ATTACHMENT 7

GEOTECHNICAL DATA

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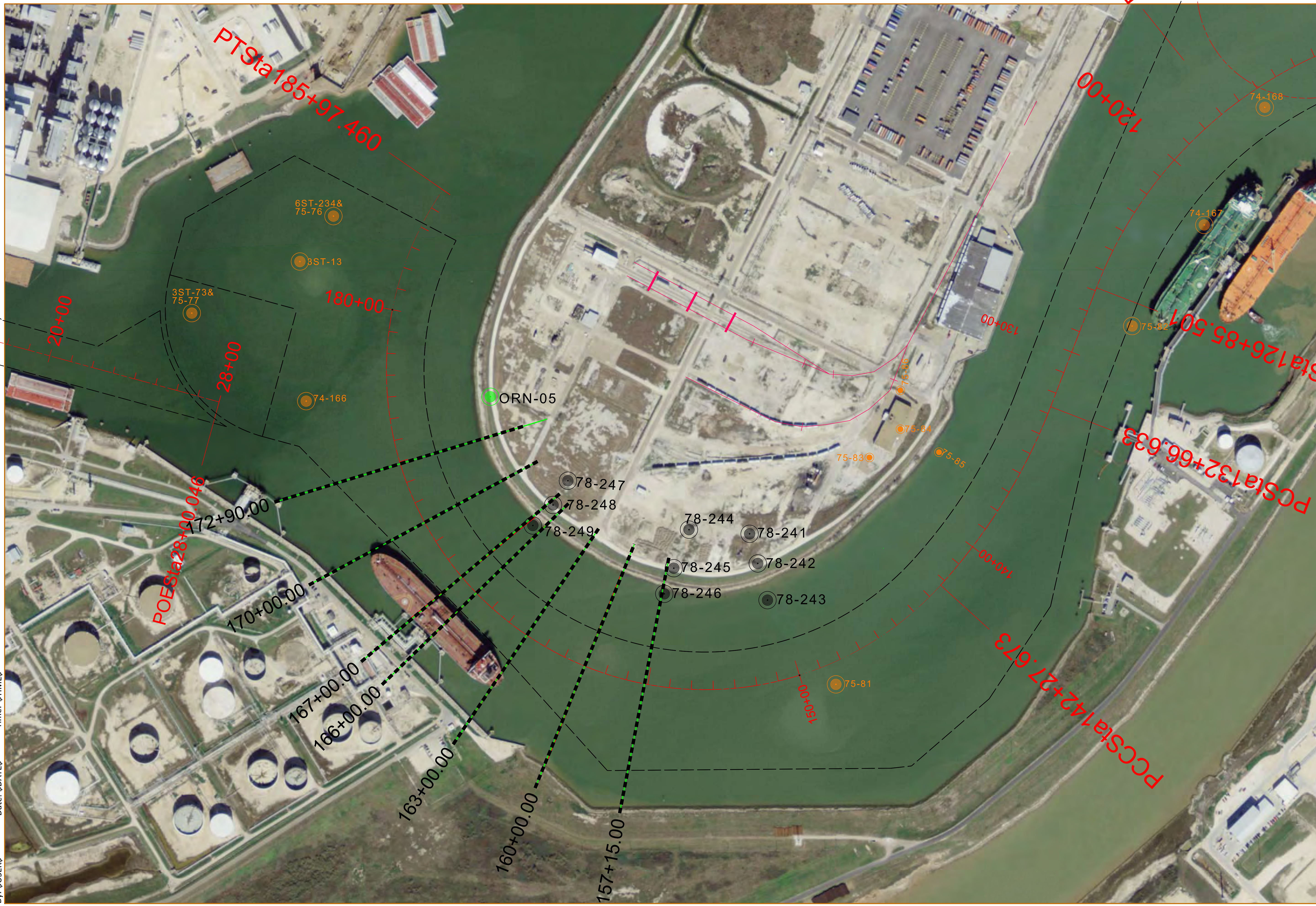


U.S. Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by: X
Designed by: X
Checked by: X
Submitted by:
LORI K. HODGES, P.E.
Chief, Geotech/Structure Section
Date: X
Scale: AS SHOWN
Approval Recommended:
JOSEPH L. KING, R.A.
Chief, Engineering Branch
Approved by:
TERRY F. BAUTISTA, P.E.
Chief, Engineering and Construction Division

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
RICHARD P. PANNELL, COL., C.E.,
DISTRICT COMMANDER

FREEPORT THUMB WAIST HISTORICAL BORING LOCATIONS

Drawing No.:
01
Sheet 1 of 1

File: $FILE$
Model Name: $MODELNAME$
By: $USER$
Date: $DATE$
Time: $TIME$

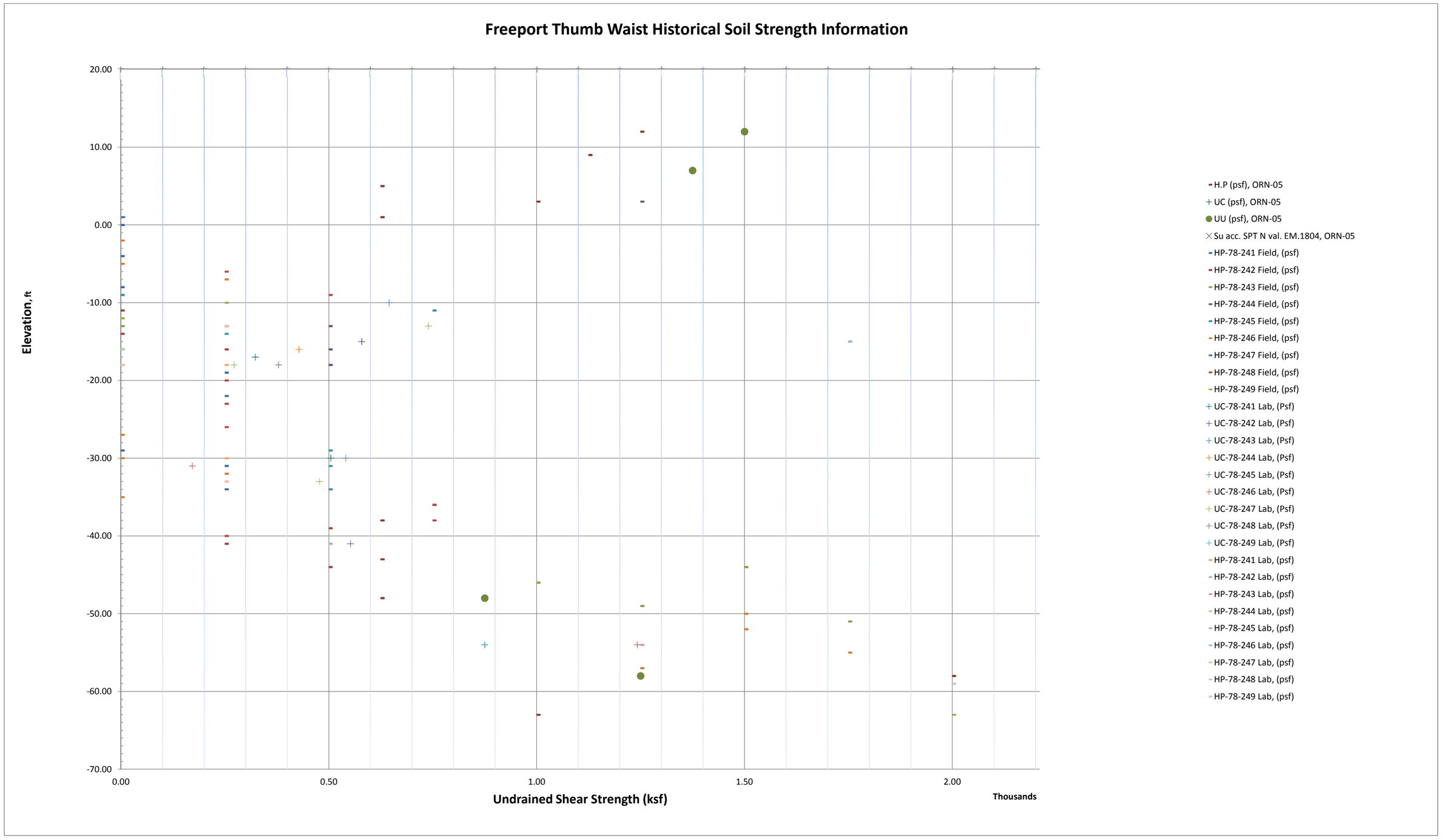
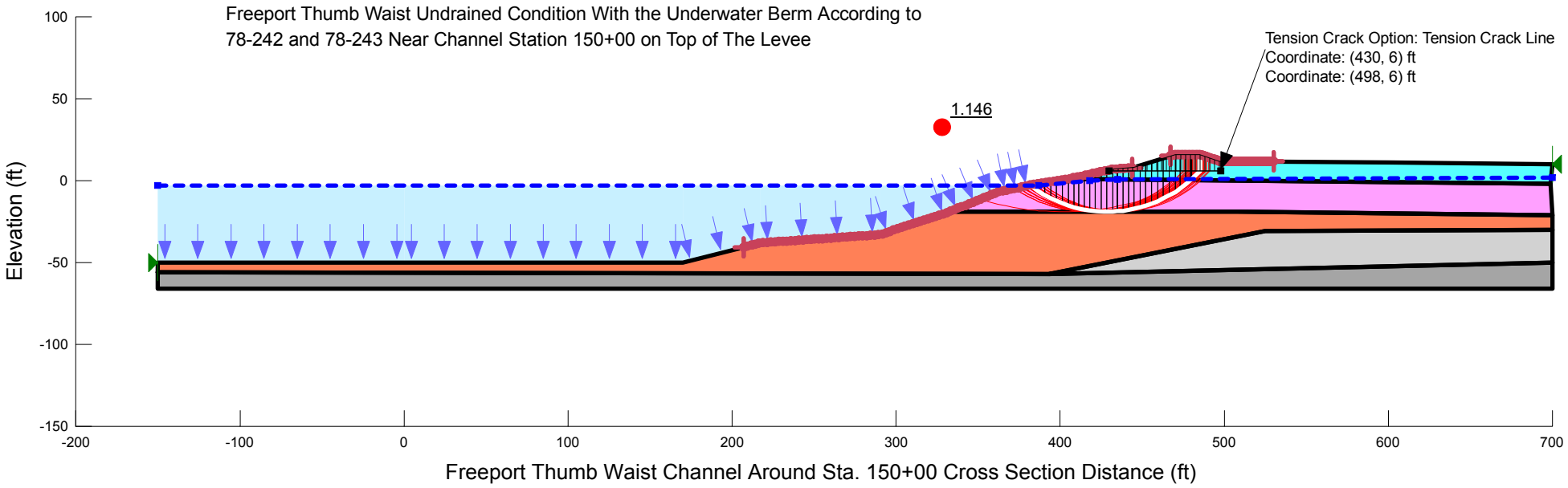


Figure 2. Cohesion vs. Depth

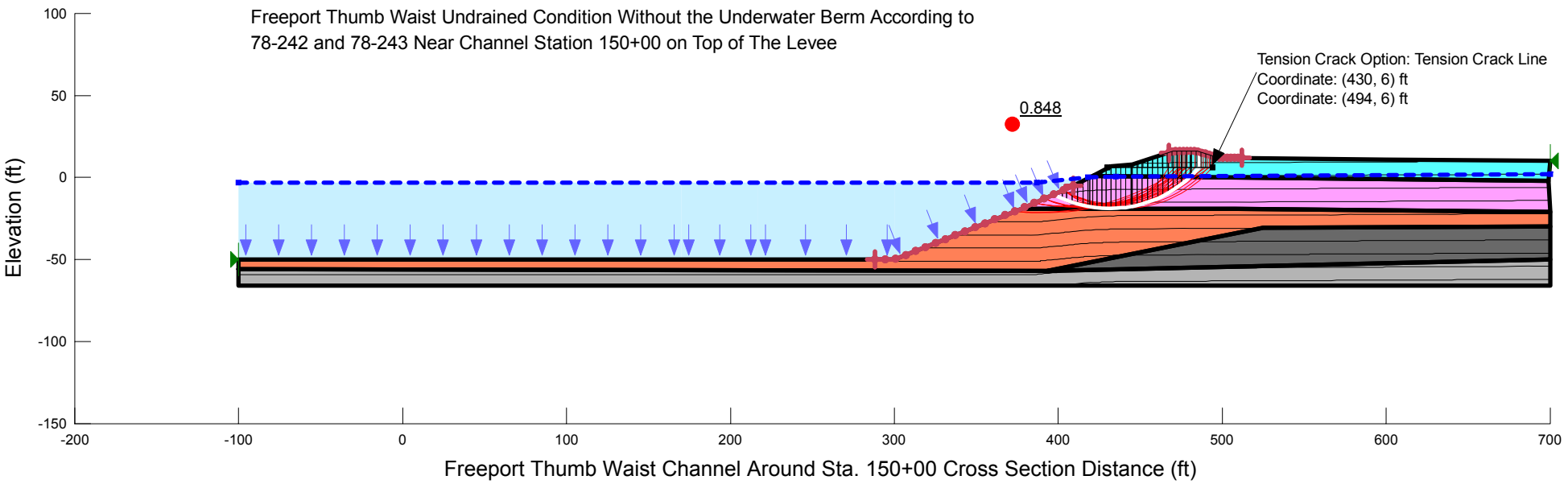


Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	Hurricane Flood Protection Levee Fill	125.9	1,000	0	1
	CH- At bottom (-56' to -66') very firm	126.5	1,375	0	1
	CH from 78-242	103.8	500	0	1
	SM with Organic (-19' to -56') No blow count info	120	0	27	1
	Very soft Layer below the levee (Mixture of SM CL SC CH)	125	300	0	1

Notes:
Limited strength information is available, undrained shear strength is correlated with the following tests:

1. ASTM D 1586, standard penetration tests (S.P.T),
2. hand penetrometer tests,
3. ASTM D2116, unconfined compression test,
4. ASTM D2850, Unconsolidated-Undrained Triaxial Compression Test.

Figure 3. Sta. 150+00 With Underwater Berm

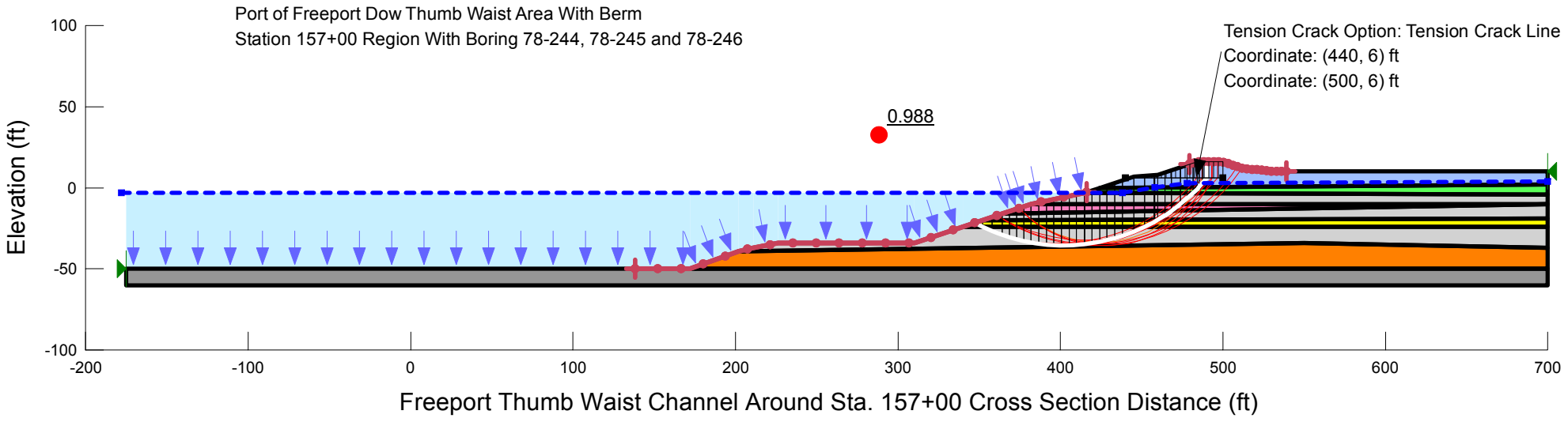


Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	1. Hurricane Flood Protection Levee Fill	125.9	1,000	0	1
	5. CH- At bottom (-56' to -66')	126.5	1,375	0	1
	4. CH from 78-242	103.8	500	0	1
	3. SM with Organic (-19' to -56') No blow count info	120	0	27	1
	2. Very soft Layer below the levee (Mixture of SM CL SC CH)	125	300	0	1

Figure 4. Sta. 150+00 Without Underwater Berm

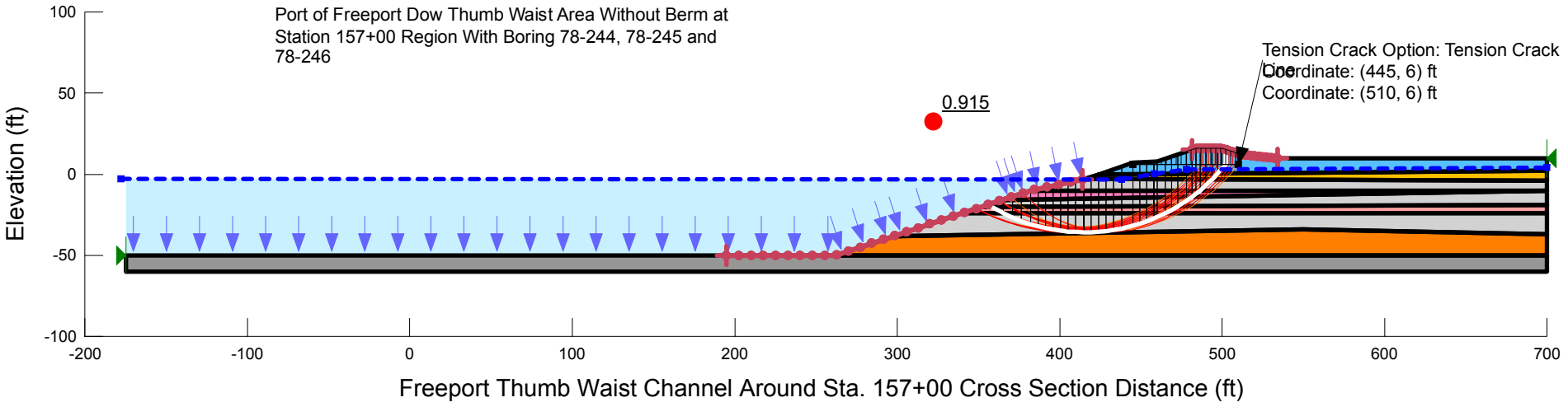
Notes:
Limited strength information is available, undrained shear strength is correlated with the following tests:

1. ASTM D 1586, standard penetration tests (S.P.T),
2. hand penetrometer tests,
3. ASTM D2116, unconfined compression test,
4. ASTM D2850, Unconsolidated-Undrained Triaxial Compression Test.
5. Engineering Judgment.



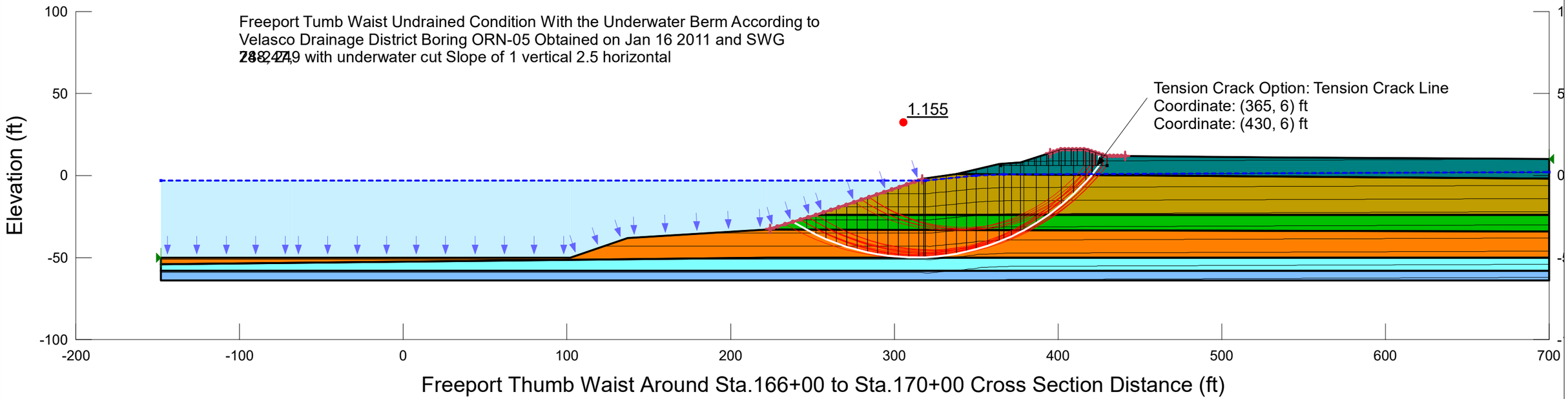
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	CH, very firm -51' to -60'	Mohr-Coulomb	120.4	1,500	0	1
	SP-SM, Medium Dense -38' to -50'	Mohr-Coulomb	115	0	32.7	1
	CH, very soft	Mohr-Coulomb	104.8	300	0	1
	SM, Medium Dense	Mohr-Coulomb	115	0	35.1	1
	Levee Fill	Mohr-Coulomb	120	1,000	0	1
	CL -2' to -5'	Mohr-Coulomb	124.1	350	0	1
	SP-SM higher thin layer	Mohr-Coulomb	110	0	30.9	1

Figure 5. Sta. 157+00 With Underwater Berm



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	1. CH, very firm -51' to -60'	Mohr-Coulomb	120.4	1,500	0	1
	2. SP-SM, Medium Dense -38' to -50'	Mohr-Coulomb	115	0	32.7	1
	3. CH, very soft	Mohr-Coulomb	104.8	300	0	1
	4. SM, Medium Dense	Mohr-Coulomb	115	0	35.1	1
	7. Levee Fill	Mohr-Coulomb	125.9	1,000	0	1
	6. CL -2' to -5'	Mohr-Coulomb	124.1	350	0	1
	5. SP-SM higher thin layer	Mohr-Coulomb	110	0	30.9	1

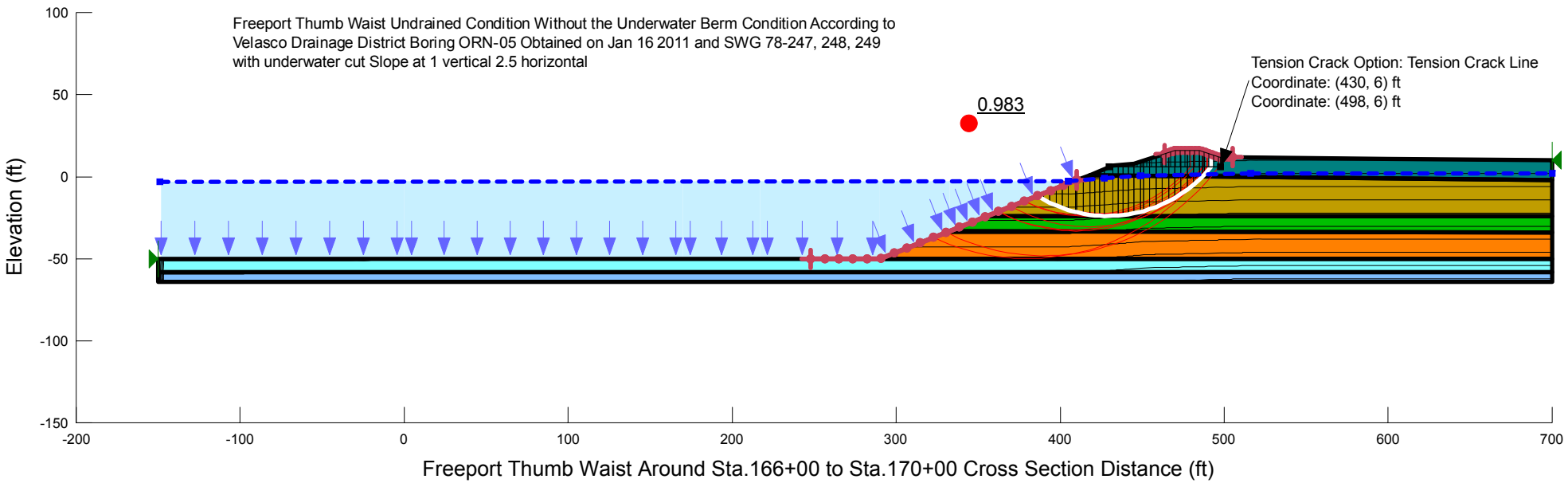
Figure 6. Sta. 157+00 Without Underwater Berm



Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	Hurricane Flood Protection Levee Fill	125.9	1,000	0	1
	CL- Lean Clay below the fill	110	375	0	1
	SC - Below the CL layer	110	500	0	1
	CH- between SC layers (-32' to -52')	111.4	600	0	1
	SC- between CH layers (-52' to -56')	115	1,500	0	1
	CH- At bottom (-56' to -64')	126.5	1,400	0	1

Figure 7. Sta. 166+00 to Sta. 170+00 With Underwater Berm

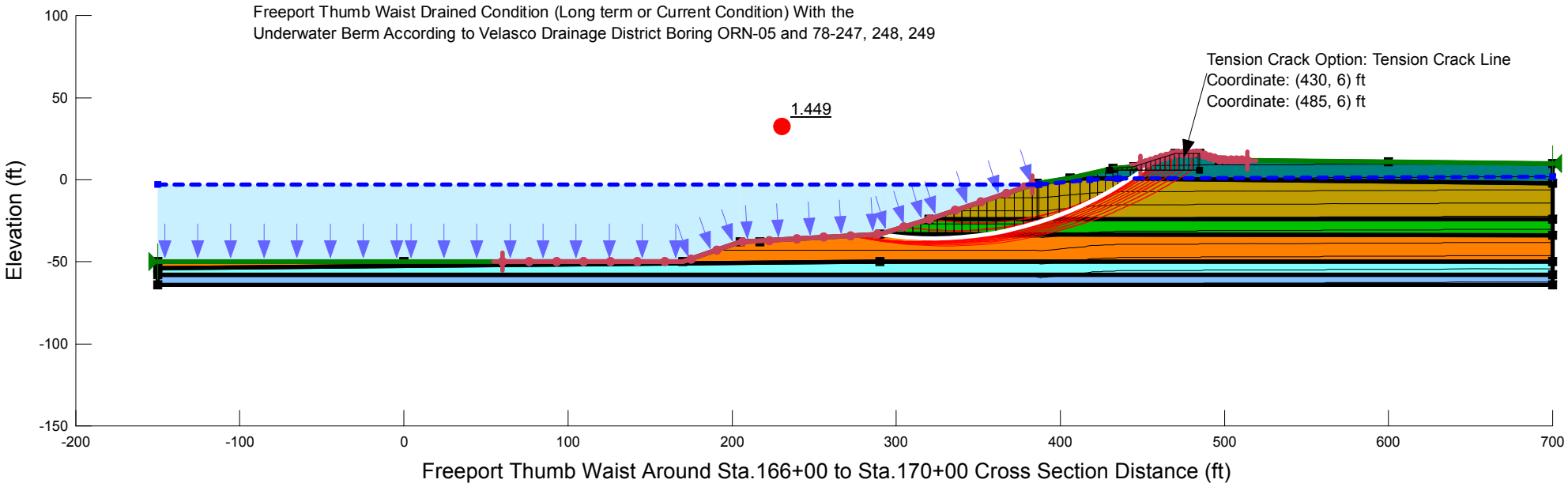
Notes:
Limited strength information is available, undrained shear strength is correlated with the following tests:
1. ASTM D 1586, standard penetration tests (S.P.T),
2. hand penetrometer tests,
3. ASTM D2116, unconfined compression test,
4. ASTM D2850, Unconsolidated-Undrained Triaxial Compression Test.



Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	Hurricane Flood Protection Levee Fill	125.9	1,000	0	1
	CL- Lean Clay below the fill	110	375	0	1
	SC - Below the CL layer	110	500	0	1
	CH- between SC layers (-32' to -52')	111.4	600	0	1
	SC- between CH layers (-52' to -56')	115	1,500	0	1
	CH- At bottom (-56' to -64')	126.5	1,400	0	1

Notes:
Limited strength information is available, undrained shear strength is correlated with the following tests:
ASTM D 1586, standard penetration tests (S.P.T),
hand penetrometer tests,
ASTM D2116, unconfined compression test,
ASTM D2850, Unconsolidated-Undrained Triaxial Compression Test.

Figure 8. Sta.166+00 to Sta. 170+00 Without Underwater Berm

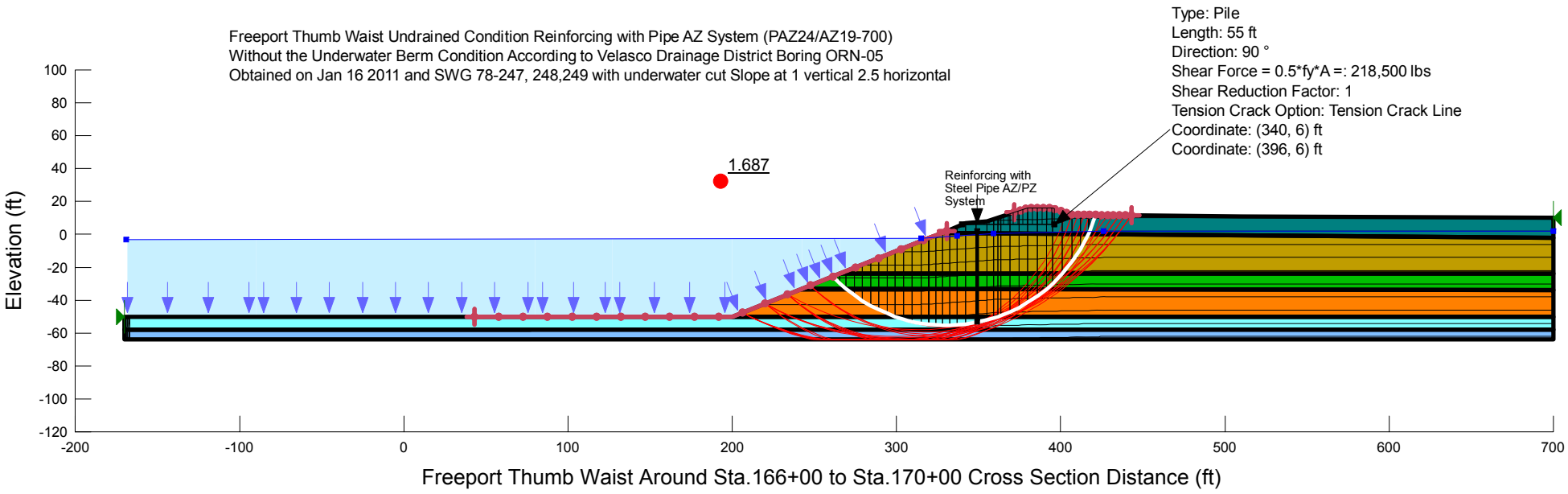


Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	Hurricane Flood Protection Levee Fill	135	50	22.5	1
	CL- Lean Clay below the fill	110	0	24.3	1
	SC - Below the CL layer	110	0	25	1
	CH- between SC layers (-32' to -52')	111.4	0	23.4	1
	SC- between CH layers (-52' to -56')	115	0	27	1
	CH- At bottom (-56' to -64')	126.5	0	17.1	1

Notes:
Very limited effective shear strength information is available, frictional angles are correlated with the following:

* Effective friction angles are correlated to PI according to EM 1110-2-1913 with 10% reduction from the line of best fit.

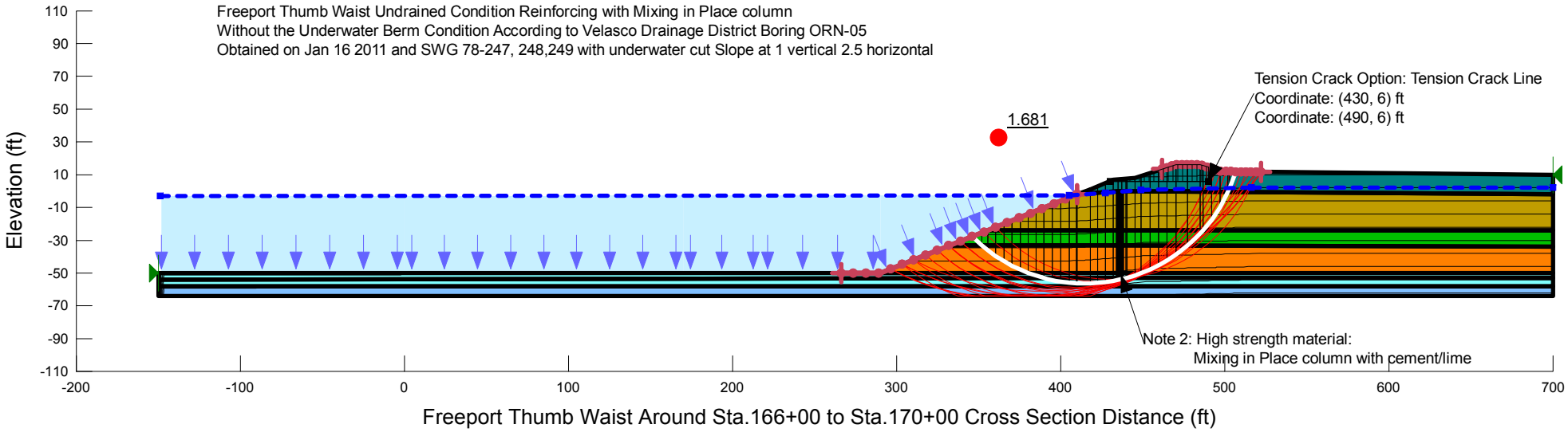
Figure 9. Sta.166+00 to Sta. 170+00 Drained Condition



Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	Hurricane Flood Protection Levee Fill	125.9	1,000	0	1
	CL- Lean Clay below the fill	110	375	0	1
	SC - Below the CL layer	110	500	0	1
	CH- between SC layers (-32' to -52')	111.4	600	0	1
	SC- between CH layers (-52' to -56')	115	1,500	0	1
	CH- At bottom (-56' to -64')	126.5	1,400	0	1

Notes:
1. Limited strength information is available, undrained shear strength is correlated with the following tests:
   * ASTM D 1586, standard penetration tests (S.P.T),
   * hand penetrometer tests,
   * ASTM D2116, unconfined compression test,
   * ASTM D2850, Unconsolidated-Undrained Triaxial Compression Test.
2. Shear force from steel foundation reinforcing system = 0.5*50ksi*8.74(inch^2) = 218,500 lbs

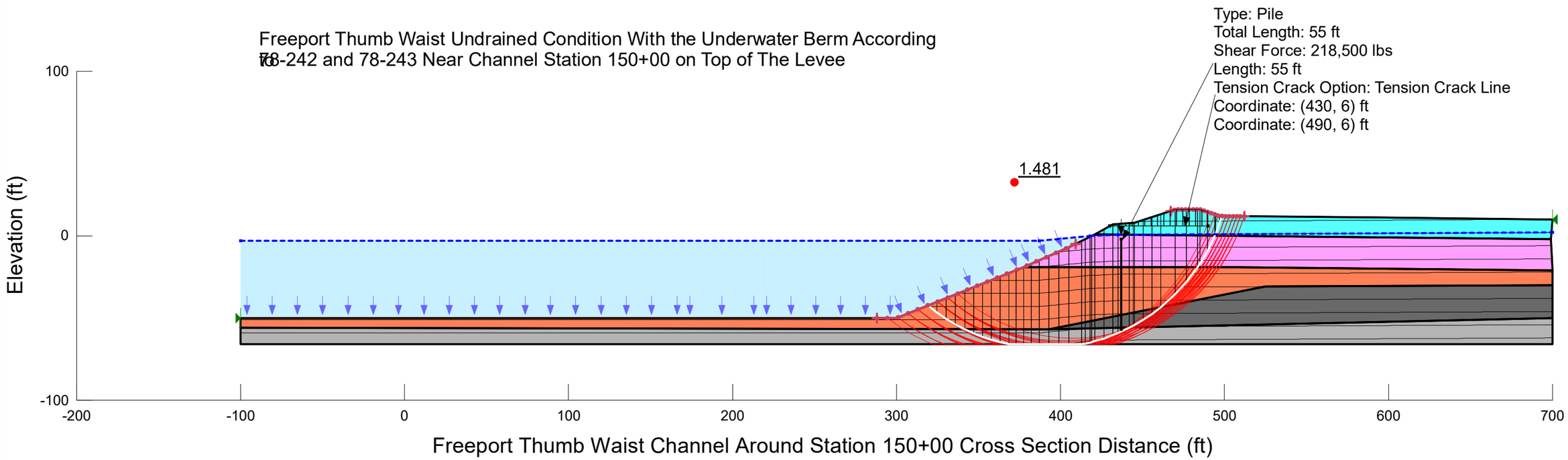
Figure 10. Sta.166+00 to Sta. 170+00 Steel Pipe AZ or PZ Combined Reinforcing System



Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	Hurricane Flood Protection Levee Fill	125.9	1,000	0	1
	CL- Lean Clay below the fill	110	375	0	1
	SC - Below the CL layer	110	500	0	1
	CH- between SC layers (-32' to -52')	111.4	600	0	1
	SC- between CH layers (-52' to -56')	115	1,500	0	1
	CH- At bottom (-56' to -64')	126.5	1,400	0	1
	Mixing in Place column with cement/lime	110			1

Notes:
1. Limited strength information is available, undrained shear strength is correlated with the following tests:
   * ASTM D 1586, standard penetration tests (S.P.T),
   * hand penetrometer tests,
   * ASTM D2116, unconfined compression test,
   * ASTM D2850, Unconsolidated-Undrained Triaxial Compression Test.
2. Foundation reinforcing with Portland cement/lime deep soil mixing. The reinforcing is modeled with default high strength function of Slope/W which assumes the strength is very high therefore any slip surface will not be able to shear through the material layer.

Figure 11. Reinforcing with Deep Soil Mixing

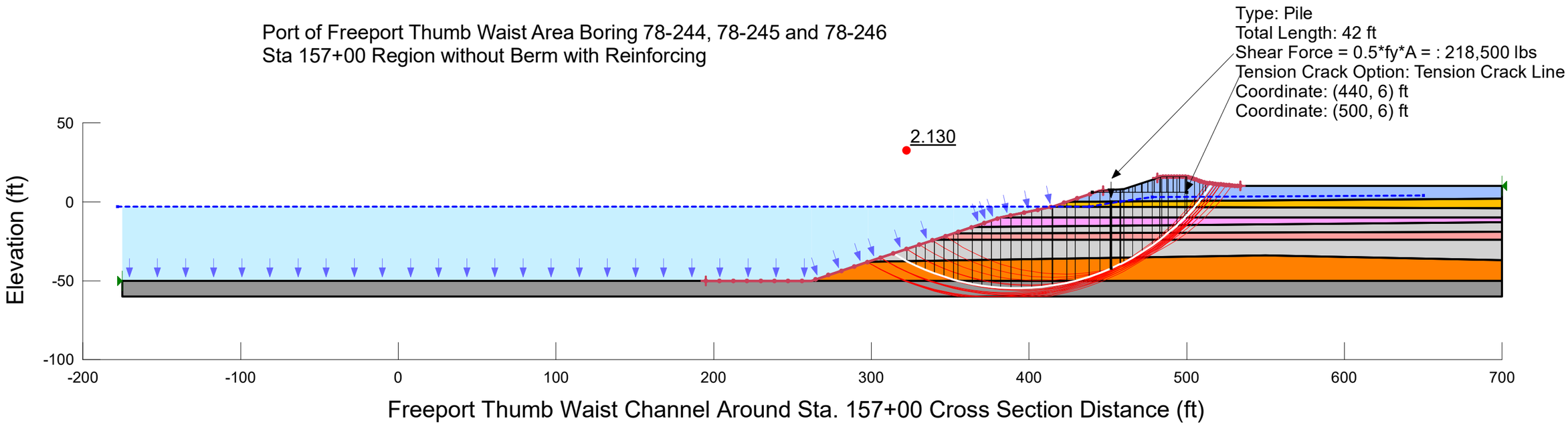


Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	Hurricane Flood Protection Levee Fill	125.9	1,000	0	1
	CH- At bottom (-56' to -66')	126.5	1,375	0	1
	CH from 78-242	103.8	500	0	1
	SM with Organic (-19' to -56') No blow count info. available, assumed frictional angle	120	0	27	1
	Very soft Layer below the levee (Mixture of SM CL SC CH)	125	300	0	1

Notes:
Limited strength information is available, undrained shear strength is correlated with the following tests:

1. ASTM D 1586, standard penetration tests (S.P.T),
2. hand penetrometer tests,
3. ASTM D2116, unconfined compression test,
4. ASTM D2850, Unconsolidated-Undrained Triaxial Compression Test.
5. Engineering Judgement.

Figure 12. Sta. 150+00 Steel Pipe AZ or PZ Combined Reinforcing System



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	CH, very firm -51' to -60'	Mohr-Coulomb	120.4	1,500	0	1
	SP-SM, Medium Dense -38' to -50'	Mohr-Coulomb	115	0	32.7	1
	CH, very soft	Mohr-Coulomb	104.8	300	0	1
	SM, Medium Dense	Mohr-Coulomb	115	0	35.1	1
	Levee Fill	Mohr-Coulomb	125.9	1,000	0	1
	CL -2' to -5'	Mohr-Coulomb	124.1	350	0	1
	SP-SM higher thin layer	Mohr-Coulomb	110	0	30.9	1

Note:

1. Limited strength information is available, undrained shear strength is correlated with the following tests:
    * ASTM D1586, standard penetration tests (S.P.T);
    * hand penetrometer tests;
    * ASTM D2116, unconfined compression test;
    * ASTM D2850, Unconsolidated-Undrained Triaxial Compression Test.

2. Shear force from steel foundation reinforcing system = 0.5*50ksi*8.74(inch^2) = 218,500 lbs

Figure 13. Sta. 157+00 Steel Pipe AZ or PZ Combined Reinforcing System

ATTACHMENT 7

Enclosure 1

FREEPORT HARBOR, TEXAS

(45-FOOT PROJECT)

PHASE II

GENERAL DESIGN MEMORANDUM NO. 1

U.S. ARMY ENGINEER DISTRICT, GALVESTON

CORPS OF ENGINEERS

GALVESTON, TEXAS

71

APRIL 1979

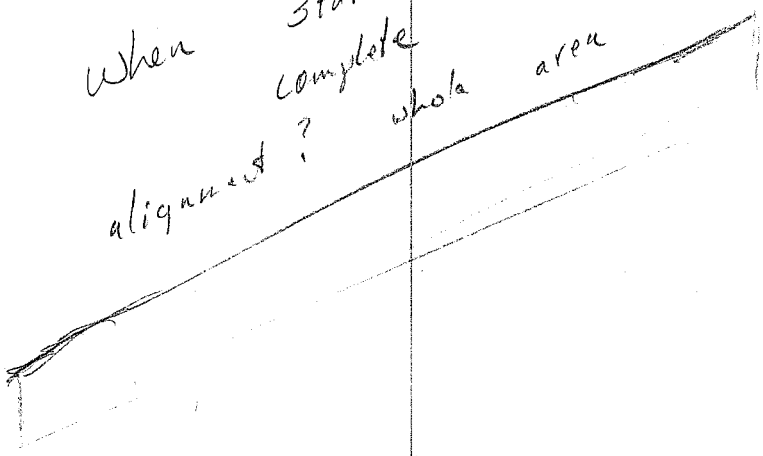
23 JULY 1980

SWDED-TG (SWGED-DP 10 May 79) 5th Ind
SUBJECT: Freeport Harbor, Texas (45-Foot Project) Phase II General Design Memorandum

DA, Southwestern Division, Corps of Engineers, Main Tower Building, 1200 Main Street, Dallas, TX 75202

TO: District Engineer, Galveston, ATTN: SWGED-DP

R. L. J.



STATUS OF CURRENT MAINTENANCE DREDGING

APPROX 350,000 cy/yr INTO DISPOSAL AREAS 2 and the large area opposite No. 3.

ESTIMATED LIFE OF DA # 2 — 16 YRS 150 AC

" " " " # 3 — 9 yrs 100 AC

~~ESTIMATE~~ " " " " # 1 — ? 290 acres

if levees could be raised to +20 MGVD.

9

DAEN-CWE-BB (SWGED-DP, 10 May 79) 4th Ind
SUBJECT: Freeport Harbor, Texas (45-Foot Project) Phase II
General Design Memorandum

DA, Office of the Chief of Engineers, Washington, D.C. 20314 8 July 1980

TO: Division Engineer, Southwestern, ATTN: SWDED-TG

The information furnished and the actions indicated in the 2nd indorsement are satisfactory.

FOR THE CHIEF OF ENGINEERS:

wd all incl

for Jack R. Thompson
LLOYD A. DUSCHA
Chief, Engineering Division
Directorate of Civil Works

290 ACRES × 43560 ft² = 12,632,400 ft² (AREA DA # 1)

ESTIMATED YEARLY MAINT DREDGING 407,500 cy = 11,002,500 cf
VOLUME

yearly input into DA # 1 only

$\frac{11,002,500 \text{ ft}^3}{12,632,400} = 0.87$ ft/YR.

TIME REQD to Fill DA's 2 & 3
w/ increased maint dredging assuming
input into 2 & 3 only

ASSUMING 50 YR LIFE

$\frac{25 \times 350,000}{407,500} = 21$ yrs ∴ 29 yrs × 0.87 ft/YR = 25 ft of fill in D.A. #1

SWDED-TG (SWGED-DP 10 May 79) 3d Ind
SUBJECT: Freeport Harbor, Texas, (45-Foot Project) - Phase II General Design Memorandum

DA, Southwestern Division, Corps of Engineers, Main Tower Building, 1200 Main Street, Dallas, TX 75202 16 JUN '80

TO: HQDA(DAEN-CWE-BB), WASH DC 20314

1. Reference 6th Indorsement, DAEN-CPW-C, 16 April 1979, to letter SWGED-PA, 31 October 1978, subject: Freeport Harbor, Texas (45-Foot Project) - Final Phase I GDM and Environmental Statement, which approved the Phase I GDM.

2. DAEN-CWE comments on the Phase I GDM were omitted from the above review and approval but were subsequently transmitted to SWD and SWG in a letter dated 11 September 1979. Galveston District's response to these comments is presented in paragraph 2 of the 2d Indorsement. SWD concurs in this response.

FOR THE DIVISION ENGINEER:

3 Incl
wd 4 cy incl 3-5

for R. TERRY COOMES, P.E.
Acting Chief, Engineering Division

SWGED-DP (10 May 79) 2d Ind
SUBJECT: Freeport Harbor, Texas, (45-Foot Project) - Phase II General Design Memorandum

3 JUN 1980

DA, Galveston District, Corps of Engineers, PO Box 1229, Galveston, Texas 77553 3 June 1980

TO: Division Engineer, Southwestern

1. The following responses are in reference to comments made in the 1st Ind:

a. Paragraph a. Concur; however, at the time the Phase II GDM was prepared and submitted (10 May 1979), the District was not fully aware of the requirements for a feasibility report for the 5-foot increment as stated in the 6th Ind dated 16 April 1979 referenced in paragraph 2 of basic letter.

b. Paragraph b. Concur; revised pages 2 and 17 inclosed.

c. Paragraph c. Concur; revised page 7 inclosed.

d. Paragraph d. Response to this comment is contained in letter SWGED-DP, 30 November 1979, subject: Freeport Harbor, Texas, (45-Foot Project) - Construction, Removal, and Rehabilitation of Jetties, which furnished plans and specifications for approval.

e. Paragraph e. Concur. The centerline of the proposed 45-foot channel will be moved only 220 feet to the north from the existing 36-foot channel centerline in lieu of 320 feet. This will result in a reduction in estimated dredging quantities of approximately 1.7 million cubic yards. It should be noted; however, that the toe of the proposed channel will be the southernmost limit of any possible future deepening or widening of the entrance and jetty channels. Therefore, any additional channel enlargement will be directed toward the new North Jetty. Details of the revised channel alignment will be presented in approval plans and specifications.

f. The minor comments are concurred in with the exception of comments 5 and 6. Response to comment 5 is contained in letter referenced in above paragraph 2d. In reference to comment 6, the table for paragraph 14.3, pg 16, presents a summary of estimated cost for principal items of the project. A breakdown of justified overdepth dredging quantities and cost are given in Appendix B of the subject DM.

2. The following responses are in reference to letter DAEN-CWE-BB, 11 September 1979, SAB, with 1st Ind SWDED-TG, 24 September 1979, copies inclosed:

a. Subparagraph 3a. Do not concur. Paragraph 76 of the Phase I GDM presents design depth considerations for the jetty and inside channels only. An allowance for pitching and rolling of vessels moving on the inside channels was not included in the design depth because of the infrequency of large (2 to 3-foot) waves within the harbor area. A 2-foot allowance was included in the design depth for the Gulf entrance channel to allow for pitching and rolling of vessels prior to entering the jetty channel. An allowance of 4 feet between the keel of the vessel and the channel bottom was included for the design of the jetty and main channels. This allowance was based on factors of trim, squat, and bottom suction of vessels. Based on discussions with industry representatives, it has been concluded that for a vast majority of large tankers the salt water intake is at least 2 feet above the keel of the vessel. Therefore, for expected vessels moving on the jetty and main channels at Freeport Harbor, the salt water intake will be at least 6 feet above the channel bottom, thus satisfying the requirement recommended in ETL 1110-2-209.

b. Subparagraph 3b. Comment refers to paragraph 79 and Figure 4 in Phase I GDM. Concur that the two are in conflict. A revised Figure 4 is inclosed.

c. Subparagraph 3c. Concur. As presented in the last sentence of paragraph 81 in the Phase I GDM, the entrance channel width has been determined by using minimum criteria for passage of a large tanker (63,000 dwt) and a large general cargo vessel (15,000 dwt). The beam dimensions for these vessels are 110 feet and 75 feet, respectively. When large tankers (greater than 63,000 dwt) move on the waterway, local pilots state that one-way traffic will prevail. The frequency of passage of two deep-draft vessels is slight and any delays experienced by larger deep-draft vessels will be minimal because of the short length of the waterway.

d. Subparagraph 3d. Slope stability studies made for the Freeport and Vicinity, Texas, Hurricane-Flood Protection Project, DM No. 9, adjacent to the navigation channel indicate lower than minimum acceptable safety values which were accepted for the existing project. Studies made for the 45-foot project, Phase I and Phase II GDM, revealed identical values. These values were obtained for the completed hurricane levee and channel slope configuration. The minimum safety factors occur when shear planes are assumed to exit at or near the toe of the existing channel slope. Stability analyses with assumed shear planes which exit at or near the

toe of the proposed 45-foot project channel indicate safety factors greater than those for the existing levee and channel slope configuration. Based on these analyses, it was concluded that shifting the 45-foot channel 70 to 95 feet farther away from the hurricane levee does not change existing stability conditions and that channel deepening will not cause slope failure. Further increase in the safety factors would require substantial modifications of the existing hurricane-flood protection system and Dow Chemical Plant facilities which were found not to be practicable during DM No. 9 studies.

FOR THE DISTRICT ENGINEER:

JOSEPH C. TRAHAN
Chief, Engineering Division

3 Incl
wd incl 2
Added 3 incl
3. Ltr DAEN-CWE-BB 11 Sep 79
w 1st Ind SWDED-TG 24 Sep 79
4. Revised Figure 4 Phase I GDM
5. Revised pgs 1, 2, 3, 6, 7, 9, 10, 17 & 19 Phase II GDM

SWDED-TG (DAEN-CWE-BB 11 Sep 79) 1st Ind
SUBJECT: Freeport Harbor, Texas (45-Foot Project) Phase II General Design Memorandum

DA, Southwestern Division, Corps of Engineers, Main Tower Building, 1200 Main Street, Dallas, TX 75202

24 SEP 79

TO: District Engineer, Galveston

By this basic letter OCE is furnishing us additional comments that were inadvertently omitted from their indorsement on the Phase I report. An indorsement reply of this basic would be appropriate.

FOR THE DIVISION ENGINEER:

R. H. BERRYHILL, P.E.
Chief, Engineering Division

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314

REPLY TO ATTENTION OF:

DAEN-CWE-BB

11 September 1979

SUBJECT: Freeport Harbor, Texas (45-Foot Project) Phase II General Design Memorandum

Division Engineer, Southwestern
ATTN: SWDED-TG

1. Reference 1st Indorsement, SWDED-TG, 22 June 1979, on letter SWGED-DP, 10 May 1979, subject as above.

2. The comments in the following paragraphs concerning the Phase I and the Phase II General Design Memoranda are furnished for appropriate action. Mr. Jerry Smith was informed by telephone on 8 Aug 1979 that OCE would furnish comments on the design memoranda.

3. The following DAEN-CWE comments on the Phase I GDM, were furnished through DAEN-CWP-C and SWD to SWGED-P prior to joint SWG/SWD/OCE conference in January 1979. These comments, which have not been addressed in the Phase II GDM, should be considered:

a. Paragraph 76. The clearance under the keel should include a rolling and pitching allowance for wave action (see EM 1110-2-1607). Also, the recommendation in ETL 1110-2-209 for providing a minimum of 5 feet between the salt water intake and a silty channel bottom should be addressed.

b. Paragraph 79 and Figure 4. The conflict between the design channel width dimensions should be resolved.

c. Paragraph 81. The vessel dimensions used to size the entrance channel width should be shown. Also, the frequency of passing situations by larger vessels should be estimated to determine if a wider channel is warranted.

d. Appendix IV, paragraph 2-3. This paragraph indicates that the levee and channel slope factor of safety approaches unity; Phase II GDM designs should be based upon adequate factors of safety.

DAEN-CWE-BB 11 September 1979

SUBJECT: Freeport Harbor, Texas (45-Foot Project) Phase II General Design Memorandum

4. Paragraph 13.1.1 of Phase II GDM. Relocation of the U.S. Coast Guard Station and demolition of the old structure, which is historically unique, is a potentially sensitive action. The GDM should be expanded to adequately address the problems involved and coordination efforts taken.

FOR THE CHIEF OF ENGINEERS:

for Jack R. Thompson
LLOYD A. DUSCHA
Chief, Engineering Division
Directorate of Civil Works

SWDED-TG (SWGED-DP 10 May 79) 1st Ind
SUBJECT: Freeport Harbor, Texas (45-Foot Project) Phase II General Design Memorandum

DA, Southwestern Division, Corps of Engineers, Main Tower Building, 1200 Main Street, Dallas, TX 75202

22 JUNE 1979

TO: District Engineer, Galveston

The subject design memorandum is approved subject to the following comments. Major comments are included in the body of this indorsement while minor comments are attached separately.

a. Transmittal ltr, para 3, and p 7, para 6.1. The referenced paragraphs indicate that a PAC summary report is being processed to Congress to obtain legislative approval of the recommended 50-foot project depth. However, OCE has advised that a feasibility report is required for the 5-foot increment (see 2d, 6th, and 7th Indorsements to the correspondence referred to in paragraph 2 of your transmittal letter).

b. P 17, Sec XV. This section should be revised to comply with EC 1110-2-193 entitled "Post-Authorization Studies - Phase II," dated 20 April 1979. In this regard the B/C ratio is required under "Pertinent Data," while a description of the estimated average annual benefits is not required in the Phase II GDM. An increase in estimated benefits of 26 percent "based on current price levels" is questionable. Since a reevaluation of benefits will be required to support the feasibility report for the 50-foot project, it is recommended that the description of average annual navigation benefits be excluded from the Phase II GDM and the "updated" BCR shown be footnoted to indicate that an ENR index was used.

c. Transmittal ltr, para 3; p 1, para 1.4; and p 3, para 3.1.1. Local acquisition of the mitigation lands should not be identified as a departure from the approved Phase I GDM. The final environmental statement was revised to cover impacts for both the authorized 45-foot project and the recommended deepening to 50 feet and to include acquisition of mitigation lands by local interests prior to initiation of physical construction. Also, letters and indorsements to the Phase I GDM regarding local rather than Federal acquisition and cost sharing for compensatory lands, constitute a change within the Phase I GDM even though the basic report was not revised. Accordingly, paragraphs 1.4 and 3.1.1 should be deleted. Also, paragraph 3 of the transmittal letter should be revised to indicate that the final environmental statement and OCE approval of the Phase I GDM provide for project construction to be accomplished in two stages:

(1) Construction of the authorized 45-foot project, including the acquisition of mitigation lands.

22 JUNE 1979

SWDED-TG (SWGED-DP 10 May 79) 1st Ind
SUBJECT: Freeport Harbor, Texas (45-Foot Project) Phase II General Design Memorandum

(2) Construction of the additional 5-foot increment (50-foot project) after Congressional authorization.

d. P 5, para 5.6 and p 12, para 11.1. Reference ETL 1110-2-242, Stability Coefficients for Placed Stone Jetties, 2 April 1979. Prior to completion of the contract plans, Galveston District should explore the availability of elongated stone shapes from local quarries and determine if placed stone procedures as outlined in the ETL would be a feasible and economically advantageous design for the Freeport Jetties.

e. Pl 2. The centerline of the proposed channel has been shifted 320 feet from centerline of existing channel. To consider previous dredging in the existing channel and to reduce the quantity of new dredging, it would appear feasible to obtain the required 400-foot channel width by maintaining the existing west slope and extending the channel 400 feet from that point. Since bend-easing approaching the lower turning basin is desirable and apparently the reason for shifting the existing channel, the easing could be accomplished by widening the channel on both left and right sides as the turning basin is approached.

FOR THE DIVISION ENGINEER:

R. H. BERRYHILL, P.E.
Chief, Engineering Division

1 Incl
wd incl 1
Added 1 incl
2. as

CF: w/incl 1 & 2
HQDA(DAEN-CWE-BB)

SWD Minor Comments
Phase II GDM
Freeport Harbor, Texas

1. P 6, para 5.6.3. The discussion of enlargement of the channel should be qualified by adding the words "...if and when authorized."

2. P 9, para 7.4. Reference should be made to Plate 5 in this narrative.

3. P 10, para 8.2. Disposal Area No. 5 is shown on Plate 1; however, it is not discussed in paragraph 8.2. This disparity should be resolved.

4. P 10, para 10.1. When the results of additional studies in connection with the National Historic Preservation Act are completed, the final EIS should be supplemented if it is determined to be deficient.

5. P 12, para 11.2. The first sentence of this paragraph should also exclude the use of cherty materials.

6. P 15, para 14.3. The quantities and costs of justified overdepth dredging should be stated separately.

7. P 19, para 17.1. A description of the operation and maintenance staff including number, positions, and location should be presented in this paragraph.

8. P 19, para 18.1. The recommendation should have more substance and succinct conclusions on which to base a more positive recommendation for the project.

9. General. Plates 1-5 should follow page 19 (before the appendixes).

INCL 2

DEPARTMENT OF THE ARMY
GALVESTON DISTRICT, CORPS OF ENGINEERS
P.O.BOX 1229
GALVESTON, TEXAS 77553

REPLY TO ATTENTION OF:

SWGED-DP

10 May 1979

SUBJECT: Freeport Harbor, Texas (45-Foot Project) Phase II General Design Memorandum

Division Engineer, Southwestern

1. Subject design memorandum is submitted for review and approval.

2. The Phase II GDM has been prepared in accordance with paragraph 3 of DAEN-CWP-C (SWGED-PA, 31 October 1978) 6th Ind dated 16 April 1979, subject: Freeport Harbor, Texas (45-Foot Project) - Final Phase I General Design Memorandum and Environmental Statement, which approved the Phase I GDM as a basis for detailed engineering and design of the 45-foot project.

3. The Phase I GDM recommended a 50-foot project, but approval was requested of the authorized 45-foot project to enable jetty construction, identical for either project depth, to be initiated pending review of a Post Authorization Change Summary Report for the 50-foot project.

FOR THE DISTRICT ENGINEER:

JOSEPH C. TRAHAN
Chief, Engineering Division

1 Incl (14 cy)
GDM

75 copies prepared

FREEPORT HARBOR, TEXAS
(45-FOOT PROJECT)

PHASE II
GENERAL DESIGN MEMORANDUM NO. 1

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APPENDICES

LIST OF PLATES

FREEPORT HARBOR, TEXAS
45-FOOT PROJECT

PHASE II
GENERAL DESIGN MEMORANDUM NO. 1

I GENERAL

1.1 General.- This general design memorandum presents the proposed plan for accomplishing the authorized 45-foot project modifications to the existing project in accordance with the approved Phase I GDM. Approval of this report will permit the orderly preparation of all dredging and construction plans and specifications.

1.2 Datum.- Elevations and depths refer to U. S. Corps of Engineers mean low tide datum, unless otherwise noted.

1.3 Proposed plan.- The proposed plan consists of modifying the existing project at Freeport Harbor to provide generally for deepening, realigning, and enlarging the main channels and turning basins from existing depths of 36 feet to depths of 45 feet, and deepening the existing Brazos Harbor channel and turning basin from a project depth of 30 feet to a depth of 36 feet. The project also provides for relocation of the North Jetty, rehabilitation of the existing South Jetty, and inclusion of public use facilities such as parking areas, sanitary facilities, and handrailings on the breakwaters for the safety and well being of visitors to both jetties.

1.4 Proposed change from Phase I GDM.- The only change in the 45-foot project plan made subsequent to approval of the Phase I GDM involves the acquisition and cost sharing for compensatory lands. The Phase I GDM plan provided for acquisition by the Federal Government of 400 acres of tidal wetlands for the purpose of compensating for environmental damages resulting from disposal of dredged material on coastal prairie habitat, with the costs to be shared between Federal and non-Federal interests in the same ratio as the total project costs. This would have required additional Congressional approval which would entail considerable delay in the start of construction. Therefore, the local sponsor, in an effort to facilitate an early construction start, has agreed to acquire and bear the full cost of all required compensatory lands without prospect of Federal reimbursement.

II PERTINENT DATA

2.1 First Costs.-

Federal first cost	$52,491,000
Non-Federal first cost	6,757,000
Total Federal and non-Federal first cost	$59,248,000

2.2 Annual Charges.- $ 6,365,000

2.3 Annual Benefits.- $43,276,000

2.4 Benefit - Cost ratio.- 6.8

2.5 Physical Features.-

Section of Waterway	Existing Project Dimensions (in feet)		Authorized and Proposed Dimensions (in feet)	
	Depth (M.L.T.)	Bottom Width	Depth (M.L.T.)	Bottom Width
Entrance Channel	38	300	47	400
Jetty Channel	36	200	45	400
Lower Turning Basin	NONE		45	750 (DIA.)
Channel to Brazosport T.B.	36	400	45	400
Brazosport Turning Basin	36	700x 700	45	1,000 (DIA.)
Channel to Upper Basin	36	375	45	375
Upper Turning Basin	36	600x 600	45	1,200 [1/] (DIA.)
Brazos Harbor Channel	30	200	36	200
Brazos Harbor Turning Basin	30	550x 600	36	750 (DIA.)

[1/] At new location.

Jetties	Offshore & Shore Portion Elev.	Length	Inshore Portion Elev.	Length
North Jetty	+8.0	4,200'	+4.5	3,500'
South Jetty (Rehab)	+8.0	4,600'	+4.5	2,040'

Recreational area facilities at each jetty.-

Asphalt parking area	Minimal landscaping
Comfort station	Handrailings on jetty
Water supply and electrical system	Asphalt jetty walkway

III LOCAL COOPERATION

3.1 Requirements of local cooperation.- The requirements of local cooperation as specified in the project document are quoted in paragraph 4 of the Phase I GDM. The Brazos River Harbor Navigation District, the local sponsor, has indicated their willingness to fulfill the requirements of local cooperation. Prior to initiation of construction, the United States Government and the Brazos River Harbor Navigation District will enter into a contractual agreement as required by Section 221 of the Flood Control Act of 1970 (Public Law 91-611).

3.1.1 In addition to the above the local sponsor has recently adopted a resolution for immediate acquisition of the required compensation lands at local expense and without prospect of Federal reimbursement, as discussed in paragraph 1.4.

IV PROJECT LOCATION

4.1 Project location.- The project is located on the central coast of Texas, in the original channel mouth of the Brazos River, approximately 60 miles south of Houston as shown on Plate 1. The tributary area served by the project consists of a 17 county area including Walker, San Jacinto, Polk, Montgomery, Liberty, Washington, Waller, Harris, Chambers, Fayette, Austin, Ft. Bend, Galveston, Colorado, Wharton, Matagorda, and Brazoria Counties. The immediate area served by the project, known as Brazosport, is made up of numerous small cities and towns including Freeport whose economy is primarily dependent upon the petroleum and petrochemical industries. There are also facilities at the harbor which import crude petroleum for distribution to midwest refineries through a network of pipelines.

V GEOLOGY AND SOILS

5.1 General geology.- The Freeport harbor project area is situated in the eastern portion of the Colorado-Brazos deltaic plain. Formations across the plain become progressively younger in the seaward direction. These formations consist of sediments deposited during the Cenezoic era. Beach areas in the vicinity are comprised primarily of littoral sands and shell of Recent age. Heavy calcareous clays with interbedded silt and sand strata, Pleistocene in age, underlie the Recent sediments. The natural land surface slopes gradually upward from elevations of about 3 to 4 feet above mean sea level behind the beaches to an elevation of 15 feet above mean sea level about 15 miles inland.

5.2 Soils investigations.- The locations and logs of borings obtained in the Freeport Harbor area are shown on Exhibits 1 and 2. Forty-nine undisturbed Shelby tube borings have been obtained in the jetty and harbor areas during the period between November 1962 and September 1978. Twenty-three of these borings have been obtained on land and twenty-six in the water. The borings generally have been drilled to elevations ranging between 40 and 90 feet below MLT. Borings 78-241 thru 78-249 were drilled in September 1978 for determining the channel slope stability adjacent to Dow Plant A.

5.3 Testing.- Laboratory testing included moisture content determination and visual classification on all samples, and pocket penetrometer readings and unit dry weight determination on all undisturbed samples. Identification testing, performed on representative samples to accurately classify each stratum, included mechanical analyses, liquid limit tests, and plastic limit tests. Further testing included unconfined compression and triaxial "Q" compression tests. These tests were performed on typical materials for use in slope stability studies. Analyses of sediment samples from numerous borings along the harbor area were made to determine the concentration of various pollutants. Results of foundation strength tests are shown on Exhibits 3, 4 and 5.

5.4 Channel design.- The soils to be excavated during harbor enlargement will consist of clays and sandy clays ranging in consistency from very soft to hard and very loose to very dense silty sands, sandy silts and clayey sands. Dredging of these materials is not expected to present unusual problems. The project channels and basins will be dredged to the depths discussed in paragraph 7.1. The proposed channel side slopes of one vertical on three horizontal are considered safe from shear failure based on results obtained from stability analyses performed on what is believed to be the most critical cross sections. The most critical areas are

adjacent to Dow Plant A where analysis of the existing levee and channel slopes indicate factors of safety as low as 1.16. The edge of the proposed channel has been relocated away from the existing levee and channel slope to prevent unloading the toe. Close control of initial construction and maintenance dredging will be required to prevent overdredging to maintain existing stability. A stability analysis of the channel side slopes at channel mile 2.9 adjacent to Dow Plant A is shown as Exhibit No. 6.

5.5 Soil conditions.- The soils to be excavated in enlarging the entrance channel consist of stiff clays and will be excavated by hopper dredge. The soils to be excavated in deepening, widening and realignment of the jetty channel consist of about 600,000 cubic yards of sand and 700,000 cubic yards of silt and clayey materials. The sand lies above elevation -20 in the relocated channel between the old and new North Jetties. These materials will be excavated by pipeline dredge. The soils to be excavated during enlargement of all other channels and basins consist of soft to stiff clays and sandy clays. These materials will be excavated by pipeline dredge. Excavated materials will be disposed of as discussed in paragraph 8.2.

5.6 Jetty design.- The design of the new North Jetty is based on the criteria presented in Appendix III of the survey report, "Review of Reports on Freeport Harbor, Texas (45-Foot Project)", April 1970. The design was updated during preparation of the Phase I GDM to reflect current design procedures. The design in this report is the same as presented in the approved Phase I GDM.

5.6.1 Cover stone sizes for the various reaches of the jetty were determined by methods outlined in the "Shore Protection Manual," Coastal Engineering Research Center, 1977, using damage factors of 2.3 and 2.0 for the trunk and head, respectively. Design wave heights used in sizing the cover stone were determined by techniques described in Beach Erosion Board Technical Memorandum No. 84 and are considered to be characteristic of a storm expected to occur in the project area once in 100 years. The design wave height at the seaward end of the jetties for these conditions is 18.4 feet.

5.6.2 The new North Jetty will be constructed to the same length as the existing North Jetty. This length has proven to be adequate for protecting navigation and for preventing the movement of littoral material into the entrance channel. Extension of the jetty to deeper water was considered and found to be unnecessary. Examination of the adjacent shoreline revealed no accretions approaching the end of the jetty. While it is probable that a minor amount of littoral material

moves around the jetty and is deposited in the entrance channel, its contribution to the cost of maintenance dredging is insignificant in relation to the high cost of deepwater jetty construction. Accordingly, the cost of extending the jetties was not investigated in detail. Decreasing the length of the new jetty was not considered economically beneficial since doing so would decrease the jetty's present effectiveness in minimizing the deposition of littoral material in the channel. Any decrease in its length would also decrease its effectiveness in minimizing wave action and cross currents on vessels navigating the entrance channel. The existing jetty length is also required for the use of Surfside Beach as a disposal area for this project and for the consideration of the beach for a possible future beachfill project. Decreasing the jetty length would decrease the potential area to store materials artificially placed on the beach.

5.6.3 The new rubble-mound North Jetty will be located 1,200 feet from the existing South Jetty. This spacing will provide adequate protection for the entrance channel and will allow room for future enlargement of the channel to a width of 600 feet and a depth of about 75 feet.

5.6.4 The plan of construction recommended in the Phase I GDM which combines the relocation of the North Jetty and the rehabilitation of the South Jetty into a joint construction program utilizing both salvaged old jetty materials and new materials is considered the most practicable and economical plan. Construction of the new jetty to its design length will be performed primarily with new materials prior to complete removal of the old jetty. The existence of the new jetty will assure continuous protection of the jetty channel and will provide improved working conditions for marine equipment at the old jetty. Partial demolition of the old North Jetty concurrently with construction of the new jetty will allow reuse of some old jetty materials in the new jetty. The majority of the stone salvaged from the old jetty, plus new stone as needed, will be used for rehabilitation of the South Jetty and for construction of the inshore sections of both jetties. The height and width of the new jetty crown have been designed to permit the Contractor to use the jetty as a haul road and construct the jetty with land-based equipment. The size of the filler stone selected will permit operations of rubber tired vehicles on the jetty prior to placement of the cover stone. However, it is anticipated that both marine and land equipment will be utilized for this project, since removal of the offshore portion of the old jetty must be accomplished entirely by marine equipment.

5.6.5 Typical jetty sections of the proposed new North Jetty and the proposed plan of rehabilitation of the South Jetty are shown on Plate 4. A stability analysis performed at the most critical area of the proposed new North Jetty is shown on Exhibit 7.

5.7 Disposal area levees.- Design of disposal area levees is based on experience with other disposal levees in the Freeport Harbor area and subsurface investigations of borrow areas for the Freeport Hurricane-Flood Protection Project. Disposal area levees will have 1V to 3H side slopes. New levees will be constructed using cast fill obtained from inside ditch borrow areas. Existing levees can be repaired, shaped, or raised where necessary using borrow obtained from within the disposal areas. The levees can be increased to a maximum elevation of about +50 when needed as the foundation areas and the construction materials will consist of stiff clays.

VI OTHER PLANS INVESTIGATED

6.1 Other plans investigated.- Six alternative plans which include (1) common loading facilities, (2) lightering, (3) channel enlargement, (4) offshore terminal facilities, (5) regional harbors, and (6) the no action plan were investigated in the Phase I GDM. Of these six plans it was determined that the channel enlargement plan was the only viable plan considering the existing and prospective commerce for the waterway, the existing substantial capital investments made by industry in their own terminal facilities, the harbor congestion that would be created by common loading and terminal facilities, and the risk of cargo spills inherent to lightering of vessels. The channel enlargement plan then studied the 40, 45, 50, and 55-foot channel depths for economic efficiency. The 50-foot depth proved to be the most beneficially economical plan. Therefore, it is viewed that there are no obvious alternative engineering schemes within the overall plan for Phase II investigation. However, since the 50-foot plan requires Congressional action, the authorized 45-foot depth plan is being presented in this Phase II GDM for approval while a recently submitted Post-Authorization Change Summary Report is awaiting legislative action.

VII DESCRIPTION OF PROPOSED STRUCTURES

7.1 General.- The authorized structures and improvements proposed in this design memorandum for modification of the Freeport Harbor project are as follows:

a. relocating the entrance channel and deepening to 47 feet;

b. deepening to 45 feet and relocating the jetty channel;

c. relocating the north jetty 640 feet to the northeast and rehabilitating the south jetty;

d. deepening and enlarging the inside main channel;

e. enlarging the widened area at Quintana Point to provide a 750-foot diameter turning area with a depth of 45 feet;

f. enlarging Brazosport turning basin to provide a 1,000-foot turning area with a depth of 45 feet;

g. constructing a new 1,200-foot diameter by 45-foot deep upper turning basin;

h. deepening Brazos Harbor Channel and turning basin to 36 feet;

i. enlarging the Brazos Harbor turning basin to 750 feet in diameter;

j. and providing public use facilities adjacent to the jetties for the public health and welfare of fishermen and other visitors.

7.2 Channels.- Under the proposed plan, the existing channels and basins will be modified to provide the authorized channel depths and widths tabulated on Plate I and shown in cross-sections on Plates 2 and 3. The required dredging of the channels and basins will be to depths greater than the authorized depth depending on the amount of advance maintenance proposed in paragraph 7.2.1. The allowable overdepths for dredging inaccuracies and proposed channel side slopes are discussed in paragraphs 7.2.2 and 7.2.3, respectively.

7.2.1 Advance maintenance.- All channels and basins to be improved will be dredged to the authorized project depth plus an additional depth for advance maintenance. Experience has shown that a minimum of 2 feet of advance maintenance is justified and should be provided

in dredging of all channels and basins to be improved. However, because of very high shoaling rates in the inside main channels and basins, four feet of advance maintenance dredging will continue to be performed as required in the past.

7.2.2 Allowable overdepth.- To compensate for possible dredging inaccuracies, two feet of allowable overdepth is proposed for the more open water areas of the entrance and jetty channels. One-foot of allowable overdepth is proposed for all other channels and basins located in more protected areas.

7.2.3 Proposed side slopes.- The proposed side slopes will be 1V on 3H for all channels and basins. The toe of slope of required dredging will be set at a depth equal to the authorized depth plus the additional advance maintenance proposed in paragraph 7.2.1.

7.3 Jetties.- The proposed plan of jetty construction combines relocation of the North Jetty 640 feet to the north to facilitate widening and shifting of the jetty channel and rehabilitation of the South Jetty by using both salvaged material from the old North Jetty and new materials. The new North Jetty will be constructed to the same height, crown elevation of 8.0 and offshore length, 4,200 feet, as the existing North Jetty. The new jetty will have an inshore section approximately 3,500 feet long with a crest elevation of 4.5. The inshore section of the South Jetty will be extended approximately 2,000 feet with a crest elevation of 4.5. These inshore sections will serve as protection against possible serious flanking during hurricanes. At station (-)5+00, the new North Jetty has been offset toward the channel to avoid destruction of the site of old Fort Velasco. The jetty plan is shown on Plate 4.

7.4 Public use facilities.- Public use facilities, such as parking areas, sanitary facilities, and handrailings on both jetties, will be provided for the public visiting the jetties. These facilities will include a 100 car parking area and asphalt access roads, a comfort station, water supply and electrical system, minimal landscaping, handrailing, and asphalt jetty walkways for each jetty. Upon completion of the project, all facilities except the jetty handrailings and walkways will be maintained and operated by local interests.

VIII DISPOSAL AREAS

8.1 General.- The materials to be dredged from the project channels and basins will be disposed of in various confined areas on land and in open water areas as indicated on Plate 1, and discussed below.

8.2 Disposal areas.- Disposal Area No. 6 is an open water disposal area in the Gulf of Mexico which will receive about 5.1 million cubic yards of material dredged by hopper dredge from the entrance channel. Disposal Areas Nos. 1, 2, and 3 will be confined areas containing 290, 150, and 100 acres, respectively. About 700,000 cubic yards of clayey material to be dredged by pipeline dredge from the jetty channel will be disposed of in Disposal Area No. 3. The remainder of material to be dredged from the jetty channel, consisting of about 600,000 cubic yards of sandy material will be disposed of on Surfside Beach to aid in reducing erosion of the shoreline. Disposal Areas 1 and 2 will contain the approximately 4.14 million cubic yards to be dredged by pipeline dredge from the main channels and basins and the Brazos Harbor Channel. Effluent from Disposal Areas 2 and 3 will be returned to the GIWW and the effluent from Area 1 will be returned to the main channels via a ditch and pumping station. The above land disposal areas could be utilized for future maintenance dredging of the project, depending on the extent of easements acquired by local interests.

IX CONSTRUCTION PROCEDURE

9.1 Construction procedure.- Construction of the proposed improvements to Freeport Harbor will require about five years. The initial contract will include construction of the new North Jetty, dismantling of the existing North Jetty, and rehabilitation of the South Jetty. The specifications will require that the new North Jetty be essentially complete prior to dismantling of the existing North Jetty. This procedure will prevent excessive shoaling of the jetty entrance channel. During the latter portion of the 3-year jetty contract period, dredging of the main channels and basins and Brazos Harbor Channel and basin will be initiated. During the last two years of the construction period, construction of the new Coast Guard station, relocation of hopper dredging range towers, removal of the abandoned Coast Guard station and, dredging of the Gulf entrance and jetty channels will be accomplished. Construction of the public use facilities will be initiated upon completion of the new North Jetty.

X ENVIRONMENTAL ANALYSIS

10.1 Reevaluation.- A reevaluation of the environmental impacts and effects of the proposed action has been accomplished during preparation of the Phase II GDM. This reevaluation has not discovered any environmental impacts which were not considered in the Phase I General Design Memorandum dated June 1978, or the Final Environmental Statement filed with the EPA on 2 March 1979. However, some additional studies and coordination are being accomplished to assure compliance with the National Historic Preservation Act.

10.2 Public notice.- On 24 January 1979 a Public Notice was issued in accordance with provisions of Federal regulations including Title 33 CFR 230 and 209.145 pursuant to Section 404 of the Federal Water Pollution Control Act. No new significant environmental issues have been identified from responses to the Public Notice. The Final Environmental Statement included an evaluation of the effects of the discharge of dredged or fill material into waters of the U. S. using the Section 404(b) guidelines. The proposed construction activities including dredging, disposal, and jetty construction have been specified through the application of the Section 404(b)(1) guideline. The EPA, in its comments on the Final Environmental Statement, stated that adequate documentation had been received to assure that the proposed project activities will be conducted in an environmentally sound manner and that the proposed action is satisfactory within the Environmental Protection Agency's areas of review under Section 309 of the Clean Air Act.

10.3 Environmental impacts of dredging.- Previous environmental studies have indicated that dredging operations will cause temporary water quality problems as a result of suspension of bottom sediments. Marine life may be affected in the immediate vicinity of the dredging operations; however, most swimming organisms will not be greatly affected because of their ability to avoid the area during dredging. The proposed project plan will not affect submersed vegetation; however, disposal of dredged materials on land will affect approximately 650 acres of coastal prairie habitat. Approximately 400 acres of marsh land will be acquired by the local sponsor to compensate for alteration of fish and wildlife habitat in 650 acres of disposal areas proposed for project use. The total effect of the project on recreation is expected to be beneficial. Various project features, including parking areas, sanitary facilities, and handrailings for both jetties, are expected to make the area more attractive for recreational fishing. The proposed project plan will have both adverse and beneficial effects on commercial fishing. Gulf shrimpers will benefit slightly by the added safety resulting from enlargement of the jetty and inside channels. Disposal of dredged material in the offshore disposal area will cause temporary turbidity, which will decrease phytoplankton productivity during dredging operations. During these periods commercial fishermen will have to go elsewhere for their catch.

10.4 Economic impacts.- As a result of construction of the project, new industries and businesses may be attracted to the area. Pollution and waste disposal problems resulting from expansion or construction of industries can be minimized through enforcement of state and Federal laws. Industrial expansion will result in increased employment

opportunities, increased local population and consequent residential development, and increased loss of wildlife habitat. Relocation of the North Jetty will require acquisition of approximately 20 summer homes. People displaced by this acquisition will generally find a new location on which to construct a new dwelling. Effects of this displacement will be minor.

XI CONSTRUCTION MATERIALS

11.1 Sources.- Materials sources for jetty construction and rehabilitation are not located near this project. The nearest suitable quarries are located along the Balcones fault zone and adjacent to the Llano uplift area. These quarries are about 175 to 200 airline miles from the project site but haul distances by rail or highway will be considerably farther. The cost of transporting the materials from the quarry to the job site will represent a large portion of the construction costs of the jetty. Although jetty cover stone is not commercially produced on a regular basis, these quarries can produce both limestone and granite in sufficient quantities and quality to supply this project. All available sources have previously been tested for various projects in the Galveston District. The name and locations of these quarries are shown on Exhibit No. 8.

11.2 Stone quality requirements.- Sound durable stone for the jetties will be insured by preparing specifications which will prevent the use of soft, lightweight, or chalky stone. The specifications will not designate the type of stone, but will permit the use of any stones conforming to the quality requirements. The minimum unit weight per cubic foot calculated from the specific gravity in accordance with ASTM C-127-73 will be 160 pounds per cubic foot for cover stone and 150 pounds per cubic foot for all other stone. The absorption using the same test method will not exceed 1.5% for cover stone. The maximum allowable abrasion loss will be 35% for cover stone and 40% for the other stone as determined by ASTM Method C 535-69, No. 1 grading. The maximum allowable magnesium sulfate loss when tested in accordance with ASTM C 88-76 will be 10% for cover stone and 15% for all other stone. These quality requirements will apply to all stone used in the jetties.

XII REAL ESTATE

12.1 Real estate requirements.- Local interests are required to furnish all lands, easements, and rights-of-way required for construction and subsequent maintenance of the proposed improvements. The total estimated cost of the real estate required for this project is $4,245,000. Details of the real estate interests required are given in Appendix A.

XIII RELOCATIONS

13.1 Relocations required.- The improvements proposed in this design memorandum will require relocation of the present U. S. Coast Guard station, portions of the Freeport hurricane-flood protection system, numerous dwellings, aids to navigation, and dredging range towers.

13.1.1 U. S. Coast Guard station.- A new Coast Guard station will be constructed on the west side of the jetty channel opposite the existing station at Surfside as shown on Plate 3. Land for the new station will be provided by the local sponsoring agency. Design and construction of the new station and demolition of the old structure will be accomplished by the U. S. Coast Guard with Federal project funds requested by the Corps of Engineers.

13.1.2 Hurricane-flood protection levee.- Approximately 2,300 linear feet of the Freeport Hurricane-Flood Protection levee will require relocation to allow construction of the 1,200-foot diameter Upper Turning Basin. Cost for levee relocation will be borne totally by non-Federal interests.

13.1.3 Navigation aids.- Relocation of certain U. S. Coast Guard navigational aids and Corps of Engineers dredging range towers will be accomplished at Federal expense.

13.1.4 Houses.- Twenty dwellings and two businesses will be acquired by non-Federal interests to provide adequate right-of-way for relocation of the North Jetty.

13.2 Utilities.- No under channel pipelines or overhead utility lines cross the waterway. Modifications of local drainage structures emptying into the harbor will not be required.

XIV COST ESTIMATE

14.1 General.- The estimated Federal and non-Federal first cost for the plan of improvement in this general design memorandum is $59,248,000 of which $6,757,000 is non-Federal first costs and $52,491,000 is Federal first costs. A detailed cost breakdown of Federal and non-Federal costs for the proposed work based on March 1979 price levels is given in Appendix B. Summary of current estimates of cost by features is as follows:

01.	Lands and Damages	$ 4,245,000
02.3	Relocations	3,581,000
09.	Channels	19,695,000
--	Disposal Levees	1,817,000
10.	Jetties	21,550,000
14.	Public Use Facilities	951,000
--	Navigational Aids	262,000
30.	Engineering and Design	1,786,000
31.	Supervision and Administration	5,361,000
	Total Federal & Non-Federal costs	$59,248,000

14.2 Comparison of costs.- The following tabulation compares the current estimated costs of the improvements considered in this design memorandum with the Phase I GDM estimate (Jan 1978), the most recently approved PB-3 estimate (approved 1 October 1978), and the Project Document estimate (April 1970).

	Item	Project Doc Est.	PB-3 Est.	Phase I GDM Est.	Phase II GDM Est.	Difference GDM Ests.*
01.	Lands & Damages	$ 1,807,000	$ 3,860,000	$ 3,997,000	$ 4,245,000	+ 248
02.	Relocations	1,045,000	2,240,000	2,919,000	3,581,000	+ 662
09.	Channels	6,899,000	22,440,000	16,648,000	19,695,000	+ 3,047
10.	Jetties	4,480,000	9,674,000	15,433,000	21,550,000	+ 6,117
14.	Public Use Facilities	215,000	467,000	669,000	951,000	+ 282
--	Navigational Aids	140,000	299,000	222,000	262,000	+ 40
--	Disposal Levees	493,000	1,053,000	890,000	1,817,000	+ 927
30.	Engineering & Design	422,000	700,000	1,425,000	1,786,000	+ 361
31.	Supervision & Administration	744,000	1,474,000	4,276,000	5,361,000	+ 1,085
	Total	$16,245,000	$42,207,000	$46,479,000	$59,248,000	+12,769

* In thousands.

14.2.1 The PB-3 estimate is the result of cost escalations applied to the Project Document estimate. The Phase II GDM increase in estimated costs of about $12.7 million over the Phase I GDM estimate results primarily from increased channel and jetty construction costs. The increase in cost of channels is attributed solely to escalation of dredging unit prices over the past year while the increase in jetty costs only partially resulted from price escalation. The additional increase results from application of unit prices which were insufficient to reflect the prevailing prices for jetty construction at the time the Phase I GDM estimate was prepared. This is borne out by bids received in 1978 for rehabilitation of the Brazos Island Harbor jetties subsequent to finalizing the Phase I GDM estimate. These bids reflected a much higher rate of escalation for jetty construction than known at the time of preparation of the Phase I GDM estimate. Increases in other items are attributable to reappraisal of lands and escalation of prices.

14.2.2 Comparison of the latest approved PB-3 estimate with the Phase II GDM estimate indicates an increase of about $17 million dollars. The greatest portion, about $12 million, is attributable to increased jetty costs which result from inclusion of costs for rehabilitation of the South Jetty which were not included in the Project Document in addition to increases in unit prices as discussed in the above paragraph. Other significant increases are attributable to relocations, engineering & design, and supervision & administration. An increase of about $1.3 million in costs for relocations results from inclusion of costs for relocating the hurricane-flood protection levee near the new upper turning basin (not included in project document estimate) and removal of abandoned structures. An increase of about $5 million in costs for engineering & design and supervision & administration are the result of additional studies and coordination efforts required to develop the proposed plan and the proportional increase for higher labor costs. A decrease of about $2.7 million in costs of channels results from bend easing dredging near the Brazosport Turning Basin of about 1.5 million cubic yards performed subsequent to preparation of the Project Document estimate.

14.3 Cost apportionment.- Costs for enlargement and realignment of all channels and basins, relocation of the North Jetty and rehabilitation of the South Jetty, relocation of the U. S. Coast Guard station and navigation aids, removal of abandoned structures, and one-half of the costs for public use facilities will be borne by the Federal Government. Costs for all lands, easements and rights-of-way, relocation of a small portion of the Freeport Hurricane-Flood Protection levee, construction of levees and spillways for dredged material disposal areas, one-half of the

public use facilities including the lands required for these facilities, and compensation lands will be borne by non-Federal interests. A breakdown of these presently estimated costs is shown below:

Item	Federal Costs	Non-Federal Costs
Relocations	$ 3,206,000	$ 375,000
Channels	19,695,000	- - -
Jetties	21,550,000	- - -
Public Use Facilities	720,000	231,000
Navigational Aids (U.S. Coast Guard)	262,000	- - -
Lands & Damages	- - -	4,245,000(1)
Disposal Levees	- - -	1,817,000
Engineering & Design	1,697,000	89,000
Supervision & Administration	5,361,000	- - -
TOTAL	$52,491,000	$6,757,000

(1) Includes costs for compensatory lands.

14.4 Estimates of annual charges.- The following is and updated tabulation of estimated annual charges based on an interest rate of 6 7/8% for a project life of 50 years.

Item	Main Channels & Basins	Brazos Harbor Channel
Construction Period	5 yrs	1/2 yr
Investment Costs		
Total First Cost	$57,132,000	$2,116,000
Interest During Construction	9,820,000	- - -
Total Investment	$66,952,000	$2,116,000
Annual Costs		
Interest & Amort.	$ 4,775,000	$ 151,000

Item	Main Channels & Basins	Brazos Harbor Channel
Dredging		
Additional Annual Maintenance		
Ent. & Jetty Channels		
(642,000 cy x $1.85/cy)	$ 1,188,000	- - -
Inside Channels & Basins		
(117,000 cy x $1.30/cy)	$ 152,000	- - -
(6,000 cy x $1.30/cy)	- - - -	$ 8,000
Navigation Aids	$ 16,000	$ 2,000
Levees & Spillways	$ 64,000	$ 3,000
Public Use Facilities	$ 6,000	- - -
Total Annual Costs	$ 6,201,000	$ 164,000

XV BENEFITS

15.1 Benefits.- Average annual navigation benefits in the Phase I GDM have been adjusted to reflect March 1979 prices and a 6 7/8 percent interest rate. For recreation benefits neither the $1.25 unit value per recreation day nor the average annual visitation of 230,000 recreation days were changed. As a result of these adjustments, benefits increased from $31,856,000 to $43,276,000.

15.2 Benefit/Cost Ratio.- Based on average annual benefits of $43,276,000 and a total annual cost of $6,365,000, the B/C ratio is 6.8.

XVI SCHEDULE FOR DESIGN AND CONSTRUCTION

16.1 Schedule for design and construction.- The proposed sequence of design and construction and funds required by fiscal years for the proposed improvements are scheduled as shown below. All construction is planned to be performed by contract.

DESIGN & CONSTRUCTION SCHEDULE

Item	Submit Plans & Specs. (Date)	Advertise for Bids (Date)	Award (Date)	Funds Required By Fiscal Year (Thousands of Dollars) FY80	FY81	FY82	FY83	FY84	FY85	Total
Construction of of Jetties	Sep 79	Nov 79	Feb 80	6,382	7,000	7,000	550			$20,932
Dredging - Main Channels & Basins and Brazos Harbor Channel & Basins	May 81	Jul 81	Oct 81			8,213				8,213
Dredging - Entrance & Jetty Channels	Sep 82	Nov 82	Feb 83				6,000	5,712		11,712
Construction of Public Use Facilities	Dec 81	Feb 82	May 82				720			720
Construction of New Coast Guard Station	Jul 82	Sep 82	Dec 82				1,290	1,290		2,580
Relocation of Hopper Dredge Range Towers	Aug 81	Oct 81	Jan 82			54	18			72
Demolish Old Coast Guard Station	Apr 84	Jun 84	Sep 84						324	324
Engineering & Design				263	263	573	322	263	13	1,697
Supervision				831	831	1,812	1,018	831	38	5,361
Total Funds				7,476	8,094	17,652	9,918	8,096	375	$51,611*

*$618,000 allocated to date.

XVII MAINTENANCE AND OPERATION

17.1 Maintenance and operation.- Maintenance and operation of project channels and jetties, including the jetty walkways which are an integral part of both jetties, will be the responsibility of the Federal Government. Maintenance and operation of terminal facilities, including berthing areas and all public use facilities except the jetty walkways, will be the responsibility of local interest.

17.2 Advance maintenance.- Required overdepth dredging of 2 feet in the entrance channel, jetty channel, and Brazos Harbor Channel and 4 feet in the inside main channels and basins is proposed for advance maintenance. This amount is considered the minimum necessary to insure that the project depths will prevail for a reasonable period after initial dredging and to provide reasonable and economical maintenance dredging intervals of about two years.

XVIII RECOMMENDATIONS

18.1 Recommendations.- It is recommended that the above proposed plan for accomplishing the authorized improvements on the Freeport Harbor Texas, 45-Foot Project be approved as a basis for preparation of contract plans and specifications.

GENERAL DESIGN MEMORANDUM NO. 1
FREEPORT HARBOR, TEXAS
(45-FOOT PROJECT)

U. S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

APPENDIX A
REAL ESTATE REQUIREMENTS

REAL ESTATE REQUIREMENTS
FREEPORT HARBOR, TEXAS
45-FOOT PROJECT

1. Purpose. The purpose of this appendix is to present the following:

a. Location and general description of the land required for the project.

b. The local cooperation requirements.

c. The appropriate minimum interest or estate to be acquired for the various elements of the project.

d. Cost estimated for real estate, relocation assistance and administrative costs for acquisition.

2. Location and General Description. The project plan calls for widening and deepening of the entrance channel and the interharbor channel at Freeport, Texas. Additional land is required along both sides of the existing channel with actual relocation of the centerline of the channel to the northeast. Additional land will be acquired to meet the requirements for public use facilities. The land required along the northeast side of the entrance channel is located within the city limits of Surfside. Numerous weekend and permanent residences are located within this area. The land required along the southwest side of the entrance channel is located within the community of Quintana and is mostly unimproved land except for the facilities of Quintana Marine, Inc. Some additional right-of-way is also required along the western bank of the existing Freeport Harbor Channel. A portion of the newly constructed Hurricane Protection Levee system will also be relocated to allow construction of a turning basin. This area is just east of the new Freeport Harbor and warehousing area. Major privately owned improvements located within the project area consist of both weekend and permanent homes located at Surfside. These homes vary considerably in value, depending on size, age, location and condition. There is a small bait and beverage business located near the jetty at Surfside and another such business located on the Quintana side near the jetty. Publicly owned facilities located within the right-of-way consist of the U. S. Coast Guard Station and the Hurricane Protection levee owned by the Velasco Drainage District. The local sponsor is required to buy a replacement site for the Coast Guard Station. The proposed site for the new station is located on the Quintana side of the channel. The local sponsor is to buy the necessary right-of-way and relocate the Hurricane Protection levee at their expense.

3. Local Cooperation. Requirements for local cooperation are set forth on page 3, paragraph 3 of the main design memorandum. The Brazos River Harbor Navigation District has indicated its intention to act as local sponsor for the project. Prior to initiating a formal request to the local sponsor for acquisition of the necessary real estate interests for this project, a formal contract providing for assurances of local cooperation, as required by the authorizing legislation, will be obtained from the local sponsor and formally approved by a contracting officer of the United States. Financial capability and legal sufficiency, with due consideration of Public Law 91-611, Section 221, will be investigated and determined to meet all regulatory and legal requirements prior to acceptance and approval of this contract. This contract will also provide that the local sponsor shall comply with the pertinent provisions of Public Law 91-646.

4. The estates to be acquired as indicated in the Real Estate Valuation Summary, are the same as contained in Chapter 5, Acquisition, for civil works projects of EP 405-1-2, Change 2, 25 April 1978.

5. Real Estate Valuation Summary.

Lands to be acquired in fee simple

14.6 ac @ $12,000/ac (Jetty ROW)	$ 175,200
3.1 ac @ $10,000/ac (Jetty ROW)	31,000
3.6 ac @ $ 5,500/ac (Coast Guard replacement site)	19,800
4.5 ac @ $15,000/ac (Public use area)	67,500
3.6 ac @ $35,000/ac (Public use area)(Lots)	126,000
6.6 ac @ $ 8,000/ac (Public use area)	52,800
400.0 ac @ $ 2,000/ac (Mitigated Lands)	800,000
Subtotal	$1,272,300
Rounded	$1,270,000

Lands to be acquired in perpetual channel easement

44.5 ac @ $12,000/ac (Channel ROW)	$534,000
18.6 ac @ $10,000/ac (Channel ROW)	186,000
Subtotal	$720,000

Lands to be acquired in perpetual dredge material disposal easement

150.0 ac @ $1,500/ac (Area 2)	$225,000
100.0 ac @ $1,000/ac (Area 3)	100,000
Subtotal	$325,000

Lands to be acquired in temporary dredge material disposal easement	
290 ac @ $1,000/ac (Area 1)	$290,000
110 ac @ $1,500/ac (Area 5)	165,000
5 ac @ $ 0/ac (Surfside Beach)	0
Subtotal	$455,000
Lands to be acquired in perpetual levee easement	
5.2 ac @ $10,000/ac (To Velasco Drainage District)	$ 52,000
Subtotal	$ 52,000
Improvements to be acquired in fee	
19 Dwellings	$456,000
2 Businesses	19,000
1 Mobile home	7,000
Subtotal	$482,000
Relocations Costs (PL 91-646)	
(1) Section 202	
20 Homeowners	$ 4,500
2 Businesses	10,000
(2) Section 203	
7 Homeowners	60,000
(3) Administrative costs	
22 Ownerships	11,000
Subtotal	$85,500
Severance damages	$ 30,000
Subtotal	$ 30,000
Acquisition costs	
80 Ownerships	$ 120,000
Subtotal	$ 120,000
Contingencies (20%)	$ 707,900
Subtotal	$ 707,900
TOTAL	$4,247,400
ROUNDED	$4,245,000

FREEPORT HARBOR, TEXAS
(45-FOOT PROJECT)

GENERAL DESIGN MEMORANDUM NO. 1

APPENDIX B
DETAILED COST ESTIMATES

FREEPORT HARBOR, TEXAS (45-FOOT PROJECT)
PHASE II GDM ESTIMATE

Item	Unit	Quantity	Unit Price	Total Costs	Federal Costs	Non-Federal Costs
MAIN CHANNELS AND BASINS						
Relocations						
U.S. Coast Guard Station	Job	LS		$ 2,150,000	$ 2,150,000	
Removal of Abandoned Coast Guard Station	Job	LS		270,000	270,000	
Removal of Steel Piling	LF	300	$ 74.00	22,200	22,200	
Removal of Timber Piling	LF	900	14.00	12,600	12,600	
Removal of Riprap	Ton	900	10.15	9,135	9,135	
Removal of railroad ties by Excavation	CY	20,800	10.00	208,000	208,000	
Hurricane Flood Protection Levee						
Embankment Fill	CY	23,200	6.10	141,520		$141,520
6" Lime Stabilization Subgrade	SY	2,990	4.00	11,960		$11,960
6" Flexible Base	CY	2,580	40.00	103,200		103,200
Asphaltic Cement	Gal	650	2.00	1,300		1,300
Cover Stone	CY	30	61.00	1,830		1,830
Tack Coat	Gal	435	2.00	870		870
Spot Sod	Ac	2.25	23,000.00	51,750		51,750
Subtotal				$2,984,365	$2,671,935	$312,430
Contingencies (20%+)				596,635	534,065	62,570
Total - Relocations				$3,581,000	$3,206,000	$375,000
Channels						
Dredging, Gulf Entrance Channel						
Project Depth (47')	CY	3,650,000	1.59	$5,803,500	$5,803,500	
Adv. Maint. (2')	CY	730,000	1.59	1,160,700	1,160,700	
Overdepth (2')	CY	720,000	1.59	1,144,800	1,144,800	
Subtotal - Ent. Chanl	CY	5,100,000	1.59	$8,109,000	$8,109,000	

FREEPORT HARBOR, TEXAS (45-FOOT PROJECT)
PHASE II GDM ESTIMATE

Item	Unit	Quantity	Unit Price	Total Costs	Federal Costs	Non-Federal Costs
Dredging, Jetty Channel						
Project Depth (45')	CY	1,032,000	1.17	$1,207,440	$1,207,440	
Adv. Maint (2')	CY	135,000	1.17	157,950	157,950	
Overdepth (2')	CY	133,000	1.17	155,610	155,610	
Subtotal - Jetty Chnl	CY	1,300,000	1.17	$1,521,000	$1,521,000	
Dredging, Main Channels and Basins						
Project Depth (45')	CY	2,144,000	1.65	$3,537,600	$3,537,600	
Adv. Maint (4')	CY	925,000	1.65	1,526,250	1,526,250	
Overdepth (2')	CY	231,000	1.65	381,150	381,150	
Subtotal - Main Chnls	CY	3,300,000	1.65	$5,455,000	$5,445,000	
Mob & Demob (Hopper Dredge)	Job	LS		$ 130,000	$ 130,000	
Mob & Demob (Pipeline Dredge)	Job	LS		139,000	139,000	
Relocation of Hopper Dredge Range Towers	EA	4	$15,000.00	60,000	60,000	
Subtotal - Chnls				$15,404,000	$15,404,000	
Contingencies (20%±)				3,081,000	3,081,000	
Total - Channels				$18,485,000	$18,485,000	
Jetties						
Relocation of North Jetty						
New Cover Stone						
4 - 6 Tons	Tons	1,200	45.00	$ 54,000	$ 54,000	
8 - 10 Tons	Tons	16,900	45.00	760,500	760,500	
10 - 12 Tons	Tons	12,200	45.00	549,000	549,000	
12 - 14 Tons	Tons	7,600	45.00	342,000	342,000	
14 - 16 Tons	Tons	5,400	45.00	243,000	243,000	
16 - 18 Tons	Tons	42,500	45.00	1,912,500	1,912,500	

FREEPORT HARBOR, TEXAS (45-FOOT PROJECT)
PHASE II GDM ESTIMATE

Item	Unit	Quantity	Unit Price	Total Costs	Federal Costs	Non-Federal Costs
New Core Stone						
200 - 1,000 lbs	Tons	4,800	34.00	163,200	163,200	
200 - 2,000 lbs	Tons	20,000	34.00	680,000	680,000	
200 - 4,000 lbs	Tons	91,400	34.00	3,107,600	3,107,600	
New Blanket						
1/2" - 200 lbs	Tons	77,100	33.00	2,544,300	2,544,300	
New Filler Stone						
1/2" - 4"	Tons	20,400	31.00	632,400	632,400	
Stone From Old North Jetty						
2 - 6 Tons	Tons	10,900	18.00	196,200	196,200	
6 - 16 Tons	Tons	16,800	18.00	302,400	302,400	
Core Stone	Tons	45,600	18.00	820,800	820,800	
Break-out Concrete Cap in Old Jetty (for reuse as Core Stone New Jetty)	CY	3,000	60.00	180,000	180,000	
Removal and Disposal of Brush Mats	CY	48,000	11.20	537,600	537,600	
Subtotal				$13,025,500	$13,025,500	
Rehabilitation of South Jetty						
New Cover Stone						
14 - 16 Tons	Tons	1,800	45.00	81,000	81,000	
16 - 18 Tons	Tons	16,300	45.00	733,500	733,500	
New Core Stone						
200 - 2,000 lbs	Tons	11,300	34.00	384,200	384,200	
200 - 4,000 lbs	Tons	11,600	34.00	394,400	394,400	
New Blanket Stone						
1/2" - 200 lbs	Tons	29,300	33.00	966,900	966,900	
New Filler Stone						
1/2" - 4"	Tons	14,000	31.00	434,000	434,000	
Stone From Old North Jetty						
4 - 6 Tons	Tons	2,400	18.00	43,200	43,200	
6 - 16 Tons	Tons	25,900	18.00	466,200	466,200	

FREEPORT HARBOR, TEXAS (45-FOOT PROJECT)
PHASE II GDM ESTIMATE

Item	Unit	Quantity	Unit Price	Total Costs	Federal Costs	Non-Federal Costs
Core Stone	Tons	60,400	18.00	1,087,200	1,087,200	
Pickup and Reset Existing Cover Stone						
6 - 12 Tons	Tons	18,400	15.00	276,000	276,000	
12 - 16 Tons	Tons	4,400	15.00	66,000	66,000	
Subtotal				$ 4,932,600	$ 4,932,600	
Contingencies (20%±)				3,591,900	3,591,900	
Total - Jetties				$21,550,000	$21,550,000	
Public Use Facilities						
Access Roads						
North Jetty	LF	1,660	$ 33.50	$ 55,610	$ 42,100	$ 13,510
South Jetty	LF	2,450	33.50	82,080	62,140	19,940
Parking Area						
North Jetty	SY	4,920	12.50	61,500	46,560	14,940
South Jetty	SY	4,920	12.50	61,500	46,560	14,940
Parking Area Guardposts (Wood, 8" dia.)						
North Jetty	EA	578	42.00	24,280	18,380	5,900
South Jetty	EA	578	42.00	24,280	18,380	5,900
Sanitary Facilities (Waterborne, Masonry Bldg on Concrete Slab)						
North Jetty	EA	1	18,500.00	18,500	14,010	4,490
South Jetty	EA	1	18,500.00	18,500	14,010	4,490
Water Well w/Pressure System						
South Jetty	EA	1	8,600.00	8,600	6,510	2,090
Water Supply Mains, 2" dia.						
North Jetty	LF	300	9.75	2,930	2,220	710
South Jetty	LF	300	9.75	2,930	2,220	710

FREEPORT HARBOR, TEXAS (45-FOOT PROJECT)
PHASE II GDM ESTIMATE

Item	Unit	Quantity	Unit Price	Total Costs	Federal Costs	Non-Federal Costs
Water Service Lines, 1" dia.						
North Jetty	LF	200	3.00	600	450	150
South Jetty	LF	200	3.00	600	450	150
Water Fountains w/Spigot	EA	4	210.00	840	640	200
Refuse Containers	EA	20	120.00	2,400	1,820	580
Bench Seats	EA	20	175.00	3,500	2,650	850
Slope Protection						
Filter Blanket, 18"	Tons	600	21.00	12,600	9,540	3,060
Core Stone, 30"	Tons	1,000	25.00	25,000	18,930	6,070
Electrical Service (Underground)	LF	4,000	12.50	50,000	37,850	12,150
Project Signs	Ea	2	$3,200.00	6,400	4,850	1,550
Outside Lighting (Mercury Vapor, Pole Mounted)	EA	13	1,100.00	14,300	10,830	3,470
Landscaping	Job	Sum		14,000	10,600	3,400
Jetty Walkway (Asphalt, 6" Thick Over Rocks)	LF	6,100	41.70	254,370	192,580	61,790
Jetty Handrails	LF	5,500	8.50	46,750	35,390	11,360
Subtotal				$792,070	$ 599,670	$ 192,400
Contingencies (20%±)				158,930	120,330	38,600
Total - Public Use Facilities				$ 951,000	$ 720,000	$ 231,000
Navigational Aids (U.S. Coast Guard)						
New Range Lights	EA	5	10,100.00	$ 50,500	$ 50,500	
New Minor Lights	EA	7	5,300.00	37,100	37,100	
New Lighted Buoys	EA	7	12,700.00	88,900	88,900	
Relocate Buoys	EA	4	2,800.00	11,200	11,200	
New Passing Lights	EA	2	700.00	1,400	1,400	
Subtotal				$ 189,100	$ 189,100	
Contingencies (15%±)				28,900	28,900	
Total - Navigational Aids				$ 218,000	$218,000	

FREEPORT HARBOR, TEXAS (45-FOOT PROJECT)
PHASE II GDM ESTIMATE

Item	Unit	Quantity	Unit Price	Total Costs	Federal Costs	Non-Federal Costs
Total - Real Estate Costs (Including Contingencies)				$3,897,000		$3,897,000 1/
Levees and Spillways						
Disposal Area Levees	CY	564,000	1.80	1,015,200		1,015,200
Spillways	EA	3	25,000.00	75,000		75,000
Ditches	CY	31,000	5.00	155,000		155,000
Culverts	LF	240	42.50	10,200		10,200
Subtotal				$1,255,400		$1,255,400
Contingencies (20%+)				250,600		250,600
Total - Levees and Spillways				$1,506,000		$1,506,000
Total - Engineering and Design				$1,736,000	$1,657,000	$ 79,000
Total - Supervision and Administration				$5,208,000	5,208,000	
TOTAL - MAIN CHANNELS AND BASINS				$57,132,000	$51,044,000	$6,088,000
BRAZOS HARBOR CHANNEL						
Channels						
Dredging, Brazos Harbor Channel						
Project Depth (36')	CY	577,000	1.20	692,400	692,400	
Adv. Maint. (4')	CY	193,000	1.20	231,600	231,600	
Overdepth (1')	CY	70,000	1.20	84,000	84,000	
Subtotal	CY	840,000	1.20	$1,008,000	$1,008,000	
Contingencies (20%+)				202,000	202,000	
Total - Channels				$1,210,000	$1,210,000	
Navigational Aids (U.S. Coast Guard)						
New Range Lights	EA	2	10,100.00	20,200	20,200	
New Minor Lights	EA	1	5,300.00	5,300	5,300	
New Lighted Buoy	EA	1	12,700.00	12,700	12,700	
Subtotal				$ 38,200	$ 38,200	
Contingencies (15%+)				5,800	5,800	
Total - Navigational Aids				$ 44,000	$ 44,000	

1/ See Real Estate Par. 12

FREEPORT HARBOR, TEXAS (45-FOOT PROJECT)
PHASE II GDM ESTIMATE

Item	Unit	Quantity	Unit Price	Total Costs	Federal Costs	Non-Federal Costs
Lands and Damages						
Total - Real Estate Costs (Including Contingencies)				$348,000		$348,000
Levees and Spillways						
Disposal Area Levees	CY	130,000	1.80	234,000		234,000
Spillways	EA	1	25,000.00	25,000		25,000
Subtotal				$259,000		$259,000
Contingencies (20%+)				52,000		52,000
Total - Levees and Spillways				$311,000		$311,000
Total - Engineering and Design				50,000	40,000	10,000
Total - Supervision and Administration				153,000	153,000	
TOTAL - BRAZOS HARBOR CHANNEL				$2,116,000	$1,447,000	$669,000

1/ See Real Estate Par. 12

FREEPORT HARBOR, TEXAS
(45-FOOT PROJECT)

GENERAL DESIGN MEMORANDUM NO. 1

APPENDIX C
EXHIBITS

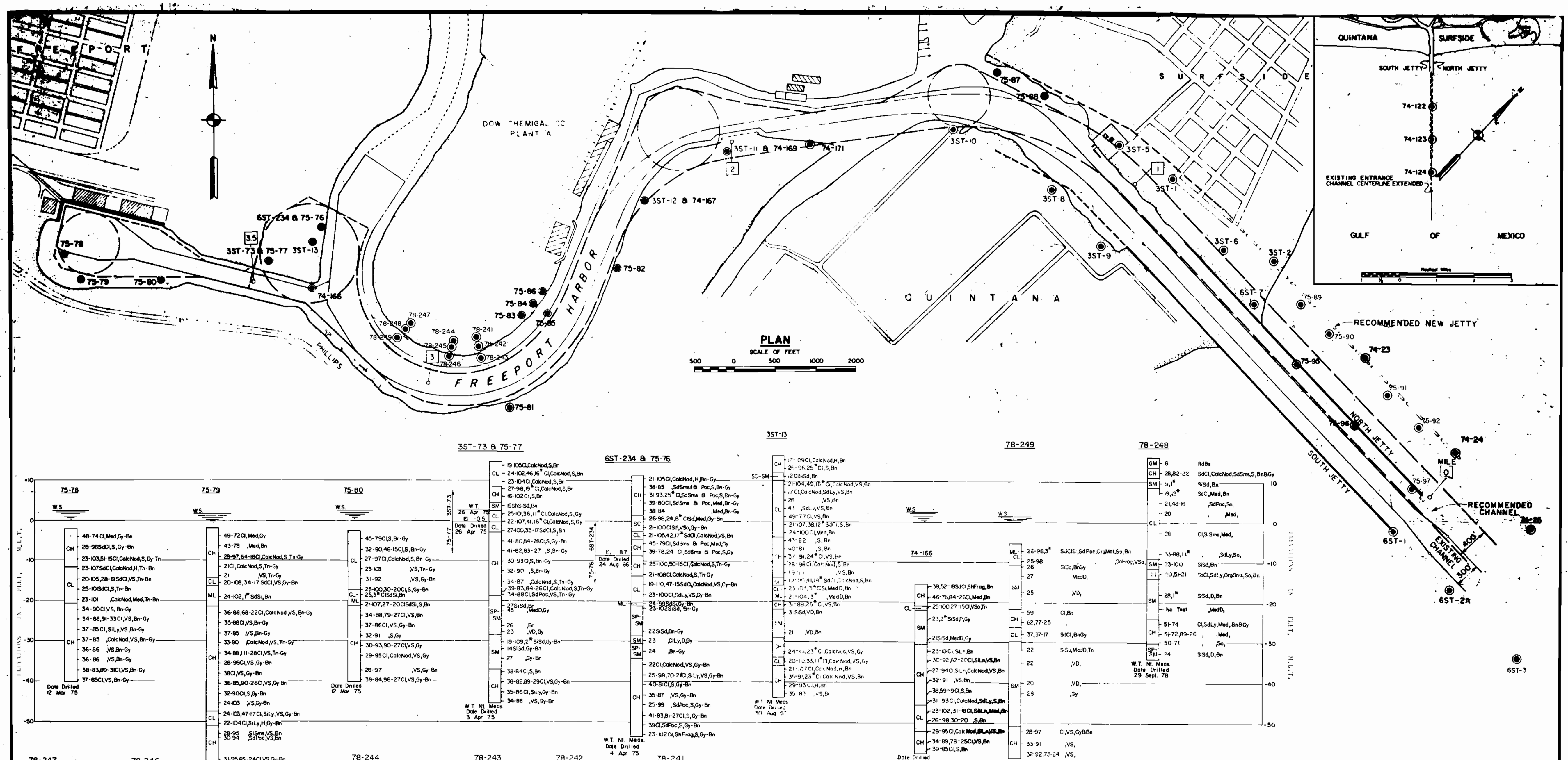
FREEPORT HARBOR, TEXAS
(45-FOOT PROJECT)

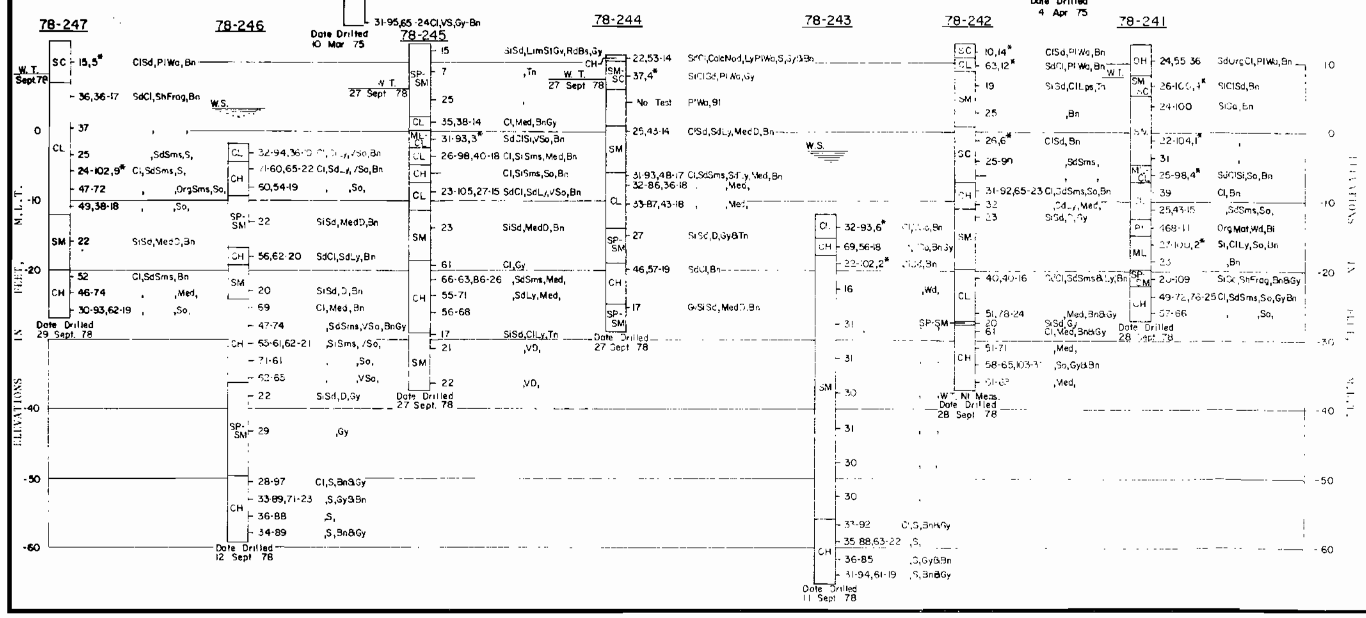
GENERAL DESIGN MEMORANDUM NO. 1

APPENDIX C

EXHIBITS

TABLE OF CONTENTS





NOTES:

1. SOILS HAVE BEEN CLASSIFIED IN ACCORDANCE WITH MILITARY STANDARD 619B "UNIFIED SOIL CLASSIFICATION SYSTEM FOR ROADS, AIRFIELDS, EMBANKMENTS AND FOUNDATIONS." CONSISTENCY OF SOILS SUCH AS SOFT, MEDIUM, HARD, LOOSE, DENSE, ETC., ARE RELATIVE TERMS BASED ON ESTIMATED UNDISTURBED SHEAR STRENGTH OF THE MATERIAL AS DETERMINED BY VISUAL CLASSIFICATION, POCKET PENETROMETER TESTS AND PENETRATION RESISTANCE DURING SAMPLING.

2. FIGURES TO THE RIGHT OF BORING LOGS ARE WATER CONTENTS IN PERCENT OF THE DRY WEIGHT, DRY DENSITY, LIQUID LIMIT, PLASTIC LIMIT, AND BAR LINEAR SHRINKAGE (MC-UDWT), (LL-PL), (B.L.S.)*

VISUAL CLASSIFICATION

Ba	Balls	H	Hard	Rd	Road		
Bin	Binder	L	Loose	Rt	Roots		
Bn	Brown or Brownish	Ln	Lense or Lenses	Re	Red		
Bs	Base	Lps	Lumps				
		Ly	Layer or Layers	S	Stiff		
Calc	Calcareous	Lim	Lime	Sd	Sand or Sandy		
Cem	Cement or Cemented			Sh	Shell or Shelly		
Cl	Clay or Clayey	Meas	Measured	Si	Silt or Silty		
		Mat	Material	Sms	Seam or Seams		
D	Dense	Med	Medium	So	Soft		
				St	Stone		
Frag	Fragments	Nod	Nodules				
		Nt	Not	Tn	Tan		
Gra	Grass			Tr	Trace		
Gy	Gravel or Gravelly	Org	Organic				
Gy	Gray or Gravish						
		Pl	Plant				
		Poc	Pocket or Pockets				

LABORATORY CLASSIFICATION

GM Silty Gravels, Gravel-Sand-Silt Mixture.

SP Poorly-Graded Sands or Gravelly Sands, Little or No Fines.

SM Silty Sands, Sand-Silt Mixtures.

SC Clayey Sands, Sand-Silt Mixtures.

ML Inorganic Silts and Very Fine Sands, with Slighty Plasticity

CL Inorganic Clays of Low to Medium Plasticity, Lean Clays.

CH Inorganic Clays of High Plasticity, Fat Clays.

OH Organic Clays of Medium to High Plasticity, Organic Silts.

Pt Peat and Other Highly Organic Soils.

REVISION	DATE		BY

OFFICE OF THE DISTRICT ENGINEER
U. S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

DRAWN BY:
TRACED BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:

FREEPORT HARBOR, TEXAS
(45-FOOT PROJECT)

LOCATIONS AND LOGS OF BORINGS

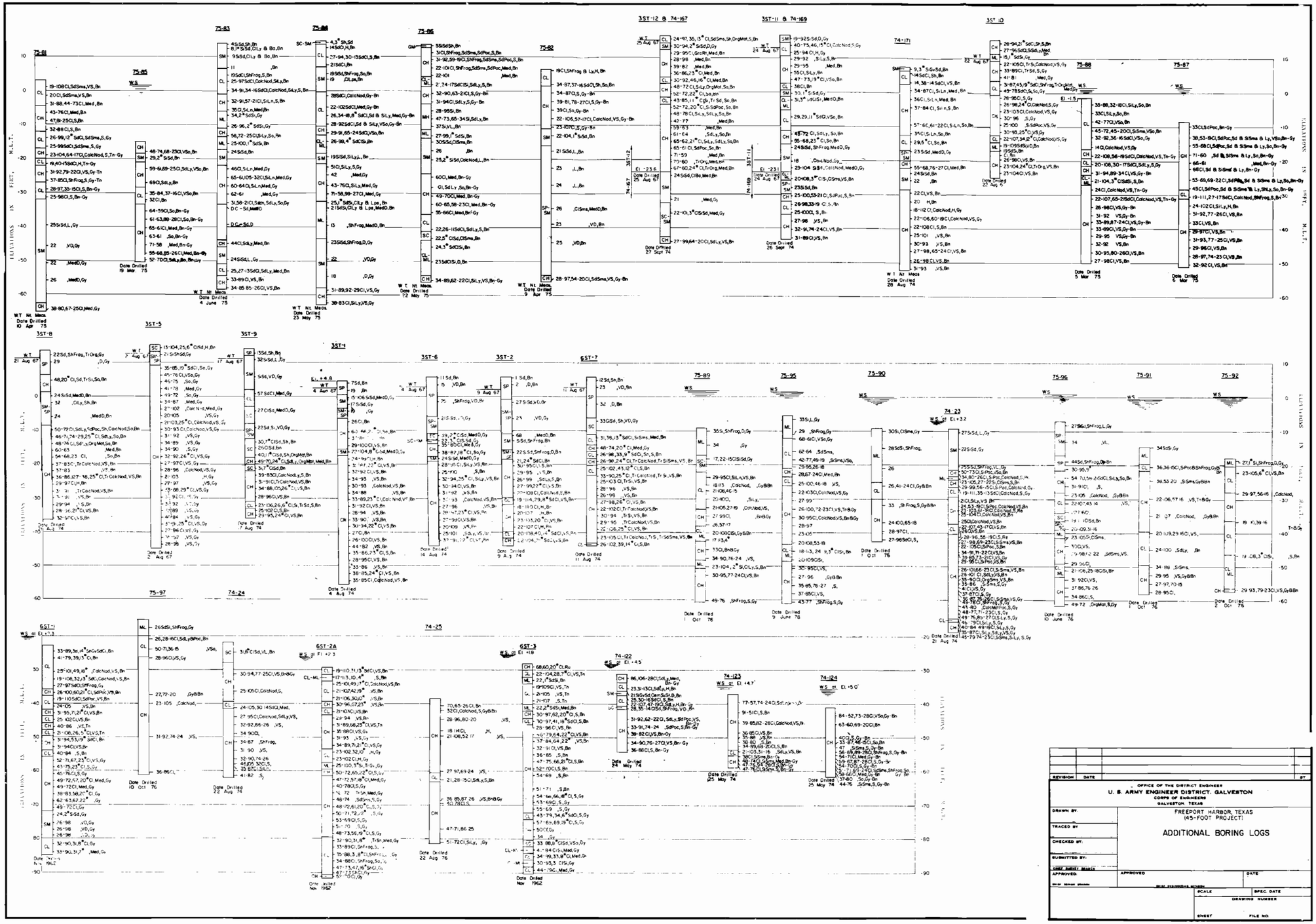
APPROVED: DATE:

SCALE: SPEC. DATE

DRAWING NUMBER

SHEET FILE NO.

EXHIBIT 1



REVISION	DATE	BY

OFFICE OF THE DISTRICT ENGINEER
U. S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

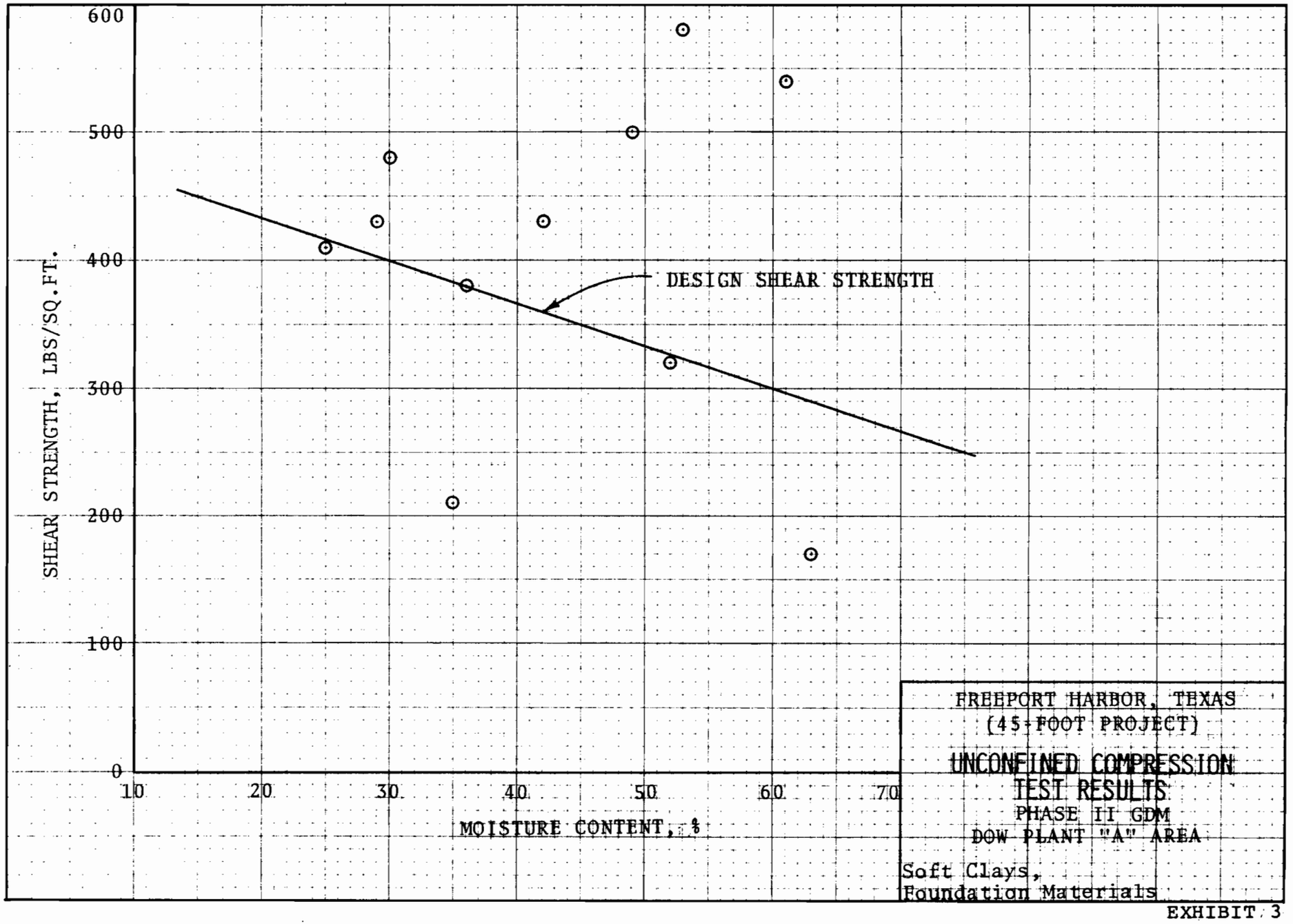
DRAWN BY:
TRACED BY:
CHECKED BY:
SUBMITTED BY:
LIMIT SHEET MARKS
APPROVED:
APPROVED
DATE:

FREEPORT HARBOR, TEXAS
(45-FOOT PROJECT)

ADDITIONAL BORING LOGS

SCALE
SPEC. DATE
DRAWING NUMBER
SHEET
FILE NO.

EXHIBIT 2



FREEPORT HARBOR, TEXAS
(45-FOOT PROJECT)

UNCONFINED COMPRESSION
TEST RESULTS
PHASE II GDM
DOW PLANT "A" AREA

Soft Clays,
Foundation Materials

EXHIBIT 3

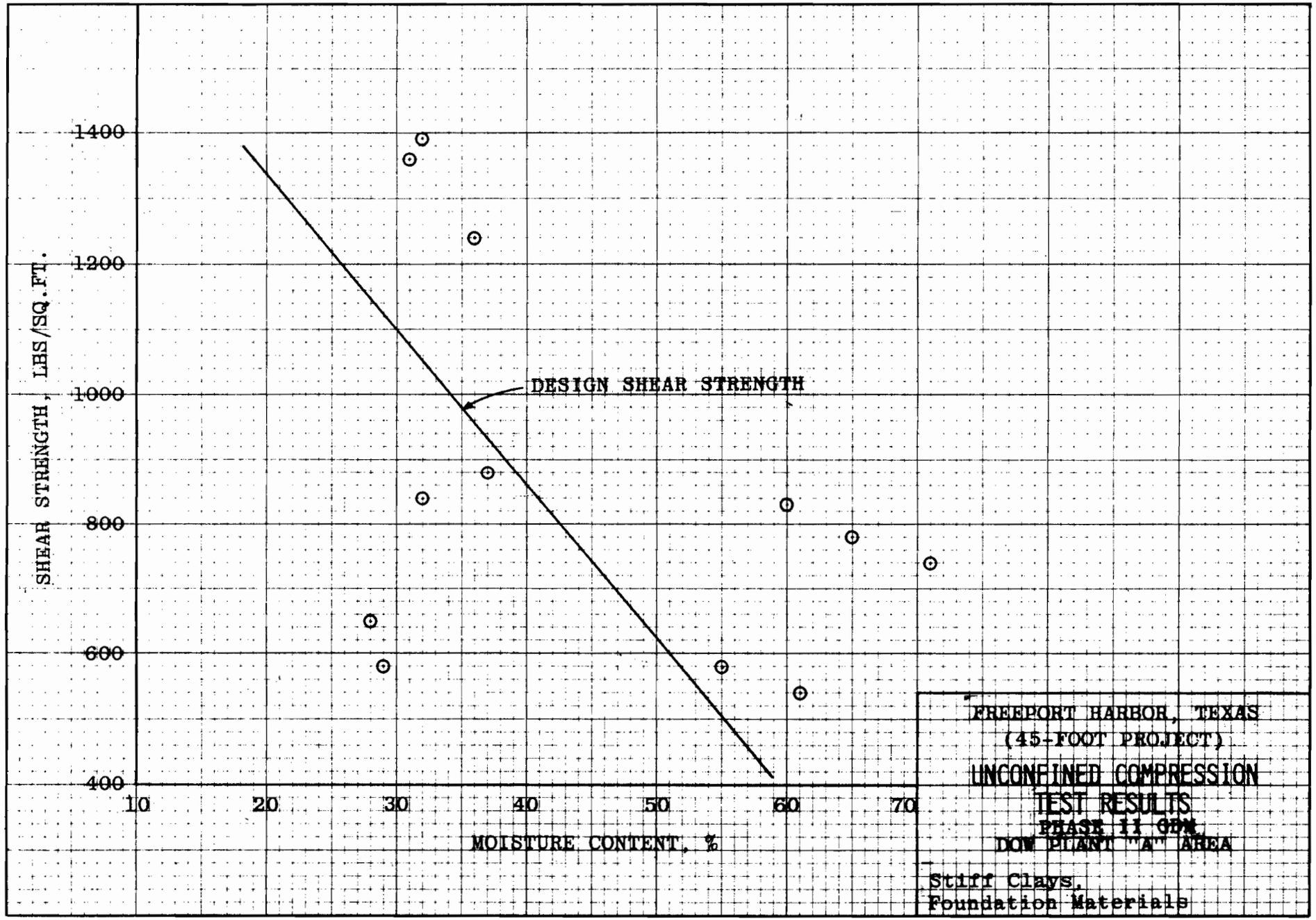

SHEAR STRENGTH, LBS/SQ.FT.
1400
1200
1000
800
600
400
DESIGN SHEAR STRENGTH
10
20
30
40
50
60
70
MOISTURE CONTENT, %
FREEPORT HARBOR, TEXAS
(45-FOOT PROJECT)
UNCONFINED COMPRESSION
TEST RESULTS
PHASE II CDM
DOW PLANT "A" AREA
Stiff Clays,
Foundation Materials

EXHIBIT 4

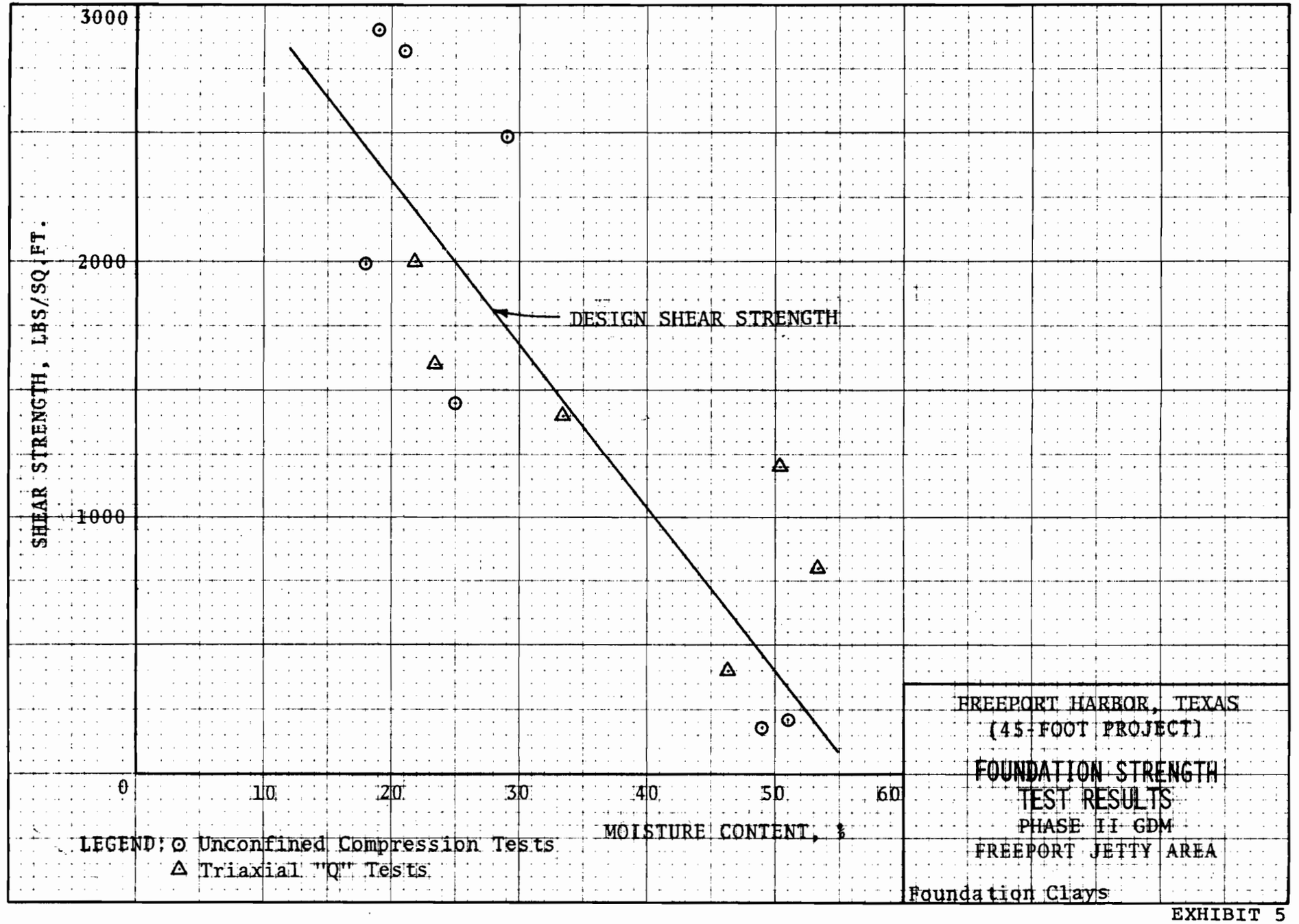
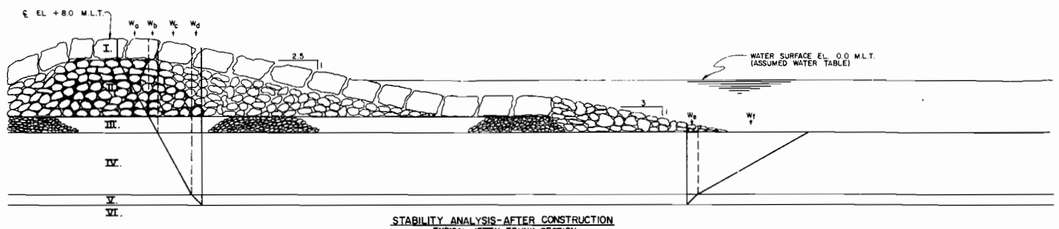
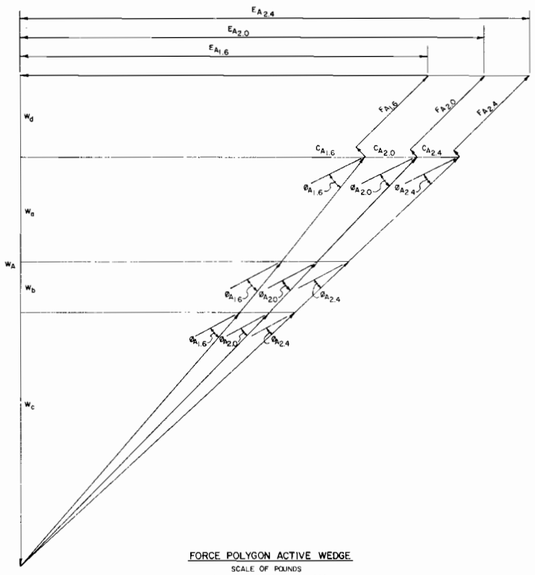

3000
2000
1000
0
10
20
30
40
50
60
SHEAR STRENGTH, LBS/SQ.FT.
DESIGN SHEAR STRENGTH
MOISTURE CONTENT, %
LEGEND: ⊙ Unconfined Compression Tests
△ Triaxial "Q" Tests
FREEPORT HARBOR, TEXAS
(45-FOOT PROJECT)
FOUNDATION STRENGTH
TEST RESULTS
PHASE II GDM
FREEPORT JETTY AREA
Foundation Clays

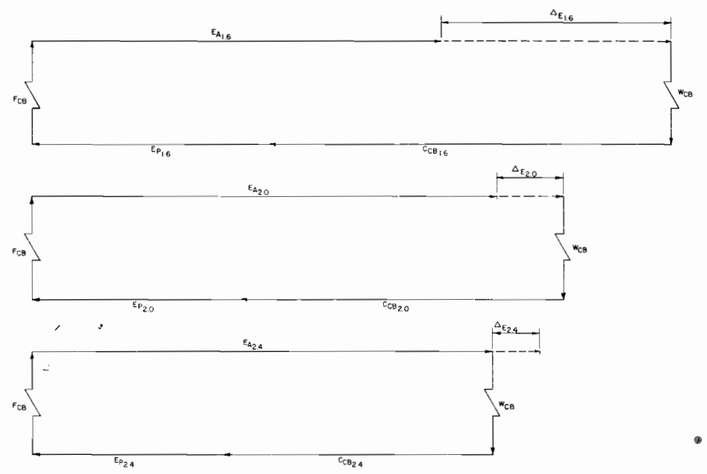
EXHIBIT 5

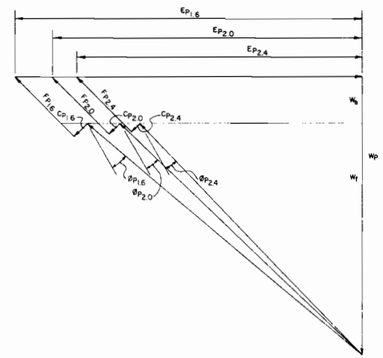
SOIL	CLASSIFICATION	MOISTURE CONTENT	γ_t (PCF)	SHEAR STRENGTH	
				Ø	C (PSF)
I	COVER STONE	–	135	0	0
II	CORE & FILLER STONE	–	140	37	0
III	BLANKET STONE	–	130	33	0
IV	SILTY SAND	30	125	30	0
V	SOFT CLAY	50	110	0	400
VI	STIFF CLAY	22	125	0	2200



STABILITY ANALYSIS-AFTER CONSTRUCTION
TYPICAL JETTY TRUNK SECTION
SCALE OF FEET
10 0 10 20 30







FORCE POLYGON ACTIVE WEDGE
SCALE OF POUNDS
3000 0 3000 6000 9000

FORCE POLYGON CENTRAL BLOCK
SCALE OF POUNDS
3000 0 3000 6000 9000

FORCE POLYGON PASSIVE WEDGE
SCALE OF POUNDS
2000 0 2000 4000 6000

ACTIVE WEDGE FORCES FOR THREE ASSUMED SAFETY FACTORS, POUNDS

ACTIVE WEDGE WEIGHT		SAFETY FACTORS	COHESION	Ø D W_a	Ø D W_b	Ø D W_c	ACTIVE FORCE
W_a = 6028	28451	1.6	707.5	25°-13'	22°-05'	9°-50'	21400
W_b = 2943		2.0	566.0	20°-39'	17°-58'	6°-06'	26700
W_c = 14728		2.4	472.0	17°-25'	15°-08'	3°-31'	29250
W_d = 4752							

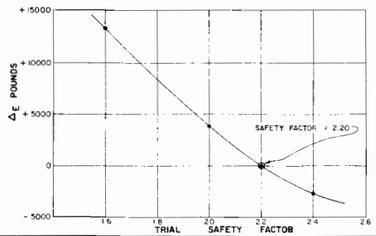
CENTRAL BLOCK FORCES FOR THREE ASSUMED SAFETY FACTORS, POUNDS

SAFETY FACTORS	COHESION	PASSIVE FORCE	ACTIVE FORCE	CENTRAL BLOCK WEIGHT	FRICTIONAL FORCE	Δ_E
1.6	23250	13400	(-) 23400	*	*	+ 13250
2.0	18600	11950	(-) 26700	*	*	+ 3850
2.4	16500	11000	(-) 29250	*	*	– 2750

* NOTE: CENTRAL BLOCK WEIGHT AND FRICTIONAL FORCE ON CENTRAL BLOCK ARE VERTICAL, EQUAL, OPPOSITE, AND HAVE NO BEARING ON DETERMINATION OF Δ_E.

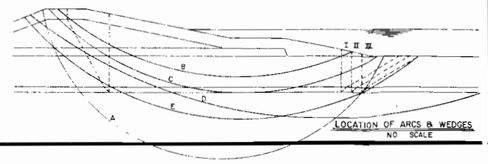
PASSIVE WEDGE FORCES FOR THREE ASSUMED SAFETY FACTORS, POUNDS

PASSIVE WEDGE		SAFETY FACTORS	COHESION	Φ_D	PASSIVE FORCE
W_e = 1797	10723	1.6	707.5	19°50'	13400
W_f = 8926		2.0	566.0	16°06'	11950
		2.4	472.0	13°31'	11000



SAFETY FACTORS FOR VARIOUS POSITIONS OF PASSIVE WEDGE AND VARIOUS SLIDING CIRCLES	
PASSIVE WEDGE POSITION	SAFETY FACTORS
I	2.21
II*	2.20
III	2.22
CIRCLE NO.	
A	6.52
B	3.16
C	2.54
D	8.18
E	6.05

* NOTE: GRAPHICAL SOLUTION OF STABILITY ANALYSIS WITH PASSIVE WEDGE AT POSITION II SHOWN ABOVE.



LOCATION OF ARCS & WEDGES
NO SCALE

REVISION	DATE	BY

OFFICE OF THE DISTRICT ENGINEER
U. S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

DRAWN BY:
TRACED BY:
CHECKED BY:
SUBMITTED BY:
CHIEF SURVEY BRANCH
APPROVED:
CHIEF, ENGR. DIVISION

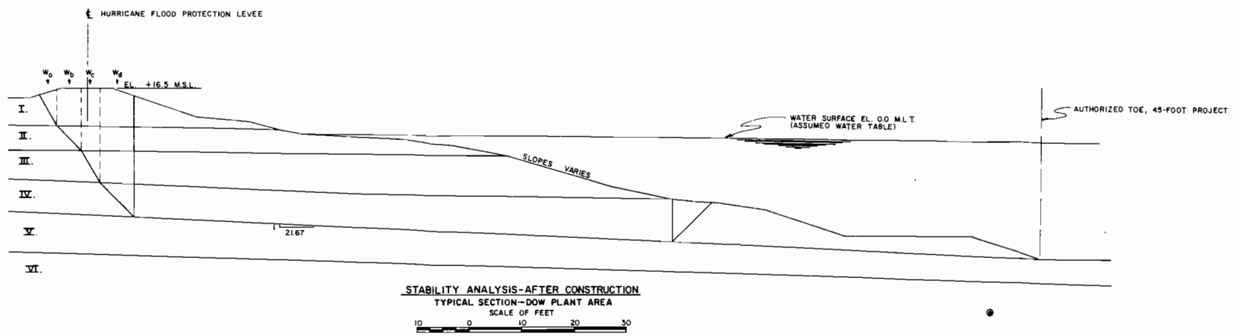
FREEPORT HARBOR, TEXAS
(45-FOOT PROJECT)

STABILITY ANALYSIS
TYPICAL JETTY SECTION

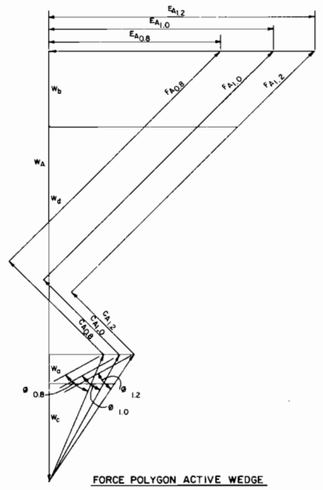
APPROVED DATE
SCALE SPEC. DATE
DRAWING NUMBER
SHEET FILE NO

EXHIBIT 6

SOIL	CLASSIFICATION	MOISTURE CONTENT	γ_s (PCF)	SHEAR STRENGTH	
				Ø	C (PSF)
I	SILTY SAND	20	120	32	0
II	STIFF CLAY	30	125	0	1100
III	SILTY SAND	24	125	32	0
IV	SOFT CLAY	60	105	0	300
V	SILTY SAND	20	125	32	0
VI	STIFF CLAY	34	125	0	1000

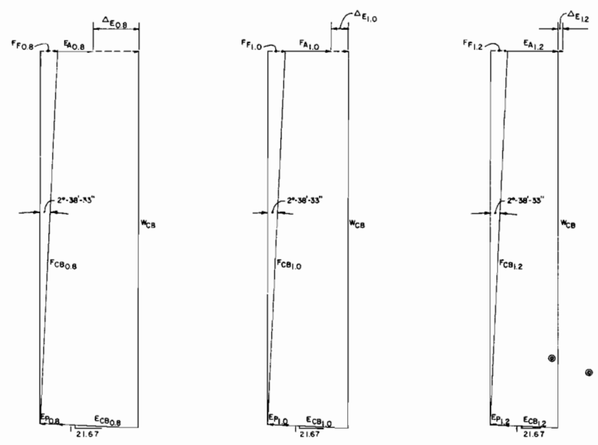


STABILITY ANALYSIS-AFTER CONSTRUCTION
TYPICAL SECTION-DOW PLANT AREA
SCALE OF FEET
10 0 10 20 30



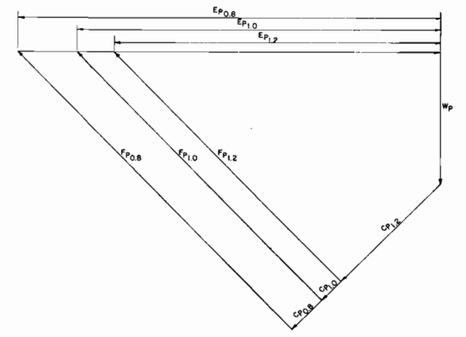
FORCE POLYGON ACTIVE WEDGE

SCALE OF POUNDS
1000 0 1000 2000 3000



FORCE POLYGON CENTRAL BLOCK

SCALE OF POUNDS
5000 0 5000 10000 15000

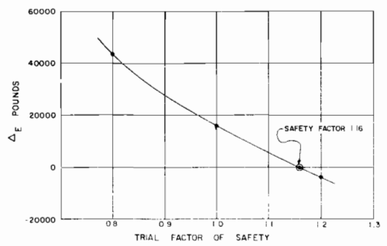


FORCE POLYGON PASSIVE WEDGE

SCALE OF POUNDS
2000 0 2000 4000 6000

ACTIVE WEDGE FORCES FOR THREE ASSUMED SAFETY FACTORS, POUNDS

ACTIVE WEDGE WEIGHT	SAFETY FACTORS	COHESION	$\frac{\Phi_D}{W_B \& W_C}$	ACTIVE FORCE
W_a = 5548 W_b = 14240 W_c = 18643 W_d = 44375 — 83006	0.8	25575	38°	33000
	1.0	20460	32°	43300
	1.2	17050	27°-30'	51000



CENTRAL BLOCK FORCES FOR THREE ASSUMED SAFETY FACTORS, POUNDS

SAFETY FACTORS	COHESION	PASSIVE FORCE	ACTIVE FORCE	CENTRAL BLOCK WEIGHT	FRICTIONAL FORCE	Δ_E
0.8	77168	16500	(-)33000	364125	(-)16641	43827
1.0	61734	14100	(-)43300	364125	(-)16674	15860
1.2	51445	12600	(-)51000	364125	(-)16696	- 3651

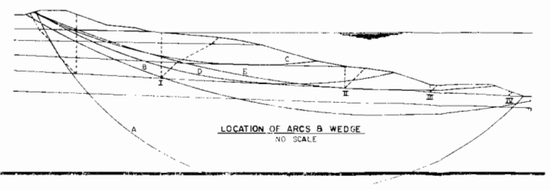
PASSIVE WEDGE FORCES FOR THREE ASSUMED SAFETY FACTORS, POUNDS

PASSIVE WEDGE WEIGHT	SAFETY FACTORS	COHESION	PASSIVE FORCE
5074	0.8	7950	16300
	1.0	6360	14100
	1.2	5300	12600

SAFETY FACTORS FOR VARIOUS POSITIONS OF PASSIVE WEDGE AND VARIOUS SLIDING CIRCLES

PASSIVE WEDGE POSITION	SAFETY FACTORS
I	1.51
II*	1.16
III	1.22
IV	1.33
CIRCLE NO.	
A	1.61
B	2.82
C	3.15
D	2.00
E	2.66

* NOTE: GRAPHICAL SOLUTION OF STABILITY ANALYSIS WITH PASSIVE WEDGE AT POSITION II SHOWN ABOVE.

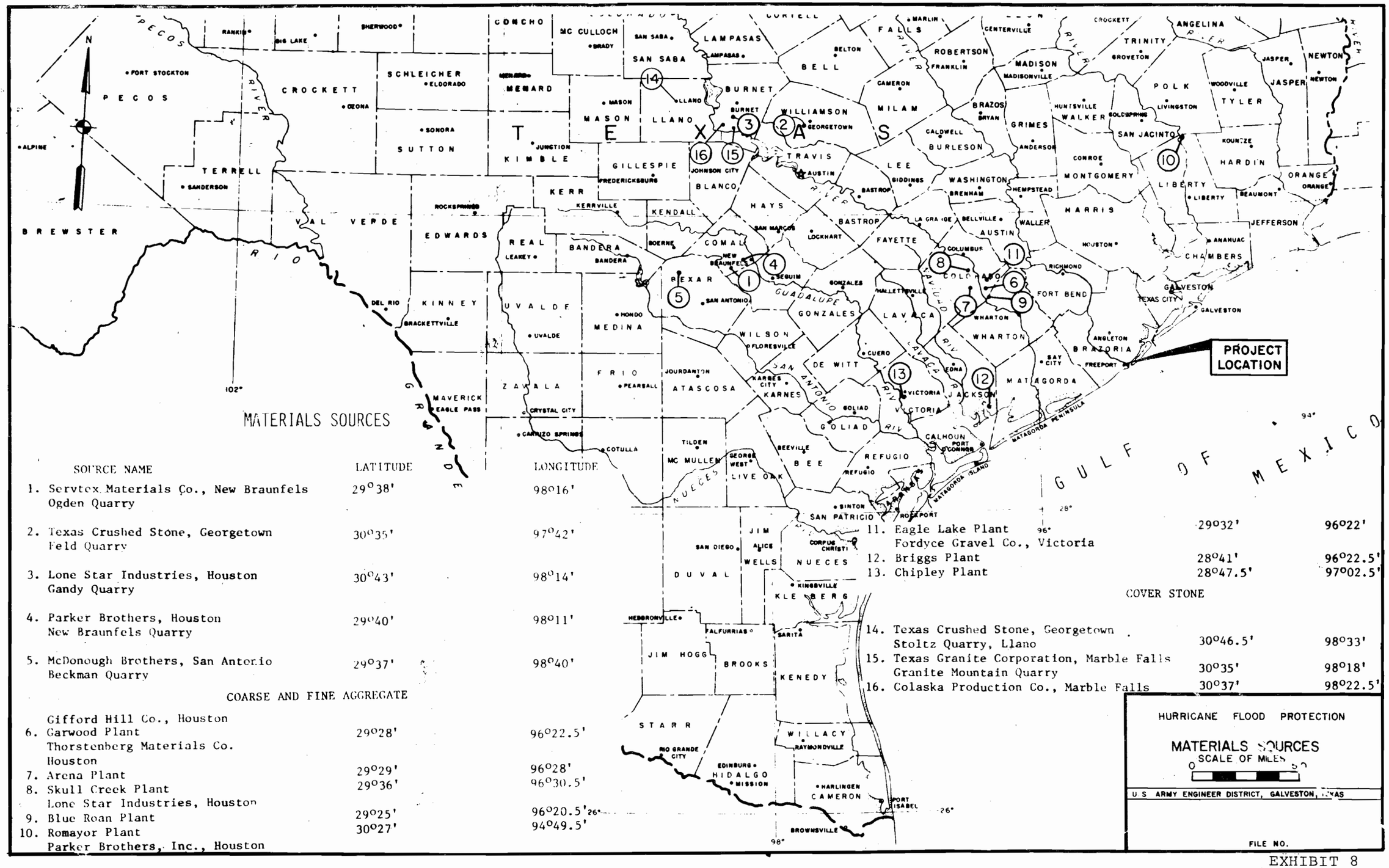


LOCATION OF ARCS & WEDGE
NO SCALE

REVISION	DATE		BY

OFFICE OF THE DISTRICT ENGINEER
U. S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

DRAWN BY:	FREEPORT HARBOR, TEXAS (45-FOOT PROJECT)
TRACED BY:	STABILITY ANALYSIS TYPICAL CHANNEL SECTION
CHECKED BY:	
SUBMITTED BY:	
CHIEF SURVEY BRANCH APPROVED:	APPROVED / DATE
CHIEF ENGR. BRANCH	CHIEF ENGINEERING DIVISION
	SCALE / SPEC DATE
	DRAWING NUMBER
	SHEET / FILE NO.



MATERIALS SOURCES

	SOURCE NAME	LATITUDE	LONGITUDE
1.	Servtex Materials Co., New Braunfels Ogden Quarry	29°38'	98°16'
2.	Texas Crushed Stone, Georgetown Feld Quarry	30°35'	97°42'
3.	Lone Star Industries, Houston Gandy Quarry	30°43'	98°14'
4.	Parker Brothers, Houston New Braunfels Quarry	29°40'	98°11'
5.	McDonough Brothers, San Antonio Beckman Quarry	29°37'	98°40'
	COARSE AND FINE AGGREGATE		
	Gifford Hill Co., Houston		
6.	Garwood Plant	29°28'	96°22.5'
	Thorstenberg Materials Co. Houston		
7.	Arena Plant	29°29'	96°28'
8.	Skull Creek Plant	29°36'	96°30.5'
	Lone Star Industries, Houston		
9.	Blue Roan Plant	29°25'	96°20.5'
10.	Romayor Plant	30°27'	94°49.5'
	Parker Brothers, Inc., Houston		
11.	Eagle Lake Plant Fordyce Gravel Co., Victoria	29°32'	96°22'
12.	Briggs Plant	28°41'	96°22.5'
13.	Chipley Plant	28°47.5'	97°02.5'
	COVER STONE		
14.	Texas Crushed Stone, Georgetown Stoltz Quarry, Llano	30°46.5'	98°33'
15.	Texas Granite Corporation, Marble Falls Granite Mountain Quarry	30°35'	98°18'
16.	Colaska Production Co., Marble Falls	30°37'	98°22.5'

HURRICANE FLOOD PROTECTION

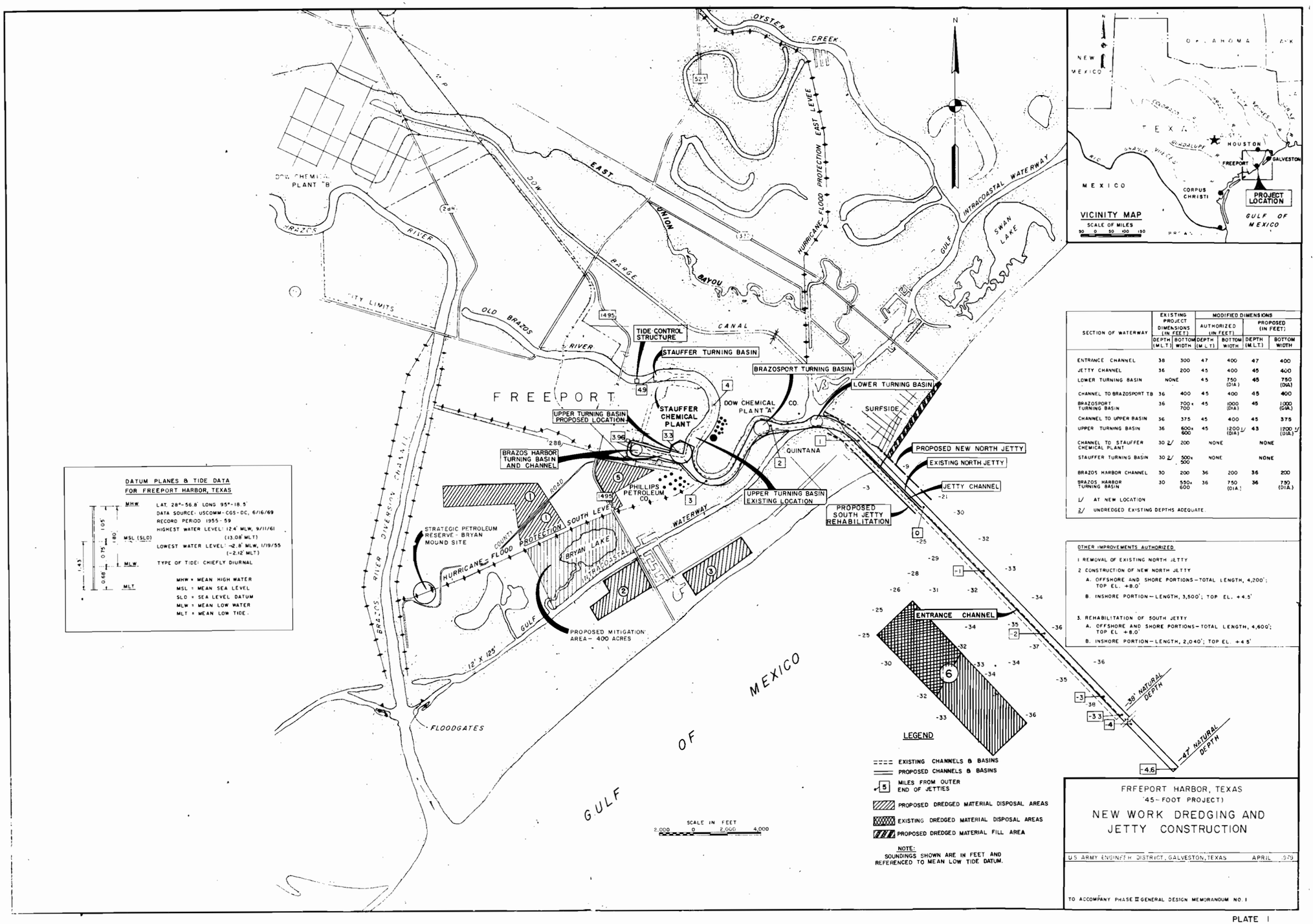
MATERIALS SOURCES

SCALE OF MILES 0 50

U S ARMY ENGINEER DISTRICT, GALVESTON, TEXAS

FILE NO.

EXHIBIT 8



VICINITY MAP

SCALE OF MILES
50 0 50 100 150

DATUM PLANES & TIDE DATA FOR FREEPORT HARBOR, TEXAS

LAT. 28°-56.8' LONG. 95°-18.5'
DATA SOURCE: USCOMM-CGS-DC, 6/16/69
RECORD PERIOD 1955-59
HIGHEST WATER LEVEL: 12.4' MLW, 9/11/61 (13.08' MLT)
LOWEST WATER LEVEL: -2.8' MLW, 1/19/55 (-2.12' MLT)
TYPE OF TIDE: CHIEFLY DIURNAL

MHW = MEAN HIGH WATER
MSL = MEAN SEA LEVEL
SLD = SEA LEVEL DATUM
MLW = MEAN LOW WATER
MLT = MEAN LOW TIDE.

SECTION OF WATERWAY	EXISTING PROJECT DIMENSIONS (IN FEET)		MODIFIED DIMENSIONS AUTHORIZED (IN FEET)		PROPOSED (IN FEET)	
	DEPTH (M.L.T.)	BOTTOM WIDTH	DEPTH (M.L.T.)	BOTTOM WIDTH	DEPTH (M.L.T.)	BOTTOM WIDTH
ENTRANCE CHANNEL	38	300	47	400	47	400
JETTY CHANNEL	36	200	45	400	45	400
LOWER TURNING BASIN	NONE		45	750 (DIA.)	45	750 (DIA.)
CHANNEL TO BRAZOSPORT TB	36	400	45	400	45	400
BRAZOSPORT TURNING BASIN	36	700 x 700	45	1000 (DIA.)	45	1000 (DIA.)
CHANNEL TO UPPER BASIN	36	375	45	400	45	375
UPPER TURNING BASIN	36	600 x 600	45	1200 1/ (DIA.)	43	1200 1/ (DIA.)
CHANNEL TO STAUFFER CHEMICAL PLANT	30 2/	200	NONE		NONE	
STAUFFER TURNING BASIN	30 2/	500 x 500	NONE		NONE	
BRAZOS HARBOR CHANNEL	30	200	36	200	36	200
BRAZOS HARBOR TURNING BASIN	30	550 x 600	36	750 (DIA.)	36	750 (DIA.)

1/ AT NEW LOCATION
2/ UNDREDGED EXISTING DEPTHS ADEQUATE.

OTHER IMPROVEMENTS AUTHORIZED

1 REMOVAL OF EXISTING NORTH JETTY
2 CONSTRUCTION OF NEW NORTH JETTY
A. OFFSHORE AND SHORE PORTIONS - TOTAL LENGTH, 4,200'; TOP EL. +8.0'
B. INSHORE PORTION - LENGTH, 3,500'; TOP EL. +4.5'
3. REHABILITATION OF SOUTH JETTY
A. OFFSHORE AND SHORE PORTIONS - TOTAL LENGTH, 4,600'; TOP EL. +8.0'
B. INSHORE PORTION - LENGTH, 2,040'; TOP EL. +4.5'

LEGEND

- EXISTING CHANNELS & BASINS
- PROPOSED CHANNELS & BASINS
- 5 MILES FROM OUTER END OF JETTIES
- PROPOSED DREDGED MATERIAL DISPOSAL AREAS
- EXISTING DREDGED MATERIAL DISPOSAL AREAS
- PROPOSED DREDGED MATERIAL FILL AREA

NOTE:
SOUNDINGS SHOWN ARE IN FEET AND REFERENCED TO MEAN LOW TIDE DATUM.

FREEPORT HARBOR, TEXAS
(45-FOOT PROJECT)
NEW WORK DREDGING AND JETTY CONSTRUCTION

U.S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS — APRIL 1979

TO ACCOMPANY PHASE II GENERAL DESIGN MEMORANDUM NO. 1

PLATE 1

SURFSIDE

QUINTANA

FOR INSHORE CHANNELS SEE PLATE 3

PROPOSED NEW NORTH JETTY

SOUTH JETTY

EXISTING -38' X 300'

ONE NAUTICAL MILE (6,080')

MINIMUM DISTANCE TO PROPOSED CHANNEL - 3,000 FEET

EXISTING OFFSHORE DISPOSAL AREA

ADDITIONAL OFFSHORE DISPOSAL AREA

10,000'

3,000'

MEXICO

OF

GULF

AUTHORIZED -47' X 400' & REALIGNMENT

PROPOSED -47' X 400' & REALIGNMENT

0

-1

-2

-3

-3.3

-4

-4.6

MI. 0.65

EXISTING SOUTH JETTY +8'

PROPOSED REHABILITATION

EXISTING JETTY ENCASE

EXISTING NORTH JETTY

PROPOSED NEW NORTH JETTY +8'

PROPOSED ROW LIMIT

NEW JETTY CHANNEL

560'

320'

-36'

APPROX MAX DEPTH OF PRIOR DREDGING

2' ADV MAINT.

-45'

-47'

200'

400'

MI. 0

OUTER END OF EXISTING JETTIES

JUNCTION OF NEW JETTY CHANNEL AND NEW ENTRANCE CHANNEL

2' ADV. MAINT.

400'

MI. - 2.1

320'

300'

APPROX. MA DEPTH OF PRIOR DREDGING

NEW ENTRANCE CHANNEL

OUTER END OF EXISTING 38' x 300' SEA BAR CHANNEL

MI. - 3.3

NEW ENTRANCE CHANNEL

MI - 4.6

OUTER END OF NEW ENTRANCE CHANNEL

LEGEND

EXISTING CHANNELS & BASINS

PROPOSED CHANNELS & BASINS

-3 MILES FROM OUTER END OF JETTIES

1:3 TYPICAL CROSS SECTION

EXISTING NAVIGATION AID

NEW OR RELOCATED NAVIGATION AID

FREEPORT HARBOR, TEXAS
(41 FOOT PROJECT)

EXISTING PROJECT AND PROPOSED MODIFICATIONS

SCALE OF FEET

OUTER CHANNEL ENTRANCE TO FREEPORT, TEXAS APRIL 1979

TO ACCOMPANY PHASE II GENERAL DESIGN MEMORANDUM NO.1

PLATE 2

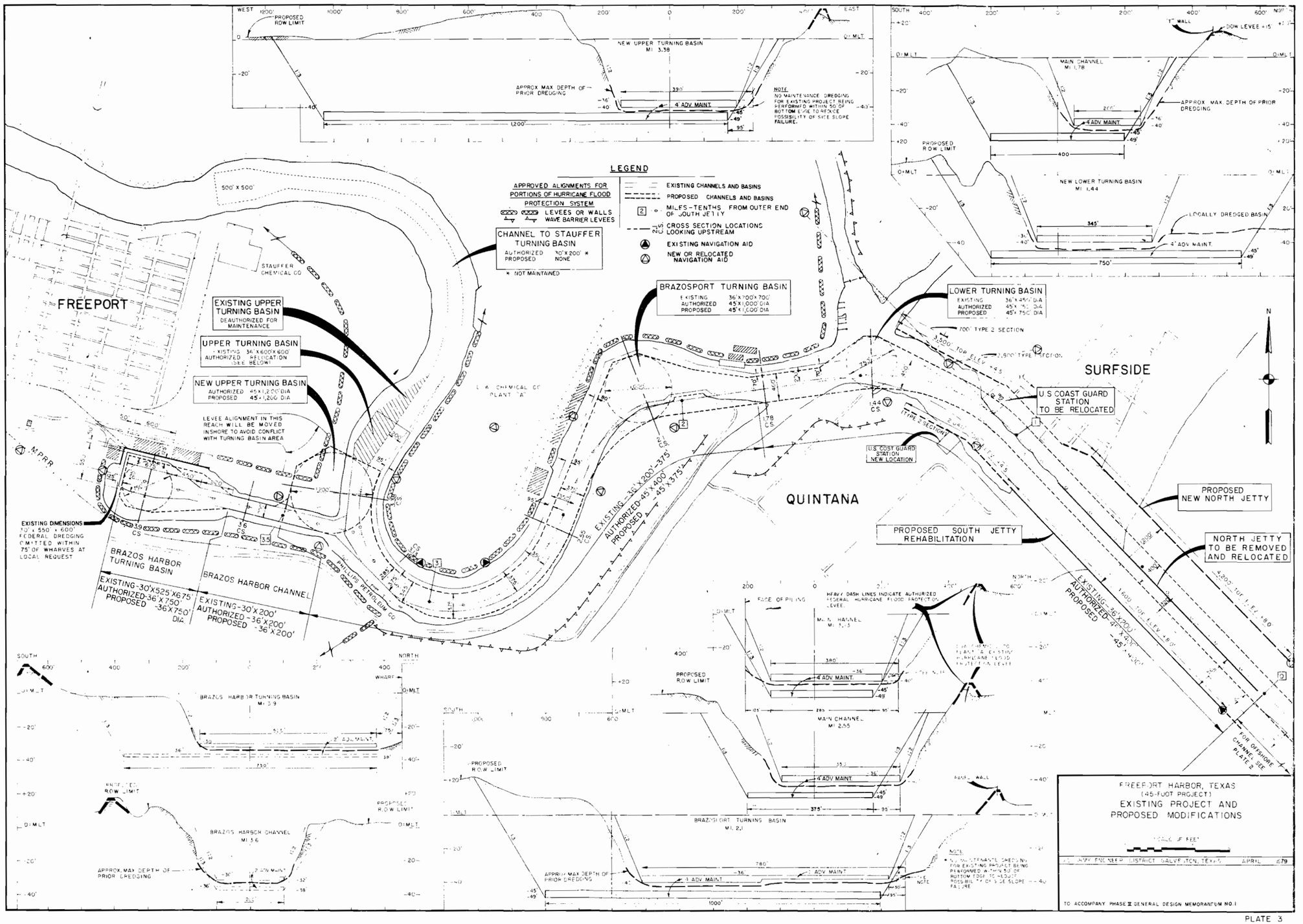
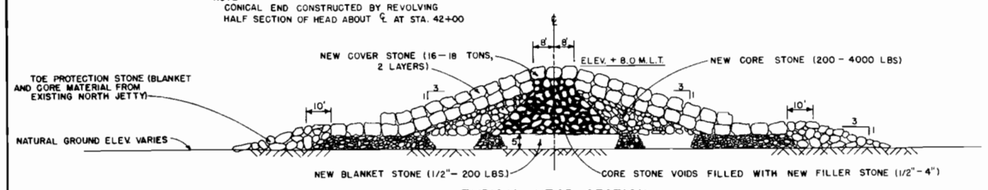

FREEPORT
SURFSIDE
QUINTANA
LEGEND
APPROVED ALIGNMENTS FOR PORTIONS OF HURRICANE FLOOD PROTECTION SYSTEM
LEVEES OR WALLS
WAVE BARRIER LEVEES
EXISTING CHANNELS AND BASINS
PROPOSED CHANNELS AND BASINS
MILES-TENTHS FROM OUTER END OF JOUTH JETTY
CROSS SECTION LOCATIONS LOOKING UPSTREAM
EXISTING NAVIGATION AID
NEW OR RELOCATED NAVIGATION AID
CHANNEL TO STAUFFER TURNING BASIN
AUTHORIZED 30'X200' *
PROPOSED NONE
* NOT MAINTAINED
BRAZOSPORT TURNING BASIN
EXISTING 36'X700'X700'
AUTHORIZED 45'X1,000 DIA
PROPOSED 45'X1,000 DIA
LOWER TURNING BASIN
EXISTING 36'X450' DIA
AUTHORIZED 45'X750' DIA
PROPOSED 45'X750' DIA
EXISTING UPPER TURNING BASIN
DEAUTHORIZED FOR MAINTENANCE
UPPER TURNING BASIN
EXISTING 36'X600'X600'
AUTHORIZED RELOCATION (SEE BELOW)
NEW UPPER TURNING BASIN
AUTHORIZED 45'X1,200' DIA
PROPOSED 45'X1,200 DIA
LEVEE ALIGNMENT IN THIS REACH WILL BE MOVED INSHORE TO AVOID CONFLICT WITH TURNING BASIN AREA
EXISTING DIMENSIONS 70' x 550' x 600' FEDERAL DREDGING OMITTED WITHIN 75' OF WHARVES AT LOCAL REQUEST
BRAZOS HARBOR TURNING BASIN
BRAZOS HARBOR CHANNEL
EXISTING-30'X525'X675'
AUTHORIZED-36'X750'
PROPOSED -36'X750' DIA
EXISTING-30'X200'
AUTHORIZED-36'X200'
PROPOSED -36'X200'
EXISTING-36'X200'-375'
AUTHORIZED-45'X400'
PROPOSED -45'X375'
U.S COAST GUARD STATION TO BE RELOCATED
U.S COAST GUARD STATION NEW LOCATION
PROPOSED NEW NORTH JETTY
NORTH JETTY TO BE REMOVED AND RELOCATED
PROPOSED SOUTH JETTY REHABILITATION
STAUFFER CHEMICAL CO
L.A. CHEMICAL CO PLANT "A"
PHILLIPS PETROLEUM CO
NEW UPPER TURNING BASIN MI 3.38
APPROX MAX DEPTH OF PRIOR DREDGING
4' ADV MAINT.
NOTE: NO MAINTENANCE DREDGING FOR EXISTING PROJECT BEING PERFORMED WITHIN 50' OF BOTTOM EDGE TO REDUCE POSSIBILITY OF SIDE SLOPE FAILURE.
MAIN CHANNEL MI 1.78
NEW LOWER TURNING BASIN MI 1.44
LOCALLY DREDGED BASIN
BRAZOS HARBOR TURNING BASIN MI 3.9
BRAZOS HARBOR CHANNEL MI 3.6
MAIN CHANNEL MI 2.55
BRAZOSPORT TURNING BASIN MI 2.1
HEAVY DASH LINES INDICATE AUTHORIZED FEDERAL HURRICANE FLOOD PROTECTION LEVEE.
FOR OFFSHORE CHANNEL, SEE PLATE 2
FREEPORT HARBOR, TEXAS
(45-FOOT PROJECT)
EXISTING PROJECT AND PROPOSED MODIFICATIONS
SCALE OF FEET
U.S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS APRIL 1979
TO ACCOMPANY PHASE II GENERAL DESIGN MEMORANDUM NO.1

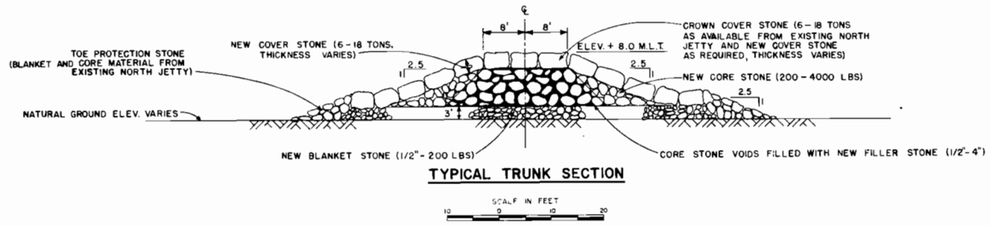
PLATE 3

NOTE
CONICAL END CONSTRUCTED BY REVOLVING HALF SECTION OF HEAD ABOUT ℄ AT STA. 42+00



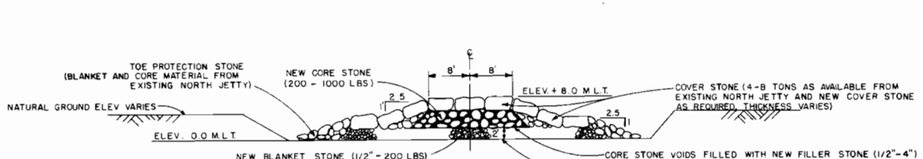
TYPICAL HEAD SECTION
(SEAWARD 200' OF JETTY AND CONICAL END)

SCALE IN FEET



TYPICAL TRUNK SECTION

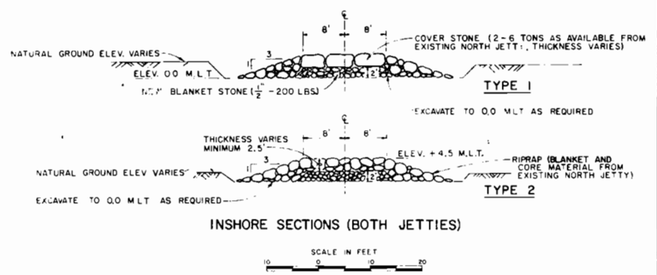
SCALE IN FEET



MINIMUM (LAND) SECTION
(WHERE NATURAL GROUND IS ABOVE ELEV. 0.0 M.L.T.)

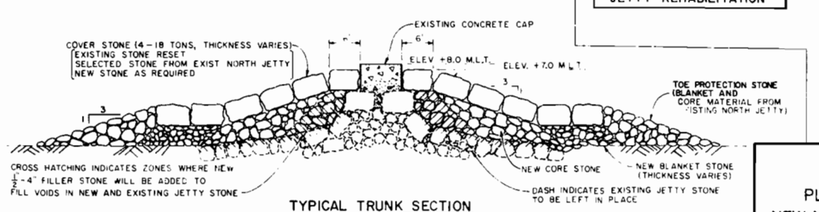
SCALE IN FEET

NEW NORTH JETTY



INSHORE SECTIONS (BOTH JETTIES)

SCALE IN FEET



TYPICAL TRUNK SECTION
SOUTH JETTY REHABILITATION

SCALE IN FEET

PLAN

SCALE IN FEET

FREEPORT HARBOR, TEXAS
(45-FOOT PROJECT)

PLAN AND TYPICAL SECTIONS NEW NORTH JETTY AND REHABILITATION OF SOUTH JETTY

SCALE AS SHOWN

U.S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS APRIL 1979

TO ACCOMPANY PHASE I GENERAL DESIGN MEMORANDUM NO. 1

RECREATIONAL FACILITY ITEMS
NOT INDICATED ON PLAN VIEWS

1 PARKING AREA GUARD POSTS.
2 REFUSE CONTAINER, 55-GAL. WITH COVERS
3 ELECTRICAL SERVICE, UNDERGROUND
4 WALKS, STEPS, INCLINES ETC. AS NECESSARY.
5 COMPLETE LANDSCAPING

LEGEND
AREA RAISED TO ELEVATION + 10' TO + 12'
SERVICE / ACCESS ROADS
B SANITARY FACILITIES, WATERBORNE
STREET LIGHTS
PROJECT SIGN

BARGE CANAL
GULF INTRACOASTAL WATERWAY
SURFSIDE BEACH
WEST 17TH STREET
FREEPORT
GIWW
QUINTANA
2ND ST
INSET B
INSET A
AUTHORIZED 45' x 400' JETTY CHANNEL
PROPOSED NORTH JETTY
SOUTH JETTY
PROPOSED R.O.W. SOUTH JETTY
EXISTING PAVED ROAD
END STREET EXTENDED
VISITOR PARKING
BEACH AREA
STONE PROTECTION
HAND RAILING ON TOP OF JETTY FOR ± 2,000'
GULF OF MEXICO
"A" AVE.
WEST 14TH STREET
SURF AVE
R.O.W. RECREATIONAL FACILITIES ± 5.5 AC
TOP OF SLOPE EL +8' TO +3'
BOTTOM EDGE 30' CHANNEL
R.O.W. NEW NORTH JETTY
BEACH AREA (10' TO +3')
STONE PROTECTION
HAND RAILING ON TOP OF JETTY FOR ± 2,000'

SCALE IN FEET
500 0 500 1000

INSET A
SCALE IN FEET
0 100 200

INSET B
SCALE IN FEET
100 0 100 200

NOTES:
1. PLAN VIEWS AND TABULATION INDICATE RECREATIONAL FACILITIES WHICH COULD BE PROVIDED FOR SIGHTSEERS AND JETTY FISHERMEN.
2. DRAWING INDICATES RECOMMENDED NAVIGATION IMPROVEMENTS "IN PLACE" (NORTH JETTY AND ENLARGED JETTY CHANNEL AT NEW LOCATION)

FREEPORT HARBOR, TEXAS
(45-FOOT PROJECT)

CONCEPT PLANS OF RECREATIONAL FACILITIES

SCALES AS SHOWN
U.S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS APRIL 1979

TO ACCOMPANY PHASE I GENERAL DESIGN MEMORANDUM NO. 1

PLATE 5

FREEPORT HARBOR, TEXAS

(45 Foot Project) GDM - Phase I

I. Introduction

1. This monograph is presented in response to instructions received at the 17 March 1978 conference in SWD on the subject study. The instructions were to make an origin destination (port-to-port) analysis on actual movements of crude petroleum into Freeport Harbor, Texas using specific distances to foreign ports. In order to accomplish the analyses, the Phillips Petroleum Company was contacted to obtain the latest full year of record of receipts of crude petroleum at Freeport, Texas. In response to GD's request, the Phillips Petroleum Company furnished a tabulation of the company's vessel unloading record for 1977 giving, in date order, each vessel unloaded during 1977, the loading port, vessel size, crude type and barrels discharged. The Phillips vessel records include 116 tanker movements of primarily Nigerian crude petroleum moving inbound to Freeport, Texas from the Curacao oil terminal, Curacao Dutch West Indies in the Caribbean in 1977. The records show that of the 4,271,599 short tons of crude petroleum imports in 1977, seven movements were from South Riding Point, Grand Bahama Island transshipment point to import 266,766 short tons; four movements were from Cayman Island lightering point to import 156,408 short tons; one movement direct from Zueitina Libya of 14,416 short tons; and one movement direct from lightering in the Gulf of Mexico of 41,248 short tons. Although the Phillips movements are predominately Nigerian crude there are occasional shipments of Algerian and Libyian crude.

2. The Phillips Petroleum Company also furnished a copy of Seaway Pipeline Company's vessel unloading records for 1977 which included the

same data as the Phillips Company's records. The vessel unloading records of the Seaway Pipeline Company's crude petroleum imports into Freeport in 1977 include 175 tanker movements involved in the import of 6,270,527 short tons of crude petroleum originating at 7 ports in Europe, Africa, and the Middle East, and at 4 ports in South America, Mexico and Alaska, all moving direct into Freeport, Texas. The Seaway Company's 1977 crude imports were predominately Libyan crude with various lesser quantities of Iranian, Arabian, Nigerian and North Sea crude included. Of interest was the movement of 36,017 short tons of crude imports by seagoing barge from Trinidad and Libya.

3. Port-to-port study - Phillips Petroleum Co. - The analysis of the Phillips Petroleum Company's 1977 crude petroleum imports is based on a comparison of the operating costs per ton of the 24,000 d.w.t. design tanker that can move fully loaded on the existing 36-foot deep channel and the design tanker of 90,000 d.w.t. that can move fully loaded on the proposed 50-foot channel at Freeport Harbor, Texas. Since 90 percent or 3,792,760 short tons of the 4,271,599 crude oil imports moved from the Curacao transshipment terminal in the Caribbean only this traffic was analyzed. The round trip distance between Freeport and Curacao is 3,914 nautical miles. Vessel operating costs furnished by the office, Chief of Engineers were used to compute vessel operating costs per ton. These data indicate that a 24,000 d.w.t. tanker has an operating cost per hour of $515 and an operating speed of 16.5 knots and the 90,000 d.w.t. tanker has an operating cost per hour of $865 and an operating speed of 16.0 knots. Over a 3,914 nautical mile round trip distance the operating costs per ton were computed to be $5.09 for the 24,000 d.w.t. tanker and $2.35 for the 90,000 d.w.t. tanker. The reduction in operating cost per ton amounts to $2.74 ($5.09 - $2.35). The benefits from a reduction in transportation cost amount to

(3,792,760 tons X $2.74) $10,392,162 for the 1977 crude petroleum imported by Phillips Petroleum Company. When questioned, the Phillips Petroleum Company's representative stated that had a 50-foot channel been available at Freeport, Texas in 1977, all of the Curacao crude oil imports would have moved direct into Freeport, Texas from Bonny, Nigeria. Using the 7008 nautical mile round trip distance from Bonny, Nigeria to Freeport, Texas the equivalent value to that evaluated above amounts to $18,622,452 in reduction of transportation cost credited as benefits from a direct movement of this commerce into Freeport Harbor, Texas in 1977.

4. Port-to-port study - Seaway Pipeline Company. - The analysis of the Seaway Pipeline Company's 1977 crude petroleum imports is made on the same basis as described for the Phillips Company analysis except that the round trip haul distance to each of seven originating ports were used to compute the reduced operating costs per ton to be applied to each originating port's portion of traffic contributing to the total direct movement into Freeport, Texas of 5,801,285 short tons by Seaway Pipeline Company in 1977. Traffic from the four ports in South America, Mexico and Alaska, representing 7 percent of the total 6,270,527 seaway commerce in 1977, was not evaluated. The benefits from a reduction in transportation cost on 5,801,285 short tons of crude oil from the direct movement of Seaway crude oil imports into Freeport Harbor, Texas in 1977 amount to $48,541,533.

5. Comparison with GDM - Phase 1 analyses. - The results of the port-to-port analyses as presented above represent fixed values for specific volumes of crude petroleum imports from specific ports of origin for a given time period (1977). There are no parallel values in the GDM - Phase I analyses

R

of benefits with which the port-to-port analyses values can be directly compared. However, if the Phillips Petroleum Company's commerce is considered to be representative of the transshipment mode of import, the $10,392,162 benefits from a reduction in transportation cost on 3,792,760 short tons of crude petroleum imports in 1977 developed in the port-to-port analysis can be likened to the $4,405,000 benefits from a reduction in transportation costs an 4,500,000 short tons of crude petroleum imports in 1980 developed in the GDM - Phase 1 analysis. Similarly, if the Seaway Pipeline Company's commerce is considered to be representative of the direct shipment mode of import, the $48,541,533 benefits from a reduction in transportation cost on 5,801,285 short tons of crude petroleum imports in 1977, developed in the port-to-port analysis can be likened to the $14,658,000 benefits from a reduction in transportation costs on 3,000,000 short tons of crude petroleum imports in 1980 developed in the GDM - Phase 1 analysis. The substantial increase of benefits estimated in the port-to-port analyses over the estimates of transportation benefits contained in the GDM - Phase 1 report indicates the degree of under statement of benefits provided by the report analyses as a means of adjusting the analyses to provide a margin for the less than optimum size tanker movements that may move in the import of crude oil into Freeport Harbor, Texas and to provide some latitude in the benefits credited to the proposed project for variations of price of crude; short term fluctuations of world tanker rates; availability of cargoes and other impacts that result in unstable crude oil movement patterns.

II. Origin - Destination Analysis. -

6. The origin-destination method of analysis as used by the Corps is a procedure for comparing total movement or transportation costs from the

producer to the consumer for competing modes of common carrier transportation as a method of estimating transportation benefits that would accrue to a shallow draft barge channel. These benefits are generally defined as the difference between waterway transportation costs and the cheapest alternate common carrier movement. The origin-destination analysis includes specific costs or rates incurred to move a specific quantity of a specific commodity from the producing point to the common carrier terminal. If the producing point is within the switching radius of the terminal operation, then the switching charges and handling charges to unload and load at the transfer point would apply. If the producing point is beyond the terminal switching radius, an additional specific overland rate would apply. The line haul costs, or rates if applicable, between the common carrier terminals nearest to the producer and consumer are then added. On a waterway these are the actual port-to-port costs or rates. At the terminal nearest the consumer, an additional switching and handling charge to unload and load is applied. If the consumer is beyond the receiving terminals switching radius, the appropriate overland commodity or class rate is also added. The accumulation of all the above described costs constitute the origin-destination costs between a specific producing point to a specific consumer point for a specific common carrier. These carriers may include barge, rail, truck, pipeline or combinations thereof. An origin-destination analysis is a severly restricted, highly detailed method of economic evaluation of comparative common carrier costs that depends on a demonstrably stable traffic pattern (based on past statistics) that is projected to remain stable for an appreciable part of the analysis period used for project analysis. The origin-destination analysis depends

on detailed commodity movement records over a sufficient period of time to demonstrate stability of these volumes and kinds of commodity movements between specific producing and consumer points for reliability of the results of the origin-destination analysis. The origin-destination analysis method is not adjustable to changes or variations of the producing and consuming points beyond the switching radius of the common carrier terminals. As used in the Penn-State studies to develop the Inland Navigation Systems Analysis (INSA) as a tool for determining where, in an inland shallow draft waterway system, traffic is being restrained by an inadequate lock, the analysis is not an origin-destination study but a port-to-port analysis of traffic densities in the movement of specific commodities in a stable traffic pattern. As such, the procedure is also dependent upon extensive and comprehensive records by commodity and direction of movement over a sufficient period of time to validate stable traffic patterns from which estimates of future volumes and traffic densities may be extrapolated. These records of shallow draft commerce are readily available in the Corps of Engineers Waterborne Commerce of the United States, Part 2. of the annual report.

7. In summary, the purpose of the origin-destination analysis is to compare common carrier modes of transportation between specific producer and consumer points for specific volumes and kinds of commodities moving in a stable transportation pattern on a total throughput cost basis to determine relative transportation efficiencies between two or more

common carrier transportation modes. The analysis method is limited by the inability to adjust for random movement patterns of commerce. The purpose of the port-to-port segment of the origin-destination analysis is (1) to measure traffic densities based on specific volumes and kinds of commodities moving in a stable pattern of commerce between two specific terminals on the waterway and (2) to measure relative efficiencies in unit costs per ton for movement of specific volumes and kinds of commodities moving in a stable pattern of commerce between two specific terminals on the waterway in two or more configurations of barge number and size or unit tows and specific towboat horsepower. The only time this method of analysis will develop reliable estimates of transportation savings in deep draft transportation studies is in the unique situation where the shipper has control of both ends of the movement of a commodity moving in a stable, captive trade, and where this stability can be sustained for an appreciable period into the future. An example of this type of movement is the movement of bauxite from a shipper-owned ore body at the point of origin and where the bauxite will move into the shipper owned ore beneficiation and/or metallic reduction plant at the receiving end of the movement. The port-to-port method of analysis is also used to measure relative efficiencies between deep draft vessels when the same conditions of ports, stability of traffic patterns and commodities can be met. The port-to-port analysis method is limited by the inability to adjust the analysis to variations in ports of origin or routing patterns.

III. Freeport Harbor, Texas GSM - Phase 1 Analysis. -

8. The analyses contained in the project study for Freeport Harbor, Texas incorporates deep draft vessel statistics on size, deadweight tons, carrying capacity, operating costs and operating speeds that have been statistically adjusted to develop linear relationships by size, operating costs per hour and draft of vessel. These approximate linear relationships provide a uniform basis upon which calculations for comparisons of vessels of different sizes may be made to derive representative differential unit costs per ton between vessel sizes. These estimates of unit costs per ton are then applied to volumes of crude petroleum imports that are limited to the quantities that the importers state they will move, with or without the proposed improvement to the project. The imported crude will move inbound from any of several originating ports throughout the world in traffic patterns that vary between ports of origin and from month to month in the percentages of total crude oil imported at Freeport that are generated at the various ports of origin. The analysis adjusts for the changing patterns of shipment from the various ports by averaging the acutal distances between Freeport, Texas and all the originating ports. The purpose of the analysis is to develop a reasonable estimate of the expected transportation savings from movement of import crude petroleum that will provide for a number of variables that influence movement patterns of crude imports. The limitation of the statistical averaging method of analysis is that it is non-specific in the results obtained relative to stable movements of given volumes of crude oil between specified ports in a given vessel.

IV. Statistics -

9. The additional detailed studies necessary to accomplish the port-to-port studies of the Phillips Petroleum and Seaway Pipeline Companies' crude petroleum

imports in 1977 are basically founded on these companies' vessel unloading records for calendar year 1977 at Freeport, Texas and supplemented by the U. S. Dept. of Energy, Office of Oil Imports, Imported Crude Oil and Petroleum Products for Calendar Year 1977, published by the American Petroleum Institute. According to the Department of Energy reports, the total crude petroleum imports into Petroleum Administration District (PAD) I-IV in 1977 amounted to over 2 billion barrels or over 305 million short tons. These volumes were distributed as follows:

CRUDE PETROLEUM IMPORTS PAD I-IV 1977

	Barrels	Short Tons
Total	2,035,769,703	305,385,445
Gulf of Mexico	1,389,616,335	208,442,450
Freeport Harbor	58,725,881	8,808,882

Based on the above statistics, government reports of receipts indicate that Freeport Harbor accounted for 2.88 percent of the total crude imports into PAD I-IV and 4.23 percent of the total crude imports into the Gulf of Mexico. Actual shippers' records indicate these percentages amount to 3.21 and 4.71 percent respectively. The Freeport Harbor imports shown above do not agree with the 65,387,255 barrels or 9,808,090 tons of crude oil imports contained in the vessel unloading records of Phillips Petroleum, and Seaway Pipeline Companies. It is assumed that the difference is attributable to reporting deficiencies on the Dept. of Energy reporting system and that the shippers' vessel unloading records are the more accurate. These tonnages in 1977 compare with the estimated 1980 commerce in crude petroleum imports of 9 million tons

contained in the project study.

10. A study was made of Department of Energy imported crude oil and petroleum products records for calendar year 1977 to determine, on the basis of the 1,389.6 million barrels of crude imports into the Gulf of Mexico, the countries of origin, loading ports, one way distance in nautical miles and the percent by country of origin of the monthly imports into the Gulf of Mexico. The results of the study of about 5000 tanker movements in 1977 is given in the table of Percent of Gulf of Mexico Imports by Origin. The table also shows the percent of traffic for each month that originated at ports over 7,500 nautical miles from Freeport by port of origin and the percent of traffic for each month that originated at ports 6000 nautical miles or less by port of origin as separated by the dash line. The accumulated monthly percentages by port of origin are given for the calendar year 1977 for comparison with the first nine months of calendar year 1975 which is the only data available for 1975. It should be noted that the percentage distribution of the monthly imports into the Gulf by ports of origin varies from month to month. It may be inferred that percentage distribution of shipments of crude oil from the various ports of origin will also vary from year-to-year. Comparable data for the period prior to the embargo and subsequent price rise of crude oil by the oil producing and export countries (OPEC) in 1972 is not available. However, it may be speculated that such action had a substantial impact on movement patterns of crude petroleum. In any event the data available appears to verify the statement by Mr. Robert C. Bowen, Director, Planning and Economics, Phillips Petroleum Company that "The continually changing political environment in souce countries has, and will continue to have a great deal of influence on international crude oil movements, and the attendant transportation

PERCENT OF GULF OF MEXICO IMPORTS BY ORIGIN

Country	Port	Distance Naw. Mi.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total% 1977	Total % First Nine Months 1975
United Arab Emirate	Abu Dhabi	9792	5.65	4.28	4.19	4.89	4.40	7.23	4.00	6.25	5.89	3.84	8.57	6.70	5.48	2.71
Iran	Abudan	9991	8.98	5.50	11.20	7.71	6.75	7.70	9.45	7.44	6.63	7.88	7.43	7.62	7.86	3.87
Iraq	Al Basrah	9991	1.19	-	.93	1.63	3.50	1.88	2.52	1.23	2.92	2.44	2.43	2.33	1.92	.20
Quatar	Dawhah	9792	.64	1.02	1.06	.67	2.56	2.58	1.43	1.73	1.06	1.55	2.30	1.56	1.51	.64
Saudi Arabia	Bahrain	9812	20.14	24.68	25.01	22.50	26.49	24.85	23.01	17.99	28.04	21.86	22.05	17.69	22.86	20.89
Indonesia	Brunei	11972	1.24	1.56	1.28	.67	.95	1.15	.55	1.43	1.04	1.43	.85	1.39	1.13	3.22
Libya	Marsu El Breqa	6063	15.59	15.02	18.08	18.50	17.78	18.14	20.84	16.01	15.93	16.24	10.86	17.75	16.73	8.58
Norway	Oslo	5549	-	2.03	1.23	1.33	1.23	.69	.42	.24	1.35	.63	2.43	1.14	1.06	.77
Algeria	Algiers	5144	10.24	11.93	6.66	13.37	6.06	6.49	9.44	16.03	9.67	8.46	10.47	9.00	9.82	9.67
England	London	4835	2.13	.27	1.41	1.28	1.60	2.08	1.21	1.72	2.83	2.19	3.14	1.23	1.76	--
Nigeria	Bonny	3504	22.43	24.44	21.16	20.56	16.88	18.78	17.96	18.24	17.06	22.82	14.54	20.88	19.65	33.39
OTHER*																
Trinidad Mexico Venesula Bonaire etc.	Avg.	1500	11.77	9.27	7.79	6.89	11.80	8.43	9.17	11.69	7.58	10.66	14.93	12.71	10.22	16.06
Percent of traffic over 7500 miles from Freeport			37.84	37.04	43.67	38.07	44.54	45.39	40.96	36.07	45.58	39.0	43.63	37.29	40.76%	31.53%
Percent of traffic 6000 miles or less from Freeport			62.16	62.96	56.33	61.93	55.33	56.61	59.04	63.93	54.42	61.0	56.37	62.71	59.24	68.47%

* About half of this traffic is from transhipment points in the Carribean and originated at foreign producing points

patterns." (emphasis added) Additional statistical information developed from the Dept. of Energy data based on the month of September statistics selected as representative for all twelve months shows that only 8 percent of the cargos lifted were in excess of 500,000 barrels or 75,000 short tons. There were 41 companies that reported imports for the month and 160 companies that reported no imports for the month. Based on the Dept. of Energy statistics a one percent variation amounts to over 3 million tons of crude oil movement into the Gulf of Mexico in 1977.

V. Discussion. -

11. The discussion of the two methods of analysis of transportation benefits (i.e. origin-destination; statistical average) given in sections II and III, respectively, delineates the differences in both the methods of analysis and the products derived from each method. In view of these differences, using one method of analysis to validate or check the other analysis results would be of minimal value.

12. From a pragmatic standpoint, the use of the origin-destination method of analysis or the port-to-port segment of the origin-destination method of analysis of deep draft transportation benefits in general investigations and design memorandums is not practical for a number of reasons. As discussed in section II, the necessary statistics upon which a specific origin-destination analysis is based are readily available for inland waterway studies. Comparable deep draft statistics are available, in raw data form, from the Dept. of Commerce; however, the cost of collating the raw data into useable base line statistics, as quoted by the department, is prohibitive. Manually acquiring the necessary statistics in traffic surveys is equally prohibitive. For example, the 1977 statistics furnished by the Department of Energy shows that

there were about 5000 movements of crude oil, just into the Gulf of Mexico. Assuming a minimum of 10 years to establish patterns of movement in this commerce would involve the manipulation of 50,000 individual shipments. If the month of September is considered as representative for the year, according to the Dept. of Energy report, a minimum of 200 shippers would be involved in acquiring the 10 year record of shipping. Timely acquisition and manipulation of these data to meet report schedules would require study resources that are not available. Acquiring these data by the use of study resources that are available would extend report study schedules beyond acceptable limits. Further, if surrogate data can be acquired at reasonable cost to provide a statistical base upon which an origin-destination or port-to-port analysis can be constructed the product derived from such a study would still be a restricted, specific analysis of a given movement for a single point in time that assumes there will be no changes in shipping patterns. Use of the result to predict probable volumes and dynamic patterns of movement over a 50 year period of analysis cannot be rationally supported or defended.

13. The statistical averaging method of analysis, as contained in the subject design memeorandum is based on guidance received at the formulation conference which directed that transshipment from the Caribbean be used as the economic base line condition and that the impact of the proposed single point mooring system (SPM) by Seadock Inc. at Freeport, Texas on the project economics be evaluated. According to petroleum industry spokesmen, the economic "break even" distance to obtain economies of scale in the very large crude carriers (VLCC) is six to eight thousand miles. In order to accomplish the anlaysis using transshipment as the base line condition certain assumptions are required. These include modal split, a radius of action that will accomodate the economics

of a VLCC, probable supply points for the forseeable future, and a level of commerce that is attainable over the period of analysis despite realtively wide fluctuations in supply, price, and supply-distribution patterns in the world crude petroleum commerce. The primary consideration in each of these assumptions is to establish a framework for the analysis that will represent a threshold level of benefits credited to the projects in the study, or more basically, that the results of the analyses based on these assumptions is a reasonable estimate of these benefits that is as insensitive to the many variables of crude petroleum supply and demand as is practicable to develop.

VI. Conclusions. -

14. It is recognized that the origin-destination or port-to-port method of analysis is a useful tool for economic evaluations of transportation benefits. The method can be used for deep draft studies where the conditions of stable traffic patterns, specific ports, stipulated volumes and kinds of commodities, and the maintenance of the stability of the movement over an appreciable period of the analysis can be met.

15. The additional study cost incurred to accomplish an origin-destination or port-to-port analysis of deep draft commerce as compared to the study cost of the statistical averaging method of analysis is not justified by a comparable improvement in the quality or reliability of the results over the results that can be attained by the statistical averaging method of analysis with an efficient use of available study resources.

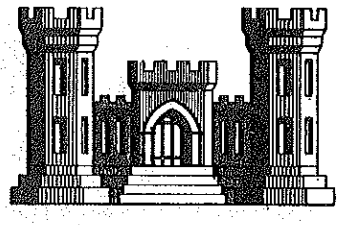
REPORT OF SOIL TESTS

FREEPORT HARBOR, TEXAS

50' PROJECT AND BEND EASING

BORING NO. 78-241 thru 249

GDLR NO. 1631



CORPS OF ENGINEERS

U. S. ARMY

GALVESTON DISTRICT LABORATORY

GALVESTON, TEXAS

15 FEBRUARY 1979

REPORT OF SOIL TESTS
FREEPORT HARBOR, TEXAS
50' PROJECT AND BEND EASING
BORING NO. 78-241 thru 249

GDLR NO. 1631

1. AUTHORITY: Test request dated 1 August 1978 from V. E. Bennett, Chief, Soils Design Section, Foundation and Materials Branch, requested the Galveston District Laboratory to conduct tests in accordance with the requirements of applicable test procedures shown in paragraph 2.

2. TEST METHODS: Tests were conducted in accordance with the following procedures:

TEST REQUIRED	TEST PROCEDURE
Unit Weight	EM 1110-2-1906,Appendix II,30 Nov 1970
Moisture Content	EM 1110-2-1906,Appendix I,30 Nov 1970
Soil Classification	MIL STD, 619-B, 12 June 1968
Liquid and Plastic Limits	EM 1110-2-1906,Appendix III,30 Nov 1970
Sieve Analysis	EM 1110-2-1906,Appendix V, 30 Nov 1970
Soil Consistency	Based on procedure outlined in EM 1110-345-147,using drive penetrometer tests for sand and pocket penetrometer tests (Soiltest Model CL-700) for clays
Unconfined Compression Strength	EM 1110-2-1906,Appendix XI,30 Nov 1970
Linear Shrinkage(Bar Method)	Paving Manual,4th Edition,Galveston District,Engineering Division,Foundation and Paving Section,Method 326,Page 252

3. PRESENTATION OF DATA:

a. Results of tests are shown on the inclosed eleven test data summary sheets.

b. Unconfined compression tests results are presented in Table 1.

c. The applied compressive stress versus axial strain relationship is presented in Plates XI-2-1 through XI-2-6.

d. Drawings 1 through 2 showing location of borings are inclosed.

e. Samples forwarded to Southwestern Division Laboratory for testing are shown on inclosed Test Request 79V021 dated 12 January 1979.

4. COMMENTS

a. Portions of samples not consumed in testing are in storage at the Galveston District Laboratory in the event additional testing is required.

b. Results of tests by Southwestern Division Laboratory will be reported directly to Foundation and Materials Branch.

c. Samples from borings 78-242, 245 and 248 were sent to Southwestern Division Laboratory for Triaxial Compression.

E E Thomas
THOMAS

1631

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
SWGED-FS	Freeport Harbor, Texas, 50' Project and Bend Easing - Boring and Testing Request

TO	FROM	DATE	CMT 1
Chief, Geology Section Chief, Matls & Testing Section	SWGED-FS	1 Aug 78 Bennett/hl/353	

1. Attached are two copies of a boring layout showing locations and bottom elevations of borings 78-241 thru 78-249 to be drilled for the subject project. The purpose of the borings is for making a study to determine the feasibility of deepening the channel to a bottom elevation of -50 feet m.l.t. and easing the channel bend adjacent to Dow Chemical Co. plant.

2. Survey Branch has been requested to set a stake at each boring location with the boring number marked thereon. Chief, Geology Section, is requested to notify the Chief, Survey Branch, when a firm drilling date is established. Before starting drilling operations Mr. George Kramig of Dow Chemical Co. should be contacted to confirm the right-of-entry for making the borings and to be sure that the drilling site is safe from encountering buried pipe and utility lines. Mr. Kramig's telephone No. is 238-3981. He has been contacted and will be expecting a call.

4. All borings should be made to obtain continuous undisturbed 3" diameter samples except where sands are encountered. Sands should be sampled at 5' depth intervals and standard penetration tests should be performed. All samples should be visually classified in the field and pocket penetrometer readings should be taken on all undisturbed samples.

5. The beginning and ending time of drilling each boring located in the water shall be recorded on the log to allow the tide to be determined after drilling. If the tide can be determined, it should be recorded on the log.

6. Charges for the work should be made to ~~BE008304J20A000~~ BE008304L20M006.

Bennett

BENNETT

2 Incl
as

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is TAGCEN.

1631

REFERENCE OR OFFICE SYMBOL	SUBJECT
SWGED-FS	Freeport Harbor, Texas (50' Project) and Bend Easing - Staking of Boring Locations

TO	FROM	DATE	CMT 1
THRU Chief, Engrg Div	SWGED-F	1 Aug 78 Bennett Bennett/h1/353	
TO Chief, Survey Br			

1. Two copies of a boring layout showing locations of borings 78-241 through 78-249 to be drilled for the subject project are attached. It is requested that all boring locations be staked or buoyed and that coordinates and elevations of the locations be determined and furnished this office.

2. Right-of-entry to boring locations should be confirmed by contacting Mr. A. A. Luckenback - phone 238-1794 or Mr. George Kramig - phone 238-3981 of Dow Chemical Co.

3. The Chief, Geology Section, has been asked to coordinate drilling and the required survey work.

4. Charges for the work should be made to BA008304J20A000.

Bennett for
POWLEDGE

1 Incl
Boring layout (dupe)

File Copy

DA FORM 2496 REPLACES DD FORM 96, WHICH IS OBSOLETE.

☆ U.S. GPO: 1976-0-765-037/13

See Dl

P.T. 236+05.57

DELE
RAMP 10

78-244
-40

78-244
-50

78-243
-60'

20'

P.C. 231+88.11

DELETE
RAMP 9

78-244
-40

P.T. 230+19.31

P.C. 228+60.69

DELETE 78-245
RAMP 8
-50

78-246
-60'

CE B-21

N46°41'17"W
TO WATER TANK

P.T. 225+94.66

Ramp No. 7
Grade 6%
See Dwg. 13.1

R.O.W.

6ST-310

HARBOR NAVIGATION LIGHT NO. 22 TO REMAIN.

6ST-310A

78-247
-40

RAMP #6D
SEE DRAWING 13.1
GRADE 10%

R.O.W. 78-248

6ST-309

78-249
-60
-10

TOE OF SLOPE AUTHORIZED 36

P.I. 234+07.65
X = 3,174,853.10
Y = 418,822.51
Δ = 43°49'58.7"
D = 10° 30'
R = 545.67'
T = 219.54'
L = 417.46'

229+40.74
3,174,398.10
418,933.70
19° 02'04.1"
12°
477.47'
80.05'
158.62'

FREEPORT HARBOR, TEXAS
50' PROJECT AND BEND EASING
BORINGS: 78-241, 244, 245 and 247
thru 249
GDLR 1631

FREEPORT HARBOR

CE B-21

FREEPORT HARBOR, TEXAS
50' PROJECT AND BEND EASING
BORINGS: 78-242, 243 and 246
GDLR 1631

SWG Form 267
12 July 1971

GDLR NO 1631

PROJECT: FREEPORT HARBOR

BORING NO. 78-241

TEST DATA SUMMARY

LOCATION: 200' Left centerline levee

DATE COMPLETED

FIELD NO.	Sample Depth, Feet From	To	CLASSIFICATION ELEVATION TOP BORING _____	Length of sample recv'd	SYMBOL	CONSISTENCY	POCKET (1) PENETROMETER	STAN. PENET. BLOWS/FT(2)	MOISTURE CONTENT %	DRY DENSITY P. c. f.	L.L.	P.L.	Lab Sample No.	BAR L.S.	SIEVE ANALYSIS PERCENT GRVL	SAND	FINES	INIT. WT.	ACC. WT. RTND. SIEVE NO. (3) NO. 4	NO. 10	NO. 40	NO. 200
1J	0.0	4.5	Brown sandy organic 0.0 - 4.5		OH				24		55	36	3107		8	40	52	50	4	3	14	24
			clay with plant waste																			
2C	4.5	7.5	Brown silty clayey 4.5-7.5	0.85	SM SC	VS	0.0		26	98			3108	4	0	56	44	50	0	0	0	28
			sand with chemical smell																			
3C	7.5	10.0	Brown silty sand 7.5 - 17.5	1.00	SM	VS	0.0		24	100			3109									
	10.0	12.5	# no recovery																			
4C	12.5	15.0	Brown silty sand	1.10		VS	0.0		22	104			3110	1	0	76	24	50	0	0	0	38
5J	15.0	17.5	Brown silty sand						31				3111									
6C	17.5	20.0	Brown sandy clayey 17.5 - 20.0	1.0	ML CL	S	0.25		25	98			3112	4	0	36	64	50	0	0	0	18
			silt																			
7J	20.0	22.5	Brown clay 20.0 - 25.2		CL				39				3113									
8C	22.5	25.0	Brown clay with random sand seams	0.95		S	0.25		25	*	43	15	3114		0	12	88	50	0	0	0	6
9C	25.0	27.5	Black organic material, 25.2 - 27.5	1.1	PT	VST	2.5		468	11 *			3115									
			rotten wood																			
0C	27.5	30.0	Brown silt with 4" 27.5 - 32.5	1.1	ML	S	0.25		27	100			3116	2	0	0	100	50	0	0	0	0
			clay layer																			
1J	30.0	32.5	Brown silt		SP				23				3117									
2C	32.5	35.0	Brown & gray silty 32.5 - 35.0	0.95	SM	VS	0.0		20	109			3118	0	2	89	9	346	6	20	49	314
			sand with shell fragments																			
3C	35.0	37.5	Gray brown clay with 35.0 - 40.0	0.95	CH	S	0.25		49	72	76	25	3119		0	0	100	50	0	0	0	0
			random sand seams																			
4C	37.5	40.0	Gray brown clay with random sand	0.95		S	0.25		57	66			3120									
			seams																			
			WATER TABLE: -4.8'																			
			#information obtained from driller's log																			
			*Disturbed																			
			**Piece of wood																			

KEY: CONSISTENCY — COHESIVE SOILS: VS Very Soft, S Soft, M Medium, ST Stiff, VST Very Stiff, H Hard; CONSISTENCY — COHESIONLESS SOILS: VL Very Loose, L Loose, M Medium, D Dense, VD Very Dense

(1) Tons/Sq.Ft. Unconfined Compressive Strength
(2) Split Barrel Sampler
(3) Acc. Wt. Rtnd ÷ Init. Wt. x 100 = % Rtnd.

BORING NO. 78-241

Bottomed at _____ Water at _____ Tide Reading _____

Sheet 1 of sheets 1

SWG Form 267
12 July 1971

GDLR NO 1631

PROJECT: FREEPORT HARBOR

BORING NO. 78-242

TEST DATA SUMMARY

LOCATION: 65'left centerline levee

DATE COMPLETED

FIELD NO.	Sample Depth, Feet From	To	CLASSIFICATION ELEVATION TOP BORING	Length of sample recv'd	SYMBOL	CONSISTENCY	POCKET (1) PENETROMETER	STAN. PENET. BLOWS/FT (2)	MOISTURE CONTENT %	DRY DENSITY p. c. f.	L.L.	P.L.	Lab Sample No.	BAR L.g.	SIEVE ANALYSIS PERCENT GRVL	SAND	FINES	INIT. WT.	ACC. WT. RTND. SIEVE NO. (3) NO. 4	NO. 10	NO. 40	NO. 200
1J	0.0	2.0	Brown clayey sand 0.0 - 2.0		SC				10				3121	14	6	56	38		3	8	17	31
			with plant waste																			
2J	2.0	4.0	Brown sandy clay with 2.0 - 4.0		CL				63				3122	12	0	38	62		0	2	8	19
			plant waste																			
3J	4.0	8.0	Tan silty sand with 4.0 - 12.0		SM				19				3123	0	0	82	18		0	0	1	41
			random clay lumps																			
4J	8.0	12.0	Brown silty sand						25				3124									
5J	12.0	16.0	Brown clayey sand 12.0 - 20.0		SC				26				3125	6	0	66	34		0	0	0	33
6C	16.0	18.0	Brown clayey sand with random sand	0.9		VS	0.0		25	99			3126									
			seams																			
7C	18.0	20.0	Brown clayey sand with	0.95		VS	0.0						3127									
			random sand seams (sent to SWD)																			
8C	20.0	22.5	Brown clay with random 20.0 - 23.9	1.0	CH	S	0.25		31	92	65	23	3128		0	2	98		0	0	0	1
			sand seams																			
9C	22.5	24.0	Brown clay with 1" layer of gray	1.1		M	0.50		32	*			3129									
			sand at bottom																			
10J	24.0	26.0	Gray silty sand 23.9 - 32.5		SM	D		31	23				3130	0	0	86	14		0	0	0	43
	26.0	29.0	# washed away																			
	29.0	31.0	# no recovery			M		17														
	31.0	32.5	# no recovery																			
11C	32.5	35.0	Brown sandy clay with 32.5 - 37.5		CL				40	*	40	16	3131		0	22	78		0	0	0	11
			random sand seams, layer last 4"																			
12C	35.0	37.5	Sent to SWD	0.95									3132									
13C	37.5	40.0	Brown and gray sandy 37.5 - 40.0	1.1		M	0.50		51		78	24	3133		0	16	84		0	0	0	0
			clay		SP																	
	40.0	40.5	Gray silty sand 40.0 - 40.5	dist	SM				20				3133A	0	0	94	6		0	0	0	47
14C	40.5	42.5	Brown & gray clay 40.5 - 50.0	0.85	CH	M	0.75		61	*			3134									
15C	42.5	45.0	Brown & gray clay	1.1		M	0.50		51	71			3135									
16C	45.0	47.5	Gray & brown clay	0.85		S	0.25		58	65	103	31	3136		0	0	100		0	0	0	0
17C	47.5	50.0	Gray & brown clay	1.15		M	0.50		61	63			3137									

KEY: CONSISTENCY — COHESIVE SOILS: VS Very Soft, S Soft, M Medium, ST Stiff, VST Very Stiff, H Hard; CONSISTENCY — COHESIONLESS SOILS: VL Very Loose, L Loose, M Medium, D Dense, VD Very Dense

(1) Tons/Sq.Ft. Unconfined Compressive Strength
(2) Split Barrel Sampler
(3) Acc. Wt. Rtnd ÷ Init. Wt. x 100 = % Rtnd.

BORING NO. 78-242

Bottomed at Water at Tide Reading

Sheet 1 of sheets 1

#Information obtained from driller's log *Disturbed

SWG Form 267
12 July 1971

GDLR NO 1631

PROJECT: FREEPORT HARBOR

BORING NO. 78-243

TEST DATA SUMMARY

LOCATION: BEND EASING

DATE COMPLETED

FIELD NO.	Sample Depth, Feet From	Sample Depth, Feet To	CLASSIFICATION ELEVATION TOP BORING _____	Length of sample recv'd	SYMBOL	CONSISTENCY	POCKET (1) PENETROMETER	STAN. PENET. BLOWS/FT (2)	MOISTURE CONTENT %	DRY DENSITY p. c. f.	L.L.	P.L.	Lab Sample No. 78	BAR L.S.	SIEVE ANALYSIS PERCENT GRVL	SAND	FINES	INIT. WT.	ACC. WT. RTND. SIEVE NO. (3) NO. 4	NO. 10	NO. 40	NO. 200
	0.0	9.0	# water 0.0 - 9.0																			
1C	9.0	12.5	Brown clay 9.0 - 12.5	0.8	CL	VS	0.0		32	93			3061	6	0	2	98	50	0	0	0	1
2C	12.5	15.0	Brownish gray clay 12.5 - 15.0	1.1	CH	VS	0.0		69	*	56	18	3062		0	2	98	50	0	0	0	1
3C	15.0	17.5	Brown silty sand 15.0 - 53.0	0.9	SM	VS	0.0		22	102			3063	2	0	62	38	50	0	0	0	31
4J	17.5	22.5	Brown silty sand with pieces of						16				3064									
			rotten wood																			
			#17.5' to 53.0' - wash samples																			
5J	22.5	27.5	Brown silty sand with pieces of						31				3065									
			rotten wood																			
6J	27.5	32.5	Brown silty sand with pieces of						31				3066	0	0	74	26	50	0	0	0	37
			rotten wood																			
7J	32.5	37.5	Brown silty sand with pieces of						30				3067									
			rotten wood																			
8J	37.5	42.5	Brown silty sand with pieces of						31				3068	0	0	76	24	50	0	0	0	38
			rotten wood																			
9J	42.5	47.5	Brown silty sand with pieces of						30				3069									
			rotten wood																			
10J	47.5	53.0	Brown silty sand with pieces of						30				3070	0	0	86	14	50	0	0	0	43
			rotten wood																			
11C	53.0	55.0	Brown & gray clay 53.0 - 62.5	1.05	CH	ST	1.50		33	92			3071									
12C	55.0	57.5	Brown & gray clay	1.1		ST	1.00		35	88	63	22	3072		0	0	100	50	0	0	0	0
13C	57.5	60.0	Gray & brown clay	1.0		ST	1.25		36	85			3073									
14C	60.0	62.5	Brown & gray clay	1.05		ST	1.75		31	94	61	19	3074		0	0	100	50	0	0	0	0
			#Tide at 11:05, -2.6'																			
			#information obtained from drillers log																			
			*Disturbed																			

KEY: CONSISTENCY — COHESIVE SOILS: VS Very Soft, S Soft, M Medium, ST Stiff, VST Very Stiff, H Hard
CONSISTENCY — COHESIONLESS SOILS: VL Very Loose, L Loose, M Medium, D Dense, VD Very Dense

(1) Tons/Sq.Ft. Unconfined Compressive Strength
(2) Split Barrel Sampler
(3) Acc. Wt. Rtnd ÷ Init. Wt. x 100 = % Rtnd.

BORING NO. 78-243

Bottomed at Water at Tide Reading

Sheet 1 of sheets 1

SWG Form 267
12 July 1971

GDLR NO. 1631

PROJECT: FREEPORT HARBOR

BORING NO. 78-244

TEST DATA SUMMARY

LOCATION: BEND EASING

DATE COMPLETED

FIELD NO.	Sample Depth, Feet From	To	CLASSIFICATION ELEVATION TOP BORING	Length of sample recv'd	SYMBOL	CONSISTENCY	POCKET (1) PENETROMETER	STAN. PENET. BLOWS/FT (2)	MOISTURE CONTENT %	DRY DENSITY p. c. f.	L.L.	P.L.	Lab No. Sample No.	BAR L.S.	SIEVE ANALYSIS PERCENT GRVL	SAND	FINES	INIT. WT.	ACC. WT. RTND. SIEVE NO. (3) NO. 4	NO. 10	NO. 40	NO. 200
			#Water Table: 3.9'																			
1C	0.0	1.0	Gray & brown sandy 0.0-1.0	0.9	CH	ST	1.25		22	*	53	14	4117		8	32	60	50	4	7	9	20
			clay with calcareous nodules and 3"																			
			layer of plant waste																			
2J	1.0	5.0	Gray silty clayey sand 1.0-5.0		SM SC				37				4118	4	6	58	36	50	3	5	12	32
			with plant waste																			
3J	5.0	8.5	Black plant waste 5.0-10.0					No	test				4119									
	8.5	10.0	#washed away																			
4J	10.0	12.0	Brown clayey sand 10.0-17.0		SC	M		9	25		43	14	4120		0	58	42	50	0	1	2	29
			with sand layers																			
	12.0	15.0	#washed away																			
	15.0	17.0	# no recovery			M		14														
5C	17.0	17.5	Brown clay with random 17.0-25.0	0.8	CL	M	0.50		31	93	48	17	4121		0	2	98	50	0	0	0	1
			sand seams with 3" layer of sand																			
6C	17.5	20.0	Brown clay with random sand seams	0.95		M	0.50		32	86	36	18	4122		0	2	98	50	0	0	0	1
7C	20.0	22.5	Brown clay with random sand seams	1.1		M	0.50		33	87	43	18	4123		0	2	98	50	0	0	0	1
	22.5	25.0	#Washed away		SP																	
8J	25.0	27.0	Gray & tan silty sand 25.0-30.0		SM	D		18	27				4124	0	0	94	6	50	0	0	0	47
	27.0	30.0	#Washed away																			
9J	30.0	32.0	Brown sandy clay 30.0-36.0		CH	L		5	46		57	19	4125		2	32	66	50	1	3	6	17
	32.0	36.0	#washed away																			
10J	36.0	38.0	Brown gravelly silty 36.0-40.0		SP SM	M		23	17				4126	0	10	80	10	50	5	8	14	45
			sand																			
	38.0	40.0	# washed away																			
			#information obtained from driller's Log																			
			*Disturbed																			

KEY: CONSISTENCY — COHESIVE SOILS: VS Very Soft, S Soft, M Medium, ST Stiff, VST Very Stiff, H Hard
CONSISTENCY — COHESIONLESS SOILS: VL Very Loose, L Loose, M Medium, D Dense, VD Very Dense

(1) Tons/Sq.Ft. Unconfined Compressive Strength
(2) Split Barrel Sampler
(3) Acc. Wt. Rtnd ÷ Init. Wt. x 100 = % Rtnd.

BORING NO. 78-244

Bottomed at Water at Tide Reading

Sheet 1 of sheets 1

SWG Form 261
12 July 1971

GDLR NO 1631

PROJECT: FREEPORT HARBOR

BORING NO. 78-245

TEST DATA SUMMARY

LOCATION: BEND EASING

DATE COMPLETED

FIELD NO.	Sample Depth, Feet From	To	CLASSIFICATION ELEVATION TOP BORING	Length of sample recv'd	SYMBOL	CONSISTENCY	POCKET (1) PENETROMETER	STAN. PENET. BLOWS/FT (2)	MOISTURE CONTENT %	DRY DENSITY p. c. f.	L.L.	P.L.	Lab Sample No. 78	BAR L.S.	SIEVE ANALYSIS PERCENT GRVL	SAND	FINES	INIT. WT.	ACC. WT. RTND. SIEVE NO. (3) NO. 4	NO. 10	NO. 40	NO. 200
			#Water table: 6.5'		SP																	
1J	0.0	2.0	Gray silty sand with 0.0 - 10.5		SM				15				4127									
			limestone gravel, roadbase																			
2J	2.0	6.0	Tan silty sand						7				4128	0	0	88	12	50	0	1	1	44
3J	6.0	10.0	Tan silty sand, excess water						25				4129									
4J	10.0	12.5	Brownish gray clay 10.5 - 12.5		CL	M		5	35		38	14	4130		0	6	94	50	0	0	0	3
5C	12.5	15.0	Brown sandy clayey 12.5 - 15.0	0.65	ML CL	VS	0.0		31	93			4131	3	0	20	80	50	0	0	0	10
			silt																			
6C	15.0	17.5	Brown clay with random 15.0 - 17.5	1.05	CL	M	0.75		26	98	40	18	4132		0	0	100	50	0	0	0	0
			silt seams																			
7C	17.5	20.0	Brown clay with random 17.5 - 20.0	1.0	CH	S	0.25						4133									
			silt seams (SWD - "R")																			
8C	20.0	22.5	Brown sandy clay 20.0 - 24.0	1.05	CL	VS	0.0		23	105	27	15	4134		0	38	62	50	0	0	0	19
			with random sand layers																			
	22.5	25.0	# no recovery 24.0 - 31.2																			
9J	25.0	28.0	Brown silty sand		SM	M		19	23				4135	0	0	72	28	50	0	0	0	36
	28.0	31.0	# washed away																			
10J	31.0	33.0	Gray clay 31.2 - 41.7		CH	VL		3	61				4136									
11C	33.0	35.0	Gray clay with random sand seams	1.1		M	0.50		66	63	86	26	4137		0	2	98	50	0	0	0	1
12C	35.0	37.5	Gray clay with random sand layers	1.1		M	0.50		55	71			4138									
13C	37.5	40.0	Gray & brown clay with random	1.15		M	0.50		56	68			4139									
			sand seams																			
14C	40.0	42.5	Tan silty sand with 41.7 - 50.0	1.1	SM	dist.			17	*			4140									
			3" clay layer at top																			
	42.5	43.0	#washed away																			
15J	43.0	45.0	Tan silty sand			VD		75	21				4141	0	0	86	14	50	0	0	0	43
	45.0	48.0	# washed away																			
16J	48.0	50.0	Gray silty sand			VD		55	22				4142									

KEY: CONSISTENCY — COHESIVE SOILS: VS Very Soft, S Soft, M Medium, ST Stiff, VST Very Stiff, H Hard
CONSISTENCY — COHESIONLESS SOILS: VL Very Loose, L Loose, M Medium, D Dense, VD Very Dense

(1) Tons/Sq.Ft. Unconfined Compressive Strength
(2) Split Barrel Sampler
(3) Acc. Wt. Rtnd ÷ Init. Wt. x 100 = % Rtnd.

BORING NO. 78-245

#information obtained from driller's log Tide Reading

Sheet 1 of sheets 1

SWG Form 267
~~2~~ July 1971

GDLR NO 1631

PROJECT: FREEPORT HARBOR

BORING NO. 78-246

TEST DATA SUMMARY

LOCATION: BEND EASING

DATE COMPLETED

FIELD NO.	Sample Depth, Feet From	To	CLASSIFICATION ELEVATION TOP BORING	Length of sample recv'd	SYMBOL	CONSISTENCY	POCKET (1) PENETROMETER	STAN. PENET. BLOWS/FT(2)	MOISTURE CONTENT %	DRY DENSITY P. c. f.	L.L.	P.L.	Lab Sample No.	BAR L.S.	SIEVE ANALYSIS PERCENT GRVL	SAND	FINES	INIT. WT.	ACC. WT. RTND. SIEVE NO. (3) NO. 4	NO. 10	NO. 40	NO. 200
	0.0	5.0	# water 0.0-5.0																			
1C	5.0	7.5	Brown clay with random 5.0-7.5	1.05	CL	VS	0.0		32	94	36	19	3075		0	0	100		0	0	0	0
			silt layers																			
2C	7.5	10.0	Brown clay with 0.2' 7.5-12.5	1.1	CH	VS	0.0		71	60	65	22	3076		0	2	98		0	0	0	1
			sand layer at top of sample																			
3C	10.0	12.5	Brown clay with random thin silt	0.95		S	0.25		60	*	54	19	3077		0	4	96		0	0	0	2
			and sand layers																			
	12.5	15.0	#No recovery		SP																	
4J	15.0	17.5	Brown silty sand 12.5-20.0		SM	M		10	22				3078	0	0	88	12		0	1	1	44
	17.5	20.0	# washed away																			
5J	20.0	22.5	Brown sandy clay with 20.0-22.5		CH	D		13	56		62	20	3079		0	16	84		0	0	1	8
			random sand layers																			
	22.5	25.0	#washed away																			
6J	25.0	27.5	Brown silty sand 22.5-27.4		SM	D		21	20				3080	0	0	86	14		0	0	1	43
7J	27.5	30.0	Brown clay 27.4-39.4		CH	M		4	69				3081									
8C	30.0	32.5	Brownish gray clay with random	0.6		VS	0.0		47	74			3082									
			sand seams																			
9C	32.5	35.0	Brownish gray clay with random	0.85		VS	0.0		65	61	62	21	3083		0	6	94		0	0	0	3
			silt seams																			
10C	35.0	37.5	Brownish gray clay with random	1.1		S	0.25		71	61			3084									
			silt seams																			
11C	37.5	40.0	Brownish gray clay with random	1.15		VS	0.0		62	65			3085									
			silt seams to 39.4#																			
12J	40.0	42.5	Gray silty sand 39.4-53.0		SP SM	D		18	22				3086	0	0	92	8		0	0	0	46
			39.4'-gray sand																			
	42.5	45.0	#no recovery - wash sample																			
13J	45.0	52.5	# wash sample						29				3087									
			Gray silty sand to 53.0' #																			

KEY: CONSISTENCY — COHESIVE SOILS: VS Very Soft, S Soft, M Medium, ST Stiff, VST Very Stiff, H Hard
CONSISTENCY — COHESIONLESS SOILS: VL Very Loose, L Loose, M Medium, D Dense, VD Very Dense

(1) Tons/Sq.Ft. Unconfined Compressive Strength
(2) Split Barrel Sampler
(3) Acc. Wt. Rtnd ÷ Init. Wt. x 100 = % Rtnd.

BORING NO. 78-246

Bottomed at Water at Tide Reading

Sheet 1 of sheets 2

July 1971

GDLR NO 1631

PROJECT: FREEPORT HARBOR

BORING NO. 78-246

TEST DATA SUMMARY

LOCATION:

DATE COMPLETED

FIELD NO.	Sample Depth, Feet From	To	CLASSIFICATION ELEVATION TOP BORING	Length of sample recv'd	SYMBOL	CONSISTENCY	POCKET(1) PENETROMETER	STAN. PENET. BLOWS/FT(2)	MOISTURE CONTENT %	DRY DENSITY p. c. f.	L.L.	P.L.	Lab Sample No. 78	BAR L.S.	SIEVE ANALYSIS PERCENT GRVL	SAND	FINES	INIT. WT.	ACC. WT. RTND. SIEVE NO. (3) NO. 4	NO. 10	NO. 40	NO. 200
4C	52.5	55.0	Brown & gray clay 53.0-62.5	1.05	CH	ST	1.50		28	97			3088									
5C	55.0	57.5	Gray & brown clay	1.0		ST	1.50		33	89	71	23	3089		0	2	98		0	0	1	1
6C	57.5	60.0	Gray & brown clay	1.1		ST	1.75		36	88			3090									
7C	60.0	62.5	Brown & gray clay	1.1		ST	1.25		34	89			3091									
			#Tide at 1050 , +3.2																			
			#Water Depth:5.0'																			
			#information obtained from driller's log																			
			*Disturbed																			

KEY: CONSISTENCY — COHESIVE SOILS: VS Very Soft, S Soft, K Medium, ST Stiff, VST Very Stiff, H Hard; CONSISTENCY — COHESIONLESS SOILS: VL Very Loose, L Loose, M Medium, D Dense, VD Very Dense

(1) Tons/Sq.Ft. Unconfined Compressive Strength
(2) Split Barrel Sampler
(3) Acc. Wt. Rtnd ÷ Init. Wt. x 100 = % Rtnd.

BORING NO. 78-246

Bottomed at Water at Tide Reading

Sheet 2 of sheets 2

SWG Form 267
12 July 1971

GDLR NO 1631

PROJECT: FREEPORT HARBOR

BORING NO. 78-247

TEST DATA SUMMARY

LOCATION: BEND EASING

DATE COMPLETED

FIELD NO.	Sample Depth, Feet From	To	CLASSIFICATION ELEVATION TOP BORING	Length of sample recv'd	SYMBOL	CONSISTENCY	POCKET (1) PENETROMETER	STAN. PENET. BLOWS/FT (2)	MOISTURE CONTENT %	DRY DENSITY P. c. f.	L.L.	P.I.	Lab Sample No.	BAR L.S.	SIEVE ANALYSIS PERCENT GRVL	SAND	FINES	INIT. WT.	ACC. WT. RTND. SIEVE NO. (3) NO. 4	NO. 10	NO. 40	NO. 200
			#Water table: -4.8'																			
1J	0.0	6.0	Brown clayey sand with plant waste on top 0.0 - 6.0		SC				15				4143	5	4	54	42	50	2	5	8	29
2J	6.0	10.0	Brown sandy clay with shell fragments 6.0 - 25.0		CL				36		36	17	4144		2	30	68	50	1	3	4	16
3J	10.0	15.0	Brown sandy clay with shell fragments						37				4145									
4C	15.0	17.5	Brown sandy clay with random sand seams	1.05		ST	1.00		25	*			4146									
5C	17.5	20.0	Brown clay with random sand seams	1.05		ST	1.00		24	102			4147	9	0	4	96	50	0	0	0	4
6C	20.0	22.5	Brown clay with random sand and organic seams	1.0		S	0.25		47	72			4148									
7C	22.5	25.0	Brown clay with random sand seams	0.9		S	0.25		49	*	38	18	4149		0	2	98	50	0	0	0	1
	25.0	27.5	#no recovery (sand) 25.0 - 33.0		SM																	
8J	27.5	30.0	Brown silty sand			M		9	22				4150	0	0	82	18	50	0	0	0	41
	30.0	33.0	#washed away (gray sand)																			
9J	33.0	35.0	Brown clay with random sand seams 33.0 - 40.0		CH	L		6	52				4151									
10C	35.0	37.5	Brown clay with random sand seams, 1" sand filled animal burrow through sample	1.0		M	0.50		46	74			4152									
11C	37.5	40.0	Brown clay with random sand seams	1.0		S	0.25		30	93	62	19	4153		0	10	90	50	0	0	0	5
			#information obtained from driller's log																			
			*Disturbed																			

KEY: CONSISTENCY — COHESIVE SOILS: VS Very Soft, S Soft, M Medium, ST Stiff, VST Very Stiff, H Hard. CONSISTENCY — COHESIONLESS SOILS: VL Very Loose, L Loose, M Medium, D Dense, VD Very Dense.

(1) Tons/Sq.Ft. Unconfined Compressive Strength
(2) Split Barrel Sampler
(3) Acc. Wt. Rtnd ÷ Init. Wt. x 100 = % Rtnd.

BORING NO. 78-247

Bottomed at Water at Tide Reading

Sheet 1 of sheets 1

SWG Form 267
12 July 1971

GDLR NO. 1631

PROJECT: FREEPORT HARBOR

BORING NO. 78-248

TEST DATA SUMMARY

LOCATION: BEND EASING

DATE COMPLETED

FIELD NO.	Sample Depth, Feet From	To	CLASSIFICATION ELEVATION TOP BORING	Length of sample recv'd	SYMBOL	CONSISTENCY	POCKET (1) PENETROMETER	STAN. PENET. BLOWS/FT (2)	MOISTURE CONTENT %	DRY DENSITY p. c. f.	L.L.	P.L.	Lab 78 Sample No.	BAR L.S.	SIEVE ANALYSIS PERCENT GRVL	SAND	FINES	INIT. WT.	ACC. WT. RTND. SIEVE NO. (3) NO. 4	NO. 10	NO. 40	NO. 200
1J	0.0	2.5	Crushed limestone, 0.0-2.5		GM				6				4154		46	31	23	620	287	351	415	480
			roadbase																			
2C	2.5	5.0	Brown & gray sandy 2.5-5.0	1.1	CH	ST	1.75		28	*	82	22	4155		0	18	82	50	0	1	2	9
			clay with calcareous nodules and																			
			sand seams																			
3C	5.0	7.5	Brown silty sand 5.0-7.5	dist.	SM				9				4156	1	0	86	14	50	0	0	0	43
4J	7.5	10.0	Brown sandy clay 7.5-25.0		CL	M		7	19				4157	12	0	26	74	50	0	0	0	13
5C	10.0	12.5	Brown sandy clay with random sand	0.85		S	0.25		21	*	48	16	4158		0	38	62	50	1	1	2	19
			pockets																			
6C	12.5	15.0	Brown sandy clay with random sand	0.9		M	0.50		20	*			4159									
			pockets																			
	15.0	17.5	#no recovery																			
7J	17.5	20.0	Brown clay with random silt seams			M		7	28				4160									
8C	20.0	22.5	sent to SWD										4161									
9C	22.5	25.0	Brown clay with random silt seams,	1.0		S	0.25		33	88			4162	11	0	0	100	50	0	0	0	0
			2" sand layer at bottom																			
10C	25.0	27.5	Brown silty sand with 25.0-27.5	1.0	SM	S	0.25		23	100			4163	0	0	80	20	50	0	0	1	40
			random clay and organic seams																			
11C	27.5	30.0	Brown sandy clay with 27.5-30.0	1.0	CH	S	0.25		40		51	21	4164		0	26	74	50	0	2	5	13
			4" sand layer and organic seams at																			
			top																			
	30.0	33.0	#washed away 30.0-40.0		SM																	
12J	33.0	35.0	Brown silty sand			D		33	28				4165	1	0	76	24	50	0	0	.1	38
13J	35.0	40.0	Brown silty sand			M		13	No	test			4166									
14C	40.0	42.5	Brown & gray clay with 40.0-46.0	1.1	CH	M	0.75		51	74			4167									
			random sand layers																			
15C	42.5	45.0	Brown & gray clay with random sand	1.1		M	0.75		51	72	99	26	4168		0	2	98	50	0	0	0	1
			layers																			
16C	45.0	47.5	Brown & gray clay with random sand	1.1		S	0.25		50	71			4169									
			layers																			

KEY: CONSISTENCY — COHESIVE SOILS: VS Very Soft, S Soft, M Medium, ST Stiff, VST Very Stiff, H Hard. CONSISTENCY — COHESIONLESS SOILS: VL Very Loose, L Loose, M Medium, D Dense, VD Very Dense.

(1) Tons/Sq.Ft. Unconfined Compressive Strength
(2) Split Barrel Sampler
(3) Acc. Wt. Rtnd ÷ Init. Wt. x 100 = % Rtnd.

BORING NO. 78-248

Bottomed at Water at Tide Reading

Sheet 1 of sheets 2

GDLR NO. 1631

FREEPORT HARBOR

BORING NO. 78- 248

TEST DATA SUMMARY

ATION: BEND EASING

DATE COMPLETED

FIELD NO.	Sample Depth, Feet From	Sample Depth, Feet To	CLASSIFICATION ELEVATION TOP BORING	Length of sample recv'd	SYMBOL	CONSISTENCY	POCKET (1) PENETROMETER	STAN. PENET. BLOWS/FT (2)	MOISTURE CONTENT %	DRY DENSITY p. c. f.	L.L.	P.L.	Lab Sample No.	BAR L.S.	SIEVE ANALYSIS PERCENT GRVL	SAND	FINES	INIT. WT.	ACC. WT. RTND. SIEVE NO. (3) NO. 4	NO. 10	NO. 40	NO. 200
17J	47.5	50.0	Brown silty sand 46.0 - 50.0		SP SM	D		30	24				4170	0	0	90	10	50	0	0	0	45
			#information obtained from driller's log																			
			*Disturbed																			

KEY: CONSISTENCY — COHESIVE SOILS: VS Very Soft, S Soft, M Medium, ST Stiff, VST Very Stiff, H Hard. CONSISTENCY — COHESIONLESS SOILS: VL Very Loose, L Loose, M Medium, D Dense, VD Very Dense.

(1) Tons/Sq.Ft. Unconfined Compressive Strength
(2) Split Barrel Sampler
(3) Acc. Wt. Rtnd ÷ Init. Wt. x 100 = % Rtnd.

BORING NO. 78-248

Bottomed at Water at Tide Reading

Sheet 2 of sheets 2

SWG Form 267
12 July 1971

GDLR NO 1631

PROJECT: FREEPORT HARBOR

BORING NO. 78-249

TEST DATA SUMMARY

LOCATION: BEND EASING

DATE COMPLETED

FIELD NO.	Sample Depth, Feet From	To	CLASSIFICATION ELEVATION TOP BORING	Length of sample recv'd	SYMBOL	CONSISTENCY	POCKET (1) PENETROMETER	STAN. PENET. BLOWS/FT (2)	MOISTURE CONTENT %	DRY DENSITY p. c. f.	L.L.	P.L.	Lab Sample No.	BAR L.S.	SIEVE ANALYSIS PERCENT GRVL	SAND	FINES	INIT. WT.	ACC. WT. RTND. SIEVE NO. (3) NO. 4	NO. 10	NO. 40	NO. 200
	0.0	6.6	#Water 0.0 - 6.6		ML																	
1C	6.6	10.0	Brown sandy clayey 6.6 - 12.0	1.05	CL	S	0.25		26	98			3092	3	0	44	56	50	0	0	0	22
			silt with random sand pockets and																			
			organic material																			
2C	10.0	12.0	Brown sandy clayey silt with	1.0		VS	0.00		25	98			3093									
			random sand pockets and organic																			
			material, some shell fragments																			
3J	12.0	12.5	Brownish gray silty 12.0 - 23.0		SM				26				3094									
			sand																			
4J	12.5	15.0	Brownish gray silty sand			M		7	27				3095	0	0	84	16	50	0	0	0	42
	15.0	17.5	# washed away																			
5J	17.5	20.0	Brownish gray silty sand			VD		27	25				3096									
	20.0	22.5	#washed away																			
6J	22.5	25.0	Brown clay 23.0 - 27.5		CH	VL		2	59				3097									
7J	25.0	27.5	Brown clay						62		77	25	3098		0	4	96	50	0	0	0	2
8J	27.5	31.0	Brownish gray sandy 27.5 - 31.0		CL				37		37	17	3099		2	46	52	50	1	0	2	24
			clay																			
9J	31.0	35.0	Tan silty sand - #no recovery on		SM	M		15	22				3100									
			drive - Wash sample 31.0 - 52.0																			
10J	35.0	37.5	Tan silty sand			VD		80	22				3101									
	37.5	40.0	# washed away																			
11J	40.0	42.5	Tan silty sand			VD		110	20				3102	0	8	76	16	50	4	5	6	42
12J	42.5	47.5	Gray silty sand , #Wash sample						28				3103									
	47.5	52.0	#wash sample																			
	52.0	52.5	#washed away																			
13C	52.5	55.0	Gray & brown clay 52.0 - 60.0	1.00	CH	VST	2.0		28	97			3104									
14C	55.0	57.5	Gray & brown clay	1.00		VST	2.5		33	91			3105									
15C	57.5	60.0	Gray & brown clay	0.90		VST	2.0		32	92	73	24	3106		0	0	100	50	0	0	0	0
			#information obtained from driller's log																			

KEY: CONSISTENCY — COHESIVE SOILS: VS Very Soft, S Soft, M Medium, ST Stiff, VST Very Stiff, H Hard. CONSISTENCY — COHESIONLESS SOILS: VL Very Loose, L Loose, M Medium, D Dense, VD Very Dense.

(1) Tons/Sq.Ft. Unconfined Compressive Strength
(2) Split Barrel Sampler
(3) Acc. Wt. Rtnd ÷ Init. Wt. x 100 = % Rtnd.

BORING NO. 78-249

Bottomed at Water at Tide Reading +2.5' at 0915

Sheet 1 of sheets 1

SWG Form 279
7 August 1973

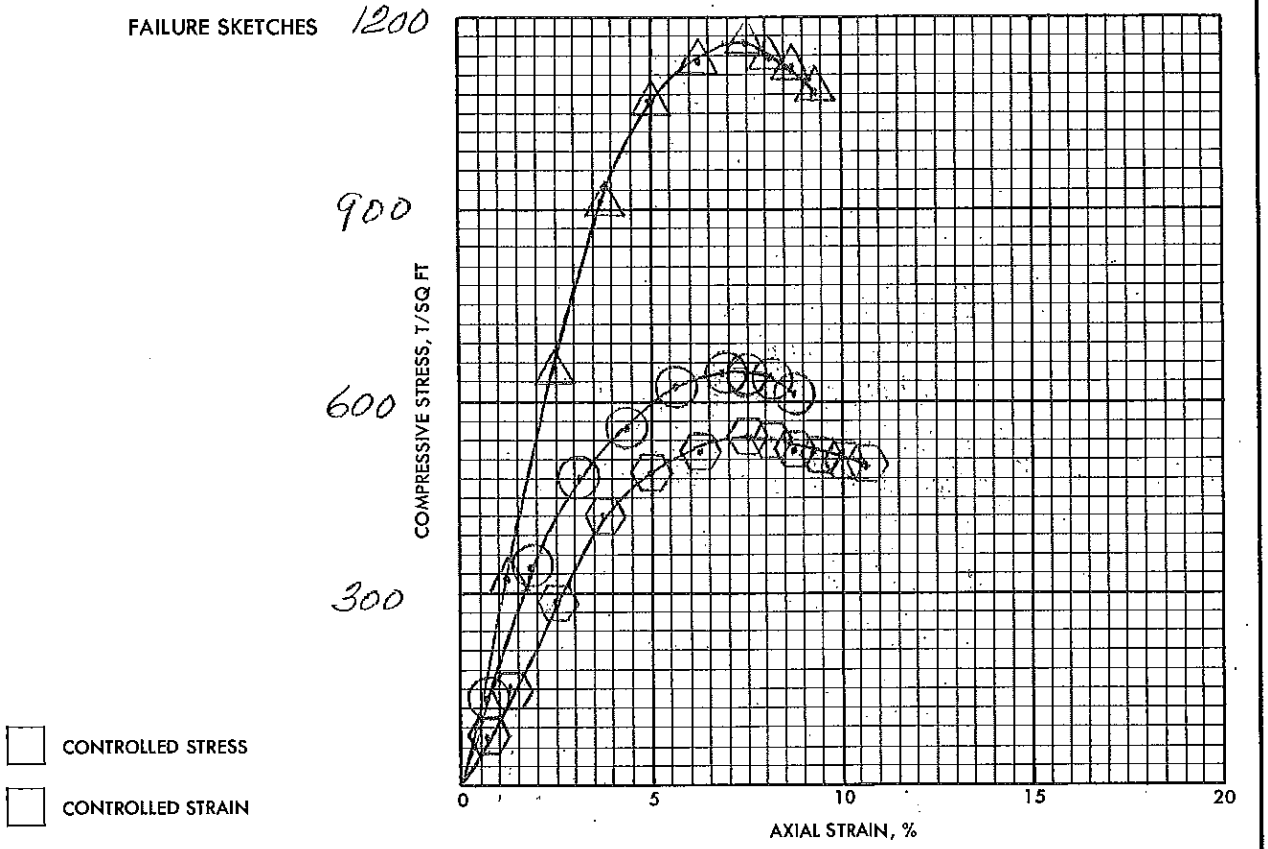
SUMMARY UNCONFINED COMPRESSION TEST DATA
TABLE 1

Freeport Harbor
PROJECT 50' Project & Bend Easing

GALVESTON DISTRICT LABORATORY REPORT NO. 631

BORING NO	DEPTH FT	% GRAVEL	% SAND	% FINES	% MOISTURE	DRY WT. P.C.F.	L.L.	P.L.	L.S.	% STRAIN @ MAX. STRESS	MAX. STRESS P.S.F.	POCKET PENETRO-METER*	CLASSIFICATION
78-241	22.5-25.0				52					6.88	646	0.25	
	35.0-37.5				71					13.13	1009	0.25	
78-242	20.0-22.5				29					7.50	1158	1.75	
	45.0-47.5				63					13.75	1104	0.50	
78-243	55.0-57.5				37					3.13	1750	1.25	
78-244	17.5-20.0				42					20.00	856	0.00	
78-245	15.0-17.5				28					8.13	1290	1.50	
245	33.0-35.0				61					5.63	1081	0.25	
78-246	32.5-35.0				63					5.00	343	0.00	
	55.0-57.5				36					10.00	2484	1.25	
78-247	17.5-20.0				22					5.63	1479	0.25	
	20.5-25.0				31					7.50	544	0.00	
	37.5-40.0				30					6.88	955	0.25	
78-248	22.5-25.0				36					6.88	758	0.25	
78-249	57.5-60				32					7.50	2777	2.00	

FAILURE SKETCHES



☐ CONTROLLED STRESS

☐ CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN						
INITIAL	WATER CONTENT	w_o	%	%	%	%
	VOID RATIO	e_o				
	SATURATION	S_o	%	%	%	%
	DRY DENSITY, LB/CU FT	γ_d				
TIME TO FAILURE, MIN		t_f				
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u				
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u				
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o				
INITIAL SPECIMEN HEIGHT, IN.		H_o				

CLASSIFICATION

LL	PL	PI	G_s

REMARKS

○ 78-241, C8, 22.5-25.0

△ 78-242, C8, 20.0-22.5

⬡ 78-247, C7, 22.5-25.0

PROJECT: FREEPORT HARBOR, TEXAS

50' PROJECT

AREA: GDLR 1631

BORING NO. | SAMPLE NO.

DEPTH EL | DATE

UNCONFINED COMPRESSION TEST REPORT

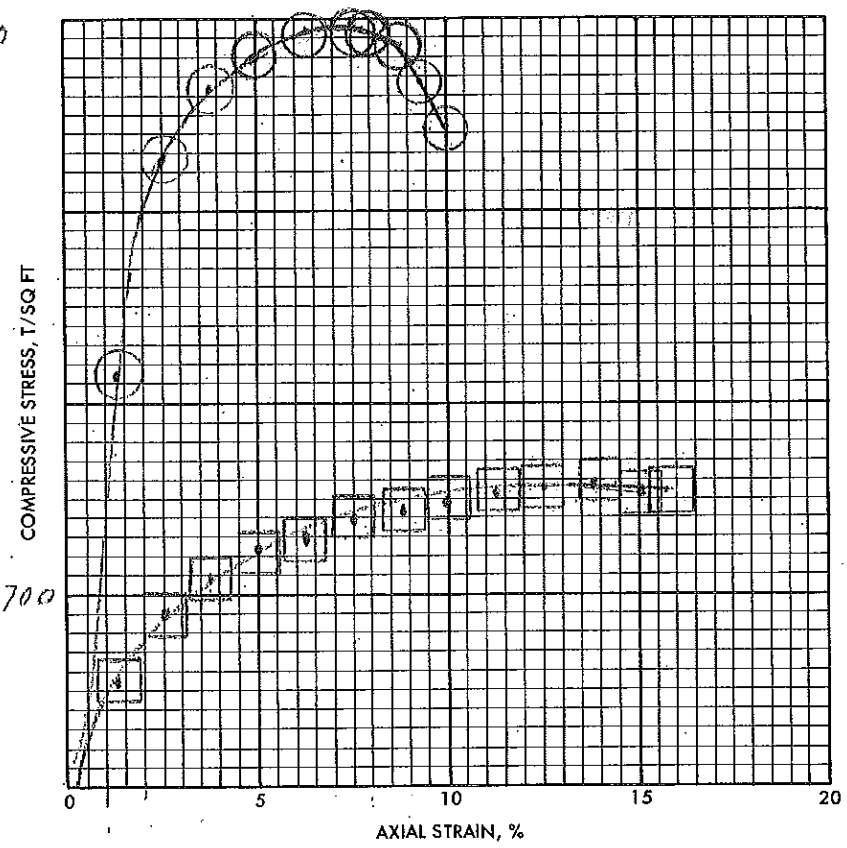
ENG FORM 1 JUN 65 **3659** *(EM 1110-2-1906)* *(TRANSLUCENT)* GPO : 1966 OF—214-946 PLATE XI-2-1

FAILURE SKETCHES 2800

2100

1400

700



☐ CONTROLLED STRESS

☐ CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN						
INITIAL	WATER CONTENT	w_o	%	%	%	%
	VOID RATIO	e_o				
	SATURATION	S_o	%	%	%	%
	DRY DENSITY, LB/CU FT	γ_d				
TIME TO FAILURE, MIN		t_f				
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u				
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u				
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o				
INITIAL SPECIMEN HEIGHT, IN.		H_o				

CLASSIFICATION

LL	PL	PI	G_s

REMARKS

● 78-249-S15, 57.5-60.0

■ 78-242-S16, 45.0-47.5

PROJECT FREEPORT HARBOR, TEXAS

50' PROJECT

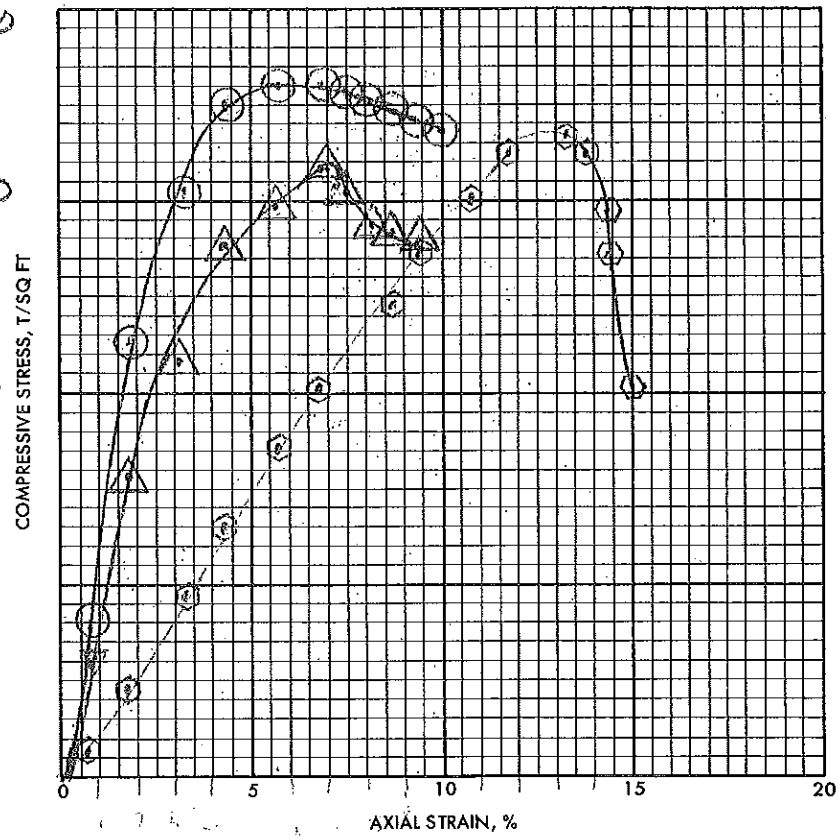
AREA GDLR 1631

BORING NO. | SAMPLE NO.

DEPTH EL | DATE

UNCONFINED COMPRESSION TEST REPORT

FAILURE SKETCHES



☐ CONTROLLED STRESS

☐ CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN						
INITIAL	WATER CONTENT	w_o	%	%	%	%
	VOID RATIO	e_o				
	SATURATION	S_o	%	%	%	%
	DRY DENSITY, LB/CU FT	γ_d				
TIME TO FAILURE, MIN		t_f				
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u				
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u				
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o				
INITIAL SPECIMEN HEIGHT, IN.		H_o				

CLASSIFICATION

LL	PL	PI	G_s

REMARKS

○ 78-245, C11, 33.0-35.0

△ 78-247, C11, 37.5-40.0

⬡ 78-241, C13, 35.0-37.5

PROJECT: FREEPORT HARBOR, TEXAS

50' PROJECT

AREA: GDLR 1631

BORING NO. | SAMPLE NO.

DEPTH EL | DATE

UNCONFINED COMPRESSION TEST REPORT

ENG FORM 3659 1 JUN 65 (EM 1110-2-1906)

(TRANSLUCENT)

GPO : 1966 OF—214-946

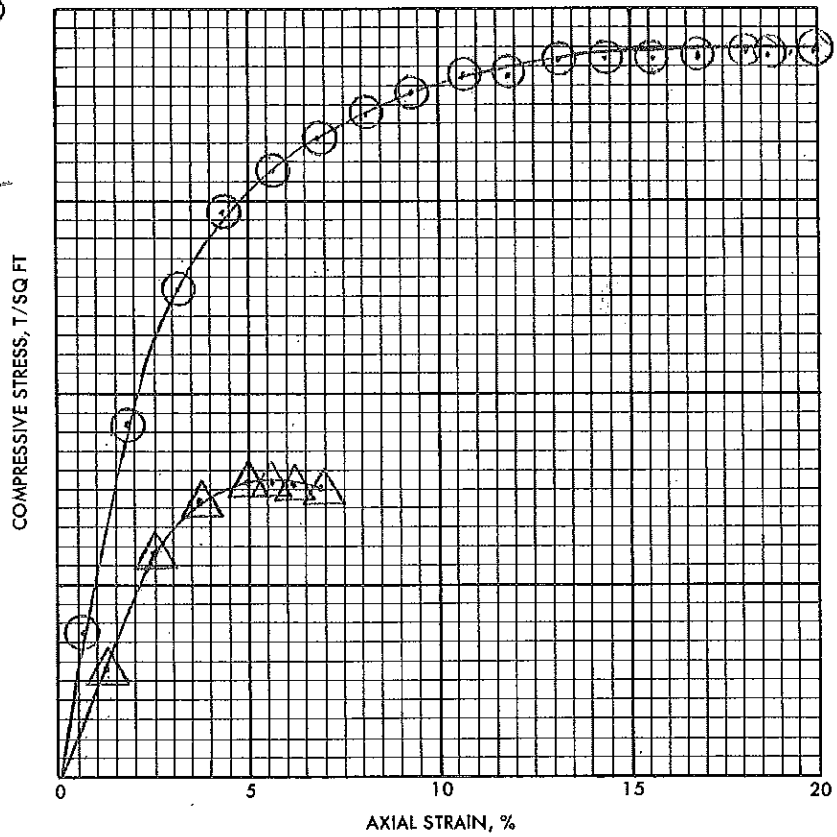
PLATE XI-2-3

FAILURE SKETCHES 900

675

450

325



☐ CONTROLLED STRESS

☐ CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN						
INITIAL	WATER CONTENT	w_o	%	%	%	%
	VOID RATIO	e_o				
	SATURATION	S_o	%	%	%	%
	DRY DENSITY, LB/CU FT	γ_d				
TIME TO FAILURE, MIN		t_f				
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u				
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u				
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o				
INITIAL SPECIMEN HEIGHT, IN.		H_o				

CLASSIFICATION

LL	PL	PI	G_s

REMARKS

○ 78-244, C6, 17.5-20.0

△ 78-246, C9, 32.5-35.0

PROJECT FREEPORT HARBOR, TEXAS

50' PROJECT

AREA GDLR 1631

BORING NO. | SAMPLE NO.

DEPTH EL | DATE

UNCONFINED COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 **3659** (EM 1110-2-1906) (TRANSLUCENT) GPO : 1966 OF—214-946 PLATE XI-2-A

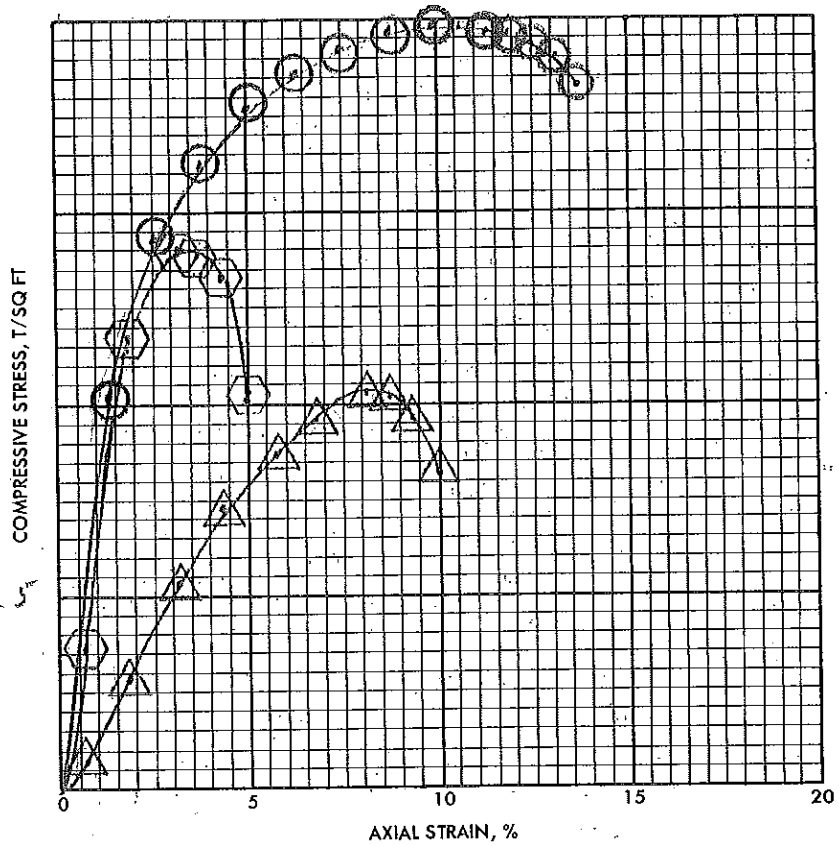
FAILURE SKETCHES

2500

1875

1250

625



☐ CONTROLLED STRESS

☐ CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN						
INITIAL	WATER CONTENT	w_o	%	%	%	%
	VOID RATIO	e_o				
	SATURATION	S_o	%	%	%	%
	DRY DENSITY, LB/CU FT	γ_d				
TIME TO FAILURE, MIN		t_f				
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u				
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u				
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o				
INITIAL SPECIMEN HEIGHT, IN.		H_o				

CLASSIFICATION

LL	PL	PI	G_s

REMARKS

○ 78-246, C15, 55.0-57.5

◇ 78-243, C12, 55.0-57.5

△ 78-245, C6, 15.0-17.5

PROJECT FREEPORT HARBOR, TEXAS

50' PROJECT

AREA GDLR 1631

BORING NO. | SAMPLE NO.

DEPTH EL | DATE

UNCONFINED COMPRESSION TEST REPORT

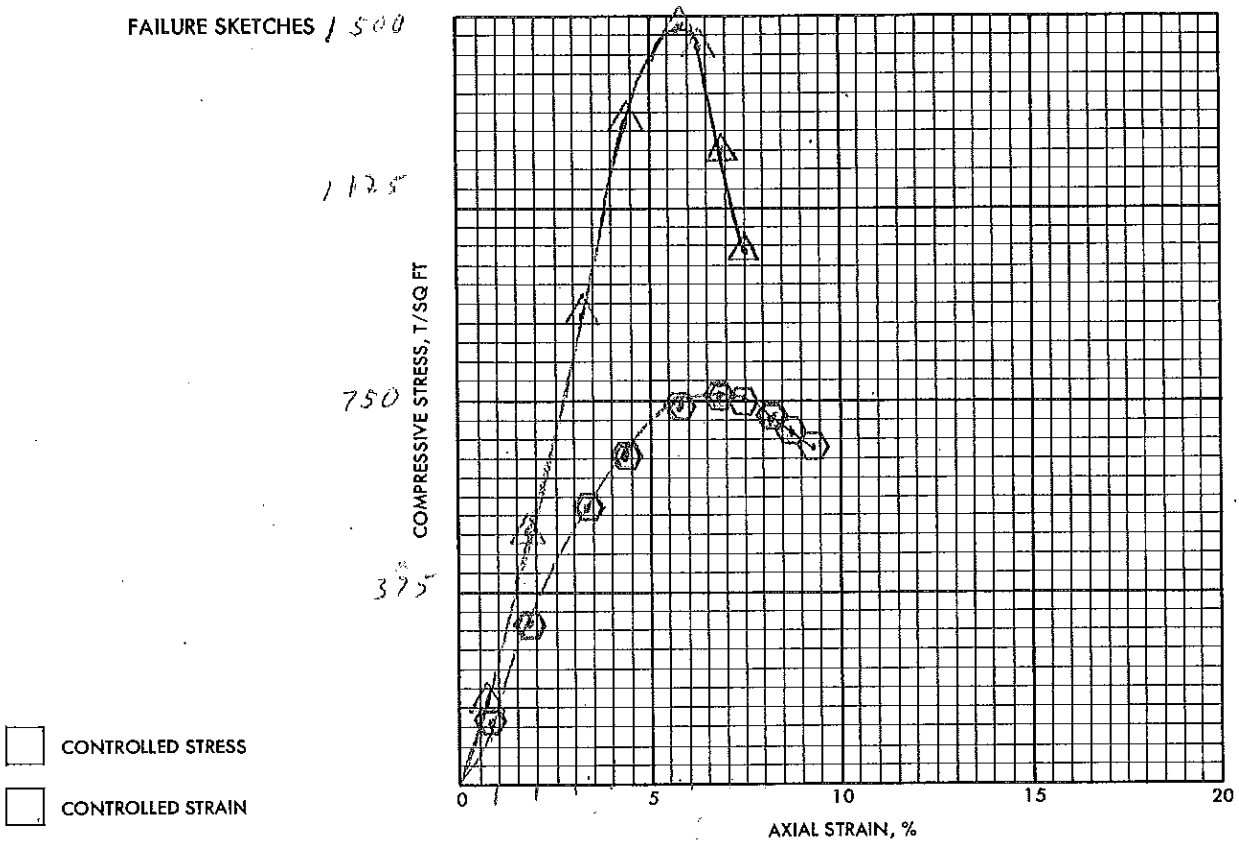
ENG FORM 3659 1 JUN 65 (EM 1110-2-1906)

(TRANSLUCENT)

GPO : 1966 OF—214-946

PLATE XI-2-5

FAILURE SKETCHES



☐ CONTROLLED STRESS

☐ CONTROLLED STRAIN

TEST NO.					
TYPE OF SPECIMEN					
INITIAL WATER CONTENT	w_o	%	%	%	%
INITIAL VOID RATIO	e_o				
INITIAL SATURATION	S_o	%	%	%	%
INITIAL DRY DENSITY, LB/CU FT	γ_d				
TIME TO FAILURE, MIN	t_f				
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT	q_u				
UNDRAINED SHEAR STRENGTH, T/SQ FT	s_u				
SENSITIVITY RATIO	S_t				
INITIAL SPECIMEN DIAMETER, IN	D_o				
INITIAL SPECIMEN HEIGHT, IN.	H_o				

CLASSIFICATION

LL	PL	PI	G_s

REMARKS

△ 78-247, C-5, 17.5-20.0

○ 78-248, C-9, 22.5-25.0

PROJECT FREEPORT HARBOR, TEXAS

50' PROJECT

AREA GDLR 1631

BORING NO. | SAMPLE NO.

DEPTH EL | DATE

UNCONFINED COMPRESSION TEST REPORT

ENG FORM 3659 1 JUN 65 (EM 1110-2-1906)

(TRANSLUCENT)

GPO : 1966 OF—214-946

PLATE XI-2-6

INTRA-ARMY ORDER FOR REIMBURSABLE SERVICES

For use of this form, see AR 37-103 and AR 37-110; the proponent agency is Office of the Comptroller of the Army.

1. RECEIVING OFFICE CONTROL NUMBER

☐ FUNDED ☐ AUTOMATIC

2. ORDER
a. NUMBER: 79V021
b. DATE: 12 Jan 79

3. CHANGE ORDER
a. NUMBER:
b. DATE:

4. ORDERED BY (Command, Installation or Activity), ADDRESS (Include zip code), AND AUTOVON NUMBER

U. S. Army Engineer District, Galveston
Corps of Engineers, P. O. Box 1229
Galveston, Texas 77553
ATTN: SWGED-F

5. TO BE PERFORMED BY (Command, Installation or Activity), ADDRESS (Include zip code), AND AUTOVON NUMBER

Southwestern Division Laboratory
U. S. Army Engr Div, Southwestern
4815 Cass Street
Dallas, Texas

6. DESCRIPTION OF SERVICES TO BE PERFORMED

Job: Freeport Harbor, Texas (45-Foot Project)
Location: Freeport, Texas
Directive Job No.: BA008304J20B000
Estimated Cost: $1,880

See attached sheet for samples submitted and tests requested. Test results are requested by 1 May 1979.

Additional Instructions:

The amount of direct charges authorized by this order will not be exceeded without prior approval of this office.

Billing will be on SF 1080 and will cite the order number shown in block 2a above, indicating either a partial or final billing. Receipt of final billing will constitute a termination of this order and an automatic withdrawal of any unused balance.

7a. NAME AND TITLE OF ORDERING OFFICER

JOSEPH C. TRAHAN
Chief, Engineering Division

b. SIGNATURE: Joseph C. Trahan

c. DATE: 4/15/79

ORIGINATING FINANCE AND ACCOUNTING OFFICE APPROVAL

8a. ACCOUNTING CLASSIFICATION: 96X3121 BA008304J20B000

b. AMOUNT: $2,068

c. CHANGE
INCREASE AMOUNT _____ DECREASE AMOUNT _____ REVISED AMOUNT _____

9. Services to be performed pursuant to this order are properly chargeable to the appropriations or other accounts indicated above until _____ (Day - Month - Year) the expiration date of this order.

10a. TYPED NAME AND TITLE OF APPROVING OFFICER

b. SIGNATURE

c. DATE

ACCEPTING OFFICER

11. THE ABOVE TERMS AND CONDITIONS ARE SATISFACTORY AND ARE ACCEPTED.

a. TYPED NAME AND TITLE OF ACCEPTING OFFICER

b. SIGNATURE

c. DATE ACCEPTED

DA FORM 1 DEC 75 2544

REPLACES EDITION OF OCT 64 WHICH WILL BE USED UNTIL EXHAUSTED.

☆ U.S.GPO:1975-0-665-697/79

12 January 1979

FREEPORT HARBOR, TEXAS
(45-FOOT PROJECT)

TEST REQUEST 79V021

A. Testing Requested on all Samples:

S-1	Visual Classification	4 @	$ 6.00	$ 24.00
S-3	Unit Weight and Water Content	4 @	24.00	96.00
S-4	Grain-size Analysis, Sieve	4 @	20.00	80.00
S-9	Liquid Limit	4 @	20.00	80.00
S-10	Plastic Limit	4 @	20.00	80.00
S-32a	Saturated Q Triaxial Compression	3 @	365.00	1,095.00
S-33	R Triaxial Compression	1 @	425.00	425.00
			Total	$1,880.00

B. Samples Submitted:

Boring No.	Sample No.	Sample Depth	Tests Requested
78-242	S-7	18.0-20.0	32a
78-242	S-12	35.0-37.5	32a
78-245	S-7	17.5-20.0	33
78-248	S-8	20.0-22.5	32a

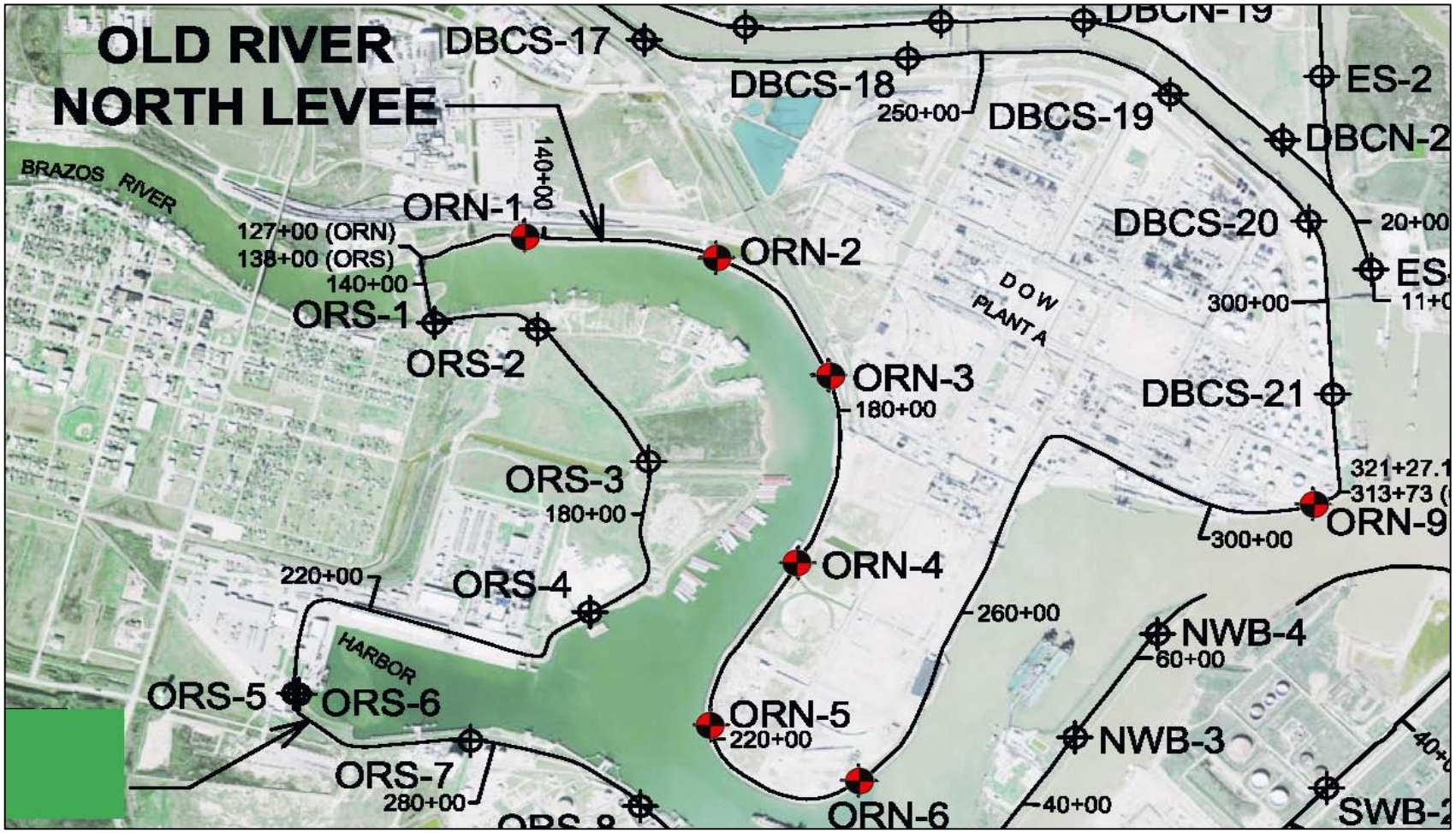
Normal loads of 0.5, 1.0 and 3.0 T/SF on all samples.

ATTACHMENT 7

Enclosure 2

APPENDIX

BORING LOCATION PLAN



NOTES:

- APPROXIMATE BORING LOCATIONS

N

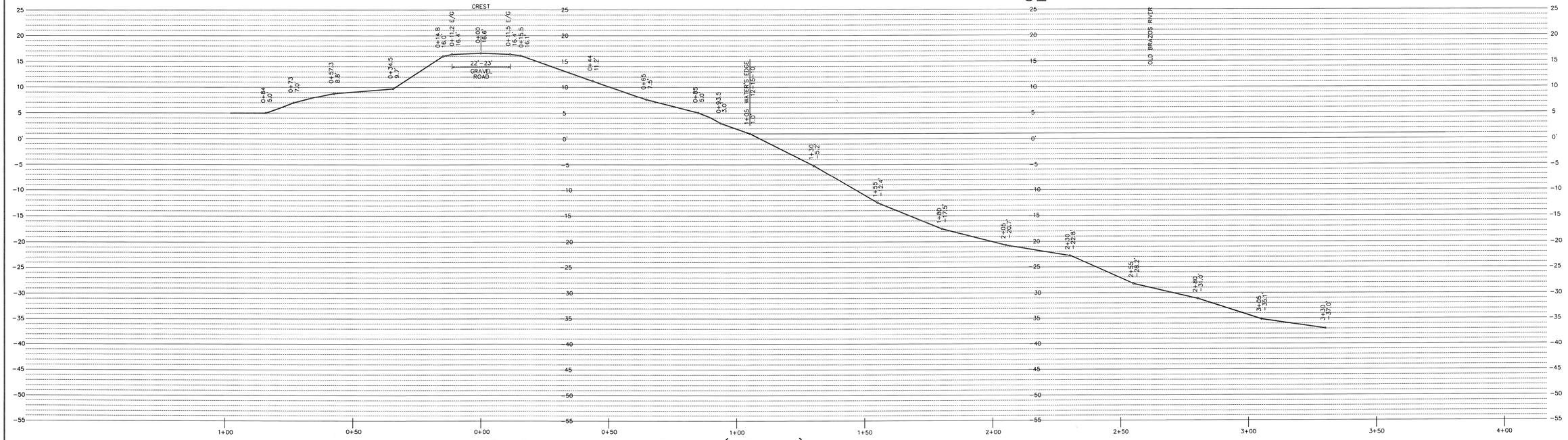
FREEPORT HURRICANE FLOOD PROTECTION LEVEE
FREEPORT, TEXAS

Professional Service Industries, Inc.
1714 Memorial Drive
Houston, Texas 77007

Drawn:	Scale:	Project No.
LN	NOT TO SCALE	291-100
Chkd:	Date:	
EC	6/17/2011	

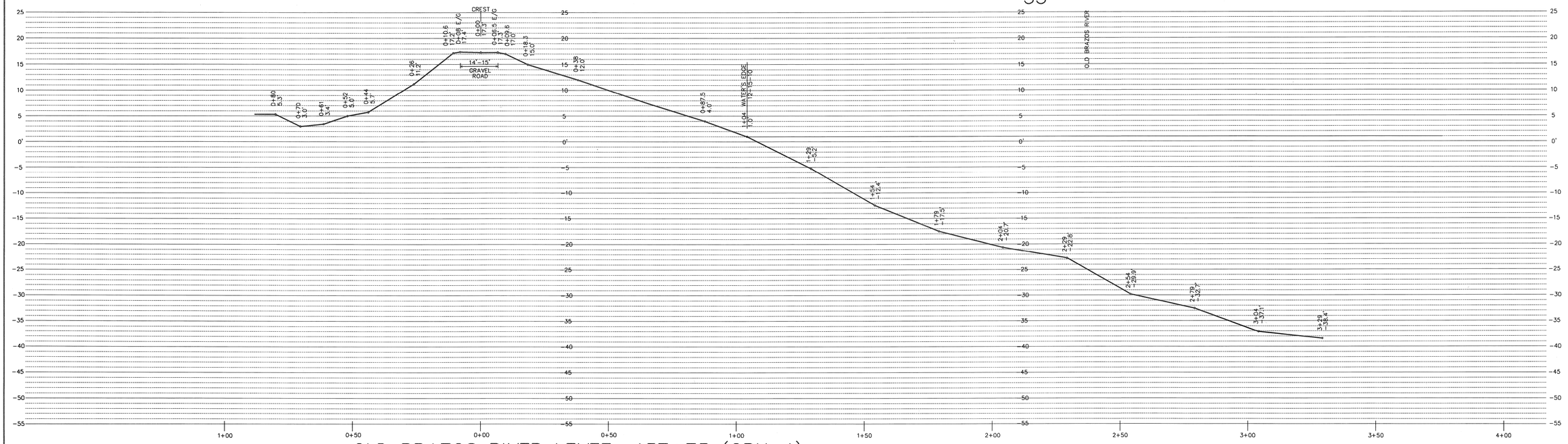
PLATE 1

52



OLD BRAZOS RIVER LEVEE 157+73 (ORN-2)

53



OLD BRAZOS RIVER LEVEE 137+73 (ORN-1)

NO.	DATE	DESCRIPTION	APPROVED

REVISIONS

DESIGNED HSS
DRAWN BB
CHECKED
DATE

B&L
BAKER & LAWSON, INC.
ENGINEERS · PLANNERS · SURVEYORS
300 E. CEDAR ST., ANGLETON, TEXAS 77515
PHONE: 979-849-8681 FAX: 979-849-4889
REG. NO. F-825

OWNER:
VELASCO DRAINAGE DISTRICT
CLUTE, TEXAS

SCALE:
PLAN:
PROFILE:
HORIZONTAL: 1"= 20'
VERTICAL: 1"= 10'

VELASCO DRAINAGE DISTRICT LEVEE COMPLIANCE DETERMINATION

SHEET 1 OF SHEETS

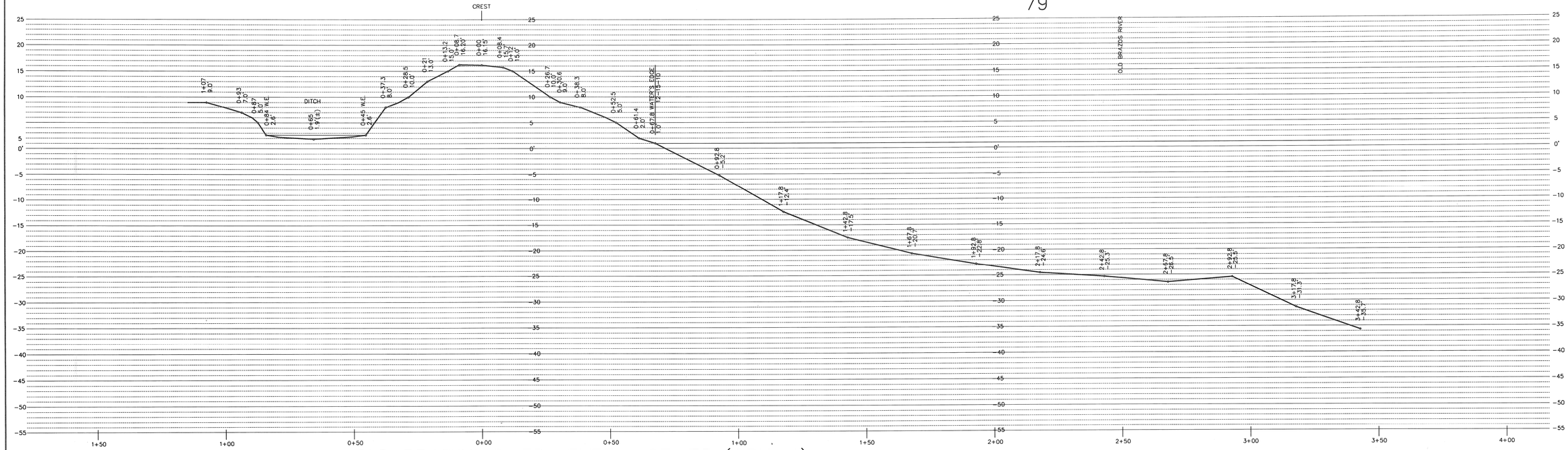
OLD RIVER
NORTH LEVEE
CROSS SECTIONS

PROJECT NO. 10507

1

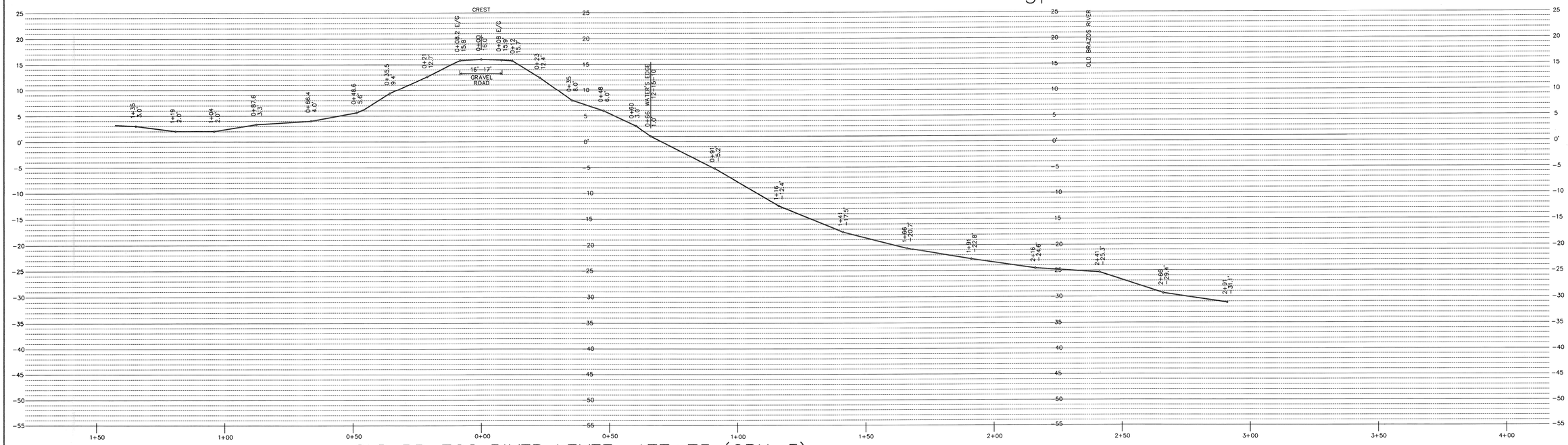
Plate 2A

79



OLD BRAZOS RIVER LEVEE 197+73 (ORN-4)

51



OLD BRAZOS RIVER LEVEE 177+73 (ORN-3)

NO.	DATE	DESCRIPTION	APPROVED
		REVISIONS	

DESIGNED HSS
DRAWN BB
CHECKED
DATE

B&L
BAKER & LAWSON, INC.
ENGINEERS • PLANNERS • SURVEYORS
300 E. CEDAR ST, ANGLETON, TEXAS 77515
PHONE: 979-849-6681 FAX: 979-849-4689
REG. NO. F-825

OWNER:
VELASCO DRAINAGE DISTRICT
CLUTE, TEXAS

SCALE:
PLAN:
PROFILE:
HORIZONTAL: 1" = 20'
VERTICAL: 1" = 10'

VELASCO DRAINAGE DISTRICT LEVEE COMPLIANCE DETERMINATION

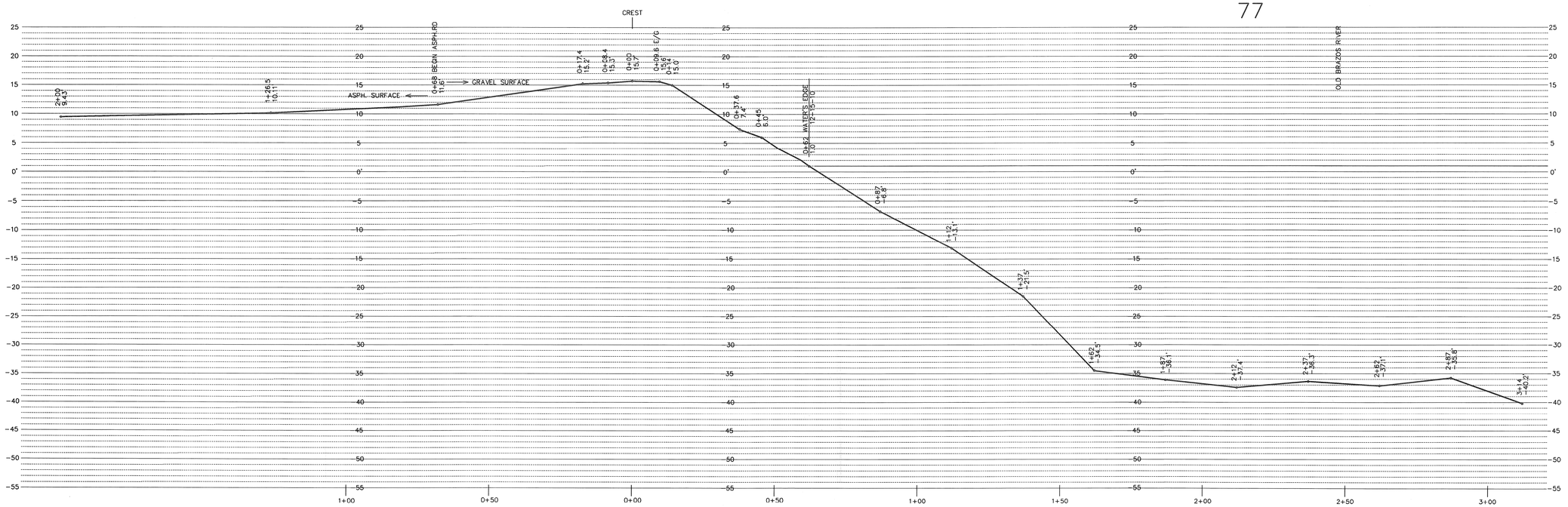
SHEET 2 OF SHEETS

OLD RIVER
NORTH LEVEE
CROSS SECTIONS

PROJECT NO. 10507

2

Plate 2B



OLD BRAZOS RIVER LEVEE 209+00

NO.	DATE	DESCRIPTION	APPROVED
		REVISIONS	

DESIGNED HSS
DRAWN BB
CHECKED
DATE

B&L
BAKER & LAWSON, INC.
ENGINEERS • PLANNERS • SURVEYORS
300 E. CEDAR ST, ANGLETON, TEXAS 77515
PHONE: 979-849-6981 FAX: 979-849-4889
REG. NO. F-825

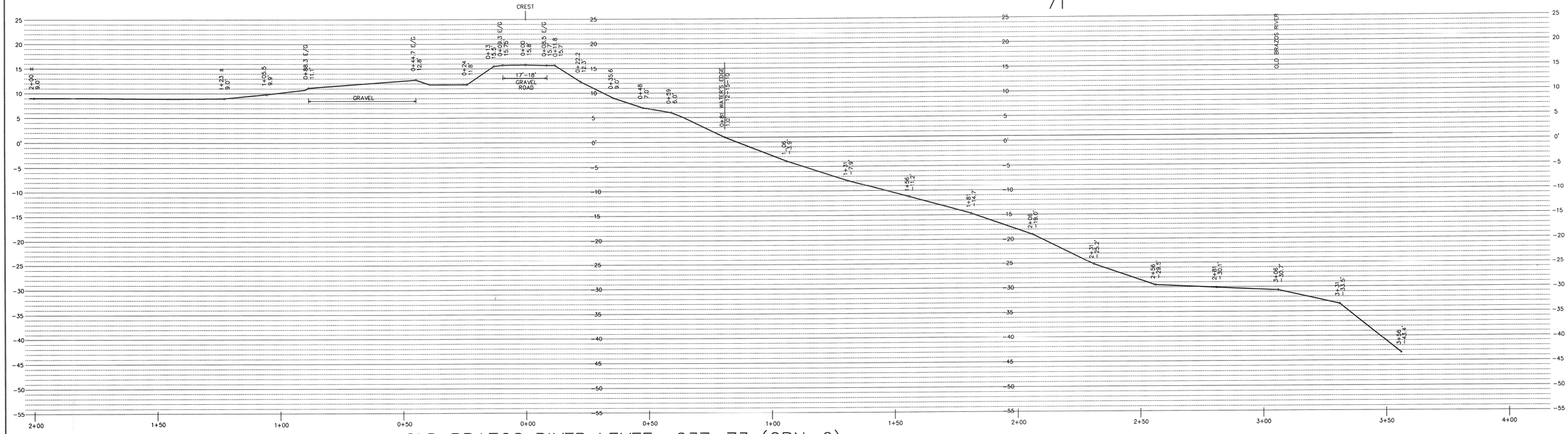
OWNER:
VELASCO DRAINAGE DISTRICT
CLUTE, TEXAS

SCALE:
PLAN:
PROFILE:
HORIZONTAL: 1"= 20'
VERTICAL: 1"= 10'

VELASCO DRAINAGE DISTRICT
LEVEE COMPLIANCE
DETERMINATION

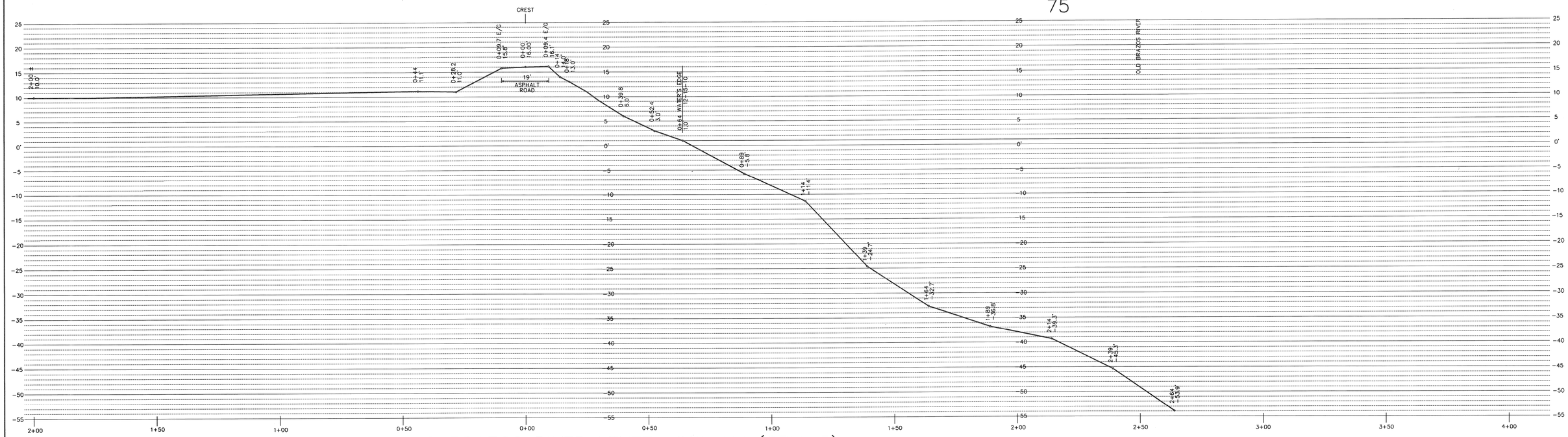
SHEET 3A OF SHEETS
OLD RIVER
NORTH LEVEE
CROSS SECTIONS
PROJECT NO. 10507
3A

71



OLD BRAZOS RIVER LEVEE 237+73 (ORN-6)

75



OLD BRAZOS RIVER LEVEE 217+73 (ORN-5)

NO.	DATE	DESCRIPTION	APPROVED

REVISIONS

DESIGNED HSS
DRAWN BB
CHECKED
DATE

B&L
BAKER & LAWSON, INC.
ENGINEERS • PLANNERS • SURVEYORS
300 E. CEDAR ST., ANGLETON, TEXAS 77515
PHONE: 979-849-9581 FAX: 979-849-4689
REG. NO. F-825

OWNER:
VELASCO DRAINAGE DISTRICT
CLUTE, TEXAS

SCALE:
PLAN:
PROFILE:
HORIZONTAL: 1"= 20'
VERTICAL: 1"= 10'

VELASCO DRAINAGE DISTRICT LEVEE COMPLIANCE DETERMINATION

SHEET 3 OF SHEETS

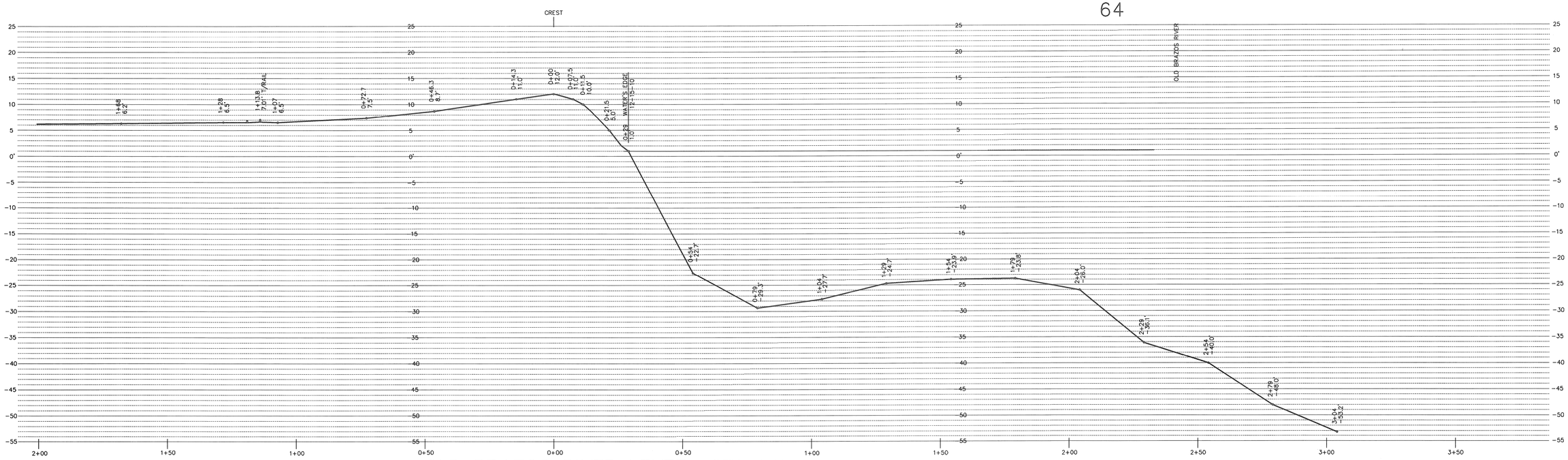
OLD RIVER
NORTH LEVEE
CROSS SECTIONS

PROJECT NO. 10507

3

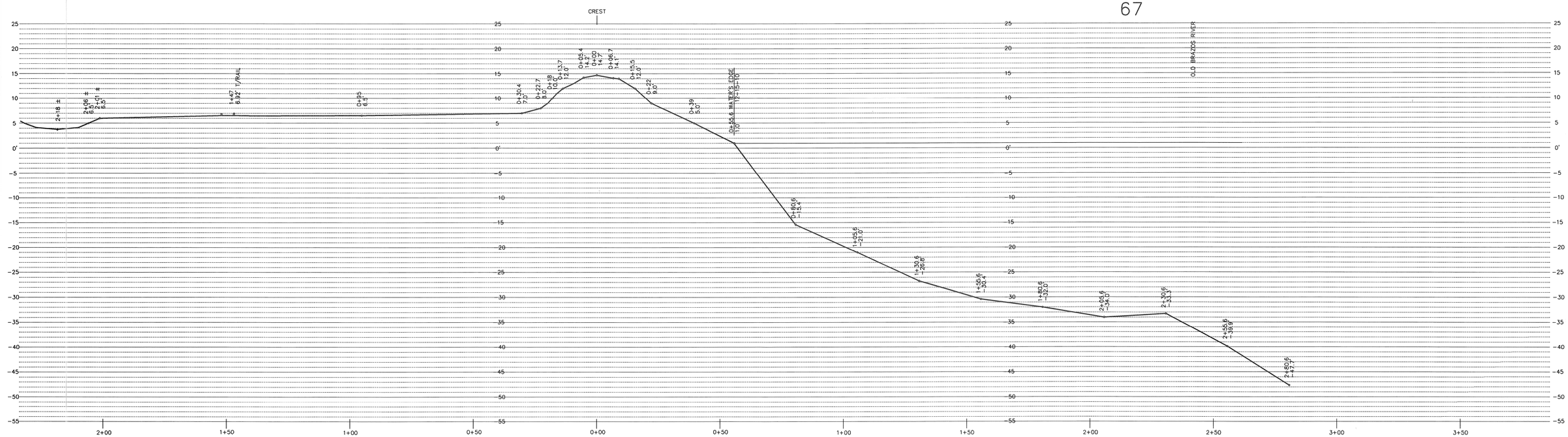
Plate 2D

64



OLD BRAZOS RIVER LEVEE 271+73

67



OLD BRAZOS RIVER LEVEE 257+73

NO.	DATE	DESCRIPTION	APPROVED
		REVISIONS	

DESIGNED HSS
DRAWN BB
CHECKED
DATE

BAKER & LAWSON, INC.
ENGINEERS • PLANNERS • SURVEYORS
300 E. CEDAR ST., ANGLETON, TEXAS 77515
PHONE: 979-849-6681 FAX: 979-849-4889
REG. NO. F-825

OWNER:
VELASCO DRAINAGE DISTRICT
CLUTE, TEXAS

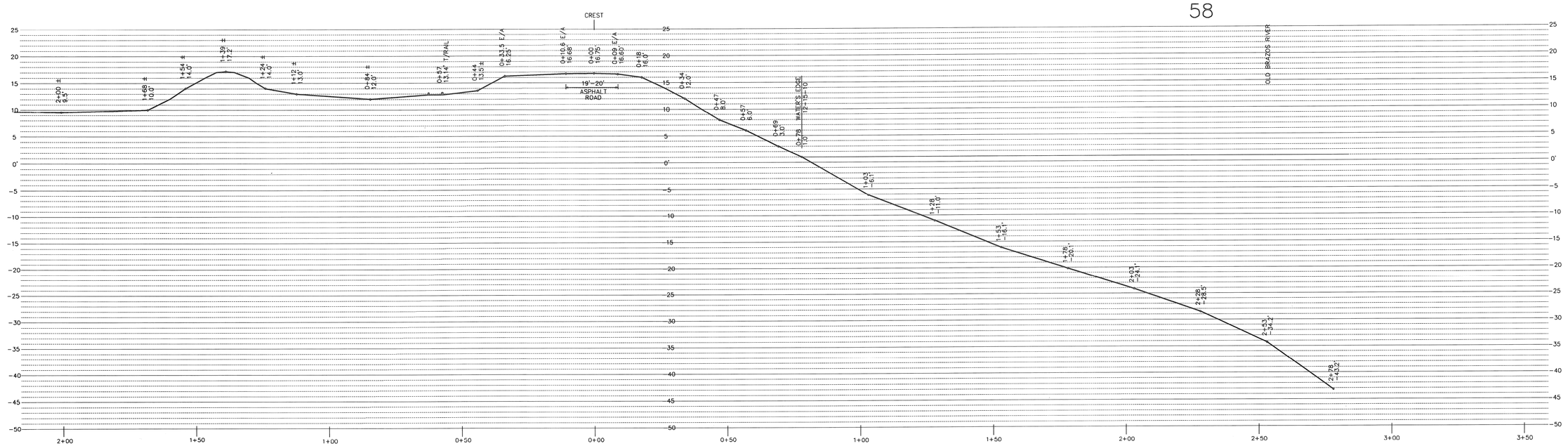
SCALE:
PLAN:
PROFILE:
HORIZONTAL: 1"= 20'
VERTICAL: 1"= 10'

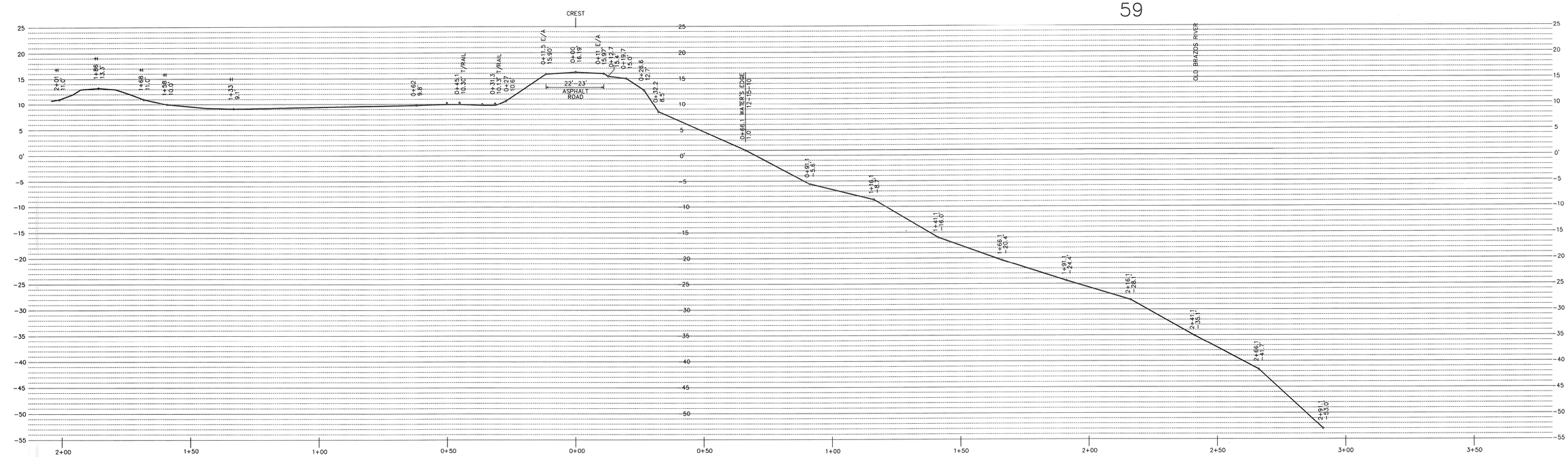
VELASCO DRAINAGE DISTRICT LEVEE COMPLIANCE DETERMINATION

SHEET 4 OF SHEETS

OLD RIVER NORTH LEVEE CROSS SECTIONS

PROJECT NO. 10507





NO.	DATE	DESCRIPTION	APPROVED
		REVISIONS	

DESIGNED HSS
DRAWN BB
CHECKED
DATE

B&L
BAKER & LAWSON, INC.
ENGINEERS • PLANNERS • SURVEYORS
300 E. CEDAR ST, ANGLETON, TEXAS 77515
PHONE: 979-849-6881 FAX: 979-849-4689
REG. NO. F-825

OWNER:
VELASCO DRAINAGE DISTRICT
CLUTE, TEXAS

SCALE:
PLAN:
PROFILE:
HORIZONTAL: 1"= 20'
VERTICAL: 1"= 10'

VELASCO DRAINAGE DISTRICT LEVEE COMPLIANCE DETERMINATION

SHEET 5 OF SHEETS

OLD RIVER
NORTH LEVEE
CROSS SECTIONS

PROJECT NO. 10507

Plate 2F

LOG OF BORING ORN-01

FREEPORT LEVEE SYSTEM: OLD RIVER NORTH LEVEE
FREEPORT, TEXAS

TYPE OF BORING: SOLID FLIGHT AUGER/WET ROTARY

PSI Project No.: 291-100

COORDINATE (X) OR EASTING: 3140243.877
COORDINATE (Y) OR NORTHING: 13548542.85
APPROXIMATE SURFACE ELEVATION: 16.76 FEET
STATION NO: 137+96

DEPTH, FT.	SOIL TYPE	USCS SYMBOL	SAMPLES	SOIL DESCRIPTION	N-BLOWS/FT.	% PASSING No. 200 SIEVE	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	SHEAR STRENGTH (tons/square foot) ○ HP ● UC △ TV ▲ UU 0.0 0.5 1.0 1.5 2.0 2.5	DRY UNIT WEIGHT (pcf)
		FILL		**FILL: CLAYEY SAND**, DENSE, GRAY - with gravel at 0-2 ft.	34					21		
		FILL		**FILL: SANDY LEAN CLAY**, STIFF TO VERY STIFF, BROWN AND YELLOWISH BROWN - with gravel at 2-6 ft. - with ferrous stains at 4-8 ft.		58	37	18	19	19 19		109
5					8					19		
				- with gravel at 8-12 ft.						18		
10				- with organic material at 10-12 ft.						15		
		FILL		**FILL: FAT CLAY WITH SAND**, FIRM TO STIFF, YELLOWISH BROWN - with calcareous nodules at 12-14 ft.	5	80	77	22	55	29		
15				- with gravel at 14-18 ft.						23		
					9					39		
		CH		**FAT CLAY (CH)**, STIFF, BROWN		90	65	25	40	31		
20				- with calcareous nodules at 20-22 ft.						32		93
				- with silt seams at 22-24 ft.	5					39		
25												
30												
35												
40												
45												
50												

DEPTH OF BORING: 24 FEET
DATE DRILLED: 1/5/11
NOTES:

INITIAL GROUND WATER: 24 FEET
FINAL GROUND WATER:

BORINGLOG_HOUSTON - PSIHOUSTON.GDT - 6/7/11 10:38 - C:\DOCUMENTS AND SETTINGS\911769\DESKTOP\003 BORING LOGS\OLD RIVER NORTH LEVEE.GPJ

psi Information To Build On
Engineering • Consulting • Testing
Geotechnical Consulting Services
1714 Memorial Drive
Houston, Texas 77007

LOG OF BORING ORN-02

FREEPORT LEVEE SYSTEM: OLD RIVER NORTH LEVEE
FREEPORT, TEXAS

TYPE OF BORING: SOLID FLIGHT AUGER/WET ROTARY

PSI Project No.: 291-100

COORDINATE (X) OR EASTING: 3142208.527
COORDINATE (Y) OR NORTHING: 13548294.31
APPROXIMATE SURFACE ELEVATION: 16.26 FEET
STATION NO: 157+92

DEPTH, FT.	SOIL TYPE	USCS SYMBOL	SAMPLES	SOIL DESCRIPTION	N-BLOWS/FT.	% PASSING No. 200 SIEVE	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	SHEAR STRENGTH (tons/square foot) ○ HP ● UC △ TV ▲ UU 0.0 0.5 1.0 1.5 2.0 2.5	DRY UNIT WEIGHT (pcf)
		FILL		**FILL: CLAYEY SAND**, MEDIUM DENSE, GRAY - with gravel at 0-2 ft.	24					9		
		FILL		**FILL: LEAN CLAY**, STIFF, GRAY AND YELLOWISH BROWN - with gravel at 2-4 ft.						21	○	
5		FILL		**FILL: CLAYEY SAND**, VERY LOOSE TO MEDIUM DENSE, BROWN - with calcareous nodules at 4-8 ft.		44	34	13	21	16	⊖	
					18					18		
					3					18		
10					6	29				45	●	110
15												
20												
25												
30												
35												
40												
45												
50												

DEPTH OF BORING: 12 FEET
DATE DRILLED: 1/5/11
NOTES:

INITIAL GROUND WATER: 12 FEET
FINAL GROUND WATER:

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LOG OF BORING ORN-03

FREEPORT LEVEE SYSTEM: OLD RIVER NORTH LEVEE
FREEPORT, TEXAS

TYPE OF BORING: SOLID FLIGHT AUGER/WET ROTARY

PSI Project No.: 291-100

COORDINATE (X) OR EASTING: 3143364.122
COORDINATE (Y) OR NORTHING: 13546989.15
APPROXIMATE SURFACE ELEVATION: 15.63 FEET
STATION NO: 175+97

DEPTH, FT.	SOIL TYPE	USCS SYMBOL	SAMPLES	SOIL DESCRIPTION	N-BLOWS/FT.	% PASSING No. 200 SIEVE	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	SHEAR STRENGTH (tons/square foot) ○ HP ● UC △ TV ▲ UU 0.0 0.5 1.0 1.5 2.0 2.5	DRY UNIT WEIGHT (pcf)
		FILL		**FILL: CLAYEY SAND**, LOOSE, BROWN - with gravel at 0-2 ft.	5					23		
		FILL		**FILL: SANDY LEAN CLAY**, STIFF, BROWN - with gravel at 2-16 ft.						18		
5										12		
						66	46	13	33	17		
				- with organic material at 8-10 ft.						11		
10										13		
		CH		**FAT CLAY (CH)**, FIRM TO VERY STIFF, BROWN, DARK BROWN, REDDISH BROWN AND GRAY - with calcareous nodules at 12-14 ft.						33		
15						96				30		
										39		
										36		
20						98	74	25	49	37		86
				- with calcareous and ferrous nodules at 24-25 ft.						33		
25										27		
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 FEET
DATE DRILLED: 1/6/11
NOTES:

INITIAL GROUND WATER: APPROX.16 FEET
FINAL GROUND WATER:

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LOG OF BORING ORN-04

FREEPORT LEVEE SYSTEM: OLD RIVER NORTH LEVEE
FREEPORT, TEXAS

TYPE OF BORING: SOLID FLIGHT AUGER/WET ROTARY

PSI Project No.: 291-100

COORDINATE (X) OR EASTING: 3143049.214
COORDINATE (Y) OR NORTHING: 13544905.8
APPROXIMATE SURFACE ELEVATION: 16.06 FEET
STATION NO: 197+84

DEPTH, FT.	SOIL TYPE	USCS SYMBOL	SAMPLES	SOIL DESCRIPTION	N-BLOWS/FT.	% PASSING No. 200 SIEVE	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	SHEAR STRENGTH (tons/square foot) ○ HP ● UC △ TV ▲ UU 0.0 0.5 1.0 1.5 2.0 2.5	DRY UNIT WEIGHT (pcf)
		FILL		**FILL: SAND AND GRAVEL**, LOOSE, GRAY - with shell fragments	7					5		
		FILL		**FILL: SANDY FAT CLAY**, STIFF, BROWN AND REDDISH BROWN - with gravel at 2-8 ft.	10	70				6		
5										20		
				- with sand pockets at 6-10 ft. - with organic material at 6-10 ft.		65	81	24	57	24		93
										23		
10		FILL		**FILL: FAT CLAY**, STIFF, DARK BROWN TO BROWN - HC at 10 to 12 ft., K=6.56 E-10 ft/sec - with sand pockets at 12-14 ft.		92	53	19	34	25		
										21		
15		CH		**FAT CLAY WITH SAND (CH)**, STIFF, DARK BROWN AND BROWN - with ferrous stains at 16-20 ft.						31		
										34		
				- with calcareous nodules at 18-20 ft.						27		
20										41		
										43		
25				- gray with calcareous nodules at 24-25 ft.		84	50	17	33	24		101
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 FEET
DATE DRILLED: 1/5/11
NOTES: HC - Hydraulic Conductivity Test

INITIAL GROUND WATER: 16 FEET
FINAL GROUND WATER:

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PLATE NO: 6 (Page 1 of 1)

LOG OF BORING ORN-05

FREEPORT LEVEE SYSTEM: OLD RIVER NORTH LEVEE
FREEPORT, TEXAS

TYPE OF BORING: SOLID FLIGHT AUGER/WET ROTARY

PSI Project No.: 291-100

COORDINATE (X) OR EASTING: 3142159.862
COORDINATE (Y) OR NORTHING: 13543106.59
APPROXIMATE SURFACE ELEVATION: 15.77 FEET
STATION NO: 218+39

DEPTH, FT.	SOIL TYPE	USCS SYMBOL	SAMPLES	SOIL DESCRIPTION	N-BLOWS/FT.	% PASSING No. 200 SIEVE	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	SHEAR STRENGTH (tons/square foot) ○ HP ● UC △ TV ▲ UU 0.0 0.5 1.0 1.5 2.0 2.5	DRY UNIT WEIGHT (pcf)
		FILL		**FILL: CLAYEY SAND**, MEDIUM DENSE, BROWN - with gravel at 0-2 ft.	13					20		
		FILL		**FILL: FAT CLAY**, STIFF, BROWN - with gravel at 2-8 ft.		86	61	25	36	9	○▲	104
5					14					14		
										19	○	
				- HC at 8 - 10 ft. - K = 2.33 E-09 ft/sec - SG at 8-10 ft. Gs=2.588							▲	105
10		FILL		**FILL: LEAN CLAY**, FIRM TO STIFF, BROWN - with silt seams	4					27	○	
										20	○	
15			▽							20	○	
					3					35		
		CL		**LEAN CLAY WITH SAND (CL)**, SOFT, BROWN -SG at 18-20 ft. Gs=2.683		80	42	17	25	38		
20					3					29		
					4					25		
25					2					39		
		CL		**SANDY LEAN CLAY (CL)**, SOFT, BROWN - with silt seams	2	56	27	15	12	32		
					2					34		
30												
					4					53		
35												
		SC		**CLAYEY SAND (SC)**, LOOSE, BROWN	6	40				23		
40												
					9					63		
45												
		CH		**FAT CLAY (CH)**, FIRM, BROWN - CU at 48-50 ft. - c'=0.58 ksf, ϕ'= 23.4^0		99	67	26	41	46		
50												

DEPTH OF BORING: 80 FEET
DATE DRILLED: 1/6/11

INITIAL GROUND WATER: 16 FEET
FINAL GROUND WATER:

NOTES: HC - Hydraulic Conductivity Test; SG - Specific Gravity Test; CU - Consolidated Undrained Triaxial Test with Pore Pressure

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LOG OF BORING ORN-05

FREEPORT LEVEE SYSTEM: OLD RIVER NORTH LEVEE
FREEPORT, TEXAS

TYPE OF BORING: SOLID FLIGHT AUGER/WET ROTARY

PSI Project No.: 291-100

COORDINATE (X) OR EASTING: 3142159.862
COORDINATE (Y) OR NORTHING: 13543106.59
APPROXIMATE SURFACE ELEVATION: 15.77 FEET
STATION NO: 218+39

DEPTH, FT.	SOIL TYPE	USCS SYMBOL	SAMPLES	SOIL DESCRIPTION	N-BLOWS/FT.	% PASSING No. 200 SIEVE	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	SHEAR STRENGTH (tons/square foot) ○ HP ● UC △ TV ▲ UU 0.0 0.5 1.0 1.5 2.0 2.5	DRY UNIT WEIGHT (pcf)
		FILL		**FILL: CLAYEY SAND**, MEDIUM DENSE, BROWN - with gravel at 0-2 ft.	13					20		
		FILL		**FILL: FAT CLAY**, STIFF, BROWN - with gravel at 2-8 ft.		86	61	25	36	9	○▲	104
5					14					14		
										19	○	
				- HC at 8 - 10 ft. - K = 2.33 E-09 ft/sec - SG at 8-10 ft. Gs=2.588							▲	105
10		FILL		**FILL: LEAN CLAY**, FIRM TO STIFF, BROWN - with silt seams	4					27	○	
										20	○	
15			▽							20	○	
					3					35		
		CL		**LEAN CLAY WITH SAND (CL)**, SOFT, BROWN -SG at 18-20 ft. Gs=2.683		80	42	17	25	38		
20					3					29		
					4					25		
25					2					39		
		CL		**SANDY LEAN CLAY (CL)**, SOFT, BROWN - with silt seams	2	56	27	15	12	32		
					2					34		
30												
					4					53		
35												
		SC		**CLAYEY SAND (SC)**, LOOSE, BROWN	6	40				23		
40												
					9					63		
45												
		CH		**FAT CLAY (CH)**, FIRM, BROWN - CU at 48-50 ft. - c'=0.58 ksf, ϕ'= 23.4^0		99	67	26	41	46		
50												

DEPTH OF BORING: 80 FEET
DATE DRILLED: 1/6/11

INITIAL GROUND WATER: 16 FEET
FINAL GROUND WATER:

NOTES: HC - Hydraulic Conductivity Test; SG - Specific Gravity Test; CU - Consolidated Undrained Triaxial Test with Pore Pressure

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LOG OF BORING ORN-05

FREEPORT LEVEE SYSTEM: OLD RIVER NORTH LEVEE
FREEPORT, TEXAS

TYPE OF BORING: SOLID FLIGHT AUGER/WET ROTARY

PSI Project No.: 291-100

DEPTH, FT.	SOIL TYPE	USCS SYMBOL	SAMPLES	SOIL DESCRIPTION	N-BLOWS/FT.	% PASSING No. 200 SIEVE	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	SHEAR STRENGTH (tons/square foot) ○ HP ● UC △ TV ▲ UU 0.0 0.5 1.0 1.5 2.0 2.5	DRY UNIT WEIGHT (pcf)
55		CH		**FAT CLAY (CH)**, FIRM, BROWN						50	○	
										46	○	
60		CH		**FAT CLAY WITH SAND (CH)**, FIRM, BROWN		75	65	25	40	41	○▲	79
65												
70		SC		**CLAYEY SAND (SC)**, MEDIUM DENSE, BROWN AND GRAY	26	27				36		
75		CH		**FAT CLAY (CH)**, STIFF, GRAY		99	84	28	56	37	▲○	81
				-with organics 78 - 80 ft.						54	○	
80												
85												
90												
95												
100												

DEPTH OF BORING: 80 FEET
DATE DRILLED: 1/6/11

INITIAL GROUND WATER: 16 FEET
FINAL GROUND WATER:

NOTES: HC - Hydraulic Conductivity Test; SG - Specific Gravity Test; CU - Consolidated Undrained Triaxial Test with Pore Pressure

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LOG OF BORING ORN-06

FREEPORT LEVEE SYSTEM: OLD RIVER NORTH LEVEE
FREEPORT, TEXAS

TYPE OF BORING: SOLID FLIGHT AUGER/WET ROTARY

PSI Project No.: 291-100

COORDINATE (X) OR EASTING: 3143668.636
COORDINATE (Y) OR NORTHING: 13542489.08
APPROXIMATE SURFACE ELEVATION: 15.71 FEET
STATION NO: 238+12

DEPTH, FT.	SOIL TYPE	USCS SYMBOL	SAMPLES	SOIL DESCRIPTION	N-BLOWS/FT.	% PASSING No. 200 SIEVE	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		FILL		**FILL: CLAYEY SAND**, MEDIUM DENSE, BROWN - with gravel	24					11
					13	23				20
5		FILL		**FILL: LEAN CLAY**, STIFF, BROWN						14
		FILL		**FILL: CLAYEY SAND**, VERY LOOSE TO MEDIUM DENSE, YELLOWISH BROWN - SA at 8 -10 ft., 0% gravel, 72.1% sand, 27.9% fines	10					12
					10	28				13
10					3					19
				- with gravel at 12-14 ft.	13	28				20
				- with root fibers 14-18 ft.						
15					3					24
					4					37
		CL		**SANDY LEAN CLAY (CL)**, VERY SOFT TO FIRM, BROWN - with silt seams	1	65	31	17	14	28
20					2					31
					6					33
25										
30										
35										
40										
45										
50										

SHEAR STRENGTH (tons/square foot)
○ HP ● UC △ TV ▲ UU
0.0 0.5 1.0 1.5 2.0 2.5

DRY UNIT WEIGHT (pcf)

DEPTH OF BORING: 24 FEET
DATE DRILLED: 1/6/11
NOTES: SA - Sieve Analysis

INITIAL GROUND WATER: 16 FEET
FINAL GROUND WATER: 15.5 FEET

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LOG OF BORING ORN-09

FREEPORT LEVEE SYSTEM: OLD RIVER NORTH LEVEE
FREEPORT, TEXAS

TYPE OF BORING: SOLID FLIGHT AUGER/WET ROTARY

PSI Project No.: 291-100

COORDINATE (X) OR EASTING: 3148325.368
COORDINATE (Y) OR NORTHING: 13545561.18
APPROXIMATE SURFACE ELEVATION: 17.17 FEET
STATION NO: 310+67

DEPTH, FT.	SOIL TYPE	USCS SYMBOL	SAMPLES	SOIL DESCRIPTION	N-BLOWS/FT.	% PASSING No. 200 SIEVE	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		FILL		**FILL: CLAYEY SAND**, MEDIUM DENSE, BROWN						13
				- with gravel - with asphalt at 0-2 ft						
				- with organic material at 2-4 ft.	12	32				17
5		FILL		**FILL: SANDY LEAN CLAY**, VERY STIFF, BROWN						15
				- with gravel at 4-6 ft. - CU at 4 - 8 ft. - c'= 0.28 ksf, ϕ'= 24.2^0						
				- SG at 6 - 8 ft.- Gs=2.731		74	44	17	27	32
		FILL		**FILL: CLAYEY SAND**, VERY LOOSE TO LOOSE, BROWN	3					33
10					3	49	23	12	11	26
					2					26
				- gray, with silt seams at 14-16 ft.						
15				- WOH: Weight of Hammer	WOH	13				25
				- with silt seams	2					24
					5	41	31	11	20	36
20										
25										
30										
35										
40										
45										
50										

SHEAR STRENGTH (tons/square foot)
○ HP ● UC △ TV ▲ UU
0.0 0.5 1.0 1.5 2.0 2.5

DRY UNIT WEIGHT (pcf)

DEPTH OF BORING: 20 FEET
DATE DRILLED: 1/7/11

INITIAL GROUND WATER: 10 FEET
FINAL GROUND WATER: 9 FEET

NOTES: SG - Specific Gravity Test; CU - Consolidated Undrained Triaxial Test with Pore Pressure

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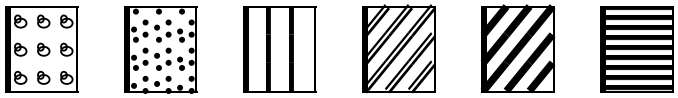
KEY TO TERMS AND SYMBOLS USED ON LOGS

SOIL TYPE

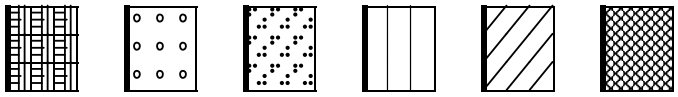


GRAVEL SAND SILT LEAN CLAY FAT CLAY PEAT

SAMPLER TYPE

NO SAMPLE | AUGER SAMPLE | SHELBY TUBE | SPLIT SPOON

MODIFIERS

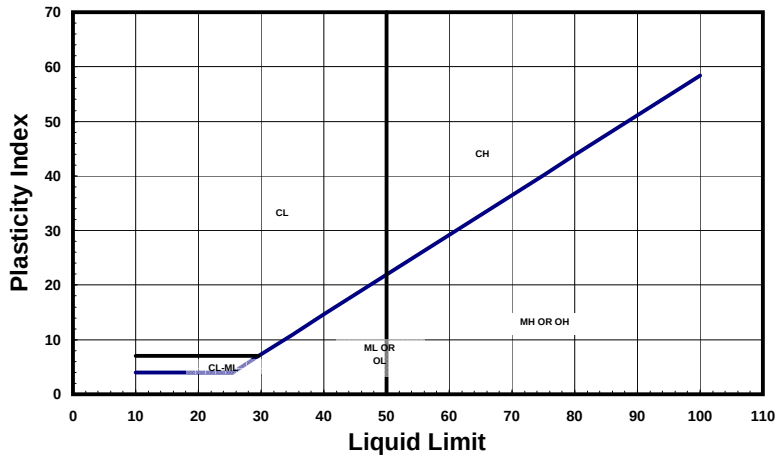


STONE GRAVELY SANDY SILTY CLAYEY MISC.

(SEE TEXT ON LOG)

NO RECOVERY | ROCK CORE | 2" SHELBY TUBE | TXDOT CONE

UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D 2487



CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	SHEAR STRENGTH IN TONS/FT^2
VERY SOFT	0 TO 0.125
SOFT	0.125 TO 0.25
FIRM	0.25 TO 0.5
STIFF	0.5 TO 1.0
VERY STIFF	1.0 TO 2.0
HARD	> 2.0 OR 2.0+

RELATIVE DENSITY - GRANULAR SOILS

CONSISTENCY	N-VALUE (BLOWS/FOOT)
VERY LOOSE	0 TO 4
LOOSE	5 TO 9
MEDIUM DENSE	10 TO 29
DENSE	30 TO 50
VERY DENSE	> 50 OR 50+

DEGREE OF PLASTICITY OF COHESIVE SOILS

DEGREE OF PLASTICITY	PLASTICITY INDEX	SWELL POTENTIAL
NONE OR SLIGHT	0 TO 4	NONE
LOW	4 TO 20	LOW
MEDIUM	20 TO 30	MEDIUM
HIGH	30 TO 40	HIGH
VERY HIGH	> 40	VERY HIGH

MOISTURE CONDITION COHESIVE SOILS

DESCRIPTION	CONDITION
Absence of moisture, dusty, dry to touch	DRY
Damp but no visible water	MOIST
Visible free water	WET

CONSISTENCY OF COHESIVE SOILS AFTER TERZAGHI (1948)

CONSISTENCY	N-VALUE (BLOWS/FOOT)
VERY SOFT	< 2
SOFT	2 TO 4
FIRM	4 TO 8
STIFF	8 TO 15
VERY STIFF	15 TO 30
HARD	> 30

ABBREVIATIONS

HP - HAND PENETROMETER
TV - TORVANE
MV - MINIATURE VANE
UC - UNCONFINED COMPRESSION TEST
UU - UNCONSOLIDATED UNDRAINED TRIAXIAL
CU - CONSOLIDATED UNDRAINED

NOTE: PLOT INDICATES SHEAR STRENGTH AS OBTAINED BY ABOVE TESTS

FINAL GROUND WATER LEVEL

INITIAL GROUND WATER LEVEL

CLASSIFICATION OF GRANULAR SOILS

U.S. STANDARD SIEVE SIZE(S)

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

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

152	76.2	19.1	4.76	2.0	0.42	0.074	0.002

GRAIN SIZE IN MM

Professional Service Industries, Inc.

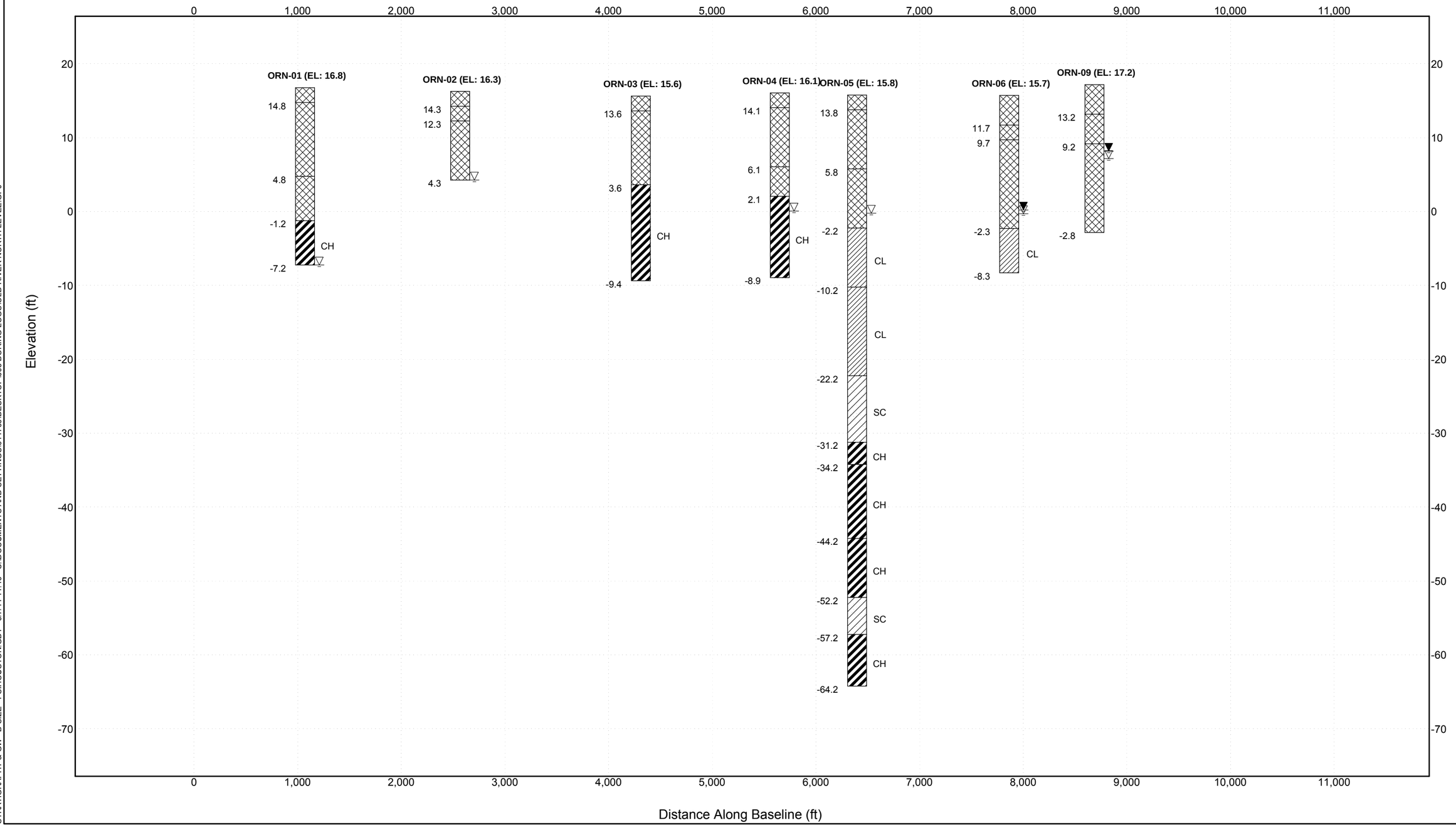
SUBSURFACE DIAGRAM
OLD RIVER NORTH LEVEE

PROJECT NAME: FREEPORT LEVEE SYSTEM: OLD RIVER NORTH LEVEE

PROJECT LOCATION: FREEPORT, TEXAS

PROJECT NUMBER:291-100

Fill Material
Fat Clay (CH)
Lean Clay (CL)
Sandy Lean Clay (CL)
Clayey Sand (SC)



STRATIGRAPHY & GW - B SIZE - PSIHOUSTON.GDT - 6/7/11 11:46 - C:\DOCUMENTS AND SETTINGS\911769\DESKTOP\003 BORING LOGS\OLD RIVER NORTH LEVEE.GPJ

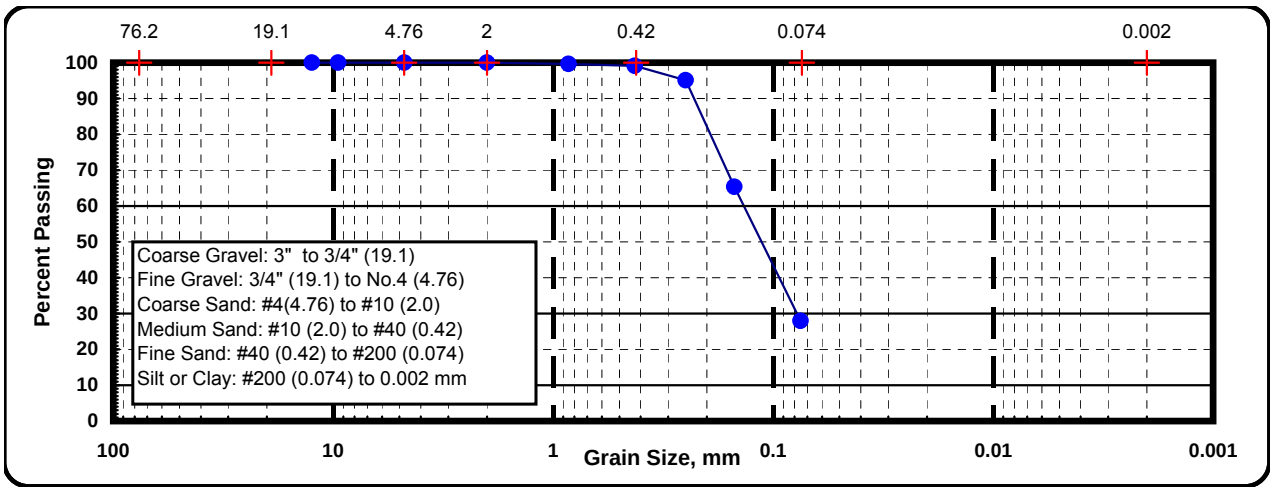
Plate 11

SIEVE ANALYSIS - ASTM D 422

Project Name: *Freeport Levee*		**Project Number:** *291-100*	
Boring Number: *ORN-6*	**Depth, feet:** *8-10 ft.*	**Sample No./ID:** *N/A*	
Oven: 286-99084419		**Specific Gravity (Assumed):** *2.700*	
Scale: D 3141118413571		**Test Date:** *01/19/11*	
Classification: *Silty Sand (SM)*		**Tested By:** *MH*	

BEFORE WASHING NO. 200 SIEVE		AFTER WASHING NO. 200 SIEVE	
Weight of Pan, gms:	191.33	**Weight of Pan and Sample, gms:**	453.23
Weight of Pan and Sample, gms:	532.42	**Weight of Dry Sample (B), gms:**	261.90
Weight of Dry Sample (A), gms:	341.09	**Percent Passing 200 {(A-B)*100/100), %:**	23.22

Percent Gravel (%):	0.0	**Percent Sand (%):**	72.1	**Percent Fines (%):**	27.9
D10 (mm):	N/A	**D30 (mm):**	0.079	**D60 (mm):**	0.139
Coefficient of Uniformity, Cu (D60/D10):	N/A	**Coeff. of Curvature, Cc ($D30^2$/D10*D60):**			N/A



Total No. of Sieves Used Including Pan: 10

US Standard Sieve No.	Sieve Size (mm)	Cumulative Weight Retained (gms)	Percent Retained on Sieve (%)	Cumulative Weight Passing (gms)	Percent Passing through Sieve (%)
1/2"	12.500	0.00	0.00	532.42	100.00
3/8"	9.500	0.00	0.00	341.09	100.00
#4	4.750	0.00	0.00	341.09	100.00
#10	2.000	0.00	0.00	341.09	100.00
#20	0.850	1.29	0.38	339.80	99.62
#40	0.425	3.07	0.90	338.02	99.10
#60	0.250	16.83	4.93	324.26	95.07
#100	0.150	118.20	34.65	222.89	65.35
#200	0.075	245.83	72.07	95.26	27.93
PAN	-	260.63	76.41	80.46	23.59

Professional Service Industries, Inc.

FALLING HEAD / RISING TAIL HYDRAULIC CONDUCTIVITY TEST
ASTM D-5084 (Method-C)

Project No:	291-100	Sample Identification:	ORN-4, 10-12 ft.
Technician:	Juan	Sample Description:	Brown Fat Clay with sand pockets

Project Name : **FREEPORT LEVEE**

INITIAL CONDITIONS				FINAL CONDITIONS			
WATER CONTENT		SPECIMEN DATA		WATER CONTENT		SPECIMEN DATA	
Tare No.:	161	Length, in:	3.197	Tare No.:	A09	Length, in:	3.257
Wet+Tare, gms:	60.75	Diameter, in:	2.826	Wet+Tare, gms:	386.74	Diameter, in:	2.875
Dry+Tare, gms:	50.24	Wet mass, gms:	643.09	Dry+Tare, gms:	341.99	Wet mass, gms:	567.76
Tare Weight, gms:	11.46	Area, sq.cm.:	40.47	Tare Weight, gms:	189.54	Area, sq.cm.:	41.88
Moisture, %	27.10	Volume, cc:	328.61	Moisture, %	29.35	Volume, cc:	346.49
		Unit wet wt, pcf:	122.12			Unit wet wt, pcf:	102.25
Specific Gravity:	2.71	Unit dry wt, pcf:	96.08	Specific Gravity:	2.71	Unit dry wt, pcf:	79.05
Saturation, %:	96	Void Ratio:	0.76	Saturation, %:	69.78	Void Ratio:	1.14
Perm. Cell No.:	Perm 4	Burret diam, cm:	1.13	Burret area,sq.cm.:	1.00	Burret factor,cm/cc:	1.0000
Cell Pressure, psi:	68.0	Head Pressure, psi:	62.0	Tail Pressure, psi:	58.0		

PERMEABILITY MEASUREMENTS

Date	Time	Elapse Time (sec)	Temp (^{0}C)	Pressure Diff. (psi)	Head Rdg (cc)	Tail Rdg (cc)	Head Change (cm)	Tail Change (cm)	Total Head (cm)	Permeability Kt (cm/sec)	Permeability K_{20} (cm/sec)
1/31/2011	08:50	0	22.1	4.0	0.0	24.5	0.000	0.0000	308.19	0.0E+00	0.0000
1/31/2011	15:35	24300	22.0	4.0	2.5	23.0	-2.500	-1.5000	303.79	5.9E-08	5.6E-08
2/1/2011	8:20	84600	22.1	4.0	3.0	22.1	-0.500	-0.9000	302.24	5.9E-09	5.7E-09
2/1/2011	12:20	99000	22.1	4.0	6.2	20.4	-3.200	-1.7000	296.85	1.8E-08	1.7E-08
2/2/2011	9:49	152040	22.1	4.0	8.5	17.9	-2.300	-2.5000	291.56	1.2E-08	1.1E-08

Coefficient of Permeability, k = 2.2E-08 cm/sec
7.4E-10 ft/sec

Computed By: VG Date: 2/8/2011 Checked By: MV Date: 3/15/2011

Professional Service Industries, Inc.

FALLING HEAD / RISING TAIL HYDRAULIC CONDUCTIVITY TEST
ASTM D-5084 (Method-C)

Project No:	291-100	Sample Identification:	ORN-5, 8-10 ft.
Technician:	Juan	Sample Description:	Brown Sandy Clay

Project Name : **FREEPORT LEVEE**

INITIAL CONDITIONS				FINAL CONDITIONS			
WATER CONTENT		SPECIMEN DATA		WATER CONTENT		SPECIMEN DATA	
Tare No.:	99	Length, in:	3.231	Tare No.:	A88	Length, in:	3.237
Wet+Tare, gms:	63.93	Diameter, in:	2.790	Wet+Tare, gms:	384.89	Diameter, in:	2.836
Dry+Tare, gms:	53.98	Wet mass, gms:	669.28	Dry+Tare, gms:	347.72	Wet mass, gms:	673.15
Tare Weight, gms:	11.24	Area, sq.cm.:	39.44	Tare Weight, gms:	187.99	Area, sq.cm.:	40.75
Moisture, %	23.28	Volume, cc:	323.70	Moisture, %	23.27	Volume, cc:	335.08
		Unit wet wt, pcf:	129.02			Unit wet wt, pcf:	125.36
Specific Gravity:	2.71	Unit dry wt, pcf:	104.66	Specific Gravity:	2.71	Unit dry wt, pcf:	101.69
Saturation, %:	96	Void Ratio:	0.62	Saturation, %:	95.03	Void Ratio:	0.66
Perm. Cell No.:	Perm 2	Burret diam, cm:	1.13	Burret area,sq.cm.:	1.00	Burret factor,cm/cc:	1.0000
Cell Pressure, psi:	68.0	Head Pressure, psi:	63.0	Tail Pressure, psi:	58.0		

PERMEABILITY MEASUREMENTS

Date	Time	Elapse Time (sec)	Temp (^{0}C)	Pressure Diff. (psi)	Head Rdg (cc)	Tail Rdg (cc)	Head Change (cm)	Tail Change (cm)	Total Head (cm)	Permeability Kt (cm/sec)	Permeability K_{20} (cm/sec)
1/31/2011	08:50	0	22.1	5.0	0.0	24.5	0.000	0.0000	378.49	0.0E+00	0.0000
1/31/2011	15:35	24300	22.0	5.0	18.2	22.0	-18.200	-2.5000	355.69	2.6E-07	2.5E-07
2/1/2011	8:20	84600	22.1	5.0	12.2	12.0	6.000	-10.0000	351.28	1.5E-08	1.4E-08
2/1/2011	12:20	99000	22.1	5.0	16.5	8.6	-4.300	-3.4000	342.80	2.5E-08	2.4E-08
2/2/2011	9:49	152040	22.1	5.0	23.0	2.0	-6.500	-6.6000	328.36	2.9E-08	2.7E-08

Coefficient of Permeability, k = 7.8E-08 cm/sec
2.6E-09 ft/sec

Computed By: VG Date: 2/8/2011 Checked By: MV Date: 3/15/2011

Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

Project Name: *Freeport Levee* ***Classification:*** *Brown fat clay (CH)*

Project Number: *291-100* ***Boring Number:*** *ORN-5* ***Depth, feet:*** *48-50 ft.* ***Sample No./ID:*** *NA*

Liquid Limit: *67* ***Plastic Limit:*** *26* ***Plasticity Index:*** *41* ***Percent Passing No. 200:*** *99.0%*

Specimen/Stage Data	Before Test			After Consolidation or Shear		
Specimen/Stage No.	1	2	3	1	2	3
Diameter (D),in.:	2.812	2.800	2.830	2.806	2.689	2.645
Height (H), in.:	5.680	5.572	5.685	5.601	5.449	5.434
Cross-Sectional Area, in^2	6.210	6.158	6.290	6.184	5.680	5.495
Vol. (Vo, Vf), cm^3:	578.1	562.2	586.0	567.5	507.2	489.3
Moisture, {Wo, Wf} %:	42.4%	45.7%	54.1%	41.6%	37.8%	40.1%
Wet Soil Wt. {Mo, Mf}, ,gm:	1028.25	986.99	977.11	1022.00	933.64	888.53
Wet Unit Weight, pcf:	111.0	109.54	104.0	112.4	114.87	113.3
Dry Unit Weight, pcf:	77.9	75.2	67.5	79.4	83.3	80.9
Specific Gravity (Assumed):	2.7	2.7	2.7	2.7	2.7	2.7
Void Ratio, eo, ef:	1.16	1.24	1.50	1.12	1.02	1.08
Degree of Saturation, So, Sf:	0.99	0.99	0.98	1.00	1.00	1.00

Description		Saturation/Consolidation		
Specimen/Stage No.		1	2	3
Method		Wet Mounting Method		
Cell Pressure, lbs/in^2		80.2	98.3	98.7
Back Pressure, lbs/in^2		60.8	58.0	39.0
B-Parameter		0.97	0.95	0.96
Consolidation Pressure, lbs/in^2		19.4	40.3	59.7
Volume Change After (ΔV), cm^3		22.2	48.5	47.8
Time for Consolidation, min.		1710	2825	1420
Failure Type:	*1*	*Single Shear*		
	2		*Single Shear*	
	3			*Bulge*

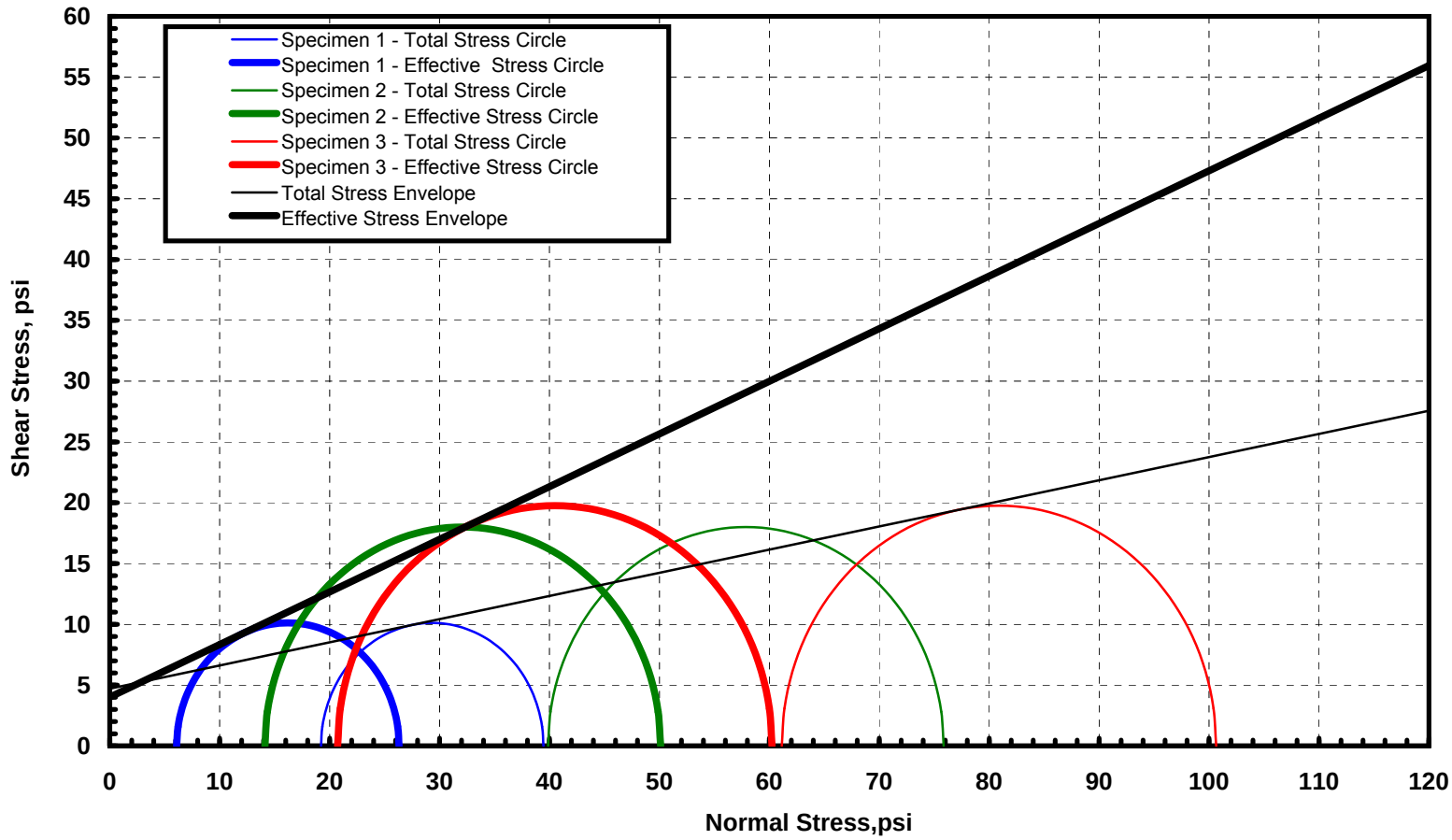
Shear Data	Specimen/Stage		
	1	2	3
Total Shearing Time, min	1800	1469	1466
Strain Rate, %/hr	0.50	0.50	0.50
Axial Strain at Failure, %	15.03	12.13	8.49
Deviator Stress, lbs/in^2 (Δσ)	20.23	35.99	39.52
Excess Pore Pressure, lbs/in^2 (u)	13.13	25.75	40.40
A-Parameter, (u/Δσ)	0.65	0.72	1.02
Total Major Pincipal Stress, lbs/in^2 ($\sigma 1 = \sigma 3 + \Delta\sigma$)	39.45	75.86	100.65
Total Minor Pincipal Stress, lbs/in^2 ($\sigma 3$)	19.22	39.87	61.12
Effectivel Major Pincipal Stress, lbs/in^2 ($\bar{\sigma}\ \bar{1} = \sigma 1 - u$)	26.32	50.11	60.25
Effectivel Minor Pincipal Stress, lbs/in^2 ($\bar{\sigma}\ \bar{3} = \sigma 3 - u$)	6.09	14.12	20.72

Remarks:

Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

Project Name:	***Freeport Levee***				***Classification:***	***Brown fat clay (CH)***	
Project Number:	***291-100***	***Boring Number:***	***ORN-5***	***Depth, feet:***	***48-50 ft.***	***Sample No./ID:***	***NA***
Cohesion (C_T), ksf:	***0.68***	***Friction Angle(ϕ_T), deg:***	***10.8***	***Cohesion (C_d), ksf:***	***0.58***	***Friction Angle(ϕ_d), deg:***	***23.4***

Remarks:



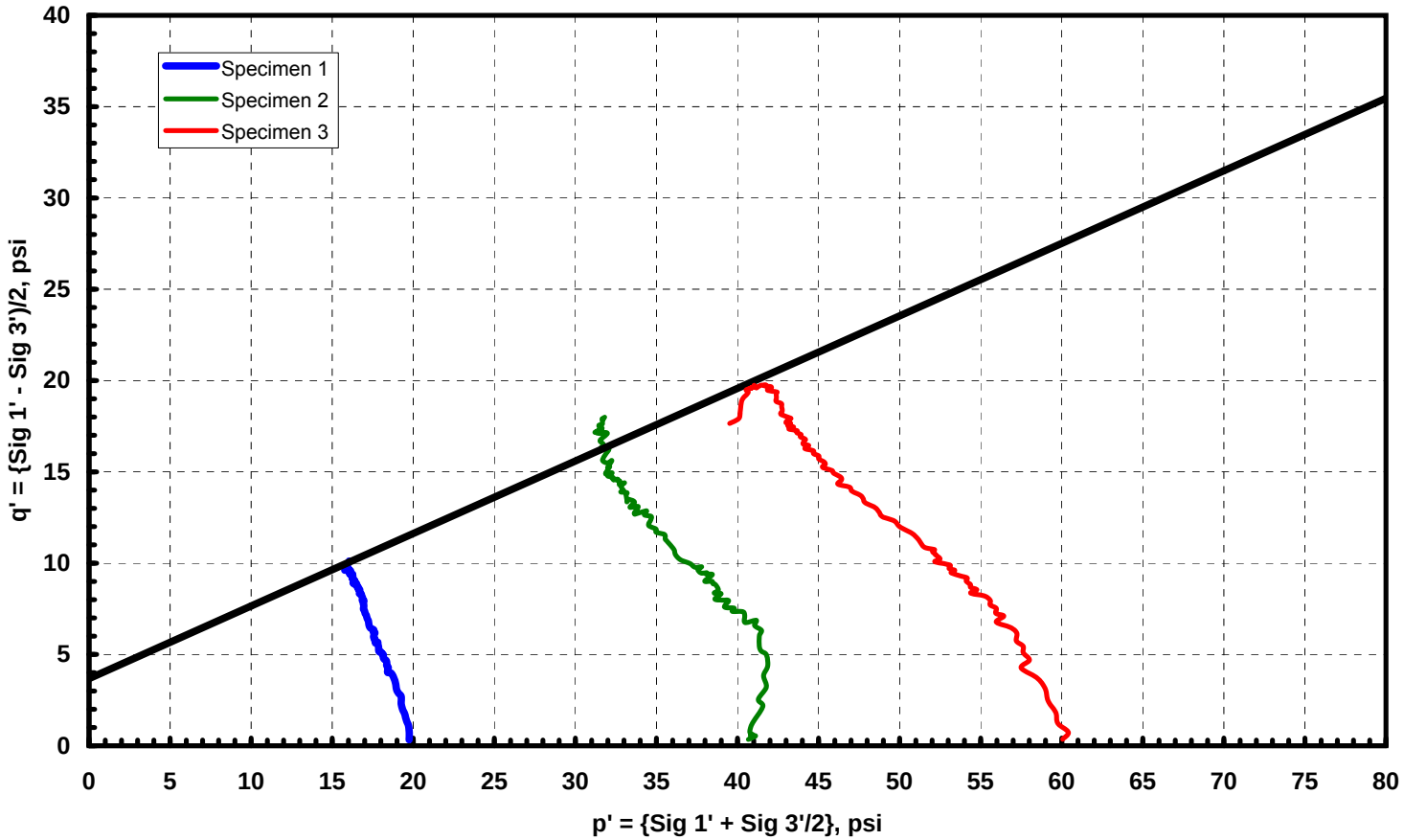
Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

Project Name: *Freeport Levee* ***Classification:*** *Brown fat clay (CH)*

Project Number: *291-100* ***Boring Number:*** *ORN-5* ***Depth, feet:*** *48-50 ft.* ***Sample No./ID:*** *NA*

Cohesion (' (C_d), ksf: *0.57* ***Friction Angle(ϕ_d), deg:*** *23.4*

Remarks:

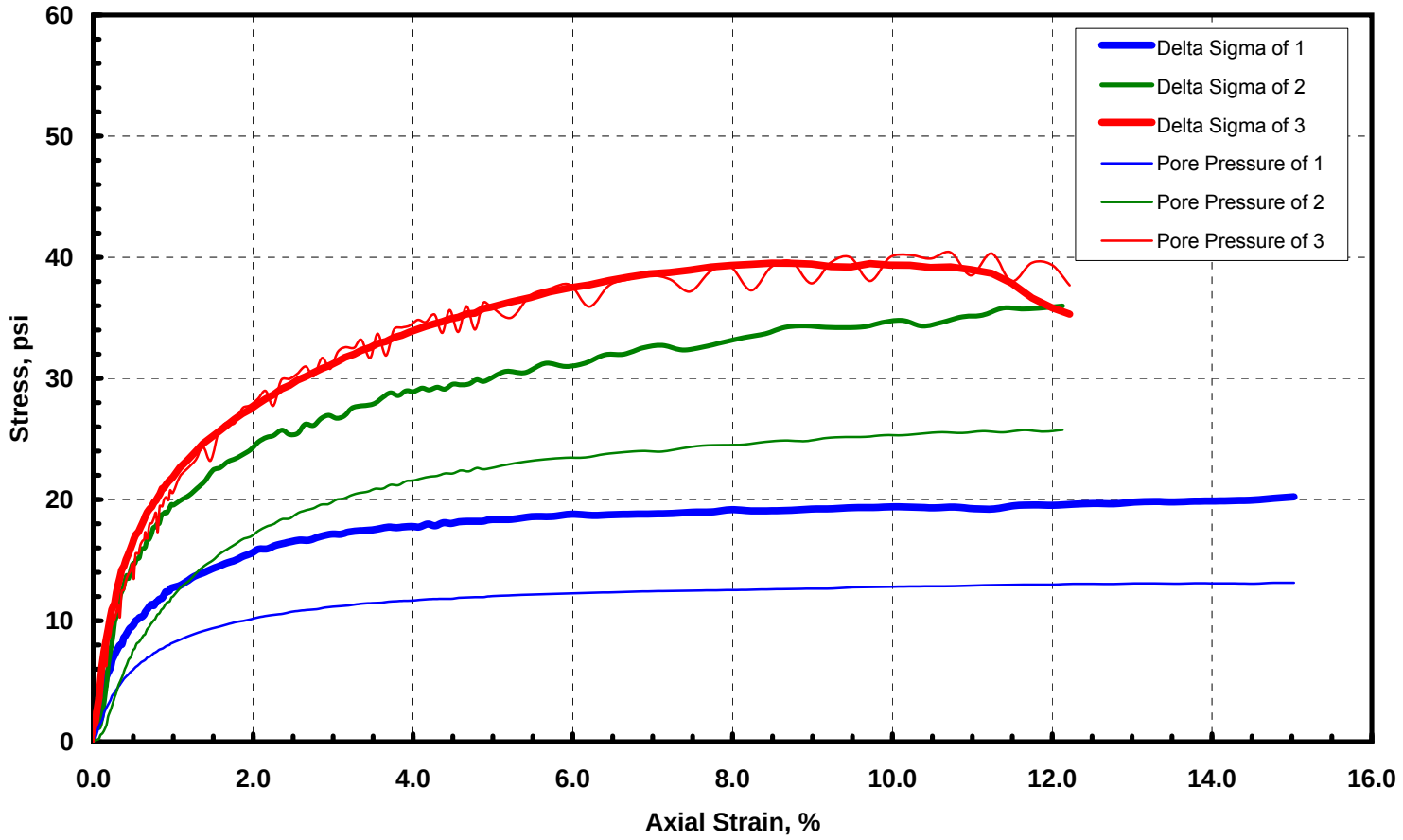


Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

Project Name: *Freeport Levee* ***Classification:*** *Brown fat clay (CH)*

Project Number: *291-100* ***Boring Number:*** *ORN-5* ***Depth, feet:*** *48-50 ft.* ***Sample No./ID:*** *N/A*

Remarks:



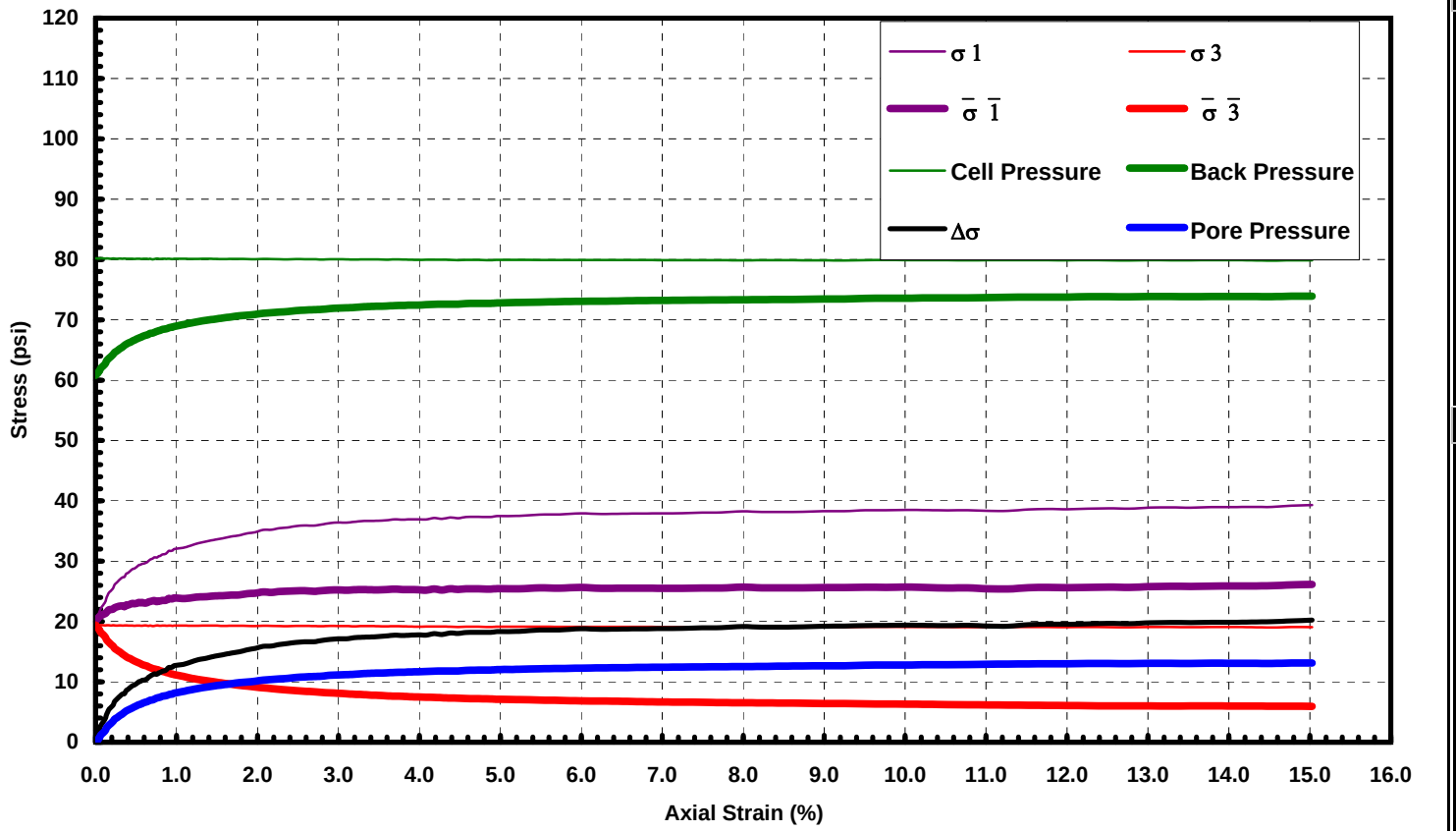
Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

Project Name: *Freeport Levee* ***Classification:*** *Brown fat clay (CH)*

Project Number: *291-100* ***Boring Number:*** *ORN-5* ***Depth, feet:*** *58-60 ft.* ***Sample No./ID:*** *N/A*

Specimen/Stage: *Specimen 1* ***Effective Confining Pressure, psi:*** *19.4* ***Failure Type:*** *Single Shear*

Remarks:



Before Shearing

After Shearing

Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

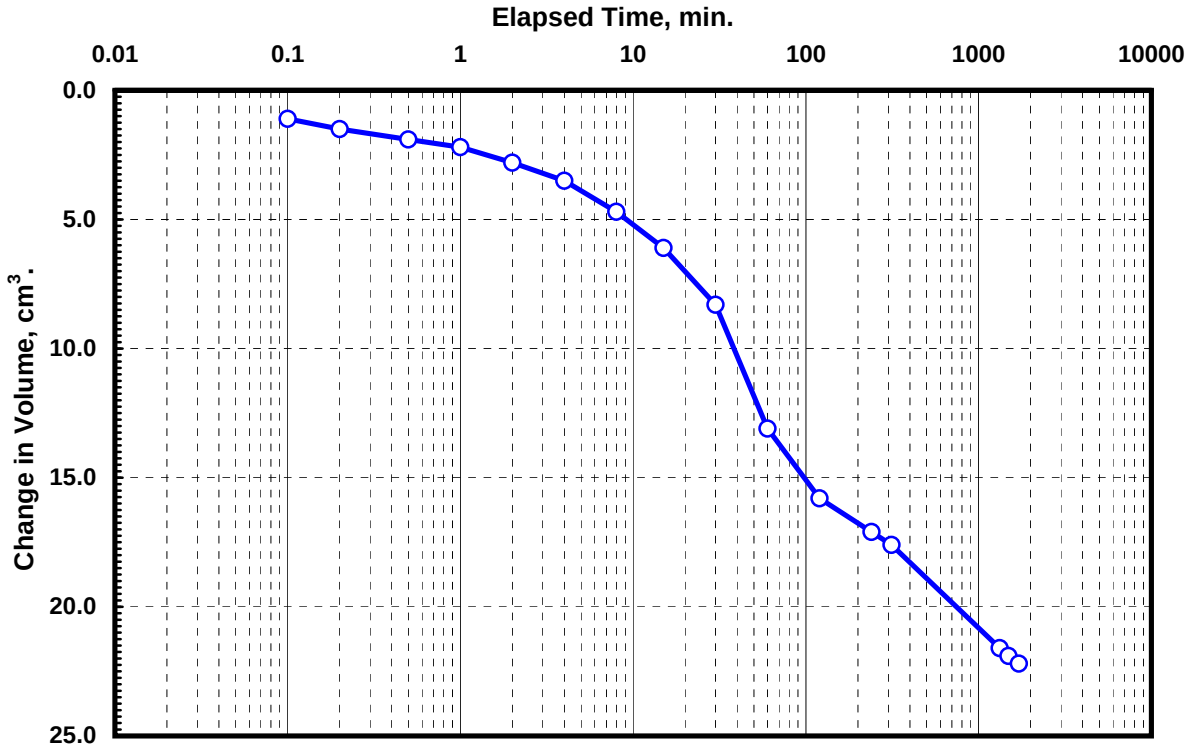
Project Name: *Freeport Levee* ***Classification:*** *Brown fat clay (CH)*

Project Number: *291-100* ***Boring Number:*** *ORN-5* ***Depth, feet:*** *58-60 ft.* ***Sample No./ID:*** *N/A*

Specimen/Stage: *Specimen 1* ***Effective Confining Pressure, psi:*** *19.4*

Remarks:

Date	Clock Time	Elaspsed Time, min.	Burrette Readings	Volume cm^3
3/1/2011	9:55:00 AM	0.0	24.5	0.0
3/1/2011	9:55:06 AM	0.1	23.4	1.1
3/1/2011	9:55:12 AM	0.2	23.0	1.5
3/1/2011	9:55:30 AM	0.5	22.6	1.9
3/1/2011	9:56:00 AM	1.0	22.3	2.2
3/1/2011	9:57:00 AM	2.0	21.7	2.8
3/1/2011	9:59:00 AM	4.0	21.0	3.5
3/1/2011	10:03:00 AM	8.0	19.8	4.7
3/1/2011	10:10:00 AM	15.0	18.4	6.1
3/1/2011	10:25:00 AM	30.0	16.2	8.3
3/1/2011	10:55:00 AM	60.0	11.4	13.1
3/1/2011	11:55:00 AM	120.0	8.7	15.8
3/1/2011	1:55:00 PM	240.0	7.4	17.1
3/1/2011	3:08:00 PM	313.0	6.9	17.6
3/2/2011	8:00:00 AM	1325.0	-	21.6
3/2/2011	10:45:00 AM	1490.0	-	21.9
3/2/2011	2:25:00 PM	1710.0	-	22.2



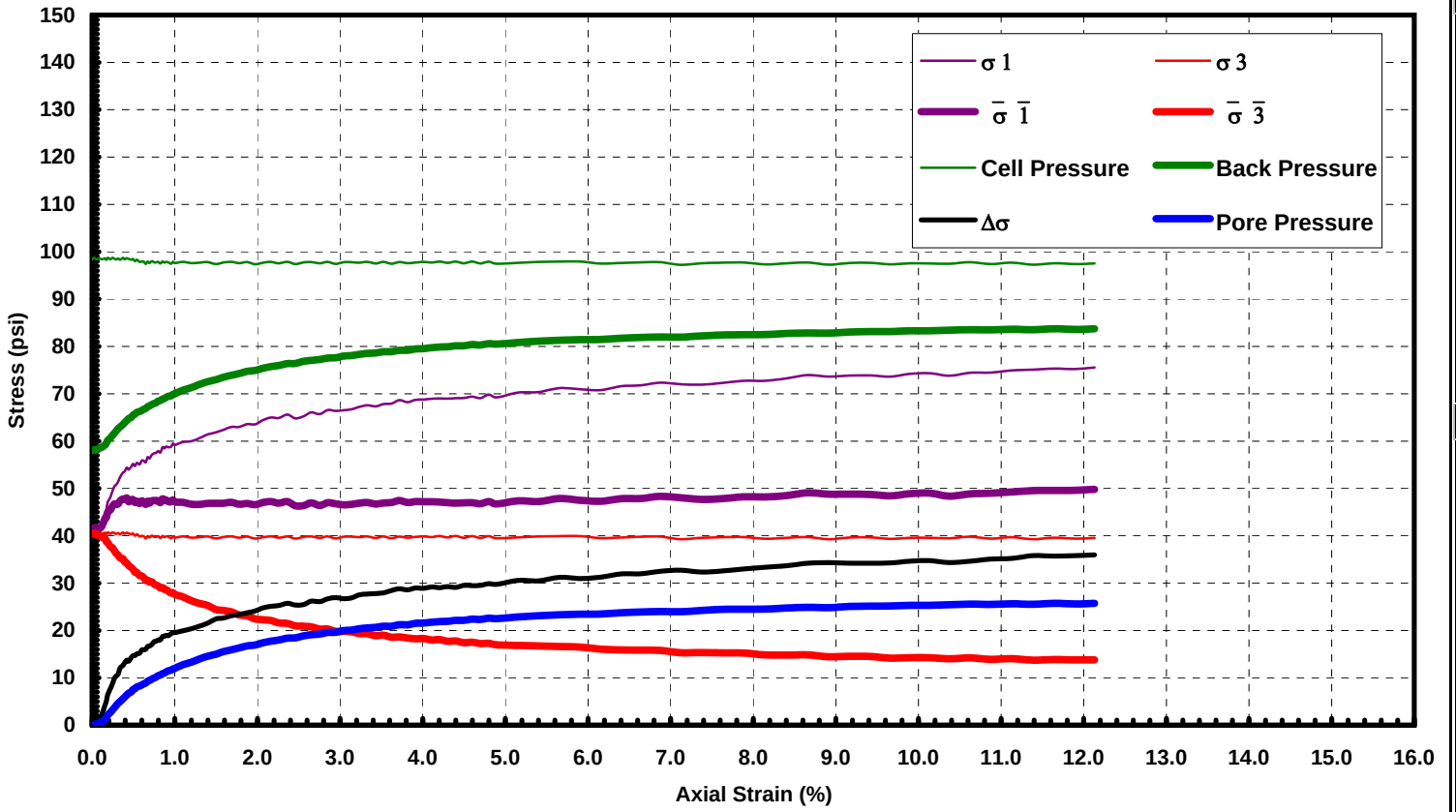
Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

Project Name: *Freeport Levee* ***Classification:*** *Brown fat clay (CH)*

Project Number: *291-100* ***Boring Number:*** *ORN-5* ***Depth, feet:*** *48-50 ft.* ***Sample No./ID:***

Specimen/Stage: *Specimen 2* ***Effective Confining Pressure, psi:*** *40.3* ***Failure Type:*** *Single Shear*

Remarks:



Before Shear

After Shear

Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

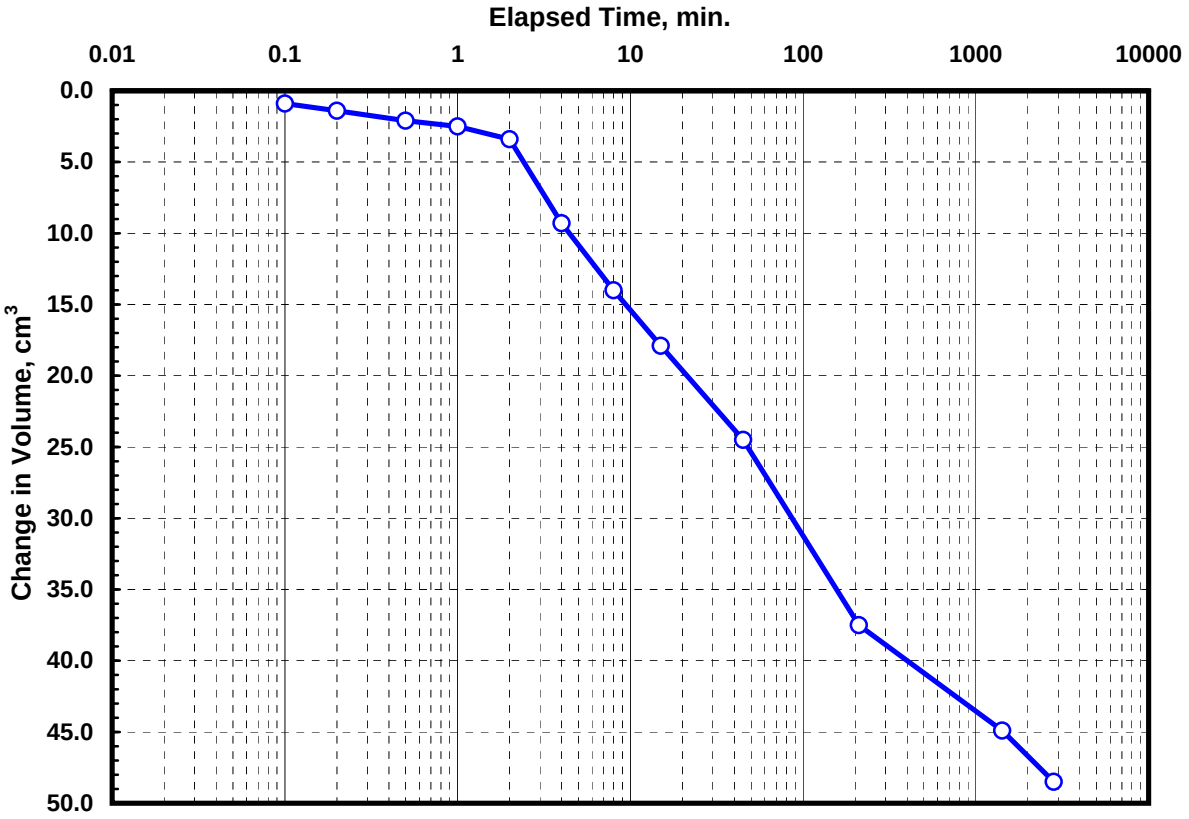
Project Name: *Freeport Levee* ***Classification:*** *Brown fat clay (CH)*

Project Number: *291-100* ***Boring Number:*** *ORN-5* ***Depth, feet:*** *48-50 ft.* ***Sample No./ID:***

Specimen/Stage: *Specimen 2* ***Effective Confining Pressure, psi:*** *40.3*

Remarks:

Date	Clock Time	Elaspsed Time, min.	Burrette Readings	Volume Cm^3
1/18/2011	10:55:00 AM	0.0	24.5	0.0
1/18/2011	10:55:06 AM	0.1	23.6	0.9
1/18/2011	10:55:12 AM	0.2	23.1	1.4
1/18/2011	10:55:30 AM	0.5	22.4	2.1
1/18/2011	10:56:00 AM	1.0	22.0	2.5
1/18/2011	10:57:00 AM	2.0	21.1	3.4
1/18/2011	10:59:00 AM	4.0	15.2	9.3
1/18/2011	11:03:00 AM	8.0	10.5	14.0
1/18/2011	11:10:00 AM	15.0	6.6	17.9
1/18/2011	11:40:00 AM	45.0	0.0	24.5
1/18/2011	2:25:00 PM	210.0	-	37.5
1/19/2011	10:35:00 AM	1420.0	-	44.9
1/20/2011	10:00:00 AM	2825.0	-	48.5



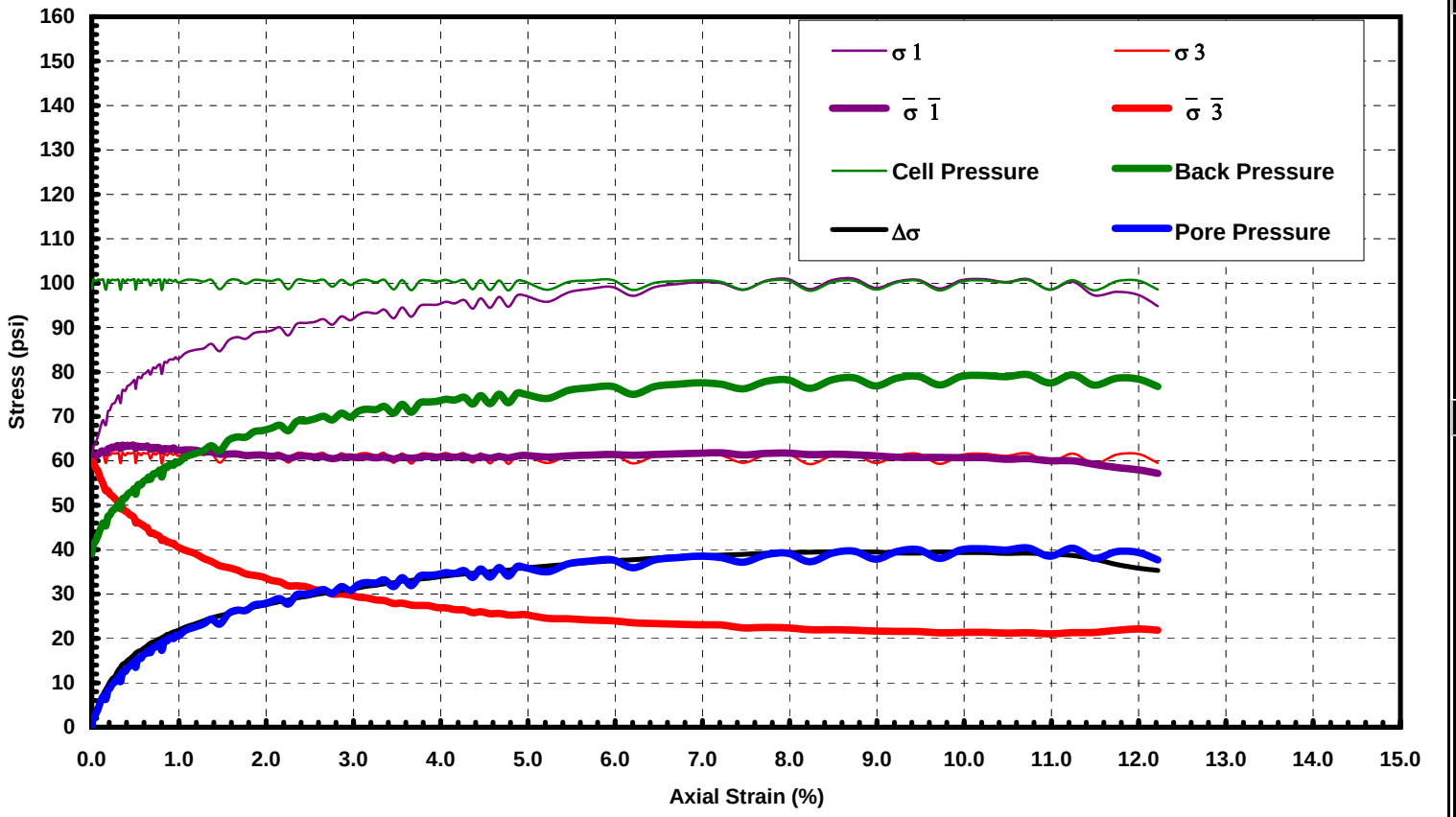
Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

Project Name: *Freeport Levee* ***Classification:*** *Brown fat clay (CH)*

Project Number: *291-100* ***Boring Number:*** *ORN-5* ***Depth, feet:*** *48-50 ft.* ***Sample No./ID:*** *N/A*

Specimen/Stage: *Specimen 3* ***Effective Confining Pressure, psi:*** *59.7* ***Failure Type:*** *Bulge*

Remarks:



Before Shear

After Shear

Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

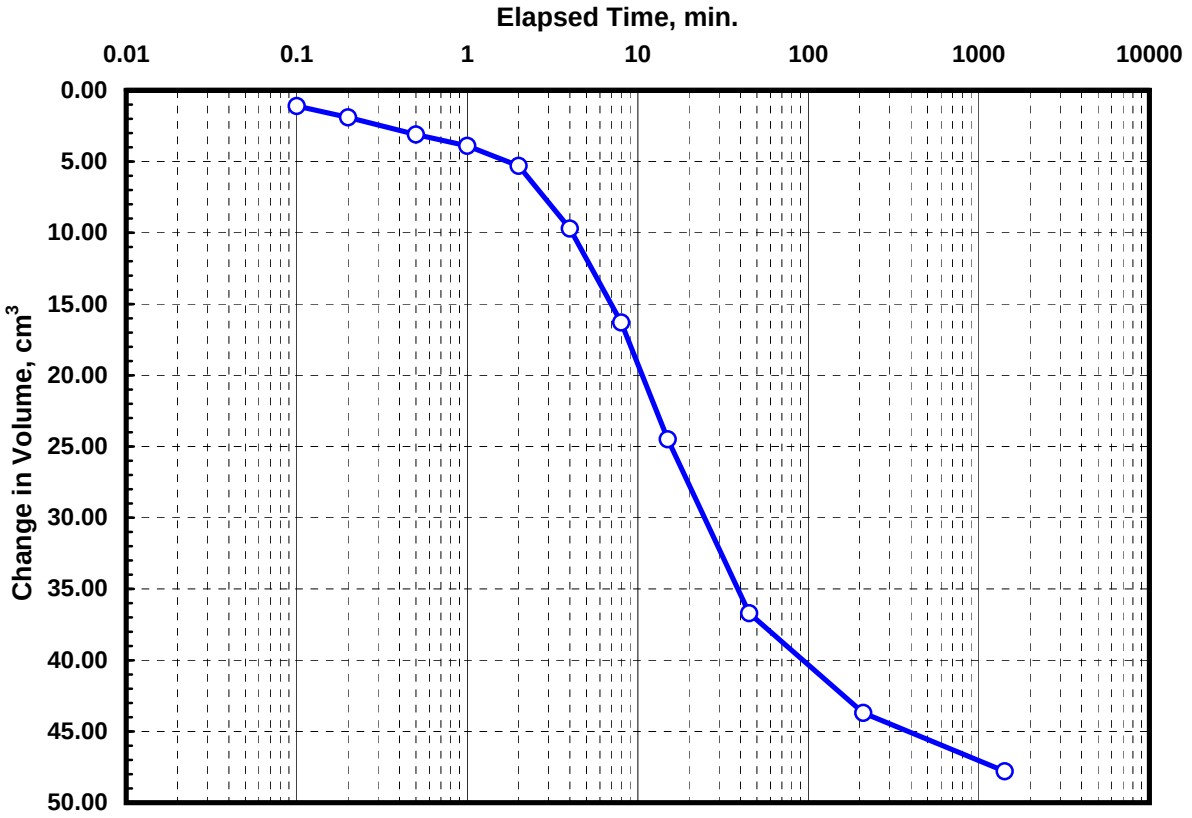
Project Name: *Freeport Levee* ***Classification:*** *Brown fat clay (CH)*

Project Number: *291-100* ***Boring Number:*** *ORN-5* ***Depth, feet:*** *48-50 ft.* ***Sample No./ID:*** *N/A*

Specimen/Stage: *Specimen 3* ***Effective Confining Pressure, psi:*** *59.7*

Remarks:

Date	Clock Time	Elaspsed Time, min.	Burrette Readings	Volume cm^3
1/18/2011	10:55:00 AM	0.0	24.5	0.0
1/18/2011	10:55:06 AM	0.1	23.4	1.1
1/18/2011	10:55:12 AM	0.2	22.6	1.9
1/18/2011	10:55:30 AM	0.5	21.4	3.1
1/18/2011	10:56:00 AM	1.0	20.6	3.9
1/18/2011	10:57:00 AM	2.0	19.2	5.3
1/18/2011	10:59:00 AM	4.0	14.8	9.7
1/18/2011	11:03:00 AM	8.0	8.2	16.3
1/18/2011	11:10:00 AM	15.0	0.0	24.5
1/18/2011	11:40:00 AM	45.0	-	36.7
1/18/2011	2:25:00 PM	210.0	-	43.7
1/19/2011	10:35:00 AM	1420.0	-	47.8



Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

Project Name: *Freeport Levee* ***Classification:*** *Brown Sandy Lean Clay (CL) with gravel*

Project Number: *291-100* ***Boring Number:*** *ORN-9* ***Depth, feet:*** *4-8 ft.* ***Sample No./ID:*** *NA*

Liquid Limit: *44* ***Plastic Limit:*** *17* ***Plasticity Index:*** *27* ***Percent Passing No. 200:*** *74.0%*

Specimen/Stage Data	Before Test			After Consolidation or Shear		
Specimen/Stage No.	1	2	3	1	2	3
Diameter (D),in.:	2.806	2.804	2.798	2.806	2.768	2.801
Height (H), in.:	5.770	5.704	5.684	5.751	5.633	5.532
Cross-Sectional Area, in^2	6.184	6.175	6.149	6.184	6.018	6.161
Vol. (Vo, Vf), cm^3:	584.7	577.2	572.7	582.7	555.4	558.6
Moisture, {Wo, Wf} %:	25.8%	25.0%	26.7%	27.0%	24.8%	25.6%
Wet Soil Wt. {Mo, Mf}, ,gm:	1144.21	1122.89	1128.96	1155.32	1121.14	1119.73
Wet Unit Weight, pcf:	122.1	121.39	123.0	123.7	125.95	125.1
Dry Unit Weight, pcf:	97.1	97.1	97.1	97.4	100.9	99.6
Specific Gravity (Assumed):	2.7	2.7	2.7	2.7	2.7	2.7
Void Ratio, eo, ef:	0.74	0.73	0.73	0.73	0.67	0.69
Degree of Saturation, So, Sf:	0.95	0.92	0.98	1.00	1.00	1.00

Description		Saturation/Consolidation		
Specimen/Stage No.		1	2	3
Method		Wet Mounting Method		
Cell Pressure, lbs/in^2		60.5	73.3	60.7
Back Pressure, lbs/in^2		54.3	60.7	33.9
B-Parameter		0.97	0.98	0.95
Consolidation Pressure, lbs/in^2		6.2	12.6	26.7
Volume Change After (ΔV), cm^3		8.4	24.5	39.6
Time for Consolidation, min.		1455	1455	1455
Failure Type:	*1*	*Bulge*		
	2		*Single Shear*	
	3			*Bulge-Fractures*

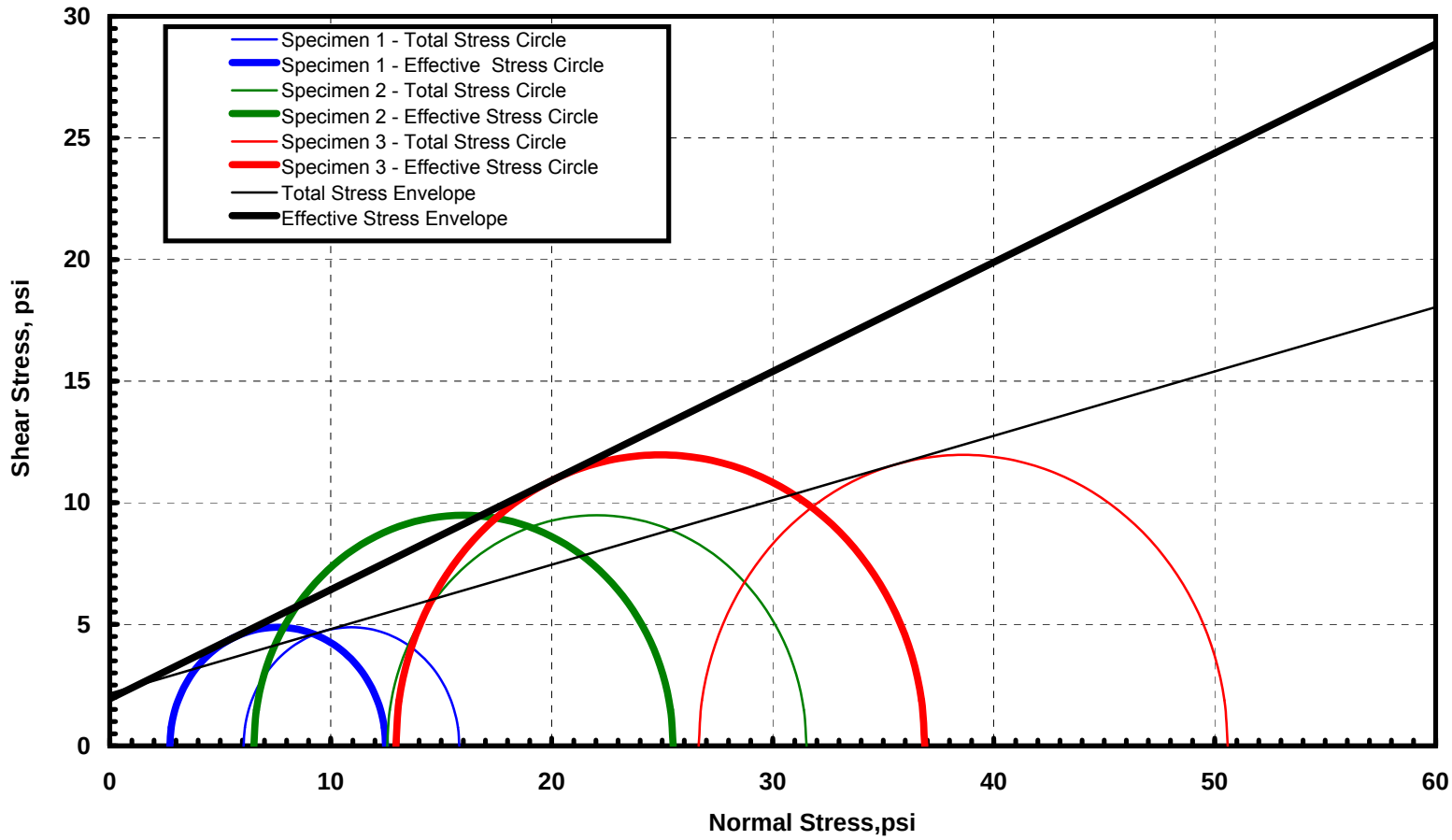
Shear Data	Specimen/Stage		
	1	2	3
Total Shearing Time, min	1170	1170	1050
Strain Rate, %/hr	0.50	0.50	0.49
Axial Strain at Failure, %	9.74	9.72	8.60
Deviator Stress, lbs/in^2 (Δσ)	9.76	18.98	23.94
Excess Pore Pressure, lbs/in^2 (u)	3.33	6.03	13.70
A-Parameter, (u/Δσ)	0.34	0.32	0.57
Total Major Pincipal Stress, lbs/in^2 ($\sigma 1 = \sigma 3 + \Delta\sigma$)	15.81	31.53	50.59
Total Minor Pincipal Stress, lbs/in^2 ($\sigma 3$)	6.05	12.55	26.65
Effectivel Major Pincipal Stress, lbs/in^2 ($\bar{\sigma}\ \bar{1} = \sigma 1 - u$)	12.48	25.50	36.88
Effectivel Minor Pincipal Stress, lbs/in^2 ($\bar{\sigma}\ \bar{3} = \sigma 3 - u$)	2.72	6.52	12.95

Remarks:

Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

Project Name:	***Freeport Levee***				***Classification:***	***Brown Sandy Lean Clay (CL) with gravel***	
Project Number:	***291-100***	***Boring Number:***	***ORN-9***	***Depth, feet:***	***4-8 ft.***	***Sample No./ID:***	***NA***
Cohesion (C_T), ksf:	***0.31***	***Friction Angle(ϕ_T), deg:***	***14.8***	***Cohesion (C_d), ksf:***	***0.28***	***Friction Angle(ϕ_d), deg:***	***24.2***

Remarks:



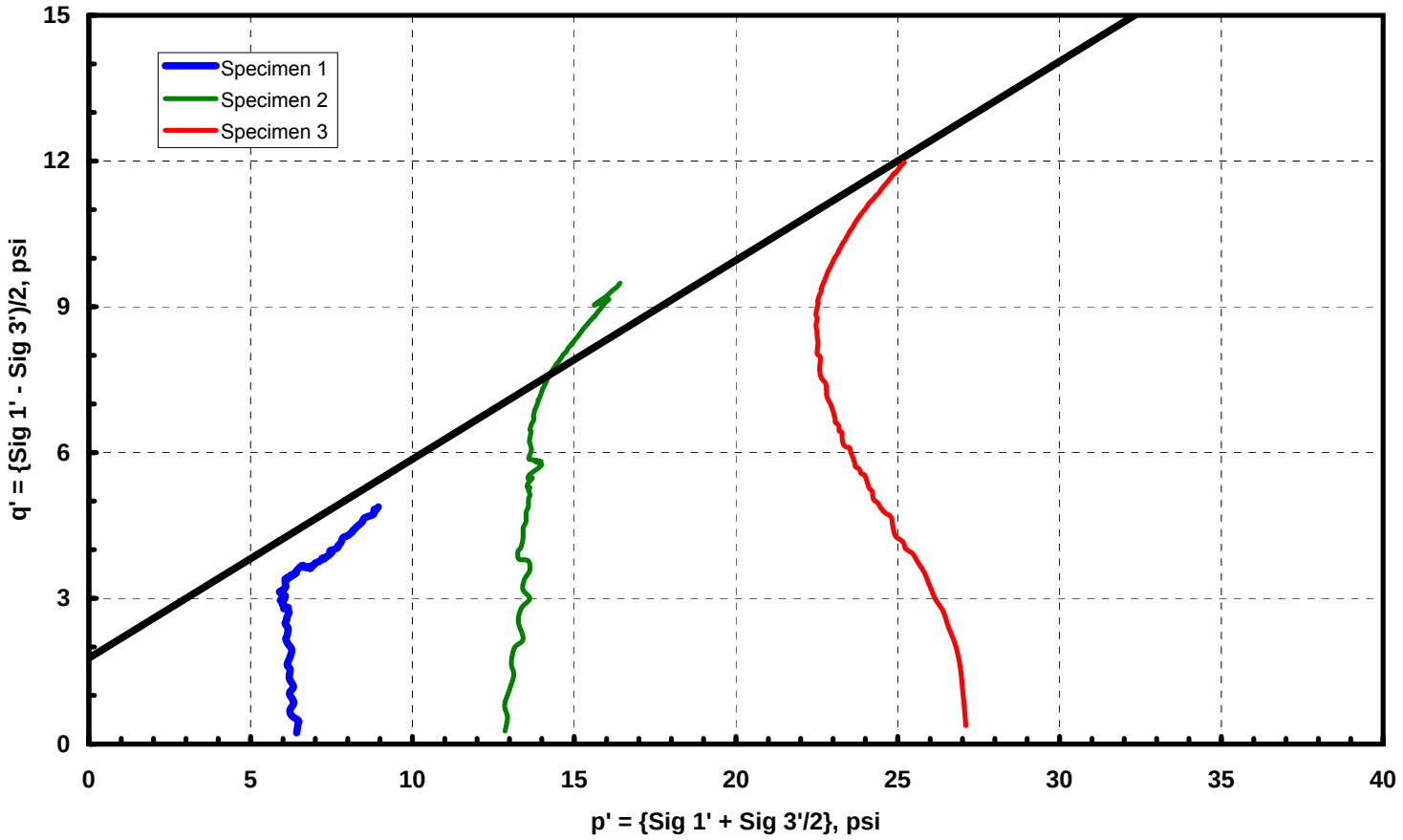
Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

Project Name: *Freeport Levee* ***Classification:*** *Brown Sandy Lean Clay (CL) with gravel*

Project Number: *291-100* ***Boring Number:*** *ORN-9* ***Depth, feet:*** *4-8 ft.* ***Sample No./ID:*** *NA*

Cohesion (' (C_d), ksf: *0.28* ***Friction Angle(ϕ_d), deg:*** *24.2*

Remarks:

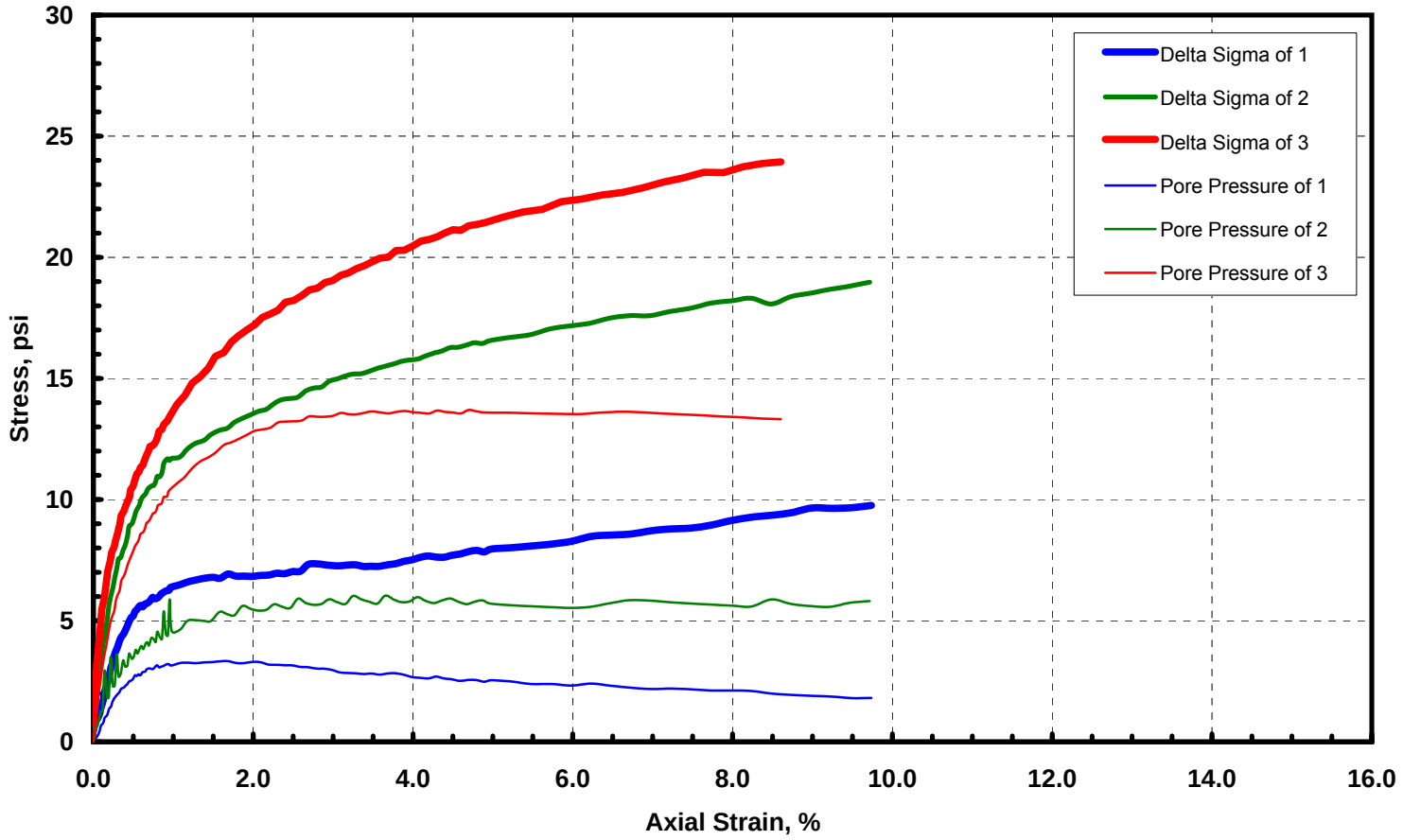


Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

Project Name: *Freeport Levee* ***Classification:*** *Brown Sandy Lean Clay (CL) with gravel*

Project Number: *291-100* ***Boring Number:*** *ORN-9* ***Depth, feet:*** *4-8 ft.* ***Sample No./ID:*** *N/A*

Remarks:



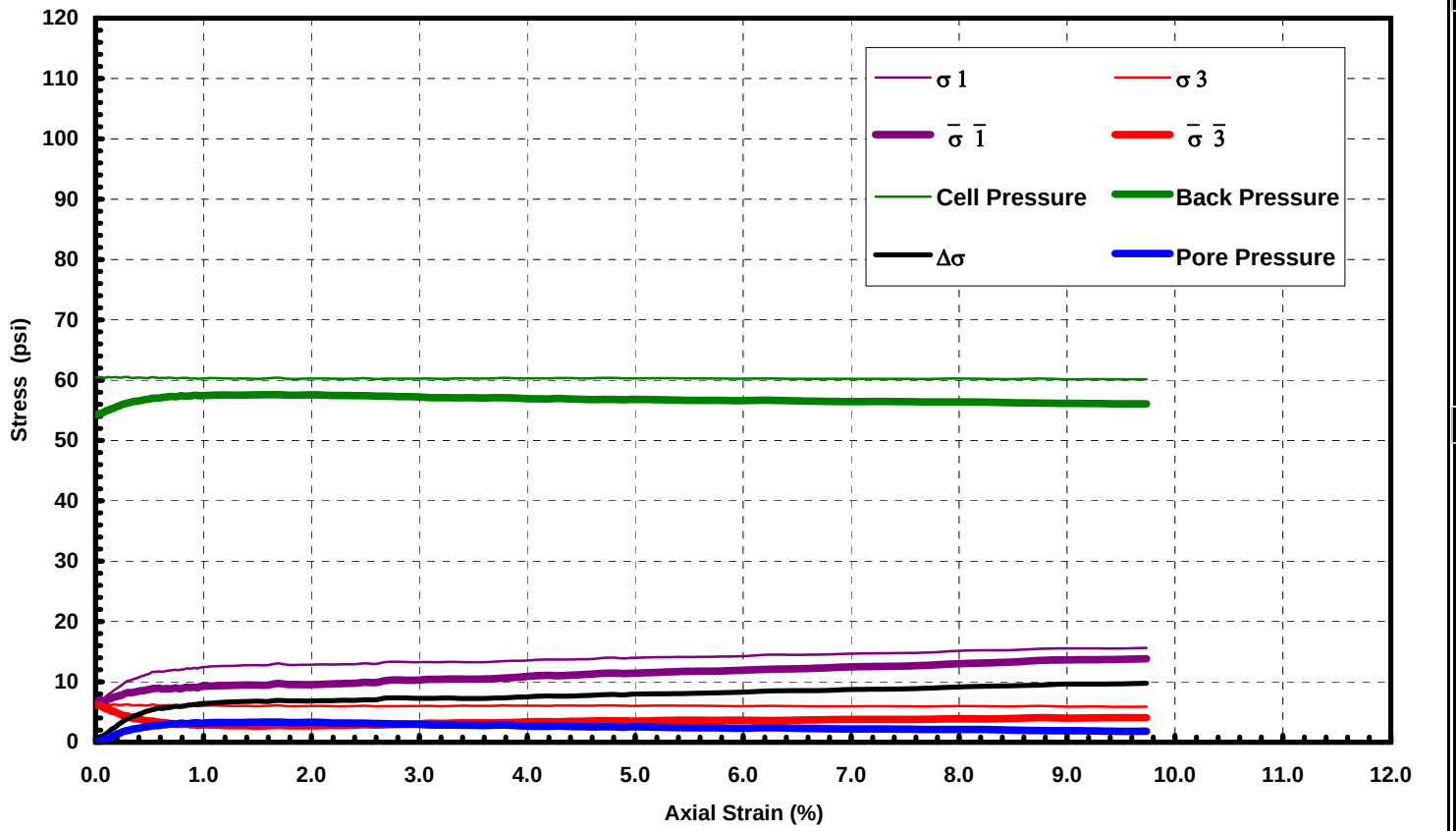
Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

Project Name: *Freeport Levee* ***Classification:*** *Brown Sandy Lean Clay (CL) with gravel*

Project Number: *291-100* ***Boring Number:*** *ORN-9* ***Depth, feet:*** *4-6 ft.* ***Sample No./ID:*** *N/A*

Specimen/Stage: *Specimen 1* ***Effective Confining Pressure, psi:*** *6.2* ***Failure Type:*** *Bulge*

Remarks:



Before Shearing

After Shearing

Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

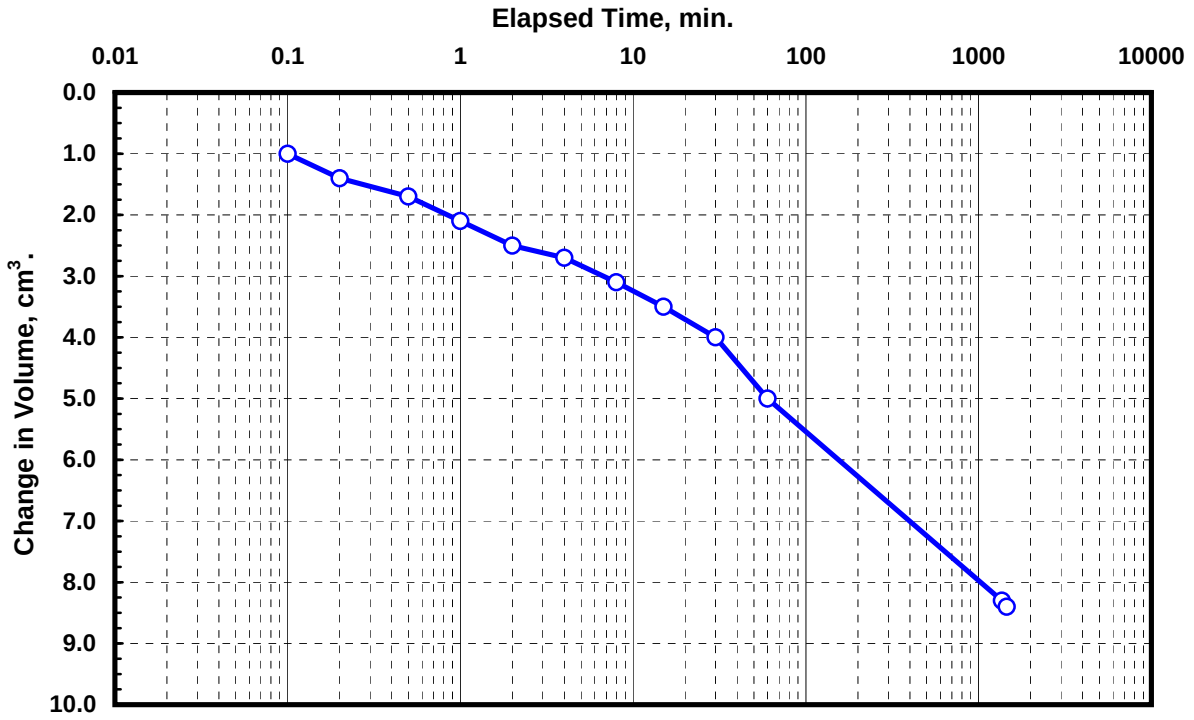
Project Name: *Freeport Levee* ***Classification:*** *Brown Sandy Lean Clay (CL) with gravel*

Project Number: *291-100* ***Boring Number:*** *ORN-9* ***Depth, feet:*** *4-6 ft.* ***Sample No./ID:*** *N/A*

Specimen/Stage: *Specimen 1* ***Effective Confining Pressure, psi:*** *6.2*

Remarks:

Date	Clock Time	Elaspsed Time, min.	Burrette Readings	Volume cm^3
1/30/2011	9:00:00 AM	0.0	24.5	0.0
1/30/2011	9:00:06 AM	0.1	23.5	1.0
1/30/2011	9:00:12 AM	0.2	23.1	1.4
1/30/2011	9:00:30 AM	0.5	22.8	1.7
1/30/2011	9:01:00 AM	1.0	22.4	2.1
1/30/2011	9:02:00 AM	2.0	22.0	2.5
1/30/2011	9:04:00 AM	4.0	21.8	2.7
1/30/2011	9:08:00 AM	8.0	21.4	3.1
1/30/2011	9:15:00 AM	15.0	21.0	3.5
1/30/2011	9:30:00 AM	30.0	20.5	4.0
1/30/2011	10:00:00 AM	60.0	19.5	5.0
1/31/2011	7:45:00 AM	1365.0	16.2	8.3
1/31/2011	9:15:00 AM	1455.0	16.1	8.4



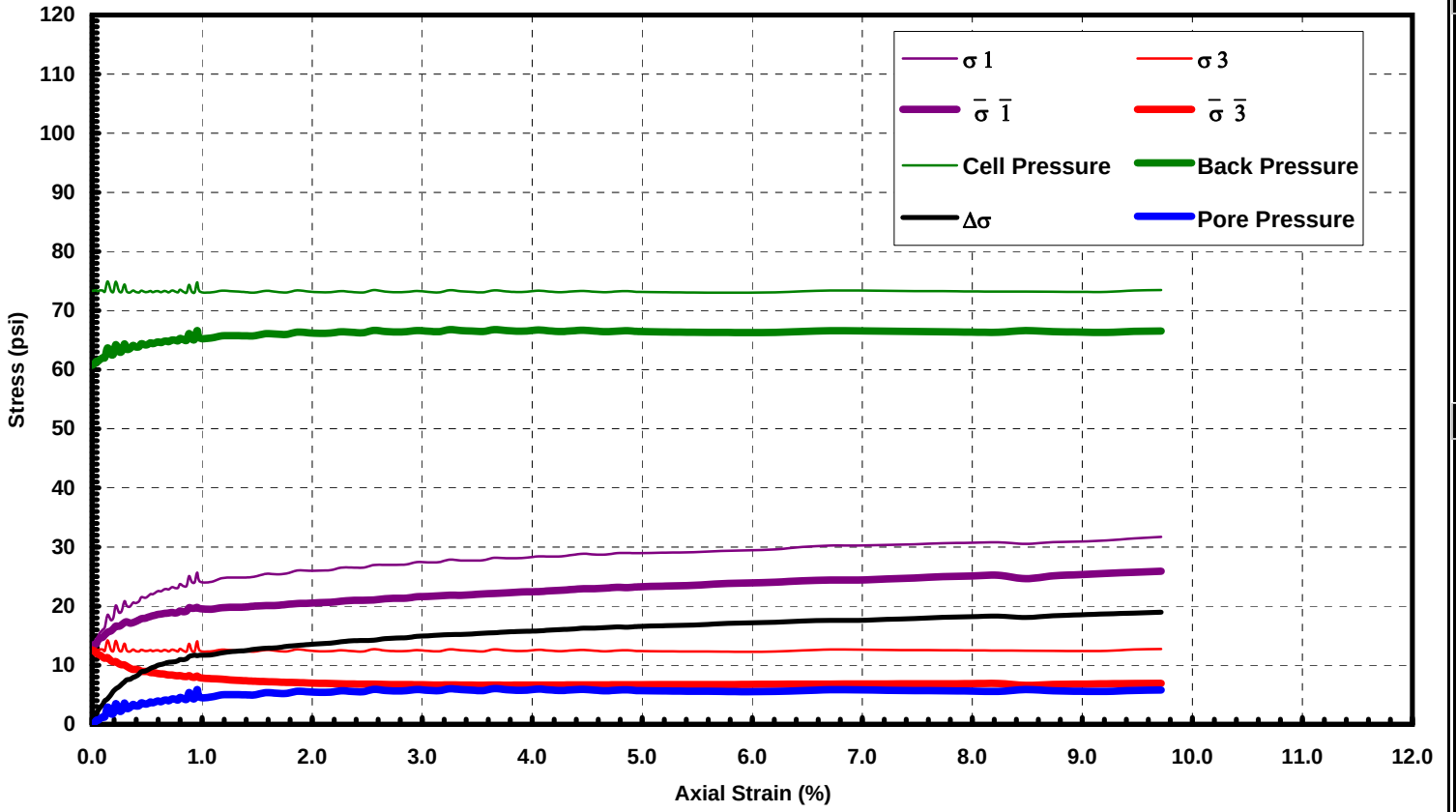
Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

Project Name: *Freeport Levee* ***Classification:*** *Brown Sandy Lean Clay (CL) with gravel*

Project Number: *291-100* ***Boring Number:*** *ORN-9* ***Depth, feet:*** *6-8 ft.* ***Sample No./ID:*** *N/A*

Specimen/Stage: *Specimen 2* ***Effective Confining Pressure, psi:*** *12.6* ***Failure Type:*** *Single Shear*

Remarks:



Before Shear

After Shear

Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

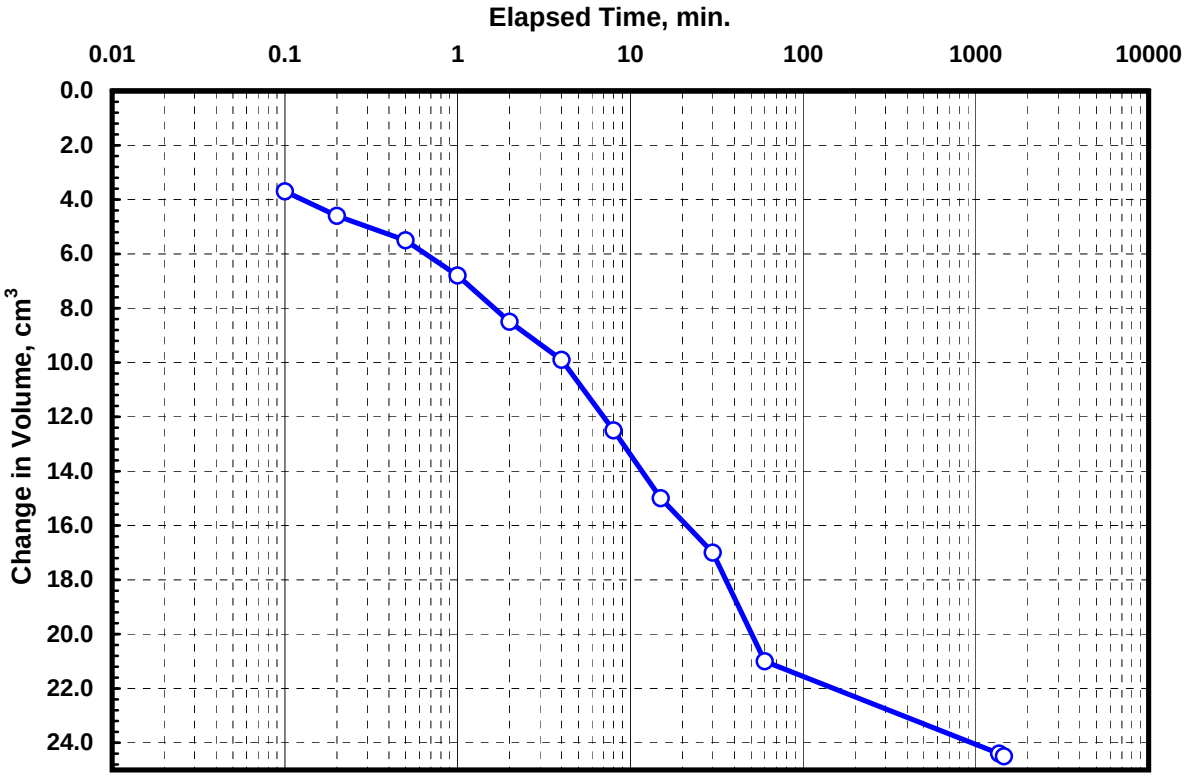
Project Name: *Freeport Levee* ***Classification:*** *Brown Sandy Lean Clay (CL) with gravel*

Project Number: *291-100* ***Boring Number:*** *ORN-9* ***Depth, feet:*** *6-8 ft.* ***Sample No./ID:*** *N/A*

Specimen/Stage: *Specimen 2* ***Effective Confining Pressure, psi:*** *12.6*

Remarks:

Date	Clock Time	Elaspsed Time, min.	Burrette Readings	Volume Cm^3
1/30/2011	9:00:00 AM	0.0	24.5	0.0
1/30/2011	9:00:06 AM	0.1	20.8	3.7
1/30/2011	9:00:12 AM	0.2	19.9	4.6
1/30/2011	9:00:30 AM	0.5	19.0	5.5
1/30/2011	9:01:00 AM	1.0	17.7	6.8
1/30/2011	9:02:00 AM	2.0	16.0	8.5
1/30/2011	9:04:00 AM	4.0	14.6	9.9
1/30/2011	9:08:00 AM	8.0	12.0	12.5
1/30/2011	9:15:00 AM	15.0	9.5	15.0
1/30/2011	9:30:00 AM	30.0	7.5	17.0
1/30/2011	10:00:00 AM	60.0	-	21.0
1/31/2011	7:45:00 AM	1365.0	-	24.4
1/31/2011	9:15:00 AM	1455.0	-	24.5



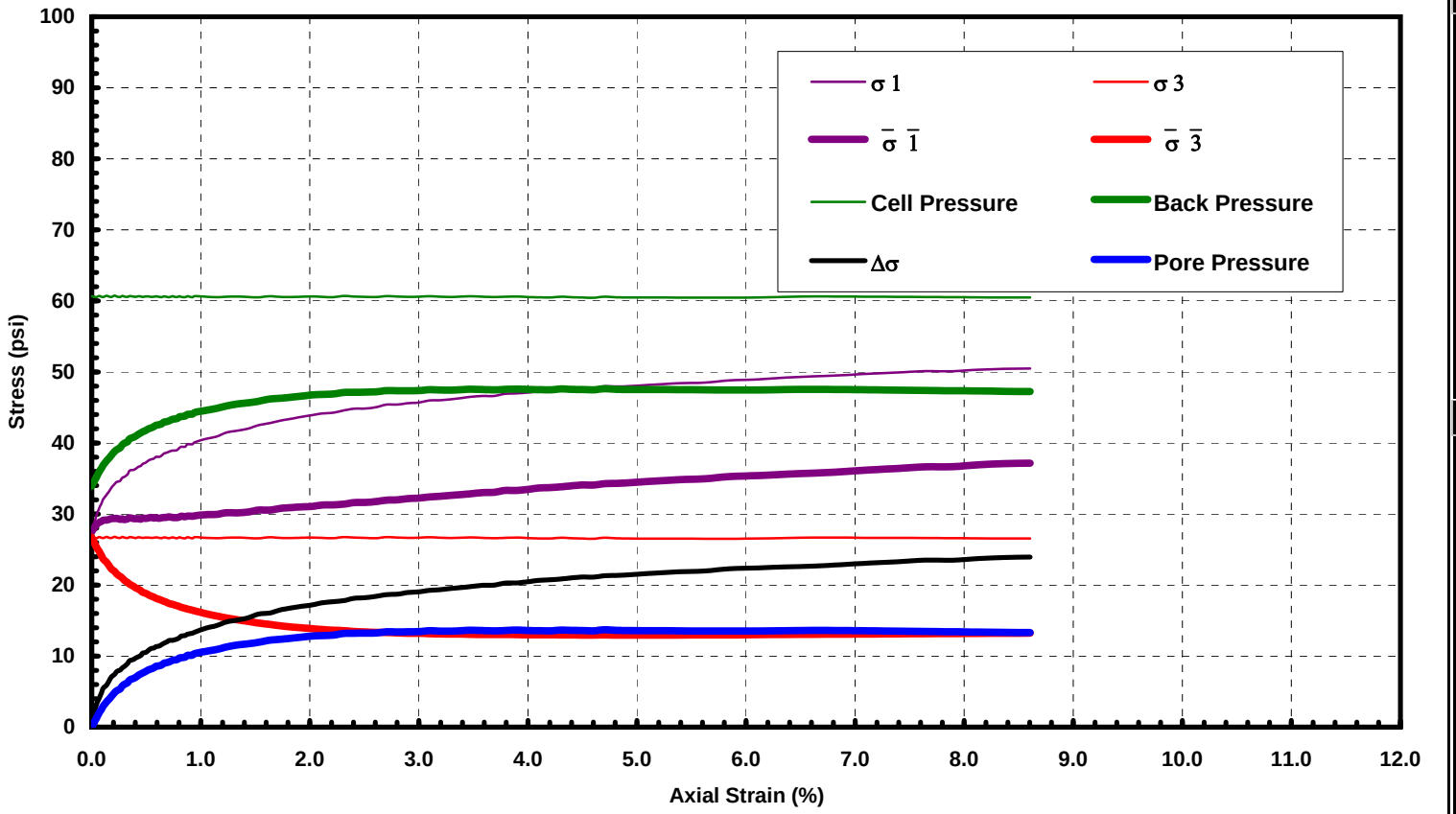
Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

Project Name: *Freeport Levee* ***Classification:*** *Brown Sandy Lean Clay (CL) with gravel*

Project Number: *291-100* ***Boring Number:*** *ORN-9* ***Depth, feet:*** *6-8 ft.* ***Sample No./ID:*** *N/A*

Specimen/Stage: *Specimen 3* ***Effective Confining Pressure, psi:*** *26.7* ***Failure Type:*** *Bulge-Fractures*

Remarks:



Before Shear

After Shear

Consolidated Undrained Triaxial Test with Pore Pressure Measurements (ASTM D 4767)

Project Name: *Freeport Levee* ***Classification:*** *Brown Sandy Lean Clay (CL) with gravel*

Project Number: *291-100* ***Boring Number:*** *ORN-9* ***Depth, feet:*** *6-8 ft.* ***Sample No./ID:*** *N/A*

Specimen/Stage: *Specimen 3* ***Effective Confining Pressure, psi:*** *26.7*

Remarks:

Date	Clock Time	Elaspsed Time, min.	Burrette Readings	Volume cm^3
1/30/2011	9:00:00 AM	0.0	24.5	0.0
1/30/2011	9:00:06 AM	0.1	20.5	4.0
1/30/2011	9:00:12 AM	0.2	19.6	4.9
1/30/2011	9:00:30 AM	0.5	18.7	5.8
1/30/2011	9:01:00 AM	1.0	17.4	7.1
1/30/2011	9:02:00 AM	2.0	14.3	10.2
1/30/2011	9:04:00 AM	4.0	10.9	13.6
1/30/2011	9:08:00 AM	8.0	5.3	19.2
1/30/2011	9:15:00 AM	15.0	2.5	22.0
1/30/2011	9:30:00 AM	30.0	1.2	23.3
1/30/2011	10:00:00 AM	60.0	-	31.9
1/31/2011	7:45:00 AM	1365.0	-	39.6
1/31/2011	9:15:00 AM	1455.0	-	39.6