FLOG/FIM Subcommittee Meeting, 12 July 2024

Agenda Items:

1 – Flood mapping updates from Hurricane Beryl by Derek Giardino

2 - Automating bridge input in 1D and 2D HEC-RAS models by Anthony Holder and Abhinav Kandpal

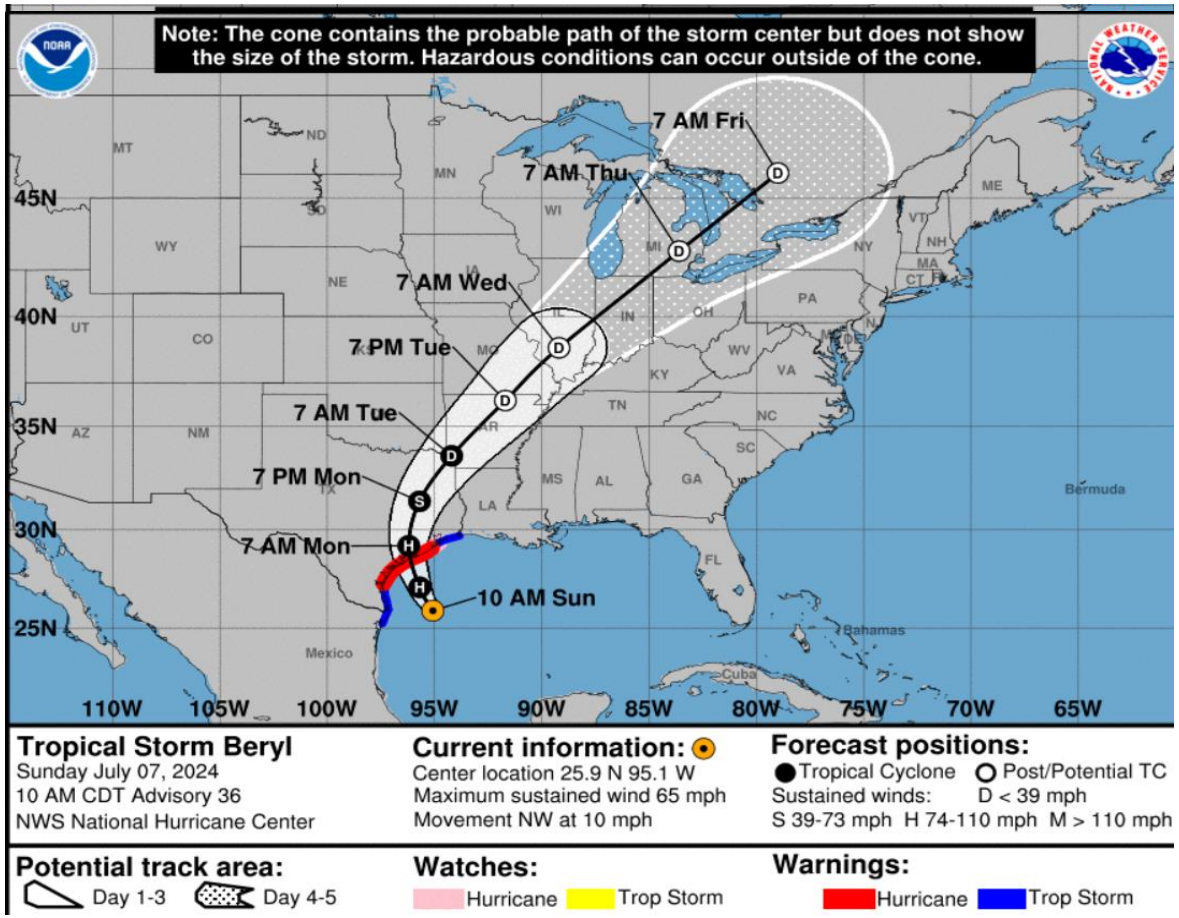
OWP | OFFICE OF WATER PREDICTION

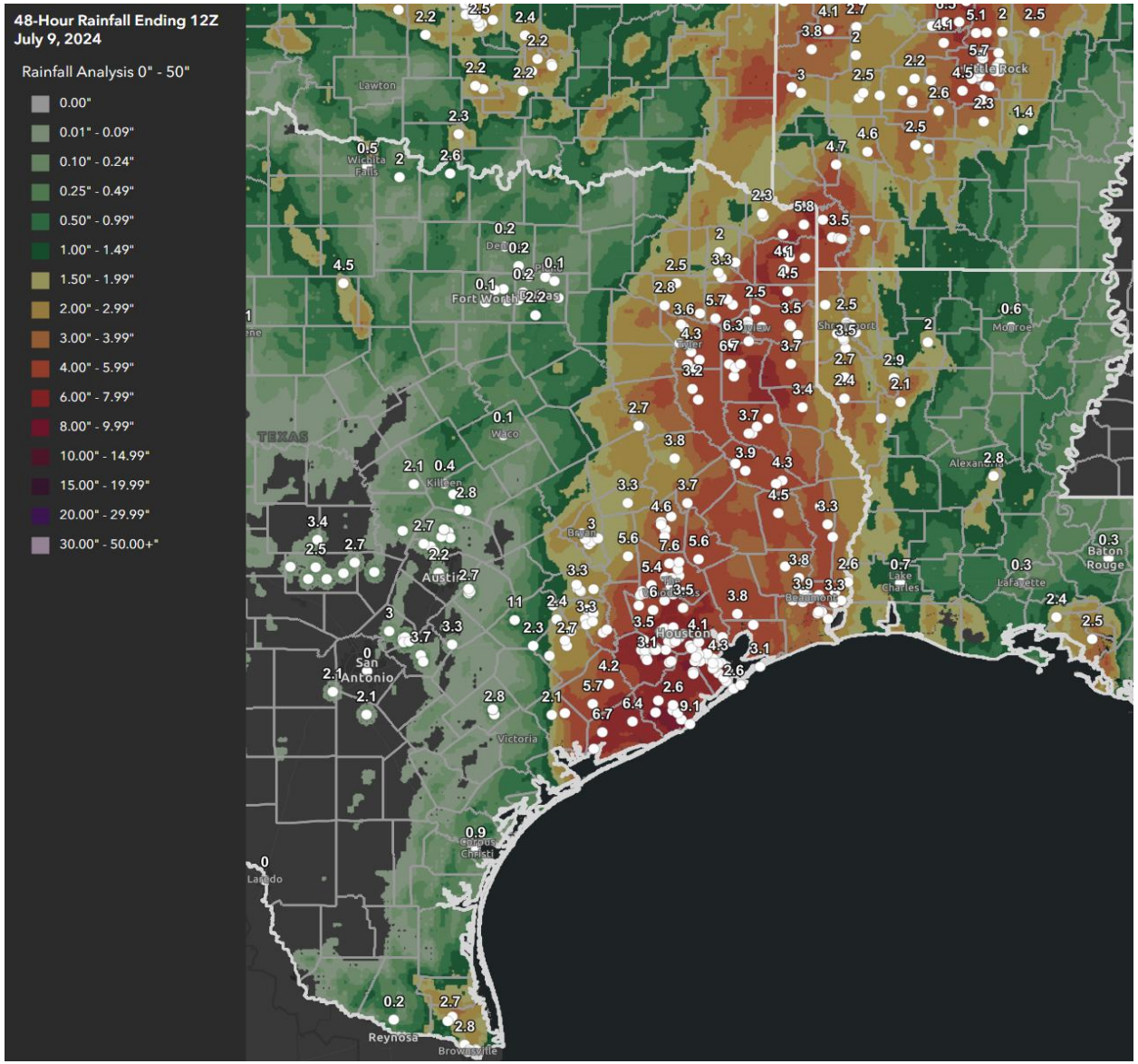
FLOG Meeting

Geo-Intelligence Division FIM Development Updates

July 12, 2024

Hurricane Beryl

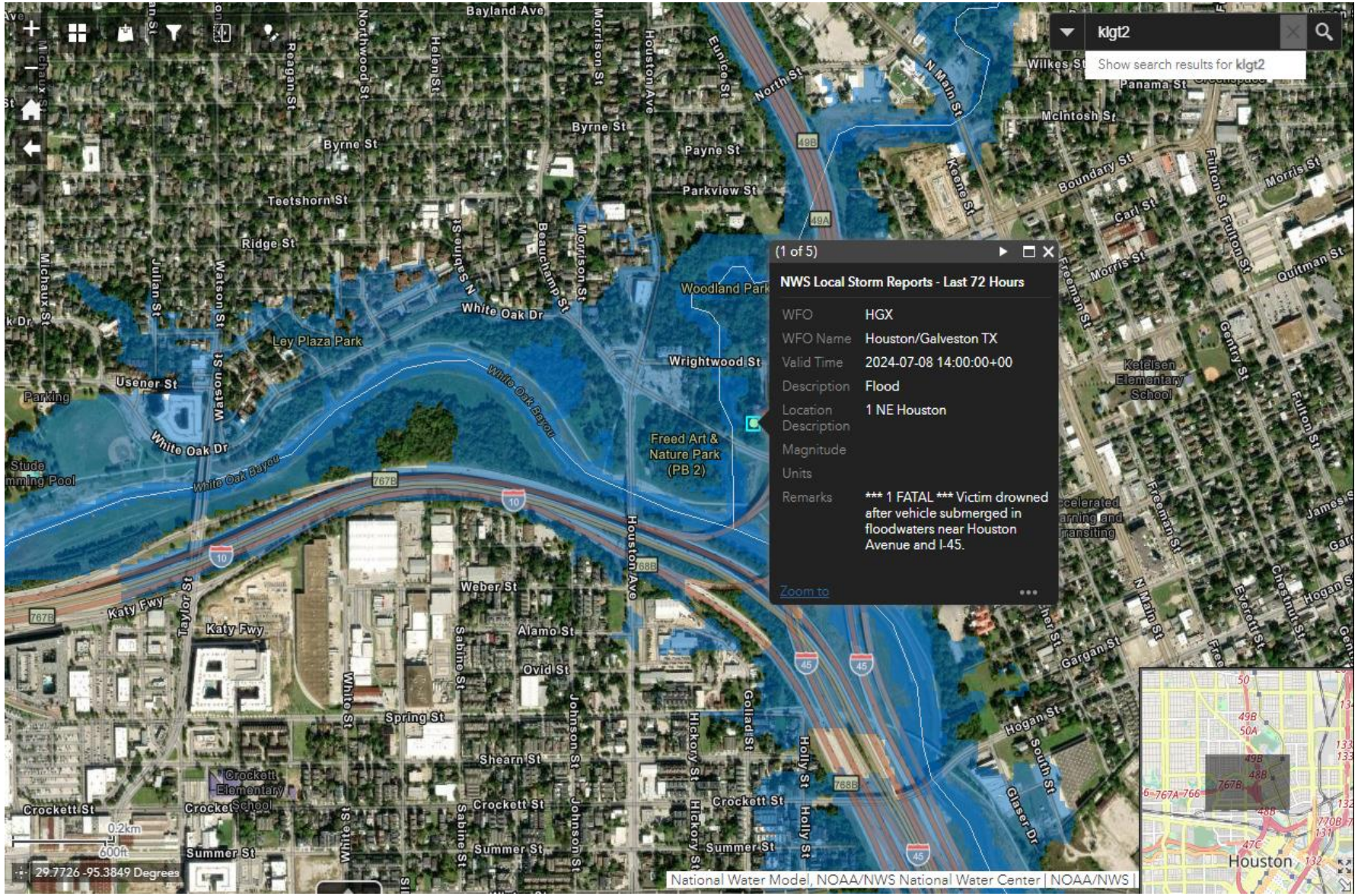




Harris County Flood Fatality

Past 14-day max inundation extent analysis FIM is verified by this unfortunate LSR near the I-10/I-45 interchange.

RFC 5-day Max Inundation Extent Forecast was inundating this area prior to the LSR being issued.



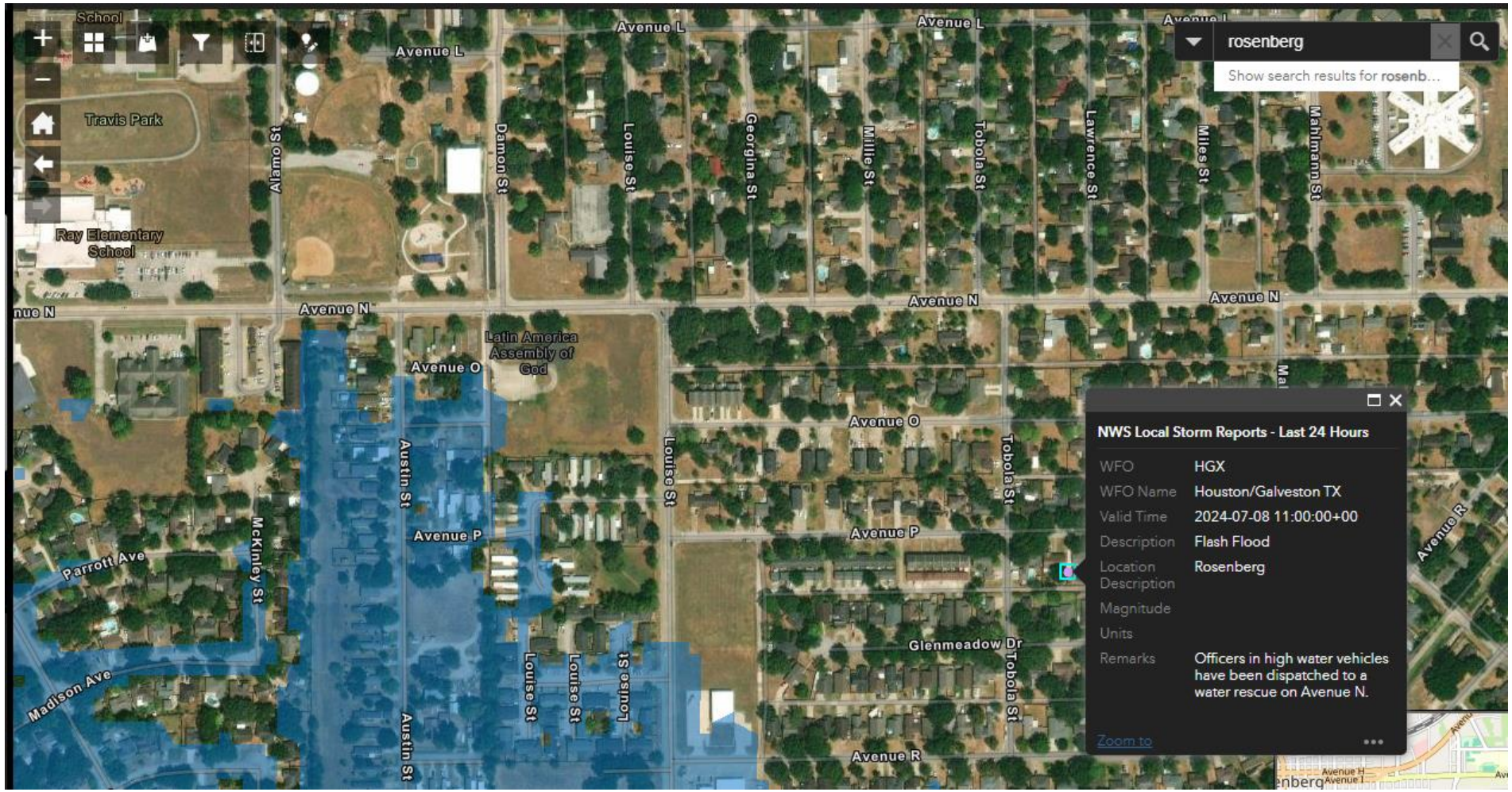
Analysis FIM Verified by X video. Location of videographer noted by white circle.

https://x.com/hashtagwarfreek/status/1810334752437608821

Verification of Analysis FIM. Image appears to be taken from near White Oak Drive looking at the baseball field.

Water flows out of the banks of White Oak Bayou into Studse Park in the Heights as Hurricane Beryl moves through town on Monday, July 8, 2024 in Houston, TX.

High water rescue on Avenue N, but not seeing any inundation in the Analysis FIM.



Automating Bridge Input in 1D and 2D HEC-RAS Models

FLOG/FIM Monthly Meeting
July 12, 2024

Anthony Holder
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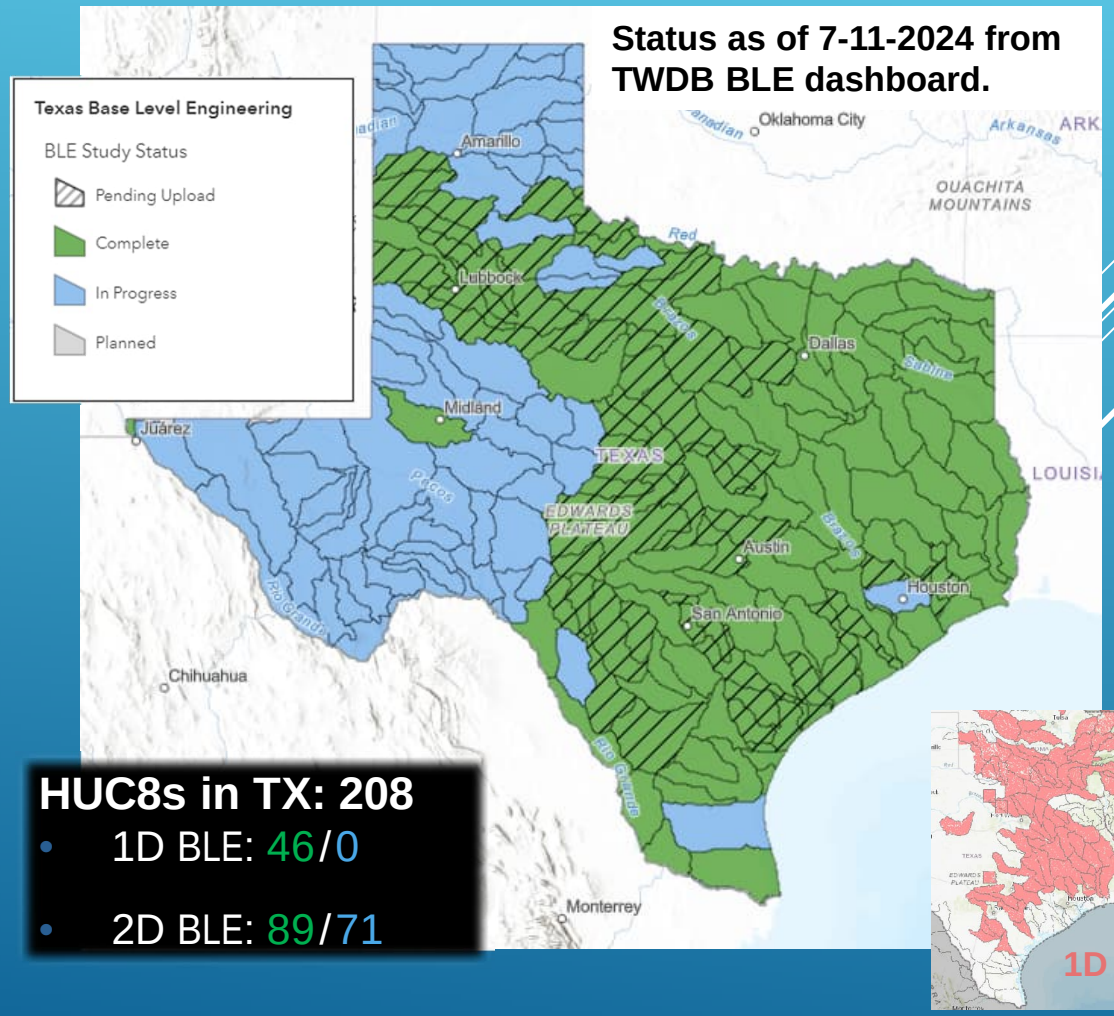
BACKGROUND

- Current Base Level Engineering (BLE) models: Limited or no bridge modeling
- Project Goal: Develop automated bridge input tool for large scale BLE HEC-RAS models
- Adding bridge improves accuracy of flood risk estimation around bridges
- Funded by TWDB and TxDOT
- Tool developed by AECOM (1D) and Stantec (2D)
- Leverages work/research by TxDOT and UT-Austin



TX-BRIDGE OVERVIEW

Created by:

Andy Carter, PE

Research Engineer
The University of Texas at Austin
Center for Water and the Environment

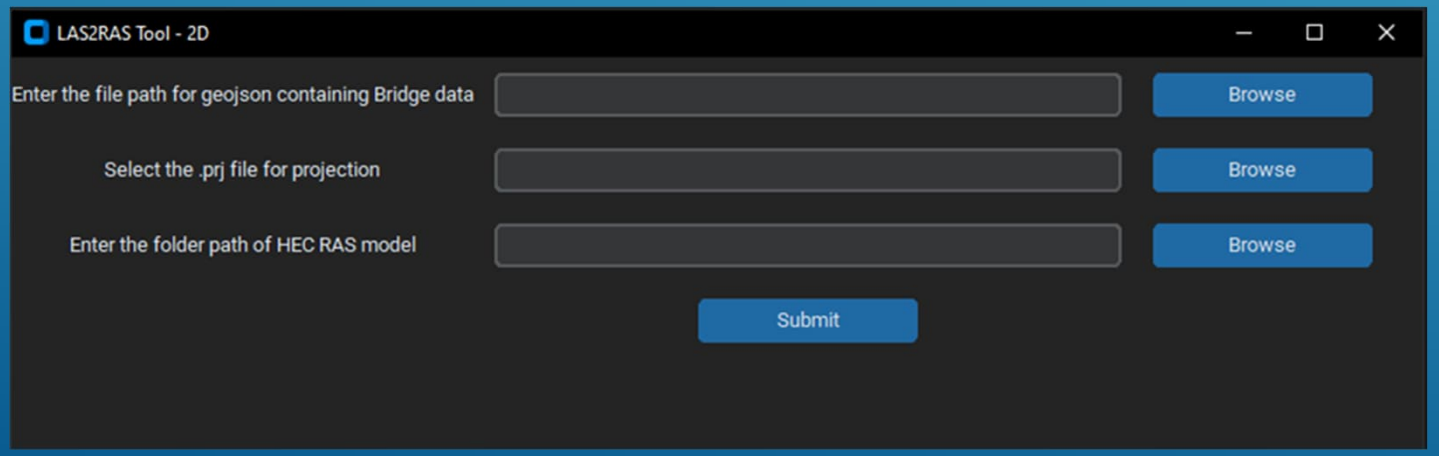
Funded by:

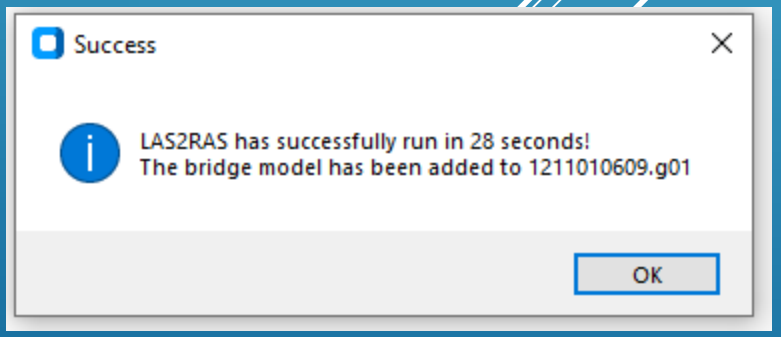
Inputs

3

INTRODUCING LAS2RAS

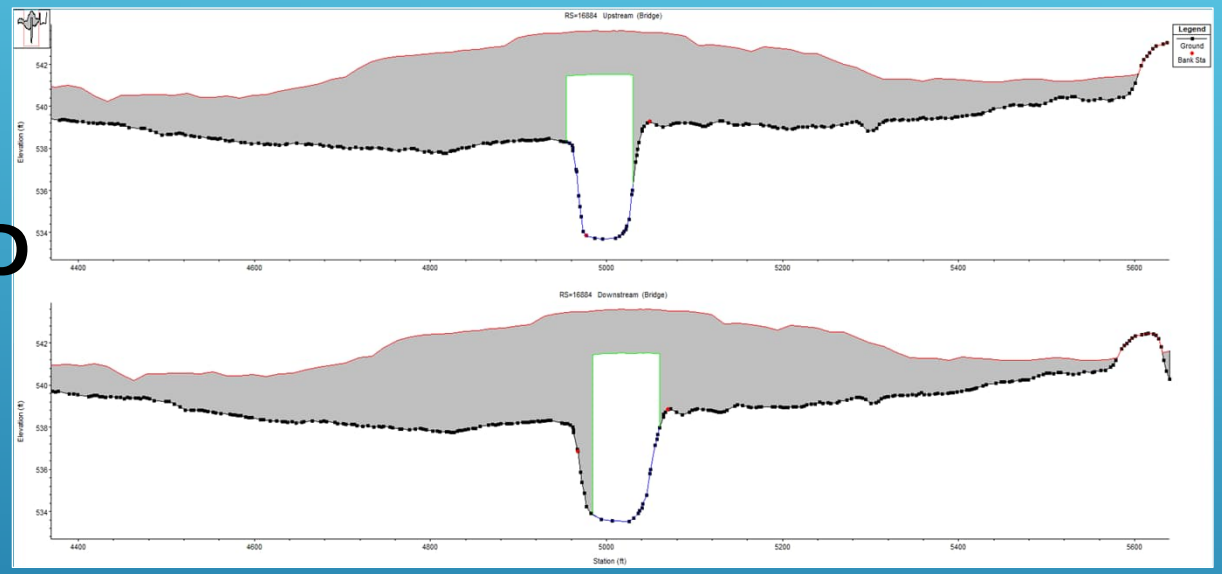
- Python-based tool that can import bridges to HEC-RAS models
- Available for both 1D and 2D models
- Takes HEC-RAS model files and TX-BRIDGE outputs
- Capable of adding bridge decks within minutes
- Comes with a cool GUI.

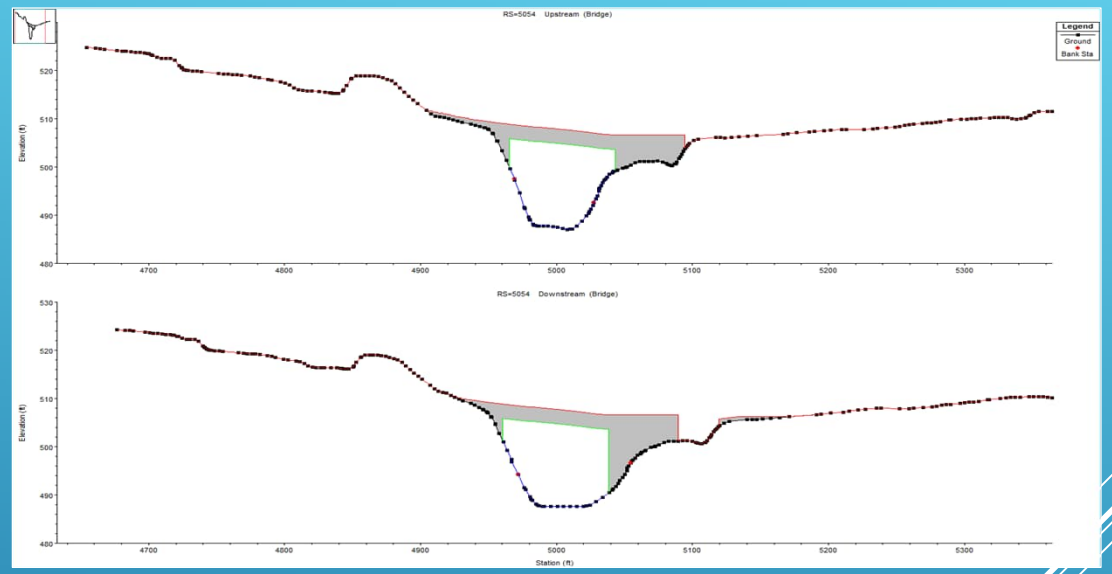




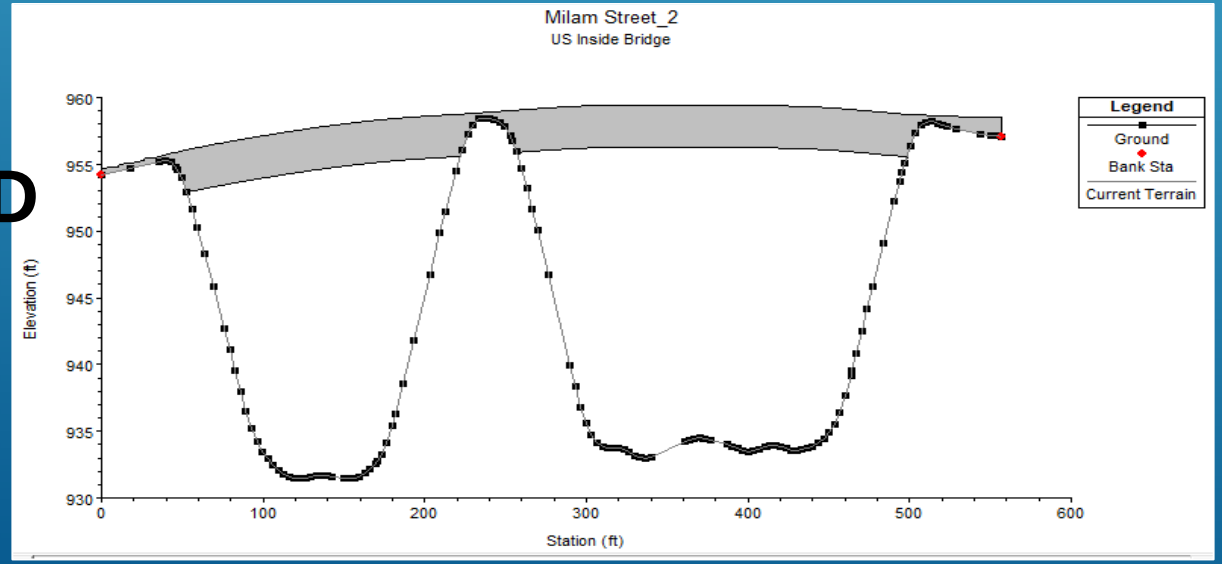
LAS2RAS BRIDGE EXAMPLES

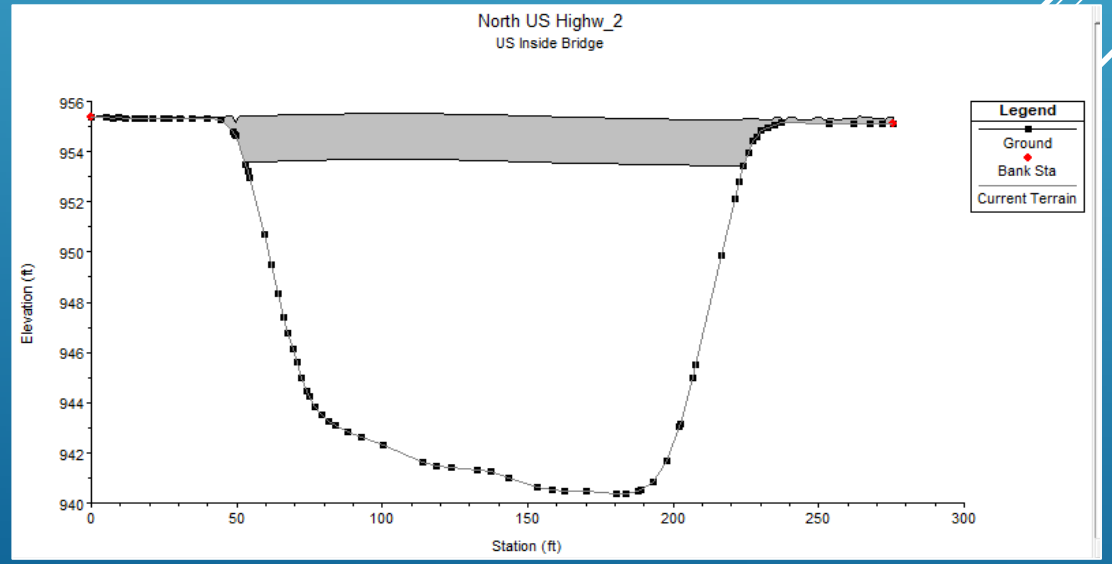
1D





2D





SENSITIVITY TESTING OF LAS2RAS

Comparison Standards

- 1D: Bridges imported from detailed FEMA effective models
- 2D: Bridges implemented from as-built data

LAS2RAS Variations

- Raw LAS2RAS: Tool + minimal tweaks to run
- Reviewed LAS2RAS: Engineering judgment to improve

1D and 2D Sensitivity Testing

- Two variations of the base model
  - 1: Unedited BLE model (1D and 2D)
  - 2: BLE model with added/improved bridge XSs (1D only)

Evaluation Criteria

- Level-of-effort
- Relative Accuracy (WSEL, peak Q, max velocity, floodplain width and area)

SENSITIVITY TESTING OF LAS2RAS

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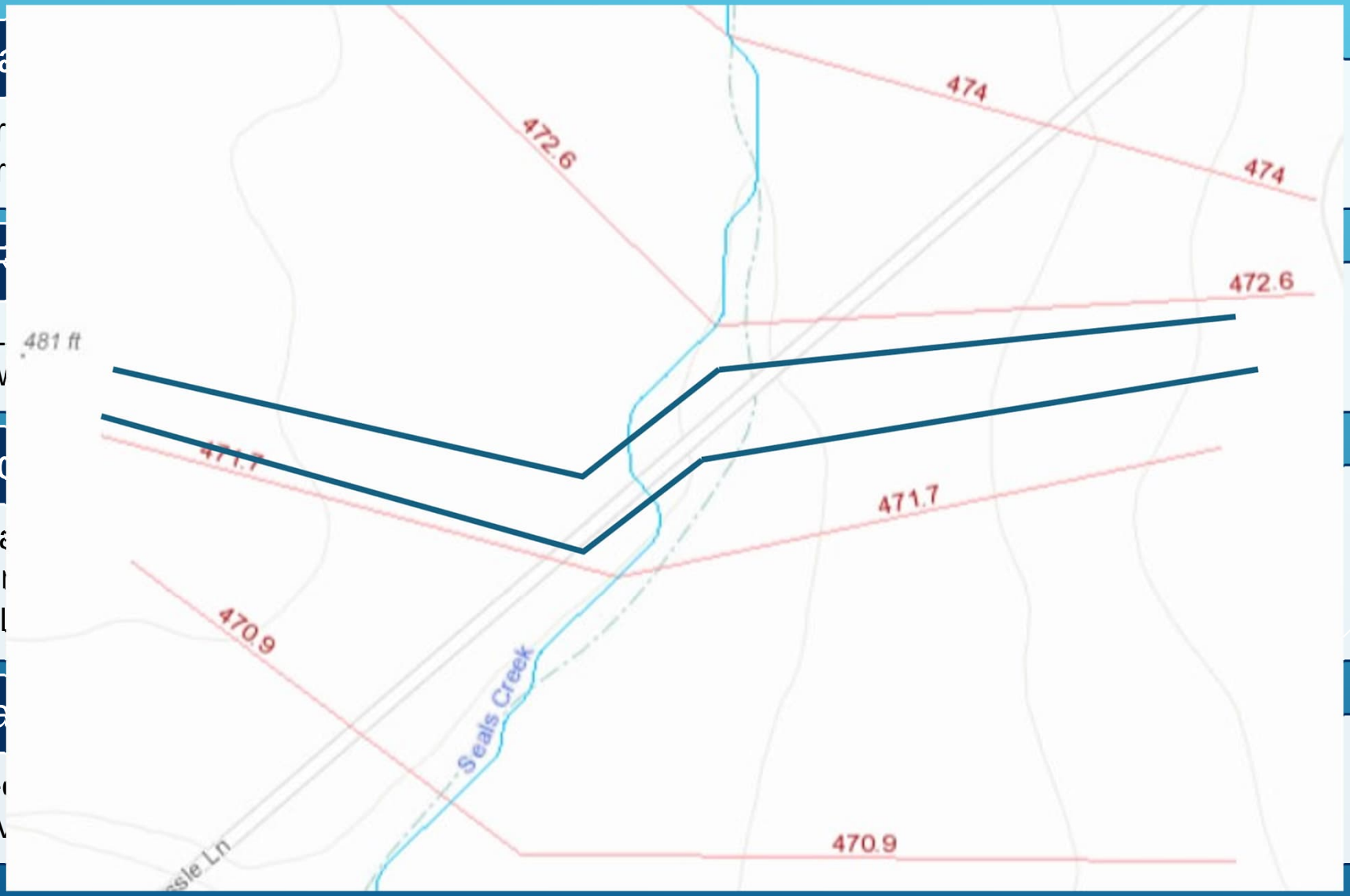


1D LEVEL OF EFFORT

- Comparison basis: S8
- Assumptions:
  - User is experienced with LAS2RAS (no training time)
  - Time to acquire TX-BRIDGE GeoJSON and running LAS2RAS is negligible

Table summarizes time accounted for specific modeling tasks.

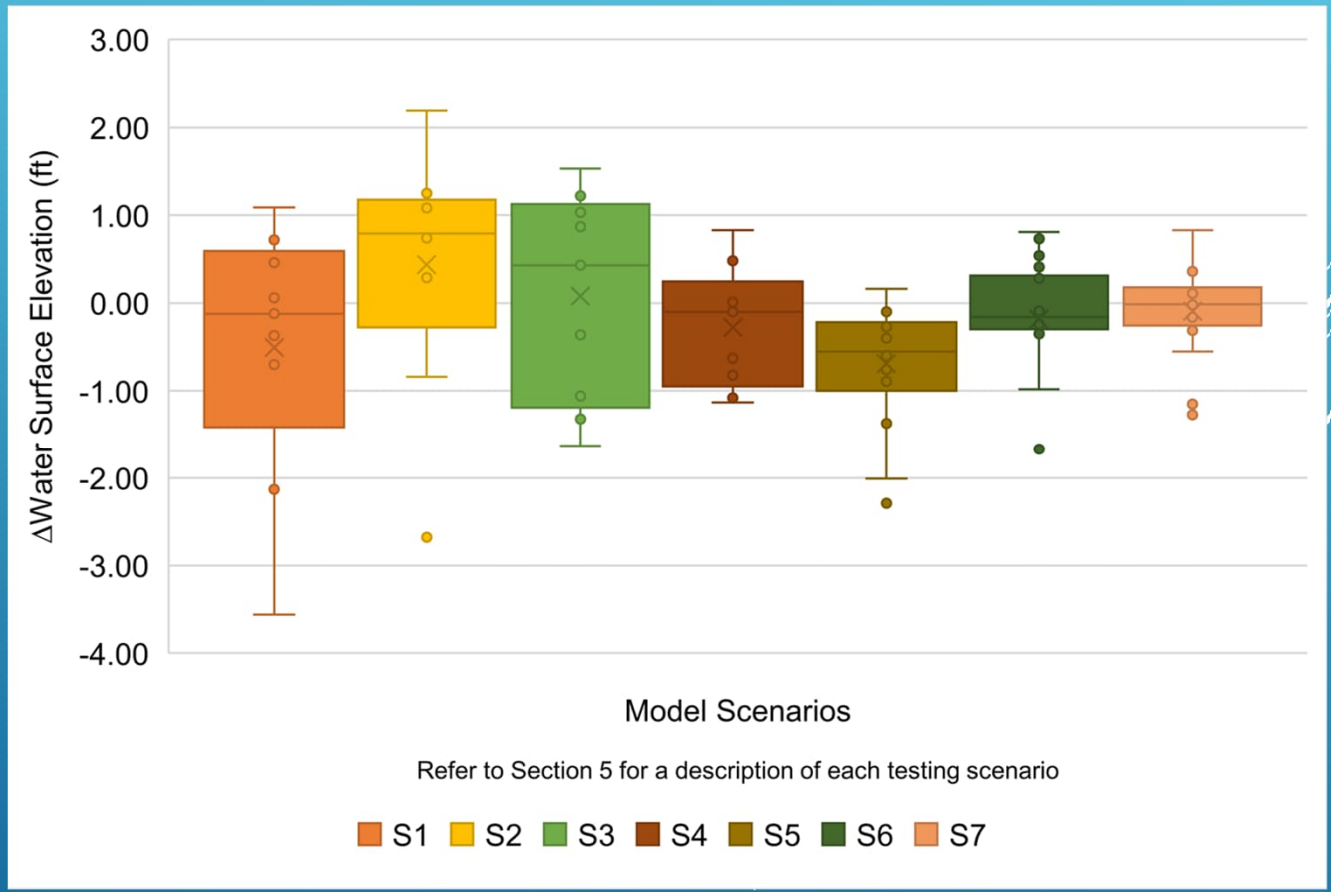
Scenario	Description	Number of Bridges	Average Time Per Bridge (Hours)	Average Cost Per Bridge	Total Cost	Percent of Added XS + Detailed Bridge Cost
S1	BLE	0	0.00	$0	$0	0%
S2	Raw LAS2RAS	19	0.15	$22	$418	20%
S3	Reviewed LAS2RAS	19	0.40	$60	$1,140	53%
S4	Detailed Bridge	19	0.56	$84	$1,596	74%
S5*	Added XS	19**	0.20	$30	$570	27%
S6*	Added XS + Raw LAS2RAS	19	0.30	$45	$855	40%
S7*	Added XS + Reviewed LAS2RAS	19	0.59	$88	$1,672	79%
S8*	Added XS + Detailed Bridge	19	0.75	$113	$2,147	100%

*Average time and cost per bridge derived as the average effort for 10 bridges – not including the Guadalupe River bridges.
**The number of locations where bounding cross-sections are expected since no bridges were modeled.

1D RELATIVE ACCURACY - WSEL

- Comparisons to S8
  - Added XS + Detailed Bridges
- Added XS improves accuracy
  - S2 vs S6
  - S3 vs S7
- Velocity, floodplain width and floodplain area comparisons indicate similar trends

Box-and-whisker plot showing variation in 100-Year WSEL differences across model scenarios vs. S8



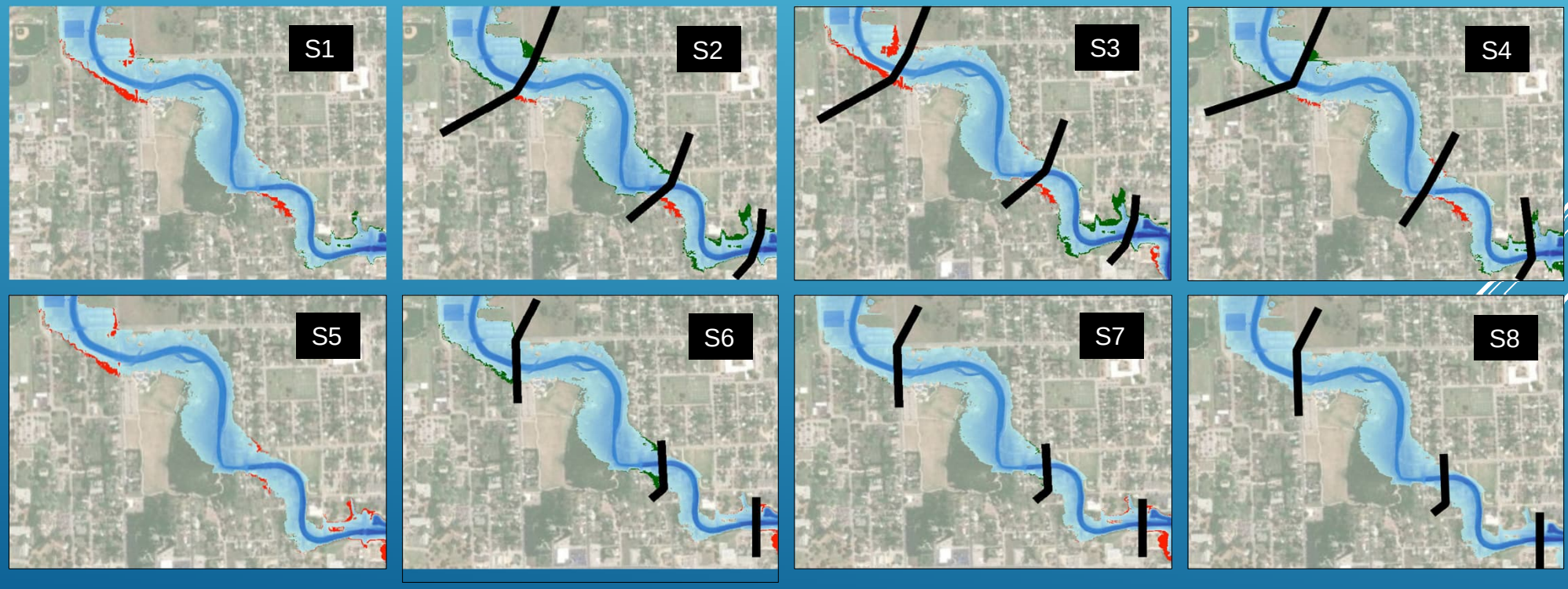
1D MAPPING IMPLICATIONS

Summary of 100-Year Floodplain Width Changes (%) Relative to S8.

Criteria	Parameter	S1	S2	S3	S4	S5	S6	S7
ΔFloodplain Width (%)	Mean	15%	98%	33%	–3%	–6%	6%	–1%
	Median	–0.7%	8%	–2%	–5%	–3%	–1%	–0.2%
	Standard Deviation	80%	232%	84%	19%	8%	33%	7%

Decrease from S8

Increase over S8



Depiction of floodplain width/extent differences (relative to S8) for a portion of the Walnut Branch tributary.

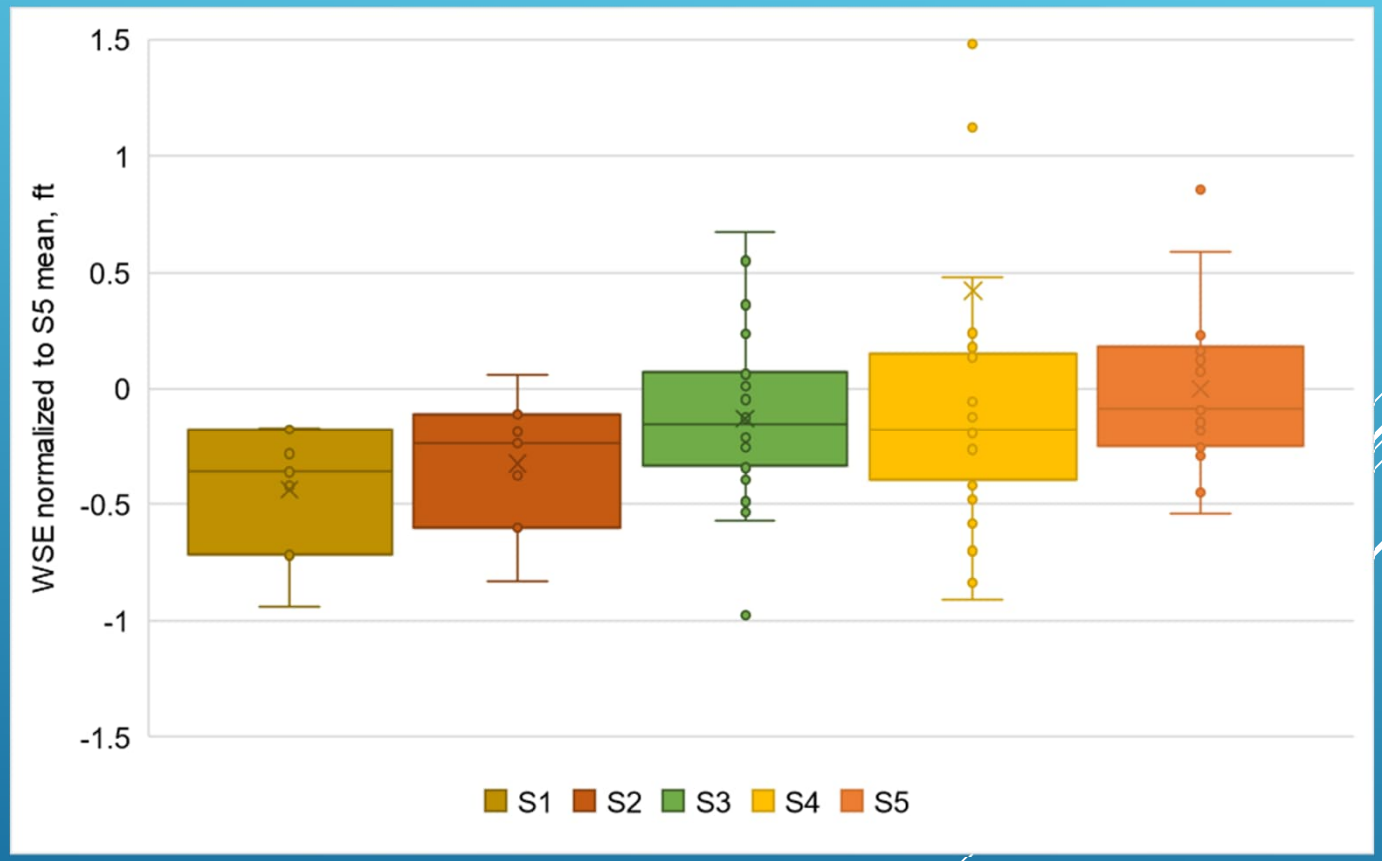
2D LEVEL OF EFFORT

- Comparison basis: S5
- Assumptions:
  - User is experienced with LAS2RAS (no training time)
  - Time to acquire TX-BRIDGE GeoJSON and running LAS2RAS is negligible
  - Time required to gather as-built data is not factored in

Scenario	Description	Number of Bridges	Average Time Per Bridge (Hours)	Average Cost Per Bridge ($150/Hour)	Total Cost	Percent of Asbuilt Cost
S1	Raw BLE	0	0.00	$0	$0	0%
S2*	Raw LAS2RAS	19	0.00	$0	$0	0%
S3	Reviewed LAS2RAS	19	0.30	$45	$855	19%
S4	Approximate Bridges	19	0.37	$55	$1,045	23%
S5	As-built Bridges	19**	1.59	$239	$4,541	100%

2D RELATIVE ACCURACY - WSEL

- S1 generally yielded lower WSEL due to bridge obstruction and model dynamics
- S2 compared less well to S3 and S4 in terms of median difference
- LAS2RAS improves bridge modeling accuracy compared to approximate methods

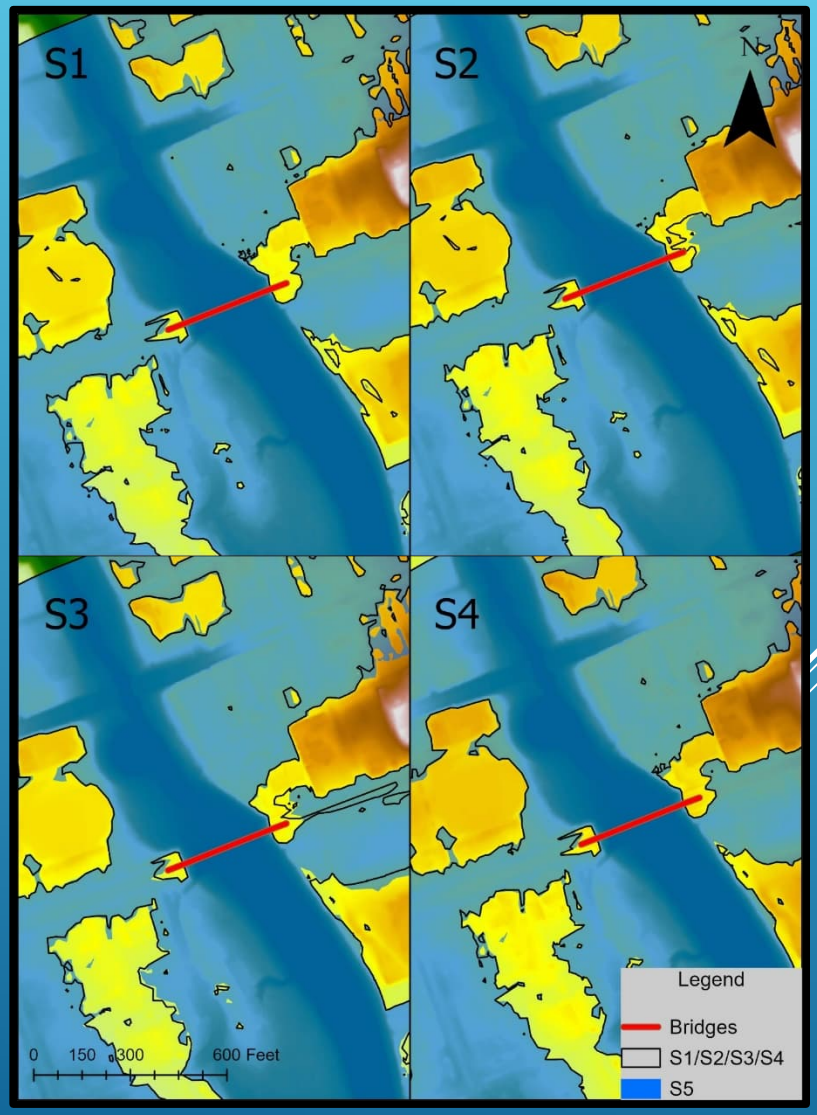


WSELs for all scenarios normalized to the S5 mean

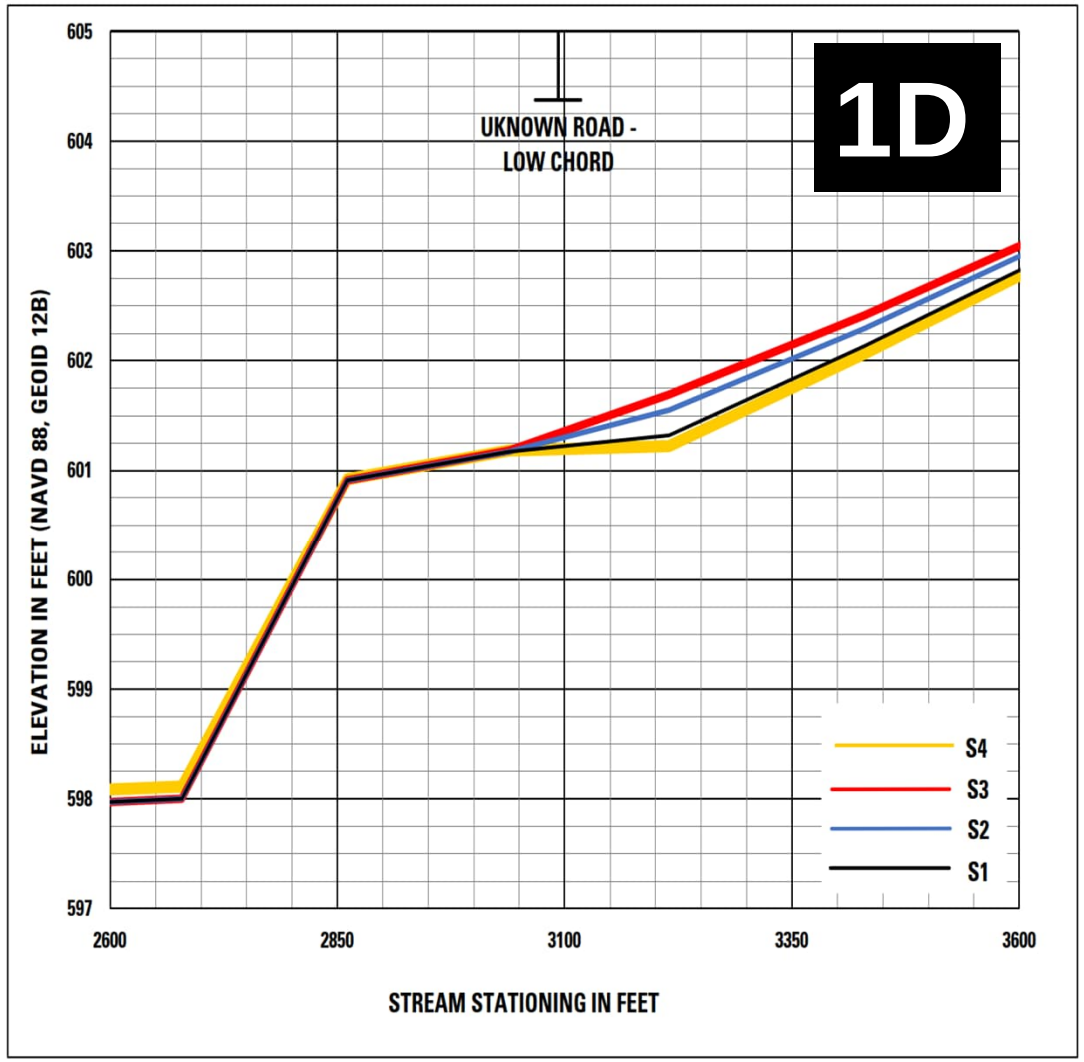
2D MAPPING IMPLICATIONS

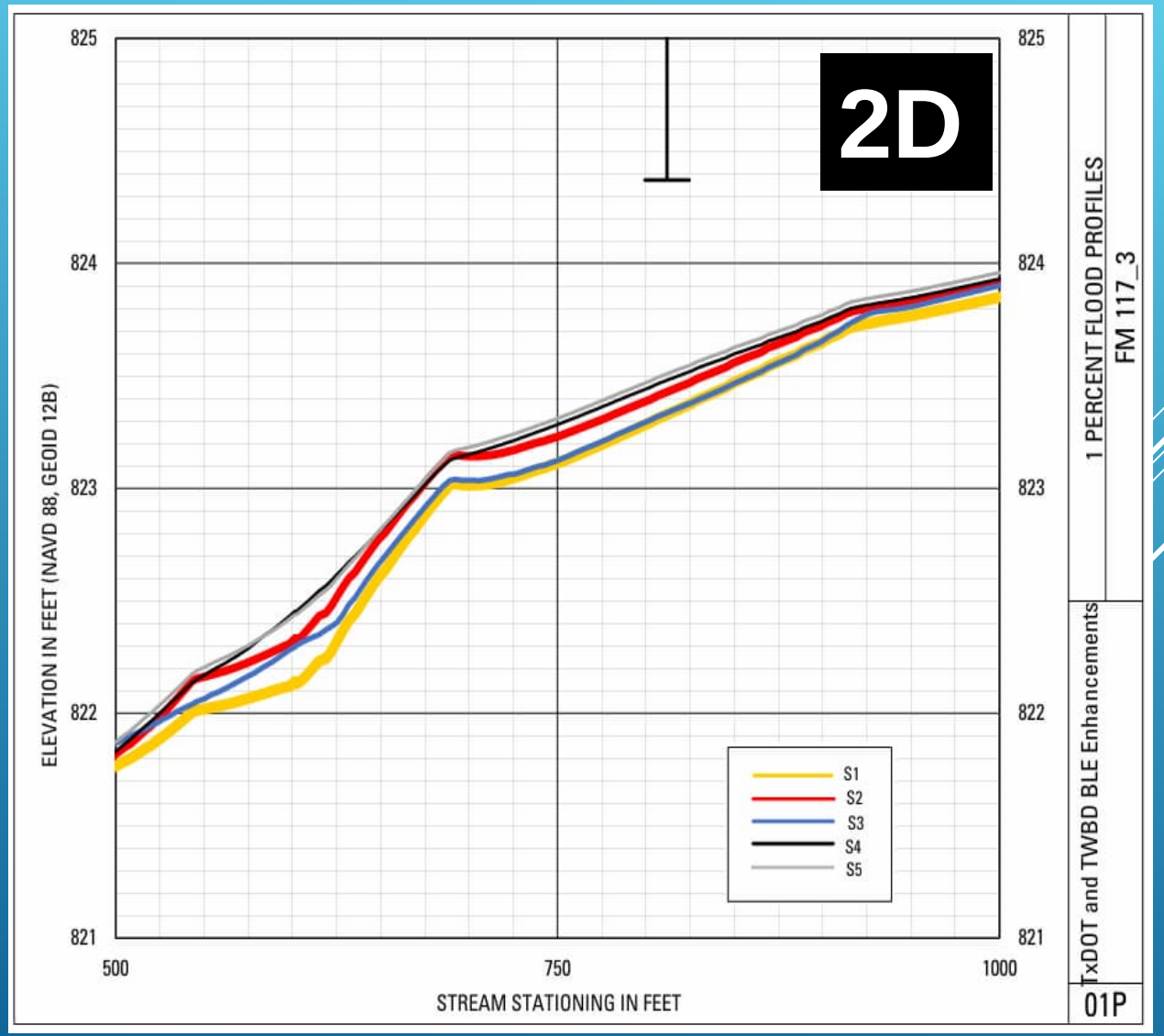
Summary of Inundation Impacts Immediately Around Bridges

Scenario	Average 100-YR Floodplain Area	Difference from S5 in Acres
S1	441.36	4.97
S2	439.61	3.22
S3	429	-7.39
S4	430.8	-5.59
S5	436.39	0.00

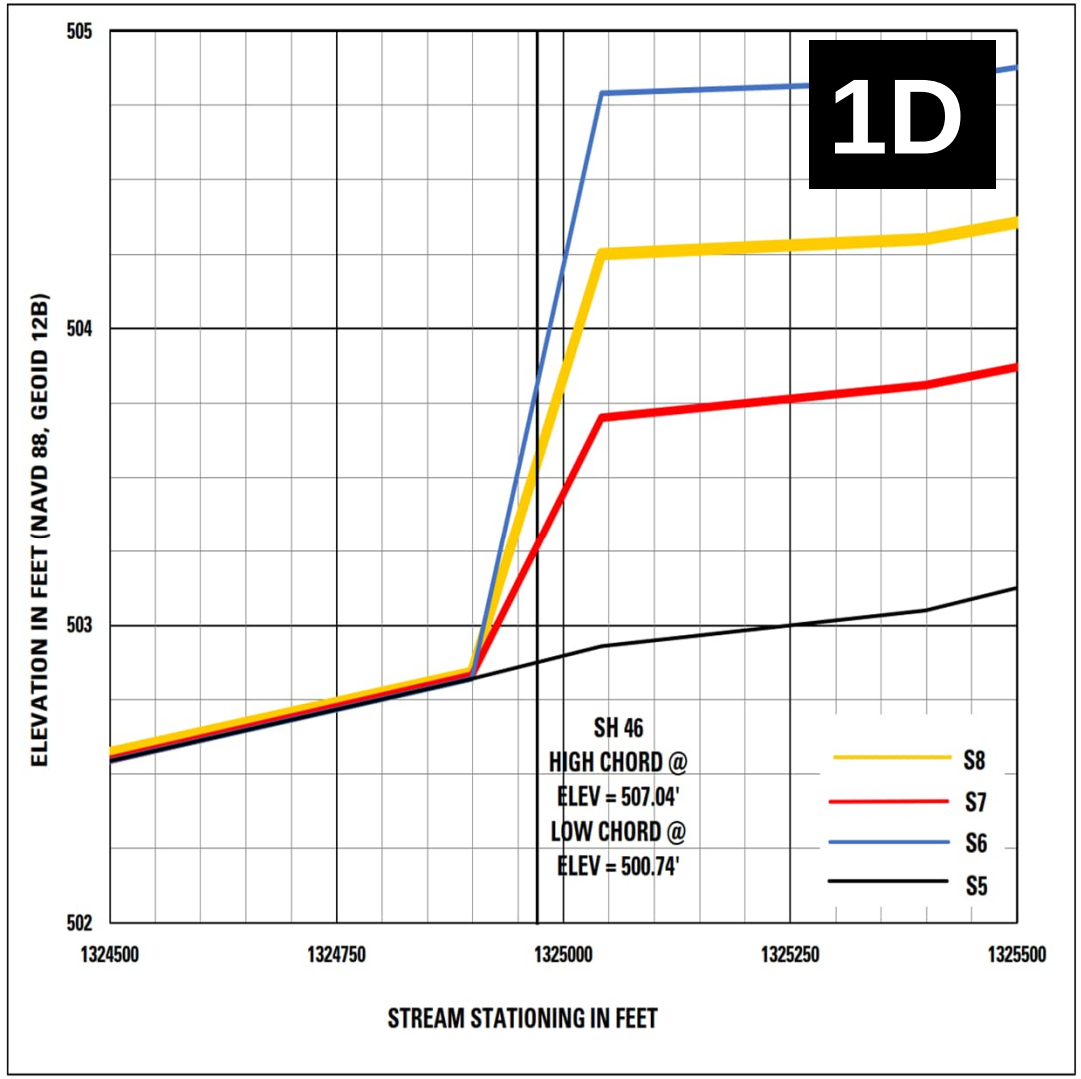


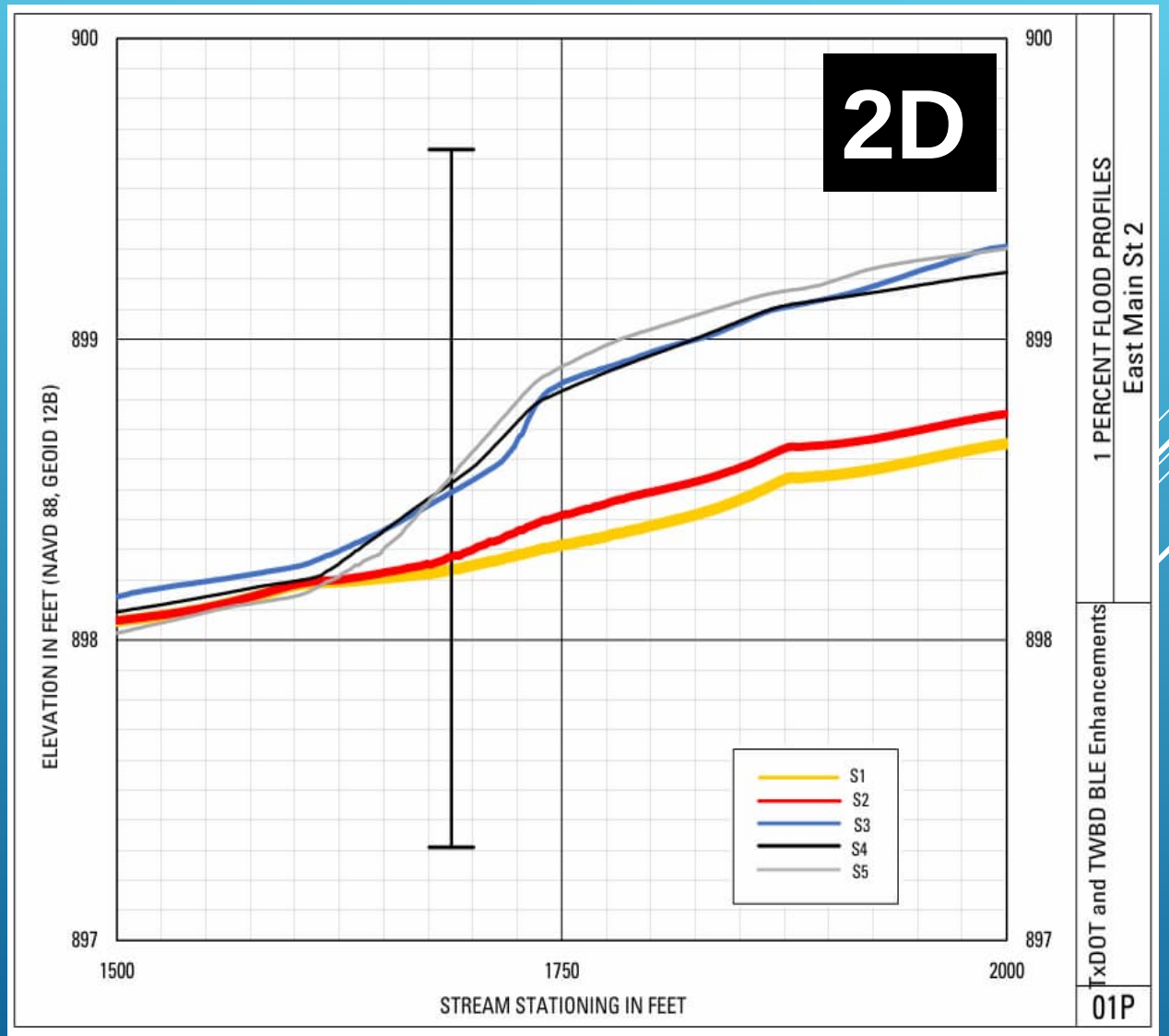
BRIDGE IMPACT - WSEL BELOW LOW CHORD



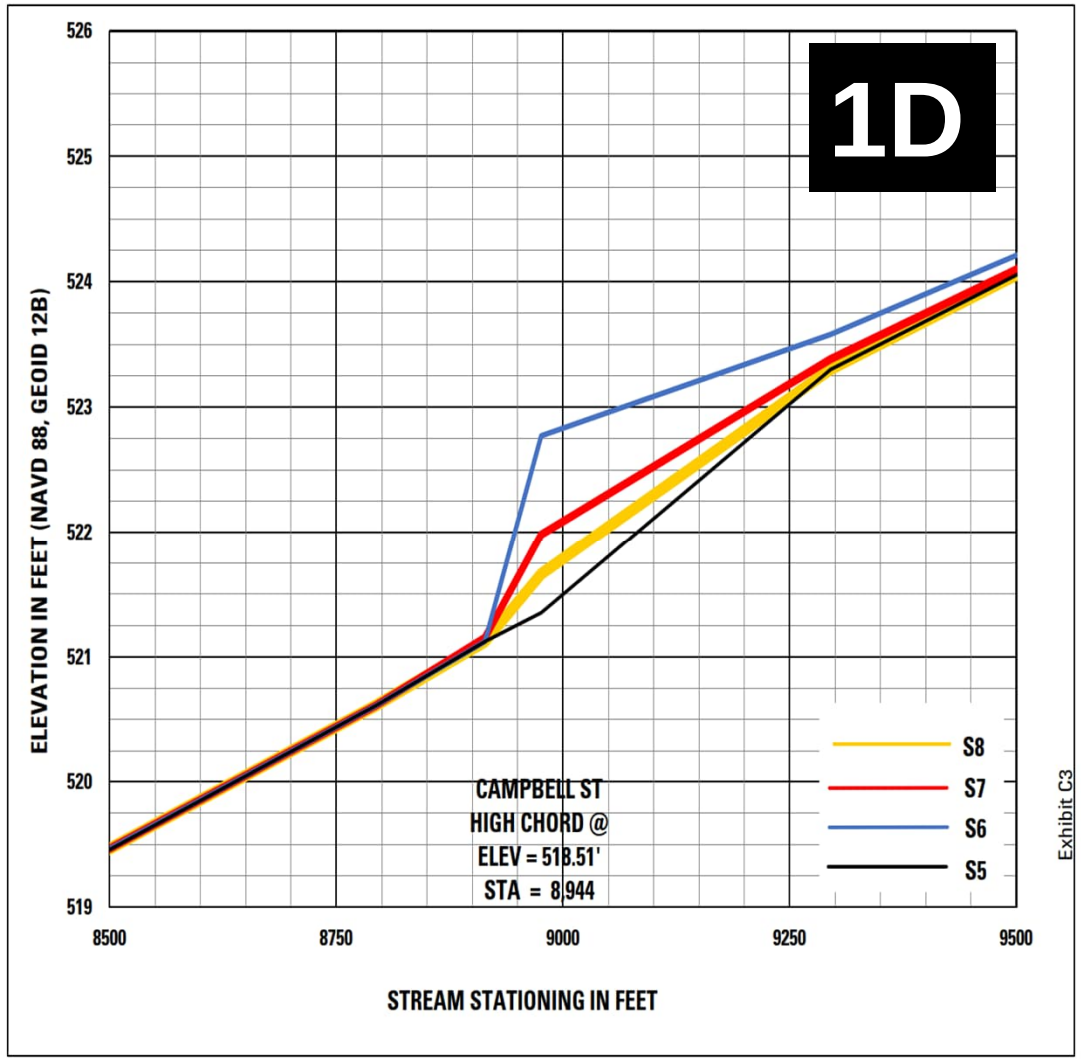


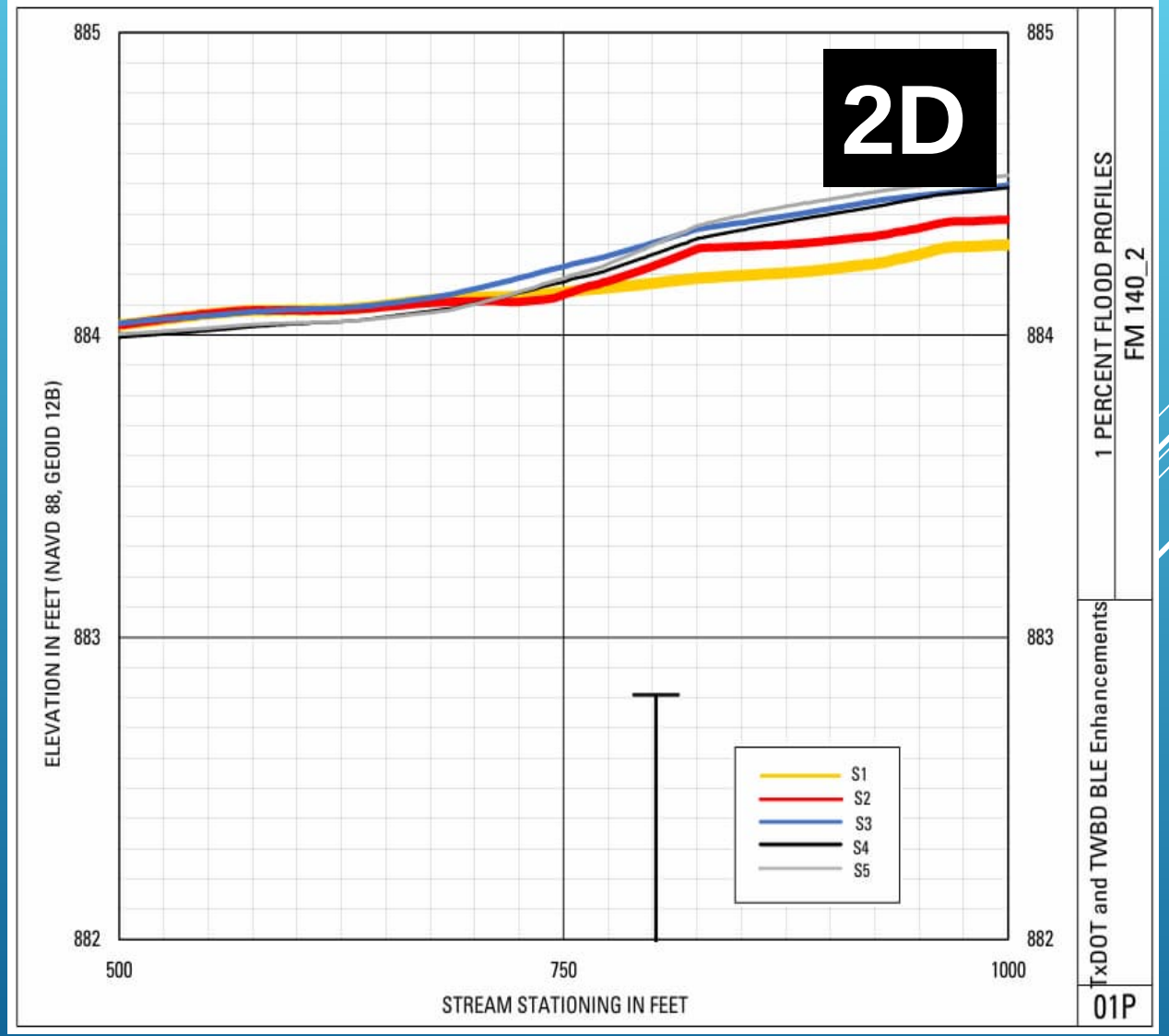
BRIDGE IMPACT - WSEL HITTING DECK





BRIDGE IMPACT - WSEL ABOVE HIGH CHORD





LAS2RAS: USAGE RECOMMENDATIONS

- 1D
  - S7: Added XS + Reviewed LAS2RAS provides the best balance of cost and benefit
  - Potential cost savings
    - Simplifying the process of adding XS
    - Simplifying the engineer review
    - Eliminating the engineer review (S6)
- 2D
  - S3: Reviewed LAS2RAS provides the best balance of cost and benefit
  - S2: Raw LAS2RAS provides the best outcome for the cost.

LAS2RAS: NEXT STEPS

- **Publish LAS2RAS version 1.0**
  - LAS2RAS User Guide
  - LAS2RAS Standard Operations Procedure
  - Open-source publication of code
- **Tool maintenance**
  - Address user-identified bugs for duration of contract
  - Better error messaging
- **Potential future improvements (currently beyond scope of this project):**
  - Correct orientation of TX-Bridge data where NHD stream data is unavailable
  - Improve tool flexibility
    - HEC-RAS versions
    - User inputs

QUESTIONS?