BROWNSVILLE NAVIGATION DISTRICT

BAHIA GRANDE CONNECTOR CHANNEL TO BROWNSVILLE SHIP CHANNEL

BAHIA GRANDE RE-FLOODING AND RESTORATION PROJECT

CAMERON COUNTY, TEXAS

6/22/04

BY:

H&H RESOURCES, INC.

June 2004

TABLE OF CONTENTS

FIGURES

TABLES

EXHIBITS

EXECUTIVE SUMMARY

The Brownsville Navigation District (BND), in cooperation with the Texas Department of Transportation (TxDOT) and the U.S. Fish and Wildlife Service (USFWS), is planning the construction of a channel to provide for the re-flooding of Bahia Grande. Bahia Grande is an inland basin in Cameron County, Texas between Brownsville and Port Isabel, north of SH 48 and south of SH 100. This improved connector channel from the Brownsville Ship Channel to Bahia Grande will allow for restoration of tidal inflows to the basin. Restoring inflows to Bahia Grande is expected to provide habitat for aquatic life, habitat for water birds and other wildlife, to reduce wind erosion from the area, and to increase public recreation. This report documents the results of an engineering study by H & H Resources, Inc. (HHR) for the BND that provides a hydraulic analysis and design for the proposed channel.

HHR utilized the EPA-Storm Water Management Model (SWMM) computer program to analyze hydraulic operation of the proposed Bahia Grande connector channel and simulate potential time-based changes in water level and velocities as flow exchanges between the Brownsville Ship Channel and Bahia Grande. Based upon input from the BND, the proposed connector channel should be a trapezoidal-shaped channel with side slopes of 4(H):1(V) and a bottom (invert) elevation of –9.00 ft. TxDOT is proposing a bridge on SH 48 over the proposed connector channel at the entrance to Bahia Grande.

This study evaluated the hydraulic operation of the proposed connector channel using actual expected tidal fluctuations in the Brownsville Ship Channel for normal tide conditions, as determined in a study by Texas A&M University. For these conditions, a 150-ft bottom width channel will convey a maximum inflow rate (rising tide) to Bahia Grande of 4030 cfs at a velocity of 2.3 ft/sec, and a maximum outflow rate of 3060 cfs at a velocity of 2.0 ft/sec. The calculated water volume exchange between Bahia Grande and the Brownsville Ship Channel is about 32% of the maximum flood volume achieved in Bahia Grande during a normal tidal cycle.

1 INRODUCTION

The Brownsville Navigation District (BND), in cooperation with the Texas Department of Transportation (TxDOT), the U.S. Fish and Wildlife Service (USFWS) and others, is planning the construction of a channel to provide for the re-flooding of Bahia Grande. The channel will connect the Brownsville Ship Channel to Bahia Grande through a new bridge on SH 48 by TxDOT. This report documents the results of an engineering study by H & H Resources, Inc. for the BND that provides a hydraulic analysis and design for the proposed channel.

1.1 Project Description and Location

The Bahia Grande is an inland basin located in Cameron County, Texas between Brownsville and Port Isabel, north of SH 48 and south of SH 100 (See Figure 1). According to an undated Final Draft Environmental Assessment (EA) for the Proposed Re-Flooding and Restoration of Bahia Grande, prepared by the U.S. Fish and Wildlife Service (USFWS), the Bahia Grande was historically a shallow bay, but now remains dry most of the time. The EA states that various construction activities over several decades have contributed to an increased isolation of Bahia Grande from tidal inflows that historically flooded the basin.

This project by the BND will provide an improved connector channel from the Brownsville Ship Channel to the Bahia Grande to allow a restoration of tidal inflows to the basin. Restoring inflows to Bahia Grande is expected to provide habitat for aquatic life, habitat for water birds and other wildlife, to reduce wind erosion from the area, and to increase public recreation.

This study was performed for the Brownsville Navigation District (BND) by H & H Resources, Inc. (HHR) though a letter agreement dated April 13, 2004 by HHR and approved by the BND in a letter dated April 23, 2004. Clarification of responsibilities

Copy to
John W
Dave B

PORT OF BROWNSVILLE
HOME PORT TO NAFTA

July 9, 2004

Mr. Ken Merritt
United States Fish and Wildlife Services
Santa Ana Wildlife Refuge
Rt. 2 Box 202A
Alamo, Texas 78516

Re: Bahia Grande Channel Project

Dear Mr. Merritt:

Enclosed find revised pages 1 and 2 for the Bahia Grande Connector Channel to Brownsville Ship Channel Hydraulic Analysis Report prepared by H&H Resources, Inc. recently submitted. Please replace these pages with those in the original report.

We thank you for your cooperation on this matter. If you have any questions or need additional information, please do not hesitate to contact me at (956) 831-4592.

Sincerely,

BROWNSVILLE NAVIGATION DISTRICT

Héctor J. López, P.E.
Director of Engineering Services

cc: Nino Gutierrez – BND
Don Blanton – Blanton & Associates

EXECUTIVE SUMMARY

The Brownsville Navigation District (BND), in cooperation with Cameron County, the Texas Department of Transportation (TxDOT) and the U.S. Fish and Wildlife Service (USFWS), is planning the construction of a channel to provide for the re-flooding of Bahia Grande. Bahia Grande is an inland basin in Cameron County, Texas between Brownsville and Port Isabel, north of SH 48 and south of SH 100. This improved connector channel from the Brownsville Ship Channel to Bahia Grande will allow for restoration of tidal inflows to the basin. Restoring inflows to Bahia Grande is expected to provide habitat for aquatic life, habitat for water birds and other wildlife, to reduce wind erosion from the area, and to increase public recreation. This report documents the results of an engineering study by H & H Resources, Inc. (HHR) for the BND that provides a hydraulic analysis and design for the proposed channel.

HHR utilized the EPA-Storm Water Management Model (SWMM) computer program to analyze hydraulic operation of the proposed Bahia Grande connector channel and simulate potential time-based changes in water level and velocities as flow exchanges between the Brownsville Ship Channel and Bahia Grande. Based upon input from the BND, the proposed connector channel should be a trapezoidal-shaped channel with side slopes of 4(H):1(V) and a bottom (invert) elevation of –9.00 ft. TxDOT is proposing a bridge on SH 48 over the proposed connector channel at the entrance to Bahia Grande.

This study evaluated the hydraulic operation of the proposed connector channel using actual expected tidal fluctuations in the Brownsville Ship Channel for normal tide conditions, as determined in a study by Texas A&M University. For these conditions, a 150-ft bottom width channel will convey a maximum inflow rate (rising tide) to Bahia Grande of 4030 cfs at a velocity of 2.3 ft/sec, and a maximum outflow rate of 3060 cfs at a velocity of 2.0 ft/sec. The calculated water volume exchange between Bahia Grande and the Brownsville Ship Channel is about 32% of the maximum flood volume achieved in Bahia Grande during a normal tidal cycle.

1 INRODUCTION

The Brownsville Navigation District (BND), in cooperation with Cameron County, the Texas Department of Transportation (TxDOT), the U.S. Fish and Wildlife Service (USFWS) and others, is planning the construction of a channel to provide for the re-flooding of Bahia Grande. The channel will connect the Brownsville Ship Channel to Bahia Grande through a new bridge on SH 48 by TxDOT. This report documents the results of an engineering study by H & H Resources, Inc. for the BND that provides a hydraulic analysis and design for the proposed channel.

1.1 Project Description and Location

The Bahia Grande is an inland basin located in Cameron County, Texas between Brownsville and Port Isabel, north of SH 48 and south of SH 100 (See Figure 1). According to an undated Final Draft Environmental Assessment (EA) for the Proposed Re-Flooding and Restoration of Bahia Grande, prepared by the U.S. Fish and Wildlife Service (USFWS), the Bahia Grande was historically a shallow bay, but now remains dry most of the time. The EA states that various construction activities over several decades have contributed to an increased isolation of Bahia Grande from tidal inflows that historically flooded the basin.

This project by the BND will provide an improved connector channel from the Brownsville Ship Channel to the Bahia Grande to allow a restoration of tidal inflows to the basin. Restoring inflows to Bahia Grande is expected to provide habitat for aquatic life, habitat for water birds and other wildlife, to reduce wind erosion from the area, and to increase public recreation.

This study was performed for the Brownsville Navigation District (BND) by H & H Resources, Inc. (HHR) though a letter agreement dated April 13, 2004 by HHR and approved by the BND in a letter dated April 23, 2004. Clarification of responsibilities

and requested deliverables was provided by the BND through discussions with Mr. Nino Gutierrez and Mr. Hector Lopez.

1.2 Purpose and Scope of Work

This study provides a time-based hydraulic analysis and design for the proposed connector channel between the Brownsville Ship Channel and Bahia Grande. Specific tasks include the following:

- Data collection and hydraulic model setup.
- Hydraulic analysis of proposed connector channel.
- Prepare design exhibit (Plan & Profile) of Channel.
- Prepare hydraulic report and analysis summary.
- Project coordination and meetings.
- Technical specification for the channel excavation

1.3 Data Sources

Types and sources of data utilized in preparing this study are described as follows:

- Topographic data defining the Bahia Grande was retrieved from a survey performed by the Natural Resources Conservation Service (NRCS) in 2000. HHR obtained a copy of this survey from Dr. Billy Edge, Professor in the Texas A&M University (TAMU) Department of Civil Engineering, Coastal and Ocean Engineering Division. A copy of the topographic map is included as Figure 2.
- BND provided the following:
  - The Environmental Assessment described above.
  - A copy of Analysis of Proposed Flooding of Bahia Grande, Cameron County, Texas, by Dianna L. Van Valkenburg and Billy L. Edge, Ocean Engineering Program, Civil Engineering Department, Texas A&M University, dated February 2003 (TAMU Report).

- Field survey along alignment of proposed channel with ties to SH 48.
- Guidance on the typical section and profile for proposed channel.

- The TxDOT Pharr District provided proposed bridge and roadway plans for SH 48.
- The Texas Natural Resources Information System (TNRIS) provided electronic copies of USGS topographic map, TxDOT County Map, and aerial photography.
- Historical tide levels at the Port of Brownsville were retrieved from a website hosted by the National Oceanic and Atmospheric Administration (NOAA) / National Ocean Service (NOS).
- Dr. Billy Edge with Texas A&M University also provided a copy of a report by the USFWS, Channel Dimensions for Restoring Flows to Bahia Grande, by James Broska, Hydrologist, October 2000. The USFWS Report provided background information on estimated flood volumes available in Bahia Grande.

2 METHODOLOGY

2.1 General Approach

HHR utilized the EPA-Storm Water Management Model (SWMM) computer program to analyze hydraulic operation of the proposed Bahia Grande connector channel. Primarily, SWMM was used to analyze and simulate potential time-based changes in water level and velocities within the proposed channel as it exchanges flow between the Brownsville Ship Channel and Bahia Grande. The boundary (tailwater) conditions for the SWMM analysis at the ship channel were defined for two conditions described below.

SWMM was selected as the primary modeling tool throughout the analysis based on its ability to incorporate all the components and aspects of Bahia Grande and the proposed connector channel system. Using a series of nodes and links in SWMM to represent the physical characteristics of the connector channel, the SH 48 bridge waterway, and the large flood storage area of the Bahia Grande, HHR used the 'Hydraulic Module' in SWMM to develop numerical simulations of the effects of time-based historical tidal fluctuations.

2.2 Model Development

In developing the SWMM model for the proposed connector channel conditions, several components were needed and are described as follows:

- The Bahia Grande flood storage area was modeled as a series of effective 'channels' in SWMM. A schematic representation of the link-node system is shown in Figure 1, where each link in the system north of SH 48 models a section of the Bahia Grande area as an effective 'channel'. Cross-sections to define the area were extracted from the NRCS topo map (Figure 2).
- The proposed connector channel was modeled in SWMM as a trapezoidal-shaped channel with various widths, side slopes of 4(H):1(V), and a bottom (invert) elevation of –9.00 ft. As noted above, guidance on channel geometry and profile was provided

by the BND. Three links define the proposed channel in the SWMM model. One link, labeled 'SH48' defines the channel through the TxDOT right of way, two other links define the 2000-ft. channel south of SH 48.

- The south end of the proposed connector channel, Node 'CC', represents the connection, or outfall, to the Brownsville Ship Channel. It is at this node that the tide elevation vs. time relationships were coded to reflect tidal fluctuations based on historical tide observations.
- Elevations presented in this report are based on the surveys provided by BND, TxDOT and NRCS.

3 HYDRAULIC ANALYSIS

3.1 Proposed Channel Description

As noted above, the proposed connector channel should be a trapezoidal-shaped channel with side slopes of 4(H):1(V) and a bottom (invert) elevation of –9.00 ft. The average natural ground elevation along the channel alignment will result in an average channel depth of about 10 ft below existing ground. The proposed typical section, plan layout and profile of the proposed channel are shown on the Plan-Profile sheets in Exhibit 1. At the direction of BND, spoil from the channel excavation will be deposited adjacent to the banks of the channel at a maximum height of 5 ft and maximum width of 200 ft.

3.2 Proposed Bridge at SH 48

Exhibit 2 contains a copy of the preliminary bridge layout for SH 48 over the proposed connector channel. TxDOT prepared the bridge layout as part of their plans for their planned expansion of the SH 48 roadway facility. The channel section under the proposed SH 48 bridge shows side slopes of 3(H):1(V) with articulated block riprap protection planned on the abutment header slopes under the bridge.

3.3 Tidal Boundary Conditions

At the confluence of the proposed connector channel with the Brownsville Ship Channel, hydraulic boundary conditions are defined in SWMM reflecting a relationship of historical tide levels varying with time. Two sets of historical data were obtained and utilized in this analysis, as described below.

3.3.1 Tidal Condition 1: March 2002 Tides – TAMU Report

The TAMU Report documents findings of a study to evaluate alternative channel locations and configurations to accomplish the desired re-flooding of Bahia Grande. Hydraulic analyses within that study utilized a two-dimensional (2-D) hydraulic

computer model, Advanced Circulation Model (ADCIRC). The 2-D hydraulic model was used to study flow circulation patterns, magnitude and direction of flows within Bahia Grande, as affected by alternative channel connections to the Brownsville Ship Channel and other adjacent inland bays. The model's network included these bodies of water and a portion of Laguna Madre and the Gulf of Mexico.

One tidal boundary condition evaluated in the TAMU Report is described therein as the 'actual expected astronomical tides . . . beginning at midnight March 26, 2002'. The TAMU Report includes results of this tidal condition in the Brownsville Ship Channel at the proposed entrance to the Bahia Grande connector channel. The tidal record covers a 28-day period from March 26 – April 23, 2002. Tide levels during this period ranged from a maximum elevation of about +1.05' to a minimum elevation of –1.35'. A graphical representation of the Condition 1 tidal record at Node CC is shown in Figure 3.

3.3.2 Tidal Condition 2: July – December 2002 Tides – Port of Brownsville Tide Gage

The NOAA/NOS web site provided records from a gage at the Port of Brownsville that recorded tide levels from 2002-03. HHR selected a six-month period from July1 through December 31, 2002 as a representative sample of historical tide levels to use in this analysis. Tide levels during this period ranged from a maximum elevation of about +0.80' to a minimum elevation of –0.65'. A graphical representation of the Condition 2 tidal record at Node CC is shown in Figure 4.

3.4 Hydraulic Analysis Results

The proposed conditions SWMM model was analyzed for each tidal condition defined above. Goals of the SWMM analyses included an estimate of potential exchange volume between the ship channel and Bahia Grande and the calculation of maximum flow rates and velocities in the connector channel. As shown in the previous section, Tidal Condition 1 presented a larger range of tide fluctuations than Tidal Condition 2. Tide levels recorded at the Port of Brownsville were expected to be lower and have a smaller

fluctuation range since the gage location was much further inland than the Bahia Grande connector channel location, and further removed from tidal influence at the shoreline.

Since Tidal Condition 1 had a greater range of tide variation than Tidal Condition 2, the SWMM model for that condition predicted larger tidal exchange volumes, flow rates and velocities in the proposed connector channel. Using Tidal Condition 1 as the boundary condition for channel design, HHR analyzed various channel widths to determine potential designs that exhibited similar hydraulic characteristics to that recommended in the TAMU Report.

3.4.1 Tidal Exchange Volumes

Exchange volume was calculated in the same manner as the TAMU Report, as the flow volume entering Bahia Grande during one tidal cycle (about 12.5 hours). The TAMU Report calculated a tidal exchange volume of up to 111 million cubic feet (MCF), or about 16% of their total assumed volume of Bahia Grande, assuming a 200-ft channel width. Apparently the TAMU report evaluated a rectangular shaped channel with various depths and a constant width of 200 ft.

The TAMU Report assumed the total volume of water in Bahia Grande as 700 MCF, based on calculations from the USFWS Report. USFWS calculated this volume assuming a 3 ft change in tide within Bahia Grande, but did not indicate the range of elevations over which this tide change occurred. HHR computed a flood volume vs. elevation relationship using reservoir storage calculation methods (conic volume) and the NRCS topographic map (Figure 2). A flood volume of 738 MCF in Bahia Grande is available at a flood elevation of about 2 ft. above MSL, based on HHR calculations (see Table 1 and Figure 5).

Three of the channel alternatives that HHR evaluated provided tidal cycle flow volumes similar to that predicted by the TAMU Report. These alternatives had bottom widths of 175 ft, 150 ft, and 125 ft, and yielded tidal exchange volumes of 118, 114, and 107 MCF,

respectively (see Table 2). Maximum flood elevations computed throughout Bahia Grande were essentially equal to that computed at Node B. For these three channel alternatives, maximum flood elevations were 0.52 ft, 0.49 ft, and 0.45 ft above MSL. Based on flood storage vs. elevation relationship (Figure 5), these elevations result in maximum flood volumes of 365 MCF, 358 MCF, and 350 MCF in Bahia Grande. The tidal exchange volumes represent about 32% of the maximum volume within Bahia Grande, based on the maximum flood elevations achieved.

3.4.2 Flow Rates and Velocities

Table 2 also presents the maximum calculated flow rates and velocities for the three channel alternatives identified in the previous section. The maximum inflow rates to Bahia Grande and maximum channel velocities were determined from the hydraulic results at the SH 48 link, the north end of the channel between Node A and AA. Maximum inflow rates range from 4300 to 3700 cfs, and maximum velocites range from 2.2 to 2.6 ft/sec. Though not shown in Table 2, the maximum outflow rates from Bahia Grande to the connector channel average about 3000 cfs and maximum outflow velocity average 2.0 ft/sec. Figure 6 shows the full range of flow and velocity variations through the complete tidal period for the 150 ft bottom width channel alternative.

4 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based upon analyses by HHR of the data acquired and/or provided for this study by others. Should additional information be acquired or provided, results, conclusions and recommendations may change.

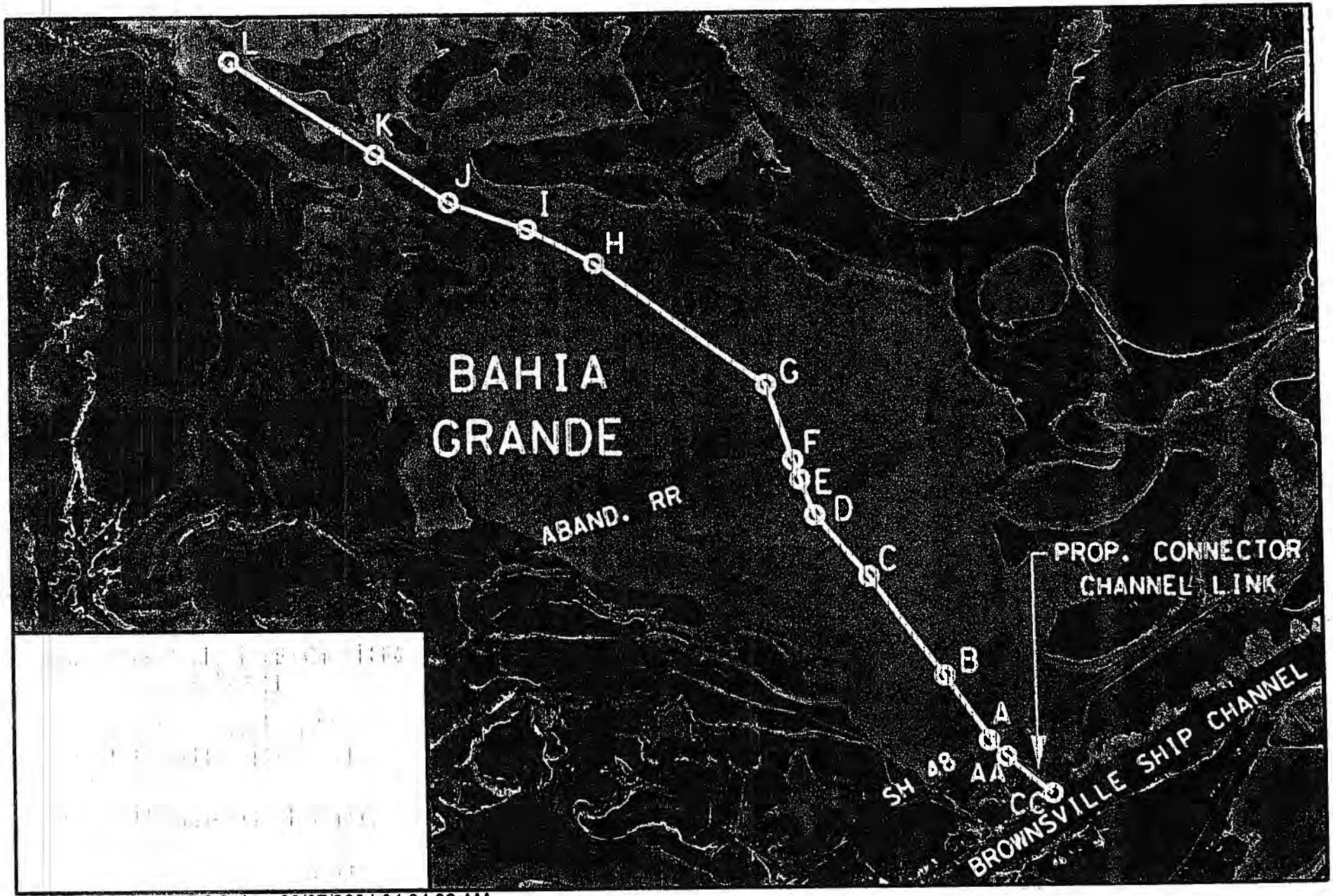
Based on the results of the hydraulic analysis and simulation of the proposed Bahia Grande Connector Channel, the following conclusions are made:

- A proposed trapezoidal-shaped connector channel with a bottom width of 150 ft, side slopes of 4(H):1(V), and a bottom (invert) elevation of –9.00 ft will allow a water volume exchange between the Brownsville Ship Channel and Bahia Grande during a normal tidal cycle of 114 MCF, or about 32% of the maximum expected flood volume of Bahia Grande.
- The 150-ft bottom width channel will have an average top width of 230 ft and will provide a similar, but slightly greater water volume exchange than the channel option evaluated in the TAMU Report.
- Maximum inflow rate to Bahia Grande for the 150 ft channel is 4030 cfs at a velocity of 2.3 ft/sec, and the maximum outflow rate from Bahia Grande to the Brownsville Ship Channel for the 150 ft channel will be about 3000 cfs at a velocity of 2.0 ft/sec.
- The above flow and velocity predictions are based upon analysis of a normal tidal cycle as determined by the TAMU Report for tide levels in the Brownsville Ship Channel.
- The maximum channel velocities calculated for the normal tidal cycle are not excessive and would not be expected to cause erosion of the channel banks or scour under the proposed SH 48 bridge. The 150-ft bottom width channel will connect to TxDOT's 175-ft bottom width channel under the proposed bridge, and thus provide a gradual transition in flow width to the much wider area of the Bahia Grande north of SH 48.

Based upon the findings and conclusions of this study and as requested by BND, HHR offers the following recommendations:

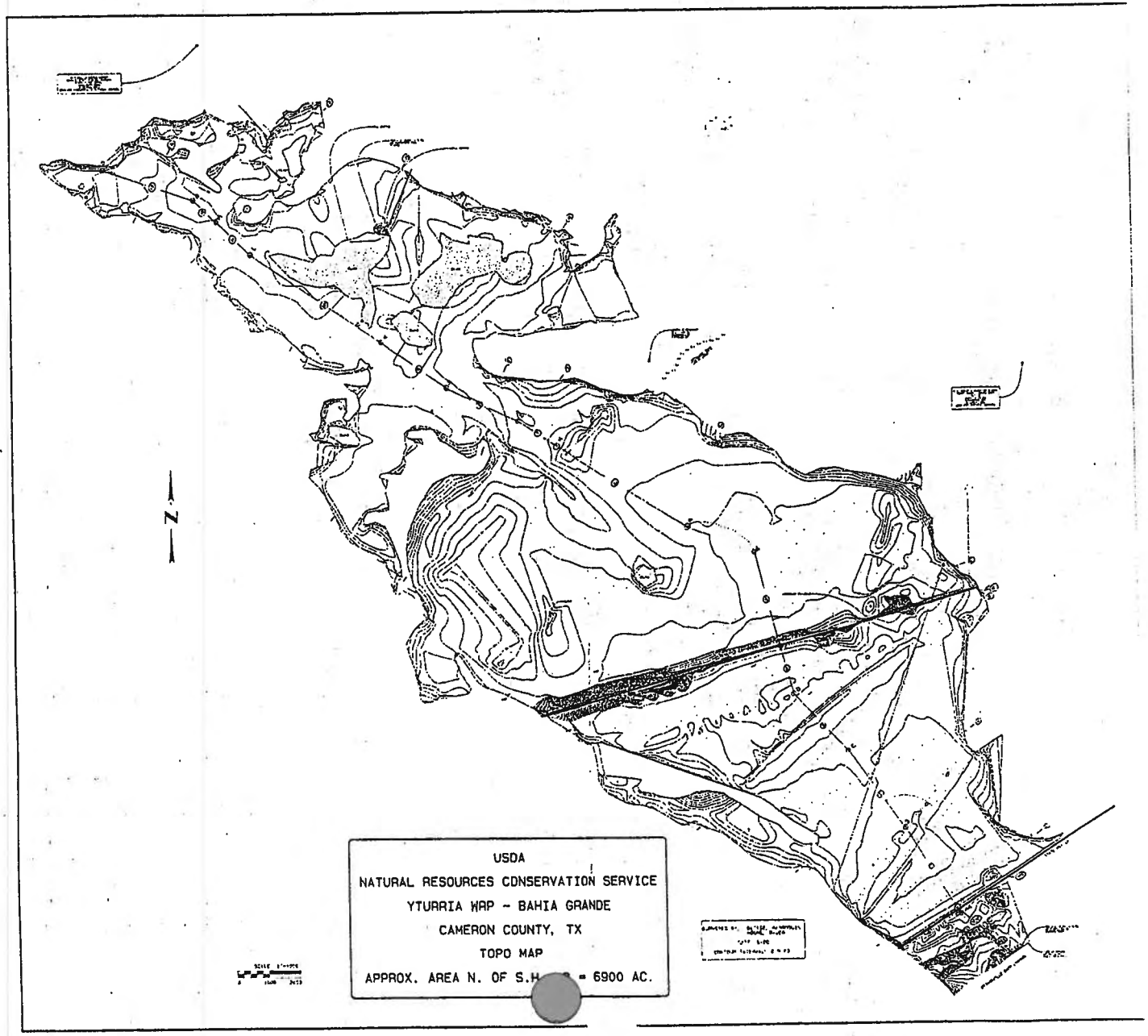
- Implement construction of the channel as shown in Exhibit 1 to provide for the re-flooding and restoration of Bahia Grande.
- Coordinate construction of the channel with TxDOT and affected resource agencies to ensure proper connection with the channel portion within TxDOT right of way and to obtain required permitting for the project.
- Provide a technical specification for construction containing the following items from the TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, June 2004:
  - Item 100 – Preparing Right of Way
  - Item 110 – Excavation
  - Item 132 - Embankment
  - Item 158 – Specialized Excavation Work
  - Item 164 – Seeding for Erosion Control
  - Item 506 – Temporary Erosion, Sedimentation, and Environmental Controls

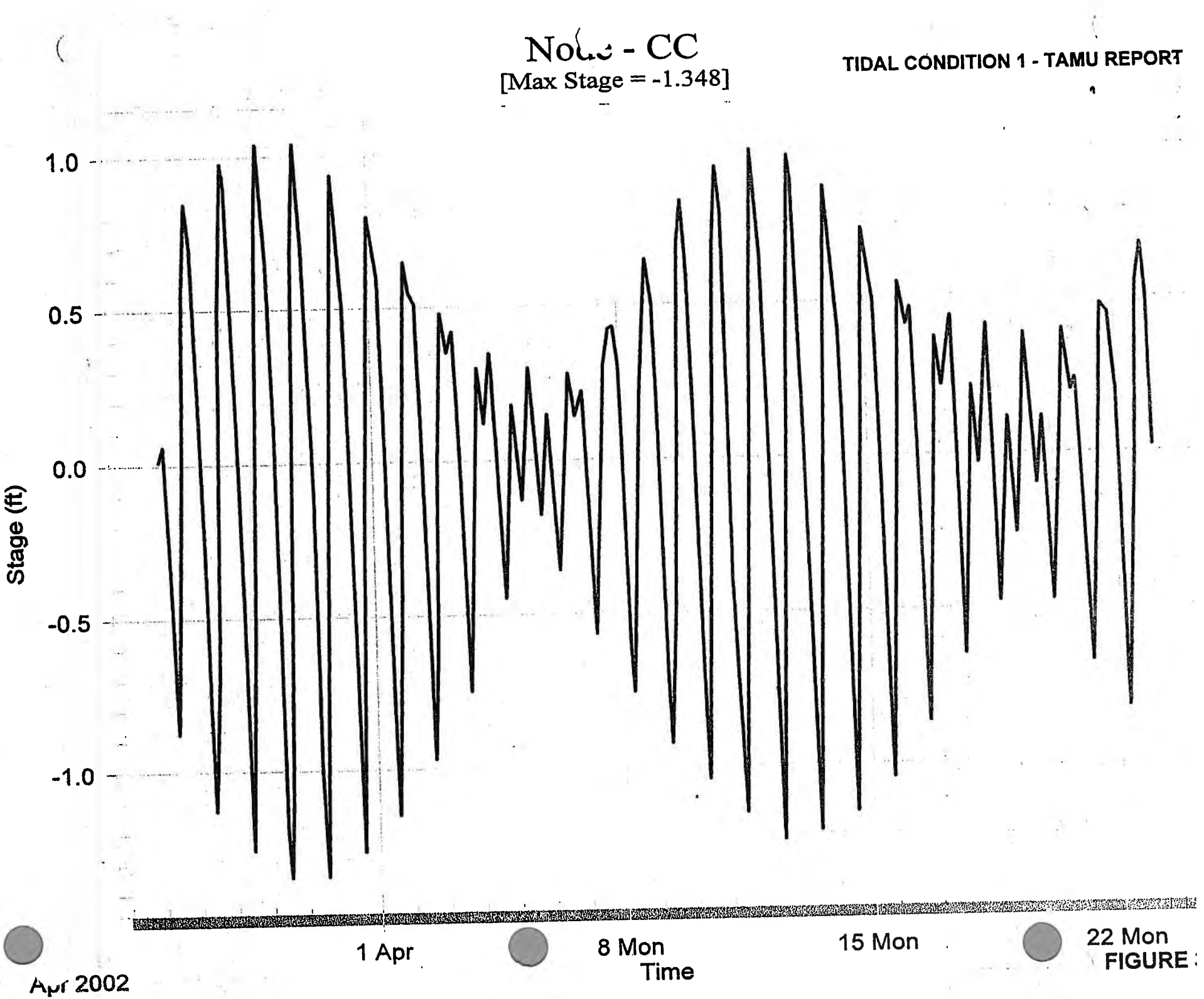
FIGURES



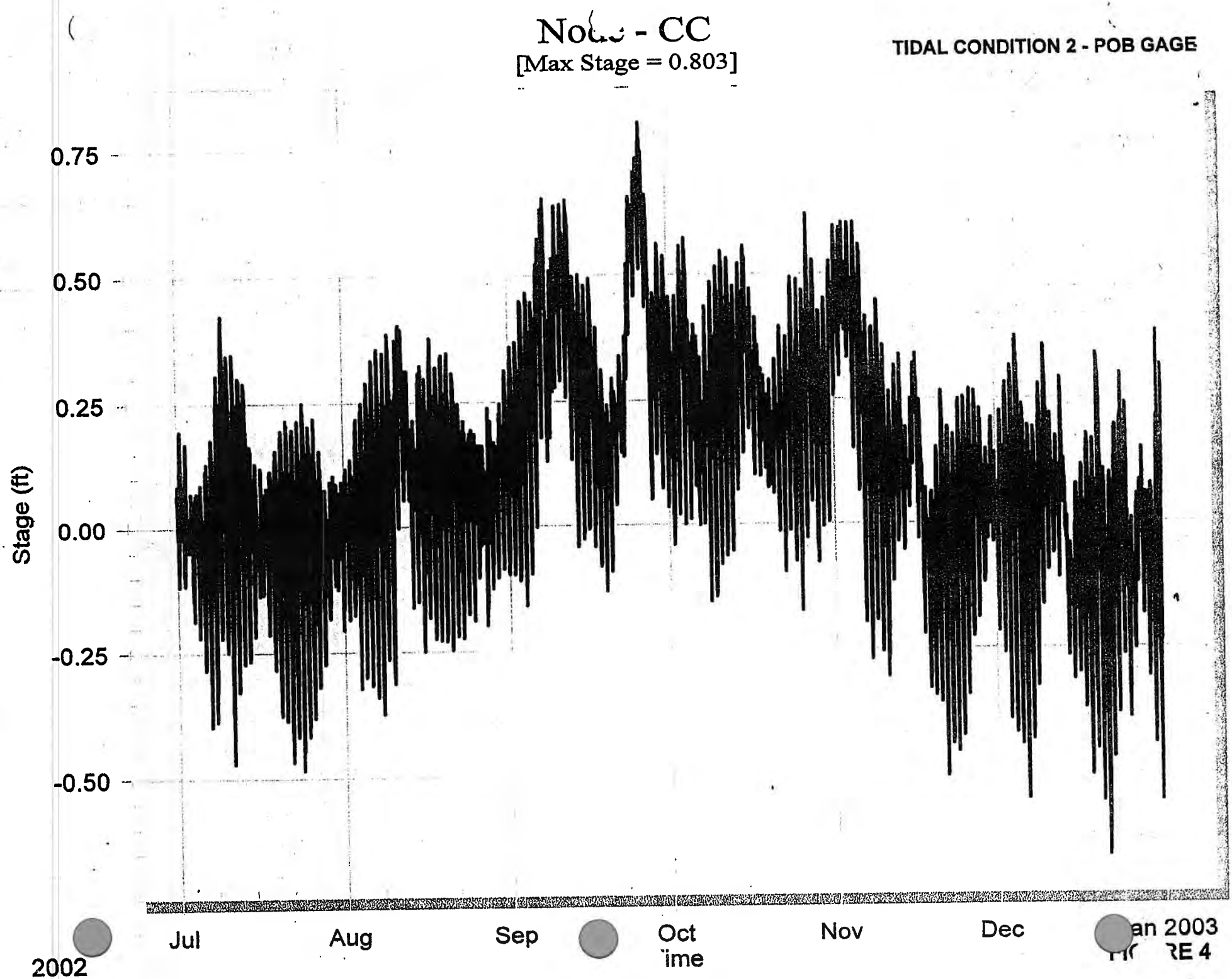
...\dgn\HHR_SH48_DOQ.dgn 06/07/2004 04:34:36 AM

FIGURE 1

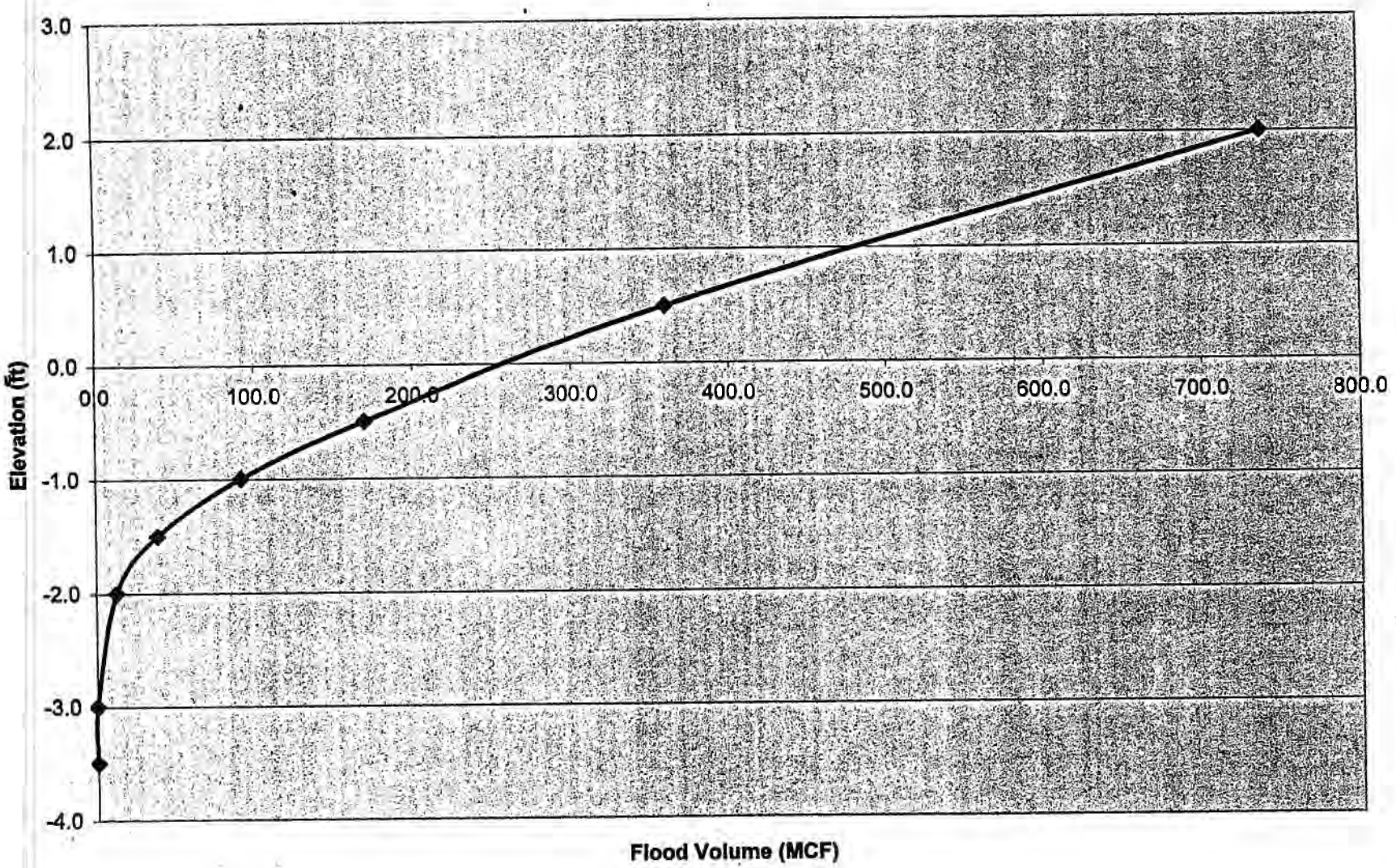

N
USDA
NATURAL RESOURCES CONSERVATION SERVICE
YTURRIA MAP - BAHIA GRANDE
CAMERON COUNTY, TX
TOPO MAP
APPROX. AREA N. OF S.H.
= 6900 AC.


Node - CC
[Max Stage = -1.348]
TIDAL CONDITION 1 - TAMU REPORT
1.0
0.5
0.0
-0.5
-1.0
Stage (ft)
Apr 2002
1 Apr
8 Mon
15 Mon
22 Mon
Time

FIGURE


Node - CC
[Max Stage = 0.803]
TIDAL CONDITION 2 - POB GAGE
0.75
0.50
0.25
0.00
-0.25
-0.50
Stage (ft)
Jul
Aug
Sep
Oct
Nov
Dec
2002
ime

BAHIA GRANDE
Flood Volume vs. Elevation Above / Below MSL



FIGU[redacted]5

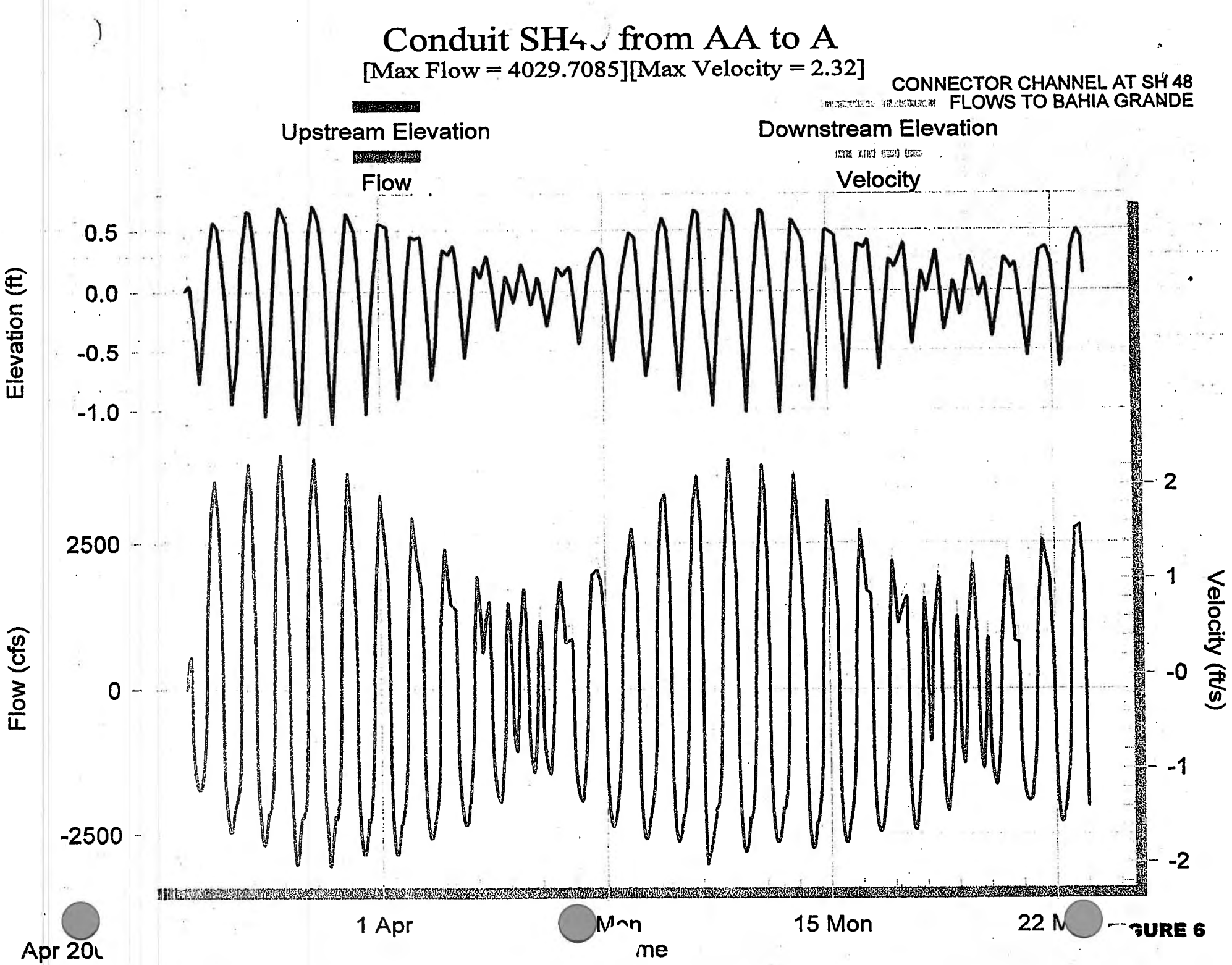

Conduit SH48 from AA to A
[Max Flow = 4029.7085][Max Velocity = 2.32]
CONNECTOR CHANNEL AT SH 48
FLOWS TO BAHIA GRANDE
Upstream Elevation
Downstream Elevation
Flow
Velocity
Elevation (ft)
0.5
0.0
-0.5
-1.0
Flow (cfs)
2500
0
-2500
Velocity (ft/s)
2
1
-0
-1
-2
1 Apr
15 Mon
22 M
Apr 20
me

FIGURE 6

TABLES

Bahia Grande Reservoir Storage Volume Calculations

(Using Conic Volume Computation)

Elevation	Surface Area (SF)	Change in Volume (CF)	Accum. Volume (CF)
2.0	295064700	378629407	738,476,035
0.5	212054536	190280797	359,846,628
-0.5	169308146	77766953	169,565,831
-1.0	142154953	53151568	91,798,877
-1.5	74112245	25807181	38,647,310
-2.0	32018088	12698080	12,840,129
-3.0	852291	142049	142,049
-3.5	0	0	
TOTAL VOLUME =		**738,476,035**	

TABLE 1

Bahia Grande Improved Connector Channel
Hydraulic Characteristics of Alternative Channel Widths

Channel Bottom Width / Top Width	Max. Elevation At SH 48, Node A	Max. Elevation in Bahia Grande At Node B	Max. Flow in Channel (cfs)	Max. Velocity in Channel (ft/sec)	Approx. Max. Volume in Bahia Grande (MCF)	Max. Tidal Cycle Volume Exchange (MCF)	Max. Flow Volume Exchange with Bahia Grande
175 / 255	0.73	0.52	4300	2.2	365	118	32%
150 / 230	0.68	0.49	4030	2.3	358	114	32%
125 / 205	0.61	0.45	3700	2.5	350	107	31%

Note:

1. TAMU Report assumed a total volume of 700 MCF in Bahia Grande. This calculation was apparently based upon a maximum flood elevation of about 2.0 ft above MSL. HHR calculates 738 MCF at Elev. 2.0, based on NRCS Topo Map.

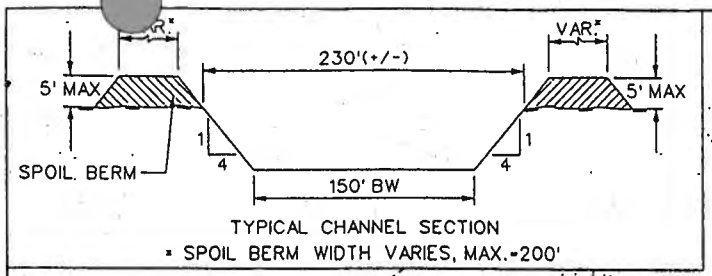
2. The TAMU Report calculated up to a 16% volume exchange for a 200 ft.-wide channel, assuming the maximum capacity of 700 MCF, which is approximately 111 MCF of water exchange in one tidal cycle (about 12 hours).

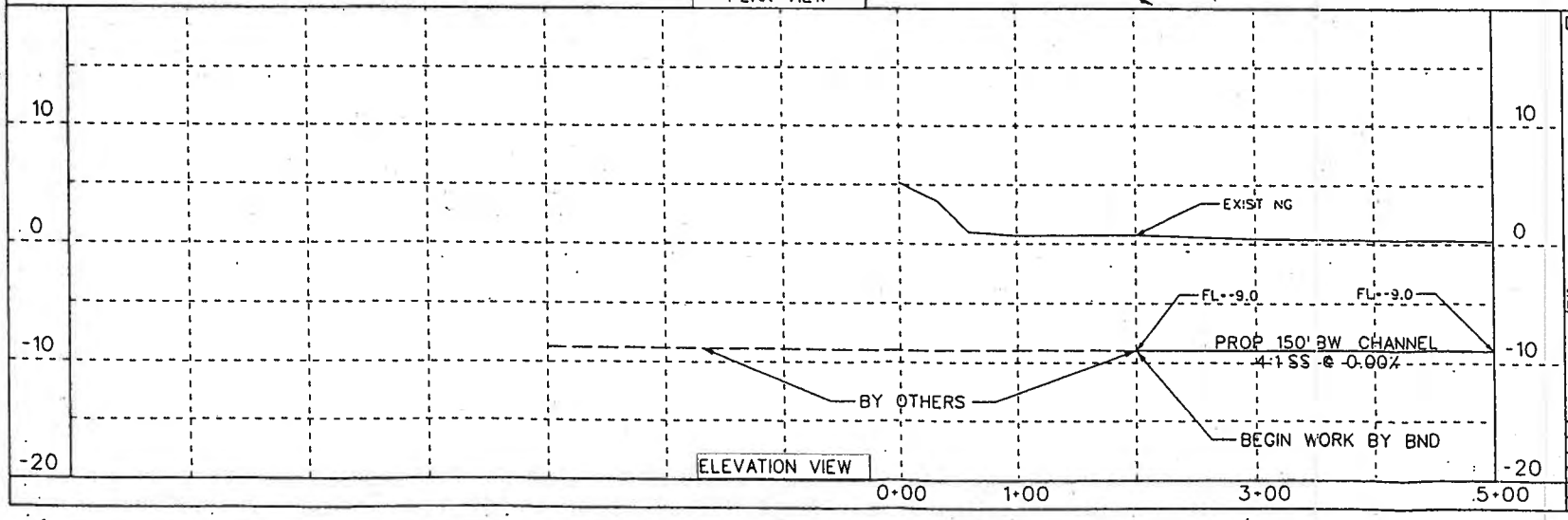
3. HHR calculates total volumes in Bahia Grande based on 'Node B' maximum flood elevation, as shown above, about half that of TAMU Report.

4. Because HHR total volume calculation is less that TAMU Report assumption, the percent volume exchange is higher for a similar size channel than that calculated by TAMU.

TABLE 2

EXHIBITS





CURVE DATA
L=227.88'
C=225.93'
D=26.1147°
R=500'
I=12.93'
E=13.27'

EXHIBIT 1, SHEET 1

BENCH MARK
ELEV. = 1.48, ROADWAY STA 1378+24, (50.0' RT.
ALUM. DISK TOP OF HEADWALL

ERIC R. FRESCH, P.E.
No. 84618
JUNE 2004

FOR INTERIM REVIEW
NOT INTENDED FOR
CONSTRUCTION, BIDDING,
OR PERMIT PURPOSES

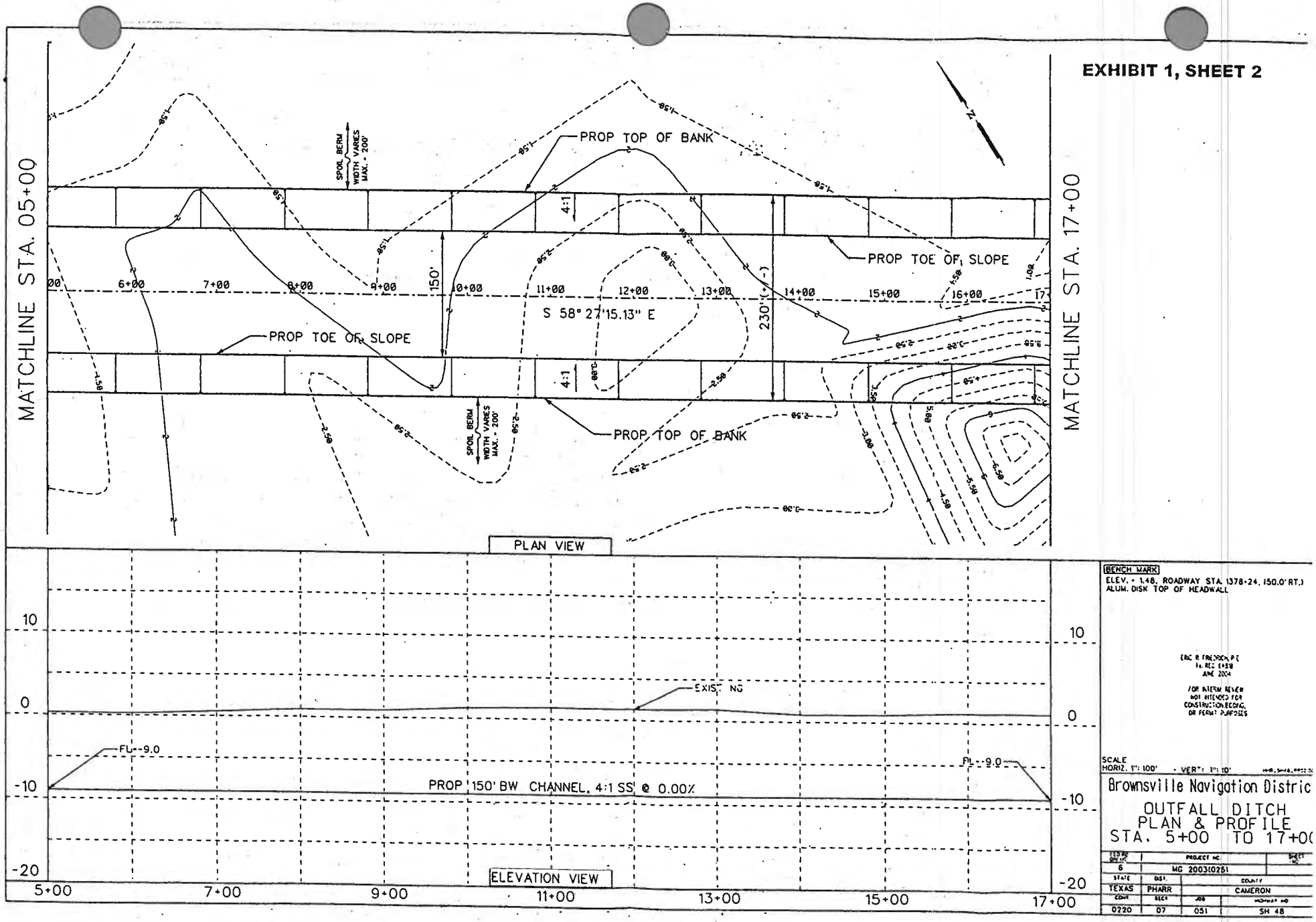
SCALE
HORIZ. 1"= 100' VERT. 1"= 10'

Brownsville Navigation Distr

OUTFALL DITCH
PLAN & PROFILE
STA. 0+00 TO 5+0

FED.RD. DIV.NO.	PROJECT NO.	
6	MG 2003(025)	
STATE	DIST.	COUNTY
TEXAS	PHARR	CAMERON
CONT.	SECT.	JOB
0220	07	051
		HIGHWAY NO.
		SH 48

EXHIBIT 1, SHEET 2



BENCH MARK
ELEV. = 1.48, ROADWAY STA. 1378+24, 150.0' RT.)
ALUM. DISK TOP OF HEADWALL

ERIC R. FREDRICK, P.E.
No. REG. 94838
JUNE 2004

FOR INTERIM REVIEW
NOT INTENDED FOR
CONSTRUCTION, BIDDING,
OR PERMIT PURPOSES

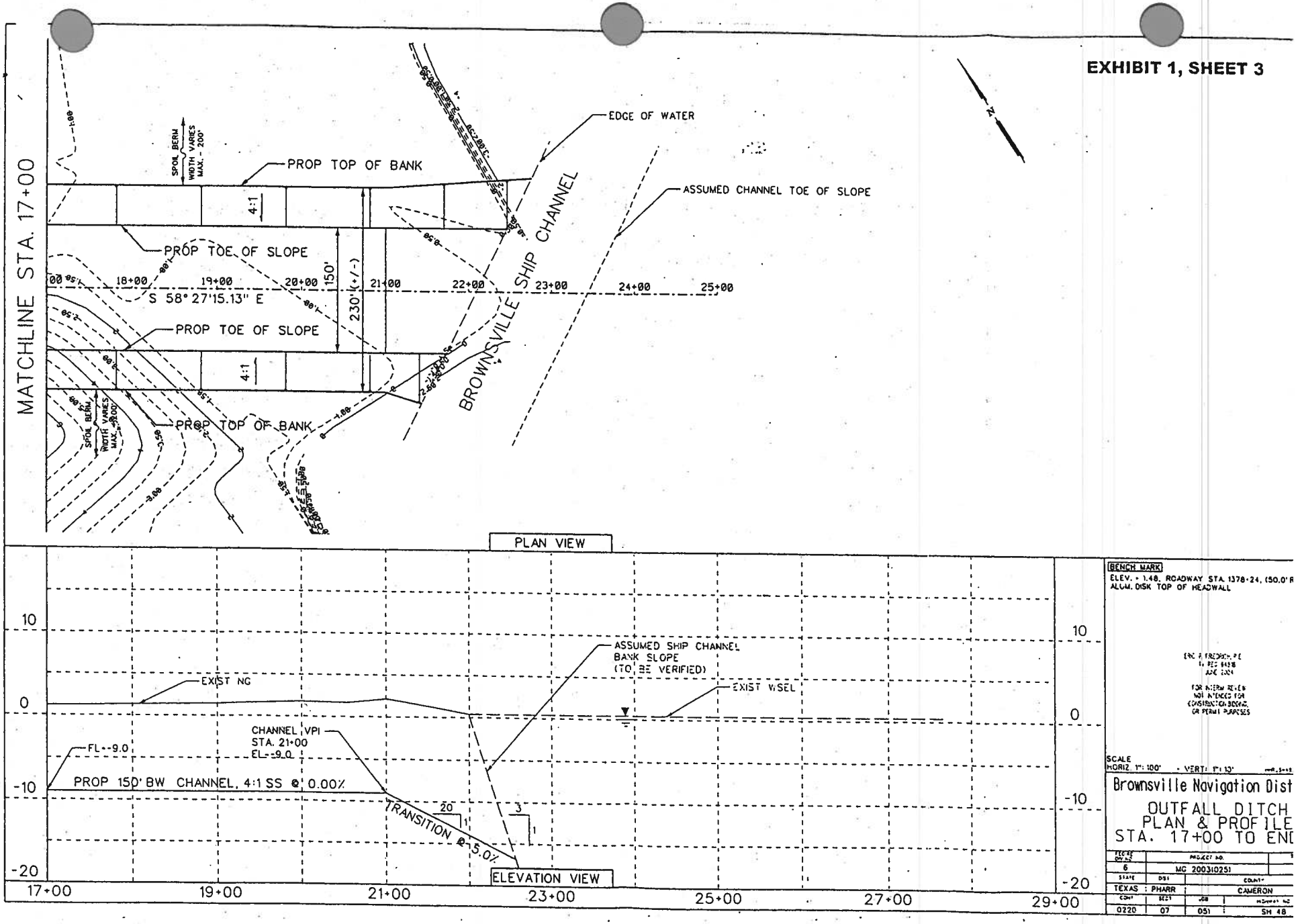
SCALE
HORIZ. 1": 100' - VERT. 1": 10'

Brownsville Navigation District

OUTFALL DITCH PLAN & PROFILE STA. 5+00 TO 17+00

CONTROL SECT. NO.		PROJECT NO.	SHEET NO.
6		MG 2003102B1	
STATE	DIST.	COUNTY	
TEXAS	PHARR	CAMERON	
CONT.	SECT.	JOB	HIGHWAY NO.
0220	07	051	SH 48

EXHIBIT 1, SHEET 3



BENCH MARK
ELEV. = 1.48, ROADWAY STA. 1378+24, (50.0' R
ALUM. DISK TOP OF HEADWALL

ERIC R. FREDRICH, P.E.
No. REG. 84318
APR. 2004

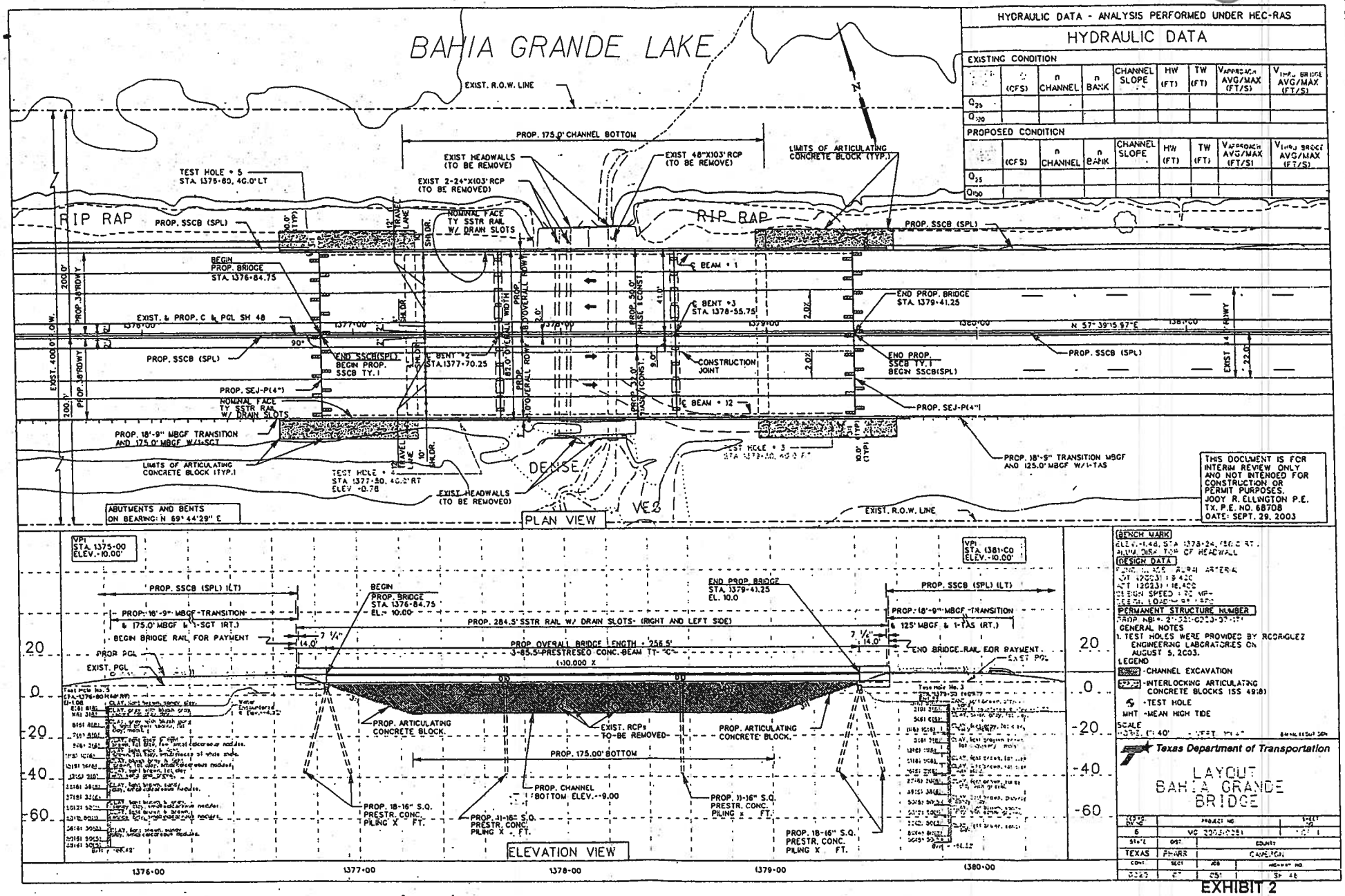
FOR INTERIM REVIEW
NOT INTENDED FOR
CONSTRUCTION BIDDING,
OR PERMIT PURPOSES

SCALE
HORIZ. 1"= 100' - VERT: 1"= 10'

Brownsville Navigation Dist

OUTFALL DITCH
PLAN & PROFILE
STA. 17+00 TO END

FIGURE OR NO.	PROJECT NO.	
6	MG 20031025)	
STATE	DIST	COUNTY
TEXAS	PHARR	CAMERON
CONT	SECT	JOB
0220	07	051
		HIGHWAY NO. SH 48



HYDRAULIC DATA - ANALYSIS PERFORMED UNDER HEC-RAS

HYDRAULIC DATA

EXISTING CONDITION

	Q (CFS)	n CHANNEL	n BANK	CHANNEL SLOPE	HW (FT)	TW (FT)	$V_{APPROACH}$ AVG/MAX (FT/S)	$V_{THRU\ BRIDGE}$ AVG/MAX (FT/S)
Q_{25}								
Q_{100}								

PROPOSED CONDITION

	Q (CFS)	n CHANNEL	n BANK	CHANNEL SLOPE	HW (FT)	TW (FT)	$V_{APPROACH}$ AVG/MAX (FT/S)	$V_{THRU\ BRIDGE}$ AVG/MAX (FT/S)
Q_{25}								
Q_{100}								

BENCH MARK

DESIGN DATA

PERMANENT STRUCTURE NUMBER

GENERAL NOTES

1. TEST HOLES WERE PROVIDED BY RODRIGUEZ ENGINEERING LABORATORIES ON AUGUST 5, 2003.

LEGEND

- CHANNEL EXCAVATION
- INTERLOCKING ARTICULATING CONCRETE BLOCKS ISS 49:8)
- TEST HOLE
- MHT -MEAN HIGH TIDE

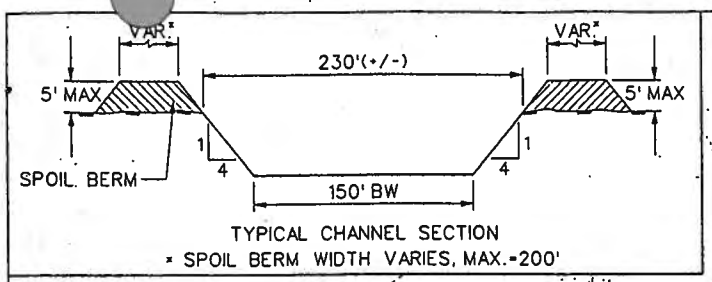
SCALE

Texas Department of Transportation

LAYOUT
BAHIA GRANDE BRIDGE

DIST	PROJECT NO	SHEET NO
6	VC 320-5(028)	
STATE	DIST	COUNTY
TEXAS	PHARR	CAMERON
CONT	SECT	JOB

EXHIBIT 2

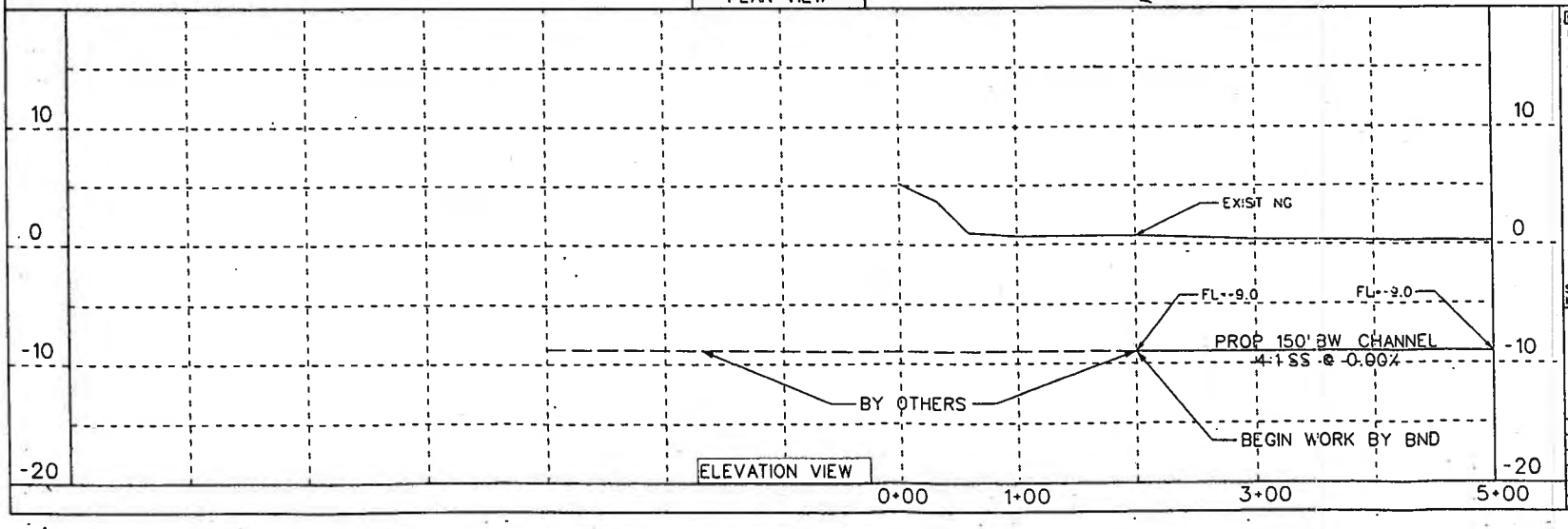


TYPICAL CHANNEL SECTION
* SPOIL BERM WIDTH VARIES, MAX.=200'

PLAN VIEW

CURVE DATA
L=227.88'
C=225.93'
D=26.1147°
R=500'
I=12.93'
E=13.27'

EXHIBIT 1, SHEET 1



ELEVATION VIEW

BENCH MARK
ELEV. = 1.48, ROADWAY STA. 1378+24, (50.0' RT.)
ALUM. DISK TOP OF HEADWALL

ERIC R. FREDRICK, P.E.
LIC. NO. 64518
JUNE 2004

FOR INTERIM REVIEW
NOT INTENDED FOR CONSTRUCTION, BIDDING OR PERMIT PURPOSES

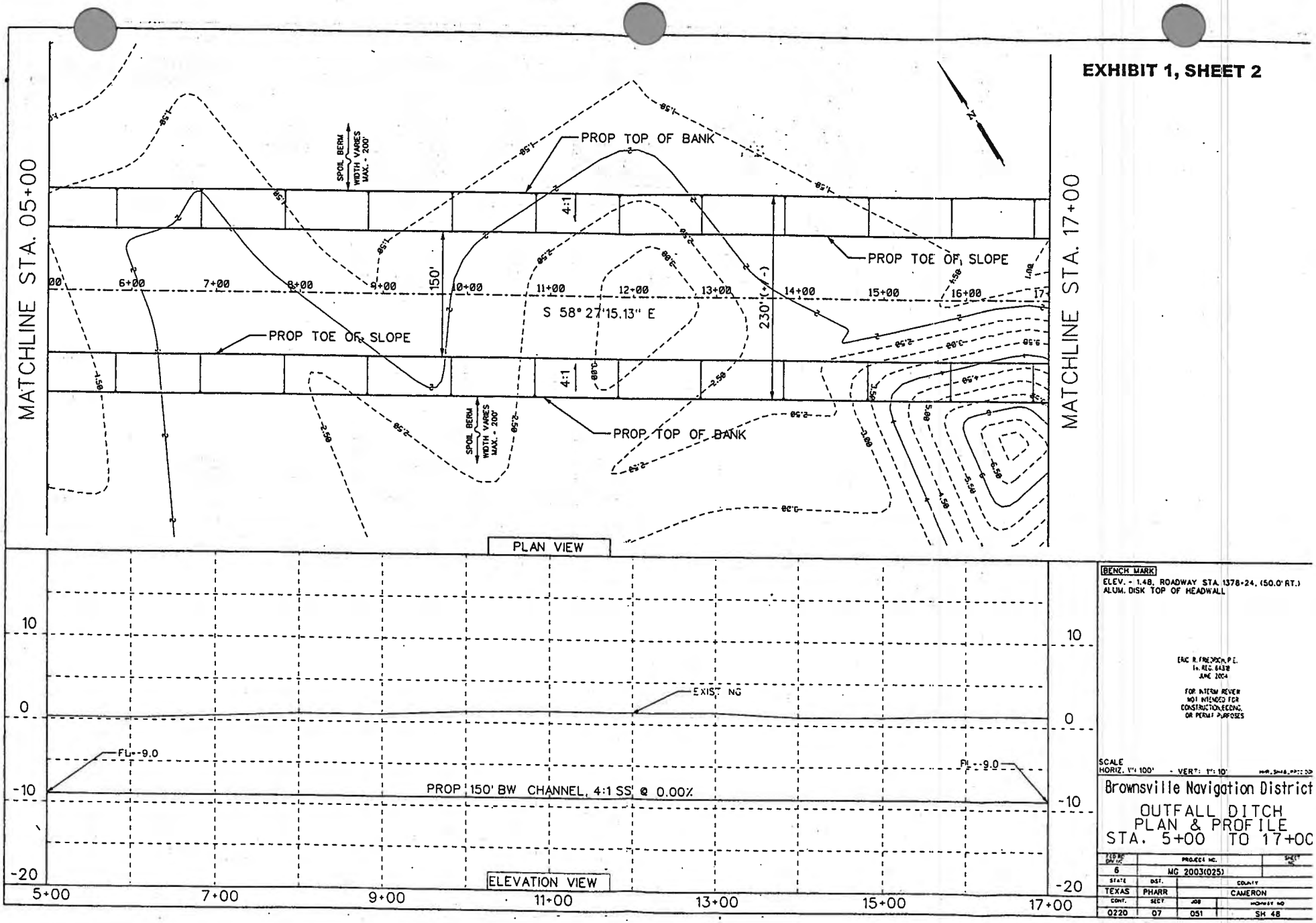
SCALE
HORIZ. 1"= 100' - VERT: 1"= 10'

Brownsville Navigation Distri

OUTFALL DITCH
PLAN & PROFILE
STA. 0+00 TO 5+00

FED.RD. DIV. NO.	PROJECT NO.	SHEET NO.
6	MG 20031025)	
STATE	DIST.	COUNTY
TEXAS	PHARR	CAMERON
CONT	SECT	JOB	HIGHWAY NO.
0220	07	051	SH 48

EXHIBIT 1, SHEET 2



BENCH MARK
ELEV. = 1.48, ROADWAY STA. 1378+24, (50.0' RT.)
ALUM. DISK TOP OF HEADWALL

ERIC R. FRERICH, P.E.
Tx. REG. 84328
JUNE 2004

FOR INTERIM REVIEW
NOT INTENDED FOR CONSTRUCTION, BIDDING, OR PERMIT PURPOSES

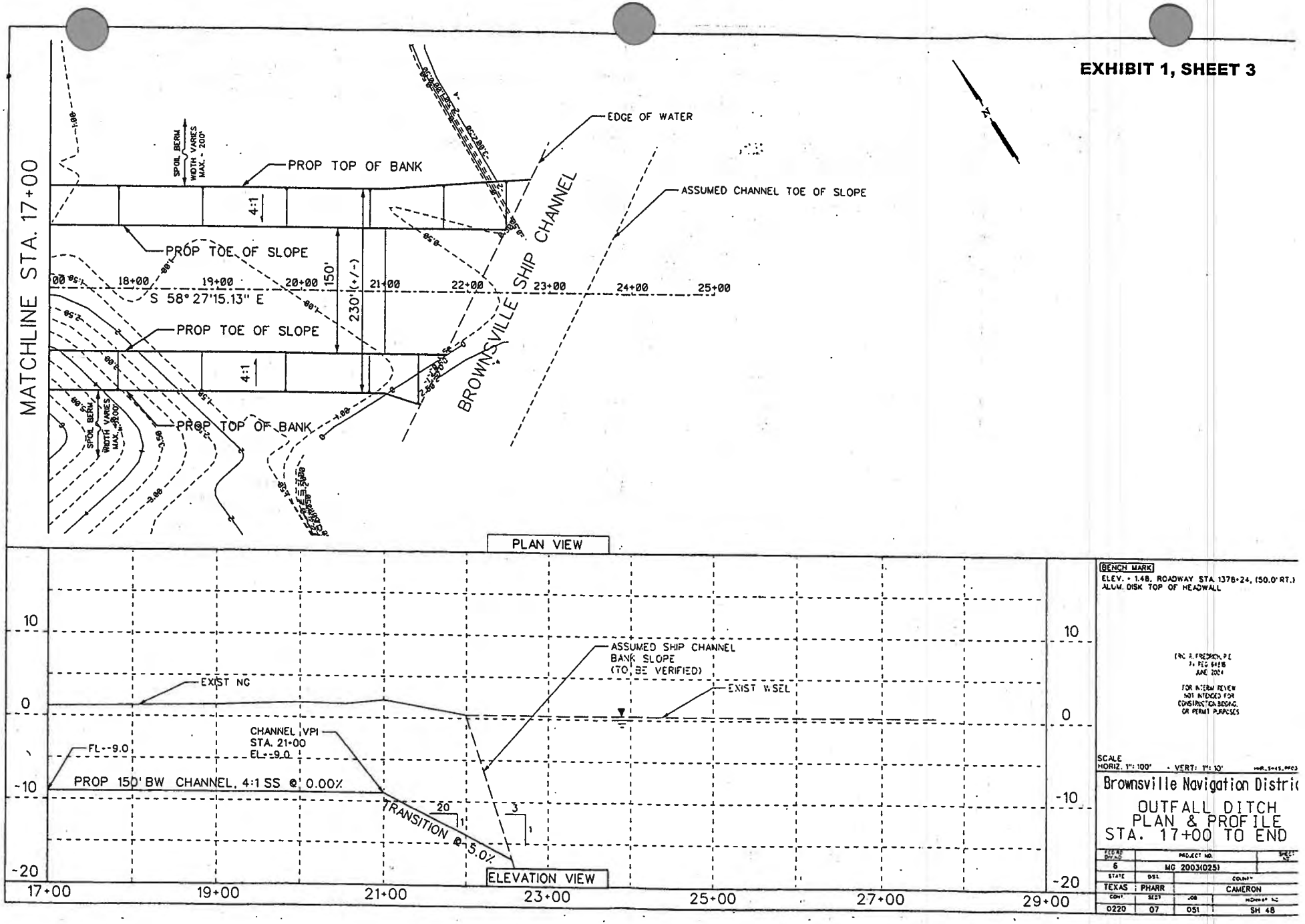
SCALE
HORIZ. 1" = 100' - VERT: 1" = 10'

Brownsville Navigation District

OUTFALL DITCH
PLAN & PROFILE
STA. 5+00 TO 17+00

FED. RD. DIV. NO.	PROJECT NO.		SHEET NO.
6	NG 2003(025)		
STATE	DIST.	COUNTY	
TEXAS	PHARR	CAMERON	
CONT.	SECT	JOB	HIGHWAY NO.
0220	07	051	SH 48

EXHIBIT 1, SHEET 3



BENCH MARK
ELEV. = 1.48, ROADWAY STA. 1378+24, (50.0' RT.)
ALUM. DISK TOP OF HEADWALL

ERIC R. FREEMAN, P.E.
No. 94818
JUNE 2024

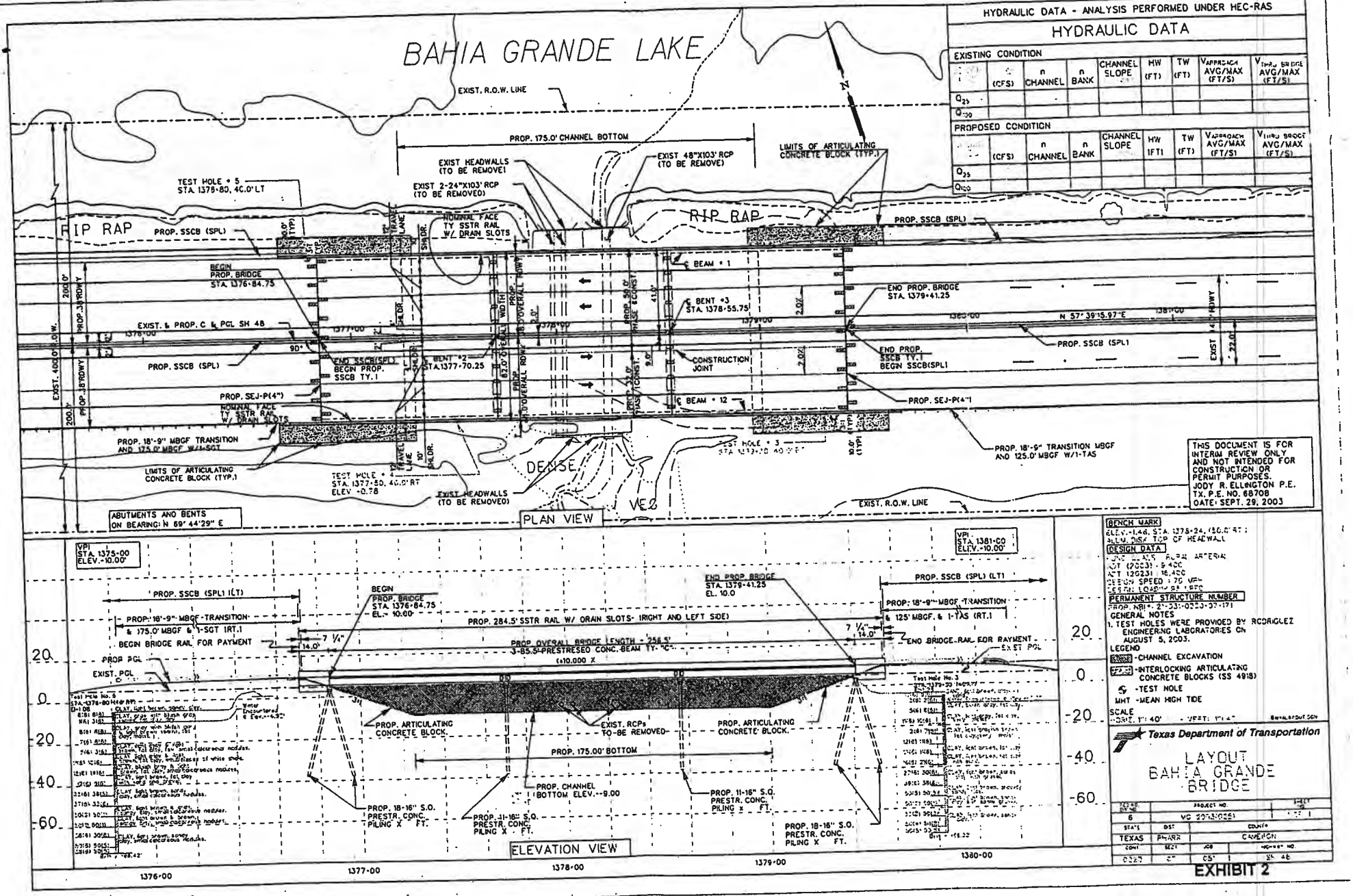
FOR INTERIM REVIEW
NOT INTENDED FOR CONSTRUCTION, BIDDING, OR PERMIT PURPOSES

SCALE
HORIZ. 1"= 100' - VERT: 1"= 10'

Brownsville Navigation District

OUTFALL DITCH PLAN & PROFILE STA. 17+00 TO END

FED.RD. DIV.NO.	PROJECT NO.		SHEET NO.
6	MG 2003(025)		
STATE	DIST.	COUNTY	
TEXAS	PHARR	CAMERON	
CONT.	SECT.	JOB	HIGHWAY NO.
0220	07	051	SH 48


BAHIA GRANDE LAKE
EXIST. R.O.W. LINE
PROP. 175.0' CHANNEL BOTTOM
EXIST HEADWALLS (TO BE REMOVE)
EXIST 48"X103' RCP (TO BE REMOVE)
LIMITS OF ARTICULATING CONCRETE BLOCK (TYP.)
EXIST 2-24"X103' RCP (TO BE REMOVED)
TEST HOLE # 5 STA 1378+80, 40.0' LT
RIP RAP
PROP. SSCB (SPL)
NOMINAL FACE TY SSTR RAIL W/ DRAIN SLOTS
BEGIN PROP. BRIDGE STA 1376+84.75
EXIST. & PROP. C & PGL SH 48
PROP. SEJ-P(4")
PROP. 18'-9" MBGF TRANSITION AND 175.0' MBGF W/1-SGT
BENT #1
BENT #3 STA 1378+55.75
BENT #2 STA 1377+70.25
CONSTRUCTION JOINT
END PROP. BRIDGE STA 1379+41.25
END PROP. SSCB TY.1 BEGIN SSCB(SPL)
PROP. 18'-9" TRANSITION MBGF AND 125.0' MBGF W/1-TAS
TEST HOLE # 4 STA 1377+50, 40.0' RT ELEV -0.78
TEST HOLE # 3 STA 1379+10 40.0' RT
EXIST HEADWALLS (TO BE REMOVED)
LIMITS OF ARTICULATING CONCRETE BLOCK (TYP.)
ABUTMENTS AND BENTS ON BEARING: N 69° 44'29" E
PLAN VIEW
DENISE
VE2
THIS DOCUMENT IS FOR INTERIM REVIEW ONLY AND NOT INTENDED FOR CONSTRUCTION OR PERMIT PURPOSES.
JODY R. ELLINGTON P.E.
TX. P.E. NO. 68708
DATE: SEPT. 29, 2003
VPI STA 1375+00 ELEV.-10.00'
VPI STA 1381+00 ELEV.-10.00'
PROP. SSCB (SPL) (LT)
PROP. 18'-9" MBGF TRANSITION & 175.0' MBGF & 1-SGT (RT.)
BEGIN BRIDGE RAIL FOR PAYMENT
PROP PGL
EXIST. PGL
PROP. 284.5' SSTR RAIL W/ DRAIN SLOTS- (RIGHT AND LEFT SIDE)
PROP OVERALL BRIDGE LENGTH = 256.5'
3-85.5' PRESTRESED CONC. BEAM (TY-"C" (±10,000 #
END BRIDGE RAIL FOR PAYMENT
PROP. 18'-9" MBGF TRANSITION & 125' MBGF, & 1-TAS (RT.)
PROP. ARTICULATING CONCRETE BLOCK.
EXIST. RCPs TO BE REMOVED
PROP. 175.00' BOTTOM
PROP. CHANNEL BOTTOM ELEV.=-9.00
PROP. 18-16" S.O. PRESTR. CONC. PILING X FT.
PROP. 11-16" S.O. PRESTR. CONC. PILING X FT.
ELEVATION VIEW
1376+00
1377+00
1378+00
1379+00
1380+00
HYDRAULIC DATA - ANALYSIS PERFORMED UNDER HEC-RAS
HYDRAULIC DATA
EXISTING CONDITION
PROPOSED CONDITION
BENCH MARK
DESIGN DATA
PERMANENT STRUCTURE NUMBER
GENERAL NOTES
1. TEST HOLES WERE PROVIDED BY RODRIGUEZ ENGINEERING LABORATORIES ON AUGUST 5, 2003.
LEGEND
-CHANNEL EXCAVATION
-INTERLOCKING ARTICULATING CONCRETE BLOCKS (SS 4918)
-TEST HOLE
MHT -MEAN HIGH TIDE
SCALE
Texas Department of Transportation
LAYOUT
BAHIA GRANDE
BRIDGE
EXHIBIT 2