

SAN JUAN METRO AREA, PUERTO RICO

COASTAL STORM RISK MANAGEMENT STUDY
DRAFT INTEGRATED FEASIBILITY STUDY
AND ENVIRONMENTAL ASSESSMENT

JULY 2020

APPENDIX D: GEOTECHNICAL ANALYSIS



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1 GEOTECHNICAL

1.1 Scope/Background

The San Juan Metro Area Coastal Strom Risk Management Study is currently investigating areas vulnerable to flooding in the Back Bay due to storm surge. The study is currently assessing six (6) planning reaches, as named and abbreviated shown in **Table 1** and **Figure 1**.

The scope of this appendix, prepared by the Geosystems Branch of the Jacksonville District, is to provide Seawall recommendations for the project, to the extent required to calculate benefit cost ratios. This appendix shall not be used for final design.

Study Areas	Study Area Abbreviation		
West San Juan Bay Area 1a	WSJB 1a		
West San Juan Bay Area 1b	WSJB 1b		
West San Juan Bay Area 2	WSJB 2		
West San Juan Bay Area 3	WSJB 3		
West San Juan Bay Area 4	WSJB 4		
Condado Lagoon	CL-1		

Table 1: Study Area.





1.2 Geology

1.2.1 Regional Geology

Puerto Rico is a volcanic island located within the boundaries of the Caribbean and North American tectonic plates. The island is predominantly composed of volcanic and plutonic rock of Jurassic to Eocene age overlain by limestone and other sedimentary deposits of Oligocene to recent age. Since the island is wedged between two active tectonic plates seismic activity is prevalent resulting in earth quakes, tsunamis and landslides.

1.2.2 Local Geology

The study area is located within the shallow marine shelf that surrounds the Commonwealth of Puerto Rico. Sediments of Holocene to and Pleistocene overlie limestone of Tertiary age. The limestone is found at depths varying from 25 feet to more than 100 feet in depth. Periods of fluctuating sea levels occurred during the glacial periods at the end of the Neogene period exposing the limestone allowing for weathering and erosion to occur. Shallow lagoons formed in depressions along the coast and sediments including silt and clay were deposited on the bottom of the Bahia de San Juan and Condado Lagoon. To date, fine gained carbonate and siliciclastic sediments are transported from upland areas by streams and are deposited into the Lagoons.

1.3 Existing Geotechnical Information

1.3.1 **Existing Borings**

San Juan Harbor is located within the Bahia de San Juan. The outline of the maintained Harbor Channels is shown Figure 2. Numerous borings were drilled within the San Juan harbor channel for deepening and maintenance dredging over the years. Those existing borings provide valuable information for this project and borings which are very close to the project site or borings which gave valuable information about the top elevation of rock were selected for inclusion in this project. The selected borings are listed in Table 2 and depicted in Figure 2. Boring logs are attached in Paragraph 1.10 Boring Logs.

State Plane, PR VI NAD27 Designation Χ Υ CB-AT90-3 612128 218410 CB-AT90-6 611895 217028 CB-AT90-12 612522 216867 CB-AC91-12 612366 219471 CB-AC91-16 612229 221369 CB-AC91-20 612116 223255 CB-ATC94-3 611803 217893 CB-ATC94-5 612260 219902 CB-ATC94-7 612215 222150 CB-PN-16

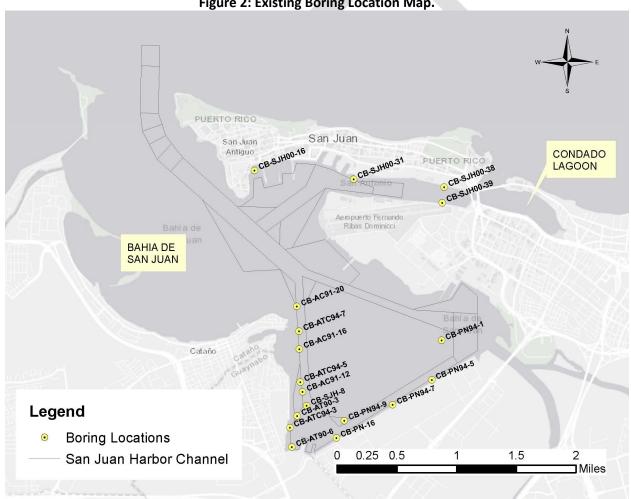
Table 2: Boring Locations.

613864

217441

Docionation	State Plane, PR VI NAD27			
Designation	X	Υ		
CB-PN94-1	618513	221752		
CB-PN94-5	618084	220007		
CB-PN94-7	616351	218905		
CB-PN94-9	614213	218205		
CB-SJH00-16	610241	229274		
CB-SJH00-31	614621	228881		
CB-SJH00-38	618629	228528		
CB-SJH00-39	618544	227844		
CB-SJH-8	612547	218864		

Figure 2: Existing Boring Location Map.



1.3.2 Laboratory Testing and Materials Encountered

Laboratory testing is available for some of the borings and is summarized in **Table 3**. The lab data sheets are attached in **Paragraph 1.11 Laboratory Testing.** For the most part the soil profile consists of soft clay over clays of varying stiffness, underlain by limestone of varying depths as shown in **Table 4** and depicted in **Figure 4** and **Figure 5**. Some of the borings encountered silty and clayey sands with intermittent limestone layers (CB-AC91-20), or layers of loose sand (CB-PN94-7, CB-SJH00-31, CB-SJH00-39). Strength testing of the rock is not available. However it is known that hard rock is present at the mouth of the Bahia de San Juan (near El Morrow) which needed to be blasted during the last harbor deepening. Boring CB-SJH00-39 which is closest to Condado Lagoon is located in shallow water and encountered a peat layer from 14.6 to 27.1 feet MLW (**Figure 5**).

Table 3: Laboratory Testing.

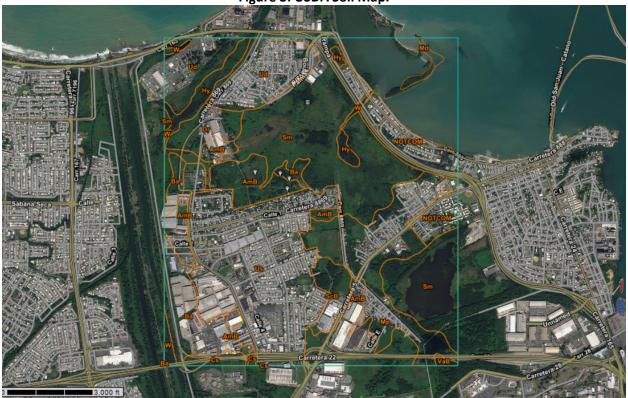
Boring Designation	Sample Designation	USCS	GS
CB-AT90-3	2	МН	2.67
CB-AT90-3	4	СН	2.70
CB-AT90-6	3	МН	2.68
CB-AT90-6	9	GP-GM*	
CB-AT90-12	2	МН	2.69
CB-AT90-12	9	СН	2.73
CB-AC91-12	2	МН	2.71
CB-AC91-16	1	МН	
CB-AC91-16	5	СН	2.65
CB-AC91-20	4	SM*	
CB-AC91-20	7	SC*	
CB-ATC94-5	5	СН	2.67
CB-ATC94-7	1	СН	

USCS: Unified Soil Classification System; Gs: specific gravity *Limestone fragments and coral fragments

1.3.3 Existing Soil Information

For the inland portions of WSJB 1, a USDA soil map was obtained. These maps are generally accurate for planning level assessments to a depth of about 80 inches. The soil map is shown below in **Figure 3**.

Figure 3: USDA Soil Map.



Legend				
Symbol	Soil			
AmB	Almirante Clay			
Ва	Bajura Clay			
Coloso Silty Clay Loam	Cs			
Durados Sandy Loam	Dr			
Made Land	Md			
Martin Pena Muck	Mp			
Sabana Seca Clay	ScB			
Saladar Muck	Sm			
Urban Land- Durados	Ud			
Complex	Ou			
Urban Land- Sabana	Us			
Seca Complex	U3			
Vega Alta Clay Loam	VaB			

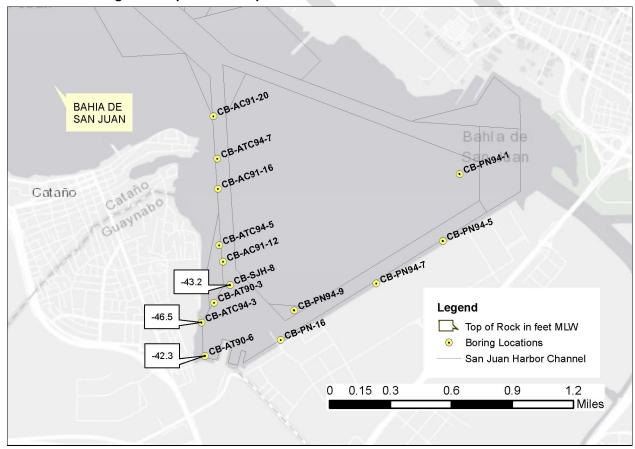
1.3.4 Top of Rock Elevations

Table 4 summarizes top of rock elevations found in the existing borings. **Figure 4** and **Figure 5** show known top of rock elevation locations throughout the harbor.

Table 4: Top of Rock Elevations.

Boring	Top of Rock Elevation (feet MLW)	Location		
CB-AT90-6	-42.3*	South Western Part of Bahia de		
CB-ATC94-3	-46.5			
CB-SJH-8	-43.2	San Juan		
CB-SJH00-16	-25.3	Northern Part of Bahia de San		
CB-SJH00-31	-35.6	Juan (San Antonio Channel)		
shown as limestone gravel and with higher blow counts on log				

Figure 4: Top of Rock Map 1: South Western Part of Bahia de San Juan



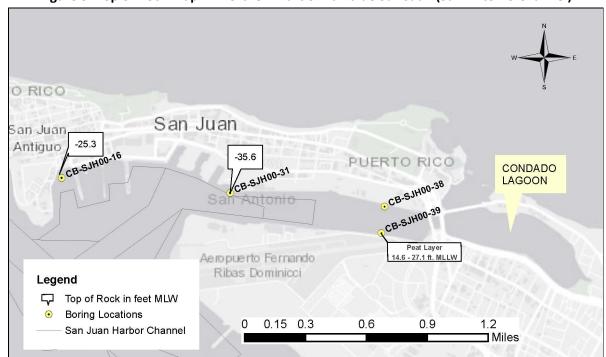


Figure 5: Top of Rock Map 2: Northern Part of Bahia de San Juan (San Antonio Channel)

1.4 Coastal Engineering Information

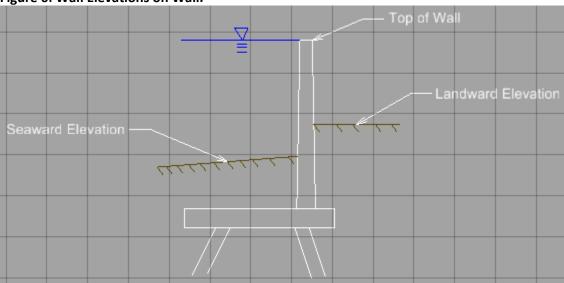
The Coastal Engineer assigned to the project provided top of wall elevations, average seaward elevation, and average landward elevation. The information provided is summarized in *Table 5* below. **Figure 6** below shows who the elevations are positioned on a typical seawall.

Top of Wall Average Average Area Seaward* Elevation* Landward* WSJB-1B, 2, and 4 -3 8 4 WSJB-3 -3.86 17.14 3.08 2.38 CL 1 -6.38 8

Table 5: Wall Elevations.

^{*}All elevations are in PRVD02 Datum

Figure 6: Wall Elevations on Wall.



1.5 Wall Alternatives Analyzed

1.5.1 Cantilevered Sheet Pile Wall

Cantilevered Sheet Pile Walls are advantageous, in comparison with other wall types, due to shorter construction durations and lower construction costs. In general if the top of rock elevation was greater than two (2) to three (3) times the maximum retained height (top of wall elevation minus average seaward elevation), it is assumed that a cantilevered sheet pile would be feasible design alternative. Cantilevered Sheet Pile Walls resist the active lateral earth pressures, hydrostatic pressure, and other loadings with passive earth pressure from the soils it is embedded in. If the sheet pile can be embedded in two (2) to three (3) times the maximum retained height into soil, enough passive earth pressure should be present to adequately resist the active and hydrostatic pressures. Limestone can, in theory, provide large amounts of passive resistance, but the pile will need to have a larger steel cross sectional area, than is usually present in sheet piles, to resist being driven into the rock. Therefore, if rock is shallower than two (2) to three (3) times the maximum retained height, a cantilevered sheet pile wall is not feasible.

1.5.2 King Pile Wall

King Pile Walls offer larger section moduli, moments of inertia, and cross sectional areas required for larger retained heights and situations in which the top of rock is not deep enough for a cantilevered sheet pile wall. King Pile Walls resist loadings using the same mechanism as the Cantilevered Sheet Pile Walls, passive earth pressure. The primary difference is that King Pile Walls are a combination of steel sheet piles and either pipe piles or W-sections. This provides the opportunity to provide a larger section modulus, moment of inertia, and steel cross sectional area. The larger steel cross sectional area would allow this type of wall to be driven into the rock. This has potential to be used in CL 1 due to high top of

rock elevation. A potential setback for this alternative is the availability of wall sections on the island. All steel required for the project will most likely be shipped from the continental United States, making the selection of common sections much more critical for both construction duration and cost. This alternative was analyzed using EM 1110-2-2504 Design of Sheet Pile Walls.

1.5.3 T-Type

T-Type Walls can be founded on soil or piles and consist of a concrete stem and footing. The main mechanism to resisting lateral earth or water pressure is the wall's weight and the weight of material(s) above the heel of the wall. Additionally, the wall can be supported on piles to resist the weight and eccentricity of the wall and sliding forces acting along the wall. Borings in the area indicate that soft clays could be present below the footings; this leads us to believe that the wall will need to be supported on piles. Piles can be driven straight of at a batter. Given the differing load scenarios, such as maximum flood were the water elevation at the front of the wall is very high or regular operations were the water elevation is at the normal pool, piles battered in opposite directions are recommended. See Figure 7 for a typical T-Type Wall layout. T-Type Walls can be designed to use common steel sections and materials which may improve construction duration and costs in comparison with King Pile Walls due to other projects throughout the island importing similar materials from the continental United States. This alternative was analyzed using EM 1110-2-2502 Retaining and Flood Walls.

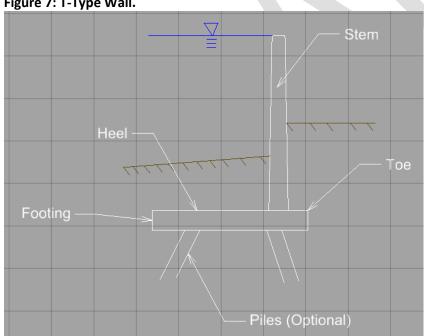


Figure 7: T-Type Wall.

1.6 Wall Alternatives by Reach

1.6.1 WSJB 1B, WSJB 2, and WSJB 4

The maximum retained height (Top of Wall minus Average Seaward) of these areas is 11 feet. With the top of rock elevation estimated to range from -42.3 to -46.5 MLW, this leaves nearly 4 times the retained height for sheet piles. It is anticipated that a Cantilevered Sheet Pile would be feasible in this location.

An alternative of a small T-Type Wall was desired by the Project Development Team (PDT). The results of the analyses are displayed in **Figure 9** and **Table 6** below.

The preliminary wall started with Figure 8.2 of Das's textbook *Principles of Foundation Engineering 6th Edition* (*Figure 8* of this appendix), which gives dimensions in terms of retained height. This was then checked for sliding and overturning stability, using the methods as outlined in EM 1110-2-2502. The loads considered were Hydrostatic from the storm surge, lateral earth, and uplift along the footing. Knowing that the area generally contains soft clays beneath the wall, piles driven into rock where chosen to meet bearing capacity requirements of the wall. For this the methods as outlined in EM 1110-2-2906 where used to calculate the Tension and Compression capacity of the piles and determine the required pile spacing for the wall. It was assumed that the pile would be driven 7.5 feet into rock. Given the unknown strength of the rock, further refinement will be required in later stages of the study.

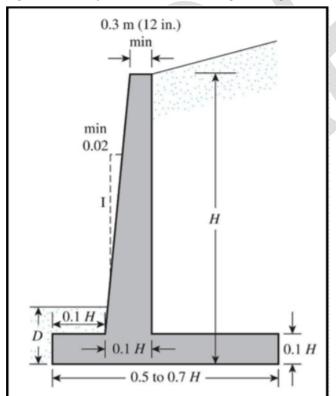
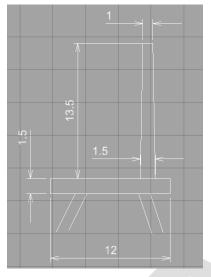


Figure 8: Principles of Foundation Engineering 6th Edition

A potential failure mode of retaining walls is global stability. This is typically a deep seated failure that could result in failure of the wall. As a result, the global stability of the wall was also checked assuming that the wall is underlain by a soft clay with a cohesion of 500 psf, based on typical values given by Das and Illinois Department of Transportation. The results of which can be found in *Table 7*. After borings are collected, global stability will be reevaluated with more accurate shear strength parameters, as this the most important soil property for global stability analyses.

Figure 9: T-Type Wall Dimensions.



^{*}All dimensions are in feet

Table 6: Pile Demand vs Capacity Results.

Dila Cassing	Required	Required Axial	Tension Capacity	Axial Capacity
Pile Spacing	Tension	Compression	(7.5' into Rock)	(7.5' into rock)
5'	11	115.2	18.3	246
7.5′	16.5	172.7	18.3	246
10'	22	230.3	18.3	246

Table 6 shows that the piles could handle the loads from either 5 foot or 7.5 foot spacing, we recommend using the 7.5 foot spacing for cost preparation purposes. The pile length to be used for cost purposes should be 55 feet, except for WSJB 4, for WSJB 4 the pile length should be 60 feet.

Table 7: Global Stability Analyses.

Event	Factor of Safety
Storm Surge	2.5
Low Tide	1.5

^{**}Requires two HP14x89 piles

Given the Low Tide Factor of Safety is close to the Criteria of 1.5, special attention will need to be paid to the Global Stability Analysis once additional borings are acquired.

1.6.2 WSJB 3

The maximum retained height (Top of Wall minus Average Seaward) is 21 feet. Given the top of rock is estimated to be at Elevation -46.5, this leaves slightly less than two times the retained height for a cantilevered sheet pile wall. The PDT decided to explore a T-Type Wall for this area, mostly due to the reasons given in 1.5 Wall Alternatives Analyzed. The results of the analyses are displayed in Figure 10 and Table 8 below.

The preliminary wall started with Figure 8.2 of Das's textbook *Principles of Foundation Engineering 6th Edition*, which gives dimensions in terms of retained height. This was then checked for sliding and overturning stability, using the methods as outlined in EM 1110-2-2502. The loads considered were Hydrostatic from the storm surge, lateral earth, and uplift along the footing. Knowing that the area generally contains soft clays beneath the wall, piles driven into rock where chosen to meet bearing capacity requirements of the wall. For this the methods as outlined in EM 1110-2-2906 where used to calculate the Tension and Compression capacity of the piles and determine the required pile spacing for the wall. It was assumed that the pile would be driven 10 feet into rock. Given the unknown strength of the rock, further refinement will be required in later stages of the study.

The global stability of the wall was also checked assuming that the wall is underlain by a soft clay with a cohesion of 500 psf, based on typical values given by Das and Illinois Department of Transportation. The results of which can be found in **Table 9**.

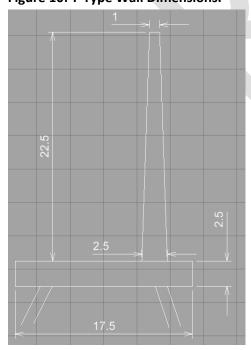


Figure 10: T-Type Wall Dimensions.

Table 8: Pile Demand vs Capacity Results.

Pile Spacing	Design Sliding Force	Weight	Tension	Axial Compression
5′	100.15	155	23.3	224
7.5'	150.23	232.5	34.9	336
10'	200.3	310	46.5	448

Table 8 Shows that the piles could handle the loads from a 5-foot spacing. The pile length to be used for cost purposes is recommended to be 55 feet.

Table 9: Global Stability Analyses.

Event	Factor of Safety	
Storm Surge	3.6	
Low Tide	1.5	

Given the Low Tide Factor of Safety is close to the Criteria of 1.5, special attention will need to be paid to the Global Stability once additional borings are acquired.

1.6.3 CL 1

The area of the project provides a unique challenge because the estimated top of rock is higher than the other areas. Boring CB-SJH00-31 shows the top of rock at elevation -35.6. While a T-Type Wall could be designed for this area, and may be the direction the PDT goes later in the study, the wall's close proximity to hotels makes a king pile desirable due to the wall having a narrower cross section than the T-Type Wall. For costs estimation purposes a Nucor King Pile Section was selected. It is noted that in final design this wall manufacturer cannot be specified because of the proprietary shape. As stated in previous sections, King Piles do have the risk of not being readily available on the island. For this preliminary analysis, EM 1110-2-2504 was consulted with only the maximum storm surge event as being the primary consideration. In later phases of the study more design cases will be considered. The results of the analysis (See **Section 11** of this Appendix) shows that the wall's tip elevation will have to be around -42 PRVD02 and that a Nucor PAZ42/NZ19 King Pile should be analyzed for cost purposes.

1.7 Future Refinements

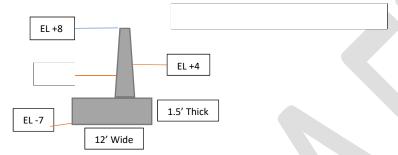
Currently, Jacksonville District's EN-GG Section is in the process of acquiring borings along the alignment of the walls. These will be SPT borings that will give better shear strength parameters. Lab tests will also be gathered from these borings. The scope of work includes gathering gradations on granular materials and pocket penetrometer readings on cohesive samples. More critically, the top of rock will be more accurately defined and since the borings will be taken to refusal, we will have a better understanding about the shear strength of the bedrock.

Other refinements will include, a more final selection of wall type which will allow for the analysis of other design events, such as low tide or seismic. Liquefaction screening from the parameters provided in the new borings will also be done. Future work will utilize the Army Corps CASE programs *CI-WALL* and *CWALSHT* and or locating other computer programs capable of analyzing the multiple scenarios given. It should be noted that *CWALSHT* will not run scenarios where the active side of soil is lower in elevation than the passive side of soil, which is the case for the storm event.

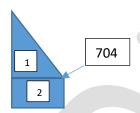
1.8 Wall Calculations per Reach

1.8.1 WSJB 1B, WSJB 2, and WSJB 4 T-Type Wall Calculations

Evaluate Storm Surge Case as shown below



Loads acting on wall: Hydrostatic, Lateral Earth, and Uplift



Max Hydrostatic Pressure= 8'-(-3)'X64 pcf=704 psf

Hydrostatic Force 1= ½ 704(11)=3.9 kips/ft Hydrostatic Force 2=704(4)=2.8 kips/ft

Max Soil Pressure=(120 pcf-64 pcf)*4 (-3-(-7))*1/3 (Ka assuming a phi of 30 degrees)=74.7 psf Soil Force= $\frac{1}{2}(74.7*4)=0.15 \text{ kips/ft}$

Uplift

Max Pressure (at heel)= (8'-(4'*11')/23')*64=390 psf

Where: 8 feet is top of water elevation, 4 feet is difference in water head along wall, 11 feet is depth of foundation landward side, and 23 is length of total drainage path

Min Pressure (at toe)=(4'-(16'*4')/23')*64=77.9 psf

Where: 4 feet is top of water elevation, 16 feet is depth of foundation seaward side plus footing width. 4 feet is difference in water head along wall, and 23 is length of drainage path

Uplift Force= 1/2(390+77.9)*12=2.8 kips/ft

Sliding Force=Hydrostatic Force+ Earth Force=3.9+2.8+0.15=6.85 kip/ft.

Apply Factor of Safety of 1.5 (per Table 4-3 of EM 1110-2-2502) to get design Sliding Force.

Design Sliding Force=6.85*1.5=10.3 kips/ft

Overturning Moment=Moment from Hydrostatic Force+ Moment from Earth Load+ Moment from Uplift Overturning Moment=3.9*7.67+2.8*2+0.15*1.33+2.8*4.7=48.9 kft/ft

Area	Unit Weight	Sq Ft	Total Weight	Arm (from	Moment
				Toe)	
Stem	145	16.88	2447.6	2.25	5507.1
Footing	145	18	2610	6	15660
Water/Heel	64	99	6336	7.5	47520
Soil/Heel	56	22.5	1260	7.5	9450
Soil/Toe	56	14.25	798	0.75	598.5
Total			13.5 kip/ft		78.7 kft/ft

78.7 (Resisting Moments)/ 48.9 (Overturning Moments)=1.6>1.5 Ok

$$\bar{x} = \frac{78.7 - 48.9}{13.5} = 2.21'$$

$$e = \frac{B}{2} - \bar{x} = 6 - 2.21 = 3.79$$

B/6=2<3.67 No Good! Need Tension from Seaward Pile

For e to be less than or equal to 2, \bar{x} must equal 4.

$$\bar{x} = \frac{78.7 - 48.9 + 10T}{13.5} = 4$$
 this implies T=2.4 kips/ft

Pile Spacing	Design Sliding Force	Weight	Tension	Axial Compression
5'	51.5	70	12	115.2
7.5′	77.25	105	18	172.7
10'	103	140	24	230.3

For a pile driven 7.5' into rock

$$q_p = q_u (N_{\varphi} + 1) \text{ Eq } 11.59 \text{ Das }$$

Assume q_u (unconfined compressive strength) is 1000 lb/sq in (from near by projects)

$$N_{\varphi} = tan^2 \left(45 + \frac{\varphi}{2} \right)$$

Assuming a phi angle of 25 degrees

$$q_p = 144 \, ksf \left(tan^2 \left(45 + \frac{25}{2}\right) + 1\right) = 498.8 \, ksf$$

$$Q_p = \frac{q_p * a_p}{FS} = \frac{498.8 \, ksf * 1.36 \, sq \, ft}{3} = 226 \, kip$$

From EM 1110-2-2906 Design of Pile Foundations

$$f_s = \sigma'_v * (K_c or K_t) * \tan(\delta) + \alpha c$$

$$\sigma_{v}' = \gamma D_{c} = 56 \ pcf * 20 * 1.17' = 1310.4 \ psf$$

Assuming a cohesion of 2500 psf (conservative for limestone) $\alpha c=0.5*2500=1250~psf$ $\delta=0.83*\varphi=0.83*25=20.75$

$$f_{s(tension)} = 0.9 * 1310.4 * (tan(20.75)) + 1250 = 1571.9 \, psf$$

$$f_{s(compression)} = 1.0 * 1310.4 * (tan(20.75)) + 1250 = 1746.5 \, psf$$

$$Q_S = \frac{f_S * a_S}{FS}$$

$$Q_{s(tension)} = \frac{1571.9 * 35}{3} = 18.3 \ k$$

$$Q_{s(compression)} = \frac{1746.5 * 35}{3} = 20.3 k$$

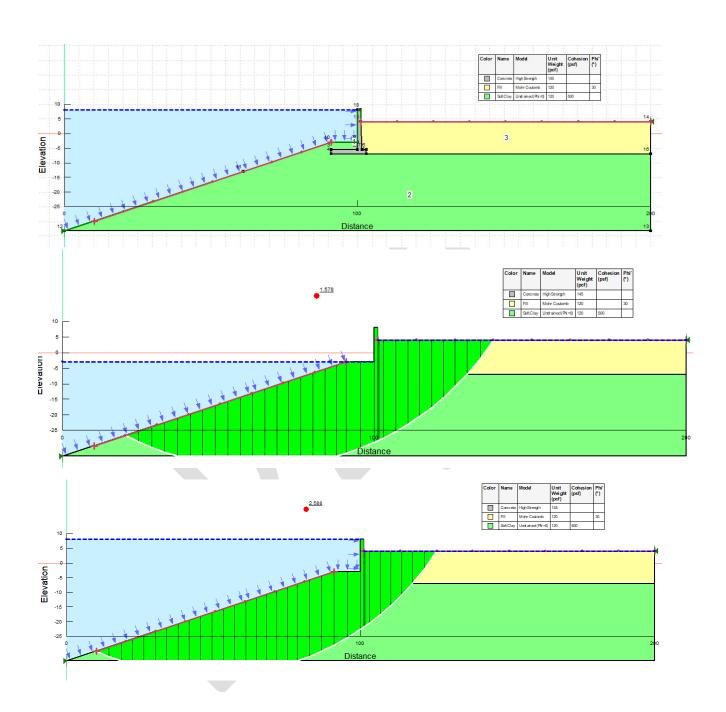
Total Axial Capacity=226+20.3=246 kips

Total Tension Capacity=18.3 kips

Capacities are adequate for 7.5 foot spacing.

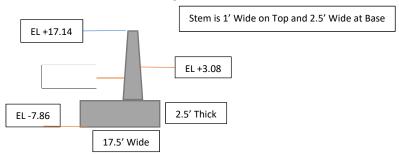
Global Stability Checks

The wall was placed into a Slope/W Model to check Global Stability both during the Storm Surge and at Low Tide, pictures of outputs are placed below. It should be noted shear strength parameters are assumed based on available boring information and will need refinement later, as more geotechnical data is acquired.

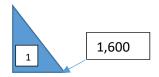


1.8.2 WSJB 3 T-Type Wall Calculations

Evaluate Storm Surge Case as shown below



Loads acting on wall: Hydrostatic, Lateral Earth, and Uplift



Max Hydrostatic Pressure= 17.14'-(-7.86)'X64 pcf=1,600 psf

Hydrostatic Force 1= ½ 1600(25)=20 kips/ft

Max Soil Pressure=(120 pcf-64 pcf)*4 (-3-(-7))*1/3 (Ka assuming a phi of 30 degrees)=74.7 psf Soil Force= $\frac{1}{2}(74.7*4)=0.15 \text{ kips/ft}$

Uplift

Max Pressure (at heel)= (17.14'-(14'*11')/28.5')*64=751 psf

Where: 17.14 feet is top of water elevation, 14 feet is difference in head along the wall, 11 feet is depth of foundation landward side, and 28.5 is length of drainage path

Min Pressure (at toe)=(3'-(14'*21.5')/28.5')*64=-483 psf.

Where: 8 feet is top of water elevation, 21.5 feet is depth of foundation seaward side plus footing width, 14 feet is difference in head along the wall, and 28.5 is length of drainage path

Uplift Force= (751+-483)*17.5=4.7 kips/ft

Sliding Force=Hydrostatic Force+ Earth Force=20+0.15=20.15 kip/ft
Apply Factor of Safety of 1.5 (per Table 4-3 of EM 1110-2-2502) to get design Sliding Force
Design Sliding Force=20.15*1.5=30.23 kips/ft

Overturning Moment=Moment from Hydrostatic Force+ Moment from Earth Load+ Moment from Uplift Overturning Moment=20*8.33+0.15*1.33+4.7*8.75=207.9 kft/ft

Area	Unit Weight	Sq Ft	Total Weight	Arm (from	Moment
				Toe)	
Stem	145	39.4	5713	3.75	21423.75
Footing	145	43.75	6343.75	8.75	55507.8
Water/Heel	64	262.5	16800	11.25	189000
Soil/Heel	56	18.75	1050	11.25	11812.5
Soil/Toe	56	24.1	1181.6	1.25	1477
	Total		31 k/ft		279.2 kft/ft

Passive Resistance Landward Side

Passive Pressure= 11 ft*56 pcf* 3 (Kp)=1848 psf

Passive Force- ½*1848 psf*11 ft=10.2 kip/ft

Passive Moment= 10.2*11/3=37.4 kipft/ft

Design Lateral Force Taken by Piles: 30.23 kips/ft-10.2 kip/ft=20.03 kip/ft

279.2+37.4 (Resisting Moments)/ 207.9 (Overturning Moments)= 1.52>1.5 Ok

$$\bar{x} = \frac{316.6 - 207.9}{31} = 3.51'$$

$$e = \frac{B}{2} - \bar{x} = 8.75 - 3.51 = 5.24$$

B/6=2.92<5.24 No Good! Need Tension from Seaward Pile.

For e to be less than or equal to 2.92, \bar{x} must equal 5.83.

$$\bar{x} = \frac{316.6 - 207.9 + 15.5T}{31} = 5.83$$
 this implies T=4.65 kips/ft

Pile Spacing	Design Sliding Force	Weight	Tension	Axial Compression
5'	100.15	155	23.3	224
7.5′	150.23	232.5	34.9	336
10'	200.3	310	46.5	448

For a pile driven 10' into rock

$$q_p=q_u(\textit{N}_{\varphi}+1)$$
 Eq 11.59 Das

Assume q_u (unconfined compressive strength) is 1,000 lb/sq in (from near by projects)

$$N_{\varphi} = tan^2 \left(45 + \frac{\varphi}{2} \right)$$

Assuming a phi angle of 25 degrees

$$q_p = 144 \, ksf \left(tan^2 \left(45 + \frac{25}{2}\right) + 1\right) = 498.8 \, ksf$$

$$Q_p = \frac{q_p * a_p}{FS} = \frac{498.8 \, ksf * 1.36 \, sq \, ft}{3} = 226 \, kip$$

From EM 1110-2-2906 Design of Pile Foundations

$$f_s = \sigma'_v * (K_c or K_t) * \tan(\delta) + \alpha c$$

$$\sigma_{v}' = \gamma D_{c} = 56 \ pcf * 20 * 1.17' = 1,310.4 \ psf$$

Assuming a cohesion of 2500 psf (conservative for limestone) $\alpha c = 0.5*2,500 = 1,250 \ psf$ $\delta = 0.83* \varphi = 0.83*25 = 20.75$

$$f_{s(tension)} = 0.9 * 1310.4 * (tan(20.75)) + 1250 = 1,571.9 psf$$

$$f_{s(compression)} = 1.0 * 1310.4 * (tan(20.75)) + 1250 = 1,746.5 psf$$

$$Q_S = \frac{f_S * a_S}{FS}$$

$$Q_{s(tension)} = \frac{1571.9 * 46.68}{3} = 24.4 k$$

$$Q_{s(compression)} = \frac{1746.5 * 46.68}{3} = 27.2 k$$

Total Axial Capacity=226+27.2=253.2 kips

Total Tension Capacity=24.4 kips

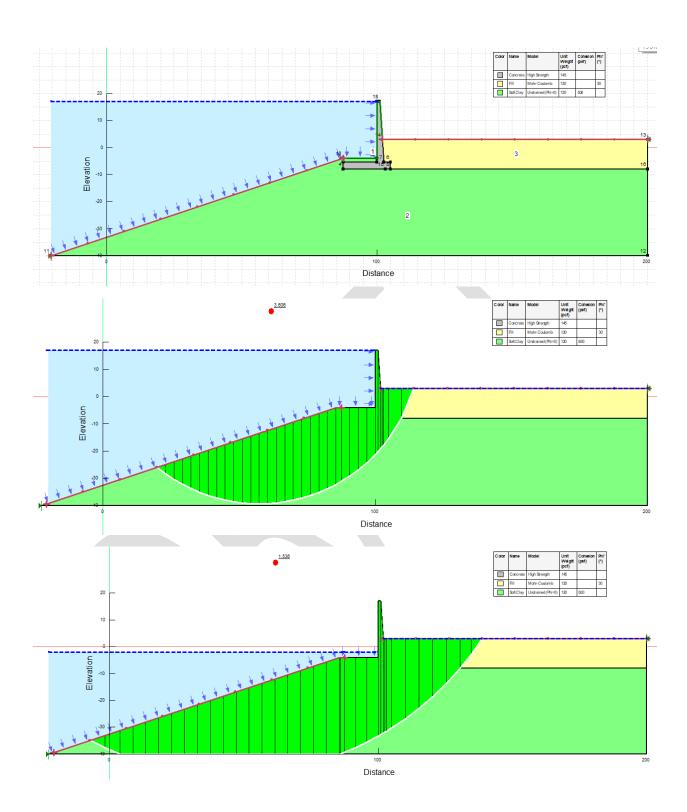
Capacities are adequate for 5 foot spacing.

The nominal bearing to drive 10 feet into the assumed rock is equal to:

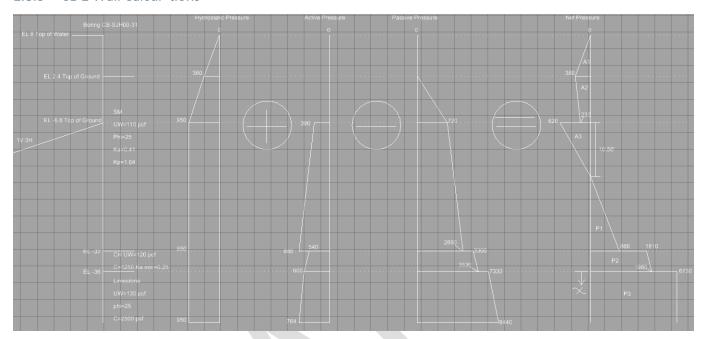
Total Axial Capacity*FS=253.2*3=759.6 kips

Using 0.85Fy as described in Figure 4-3 of EM 1110-2-2906 the max nominal bearing of an HP 14x89 is 1109 kips. So this design is ok.

Global Stability Checks



1.8.3 CL-1 Wall Calculations



Factor of Safety of 1.5 was applied to passive pressures.

Need to determine embedment depth:

Area	Force (pound)	Moment Arm
A1	½*360*5.6=1008	40.3+x
A2	(1/2*(360+230))*9.2=2714	34.1+x
A3	½*620*10.56=3274	18.2+x
P1	½*860*14.64=6295	8.9+x
P2	(1/2*(1810+1980))*4=7580	2+x
		•

Table sets up following equation:

$$\sum M = 0 = -1008(40.3 + x) - 2714(34.1 + x) - 3274(18.2 + x) + 6295(8.9 + x) + 7580(2 + x) + 6730(x)(^{x}/_{2})$$

This simplifies to...

 $0 = -40622.4 - 1008x - 92547.4 - 2714x - 59586.8 - 3274x + 56025.5 + 6295x + 15160 + 7580x + 3365x^2$

Further simplifies to...

 $0=3365x^2+6879x-121571.1$

or...

 $0=x^2+2.04x-36.13$

using solver function on TI-83 Plus x=5.08′. We will use 6′. Which leaves use with a tip elevation of -36-6=-42 PRVD02.

Next we will solve for the maximum moment, to do this the point of Zero Shear must be found.

A1+A2+A3=6996 lbs

P1=6295 lbs

6996-6295=701 lb

Location of zero shear is within P2 Thus...

0=1810x-710

Implies x=0.4'

Next we must sum moments about this point

Area	Force (pound)	Moment Arm
A1	1008	36.7
A2	2714	30.5
A3	3274	22.1
P1	6295	5.3
P2'	701	0.2

This sets up the following:

$$\sum_{\nu=0}^{\infty} M_{\nu=0} = 1008 * 36.7 + 2714 * 30.5 + 3274 * 22.1 - 6295 * 5.3 - 701 * 0.2 = 158622.3 \ lbft/ft$$

Using the maximum moment the section modulus can be determined as outline in EM 1110-2-2906:

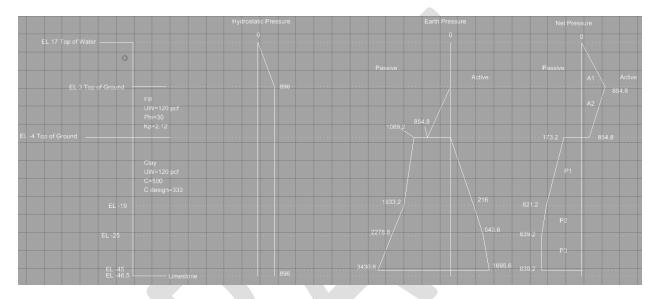
$$S = \frac{158622.3 \frac{lbft}{ft} * 12 \frac{in}{ft} * \frac{1}{1000} k/lb}{50 \text{ ksi} * 0.5} = \frac{1904}{25} = 76.2 \text{ in}^3/ft$$

Selected section must meet section modulus requirement and have a large enough area of steel to be driven 6 feet into rock. From Section 10 of this appendix this could be on the range of 800+ kips.

Pile (Nucor Shapes)	$S(\frac{in^3}{ft})$	Area of Steel (in^2/ft)	Max Nominal Bearing (kips)
AZ 42-700N	78.2	12.22	305.5
AZ 46-700N	85.7	13.56	339
AZ 50	93.3	15.22	380.5
PAZ42/NZ 19	88.1	65.2	2771

1.8.4 Verification of Sheet Pile Wall Depth Assumption

To verify the assumption of Cantilevered Sheet Pile Walls are feasible if the rock is deeper than two (2) to three (3) time the retained height, this section will analyze the tallest retained height, WSJB-3, assuming low shear strength properties. All calculations will be refined once additional borings are acquired.



Factor of Safety of 1.5 was applied to passive pressures.

Need to determine embedment depth:

Area	Force (kip)	Moment Arm
A1	6.27	32.67+x
A2	3.28	25.56+x
P1	7.46	11.87+x
P2	4.98	2.99+x

Table sets up following equation:

$$\sum M = 0 = 6.27(32.67 + x) + 3.28(25.56 + x) - 7.46(11.87 + x) - 4.98(2.99 + x) - 0.839(x)(\frac{x}{2})$$

This simplifies to...

 $0=204.8+6.27x+83.8+3.28x-88.55-7.46x-14.62-4.89x-0.42x^2$

 $0=185.43-2.8x-0.42x^2$

Using Excel to solve for x

X	Мо	
17	16.45	
17.5	7.805	
17.75	3.40375	
17.85	1.62855	
17.9	0.7378	
17.95	-0.15505	

This implies x is roughly 18 feet below P2's bottom elevation of -25, or around elevation -43. This makes the total depth of embedment equal to 39 feet, which is 1.86 times the retained height, validating the assumption that bedrock needs to be 2 to 3 times deeper than the maximum retained height, provided the average shear strength of materials present, when borings are acquired, is 500 psf.

1.9 References

Das, B. M. (2007). *Principles of Foundation Engineering* (6th ed., Vol. 1). Toronto, Ontario Canada: Thomson Canada Limited.

USACE Engineering Manual 1110-2-2502 Retaining and Flood Walls, 29 September 1989.

USACE Engineering Manual 1110-2-2906 Design of Pile Foundations, 15 January 1991.

USACE Engineering Manual 1110-2-2504 Design of Sheet Pile Walls, 31 March 1994.

USACE Engineering Manual 1110-2-1902 Slope Stability, 31 October 2003.



1.10 Boring Logs



Hole No. CB-AT90-3 INSTALLATION DIVISION **DRILLING LOG** Jacksonville District South Atlantic OF SHEETS 10. SIZE AND TYPE OF BIT See remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MEL) San Juan Harbor Deepening x=612,128 y=2 y=218,410 12. MANUFACTURER'S DESIGNATION OF DRILL 3. DRILLING AGENCY Corps of Engineers Failing 1500 DISTURBED UNDISTURBED 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN 4. HOLE NO. (As shown on drawing title and file number) CB-AT90-3 14. TOTAL NUMBER CORE BOXES . NAME OF DRILLER 15. ELEVATION GROUND WATER M. Whitson Tidal 6. DIRECTION OF HOLE STARTED COMPLETED 16. DATE HOLE <u>1/3</u>1/91 1/31/91 X VERTICAL __INCLINED_ 17. ELEVATION TOP OF HOLE -35.57. THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING 68 8. DEPTH DRILLED INTO ROCK 19. SIGNATURE OF INSPECTOR 9. TOTAL DEPTH OF HOLE 10.5' Geologist, G. Bacuta % CORE RECOV-SAMPLE NO. REMARKS
(Drilling time, water loss, depth of weathering, etc., if significant) CLASSIFICATION OF MATERIALS (Description) ELEVATION DEPTH LEGEND Bit or Barrel Blows/0.5Ft -35.5 -35.5 0.0 CLAY, very soft, medium plasticity, trace silt, settled Split Spoon 33 trace quartz sand, trace -37.0 shell, gray (CL) settled 67 2 -38.5<u>settled</u> 13 3 -40.0 -40.0 4.5 12 CLAY, stiff to very stiff, brown with red stains, high 93 4 20 plasticity (CH) 24 -41.5 16 100 5 -42.5 7.0 -30 bed of sandy clay from -42.5 40 -43.0 7.5 -43.0 to -43.0 19 80 6 23 36 -44.5 8 87 7 14 -46.0 10.5° -46.0 140# hammer with Soils are field visually 30" drop used on 2.0' split spoon. (1-3/8" ID x 2" OD) classified in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION CLASSIFICATION -37.0 to -38.5 (MH)* -40.0 to -41.5 (CH)* *Visual classification based on Gradation Curve. No Atterberg Limits.

Hole No. CB-AT90-6 DIVISION INSTALLATION SHEET DRILLING LOG South Atlantic Jacksonville District 10. SIZE AND TYPE OF BIT See remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) San Juan Harbor Deepening 2. LOCATION (Coordinates or Station) X=611,895 y=217,028
3. DRILLING AGENCY 12. MANUFACTURER'S DESIGNATION OF DRILL Failing Corps of Engineers
HOLE NO. (As shown on drawing title and tile number) DISTURBED UNDISTURBED 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN CB-AT90-6 14. TOTAL NUMBER CORE BOXES S. NAME OF DRILLER 15. ELEVATION GROUND WATER Tidal M. Whitson 6. DIRECTION OF HOLE COMPLETED 16. DATE HOLE 3/1/91 3/1/91 XX VERTICAL ___INCLINED DEG. FROM VERT. 17. ELEVATION TOP OF HOLE -30.37. THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING 35 8. DEPTH DRILLED INTO ROCK 19. SIGNATURE OF INSPECTOR 9. TOTAL DEPTH OF HOLE 15.0 Geologist, G. Bacuta % CORE RECOV-ERY (Drilling time, water loss, depth of weathering, etc., if significant) 9 CLASSIFICATION OF MATERIALS (Description) SAMPLE NO. ELEVATION DEPTH LEGEND Bit or Barrel -30.3 -30.3 0.0-CLAY, soft to very soft, Split Spoon | settled medium plasticity, gray 27 1 (CL) -31.8 settled 27 2 3.0 -33.3-33.3trace organics (wood) and settled trace shell from -33.3 to п 100 3 -36.3 -34.8 settled п 53 4 6.0 -36.3 -36.3 settled 0 5 -37.8 settled п 47 6 -39.3 settled 7 13 -40.8settled 0 8 -41.8 11.5 CLAY, high plasticity, brown (CH) -42.3 12.0 -42.3 9/ 16 GRAVEL, trace brown stiff п clay, large limestone frag-ments (moderately hard to 9 18 6ΰ ments (moderately name of hard, little pits and pores) 43 -43.8 2 tan to light brown, gray stains (GC) п 5 27 10 // 9 -45.3 -45.3 15.0 140# hammer with Soils are field visually 30" drop used on classified in accordance 2.0' split spoon. (1-3/8" ID x 2" OD) with the Unified Soils Classification System. SAMPLE LABORATORY **ELEVATION** CLASSIFICATION -33.3 to -34.8 (MH)* -42.3 to -43.8 (GP-GM)* *Visual classification based on Gradation Curve. No Atterberg Limits.

Hole No. CB-AT90-12

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			SAMPLE LABORAT	TORY	40	2					
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		///	-30.1 to -31.6 (MH) ³	k					s <u>e</u> 1	ttled	
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		///	*Visual classification based	d on			-33.1				
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Hole No. CB-AC91-12 INSTALLATION DIVISION DRILLING LOG OF I SHEETS Jacksonville District South Atlantic 10. SIZE AND TYPE OF BIT See remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) San Juan Harbor Deepening LOCATION (Coordinates or Station x=612.366 y=219 3. DRILLING AGENCY Corps of Engineers y=219,471 12. MANUFACTURER'S DESIGNATION OF DRILL Failing UNDISTURBED DISTURBED 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN 4. HOLE NO. (As shown on drawing title and tile number) CB-AC91-12 14. TOTAL NUMBER CORE BOXES 5. NAME OF DRILLER 15. ELEVATION GROUND WATER Tidal M. Whitson
6. DIRECTION OF HOLE 2/1/91 16. DATE HOLE 2/1/91 VERTICAL INCLINED DEG. FROM VERT. 17. ELEVATION TOP OF HOLE -40.27. THICKNESS OF OVERBURDEN IB. TOTAL CORE RECOVERY FOR BORING 8. DEPTH DRILLED INTO ROCK 19. SIGNATURE OF INSPECTOR 6.0' 9. TOTAL DEPTH OF HOLE <u>Geologist.</u> G. Bacuta % CORE SAMPLE NO. REMARKS CLASSIFICATION OF MATERIALS (Description) (Drilling time, water loss, depth of weathering, etc., if significant) ELEVATION DEPTH LEGEND Bit or Barrel <u>-40.2</u> 0.0 Blows/0.5 Ft settled CLAY, very soft, trace silt, trace shell, medium plastic-Split Spoon ity, gray (CL) -41..7 -41.7 3 16 67 2 CLAY, stiff, with small 13 -43.2 lenses of sandy clay, traces of black stains (organics), 10 53 10 light brown (CH) 12 -44.7 11 73 4 20 -46.2 21 -46.2Soils are field visually 140# hammer with 30" drop used on 2.0' split spoon. (1-3/8" ID x 2" 0D) classified in accordance with the Unified Soils Classification System. SAMPLE LABORATORY CLASSIFICATION ELEVATION (CH)* -41.7 to -43.2 * Visual classification based on Gradation Curve. No Atterberg Limits.

Hole No. CB-AC91-16

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ENG FORM 18 36 PREVIOUS EDITIONS ARE OBSOLETE.

San Juan Harbor Deepening CB-AC91-16

DRILL	ING LO	G D	South Atlantic	Jac	ATION KSONVil	le Dis	trict	OF]	T] SHEETS		
			10. SIZE AND TYPE OF BIT See remarks 11. DATUM FOR ELEVATION SHOWN (TBM or MSL)						1		
2. LOCATION (Coordinates or Station)					MLW						
3. DRILLING	DRILLING AGENCY				12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500						
Corps (4. Hole No. and file num			ing title	13. TOTA	L NO. OF	OVER- LES TAKE	DISTURBED	UNDI	TURBED]	
and file num			CB-AC91-20	14. TOT	L NUMBE	R CORE 8	oxes 1	i]	
M. Whit	tson			15. ELEV	ATION GE		1100	al Icomplet]	
6. DIRECTION			DEG. FROM VERT.	16. DATE	HOLE	3TA	1/25/91	1/25]	
7. THICKNES	S OF OVE	RBURDE	N .		ATION TO			1	•	-	
8. DEPTH DR	ILLED IN	TO ROCE	<	1	ATURE OF		Y FOR BORING		42 %	-	
9. TOTAL DE	РТН ОБ	HOLE	18.0'	·	ogist,					┨	
ELEVATION d	DEPTH b	LEGEND	CLASSIFICATION OF MATERIA (Description)	LS	% CORE RECOV- ERY	SAMPLE NO.	(Drilling time.	EMARKS water lose, etc., if aigni	depth of licant)		
<u></u>						· · · · · · · · · · · · · · · · · · ·				E	
							Bit	or Barre	el	E	
										E	
-28.1	0.0						-28.1	Blows/	'0.5 Ft	E	
-20.1	0.0	//	CLAY, very soft, slight			<u> </u>			settled	F	
			plasticity, gray (CL)	Ì	0	1	·	t Spoon		E	
-29.6	1.5	//.			••••••••••••••••••••••••••••••••••••••		-29.6		\vee	F	
	=	, ,	SAND, fine to medium que trace silt, very soft t		20	2		u :	settled	E	
-31.1	3.0-		stiff, trace to some sh	nell,	20		-31.1			F	
-31.1	 	•	light brown to gray (SA	4) ·			31.1		1	 	
		7.	traces of gravel (cm-si	ze	13	3		11	3	E	
		*))	cemented shell, corals	and			-32.6		2	E	
			sand) and small lenses clay (CH) from -31.1 to	of _25_1	22	,		п	7	上	
	Ξ)・)・	cray (cn) from -31.1 co	-33.1	33	4	-34.1		3	-	
		€,	SAMPLE LABORATOR				-34.1		22	_	
-35.1	7.0	, 4	ELEVATION CLASSIFIC -32.6 to -34.1 (SM)*		53	5		11	10	_	
	_		-32.6 to -34.1 (3")" -37.1 to -38.6 (SC)*				-35.6		3	E,	
			-41.6 to -43.1 (SC)*		_	_			40	_	
27.1			* Visual classification base Gradation Curve. No Atterbe		0	6	27 1	n	<u>4</u> settled		
-37.1	9.0	(Limits.	r y			-37.1		sectied 5	_	
	_		. The second		47	7		п	4	_	
			ý.				-38.6		6		
) -		_	07			п	4		
		4	trace gravel (cm-size (27	8	-40.1		settled 7		
-40.6	12.5) .] .	from -37.1 to -40.6	• ,			TU. 1		13		
70.0	·-··	//	CLAY, stiff to very sti	ff.	80	9		11	11	_	
		9/2	traces of small lenses	of			-41.6		18		
			cemented sand-shell, br	own	00	10		II	11	_	
		K	(011)		80	10	-43.1		<u>20</u> 26	_	
	<u> </u>					 	70.1		· 7		
			· ·		67	11		11	25	E	
-44.6	16. 5		traces of limestone gra	ve1		<u> </u>	-44.6		26		
	_	1/2	from -44.6 to -46.1			1.0		ti.	15		
86.3	10 0=	6/			87	12	-46.1		13 15		
-46.1	18.0	# 1/9	4	- 						_ _	
		1	Soils are field visua				140# har 30" dros				
		}	classified in accorda with the Unified Soil				2.01 sp	lit spoo	n.	F	
			Classification System				(1-3/8" 1	ID x 2"	OD)	E -2	
	_]	,							E	
	<u> </u>	1								E-	
	=	1								E	
		<u> </u>			000:			· .	NE NO	上	
ENG FORM	1836	PREVIO	OUS EDITIONS ARE OBSOLETE.		San J	luan Ha	rbor Deepe		B-AC91-	20	

Hole No.CB-ATC94-3

DRILLING LOG	South Atlantic		LLATIO		District	SHEET 1
I. PROJECT	South Atlantic	 			OFBIT See Remarks	OF 1
San Juan Harbor D					ATION SHOWN (TBM or MSL)	
2. LOCATION (Coordinates		ML		,		ŀ
X=611,803 Y=217,8 3. DRILLING AGENCY	93	12. MAI	NUFACT		S DESIGNATION OF DRILL	
Corps of Engineers			iling 14		150011005	
4. HOLE NO. (As shown on	drawing title				VERBURDEN SAMPLES TAKEN	
and file number)	CB-ATC94-3		turbe		undisturbed: 0	
5. NAME OF DRILLER					OF CORE BOXES 1	
R. Gordon					JND WATER Tidal	
6. DIRECTION OF HOLE		IIG, DA	ı ⊨ HOL		ARTED COMPLETED /16/94 4/16/94	•
☑ VERTICAL ☐ INC	LINED					
7. THICKNESS OF BURDEN	0 Ft.				of HoLE −27.3 Ft.	
8. DEPTH DRILLED INTO R	OCK OFt.	1			COVERY FOR BORING 45 %	
9. TOTAL DEPTH OF HOLE			SNATUR Goff	E OF G	EOLOGIST	
		1			Τ	
ELEV. DEPTH Q	CLASSIFICATION OF MATERIA (Description)	LS	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/
<i>-27.3</i> .0			 			
	CLAY, very soft, very wet, trac	· o	 	1	<i>−27.3</i>	SETTLED-
	peat, & silt dark gray to black (CH)	:e				SETTLEL
=						Ė
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\						· F
- ///			10	1	SPLIT SPOON	<u> </u>
	:					
3///						
	·					F
¥///\						ţ
						Ė
				 	-32.3	
*///				l .		SETTLEC-
						F
						Į.
· • • • • • • • • • • • • • • • • • •						į.
1						E
			43	2	SPLIT SPOON	<u> </u>
						<u></u>
						-
1 1 1 1 1 1 1 1 1 1			.			Ė
\ \ \ \ \\\\\\						F
	blue gray with trace of sand		<u> </u>	ļ	<i>−37.3</i>	
1 1 1 1 1 1 1 1 1 1	from −37.0 to −37.3					SETTLEO-
						F
			64	3	SPLIT SPOON	L.
	,					E
		•		}		F
<i>-\fi//</i> }					-39.8	
			1	1		SETTLED-
\ \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\						
1 = 1//			24	4	SPLIT SPOON	<u>L</u>
\ \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\			-	-	3, 21, 3, 001	F
\ \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\			1			Į.
1 -1//				<u> </u>	-42.3	<u></u> _t
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\			1	5		SETTLET- "
-43.3 16.0			100	L	SPLIT SPOON	<u> </u>
-43.8 16.5 + + + +	LIMESTONE, moderately hard,		1	6		44
10.0	slightly pitted, slightly	/-	 	<u> </u>	<i>-43.8</i>	
¥///\	weathered, white	/				28 -
	CLAY, firm to stiff, fat, some		60	7	SPLIT SPOON	6 - 17
<i>-\///</i>	limestone fragments (to grave)				-45.3	8 - "
	size), yellowish-brown (CH)					14 -
	soft below -45.3		73	8	SPLIT SPOON	
-46.5 19.2 -]	<u></u>		
1 1 1	LIMESTONE, with clay (soft,		ļ	9	-46.8	22 -
I ⊣≐≐≝	yellow-brown), weathered,					- 14 - 2
III	pitted, white		73	10	SPLIT SPOON	18 -
- -	pittod, tilito			ł	•	13 -
	pitted at Airica				1-483	
	prito di mini				<u>-48.3</u>	
				44		14 -
			53	11	SPLIT SPOON	14 — 17 —
-49.8 22.5 TTT			53	11		14 -

Hole No.CB-ATC94-5

DRILLING LOG	DIVISION South Atlantic	INSTAL			istrict		SHEET 1 OF 1
1. PROJECT		10. SIZ	E AND	TYPE (OF BIT Se	e Remarks	UF I
San Juan Harbor De 2. LOCATION (Coordinates				RELEV	ATION SHOW	IN (TBM or MSL)	
X=612,260 Y=219,9	·	ML/		URER'S	S DESIGNAT	ION OF DRILL	
3. DRILLING AGENCY Corps of Engineers			ling 1		(EDDUBBEL)		
4. HOLE NO. (As shown on o	HOLE NO. (As shown on drawing title			. or ov d: 0		SAMPLES TAKEN turbed: 0	
and file number) 5. NAME OF DRILLER	OD A1034 0				OF CORE BO		
R. Gordon					JND WATER		
6. DIRECTION OF HOLE		16. DAT	E HOL		ARTED CO /22/94 4		
		17 FLF	VATIO		0F HOLE -		
7. THICKNESS OF BURDEN						BORING 64 %	
	DEPTH DRILLED INTO ROCK O Ft.				EOLOGIST		
9. TOTAL DEPTH OF HOLE			Goff T	ωœ	1		
ELEV. DEPTH S	CLASSIFICATION OF MATERIA (Description)	LS	CORE REC %	SAMPLE		REMARKS Bit or Barrel	BLOWS/
-26.9 .0					-26.9		
	CLAY, very soft, very wet, trac	:e					SETTLET
<i>−27.8</i> .9 -	shell & limestone fragments, gray-black (CH)	_	13	1		SPLIT SPOON	‡
	CLAY, fat, soft to stiff, with			ļ	-28.4		5 -
	layers of white, sandy, moderately hard limestone					ODLIT ODGO	9
	throughout		60	2		SPLIT SPOON	2
					-29.9		6
			73	3	[SPLIT SPOON	
			'		-31.4	OF LEEF OF OUR	9 -
					-57.4		7
			73	4		SPLIT SPOON	8 -5
					<i>−32.9</i>		10
					02.0		9 -
			67	5		SPLIT SPOON	11 -
					-34.4		9 - ,
					 		8 -7
3//			67	6		SPLIT SPOON	12
- 1//2					-35.9		11
							6
			57	7		SPLIT SPOON	9 -10
<i>- 188</i> 2					-37.4		11
							6
			73	8		SPLIT SPOON	7
					-38.9		4 -
			100	9		SPLIT SPOON	4 -12
			100	9	10.4	SPLIT SPOON	7
					-40.4		7
			73	10		SPLIT SPOON	8 -
			'		-41.9	GIETT GIOON	15
					41.0		15 - K
			67	11		SPLIT SPOON	8
					-43.4		10
		•					12 -
			80	12		SPLIT SPOON	6 -1
					-44.9		12 -
							16
			53	13		SPLIT SPOON	16
					-46.4		9 -
							9 -2
			67	14		SPLIT SPOON	7
					-47.9		13
							10
			47	15		SPLIT SPOON	11 -
-49.4 22.5 -					-49.4		12 -2
ENG FORM 4030 POST TO THE	DITTONO ADE ODOGISTO	-c-				Line	
ENG FORM 1838 PREVIOUS EI MAR 71	DITIONS ARE OBSOLETE. PROJE		Harho	r Doc	enenina		ENUMBER -ATC94-5

Hole No.CB-ATC94-7

PROJECT San Juan Harbor Deepening 10. SIZE AND TYPE OF BIT See Remarks 11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MLW 12. MANUFACTURER'R DESGNATION OF DRILL Failing 1400 13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0	DRILLING LOG	DIVISION South Atlantic	INSTA			ietrict	SHEET 1 OF 1	
COATION (Coordinates of Station)	, PROJECT						<u> </u>	
X=012,25, Y=222,160 TABLETE CONTENT DESCRIPTIONS OF DRILL					R ELEV	ATION SHOWN (TBM or MSL)		
SellLine ABENCY					HRER'S	DESCNATION OF DRILL		
CBC A C A Section on distance (10) CBC A T	3. DRILLING AGENCY							
### CB-ATC84-7 ### CONTRICER								
S. ELEVATION OF HOLE	and file number)							
DIRECTION OF PACE 38. DATE HOLE STAMPED APPLIETED APPLIETED APPLIETED APPLIETED APPLIED AP	NAME OF DRILLER							
Martical Directived Processor Burdown of Pt. Stevarion for one blee 30.2 Pt. Stevarion for 30.2 Pt. Stevarion for one blee								
THICKNESS OF BURDEN 0 Ft. THE EVATION TO FOR MACE -36.2 Ft. THE PROBLED INTO ROOK 0 Ft. THE PROBLED INTO ROOK		: INFO	10, 54,	21,00				
Second S		**************************************	17. ELE	OITAV	N TOP	OF HOLE −36.2 Ft.		
DITAL DEPTH OF HOLE 14 Ft.	····							
CLASSIFICATION OF MATERIALS CORE CREEK			1		E OF G	EOLOGIST		
CLAY, soft, very wet, gray (CH) 20 1 2" X 5" SPOON					11100		\neg	
CLAY, soft, very wet, gray (CH) 20 1 2" X 5" SPOON	ELEV. DEPTH N		ALS	CORE REC %	SAMPLI	REMARKS Bit or Barrel	BLOWS	
SETTLE	-36.2 .0							
Stiff, brown from -41.0 to -50.2	-///	CLAY, soft, very wet, gray (C	:H)				SETTLE	
Stiff, brown from -41.0 to -50.2	- 1							
Stiff, brown from -41.0 to -50.2		•		<u> </u>				
Stiff, brown from -41.0 to -50.2	=							
Stiff, brown from -41.0 to -50.2	<i>=\ </i>							
Soils are field visually classified in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION -36.2/-39.9 (CH)X Classification Curve. No Atterberg Classification Curve. No Atterberg Classification Curve. No Atterberg Classification System. SPLIT SPOON Classification Curve. No Atterberg C	=			20	1	2" X 5' SPOON	N	
Soils are field visually classified in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION -36.2/-39.9 (CH)X Classification Curve. No Atterberg Classification Curve. No Atterberg Classification Curve. No Atterberg Classification System. SPLIT SPOON Classification Curve. No Atterberg C	1 1							
Soils are field visually classified in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION -36.2/-39.9 (CH)X Classification Curve. No Atterberg Classification Curve. No Atterberg Classification Curve. No Atterberg Classification System. SPLIT SPOON Classification Curve. No Atterberg C								
Soils are field visually classified in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION -36.2/-39.9 (CH)X Classification Curve. No Atterberg Classification Curve. No Atterberg Classification Curve. No Atterberg Classification System. SPLIT SPOON Classification Curve. No Atterberg C	*// /							
94 3 SPLIT SPOON 4 -42.7 8 3 3 4 SPLIT SPOON 6 6 -44.2 8 94 5 SPLIT SPOON 6 6 -45.7 9 6 SPLIT SPOON 6 -47.2 14 14 -47.2 11 14 -47.2 11 14 -47.2 11 14 -47.2 11 14 -48.7 11 15 5 5 5 5 5 5 5		stiff, brown from -41.0 to -50	.2	Į		-412		
-42.7 8 3 3 3 4 SPLIT SPOON 6 -44.2 4 94 5 SPLIT SPOON 6 -45.7 9 74 6 SPLIT SPOON 11 -47.0 to -50.2 11 33 7 SPLIT SPOON 12 -48.7 11 33 8 SPLIT SPOON 12 -48.7 5 Soils are field visually classified in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION CLASSIFICATION -36.27-39.9 (CH)* **Visual classifiction based on Gradation Curve. No Atterberg Limits.							3	
142,7 8 3 3 4 SPLIT SPOON 6 6 6 6 6 6 6 6 6	- - ///			94	3	SPLIT SPOON	4	
33 4 SPLIT SPOON 6 8 94 5 SPLIT SPOON 6 94 5 SPLIT SPOON 6 94 5 SPLIT SPOON 6 95 95 95 95 95 95 95								
nodules and layers of hard fine grained quartz sandstone from 47.0 to -50.2 Soils are field visually classified in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION -38.2/-39.9 (CH)* **Visual classification based on Gradation Curve. No Atterberg Limits. **Augusta 133	*///					42./		
nodules and layers of hard fine grained quartz sandstone from -47.0 to -50.2 Soils are field visually classified in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION -38.2/-39.9 (CH)* XVisual classifiction based on Gradation Curve. No Atterberg Limits.	*			33	4	SPLIT SPOON	-,	
nodules and layers of hard fine grained quartz sandstone from -47.0 to -50.2 Soils are field visually classified in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION -38.2/-39.9 (CH)% **Visual classifiction based on Gradation Curve. No Atterberg Limits. **Yes and some standard fine grained and provided in the Unified Soils Classification System. **SPLIT SPOON 11/14 -47.2 33 7 SPLIT SPOON 11/19 -48.7 11 10 2 3 3 7 SPLIT SPOON 11/19 -48.7 14 4 8 SPLIT SPOON 11/19 -47.2 33 8 SPLIT SPOON 11/19 -48.7 14 14 #AMMER WITH 30" DROP USED ON 2" SPLIT SPOON (1 3/8" ID X 2" 0D)) `			
nodules and layers of hard fine grained quartz sandstone from -47.0 to -50.2 Soils are field visually classified in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION -38.2/-39.9 (CH)X XVisual classifiction based on Gradation Curve. No Atterberg Limits.						<u> </u>		
nodules and layers of hard fine grained quartz sandstone from -47.0 to -50.2 33 7 SPLIT SPOON 11 -47.0 to -50.2 33 8 SPLIT SPOON 8 -50.2 14.0 Soils are field visually classified in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION CLASSIFICATION -36.2/-39.9 (CH)X *Visual classifiction based on Gradation Curve. No Atterberg Limits.				۵A		SPLIT SPOOM		
nodules and layers of hard fine grained quartz sandstone from -47.0 to -50.2 33 7 SPLIT SPOON 11 14 14 15 11 15 15 16 16 16 16	<u> </u>			07				
nodules and layers of hard fine grained quartz sandstone from -47.0 to -50.2 11			i			-45./		
nodules and layers of hard fine grained quartz sandstone from 47.0 to -50.2 33 7 SPLIT SPOON 12 11 11 5 8 11 11 5 8 11 11				74	ا ا	COLIT CDOOM		
33 7 SPLIT SPOON 11 1 1 1 1 5 1 1 1 1 1 5 5 8 1 1 1 1 1	-	nodules and layers of hard fin	ie	74	١٠			
Soils are field visually classified in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION —36.2/—39.9 (CH)X **Visual classifiction based on Gradation Curve. No Atterberg Limits.** SPLIT SPOON 12 14.0 15.0 16.0 17.0 18.0 18.0 19.0 19.0 10.0 1		grained quartz sandstone from	T)			-47.2		
-50.2 14.0 -48.7 11 5 5 8 -50.2 14.0 -50.2 14.0 -50.2 14.0 -50.2 8 8 -50.2 8 140	<u> </u>	41.0 (0 00.2		22	7	NOORS TI IDS		
Soils are field visually classified in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION CLASSIFICATION -38.2/-39.9 (CH)* **Visual classifiction based on Gradation Curve. No Atterberg Limits.** SPLIT SPOON 14.0** 14.0** HAMMER WITH 30" DROP USED ON 2" SPLIT SPOON (1 3/8" ID X 2" OD) **OPEN TO THE CONTROL OF TH				33	'			
Soils are field visually classified in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION CLASSIFICATION -36.2/-39.9 (CH)x **Visual classifiction based on Gradation Curve. No Atterberg Limits.** Soils are field visually classified in accordance with the Unified Soils (13/8" ID X 2" OD) 14.0 # HAMMER WITH 30" DROP USED ON 2" SPLIT SPOON (13/8" ID X 2" OD) 14.0 # HAMMER WITH 30" DROP USED ON 2" SPLIT SPOON (13/8" ID X 2" OD)			İ			<u> </u>		
Soils are field visually classified in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION CLASSIFICATION -36.2/-39.9 (CH)* **Visual classifiction based on Gradation Curve. No Atterberg Limits.** **Visual classification based on Gradation Curve. No Atterberg Limits.**		_		22	B	SDI IT SPAAN		
Soils are field visually classified in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION CLASSIFICATION -38.2/-39.9 (CH)* *Visual classifiction based on Gradation Curve. No Atterberg Limits.	-50 2 14 0	·		33				
in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION CLASSIFICATION -36.2/-39.9 (CH)* *Visual classifiction based on Gradation Curve. No Atterberg Limits.	-00.2 14.0				 	-50.2		
in accordance with the Unified Soils Classification System. SAMPLE LABORATORY ELEVATION CLASSIFICATION -36.2/-39.9 (CH)* *Visual classifiction based on Gradation Curve. No Atterberg Limits.							:	
Classification System. SAMPLE LABORATORY ELEVATION CLASSIFICATION -36.2/-39.9 (CH)* *Visual classifiction based on Gradation Curve. No Atterberg Limits.	-							
SAMPLE LABORATORY ELEVATION CLASSIFICATION -36.2/-39.9 (CH)* *Visual classifiction based on Gradation Curve. No Atterberg Limits.			1 20118			(13/8" ID X 2" NN)	UIN i	
ELEVATION CLASSIFICATION -36.2/-39.9 (CH)* *Visual classifiction based on Gradation Curve. No Atterberg Limits.						(, J, J + L / , L OD)		
ELEVATION CLASSIFICATION -36.2/-39.9 (CH)* *Visual classifiction based on Gradation Curve. No Atterberg Limits.	[SAMPLE LABORATORY	v .					
-36.2/-39.9 (CH)* *Visual classifiction based on Gradation Curve. No Atterberg Limits.	-	ELEVATION CLASSIFICA						
Gradation Curve. No Atterberg Limits.	-}							
Gradation Curve. No Atterberg Limits.]	*Visual classifiction based on			l			
Limits.]	Gradation Curve. No Atterberg						
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]							
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	-				j			
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	7	-	ł	(ļ			
		·						
		-						
							F 100.000	

Hole No. CB-PN-16 DIVISION INSTALLATION SHEET DRILLING LOG Jacksonville District OF | SHEETS South Atlantic ROJECT 10. SIZE AND TYPE OF BIT SEE TEMATKS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) San Juan Harbor Deepening x=613,86412. MANUFACTURER'S DESIGNATION OF DRILL DRILLING AGENCY Failing Corps of Engineers 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN HOLE NO. (As shown on drawing title and file number) CB-PN-16 14. TOTAL NUMBER CORE BOXES S. NAME OF DRILLER 15. ELEVATION GROUND WATER Tidal M. Whitson COMPLETED 6. DIRECTION OF HOLE 16. DATE HOLE 2/12/91 2/12/91 XVERTICAL | INCLINED DES. FROM VERT 17. ELEVATION TOP OF HOLE -33.77. THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING 8. DEPTH DRILLED INTO ROCK 19. SIGNATURE OF INSPECTOR S. TOTAL DEPTH OF HOLE Geologist, G. Bacuta 12.0' % CORE RECOV-ERY REMARKS CLASSIFICATION OF MATERIALS (Description) SAMPLI NO. (Drilling time, water loss, depth of weathering, etc., if significant) ELEVATION DEPTH LEGEND Bit or Barrel -33.7 0.0 -33.7Blows/0.5 Ft settled CLAY, soft to very soft, Split Spoon 1 medium plasticity, trace 13 shell, trace silt, gray from -33.7 to -35.7 (CL) -35.2 -35.7 2. settled 2 80 2 12 -36.7 6 16 73 3 CLAY, stiff, traces of -38.2 23 weathered black and red 9 fragments (possible metallic) 4 9 reddish brown, high plasticity (CH) 26 -39.7 12 80 5 28 38 <u>-41.2</u> 12 87 6 19 25 -42.7 8 16 67 7 16 -44.2 11 73 8 16 23 ~45.7 12.0 45.7 Soils are field visually 140# hammer with classified in accordance 30" drop used on 2.0' split spoon. (1-3/8" ID x 2" OD) with the Unified Soils Classification System. SAMPLE LABORATORY CLASSIFICATION ELEVATION -35.7 to -36.7 (CH)* * Visual classification based on Gradation Curve. No Atterberg Limits.

PROJECT

HOLE NO.

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.

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South Attendo	DRILLING LO	G DIVISION South Atlantic	INSTALLATI		District	SHEET 1		
Sam Juan Harbor Departing	1. PROJECT	30tti Atlantio				0F 1		
X-961-613 Y - Y-21/152 TRAIN-PATCHINERS DESIGNATION OF DRIFT TRAIN-PATCHINERS DE		Deepening						
SPILITE NEEDED		750		TUNEN	C DECIONATION OF BOY			
TOTAL FOR ENGINEER TAKEN CB-PN94-1 TOTAL NUMBER OF CORE BOXES TOTAL CEPTOR OF CRITICAL TOTAL NUMBER OF CORE BOXES TOTAL CEPTOR OF CRITICAL TOTAL NUMBER OF CORE BOXES TOTAL CEPTOR OF CRITICAL TOTAL NUMBER OF CORE BOXES TOTAL CEPTOR OF CRITICAL TOTAL NUMBER OF CORE BOXES TOTAL CEPTOR OF CRITICAL TOTAL NUMBER OF CORE BOXES TOTAL CEPTOR OF CRITICAL TOTAL NUMBER OF CORE BOXES TOTAL CEPTOR OF CRITICAL TOTAL CEPTOR OF CR	3. DRILLING AGENCY				5 DESIGNATION OF DRILL			
Amage of pRILER STATUS STATUS SETTLEF			13. TOTAL NO). OF 0				
S. NAME OF DRILLER	and file number)	CB-PN94-1		-				
S. DIRCTION OF HOLE S. CATTERIOL STATES CONTINUENCE								
EXEMPTION DIRECTOR DIRECTOR T. FILEVATION CORE DIRECTOR T. FILEVATION TOP OF NACE 30, 151.								
7. THICKNESS OF BUNDEN O FI. 8. DEPTH DRILLED INTO ROOK O FI. 9. STOKAL DEPTH OF HOLE 17.5 FI. 1. STOKAL DEPTH OF HOLE 17.5 FI. 20 1 SPLIT SPOON 21 SPLIT SPOON 22 SPLIT SPOON 22 SPLIT SPOON 23 SPLIT SPOON 24 SPLIT SPOON 25 STILES 26 SPLIT SPOON 27 SPLIT SPOON 28 STILES 29 SPLIT SPOON 20 STILES 20 SPLIT SPOON 20 STILES 20 SPLIT SPOON 21 SPLIT SPOON 22 SPLIT SPOON 31 SPLIT SPOON 32 SPLIT SPOON 33 SPLIT SPOON 34 SPLIT SPOON 35 STILES 36 SPLIT SPOON 37 SPLIT SPOON 37 SPLIT SPOON 38 SPLIT SPOON 39 SETTLES 30 SPLIT SPOON 30 SETTLES 30 SPLIT SPOON 30 SETTLES 31 SPOON 30 SETTLES 31 SPLIT SPOON 31 SETTLES 32 SPLIT SPOON 31 SETTLES 33 SPLIT SPOON 35 SPLIT SPOON 36 SPLIT SPOON 37 SPLIT SPOON 37 SPLIT SPOON 38 SPLIT SPOON 30 SETTLES 40 SPLIT SPOON 40 SPLIT SPOON 40 SPLIT SPOON 40 SPLIT SPOON 41 SPLIT SPOON 41 SPLIT SPOON 42 SPLIT SPOON 42 SPLIT SPOON 43 SPLIT SPOON 44 SPLIT SPOON 55 SPLIT SPOON 56 SPLIT SPOON 57 SPLIT SPOON 57 SPLIT SPOON 57 SPLIT SPOON 57 SPLIT SPOON 57 SPLIT SPOON 57 SPLIT SPOON 57 SPLIT SPOON 57 SPLIT SPOON 57 SPLIT SPOON 67 SPLIT SPOON 68 SPLIT SPOON 69 SPLIT SPOON 69 SPLIT SPOON 60 SPLIT SPOON 60 SPLIT SPOON 61 SPLI	1		16. DATE HUI					
1. HINDRESS & BUDGET 1. SETTILES 1. SE	·		17. ELEVATIO					
Total Depth of Mode 17.5 Ft. Total Depth of Mode 17.5 Ft. M. 6011		N UFT.	***************************************					
CLAY, fet, trace slit, green (CH) CLAY, fet, trace slit, green		ROCK OFT.	19. SIGNATU					
-48.1 9.0 CLAY, fait, trace sit, preen (CH) -48.1 9.0 CLAY, fait, trace sit, green (CH) -47.6 SPLIT SPOON -47.6 SETTLES -49.1 SPLIT SPOON -49.1 SPLIT SPOON -49.1 SPLIT SPOON -50.6 SPLIT SPOON -50.6 SPLIT SPOON -51.6 SPLIT SPOON -51.6 SPLIT SPOON -52.1 SPLIT SPOON -53.6 SPLIT SPOON -55.1 SPLIT SPOON -65.1 MAD# HAMMER MITH 30" DROP USED ON 2" SPLIT SPOON (1 3/8" ID X 2" OD) -2 SPLIT SPOON -68.8 SPLIT SPOON -69.8		E 17.5 Ft.		T:	·			
-48.1 9.0 CLAY, fait, trace sit, preen (CH) -48.1 9.0 CLAY, fait, trace sit, green (CH) -47.6 SPLIT SPOON -47.6 SETTLES -49.1 SPLIT SPOON -49.1 SPLIT SPOON -49.1 SPLIT SPOON -50.6 SPLIT SPOON -50.6 SPLIT SPOON -51.6 SPLIT SPOON -51.6 SPLIT SPOON -52.1 SPLIT SPOON -53.6 SPLIT SPOON -55.1 SPLIT SPOON -65.1 MAD# HAMMER MITH 30" DROP USED ON 2" SPLIT SPOON (1 3/8" ID X 2" OD) -2 SPLIT SPOON -68.8 SPLIT SPOON -69.8	ELEV. DEPTH N		S CORI REC %	SAMPLE	REMARKS Bit or Barrel	BLOWS/		
CLAY, 1st, very wet, trace slit, black (CH) 20 1 SPLIT SPOON -44.1 SETTLEST SPLIT SPOON SETTLEST SPLIT SPO	<i>−39.1</i> .0					•		
SPLIT SPOON SETTLED						SETTLE		
-43.1 9.0 CLAY, fat, trace silt, green (CH) Trace of sand size rock fragments 100 4 SPLIT SPOON SETTLED -50.6 SPLIT SPOON 2 -52.1 SPLIT SPOON 2 -52.1 SPLIT SPOON 2 -53.8 SPLIT SPOON 2 -55.1 SPLIT SPOON 2 -55.1 SPLIT SPOON 2 -55.1 SPLIT SPOON 2 -55.1 SPLIT SPOON 2 -56.6 IT.5 Soils are field visually classified in accordance with the Unified Soils Classification System.	│	black (CH)				-		
-43.1 9.0 CLAY, fat, trace silt, green (CH) Trace of sand size rock fragments 100 4 SPLIT SPOON SETTLED -50.6 SPLIT SPOON 2 -52.1 SPLIT SPOON 2 -52.1 SPLIT SPOON 2 -53.8 SPLIT SPOON 2 -55.1 SPLIT SPOON 2 -55.1 SPLIT SPOON 2 -55.1 SPLIT SPOON 2 -55.1 SPLIT SPOON 2 -56.6 IT.5 Soils are field visually classified in accordance with the Unified Soils Classification System.		•				Ļ		
-43.1 9.0 CLAY, fat, trace silt, green (CH) Trace of sand size rock fragments 100 4 SPLIT SPOON SETTLED -50.6 SPLIT SPOON 2 -52.1 SPLIT SPOON 2 -52.1 SPLIT SPOON 2 -53.8 SPLIT SPOON 2 -55.1 SPLIT SPOON 2 -55.1 SPLIT SPOON 2 -55.1 SPLIT SPOON 2 -55.1 SPLIT SPOON 2 -56.6 IT.5 Soils are field visually classified in accordance with the Unified Soils Classification System.						‡		
-43.1 9.0 CLAY, fat, trace silt, green (CH) Trace of sand size rock fragments 100 4 SPLIT SPOON SETTLED -50.6 SPLIT SPOON 2 -52.1 SPLIT SPOON 2 -52.1 SPLIT SPOON 2 -53.8 SPLIT SPOON 2 -55.1 SPLIT SPOON 2 -55.1 SPLIT SPOON 2 -55.1 SPLIT SPOON 2 -55.1 SPLIT SPOON 2 -56.6 IT.5 Soils are field visually classified in accordance with the Unified Soils Classification System.						Į.		
30 2 SPLIT SPOON SETTLET -48.1 9.0 CLAY, fat, trace silt, green (CH) 3 SPLIT SPOON SETTLET -49.1 100 4 SPLIT SPOON 3 1 -50.6 SPLIT SPOON 2 -52.1 2 -52.1 2 -52.1 2 -52.1 2 -52.1 2 -52.1 3 -50.6 SPLIT SPOON SETTLET -53.6 SPLIT SPOON SETTLET -55.1 3 SPLIT SPOON SETTLET -55.1 3 SPLIT SPOON SETTLET -56.6 17.5 3 SPLIT SPOON SETTLET -56.7 SPLIT SPOON 3 -56.8			20	1 1	SPLIT SPOON	<u></u>		
30 2 SPLIT SPOON SETTLET -48.1 9.0 CLAY, fat, trace silt, green (CH) 3 SPLIT SPOON SETTLET -49.1 100 4 SPLIT SPOON 3 1 -50.6 SPLIT SPOON 2 -52.1 2 -52.1 2 -52.1 2 -52.1 2 -52.1 2 -52.1 3 -50.6 SPLIT SPOON SETTLET -53.6 SPLIT SPOON SETTLET -55.1 3 SPLIT SPOON SETTLET -55.1 3 SPLIT SPOON SETTLET -56.6 17.5 3 SPLIT SPOON SETTLET -56.7 SPLIT SPOON 3 -56.8				1		<u> </u>		
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-48.7 9.0 - CLAY, fat, trace silt, green (CH) CLAY, fat, trace silt, green (CH) Trace of sand size rock fragments 100 5 SPLIT SPOON 3 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2				· · · · · · · · · · · · · · · · · · ·		eetti en		
-48.1 9.0 CLAY, fat, trace silt, green (CH) CLAY, fat, trace silt, green (CH) 100 4 SPLIT SPOON 3 1 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3					/	SETTLET		
-48.1 9.0 CLAY, fat, trace silt, green (CH) CLAY, fat, trace silt, green (CH) 100 4 SPLIT SPOON 3 1 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3						F		
-48.1 9.0 CLAY, fat, trace silt, green (CH) CLAY, fat, trace silt, green (CH) 100 4 SPLIT SPOON 3 1 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	l :		7.0	2	CPL IT CROOM	F		
-48.1 9.0 CLAY, fat, trace silt, green (CH) CLAY, fat, trace silt, green (CH) Trace of sand size rock fragments 100 4 SPLIT SPOON 3 1 1 - 50.6 Trace of sand size rock fragments 100 5 SPLIT SPOON 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2		•	30	-	SPLIT SPOON	F		
-48.1 9.0 CLAY, fat, trace silt, green (CH) CLAY, fat, trace silt, green (CH) Trace of sand size rock fragments 100 4 SPLIT SPOON 3 1 1 - 50.6 Trace of sand size rock fragments 100 5 SPLIT SPOON 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2						<u> </u>		
CLAY, fat, trace silt, green (CH) 3 SPLIT SPOON SETTLET -49.1						L		
CLAY, fat, trace silt, green (CH) 3				<u> </u>	-47.6			
100 4 SPLIT SPOON 3 1 2 2 1 2 2	-48.1 9.0 -	OLAN FELL WITH THE TOTAL T						
trace of sand size rock fragments 100 4 SPLIT SPOON 3 1 2	#///	ULAY, tat, trace silt, green (CH)) [.	3	SPLIT SPOON	SETTLE		
trace of sand size rock fragments 100 4 SPLIT SPOON 3 1 2 2 2 2 2 2 2 2 2	-\$///				-49.1	<u>L</u> 1		
trace of sand size rock fragments 100 5						3		
trace of sand size rock fragments 100 5 SPLIT SPOON 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2			100	4	SPLIT SPOON			
100 5 SPLIT SPOON 2 2 2 2 2 2 3 3 6 SPLIT SPOON 3 5 SETTLEL -53.6 SPLIT SPOON 3 4 4 4 4 5 5 5 6 SPLIT SPOON 7 SPLIT SPOON 7 3 4 4 4 5 5 6 5 6 6 6 6 6 6					-50.6	³ 2		
100 5 SPLIT SPOON 2 2 2 2 2 3 3 4 4 4 5 5 5 5 5 5 5		trace of cand size rook				2		
Soft to firm SPLIT SPOON SETTLEF -53.6			100	5	SPLIT SPOON	2 -		
soft to firm 100 7 SPLIT SPOON SETTLED -53.6 SPLIT SPOON SETTLED 3 4 100 8 SPLIT SPOON 2 3 -56.6 Soils are field visually classified in accordance with the Unified Soils Classification System. Soils are field visually classified in accordance with the Unified Soils Classification System.								
Soft to firm Settlet	<i> </i> ///					2		
soft to firm 100 7 SPLIT SPOON 3 4 2 -55.1 100 8 SPLIT SPOON 3 6 7 6 Soils are field visually classified in accordance with the Unified Soils Classification System. 140# HAMMER WITH 30" DROP USED ON 2" SPLIT SPOON (1 3/8" ID X 2" OD) -2		.	53	6	SPLIT SPOON			
soft to firm 100 7 SPLIT SPOON 3 4 4 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	<i>*///</i>		1					
Soils are field visually classified in accordance with the Unified Soils Classification System. 100 7 SPLIT SPOON 3 4 2 4 2 - 100 8 SPLIT SPOON 3 6 - 100 8 SPLIT SPOON 1 3 6 - 100 8 SPLIT SPOON 1 3 6 - 100 8 SPLIT SPOON 1 3 6 - 100 8 SPLIT SPOON 1 3 6 - 100 8 SPLIT SPOON 1 3 6 - 100 8 SPLIT SPOON 1 3 6 - 100 8 SPLIT SPOON 1 3 6 - 100 8 SPLIT SPOON 1 3 6 - 100 8 SPLIT SPOON 1 3 6 - 100 8 SPLIT SPOON 1 3 6 - 100 8 SPLIT SPOON 1 5 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6					00.0	SFTTI FIL		
-56.6 17.5 Soils are field visually classified in accordance with the Unified Soils Classification System. Soils are field visually classified in accordance with the Unified Soils Classification System.		soft to firm	100	7	SPLIT SPOON			
Soils are field visually classified in accordance with the Unified Soils Classification System. Soils are field visually classified in accordance with the Unified Soils Classification System. Soils are field visually classified in accordance with the Unified Soils Classification System.			1.55		,	7.		
Soils are field visually classified in accordance with the Unified Soils Classification System. Soils are field visually classified in accordance with the Unified Soils Classification System. Soils are field visually classified USED ON 2" SPLIT SPOON (1 3/8" ID X 2" OD)			ļ		`UU.!			
Soils are field visually classified in accordance with the Unified Soils Classification System. Soils are field visually classified in accordance with the Unified Soils Classification System. 140# HAMMER WITH 30" DROP USED ON 2" SPLIT SPOON (1 3/8" ID X 2" OD)			100	_g	CDI IT CDUUN			
Soils are field visually classified in accordance with the Unified Soils Classification System. 140# HAMMER WITH 30" DROP USED ON 2" SPLIT SPOON (1 3/8" ID X 2" OD)	-56 6 17 F - 56 6		1 100		Δ			
in accordance with the Unified Soils Classification System. USED ON 2" SPLIT SPOON (1 3/8" ID X 2" OD)	00.0 17.3	74444			<u>-00.0</u>	<u>°</u> -		
in accordance with the Unified Soils Classification System. USED ON 2" SPLIT SPOON (1 3/8" ID X 2" OD)						F		
Classification System. (1 3/8" ID X 2" 0D)		Soils are field visually classified			140# HAMMER WITH 30" DF	ROP F		
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	-	=/===//outforf Gyatom.			(10/0 10 / 2 00)	ţ.		
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NG FORM 1830 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NUMBER						├ ²		
	NG FORM 1838 PREVIOUS	EDITIONS ARE OBSOLETE. PROJEC	T '		HOLE I	NUMBER		

DRILLING LOG	DIVISION South Atlantic	INSTAL			istrict		SHEET 1 OF 1
1. PROJECT	Joden Addition				OF BIT See Remark	.s	UF I
San Juan Harbor D 2. LOCATION (Coordinates		11. DAT	UM FOR		ATION SHOWN (TBM or		
X=618,084 Y=220,		MLV		HRER'S	S DESIGNATION OF DRI	71 1	
3. DRILLING AGENCY		Failing 1400					
Corps of Engineers 4. HOLE NO. (As shown on		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: O undisturbed: O					
and file number)	CB-PN94-5				OF CORE BOXES 1		
5. NAME OF DRILLER R. Gordon					JND WATER Tidal		
6. DIRECTION OF HOLE					ARTED COMPLETED		
☑ VERTICAL ☐ INC	LINED		····		/21/94 4/21/94		
7. THICKNESS OF BURDEN	0 Ft				of HOLE -38.3 Ft.		
8. DEPTH DRILLED INTO R					COVERY FOR BORING 7	73 %	
9. TOTAL DEPTH OF HOLE		M. (EUFU	EOLOGIST		
ELEV. DEPTH Q	CLASSIFICATION OF MATERIA (Description)	LS	CORE REC %	SAMPLE NUMBER	REMARI Bit or Ba		BLOWS/
-38.3 .0				0,2	-38.3		
	CLAY, very, soft, very wet, dar gray – black (CH)	k	40	1		Γ SPOON	SETTLET-
-41.3 3.0 -	SILT, with some fat clay,				-41.3		5
-42.8 4.5	yellow-brown, with veins of white clayey silt (MH)		73	2	SPLIT -42.8	r spoon	6 10
	CLAY, firm to stiff, fat, trace weathered rock fragments and shell, gray-green to yellow-ta (CH)		93	3	SPLIT	Γ SPOON	5 - 9 - 18 -
	· •		87	4	SPLIT	Γ SPOON	5 11 17
	trace of black, damp, orgnic material		80	5		Γ SPOON	6 -
			80	6		Γ SPOON	5 10 15
-50.3 12.0 ·			93	7	1.0	SPOON	6 8
	Soils are field visually classifie in accordance with the Unified Classification System.	d Soils			140# HAMMER W USED ON 2" SPL (1 3/8" ID X 2"	IT SPOON	- - - - -
					·		
							1. 1. 1. 1. 1.
ENG FORM 1838 PREVIOUS E	DITIONS ARE OBSOLETE. PROJ		·			HOLE	IUMBER
MAR 71	San		Harbo	r Dee	pening		N94-5

DRILLING LO	G DIVISION South Atlantic	INSTALLATION SHEET 1 Jacksonville District OF 1					
1. PROJECT	South Atlantic				ostrict Of BIT See Remarks	0F 1	
San Juan Harbor		11. DAT	UM FOR		ATION SHOWN (TBM or MSL)		
2. LOCATION (Coordinate X=616,351 Y=218,		MLV				**************************************	
3. DRILLING AGENCY			ling 14		S DESIGNATION OF DRILL		
Corps of Enginee 4. HOLE NO. (As shown of		13. TOT	AL NO.	OF OV	ERBURDEN SAMPLES TAKEN		
and file number)	CB-PN94-7		turbe		undisturbed: 0 of core boxes 1		
5. NAME OF DRILLER					UND WATER Tidal		
R. Gordon 6. DIRECTION OF HOLE		1			ARTED COMPLETED		
⊠ VERTICAL □ IN	CLINED				18/94 4/18/94		
7. THICKNESS OF BURDE	N OFt.				of HoLE −37.4 Ft.		
8. DEPTH DRILLED INTO	ROCK OFt.				COVERY FOR BORING 70 %		
9. TOTAL DEPTH OF HOL	E 13 Ft.	М. (GOff				
ELEV. DEPTH ON S	CLASSIFICATION OF MATERI (Description)	IALS	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/	
<i>−37.4</i> .0					-37.4		
l	CLAY, very, soft, dark gray – black (CH)					SETTLEE- *	
l	DIBCK (CH)					ļ.	
#///	•		60	Ť	SPLIT SPOON	F	
*///						†	
						<u>-</u> -2.	
-40.4 3.0 -	SAND, quartz, fine to medium,				-40.4	6	
	trace clay, gray (SP)					7	
			55	2	SPLIT SPOON	9	
					-42.4	9 -5	
				····		4 -9	
			60	3	SPLIT SPOON	6 -	
					<i>-43.9</i>	8 -	
			:			3	
			20	4	SPLIT SPOON	<u> </u>	
	•			·		SETTLET "	
-45.9 8.5 T					<i>-45.9</i>	<u></u>	
	CLAY, soft, slightly wet, trace coarse sand size rock	?	100	5	SPLIT SPOON	<u> </u>	
	fragments and peat, yellow to)	100	ິວ		SETTLED	
<i> -{///</i> }	brown mottled (CH)				<u>-47.4</u>	2 - 10	
<i> *///</i> 2			100	6	SPLIT SPOON	3	
<i>-:///</i>					-48.9	10	
#///					<u> </u>	6	
			100	7	SPLIT SPOON	10	
<i>-50.4</i> 13.0	<u> </u>			-	-50.4	18 -12	
	Soils are field visually classifier in accordance with the Unified Classification System.	ed d Solls			140# HAMMER WITH 30" D USED ON 2" SPLIT SPOON (1 3/8" ID X 2" OD)		
			The state of the s				
ENG FORM 1838 PREVIOUS		JECT n Juan l	Harbo	r Dee		-22 NUMBER -PN94-7	

Hole No.CB-PN94-9 DRILLING LOG DIVISION INSTALLATION South Atlantic Jacksonville District 10. SIZE AND TYPE OF BIT See Remarks San Juan Harbor Deepening 11. DATUM FOR ELEVATION SHOWN (TBM or MSL) 2. LOCATION (Coordinates or Station) MI W X=614,213 Y=218,205 12. MANUFACTURER'S DESIGNATION OF DRILL 3. DRILLING AGENCY Failing 1400 Corps of Engineers 13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN 4. HOLE NO. (As shown on drawing title and file number) disturbed: 0 undisturbed: 0 CB-PN94-9 14. TOTAL NUMBER OF CORE BOXES 2 5. NAME OF DRILLER R. Gordon 15. ELEVATION GROUND WATER Tidal 6. DIRECTION OF HOLE **STARTED COMPLETED** 4/15/94 4/15/94 16. DATE HOLE 17. ELEVATION TOP OF HOLE -3.5 Ft. 7. THICKNESS OF BURDEN O Ft. 18. TOTAL CORE RECOVERY FOR BORING 65 % 8. DEPTH DRILLED INTO ROCK OFt. 19. SIGNATURE OF GEOLOGIST 9. TOTAL DEPTH OF HOLE 43.5 Ft. M. GOff SAMPLE NUMBER EGEND. ELEV. DEPTH CLASSIFICATION OF MATERIALS CORE .0WS/ REMARKS (Description) REC Bit or Barrel 面 -3.5 0 -3.5CLAY, very soft to soft, wet, trace shell, silt and sand, dark SETTLE gray to brown (CH) -2.5 24 1 SPLIT SPOON -7.5SETTLE 60 2 SPLIT SPOON 10 -16.0 SETTLE 100 3 SPLIT SPOON -17.5 SETTLE 60 4 SPLIT SPOON -20.5 SETTLE -17.5 76 5 SPLIT SPOON -23.0 SETTLE 76 6 SPLIT SPOON -25.5 SETTLET-22.5

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT San Juan Harbor Deepening

60

7

(continued)

HOLE NUMBER CB-PN94-9

SPLIT SPOON

JECT JECT	LOG	(Cont. Sheet)	TOP OF HOL	-3	.5 Ft.	SHEET 2 OF 2
San Juan Ha	rbor D	Deepening J	NSTALLATIO Jackson		District	
EV. DEPTH	LEGEND	CLASSIFICATION OF MATERIAL (Description)	S CORE	SAMPLE	REMARKS Bit or Barrel	BLOWS/
2 <u>6.0</u> 22.5			60	7	SPLIT SPOON	
1			100	8	-28.5 SPLIT SPOON -30.0	SETTLE
		_	100	9	SPLIT SPOON	SETTLE
		•	100	10	SPLIT SPOON -33.5	SETTLE
			100	11	SPLIT SPOON	SETTLE
			100	12	SPLIT SPOON -36.5	2 SETTLE
		CLAY, soft to firm, fat, trace silt, yellow-brown (CH)	73	13	SPLIT SPOON -38.0 SPLIT SPOON	1 2 4 5
		firm to stiff	73	15	-39.5 SPLIT SPOON	6 2 4
		-	60	16	-41.0 SPLIT SPOON	12 6 8 16
			47	17	-42.5 SPLIT SPOON -44.0	7 10 18
			67	18	SPLIT SPOON -45.5	6 16 24
17.0 43.5		stiff to very stiff	67	19	SPLIT SPOON	7 10 22
		Soils are field visually classified in accordance with the Unified So Classification System.	ils		140# HAMMER WITH 30" DI USED ON 2" SPLIT SPOON (1 3/8" ID X 2" OD)	ROP
		SAMPLE LABORATORY ELEVATION CLASSIFICATIO -11.0/-16.0 (CH)39.0/-30.5 (CH)	N			
 	- 1	*Visual classifiction based on Gradation Curve. No Atterberg Limits.	en en en en en en en en en en en en en e			;
FORM 1836 PREV	TOUS ED	ITTIONS ARE OBSOLETE. PROJECT			Lucie	NUMBER

Hole No.CB-SJH00-16								
DRILLING	LOG	DIVISION South Atlantic	INSTAL		iN ille Di		HEET I OF I	
PROJECT		Octil Atlanto	1			OF BIT See Remarks	<u> </u>	
San Juan Hai						VATION SHOWN (TEM OF MSL)		
. LOCATION (Co X=610,241 Y						5201/NGVD 29 MLW		
, DRILLING AGEN	VCY		12. MANUFACTURER'S DESIGNATION OF DRILL Acker Tripod on Barge					
Corps of Eng	gineers					VERBURDEN SAMPLES TAKEN		
. HOLE NO. (As s and file number			dist	urbec	1: 7	undisturbed: 0		
NAME OF DRILL		CB-SJH00-16	14. TOT	TAL NU	MBER	OF CORE BOXES		
L. C. Gregory			16. ELE	VATIO	N GRO	UND WATER tidal		
. DIRECTION OF			16. DAT	E HOL		TARTED COMPLETED		
VERTICAL		CLINED	<u> </u>			0/07/00 10/07/00		
. THICKNESS OF	BURDE	N OFt.	—			OF HOLE -20.8 Ft.		
, DEPTH ORILLE						COVERY FOR BORING 51 %		
, TOTAL DEPTH			1	na tur 'apier		EOLOGIST		
ELEV. DEPTH	LEGEND	CLASSIFICATION OF MATERIAL (Description)	LS	CORE REC	도띪	REMARKS	BLOWS/	
		(Description)		X	₹ĕ	Bit or Barrel	2"	
	=				ωz.		i m	
- <i>20.8</i> 0.0						-20.8		
		CLAY, silty, very soft, saturated	1,				WOR	
1 7		dark gray, (CH).					WOR	
-							WOR	
-					Ι.		WOR	
-				20	<u> </u> D–1	5' X 1 3/8" ID SPOON	WOR -	
-					"		WOR -	
7							WOR	
_							WOR	
-25.3 4.5 -						_3E 3	WOR	
-25.3 4.5	I	LIMESTONE, coral, soft,		_		-25.3	4	
-		interlayered with clay and		67	١	SPLIT SPOON	20	
	II]	occasional shells, gray to green	١,	07	2		—	
	II]	(LM).			<u> </u>	-26.8	5	
-	II!			İ	Ì		14	
1 :	II			47	3	SPLIT SPOON	15	
	ΙĪ]			L		-28.3	5 -	
	1						<u> </u>	
	1 ‡ ‡			14	N/S	SPLIT SPOON	5 -	
-	1± d					29.8	6	
:	1 <u>+</u> 1						6	
	II			47	[4,	SPLIT SPOON	6	
-	II!			l	D-4	-31,3	7	
:	t It			 		-51,5	4	
<u> </u>	[I			53	5	SPLIT SPOON	5	
-	1			93	ľ		9	
-	₹‡‡					-32.8		
	1 1 1				_	ON 17 00001	5 -	
	17			67	6	SPLIT SPOON	4	
	1I]	•		L		-34.3	5 -	
- 1	III			l			2	
1	trt			40	N/S	SPLIT SPOON	4	
	∃∓∃			L	L	-35,8	6 -	
-	<u></u> 1 →			l			1 -	
1 -	1# #						6	
	17 1			۱.	_	et at to tour on one or	7	
:	[⊥]			33	7	5' X 1 3/8" ID SPOON	10	
1 -	I			l			10	
_	1 1					20.0	9	
30 6 45 5	IIL					-38.8		
-38.8 18.0 ·	1			I	l	140# Hammer with 30" drop us	ed 🕻	
-38.8 18.0	<u> </u>	NOTES:		1	1		/ ภบ - T	
-38.8 18.0 -	<u> </u>	NOTES:				2.0' split spoon (1 3/8" I.D. X 0. D.) or 5' X 1 3/8" ID spoon	(2" 	
-38.8 18.0 ·		1. Soils are field visually	_			O. D.) or 5' X 1 3/8" ID spoon Wash to depth before spoon	(2" 	
-38.8 18.0		Soils are field visually classified in accordance with th				O. D.) or 5' X 1 3/8" ID spoon	(2" 	
-38.8 18.0 -		1. Soils are field visually				O. D.) or 5' X 1 3/8" ID spoon Wash to depth before spoon	(2" 	
38.8 18.0 -		Soils are field visually classified in accordance with th				O. D.) or 5' X 1 3/8" ID spoon Wash to depth before spoon	(2" 	
38.8 18.0 -		Soils are field visually classified in accordance with th				O. D.) or 5' X 1 3/8" ID spoon Wash to depth before spoon	(2" 	
38.8 18.0 -		Soils are field visually classified in accordance with th				O. D.) or 5' X 1 3/8" ID spoon Wash to depth before spoon	(2" 	
38.8 18.0 -		Soils are field visually classified in accordance with th			maria de la compansa de la compansa de la compansa de la compansa de la compansa de la compansa de la compansa	O. D.) or 5' X 1 3/8" ID spoon Wash to depth before spoon	(2" 	
38.8 18.0 ·		Soils are field visually classified in accordance with th				O. D.) or 5' X 1 3/8" ID spoon Wash to depth before spoon	(2" 	
		Soils are field visually classified in accordance with th Unified Soils Classification Systems				O. D.) or 5' X 1 3/8" ID spoon Wash to depth before spoon	(2"	

Hole No.CB-SJH00-31 DRILLING LOG DIVISION **NSTALLATION** South Atlantic Jacksonville District 10. SIZE AND TYPE OF BIT See Remarks 18. DATUM FOR ELEVATION SHOWN (TEN of MSC) NAD 27 PR VI 5201/NGVD 29 MLW San Juan Harbor, Puerto Rico 2. LOCATION (Coordinates or Station) X=814,821 Y=228,881 12. HANDFACTUREA'S DESIGNATION OF DRILL DRILLING AGENCY Acker Tripod on Barge
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN Corps of Engineers L. HOLE NO. (As shown on drawing little disturbed: 6 undisturbed: 0 and He number) CB-SJH00-31 5. NAME OF DRILLER 14. TOTAL NUMBER OF CORE BOXES | L. C. Gregory 16. ELEVATION GROUND WATER Tidal STARTED COMPLETED 10/03/00 10/03/00 16. DATE HOLE ☑ VERTICAL ☐ INCLINED 17. ELEVATION TOP OF HOLE -28.9 Ft. 7. THICKNESS OF BURDEN OFT 18. TOTAL CORE RECOVERY FOR BORING 48 % LOEPTH DRILLED INTO ROCK OFt. 19. SIGNATURE OF GEOLOGIST 9. TOTAL DEPTH OF HOLE 9.0 Ft. C. Papiernik CORE SANS ELEV. DEPTH CLASSIFICATION OF MATERIALS BLOWS/ REMARKS (Description) Bit or Barrel 0,0 -28.9 -28,9 SAND, sifty with little shells, very WOR loose, saturated, dark gray. 87 SPLIT SPOON WOR D-1 30,4 WOR WOR 20 SPLIT SPOON HON -2.5 3 -31.9 -32,2 6 CLAY, fat, stiff, moist, trace sand in upper 1/2 foot, brown. (CH) 47 SPLIT SPOON ₿ D-3 В -3*3.4* Stiff sample slipped out of spoon 4.5-6 feet. 18 -6 n SPLIT SPOON 14 9 -34.9 25 4 -35.6 .67 SPLIT SPOON LIMESTONE, weathered, hard with clay lenses, tan. (LM) 18 5 36.4 20 -7.5 76 6 67 SPLIT SPOON 43 -37.9 56 37.9 140# Hammer with 30" drop used NOTES: 2.0' split spoon (1 3/8" I.D. X 2" 0. D.) Wash to depth before split -10 1. Soils are field visually spoon advancement, classified in accordance with the Unified Soils Classification System. 12.5 17.5 -20 22.5 ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. HOLE NUMBER San Juan Harbor, Puerto Rico CB-SJH00-31

DRILLING LO	C DIVISION	INSTAL				HEET !	
PROJECT	South Atlantic		ksonvi		strict OF BIT See Remarks	OF 1	
San Juan Harbor,		II. DATUM FOR ELEVATION SHOWN (TOM or MSL)					
LOCATION (Coordin		NAD 27 PR VI 5201/NGVD 29 MLW 12. NANUFACTURER'S DESIGNATION OF DRILL					
X=618,629 Y=22 DRILLING AGENCY	0,020				s designation of unit. In Barge		
Corps of Enginee		13. 101	AL NO.	OF O	VERBURDEN SAMPLES TAKEN		
. HOLE NO. (As shown and file number)	on drawing title CB-SJH00-38	dist	turbed	l: 5	undisturbed: 0		
NAME OF DRILLER	CB-30H00-36				OF CORE BOXES 1		
L. C. Gregory					UND WATER tidal		
. DIRECTION OF HOLE		10. DA1	re Holi		TARTED COMPLETED 1/17/00 10/17/00		
☑ VERTICAL ☐	INCLINED	17 FI F	VATIO		OF HOLE -26.2 Ft.		
, THICKNESS OF BUR	DEN OFt.				COVERY FOR BORING 49 %		
, DEPTH DRILLED IN		19. SIG	NATUR	E OFG	EOLOGIST		
. TOTAL DEPTH OF H	DLE 12.5 Ft.		apier				
ELEV. DEPTH R	CLASSIFICATION OF MATERIA (Description)	LS	CORE REC	SAMPLE	REMARKS Bit or Barrel	BLOWS/	
-26.2 0.0					-26.2		
	CLAY, silty, trace sand to 5',					WOR -	
1 1/	very soft, organic, plastic,					WOR -	
1 4/	saturated, dark gray, (CH).					WOR	
1 1/2	4					WOR -	
1 1/	1		20	1	5' X 1 3/8" ID SPOON	WOR	
1//	1		20	D-I	0 V 10\0 ID 0L00M	WOR -	
1/	7		'	1	1	WOR	
- 4/2	4		1			WOR	
1 1/	1		[WOR	
1/	1				-31.2	WOR -	
	1					WOR -	
1 1/	a		1			WOR -	
-1/	1					WOR	
1/	CLAY as above, less sand with depth					WOR	
1/	1 deptil		79	2	5' X 1 3/8" ID SPOON	WOR -	
- //	3		1			WOR -	
1/2	A					WOR -	
1 1/2	1		l			WOR -	
1/	CLAY as above, turning green and more firm at 9'.		1		-35.7	WOR -	
//	7		-	3,0-3		5 -	
	CLAY, sandy, stiff, plastic, cohesive, moist, light gray,		73		SPLIT SPOON	11	
1 1/2	beginning at 10.0.			4	-37,2	12	
1/	1		-	\vdash	V. 1.2	5	
1/	1		33	5_	SPLIT SPOON	12 -	
-38.7 12.5				D - 5	-38,7	17	
<i>−38.7</i> 12.5			\vdash	1	140# Hammer with 30" drop u	sed F	
]	NOTES:				5.0' spoon (13/8" I.D. X 5')	or 2' -	
1 -	Soils are field visually			1	X 13/8"ID split spoon, Wash	to F	
I I	classified in accordance with the	he		1	depth before spoon advance	ment.	
I 3	Unified Soils Classification Syst			1		ţ	
					Į.	F	
1 3						į.	
				1		Ŀ	
7			1			ţ	
l I	1					t	
l I						-	
1 7						Ŀ	
1 7			1			Ŀ	
1	***					E	
‡						E	
	1			Į.		E	
1					1	F	
1 -			1			F	
4						F	
-			1	1	l .	E	
 					1	- F	
1						F	
1	IOUS EDITIONS ARE OBSOLETE. PRO	DJECT			HOLE N		

1011 ING NC	UIAIZION	INSTALL				HEET I	
DRILLING LOG	South Atlantic	Jacks			trict OF BIT See Remarks	0F 2	
San Juan Harbor, Pu		II. DATUM	FOR	ELEV	ATION SHOWN (TBM or MSL)		
LOCATION (Coordinate		NAD 2	27 PI	R VI 5	5201/NGVD 29 MLW		
X=618,544 Y=227,8 DRILLING AGENCY	144	12. MANUFACTURER'S DESIGNATION OF DRILL Acker Tripod on Barge					
Corps of Engineers		13. TOTAL	L NO.	OF OV	ERBURDEN SAMPLES TAKEN		
HOLE NO. (As shown on and file number)	CB-SJH00-39	distur			undisturbed: 0		
NAME OF DRILLER	55 34,45				OF CORE BOXES 1		
D. Hewilt		15. ELEVA			UND WATER Tidal ARTED COMPLETED		
DIRECTION OF HOLE SVERTICAL □ INC	34 TAKE D	IO. DATE	HULL		/18/00 10/18/00		
		17. ELEV	ATIO	N TOP	OF HOLE -14.6 Ft.		
THICKNESS OF BURDE		18. TOTAL	L CO	RE REC	COVERY FOR BORING 53 %		
DEPTH DRILLED INTO I		7			EOLOGIST		
TOTAL DEPTH OF HOLE	24.5 Ft.	C. Pa				$\overline{}$	
ELEV. DEPTH S	CLASSIFICATION OF MATERIA (Description)	LS CO	ORE REC *	SAMPLE	REMARKS Bit or Barrel	BLOWS/	
-14,6 0.0					-14.6		
74.0 °°° LW	PEAT, trace fine sand and shells	s,				WOR -	
1 444	very soft, saturated, brown,		1			WOR	
1 4111	(OL).					WOR	
						WOR -	
		ļ	20	1	5' X 1 3/8" ID SPOON	WOR -	
<u> </u>			4۷	D-1	A VIOLO TO DECOM	WOR	
15		1				WOR	
						WOR	
I III						WOR	
I III	Clean organic debris (peat)	Ĺ			-19.6	WOR -	
그 그새	beginning at 5'.					WOR	
1 122	20gg 21 21					WOR	
 		- [WOR	
I III						WOR	
1 444		1	30	2	5' X 3/8" ID SPOON	WOR -	
1 711			30	2	5 X 1 3/6 10 3 OON	WOR -	
						WOR -	
 						WOR	
1 1111						WOR	
1 133					-24.6	WOR	
I TW						WOR -	
<u> </u>						WOR	
1 344		1	20		5' X 1 3/8" ID SPOON	WOR	
1 333						WOR	
-27.1 12.5 UU					-27,1	WOR	
	CLAY, soft, moist, light gray,	1		3			
	(CH).	İ	100	0-3	SPLIT SPOON	2	
1//		Į.			-28.6	2	
1 1//				4		2	
-29.6 15.0			100		SPLIT SPOON	7	
	SAND, clayey, clay content varies with depth, dense, moist,			5	-30.1	13	
	varies with depth, dense, ilioist, light green, (SP-SC).	·		6		7	
	.		67	D-6	SPLIT SPOON	13	
1 1/1		ļ.		ļ <u> </u>	-31.6	20	
		l		_	ON IT COOK!	10	
		1	80	7	SPLIT SPOON	12	
			-	ļ	-33./	15	
						B	
			100	8	SPLIT SPOON	12	
				<u> </u>	-34.6	19	
				1		7	
-35.6 21.0			87	9	SPLIT SPOON	13	
7///	SAND, fine grained, quartz, tra	ce			-36.1	19	
<u> </u>	medium sand and sitt, dense, saturated, white, (SP).		60	10	SPLIT SPOON	3	
	Saturator, Wille, (SI).			D-10	1	12	
							
	S EDITIONS ARE OBSOLETE. PRO	DJECT			(continued)		

·	LUG	(Cont. Sheet)	ELEVATION TO	OF HUL		.6 Ft.	HEET 2
DJECT			INST	ALLATIO ackson	N		0F 2
San Juan Ha	irbor, r	derto Rico	(00	CKSOM	(lie Di	strict	
.EV. DEPTH	LEGEND	CLASSIFICATION OF (Description	MATERIALS n)	CORE REC	SAMPLE	REMARKS Bit or Barrel	BLOWS/
·37.1 22.5				60		-37.6 SPLIT SPOON	26
39.1 24.5				67	#	SPLIT SPOON -39.1	7 30 63
		NOTES: 1. Soits are field visual classified in accordance Unified Soils Classification of the control of the c	PROJECT			140# Hammer with 30" drop u 2.0' split spoon (1 3/8" I.D. O. D.) or 5' X I 3/8"ID spoon Wash to depth before spoon advancement.	

INSTALLATION SHEET DIVISION DRILLING LOG Jacksonville District of 1 SHEETS South Atlantic See remarks PROJECT 10. SIZE AND TYPE OF BIT 11. DATUM FOR ELEVATION SHOWN (TBM or MSL) San Juan Harbor X=612,547 Y=218,864 LOCATION (Coordinates or Station) MLW
12. MANUFACTURER'S DESIGNATION OF DRILL DRILLING AGENCY Acker Drive Head Corps of Engineers UNDISTURBED DISTURBED TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN HOLE NO. (As shown on drawing title and file number) CB-SJH-8 14. TOTAL NUMBER CORE BOXES part (1/2) S. NAME OF DRILLER 15. ELEVATION GROUND WATER H. Sierra Tidal STARTED COMPLETED 6. DIRECTION OF HOLE 16. DATE HOLE 3-27-72 3-27-72 VERTICAL __INCLINED_ -39.217. ELEVATION TOP OF HOLE 7. THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING 61% 8. DEPTH DRILLED INTO ROCK 19. WELLENDERSON HIS NEW YORK GEOLOGIST: 10.5' 9. TOTAL DEPTH OF HOLE SAMPLE NO. REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) CLASSIFICATION OF MATERIALS (Description) % CORE RECOV-ERY ELEVATION DEPTH LEGEND ď . BIT OR BARREL -39.2 Bls/0.5 ft. -39.2 CLAY, very soft, gray settled (CL) SPLIT SPOON 38 1 -40.2 -40.7 pushed CLAY, yellowish brown, stiff, 11 sandy (CH), limestone 77 8 and sandstone cobbles, -42.2 8 fragments, some 14 weathered, some not, range from soft to hard 3 44 6 -43.2 4.0 from -40.7 to -43.2-43.710 LIMESTONE, sandy, medium hard <u>17</u> 11 with hard layers, clay-15 ey, yellowish -45.2 27 15 **11** 23 -55 $\mathbf{I}\mathbf{0}$ -46.7 11 88 18 48.2 28 19 72 21 -49.7 10.5 -49.7 26 140# hammer with 30" drop used on 2.0' split spoon. (1-3/8" I.D. X 2" 0.D.) ENG FORM 18 36 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO.

San Juan Harbor

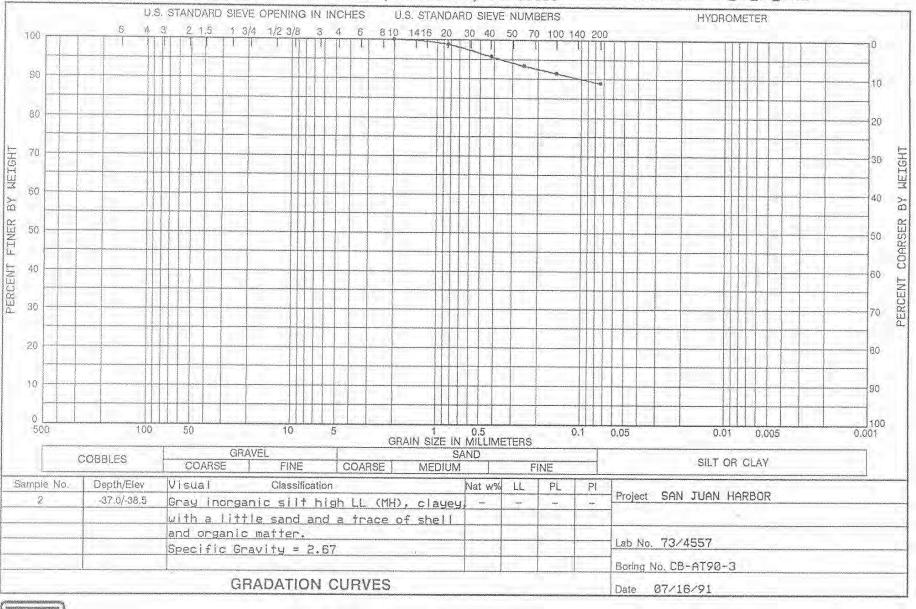
CB-SJH-8

1.11 Laboratory Testing

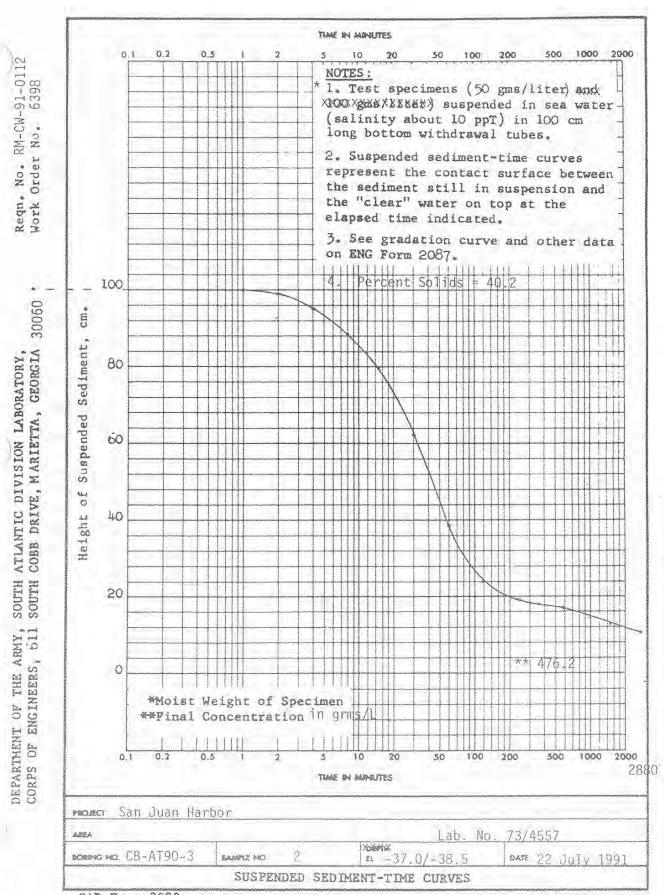


WORK ORDER: 6398

REQUISITION: RM_CW_91_0112

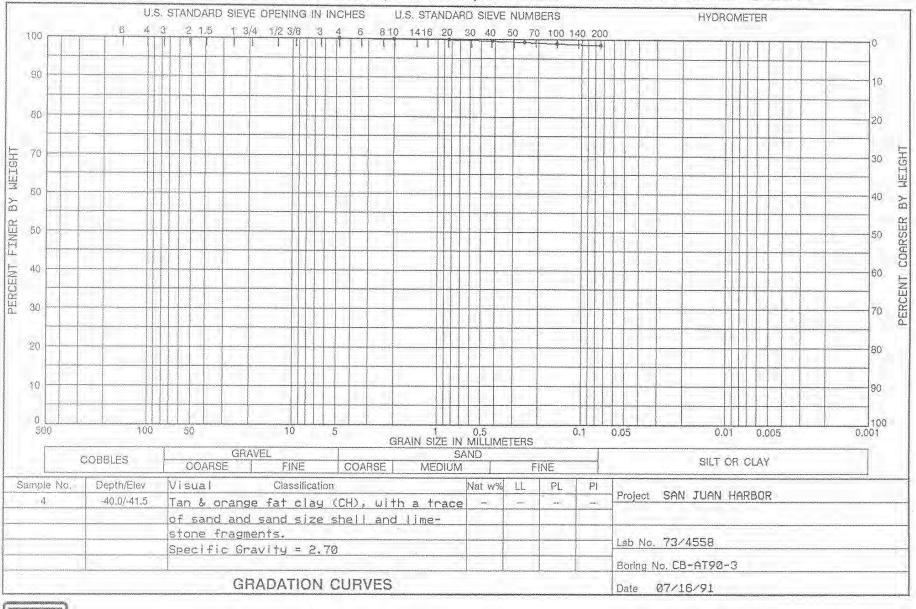






WORK ORDER: 6398

REQUISITION: RM_CW_91_0112

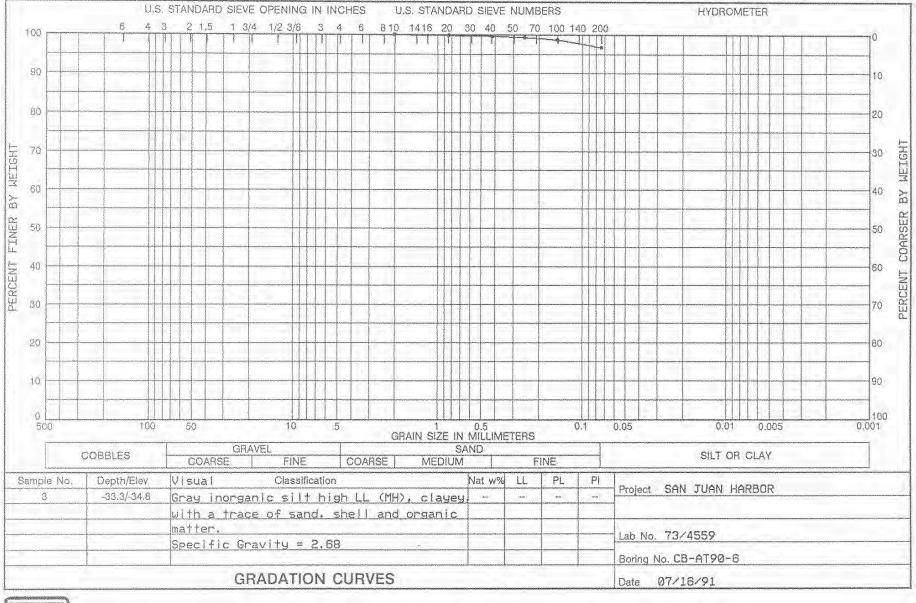




SAD Form 3023 26 Oct 72

WORK ORDER: 6398

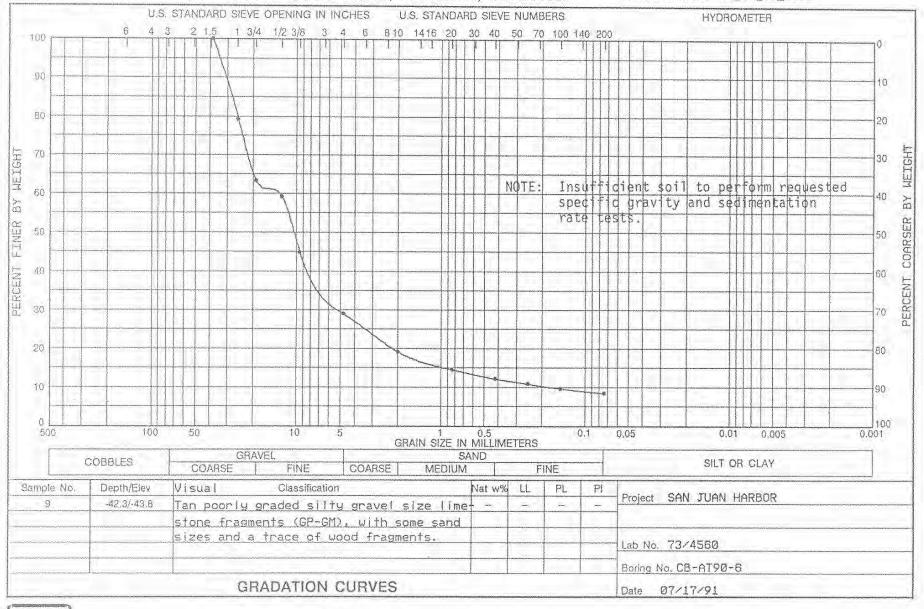
REQUISITION: RM_CW_91_0112





WORK ORDER: 6398

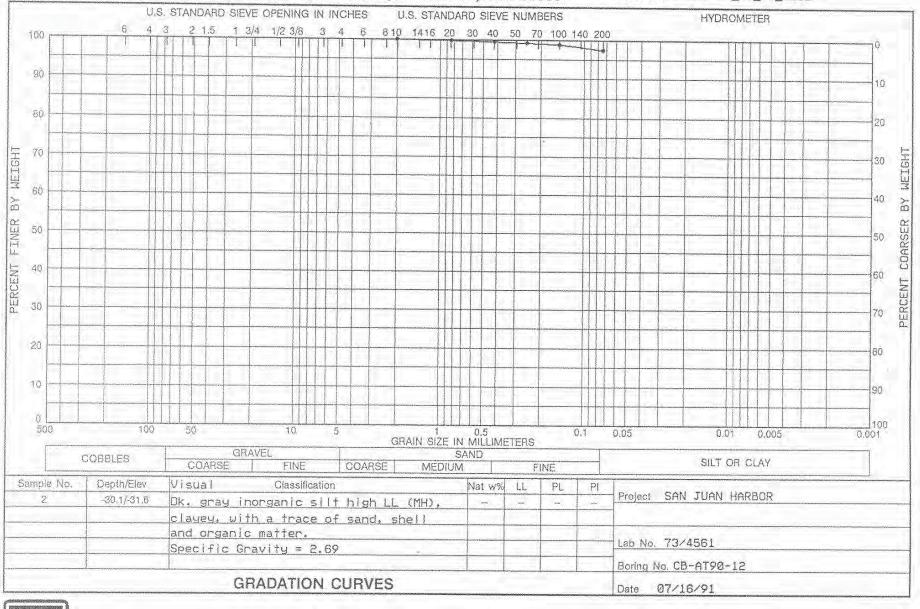
REQUISITION: RM_CW_91_0112



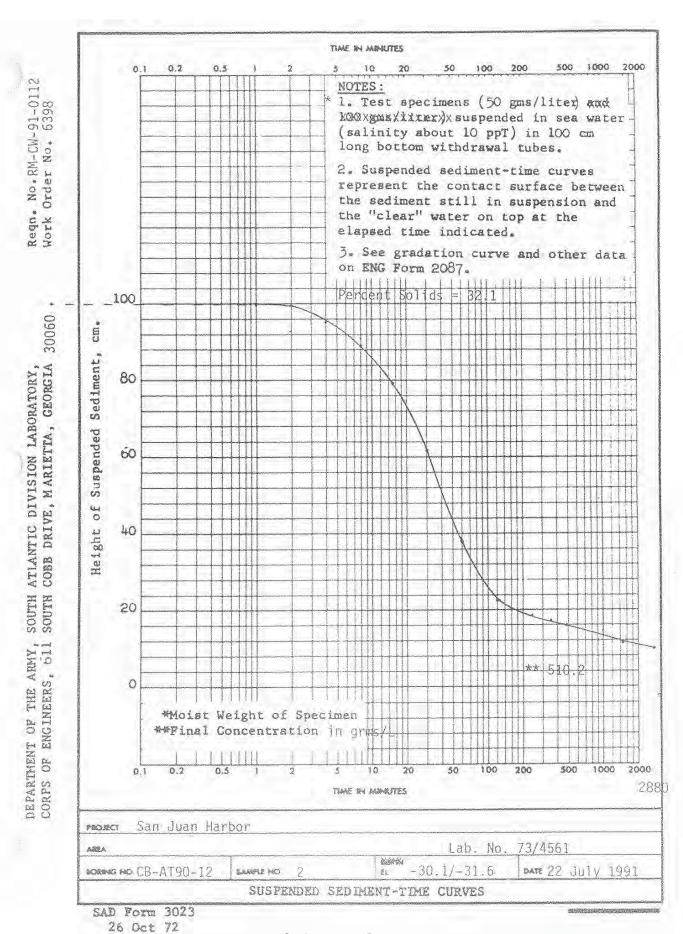


WORK ORDER: 6398

REDUISITION: RM_CW_91_0112

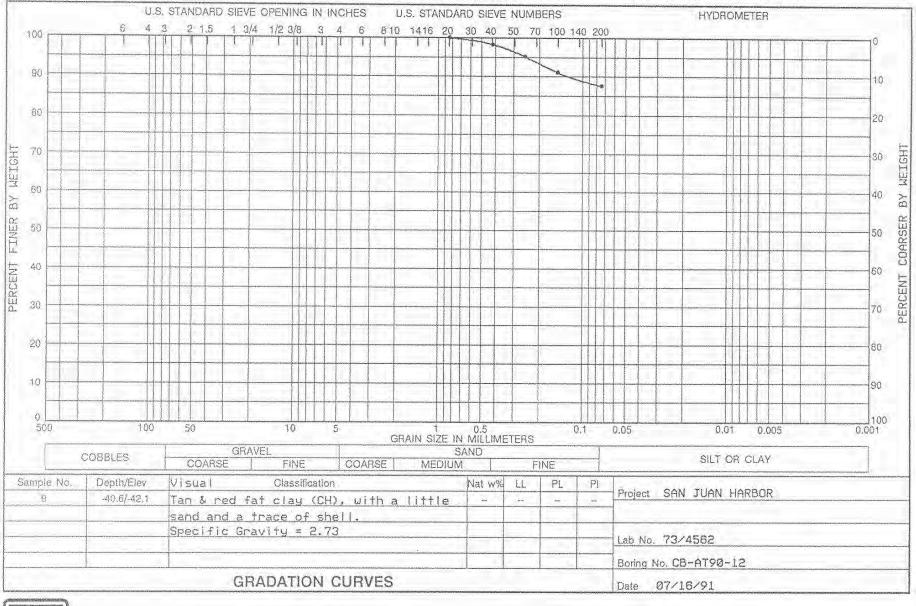






WORK ORDER: 6398

REQUISITION: RM_CW_91_0112

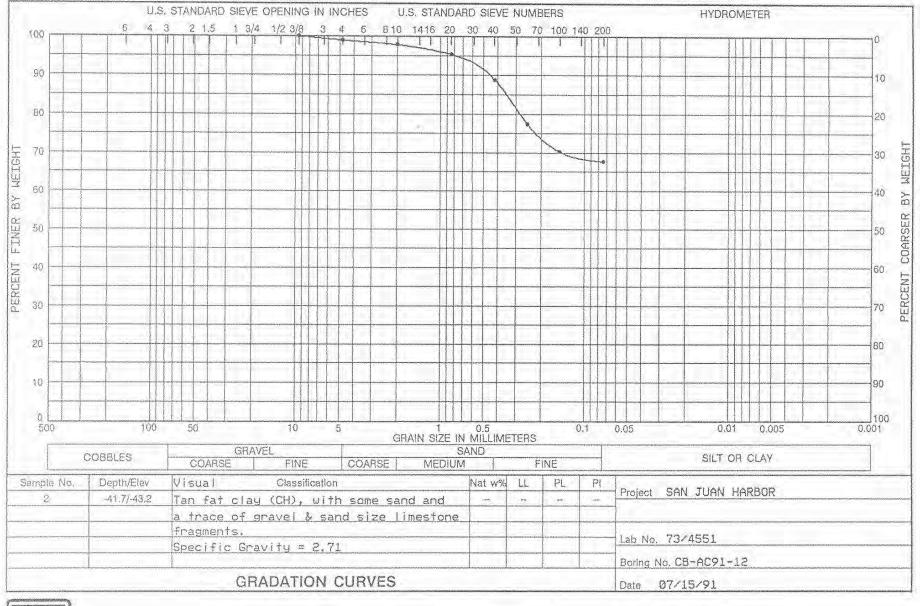




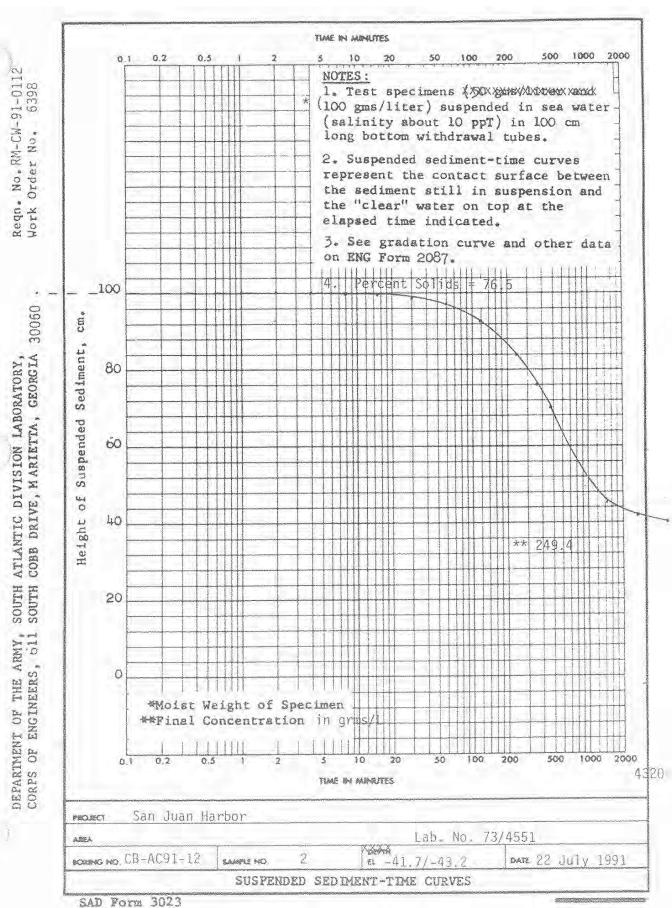
SUSPENDED SEDIMENT-TIME CURVES

WORK ORDER: 6398

REQUISITION: RM_CW_91_0112

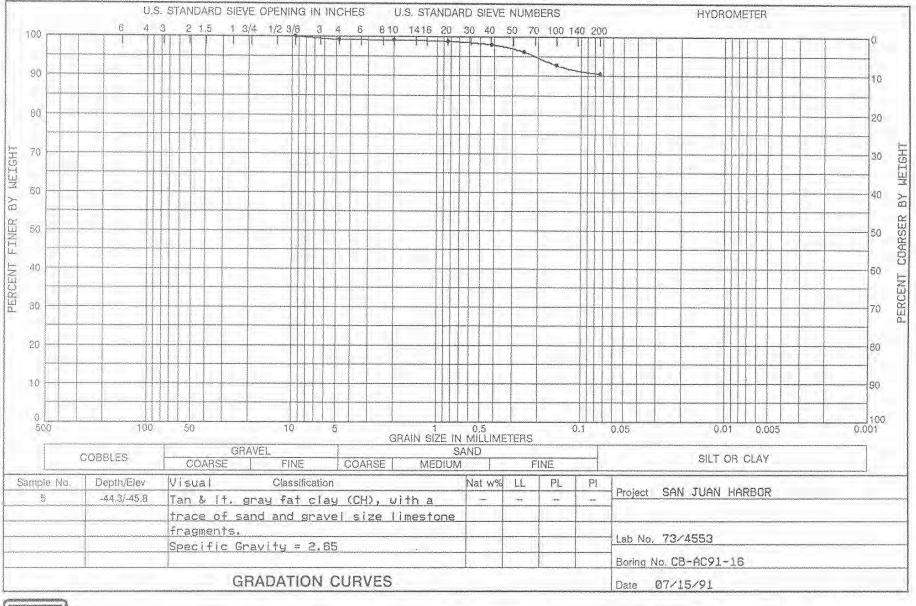






WORK ORDER: 6398

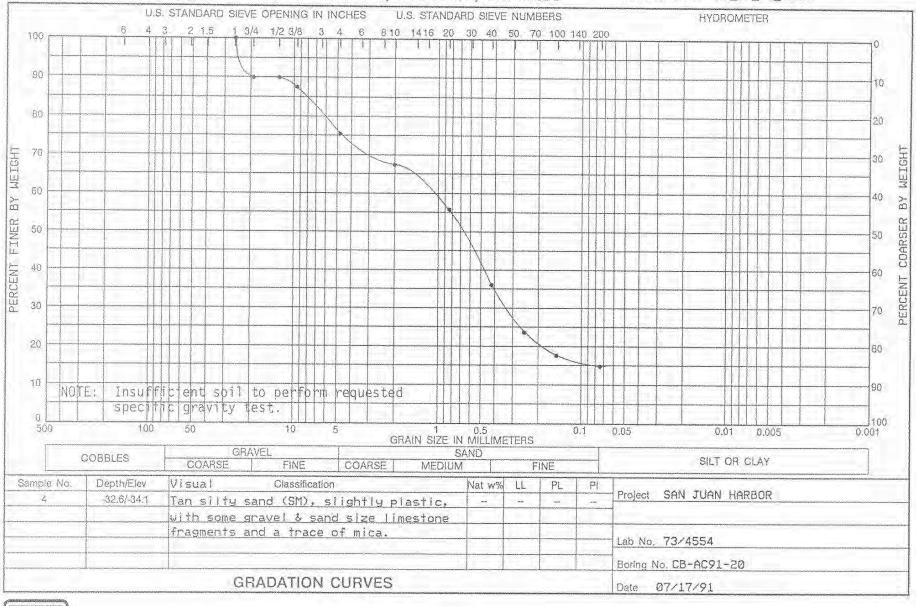
REQUISITION: RM_CW_91_0112



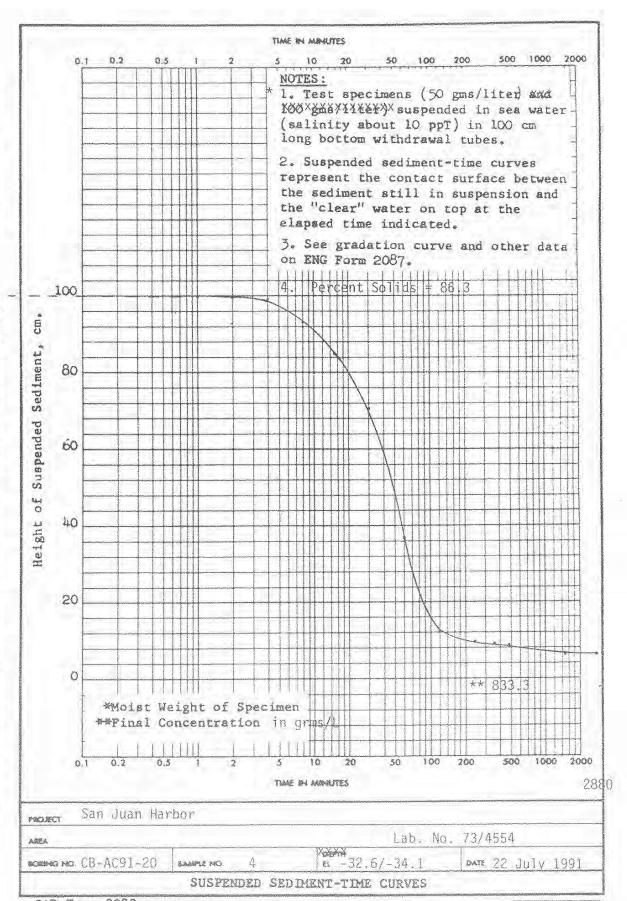


WORK ORDER: 6398

REQUISITION: RM_CW_91_0112

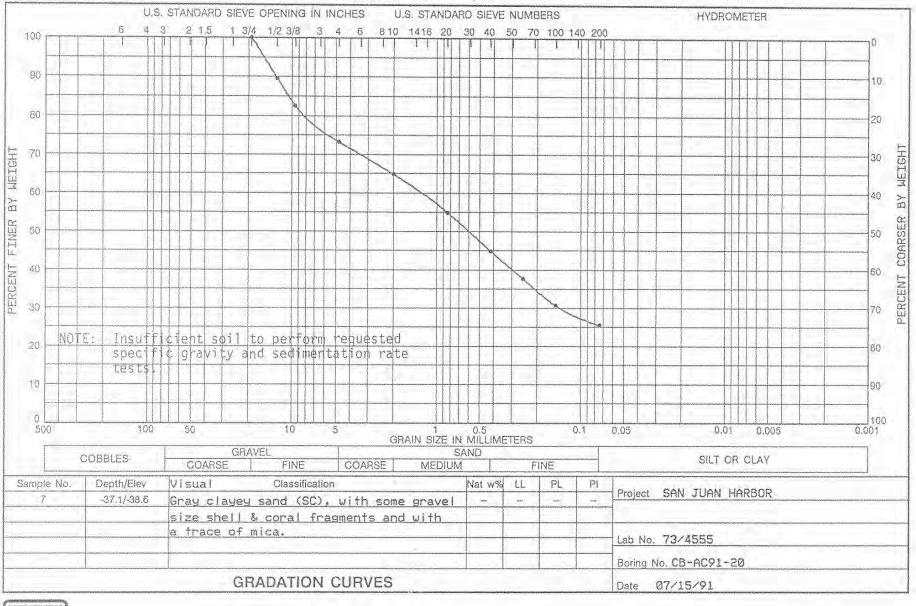






WORK ORDER: 6398

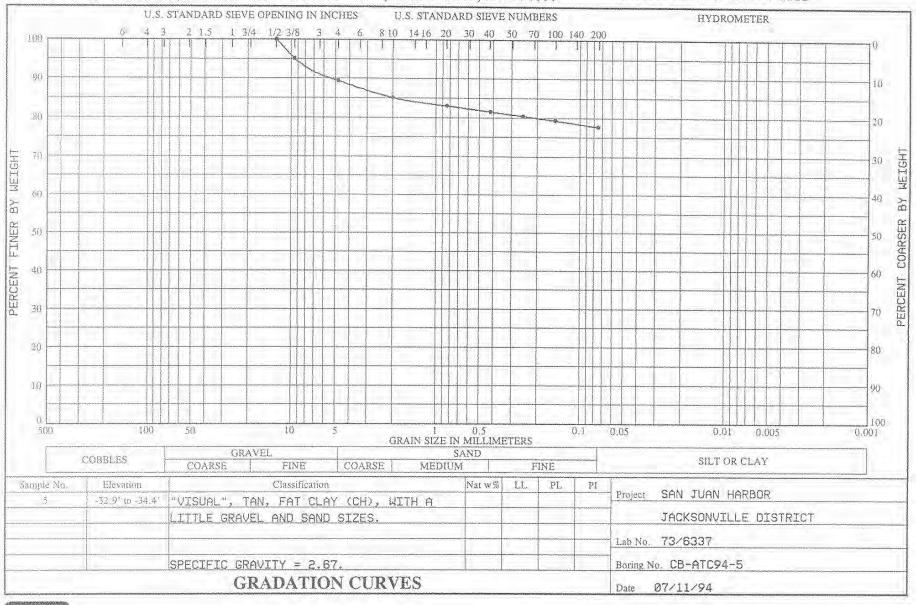
REQUISITION: RM_CW_91_0112





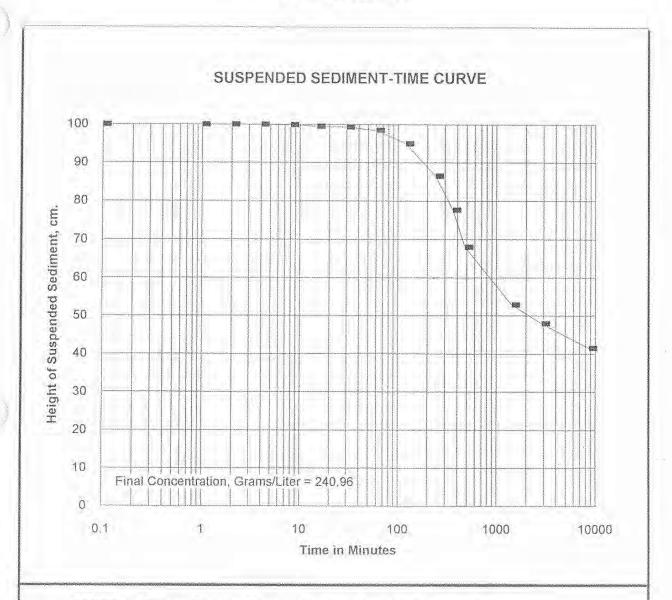
WORK ORDER: 7302

REQUISITION: RM-CW-94-0112





U.S. ARMY CORPS OF ENGINEERS SOUTH ATLANTIC DIVISION LABORATORY MARIETTA, GEORGIA

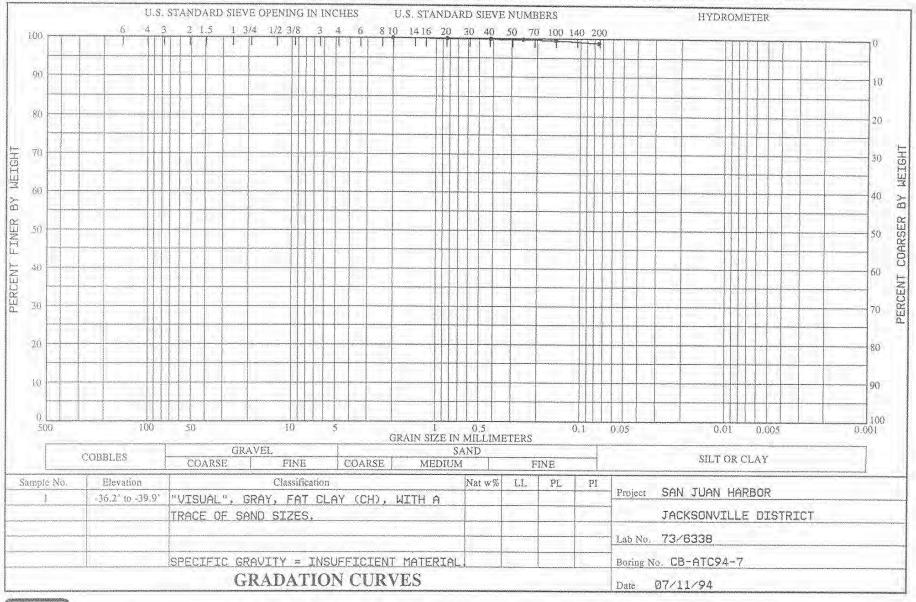


- NOTES: 1. Test specimens (100 grams/ liter ,moist weight of specimen) suspended in sea water(salinity about 10 ppT) in 100 cm. long bottom withdrawal tubes.
 - 2. Suspended sediment-time curves represent the contact surface between the sediment still in suspension and the "clear" water on top at the elapsed time indicated.
 - 3. See grain-size data on enclosed gradation curve.
 - 4. Percent Solids = 72.94

PROJECT: San Juan Harbor			REQ'N NO:	RM-CW-94-0112
			W.O. NO:	7302
AREA:		**************************************	DATE RECEIVED:	4-May-94
			DATE REPORTED:	13-Jul-94
BORING NO:	CB-ATC94-5	ELEV:	-32.9 to -34.4	
SAMPLE NO:	5	LAB NO:	73 / 6337	

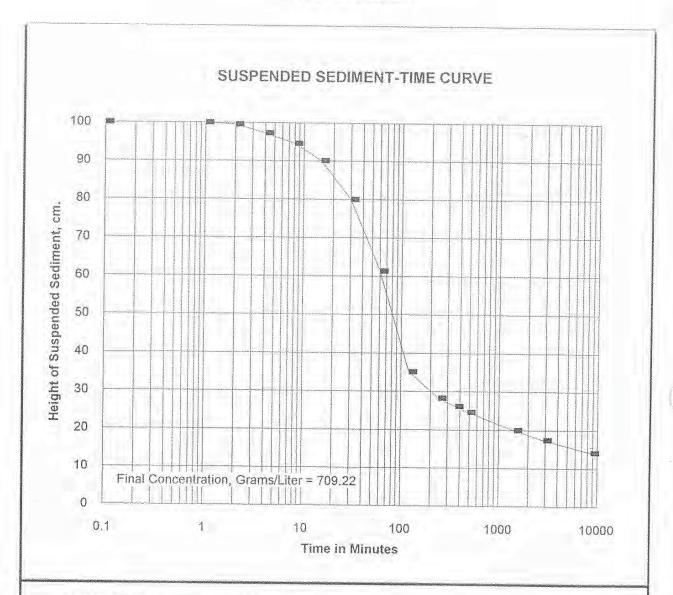
WORK ORDER: 7302

REQUISITION: RM-CW-94-0112





U.S. ARMY CORPS OF ENGINEERS SOUTH ATLANTIC DIVISION LABORATORY MARIETTA, GEORGIA



- NOTES: 1. Test specimens (100 grams/ liter ,moist weight of specimen) suspended in sea water(salinity about 10 ppT) in 100 cm. long bottom withdrawal tubes.
 - Suspended sediment-time curves represent the contact surface between the sediment still in suspension and the "clear" water on top at the elapsed time indicated.
 - 3. See grain-size data on enclosed gradation curve.
 - 4 Percent Solids = 40.06

PROJECT: San Juan Harbor		REQ'N NO:	RM-CW-94-0112	
			W.O. NO:	7302
AREA:			DATE RECEIVED:	4-May-94
			DATE REPORTED:	13-Jul-94
BORING NO:	CB-ATC94-7	ELEV:	-36.2 to -39.9	
SAMPLE NO:		LAB NO:	73 / 6338	