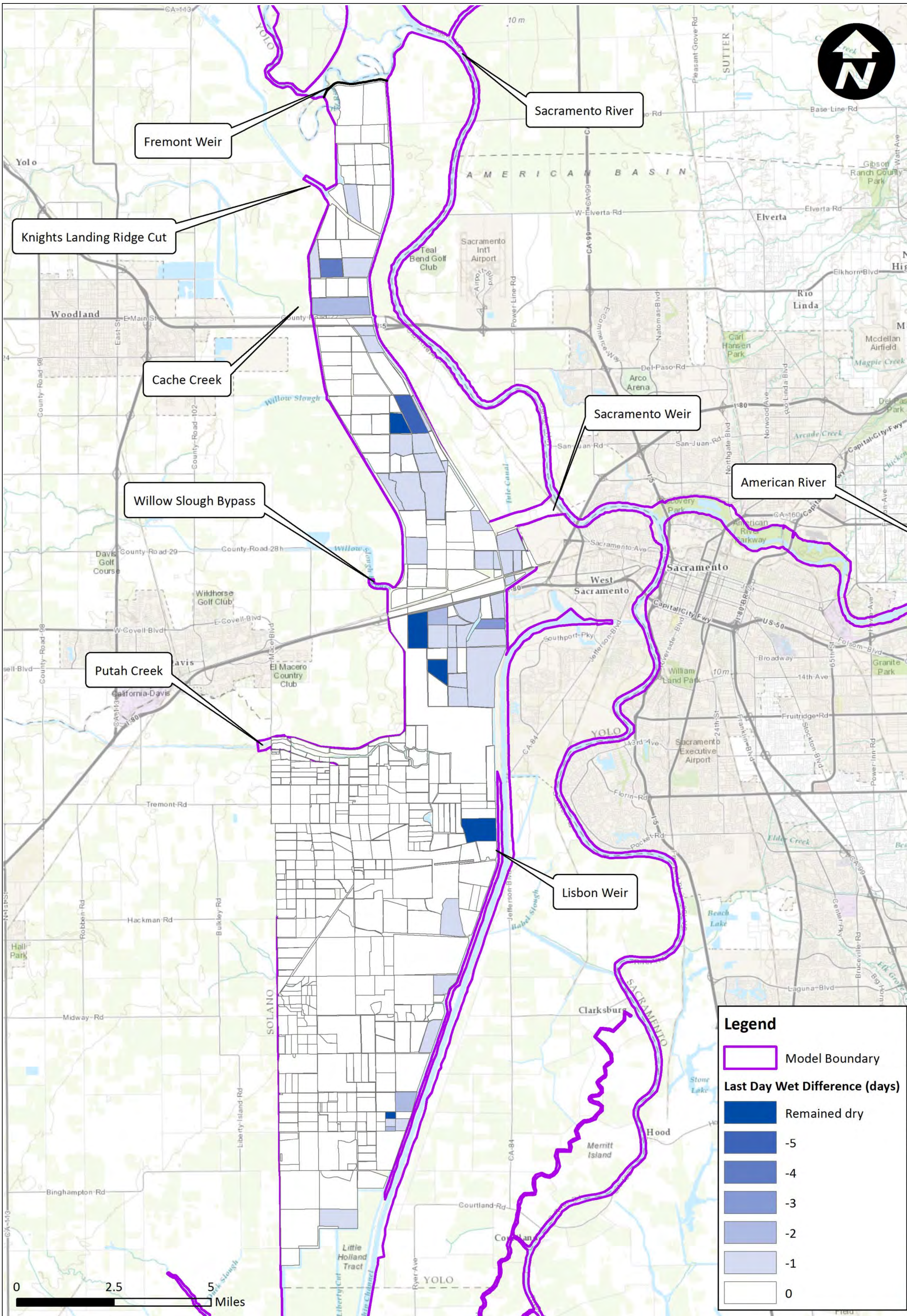
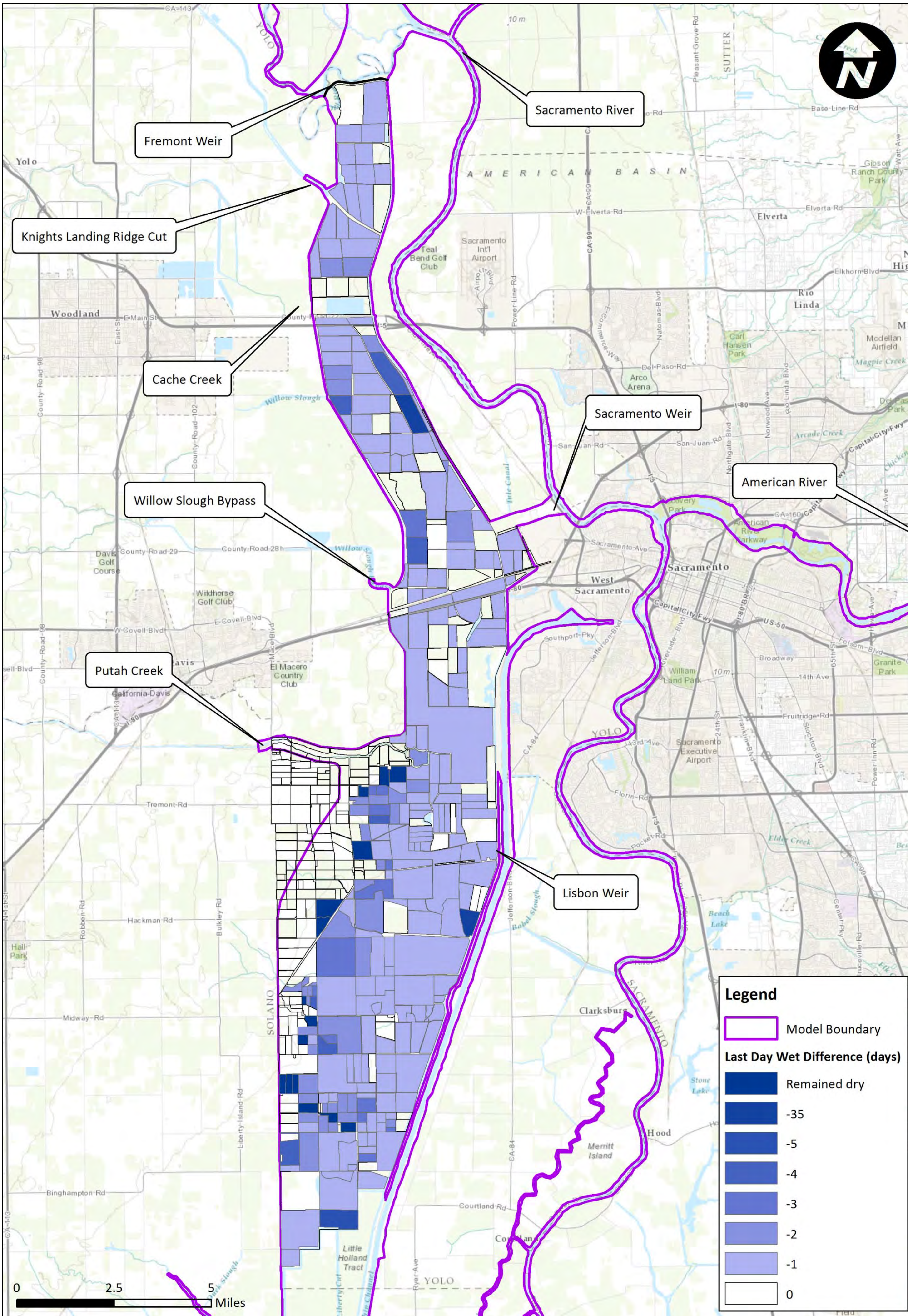


Notes: Differences to Last Day Wet for existing conditions when decreasing inflows 10%. Negative values indicate earlier Last Day Wet.

Yolo Bypass Salmonid Habitat Restoration and Fish Passage

Existing LDW Sensitivity to 10% Decrease in Flow 2001

Prepared for DWR | Created By: RDJ | **Figure 8-11**



Notes: Differences to Last Day Wet for existing conditions when decreasing inflows 10%. Negative values indicate earlier Last Day Wet.

HDR cbec eco engineering

Yolo Bypass Salmonid Habitat Restoration and Fish Passage

Existing LDW Sensitivity to 10% Decrease in Flow WY 2011

Prepared for DWR	Created By: RDJ	**Figure 8-12**

9.0 Conclusions

A TUFLOW classic hydrodynamic model has been developed to help evaluate impacts and benefits of potential alternatives for the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project. Three alternatives for channel and gate designs at the Fremont Weir and an alternative with channels and gates at the Sacramento Weir were evaluated. The model domain extends along the Sacramento River just South of Tisdale Bypass to near Rio Vista, includes the Yolo Bypass, and includes portions of the Feather River, Sutter Bypass, American River and various North Delta sloughs.

Model results have been provided for use in analyses to quantify the impacts and benefits of the four alternatives modeled. While the benefits and impacts will be evaluated by other analyses, some observations can be made from the TUFLOW model results. All of the alternatives increase the extent and duration of inundation events within the Bypass. The three Fremont Weir alternatives provide similar increases in inundation. The FreLg alternative provides the largest inundation benefit of 7,700 acres in 2 out of 3 years. The SacW alternative typically provides half the inundation increase of the Fremont Weir alternatives.

Potential changes to sediment erosion and deposition within the Bypass and in the Sacramento River are currently being evaluated.

The comprehensive nature of the model makes it a useful tool to serve as a basis for future analyses.

9.1 Summary of Modeling Work/Data Passed Along

Post-processed model results have been provided to other teams to inform other analyses. The Agriculture Economics team has been provided GIS data indicating the last day of inundation anticipated for individual field units within the Bypass. The fisheries team has been provided daily GIS raster data for depths and velocity magnitudes within the Bypass and time-series discharge data at specific locations within the model. The CALSIM Modeling team has been provided discharge versus discharge scatter plots for the each of the modeled alternatives to define rating curves for CALSIM model input.

9.2 Recommendations for Future Model Improvements

The gate/channel designs and operations used for this study are preliminary and this modeling effort focused on identifying the relative differences between alternatives. Changes to the design and operation may impact the results.

A datum error for some of the water years at the downstream WSE versus time boundary condition at Rio Vista are discussed in Section 6.2. Sensitivity analysis confirmed that the change would have had little impact on the results but future analyses should use the corrected boundary data.

Bridges inside and outside of the Bypass were not represented in the model. Most bridges are not submerged even in large floods but pier losses could be added in appropriate places. It was learned through the modeling that the County Road 22 bridge over the Tule Canal is low enough to become submerged in large floods. Model calibration suggests that incorporating this change is not important for large scale analysis. Should the need for bridges or bridge piers to be incorporated more explicitly in model arise, it should be recognized that calibration may need to be revisited.

The number and length of simulations greatly constrained cell sizes and time steps. Smaller cells within the Bypass would have better represented the topography, particularly features incorporated using polylines which are smaller than the 100 feet elevation spacing (i.e., berms and drainage ditches). Local WSE oscillations which occurred near 1D/2D domain boundaries during high discharge periods due to differences in the 1D/2D time steps may benefit from adjusting 2D cell-sizes and time steps. Future modeling efforts involving fewer simulations and/or shorter durations should attempt to make this refinement.

Hydraulic structures (e.g., culverts, gates) along the drainage features within the Bypass could be added to more accurately represent flow constrictions and impediments to drainage, however, it should be recognized that culverts and gates for individual fields may change from season to season.

The model was calibrated to three events specifically chosen to represent a high flow period, a low-flow period, and a receding limb period. Data is available for other flood events such as the 2006 flood which could be used to further calibrate or validate the model. In addition, the USGS maintains a comprehensive network of gauges recording stage and flow in the slough system south of the Stair Step and Courtland that can be used to calibrate the flow splits within the Cache Slough Complex.

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Appendix A

Sacramento Slough and Willow Slough Bathymetric Survey

Technical Memorandums

TECHNICAL MEMORANDUM

Date:	June 6, 2014
To:	Project File
From:	Chris Campbell, MS, Benjamin Taber, BS, PE
Project:	13-1027 – Yolo Bypass Salmonid Habitat Restoration and Fish Passage
Subject:	Sacramento Slough Bathymetric Survey

1 INTRODUCTION

cbec, inc., eco engineering (cbec) performed a bathymetric survey of Sacramento Slough on September 6th, 2013 to support hydrodynamic model development for the Yolo Bypass Modeling Project. The objective of the survey was to define the geometry of the slough channel bed such that the slough could be represented in 1D as a series of cross sections or transects. The surveyed reach extends from the confluence with the Sacramento River upstream approximately 8.5 miles. Transects were taken at select locations with a spacing of approximately 2,000 feet on the lower reach (from the confluence to the RD 1500 pumps) and a spacing of approximately 4,000 feet on the upper reach (upstream of the RD 1500 pumps). Transects were field fitted to select areas with minimal riparian vegetation on the banks with the assumption that the Central Valley Floodplain Evaluation and Delineation (CVFED) LiDAR data would be used to represent the overbank areas at each transect. Transects on the upper section were chosen to capture the constrictions in channel geometry where the existing earthen spur dikes protrude into the channel, and also because dense aquatic vegetation was present between the spur dikes, which preclude bathymetric data collection. Additional cross sections were recorded on the upstream and downstream sides of the two bridges within the study reach, as well as additional survey data to characterize the bridge geometry. See Figure 1 for a map of Sacramento Slough showing the extents of the surveyed reach and transect locations.

2 METHODS

2.1 BATHYMETRY

The bathymetric survey was performed utilizing an Ohmex Sonarmite echosounder integrated with a Trimble R8 Global Navigation Satellite System (GNSS) receiver mounted to a boat. The echosounder produces sound pulses that measure the distance from the transducer to the bottom of the water body being surveyed. Real Time Kinematic (RTK) Global Positioning System (GPS) was used in conjunction with

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California Survey and Drafting Supply (CSDS) VSN mobile base network to provide positional corrections to the Trimble receiver. Both position and depth were recorded on a mobile data collector in real time while performing the survey. Equipment data sheets are provided in Appendix A.

2.2 CONTROL AND DATUMS

Prior to surveying, the cbec field crew occupied two benchmarks reported in the CVFED LiDAR survey control documentation (see Table 1) to correct for horizontal and vertical variations in the observations. These variations are caused by atmospheric conditions as well as specific satellite geometry at the time of data acquisition.

Table 1. CVFED benchmarks (this survey)

Benchmark	Reported Northing[1]	Reported Easting[1]	Reported Elevation (ft,NAVD88)[2]	Observed Northing[1]	Observed Easting[1]	Observed Elevation (ft,NAVD88)[2]
NGS (AI5071)	2067336.22	6632368.27	25.09	2067336.26	6632368.19	25.12
WR168	2034616.71	6649412.49	42.74	2034594.71	6648606.76	42.71

[1] California State Planes, Zone 2, NAD 83, US Survey feet
[2] North American Vertical Datum 1988 (NAVD88), Geoid 2009

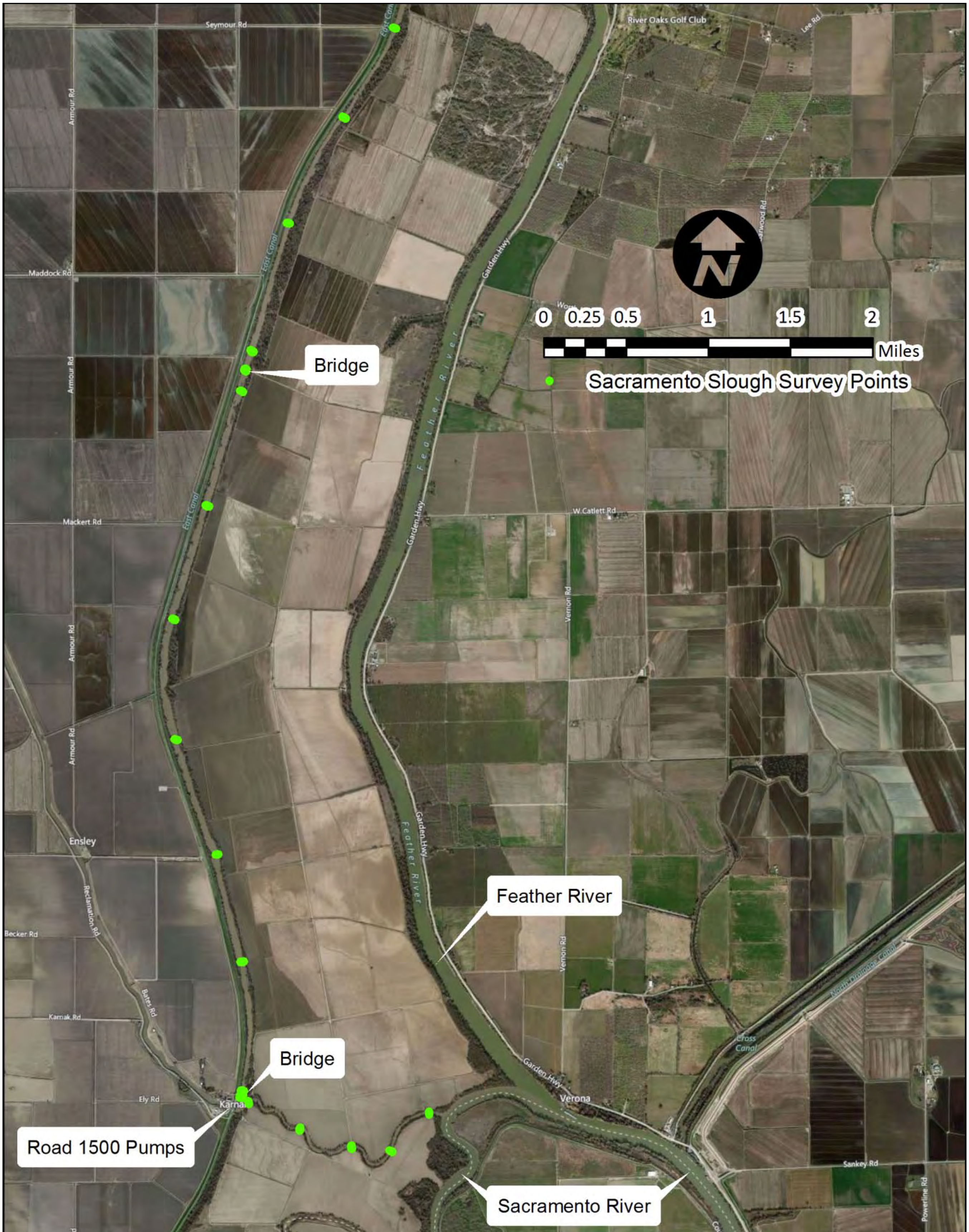
2.3 QUALITY ASSURANCE / QUALITY CONTROL

Quality assurance and quality control is a priority task when performing bathymetric surveys. A standard bar check was performed prior to collecting data to calibrate the sonar for local site conditions as they relate to sound velocity. As transects were being recorded, recorded depths and positions were reviewed for irregularities and the potential effects of submerged aquatic vegetation. Once in the office, post processing involved calibrating the positional data to the local CVFED benchmarks and visually inspecting the data for erroneous readings.

3 RESULTS SUMMARY

Quality control results showed an acceptable range when tying into control less than or equal to the accuracy of the instrumentation (i.e., H: 0.10 ft and V: 0.15 ft). The sounding data also passed an in-house quality control standard of less than 5% bad or missing depths. All suspected vegetation returns were manually filtered from the data set prior to exporting and the corrected points are provided in the attached file. Twenty cross sections and two bridges were recorded in total. The surveyed transects provide sufficient channel geometry to characterize 1D flows in Sacramento Slough for the purpose of the Yolo Bypass Fish Passage Project.

Attachment: 13-1027_SacSl_090613_88_g09_QCcadeport.csv



Notes: image courtesy of Bing Maps	HDR cbec eco engineering	*Yolo Bypass Salmonid Habitat Restoration and Fish Passage* **Sacramento Slough Transect Locations**		
		Prepared for DWR	Created By: BST	**Figure 1**

APPENDIX A

DATASHEET

TRIMBLE R8 GNSS RECEIVER

KEY FEATURES

Advanced Trimble R-Track technology

Unmatched GNSS tracking performance

Includes Trimble Maxwell 6 chip with 220 channels

Remote configuration and access

Base and rover communications options to suit any application

The Trimble® R8 GNSS Receiver sets the new standard for full-featured GNSS (Global Navigation Satellite System) receiver technology. This integrated system delivers unmatched power, accuracy and performance in a rugged, compact unit.

ADVANCED TRIMBLE R-TRACK TECHNOLOGY

The Trimble R8 GNSS delivers the latest advancements in R-Track™ technology, designed to deliver reliable, precise positioning performance. In challenging areas for GNSS surveying, such as tree cover or limited sky view, Trimble R-Track provides unmatched tracking performance of GNSS satellite signals.

Trimble R-Track with Signal Prediction™ compensates for intermittent or marginal RTK correction signals, enabling extended precision operation after an RTK signal is interrupted.

The new CMRx communications protocol provides unprecedented correction compression for optimized bandwidth and full utilization all of the satellites in view, giving you the most reliable positioning performance.

Featuring the Trimble Maxwell™ 6 chip, the Trimble R8 GNSS advances the industry with more memory and more GNSS channels. Trimble delivers business confidence with a sound GNSS investment for today and into the future.

Broad GNSS Support

The Trimble R8 GNSS supports a wide range of satellite signals, including GPS L2C and L5 and GLONASS L1/L2 signals. In addition, Trimble is committed to the next generation of modernized GNSS configurations by providing Galileo-compatible products available for customers well in advance of Galileo system availability[1,2]. In support of this plan, the new Trimble R8 GNSS is capable of tracking the experimental GIOVE-A and GIOVE-B test satellites for signal evaluation and test purposes.

FLEXIBLE SYSTEM DESIGN

The Trimble R8 GNSS receiver combines the most comprehensive feature set into an integrated and flexible system for demanding surveying applications. The Trimble R8 GNSS includes a built-in transmit/receive UHF radio, enabling ultimate flexibility for rover or base operation. As a base station, the internal NTRIP caster provides you with customized access[3] to base station corrections via the internet.

Trimble's exclusive, Web UI™ eliminates travel requirements for routine monitoring of base station receivers. Now you can assess the health and status of base receivers and perform remote configurations from the office. Likewise, you can download post-processing data through Web UI and save additional trips out to the field.

ENABLING THE CONNECTED SITE

Pair the speed and accuracy of the Trimble R8 GNSS receiver with flexibility and collaboration tools of Trimble Access™ software. Trimble Access brings field and office teams closer by enabling data sharing and collaboration in a secure, web-based environment. With optional streamlined workflows, Trimble Access further empowers surveyors and survey teams for success. Now it is easier than ever to realize the potential of the Trimble Connected Site. Connecting the right tools, techniques, services and relationships enables surveying businesses to achieve more every day.

1 ***Galileo Commercial Authorization***
Receiver technology having Galileo capability to operate in the Galileo frequency bands and using information from the Galileo system for future operational satellites is restricted in the publicly available Galileo Open Service Signal-In-Space Interface Control Document (GAL OS SIS ICD) and is not currently authorized for commercial use.
Receiver technology that tracks the GIOVE-A and GIOVE-B test satellites uses information that is unrestricted in the public domain in the GIOVE A + B Navigation Signals-In-Space Interface Control Document. Receiver technology having developmental GIOVE-A and B capability is intended for signal evaluation and test purposes.

2 *For more information about Trimble and GNSS modernization, please visit* ***http://www.trimble.com/srv_new_era.shtml****.*

3 *Cellular modem required.*

Trimble.

PERFORMANCE SPECIFICATIONS

Measurements

- Trimble R-Track technology
- Advanced Trimble Maxwell 6 Custom Survey GNSS chip with 220 channels
- High precision multiple correlator for GNSS pseudorange measurements
- Unfiltered, unsmoothed pseudorange measurements data for low noise, low multipath error, low time domain correlation and high dynamic response
- Very low noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- Signal-to-Noise ratios reported in dB-Hz
- Proven Trimble low elevation tracking technology
- Satellite signals tracked simultaneously:
  - GPS: L1C/A, L2C, L2E (Trimble method for tracking L2P), L5
  - GLONASS: L1C/A, L1P, L2C/A (GLONASS M only), L2P
  - SBAS: L1C/A, L5
  - Galileo GIOVE-A and GIOVE-B

Code differential GNSS positioning[1]

Horizontal	0.25 m + 1 ppm RMS
Vertical	0.50 m + 1 ppm RMS
WAAS differential positioning accuracy[2]	typically <5 m 3DRMS

Static and FastStatic GNSS surveying[1]

Horizontal	3 mm + 0.1 ppm RMS
Vertical	3.5 mm + 0.4 ppm RMS

Kinematic surveying[1]

Horizontal	10 mm + 1 ppm RMS
Vertical	20 mm + 1 ppm RMS
Initialization time[3]	typically <10 seconds
Initialization reliability[4]	typically >99.9%

HARDWARE

Physical

Dimensions (W×H)	19 cm × 11.2 cm (7.5 in x 4.4 in), including connectors
Weight	1.34 kg (2.95 lb) with internal battery, internal radio, standard UHF antenna. 3.70 kg (8.16 lb) entire RTK rover including batteries, range pole, controller and bracket
Temperature[5]	
Operating	–40 °C to +65 °C (–40 °F to +149 °F)
Storage	–40 °C to +75 °C (–40 °F to +167 °F)
Humidity	100%, condensing
Water/dustproof	IP67 dustproof, protected from temporary immersion to depth of 1 m (3.28 ft)
Shock and vibration	Tested and meets the following environmental standards:
Shock	Non-operating: Designed to survive a 2 m (6.6 ft) pole drop onto concrete. Operating: to 40 G, 10 msec, sawtooth
Vibration	MIL-STD-810F, FIG.514.5C-1

Electrical

- Power 11 to 28 V DC external power input with over-voltage protection on Port 1 (7-pin Lemo)
- Rechargeable, removable 7.4 V, 2.4 Ah Lithium-Ion battery in internal battery compartment. Power consumption is 3.2 W, in RTK rover mode with internal radio. Operating times on internal battery:
  - 450 MHz receive only option .... 5.8 hours[7]
  - 450 MHz receive/transmit option .... 3.7 hours[8]
  - GSM/GPRS .... 4.1 hours[7]
- Certification Class B Part 15, 22, 24 FCC certification, 850/1900 MHz. Class 10 GSM/GPRS module. CE Mark approval, and C-tick approval

Communications and Data Storage

- 3-wire serial (7-pin Lemo) on Port 1. Full RS-232 serial on Port 2 (Dsub 9 pin)
- Fully Integrated, fully sealed internal 450 MHz receiver/transmitter option:
  - Transmit power: 0.5 W
  - Range[6]: 3–5 km typical / 10 km optimal
- Fully integrated, fully sealed internal GSM/GPRS option[7]
- Fully integrated, fully sealed 2.4 GHz communications port (Bluetooth®)[9]
- External cellphone support for GSM/GPRS/CDPD modems for RTK and VRS operations
- Data storage on 57 MB internal memory: 40.7 days of raw observables (approx. 1.4 MB /Day), based on recording every 15 seconds from an average of 14 satellites
- 1 Hz, 2 Hz, 5 Hz, 10 Hz, and 20 Hz positioning
- CMR+, CMRx, RTCM 2.1, RTCM 2.3, RTCM 3.0, RTCM 3.1 Input and Output
- 16 NMEA outputs, GSOF, RT17 and RT27 outputs. Supports BINEX and smoothed carrier

1 Accuracy and reliability may be subject to anomalies due to multipath, obstructions, satellite geometry, and atmospheric conditions. Always follow recommended survey practices.
2 Depends on WAAS/EGNOS system performance.
3 May be affected by atmospheric conditions, signal multipath, obstructions and satellite geometry.
4 May be affected by atmospheric conditions, signal multipath, and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.
5 Receiver will operate normally to –40 °C, internal batteries are rated to –20 °C.
6 Varies with terrain and operating conditions.
7 Varies with temperature.
8 Varies with temperature and wireless data rate.
9 Bluetooth type approvals are country specific. Contact your local Trimble Authorized Distribution Partner for more information.

Specifications subject to change without notice.

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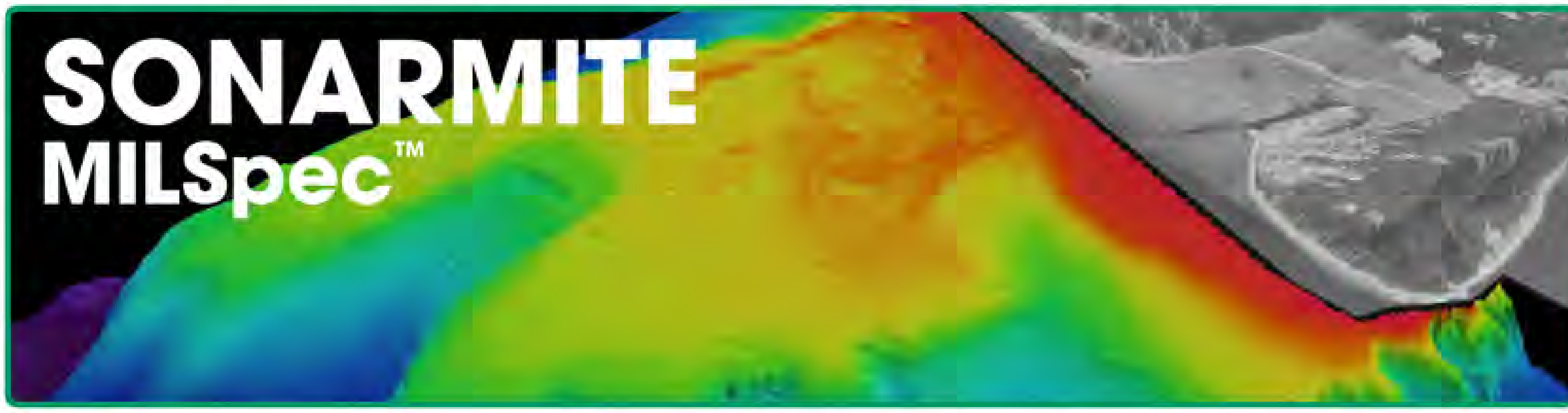
SONARMITE MILSpec™



ABOUT

The SonarMite MILSpec™ Echo Sounder is result of nearly two years research and development tofurther extend the boundaries of shallow water hydrographic surveying equipment. The introduction by Ohmex in 1997 of the SonarLite, the worlds first truly portable echo sounder system, has been a hard act to follow and it remains the portable instrument of choice in many survey companies around the world. The release of the SonarMite instrument marks the next stage introducing a series of equipment designed around the WinSTRUMENT concept using the latest portable computer integrated with new measurment technologies.

FEATURES

- Rugged, field-proven survey grade echosounder
- Bluetooth technology integrated with Windows Pocket PC devices
- Proven 'Smart' transducer design with QA output
- Internal rechargeable battery for all day use
- Easily integrated with other modern software & GPS technology

OPTIONS

- Data collection software
- Heave, Pitch and Roll measurements
- Sound velocimeter
- Portable mounting bracket
- Rugged shipping case
- Extended warranty

SPECS

ECHOSOUNDER

- Frequency: 200-KHz
- Beam width: 4-degrees
- Ping Rate: 6 Hz
- Depth Accuracy: 1cm /0.1% of depth
- Output Formats: NMEA, ASCII
- Range: 0.3m-75m
- I/O: Serial, Bluetooth
- Environmental: IP-65
- Power: Rechargable 12V battery

PHOTOS

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TECHNICAL MEMORANDUM

Date:	June 6, 2014
To:	Project File
From:	Chris Campbell, MS, Benjamin Taber, BS, PE
Project:	13-1027 – Yolo Bypass Salmonid Habitat Restoration and Fish Passage
Subject:	Willow Slough Bathymetric Survey

1 INTRODUCTION

cbec, inc., eco engineering (cbec) performed a bathymetric survey of Willow Slough on October 8th, 2013 to support hydrodynamic model development for the Yolo Bypass Modeling Project. The objective of the survey was to define the geometry of the slough channel bed such that the slough could be represented in 1D as a series of cross sections or transects. The surveyed reach extends from the confluence with the Tule Canal upstream approximately 3.75 miles where transects were taken at select locations with a spacing of approximately 2,000 feet. Surveyed cross sections were field fitted to select areas with minimal riparian vegetation on the banks with the assumption that the Central Valley Floodplain Evaluation and Delineation (CVFED) LiDAR data would be used to represent the overbank areas at each transect. Additional cross sections were recorded on the upstream and downstream sides of the two bridges within the study reach, as well as additional survey data to characterize the bridge geometry. See Figure 1 for a map of Willow Slough showing the extents of the surveyed reach and transect locations.

2 METHODS

2.1 BATHYMETRY

The bathymetric survey was performed utilizing Real Time Kinematic (RTK) Global Positioning System (GPS) terrestrial wading, as well as employing an inflatable kayak with a longer stadia rod for areas with greater depths. RTK GPS was used in conjunction with California Survey and Drafting Supply (CSDS) VSN mobile base network to provide positional corrections to the Trimble receiver. Equipment data sheets are provided in Appendix A.

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2.2 CONTROL AND DATUMS

Prior to surveying, the cbec field crew occupied one benchmark reported in the CVFED LiDAR survey control documentation (see Table 1) to correct for horizontal and vertical variations in the observations. These variations are caused by atmospheric conditions as well as specific satellite geometry at the time of data acquisition.

Table 1. CVFED benchmarks (this survey)

Benchmark	Reported Northing[1]	Reported Easting[1]	Reported Elevation (ft,NAVD88)[2]	Observed Northing[1]	Observed Easting[1]	Observed Elevation (ft,NAVD88)[2]
WR145	1967746.71	6664280.36	24.777	1967746.896	6664280.142	24.491
[1] California State Planes, Zone 2, NAD 83, US Survey feet [2] North American Vertical Datum 1988 (NAVD88), Geoid 2009						

2.3 QUALITY ASSURANCE / QUALITY CONTROL

Quality assurance and quality control is a priority task when performing bathymetric and topographic surveys. Field software is programmed to only store points within the accuracy of the instrumentation (i.e., H: 0.10 ft and V: 0.15 ft). Upon completion of the survey, cbec staff provided an in house visual inspection of the field data in order to identify potentially erroneous data by plotting cross sections in processing software. All observed data was calibrated in order to match the local CVFED benchmark.

3 RESULTS SUMMARY

Sufficient data to characterize nineteen cross sections and two bridges/crossings were recorded in total. The surveyed transects provide sufficient channel geometry to characterize 1D flows in Willow Slough for the purpose of the Yolo Bypass Salmonid Habitat Restoration and Fish Passage.

Attachment: 13-1027_WillowSl_100813_88_g09.csv

Notes: image courtesy of Bing Maps

Yolo Bypass Salmonid Habitat Restoration and Fish Passage

Willow Slough Transect Locations

Prepared for DWR	Created By: BST	**Figure 1**

APPENDIX A

DATASHEET

TRIMBLE R8 GNSS RECEIVER

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Remote configuration and access

Base and rover communications options to suit any application

The Trimble® R8 GNSS Receiver sets the new standard for full-featured GNSS (Global Navigation Satellite System) receiver technology. This integrated system delivers unmatched power, accuracy and performance in a rugged, compact unit.

ADVANCED TRIMBLE R-TRACK TECHNOLOGY

The Trimble R8 GNSS delivers the latest advancements in R-Track™ technology, designed to deliver reliable, precise positioning performance. In challenging areas for GNSS surveying, such as tree cover or limited sky view, Trimble R-Track provides unmatched tracking performance of GNSS satellite signals.

Trimble R-Track with Signal Prediction™ compensates for intermittent or marginal RTK correction signals, enabling extended precision operation after an RTK signal is interrupted.

The new CMRx communications protocol provides unprecedented correction compression for optimized bandwidth and full utilization all of the satellites in view, giving you the most reliable positioning performance.

Featuring the Trimble Maxwell™ 6 chip, the Trimble R8 GNSS advances the industry with more memory and more GNSS channels. Trimble delivers business confidence with a sound GNSS investment for today and into the future.

Broad GNSS Support

The Trimble R8 GNSS supports a wide range of satellite signals, including GPS L2C and L5 and GLONASS L1/L2 signals. In addition, Trimble is committed to the next generation of modernized GNSS configurations by providing Galileo-compatible products available for customers well in advance of Galileo system availability[1,2]. In support of this plan, the new Trimble R8 GNSS is capable of tracking the experimental GIOVE-A and GIOVE-B test satellites for signal evaluation and test purposes.

FLEXIBLE SYSTEM DESIGN

The Trimble R8 GNSS receiver combines the most comprehensive feature set into an integrated and flexible system for demanding surveying applications. The Trimble R8 GNSS includes a built-in transmit/receive UHF radio, enabling ultimate flexibility for rover or base operation. As a base station, the internal NTRIP caster provides you with customized access[3] to base station corrections via the internet.

Trimble's exclusive, Web UI™ eliminates travel requirements for routine monitoring of base station receivers. Now you can assess the health and status of base receivers and perform remote configurations from the office. Likewise, you can download post-processing data through Web UI and save additional trips out to the field.

ENABLING THE CONNECTED SITE

Pair the speed and accuracy of the Trimble R8 GNSS receiver with flexibility and collaboration tools of Trimble Access™ software. Trimble Access brings field and office teams closer by enabling data sharing and collaboration in a secure, web-based environment. With optional streamlined workflows, Trimble Access further empowers surveyors and survey teams for success. Now it is easier than ever to realize the potential of the Trimble Connected Site. Connecting the right tools, techniques, services and relationships enables surveying businesses to achieve more every day.

*1 **Galileo Commercial Authorization***
Receiver technology having Galileo capability to operate in the Galileo frequency bands and using information from the Galileo system for future operational satellites is restricted in the publicly available Galileo Open Service Signal-In-Space Interface Control Document (GAL OS SIS ICD) and is not currently authorized for commercial use.
Receiver technology that tracks the GIOVE-A and GIOVE-B test satellites uses information that is unrestricted in the public domain in the GIOVE A + B Navigation Signals-In-Space Interface Control Document. Receiver technology having developmental GIOVE-A and B capability is intended for signal evaluation and test purposes.

*2 For more information about Trimble and GNSS modernization, please visit **http://www.trimble.com/srv_new_era.shtml**.*

3 Cellular modem required.

Trimble.

PERFORMANCE SPECIFICATIONS

Measurements

- Trimble R-Track technology
- Advanced Trimble Maxwell 6 Custom Survey GNSS chip with 220 channels
- High precision multiple correlator for GNSS pseudorange measurements
- Unfiltered, unsmoothed pseudorange measurements data for low noise, low multipath error, low time domain correlation and high dynamic response
- Very low noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- Signal-to-Noise ratios reported in dB-Hz
- Proven Trimble low elevation tracking technology
- Satellite signals tracked simultaneously:
  - GPS: L1C/A, L2C, L2E (Trimble method for tracking L2P), L5
  - GLONASS: L1C/A, L1P, L2C/A (GLONASS M only), L2P
  - SBAS: L1C/A, L5
  - Galileo GIOVE-A and GIOVE-B

Code differential GNSS positioning[1]

Horizontal . . . . 0.25 m + 1 ppm RMS
Vertical . . . . 0.50 m + 1 ppm RMS
WAAS differential positioning accuracy[2] . . . . typically <5 m 3DRMS

Static and FastStatic GNSS surveying[1]

Horizontal . . . . 3 mm + 0.1 ppm RMS
Vertical . . . . 3.5 mm + 0.4 ppm RMS

Kinematic surveying[1]

Horizontal . . . . 10 mm + 1 ppm RMS
Vertical . . . . 20 mm + 1 ppm RMS
Initialization time[3] . . . . typically <10 seconds
Initialization reliability[4] . . . . typically >99.9%

HARDWARE

Physical

Dimensions (W×H) . . . . 19 cm × 11.2 cm (7.5 in x 4.4 in), including connectors
Weight . . . . 1.34 kg (2.95 lb) with internal battery, internal radio, standard UHF antenna.
3.70 kg (8.16 lb) entire RTK rover including batteries, range pole, controller and bracket
Temperature[5]
Operating . . . . –40 °C to +65 °C (–40 °F to +149 °F)
Storage . . . . –40 °C to +75 °C (–40 °F to +167 °F)
Humidity . . . . 100%, condensing
Water/dustproof . . . . IP67 dustproof, protected from temporary immersion to depth of 1 m (3.28 ft)
Shock and vibration . . . . Tested and meets the following environmental standards:
Shock . . . . Non-operating: Designed to survive a 2 m (6.6 ft) pole drop onto concrete. Operating: to 40 G, 10 msec, sawtooth
Vibration MIL-STD-810F, FIG.514.5C-1

Electrical

- Power 11 to 28 V DC external power input with over-voltage protection on Port 1 (7-pin Lemo)
- Rechargeable, removable 7.4 V, 2.4 Ah Lithium-Ion battery in internal battery compartment. Power consumption is 3.2 W, in RTK rover mode with internal radio. Operating times on internal battery:
  - 450 MHz receive only option . . . . 5.8 hours[7]
  - 450 MHz receive/transmit option . . . . 3.7 hours[8]
  - GSM/GPRS . . . . 4.1 hours[7]
- Certification Class B Part 15, 22, 24 FCC certification, 850/1900 MHz. Class 10 GSM/GPRS module. CE Mark approval, and C-tick approval

Communications and Data Storage

- 3-wire serial (7-pin Lemo) on Port 1. Full RS-232 serial on Port 2 (Dsub 9 pin)
- Fully Integrated, fully sealed internal 450 MHz receiver/transmitter option:
  - Transmit power: 0.5 W
  - Range[6]: 3–5 km typical / 10 km optimal
- Fully integrated, fully sealed internal GSM/GPRS option[7]
- Fully integrated, fully sealed 2.4 GHz communications port (Bluetooth®)[9]
- External cellphone support for GSM/GPRS/CDPD modems for RTK and VRS operations
- Data storage on 57 MB internal memory: 40.7 days of raw observables (approx. 1.4 MB /Day), based on recording every 15 seconds from an average of 14 satellites
- 1 Hz, 2 Hz, 5 Hz, 10 Hz, and 20 Hz positioning
- CMR+, CMRx, RTCM 2.1, RTCM 2.3, RTCM 3.0, RTCM 3.1 Input and Output
- 16 NMEA outputs, GSOF, RT17 and RT27 outputs. Supports BINEX and smoothed carrier

1 Accuracy and reliability may be subject to anomalies due to multipath, obstructions, satellite geometry, and atmospheric conditions. Always follow recommended survey practices.
2 Depends on WAAS/EGNOS system performance.
3 May be affected by atmospheric conditions, signal multipath, obstructions and satellite geometry.
4 May be affected by atmospheric conditions, signal multipath, and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.
5 Receiver will operate normally to –40 °C, internal batteries are rated to –20 °C.
6 Varies with terrain and operating conditions.
7 Varies with temperature.
8 Varies with temperature and wireless data rate.
9 Bluetooth type approvals are country specific. Contact your local Trimble Authorized Distribution Partner for more information.

Specifications subject to change without notice.

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Appendix B

Sacramento Weir Information

E. Pratt

SUPPLEMENT TO STANDARD OPERATION AND MAINTENANCE MANUAL

SACRAMENTO RIVER

FLOOD CONTROL PROJECT

UNIT NO. 158

SACRAMENTO WEIR

SACRAMENTO RIVER, CALIFORNIA

SACRAMENTO DISTRICT

CORPS OF ENGINEERS

U. S. ARMY

SACRAMENTO, CALIFORNIA

CORPS OF ENGINEERS
U. S. ARMY

SUPPLEMENT TO STANDARD OPERATION AND MAINTENANCE MANUAL SACRAMENTO RIVER FLOOD CONTROL PROJECT

UNIT NO. 158
SACRAMENTO WEIR
SACRAMENTO RIVER, CALIFORNIA

Prepared by the Sacramento District
Corps of Engineers, U. S. Army
August 1955

UNIT NO. 158
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SUBJECT
SECTION I - INTRODUCTION

SECTION II - FEATURES OF THE PROJECT SUBJECT TO FLOOD CONTROL REGULATIONS

SECTION III - REPAIR OF DAMAGE TO PROJECT WORKS AND METHODS OF COMBATING FLOOD CONDITIONS

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EXHIBITS

SUPPLEMENT TO STANDARD
OPERATION AND MAINTENANCE MANUAL
SACRAMENTO RIVER FLOOD CONTROL PROJECT

UNIT NO. 158
SACRAMENTO WEIR
SACRAMENTO RIVER, CALIFORNIA

SECTION I - INTRODUCTION

1-01. Location. - The improvement covered by this manual is that part of the Sacramento River Flood Control Project which comprises the Sacramento Weir together with its adjoining channel, levees at the abutments, railroad bridge, highway bridge and appurtenances, as shown on the location map, Exhibit A-1 and drawings of Exhibit B. The weir is located in Yolo County, California along the right bank of the Sacramento River near Bryte, California and about 3.1 miles northwesterly from the City of Sacramento.

1-02. Project Works. - The Sacramento Weir is a reinforced concrete weir with wooden needles that provide a movable crest. There are 48 weir sections each 38 feet long. A highway bridge 20 feet wide and a single track railroad traverses the length of the weir. Concrete abutments at each end tie into the west levee of the Sacramento River and the north and south levees of the Sacramento Bypass. For more complete details of these structures see drawings of Exhibit B.

1-03. Protection Provided. - The Sacramento Weir is designed to protect the City of Sacramento and adjacent area from flood damage by providing means for release of excess over-flow waters of the Sacramento and American Rivers into the Yolo Bypass system. The project design capacity of the Sacramento Weir is 112,000 cubic feet per second.

1-04. Construction Data and Contractor. - The Sacramento Weir was constructed by Teichert & Ambrose under contract which was awarded by the City of Sacramento in June 1916. Subsequently the City was reimbursed for the costs of construction by the Sacramento District.

1-05. Flood Flows. - For purpose of this manual, the term "flood" or "high water period" shall refer to flows when the water surface in the Sacramento River reaches or exceeds the reading of 25.0 on the continuous water stage recorder and staff gage of the U. S. Weather Bureau and State Division of Water Resources located on the left bank of the Sacramento River at the foot of "I" Street, City of Sacramento. Zero of staff gage and recorders is set at elevation 3.10 U. S. Corps of Engineers datum and 0.03 foot U.S.G.S. datum. The term "flood" or "high water period" may also apply when the water surface in the Sacramento River reaches or exceeds the reading of 29.0 on the continuous water stage recorder and staff gage of the U. S. Corps of Engineers and the State Division of Water Resources located on a pile dolphin on the right bank of the Sacramento River 100 feet downstream from the Sacramento Weir. Zero of this gage is set at 0.00 feet U. S. Corps of Engineers datum and minus 3.07 feet U.S.G.S. datum.

1-06. Assurances Provided by Local Interests. - Assurances of cooperation by local interests is provided by State legislation as contained in Chapter 3, Part 2, Division 5 of the State Water Code (see paragraph 2-02a of the Standard Manual).

1-07. Acceptance by State Reclamation Board. - Responsibility for operating and maintaining the completed works was officially accepted by the Reclamation Board of the State of California on 18 December 1951, as shown on the attached letter of acceptance, Exhibit F.

1-08. Superintendent. - The name and address of the Superintendent appointed by the State or acting as a representative of the State Division of Water Resources for the continuous inspection, operation and maintenance of the Project works shall be furnished the District Engineer, and in case of any change of Superintendent, The District Engineer shall be so notified.

SECTION II

FEATURES OF THE PROJECT SUBJECT TO FLOOD CONTROL REGULATIONS

2-01. Drainage and Weir Structure.

a. Description. The Sacramento Weir is a reinforced fixed concrete structure located along the right bank of the Sacramento River about 3.1 miles northwesterly from the City of Sacramento. A concrete sheet pile cut-off wall extends the full length of the weir, a distance of 1,980 feet. The weir crest elevation is 24.75 feet. Hinged 3" x 12" wooden needles backed by a 20" x 28" wooden needle beam make it possible to raise the crest to elevation 31.0. ~~A float release mechanism capable of dropping the needle gates to elevation 25.0 can be adjusted to release when the water level reaches any elevation from 31.0 to 38.0.~~ Concrete piers on 41.25 foot centers carry highway and railroad bridges across the weir. Concrete abutments at each end of the weir tie into the levees on the west side of the Sacramento River at this location. The abutments also tie into the north and south levees of the Sacramento Bypass. The leveed bypass has an average channel width of 1,800 feet and extends southwesterly from the weir to the Yolo Bypass. For more complete details of these structures see drawings of Exhibit B.

b. For pertinent Requirements of the Code of Federal Regulations and other requirements see the following:

(1) Maintenance - Paragraph 5-02 of the Standard Manual.

(2) Check Lists - Exhibit E of this Supplement Manual.

(3) Operation - Paragraph 5-04 of the Standard Manual.

(4) Additional Requirements - Paragraph 5-05 of the Standard Manual.

(5) Safety Requirements - Paragraph 5-06 of the Standard Manual.

c. Special requirements pertaining to the Sacramento Weir:

(1) All missing parts of the hinged needles shall be replaced immediately following each flood period and that another inspection is made prior to the next flood season to be certain that all missing posts have been replaced.

(2) On the tripping devices the Superintendent shall make certain that:

(a) No parts are missing.

(b) Metal parts are adequatly covered with paint.

(c) All movable parts are in satisfactory working order.

(d) All padlocks are not corroded and can be opened with a proper key.

(e) Sufficient replacement materials are on hand and will be readily available in times of emergency.

(3) A sufficient stockpile of needle beams, hinged needles, and cable is available for replacement in times of emergency. The extra beam used for raising needles is readily available and in good operating condition at all times. Make certain that arrangements have been made to employ a mobile crane capable of handling the needle beams if and when needed.

(4) There are no encreachments upon the right-of-way which might endanger the structure or hinder its functioning in time of flood.

(5) A schedule of operation for the movable top of the Sacramento Weir is contained in Exhibit H of this manual.

2-02. Channel.

a. Description. For purpose of this manual the channel will be considered as that portion which extends from the Sacramento River to a point 200 feet downstream from the lower face of the weir structure. Beyond this point the channel maintenance is covered by other manuals.

b. For pertinent Requirements of the Code of Federal Regulations and other requirements see the following:

(1) Maintenance - Paragraph 6-02 of the Standard Manual.

(2) Check Lists - Exhibit E of this Supplement Manual.

(3) Operation - Paragraph 6-04 of the Standard Manual.

(4) Safety Requirements - Paragraph 6-05 of the Standard Manual.

It shall be the duty of the Superintendent to maintain a patrol of the project works during all periods of flood flow in excess of a reading of 25.0 on the gage located at the foot of"I" Street or 29.0 on a gage located 100 feet downstream from the Sacramento Weir, as indicated in paragraph 1-05 of this manual. The Superintendent shall dispatch a message by the most suitable means to the District Engineer