



US Army Corps  
of Engineers®  
Jacksonville District

# 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

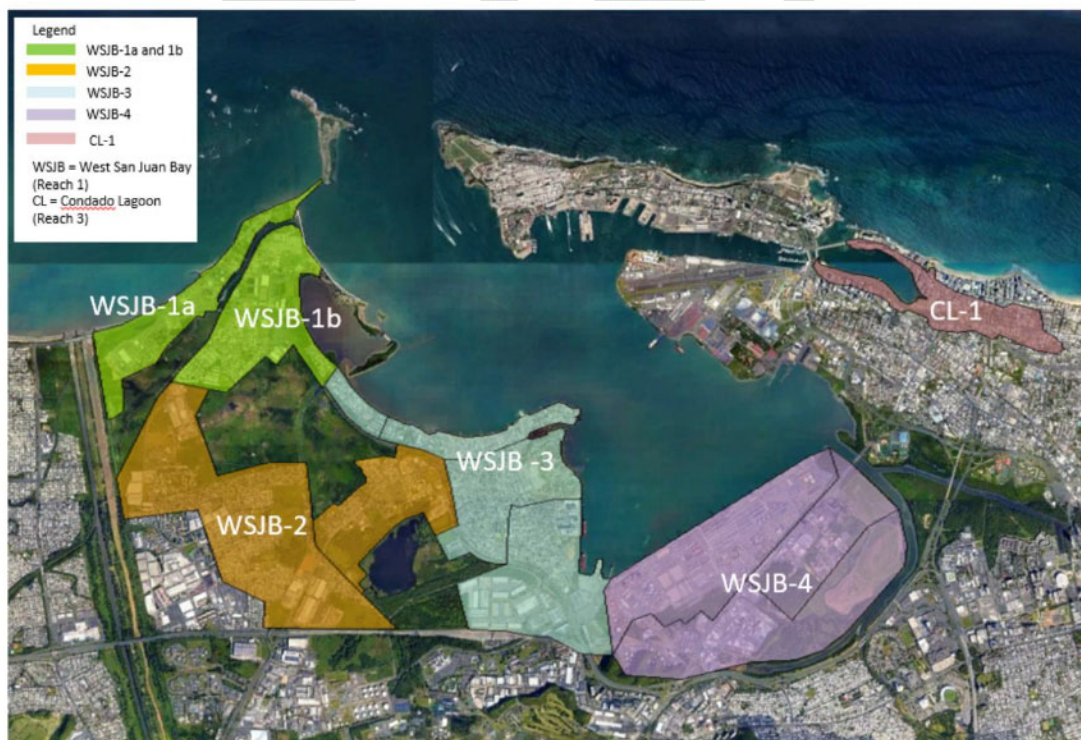
The San Juan Metro Area Coastal Storm Risk Management Study is currently investigating areas vulnerable to flooding in the Back Bay due to storm surge. The study is currently assessing six (6) planning reaches, as named and abbreviated shown in **Table 1** and **Figure 1**.

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.

**Table 1: Study Area.**

| 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                    |

**Figure 1: General Location Map of Study.**





## 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 earthquakes, 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 grained 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

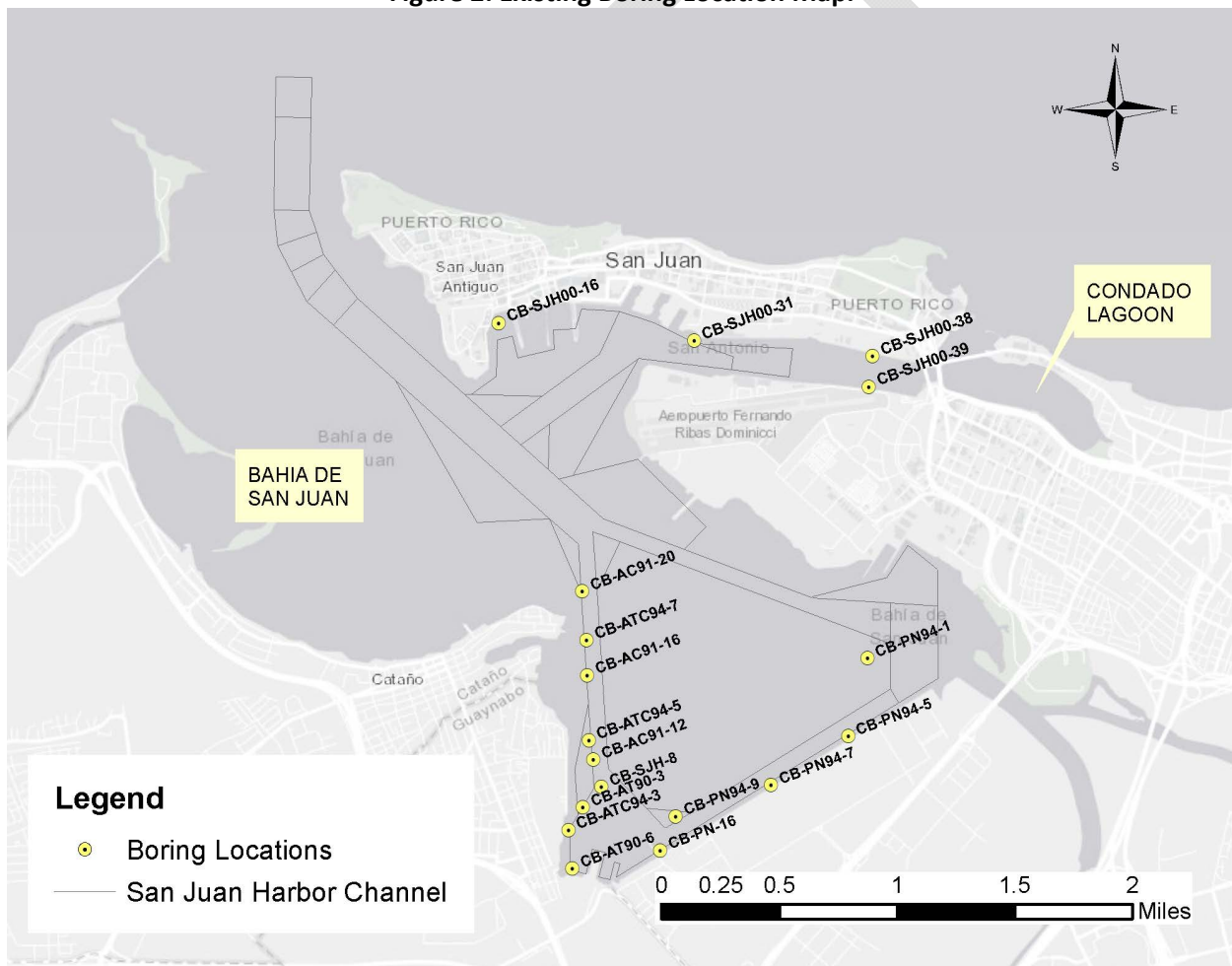
San Juan Harbor is located within the Bahia de San Juan. The outline of the maintained Harbor Channels is shown **Figure 2**. Numerous borings were drilled within the San Juan harbor channel for deepening and maintenance dredging over the years. Those existing borings provide valuable information for 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**.

**Table 2: Boring Locations.**

| <i>Designation</i> | <i>State Plane, PR VI NAD27</i> |          |
|--------------------|---------------------------------|----------|
|                    | <b>X</b>                        | <b>Y</b> |
| 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           | 613864                          | 217441   |

| Designation | State Plane, PR VI NAD27 |        |
|-------------|--------------------------|--------|
|             | X                        | Y      |
| 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 Morro) 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**).

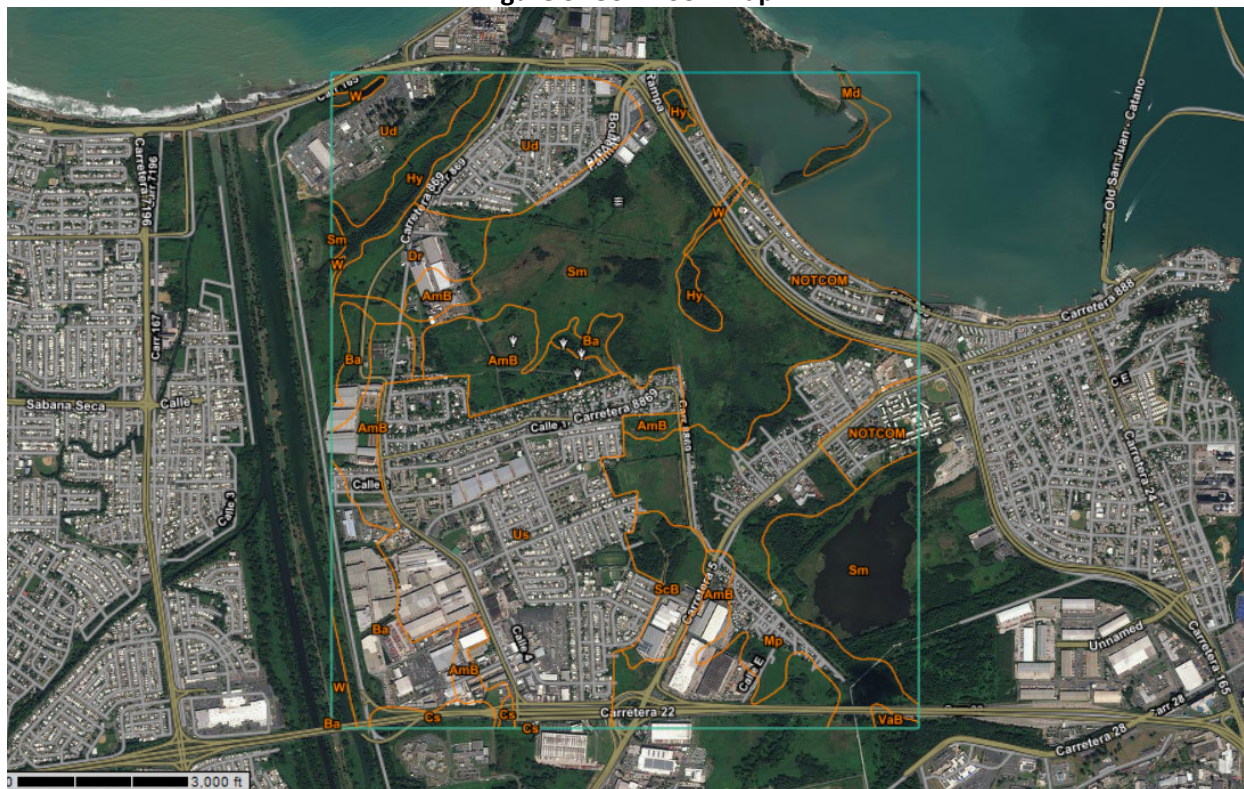
**Table 3: Laboratory Testing.**

| Boring Designation   | Sample Designation | USCS   | GS   |
|--|--------------------|--------|------|
| CB-AT90-3  | 2                  | MH     | 2.67 |
| CB-AT90-3  | 4                  | CH     | 2.70 |
| CB-AT90-6  | 3                  | MH     | 2.68 |
| CB-AT90-6  | 9                  | GP-GM* |      |
| CB-AT90-12   | 2                  | MH     | 2.69 |
| CB-AT90-12   | 9                  | CH     | 2.73 |
| CB-AC91-12   | 2                  | MH     | 2.71 |
| CB-AC91-16   | 1                  | MH     |      |
| CB-AC91-16   | 5                  | CH     | 2.65 |
| CB-AC91-20   | 4                  | SM*    |      |
| CB-AC91-20   | 7                  | SC*    |      |
| CB-ATC94-5   | 5                  | CH     | 2.67 |
| CB-ATC94-7   | 1                  | CH     |      |
| USCS: Unified Soil Classification System; Gs: specific gravity<br>*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 |
| Ba                              | 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 Complex     | Ud             |
| Urban Land- Sabana Seca Complex | Us             |
| Vega Alta Clay Loam             | VaB            |



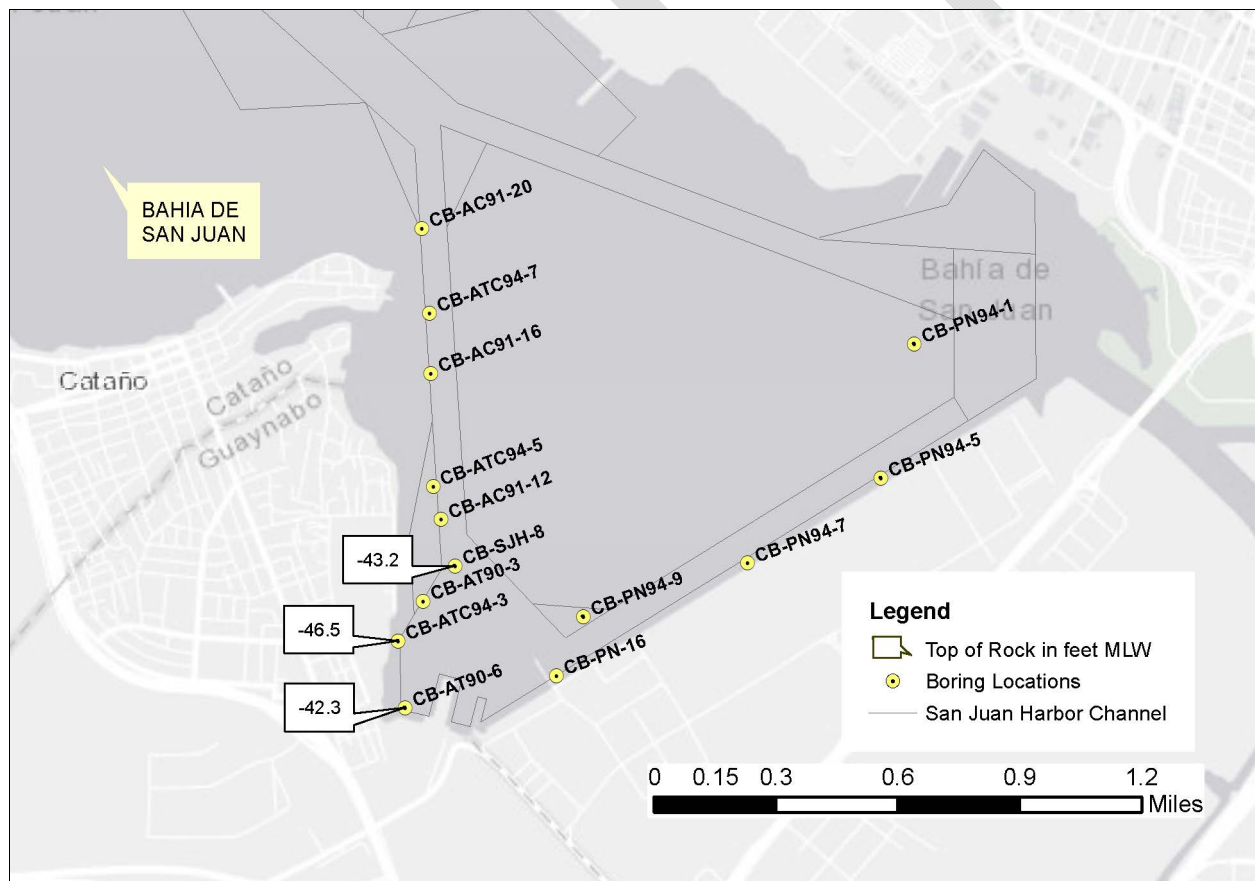
### 1.3.4 Top of Rock Elevations

**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.

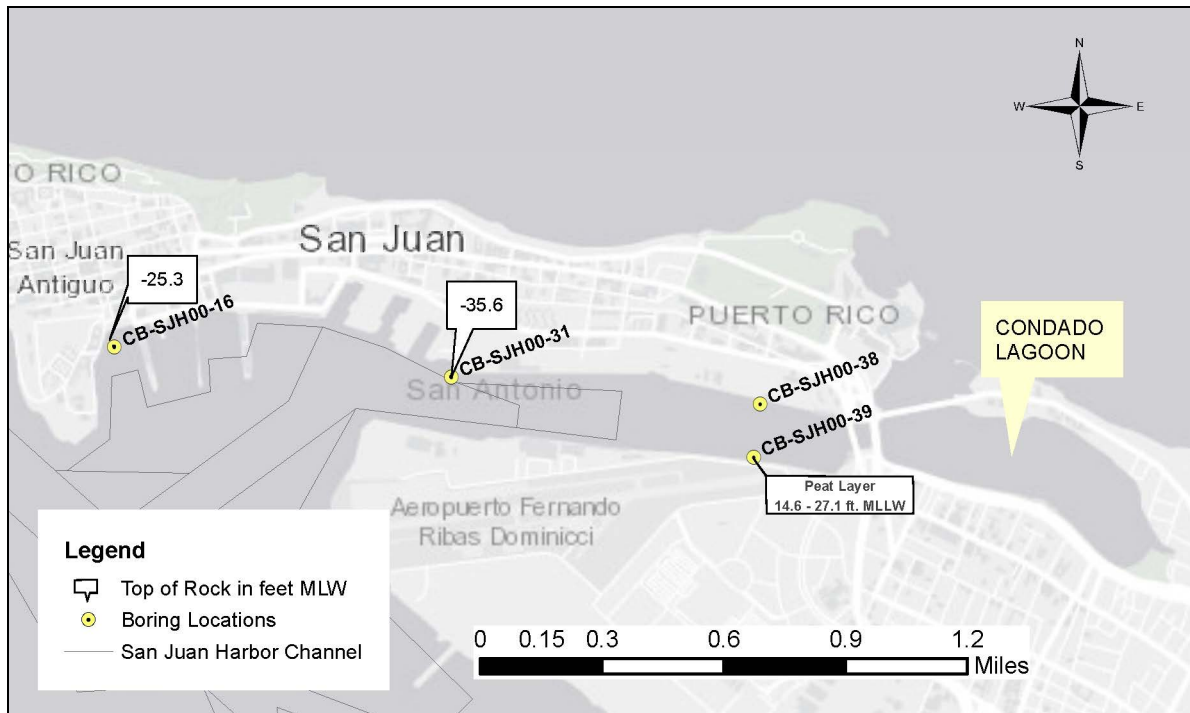
**Table 4: Top of Rock Elevations.**

| Boring   | Top of Rock Elevation<br>(feet MLW) | Location   |
|--|-------------------------------------|--|
| CB-AT90-6  | -42.3*                              | South Western Part of Bahia de San Juan                  |
| CB-ATC94-3   | -46.5                               |  |
| CB-SJH-8   | -43.2                               |  |
| CB-SJH00-16  | -25.3                               | Northern Part of Bahia de San Juan (San Antonio Channel) |
| CB-SJH00-31  | -35.6                               |  |
| *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 where the elevations are positioned on a typical seawall.

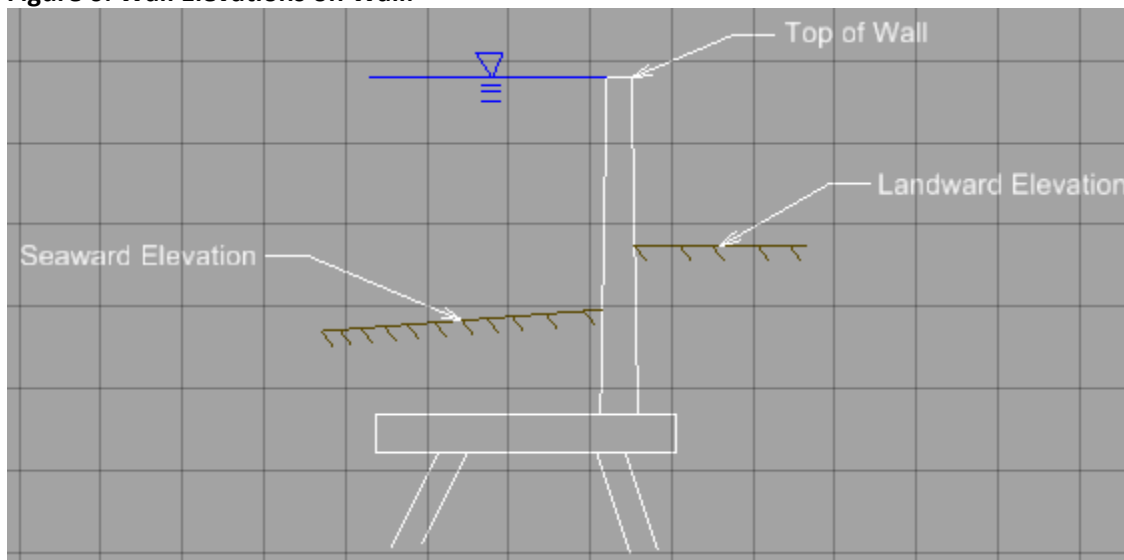
**Table 5: Wall Elevations.**

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

\*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 a 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

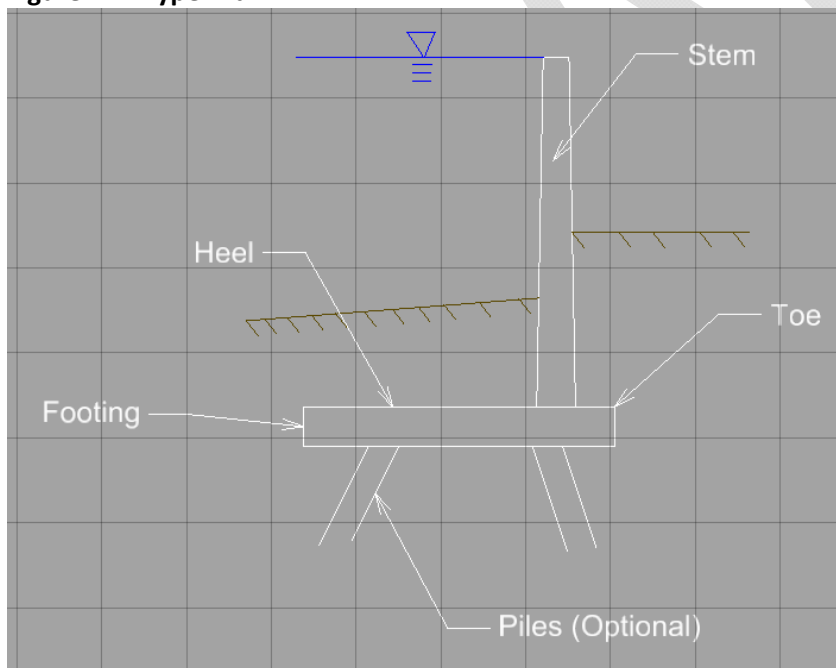
King Pile Walls offer larger section moduli, moments of inertia, and cross sectional areas required for larger retained heights and situations in which the top of rock is not deep enough for a cantilevered sheet pile wall. King Pile Walls resist loadings using the same mechanism as the Cantilevered Sheet 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 or at a batter. Given the differing load scenarios, such as maximum flood where the water elevation at the front of the wall is very high or regular operations where 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

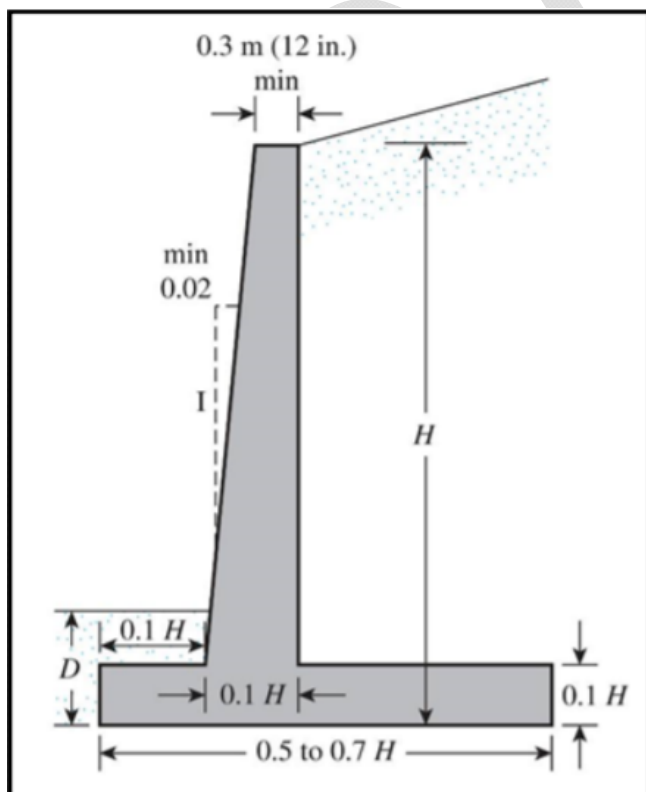
### 1.6.1 WSJB 1B, WSJB 2, and WSJB 4

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.

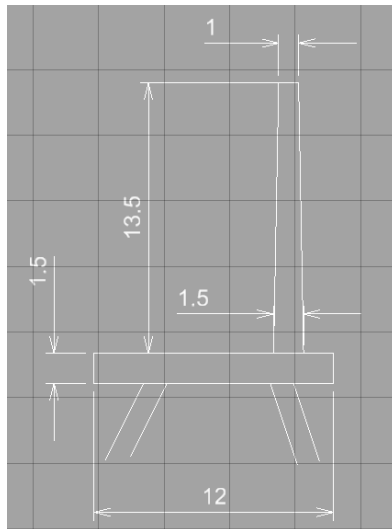
The preliminary wall started with Figure 8.2 of Das's textbook *Principles of Foundation Engineering 6<sup>th</sup> Edition* (**Figure 8** of this appendix), which gives dimensions in terms of retained height. This was then checked for sliding and overturning stability, using the methods as outlined 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 were 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

\*\*Requires two HP14x89 piles

**Table 6: Pile Demand vs Capacity Results.**

| Pile Spacing | Required Tension | Required Axial Compression | Tension Capacity (7.5' into Rock) | Axial Capacity (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              |

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.

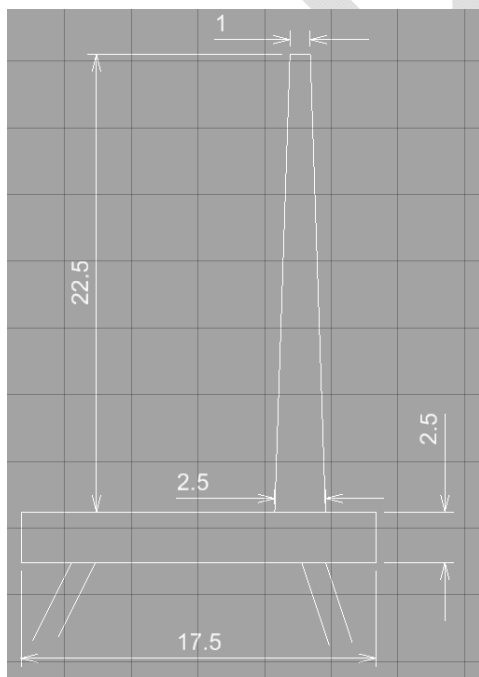
### 1.6.2 WSJB 3

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 6<sup>th</sup> 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 were chosen to meet bearing capacity requirements of the wall. For this the methods as outlined in EM 1110-2-2906 were 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.

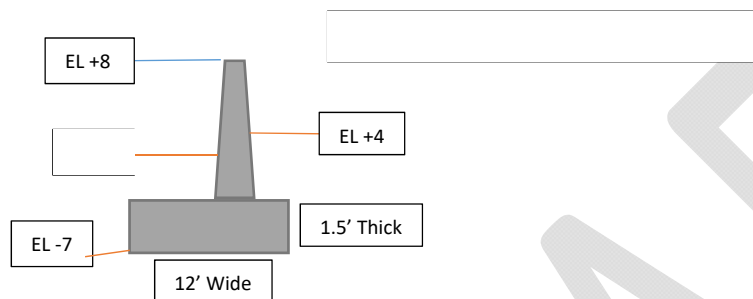


Other refinements will include, a more final selection of wall type which will allow for the analysis of other design events, such as low tide or seismic. Liquefaction screening from the parameters provided in the new borings will also be done. Future work will utilize the Army Corps CASE programs *CI-WALL* 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.

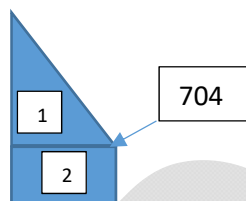
## 1.8 Wall Calculations per Reach

### 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



$$\text{Max Hydrostatic Pressure} = 8' - (-3') \times 64 \text{ pcf} = 704 \text{ psf}$$

$$\text{Hydrostatic Force 1} = \frac{1}{2} 704(11) = 3.9 \text{ kips/ft}$$

$$\text{Hydrostatic Force 2} = 704(4) = 2.8 \text{ kips/ft}$$

$$\text{Max Soil Pressure} = (120 \text{ pcf} - 64 \text{ pcf}) \times 4 \text{ } (-3 - (-7)) \times \frac{1}{3} \text{ (Ka assuming a phi of 30 degrees)} = 74.7 \text{ psf}$$

$$\text{Soil Force} = \frac{1}{2} (74.7 \times 4) = 0.15 \text{ kips/ft}$$

Uplift

$$\text{Max Pressure (at heel)} = (8' - (4' \times 11') / 23') \times 64 = 390 \text{ psf}$$

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

$$\text{Min Pressure (at toe)} = (4' - (16' \times 4') / 23') \times 64 = 77.9 \text{ psf}$$

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=  $\frac{1}{2}(390+77.9)*12=2.8$  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 Toe) | Moment      |
|------------|-------------|-------|--------------|----------------|-------------|
| 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.

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

| 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

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

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

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

Assuming a phi angle of 25 degrees

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

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

From EM 1110-2-2906 Design of Pile Foundations

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

$$\sigma'_v = \gamma D_c = 56 \text{ pcf} * 20 * 1.17' = 1310.4 \text{ psf}$$

Assuming a cohesion of 2500 psf (conservative for limestone)  $\alpha c = 0.5 * 2500 = 1250 \text{ psf}$

$$\delta = 0.83 * \varphi = 0.83 * 25 = 20.75$$

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

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

$$Q_s = \frac{f_s * a_s}{FS}$$

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

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

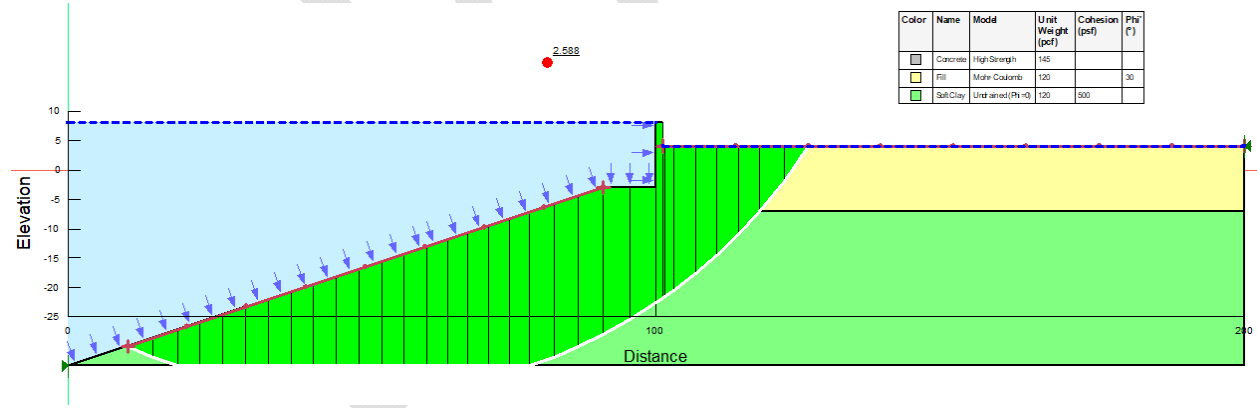
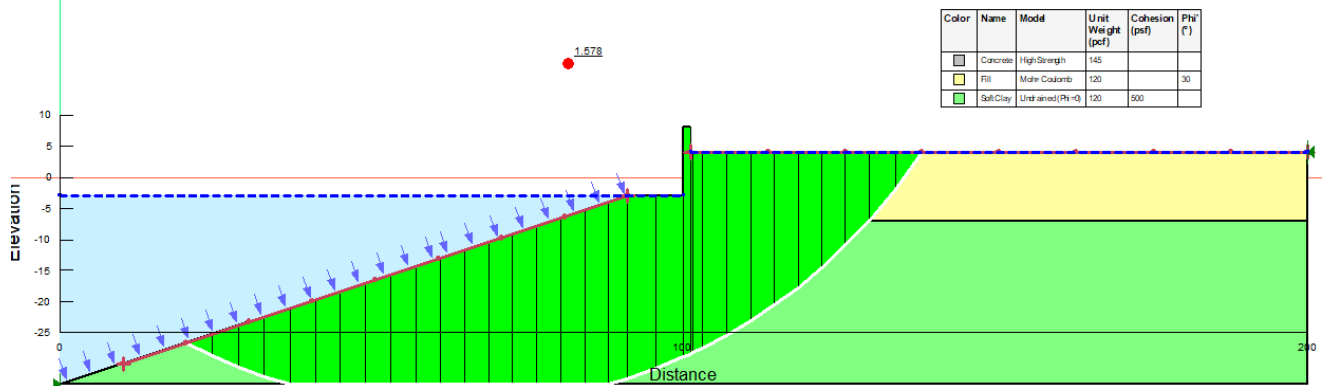
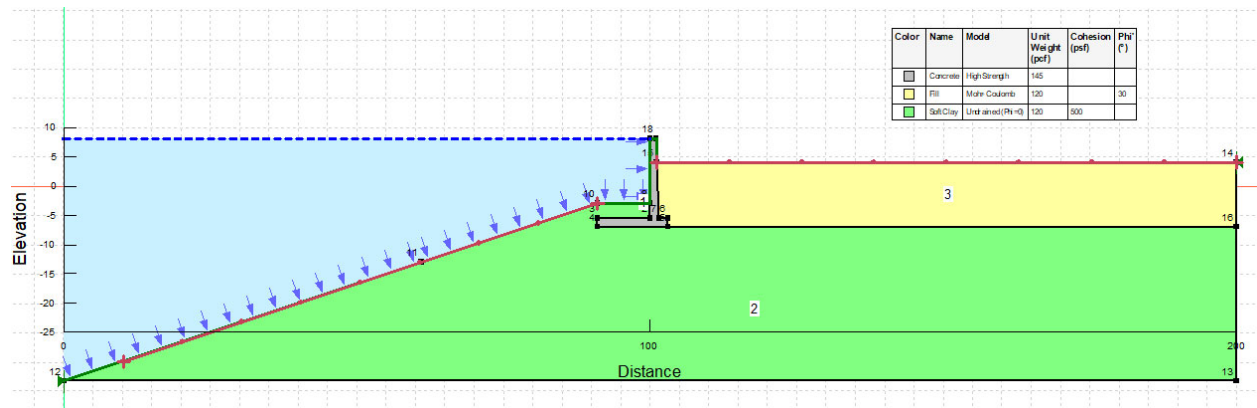
Total Axial Capacity=226+20.3=246 kips

Total Tension Capacity=18.3 kips

Capacities are adequate for 7.5 foot spacing.

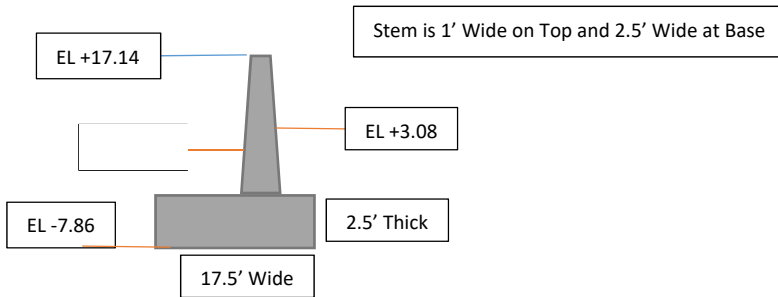
#### Global Stability Checks

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.

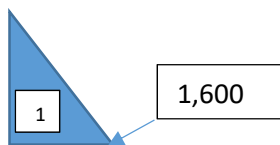


## 1.8.2 WSJB 3 T-Type Wall Calculations

Evaluate Storm Surge Case as shown below



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



$$\text{Max Hydrostatic Pressure} = 17.14' - (-7.86') \times 64 \text{ pcf} = 1,600 \text{ psf}$$

$$\text{Hydrostatic Force} = \frac{1}{2} 1600(25) = 20 \text{ kips/ft}$$

$$\text{Max Soil Pressure} = (120 \text{ pcf} - 64 \text{ pcf}) \times 4 \times (-3 - (-7)) \times \frac{1}{3} \text{ (Ka assuming a phi of 30 degrees)} = 74.7 \text{ psf}$$

$$\text{Soil Force} = \frac{1}{2} (74.7 \times 4) = 0.15 \text{ kips/ft}$$

Uplift

$$\text{Max Pressure (at heel)} = (17.14' - (14' \times 11') / 28.5') \times 64 = 751 \text{ psf}$$

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

$$\text{Min Pressure (at toe)} = (3' - (14' \times 21.5') / 28.5') \times 64 = -483 \text{ psf}$$

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

$$\text{Uplift Force} = (751 - 483) \times 17.5 = 4.7 \text{ kips/ft}$$

$$\text{Sliding Force} = \text{Hydrostatic Force} + \text{Earth Force} = 20 + 0.15 = 20.15 \text{ kip/ft}$$

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

$$\text{Design Sliding Force} = 20.15 \times 1.5 = 30.23 \text{ kips/ft}$$

$$\text{Overturning Moment} = \text{Moment from Hydrostatic Force} + \text{Moment from Earth Load} + \text{Moment from Uplift}$$

$$\text{Overturning Moment} = 20 \times 8.33 + 0.15 \times 1.33 + 4.7 \times 8.75 = 207.9 \text{ kft/ft}$$

| Area       | Unit Weight | Sq Ft | Total Weight | Arm (from Toe) | Moment       |
|------------|-------------|-------|--------------|----------------|--------------|
| 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-  $\frac{1}{2}$ \*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.

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

| 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

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

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

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

Assuming a phi angle of 25 degrees



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

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

From EM 1110-2-2906 Design of Pile Foundations

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

$$\sigma'_v = \gamma D_c = 56 \text{ pcf} * 20 * 1.17' = 1,310.4 \text{ psf}$$

Assuming a cohesion of 2500 psf (conservative for limestone)  $\alpha c = 0.5 * 2,500 = 1,250 \text{ psf}$

$$\delta = 0.83 * \varphi = 0.83 * 25 = 20.75$$

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

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

$$Q_s = \frac{f_s * a_s}{FS}$$

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

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

Total Axial Capacity=226+27.2=253.2 kips

Total Tension Capacity=24.4 kips

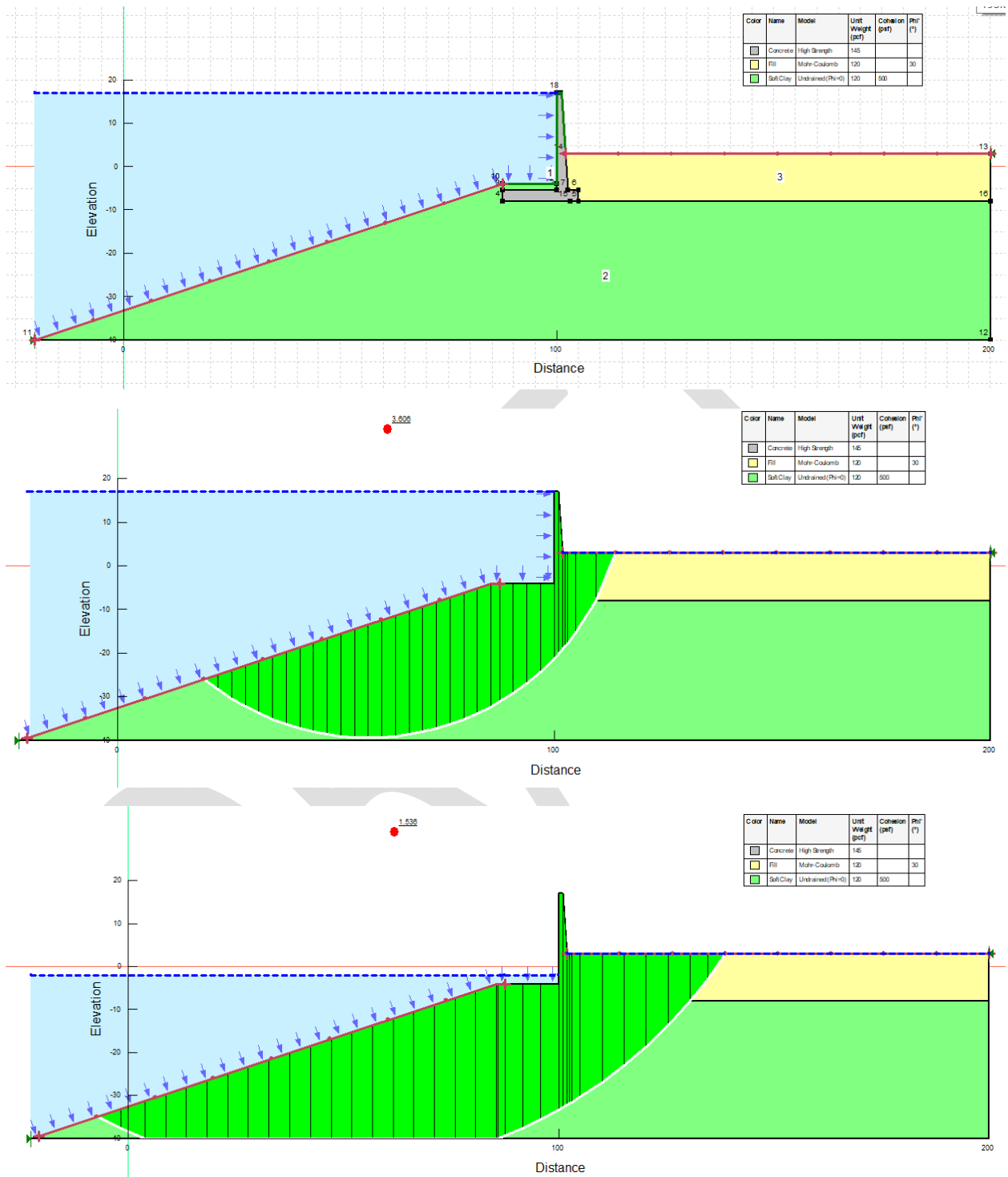
Capacities are adequate for 5 foot spacing.

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

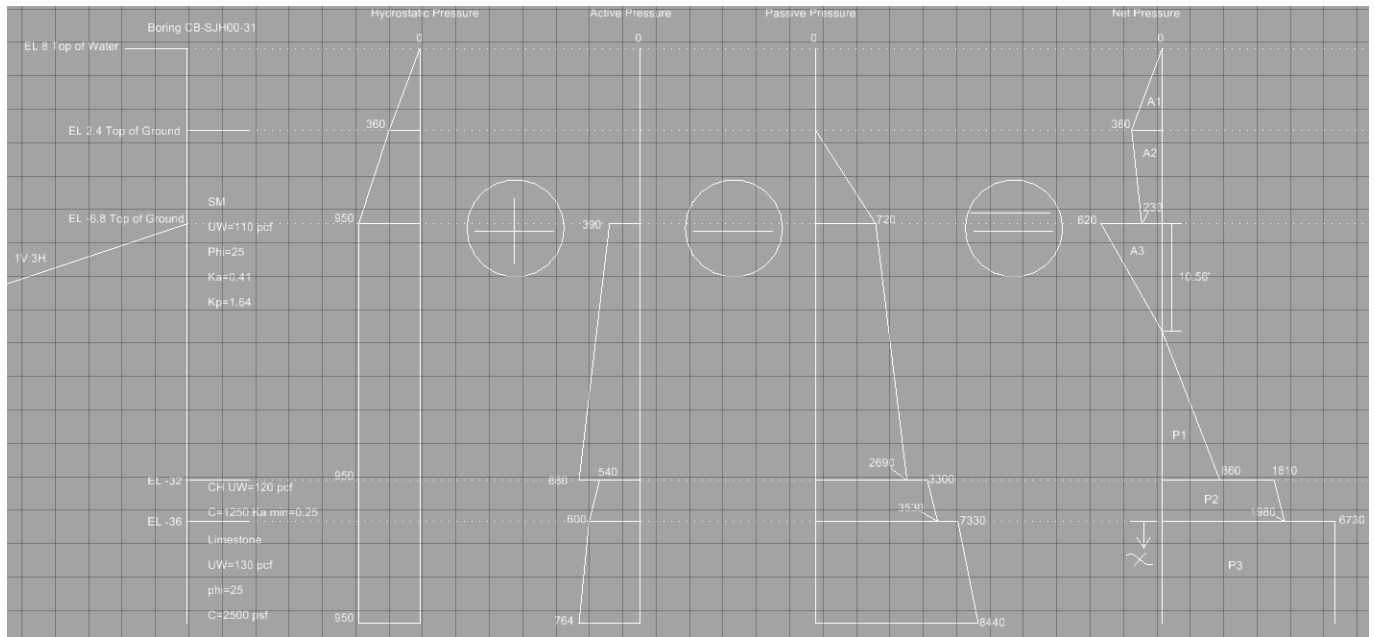
Total Axial Capacity\*FS=253.2\*3=759.6 kips

Using 0.85F<sub>y</sub> 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   | $\frac{1}{2} * 360 * 5.6 = 1008$           | $40.3 + x$ |
| A2   | $(\frac{1}{2} * (360 + 230)) * 9.2 = 2714$ | $34.1 + x$ |
| A3   | $\frac{1}{2} * 620 * 10.56 = 3274$         | $18.2 + x$ |
| P1   | $\frac{1}{2} * 860 * 14.64 = 6295$         | $8.9 + x$  |
| P2   | $(\frac{1}{2} * (1810 + 1980)) * 4 = 7580$ | $2 + x$    |

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.

$$A1 + A2 + A3 = 6996 \text{ lbs}$$

$$P1 = 6295 \text{ lbs}$$

$$6996 - 6295 = 701 \text{ lb}$$

Location of zero shear is within P2 Thus...

$$0 = 1810x - 710$$

$$\text{Implies } x = 0.4'$$

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:

$$\sum M_{v=0} = 1008 * 36.7 + 2714 * 30.5 + 3274 * 22.1 - 6295 * 5.3 - 701 * 0.2 = 158622.3 \text{ lbft/ft}$$

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

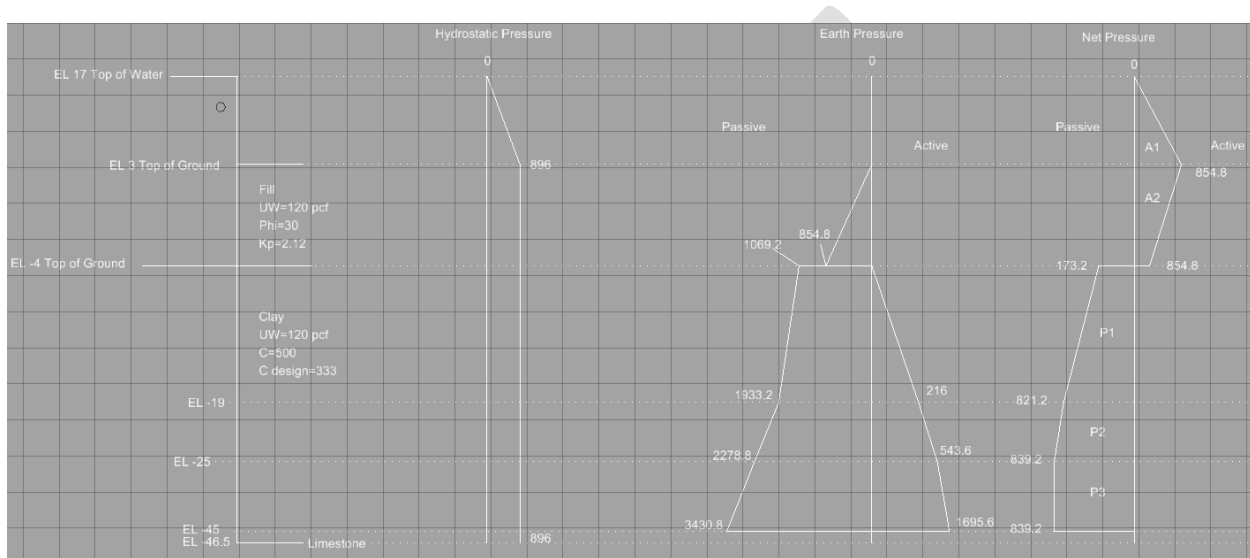
$$S = \frac{158622.3 \frac{\text{lbft}}{\text{ft}} * 12 \frac{\text{in}}{\text{ft}} * \frac{1}{1000} \text{ k/lb}}{50 \text{ ksi} * 0.5} = \frac{1904}{25} = 76.2 \text{ in}^3/\text{ft}$$

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) | $S (\frac{\text{in}^3}{\text{ft}})$ | Area of Steel ( $\text{in}^2/\text{ft}$ ) | 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:

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

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     | Mo       |
|-------|----------|
| 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.

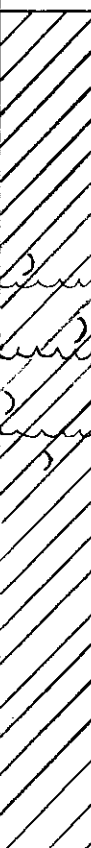

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## 1.10 Boring Logs



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|   |  |                                   |  |  |  |  |
|---|--|-----------------------------------|--|--|--|--|
| <b>DRILLING LOG</b>   |  | <b>DIVISION</b><br>South Atlantic | <b>INSTALLATION</b><br>Jacksonville District                   |  | <b>SHEET</b><br>OF 1 SHEETS            |  |
| <b>1. PROJECT</b><br>San Juan Harbor Deepening  |  |                                   | <b>10. SIZE AND TYPE OF BIT</b> See remarks                    |  |  |  |
| <b>2. LOCATION (Coordinates or Station)</b><br>x=612,128 y=218,410  |  |                                   | <b>11. DATUM FOR ELEVATION SHOWN (TBM or MSL)</b><br>MLW       |  |  |  |
| <b>3. DRILLING AGENCY</b><br>Corps of Engineers   |  |                                   | <b>12. MANUFACTURER'S DESIGNATION OF DRILL</b><br>Failing 1500 |  |  |  |
| <b>4. HOLE NO. (As shown on drawing title and file number)</b><br>CB-AT90-3   |  |                                   | <b>13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN</b>              |  | <b>DISTURBED</b><br><b>UNDISTURBED</b> |  |
| <b>5. NAME OF DRILLER</b><br>M. Whitson   |  |                                   | <b>14. TOTAL NUMBER CORE BOXES</b> 1                           |  |  |  |
| <b>6. DIRECTION OF HOLE</b><br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT. |  |                                   | <b>15. ELEVATION GROUND WATER</b> Tidal                        |  |  |  |
| <b>7. THICKNESS OF OVERBURDEN</b>   |  |                                   | <b>16. DATE HOLE</b> STARTED 1/31/91 COMPLETED 1/31/91         |  |  |  |
| <b>8. DEPTH DRILLED INTO ROCK</b>   |  |                                   | <b>17. ELEVATION TOP OF HOLE</b> -35.5                         |  |  |  |
| <b>9. TOTAL DEPTH OF HOLE</b> 10.5'   |  |                                   | <b>18. TOTAL CORE RECOVERY FOR BORING</b> 68 %                 |  |  |  |
|   |  |                                   | <b>19. SIGNATURE OF INSPECTOR</b><br>Geologist, G. Bacuta      |  |  |  |

| ELEVATION<br>a | DEPTH<br>b | LEGEND<br>c | CLASSIFICATION OF MATERIALS<br>(Description)<br>d   | % CORE RECOVERY<br>e | SAMPLE NO.<br>f | REMARKS<br>(Drilling time, water loss, depth of weathering, etc., if significant)<br>g |
|----------------|------------|-------------|---|----------------------|-----------------|--|
| -35.5          | 0.0        |             |   |                      |                 | Bit or Barrel<br>-35.5 Blows/0.5Ft   |
|                |            |             | CLAY, very soft, medium plasticity, trace silt, trace quartz sand, trace shell, gray (CL)                       | 33                   | 1               | Split Spoon settled  |
|                |            |             |   | 67                   | 2               | " settled  |
|                |            |             |   | 13                   | 3               | " settled  |
| -40.0          | 4.5        |             |   |                      |                 | -40.0  |
|                |            |             | CLAY, stiff to very stiff, brown with red stains, high plasticity (CH)<br>bed of sandy clay from -42.5 to -43.0 | 93                   | 4               | " 12<br>20<br>24   |
| -42.5          | 7.0        |             |   | 100                  | 5               | " 16<br>30   |
| -43.0          | 7.5        |             |   |                      |                 | -43.0 40   |
|                |            |             |   | 80                   | 6               | " 19<br>23<br>36   |
|                |            |             |   | 87                   | 7               | " 8<br>14<br>30  |
| -46.0          | 10.5       |             |   |                      |                 | -46.0  |
|                |            |             | Soils are field visually classified in accordance with the Unified Soils Classification System.                 |                      |                 | 140# hammer with 30" drop used on 2.0' split spoon. (1-3/8" ID x 2" OD)                |
|                |            |             | SAMPLE ELEVATION      LABORATORY CLASSIFICATION   |                      |                 |  |
|                |            |             | -37.0 to -38.5      (MH)*   |                      |                 |  |
|                |            |             | -40.0 to -41.5      (CH)*   |                      |                 |  |
|                |            |             | *Visual classification based on Gradation Curve. No Atterberg Limits.   |                      |                 |  |

| DRILLING LOG   |            | DIVISION<br>South Atlantic  |  | INSTALLATION<br>Jacksonville District              |                 | SHEET<br>1 OF 1 SHEETS   |                |
|--|------------|---|--|--|-----------------|--|----------------|
| 1. PROJECT<br>San Juan Harbor Deepening  |            |   |  | 10. SIZE AND TYPE OF BIT<br>See remarks            |                 |  |                |
| 2. LOCATION (Coordinates or Station)<br>x=611,895 y=217,028  |            |   |  | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL)<br>MLW  |                 |  |                |
| 3. DRILLING AGENCY<br>Corps of Engineers   |            |   |  | 12. MANUFACTURER'S DESIGNATION OF DRILL<br>Failing |                 |  |                |
| 4. HOLE NO. (As shown on drawing title and file number)<br>CB-AT90-6   |            |   |  | 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN         |                 | DISTURBED<br>UNDISTURBED   |                |
| 5. NAME OF DRILLER<br>M. Whitson   |            |   |  | 14. TOTAL NUMBER CORE BOXES<br>1                   |                 |  |                |
| 6. DIRECTION OF HOLE<br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT. |            |   |  | 15. ELEVATION GROUND WATER<br>Tidal                |                 | 16. DATE HOLE<br>STARTED 3/1/91 COMPLETED 3/1/91                                       |                |
| 7. THICKNESS OF OVERBURDEN   |            |   |  | 17. ELEVATION TOP OF HOLE<br>-30.3                 |                 |  |                |
| 8. DEPTH DRILLED INTO ROCK   |            |   |  | 18. TOTAL CORE RECOVERY FOR BORING<br>35 %         |                 |  |                |
| 9. TOTAL DEPTH OF HOLE<br>15.0'  |            |   |  | 19. SIGNATURE OF INSPECTOR<br>Geologist, G. Bacuta |                 |  |                |
| ELEVATION<br>a   | DEPTH<br>b | LEGEND<br>c   | CLASSIFICATION OF MATERIALS<br>(Description)<br>d  | % CORE RECOVERY<br>e                               | SAMPLE NO.<br>f | REMARKS<br>(Drilling time, water loss, depth of weathering, etc., if significant)<br>g |                |
| -30.3  | 0.0        |   |  |  |                 | Bit or Barrel  |                |
| -33.3  | 3.0        |   | CLAY, soft to very soft, medium plasticity, gray (CL)<br><br>trace organics (wood) and trace shell from -33.3 to -36.3                           | 27   | 1               | Split Spoon  | settled        |
|  |            |   |  |  |                 |  |                |
|  |            |   |  |  |                 |  |                |
|  |            |   |  |  |                 |  |                |
|  |            |   |  |  |                 |  |                |
|  |            |   |  |  |                 |  |                |
|  |            |   |  |  |                 |  |                |
|  |            |   |  |  |                 |  |                |
| -36.3  | 6.0        |   |  | 53   | 4               | "  | settled        |
|  |            |   |  | 0  | 5               | "  | settled        |
|  |            |   |  | 47   | 6               | "  | settled        |
|  |            |   |  | 13   | 7               | "  | settled        |
|  |            |   |  | 0  | 8               | "  | settled        |
| -41.8  | 11.5       |   | CLAY, high plasticity, brown (CH)  |  |                 |  |                |
| -42.3  | 12.0       |   |  |  |                 |  |                |
|  |            |  | GRAVEL, trace brown stiff clay, large limestone fragments (moderately hard to hard, little pits and pores), tan to light brown, gray stains (GC) | 60   | 9               | "  | 16<br>18<br>43 |
|  |            |   |  |  |                 |  |                |
| -45.3  | 15.0       |   |  | 27   | 10              | "  | 2<br>5<br>9    |
|  |            |   | Soils are field visually classified in accordance with the Unified Soils Classification System.  |  |                 | 140# hammer with 30" drop used on 2.0' split spoon. (1-3/8" ID x 2" OD)                |                |
|  |            |   | SAMPLE ELEVATION<br>-33.3 to -34.8<br>-42.3 to -43.8   |  |                 | LABORATORY CLASSIFICATION<br>(MH)*<br>(GP-GM)*   |                |
|  |            |   | *Visual classification based on Gradation Curve. No Atterberg Limits.  |  |                 |  |                |

|  |            |                            |   |   |                 |  |                   |  |
|--|------------|----------------------------|---|---|-----------------|--|-------------------|--|
| DRILLING LOG   |            | DIVISION<br>South Atlantic |   | INSTALLATION<br>Jacksonville District                   |                 | SHEET 1<br>OF 1 SHEETS   |                   |  |
| 1. PROJECT<br>San Juan Harbor Deepening  |            |                            |   | 10. SIZE AND TYPE OF BIT<br>See remarks                 |                 |  |                   |  |
| 2. LOCATION (Coordinates of Station)<br>x=612,522 y=216,867  |            |                            |   | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL)<br>MLW       |                 |  |                   |  |
| 3. DRILLING AGENCY<br>Corps of Engineers   |            |                            |   | 12. MANUFACTURER'S DESIGNATION OF DRILL<br>Failing 1500 |                 |  |                   |  |
| 4. HOLE NO. (As shown on drawing title and file number)<br>CB-AT90-12  |            |                            |   | 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN              |                 | DISTURBED<br>UNDISTURBED   |                   |  |
| 5. NAME OF DRILLER<br>M. Whitson   |            |                            |   | 14. TOTAL NUMBER CORE BOXES<br>1                        |                 |  |                   |  |
| 6. DIRECTION OF HOLE<br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT. |            |                            |   | 16. DATE HOLE<br>2/15/91                                |                 | STARTED<br>COMPLETED<br>2/15/91  |                   |  |
| 7. THICKNESS OF OVERBURDEN   |            |                            |   | 17. ELEVATION TOP OF HOLE<br>-28.6                      |                 |  |                   |  |
| 8. DEPTH DRILLED INTO ROCK   |            |                            |   | 18. TOTAL CORE RECOVERY FOR BORING<br>50 %              |                 |  |                   |  |
| 9. TOTAL DEPTH OF HOLE<br>16.5'  |            |                            |   | 19. SIGNATURE OF INSPECTOR<br>Geologist, G. Bacuta      |                 |  |                   |  |
| ELEVATION<br>a   | DEPTH<br>b | LEGEND<br>c                | CLASSIFICATION OF MATERIALS<br>(Description)<br>d   | % CORE RECOVERY<br>e                                    | SAMPLE NO.<br>f | REMARKS<br>(Drilling time, water loss, depth of weathering, etc., if significant)<br>g |                   |  |
| -28.6  | 0.0        |                            |   |   |                 | Bit or Barrel  |                   |  |
|  |            |                            | CLAY, very soft, trace of shell, medium plasticity, dark gray to black (CL)<br><br>SAMPLE ELEVATION      LABORATORY CLASSIFICATION<br>-30.1 to -31.6      (MH)*<br>-40.6 to -42.1      (CH)*<br><br>*Visual classification based on Gradation Curve. No Atterberg Limits. | 27  | 1               | -28.6 Blows/0.5 Ft settled   |                   |  |
|  |            |                            |   |   | 40              | 2  | -30.1 Split Spoon |  |
|  |            |                            |   |   |                 |  | -31.6 " settled   |  |
|  |            |                            |   |   |                 |  | -33.1 " settled   |  |
|  |            |                            |   |   |                 |  | -34.6 " settled   |  |
|  |            |                            |   |   |                 |  | -36.1 " settled   |  |
|  |            |                            |   |   |                 |  | -37.6 " settled   |  |
|  |            |                            |   |   |                 |  | -39.1 " settled   |  |
|  |            |                            |   |   |                 |  | -40.6 " settled   |  |
|  |            |                            |   |   |                 |  | -42.1 " settled   |  |
| -38.9  | 10.3       |                            | CLAY, trace shell, red and black stains, brown (CH) very soft from -38.9 to -40.6 soft to very stiff, high plasticity, traces of small lenses of white clay from -40.6 to -42.1   | 33  | 8               | -40.6 " settled  |                   |  |
| -40.6  | 12.0       |                            |   |   |                 | -42.1 " 3 9 10 4 16 17 6 12 15   |                   |  |
| -42.1  | 13.5       |                            |   |   |                 | -43.6 " settled  |                   |  |
| -44.6  | 15.5       |                            |   |   |                 | -45.1 " settled  |                   |  |
| -45.1  | 16.5       |                            |   |   |                 | -45.1 " settled  |                   |  |
|  |            |                            | Soils are field visually classified in accordance with the Unified Soils Classification System.   |   |                 | 140# hammer with 30" drop used on 2.0' split spoon. (1-3/8" ID x 2" OD)                |                   |  |

|  |            |  |   |   |                 |  |  |
|--|------------|--|---|---|-----------------|--|--|
| DRILLING LOG   |            | DIVISION<br>South Atlantic   |   | INSTALLATION<br>Jacksonville District                                   |                 | SHEET 1<br>OF 1 SHEETS   |  |
| 1. PROJECT<br>San Juan Harbor Deepening  |            |  |   | 10. SIZE AND TYPE OF BIT<br>See remarks                                 |                 |  |  |
| 2. LOCATION (Coordinates or Station)<br>x=612,366 y=219,471  |            |  |   | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL)<br>MLW                       |                 |  |  |
| 3. DRILLING AGENCY<br>Corps of Engineers   |            |  |   | 12. MANUFACTURER'S DESIGNATION OF DRILL<br>Failing                      |                 |  |  |
| 4. HOLE NO. (As shown on drawing title and file number)<br>CB-AC91-12  |            |  |   | 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN                              |                 | DISTURBED<br>UNDISTURBED   |  |
| 5. NAME OF DRILLER<br>M. Whitson   |            |  |   | 14. TOTAL NUMBER CORE BOXES<br>1  |                 |  |  |
| 6. DIRECTION OF HOLE<br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT. |            |  |   | 15. ELEVATION GROUND WATER<br>Tidal                                     |                 | 16. DATE HOLE<br>2/1/91  |  |
| 7. THICKNESS OF OVERBURDEN   |            |  |   | 17. ELEVATION TOP OF HOLE<br>-40.2                                      |                 | 18. TOTAL CORE RECOVERY FOR BORING<br>52 %   |  |
| 8. DEPTH DRILLED INTO ROCK   |            |  |   | 19. SIGNATURE OF INSPECTOR<br>Geologist, G. Bacuta                      |                 |  |  |
| 9. TOTAL DEPTH OF HOLE<br>6.0'   |            |  |   |   |                 |  |  |
| ELEVATION<br>a   | DEPTH<br>b | LEGEND<br>c  | CLASSIFICATION OF MATERIALS<br>(Description)<br>d   | % CORE RECOVERY<br>e  | SAMPLE NO.<br>f | REMARKS<br>(Drilling time, water loss, depth of weathering, etc., if significant)<br>g |  |
| -40.2  | 0.0        |  |   |   |                 | Bit or Barrel  |  |
| -41.7  | 1.5        |   | CLAY, very soft, trace silt, trace shell, medium plasticity, gray (CL)                            | 13  | 1               | -40.2 Blows/0.5 Ft settled<br>Split Spoon<br>-41.7                                     |  |
| -46.2  | 6.0        |  | CLAY, stiff, with small lenses of sandy clay, traces of black stains (organics), light brown (CH) | 67  | 2               | -43.2 3<br>16  |  |
|  |            |  |   | 53  | 3               | -44.7 10<br>10   |  |
|  |            |  |   | 73  | 4               | -46.2 11<br>20<br>21   |  |
| Soils are field visually classified in accordance with the Unified Soils Classification System.                              |            |  |   | 140# hammer with 30" drop used on 2.0' split spoon. (1-3/8" ID x 2" OD) |                 |  |  |
| SAMPLE ELEVATION<br>-41.7 to -43.2   |            |  |   | LABORATORY CLASSIFICATION<br>(CH)*                                      |                 |  |  |
| * Visual classification based on Gradation Curve. No Atterberg Limits.   |            |  |   |   |                 |  |  |

|  |  |                                   |   |                               |
|--|--|-----------------------------------|---|-------------------------------|
| <b>DRILLING LOG</b>  |  | <b>DIVISION</b><br>South Atlantic | <b>INSTALLATION</b><br>Jacksonville District            | <b>SHEET</b> 1<br>OF 1 SHEETS |
| 1. PROJECT<br>San Juan Harbor Deepening  |  |                                   | 10. SIZE AND TYPE OF BIT See remarks                    |                               |
| 2. LOCATION (Coordinates or Station)<br>x=612,229 y=221,369  |  |                                   | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL)<br>MLW       |                               |
| 3. DRILLING AGENCY<br>Corps of Engineers   |  |                                   | 12. MANUFACTURER'S DESIGNATION OF DRILL<br>Failing 1500 |                               |
| 4. HOLE NO. (As shown on drawing title and file number)<br>CB-AC91-16  |  |                                   | 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN              |                               |
| 5. NAME OF DRILLER<br>M. Whitson   |  |                                   | 14. TOTAL NUMBER CORE BOXES 1                           |                               |
| 6. DIRECTION OF HOLE<br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT. |  |                                   | 15. ELEVATION GROUND WATER Tidal                        |                               |
| 7. THICKNESS OF OVERBURDEN   |  |                                   | 16. DATE HOLE STARTED 2/6/91 COMPLETED 2/6/91           |                               |
| 8. DEPTH DRILLED INTO ROCK   |  |                                   | 17. ELEVATION TOP OF HOLE -38.3                         |                               |
| 9. TOTAL DEPTH OF HOLE 7.5'  |  |                                   | 18. TOTAL CORE RECOVERY FOR BORING 67 %                 |                               |
|  |  |                                   | 19. SIGNATURE OF INSPECTOR<br>Geologist, G. Bacuta      |                               |

| ELEVATION<br>a | DEPTH<br>b | LEGEND<br>c | CLASSIFICATION OF MATERIALS<br>(Description)<br>d  | % CORE<br>RECOV-<br>ERY<br>e | SAMPLE<br>NO.<br>f | REMARKS<br>(Drilling time, water loss, depth of<br>weathering, etc., if significant)<br>g |
|----------------|------------|-------------|--|------------------------------|--------------------|---|
| -38.3          | 0.0        |             |  |                              |                    | Bit or Barrel   |
| -39.8          | 1.5        |             | CLAY, very soft, slight to medium plasticity, trace shell, gray (CL)   | 53                           | 1                  | -38.3 Blows/0.5 Ft settled<br>Split Spoon<br>-39.8  |
| -40.3          | 2.0        |             | CLAY, medium to high plasticity, very soft to stiff, light brown with black and red stains (CH); trace shell from -39.8 to -40.3; trace limestone gravel from -41.3 to -41.8 and from -42.8 to -44.8 | 67                           | 2                  | " settled<br>-41.3  |
| -41.3          | 3.0        |             |  | 73                           | 3                  | " 6<br>4<br>-42.8 8   |
| -41.8          | 3.5        |             |  | 67                           | 4                  | " 2<br>6<br>-44.3 10  |
| -42.8          | 4.5        |             |  | 73                           | 5                  | " 4<br>8<br>-45.8 11  |
| -44.8          | 6.5        |             |  |                              |                    |   |
| -45.8          | 7.5        |             |  |                              |                    |   |
|                |            |             | Soils are field visually classified in accordance with the Unified Soils Classification System.  |                              |                    | 140# hammer with 30" drop used on 2.0' split spoon. (1-3/8" ID x 2" OD)                   |
|                |            |             | SAMPLE ELEVATION<br>-38.3 to -39.8 (MH)*<br>-44.3 to -45.0 (CH)*<br>* Visual classification based on Gradation Curve. No Atterberg Limits.   |                              |                    |   |




| DRILLING LOG   |            | DIVISION<br>South Atlantic |  | INSTALLATION<br>Jacksonville District                   |                 | SHEET<br>1<br>OF 1 SHEETS  |  |
|--|------------|----------------------------|--|---|-----------------|--|--|
| 1. PROJECT<br>San Juan Harbor Deepening  |            |                            |  | 10. SIZE AND TYPE OF BIT See remarks                    |                 |  |  |
| 2. LOCATION (Coordinates or Station)<br>x=612,116 y-223,255  |            |                            |  | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL)<br>MLW       |                 |  |  |
| 3. DRILLING AGENCY<br>Corps of Engineers   |            |                            |  | 12. MANUFACTURER'S DESIGNATION OF DRILL<br>Failing 1500 |                 |  |  |
| 4. HOLE NO. (As shown on drawing title and file number)<br>CB-AC91-20  |            |                            |  | 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN              |                 | DISTURBED<br>UNDISTURBED   |  |
| 5. NAME OF DRILLER<br>M. Whitson   |            |                            |  | 14. TOTAL NUMBER CORE BOXES 1                           |                 |  |  |
| 6. DIRECTION OF HOLE<br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT. |            |                            |  | 15. ELEVATION GROUND WATER Tidal                        |                 |  |  |
| 7. THICKNESS OF OVERBURDEN   |            |                            |  | 16. DATE HOLE   |                 | STARTED<br>1/25/91<br>COMPLETED<br>1/25/91   |  |
| 8. DEPTH DRILLED INTO ROCK   |            |                            |  | 17. ELEVATION TOP OF HOLE -28.1                         |                 |  |  |
| 9. TOTAL DEPTH OF HOLE 18.0'   |            |                            |  | 18. TOTAL CORE RECOVERY FOR BORING 42 %                 |                 |  |  |
|  |            |                            |  | 19. SIGNATURE OF INSPECTOR<br>Geologist, G. Bacuta      |                 |  |  |
| ELEVATION<br>a   | DEPTH<br>b | LEGEND<br>c                | CLASSIFICATION OF MATERIALS<br>(Description)<br>d  | % CORE RECOVERY<br>e                                    | SAMPLE NO.<br>f | REMARKS<br>(Drilling time, water loss, depth of weathering, etc., if significant)<br>g |  |
| -28.1  | 0.0        |                            |  |   |                 | Bit or Barrel  |  |
| -29.6  | 1.5        |                            | CLAY, very soft, slight plasticity, gray (CL)  | 0   | 1               | -28.1 Blows/0.5 Ft settled<br>Split Spoon  |  |
| -31.1  | 3.0        |                            | SAND, fine to medium quartz, trace silt, very soft to stiff, trace to some shell, light brown to gray (SM)   | 20  | 2               | " settled  |  |
| -35.1  | 7.0        |                            | traces of gravel (cm-size cemented shell, corals and sand) and small lenses of clay (CH) from -31.1 to -35.1   | 13  | 3               | " 1<br>3<br>2<br>7   |  |
| -37.1  | 9.0        |                            | SAMPLE ELEVATION LABORATORY CLASSIFICATION<br>-32.6 to -34.1 (SM)*<br>-37.1 to -38.6 (SC)*<br>-41.6 to -43.1 (SC)*<br>* Visual classification based on Gradation Curve. No Atterberg Limits. | 33  | 4               | -32.6 " 2<br>-34.1 " 3<br>-35.6 " 22<br>-37.1 " 10<br>-38.6 " 3                        |  |
| -40.6  | 12.5       |                            | trace gravel (cm-size coral, sand and cemented shell) from -37.1 to -40.6  | 0   | 6               | -37.1 " 40<br>-38.6 " 4<br>-40.1 " 4<br>settled 7                                      |  |
| -44.6  | 16.5       |                            | CLAY, stiff to very stiff, traces of small lenses of cemented sand-shell, brown (CH)   | 47  | 7               | -41.6 " 5<br>-43.1 " 4<br>-44.6 " 6<br>-46.1 " 4                                       |  |
| -46.1  | 18.0       |                            | traces of limestone gravel from -44.6 to -46.1   | 27  | 8               | -41.6 " 11<br>-43.1 " 18<br>-44.6 " 11<br>-46.1 " 20<br>-47.1 " 26                     |  |
|  |            |                            | Soils are field visually classified in accordance with the Unified Soils Classification System.  | 80  | 9               | -41.6 " 11<br>-43.1 " 18<br>-44.6 " 11<br>-46.1 " 20<br>-47.1 " 26                     |  |
|  |            |                            |  | 80  | 10              | -41.6 " 11<br>-43.1 " 18<br>-44.6 " 11<br>-46.1 " 20<br>-47.1 " 26                     |  |
|  |            |                            |  | 67  | 11              | -41.6 " 11<br>-43.1 " 18<br>-44.6 " 11<br>-46.1 " 20<br>-47.1 " 26                     |  |
|  |            |                            |  | 87  | 12              | -41.6 " 11<br>-43.1 " 18<br>-44.6 " 11<br>-46.1 " 20<br>-47.1 " 26                     |  |
|  |            |                            |  |   |                 | 140# hammer with 30" drop used on 2.0' split spoon. (1-3/8" ID x 2" OD)                |  |

|  |  |                            |   |                 |  |
|--|--|----------------------------|---|-----------------|--|
| <b>DRILLING LOG</b>  |  | DIVISION<br>South Atlantic | INSTALLATION<br>Jacksonville District   | SHEET 1<br>OF 1 |  |
| 1. PROJECT<br>San Juan Harbor Deepening  |  |                            | 10. SIZE AND TYPE OF BIT See Remarks  |                 |  |
| 2. LOCATION (Coordinates or Station)<br>X=611,803 Y=217,893  |  |                            | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL)<br>MLW                             |                 |  |
| 3. DRILLING AGENCY<br>Corps of Engineers   |  |                            | 12. MANUFACTURER'S DESIGNATION OF DRILL<br>Failing 1400                       |                 |  |
| 4. HOLE NO. (As shown on drawing title and file number)<br>CB-ATC94-3                                  |  |                            | 13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN<br>disturbed: 0      undisturbed: 0 |                 |  |
| 5. NAME OF DRILLER<br>R. Gordon  |  |                            | 14. TOTAL NUMBER OF CORE BOXES 1  |                 |  |
| 6. DIRECTION OF HOLE<br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED |  |                            | 15. ELEVATION GROUND WATER Tidal  |                 |  |
| 7. THICKNESS OF BURDEN 0 Ft.   |  |                            | 16. DATE HOLE    STARTED    COMPLETED<br>4/16/94   4/16/94                    |                 |  |
| 8. DEPTH DRILLED INTO ROCK 0 Ft.   |  |                            | 17. ELEVATION TOP OF HOLE -27.3 Ft.   |                 |  |
| 9. TOTAL DEPTH OF HOLE 22.5 Ft.  |  |                            | 18. TOTAL CORE RECOVERY FOR BORING 45 %                                       |                 |  |
|  |  |                            | 19. SIGNATURE OF GEOLOGIST<br>M. Goff   |                 |  |

| ELEV. | DEPTH | LEGEND | CLASSIFICATION OF MATERIALS<br>(Description)  | CORE<br>REC<br>% | SAMPLE<br>NUMBER | REMARKS<br>Bit or Barrel | BLOWS/<br>5' |
|-------|-------|--------|---|------------------|------------------|--------------------------|--------------|
| -27.3 | .0    |        |   |                  |                  | -27.3                    |              |
|       |       |        | CLAY, very soft, very wet, trace<br>peat, & silt dark gray to black<br>(CH)   | 10               | 1                | SPLIT SPOON              | 0            |
|       |       |        |   |                  |                  | -32.3                    | 5            |
|       |       |        |   | 43               | 2                | SPLIT SPOON              | 7.5          |
|       |       |        | blue gray with trace of sand<br>from -37.0 to -37.3   |                  |                  | -37.3                    | 10           |
|       |       |        |   | 64               | 3                | SPLIT SPOON              | 12.5         |
|       |       |        |   |                  |                  | -39.8                    |              |
|       |       |        |   | 24               | 4                | SPLIT SPOON              | 15           |
|       |       |        |   |                  |                  | -42.3                    |              |
| -43.3 | 16.0  |        |   | 100              | 5                | SPLIT SPOON              | 44           |
| -43.8 | 16.5  |        | LIMESTONE, moderately hard,<br>slightly pitted, slightly<br>weathered, white  |                  | 6                | -43.8                    | 28           |
|       |       |        | CLAY, firm to stiff, fat, some<br>limestone fragments (to gravel<br>size), yellowish-brown (CH)<br>soft below -45.3 | 60               | 7                | SPLIT SPOON              | 6            |
|       |       |        |   |                  |                  | -45.3                    | 8            |
| -46.5 | 19.2  |        |   | 73               | 8                | SPLIT SPOON              | 14           |
|       |       |        |   |                  | 9                | -46.8                    | 8            |
|       |       |        | LIMESTONE, with clay (soft,<br>yellow-brown), weathered,<br>pitted, white   | 73               | 10               | SPLIT SPOON              | 22           |
|       |       |        |   |                  |                  | -48.3                    | 14           |
|       |       |        |   | 53               | 11               | SPLIT SPOON              | 18           |
| -49.8 | 22.5  |        |   |                  |                  | -49.8                    | 13           |
|       |       |        |   |                  |                  |                          | 14           |
|       |       |        |   |                  |                  |                          | 17           |
|       |       |        |   |                  |                  |                          | 21           |
|       |       |        |   |                  |                  |                          | 22.5         |

|  |   |  |  |
|--|---|--|--|
| <b>DRILLING LOG</b>                    | <b>DIVISION</b><br>South Atlantic   | <b>INSTALLATION</b><br>Jacksonville District   | <b>SHEET 1</b><br>OF 1   |
|  | <b>1. PROJECT</b><br>San Juan Harbor Deepening  |  | <b>10. SIZE AND TYPE OF BIT</b> See Remarks  |
|  | <b>2. LOCATION (Coordinates or Station)</b><br>X=612,260 Y=219,902  |  | <b>11. DATUM FOR ELEVATION SHOWN (TBM or MSL)</b><br>MLW                             |
|  | <b>3. DRILLING AGENCY</b><br>Corps of Engineers   |  | <b>12. MANUFACTURER'S DESIGNATION OF DRILL</b><br>Failing 1400                       |
|  | <b>4. HOLE NO. (As shown on drawing title and file number)</b><br>CB-ATC94-5                                  |  | <b>13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN</b><br>disturbed: 0      undisturbed: 0 |
|  | <b>5. NAME OF DRILLER</b><br>R. Gordon  |  | <b>14. TOTAL NUMBER OF CORE BOXES</b> 1  |
|  | <b>6. DIRECTION OF HOLE</b><br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED |  | <b>15. ELEVATION GROUND WATER</b> Tidal  |
|  | <b>7. THICKNESS OF BURDEN</b> 0 Ft.   |  | <b>16. DATE HOLE STARTED COMPLETED</b><br>4/22/94    4/22/94                         |
|  | <b>8. DEPTH DRILLED INTO ROCK</b> 0 Ft.   |  | <b>17. ELEVATION TOP OF HOLE</b> -26.9 Ft.   |
| <b>9. TOTAL DEPTH OF HOLE</b> 22.5 Ft. |   | <b>18. TOTAL CORE RECOVERY FOR BORING</b> 64 % |  |
|  |   | <b>19. SIGNATURE OF GEOLOGIST</b><br>M. Goff   |  |

| ELEV. | DEPTH | LEGEND | CLASSIFICATION OF MATERIALS<br>(Description)  | CORE<br>REC<br>% | SAMPLE<br>NUMBER | REMARKS<br>Bit or Barrel | BLOWS/<br>5' |
|-------|-------|--------|---|------------------|------------------|--------------------------|--------------|
| -26.9 | .0    |        |   |                  |                  | -26.9                    |              |
| -27.8 | .9    |        | CLAY, very soft, very wet, trace shell & limestone fragments, gray-black (CH)               | 13               | 1                | SPLIT SPOON              | SETTLED      |
|       |       |        | CLAY, fat, soft to stiff, with layers of white, sandy, moderately hard limestone throughout | 60               | 2                | SPLIT SPOON              | 5            |
|       |       |        |   | 73               | 3                | SPLIT SPOON              | 9            |
|       |       |        |   | 73               | 4                | SPLIT SPOON              | 8            |
|       |       |        |   | 67               | 5                | SPLIT SPOON              | 11           |
|       |       |        |   | 67               | 6                | SPLIT SPOON              | 12           |
|       |       |        |   | 57               | 7                | SPLIT SPOON              | 9            |
|       |       |        |   | 73               | 8                | SPLIT SPOON              | 7            |
|       |       |        |   | 100              | 9                | SPLIT SPOON              | 4            |
|       |       |        |   | 73               | 10               | SPLIT SPOON              | 8            |
|       |       |        |   | 67               | 11               | SPLIT SPOON              | 8            |
|       |       |        |   | 80               | 12               | SPLIT SPOON              | 6            |
|       |       |        |   | 53               | 13               | SPLIT SPOON              | 9            |
|       |       |        |   | 67               | 14               | SPLIT SPOON              | 7            |
|       |       |        |   | 47               | 15               | SPLIT SPOON              | 11           |
| -49.4 | 22.5  |        |   |                  |                  | -49.4                    | 12           |

| DRILLING LOG   |       | DIVISION<br>South Atlantic   |   | INSTALLATION<br>Jacksonville District                                    |                  | SHEET 1<br>OF 1  |                |
|--|-------|--|---|--|------------------|--|----------------|
| 1. PROJECT<br>San Juan Harbor Deepening  |       |  |   | 10. SIZE AND TYPE OF BIT See Remarks                                     |                  |  |                |
| 2. LOCATION (Coordinates or Station)<br>X=612,215, Y=222,150   |       |  |   | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL)<br>MLW                        |                  |  |                |
| 3. DRILLING AGENCY<br>Corps of Engineers   |       |  |   | 12. MANUFACTURER'S DESIGNATION OF DRILL<br>Failing 1400                  |                  |  |                |
| 4. HOLE NO. (As shown on drawing title and file number)<br>CB-ATC94-7                                  |       |  |   | 13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN<br>disturbed: 0 undisturbed: 0 |                  |  |                |
| 5. NAME OF DRILLER<br>R. Gordon  |       |  |   | 14. TOTAL NUMBER OF CORE BOXES 1   |                  |  |                |
| 6. DIRECTION OF HOLE<br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED |       |  |   | 15. ELEVATION GROUND WATER Tidal   |                  |  |                |
| 7. THICKNESS OF BURDEN 0 Ft.   |       |  |   | 16. DATE HOLE STARTED COMPLETED<br>4/7/94 4/7/94                         |                  |  |                |
| 8. DEPTH DRILLED INTO ROCK 0 Ft.   |       |  |   | 17. ELEVATION TOP OF HOLE -36.2 Ft.                                      |                  |  |                |
| 9. TOTAL DEPTH OF HOLE 14 Ft.  |       |  |   | 18. TOTAL CORE RECOVERY FOR BORING 46 %                                  |                  |  |                |
|  |       |  |   | 19. SIGNATURE OF GEOLOGIST<br>J. Hand                                    |                  |  |                |
| ELEV.  | DEPTH | LEGEND   | CLASSIFICATION OF MATERIALS<br>(Description)  | CORE<br>REC<br>%   | SAMPLE<br>NUMBER | REMARKS<br>Bit or Barrel   | BLOWS/<br>5'   |
| -36.2  | .0    |  |   |  |                  | -36.2  | 0              |
|  |       |  | CLAY, soft, very wet, gray (CH)   |  |                  |  | SETTLED        |
|  |       |  | stiff, brown from -41.0 to -50.2  | 20   | 1                | 2" X 5' SPOON  | 2.5            |
|  |       |  |   |  |                  |  |                |
|  |       |  |   | 94   | 3                | SPLIT SPOON  | 3<br>4<br>8    |
|  |       |  |   | 33   | 4                | SPLIT SPOON  | 3<br>6<br>8    |
|  |       |  |   | 94   | 5                | SPLIT SPOON  | 4<br>6<br>9    |
|  |       |  |   | 74   | 6                | SPLIT SPOON  | 5<br>11<br>14  |
|  |       |  |   | 33   | 7                | SPLIT SPOON  | 11<br>12<br>11 |
|  |       |  |   | 33   | 8                | SPLIT SPOON  | 5<br>8<br>8    |
| -50.2  | 14.0  |  |   |  |                  | -50.2  |                |
|  |       |  | 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) | 15             |
|  |       |  | SAMPLE ELEVATION -36.2/-39.9 LABORATORY CLASSIFICATION (CH)*                                    |  |                  |  | 17.            |
|  |       |  | *Visual classification based on Gradation Curve. No Atterberg Limits.                           |  |                  |  | 20             |
|  |       |  |   |  |                  |  | 22             |

| DRILLING LOG   |            | DIVISION<br>South Atlantic |  | INSTALLATION<br>Jacksonville District              |                 | SHEET<br>1 OF 1 SHEETS   |  |
|--|------------|----------------------------|--|--|-----------------|--|--|
| 1. PROJECT<br>San Juan Harbor Deepening  |            |                            |  | 10. SIZE AND TYPE OF BIT See remarks               |                 |  |  |
| 2. LOCATION (Coordinates or Station)<br>x=613,864 y=217,441  |            |                            |  | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL)<br>MLW  |                 |  |  |
| 3. DRILLING AGENCY<br>Corps of Engineers   |            |                            |  | 12. MANUFACTURER'S DESIGNATION OF DRILL<br>Failing |                 |  |  |
| 4. HOLE NO. (As shown on drawing title and file number)<br>CB-PN-16  |            |                            |  | 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN         |                 | DISTURBED<br>UNDISTURBED   |  |
| 5. NAME OF DRILLER<br>M. Whitson   |            |                            |  | 14. TOTAL NUMBER CORE BOXES<br>1                   |                 |  |  |
| 6. DIRECTION OF HOLE<br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT. |            |                            |  | 15. ELEVATION GROUND WATER<br>Tidal                |                 | 16. DATE HOLE<br>STARTED 2/12/91 COMPLETED 2/12/91                                     |  |
| 7. THICKNESS OF OVERBURDEN   |            |                            |  | 17. ELEVATION TOP OF HOLE<br>-33.7                 |                 |  |  |
| 8. DEPTH DRILLED INTO ROCK   |            |                            |  | 18. TOTAL CORE RECOVERY FOR BORING<br>68 %         |                 |  |  |
| 9. TOTAL DEPTH OF HOLE<br>12.0'  |            |                            |  | 19. SIGNATURE OF INSPECTOR<br>Geologist, G. Bacuta |                 |  |  |
| ELEVATION<br>a   | DEPTH<br>b | LEGEND<br>c                | CLASSIFICATION OF MATERIALS<br>(Description)<br>d  | % CORE RECOVERY<br>e                               | SAMPLE NO.<br>f | REMARKS<br>(Drilling time, water loss, depth of weathering, etc., if significant)<br>g |  |
| -33.7  | 0.0        |                            |  |  |                 | Bit or Barrel  |  |
| -35.7  | 2.0        |                            | CLAY, soft to very soft, medium plasticity, trace shell, trace silt, gray from -33.7 to -35.7 (CL)               | 13   | 1               | -33.7 Blows/0.5 Ft settled<br>Split Spoon<br>-35.2                                     |  |
|  |            |                            |  | 80   | 2               | " settled<br>2   |  |
|  |            |                            |  | 73   | 3               | " 12<br>6  |  |
|  |            |                            | CLAY, stiff, traces of weathered black and red fragments (possible metallic) reddish brown, high plasticity (CH) | 67   | 4               | " 16<br>23   |  |
|  |            |                            |  | 80   | 5               | " 9<br>9   |  |
|  |            |                            |  | 87   | 6               | " 26<br>12   |  |
|  |            |                            |  | 67   | 7               | " 28<br>38   |  |
|  |            |                            |  | 73   | 8               | " 12<br>19   |  |
| -45.7  | 12.0       |                            |  |  |                 | -42.7 25<br>8<br>16<br>16<br>11<br>16<br>23  |  |
|  |            |                            | Soils are field visually classified in accordance with the Unified Soils Classification System.                  |  |                 | 140# hammer with 30" drop used on 2.0' split spoon. (1-3/8" ID x 2" OD)                |  |
|  |            |                            | SAMPLE ELEVATION -35.7 to -36.7  |  |                 |  |  |
|  |            |                            | LABORATORY CLASSIFICATION (CH)*  |  |                 |  |  |
|  |            |                            | * Visual classification based on Gradation Curve. No Atterberg Limits.   |  |                 |  |  |


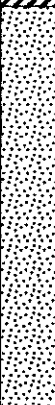

|  |       |                            |   |   |                  |  |              |      |
|--|-------|----------------------------|---|---|------------------|--|--------------|------|
| <b>DRILLING LOG</b>  |       | DIVISION<br>South Atlantic |   | INSTALLATION<br>Jacksonville District   |                  | SHEET 1<br>OF 1  |              |      |
| 1. PROJECT<br>San Juan Harbor Deepening  |       |                            |   | 10. SIZE AND TYPE OF BIT See Remarks  |                  |  |              |      |
| 2. LOCATION (Coordinates or Station)<br>X=619,513 Y=221,752  |       |                            |   | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL)<br>MLW                             |                  |  |              |      |
| 3. DRILLING AGENCY<br>Corps of Engineers   |       |                            |   | 12. MANUFACTURER'S DESIGNATION OF DRILL<br>Failing 1400                       |                  |  |              |      |
| 4. HOLE NO. (As shown on drawing title and file number)<br>CB-PN94-1                                   |       |                            |   | 13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN<br>disturbed: 0      undisturbed: 0 |                  |  |              |      |
| 5. NAME OF DRILLER<br>R. Gordon  |       |                            |   | 14. TOTAL NUMBER OF CORE BOXES 1  |                  |  |              |      |
| 6. DIRECTION OF HOLE<br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED |       |                            |   | 15. ELEVATION GROUND WATER Tidal  |                  |  |              |      |
| 7. THICKNESS OF BURDEN 0 Ft.   |       |                            |   | 16. DATE HOLE STARTED COMPLETED<br>4/14/94    4/14/94                         |                  |  |              |      |
| 8. DEPTH DRILLED INTO ROCK 0 Ft.   |       |                            |   | 17. ELEVATION TOP OF HOLE -39.1 Ft.   |                  |  |              |      |
| 9. TOTAL DEPTH OF HOLE 17.5 Ft.  |       |                            |   | 18. TOTAL CORE RECOVERY FOR BORING 53 %                                       |                  |  |              |      |
|  |       |                            |   | 19. SIGNATURE OF GEOLOGIST<br>M. Goff   |                  |  |              |      |
| ELEV.  | DEPTH | LEGEND                     | CLASSIFICATION OF MATERIALS<br>(Description)  | CORE<br>REC<br>%  | SAMPLE<br>NUMBER | REMARKS<br>Bit or Barrel   | BLOWS/<br>5' |      |
| -39.1  | .0    |                            |   |   |                  | -39.1  | 0            |      |
|  |       |                            | CLAY,soft, very wet, trace silt, black (CH)   | 20  | 1                | SPLIT SPOON  | 2.5          |      |
|  |       |                            |   |   |                  | -44.1  | 5            |      |
|  |       |                            |   |   | 30               | 2  | SPLIT SPOON  | 7.5  |
| -48.1  | 9.0   |                            | CLAY, fat, trace silt, green (CH)   |   | 3                | SPLIT SPOON  | 10           |      |
|  |       |                            |   |   | 100              | 4  | SPLIT SPOON  | 12   |
|  |       |                            | trace of sand size rock fragments   |   | 100              | 5  | SPLIT SPOON  | 12.5 |
|  |       |                            |   |   | 53               | 6  | SPLIT SPOON  | 15   |
|  |       |                            | soft to firm  |   | 100              | 7  | SPLIT SPOON  | 17.5 |
|  |       |                            |   |   | 100              | 8  | SPLIT SPOON  | 17.5 |
| -56.6  | 17.5  |                            |   |   |                  |  | -56.6        | 17.5 |
|  |       |                            | 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) | 20           |      |
|  |       |                            |   |   |                  |  | 22.5         |      |

|  |  |  |                                       |                 |
|--|--|--|---------------------------------------|-----------------|
| <b>DRILLING LOG</b>  |  | DIVISION<br>South Atlantic   | INSTALLATION<br>Jacksonville District | SHEET 1<br>OF 1 |
| 1. PROJECT<br>San Juan Harbor Deepening  |  | 10. SIZE AND TYPE OF BIT See Remarks                                     |                                       |                 |
| 2. LOCATION (Coordinates or Station)<br>X=618,084 Y=220,007  |  | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL)<br>MLW                        |                                       |                 |
| 3. DRILLING AGENCY<br>Corps of Engineers   |  | 12. MANUFACTURER'S DESIGNATION OF DRILL<br>Falling 1400                  |                                       |                 |
| 4. HOLE NO. (As shown on drawing title and file number)<br>CB-PN94-5                                   |  | 13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN<br>disturbed: 0 undisturbed: 0 |                                       |                 |
| 5. NAME OF DRILLER<br>R. Gordon  |  | 14. TOTAL NUMBER OF CORE BOXES 1   |                                       |                 |
| 6. DIRECTION OF HOLE<br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED |  | 15. ELEVATION GROUND WATER Tidal   |                                       |                 |
| 7. THICKNESS OF BURDEN 0 Ft.   |  | 16. DATE HOLE STARTED COMPLETED<br>4/21/94 4/21/94                       |                                       |                 |
| 8. DEPTH DRILLED INTO ROCK 0 Ft.   |  | 17. ELEVATION TOP OF HOLE -38.3 Ft.                                      |                                       |                 |
| 9. TOTAL DEPTH OF HOLE 12 Ft.  |  | 18. TOTAL CORE RECOVERY FOR BORING 73 %                                  |                                       |                 |
|  |  | 19. SIGNATURE OF GEOLOGIST<br>M. Goff                                    |                                       |                 |

| ELEV. | DEPTH | LEGEND | CLASSIFICATION OF MATERIALS<br>(Description)  | CORE<br>REC<br>% | SAMPLE<br>NUMBER | REMARKS<br>Bit or Barrel   | BLOWS/<br>5' |
|-------|-------|--------|---|------------------|------------------|--|--------------|
| -38.3 | .0    |        |   |                  |                  | -38.3  | 0            |
|       |       |        | CLAY, very, soft, very wet, dark gray - black (CH)  | 40               | 1                | SPLIT SPOON  | SETTLED      |
| -41.3 | 3.0   |        |   |                  |                  | -41.3  | 2.5          |
|       |       |        | SILT, with some fat clay, yellow-brown, with veins of white clayey silt (MH)                      | 73               | 2                | SPLIT SPOON  | 5            |
| -42.8 | 4.5   |        |   |                  |                  | -42.8  | 6            |
|       |       |        | CLAY, firm to stiff, fat, trace weathered rock fragments and shell, gray-green to yellow-tan (CH) | 93               | 3                | SPLIT SPOON  | 10           |
|       |       |        |   |                  |                  | -44.3  | 5            |
|       |       |        |   | 87               | 4                | SPLIT SPOON  | 9            |
|       |       |        | trace of black, damp, orgnic material   |                  |                  | -45.8  | 18           |
|       |       |        |   | 80               | 5                | SPLIT SPOON  | 5            |
|       |       |        |   |                  |                  | -47.3  | 11           |
|       |       |        |   | 80               | 6                | SPLIT SPOON  | 17           |
|       |       |        |   |                  |                  | -48.8  | 6            |
|       |       |        |   | 93               | 7                | SPLIT SPOON  | 11           |
| -50.3 | 12.0  |        |   |                  |                  | -50.3  | 17           |
|       |       |        | 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) | 8            |
|       |       |        |   |                  |                  |  | 12           |
|       |       |        |   |                  |                  |  | 12.5         |
|       |       |        |   |                  |                  |  | 15           |
|       |       |        |   |                  |                  |  | 17.5         |
|       |       |        |   |                  |                  |  | 20           |
|       |       |        |   |                  |                  |  | 22.5         |



|                               |  |   |  |
|-------------------------------|--|---|--|
| <b>DRILLING LOG</b>           | DIVISION<br>South Atlantic   | INSTALLATION<br>Jacksonville District   | SHEET 1<br>OF 1  |
|                               | 1. PROJECT<br>San Juan Harbor Deepening  |   | 10. SIZE AND TYPE OF BIT See Remarks                                     |
|                               | 2. LOCATION (Coordinates or Station)<br>X=616,351 Y=218,905  |   | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL)<br>MLW                        |
|                               | 3. DRILLING AGENCY<br>Corps of Engineers   |   | 12. MANUFACTURER'S DESIGNATION OF DRILL<br>Failing 1400                  |
|                               | 4. HOLE NO. (As shown on drawing title and file number)<br>CB-PN94-7                                   |   | 13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN<br>disturbed: 0 undisturbed: 0 |
|                               | 5. NAME OF DRILLER<br>R. Gordon  |   | 14. TOTAL NUMBER OF CORE BOXES 1   |
|                               | 6. DIRECTION OF HOLE<br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED |   | 15. ELEVATION GROUND WATER Tidal   |
|                               | 7. THICKNESS OF BURDEN 0 Ft.   |   | 16. DATE HOLE STARTED COMPLETED<br>4/18/94 4/18/94                       |
|                               | 8. DEPTH DRILLED INTO ROCK 0 Ft.   |   | 17. ELEVATION TOP OF HOLE -37.4 Ft.                                      |
| 9. TOTAL DEPTH OF HOLE 13 Ft. |  | 18. TOTAL CORE RECOVERY FOR BORING 70 % |  |
|                               |  | 19. SIGNATURE OF GEOLOGIST<br>M. Goff   |  |

| ELEV. | DEPTH | LEGEND  | CLASSIFICATION OF MATERIALS<br>(Description)   | CORE<br>REC<br>% | SAMPLE<br>NUMBER | REMARKS<br>Bit or Barrel   | BLOWS/<br>5'               |
|-------|-------|---|--|------------------|------------------|--|----------------------------|
| -37.4 | .0    |   |  |                  |                  | -37.4  | 0                          |
|       |       |   | CLAY, very, soft, dark gray - black (CH)   | 60               | 1                | SPLIT SPOON  | SETTLED                    |
| -40.4 | 3.0   |  | SAND, quartz, fine to medium, trace clay, gray (SP)  | 55               | 2                | SPLIT SPOON  | 6<br>7<br>9                |
|       |       |   |  | 60               | 3                | SPLIT SPOON  | -42.4<br>4<br>6<br>8       |
|       |       |   |  | 20               | 4                | SPLIT SPOON  | -43.9<br>3<br>1<br>SETTLED |
| -45.9 | 8.5   |  | CLAY, soft, slightly wet, trace coarse sand size rock fragments and peat, yellow to brown mottled (CH) | 100              | 5                | SPLIT SPOON  | -45.9<br>1<br>SETTLED      |
|       |       |   |  | 100              | 6                | SPLIT SPOON  | -47.4<br>2<br>3<br>10      |
|       |       |   |  | 100              | 7                | SPLIT SPOON  | -48.9<br>6<br>10<br>18     |
| -50.4 | 13.0  |   |  |                  |                  | -50.4  | 12.5                       |
|       |       |   | 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) | 15<br>17.5<br>20<br>22.5   |

| ELEV. | DEPTH | LEGEND | CLASSIFICATION OF MATERIALS<br>(Description)  | CORE<br>REC<br>% | SAMPLE<br>NUMBER | REMARKS<br>Bit or Barrel | BLOWS/<br>5' |
|-------|-------|--------|---|------------------|------------------|--------------------------|--------------|
| -3.5  | .0    |        |   |                  |                  | -3.5                     | 0            |
|       |       |        | CLAY, very soft to soft, wet,<br>trace shell, silt and sand, dark<br>gray to brown (CH) | 24               | 1                | SPLIT SPOON              | 2.5          |
|       |       |        |   |                  |                  | -11.0                    | 7.5          |
|       |       |        |   | 60               | 2                | SPLIT SPOON              | 10           |
|       |       |        |   |                  |                  | -16.0                    | 12.5         |
|       |       |        |   | 100              | 3                | SPLIT SPOON              | 15           |
|       |       |        |   |                  |                  | -17.5                    | 17.5         |
|       |       |        |   | 60               | 4                | SPLIT SPOON              | 20           |
|       |       |        |   |                  |                  | -20.5                    | 22.5         |
|       |       |        |   | 76               | 5                | SPLIT SPOON              | 25           |
|       |       |        |   |                  |                  | -23.0                    | 27.5         |
|       |       |        |   | 76               | 6                | SPLIT SPOON              | 30           |
|       |       |        |   |                  |                  | -25.5                    | 32.5         |
|       |       |        |   | 60               | 7                | SPLIT SPOON              | 35           |
|       |       |        |   |                  |                  | (continued)              | 37.5         |

## DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE

-3.5 Ft.

SHEET 2  
OF 2

PROJECT

San Juan Harbor Deepening

INSTALLATION

Jacksonville District

| ELEV. | DEPTH | LEGEND | CLASSIFICATION OF MATERIALS<br>(Description)  | CORE<br>REC<br>%                             | SAMPLE<br>NUMBER | REMARKS<br>Bit or Barrel   | BLOWS/<br>5' |
|-------|-------|--------|---|--|------------------|--|--------------|
| -26.0 | 22.5  |        |   |  |                  |  |              |
|       |       |        |   | 60   | 7                | SPLIT SPOON  |              |
|       |       |        |   |  |                  | -28.5  |              |
|       |       |        |   | 100  | 8                | SPLIT SPOON  | SETTLED      |
|       |       |        |   |  |                  | -30.0  |              |
|       |       |        |   | 100  | 9                | SPLIT SPOON  | SETTLED      |
|       |       |        |   |  |                  | -32.0  |              |
|       |       |        |   | 100  | 10               | SPLIT SPOON  | SETTLED      |
|       |       |        |   |  |                  | -33.5  |              |
|       |       |        |   | 100  | 11               | SPLIT SPOON  | SETTLED      |
|       |       |        |   |  |                  | -35.0  |              |
|       |       |        |   | 100  | 12               | SPLIT SPOON  | SETTLED      |
|       |       |        |   |  |                  | -36.5  | 2            |
|       |       |        |   | 100  | 13               | SPLIT SPOON  | SETTLED      |
|       |       |        |   |  |                  | -38.0  | 1            |
|       |       |        | CLAY, soft to firm, fat, trace<br>silt, yellow-brown (CH)   |  |                  |  | 2            |
|       |       |        |   | 73   | 14               | SPLIT SPOON  | 4            |
|       |       |        |   |  |                  | -39.5  | 5            |
|       |       |        | firm to stiff   |  |                  |  | 6            |
|       |       |        |   | 73   | 15               | SPLIT SPOON  | 2            |
|       |       |        |   |  |                  | -41.0  | 4            |
|       |       |        |   |  |                  |  | 12           |
|       |       |        |   | 60   | 16               | SPLIT SPOON  | 6            |
|       |       |        |   |  |                  | -42.5  | 8            |
|       |       |        |   |  |                  |  | 16           |
|       |       |        |   | 47   | 17               | SPLIT SPOON  | 7            |
|       |       |        |   |  |                  | -44.0  | 10           |
|       |       |        |   |  |                  |  | 18           |
|       |       |        |   | 67   | 18               | SPLIT SPOON  | 6            |
|       |       |        |   |  |                  | -45.5  | 16           |
|       |       |        |   |  |                  |  | 24           |
|       |       |        | stiff to very stiff   |  |                  |  | 7            |
|       |       |        |   | 67   | 19               | SPLIT SPOON  | 10           |
| -47.0 | 43.5  |        |   |  |                  | -47.0  | 22           |
|       |       |        | Soils are field visually classified<br>in accordance with the Unified Soils<br>Classification System. |  |                  | 140# HAMMER WITH 30" DROP<br>USED ON 2" SPLIT SPOON<br>(1 3/8" ID X 2" OD) |              |
|       |       |        | SAMPLE ELEVATION<br>-11.0/-16.0<br>-39.0/-30.5  | LABORATORY<br>CLASSIFICATION<br>(CH)<br>(CH) |                  |  |              |
|       |       |        | *Visual classification based on<br>Gradation Curve. No Atterberg<br>Limits.                           |  |                  |  |              |

PROJECT

San Juan Harbor Deepening

HOLE NUMBER

CB-PN94-9

## Hole No.CB-SJH00-16

| DRILLING LOG   |       | DIVISION<br>South Atlantic |  | INSTALLATION<br>Jacksonville District                                       |                  | SHEET 1<br>OF 1   |  |
|--|-------|----------------------------|--|---|------------------|---|--|
| 1. PROJECT<br>San Juan Harbor, Puerto Rico   |       |                            |  | 10. SIZE AND TYPE OF BIT See Remarks  |                  |   |  |
| 2. LOCATION (Coordinates or Station)<br>X=610,241 Y=229,274  |       |                            |  | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL)<br>NAD 27 PR VI 5201/NGVD 29 MLW |                  |   |  |
| 3. DRILLING AGENCY<br>Corps of Engineers   |       |                            |  | 12. MANUFACTURER'S DESIGNATION OF DRILL<br>Acker Tripod on Barge            |                  |   |  |
| 4. HOLE NO. (As shown on drawing title and file number)<br>CB-SJH00-16                                 |       |                            |  | 13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN<br>disturbed: 7 undisturbed: 0    |                  |   |  |
| 5. NAME OF DRILLER<br>L. C. Gregory  |       |                            |  | 14. TOTAL NUMBER OF CORE BOXES 1  |                  |   |  |
| 6. DIRECTION OF HOLE<br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED |       |                            |  | 15. ELEVATION GROUND WATER tidal  |                  |   |  |
| 7. THICKNESS OF BURDEN 0 Ft.   |       |                            |  | 16. DATE HOLE STARTED COMPLETED<br>10/07/00 10/07/00                        |                  |   |  |
| 8. DEPTH DRILLED INTO ROCK 0 Ft.   |       |                            |  | 17. ELEVATION TOP OF HOLE -20.8 Ft.   |                  |   |  |
| 9. TOTAL DEPTH OF HOLE 18.0 Ft.  |       |                            |  | 18. TOTAL CORE RECOVERY FOR BORING 51 %                                     |                  |   |  |
|  |       |                            |  | 19. SIGNATURE OF GEOLOGIST<br>C. Papiernik                                  |                  |   |  |
| ELEV.  | DEPTH | LEGEND                     | CLASSIFICATION OF MATERIALS<br>(Description)   | CORE<br>REC<br>%  | SAMPLE<br>NUMBER | REMARKS<br>Bit or Barrel  | BLOWS/<br>ft.  |
| -20.8  | 0.0   |                            |  |   |                  | -20.8   | 0  |
|  |       |                            | CLAY, silty, very soft, saturated, dark gray, (CH).  | 20  | 1<br>D-1         | 5' X 1 3/8" ID SPOON  | WOR<br>WOR<br>WOR<br>WOR<br>WOR<br>WOR<br>WOR<br>WOR |
| -25.3  | 4.5   |                            |  |   |                  | -25.3   | 2.5  |
|  |       |                            | LIMESTONE, coral, soft, interlayered with clay and occasional shells, gray to green, (LM).                       | 67  | 2                | SPLIT SPOON   | 4<br>20<br>5   |
|  |       |                            |  | 47  | 3                | SPLIT SPOON   | 14<br>15<br>5  |
|  |       |                            |  | 14  | N/S              | SPLIT SPOON   | 1<br>5<br>8  |
|  |       |                            |  | 47  | 4<br>D-4         | SPLIT SPOON   | 6<br>6<br>7  |
|  |       |                            |  | 53  | 5                | SPLIT SPOON   | 4<br>5<br>9  |
|  |       |                            |  | 67  | 6                | SPLIT SPOON   | 5<br>4<br>5  |
|  |       |                            |  | 40  | N/S              | SPLIT SPOON   | 2<br>4<br>6  |
|  |       |                            |  | 33  | 7                | 5' X 1 3/8" ID SPOON  | 1<br>6<br>7<br>10<br>10                              |
| -38.8  | 18.0  |                            |  |   |                  | -38.8   | 17.5   |
|  |       |                            | NOTES:<br><br>1. Soils are field visually classified in accordance with the Unified Soils Classification System. |   |                  | 140# Hammer with 30" drop used 2.0' split spoon (1 3/8" I.D. X 2" O. D.) or 5' X 1 3/8" ID spoon. Wash to depth before spoon advancement. | 9<br>20<br>22.5                                      |

## Hole No. CB-SJH00-31

| DRILLING LOG   |       | DIVISION       |  | INSTALLATION  |               | SHEET 1 OF 1   |          |
|--|-------|----------------|--|---|---------------|--|----------|
| 1. PROJECT<br>San Juan Harbor, Puerto Rico   |       | South Atlantic |  | Jacksonville District   |               |  |          |
| 2. LOCATION (Coordinates of Station)<br>X=814,821 Y=228,881  |       |                |  | 10. SIZE AND TYPE OF BIT See Remarks  |               |  |          |
| 3. DRILLING AGENCY<br>Corps of Engineers   |       |                |  | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL)<br>NAD 27 PR VI 5201/NGVD 29 MLW |               |  |          |
| 4. HOLE NO. (As shown on drawing title and file number)<br>CB-SJH00-31                                 |       |                |  | 12. MANUFACTURER'S DESIGNATION OF DRILL<br>Acker Tripod on Barge            |               |  |          |
| 5. NAME OF DRILLER<br>L. C. Gregory  |       |                |  | 13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN<br>disturbed: 8 undisturbed: 0    |               |  |          |
| 6. DIRECTION OF HOLE<br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED |       |                |  | 14. TOTAL NUMBER OF CORE BOXES 1  |               |  |          |
| 7. THICKNESS OF BURDEN 0 Ft.   |       |                |  | 15. ELEVATION GROUND WATER Tidal  |               |  |          |
| 8. DEPTH DRILLED INTO ROCK 0 Ft.   |       |                |  | 16. DATE HOLE STARTED COMPLETED<br>10/03/00 10/03/00                        |               |  |          |
| 9. TOTAL DEPTH OF HOLE 9.0 Ft.   |       |                |  | 17. ELEVATION TOP OF HOLE -28.9 Ft.   |               |  |          |
|  |       |                |  | 18. TOTAL CORE RECOVERY FOR BORING 48 %                                     |               |  |          |
|  |       |                |  | 19. SIGNATURE OF GEOLOGIST<br>C. Papiernik                                  |               |  |          |
| ELEV.  | DEPTH | LEGEND         | CLASSIFICATION OF MATERIALS (Description)  | CORE REC %  | SAMPLE NUMBER | REMARKS Bit or Barrel  | BLOWS/5' |
| -28.9  | 0.0   |                |  |   |               | -28.9  | 0        |
|  |       |                | SAND, silty with little shells, very loose, saturated, dark gray. (SM)                                       | 87  | 1 D-1         | SPLIT SPOON  | WOR      |
|  |       |                |  | 20  | 2             | SPLIT SPOON  | WOR      |
| -32.2  | 3.3   |                |  |   |               | -30.4  | 2.5      |
|  |       |                | CLAY, fat, stiff, moist, trace sand in upper 1/2 foot, brown. (CH)   | 47  | 3 D-3         | SPLIT SPOON  | 3        |
|  |       |                | Stiff sample slipped out of spoon 4.5-6 feet.  | 0   |               | SPLIT SPOON  | 6        |
| -35.6  | 6.7   |                |  |   |               | -31.9  | 5        |
|  |       |                | LIMESTONE, weathered, hard with clay lenses, tan. (LM)   | 67  | 4             | SPLIT SPOON  | 8        |
|  |       |                |  | 67  | 5             | SPLIT SPOON  | 9        |
| -37.9  | 9.0   |                |  |   |               | -33.4  | 7.5      |
|  |       |                |  | 67  | 6 D-8         | SPLIT SPOON  | 18       |
|  |       |                |  |   |               | -34.9  | 6        |
|  |       |                |  |   |               | -36.4  | 7.5      |
|  |       |                |  |   |               | -37.9  | 10       |
|  |       |                | NOTES:<br>1. Soils are field visually classified in accordance with the Unified Soils Classification System. |   |               | 140# Hammer with 30" drop used 2.0' split spoon (1 3/8" I.D. X 2" O. D.) Wash to depth before split spoon advancement. | 10       |
|  |       |                |  |   |               |  | 12.5     |
|  |       |                |  |   |               |  | 15       |
|  |       |                |  |   |               |  | 17.5     |
|  |       |                |  |   |               |  | 20       |
|  |       |                |  |   |               |  | 22.5     |

## Hole No.CB-SJH00-38

| DRILLING LOG   |       | DIVISION<br>South Atlantic | INSTALLATION<br>Jacksonville District   | SHEET 1<br>OF 1  |                  |                          |   |      |
|--|-------|----------------------------|---|--|------------------|--------------------------|---|------|
| 1. PROJECT<br>San Juan Harbor, Puerto Rico   |       |                            | 10. SIZE AND TYPE OF BIT See Remarks  |  |                  |                          |   |      |
| 2. LOCATION (Coordinates or Station)<br>X=618,629 Y=228,528  |       |                            | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL)<br>NAD 27 PR VI 5201/NGVD 29 MLW             |  |                  |                          |   |      |
| 3. DRILLING AGENCY<br>Corps of Engineers   |       |                            | 12. MANUFACTURER'S DESIGNATION OF DRILL<br>Acker Tripod on Barge                        |  |                  |                          |   |      |
| 4. HOLE NO. (As shown on drawing title and file number)<br>CB-SJH00-38                                 |       |                            | 13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN<br>disturbed: 5 undisturbed: 0                |  |                  |                          |   |      |
| 5. NAME OF DRILLER<br>L. C. Gregory  |       |                            | 14. TOTAL NUMBER OF CORE BOXES 1  |  |                  |                          |   |      |
| 6. DIRECTION OF HOLE<br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED |       |                            | 15. ELEVATION GROUND WATER tidal  |  |                  |                          |   |      |
| 7. THICKNESS OF BURDEN 0 Ft.   |       |                            | 16. DATE HOLE STARTED COMPLETED<br>10/17/00 10/17/00                                    |  |                  |                          |   |      |
| 8. DEPTH DRILLED INTO ROCK 0 Ft.   |       |                            | 17. ELEVATION TOP OF HOLE -26.2 Ft.   |  |                  |                          |   |      |
| 9. TOTAL DEPTH OF HOLE 12.5 Ft.  |       |                            | 18. TOTAL CORE RECOVERY FOR BORING 49 %   |  |                  |                          |   |      |
|  |       |                            | 19. SIGNATURE OF GEOLOGIST<br>C. Papiernik  |  |                  |                          |   |      |
| ELEV.  | DEPTH | LEGEND                     | CLASSIFICATION OF MATERIALS<br>(Description)  | CORE<br>REC<br>%   | SAMPLE<br>NUMBER | REMARKS<br>Bit or Barrel | BLOWS/<br>ft.   |      |
| -26.2  | 0.0   |                            |   |  |                  | -26.2                    | 0   |      |
|  |       |                            | CLAY, silty, trace sand to 5', very soft, organic, plastic, saturated, dark gray, (CH). | 20   | 1<br>0-1         | 5' X 1 3/8" ID SPOON     | WOR<br>WOR<br>WOR<br>WOR<br>WOR<br>WOR<br>WOR<br>WOR<br>WOR<br>WOR  |      |
|  |       |                            | CLAY as above, less sand with depth   | 79   | 2                | 5' X 1 3/8" ID SPOON     | WOR<br>WOR<br>WOR<br>WOR<br>WOR<br>WOR<br>WOR<br>WOR  |      |
|  |       |                            | CLAY as above, turning green and more firm at 9'.                                       |  |                  |                          |   |      |
|  |       |                            | CLAY, sandy, stiff, plastic, cohesive, moist, light gray, beginning at 10.0.            | 73   | 3D-3<br>4        | SPLIT SPOON              | 5<br>11<br>12   |      |
|  |       |                            |   | 33   | 5<br>0-5         | SPLIT SPOON              | 5<br>12<br>17   |      |
| -38.7  | 12.5  |                            |   |  |                  |                          | -38.7   | 12.5 |
|  |       |                            |   | NOTES:<br>1. Soils are field visually classified in accordance with the Unified Soils Classification System. |                  |                          | 140# Hammer with 30" drop used 5.0' spoon (1 3/8" I.D. X 5') or 2' X 1 3/8" ID split spoon. Wash to depth before spoon advancement. |      |
|  |       |                            |   |  |                  |                          |   | 15   |
|  |       |                            |   |  |                  |                          |   | 17.5 |
|  |       |                            |   |  |                  |                          |   | 20   |
|  |       |                            |   |  |                  |                          | 22.5  |      |

## Hole No.CB-SJH00-39

| DRILLING LOG   |       | DIVISION<br>South Atlantic |  | INSTALLATION<br>Jacksonville District                                       |                  | SHEET 1<br>OF 2          |               |
|--|-------|----------------------------|--|---|------------------|--------------------------|---------------|
| 1. PROJECT<br>San Juan Harbor, Puerto Rico   |       |                            |  | 10. SIZE AND TYPE OF BIT See Remarks  |                  |                          |               |
| 2. LOCATION (Coordinates or Station)<br>X=618,544 Y=227,844  |       |                            |  | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL)<br>NAD 27 PR VI 5201/NGVD 29 MLW |                  |                          |               |
| 3. DRILLING AGENCY<br>Corps of Engineers   |       |                            |  | 12. MANUFACTURER'S DESIGNATION OF DRILL<br>Acker Tripod on Barge            |                  |                          |               |
| 4. HOLE NO. (As shown on drawing title and file number)<br>CB-SJH00-39                                 |       |                            |  | 13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN<br>disturbed: 11 undisturbed: 0   |                  |                          |               |
| 5. NAME OF DRILLER<br>D. Hewitt  |       |                            |  | 14. TOTAL NUMBER OF CORE BOXES 1  |                  |                          |               |
| 6. DIRECTION OF HOLE<br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED |       |                            |  | 15. ELEVATION GROUND WATER Tidal  |                  |                          |               |
| 7. THICKNESS OF BURDEN 0 Ft.   |       |                            |  | 16. DATE HOLE STARTED COMPLETED<br>10/18/00 10/18/00                        |                  |                          |               |
| 8. DEPTH DRILLED INTO ROCK 0 Ft.   |       |                            |  | 17. ELEVATION TOP OF HOLE -14.6 Ft.   |                  |                          |               |
| 9. TOTAL DEPTH OF HOLE 24.5 Ft.  |       |                            |  | 18. TOTAL CORE RECOVERY FOR BORING 53 %                                     |                  |                          |               |
|  |       |                            |  | 19. SIGNATURE OF GEOLOGIST<br>C. Papiernik                                  |                  |                          |               |
| ELEV.  | DEPTH | LEGEND                     | CLASSIFICATION OF MATERIALS<br>(Description)   | CORE<br>REC<br>%  | SAMPLE<br>NUMBER | REMARKS<br>Bit or Barrel | BLOWS/<br>ft. |
| -14.6  | 0.0   |                            |  |   |                  | -14.6                    | 0             |
|  |       |                            | PEAT, trace fine sand and shells,<br>very soft, saturated, brown,<br>(OL).                   | 20  | 1<br>D-1         | 5' X 1 3/8" ID SPOON     | WOR           |
|  |       |                            | Clean organic debris (peat)<br>beginning at 5'.  |   |                  |                          | WOR           |
|  |       |                            |  | 30  | 2                | 5' X 1 3/8" ID SPOON     | WOR           |
|  |       |                            |  |   |                  |                          | WOR           |
|  |       |                            |  | 20  |                  | 5' X 1 3/8" ID SPOON     | WOR           |
| -27.1  | 12.5  |                            | CLAY, soft, moist, light gray,<br>(CH).  | 100   | 3<br>D-3         | SPLIT SPOON              | 1             |
|  |       |                            |  |   |                  |                          | 2             |
| -29.6  | 15.0  |                            | SAND, clayey, clay content<br>varies with depth, dense, moist,<br>light green, (SP-SC).      | 100   | 4                | SPLIT SPOON              | 2             |
|  |       |                            |  |   | 5                |                          | 7             |
|  |       |                            |  | 67  | 6<br>D-6         | SPLIT SPOON              | 13            |
|  |       |                            |  |   |                  |                          | 7             |
|  |       |                            |  | 80  | 7                | SPLIT SPOON              | 13            |
|  |       |                            |  |   |                  |                          | 20            |
|  |       |                            |  | 100   | 8                | SPLIT SPOON              | 12            |
|  |       |                            |  |   |                  |                          | 19            |
| -35.6  | 21.0  |                            | SAND, fine grained, quartz, trace<br>medium sand and silt, dense,<br>saturated, white, (SP). | 87  | 9                | SPLIT SPOON              | 7             |
|  |       |                            |  |   |                  |                          | 13            |
|  |       |                            |  | 60  | 10<br>D-10       | SPLIT SPOON              | 3             |
|  |       |                            |  |   |                  |                          | 12            |
|  |       |                            |  |   |                  | (continued)              |               |



| DRILLING LOG (Cont. Sheet)              |       |        | ELEVATION TOP OF HOLE<br>-14.6 Ft.   |                  | SHEET 2<br>OF 2  |   |              |
|---|-------|--------|--|------------------|------------------|---|--------------|
| PROJECT<br>San Juan Harbor, Puerto Rico |       |        | INSTALLATION<br>Jacksonville District  |                  |                  |   |              |
| ELEV.                                   | DEPTH | LEGEND | CLASSIFICATION OF MATERIALS<br>(Description)   | CORE<br>REC<br>% | SAMPLE<br>NUMBER | REMARKS<br>Bit or Barrel  | BLOWS/<br>2' |
| -37.1                                   | 22.5  |        |  | 60               |                  | -37.6 SPLIT SPOON   | 26           |
|   |       |        |  |                  |                  |   | 7            |
|   |       |        |  | 67               | II               | SPLIT SPOON   | 30           |
| -39.1                                   | 24.5  |        |  |                  |                  | -39.1   | 63           |
|   |       |        | NOTES:<br><br>I. Soils are field visually<br>classified in accordance with the<br>Unified Soils Classification System. |                  |                  | 140# Hammer with 30" drop used<br>2.0' split spoon (1 3/8" I.D. X 2"<br>O. D.) or 5' X 1 3/8" ID spoon.<br>Wash to depth before spoon<br>advancement. | 25           |
|   |       |        |  |                  |                  |   | 27.5         |
|   |       |        |  |                  |                  |   | 30           |
|   |       |        |  |                  |                  |   | 32.5         |
|   |       |        |  |                  |                  |   | 35           |
|   |       |        |  |                  |                  |   | 37.5         |
|   |       |        |  |                  |                  |   | 40           |
|   |       |        |  |                  |                  |   | 42.5         |
|   |       |        |  |                  |                  |   | 45           |
|   |       |        |  |                  |                  |   | 47.5         |
|   |       |        |  |                  |                  |   | 50           |

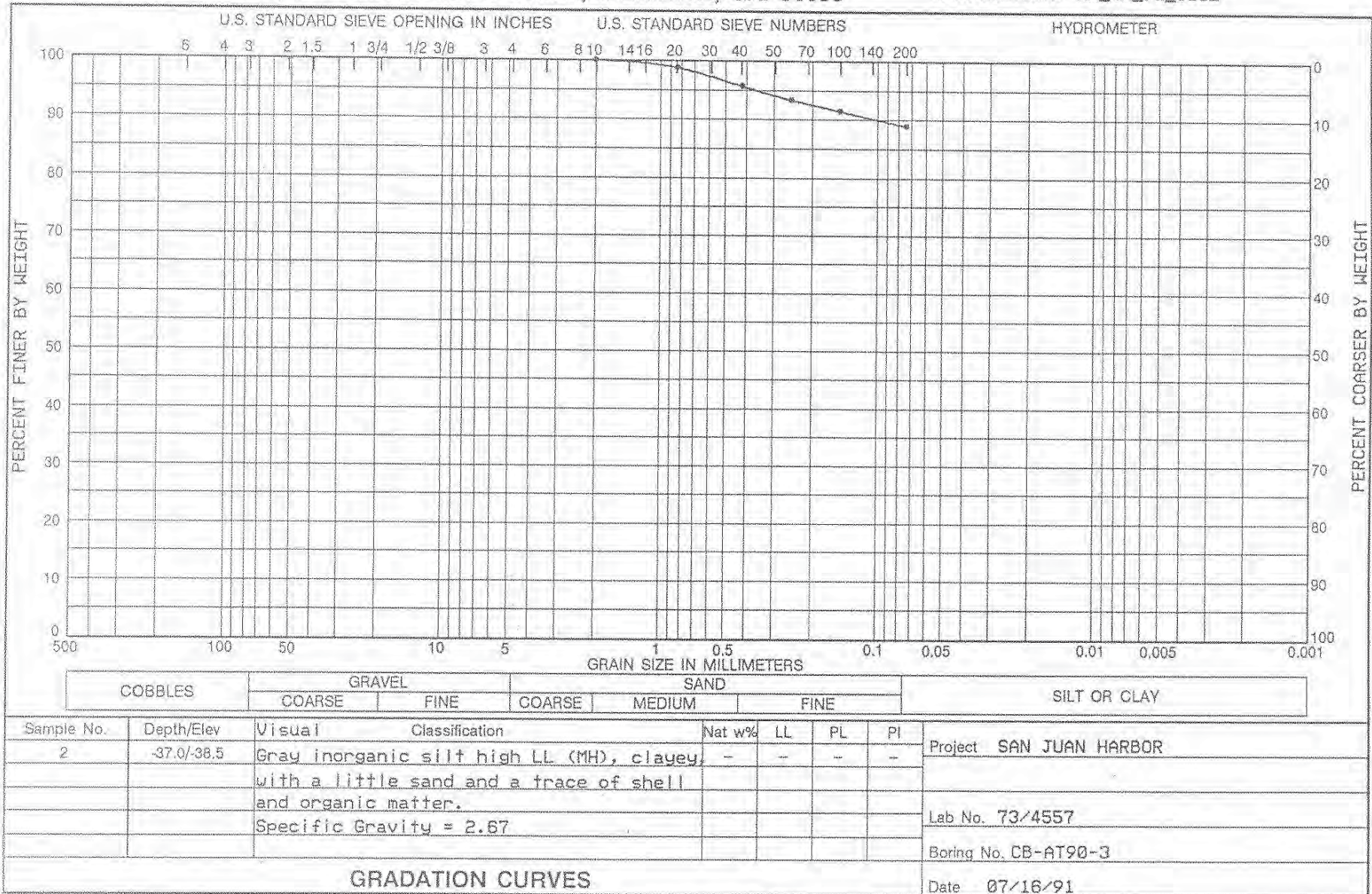
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|--|------------|----------------------------|---|--|-----------------|--|--|
| DRILLING LOG   |            | DIVISION<br>South Atlantic |   | INSTALLATION<br>Jacksonville District                          |                 | SHEET 1<br>OF 1 SHEETS   |  |
| 1. PROJECT<br>San Juan Harbor  |            |                            |   | 10. SIZE AND TYPE OF BIT See remarks                           |                 |  |  |
| 2. LOCATION (Coordinates or Station) X=612,547<br>Y=218,864  |            |                            |   | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL)<br>MLW              |                 |  |  |
| 3. DRILLING AGENCY<br>Corps of Engineers   |            |                            |   | 12. MANUFACTURER'S DESIGNATION OF DRILL<br>Acker Drive Head    |                 |  |  |
| 4. HOLE NO. (As shown on drawing title and file number) CB-SJH-8   |            |                            |   | 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN                     |                 | DISTURBED<br>UNDISTURBED   |  |
| 5. NAME OF DRILLER<br>H. Sierra  |            |                            |   | 14. TOTAL NUMBER CORE BOXES part (1/2)                         |                 |  |  |
| 6. DIRECTION OF HOLE<br><input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT. |            |                            |   | 15. ELEVATION GROUND WATER Tidal                               |                 | 16. DATE HOLE<br>STARTED 3-27-72<br>COMPLETED 3-27-72                                  |  |
| 7. THICKNESS OF OVERBURDEN   |            |                            |   | 17. ELEVATION TOP OF HOLE -39.2                                |                 |  |  |
| 8. DEPTH DRILLED INTO ROCK   |            |                            |   | 18. TOTAL CORE RECOVERY FOR BORING 61%                         |                 |  |  |
| 9. TOTAL DEPTH OF HOLE 10.5'   |            |                            |   | 19. <del>SIGNATURE OF INSPECTOR</del><br>GEOLOGIST: J. Mindock |                 |  |  |
| ELEVATION<br>a   | DEPTH<br>b | LEGEND<br>c                | CLASSIFICATION OF MATERIALS<br>(Description)<br>d   | % CORE RECOVERY<br>e   | SAMPLE NO.<br>f | REMARKS<br>(Drilling time, water loss, depth of weathering, etc., if significant)<br>g |  |
| -39.2  | 0.0        |                            |   |  |                 | BIT OR BARREL  |  |
| -40.2  | 1.0        |                            | CLAY, very soft, gray (CL)  | 38   | 1               | -39.2 Bls/0.5 ft. settled  |  |
|  |            |                            | CLAY, yellowish brown, stiff, sandy (CH), limestone and sandstone cobbles, fragments, some weathered, some not, range from soft to hard from -40.7 to -43.2 | 77   | 2               | -40.7 SPLIT SPOON pushed   |  |
| -43.2  | 4.0        |                            |   | 44   | 3               | " " 5  |  |
|  |            |                            | LIMESTONE, sandy, medium hard with hard layers, clayey, yellowish   | 55   |                 | " " 8  |  |
|  |            |                            |   | 55   |                 | -42.2 8  |  |
|  |            |                            |   | 88   |                 | " " 14   |  |
|  |            |                            |   | 72   |                 | " " 6  |  |
| -49.7  | 10.5       |                            |   |  |                 | -43.7 10   |  |
|  |            |                            |   |  |                 | " " 17   |  |
|  |            |                            |   |  |                 | -45.2 15   |  |
|  |            |                            |   |  |                 | " " 27   |  |
|  |            |                            |   |  |                 | -46.7 15   |  |
|  |            |                            |   |  |                 | " " 23   |  |
|  |            |                            |   |  |                 | -48.2 10   |  |
|  |            |                            |   |  |                 | " " 11   |  |
|  |            |                            |   |  |                 | -49.7 18   |  |
|  |            |                            |   |  |                 | " " 28   |  |
|  |            |                            |   |  |                 | " " 19   |  |
|  |            |                            |   |  |                 | -49.7 21   |  |
|  |            |                            |   |  |                 | " " 26   |  |
|  |            |                            |   |  |                 | 140# hammer with 30" drop used on 2.0' split spoon. (1-3/8" I.D. X 2" O.D.)            |  |

## 1.11 Laboratory Testing

DRAFT

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

WORK ORDER: 6398  
REQUISITION: RM\_CW\_91\_0112

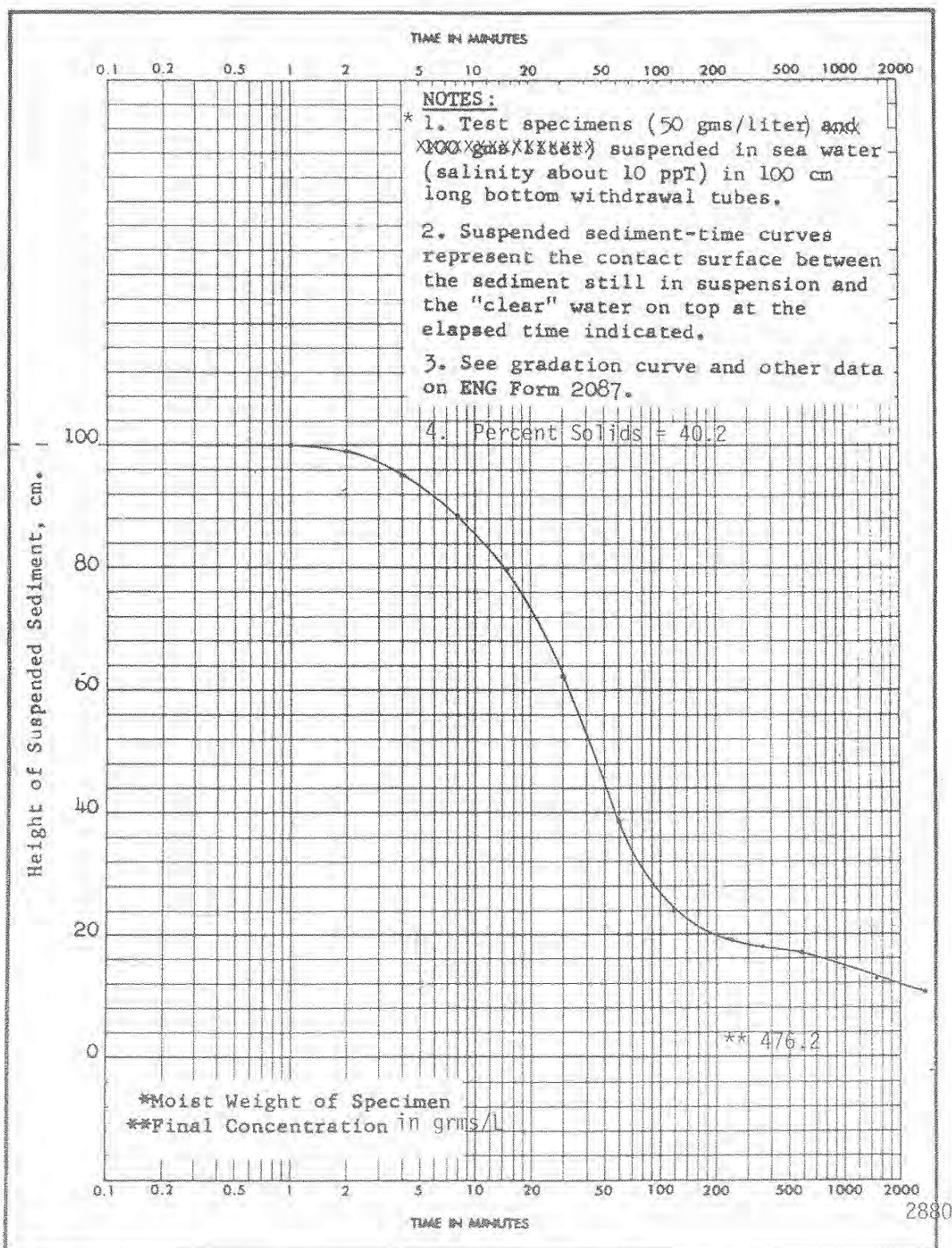


See Sedimentation Rate Time Curve on SAD Form 3023.



Reqn. No. RM-CW-91-0112  
Work Order No. 6398

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY,  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GEORGIA 30060



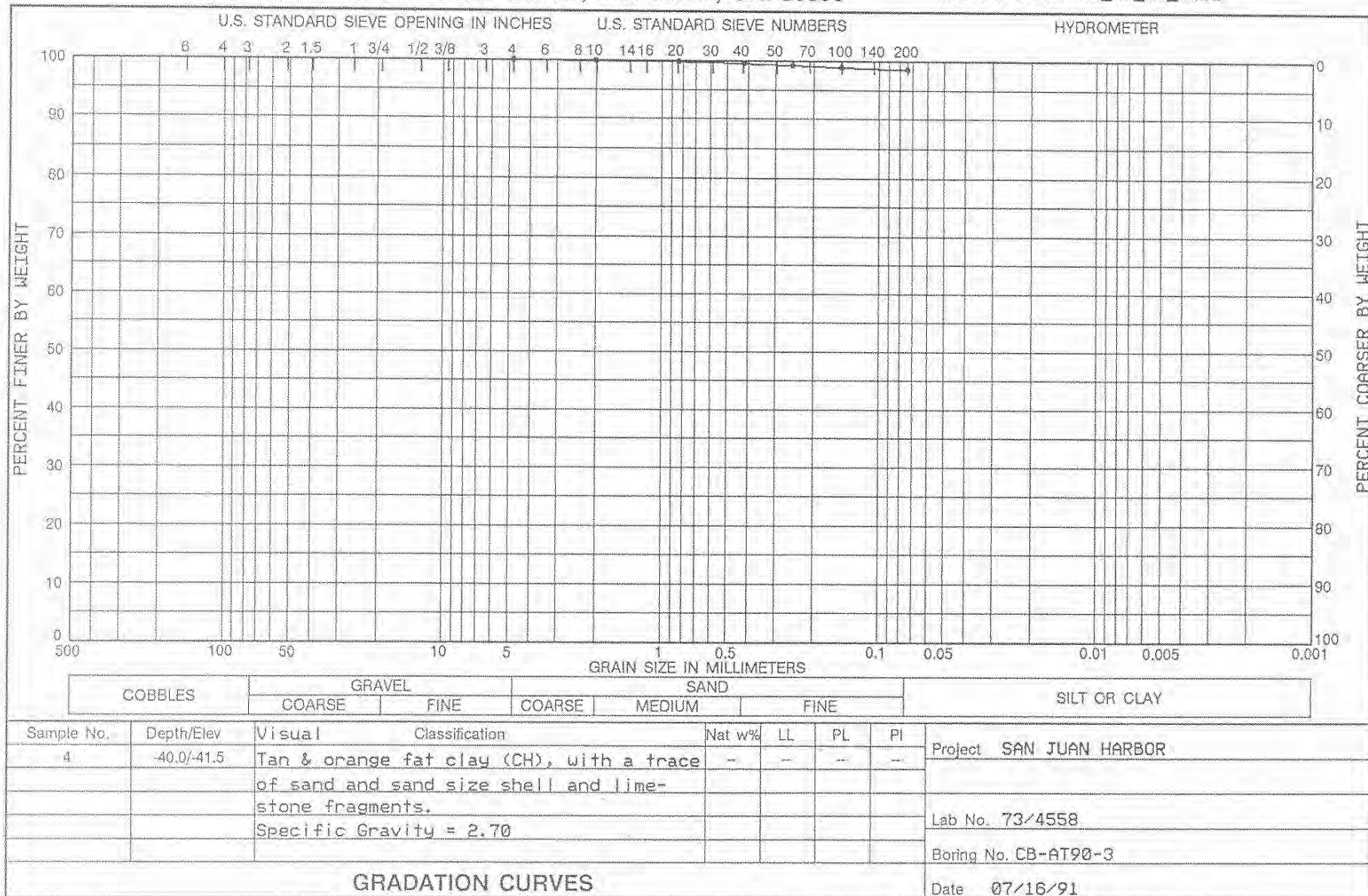
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|--------------------------------|--------------|----------------------|-------------------|
| PROJECT San Juan Harbor        |              |                      |                   |
| AREA                           |              | Lab. No. 73/4557     |                   |
| BORING NO. CB-AT90-3           | SAMPLE NO. 2 | DEPTH EL -37.0/-38.5 | DATE 22 July 1991 |
| SUSPENDED SEDIMENT-TIME CURVES |              |                      |                   |

SAD Form 3023  
26 Oct 72



DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

WORK ORDER: 6398  
REQUISITION: RM\_CW\_91\_0112



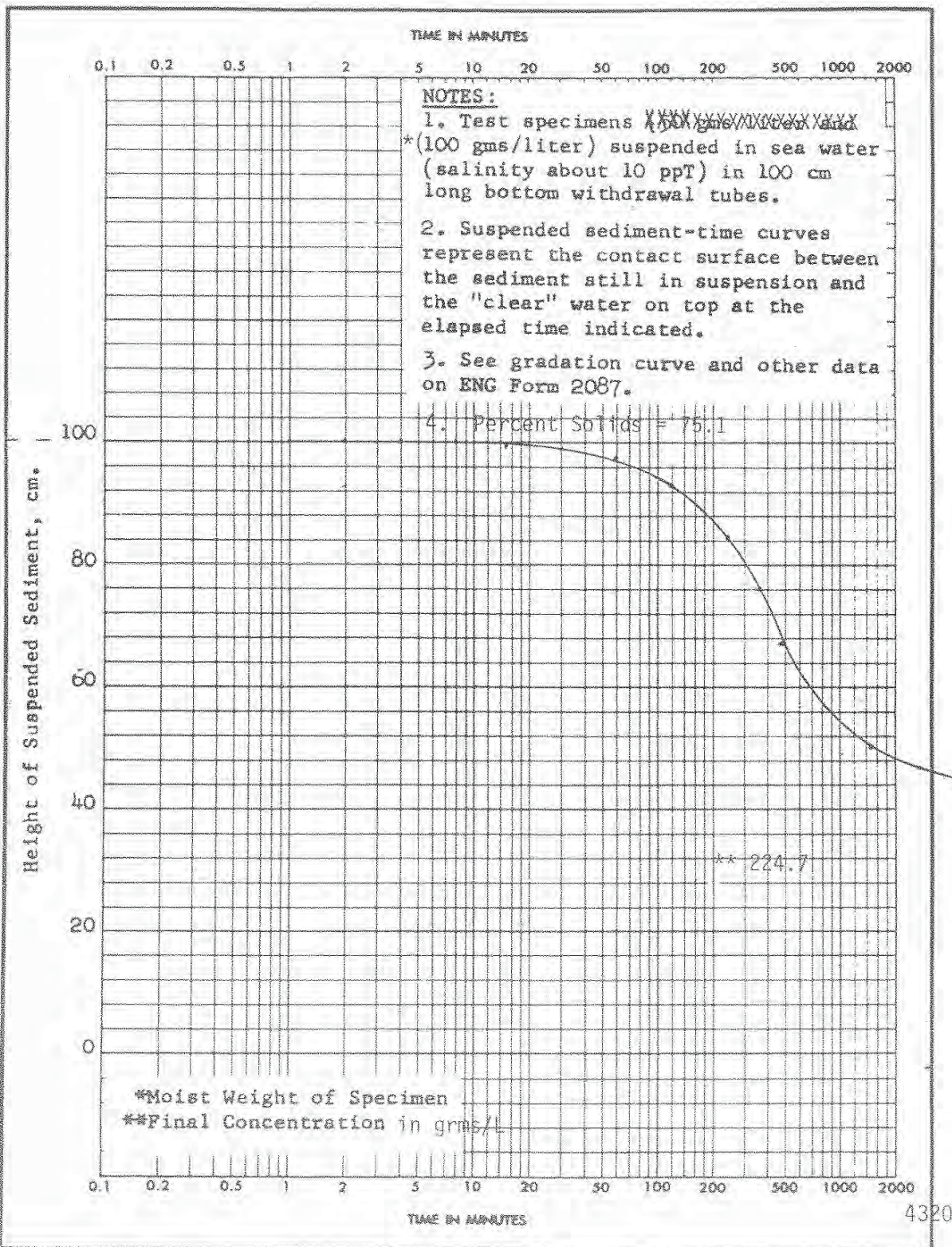
See Sedimentation Rate Time Curve on SAD Form 3023.





Reqn. No. RM-CW-91-0112  
Work Order No. 6398

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY,  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GEORGIA 30060



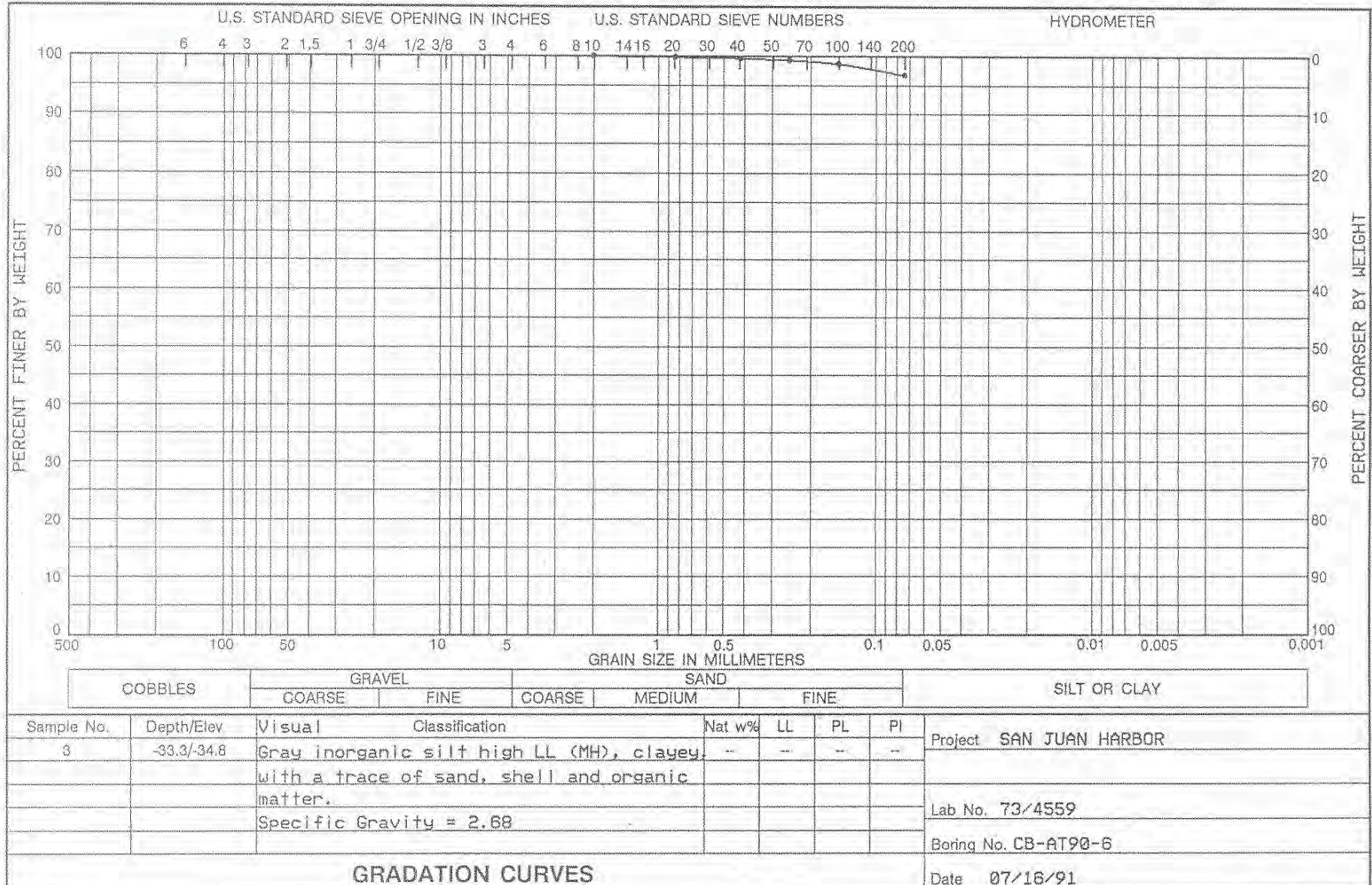
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| PROJECT San Juan Harbor        |              |                      |                   |
| AREA                           |              | Lab. No. 4558        |                   |
| BORING NO. CB-AT90-3           | SAMPLE NO. 4 | DEPTH EL -40.0/-41.5 | DATE 22 July 1991 |
| SUSPENDED SEDIMENT-TIME CURVES |              |                      |                   |

SAD Form 3023  
26 Oct 72



DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

WORK ORDER: 6398  
REQUISITION: RM\_CW\_91\_0112



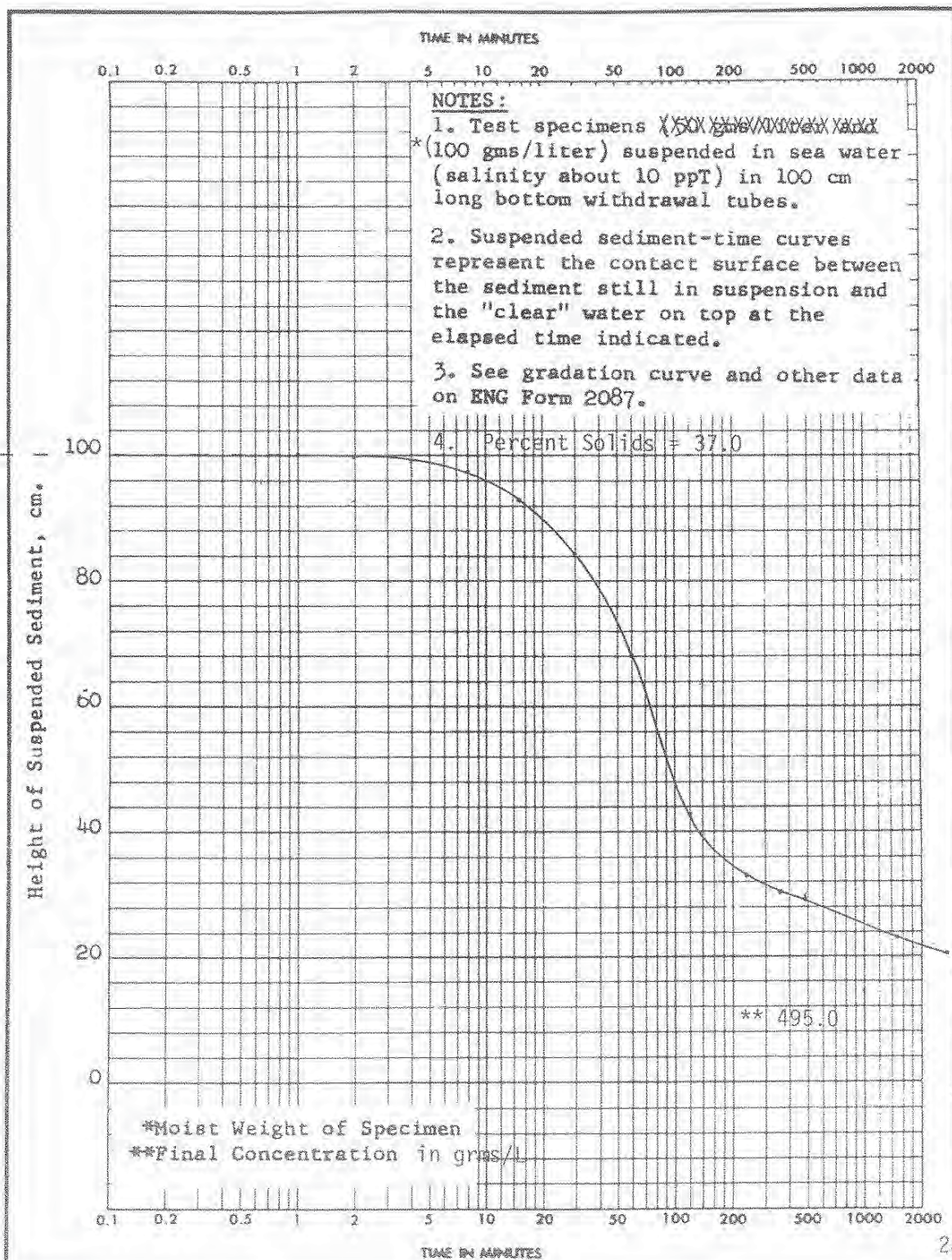
See Sedimentation Rate Time  
Curve on SAD Form 3023.





Reqn. No. RM-CW-91-0112  
Work Order No. 6398

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY,  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GEORGIA 30060



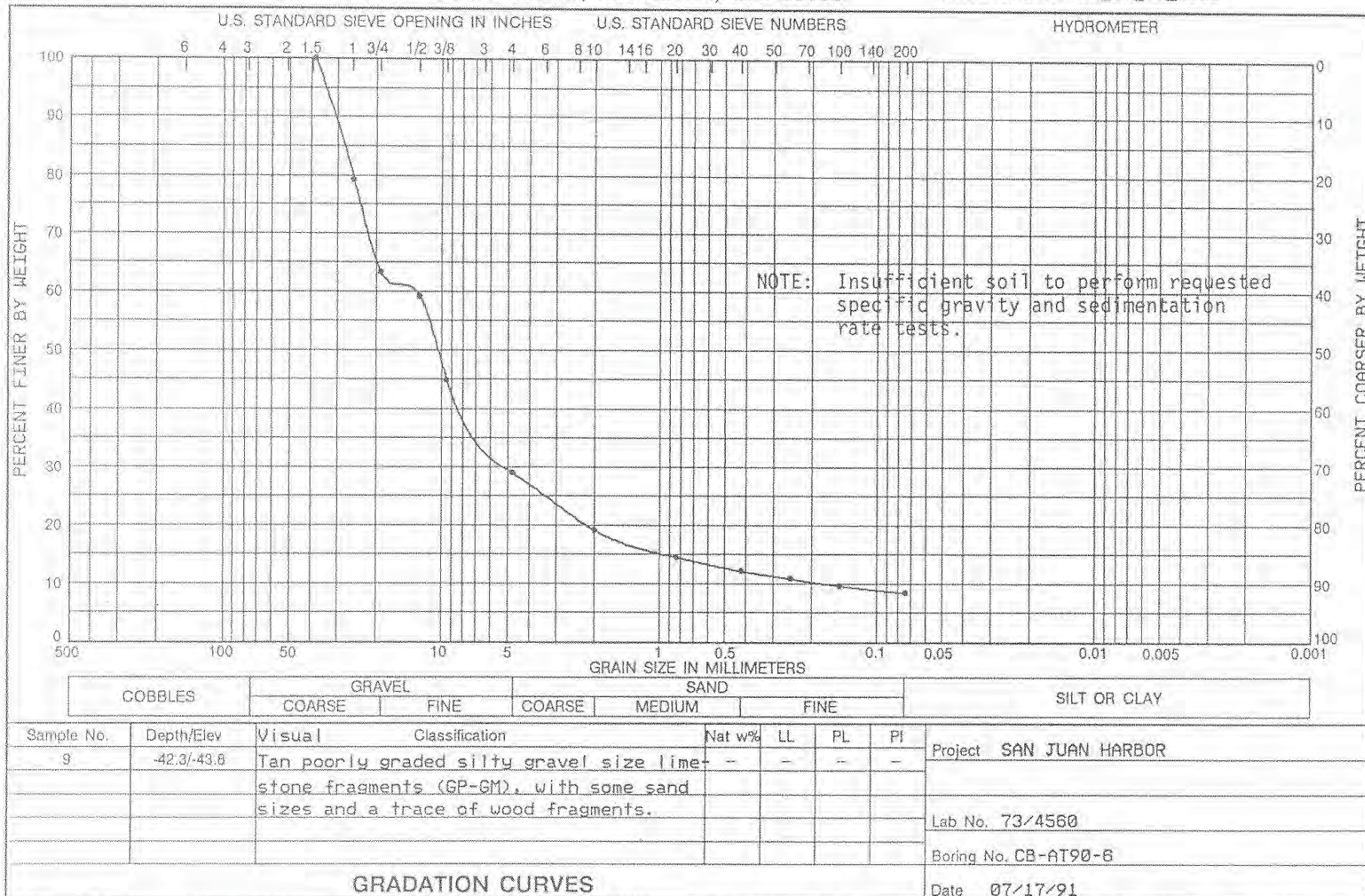
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|                                |              |                      |                   |
|--------------------------------|--------------|----------------------|-------------------|
| PROJECT San Juan Harbor        |              |                      |                   |
| AREA                           |              | Lab. No. 73/4559     |                   |
| BORING NO. CB-AT90-6           | SAMPLE NO. 3 | DEPTH EL -33.3/-34.8 | DATE 22 July 1991 |
| SUSPENDED SEDIMENT-TIME CURVES |              |                      |                   |

SAD Form 3023  
26 Oct 72



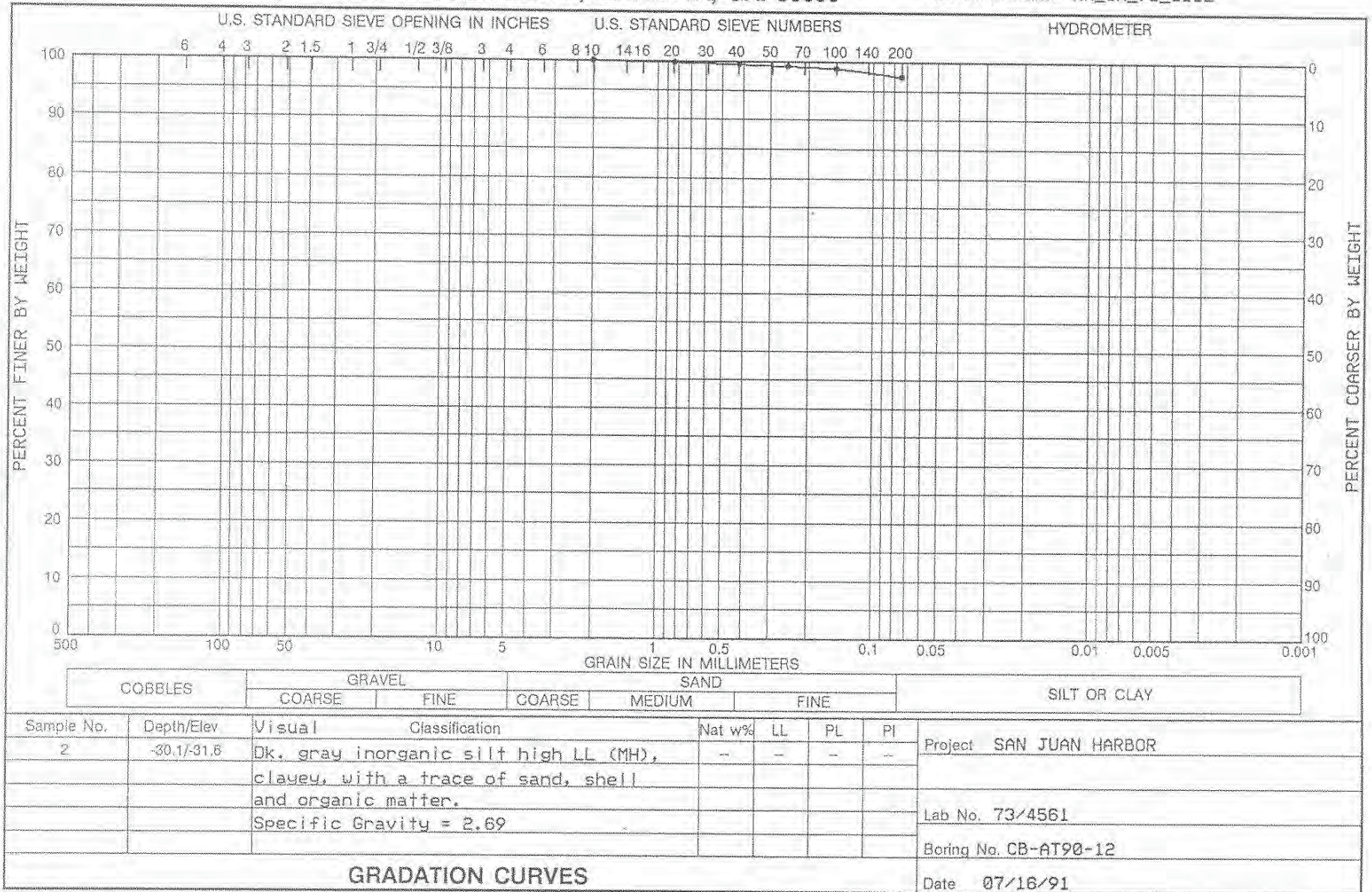
WORK ORDER: 6398  
REQUISITION: RM\_CW\_91\_0112





DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

WORK ORDER: 6398  
REQUISITION: RM\_CW\_91\_0112

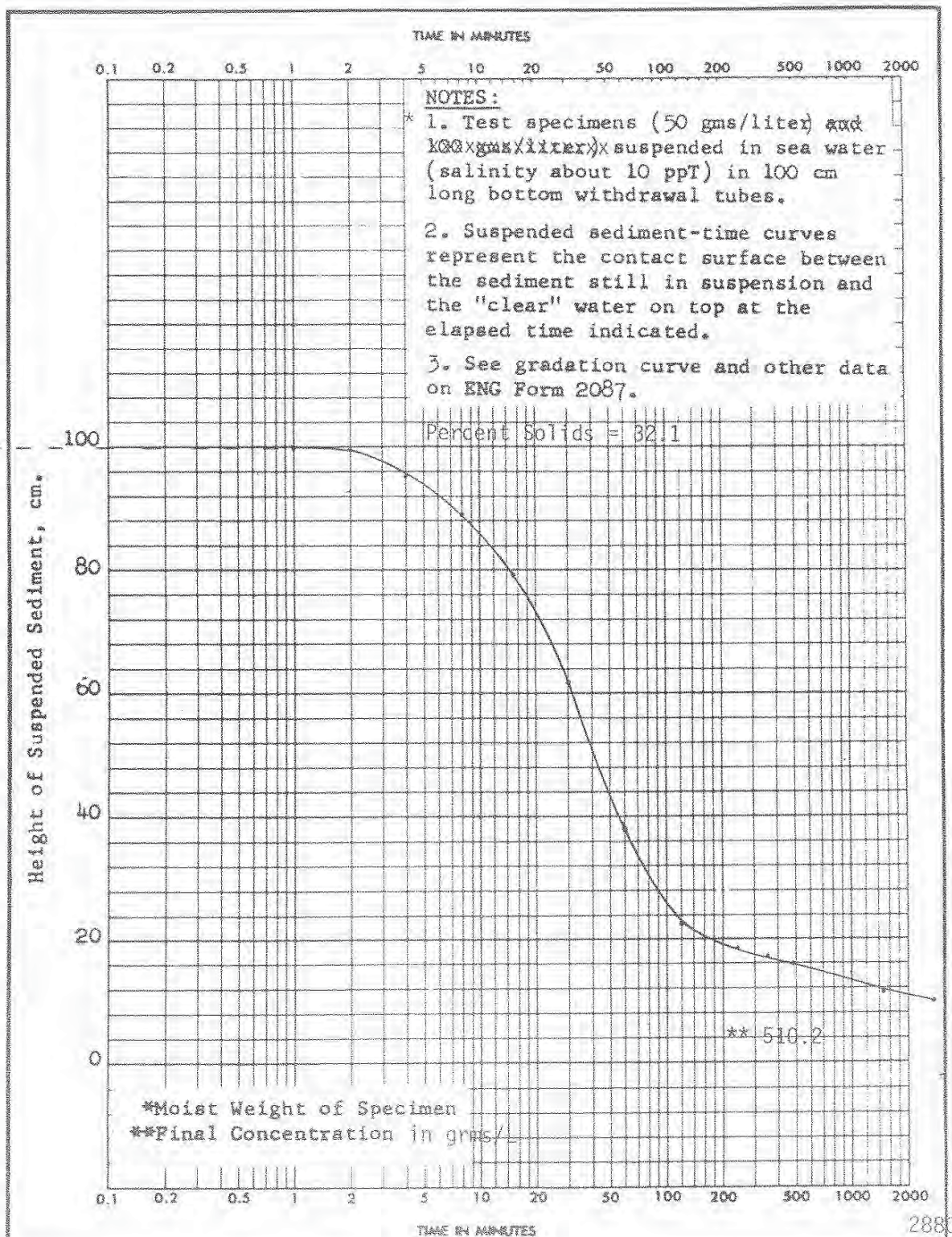


See Sedimentation Rate Time  
Curve on SAD Form 3023.



Reqn. No. RM-CW-91-0112  
Work Order No. 6398

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY,  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GEORGIA 30060



PROJECT San Juan Harbor

AREA

Lab. No. 73/4561

BORING NO. CB-AT90-12

SAMPLE NO. 2

EL

-30.1/-31.6

DATE 22 July 1991

SUSPENDED SEDIMENT-TIME CURVES

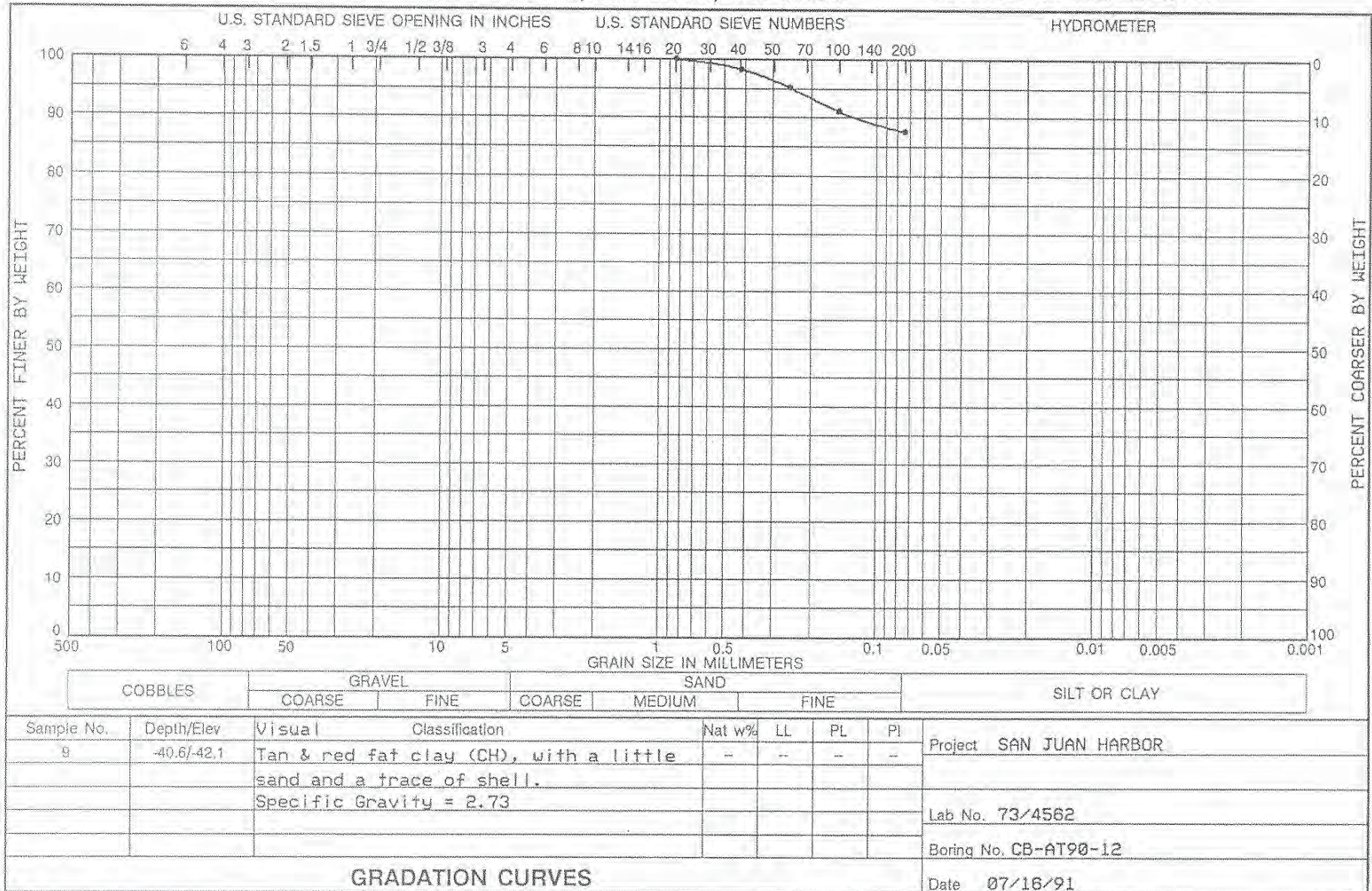
SAD Form 3023

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DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

WORK ORDER: 6398  
REQUISITION: RM\_CW\_91\_0112

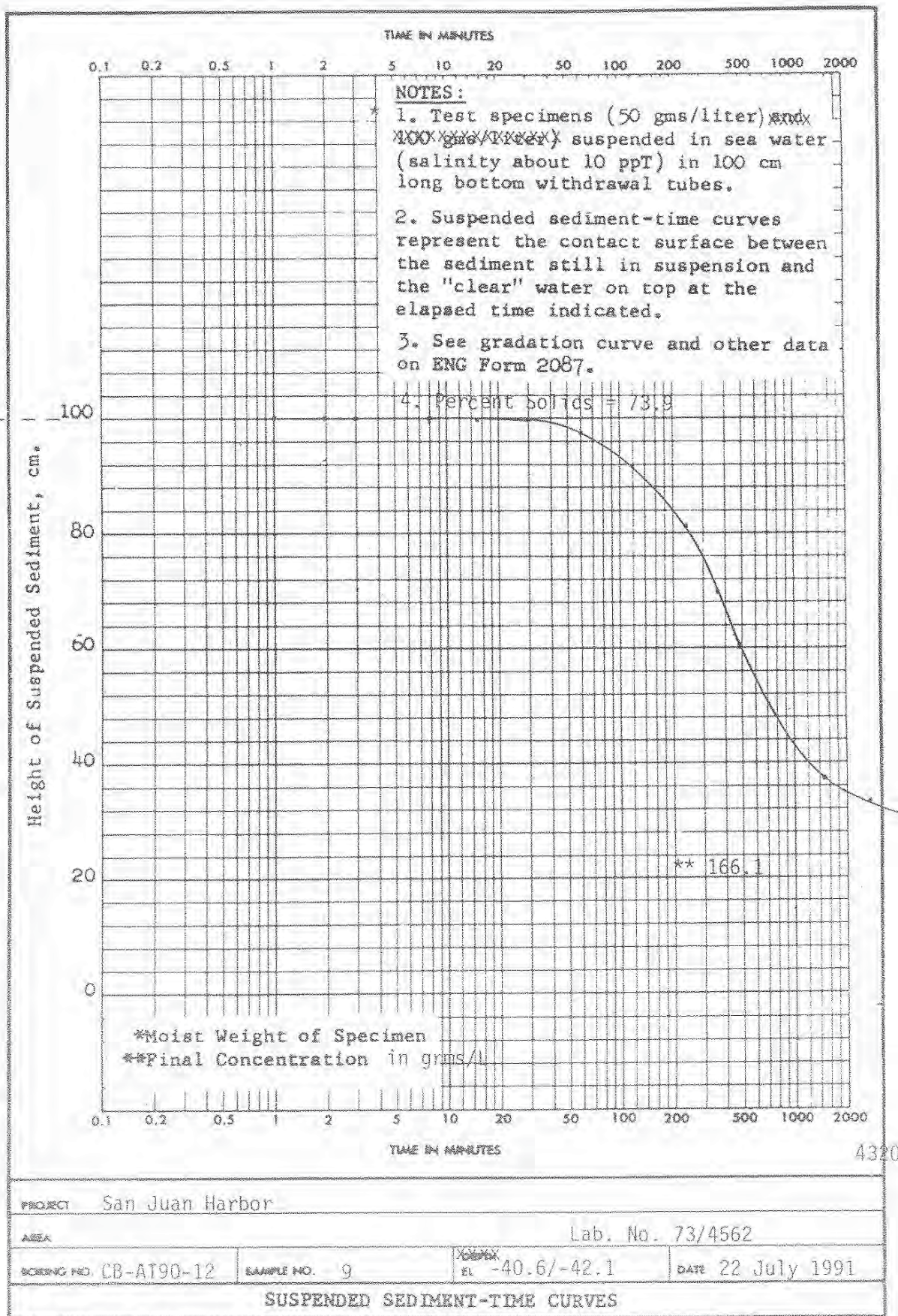


See Sedimentation Rate Time Curve on SAD Form 3023.



Reqn. No. RM-CW-91-0112  
Work Order No. 6398

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY,  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GEORGIA 30060

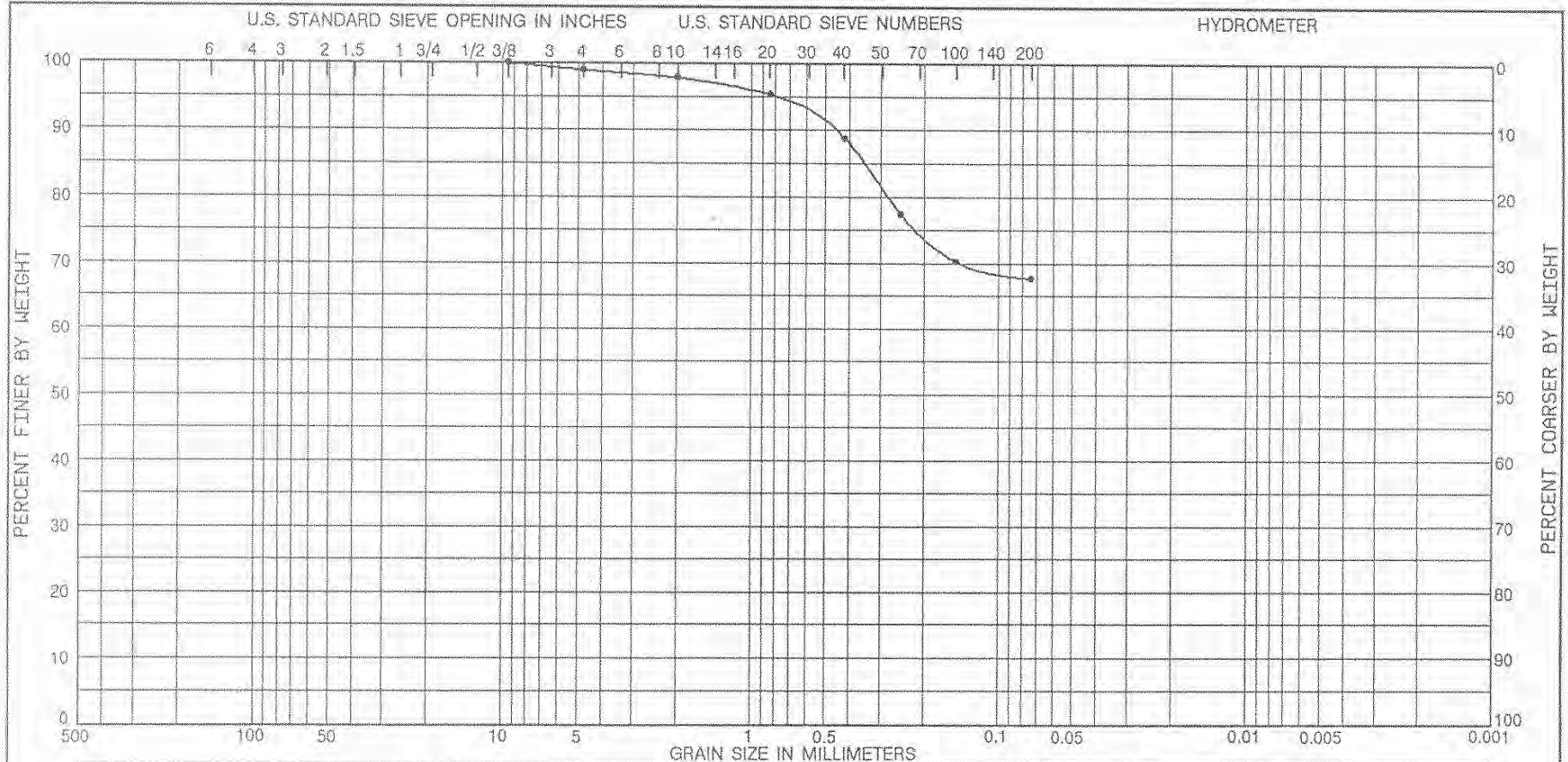


SAD Form 3023  
26 Oct 72



DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

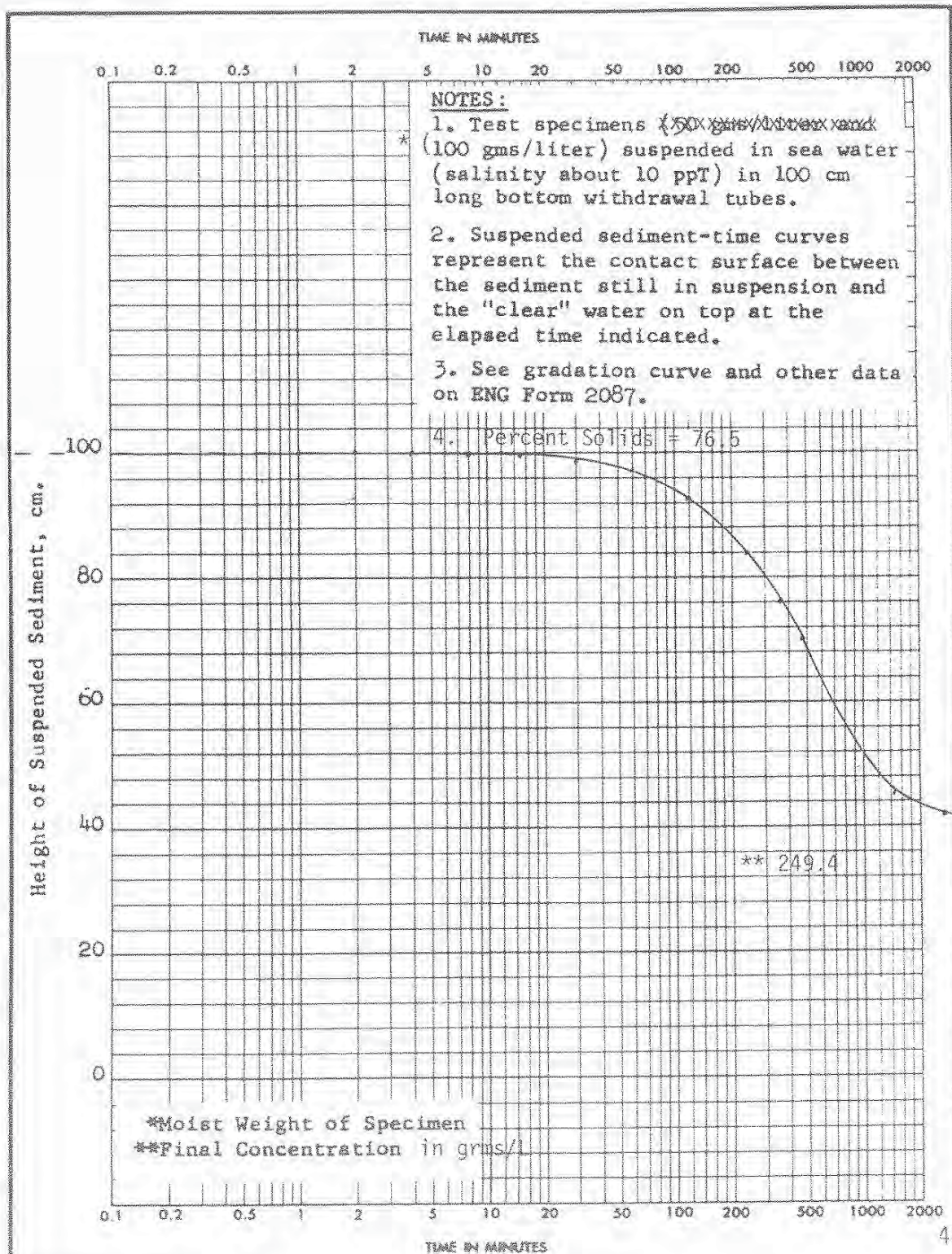
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REQUISITION: RM\_CW\_91\_0112





Reqn. No. RM-CW-91-0112  
Work Order No. 6398

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY,  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GEORGIA 30060



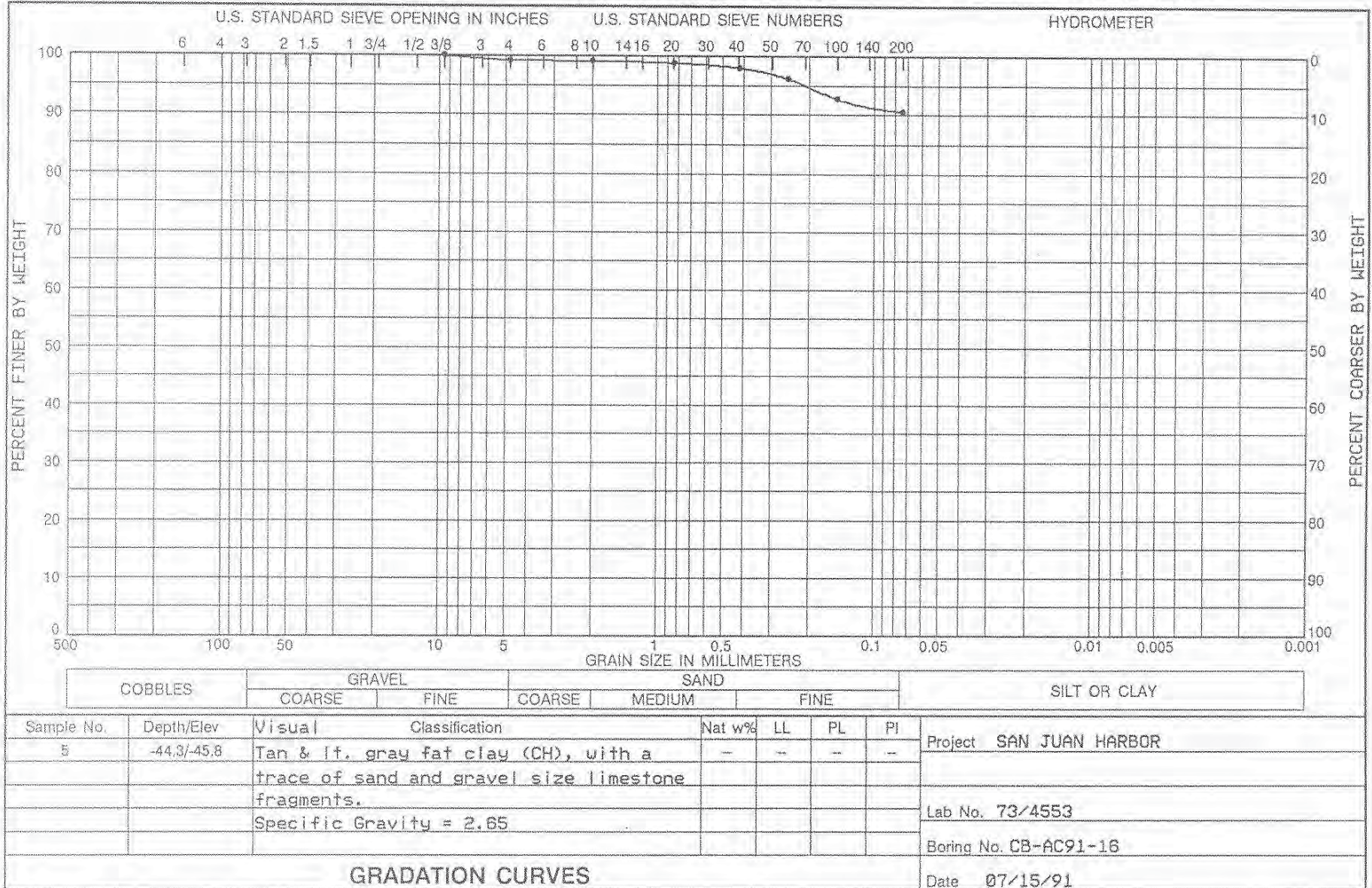
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|--------------------------------|--------------|-------------------------|-------------------|
| PROJECT San Juan Harbor        |              |                         |                   |
| AREA                           |              | Lab. No. 73/4551        |                   |
| BORING NO. CB-AC91-12          | SAMPLE NO. 2 | DEPTH<br>EL -41.7/-43.2 | DATE 22 July 1991 |
| SUSPENDED SEDIMENT-TIME CURVES |              |                         |                   |

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26 Oct 72



DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

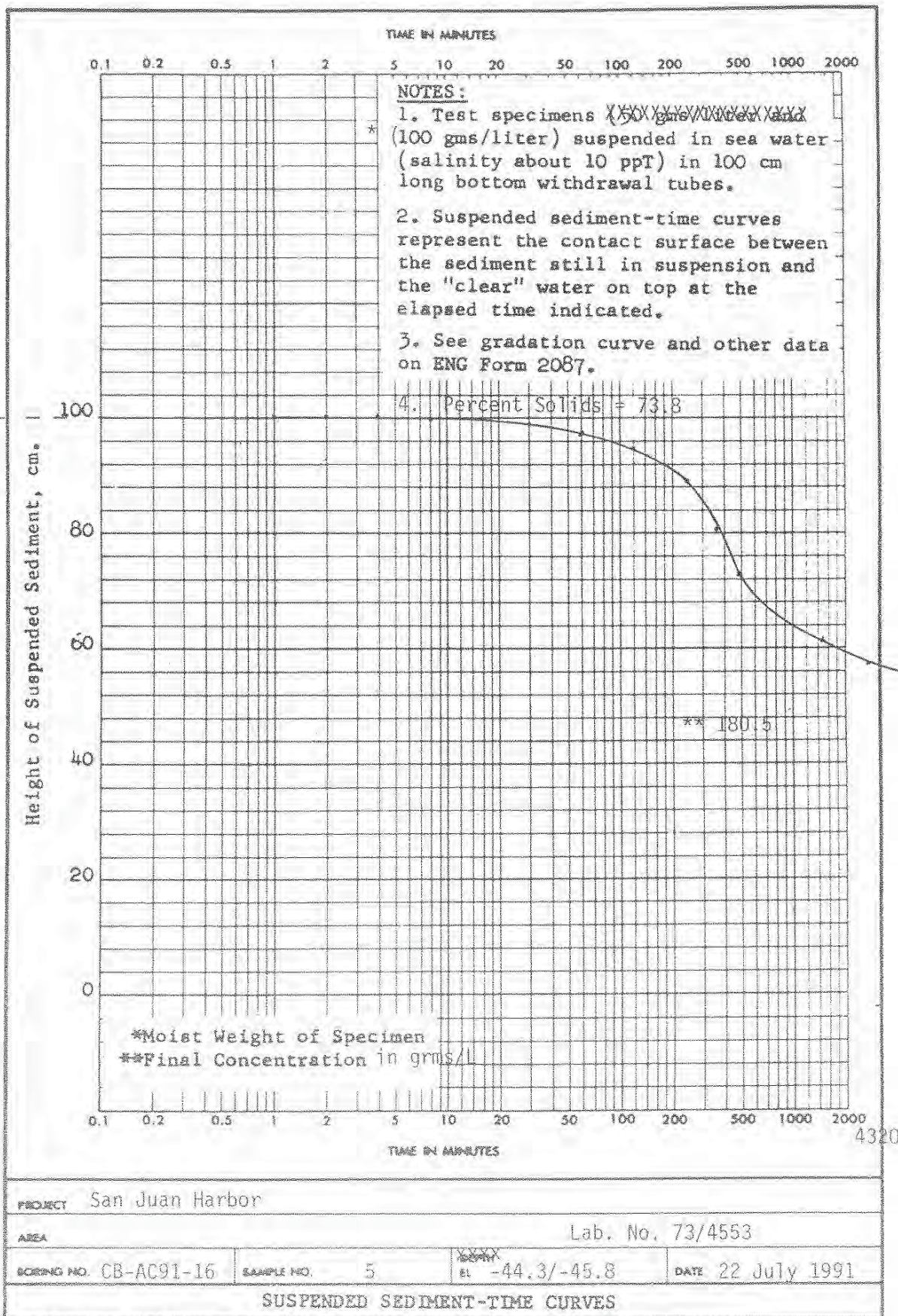
WORK ORDER: 6398  
REQUISITION: RM\_CW\_91\_0112





Reqn. No. RM-CW-91-0112  
Work Order No. 6398

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY,  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GEORGIA 30060

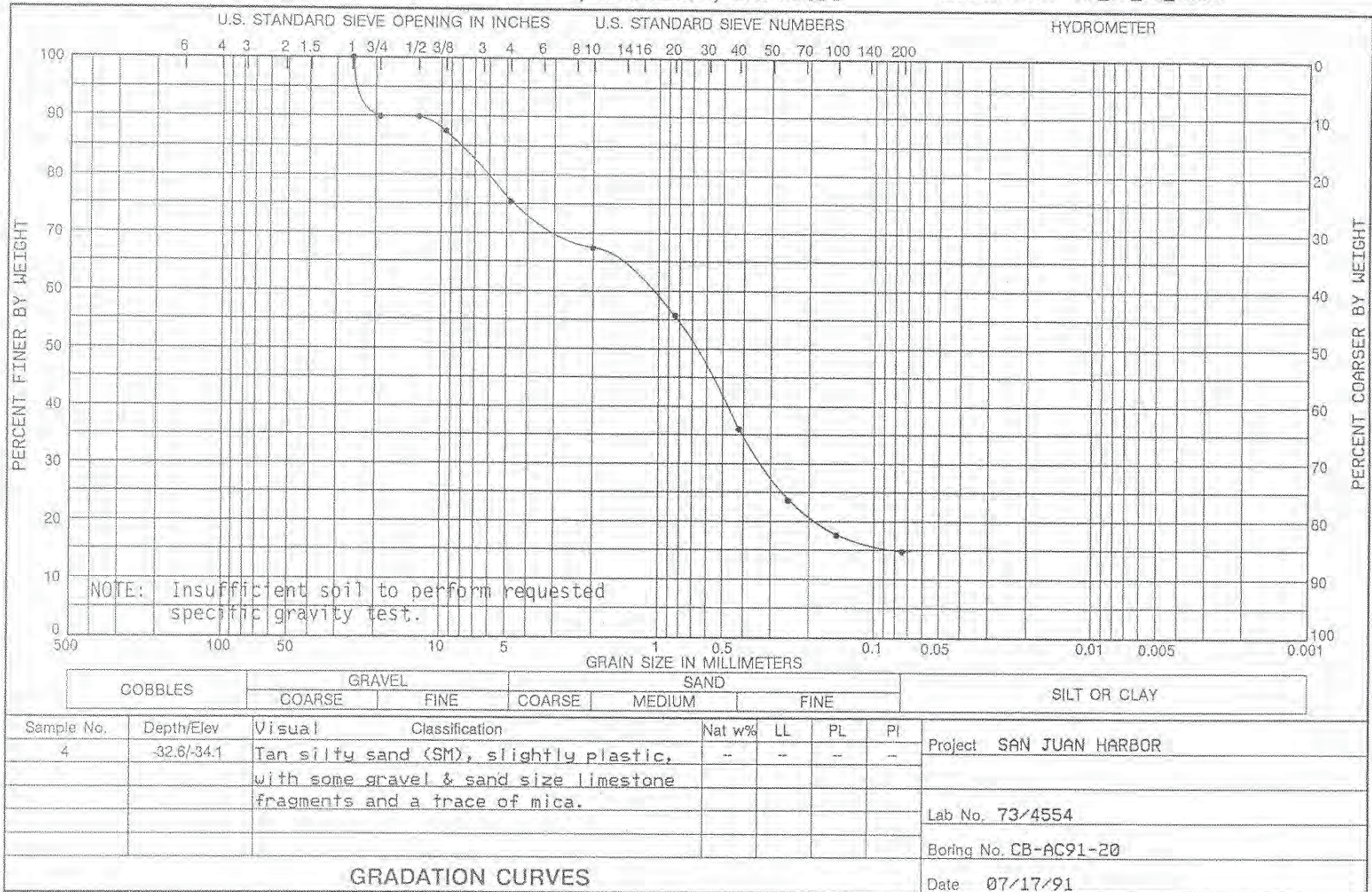


SAD Form 3023  
26 Oct 72



DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

WORK ORDER: 6398  
REQUISITION: RM\_CW\_91\_0112

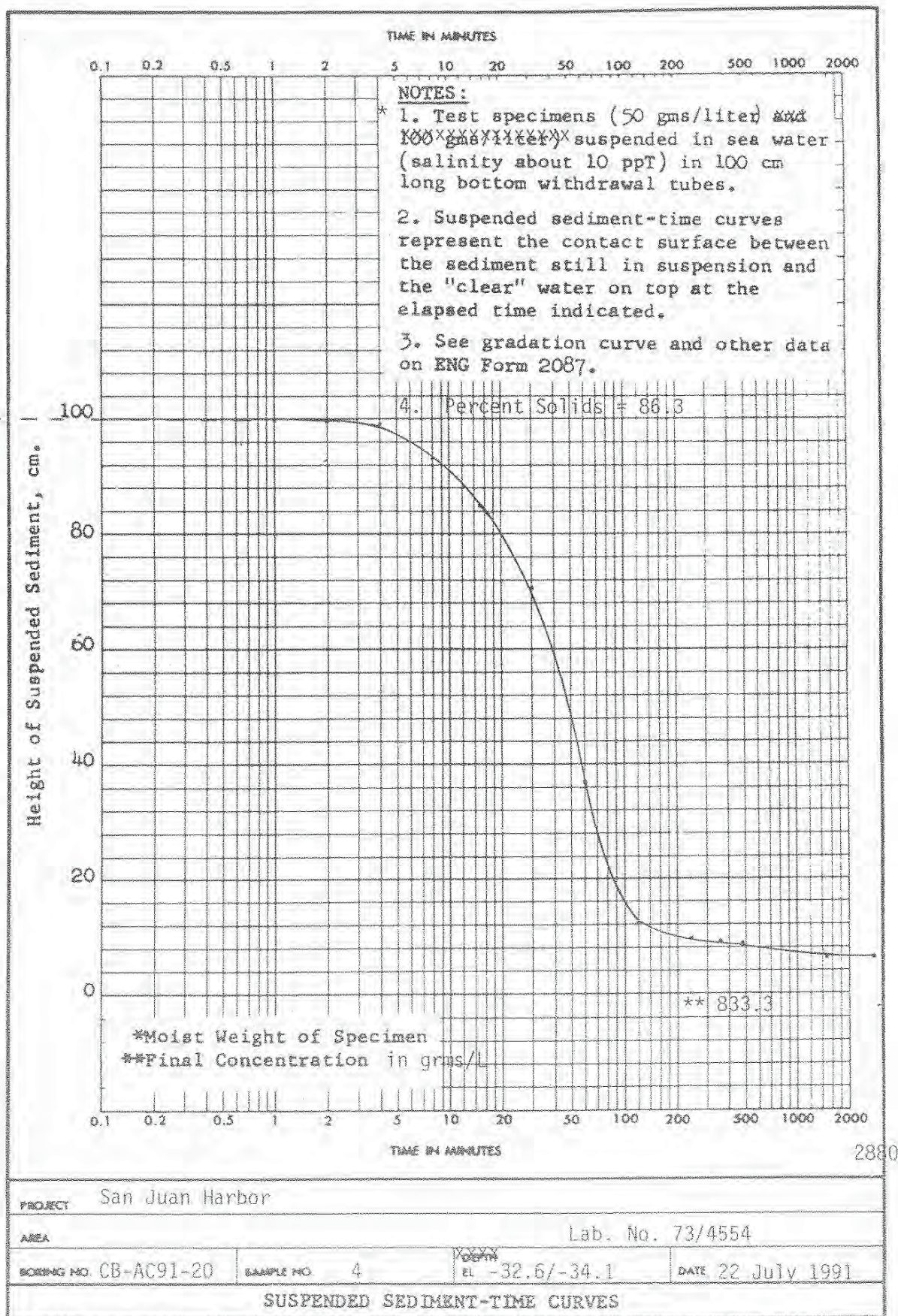


See Sedimentation Rate Time Curve on SAD Form 3023.



Reqn. No. RM-CW-91-0112  
Work Order No. 6398

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY,  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GEORGIA 30060

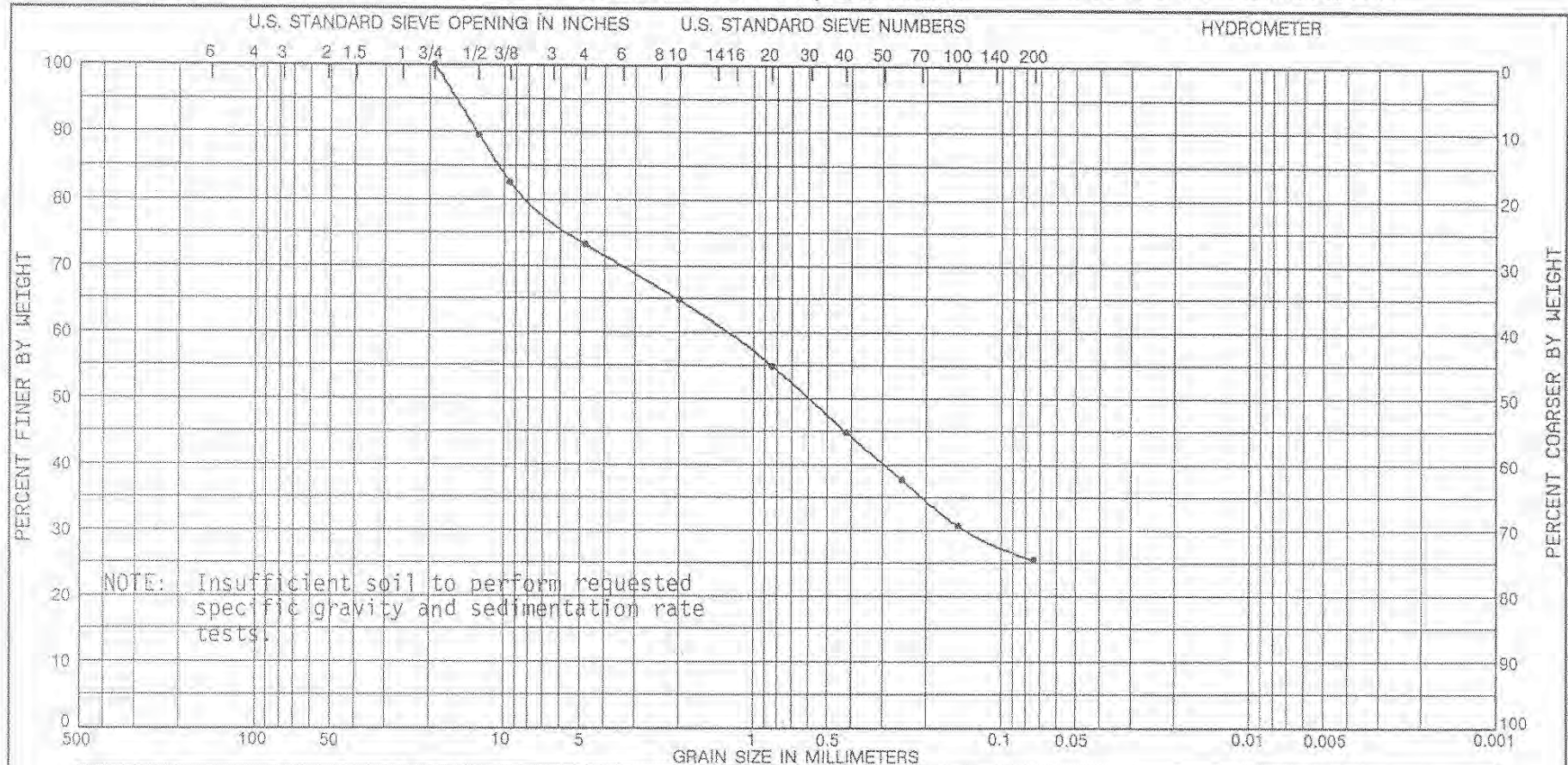


SAD Form 3023  
26 Oct 72



DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

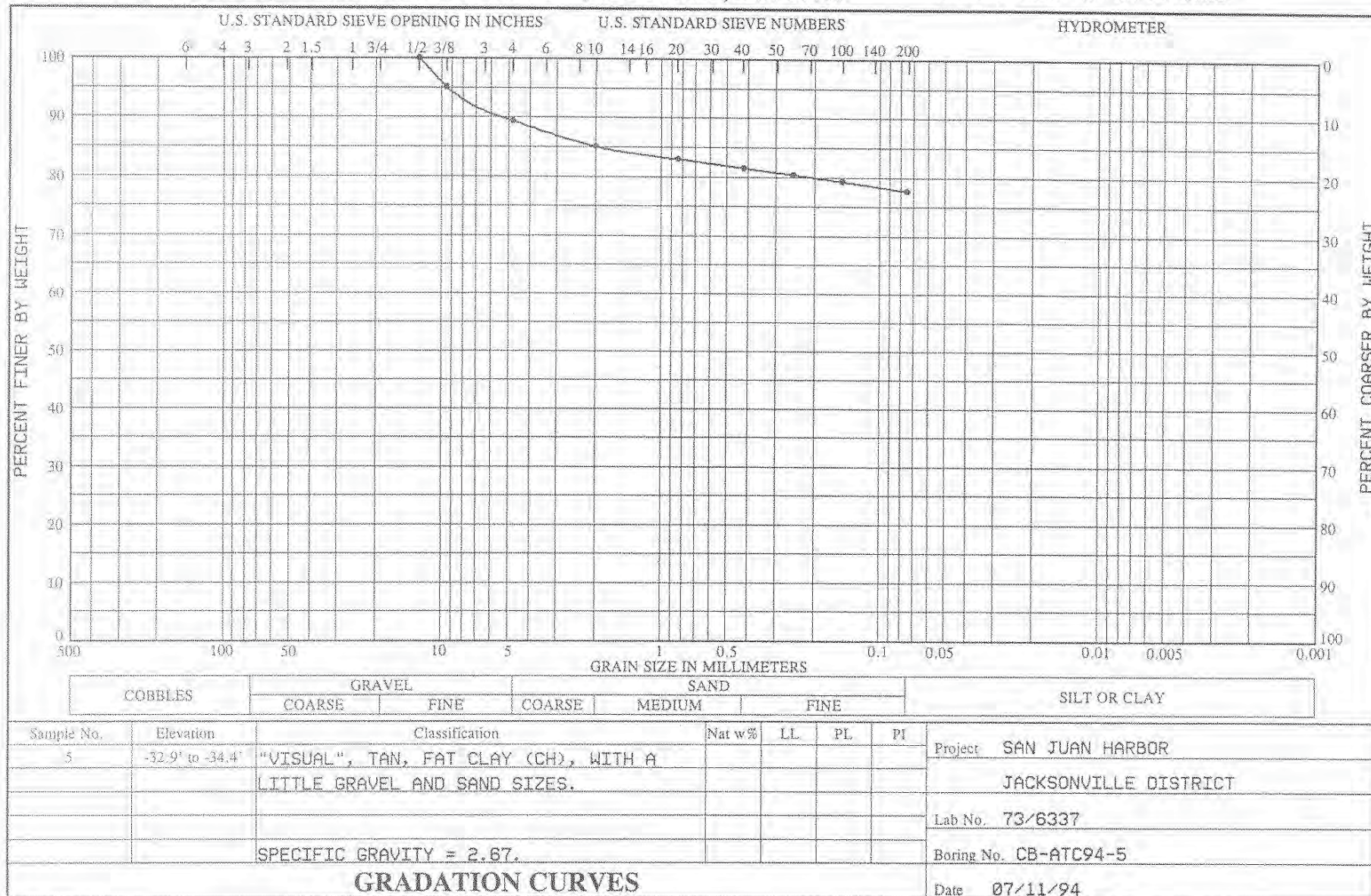
WORK ORDER: 6398  
REQUISITION: RM\_CW\_91\_0112





DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION, LABORATORY  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

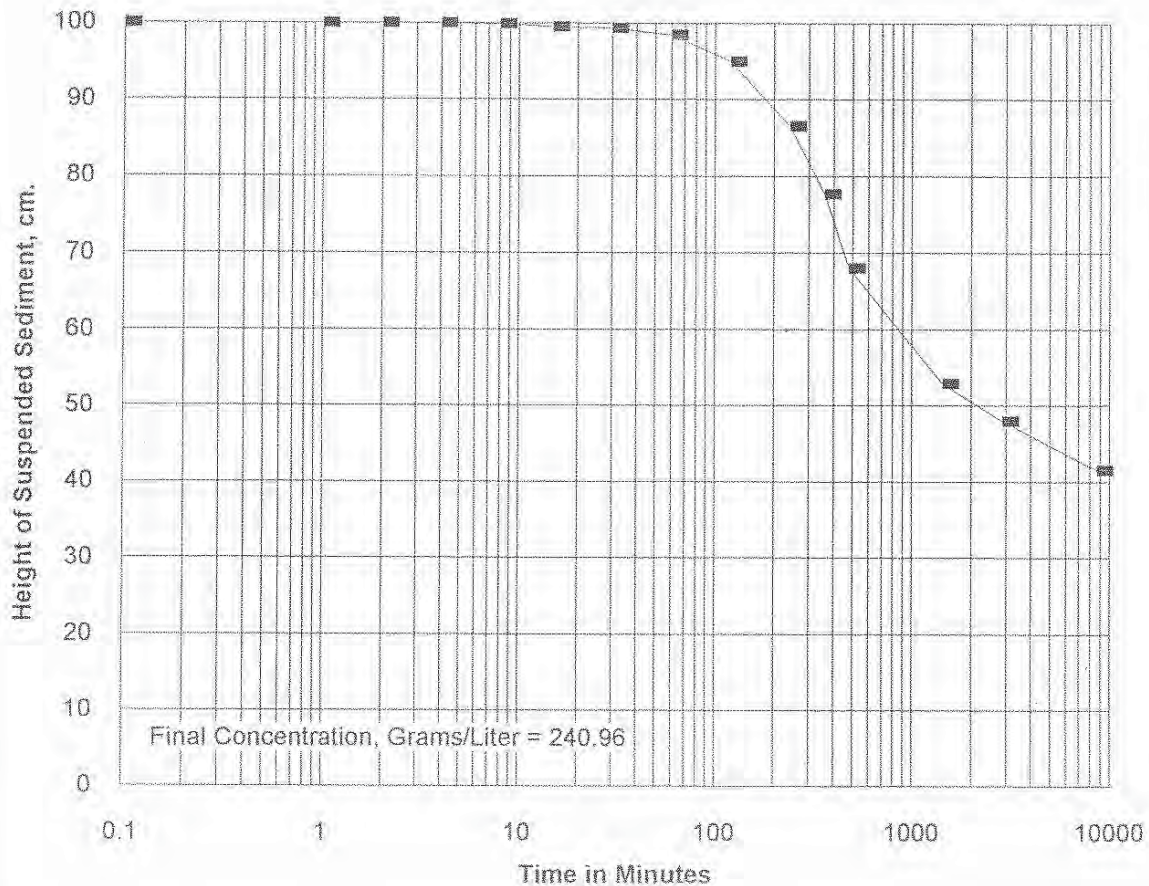
WORK ORDER: 7302  
REQUISITION: RM-CW-94-0112





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

**SUSPENDED SEDIMENT-TIME CURVE**



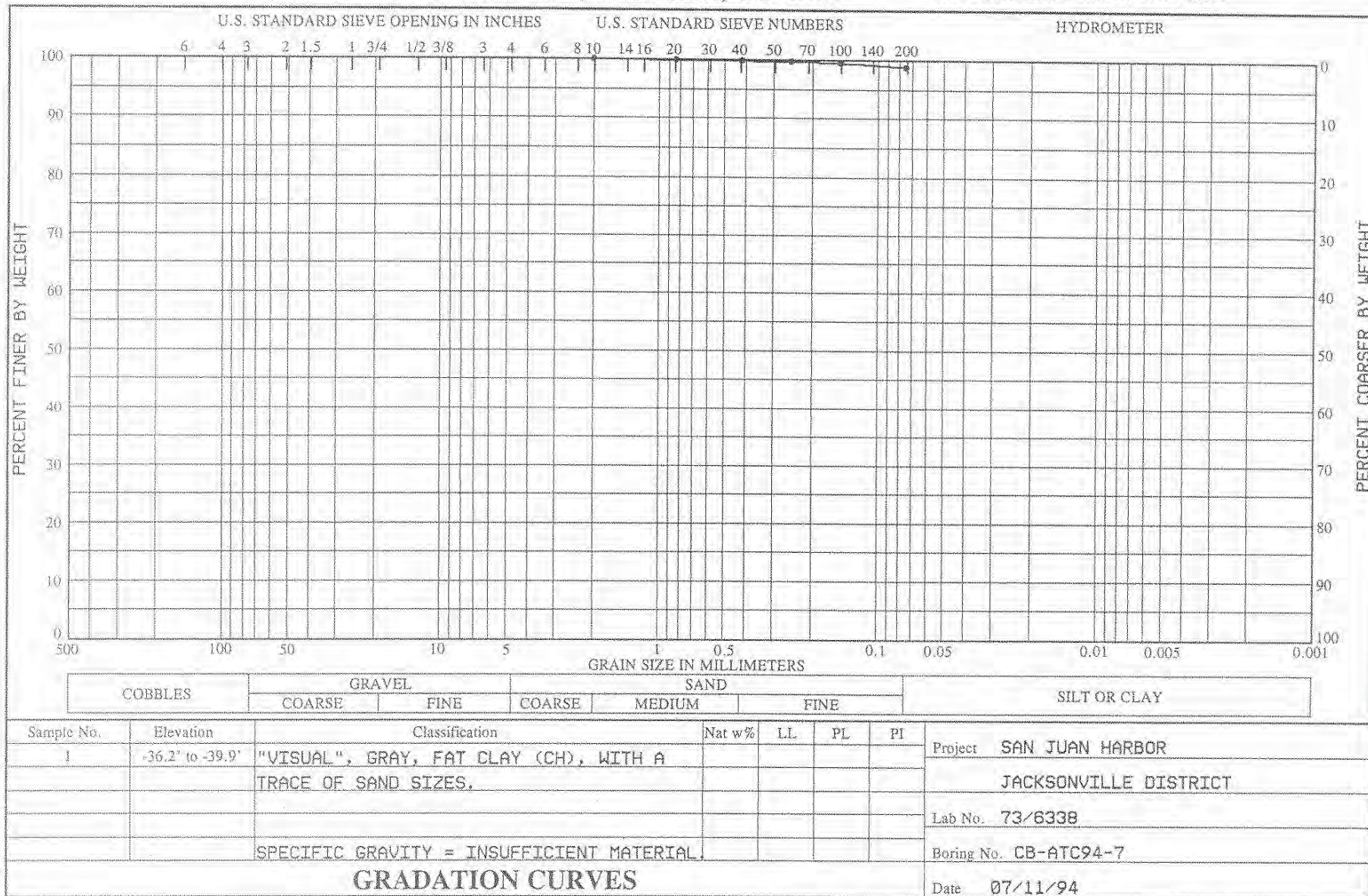
- NOTES: 1. Test specimens (100 grams/ liter ,moist weight of specimen) suspended in sea water(salinity about 10 ppt) in 100 cm. long bottom withdrawal tubes.
2. Suspended sediment-time curves represent the contact surface between the sediment still in suspension and the "clear" water on top at the elapsed 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  |                |
| AREA:                    |            | W.O. NO: 7302            |                |
|                          |            | 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      |



DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY  
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

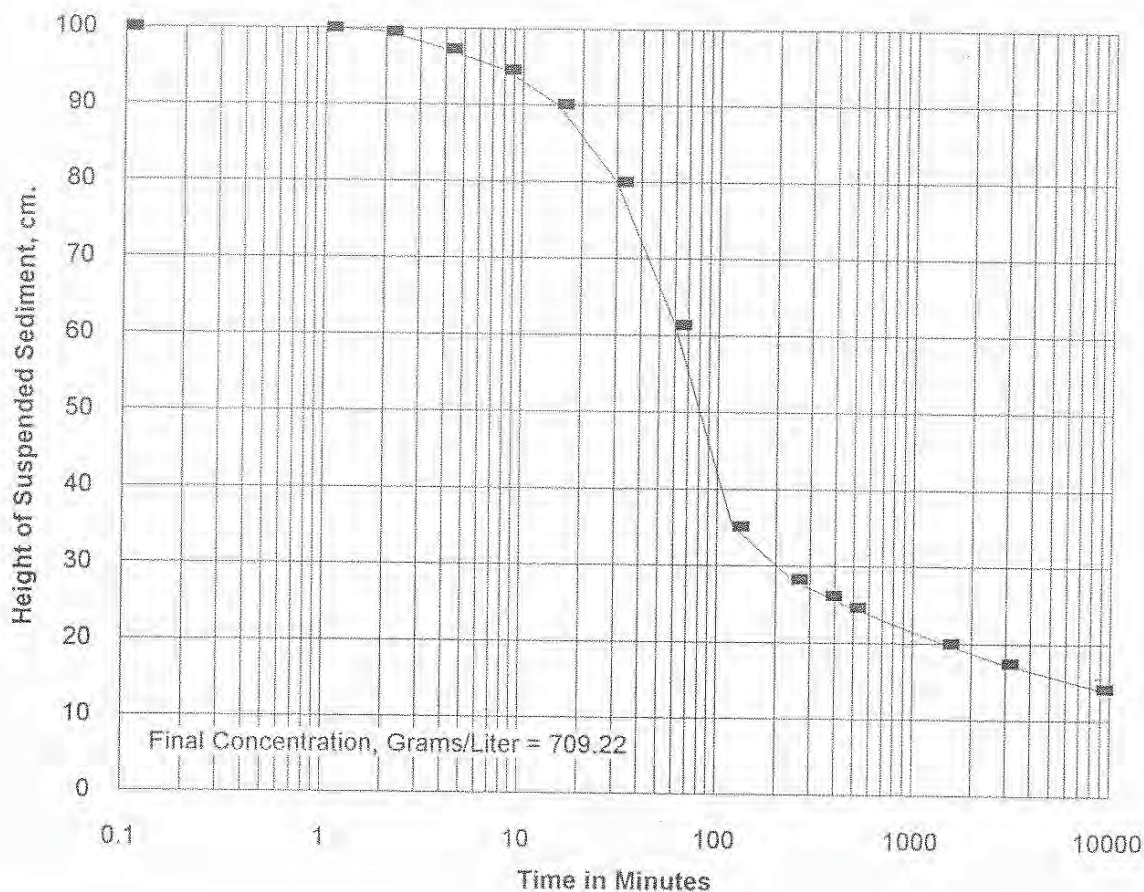
WORK ORDER: 7302  
REQUISITION: RM-CW-94-0112





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

### SUSPENDED SEDIMENT-TIME CURVE



- 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 = 40.06

|                          |            |                |                |
|--------------------------|------------|----------------|----------------|
| PROJECT: San Juan Harbor |            | REQ'N NO:      | RM-CW-94-0112  |
| AREA:                    |            | W.O. NO:       | 7302           |
|                          |            | DATE RECEIVED: | 4-May-94       |
|                          |            | DATE REPORTED: | 13-Jul-94      |
| BORING NO:               | CB-ATC94-7 | ELEV:          | -36.2 to -39.9 |
| SAMPLE NO:               | 1          | LAB NO:        | 73 / 6338      |