
December 13, 2022

# Technical Memorandum

**To:** Troy Barnhart, Public Works, County of San Luis Obispo

**From:** Cathy Avila, PE, Principal, Avila and Associates

**Date:** July 15, 2022

**RE:** **Review and Update of the Draft FEMA HEC-RAS Model for the Floodplain Delineation Study of San Luis Obispo Creek, San Luis Obispo County, California**

The San Luis Obispo Creek floodplain between Avila Beach and the southern city limit of San Luis Obispo is currently being re-evaluated for FEMA by STARR II. San Luis Obispo County acquired a draft of the HEC-RAS (Version 5.0.7) model from STARR II. A pedestrian/bike trail, Bob Jones Trail, is proposed within the creek floodplain which is being designed by Wallace Group (WG). A topographic survey along the alignment of the proposed trail was recently performed and provided to Avila and Associates (Avila) by WG. Avila was given the opportunity to review the draft HEC-RAS model and to make changes to the model geometry that incorporates the WG topographic survey. The WG topographic survey also included the bridges at Highway 101, the Bunnell property, and Higuera Street. Avila was requested to update the bridge geometries in the model to reflect the WG topographic survey. The final STARR II HEC-RAS model will be used by Avila for the hydraulic analysis of San Luis Obispo Creek with the proposed Bob Jones Trail and it is recommended that the changes made be incorporated in the final model. This memo summarizes the results of our review and the changes made to the model geometry.

Following, is a summary of the changes made to the model geometry and the justification for each change (starting downstream):

### Highway 101 Bridge (RS 14848)

In the FEMA model, the northbound and southbound bridges were modeled as a single structure without a skew angle. A 2D hydraulic analysis of the bridge reach shows that the existing bridges are skewed approximately 30 degrees to the flow as shown in Figure 1. The following changes were made to the model geometry:

- The northbound and southbound bridges were modeled as two separate structures skewed 30 degrees. The deck, railing, and soffit elevation data was based on the WG topographic survey and match the as-built plans.

- Cross sections at river stations 14713 and 14934 were manually skewed 30 degrees and supplemented with the WG topographic survey.

- Cross sections were added at river stations 14808 and 14819 between the bridges. The sections are skewed 30 degrees and are based on the WG topographic survey.

- Internal sections for both bridges were added based on the WG topographic survey and skewed 30 degrees.

A comparison of the upstream face of the northbound bridge (RS 14848) between the FEMA model and the changes made based on the skew angle and the WG topographic survey is shown in Figure 2.

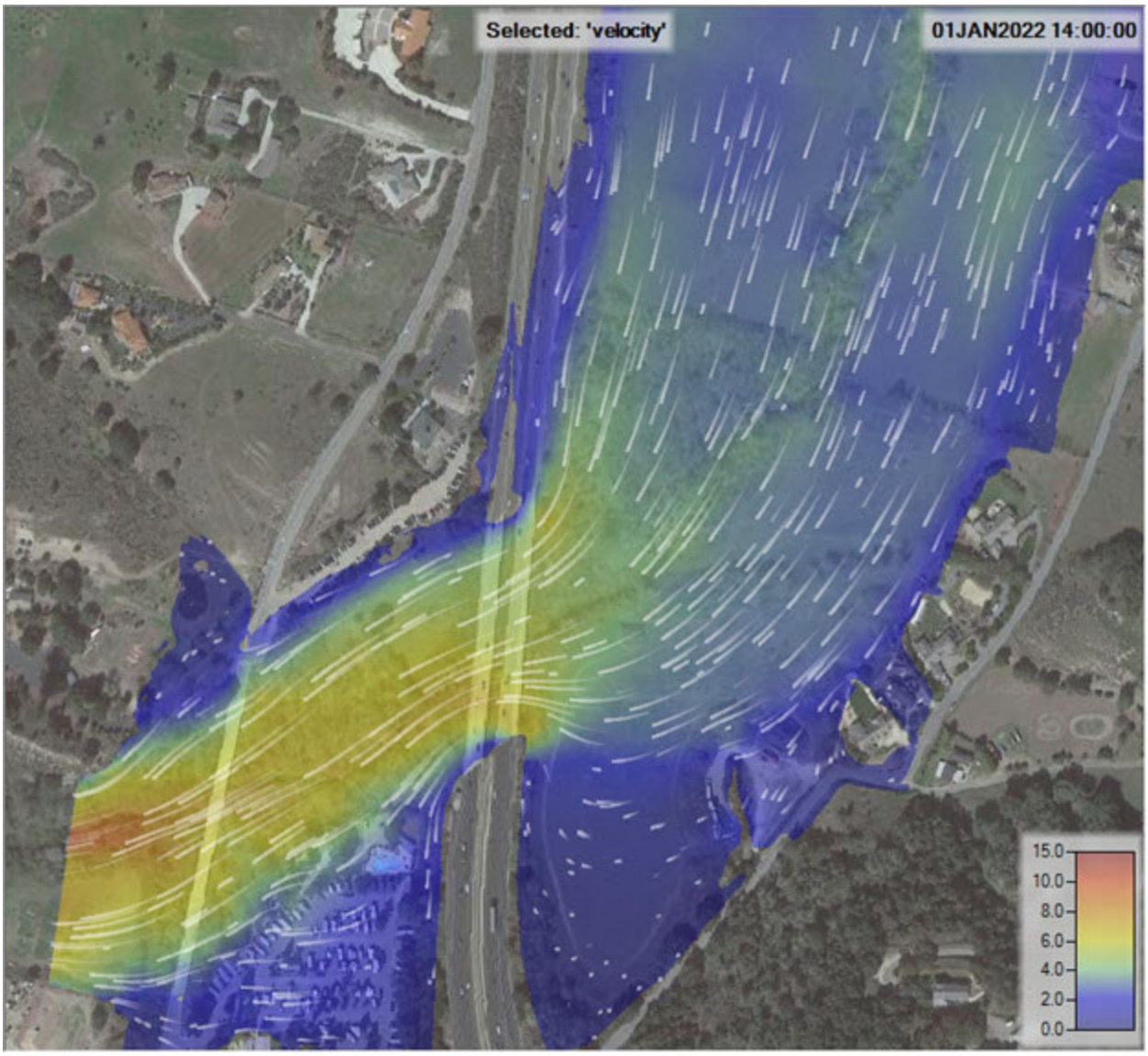


*Figure 1. Flow pattern through Highway 101 bridges.*

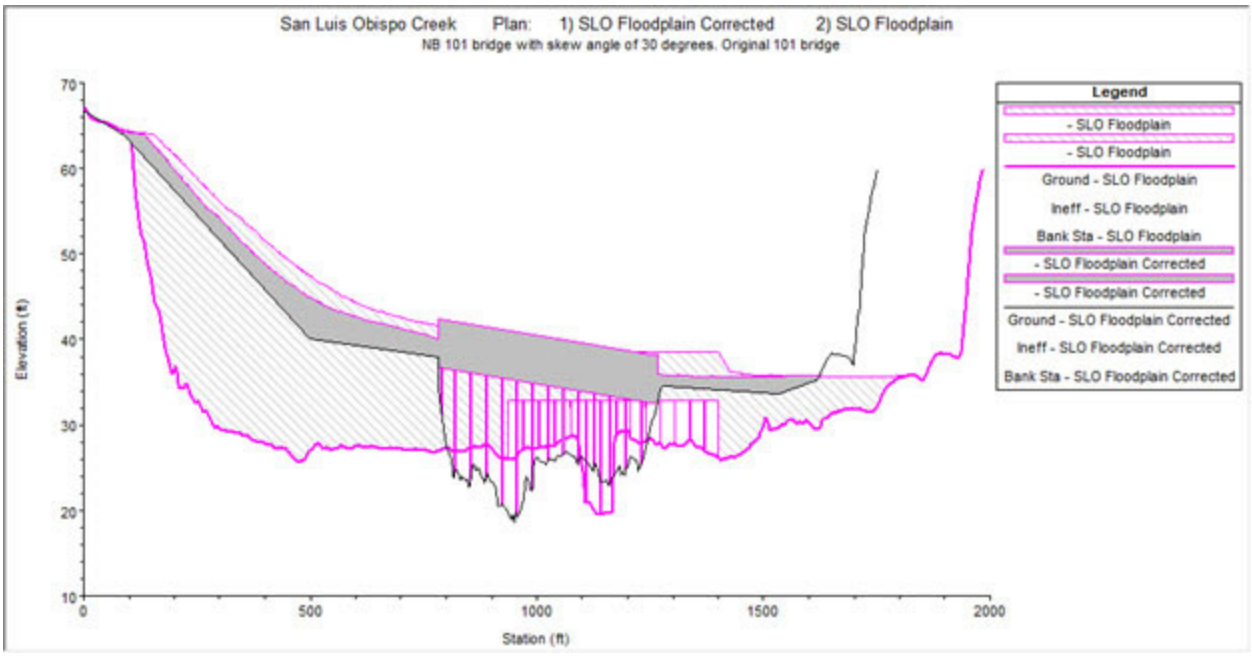


*Figure 2. Comparison of the FEMA geometry (cross hatched) to the changed geometry (shaded gray) of the upstream face of the northbound Highway 101 bridge.*

### Miscellaneous Cross Sections

The following cross sections were changed to reflect the WG topographic survey:

- RS 23407
- RS 26872
- RS 27027
- RS 27317
- RS 27595

**Existing Bunnell Bridge (RS 29399)**

The existing Bunnell bridge was revised to incorporate the WG topographic survey. Internal sections were also added based on the WG topographic survey. A comparison of the FEMA geometry to the changed geometry of the upstream bridge face is shown in Figure 3.

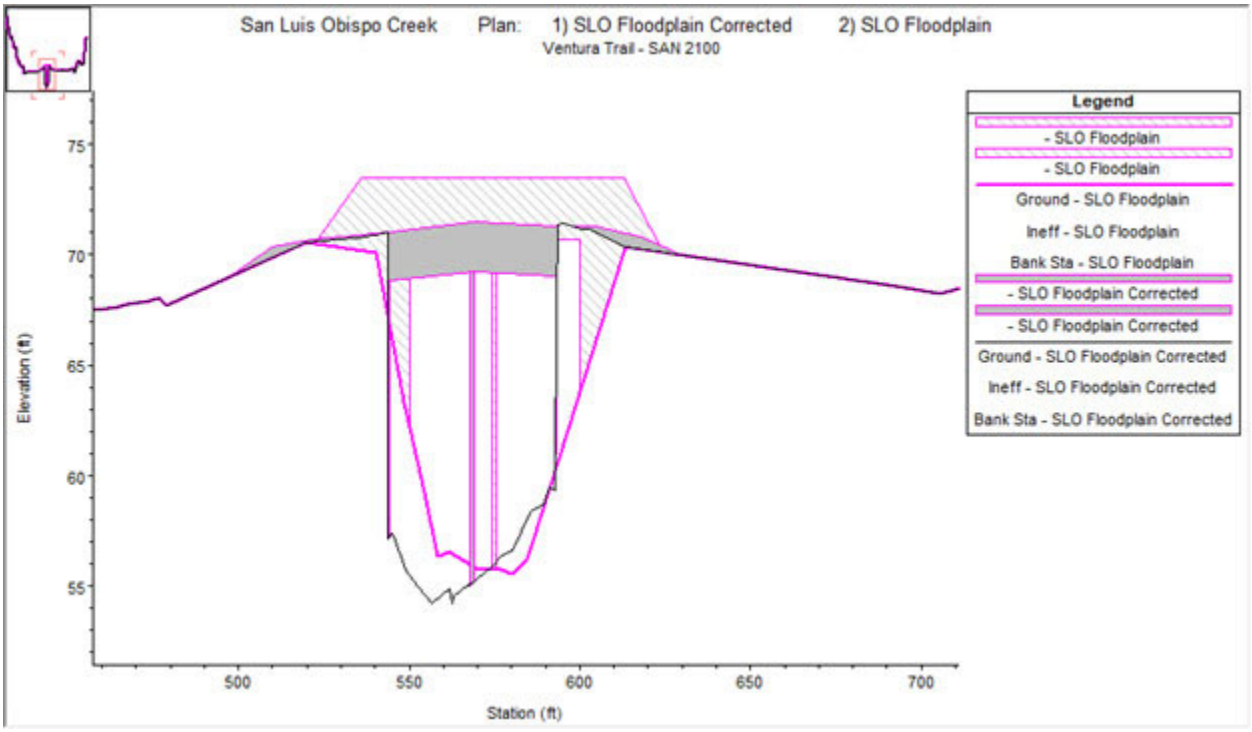


*Figure 3. Comparison of the FEMA geometry (cross hatched) to the changed geometry (shaded gray) for the Bunnell Bridge (RS 29399)*

**Higuera Street Bridge (RS 33278)**

The Higuera Street bridge along with the bounding cross sections in the FEMA geometry are shown in Figure 4 and Figure 5. The bridge is skewed 45 degrees to the channel. For both cross sections RS 33345 and RS 33253, the skew angle option is used in the cross section geometry with an angle of 45 degrees. However, when the "Plot Terrain" option is used in the section geometry editor window, the cross section data matches the terrain. This indicates that the section data is not skewed. RS 33345 and RS 33253 were changed as follows:

- Cross section data for Segment A-B (as shown in Figure 5) was maintained without a skew angle.
- Cross section data for Segment B-C was skewed with an angle of 45 degrees and updated to reflect the WG topographic survey.
- Cross section data for Segment C-D was maintained without a skew angle.

The resulting cross section data for the two river stations compared to the FEMA geometry is shown in Figure 6 and Figure 7.

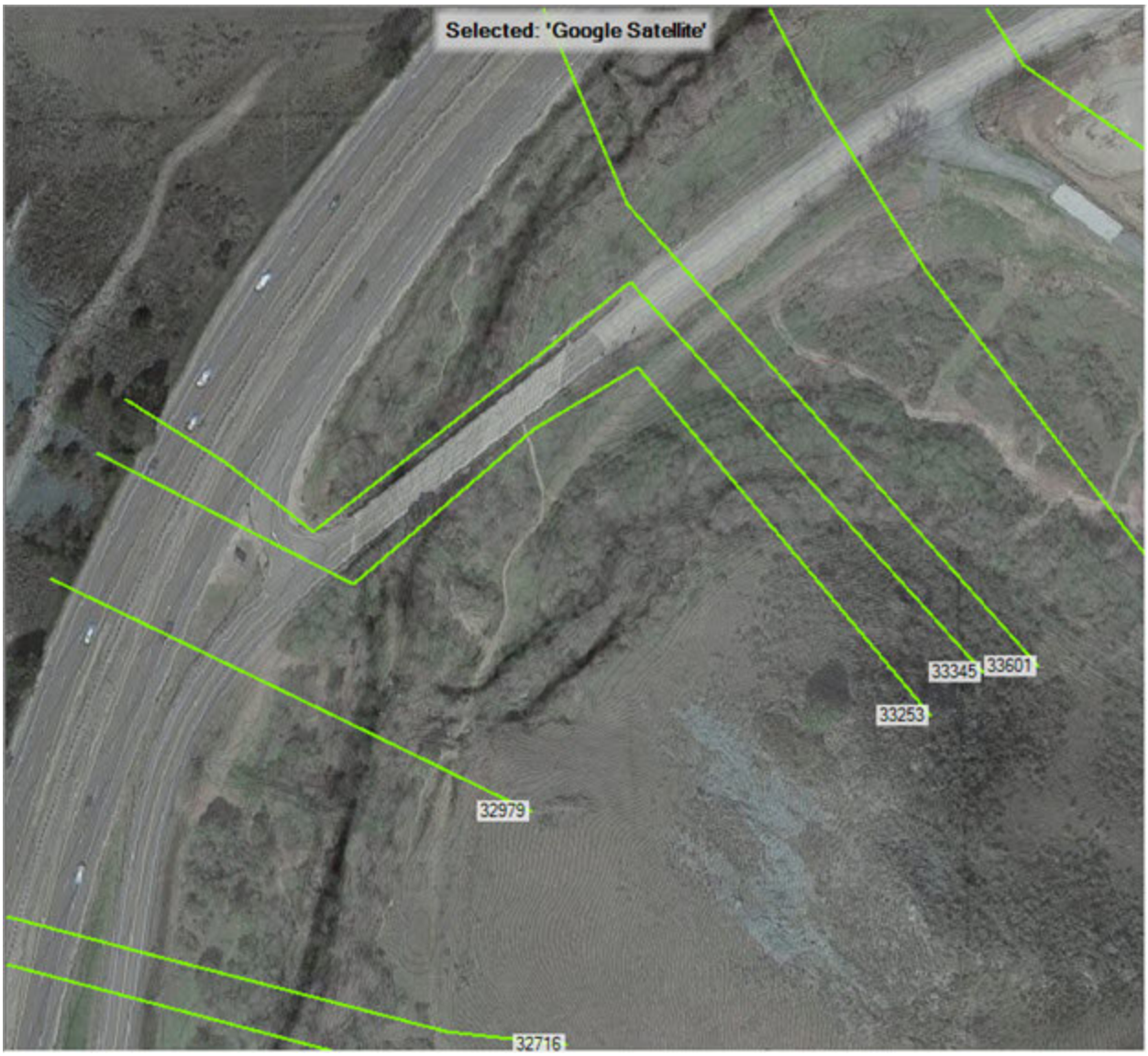


*Figure 4. Higuera Street Bridge with FEMA model cross sections*

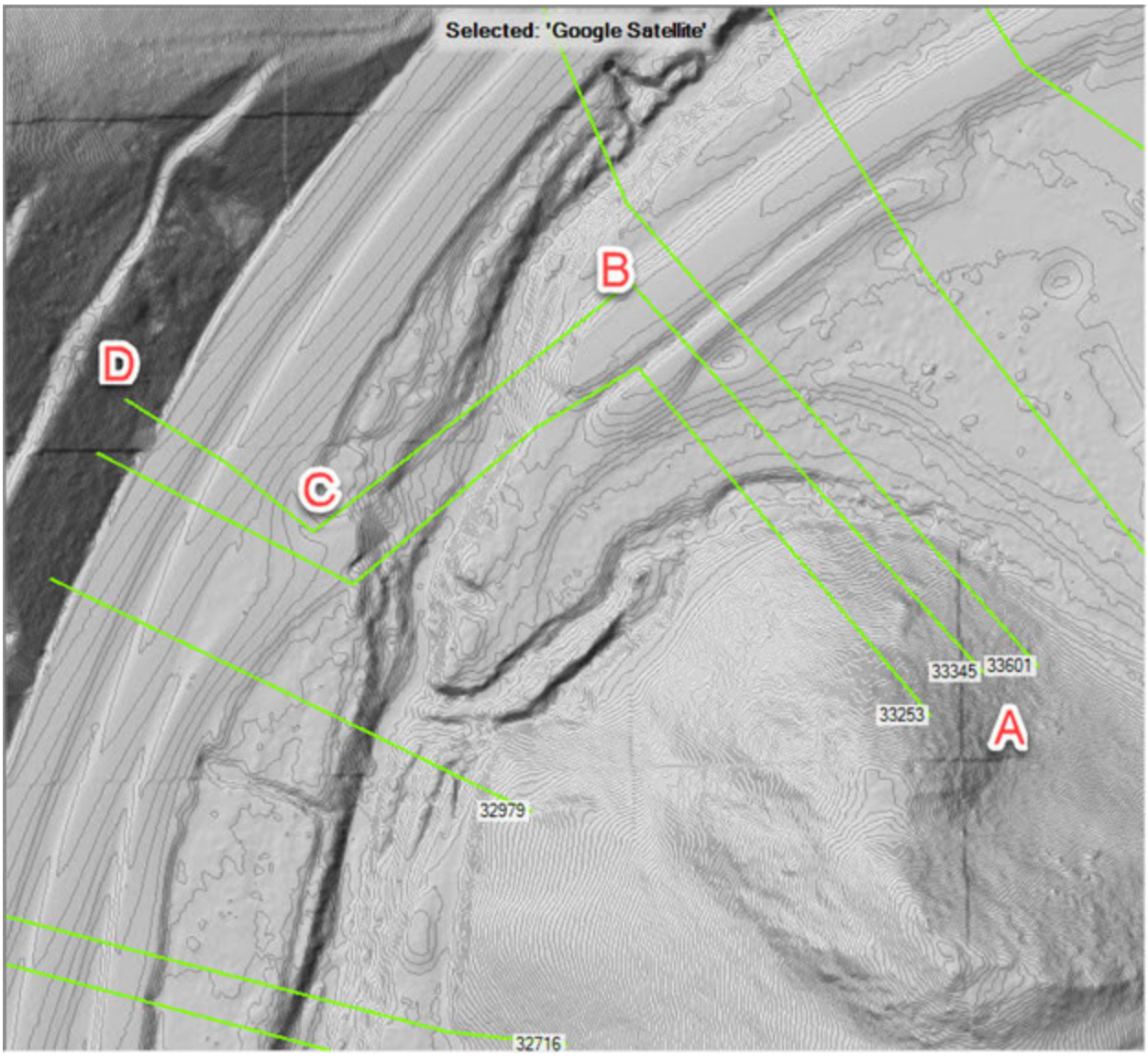


*Figure 5. Higuera Street Bridge with terrain and FEMA model cross sections*

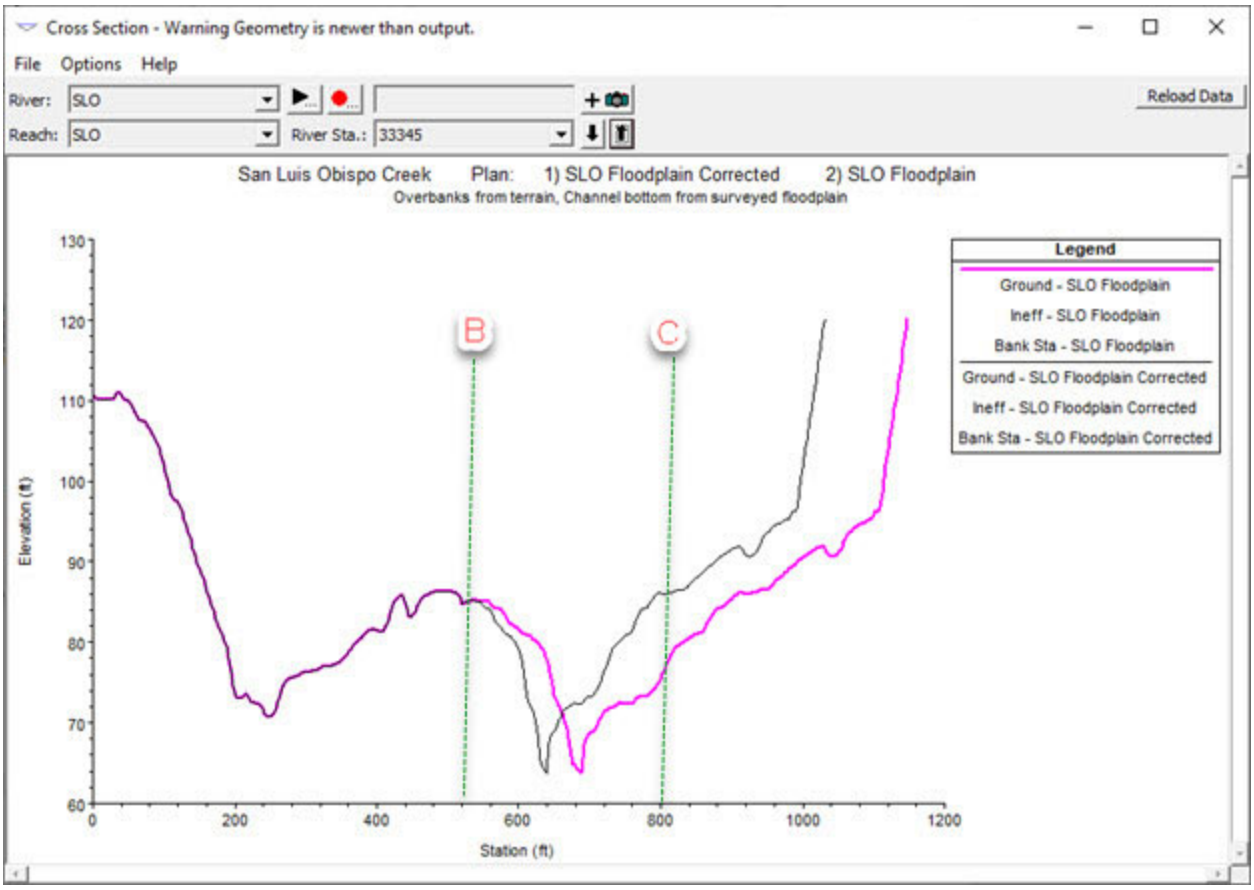


*Figure 6. Comparison of RS 33345 cross section data between FEMA (magenta) and changed (black) with segment between B-C skewed 45 degrees*

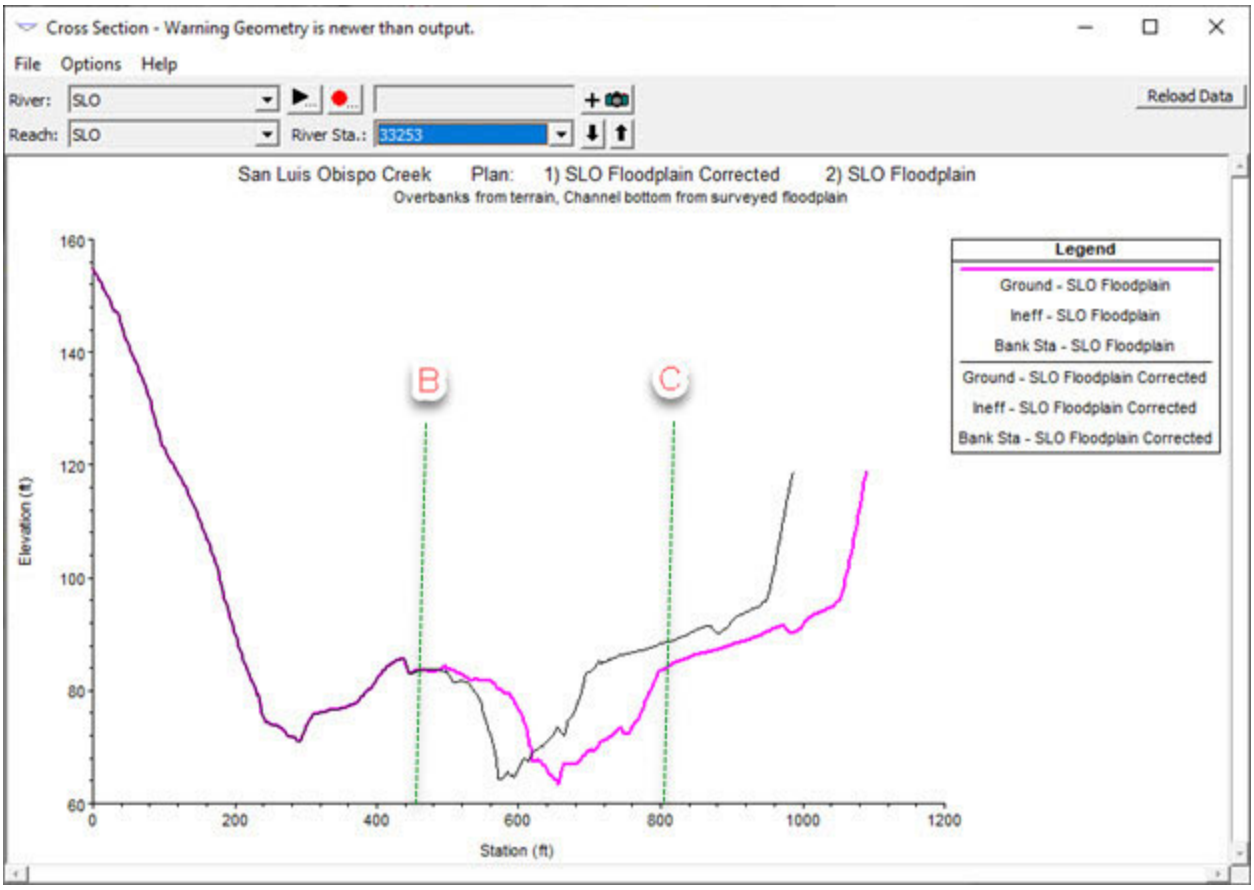


*Figure 7. Comparison of RS 33253 cross section data between FEMA (magenta) and changed (black) with segment between B-C skewed 45 degrees*

The following changes were made to Higuera Street Bridge geometry as follows:

- The deck, railing, and soffit elevation data was based on the WG topographic survey and skewed 45 degrees.

- Internal sections were defined based on the WG topographic survey and skewed 45 degrees.

A comparison of the upstream face of the Higuera Street bridge (RS 33278) between the FEMA model and the changes made based on the skew angle and the WG topographic survey is shown in Figure 8 and Figure 9.

Based on the WG topographic survey, the effective hydraulic opening of the bridge (distance between abutments normal to the direction of flow) is approximately 185 feet. The effective hydraulic opening in the FEMA bridge geometry is approximately 119 feet. This difference can be seen in Figure 9. To illustrate what a hydraulic opening of 119 feet would look like in plan view, it has been added to Figure 10 which shows the surveyed abutments and hydraulic opening of 185 feet. Note that the 119 feet dimension is not the location of the opening in the FEMA model and is for illustrative purposes only. The skew angle option for the bridge deck data in the FEMA geometry is not used.

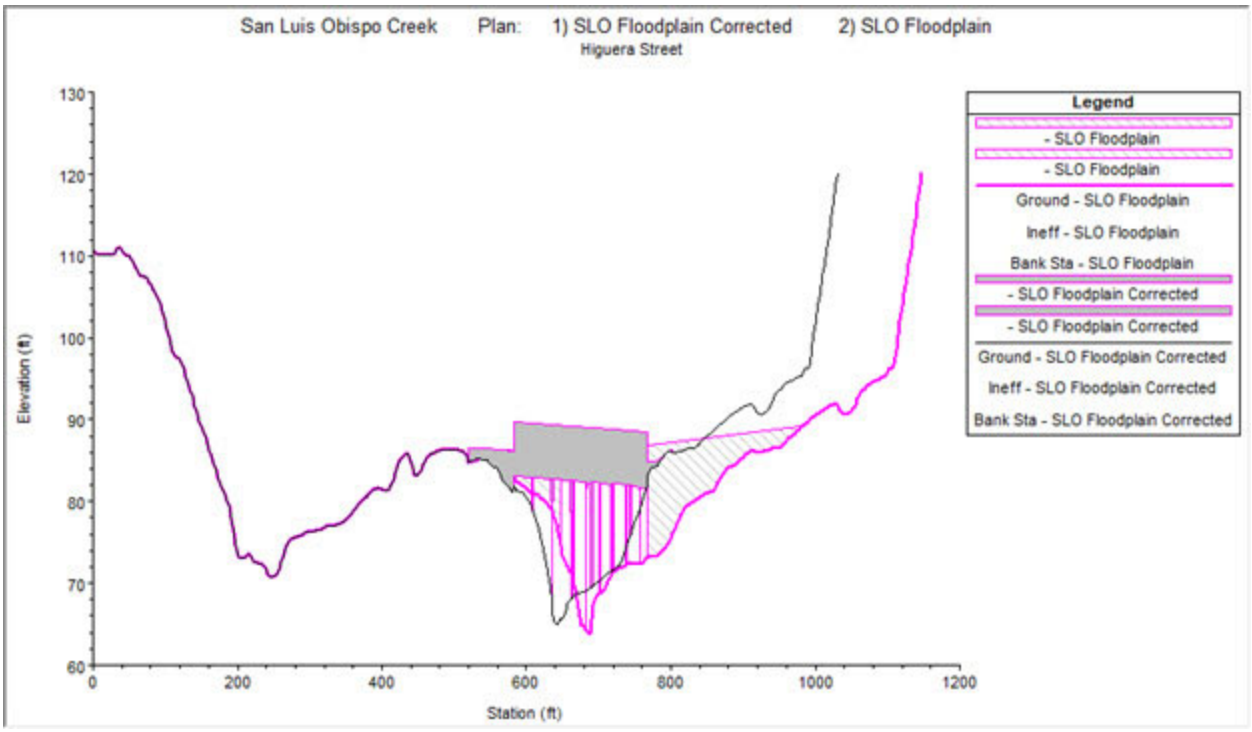


*Figure 8. Comparison of the FEMA geometry to the changed geometry for the Higuera Street Bridge (RS 33278)*

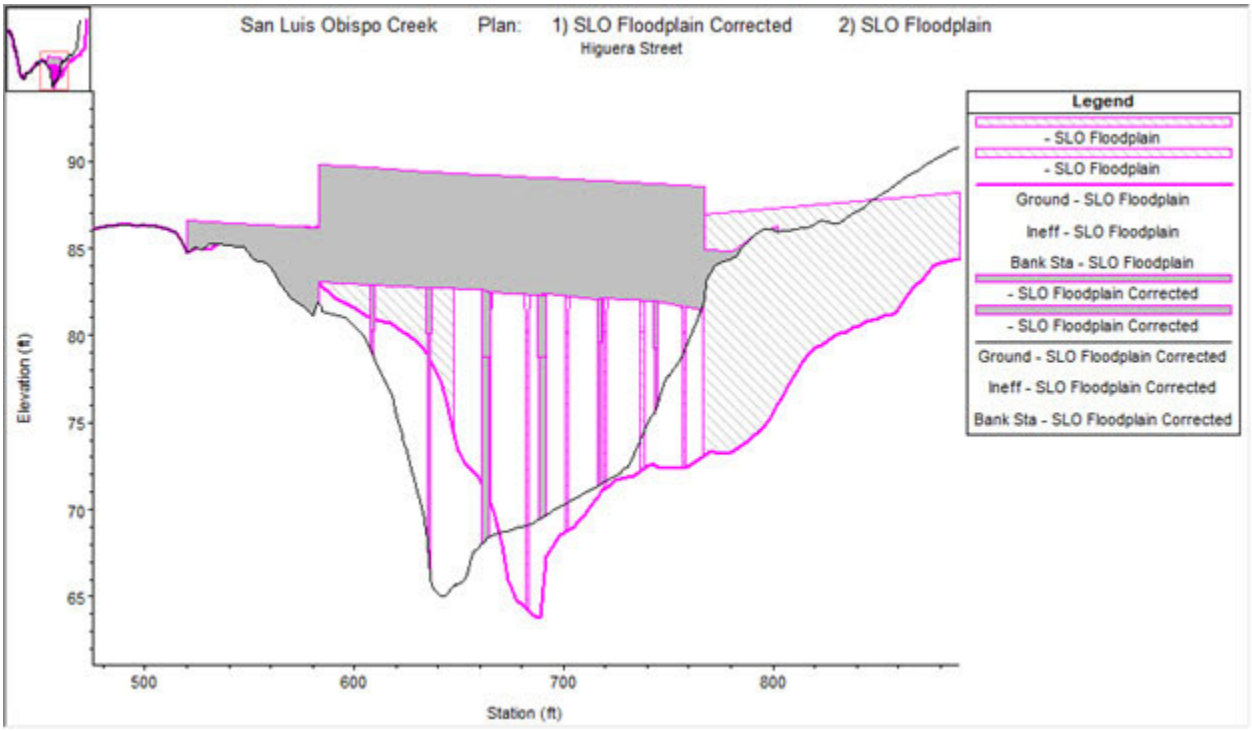


*Figure 9. Comparison of the FEMA geometry to the changed geometry for the Higuera Street Bridge (RS 33278) zoomed in*

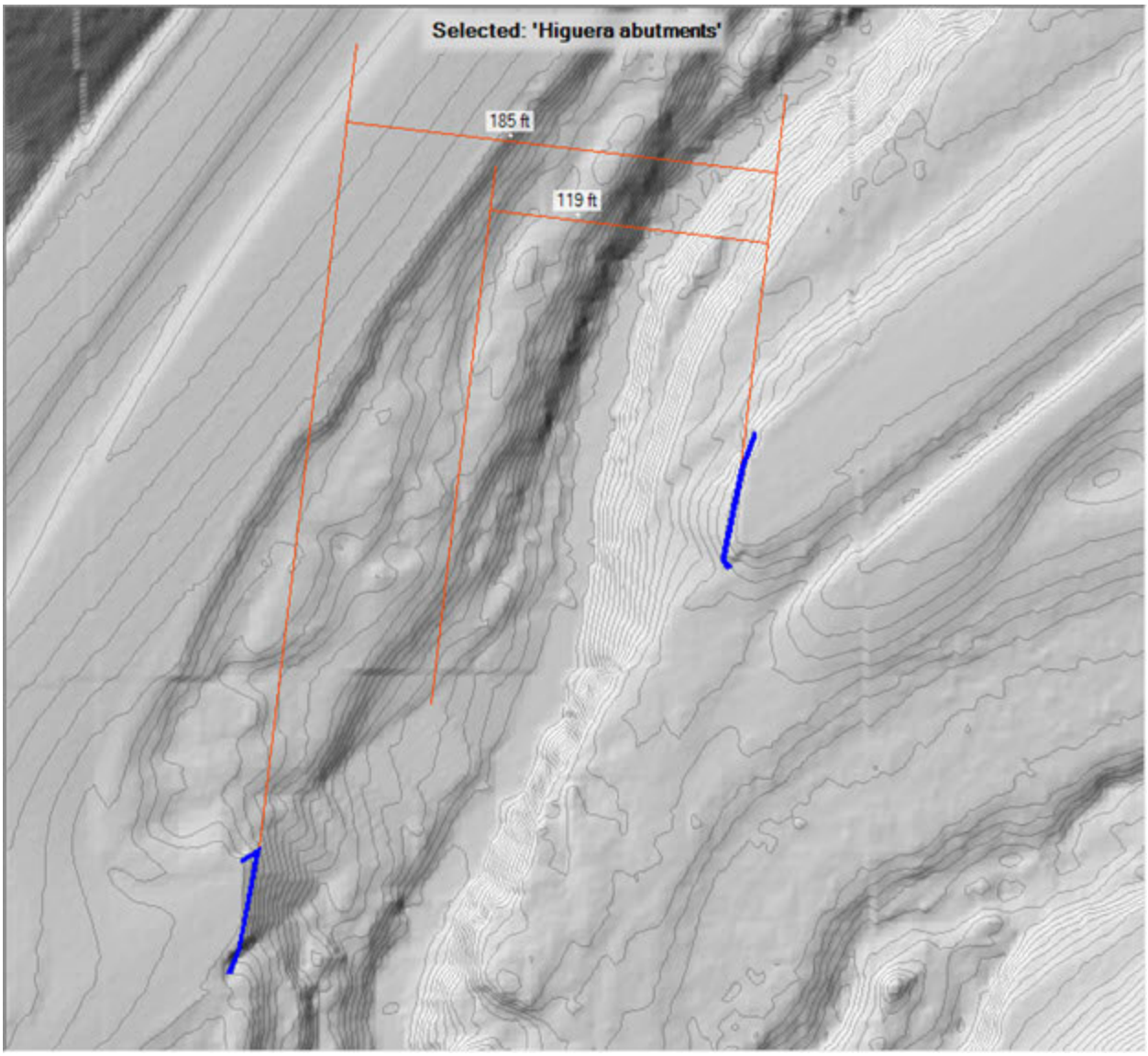


*Figure 10. Comparison of the effective hydraulic openings between the FEMA geometry (119 ft) and the changed geometry (185 ft). Surveyed abutments shown in blue.*

### Discussion About Modeling Skew Angles in HEC-RAS

There are options available in HEC-RAS to apply a skew angle to cross sections and bridge deck data. It has been our experience that the skew option is cumbersome and very easy to lose the integrity of the original unskewed data if changes are made to the skew angle. For this reason, all skew angles were applied manually using an Excel spreadsheet.