



SOURCE: ESRI Service Layers

Butte Creek - Sutter Bypass Weir 1
Feasibility Study and Alternatives Analysis

Figure A-1
System Overview



2. HYDROLOGY

The Butte Slough near Meridian (BSL) DWR gage is the closest surface water gage to the project area (Figure A-1). The BSL gage is upstream of the East-West Diversion weir that diverts flow between the East and West Borrow Canals within the Sutter Bypass. A 60/40 flow split between the east and west canals, respectively, has been reported in previous studies (ICF 2008). Downstream of the East-West Diversion, and upstream of Weir 1, there are several operable weirs (Weir 3 and Weir 5) that divert water for irrigation with limited flow diversion records.

Because of data limitations within the West Borrow Canal, modeled data from the Tisdale Bypass Fish Passage Improvement Project (ESA 2020) was used to assess flow conditions at Weir 1. The Tisdale Bypass Fish Passage Improvement Project used a TUFLOW hydrodynamic model (TUFLOW model) to simulate conditions within the Sutter Bypass and adjacent canals for a period of 22 years (1997 – 2018). The West Borrow Canal was modeled as a 1-D channel within the TUFLOW model and included weir gate operations for upstream structures. The hydraulic results from the TUFLOW model served as an initial assessment of flow conditions within the West Borrow Canal under several seasons and water year types.

Flow results from the TUFLOW model for several critical and dry years were assessed. Because fish passage is not a concern when the weir and adjacent bypass are inundated, relatively dry water years with minimal overtopping of Tisdale weir were determined to create the most difficult fish passage conditions at Weir 1. Ultimately, TUFLOW model results from water year 2014 were used to determine critical flow rates within the West Borrow Canal within the spring-run Chinook salmon migration window (January through June). Water Year 2014 was a critically dry year with limited inundation of the Sutter Bypass and had no spill events over the Tisdale Weir (**Figure A-2**). These characteristics are expected to create difficult fish passage conditions at Weir 1.

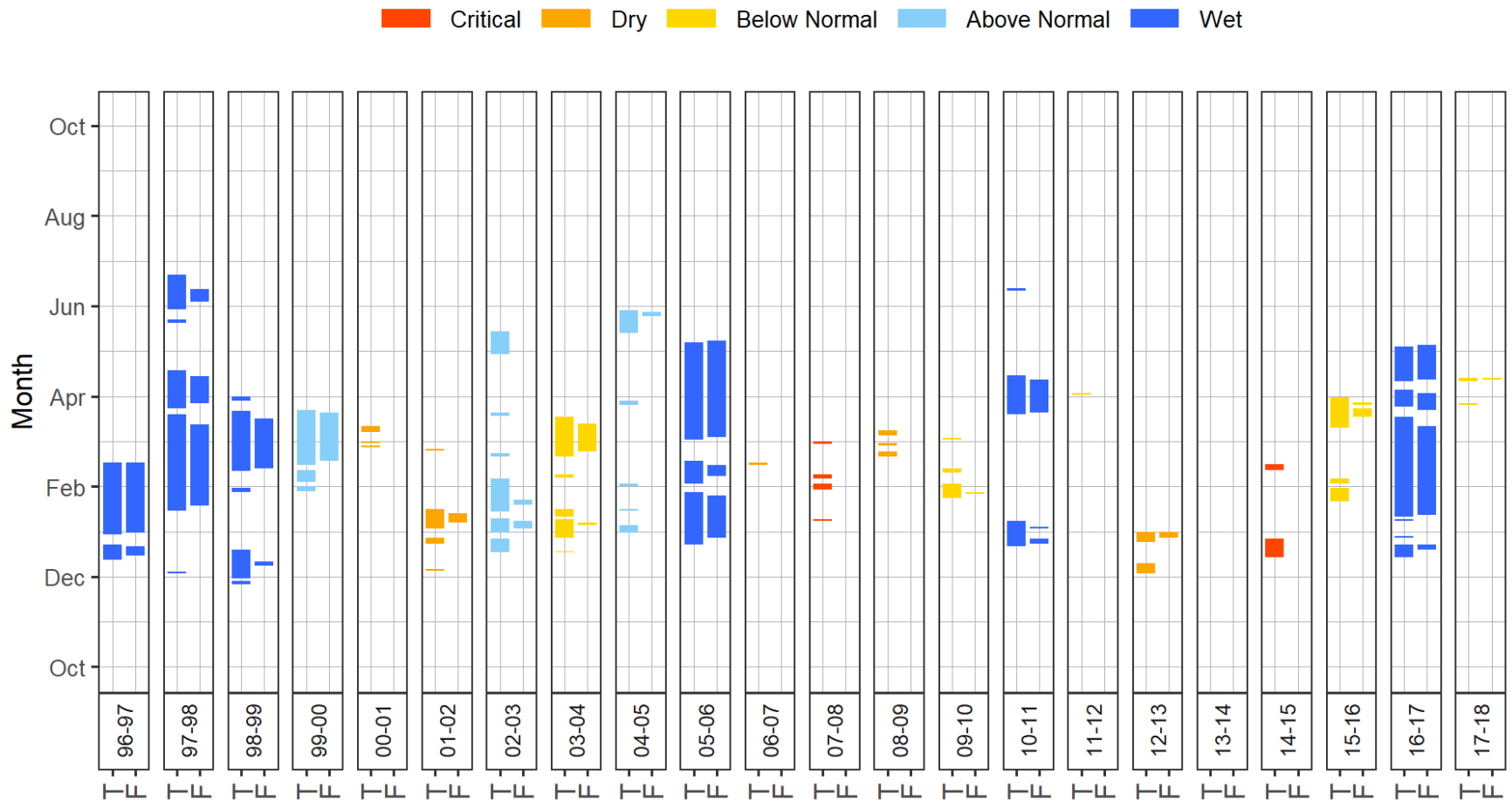


Figure A-2
Fremont and Tisdale Weir Spill Plot by Water Year

TUFLOW flow data within the West Borrow Canal for Water Year 2014 was used to calculate the high-, median- and low-fish passage flows for spring-run chinook (**Table A-1**). The passage flow values were calculated based on their relevancy to the spring-run adult Chinook salmon. The migration period was refined from prior studies to span January through June based on communication with Tracy McReynolds from CDFW and observations from the Butte Creek Parrot-Phelan Canal Diversion Trap Daily Catch and Effort Summaries published by CDFW in 2021, 2022, and 2023.

TABLE A-1
FISH PASSAGE FLOWS FOR HYDRAULIC MODEL

Flow (cfs) Spring-Run Chinook Salmon Season	Description
356	Low passage flow (90% exceedance for spring-run Chinook salmon)
380	Median passage flow (50% exceedance for spring-run Chinook salmon)
953	High passage flow (5% exceedance for spring-run Chinook salmon) ¹

¹ The recent publication, NOAA Fisheries Pre-Design Guidelines for California Fish Passage Projects, suggests using a 1% exceedance value for the high flow design discharge (NMFS 2023) instead of the 5% exceedance value suggested in prior publications (NMFS 2011). The high flow design discharge can be updated in future phases of the work to use the 1% exceedance flow. The 1% exceedance flow for the WBC based on TUFLOW model results for WY 2014 would be approximately 1,100 cfs.

The fish passage flows were used as the input hydrology for the 2D-HECRAS model. A rating curve derived from the TUFLOW model results was utilized as the downstream boundary condition (**Figure A-3**).

This page intentionally left blank

3. HYDRAULIC ANALYSIS – ALTERNATIVE 0 (NO ACTION)

The HEC-RAS modeling platform (version 6.4.1) was used to develop a 2D quasi-steady hydrodynamic model for the study. The following sections describe how the model was developed.

3.1 Computational domain

The computational domain extended from approximately half a mile upstream of Guisti Weir to approximately half a mile downstream of Weir 1 and extends from levee to levee on the west and east sides. The 2-dimensional domain was discretized within these limits using a nominal mesh cell sizes of 50 feet for the Sutter Bypass and 10 feet for the West Borrow Canal (**Figure A-4**). A nominal 10-foot mesh was applied to the West Borrow Canal and adjacent wetlands to capture the details of the hydraulics in this area. Additionally, break lines for the top of the levees (on the east and west side), channel banks, and channel centerline were used to help align the mesh faces parallel to the flow.

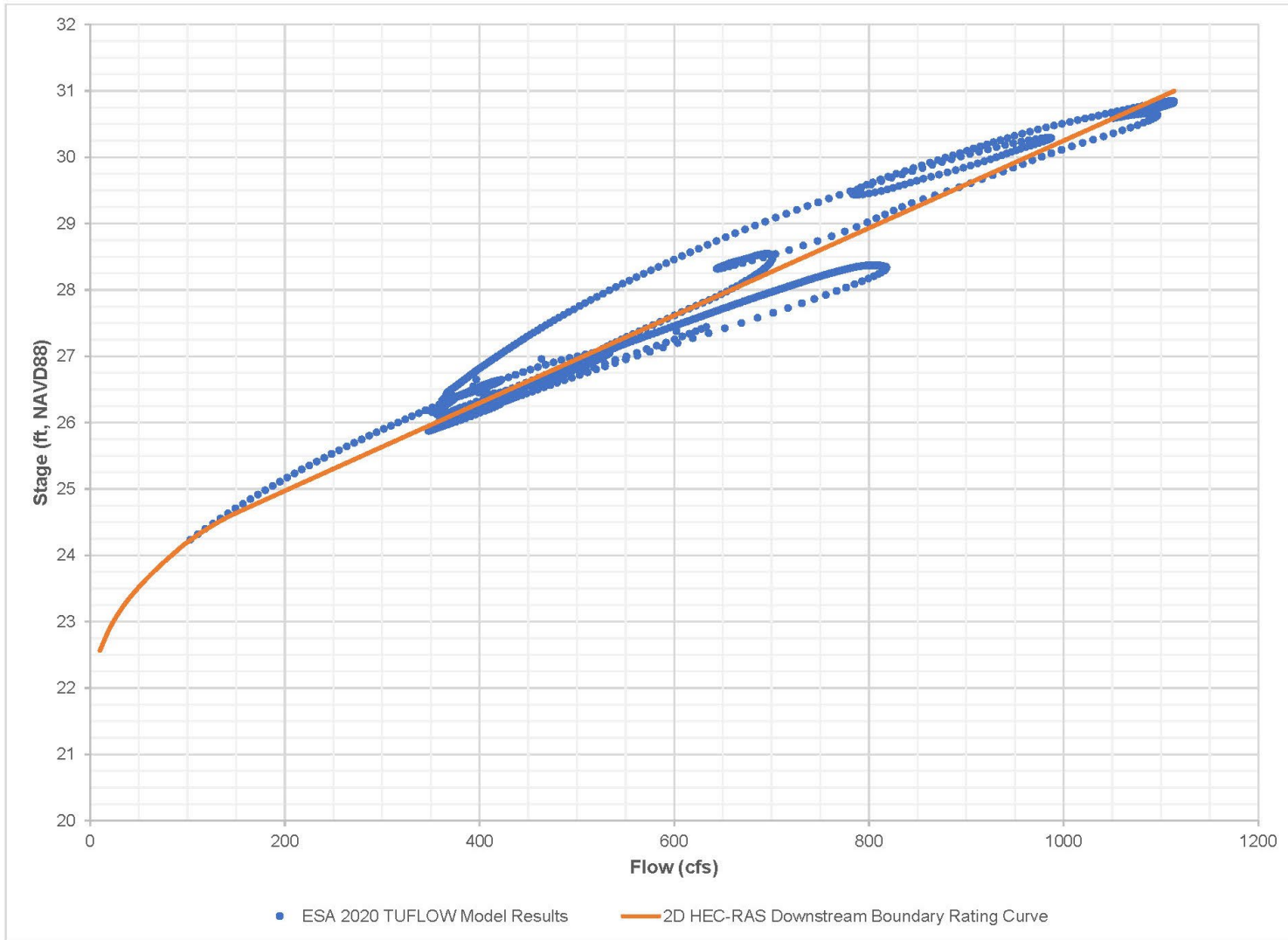
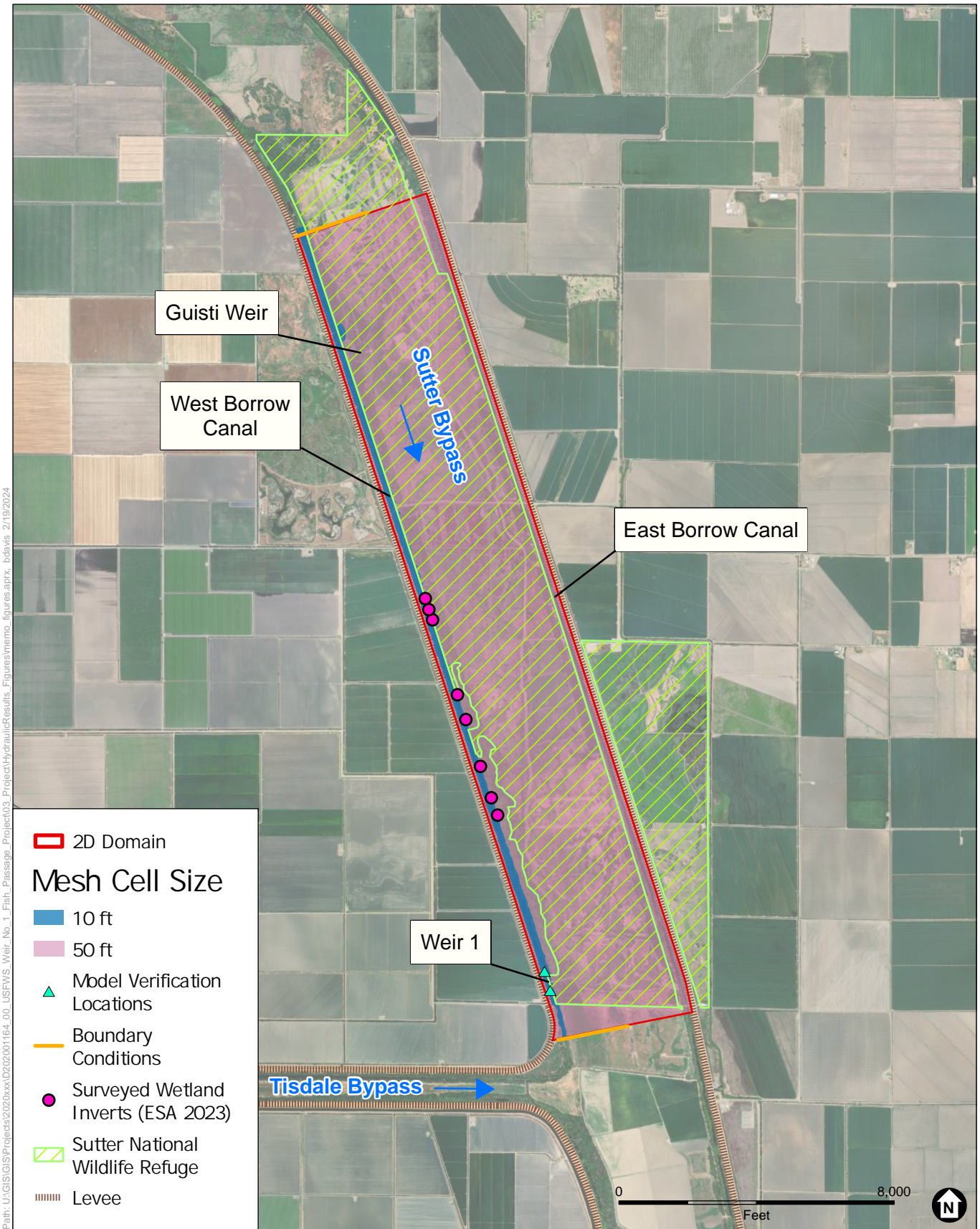


Figure A-3
Two-Dimensional HEC-RAS Model Downstream Boundary Rating Curve



SOURCE: Levees (DWR 2012)

Butte Creek - Sutter Bypass Weir 1
Feasibility Study and Alternatives Analysis

Figure A-4

Two-dimensional HEC-RAS Model Computational Domain



3.2 Terrain

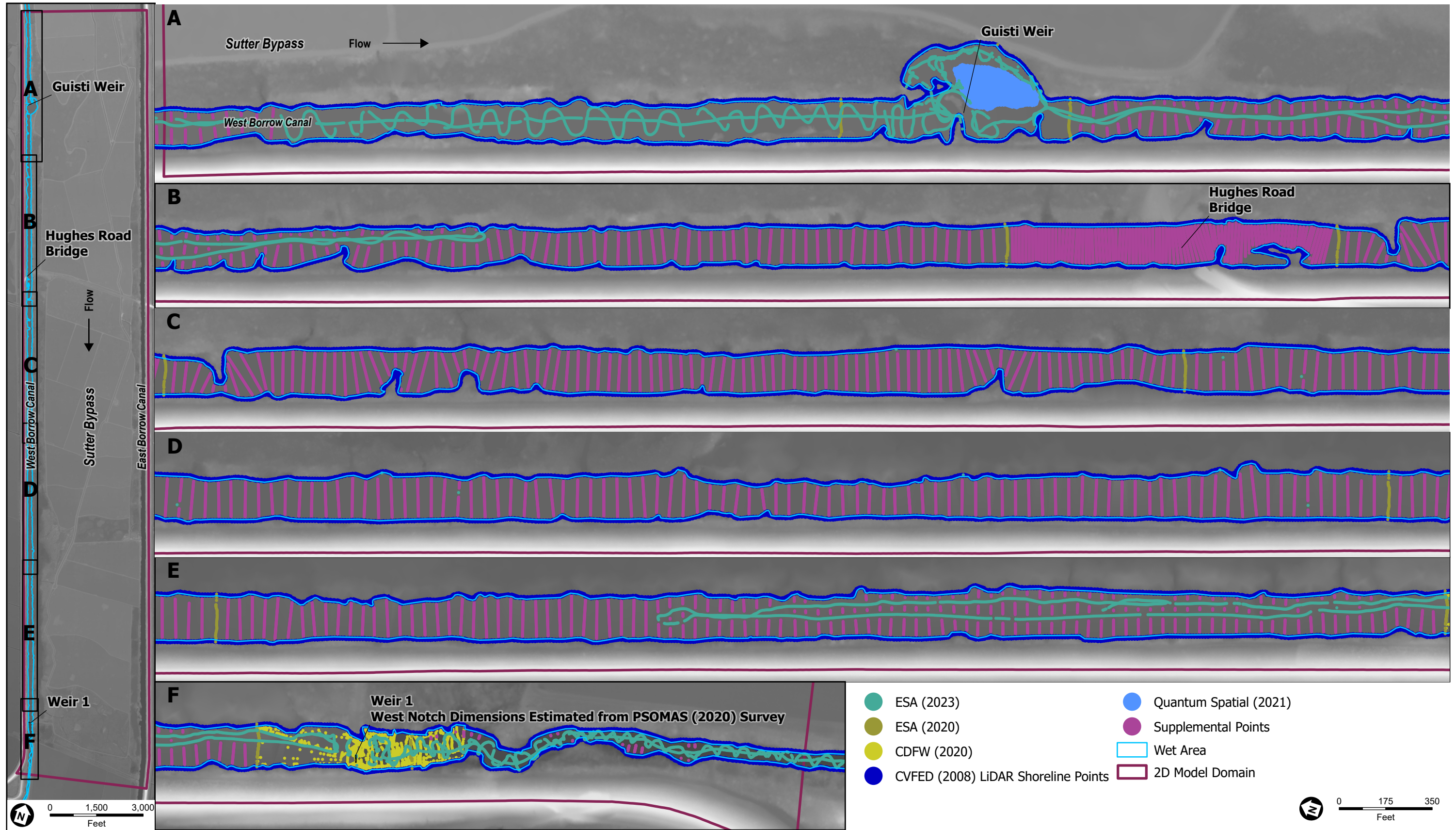
Several sources of bathymetry and topography data were used to develop the underlying terrain for the existing conditions 2D hydraulic model. Details of the terrain development are described below.

Survey Data

In 2020 ESA developed a 1D/2D TUFLOW model of the Sutter Bypass including the East and West borrow canals modeled in 1D. As part of the 2020 Tisdale study, ESA (2020) performed RTK-GPS cross-section surveys to develop 1D cross-sections for the Tisdale model, which had sufficient resolution for answering questions centered around flooding in the Sutter Bypass. For evaluating fish passage at Weir 1, which requires understanding how depth and velocity vary spatially at a resolution small enough to estimate passage width, ESA performed additional RTK-GPS and echosounder surveys to more accurately define bathymetry. After supplementing the data with the CDFW (2020) survey of Weir 1 and the Quantum Spatial (2021) Light Detection and Ranging (LiDAR) survey to represent the island at Guisti Weir the cross-section surveys from ESA (2020) were interpolated and scaled based on the dimensions of the assumed water surface to create supplemental points. The Sutter Bypass was represented using the Central Valley Floodplain Evaluation and Delineation Program (CVFED) LiDAR survey (DWR 2010; Fugro Earth Data 2010; Photo Science 2009) that was used previously in the Tisdale model. Refer to **Figure A-5** for the extents of these surveys.

Existing Conditions

To create a surface fitting the bathymetry points and edges of the LiDAR, Functional Data Analysis with Partial Differential Equations (fdaPDE)—a bathymetry technique currently used by the DWR Bay-Delta Office (Wang et al. 2018)—was employed to fit a smooth spline through the bathymetry points and supplemental points within the wet area of the LiDAR as well as the shoreline of the CVFED LiDAR to create a smooth transition. Upon completion, fdaPDE was reapplied until both a satisfactory fit was achieved and overfitting artifacts were sufficiently small based on professional judgement. An additional edit to reinforce the weir crest elevation at Weir 1 was applied using the footprint of the PSOMAS (2020) Weir 1 structure survey. Refer to **Figure A-6** for the resulting combined surface representing existing conditions and the extent of the interpolation mesh.



Butte Creek - Sutter Bypass Weir 1
Feasibility Study and Alternatives Analysis

Figure A-5
Topography and Bathymetry Data Sources