

SCOUR ANALYSIS REPORT

FM 518 BYPASS BIKEWAY PROPOSED BIKEWAY/PEDESTRIAN BRIDGE OVER ROBINSON BAYOU

GALVESTON COUNTY, TEXAS
CSJ No. 0912-73-179

Prepared for:



Houston District

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DATE: MAY 16, 2014

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CEI Project No. 340004.00
May 2014

Submitted by
CivilTech
Engineering, Inc.
Firm Registration # F-382

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1. Introduction

CivilTech Engineering, Inc. was contracted by AIA Engineers, Ltd. to perform a bridge scour analysis for the proposed bikeway/pedestrian bridge crossing over Robinson Bayou as part of the FM 518 Bypass Bikeway Project. This study report presents a detailed scour analysis of the proposed bridge that crosses the 100-year floodplain of Robinson Bayou. This scour analysis was developed in conjunction with the hydraulic impact study for the proposed project titled, Hydraulic Impact Study – Proposed Pedestrian Bridge over Robinson Bayou (FM 518 Bypass Bikeway Project), dated May 2014, prepared by CivilTech Engineering, Inc.

2. Project Location and Description

The proposed bikeway pedestrian bridge will be located over Robinson Bayou in the northeast portion of League City, Texas. The project location is shown on the **Project Vicinity Map** in **Appendix A**. The proposed bridge will be constructed as part of the FM 518 Bypass Bikeway Project. The proposed bikeway/pedestrian bridge will be located along the north face of the existing FM 270 Bridge crossing over Robinson Bayou. The alignment of the proposed bridge is generally parallel to the alignment of the existing FM 270 Bridge.

3. Project Datum

All elevations in this study are referenced to the North American Vertical Datum (NAVD) of 1988, 1996 Adjustment Datum unless otherwise stated. The NAVD 1988, 1996 Adjustment datum is referred to as the Project Datum. The FEMA Flood Insurance Rate Map (FIRM) is referenced to NGVD 1929, 1984 Adjustment. The LiDAR DEM used in this study to develop the cross section overbank information is referenced to NAVD 1988, 2001 Adjustment. The datum conversions from these two datums to the Project Datum are presented in **Table 1**.

Table 1. Datum Conversion

Datum Conversion		Conversion Value
From	To	(ft)
NAVD 1988, 2001 Adj.	Project Datum (NAVD 1988, 1996 Adj.)	+0.14
NGVD 1929, 1984 Adj.	Project Datum (NAVD 1988, 1996 Adj.)	-0.46

4. Criteria and References

This scour analysis was developed in conjunction with the hydraulic impact study for the proposed project. The hydraulic impact study utilized the design information provided by AIA Engineers, Ltd. for the proposed project reach. The design information provided by AIA Engineers, Ltd. included survey data, record construction drawings, and bridge design plans. Additional materials utilized and referenced as part of this analysis include:

- *Hydraulic Design Manual*, Texas Department of Transportation, revised May 2014.
- *Geotechnical Manual*, Texas Department of Transportation, revised December 2012.
- *Evaluating Scour at Bridges, Hydraulic Engineering Circular No. 18*, Federal Highway Administration, April 2012.
- *Stream Stability at Highway Structures, Hydraulic Engineering Circular No. 20*, Federal Highway Administration, April 2012.

5. Scour Analysis

The scour analysis was performed for the proposed bikeway/pedestrian bridge crossing over Robinson Bayou. The alignment of the proposed bikeway/pedestrian bridge is generally parallel to the alignment of the existing FM 270 Bridge over Robinson Bayou and will be located along the north face of the existing FM 270 Bridge. The photographs of Robinson Bayou in the vicinity of the proposed bridge and the FM 270 Bridge are provided in **Appendix A**.

Methodology

The bridge scour analysis was performed using the methodologies and procedures presented in TxDOT Geotechnical Manual (December 2012), TxDOT Hydraulic Design Manual (May 2014) and Federal Highway Administration (FHWA) HEC-18 and HEC-20 publications. The scour analysis contained the following components:

- Determination of stream stability
- Determination of long term degradation and aggradation
- Magnitude of contraction scour
- Magnitude of local scour at piers
- Plot of total scour depth

The potential scour evaluations were performed for the 100-year storm event and were checked for the 500-year storm event.

Since Robinson Bayou is not a studied stream, a hydraulic model was developed for Robinson Bayou in the vicinity of the proposed bikeway/pedestrian bridge crossing using USACE’s HEC-RAS hydraulic modeling software as part of the hydraulic impact study for the proposed project titled, *Hydraulic Impact Study – Proposed Pedestrian Bridge over Robinson Bayou (FM 518 Bypass Bikeway Project)*, dated May 2014, prepared by CivilTech Engineering, Inc. The model was used in this study to perform the scour calculations. The HEC-RAS plan representing the proposed bridge is referred to as ‘PROPOSED’. The HEC-RAS output is included in **Appendix B**.

Proposed Bridge Description

A bridge layout of the proposed bikeway/pedestrian bridge was provided by AIA Engineers, Ltd. and is presented in **Appendix C**. The proposed bridge is a three-span bridge supported by two bents in the middle and abutments on each end. Each of the three spans is approximately 41.75 feet in length. The alignment of the proposed bridge has a skew of 25 degrees with respect to Robinson Bayou channel centerline; however, the bents are aligned in the direction of flow. The proposed bridge will be supported by 30-inch diameter piers along the bents. The overall deck width of the proposed bikeway/pedestrian bridge is 16.0 feet. The proposed bridge low chord elevation is 10.60 feet. The bridge configuration details are presented in **Table 2**.

Table 2. Proposed Bikeway/Pedestrian Bridge Details

Bridge Length	Total No. of Spans	Total No. of Bents	Piers Per Bent	Pier Diameter	Drilled Shafts Diameter	Bridge Skew ¹	Bent Skew ¹	Min. Low Chord Elev. ²	Effective 1% WSEL
(ft)				(in)	(in)	(degrees)	(degrees)	(ft)	(ft)
125.25	3	2	2	30	30	25	0	10.60	10.54

¹skew computed with respect to the flow.

Soil Borings

Soil borings for the existing bridge were utilized for this analysis. The soil boring logs used in this scour analysis are shown in **Appendix C** and are as follows:

- Boring Hole-1
- Boring Hole-2

Boring Hole-1 is located immediately downstream of the existing FM 270 Bridge within the west bank of the channel. Boring Hole-2 is located immediately downstream of the existing FM 270 Bridge within the east overbank area of the channel. Both boring logs show soil layers consisting mainly of clay; therefore, the minimum D₅₀ particle size of 0.10 mm was used for the scour calculations.

According to the TxDOT Geotechnical Manual (Chapter 5, Section 5), a reduction factor of 0.5 should be applied to the HEC-18 computed pier scour depths for soils with 11% or more clay. According to information from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey, the soil in the vicinity of proposed bikeway/pedestrian bridge consists of more than 40% clay; therefore the reduction factor will be applied to the pier scour calculations. An exhibit of the USDA NRCS Soil Survey showing the project area and chemical and physical characteristics of the soil is provided in **Appendix C**.

Stream Stability

An exhibit comparing 1978 and 2014 aerial photographs of Robinson Bayou is shown in **Appendix D**. The comparison of the aerials shows that Robinson Bayou channel alignment has not varied over the last 36 years. Therefore, the Robinson Bayou channel appears to be relatively stable. In addition, a Rapid Assessment of Channel Stability (Section 5.4 of HEC-20) was performed for qualitative determination of channel stability. The results of the rapid assessment are presented in **Table 3**.

Table 3. Rapid Assessment of Channel Stability for Robinson Bayou

Stability Indicator	Description of Indicator	Rating	Description
1	Watershed and floodplain activity	9	Frequent disturbances due to construction and urbanization.
2	Flow Habitat	3	Perennial stream with no flashy behavior.
3	Channel Pattern	5	Meandering, moderate radius of curvature.
4	Entrenchment/ Channel Confinement	2	Active floodplain exists, no levees.
5	Bed Material	1	$F_s < 20\%$
6	Bar Development	5	Minimal recent growth of channel bar.
7	Obstructions	5	Occasional.
8	Bank Soil Texture	1	Clay and silty clay
9	Average Bank Slope	2	Bank slopes = 2.5H:1V with cohesive materials.
10	Vegetative or Engineered Bank Protection	2	Woody vegetation present and both banks are lined.
11	Bank Cutting	3	Little or no evidence.
12	Mass Wasting, Bank Failure	5	Minor mass wasting.
13	Upstream Distance to Bridge from Meander Impact Point and Alignment	11	Poorly aligned with flow.
Total Rating (R)		54	Good Stability

The total channel stability rating was determined to be 54, which represents a channel with good stability ($49 \leq R \leq 85$ for plane-bed channels).

Long Term Degradation and Aggradation

From the comparison of aerial photographs, no significant change can be seen in the channel in the last 36 years. There is no evidence of stream bed mining, dams, or reservoirs along the channel. All these indicate no significant long term degradation or aggradation in the channel.

Contraction and Local Pier Scour

The 100-year storm event design and 500-year storm event check scour computations for the bikeway/pedestrian bridge are shown in **Table 4** and detailed computations are presented in **Appendix D**. As shown on the bridge layout sheet, embankment protection will be provided in the overbank areas under the bridge to protect against scour. The 100-year contraction scour was determined to be Live-Bed scour with scour depth of 0.0 feet in the channel. The 100-year pier scour depths for the piers along the west and east bents were computed with the reduction factor as 2.2 feet and 2.1 feet respectively.

The 500-year storm event check analysis showed a Live-Bed contraction scour with a scour depth of 0.0 feet. The check analysis pier scour depth for piers along the west and east bents was computed as 2.3 and 2.2 feet respectively.

Table 4. Proposed Bikeway/Pedestrian Bridge Scour Computations

Bent No.*	Bent Location	100-year Storm Event			500-year Storm Event		
		Pier Scour (ft)	Contraction Scour (ft)	Total Scour (ft)	Pier Scour (ft)	Contraction Scour (ft)	Total Scour (ft)
1	West Bank of Robinson Bayou Main Channel	2.2	0.0	2.2	2.3	0.0	2.3
2	East Bank of Robinson Bayou Main Channel	2.1	0.0	2.1	2.2	0.0	2.2

*Bents numbered from west to east

Plot of Total Scour Depth

A plot of total 100-year scour depth for the proposed bikeway/pedestrian bridge is presented in **Appendix D**.

6. Conclusions

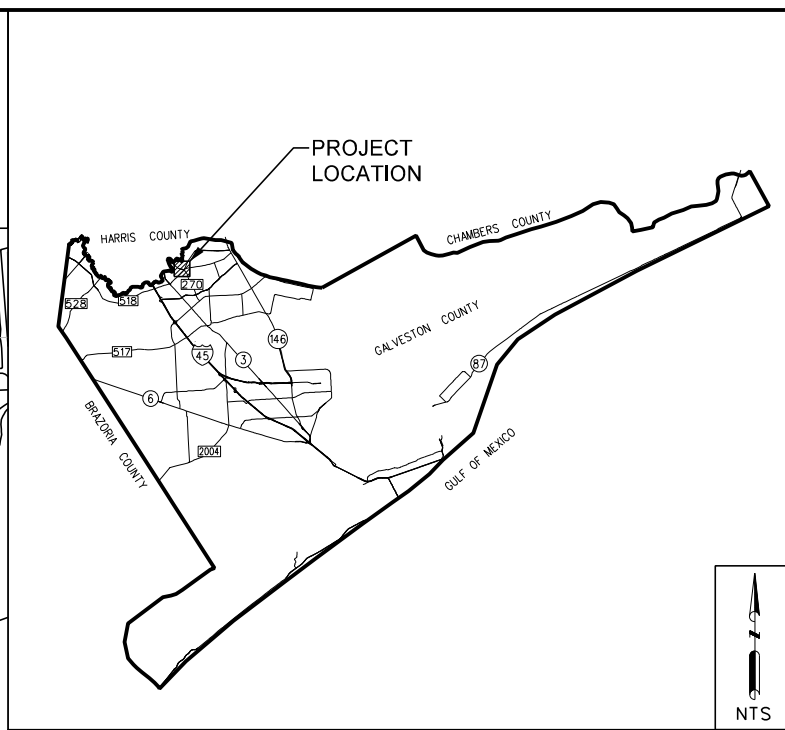
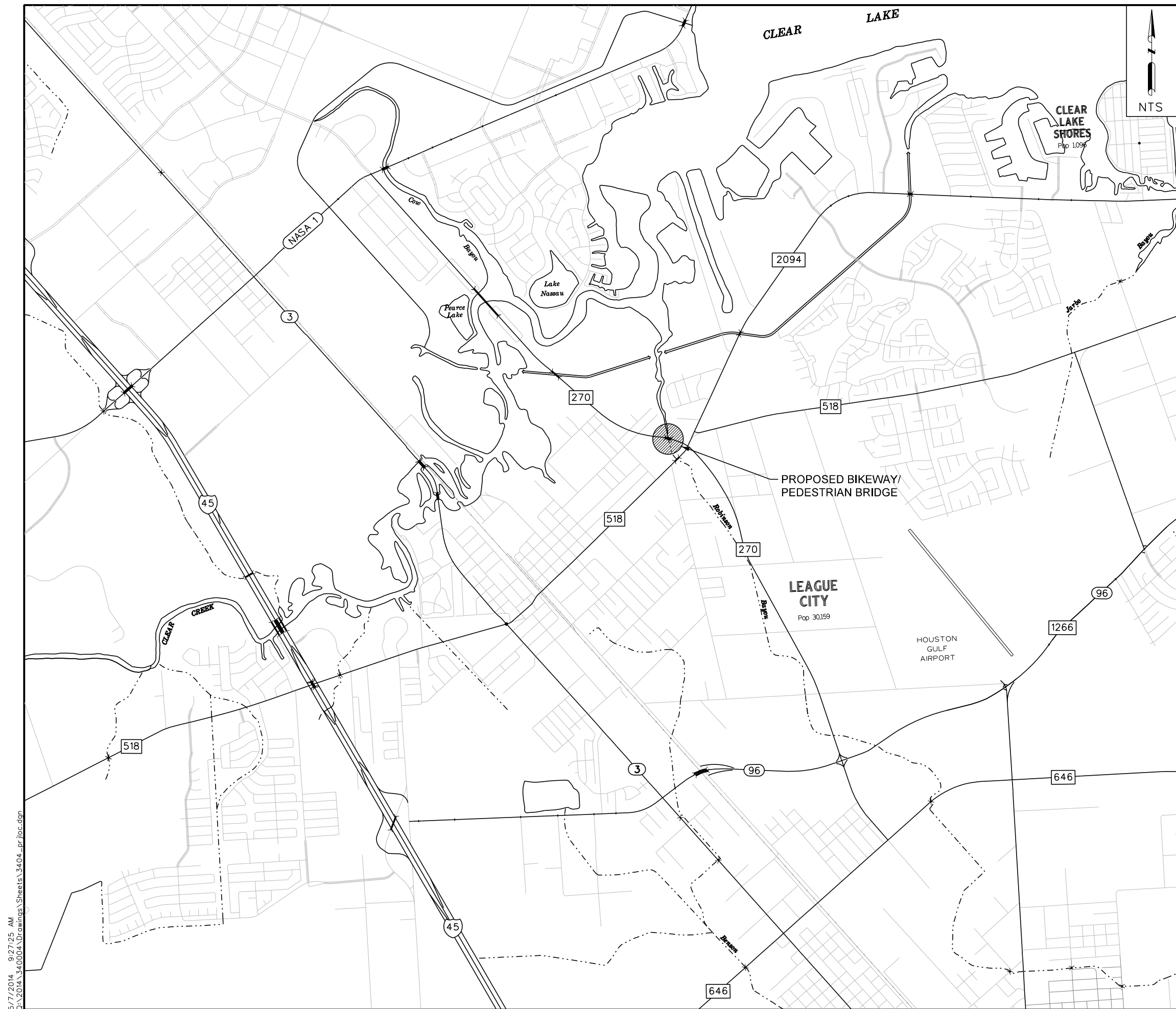
The scour analysis was performed for the proposed bikeway/pedestrian bridge using USACE HEC-RAS hydraulic model for the 100-year storm event. A check analysis was performed for the 500-year storm event. The 100-year scour analysis computations resulted in a maximum pier scour depth of 2.2 feet for the proposed bikeway/pedestrian bridge.

APPENDIX A

PROJECT VICINITY MAP

PHOTOGRAPHS OF ROBINSON BAYOU AND FM 270

NEAR PROPOSED BIKEWAY/PEDESTRIAN BRIDGE



VICINITY MAP

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**FM 518
 BYPASS BIKEWAY
 GALVESTON COUNTY**

**PROJECT LOCATION
 MAP**

5/7/2014 9:27:25 AM
 C:\2014\340004\Drawings\Sheets\3404-pr-loc.dgn

Photograph Registry – Robinson Bayou and FM 270 Bridge near the Proposed Bikeway/Pedestrian Bridge



Robinson Bayou Downstream of the Proposed Bikeway/Pedestrian Bridge – Looking North from FM 270 Bridge.

Photograph Registry – Robinson Bayou and FM 270 Bridge near the Proposed Bikeway/Pedestrian Bridge



Robinson Bayou Downstream of the Proposed Bikeway/Pedestrian Bridge – Looking Northwest from the East Overbank.

Photograph Registry – Robinson Bayou and FM 270 Bridge near the Proposed Bikeway/Pedestrian Bridge



Robinson Bayou Upstream of the Proposed Bikeway/Pedestrian Bridge – Looking South from FM 270 Bridge.

Photograph Registry – Robinson Bayou and FM 270 Bridge near the Proposed Bikeway/Pedestrian Bridge



Robinson Bayou Upstream of the Proposed Bikeway/Pedestrian Bridge – Looking Southwest from the East Overbank.

Photograph Registry – Robinson Bayou and FM 270 Bridge near the Proposed Bikeway/Pedestrian Bridge



FM 270 Bridge Downstream Face – Looking Southwest.

Photograph Registry – Robinson Bayou and FM 270 Bridge near the Proposed Bikeway/Pedestrian Bridge



FM 270 Bridge Upstream Face – Looking Northwest.

APPENDIX B

HEC-RAS OUTPUT

Hydraulic Impact Analysis – FM 518 Bypass Bikeway – Proposed Bikeway/Pedestrian Bridge at Robinson Bayou
Proposed Conditions HEC-RAS Output

HEC-RAS Version 4.1.0 Jan 2010
 U.S. Army Corps of Engineers
 Hydrologic Engineering Center
 609 Second Street
 Davis, California

```

X   X  XXXXXX   XXXX   XXXX   XX   XXXX
X   X  X       X   X   X   X   X   X   X
X   X  X       X   X   X   X   X   X   X
XXXXXXXX XXXX   X       XXX  XXXX  XXXXXX  XXXX
X   X  X       X       X   X   X   X       X
X   X  X       X   X   X   X   X   X       X
X   X  XXXXXX   XXXX   X   X   X   X  XXXXX
    
```

PROJECT DATA

Project Title: Bikeway Bridge at RobinsonBayou
 Project File : ROBINSON.prj
 Run Date and Time: 5/16/2014 3:33:00 PM

Project in English units

Project Description:

PLAN DATA

Plan Title: PROPOSED
 Plan File : Q:\2014\340004\Models\HEC_RAS\Final\ROBINSON.p02

Geometry Title: PROPOSED
 Geometry File : Q:\2014\340004\Models\HEC_RAS\Final\ROBINSON.g18

Flow Title : ROBINSON BAYOU FLOWS
 Flow File : Q:\2014\340004\Models\HEC_RAS\Final\ROBINSON.f05

Plan Summary Information:

Number of: Cross Sections = 10 Multiple Openings = 0
 Culverts = 0 Inline Structures = 0
 Bridges = 2 Lateral Structures = 0

Computational Information

Water surface calculation tolerance = 0.01
 Critical depth calculation tolerance = 0.01
 Maximum number of iterations = 20
 Maximum difference tolerance = 0.3
 Flow tolerance factor = 0.001

Computation Options

Critical depth computed only where necessary
 Conveyance Calculation Method: At breaks in n values only
 Friction Slope Method: Average Conveyance
 Computational Flow Regime: Subcritical Flow

FLOW DATA

Flow Title: ROBINSON BAYOU FLOWS
 Flow File : Q:\2014\340004\Models\HEC_RAS\Final\ROBINSON.f05

Flow Data (cfs)

River	Reach	RS	10-Year (10%)	50-Year (2%)	100-Year (1%)
RobinsonGully	001	4905.289	1075	1643	1950
RobinsonGully	001	4611.514	1075	1643	1950
RobinsonGully	001	4500.604	1075	1643	1950
RobinsonGully	001	4236.417	1075	1643	1950

Boundary Conditions

River	Reach	Profile	Upstream	Downstream

Hydraulic Impact Analysis – FM 518 Bypass Bikeway – Proposed Bikeway/Pedestrian Bridge at Robinson Bayou
Proposed Conditions HEC-RAS Output

RobinsonGully 001 10-Year (10%) Normal S = 0.0007
RobinsonGully 001 50-Year (2%) Normal S = 0.0007
RobinsonGully 001 100-Year (1%) Normal S = 0.0007

GEOMETRY DATA

Geometry Title: PROPOSED
Geometry File : Q:\2014\340004\Models\HEC_RAS\Final\ROBINSON.g18

CROSS SECTION

RIVER: RobinsonGully
REACH: 001 RS: 4905.289

INPUT

Description:

Station Elevation Data		num= 239	
Sta	Elev	Sta	Elev
0	13	14.66	12.2
73.3	11.81	87.96	11.8
146.6	12.4	161.25	12.47
219.89	11.59	234.55	11.59
293.19	11.56	307.85	11.52
366.49	11.9	381.15	12.23
439.79	11.77	454.45	12.3
513.08	11.37	527.74	10.9
586.38	10.83	601.04	10.58
659.23	10.05	673.74	10.14
731.78	4.34	746.29	4.17
803.78	4.12	818.02	4.12
843.59	3.39	843.99	3.27
845.58	1.22	845.98	.39
847.57	-1.02	847.97	-1.18
849.57	-1.67	849.97	-1.78
851.56	-2.26	851.96	-2.37
853.55	-2.83	853.95	-2.85
855.55	-3.3	855.94	-3.47
857.54	-4.08	857.94	-4.27
859.53	-4.83	859.93	-4.97
861.53	-5.47	861.92	-5.48
863.52	-5.26	863.92	-5.2
865.51	-4.89	865.91	-4.81
867.5	-4.57	867.9	-4.52
869.5	-3.68	869.9	-3.21
871.49	-1.59	871.89	-1.3
873.48	-.26	873.88	-.04
875.48	.83	875.88	1.02
877.47	1.83	877.87	2.01
879.46	2.59	879.86	2.7
881.46	3.23	881.85	3.38
883.45	3.91	883.85	4.03
885.44	4.55	885.84	4.7
887.44	5.25	887.83	5.36
889.43	5.91	889.83	6.06
891.42	6.54	891.82	6.59
893.41	6.92	893.81	7.01
895.41	7.29	895.81	7.38
897.4	7.67	897.8	7.74
899.39	8.05	899.79	8.12
901.39	8.41	901.79	8.49
917.68	9.93	931.91	11.01
988.86	11.28	1003.27	11.45
1060.93	11.63	1075.34	11.82
1133	12.96	1147.41	13.23
1205.07	13.63	1219.48	13.49
1277.13	11.97	1291.55	11.76

Manning's n Values		num= 5	
Sta	n Val	Sta	n Val
0	.1	803.78	.04
		842.79	.035
		883.85	.04
		903.44	.08

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	842.79	883.85		103.68	80.83	52.6		.1	.3
Ineffective Flow	num= 1								
Sta L	Sta R	Elev	Permanent						
999.87	1320.37	16	F						

Hydraulic Impact Analysis – FM 518 Bypass Bikeway – Proposed Bikeway/Pedestrian Bridge at Robinson Bayou
Proposed Conditions HEC-RAS Output

CROSS SECTION

RIVER: RobinsonGully
 REACH: 001 RS: 4824.464

INPUT

Description:

Station		Elevation		Data		num=		216	
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	12.6	14.84	12.29	29.69	12.44	44.53	12.4	59.38	12.36
74.22	11.98	89.07	12.27	103.91	12.69	118.76	12.44	133.6	12.44
148.44	12.85	163.29	12.55	178.13	12.51	192.98	12.57	207.82	12.53
222.67	12.48	237.51	12.45	252.35	12.64	267.2	12.94	282.04	12.99
296.89	12.78	311.73	12.5	326.58	12.32	341.42	12.19	356.27	12.03
371.11	11.95	385.95	11.8	400.8	11.77	415.64	11.82	430.49	11.91
445.33	12.05	460.18	12.12	475.02	11.9	489.87	11.63	504.71	11.6
519.55	11.41	534.4	10.98	549.24	10.85	564.09	11.2	578.93	11.96
593.78	12.79	608.62	13.08	623.46	12.94	638.31	12.62	653.15	11.94
668	11.14	682.84	10.61	697.69	10.88	712.53	11.45	726.02	11.88
739.5	11.89	752.99	10.96	766.47	9.88	779.96	8.48	793.44	6.66
807.41	5.13	821.37	4.63	835.33	4.08	849.29	3.42	860.46	2.65
860.86	2.36	861.26	1.86	861.66	1.15	862.06	.41	862.46	-.26
862.86	-.75	863.26	-1.05	863.66	-1.22	864.06	-1.33	864.46	-1.44
864.85	-1.61	865.25	-1.73	865.65	-1.84	866.05	-2	866.45	-2.11
866.85	-2.24	867.25	-2.4	867.65	-2.51	868.05	-2.63	868.45	-2.79
868.85	-2.89	869.24	-3.03	869.64	-3.2	870.04	-3.29	870.44	-3.42
870.84	-3.55	871.24	-3.65	871.64	-3.82	872.04	-3.96	872.44	-4.03
872.84	-4.05	873.24	-4.04	873.63	-4.02	874.03	-4	874.43	-4
874.83	-4	875.23	-4	875.63	-4	876.03	-4	876.43	-4
876.83	-4	877.23	-4	877.63	-3.99	878.02	-4	878.42	-4.01
878.82	-4.01	879.22	-4.01	879.62	-3.99	880.02	-3.95	880.42	-3.91
880.82	-3.87	881.22	-3.83	881.62	-3.8	882.02	-3.75	882.42	-3.71
882.81	-3.66	883.21	-3.62	883.61	-3.59	884.01	-3.55	884.41	-3.5
884.81	-3.45	885.21	-3.41	885.61	-3.39	886.01	-3.37	886.41	-3.34
886.81	-3.31	887.2	-3.26	887.6	-3.19	888	-3.02	888.4	-2.9
888.8	-2.81	889.2	-2.71	889.6	-2.61	890	-2.51	890.4	-2.41
890.8	-2.31	891.2	-2.21	891.59	-2.11	891.99	-2.01	892.39	-1.91
892.79	-1.81	893.19	-1.7	893.59	-1.61	893.99	-1.59	894.39	-1.55
894.79	-1.39	895.19	-.99	895.59	-.36	895.98	.38	896.38	1.16
896.78	1.94	897.18	2.66	897.58	3.24	897.98	3.61	898.38	3.47
898.78	3.6	899.18	3.97	899.58	4.19	899.98	4.31	900.37	4.39
900.77	4.45	901.17	4.52	901.57	4.59	901.97	4.68	902.37	4.78
902.77	4.87	903.17	4.96	903.57	5.02	903.97	5.09	904.37	5.18
904.76	5.26	905.16	5.34	905.56	5.4	905.96	5.45	906.36	5.5
906.76	5.54	907.16	5.59	907.56	5.64	907.96	5.71	908.36	5.8
908.76	5.95	909.15	6.14	909.55	6.34	909.95	6.47	910.35	6.58
910.75	6.73	911.15	6.84	919.1	8.47	933.07	10.29	947.03	10.65
960.99	11.01	974.95	11.05	989.43	11.14	1003.91	11.41	1018.39	11.59
1032.87	11.52	1047.35	11.51	1061.84	11.53	1076.32	11.86	1090.8	12.13
1105.28	11.85	1119.76	12.03	1134.24	12.16	1148.72	13.35	1163.2	13.4
1177.68	13.22	1192.16	13.32	1206.64	13.41	1221.12	13.51	1235.6	13.58
1250.08	13.61	1264.56	13.52	1279.04	13.46	1293.52	13.15	1308	12.75
1322.48	12.72								

Manning's n		Values		num=		5			
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val		
0	.1	821.37	.04	860.46	.035	897.18	.04	933.07	.08

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	860.46	897.18		119.9	90.52	84.79		.1	.3
Ineffective Flow	num=		1						
Sta L	Sta R	Elev	Permanent						
1028.85	1322.48	16	F						

CROSS SECTION

RIVER: RobinsonGully
 REACH: 001 RS: 4733.942

INPUT

Description:

Station		Elevation		Data		num=		188	
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	12.35	14.78	11.93	29.55	11.81	44.33	12.02	59.1	11.95
73.88	11.87	88.65	12.3	103.43	12.35	118.2	12.62	132.98	12.63
147.75	12.84	162.53	12.88	177.31	12.6	192.08	12.39	206.86	12.66
221.63	12.34	236.41	12.21	251.18	11.9	265.96	11.7	280.73	11.79
295.51	11.97	310.28	12.2	325.06	12.41	339.84	12.32	354.61	12.01

Hydraulic Impact Analysis – FM 518 Bypass Bikeway – Proposed Bikeway/Pedestrian Bridge at Robinson Bayou
Proposed Conditions HEC-RAS Output

779.887	-1.98	780.249	-1.53	780.603	-1.26	780.965	-1.23	781.328	-1.39
781.681	-1.64	782.044	-1.75	782.406	-1.37	782.76	-1.06	783.122	-.87
783.485	-.76	783.838	-.7	784.201	-.64	784.563	-.61	784.917	-.6
785.279	-.54	785.642	-.43	785.995	-.22	786.358	.1	786.72	.31
787.083	.54	787.437	.87	787.799	1.32	788.162	1.71	788.515	2.06
788.878	2.39	789.24	2.63	792.041	4.08	804.765	4.53	817.499	7.11
830.74	9.79	843.99	11.2	857.231	11.9	870.481	12.36	883.859	12.15
897.236	12.18	910.613	12.41	923.99	12.22	937.358	12.23	950.635	12.4
963.904	12.29	977.172	12.23	990.44	12.28	1003.709	12.43	1016.977	12.13
1029.221	12.11	1041.465	11.94	1053.71	11.89	1066.761	12.05	1079.802	11.96
1092.853	11.85	1105.315	11.94	1117.777	11.89	1130.238	11.65	1142.709	11.66
1155.171	11.74	1167.769	11.72	1180.375	11.82	1192.982	11.77	1205.58	11.82
1218.186	12.3								

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
89.842	.08	702.969	.015	752.199	.04	789.24	.015	830.74	.08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

752.199	789.24	98.52	110.91	106.54	.3	.5
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Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
89.842	710.074	12.26	F
822.982	1218.186	12.29	F

Skew Angle = 25

BRIDGE

RIVER: RobinsonGully
 REACH: 001 RS: 4554.23

INPUT

Description:
 Distance from Upstream XS = 5.7
 Deck/Roadway Width = 99.7
 Weir Coefficient = 2.6
 Bridge Deck/Roadway Skew = 25
 Upstream Deck/Roadway Coordinates

num= 19														
Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
0	12.58		10	113.941	12.26		216.825	12.382						
315.459	12.78		10	420.355	13.21		523.275	13.7						
710.074	12.92		7	710.074	15.62	10.12	747.713	15.62	10.12					
766.528	15.75	10.25	785.343	15.62	10.12	822.982	15.62	10.12						
822.982	12.92		6	893.302	13.34		982.229	13						
1079.911	12.63		1173.868	12.29		1218.186	12.29	10						
1218.35	12.37													

Upstream Bridge Cross Section Data

Station Elevation Data num= 191											
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
89.842	12.45	101.661	11.68	113.47	11.54	125.279	11.54	137.097	11.56		
148.906	11.61	160.652	11.86	172.398	11.77	184.144	11.65	195.889	11.62		
207.635	11.75	219.381	11.9	231.127	11.99	243.208	12.26	255.289	12.15		
267.361	12.01	279.442	11.98	291.523	11.97	303.595	12.05	316.528	12.23		
329.461	12.28	342.394	12.16	355.327	12.15	368.26	12.19	381.193	12.47		
394.117	12.4	407.05	12.4	419.983	12.46	432.916	12.62	446.429	12.81		
459.942	12.96	473.455	13.12	486.968	13.27	500.481	13.11	513.994	13.09		
527.507	13.03	541.02	12.96	554.534	12.94	568.047	13.08	581.56	13.19		
593.55	13.26	605.55	13.32	617.54	13.27	629.54	13.14	641.53	13.03		
653.53	13.02	665.52	13.07	677.519	12.86	690.244	12.18	702.969	10.72		
715.693	8.23	728.418	5.38	741.142	4.08	752.199	3.17	752.562	2.72		
752.915	2.31	753.278	1.94	753.64	1.55	753.994	1.05	754.356	.45		
754.719	-.13	755.072	-.51	755.435	-.74	755.797	-.92	756.151	-1.05		
756.513	-1.16	756.876	-1.3	757.229	-1.43	757.592	-1.54	757.954	-1.7		
758.308	-1.85	758.67	-1.97	759.033	-2.1	759.395	-2.24	759.749	-2.35		
760.111	-2.48	760.474	-2.66	760.827	-2.81	761.19	-2.96	761.552	-3.09		
761.906	-3.23	762.268	-3.34	762.631	-3.52	762.984	-3.76	763.347	-3.87		
763.709	-4.05	764.063	-4.19	764.425	-4.26	764.788	-4.34	765.141	-4.44		
765.504	-4.65	765.866	-4.88	766.22	-5.04	766.582	-5.21	766.945	-5.39		
767.298	-5.55	767.661	-5.81	768.023	-6.03	768.377	-6.21	768.739	-6.42		
769.102	-6.58	769.455	-6.6	769.818	-6.53	770.18	-6.4	770.534	-6.23		
770.896	-6.05	771.259	-5.93	771.612	-5.85	771.975	-5.78	772.337	-5.65		
772.7	-5.48	773.053	-5.36	773.416	-5.25	773.778	-5.14	774.132	-5.02		
774.494	-4.86	774.857	-4.58	775.21	-4.11	775.573	-3.55	775.935	-3.08		
776.289	-2.68	776.651	-2.58	777.014	-3	777.367	-3.37	777.73	-3.13		
778.092	-2.49	778.446	-1.96	778.808	-1.85	779.171	-2.2	779.524	-2.49		
779.887	-1.98	780.249	-1.53	780.603	-1.26	780.965	-1.23	781.328	-1.39		
781.681	-1.64	782.044	-1.75	782.406	-1.37	782.76	-1.06	783.122	-.87		
783.485	-.76	783.838	-.7	784.201	-.64	784.563	-.61	784.917	-.6		

Hydraulic Impact Analysis – FM 518 Bypass Bikeway – Proposed Bikeway/Pedestrian Bridge at Robinson Bayou
Proposed Conditions HEC-RAS Output

785.279	-.54	785.642	-.43	785.995	-.22	786.358	.1	786.72	.31
787.083	.54	787.437	.87	787.799	1.32	788.162	1.71	788.515	2.06
788.878	2.39	789.24	2.63	792.041	4.08	804.765	4.53	817.499	7.11
830.74	9.79	843.99	11.2	857.231	11.9	870.481	12.36	883.859	12.15
897.236	12.18	910.613	12.41	923.99	12.22	937.358	12.23	950.635	12.4
963.904	12.29	977.172	12.23	990.44	12.281003	709	12.431016	977	12.13
1029.221	12.111041	465	11.94	1053.71	11.891066	761	12.051079	802	11.96
1092.853	11.851105	315	11.941117	777	11.891130	238	11.651142	709	11.66
1155.171	11.741167	769	11.721180	375	11.821192	982	11.77	1205.58	11.82
1218.186	12.3								

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
89.842	.08	702.969	.015	752.199	.04	789.24	.015	830.74	.08

Bank Sta: Left Right Coeff Contr. Expan.

752.199	789.24	.3	.5
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Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
89.842	710.074	12.26	F
822.982	1218.186	12.29	F

Skew Angle = 25

Downstream Deck/Roadway Coordinates num= 19

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	12.58	11	113.116	12.26	209.928	12.382		
305.48	12.78		410.385	13.21	513.079	13.7		
665.076	14.8	7	665.076	17.5	12	702.751	17.5	12
721.584	17.63	12.13	740.426	17.5	12	778.092	17.5	12
778.092	14.8	6	893.266	13.34	985.882	13		
1087.905	12.63		1187.29	12.29	1235.569	12.29	11	
1235.733	12.37							

Downstream Bridge Cross Section Data Station Elevation Data num= 209

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	11.8	13.006	11.69	26.002	11.6	39.007	11.68	52.013	11.95
65.009	11.71	78.414	11.51	91.818	11.43	105.222	11.44	118.627	11.56
132.031	11.52	145.435	11.29	158.667	11.13	171.89	11.32	185.122	11.48
198.355	11.42	211.587	11.49	224.81	11.47	236.465	11.56	248.111	11.57
259.757	11.66	271.403	11.74	283.049	11.86	294.695	12.01	307.42	12.15
320.135	12.05	332.851	12.11	345.575	12.1	358.291	12.16	371.006	12.25
383.731	12.43	396.446	12.65	409.171	12.91	421.886	13.05	434.384	13.08
446.873	13.08	459.371	13.16	471.869	13.18	484.358	13.11	496.856	13.05
509.354	12.95	521.843	13	534.341	13.06	546.839	13.15	559.328	13.21
571.826	13.36	584.242	13.56	596.668	13.86	609.084	14.05	621.51	13.89
633.926	13.73	646.342	13.47	658.768	11.58	671.184	8.44	684.217	5.29
697.241	4.26	700.331	2.49	700.694	1.86	701.056	1.17	701.41	.65
701.772	.36	702.135	.25	702.497	.22	702.86	.21	703.222	.19
703.576	.17	703.938	.13	704.301	.09	704.663	.04	705.026	0
705.379	-.03	705.742	-.08	706.104	-.14	706.467	-.2	706.829	-.26
707.192	-.37	707.545	-.5	707.908	-.62	708.271	-.71	708.633	-.8
708.996	-.93	709.349	-1.01	709.712	-1.1	710.074	-1.18	710.437	-1.24
710.799	-1.31	711.162	-1.39	711.515	-1.48	711.878	-1.58	712.24	-1.68
712.603	-1.77	712.965	-1.84	713.319	-1.89	713.681	-1.98	714.044	-2.13
714.406	-2.25	714.769	-2.35	715.122	-2.43	715.485	-2.54	715.847	-2.67
716.21	-2.81	716.572	-2.96	716.935	-3.12	717.288	-3.3	717.651	-3.49
718.013	-3.69	718.376	-3.88	718.738	-4.03	719.092	-4.14	719.454	-4.27
719.817	-4.43	720.179	-4.59	720.542	-4.78	720.904	-5.07	721.258	-5.26
721.62	-5.37	721.983	-5.38	722.345	-5.32	722.708	-5.21	723.061	-5.09
723.424	-5	723.786	-4.94	724.149	-4.87	724.512	-4.71	724.874	-4.49
725.228	-4.38	725.59	-4.28	725.953	-4.15	726.315	-4.01	726.678	-3.92
727.031	-3.83	727.394	-3.75	727.756	-3.61	728.119	-3.48	728.481	-3.38
728.844	-3.23	729.197	-3.12	729.56	-3	729.922	-2.86	730.285	-2.77
730.647	-2.63	731.001	-2.54	731.363	-2.42	731.726	-2.27	732.088	-2.16
732.451	-2.03	732.813	-1.9	733.167	-1.8	733.529	-1.66	733.892	-1.49
734.254	-1.36	734.617	-1.24	734.97	-1.14	735.333	-1.04	735.695	-.92
736.058	-.82	736.42	-.7	736.783	-.59	737.136	-.47	737.499	-.34
737.861	-.22	738.224	-.03	738.586	.26	738.94	.38	739.302	.52
739.665	.9	740.028	1.43	740.39	2.04	740.744	2.61	749.353	3.88
762.377	6.14	775.41	10	788.433	12.68	801.466	13.04	814.49	13
826.127	13.5	837.773	14.03	849.41	13.83	861.047	13.57	872.693	13.46
884.493	13.68	896.293	13.96	908.102	13.46	919.902	13.53	931.703	13.4
943.503	13.53	957.07	13.74	970.628	13.75	984.187	13.87	997.754	14.1
1011.313	13.97	1024.88	13.851037	242	13.911049	613	13.711061	984	13.51
1075.398	13.341088	802	13.121102	206	12.811114	478	12.72	1126.74	12.78
1139.011	12.711151	274	12.411163	545	12.321175	554	12.251187	553	12.15
1199.562	12.141211	561	12.05	1223.57	11.851235	569	11.96		

Manning's n Values num= 5

Hydraulic Impact Analysis – FM 518 Bypass Bikeway – Proposed Bikeway/Pedestrian Bridge at Robinson Bayou
Proposed Conditions HEC-RAS Output

Sta n Val Sta n Val Sta n Val Sta n Val Sta n Val
 0 .08 671.184 .015 700.331 .04 740.744 .015 775.41 .08

Bank Sta: Left Right Coeff Contr. Expan.
 700.331 740.744 .3 .5

Ineffective Flow num= 2
 Sta L Sta R Elev Permanent
 0 665.076 12.26 F
 778.0921235.569 12.29 F
 Skew Angle = 25

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
 Downstream Embankment side slope = 0 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .98
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Abutments = 2

Abutment Data

Upstream num= 4
 Sta Elev Sta Elev Sta Elev Sta Elev
 710.074 10.12 711.207 10.12 711.207 9.37 720.941 4
 Downstream num= 4
 Sta Elev Sta Elev Sta Elev Sta Elev
 665.076 12 666.209 12 666.209 11.25 679.35 4

Abutment Data

Upstream num= 4
 Sta Elev Sta Elev Sta Elev Sta Elev
 812.115 4 821.849 9.37 821.849 10.12 822.982 10.12
 Downstream num= 4
 Sta Elev Sta Elev Sta Elev Sta Elev
 763.821 4 776.962 11.25 776.962 12 778.092 12

Number of Piers = 2

Pier Data

Pier Station Upstream= 747.713 Downstream= 702.751
 Upstream num= 2
 Width Elev Width Elev
 1.25 0 1.25 13
 Downstream num= 2
 Width Elev Width Elev
 1.25 0 1.25 13

Pier Data

Pier Station Upstream= 785.343 Downstream= 740.426
 Upstream num= 2
 Width Elev Width Elev
 1.25 0 1.25 13
 Downstream num= 2
 Width Elev Width Elev
 1.25 0 1.25 13

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data

Energy
 Momentum Cd = 2
 Selected Low Flow Methods = Highest Energy Answer

High Flow Method

Energy Only

Additional Bridge Parameters

Add Friction component to Momentum
 Do not add Weight component to Momentum
 Class B flow critical depth computations use critical depth
 inside the bridge at the upstream end
 Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION

RIVER: RobinsonGully
 REACH: 001 RS: 4500.604

INPUT

Hydraulic Impact Analysis – FM 518 Bypass Bikeway – Proposed Bikeway/Pedestrian Bridge at Robinson Bayou
Proposed Conditions HEC-RAS Output

Description:

Station Elevation Data num= 209											
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	11.8	13.006	11.69	26.002	11.6	39.007	11.68	52.013	11.95		
65.009	11.71	78.414	11.51	91.818	11.43	105.222	11.44	118.627	11.56		
132.031	11.52	145.435	11.29	158.667	11.13	171.89	11.32	185.122	11.48		
198.355	11.42	211.587	11.49	224.81	11.47	236.465	11.56	248.111	11.57		
259.757	11.66	271.403	11.74	283.049	11.86	294.695	12.01	307.42	12.15		
320.135	12.05	332.851	12.11	345.575	12.1	358.291	12.16	371.006	12.25		
383.731	12.43	396.446	12.65	409.171	12.91	421.886	13.05	434.384	13.08		
446.873	13.08	459.371	13.16	471.869	13.18	484.358	13.11	496.856	13.05		
509.354	12.95	521.843	13	534.341	13.06	546.839	13.15	559.328	13.21		
571.826	13.36	584.242	13.56	596.668	13.86	609.084	14.05	621.51	13.89		
633.926	13.73	646.342	13.47	658.768	11.58	671.184	8.44	684.217	5.29		
697.241	4.26	700.331	2.49	700.694	1.86	701.056	1.17	701.41	.65		
701.772	.36	702.135	.25	702.497	.22	702.86	.21	703.222	.19		
703.576	.17	703.938	.13	704.301	.09	704.663	.04	705.026	0		
705.379	-.03	705.742	-.08	706.104	-.14	706.467	-.2	706.829	-.26		
707.192	-.37	707.545	-.5	707.908	-.62	708.271	-.71	708.633	-.8		
708.996	-.93	709.349	-1.01	709.712	-1.1	710.074	-1.18	710.437	-1.24		
710.799	-1.31	711.162	-1.39	711.515	-1.48	711.878	-1.58	712.24	-1.68		
712.603	-1.77	712.965	-1.84	713.319	-1.89	713.681	-1.98	714.044	-2.13		
714.406	-2.25	714.769	-2.35	715.122	-2.43	715.485	-2.54	715.847	-2.67		
716.21	-2.81	716.572	-2.96	716.935	-3.12	717.288	-3.3	717.651	-3.49		
718.013	-3.69	718.376	-3.88	718.738	-4.03	719.092	-4.14	719.454	-4.27		
719.817	-4.43	720.179	-4.59	720.542	-4.78	720.904	-5.07	721.258	-5.26		
721.62	-5.37	721.983	-5.38	722.345	-5.32	722.708	-5.21	723.061	-5.09		
723.424	-5	723.786	-4.94	724.149	-4.87	724.512	-4.71	724.874	-4.49		
725.228	-4.38	725.59	-4.28	725.953	-4.15	726.315	-4.01	726.678	-3.92		
727.031	-3.83	727.394	-3.75	727.756	-3.61	728.119	-3.48	728.481	-3.38		
728.844	-3.23	729.197	-3.12	729.56	-3	729.922	-2.86	730.285	-2.77		
730.647	-2.63	731.001	-2.54	731.363	-2.42	731.726	-2.27	732.088	-2.16		
732.451	-2.03	732.813	-1.9	733.167	-1.8	733.529	-1.66	733.892	-1.49		
734.254	-1.36	734.617	-1.24	734.97	-1.14	735.333	-1.04	735.695	-.92		
736.058	-.82	736.42	-.7	736.783	-.59	737.136	-.47	737.499	-.34		
737.861	-.22	738.224	-.03	738.586	.26	738.94	.38	739.302	.52		
739.665	.9	740.028	1.43	740.39	2.04	740.744	2.61	749.353	3.88		
762.377	6.14	775.41	10	788.433	12.68	801.466	13.04	814.49	13		
826.127	13.5	837.773	14.03	849.41	13.83	861.047	13.57	872.693	13.46		
884.493	13.68	896.293	13.96	908.102	13.46	919.902	13.53	931.703	13.4		
943.503	13.53	957.07	13.74	970.628	13.75	984.187	13.87	997.754	14.1		
1011.313	13.97	1024.88	13.85	1037.242	13.91	1049.613	13.71	1061.984	13.51		
1075.398	13.34	1088.802	13.12	1102.206	12.81	1114.478	12.72	1126.74	12.78		
1139.011	12.71	1151.274	12.41	1163.545	12.32	1175.554	12.25	1187.553	12.15		
1199.562	12.14	1211.561	12.05	1223.57	11.85	1235.569	11.96				

Manning's n Values num= 5											
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.08	671.184	.015	700.331	.04	740.744	.015	775.41	.08		

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.	
700.331	740.744		20	22.83	20		.3	.5		
Ineffective Flow num= 2										
Sta L	Sta R	Elev	Permanent	F	F					
0	665.076	12.26	F							
778.092	1235.569	12.29	F							

Skew Angle = 25

BRIDGE

RIVER: RobinsonGully
REACH: 001 RS: 4489.47

INPUT

Description:

Distance from Upstream XS = 2.12
Deck/Roadway Width = 18.03
Weir Coefficient = 2.6
Bridge Deck/Roadway Skew = 25

Upstream Deck/Roadway Coordinates

num= 8														
Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
0	12.58		10	664.605	13.98	10	664.605	17.65	10.7					
702.443	17.65	10.7	740.281	17.65	10.7	778.092	17.7	10.7						
778.092	14.03		101235.569	12.3	10									

Upstream Bridge Cross Section Data

Station Elevation Data num= 209											
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	11.8	13.006	11.69	26.002	11.6	39.007	11.68	52.013	11.95		

Hydraulic Impact Analysis – FM 518 Bypass Bikeway – Proposed Bikeway/Pedestrian Bridge at Robinson Bayou
Proposed Conditions HEC-RAS Output

65.009	11.71	78.414	11.51	91.818	11.43	105.222	11.44	118.627	11.56
132.031	11.52	145.435	11.29	158.667	11.13	171.89	11.32	185.122	11.48
198.355	11.42	211.587	11.49	224.81	11.47	236.465	11.56	248.111	11.57
259.757	11.66	271.403	11.74	283.049	11.86	294.695	12.01	307.42	12.15
320.135	12.05	332.851	12.11	345.575	12.1	358.291	12.16	371.006	12.25
383.731	12.43	396.446	12.65	409.171	12.91	421.886	13.05	434.384	13.08
446.873	13.08	459.371	13.16	471.869	13.18	484.358	13.11	496.856	13.05
509.354	12.95	521.843	13	534.341	13.06	546.839	13.15	559.328	13.21
571.826	13.36	584.242	13.56	596.668	13.86	609.084	14.05	621.51	13.89
633.926	13.73	646.342	13.47	658.768	11.58	671.184	8.44	684.217	5.29
697.241	4.26	700.331	2.49	700.694	1.86	701.056	1.17	701.41	.65
701.772	.36	702.135	.25	702.497	.22	702.86	.21	703.222	.19
703.576	.17	703.938	.13	704.301	.09	704.663	.04	705.026	0
705.379	-.03	705.742	-.08	706.104	-.14	706.467	-.2	706.829	-.26
707.192	-.37	707.545	-.5	707.908	-.62	708.271	-.71	708.633	-.8
708.996	-.93	709.349	-1.01	709.712	-1.1	710.074	-1.18	710.437	-1.24
710.799	-1.31	711.162	-1.39	711.515	-1.48	711.878	-1.58	712.24	-1.68
712.603	-1.77	712.965	-1.84	713.319	-1.89	713.681	-1.98	714.044	-2.13
714.406	-2.25	714.769	-2.35	715.122	-2.43	715.485	-2.54	715.847	-2.67
716.21	-2.81	716.572	-2.96	716.935	-3.12	717.288	-3.3	717.651	-3.49
718.013	-3.69	718.376	-3.88	718.738	-4.03	719.092	-4.14	719.454	-4.27
719.817	-4.43	720.179	-4.59	720.542	-4.78	720.904	-5.07	721.258	-5.26
721.62	-5.37	721.983	-5.38	722.345	-5.32	722.708	-5.21	723.061	-5.09
723.424	-5	723.786	-4.94	724.149	-4.87	724.512	-4.71	724.874	-4.49
725.228	-4.38	725.59	-4.28	725.953	-4.15	726.315	-4.01	726.678	-3.92
727.031	-3.83	727.394	-3.75	727.756	-3.61	728.119	-3.48	728.481	-3.38
728.844	-3.23	729.197	-3.12	729.56	-3	729.922	-2.86	730.285	-2.77
730.647	-2.63	731.001	-2.54	731.363	-2.42	731.726	-2.27	732.088	-2.16
732.451	-2.03	732.813	-1.9	733.167	-1.8	733.529	-1.66	733.892	-1.49
734.254	-1.36	734.617	-1.24	734.97	-1.14	735.333	-1.04	735.695	-.92
736.058	-.82	736.42	-.7	736.783	-.59	737.136	-.47	737.499	-.34
737.861	-.22	738.224	-.03	738.586	.26	738.94	.38	739.302	.52
739.665	.9	740.028	1.43	740.39	2.04	740.744	2.61	749.353	3.88
762.377	6.14	775.41	10	788.433	12.68	801.466	13.04	814.49	13
826.127	13.5	837.773	14.03	849.41	13.83	861.047	13.57	872.693	13.46
884.493	13.68	896.293	13.96	908.102	13.46	919.902	13.53	931.703	13.4
943.503	13.53	957.07	13.74	970.628	13.75	984.187	13.87	997.754	14.1
1011.313	13.97	1024.88	13.85	1037.242	13.91	1049.613	13.71	1061.984	13.51
1075.398	13.34	1088.802	13.12	1102.206	12.81	1114.478	12.72	1126.74	12.78
1139.011	12.71	1151.274	12.41	1163.545	12.32	1175.554	12.25	1187.553	12.15
1199.562	12.14	1211.561	12.05	1223.57	11.85	1235.569	11.96		

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.08	671.184	.015	700.331	.04	740.744	.015	775.41	.08

Bank Sta: Left Right Coeff Contr. Expan.
 700.331 740.744 .3 .5

Ineffective Flow num= 2
 Sta L Sta R Elev Permanent
 0 665.076 12.26 F
 778.092 1235.569 12.29 F
 Skew Angle = 25

Downstream Deck/Roadway Coordinates num= 8

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
0	12.58	10.6	664.605	13.82	10	664.605	17.49	10.6						
702.443	17.49	10.6	740.281	17.49	10.6	778.092	17.54	10.6						
778.092	13.87	101	235.569	12.3	10									

Downstream Bridge Cross Section Data Station Elevation Data num= 209

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	11.8	13.006	11.69	26.002	11.6	39.007	11.68	52.013	11.95
65.009	11.71	78.414	11.51	91.818	11.43	105.222	11.44	118.627	11.56
132.031	11.52	145.435	11.29	158.667	11.13	171.89	11.32	185.122	11.48
198.355	11.42	211.587	11.49	224.81	11.47	236.465	11.56	248.111	11.57
259.757	11.66	271.403	11.74	283.049	11.86	294.695	12.01	307.42	12.15
320.135	12.05	332.851	12.11	345.575	12.1	358.291	12.16	371.006	12.25
383.731	12.43	396.446	12.65	409.171	12.91	421.886	13.05	434.384	13.08
446.873	13.08	459.371	13.16	471.869	13.18	484.358	13.11	496.856	13.05
509.354	12.95	521.843	13	534.341	13.06	546.839	13.15	559.328	13.21
571.826	13.36	584.242	13.56	596.668	13.86	609.084	14.05	621.51	13.89
633.926	13.73	646.342	13.47	658.768	11.58	671.184	8.44	684.217	5.29
697.241	4.26	700.331	2.49	700.694	1.86	701.056	1.17	701.41	.65
701.772	.36	702.135	.25	702.497	.22	702.86	.21	703.222	.19
703.576	.17	703.938	.13	704.301	.09	704.663	.04	705.026	0
705.379	-.03	705.742	-.08	706.104	-.14	706.467	-.2	706.829	-.26
707.192	-.37	707.545	-.5	707.908	-.62	708.271	-.71	708.633	-.8
708.996	-.93	709.349	-1.01	709.712	-1.1	710.074	-1.18	710.437	-1.24

Hydraulic Impact Analysis – FM 518 Bypass Bikeway – Proposed Bikeway/Pedestrian Bridge at Robinson Bayou
Proposed Conditions HEC-RAS Output

710.799	-1.31	711.162	-1.39	711.515	-1.48	711.878	-1.58	712.24	-1.68
712.603	-1.77	712.965	-1.84	713.319	-1.89	713.681	-1.98	714.044	-2.13
714.406	-2.25	714.769	-2.35	715.122	-2.43	715.485	-2.54	715.847	-2.67
716.21	-2.81	716.572	-2.96	716.935	-3.12	717.288	-3.3	717.651	-3.49
718.013	-3.69	718.376	-3.88	718.738	-4.03	719.092	-4.14	719.454	-4.27
719.817	-4.43	720.179	-4.59	720.542	-4.78	720.904	-5.07	721.258	-5.26
721.62	-5.37	721.983	-5.38	722.345	-5.32	722.708	-5.21	723.061	-5.09
723.424	-5	723.786	-4.94	724.149	-4.87	724.512	-4.71	724.874	-4.49
725.228	-4.38	725.59	-4.28	725.953	-4.15	726.315	-4.01	726.678	-3.92
727.031	-3.83	727.394	-3.75	727.756	-3.61	728.119	-3.48	728.481	-3.38
728.844	-3.23	729.197	-3.12	729.56	-3	729.922	-2.86	730.285	-2.77
730.647	-2.63	731.001	-2.54	731.363	-2.42	731.726	-2.27	732.088	-2.16
732.451	-2.03	732.813	-1.9	733.167	-1.8	733.529	-1.66	733.892	-1.49
734.254	-1.36	734.617	-1.24	734.97	-1.14	735.333	-1.04	735.695	-.92
736.058	-.82	736.42	-.7	736.783	-.59	737.136	-.47	737.499	-.34
737.861	-.22	738.224	-.03	738.586	.26	738.94	.38	739.302	.52
739.665	.9	740.028	1.43	740.39	2.04	740.744	2.61	749.353	3.88
762.377	6.14	775.41	10	788.433	12.68	801.466	13.04	814.49	13
826.127	13.5	837.773	14.03	849.41	13.83	861.047	13.57	872.693	13.46
884.493	13.68	896.293	13.96	908.102	13.46	919.902	13.53	931.703	13.4
943.503	13.53	957.07	13.74	970.628	13.75	984.187	13.87	997.754	14.1
1011.313	13.97	1024.88	13.85	1037.242	13.91	1049.613	13.71	1061.984	13.51
1075.398	13.34	1088.802	13.12	1102.206	12.81	1114.478	12.72	1126.74	12.78
1139.011	12.71	1151.274	12.41	1163.545	12.32	1175.554	12.25	1187.553	12.15
1199.562	12.14	1211.561	12.05	1223.57	11.85	1235.569	11.96		

Manning's n Values num= 5
 Sta n Val Sta n Val Sta n Val Sta n Val
 0 .08 671.184 .015 700.331 .04 740.744 .015 775.41 .08

Bank Sta: Left Right Coeff Contr. Expan.
 700.331 740.744 .3 .5

Ineffective Flow num= 2
 Sta L Sta R Elev Permanent
 0 665.08 12.26 F
 778.091 235.569 12.29 F

Skew Angle = 25

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
 Downstream Embankment side slope = 0 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .98
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Abutments = 2

Abutment Data
 Upstream num= 4
 Sta Elev Sta Elev Sta Elev Sta Elev
 664.605 10.73 665.737 10.73 665.737 9.9 677.519 4
 Downstream num= 4
 Sta Elev Sta Elev Sta Elev Sta Elev
 664.605 10.57 665.737 10.57 665.737 9.9 677.519 4

Abutment Data
 Upstream num= 4
 Sta Elev Sta Elev Sta Elev Sta Elev
 765.178 4 776.96 9.95 776.96 10.78 778.092 10.78
 Downstream num= 4
 Sta Elev Sta Elev Sta Elev Sta Elev
 765.178 4 776.96 9.95 776.96 10.62 778.092 10.62

Number of Piers = 2

Pier Data
 Pier Station Upstream= 702.443 Downstream= 702.443
 Upstream num= 2
 Width Elev Width Elev
 2.5 0 2.5 13
 Downstream num= 2
 Width Elev Width Elev
 2.5 0 2.5 13

Pier Data
 Pier Station Upstream= 740.281 Downstream= 740.281
 Upstream num= 2
 Width Elev Width Elev
 2.5 0 2.5 13
 Downstream num= 2

Hydraulic Impact Analysis – FM 518 Bypass Bikeway – Proposed Bikeway/Pedestrian Bridge at Robinson Bayou
Proposed Conditions HEC-RAS Output

Width Elev Width Elev
 2.5 0 2.5 13

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data

Energy
 Momentum Cd = 1.2
 Selected Low Flow Methods = Energy

High Flow Method
 Energy Only

Additional Bridge Parameters

Add Friction component to Momentum
 Do not add Weight component to Momentum
 Class B flow critical depth computations use critical depth
 inside the bridge at the upstream end
 Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION

RIVER: RobinsonGully
 REACH: 001 RS: 4477.771

INPUT

Description:

Station Elevation Data num= 209											
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	11.8	13.006	11.69	26.002	11.6	39.007	11.68	52.013	11.95		
65.009	11.71	78.414	11.51	91.818	11.43	105.222	11.44	118.627	11.56		
132.031	11.52	145.435	11.29	158.667	11.13	171.89	11.32	185.122	11.48		
198.355	11.42	211.587	11.49	224.81	11.47	236.465	11.56	248.111	11.57		
259.757	11.66	271.403	11.74	283.049	11.86	294.695	12.01	307.42	12.15		
320.135	12.05	332.851	12.11	345.575	12.1	358.291	12.16	371.006	12.25		
383.731	12.43	396.446	12.65	409.171	12.91	421.886	13.05	434.384	13.08		
446.873	13.08	459.371	13.16	471.869	13.18	484.358	13.11	496.856	13.05		
509.354	12.95	521.843	13	534.341	13.06	546.839	13.15	559.328	13.21		
571.826	13.36	584.242	13.56	596.668	13.86	609.084	14.05	621.51	13.89		
633.926	13.73	646.342	13.47	658.768	11.58	671.184	8.44	684.217	5.29		
697.241	4.26	700.331	2.49	700.694	1.86	701.056	1.17	701.41	.65		
701.772	.36	702.135	.25	702.497	.22	702.86	.21	703.222	.19		
703.576	.17	703.938	.13	704.301	.09	704.663	.04	705.026	0		
705.379	-.03	705.742	-.08	706.104	-.14	706.467	-.2	706.829	-.26		
707.192	-.37	707.545	-.5	707.908	-.62	708.271	-.71	708.633	-.8		
708.996	-.93	709.349	-1.01	709.712	-1.1	710.074	-1.18	710.437	-1.24		
710.799	-1.31	711.162	-1.39	711.515	-1.48	711.878	-1.58	712.24	-1.68		
712.603	-1.77	712.965	-1.84	713.319	-1.89	713.681	-1.98	714.044	-2.13		
714.406	-2.25	714.769	-2.35	715.122	-2.43	715.485	-2.54	715.847	-2.67		
716.21	-2.81	716.572	-2.96	716.935	-3.12	717.288	-3.3	717.651	-3.49		
718.013	-3.69	718.376	-3.88	718.738	-4.03	719.092	-4.14	719.454	-4.27		
719.817	-4.43	720.179	-4.59	720.542	-4.78	720.904	-5.07	721.258	-5.26		
721.62	-5.37	721.983	-5.38	722.345	-5.32	722.708	-5.21	723.061	-5.09		
723.424	-5	723.786	-4.94	724.149	-4.87	724.512	-4.71	724.874	-4.49		
725.228	-4.38	725.59	-4.28	725.953	-4.15	726.315	-4.01	726.678	-3.92		
727.031	-3.83	727.394	-3.75	727.756	-3.61	728.119	-3.48	728.481	-3.38		
728.844	-3.23	729.197	-3.12	729.56	-3	729.922	-2.86	730.285	-2.77		
730.647	-2.63	731.001	-2.54	731.363	-2.42	731.726	-2.27	732.088	-2.16		
732.451	-2.03	732.813	-1.9	733.167	-1.8	733.529	-1.66	733.892	-1.49		
734.254	-1.36	734.617	-1.24	734.97	-1.14	735.333	-1.04	735.695	-.92		
736.058	-.82	736.42	-.7	736.783	-.59	737.136	-.47	737.499	-.34		
737.861	-.22	738.224	-.03	738.586	.26	738.94	.38	739.302	.52		
739.665	.9	740.028	1.43	740.39	2.04	740.744	2.61	749.353	3.88		
762.377	6.14	775.41	10	788.433	12.68	801.466	13.04	814.49	13		
826.127	13.5	837.773	14.03	849.41	13.83	861.047	13.57	872.693	13.46		
884.493	13.68	896.293	13.96	908.102	13.46	919.902	13.53	931.703	13.4		
943.503	13.53	957.07	13.74	970.628	13.75	984.187	13.87	997.754	14.1		
1011.313	13.97	1024.88	13.85	1037.242	13.91	1049.613	13.71	1061.984	13.51		
1075.398	13.34	1088.802	13.12	1102.206	12.81	1114.478	12.72	1126.74	12.78		
1139.011	12.71	1151.274	12.41	1163.545	12.32	1175.554	12.25	1187.553	12.15		
1199.562	12.14	1211.561	12.05	1223.57	11.85	1235.569	11.96				

Manning's n Values num= 5											
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.08	671.184	.015	700.331	.04	740.744	.015	775.41	.08		

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 700.331 740.744 12.08 34.4 17.77 .3 .5
 Ineffective Flow num= 2
 Sta L Sta R Elev Permanent

Hydraulic Impact Analysis – FM 518 Bypass Bikeway – Proposed Bikeway/Pedestrian Bridge at Robinson Bayou
Proposed Conditions HEC-RAS Output

0 665.08 12.26 F
778.091235.569 12.29 F
Skew Angle = 25

CROSS SECTION

RIVER: RobinsonGully
REACH: 001 RS: 4443.371

INPUT

Description:

Station Elevation Data		num= 227	
Sta	Elev	Sta	Elev
0	11.42	14.63	10.28
73.15	11.14	87.78	11.21
146.3	11.19	160.93	11.2
219.45	10.87	234.08	10.9
292.6	10.88	307.23	11.07
365.99	10.85	380.87	10.64
440.38	10.1	455.25	9.91
514.76	9.4	529.64	9.03
589.14	7.29	604.02	6.97
663.53	6.68	678.4	6.54
734.91	3.4	746.82	3.06
748.42	.77	748.82	.44
750.42	.02	750.82	-.01
752.41	-.34	752.81	-.42
754.41	-.73	754.81	-.8
756.41	-1.06	756.81	-1.14
758.41	-1.53	758.81	-1.62
760.4	-1.97	760.8	-2.05
762.4	-2.46	762.8	-2.57
764.4	-2.96	764.8	-3.04
766.4	-3.45	766.8	-3.63
768.39	-4.16	768.79	-4.33
770.39	-4.67	770.79	-4.47
772.39	-3.86	772.79	-3.72
774.39	-3.04	774.79	-2.93
776.38	-2.45	776.78	-2.33
778.38	-1.96	778.78	-1.88
780.38	-1.47	780.78	-1.36
782.38	-.95	782.78	-.86
784.37	-.49	784.77	-.39
786.37	.01	786.77	.13
788.37	-.31	788.77	-.39
790.37	-.13	790.77	-.02
792.36	.2	792.76	.2
794.36	.38	794.76	.44
796.36	.65	796.76	.65
801.8	2.73	815.17	2.56
872.81	2.46	887.56	2.79
946.58	3.49	961.33	3.84
1020.34	5.53	1035.1	6.51
1094.11	8.22	1108.86	8.97
1167.87	12.87	1182.63	13.17
1241.64	10.89	1256.39	10.96
1315.41	13.37	1330.16	13.33
1389.17	13.34	1403.93	13.19
1462.94	12.51	1477.69	12.71

Manning's n Values		num= 3	
Sta	n Val	Sta	n Val
0	.1	746.82	.04
		801.8	.08

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	746.82	801.8		104.4	105.78	167.08	.3	.5	

Ineffective Flow		num= 2	
Sta L	Sta R	Elev	Permanent
0	696.92	12.26	F
871.19	1477.69	12.29	F

CROSS SECTION

RIVER: RobinsonGully
REACH: 001 RS: 4337.592

INPUT

Description:

Station Elevation Data		num= 201	
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Hydraulic Impact Analysis – FM 518 Bypass Bikeway – Proposed Bikeway/Pedestrian Bridge at Robinson Bayou
Proposed Conditions HEC-RAS Output

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	12.4	14.51	12.31	29.02	12.34	43.53	12.13	58.04	11.99
72.55	11.95	87.06	11.93	101.57	11.87	116.08	11.7	130.59	11.43
145.1	11.29	159.61	11.28	174.12	11.34	188.63	11.39	203.14	11
217.65	11.55	232.16	12.05	246.67	12.57	261.18	12.24	275.69	11.73
290.2	11.2	304.71	10.68	319.22	10.59	333.73	10.95	348.24	11.4
362.84	11.59	377.44	11.62	392.03	12.19	406.63	13.08	421.23	13.6
435.83	13.92	450.42	14.32	465.02	14.41	479.62	13.77	494.21	12.66
508.81	11.52	523.41	10.38	538.01	9.25	552.6	8.11	567.2	6.97
581.8	5.86	596.39	4.84	610.99	3.85	625.59	3.83	640.19	3.98
654.78	4.2	669.38	4.14	683.98	4.11	697.99	4.01	711.48	3.53
711.88	3.32	712.28	2.95	712.68	2.52	713.08	2.05	713.48	1.58
713.88	1.11	714.28	.66	714.68	.3	715.08	.04	715.47	-.15
715.87	-.33	716.27	-.47	716.67	-.57	717.07	-.73	717.47	-.89
717.87	-1.02	718.27	-1.15	718.67	-1.29	719.07	-1.41	719.47	-1.54
719.87	-1.7	720.27	-1.83	720.67	-1.95	721.07	-2.11	721.47	-2.24
721.87	-2.35	722.27	-2.48	722.67	-2.61	723.07	-2.73	723.46	-2.89
723.86	-3.02	724.26	-3.14	724.66	-3.3	725.06	-3.43	725.46	-3.54
725.86	-3.68	726.26	-3.8	726.66	-3.92	727.06	-4.08	727.46	-4.22
727.86	-4.33	728.26	-4.45	728.66	-4.55	729.06	-4.6	729.46	-4.56
729.86	-4.47	730.26	-4.36	730.66	-4.27	731.05	-4.18	731.45	-4.11
731.85	-4.03	732.25	-3.95	732.65	-3.86	733.05	-3.77	733.45	-3.67
733.85	-3.57	734.25	-3.47	734.65	-3.38	735.05	-3.3	735.45	-3.22
735.85	-3.15	736.25	-3.07	736.65	-2.98	737.05	-2.88	737.45	-2.78
737.85	-2.67	738.25	-2.58	738.65	-2.5	739.04	-2.42	739.44	-2.35
739.84	-2.26	740.24	-2.18	740.64	-2.08	741.04	-1.98	741.44	-1.88
741.84	-1.78	742.24	-1.68	742.64	-1.59	743.04	-1.5	743.44	-1.42
743.84	-1.35	744.24	-1.26	744.64	-1.19	745.04	-1.09	745.44	-.98
745.84	-.8	746.24	-.6	746.64	-.38	747.03	-.14	747.43	.17
747.83	.4	748.23	.62	748.63	.87	749.03	1.18	749.43	1.45
749.83	1.73	750.23	1.99	750.63	2.19	754.06	3.08	768.08	3.43
782.1	4.1	796.12	5.09	810.13	5.8	824.83	6.37	839.53	6.9
854.23	7.57	868.92	8.45	883.62	8.95	898.32	9.22	913.02	9.49
927.7	9.66	942.41	9.83	957.11	10.17	971.81	10.46	986.51	10.56
1001.21	10.77	1015.9	10.94	1030.6	11.22	1045.3	11.55	1060	11.86
1074.69	12.18	1089.39	12.55	1104.09	12.77	1118.79	12.88	1133.49	13.09
1148.18	13.33	1162.88	13.59	1177.58	13.86	1192.28	14.19	1206.98	14.82
1221.67	15.43	1236.37	15.75	1251.07	15.6	1265.77	14.76	1280.46	14.83
1295.16	14.98	1309.86	14.95	1324.56	15.02	1339.26	14.96	1353.95	14.8
1368.65	14.63	1383.35	14.48	1398.05	14.29	1412.75	14.12	1427.44	14.31
1442.14	13.94	1456.84	13.92	1471.54	14	1486.24	13.64	1500.93	12.98
1515.63	12.92								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	711.48	.04	754.06	.08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

711.48	754.06	98.08	101.17	158.43	.3	.5
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Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	591.48	12.26	F
880.19	1515.63	12.29	F

CROSS SECTION

RIVER: RobinsonGully
REACH: 001 RS: 4236.417

INPUT

Description: num= 206

Station	Elevation	Data	num=	206	Sta	Elev	Sta	Elev	Sta	Elev
0	11.77	14.39	11.92	28.78	11.99	43.17	11.75	57.56	11.53	
71.95	11.52	86.34	11.62	100.73	11.53	115.12	11.03	129.51	10.75	
143.9	10.9	158.3	10.94	172.69	10.96	187.08	11.03	201.47	11.03	
215.86	11	230.25	10.69	244.64	10.63	259.03	10.8	273.42	10.99	
287.81	11.46	302.2	12.02	316.59	12.61	330.98	13.18	345.37	13.77	
359.84	14.36	374.31	14.85	388.78	15.27	403.25	15.67	417.72	16.19	
432.19	17.04	446.66	18.01	461.13	18.5	475.6	18.46	490.07	18.33	
504.54	17.03	519.01	15.4	533.48	13.8	547.94	13.26	562.41	13.39	
576.88	7.63	591.35	4.08	605.82	3.61	620.29	3.5	634.76	3.08	
649.23	3.34	663.79	3.51	678.35	3.42	678.55	3.42	678.95	3.02	
679.35	2.39	679.75	1.66	680.14	.95	680.54	.36	680.94	-.02	
681.34	-.22	681.74	-.35	682.14	-.55	682.54	-.81	682.94	-1.01	
683.33	-1.13	683.73	-1.28	684.13	-1.46	684.53	-1.57	684.93	-1.61	
685.33	-1.63	685.73	-1.67	686.13	-1.77	686.52	-1.78	686.92	-1.74	
687.32	-1.81	687.72	-2.01	688.12	-2.13	688.52	-2.22	688.92	-2.31	
689.32	-2.4	689.71	-2.5	690.11	-2.62	690.51	-2.77	690.91	-2.95	
691.31	-3.15	691.71	-3.35	692.11	-3.51	692.5	-3.64	692.9	-3.73	

Hydraulic Impact Analysis – FM 518 Bypass Bikeway – Proposed Bikeway/Pedestrian Bridge at Robinson Bayou
Proposed Conditions HEC-RAS Output

693.3	-3.77	693.7	-3.81	694.1	-3.87	694.5	-3.96	694.9	-4.11
695.3	-4.11	695.69	-4.08	696.09	-3.95	696.49	-3.82	696.89	-3.94
697.29	-4.1	697.69	-4.22	698.09	-4.25	698.49	-4.16	698.88	-4
699.28	-3.81	699.68	-3.69	700.08	-3.7	700.48	-3.83	700.88	-3.99
701.28	-4.12	701.67	-4.19	702.07	-4.19	702.47	-4.14	702.87	-4.05
703.27	-3.97	703.67	-3.9	704.07	-3.83	704.47	-3.77	704.86	-3.65
705.26	-3.42	705.66	-3.03	706.06	-3.01	706.46	-3.26	706.86	-3.38
707.26	-3.32	707.66	-3.24	708.05	-3.15	708.45	-3.03	708.85	-2.86
709.25	-2.6	709.65	-2.31	710.05	-2.09	710.45	-2.01	710.85	-2.11
711.24	-2.36	711.64	-2.55	712.04	-2.57	712.44	-2.46	712.84	-2.31
713.24	-2.14	713.64	-1.85	714.03	-1.48	714.43	-1.19	714.83	-1.04
715.23	-.77	715.63	-.54	716.03	-.34	716.43	-.15	716.83	.05
717.22	.25	717.62	.43	718.02	.62	718.42	.82	718.82	1.05
719.22	1.33	719.62	1.61	720.02	1.83	720.41	1.97	720.81	2.19
721.21	2.13	721.61	2.31	722.01	2.44	736.59	3.53	751.15	4.02
765.71	5.79	780.27	7.46	794.82	8.48	809.38	8.81	824.1	8.7
838.81	8.97	853.52	9.35	868.23	9.68	882.94	9.96	897.66	10.26
912.37	10.35	927.08	10.44	941.79	10.38	956.51	10.65	971.22	10.8
985.93	10.99	1000.64	11.23	1015.35	11.53	1030.07	11.94	1044.78	11.79
1059.49	12.09	1074.2	11.93	1088.91	12.13	1103.63	12.13	1118.34	12.41
1133.05	12.53	1147.76	12.52	1162.47	12.75	1177.19	12.84	1191.9	13.21
1206.61	13.56	1221.32	13.66	1236.04	13.96	1250.75	14.28	1265.46	14.35
1280.17	14.43	1294.88	14.72	1309.6	15.2	1324.31	15.41	1339.02	15.22
1353.73	15.12	1368.44	15.24	1383.16	15.35	1397.87	15.58	1412.58	15.81
1427.29	15.8								

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .1 678.55 .04 736.59 .08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 678.55 736.59 91.81 103.39 93.21 .1 .3
 Ineffective Flow num= 1
 Sta L Sta R Elev Permanent
 847.48 1427.29 20 T

CROSS SECTION

RIVER: RobinsonGully
 REACH: 001 RS: 4133.029

INPUT

Description:

Station Elevation Data num= 206											
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	12.17	14.39	12.13	28.78	11.96	43.17	12.28	57.56	12.61		
71.95	12.49	86.34	12.31	100.73	12.22	115.12	12.14	129.51	11.99		
143.9	11.69	158.3	11.67	172.69	11.59	187.08	11.52	201.47	11.26		
215.86	11.27	230.25	11.34	244.64	11.6	259.03	11.38	273.42	11.41		
287.81	11.61	302.2	11.76	316.59	11.94	330.98	12	345.37	11.96		
360.22	12.09	375.06	12.5	389.9	12.97	404.75	13.41	419.59	13.69		
434.44	13.65	449.28	13.38	464.13	13.12	478.97	12.86	493.82	12.67		
508.66	12.78	523.5	12.86	538.35	12.43	553.19	11.84	568.04	10.94		
582.88	9.22	597.73	7.48	612.57	6.17	627.42	5.54	642.26	5.17		
657.1	4.8	670.97	4.38	684.83	3.94	698.69	3.8	712.55	3.69		
723.21	3.42	723.61	3.02	724.01	2.39	724.41	1.66	724.8	.95		
725.2	.36	725.6	-.02	726	-.22	726.4	-.35	726.8	-.55		
727.2	-.81	727.6	-1.01	727.99	-1.13	728.39	-1.28	728.79	-1.46		
729.19	-1.57	729.59	-1.61	729.99	-1.63	730.39	-1.67	730.79	-1.77		
731.18	-1.78	731.58	-1.74	731.98	-1.81	732.38	-2.01	732.78	-2.13		
733.18	-2.22	733.58	-2.31	733.98	-2.4	734.37	-2.5	734.77	-2.62		
735.17	-2.77	735.57	-2.95	735.97	-3.15	736.37	-3.35	736.77	-3.51		
737.16	-3.64	737.56	-3.73	737.96	-3.77	738.36	-3.81	738.76	-3.87		
739.16	-3.96	739.56	-4.11	739.96	-4.11	740.35	-4.08	740.75	-3.95		
741.15	-3.82	741.55	-3.94	741.95	-4.1	742.35	-4.22	742.75	-4.25		
743.15	-4.16	743.54	-.4	743.94	-3.81	744.34	-3.69	744.74	-3.7		
745.14	-3.83	745.54	-3.99	745.94	-4.12	746.33	-4.19	746.73	-4.19		
747.13	-4.14	747.53	-4.05	747.93	-3.97	748.33	-3.9	748.73	-3.83		
749.13	-3.77	749.52	-3.65	749.92	-3.42	750.32	-3.03	750.72	-3.01		
751.12	-3.26	751.52	-3.38	751.92	-3.32	752.32	-3.24	752.71	-3.15		
753.11	-3.03	753.51	-2.86	753.91	-2.6	754.31	-2.31	754.71	-2.09		
755.11	-2.01	755.51	-2.11	755.9	-2.36	756.3	-2.55	756.7	-2.57		
757.1	-2.46	757.5	-2.31	757.9	-2.14	758.3	-1.85	758.69	-1.48		
759.09	-1.19	759.49	-1.04	759.89	-.77	760.29	-.54	760.69	-.34		
761.09	-.15	761.49	.05	761.88	.25	762.28	.43	762.68	.62		
763.08	.82	763.48	1.05	763.88	1.33	764.28	1.61	764.68	1.83		
765.07	1.97	765.47	2.19	765.87	2.13	766.27	2.31	766.67	2.44		
768	3.63	781.86	3.58	795.73	3.84	809.59	4.77	823.45	5.88		
838.18	6.78	852.91	7.73	867.64	8.29	882.37	8.51	897.1	8.58		
911.83	8.72	926.56	9.08	941.3	9.45	956.03	9.87	970.76	10.29		

Hydraulic Impact Analysis – FM 518 Bypass Bikeway – Proposed Bikeway/Pedestrian Bridge at Robinson Bayou
Proposed Conditions HEC-RAS Output

985.49	10.71	1000.22	10.96	1014.95	11.2	1029.68	11.44	1044.41	11.68
1059.14	11.92	1073.87	12.19	1088.6	12.56	1103.33	12.83	1118.06	12.76
1132.79	12.68	1147.52	12.74	1162.25	12.65	1176.99	12.84	1191.72	13.23
1206.45	13.35	1221.18	13.52	1235.91	13.68	1250.64	13.77	1265.37	13.76
1280.1	13.85	1294.83	14.16	1309.56	14.41	1324.29	14.56	1339.02	14.64
1353.75	14.66	1368.48	14.85	1383.21	15.24	1397.95	15.58	1412.68	15.67
1427.41	15.9								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	723.21	.04	768	.08

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	723.21	768		4084.81	4133.03	4119.35	.1	.3
Ineffective Flow			num=	1				
Sta L	Sta R	Elev	Permanent					
913.41	1427.41	20	T					

SUMMARY OF MANNING'S N VALUES

River: RobinsonGully

Reach	River Sta.	n1	n2	n3	n4	n5
001	4905.289	.1	.04	.035	.04	.08
001	4824.464	.1	.04	.035	.04	.08
001	4733.942	.1	.04	.035	.04	.08
001	4611.514	.08	.015	.04	.015	.08
001	4554.23	Bridge				
001	4500.604	.08	.015	.04	.015	.08
001	4489.47	Bridge				
001	4477.771	.08	.015	.04	.015	.08
001	4443.371	.1	.04	.08		
001	4337.592	.1	.04	.08		
001	4236.417	.1	.04	.08		
001	4133.029	.1	.04	.08		

SUMMARY OF REACH LENGTHS

River: RobinsonGully

Reach	River Sta.	Left	Channel	Right
001	4905.289	103.68	80.83	52.6
001	4824.464	119.9	90.52	84.79
001	4733.942	127.5	122.43	79.33
001	4611.514	98.52	110.91	106.54
001	4554.23	Bridge		
001	4500.604	20	22.83	20
001	4489.47	Bridge		
001	4477.771	12.08	34.4	17.77
001	4443.371	104.4	105.78	167.08
001	4337.592	98.08	101.17	158.43
001	4236.417	91.81	103.39	93.21
001	4133.029	4084.81	4133.03	4119.35

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS

River: RobinsonGully

Reach	River Sta.	Contr.	Expan.
001	4905.289	.1	.3
001	4824.464	.1	.3
001	4733.942	.3	.5
001	4611.514	.3	.5
001	4554.23	Bridge	
001	4500.604	.3	.5
001	4489.47	Bridge	
001	4477.771	.3	.5
001	4443.371	.3	.5
001	4337.592	.3	.5
001	4236.417	.1	.3

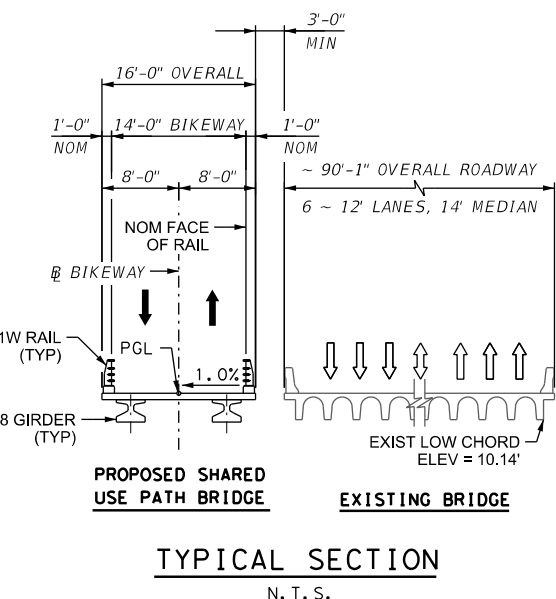
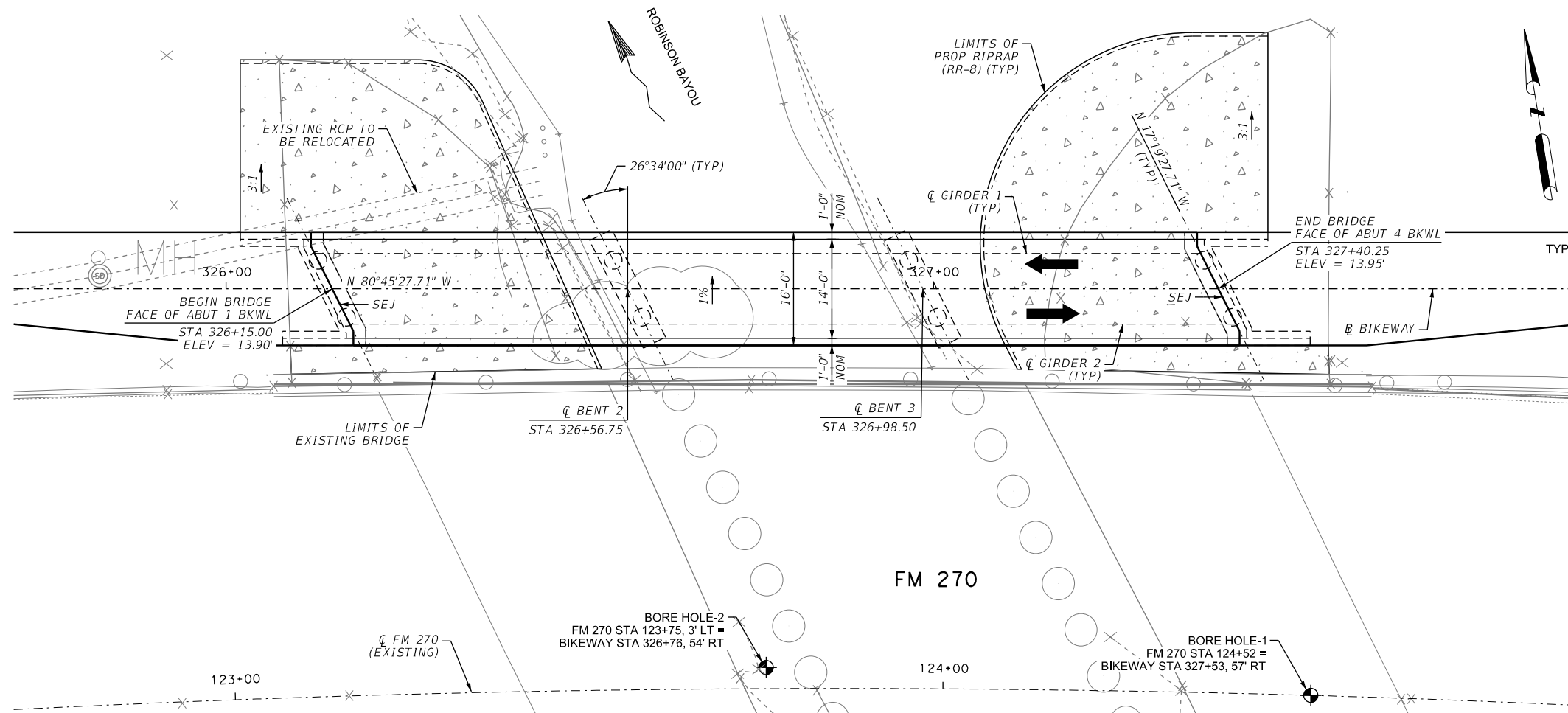
Hydraulic Impact Analysis – FM 518 Bypass Bikeway – Proposed Bikeway/Pedestrian Bridge at Robinson Bayou
Proposed Conditions HEC-RAS Output

001 4133.029 .1 .3

Profile Output Table - REPORT

Reach	River Sta	Profile	Q Total (cfs)	W.S. Elev (ft)	E.G. Elev (ft)	Vel Total (ft/s)	Flow Area (sq ft)	Top Width (ft)
001	4133.029	10-Year (10%)	1075.00	5.08	5.24	2.49	432.22	167.41
001	4133.029	50-Year (2%)	1643.00	6.55	6.73	2.26	726.58	226.03
001	4133.029	100-Year (1%)	1950.00	7.18	7.38	2.23	875.01	243.21
001	4236.417	10-Year (10%)	1075.00	5.19	5.31	2.05	523.28	173.99
001	4236.417	50-Year (2%)	1643.00	6.67	6.80	2.07	793.67	192.58
001	4236.417	100-Year (1%)	1950.00	7.30	7.45	2.13	917.55	200.64
001	4337.592	10-Year (10%)	1075.00	5.24	5.40	2.23	481.01	208.33
001	4337.592	50-Year (2%)	1643.00	6.72	6.89	2.02	811.84	263.85
001	4337.592	100-Year (1%)	1950.00	7.35	7.53	2.01	970.81	287.04
001	4443.371	10-Year (10%)	1075.00	5.40	5.49	1.78	602.64	304.89
001	4443.371	50-Year (2%)	1643.00	6.86	6.97	1.94	846.03	445.47
001	4443.371	100-Year (1%)	1950.00	7.48	7.60	2.04	954.78	483.68
001	4477.771	10-Year (10%)	1075.00	5.38	5.54	3.20	335.53	74.18
001	4477.771	50-Year (2%)	1643.00	6.83	7.03	3.63	452.39	86.83
001	4477.771	100-Year (1%)	1950.00	7.44	7.68	3.84	507.32	91.46
001	4489.47	Bridge						
001	4500.604	10-Year (10%)	1075.00	5.43	5.58	3.17	338.72	74.60
001	4500.604	50-Year (2%)	1643.00	6.88	7.08	3.59	457.22	87.25
001	4500.604	100-Year (1%)	1950.00	7.51	7.74	3.80	513.44	91.97
001	4554.23	Bridge						
001	4611.514	10-Year (10%)	1075.00	5.54	5.69	3.03	354.64	82.08
001	4611.514	50-Year (2%)	1643.00	7.01	7.19	3.38	485.40	95.89
001	4611.514	100-Year (1%)	1950.00	7.65	7.85	3.55	548.65	101.91
001	4733.942	10-Year (10%)	1075.00	5.59	5.77	2.92	368.63	100.42
001	4733.942	50-Year (2%)	1643.00	7.06	7.27	3.08	533.10	123.28
001	4733.942	100-Year (1%)	1950.00	7.70	7.92	3.17	615.19	132.80
001	4824.464	10-Year (10%)	1075.00	5.66	5.81	2.70	398.57	105.13
001	4824.464	50-Year (2%)	1643.00	7.13	7.32	2.91	565.36	122.56
001	4824.464	100-Year (1%)	1950.00	7.76	7.97	3.02	645.87	130.38
001	4905.289	10-Year (10%)	1075.00	5.70	5.85	2.27	474.51	183.56
001	4905.289	50-Year (2%)	1643.00	7.20	7.36	2.14	767.76	206.27
001	4905.289	100-Year (1%)	1950.00	7.86	8.02	2.15	905.23	213.28

APPENDIX C
BRIDGE LAYOUT SHEET
SOIL BORING LOGS
USDA NRCS SOIL SURVEY DATA

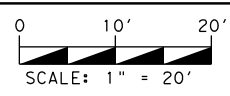


- NOTES:
- DESIGN LOAD H-10. DESIGNED IN ACCORDANCE WITH AASHTO LRFD SPECIFICATIONS, 5TH ED. (2010).
 - SEE BORING LOG SHEETS FOR TEST HOLE DATA.
 - "D" DENOTES DOWELED LOCATION.
 - FUNCTIONAL CLASS: SHARED USE PATH.
 - PED RAIL SHALL BE CONTINUOUS BEYOND LIMITS OF BRIDGE. SEE ROADWAY PLANS.
 - THE "H" VALUES SHOWN ARE ESTIMATED COLUMN HEIGHTS. THE CONTRACTOR IS RESPONSIBLE TO CALCULATE COLUMNS BASED ON FIELD CONDITIONS.

HYDRAULIC DATA

$Q_{50} = 1,643$ (cfs)	$Q_{100} = 1,950$ (cfs)
WSEL ₅₀ = 6.86 (ft)	WSEL ₁₀₀ = 7.51 (ft)
$V_{50} = 1.9$ (fps)	$V_{100} = 2.0$ (fps)

H-10 LOADING



PRELIMINARY

SUBMITTED FOR 30% REVIEW BY STEVEN E. LEWIS, P.E. TX 85497

AIA ENGINEERS, LTD.
FIRM REGISTRATION NUMBER: 2801
5/14/2014

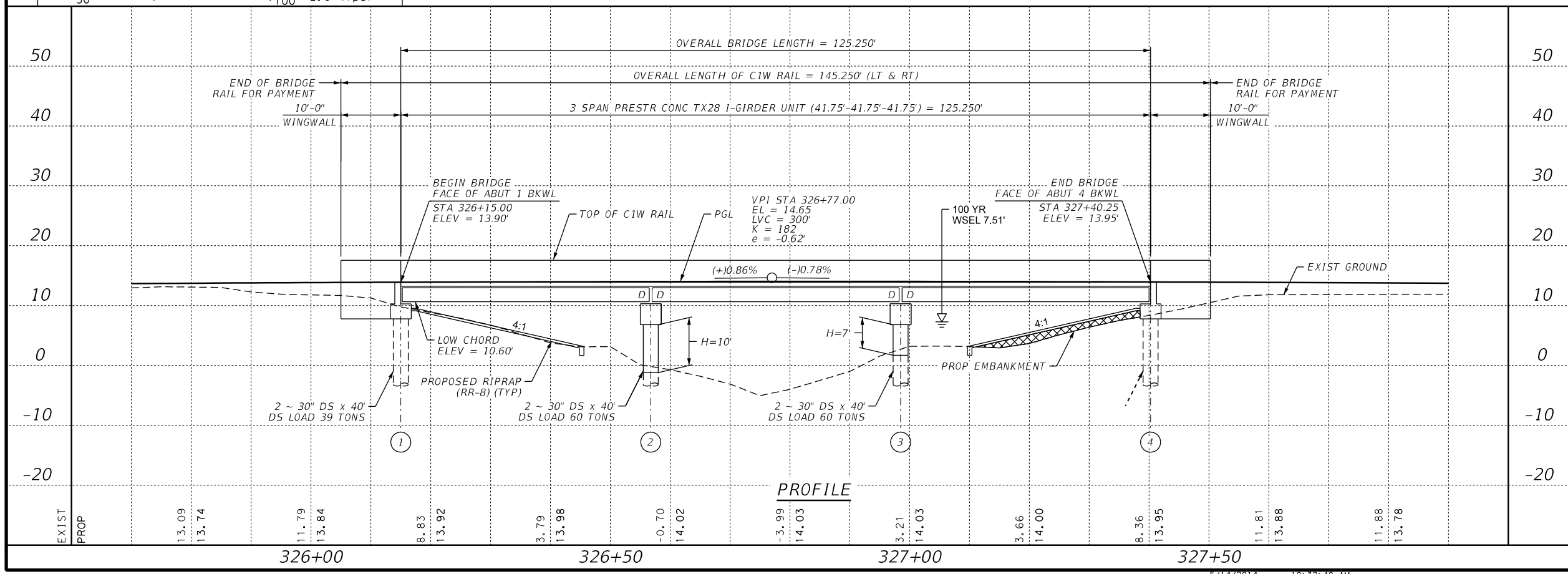
NOT FOR CONSTRUCTION, BIDDING OR PERMITTING

AIA ENGINEERS, LTD.
CONSULTANTS
15310 PARK ROW HOUSTON, TX 77084
PHONE: (281) 493-4140 TBPE # 2801

Texas Department of Transportation

FM 518
BYPASS BIKEWAY
BRIDGE LAYOUT
ROBINSON BAYOU
BRIDGE
(STA 326+06.50 TO STA 327+56.50)

FED RD DIV NO. 6	FEDERAL AID PROJECT	SHEET NO.
STATE TEXAS	DISTRICT HOU	COUNTY GALVESTON
CONTROL 0912	SECTION 73	JOB 179
		HIGHWAY FM 518



F:\TXPROJ\TX2210-00\Drawings\DCN\Bridges\AA\FM518*BL01.dgn
10:32:48 AM
5/14/2014

5/14/2014 10:32:48 AM

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DRILLING LOG

1 of 1

WinCore
Version 3.1

County Galveston
Highway FM 270
CSJ 0912-73-179

Hole 1
Structure Robinson Bayou
Station 124+52
Offset 0

District Houston
Date 5/27/75
Grnd. Elev. 6.00 ft
GW Elev. N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test		Properties				Additional Remarks
				Lateral Press. (psi)	Deviator Stress (psi)	MC	LL	PI	Wet Den. (pcf)	
5			CLAY, tan, gray, soft, wet (SC)	0	13	24	63	44	123	
				5	13	28	70	48	123	
				10	7	30	72	50	119	
				5	16	36	85	57	116	
				10	27	36	83	55	115	
-4		12 (6) 11 (6)	CLAY, sly, silty, tan, gray, stiff, wet (SC)	0	18	29	76	52	123	
				5	25	24	67	44	124	
				10	34	23	64	43	125	
				5	25	35	90	61	116	
				15	41	30	76	51	121	
-9			CLAY, red, brown, gray, stiff, wet (SC)	0	16	30	73	50	123	
				5	34	30	87	61	122	
				10	35	29	62	43	122	
				15	42	21	42	22	128	
-13		7 (6) 8 (6)	CLAY, silty, tan, gray, soft, wet (SC)	10	28	19	40	23	132	
-16			SILT, tan, loose, clayey	10	42	22	25	5	128	
-19		14 (6) 19 (6)	SAND, silty, no recovery							
-25		24 (6) 19 (6)								
			CLAY, slightly silty, tan, gray, stiff, moist (SC)	0	12	20	42	25	130	
				5	23	19	39	21	131	
				10	35	19	42	25	132	
				15	51	19	42	22	132	
-29			CLAY, silty, gray, stiff, moist (SC)	0	44	19	47	29	132	
				5	33	19	52	34	131	
				10	40	21	39	21	129	
				15	51	18	53	30	131	
40		13 (6) 12 (6)		0	14	27	73	48	124	
				5	48	26	73	47	124	
				10	55	26	75	49	127	
				0	47	24	48	28	134	
				10	55	19	57	39	131	
				0	34	20	58	39	132	
				5	36	19	57	40	132	
				10	51	21	62	44	130	
				15	68	22	61	46	130	
50		25 (6) 21 (6)		0	11	19	33	15	133	
				5	38	13	36	19	134	
				10	54	18	33	18	130	
				0	11	22	37	17	125	
				5	27	21	53	31	128	
				10	36	26	44	21	127	
-54		50 (4) 50 (3)	SAND, No recovery, wash sand and silt							
-59		47 (6) 47 (6)								

Remarks:

The ground water elevation was not determined during the course of this boring.

Driller: Holy

Logger: Fendley

Organization:

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DRILLING LOG

1 of 1

WinCore
Version 3.1

County Galveston
Highway FM 270
CSJ 0912-73-179

Hole 2
Structure Robinson Bayou
Station 123+75
Offset 3 ft left

District Houston
Date 6/2/75
Grnd. Elev. 5.40 ft
GW Elev. N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test		Properties				Additional Remarks
				Lateral Press. (psi)	Deviator Stress (psi)	MC	LL	PI	Wet Den. (pcf)	
5			CLAY, brown, tan, moist, w/sctrd calc. material (CL)	5	18	24	57	37	123	
				0	9	28	70	50	122	
				10	24	25	56	38	124	
				5	17	24	51	32	126	
				10	30	24	57	37	125	
-2.6		6 (6) 7 (6)	CLAY, silty, tan, gray, soft (SC)	0	13	27	63	38	123	
				0	11	32	79	52	121	
				5	25	24	60	37	124	
				10	26	32	82	56	115	
				0	22	28	80	54	122	
				5	31	30	89	45	121	
-9.6			CLAY, red, gray, stiff (SC)	10	38	28	79	55	122	
				5	38	21	52	34	130	
				15	37	23	58	37	126	
-12.6		11 (6) 12 (6)	CLAY, tan, red, silty, soft (SC)	0	36	19	48	31	132	
				5	53	20	51	33	130	
				10	30	22	38	14	129	
				15	49	21	37	17	129	
				10	36	17	37	21	132	
				5	24	17	31	14	129	
				0	7	18	28	8	131	
-15.6		21 (6) 23 (6)	CLAY, tan, gray, silty (SC)	5	34	20	41	21	130	
				10	45	23	43	23	130	
				0	4	19	33	17	119	
				15	52	20	46	29	132	
-24.6			CLAY, tan, soft (SC)	0	28	19	44	27	133	
				5	40	19	43	26	132	
				10	55	18	47	29	132	
				15	35	23	37	18	130	
				0	7	21	36	18	128	
-31.6		10 (6) 11 (6)	CLAY, silty, tan, gray, soft, moist (SC)	10	35	24	51	30	126	
				0	32	21	46	23	128	
				5	39	24	55	43	126	
				10	54	28	75	45	126	
				0	35	23	68	50	129	
				5	48	19	55	37	135	
				10	52	20	63	45	130	
				15	60	21	59	42	129	
-37.6			CLAY, gray, silty, stiff (SC)	0	33	23	67	44	128	
				5	56	21	60	40	131	
				10	31	17	61	42	131	
				0	25	17	45	27	134	
				5	17	24	44	22	128	
-43.6		12 (6) 16 (6)	CLAY, silty, gray, tan, calcareous (CL)	10	32	22	47	21	127	
				15	52	24	45	28	129	
-48.6		55	CLAY, very silty, tan, gray, stiff, moist (SC)							
-51.6		50 (5.75) 38 (6.25)	SAND, silty, no recovery							
60		50 (5.5) 50 (2)								
-59.6		65								
70										
75										

Remarks:

The ground water elevation was not determined during the course of this boring.

Driller: Holy

Logger: Springer

Organization:

F:\TXPROJ\TX2210-00\Documentation\Design Calculations\geotech\RobinsonBayou.CLG

PRELIMINARY

SUBMITTED FOR 30% REVIEW BY
STEVEN E. LEWIS, P.E. TX 85497

AIA ENGINEERS, LTD.
FIRM REGISTRATION NUMBER: 2801
5/8/2014

NOT FOR CONSTRUCTION,
BIDDING OR PERMITTING



FM 518
BYPASS BIKEWAY
BRIDGE LAYOUT
BORING LOGS

SHEET X OF Y

FED RD DIV NO.	FEDERAL AID PROJECT		SHEET NO.
6			
STATE	DISTRICT	COUNTY	
TEXAS	HOU	GALVESTON	
CONTROL	SECTION	JOB	HIGHWAY
0912	73	179	FM 518

Soil Map—Galveston County, Texas



Map Scale: 1:9,720 if printed on A landscape (11" x 8.5") sheet.

0 100 200 400 600 Meters


0 450 900 1800 2700 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84



MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Galveston County, Texas
 Survey Area Data: Version 10, Dec 19, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 26, 2011—Mar 6, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Galveston County, Texas (TX167)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Be	Bernard clay loam	77.0	20.0%
Bu	Bernard-Urban land complex	25.7	6.7%
Ed	Edna fine sandy loam	35.8	9.3%
KeA	Kemah silt loam, 0 to 1 percent slopes	42.7	11.1%
LaB	Lake Charles clay, 2 to 5 percent slopes	38.3	10.0%
Ve	Verland silty clay loam	163.5	42.6%
W	Water	1.2	0.3%
Totals for Area of Interest		384.2	100.0%

Engineering Properties

Galveston County, Texas

[Absence of an entry indicates that the data were not estimated. This report shows only the major soils in each map unit]

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percent passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 Inches	3-10 Inches	4	10	40	200		
	<i>In</i>				<i>Pct</i>	<i>Pct</i>					<i>Pct</i>	
LaB: Lake Charles	0-4	Clay	CH, CL	A-7-6	0	0	98-100	98-100	97-100	91-95	45-65	27-45
	4-59	Clay	CH	A-7-6	0	0	99-100	98-100	96-99	90-95	55-67	36-46
	59-65	Clay	CH	A-7-6	0	0	98-99	97-98	95-97	89-91	53-66	35-45
	65-80	Clay	CH	A-7-6	0	0	99-100	97-100	95-100	95-99	62-65	42-45

Physical Soil Properties

Galveston County, Texas

[Entries under "Erosion Factors--T" apply to the entire profile. Entries under "Wind Erodibility Group" and "Wind Erodibility Index" apply only to the surface layer. Absence of an entry indicates that data were not estimated. This report shows only the major soils in each map unit]

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	<i>In</i>	<i>Pct</i>	<i>Pct</i>	<i>Pct</i>	<i>g/cc</i>	<i>micro m/sec</i>	<i>In/In</i>	<i>Pct</i>	<i>Pct</i>					
LaB:														
Lake Charles	0-4	8-18	28-43	39-62	1.13-1.18	0.10-1.00	0.10-0.15	9.1-15.9	2.0-6.0	.32	.32	5	4	86
	4-59	7-15	25-34	51-64	1.29-1.37	0.01-0.10	0.10-0.13	10.6-	1.0-2.0	.32	.32			
	59-65	9-14	24-37	49-63	1.35-1.46	0.01-0.10	0.10-0.11	9.1-14.9	0.5-2.0	.32	.32			
	65-80	1-10	29-37	59-62	1.35-1.48	0.01-0.10	0.10-0.11	10.0-	0.5-1.0	.32	.32			

APPENDIX D

AERIAL COMPARISON

STREAM STABILITY COMPUTATIONS

HEC-RAS SCOUR COMPUTATIONS

100-YEAR SCOUR PLOT

**Stream Stability Determination
Aerial Photograph Comparison**



2014 Google Earth aerial photograph of Robinson Bayou at FM 270 crossing location



1978 Google Earth aerial photograph of Robinson Bayou at FM 270 crossing location

Stability Indicator	Description of Indicator	Rating	Description
1	Watershed and floodplain activity	9	Frequent disturbances due to construction and urbanization.
2	Flow Habitat	3	Perennial stream with no flashy behavior.
3	Channel Pattern	5	Meandering, moderate radius of curvature.
4	Entrenchment/ Channel Confinement	2	Active floodplain exists, no levees.
5	Bed Material	1	Fs < 20%
6	Bar Development	5	Minimal recent growth of channel bar.
7	Obstructions	5	Occasional.
8	Bank Soil Texture	1	Clay and silty clay
9	Average Bank Slope	2	Bank slopes = 2.5H:1V with cohesive materials.
10	Vegetative or Engineered Bank Protection	2	Woody vegetation present and both banks are lined.
11	Bank Cutting	3	Little or no evidence.
12	Mass Wasting, Bank Failure	5	Minor mass wasting.
13	Upstream Distance to Bridge from Meander Impact Point and Alignment	11	Poorly aligned with flow.
Total Rating (R)		54	Good Stability

Plain-Bed Channel Rating	Stability
R < 49	Excellent
49 ≤ R < 85	Good
85 ≤ R < 120	Fair
120 ≤ R	Poor

100-YEAR HEC-RAS SCOUR COMPUTATIONS

Contraction Scour

	Left	Channel	Right
Input Data			
Average Depth (ft):	3.02	10.32	2.16
Approach Velocity (ft/s):	1.58	4.06	1.31
Br Average Depth (ft):	2.27	9.70	2.65
BR Opening Flow (cfs):	294.22	1310.31	345.47
BR Top WD (ft):	25.01	36.20	25.23
Grain Size D50 (mm):	0.10	0.10	0.10
Approach Flow (cfs):	358.10	1539.68	52.22
Approach Top WD (ft):	75.19	36.72	18.47
K1 Coefficient:	0.690	0.690	0.690
Results			
Scour Depth Ys (ft):	3.18	0.00	6.14
Critical Velocity (ft/s):	0.93	1.14	0.88
Equation:	Live	Live	Live

Pier Scour

Pier: #1 (CL = 702.443)

Input Data

Pier Shape:	Round nose
Pier Width (ft):	2.50
Grain Size D50 (mm):	0.10000
Depth Upstream (ft):	7.28
Velocity Upstream (ft/s):	3.64
K1 Nose Shape:	1.00
Pier Angle:	0.00
Pier Length (ft):	18.03
K2 Angle Coef:	1.00
K3 Bed Cond Coef:	1.10
Grain Size D90 (mm):	
K4 Armouring Coef:	1.00

Results

Scour Depth Ys (ft):	4.31
Froude #:	0.24
Equation:	CSU equation

Pier: #2 (CL = 740.281)

Input Data

Pier Shape:	Round nose
Pier Width (ft):	2.50
Grain Size D50 (mm):	0.10000
Depth Upstream (ft):	5.65
Velocity Upstream (ft/s):	3.64
K1 Nose Shape:	1.00
Pier Angle:	0.00
Pier Length (ft):	18.03
K2 Angle Coef:	1.00
K3 Bed Cond Coef:	1.10
Grain Size D90 (mm):	
K4 Armouring Coef:	1.00

Results

Scour Depth Ys (ft):	4.16
Froude #:	0.27
Equation:	CSU equation

100-YEAR HEC-RAS SCOUR COMPUTATIONS

Combined Scour Depths

Pier : #1 (CL = 702.443) (Contr + Pier) (ft):	4.31
Pier : #2 (CL = 740.281) (Contr + Pier) (ft):	4.16

500-YEAR HEC-RAS SCOUR COMPUTATIONS

Contraction Scour

	Left	Channel	Right
Input Data			
Average Depth (ft):	4.06	11.99	2.69
Approach Velocity (ft/s):	1.90	4.65	1.59
Br Average Depth (ft):	3.21	11.26	3.61
BR Opening Flow (cfs):	658.65	1540.13	667.21
BR Top WD (ft):	31.34	36.20	30.48
Grain Size D50 (mm):	0.10	0.10	0.10
Approach Flow (cfs):	692.31	2048.35	125.34
Approach Top WD (ft):	89.68	36.72	29.31
K1 Coefficient:	0.690	0.690	0.690
Results			
Scour Depth Ys (ft):	4.83	0.00	7.36
Critical Velocity (ft/s):	0.98	1.17	0.91
Equation:	Live	Live	Live

Pier Scour

Pier: #1 (CL = 702.443)

Input Data

Pier Shape:	Round nose
Pier Width (ft):	2.50
Grain Size D50 (mm):	0.10000
Depth Upstream (ft):	8.91
Velocity Upstream (ft/s):	3.83
K1 Nose Shape:	1.00
Pier Angle:	0.00
Pier Length (ft):	18.03
K2 Angle Coef:	1.00
K3 Bed Cond Coef:	1.10
Grain Size D90 (mm):	
K4 Armouring Coef:	1.00

Results

Scour Depth Ys (ft):	4.53
Froude #:	0.23
Equation:	CSU equation

Pier: #2 (CL = 740.281)

Input Data

Pier Shape:	Round nose
Pier Width (ft):	2.50
Grain Size D50 (mm):	0.10000
Depth Upstream (ft):	7.28
Velocity Upstream (ft/s):	3.83
K1 Nose Shape:	1.00
Pier Angle:	0.00
Pier Length (ft):	18.03
K2 Angle Coef:	1.00
K3 Bed Cond Coef:	1.10
Grain Size D90 (mm):	
K4 Armouring Coef:	1.00

Results

Scour Depth Ys (ft):	4.41
Froude #:	0.25
Equation:	CSU equation

500-YEAR HEC-RAS SCOUR COMPUTATIONS

Combined Scour Depths

Pier : #1 (CL = 702.443) (Contr + Pier) (ft):	4.53
Pier : #2 (CL = 740.281) (Contr + Pier) (ft):	4.41

Bridge Scour RS = 4489.47

Legend

- WS 100-Year (1%)
- Ground
- Ineff
- Bank Sta
- Contr Scour
- Total Scour

