THE WELL INSTALLATION & GEOLOGIC INVESTIGATION FOR THE ISOLATED WETLANDS RESEARCH PROGRAM - PHASE 2

by Kevin P. Rohrer, P.G.

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South Florida Water Management District
Water Use Regulation Department

3301 Gun Club Road • West Palm Beach, Florida 33406 • www.sfwmd.gov

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By Kevin P. Rohrer, P.G.
South Florida Water Management District
Water Use Regulation Department
Criteria and Rule Making Division
3301 Gun Club Road
West Palm Beach, FL 33306
(561) 686-8800
www.sfwmd.gov
krohrer@sfwmd.gov

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EXECUTIVE SUMMARY

The Isolated Wetlands Research Program was initiated in 1996 at the request of the Regulation and Planning Departments of the South Florida Water Management District. The objectives of this program were to develop a better understanding of the hydrology and ecology of isolated wetlands and provide guidance on the development of wetland protection criteria for water use permitting. The information collected as part of Phase 2 will assist in the interpretation of wetland hydrology and the geologic characterization of different wetland settings in South Florida.

This report provides a compilation and summary of drilling and construction information, geology, and lab analysis obtained during Phase 2 of the Isolated Wetlands Research Program. Twenty six wetland monitor wells in four study areas were installed as part of Phase 2. The four study areas include the Flint Pen Strand, Stairstep Project, Hogan Island Farms and Citrus Project. Nine "local" wells, approximately 60 feet deep, and 17 shallow wells approximately 20 feet deep were drilled to obtain information on geology and to establish the infrastructure for long-term hydrological monitoring of isolated wetlands. Water level data collected from these wells will assist in determining local ground water gradients in the surficial aquifer system and to evaluate ground water influences on wetland water levels.

This report provides a compilation and summary of drilling and construction information, geology and lab analysis obtained during Phase 2 of the Isolated Wetlands Research Program.

Hollow stem auger, tripod and mud rotary drilling methods were used to construct the wetland monitor wells to accommodate the site-specific field conditions and minimize environmental impacts. During the drilling of each well, unconsolidated lithologic samples were collected using a split-spoon sampler. Selected split-spoon samples were analyzed for particle size distribution (sieve analysis) on 371 samples to determine subsurface conditions that control ground water movement. Sieve analyses were plotted with respect to percent by weight for each sample. Using an NX core barrel, consolidated samples of limestone were also collected and analyzed in the laboratory for vertical and horizontal hydraulic conductivity. In addition, boring logs for each well provides lithologic descriptions of samples, and document standard penetration tests conducted on the entire depth of each well.

Site specific soil maps for each study area show soil types found in the study areas and are discussed as they relate to the water table and soil charactistics. Using the lithologic samples collected during drilling, geologic cross sections were drawn for each of the four study areas.

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1.0 INTRODUCTION

1.1 Background

The Isolated Wetlands Research Program was initiated in 1996 at the request of the Regulation and Planning Departments of the South Florida Water Management District (SFWMD). The objectives of this Program were to develop a better understanding of the hydrology and ecology of isolated wetlands in South Florida and provide guidance on the development of wetland protection criteria for water use permitting. Staff from the Resource Assessment Division of the SFWMD were charged with establishing a network of long term monitoring sites in isolated wetlands. The scope of the study is to address the following:

- The natural seasonal and annual hydrologic variability of isolated wetlands
- The influence of ground water withdrawals on the frequency, timing, and magnitude of key-hydrologic parameters
- The links between changes in hydrology and adverse changes in wetlands functions

Drilling for this project was divided into two Phases. In Phase 1, 20 wetland monitor wells were installed and instrumented in municipal wellfields and unimpacted reference areas in Lee, Martin, Osceola and Polk counties (Engineered Environmental Solutions Inc., 1997). This phase was completed in the spring of 1997.

In Phase 2, 26 wetland monitor wells were installed, which included 17 shallow wells (approximately 20 feet deep) and nine "local" wells (approximately 60 feet deep). The work was completed in June 1998. This report provides a compilation and summary of the drilling and construction information, geology and lab analysis obtained during phase 2 of the Isolated Wetlands Research Program.

1.2 Purpose and Scope

The purpose of the monitor wells is to establish the infrastructure for long-term hydrological monitoring of the isolated wetlands. Groundwater level measurements will determine local groundwater gradients of the surficial aquifer system that affect and impact the isolated wetland. Long-term monitoring will help to determine seasonal water level variations and detecting potential impacts to isolated wetlands from groundwater pumping. The information collected from the four study areas will assist in the interpretation of wetland hydrology and the geologic characterization of different wetland settings in South Florida.

During the installation of 26 surficial monitoring wells, geologic data was collected and then analyzed to interpret the geologic controls that impact the distribution and movement of the ground water. In addition to describing geology, standard penetration tests were conducted on the entire depth of each well, and grain size was plotted with respect to percent by weight was analyzed to interpret uniformity coefficients and density.

Figure 1 shows the location of the four study areas for Phase 2. The three study areas in Lee County are Flint Pen Strand, Stairstep Project, and Citrus Project; the one study area in Collier County is Hogan Island Farms. Wells drilled in the Flint Pen Strand were intended to supplement seven wetland wells installed as part of Phase 1.

Phase 2 wells in this study area consist of one "local" well installed to the approximate depth of the production zone of the nearby Lee County Utilities Corkscrew Wellfield and two additional

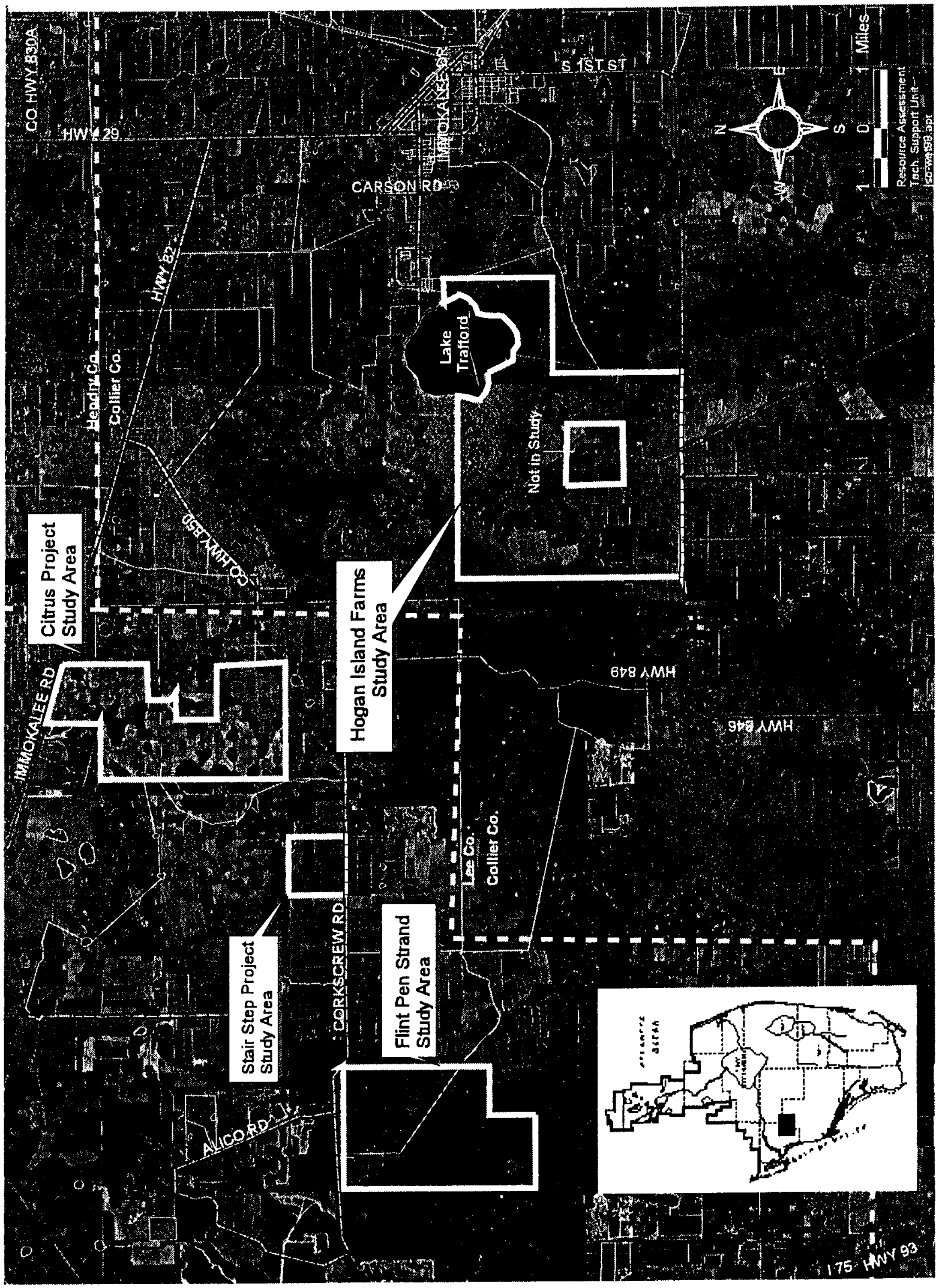

Figure 1. Location of Isolated Wetlands Study Areas

wells installed in hydric flatwoods type wetlands that had not previously been monitored in this area. The Citrus Project and Hogan Island Farms sites were selected as representative of wetlands in lower west coast agricultural settings. Sites in the Citrus Project are located in and adjacent to wetlands in a large surface water management reservoir that is potentially influenced by groundwater pumping for irrigation of citrus groves. Sites in Hogan Island Farms are located in and adjacent to wetlands potentially influenced by groundwater pumping for irrigation of seasonal small vegetable crops. These wetlands are located in unfarmed flatwoods areas adjacent to irrigated fields. Groundwater pumping at both the Citrus Project and Hogan Island Farms is from the surficial (water table) aquifer. Wells installed at the Stairstep Project are intended as reference sites for wetlands on the Citrus Project. Some of these wells are also intended to provide water table information needed to support District land management and restoration activities being conducted on the southern portion of the Stairstep property.

2.0 DRILLING METHODS

2.1 General

Three different drilling methods were used to construct the 26 wetland monitor wells. Methods were selected to accommodate site-specific field subsurface conditions and minimize environmental impacts. The different methods include; the hollow stem auger method, the tripod method and the mud rotary method. During the drilling of each well, unconsolidated samples were collected using a split spoon sampler. Consolidated formation samples were collected by coring to obtain an undisturbed sample. All samples were described and marked for analysis. A detailed description of each drilling method used in Phase 2 is provided below.

2.2 Hollow Stem Auger Method

The majority of the wells (21) were drilled using a 6-5/8 inch inside diameter (I.D) hollow stem auger. This was the preferred method for drilling the shallow 20-foot and 60-foot wells because it was the fastest drilling. To obtain undisturbed samples with the hollow stem auger, the two foot split spoon sampler is attached to a 1-inch drill pipe and placed inside the hollow stem auger and driven into the ground using a slide hammer. After the sample is collected, the hollow stem auger is advanced. The hollow stem auger offers additional advantages in split spoon sampling because the augers do not have to be removed to advance the hole, the rate of penetration is quicker than the other methods, and reliable samples can be collected below the drill bit. After penetrating the length of the split spoon (2 feet), the hollow stem is advanced. Any additional cuttings in the hollow stem is than washed with water to remove the cuttings and to prevent cross contamination of samples from non targeted depths. After completing the borehole, a 2-inch PVC (polyvinylchloride) well casing was lowered down the center of the hollow stem and silica sand was poured around the casing. The hollow stem augers were then pulled out in sections while maintaining the level of sand until the sand was two feet above the 2-foot screen. Bentonite pellets are then poured on top of the sand to provide a 2-foot seal between the sand and cement grout. To complete the well, cement grout is poured down the center of the hollow stem auger and five foot section of augers are than removed while maintaining the level of cement to land surface.

In order to use the hollow stem auger method the drill rig required convenient access and to have dry ground to support the weight of the drill rig. Each site also had to be free of obstructions and trees. If these site conditions could not be met, the tripod method was employed.

2.3 Tripod Method

The tripod method was used to drill three wells HF3, WF1 and WF2. These wells are located in areas with difficult access or when standing water prevented using a hollow stem auger drill rig. This is a labor intensive and time-consuming method requiring all equipment to be hand carried to the site. This method is similar to the method used by a cable tool drill rig where the operator uses a slide hammer to drive the split spoon sampler and steel surface casing in the ground to collect the sample. After removing the sample, a 4-inch diameter, 5-foot long steel casing was driven in the ground again, using the slide hammer. Cuttings are then washed out of the casing using water and the process is repeated until the desired depth is achieved. Two-inch PVC casing is lowered down into the 4-inch steel casing. Then silica sand is poured around the PVC screen.

The steel casing is pulled out in sections while maintaining the level of sand, bentonite and cement grout.

2.4 Rotary Mud Method

The mud rotary drilling method was used on seven of the 60-foot wells ("local wells") FP-11, HF5, HF6, WF8, WF10, ST4 and ST5. At these sites, the formation consisted of consolidated limestone that was too hard to advance the borehole using the hollow stem auger method. On several occasions, circulation was either lost or the hole would not remain open due to sand lenses located in the limestone. Rotary drilling requires using bentonite mud that is re-circulated from a mud pan through the hollow drill pipe. The bentonite mud assists to lift the drill cuttings from the bottom of the hole. The drill fluid builds a mud cake around the walls of the borehole to keep unconsolidated sediments from collapsing around the drill bit and to keep the hole open to install well casing.

A core barrel was attached to the drill pipe to advance the borehole and collect the samples of the consolidated limestone. After collecting the core sample, a larger diameter tri-cone bit was attached to the drill stem and used to ream the borehole to the required casing diameter. To obtain unconsolidated samples within the limestone (sand layer) the split spoon sampler was attached to the drill pipe and hammered in the sediments.

After the designated depth was obtained, the well casing was lowered in the borehole. Tremie pipe was then lowered in the annular space between the well casing and the borehole. Silica sand was poured down the tremie pipe into the annular space until the sand was two feet above the 10-foot screen. Bentonite pellets were then poured in the tremie pipe 2-feet above the sand. To complete the construction of the well, cement is poured through the tremie pipe from the bentonite pellets to land surface.

3.0 WELL CONSTRUCTION AND SAMPLING METHODS

3.1 General

Phase 2 includes the design, construction and analysis of samples collected during the installation of the isolated wetland monitor well network. During well drilling, samples were collected, described, and tabulated for each well. Also documented were the percent recovery, blow counts, drilling methods, photographs of the core and cuttings, well construction specifications and monitor well location maps. Both the 20-foot and 60-foot deep wells were completed to the contractual agreed upon depth or the first occurrence of a competent semi-confining layer that could impede the downward movement of the water table. The 20-foot wells are located in the interior or edge of a wetland and are used to measure ground water levels directly influencing the wetland. The 60-foot wells referred to as "local" wells are used to measure adjacent background water levels to determine the hydraulic gradients and water table influences in the production zone that directly influence water levels in the wetland. Drilling continued past the contractual 60-foot depth at several sites to determine thickness of the clay or limestone encountered during well construction. This information is helpful when determining factors affecting ground water movement. **Figure 2** shows the typical construction design of the 20 and 60-foot isolated wetland monitor wells.

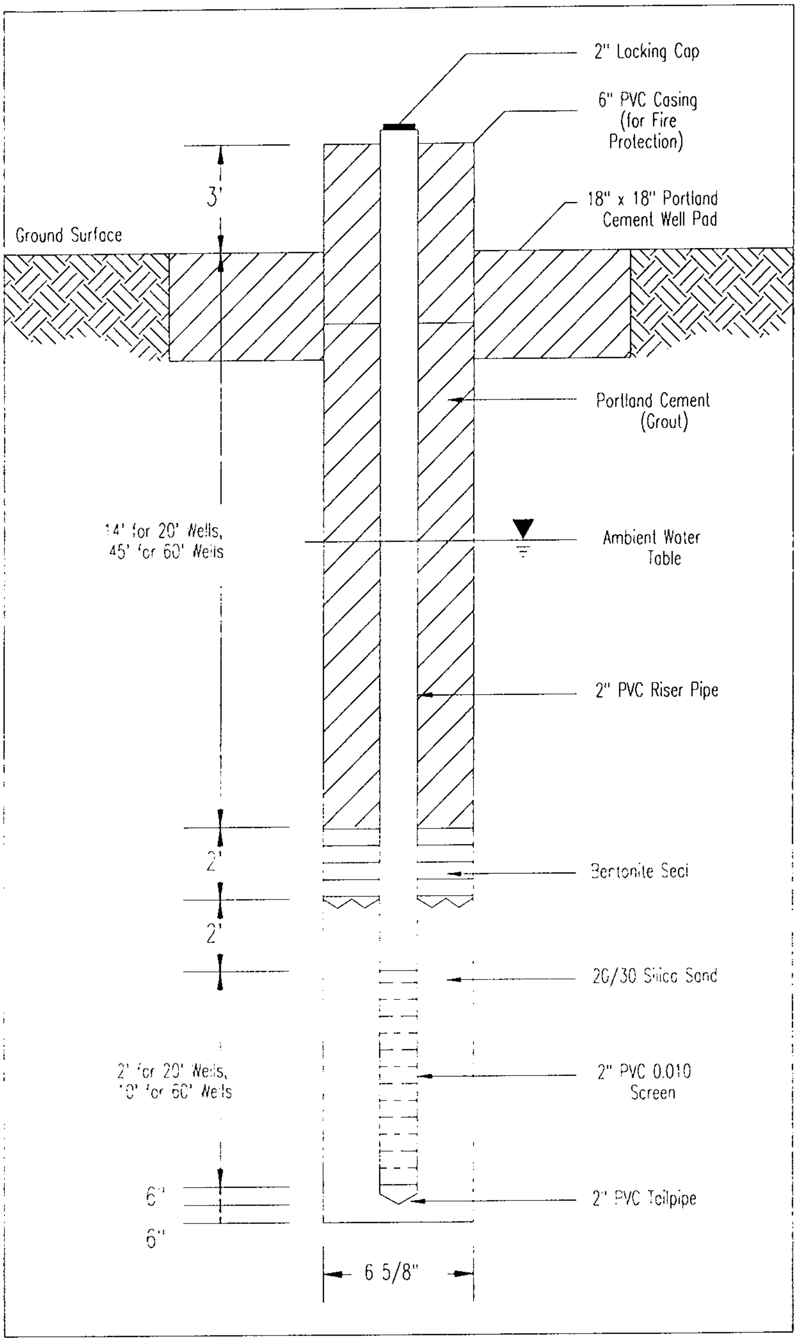

Figure 2. The typical construction design of a Wetland Monitoring Well for the Isolated Wetland Project - Phase 2

Table 1 lists the construction specifications for each of the monitor wells. Each well was constructed of 2-inch diameter, schedule 40 PVC casing with 2-inch diameter 0.010-inch slotted PVC screens. The shallow monitoring wells had 2 feet of screen and the 60-foot wells used 10 feet of screen. All wells were constructed using tri-loc threaded connections. Each well screen was packed with 20/30 silica sand followed by two feet of bentonite clay. Portland cement completed the well to the surface. All wells were fully developed using either centrifugal pump or airlift method until all visible particulate matter had been removed from the water. Discharge water from the well was placed on upland areas to minimize impacts to the wetland.

3.2 Penetration Rates and Split Spoon Sampling

The standard procedure for split spoon sampling followed the criteria established in the ASTM D-1586. Penetration rates were timed and recorded for each six inch split spoon sample collected. Sediment density is obtained from penetration rates in which the number of blows per foot are recorded as a split spoon sampler is driven by a 140 lb hammer falling 30 inches (Driscoll, 1987). Rate of penetration was recorded on the lithologic drilling log located in the Appendices A, B, C and D. The penetration rates for each well was also included in the study site boring logs, which is located in the separate chapters for each study area. Estimates of hydraulic conductivity of surficial material can be estimated from graphs based on particle size, uniformity coefficients and density (Holtz, 1981). This investigation does not include estimates of hydraulic conductivity for the samples collected.

The spilt spoon sampler is one of the best methods to collect an undisturbed sample from a known depth (Driscoll, 1987). This method was used for all wells, regardless of drilling method. The split spoon sampler was driven 2-feet ahead of the drill bit for each well. When using the rotary mud method the split spoon was attached to the drill rod and hydraulically pressed into the unconsolidated formation. The sample was collected and removed from the borehole, the split spoon sampler was opened and the inner transparent plastic tube containing the sample was removed and the sample described.

Once recovered, the clear plastic liner containing the split-spoon sample was capped at both ends to prevent the loss of the sample. General lithology was described by inspecting the contents of the clear plastic tube or by inspecting samples in the bit of the split spoon sampler that was not inside the plastic tube. Four, six-inch sections was measured and marked on the two foot clear tube to indicate which portion of the sample would be analyzed for grain size. The selected six-inch interval was than recorded in the field notes. The field notes documenting the interval as well as the general lithologic description for each well is located in the designated chapter Appendices of this report.

Consolidated samples that could not be collected with the split spoon method were cored using a NX core barrel that was attached to the drill rod. Inspected core samples were placed in corrugated cardboard core boxes and photographed. They were measured to obtain the required six-inch sample to determine percent return and record for falling-head permeability analysis. The results of the permeability analysis are tabulated for each study area in chapters 4 through 7.

3.3 Classification of Soils and Grain Size Distribution

Particle size analyses is useful in classifying soils for interpreting wetland hydrology. Knowing the distribution of grain size with depth helps to determine the subsurface conditions that con-

Table 1. Well Construction Specifications for Isolated Wetland Monitoring Wells

Map Number	Site Name	SFWMD Well ID	Latitude	Longitude	Easting (X)	Northing (Y)	S/TWP/RGE	Well Diameter (inches)	Casing Depth feet (bls)	Total Depth feet (bls)	Screen Interval (feet)	Approx. Height of measuring Point from landsurface (feet)	Elevation of MP (feet) (NGVD)
1	Flint Pen Strand	FP9	264233	817219	419489	760224	33/46S/26/E	2	17	19	2	3.00	19.56
2	Flint Pen Strand	FP10	264332	817234	419424	763818	33/46S/26/E	2	14	16	2	3.00	19.19
3	Flint Pen Strand	FP11	264352	817161	421819	764546	33/46S/26/E	2	50	60	10	2.95	19.26
4	StairStep Project	ST1	264601	816322	449332	773461	20/46S/27E	2	18	20	2	2.80	31.27
5	StairStep Project	ST2	26445	816323	449295	775023	20/46S/27E	2	18	20	2	3.00	31.16
6	StairStep Project	ST3	264643	816384	447286	774989	20/46S/27E	2	18	20	2	3.00	31.04
7	StairStep Project	ST4	264648	816333	448977	775157	20/46S/27E	2	50	60	10	3.10	32.19
8	StairStep Project	ST5	264509	816434	445627	770106	20/46S/27E	2	50	60	10	3.20	30.32
9	Hogan Island Farms	HF1	263963	815268	483720	750094	09/47S/28E	2	19	21	2	2.44	21.92
10	Hogan Island Farms	HF2	263964	815255	484124	750152	09/47S/28E	2	18	20	2	2.94	21.86
11	Hogan Island Farms	HF3	263807	815295	482806	744433	21/47S/28E	2	15	17	2	3.24	25.28
12	Hogan Island Farms	HF4	263904	815260	483964	750501	09/47S/28E	2	18	20	2	3.00	23.41
13	Hogan Island Farms	HF5	263805	815278	483353	744352	21/47S/28E	2	62	72	10	2.75	25.89
14	Hogan Island Farms	HF6	263961	815266	483770	750039	09/47S/28E	2	65	75	10	3.29	24.05
15	Hogan Island Farms	HF7	263975	815266	483775	750526	09/47S/27E	2	18	20	2	3.20	24.64
16	Hogan Island Farms	HF8	263705	815325	484762	740707	21/47S/28E	2	70	80	10	2.60	26.39
17	Citrus Grove	WF1	265184	815806	466285	794548	35/45S/27E	2	16.5	18.5	2	3.34	32.26
18	Citrus Grove	WF2	265018	815900	463192	788550	02/46S/27E	2	17.5	19.5	2	4.00	33.29
19	Citrus Grove	WF3	264924	816128	455729	785154	10/46S/27E	2	18	20	2	2.69	30.35
20	Citrus Grove	WF4	264777	816115	456107	779802	15/46S/27E	2	20	22	2	3.15	30.83
21	Citrus Grove	WF5	264856	815978	445627	770106	10/46S/27E	2	18	20	2	2.55	31.72
22	Citrus Grove	WF6	264784	816050	458262	780059	15/46S/27E	2	17	19	2	3.35	31.40
23	Citrus Grove	WF7	264796	815982	460483	780468	15/46S/27E	2	18	20	2	2.60	31.79
24	Citrus Grove	WF8	265184	815804	466360	794556	35/45S/27E	2	35	45	10	2.80	33.16
25	Citrus Grove	WF9	265021	815899	463219	788663	02/46S/27E	2	35	45	10	2.90	32.87
26	Citrus Grove	WF10	264795	815982	460474	780464	15/46S27E	2	55	65	10	2.96	32.18

trol ground water movement. Particle size analysis was performed on a total of 371 soil samples during this Phase 2 investigation.

Specific split spoon samples were analyzed for particle size distribution by the contractor, Engineered Environmental Solutions Inc., (EESI). A procedure for determining particle size distribution is described in the American Society for Testing and Materials (ASTM, 1980). The six-inch intervals were sieved using the procedure outlined in the ASTM-422 standard. The set of sieves used to determine gain size distribution includes numbers (mesh opening) 10 (2.0mm), 20 (0.85mm), 30(0.60mm), 40(0.42mm), 50(0.30mm), 60(0.25mm), 80(0.18mm), 100(0.15mm), 140(0.0.106mm), 170(0.09mm), and 200(0.075mm). The fraction smaller than a 200 sieve was analyzed by the hydrometer method as described in the above ASTM standards. The procedure for particle size gradation included taking a portion of the sample interval and oven drying at temperatures below 110 degrees Fahrenheit (higher temperatures may destroy clay particles). The sample is than pre-sieved, weighed and recorded. The oven-dried samples are placed on the largest mesh-size sieve of a group of interlocking sieves. The sample is then placed into the sieve stack, and is vibrated to enable individual particles to fall through the progressively smaller mesh size sieves. The shaker operates for 15 minutes per sample. The material retained on each sieve is weighed and expressed as a percentage of the total sample. The percent difference between the initial weight and the recovered weight should be less than 3 percent.

The sieve data was then entered into the Geotechnical Integrator Software (gINT) version 3.2. The results were then output by gINT in the form of grain size distribution curves. The curve is plotted on a graph which is comprised of grain size in millimeters along the X-axis and percent finer by weight along the Y-axis. In addition to the curves, gINT will interpret the curve and automatically classify the soil according to American Society of Testing Materials (ASTM) and Unified Soil Classification System (USCS). In certain instances, samples contained large amounts of shell material and limestone. This resulted in a large portion of the sample being retained on the #10 sieve and thereby altering the gradation curve. The gINT program would not classify the material under these circumstances and appropriate field was left blank. This required the soil classification be input manually and where this occurred, the soil classification is preceded with an asterisk.

The overall gradation of a soil may be determined from the shape of the plotted curve. As an example, a near-vertical curve indicates a poorly-graded sand where all particles are of the nearly the same size and fall within the sand size range. Conversely, the spread of particles sizes over a relatively large range of grain size suggests a well graded soil. This distinction between poorly graded and well graded soils may be expressed numerically by a uniformity coefficient defined by the ratio of the D_{60} sieve and the D_{10} the sieve (ASTM, 1980):

$C_u = D_{60}/D_{10}$

Where Cu =uniformity coefficient

D_{60}=grain diameter at 60 percent passing

D_{10}=grain diameter at 10 percent passing

For gravel, a uniformity coefficient of less than 4 indicates poor gradation, and greater than 4 indicates a good gradation and is represented by a smooth and reasonably symmetrical curve. In sands, the value of the uniformity coefficient for poorly graded soils from well-graded soils is 6 and greater than 6 indicate good gradation. A well graded soil is typically poorly sorted and has low permeability. A soil sample in which more than 50 percent of the coarse fraction by weight is retained on the number 40 (0.42mm) sieve may be described as gravel. A sample with more than 50 percent of the material passing the number 40 sieve but more than 50 percent of the retained on the number 200 (0.075mm) sieve may be described as a sand. Fine-grained soils are indicated, if more than 50 percent of the sample passes through the number 200 sieve size (Watson, 1993).

Another numerical parameter used to confirm conclusions based on the uniformity coefficient results, is the coefficient of curvature:

$$C_c = D_{30}^{2} / (D_{10} D_{60}) \qquad \textbf{Equation 1}$$

Where: C_c =coefficient of curvature

D_{30} =grain diameter at 30 percent passing.

The coefficient of curvature should be between 1 and 3 for well graded sands. In general, the uniformity coefficient and coefficient of curvature are useful in determining the gradation of marginal soils, where it may be difficult to directly interpret the curve.

The sands with silt size fines may be considered a semi-confining layer that impedes the infiltration of ground water from the water table. The classification of this sand after particle size analyses indicates the sand is poorly graded with silty sand mixture (USCS classification). Fine grained soils, such as silt and fined grained sand, tend to have permeabilities that are lower then those of coarse grained, well graded soils. **Table 2** shows an abbreviated list of general hydrologic properties for soils that were characterized in this investigation.

Table 2. Hydrologic Properties of Selected Soils

USCS Symbol	Relative Permeability	K= ft /day	Drainage
SP	High	>28.35	Good
SW	Medium to High	> 2.835	Good
SM	Medium to Low	2.835 - 0.0028	Fair to poor
SC	Low	0.0028 - 0.0003	Very Poor
ML	Low	0.2835 - 0.0028	Poor

Modified from I.Watson and A. Burnett 1993

S= sand
W= well graded
C= inorganic clay
M= inorganic silt
L = low liquid level /plasticity
P= poorly graded

3.4 Core Analysis

Coring was performed on selected consolidated formations using procedures described in ASTM standard, 2113-83. A NX core barrel was used to obtain samples of limestone too hard for the split spoon sampler to penetrate. These samples were collected and the depth interval recorded on the core sample. The core samples were than analyzed for vertical and horizontal permeability. Samples six inches in length that appeared to be representative of the formation or appeared to be atypical were selected for analyses to compare values that affect vertical ground water movement.

A total of eighteen rock core samples were collected during the construction of monitoring wells in Phase 2. Vertical permeability was calculated using a steady state air cross-flow method to determine air permeability. The testing was performed by Core Laboratories in Midland, Texas. The sample is placed in a rubber hassler sleeve under a pressure up to 400 psi to simulate the pressure at the depth of sample during testing. Upstream and downstream pressures are taken using mercury and water manometer gauges. Flow rates are measured across ceramic plates located between the sample.

The equation to convert permeability to hydraulic conductivity (ft /day) is (Core Laboratories, 1998):

$$K = (V\ L) / (A\ T\ P) \qquad \textbf{Equation 2}$$

where:
K= Hydraulic conductivity (ft/day)
V= Incremental produced volume (ft^3)
L= Length (ft)
P= Differential pressure (ft of H_2O)
A= Cross-sectional area (ft^2)
T= Incremental time (sec)

4.0 FLINT PEN STRAND STUDY AREA

4.1 Site Description

The Flint Pen Strand study area is located in south central Lee County in the vicinity of Lee County Utilities Corkscrew Well Field. The wetland monitoring sites are located just south of Corkscrew Road (CR-850) and approximately 3 miles east of Interstate 75 as shown in **Figure 3.**

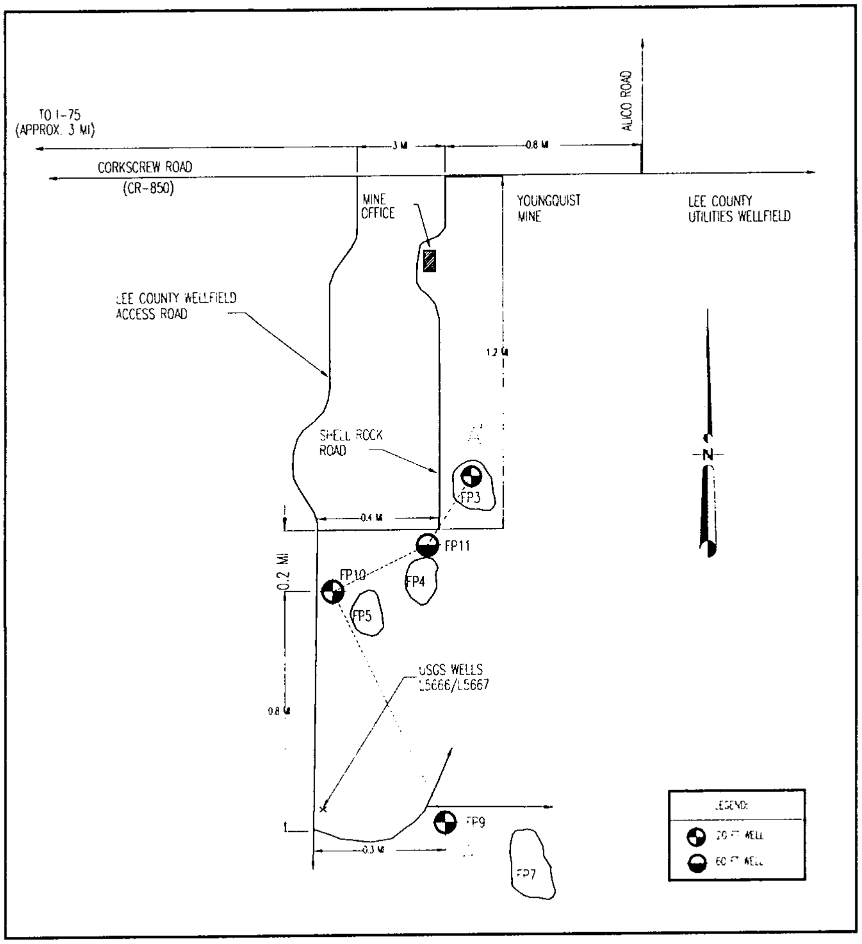

Figure 3. Location of Wetland Monitoring Wells and Geologic Cross Section A-A′ at Flint Pen Strand Study Area, Lee County

This site is likely impacted in several ways, including lowering of water levels in the water table from the nearby wellfield. In addition, many land use changes occurred near the well construction sites during Phase 2. Currently, in a section of the Flint Pen Strand study area there is ongoing mining activity for road building aggregate and processing for cement production. Road building and altering the landscape for future residential development was also occurring at the time wells was being constructed.

Monitor wells installed in Phase 1 were located in cypress dome swamp surrounded by pine or hydric flatwoods. In Phase 2, the monitoring wells are located in hydric flatwoods and wet prairie settings. Three monitor wells are constructed at the Flint Pen Site as part of Phase 2.

4.2 Well Construction

Wells drilled at this site are designated with the letters FP. **Table 1** shows well construction specifications for the wells drilled at the Flint Pen study area. Monitoring wells FP9 and FP10, located in the hydric flatwoods and wet prairie settings were drilled 19 feet and 16 feet bls respectively. An additional 60-foot monitoring well (FP11), was installed to monitor water levels in the approximate zone that Lee County Utility is pumping ground water for water supply. This well is located near study wetland FP4 and along the edge of flat-pinewood margin.

The hollow stem auger method was used to construct wells FP9 and FP10. Well FP11 was first drilled using the hollow stem auger until limestone was encountered at approximately 23 feet bls. Difficulty washing the cuttings out of the borehole as well as drilling through the limestone using the auger bit necessitated changing to the mud rotary drilling method. The NX core barrel replaced the split-spoon sampler, and a four-foot sample was collected. After removing core samples, a tri-cone bit was installed and the core bore hole was reamed using the rotary method. This procedure was repeated until the well was completed. Wells FP9 and FP10 were completed in sand with a 2-foot screen. Well FP11 is completed with a 10-screen in limestone containing shell.

The bore logs for wells FP9, FP10, and FP11 are shown in Figures **4**, **5** and **6**. Penetration rates (blows/foot) were relativity consistent for wells FP9 and FP10. Where the first limestone was encountered approximately 16-feet bls (1 ft NGVD) the penetration resistances increase 80 percent to 76 (blows/foot). Penetration rates decreased after passing through the limestone layer.

4.3 Geology

The geologic cross-section A – A' (**Figure 7**) is based on cuttings descriptions from wells drilled at the Flint Pen study area. Also included in this cross-section is FP3 installed during Phase I. Soil and geologic samples collected at this site indicate two feet of organic material overlies sand and shell mixture which grades into a fine sand and silt. Top of the limestone ranges from 16 feet to 24 feet bls (1 to -7 feet NGVD). In the 60 foot well (FP11) the top of the limestone is located at -7 feet NGVD. A three-foot thick lens of fine grained sand was encountered between 35 to 38 feet bls (-18 to -21 feet NGVD). Also observed was a five foot void between 45 to 50 feet bls (-28 to -33 feet NGVD). General descriptions of well cuttings, sieve analysis intervals and blow counts are provided in **Appendix A.**

4.4 Classification of Soils and Grain Size Distribution

Figure 8 shows the soil survey map for the Flint Pen Study area. The US Department of Agriculture Natural Resource Conservation Service (NRCS) has classified the soils at FP9 and FP10 as Pineda fine sand. This sand has characteristics of loamy, siliceous, hyperthermic Arenic Glossaqualfs. Pineda fine sand has an argillic horizon at a depth of approximately 40-70 inches bls. At site FP11 the soil is classified as Felda Series, is described as a deep, poorly drained, moderately permeable soil found in sloughs or depressions (USDA, 1990). The silty sand layer is also associated with increased blow counts indicating a more condensed and packed formation.

The surficial sands collected at the Flint Pen study area were analyzed for grain size distribution. The classification of sands after gradation analysis indicates that the sands are poorly graded silty sand and is designated by the USCS classification code as a SP soil suggesting a relative high

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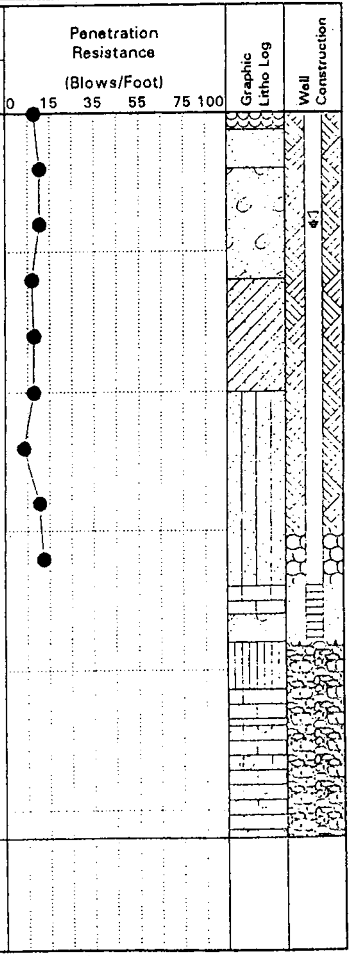
BORING/WELL NO. FP-9

BORING LOG

PROJECT NO./NAME: 1163/Isolated Wetlands Drilling Program - Phase II
LOCATION: Flint Pen Strand, Lee County, Florida
DRILLING CONTRACTOR/DRILLER: Precision Drilling/Robert Miller
GEOLOGIST/OFFICE: Kevin Rohrer/South Florida Water Management District
DRILLING EQUIPMENT/METHOD: Drill Rig/Hollow Stem Auger
SIZE/TYPE OF BIT: 4.5" Hollow Stem Auger
SAMPLING METHOD: Split Spoon
START/FINISH DATE: 5/8/98-5/8/98
WELL INSTALLED? YES ☒ NO ☐
CASING MAT./DIA.: Sch.40 PVC/2"
SCREEN: TYPE Slotted MAT. PVC LENGTH 2' DIA. 2" SLOT SIZE .010
ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING TOP & BOTTOM SCREEN 17'/19' DATE 5/8/98
REMARKS:

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION		Log Notes
		S1	3 3 4 6 7	PT	Organic material Sand	0.6 2.0	
		S2	7 4 6 7 10	SP	Sand, yellow/red w/ shell fragments		
5		S3	6 4 6 7 10	SM-SC		6.0	
		S4	4 3 3 5 6		Sand, organic fine silty sand, gray clay		
		S5	3 3 4 5 7			10.0	
10		S6	4 4 3 7 7	SM	Fine silty sand		
		S7	1 1 1 2 2				
15		S8	3 4 6 6 10		Fine silty sand w/ some organic streaks		
		S9	4 4 8 30 12			17.0	
					Limestone	18.0	
		S10	8 25 refusal		Sand, shell w/ limestone fragments	19.0	
20		S11			Very fine sand	20.7	
		S12			Limestone, light gray, very hard, shell fragments	22.0	
		S13			Limestone, white, micro crystalline, surcosic, shell grading to more shell		
		S14					
25		S15					
		S16				26.0	



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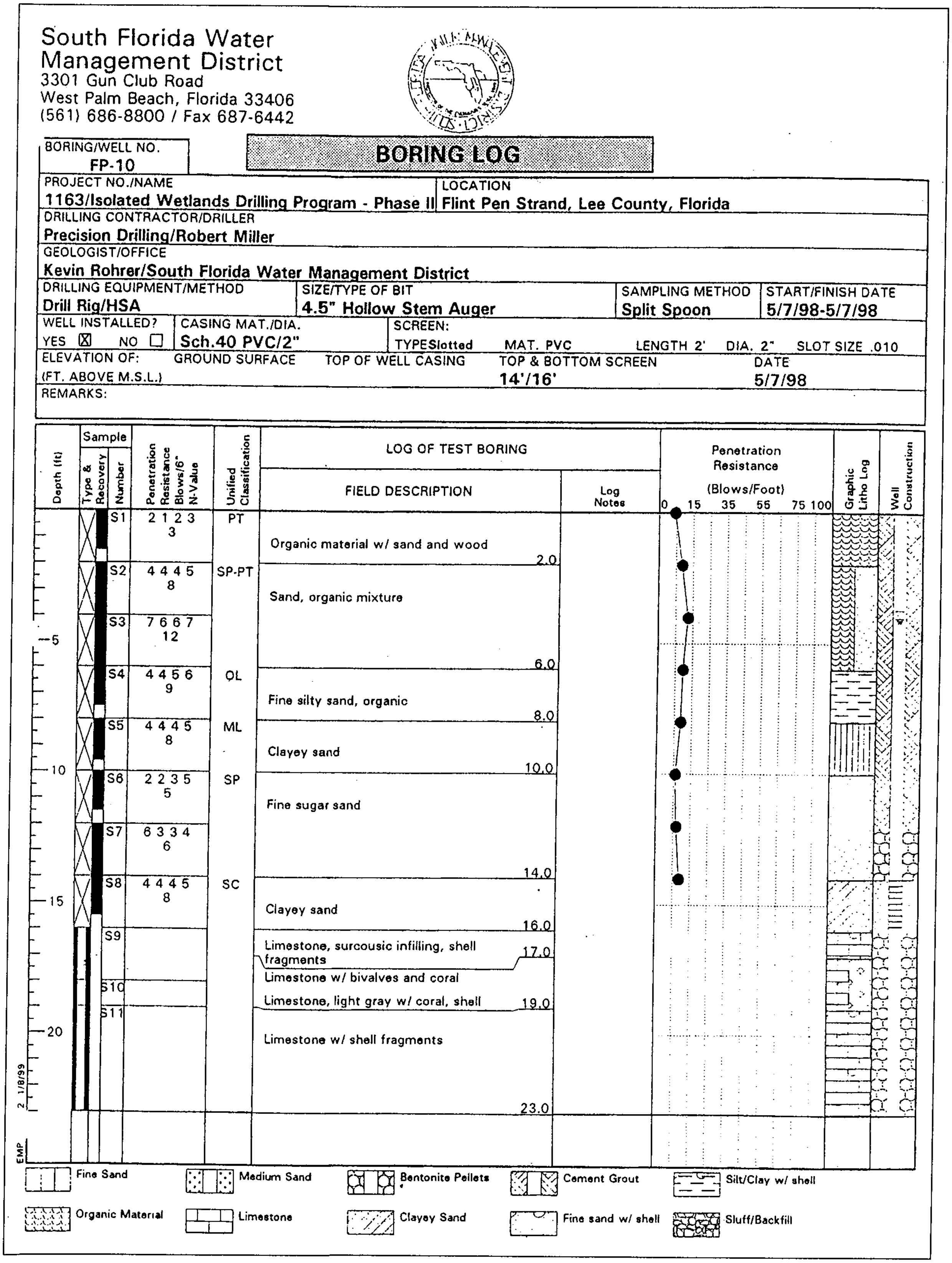
Fine Sand	Medium Sand
Bentonite Pellets	Cement Grout
Silt/Clay w/ shell	Organic Material
Limestone	Clayey Sand
Fine sand w/ shell	Sluff/Backfill

Figure 4. Boring Logs for FP9



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BORING LOG

BORING/WELL NO.: FP-10

PROJECT NO./NAME: 1163/Isolated Wetlands Drilling Program - Phase II

LOCATION: Flint Pen Strand, Lee County, Florida

DRILLING CONTRACTOR/DRILLER: Precision Drilling/Robert Miller

GEOLOGIST/OFFICE: Kevin Rohrer/South Florida Water Management District

DRILLING EQUIPMENT/METHOD: Drill Rig/HSA

SIZE/TYPE OF BIT: 4.5" Hollow Stem Auger

SAMPLING METHOD: Split Spoon

START/FINISH DATE: 5/7/98-5/7/98

WELL INSTALLED? YES ☒ NO ☐

CASING MAT./DIA.: Sch.40 PVC/2"

SCREEN: TYPE Slotted MAT. PVC LENGTH 2' DIA. 2" SLOT SIZE .010

ELEVATION OF: GROUND SURFACE TOP OF WELL CASING TOP & BOTTOM SCREEN DATE
(FT. ABOVE M.S.L.) 14'/16' 5/7/98

REMARKS:

Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	
S1	2 1 2 3 3	PT	Organic material w/ sand and wood	2.0
S2	4 4 4 5 8	SP-PT	Sand, organic mixture	
S3	7 6 6 7 12			6.0
S4	4 4 5 6 9	OL	Fine silty sand, organic	8.0
S5	4 4 4 5 8	ML	Clayey sand	10.0
S6	2 2 3 5 5	SP	Fine sugar sand	
S7	6 3 3 4 6			14.0
S8	4 4 4 5 8	SC	Clayey sand	16.0
S9			Limestone, surcousic infilling, shell fragments	17.0
			Limestone w/ bivalves and coral	
S10			Limestone, light gray w/ coral, shell	19.0
S11			Limestone w/ shell fragments	23.0

Figure 5. Boring Logs for FP10

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BORING/WELL NO.
FP-11

BORING LOG

PROJECT NO./NAME: 1163/Isolated Wetlands Drilling Program - Phase II
LOCATION: Flint Pen Strand, Lee County, Florida
DRILLING CONTRACTOR/DRILLER: Precision Drilling/Robert Miller
GEOLOGIST/OFFICE: Kevin Rohrer/South Florida Water Management District
DRILLING EQUIPMENT/METHOD: Drill Rig/Mud Rotary
SIZE/TYPE OF BIT: 4.5" Hollow Stem Auger
SAMPLING METHOD: Split Spoon
START/FINISH DATE: 5/6/98-5/11/98
WELL INSTALLED? YES ☒ NO ☐
CASING MAT./DIA.: Sch.40 PVC/2"
SCREEN: TYPE Slotted MAT. PVC LENGTH 10' DIA. 2" SLOT SIZE .010
ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING
TOP & BOTTOM SCREEN: 50'/60'
DATE: 5/6/98
REMARKS:

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
		S1	3 4 5 6 9	PT	Organic 0.5 Sand	
		S2	7 7 8 7 15	SP	Fine sand yellow, organic 4.0	
5		S3	5 4 5 5 9		Sand, yellow/red, w/ shell fragments 6.0	
		S4	4 4 6 6 10		Sand, gray to white	
		S5	5 5 5 7 10			
10		S6	4 4 6 8 10			
		S7	4 4 5 6 9		Sand, white, sugar texture	
15		S8	3 3 5 5 8			
		S9	6 4 4 5 8		18.0	
		S10	4 7 5 5 12		Sand w/ shell fragments	
20		S11	6 7 12 0 19		Sand, shell w/ some limestone 22.0	
		S12	19 36 40 - 76		Fine grained sand white 24.0	
25		S13			Limestone, light gray, very hard w/ shell fragments 29.0	
		S14	15 3 12 -			

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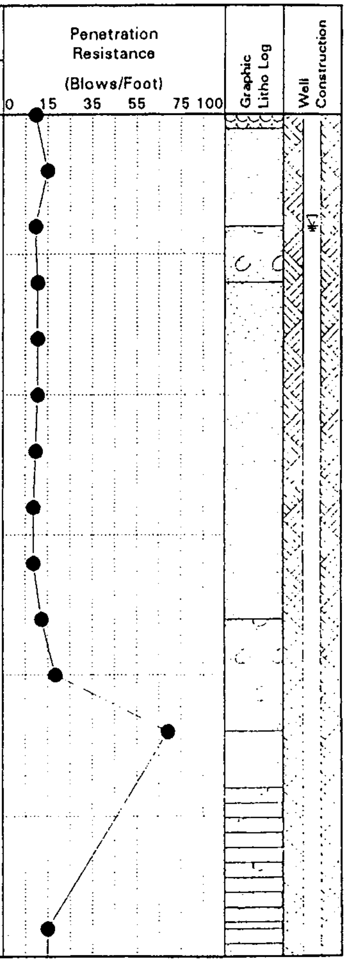
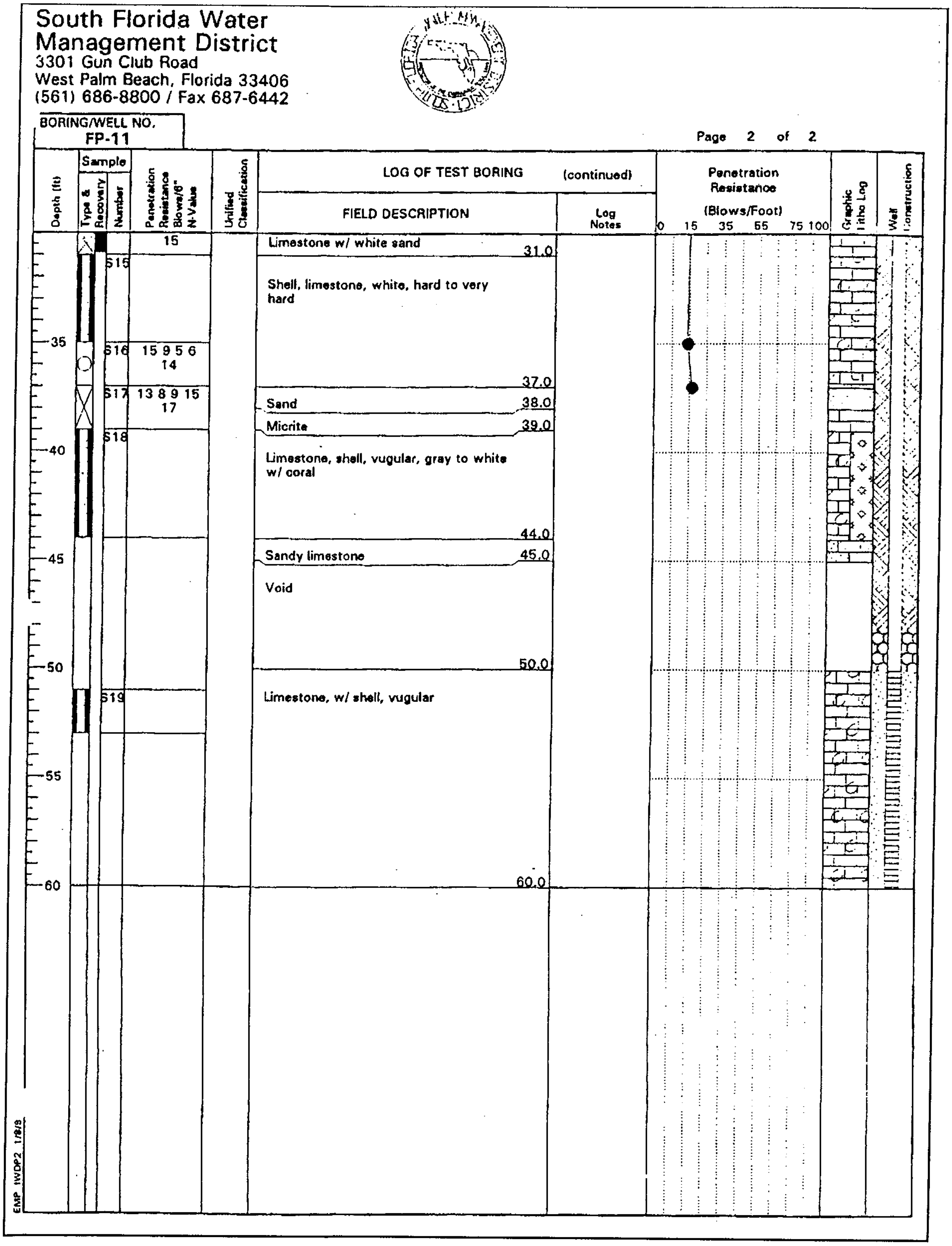


Legend:
- Fine Sand
- Medium Sand
- Bentonite Pellets
- Cement Grout
- Silt/Clay w/ shell
- Organic Material
- Limestone
- Clayey Sand
- Fine sand w/ shell
- Sluff/Backfill

Figure 6. Boring Logs for FP11 (page 1 of 2)



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BORING/WELL NO.
FP-11

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LOG OF TEST BORING (continued)

Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	FIELD DESCRIPTION		Log Notes
	15		Limestone w/ white sand	31.0	
S15			Shell, limestone, white, hard to very hard		
S16	15 9 5 6 14			37.0	
S17	13 8 9 15 17		Sand	38.0	
			Micrite	39.0	
S18			Limestone, shell, vugular, gray to white w/ coral	44.0	
			Sandy limestone	45.0	
			Void	50.0	
S19			Limestone, w/ shell, vugular	60.0	

Figure 6. Boring Logs for FP11 (page 2 of 2)

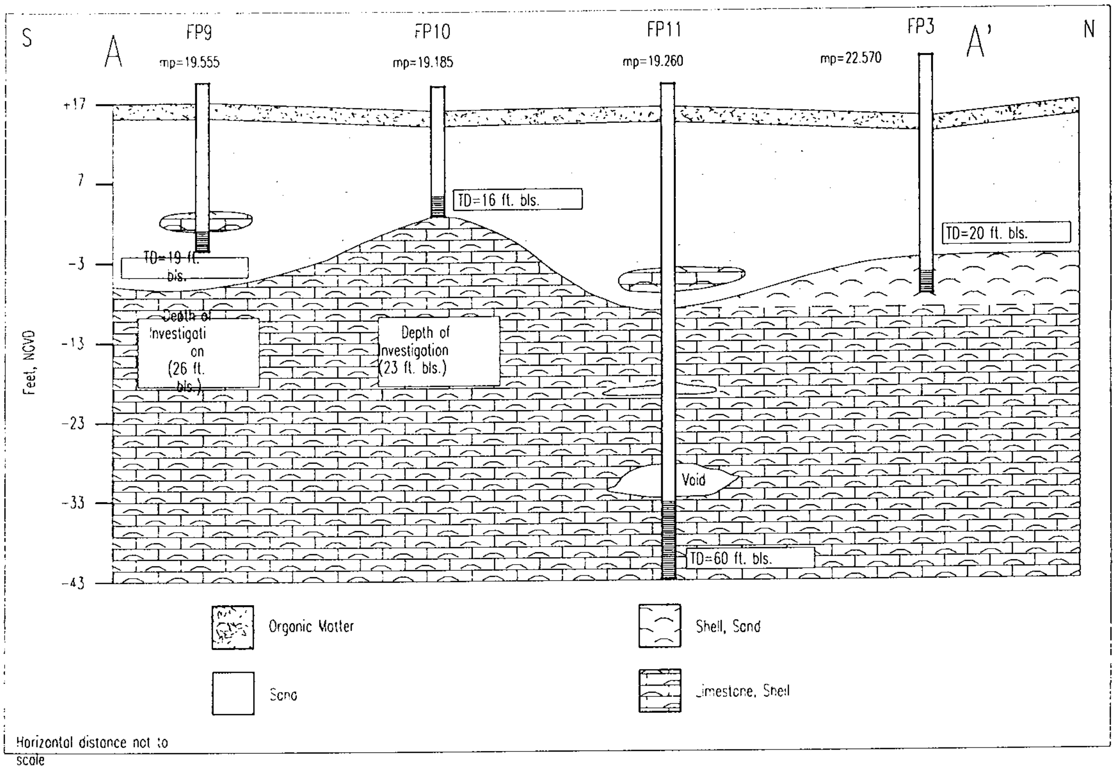

Figure 7. Geologic cross section A-A′ at Flint-Pen Strand Study Area, Lee County

permeability. However, values of coefficient of curvature (Cc) ranged from 0.95 to 1.11 for FP9 and 0.93 to 1.14 for FP10 indicating well-graded sands. This discrepancy may be because of the USCS countywide scale and not site specific environmental factors. Samples taken from FP11 had a larger range of Cc numbers (0.23 to 1.12) primarily due to limestone and shell that was collected at this site. The uniformity coefficient (Cu) ranged from 1.6 to 4.4 for FP9, 1.5 to 1.8 for FP10 and 1.7 to 15.1 for FP11. The gradation curves plotted from grain size distributions data is provided in **Appendix A**.

The fine-grained soils, such as silts and fine-grained sand, tend to have lower permeabilities then those of coarse grained, well graded soils. Sands with more of a silt component may be considered a semi-confining layer that impedes the downward infiltration into the shallow water table. The smaller grain size results in a greater surface area and, in turn, a greater frictional resistance to the flow of ground water.

4.5 Core Analysis

Wells FP9 and FP11 contained consolidated formations which were cored. The rock core samples were analyzed in the lab for hydraulic conductivity. **Table 3** lists the selected intervals that were analyzed in the Flint Pen Strand study area.

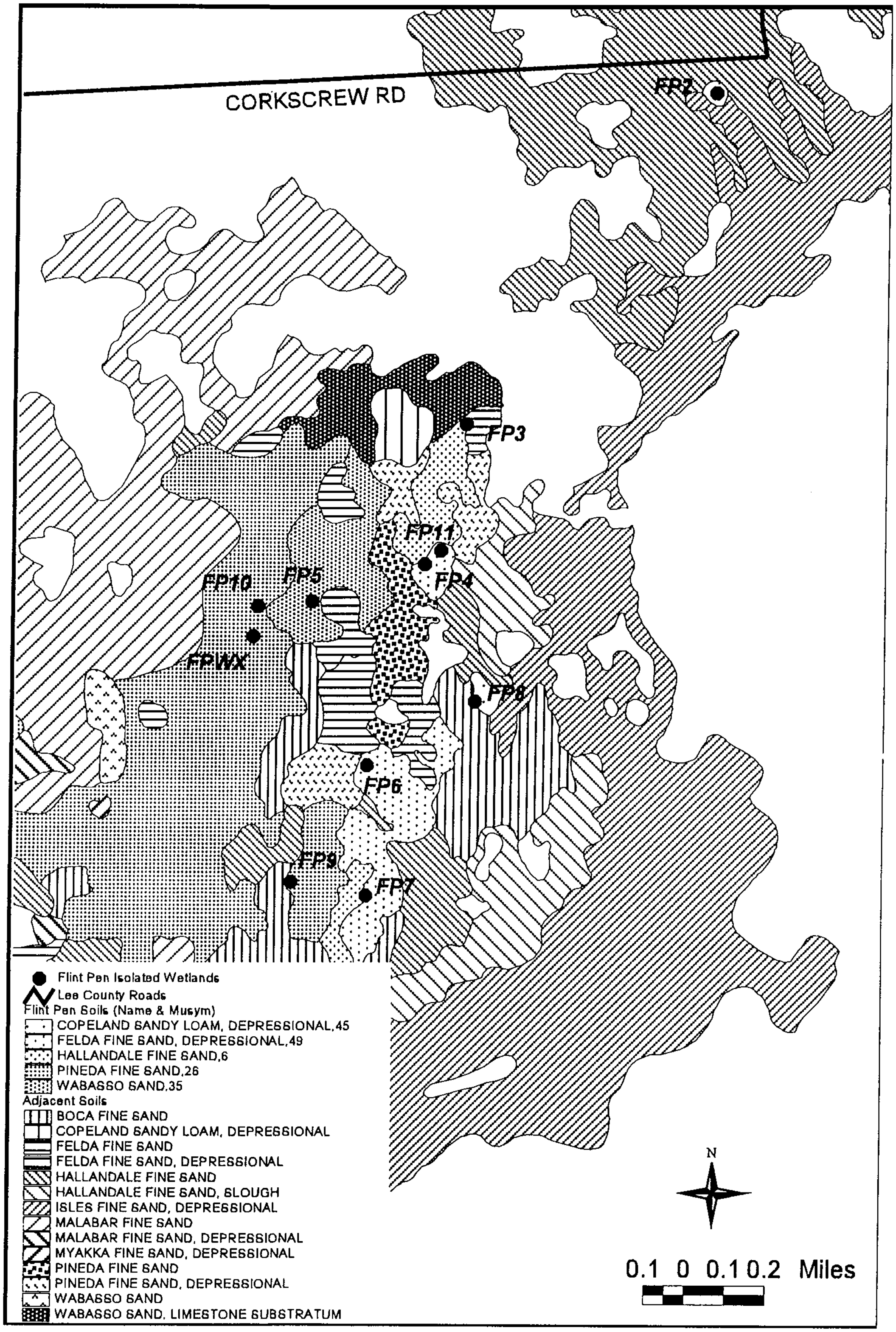

Figure 8. Selected Soil Survey Map of Lee County at the Flint Pen Strand Study Area

Table 3. Values of Hydraulic Conductivity for Selected Intervals at Flint Pen Strand Study Area

Sample Number	Site Name	Top Depth of core interval (ft-bls)	Bottom Depth of core interval (ft-bls)	Horizontal Hydraulic Conductivity (K_h) ft/day	Vertical Hydraulic Conductivity (K_v) ft/day	Description of core
8	FP9	22.5	23.0	0.0005	0.0098	Limestone
9	FP9	24.2	24.7	0.0004	0.0066	Limestone
10	FP9	25.5	26.0	0.0004	0.0066	Limestone
15	FP11	34.0	34.5	0.0005	0.0098	Limestone
16	FP11	40.3	40.8	0.0005	0.0098	Limestone
17	FP11	43.0	43.5	0.0003	0.0066	Limestone
18	FP11	57.0	57.3	0.0008	0.0131	Limestone

5.0 STAIRSTEP PROJECT STUDY AREA

5.1 Site Description

The Stairstep Project study area is part of a regional ecosystem of approximately 5,230 acres (including the Imperial Marsh) established as mitigation for impacts to wetlands associated with the Southwest Florida International Airport. The Stairstep Project is located in southeast Lee County off Corkscrew Road, approximately 4.7 miles east of its junction with Alico Road and 7.5 miles east of I-75 (**Figure 9**). Many of the cypress domes in and adjacent to pasture land were rim-ditched as part of past drainage efforts to convey excess surface water away from the edge of wetlands.

The study area consists of cypress dome swamps, wet prairie, and pasture. Five monitor wells were constructed at this site designated ST1 through ST5. Three shallow wells (ST1 through ST3), completed to a depth of 20 feet bls, are located in selected isolated cypress and marsh wetlands in the northern part of the property. These wetlands were selected as reference sites for wetlands of similar soil types and communities on the Citrus Project. Two "local" wells (ST4 and ST5), completed to a depth of 60 feet bls, are located in upland areas at the north-central and southwest edges of the property. Monitoring well ST4 is located in an uplands stand of pine trees adjacent to wetland ST2 that goes by the same name as the monitoring well found at this site. Well ST5 is located on the edge of a pasture in the southwest corner of the property along Corkscrew Road (SR850). These sites provide information on deeper ground water and on water table gradients between the wetlands and uplands. The monitoring wells are located in a large depression marsh associated with an offsite cypress dome that extends southward to this study site.

5.2 Well Construction

Table 1 shows well construction specifications for wells drilled at the Stairstep Project study area. Monitor wells ST1, ST2, and ST3 are completed to a total depth 20-foot bls (approximately 8.3 NGVD) with 2-foot screens completed in a fine-grained sand. These wells were constructed to monitor shallow water levels in isolated cypress dome wetlands. The hollow stem auger method was used to construct each of these wells. Using a slide hammer, the split-spoon sampler was driven ahead of the auger bit to obtain relatively undisturbed samples. After obtaining a 2-foot sample, the auger was advanced and washed out. This was repeated until achieving the desired depth.

Wells ST4 and ST5 are completed to a total depth of 60-foot bls (approximately 32 feet NGVD) wells that were completed with 10-foot screens within a limestone formation. Both of these wells were constructed using the mud rotary method. Split-spoon samples were collected in the unconsolidated sediments as described in section 3.2 of this report. A core barrel was later attached to the drill rod and limestone samples were collected below 24 feet NGVD. After removing core samples, a tri-cone bit was used to ream the borehole to facilitate continuous coring and well installation. This procedure was repeated until the well was completed.

5.3 Geology

Figure 10 shows the geologic cross-section A - A' based on information obtained from wells drilled at the Stairstep Project study area. The cross-section illustrates the general alignment of

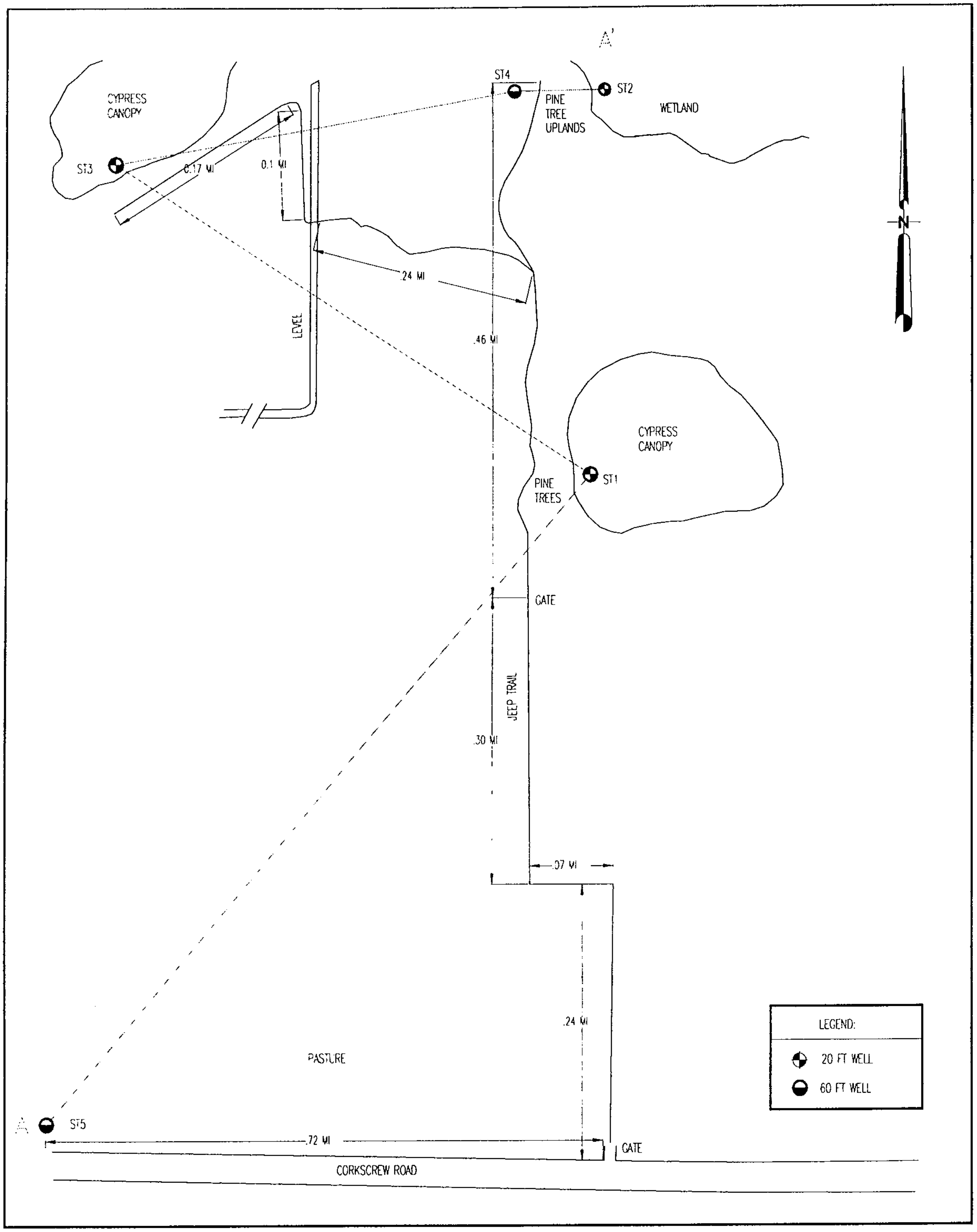

Figure 9. Location of Monitoring Wells on Stairstep Project Study, Lee County Showing Cross Section A-A'

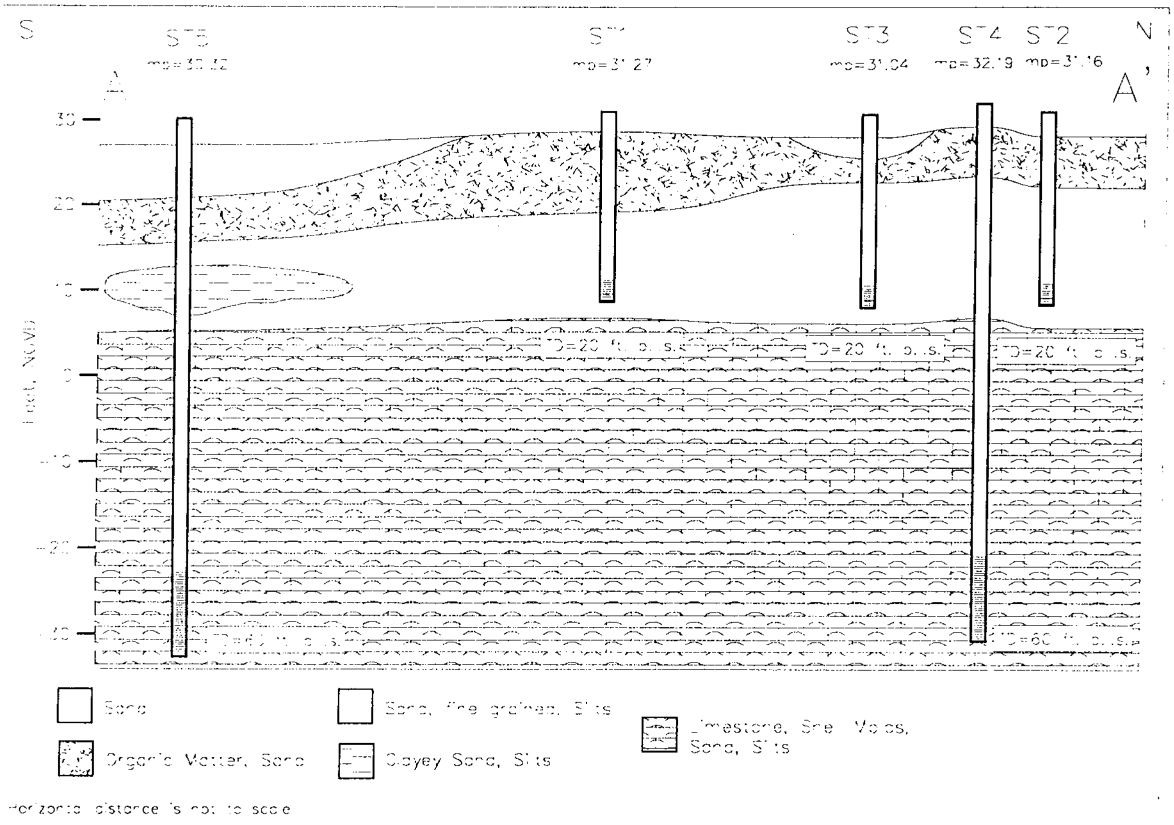

Figure 10. Geologic Cross-Section A-A' at Stair Step Study Area, Lee County

wells and the relatively uniform geology found at each well site. Wells ST1, ST3, and ST2 were completed in fine-grained sand with alternating bands of organic matter. The thickness of this sand is approximately 23 feet as indicated by the cutting samples from wells ST5 and ST4. A very fine-grained sand deposit between 2 and 4 feet thick was observed in wells at ST1, ST2, and ST5 at a depth of 11 to15 feet bls (approximately 10 feet NGVD). These wells are most likely completed in the water table aquifer. Wells ST5 and ST4 indicate limestone occurring at 23 feet bls (approximately 5 NGVD). The thickness of the limestone is not known because none of the wells penetrated deeper then 60 feet bls. The limestone consists of shell fragments, sand and silts most likely correlated to confining beds of the lower Tamiami aquifer. Knapp et. Al. (1986) reported the thickness of the lower Tamiami to be 150 feet.

Bore logs for the five wells are shown in **Figures 11, 12, 13, 14** and **15**. Penetration resistance (blows/foot) was relativity consistent for the 20-foot wells from land surface to about 12 feet bls. At depths approximately 12 feet bls, where fine grained sand was encountered, the blow counts increased approximately 30 percent.

5.4 Classification of Soils and Grain Size Distribution

Figure 16 shows the soil survey map for the Stairstep study area. The majority of sands associated with the depression of the slough system are the Immokalee Sand where monitoring well ST5 is located. The Valkaria Fine Sand and Myakka Fine Sand, where ST2 and ST4 are located, is associated with the cypress dome and the upland pine flatwoods. Pompano Find Sand is associated with a pond cypress dome where ST3 is located. ST1 is located in a wetland depression that is associated with Felda Fine Sand.

The Immokalee Sand is associated with a nearly level, poorly drained soil found in historic flatwoods areas. Most of the time the water table is within 10 inches of the surface for 1 to 3 months and 10 to 40 inches below the surface for 2 to 6 months. The available water capacity is termed as medium in the subsoil and very low in the surface and subsurface layers (USDA, 1998). The Valkaria Fine Sand is associated with wet prairie sloughs. In most years the water table is within 10 inches of the surface for 1 to 3 months and 10 to 40 inches below surface for 6 months, and recedes to a depth of 40 inches for about three months. The Myakka Fine Sand is a deep, moderately permeable soil formed in thick beds of marine sands. Typically, the water table is within 10 inches of the surface from 1 to 3 months and 10 to 40 inches below the surface for 2 to 6 months. The Pompano fine sand is a deep, poorly drained soil that forms in thick beds of sandy soils that occurs in depressions, including most of the cypress domes on the site.

The surficial sand collected at the Stairstep Project site area was analyzed for grain size distribution. The classification of the sands after particle size analysis indicates that the sands are predominately, poorly graded sand with silty sand mixture and is designated by the USCS classification code as a SP soil. Coefficient of curvature values (Cc) ranged from 0.95 to 1.22 for ST1; 0.97 to 1.25 for ST2; 0.74 to 1.34 for ST3; 0.43 to 1.19 for ST4; and 0.37 to 1.19 for ST5. The value for coefficient of uniformity (Cu) for ST1 and ST2 ranged from 1.5 to 1.8, for ST3 the range is from 1.5 to 3.7, for ST4 from 1.5 to 28.2 and for ST5 values ranged from 1.4 to 14.5. The gradation curves plotted from grain size distribution data is located in **Appendix B**.

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BORING LOG

BORING/WELL NO. **ST-1**

PROJECT NO./NAME **1163/Isolated Wetlands Drilling Program - Phase II**

LOCATION **Stairstep Project, Lee County, Florida**

DRILLING CONTRACTOR/DRILLER **Precision Drilling/Robert Miller**

GEOLOGIST/OFFICE **Kevin Rohrer/South Florida Water Management District**

DRILLING EQUIPMENT/METHOD **Drill Rig/HSA**

SIZE/TYPE OF BIT **4.5" Hollow Stem Auger**

SAMPLING METHOD **Split Spoon**

START/FINISH DATE **5/14/98-5/14/98**

WELL INSTALLED? YES ☒ NO ☐

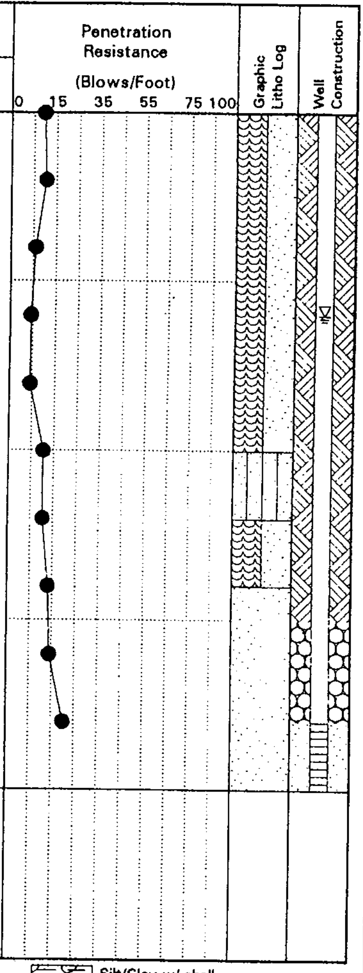
CASING MAT./DIA. **Sch.40 PVC/2"**

SCREEN: TYPE **Slotted** MAT. **PVC** LENGTH **2'** DIA. **2"** SLOT SIZE **.010**

ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING TOP & BOTTOM SCREEN **18'/20'** DATE **5/14/98**

REMARKS:

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
	☒	S1	4 4 5 6 9	PT	Organic, sand	
	☒	S2	4 5 5 7 10	SP-PT	Sand, organic, brown to tan	
5	☒	S3	2 2 3 2 5		Sand (50%), organic (50%)	
	☒	S4	2 1 2 3 3		Organic (70%), sand (30%) brown	
	☒	S5	2 1 2 2 3		Organic (50%), sand (50%) 10.0	
10	☒	S6	2 4 6 6 10	SP	Sand, fine silty 12.0	
	☒	S7	4 4 6 8 10		Organic (50%), sand white (50%) 14.0	
15	☒	S8	6 6 7 7 13		Sand, fine grained, streaks of organic	
	☒	S9	5 6 8 11 14			
	☒	S10	8 10 11 14 21		Sand, very fine, sugar 20.0	
20						



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Fine Sand
Organic Material
Medium Sand
Limestone
Bentonite Pellets
Clayey Sand
Cement Grout
Fine sand w/ shell
Silt/Clay w/ shell
Sluff/Backfill

Figure 11. Boring Logs for ST1

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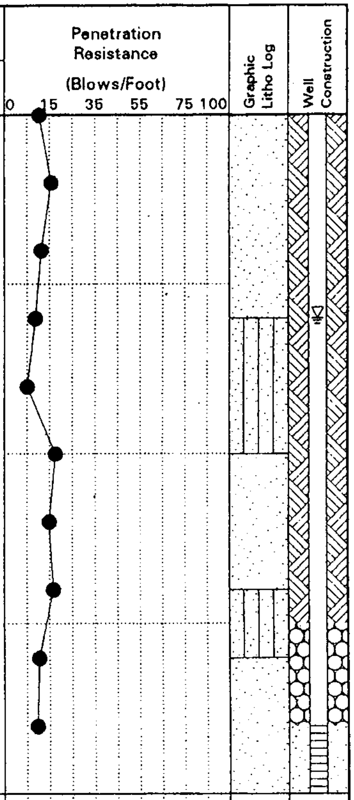
BORING/WELL NO. **ST-2**

BORING LOG

PROJECT NO./NAME: **1163/Isolated Wetlands Drilling Program - Phase II**
LOCATION: **Stairstep Project, Lee County, Florida**
DRILLING CONTRACTOR/DRILLER: **Precision Drilling/Robert Miller**
GEOLOGIST/OFFICE: **Kevin Rohrer/South Florida Water Management District**
DRILLING EQUIPMENT/METHOD: **Drill Rig/Hollow Stem Auger**
SIZE/TYPE OF BIT: **4.5" Hollow Stem Auger**
SAMPLING METHOD: **Split Spoon**
START/FINISH DATE: **5/14/98-5/14/98**
WELL INSTALLED? YES ☒ NO ☐
CASING MAT./DIA. **Sch.40 PVC/2"**
SCREEN: TYPE Slotted MAT. PVC LENGTH 2' DIA. 2" SLOT SIZE .010
ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING TOP & BOTTOM SCREEN **18'/20'** DATE **5/14/98**
REMARKS:

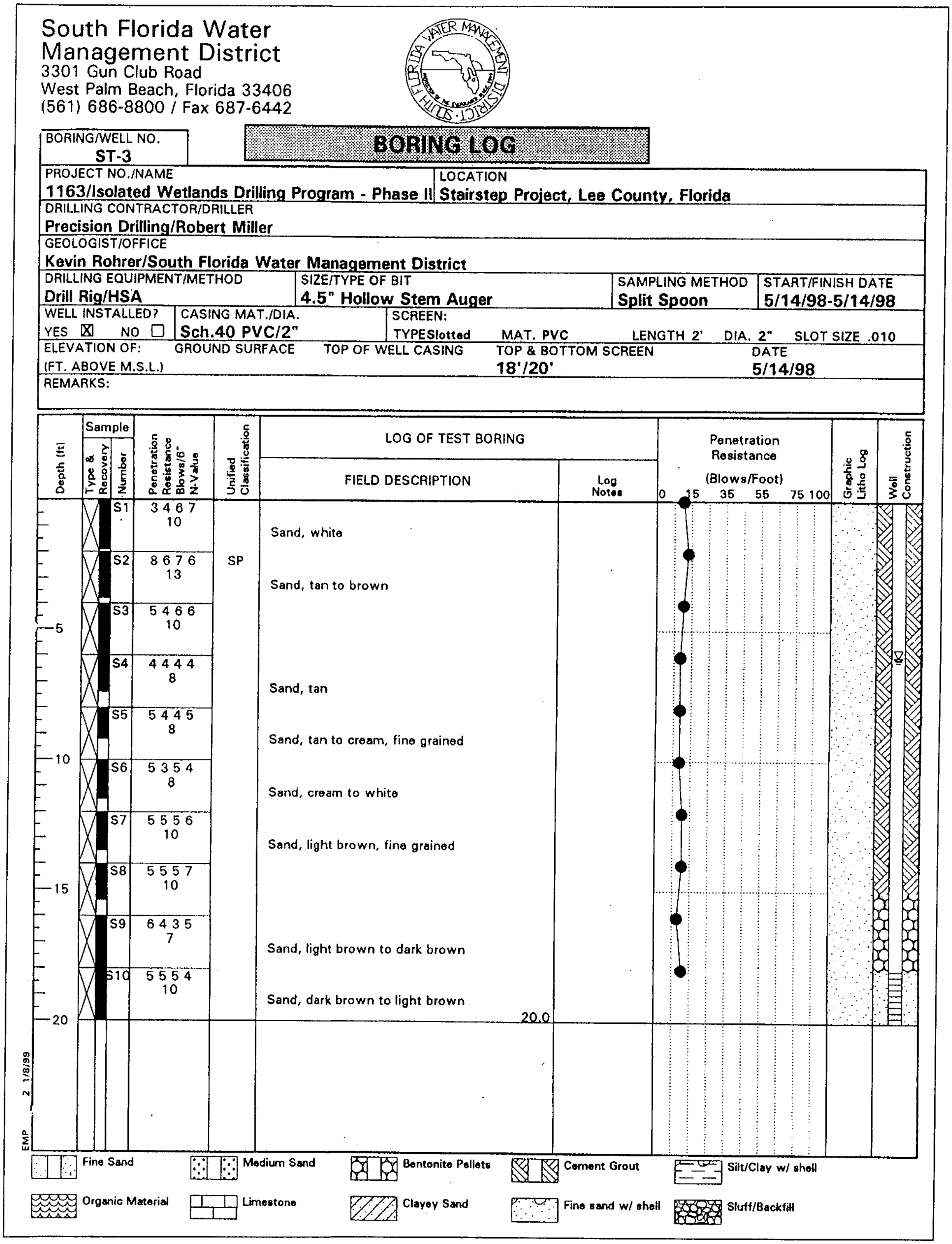
Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
		S1	5 4 6 7 10	PT	2 inches of organic Fine grained sand	
		S2	8 8 8 9 16	SP	Sand, light brown, some organic material	
5		S3	7 5 6 6 11		6.0	
		S4	5 4 4 3 8		Sand, silt, clay?	
		S5	2 2 2 6 4		Sand, silt 10.0	
10		S6	6 8 10 13 18		Sand, fine grained	
		S7	7 6 9 11 15		14.0	
15		S8	7 7 10 12 17		Sand, silt 16.0	
		S9	7 4 6 6 10		Sand	
		S10	5 5 4 6 9		20.0	
20						



EMP 2 1/8/99

Fine Sand
Medium Sand
Bentonite Pellets
Cement Grout
Silt/Clay w/ shell
Organic Material
Limestone
Clayey Sand
Fine sand w/ shell
Sluff/Backfill

Figure 12. Boring Logs for ST2



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BORING/WELL NO. **ST-3**

BORING LOG

PROJECT NO./NAME: **1163/Isolated Wetlands Drilling Program - Phase II**
LOCATION: **Stairstep Project, Lee County, Florida**
DRILLING CONTRACTOR/DRILLER: **Precision Drilling/Robert Miller**
GEOLOGIST/OFFICE: **Kevin Rohrer/South Florida Water Management District**
DRILLING EQUIPMENT/METHOD: **Drill Rig/HSA**
SIZE/TYPE OF BIT: **4.5" Hollow Stem Auger**
SAMPLING METHOD: **Split Spoon**
START/FINISH DATE: **5/14/98-5/14/98**
WELL INSTALLED? YES ☒ NO ☐
CASING MAT./DIA.: **Sch.40 PVC/2"**
SCREEN: TYPE Slotted MAT. PVC LENGTH 2' DIA. 2" SLOT SIZE .010
ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING
TOP & BOTTOM SCREEN: **18'/20'**
DATE: **5/14/98**
REMARKS:

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING Field Description	Log Notes
		S1	3 4 6 7 10		Sand, white	
		S2	8 6 7 6 13	SP	Sand, tan to brown	
5		S3	5 4 6 6 10			
		S4	4 4 4 4 8		Sand, tan	
		S5	5 4 4 5 8		Sand, tan to cream, fine grained	
10		S6	5 3 5 4 8		Sand, cream to white	
		S7	5 5 5 6 10		Sand, light brown, fine grained	
15		S8	5 5 5 7 10			
		S9	6 4 3 5 7		Sand, light brown to dark brown	
		S10	5 5 5 4 10		Sand, dark brown to light brown	
20					20.0	

Fine Sand
Medium Sand
Bentonite Pellets
Cement Grout
Silt/Clay w/ shell
Organic Material
Limestone
Clayey Sand
Fine sand w/ shell
Sluff/Backfill

Figure 13. Boring Logs for ST3

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BORING/WELL NO. **ST-4**

BORING LOG

PROJECT NO./NAME **1163/Isolated Wetlands Drilling Program - Phase II**	LOCATION **Stairstep Project, Lee County, Florida**

DRILLING CONTRACTOR/DRILLER
Precision Drilling/Robert Miller

GEOLOGIST/OFFICE
Kevin Rohrer/South Florida Water Management District

DRILLING EQUIPMENT/METHOD **Drill Rig/Mud Rotary**	SIZE/TYPE OF BIT **4.5" Hollow Stem Auger**	SAMPLING METHOD **Split Spoon**	START/FINISH DATE **5/12/98-5/13/98**

WELL INSTALLED? YES ☒ NO ☐	CASING MAT./DIA. **Sch.40 PVC/2"**	SCREEN: TYPE **Slotted** MAT. **PVC** LENGTH **10'** DIA. **2"** SLOT SIZE **.010**

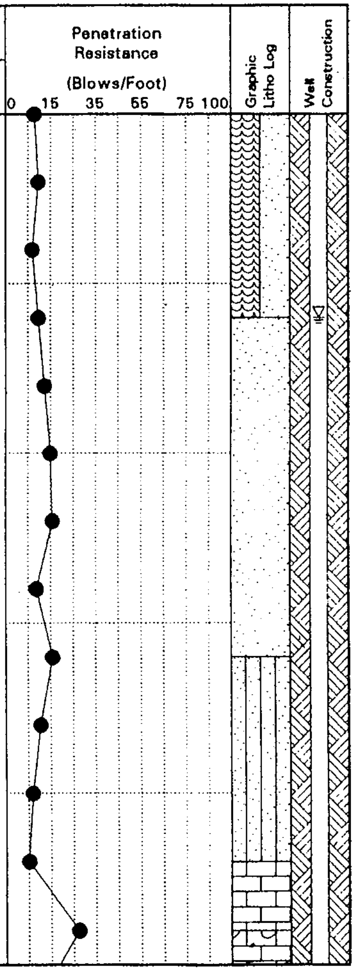
ELEVATION OF: (FT. ABOVE M.S.L.)	GROUND SURFACE	TOP OF WELL CASING	TOP & BOTTOM SCREEN **50'/60'**	DATE **5/13/98**

REMARKS:

LOG OF TEST BORING

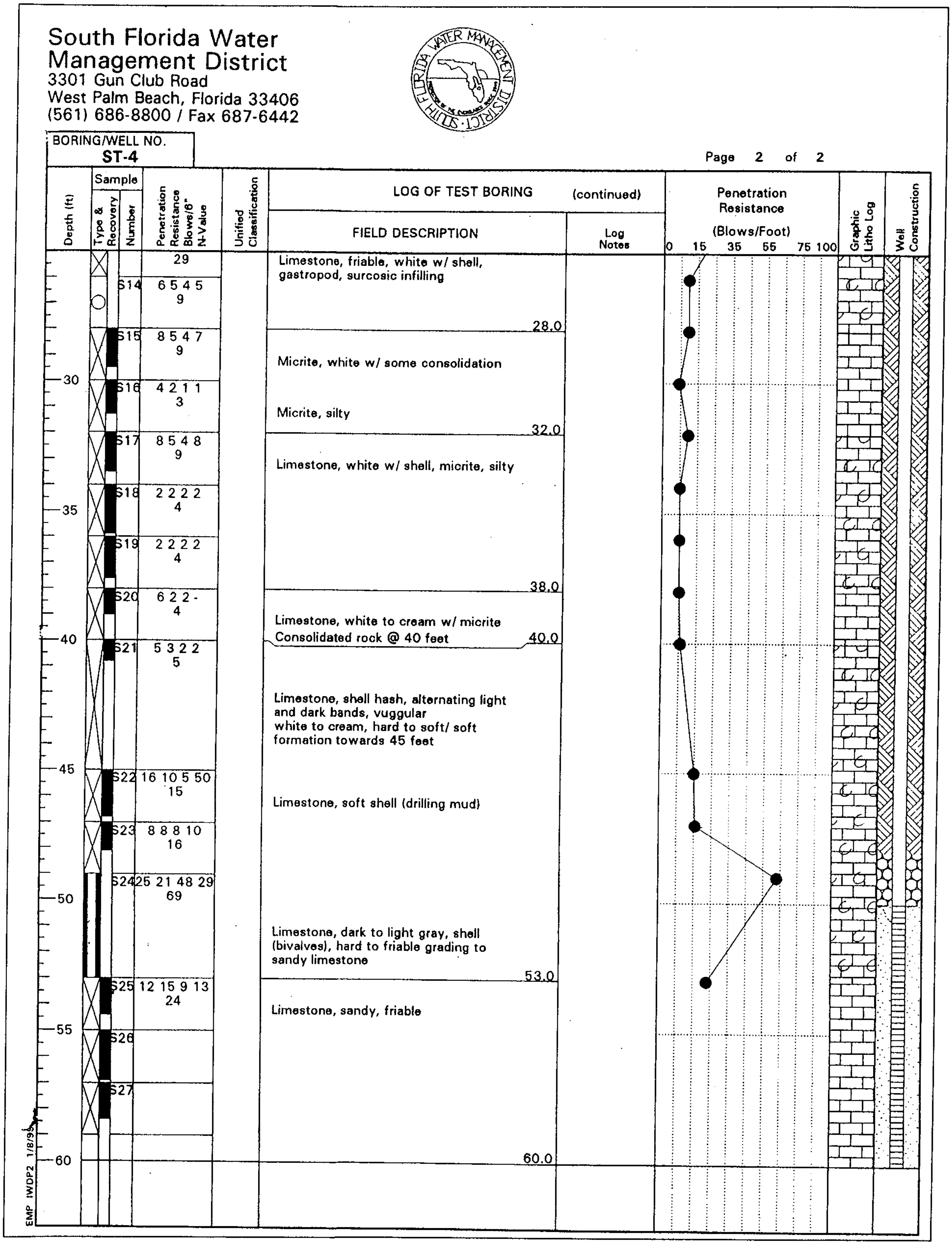
Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	FIELD DESCRIPTION	Log Notes
		S1	3 3 4 4 7	PT	Organic, sand, brown	
		S2	4 5 4 4 9	SP	Sand, white, organic matter	
5		S3	2 3 3 3 6		6.0	
		S4	3 4 5 5 9		Sand, brown	
		S5	6 6 6 8 12		Sand, tan fine grained	
10		S6	6 7 8 8 15			
		S7	6 7 9 9 16			
15		S8	6 4 4 6 8		16.0	
		S9	7 8 8 6 16		Sand, silty, tan	
		S10	5 5 5 2 10		Sand, silty tan/gray	
20		S11	4 3 3 12 6		22.0	
		S12	7 2 2 5 4		Lime mud w/ pieces of limestone, micrite 24.0	
		S13	17 18 11 8			

EMP 2 1/8/99



Fine Sand
Medium Sand
Bentonite Pellets
Cement Grout
Silt/Clay w/ shell
Organic Material
Limestone
Clayey Sand
Fine sand w/ shell
Sluff/Backfill

Figure 14. Boring Logs for ST4 (continued on Page 31)



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BORING/WELL NO.
ST-4

Page 2 of 2

LOG OF TEST BORING (continued)

Depth (ft)	Sample Number	Penetration Resistance Blows/6" N-Value
		29
	S14	6 5 4 5 9
	S15	8 5 4 7 9
30	S16	4 2 1 1 3
	S17	8 5 4 8 9
35	S18	2 2 2 2 4
	S19	2 2 2 2 4
	S20	6 2 2 - 4
40	S21	5 3 2 2 5
45	S22	16 10 5 50 15
	S23	8 8 8 10 16
50	S24	25 21 48 29 69
	S25	12 15 9 13 24
55	S26	
	S27	
60		

FIELD DESCRIPTION

Limestone, friable, white w/ shell, gastropod, surcosic infilling

28.0

Micrite, white w/ some consolidation

Micrite, silty

32.0

Limestone, white w/ shell, micrite, silty

38.0

Limestone, white to cream w/ micrite
Consolidated rock @ 40 feet

40.0

Limestone, shell hash, alternating light and dark bands, vuggular white to cream, hard to soft/ soft formation towards 45 feet

Limestone, soft shell (drilling mud)

Limestone, dark to light gray, shell (bivalves), hard to friable grading to sandy limestone

53.0

Limestone, sandy, friable

60.0

Figure 14. Boring Logs for ST4 (continued from Page 30)

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BORING LOG

BORING/WELL NO. **ST-5**

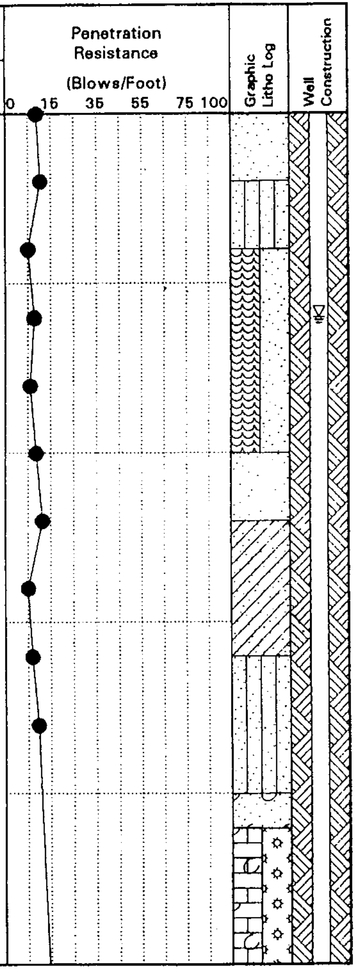
PROJECT NO./NAME **1163/Isolated Wetlands Drilling Program - Phase II**
LOCATION **Stairstep Project, Lee County, Florida**
DRILLING CONTRACTOR/DRILLER **Precision Drilling/Robert Miller**
GEOLOGIST/OFFICE **Kevin Rohrer/South Florida Water Management District**
DRILLING EQUIPMENT/METHOD **Drill Rig/Mud Rotary**
SIZE/TYPE OF BIT **4.5" Hollow Stem Auger**
SAMPLING METHOD **Split Spoon**
START/FINISH DATE **5/15/98-5/19/98**
WELL INSTALLED? YES ☒ NO ☐
CASING MAT./DIA. **Sch.40 PVC/2"**
SCREEN: TYPE Slotted MAT. PVC LENGTH 10' DIA. 2" SLOT SIZE .010
ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING
TOP & BOTTOM SCREEN **50'/60'**
DATE **5/19/98**
REMARKS:

LOG OF TEST BORING

Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	Field Description	Log Notes
S1	3 4 4 6 8	SP	Sand, white 2.0	
S2	7 4 6 4 10		Sand, tan, silts 4.0	
S3	4 2 2 2 4		Sand, tan to dark brown, organic	
S4	3 3 4 5 7	SP-PT	Sand to organic material, white to dark brown	
S5	3 2 3 3 5		Sand to sandy organic material, light brown 10.0	
S6	4 4 4 5 8		Sand, tan to light brown 12.0	
S7	4 4 7 8 11		Sand, white, clayey sand @ 14 feet	
S8	2 2 2 3 4	SC	Clayey sand, white to cream, very fine grained 16.0	
S9	3 2 4 8 6	SP	Sand, white, very fine	
S10	7 6 3 2 9		20.0	
S11	6 Refusal		Limey sand w/ gastropods and sphilapod 21.0	
S12			Limestone, coral, shell molds, vuggular	
S13				

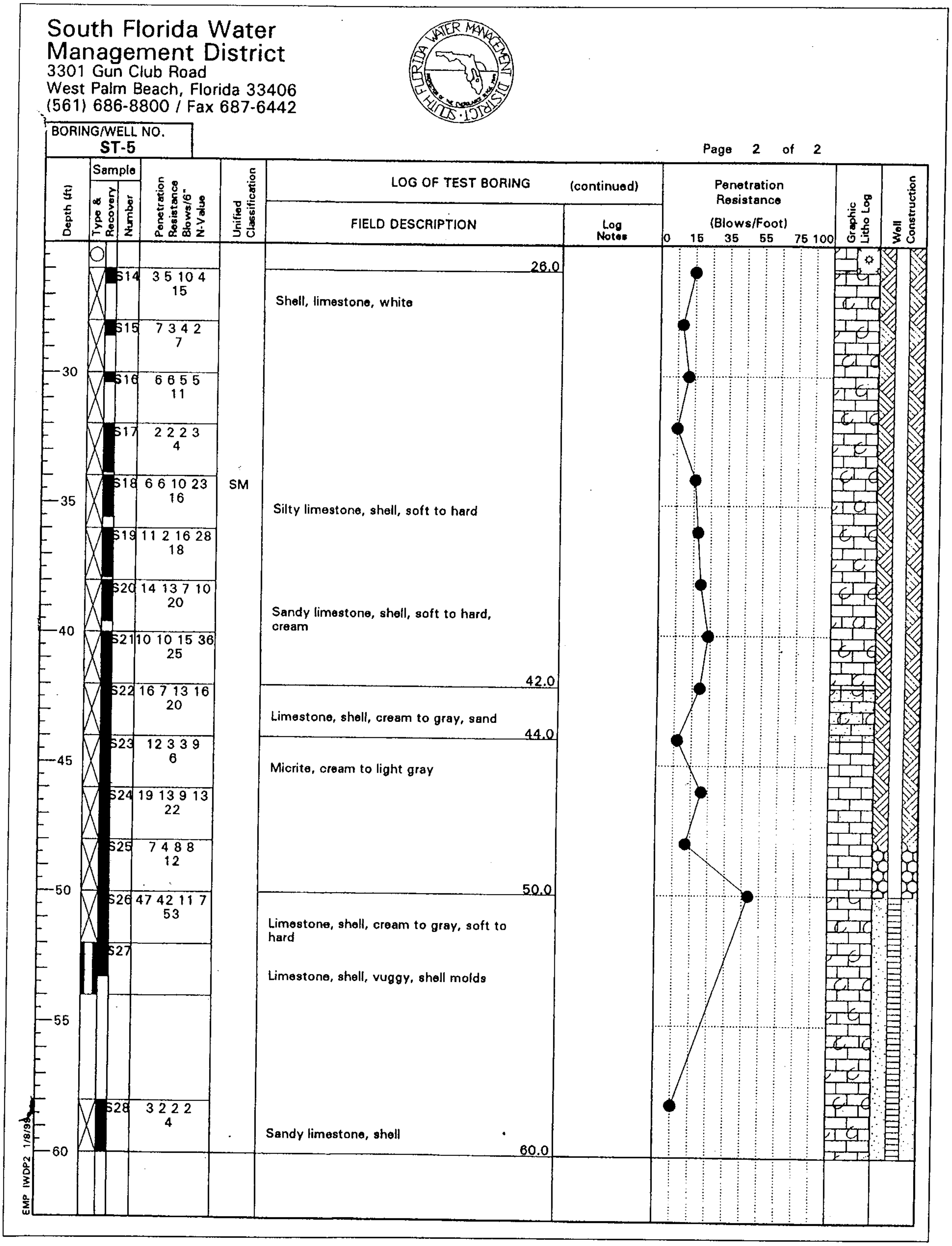
Depth (ft): 5, 10, 15, 20

EMP 2 1/8/99



▥ Fine Sand
▩ Medium Sand
▦ Bentonite Pellets
▧ Cement Grout
▤ Silt/Clay w/ shell
▒ Organic Material
▦ Limestone
▨ Clayey Sand
░ Fine sand w/ shell
▩ Sluff/Backfill

Figure 15. Boring Logs for ST5 (continued on Page 33)



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BORING/WELL NO.
ST-5

Page 2 of 2

LOG OF TEST BORING (continued)

Depth (ft)	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	FIELD DESCRIPTION	Log Notes
26.0	S14	3 5 10 4 15		Shell, limestone, white	
	S15	7 3 4 2 7			
30	S16	6 6 5 5 11			
	S17	2 2 2 3 4			
35	S18	6 6 10 23 16	SM	Silty limestone, shell, soft to hard	
	S19	11 2 16 28 18			
	S20	14 13 7 10 20		Sandy limestone, shell, soft to hard, cream	
40	S21	10 10 15 36 25			
42.0	S22	16 7 13 16 20		Limestone, shell, cream to gray, sand	
44.0	S23	12 3 3 9 6		Micrite, cream to light gray	
45	S24	19 13 9 13 22			
	S25	7 4 8 8 12			
50.0	S26	47 42 11 7 53		Limestone, shell, cream to gray, soft to hard	
	S27			Limestone, shell, vuggy, shell molds	
55					
	S28	3 2 2 2 4		Sandy limestone, shell	
60.0					

Figure 15. Boring Logs for ST5 (continued from Page 32)

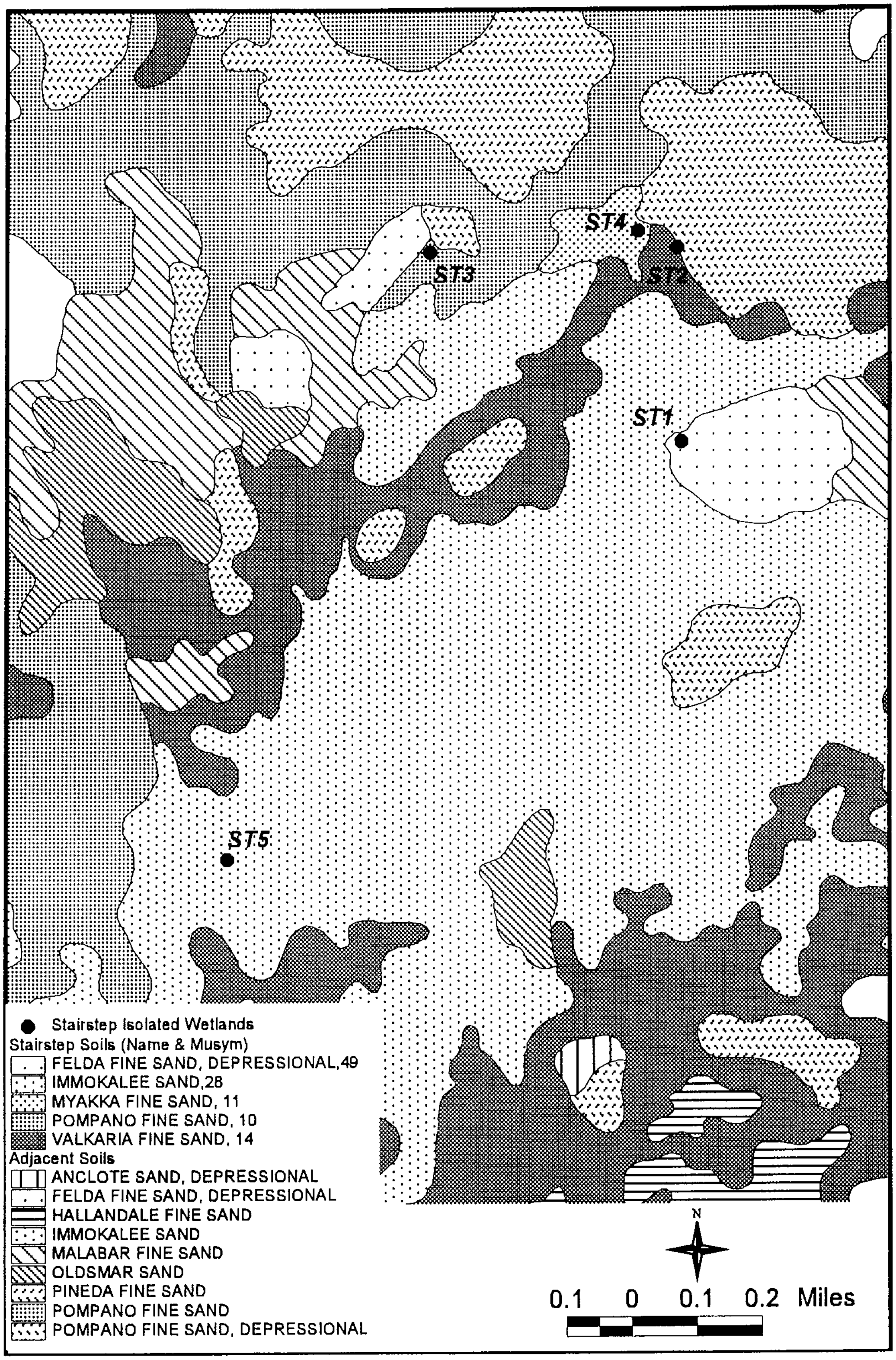

Figure 16. Selected Soil Survey map of Lee County at the Stair Step Project Study Area

5.5 Core Analysis

Wells ST4 and ST5 contained consolidated sediments that were cored and analyzed in the lab for hydraulic conductivity. **Table 4** lists the selected intervals that were analyzed.

Table 4. Values of Hydraulic Conductivity for selected Intervals at Stairstep Project Study Area

Sample Number	Site Name	Top Depth of core interval (ft-bls)	Bottom Depth of core interval (ft-bls)	Horizontal Hydraulic Conductivity (K_h) ft/day	Vertical Hydraulic Conductivity (K_v) ft/day	Description of core
2	ST4	42.6	43.0	16.6316	313.877	Limestone
3	ST4	52.5	53.0	0.0003	0.0066	Limestone
4	ST5	21.0	21.5	0.0004	0.0066	Limestone
5	ST5	52.2	52.7	20.671	390.101	Limestone

6.0 HOGAN ISLAND FARMS STUDY AREA

6.1 Site Description

Figure 17 shows the location of the monitoring sites located on Hogan Island Farms in Collier County. This site is characterized by isolated wetlands surrounded by small vegetable farming operations, pasture, rangeland, and hardwood hammocks. Wells drilled at this site are designated with the letters HF. Eight wells (HF1 through HF8) were drilled at this site to characterize the geology and to interpret ground water movement and wetland hydrology. Wells HF1, HF2, and HF4 are located on the edge of isolated wetlands. Well HF3 is located on the edge of an isolated wetland that was most likely once a part of a slough system. Altering the landscape to build an access road and crop fields may have isolated this wetland. Well HF7 is located in a hardwood hammock. Wells HF5 (73 feet) HF6 (75 feet) and HF8 (80 feet) were drilled as back ground "local" wells. These wells were drilled to provide information on the water table gradients between the isolated wetlands and the uploads. The remainder of the wells HF1, HF2, HF3, HF4 and HF7 (approximately 20-foot) were constructed on the edge of wetlands to determine geologic controls that may influence the water levels in the wetlands and to indicate direction of ground water movement.

6.2 Well Construction

Table 1 shows well construction specifications for wells drilled at the Hogan Island Farms study area. Wells HF1, HF2, HF4 and HF7 were drilled approximately 20 feet bls using the hollow stem auger method. Well HF3 was drilled to 17 feet using the tripod method because of the sensitivity of the wetland and difficulty accessing the site with a mobile drilling rig. Each of these wells is completed with 2-foot screens.

The deeper wells HF5 (-46.11 feet NGVD), and HF6 (-50.95 feet NGVD) were initially drilled using the hollow stem auger method until limestone was encountered at approximately 20 feet bls. Difficulty washing the cuttings out of the borehole as well as difficulty drilling through the limestone using the auger bit nessitated changing to the mud rotary drilling method. The NX core barrel replaced the split-spoon sampler for formation samples. Well HF8 (-56 feet NGVD) was drilled using the mud rotary method through out its entire depth. The NX core barrel was used after getting to the consolidated limestone approximately 20 feet bls. Each of these wells is completed with 10-foot screens. Boring logs for wells HF1 through HF8 are shown in **Figure 18** through **25**. Penetration rates (blows per foot) were relatively consistent for each well for unconsolidated soils while high rates reflected consolidated composition, such as limestone, shell and fine sand.

6.3 Geology

Well cuttings and split-spoon samples were examined to determine the general lithologic units from eight monitoring wells drilled on the Hogan Island Farms study area. **Figure 26** shows the geologic cross-section A – A' of eight wells. In most of the wells one to two feet of organic matter was observed from land surface except in well HF8, where organic matter was observed underlying approximately 5 foot of sand. Split spoon samples from wells HF5 and HF3, indicate approximately 8 feet of organic and sand mixture before undifferentiated sand was observed. Following the organic matter is a sequence of undifferentiated sands that ranged 6 to 19 feet thick and

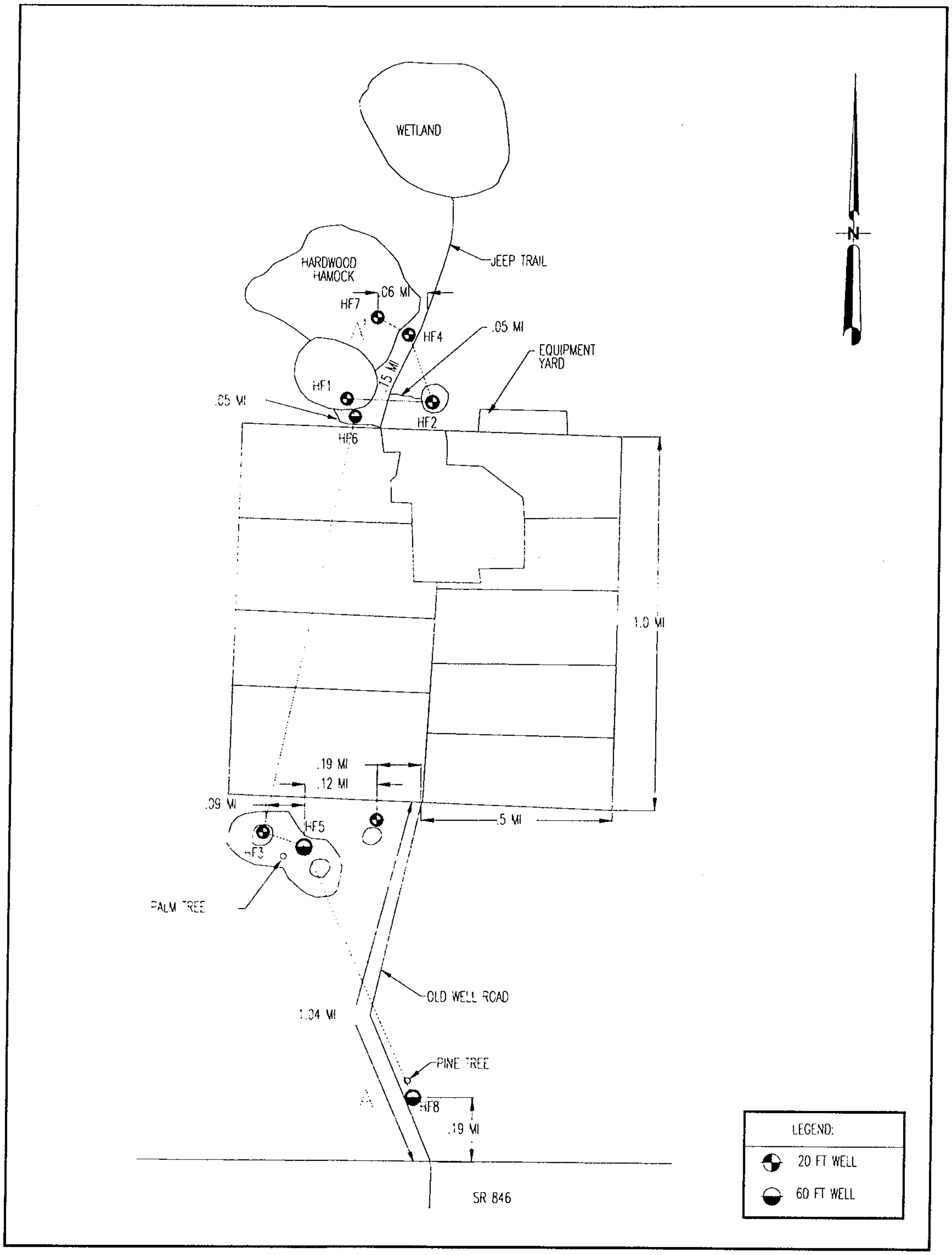

Figure 17. Location of Monitoring Wells on Hogan Island Farms, Collier County, Showing Cross Section A-A'

extended down between 13 feet to approximately –7 feet NGVD. Underlying the undifferentiated sands is sandy limestone, sand and shell mixture. The top of the sandy limestone ranges from 10 feet NGVD to approximately -16 NGVD and averages approximately 20-feet thick. Split spoon samples from monitoring well HF5, located between HF8 and HF6, indicated the shallow limestone layer is absent and is replaced by a thicker sequence of sand (34 feet thick). The absence of limestone in HF5 suggests a sedimentary facies change occurred. This may be either a result of a clastic depositional environment that was formed during the deposition of carbonate limestone, or a fluvial environment that eroded the limestone and sand was deposited in its place. In well HF3, located adjacent to HF5, limestone was observed at approximately 10 feet NGVD. Twenty foot wells, HF2, HF4 and HF7 also did not penetrate in the limestone suggesting the formation is dipping to the north in the study area.

Underlying the limestone is a horizon of variable clay, sand and silt approximately 30 feet thick. Samples collected from monitoring well HF6 located approximately 1.8 miles north of site HF8 is the same lithologic sequence but the depths are shifted approximately six feet shallower. The lowest unit penetrated by the monitor wells is another sequence of sandy limestone, limestone and phosphate. The top of this unit ranges in depth from –36 feet NGVD to –46 feet NGVD.

6.4 Classification of Soils and Grain Size Distribution

Figure 27 shows the soil survey map on the Hogan Island Farms study area. The majority of soils occurs at this site are associated with the Oldsmar Fine Sand (wells HF5, HF8). Sands collected from wells installed on wetland edges (HF1 and HF3) are most likely from the Chobee series unit associated with depressional wetlands. Boca fine sand is associated with the upland fringe of wetlands where wells HF2, HF4, HF6, and HF7 are located.

Oldsmar fine sand is a nearly level, poorly drained soil found in flatwoods. Typically, the surface layer is dark grayish brown fine sand about 4 inches thick. The subsurface layer is fine sand to a depth of about 35 inches. The upper part of the subsurface layer is light gray, and the lower part is light brownish gray. The subsoil extends to a depth of about 60 inches. The permeability of this soil is typically slow. Under natural conditions, the seasonal high water table is between 6 to 18 inches for 1 to 6 months. During the remainder of the months the water table is below a depth of 18 inches, and recedes to a depth of more than 40 inches during extended dry periods (USDA, 1998).

The Chobee series consists of level, very poorly drained soils located mostly in swamps and marshes. These soils formed in thick beds of loamy marine sediments. The surface layer of these soils are black fine-loamy, siliceous, and are about 6 inches thick. The subsurface layer is also black fine sandy loam to a depth of about 13 inches. The subsoil is mottled sandy clay loam to a depth of about 45 inches. The upper part of the subsoil is dark gray, and the lower part is gray. The permeability of the Chobee soil is moderate. Under natural conditions, these soils are ponded for 6 months or more during most years. During other months, the water table is within a depth of 12 inches, and it recedes to a depth of 12 to 40 inches during extended dry periods. (USDA, 1998).

The Boca fine sand is a nearly level, poorly drained soil located in flatwoods. The surface layer is very dark gray fine sand about 4 inches thick. The subsurface layer is fine sand to a depth of about 26 inches. The upper part of the subsurface layer is light gray, and the lower part is brown. The subsoil is grayish brown fine sandy loam to a depth of about 30 inches. The permeability of this soil is moderate. The seasonal high water table is at a depth of 6 to 18 inches for 1 to

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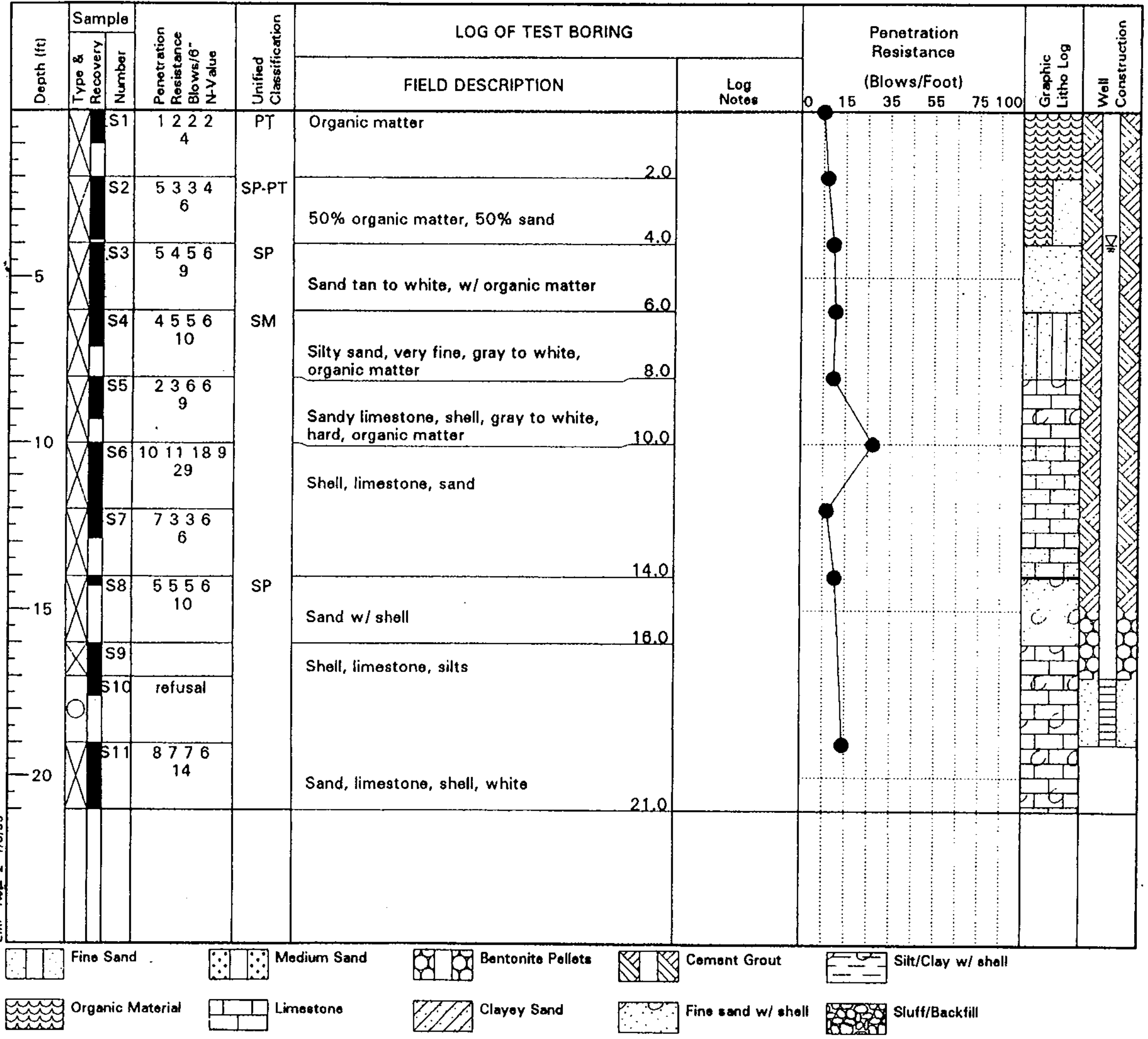
BORING LOG

BORING/WELL NO.	**HF-1**
PROJECT NO./NAME	**1163/Isolated Wetlands Drilling Program - Phase II**
LOCATION	**Hogan Island Farms, Collier County, Florida**
DRILLING CONTRACTOR/DRILLER	**Precision Drilling/Robert Miller**
GEOLOGIST/OFFICE	**Kevin Rohrer/South Florida Water Management District**
DRILLING EQUIPMENT/METHOD	**Drill Rig/Hollow Stem Auger**
SIZE/TYPE OF BIT	**4.5" Hollow Stem Auger**
SAMPLING METHOD	**Split Spoon**
START/FINISH DATE	**5/21/98-5/21/98**
WELL INSTALLED?	YES ☒ NO ☐
CASING MAT./DIA.	**Sch.40 PVC/2"**
SCREEN:	TYPE Slotted MAT. PVC LENGTH 2' DIA. 2" SLOT SIZE .010
ELEVATION OF: (FT. ABOVE M.S.L.)	GROUND SURFACE TOP OF WELL CASING
TOP & BOTTOM SCREEN	**19'/21'**
DATE	**5/21/98**
REMARKS:	



Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
		S1	1 2 2 2 4	PT	Organic matter 2.0	
		S2	5 3 3 4 6	SP-PT	50% organic matter, 50% sand 4.0	
5		S3	5 4 5 6 9	SP	Sand tan to white, w/ organic matter 6.0	
		S4	4 5 5 6 10	SM	Silty sand, very fine, gray to white, organic matter 8.0	
		S5	2 3 6 6 9		Sandy limestone, shell, gray to white, hard, organic matter 10.0	
10		S6	10 11 18 9 29		Shell, limestone, sand	
		S7	7 3 3 6 6		14.0	
15		S8	5 5 5 6 10	SP	Sand w/ shell 16.0	
		S9			Shell, limestone, silts	
	○	S10	refusal			
20		S11	8 7 7 6 14		Sand, limestone, shell, white 21.0	

EMP 2 1/8/99

Figure 18. Boring Logs for HF1

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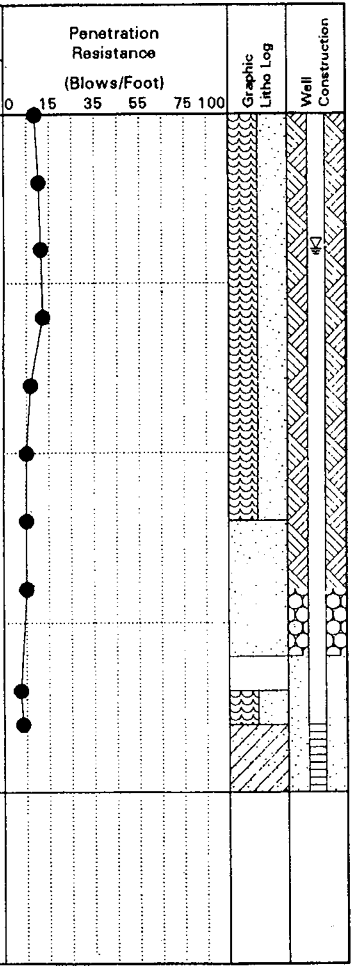
BORING/WELL NO.
HF-2

BORING LOG

PROJECT NO./NAME: **1163/Isolated Wetlands Drilling Program - Phase II**
LOCATION: **Hogan Island Farms, Collier County, Florida**
DRILLING CONTRACTOR/DRILLER: **Precision Drilling/Robert Miller**
GEOLOGIST/OFFICE: **Kevin Rohrer/South Florida Water Management District**
DRILLING EQUIPMENT/METHOD: **Drill Rig/HSA**
SIZE/TYPE OF BIT: **4.5" Hollow Stem Auger**
SAMPLING METHOD: **Split Spoon**
START/FINISH DATE: **5/22/98-5/22/98**
WELL INSTALLED? YES ☒ NO ☐
CASING MAT./DIA.: **Sch.40 PVC/2"**
SCREEN: TYPE Slotted MAT. PVC LENGTH 2' DIA. 2" SLOT SIZE .010
ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING TOP & BOTTOM SCREEN **18'/20'** DATE **5/22/98**
REMARKS:

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
		S1	5 4 4 2 8	SP-PT	Sand, organic matter, off white, fine grained	
		S2	5 5 5 6 10		Sand, organic matter mix light gray, fine grained	
5		S3	5 5 6 7 11		Sand, organic matter, light gray fine grained	
		S4	10 6 6 6 12		Sand, organic matter, off white, fine grained	
		S5	4 3 3 4 6		Sand, w/ some organic matter, light gray fine grained	
10		S6	2 2 2 3 4		Sand, organic matter, light brown to gray 12.0	
		S7	2 2 2 2 4	SP	Sand, light brown	
15		S8	1 2 2 2 4		16.0	
					void 17.0	
		S9	2 1 0 4 1		Sand, 50% organic matter 50% 18.0	
20		S10	1 0 2 2 2	SC	Sand to sandy clay 20.0	



EMP 1/8/99

▥ Fine Sand
▦ Medium Sand
▩ Bentonite Pellets
▧ Cement Grout
☰ Silt/Clay w/ shell
▤ Organic Material
▦ Limestone
▨ Clayey Sand
▦ Fine sand w/ shell
▩ Sluff/Backfill

Figure 19. Boring Logs for HF2

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BORING/WELL NO.
HF-3

BORING LOG

PROJECT NO./NAME
1163/Isolated Wetlands Drilling Program - Phase II

LOCATION
Hogan Island Farms, Collier County, Florida

DRILLING CONTRACTOR/DRILLER
Precision Drilling/Robert Miller

GEOLOGIST/OFFICE
Kevin Rohrer/South Florida Water Management District

DRILLING EQUIPMENT/METHOD
Tripod/SPT

SIZE/TYPE OF BIT
3'-5" dia. casing, driven and washed

SAMPLING METHOD
Split Spoon

START/FINISH DATE
5/27/98-5/28/98

WELL INSTALLED? YES ☒ NO ☐

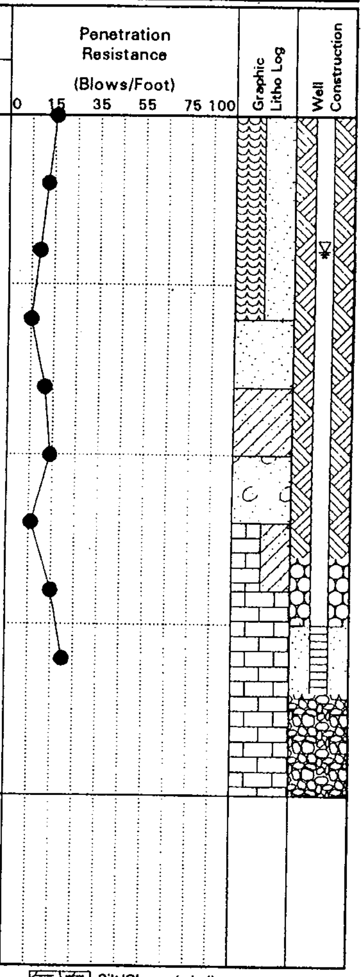
CASING MAT./DIA.
Sch.40 PVC/2"

SCREEN:
TYPE Slotted MAT. PVC LENGTH 2' DIA. 2" SLOT SIZE .010

ELEVATION OF: GROUND SURFACE TOP OF WELL CASING TOP & BOTTOM SCREEN DATE
(FT. ABOVE M.S.L.)
15'/17' 5/28/98

REMARKS:

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
		S1	5 7 9 11 16	SP-PT	Sand, some organic matter	
		S2	11 6 6 5 12		Sand (40%), organic matter (60%)	
5		S3	4 4 4 4 8		Organio (60%), Sand (40%), brown to light brown 6.0	
		S4	3 2 2 3 4	SP	Sand, white to light gray, some organic matter 8.0	
		S5	5 6 5 7 11	SC	Sand to sandy clay, silty, gray 10.0	
10		S6	5 6 8 10 14		Sand, fine grained, white, shell fragments, micritic 12.0	
		S7	4 3 2 2 5		Sandy clay, limestone, gray, friable, shell fragments 14.0	
15		S8	4 7 8 10 15		Limestone, friable, gray shell fragments micritic	
		S9	10 10 11 12 21		Limestone, friable gray	
20		S10			20.0	



EMP 2 1/8/99

Fine Sand
Medium Sand
Bentonite Pellets
Cement Grout
Silt/Clay w/ shell
Organic Material
Limestone
Clayey Sand
Fine sand w/ shell
Sluff/Backfill

Figure 20. Boring Logs for HF3

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BORING LOG

BORING/WELL NO. **HF-4**

PROJECT NO./NAME **1163/Isolated Wetlands Drilling Program - Phase II**	LOCATION **Hogan Island Farms, Collier County, Florida**

DRILLING CONTRACTOR/DRILLER **Precision Drilling/Robert Miller**

GEOLOGIST/OFFICE **Kevin Rohrer/South Florida Water Management District**

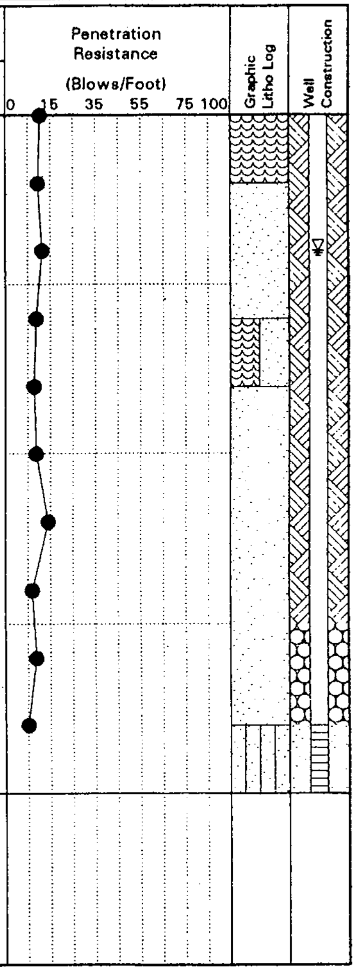
DRILLING EQUIPMENT/METHOD **Drill Rig/HSA**	SIZE/TYPE OF BIT **4.5" Hollow Stem Auger**	SAMPLING METHOD **Split Spoon**	START/FINISH DATE **5/21/98-5/21/98**

WELL INSTALLED? YES ☒ NO ☐ | CASING MAT./DIA. **Sch.40 PVC/2"** | SCREEN: TYPE Slotted MAT. PVC LENGTH 2' DIA. 2" SLOT SIZE .010

ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING TOP & BOTTOM SCREEN **18'/20'** DATE **5/21/98**

REMARKS:

Depth (ft)	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
	S1	4 4 6 4 10	PT	Organic matter, sand 2.0	
	S2	4 4 5 6 9	SP	Sand, tan to light gray and light brown	
5	S3	5 5 6 6 11		Sand, light gray, very fine grained 6.0	
	S4	4 4 4 5 8		Sand, organic matter 8.0	
	S5	4 3 4 4 7		Sand, very fine, light gray	
10	S6	3 3 5 5 8			
	S7	7 7 7 5 14			
15	S8	3 3 3 5 6			
	S9	5 3 5 5 8		18.0	
20	S10	2 2 2 2 4	SM	Sand, silty, gray to blue 20.0	



EMP 2 1/8/99

- ▯ Fine Sand
- ▦ Medium Sand
- ▣ Bentonite Pellets
- ▨ Cement Grout
- ▤ Silt/Clay w/ shell
- ▒ Organic Material
- ▭ Limestone
- ▧ Clayey Sand
- ▢ Fine sand w/ shell
- ▩ Sluff/Backfill

Figure 21. Boring Logs for HF4

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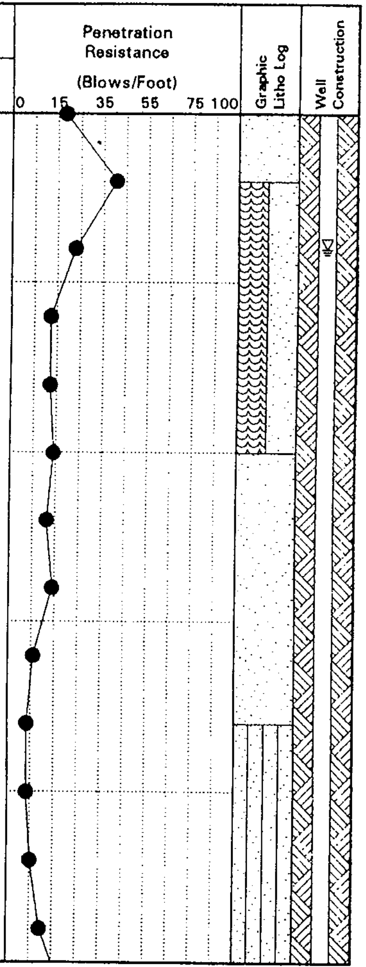
BORING LOG

BORING/WELL NO.
HF-5

PROJECT NO./NAME: **1163/Isolated Wetlands Drilling Program - Phase II**
LOCATION: **Hogan Island Farms, Collier County, Florida**
DRILLING CONTRACTOR/DRILLER: **Precision Drilling/Robert Miller**
GEOLOGIST/OFFICE: **Kevin Rohrer/South Florida Water Management District**
DRILLING EQUIPMENT/METHOD: **Drill Rig/Mud Rotary**
SIZE/TYPE OF BIT: **4.5" Hollow Stem Auger**
SAMPLING METHOD: **Split Spoon**
START/FINISH DATE: **6/8/98-6/9/98**
WELL INSTALLED? YES ☒ NO ☐
CASING MAT./DIA.: **Sch.40 PVC/2"**
SCREEN: TYPE Slotted MAT. PVC LENGTH 10' DIA. 2" SLOT SIZE .010
ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING
TOP & BOTTOM SCREEN: **62'/72'**
DATE: **6/9/98**
REMARKS:

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
		S1	9 9 10 12 19	SP	Organic matter (10%), sand (90%), light brown 2.0	
		S2	16 16 28 22 44	SP-PT	Sand (50%), organic matter (50%)	
5		S3	18 12 12 12 24		Organic matter (80%), sand (20%), fine and silty light brown	
		S4	5 5 7 8 12		Sand (60%), organic matter (40%), light brown	
		S5	6 6 6 7 12		Sand (70%), organic matter (30%), light brown to tan, fine grained 10.0	
10		S6	6 6 8 8 14	SP	Sand light, dark brown to light brown, fine grained	
		S7	5 5 6 7 11		Sand light gray to yellow, fine grained	
15		S8	6 6 8 6 14		Sand, light brown, fine grained	
		S9	4 2 3 3 5		Sand, light brown to tan, fine grained 18.0	
		S10	2 1 1 1 2	SM	Sand, silts, very fine grained	
20		S11	1 1 1 1 2			
		S12	4 2 2 4 4			
		S13	4 4 5 5			

EMP 2 1/8/99



Fine Sand
Medium Sand
Bentonite Pellets
Cement Grout
Silt/Clay w/ shell
Organic Material
Limestone
Clayey Sand
Fine sand w/ shell
Sluff/Backfill

Figure 22. Boring Logs for HF5 (page 1 of 3)

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BORING/WELL NO.
HF-5

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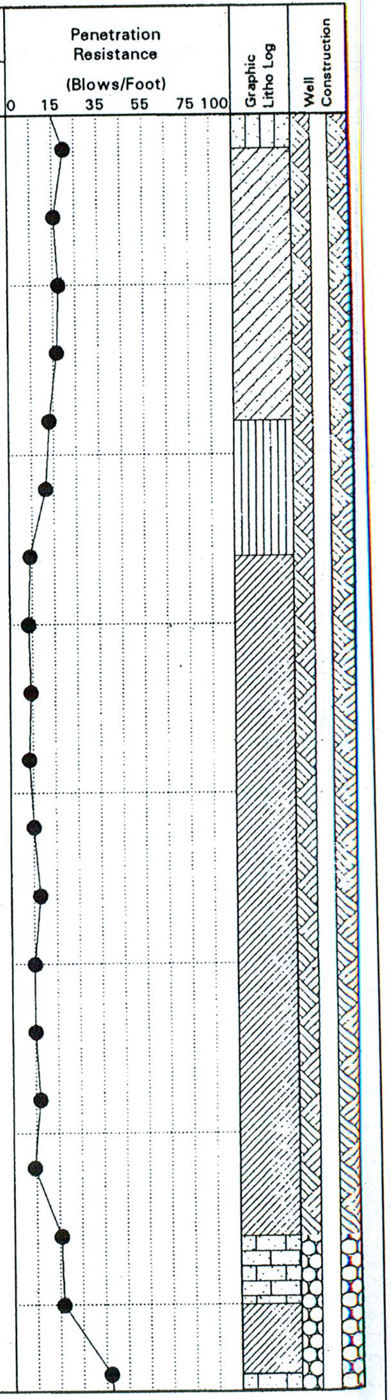
LOG OF TEST BORING (continued)

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	FIELD DESCRIPTION	Log Notes
			9		Sand, silts, shell fragments, clean sand, very fine 26.0	
		S14	9 9 12 12 21	SC	Sand (60%), light brown, clayey sand, light blue	
		S15	9 7 9 11 16		Sand, shell, clayey sand, light gray to blue	
30		S16	9 9 9 9 18	ML	Sandy clay, shell fragments, light gray to blue	
		S17	7 8 9 9 17		Silty clayey sand, light blue to gray 34.0	
35		S18	11 6 7 7 13		Sandy clay, silts, light blue to gray	
		S19	8 7 4 2 11		Sandy clay, more plastic, light gray to blue 38.0	
		S20	5 2 1 1 3	CL	Clay, silty, fine sand	
40		S21	2 1 1 1 2		Clay silty, plastic, gray to white/blue	
		S22	1 1 2 2 3		Clay silty, plastic, gray	
45		S23	1 1 1 1 2			
		S24	2 2 2 3 4			
		S25	3 3 4 3 7			
50		S26	2 2 2 2 4			
		S27	2 2 2 3 4			
55		S28	3 3 3 3 6			
		S29	1 1 2 2 3		58.0	
		S30	4 5 11 11 16		Limestone, sandy, phosphatic white to gray 60.0	
60		S31	11 11 6 2 17		Clay, limestone fragments, light gray to light blue 62.0	



EMP IWDP2 1/8/99

Figure 22. Boring Logs for HF5 (page 2 of 3)

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BORING/WELL NO.
HF-5

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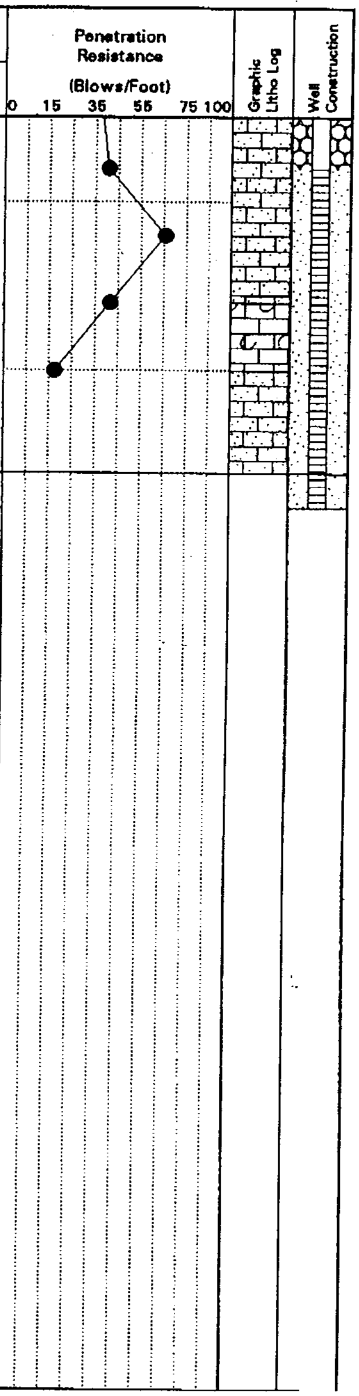
LOG OF TEST BORING (continued)

Depth (ft)	Sample: Type & Recovery	Sample: Number	Penetration Resistance Blows/6" N-Value	Unified Classification	FIELD DESCRIPTION	Log Notes
		S32	14 28 04 10		Sandy limestone (60%), white, some clay, phosphatic	
65		S33	5 21 23 34 44		Sandy limestone (85%) white, phosphatic clay (15%)	
		S34	37 38 34 18 72		Limestone, sandy, phosphatio gray to white 68.0	
		S35	14 17 28 13 45		Limestone, sand, shell, micrite white to gray 70.0	
70		S36	14 10 8 7 18		Limestone, sand, w/ some clay, phosphate from 68 to 70 foot interval? 73.0	



EMP IWDP2 1/8/88

Figure 22. Boring Logs for HF5 (page 3 of 3)

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BORING LOG

BORING/WELL NO. **HF-6**

PROJECT NO./NAME **1163/Isolated Wetlands Drilling Program - Phase II**

LOCATION **Hogan Island Farms, Collier County, Florida**

DRILLING CONTRACTOR/DRILLER **Precision Drilling/Robert Miller**

GEOLOGIST/OFFICE **Kevin Rohrer/South Florida Water Management District**

DRILLING EQUIPMENT/METHOD **Drill Rig/Mud Rotary**

SIZE/TYPE OF BIT **4.5" Hollow Stem Auger**

SAMPLING METHOD **Split Spoon**

START/FINISH DATE **5/30/98-5/30/98**

WELL INSTALLED? YES ☒ NO ☐

CASING MAT./DIA. **Sch.40 PVC/2"**

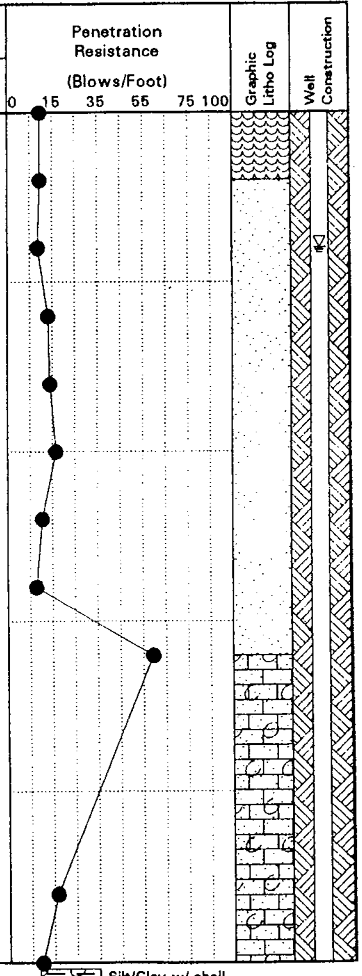
SCREEN: TYPE Slotted MAT. PVC LENGTH 10' DIA. 2" SLOT SIZE .010

ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING TOP & BOTTOM SCREEN **65'/75'** DATE **5/30/98**

REMARKS:

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
		S1	4 4 5 3 9	PT	Organic matter, sand dark to tan 2.0	
		S2	6 5 4 4 9	SP	Sand, white to yellow, tan streaks, fine grained	
5		S3	6 5 3 3 8		Sand, yellow to tan, some organic matter, fine	
		S4	4 5 8 9 13		Sand, yellow to brown, fine	
		S5	8 7 7 9 14		Sand, yellow to tan, fine	
10		S6	9 9 8 9 17		Sand, light brown, fine	
		S7	5 4 6 6 10			
15		S8	4 4 3 2 7		Sand, white, fine 16.0	
		S9	6 3 62 65 65		Sandy limestone, shell, gray course to fine, bivalves (18 ft)	
20						
		S10	13 8 9 7 17		Limestone, calcite, white, shell, bivalves	

EMP 2 1/8/99



▥	Fine Sand
⁘	Medium Sand
⊠	Bentonite Pellets
▧	Cement Grout
▤	Silt/Clay w/ shell
≈	Organic Material
▦	Limestone
▨	Clayey Sand
⁖	Fine sand w/ shell
▩	Sluff/Backfill

Figure 23. Boring Logs for HF6 (page 1 of 3)

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BORING/WELL NO.
HF-6

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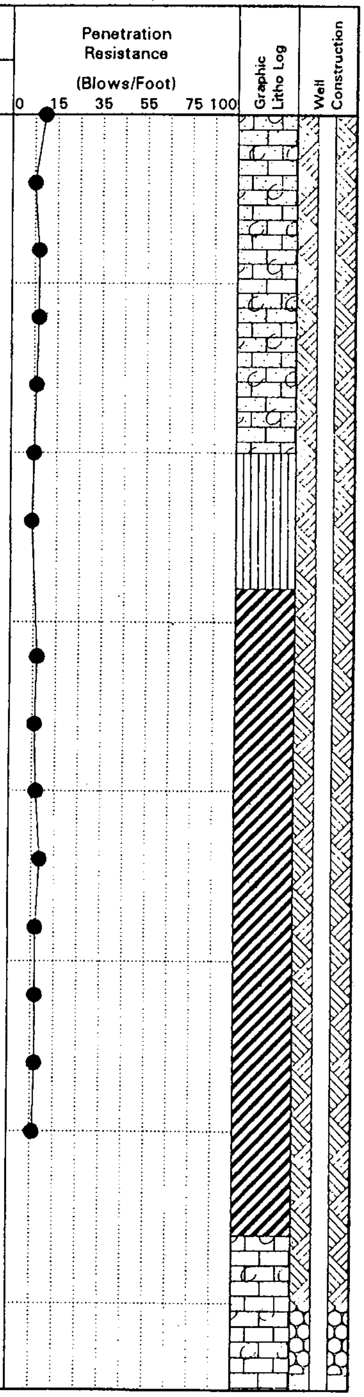
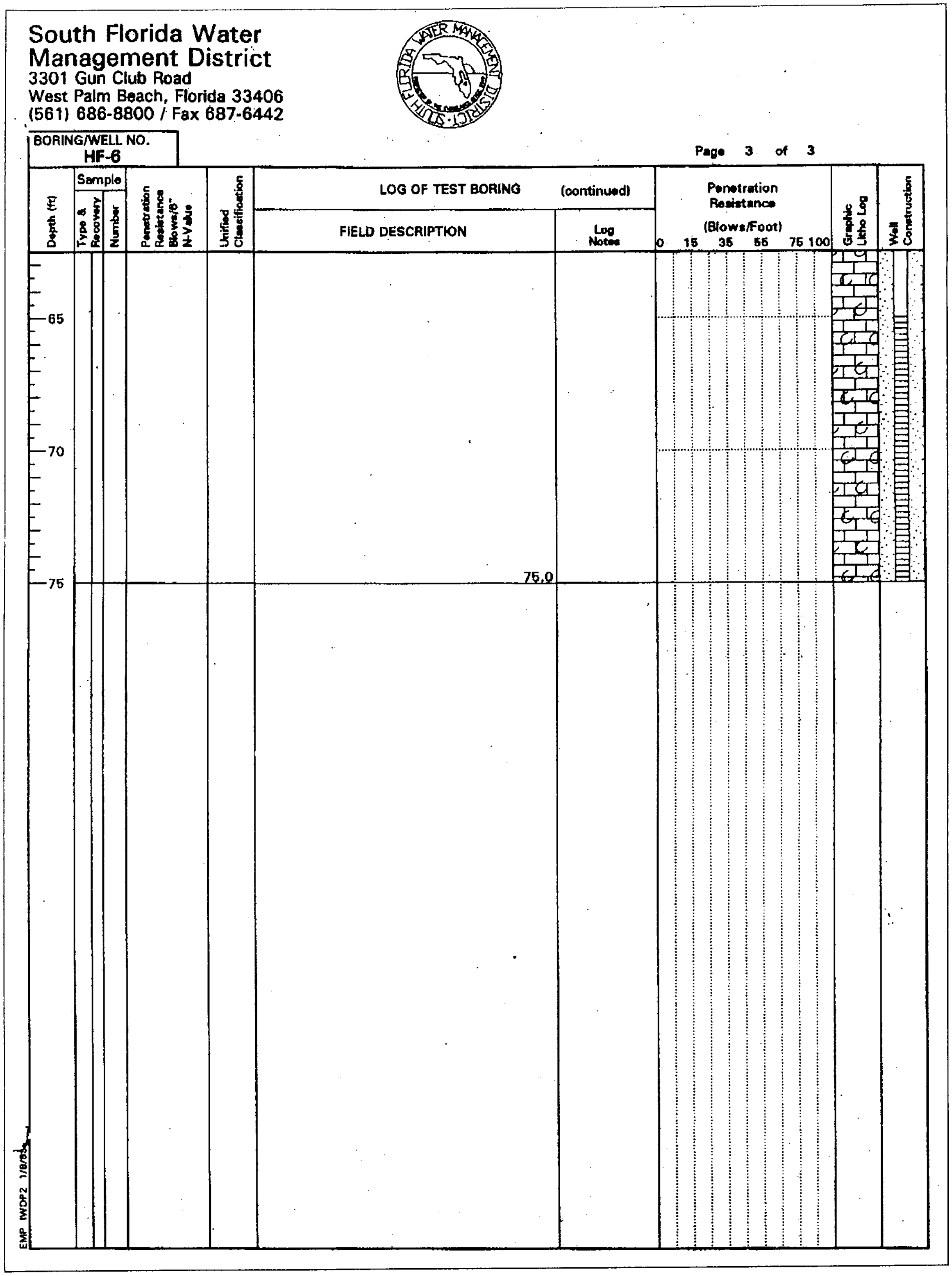
LOG OF TEST BORING (continued)

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	FIELD DESCRIPTION	Log Notes
		S11	7 5 4 4 9		Sandy limestone, shell gray	
		S12	5 2 2 4 4			
30		S13	2 2 4 7 6		Sandy limestone, silty, shell present	
		S14	3 3 3 3 6			
		S15	2 2 3 3 5		35.0	
35		S16	4 2 2 4 4	ML	Sandy clay, white to light gray, phosphate present	
		S17	1 1 2 2 3		39.0	
40		S18		CH	Clay, green silty, phosphatic	
		S19	2 3 3 4 6			
		S20	2 2 3 3 5			
45		S21	4 3 3 4 6			
		S22	2 4 4 5 8			
50		S23	4 3 3 4 6			
		S24	3 3 3 5 6		Clay, green, w/ some light gray clay	
		S25	3 3 3 3 6			
55		S26	3 2 3 4 5		58.0	
60					Limestone, gray, shell molds, vugular Limestone, shell, white to cream, friable, phosphatic	



EMP IWOP2 1/8/99

Figure 23. Boring Logs for HF6 (page 2 of 3)



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BORING/WELL NO.
HF-6

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LOG OF TEST BORING (continued)

Depth (ft)	Sample: Type & Recovery	Sample: Number	Penetration Resistance Blows/6" N-Value	Unified Classification	FIELD DESCRIPTION	Log Notes	Penetration Resistance (Blows/Foot) 0 15 35 55 75 100	Graphic Litho Log	Well Construction
65									
70									
75					75.0				

Figure 23. Boring Logs for HF6 (page 3 of 3)

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BORING/WELL NO.
HF-7

BORING LOG

PROJECT NO./NAME: 1163/Isolated Wetlands Drilling Program - Phase II

LOCATION: Hogan Island Farms, Collier County, Florida

DRILLING CONTRACTOR/DRILLER: Precision Drilling/Robert Miller

GEOLOGIST/OFFICE: Kevin Rohrer/South Florida Water Management District

DRILLING EQUIPMENT/METHOD: Drill Rig/HSA

SIZE/TYPE OF BIT: 4.5" Hollow Stem Auger

SAMPLING METHOD: Split Spoon

START/FINISH DATE: 5/22/98-5/22/98

WELL INSTALLED? YES ☒ NO ☐

CASING MAT./DIA.: Sch.40 PVC/2"

SCREEN: TYPE Slotted MAT. PVC LENGTH 2' DIA. 2" SLOT SIZE .010

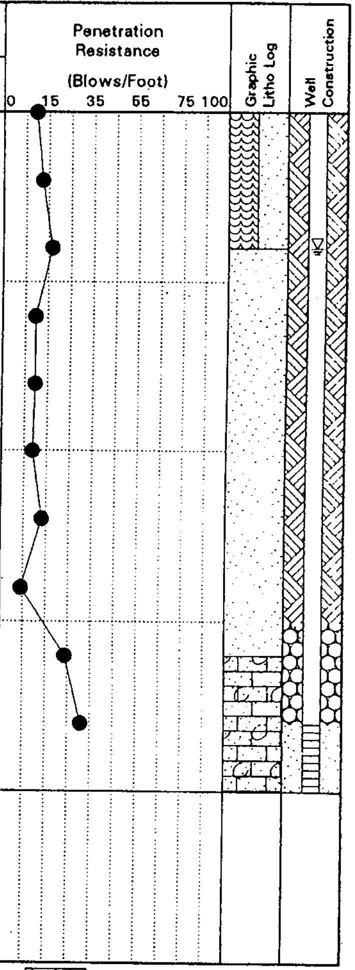
ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING

TOP & BOTTOM SCREEN: 18'/20'

DATE: 5/22/98

REMARKS:

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
		S1	3 3 6 6 9	SP-PT	Organic matter, sand, light gray to brown	
		S2	4 4 8 10 12	SP	Organic matter, sand, slight yellow to cream 4.0	
5		S3	9 10 7 6 17		Sand, yellow fine grained	
		S4	6 4 5 5 9		Sand, brown to gray to white, fine grained	
		S5	4 4 5 7 9		Sand, fine grained white	
10		S6	4 4 4 5 8			
		S7	4 6 7 9 13			
15		S8	4 2 1 3 3		Sand, some organic matter 16.0	
		S9	4 7 18 22 25		Sand, shell, micrite	
		S10	14 18 15 18 33		20.0	
20						



EMP 2 1/8/99

Fine Sand
Medium Sand
Bentonite Pellets
Cement Grout
Silt/Clay w/ shell
Organic Material
Limestone
Clayey Sand
Fine sand w/ shell
Sluff/Backfill

Figure 24. Boring Logs for HF7

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BORING LOG

BORING/WELL NO. **HF-8**

PROJECT NO./NAME **1163/Isolated Wetlands Drilling Program - Phase II**

LOCATION **Hogan Island Farms, Collier County, Florida**

DRILLING CONTRACTOR/DRILLER **Precision Drilling/Robert Miller**

GEOLOGIST/OFFICE **Kevin Rohrer/South Florida Water Management District**

DRILLING EQUIPMENT/METHOD **Drill Rig/Mud Rotary**

SIZE/TYPE OF BIT **4.5" Hollow Stem Auger**

SAMPLING METHOD **Split Spoon**

START/FINISH DATE **6/9/98-6/10/98**

WELL INSTALLED? YES ☒ NO ☐

CASING MAT./DIA. **Sch.40 PVC/2"**

SCREEN: TYPE Slotted MAT. PVC LENGTH 10' DIA. 2" SLOT SIZE .010

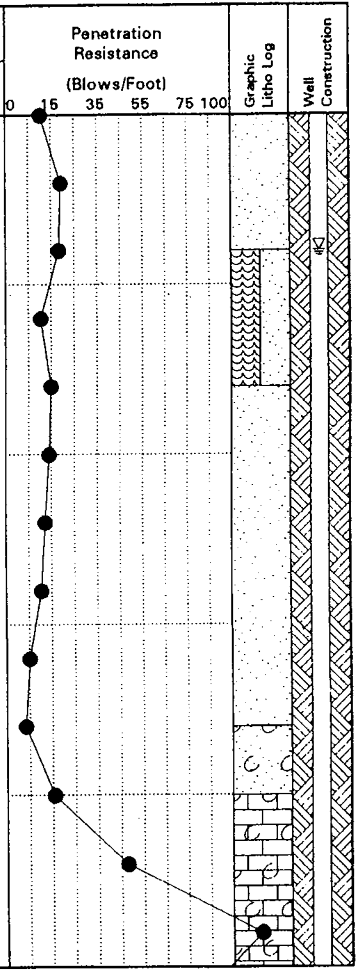
ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING

TOP & BOTTOM SCREEN **70'/80'**

DATE **6/10/98**

REMARKS:

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
		S1	3 3 7 7 10	SP	Fill material, white sand	
		S2	10 10 10 10 20		4.0	
5		S3	8 9 10 10 19	SP-PT	Sand, organic matter (85%)	
		S4	3 4 6 8 10		Sand (60%) organic matter (40%), light brown 8.0	
		S5	6 6 9 9 15	SP	Sand light brown to tan	
10		S6	6 6 8 8 14			
		S7	6 6 6 6 12			
15		S8	5 5 5 6 10		Sand light gray to brown silty	
		S9	2 2 2 2 4		18.0	
		S10	2 1 1 2 2		Sand (90%), Limestone, shell (10%) 20.0	
20		S11	4 4 12 12 16		Sand (10%) limestone, shell, silts, white to cream	
		S12	11 17 35 40 52		Limestone, shell, sand, white	
		S13	18 60 60			



EMP 2 1/8/99

Fine Sand
Medium Sand
Bentonite Pellets
Cement Grout
Silt/Clay w/ shell
Organic Material
Limestone
Clayey Sand
Fine sand w/ shell
Sluff/Backfill

Figure 25. Boring Logs for HF8 (page 1 of 3)

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BORING/WELL NO.
HF-8

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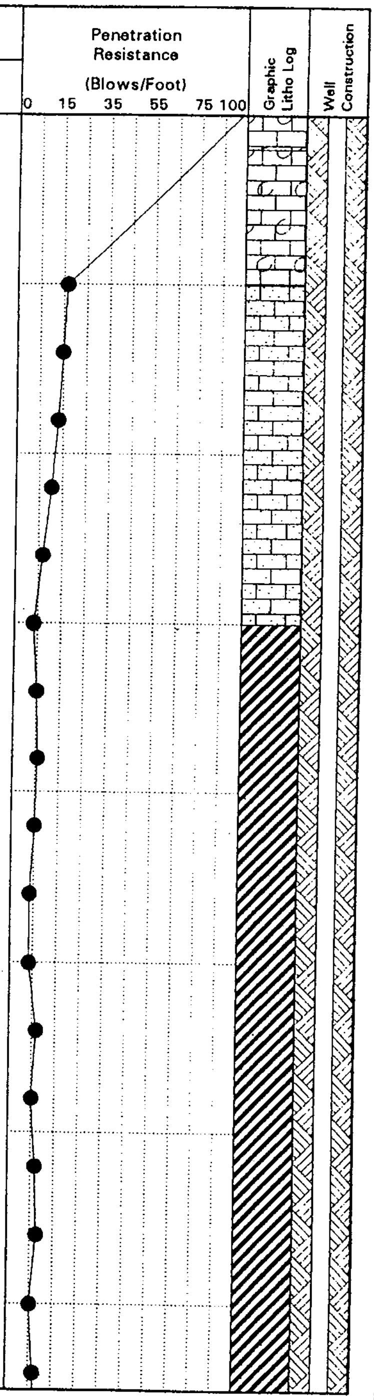
LOG OF TEST BORING (continued)

Depth (ft)	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	FIELD DESCRIPTION	Log Notes
		120		Limestone, shell, sand, white, silts, tan 26.0	
	S14			Shell, limestone, well cemented	
	S15			30.0	
30	S16	21 14 3 3 17		Sand (60%), white clean fine grained sandy limestone (40%)	
	S17	9 9 6 6 15		Sand (50%), limestone fragments and micrite, (50%)	
35	S18	6 6 7 7 13		Sandy limestone, white to cream	
	S19	6 5 5 5 10		Sandy limestone, gray to white, silty	
	S20	4 4 2 2 6		Sandy limestone (70%) sandy clay, phosphatic, green 40.0	
40	S21	1 1 1 3 2	CH	Clay, sandy clay, silty, green	
	S22	2 2 2 3 4			
45	S23	3 2 3 2 5			
	S24	1 1 3 2 4		Clay, sandy, green, plastic	
	S25	1 1 1 1 2		Clay, little less sandy, silts	
50	S26	1 1 1 2 2		Clay, silty, green, phosphatic	
	S27	3 3 3 4 6		Clay, silty, green, plastic	
55	S28	3 2 2 3 4		Clay, silty, sand, phosphatic	
	S29	2 2 4 3 6			
	S30	3 3 4 4 7			
60	S31	2 2 2 3 4			



EMP IWDP2 1/8/99

Figure 25. Boring Logs for HF8 (page 2 of 3)

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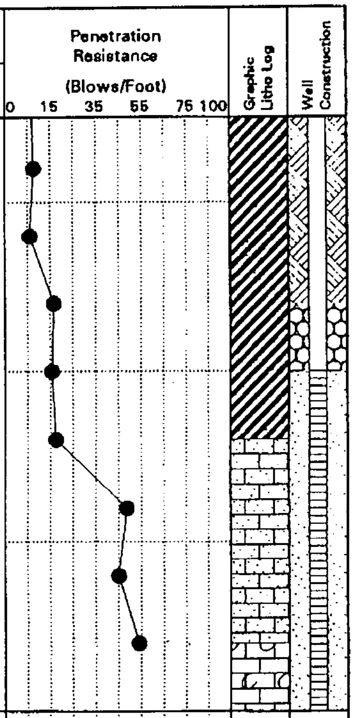
BORING/WELL NO.
HF-8

Page 3 of 3

LOG OF TEST BORING (continued)

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	FIELD DESCRIPTION	Log Notes
	☒	S32	6 363 4			
65	☒	S33	2 4 3 2 7			
	☒	S34	1 1 4 4 5			
	☒	S35	1 7 10 22 17		Clay, phosphatic, top of limestone = 69.5, green-gray	
70	☒	S36	8 12 4 20 16		Phosphatic clay blue-green, some limestone from 68 to 70 foot interval 72.0	
	☒	S37	10 8 10 20 18		Sandy limestone, micrite, shell	
75	☒	S38	10 23 30 26 53		Sandy limestone, clay?	
	☒	S39	18 31 18 23 49		78.0	
80	☒	S40	20 27 32 21 59		Limestone, shell fragments, phosphate present 80.0	



EMP IWDP2 1/8/95

Figure 25. Boring Logs for HF8 (page 3 of 3)

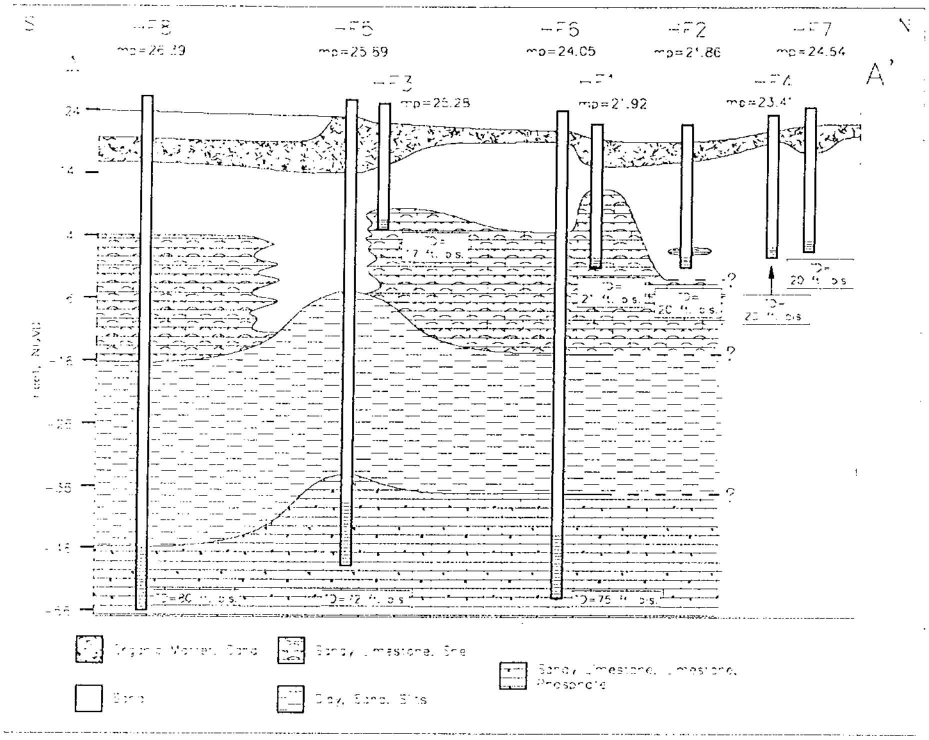


Figure 26. Geologic Cross Section A-A′ at Hogan Island Farms Study Area, Collier County

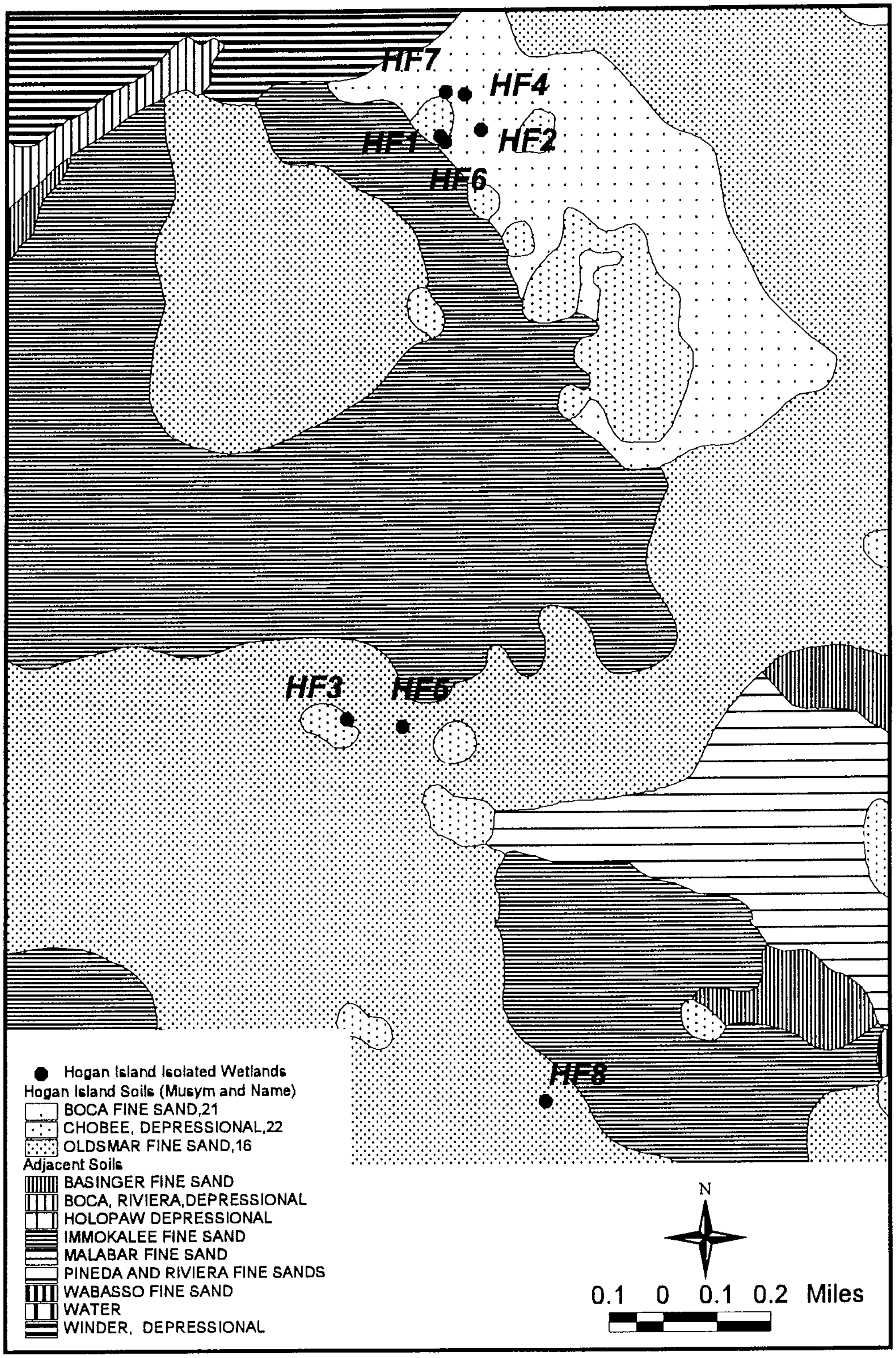


Figure 27. Selected Soil Survey Map of Collier County at the Hogan Island Farms Study Are

6 months. During the other months, the water table is below a depth of 18 inches, and can be as great as 40 inches during extended dry periods.

The surficial sands collected at Hogan Island Farms study area were analyzed for grain size distribution. The classification of sands after gradation analysis indicates wells HF1, HF3, and HF5 are predominately poorly graded sand with silt with a classification of SP-SM. Wells HF2, HF4, HF6, HF7 and HF8 are poorly graded sand and are classified as SP soils. Values for the coefficient of curvature (Cc) and the uniformity coefficient (Cu) are shown in **Table 5**.

Table 5. Range of Coefficient of Curvature (Cc) and Uniformity Coefficient (Cu) for Hogan Island Farms

Well Name	Coefficient of Curvature (Cc)		Uniformity Coefficient (Cu)	
	Minimum	Maximum	Minimum	Maximum
HF1	0.16	1.09	1.7	17.4
HF2	0.98	1.16	1.7	2.5
HF3	0.36	1.22	1.8	19.4
HF4	0.93	1.25	1.4	2.4
HF5	0.39	1.48	1.7	16.5
HF6	0.50	1.10	1.4	16.5
HF7	0.45	1.11	1.6	10.9
HF8	0.54	1.83	1.5	13.2

6.5 Core Analysis

All samples collected at this site were collected using the split spoon sampler. The sandy limestone at this site was not sufficiently consolidated to effectively use a core barrel. Therefore, no core analysis was performed at this site.

7.0 CITRUS PROJECT STUDY AREA

7.1 Site Description

The Citrus Project study area is located in central Lee County off Immokalee Road (SR82), approximately 1.4 miles east of Bell Road near Lehigh Acres and 15.5 miles southeast of I-75 (**Figure 28**). **Figure 28** also shows the geologic cross-sections A-A' and A'-B'. The Citrus Project study area is characterized by citrus groves and diked wetlands reservoirs that are part of the water management system. The wetland reservoirs are interconnected with canals that regulate water levels at many of the wetland sites.

Ten wells designated by WF1 through WF10 were drilled at this site. Wells WF8, WF9, and WF10 are considered "local" wells and are drilled to depths of 45 feet, 45 feet and 65-feet deep respectively. These monitor wells were installed to determine the regional extent of the water table influences on the wetlands. The remaining wells (WF1 through WF7) were drilled shallow to an average depth of 20 feet bls. These wells were constructed adjacent to wetlands to measure ground water levels directly influencing the surface water levels in the wetlands. **Table 6** provides a summary of the environmental setting and dominant wetland plant types for each wetland monitoring well site.

Table 6. Environmental Setting and Dominate Wetland Plants

Well Name	Wetland Number	Environmental Setting and Dominant Wetland Plants
WF1	2	Grassy marsh with saw grass (*Cladium jamaicense*), Alligator Flag (*Thalia geniculata* L.)
WF2	4	Grassy marsh with Torpedo grass (*Panicum repens*)
WF3	10	Pond with pond cypress (*Taxodium ascendans),* Spike rush (*Eleocharis cellulosa Torr*)
WF4	10	Marsh with Spike rush (*Eleocharis cellulosa Torr*)
WF5	8	Cypress head (*Taxodium distichum*)
WF6	11	Cypress head (*Taxodium distichum*)
WF7	12	Pine flatwoods near edge of wet prairie
WF8	2	Upland adjacent to WF1 (no dominant vegetation type)
WF9	4	Upland adjacent to WF2 (no dominant vegetation type)
WF10	12	Pine flatwoods near edge of wet prairie

7.2 Well Construction

Wells WF8 and WF10 ("local") were drilled using the mud rotary method. They were completed to 45 feet bls (-12 feet NGVD) and 65 feet bls (-33 feet NGVD) respectively. WF8 was originally drilled to 85 feet bls and back filled with cement and completed to -35 feet NGVD. Well WF9, also considered a "local" well, was drilled using the hollow stem auger method and drilled to 45 bls (-12 feet NGVD). These wells are completed with a 10 feet screen in a combination of sand, shell and silt.

Table 1 provides well construction specifications for wells drilled at the Citrus Project study area. Monitor wells WF1 through WF7 are completed to an average depth of 20 feet bls (approximately 10 feet NGVD) with 2-foot screens at the bottom of the well. With the exception of monitor well WF4, these wells are completed in fine sands. Monitor well WF4 is completed in a combination of sand, shell and silts. Each of these wells was drilled using the hollow stem auger method.

Boring logs for wells WF1 through WF10 are shown in Figures **29** through **37**. Penetration rates (blows/foot) were relativity consistent for wells WF1 through WF7. These wells were completed in sand except WF4. Well WF4 was completed in shell that contained sand, resulting in a 72 percent resistance (blows/foot) increase when this strata was encountered at approximately 17 feet bls (13 feet NGVD). In well WF8, where limestone was encountered at 33 feet bls the penetration rates increased 41 percent from 20 to 34 blow counts. In well WF9 penetration rates increased from 20 to 60 blows/foot when a layer of shell was encountered at approximately 16 feet bls (16.87 feet NGVD) and, again at 42 feet bls, where it increased 75 percent from 18 to 71 blows/foot. Well WF10 showed two occurrences where penetration rates increased due to the presence of shell and limestone. The first was at 20 feet bls (12.18 NGVD) and the second was at 42 feet bls (-9.82 NGVD). These increases were 69 and 92 percent respectfully.

7.3 Geology

Figures 38 and **39** show the geologic cross-sections A – A' and A'-B. These cross-sections are based on cuttings descriptions of split-spoon samples collected during installation of wells drilled at the Citrus Project study area. Soil and geologic samples collected at this site indicate approximately a 25-foot layer of sand overlaying sand, shell and silt. A layer of organic matter several feet thick was present in wells WF5, WF3, WF2, and WF1 at a depth of 29 to 25 feet NGVD. Also observed at wells WF8 and WF6 is a lens of organic matter that is buried beneath several feet of sand at approximately 25 feet NGVD. At well WF4, a 2-foot layer of sandy clay was encountered at approximately 15 feet NGVD underlain by 5-feet of sand and 2-foot layer of shell at a depth of approximately 10 feet NGVD. Underlying the layer of sand and shell approximately 30 feet bls (-2 feet NGVD) is a layer of limestone (approximately 25 feet thick). This layer contains silts and shell fragments including sand. At well WF10 a 10-foot layer of lime mud was observed starting at approximately 33 feet bls (-5 NGVD). Below the layer of limestone is an another layer of limestone that grades more to a semi-consolidated limestone which contains shell and more fine-grained sand. A distinction was made due to the percentage increase of fine-grained sand observed in the cuttings.

7.4 Classification of Soils and Grain Size Distribution

Figure 40 shows the soil survey map for the Citrus Project study area. In general, soils that occur at each wetland site are characteristic of the setting of the wetland. Soils collected from wells WF4 and WF7 are classified as Felda Fine Sand and are typically found in poorly drained depressions. Typically, the surface layer is fine sand about 4-inches thick and the subsurface layers extend to a depth approximately 3 feet. Under natural conditions, the soil is ponded for about 3 to 6 months or more. The water table is within a depth of 10 to 40 inches for the remaining 4 to 6 months. The permeability of Felda Fine Sand is rapid in the surface and subsurface layers and moderate or moderately rapid in the subsoil (USDA, 1984).

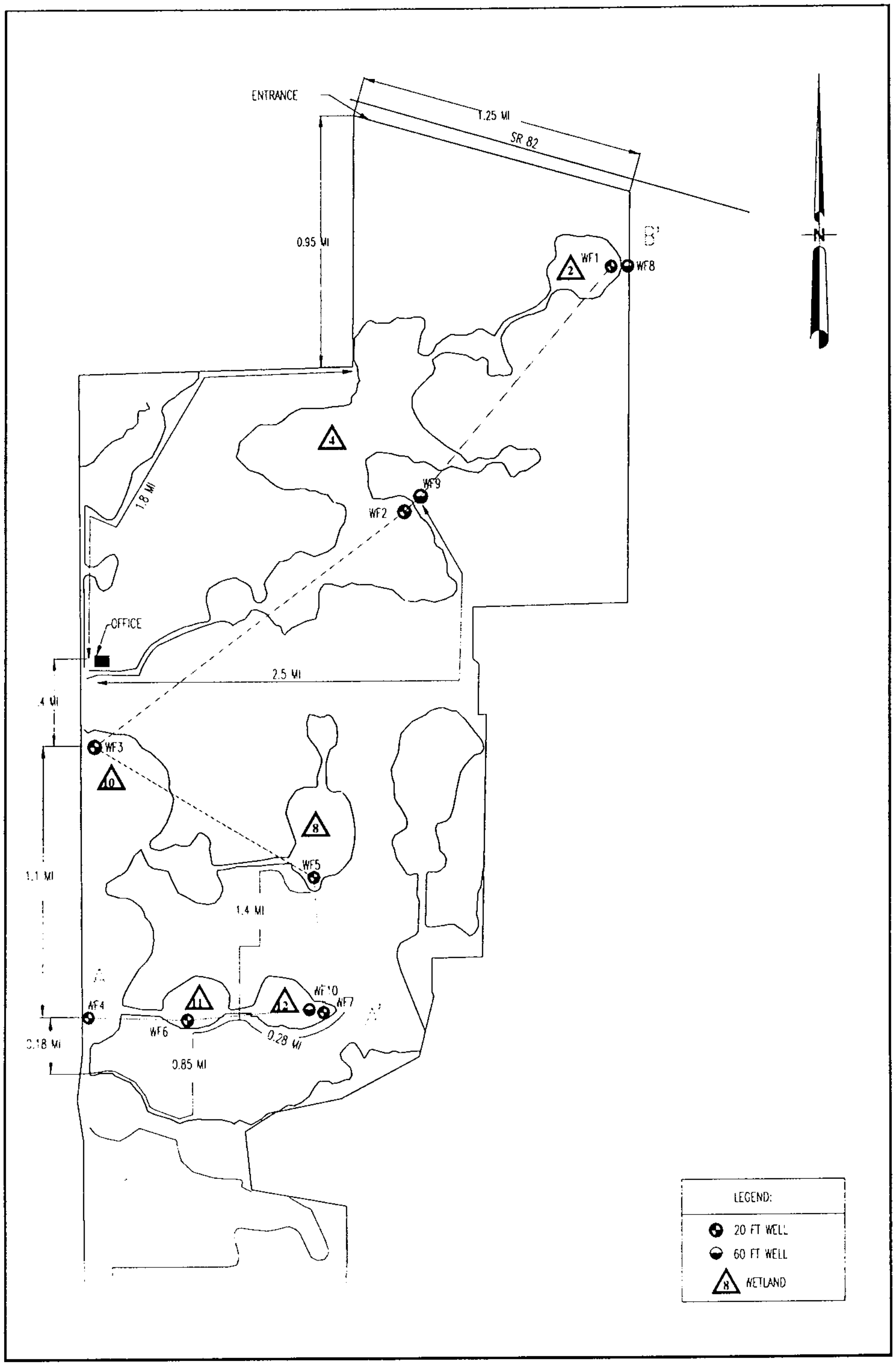
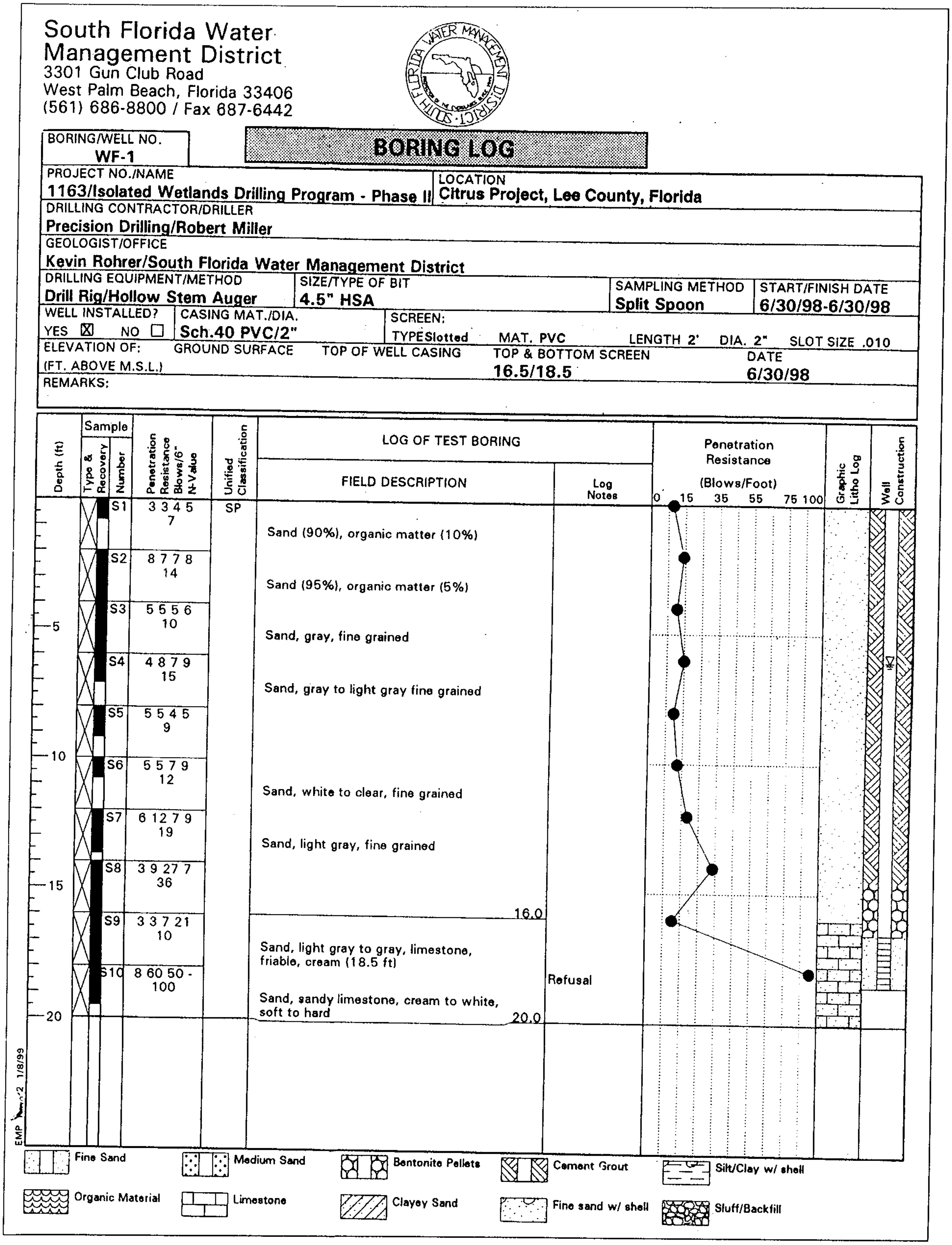


Figure 28. Location of Monitoring Wells on Citrus Project Study Area, Lee County, Showing Cross-Section A-A' and A'-B



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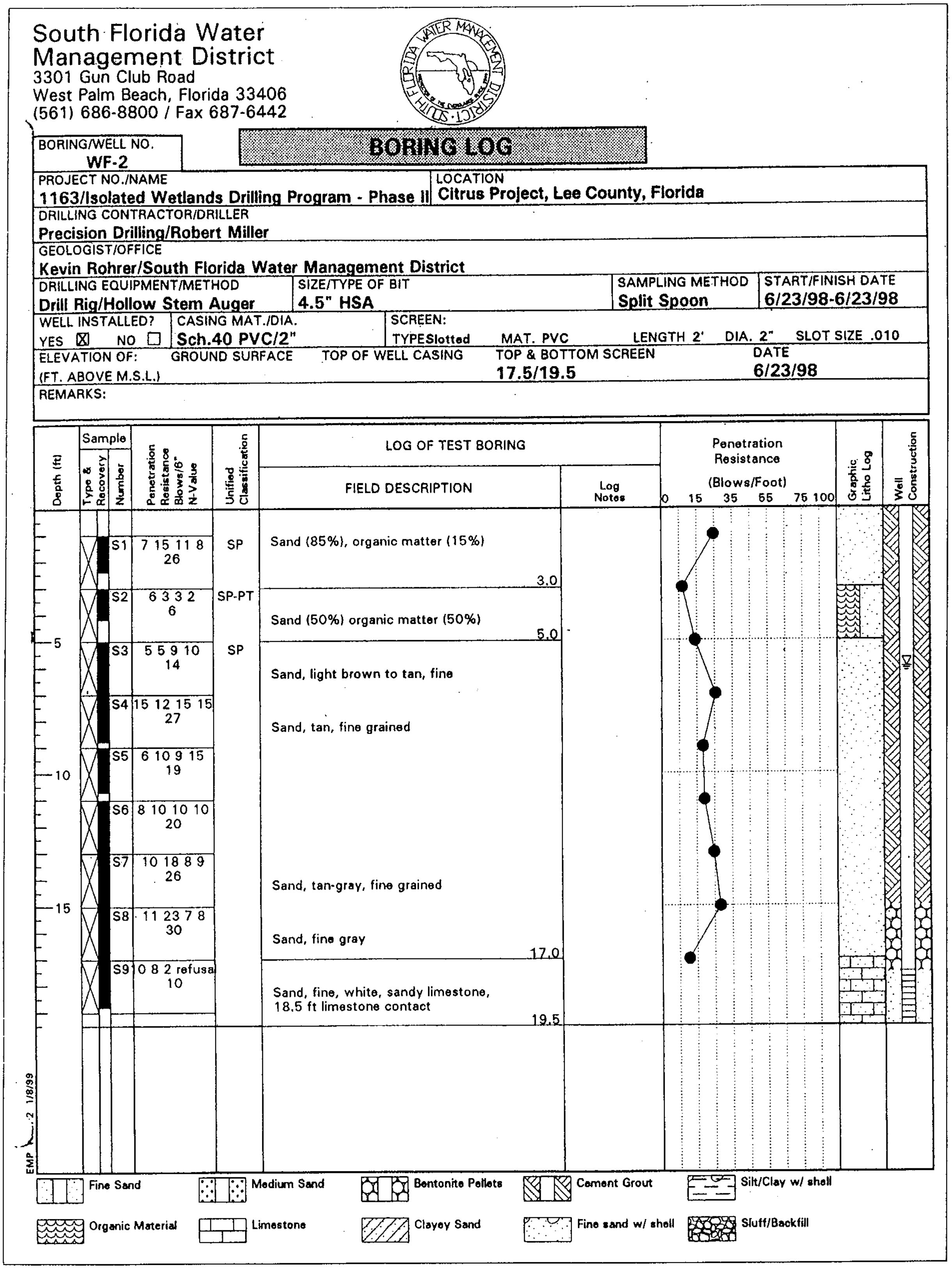
BORING/WELL NO. **WF-1**

BORING LOG

PROJECT NO./NAME **1163/Isolated Wetlands Drilling Program - Phase II**
LOCATION **Citrus Project, Lee County, Florida**
DRILLING CONTRACTOR/DRILLER **Precision Drilling/Robert Miller**
GEOLOGIST/OFFICE **Kevin Rohrer/South Florida Water Management District**
DRILLING EQUIPMENT/METHOD **Drill Rig/Hollow Stem Auger**
SIZE/TYPE OF BIT **4.5" HSA**
SAMPLING METHOD **Split Spoon**
START/FINISH DATE **6/30/98-6/30/98**
WELL INSTALLED? YES ☒ NO ☐
CASING MAT./DIA. **Sch.40 PVC/2"**
SCREEN: TYPE **Slotted** MAT. **PVC** LENGTH **2'** DIA. **2"** SLOT SIZE **.010**
ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING
TOP & BOTTOM SCREEN **16.5/18.5**
DATE **6/30/98**
REMARKS:

Depth (ft)	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
	S1	3 3 4 5 7	SP	Sand (90%), organic matter (10%)	
	S2	8 7 7 8 14		Sand (95%), organic matter (5%)	
5	S3	5 5 5 6 10		Sand, gray, fine grained	
	S4	4 8 7 9 15		Sand, gray to light gray fine grained	
	S5	5 5 4 5 9			
10	S6	5 5 7 9 12		Sand, white to clear, fine grained	
	S7	6 12 7 9 19		Sand, light gray, fine grained	
15	S8	3 9 27 7 36		16.0	
	S9	3 3 7 21 10		Sand, light gray to gray, limestone, friable, cream (18.5 ft)	
20	S10	8 60 50 - 100		Sand, sandy limestone, cream to white, soft to hard 20.0	Refusal

Figure 29. Boring Logs for WF1



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BORING LOG

BORING/WELL NO. **WF-2**

PROJECT NO./NAME **1163/Isolated Wetlands Drilling Program - Phase II**

LOCATION **Citrus Project, Lee County, Florida**

DRILLING CONTRACTOR/DRILLER **Precision Drilling/Robert Miller**

GEOLOGIST/OFFICE **Kevin Rohrer/South Florida Water Management District**

DRILLING EQUIPMENT/METHOD **Drill Rig/Hollow Stem Auger**

SIZE/TYPE OF BIT **4.5" HSA**

SAMPLING METHOD **Split Spoon**

START/FINISH DATE **6/23/98-6/23/98**

WELL INSTALLED? YES ☒ NO ☐

CASING MAT./DIA. **Sch.40 PVC/2"**

SCREEN: TYPESlotted MAT. PVC LENGTH 2' DIA. 2" SLOT SIZE .010

ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING TOP & BOTTOM SCREEN **17.5/19.5** DATE **6/23/98**

REMARKS:

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
		S1	7 15 11 8 26	SP	Sand (85%), organic matter (15%) 3.0	
		S2	6 3 3 2 6	SP-PT	Sand (50%) organic matter (50%) 5.0	
5		S3	5 5 9 10 14	SP	Sand, light brown to tan, fine	
		S4	15 12 15 15 27		Sand, tan, fine grained	
10		S5	6 10 9 15 19			
		S6	8 10 10 10 20			
		S7	10 18 8 9 26		Sand, tan-gray, fine grained	
15		S8	11 23 7 8 30		Sand, fine gray 17.0	
		S9	0 8 2 refusa 10		Sand, fine, white, sandy limestone, 18.5 ft limestone contact 19.5	

EMP .2 1/8/99

- Fine Sand
- Medium Sand
- Bentonite Pellets
- Cement Grout
- Silt/Clay w/ shell
- Organic Material
- Limestone
- Clayey Sand
- Fine sand w/ shell
- Sluff/Backfill

Figure 30. Boring Logs for WF2

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BORING/WELL NO.
WF-3

BORING LOG

PROJECT NO./NAME
1163/Isolated Wetlands Drilling Program - Phase II

LOCATION
Citrus Project, Lee County, Florida

DRILLING CONTRACTOR/DRILLER
Precision Drilling/Robert Miller

GEOLOGIST/OFFICE
Kevin Rohrer/South Florida Water Management District

DRILLING EQUIPMENT/METHOD
Drill Rig/Hollow Stem Auger

SIZE/TYPE OF BIT
4.5" HSA

SAMPLING METHOD
Split Spoon

START/FINISH DATE
6/23/98-6/23/98

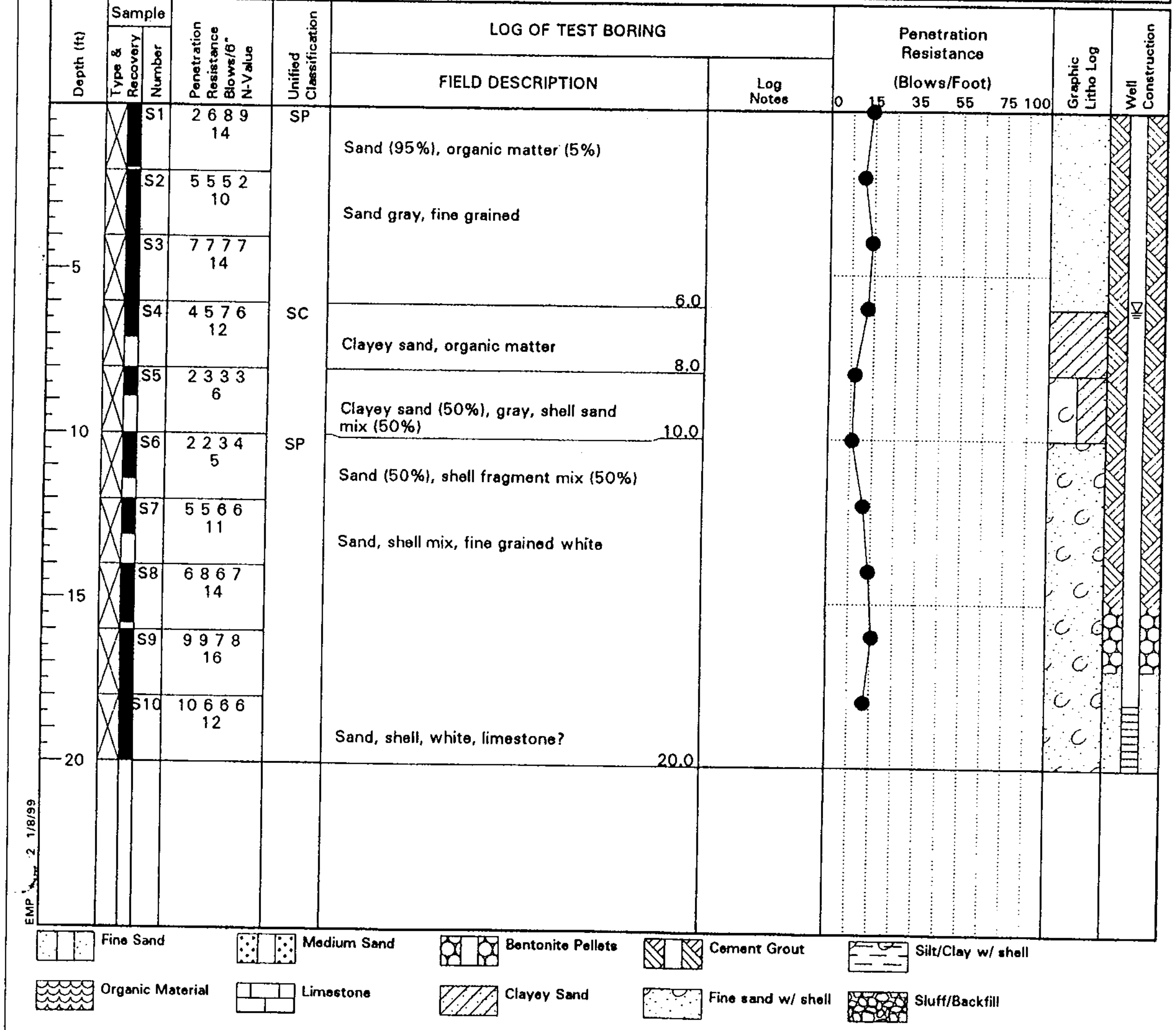
WELL INSTALLED? YES ☒ NO ☐

CASING MAT./DIA.
Sch.40 PVC/2"

SCREEN: TYPE Slotted MAT. PVC LENGTH 2' DIA. 2" SLOT SIZE .010

ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING TOP & BOTTOM SCREEN **18/20** DATE **6/23/98**

REMARKS:



Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	Field Description
S1	2 6 8 9 14	SP	Sand (95%), organic matter (5%)
S2	5 5 5 2 10		Sand gray, fine grained
S3	7 7 7 7 14		6.0
S4	4 5 7 6 12	SC	Clayey sand, organic matter 8.0
S5	2 3 3 3 6		Clayey sand (50%), gray, shell sand mix (50%) 10.0
S6	2 2 3 4 5	SP	Sand (50%), shell fragment mix (50%)
S7	5 5 6 6 11		Sand, shell mix, fine grained white
S8	6 8 6 7 14		
S9	9 9 7 8 16		
S10	10 6 6 6 12		Sand, shell, white, limestone? 20.0

EMP 2 1/8/99

Figure 31. Boring Logs for WF3

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BORING LOG

BORING/WELL NO.: WF-4

PROJECT NO./NAME: 1163/Isolated Wetlands Drilling Program - Phase II

LOCATION: Citrus Project, Lee County, Florida

DRILLING CONTRACTOR/DRILLER: Precision Drilling/Robert Miller

GEOLOGIST/OFFICE: Kevin Rohrer/South Florida Water Management District

DRILLING EQUIPMENT/METHOD: Drill Rig/Hollow Stem Auger

SIZE/TYPE OF BIT: 4.5" HSA

SAMPLING METHOD: Split Spoon

START/FINISH DATE: 6/23/98-6/23/98

WELL INSTALLED? YES ☒ NO ☐

CASING MAT./DIA.: Sch.40 PVC/2"

SCREEN: TYPE Slotted MAT. PVC LENGTH 2' DIA. 2" SLOT SIZE .010

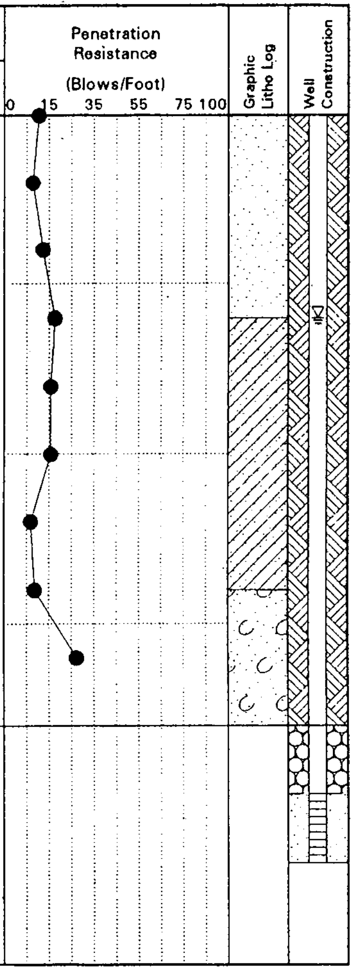
ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING

TOP & BOTTOM SCREEN: 20/22

DATE: 6/23/98

REMARKS:

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
		S1	4 4 6 8 10	SP	Sand, white, fine grained	
		S2	6 3 4 7 7		Sand, gray to brown, fine grained	
5		S3	7 6 6 6 12		Sand, gray to brown 6.0	
		S4	7 8 10 12 18	SC	Clayey sand, gray	
		S5	7 8 8 10 16		Sand clayey sand, gray to dark gray	
10		S6	9 9 7 7 16		Clayey sand, dark gray to gray	
		S7	3 3 3 3 6		Sand, clayey sand, gray to dark gray 14.0	
15		S8	4 4 4 7 8	SP	Sand (60%), shell (40%), tan to cream	
		S9	9 10 19 50 29		Sand (50%), shell (50%), mixture, light gray to white 18.0 17.5 feet, calcite, shell, hard to very hard	
		S10			Limestone, shell, tan to cream, vugular, hard to very hard	



EMP [illegible] 2 1/8/99

- Fine Sand
- Medium Sand
- Bentonite Pellets
- Cement Grout
- Silt/Clay w/ shell
- Organic Material
- Limestone
- ▨ Clayey Sand
- Fine sand w/ shell
- Sluff/Backfill

Figure 32. Boring Logs for WF4

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BORING/WELL NO.
WF-5

BORING LOG

PROJECT NO./NAME **1163/Isolated Wetlands Drilling Program - Phase II**	LOCATION **Citrus Project, Lee County, Florida**

DRILLING CONTRACTOR/DRILLER
Precision Drilling/Robert Miller

GEOLOGIST/OFFICE
Kevin Rohrer/South Florida Water Management District

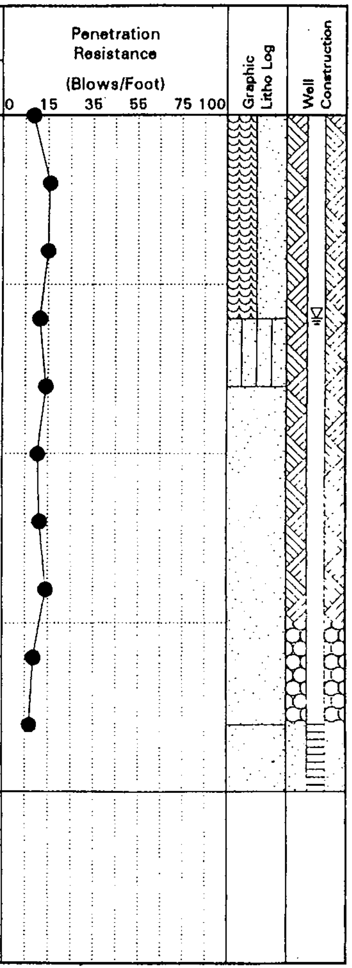
DRILLING EQUIPMENT/METHOD **Drill Rig/Hollow Stem Auger**	SIZE/TYPE OF BIT **4.5" HSA**	SAMPLING METHOD **Split Spoon**	START/FINISH DATE **6/26/98-6/26/98**

WELL INSTALLED? YES ☒ NO ☐	CASING MAT./DIA. **Sch.40 PVC/2"**	SCREEN: TYPE Slotted MAT. PVC LENGTH 2' DIA. 2" SLOT SIZE .010

ELEVATION OF: (FT. ABOVE M.S.L.)	GROUND SURFACE	TOP OF WELL CASING	TOP & BOTTOM SCREEN	DATE
			18/20	6/26/98

REMARKS:

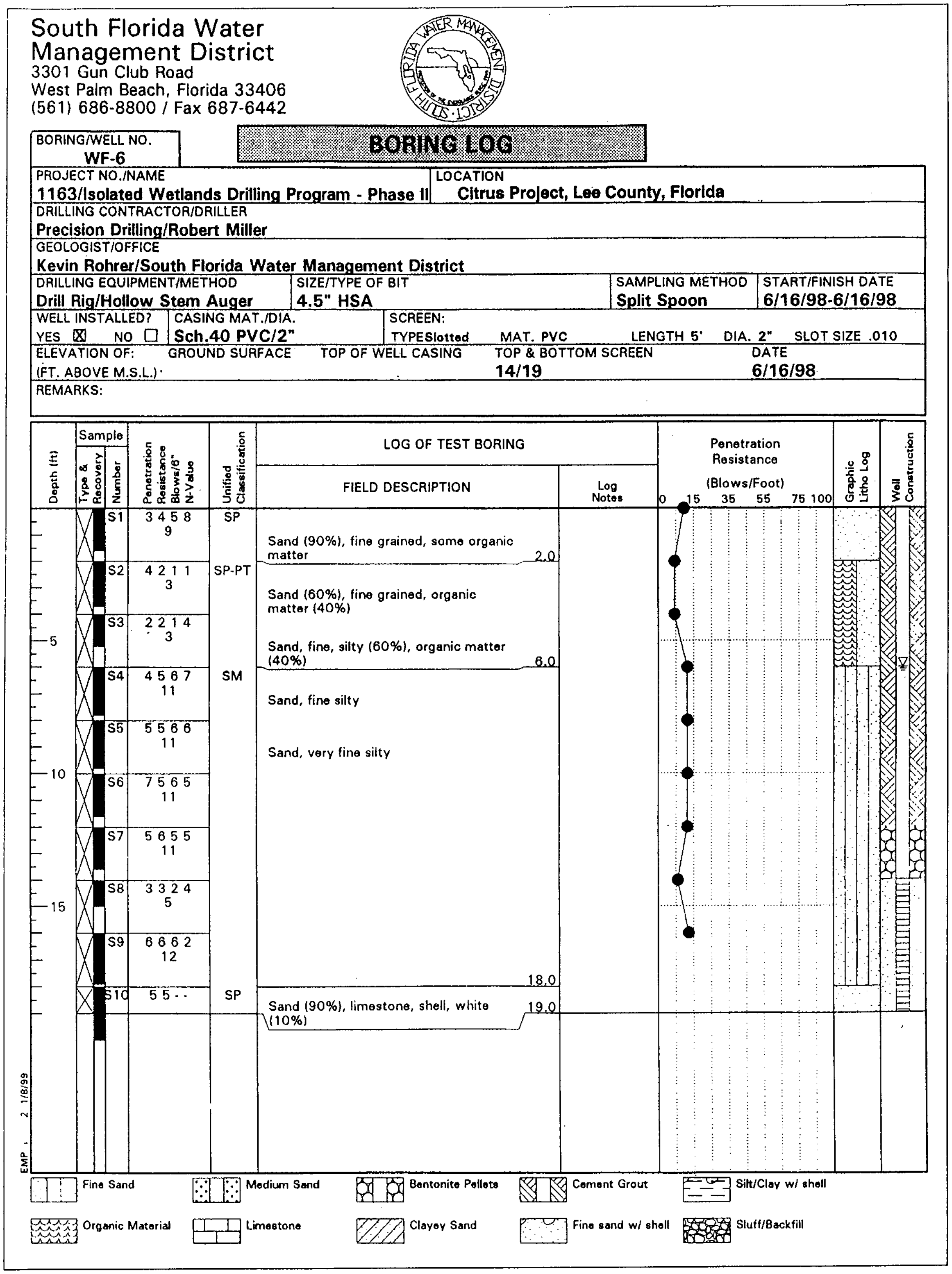
Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
		S1	3 4 4 4 8	SP-PT	Sand, organic matter, fine grained	
		S2	6 7 9 8 16		Sand (20%), organic matter (80%), fine silty	
5		S3	6 7 8 7 15		Sand (50%) dark gray, organic matter (50%) 6.0	
		S4	4 5 6 8 11	SM	Sand, dark brown to gray fine silts 8.0	
		S5	6 7 7 7 14	SP	Sand, brown to light gray, fine grained	
10		S6	5 5 5 5 10		Sand, light brown to tan, fine grained	
		S7	4 4 7 6 11			
15		S8	6 6 8 8 14			
		S9	4 4 4 4 8		18.0	
20		S10	3 3 3 2 6		Sand, tan, limestone fragments located at 20 feet 20.0	



EMP I. 2 1/8/99

- ▥ Fine Sand
- ▦ Medium Sand
- ▩ Bentonite Pellets
- ▧ Cement Grout
- ▤ Silt/Clay w/ shell
- ▒ Organic Material
- ▤ Limestone
- ▨ Clayey Sand
- ░ Fine sand w/ shell
- ▩ Sluff/Backfill

Figure 33. Boring Logs for WF5



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BORING LOG

BORING/WELL NO.: WF-6
PROJECT NO./NAME: 1163/Isolated Wetlands Drilling Program - Phase II
LOCATION: Citrus Project, Lee County, Florida
DRILLING CONTRACTOR/DRILLER: Precision Drilling/Robert Miller
GEOLOGIST/OFFICE: Kevin Rohrer/South Florida Water Management District
DRILLING EQUIPMENT/METHOD: Drill Rig/Hollow Stem Auger
SIZE/TYPE OF BIT: 4.5" HSA
SAMPLING METHOD: Split Spoon
START/FINISH DATE: 6/16/98-6/16/98
WELL INSTALLED? YES ☒ NO ☐
CASING MAT./DIA.: Sch.40 PVC/2"
SCREEN: TYPE Slotted MAT. PVC LENGTH 5' DIA. 2" SLOT SIZE .010
ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING TOP & BOTTOM SCREEN 14/19 DATE 6/16/98
REMARKS:

LOG OF TEST BORING

Depth (ft)	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	FIELD DESCRIPTION	Log Notes
	S1	3 4 5 8 9	SP	Sand (90%), fine grained, some organic matter 2.0	
	S2	4 2 1 1 3	SP-PT	Sand (60%), fine grained, organic matter (40%)	
5	S3	2 2 1 4 3		Sand, fine, silty (60%), organic matter (40%) 6.0	
	S4	4 5 6 7 11	SM	Sand, fine silty	
	S5	5 5 6 6 11		Sand, very fine silty	
10	S6	7 5 6 5 11			
	S7	5 6 5 5 11			
15	S8	3 3 2 4 5			
	S9	6 6 6 2 12		18.0	
	S10	5 5 - -	SP	Sand (90%), limestone, shell, white (10%) 19.0	

Fine Sand
Medium Sand
Bentonite Pellets
Cement Grout
Silt/Clay w/ shell
Organic Material
Limestone
Clayey Sand
Fine sand w/ shell
Sluff/Backfill

Figure 34. Boring Logs for WF6

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BORING/WELL NO.
WF-8

BORING LOG

PROJECT NO./NAME **1163/Isolated Wetlands Drilling Program - Phase II**	LOCATION **Citrus Project, Lee County, Florida**

DRILLING CONTRACTOR/DRILLER
Precision Drilling/Robert Miller

GEOLOGIST/OFFICE
Kevin Rohrer/South Florida Water Management District

DRILLING EQUIPMENT/METHOD **Drill Rig/Mud Rotary**	SIZE/TYPE OF BIT **4.5" HSA**	SAMPLING METHOD **Split Spoon**	START/FINISH DATE **6/17/98-6/18/98**

WELL INSTALLED? YES ☒ NO ☐
CASING MAT./DIA. **Sch.40 PVC/2"**
SCREEN: TYPE Slotted MAT. PVC LENGTH 10 DIA. 2" SLOT SIZE .010

ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING TOP & BOTTOM SCREEN **35/45** DATE **6/18/98**

REMARKS:

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
	☒	S1	2 2 4 3 6	SP	Sand, fill material from levee	
	☒	S2	4 3 6 6 9			
5	☒	S3	6 4 5 5 9		Sand, some organic matter, light brown 6.0	
	☒	S4	4 3 3 5 6	SM	Sand, fine silty, gray	
	☒	S5	3 4 5 6 9			
10	☒	S6	7 7 7 7 14		12.0	
	☒	S7	5 5 5 7 10	SP	Sand, shell fragments, fine grained 14.0	
15	☒	S8	4 4 refusal	SM	Sand, silty, gray to light gray 16.0	
	☒	S9			Sand, gray, limestone, white, weathered, silty 18.0	
20					Limestone, well cemented, micro-crystalline, shell fragments	
		S10				
		S11				

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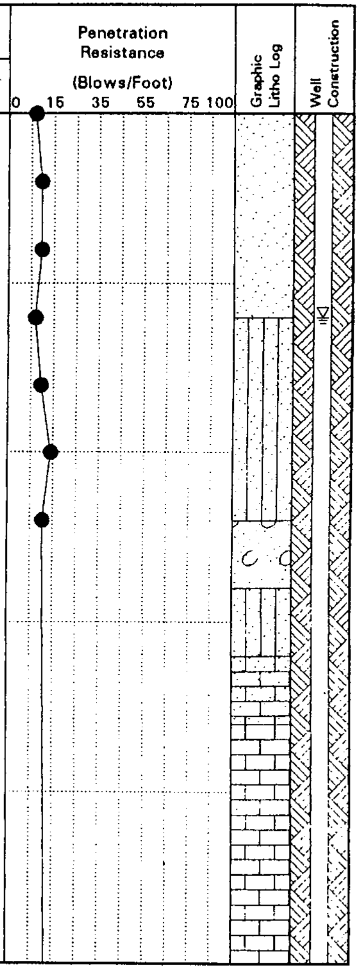
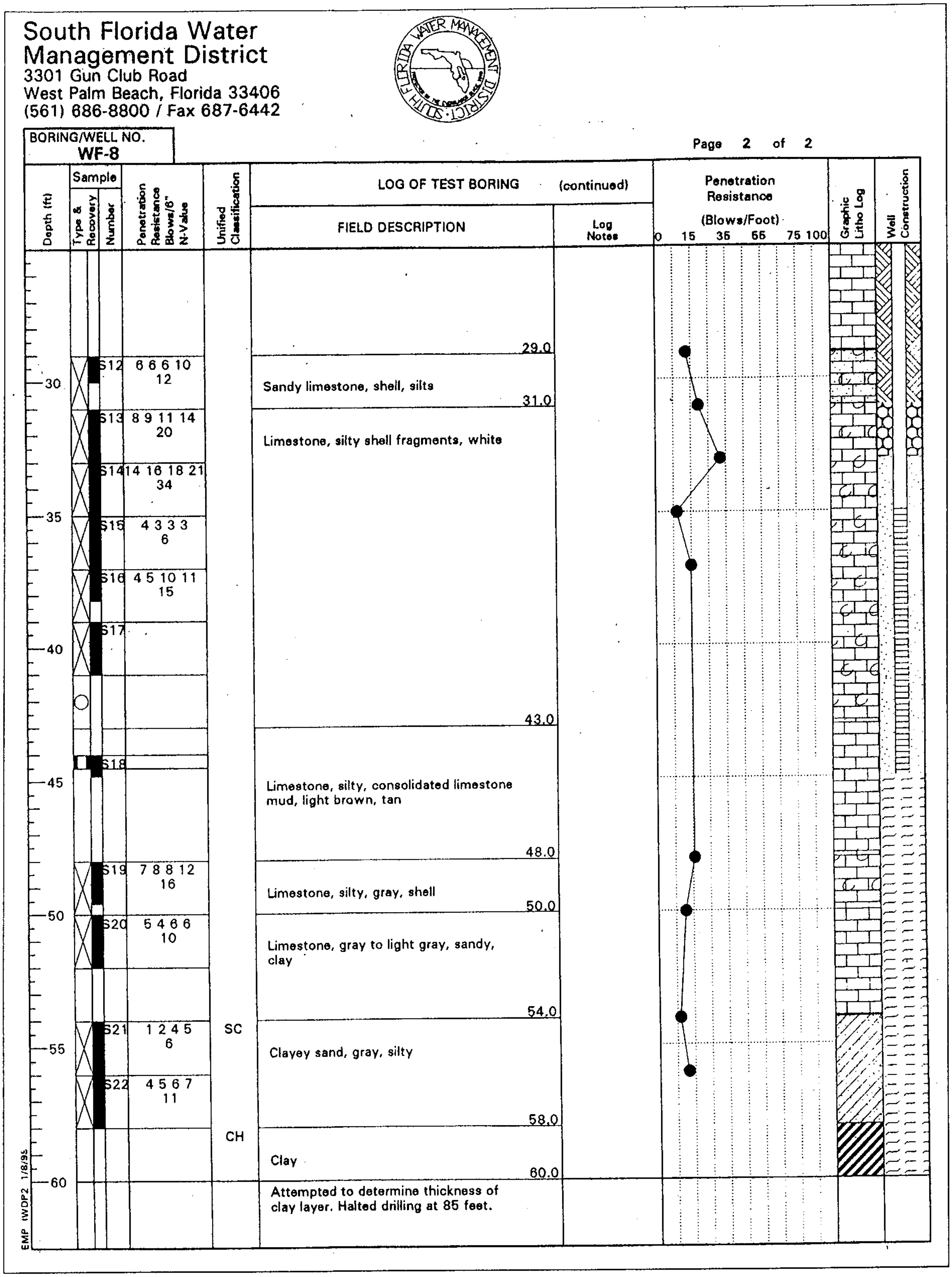


▥ Fine Sand
▦ Medium Sand
▩ Bentonite Pellets
▧ Cement Grout
▤ Silt/Clay w/ shell
▨ Organic Material
▦ Limestone
▨ Clayey Sand
▢ Fine sand w/ shell
▩ Sluff/Backfill

Figure 35. Boring Logs for WF8 (page 1 of 2)



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BORING/WELL NO.
WF-8

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LOG OF TEST BORING (continued)

Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification
S12	6 6 6 10 12	
S13	8 9 11 14 20	
S14	14 16 18 21 34	
S15	4 3 3 3 6	
S16	4 5 10 11 15	
S17		
S18		
S19	7 8 8 12 16	
S20	5 4 6 6 10	
S21	1 2 4 5 6	SC
S22	4 5 6 7 11	
		CH

FIELD DESCRIPTION	
	29.0
Sandy limestone, shell, silts	31.0
Limestone, silty shell fragments, white	43.0
Limestone, silty, consolidated limestone mud, light brown, tan	48.0
Limestone, silty, gray, shell	50.0
Limestone, gray to light gray, sandy, clay	54.0
Clayey sand, gray, silty	58.0
Clay	60.0
Attempted to determine thickness of clay layer. Halted drilling at 85 feet.	

Figure 35. Boring Logs for WF8 (page 2 of 2)

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BORING/WELL NO. **WF-9**

BORING LOG

PROJECT NO./NAME: **1163/Isolated Wetlands Drilling Program - Phase II**
LOCATION: **Citrus Project, Lee County, Florida**
DRILLING CONTRACTOR/DRILLER: **Precision Drilling/Robert Miller**
GEOLOGIST/OFFICE: **Kevin Rohrer/South Florida Water Management District**
DRILLING EQUIPMENT/METHOD: **Drill Rig/Hollow Stem Auger**
SIZE/TYPE OF BIT: **4.5" HSA**
SAMPLING METHOD: **Split Spoon**
START/FINISH DATE: **6/18/98-6/19/98**
WELL INSTALLED? YES ☒ NO ☐
CASING MAT./DIA. **Sch.40 PVC/2"**
SCREEN: TYPE Slotted MAT. PVC LENGTH 10' DIA. 2" SLOT SIZE .010
ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING TOP & BOTTOM SCREEN **35/45** DATE **6/19/98**
REMARKS:

Depth (ft)	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
	S1	5 4 5 5 9	SP	Sand, yellow to tan, road material	
	S2	5 5 8 8 13		Sand, yellow to light brown, fine grained	
5	S3	5 5 4 5 9		Sand, light brown to light gray, fine grained	
	S4	5 6 6 6 12			
	S5	6 6 10 10 16			
10	S6	5 5 7 8 13		Sand, light gray to dark gray, fine grained 12.0	
	S7	4 4 4 6 8		Sand, light gray, shell	
15	S8	7 9 11 15 20		Sand (50%), shell fragments (50%)	
	S9	15 32 30 26 62		Shell (60%), sand (40%), weathered limestone	
	S10	30 33 refusal		19.0	
20				Limestone, bottom of interval is dolomitic, 20-22 ft is limestone, vugular with shell casts, tan to light brown	
	S11				
	S12	11 2 2 2			

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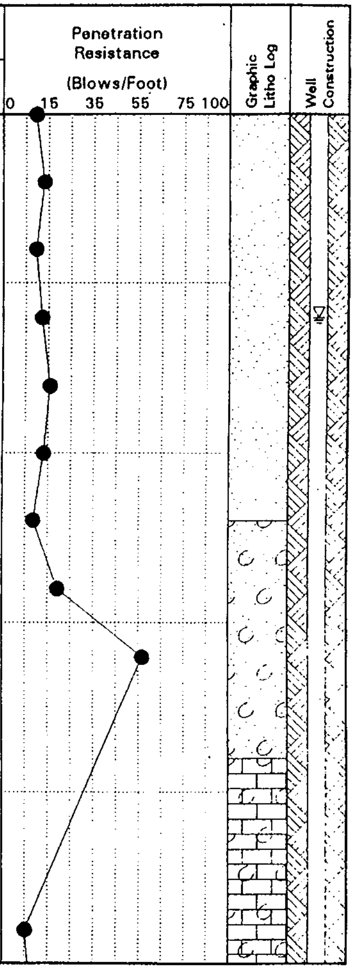

Fine Sand	Medium Sand	Bentonite Pellets	Cement Grout
Silt/Clay w/ shell	Organic Material	Limestone	Clayey Sand
Fine sand w/ shell	Sluff/Backfill		

Figure 36. Boring Logs for WF9 (page 1 of 2)

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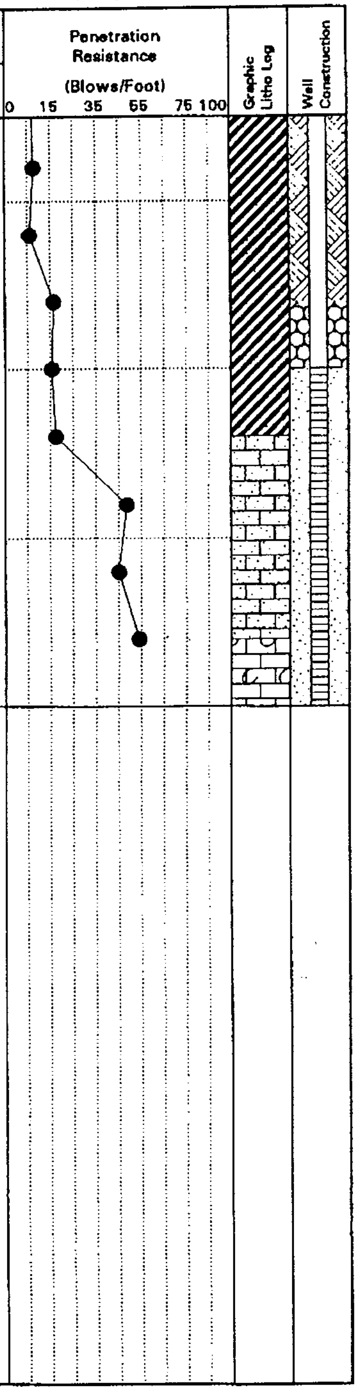
BORING/WELL NO.
HF-8

Page 3 of 3

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING (continued) FIELD DESCRIPTION	Log Notes
	☒	S32	6 363 4			
65	☒	S33	2 4 3 2 7			
	☒	S34	1 1 4 4 5			
	☒	S35	1 7 10 22 17		Clay, phosphatic, top of limestone = 69.5, green-gray	
70	☒	S36	8 12 4 20 16		Phosphatic clay blue-green, some limestone from 68 to 70 foot interval 72.0	
	☒	S37	10 8 10 20 18		Sandy limestone, micrite, shell	
75	☒	S38	10 23 30 26 53		Sandy limestone, clay?	
	☒	S39	18 31 18 23 48		78.0	
	☒	S40	20 27 32 21 59		Limestone, shell fragments, phosphate present 80.0	
80						



EMP IWOP2 1/8/95

Figure 36. Boring Logs for WF9 (page 2 of 2)

South Florida Water
Management District
3301 Gun Club Road
West Palm Beach, Florida 33406
(561) 686-8800 / Fax 687-6442

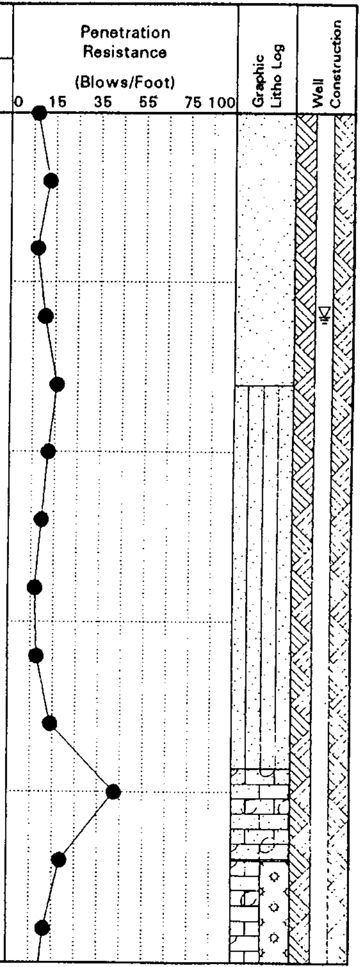
BORING/WELL NO.
WF-10

BORING LOG

PROJECT NO./NAME
1163/Isolated Wetlands Drilling Program - Phase II
LOCATION
Citrus Project, Lee County, Florida
DRILLING CONTRACTOR/DRILLER
Precision Drilling/Robert Miller
GEOLOGIST/OFFICE
Kevin Rohrer/South Florida Water Management District
DRILLING EQUIPMENT/METHOD
Drill Rig/Mud Rotary
SIZE/TYPE OF BIT
4.5" HSA
SAMPLING METHOD
Split Spoon
START/FINISH DATE
6/25/98-6/25/98
WELL INSTALLED? YES ☒ NO ☐
CASING MAT./DIA.
Sch.40 PVC/2"
SCREEN: TYPE Slotted MAT. PVC LENGTH 10' DIA. 2" SLOT SIZE .010
ELEVATION OF: (FT. ABOVE M.S.L.) GROUND SURFACE TOP OF WELL CASING
TOP & BOTTOM SCREEN **55/65**
DATE **6/25/98**
REMARKS:

Depth (ft)	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING FIELD DESCRIPTION	Log Notes
	S1	2 2 4 6 6	SP	Sand, white fine	
	S2	6 6 6 5 12		Sand, light brown, fine grained	
5	S3	4 3 3 3 6		Sand, light brown to brown, fine grained, organic matter	
	S4	5 5 5 7 10		8.0	
	S5	4 7 9 10 16	SM	Sand, dark brown to gray fine silts	
10	S6	4 6 6 7 12		Sand, brown to gray, fine grained, silts	
	S7	3 5 4 4 9			
15	S8	2 2 4 2 6			
	S9	3 3 4 4 7		Sand, silts, brown to dark gray	
	S10	12 5 9 9 14		Sand, silts, brown to dark gray 19.3	
20	S11	8 8 38 44 46		Micrite, shell, white Sand, micrite, silty limestone mud 22.0	
	S12	11 12 7 4 19		Sand, limestone, coral, shell, white	
	S13	4 4 7 3			

2 1/8/99
EMP



- ▯ Fine Sand
- ⁙ Medium Sand
- ⌧ Bentonite Pellets
- ▧ Cement Grout
- ▤ Silt/Clay w/ shell
- ⩚ Organic Material
- ▦ Limestone
- ▨ Clayey Sand
- ░ Fine sand w/ shell
- ▩ Sluff/Backfill

Figure 37. Boring Logs for WF10 (page 1 of 3)

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Management District
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West Palm Beach, Florida 33406
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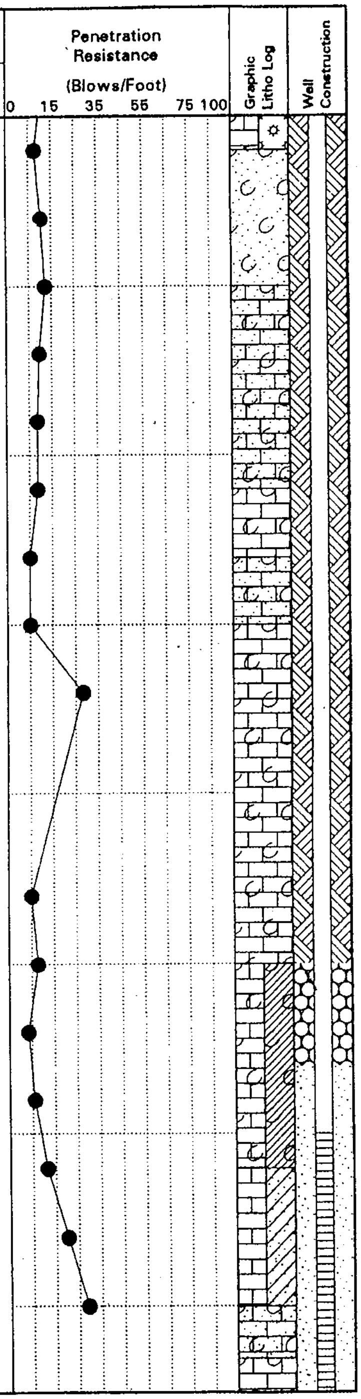
BORING/WELL NO.
WF-10

Page 2 of 3

LOG OF TEST BORING (continued)

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	FIELD DESCRIPTION	Log Notes
			11		Sand, coral, limestone, shell, light brown, tan 26.0	
		S14	6 4 3 3 7		Sand, fine grained, shell fragments	
		S15	8 4 6 5 10		30.0	
30		S16	5 5 7 7 12		Sand, tan, shell and limestone	
		S17	3 5 4 5 9		Sand and shell mixture (40%), micrite (60%)	
35		S18	4 4 4 3 8		36.0	
		S19	2 3 5 2 8		Micrite, shell, white to cream 38.0	
		S20	2 2 2 1 4		Sand (50%), micrite (50%), shell fragments 40.0	
40		S21	1 1 3 5 4		Micrite, shell, white to cream	
		S22	10 10 20 50 30		Micrite, limestone, shell	
		S23				
45					Limestone, light brown to tan, shell, vuggular, friable to hard	
		S24	5 2 2 4 4	CL	Limestone, silty, clay, shell fragments 50.0	
50	○	S25	2 4 3 4 7		Limestone, gray clay	
		S26	3 1 1 1 2		Limestone, clay, shell gray	
55	○	S27	4 3 2 2 5		56.0	
		S28	2 3 8 2 11		Limestone, clayey sand, shell gray	
		S29	2 3 18 21 21		60.0	
60		S30	0 9 22 50 31		Limestone, gray to white sand, shell 61.5	
		S31				



EMP IWDP2 1/8/9

Figure 37. Boring Logs for WF10 (page 2 of 3)

South Florida Water
Management District
3301 Gun Club Road
West Palm Beach, Florida 33406
(561) 686-8800 / Fax 687-6442

BORING/WELL NO.
WF-10

Page 3 of 3

Depth (ft)	Sample Type & Recovery	Sample Number	Penetration Resistance Blows/6" N-Value	Unified Classification	LOG OF TEST BORING (continued) FIELD DESCRIPTION	Log Notes	Penetration Resistance (Blows/Foot) 0 15 35 55 75 100	Graphic Litho Log	Well Construction
65					Limestone,tan,shell, vuggular, friable to hard 65.0				

EMP IWDP2 1/8/9

Figure 37. Boring Logs for WF10 (page 3 of 3)

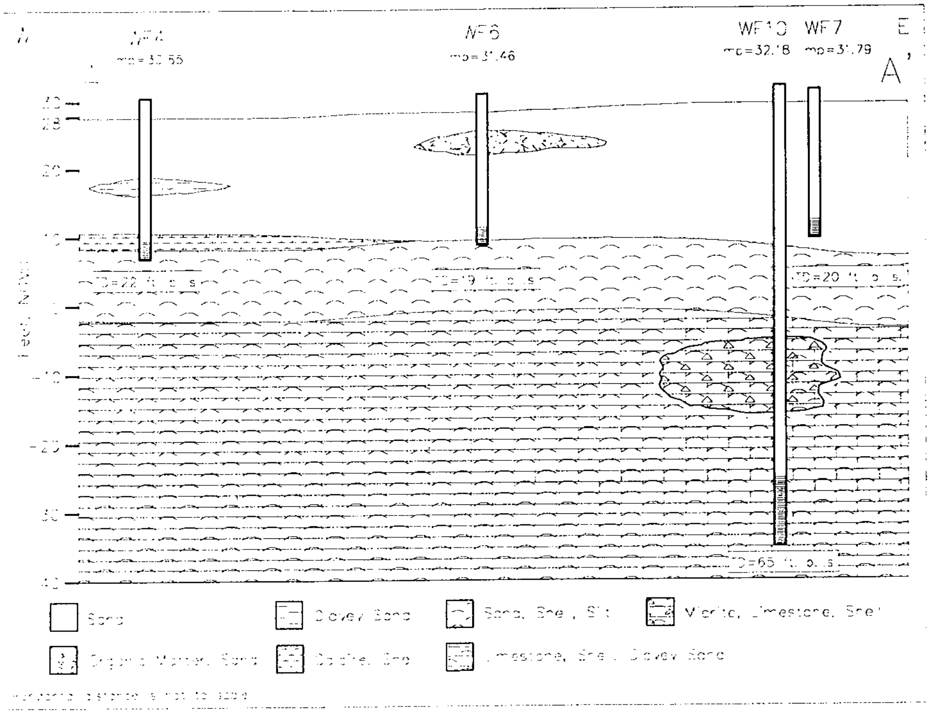


Figure 38. Geologic Cross-Section A-A' at Citrus Project Study Area, Lee County

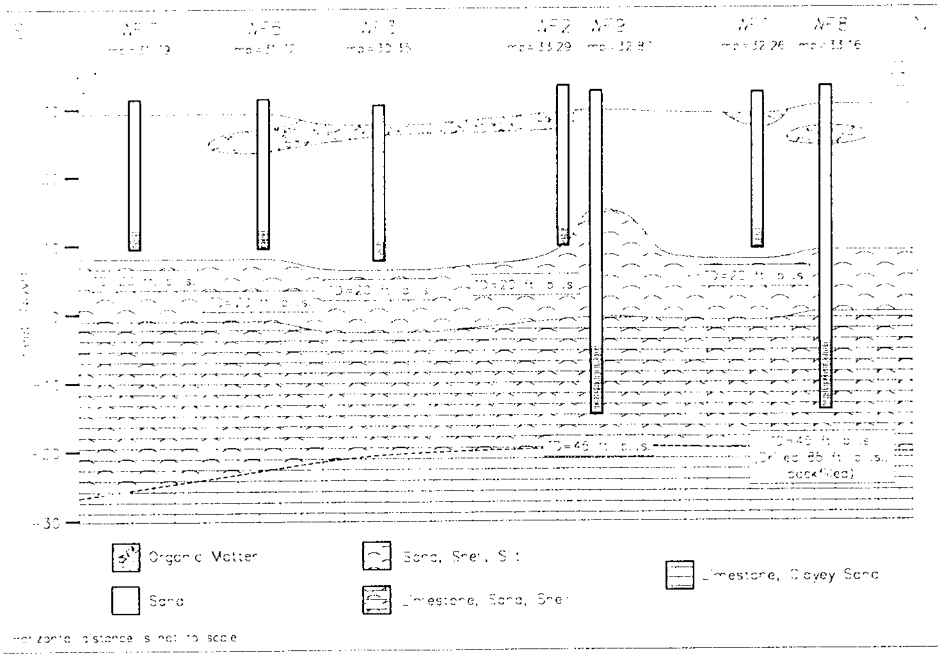


Figure 39. Geologic Cross-Section A'-B at Citrus Project Study Area, Lee County

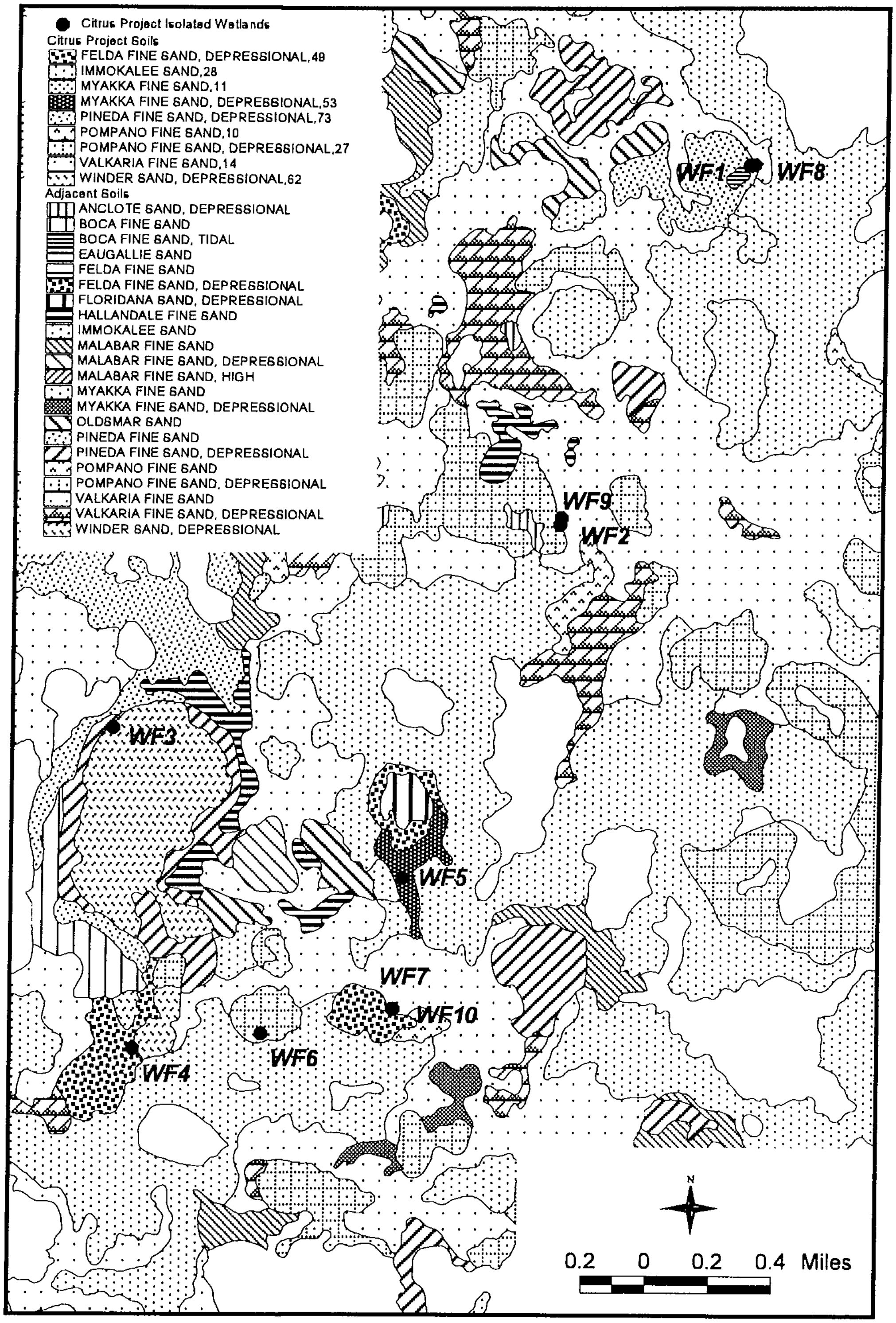


Figure 40. Selected Soil Survey Map of Lee County at the Citrus Project Study Area

Soils found at sites WF2 and WF6 are classified as Pompano Fine Sand. The surface layer is gray fine sand that is approximately 3-inches thick. The substratum is fine sand to a depth of 80 inches or more (USDA, 1984). Under most conditions, the water table is within 10 inches of the surface for about 3 months and up to 40 inches for more than five months. The available water capacity is low; however, the permeability is rapid (USDA, 1984).

At wells WF8 and WF9, Valkaria Fine Sand is the predominant surficial deposit at these locations. Typically, the surface layer is dark gray fine sand about 1-inch thick. The subsurface layer is about 4 inches of light gray sand. The sublayer is normally brown fine sand that extends to depths of 80 inches. Most of the time the water table is with 10 inches of the surface for about 6 months, and the soil is ponded for about 3 months. The water table is 10 to 40 inches below the surface most of the rest of the year. The available water capacity is very low and permeability is high (USDA, 1984).

At well WF3 the majority of the sand is classified as Winder Sand. This soil is found typically in depressions. The surface layer is dark gray sand about 3-inches thick. The subsoil extends to a depth of 29 inches. The upper 7 inches is gray sandy loam and the lower 6 inches is gray sand. The substratum extends to a depth of 80 inches or more. Under natural conditions, the water table is above the surface for 3 to 6 months. It is 10 to 40 inches below the surface during extended dry periods (USDA, 1984). The available water capacity is low in the surface and subsurface layers and medium in the subsoil. Permeability is rapid in the surface and subsurface layers and slow in the subsoil.

Soil at WF6 is classified as Myakka fine sand. The Myakka Fine Sand is a deep, moderately permeable soil formed in thick beds of marine sands. Typically, the water table is within 10 inches of the surface from 1 to 3 months and 10 to 40 inches below the surface for 3 to 6 months. Permeability is rapid in the surface and subsurface layers and moderate to moderately rapid in the subsoil (USDA, 1984).

Values for the coefficient of curvature (Cc) and the uniformity coefficient (Cu) are shown in **Table** 7 for well WF1 through WF10. No analysis was performed at site WF7 since it is located immediately adjacent to deeper well WF10.

7.5 Core Analysis

Wells WF4, WF8 and WF9 contained consolidated sediments that were cored and analyzed in the lab for hydraulic conductivity. **Table 8** lists the selected intervals that were analyzed and the results of this analysis.

Table 7. Range for Coefficient of Curvature (Cc) and Uniformity Coefficient for Citrus Project Study Area

Well Name	Coefficient of Curvature (Cc)		Uniformity Coefficient (Cu)	
	Minimum	Maximum	Minimum	Maximum
WF1	0.94	1.18	1.5	4.3
WF2	0.85	1.14	1.7	2.3
WF3	0.46	1.25	1.7	5.7
WF4	0.18	1.16	1.16	17.4
WF5	0.87	1.13	1.7	1.9
WF6	0.33	1.17	1.6	12.9
WF7	No analysis was performed at this site			
WF8	0.69	1.15	1.6	15.4
WF9	0.33	1.08	1.6	20.0
WF10	0.63	1.16	1.6	12.9

Table 8. Values of Hydraulic Conductivity for selected Intervals at Citrus Project Study Area

Sample Number	Site Name	Top Depth of core interval (ft-bls)	Bottom Depth of core interval (ft-bls)	Horizontal Hydraulic Conductivity (K_h) ft/day	Vertical Hydraulic Conductivity (K_v) ft/day	Description of core
1	WF4	18.0	18.5	0.0046	0.0853	Limestone
6	WF8	21.5	22.1	0.0004	0.0066	Limestone
7	WF8	24.0	24.5	0.0002	0.0033	Limestone
11	WF9	21.0	21.5	0.0009	0.0164	Limestone

8.0 CONCLUSIONS

This report provides a compilation and summary for the drilling and construction information collected during Phase 2 of the Isolated Wetlands Research Program. The 26 wetland monitor wells provide valuable geologic information to assist in the interpretation of wetland hydrology and the geologic characterization of different wetland settings. The monitor wells provide the infrastructure for the long-term hydrological monitoring for four isolated wetland study areas, which will help to determine seasonal water level variations and detection for potential impacts to isolated wetlands from adjacent ground water withdrawals.

Researchers will find this report useful when conducting investigations on the study wetlands and influences that ground water have on them. This report compiles hydrogeologic information collected for each of the study areas and addresses modeling data needs.

Unconsolidated samples collected during the drilling of the monitor wells were analyzed for grain size distribution (sieve analysis). Coefficient of curvature (Cc) values ranged from 0.23 to 1.14 at Flint Pen Strand study area. Stairstep study area the values ranged form 0.43 to 1.25. Hogan Island Farms ranged from 0.16 to 1.86, and at Citrus Project study area values for coefficient of curvature ranged from 0.18 to 1.25. The uniformity coefficient (Cu) ranged from 1.5 to 15.1 at Flint Pen Strand study area. At Stairstep the values for Cu ranged from 1.4 to 28.2. Hogan Island Farms Cu values ranged from 0.98 to 21.7and the Citrus Project study area Cu values ranged from 1.5 to 20.0.

Selective sections of the consolidated limestone were analyzed for vertical and horizontal hydraulic conductivity. Horizontal hydraulic conductivity values ranged from 0.002 to 20.671 and averaged 2.4875. Vertical hydraulic conductivity values ranged from 0.0033 to 390.101 with an average of 46.9443.

Rate of penetration was recorded for each of the wells. Geologic cross-sections were drawn for each of the study areas. Soil survey maps are presented to provide characterization of the soil in and adjacent to wetlands that may influence them.

9.0 RECOMMENDATIONS

Develop a maintenance program to ensure accurate water level measurements from wetland monitoring wells.

Install staff gauges near shallow (20-foot) wells to compare surface water elevations to ground water levels and provide back up for monitoring water level accuracy when surface water is at the same altitude as ground water.

Continue collecting monthly water level data to establish wetland base line conditions. Data recorders should be installed to provide more detailed water level data with greater temporal resolution. The ongoing water level monitoring will provide a long-term database to assist in the interpretation of hydrologic influences that impact the wetland in the study areas.

Calculate hydraulic conductivity from the sieve analysis data provided in this report. From the data provided, hydraulic conductivity can be calculated for 2-foot intervals for the entire depth of each monitor well. This would be helpful input data to a calibrated wetland model.

Develop a calibrated wetland model using MIKE SHE or similar model that can simulate interaction of surface and ground water for each of the study areas. The model should have the capability to estimate the vertical and horizontal movement of water. This model should also provide an evaluation of the controlling hydraulic conditions on other dependent variables.

Using data obtained during this investigation, develop wetland protection criteria for water use permitting.

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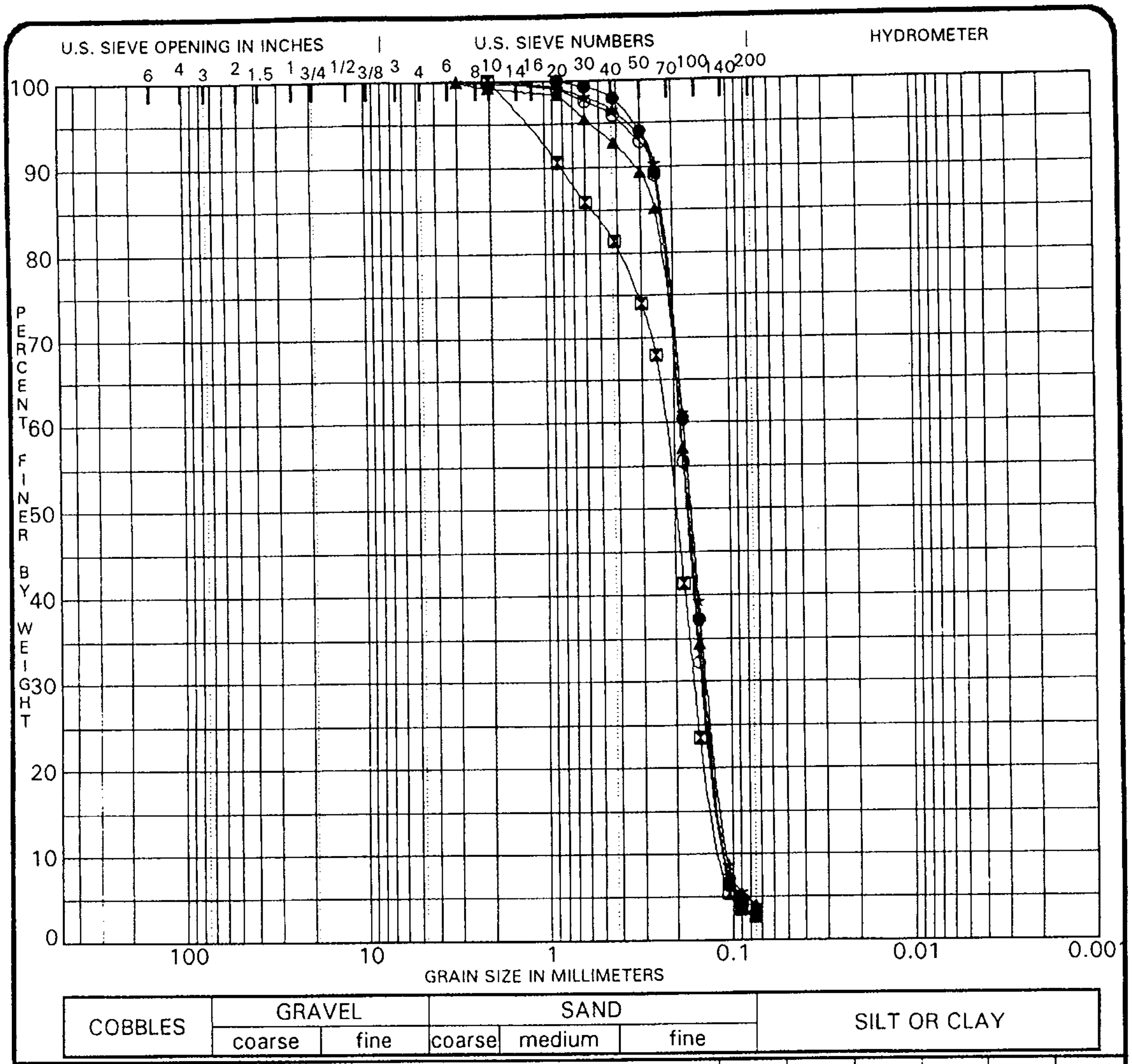
APPENDIX A

Flint Pen Strand Field Notes



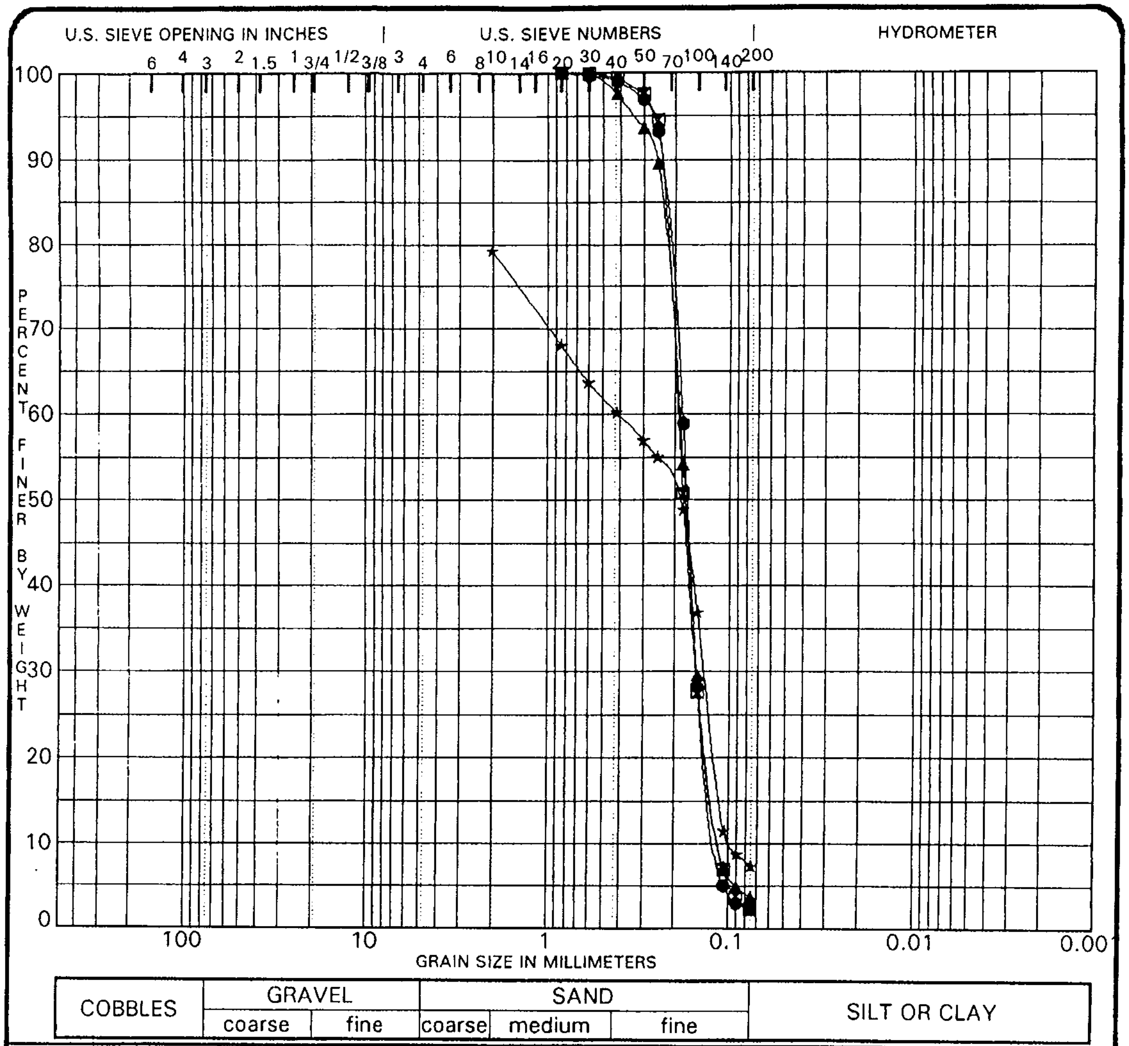
	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	FP-9	1.0	POORLY GRADED SAND SP					0.97	1.6
⊠	FP-9	3.0	POORLY GRADED SAND SP					0.98	2.0
▲	FP-9	5.0	POORLY GRADED SAND SP					0.98	1.7
★	FP-9	7.0	POORLY GRADED SAND SP					0.95	1.7
○	FP-9	9.0	POORLY GRADED SAND SP					1.02	1.7

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	FP-9	1.0	0.85	0.18	0.138	0.1105	0.0	97.2	2.8	
⊠	FP-9	3.0	2.00	0.23	0.160	0.1158	0.0	97.2	2.8	
▲	FP-9	5.0	3.00	0.19	0.142	0.1096	0.0	95.9	4.1	
★	FP-9	7.0	3.00	0.18	0.135	0.1076	0.0	95.9	4.1	
○	FP-9	9.0	2.00	0.19	0.146	0.1103	0.0	96.5	3.5	

PROJECT **Isolated Wetlands Drilling Program - Phase II - Flint Pen Strand, Lee County, Florida**

JOB NO. 1163

DATE 1/8/99



	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	FP-9	11.0	POORLY GRADED SAND SP					1.11	1.6
☒	FP-9	13.0	POORLY GRADED SAND SP					1.09	1.7
▲	FP-9	15.0	POORLY GRADED SAND SP					1.08	1.7
★	FP-9	17.0	*LIMESTONE					0.47	4.2

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	FP-9	11.0	0.85	0.18	0.152	0.1141	0.0	97.5	2.5	
☒	FP-9	13.0	0.85	0.19	0.153	0.1115	0.0	97.7	2.3	
▲	FP-9	15.0	0.85	0.19	0.151	0.1106	0.0	96.3	3.7	
★	FP-9	17.0		0.41	0.137	0.0968			7.4	

PROJECT **Isolated Wetlands Drilling Program - Phase II -**
Flint Pen Strand, Lee County, Florida

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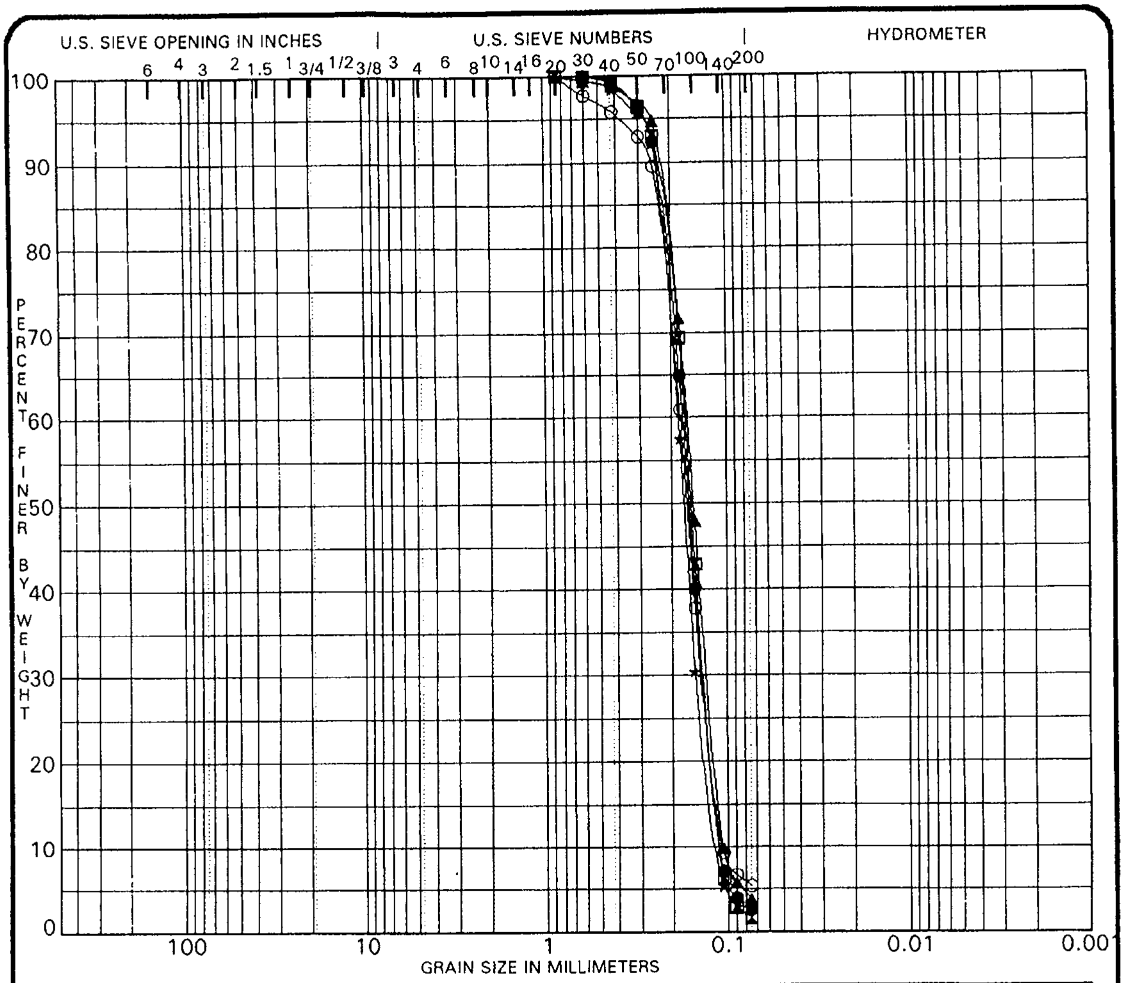


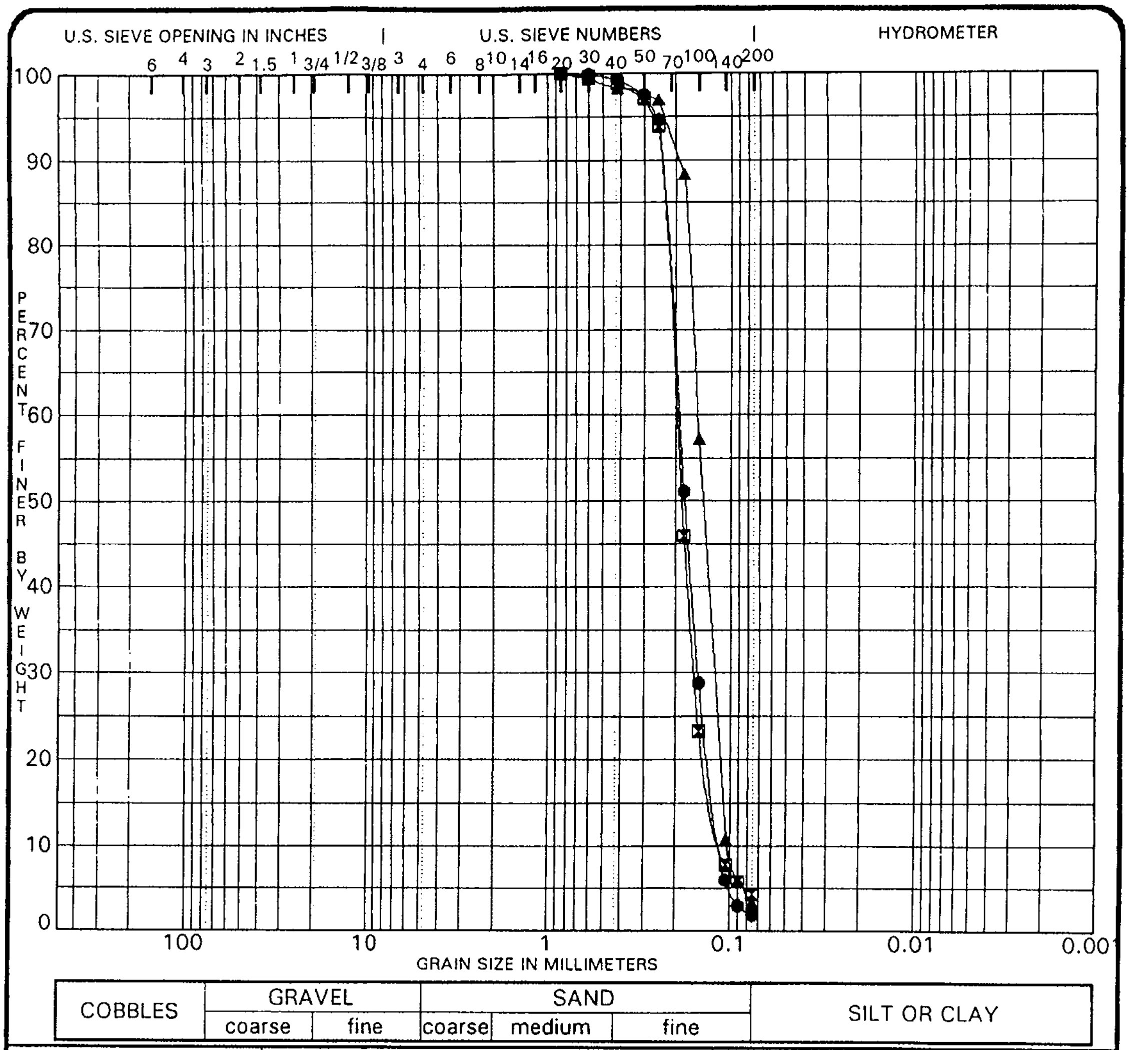
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	FP-10	1.0	**POORLY GRADED SAND SP**					0.96	1.6
☒	FP-10	3.0	**POORLY GRADED SAND SP**					0.95	1.5
▲	FP-10	5.0	**POORLY GRADED SAND SP**					0.93	1.6
★	FP-10	7.0	**POORLY GRADED SAND SP**					1.07	1.6
○	FP-10	9.0	**POORLY GRADED SAND with SILT SP-SM**		NP	NP	NP	0.97	1.7

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	FP-10	1.0	0.60	0.17	0.135	0.1093	0.0	97.0	3.0	
☒	FP-10	3.0	0.85	0.17	0.133	0.1098	0.0	98.3	1.7	
▲	FP-10	5.0	0.85	0.16	0.127	0.1062	0.0	96.2	3.8	
★	FP-10	7.0	0.85	0.18	0.149	0.1130	0.0	97.3	2.7	
○	FP-10	9.0	0.85	0.18	0.136	0.1069	0.0	94.6	5.4	

PROJECT **Isolated Wetlands Drilling Program - Phase II - Flint Pen Strand, Lee County, Florida**

JOB NO. 1163
DATE 1/8/99

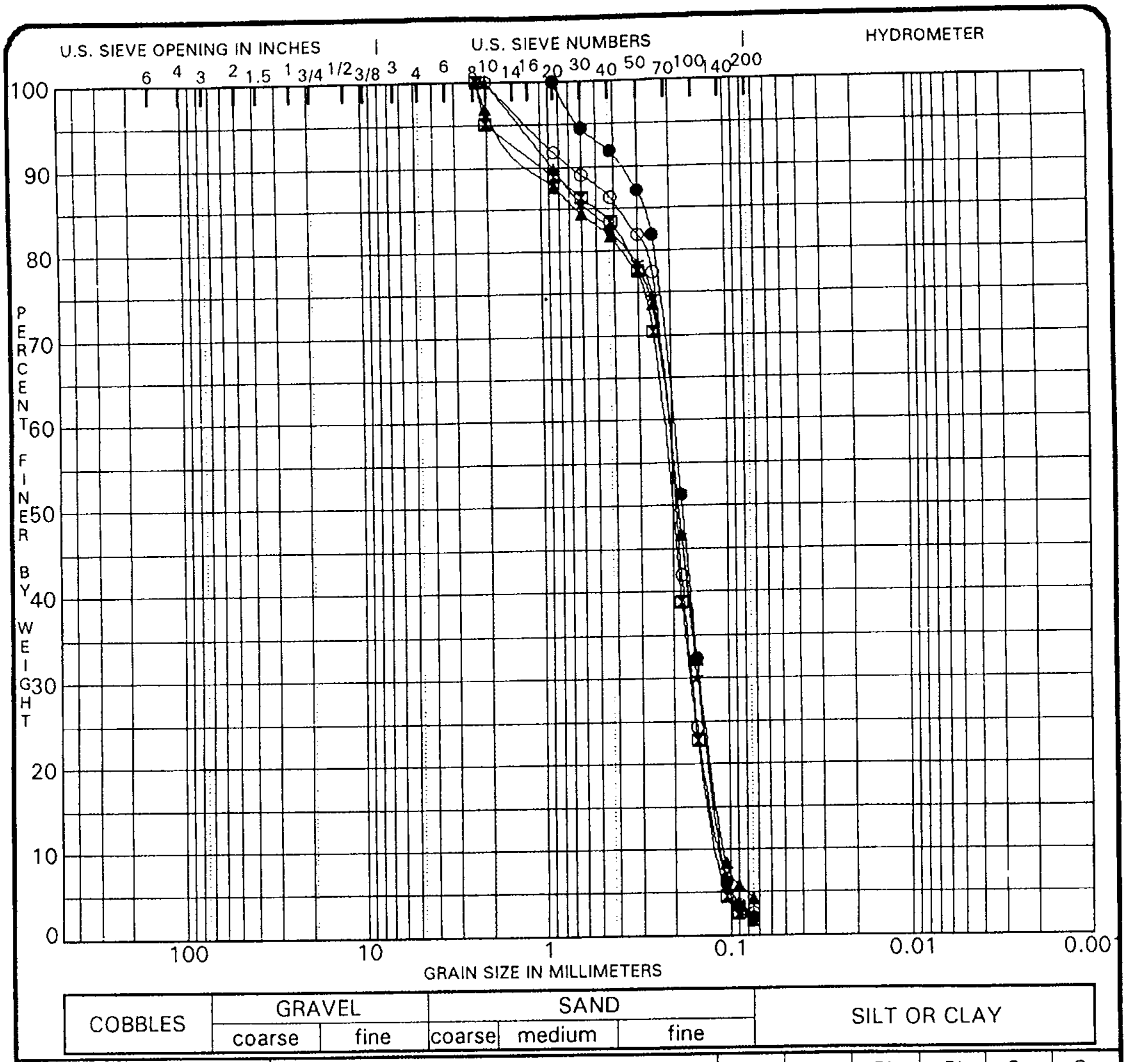


Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	FP-10	11.0	POORLY GRADED SAND SP					1.06	1.7
☒	FP-10	13.0	POORLY GRADED SAND SP					1.14	1.8
▲	FP-10	15.0	POORLY GRADED SAND SP					0.95	1.5

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	FP-10	11.0	0.85	0.19	0.152	0.1127	0.0	98.1	1.9	
☒	FP-10	13.0	0.85	0.20	0.158	0.1111	0.0	95.6	4.4	
▲	FP-10	15.0	0.85	0.15	0.122	0.1032	0.0	96.7	3.3	

PROJECT **Isolated Wetlands Drilling Program - Phase II - Flint Pen Strand, Lee County, Florida**

JOB NO. 1163
DATE 1/8/99

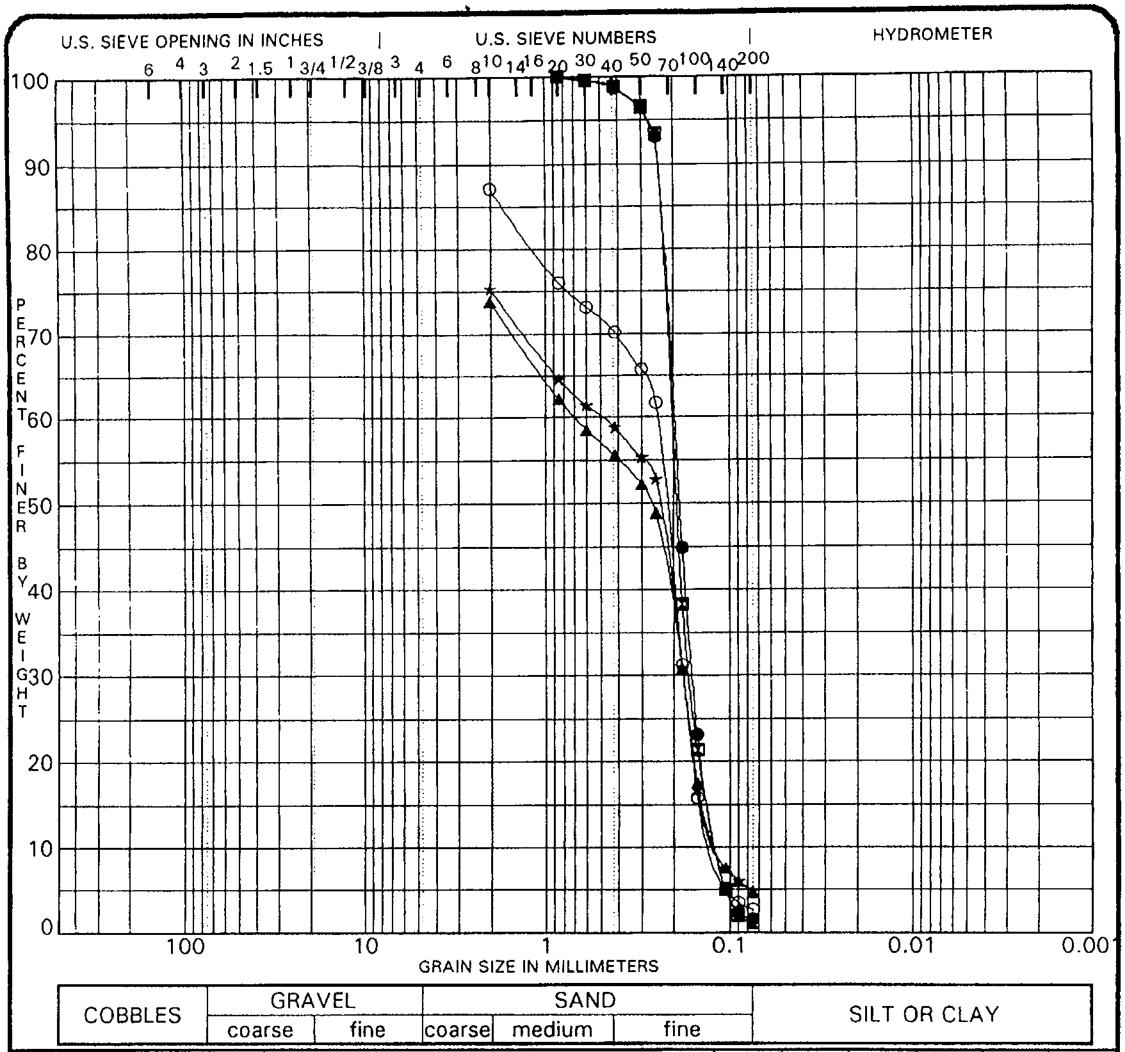


Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● FP-11 1.3	POORLY GRADED SAND SP					0.96	1.8
⌧ FP-11 3.3	POORLY GRADED SAND SP		NP	NP	NP	1.01	1.9
▲ FP-11 5.3	POORLY GRADED SAND SP		NP	NP	NP	0.92	2.0
★ FP-11 7.3	POORLY GRADED SAND SP					0.96	1.9
○ FP-11 9.3	POORLY GRADED SAND SP					1.05	1.9

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● FP-11 1.3	0.85	0.20	0.146	0.1116	0.0	97.9	2.1	
⌧ FP-11 3.3	2.25	0.22	0.163	0.1175	0.0	98.2	1.8	
▲ FP-11 5.3	2.25	0.21	0.146	0.1085	0.0	95.7	4.3	
★ FP-11 7.3	2.00	0.21	0.150	0.1113	0.0	97.5	2.5	
○ FP-11 9.3	2.00	0.21	0.159	0.1135	0.0	97.4	2.6	

PROJECT **Isolated Wetlands Drilling Program - Phase II -**
Flint Pen Strand, Lee County, Florida

JOB NO. 1163
DATE 1/8/99

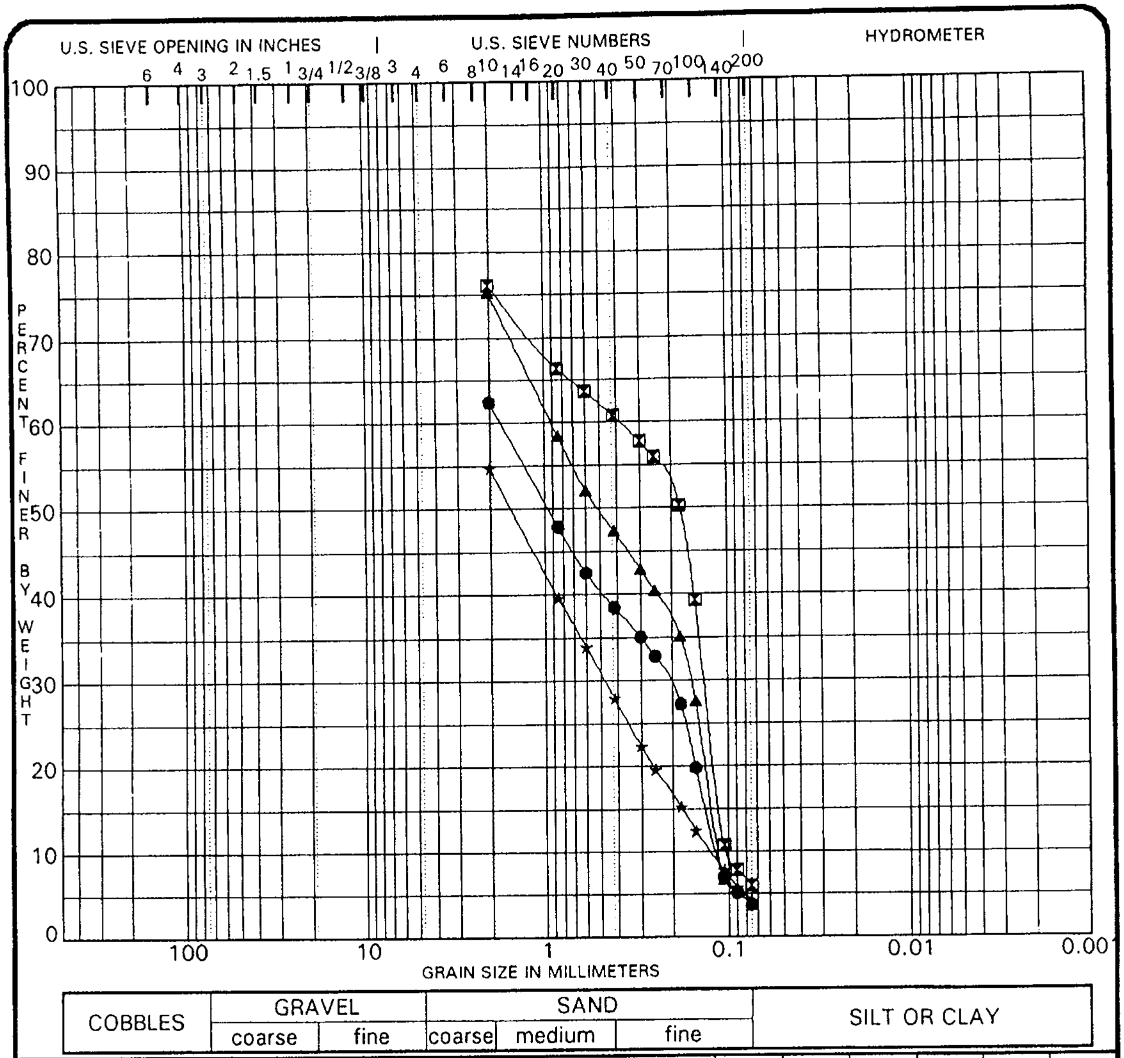


Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
● FP-11	11.3	POORLY GRADED SAND SP					1.09	1.7
⊠ FP-11	13.4	POORLY GRADED SAND SP					1.12	1.7
▲ FP-11	15.5	*SAND/LIMESTONE					0.40	6.0
★ FP-11	17.5	*SAND/LIMESTONE					0.55	4.3
○ FP-11	19.0	*SAND/SHELL					1.03	2.0

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● FP-11	11.3	0.85	0.20	0.159	0.1163	0.0	98.4	1.6	
⊠ FP-11	13.4	0.85	0.20	0.165	0.1177	0.0	98.8	1.2	
▲ FP-11	15.5		0.69	0.178	0.1153			4.7	
★ FP-11	17.5		0.50	0.178	0.1162			4.9	
○ FP-11	19.0		0.25	0.178	0.1243			2.7	

PROJECT **Isolated Wetlands Drilling Program - Phase II -**
Flint Pen Strand, Lee County, Florida

JOB NO. 1163
DATE 1/8/99



Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	FP-11	21.3	*SAND/SHELL/LIMESTONE					0.23	15.1
☒	FP-11	23.3	*SAND/SHELL					0.45	3.8
▲	FP-11	30.3	SHELL MATERIAL					0.25	8.2
★	FP-11	51.0	SHELL AND LIMEROCK						

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	FP-11	21.3		1.74	0.212	0.1150			3.8	
☒	FP-11	23.3		0.39	0.134	0.1019			6.0	
▲	FP-11	30.3		0.92	0.159	0.1118			4.2	
★	FP-11	51.0			0.476	0.1251			4.2	

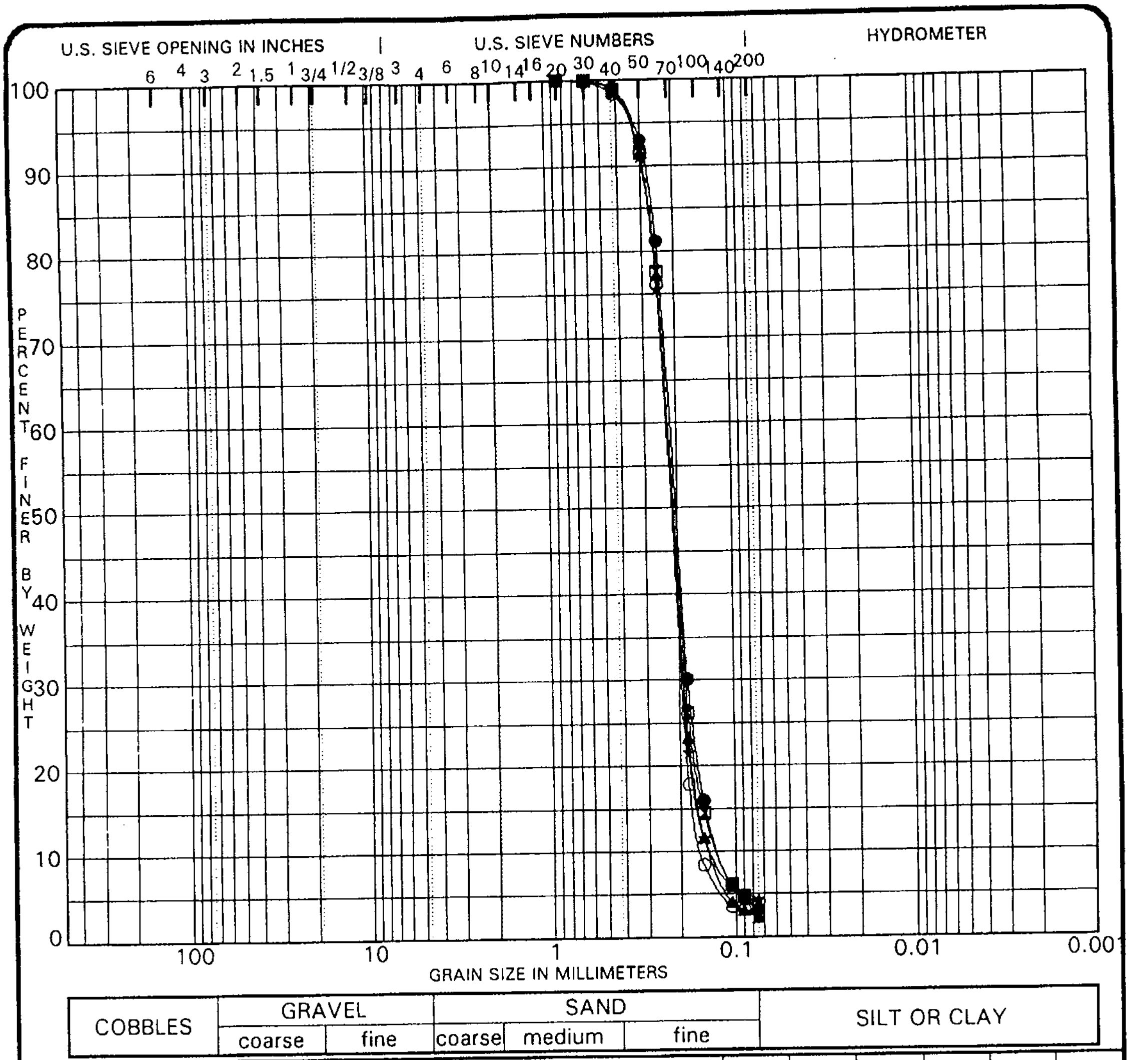
PROJECT **Isolated Wetlands Drilling Program - Phase II - Flint Pen Strand, Lee County, Florida**

JOB NO. 1163

DATE 1/8/99

APPENDIX B

Stairstep Project Field Notes



	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	ST-1	1.0	POORLY GRADED SAND SP		NP	NP	NP	1.21	1.8
⊠	ST-1	3.0	POORLY GRADED SAND SP		NP	NP	NP	1.22	1.8
▲	ST-1	5.0	POORLY GRADED SAND SP		NP	NP	NP	1.12	1.6
★	ST-1	7.0	POORLY GRADED SAND SP		NP	NP	NP	1.15	1.7
○	ST-1	9.0	POORLY GRADED SAND SP		NP	NP	NP	1.05	1.5

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	ST-1	1.0	0.85	0.22	0.180	0.1220	0.0	96.8	3.2	
⊠	ST-1	3.0	0.85	0.22	0.184	0.1243	0.0	96.1	3.9	
▲	ST-1	5.0	0.85	0.23	0.188	0.1393	0.0	97.7	2.3	
★	ST-1	7.0	0.85	0.23	0.190	0.1369	0.0	95.6	4.4	
○	ST-1	9.0	0.85	0.23	0.193	0.1547	0.0	97.1	2.9	

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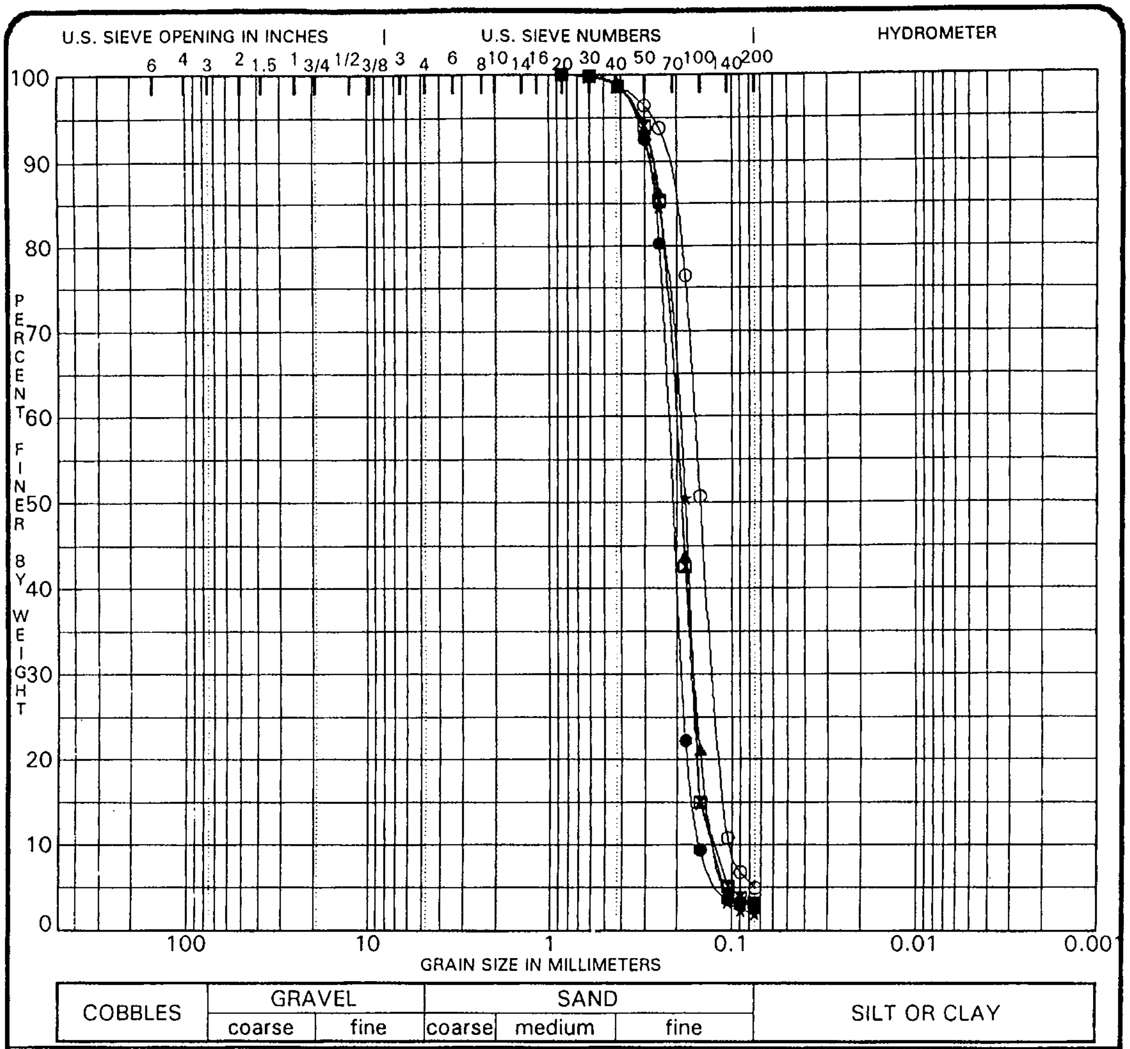
GRADATION CURVES



Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● ST-1 11.0	**POORLY GRADED SAND SP**		**NP**	**NP**	**NP**	**1.05**	**1.5**
⊠ ST-1 13.0	**POORLY GRADED SAND SP**		**NP**	**NP**	**NP**	**1.06**	**1.6**
▲ ST-1 15.0	**POORLY GRADED SAND SP**		**NP**	**NP**	**NP**	**1.06**	**1.7**
★ ST-1 17.0	**POORLY GRADED SAND SP**		**NP**	**NP**	**NP**	**1.03**	**1.5**
○ ST-1 19.0	**POORLY GRADED SAND with SILT SP-SM**		**NP**	**NP**	**NP**	**0.95**	**1.6**

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● ST-1 11.0	0.85	0.22	0.188	0.1513	0.0	96.8	3.2	
⊠ ST-1 13.0	0.85	0.21	0.166	0.1256	0.0	96.7	3.3	
▲ ST-1 15.0	0.85	0.20	0.161	0.1199	0.0	97.1	2.9	
★ ST-1 17.0	0.85	0.20	0.162	0.1298	0.0	98.0	2.0	
○ ST-1 19.0	0.85	0.16	0.125	0.1026	0.0	95.0	5.0	

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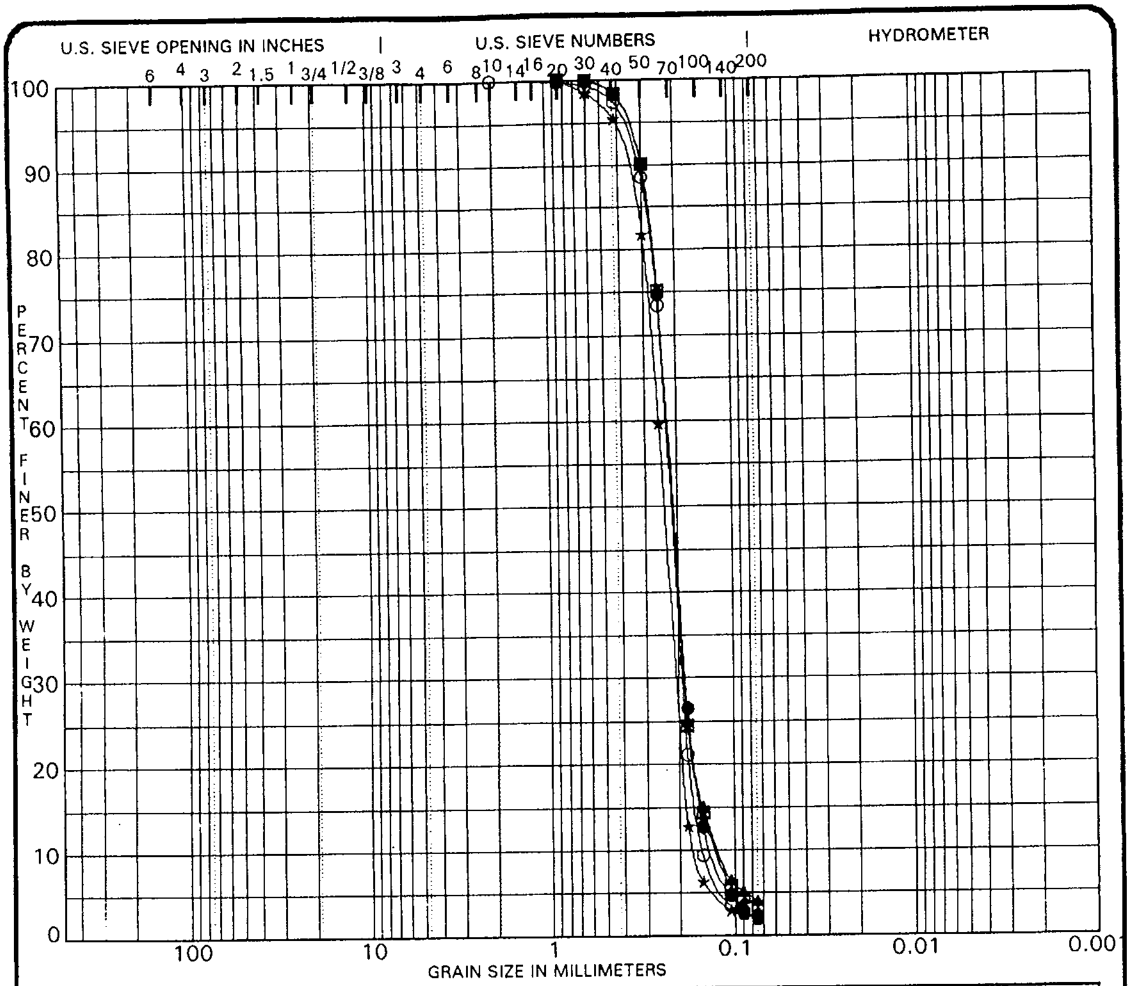

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	ST-2	1.2	POORLY GRADED SAND SP		NP	NP	NP	1.13	1.7
⊠	ST-2	3.0	POORLY GRADED SAND SP		NP	NP	NP	1.22	1.8
▲	ST-2	5.0	POORLY GRADED SAND SP		NP	NP	NP	1.25	1.8
★	ST-2	7.4	POORLY GRADED SAND SP		NP	NP	NP	0.99	1.5
○	ST-2	9.4	POORLY GRADED SAND SP		NP	NP	NP	1.04	1.5

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	ST-2	1.2	0.85	0.23	0.184	0.1334	0.0	98.0	2.0	
⊠	ST-2	3.0	0.85	0.23	0.187	0.1256	0.0	96.6	3.4	
▲	ST-2	5.0	0.85	0.23	0.186	0.1223	0.0	95.9	4.1	
★	ST-2	7.4	0.85	0.25	0.203	0.1664	0.0	97.8	2.2	
○	ST-2	9.4	2.00	0.23	0.190	0.1514	0.0	97.9	2.1	

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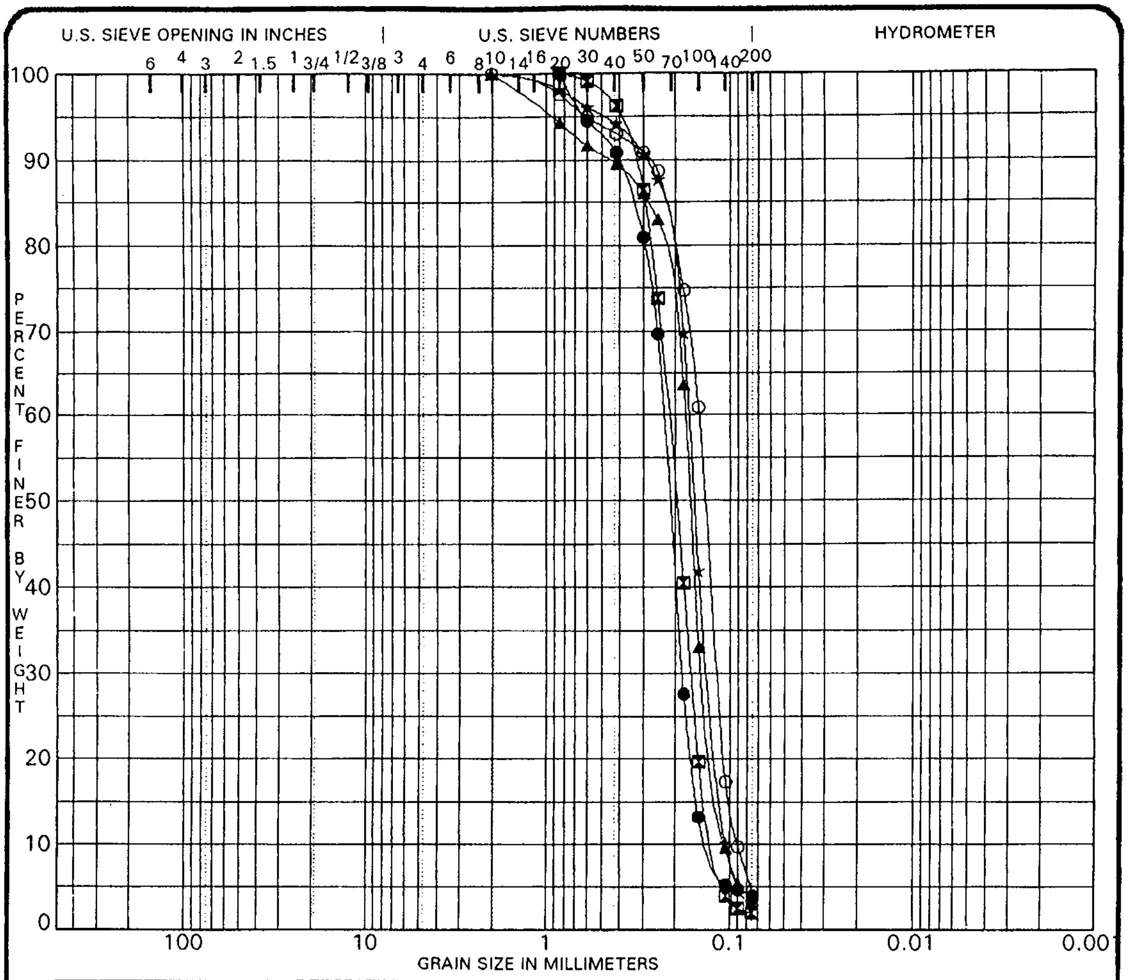

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	ST-2	11.2	POORLY GRADED SAND SP		NP	NP	NP	1.11	1.8
☒	ST-2	13.3	POORLY GRADED SAND SP		NP	NP	NP	1.02	1.8
▲	ST-2	15.4	POORLY GRADED SAND SP		NP	NP	NP	1.09	1.7
★	ST-2	17.3	POORLY GRADED SAND SP		NP	NP	NP	0.97	1.6
○	ST-2	19.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.02	1.6

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	ST-2	11.2	0.85	0.23	0.183	0.1303	0.0	96.0	4.0	
☒	ST-2	13.3	0.85	0.22	0.164	0.1210	0.0	98.0	2.0	
▲	ST-2	15.4	2.00	0.18	0.143	0.1068	0.0	96.0	4.0	
★	ST-2	17.3	2.00	0.17	0.132	0.1057	0.0	97.0	3.0	
○	ST-2	19.0	2.00	0.15	0.117	0.0906	0.0	95.5	4.5	

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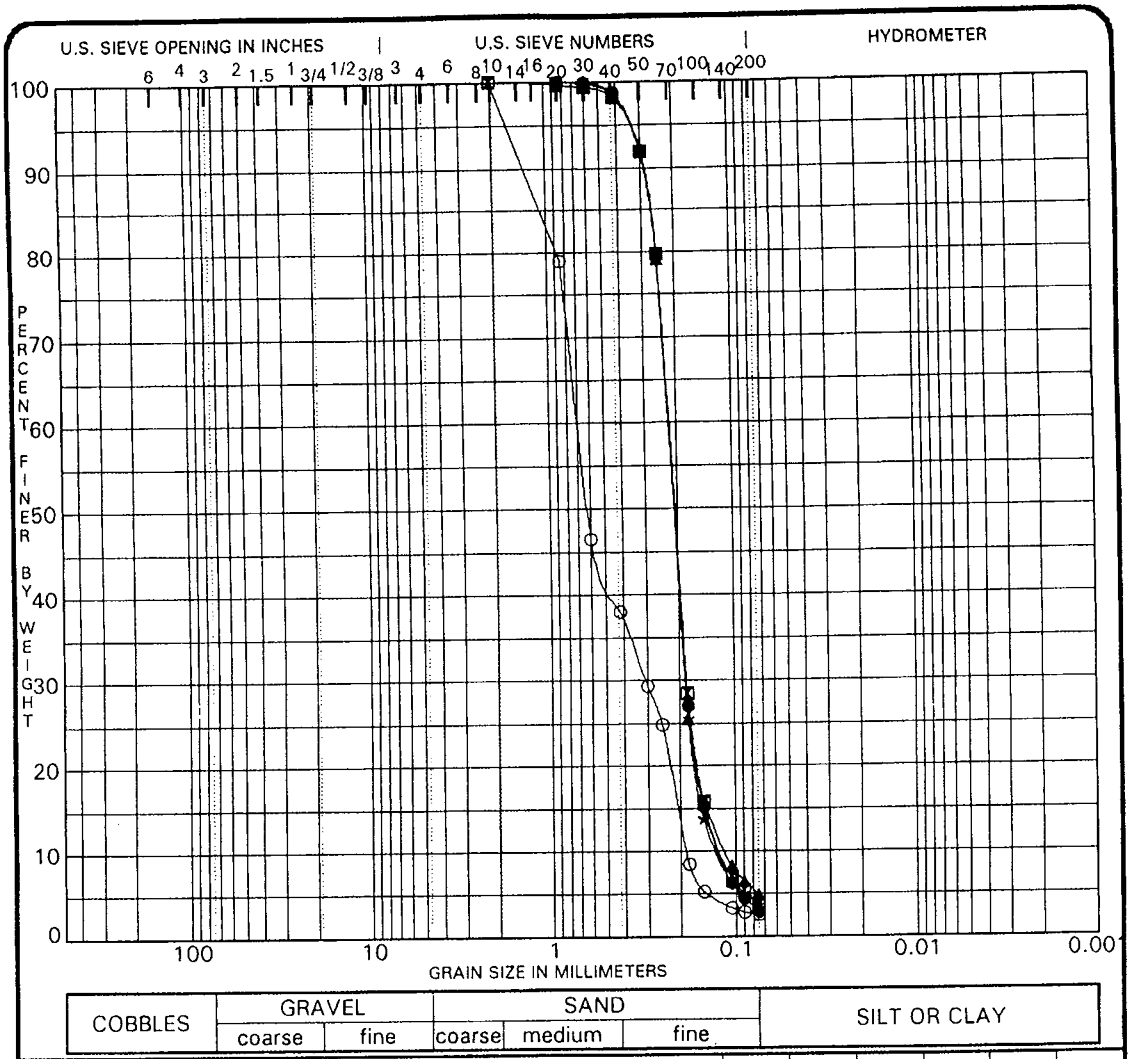

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	ST-3	1.0	POORLY GRADED SAND SP		NP	NP	NP	1.24	1.8
⊠	ST-3	3.3	POORLY GRADED SAND SP		NP	NP	NP	1.26	1.8
▲	ST-3	5.2	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.34	1.9
★	ST-3	7.3	POORLY GRADED SAND SP		NP	NP	NP	1.23	1.8
○	ST-3	9.3	POORLY GRADED SAND SP		NP	NP	NP	0.74	3.7

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	ST-3	1.0	0.85	0.22	0.183	0.1225	0.0	97.0	3.0	
⊠	ST-3	3.3	2.00	0.22	0.182	0.1193	0.0	96.1	3.9	
▲	ST-3	5.2	0.85	0.22	0.185	0.1146	0.0	95.1	4.9	
★	ST-3	7.3	0.85	0.22	0.185	0.1252	0.0	96.2	3.8	
○	ST-3	9.3	2.00	0.69	0.308	0.1855	0.0	97.4	2.6	

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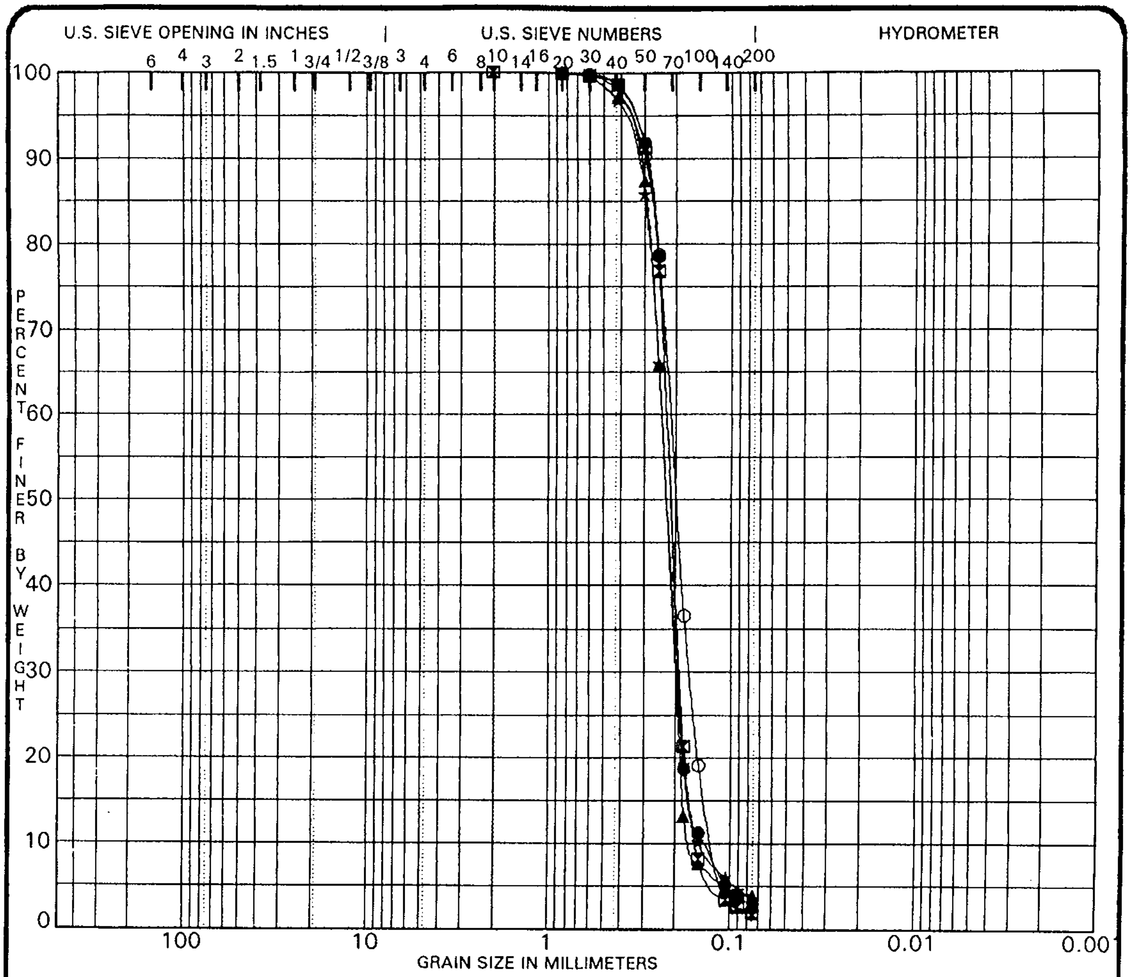

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	ST-3	11.4	POORLY GRADED SAND SP		NP	NP	NP	1.16	1.6
⊠	ST-3	13.2	POORLY GRADED SAND SP		NP	NP	NP	1.03	1.5
▲	ST-3	15.4	POORLY GRADED SAND SP		NP	NP	NP	1.02	1.5
★	ST-3	17.3	POORLY GRADED SAND SP		NP	NP	NP	1.07	1.6
○	ST-3	18.6	POORLY GRADED SAND SP		NP	NP	NP	1.07	1.8

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	ST-3	11.4	0.85	0.23	0.192	0.1399	0.0	97.4	2.6	
⊠	ST-3	13.2	2.00	0.23	0.190	0.1538	0.0	98.1	1.9	
▲	ST-3	15.4	0.85	0.24	0.200	0.1624	0.0	96.1	3.9	
★	ST-3	17.3	0.85	0.24	0.194	0.1475	0.0	96.5	3.5	
○	ST-3	18.6	0.85	0.22	0.168	0.1225	0.0	98.0	2.0	

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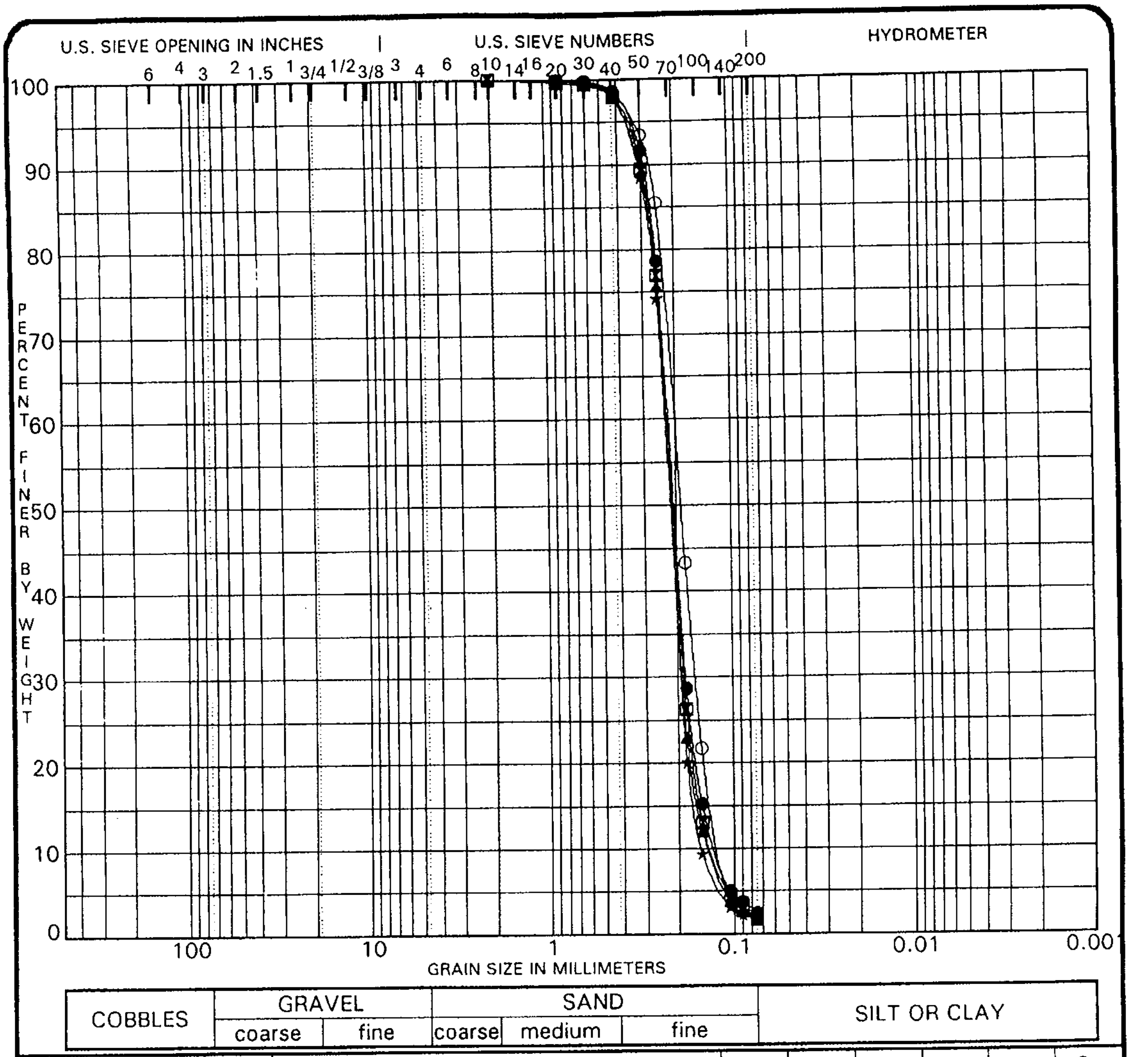

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	ST-4	1.3	POORLY GRADED SAND SP		NP	NP	NP	1.19	1.8
⊠	ST-4	2.8	POORLY GRADED SAND SP		NP	NP	NP	1.15	1.7
▲	ST-4	5.3	POORLY GRADED SAND SP		NP	NP	NP	1.13	1.6
★	ST-4	7.4	POORLY GRADED SAND SP		NP	NP	NP	1.05	1.5
○	ST-4	9.4	POORLY GRADED SAND SP		NP	NP	NP	1.06	1.7

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	ST-4	1.3	0.85	0.22	0.182	0.1254	0.0	97.5	2.5	
⊠	ST-4	2.8	2.00	0.22	0.184	0.1325	0.0	98.2	1.8	
▲	ST-4	5.3	2.00	0.23	0.188	0.1377	0.0	97.9	2.1	
★	ST-4	7.4	0.85	0.23	0.191	0.1515	0.0	98.3	1.7	
○	ST-4	9.4	0.85	0.21	0.161	0.1186	0.0	97.6	2.4	

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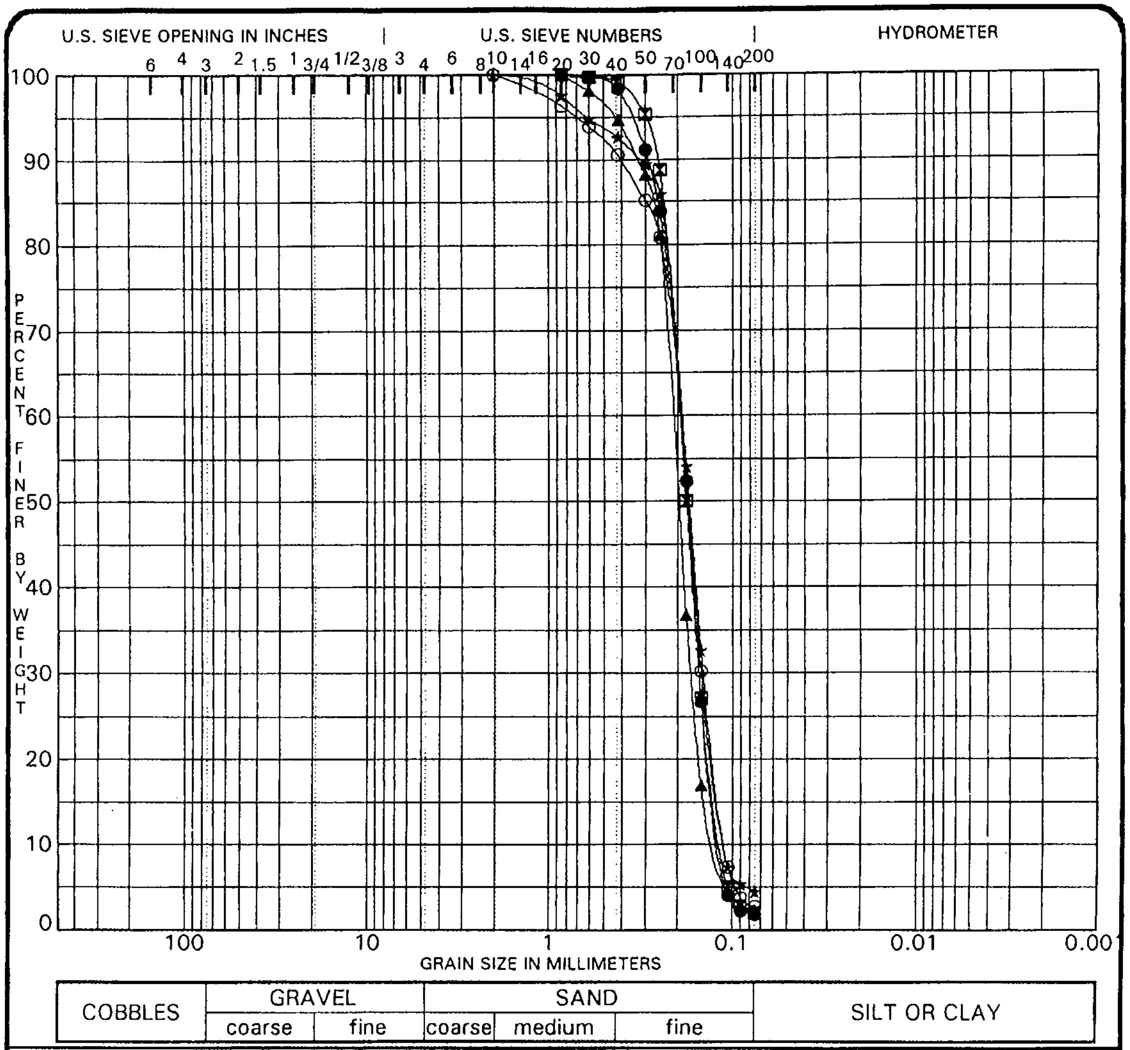

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● ST-4 11.3	POORLY GRADED SAND SP		NP	NP	NP	1.04	1.7
⊠ ST-4 13.3	POORLY GRADED SAND SP		NP	NP	NP	1.05	1.7
▲ ST-4 15.4	POORLY GRADED SAND SP		NP	NP	NP	1.08	1.7
★ ST-4 17.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.00	1.7
○ ST-4 19.4	POORLY GRADED SAND SP		NP	NP	NP	1.03	1.8

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● ST-4 11.3	0.85	0.19	0.154	0.1161	0.0	98.1	1.9	
⊠ ST-4 13.3	0.85	0.20	0.154	0.1145	0.0	98.0	2.0	
▲ ST-4 15.4	0.85	0.21	0.169	0.1236	0.0	97.6	2.4	
★ ST-4 17.0	2.00	0.19	0.145	0.1099	0.0	95.5	4.5	
○ ST-4 19.4	2.00	0.20	0.150	0.1103	0.0	97.2	2.8	

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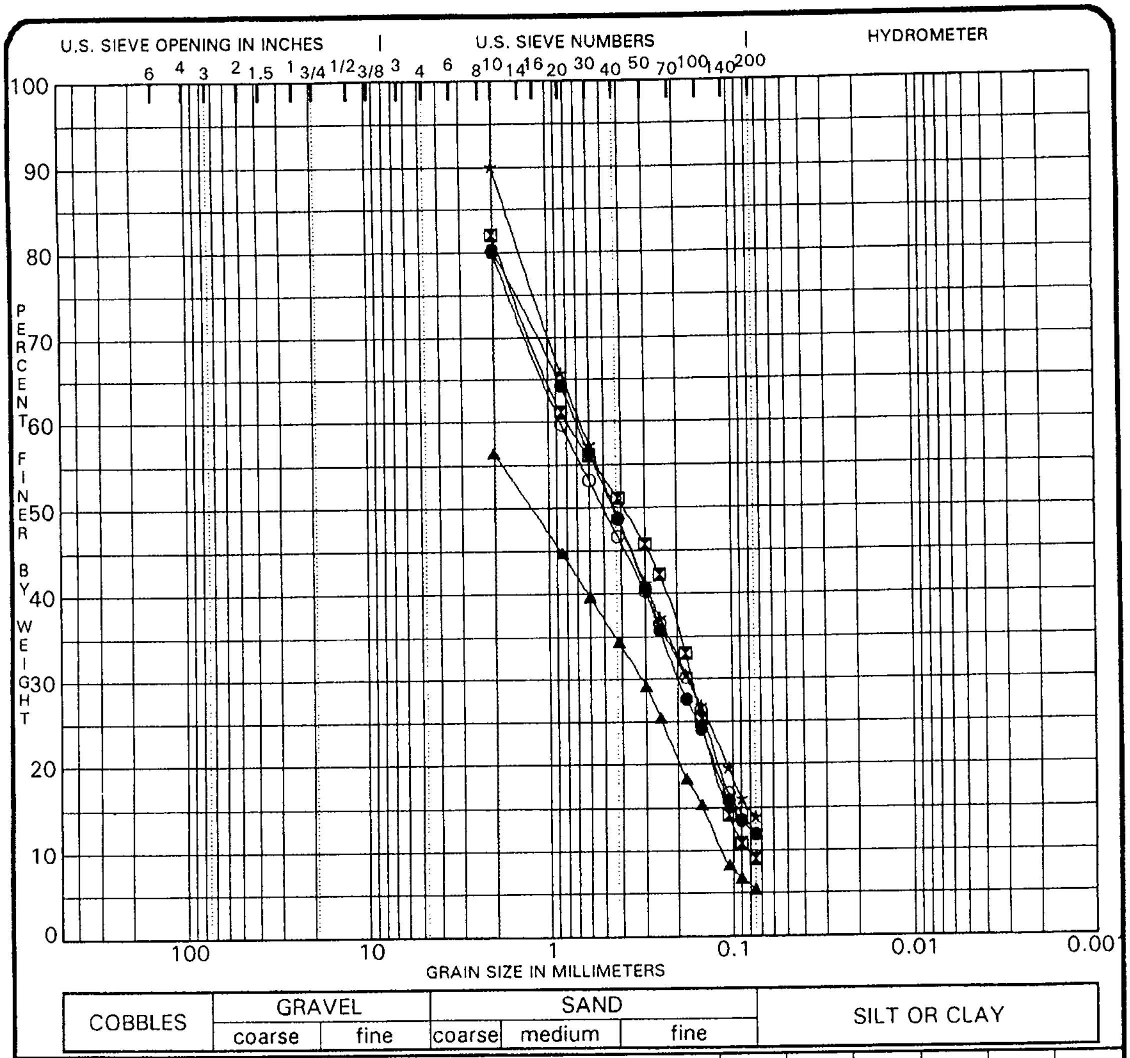

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	ST-4	21.5	*LIMESTONE/WHITE MICRITE		NP	NP	NP	0.80	10.1
☒	ST-4	23.3	*MICRITE/FRIABLE LIMESTONE		NP	NP	NP	0.43	9.6
▲	ST-4	25.5	*LIMESTONE W/ SHELL FRAGMENTS		NP	NP	NP		
★	ST-4	29.3	*FRIABLE LIMESTONE		NP	NP	NP		
○	ST-4	31.4	*FRIABLE LIMESTONE		NP	NP	NP	0.53	12.3

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	ST-4	21.5		0.70	0.198				11.9	
☒	ST-4	23.3		0.79	0.168	0.0822			9.1	
▲	ST-4	25.5			0.316	0.1153			5.5	
★	ST-4	29.3		0.67	0.175				13.9	
○	ST-4	31.4		0.86	0.178				11.9	

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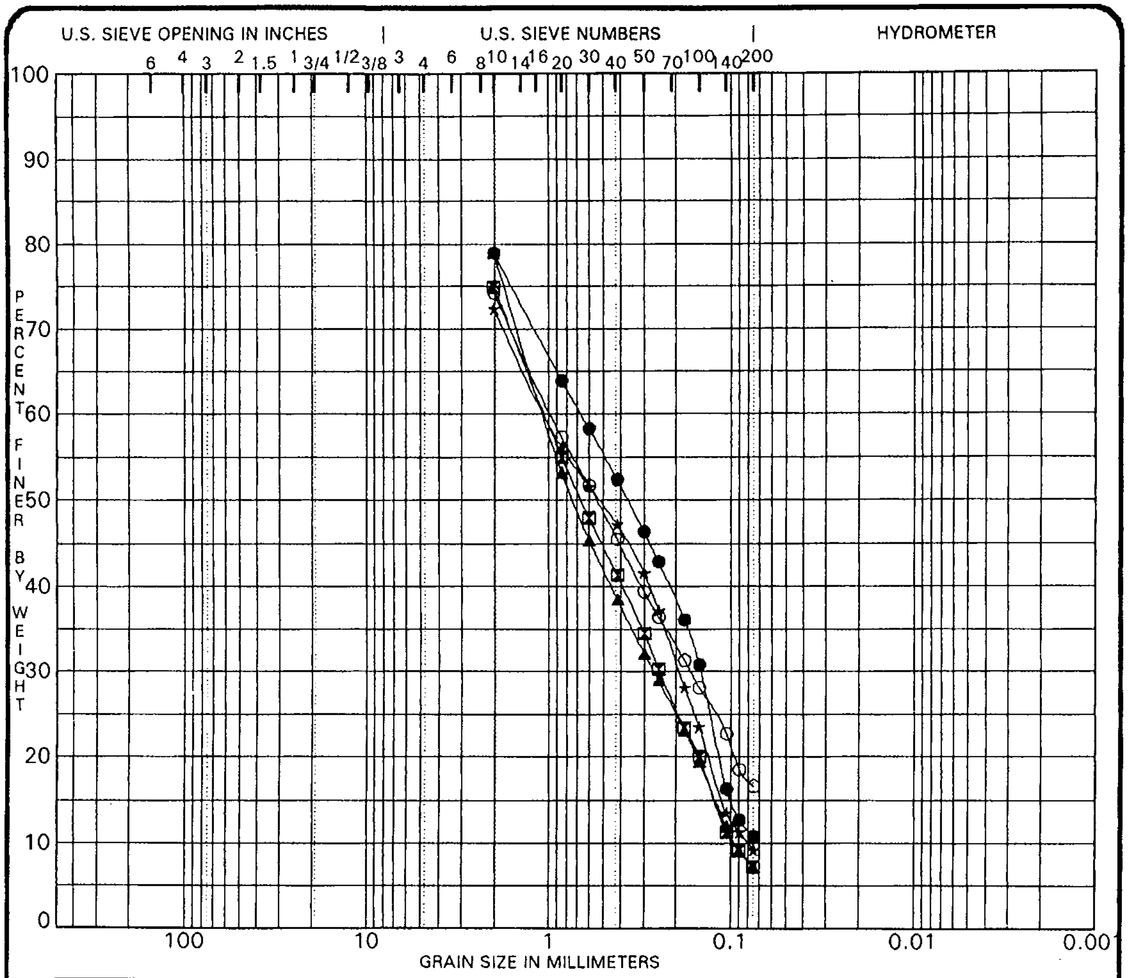

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	ST-4	33.2	*SILTY LIMESTONE W/ SHELL		NP	NP	NP	0.46	9.5
☒	ST-4	35.0	*SILTY LIMESTONE W/ SHELL		NP	NP	NP	0.60	11.0
▲	ST-4	37.5	*SILTY LIMESTONE W/ SHELL		NP	NP	NP	0.70	11.3
★	ST-4	39.5	*SILTY LIMESTONE W/ SHELL		NP	NP	NP	0.44	13.0
○	ST-4	46.0	*SANDY LIMESTONE W/ SHELL		NP	NP	NP		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	ST-4	33.2		0.67	0.147				10.8	
☒	ST-4	35.0		1.05	0.247	0.0958			7.2	
▲	ST-4	37.5		1.07	0.266	0.0947			7.3	
★	ST-4	39.5		1.04	0.193	0.0804			9.2	
○	ST-4	46.0		0.97	0.167				16.6	

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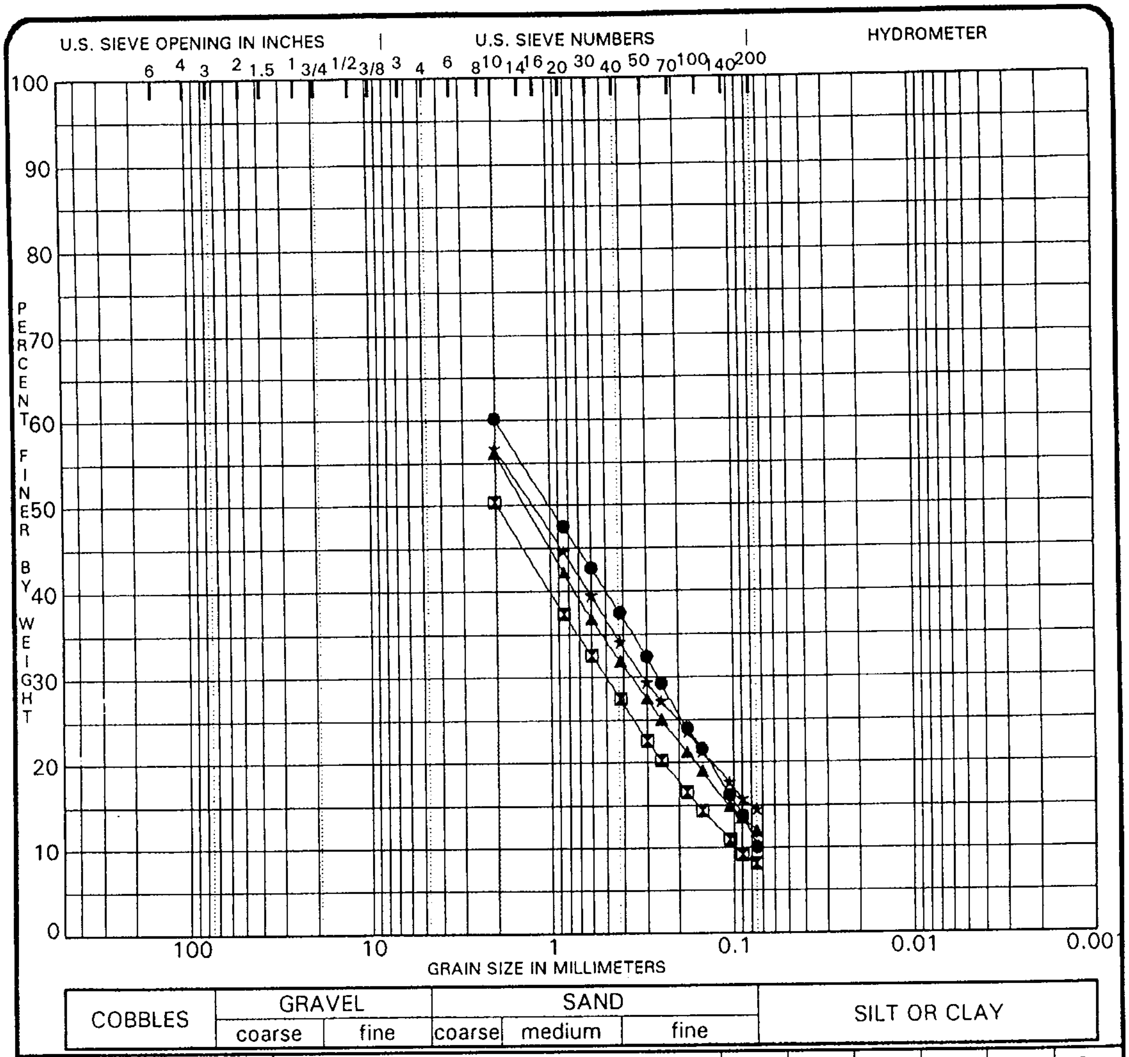

Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
● ST-4	48.5	*SANDY LIMESTONE W/ SHELL		NP	NP	NP	0.49	28.2
⧗ ST-4	54.5	*SANDY LIMESTONE/FRIABLE		NP	NP	NP		
▲ ST-4	56.3	*SANDY LIMESTONE/FRIABLE		NP	NP	NP		
★ ST-4	58.3	*SANDY LIMESTONE/FRIABLE		NP	NP	NP		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● ST-4	48.5		1.97	0.261				10.1	
⧗ ST-4	54.5			0.500	0.0968			8.2	
▲ ST-4	56.3			0.363				12.0	
★ ST-4	58.3			0.313				14.5	

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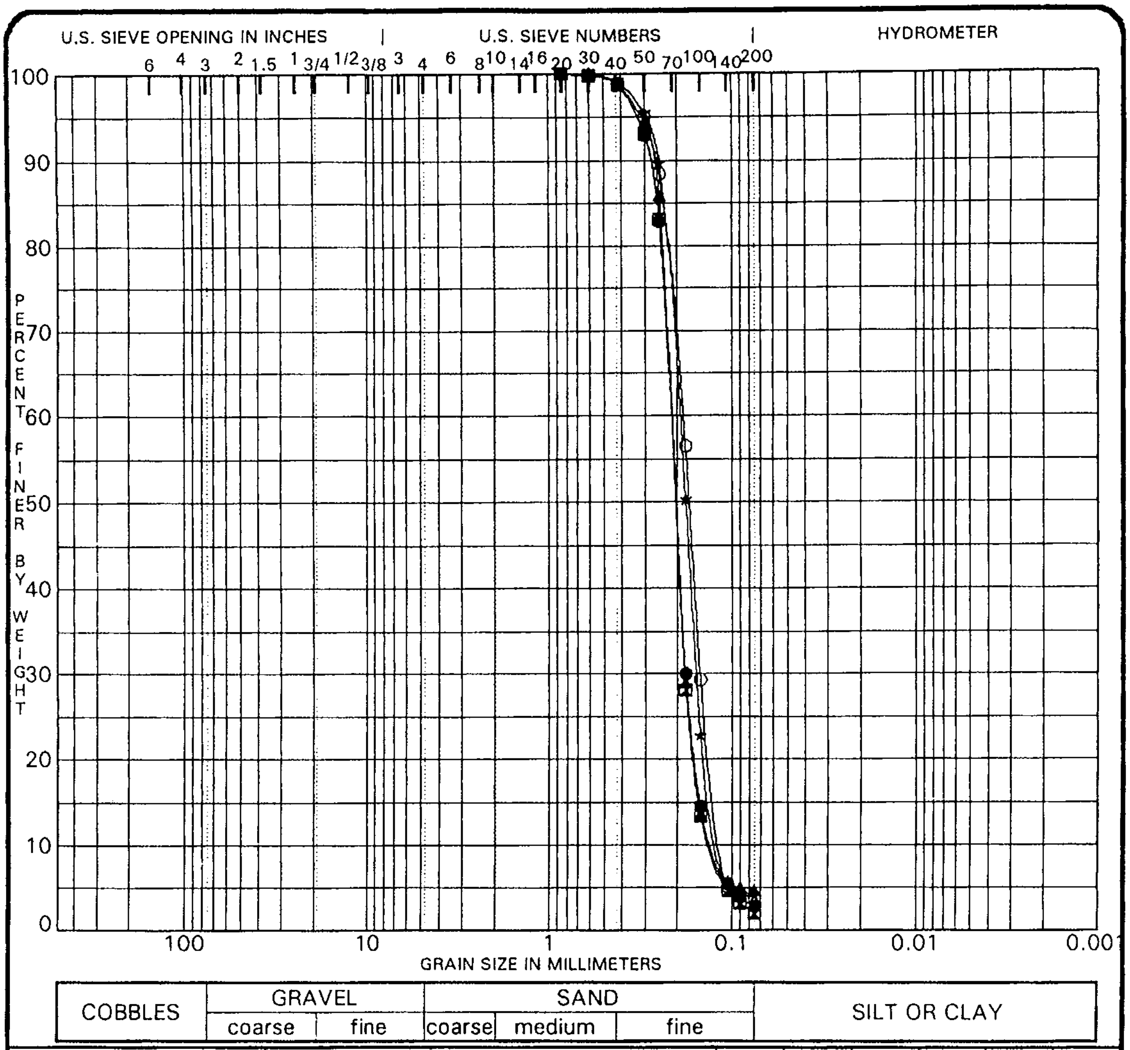

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	ST-5	1.0	POORLY GRADED SAND SP		NP	NP	NP	1.18	1.7
☒	ST-5	3.0	POORLY GRADED SAND SP		NP	NP	NP	1.16	1.7
▲	ST-5	5.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.19	1.7
★	ST-5	7.0	POORLY GRADED SAND SP		NP	NP	NP	1.10	1.7
○	ST-5	9.0	POORLY GRADED SAND SP		NP	NP	NP	1.07	1.6

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	ST-5	1.0	0.85	0.22	0.180	0.1261	0.0	97.2	2.8	
☒	ST-5	3.0	0.85	0.22	0.182	0.1310	0.0	97.9	2.1	
▲	ST-5	5.0	0.85	0.22	0.181	0.1283	0.0	95.3	4.7	
★	ST-5	7.0	0.85	0.20	0.157	0.1153	0.0	95.9	4.1	
○	ST-5	9.0	0.85	0.19	0.151	0.1136	0.0	96.2	3.8	

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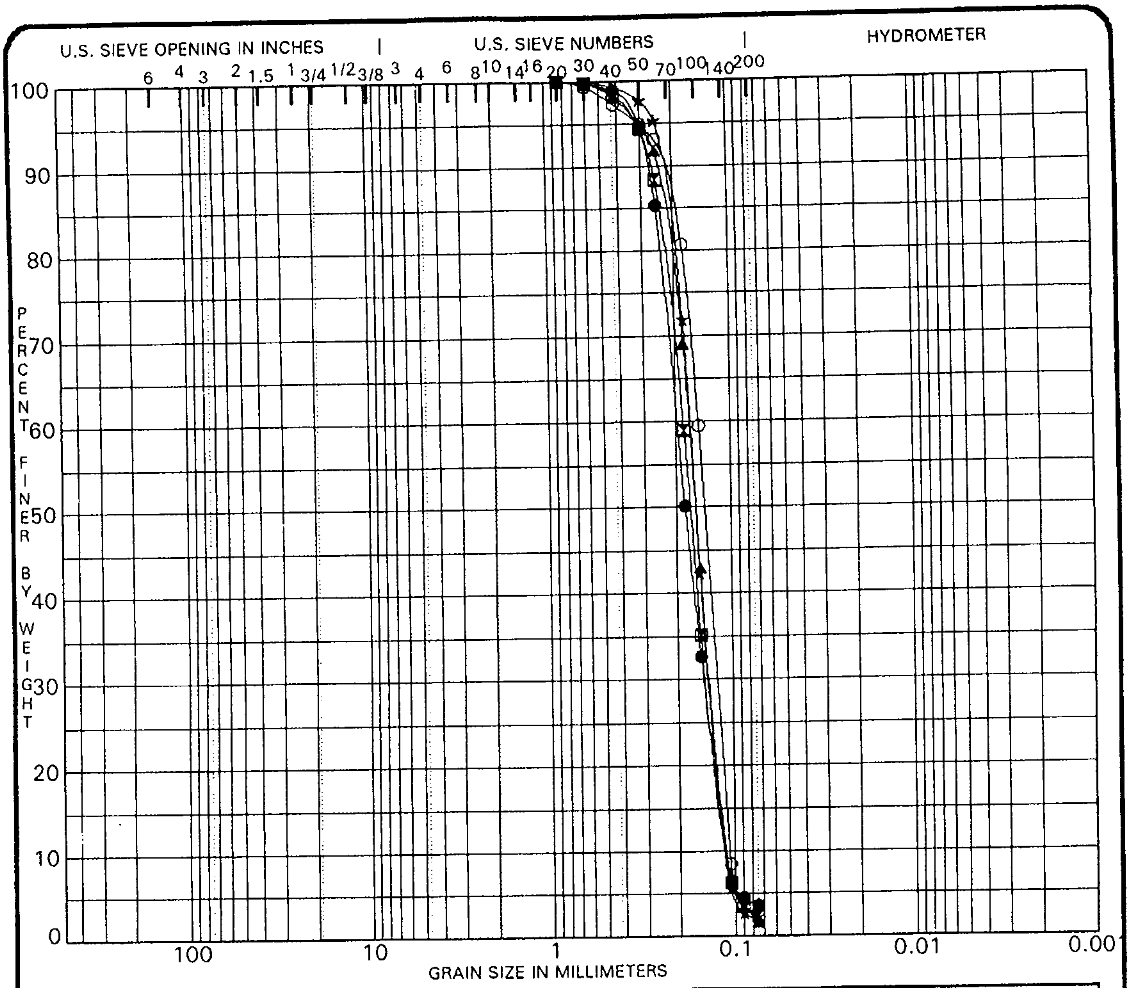

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	ST-5	11.0	POORLY GRADED SAND SP		NP	NP	NP	0.96	1.8
⊠	ST-5	13.0	POORLY GRADED SAND SP		NP	NP	NP	0.99	1.6
▲	ST-5	15.0	POORLY GRADED SAND SP		NP	NP	NP	0.95	1.5
★	ST-5	17.0	POORLY GRADED SAND SP		NP	NP	NP	0.96	1.5
○	ST-5	19.0	POORLY GRADED SAND SP		NP	NP	NP	0.93	1.4

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	ST-5	11.0	0.85	0.20	0.145	0.1111	0.0	96.4	3.6	
⊠	ST-5	13.0	0.85	0.18	0.141	0.1108	0.0	97.6	2.4	
▲	ST-5	15.0	0.85	0.17	0.132	0.1091	0.0	98.3	1.7	
★	ST-5	17.0	0.85	0.17	0.134	0.1105	0.0	98.4	1.6	
○	ST-5	19.0	0.85	0.15	0.123	0.1071	0.0	97.0	3.0	

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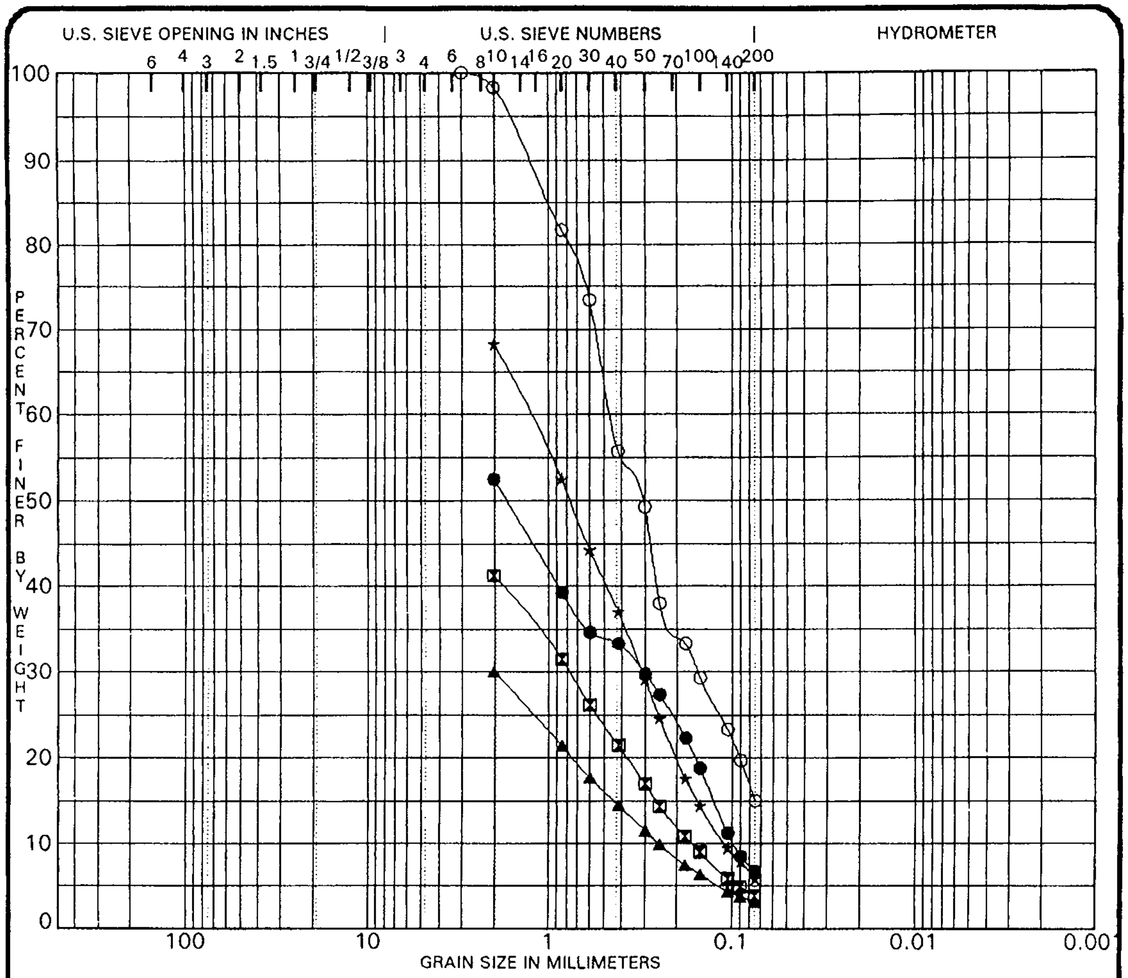

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	ST-5	21.0	*SANDY LIMESTONE W/ SHELL						
☒	ST-5	28.0	*SHELL W/ LIMESTONE						
▲	ST-5	29.5	*SHELL W/ LIMESTONE						
★	ST-5	31.5	*SHELL W/ LIMESTONE					0.69	11.6
○	ST-5	33.6	SILTY SAND SM		NP	NP	NP		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	ST-5	21.0			0.306	0.0986			6.8	
☒	ST-5	28.0			0.770	0.1660			3.9	
▲	ST-5	29.5			2.000	0.2529			3.1	
★	ST-5	31.5		1.28	0.312	0.1098			5.9	
○	ST-5	33.6	3.00	0.46	0.155		0.0	85.0	15.0	

PROJECT **Isolated Wetlands Drilling Program - Phase II -**
Stairstep Project, Lee County, Florida
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GRADATION CURVES

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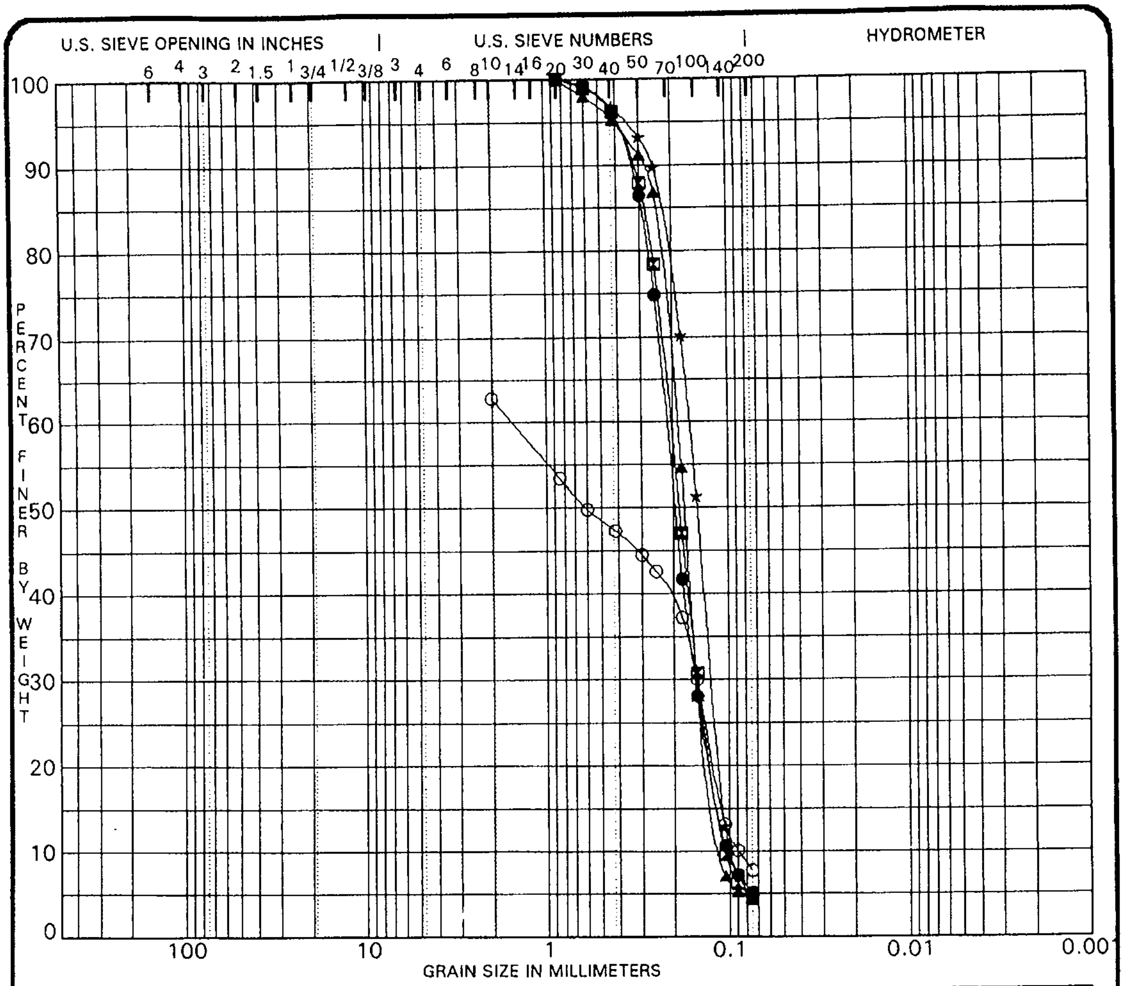
APPENDIX C

Hogan Island Farms Field Notes



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

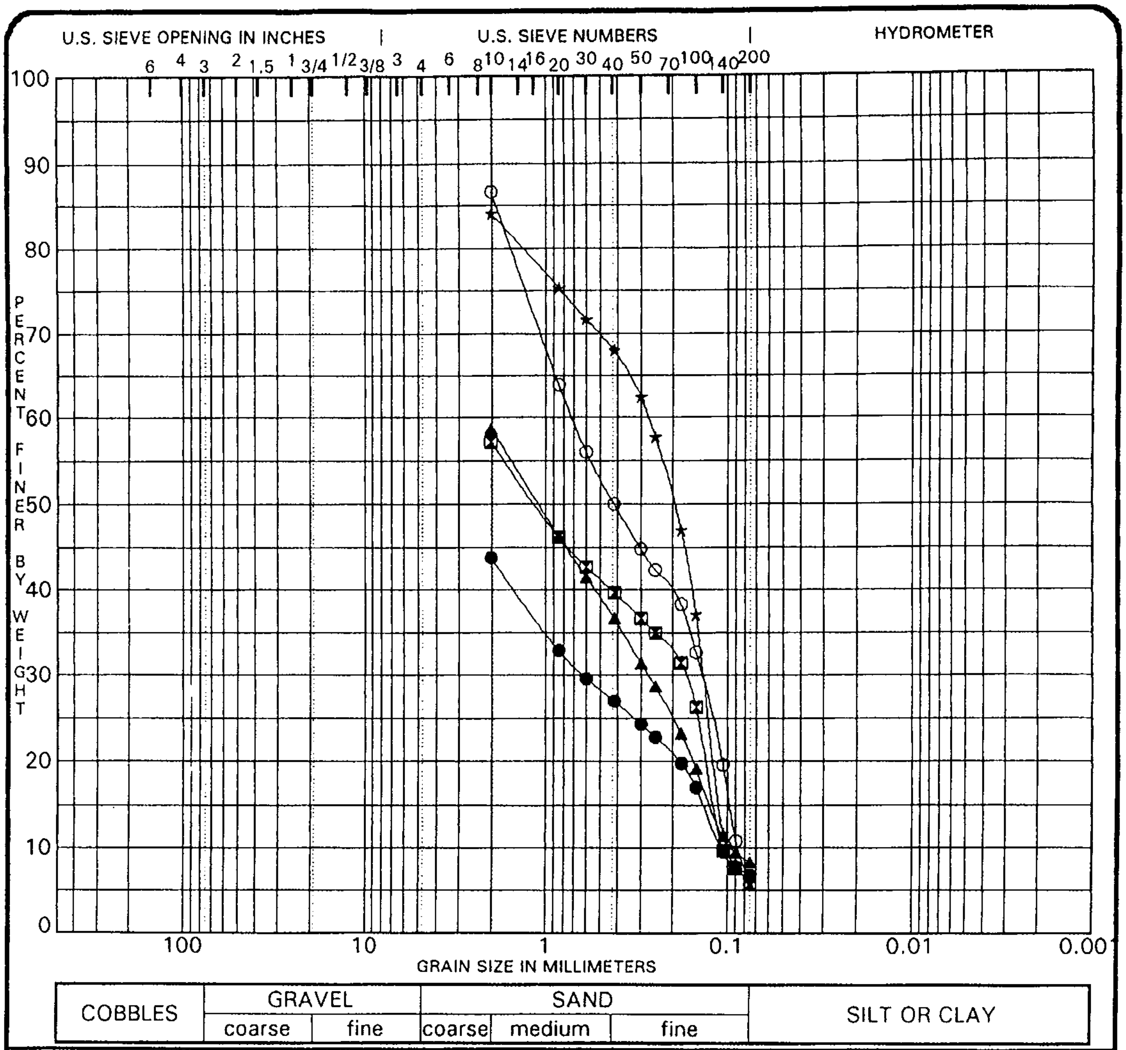
Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-1	1.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.07	2.1
⊠	HF-1	3.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.00	1.9
▲	HF-1	5.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.09	1.7
★	HF-1	7.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	0.96	1.7
○	HF-1	9.0	*SANDY LIMESTONE W/ SHELL					0.16	17.4

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-1	1.0	0.85	0.22	0.154	0.1029	0.0	94.8	5.2	
⊠	HF-1	3.0	0.85	0.21	0.148	0.1065	0.0	95.5	4.5	
▲	HF-1	5.0	0.85	0.19	0.152	0.1112	0.0	95.4	4.6	
★	HF-1	7.0	0.85	0.16	0.124	0.0977	0.0	95.4	4.6	
○	HF-1	9.0		1.55	0.150	0.0893			7.8	

PROJECT Isolated Wetlands Drilling Program - Phase II -
Hogan Island Farms, Collier County, Florida

JOB NO. 1163
DATE 1/8/99

GRADATION CURVES



Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-1	11.0	*SHELL/LIMESTONE/SAND						
☒	HF-1	13.0	*SILTY LIMESTONE W/ SHELL						
▲	HF-1	15.0	*SHELLY SAND						
★	HF-1	16.0	*SHELL/LIMESTONE/SILT					0.69	2.8
⊙	HF-1	20.0	*SAND/LIMESTONE/SHELL					0.31	8.2

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-1	11.0			0.626	0.1085			6.8	
☒	HF-1	13.0			0.171	0.1067			5.8	
▲	HF-1	15.0			0.273	0.0948			8.3	
★	HF-1	16.0		0.27	0.136	0.0989			5.9	
⊙	HF-1	20.0		0.72	0.140	0.0869			6.6	

PROJECT **Isolated Wetlands Drilling Program - Phase II -**
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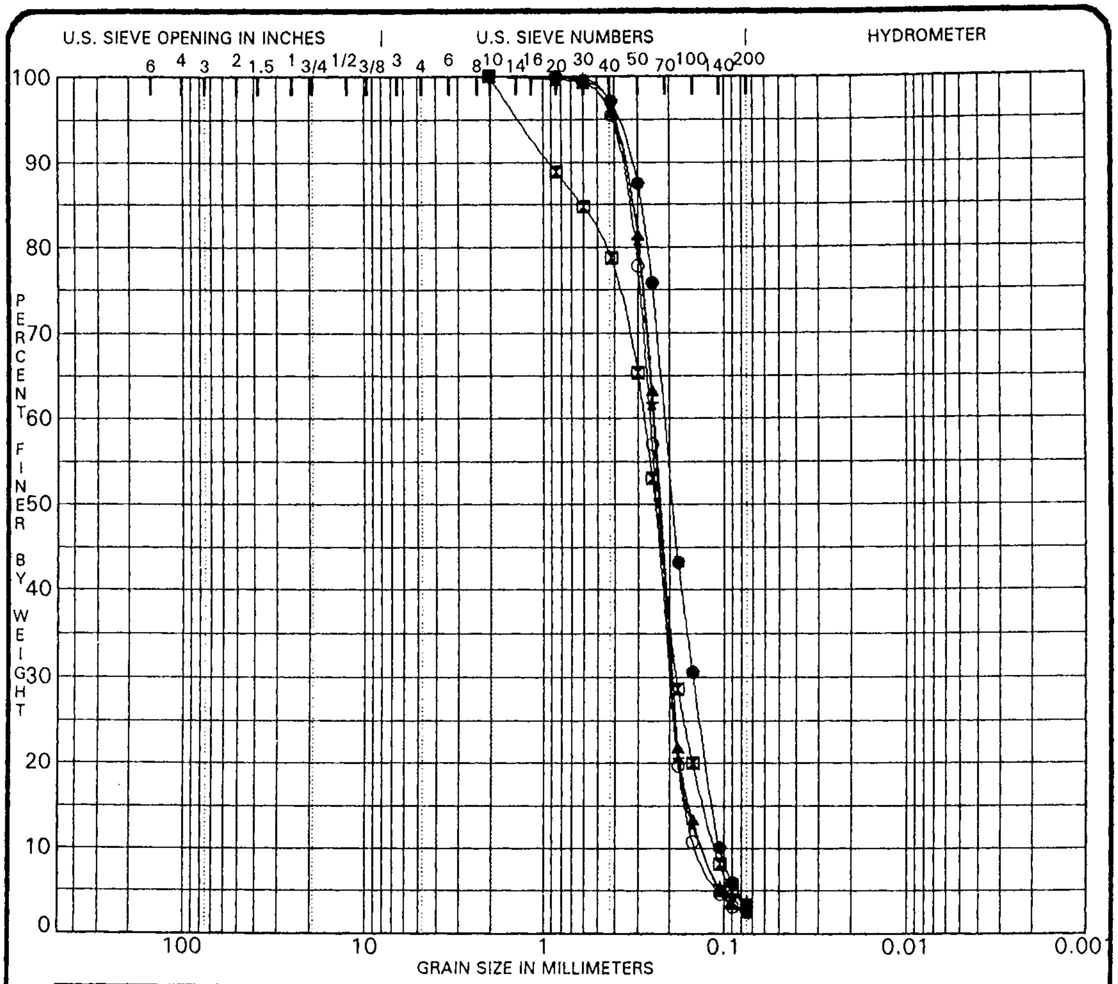
GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-2	1.2	POORLY GRADED SAND SP		NP	NP	NP	0.98	2.0
☒	HF-2	3.2	POORLY GRADED SAND SP		NP	NP	NP	1.08	2.5
▲	HF-2	5.3	POORLY GRADED SAND SP		NP	NP	NP	1.16	1.9
★	HF-2	7.3	POORLY GRADED SAND SP		NP	NP	NP	1.16	1.9
○	HF-2	9.2	POORLY GRADED SAND SP		NP	NP	NP	1.06	1.8

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-2	1.2	2.00	0.21	0.149	0.1056	0.0	96.6	3.4	
☒	HF-2	3.2	2.00	0.28	0.183	0.1118	0.0	96.6	3.4	
▲	HF-2	5.3	2.00	0.24	0.192	0.1303	0.0	97.5	2.5	
★	HF-2	7.3	0.85	0.25	0.194	0.1314	0.0	96.1	3.9	
○	HF-2	9.2	0.85	0.26	0.197	0.1433	0.0	97.5	2.5	

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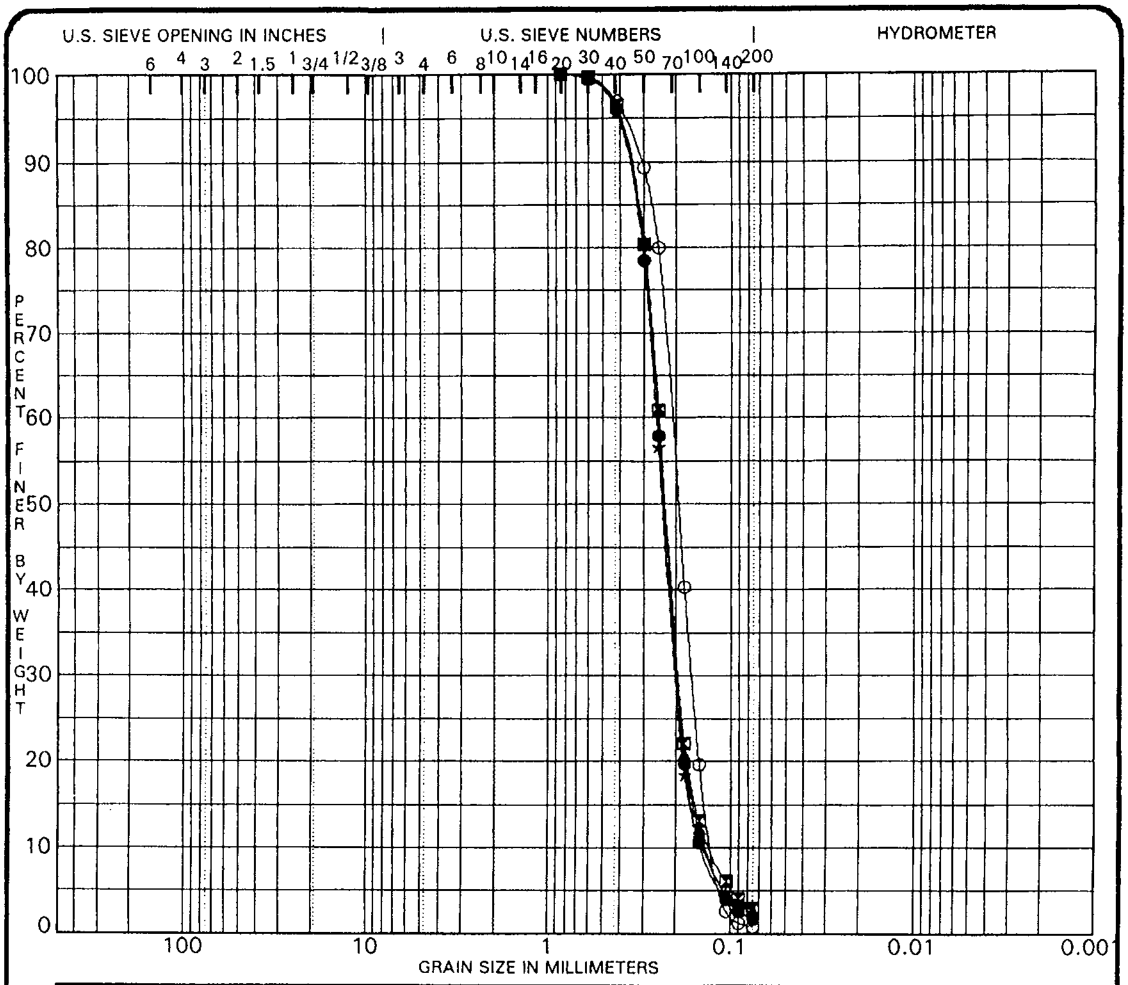

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● HF-2 11.3	POORLY GRADED SAND SP		NP	NP	NP	1.05	1.8
⌧ HF-2 13.3	POORLY GRADED SAND SP		NP	NP	NP	1.16	1.9
▲ HF-2 15.3	POORLY GRADED SAND SP		NP	NP	NP	1.12	1.8
★ HF-2 17.4	POORLY GRADED SAND SP		NP	NP	NP	1.09	1.8
○ HF-2 19.3	POORLY GRADED SAND SP		NP	NP	NP	1.04	1.7

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● HF-2 11.3	0.85	0.25	0.197	0.1453	0.0	98.2	1.8	
⌧ HF-2 13.3	0.85	0.25	0.193	0.1286	0.0	97.0	3.0	
▲ HF-2 15.3	0.85	0.25	0.194	0.1357	0.0	97.2	2.8	
★ HF-2 17.4	0.85	0.26	0.199	0.1405	0.0	96.7	3.3	
○ HF-2 19.3	0.85	0.21	0.164	0.1232	0.0	99.1	0.9	

PROJECT **Isolated Wetlands Drilling Program - Phase II -**
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JOB NO. **1163**
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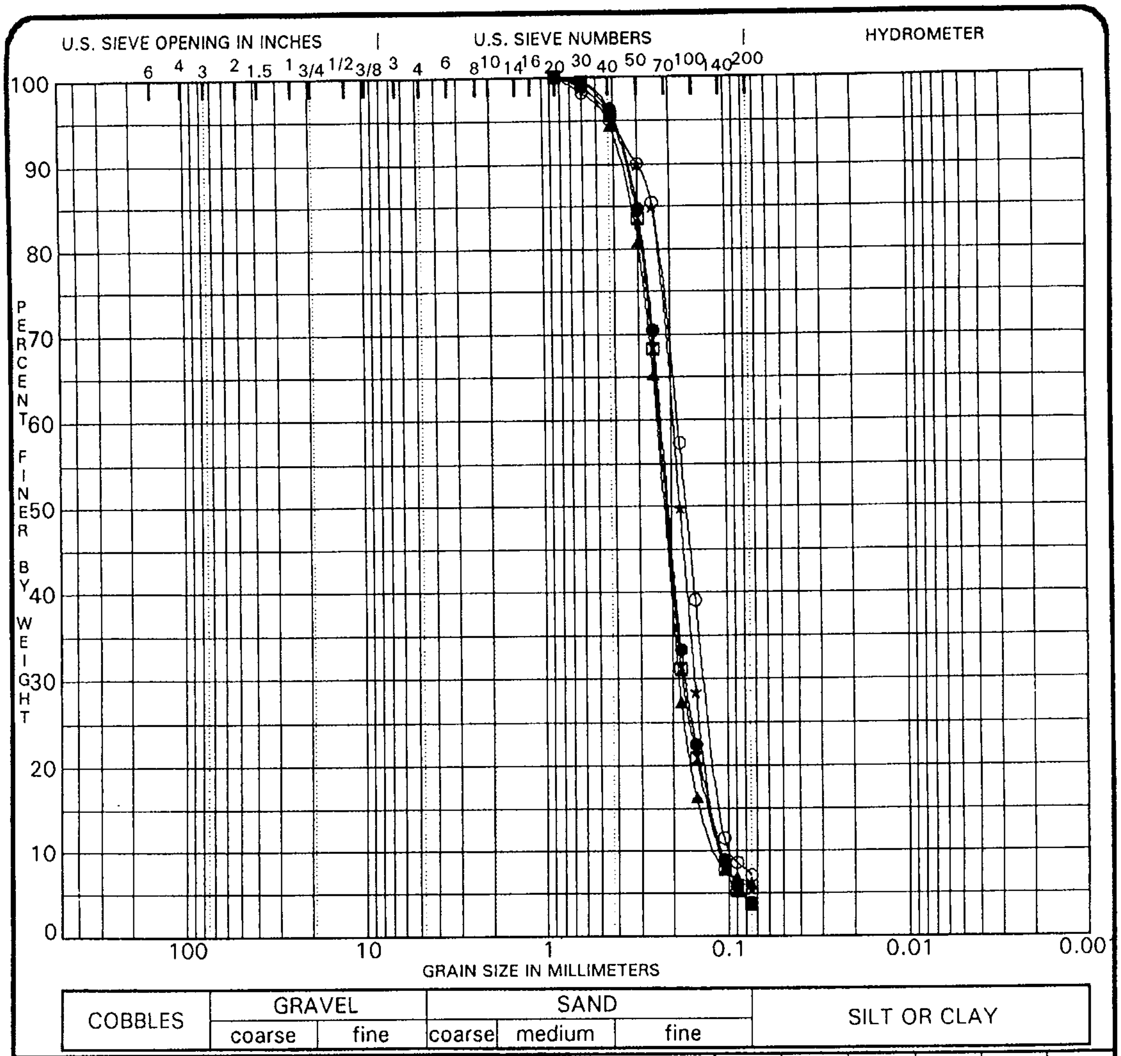
GRADATION CURVES



Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-3	1.0	POORLY GRADED SAND SP					1.17	2.1
⊠	HF-3	3.0	POORLY GRADED SAND SP					1.20	2.1
▲	HF-3	5.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.22	2.1
★	HF-3	7.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.06	1.8
○	HF-3	9.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	0.99	1.9

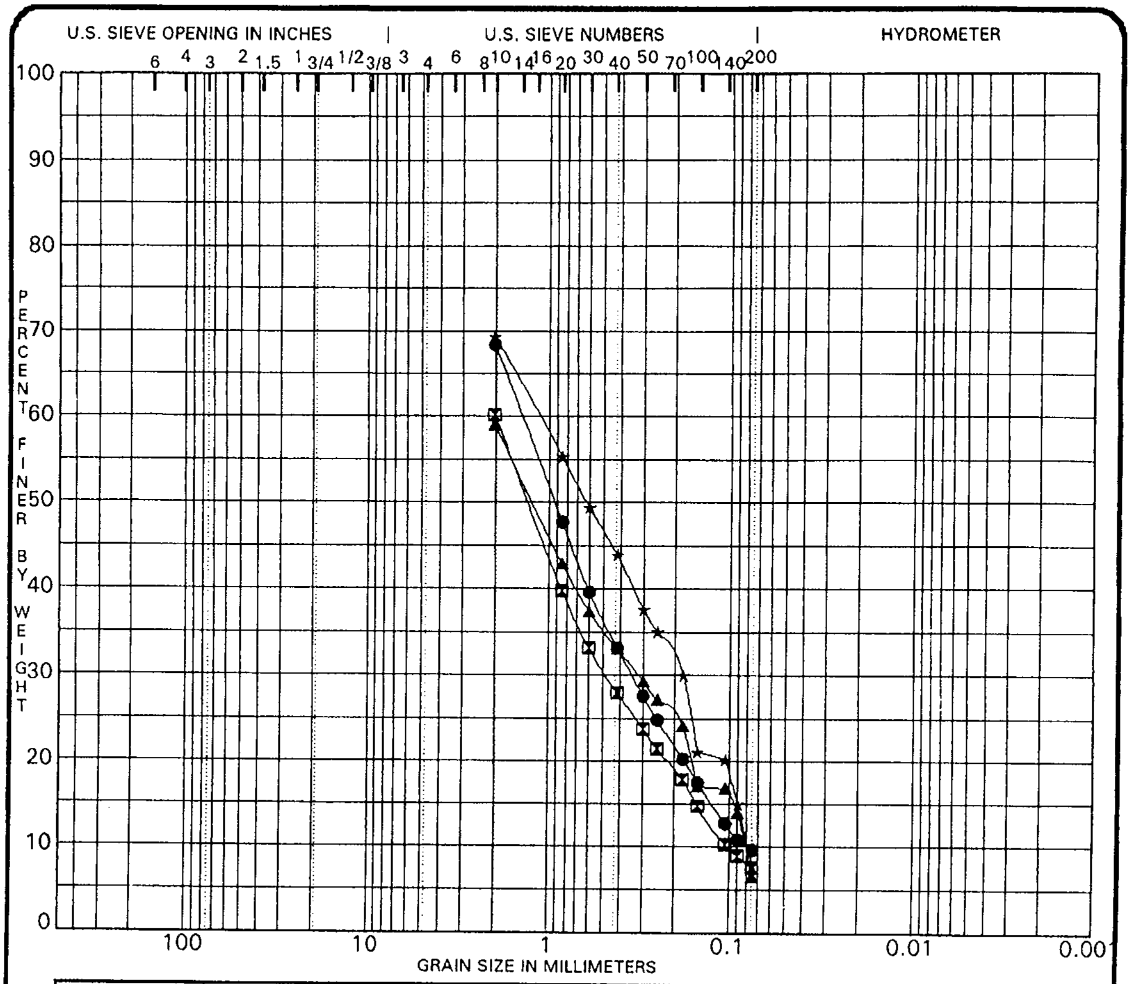
Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-3	1.0	0.85	0.23	0.170	0.1090	0.0	96.1	3.9	
⊠	HF-3	3.0	0.85	0.23	0.177	0.1119	0.0	96.3	3.7	
▲	HF-3	5.0	0.85	0.24	0.184	0.1163	0.0	93.9	6.1	
★	HF-3	7.0	0.85	0.20	0.152	0.1095	0.0	94.5	5.5	
○	HF-3	9.0	0.85	0.19	0.134	0.0974	0.0	92.9	7.1	

PROJECT **Isolated Wetlands Drilling Program - Phase II - Hogan Island Farms, Collier County, Florida**

JOB NO. 1163

DATE 1/8/99

GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-3	11.0	*SAND W/ SHELL FRAG.					1.07	17.7
⌧	HF-3	13.0	*SANDY CLAY/LIMESTONE/SHELL					1.15	19.4
▲	HF-3	15.0	*LIMESTONE W/ SHELL						
★	HF-3	17.0	*FRIABLE LIMESTONE					0.36	14.3

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-3	11.0		1.41	0.347	0.0797			9.6	
⌧	HF-3	13.0		1.98	0.483	0.1023			7.6	
▲	HF-3	15.0			0.320	0.0818			6.5	
★	HF-3	17.0		1.13	0.180	0.0794			7.8	

PROJECT Isolated Wetlands Drilling Program - Phase II -
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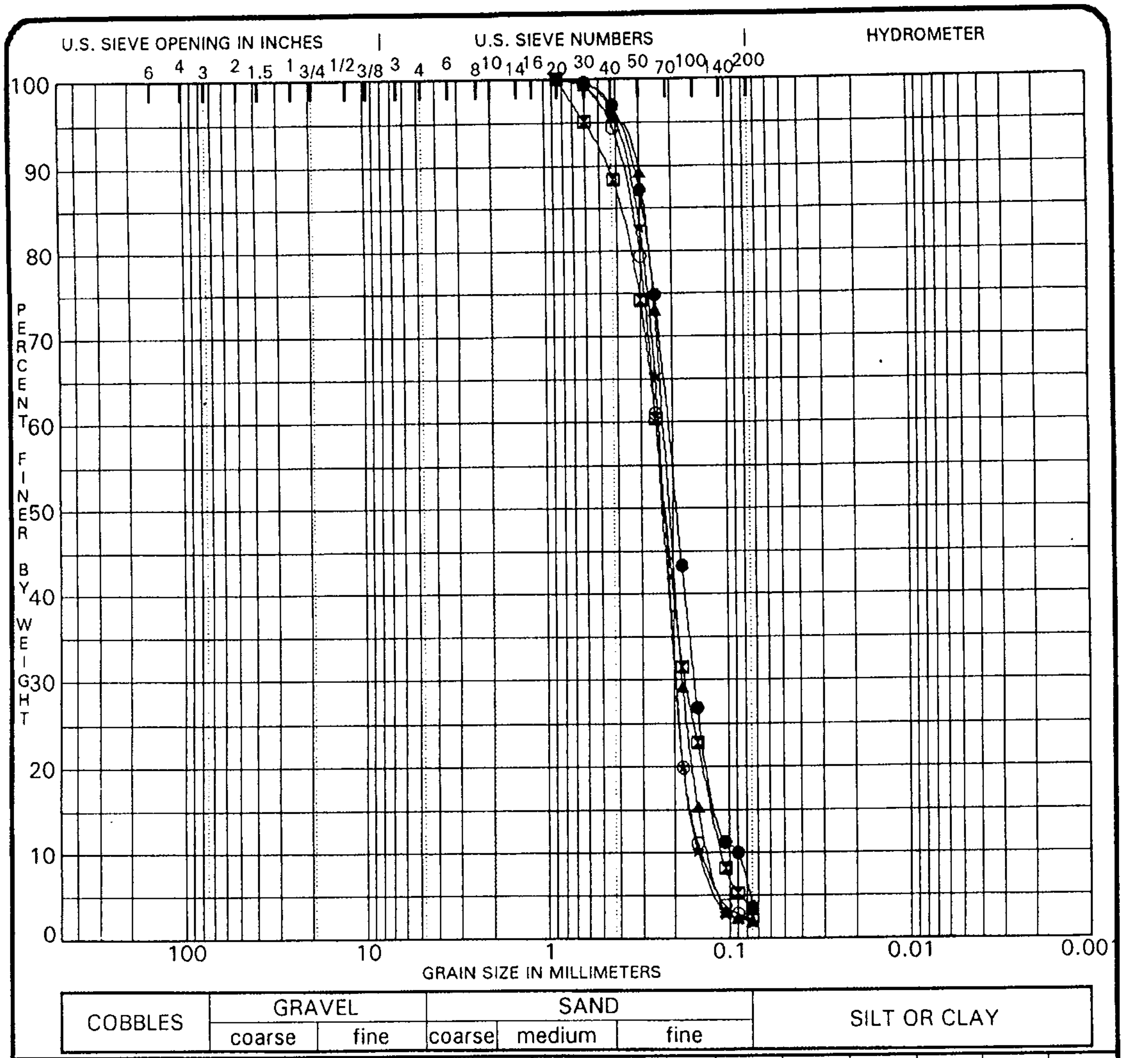

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-4	1.0	POORLY GRADED SAND SP		NP	NP	NP	1.25	2.4
⊠	HF-4	3.0	POORLY GRADED SAND SP		NP	NP	NP	1.11	2.2
▲	HF-4	5.0	POORLY GRADED SAND SP		NP	NP	NP	1.12	1.8
★	HF-4	7.0	POORLY GRADED SAND SP		NP	NP	NP	1.05	1.6
○	HF-4	9.0	POORLY GRADED SAND SP		NP	NP	NP	1.08	1.7

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-4	1.0	0.85	0.21	0.155	0.0900	0.0	96.3	3.7	
⊠	HF-4	3.0	0.85	0.25	0.174	0.1106	0.0	96.5	3.5	
▲	HF-4	5.0	0.85	0.23	0.181	0.1288	0.0	97.9	2.1	
★	HF-4	7.0	0.85	0.24	0.194	0.1486	0.0	98.0	2.0	
○	HF-4	9.0	0.85	0.25	0.195	0.1423	0.0	97.8	2.2	

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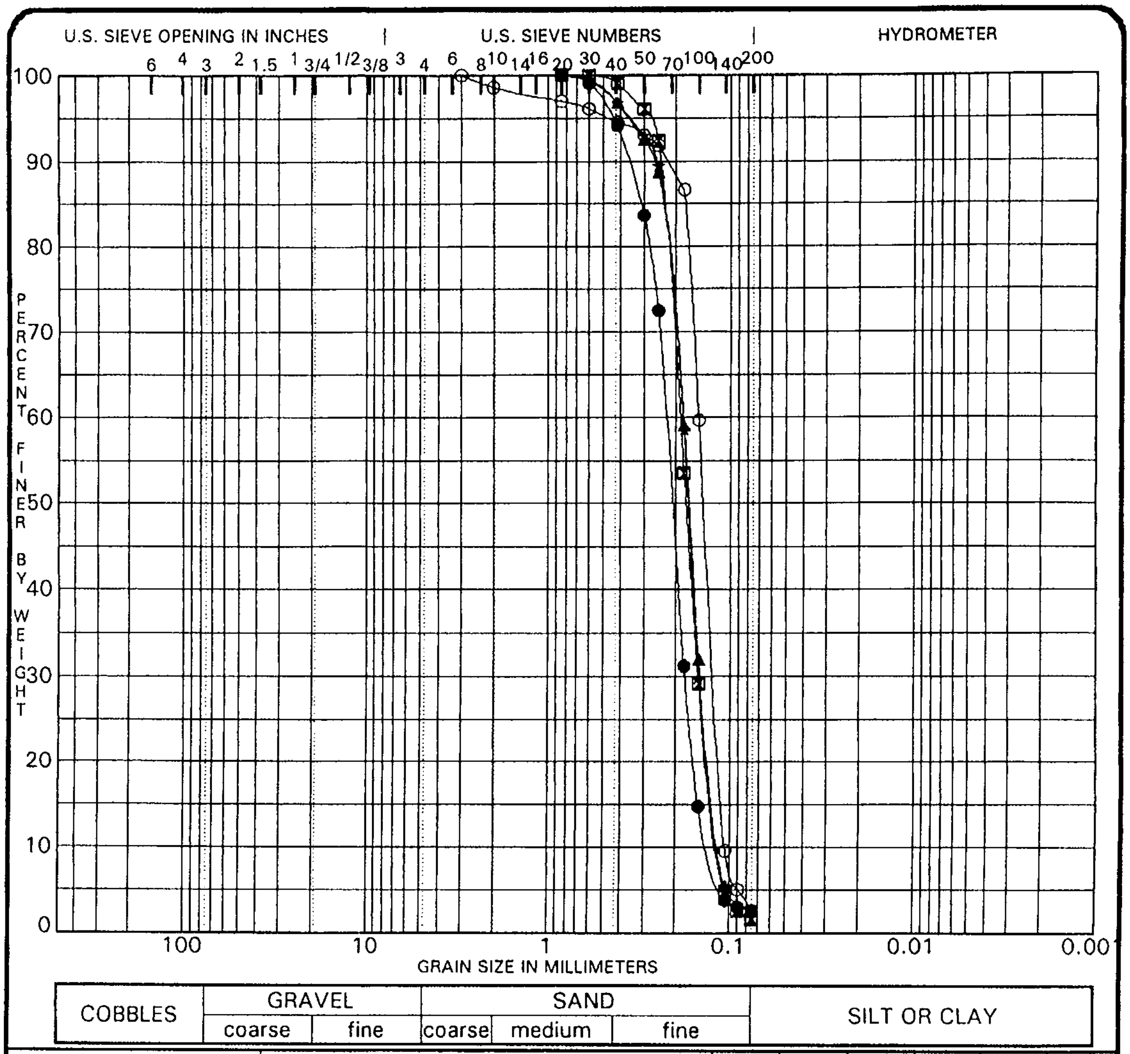
DATE 1/8/99

GRADATION CURVES



Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● HF-4 11.0	**POORLY GRADED SAND SP**		**NP**	**NP**	**NP**	1.08	1.8
☒ HF-4 13.0	**POORLY GRADED SAND SP**		**NP**	**NP**	**NP**	1.05	1.7
▲ HF-4 15.0	**POORLY GRADED SAND SP**		**NP**	**NP**	**NP**	1.04	1.6
★ HF-4 17.0	**POORLY GRADED SAND SP**		**NP**	**NP**	**NP**	1.08	1.6
○ HF-4 19.0	**POORLY GRADED SAND SP**		**NP**	**NP**	**NP**	0.93	1.4

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● HF-4 11.0	0.85	0.23	0.178	0.1290	0.0	97.3	2.7	
☒ HF-4 13.0	0.85	0.19	0.151	0.1139	0.0	98.3	1.7	
▲ HF-4 15.0	0.85	0.18	0.146	0.1124	0.0	97.1	2.9	
★ HF-4 17.0	0.85	0.18	0.150	0.1138	0.0	98.1	1.9	
○ HF-4 19.0	3.00	0.15	0.122	0.1063	0.0	97.3	2.7	

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Hogan Island Farms, Collier County, Florida
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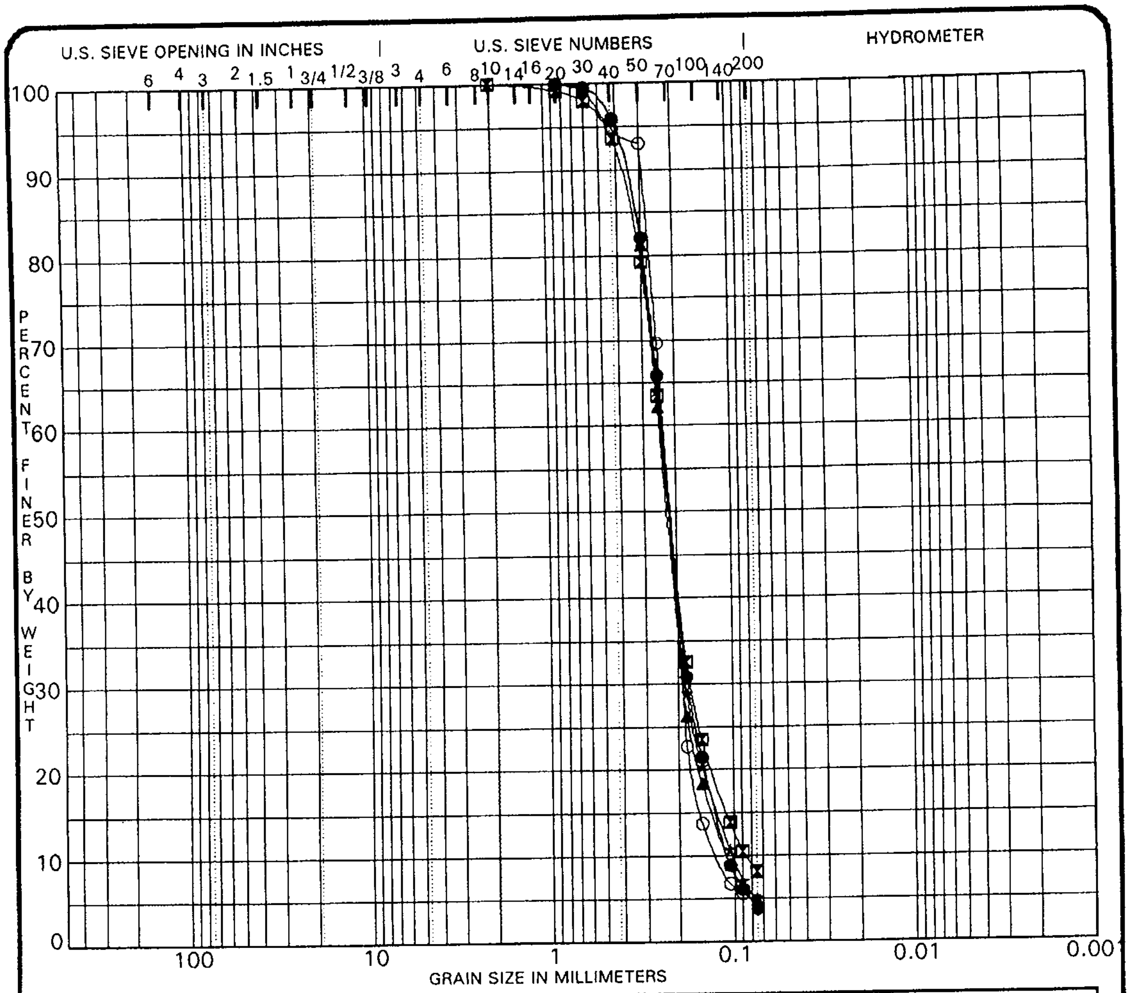
DATE **1/8/99**

GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-5	1.5	POORLY GRADED SAND SP		NP	NP	NP	1.21	2.2
☒	HF-5	3.4	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.40	2.8
▲	HF-5	5.3	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.28	2.2
★	HF-5	7.2	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.34	2.3
○	HF-5	9.3	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.23	1.9

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-5	1.5	0.85	0.24	0.177	0.1093	0.0	96.1	3.9	
☒	HF-5	3.4	2.00	0.24	0.171	0.0865	0.0	91.8	8.2	
▲	HF-5	5.3	0.85	0.25	0.186	0.1103	0.0	95.2	4.8	
★	HF-5	7.2	0.85	0.24	0.182	0.1027	0.0	95.0	5.0	
○	HF-5	9.3	0.85	0.23	0.189	0.1245	0.0	95.3	4.7	

PROJECT **Isolated Wetlands Drilling Program - Phase II -**
Hogan Island Farms, Collier County, Florida

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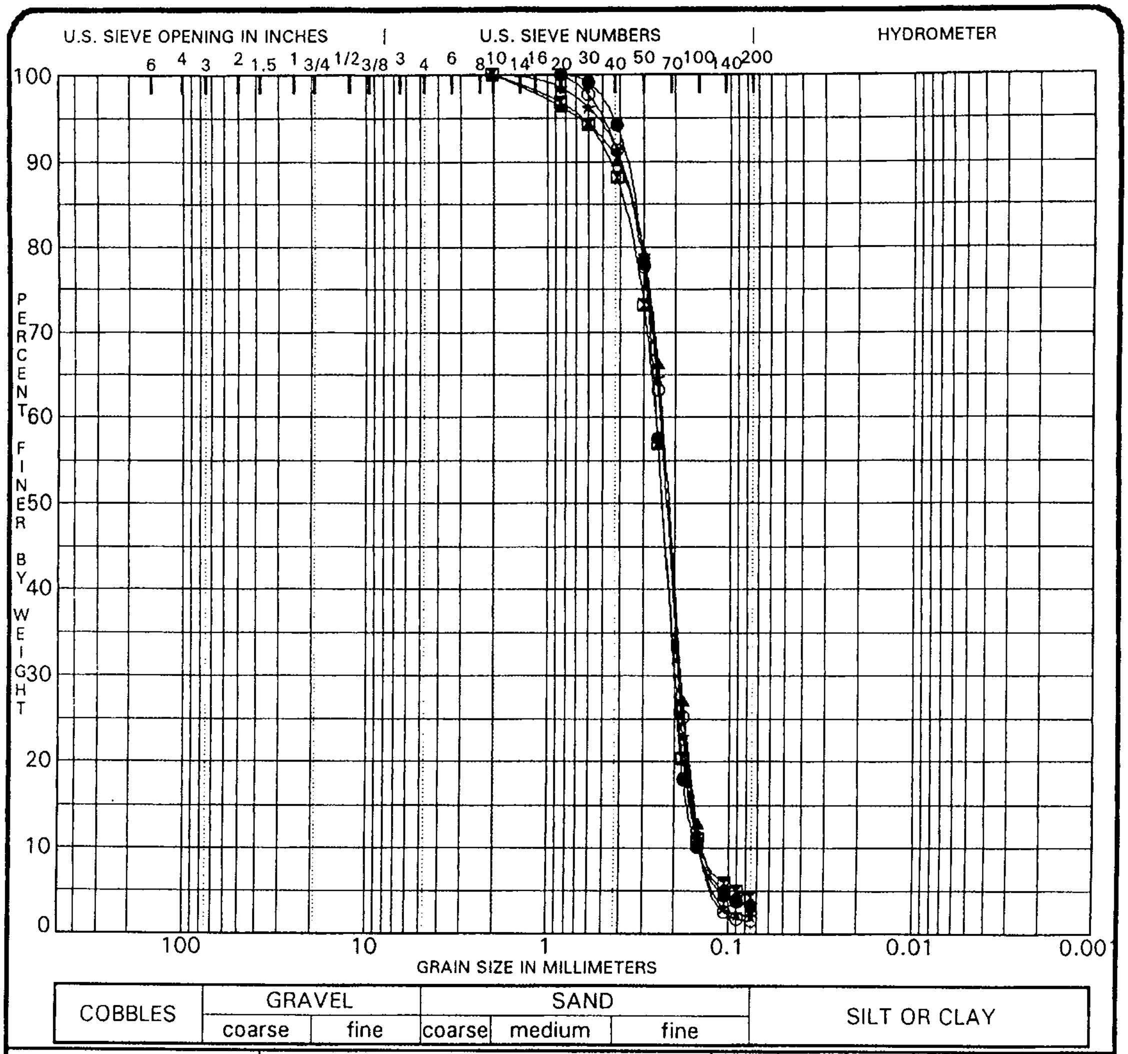
GRADATION CURVES



	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-5	11.3	POORLY GRADED SAND SP		NP	NP	NP	1.04	1.7
⊠	HF-5	13.2	POORLY GRADED SAND SP		NP	NP	NP	1.07	1.9
▲	HF-5	15.4	POORLY GRADED SAND SP					1.09	1.8
★	HF-5	17.4	POORLY GRADED SAND SP					1.05	1.7
○	HF-5	19.3	POORLY GRADED SAND SP		NP	NP	NP	1.02	1.7

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-5	11.3	0.85	0.26	0.199	0.1491	0.0	96.8	3.2	
⊠	HF-5	13.2	2.00	0.26	0.196	0.1392	0.0	95.6	4.4	
▲	HF-5	15.4	2.00	0.24	0.184	0.1318	0.0	96.6	3.4	
★	HF-5	17.4	2.00	0.24	0.190	0.1430	0.0	97.9	2.1	
○	HF-5	19.3	0.85	0.24	0.188	0.1424	0.0	98.4	1.6	

PROJECT **Isolated Wetlands Drilling Program - Phase II -**
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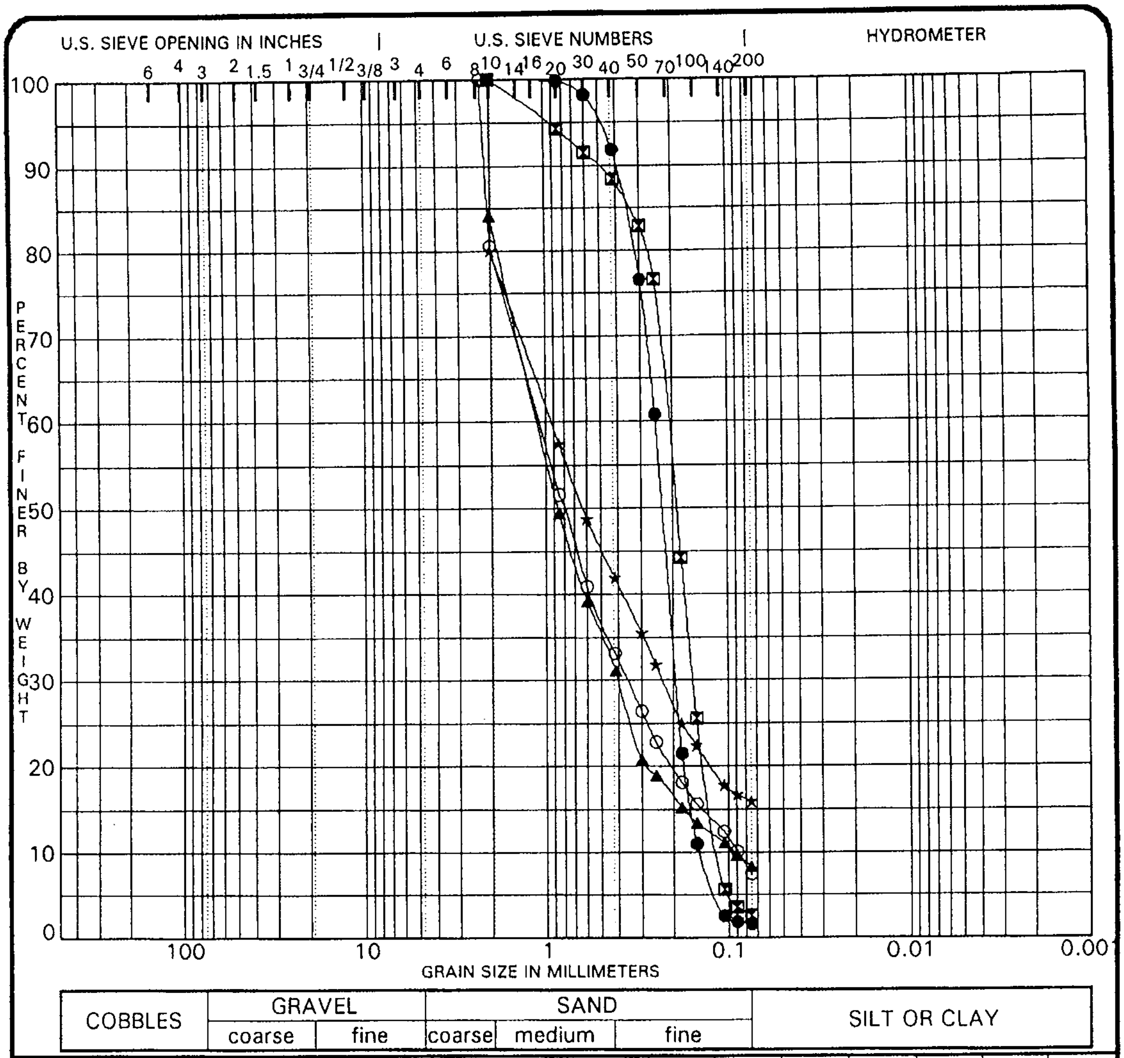
GRADATION CURVES



Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-5	21.3	POORLY GRADED SAND SP		NP	NP	NP	1.04	1.7
☒	HF-5	23.3	POORLY GRADED SAND SP					1.02	1.8
▲	HF-5	25.4	*SAND W/ SHELL					1.60	11.8
★	HF-5	27.5	*CLAYEY SAND/SHELL						
○	HF-5	29.5	WELL GRADED SAND with SILT SW-SM		NP	NP	NP	1.33	12.2

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-5	21.3	2.00	0.25	0.193	0.1439	0.0	98.3	1.7	
☒	HF-5	23.3	2.00	0.21	0.157	0.1143	0.0	97.3	2.7	
▲	HF-5	25.4		1.10	0.405	0.0932			8.3	
★	HF-5	27.5		0.93	0.230				15.9	
○	HF-5	29.5	2.25	1.09	0.359	0.0894	0.0	92.5	7.5	

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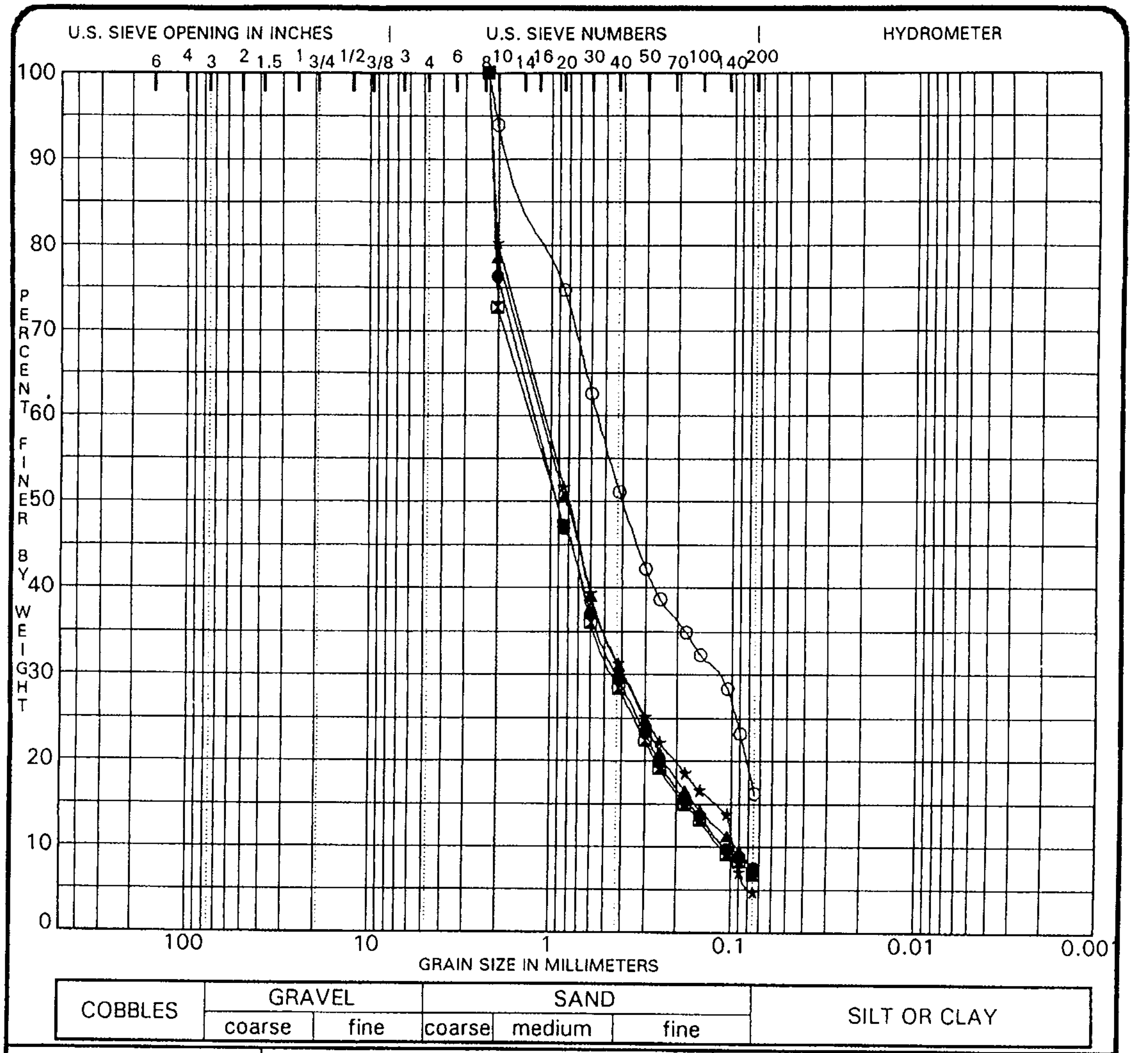

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-5	31.4	WELL GRADED SAND with SILT SW-SM		NP	NP	NP	1.37	11.4
⊠	HF-5	33.5	WELL GRADED SAND with SILT SW-SM		NP	NP	NP	1.36	11.5
▲	HF-5	35.3	WELL GRADED SAND with SILT SW-SM		NP	NP	NP	1.48	12.0
★	HF-5	37.2	WELL GRADED SAND with SILT SW-SM		NP	NP	NP	1.45	11.3
○	HF-5	39.3	SILTY SAND SM		NP	NP	NP		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-5	31.4	2.25	1.25	0.430	0.1089	0.0	92.5	7.5	
⊠	HF-5	33.5	2.25	1.31	0.451	0.1138	0.0	93.1	6.9	
▲	HF-5	35.3	2.25	1.14	0.398	0.0944	0.0	92.7	7.3	
★	HF-5	37.2	2.25	1.09	0.391	0.0966	0.0	95.2	4.8	
○	HF-5	39.3	2.25	0.55	0.122		0.0	83.8	16.2	

PROJECT Isolated Wetlands Drilling Program - Phase II -
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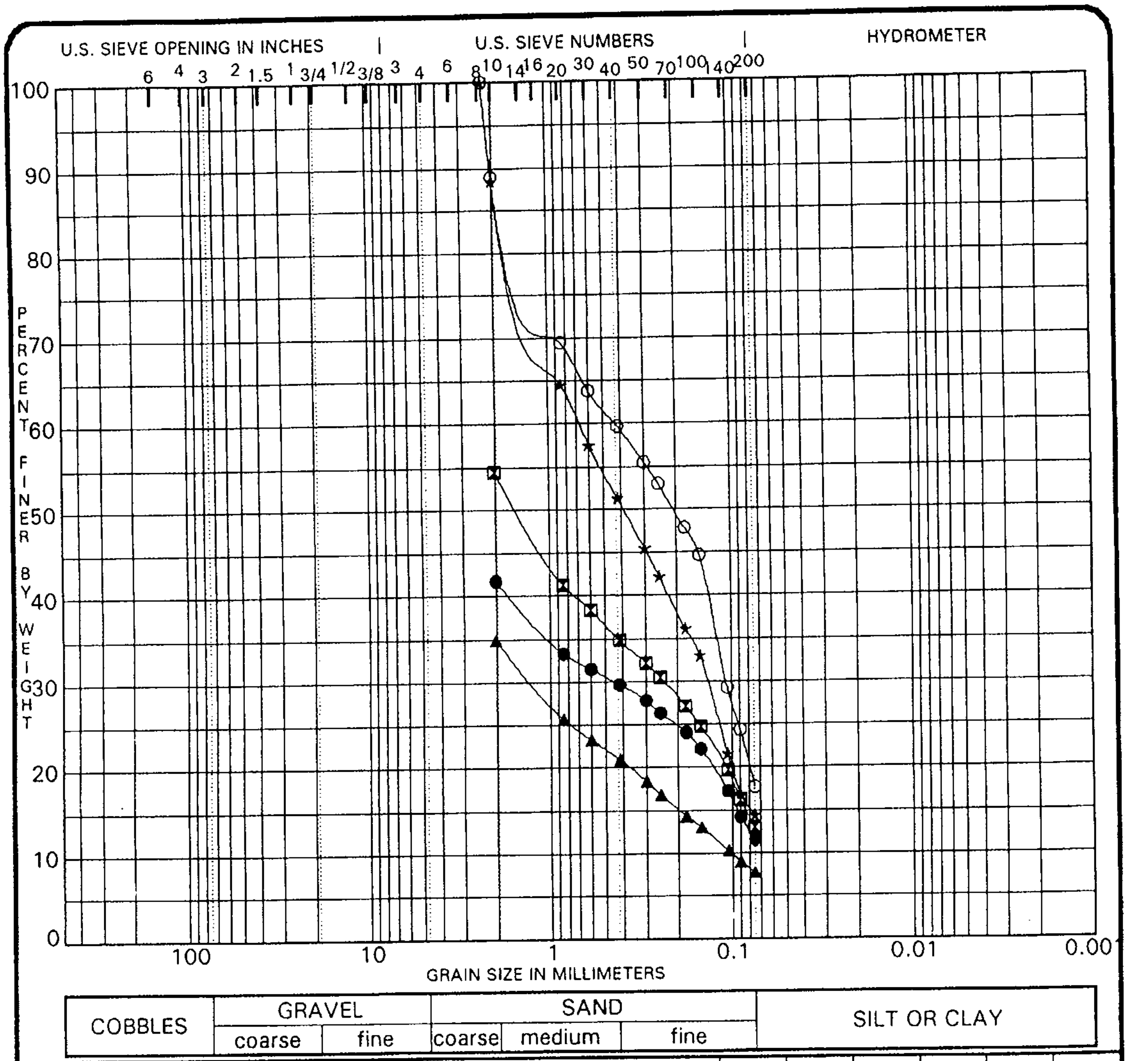
DATE 1/8/99

GRADATION CURVES



Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-5	41.3	*SILTY CLAY/SHELL						
⌧	HF-5	43.3	*SILTY CLAY/ SHELL						
▲	HF-5	45.3	*SILTY CLAY/SHELL						
★	HF-5	46.8	SILTY SAND SM		NP	NP	NP		
○	HF-5	49.3	SILTY SAND SM		NP	NP	NP		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-5	41.3			0.446				11.6	
⌧	HF-5	43.3			0.238				13.0	
▲	HF-5	45.3			1.274	0.1021			7.7	
★	HF-5	46.8	2.25	0.68	0.137		0.0	85.6	14.4	
○	HF-5	49.3	2.25	0.43	0.108		0.0	82.3	17.7	

PROJECT Isolated Wetlands Drilling Program - Phase II - Hogan Island Farms, Collier County, Florida

JOB NO. 1163

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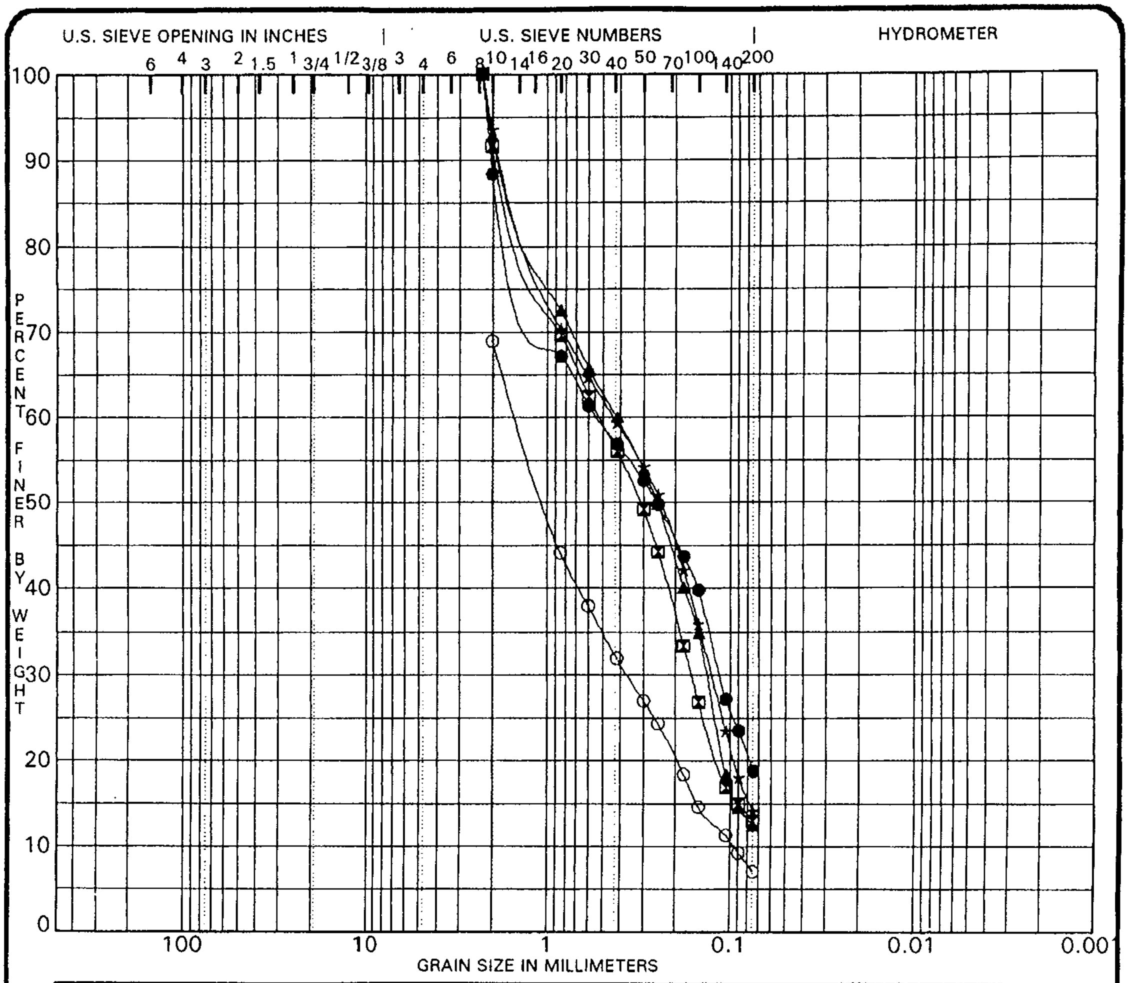
GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-5	51.2	SILTY SAND SM		NP	NP	NP		
⌧	HF-5	53.2	SILTY SAND SM		NP	NP	NP		
▲	HF-5	55.2	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	0.62	6.0
★	HF-5	57.3	SILTY SAND SM		NP	NP	NP		
○	HF-5	59.2	*SANDY LIMESTONE					0.97	15.4

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-5	51.2	2.25	0.54	0.115		0.0	81.2	18.8	
⌧	HF-5	53.2	2.25	0.52	0.164		0.0	87.1	12.9	
▲	HF-5	55.2	2.25	0.42	0.135		0.0	87.6	12.4	
★	HF-5	57.3	2.25	0.44	0.127		0.0	85.9	14.1	
○	HF-5	59.2		1.47	0.369	0.0953			7.1	

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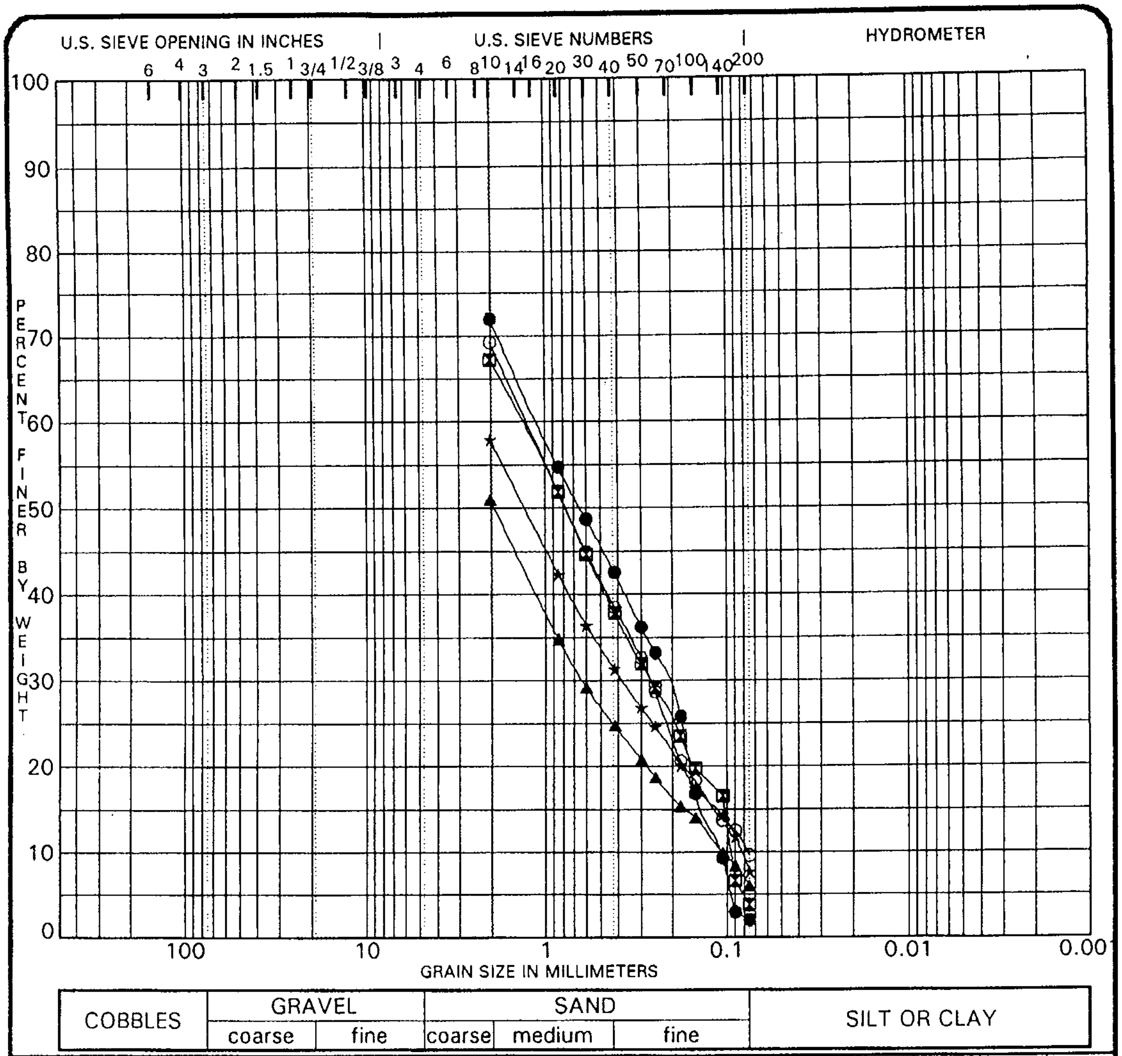
GRADATION CURVES



Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● HF-5 61.4	*CLAY, LIMESTONE					0.39	10.1
☒ HF-5 63.3	*SANDY LIMESTONE					0.55	14.1
▲ HF-5 65.2	*SANDY LIMESTONE						
★ HF-5 67.2	*SANDY LIMESTONE						
○ HF-5 69.0	*LIMESTONE W/ SHELL					0.72	16.5

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● HF-5 61.4		1.11	0.217	0.1095			2.1	
☒ HF-5 63.3		1.34	0.264	0.0952			3.9	
▲ HF-5 65.2			0.631	0.1069			6.0	
★ HF-5 67.2			0.381	0.0831			7.7	
○ HF-5 69.0		1.27	0.266	0.0769			9.6	

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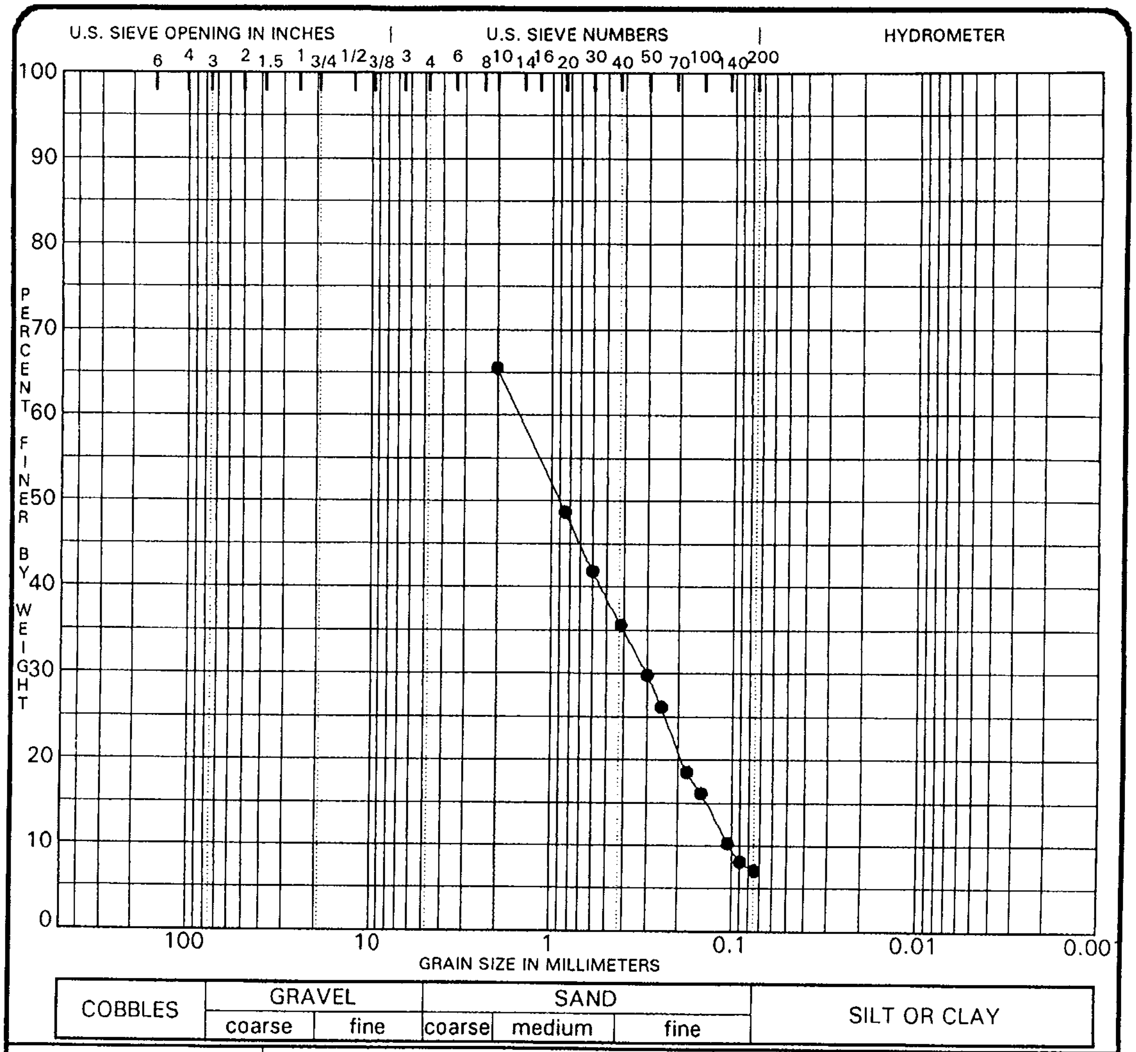

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-5 71.4	*LIMESTONE W/ CLAY					0.59	14.6

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-5 71.4		1.51	0.304	0.1037			7.1	

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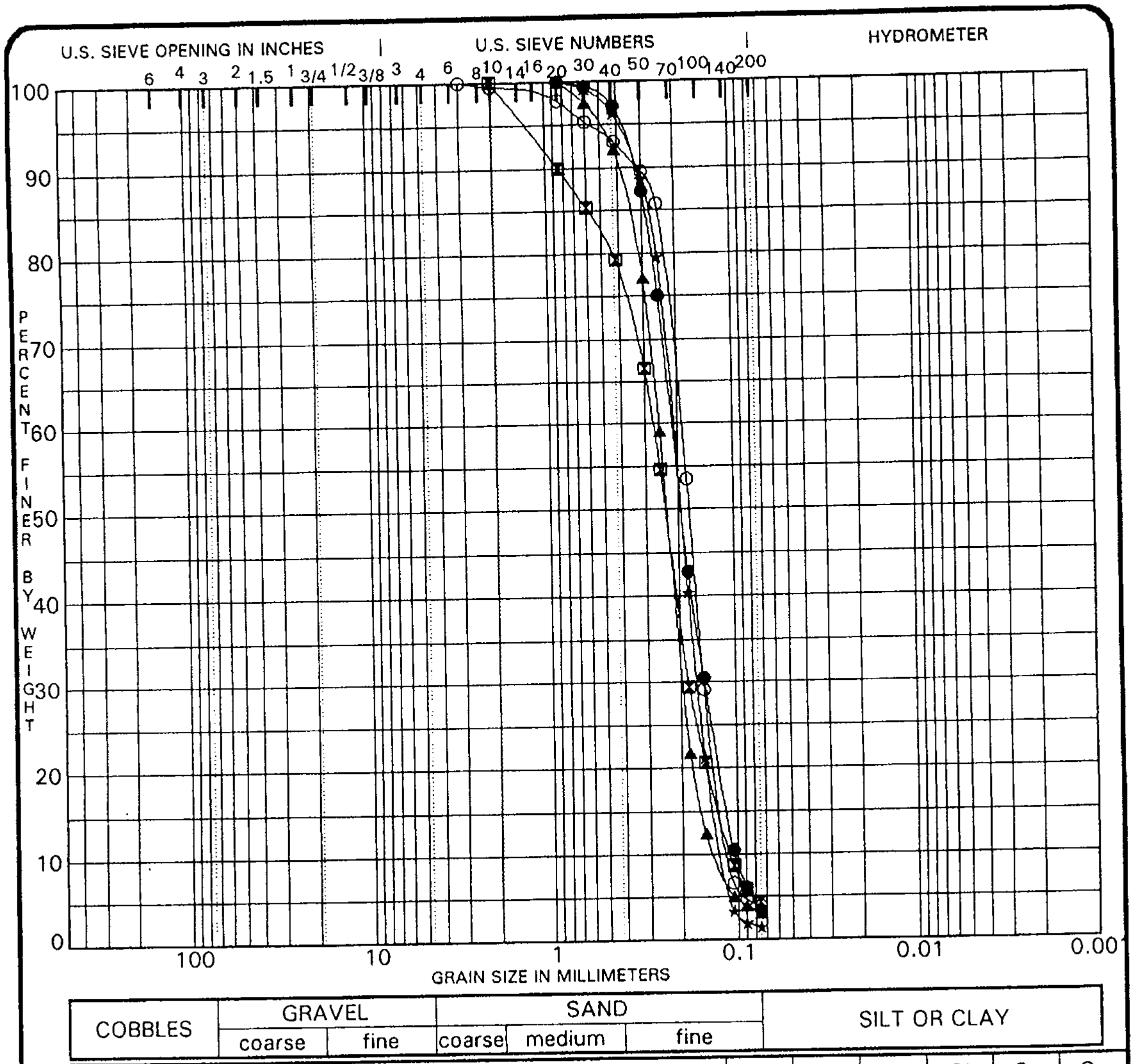

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-6	1.0	POORLY GRADED SAND SP		NP	NP	NP	0.99	2.1
☒	HF-6	3.1	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.10	2.5
▲	HF-6	5.3	POORLY GRADED SAND SP		NP	NP	NP	1.11	1.9
★	HF-6	7.3	POORLY GRADED SAND SP		NP	NP	NP	1.04	1.8
○	HF-6	9.4	POORLY GRADED SAND SP					1.06	1.7

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-6	1.0	0.85	0.21	0.149	0.1040	0.0	96.7	3.3	
☒	HF-6	3.1	2.00	0.27	0.181	0.1101	0.0	95.5	4.5	
▲	HF-6	5.3	0.85	0.25	0.194	0.1338	0.0	96.9	3.1	
★	HF-6	7.3	0.85	0.21	0.163	0.1206	0.0	98.5	1.5	
○	HF-6	9.4	3.00	0.19	0.151	0.1117	0.0	96.1	3.9	

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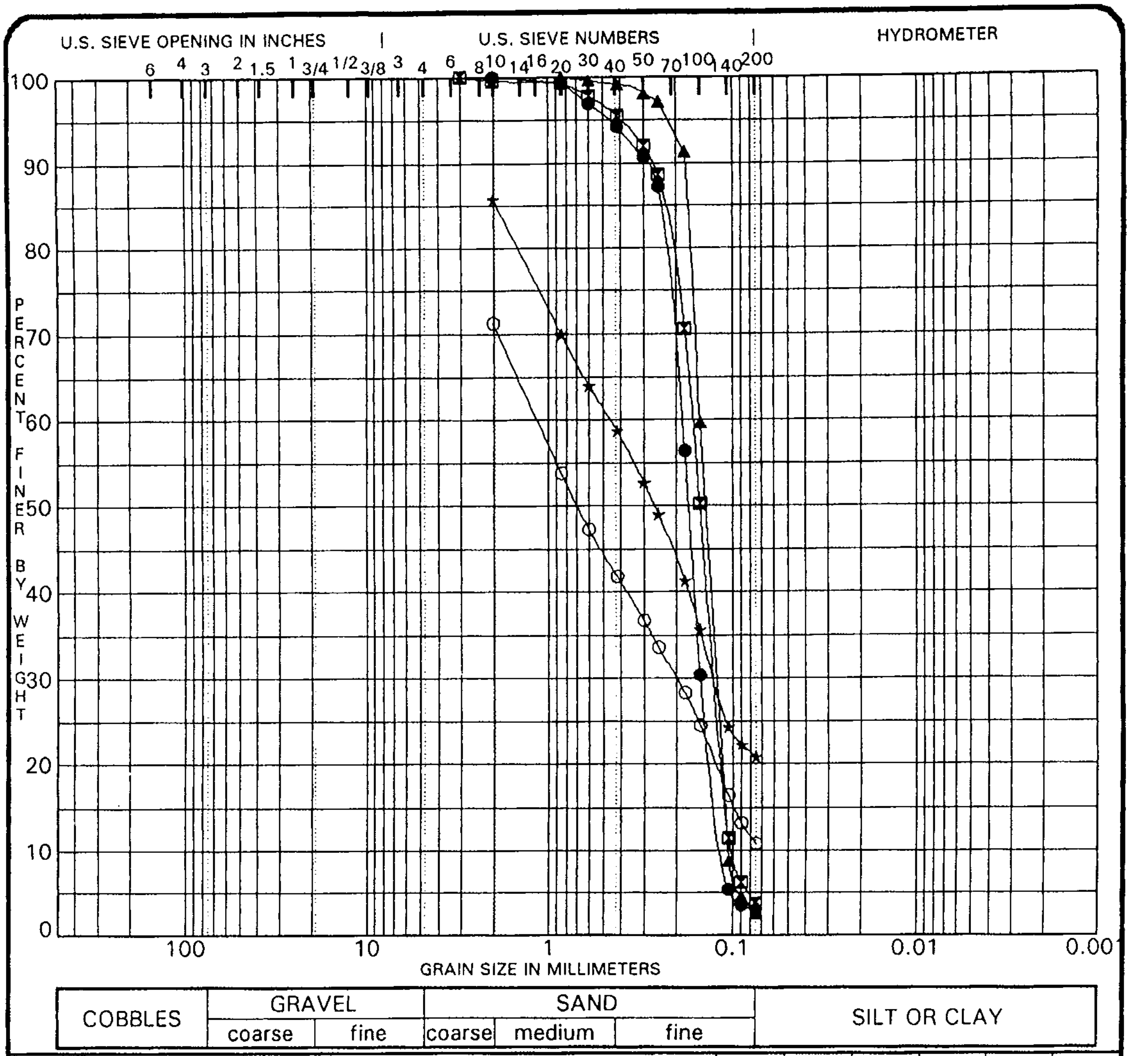
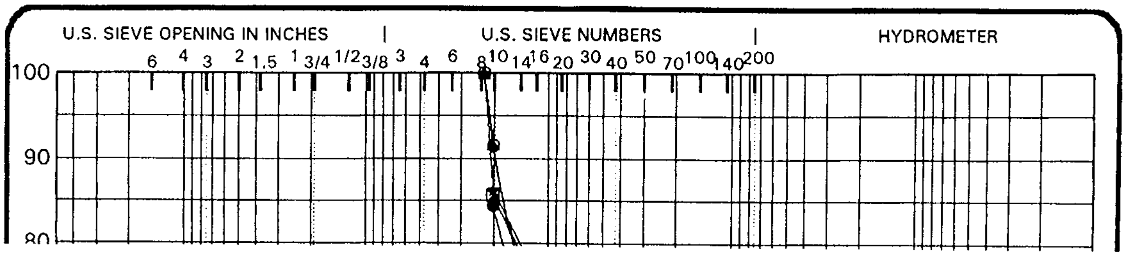
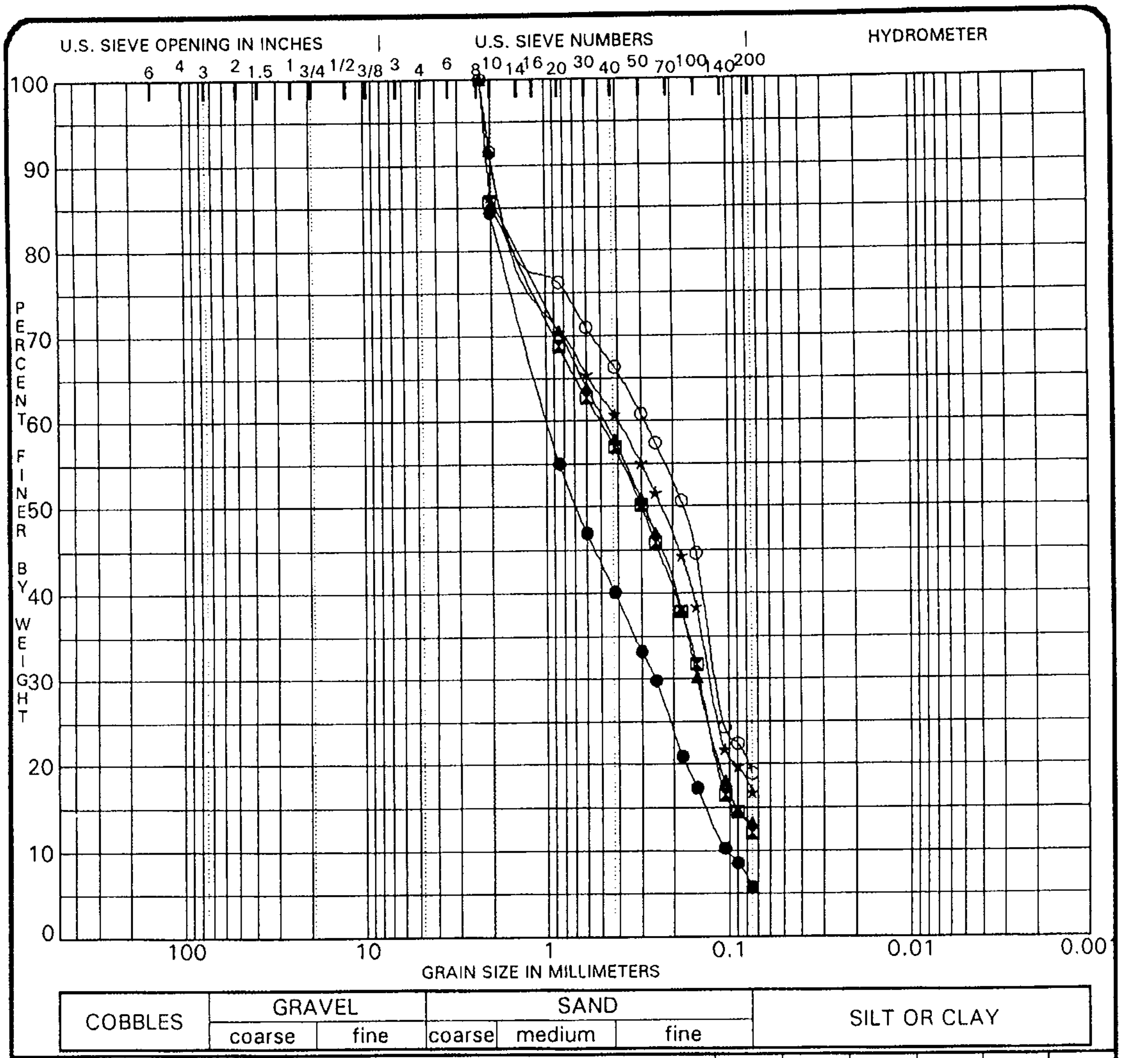


Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-6	11.0	POORLY GRADED SAND SP		NP	NP	NP	1.05	1.7
☒	HF-6	14.4	POORLY GRADED SAND SP		NP	NP	NP	0.95	1.6
▲	HF-6	15.4	POORLY GRADED SAND SP		NP	NP	NP	0.93	1.4
★	HF-6	17.0	*SANDY LIMESTONE W/ SHELL						
○	HF-6	24.5	*LIMESTONE W/ SHELL					0.50	16.5

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-6	11.0	2.00	0.19	0.149	0.1130	0.0	97.0	3.0	





	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-6	26.4	*SANDY LIMESTONE W/ SHELL					0.63	9.5
☒	HF-6	28.4	*SANDY LIMESTONE W/ SHELL					0.59	7.3
▲	HF-6	30.3	SILTY SAND SM		NP	NP	NP		
★	HF-6	32.2	SILTY SAND SM		NP	NP	NP		
○	HF-6	34.1	SILTY SAND SM		NP	NP	NP		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-6	26.4		0.98	0.253	0.1030			5.8	
☒	HF-6	28.4		0.51	0.144				12.1	
▲	HF-6	30.3	2.25	0.48	0.149		0.0	86.8	13.2	
★	HF-6	32.2	2.25	0.40	0.126		0.0	83.3	16.7	
○	HF-6	34.1	2.25	0.29	0.117		0.0	81.1	18.9	

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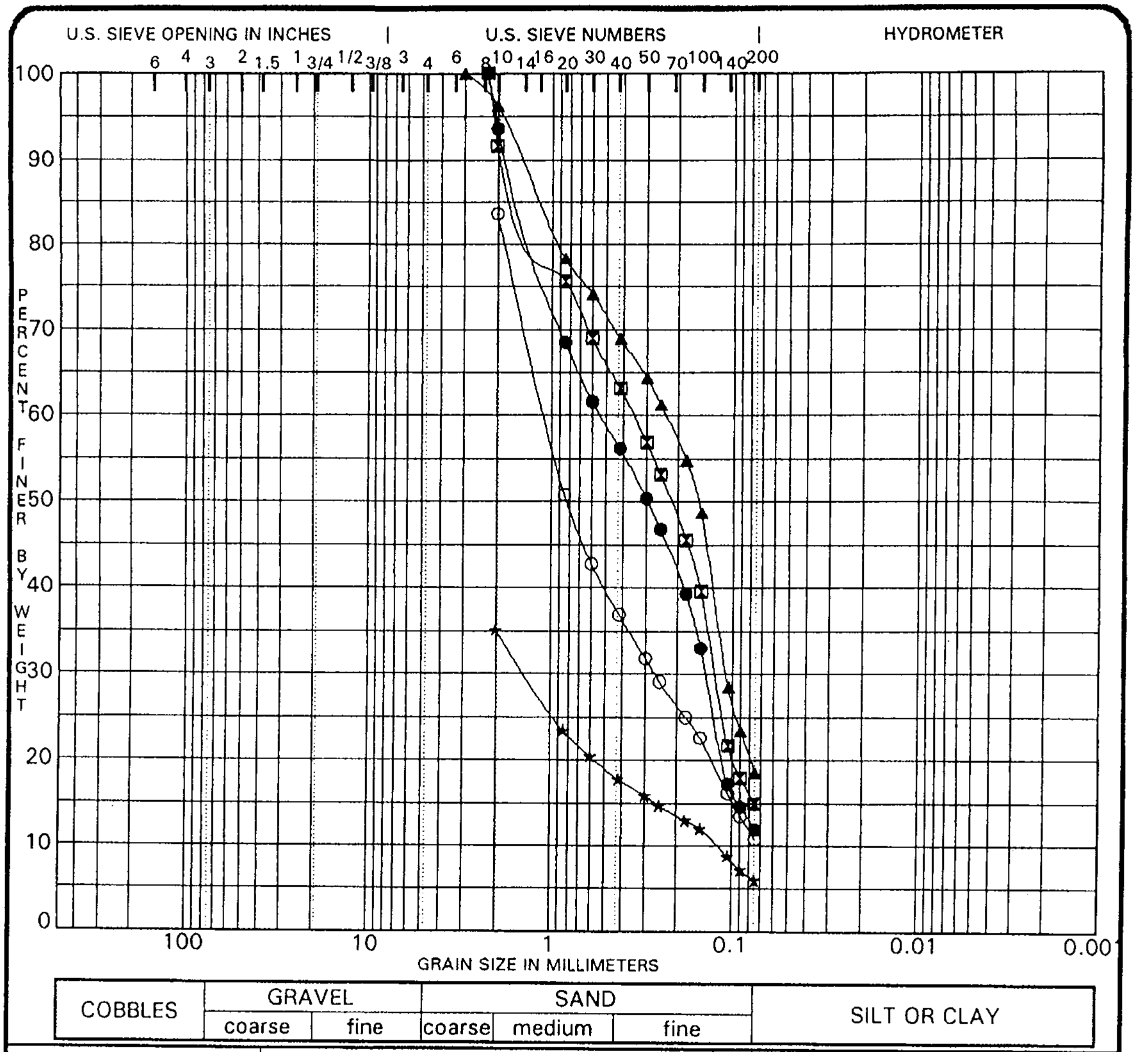
GRADATION CURVES



Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● HF-6 36.4	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	0.52	7.7
⊠ HF-6 38.3	SILTY SAND SM		NP	NP	NP		
▲ HF-6 42.4	SILTY SAND SM		NP	NP	NP		
★ HF-6 44.0	*SHELL/CLAY						
○ HF-6 46.1	*SHELL/CLAY					0.93	15.4

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● HF-6 36.4	2.25	0.54	0.140		0.0	88.1	11.9	
⊠ HF-6 38.3	2.25	0.35	0.125		0.0	85.1	14.9	
▲ HF-6 42.4	3.00	0.24	0.109		0.0	81.4	18.6	
★ HF-6 44.0			1.377	0.1207			6.0	
○ HF-6 46.1		1.08	0.266				10.8	

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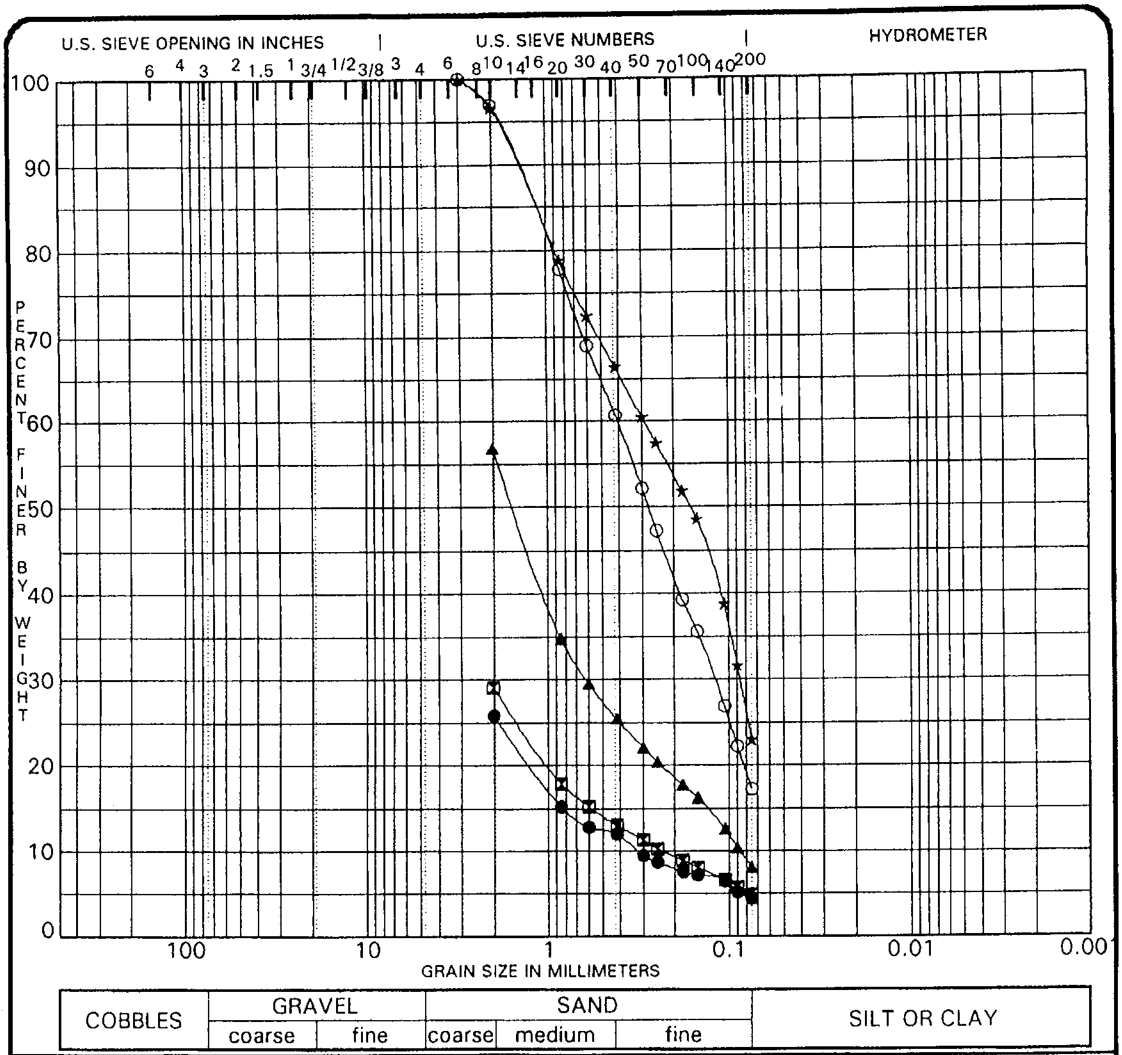

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● HF-6 48.3	*SHELL/CLAY						
⊠ HF-6 50.2	*SILTY CLAY/SHELL						
▲ HF-6 52.1	*CLAY/SHELL						
★ HF-6 54.0	SILTY SAND SM		NP	NP	NP		
○ HF-6 56.2	SILTY SAND SM		NP	NP	NP		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● HF-6 48.3				0.3209			4.4	
⊠ HF-6 50.2				0.2330			5.0	
▲ HF-6 52.1			0.620	0.0872			8.1	
★ HF-6 54.0	3.00	0.29	0.087		0.0	77.0	23.0	
○ HF-6 56.2	3.00	0.41	0.120		0.0	82.8	17.2	

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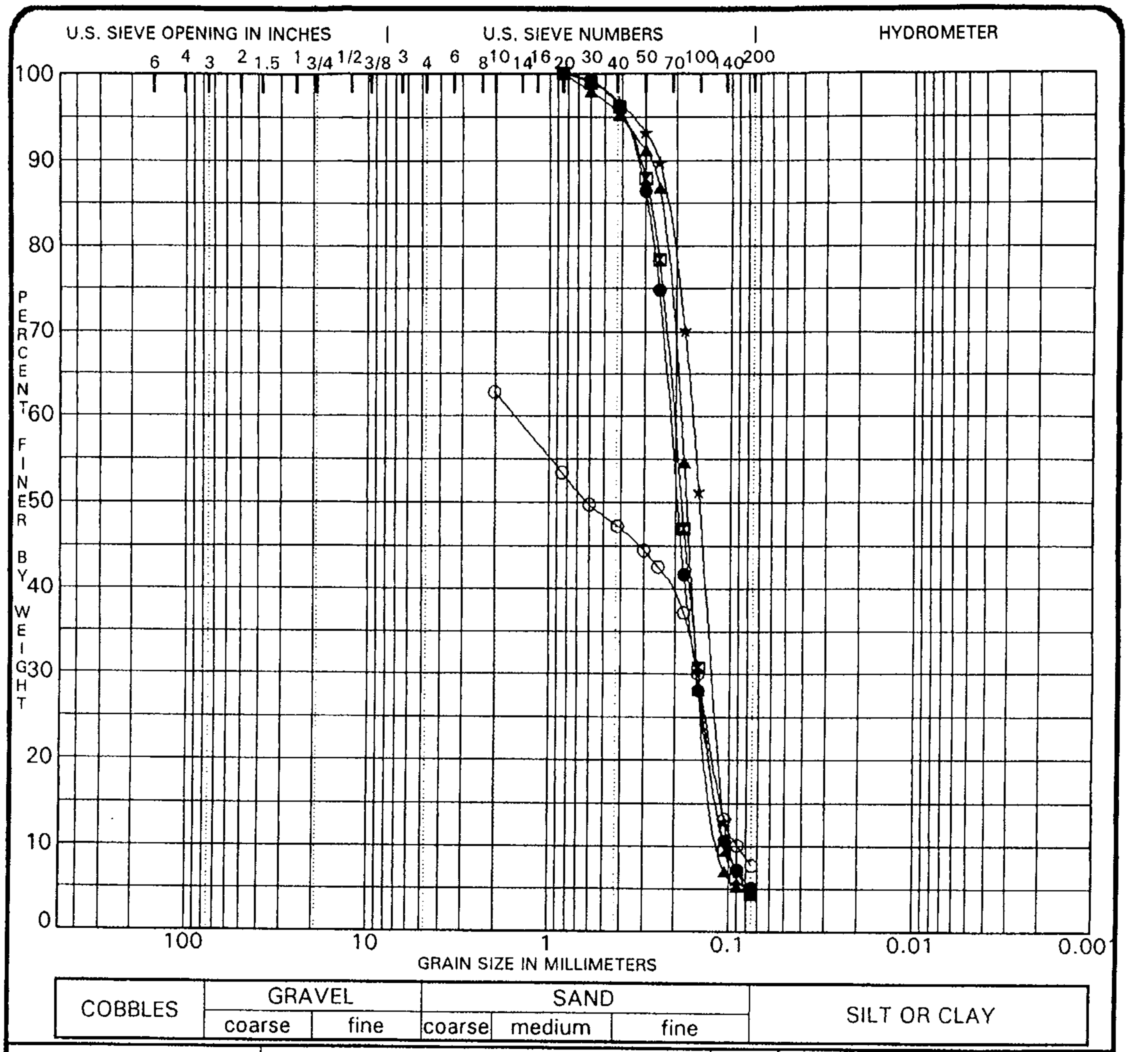

Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
● HF-1	1.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.07	2.1
☒ HF-1	3.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.00	1.9
▲ HF-1	5.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.09	1.7
★ HF-1	7.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	0.96	1.7
○ HF-1	9.0	*SANDY LIMESTONE W/ SHELL					0.16	17.4

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● HF-1	1.0	0.85	0.22	0.154	0.1029	0.0	94.8	5.2	
☒ HF-1	3.0	0.85	0.21	0.148	0.1065	0.0	95.5	4.5	
▲ HF-1	5.0	0.85	0.19	0.152	0.1112	0.0	95.4	4.6	
★ HF-1	7.0	0.85	0.16	0.124	0.0977	0.0	95.4	4.6	
○ HF-1	9.0		1.55	0.150	0.0893			7.8	

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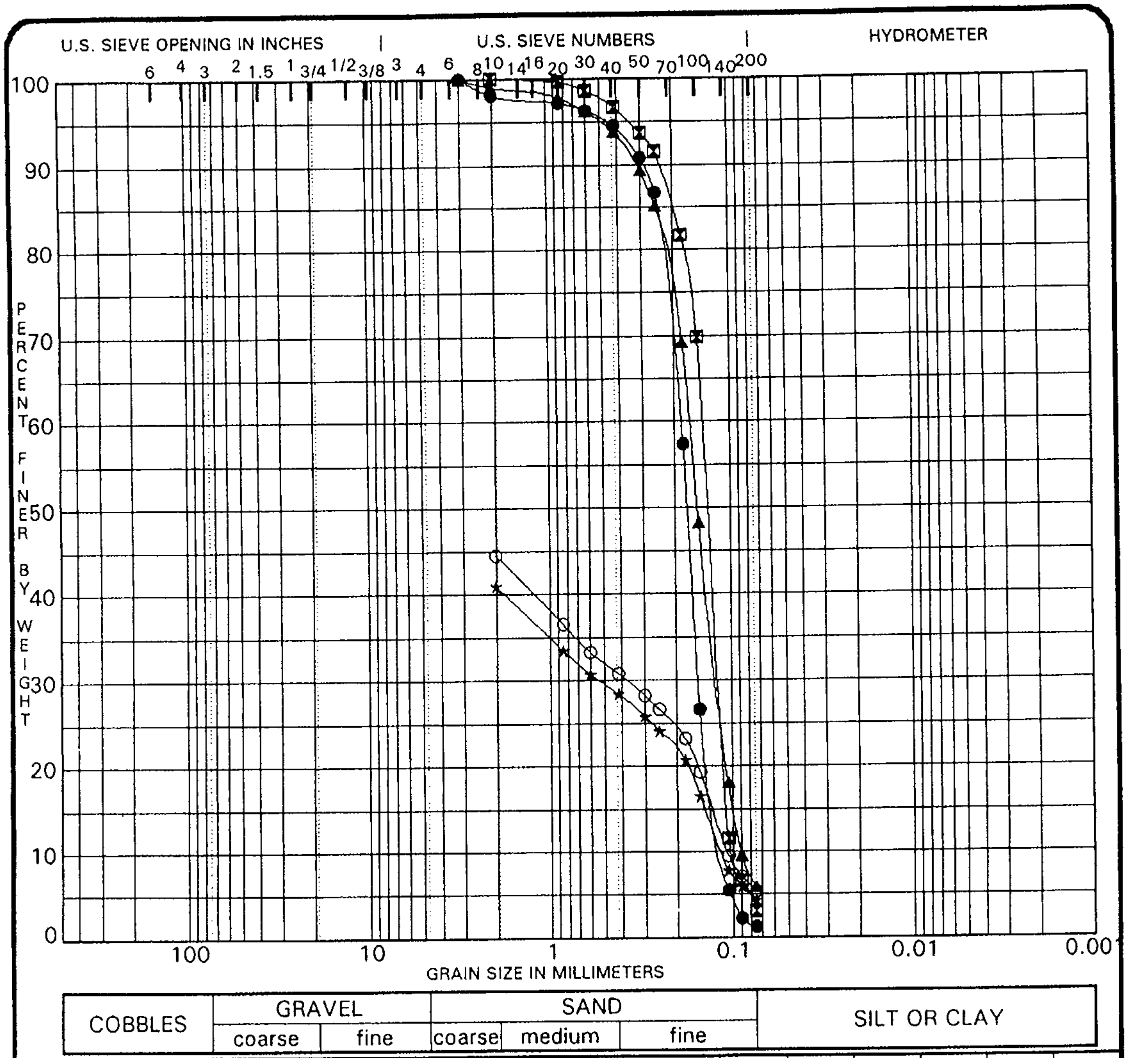
GRADATION CURVES



Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-7	11.2	POORLY GRADED SAND SP		NP	NP	NP	1.11	1.6
☒	HF-7	13.0	POORLY GRADED SAND SP		NP	NP	NP	0.98	1.4
▲	HF-7	15.4	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	0.98	1.8
★	HF-7	17.0	*SAND/SHELL/LIMESTONE						
○	HF-7	19.3	*SAND/ LIMESTONE W/ SHELL						

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-7	11.2	3.00	0.19	0.153	0.1141	0.0	98.7	1.3	
☒	HF-7	13.0	2.00	0.14	0.118	0.1006	0.0	96.9	3.1	
▲	HF-7	15.4	3.00	0.17	0.122	0.0907	0.0	94.1	5.9	
★	HF-7	17.0			0.538	0.1157			4.4	
○	HF-7	19.3			0.379	0.1079			5.4	

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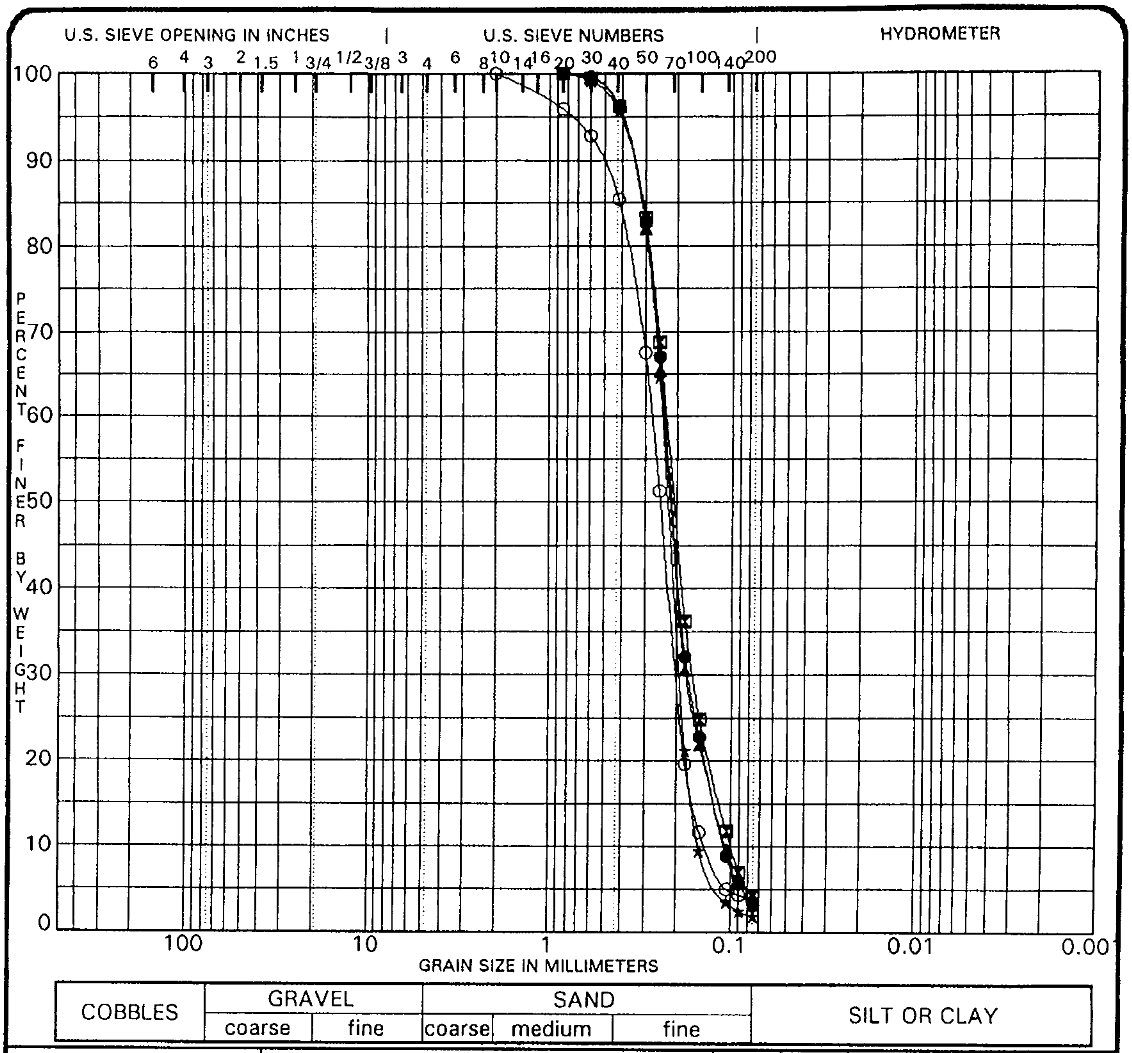
GRADATION CURVES



Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-8	1.0	POORLY GRADED SAND SP		NP	NP	NP	1.17	2.1
☒	HF-8	3.0	POORLY GRADED SAND SP		NP	NP	NP	1.16	2.3
▲	HF-8	5.0	POORLY GRADED SAND SP		NP	NP	NP	1.25	2.2
★	HF-8	7.3	POORLY GRADED SAND SP		NP	NP	NP	1.01	1.6
○	HF-8	9.1	POORLY GRADED SAND SP		NP	NP	NP	1.06	2.0

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-8	1.0	0.85	0.23	0.173	0.1090	0.0	96.8	3.2	
☒	HF-8	3.0	0.85	0.23	0.163	0.0997	0.0	95.8	4.2	
▲	HF-8	5.0	0.85	0.24	0.178	0.1069	0.0	95.8	4.2	
★	HF-8	7.3	0.85	0.24	0.192	0.1512	0.0	98.1	1.9	
○	HF-8	9.1	2.00	0.28	0.201	0.1372	0.0	96.4	3.6	

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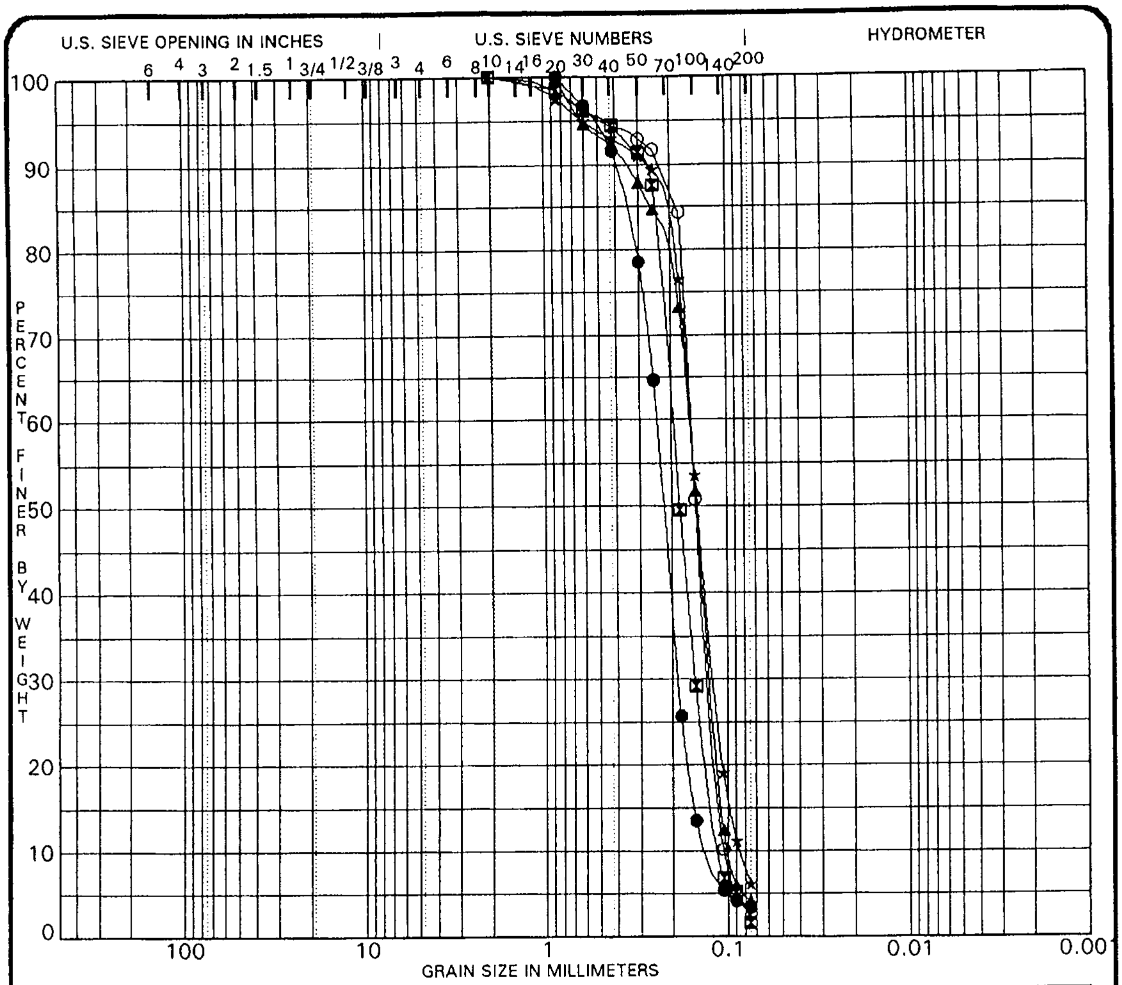
GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-8	11.2	POORLY GRADED SAND SP		NP	NP	NP	1.12	1.9
⌧	HF-8	13.2	POORLY GRADED SAND SP		NP	NP	NP	1.04	1.8
▲	HF-8	15.4	POORLY GRADED SAND SP		NP	NP	NP	0.96	1.6
★	HF-8	17.3	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.03	1.8
○	HF-8	19.2	POORLY GRADED SAND SP		NP	NP	NP	0.95	1.5

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-8	11.2	0.85	0.24	0.187	0.1291	0.0	96.5	3.5	
⌧	HF-8	13.2	2.00	0.20	0.151	0.1112	0.0	98.3	1.7	
▲	HF-8	15.4	0.85	0.16	0.124	0.0997	0.0	95.8	4.2	
★	HF-8	17.3	2.00	0.16	0.118	0.0861	0.0	93.8	6.2	
○	HF-8	19.2	2.00	0.16	0.126	0.1054	0.0	97.4	2.6	

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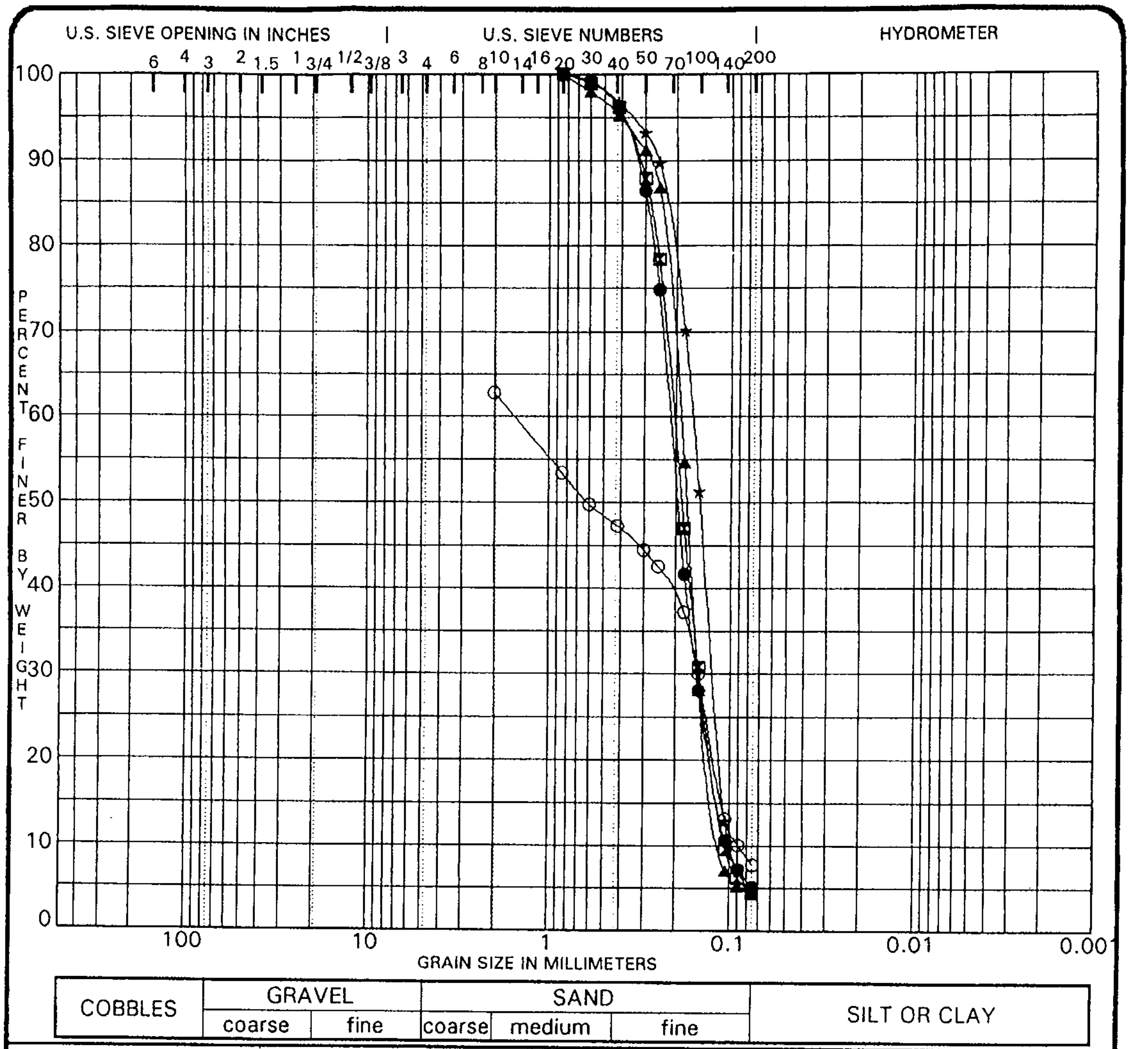

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-1	1.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.07	2.1
⊠	HF-1	3.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.00	1.9
▲	HF-1	5.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.09	1.7
★	HF-1	7.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	0.96	1.7
○	HF-1	9.0	*SANDY LIMESTONE W/ SHELL					0.16	17.4

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-1	1.0	0.85	0.22	0.154	0.1029	0.0	94.8	5.2	
⊠	HF-1	3.0	0.85	0.21	0.148	0.1065	0.0	95.5	4.5	
▲	HF-1	5.0	0.85	0.19	0.152	0.1112	0.0	95.4	4.6	
★	HF-1	7.0	0.85	0.16	0.124	0.0977	0.0	95.4	4.6	
○	HF-1	9.0		1.55	0.150	0.0893			7.8	

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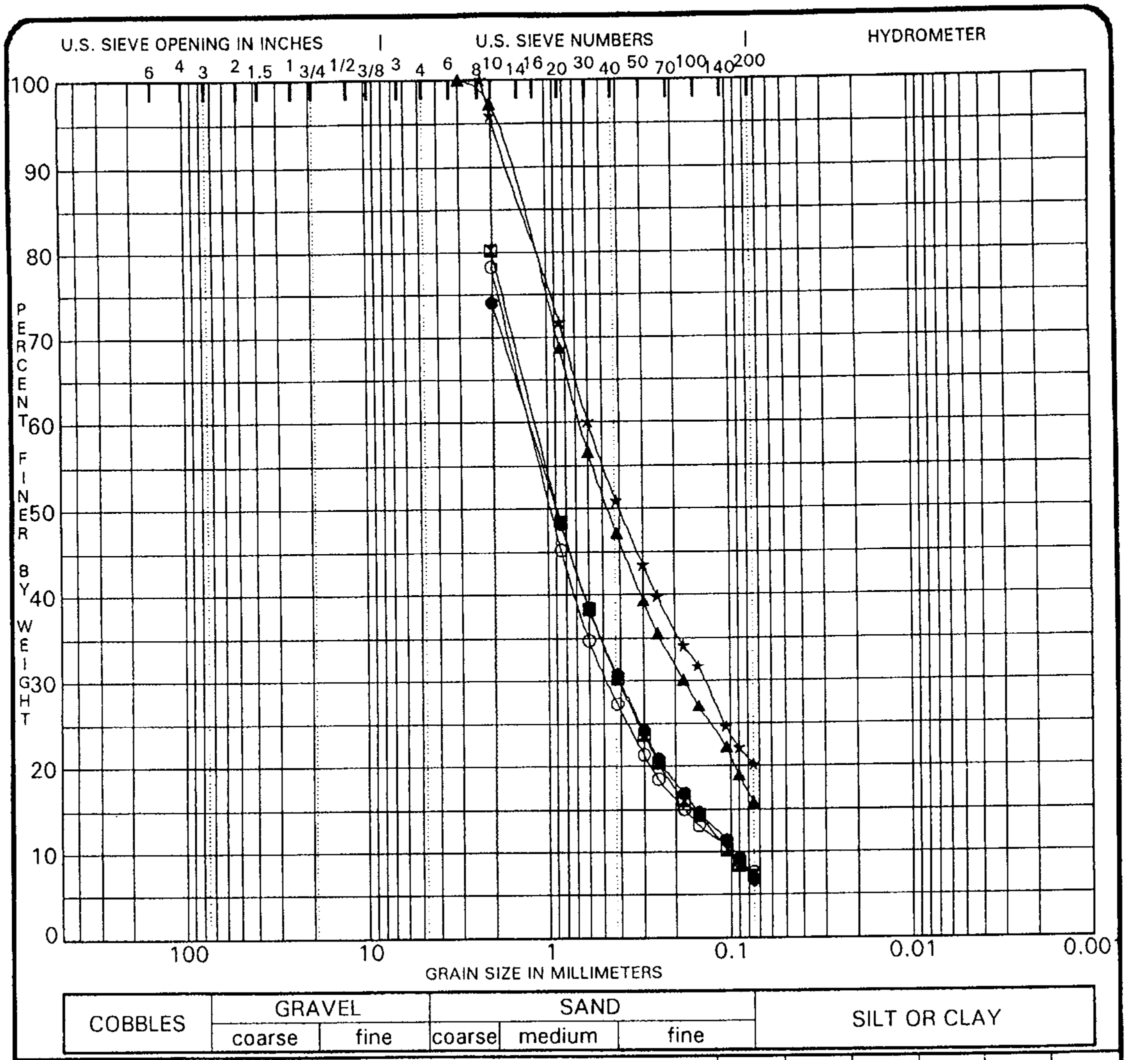

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-8	35.3	*SANDY LIMESTONE					1.37	13.2
⌧	HF-8	37.1	*SANDY LIMESTONE					1.43	11.2
▲	HF-8	39.2	SILTY SAND SM		NP	NP	NP		
★	HF-8	41.2	SILTY SAND SM		NP	NP	NP		
○	HF-8	43.2	*SANDY LIMESTONE/CLAY					1.83	12.5

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-8	35.3		1.26	0.405	0.0955			6.8	
⌧	HF-8	37.1		1.16	0.414	0.1031			7.2	
▲	HF-8	39.2	3.00	0.66	0.179		0.0	84.2	15.8	
★	HF-8	41.2	2.25	0.60	0.138		0.0	79.8	20.2	
○	HF-8	43.2		1.25	0.478	0.1001			7.6	

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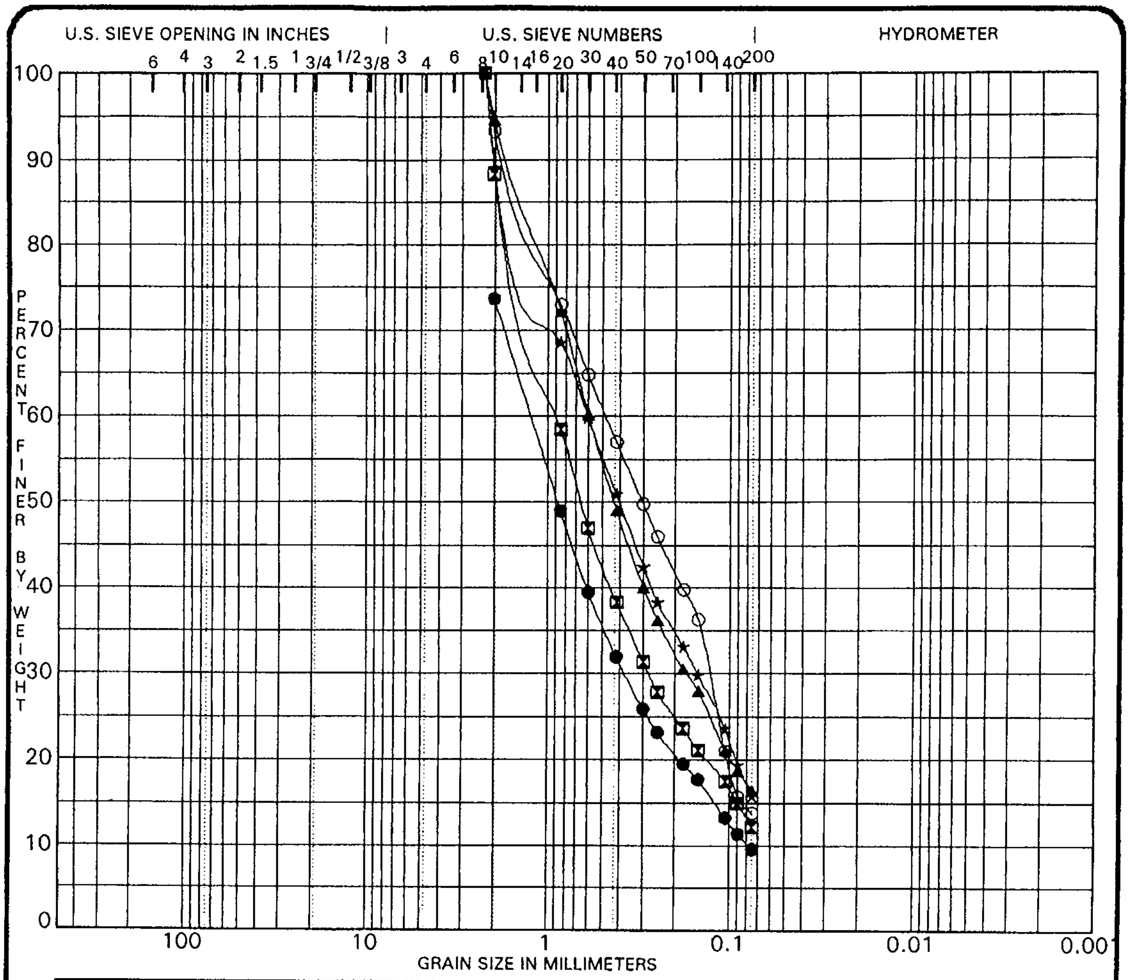

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-8	45.2	*SANDY LIMESTONE/CLAY					1.46	16.0
☒	HF-8	47.0	WELL GRADED SAND with SILT SW-SM		NP	NP	NP	1.25	12.7
▲	HF-8	49.2	SILTY SAND SM		NP	NP	NP		
★	HF-8	51.2	SILTY SAND SM		NP	NP	NP		
○	HF-8	53.2	SILTY SAND SM		NP	NP	NP		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-8	45.2		1.25	0.378	0.0781			9.6	
☒	HF-8	47.0	2.25	0.89	0.279		0.0	87.8	12.2	
▲	HF-8	49.2	2.26	0.60	0.174		0.0	83.6	16.4	
★	HF-8	51.2	2.25	0.60	0.152		0.0	84.2	15.8	
○	HF-8	53.2	2.25	0.48	0.130		0.0	86.2	13.8	

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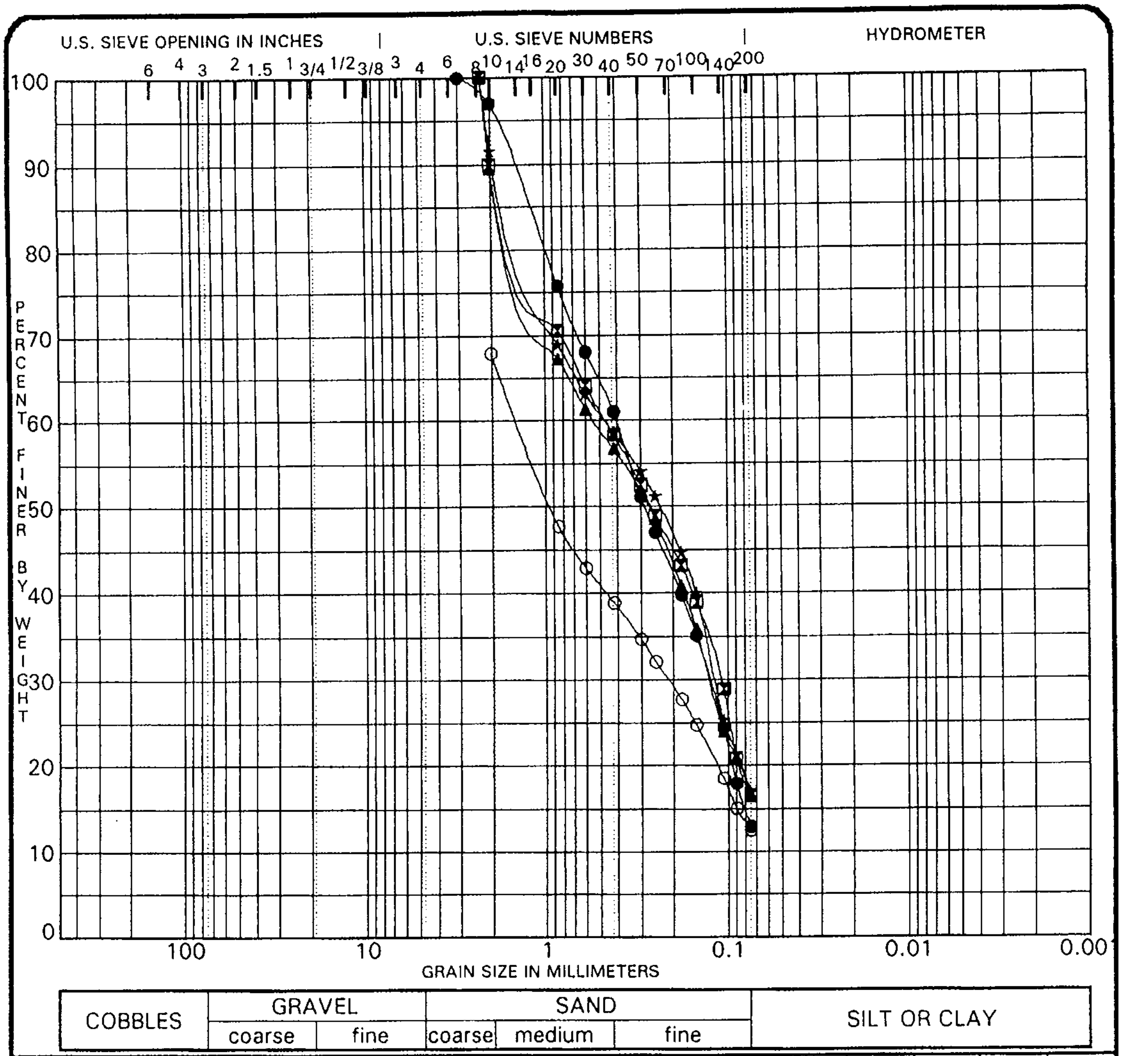

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-8	55.1	SILTY SAND SM		NP	NP	NP		
⌧	HF-8	57.2	SILTY SAND SM		NP	NP	NP		
▲	HF-8	58.4	SILTY SAND SM		NP	NP	NP		
★	HF-8	61.2	SILTY SAND SM		NP	NP	NP		
○	HF-8	63.4	*SILTY CLAY/ LIMESTONE						

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-8	55.1	3.00	0.41	0.127		0.0	87.1	12.9	
⌧	HF-8	57.2	2.25	0.46	0.110		0.0	83.5	16.5	
▲	HF-8	58.4	2.25	0.54	0.127		0.0	83.3	16.7	
★	HF-8	61.2	2.25	0.47	0.118		0.0	83.1	16.9	
○	HF-8	63.4		1.43	0.214				12.5	

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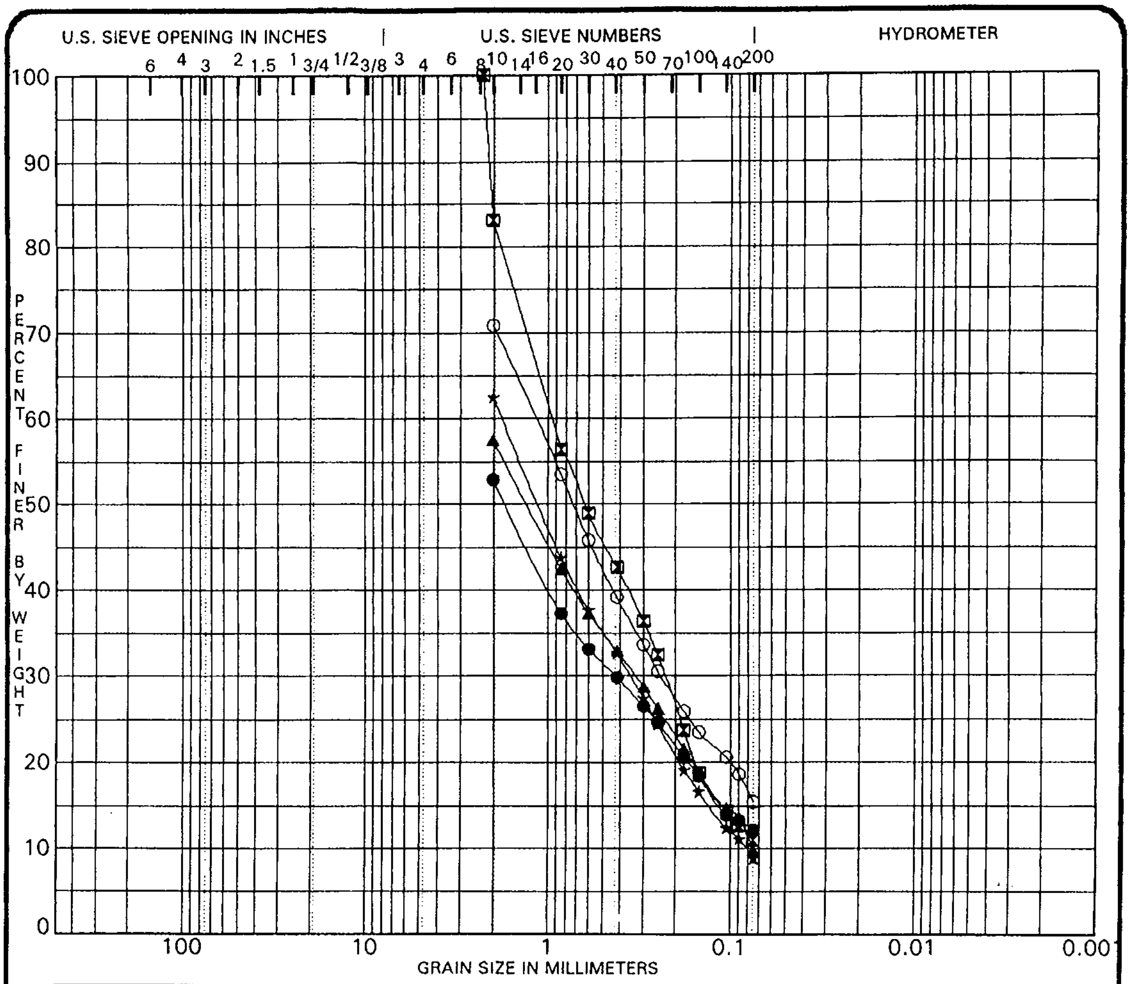
GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	HF-8	65.2	*SILTY CLAY/LIMESTONE						
☒	HF-8	67.2	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	0.78	13.6
▲	HF-8	69.4	*CLAY/LIMESTONE						
★	HF-8	71.4	*CLAY/LIMESTONE					0.86	21.7
○	HF-8	73.3	*SANDY LIMESTONE						

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HF-8	65.2			0.429				12.1	
☒	HF-8	67.2	2.25	0.95	0.228		0.0	89.0	11.0	
▲	HF-8	69.4			0.333	0.0757			9.8	
★	HF-8	71.4		1.78	0.355	0.0822			8.9	
○	HF-8	73.3		1.17	0.241				15.4	

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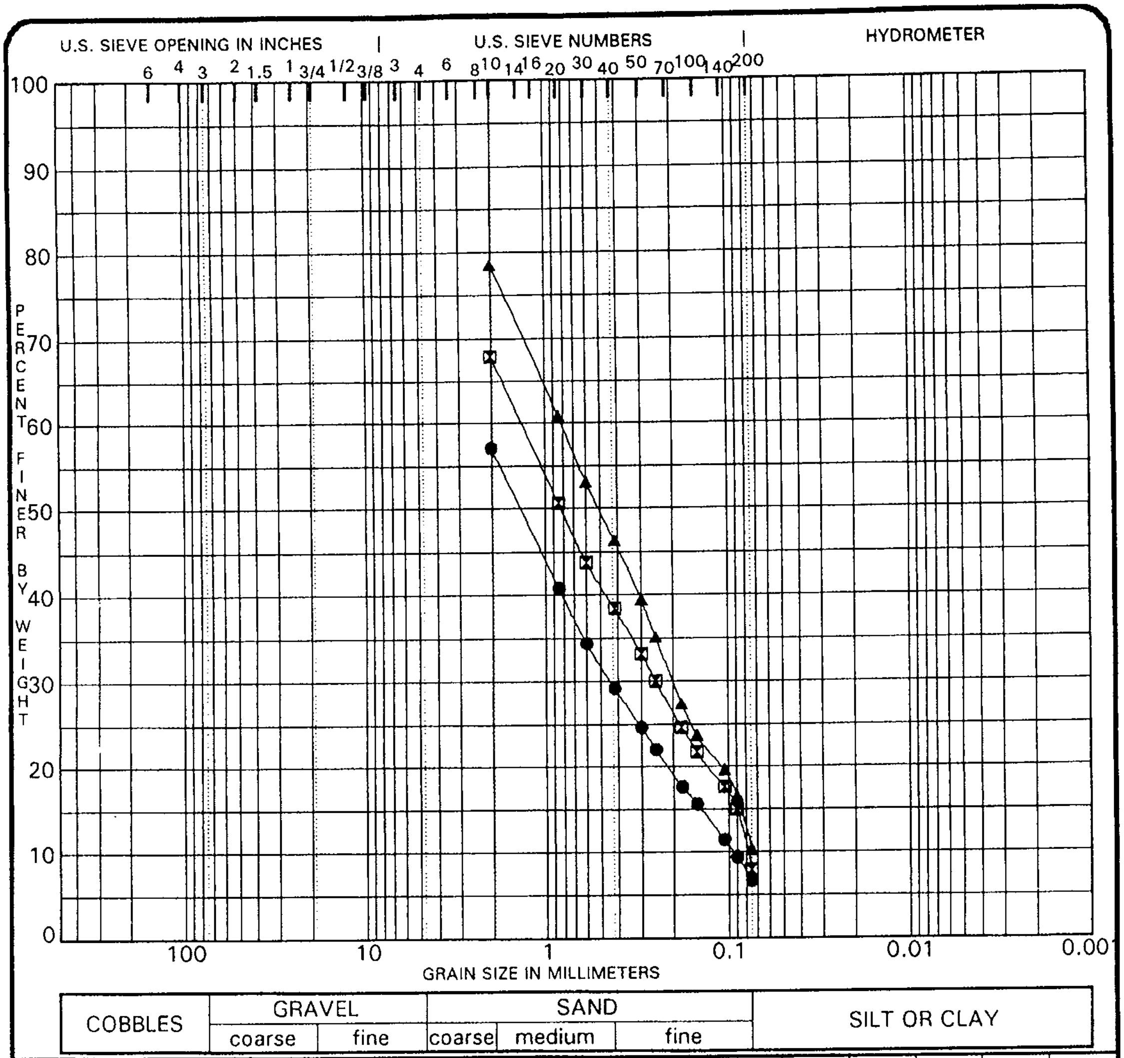

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● HF-8 75.4	*SANDY LIMESTONE/CLAY						
☒ HF-8 77.5	*SANDY LIMESTONE/CLAY					0.58	17.1
▲ HF-8 79.3	*LIMESTONE W/ SHELL					0.71	11.7

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● HF-8 75.4			0.444	0.0945			6.7	
☒ HF-8 77.5		1.35	0.250	0.0791			8.0	
▲ HF-8 79.3		0.82	0.201				10.3	

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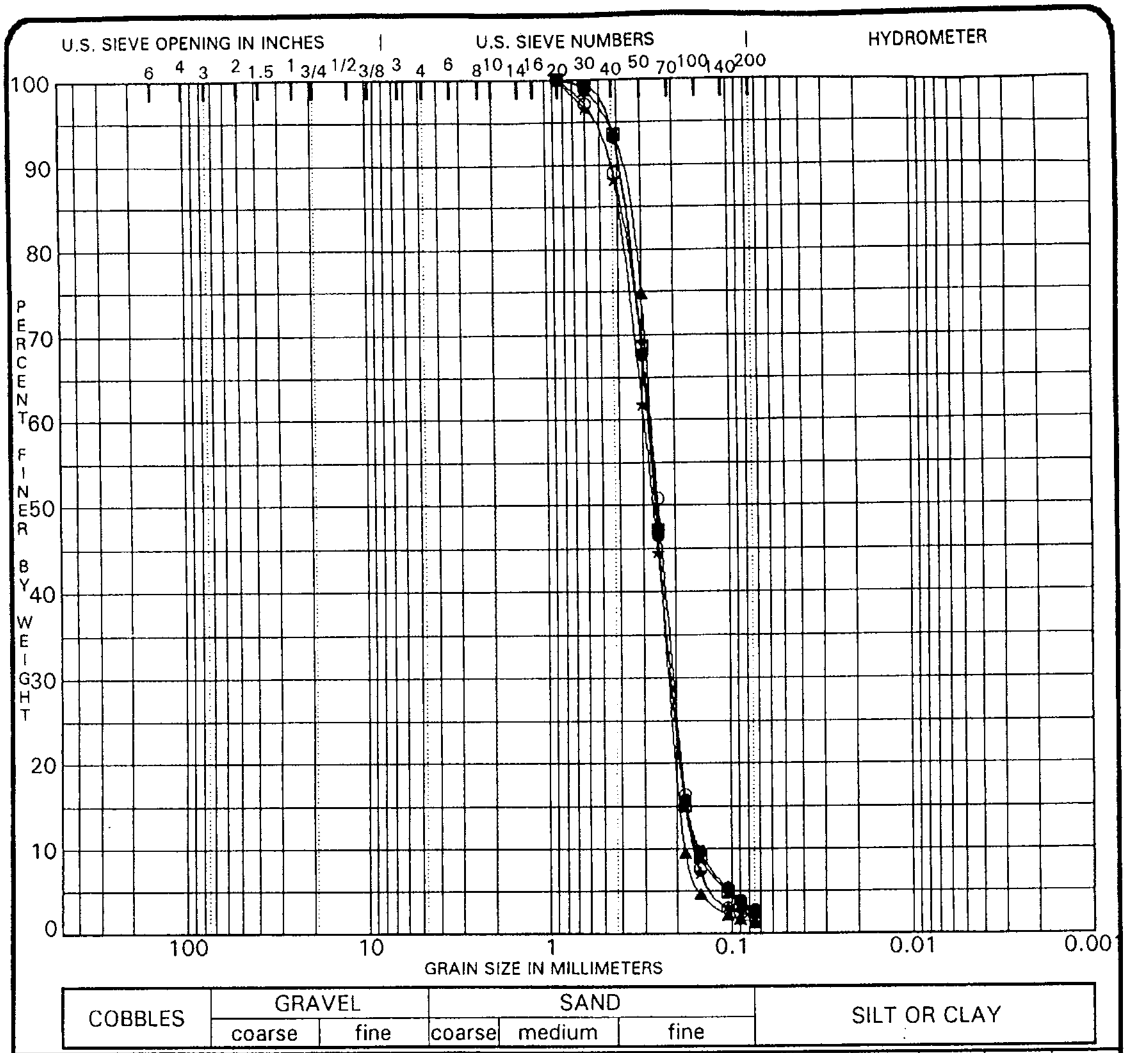
GRADATION CURVES

APPENDIX D

Citrus Project Field Notes



Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● WF-1 1.4	POORLY GRADED SAND SP		NP	NP	NP	1.03	1.9
☒ WF-1 3.3	POORLY GRADED SAND SP		NP	NP	NP	1.02	1.8
▲ WF-1 5.4	POORLY GRADED SAND SP		NP	NP	NP	0.94	1.5
★ WF-1 7.3	POORLY GRADED SAND SP		NP	NP	NP	0.96	1.8
○ WF-1 9.3	POORLY GRADED SAND SP		NP	NP	NP	0.97	1.7

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● WF-1 1.4	0.85	0.28	0.210	0.1514	0.0	97.2	2.8	
☒ WF-1 3.3	0.85	0.28	0.210	0.1542	0.0	97.5	2.5	
▲ WF-1 5.4	0.85	0.27	0.215	0.1808	0.0	98.6	1.4	
★ WF-1 7.3	0.85	0.29	0.213	0.1603	0.0	98.0	2.0	
○ WF-1 9.3	0.85	0.27	0.205	0.1577	0.0	98.0	2.0	

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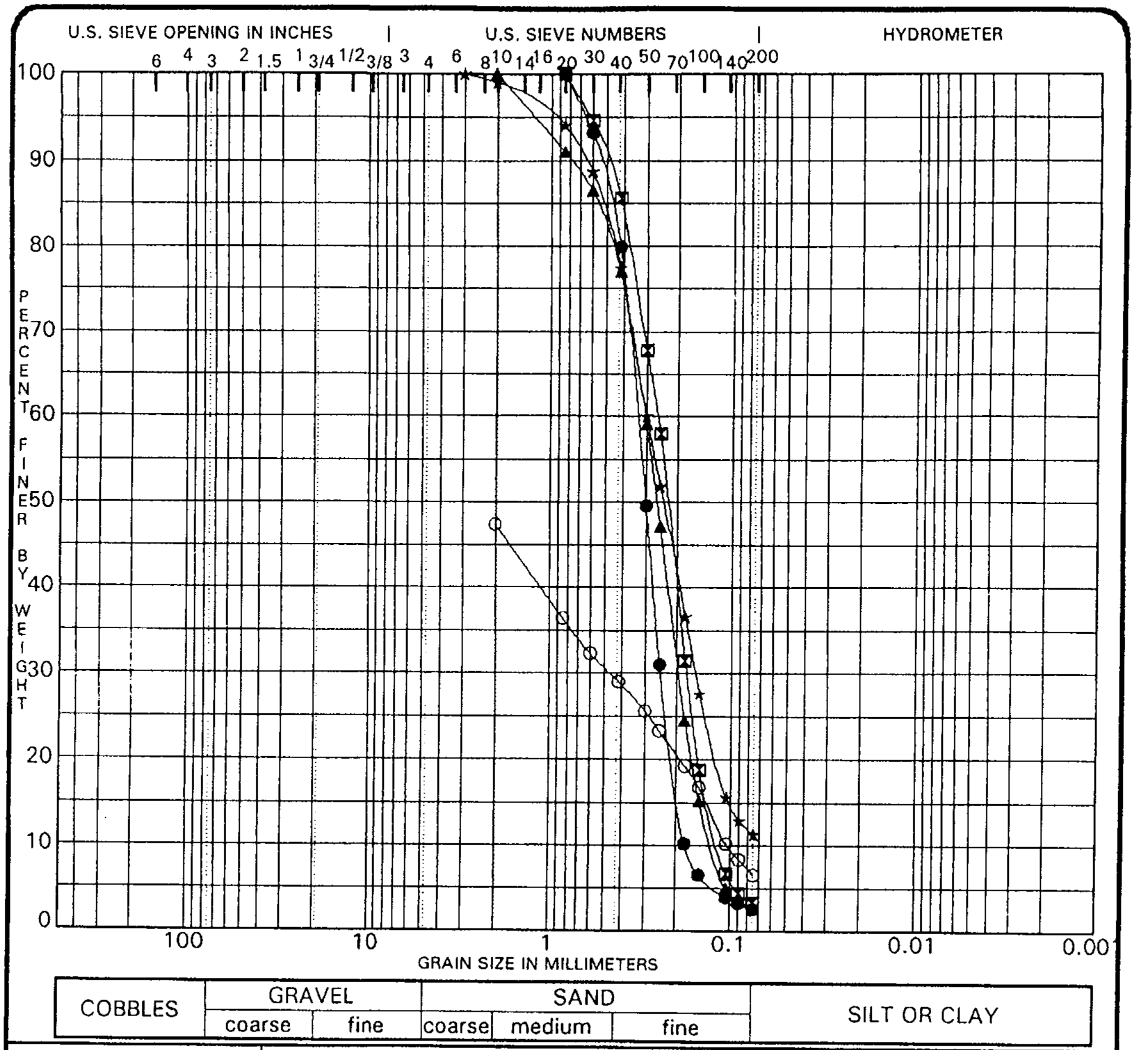
GRADATION CURVES



Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-1	11.5	POORLY GRADED SAND SP		NP	NP	NP	1.01	1.9
⊠	WF-1	13.3	POORLY GRADED SAND SP		NP	NP	NP	1.03	2.2
▲	WF-1	15.2	POORLY GRADED SAND SP		NP	NP	NP	0.99	2.4
★	WF-1	17.5	*FRIABLE LIMESTONE W/ SAND					1.18	4.3
○	WF-1	19.5	*SANDY LIMESTONE		NP	NP	NP		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-1	11.5	0.85	0.34	0.246	0.1782	0.0	97.4	2.6	
⊠	WF-1	13.3	0.85	0.26	0.176	0.1163	0.0	96.6	3.4	
▲	WF-1	15.2	2.00	0.31	0.195	0.1254	0.0	97.3	2.7	
★	WF-1	17.5	3.00	0.30	0.158		0.0	88.7	11.3	
○	WF-1	19.5			0.468	0.1041			6.6	

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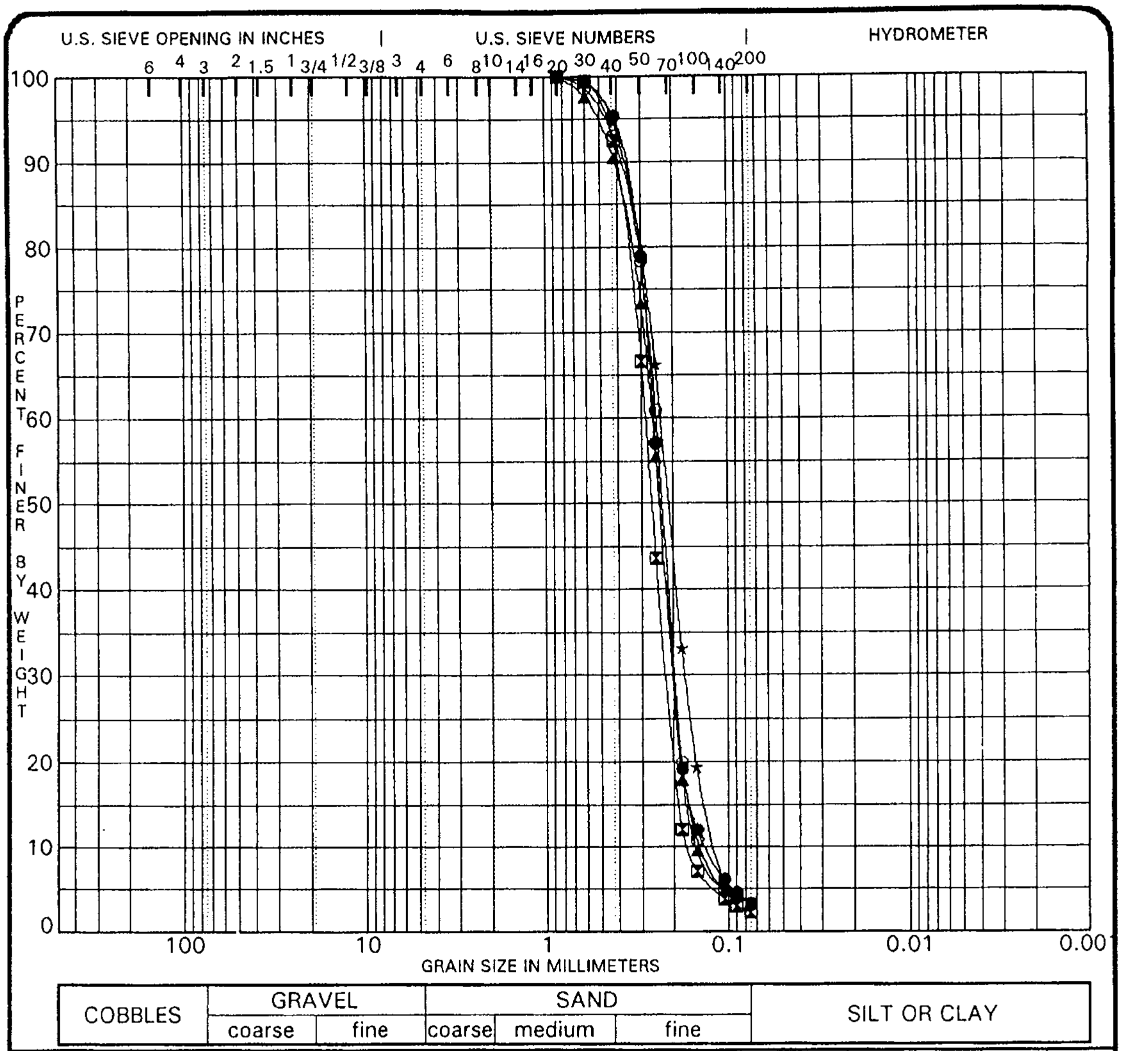

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-2	2.3	POORLY GRADED SAND SP		NP	NP	NP	1.14	1.9
☒	WF-2	4.4	POORLY GRADED SAND SP		NP	NP	NP	0.99	1.7
▲	WF-2	6.3	POORLY GRADED SAND SP		NP	NP	NP	1.01	1.7
★	WF-2	8.2	POORLY GRADED SAND SP		NP	NP	NP	1.08	2.0
○	WF-2	10.2	POORLY GRADED SAND SP		NP	NP	NP	1.07	1.7

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-2	2.3	0.85	0.26	0.198	0.1333	0.0	96.7	3.3	
☒	WF-2	4.4	0.85	0.28	0.217	0.1671	0.0	97.7	2.3	
▲	WF-2	6.3	0.85	0.26	0.200	0.1516	0.0	96.7	3.3	
★	WF-2	8.2	0.85	0.24	0.173	0.1174	0.0	96.5	3.5	
○	WF-2	10.2	0.85	0.25	0.195	0.1431	0.0	96.8	3.2	

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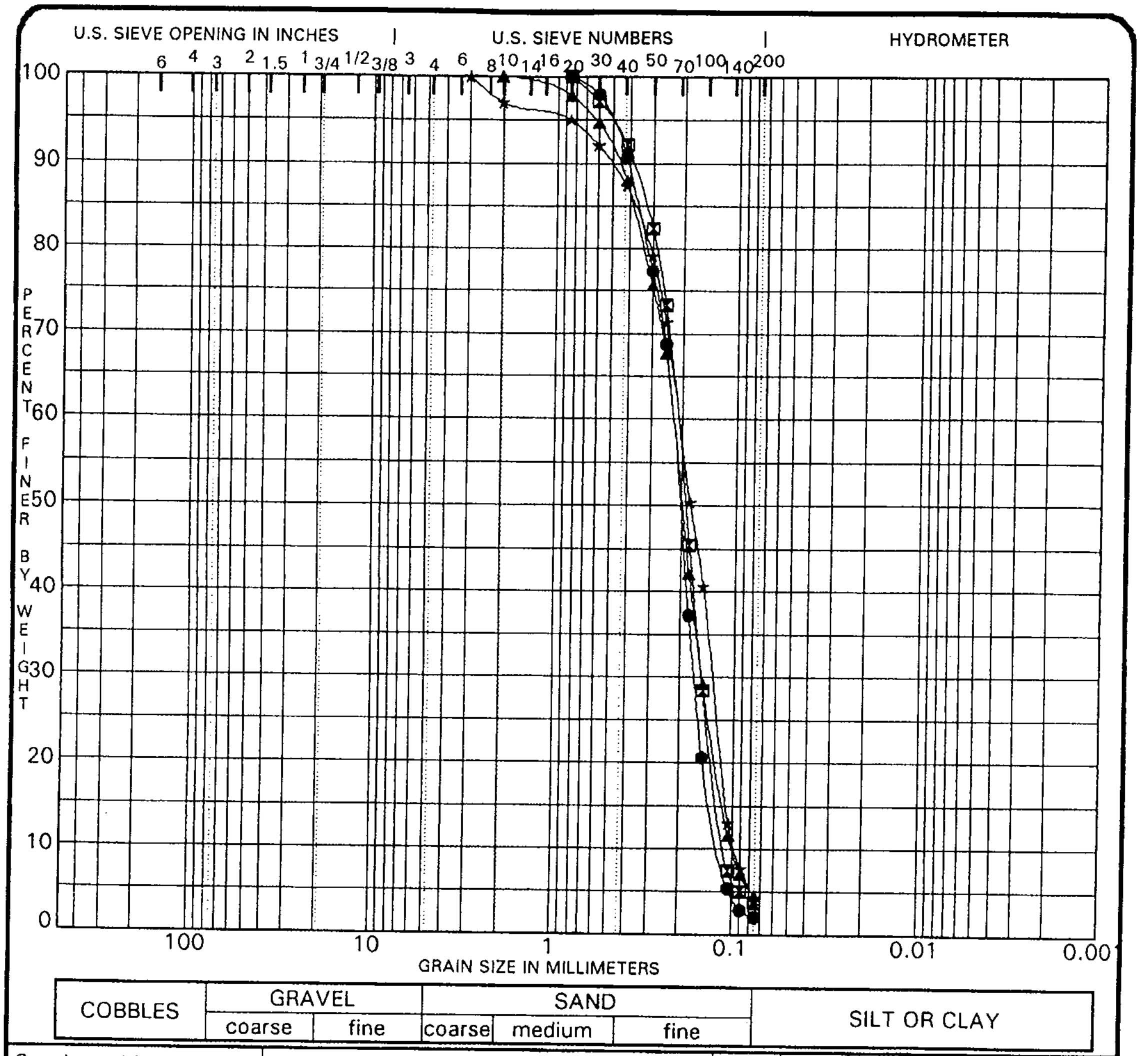

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-2	12.3	POORLY GRADED SAND SP		NP	NP	NP	1.03	1.9
☒	WF-2	14.2	POORLY GRADED SAND SP		NP	NP	NP	0.98	1.9
▲	WF-2	16.2	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.01	2.3
★	WF-2	18.3	POORLY GRADED SAND SP					0.85	2.2

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-2	12.3	0.85	0.23	0.166	0.1177	0.0	97.9	2.1	
☒	WF-2	14.2	0.85	0.21	0.152	0.1105	0.0	96.3	3.7	
▲	WF-2	16.2	2.00	0.23	0.152	0.1001	0.0	95.4	4.6	
★	WF-2	18.3	3.00	0.21	0.131	0.0966	0.0	95.8	4.2	

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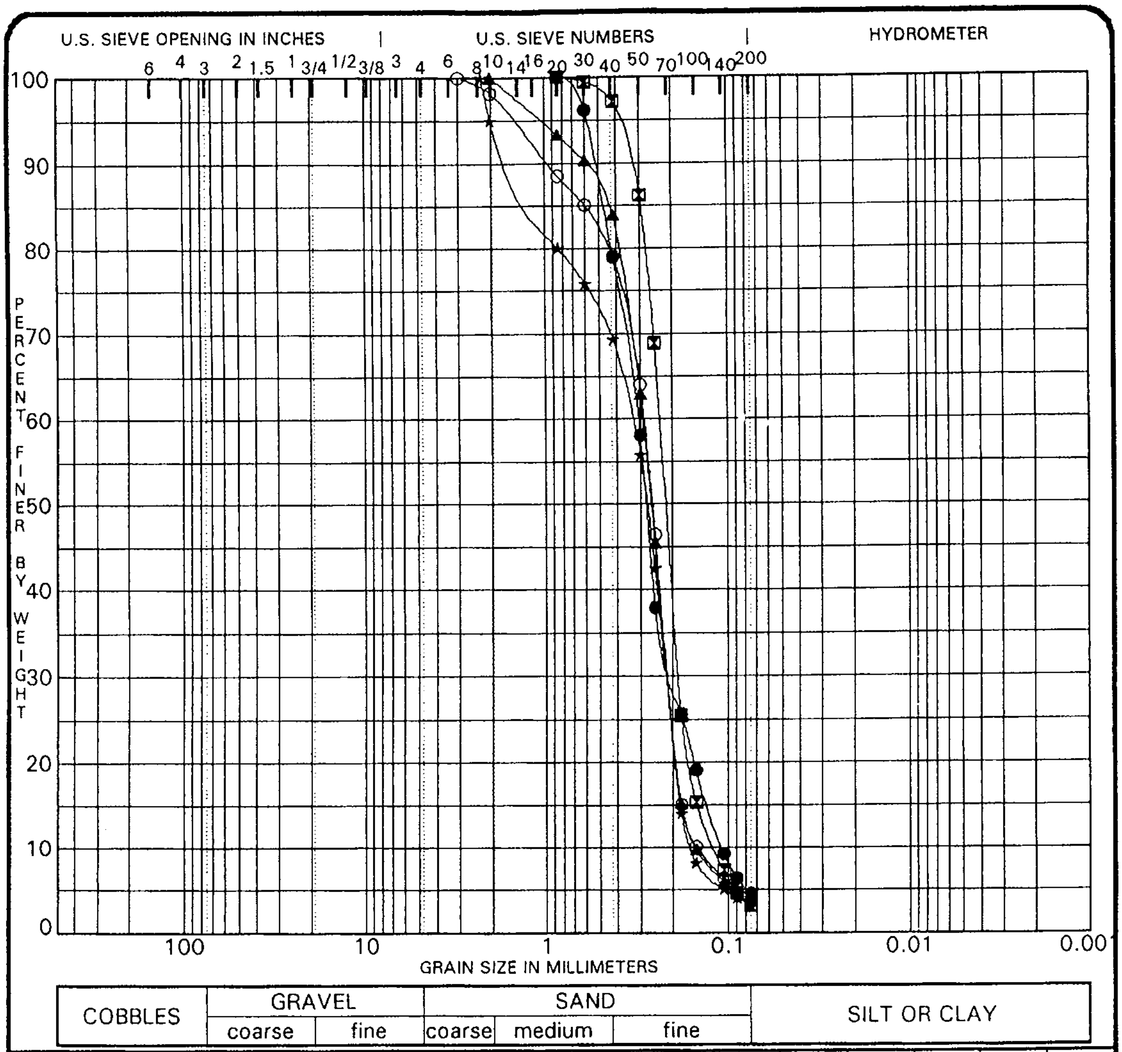

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-3	1.3	**POORLY GRADED SAND with SILT SP-SM**		**NP**	**NP**	**NP**	1.22	2.8
☒	WF-3	3.1	**POORLY GRADED SAND SP**		**NP**	**NP**	**NP**	1.25	2.0
▲	WF-3	5.3	**POORLY GRADED SAND SP**					1.02	1.9
★	WF-3	7.4	**POORLY GRADED SAND SP**		**NP**	**NP**	**NP**	0.89	2.1
○	WF-3	9.1	**POORLY GRADED SAND SP**		**NP**	**NP**	**NP**	1.04	1.9

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-3	1.3	0.85	0.31	0.202	0.1087	0.0	95.4	4.6	
☒	WF-3	3.1	0.85	0.23	0.186	0.1192	0.0	96.8	3.2	
▲	WF-3	5.3	2.00	0.29	0.211	0.1510	0.0	96.3	3.7	
★	WF-3	7.4	2.25	0.33	0.217	0.1587	0.0	96.8	3.2	
○	WF-3	9.1	3.00	0.29	0.211	0.1486	0.0	95.8	4.2	

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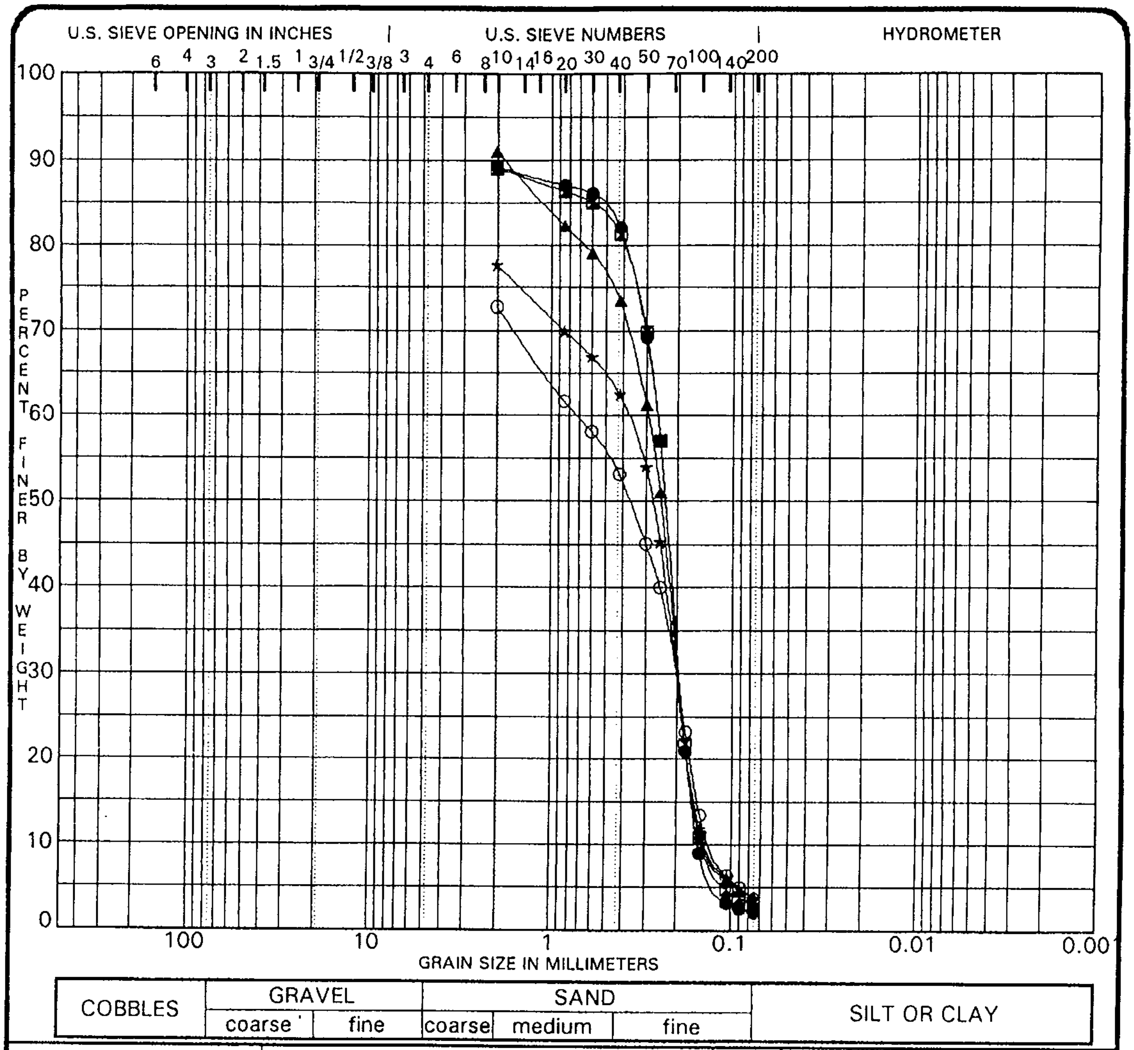

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-3	11.2	*SAND W/ SHELL					0.96	1.7
⊠	WF-3	13.2	*SAND W/ SHELL					1.02	1.8
▲	WF-3	15.1	*SAND W/ SHELL					0.97	2.1
★	WF-3	17.0	*SAND W/ SHELL, LIMESTONE					0.81	2.8
○	WF-3	19.2	*SAND W/ SHELL, LIMESTONE					0.46	5.7

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-3	11.2		0.26	0.196	0.1523			2.2	
⊠	WF-3	13.2		0.26	0.195	0.1425			3.1	
▲	WF-3	15.1		0.29	0.198	0.1387			3.4	
★	WF-3	17.0		0.38	0.203	0.1342			3.9	
○	WF-3	19.2		0.72	0.206	0.1267			3.7	

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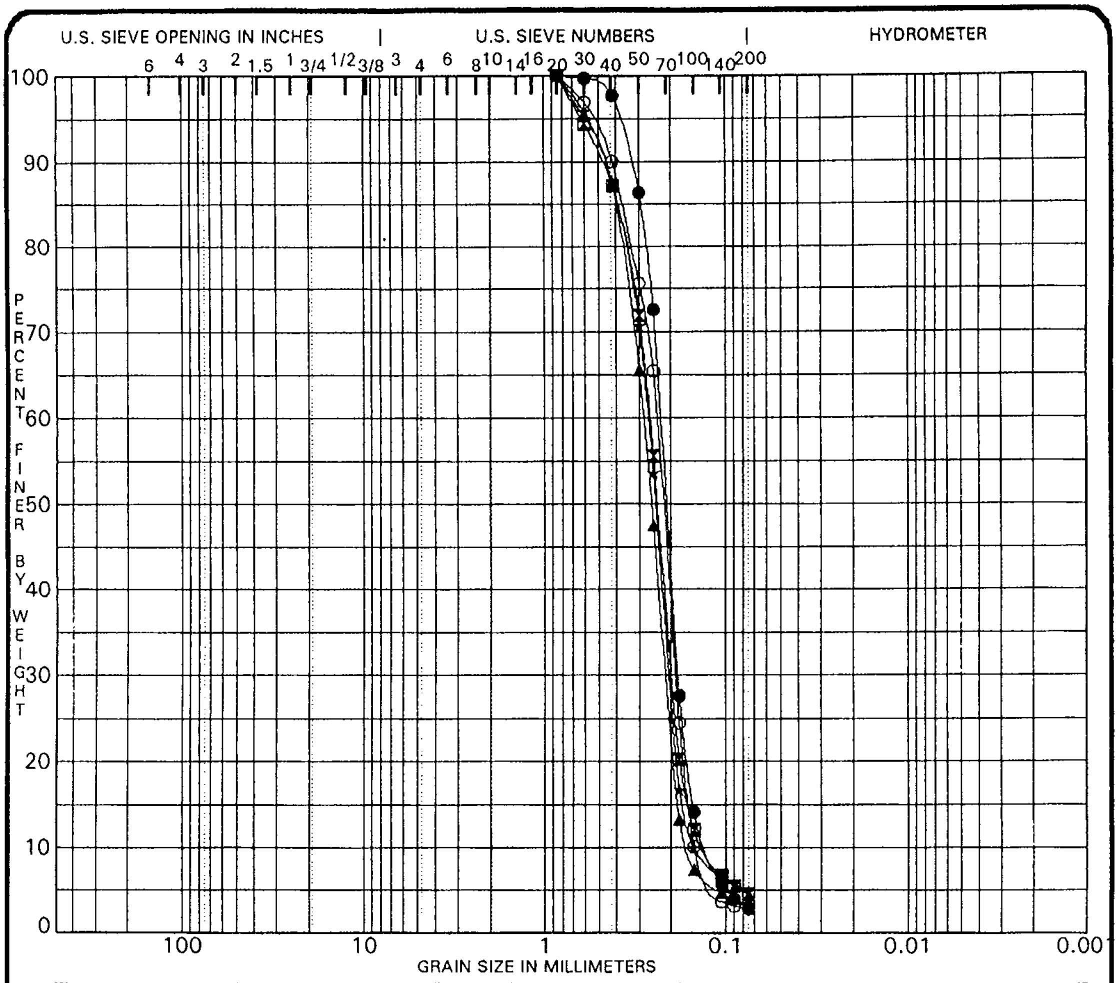

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-4	1.1	POORLY GRADED SAND SP		NP	NP	NP	1.16	1.8
⌧	WF-4	3.2	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.12	2.0
▲	WF-4	5.2	POORLY GRADED SAND SP		NP	NP	NP	0.97	1.7
★	WF-4	7.2	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	1.02	1.8
○	WF-4	9.1	POORLY GRADED SAND SP		NP	NP	NP	0.99	1.6

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-4	1.1	0.85	0.23	0.183	0.1264	0.0	97.0	3.0	
⌧	WF-4	3.2	0.85	0.26	0.197	0.1316	0.0	95.4	4.6	
▲	WF-4	5.2	0.85	0.28	0.211	0.1628	0.0	96.7	3.3	
★	WF-4	7.2	0.85	0.27	0.203	0.1500	0.0	95.1	4.9	
○	WF-4	9.1	0.85	0.24	0.188	0.1492	0.0	97.1	2.9	

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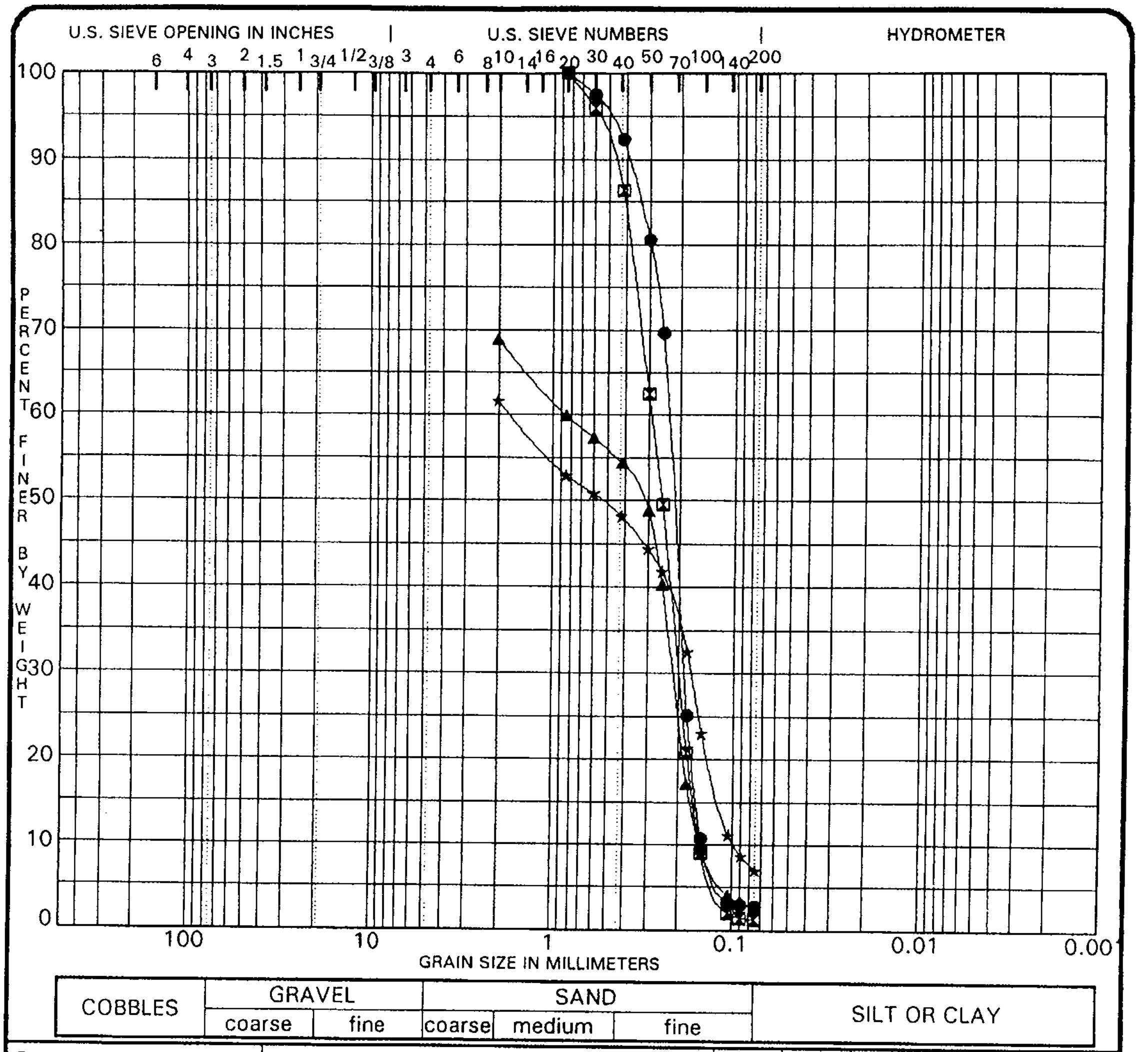

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-4	11.2	POORLY GRADED SAND SP		NP	NP	NP	1.03	1.6
⊠	WF-4	13.2	POORLY GRADED SAND SP		NP	NP	NP	0.91	1.9
▲	WF-4	15.1	*SAND W/ SHELL					0.36	5.7
★	WF-4	17.2	*SAND W/ SHELL					0.18	17.4

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-4	11.2	0.85	0.23	0.187	0.1451	0.0	97.2	2.8	
⊠	WF-4	13.2	0.85	0.29	0.200	0.1521	0.0	98.7	1.3	
▲	WF-4	15.1		0.86	0.216	0.1515			2.8	
★	WF-4	17.2		1.71	0.172	0.0983			7.0	

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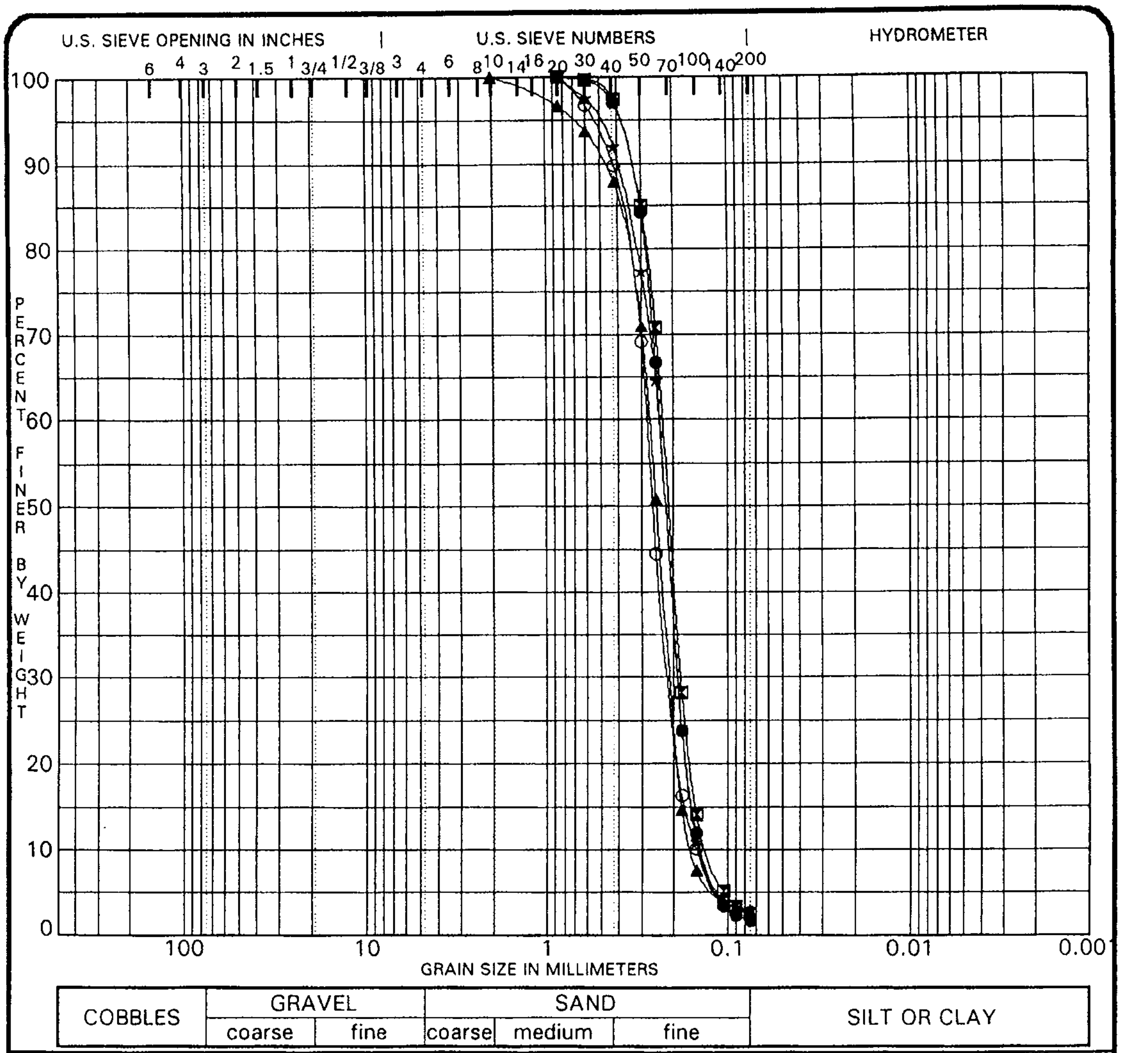

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-5	1.3	POORLY GRADED SAND SP		NP	NP	NP	1.08	1.7
⊠	WF-5	2.9	POORLY GRADED SAND SP		NP	NP	NP	1.13	1.8
▲	WF-5	6.1	POORLY GRADED SAND SP					0.99	1.7
★	WF-5	7.0	POORLY GRADED SAND SP		NP	NP	NP	1.03	1.7
○	WF-5	9.1	POORLY GRADED SAND SP		NP	NP	NP	1.07	1.9

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-5	1.3	0.85	0.24	0.189	0.1387	0.0	98.2	1.8	
⊠	WF-5	2.9	0.85	0.23	0.183	0.1278	0.0	97.5	2.5	
▲	WF-5	6.1	2.00	0.27	0.207	0.1597	0.0	97.2	2.8	
★	WF-5	7.0	0.85	0.24	0.189	0.1434	0.0	97.0	3.0	
○	WF-5	9.1	0.85	0.28	0.211	0.1491	0.0	97.3	2.7	

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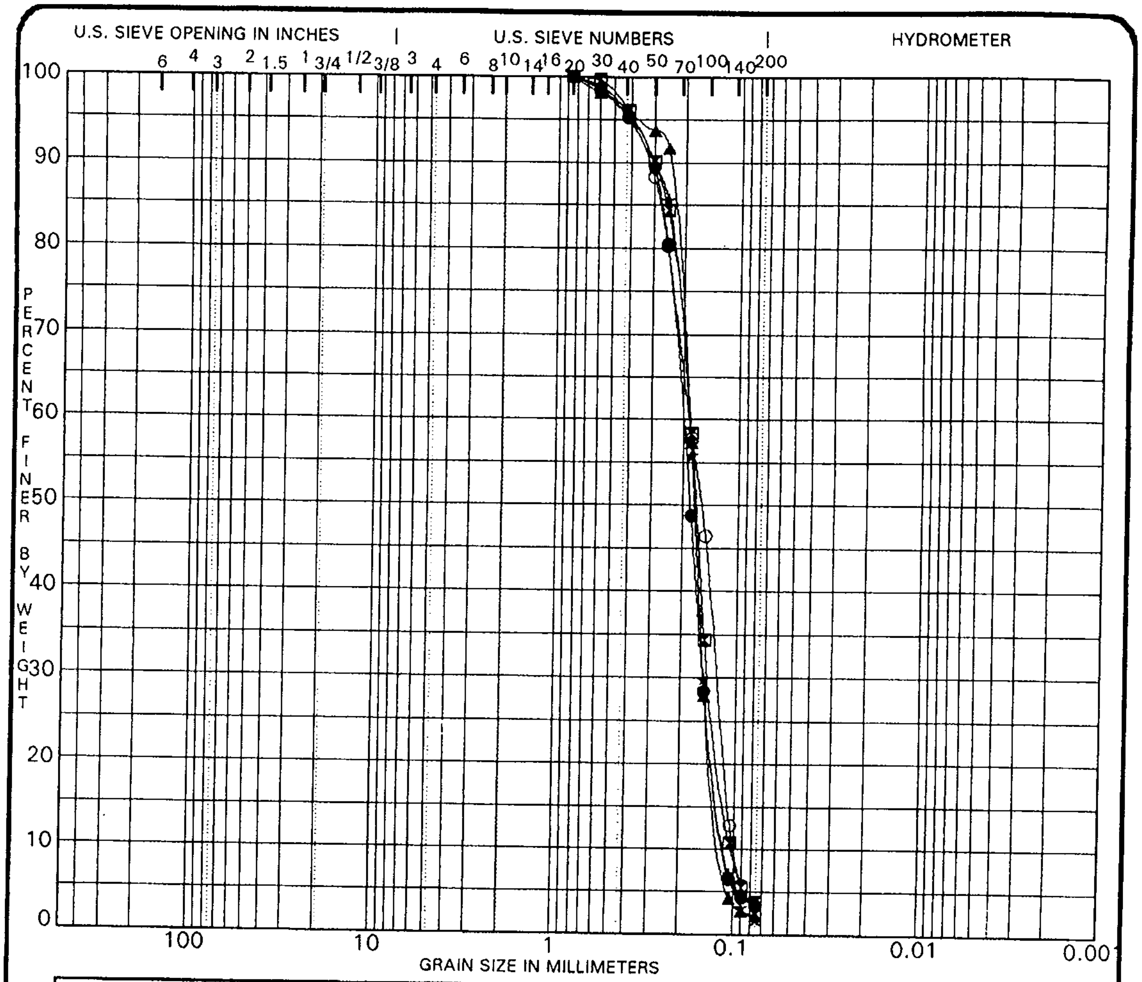

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-5	11.2	POORLY GRADED SAND SP		NP	NP	NP	1.02	1.8
☒	WF-5	13.2	POORLY GRADED SAND SP		NP	NP	NP	1.04	1.8
▲	WF-5	15.2	POORLY GRADED SAND SP		NP	NP	NP	1.08	1.6
★	WF-5	17.1	POORLY GRADED SAND SP		NP	NP	NP	1.08	1.7
○	WF-5	19.3	*SAND W/ LIMESTONE					0.87	1.9

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-5	11.2	0.85	0.20	0.152	0.1120	0.0	96.6	3.4	
☒	WF-5	13.2	0.85	0.18	0.141	0.1037	0.0	96.2	3.8	
▲	WF-5	15.2	0.85	0.18	0.152	0.1153	0.0	97.7	2.3	
★	WF-5	17.1	0.85	0.19	0.150	0.1108	0.0	98.1	1.9	
○	WF-5	19.3	0.85	0.19	0.127	0.0993	0.0	97.6	2.4	

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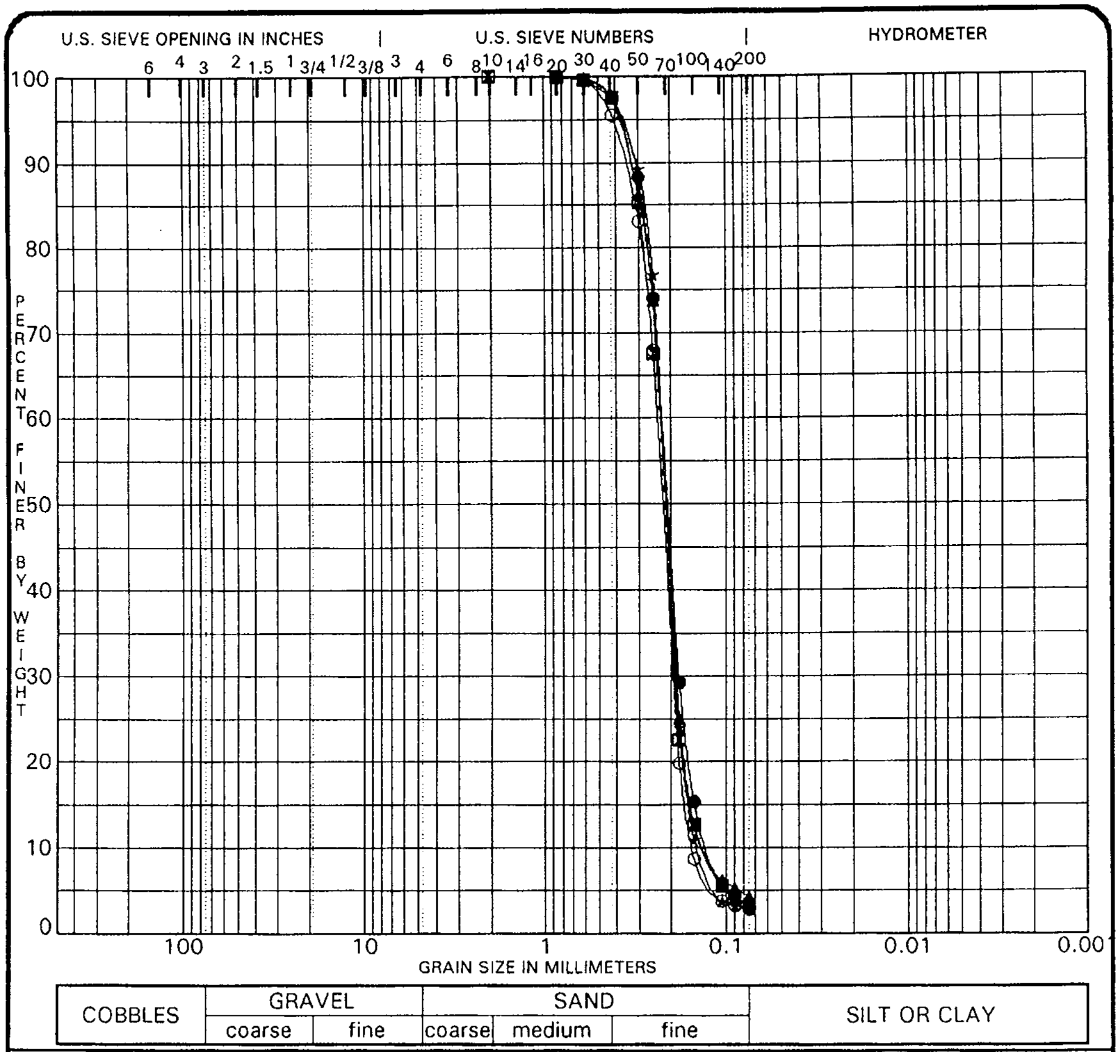

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-6	1.2	POORLY GRADED SAND SP		NP	NP	NP	1.17	1.8
⊠	WF-6	3.0	POORLY GRADED SAND SP		NP	NP	NP	1.16	1.8
▲	WF-6	5.1	POORLY GRADED SAND SP		NP	NP	NP	1.17	1.8
★	WF-6	7.2	POORLY GRADED SAND SP		NP	NP	NP	1.08	1.6
○	WF-6	9.2	POORLY GRADED SAND SP		NP	NP	NP	1.03	1.5

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-6	1.2	0.85	0.23	0.181	0.1236	0.0	96.9	3.1	
⊠	WF-6	3.0	2.00	0.24	0.190	0.1317	0.0	96.8	3.2	
▲	WF-6	5.1	0.85	0.23	0.186	0.1300	0.0	95.7	4.3	
★	WF-6	7.2	0.85	0.23	0.187	0.1435	0.0	97.1	2.9	
○	WF-6	9.2	0.85	0.24	0.193	0.1532	0.0	97.1	2.9	

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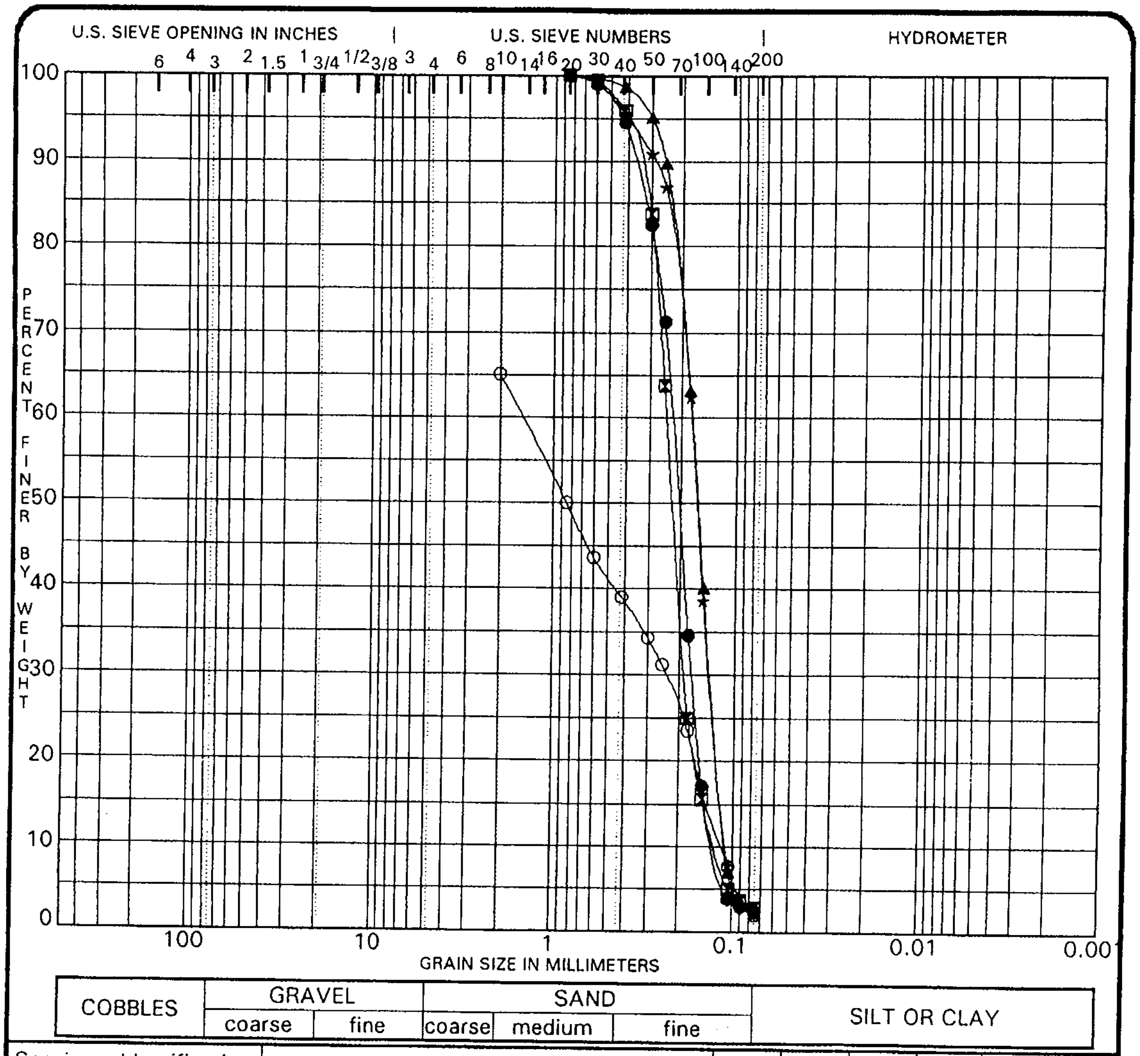

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-6	11.1	POORLY GRADED SAND SP		NP	NP	NP	1.05	1.8
⊠	WF-6	13.2	POORLY GRADED SAND SP		NP	NP	NP	1.17	1.9
▲	WF-6	15.3	POORLY GRADED SAND SP		NP	NP	NP	0.95	1.6
★	WF-6	17.3	POORLY GRADED SAND SP		NP	NP	NP	0.97	1.6
○	WF-6	18.4	*SAND W/ LIMESTONE					0.33	12.9

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-6	11.1	0.85	0.23	0.172	0.1244	0.0	97.5	2.5	
⊠	WF-6	13.2	0.85	0.24	0.188	0.1246	0.0	97.1	2.9	
▲	WF-6	15.3	0.85	0.18	0.135	0.1094	0.0	97.7	2.3	
★	WF-6	17.3	0.85	0.18	0.136	0.1085	0.0	97.8	2.2	
○	WF-6	18.4		1.50	0.238	0.1158			2.0	

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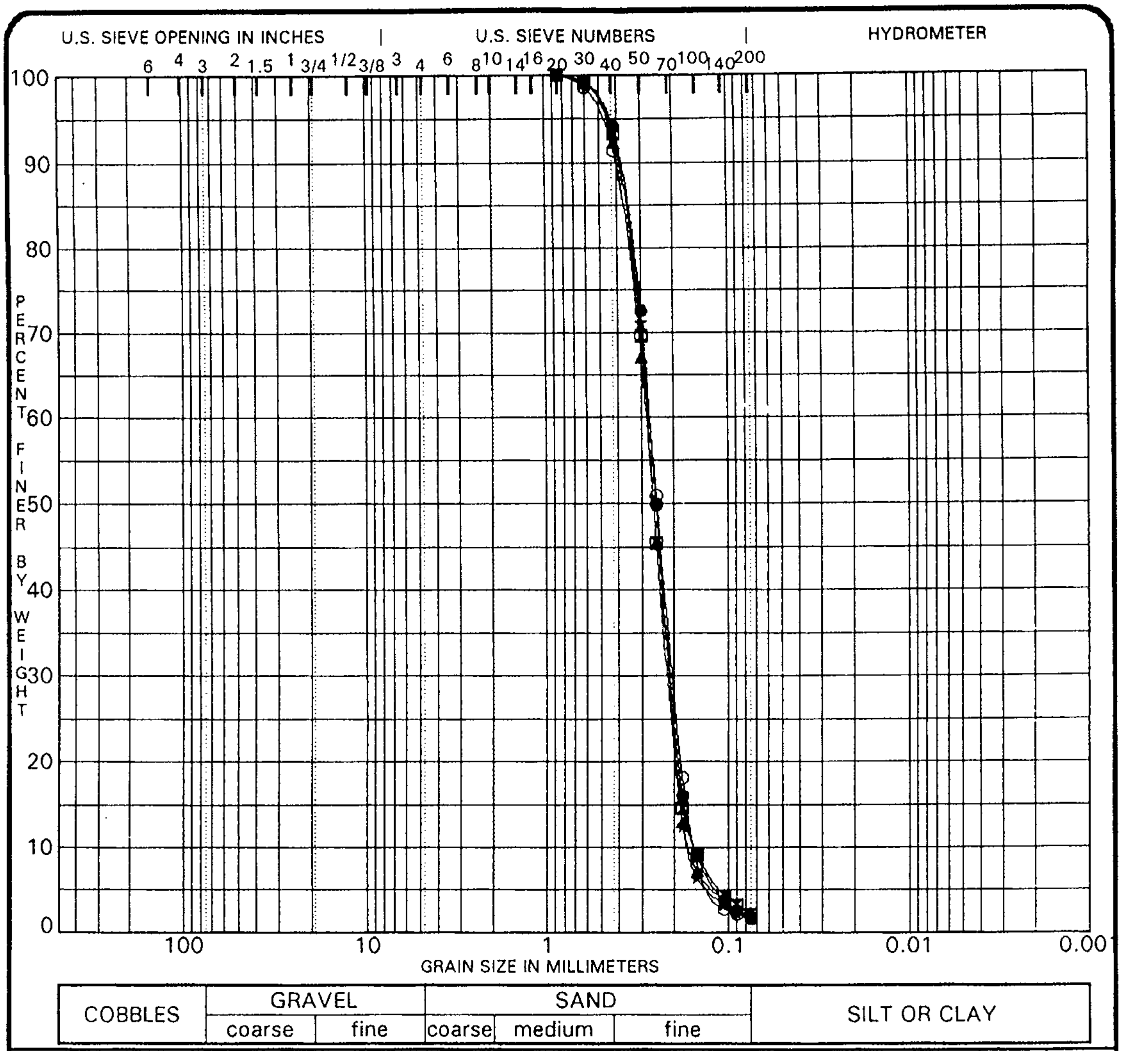
GRADATION CURVES



Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-8	1.1	POORLY GRADED SAND SP		NP	NP	NP	1.02	1.8
☒	WF-8	3.3	POORLY GRADED SAND SP		NP	NP	NP	1.05	1.8
▲	WF-8	5.2	POORLY GRADED SAND SP		NP	NP	NP	0.99	1.7
★	WF-8	7.1	POORLY GRADED SAND SP		NP	NP	NP	0.97	1.6
○	WF-8	9.2	POORLY GRADED SAND SP		NP	NP	NP	0.97	1.8

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-8	1.1	0.85	0.27	0.206	0.1540	0.0	98.3	1.7	
☒	WF-8	3.3	0.85	0.28	0.212	0.1541	0.0	97.8	2.2	
▲	WF-8	5.2	0.85	0.28	0.214	0.1641	0.0	98.0	2.0	
★	WF-8	7.1	0.85	0.27	0.210	0.1670	0.0	98.3	1.7	
○	WF-8	9.2	0.85	0.27	0.203	0.1555	0.0	98.2	1.8	

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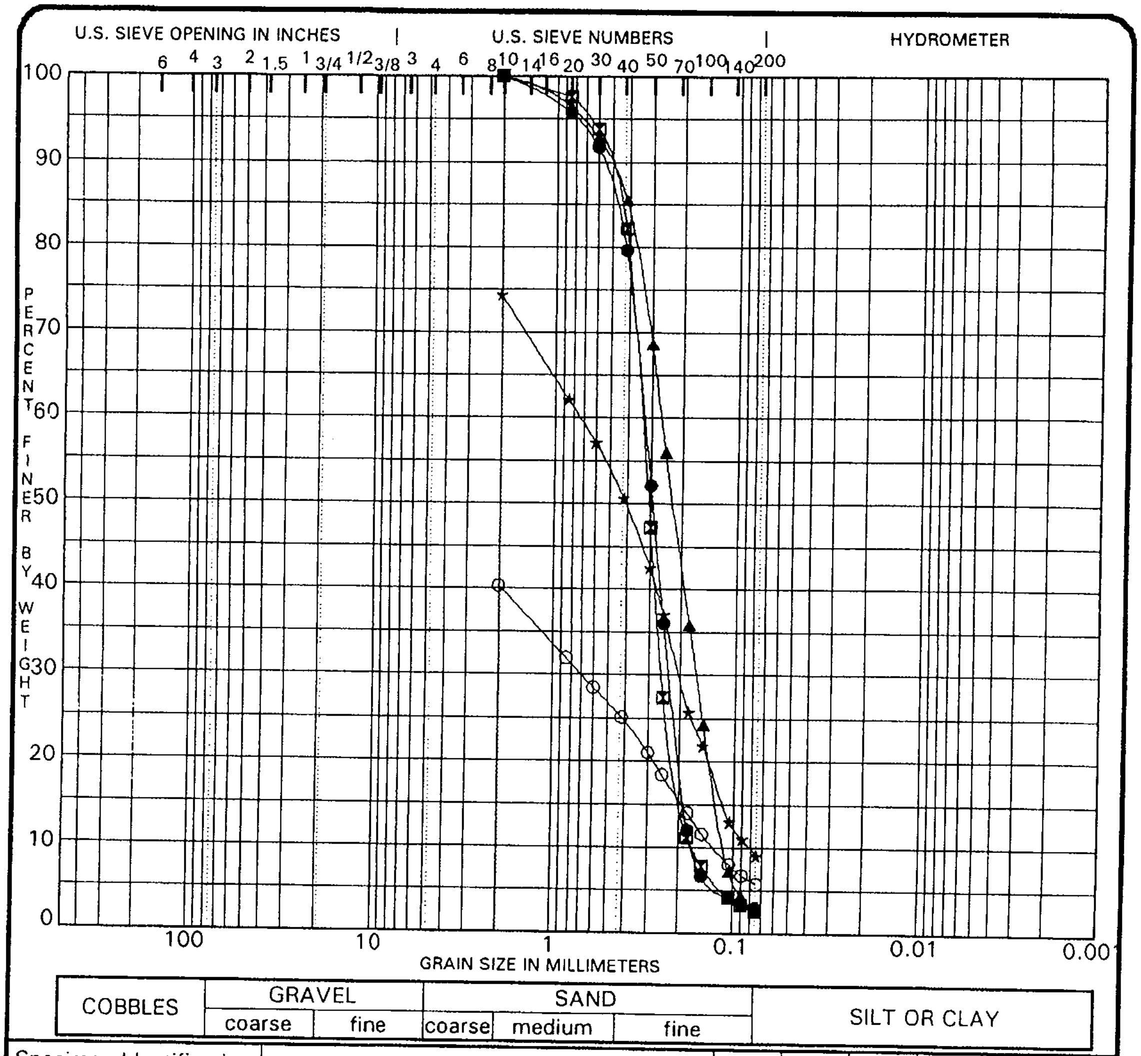

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-8	11.2	POORLY GRADED SAND SP		NP	NP	NP	0.96	2.0
☒	WF-8	13.4	POORLY GRADED SAND SP					1.15	2.0
▲	WF-8	15.2	POORLY GRADED SAND SP					0.91	2.4
★	WF-8	17.5	*SILTY SAND W/ LIMESTONE					0.69	9.0
○	WF-8	30.5	*SANDY LIMESTONE W/ SHELL						

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-8	11.2	2.00	0.33	0.230	0.1680	0.0	97.0	3.0	
☒	WF-8	13.4	2.00	0.34	0.256	0.1685	0.0	97.3	2.7	
▲	WF-8	15.2	2.00	0.26	0.164	0.1122	0.0	97.1	2.9	
★	WF-8	17.5		0.73	0.204	0.0818			9.1	
○	WF-8	30.5			0.700	0.1280			5.8	

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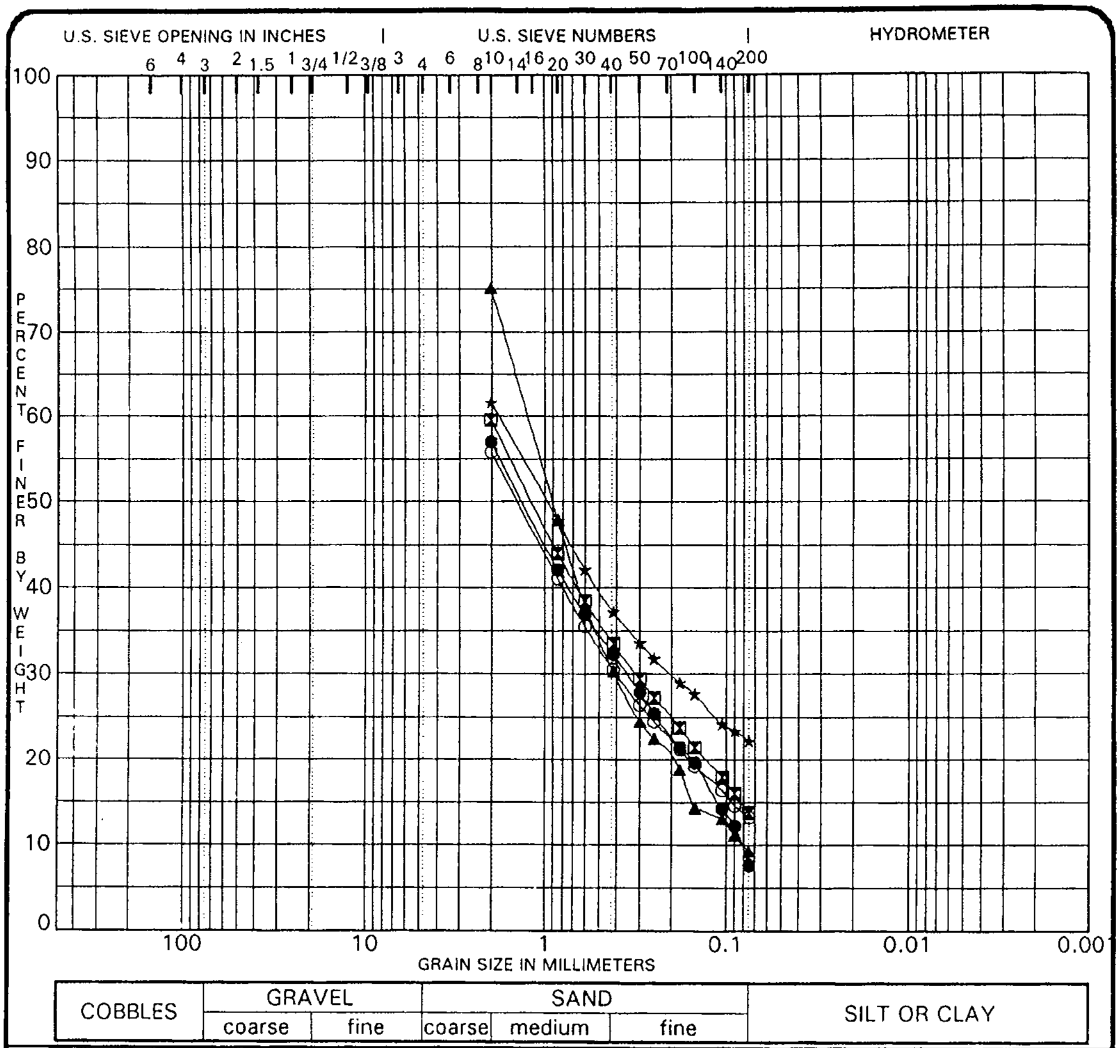

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-8	32.2	*SILTY LIMESTONE W/ SHELL						
⊠	WF-8	34.2	*SILTY LIMESTONE W/ SHELL						
▲	WF-8	36.3	*SILTY LIMESTONE W/ SHELL					1.70	15.4
★	WF-8	38.3	*SILTY LIMESTONE W/ SHELL						
○	WF-8	40.4	*SILTY LIMESTONE W/ SHELL						

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-8	32.2			0.352	0.0823			7.7	
⊠	WF-8	34.2			0.315				13.7	
▲	WF-8	36.3		1.24	0.413	0.0805			9.3	
★	WF-8	38.3		1.81	0.202				22.2	
○	WF-8	40.4			0.403				13.2	

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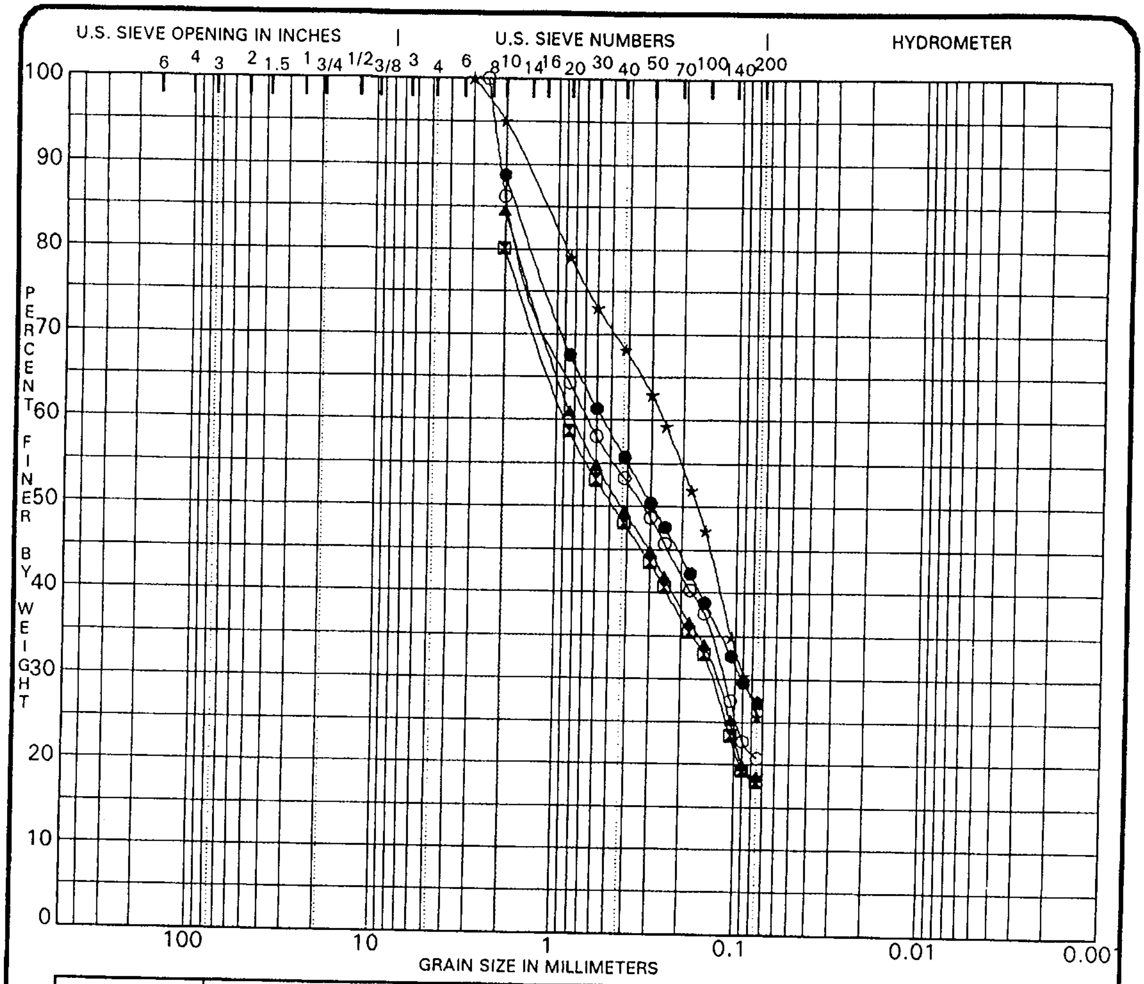
GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-8	49.3	*SILTY LIMESTONE W/ SHELL						
⊠	WF-8	51.2	*SANDY LIMESTONE W/ CLAY						
▲	WF-8	53.1	*SANDY LIMESTONE						
★	WF-8	55.1	SILTY SAND SM		NP	NP	NP		
○	WF-8	57.4	SILTY SAND SM		NP	NP	NP		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-8	49.3		0.55	0.092				27.2	
⊠	WF-8	51.2		0.90	0.135				18.0	
▲	WF-8	53.1		0.80	0.128				18.6	
★	WF-8	55.1	3.00	0.26	0.089		0.0	74.4	25.6	
○	WF-8	57.4	2.50	0.67	0.116		0.0	79.3	20.7	

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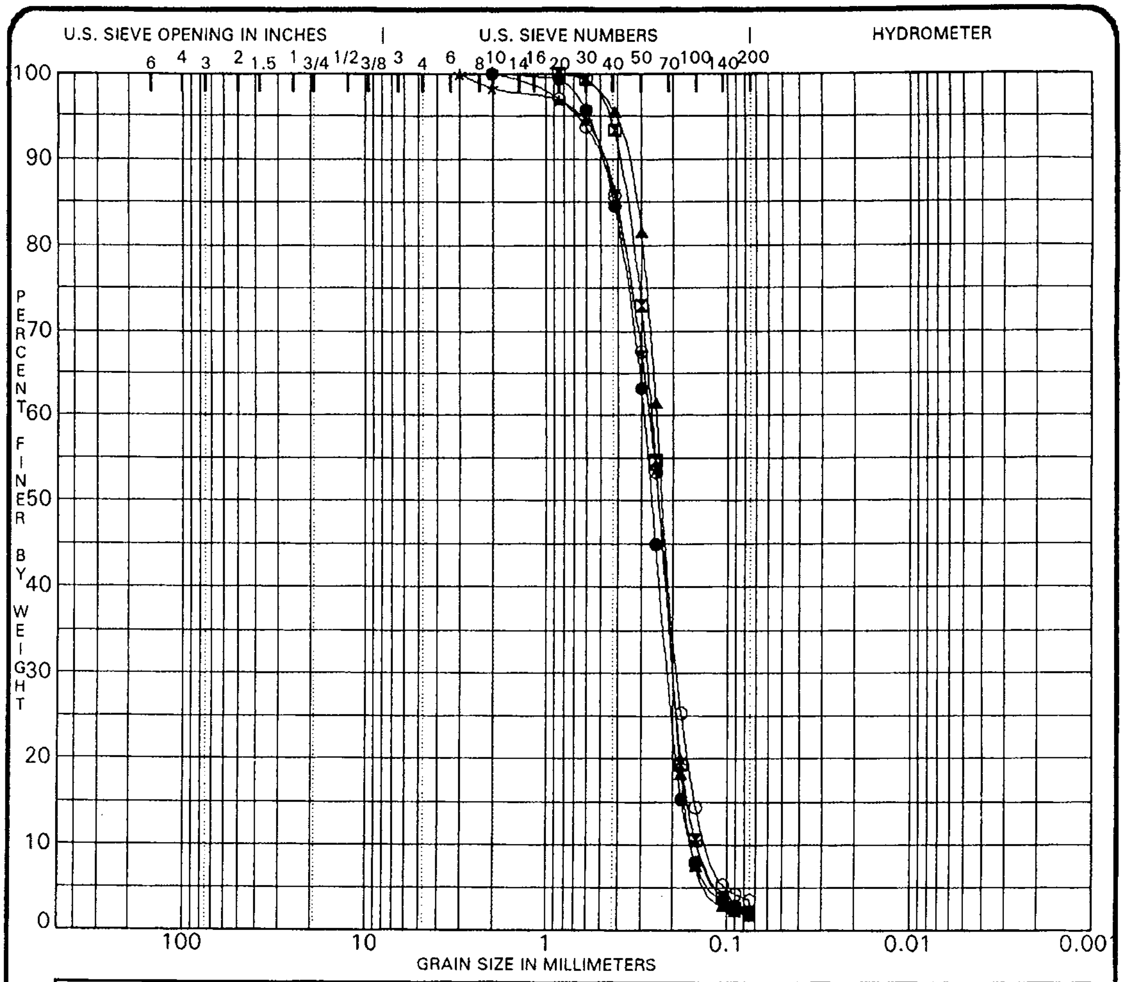

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-9	1.3	POORLY GRADED SAND SP		NP	NP	NP	0.98	1.8
☒	WF-9	3.0	POORLY GRADED SAND SP		NP	NP	NP	1.03	1.8
▲	WF-9	5.2	POORLY GRADED SAND SP		NP	NP	NP	1.00	1.6
★	WF-9	7.1	POORLY GRADED SAND SP		NP	NP	NP	0.99	1.9
○	WF-9	9.2	POORLY GRADED SAND SP					1.05	2.2

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-9	1.3	2.00	0.29	0.212	0.1577	0.0	97.7	2.3	
☒	WF-9	3.0	0.85	0.26	0.199	0.1454	0.0	98.1	1.9	
▲	WF-9	5.2	0.85	0.25	0.197	0.1563	0.0	98.1	1.9	
★	WF-9	7.1	3.00	0.27	0.199	0.1468	0.0	97.3	2.7	
○	WF-9	9.2	2.00	0.27	0.190	0.1266	0.0	96.4	3.6	

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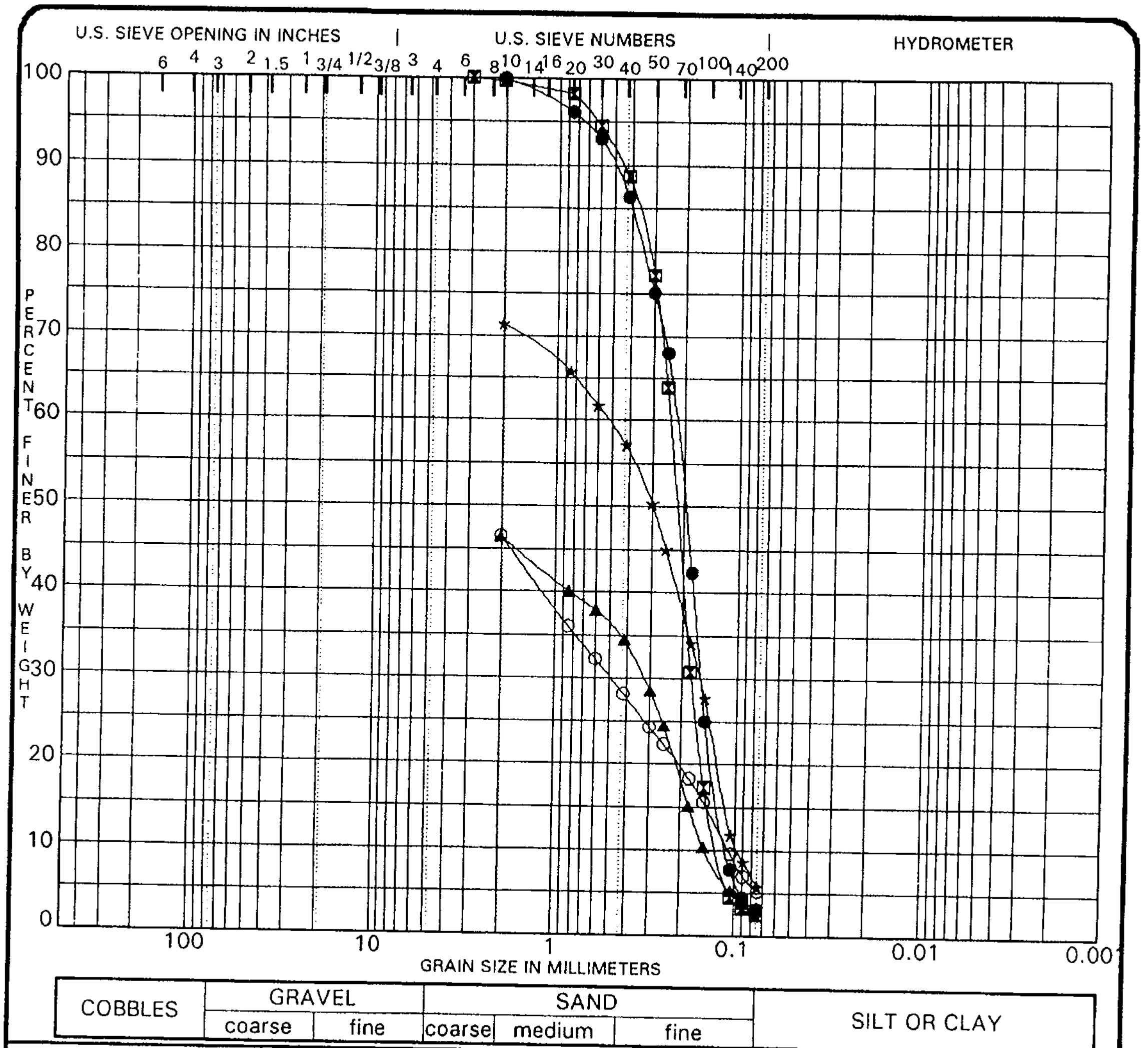

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-9	11.1	POORLY GRADED SAND SP					1.00	2.0
☒	WF-9	13.2	POORLY GRADED SAND SP					1.08	2.0
▲	WF-9	15.1	*SAND W/ SHELL						
★	WF-9	17.1	*SHELL W/ SAND, LIMESTONE					0.51	5.5
○	WF-9	19.0	*SHELL W/ SAND, LIMESTONE						

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-9	11.1	2.00	0.23	0.158	0.1108	0.0	96.8	3.2	
☒	WF-9	13.2	3.00	0.24	0.178	0.1229	0.0	97.5	2.5	
▲	WF-9	15.1			0.325	0.1460			3.0	
★	WF-9	17.1		0.53	0.160	0.0964			5.8	
○	WF-9	19.0			0.493	0.1085			5.3	

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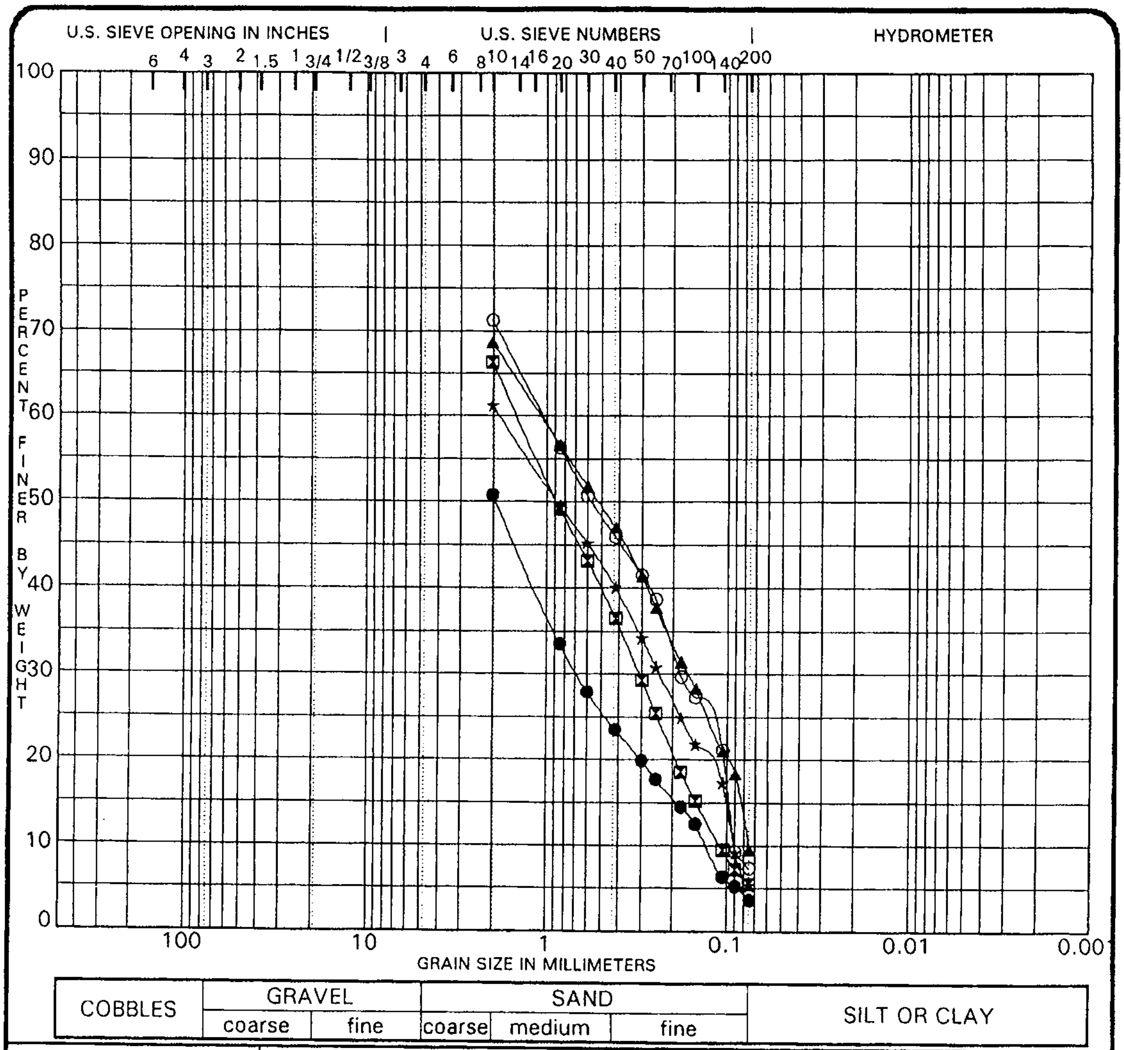

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-9	25.5	*SANDY LIMESTONE W/ SHELL						
☒	WF-9	27.5	*SANDY LIMESTONE W/ SHELL					0.60	13.4
▲	WF-9	34.5	*SILTY LIMESTONE W/ SHELL					0.33	14.3
★	WF-9	36.3	*SILTY LIMESTONE W/ SHELL					0.34	20.0
○	WF-9	38.2	*SILTY LIMESTONE W/ SHELL					0.35	11.6

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-9	25.5			0.684	0.1301			3.7	
☒	WF-9	27.5		1.46	0.310	0.1093			5.6	
▲	WF-9	34.5		1.08	0.166	0.0758			9.5	
★	WF-9	36.3		1.83	0.239	0.0915			5.4	
○	WF-9	38.2		1.05	0.182	0.0909			7.4	

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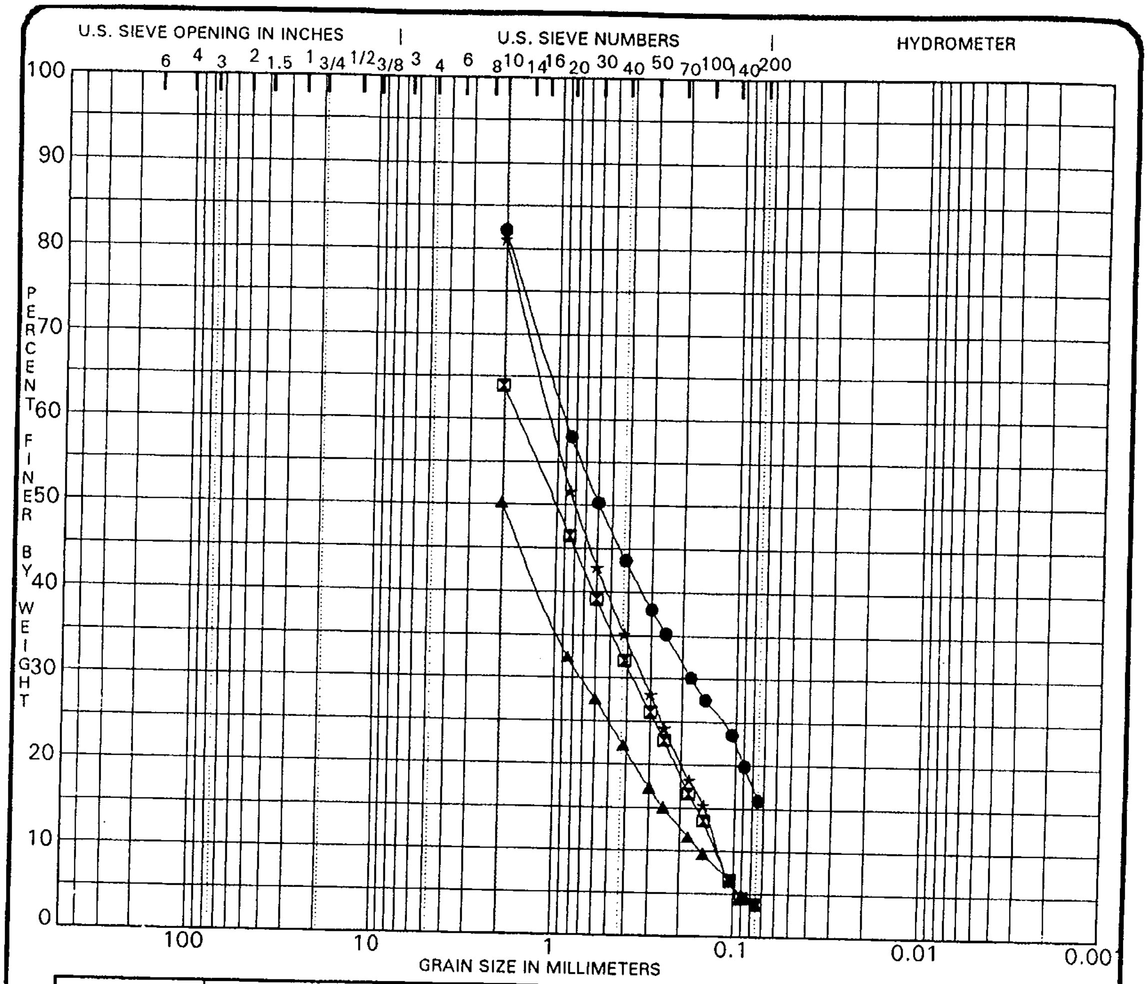

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-9	40.2	*SILTY LIMESTONE W/ SHELL						
⊠	WF-9	42.1	*SILTY LIMESTONE W/ SHELL					0.67	13.1
▲	WF-9	44.1	*LIMESTONE W/ SHELL						
★	WF-9	46.4	*LIMESTONE/SHELL/SILT					0.82	8.9

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-9	40.2		0.91	0.179				15.9	
⊠	WF-9	42.1		1.65	0.374	0.1258			3.9	
▲	WF-9	44.1			0.717	0.1544			3.9	
★	WF-9	46.4		1.09	0.329	0.1217			4.1	

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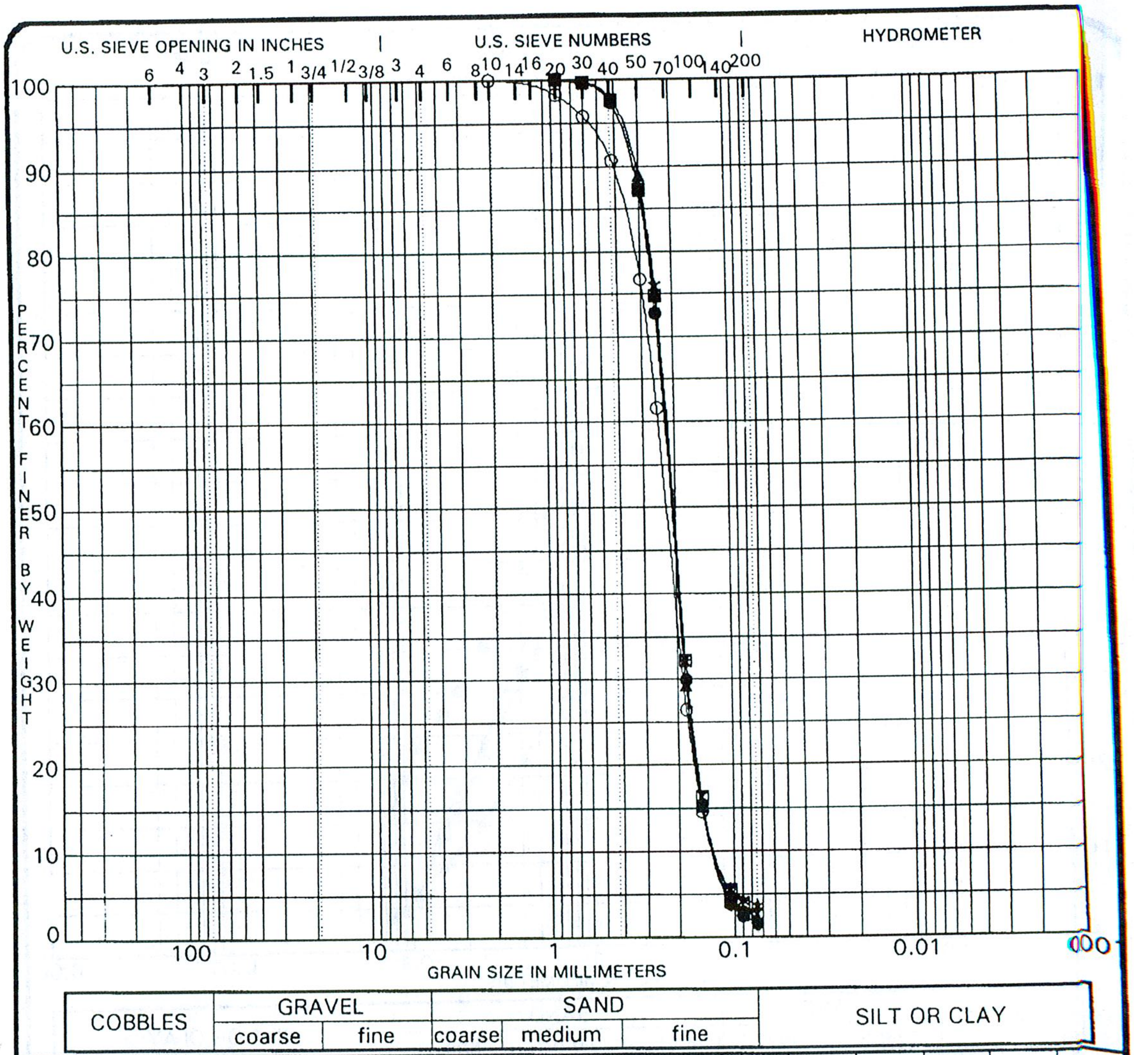

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-10	1.3	POORLY GRADED SAND SP		NP	NP	NP	1.12	1.8
⊠	WF-10	3.3	POORLY GRADED SAND SP		NP	NP	NP	1.13	1.8
▲	WF-10	5.3	POORLY GRADED SAND SP		NP	NP	NP	1.15	1.8
★	WF-10	7.4	POORLY GRADED SAND SP		NP	NP	NP	1.13	1.8
○	WF-10	9.3	POORLY GRADED SAND SP					1.10	1.9

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-10	1.3	0.85	0.23	0.180	0.1274	0.0	98.4	1.6	
⊠	WF-10	3.3	0.85	0.22	0.176	0.1223	0.0	97.3	2.7	
▲	WF-10	5.3	0.85	0.22	0.181	0.1269	0.0	97.7	2.3	
★	WF-10	7.4	0.85	0.22	0.176	0.1233	0.0	96.2	3.8	
○	WF-10	9.3	2.00	0.25	0.186	0.1277	0.0	97.3	2.7	

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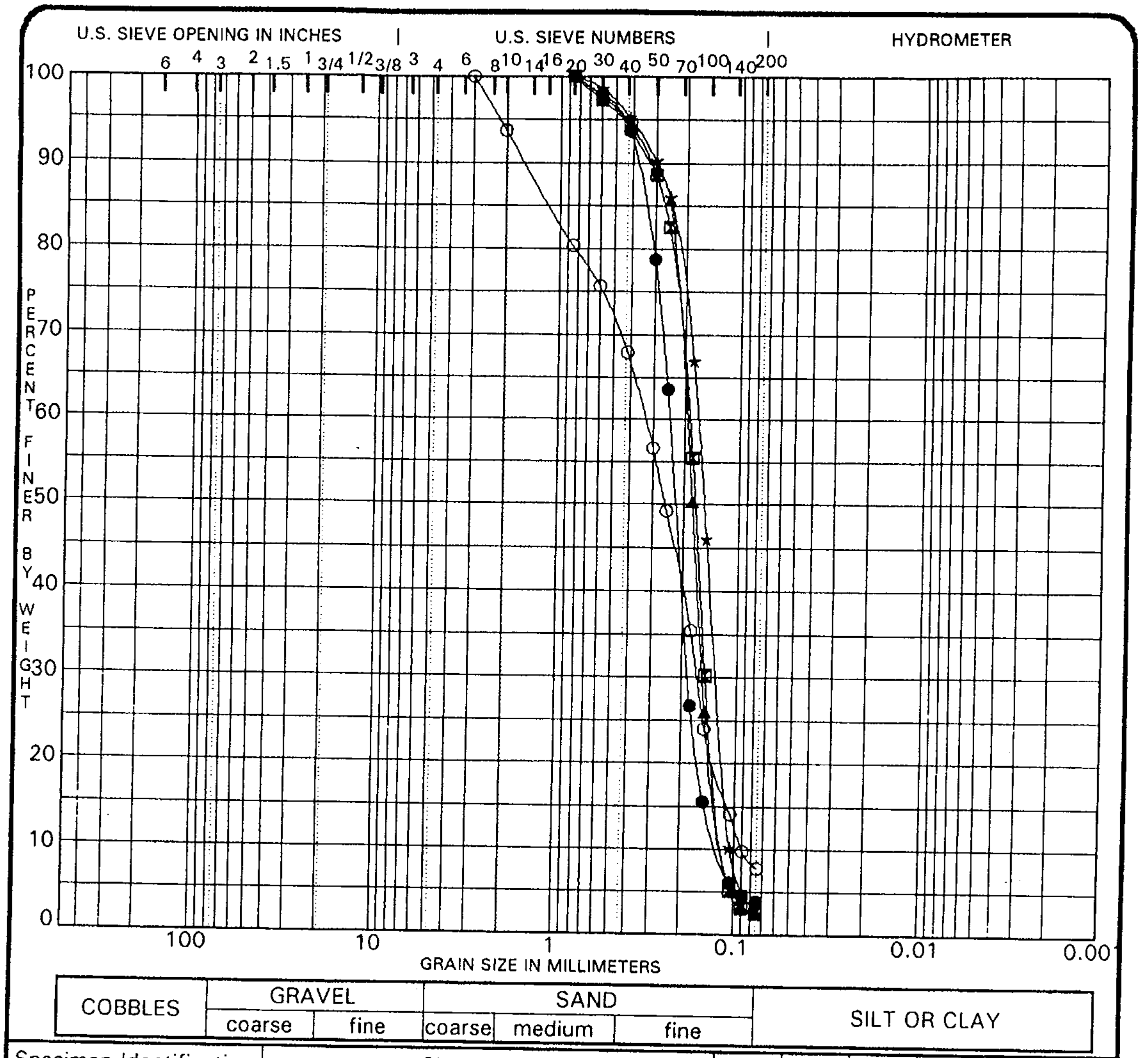
GRADATION CURVES



Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-10	11.2	POORLY GRADED SAND SP		NP	NP	NP	1.16	2.0
⊠	WF-10	13.1	POORLY GRADED SAND SP		NP	NP	NP	1.04	1.7
▲	WF-10	15.2	POORLY GRADED SAND SP		NP	NP	NP	1.07	1.7
★	WF-10	17.3	POORLY GRADED SAND SP		NP	NP	NP	0.92	1.6
○	WF-10	19.0	POORLY GRADED SAND with SILT SP-SM		NP	NP	NP	0.91	3.7

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-10	11.2	0.85	0.24	0.185	0.1224	0.0	96.1	3.9	
⊠	WF-10	13.1	0.85	0.19	0.150	0.1133	0.0	97.5	2.5	
▲	WF-10	15.2	0.85	0.20	0.155	0.1136	0.0	97.4	2.6	
★	WF-10	17.3	0.85	0.17	0.128	0.1053	0.0	97.5	2.5	
○	WF-10	19.0	3.00	0.33	0.165	0.0907	0.0	92.2	7.8	

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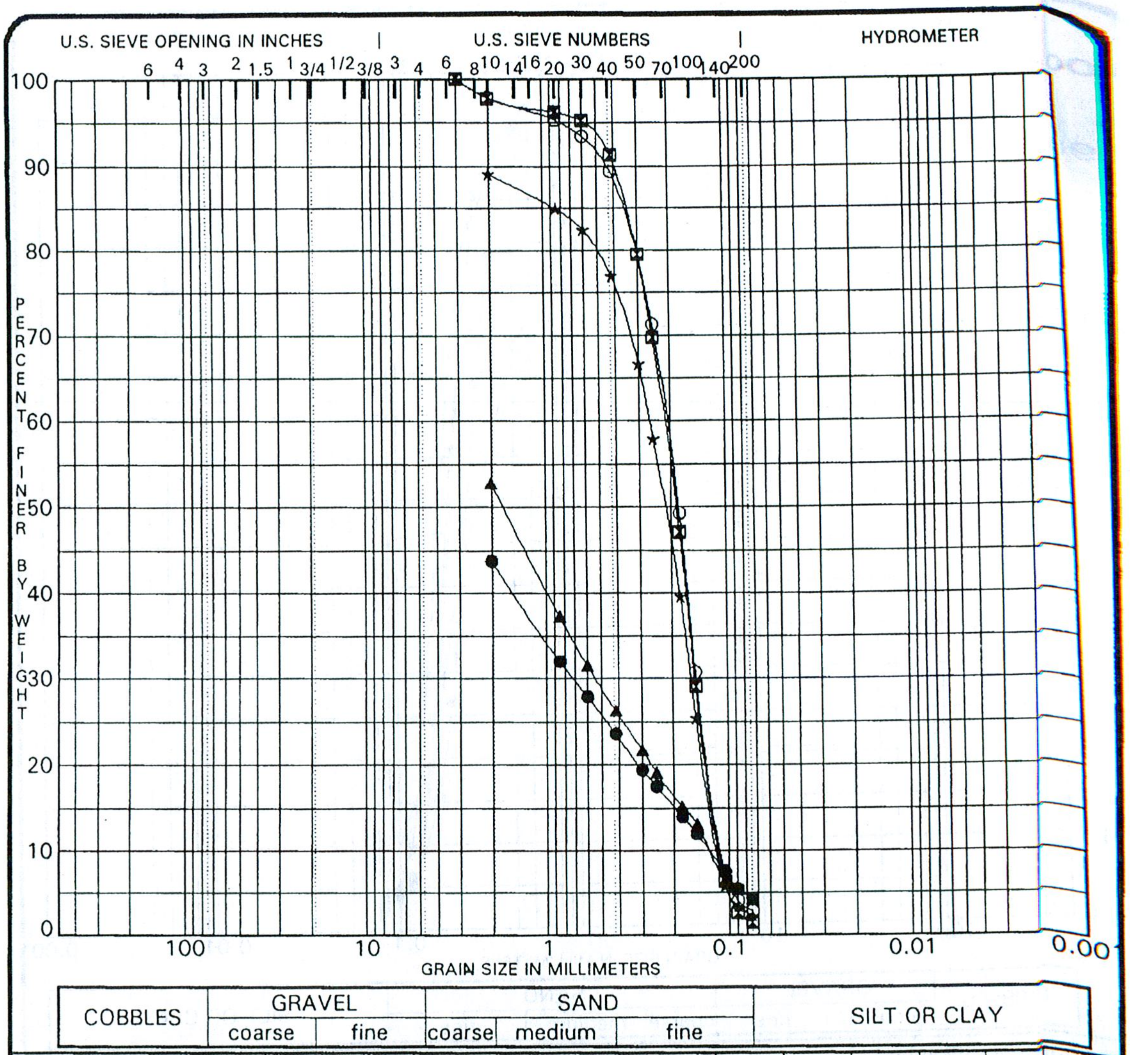

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-10	21.1	*SAND/ SILTY LIMESTONE						
⌧	WF-10	23.2	POORLY GRADED SAND SP		NP	NP	NP	0.94	1.9
▲	WF-10	25.3	*SAND/CORAL/LIMESTONE/SHELL						
★	WF-10	27.2	*SAND W/ SHELL					0.85	2.3
○	WF-10	29.3	POORLY GRADED SAND SP		NP	NP	NP	0.95	1.9

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-10	21.1			0.717	0.1286			4.4	
⌧	WF-10	23.2	3.00	0.22	0.151	0.1120	0.0	98.4	1.6	
▲	WF-10	25.3			0.541	0.1274			4.4	
★	WF-10	27.2		0.26	0.159	0.1142			2.3	
○	WF-10	29.3	3.00	0.21	0.148	0.1099	0.0	97.1	2.9	

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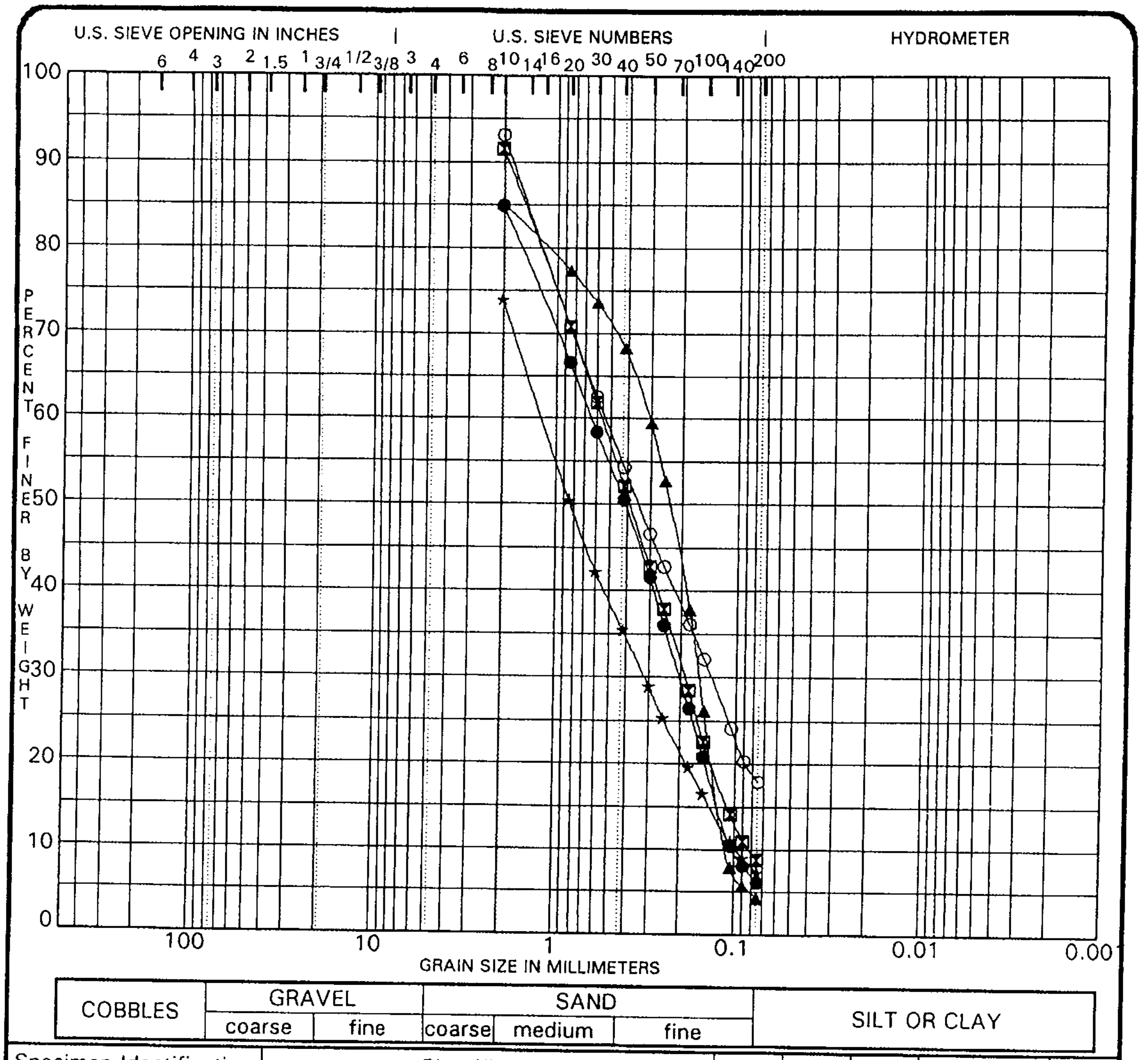

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-10	31.2	*SAND W/ SHELL, LIMESTONE					0.63	6.3
☒	WF-10	33.2	*SAND W/ SHELL, LIMESTONE					0.77	6.8
▲	WF-10	35.4	*SAND W/ SHELL, LIMESTONE					0.75	2.8
★	WF-10	37.3	*LIMESTONE W/ SHELL					0.85	12.3
○	WF-10	39.4	*SAND/LIMESTONE W/ SHELL FRAG.						

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-10	31.2		0.64	0.204	0.1024			6.1	
☒	WF-10	33.2		0.56	0.190	0.0828			8.8	
▲	WF-10	35.4		0.31	0.159	0.1103			4.3	
★	WF-10	37.3		1.21	0.318	0.0981			7.3	
○	WF-10	39.4		0.54	0.137				17.9	

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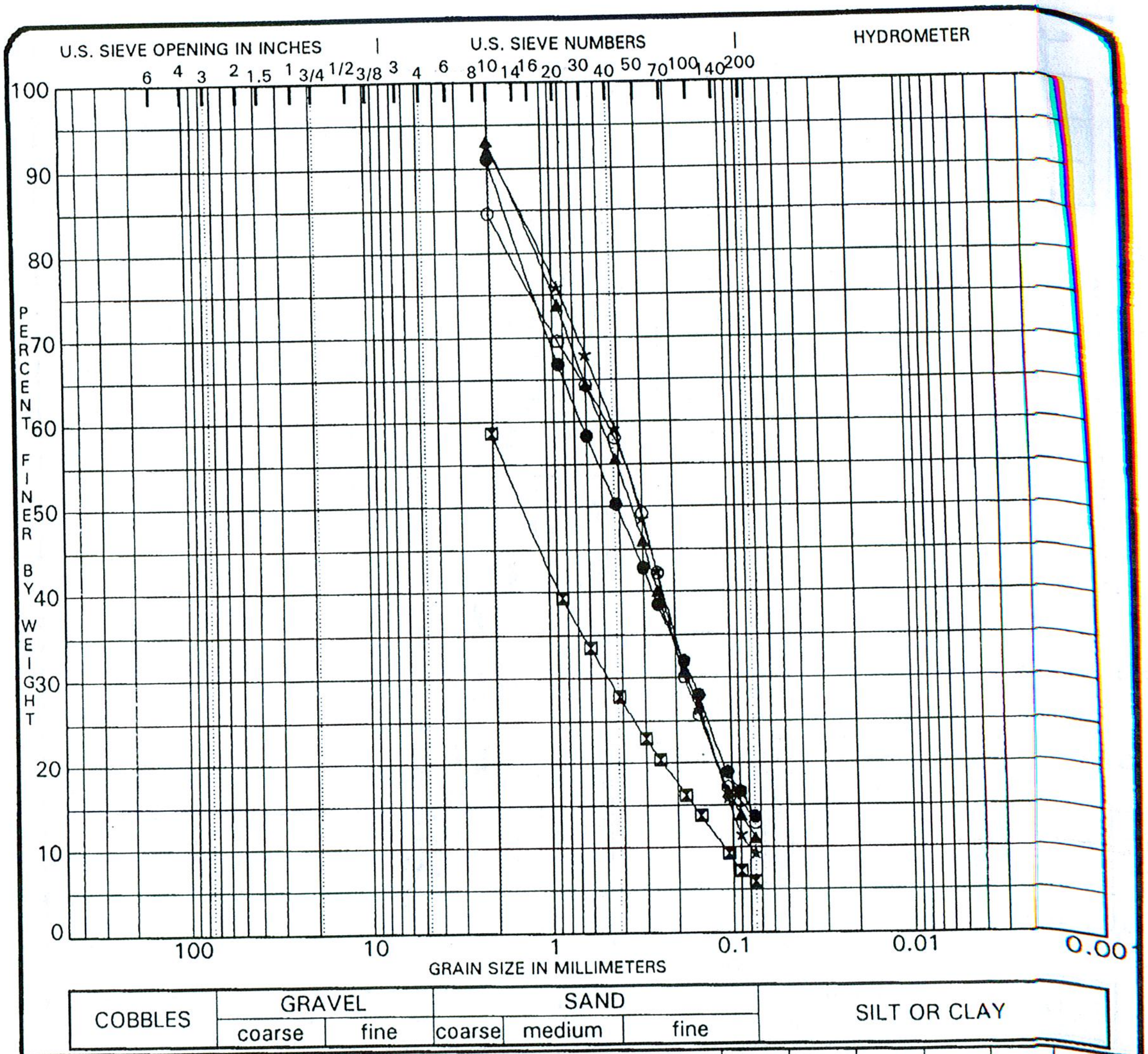

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● WF-10 41.2	*LIMESTONE W/ SHELL						
⊠ WF-10 43.3	*LIMESTONE W/ SHELL						
▲ WF-10 48.1	*SILTY LIMESTONE W/ SHELL, CLAY					0.87	7.2
★ WF-10 52.1	*LIMESTONE W/ SHELL, CLAY					0.84	5.5
○ WF-10 57.2	*LIMESTONE/SHELL/CLAYEY SAND						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● WF-10 41.2		0.64	0.165				13.6	
⊠ WF-10 43.3			0.480	0.1120			6.0	
▲ WF-10 48.1		0.50	0.175				11.1	
★ WF-10 52.1		0.44	0.171	0.0795			9.3	
○ WF-10 57.2		0.47	0.179				12.9	

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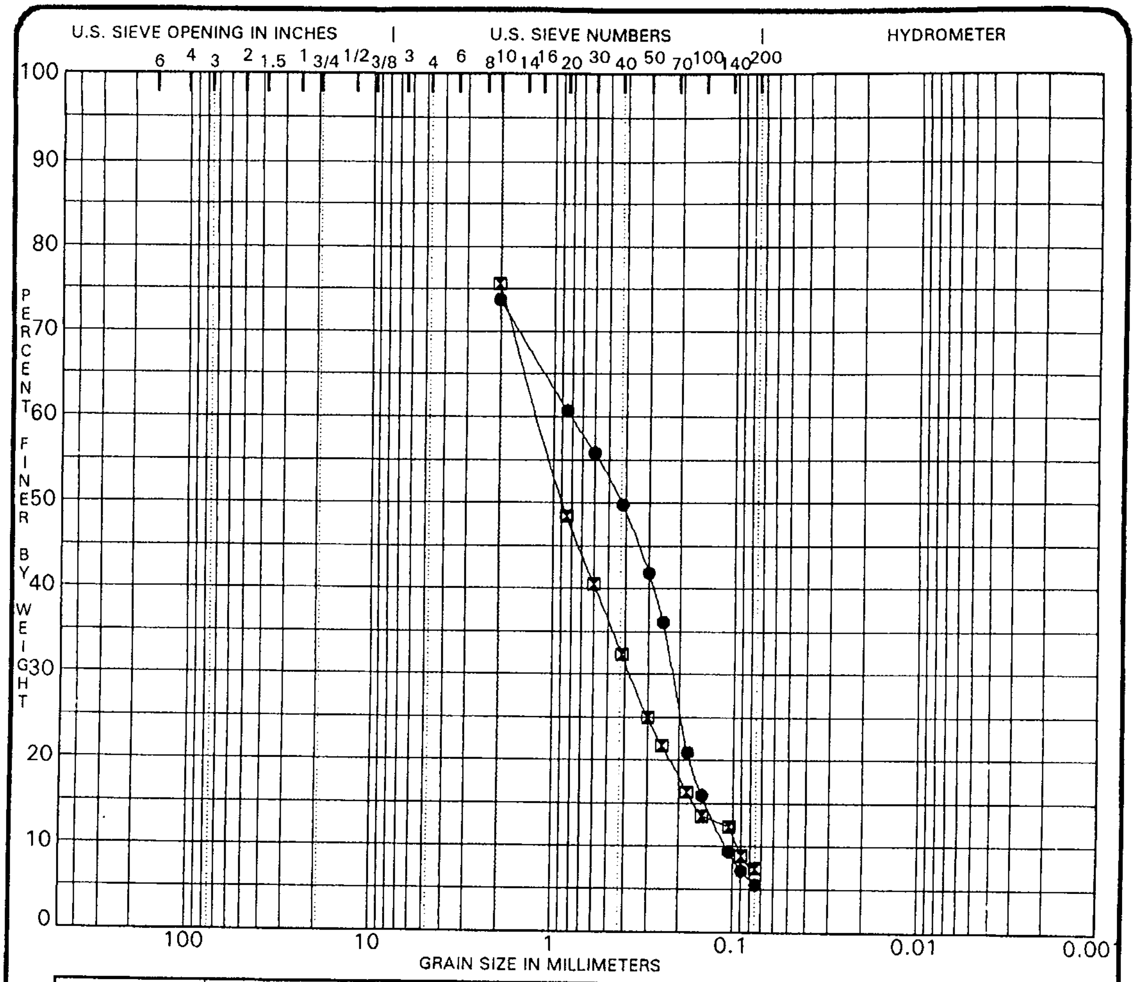

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	WF-10	59.2	*LIMESTONE/SHELL/CLAYEY SAND					0.54	7.4
☒	WF-10	60.8	*LIMESTONE/SAND/SHELL					1.23	12.9

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	WF-10	59.2		0.81	0.219	0.1095			5.6	
☒	WF-10	60.8		1.22	0.378	0.0949			7.5	

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