



Hydraulic Analysis Technical Memorandum

Veloweb Hike and Bike Trail at Grapevine Creek (Bridge #10P)

**Dallas Area Rapid Transit
Cotton Belt Regional Rail Corridor
Contract C-2033270-01**

This document is for interim review and not intended for regulatory approval, permit, bidding, or construction purposes.

Brandon Oliver, P.E. (# 135838) 08/01/2023





Memorandum

Veloweb Hike and Bike Trail

Grapevine Creek Hydraulic Analysis (Bridge #10P)
100% Milestone Submittal

Submittal Date: August 01, 2023

Attention Reza Shirmanesh, P.E. - Dallas Area Rapid Transit Authority

From Brandon Oliver, P.E. (# 135838)
IEA Inc., TBPE # F 10161

Subject **Veloweb Hike and Bike Trail at Grapevine Creek (Bridge #10P)**
Cotton Belt Regional Rail Corridor
Limits: From DFW Intl. Airport to Shiloh Road in Plano, TX
Segment: CB-1
Hydraulic Analysis Technical Memorandum
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Copies to Ken VanOverberghe - Jacobs Engineering Group Inc
David Kelly, P.E. - Jacobs Engineering Group Inc
Mike Khairy, P.E. - Jacobs Engineering Group Inc

INTRODUCTION

As part of the referenced contract, IEA, Inc. was authorized to perform engineering services as a sub-consultant to Jacobs Engineering Group Inc. under the Archer Western Herzog 4.0 Joint Venture LLC for the preparation of the plans, specifications, and estimates (PS&E) and associated hydrologic and hydraulic studies for the Veloweb Hike and Bike Trail located within the limits of Dallas Area Rapid Transit Authority (DART) Cotton Belt rail corridor.

The trail project segment covers from Station 1013+00 to Station 3589+29 (from 1200 ft West of Texan Trail to Shiloh Road). The drainage analyses and design scope include the design of bridge structures and storm sewer/open ditches for proposed trail improvements. The purpose of this technical memorandum is to document the hydraulic analysis associated with the proposed trail improvements crossing parallel to the DART rail crossing over Grapevine Creek (Bridge #10P) located within the City of Coppell.

The purposes of this technical memorandum are:

- To document the hydraulic analysis associated with the proposed Veloweb Hike and Bike Trail improvement and placing a new pedestrian bridge crossing #10P at Grapevine Creek.
- To demonstrate that the proposed trail improvement (i.e., a new pedestrian bridge at Grapevine Creek) with track Bridge #10 in the existing condition will not have any adverse hydraulic impacts on properties or structures located outside the existing DART right-of-way (ROW).

PROJECT LOCATION

The existing track Bridge #10 is located North of S. Northlake Rd and West of Mockingbird Lane in the City of Coppell. The project location map for the Bridge #10P crossing is provided in Exhibit A. As shown in Exhibit A, Bridge #10P crosses over Grapevine Creek at Station 1320+00, and it is located approximately 130-ft north of Roadway Bridge at Belt Line Rd. **Figure 1** shows the Google Earth image of the Bridge #10P, including its location, vicinity area, existing Cotton Belt DART rail and the existing Right of Way.

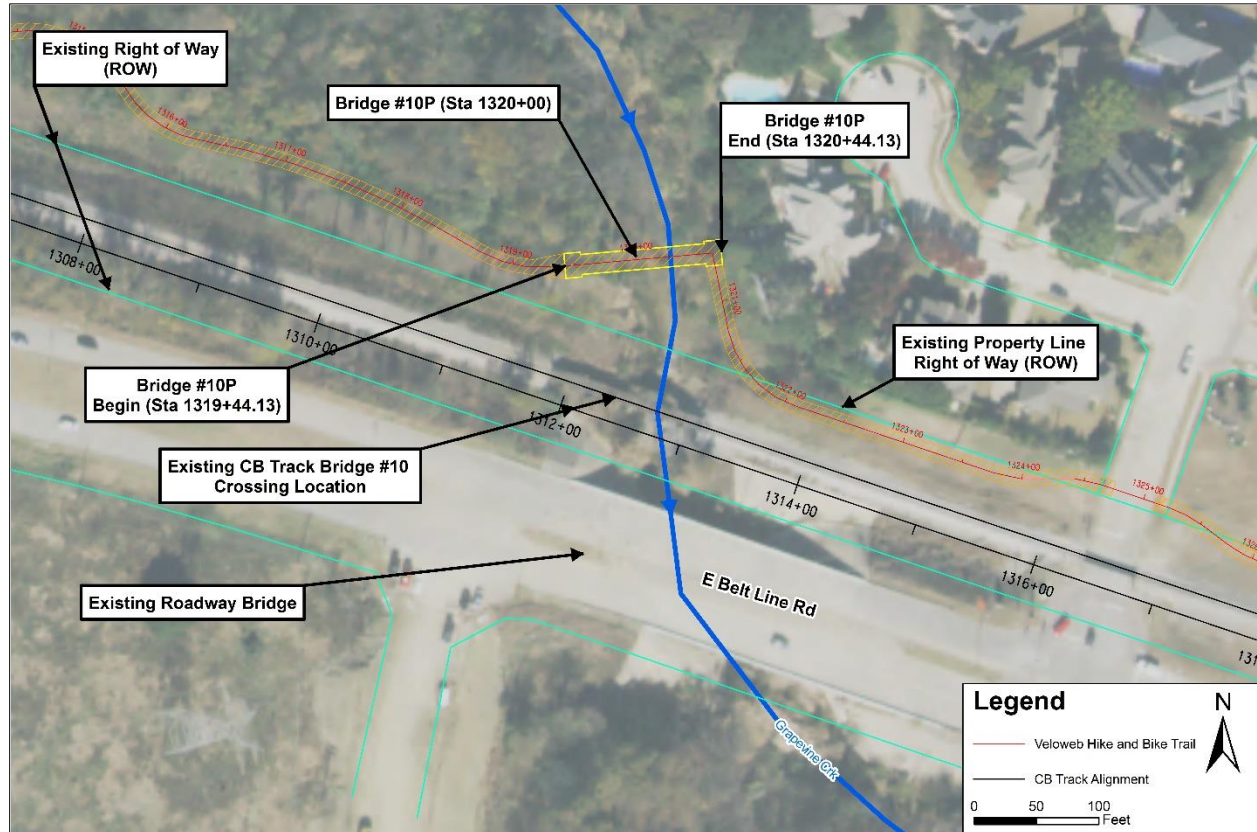


Figure 1: Google Earth Image Showing Bridge #10P Location and Right of Way (ROW)

PROJECT DATUM

All vertical data is referenced to the North American Vertical Datum of 1988 (NAVD88). The horizontal projection and datum are State Plane Texas North Central FIPS 4202 (Feet), NAD 1983.

SURVEY DATA

On-the-ground topographic survey was used for Bridge #10P crossing analysis (Figure 1). Additionally, spot elevations throughout the project location were collected including nearby structures, channels, and overbanks.

DESIGN CRITERIA

The criteria of the Dallas Area Rapid Transit Authority, City of Coppell, and Federal Emergency Management Agency (FEMA) were followed for evaluating both existing and proposed conditions. The DART Requirements for Drainage were obtained from *Dallas Area Rapid Transit Light Rail Project Design Criteria Manual*, Chapter 7, Vol. 1, dated January 31, 2003. FEMA Requirement is based on *National Flood Insurance Program (NFIP) Section 60.3 (d)*. FEMA requirement is described in 44 Code of Federal Regulation (CFR) 60.3 (D). The City of Coppell drainage requirements were obtained from Section 16-4-21 of Chapter 16 - DISASTER CONTROL Code of Ordinances Coppell, TX.



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DART Requirements for Drainage:

Design storm event: For cross culverts and bridge structures, the design storm event is a 100-year or 1% Annual Chance Flood Hazard. The proposed bridge crossing is designed to pass the design storm flow under a roadway or railroad without causing adverse impacts including increases in backwater and downstream velocities. (The requirement for design storm is provided in Section 7.7.2, Table 7-1 of the Design Criteria Manual).

DART Requirement for Riprap:

As previously outlined, the hydraulic velocities in the channel shall be reduced to or below the maximum permissible values (i.e., 6 to 15 fps) for proposed conditions in the channel. Riprap protection is specified for any erosive velocities in the project area. (Outlet velocity requirements are provided in Section 7.5.4 of the Design Criteria Manual).

Riprap Sizing (Item 432, Riprap):

Stone riprap will be specified as necessary for proposed improvements based on the trail design, hydraulic results, and scour analysis. All riprap extents and sizes are designed following basic guidelines laid out in Hydraulic Engineering Circular No. 23 (HEC-23, Section 5.2, 3rd Edition dated September 2009), and Texas Department of Transportation (TxDOT) specification.

FEMA Requirements for Drainage:

Proposed improvements in the floodplain shall not adversely impact the floodway and existing regulatory effective 100-year base flood elevations (BFEs) and floodway. Furthermore, improvements shall satisfy NFIP requirements of no rise outside DART ROW since this crossing is located in the FEMA Zone AE and 1% Annual Chance Flood Hazard floodway.

City of Coppel Requirements for Drainage:

The analysis outlined in this memo satisfies the City of Coppel criteria per Coppel Ordinance No. 2001-952; Article 16-4 - Floodplain Management Ordinance; Section 16-4-21, as follows:

- Part 3a: For drainage areas of 0 to 100 square miles the valley storage reduction shall not exceed 15 percent for the 100-year flood and 20 percent for the standard project flood (SPF, 500-yr);
- Part 3b: For drainage areas, of more than 100 square miles, the valley storage reduction shall not exceed 0 percent for the 100-year flood and five percent, for the standard project flood.
- Part 5a: Proposed improvements in the floodplain will not increase the water surface elevations of the design base flood outside DART property.
- Part 5b: Proposed improvements floodplain will not increase the effective FIS base flood (existing condition watershed) elevations by more than one foot.
- Part 5c: Proposed floodplain doesn't increase the base flood water surface elevations of the FIS regulatory floodway outside DART property.

City of Coppel and DART Requirement for Freeboard:

The bridge is located in the City of Coppel and will be maintained by the City. The freeboard requirement both by the City of Coppel and DART are noted as follows:

- City of Coppel: The City of Coppel requires that bridges shall be designed to remain operable and accessible with a minimum of 2.0 feet of freeboard above adjacent Flood Insurance Studies (FIS) Base Flood Elevation (BFE) or the design base flood, whichever is greater.
- DART: According to DART requirement, the approved freeboard (i.e., minimum 100-year water surface depth below bridge low chord) requirement for the project was 1.0 ft.

The City of Coppel and DART have coordinated the freeboard requirement as needed, the proposed 10P bridge layout lies outside of DART ROW. The city waived the 100-year freeboard requirements for the approved schematic trail plans and Letter of Map Revision (LOMR).

FLOODPLAIN

The regulatory floodway at Bridge #10P crossing is shown on FEMA FIRM Panel No. 48113C0155K (Effective Date: July 7, 2014) (Exhibit B-1). The Letter of Map Revision (LOMR) (LOMR 15-06-0173P, Effective December 12, 2014) for this site is shown in **Exhibit B-2**. The LOMR in Exhibit B-2 shows the floodway and floodplain delineation upstream and downstream of Bridge #10P. The floodway and floodplain delineation is shown in **Figure 2**. The Base Flood Elevation (BFE) is approximately 458 ft in the vicinity of Bridge #10P crossing. The regulatory floodway widths are measured at bounding cross-sections upstream of proposed Bridge #10P and immediately downstream of the proposed improvements. There is no observed change in the modeled floodway since the proposed bridge crossing spans the effective floodway.

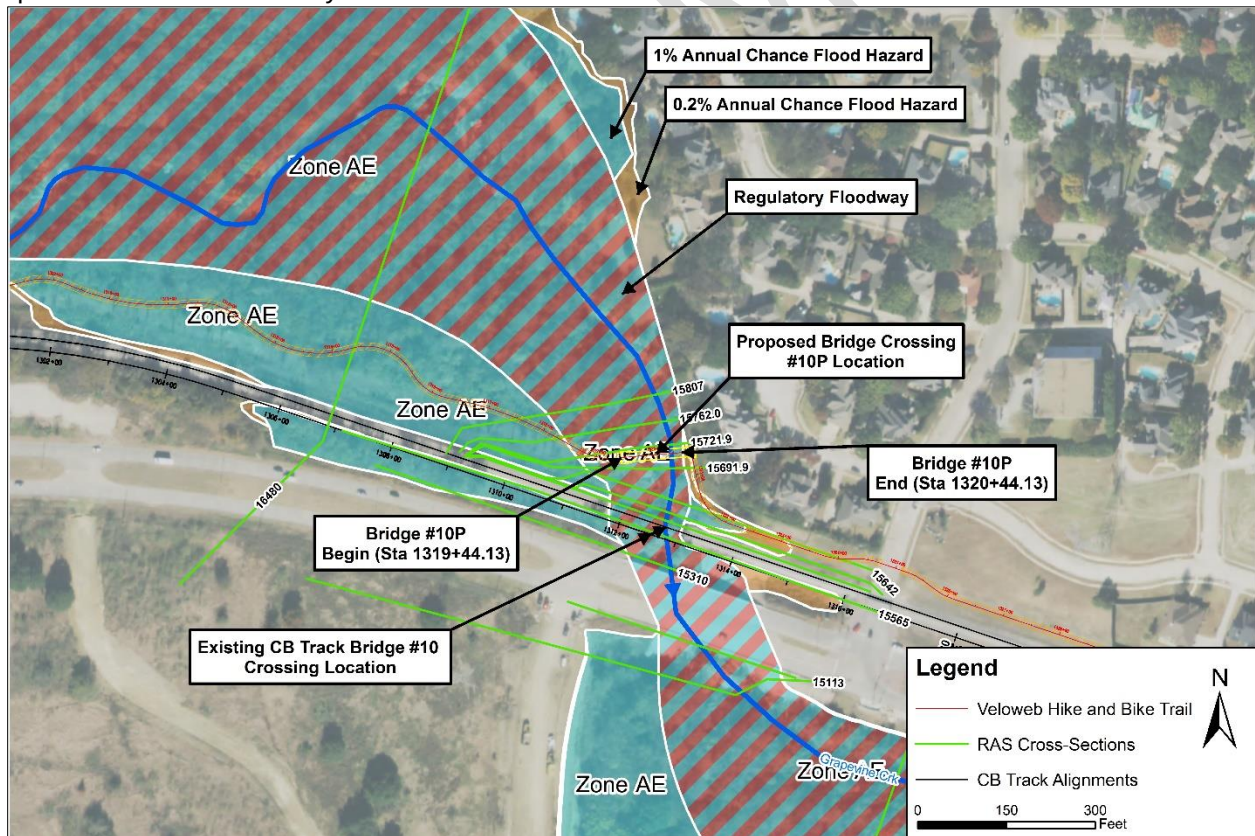


Figure 2: Upstream and Downstream Floodway and Floodplain of Bridge #10P Crossing



The regulatory floodway widths are measured at bounding cross-sections upstream of proposed Bridge #10P and immediately downstream of the proposed improvements, as shown in **Table 1**. There is no observed change in the modeled floodway for the proposed bridge crossing.

**Table 1: Upstream and Downstream Floodplain and Floodway
Widths at Bridge #10P Crossing**

Zones	Upstream	Downstream
Floodway Width, ft	180	168

SCOPE OF WORK

The specific scope of this work includes:

- Review previous hydraulic studies performed by others in this location and ensure to produce similar results.
- Perform hydraulic analysis of the Existing Condition (based on previous Cotton Belt DART rail design by others) and the “Proposed Condition” of Bridge Crossing #10P over Grapevine Creek.
- Compare modeling results between existing and proposed conditions to identify any adverse hydraulic impacts and identify methods to mitigate adverse hydraulic impacts if necessary.

Hydraulic models and results outlined in this memo have been developed based on the 60% design per the approved design criteria as detailed in the previous sections.

METHODOLOGY

The detailed modeling approach for this analysis is described in the subsequent sections:

Hydrologic Data Source

This includes gathering hydrologic, floodplain-related data from the following sources:

- FEMA Effective HEC-RAS Model (2018 LOMR 17-06-2181P) was obtained from the City of Coppell (Appendix A-1).
- Grapevine Creek Channel Data in the Vicinity of Crossing #10P (Appendix A-2)
- The project area digital elevation model (DEM) was based on LiDAR data obtained from the United States Geological Survey (USGS) website. This DEM was prepared using ArcGIS software. The LiDAR map is provided in the Attachment section (Exhibit C) of the report.
- The project area drainage map (Exhibit D-1) upstream of the Bridge Crossing #10P was prepared using ArcGIS software. The delineated drainage area is estimated to be 9.65 mile².
- Floodplain data includes FEMA Flood Insurance Study (FIS). FEMA FIS, which includes Grapevine Creek flows and flow location points (Appendix A-3), was obtained from the FEMA Internet website (www.fema.msc.gov).
- Flow Location Points obtained from FIS are shown in Appendix A-4.



Hydrologic Parameter and Hydrologic Modeling

The hydrologic methodology and results were documented and approved from the previous Cotton Belt Silver Line Track Improvement Submittal.

Hydraulic Modeling

Hydraulic modeling performed in this analysis includes the development of the HEC-RAS (version 5.0.3) model for both existing and proposed conditions. Two geometry files were created, referred to as “Existing Conditions” and “Proposed Conditions”.

Existing (Pre-Project) Conditions

This study utilizes the “Proposed” Cotton Belt DART rail design model as the baseline for this analysis to represent Existing Conditions for the Veloweb Hike and Bike Trail model. Flow data and boundary conditions (i.e., flow vs. water surface elevation) remain unchanged. The Existing Condition HEC-RAS plan includes the following crossing structures in **Table 2**.

Table 2: Drainage Structures at HEC-RAS “Existing Conditions” Model

HEC-RAS Rivers Station	Description of Structure
15708 +00 (Upstream of Bridge #10)	Approximately 100 ft long (perpendicular to channel flow), and 10 ft wide (parallel to channel flow)
15605 +00	Bridge #10 Cotton Belt DART Rail (by others)
15235 +00 (Downstream of Bridge #10)	Approximately 150 ft long (perpendicular to channel flow), and 154 ft wide (parallel to channel flow)

Source: Grapevine Creek Flood Study HEC-RAS Model

Existing drainage structures shown in **Table 2** and all others included in the developed models remain unchanged from existing to proposed conditions for the Bridge Crossing #10P hydraulic analysis.

Proposed (Post-Project) Conditions

For proposed conditions, the proposed Bridge #10P will be constructed upstream of the Cotton Belt DART rail (By Others) with an approximate width of 16 ft, and an approximate length of 100 ft. The bridge crossing will have concrete slope protection to protect the abutments. The proposed Bridge #10P layout is provided in Appendix D of this report. The proposed Bridge #10P crossing is represented in the model as a bridge hydraulic structure with a deck and abutments placed on the overbank portion of the channel, and riprap protection along the west bank of the main channel. The proposed conditions HEC-RAS cross-sections at the upstream and downstream of the bridge are shown in **Figure 3-a**, and **Figure 3-b**, respectively.



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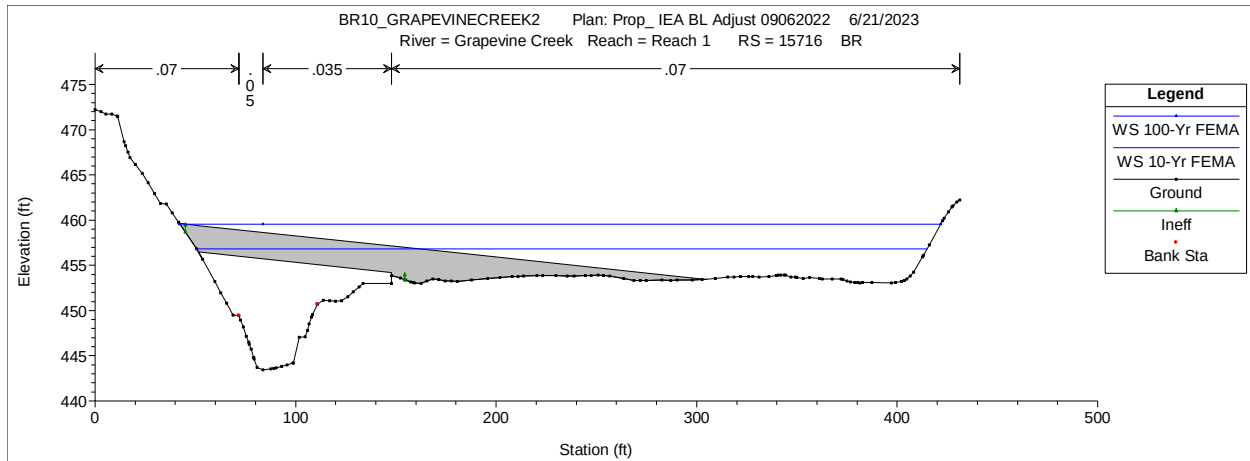


Figure 3-a: HEC-RAS Cross-Sections at Upstream of Bridge #10P for Proposed Conditions

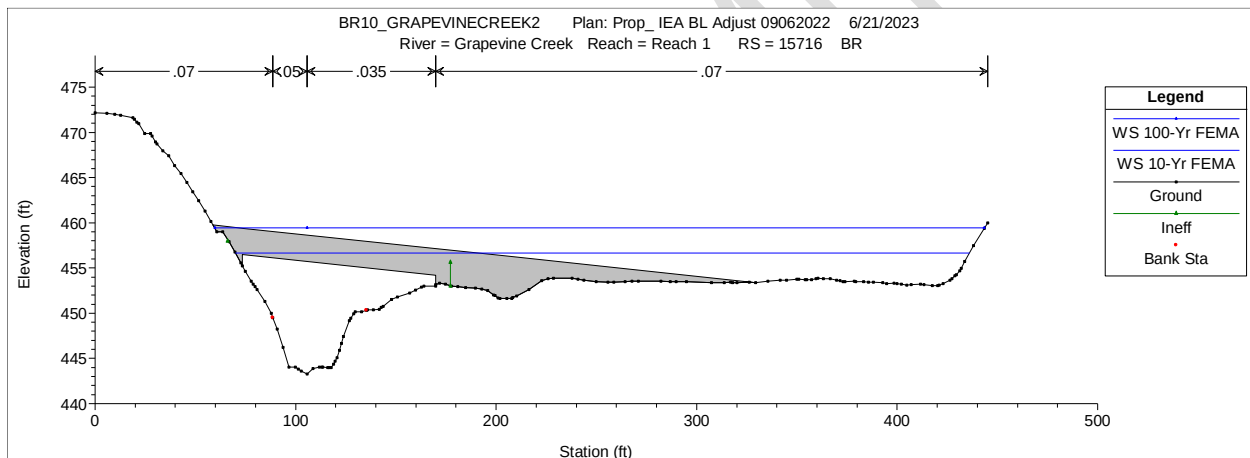


Figure 3-b: HEC-RAS Cross-Sections at Downstream of Bridge #10P for Proposed Conditions

Exhibit B-1 & Exhibit B-2 shows the Bridge Crossing #10P and the FEMA Effective Model. The FEMA Effective Hydraulic Model (i.e., HEC-RAS) based on LOMR: 17-06-2181P has been included in the digital model for reference. IEA, Inc. obtained the Effective Model from the City of Coppell.

Appendix C-1 shows the layout of the HEC-RAS cross-sections for the existing and proposed conditions models related to the DART rail crossings and proposed pedestrian bridge. To estimate hydraulic impacts, results of the HEC-RAS model (i.e., pre-project vs. post-project plan) were compared for the water surface elevations at the corresponding cross-sections. The steps listed below were also followed to develop the HEC-RAS model.



Steady-state flow data and boundary conditions

FEMA Effective Model flows for 10-year, 50-year, 100-year, 200-year, and 500-year are used for steady-state hydraulic analysis in this study. The steady-state flow data was obtained from FEMA Effective model, as shown in **Table 3** below.

Table 3: FEMA Effective Model Flows for Bridge #10P

Flows (cfs) of Storm Design Event					
HEC-RAS River Section (RS)	10-year	50-year	100-Year	200-Year	500-Year
RS 18210	7,500	10,500	11,180	13,244	15,100
RS 16480	6,900	9,700	11,000	12,389	14,200
RS 13339	5,900	8,600	9,700	11,029	12,700

The known water surface elevations obtained from FEMA Effective Floodplain Model were used as a boundary condition. The boundary conditions are provided in **Table 4**:

Table 4: FEMA Effective Floodplain Model Boundary Condition

Flows, cfs	Known Water Surface Elevation, ft
5,900	445.77
8,600	447.31
9,700	447.85
11,029	449.12
12,700	449.12

RESULTS

The results of the HEC-RAS model for the existing and proposed conditions of Bridge Crossing #10P are shown in the following tables, figures, and appendices.

Hydraulic Modeling Results

Hydraulic results for Bridge Crossing #10P are summarized in **Table 5** and a detailed HEC-RAS Results Summary Table is included in Appendix C-1.

Table 5: Water Surface Elevations and Velocity for the Proposed Bridge #10P

Design Storm	Station		Q	WSEL [1]	Vel	Bridge Low Chord Elev. [2]	Proposed PGL	Calculated Freeboard [2] - [1]
	From	To	(CFS)	(FT)	(FPS)	(FT)	(FT)	(FT)
10-Yr	1319+76.74	1320+76.74	6,900	456.84	8.43	454.14	457.10	-2.7
100-Yr			11,000	459.57	8.07			-5.43

The hydraulic study was performed by following the previous study. The hydraulic results for the Proposed Bridge #10P shown in the table meet the required drainage design criteria for allowable velocities, and design storm WSEL requirements. However, the hydraulic results show that the Proposed Bridge #10P does not meet the 100-Yr criteria as detailed in the previous sections of this memorandum.

The HEC-RAS profile comparison for the project area is shown in **Figure 4**.



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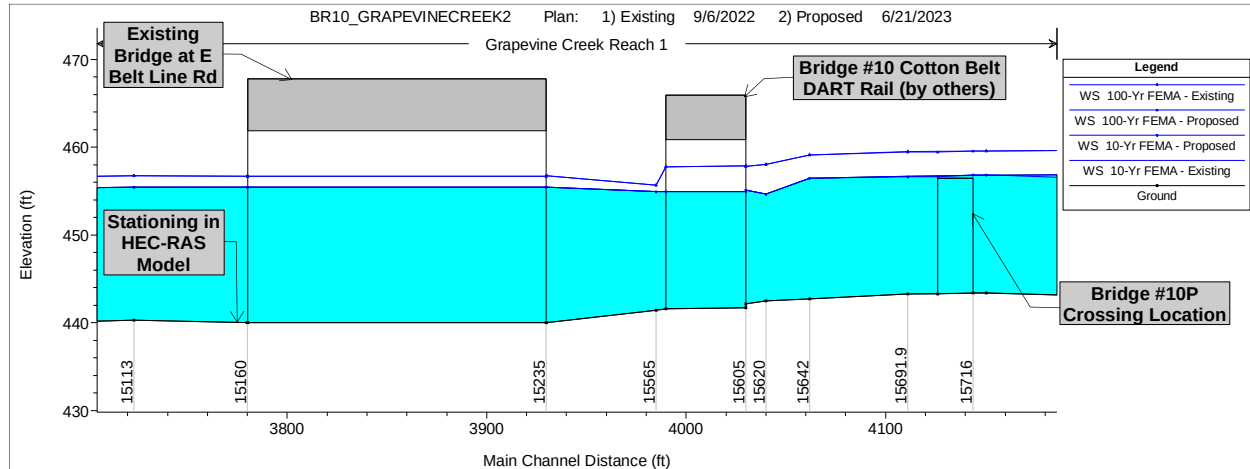


Figure 4: Water Surface Elevations of the Grapevine Creek at the Existing and Proposed Conditions.

The profiles shown from the hydraulic model indicate the proposed pedestrian bridge crossing #10P does not adversely impact adjacent structures beyond the project area.

Table 6 provides a comparison of the hydraulic results for existing and proposed conditions at pedestrian Bridge 10P during the location for the 10-year and 100-year design storm event.

Table 6: Hydraulic Results – Grapevine Creek (Existing vs. Proposed)

REACH NAME	HEC-RAS RIVER STA	DOWNSTREAM CHANNEL REACH LENGTH (FT)	DESIGN STORM	COMPUTED WATER SURFACE ELEVATION (FT)			CHANNEL VELOCITIES (FPS)	
				EXIST	PROP	Δ WSE	EXIST	PROP
						(PROP - EXIST)		
Grapevine Creek	16480	617.41	10-Yr	458.89	459.19	0.3	4.9	4.57
			100-Yr	461.09	461.09	0	4.85	4.85
	15807	45.15	10-Yr	456.99	457.91	0.92	9.01	7.41
			100-Yr	459.66	459.66	0	8.66	8.66
	15762	40.15	10-Yr	456.88	456.58	-0.3	8.43	10.67
			100-Yr	459.63	459.63	0	7.73	7.73
	15721.9	39.18	10-Yr	456.8	456.84	0.04	8.37	8.43
			100-Yr	459.57	459.57	0	7.71	8.07
	15716	Veloweb Hike and Bike Trail Pedestrian Bridge #10P						
	15691.9	49.24	10-Yr	456.71	456.64	-0.07	7.68	7.85
			100-Yr	459.5	459.44	-0.06	7.23	7.53



REACH NAME	HEC-RAS RIVER STA	DOWNSTREAM CHANNEL REACH LENGTH (FT)	DESIGN STORM	COMPUTED WATER SURFACE ELEVATION (FT)			CHANNEL VELOCITIES (FPS)	
				EXIST	PROP	Δ WSE	EXIST	PROP
						(PROP - EXIST)		
Grapevine Creek	15642	22	10-Yr	456.48	456.48	0	7.21	7.21
			100-Yr	459.13	459.13	0	7.62	7.62
	15620	10	10-Yr	454.66	454.66	0	12.48	12.48
			100-Yr	458.02	458.02	0	11.03	11.03
	15610	45	10-Yr	455.11	455.11	0	10.17	10.17
			100-Yr	457.8	457.8	0	11.43	11.43
	15605	Cotton Belt Railway Bridge 10						
	15565	55	10-Yr	454.95	454.95	0	10.72	10.72
			100-Yr	455.67	455.67	0	15.61	15.61

The comparison of results shows that there is no increase in 100-Yr WSELs from the proposed pedestrian bridge structure. The velocities also remain comparable throughout the study location.

Channel Riprap Protection

The following section discusses the selection and sizing of riprap.

Riprap Sizing: Stone riprap will be provided at the upstream and downstream end of Bridge #10P over Grapevine Creek. Riprap sizes and riprap aprons were designed following the basic guidelines laid out in Hydraulic Engineering Circular No. 23 (Source: Design Guideline 4, Riprap Revetment, Hydraulic Engineering Circular No. 23, HEC-23, 3rd Edition, Volume 2, dated September 2009).

Input parameter for riprap sizing: The input values channel riprap design for Bridge #10P is provided in **Table 7** below.

Table 7: Input Parameter Values for Riprap Sizing

Parameter	Value	Parameter	Value
Local Depth of Flow (y)	16.15 ft	Specific Gravity of Rock Riprap (Ss)	2.65
Average Channel Velocity (V_{avg})	8.07 ft/s	Acceleration due to Gravity (g)	32.2 ft/s ²
Radius of Curvature (R_c)	0 ft	Bank Side Slopes (H:V)	1.5:1
Width of Water Surface (W)	379 ft	Bank Angle (Θ)	33.7

Based on input values from **Table 7**, the D30, D50, and D100 values are calculated to be 3.8 in., 4.7 in., and 7 in. respectively. The calculated D50 value is compared with the standard in-place stone size of riprap provided in Table 2, Item 432 Riprap, TxDOT Specifications (Appendix F). Based on the design guidance calculations, D50 of 4.7 inches, corresponds to the nominal riprap stone size of 12 in. (TxDOT Specification 432, Table 2). Furthermore, the recommended thickness of the riprap is 12 in. (HEC 23,



Section 4.3.2.1) for the channel revetment at Bridge #10P. Detailed calculations of the riprap sizing are provided in Appendix F.

VALLEY STORAGE

On-Site valley storage and changes associated with the proposed improvements were measured using OpenRoads Designer cross-sections of the ROW, using an average end area method. The trail cross-sections used in the valley storage analysis are provided in **Appendix D**. The proposed improvements cause no increase in 100-yr and SPF WSEL. For the 100-year and SPF events, the maximum allowable valley storage loss is 15.0% and 20.0% respectively. There was a net gain in valley storage for the 100-year and SPF event. Therefore, no mitigation measure was proposed.

Table 8 summarizes the existing and proposed valley storage for both the 100-yr and SPF and the changes in valley storage. It provides a summary of the valley storage evaluation and reflects the proposed improvements at Grapevine Creek Bridge #10P. Detailed valley storage calculations are provided in **Appendix D**.

Table 8: Valley Storage Comparison – Grapevine Creek (Bridge #10P) at Cotton Belt

Event	Valley Storage (Ac-Ft)					
	Existing Conditions		Proposed Conditions		Δ (Ac-Ft)	Δ (%)*
	On-Site	Off-Site	On-Site	Off-Site		
100-Yr	2.6	N/A	2.7	N/A	0.1	2.3
SPF	4.2	N/A	4.3	N/A	0.1	2.0
*Expressed as % of Existing On-Site Storage						

As indicated above, the project results in a 2.3% gain in valley storage at the 100-yr event while at the SPF event, the project results in a 2.0% gain in valley storage. As there is no loss in valley storage in the proposed condition, it is not necessary to request a variance for the excess loss of storage from the Cities of Coppel, NCTCOG, and USACE.

SCOUR ANALYSIS

The computation of contraction and pier scour of the new pedestrian Bridge #10P at Grapevine Creek was analyzed using the US Army Corps of Engineers HEC-RAS version 5.0.3. Appendix E provides the scour hydraulic design output. These computations are based upon the methods outlined in Hydraulic Engineering Circular No. 18 (HEC 18, FHWA, 2001). The TxDOT Geotechnical Manual, 2020 defines the scour design frequency and scour design check flood frequency for a given hydraulic design frequency. For the 100-YR design storm, the scour analysis will utilize the 200-year design storm and 500-year check storm.

Soil subsurface conditions were evaluated through various depths of borings based on their required use in the analysis. Two bridge borings were drilled and sampled from the proximity of the proposed pedestrian Bridge #10P and the soil samples were tested in the laboratory to determine applicable physical and engineering properties. Additional borings (BW1-1-1 and BW1-1-2) were advanced along the corridor used in the analysis. A hydrometer and sieve analysis test was performed on the Grapevine Creek bed sample to determine the D50 and D95 parameters used in the hydraulic scour analysis. The



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overburden soils were found to consist of a combination of filling materials (ballast), fat clay soils, sandy clays, and clayey sands that extended to depths of 25 ft. Typically dark gray colored (in the fresh and unweathered state) and very soft to hard (in rock hardness) Eagle Ford shale was encountered beneath the overburden soils. The sample near the Grapevine Creek Bridge #10P shows Clayey Sand (SC) classification.

The geotechnical report suggests using a D50 value of 0.0023 mm and a D95 value of 10.2 mm from hydrometer and sieve analysis for hydraulic scour computations. The D50 value was too low for clay so a default value of 0.2 mm was used as input for the Colorado State University (CSU) equation methods outlined in Hydraulic Engineering Circular No. 18 (HEC 18, FHWA, 2001) to obtain the scour depths. The summary of calculated Scour Elevations can be found in **Table 8**.

Table 8: Scour Depth for Bridge #10P at 200-year and 500-year Flow.

200-year Flow (13244 cfs)	Contraction Scour Depth (ft)		
	LOB	Channel	ROB
	1.09	0	2.8
500-year Flow (15100 cfs)	Contraction Scour Depth (ft)		
	LOB	Channel	ROB
	0	0	2.87

SUMMARY AND CONCLUSION

This technical memorandum documents hydraulic data, analysis methodology, and modeling results for the Veloweb Hike and Bike Trail Bridge #10P 100% design. This study was conducted with the best available data for the existing and proposed pedestrian bridge crossing. Based on the results of the analysis, the proposed bridge crossing #10P design will meet the design criteria as directed by the City. Hydraulic results of the analysis show the proposed pedestrian bridge crossing #10P over Grapevine Creek does not have an adverse impact on the WSEL and shows no adverse impacts when compared to the proposed conditions. Bridge #10P will be overtopped by a 10-year storm and it will be treated as a low-water crossing. This crossing will also not adversely impact FEMA floodplain/floodway and properties or structures adjacent to proposed improvements as shown in the HEC-RAS Results Summary Table in **Appendix C-1**.



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ATTACHMENTS

Exhibit A: Project Location Map

Exhibit B: FEMA FIRM and Floodplain Map

- Exhibit B-1: Bridge Crossing #10P Location in FEMA Floodplain
- Exhibit B-2: FEMA Floodplain Map (Cross-Section Layout)

Exhibit C: Project Area LiDAR Map

Exhibit D: Drainage Area Map of Grapevine Creek

- Exhibit D-1: Drainage Area Map of Grapevine Creek (Upstream of Bridge Crossing #10P)



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APPENDICES

Appendix A: Survey Data, Site Photos, and Federal Emergency Management Agency Data

- Appendix A-1: FEMA Letter of Map Revision (LOMR 15-06-0173P, Effective December 12, 2014)
- Appendix A-2: Grapevine Creek Channel Data in the Vicinity of Crossing #10P
- Appendix A-3: Grapevine Creek Flows based on FEMA Flood Insurance Study (FIS)
- Appendix A-4: Grapevine Creek Flow Location Points

Appendix B: HEC-RAS Models

- Appendix B-1: Modeling – Bridge Crossing #10P HEC-RAS Models

Appendix C: Comparisons of HEC-RAS Output Data, Existing vs. Proposed Conditions (100-Year Storm Event)

- Appendix C-1: River Stations Output Data – Water Surface Elevation, Slope, Velocity and Flow Area
- Appendix C-2: HEC-RAS Cross-Sections with Water Surface Elevations

Appendix D: Bridge #10P Design Sheets & Trail Cross-Sections for Valley Storage Calculations

- Appendix D-1: Bridge #10P Design Sheets
- Appendix D-2: Valley Storage Documentation

Appendix E: Riprap Sizing for Channel Revetment of Bridge #10P

Appendix F: Scour Analysis Result

Exhibit A

Project Location Map

Exhibit A: Project Location Map

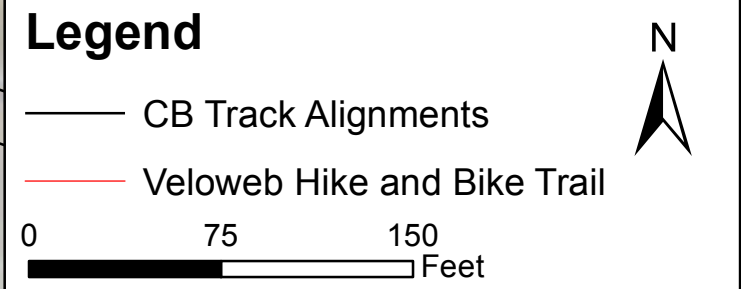
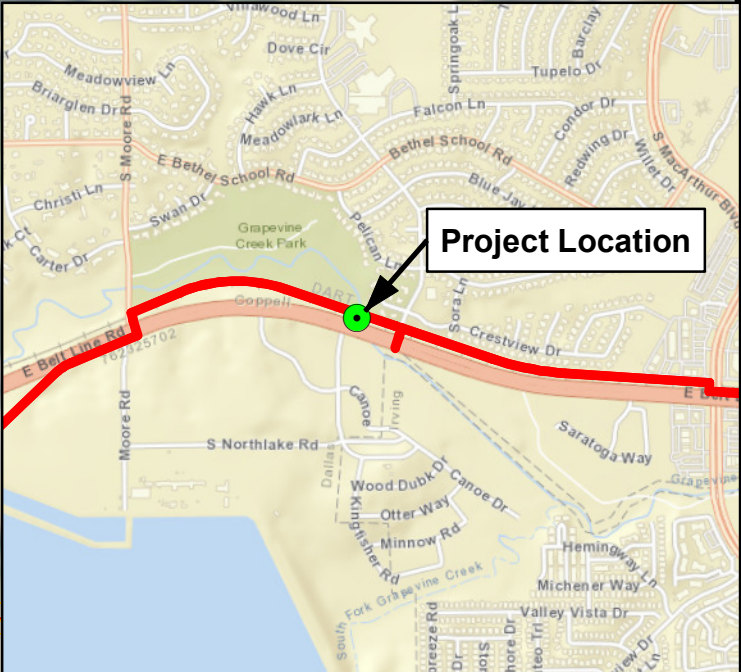
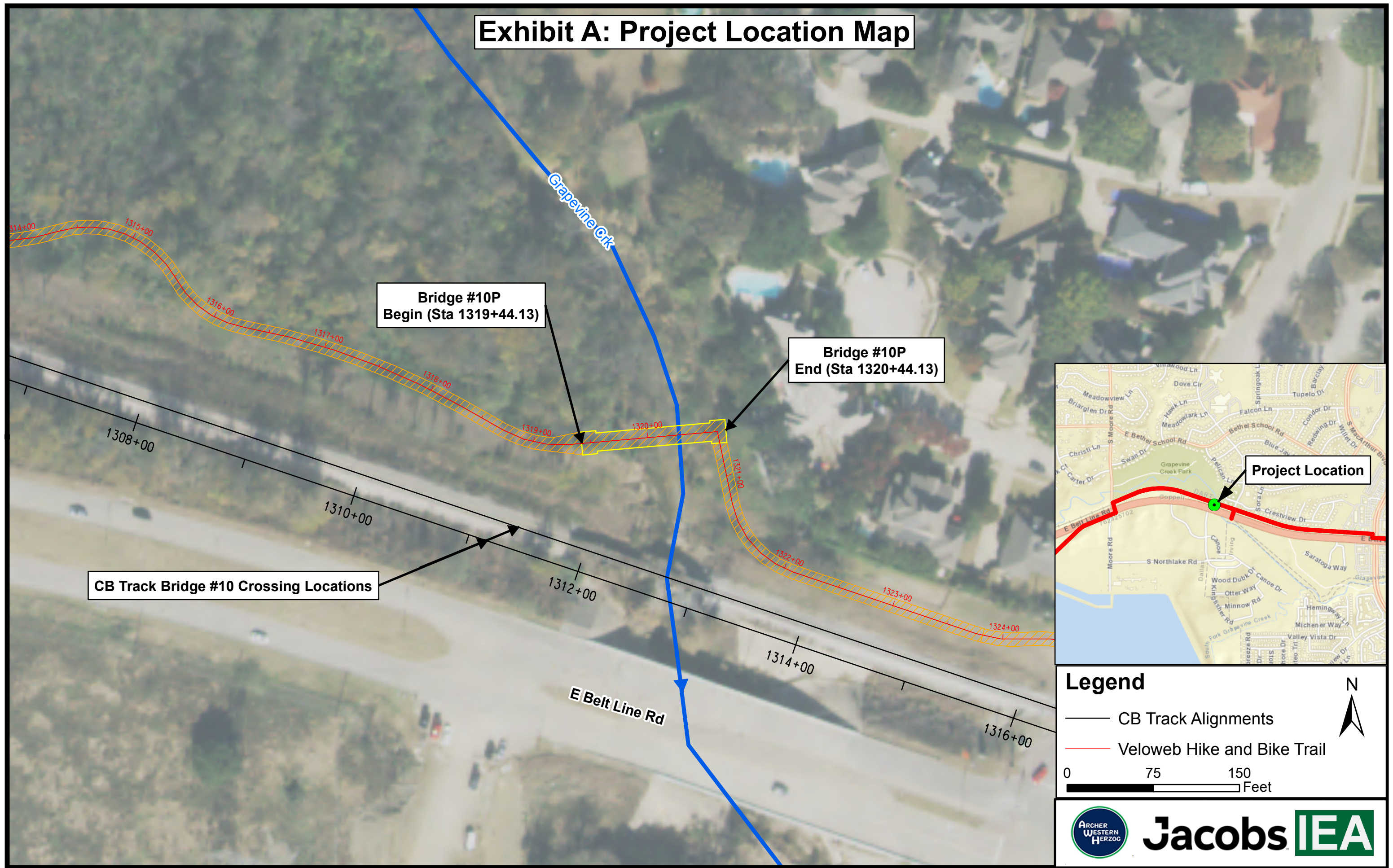


Exhibit B

FEMA FIRM and Floodplain Map

Exhibit B-1: Bridge Crossing #10P Location in FEMA Floodplain

Exhibit B-1: Bridge #10 Location in FEMA Floodplain

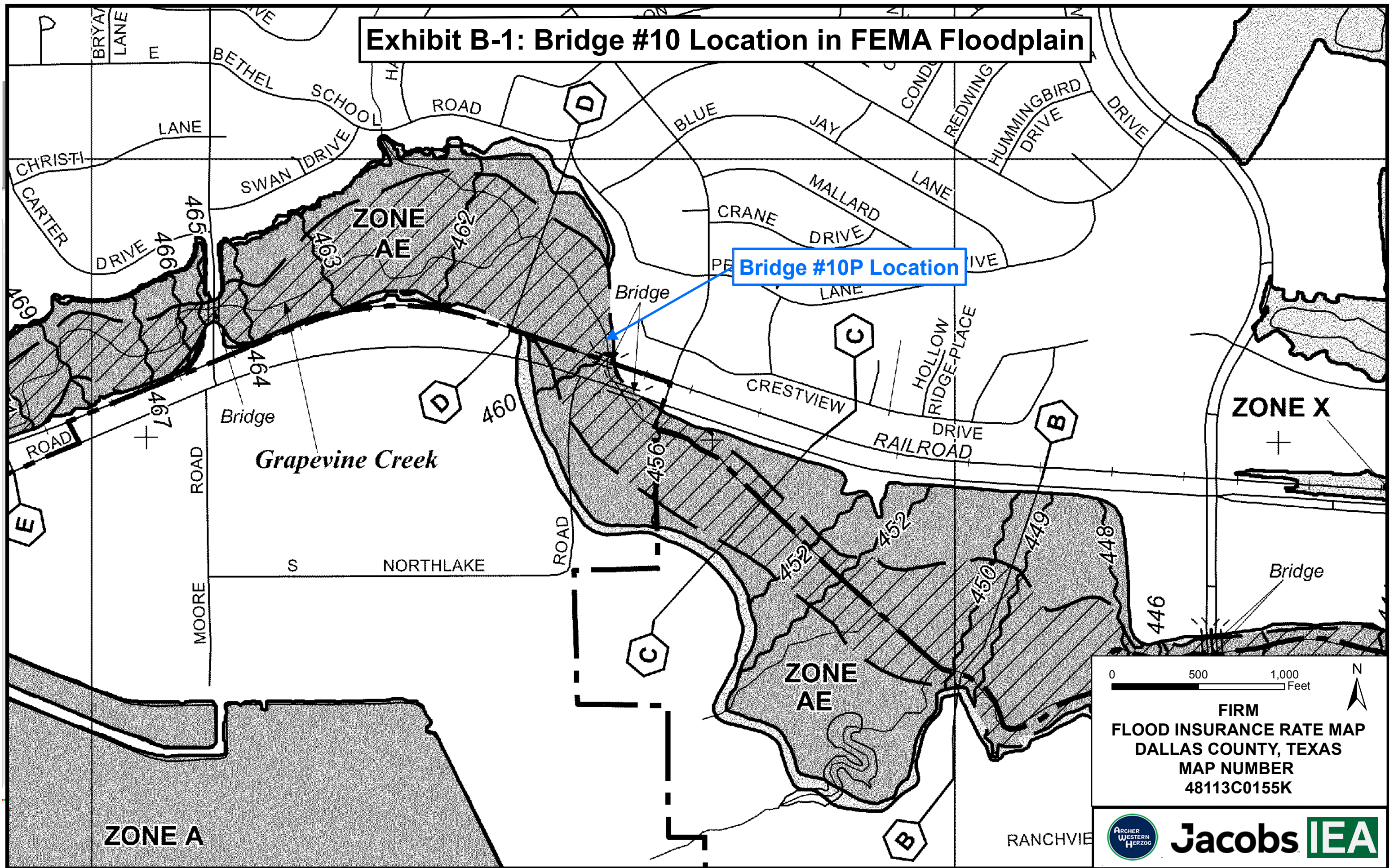
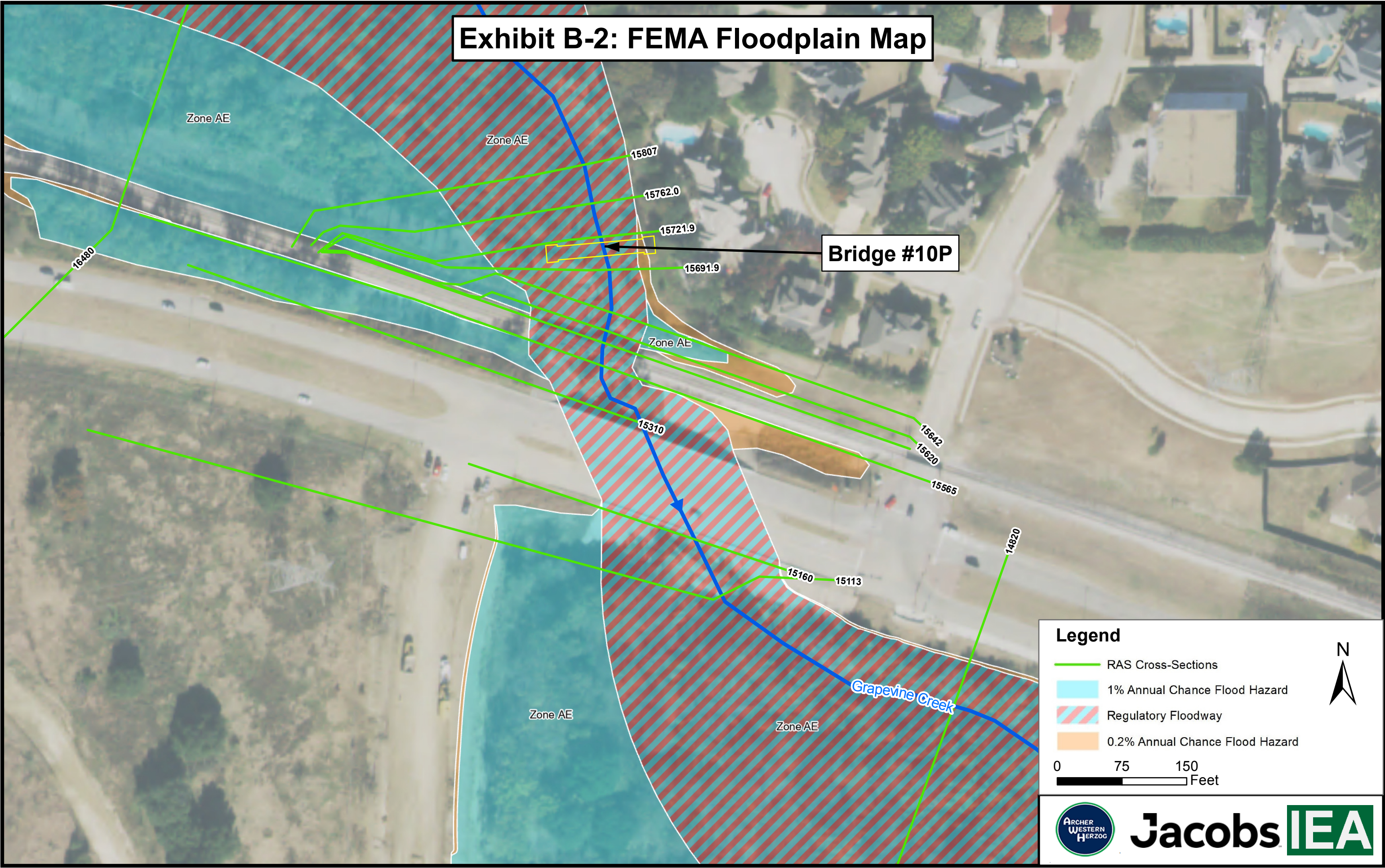


Exhibit B-2: FEMA Floodplain Map (Cross-Section Layout)

Exhibit B-2: FEMA Floodplain Map



Legend

- RAS Cross-Sections
- 1% Annual Chance Flood Hazard
- Regulatory Floodway
- 0.2% Annual Chance Flood Hazard

0 75 150
Feet



Jacobs IEA

Exhibit C

Project Area LiDAR Map

Exhibit C: Project Area LiDAR Map

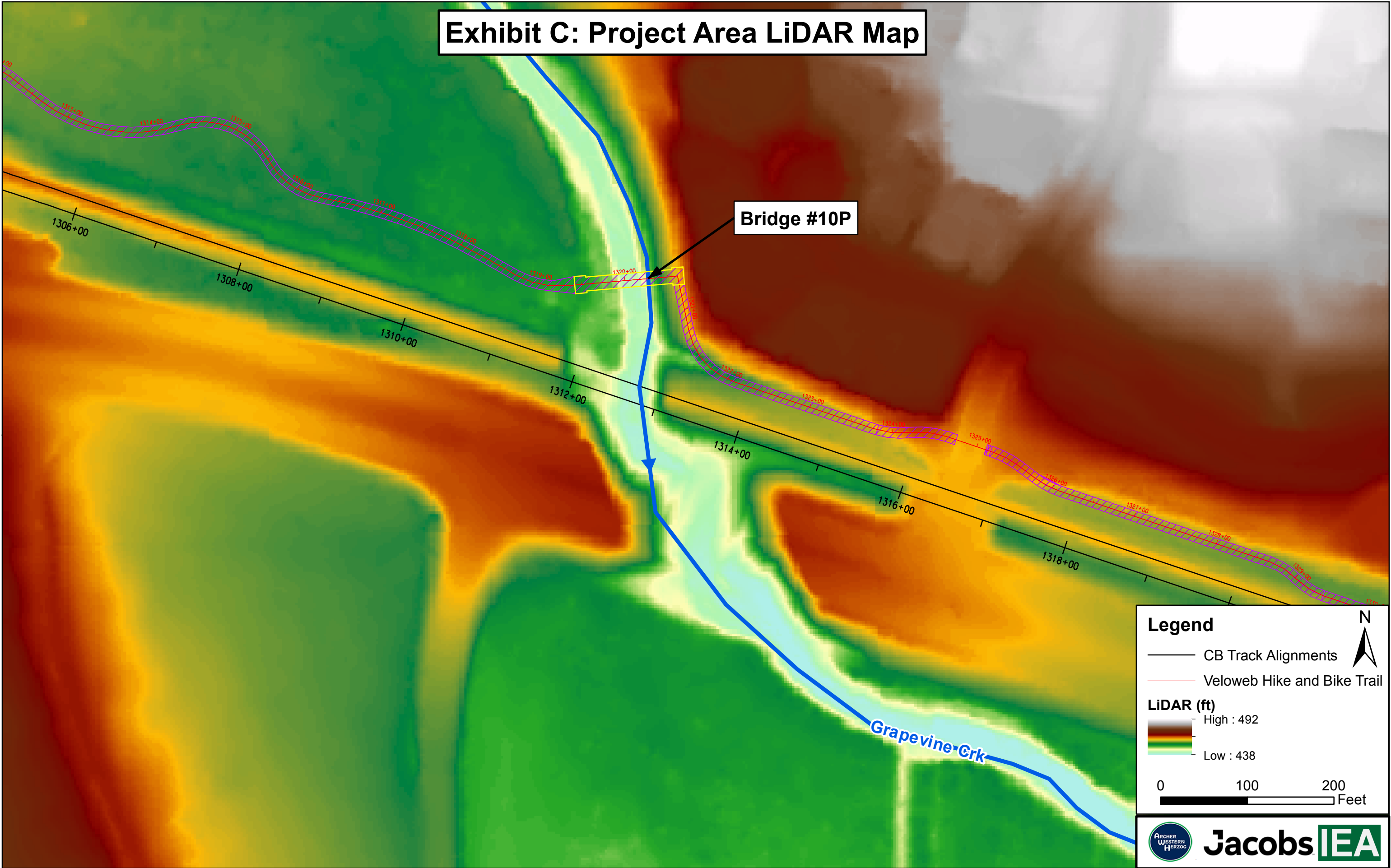


Exhibit D

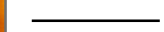
Drainage Area Map of Grapevine Creek

Exhibit D-1: Grapevine Creek Drainage Area (Bridge #10P)

Total Drainage Area ~9.65 sq.mile

Bridge #10P (Sta 1320+00)

Legend

-  Drainage Area
-  CB Track Alignments
-  Veloweb Hike and Bike Trail

DEM.tif

High : 669

Low : 418

0 2,500 5,000 Feet



Jacobs IEA

Appendix A

Federal Emergency Management Agency Data

**Appendix A-1: FEMA Letter of Map Revision, LOMR
(LOMR 15-06-0173P, Effective December 12, 2014)**



Federal Emergency Management Agency

Washington, D.C. 20472

LETTER OF MAP REVISION DETERMINATION DOCUMENT

COMMUNITY AND REVISION INFORMATION		PROJECT DESCRIPTION	BASIS OF REQUEST
COMMUNITY	City of Coppell Dallas County Texas	NO PROJECT	UPDATE
	COMMUNITY NO.: 480170		
IDENTIFIER	MacArthur Center(Re-issuance of LOMR: 13-06-1839P)	APPROXIMATE LATITUDE AND LONGITUDE: 32.953, -96.967 SOURCE: Precision Mapping Streets DATUM: NAD 83	
ANNOTATED MAPPING ENCLOSURES		ANNOTATED STUDY ENCLOSURES	
TYPE: FIRM* NO.: 48113C0155K DATE: July 7, 2014		DATE OF EFFECTIVE FLOOD INSURANCE STUDY: July 07, 2014 PROFILE(S): 188P AND 189P FLOODWAY DATA TABLE: 6	

Enclosures reflect changes to flooding sources affected by this revision.

* FIRM - Flood Insurance Rate Map;

FLOODING SOURCE AND REVISED REACH

Grapevine Creek - from approximately 350 feet upstream of MacArthur Boulevard to approximately 950 feet downstream of Moore Road

SUMMARY OF REVISIONS

This Letter of Map Revision (LOMR) is a partial re-issuance of the LOMR that became effective on July 7, 2014 (Case No. 13-06-1839P), which revised the Special Flood Hazard Areas (SFHA), the area subject to inundation by the base (1-percent-annual-chance) flood, floodway, BFEs* along Grapevine Creek. Please see attached annotated Floodway Data Table 6 and Flood Profiles 188P and 189P for Grapevine Creek shown in the Flood Insurance Study (FIS) Report dated July 7, 2014.* BFEs - Base Flood Elevations

* BFEs - Base Flood Elevations

DETERMINATION

This document provides the determination from the Department of Homeland Security's Federal Emergency Management Agency (FEMA) regarding a request for a Letter of Map Revision (LOMR) for the area described above. Using the information submitted, we have determined that a revision to the flood hazards depicted in the Flood Insurance Study (FIS) report and/or National Flood Insurance Program (NFIP) map is warranted. This document revises the effective NFIP map, as indicated in the attached documentation. Please use the enclosed annotated map panels revised by this LOMR for floodplain management purposes and for all flood insurance policies and renewals in your community.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Information eXchange toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 847 South Pickett Street, Alexandria, VA 22304-4605. Additional Information about the NFIP is available on our Web site at <http://www.fema.gov/business/nfip>.

Luis Rodriguez, P.E., Chief
Engineering Management Branch
Federal Insurance and Mitigation Administration

15-06-0173P

102-D

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET/SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					FEET (NAVD 88)			
Glenn Branch								
A	680 ¹	64	576	8.2	636.8	636.8	637.8	1.0
B	1,940 ¹	58	531	8.1	644.4	644.4	645.2	0.8
C	2,750 ¹	55	343	8.6	650.4	650.4	651.2	0.8
D	3,670 ¹	69	464	6.4	658.7	658.7	659.6	0.9
E	5,100 ¹	130	479	6.2	688.9	688.9	689.9	1.0
Grapevine Creek		REVISED DATA						
A	8,500 ²	300 ³	1,778	5.5	439.6	438.5 ⁴	438.5	0.0
B	12,920 ²	549	3,002	3.2	448.8	448.8	448.8	0.0
C	14,458 ²	550	3,028	3.6	454.4	454.4	455.1	0.7
D	16,575 ²	595	3,628	3.0	460.9	460.9	461.6	0.7
E	20,700 ²	370	3,071	6.2	471.5	471.5	472.3	0.8
F	22,700 ²	200	1,566	7.5	478.0	478.0	478.4	0.4
G	24,000 ²	349	2,498	4.7	482.5	482.5	482.9	0.4
H	26,851 ²	136	1,061	11.2	488.3	488.3	488.4	0.1
I	31,680 ²	239	2,982	3.5	508.2	508.2	508.5	0.3
J	45,970 ²	250	1,022	6.9	543.1	543.1	543.2	0.1
K	46,710 ²	220	1,777	4.0	545.1	545.1	545.7	0.6
Hackberry Creek								
A	3,585 ²	318	8,073	2.3	430.5	420.6 ⁴	420.6	0.0
B	5,659 ²	873	6,956	2.2	432.7	432.7	433.0	0.3
C	7,749 ²	945	7,273	2.1	433.8	433.8	434.1	0.3
D	9,919 ²	291	3,966	3.9	436.7	436.7	437.0	0.3
E	11,334 ²	239	3,551	4.9	437.0	437.0	437.3	0.3
F	12,641 ²	149	4,519	2.9	441.6	441.6	441.9	0.3
G	13,979 ²	381	3,323	3.9	445.0	445.0	445.8	0.8

REVISED BY
EFFECTIVE:
December 15, 2014

¹ Feet above confluence with Little Creek

³ Topwidth does not match mapping due to thickness of levee

² Feet above confluence with Elm Fork of Trinity River

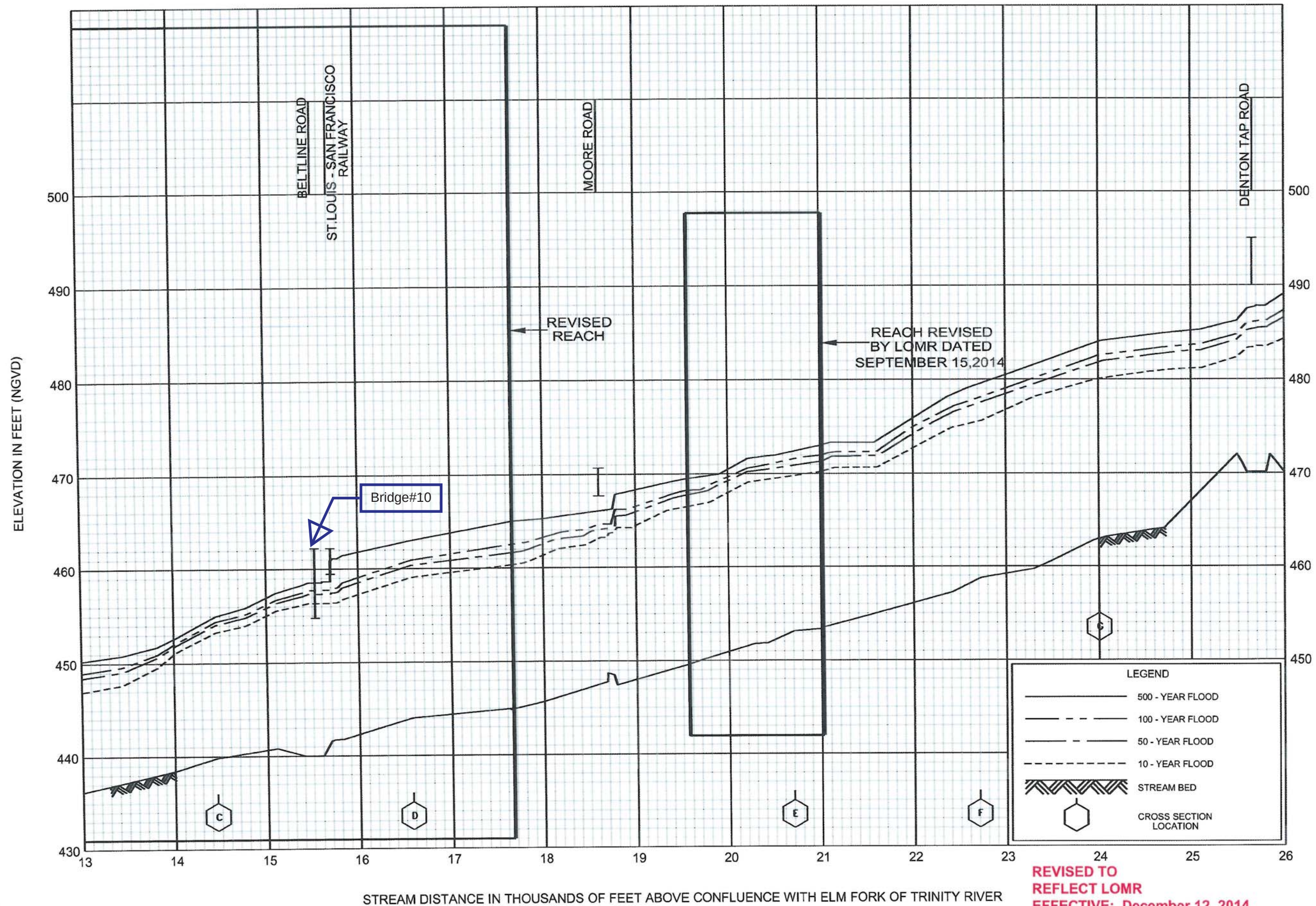
⁴ Water surface elevation computed without consideration of backwater effects

Table 6

FEDERAL EMERGENCY MANAGEMENT AGENCY
DALLAS COUNTY, TEXAS
AND INCORPORATED AREAS

REVISED TO
REFLECT LOMR
EFFECTIVE: December 12, 2014
GLENN BRANCH – GRAPEVINE CREEK – HACKBERRY CREEK

Appendix A-2: Grapevine Creek Channel Data in the Vicinity of Crossing #10P



REVISED TO
REFLECT LOMR
EFFECTIVE: December 12, 2014

Appendix A-3: Grapevine Creek Flows based on FEMA Flood Insurance Study (FIS)

FLOOD INSURANCE STUDY



DALLAS COUNTY, TEXAS AND INCORPORATED AREAS VOLUME 1 OF 9

Community Name

Community Number

DALLAS COUNTY
UNINCORPORATED AREAS

480165

ADDISON, TOWN OF

481089

BALCH SPRINGS, CITY OF

480166

CARROLLTON, CITY OF

480167

CEDAR HILL, CITY OF

480168

COCKRELL HILL, CITY OF

480169

COMBINE, CITY OF

480408

COPPELL, CITY OF

480170

DALLAS, CITY OF

480171

DESOTO, CITY OF

480172

DUNCANVILLE, CITY OF

480173

FARMERS BRANCH, CITY OF

480174

FERRIS, CITY OF

481076

GARLAND, CITY OF

485471

GLENN HEIGHTS, CITY OF

481265

GRAND PRAIRIE, CITY OF

485472

GRAPEVINE, CITY OF

480598

HIGHLAND PARK, TOWN OF

480178

HUTCHINS, CITY OF

480179

IRVING, CITY OF

480180

LANCASTER, CITY OF

480182

LEWISVILLE, CITY OF

480195

MESQUITE, CITY OF

485490

OVILLA, CITY OF

481155

RICHARDSON, CITY OF

480184

ROWLETT, CITY OF

480185

SACHSE, CITY OF

480186

SEAGOVILLE, CITY OF

480187

SUNNYVALE, TOWN OF

480188

UNIVERSITY PARK, CITY OF

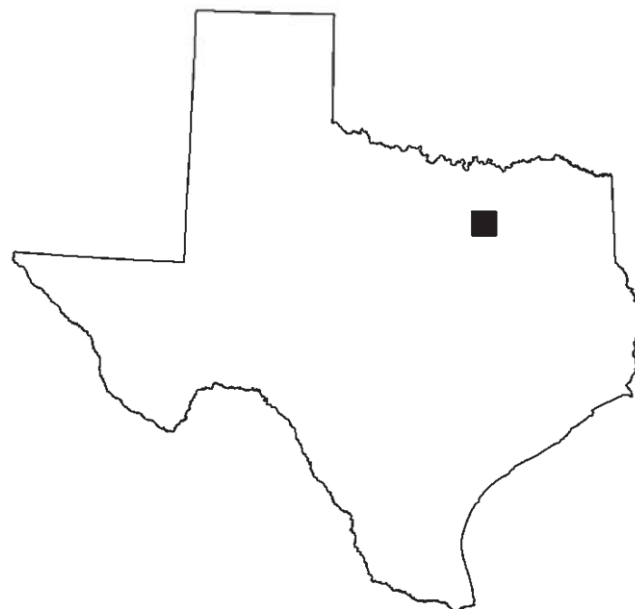
480189

WILMER, CITY OF

480190

WYLIE, CITY OF

480759



Revised March 21, 2019

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER

48113CV001E

Table 4 – Summary Of Discharges

<u>FLOODING SOURCE AND LOCATION</u>	<u>DRAINAGE AREA (sq. mile)</u>	<u>10% Annual Chance</u>	<u>PEAK DISCHARGES (cfs)</u>		
			<u>2% Annual Chance</u>	<u>1% Annual Chance</u>	<u>0.20% Annual Chance</u>
<u>Redelineation Detailed Study Streams</u>					
FARMERS BRANCH CREEK (CONTINUED)					
At confluence of Stream 6Hl	2.29	5,190	6,754	7,496	8,468
At Spring Valley Road	-- ¹⁵	1,370	1,770	1,950	2,480
850 feet above Spring Valley Road	-- ¹⁵	1,240	1,600	1,770	2,350
At Midway Road	0.40	1,154	1,509	1,676	1,799
1,795 feet above confluence of Stream 6Hl	-- ¹⁵	590	760	860	940
FIVEMILE CREEK					
Below confluence of Newton Creek ¹⁶	55.22	20,300	30,100	33,200	42,900
Above confluence of Newton Creek ¹⁶	44.14	10,150	15,400	16,900	21,000
Below confluence of Alta Mesa Branch	39.92	30,100	42,300	47,700	61,000
Above confluence of Alta Mesa Branch	38.79	24,700	38,200	44,600	61,000
Below confluence of Woody Branch	24.99	19,000	29,300	34,200	46,600
Above confluence of Woody Branch	14.42	11,200	17,300	20,200	27,600
Below confluence of Crow Creek	11.16	10,400	16,200	18,900	25,900
Above confluence of Crow Creek	8.54	9,400	12,900	14,500	18,300
Below confluence of Ledbetter Branch	4.57	6,500	8,800	9,900	12,400
Above confluence of Ledbetter Branch	2.61	3,400	4,700	5,200	6,600
At Ledbetter Road	1.07	1,930	2,630	2,925	3,670
FORNEY BRANCH					
At confluence with White Rock Creek	2.27	4,000	5,400	6,100	7,600
Below tributary just above Forney Road	1.62	3,200	4,350	4,900	6,100
Above tributary just above Forney Road	1.35	2,700	3,000	4,100	5,100
At Jim Miller Road	0.71	1,350	1,800	2,000	2,450
GLENN BRANCH					
At confluence with Little Creek	2.02	3,050	4,200	4,700	5,900
3,200 feet below Bear Creek Road	1.67	2,800	3,850	4,300	5,400
3,000 feet below Bear Creek Road	1.18	1,900	2,650	2,950	3,700
At Bear Creek Road	1.06	1,900	2,650	2,950	3,700
GRAPEVINE CREEK					
At Mouth	11.48	5,900	8,600	9,700	12,700
At intersection with extension of Cotton Road	5.95	7,300	10,000	11,200	14,200

¹⁵Data not Available

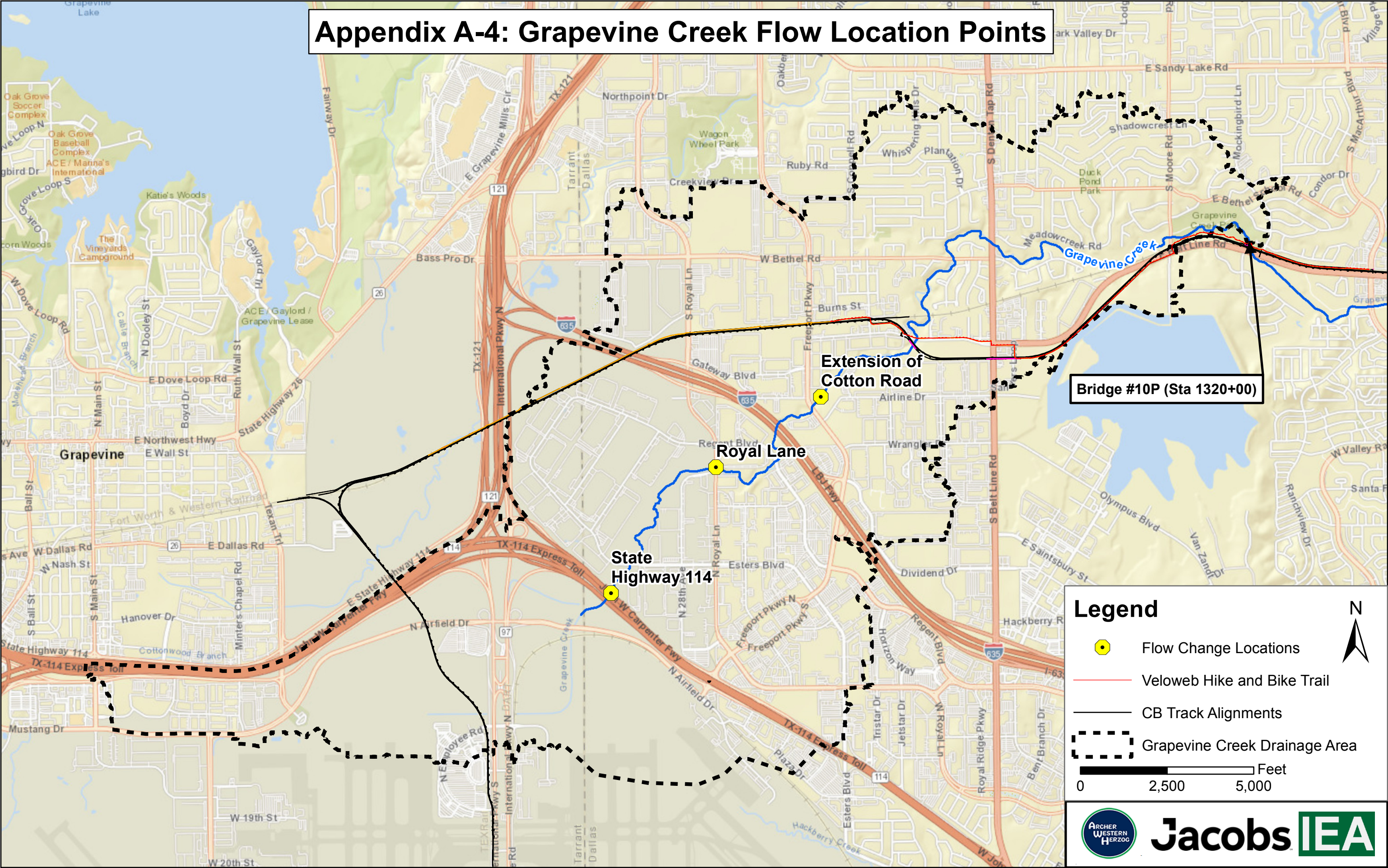
¹⁶Flow in main channel

Table 4 – Summary Of Discharges

<u>FLOODING SOURCE AND LOCATION</u>	<u>DRAINAGE AREA (sq. mile)</u>	<u>10% Annual Chance</u>	<u>PEAK DISCHARGES (cfs)</u>		
			<u>2% Annual Chance</u>	<u>1% Annual Chance</u>	<u>0.20% Annual Chance</u>
Redelineation Detailed Study Streams					
GRAPEVINE CREEK (CONTINUED)					
At Royal Lane	4.18	4,200	5,980	6,930	8,720
At State Highway 114	3.08	4,510	6,190	7,040	9,020
HACKBERRY CREEK					
At Mouth	21.22	13,300	18,900	21,400	27,700
Above confluence of Cottonwood Branch	15.13	9,400	13,400	15,200	19,600
Below confluence of South Fork of Hackberry Creek	13.66	11,000	15,400	17,300	22,100
Above confluence of South Fork of Hackberry Creek	10.44	8,200	13,200	14,900	18,900
Below confluence of Mud Springs Creek	5.45	8,000	11,000	12,300	15,500
Above confluence of Mud Springs Creek	1.76	3,050	4,150	4,600	5,800
HALL BRANCH					
At confluence with White Rock Creek	2.16	3,150	4,350	4,850	3,650
Above right bank tributary 400 feet below Weber Road	1.44	2,050	2,700	3,000	3,650
At upstream limit of study	0.39	850	1,100	1,250	1,500
HALLS BRANCH					
At confluence with Tenmile Creek	1.40	2,350	3,200	3,600	4,500
At West Main Street	0.86	1,850	2,450	2,700	3,350
HEATH CREEK					
At confluence with Tenmile Creek	3.95	5,600	7,700	8,600	10,800
Below confluence of Stream 3A15	3.46	5,700	7,900	8,800	11,000
Above confluence of Stream 3A15	2.46	3,950	5,400	6,000	7,600
Below confluence of Stream 3A21	1.96	3,450	4,750	5,300	6,600
HONEY SPRINGS BRANCH					
Below confluence of South Honey Springs Branch	1.64	2,850	3,900	4,400	5,500
Above confluence of South Honey Springs Branch	1.25	2,150	2,950	3,300	4,150
At Fordam Avenue	1.02	1,950	2,650	2,950	3,650
At Sunnyvale Street	0.54	1,250	1,650	1,850	2,250

Appendix A-4: Grapevine Creek Flow Location Points

Appendix A-4: Grapevine Creek Flow Location Points



Appendix B

**Bridge Crossing #10P HEC-RAS Models
(Submitted Electronically)**

Appendix C

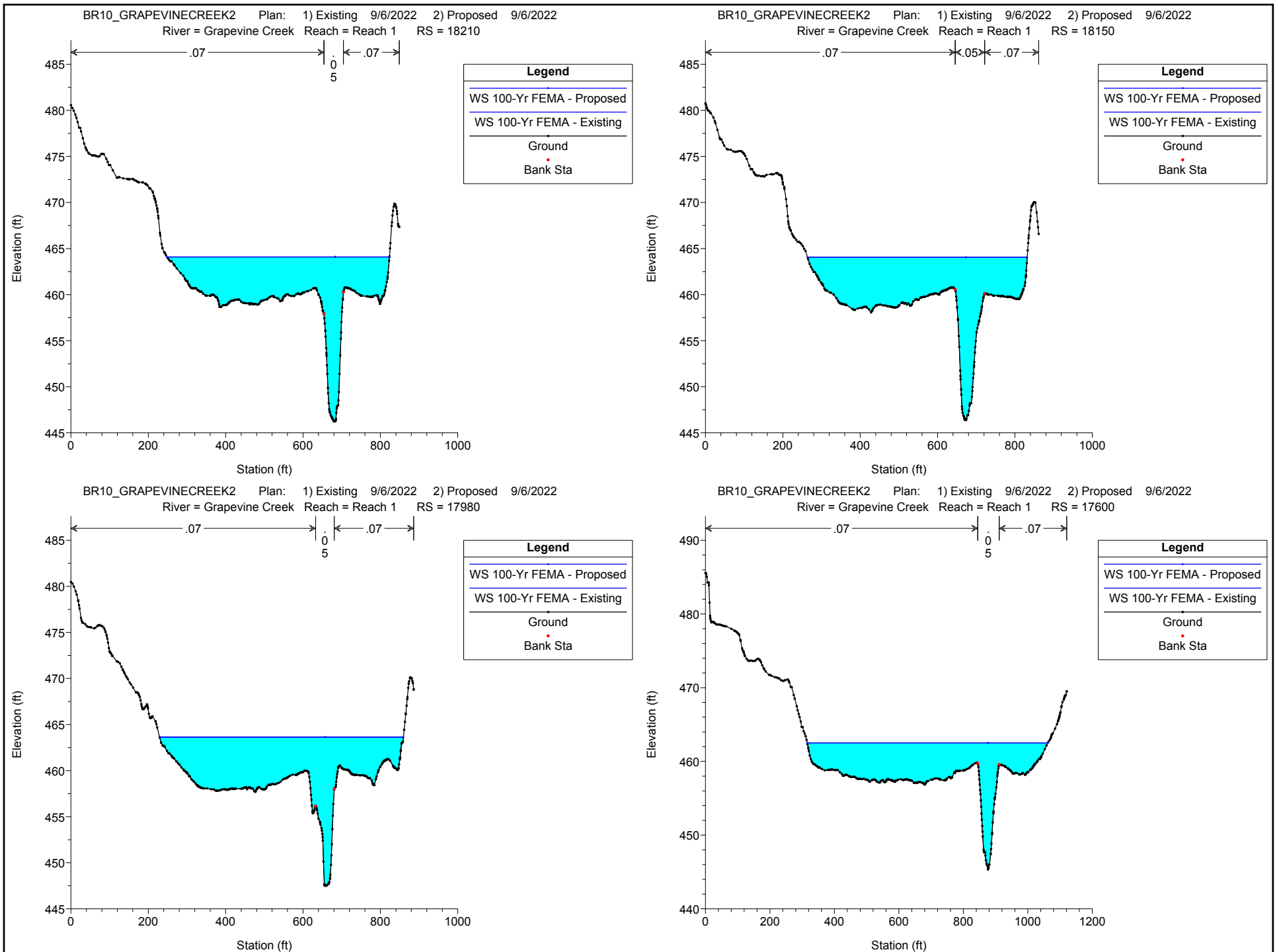
Comparisons of HEC-RAS Output Data, Existing vs. Proposed Conditions (100-Year Storm Event)

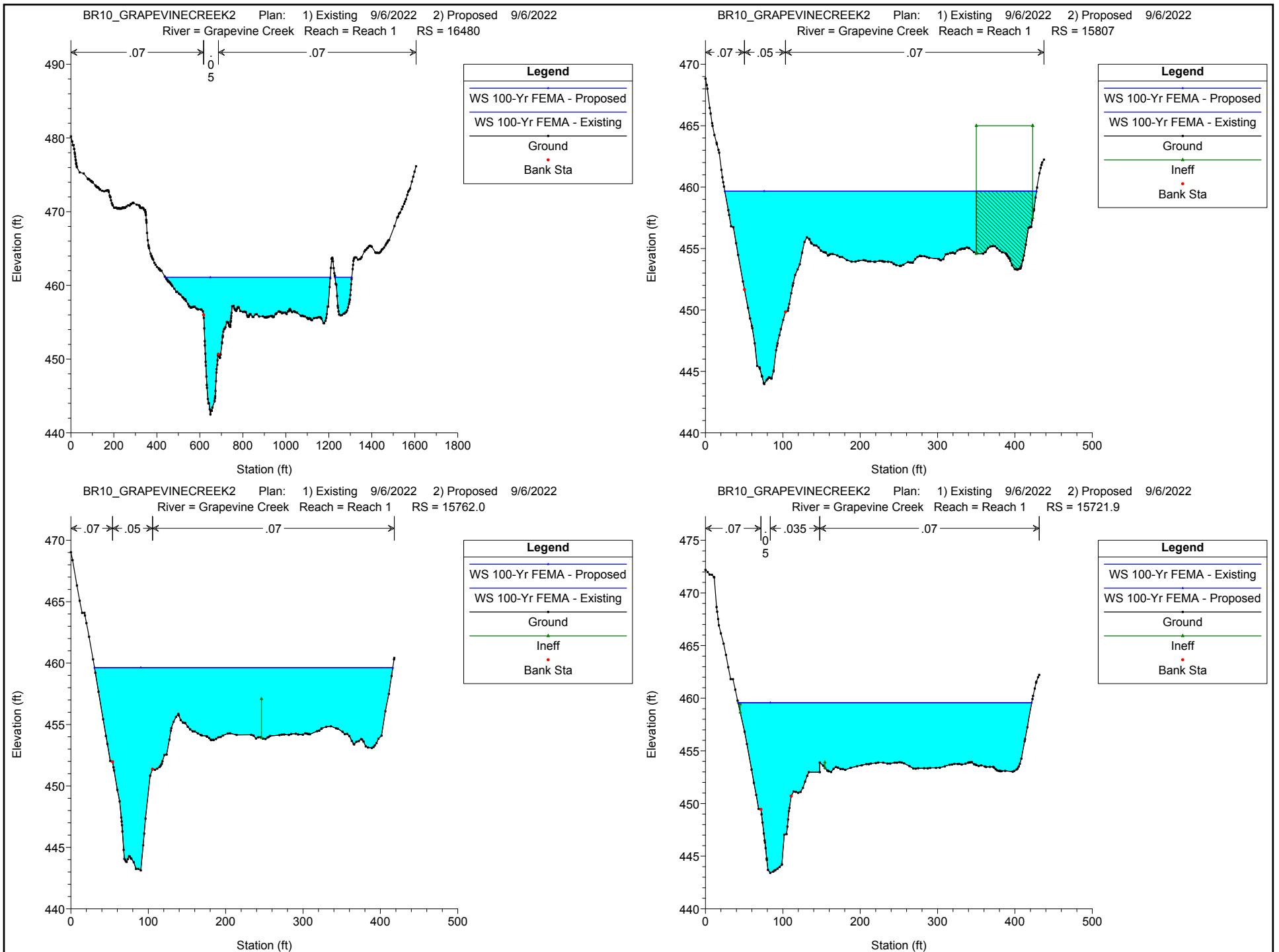
Appendix C-1: River Sections Output Data – Water Surface Elevation, Slope, Velocity and Flow Area

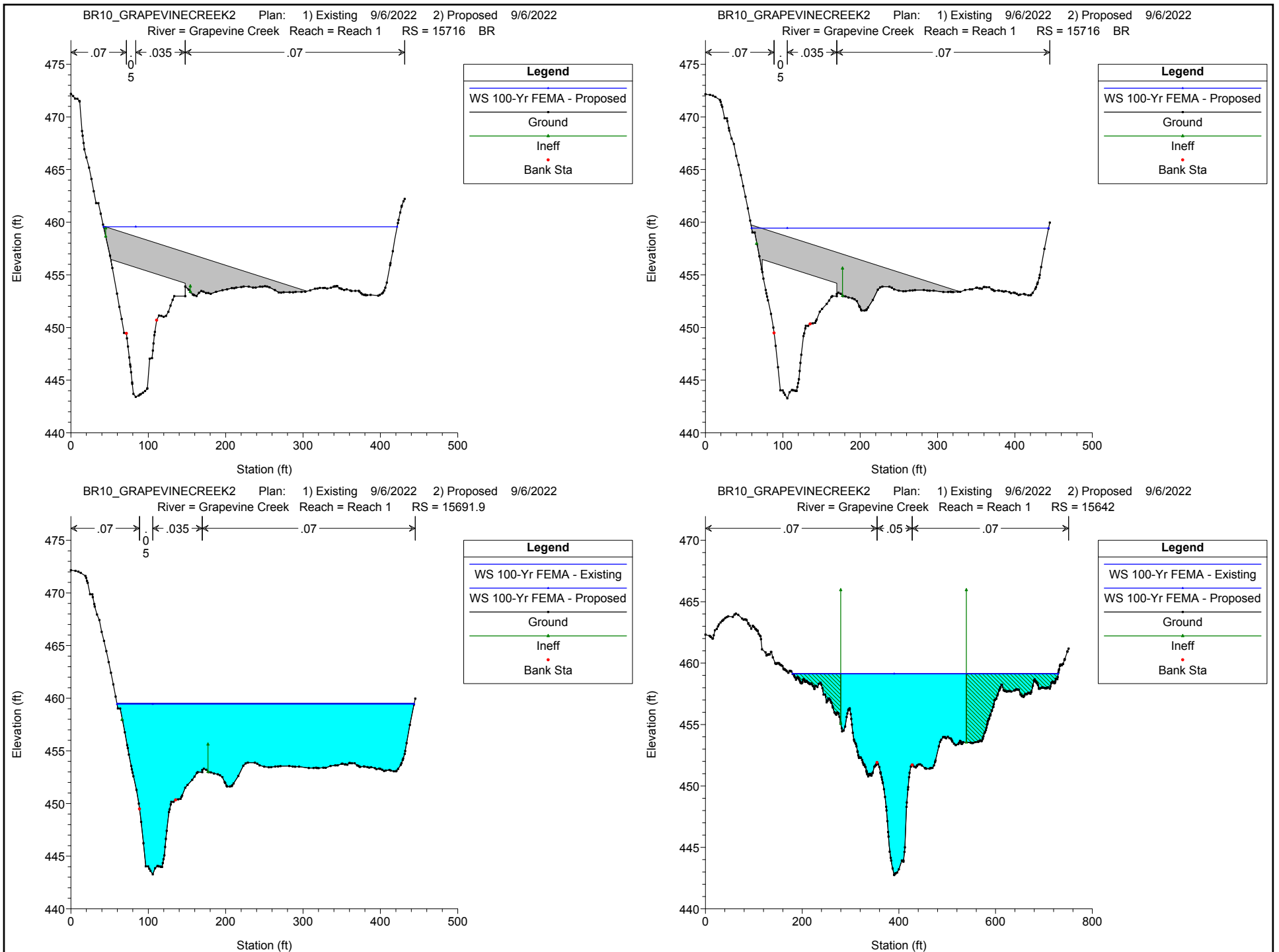
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	18210	10-Yr FEMA	Proposed	7500.00	446.24	462.61		463.18	0.002925	7.54	1928.21	542.18	0.38
Reach 1	18210	10-Yr FEMA	Existing	7500.00	446.24	462.60		463.17	0.002939	7.55	1924.27	542.03	0.38
Reach 1	18210	100-Yr FEMA	Proposed	11800.00	446.24	464.10		464.69	0.003080	8.36	2756.82	574.88	0.40
Reach 1	18210	100-Yr FEMA	Existing	11800.00	446.24	464.10		464.69	0.003080	8.36	2756.77	574.88	0.40
Reach 1	18150	10-Yr FEMA	Proposed	7500.00	446.38	462.59		462.96	0.002277	6.08	2162.35	551.32	0.34
Reach 1	18150	10-Yr FEMA	Existing	7500.00	446.38	462.58		462.96	0.002287	6.09	2158.38	551.22	0.34
Reach 1	18150	100-Yr FEMA	Proposed	11800.00	446.38	464.04		464.47	0.002446	6.92	2975.79	567.77	0.36
Reach 1	18150	100-Yr FEMA	Existing	11800.00	446.38	464.04		464.47	0.002446	6.92	2975.74	567.77	0.36
Reach 1	17980	10-Yr FEMA	Proposed	7500.00	447.49	462.15		462.54	0.002843	6.92	2182.28	604.73	0.38
Reach 1	17980	10-Yr FEMA	Existing	7500.00	447.49	462.14		462.53	0.002866	6.94	2175.24	604.54	0.38
Reach 1	17980	100-Yr FEMA	Proposed	11800.00	447.49	463.63		464.03	0.002756	7.44	3101.37	630.18	0.38
Reach 1	17980	100-Yr FEMA	Existing	11800.00	447.49	463.63		464.03	0.002757	7.44	3101.28	630.18	0.38
Reach 1	17600	10-Yr FEMA	Proposed	7500.00	445.34	460.82		461.18	0.002912	6.42	2282.44	720.27	0.38
Reach 1	17600	10-Yr FEMA	Existing	7500.00	445.34	460.77		461.15	0.003033	6.53	2246.15	719.41	0.39
Reach 1	17600	100-Yr FEMA	Proposed	11800.00	445.34	462.52		462.82	0.002220	6.30	3528.45	746.55	0.34
Reach 1	17600	100-Yr FEMA	Existing	11800.00	445.34	462.52		462.82	0.002220	6.30	3528.18	746.55	0.34
Reach 1	16480	10-Yr FEMA	Proposed	6900.00	442.50	459.19		459.39	0.000870	4.57	3022.18	777.92	0.23
Reach 1	16480	10-Yr FEMA	Existing	6900.00	442.50	458.89		459.13	0.001034	4.90	2795.11	762.13	0.24
Reach 1	16480	100-Yr FEMA	Proposed	11000.00	442.50	461.09		461.28	0.000814	4.85	4565.62	845.29	0.22
Reach 1	16480	100-Yr FEMA	Existing	11000.00	442.50	461.09		461.28	0.000815	4.85	4564.84	845.26	0.22
Reach 1	15807	10-Yr FEMA	Proposed	6900.00	443.97	457.91	455.79	458.49	0.002684	7.41	1567.23	393.81	0.39
Reach 1	15807	10-Yr FEMA	Existing	6900.00	443.97	456.99	455.79	457.92	0.004457	9.01	1273.75	388.97	0.50
Reach 1	15807	100-Yr FEMA	Proposed	11000.00	443.97	459.66	457.37	460.37	0.003007	8.66	2136.51	402.94	0.43
Reach 1	15807	100-Yr FEMA	Existing	11000.00	443.97	459.66	457.37	460.37	0.003009	8.66	2135.91	402.93	0.43
Reach 1	15762.0	10-Yr FEMA	Proposed	6900.00	443.13	456.58	455.58	458.04	0.006596	10.67	930.82	369.35	0.59
Reach 1	15762.0	10-Yr FEMA	Existing	6900.00	443.13	456.88		457.65	0.003957	8.43	1434.25	371.10	0.46
Reach 1	15762.0	100-Yr FEMA	Proposed	11000.00	443.13	459.63	457.11	460.16	0.002437	7.73	2474.62	385.55	0.38
Reach 1	15762.0	100-Yr FEMA	Existing	11000.00	443.13	459.63		460.16	0.002439	7.73	2473.91	385.54	0.38
Reach 1	15721.9	10-Yr FEMA	Proposed	6900.00	443.42	456.84	455.50	457.49	0.002337	8.43	1575.30	364.45	0.44
Reach 1	15721.9	10-Yr FEMA	Existing	6900.00	443.42	456.80		457.43	0.003596	8.37	1558.59	364.21	0.44
Reach 1	15721.9	100-Yr FEMA	Proposed	11000.00	443.42	459.57	456.70	460.06	0.001601	8.07	2589.14	379.52	0.38
Reach 1	15721.9	100-Yr FEMA	Existing	11000.00	443.42	459.57		460.03	0.002272	7.71	2590.51	379.53	0.36
Reach 1	15716			Bridge									
Reach 1	15691.9	10-Yr FEMA	Proposed	6900.00	443.28	456.64	454.86	457.23	0.002192	7.85	1601.70	366.00	0.42
Reach 1	15691.9	10-Yr FEMA	Existing	6900.00	443.28	456.71		457.27	0.003105	7.68	1623.85	366.31	0.41
Reach 1	15691.9	100-Yr FEMA	Proposed	11000.00	443.28	459.44	456.31	459.90	0.001479	7.53	2646.88	383.88	0.36
Reach 1	15691.9	100-Yr FEMA	Existing	11000.00	443.28	459.50		459.93	0.002016	7.23	2671.35	384.25	0.35
Reach 1	15642	10-Yr FEMA	Proposed	6900.00	442.75	456.48	454.09	457.10	0.003098	7.21	1375.03	332.47	0.41
Reach 1	15642	10-Yr FEMA	Existing	6900.00	442.75	456.48	454.09	457.10	0.003098	7.21	1375.03	332.47	0.41
Reach 1	15642	100-Yr FEMA	Proposed	11000.00	442.75	459.13	455.60	459.76	0.002502	7.62	2063.68	549.19	0.38
Reach 1	15642	100-Yr FEMA	Existing	11000.00	442.75	459.13	455.60	459.76	0.002502	7.62	2063.68	549.19	0.38
Reach 1	15620	10-Yr FEMA	Proposed	6900.00	442.48	454.66	454.33	456.83	0.014327	12.48	651.32	152.67	0.83
Reach 1	15620	10-Yr FEMA	Existing	6900.00	442.48	454.66	454.33	456.83	0.014327	12.48	651.32	152.67	0.83
Reach 1	15620	100-Yr FEMA	Proposed	11000.00	442.48	458.02	456.81	459.59	0.009010	11.03	1212.48	308.44	0.68
Reach 1	15620	100-Yr FEMA	Existing	11000.00	442.48	458.02	456.81	459.59	0.009010	11.03	1212.48	308.44	0.68
Reach 1	15610	10-Yr FEMA	Proposed	6900.00	442.16	455.11	453.27	456.48	0.007378	10.17	810.53	118.19	0.61
Reach 1	15610	10-Yr FEMA	Existing	6900.00	442.16	455.11	453.27	456.48	0.007378	10.17	810.53	118.19	0.61
Reach 1	15610	100-Yr FEMA	Proposed	11000.00	442.16	457.80	455.27	459.49	0.007344	11.43	1143.89	130.49	0.63
Reach 1	15610	100-Yr FEMA	Existing	11000.00	442.16	457.80	455.27	459.49	0.007344	11.43	1143.89	130.49	0.63
Reach 1	15605 Bridge # 10			Bridge									
Reach 1	15565	10-Yr FEMA	Proposed	6900.00	441.40	454.95	452.65	456.47	0.005875	10.72	821.65	232.81	0.57
Reach 1	15565	10-Yr FEMA	Existing	6900.00	441.40	454.95	452.65	456.47	0.005875	10.72	821.65	232.81	0.57
Reach 1	15565	100-Yr FEMA	Proposed	11000.00	441.40	455.67	455.26	458.82	0.011442	15.61	906.84	299.76	0.80
Reach 1	15565	100-Yr FEMA	Existing	11000.00	441.40	455.67	455.26	458.82	0.011442	15.61	906.84	299.76	0.80
Reach 1	15310	10-Yr FEMA	Proposed	6900.00	440.00	455.47	446.74	455.82	0.000515	4.73	1457.91	127.00	0.25
Reach 1	15310	10-Yr FEMA	Existing	6900.00	440.00	455.47	446.74	455.82	0.000515	4.73	1457.91	127.00	0.25
Reach 1	15310	100-Yr FEMA	Proposed	11000.00	440.00	456.76	448.96	457.47	0.000967	6.77	1625.03	132.45	0.34
Reach 1	15310	100-Yr FEMA	Existing	11000.00	440.00	456.76	448.96	457.47	0.000967	6.77	1625.03	132.45	0.34
Reach 1	15235			Bridge									
Reach 1	15160	10-Yr FEMA	Proposed	6900.00	440.00	455.44	446.74	455.79	0.000519	4.75	1454.16	126.87	0.25
Reach 1	15160	10-Yr FEMA	Existing	6900.00	440.00	455.44	446.74	455.79	0.000519	4.75	1454.16	126.87	0.25
Reach 1	15160	100-Yr FEMA	Proposed	11000.00	440.00	456.68	448.96	457.40	0.000985	6.81	1614.24	132.11	0.34
Reach 1	15160	100-Yr FEMA	Existing	11000.00	440.00	456.68	448.96	457.40	0.000985	6.81	1614.24	132.11	0.34
Reach 1	15113	10-Yr FEMA	Proposed	6900.00	440.28	455.45	449.00	455.69	0.001130	3.96	1742.21	331.22	0.25
Reach 1	15113	10-Yr FEMA	Existing	6900.00	440.28	455.45	449.00	455.69	0.001130	3.96	1742.21	331.22	0.25
Reach 1	15113	100-Yr FEMA	Proposed	11000.00	440.28	456.74	450.88	457.19	0.001744	5.39	2132.38	508.74	0.31
Reach 1	15113	100-Yr FEMA	Existing	11000.00	440.28	456.74	450.88	457.19	0.001744	5.39	2132.38	508.74	0.31
Reach 1	14820	10-Yr FEMA	Proposed	6900.00	439.01	454.68	452.84	454.99	0.004301	5.64	2050.80	758.00	0.35
Reach 1	14820	10-Yr FEMA	Existing	6900.00	439.01	454.68	452.84	454.99	0.004301	5.64	2050.80	758.00	0.35
Reach 1	14820	100-Yr FEMA	Proposed	11000.00	439.01	455.88	454.41	456.17	0.004230	5.83	2998.58	815.59	0.35
Reach 1	14820	100-Yr FEMA	Existing	11000.00	439.01	455.88	454.41	456.17	0.004230	5.83	2998.58	815.59	0.35
Reach 1	14495	10-Yr FEMA	Proposed	6900.00	438.39	453.46		453.88	0.002878	6.57	1750.61	602.72	0.38
Reach 1	14495	10-Yr FEMA	Existing	6900.00	438.39	453.46		453.88	0.002878	6.57	1750.61	602.72	0.38
Reach 1	14495	100-Yr FEMA	Proposed	11000.00	438.39	454.49		454.98	0.003283	7.53	2384.59	627.15	0.42

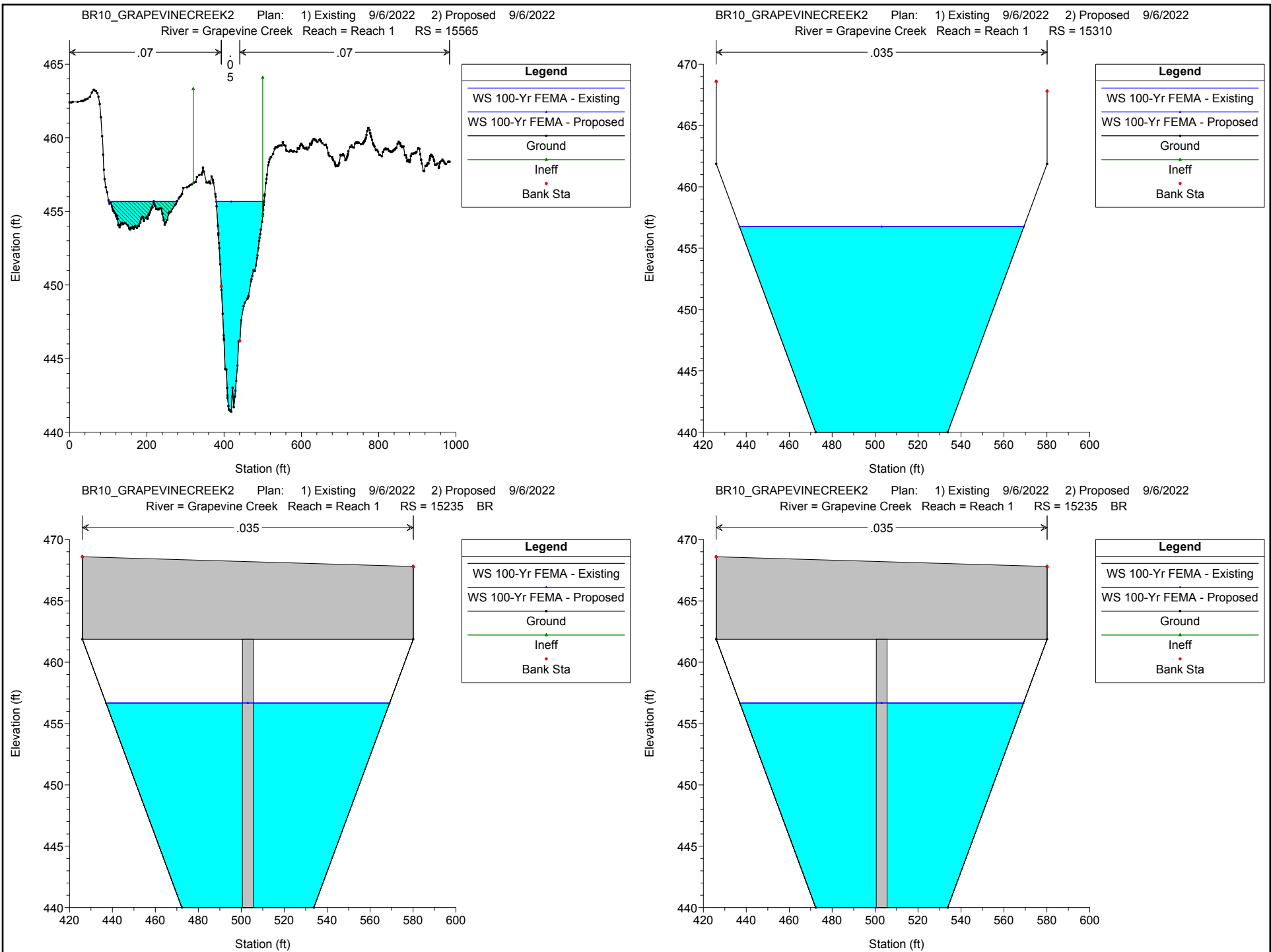
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	14495	100-Yr FEMA	Existing	11000.00	438.39	454.49		454.98	0.003283	7.53	2384.59	627.15	0.42
Reach 1	14170	10-Yr FEMA	Proposed	6900.00	439.07	452.05		452.64	0.006299	7.86	1532.87	637.87	0.50
Reach 1	14170	10-Yr FEMA	Existing	6900.00	439.07	452.05		452.64	0.006299	7.86	1532.87	637.87	0.50
Reach 1	14170	100-Yr FEMA	Proposed	11000.00	439.07	453.21		453.75	0.005584	8.09	2289.39	671.18	0.48
Reach 1	14170	100-Yr FEMA	Existing	11000.00	439.07	453.21		453.75	0.005584	8.09	2289.39	671.18	0.48
Reach 1	13829	10-Yr FEMA	Proposed	6900.00	435.72	450.14		450.51	0.003876	6.38	1831.69	740.71	0.39
Reach 1	13829	10-Yr FEMA	Existing	6900.00	435.72	450.14		450.51	0.003876	6.38	1831.69	740.71	0.39
Reach 1	13829	100-Yr FEMA	Proposed	11000.00	435.72	451.21		451.63	0.004361	7.28	2734.44	905.91	0.42
Reach 1	13829	100-Yr FEMA	Existing	11000.00	435.72	451.21		451.63	0.004361	7.28	2734.44	905.91	0.42
Reach 1	13620	10-Yr FEMA	Proposed	6900.00	435.14	448.96	448.36	449.51	0.005990	7.41	1548.73	848.57	0.48
Reach 1	13620	10-Yr FEMA	Existing	6900.00	435.14	448.96	448.36	449.51	0.005990	7.41	1548.73	848.57	0.48
Reach 1	13620	100-Yr FEMA	Proposed	11000.00	435.14	450.29	449.27	450.71	0.004576	7.24	2808.76	1136.89	0.44
Reach 1	13620	100-Yr FEMA	Existing	11000.00	435.14	450.29	449.27	450.71	0.004576	7.24	2808.76	1136.89	0.44
Reach 1	13339	10-Yr FEMA	Proposed	5900.00	435.64	447.29	445.26	447.57	0.004061	5.19	1516.49	725.25	0.36
Reach 1	13339	10-Yr FEMA	Existing	5900.00	435.64	447.29	445.26	447.57	0.004061	5.19	1516.49	725.25	0.36
Reach 1	13339	100-Yr FEMA	Proposed	9700.00	435.64	449.30	446.37	449.46	0.002146	4.41	3376.03	1660.86	0.27
Reach 1	13339	100-Yr FEMA	Existing	9700.00	435.64	449.30	446.37	449.46	0.002146	4.41	3376.03	1660.86	0.27
Reach 1	12820	10-Yr FEMA	Proposed	5900.00	436.23	446.54	442.82	446.66	0.001063	3.22	2240.29	673.89	0.21
Reach 1	12820	10-Yr FEMA	Existing	5900.00	436.23	446.54	442.82	446.66	0.001063	3.22	2240.29	673.89	0.21
Reach 1	12820	100-Yr FEMA	Proposed	9700.00	436.23	448.65	443.73	448.79	0.000991	3.66	3279.29	782.23	0.21
Reach 1	12820	100-Yr FEMA	Existing	9700.00	436.23	448.65	443.73	448.79	0.000991	3.66	3279.29	782.23	0.21
Reach 1	12402	10-Yr FEMA	Proposed	5900.00	435.52	446.32	441.78	446.40	0.000744	2.57	2637.21	567.51	0.17
Reach 1	12402	10-Yr FEMA	Existing	5900.00	435.52	446.32	441.78	446.40	0.000744	2.57	2637.21	567.51	0.17
Reach 1	12402	100-Yr FEMA	Proposed	9700.00	435.52	448.46	442.75	448.56	0.000686	2.82	3888.12	654.60	0.17
Reach 1	12402	100-Yr FEMA	Existing	9700.00	435.52	448.46	442.75	448.56	0.000686	2.82	3888.12	654.60	0.17
Reach 1	11588	10-Yr FEMA	Proposed	5900.00	433.63	445.77	440.68	445.96	0.000713	3.84	1899.68	375.49	0.22
Reach 1	11588	10-Yr FEMA	Existing	5900.00	433.63	445.77	440.68	445.96	0.000713	3.84	1899.68	375.49	0.22
Reach 1	11588	100-Yr FEMA	Proposed	9700.00	433.63	447.85	442.05	448.11	0.000789	4.57	2709.65	400.66	0.24
Reach 1	11588	100-Yr FEMA	Existing	9700.00	433.63	447.85	442.05	448.11	0.000789	4.57	2709.65	400.66	0.24

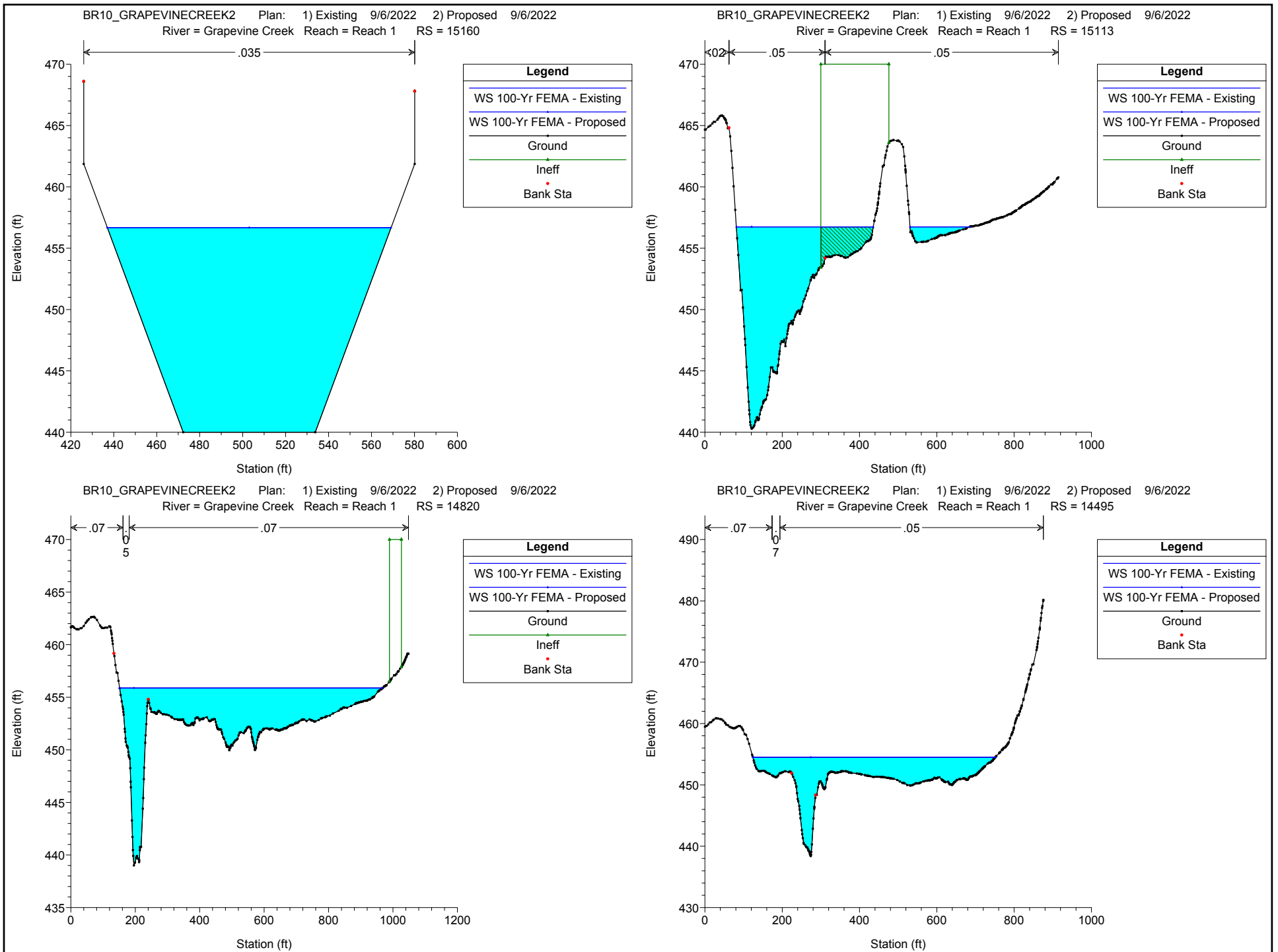
Appendix C-2: HEC-RAS Cross-Sections with Water Surface Elevations

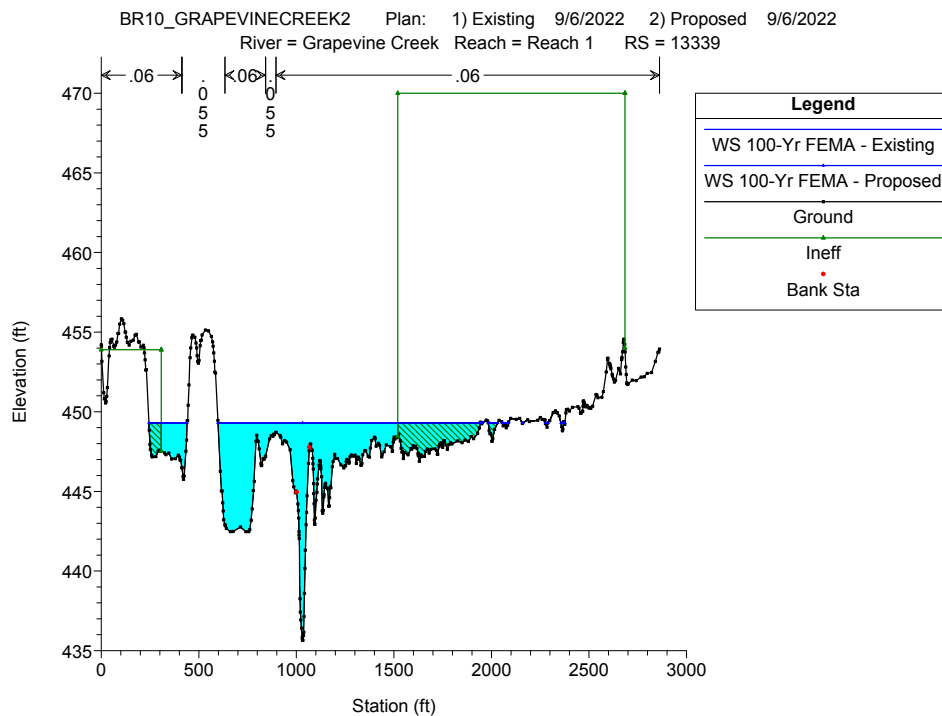
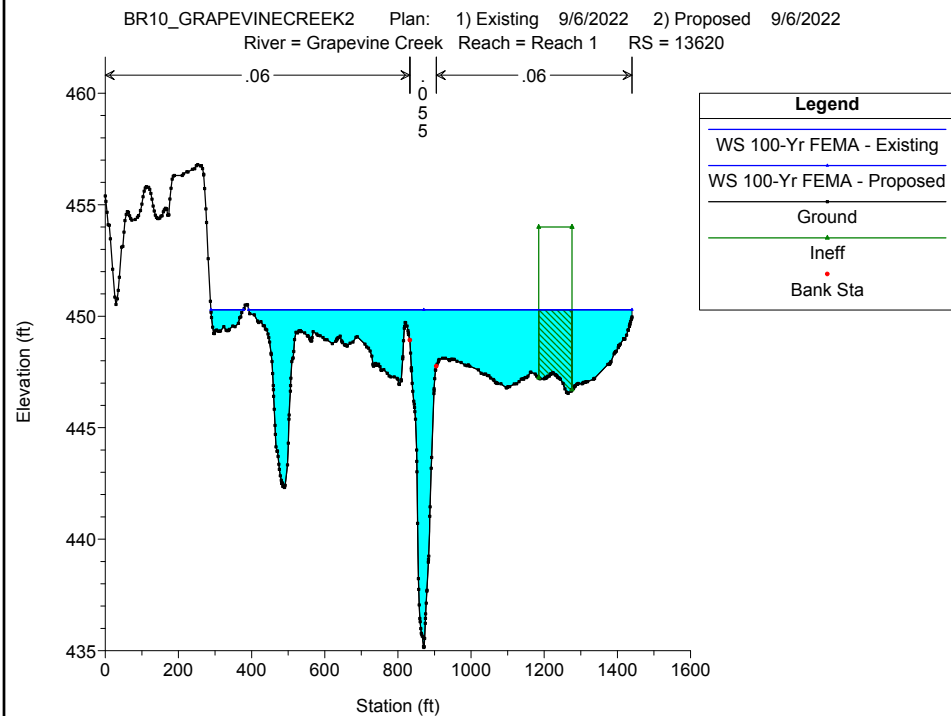
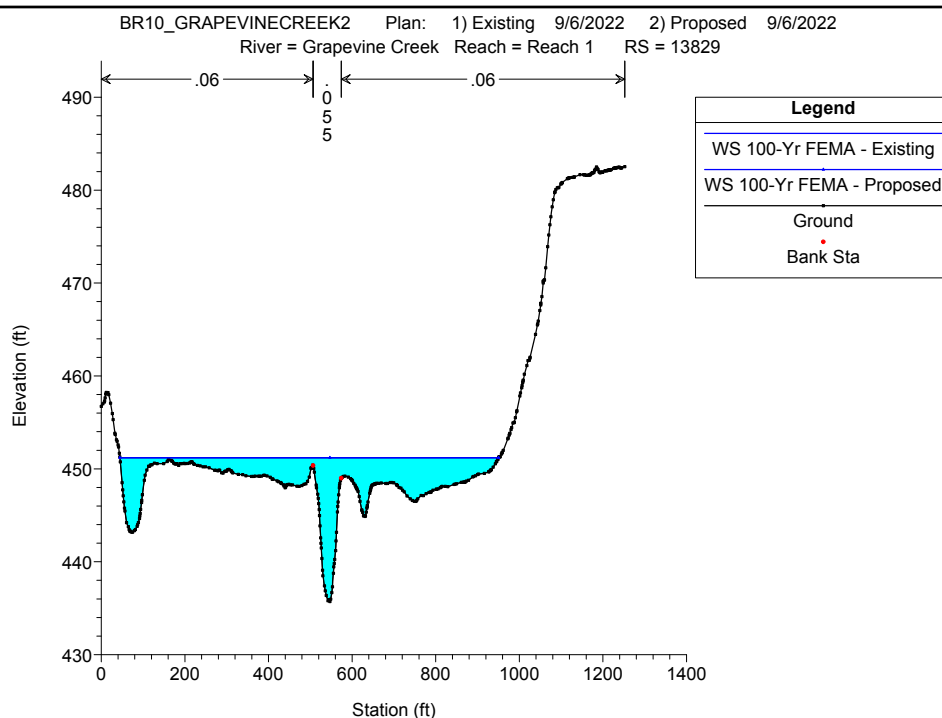
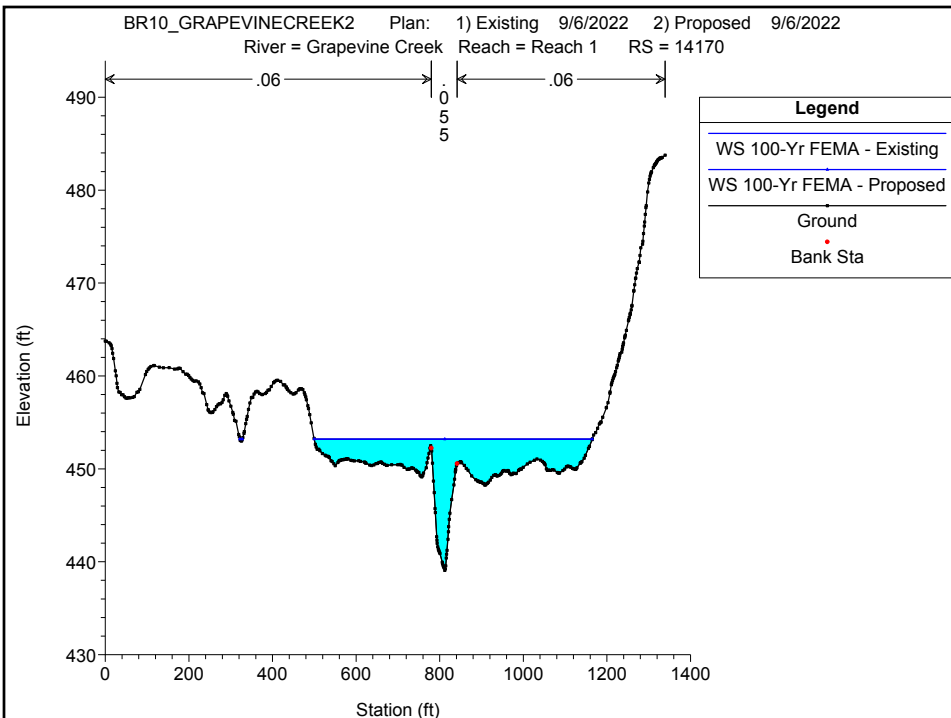


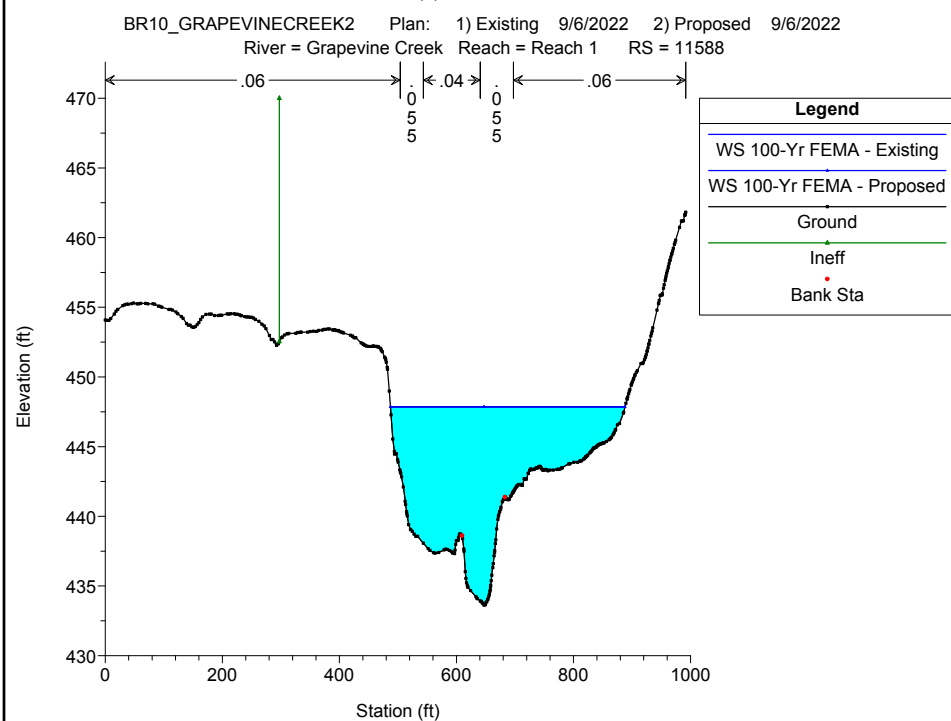
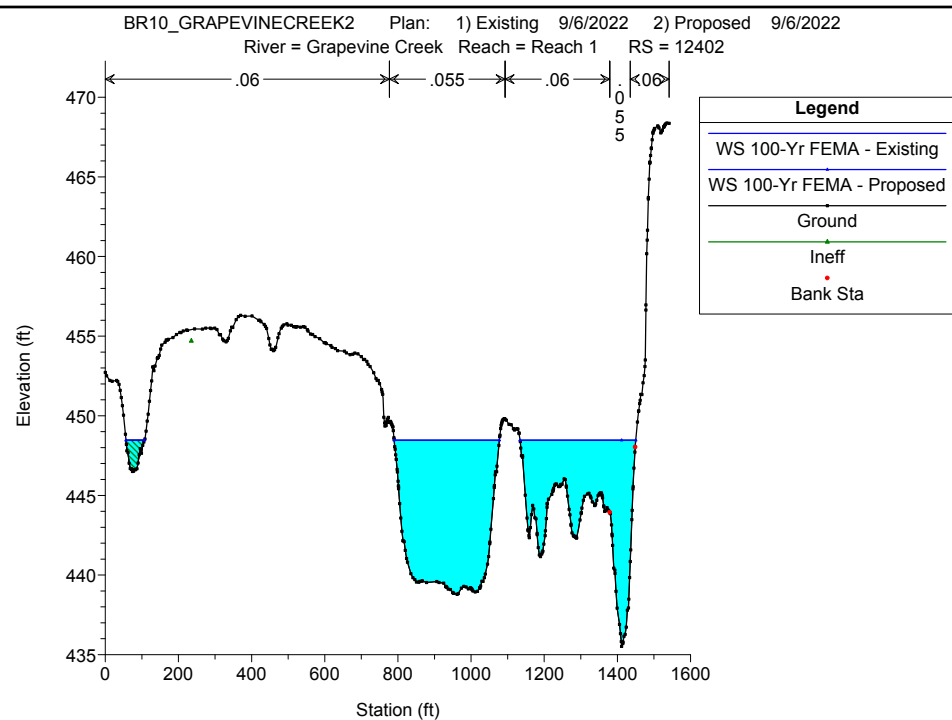
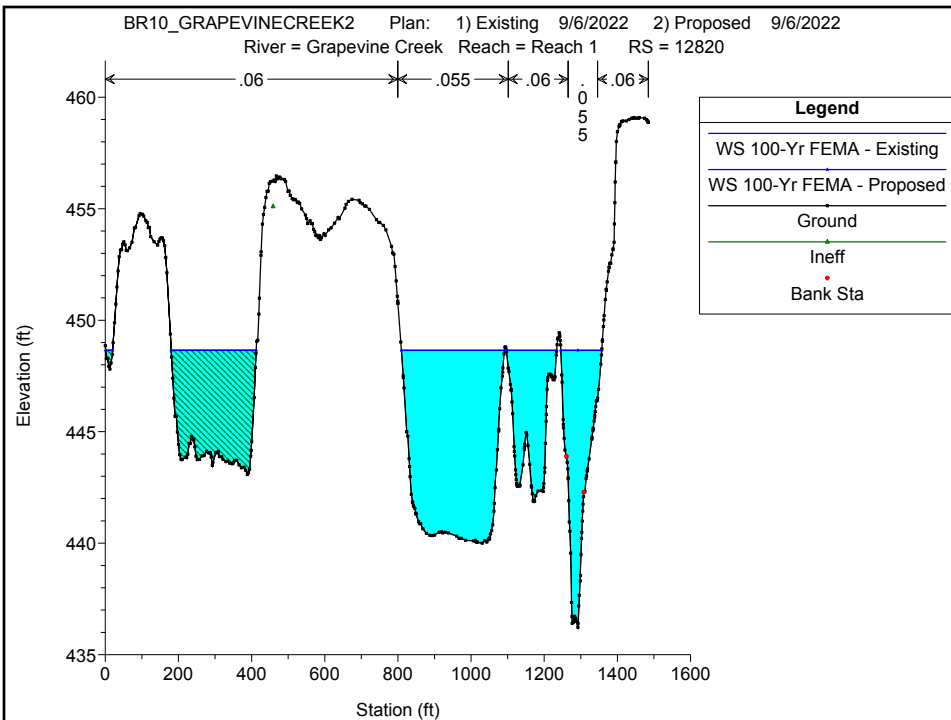










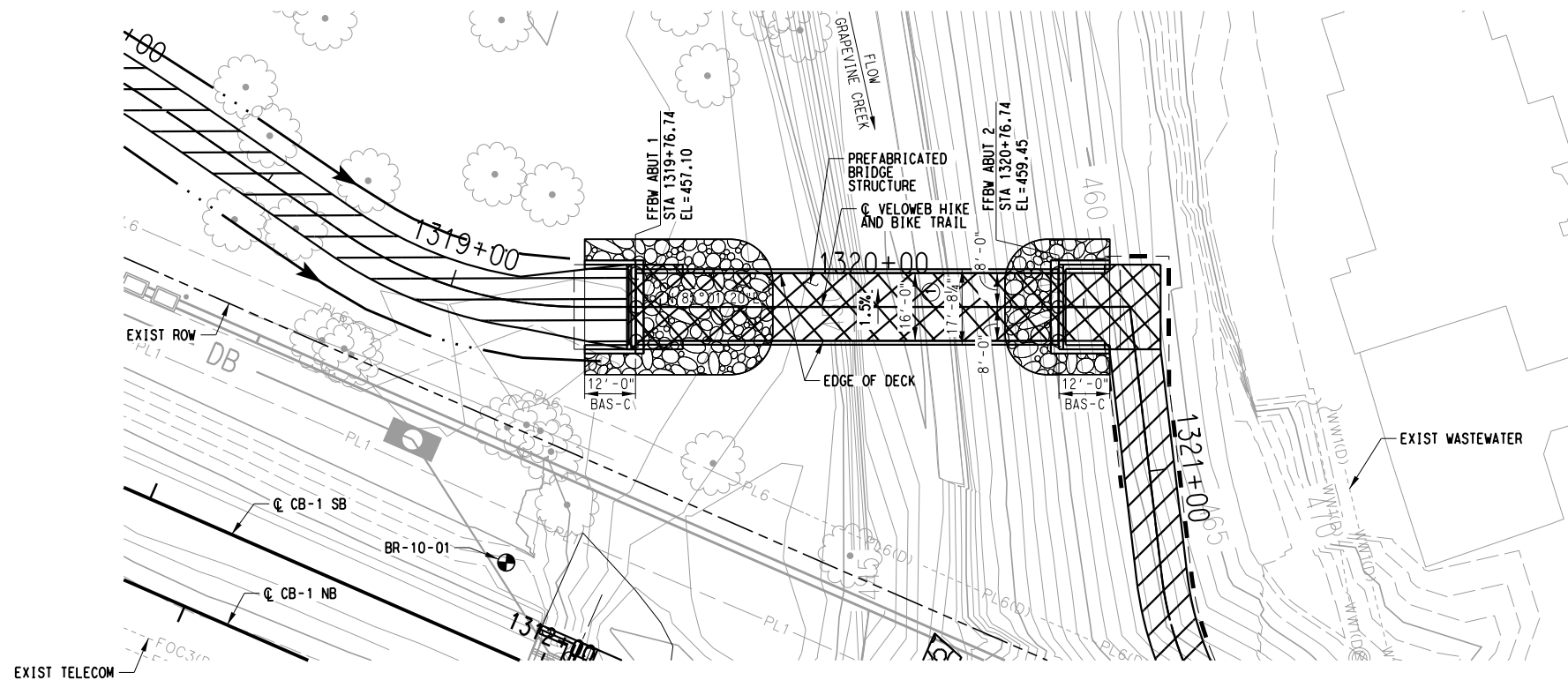


Appendix D

Bridge #10P Layout Sheet

**Trail Cross-Sections for Valley
Storage Calculations**

Appendix D-1: Bridge #10P Design Sheets

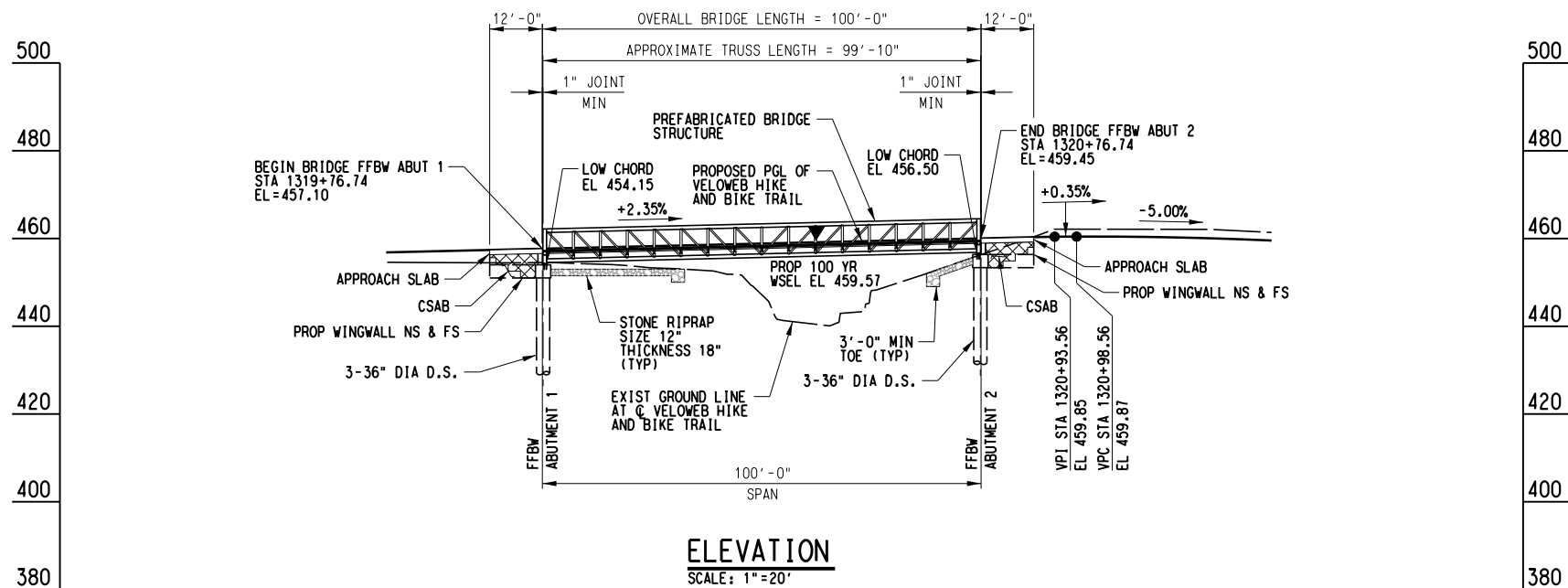
SCALE (IN FEET)
0 10 20 40ALL ABUTMENTS AND PIERS ARE ALONG
BEARING: N4°58'40"W

PLAN

SCALE: 1"=20'

① TOTAL BRIDGE WIDTH IS SUBJECT TO CHANGE.
REFER TO THE PREFABRICATED BRIDGE PLANS
BY OTHERS FOR FINAL BRIDGE DETAILS.

HYDRAULIC DATA		
100-Yr FLOW (CFS)	WATER SURFACE ELEV.	VELOCITY (FPS)
11,000	459.57	8.07



ELEVATION

SCALE: 1"=20'

NOTES:

- DESIGNED IN ACCORDANCE WITH AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS 8TH EDITION, 2017.
- SPAN LENGTH STATIONING AND VERTICAL PROFILE ARE SHOWN ALONG THE CENTERLINE OF THE TRAIL. TOP OF DECK IS THE CONTROL AND PROFILE GRADE LINE.
- FOR PEDESTRIAN TRAIL PLAN AND PROFILE, SEE VELOWEB HIKE AND BIKE PLAN AND PROFILE SHEETS.
- FOR OTHER TRAIL DETAILS INCLUDING STRIPING AND FENCE, SEE CIVIL PLANS.
- FOR UTILITY LOCATIONS AND RELOCATION SEE UTILITY DRAWINGS.
- FOR DRAINAGE ELEMENTS, SEE DRAINAGE PLANS.
- FOR EXACT LOCATIONS OF BORING LOGS AND SOIL PARAMETERS, SEE GEOTECHNICAL REPORT.
- DESIGN PEDESTRIAN LIVE LOAD IS 90 PSF AND DESIGN VEHICULAR LIVE LOAD IS H-10.
- TEMPORARY OR PERMANENT CASING MAY BE USED AT THE ABUTMENTS AS REQUIRED.
- FOR SLOPE PROTECTION, SEE STANDARD DRAWING NO TXDOT SRR STANDARD.
- FOR CEMENT STABILIZED ABUTMENT BACKFILL DETAILS, SEE TXDOT CSAB STANDARD.
- FOR BRIDGE APPROACH SLAB DETAILS, SEE TXDOT BAS-C STANDARD.
- FOR PREFABRICATED BRIDGE TRUSS REQUIREMENTS AND NOTES, SEE DRAWING NO. SC8-1091.
- PREFABRICATED BRIDGE SUPERSTRUCTURE, DECK FORM, SIDE DAMS, BEARING ASSEMBLIES, EXPANSION JOINTS, AND EXPANSION JOINT COVER PLATES ARE TO BE PROVIDED BY THE PREFABRICATED BRIDGE VENDOR.
- PREFABRICATED BRIDGE STRUCTURES AND ESTIMATED DIMENSIONS BASED ON THE PIONEER TRAILBLAZER BRIDGE TYPE. SUPERSTRUCTURE DIMENSIONS AND FINAL LOADINGS SHALL BE PROVIDED BY THE VENDOR.
- JOINT OPENING SIZES ARE MINIMUM, REFER TO PREFABRICATED BRIDGE VENDOR'S PLANS FOR OPENING SIZE.
- THE PROPOSED STEEL TRUSSES SHALL BE WEATHERING STEEL.
- THE DISTANCE FROM PGL TO LOW CHORD IS ASSUMED TO BE 2'-11 7/16". THE DISTANCE FROM PGL TO TOP OF CAP IS ASSUMED TO BE 3'-2 7/16".

NOT AN APPROVED DRAWING
FINAL 100% DESIGN

CONTRACT SHEET No. 31 OF 356

COTTON BELT REGIONAL RAIL
VELOWEB HIKE & BIKE TRAILCITY OF COPPELL
PEDESTRIAN BRIDGE (#10P)
PLAN AND ELEVATIONIN-PROGRESS
REVIEWTHIS DOCUMENT IS RELEASED
FOR THE PURPOSE OF REVIEW UNDER THE
AUTHORITY OF:

FRANKLIN R. KELLY II, P.E., 86960

ON

10-MAR-2023 08:37

IEA

TBPE FIRM NO. F-10161

IT IS NOT TO BE USED FOR CONSTRUCTION,
BIDDING, OR PERMIT PURPOSES.

Jacobs

1999 BRYAN ST, SUITE 1200
DALLAS, TX 75201-3136
Phone: +1 (214) 638-0145
Firm Registration No. F-296618383 PRESTON ROAD, SUITE 500
DALLAS, TX 75252
Phone: +1 (214) 884-4263
Firm Registration No. F-10161

DART PROJECT

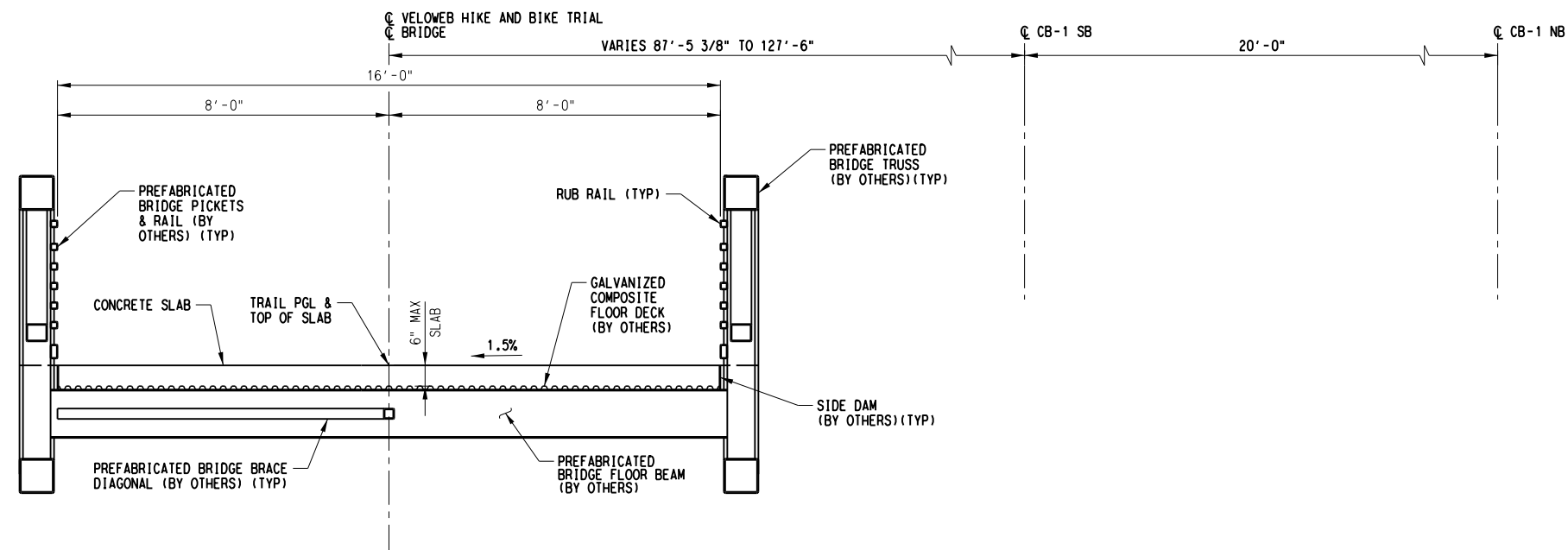


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SCALE	1"=20'
DRAWN	M. MEYER
DESIGNED	R. RILEY
CHECKED	M. MUENKS
IN CHARGE	J. FINKE
DATE	10 APR 23

CONTRACT
C-2033270-01DWG No.
SC2-1001REV
D

CB05-SC2-1001.020



NO SCALE
LOOKING AHEAD STATION

1. REFER TO DRAWING SC2-1001 FOR NOTES.
2. RUB RAIL HORIZONTAL PICKETS ARE FOR ILLUSTRATIVE PURPOSES ONLY. REFER TO PREFABRICATED BRIDGE VENDOR DETAILS FOR DETAILS.

CONTRACT SHEET No. 33 OF 356

CITY OF COPPELL
PEDESTRIAN BRIDGE (#10P)
TYPICAL SECTION

CONTRACT	DWG No.
C-2033270-01	SC8-1001

	RE
--	----

[illegible]

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IEA

18383 PRESTON ROAD, SUITE 500
DALLAS, TX 75252
Phone: +1 (214) 884-4253
Firm Registration: F-10161



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SCALE	NO SCALE
DRAWN	M. KING
DESIGNED	M. MUENKSTADT
CHECKED	M. MUENKSTADT
IN CHARGE	J. FINKEL
DATE	10 APR 23



Appendix D-2: Valley Storage Documentation

CB Veloweb H&B Trail at Grapevine Creek Floodplain Valley Storage Calculations Summary

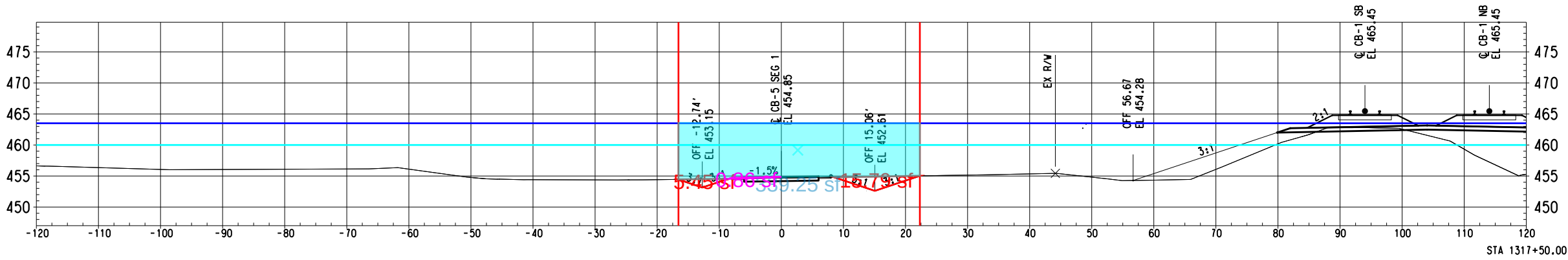
CB Veloweb H&B Trail at Grapevine Creek 100-Yr (STA 1317+50- 1321+50) [WSEL₁₀₀ = 460.04']

Ex Vol	Prop Vol Cut	Bridge Volume Fill	Diff (CF)	Difference (%)
115357.5	7527.5	4871	2656.5	2.30%

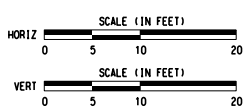
CB Veloweb H&B Trail at Grapevine Creek SPF (STA 1317+50- 1321+50) [WSEL_{SPF} = 463.48']
--

Ex Vol	Prop Vol Cut	Bridge Volume Fill	Diff (CF)	Difference (%)
181266.25	8572	4877.75	3694.25	2.04%

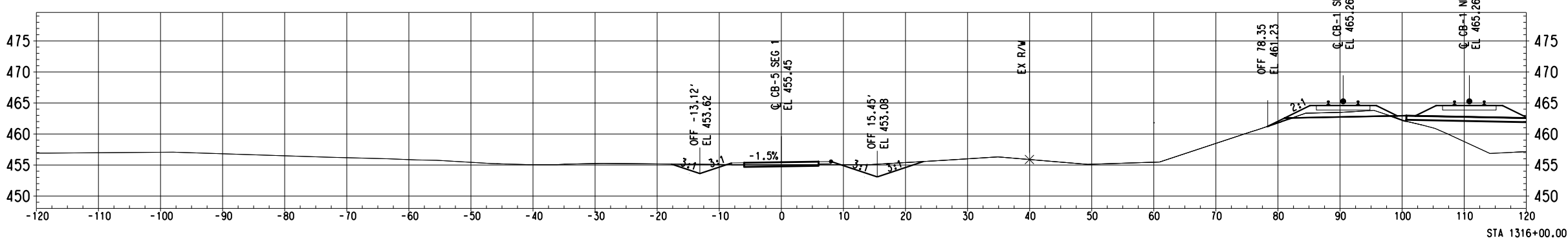
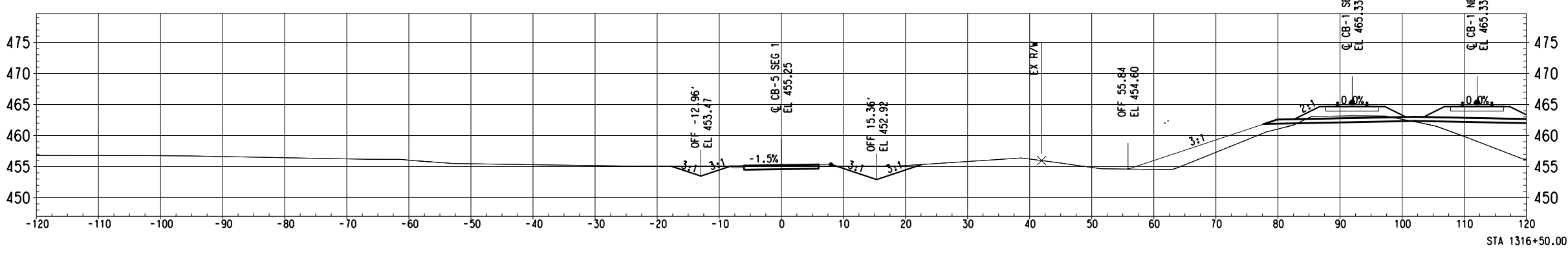
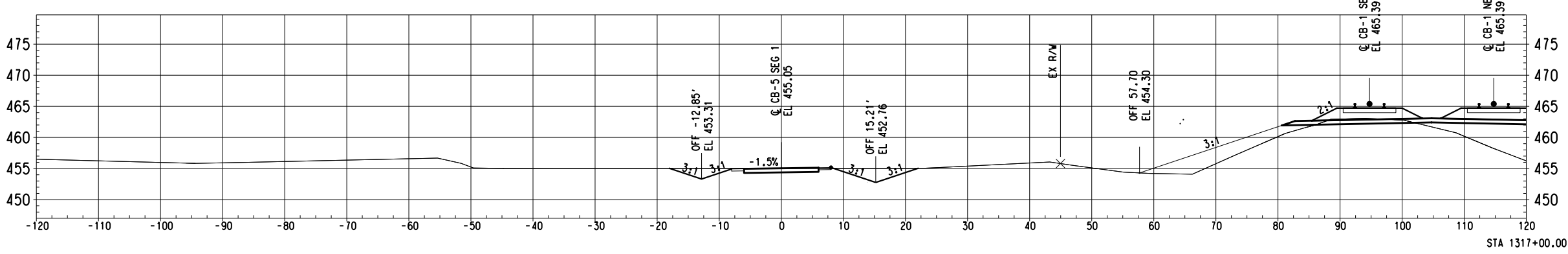
**Valley storage volumes are represented as cubic feet*



NOTE:
SEE PLAN AND PROFILE SHEETS FOR FENCE
AND RIP RAP LOCATIONS AND LIMITS

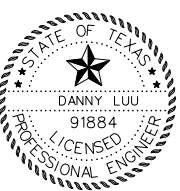


- SPF WSEL
463.48'
- 100 Yr WSEL
460.04'
- CUT AREA
- FILL AREA



FINAL 100% DESIGN

CONTRACT SHEET No.		182 OF 384
COTTON BELT REGIONAL RAIL VELOWEB HIKE & BIKE TRAIL		
CITY OF COPPELL CROSS SECTIONS SHEET 80 OF 105		
CONTRACT C-2033270-01	DWG No. CC1-6399	REV D



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ARS
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(214) 739-3152 Fax (214) 739-3169
FIRM NO. F-819



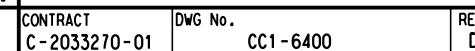
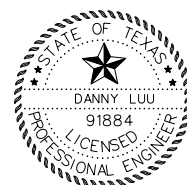
DART PROJECT

DART

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SCALE	AS NOTED
DRAWN	S. SALEH
DESIGNED	S. SALEH
CHECKED	D. LUU
IN CHARGE	D. LUU
DATE	17 AUG 23

CB05-CC1-6399.000

[illegible]

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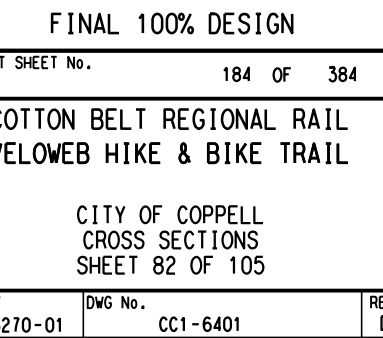
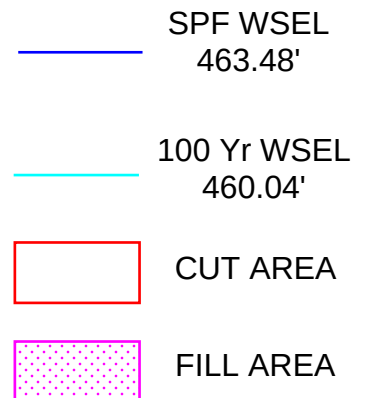
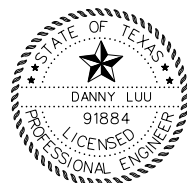
SCALE	AS NOTED
DRAWN	S. SALEH
DESIGNED	S. SALEH
CHECKED	D. LUU
IN CHARGE	D. LUU
DATE	17 AUG 23



CB05-CC1-6400.000

HORIZ  SCALE (IN FEET)
0 5 10 20

VERT  SCALE (IN FEET)
0 5 10 20

[illegible]

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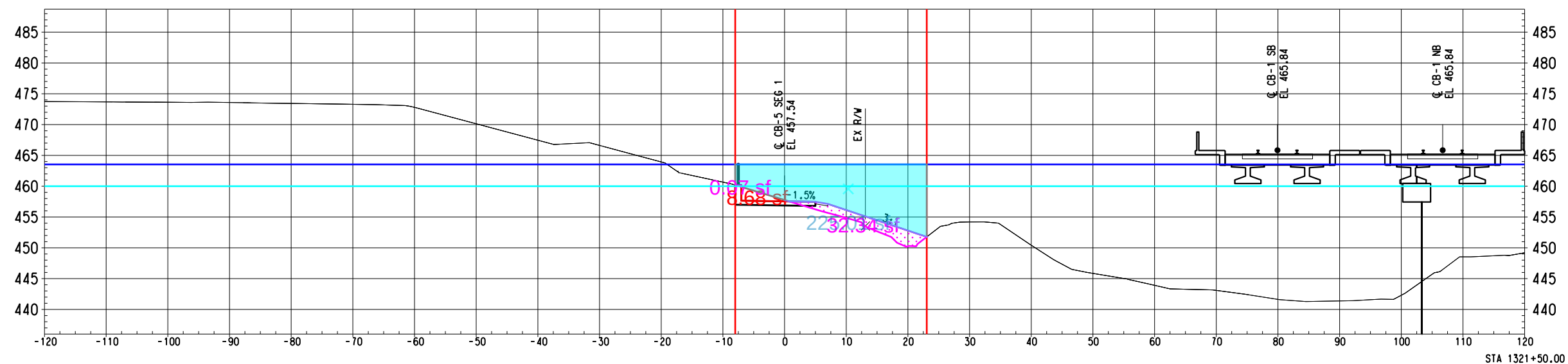
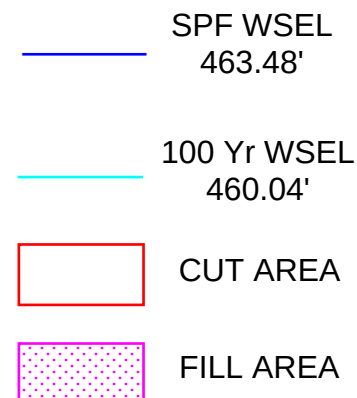
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DRAWN	S. SALEH
DESIGNED	S. SALEH
CHECKED	D. LUU
IN CHARGE	D. LUU
DATE	17 AUG 23



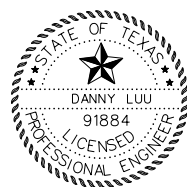
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HORIZ SCALE (IN FEET)
0 5 10 20

VERT SCALE (IN FEET)
0 5 10 20



REV	
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CHECKED	D. LUU
IN CHARGE	D. LUU
DATE	17 AUG 23



CB05-CC1-6402.000

COTTON BELT HIKE AND BIKE TRAIL

ON-SITE-END AREA METHOD

GRAPEVINE CREEK ON-SITE VALLEY STORAGE COMPUTATIONS

CB CL STA	EXIST 100YR WSEL (AVERAGE)	EXIST 100YR WSEL VALLEY STORAGE AREA (SF)	EXIST 100YR WSEL VALLEY STORAGE VOLUME (CY)	PROP 100 YR WSEL (AVERAGE)	PROP 100YR WSEL VALLEY STORAGE AREA (SF)	PROP 100YR WSEL VALLEY STORAGE VOLUME (CY)	PROP 100YR WSEL% VOL OF EXIST	EXIST SPF WSEL (AVERAGE)	EXIST SPF WSEL VALLEY STORAGE AREA (SF)	EXIST SPF WSEL VALLEY STORAGE VOLUME (CY)	PROP SPF WSEL (AVERAGE)	PROP SPF WSEL VALLEY STORAGE AREA (SF)	PROP SPF WSEL VALLEY STORAGE VOLUME (CY)	PROP SPF WSEL% VOL OF EXIST
1317+50	460.04	203	0	460.04	223	0	100%	463.48	340	0	463.48	360	0	100%
1318+00	460.04	218	390	460.04	220	410	100%	463.48	349	638	463.48	350	658	100%
1318+50	460.04	337	513	460.04	343	521	100%	463.48	542	824	463.48	548	832	100%
1319+00	460.04	488	763	460.04	484	765	100%	463.48	783	1226	463.48	779	1228	100%
1319+50	460.04	566	976	460.04	619	1021	105%	463.48	885	1544	463.48	938	1589	103%
1320+00	460.04	311	812	460.04	311	861	106%	463.48	367	1159	463.48	367	1208	104%
1320+50	460.04	36	321	460.04	36	321	100%	463.48	92	426	463.48	92	426	100%
1321+00	460.04	177	197	460.04	175	196	99%	463.48	309	372	463.48	328	389	105%
1321+50	460.04	147	300	460.04	124	277	92%	463.48	257	525	463.48	234	520	99%
TOTALS (CY)			4,273	4,371				6,714			6,850			
DELTA VOL (CY)			TARGET (15%)	98							137			
%LOSS OR %GAIN				2.3%							2.0%			
TOTAL (AC-FT)				2.6				2.7			4.2			4.2
DELTA COL (AC-FT)								0.1						0.0

Appendix E

Riprap Sizing for Channel Revetment of Bridge #10P

Channel Riprap Design

Description: Proposed Bridge 10P Grapevine Creek

Location: Coppell, Texas

HEC-RAS XS: 15631

Storm: 100-Year

Local Depth of Flow (y) =	16.15	ft	Safety Factor (S _f) =	1.1	Recommended for Bank Revetment
Average Channel Velocity (V _{avg}) =	8.07	ft/s	Stability Coefficient (C _s) =	0.300	(Angular Rock)
Radius of Curvature (R _c) =	0	ft	Velocity Distribution Coefficient (C _v) =	1.00	(Straight Channel)
Width of Water Surface (W) =	379	ft	Blanket Thickness Coefficient (C _T) =	1.0	Recommended Due to Limited Data
R _c /W =	0.0				
Specific Gravity of Rock Riprap (S _s) =	2.65				
Density of Rock Riprap (γ _s) =	165	lbs/ft ³	C _s = 0.30 for angular rock		
Acceleration of Gravity (g) =	32.2	ft/s ²	= 0.375 for rounded rock		
Bank Side Slopes (H:V) =	1.5	:1			
Bank Angle (Θ) =	33.7		C _v = 1.0 for straight channels or the inside of bends		
			= 1.283 - 0.2log(R _c /W) for the outside of bends (1.0 for R _c /W > 26)		
			= 1.25 downstream from concrete channels		
			= 1.25 at the end of dikes		

1. Determine Characteristic Velocity (V_{des})

For natural channels,	V _{des} = V _{avg} (1.74 – 0.52log(R _c /W))	Channel Type =	Natural
	V _{des} = V _{avg} for R _c /W > 26	Characteristic Velocity (V _{avg}) =	8.07 ft/s (Natural)
For trapezoidal channels,	V _{des} = V _{avg} (1.71 – 0.78 log (R _c /W))	Characteristic Velocity (V _{avg}) =	N/A ft/s (Trapezoidal)
	V _{des} = V _{avg} for R _c /W > 8		

2. Side Slope Correction Factor, K₁

$$K_1 = \sqrt{1 - \left(\frac{\sin(\theta - 14^\circ)}{\sin(32^\circ)} \right)^{1.5}}$$

K₁ = 0.72

3. Determine Rock Riprap Size

$$d_{30} = y(S_I C_S C_V C_T) \left[\frac{(V_{des})}{\sqrt{K_1(S_g - 1)gy}} \right]^{2.5}$$

(HEC-23 4.1)

$$W = 0.85(\gamma_s D^3)$$

(HEC-23 5.4 (Relationship between size and weight))

D₃₀ = 0.32 ft

D₅₀ = 1.2D₃₀ = 0.39 ft

D₁₀₀ = 1.5D₅₀ = 0.58 ft

W₃₀ = 5 lbs

W₅₀ = 8 lbs

W₁₀₀ = 27 lbs

4. Determine Stone Size (Table 2 Item 432 Riprap, TxDOT Specifications)

Table 2 Protection Riprap Stone Size ¹				
Size	Dmax (in.)	D90 (in.)	D50 (in.)	D8 (in.)
12 in.	13.76	10.14–13.29	7.31–9.92	3.39
15 in.	16.10	13.04–15.75	9.21–12.91	6.39
18 in.	19.04	15.58–18.36	11.10–14.21	6.59
21 in.	21.85	18.17–21.09	13.16–15.75	6.88
24 in.	23.53	19.28–22.29	13.76–16.18	7.31
30 in.	32.36	24.65–30.84	17.34–22.72	8.05

D₅₀ 4.68 in

Nominal Stone Size 12.00 in

Thickness of Riprap 12.00 in

References:

(i) Table 2, Item 432 Riprap, TxDOT Specifications, <https://ftp.dot.state.tx.us/pub/txdot-info/cmd/cserve/specs/2014/standard/s432.pdf>, accessed on Dec 24, 2019

(ii) Hydraulic Engineering Circular No. 23 (HEC-23), "Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance". Third Edition, September 2009

Appendix F

Scour Analysis Results

GRAPEVINE CREEK (BRIDGE #10P): HEC-RAS SCOUR OUTPUT FOR 200 YEAR DESIGN STORM

Contraction Scour

	Left	Channel	Right
Input Data			
Average Depth (ft):	4.80	14.15	6.40
Approach Velocity (ft/s):	2.64	7.46	3.31
Br Average Depth (ft):	4.01	12.45	6.23
BR Opening Flow (cfs):	422.33	2323.45	9915.66
BR Top WD (ft):	32.38	39.19	313.56
Grain Size D50 (mm):	0.20	0.20	0.20
Approach Flow (cfs):	330.31	5444.95	6613.74
Approach Top WD (ft):	26.07	51.57	312.52
K1 Coefficient:	0.690	0.690	0.690
Results			
Scour Depth Ys (ft):	1.09	0.00	2.80
Critical Velocity (ft/s):	1.26	1.51	1.33
Equation:	Live	Live	Live

GRAPEVINE CREEK (BRIDGE #10P): HEC-RAS SCOUR OUTPUT FOR 500 YEAR DESIGN STORM

Contraction Scour

		Left	Channel	Right
Input Data	Average Depth (ft):	6.19	17.13	9.38
	Approach Velocity (ft/s):	2.16	5.84	2.92
	Br Average Depth (ft):	5.54	15.27	8.91
	BR Opening Flow (cfs):	450.65	2485.39	11412.02
	BR Top WD (ft):	43.79	39.19	320.46
	Grain Size D50 (mm):	0.20	0.20	0.20
	Approach Flow (cfs):	465.24	5160.93	8573.83
	Approach Top WD (ft):	34.85	51.57	312.52
	K1 Coefficient:	0.690	0.690	0.690
Results	Scour Depth Ys (ft):	0.00	0.00	2.87
	Critical Velocity (ft/s):	1.32	1.56	1.41
	Equation:	Live	Live	Live