



North Central Texas
Council of Governments

Integrating Transportation and Stormwater Infrastructure

Hydraulic Modeling for the Mountain Creek Watershed

June 2026



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Integrating Transportation and Stormwater Infrastructure (TSI) HEC-RAS Modeling for the Mountain Creek Watershed

U.S. Army Corps of Engineers

1. Executive Summary

This report presents an enhanced two-dimensional (2D) hydraulic model of the Mountain Creek Watershed, based on the Base Level Engineering (BLE) Study from the Texas Water Development Board (TWDB). Using the refined Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) derived runoff results, the model estimates flood depths and peak water surface elevations across the integrating Transportation and Stormwater Infrastructure (TSI) study area.

Enhancements to the BLE model include the addition of 37 structures, consisting of 27 bridges and 10 culverts, with as-built data or standard assumptions, refined computational meshes at crossings, updated terrain from the latest topographic data, and conversion of rain-on-grid inputs to boundary-applied inflow hydrographs. Various simulation plans cover existing (2020) and future (2070) land use 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 Hydrologic Unit Code (HUC)-10 watersheds within the Lower West Fork Trinity Watershed. The BLE Mountain Creek watershed model (HUC-10: 1203010206 above Joe Pool Lake) 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 the Hydrologic Engineering Center – River Analysis System

(HEC-RAS) model. 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 changes in the terrain, 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 37 structures were added, including 27 bridges and 10 culverts.

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 information provided: Major bridge parameters, including total length, number of piers, and width, were obtained using the Texas Department of Transportation (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 Light Detection and Ranging (LiDAR) data with the converted elevation in the current datum. Additionally, for structures with as-built documentation dated prior to 1987, a conversion from the National Geodetic Vertical Datum of 1929 (NGVD 29) to the North American Vertical Datum of 1988 (NAVD 88) was adopted. The conversion factor, typically ranging from 0.0 to 0.2 feet, was selected based on the specific crossing location.

Table 1 lists the added structures and **Figure 1** shows their locations within the Mountain Creek watershed. The TxDOT IDs used for the National Bridge Inventory (NBI) are listed for the applicable crossings.

Table 1: List of SA/2D Connections

TxDOT ID	Type	Feature Crossed	Facility Carried
022200S54705002	Bridge	Joe Pool Lake	Lake Ridge Parkway
021270AA0510003	Bridge	King Branch	CR 519
021270AA0512001	Bridge	King Branch	CR 608A
022200M00735001	Bridge	Lowe Branch	Seeton Road
022200226602107	Culvert	Lowe Branch	SH 360 Right Frontage Road
022200226602106	Culvert	Lowe Branch	SH 360 Left Frontage Road
022200M00270002	Culvert	Lowe Branch	Holland Road
022200226602076	Bridge	Lowe Branch	SH 360 NB
021270AA0566001	Bridge	Mountain Creek	CR 511
021270AA0615001	Bridge	Mountain Creek	CR 615
021270AA0589002	Bridge	Mountain Creek	CR 616
021270074705057	Bridge	Mountain Creek	FM 157
021270276201002	Bridge	Mountain Creek	FM 2738
021270074705003	Bridge	Mountain Creek Tributary	FM 517
021270M00568001	Culvert	Reece Branch	Cordes Drive
021270AA0566002	Bridge	Reece Branch	CR 511
021270AA0570001	Bridge	Reece Branch	CR 515
021270074705002	Bridge	Reece Branch	FM 157
021270118104004	Culvert	Reece Branch	FM 917
021270AA0528001	Bridge	Valley Ranch	CR 528
021270AA0604001	Bridge	Walnut Creek Tributary	CR 604
021270AA0521004	Culvert	Walnut Creek Tributary	Renfro Street
021270AA0519001	Bridge	Walnut Creek	CR 519
021270AA0546001	Bridge	Walnut Creek	CR 528
021270AA0580002	Culvert	Walnut Creek	CR 600
021270AA0577001	Bridge	Walnut Creek	CR 604
021270AA0510001	Bridge	Walnut Creek	CR 608
021270301002002	Bridge	Walnut Creek	FM 2738
021270118104008	Bridge	Walnut Creek	FM 917
022200017202193	Bridge	Walnut Creek	Main Street
022200M00455001	Bridge	Walnut Creek	North Street
022200M00545001	Culvert	Walnut Creek	Retta Road
022200017209449	Bridge	Walnut Creek	US 287 SB Frontage Road
022200017209448	Bridge	Walnut Creek	US 287 NB Frontage Road
022200M00665002, 022200M00665003*	Bridge	Walnut Creek	Walnut Creek Drive
022200AA0599001	Culvert	Willow Branch	Bennett Lawson Road
022200133002013	Culvert	Willow Branch	FM 1187

* Given the short distance between the two bridges and their similar structural profiles, the bridges were combined into a single structure to more accurately represent hydraulic conditions and prevent stability issues.

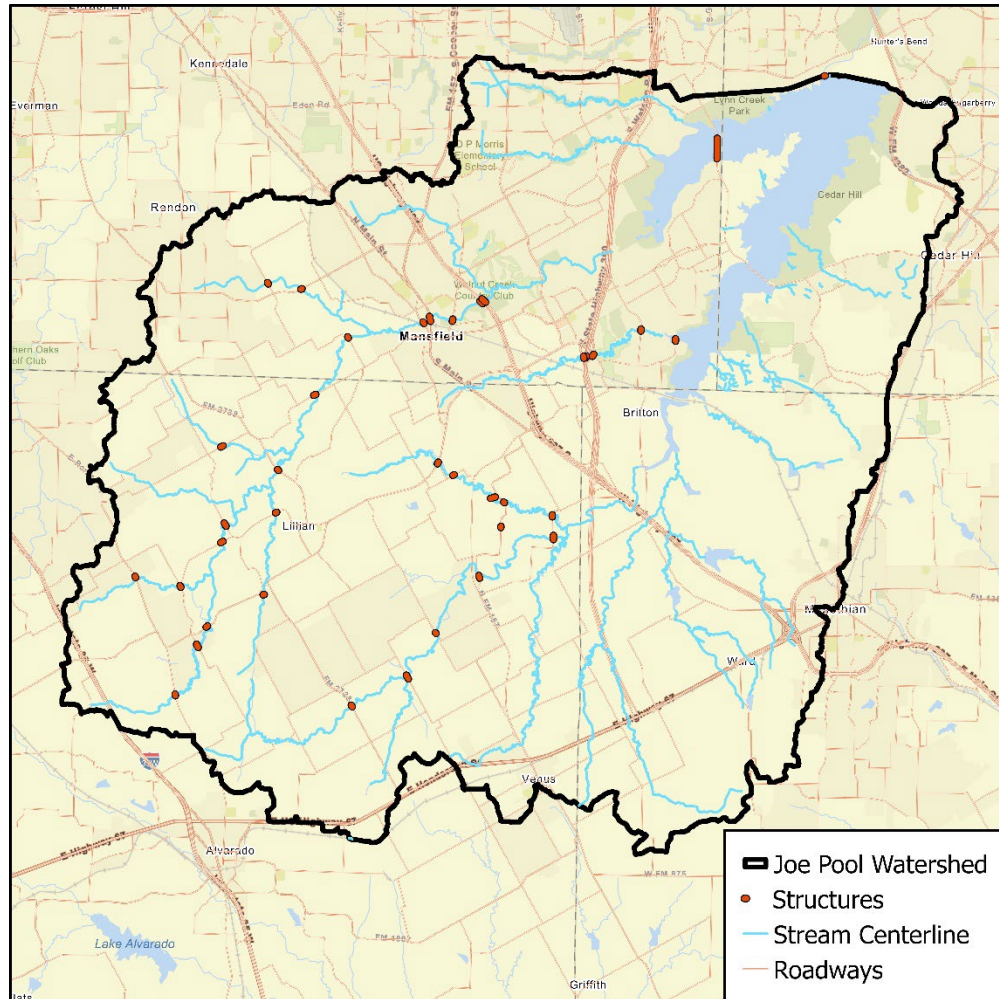


Figure 1: Locations of 2D Structures

2.2.2 2D Mesh

At each bridge location, the computational mesh was refined to ensure that a minimum of two cells spanned the full length of each bridge structure. For culverts, the mesh configuration was developed to include all culvert barrels within a single computational cell upstream and a single cell downstream except for cases where the mesh was too fine. These refinements were achieved by adjusting the near spacing, near repeats, and far spacing of the 2D mesh connections.

Breaklines were modified to accommodate the structures and associated mesh cells. To prevent interference with the mesh around the structures, the breaklines representing the stream and roadway were shortened in the vicinity of each structure, ensuring that the mesh configuration at these locations adhered to the strategy described in the previous paragraph. Once these adjustments were made, the modifications were implemented by enforcing all breaklines.

2.2.3 Unsteady Flow Data

The HEC-HMS version 4.12 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 Mountain Creek Watershed” report.

In addition to the five original BLE plans corresponding to the 2-, 10-, 50-, 100-, and 500-year storms, five plans representing 2020 existing conditions and five plans representing 2070 future conditions were developed for the same recurrence intervals. All additional plans utilize the same geometric configuration, with variations only in the assigned unsteady flow data.

2.2.4 Terrain and Manning’s Number Layer Updates

The BLE terrain was updated by Freese and Nichols (FNI) to incorporate lake bathymetry data and terrain modifications for culverts. FNI stitched together the BLE terrain and a surface generated from TWDB bathymetric survey of Joe Pool Lake dated May 2022. Terrain modifications were applied to approximate smaller culverts not modeled as Storage Area/2D Flow Area (SA/2D) connections, adjust culvert inverts to match flowlines, and improve stability of crossings.

The Manning’s roughness layer was updated by FNI to better reflect current land cover conditions, as the source BLE land cover was a post-processed version of the National Land Cover Dataset (NLCD) that did not increase the model resolution. FNI processed the source NLCD and added delineations of the roadway network based on the 2019 North Central Texas Council of Governments (NCTCOG) roads dataset and the channel. The roads were defined using buffers based upon NCTCOG road type (shown in **Table 2**). The channel was defined based on a semi-automated process that combines 10-year depths with a 25-foot buffer of the BLE stream centerlines. **Table 3** lists the Manning’s n values adopted for each land cover area present in the enhanced model.

Table 2: NCTCOG Road Type and Buffer Width Applied

Road Type	Buffer (ft)
Access Ramp	8
Connecting Road*	n/a
Driveway	5
Major Arterial	18
Minor Arterial	12
Other	5
Primary Highway	30
Private Road	5
Secondary Highway	20
Service Road	8
Trail	5
*Generally covered by highway buffers	

Table 3: Manning's n Values by Land Cover

Land Cover	n
Grassland-Herbaceous	0.03
Deciduous Forest	0.12 (0.1)*
Shrub-Scrub	0.06
Developed, Open Space	0.04
Cultivated Crops	0.04 (0.025)*
Pasture-Hay	0.04
Open Water	0.03 (0.025)*
Developed, High Intensity	0.12
Developed, Medium Intensity	0.08
Developed, Low Intensity	0.06
Emergent Herbaceous Wetlands	0.08 (0.075)*
Woody Wetlands	0.1 (0.08)*
Mixed Forest	0.12 (0.1)*
Barren Land Rock-Sand-Clay	0.03
Evergreen Forest	0.12 (0.1)*
Channel	0.04
Roads	0.02
*BLE modification to default value	

3. Results and Conclusions

Existing flood risk within the Mountain Creek watershed is distributed across many locations. When evaluated against National Structure Inventory (NSI) building data and the road network dataset, the 100-year 2020 flood event affects 176 structures (WSE above NSI ground elevation) and 19.6 miles of road (depth greater than 6 inches). This is shown in **Figure 2**.

With the future increases in impervious surface area in the Mountain Creek watershed, flood risk increases. The 100-year 2070 flood event affects 801 structures (WSE above NSI ground elevation) and 20.8 miles of road (depth greater than 6 inches). This is shown in **Figure 3**. The increase in 100-year flood elevations from the 2020 to 2070 existing storm events is shown in **Figure 4**.

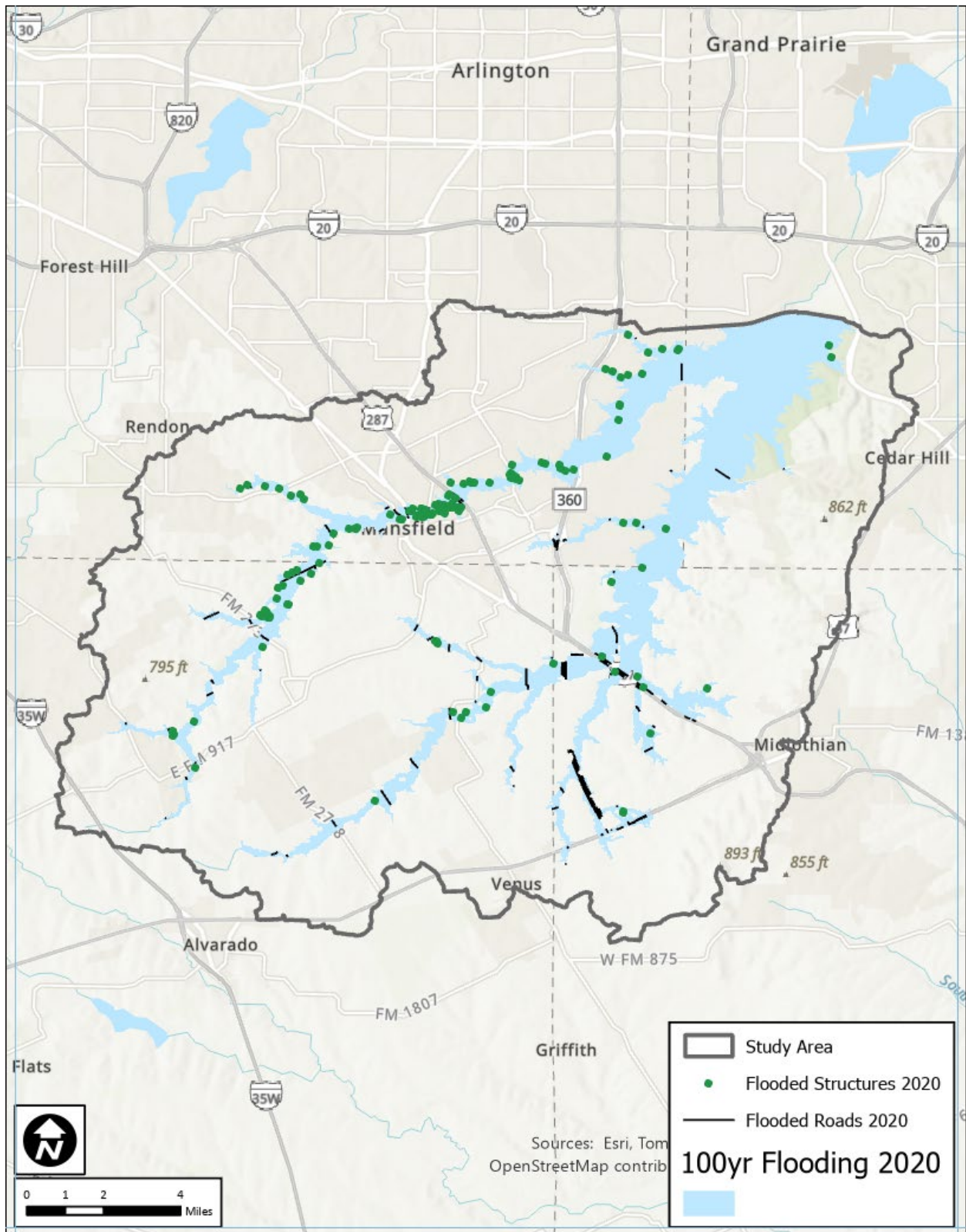


Figure 2: Existing Conditions, 100-year Flooding in 2020

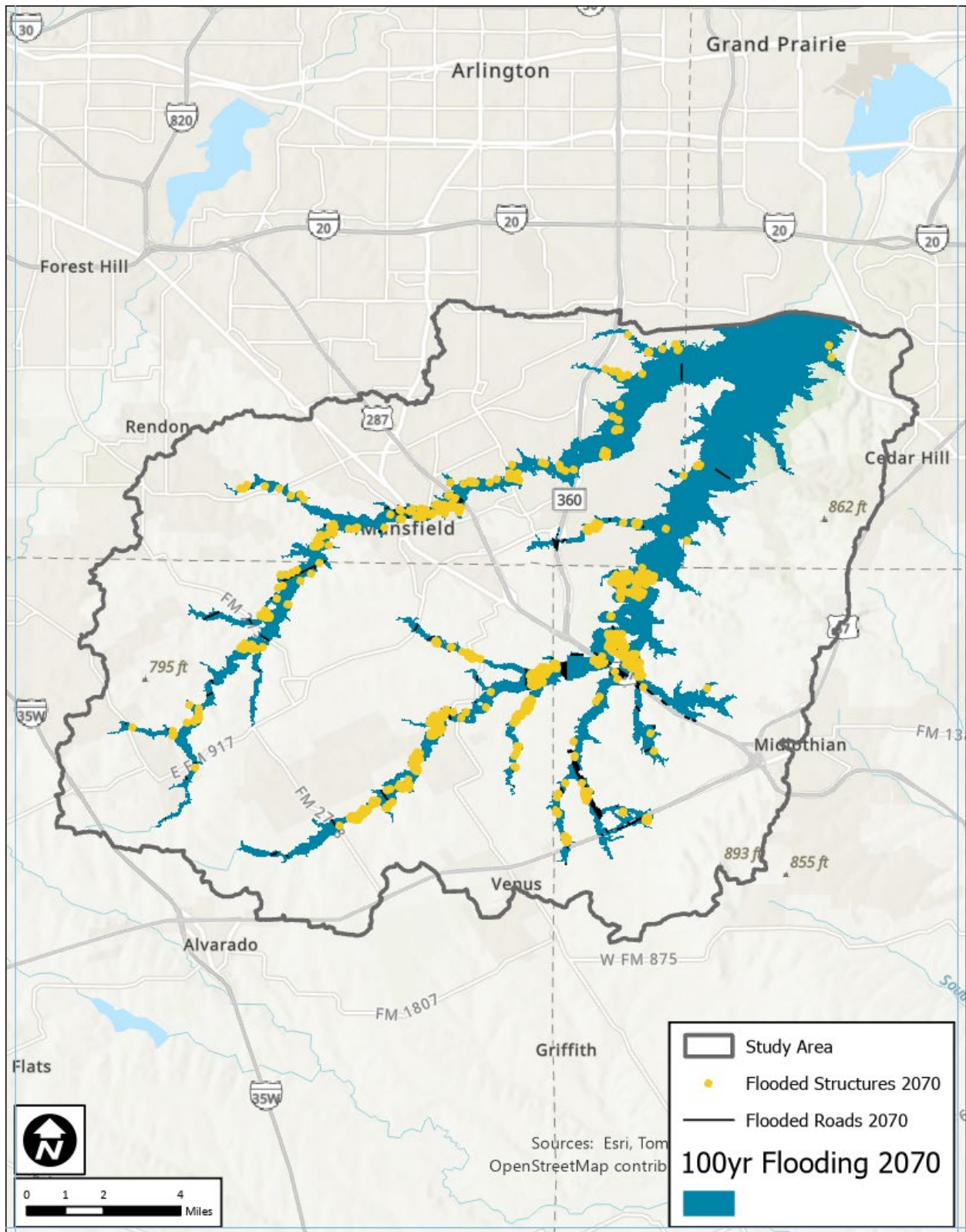


Figure 3: Existing Conditions, 100-year Flooding in 2070

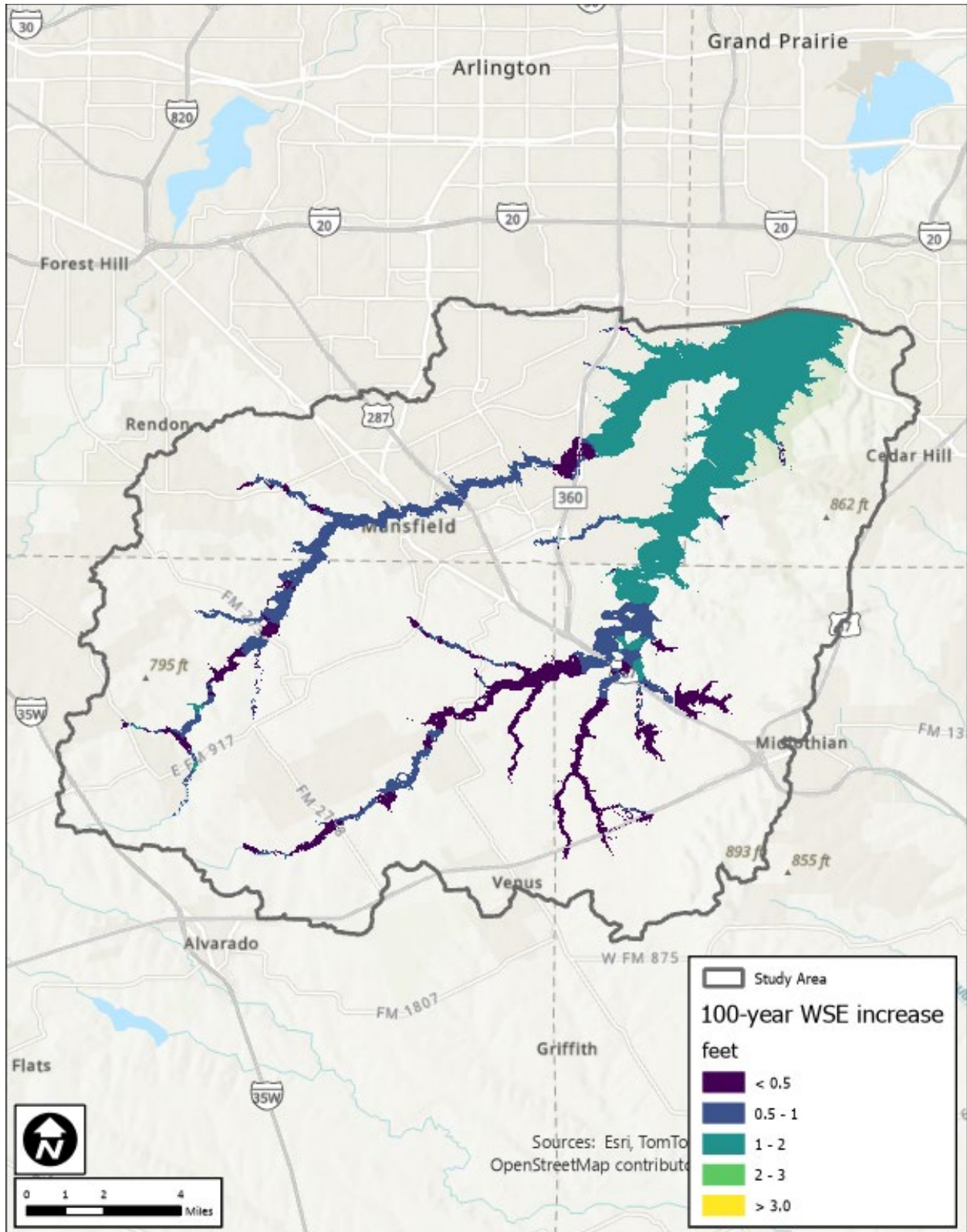


Figure 4: Increase in 100-year flood elevations from 2020 to 2070 without TSI projects

4. References

- National Oceanic and Atmospheric Administration (NOAA). (2018). NOAA Atlas 14 – Precipitation Frequency Data Server (PFDS). <https://hdsc.nws.noaa.gov/hdsc/pfds/>
- North Central Texas Council of Governments (NCTCOG). (2019). Roads. <https://data-nctcoggis.hub.arcgis.com/>
- Texas Department of Transportation (TxDOT). (2025). TxDOT Bridges SNBI. <https://gis-txdot.opendata.arcgis.com/>
- Texas Water Development Board (TWDB). (2023). Volumetric Survey of Joe Pool Lake. <https://www.twdb.texas.gov/surfacewater/surveys/completed/index.asp>
- U.S. Army Corps of Engineers (USACE). (2022). National Structure Inventory. <https://www.hec.usace.army.mil/confluence/nsi>
- U.S. Army Corps of Engineers (USACE). (2024). HEC-RAS Version 6.5. <https://www.hec.usace.army.mil/confluence/rasdocs>
- U.S. Geological Survey (USGS). (2019). National Land Cover Database. <https://www.usgs.gov/centers/eros/science/national-land-cover-database>
- U.S. Geological Survey (USGS). (2023). Estimated Base Flood Elevation (BFE) Viewer. <https://webapps.usgs.gov/infrm/estbfe/>