft into undisturbed soil with a 140-pound hammer free falling 30 in. After the sampler is seated 6 in. into undisturbed soil, the number of blows required to drive the sampler the last 12 in. is the Standard Penetration Resistance or "N" value, which is recorded as blows per foot as described below.

SPLIT-BARREL SAMPLER DRIVING RECORD

Blows Per Foot	Description
25	25 blows drove sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows drove sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows drove sampler 3 inches during initial 6-inch seating interval.

NOTE: To avoid damage to sampling tools, driving is limited to 50 blows during or after seating interval.

DENSITY OF GRANULAR SOILS

Descriptive Term	*Relative Density, %	**Blows Per Foot (SPT)
Very Loose	< 15	0 to 4
Loose	15 to 35	5 to 10
Medium Dense	35 to 65	11 to 30
Dense	65 to 85	31 to 50
Very Dense	> 85	> 50

*Estimated from sampler driving record.

**Requires correction for depth, groundwater level, and grain size.

STRENGTH OF COHESIVE SOILS

Term	Undrained Shear Strength, ksf	Blows Per Foot (SPT) (approximate)
Very Soft	< 0.25	0 to 2
Soft	0.25 to 0.50	2 to 4
Firm	0.50 to 1.00	4 to 8
Stiff	1.00 to 2.00	8 to 16
Very Stiff	2.00 to 4.00	16 to 32
Hard	> 4.00	> 32

SHEAR STRENGTH TEST METHOD

U - Unconfined Q = Unconsolidated - Undrained Triaxial

P = Pocket Penetrometer T = Torvane V = Miniature Vane F = Field Vane

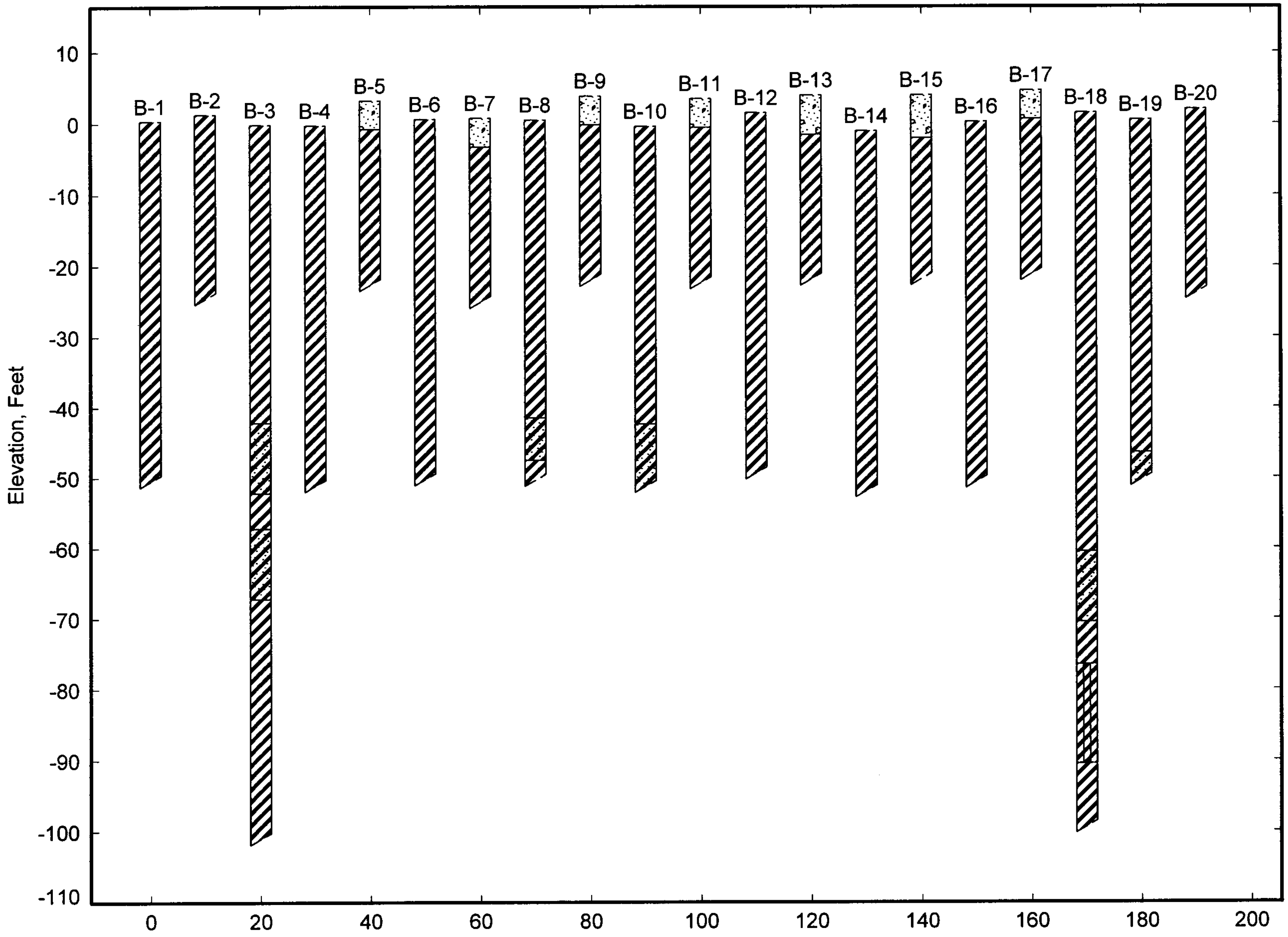
HAND PENETROMETER CORRECTION

Our experience has shown that the hand penetrometer generally overestimates the in-situ undrained shear strength of over consolidated Pleistocene Gulf Coast clays. These strengths are partially controlled by the presence of macroscopic soil defects such as slickensides, which generally do not influence smaller scale tests like the hand penetrometer. Based on our experience, we have adjusted these field estimates of the undrained shear strength of natural, overconsolidated Pleistocene Gulf Coast soils by multiplying the measured penetrometer reading by a factor of 0.6. These adjusted strength estimates are recorded in the "Shear Strength" column on the boring logs. Except as described in the text, we have not adjusted estimates of the undrained shear strength for projects located outside of the Pleistocene Gulf Coast formations.

Information on each boring log is a compilation of subsurface conditions and soil or rock classifications obtained from the field as well as from laboratory testing of samples. Strata have been interpreted by commonly accepted procedures. The stratum lines on the logs may be transitional and approximate in nature. Water level measurements refer only to those observed at the time and places indicated, and can vary with time, geologic condition, or construction activity.

TERMS AND SYMBOLS USED ON BORING LOGS

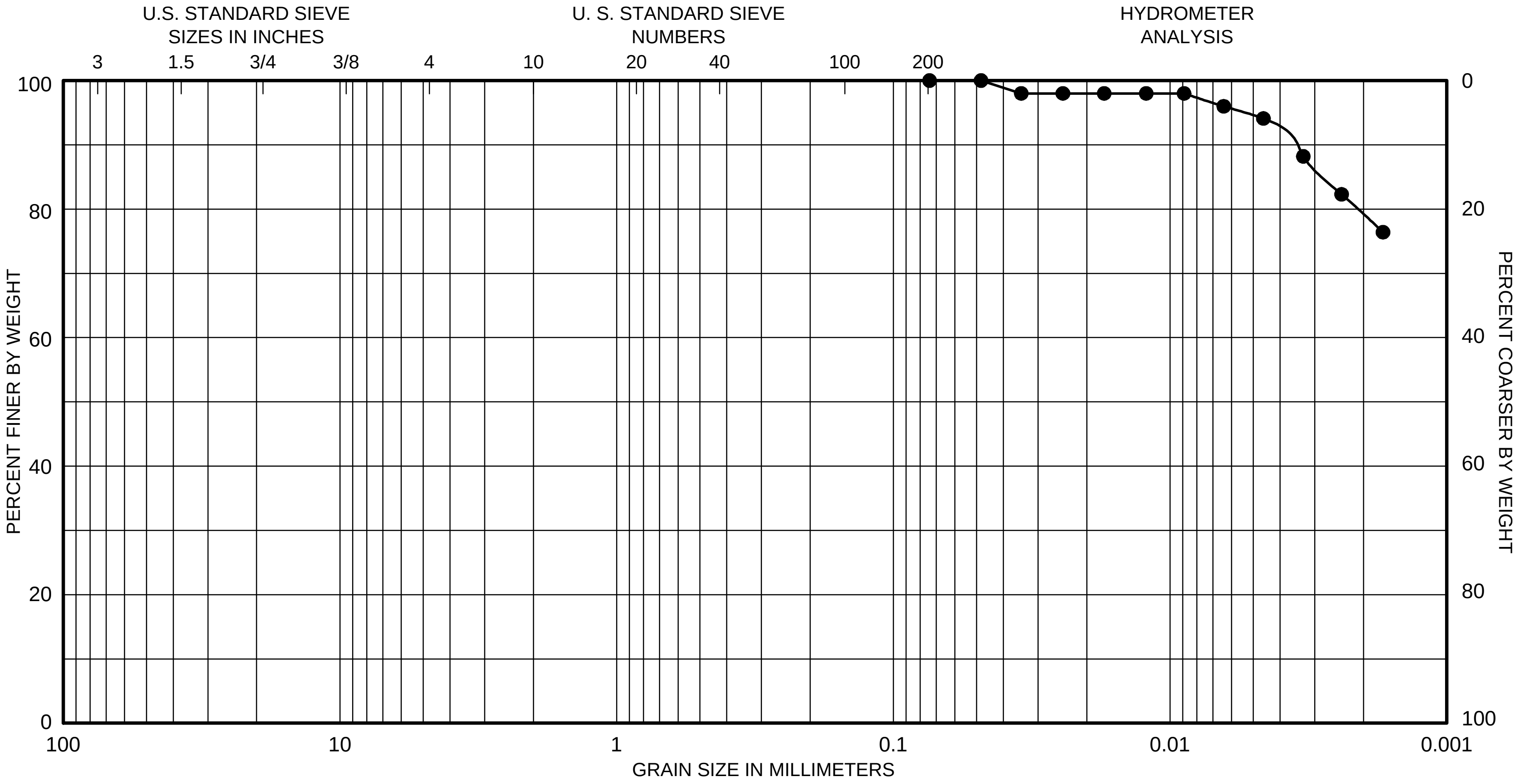
SOIL CLASSIFICATION (2 of 2)



GENERALIZED SUBSURFACE PROFILE

Not-to-Scale

APPENDIX A

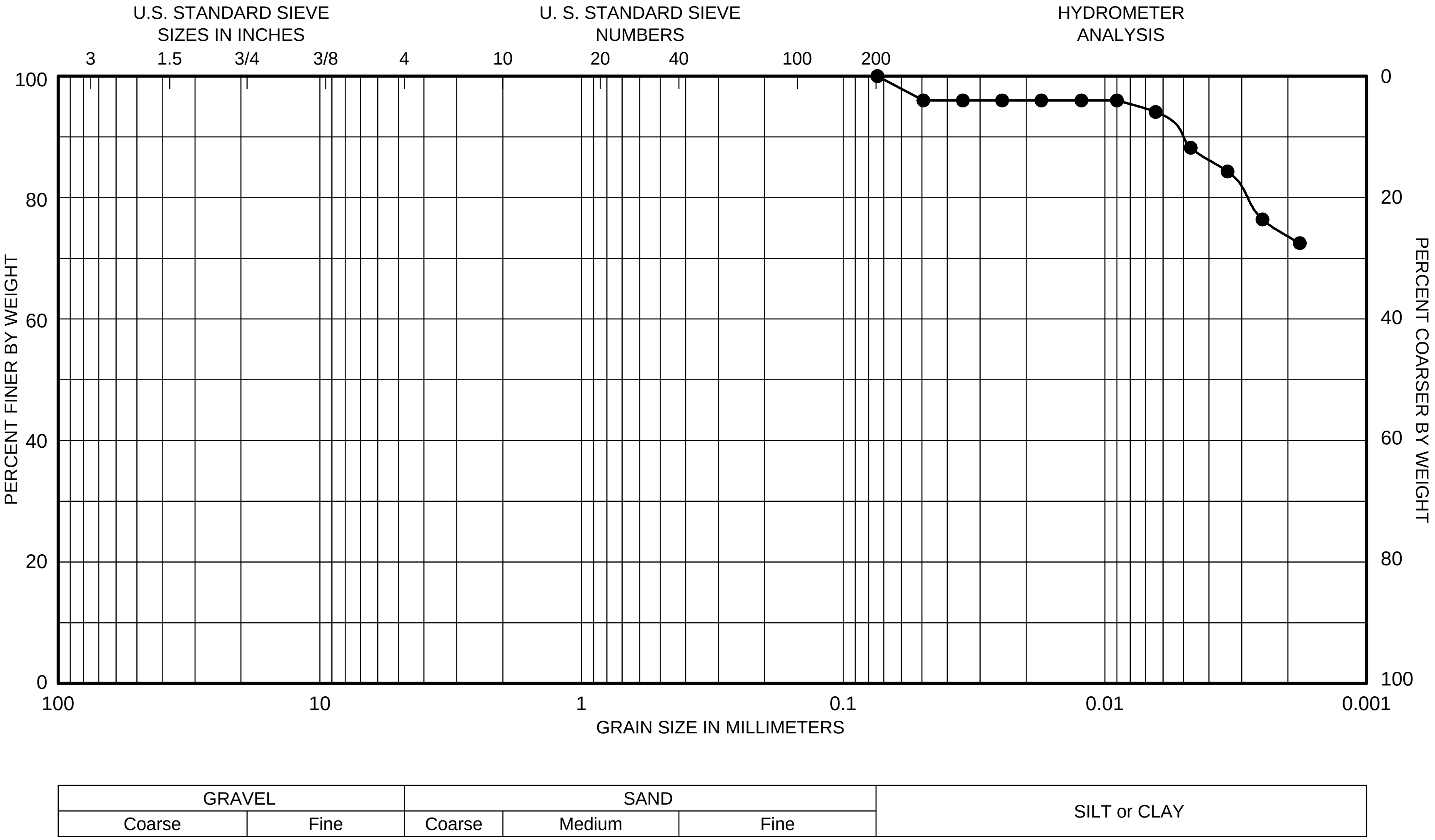


GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	BORING	DEPTH, FT	CLASSIFICATION
●	B-3	29.0	CLAY

GRAIN SIZE CURVE

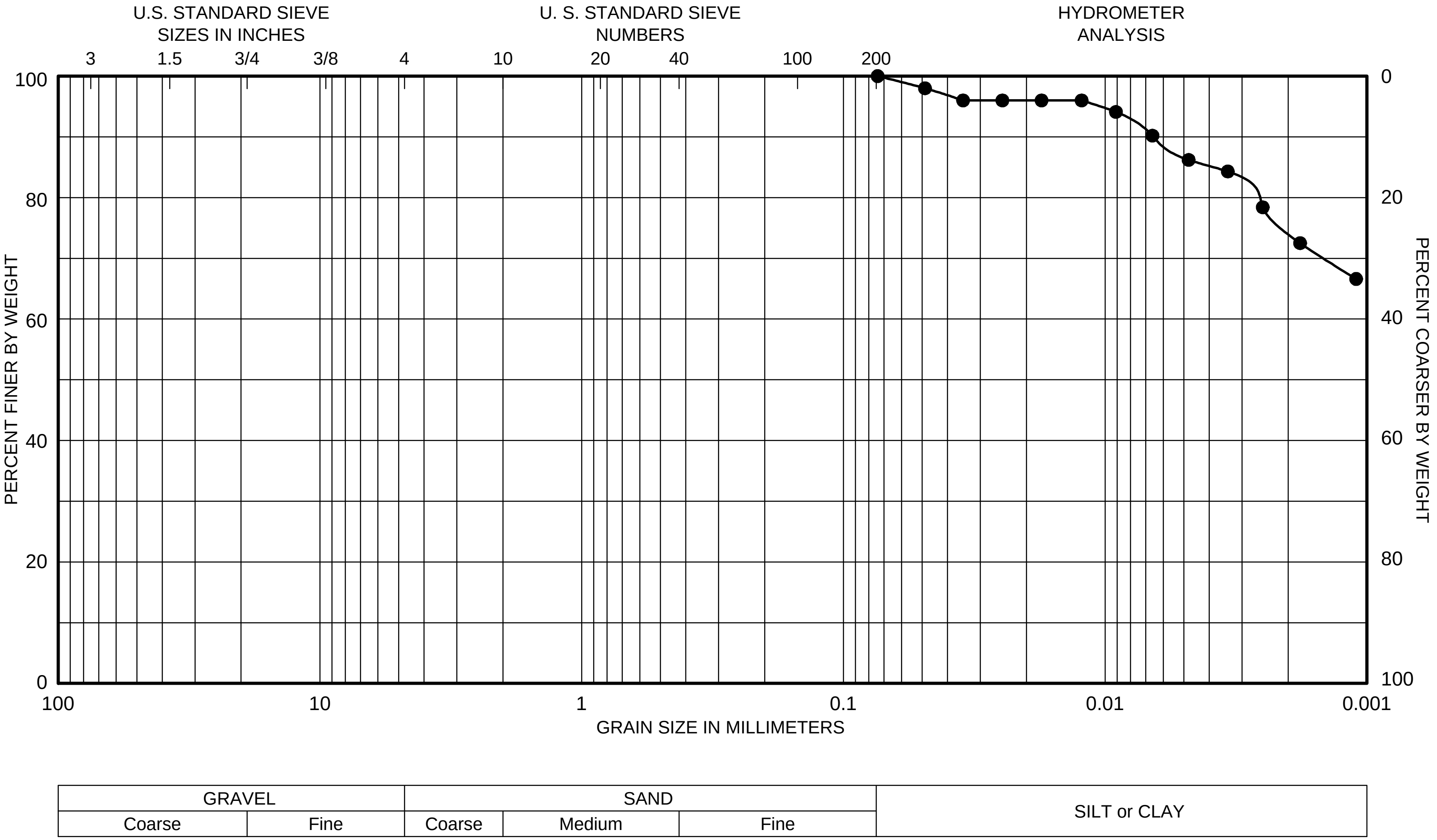
PLATE A-1



SYMBOL	BORING	DEPTH, FT	CLASSIFICATION
●	B-4	8.0	CLAY

GRAIN SIZE CURVE

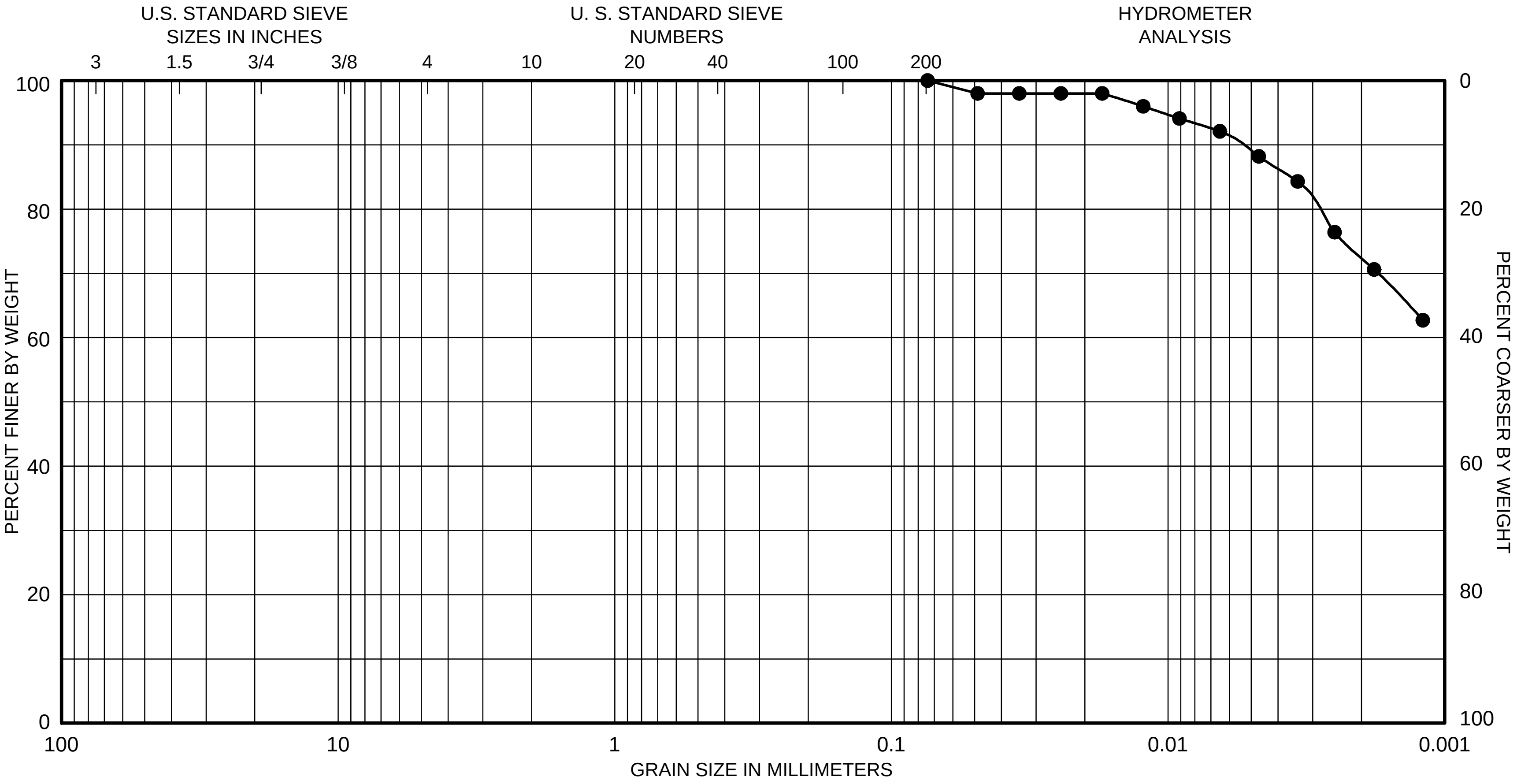
Report No. 0602-1316



SYMBOL	BORING	DEPTH, FT	CLASSIFICATION
●	B-6	14.0	CLAY

PLATE A-3

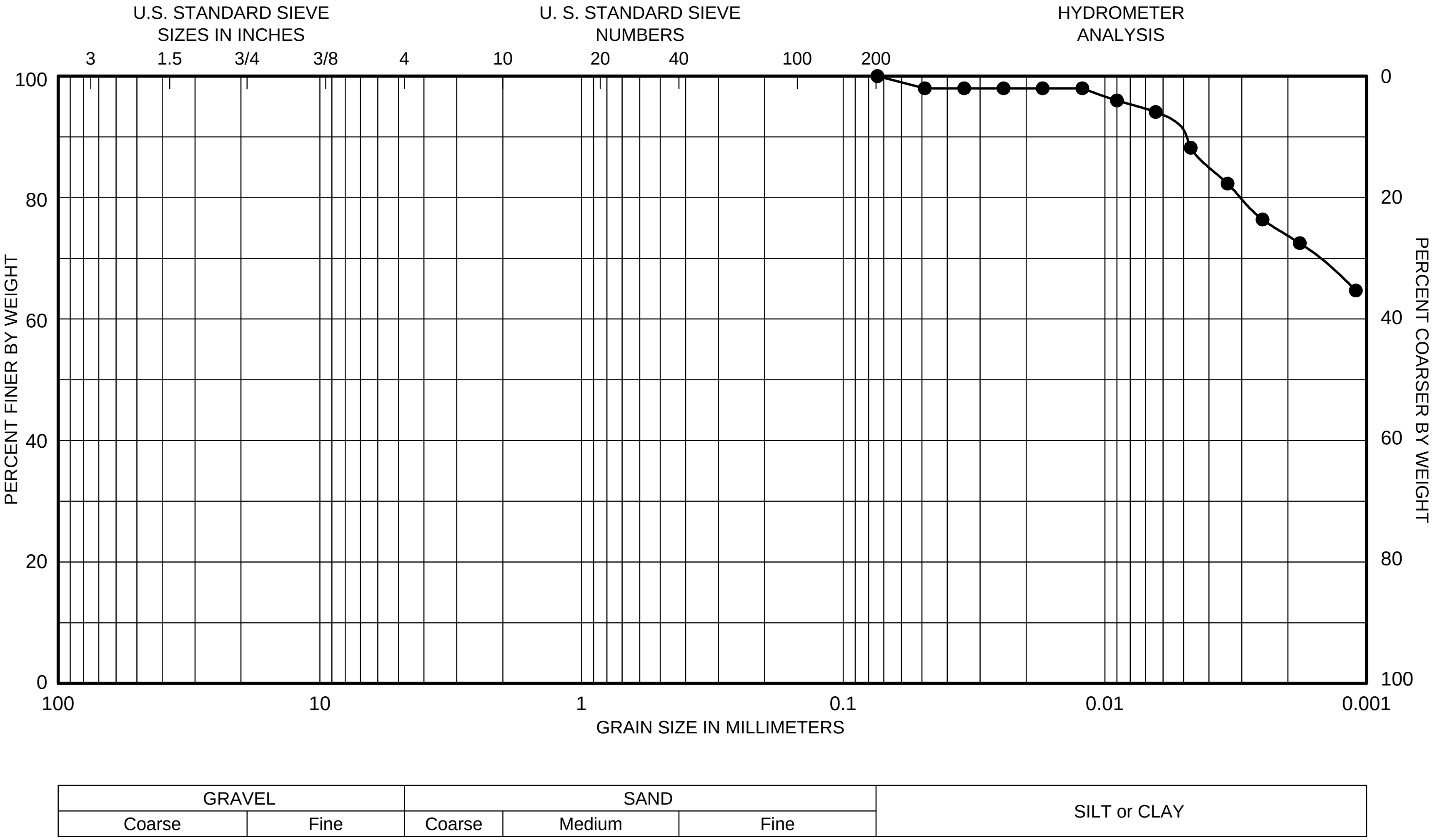
GRAIN SIZE CURVE



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	BORING	DEPTH, FT	CLASSIFICATION
●	B-8	13.0	CLAY

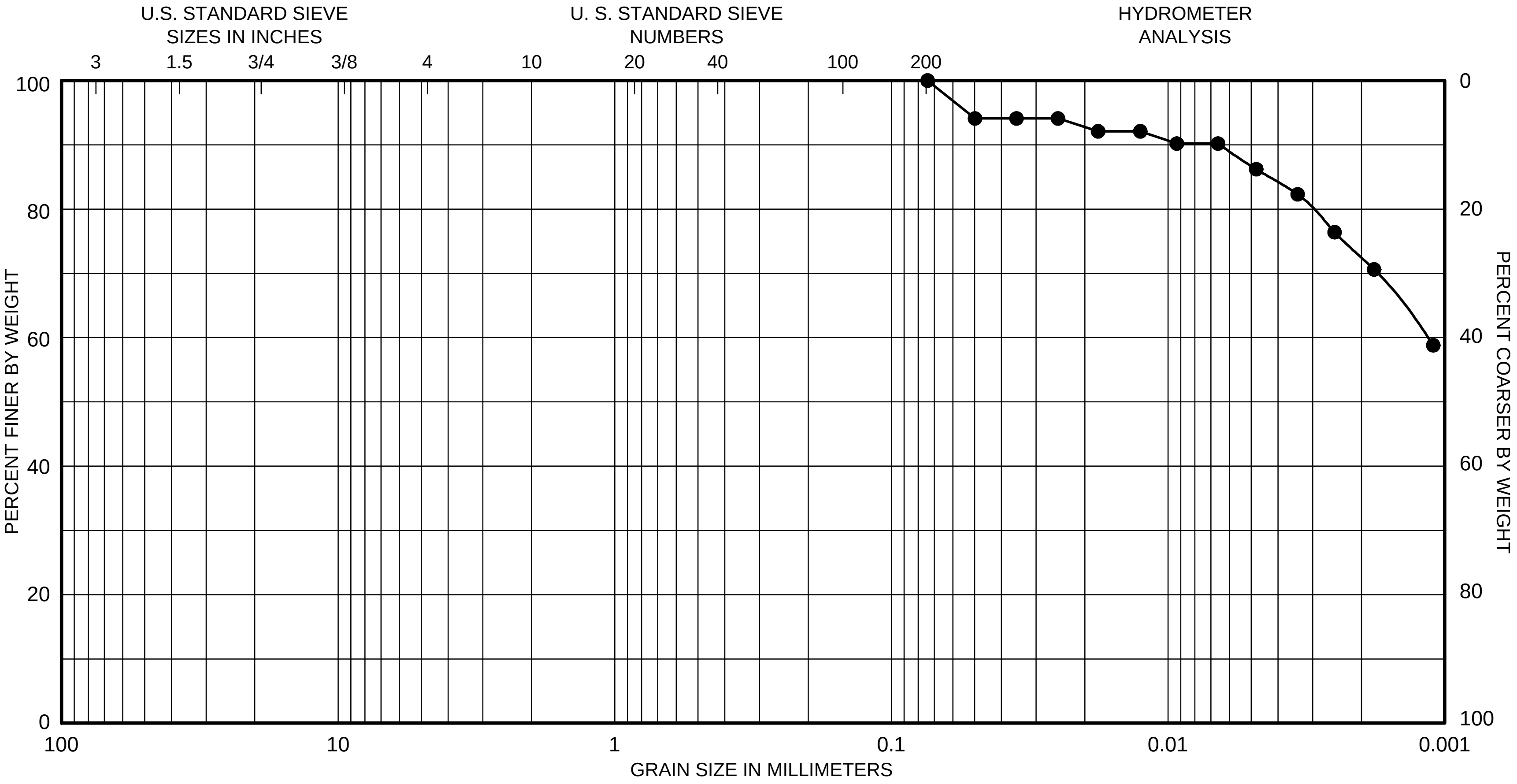
GRAIN SIZE CURVE



SYMBOL	BORING	DEPTH, FT	CLASSIFICATION
●	B-10	14.0	CLAY

GRAIN SIZE CURVE

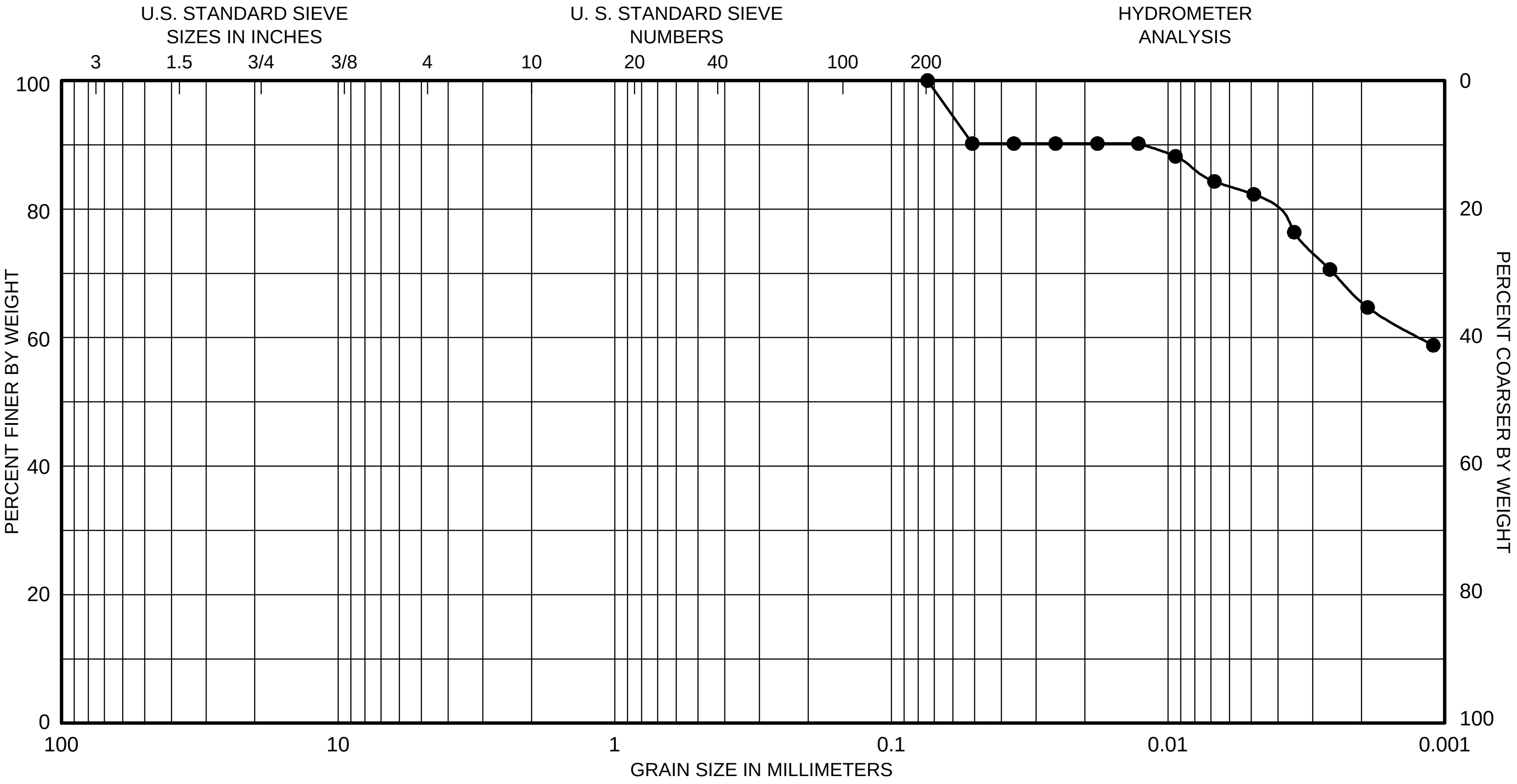
PLATE A-5



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	BORING	DEPTH, FT	CLASSIFICATION
●	B-12	14.0	CLAY

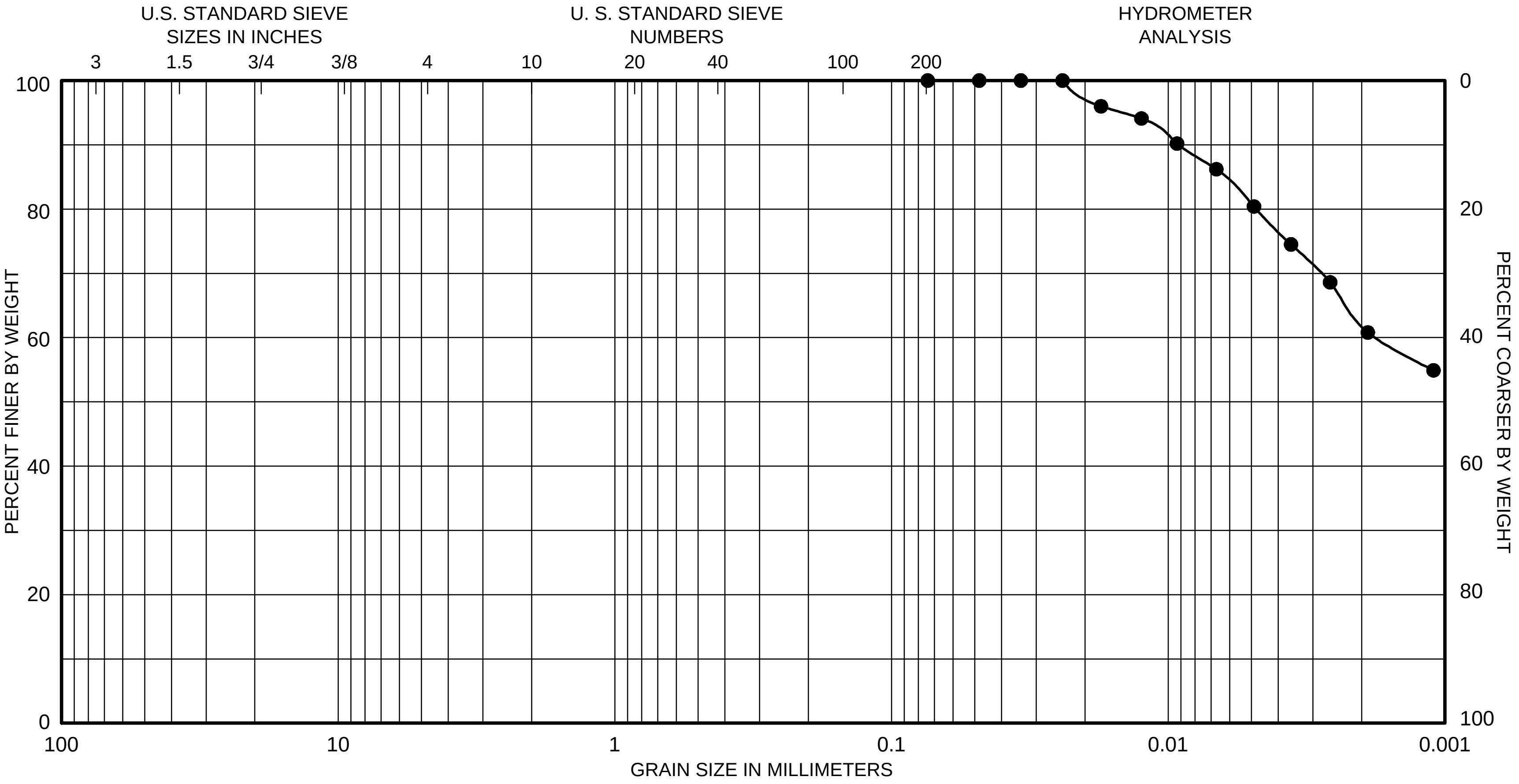
GRAIN SIZE CURVE



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	BORING	DEPTH, FT	CLASSIFICATION
●	B-14	10.0	CLAY

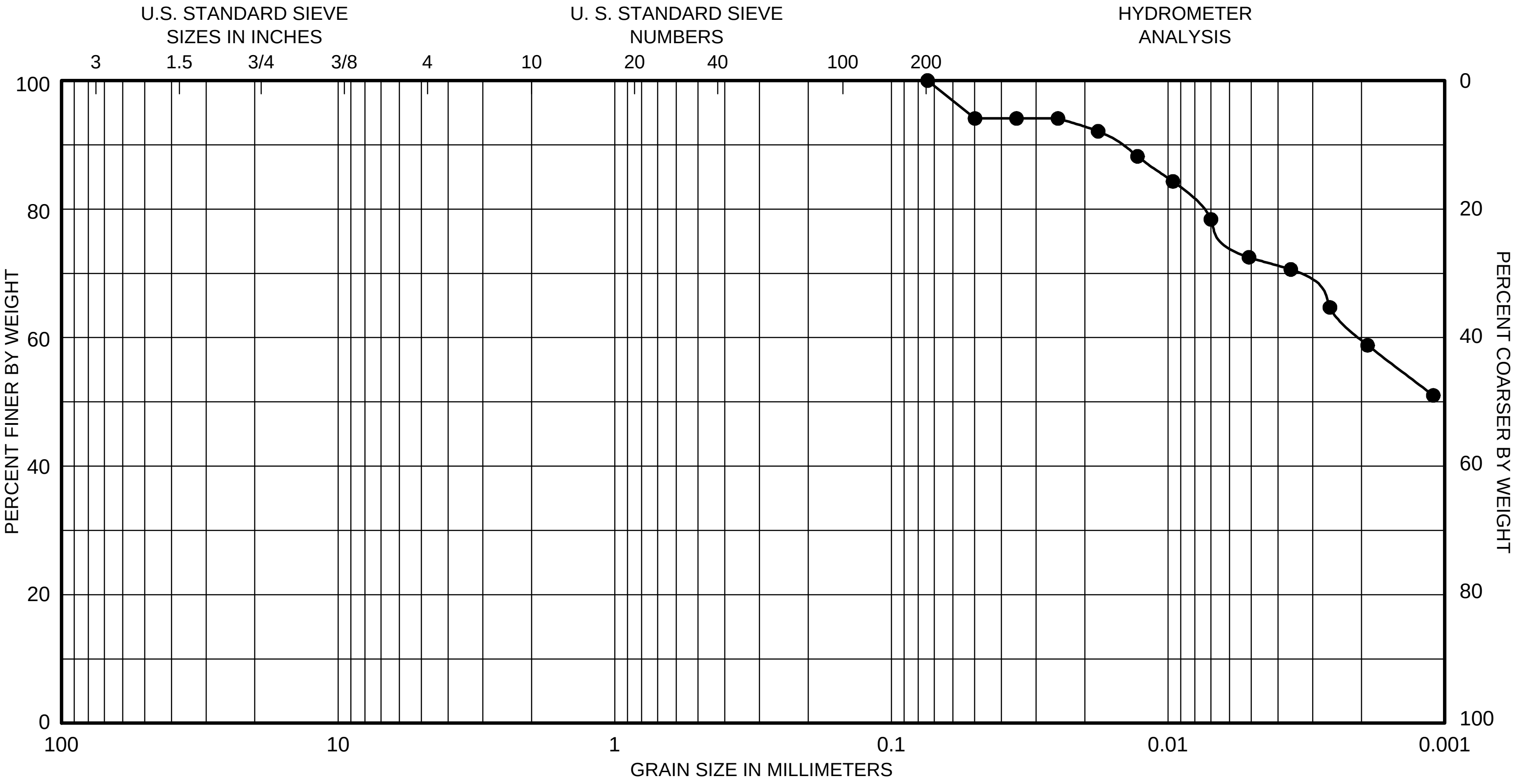
GRAIN SIZE CURVE



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	BORING	DEPTH, FT	CLASSIFICATION
●	B-16	16.0	CLAY

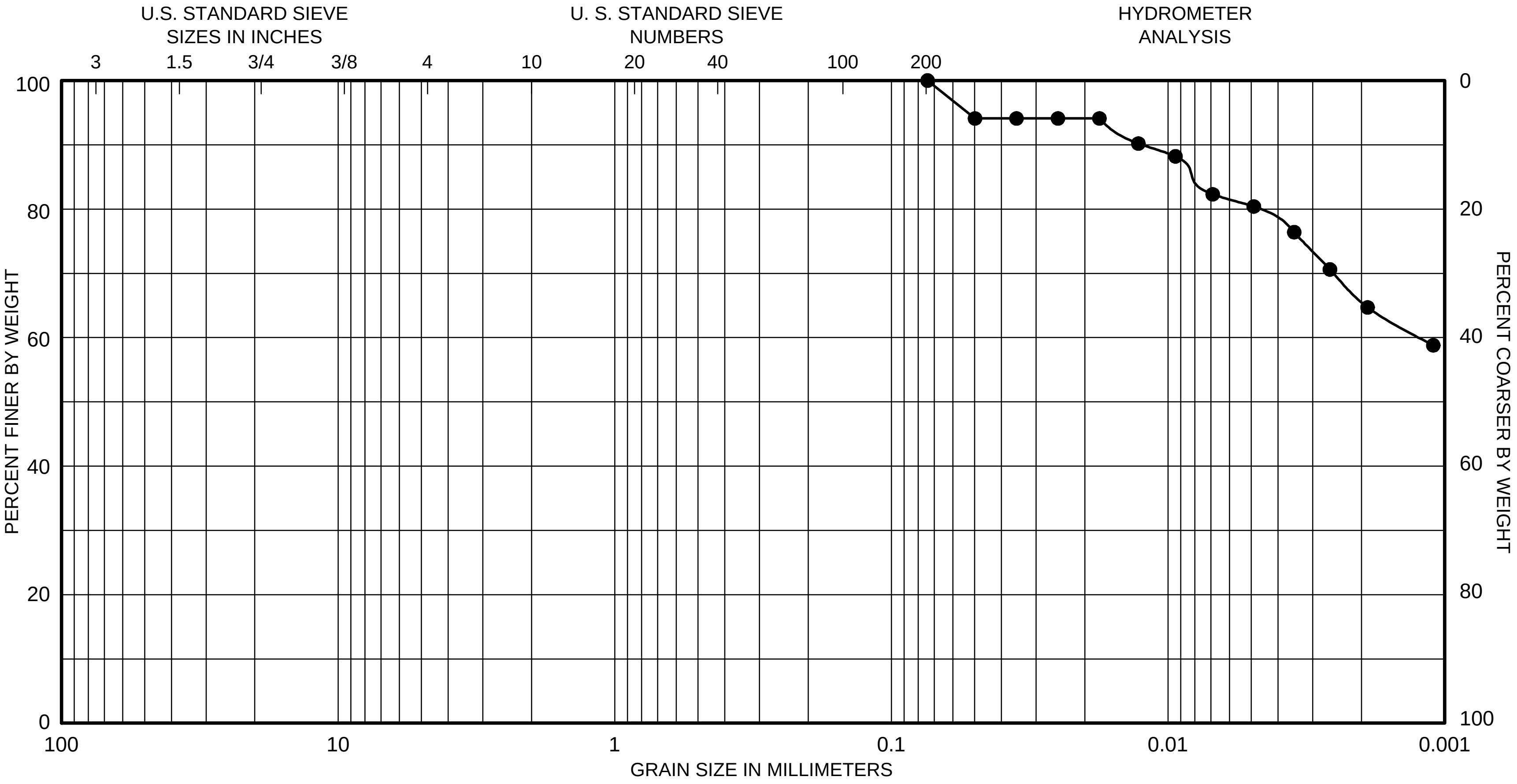
GRAIN SIZE CURVE



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	BORING	DEPTH, FT	CLASSIFICATION
●	B-17	12.0	CLAY

GRAIN SIZE CURVE

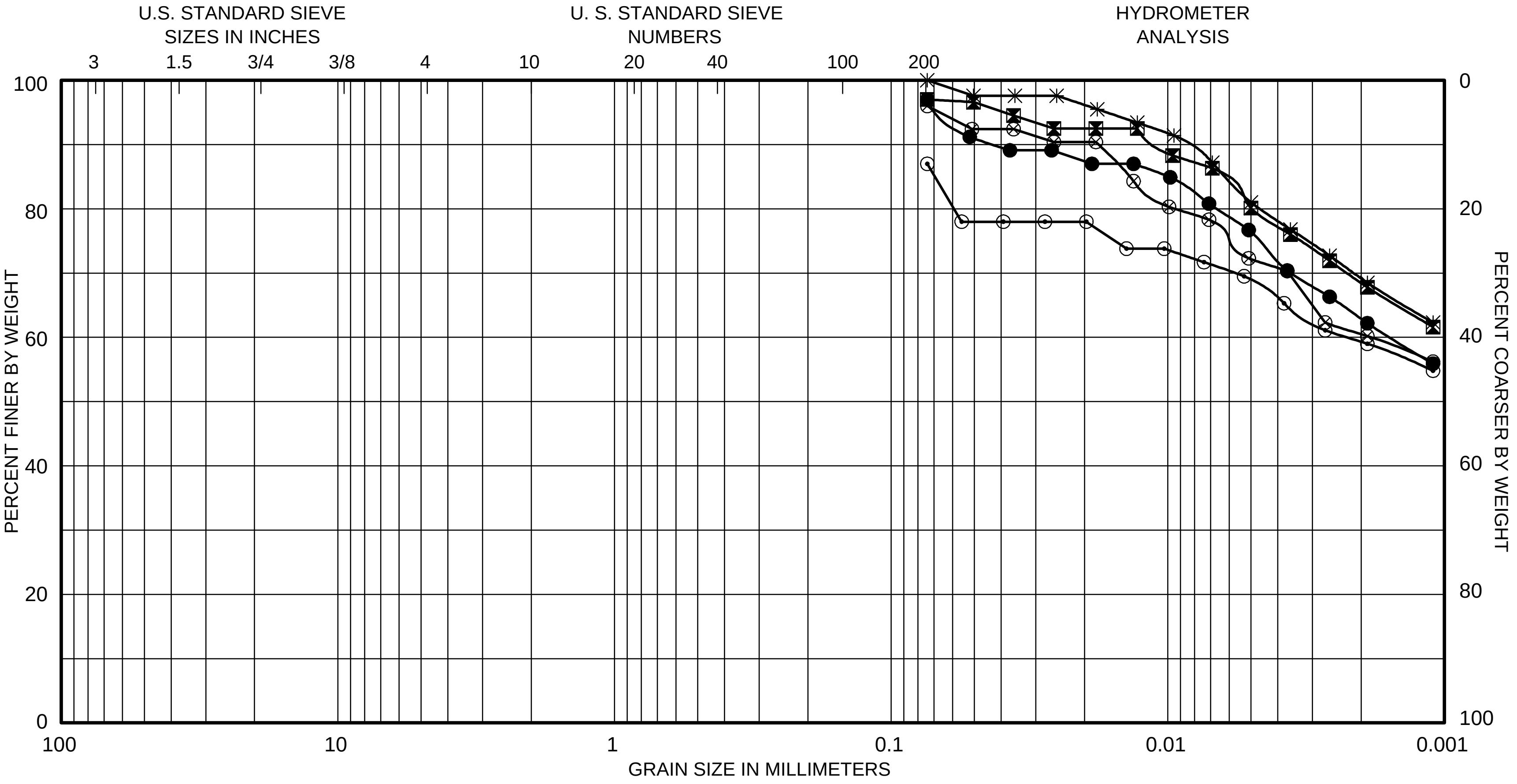


GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	BORING	DEPTH, FT	CLASSIFICATION
●	B-20	10.0	CLAY

GRAIN SIZE CURVE

APPENDIX B

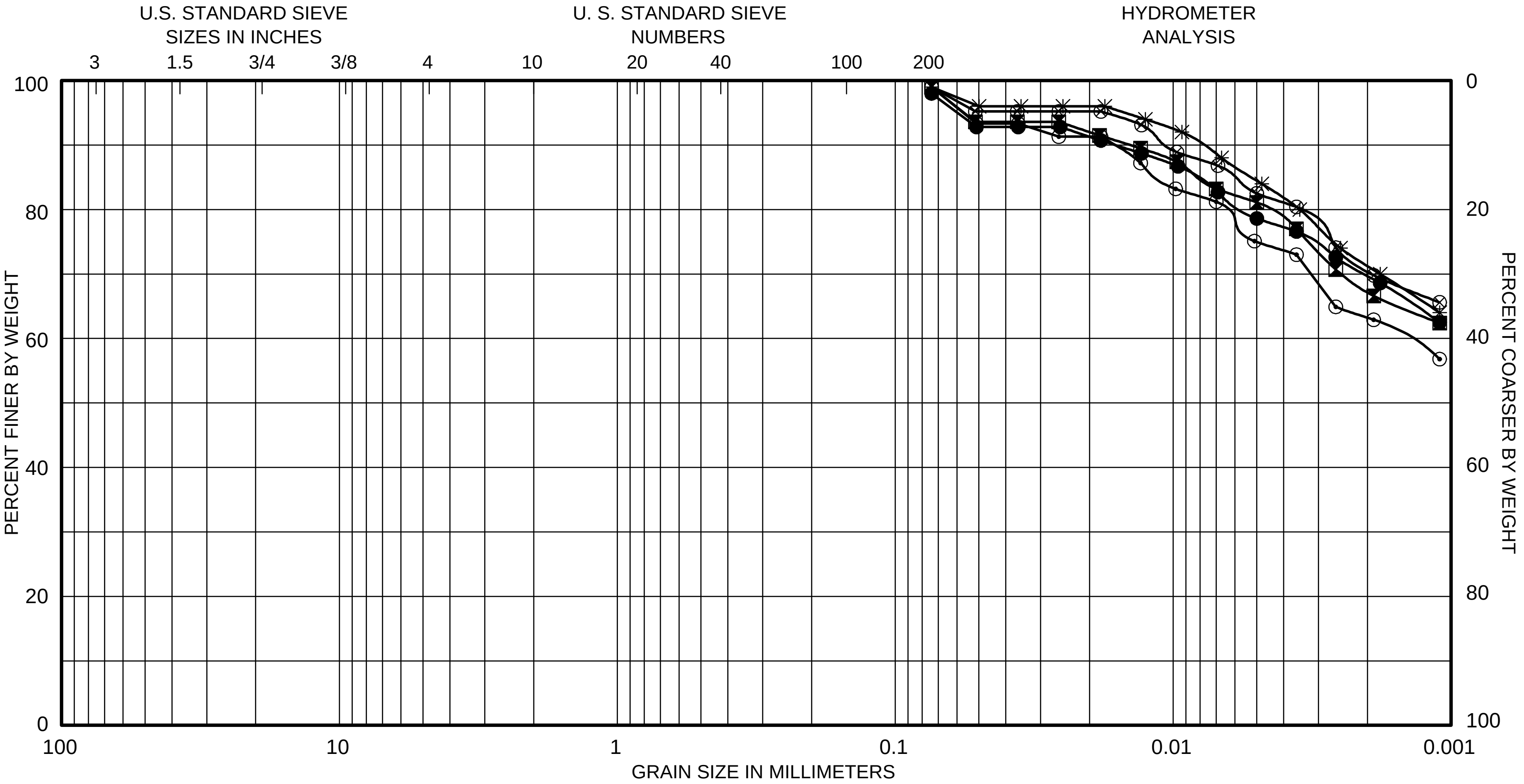


GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-1	1.0	CLAY
⧗	B-1	2.0	CLAY
✳	B-1	3.0	CLAY
⊗	B-1	4.0	CLAY
⊙	B-1	5.0	CLAY

GRAIN SIZE CURVES

PLATE B-1

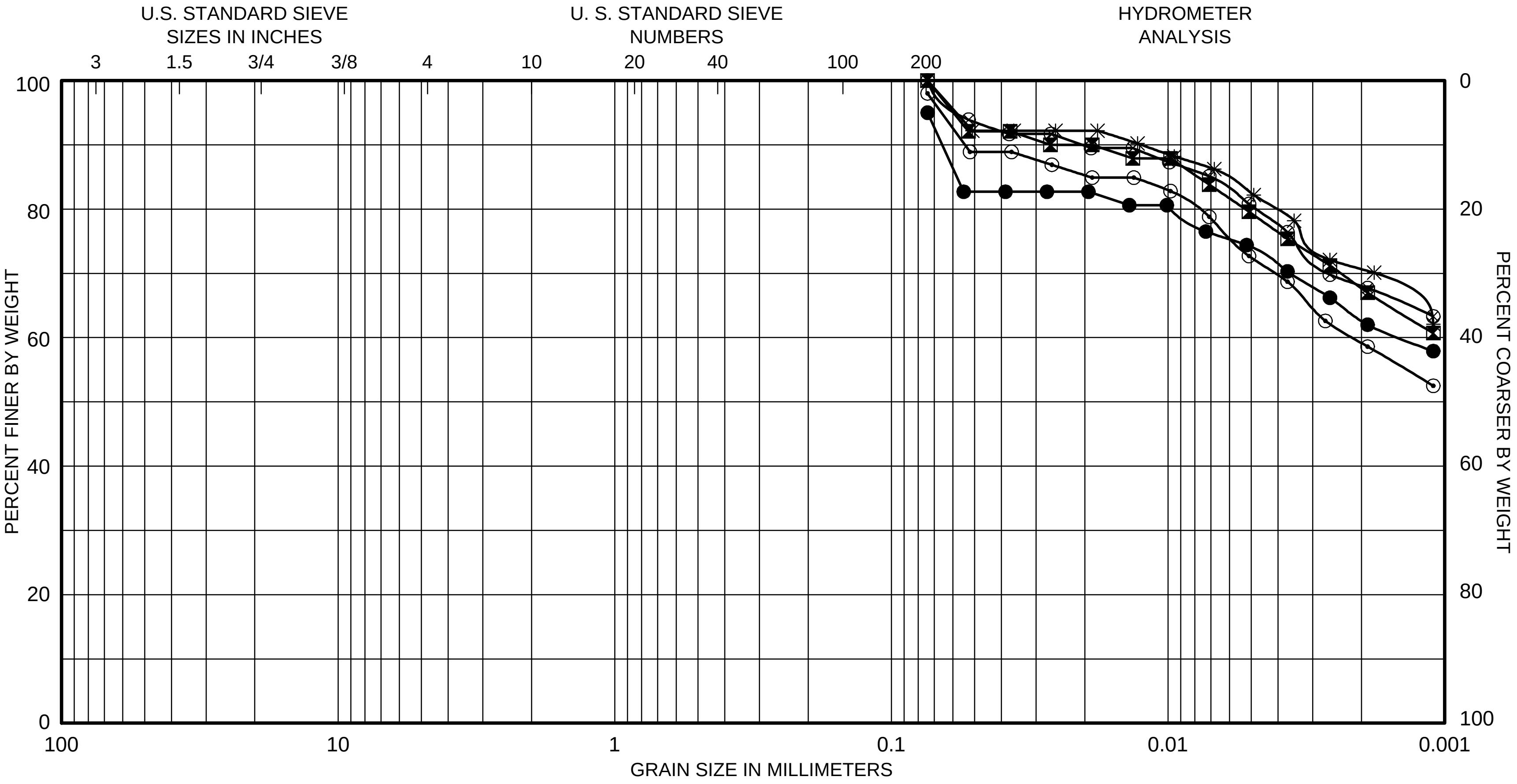


GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-2	1.0	CLAY
⧗	B-2	2.0	CLAY
✳	B-2	3.0	CLAY
⊗	B-2	4.0	CLAY
⊙	B-2	5.0	CLAY

GRAIN SIZE CURVES

Report No. 0602-1316



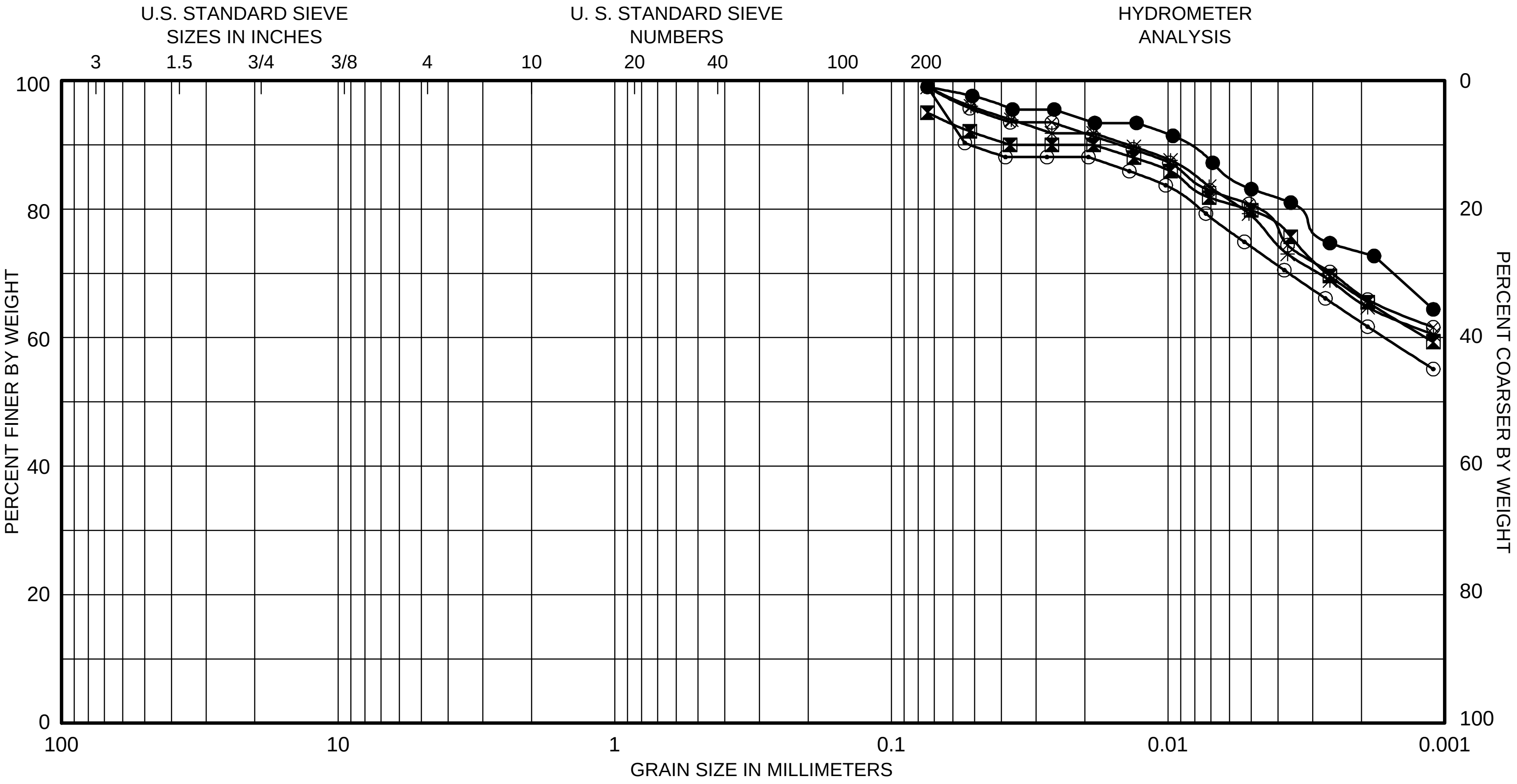
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-3	1.0	CLAY
⧗	B-3	2.0	CLAY
✳	B-3	3.0	CLAY
⊗	B-3	4.0	CLAY
⊙	B-3	5.0	CLAY

GRAIN SIZE CURVE

PLATE B-3

Report No. 0602-1316

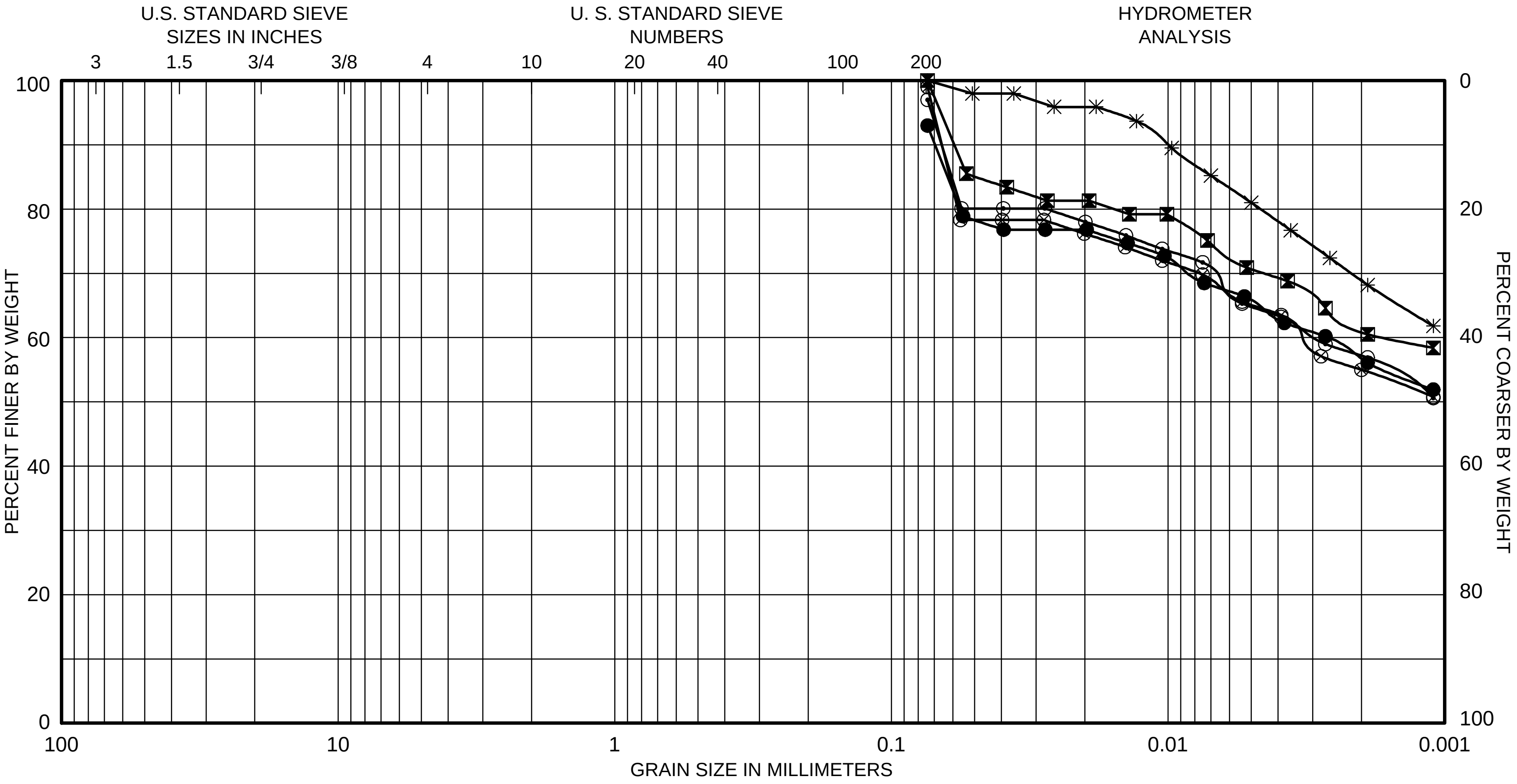


GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-4	1.0	CLAY
⧗	B-4	2.0	CLAY
✳	B-4	3.0	CLAY
⊗	B-4	4.0	CLAY
⊙	B-4	5.0	CLAY

GRAIN SIZE CURVE

PLATE B-4



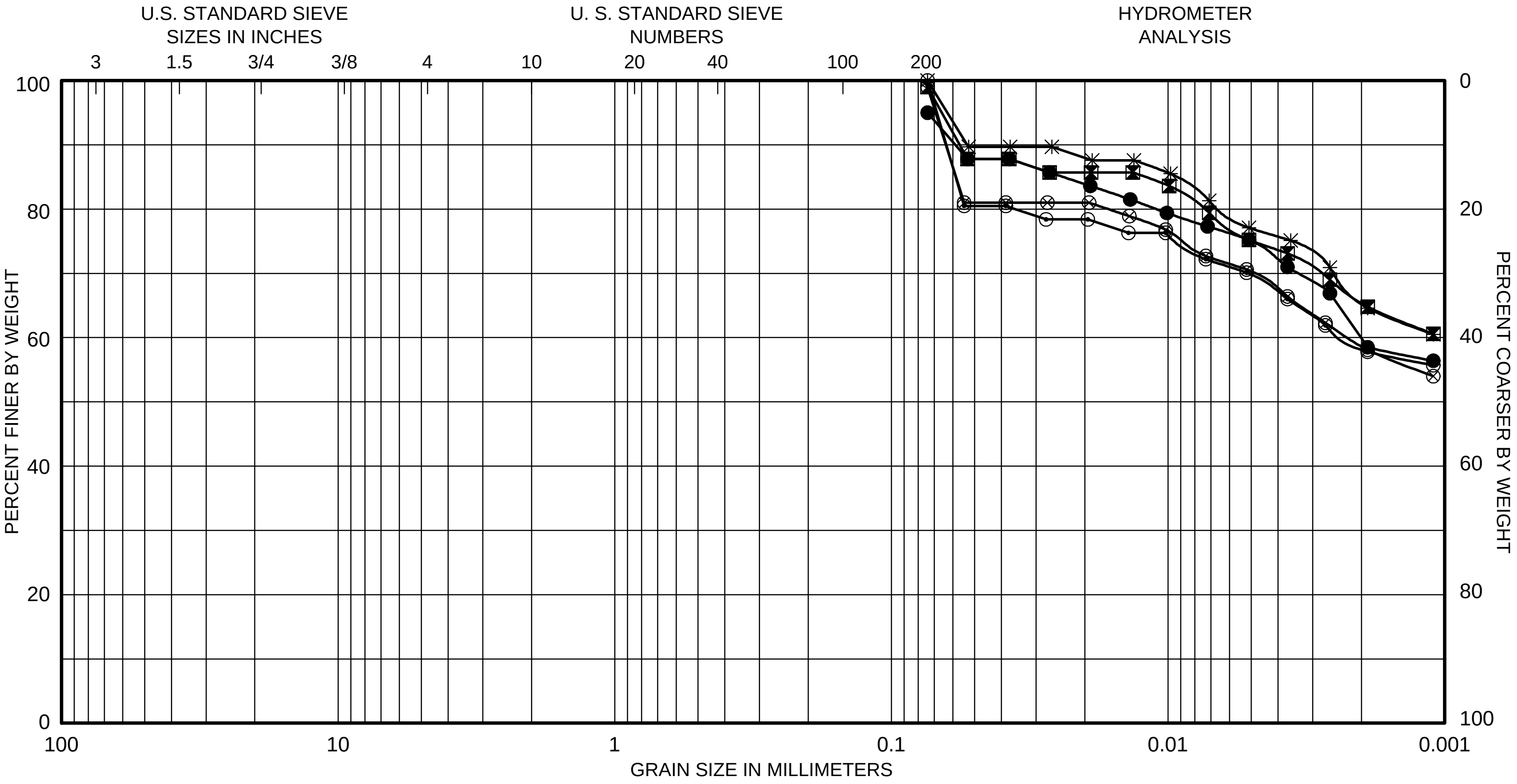
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-5	1.0	CLAY
⧗	B-5	2.0	CLAY
✳	B-5	3.0	CLAY
⊗	B-5	4.0	CLAY
⊙	B-5	5.0	CLAY

GRAIN SIZE CURVE

PLATE B-5

Report No. 0602-1316



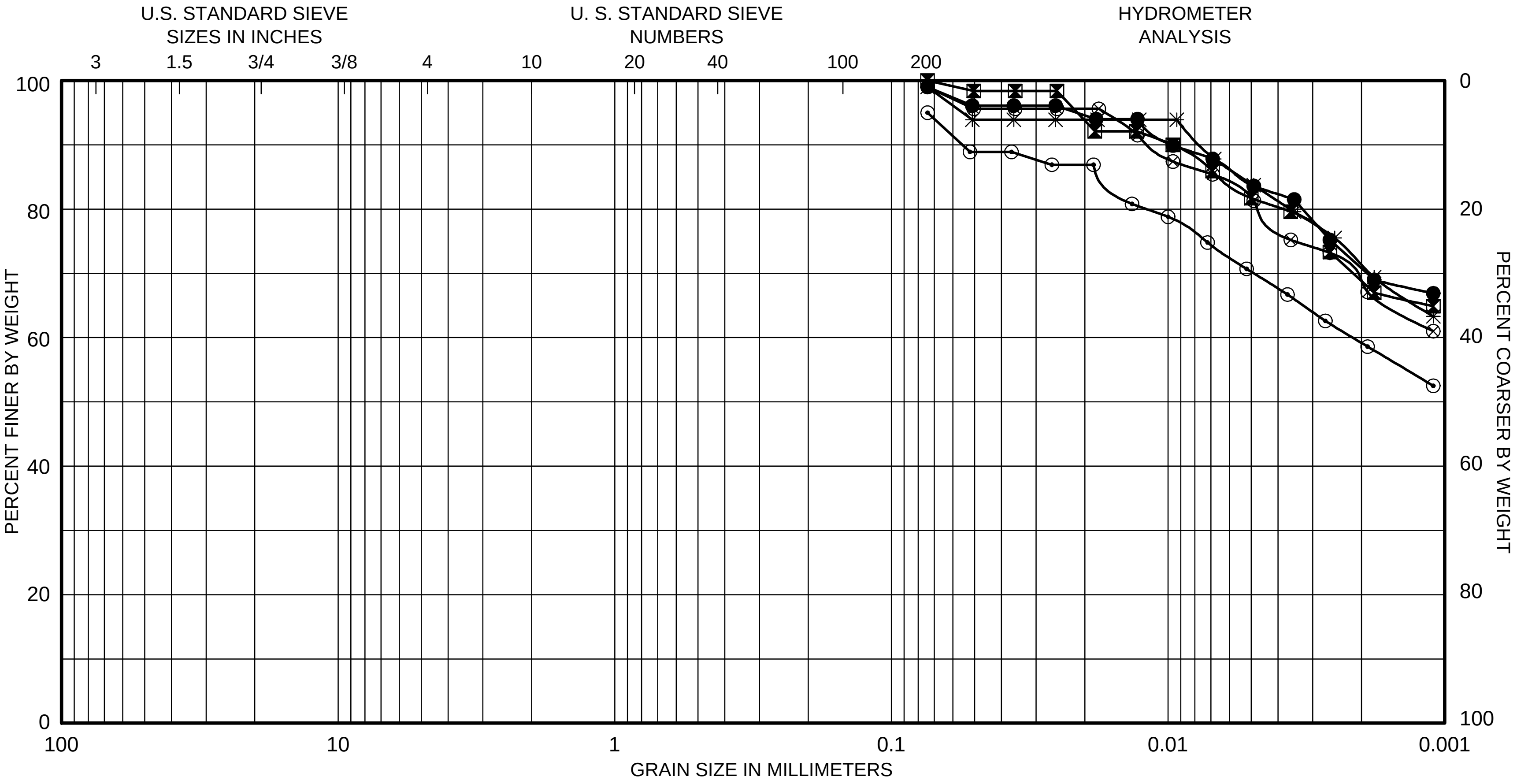
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-6	1.0	CLAY
⧗	B-6	2.0	CLAY
✳	B-6	3.0	CLAY
⊗	B-6	4.0	CLAY
⊙	B-6	5.0	CLAY

GRAIN SIZE CURVE

PLATE B-6

Report No. 0602-1316



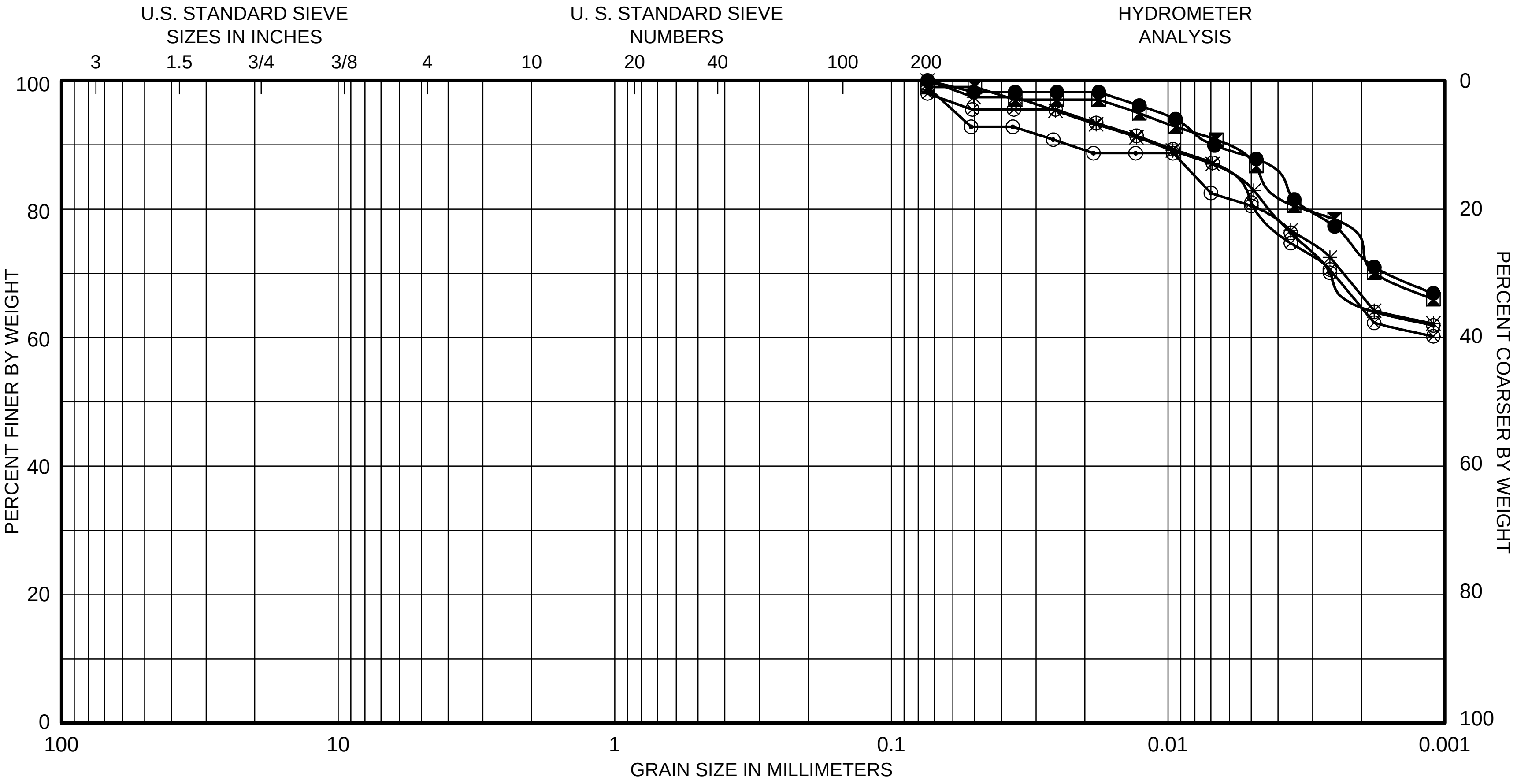
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-7	1.0	CLAY
⧗	B-7	2.0	CLAY
✳	B-7	3.0	CLAY
⊗	B-7	4.0	CLAY
⊙	B-7	5.0	CLAY

GRAIN SIZE CURVE

PLATE B-7

Report No. 0602-1316



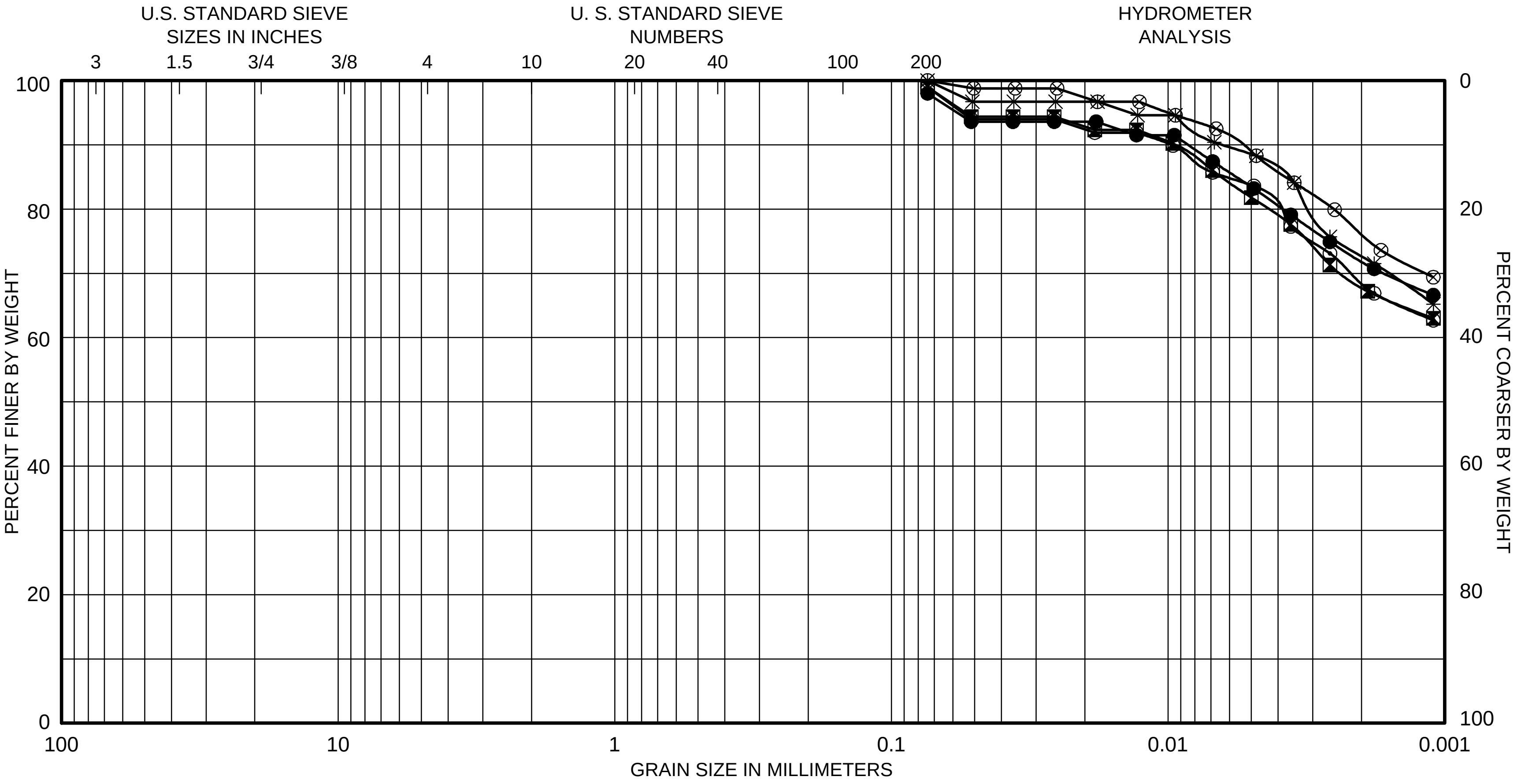
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-8	1.0	CLAY
⧗	B-8	2.0	CLAY
✳	B-8	3.0	CLAY
⊗	B-8	4.0	CLAY
⊙	B-8	5.0	CLAY

GRAIN SIZE CURVE

PLATE B-8

Report No. 0602-1316



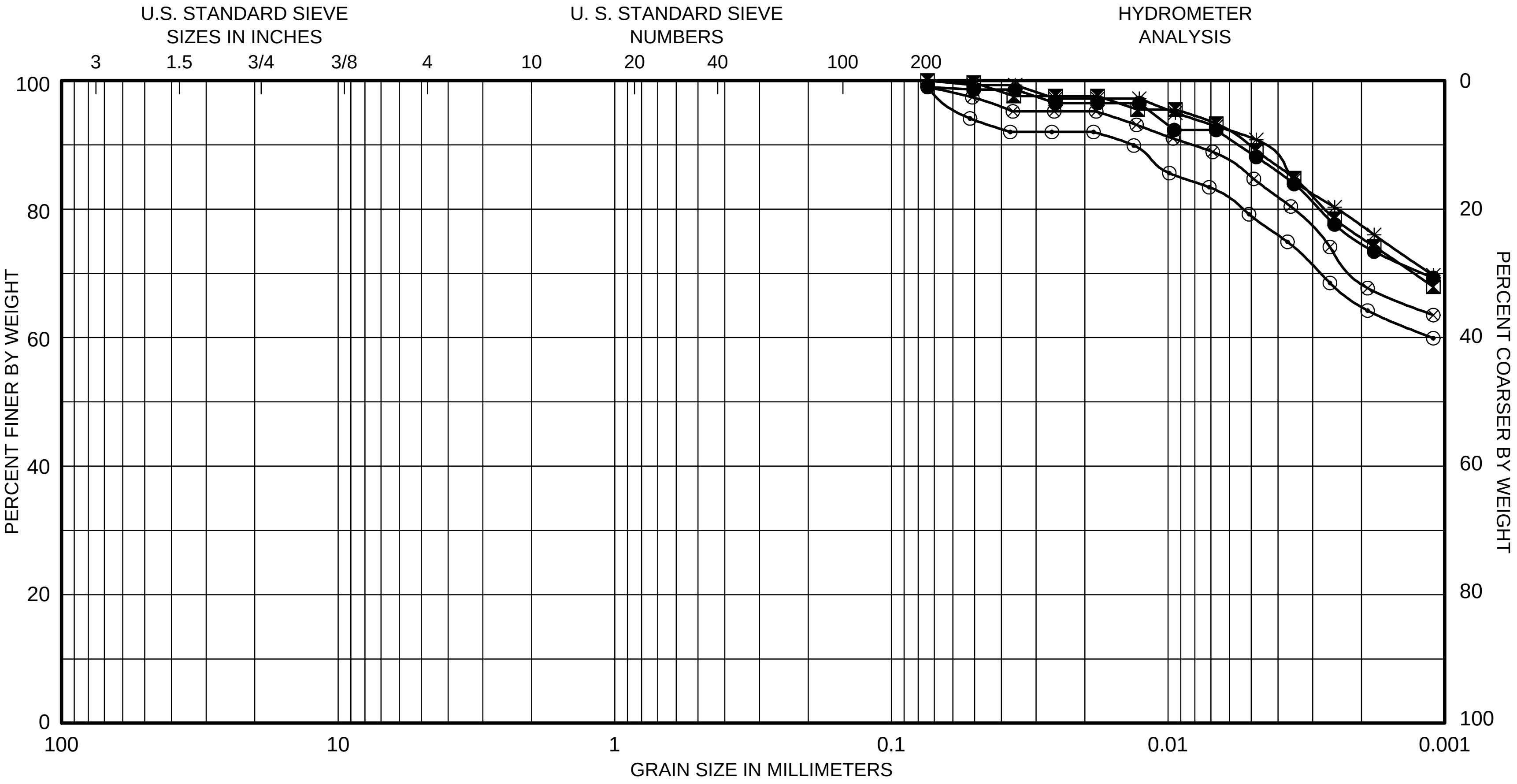
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-9	1.0	CLAY
⧗	B-9	2.0	CLAY
✳	B-9	3.0	CLAY
⊗	B-9	4.0	CLAY
⊙	B-9	5.0	CLAY

GRAIN SIZE CURVE

PLATE B-9

Report No. 0602-1316



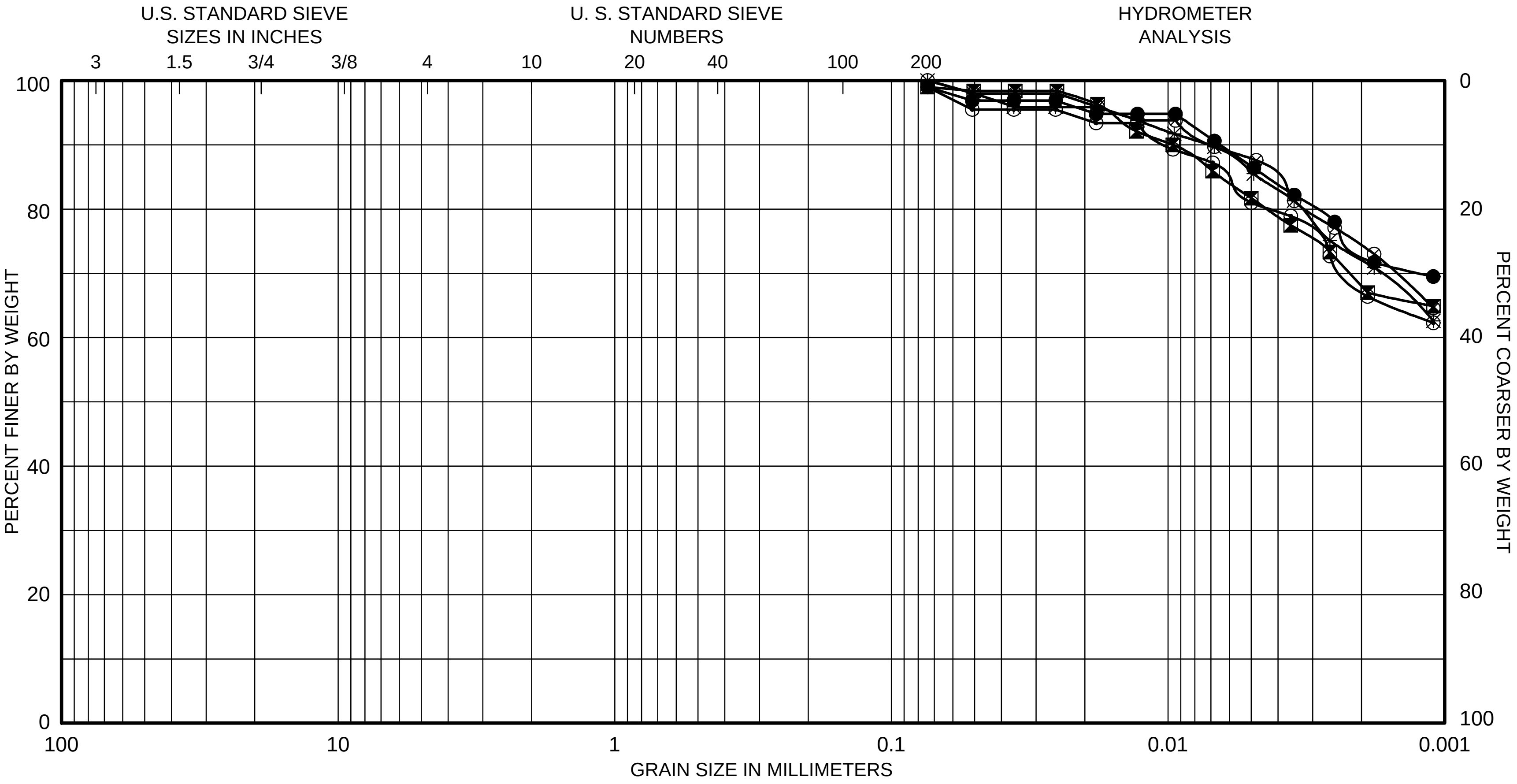
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-10	1.0	CLAY
⧗	B-10	2.0	CLAY
✳	B-10	3.0	CLAY
⊗	B-10	4.0	CLAY
⊙	B-10	5.0	CLAY

GRAIN SIZE CURVE

PLATE B-10

Report No. 0602-1316



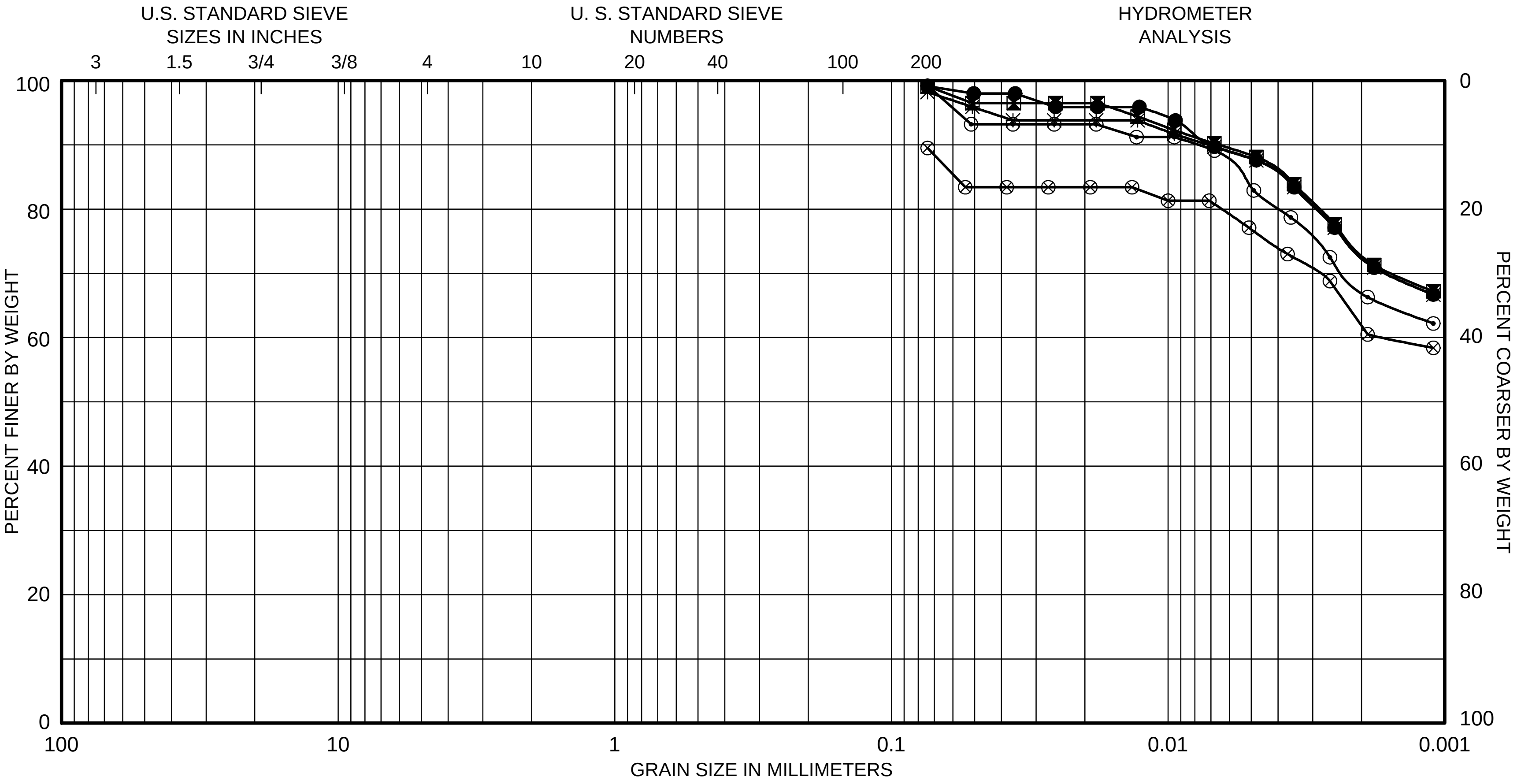
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-11	1.0	CLAY
⧗	B-11	2.0	CLAY
✳	B-11	3.0	CLAY
⊗	B-11	4.0	CLAY
⊙	B-11	5.0	CLAY

GRAIN SIZE CURVE

PLATE B-11

Report No. 0602-1316



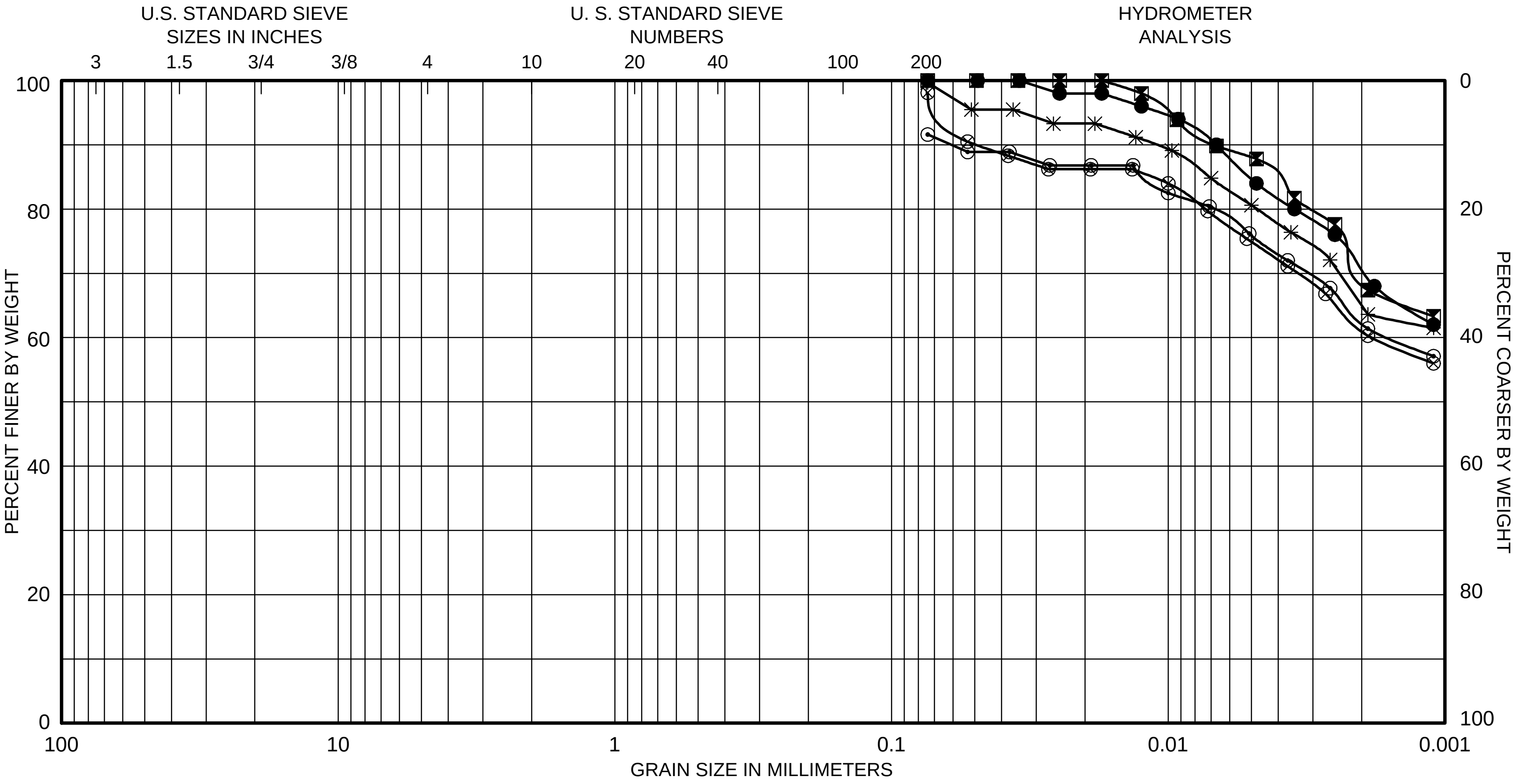
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-12	1.0	CLAY
☒	B-12	2.0	CLAY
✳	B-12	3.0	CLAY
⊗	B-12	4.0	CLAY
⊙	B-12	5.0	CLAY

GRAIN SIZE CURVE

PLATE B-12

Report No. 0602-1316

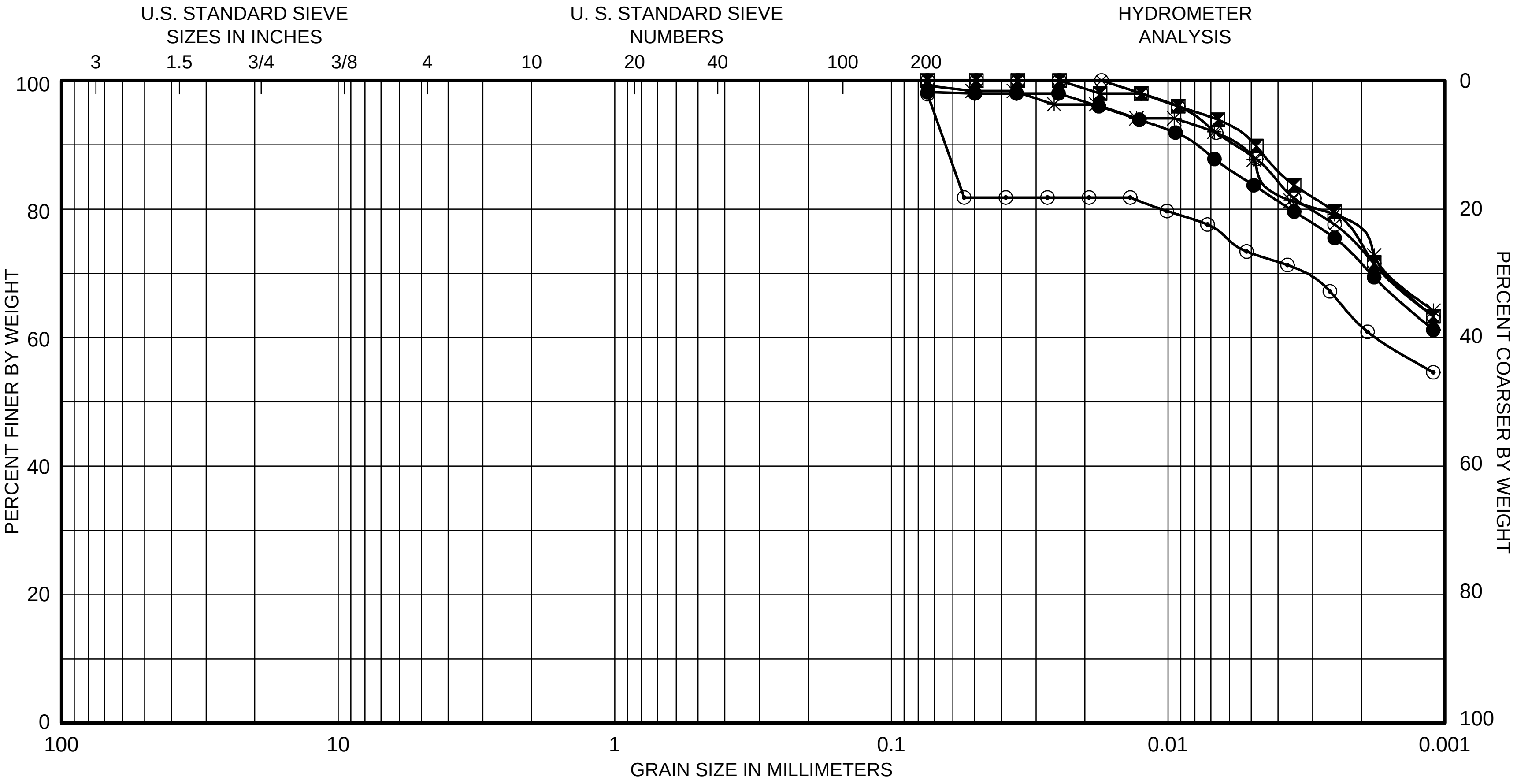


GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-13	1.0	CLAY
⧗	B-13	2.0	CLAY
✳	B-13	3.0	CLAY
⊗	B-13	4.0	CLAY
⊙	B-13	5.0	CLAY

GRAIN SIZE CURVE

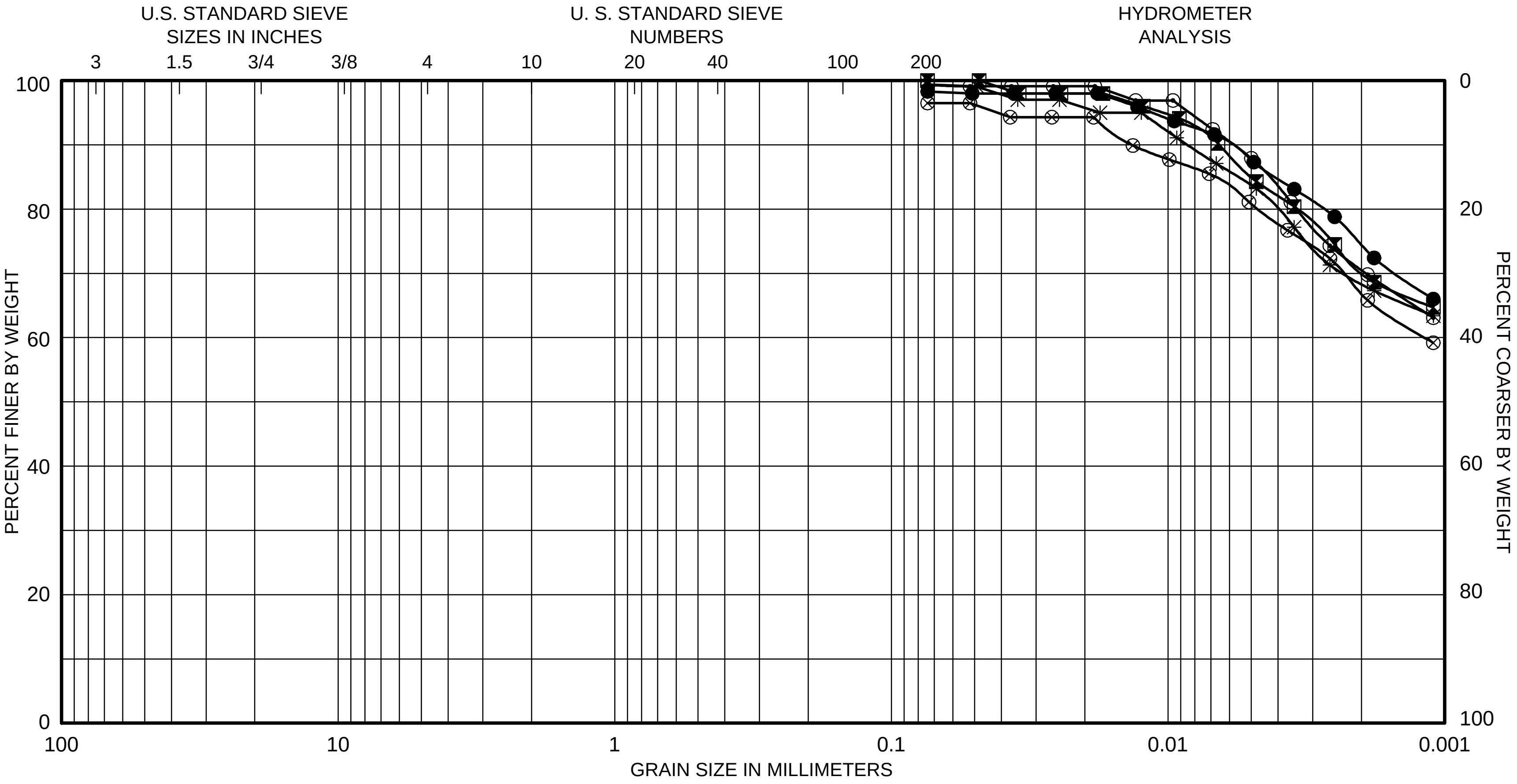
PLATE B-13



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-14	1.0	CLAY
⧗	B-14	2.0	CLAY
✳	B-14	3.0	CLAY
⊗	B-14	4.0	CLAY
⊙	B-14	5.0	CLAY

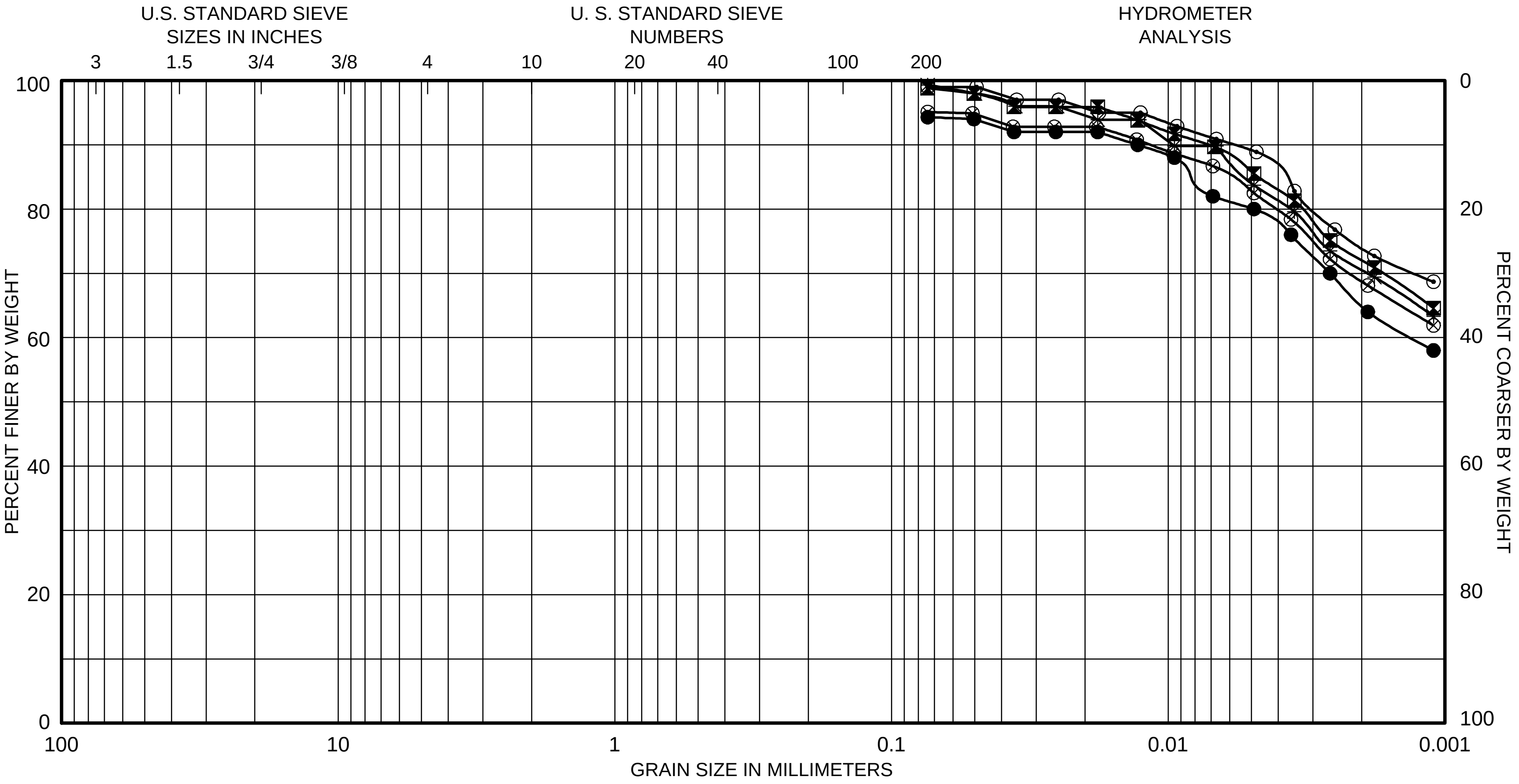
GRAIN SIZE CURVE



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-15	1.0	CLAY
⧗	B-15	2.0	CLAY
✳	B-15	3.0	CLAY
⊗	B-15	4.0	CLAY
⊙	B-15	5.0	CLAY

GRAIN SIZE CURVE

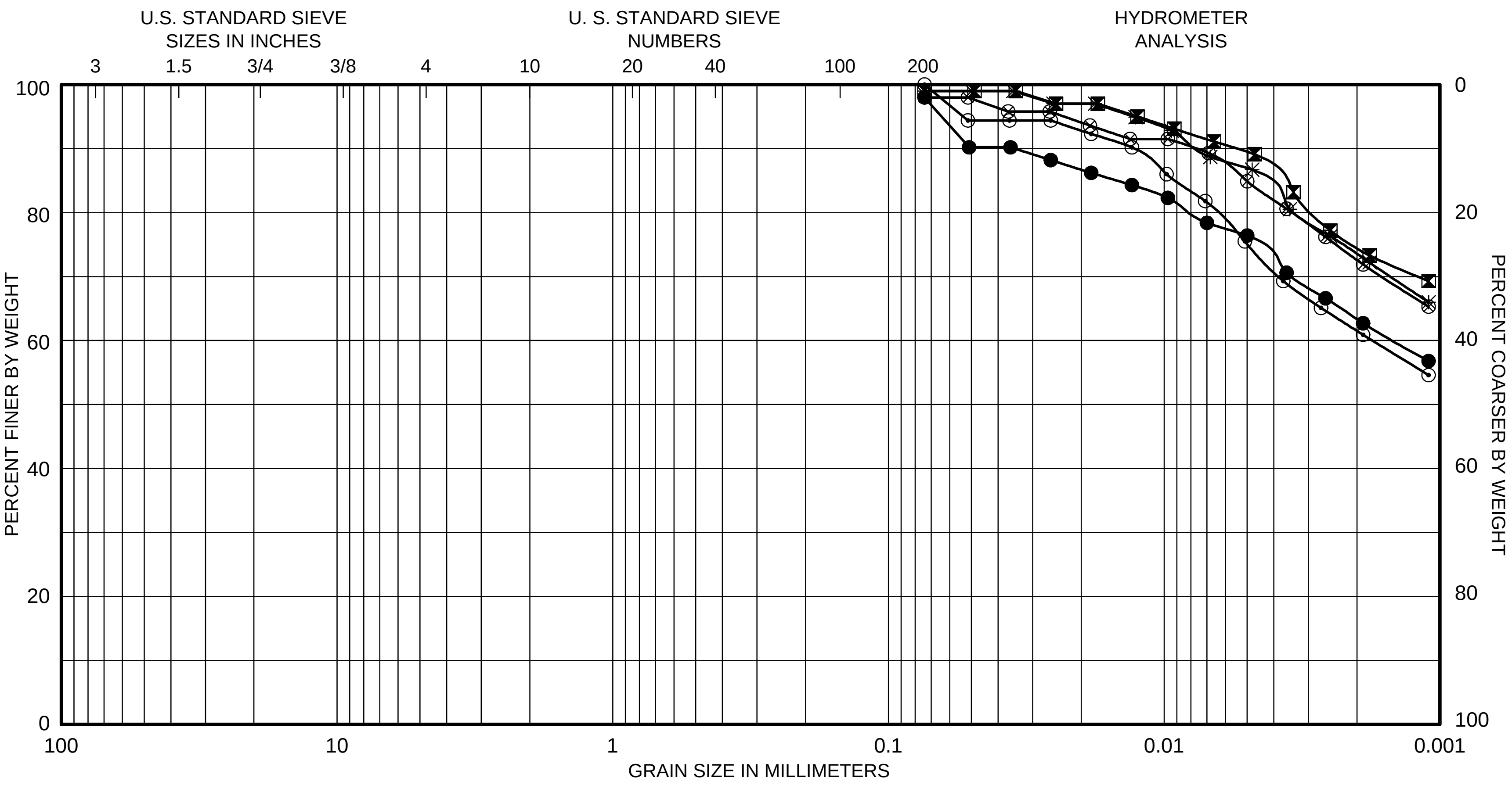


GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-16	1.0	CLAY
⧗	B-16	2.0	CLAY
✳	B-16	3.0	CLAY
⊗	B-16	4.0	CLAY
⊙	B-16	5.0	CLAY

GRAIN SIZE CURVE

Report No. 0602-1316



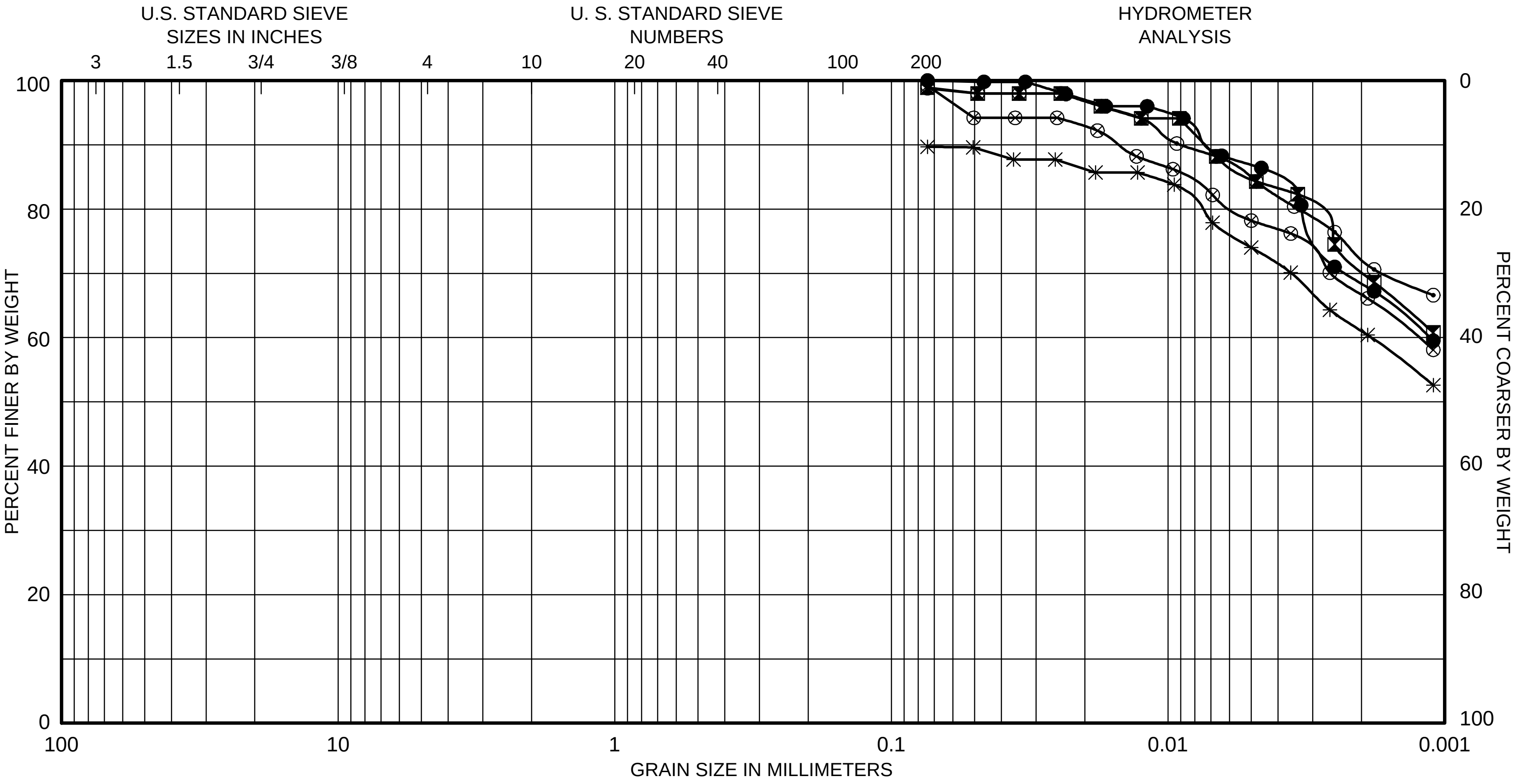
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-17	1.0	CLAY
⧗	B-17	2.0	CLAY
✳	B-17	3.0	CLAY
⊗	B-17	4.0	CLAY
⊙	B-17	5.0	CLAY

GRAIN SIZE CURVE

PLATE B-17

Report No. 0602-1316



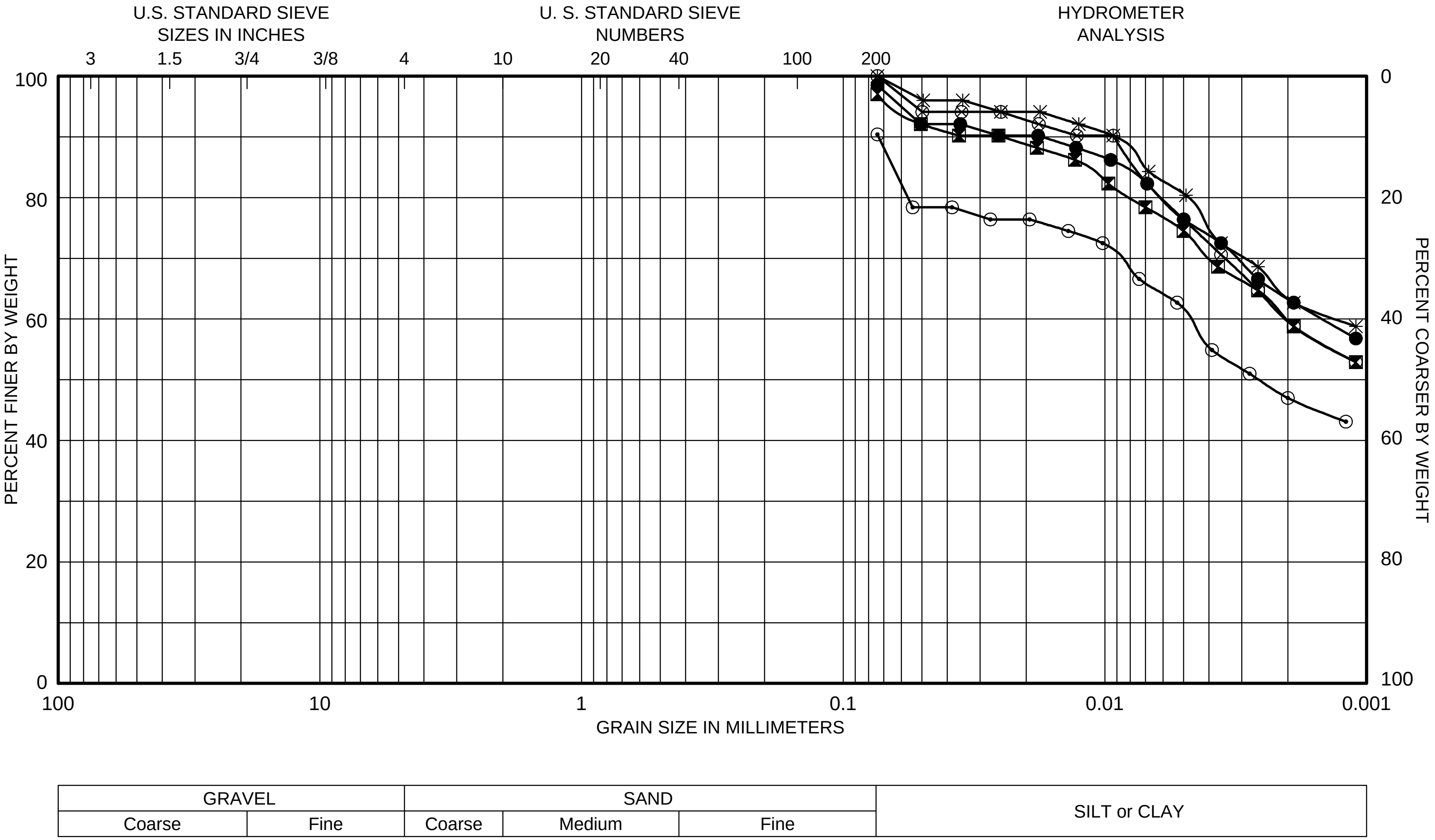
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-18	1.0	CLAY
⧗	B-18	2.0	CLAY
✳	B-18	3.0	CLAY
⊗	B-18	4.0	CLAY
⊙	B-18	5.0	CLAY

GRAIN SIZE CURVE

PLATE B-18

Report No. 0602-1316

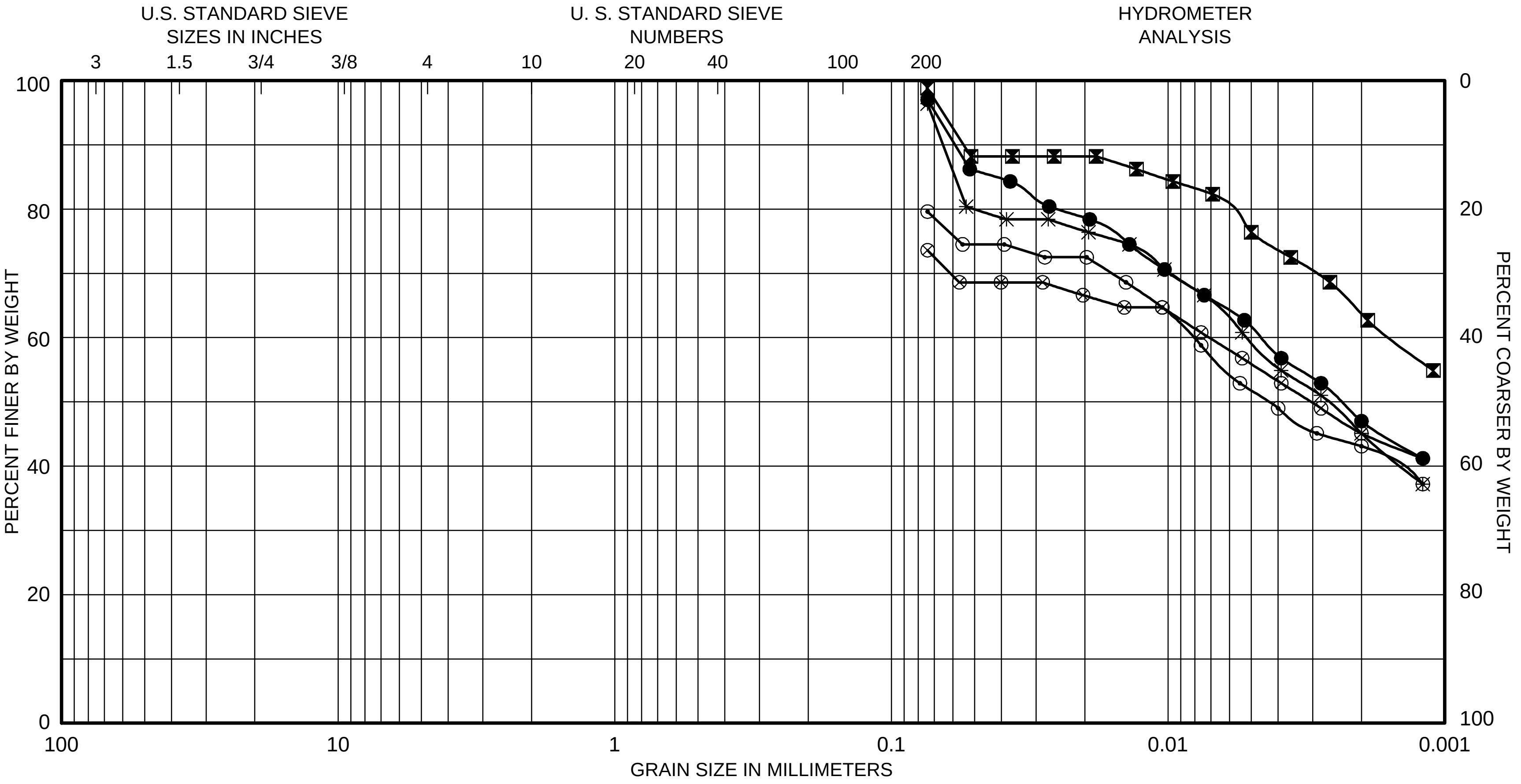


SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-19	1.0	CLAY
⧗	B-19	2.0	CLAY
✳	B-19	3.0	CLAY
⊗	B-19	4.0	CLAY
⊙	B-19	5.0	CLAY

GRAIN SIZE CURVE

PLATE B-19

Report No. 0602-1316



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	LOCATION	SAMPLE NO.	CLASSIFICATION
●	B-20	1.0	CLAY
⧗	B-20	2.0	CLAY
✳	B-20	3.0	CLAY
⊗	B-20	4.0	CLAY
⊙	B-20	5.0	CLAY

GRAIN SIZE CURVE

PLATE B-20