



North Central Texas
Council of Governments

Integrating Transportation and Stormwater Infrastructure

Hydraulic Modeling for the Mary's Creek Watershed

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Integrating Transportation and Stormwater Infrastructure (TSI)

HEC-RAS Modeling for the Mary's Creek Watershed

U.S. Army Corps of Engineers

1. Executive Summary

This report presents an enhanced 2D hydraulic model of the Mary's Creek Watershed, based on the Base Level Engineering (BLE) Study from the Texas Water Development Board (TWDB). Using the refined HEC-HMS-derived runoff, the model estimates flood depths and peak water surface elevations across the study area.

Enhancements to the BLE model include the addition of 22 structures with as-built data or standard assumptions, refined computational meshes at crossings, and conversion of rain-on-grid inputs to boundary-applied inflow hydrographs. Various simulation plans cover existing (2020) and future (2070) conditions across a range of recurrence intervals (2- to 500-year).

The enhanced model provides a tool for flood assessment, hydraulic analysis, and evaluating potential impacts of future development within the watershed.

2. HEC-RAS Methodology

2.1. Original Model

The BLE study for the Lower West Fork Trinity Watershed (HUC-08: 12030102) obtained from TWDB was used as the basis for the enhanced hydraulic model. The 2023 study includes the development of 2D hydraulic models for seven HUC-10 watersheds within the Lower West Fork Trinity Watershed. The BLE Lower Clear Fork watershed model (HUC-10: 1203010203 Lower Clear Fork Trinity River) served as the starting point for the hydraulic modeling developed for this project. Precipitation depths for this analysis were derived from National Oceanic and Atmospheric Administration (NOAA) Atlas 14 rainfall data. HEC-HMS was used to develop a simplified hydrologic model to generate rainfall-runoff estimates, which were then applied in a rain-on-grid, 2D hydraulic simulation using HEC-RAS. The hydraulic model was used to estimate flood depths and peak water surface elevations across the study area.

2.2. Enhanced Model

Several modifications were implemented to the original BLE hydraulic model to more accurately represent existing conditions and to evaluate potential impacts of future development within the study area. The primary modifications included addition of structures and the conversion of the rain-on-grid approach to inflow hydrographs. The following chapters provide additional details on each of the modifications done in the hydraulics model.

2.2.1 Structures Data

Bridges and culverts were added to the BLE model at major crossings to more accurately represent hydraulic conditions, including velocity, water surface elevation (WSE), and flow rate at those locations. A total of 22 structures were added.

As-built data was used as inputs for these structures when available. If as-built information was not provided or if data was missing from the document, the following assumptions and procedures were applied:

- No as-built provided: Major bridge parameters, including total length, number of piers, and width, were obtained using the TxDOT Open Data Portal.
- Missing bridge dimensions: If bridge dimensions (span lengths, widths, or heights) were not provided, measurement tools were applied directly to the document using the sheet scale.
- Unknown elevation datum: In cases where elevations were reported in an undetermined datum—such as some as-builts setting the channel bottom to zero—an offset was applied to align the roadway elevation from the LiDAR with the converted elevation in the current datum. **Table 2-1.** lists the added structures and **Figure 2-1** shows their locations within the Mary's Creek watershed.

Table 2-1. List of SA/2D Connections

Feature Crossed	Facility Carried
Little Marys Ck	FM 3325
Little Marys Ck	FM3325 Relief
Little Marys Ck Trib	FM 3325
Marys Ck	Camp Bowie EB
Marys Ck	Camp Bowie WB
Marys Ck	FM 3325
Marys Ck	IH 30 EBFR
Marys Ck	IH 30 EBML
Marys Ck	IH 30 WBML
Marys Ck	IH 820 ML
Marys Ck	IH 820 NBFR
Marys Ck	IH 820 SBFR
Marys Ck	IH30 WBFR
Marys Ck	Longvue Ave
Marys Ck	Old Weatherford Rd
Marys Ck	Old Weatherford Rd Relief
Marys Ck	US 377
Marys Ck	Winscott Rd
South Marys Ck	Diamond Bar Trl
South Marys Ck	I 20
South Marys Ck	Lost Creek Blvd
South Marys Ck	Old Weatherford Rd

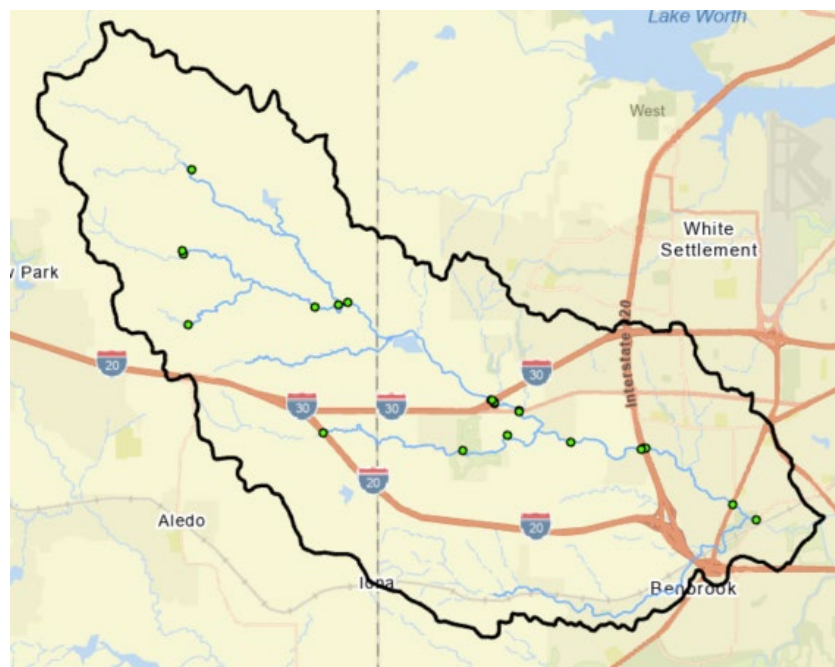


Figure 2-1. Locations of 2D Structures

2.2.2 2D Mesh

The BLE model had extensive breaklines set up throughout the watershed and while there were some modifications to the 2D mesh, cell alignment was generally sufficient and adjustments were minimal.

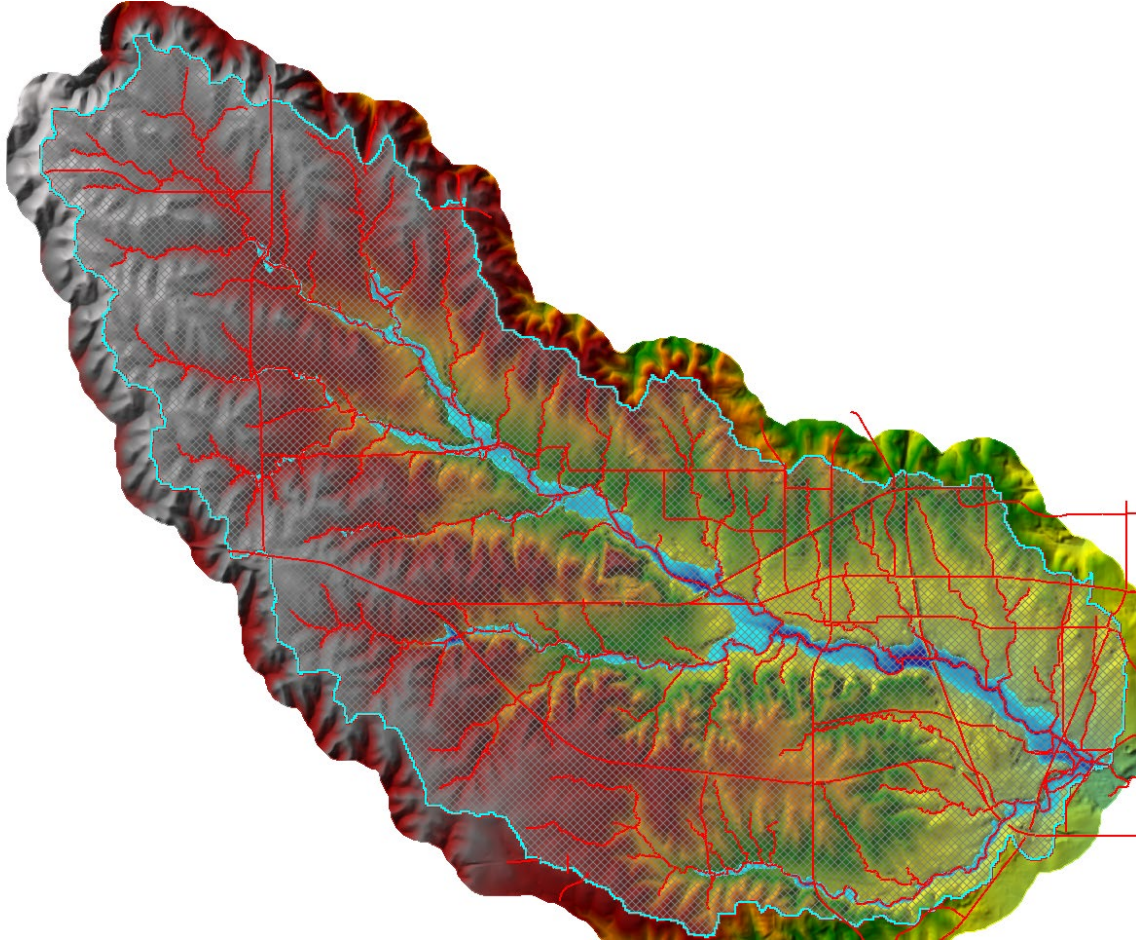


Figure 2-2. Breaklines (Red) within 2D Mesh

2.2.3 Unsteady Flow Data

The HEC-HMS version 4.11 model developed for this watershed was used to provide inflows for the 2D HEC-RAS model for this watershed. This replaced the rain-on-grid approach from the BLE model. Documentation of this model is provided in the “HEC-HMS Modeling for the Mary's Creek Pilot Area” report.

Five plans representing 2020 existing conditions and five plans representing 2070 future conditions were developed for the same recurrence intervals.

One challenge encountered and limitation that is acknowledged in the modeling effort for the Mary's Creek watershed is how loss of valley storage is accounted for. During initial modeling considerations and investigation, it was unclear how to best model this situation in geometry across the entire 54 square mile watershed. Several concerns and questions were raised and investigated. However, an acceptable approach to fully account for encroachments in HEC-RAS was unable to be identified given the time and budget constraints of the planning study.

Ultimately, the impacts of losing valley storage were accounted for in HEC-HMS but not fully accounted for in HEC-RAS. They were partially accounted for in HEC-RAS model by accounting for the peak discharge increases that would be estimated to occur through the loss of valley storage. Loss of valley storage was not fully accounted for in HEC-RAS because the encroachments on the floodway fringe were not accounted for by modifications to the terrain. The downside of this approach is it doesn't capture reductions to the conveyance for a given section of the stream. The benefit is that it does account for increases in flow that are estimated from a loss of valley storage upstream of a given section of the stream. More information about how valley storage loss was computed can be found in the HMS SOP Appendix.

To leverage flows from HEC-HMS, flow was increased through the system by a series of internal boundary conditions using constant hydrographs such that the peak flows in the HEC-RAS model matched the peak flows being produced in the HEC-HMS model. Figure 2-3 provides an example of how flows were added to the HEC-RAS model. A complete list of the flows used in the HEC-RAS model can be found in the Mary's Creek HEC-HMS report.

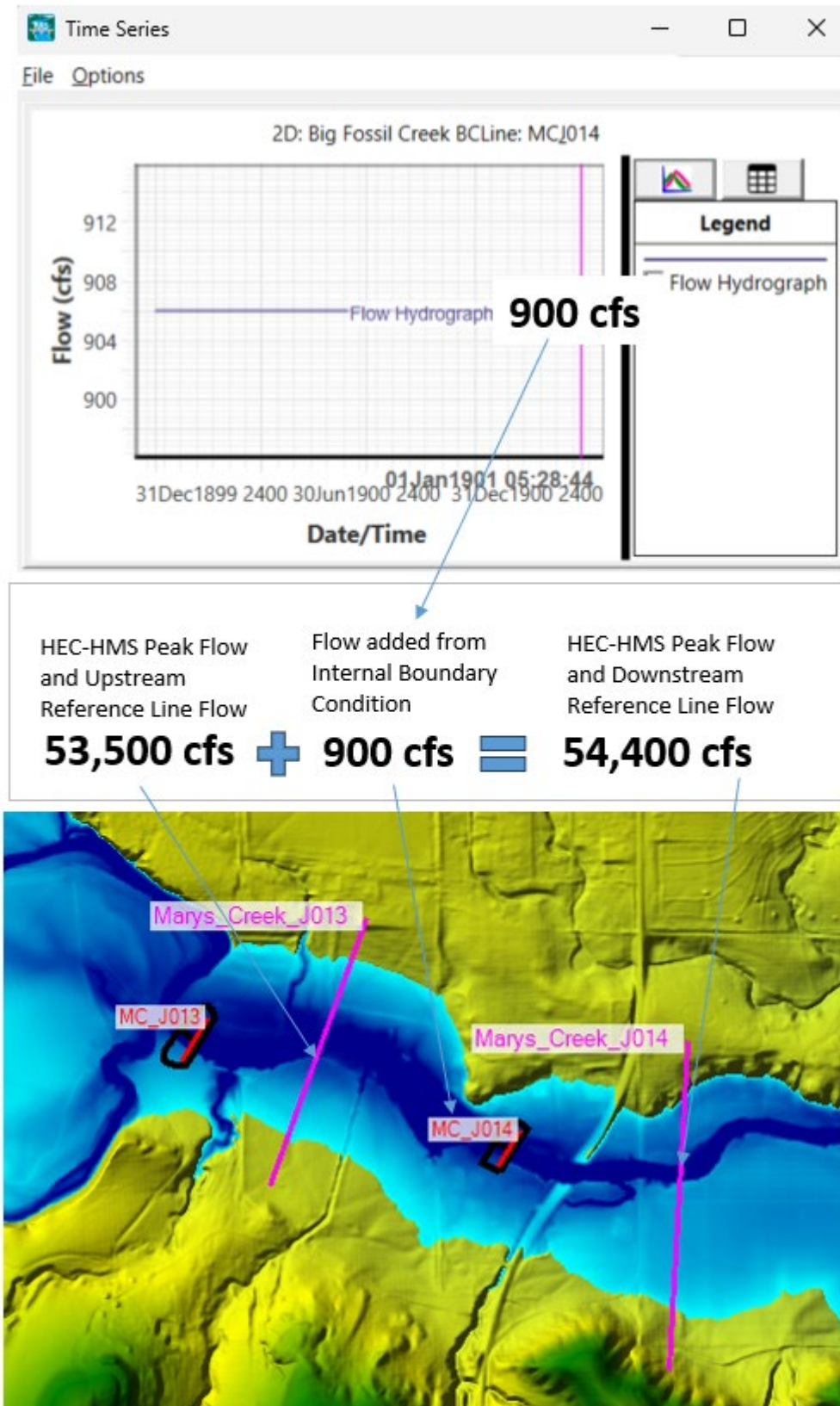


Figure 2-3. Internal Boundary Conditions Results - HEC-RAS Peaks Match HEC-HMS Peaks

2.2.4 Terrain and Manning's Number Layer Updates

The BLE terrain in the BLE model was leveraged but was clipped to the Mary's Ck watershed extents.

The Manning's roughness layer was updated to better reflect current land cover conditions. Channel roughness values were added by buffering the channel centerline. Calibration regions were added to improve the delineation between forest and developed areas. The channel was buffered 60-feet based off of the HEC-HMS flowlines and the area was assigned a Manning's value of 0.04. **Table 2-2** lists the Manning's n values adopted for each land cover area present in the enhanced model.

Table 2-2. Manning's n Values by Land Cover

Land Use	Manning's Value
Barren Land	0.03
Cultivated Crops	0.04
Deciduous Forest	0.12
Developed High Intensity	0.12
Developed Low Intensity	0.06
Developed Medium Intensity	0.08
Developed Open Space	0.04
Emergent Herbaceous Wetlands	0.08
Evergreen Forest	0.12
Hay Pasture	0.04
Herbaceous	0.03
Mixed Forest	0.12
Open Water	0.03
Shrub Scrub	0.06
Woody Wetlands	0.1

3. Results and Conclusions

Existing flood risk within the Mary's Creek watershed is distributed across many locations but is most highly concentrated near Mary's Creek Drive between Loop 820 and US-377. Future increases to impervious cover and loss of valley storage resulting from development are expected to increase flood risk throughout the watershed unless new mitigation measures are implemented. The 100-yr floodplain inundation area increased 7% from 2,441 acres to 2,611 acres from 2020 to 2070 conditions. The number of National Structure Inventory (NSI) structures located within the 100-yr inundation area increased 20% from 323 to 386. Figure 3-1 illustrates flooding conditions for 2020 100-yr event while Figure 3-2 illustrates flooding conditions for the 2070 100-yr event.



Figure 3-1. Existing Conditions, 100-year Flooding in 2020

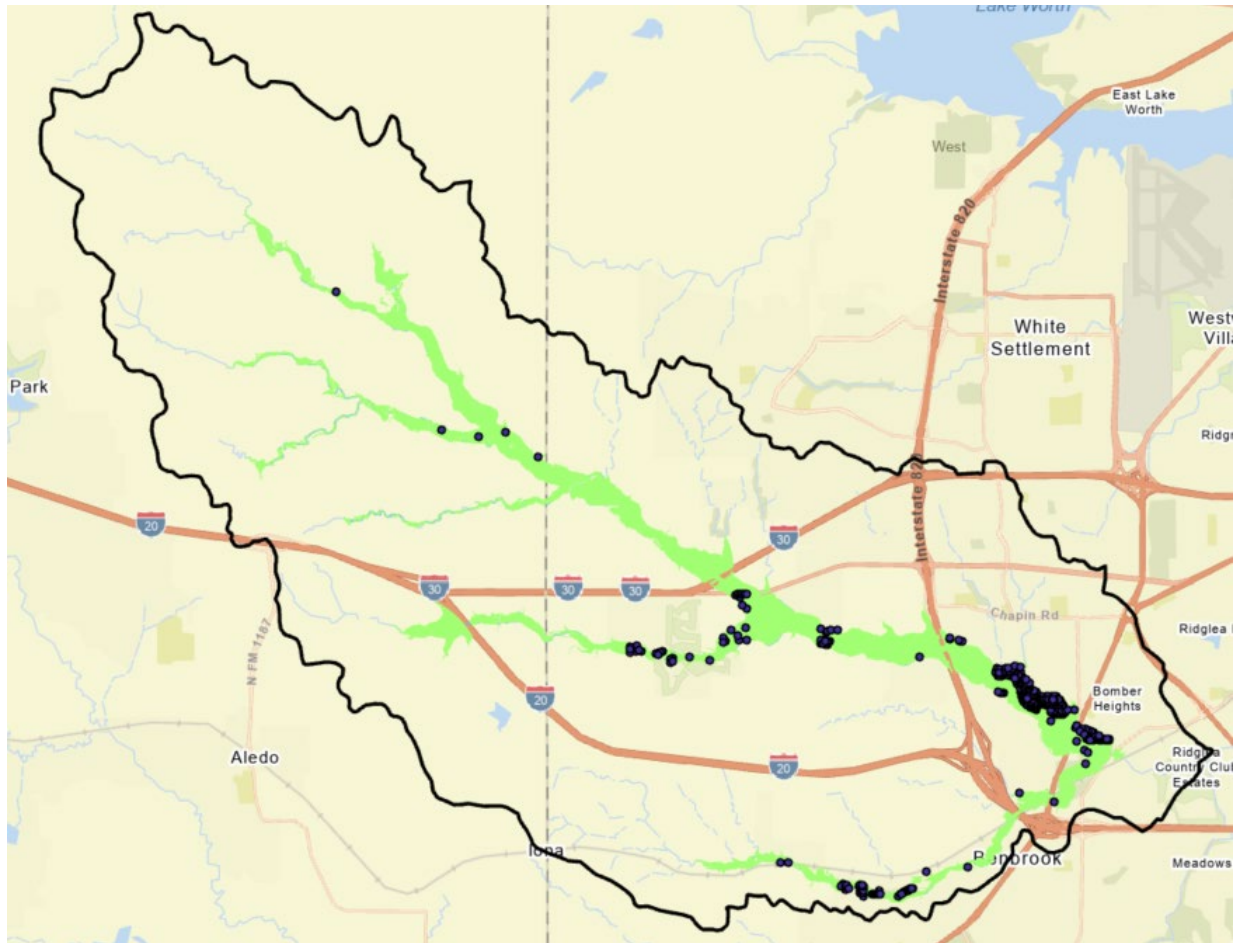


Figure 3-2 Existing Conditions, 100-year Flooding in 2070

Figure 3-3 illustrates 100-yr water surface elevation increases up to 2 feet are observed in the watershed but generally range between 0.5 to 1.0 feet from the 2020 to 2070 conditions.

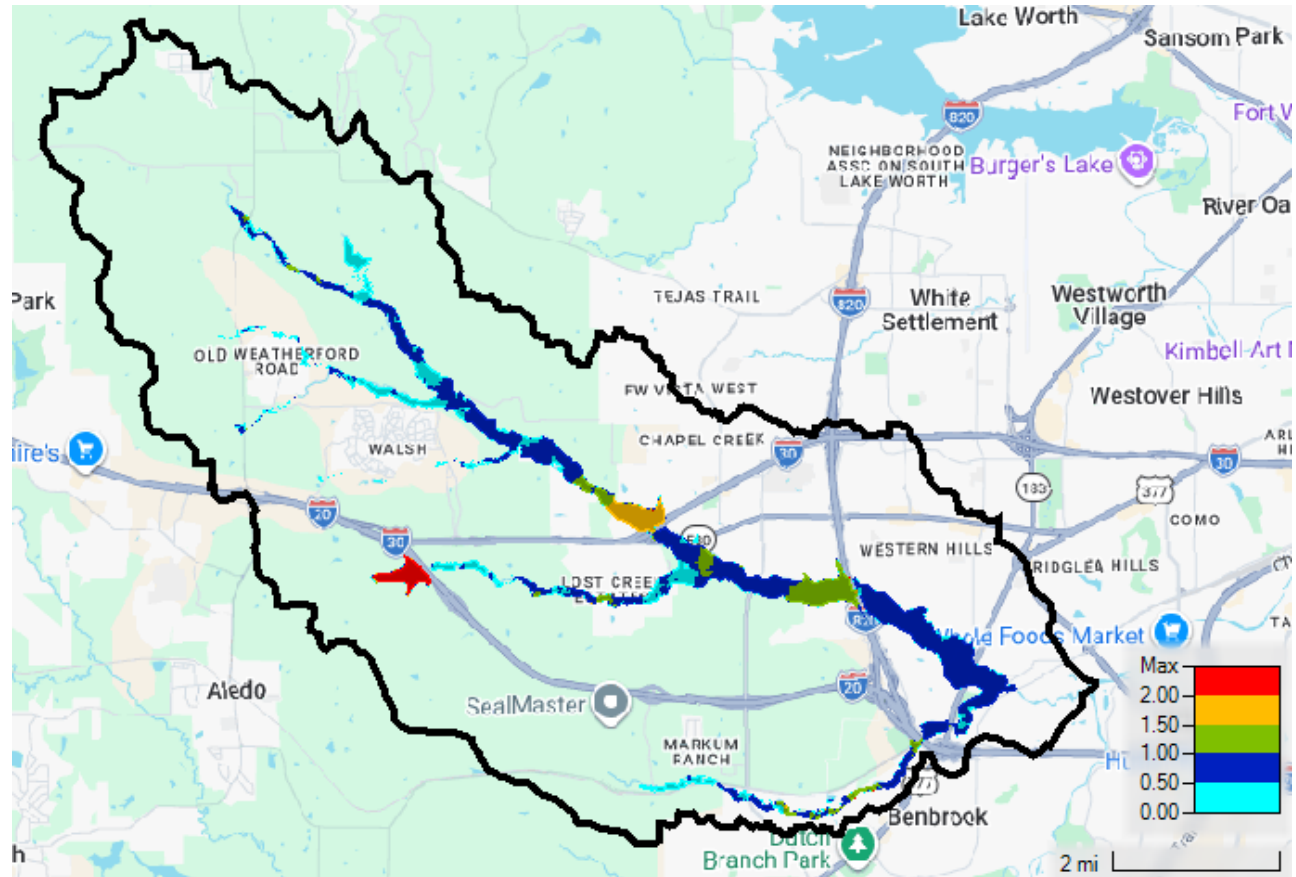


Figure3-3. Increase in 100-year flood elevation (feet) from 2020 to 2070

4. References

- National Oceanic and Atmospheric Administration (NOAA). (2018). NOAA Atlas 14 – Precipitation Frequency Data Server (PFDS). <https://hdsc.nws.noaa.gov/hdsc/pfds/>
- Texas Department of Transportation (TxDOT). (2025). TxDOT Bridges SNBI. <https://gis-txdot.opendata.arcgis.com/>
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