

From Storm to Impact: Applications of Statewide 2D BLE Modeling

Garrett Johnston, PE (TX), CFM, GISP

JGJ@freese.com

Héctor Olmos, PE (TX, FL, CO), CFM

HEO@freese.com



Outline



BLE Basics

- Methodology Assumptions
- Data Sources & Uses



Case Studies

- July 4 Emergency Response
- Buffalo San Jacinto Structures



Considerations

- Level of Effort
- LAS2RAS
- Best Practices

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BLE Basics

- Initial investment for communities
- Approximate, cost-effective modeling
- Various methods 1D & 2D
- Studied by HUC 8 Watershed – average size 1,200 mi²

www.fema.gov/sites/default/files/documents/fema_ble-overview.pdf

BASE LEVEL ENGINEERING
Flood data to expand local risk awareness



WHAT IS BASE LEVEL ENGINEERING?

Base Level Engineering produces quality data. The Base Level Engineering production approach combines high-resolution ground elevation data, and modeling technology advancements to create engineering models and flood hazard data. These analyses are produced at a large scale, like a watershed, as opposed to targeting individual stream reaches. The flood hazard information prepared is based off engineering models that determine flood elevations along each stream reach studied. The data prepared provides flood hazard information to community officials and allows them to interact with analysis results and review areas identified as prone to flooding.

Base Level Engineering increases public awareness. Producing and sharing this data provides FEMA an opportunity to broaden and expand risk awareness conversations with local communities, ultimately strengthening disaster resilience, and reducing public spending on recovery efforts after a flood event. The Estimated Base Flood Elevation Viewer, an interactive web portal, allows Federal, State, Regional, local entities; industry professionals; and the public at large to interact with the Base Level Engineering results. This tool increases FEMA's ability to present comprehensive flood hazard information to public, providing additional risk assessment resources where there are currently gaps in the current national flood hazard data inventory.

Base Level Engineering will lead to flood risk reduction. Communities can access and use data prior to updates to their regulatory Flood Insurance Rate Maps (FIRMs). Once a Base Level Engineering assessment is completed, FEMA releases the flood risk information on the Estimated Base Flood Elevation Viewer (<https://go.usa.gov/xsGdn>), providing flood risk information that may be immediately used for community floodplain management activities, local land use discussions, all-hazard mitigation planning, and identification of mitigation strategies, as well as providing a basis for more informed community development. The datasets may be used to inform future land use decisions, support grant submissions, generate flood vulnerability assessments, prioritize flood risk reduction projects, evaluate, design and prioritize capital improvement projects. The approach ultimately will allow FEMA to build a more robust network of flood risk information, an expedited process to update regulatory products and enable future expansion to risk-based analysis and future risk scenario modeling opportunities.



Base Level Engineering is collaborative. FEMA worked with Federal, State, Regional and Local entities to develop the Base Level Engineering concept. FEMA has interacted with a variety of State and local officials to further refine the concept, and inform the identification of flood risk datasets prepared. Base Level Engineering assessments produce datasets that can be shared publicly to broaden conversations about flood risk and inform opportunities for disaster resilient growth and restoration. The data produced by these assessments can be used across a variety of FEMA programs to assist in the identification and prioritization of projects. This effort allows increased transparency and data availability at all levels of government, growing the efficiency and integration of agencies working in the realm of flood risk.

Can I use Base Level Engineering to determine Base Flood Elevations in my community?
Yes, in most cases, the data made available through the Estimated Base Flood Elevation Viewer can be used to inform local community identification of the Base Flood Elevations. The data on the viewer (<https://go.usa.gov/xsGdn>) can be used if the stream is shown as a Zone A flood zone and the floodplains are similar in shape and width OR if the stream is not shown on the current effective FIRM. If the stream has been studied by more detailed methods (Zone AE), then the current effective Flood Insurance Rate Maps (FIRMs) and stream profiles in the Flood Insurance Study (FIS) text should be used to determine the Base Flood Elevation in detailed study areas.

Using Base Level Engineering to update Flood Insurance Rate Maps (FIRMs)
The engineering approach used to prepare Base Level Engineering meets all modeling and mapping standards outlined in FEMA's Standards for Flood Risk Projects and the results may be used to rapidly update Zone A. The models developed during these assessments can be refined by communities or FEMA to include survey and structure information to efficiently update the detailed study (Zone AE) areas experiencing growth.

Developers can download and refine engineering models to identify the floodplain changes and determine Base Flood Elevations in project areas near streams analyzed with Base Level Engineering.

Why is FEMA investing in Base Level Engineering? Each mile of stream shown on a Flood Insurance Rate Map (FIRM) is required to be reviewed and validated by FEMA every five years. The flood hazard information is reviewed to determine if the built environment or expected flood flows have changed since the previous study was performed. A large portion of the national flood hazard inventory of stream miles is currently unknown or unverified.

How are watersheds selected for Base Level Engineering assessment? FEMA works with its Federal, State and local partners to determine areas where high resolution ground elevation data (i.e. LIDAR) is available. High resolution ground data allows more accurate results than previous Zone A efforts. Incoming requests are prioritized with help from our State partners.

Does Base Level Engineering replace the Flood Insurance Rate Maps for my community? Base Level Engineering information does not replace the information shown on any current effective FIRM panel in a community. The Base Level Engineering is used to assess the current validity of the existing flood hazard inventory and assists local communities to estimate Base Flood Elevations (BFEs) in Zone A areas.

Community & Public Access to Results

Base Level Engineering results are available for use by the public on the Estimated Base Flood Elevation Viewer at: <https://go.usa.gov/xsGdn>

Users can interact with data through the on-line portal, view data with a singular or side-by-side window. Users may also point-click and download:

- engineering models,
- floodplain extents, and
- estimated flood depths, and
- water surface elevations.

Users may also run a site specific report to review flood risk in their vicinity at their convenience.

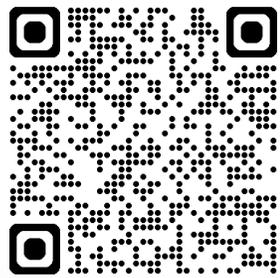
Estimated Base Flood Elevation Viewer

Download Datasets & Models

View Base Level Engineering Data

Property Look Up

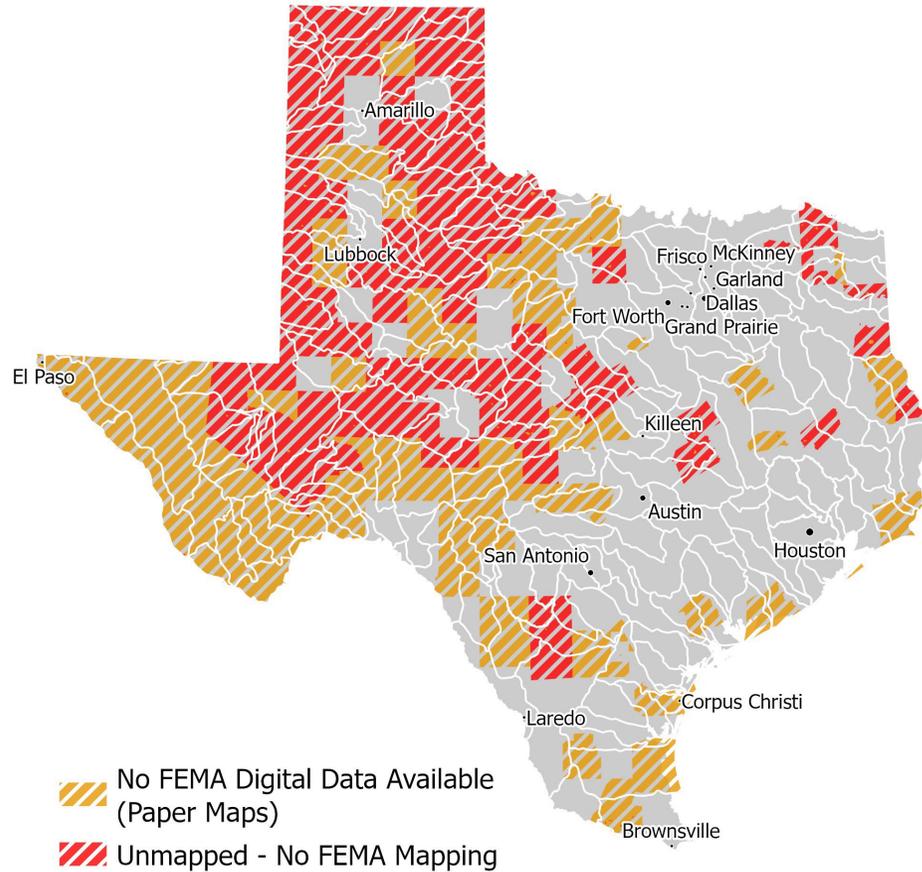
Click a Map to get started



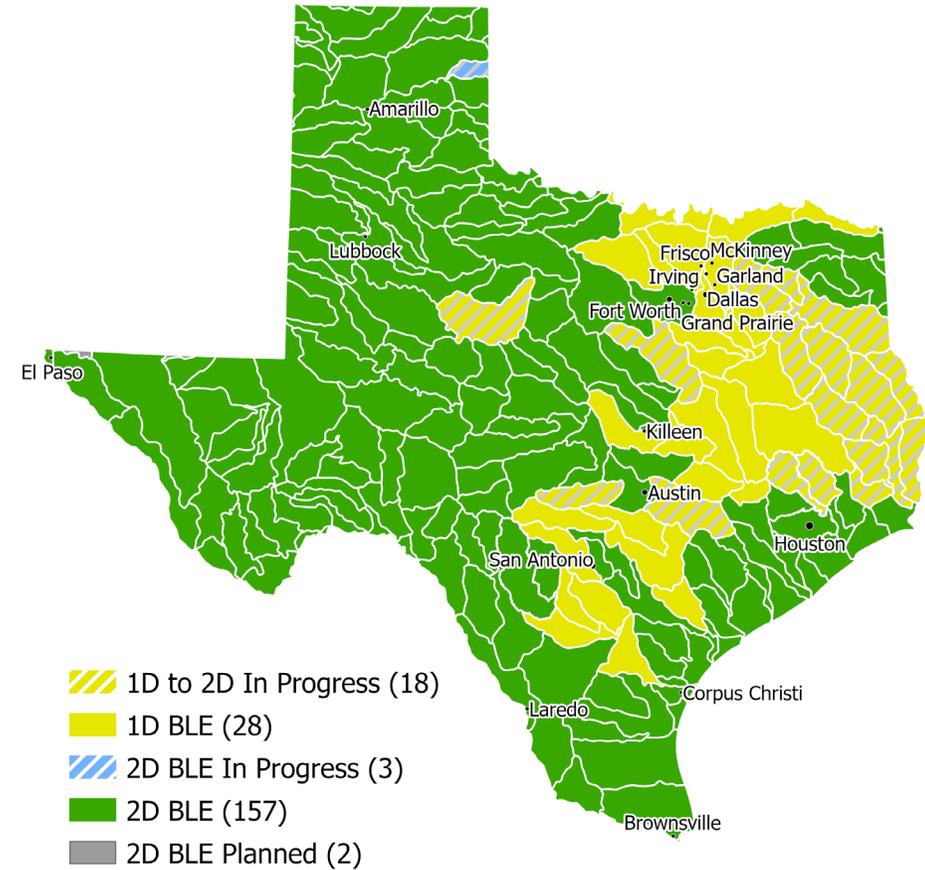


BLE Basics

FEMA Availability

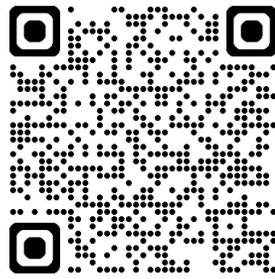


2025 BLE Availability





TWDB BLE



Total HUC 8s in Texas

208

HUCs Completed by TWDB

138

HUC 8s Completed by FEMA

65

Completed

203

In Progress

3

Planned

2

70
Pending Upload to the EBFV Viewer

133
Available for download*

BLE Progress Gauge

98%

BLE Status Counts by Funding Source

Funding Source	Complete	In Progress	Planned
CTP	23	0	0
Federal	65	3	2
State	115	0	0

Study Status Count by BLE Study Type

BLE Study Type	Complete	In Progress	Planned
1D	46	0	0
2D	157	0	0

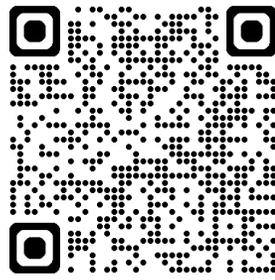
*Click [here](#) to go to the EBFV Viewer

BLE Status Map

HUC 8 Watershed Search



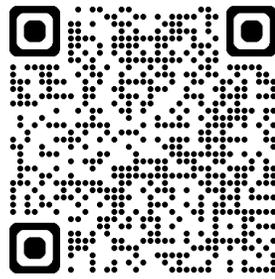
Data Sources for Flood Risk



Data Source/ Characteristics	FEMA Regulatory	BLE	Cursory (Fathom)	TWDB Quilt	2024 State Flood Planning Dataset
Maintained By	FEMA and CTPs	TWDB/FEMA, USGS (hosting)	TWDB	TWDB	RFPGs, TWDB (hosting)
Sources/Methods	Approximate and Detailed	Approximate	Approximate	Merge FEMA+BLE+Cursory	Merge variety of sources
Coverage	Selected Areas	Statewide	Statewide	Statewide	Statewide
Formats	Polygons	Polygons, Rasters	Rasters	Polygons	Polygons
Mapped Frequencies	100-, 500-Yr	10-, 100-, 500-Yr	10-, 50-, 100-, 500-Yr	100-, 500-Yr	100-, 500-Yr
Inundation Areas	Yes	Yes	Yes	Yes	Yes
Flood Elevations	Yes	Yes	Yes	No	No
Model Availability	Partially	Yes!	No	Source dependent	Source dependent
Min/Max Download Unit	Models - Reach/ Watershed Mapping - Countywide	HUC-8	1-degree tiles / Statewide	Regionwide / Statewide	Regionwide / Statewide
Model Types	1D, limited 2D	1D, 2D (evolving to all 2D)	2D	1D, 2D	1D, 2D
Update Frequency	Varies	5 years	Undetermined	5 years	Planning Cycle (typically 5 yrs)



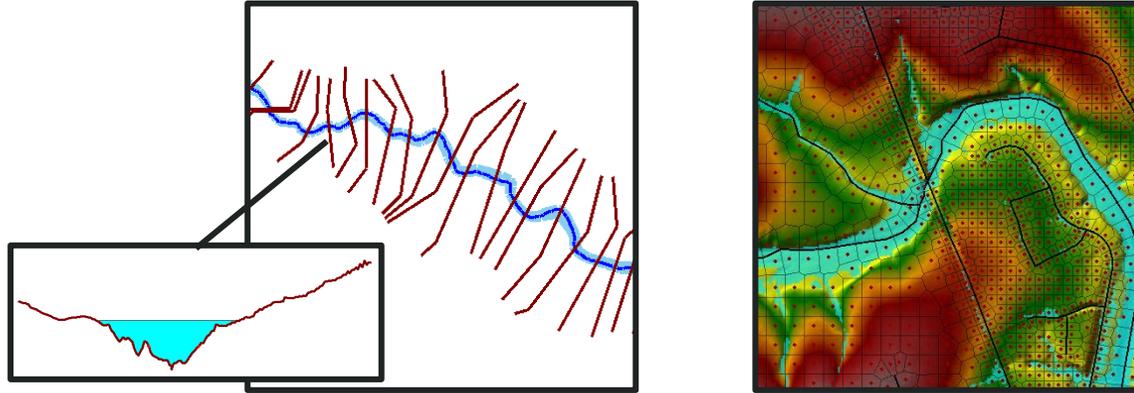
Data Sources vs Uses



Use Categories	Data Sources/Uses	FEMA Regulatory	BLE	Cursory (Fathom)	TWDB Quilt	Flood Planning Dataset
Regulatory Mapping	Updating FEMA Regulatory Maps (LOMR, PMR, FIRM)	Always	Sometimes	Never	Never	Never
Emergency Management	Preparedness	Always	Always	Sometimes	Rarely	Rarely
	Flood Forecasting	Rarely	Sometimes	Rarely	Never	Never
	Flood Hindcasting	Sometimes	Always	Rarely	Never	Never
Science and Research	Flood Science and Research	Sometimes	Always	Always	Sometimes	Sometimes
Planning	Flood Mitigation Planning	Always	Always	Sometimes	Sometimes	Always
	Land Use Planning	Always	Always	Sometimes	Sometimes	Always
	Statewide Vulnerability Planning (TxDOT, other state agencies)	Sometimes	Sometimes	Always	Sometimes	Sometimes
Infrastructure Design	Design Stormwater Infrastructure	Sometimes	Always	Sometimes	Never	Never
Permitting	Regulatory Permitting	Always	Sometimes	Sometimes	Rarely	Never
	BFE Estimation	Always	Sometimes	Sometimes	Never	Never



BLE Methods Summary



	1D BLE	Typical TWDB 2D BLE	Potential BLE Enhancements
Hydrology	Gage Analysis + HMS CN AMC-II	Rain on Mesh - CN AMC-II – validated to stream gages where available	Regional adjusted losses
Model Area	Per Stream	~HUC-10	
Cell Size	Automated XS placement at set spacing	Typical - 200 ft, Urban – 50 - 100 ft	Additional Refinements
Storage/Routing	Simplified Routing Method – Lag or Muskingum-Cunge	Breaklines from established datasets supplemented and revised to terrain	Additional Refinements
Structures	None	Terrain mod at restrictions (at least 100-yr event); may include rating curves	Structure Modeling at Various Levels of Detail, Storm Drain Conveyance
Land Cover	NLCD	NLCD or zoning with channel refinements	Local land use/zoning
Flow Path	Stream centerlines delineated based on terrain to 1 sq mi or 0.5 sq mi urban	Stream centerlines delineated based on terrain to 1 sq mi or 0.5 sq mi urban	Additional Refinements

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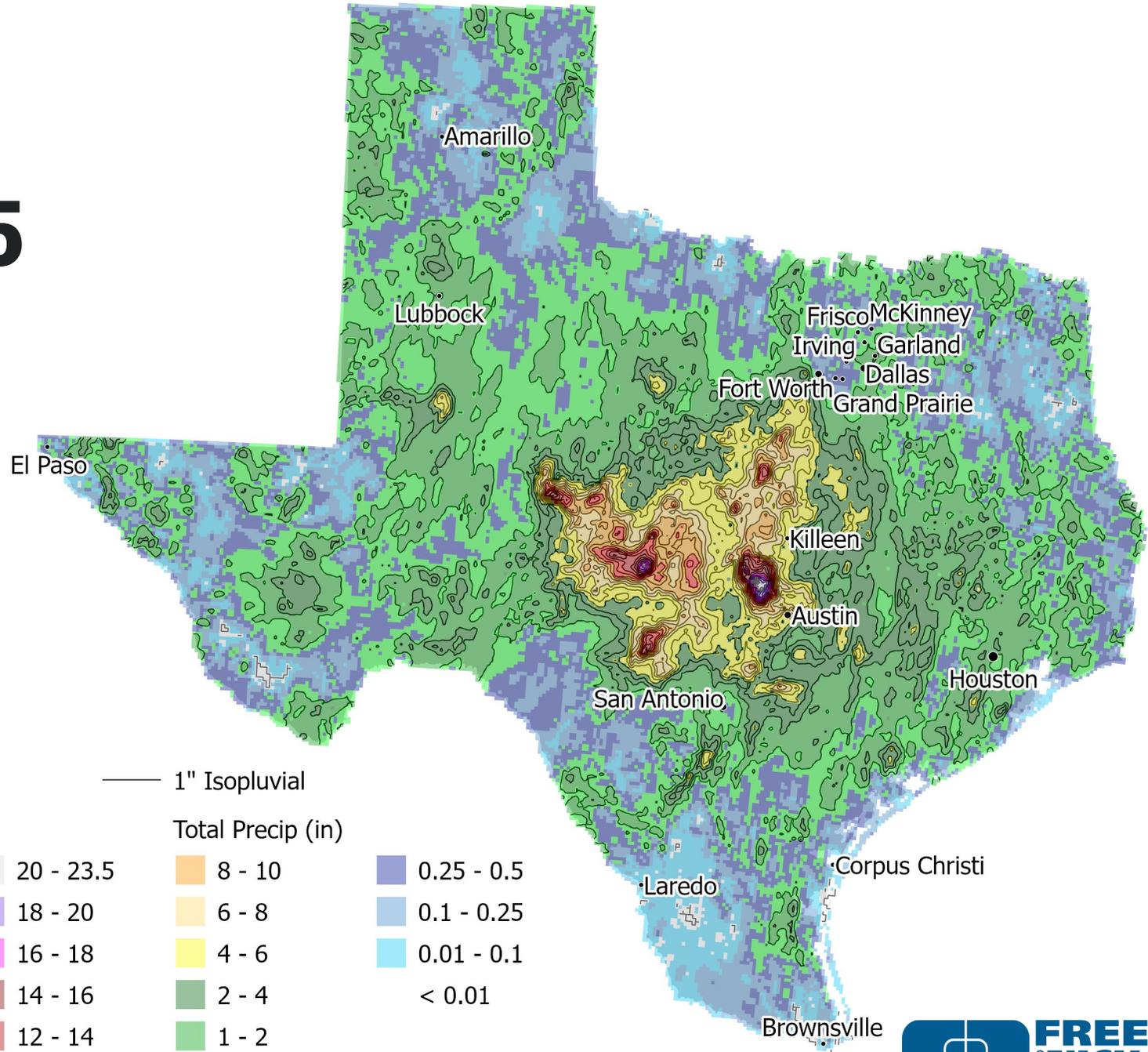


Considerations

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- Best Practices



July 4-7, 2025 Rainfall



— 1" Isopluvial

Total Precip (in)

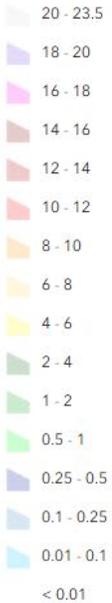
20 - 23.5	8 - 10	0.25 - 0.5
18 - 20	6 - 8	0.1 - 0.25
16 - 18	4 - 6	0.01 - 0.1
14 - 16	2 - 4	< 0.01
12 - 14	1 - 2	
10 - 12	0.5 - 1	



July 4th Post Disaster Analysis

Legend Map Layers Bookmarks

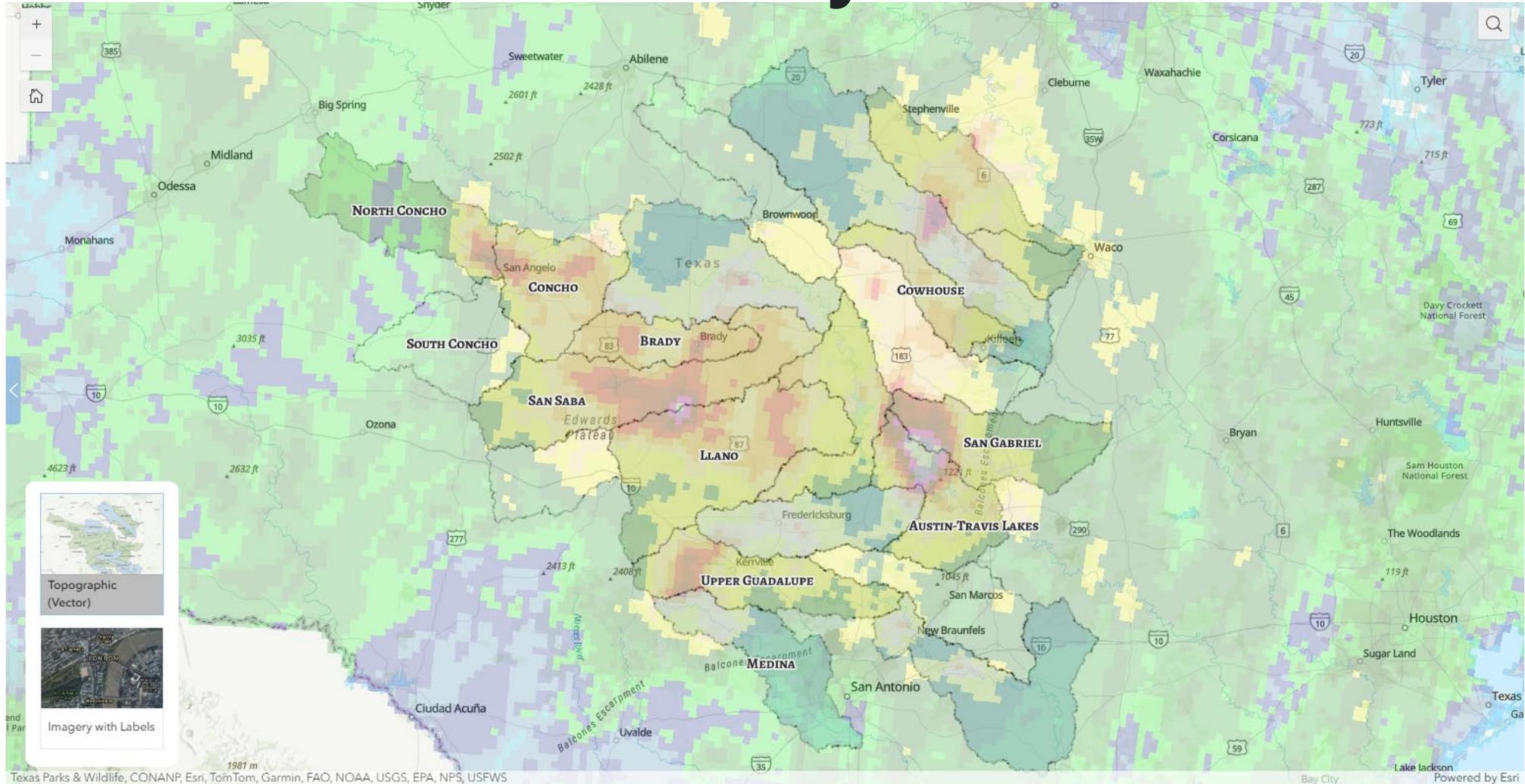
Rainfall Total Precipitation (in)



July 2025 Flood Model Results

Model Status

- Draft Complete
- In Progress
- Not Started



Topographic (Vector)



Imagery with Labels

Texas Parks & Wildlife, CONANP, Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, NPS, USFWS

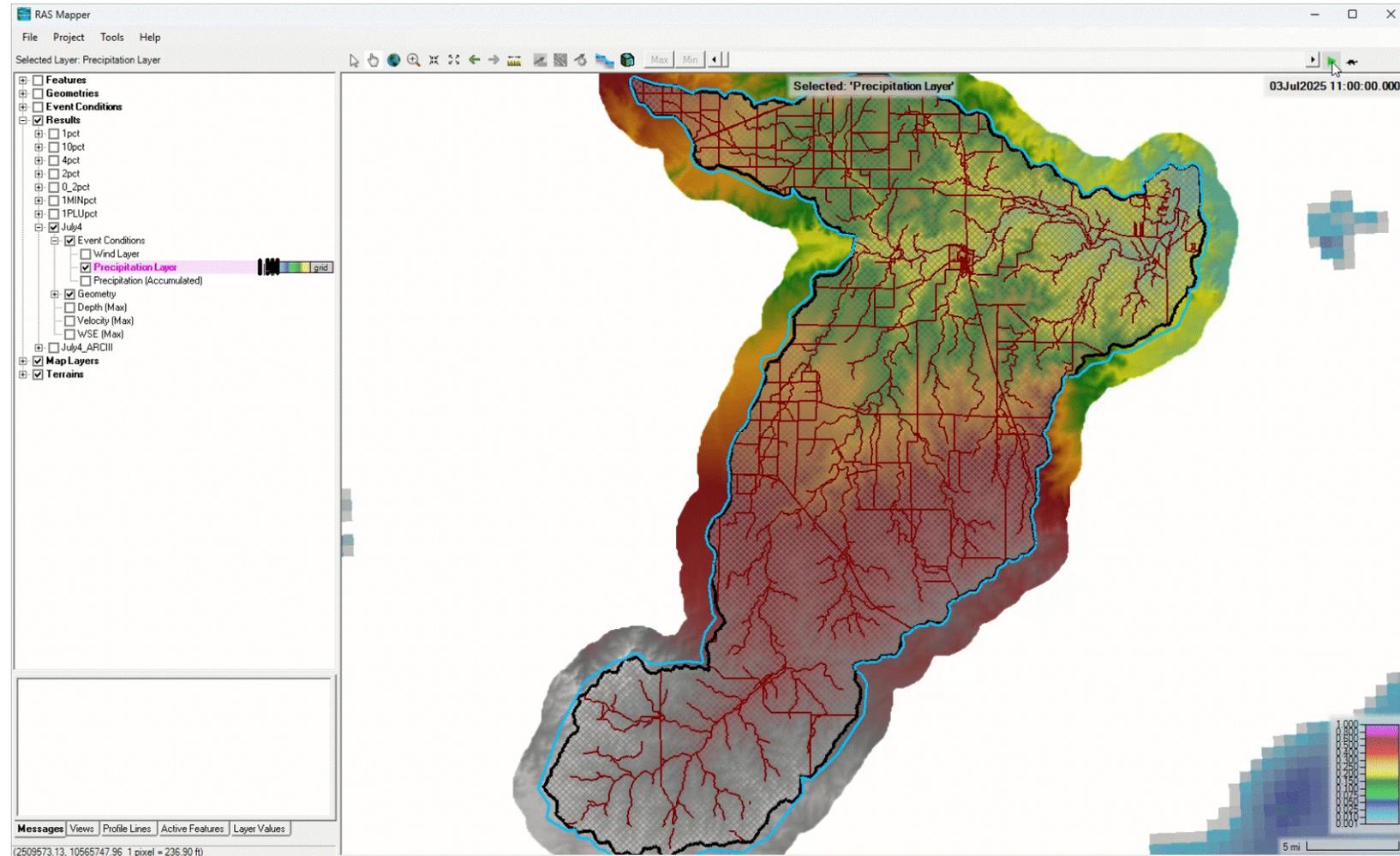
Bay City Powered by Esri





Running Historical Events

1. Update geometry if appropriate; Consider adding reference points and reference lines at stream gages
2. Update precipitation
3. Confirm boundary conditions and hydrologic losses are appropriate



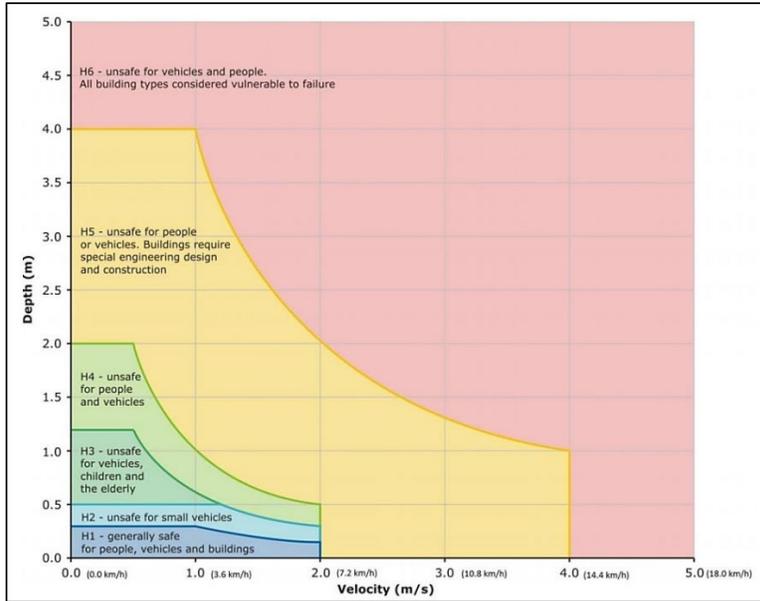
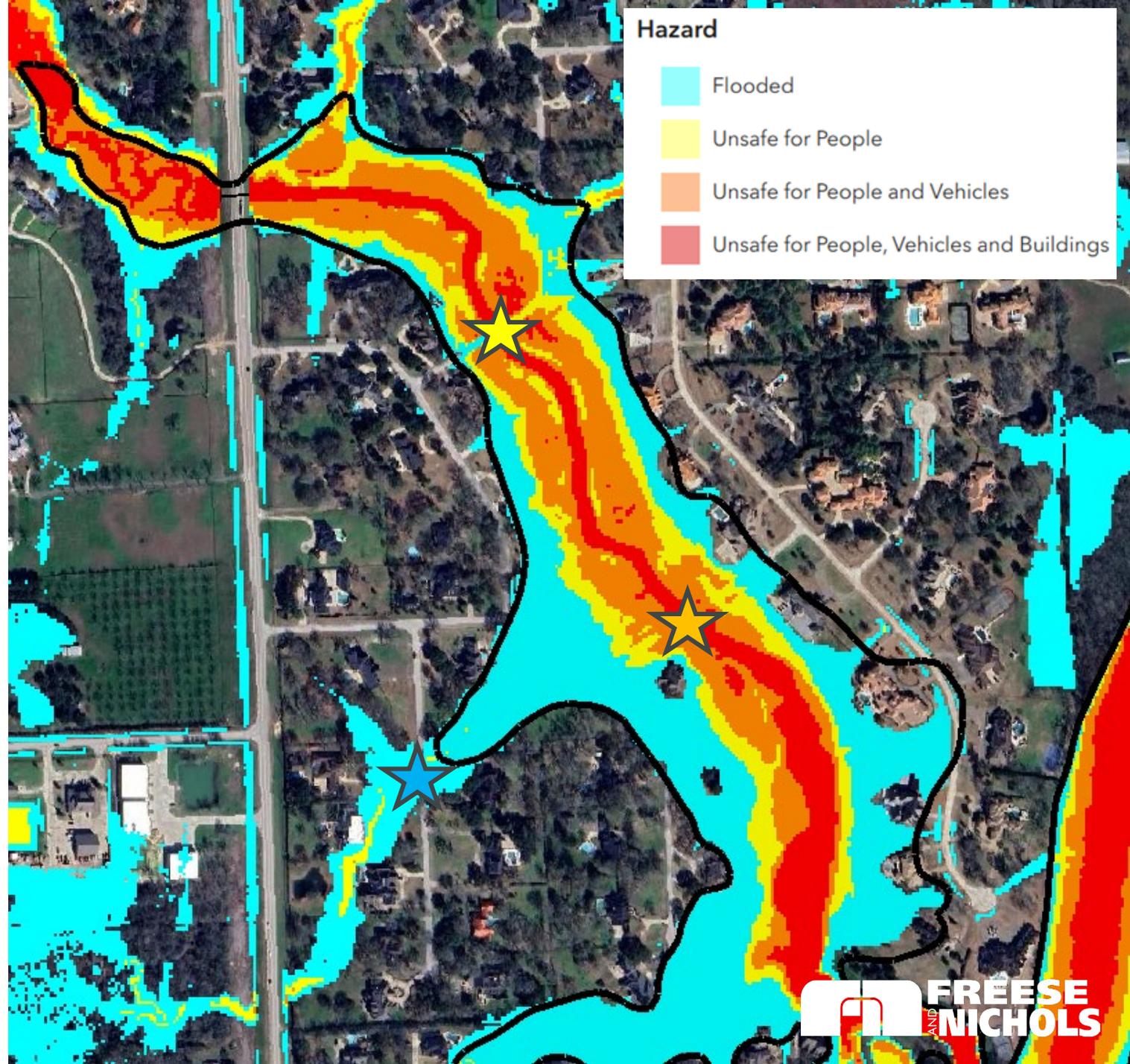


Figure F - 2. Flood hazard vulnerability curves (Smith et al. 2017).



Hazard

- Flooded
- Unsafe for People
- Unsafe for People and Vehicles
- Unsafe for People, Vehicles and Buildings

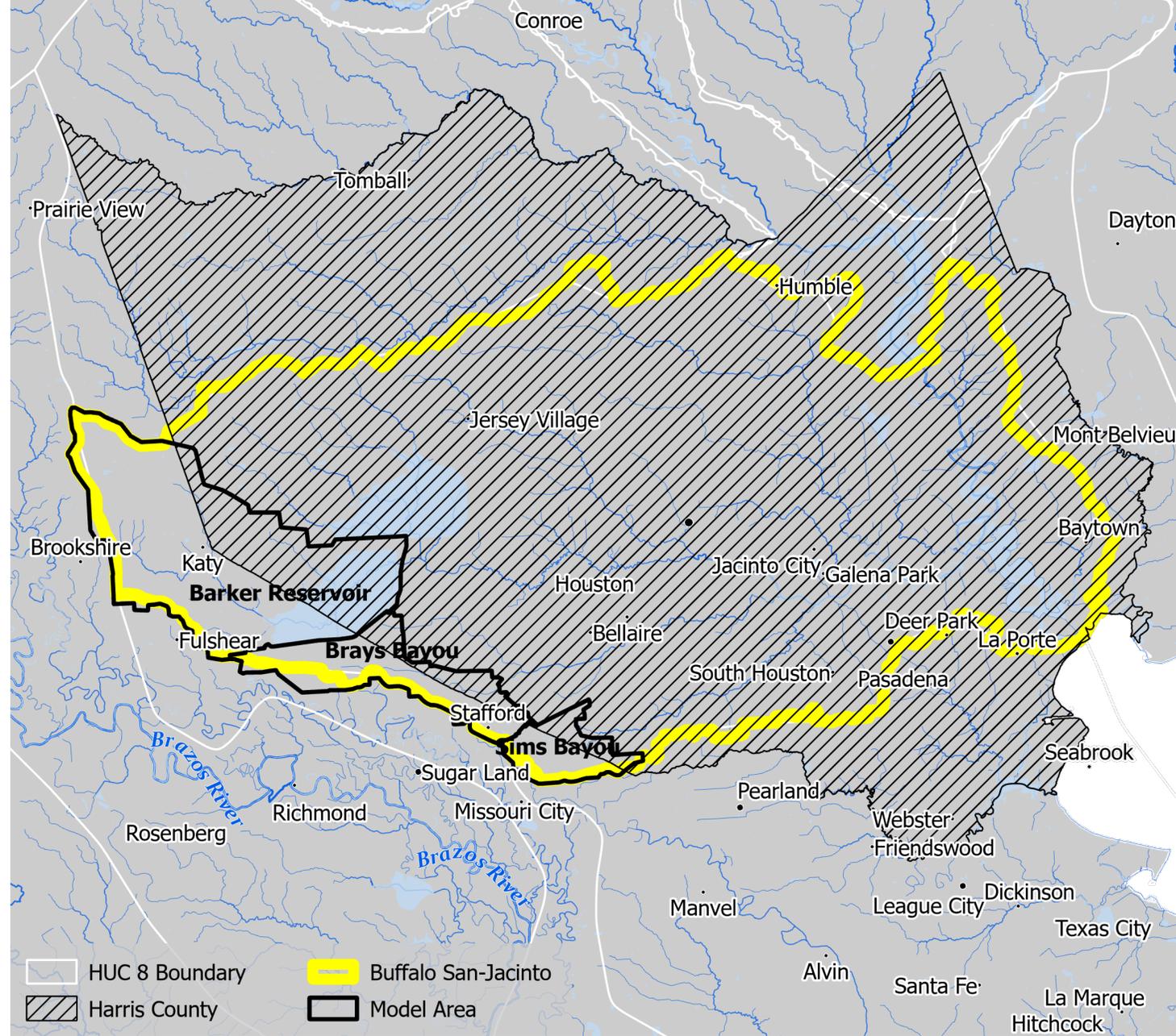
Hazard Estimation

Based on Depth & Velocity



Buffalo/ San Jacinto

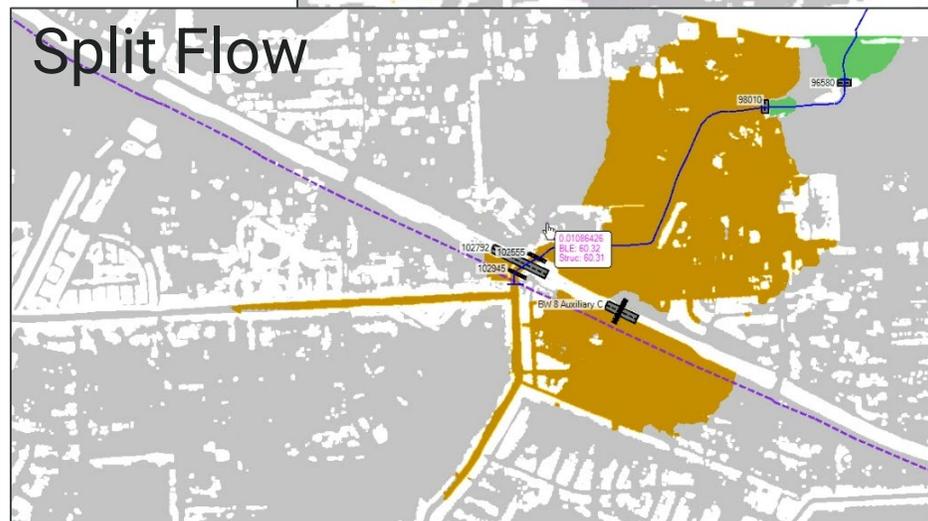
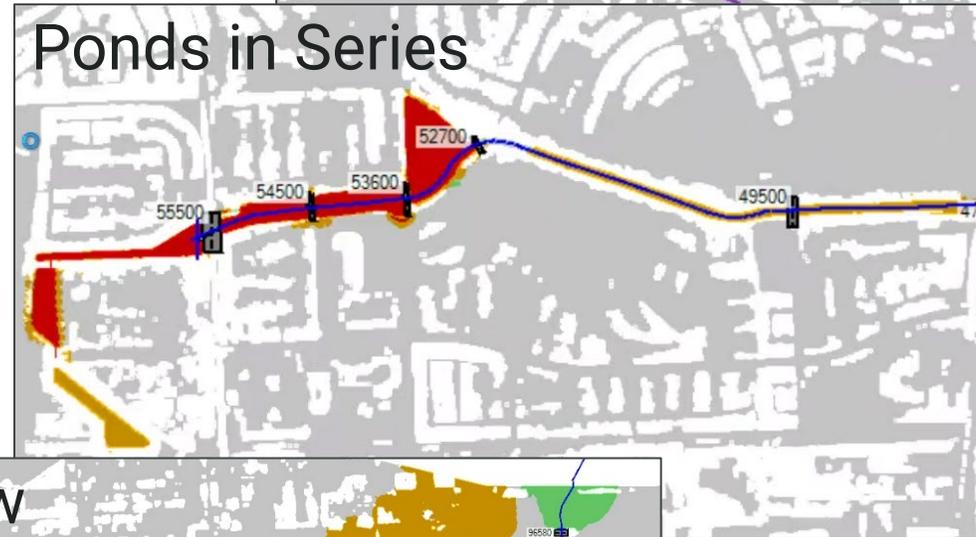
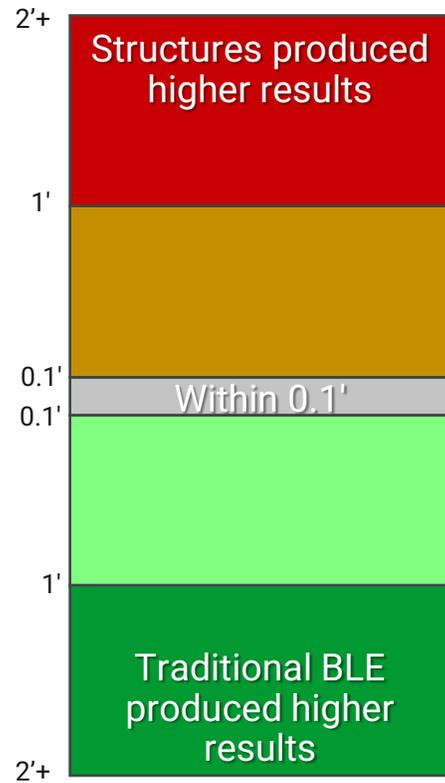
Pilot Study Leveraging
MAAPNext Structures from
Harris County Flood Control





Buffalo/San Jacinto

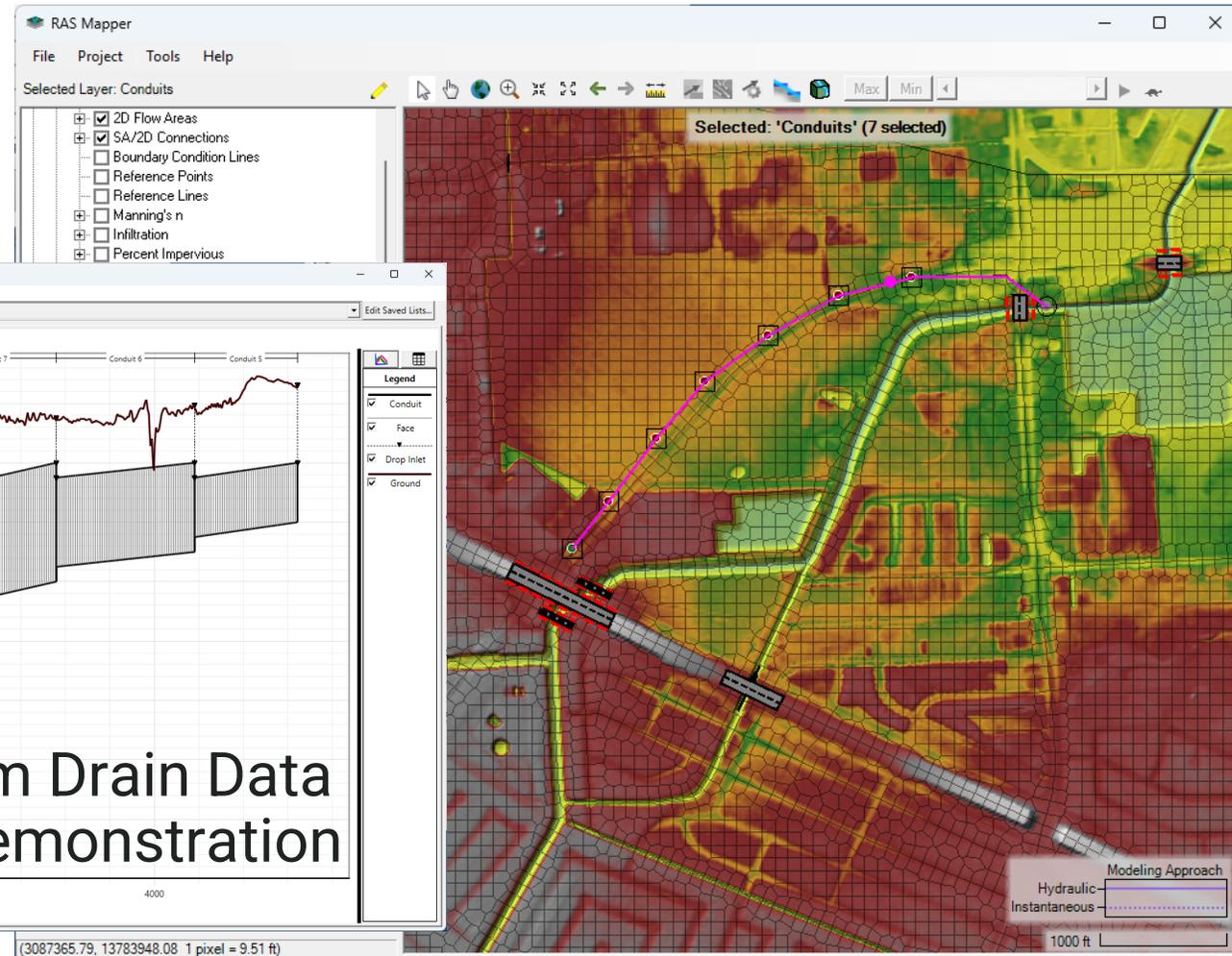
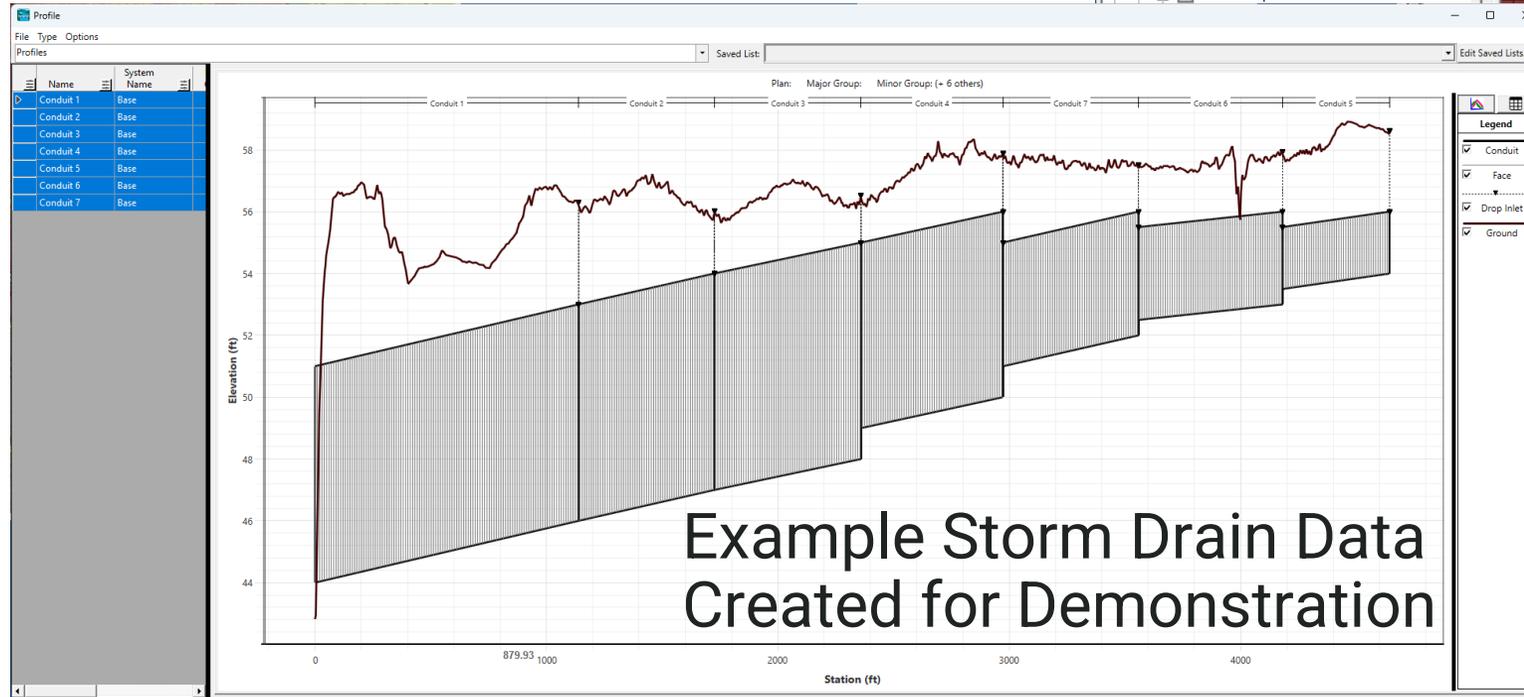
WSE Comparisons (100yr)





Buffalo/San Jacinto

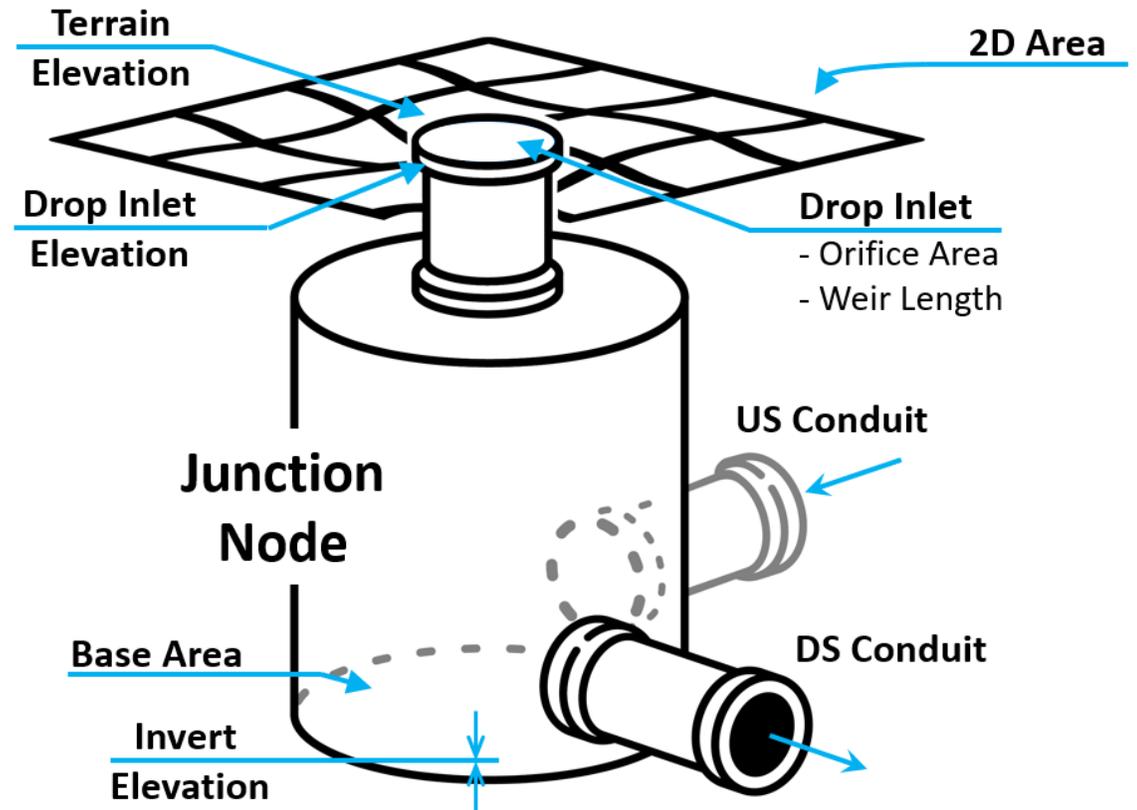
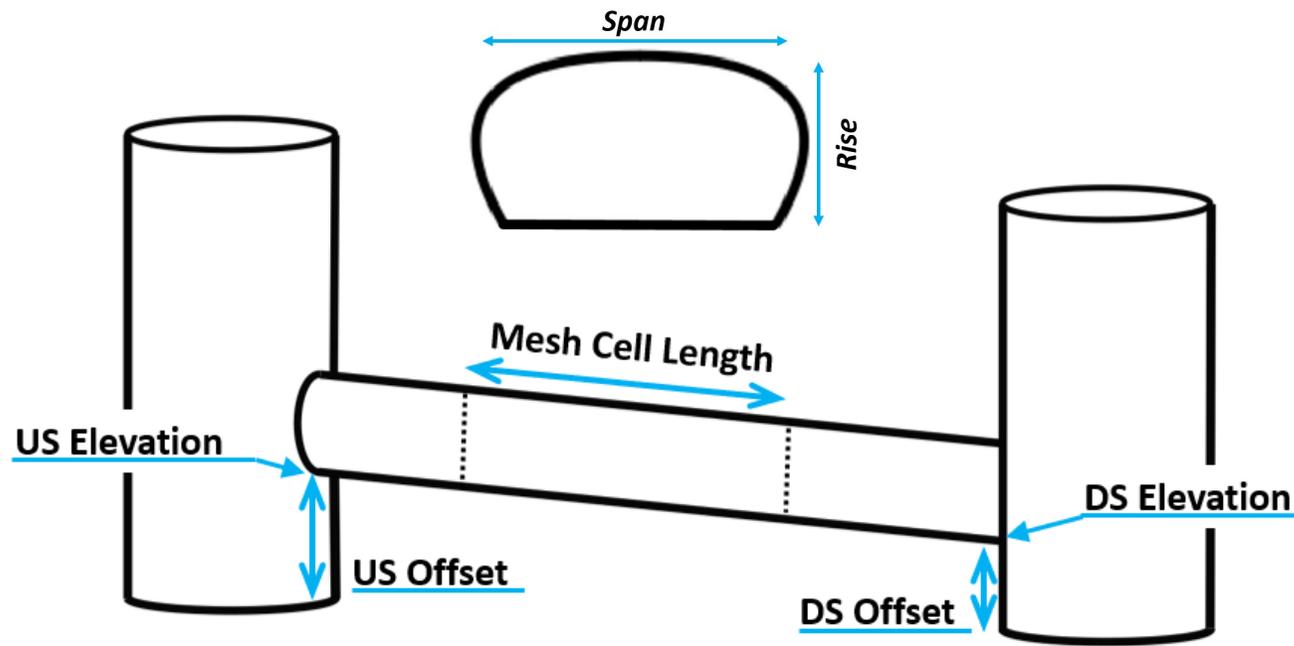
Adding Storm Drain Conveyance





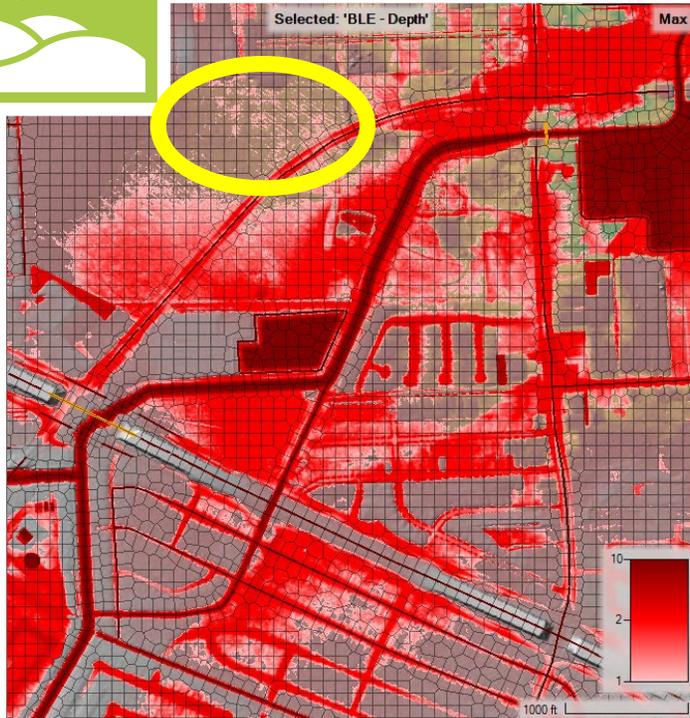
Buffalo/San Jacinto

Adding Storm Drain Conveyance





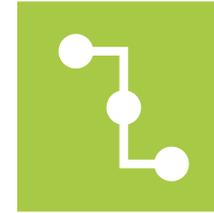
Buffalo/San Jacinto



Unsteady Flow Computations	1:46:32
Complete Process	1:52:04



Unsteady Flow Computations	3:41:55
Complete Process	4:01:11



Unsteady Flow Computations	5:21:44
Complete Process	5:22:44

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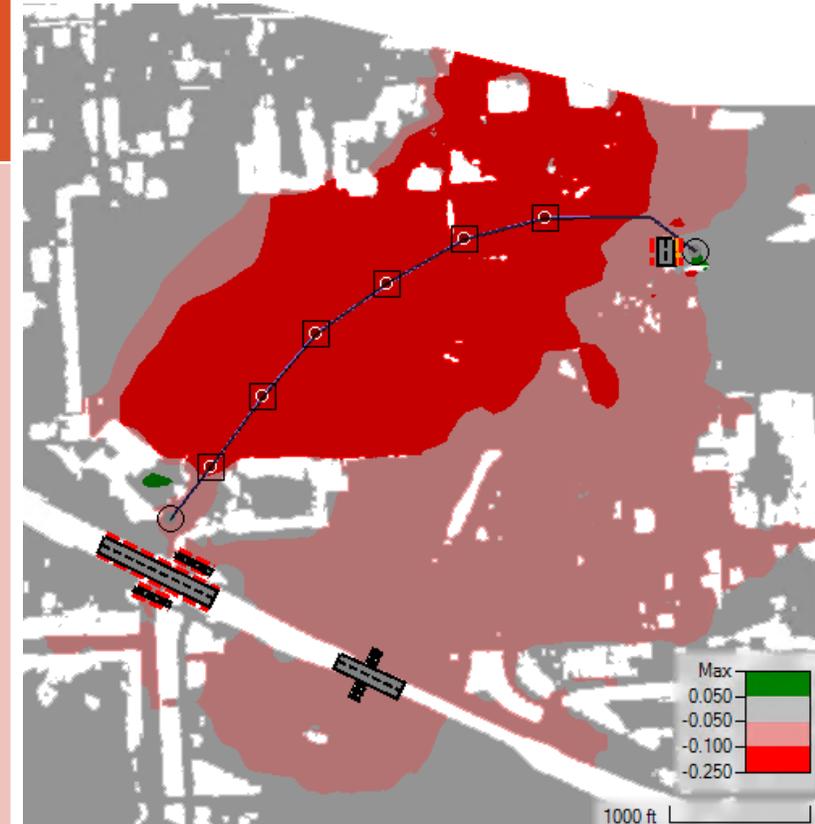
Considerations

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- **Best Practices**



Level of Effort – 2D BLE

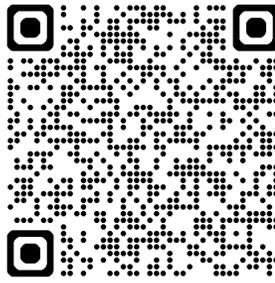
Low	Medium	High
Preparedness Planning Historical Event Modeling	Bridge or Culvert Modeling Flood Mitigation Planning	No Negative Impact Analysis Storm Drain Modeling





LAS2RAS

- Approximate Bridge Modeling Automation
- TWDB + TxDOT Tool
- LiDAR-derived bridge decks + National Bridge Inventory for 1D or 2D models



LAS2RAS Tool

Enter the file path for geojson containing Bridge data

Select the .prj file for projection

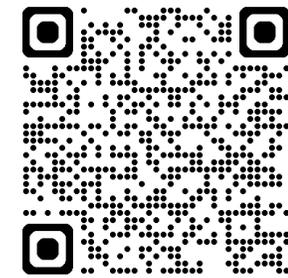
Enter the folder path of HEC RAS model



Best Practices

- Review model methods with your data use in mind
- Revise models to optimize for your needs
- Document assumptions/ data sources/ methods in model notes
- Use appropriate disclaimers when publishing data

Use Categories	Data Sources/Uses	BLE
Regulatory Mapping	Updating FEMA Regulatory Maps (LOMR, PMR, FIRM)	Sometimes
Emergency Management	Preparedness	Always
	Flood Forecasting	Sometimes
	Flood Hindcasting	Always
Science and Research	Flood Science and Research	Always
Planning	Flood Mitigation Planning	Always
	Land Use Planning	Always
	Statewide Vulnerability Planning (TxDOT, other state agencies)	Sometimes
Infrastructure Design	Design Stormwater Infrastructure	Always
Permitting	Regulatory Permitting	Sometimes
	BFE Estimation	Sometimes



Thank you

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