

Appendix F

TECHNICAL MEMORANDUM

Date: May 30, 2024

To: Joseph Caldwell, Ranjit Singh, Albert A. Webb Associates

From: Hank Fehlman, Northwest Hydraulic Consultants

Subject: High Level Assessment of Potential Sediment Transport Impacts Associated with the Updated Sun Lakes Boulevard Improvement Project

1 INTRODUCTION

The study summarized in this memorandum was conducted to assess the potential sediment transport impacts associated with the improvement of Sun Lakes Boulevard (Westward Avenue) east of the Sun Lakes golf course, near Banning, California. The proposed road improvements involve the addition of several new tributary crossings that are to be constructed upstream of two existing dry weather crossings. The existing dry weather crossings are to remain in place with the proposed re-aligned road improvement plan.

Impacts on sediment transport will be very dependent on the configuration proposed for the new crossings to be located upstream of the existing dry weather crossings. A high-level assessment of potential impacts was completed through comparison of hydraulic characteristics pre- and post-project.

This study is an update of a similar analysis conducted in 2021 for the project site. The proposed crossing configurations at the project site have been recently revised, and this study was conducted to analyze the updated crossing geometries.

2 DATA SOURCES

Albert A. Webb Associates provided: (1) 2D model hydraulic models (HEC-RAS) of existing conditions in the project vicinity and the proposed improvement plan (dated May 22, 2024) to be evaluated, which included flow rates that are being used in design of the proposed crossings; and, (2) a geotechnical report (Ref. 2) that included sediment size distributions of the local bed material on each reach. No information was available regarding the erosion protection measures incorporated in the existing dry weather crossings.

References are listed at the end of this report.

3 PROJECT LOCATION AND CONDITIONS

The study area is shown in Figure 1. A plan view showing the proposed Sun Lakes Boulevard alignment is shown in Figure 2. Topographic variation and cross-sections of the study streams at the existing dip crossings and at a location immediately downstream of each crossing are shown in Figure 3 and 4 (West crossing) and Figures 5 and 6 (East crossing). As may be noted in Figures 4 and 6, the existing channel cross-sections downstream of the existing crossings are significantly lower than the profile through each dip crossing. The existing crossings act as grade controls in the existing stream reaches. Scour downstream of these structures can occur during high flow events due to sediment trapping upstream of these flow barriers, and due to local scour associated with the grade breaks.



Figure 1. Study area

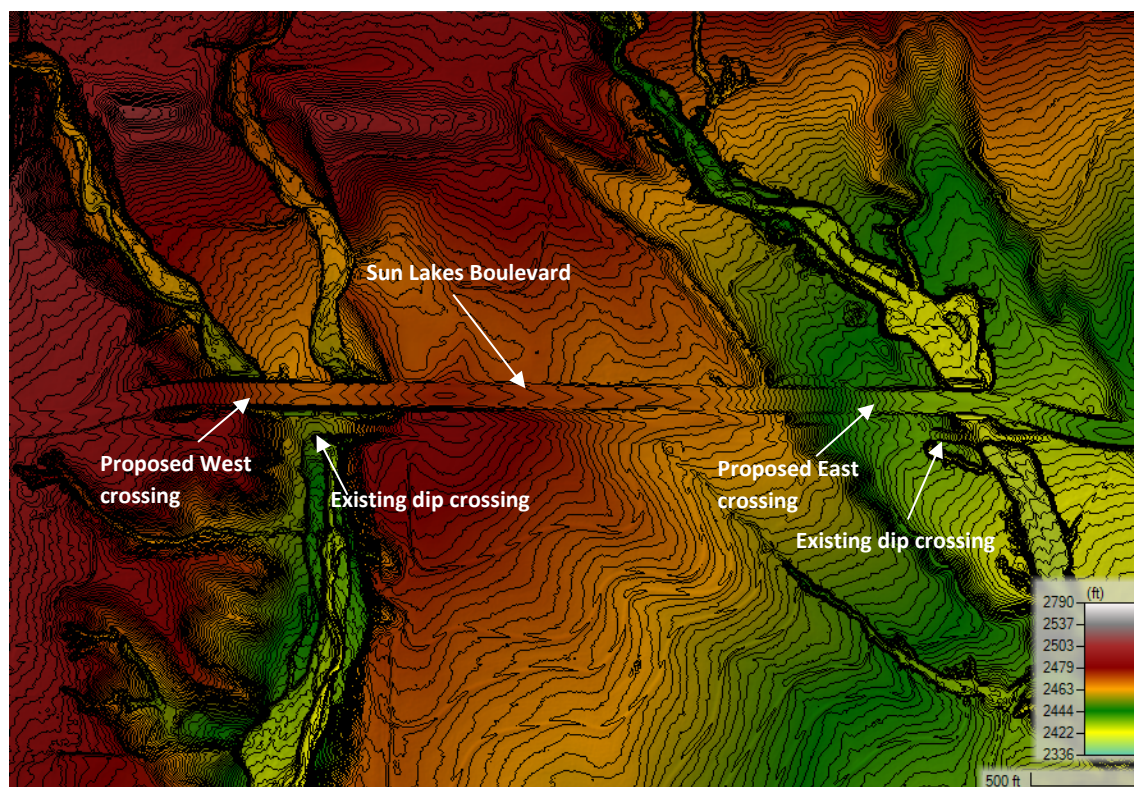


Figure 2. Local view of proposed Sun Lakes Boulevard realignment plan

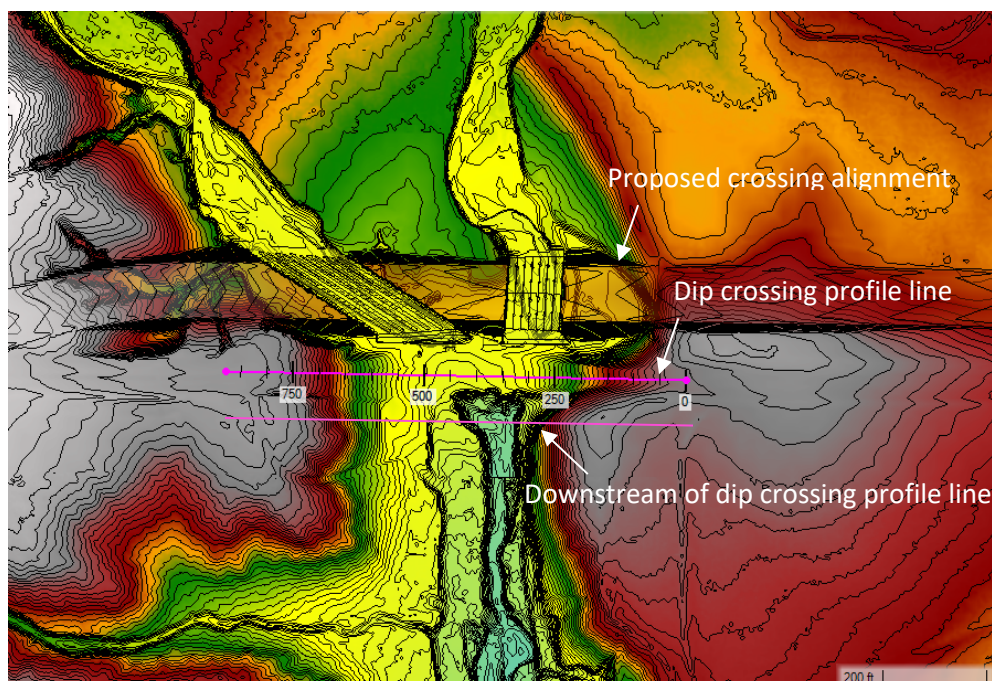


Figure 3. Profile line locations for cross-sectional comparison shown in Figure 4, West crossing

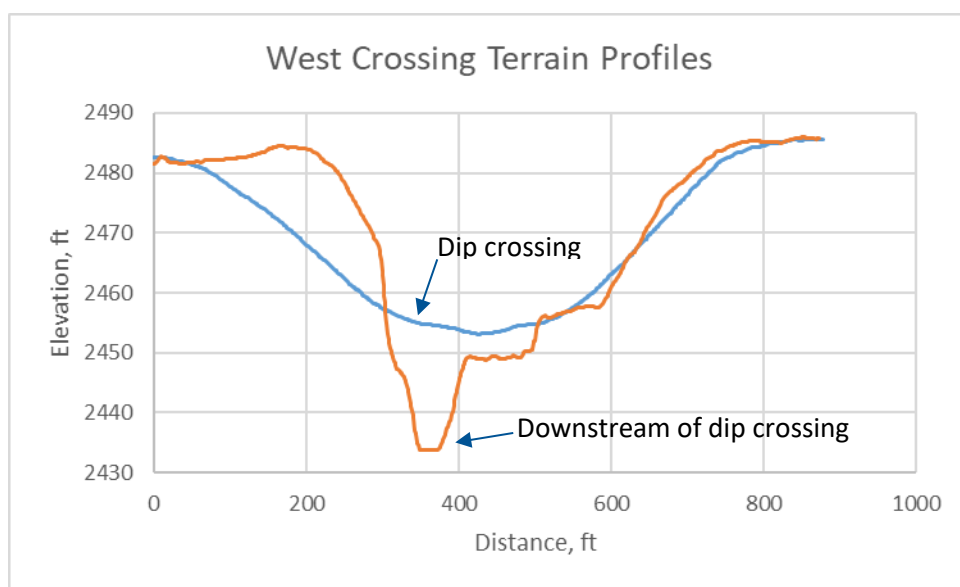


Figure 4. Cross-sectional comparison at the West crossing, at the existing dip crossing and immediately downstream

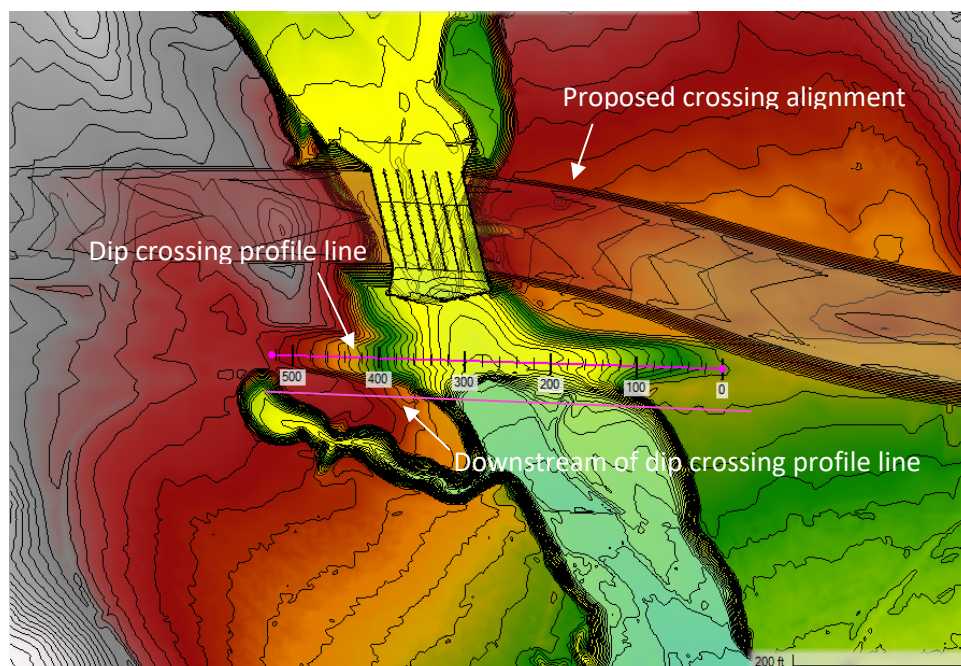


Figure 5. Profile line locations for cross-sectional comparison shown in Figure 6, East crossing

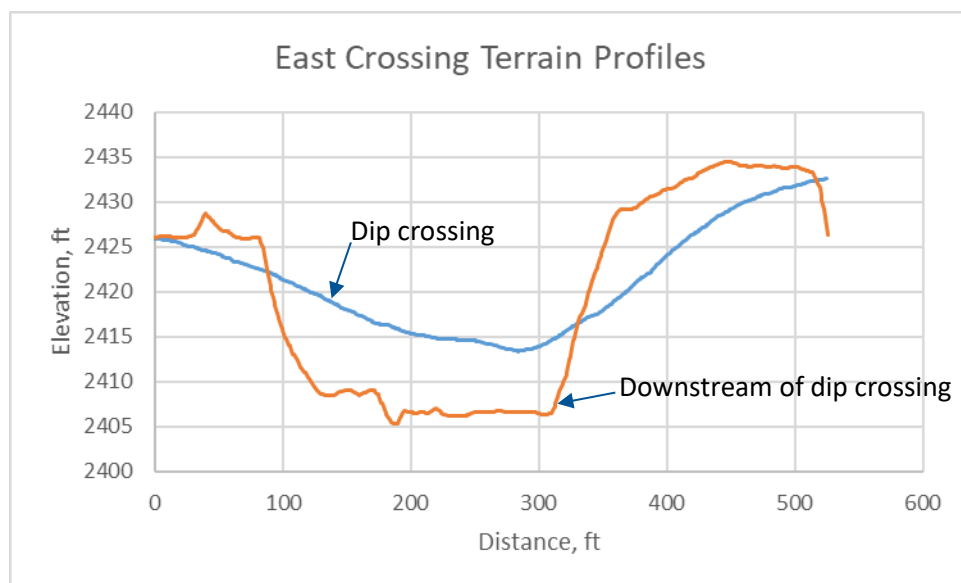


Figure 6. Cross-sectional comparison at the East crossing, at the existing dip crossing and immediately downstream

Size distribution of the local bed material of the subject streams is unavailable. Gradation information is available for borings taken along the alignment of the existing Sun Lakes Boulevard, including two

located near the west and east channel crossing locations (Samples B-2 and B-7 in Ref. 1, respectively). For this assessment, it assumed that the available gradations from the boring data represents the size distribution of the sub-surface material in the study area, and any ‘armor’ layer of coarser material present along the study reaches is insufficient to prevent mobilization of bed material during design flood events.

Size distributions from the available boring data are presented in Figure 7. Median grain sizes (D50) of the relevant samples are 0.16 and 0.31 mm (fine to medium sand). Grain sizes in this range are mobilized with flow velocities of less than 1 ft/s.

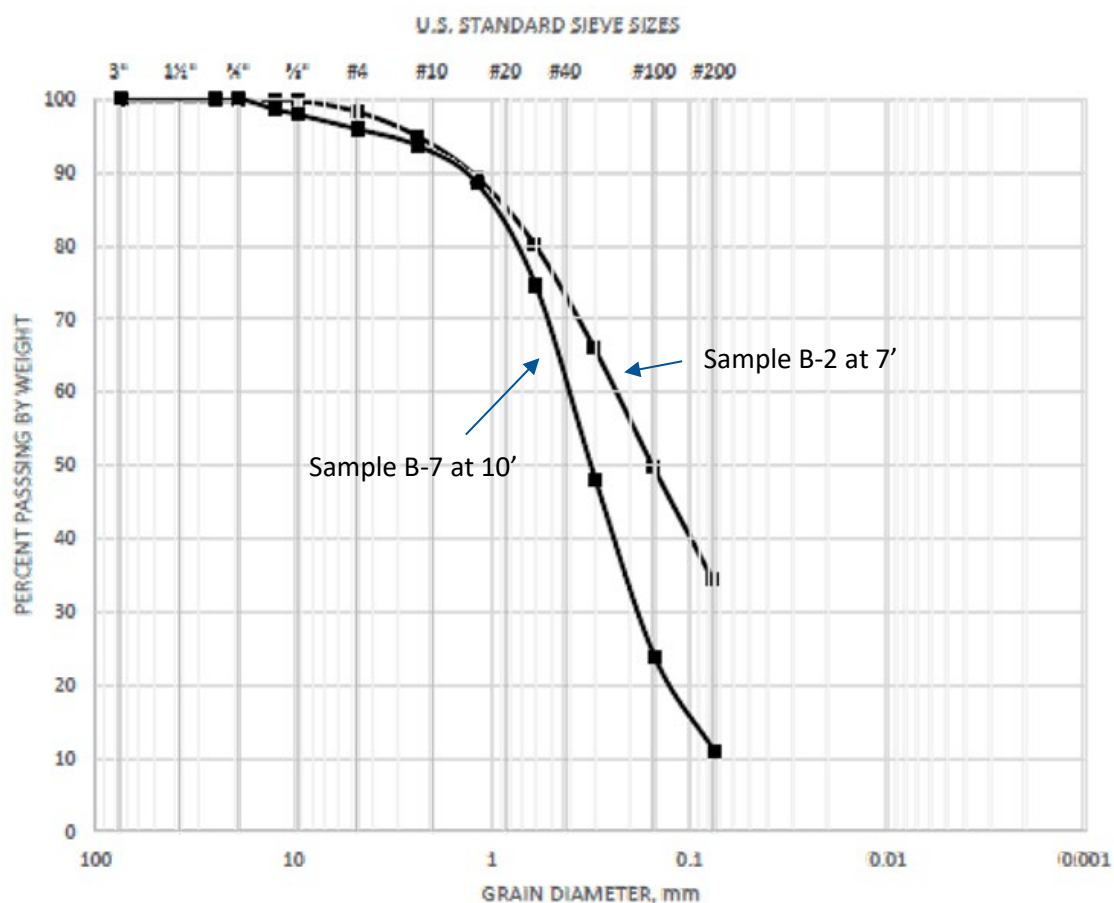


Figure 7. Grain size distributions in the project vicinity (shallowest samples at B-2 and B-7 from Ref. 2)

4 SEDIMENT TRANSPORT POTENTIAL

Flows within alluvial channels typically carry sediment, with concentrations that tend to increase with flow rate. The ability of flow to move sediment as it passes downstream is termed its sediment

transport capacity. Hydraulic properties, particularly flow velocity, and bed material properties, such as median grain size, determine the sediment transport capacity of a given river reach.

The capacity of a flow to transport particles of a given diameter is exponentially related to the flow velocity (above a given incipient or threshold velocity). In channels with similar bed material composition, higher velocities result in increased sediment transport capability. A qualitative assessment of changes in sediment transport potential of a given river reach can be made through comparison of computed flow velocities, pre-and post-project, under a given flow condition. If velocities in the reach upstream of the proposed improvements are relatively unchanged post project, the likelihood is that the project-related impacts to sediment transport (and downstream scour) are minimal.

5 HYDRAULICS

Hydraulic modeling results for existing and with-project conditions were compared for assessment of potential sediment transport impacts associated with the proposed crossing improvement plan. The model configurations, loss assumptions, design flow rates and results are as provided in the HEC-RAS model project delivered by Albert A. Webb via email dated May 22, 2024. The with-project model includes conveyance structures at the West crossing consisting of six 13.9-ft wide openings with 8-inch support piers on the west branch and seven 13.9-ft wide openings with 8-inch support piers on the east branch (middle crossing). The with-project model also includes conveyance structures at the East crossing consisting of seven 13.9-ft wide openings with 8-inch support piers. Flows in the model are 1715 cfs on the west branch of the West crossing, 2540 cfs on the east branch of the West crossing (the Middle crossing), and 2690 cfs in the East crossing.

West Crossing Results:

Pre- and post-project velocity maps for the vicinity of the West crossing are presented in Figure 8. This figure compares computed velocities under design flow conditions. Existing and with-project velocities are sufficient to mobilize the assumed channel bed material in both reaches.

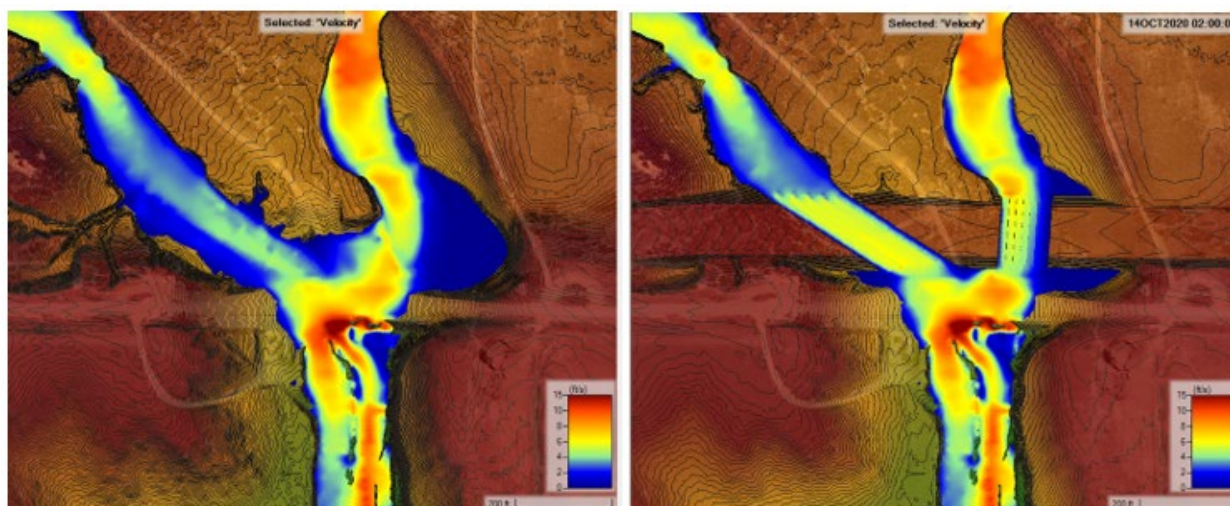


Figure 8. Existing velocities, ft/s (left) compared to proposed velocities and grading (right), west crossing

Both the west and middle branch velocities upstream of the new crossing locations appear to be only minimally altered with the proposed improvement plan. Computed velocities are contrasted at the west branch location shown in Figure 9 in the plot presented in Figure 10. Computed velocities are contrasted at the east branch location shown in Figure 11 in the plot presented in Figure 12. Velocities across the sections shown are slightly increased with-project along the east branch, and slightly decreased with-project along the middle branch. In both cases, the velocity changes are very local – hydraulic conditions in the with-project conditions upstream of the sections shown are nearly identical to the existing case, as indicated in Figure 8. Locally higher velocities through the crossings themselves (as most clearly indicated for the west crossing in Figure 8) are not of concern, since the crossings are to be lined. Locally higher velocities through the structures will assist in keeping the crossings clear of deposition during flood events.

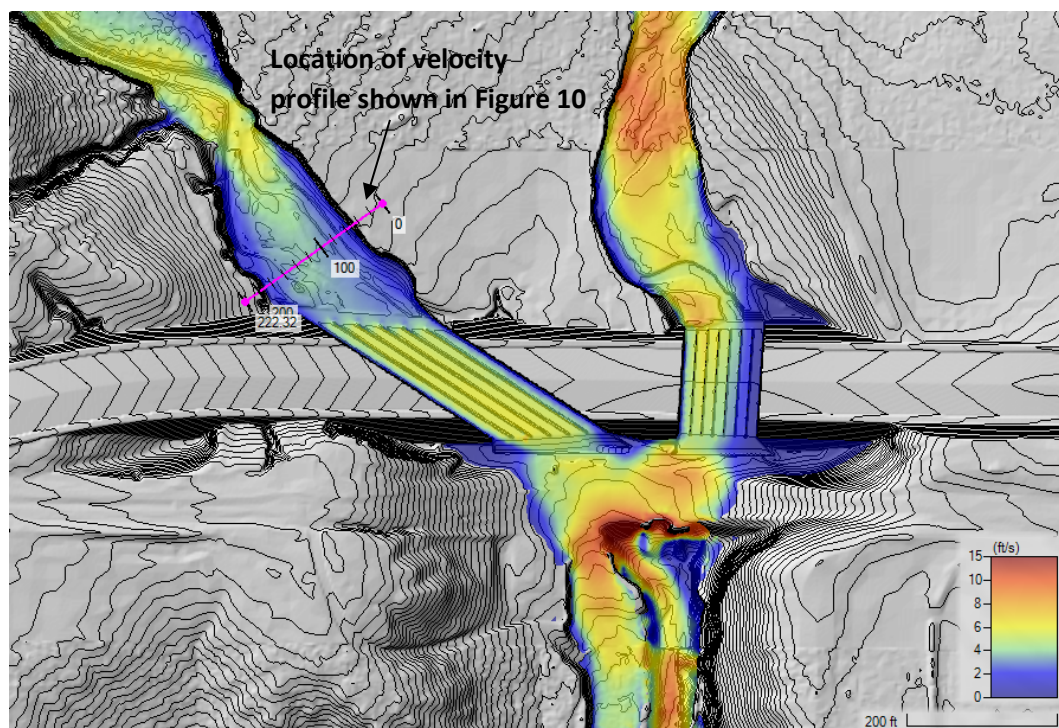


Figure 9. Location map for velocity profile comparison shown in Figure 10

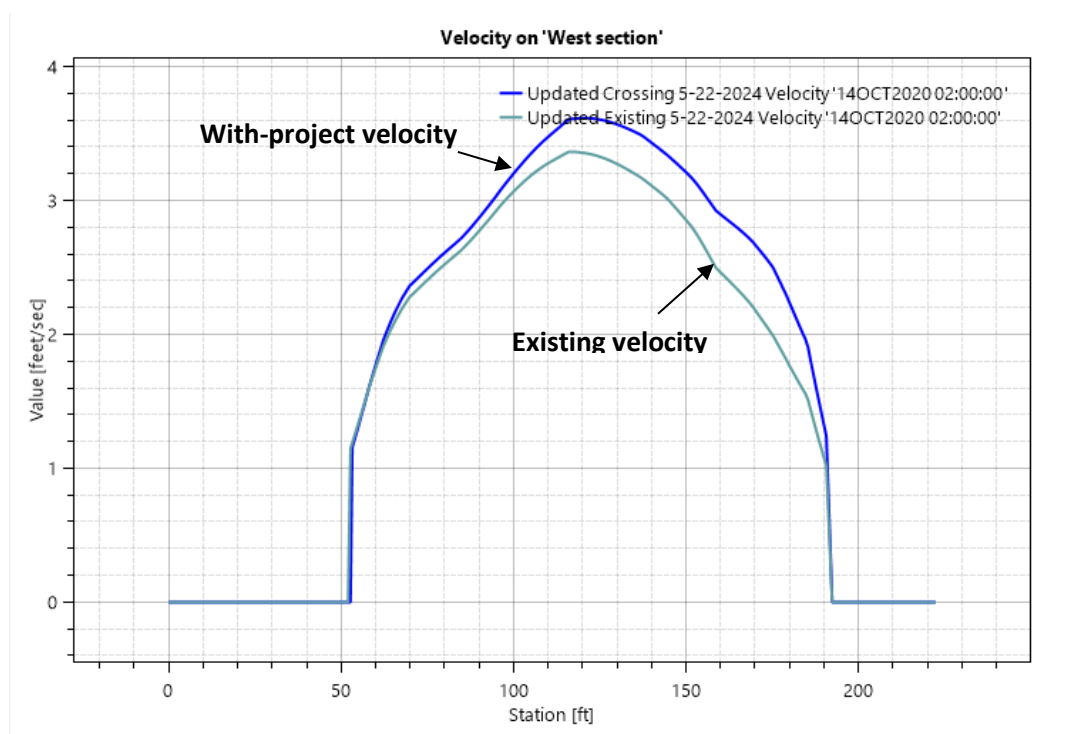


Figure 10. Design flow velocity comparison at section location shown in Figure 9, west branch of West crossing

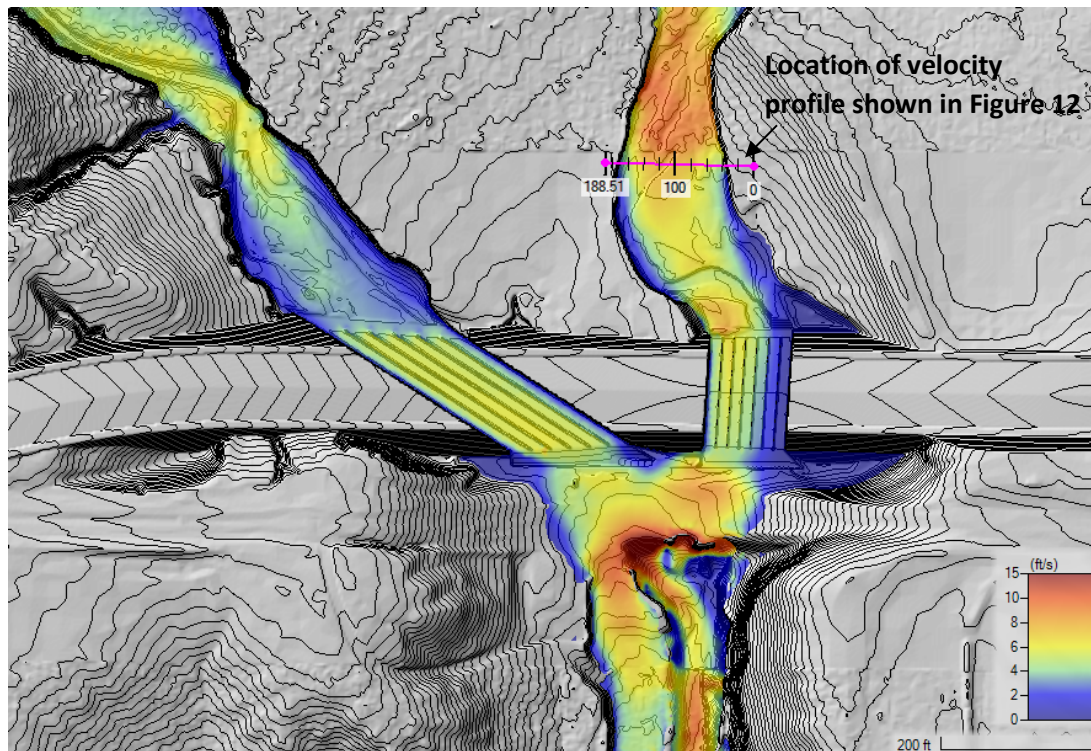


Figure 11. Location map for velocity profile comparison shown in Figure 12

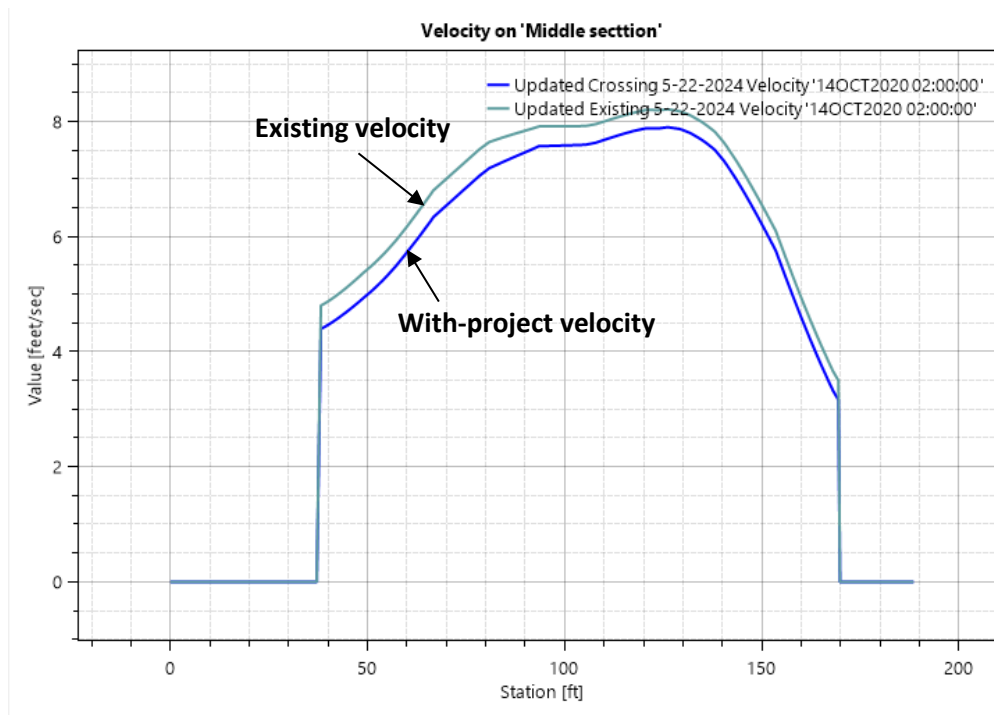


Figure 12. Design flow velocity comparison at section location shown in Figure 11, east branch of West crossing (also termed the Middle crossing)

East Crossing Results:

Pre- and post-project velocity maps for the vicinity of the East crossing are presented in Figure 13. This figure compares computed velocities under design flow conditions. As was the case for the West crossing, existing and with-project velocities are sufficient to mobilize the assumed channel bed material in both reaches.

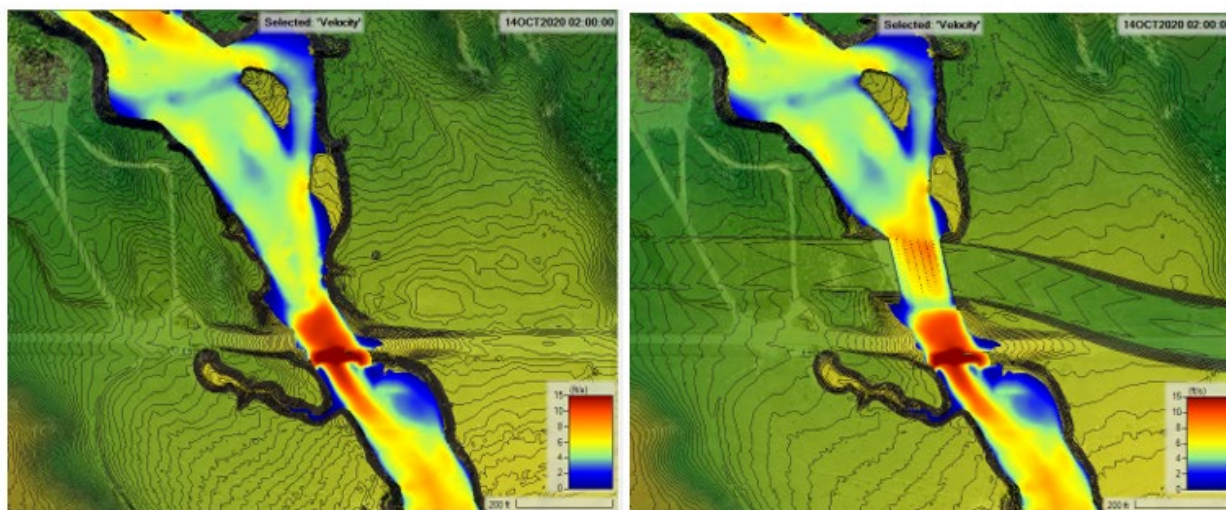


Figure 13. Existing velocities, ft/s (left) compared to proposed velocities and grading (right), east crossing

Velocities local to the upstream end of the proposed east crossing structure are slightly increased with-project, but not appreciably so. Hydraulic changes are again very local – upstream conditions are nearly identical in both with-project and existing cases, as shown in Figure 13. Computed velocities are contrasted at the East crossing location shown in Figure 14 in the plot presented in Figure 15. The results indicate that sediment transport capacities upstream of the crossing location would be expected to be only minimally affected by the proposed structures. Higher local velocities through the crossing itself (as may be noted in Figure 13) will aid in keeping the crossing clear of deposition during flood events.

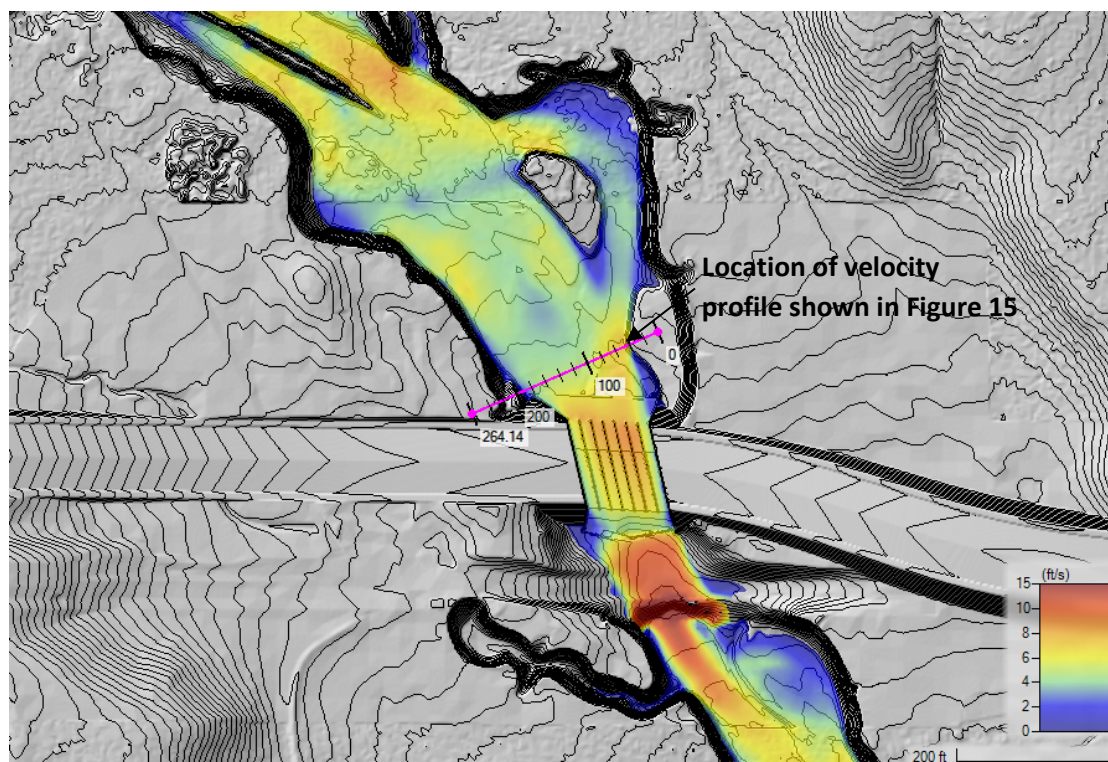


Figure 14. Location map for velocity profile comparison shown in Figure 15

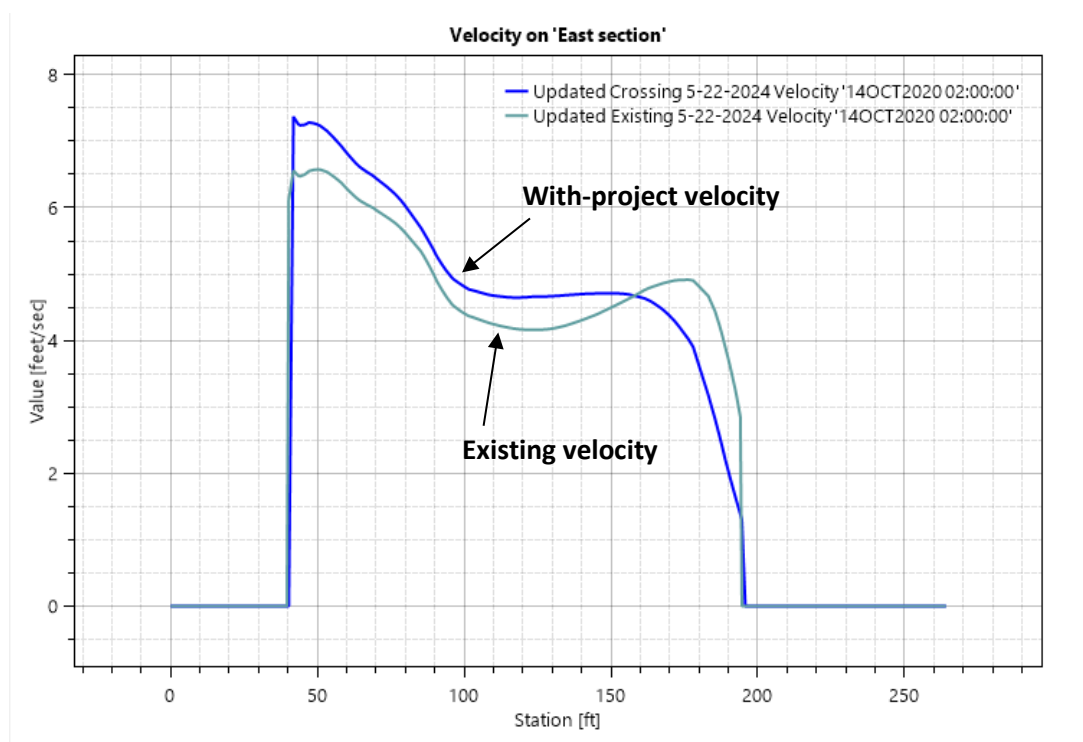


Figure 15. Design flow velocity comparison at the section location shown in Figure 14, East crossing

6 SUMMARY AND RECOMMENDATIONS

Minimizing disruption to sediment transport potential is of particular importance at the subject crossings due to the presence of the existing dip crossings, which are to remain downstream of the proposed new culverts. The existing dip crossings act as grade controls within the existing stream profiles. The stability of these existing crossings has not been assessed in this study; however, it can be concluded that reduction of sediment throughput in the project reaches upstream would increase scour potential downstream of these existing structures, which would increase their likelihood of failure. Should failure of these existing crossings occur after completion of the road improvement plan, the stability of the with-project structures would be jeopardized.

Comparison of the provided hydraulic modeling results indicates that there would likely be minimal sediment transport impacts associated with the current crossing improvement plans. Hydraulic conditions upstream of all three of the proposed crossings are very comparable under pre- and post-project scenarios.

Note that the with-project hydraulic simulation results reflect proposed as-built conditions, and assume the crossing openings are clear of accumulations and the support piers are clear of debris at the time of the peak flow event. It is recommended that regular inspections and clearing (as-needed) of the crossings be conducted to maintain these conditions. Maintenance inspections should occur, at minimum, annually prior to flood season and after any significant runoff event. Pier nose extensions (debris fins) or debris sweepers are recommended at the front end of the support piers if vegetative debris loading is of concern, to minimize the impact of pier debris accumulation on upstream hydraulics during flood events.

It is highly recommended that the stability of the existing dip crossings under design flood events be assessed.

7 REFERENCES

- (1) Albert A. Webb Associates, 2024. HEC-RAS model of existing conditions and proposed improvements to Sun Lakes Boulevard crossings east of the Sun Lakes golf course, dated 5-22-24.
- (2) Geocon West, Inc., 2019. Preliminary Geotechnical Pavement Investigation Sun Lakes Boulevard Realignment South Highland Home Road To Sunset Avenue, Banning, California.