Lower Colorado-Lavaca
REGIONAL FLOOD
PLANNING GROUP
REGION 10

Flood Management Evaluation Memorandum

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DATE: April 12, 2023

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PROJECT: LCRA Contract No. 5809
Halff AVO 43796.001
FNI HAF21363

SUBJECT: **FME ID:** 101000053
Project Sponsor: City of Fredericksburg
Project Name: Creek Street at Barons Creek

DRAFT
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FREESE AND NICHOLS, INC.
TEXAS REGISTERED ENGINEERING FIRM F- 2144

On September 15, 2022, the Lower Colorado-Lavaca Regional Flood Planning Group (RFPG) approved the evaluation of this Flood Management Evaluation (FME) to identify, evaluate and recommend additional potentially feasible Flood Mitigation Projects (FMP).

Introduction

The City's 2016 Drainage Master Plan (DMP) proposed the implementation of a Flood Early Warning System (FEWS) at Creek Street. This action is included in the adopted Regional Flood Plan as a recommended FMP that anticipated installation of the flood early warning system with no structural improvements to the roadway crossing. However, during the preparation of the Regional Flood Plan the City indicated they would prefer to look at structural solutions. Based on the Sponsor request, the Regional Flood Planning Group (RFPG) recommended inclusion in the Regional Flood Plan (RFP) as FME 101000053.

Mr. Garret Bonn, Assistant City Engineer, and Interim Director of Development Services, was contacted to confirm the City's support to have the RFPG perform this FME, as described herein, as part of the Task 12 effort. Mr. Bonn confirmed the general nature of the flood problem, is supportive of the study, and assisted with local information and will review the report deliverables.

This FME includes updating the FEMA flood hazard analysis and mapping with ATLAS 14 rainfall data and evaluation of mitigation alternatives. This FME also includes preliminary capital cost estimates, quantification of flood risk reduction benefits, benefit-cost analyses, adverse impacts evaluation, and a high-level evaluation of potential constraints including environmental permitting, utility relocations, right-of-way acquisition, and constructability issues in accordance with adopted FMP screening criteria.

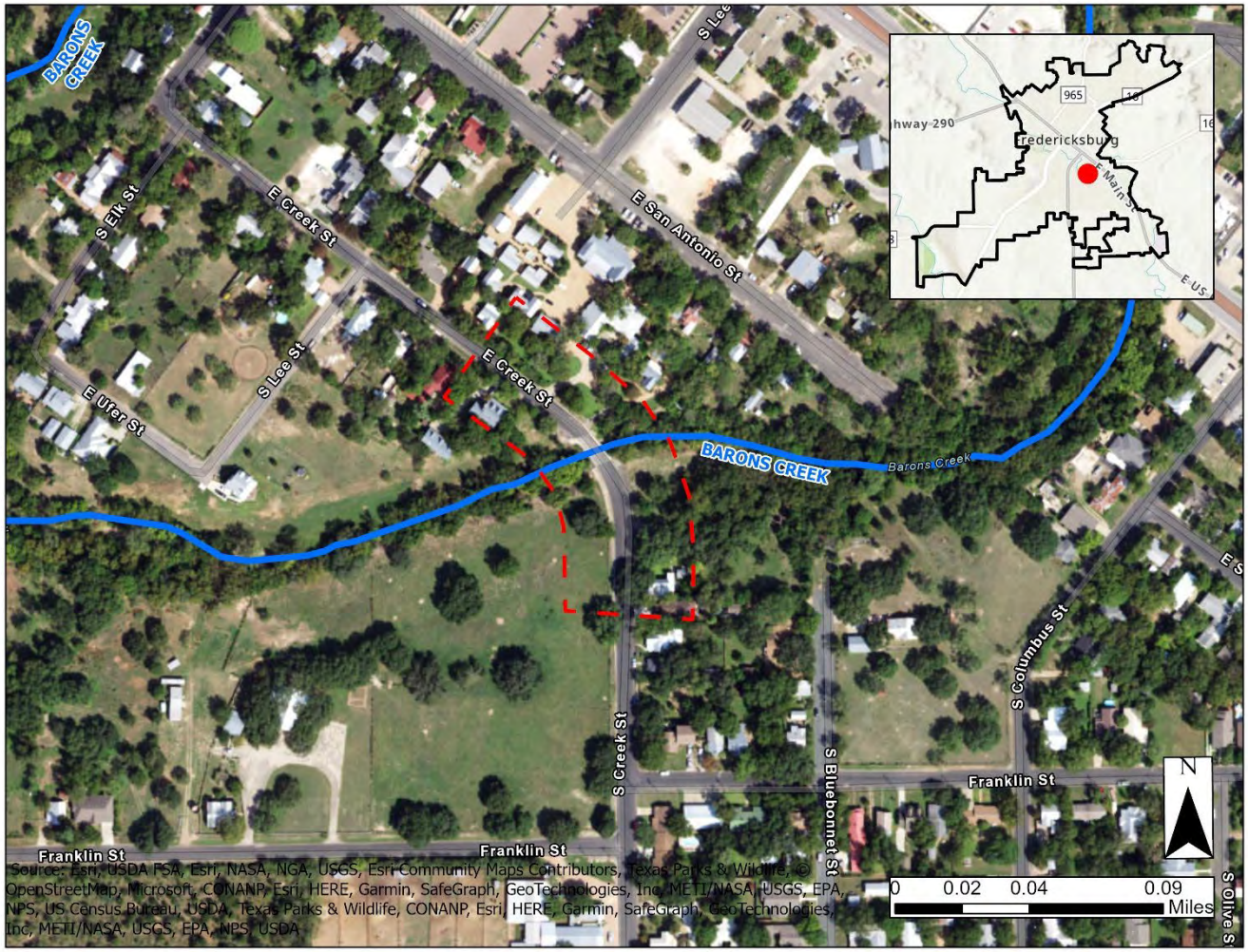

Figure 1: Study Area Location

Modeling Analysis

The following sections provide an overview of the data, methodologies, hydrologic analysis, and hydraulic analysis used to identify the existing condition flood risk.

Data Collection

The sources of the key data collected and leveraged for analysis are listed below.

- Terrain Data: 2019 LiDAR (70cm), obtained from Texas Natural Resources Information System (TINRIS).
- Soils Data: 2022 Natural Resource Conservation Service (NRCS) Web Soil Survey.
- Land Use Data: 2019 National Land Cover Database (NLCD).
- Survey Data: Creek St Culvert survey data was provided by City of Fredericksburg.
- Hydraulic model: HEC-RAS 1D model for Barons Creek was obtained from Federal Emergency Management Agency (FEMA) Base Level Engineering (BLE) Tools and Resources website.
- FEMA effective model: obtained from the 2016 DMP study.
- Spot elevations (survey) provided by the City.

Hydrology

In the original HEC-RAS 1D BLE model, Regression Equation was applied to calculate the peak flows. There is no HEC-HMS model available for the entire BLE area. To update the hydraulic model with NOAA Atlas 14 rainfall, a HEC-RAS 2D Rain-on-Grid model was developed to generate peak flows for the HEC-RAS 1D BLE model.

- Modeling Software: HEC-RAS version 6.3.1
- Rainfall Data: NOAA Atlas 14, 24-hour duration (2-, 5-, 10-, 25-, 50-, 100-, and 500-year frequency storms).
- Loss Method: NRCS Curve Number loss rate method

Hydraulics

The HEC-RAS 1D BLE model was updated with Atlas 14 computed flows and utilized for hydraulic analysis. Because the 1D BLE model is a low-detail engineering approach to provide a baseline understanding of the flood hazards, no hydraulic structures are included in the model. Structure data from FEMA effective model in the vicinity of project area were added to the model (Lincoln St, Washington St, Creek St, Main St, and FM 1631).

- Modeling Software: HEC-RAS version 6.3.1, 1D steady-state simulation
- Hydrologic Data: see above
- Boundary Conditions: Downstream normal depth

Existing Condition Flood Risk

The existing structure on Creek Street over Barons Creek is a triple 8' x 7' concrete box culvert. The capacity of the culvert is approximately 1,005 cfs without overtopping the road. Peak water surface elevations for the Q2 through Q100 storm events are presented in **Table 1**.

Table 1: Peak Flow Rates

Storm Event (YR)	Water Surface Elevation (FT)	Overtopping Depth (FT)
2	1,648.58	3.58
5	1,651.68	6.68
10	1,654.20	9.20
25	1,659.82	14.82
50	1,662.34	17.34
100	1,663.91	18.91

The road elevation is approximate elevation 1,645 feet, which is lower than the 2-year storm maximum water surface elevation. This, the existing crossing provides less than 2-year level of service. The existing inundation map for each of the 2-, 5-, 10-, 25-, 50-, and 100-year frequency storm is presented in **Figure 2.**

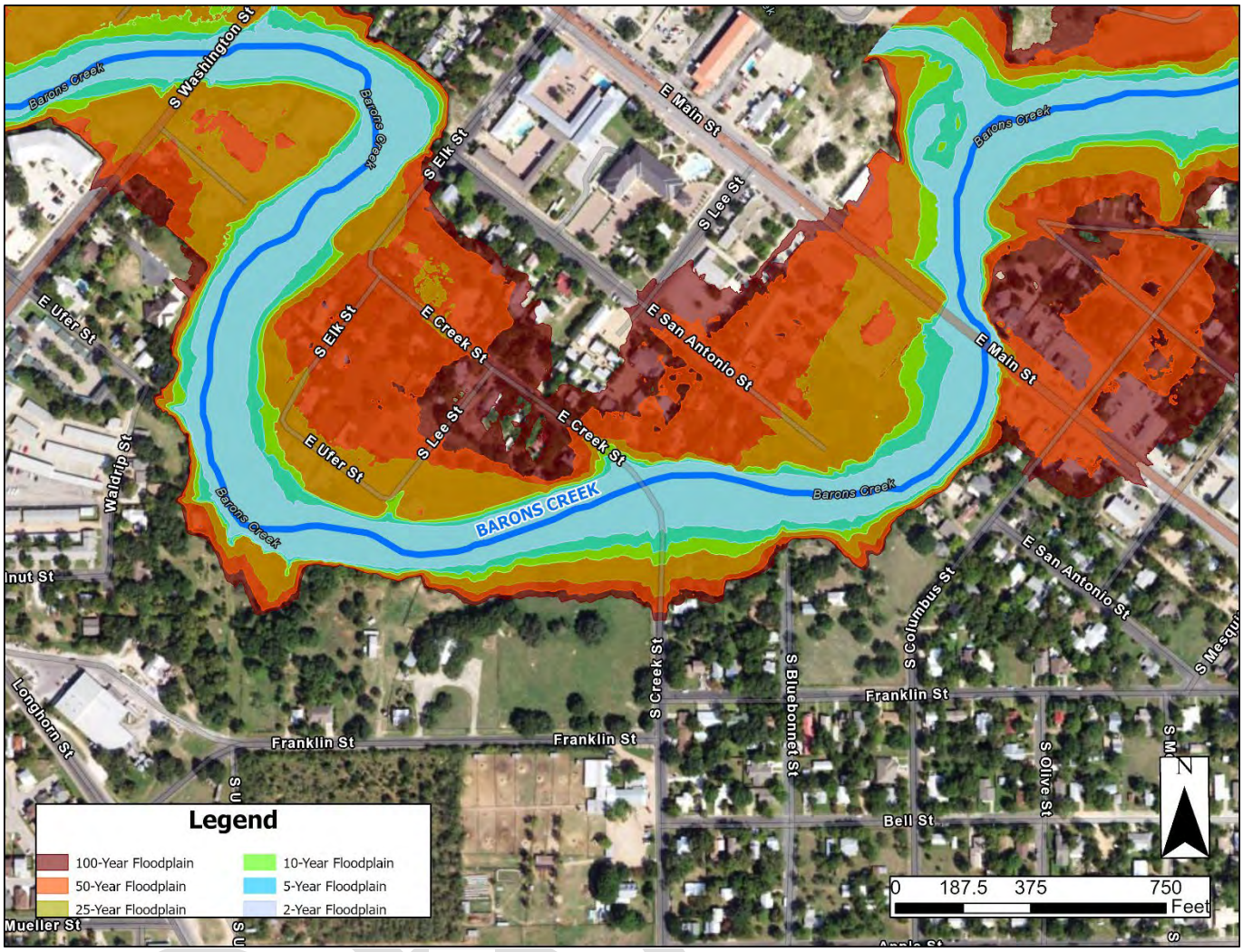

Figure 2: Existing Condition Flood Risk

Proposed Improvements

Alternatives evaluated included cleaning the existing structure to remove significant sediment blockages, adding box culverts, and replacing the existing box culverts with a bridge. A summary of the results is presented in **Table 2**.

Table 2 – Summary of Results

Improvement ID	Proposed Improvement		
	Culvert Improvement	Roadway Improvement	Overtopping Event
Clean Out	Desilt existing RCBs	-	2-YR
4-8x7RCB	Additional 8'x7' RCB barrel	-	2-YR
Road Raise (10 year)	-	Raise to 1658.50 feet	25-YR
Road Raise (100 year)	-	Raise to 1665.50 feet	>100-YR

Due to the depth of overtopping and because overtopping is dominated by the channel capacity and flow depth rather than culvert capacity (the road and culvert do not act as a dam causing overtopping) the desilting of the

existing structure and addition of conveyance (additional box culverts) do not increase the level-of-service (i.e. reduce flood risk) for this crossing. Therefore, alternatives to raise the elevation of the roadway were considered. Those alternatives included raising the road to increase the level of service to safely pass the 10-year and 100-year events. Initial results were discussed with Mr. Bonn and the 100-year bridge (corresponding to 24-hour rainfall depth of 11.93 inches) was determined to not be feasible due to the configuration of the road as well as the number of adjacent privately owned parcels and structures. The City and Freese and Nichols agreed that the 10-year event (corresponding to a 24-hour rainfall of 6.46 inches) is feasible, will provide significant safety and mobility improvements, and would be supported as a potential FMP.

The 10-year road raise alternative will local channel modifications to offset rises in the 100-year water surface elevation. Those improvements include widening the channel from the crossing to a point approximately 225 feet upstream with limited downstream improvements to tie into the existing channel.

Estimate of Probable Cost

The capital cost estimates for the flood mitigation alternative are based on previous expereince with similar project and unit costs and reviewing bid tabulations. The opinion of probable construction costs is an AACE Class 4 Estimate with an accuracy range of -20 to +30 percent. Total project costs include anticipated costs for final design, construction inspection, and easement acquisition. The opinion of probable construction cost was developed for elevation of the roadway above the 10-year storm event at a roadway deck elevation of 1,658.5 feet. The total construction cost is approximately $1,613,000 and the total estimated project cost is approximately $2,027,000.

Project Constraints

The purpose of identifying constraints early is twofold. The first is to confirm there are no unusual obstacles to implementation that would make a project not feasible. The second is an effort to identify and capture total project costs to minimize cost increases and delays in implementation. Potential constraints include environmental permitting, utility conflicts and relocations, right-of-way acquisition, and constructability.

As noted above, elevating the roadway will require channel modifications to mitigate potential increases in the 100-year water surface elevation. Because this is an existing crossing it is anticipated that the modifications would be eligible to be permitted under a U.S. Army Corps of Engineers (USACE) Nationwide Permit (NWP) 14 for linear transportation projects. NWPs have thresholds for maximum disturbances such as excavation and fill within Waters of the United States as well as other cultural and environmental permitting requirements. If the thresholds are exceeded USACE may require public notification, mitigation, and potentially could require an individual permit.

Preliminary channel modifications and mitigation are based on HEC-RAS cross-section data and LiDAR topographic data and therefore lack the level of detail that will be included in final design; however, based on preliminary modeling the increases can be mitigated. Preliminary design indicates the bottom of the flood channel will need to be approximately 75 feet wide and will extend 225 feet upstream of the road.

Final design will include refinements to the selected alternative and hydraulic models based on survey. It is recommended final design include considerations such as natural channel design in the development of the final mitigation design. Natural channel design considerations should include preserving the existing low-flow channel or constructing an inset flood bench (multi-stage channel) to replace the low flow channel if needed, using natural channel boundary materials such as rock and boulders to provide grade control or erosion protection, and site restoration using native grasses, understory plants, and trees. These features will preserve/mitigate impacts to the

natural functions of the channel necessary for permitting, preserve the existing character of the creek, and reduce or eliminate the need for long-term maintenance.

The project may require localized utility adjustments to accommodate the design and construction of the roadway improvements but nothing that is atypical for this type of project. There is at least one driveway that will need to be adjusted to tie into the new road and an easement (fully inside the 100-year floodplain) will be required for the channel modifications.

Benefit Cost Analysis

The TWDB Benefit Cost Calculation tool was used to develop pre- and post-project damage estimates and the FEMA BCA Toolkit was used to annualize those costs over a 30-year project life. The project is primarily focused on accessibility and the pre- and post-project damage estimates reflect the impacts of detours, delayed emergency access, and damage to the roadway and structure. The project benefits are the difference between the pre- and post-project damages annualized over the life of the project. The average daily traffic count was sourced from the Texas Department of Transportation, System Support Branch's TPP District Traffic Database. Expected damages were calculated with recurrence intervals at the 5-, 10- and 100-year storm events. Overtopping Impact (duration) was assumed to be 12 hours per 1-ft of inundation. The TWDB tool estimated benefits due to these factors are approximately $719,200 with annualized benefits of $301,960 from the FEMA BCA Toolkit. TWDB's tool includes other project benefits which, for this type of project include the residual value of the investment and environmental benefits. The TWDB tool estimates the residual value of the investment at $79,620 and the environmental benefits at approximately $268,900.

The Benefit Cost Analysis (BCA) generated a Benefit Cost Ratio (BCR) of 0.3. It is important to note that the environmental benefits identified above assume the natural channel design/riparian corridor elements recommended above are included in the final design. If those benefits are not realized the BCR will be reduced to 0.2.

No Negative Impact

In accordance with the *TWDB Technical Guidelines for Regional Flood Planning*, "No Negative Impact means that a project will not increase flood risk of surrounding properties. Using the best available data, the increase in flood risk must be measured by the 1 percent annual chance event water surface elevation and peak discharge. It is recommended that no rise in water surface elevation or discharge should be permissible and that the analysis extent must be vast enough to prove proposed project conditions are equal to or less than the existing conditions."

Mitigation Measures

Table 3 presents the results of the pre- and post- 100-year water surface elevations for the culvert cleanout, additional box culvert, and the elevation of the roadway above the 10-year flood depth with and without mitigation measures. As shown, structural improvements to the crossing without mitigation will result in a maximum rise in the 100-year water surface elevation of 0.67 feet at Station 27210. Model results including the proposed mitigation show there will be a minor decrease in the 100-year water surface elevation for a short distance upstream and downstream of the crossing. The lack of visible post-project 100-year floodplain in **Figure 3** reinforces the fact that it is overlaid entirely by the pre-project floodplain.

Table 3 – Comparison of Pre- and Post-Project Water Surface Elevations

	Existing Conditions	4-8x7 RCBs		Clean Out		Road Raise Above 10-YR		Road Raise Above 10-YR with Channel Improvements	
Cross Section	WSEL	WSEL	Difference	WSEL	Difference	WSEL	Difference	WSEL	Difference
37042	1698.57	1698.57	0.00	1698.57	0.00	1698.57	0.00	1698.57	0.00
36500	1696.51	1696.51	0.00	1696.51	0.00	1696.51	0.00	1696.51	0.00
35951	1691.54	1691.54	0.00	1691.54	0.00	1691.54	0.00	1691.54	0.00
35184	1690.92	1690.92	0.00	1690.92	0.00	1690.92	0.00	1690.92	0.00
34429	1689.33	1689.33	0.00	1689.33	0.00	1689.33	0.00	1689.33	0.00
34078	1686.47	1686.47	0.00	1686.47	0.00	1686.47	0.00	1686.47	0.00
33632	1685.08	1685.08	0.00	1685.08	0.00	1685.08	0.00	1685.08	0.00
32855	1684.34	1684.34	0.00	1684.34	0.00	1684.34	0.00	1684.34	0.00
32568	1683.61	1683.61	0.00	1683.61	0.00	1683.61	0.00	1683.61	0.00
32134	1682.20	1682.2	0.00	1682.2	0.00	1682.2	0.00	1682.2	0.00
31681	1678.96	1678.96	0.00	1678.96	0.00	1678.96	0.00	1678.96	0.00
31267	1678.00	1678	0.00	1678	0.00	1678	0.00	1678	0.00
31177	1677.26	1677.26	0.00	1677.26	0.00	1677.26	0.00	1677.26	0.00
30806	1675.59	1675.59	0.00	1675.59	0.00	1675.59	0.00	1675.59	0.00
30292	1675.41	1675.41	0.00	1675.41	0.00	1675.41	0.00	1675.41	0.00
30109	1673.22	1673.22	0.00	1673.22	0.00	1673.23	0.01	1673.22	0.00
29279	1671.50	1671.5	0.00	1671.5	0.00	1671.51	0.01	1671.5	0.00
28712	1669.92	1669.92	0.00	1669.92	0.00	1669.93	0.01	1669.92	0.00
28040	1666.46	1666.47	0.01	1666.46	0.00	1666.76	0.3	1666.41	-0.05
27416	1663.70	1663.73	0.03	1663.72	0.02	1664.36	0.66	1663.59	-0.11
27210	1663.75	1663.78	0.03	1663.77	0.02	1664.42	0.67	1663.64	-0.11
CREEK STREET CULVERT CROSSING									
27094	1663.49	1663.47	-0.02	1663.5	0.01	1663.47	-0.02	1662.82	-0.67
26869	1663.05	1663.05	0.00	1663.05	0.00	1663.05	0.00	1662.35	-0.70
26466	1661.22	1661.22	0.00	1661.22	0.00	1661.22	0.00	1661.22	0.00
26049	1660.91	1660.91	0.00	1660.91	0.00	1660.91	0.00	1660.91	0.00
25736	1658.28	1658.28	0.00	1658.28	0.00	1658.28	0.00	1658.28	0.00
25440	1657.80	1657.8	0.00	1657.8	0.00	1657.8	0.00	1657.8	0.00
25052	1656.49	1656.49	0.00	1656.49	0.00	1656.49	0.00	1656.49	0.00
24679	1655.53	1655.53	0.00	1655.53	0.00	1655.53	0.00	1655.53	0.00
24337	1654.05	1654.05	0.00	1654.05	0.00	1654.05	0.00	1654.05	0.00
23798	1652.49	1652.49	0.00	1652.49	0.00	1652.49	0.00	1652.49	0.00
23353	1650.11	1650.11	0.00	1650.11	0.00	1650.11	0.00	1650.11	0.00
22917	1649.35	1649.35	0.00	1649.35	0.00	1649.35	0.00	1649.35	0.00
22728	1649.27	1649.27	0.00	1649.27	0.00	1649.27	0.00	1649.27	0.00
22636	1648.66	1648.66	0.00	1648.66	0.00	1648.66	0.00	1648.66	0.00
22404	1648.14	1648.14	0.00	1648.14	0.00	1648.14	0.00	1648.14	0.00

	Existing Conditions	4-8x7 RCBs		Clean Out		Road Raise Above 10-YR		Road Raise Above 10-YR with Channel Improvements	
Cross Section	WSEL	WSEL	Difference	WSEL	Difference	WSEL	Difference	WSEL	Difference
21870	1646.99	1646.99	0.00	1646.99	0.00	1646.99	0.00	1646.99	0.00
21329	1643.72	1643.72	0.00	1643.72	0.00	1643.72	0.00	1643.72	0.00
20682	1642.31	1642.31	0.00	1642.31	0.00	1642.31	0.00	1642.31	0.00
20210	1641.55	1641.55	0.00	1641.55	0.00	1641.55	0.00	1641.55	0.00
19672	1640.62	1640.62	0.00	1640.62	0.00	1640.62	0.00	1640.62	0.00
19135	1637.75	1637.75	0.00	1637.75	0.00	1637.75	0.00	1637.75	0.00
18731	1634.43	1634.43	0.00	1634.43	0.00	1634.43	0.00	1634.43	0.00
18575	1634.11	1634.11	0.00	1634.11	0.00	1634.11	0.00	1634.11	0.00
18423	1633.37	1633.37	0.00	1633.37	0.00	1633.37	0.00	1633.37	0.00
18121	1631.78	1631.78	0.00	1631.78	0.00	1631.78	0.00	1631.78	0.00
17494	1627.66	1627.66	0.00	1627.66	0.00	1627.66	0.00	1627.66	0.00

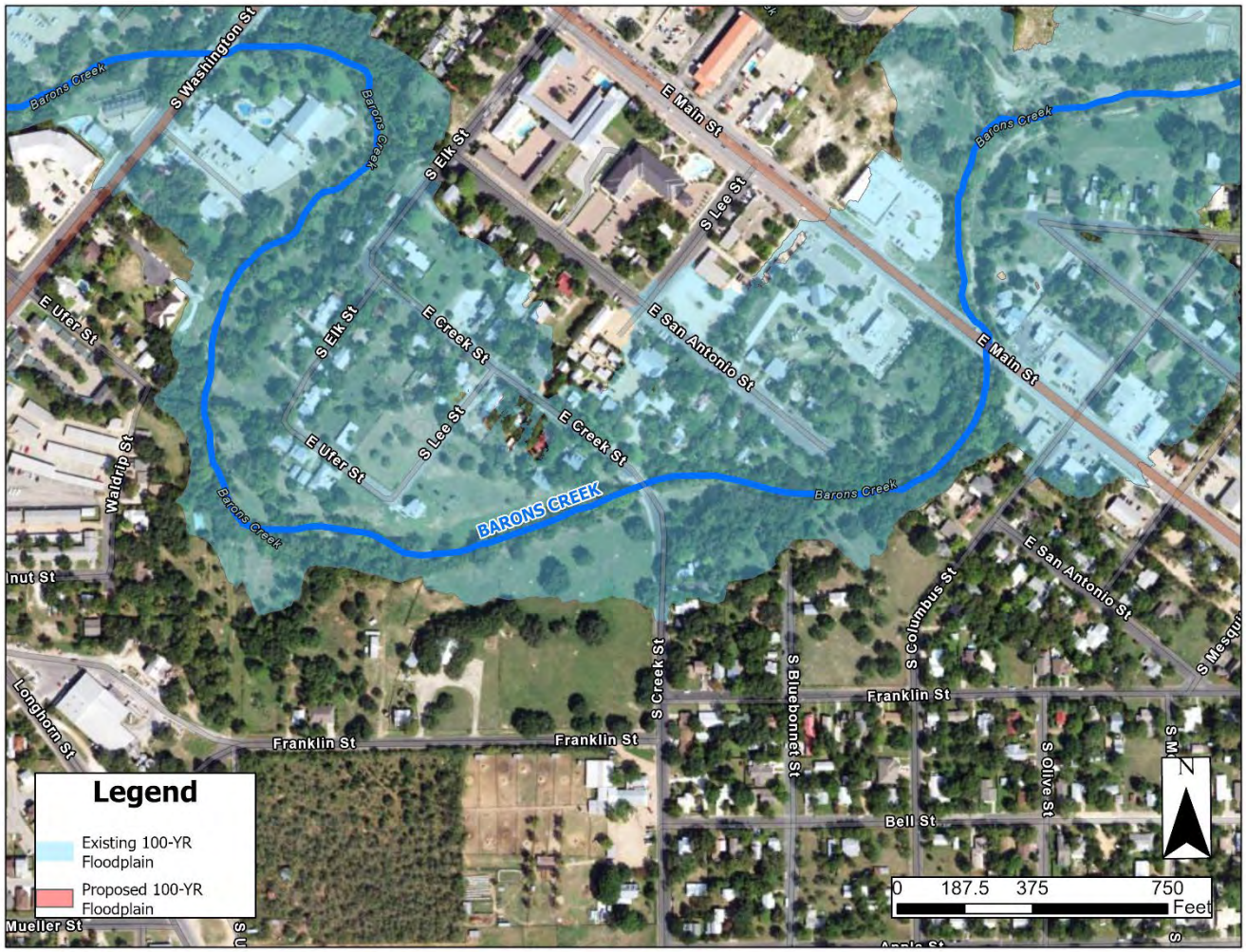

Figure 3: 100-Year Stormwater Inundation Boundary

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Technical Memorandum Attachments

Attachment 1. TWDB-Required Tables

- Table 16: Recommended Flood Mitigation Projects
- Geodatabase Table: Project Details

Attachment 2. Flood Mitigation Project

- FMP Summary Sheet
- Cost Estimate
- Benefit Cost Ratio

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Attachment 1

TWDB-Required Tables

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Attachment 2

Flood Mitigation Project

Flood Mitigation Project (FMP)

Lower Colorado-Lavaca
REGIONAL FLOOD PLANNING GROUP
REGION 10

Title: Creek St at Barons Creek | ID#: TBD

Sponsor (note if City or County): Fredericksburg (Municipality) | Commitment: ☑ Yes ☐ No

Technical committee recommend: ☐ Yes ☐ No | RFPG recommend: ☐ Yes ☐ No

Project Type

STRUCTURAL

☐ Detention ☑ Channel modification ☑ Bridge/culvert ☐ Storm drain ☐ Levee/floodwall

Other:

NON-STRUCTURAL

☐ Property buyouts ☐ Floodproofing ☐ Flood readiness/resilience ☐ Flood warning system/gauges

Other:

Problem Area

City: Fredericksburg | County: Gillespie

Watershed name(s): Barons Creek

Tributary(ies): Barons Creek

HUC#(s): 12090206 | Stream miles (est.): TBD

Drainage area: square miles, est: 0.01 | or acreage, est:

Social Vulnerability Index (SVI): 0.1

(SVI score 0.0 indicates least vulnerable; 1.0 indicates most vulnerable.)

Other:

Flood Risk Description

The crossing on Creek Street at Barons Creek is in a residential area approximately 1,100 feet south of Interstate 290. Hydraulic analysis shows the overtopping of Creek Street to a depth of 3.38 feet during the 2-year event and 18.9 feet during the 100-year event.

Proposed level-of-service: 10-year | Status: N/A | Atlas 14 rainfall used: Yes

Project Description

Proposed improvements include the construction of a new bridge including approximately 300-ft of roadway improvements and approximately 225 feet of channel modifications. Final design considerations for the channel modifications include incorporating natural channel design features such as a multi-stage channel section, use of natural materials for the channel bottom and side slopes, and native vegetation for site restoration.

Related Goal(s)

6.2 Increase the number of entities that mitigate flood risk at vulnerable roadways or waterways (e.g., low-water crossings, irrigation canals).

Estimated Project Cost

Capital cost: $2,027,000 | Ongoing O&M costs: TBD | Cost/benefit analysis: 0.3

Potential funding source(s): TBD