BUREAU OF RECLAMATION

ACWA
Meeting Request Form
Meet With
Regional Director
Wednesday or Thursday, November 30 – December 1, 2022
Renaissance Esmeralda Resort & Spa, 44400 Indian Wells Ln, Indian Wells, CA 92210
Corsica and Gibraltar rooms

Preferred Date: Wednesday

Organization Name: Sites Reservoir Project

Contact Person: Marcia Kivett Title: Project Coordinator

Contact Person Phone Number: 561-843-9740

Contact Person Email: mkivett@sitesproject.org

Contact Person Name/Phone Number at Meeting Location: Jerry Brown 925-260-7417

List of Attendees: Jerry Brown (Sites ED), Ali Forsythe (Sites EPP Manager), JP Robinette (Sites E&O Manager), Jeff Sutton (Sites Authority Board Vice-Chairman & TCCA GM), Thad Bettner (Sites Reservoir Committee Chairman & GCID GM)

Topics you wish to discuss:
- Final EIR/EIS - ROD/NOD Timing
- BA/BO for Sites
- Reclamation Investment

Special requests (i.e. specific times you cannot meet)

The only day this team can meet is on Wednesday.

Please fill out the enclosed form and return to Ankur Bhattacharya via email to ankurbhattacharya@usbr.gov by Friday, October 28, 2022.
If you have any questions, please contact Ankur at 916-202-5915.

From: Alicia Forsythe [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A6CDF06A7E904B65BAA21702A82AD329-AFORSYTHE]
Sent: 11/1/2022 8:39:47 AM
To: Spranza, John [john.spranza@hdrinc.com]; Luu, Henry [Henry.Luu@hdrinc.com]; Hendrick, Mike [Mike.Hendrick@icf.com]; Angela Bezzone [bezzone@mbkengineers.com]; Rude, Pete/RDD [Pete.Rude@jacobs.com]
Subject: Sites Project - Funks and Stone Corral Creek Releases and Design Considerations

Hi all – I would like to schedule a call to discuss Funks and Stone Corral Creek Releases and Design Considerations. Below are some dates/times that work for me. Please fill in your availability.

	11/8 – 2 pm	11/9 – 11 am	11/9 – 1 pm	11/9 – 2 pm	11/10 – 4 pm	11/14 – 10 am	11/14 – 11 am	11/15 – 1 pm	11/16 – 11 am
John									
Henry									
Mike									
Angela									
Pete									

Some agenda items/questions:

1. EIR/EIS Document Approach (Range of 0 to 100 cfs)
2. Follow on Studies and Timing
3. Design Considerations

a. Valve limitations and capabilities
b. Challenges with accurately releasing very low, lower and higher flows

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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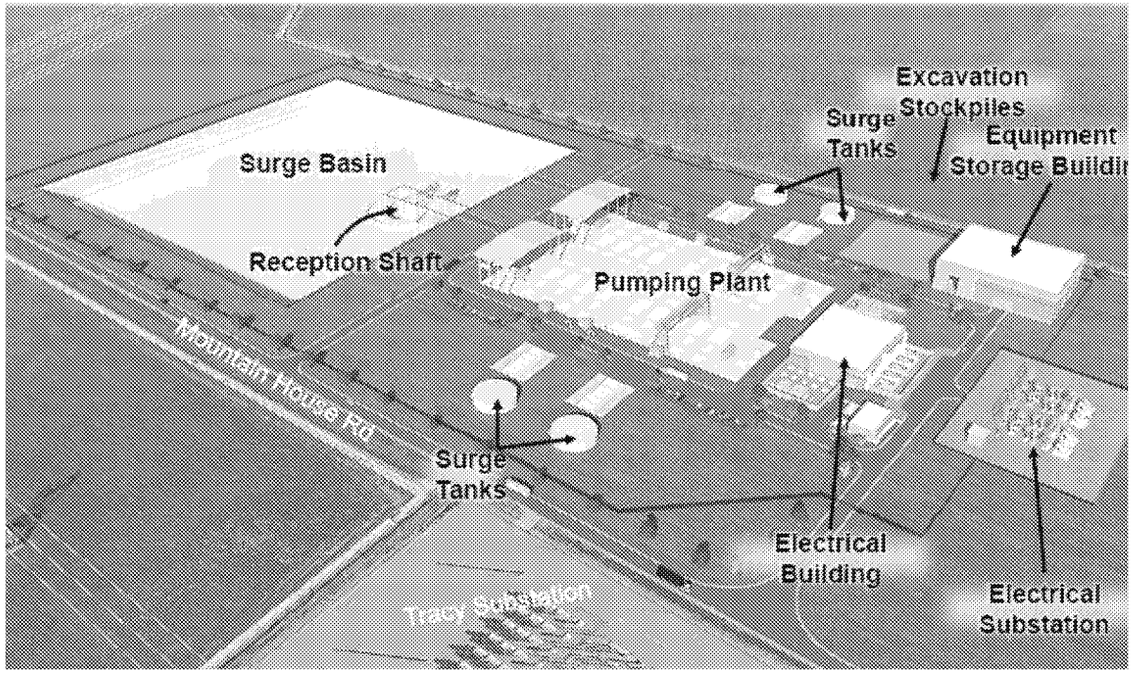
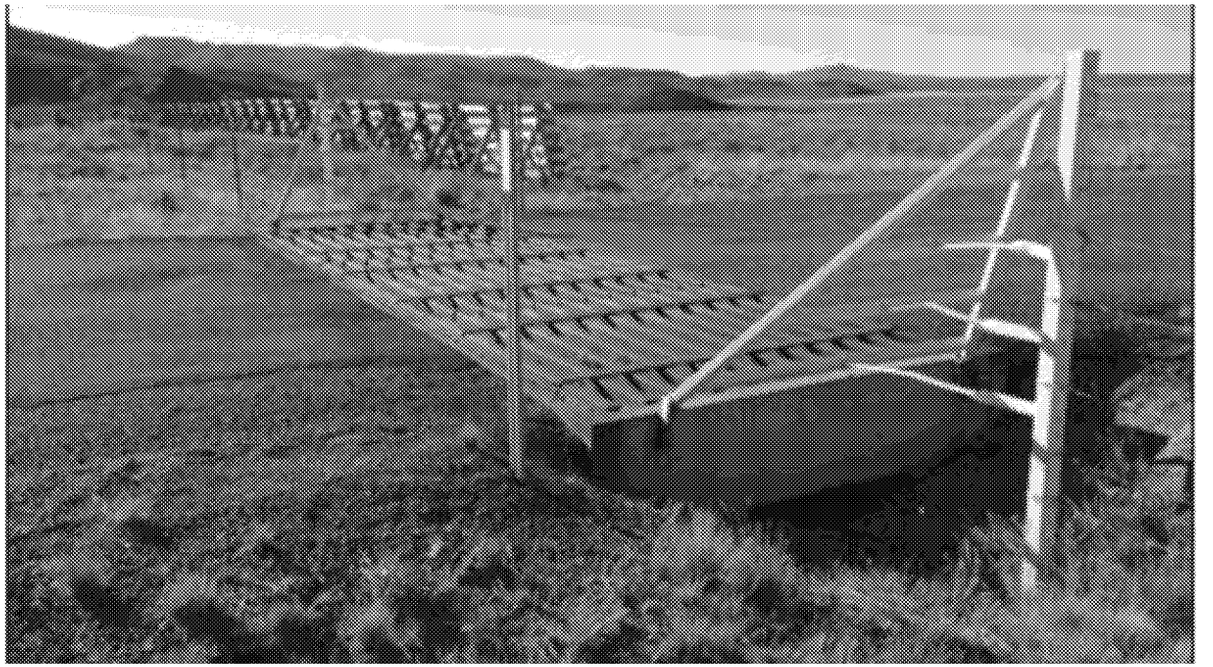
Sites Reservoir
Wildlife Connectivity Impacts and Mitigation Measures Summary

- Multiple project components have potential to cause fragmentation & movement impacts for wildlife (e.g., roads, fencing, buildings, TRR complex, pipelines, etc.)

- Mitigation Measures Include:
  - Design and construct wildlife connectivity enhancement measures and wildlife crossings at suitable locations
  - Monitor and maintain wildlife crossings



Wildlife Connectivity Enhancement Examples



Project Design and Engineering Questions

Do you have locations, dimensions, plans, and/or concepts/renderings of the proposed bridges and culverts that will be built for the project?

Will the water level in Sites Reservoir fluctuate and by how much? When will it be inundated?

Will all water conveyance pipelines be underground? Will there be earthen material put on top of the pipeline area and will it be revegetated? What does the operational condition look like in these areas?

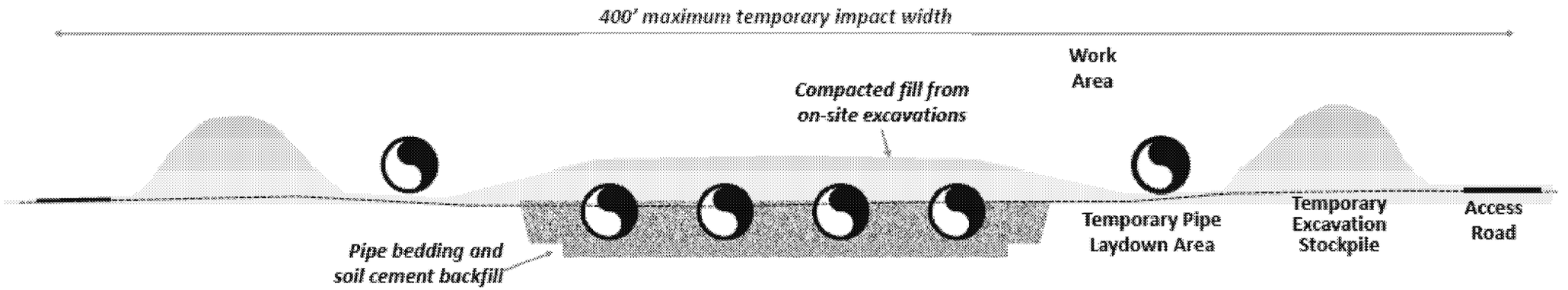
Do you have a detailed schematic of the TRR complex? We are looking for more detail on the operational condition of the area (PGP, buildings, reservoir, fencing, etc.)

Are there any other concepts/renderings available for the above ground project facilities?

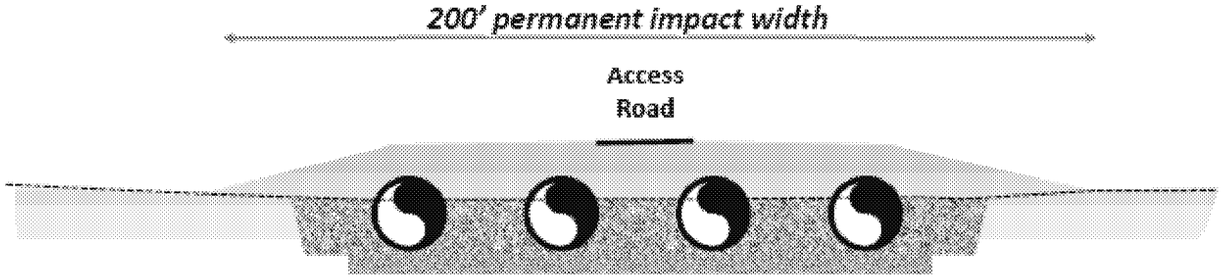
ICF

Examples for reference

Typical construction phase trench section for open cut reaches of pipeline alignment

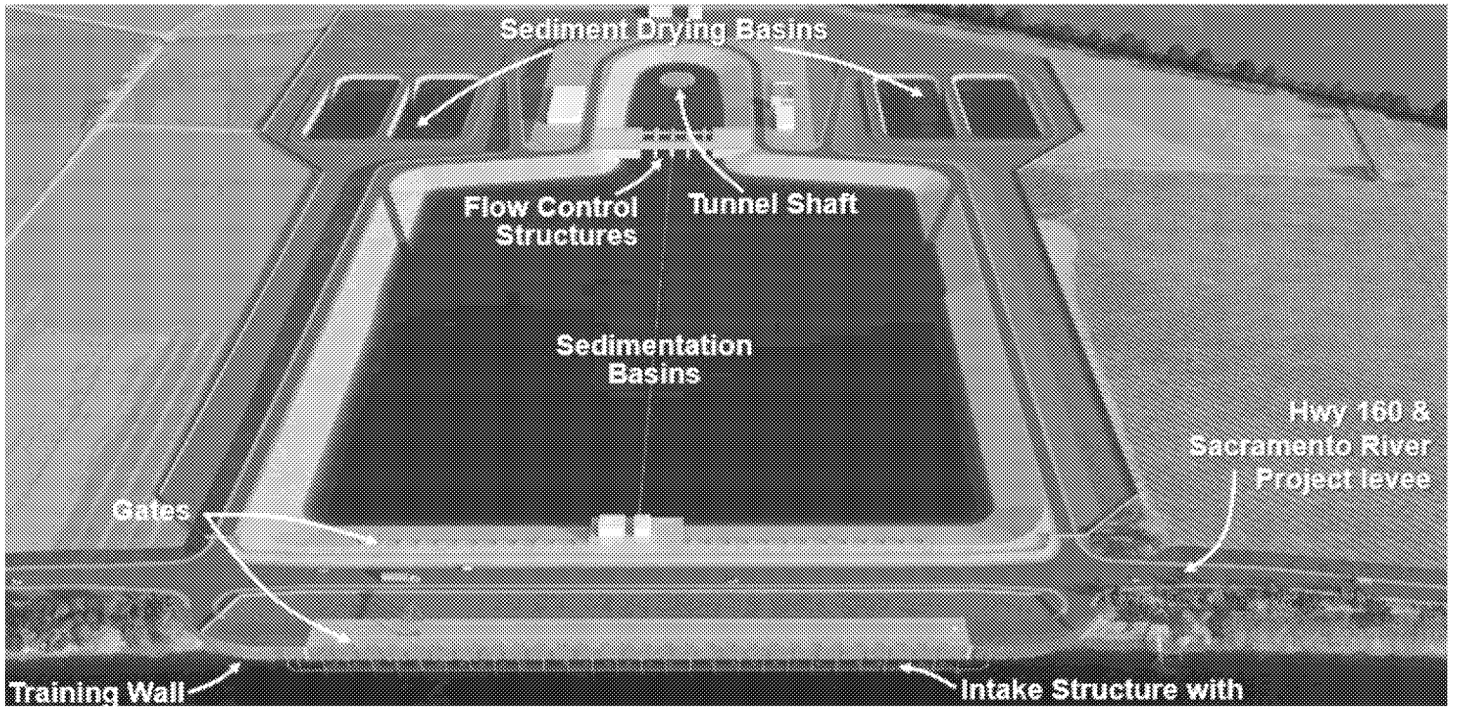


Typical completed section for open cut reaches of pipeline alignment



Examples for reference

Additional examples of above ground infrastructure with potential to affect wildlife movement and habitat fragmentation



Examples for reference

From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 11/1/2022 10:26:33 AM
To: Rude, Pete [Pete.Rude@jacobs.com]; Angela Bezzone [bezzone@mbkengineers.com]; Hendrick, Mike [mike.hendrick@icf.com]; Alicia Forsythe [aforsythe@sitesproject.org]; Luu, Henry [henry.luu@hdrinc.com]
Subject: RE: Sites Project - Funks and Stone Corral Creek Releases and Design Considerations

Please see below

John Spranza

D 916.679.8858 M 818.640.2487

From: Rude, Pete <Pete.Rude@jacobs.com>
Sent: Tuesday, November 1, 2022 9:27 AM
To: Angela Bezzone <bezzone@mbkengineers.com>; Hendrick, Mike <mike.hendrick@icf.com>; Alicia Forsythe <aforsythe@sitesproject.org>; Spranza, John <john.spranza@hdrinc.com>; Luu, Henry <Henry.Luu@hdrinc.com>
Subject: RE: Sites Project - Funks and Stone Corral Creek Releases and Design Considerations

CAUTION: [EXTERNAL] This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

My availability is below:

Peter H. Rude, PE (*CA, OR, HI, CO*) /Jacobs/ Civil Engineer & Principal Project Manager
1-530-229-3396 (office)/ 1-530-917-4164 (mobile)/ 2525 Airpark Drive, Redding, CA 96001
pete.rude@jacobs.com / www.jacobs.com

From: Angela Bezzone <bezzone@mbkengineers.com>
Sent: Tuesday, November 01, 2022 9:13 AM
To: Hendrick, Mike <mike.hendrick@icf.com>; Alicia Forsythe <aforsythe@sitesproject.org>; Spranza, John <john.spranza@hdrinc.com>; Luu, Henry <Henry.Luu@hdrinc.com>; Rude, Pete <Pete.Rude@jacobs.com>
Subject: [EXTERNAL] RE: Sites Project - Funks and Stone Corral Creek Releases and Design Considerations

My availability is below.

Angela

From: Hendrick, Mike <Mike.Hendrick@icf.com>
Sent: Tuesday, November 1, 2022 8:42 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Spranza, John <john.spranza@hdrinc.com>; Luu, Henry <Henry.Luu@hdrinc.com>; Angela Bezzone <bezzone@mbkengineers.com>; Rude, Pete/RDD <Pete.Rude@jacobs.com>
Subject: RE: Sites Project - Funks and Stone Corral Creek Releases and Design Considerations

You don't often get email from mike.hendrick@icf.com. Learn why this is important

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Mine are below

Mike H

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Tuesday, November 1, 2022 8:40 AM
To: Spranza, John <john.spranza@hdrinc.com>; Luu, Henry <Henry.Luu@hdrinc.com>; Hendrick, Mike <Mike.Hendrick@icf.com>; Angela Bezzone <bezzone@mbkengineers.com>; Rude, Pete/RDD <Pete.Rude@jacobs.com>
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John	Y	N	Y	Y	Y	Y	Y	Y	Y
Henry									
Mike	Yes	Yes	Yes	Yes	No	Yes	No	No	No
Angela	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No
Pete	yes	Yes	Yes	Yes	No	No	No	No	No

Some agenda items/questions:

1. EIR/EIS Document Approach (Range of 0 to 100 cfs)
2. Follow on Studies and Timing
3. Design Considerations

a. Valve limitations and capabilities
b. Challenges with accurately releasing very low, lower and higher flows

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Alicia Forsythe [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A6CDF06A7E904B65BAA21702A82AD329-AFORSYTHE]
Sent: 11/1/2022 3:04:36 PM
To: steve.micko@jacobs.com
CC: Angela Bezzone [bezzone@mbkengineers.com]
Subject: FW: Final Documents
Attachments: 20221004_WSIP_CFS_FINAL.pdf; WSIP Cumulative Narrative Paper Final.pdf

Steve- See Jerry's message below. Can you verify that the Table on page 7 of the WSIP Cumulative Narrative Paper is correct?

I now cant remember if this report uses our RDEIR/SDEIS modeling or the BA modeling. But I think it was the RDEIR/SDEIS modeling.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Jerry Brown <jbrown@sitesproject.org>
Sent: Saturday, October 29, 2022 6:10 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Angela Bezzone <no-reply@sharepointonline.com>
Subject: FW: Final Documents

Please verify that the table on page 7 of the DWR report is correct for the delta exports. I believe the average annual amount of 80TAF shown is low and should be closer to 160TAF (~120taf for SOD Participants + ~40taf for P1 ecosystem water).

If 80taf is correct please explain what I'm missing and if it is incorrect please ask DWR to make a correction.

thanks

From: "Okita, David@DWR" <David.Okita@water.ca.gov>
Date: Friday, October 28, 2022 at 7:02 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>, Andrew Garcia <AndrewGarcia@valleywater.org>, Angela Bezzone <bezzone@mbkengineers.com>, "Boland-Brien, Samuel@Waterboards" <Samuel.Boland-Brien@waterboards.ca.gov>, Cindy Kao <ckao@valleywater.org>, Dana Jacobson <DJacobson@valleywater.org>, Dave Richardson <drichardson@woodardcurran.com>, Jerry Brown <jbrown@sitesproject.org>, Marguerite Patil <mpatil@ccwater.com>, Maureen Martin <mmartin@ccwater.com>, Michael Martin <MichaelMartin@valleywater.org>, "Riddle, Diane@Waterboards" <Diane.Riddle@waterboards.ca.gov>, "Sugar, Sarah@Waterboards" <Sarah.Sugar@Waterboards.ca.gov>, Terrie Mitchell <mitchellt@sacsewer.com>, "Young, Amy@DWR" <Amy.Young@water.ca.gov>
Subject: Final Documents

Attached are the final version of the WSIP Cumulative Flow Study. They are the Stantec Report and the DWR prepared Narrative. These have been revised based on comment received and some editorial updates. The main addition is a new section on Delta Outflow.

Note that the 3 WSIP Pulse Flow projects (and CDFW) are on a separate mailing list.

David Okita, PE
Department of Water Resources
530 902-7588

Stantec

Cumulative Flow Effect Analysis for the Water Storage Investment Program Projects

Results Summary

October 4, 2022

Prepared for:

California Department of Water Resources

Prepared by:

Stantec Consulting Services Inc.
3301 C St Suite 1900
Sacramento, CA 95816

Draft_0020072

CUMULATIVE FLOW EFFECT ANALYSIS FOR THE WATER STORAGE INVESTMENT PROGRAM PROJECTS

Revision	Description	Author	Date	Quality Check	Date	Independent Review	Date
0	DRAFT	AW, SH, TF	12/11/2021	YS	12/11/2021		
1	DRAFT	AW, SH, TF	12/17/2021	YS	12/19/2021	DO, CS, AM	04/12/2022
2	DRAFT	AW, SH, TF	06/22/2022	YS	6/26/2022	DO, AM	07/18/2022
3	DRAFT	AW, SH, TF	07/21/2022	YS	08/04/2022		
4	DRAFT	AW, SH, TF	09/19/2022	YS	09/20/2022		
5	FINAL	AW, SH, TF	10/04/2022	YS	10/04/2022		

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1.0 BACKGROUND

In 2017, eight water storage projects were funded by the State of California under the planning efforts related to the Water Storage Investment Program (WSIP). One project, the Temperance Flat Reservoir, was withdrawn. The seven remaining projects consist of four surface water diversion projects and three groundwater (GW) storage banks (Figure 1). Three surface water diversion projects are located north of the Sacramento-San Joaquin Delta (Delta) or in the Delta: Sites Reservoir Project (Sites), Harvest Water Program (Harvest) (formerly known as the South County Ag Program), and the Los Vaqueros Reservoir Expansion Project (LVE). One surface water diversion project, the Pacheco Reservoir Expansion Project (PREP), is located south of the Delta. The three GW banks are located south of the Delta: Chino Basin Program (Chino Basin), Kern Fan Groundwater Storage Project (Kern Fan), and Willow Springs Water Bank Conjunctive Use Project (Willow Springs). Because PREP has no direct impact on the Delta watershed analyzed in this study, it was excluded from the analysis.

The six WSIP projects analyzed in this study operate independently of each other with different timelines for implementation, and it is possible some will not be implemented. Each project has developed an independent set of modeling tools and analysis used to support the original WSIP application and subsequent permitting and feasibility assessments. The primary focus of this study is to integrate the six independent models and quantitatively analyze the cumulative flow effects and potential interactions between all six WSIP projects, and to assess the resulting Central Valley Project (CVP) and State Water Project (SWP) operations in the Sacramento River, Feather River, and Delta.

Three surface water diversion projects north of the Delta or in the Delta – Sites, Harvest, and LVE – potentially contribute to operational changes and relative water availability in the Delta, primarily through changes to flows in the Feather River, Sacramento River, and Cosumnes River, and subsequent changes to Delta inflows, Delta surplus flows, and exports from the Harvey O. Banks Pumping Plant (Banks) and the C.W. Bill Jones Pumping Plant (Jones). Three south-of-Delta GW bank projects include Chino Basin, Kern Fan, and Willow Springs; each include a GW storage component that could potentially contribute to operational changes and relative water availability in the Delta through changes to Delta inflows, Delta surplus flows, and Banks exports, and through a coordinated pulse flow released from Lake Oroville.

The California Department of Water Resources (DWR) is proposing to release pulse flows into the Feather River from Lake Oroville using water exchanged with the three south-of-Delta GW banks. The periodic release of pulse flows from Lake Oroville are intended to facilitate fish migration and survival, and the estimated release frequency is once every 3 to 4 years. The pulse flow volumes are estimated to range up to 100 thousand acre-feet (TAF) released over a period of several days to several weeks and would typically be released during the months of March through May in dry and below-normal years (as described later, the pulse flow for this analysis is applied exclusively in the month of April in Below Normal years and Dry years as defined by the Sacramento Valley Index). DWR will be applying to the State Water Resources Control Board (SWRCB) for a California Water Code 1707 instream flow dedication for these pulse flows to prevent further diversion and to contribute to the Delta outflows.

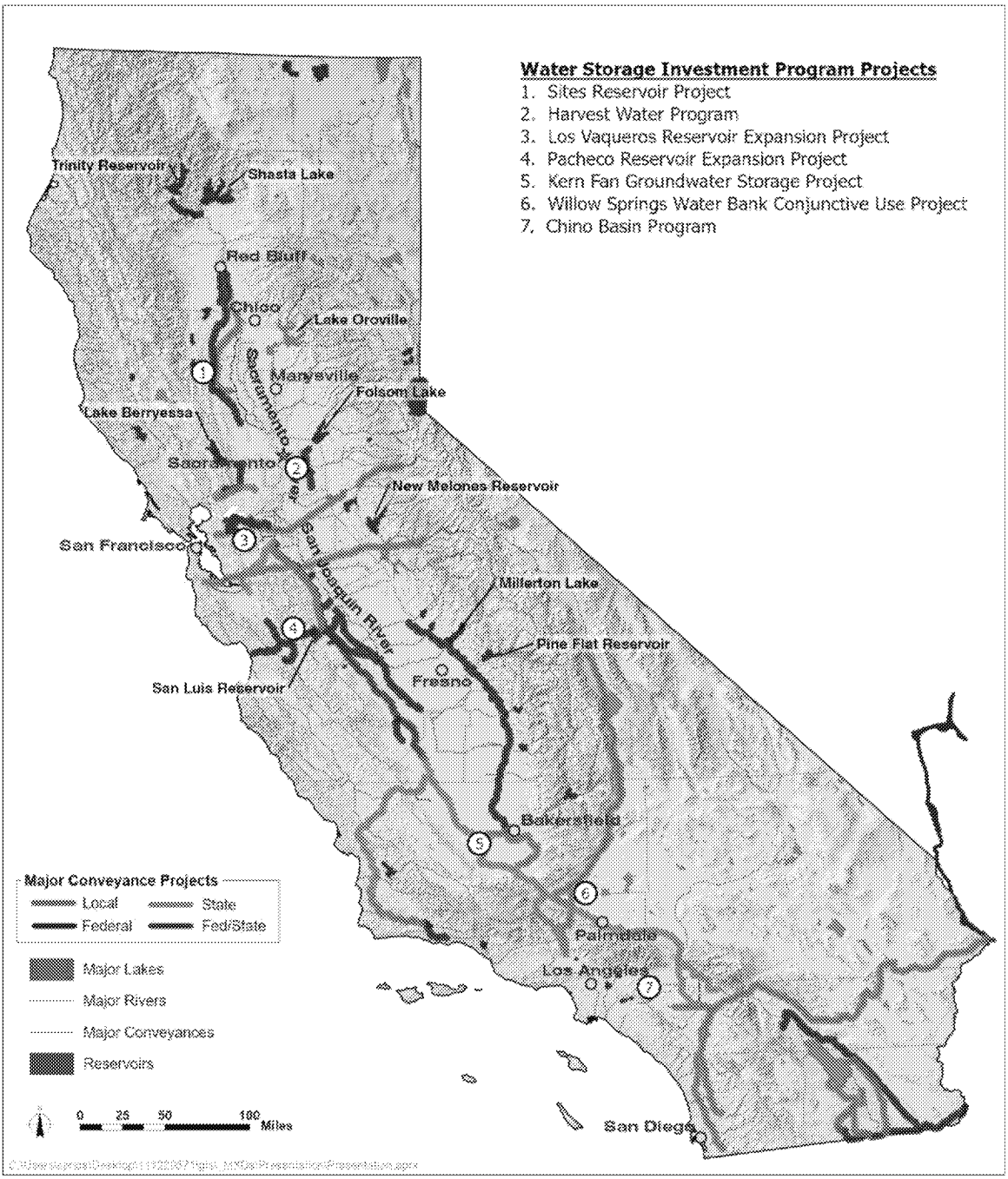

Figure 1. Map of Seven Water Storage Investment Program Projects Analyzed.

The volume of water released for the pulse flows would become available through an exchange facilitated by the applicable WSIP GW project with participating SWP contractors (Partner Contractors). There would not be a direct transfer of additional water supplies into Lake Oroville; instead, an exchange of water supplies would occur, where new water banked in GW facilities would be distributed to Partner Contractors in lieu of receiving SWP deliveries directly from the SWP. New water supplied to the GW banks would come from sources of water not currently utilized or previously allocated (e.g., Delta surplus or local recycled water). The additional water distributed from each GW bank would allow for reduced direct SWP deliveries to Partner Contractors. These reductions would, by operational exchanges in the SWP, create the pulse flow volumes released from Lake Oroville.

Implementation of the three south-of-Delta GW bank WSIP projects and the three north-of-Delta or in Delta surface water storage projects may affect operations of the SWP, including operations of south Delta pumping facilities and San Luis Reservoir, and water availability in the system during and immediately following the release of pulse flows. As needed, San Luis Reservoir would be operated to facilitate exchanges needed to compensate for pulse flow releases from Lake Oroville. However, San Luis Reservoir would be replenished, and water supplies made whole via exchange with the GW banks used by the pulse flow projects. (As described later in the document, the hedging and payback for San Luis Reservoir are not included in the analysis.)

Stantec was retained by DWR to provide support services for the cumulative flow analysis, including cumulative implementation of three south-of-Delta GW bank WSIP projects and three north-of-Delta or in Delta surface water diversion WSIP projects onto a baseline existing conditions model, development of coordinated pulse flow operations, and analysis of changes to hydrologic conditions, including flows in the Sacramento River and Feather River, Delta inflow and surplus conditions, SWP diversions from the Delta, and diversions from the Sacramento River, Delta, or San Luis Reservoir by SWP contractors that could result from implementation of the six WSIP projects. The assumptions developed in this analysis are preliminary and subject to ongoing review.

2.0 PROCEDURAL SUMMARY

A post-processing tool was developed to model and evaluate the cumulative implementation and pulse flow effects of six WSIP Projects: Sites, Harvest, LVE, Kern Fan, Willow Springs, and Chino Basin. A summary of the tool development and analysis procedure is provided below, and more details are available in Appendix A. DWR states that the purpose of this analysis is to get a general sense of flow impacts of all the WSIP projects operating. The analysis is not intended to be used in regulatory or water rights proceedings. There are some simplifications and assumptions made that make results potentially not suitable for these types of uses. This analysis includes explanations of the simplifications and assumptions.

2.1 MAIN ASSUMPTIONS

An existing conditions WSIP baseline CalSim II model (WSIP Baseline[1]) was developed by DWR in 2021 and served as the basis of CVP and SWP system operations. The WSIP Baseline included historical hydrology, 2019 Biological Opinions (BiOps) for the long-term CVP and SWP operations, and the 2020 Incidental Take Permit (ITP) for the SWP operations, among other regulatory conditions. The general approach to the cumulative effects analysis includes adding to or subtracting from flow values in the WSIP Baseline based on the operations of each individual WSIP project, subject to regulatory and operational constraints of the WSIP Baseline.

To modify the WSIP Baseline, a post-processing tool was developed to incrementally augment specific CalSim II variables based on simplified operations of the six WSIP Projects. Three surface water diversion projects north of the Delta or in the Delta were implemented incrementally from north to south: Sites, Harvest, then LVE. Then the coordinated operations of all three south-of-Delta GW banks were implemented: Kern Fan, Willow Springs, and Chino Basin. This coordinated operation assumes Kern Fan and Willow Springs have equal access to exportable Delta surplus for filling operations (Chino Basin fills with local supply), and that stored GW across all banks is exchanged for water in Lake Oroville, enabling (1) the GW banks to deliver previously stored GW supplies to Partner Contractors in lieu of SWP supply from the SWP and (2) a pulse flow to be released from Lake Oroville using exchanged water.

This report focuses on current conditions as depicted in the WSIP Baseline CalSim II model and near-term modeling used by WSIP projects. Future conditions such as 2070 scenarios and future climate change impacts were not evaluated in this report.

The simplified operations and facility assumptions for each WSIP project were obtained from existing documentation (Table 1), either WSIP application documents and modeling, or other updated documents and modeling (e.g., related EIRs) provided to DWR for the analysis. Modifications to the WSIP Baseline to reflect WSIP project operations in the post-processor were made in three ways:

- *For Sites and LVE:* An alternative CalSim II model and baseline CalSim II model were available for each project. The difference between the alternative model variable and the baseline model variable was added to the WSIP Baseline variable.
- *For Harvest:* WSIP application documentation was used to identify a variable of interest (e.g., changes in Sacramento River flows) and a corresponding calculation node in CalSim II. A net change in the variable between a baseline condition and alternative condition was calculated, and the net change was then added to the corresponding CalSim II node in the WSIP Baseline.

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[1]An existing conditions CalSim II baseline model and four future conditions CalSim II baseline models were developed in 2017 by DWR and Reclamation for use in WSIP applications. In September 2021, DWR updated these baseline models to account for current regulations governing Delta operations and to include all other CalSim II model updates as of September 2021, including updates from DWR's 2019 Delivery Capability Report.

- *For Chino Basin, Kern Fan, and Willow Springs:* Spreadsheet models for each project were available that simulated GW bank operations using variables from a baseline CalSim II model. Each spreadsheet model was modified to read CalSim II variables from the WSIP Baseline, and the spreadsheet model parameters were modified to incorporate operational changes expected from the cumulative implementation of WSIP projects (e.g., coordinated pulse flows in the same month released from all GW banks). Any resulting net changes to a CalSim II variable (e.g., increases in Feather River flows due to a pulse flow release) were added to the WSIP Baseline variable.

Table 1. Basis of WSIP Project Modeling Included in the Post-processing Analysis

Scenario/Project	Existing Conditions Model (date developed)	Project Alternative Model
WSIP Baseline	2021 WSIP Baseline CalSim II model (09/30/2021, prepared by DWR)	N/A
Sites	2022 Baseline CalSim II model (5/14//2022) File Name: CALSIM_MMv5_NOACTION_051422	Sites Alt 3 (modified from Existing Conditions Baseline) File Name: CALSIM_MMv5_ALT3_051722
Harvest	2017 WSIP 2030 Baseline CalSim II model (2017. Note this CalSim II model run was not used in the post-processor, only the results from the Harvest Project Alternative Model)	Regional San Program, Year 20 equilibrium conditions (modified from Existing Conditions Baseline) Reference: From 2017 WSIP Application Info, Regional San_CALSIM_HEC5Q_ModelingTM_A.1ProjectConditions_SecBCMR.pdf
LVE	2017 LVE Baseline CalSim II model (05/02/2017) File Name: CALSIM_LVE275_EC_050217/LVE275_DSEIR_EC_160TAF	LVE Alt 1B (modified from Existing Conditions Baseline) File Name: CALSIM_LVE275_EC_050217/LVE275_DSEIR_EC_Alt1B
Willow Springs	N/A	Custom spreadsheet model (based on Conjunctive Operations Concept for the Willow Springs Water Bank memo dated 04/06/2022)
Kern Fan	N/A	Spreadsheet model (based on WSIP 2030 operation, "Model_KernFan_02_09_2018.xlsm")
Chino Basin	N/A	Spreadsheet model (based on WSIP 2030 operation, Chino Basin Program Water Supply Investment Program Water Exchange Operations Model, "CBP WSIP Operations Analysis Tool v 20211001.xlsx")

2.2 SURFACE WATER DIVERSIONS, RELEASES, AND DELTA ASSUMPTIONS (MOD1)

Operations for the three surface water diversion projects north of the Delta or in the Delta are incorporated cumulatively from north to south – Sites, Harvest, then LVE – and are referred to collectively as modification 1 (MOD1). The analysis uses the WSIP Baseline and applies the incremental difference between the individual WSIP project CalSim II baseline and alternative models (Alternative CalSim II models), or the difference between a project alternative and a baseline quantified using other modeling tools, to the WSIP Baseline. The WSIP Baseline includes updates to the regulatory and operational assumptions that have the potential to change the timing and availability of surplus flows compared to previous CalSim II models that may have been used to model existing conditions for the surface water diversion projects. The changes in flows from each surface water diversion project were evaluated in the post-processing tool and constrained by Delta conditions in the WSIP Baseline. This is because it is important to analyze the changes from the WSIP projects in the context of Delta surplus and balanced as exists under the current regulatory conditions in the WSIP Baseline.

If the results of Alternative CalSim II models, when incrementally added to the WSIP Baseline, show that pumping at Banks is increased beyond regulatory capacity in the WSIP Baseline, this analysis identifies that increment as "infeasible" meaning that the WSIP project yield is overestimated. The assumption is that operational agreements with DWR would not allow significant impacts to Banks pumping. Likewise, if the results of Alternative CalSim II models, when incrementally added to the WSIP Baseline, show that Delta surplus is reduced beyond what is currently available based on regulatory conditions in the WSIP Baseline, which would require a corresponding reduction in Banks exports to maintain balance in the Delta, this analysis identifies that increment as "infeasible" meaning that the WSIP project yield is overestimated.

The major assumptions for implementing each project are described below:

- **Sites**: Operations are modeled as a change in flow at four locations: Feather River (CalSim II node C203 and C223), Delta inflow from the Sacramento River at Hood, Yolo bypass flow into the Delta, and Banks exports.

    a. The net difference between Delta inflow (Sacramento River flows at Hood plus Yolo bypass flow) and Banks exports between the Sites Alternative CalSim II model and the Sites baseline CalSim II model is added to (if positive) or subtracted from (if negative) the WSIP Baseline Delta surplus. If the Sites adjustment results in reductions to Delta surplus that were greater than available Delta surplus in the WSIP Baseline, these adjustments are tracked as infeasible (i.e., reduction in Sites yield). Any increase in Delta inflow due to releases from Sites (either through the Sacramento River or through Yolo Bypass) are protected through to Delta outflow and are not made available for export by other WSIP surface water diversion or GW projects. The updated Delta outflow variable is calculated by adding or subtracting net changes to Delta surplus.

    b. The difference in Banks exports between the Sites Alternative CalSim II model and the Sites baseline CalSim II model is added to (if positive) or subtracted from (if negative) Banks exports.

If the Sites adjustments result in increases or reductions to Banks exports that are greater than available permit/regulatory capacity in the WSIP Baseline or less than the health and safety minimum (300 cubic feet per second (cfs)), these adjustments are tracked as infeasible.

- **Harvest**: Operations are modeled as a change in Delta inflow, which reflects the combined net change in flow of the Sacramento River at Hood and the Cosumnes River.

  a. The net difference between decreased releases and increased surface water return flow to the Sacramento River at Hood from Harvest is calculated using a monthly pattern of flow applied to an annual flow volume defined in the WSIP application, assuming the project has reached equilibrium after 20 years of operation. The net difference is added to the WSIP Baseline Sacramento River flow at Hood. Note that in earlier years of operations there would be less return flows to the Sacramento River or to the Delta in general through the Consumnes River so impacts are greater in the first part of the 20 years of operation.

  b. The increase in streamflow to the Cosumnes River is calculated using a monthly pattern of flow applied to an annual flow volume defined in the WSIP application, assuming the project has reached equilibrium after 20 years of operation. The net difference is added to the WSIP Baseline Consumnes River flow.

  c. The net change in Delta inflow (Delta inflow from the Sacramento River plus Consumnes River) is added to (if positive) or subtracted from (if negative) the Sites modified Delta surplus. Changes to Delta outflow are calculated by adding or subtracting net changes to Delta surplus. If Delta inflow is reduced and the Delta is in a balanced condition, Banks exports are reduced to maintain a balanced Delta condition and Delta outflow is not reduced.

- **LVE**: Operations are modeled as a change in Delta surplus and Banks exports.

  a. The net difference in Delta surplus between the LVE Alternative CalSim II model and the LVE baseline CalSim II model is added to (if positive) or subtracted from (if negative) the Sites/Harvest modified Delta surplus. If the LVE adjustments result in reductions to Delta surplus that were greater than Sites/Harvest modified available Delta surplus, these adjustments are tracked as infeasible (i.e., reduction in LVE yield). The updated Delta outflow variable is calculated by adding or subtracting net changes to Delta surplus.

  b. The difference in Banks exports between the LVE Alternative CalSim II model and the LVE baseline CalSim II model is added to (if positive) or subtracted from (if negative) the Sites/Harvest modified Banks exports. If the LVE adjustments result in increases or reductions to Banks exports that are greater than available permit/regulatory capacity or less than the health and safety minimum, these adjustments are tracked as infeasible.

Based on Sites and LVE Alternative CalSim II modeling, implementation of these two surface water diversion projects causes some minimal changes in storage in the major CVP and SWP reservoirs (Oroville, Shasta, Trinity, Folsom, San Luis Reservoirs) and SWP and CVP allocations, so these changes are ignored for purposes of this post-processing analysis because the focus of the analysis is on changes

to Delta inflows and exports and tracking additional upstream reservoir storage changes could be too complicated for its worth.

The controlling regulations in the Delta are a critical component of the analysis that is referenced for each project. For each month in the WSIP Baseline, Delta conditions are classified as surplus (i.e., with no controlling Delta regulations), Surplus with export restrictions (i.e., when the Delta is in surplus but Delta regulations are limiting exports), or Balanced. For these last two classifications, Delta control is identified as EI ratio cap export control, OMR control, D-1641 April-May export cap control, D-1641 outflow control, D-1641 salinity control, or SWP ITP export cut to enforce the spring outflow requirement in April and May. The post-processor does not recalculate or change Delta control in any month based on the represented operations of the WSIP projects. The WSIP Baseline control is assumed to remain in control throughout all post-processor modifications, with exceptions noted below.

In any given month, implementation of a surface water diversion project may result in changes in Delta inflow, which then are used to cumulatively adjust Delta surplus. Adjustments to Delta surplus can be categorized as increased Delta surplus, reduced but still positive Delta surplus, a reduction in Delta surplus to balanced conditions (i.e., reduction of all Delta surplus), or an infeasible reduction in Delta surplus beyond what is available in the WSIP Baseline or subsequent incremental adjustments. If Delta surplus increases, the increase is tracked separately but not made available for cumulative WSIP projects. If Delta surplus is reduced but still positive, the reduced volume of Delta surplus is available for cumulative WSIP projects. If Delta surplus is reduced to 0 (balanced conditions), no Delta surplus is available for cumulative WSIP projects. If Delta surplus is reduced below 0, the additional reductions below 0 are tracked as infeasible, and Delta surplus remains at 0 for WSIP cumulative projects. Adjustments to Delta surplus are tracked as 'infeasible' if they present conflicts with SWP operations, i.e., if they require Banks export cuts. Reductions in surplus and the required SWP export cuts that would be necessary (but are not tracked cumulatively) are made based on rules listed in Table 2.

Table 2. Delta Condition Classification and Corresponding Post-processor Treatment when Delta Inflow is Reduced

Controlling Regulation	Surplus with restrictions	Balanced[1]
EI ratio cap export control	Split reduction between SWP exports and Delta outflow by appropriate proportion to maintain EI ratio control. Track volume of required Delta outflow reductions[1].	Split reduction between SWP exports and Delta outflow by appropriate proportion to maintain EI ratio control. Track volume of required Delta outflow reductions.
OMR control	Reduce surplus 1:1 to Delta inflow reduction until all surplus is eliminated, then refer to Balanced condition	Reduce SWP exports at a 1:1 ratio to Delta inflow reduction
D-1641 April-May export cap control	Reduce surplus 1:1 to Delta inflow reduction until all surplus is eliminated, then refer to Balanced condition	Reduce SWP exports at a 1:1 ratio to Delta inflow reduction
D-1641 outflow control	Not applicable	Reduce SWP exports at a 1:1 ratio to Delta inflow reduction
D-1641 salinity control	Not applicable	Split reduction between exports and Delta outflow based on carriage water requirements. Track volume of required Delta outflow reductions.
SWP ITP export cut (April-May spring outflow)	Reduce surplus 1:1 to Delta inflow reduction until all surplus is eliminated, then refer to Balanced condition	Not applicable unless all surplus has been reduced, then reduce SWP exports at a 1:1 ratio to Delta inflow reduction

[1] For Sites and LVE, these export cuts are tracked as 'infeasible' with the WSIP Baseline and are not cumulatively implemented.

The above modeling assumptions were developed to reduce available Delta surplus without impacting the SWP operations within the WSIP Baseline (i.e., Table A deliveries and Article 21 deliveries in the WSIP Baseline are preserved). Sites and LVE operations that assume modifications of Delta surplus during balanced conditions, when no Delta surplus is available, are incompatible with SWP operations in the WISP Baseline and are tracked separately without cumulatively impacting the analysis. At this time, the analysis is focused exclusively on the SWP system, and no CVP system effects were analyzed. Modeling results from the Sites and LVE environmental documents can be referenced for specific CVP system effects.

Carriage water requirements from the WSIP Baseline are generally maintained in the surface water diversion portion of the MOD1 analysis, with the following clarifications:

- When D-1641 salinity control is in place and Delta inflow is reduced, the ratio of required export reduction to Delta inflow reduction may be less than 1:1 since a portion of inflow is going to carriage water. This is only applicable to the Harvest adjustment, which can reduce Delta inflows during Delta balanced conditions.

- Sites and LVE reductions to Delta surplus are only allowed cumulatively when the Delta is in a surplus condition. In these conditions, reductions to Delta surplus do not require a cut to Banks exports. Since D-1641 salinity control is never controlling during surplus conditions, there are no carriage water requirements to account for during Sites and LVE Delta surplus reductions.

- Sites increases to Delta inflow, generally in July through November, support additional Banks exports. These inflows are greater than Banks exports due to carriage water requirements and Sites environmental flows through the Yolo Bypass. The post-processor does not calculate these carriage water requirements. For simplicity, increases in Delta inflow minus Banks export increases are added to Delta surplus. However, these increases are not made available to be exported by subsequent WSIP projects in this analysis. This assumption is consistent with the Sites project description, which states Sites releases would allow increases in Delta outflow during drier months due to the Yolo Bypass habitat flows and increases in carriage water.

2.3 GROUNDWATER PROJECT OPERATIONS ASSUMPTIONS (MOD2)

The three GW banks located south of the Delta are represented in the post-processor using a water balance that consists of fill, release, and loss. Fill operations are either independent of CalSim II variables (Chino Basin) or rely on Delta surplus flow or modifications to San Luis Reservoir (Kern Fan, Willow Springs) that cumulatively impact the CalSim II variables described in MOD1. Release operations are based on the pulse flow assumptions described below and result in additional cumulative changes to the CalSim II variables described in MOD1. The collective modification of WSIP Baseline and MOD1 variables by GW projects is referred to as modification 2 (MOD2).

The main components of each GW banks operations are as follows:

- **Chino Basin:** Fill occurs with a constant supply of 15 TAF/year of treated water using a time series consistent with the WSIP application. The proposed local fill to support Chino Basin operations is limited to the throughput of the proposed advanced water purification facilities (i.e., 15 TAF/year). Releases for pulse flows are based on the assumptions described below. To be consistent with the WSIP application, the target volume for each pulse flow is 50 TAF (resulting in only 40 TAF of GW bank storage reduction for each pulse due to an assumed 20% carriage water savings), total storage available in the GW bank is 150 TAF, total borrowing capacity (i.e., deliveries debited against other Chino Basin groundwater) is 100 TAF, and initial storage is set to 75 TAF as described in application project operations documents. Chino Basin pulse flow operations are decoupled from releases to Partner Contractors (in this case, Metropolitan Water District of Southern California, or MWD). In years when a pulse flow is made in the model, MWD does not necessarily take delivery of supplies from Chino Basin in lieu of SWP export reductions from Banks. MWD would reduce SWP deliveries in that year and call on Chino Basin in non-pulse flow years for delivery of stored supplies when SWP Table A allocations dropped below a user defined threshold value (42% in the spreadsheet model). This threshold value was determined by trial and error in the model to maintain reasonable GW storage over time in terms of debit or surplus deliveries. While not necessarily applicable to this cumulative flow analysis, the Chino Basin WSIP proposal also includes a limited term to support pulse flow operations of 25 years. In other words, as proposed, Chino Basin will support a total volume of up to 375 TAF of pulse flows over 25 years of operations. This limited term for support of pulse flow operations over 25 years is not reflected in this cumulative flow analysis.

- **Kern Fan:** Fill occurs based on the availability of current month Delta surplus flow available as Article 21 supplies from MOD1 (i.e., Delta surplus flow in excess of Article 21 supplies delivered in the WSIP Baseline, when SWP San Luis Reservoir is full). Delivery of Article 21 supplies to Kern Fan is limited by Banks permit/regulatory export capacity from MOD1 (i.e., preserving Article 21 deliveries from the WSIP Baseline and considering any additional export cuts or increases from surface water diversion projects) and the California Aqueduct conveyance constraint at the Kern Fan turn-out, which was set at a constant 400 cfs (23.8 TAF per month). This fill is split between an environmental account for pulse flows, storage for Irvine Ranch Water District (IRWD), and storage for Rosedale Rio-Bravo Water Storage District (RR). Releases for pulse flows are based on the assumptions described below. Total storage available in the environmental account for pulse flows is 25 TAF, but the target volume for each pulse flow is 18 TAF (resulting in only 14 TAF of GW bank storage reduction for each pulse due to an assumed 23% carriage water savings), and initial storage was set at 0 TAF, consistent with the WSIP application. Total storage in the GW bank across all accounts is 100 TAF.

- **Willow Springs:** Fill occurs using opportunistically captured Delta surplus flow, which is stored in San Luis Reservoir in Pre-Evacuated Public Benefit Space that was created by moving water from San Luis Reservoir to the Water Bank earlier in the year. A simplified spreadsheet model of the Willow Springs operation, based on the April 6, 2022 Technical Memo from Willow Springs, determines the operation. Storage space in San Luis Reservoir made available by pre-evacuation can be filled by additional exports of Delta surplus from MOD1 (as limited by permit/regulatory export capacity), thereby generating additional yield. This additional yield is then moved into the GW bank into an Ecological Benefit Storage account, which is used to compensate for pulse flow releases. The deficit in San Luis Reservoir due to pre-evacuation is always made up by the end of the water year, either by the Antelope Valley-East Kern Water Agency (AVEK) taking its Table A allocation from the GW bank instead of San Luis Reservoir, or by returning pre-evacuated water to the California Aqueduct. Water stored in the GW bank is subject to a 10% leave-behind, removed from the Ecological Benefit Storage account, in two cases. First, when additional yield is moved into the Ecological Benefit Storage account, and second, when pre-evacuated water is returned to the California Aqueduct. Consistent with recent modeling updates, the target volume for each pulse flow is 28.6 TAF per year. Initial storage was set at 0 TAF to be consistent with the Kern Fan assumptions. Total storage capacity of the GW bank is 560 TAF, with inflow and outflow capacity of 200 cfs.

- **Fill priority:** For the purposes of modeling and treating two Article 21-dependent groundwater banks equally, half of the MOD1 Delta surplus flow available in a given month will be made available for additional San Luis fill facilitated by the Willow Springs operation, and the other half will be made available to Kern Fan. Note that these deliveries would be in addition to the Article 21 deliveries simulated in the WSIP Baseline, which are preserved through MOD1 and MOD2.

Supplies in each GW bank are indirectly exchanged for storage in Oroville to enable a spring pulse flow release from Oroville in April of Below Normal and Dry water year types, as defined by the Sacramento Valley Index. Capacity would be combined from multiple GW banks to deliver a pulse flow with a magnitude up to 100 TAF in a given year (the combined storage volume for pulse flow exchange water of

all GW banks is up to 97 TAF for this analysis), but magnitude of allowable pulse flow would be constrained by several factors:

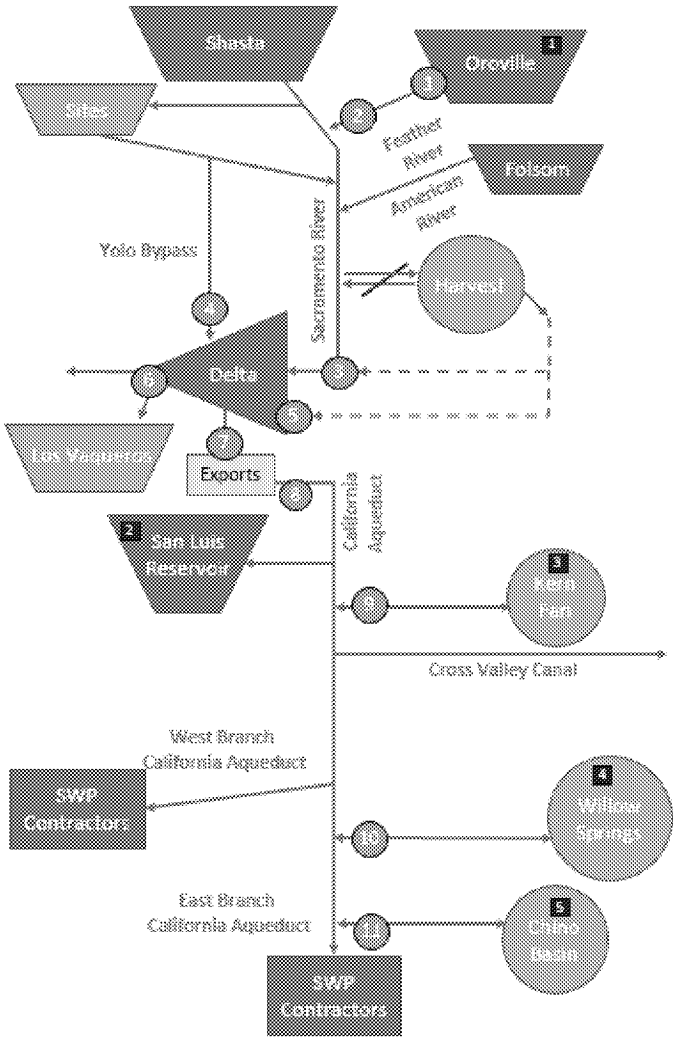
- The volume each GW bank had in their pulse flow storage account in April
- GW bank specific pulse flow triggers as described in project assumptions or implemented in spreadsheet models:
  - Chino Basin pulse flow releases were represented based on the WSIP assumption to only make a pulse flow for either 3 consecutive or 4 out of 10 years, and only if Lake Oroville storage and San Luis Reservoir storage are within minimum and maximum threshold values. While removing this frequency limitation would result in an increase in the magnitude and frequency of pulse flows facilitated by Chino Basin, this would be at expense of depleting the initial storage assumed to be in place at the beginning of the simulation and the resulting pulse flow volume would significantly exceed Chino Basin's commitment at an average of 15 TAF/year over the term of the proposed exchange agreement. Therefore, this cumulative pulse flow analysis uses the WSIP assumption to only make a pulse flow for either 3 consecutive or 4 out of 10 years.
  - Kern Fan will only make a pulse flow if final SWP Table A allocations are greater than 20% and only if sufficient storage has accumulated in the account to deliver the full pulse flow requested (i.e., Kern Fan will not make partial delivery).
  - Willow Springs does not have an SWP Table A allocation threshold or minimum storage level for making a pulse flow.
- The total volume of Feather River flow reductions in July through September that would still ensure Feather River minimum flow requirements are met. This is based on the concept that DWR would forecast summer releases and Feather River minimum flow requirements before a pulse flow is approved, and would only deliver a pulse flow volume in the spring that could be compensated with reduced releases in summer months that still meet or exceed Feather River minimum flow requirements. The total flow release reductions would allow Lake Oroville storage to recover by the end of the water year to the anticipated storage without the pulse flow operation.
- The magnitude of additional Banks export reductions that could occur due to decreases in Delta inflow while still maintaining exports above the minimum health and safety threshold of 300 cfs.

Feather River releases or Banks export reductions could be reduced across several months or could be reduced in some months and not others, depending on the constraints above. There would be no priority to modify flows or exports evenly across months. In general, Delta outflow would be increased during the pulse flow release months and would remain relatively unchanged during pulse flow compensation reduction months, when Delta inflows would be reduced but Banks exports would be reduced an equivalent amount, resulting in relatively unchanged Delta outflows. In real-time operations, the effects of these operations on antecedent salinity conditions could result in changes in carriage water requirements and Delta operations, but these effects are beyond the scope of this analysis.

To simplify the analysis, no carriage water savings are calculated during the pulse flow compensation summer months, when Banks exports are reduced, and the GW banks are delivering SWP supplies to Partner Contractors in lieu of Banks exports.

2.4 SCHEMATIC

The main variables developed in the post-processing tool are outlined in the schematic shown in Figure 2.



NODES/STORAGE FROM CALSIM FOR WSIP BASELINE, MOD1, AND MOD2

	Flow Variable	CalSim II Node
1	Feather River Flow below Thermalito	C203
2	Feather River Flow at mouth	C223
3	Sacramento River Flow at Hood	C400
4	Flow through Yolo Bypass	C157
5	Mokelumne River inflow to Delta	C504
6	Delta outflow surplus	C407_SWP + C407_CVP
7	Banks Exports	D419
8	Article 21 Delivered SOD	DEL_SWP_PIN (minus NOD deliveries)
9	Deliveries to Kern Fan	N/A
10	Deliveries to Willow Springs	N/A
11	Deliveries to Chino Basin	N/A

	Storage Variable	
1	Oroville Storage	S6
2	SWP San Luis Reservoir	S12
3	Kern Fan	N/A
4	Willow Springs	N/A
5	Chino Basin	N/A

Figure 2. Schematic of Variables Adjusted in the Cumulative Flow Analysis.

3.0 PRELIMINARY RESULTS

The preliminary results from the analysis are described in terms of surface water diversion project adjustments (MOD1) to the WSIP Baseline, groundwater project adjustments (MOD2) to MOD1 and the WSIP Baseline, and summary results of modeled pulse flow delivery and pulse flow compensation reductions.

3.1 SURFACE WATER DIVERSION PROJECT ADJUSTMENTS (MOD1)

3.1.1 Delta Surplus

The long-term monthly average cumulative effects of the three surface water diversion WSIP projects on Delta surplus is shown in Figure 3 and Table 3. Each MOD1 adjustment to Delta surplus is only tracked when the WSIP Baseline shows a Delta surplus condition based on controlling regulations. If the Delta is in a balanced condition, the adjustments are not cumulatively added. In general, diversions to Sites in winter months (January through March) result in reduced Delta inflow, and subsequently, reduced Delta surplus. In summer months, Sites releases to the Sacramento River and Yolo bypass increase Delta inflow but correlating increases in Delta exports generally results in relatively small increases to Delta surplus. These increases in Delta surplus are not available for export by other WSIP projects. Harvest adjustments to Delta inflow generally results in minor reductions to Delta surplus. LVE use of Delta surplus occurs in wet winter months (January through March). Mean annual reductions in Delta surplus throughout the simulation period are 317 TAF, or 3% of the total 10,473 TAF of mean annual Delta surplus. As noted in Section 2, carriage water costs are not subtracted from the Sites increases in Delta inflow in summer months that support additional Banks exports, and thus summer increases in Delta surplus due to Sites operations may be slightly overstated. The long-term monthly average cumulative effects of the three surface water diversion WSIP projects on Delta surplus by water year type is shown in Figure 4 and in Tables 4 through 8.

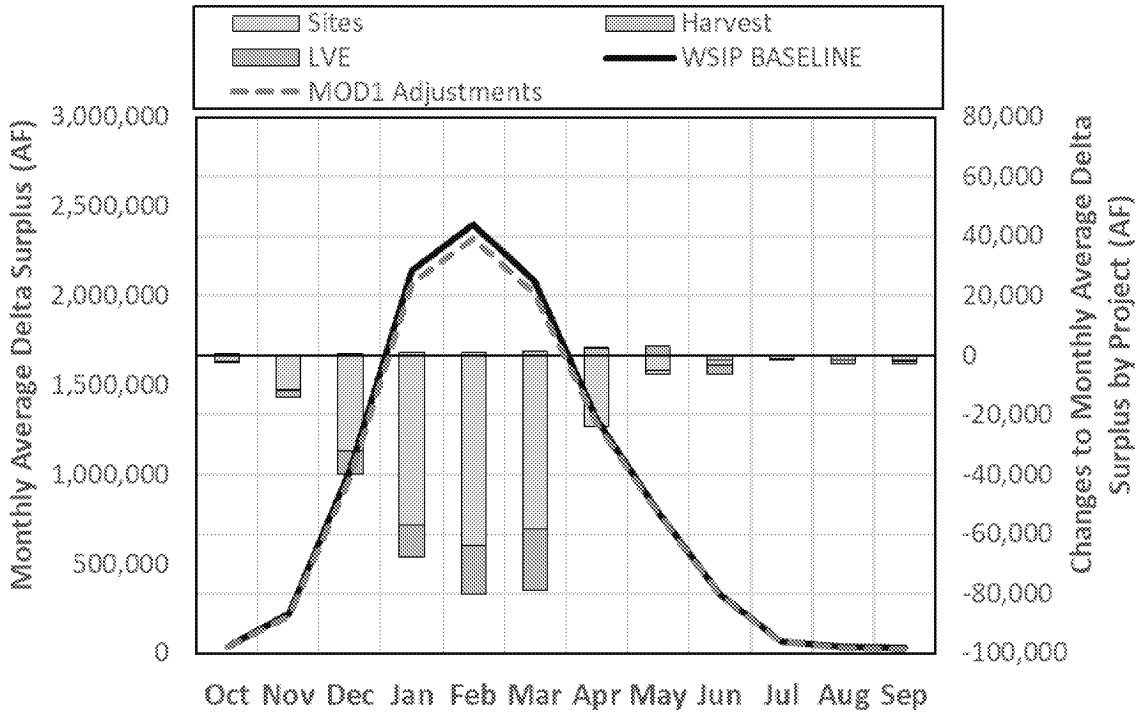


Figure 3. Monthly Average Delta Surplus for WSIP Baseline and MOD1 Adjustments and Changes to Monthly Average Delta Surplus by Project (in acre-feet))

Table 3. Monthly Average Delta Surplus and Changes to Monthly Average Delta Surplus, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	38	224	1,031	2,140	2,401	2,088	1,307	787	332	64	34	28	10,473
MOD1 Adjustment	36	210	991	2,073	2,322	2,010	1,285	784	326	63	31	25	10,157
MOD1 Adjustment by Sites	-2	-12	-32	-57	-64	-58	-24	-5	-2	0	0	-2	-258
MOD1 Adjustment by Harvest	0	0	0	1	1	2	2	-1	-1	-1	-2	0	1
MOD1 Adjustment by LVE	0	-2	-8	-11	-16	-21	0	3	-3	0	-1	-1	-60
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-2	-14	-40	-67	-79	-77	-22	-3	-6	-1	-3	-3	-317
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-5%	-6%	-4%	-3%	-3%	-4%	-2%	0%	-2%	-2%	-9%	-11%	-3%

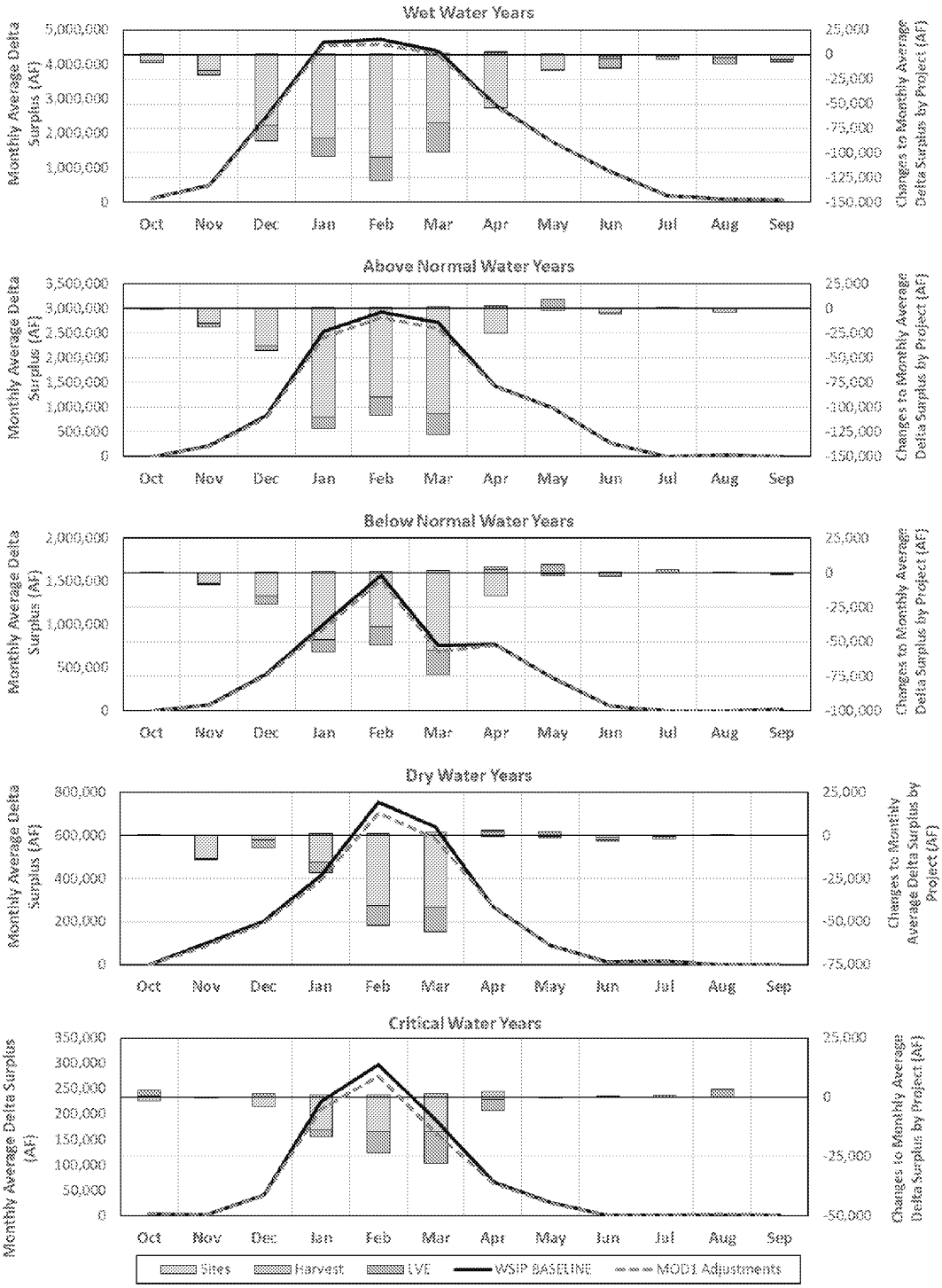


Figure 4. Monthly Average Changes to Delta Surplus for WSIP Baseline and MOD1 Adjustments, and by Individual Project (in acre-feet), by Water Year Type

Table 4. Monthly Average Delta Surplus and Changes to Monthly Average Delta Surplus, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Wet Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	118	498	2,479	4,649	4,719	4,392	2,827	1,751	881	193	87	80	22,676
MOD1 Adjustment	110	477	2,392	4,547	4,593	4,295	2,775	1,736	867	188	77	72	22,130
MOD1 Adjustment by Sites	-6	-16	-72	-85	-104	-69	-54	-15	-2	-1	0	-5	-428
MOD1 Adjustment by Harvest	0	0	0	1	1	2	2	-1	-2	-1	-4	0	-3
MOD1 Adjustment by LVE	-2	-4	-16	-18	-24	-30	0	1	-10	-3	-6	-3	-115
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-8	-20	-88	-102	-127	-97	-52	-15	-14	-5	-10	-8	-546
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-7%	-4%	-4%	-2%	-3%	-2%	-2%	-1%	-2%	-3%	-11%	-10%	-2%

Table 5. Monthly Average Delta Surplus and Changes to Monthly Average Delta Surplus, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Above Normal Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	1	223	831	2,531	2,922	2,715	1,433	979	275	0	42	0	11,950
MOD1 Adjustment	1	204	789	2,410	2,814	2,589	1,411	986	270	1	38	0	11,512
MOD1 Adjustment by Sites	0	-15	-37	-110	-90	-107	-25	-1	-4	0	0	0	-390
MOD1 Adjustment by Harvest	0	0	0	1	1	2	2	-1	-1	0	-4	0	0
MOD1 Adjustment by LVE	0	-4	-5	-12	-19	-21	1	10	1	1	0	0	-49
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0	-19	-42	-121	-108	-126	-22	8	-4	1	-4	0	-439
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0%	-9%	-5%	-5%	-4%	-5%	-2%	1%	-1%	0%	-10%	0%	-4%

Table 6. Monthly Average Delta Surplus and Changes to Monthly Average Delta Surplus, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Below Normal Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	0	69	430	1,005	1,569	758	770	380	54	0	0	13	5,049
MOD1 Adjustment	0	60	408	949	1,518	686	758	384	52	2	0	12	4,828
MOD1 Adjustment by Sites	0	-8	-17	-49	-39	-56	-17	-1	-2	0	0	0	-188
MOD1 Adjustment by Harvest	0	0	0	1	1	2	2	-1	-1	0	0	-1	4
MOD1 Adjustment by LVE	0	-1	-6	-9	-13	-18	2	6	1	2	0	0	-36
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0	-9	-23	-57	-51	-72	-13	4	-2	2	0	-1	-220
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0%	-13%	-5%	-6%	-3%	-9%	-2%	1%	-4%	0%	0%	-8%	-4%

Table 7. Monthly Average Delta Surplus and Changes to Monthly Average Delta Surplus, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Dry Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	0	99	200	413	755	641	271	89	14	15	0	0	2,497
MOD1 Adjustment	0	85	193	393	704	587	273	90	11	13	1	0	2,350
MOD1 Adjustment by Sites	0	-13	-3	-16	-41	-42	0	0	-1	0	0	0	-117
MOD1 Adjustment by Harvest	0	0	0	1	1	2	2	-1	-1	-2	0	0	3
MOD1 Adjustment by LVE	0	0	-5	-6	-12	-14	1	2	-1	0	1	0	-34
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0	-13	-8	-21	-52	-54	3	1	-3	-2	1	0	-148
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0%	-13%	-4%	-5%	-7%	-8%	1%	1%	-21%	-13%	0%	0%	-6%

Table 8. Monthly Average Delta Surplus and Changes to Monthly Average Delta Surplus, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Critical Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	3	2	41	225	297	189	67	25	0	0	0	0	850
MOD1 Adjustment	5	2	39	209	274	162	64	25	0	1	3	0	785
MOD1 Adjustment by Sites	-2	0	-4	-14	-15	-15	-1	0	0	0	0	0	-50
MOD1 Adjustment by Harvest	0	0	0	1	1	2	2	0	0	0	0	0	6
MOD1 Adjustment by LVE	3	0	2	-3	-9	-13	-4	0	0	1	3	0	-21
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	1	0	-2	-16	-23	-26	-3	0	0	1	3	0	-65
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	33%	0%	-5%	-7%	-8%	-14%	-4%	0%	0%	0%	0%	0%	-8%

3.1.2 Banks Exports

The long-term monthly average cumulative effects of the three surface water diversion projects on Banks exports are shown in Figure 5 and Table 9. Sites results in increased Banks exports of transfers in summer months, concurrent with Sites releases that increase Delta inflow. Reductions in Banks exports in winter months from Sites are due to random model variation, a result of inconsistent application of the Delta Cross Channel Reasonable and Prudent Alternative (RPA) export restriction in a few months in the Sites Baseline and Alternative CalSim II models. In other words, they are modeling artifacts.

Implementation of both Harvest and LVE results in decreases in Banks exports throughout the year, with greater export cuts in the summer months. Adjustments from Harvest are due to required cuts to exports when Delta inflows are reduced, and the Delta is not in a surplus condition. Adjustments from LVE are likely due to random model variation occurring in the LVE Alternative CalSim II model relative to the LVE CalSim II baseline model. Different from the above Sites scenario, the exact reason for these minor changes have not been identified; however, it is certain that they are not caused by any intentional operation in the LVE Alternative. For the cumulative analysis, these export decreases are still included in the calculations here for reasons of completeness as their relative magnitude is minor (well below a 1% annual average change in exports), creating limited effects on the results of this cumulative analysis. The long-term monthly average cumulative effects of the three surface water diversion projects on Banks exports by water year type are shown in Figure 6 and in Tables 10 through 14.

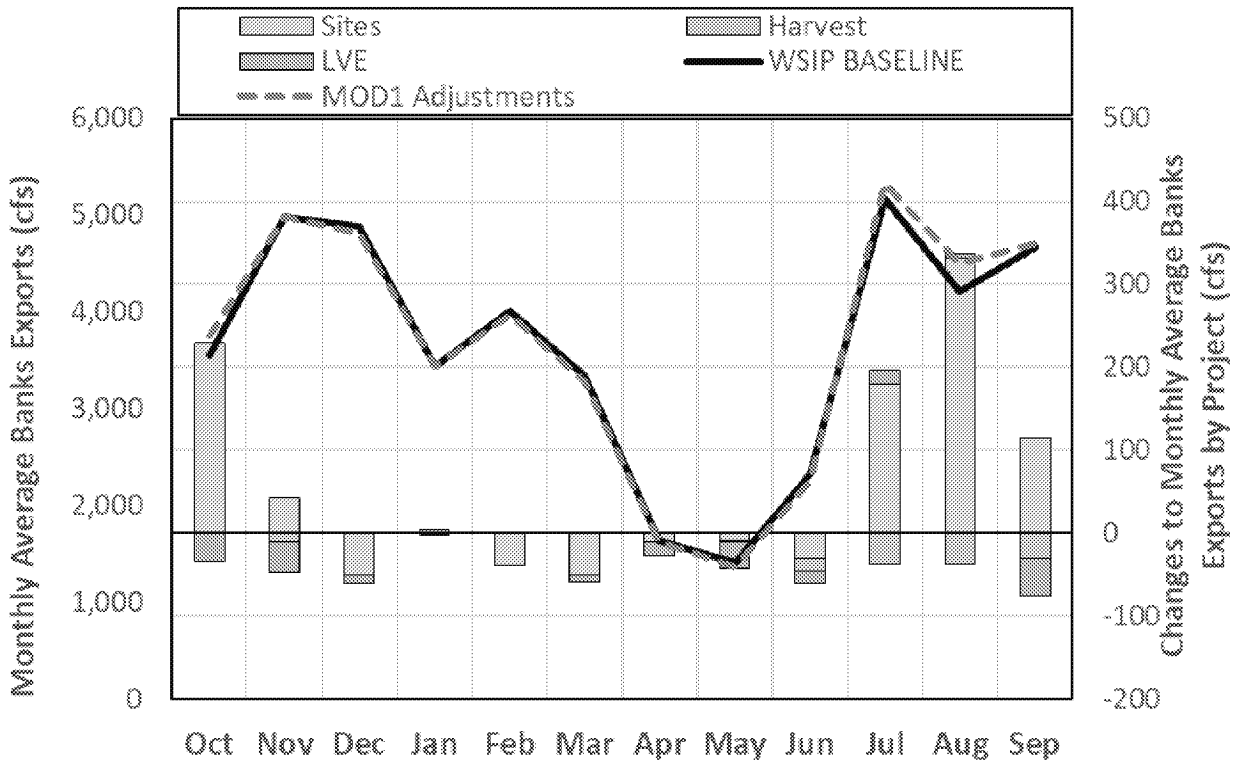


Figure 5. Monthly Average Banks Exports for WSIP Baseline and MOD1 Adjustments and Changes to Monthly Average Banks Exports by Project (in cubic feet per second)

Table 9. Monthly Average Banks Exports and Changes to Monthly Average Banks Exports, WSIP Baseline and MOD1 Adjustments (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,555	4,986	4,879	3,433	4,009	3,345	1,642	1,406	2,317	5,171	4,206	4,671	3,635
MOD 1 Adjustment	3,750	4,981	4,818	3,435	3,970	3,286	1,614	1,364	2,256	5,330	4,505	4,710	3,668
MOD 1 Adjustment by Sites	229	43	-50	4	-39	-51	-11	-10	-31	179	332	115	59
MOD 1 Adjustment by Harvest	0	-10	0	0	0	0	0	-2	-16	-37	-38	-30	-11
MOD 1 Adjustment by LVE	-35	-37	-10	-2	0	-8	-16	-31	-15	17	5	-46	-15
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	194	-4	-60	2	-39	-59	-27	-43	-62	159	299	39	33
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	5%	0%	-1%	0%	-1%	-2%	-2%	-3%	-3%	3%	7%	1%	1%

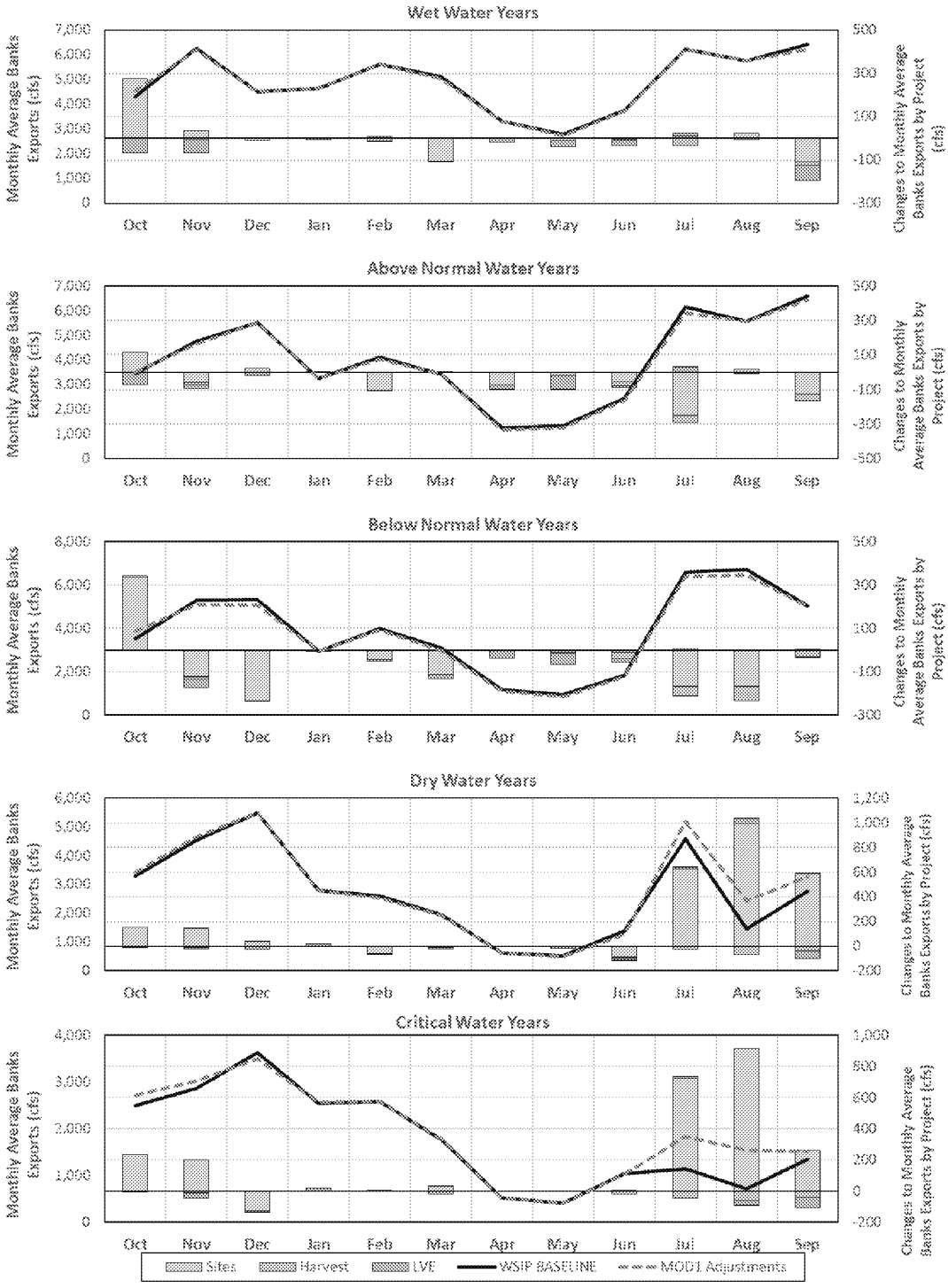


Figure 6. Monthly Average Banks Exports for WSIP Baseline and MOD1 Adjustments, and by Individual Project (in cubic feet per second), by Water Year Type

Table 10. Monthly Average Banks Exports and Changes to Monthly Average Banks Exports, WSIP Baseline and MOD1 Adjustments (in cubic feet per second), Wet Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	4,309	6,239	4,515	4,638	5,609	5,124	3,311	2,773	3,756	6,220	5,740	6,420	4,888
MOD 1 Adjustment	4,517	6,206	4,506	4,630	5,605	5,016	3,294	2,734	3,724	6,212	5,755	6,224	4,869
MOD 1 Adjustment by Sites	276	34	-11	1	-13	-107	-1	-12	-5	10	22	-109	7
MOD 1 Adjustment by Harvest	0	-7	0	0	0	0	0	0	-5	-33	-8	-15	-6
MOD 1 Adjustment by LVE	-68	-60	1	-8	9	0	-15	-27	-23	15	0	-72	-21
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	208	-33	-10	-7	-4	-107	-16	-39	-33	-8	14	-196	-20
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	5%	-1%	0%	0%	0%	-2%	0%	-1%	-1%	0%	0%	-3%	0%

Table 11. Monthly Average Banks Exports and Changes to Monthly Average Banks Exports, WSIP Baseline and MOD1 Adjustments (in cubic feet per second), Above Normal Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,453	4,744	5,505	3,259	4,123	3,418	1,258	1,335	2,447	6,149	5,554	6,604	3,987
MOD 1 Adjustment	3,496	4,649	5,507	3,258	4,022	3,419	1,161	1,238	2,362	5,891	5,566	6,438	3,917
MOD 1 Adjustment by Sites	116	-59	23	0	-101	1	-73	-19	-56	-251	18	-127	-44
MOD 1 Adjustment by Harvest	0	-12	0	0	0	0	0	0	-22	-40	-6	-39	-10
MOD 1 Adjustment by LVE	-72	-24	-21	-1	0	0	-24	-78	-7	32	0	0	-16
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	44	-95	2	-1	-101	1	-97	-97	-85	-259	12	-166	-70
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	1%	-2%	0%	0%	-2%	0%	-8%	-7%	-3%	-4%	0%	-3%	-2%

Table 12. Monthly Average Banks Exports and Changes to Monthly Average Banks Exports, WSIP Baseline and MOD1 Adjustments (in cubic feet per second), Below Normal Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,504	5,279	5,322	2,942	3,976	3,114	1,149	922	1,833	6,607	6,717	5,052	3,868
MOD 1 Adjustment	3,847	5,104	5,086	2,935	3,926	2,982	1,110	856	1,776	6,399	6,481	5,017	3,793
MOD 1 Adjustment by Sites	338	-125	-234	0	-43	-115	-1	-13	-13	-170	-169	1	-45
MOD 1 Adjustment by Harvest	0	-12	0	0	0	0	0	-1	-26	-44	-66	-31	-15
MOD 1 Adjustment by LVE	6	-38	-2	-6	-7	-17	-38	-51	-17	7	0	-5	-14
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	344	-175	-236	-6	-50	-132	-39	-65	-56	-207	-235	-35	-74
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	10%	-3%	-4%	0%	-1%	-4%	-3%	-7%	-3%	-3%	-3%	-1%	-2%

Table 13. Monthly Average Banks Exports and Changes to Monthly Average Banks Exports, WSIP Baseline and MOD1 Adjustments (in cubic feet per second), Dry Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,282	4,523	5,475	2,786	2,597	1,950	614	524	1,377	4,568	1,460	2,777	2,661
MOD 1 Adjustment	3,420	4,647	5,484	2,797	2,532	1,929	611	506	1,259	5,183	2,427	3,269	2,839
MOD 1 Adjustment by Sites	149	147	37	16	-61	-11	0	-1	-88	621	989	591	199
MOD 1 Adjustment by Harvest	0	-11	0	0	0	0	0	-7	-14	-26	-67	-40	-14
MOD 1 Adjustment by LVE	-11	-13	-28	-5	-4	-10	-3	-10	-15	20	45	-58	-8
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	138	123	9	11	-65	-21	-3	-18	-117	615	967	493	177
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	4%	3%	0%	0%	-3%	-1%	0%	-3%	-8%	13%	66%	18%	7%

Table 14. Monthly Average Banks Exports and Changes to Monthly Average Banks Exports, WSIP Baseline and MOD1 Adjustments (in cubic feet per second), Critical Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	2,495	2,864	3,633	2,542	2,582	1,781	525	407	1,043	1,146	722	1,348	1,757
MOD 1 Adjustment	2,722	3,017	3,496	2,561	2,583	1,793	521	403	1,023	1,829	1,544	1,504	1,916
MOD 1 Adjustment by Sites	235	201	-127	1	2	34	0	-4	1	720	914	264	187
MOD 1 Adjustment by Harvest	0	-13	0	0	0	0	0	0	-22	-49	-59	-38	-15
MOD 1 Adjustment by LVE	-8	-35	-10	18	-1	-22	-3	0	0	13	-33	-69	-13
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	227	153	-137	19	1	12	-3	-4	-21	684	822	157	159
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	9%	5%	-4%	1%	0%	1%	-1%	-1%	-2%	60%	114%	12%	9%

As noted in the assumption discussion, the simulated Article 21 deliveries from the WSIP Baseline are preserved since none of the projects' impacts to Delta surplus that would require cuts to Banks exports are implemented in the model or tracked cumulatively.

Delta surplus reductions made in the Sites and LVE Alternative CalSim II models relative to their project baseline did not always occur when Delta surplus was available in the WSIP Baseline. In this case, the assumed Delta surplus reduction from each project was tracked as 'infeasible', i.e., a reduction in their project yield in this analysis relative to the project analysis, and these values were tracked separately but not implemented cumulatively in the model. This assumption ensured Banks exports were not negatively affected by LVE and Sites operations. However, export reductions due to Harvest operations were implemented cumulatively in the model to remain consistent with the Harvest wastewater change petition approved by the State Water Resources Control Board, and for simplicity these reductions were applied only to Banks. As shown in Table 15, throughout the 82-year simulation period, approximately 20,425 TAF (249 TAF per year) in Sites reductions to Delta surplus occurred when surplus was available, while 846 TAF (10 TAF per year) occurred when there was no Delta surplus (i.e., Sites reduced Delta inflow and the Delta was in a balanced condition). For purposes of this analysis, Sites yield is reduced by 4% due to differences with the WSIP Baseline. For LVE, 5,914 TAF (72 TAF per year) in LVE reductions to Delta surplus occurred when surplus was available, while 662 TAF (7.6 TAF per year) occurred when there was no Delta surplus (i.e., LVE reduced Delta surplus and the Delta was in a balanced condition). For purposes of this analysis, LVE yield is reduced by 10% due to differences with the WSIP Baseline.

Table 15. Monthly average Delta condition and feasibility of Delta surplus reductions

	WSIP Baseline	Delta surplus available and cumulatively reduced by project		Delta surplus not available to be reduced[1]	
		Sites Adjustments			
Type of Delta Control	# of months	# of months	Total Volume (AF)	# of months	Total Volume (AF)
EI ratio cap export control	59	0	0	8	179,932
OMR control	273	171	13,455,687	14	130,776
D-1641 Outflow control	259	0	0	42	392,828
D-1641 Salinity control	111	0	0	20	136,695
D-1641 April-May export cap control	11	7	1,093,762	0	0
SWP ITP control	109	39	280,994	1	3,222
Surplus	162	68	5,594,867	2	3,373
TOTAL	**984**	**285**	**20,425,310**	**87**	**846,826**
		LVE Adjustments			
Type of Delta Control	# of months	# of months	Total Volume (AF)	# of months	Total Volume (AF)
EI ratio cap export control	59	0	0	26	219,316
OMR control	273	208	3,720,157	3	37,249
D-1641 Outflow control	259	0	0	26	147,803
D-1641 Salinity control	111	0	0	39	210,700
D-1641 April-May export cap control	11	6	21,723	0	0
SWP ITP control	148	45	204,201	1	664
Surplus	123	86	1,968,165	2	6,939
TOTAL	**984**	**345**	**5,914,246**	**97**	**622,672**

[1] For this analysis, Delta surplus not available to be reduced reflects a balanced Delta condition in the WSIP Baseline. The Sites or LVE reduction in Delta surplus during these conditions is considered an 'infeasible' operation that would have required cuts to Banks exports to implement. This column thus reflects a reduction to the project yield due to conflicts with the WSIP Baseline – these surplus reductions were not implemented in the model.

3.1.3 Delta Inflow from Sacramento River

The long-term monthly average cumulative effects of the three surface water diversion projects on Delta Inflow from Sacramento River is shown in Figure 7 and Table 16. Mean annual reductions in Delta Inflow from Sacramento River throughout the simulation period are 45 TAF, or 0.3% of the total 15,478 TAF of mean annual Delta Inflow from Sacramento River. The long-term monthly average cumulative effects of the three surface water diversion WSIP projects on Delta Inflow from the Sacramento River by water year type are shown in Figure 8 and in Tables 17 through 21.

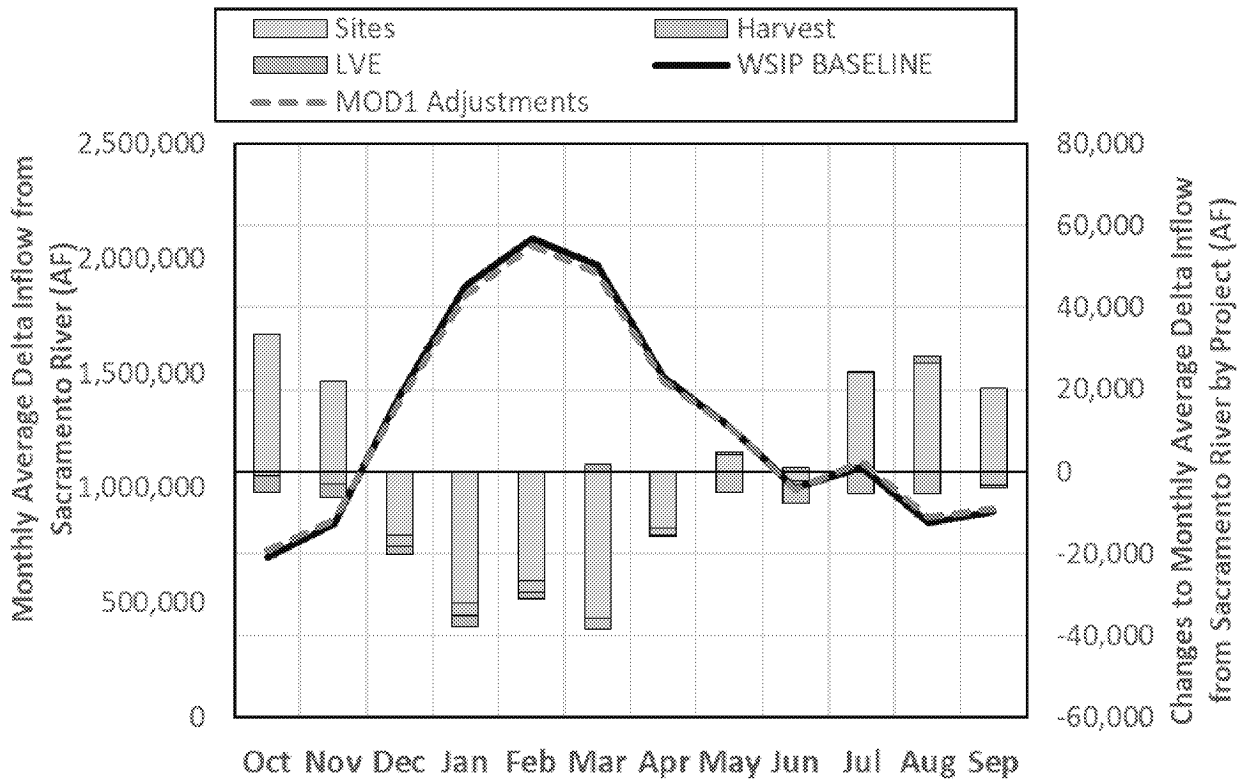


Figure 7. Monthly Average Delta Inflow from Sacramento River for WSIP Baseline and MOD1 Adjustments and Changes to Monthly Average Delta Inflow from Sacramento River by Project (in acre-feet)

Table 16. Monthly Average Delta Inflow from Sacramento River and Changes to Monthly Average Delta Inflow from Sacramento River, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	699	846	1,397	1,880	2,089	1,975	1,482	1,266	1,002	1,094	851	896	15,478
MOD 1 Adjustment	728	861	1,377	1,842	2,058	1,938	1,466	1,266	996	1,113	874	913	15,432
MOD 1 Adjustment by Sites	33	22	-15	-32	-26	-36	-14	4	-2	24	26	20	5
MOD 1 Adjustment by Harvest	-1	-3	-3	-3	-3	-3	-2	-5	-5	-5	-5	-3	-41
MOD 1 Adjustment by LVE	-4	-4	-2	-3	-2	2	0	1	1	0	2	-1	-9
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	28	15	-20	-38	-31	-37	-16	0	-6	19	23	16	-45
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	4%	2%	-1%	-2%	-1%	-2%	-1%	0%	-1%	2%	3%	2%	0%

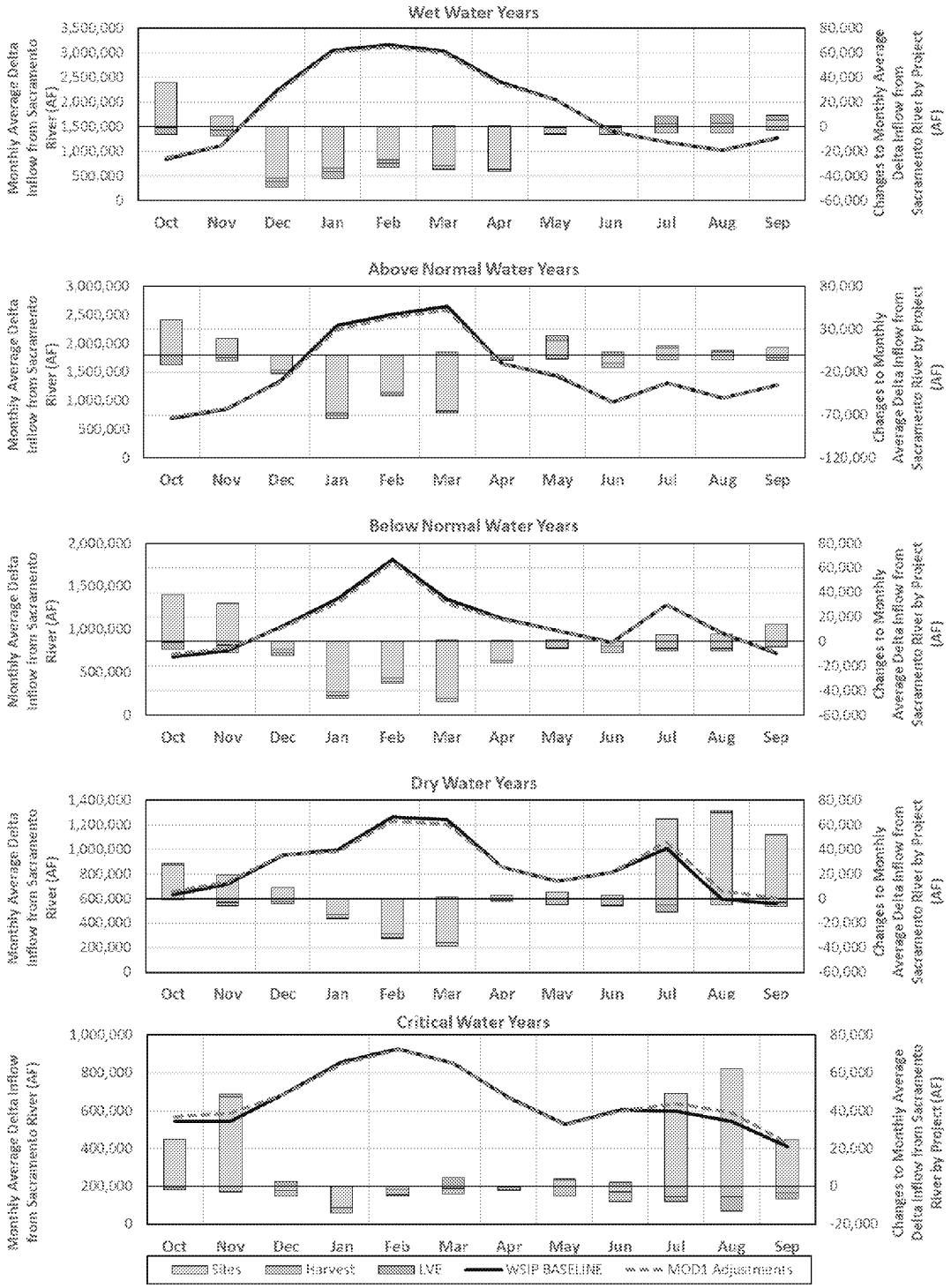


Figure 8. Monthly Average Delta Inflow from Sacramento River for WSIP Baseline and MOD1 Adjustments, and by Project (in acre-feet), by Water Year Type

Table 17. Monthly Average Delta Inflow from Sacramento River and Changes to Monthly Average Delta Inflow from Sacramento River, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Wet Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	836	1,117	2,238	3,045	3,153	3,028	2,405	2,047	1,409	1,179	1,021	1,274	22,751
MOD 1 Adjustment	865	1,119	2,189	3,002	3,120	2,993	2,369	2,040	1,403	1,182	1,025	1,279	22,586
MOD 1 Adjustment by Sites	36	9	-42	-34	-27	-32	-35	-1	-1	2	2	5	-118
MOD 1 Adjustment by Harvest	-1	-3	-3	-3	-3	-3	-2	-5	-5	-5	-5	-3	-41
MOD 1 Adjustment by LVE	-6	-5	-4	-6	-3	0	0	0	1	6	7	4	-6
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	29	1	-49	-43	-33	-35	-37	-6	-5	3	4	6	-165
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	3%	0%	-2%	-1%	-1%	-1%	-2%	0%	0%	0%	0%	0%	-1%

Table 18. Monthly Average Delta Inflow from Sacramento River and Changes to Monthly Average Delta Inflow from Sacramento River, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Above Normal Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	687	856	1,357	2,311	2,508	2,643	1,639	1,432	981	1,311	1,047	1,274	18,046
MOD 1 Adjustment	716	868	1,335	2,237	2,461	2,578	1,633	1,449	969	1,316	1,047	1,277	17,887
MOD 1 Adjustment by Sites	41	19	-17	-67	-43	-65	-4	17	-10	8	3	8	-110
MOD 1 Adjustment by Harvest	-1	-3	-3	-3	-3	-3	-2	-5	-5	-5	-5	-3	-41
MOD 1 Adjustment by LVE	-11	-4	-2	-4	-2	3	0	6	3	2	3	-3	-8
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	29	12	-22	-74	-48	-65	-6	18	-12	5	1	2	-159
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	4%	1%	-2%	-3%	-2%	-2%	0%	1%	-1%	0%	0%	0%	-1%

Table 19. Monthly Average Delta Inflow from Sacramento River and Changes to Monthly Average Delta Inflow from Sacramento River, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Below Normal Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	680	753	1,037	1,358	1,810	1,353	1,130	988	847	1,290	957	725	12,928
MOD 1 Adjustment	712	775	1,026	1,311	1,776	1,306	1,113	985	839	1,287	955	735	12,822
MOD 1 Adjustment by Sites	38	31	-6	-41	-30	-46	-16	1	-4	5	6	15	-46
MOD 1 Adjustment by Harvest	-1	-3	-3	-3	-3	-3	-2	-5	-5	-5	-5	-3	-41
MOD 1 Adjustment by LVE	-5	-6	-2	-3	-2	2	1	0	1	-2	-2	-1	-20
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	32	22	-11	-47	-35	-47	-17	-4	-8	-2	-1	11	-107
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	5%	3%	-1%	-3%	-2%	-3%	-2%	0%	-1%	0%	0%	2%	-1%

Table 20. Monthly Average Delta Inflow from Sacramento River and Changes to Monthly Average Delta Inflow from Sacramento River, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Dry Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	629	721	955	998	1,264	1,243	858	738	815	1,005	597	558	10,380
MOD 1 Adjustment	657	734	959	982	1,231	1,205	858	738	812	1,059	663	604	10,501
MOD 1 Adjustment by Sites	27	19	9	-13	-29	-36	3	5	2	64	70	52	173
MOD 1 Adjustment by Harvest	-1	-3	-3	-3	-3	-3	-2	-5	-5	-5	-5	-3	-41
MOD 1 Adjustment by LVE	2	-3	-2	0	0	1	-1	0	-1	-5	2	-3	-11
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	28	13	4	-16	-32	-38	0	0	-4	54	67	46	121
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	4%	2%	0%	-2%	-3%	-3%	0%	0%	0%	5%	11%	8%	1%

Table 21. Monthly Average Delta Inflow from Sacramento River and Changes to Monthly Average Delta Inflow from Sacramento River, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Critical Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	544	542	696	859	927	851	670	528	605	598	542	409	7,770
MOD 1 Adjustment	567	588	693	846	922	852	668	526	599	639	591	427	7,917
MOD 1 Adjustment by Sites	25	47	-2	-11	-2	-1	0	3	-3	49	62	24	191
MOD 1 Adjustment by Harvest	-1	-3	-3	-3	-3	-3	-2	-5	-5	-5	-5	-3	-41
MOD 1 Adjustment by LVE	-1	2	2	0	-1	5	0	1	2	-3	-8	-3	-4
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	23	46	-3	-14	-6	1	-2	-1	-6	41	49	18	146
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	4%	8%	0%	-2%	-1%	0%	0%	0%	-1%	7%	9%	4%	2%

3.1.4 Delta Inflow from Yolo Bypass

The Sites project provides environmental flows into the Yolo Bypass as part of its provision of public benefits. These are shown below as summer increases in flow in the Yolo Bypass. Sites also diverts water to storage in excess conditions that can reduce spills from the Sacramento River into the Yolo Bypass. That is shown as a decrease in Delta inflow from Yolo Bypass below. The long-term monthly average cumulative effects of the three surface water diversion projects on Delta Inflow from Yolo Bypass is shown in Figure 9 and Table 22. Mean annual reductions in Delta Inflow from Yolo Bypass throughout the simulation period are 56 TAF, or 2.3% of the total 2,428 TAF of mean annual Delta Inflow from Yolo Bypass. The long-term monthly average cumulative effects of the three surface water diversion WSIP projects on Delta Inflow from the Yolo Bypass by water year type are shown in Figure 10 and in Tables 23 through 27.

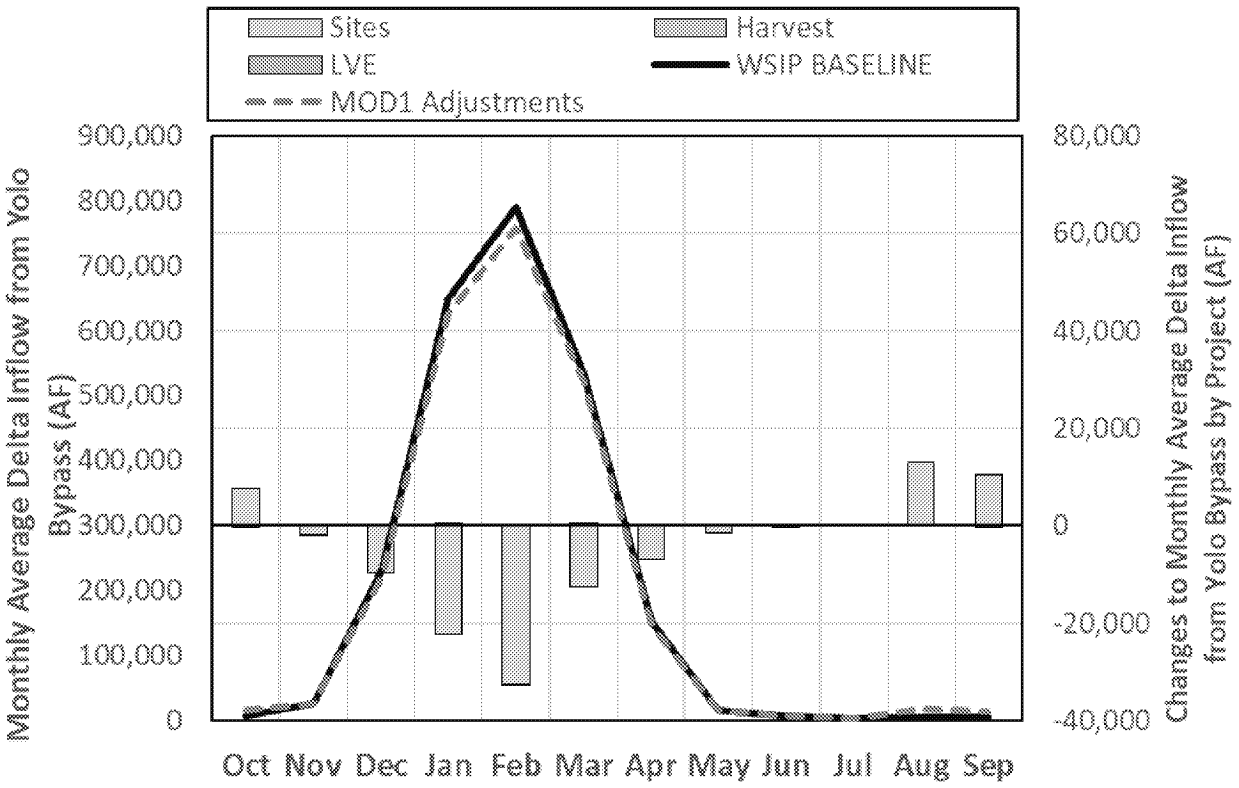


Figure 9. Monthly Average Delta Inflow from Yolo Bypass for WSIP Baseline and MOD1 Adjustments, by Project (in acre-feet)

Table 22. Monthly Average Delta Inflow from Yolo Bypass and Changes to Monthly Average Delta Inflow from Yolo Bypass, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	7	28	231	649	790	534	152	17	7	3	6	4	2,428
MOD 1 Adjustment	15	26	221	627	758	521	145	15	7	3	19	15	2,373
MOD 1 Adjustment by Sites	8	-2	-10	-22	-33	-13	-7	-1	0	0	13	10	-56
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	0	0	0	0	0	0	0	0	0	0	0	0	1
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	8	-2	-10	-22	-33	-13	-7	-1	0	0	13	10	-55
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	114%	-7%	-4%	-3%	-4%	-2%	-5%	-6%	0%	0%	217%	250%	-2%

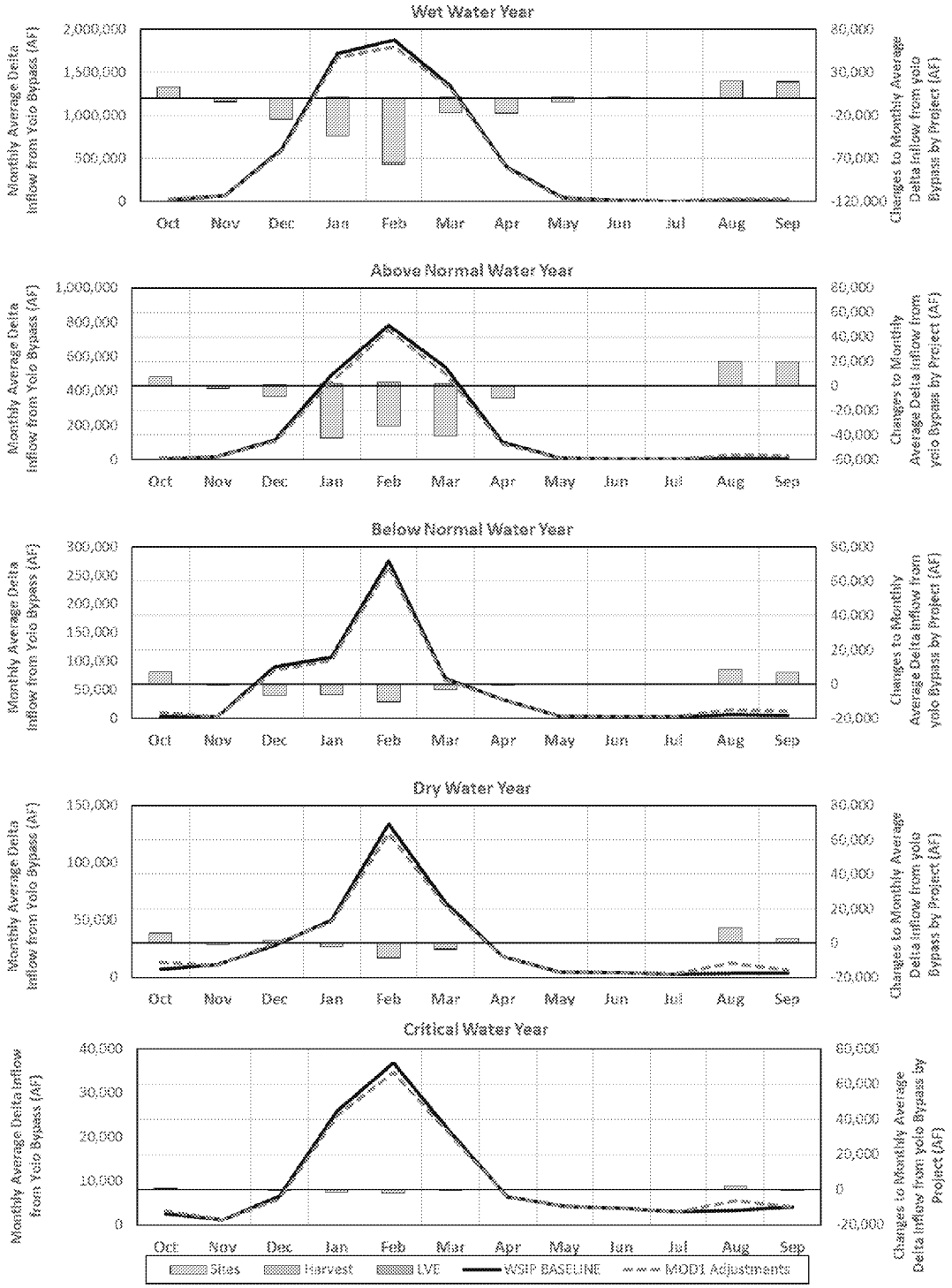


Figure 10. Monthly Average Delta Inflow from Yolo Bypass for WSIP Baseline and MOD1 Adjustments, and by Individual Project (in acre-feet), by Water Year Type

Table 23. Monthly Average Delta Inflow from Yolo Bypass and Changes to Monthly Average Delta Inflow from Yolo Bypass, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Wet Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	15	68	604	1,714	1,873	1,341	400	39	14	3	9	4	6,084
MOD 1 Adjustment	27	64	579	1,669	1,796	1,324	383	35	14	3	29	23	5,946
MOD 1 Adjustment by Sites	13	-4	-24	-45	-75	-17	-17	-4	0	0	20	18	-136
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	0	0	0	0	-2	0	0	0	0	0	0	0	-2
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	13	-4	-24	-45	-77	-17	-17	-4	0	0	20	18	-138
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	87%	-6%	-4%	-3%	-4%	-1%	-4%	-10%	0%	0%	222%	450%	-2%

Table 24. Monthly Average Delta Inflow from Yolo Bypass and Changes to Monthly Average Delta Inflow from Yolo Bypass, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Above Normal Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	2	20	114	493	782	539	101	12	4	3	6	4	2,081
MOD 1 Adjustment	10	19	107	453	753	501	91	12	4	3	26	23	2,002
MOD 1 Adjustment by Sites	8	-2	-8	-43	-32	-40	-10	0	0	0	20	19	-88
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	0	0	1	2	3	2	0	0	0	0	0	0	9
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	8	-2	-7	-41	-29	-38	-10	0	0	0	20	19	-79
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	400%	-10%	-6%	-8%	-4%	-7%	-10%	0%	0%	0%	333%	475%	-4%

Table 25. Monthly Average Delta Inflow from Yolo Bypass and Changes to Monthly Average Delta Inflow from Yolo Bypass, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Below Normal Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	3	3	91	108	276	71	33	4	4	3	7	6	608
MOD 1 Adjustment	10	3	84	101	265	67	33	4	4	3	16	13	604
MOD 1 Adjustment by Sites	7	0	-7	-6	-10	-3	0	0	0	0	9	7	-4
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	7	0	-7	-6	-10	-3	0	0	0	0	9	7	-4
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	233%	0%	-8%	-6%	-4%	-4%	0%	0%	0%	0%	129%	117%	-1%

Table 26. Monthly Average Delta Inflow from Yolo Bypass and Changes to Monthly Average Delta Inflow from Yolo Bypass, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Dry Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	7	11	28	50	134	66	18	5	4	3	4	4	334
MOD 1 Adjustment	13	11	30	48	126	62	18	5	4	3	13	7	339
MOD 1 Adjustment by Sites	6	-1	2	-2	-9	-3	0	0	0	0	9	3	5
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	6	-1	2	-2	-9	-3	0	0	0	0	9	3	5
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	86%	-9%	7%	-4%	-7%	-5%	0%	0%	0%	0%	225%	75%	1%

Table 27. Monthly Average Delta Inflow from Yolo Bypass and Changes to Monthly Average Delta Inflow from Yolo Bypass, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Critical Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	3	1	7	26	37	21	6	4	4	3	3	4	119
MOD 1 Adjustment	3	1	6	25	35	20	6	4	4	3	6	4	117
MOD 1 Adjustment by Sites	1	0	-1	-1	-2	-1	0	0	0	0	2	0	-2
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	1	0	-1	-1	-2	-1	0	0	0	0	2	0	-2
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	33%	0%	-14%	-4%	-5%	-5%	0%	0%	0%	0%	67%	0%	-2%

3.1.5 Feather River Flow

The Sites operations includes an exchange with the SWP at Oroville for delivery management. In primarily June and July of drier years, Sites releases additional water from storage to meet part of the outflow requirements of the SWP/CVP. In August and later, Oroville releases are commensurately increased and exported during the transfer window. The long-term monthly average cumulative effects of the three surface water diversion on Feather River flow from Thermalito Junction (CalSim II node C203) are shown in Figure 11 and Table 28. Mean annual decrease in Feather River flow throughout the simulation period are less than 1 cfs, or less than 0.1% of the 3,984 cfs of mean annual Feather River flow. The long-term monthly average cumulative effects of the three surface water diversion WSIP projects on Feather River flow from Thermalito Junction (CalSim II node C203) by water year type are shown in Figure 12 and in Tables 29 through 33.

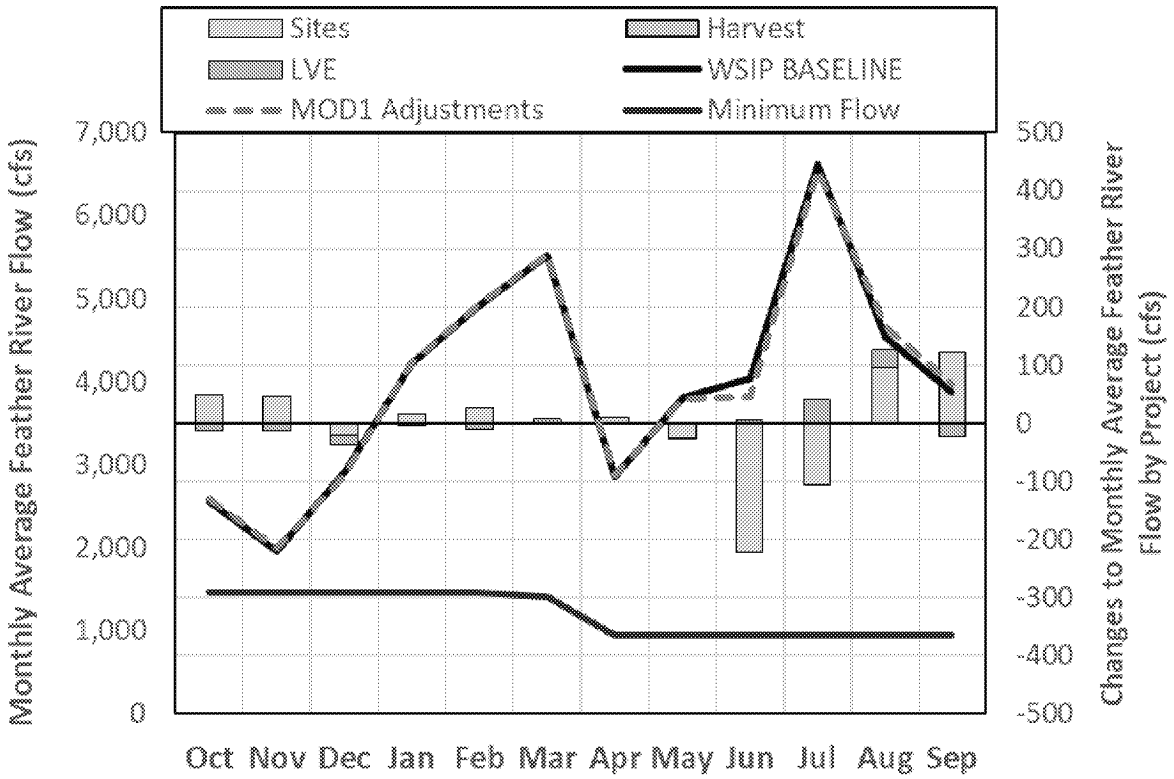


Figure 11. Monthly Average Feather River Flow from Thermalito Junction (C203) for WSIP Baseline and MOD1 Adjustments and Changes to Monthly Average Feather River Flow by Project (in acre-feet)

Table 28. Monthly Average Feather River Flow from Thermalito Junction (C203), Changes to Monthly Average Feather River Flow, WSIP Baseline and MOD1 Adjustments (in cfs)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	2,549	1,961	2,907	4,219	4,915	5,521	2,858	3,810	4,043	6,613	4,537	3,875	3,984
MOD 1 Adjustment	2,584	1,992	2,870	4,230	4,930	5,530	2,867	3,784	3,826	6,550	4,665	3,977	3,984
MOD 1 Adjustment by Sites	49	45	-22	16	26	1	11	-25	-222	-105	95	123	-1
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	-14	-13	-15	-4	-12	8	-2	0	5	42	33	-22	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	35	32	-37	12	14	9	9	-25	-217	-63	128	101	-1
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	1%	2%	-1%	0%	0%	0%	0%	-1%	-5%	-1%	3%	3%	0%
Minimum Flow Requirement	1,461	1,461	1,461	1,461	1,461	1,401	945	945	945	945	945	945	1,198

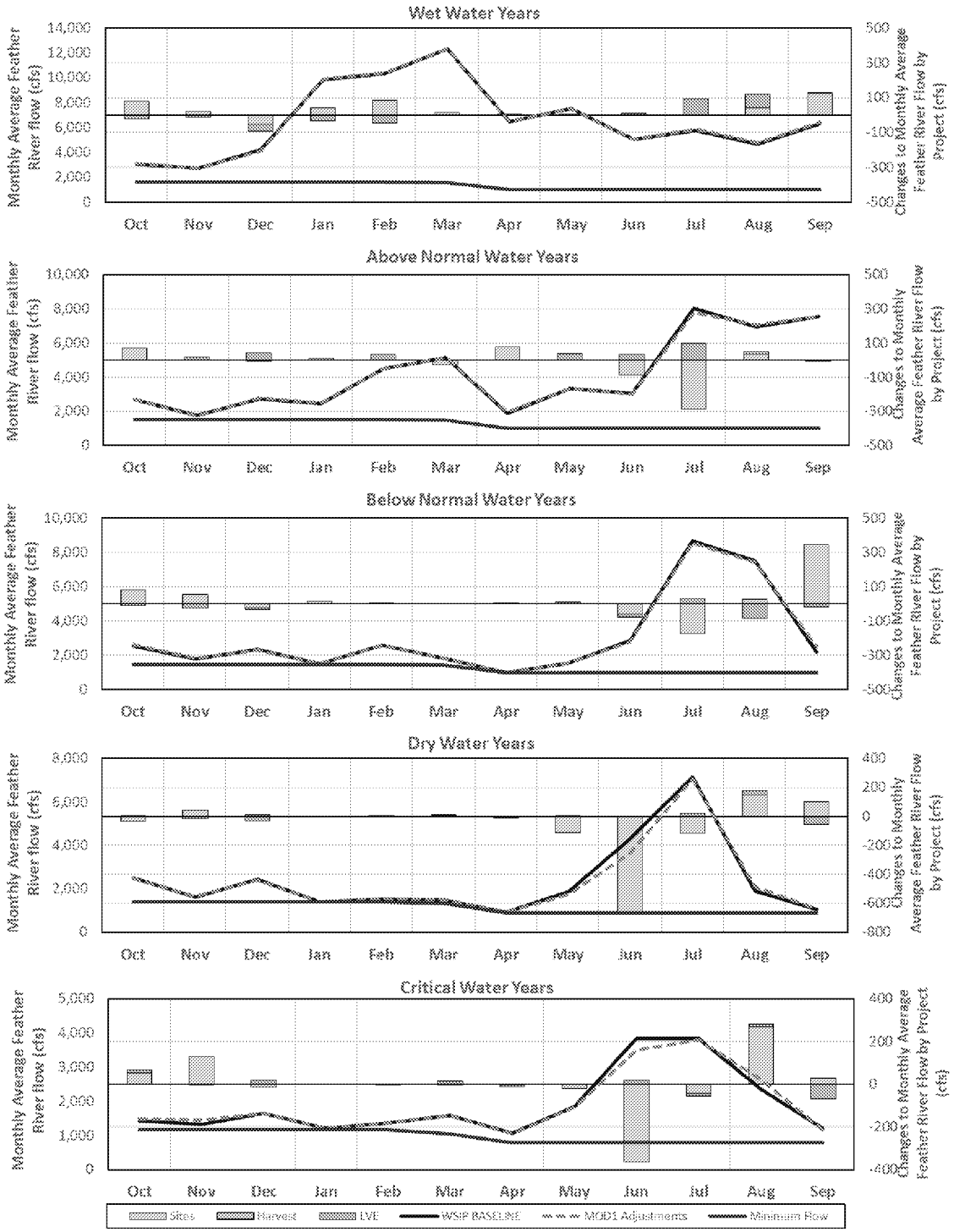


Figure 12. Monthly Average Feather River Flow from Thermalito Junction (C203) for WSIP Baseline and MOD1 Adjustments, and by Individual Project, by Water Year Type (in cubic feet per second)

Table 29. Monthly Average Feather River Flow from Thermalito Junction (C203), Changes to Monthly Average Feather River Flow, WSIP Baseline and MOD1 Adjustments, Wet Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,042	2,693	4,195	9,862	10,347	12,325	6,486	7,521	5,052	5,752	4,661	6,297	6,519
MOD 1 Adjustment	3,100	2,700	4,103	9,870	10,385	12,341	6,489	7,523	5,058	5,843	4,781	6,426	6,552
MOD 1 Adjustment by Sites	80	22	-54	43	83	15	3	3	-3	-3	42	124	30
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	-21	-14	-38	-34	-44	0	0	-1	9	94	78	5	3
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	59	8	-92	9	39	15	3	2	6	91	120	129	33
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	2%	0%	-2%	0%	0%	0%	0%	0%	0%	2%	3%	2%	1%
Minimum Flow Requirement	1,612	1,612	1,612	1,612	1,612	1,583	1,000	1,000	1,000	1,000	1,000	1,000	1,303

Table 30. Monthly Average Feather River Flow from Thermalito Junction (C203), Changes to Monthly Average Feather River Flow, WSIP Baseline and MOD1 Adjustments, Above Normal Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	2,682	1,746	2,742	2,444	4,489	5,126	1,871	3,335	3,062	8,034	6,947	7,540	4,168
MOD 1 Adjustment	2,694	1,745	2,756	2,487	4,500	5,132	1,950	3,334	3,012	7,783	7,082	7,549	4,169
MOD 1 Adjustment by Sites	70	0	-4	0	3	-27	79	-1	-87	-286	36	-6	-19
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	-57	-1	19	44	8	33	0	0	38	35	99	14	19
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	13	-1	15	44	11	6	79	-1	-49	-251	135	8	0
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0%	0%	1%	2%	0%	0%	4%	0%	-2%	-3%	2%	0%	0%
Minimum Flow Requirement	1,525	1,525	1,525	1,525	1,525	1,483	1,000	1,000	1,000	1,000	1,000	1,000	1,259

Table 31. Monthly Average Feather River Flow from Thermalito Junction (C203), Changes to Monthly Average Feather River Flow, WSIP Baseline and MOD1 Adjustments, Below Normal Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	2,543	1,778	2,347	1,480	2,579	1,798	982	1,520	2,853	8,674	7,494	2,168	3,018
MOD 1 Adjustment	2,615	1,805	2,313	1,492	2,579	1,798	982	1,531	2,775	8,529	7,435	2,495	3,029
MOD 1 Adjustment by Sites	81	53	-23	12	0	0	0	11	-62	-176	25	344	22
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	-9	-26	-11	0	0	0	0	-1	-16	30	-85	-17	-11
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	72	27	-34	12	0	0	0	10	-78	-146	-60	327	11
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	3%	2%	-1%	1%	0%	0%	0%	1%	-3%	-2%	-1%	15%	0%
Minimum Flow Requirement	1,457	1,457	1,457	1,457	1,457	1,396	982	982	982	982	982	982	1,215

Table 32. Monthly Average Feather River Flow from Thermalito Junction (C203), Changes to Monthly Average Feather River Flow, WSIP Baseline and MOD1 Adjustments, Dry Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	2,500	1,617	2,431	1,397	1,534	1,479	938	1,855	4,297	7,148	1,904	1,047	2,346
MOD 1 Adjustment	2,466	1,645	2,411	1,397	1,537	1,486	930	1,743	3,625	7,049	2,082	1,090	2,288
MOD 1 Adjustment by Sites	-37	45	11	0	-1	5	-6	-113	-659	-119	149	99	-52
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	2	-17	-31	0	4	2	-2	0	-13	19	29	-56	-5
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-35	28	-20	0	3	7	-8	-113	-672	-100	178	43	-57
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-1%	2%	-1%	0%	0%	0%	-1%	-6%	-16%	-1%	9%	4%	-2%
Minimum Flow Requirement	1,394	1,394	1,394	1,394	1,394	1,319	903	903	903	903	903	903	1,142

Table 33. Monthly Average Feather River Flow from Thermalito Junction (C203), Changes to Monthly Average Feather River Flow, WSIP Baseline and MOD1 Adjustments, Critical Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	1,429	1,317	1,648	1,196	1,370	1,581	1,056	1,846	3,846	3,847	2,360	1,197	1,891
MOD 1 Adjustment	1,496	1,442	1,652	1,196	1,370	1,591	1,044	1,824	3,500	3,790	2,641	1,156	1,892
MOD 1 Adjustment by Sites	53	129	-15	0	0	-6	-3	-22	-363	-43	268	29	2
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	14	-5	18	0	0	16	-9	0	17	-15	13	-70	-2
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	67	124	3	0	0	10	-12	-22	-346	-58	281	-41	0
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	5%	9%	0%	0%	0%	1%	-1%	-1%	-9%	-2%	12%	-3%	0%
Minimum Flow Requirement	1,175	1,175	1,175	1,175	1,175	1,050	792	792	792	792	792	792	973

The long-term monthly average cumulative effects of the three surface water diversion projects on Feather River flow at Sacramento River Junction (CalSim II node C223) is shown in Figure 13 and Table 34. Mean annual decrease in Feather River flow throughout the simulation period are 1 cfs, or less than 0.1% of the total 7,418 cfs of mean annual Feather River flow. The long-term monthly average cumulative effects of the three surface water diversion WSIP projects on Feather River flow at Sacramento River Junction (C223) by water year type are shown in Figure 14 and in Tables 35 through 39.

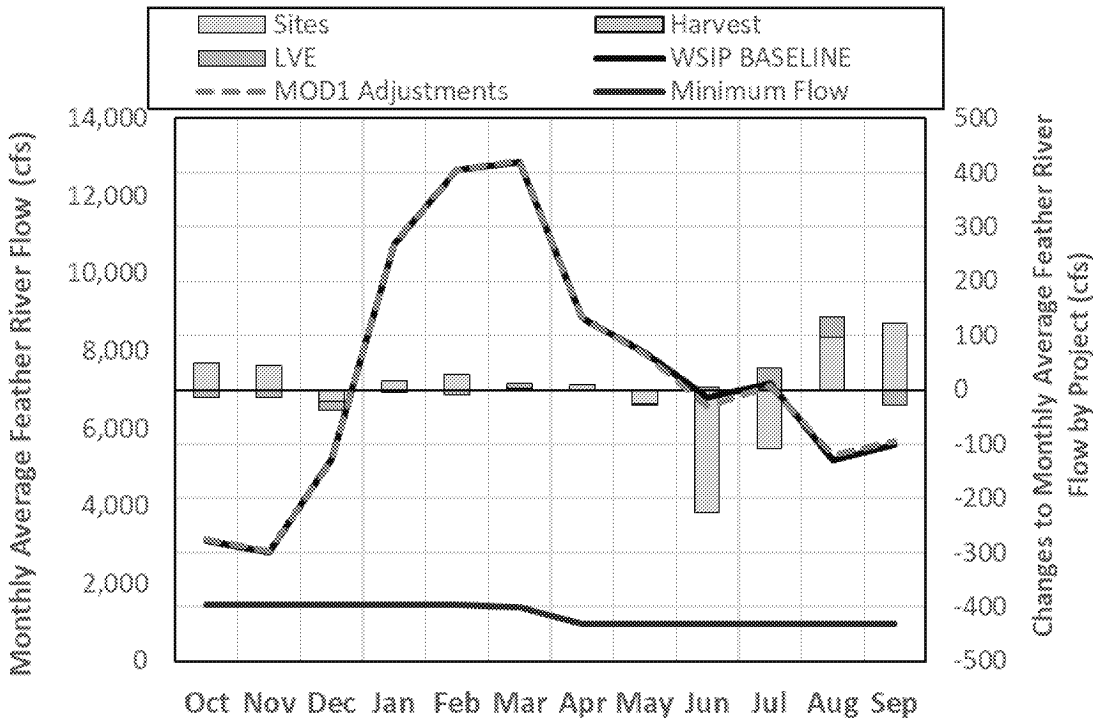


Figure 13. Monthly Average Feather River Flow at Sacramento River Junction (C223) for WSIP Baseline and MOD1 Adjustments and Changes to Monthly Average Feather River Flow by Project (in acre-feet)

Table 34. Monthly Average Feather River Flow at Sacramento River Junction (C223), Changes to Monthly Average Feather River Flow, WSIP Baseline and MOD1 Adjustments (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,101	2,819	5,219	10,767	12,671	12,886	8,852	7,956	6,798	7,180	5,178	5,592	7,418
MOD 1 Adjustment	3,135	2,850	5,182	10,781	12,688	12,897	8,861	7,929	6,577	7,112	5,311	5,688	7,417
MOD 1 Adjustment by Sites	48	45	-21	17	28	3	10	-27	-227	-109	96	123	-1
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	-14	-13	-15	-4	-11	9	-1	0	5	41	37	-28	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	34	32	-36	13	17	12	9	-27	-222	-68	133	95	-1
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	1%	1%	-1%	0%	0%	0%	0%	0%	-3%	-1%	3%	2%	0%
Minimum Flow Requirement	1,461	1,459	1,461	1,461	1,461	1,401	945	945	945	945	945	945	1,198

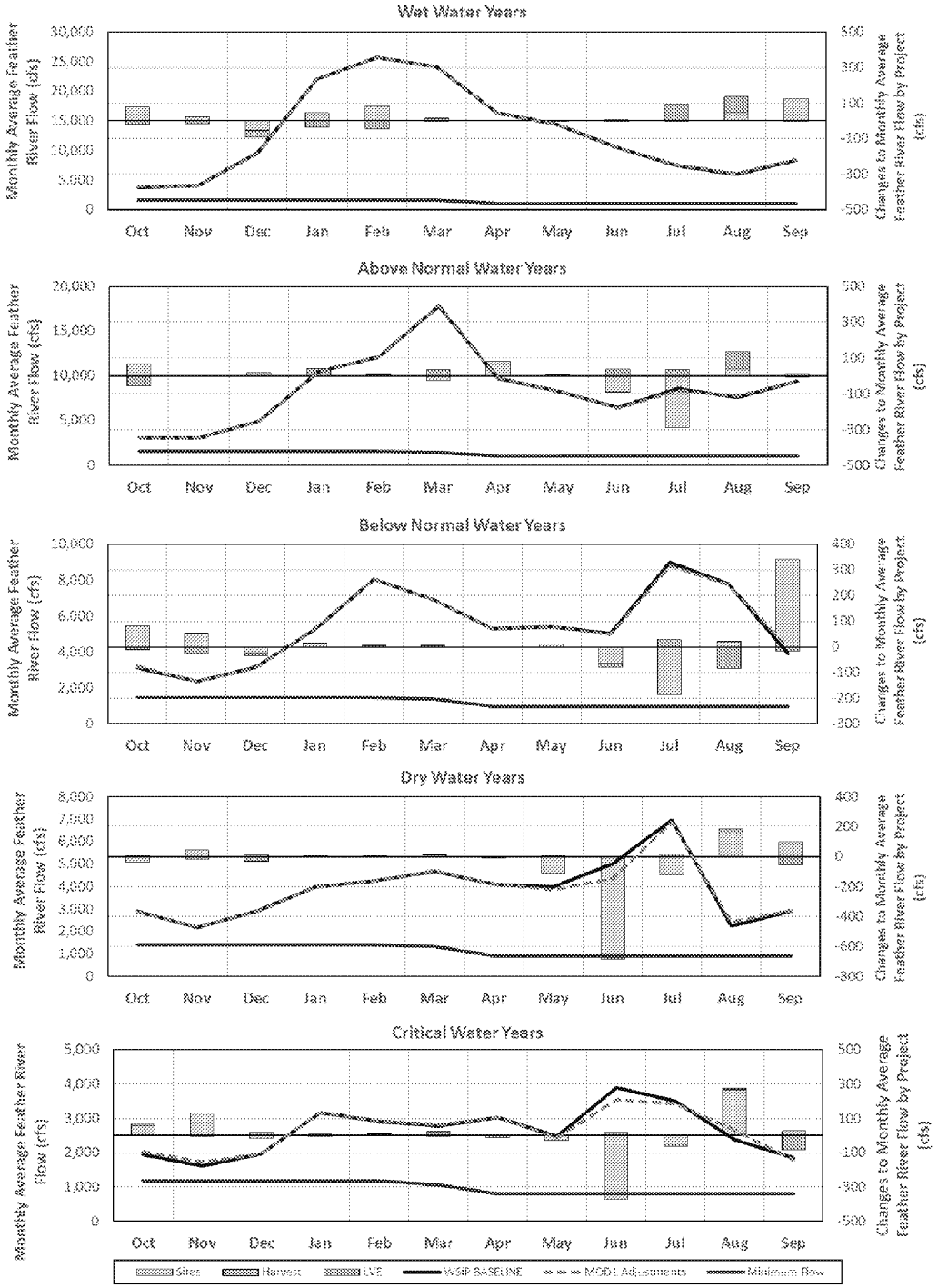


Figure 14. Monthly Average Feather River Flow at Sacramento River Junction (C223) for WSIP Baseline and MOD1 Adjustments, and by Individual Project, by Water Year Type (in cubic feet per second)

Table 35. Monthly Average Feather River Flow at Sacramento River Junction (C223), Changes to Monthly Average Feather River Flow, WSIP Baseline and MOD1 Adjustments, Wet Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,798	3,993	9,571	22,085	25,734	24,148	16,345	14,467	10,476	7,416	5,988	8,326	12,695
MOD 1 Adjustment	3,856	4,000	9,479	22,095	25,772	24,163	16,346	14,467	10,481	7,506	6,123	8,446	12,728
MOD 1 Adjustment by Sites	80	22	-54	43	83	15	0	0	-3	-4	46	127	30
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	-21	-14	-38	-34	-44	0	1	0	9	93	89	-6	3
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	59	8	-92	9	39	15	1	0	6	89	135	121	33
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	2%	0%	-1%	0%	0%	0%	0%	0%	0%	1%	2%	1%	0%
Minimum Flow Requirement	1,612	1,605	1,612	1,612	1,612	1,583	1,000	1,000	1,000	1,000	1,000	1,000	1,303

Table 36. Monthly Average Feather River Flow at Sacramento River Junction (C223), Changes to Monthly Average Feather River Flow, WSIP Baseline and MOD1 Adjustments, Above Normal Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,012	3,027	4,943	10,443	12,148	17,846	9,694	8,293	6,462	8,582	7,600	9,418	8,456
MOD 1 Adjustment	3,024	3,026	4,957	10,487	12,159	17,853	9,774	8,292	6,413	8,326	7,737	9,424	8,456
MOD 1 Adjustment by Sites	69	0	-4	0	3	-26	80	-1	-89	-291	39	-6	-19
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	-57	-1	18	43	8	33	0	0	39	35	99	13	19
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	12	-1	14	43	11	7	80	-1	-50	-256	138	7	0
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0%	0%	0%	0%	0%	0%	1%	0%	-1%	-3%	2%	0%	0%
Minimum Flow Requirement	1,525	1,525	1,525	1,525	1,525	1,483	1,000	1,000	1,000	1,000	1,000	1,000	1,259

Table 37. Monthly Average Feather River Flow at Sacramento River Junction (C223), Changes to Monthly Average Feather River Flow, WSIP Baseline and MOD1 Adjustments, Below Normal Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,132	2,350	3,150	5,271	8,049	6,927	5,314	5,400	5,047	8,972	7,797	3,924	5,444
MOD 1 Adjustment	3,203	2,377	3,117	5,286	8,055	6,930	5,314	5,410	4,968	8,815	7,735	4,251	5,455
MOD 1 Adjustment by Sites	81	53	-22	12	0	0	0	11	-64	-186	22	343	21
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	-9	-26	-11	3	6	4	0	-1	-16	29	-85	-16	-10
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	72	27	-33	15	6	4	0	10	-80	-157	-63	327	11
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	2%	1%	-1%	0%	0%	0%	0%	0%	-2%	-2%	-1%	8%	0%
Minimum Flow Requirement	1,457	1,457	1,457	1,457	1,457	1,396	982	982	982	982	982	982	1,215

Table 38. Monthly Average Feather River Flow at Sacramento River Junction (C223), Changes to Monthly Average Feather River Flow, WSIP Baseline and MOD1 Adjustments, Dry Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	2,899	2,162	2,895	3,977	4,252	4,684	4,099	3,972	5,014	6,969	2,221	2,894	3,837
MOD 1 Adjustment	2,863	2,191	2,875	3,980	4,258	4,693	4,092	3,860	4,329	6,867	2,408	2,933	3,779
MOD 1 Adjustment by Sites	-38	46	11	2	2	8	-6	-112	-671	-121	149	98	-53
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	3	-17	-30	0	4	2	-2	0	-13	19	37	-59	-5
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-35	29	-19	2	6	10	-8	-112	-684	-102	186	39	-58
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-1%	1%	-1%	0%	0%	0%	0%	-3%	-14%	-1%	8%	1%	-2%
Minimum Flow Requirement	1,394	1,394	1,394	1,394	1,394	1,319	903	903	903	903	903	903	1,142

Table 39. Monthly Average Feather River Flow at Sacramento River Junction (C223), Changes to Monthly Average Feather River Flow, WSIP Baseline and MOD1 Adjustments, Critical Water Years (in cfs)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	1,946	1,597	1,964	3,167	2,911	2,779	3,032	2,467	3,887	3,491	2,378	1,838	2,621
MOD 1 Adjustment	2,011	1,721	1,967	3,173	2,918	2,800	3,020	2,440	3,532	3,425	2,654	1,782	2,620
MOD 1 Adjustment by Sites	52	129	-15	7	5	-1	-3	-27	-372	-45	268	28	2
MOD 1 Adjustment by Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD 1 Adjustment by LVE	13	-5	18	-1	2	22	-9	1	17	-21	7	-83	-3
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	65	124	3	6	7	21	-12	-26	-355	-66	275	-55	-1
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	3%	8%	0%	0%	0%	1%	0%	-1%	-9%	-2%	12%	-3%	0%
Minimum Flow Requirement	1,175	1,175	1,175	1,175	1,175	1,050	792	792	792	792	792	792	973

3.1.6 Delta Outflow

The long-term monthly average cumulative effects of the three surface water diversion WSIP projects on Delta outflow is shown in Figure 15 and Table 40. In general, diversions to Sites in winter months (January through March) result in reduced Delta inflow, and subsequently, reduced Delta outflow. In summer months, Sites releases to the Sacramento River and Yolo bypass increase Delta inflow but correlating increases in Delta exports generally results in relatively small increases to Delta outflow. Harvest adjustments to Delta inflow generally results in minor reductions to Delta outflow. LVE use of Delta surplus occurs in wet winter months (January through March). Mean annual reductions in Delta outflow throughout the simulation period are 317 TAF, or 2% of the total 15,539 TAF of mean annual Delta outflow. The long-term monthly average cumulative effects of the three surface water diversion WSIP projects on Delta outflow by water year type is shown in Figure 16 and in Tables 41 through 45.

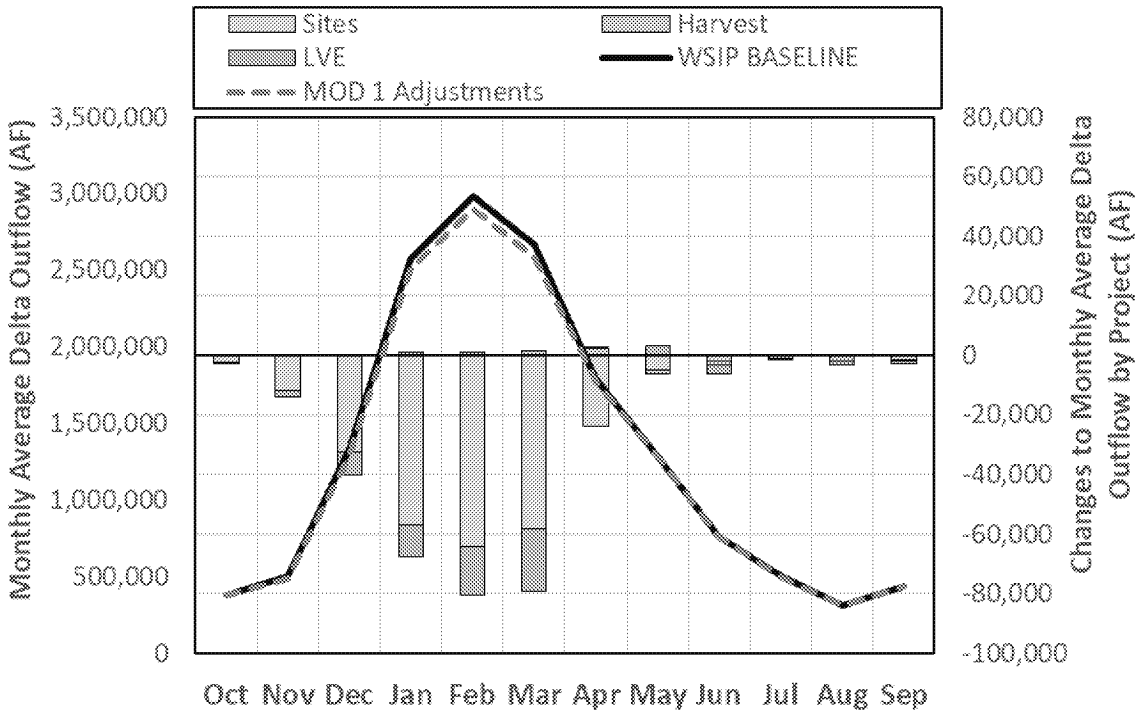


Figure 15. Monthly Average Delta Outflow for WSIP Baseline and MOD1 Adjustments and Changes to Monthly Average Delta Outflow by Project (in acre-feet))

Table 40. Monthly Average Delta Outflow and Changes to Monthly Average Delta Outflow, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	380	501	1,331	2,576	2,983	2,664	1,794	1,292	766	501	315	436	15,539
MOD1 Adjustment	378	487	1,292	2,509	2,903	2,587	1,773	1,289	759	500	312	434	15,222
MOD1 Adjustment by Sites	-2	-12	-32	-57	-64	-58	-24	-5	-2	0	0	-2	-258
MOD1 Adjustment by Harvest	0	0	0	1	1	2	2	-1	-1	-1	-2	0	1
MOD1 Adjustment by LVE	0	-2	-8	-11	-16	-21	0	3	-3	0	-1	-1	-60
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-2	-14	-40	-67	-79	-77	-22	-3	-6	-1	-3	-3	-317
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-1%	-3%	-3%	-3%	-3%	-3%	-1%	0%	-1%	0%	-1%	-1%	-2%

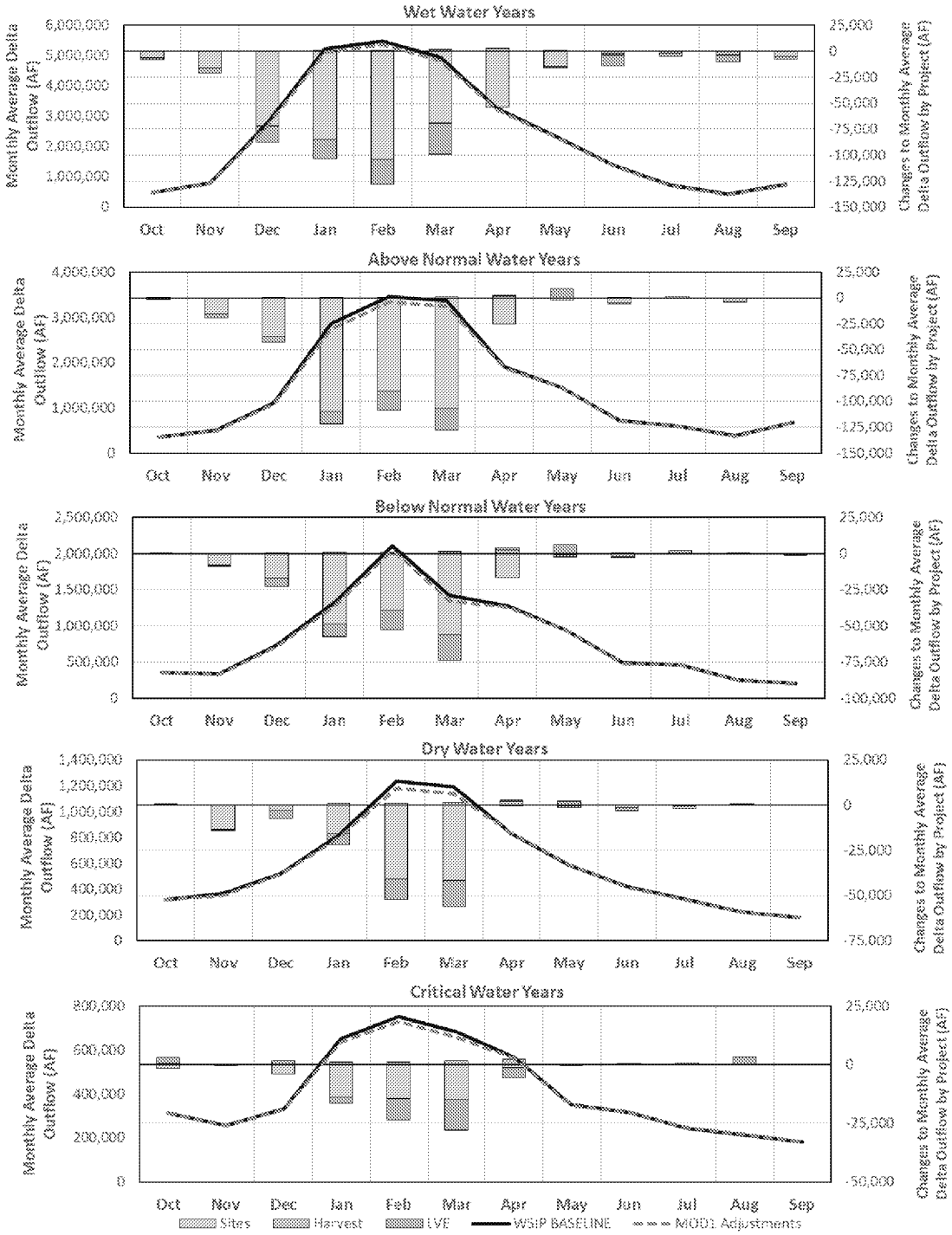


Figure 16. Monthly Average Changes to Delta Outflow for WSIP Baseline and MOD1 Adjustments, and by Individual Project (in acre-feet), by Water Year Type

Table 41. Monthly Average Delta Outflow and Changes to Monthly Average Delta Outflow, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Wet Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	477	789	2,768	5,214	5,477	4,943	3,257	2,331	1,387	720	431	745	28,539
MOD1 Adjustment	469	769	2,681	5,112	5,350	4,845	3,206	2,315	1,373	716	421	737	27,993
MOD1 Adjustment by Sites	-6	-16	-72	-85	-104	-69	-54	-15	-2	-1	0	-5	-428
MOD1 Adjustment by Harvest	0	0	0	1	1	2	2	-1	-2	-1	-4	0	-3
MOD1 Adjustment by LVE	-2	-4	-16	-18	-24	-30	0	1	-10	-3	-6	-3	-115
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-8	-20	-88	-102	-127	-97	-52	-15	-14	-5	-10	-8	-546
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-2%	-3%	-3%	-2%	-2%	-2%	-2%	-1%	-1%	-1%	-2%	-1%	-2%

Table 42. Monthly Average Delta Outflow and Changes to Monthly Average Delta Outflow, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Above Normal Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	355	507	1,120	2,873	3,454	3,369	1,904	1,444	712	595	380	681	17,394
MOD1 Adjustment	355	488	1,078	2,752	3,347	3,243	1,882	1,451	707	597	376	681	16,956
MOD1 Adjustment by Sites	0	-15	-37	-110	-90	-107	-25	-1	-4	0	0	0	-390
MOD1 Adjustment by Harvest	0	0	0	1	1	2	2	-1	-1	0	-4	0	0
MOD1 Adjustment by LVE	0	-4	-5	-12	-19	-21	1	10	1	1	0	0	-49
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0	-19	-42	-121	-108	-126	-22	8	-4	1	-4	0	-439
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0%	-4%	-4%	-4%	-3%	-4%	-1%	1%	-1%	0%	-1%	0%	-3%

Table 43. Monthly Average Delta Outflow and Changes to Monthly Average Delta Outflow, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Below Normal Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	355	341	742	1,332	2,104	1,421	1,276	944	487	464	248	204	9,918
MOD1 Adjustment	355	332	719	1,275	2,053	1,348	1,264	948	485	466	248	203	9,698
MOD1 Adjustment by Sites	0	-8	-17	-49	-39	-56	-17	-1	-2	0	0	0	-188
MOD1 Adjustment by Harvest	0	0	0	1	1	2	2	-1	-1	0	0	-1	4
MOD1 Adjustment by LVE	0	-1	-6	-9	-13	-18	2	6	1	2	0	0	-36
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0	-9	-23	-57	-51	-72	-13	4	-2	2	0	-1	-220
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0%	-3%	-3%	-4%	-2%	-5%	-1%	0%	0%	0%	0%	0%	-2%

Table 44. Monthly Average Delta Outflow and Changes to Monthly Average Delta Outflow, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Dry Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	320	366	521	818	1,236	1,192	831	587	419	322	224	179	7,016
MOD1 Adjustment	320	352	514	797	1,185	1,138	834	588	416	320	225	179	6,868
MOD1 Adjustment by Sites	0	-13	-3	-16	-41	-42	0	0	-1	0	0	0	-117
MOD1 Adjustment by Harvest	0	0	0	1	1	2	2	-1	-1	-2	0	0	3
MOD1 Adjustment by LVE	0	0	-5	-6	-12	-14	1	2	-1	0	1	0	-34
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0	-13	-8	-21	-52	-54	3	1	-3	-2	1	0	-148
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0%	-4%	-2%	-3%	-4%	-5%	0%	0%	-1%	-1%	0%	0%	-2%

Table 45. Monthly Average Delta Outflow and Changes to Monthly Average Delta Outflow, WSIP Baseline and MOD1 Adjustments (in thousand acre-feet), Critical Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	312	258	332	651	753	682	566	350	317	246	213	181	4,860
MOD1 Adjustment	314	258	330	636	730	656	562	349	317	246	217	181	4,796
MOD1 Adjustment by Sites	-2	0	-4	-14	-15	-15	-1	0	0	0	0	0	-50
MOD1 Adjustment by Harvest	0	0	0	1	1	2	2	0	0	0	0	0	6
MOD1 Adjustment by LVE	3	0	2	-3	-9	-13	-4	0	0	1	3	0	-21
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	1	0	-2	-16	-23	-26	-3	0	0	1	3	0	-65
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0%	0%	-1%	-2%	-3%	-4%	-1%	0%	0%	0%	1%	0%	-1%

3.2 GROUNDWATER PROJECT ADJUSTMENTS (MOD2)

Using MOD1 adjusted values, the groundwater projects were used to cumulatively adjust Delta surplus and Banks exports based on their proposed fill operations. A reduction was also made to Banks exports in summer months to compensate for reduced releases from Oroville that resulted in unbalanced Delta conditions (except in limited cases when Delta surplus was available in summer months).

3.2.1 Delta Surplus

The long-term monthly average cumulative effects of the three GW WSIP project Delta surplus decreases, and pulse flow release are shown in Figure 17 and Table 46. Mean annual reductions in Delta surplus throughout the simulation period are 308 TAF, or 3% of the total 10,473 TAF of mean annual Delta surplus. Note that MOD1 and MOD2 lines are almost equal because of the smaller magnitude of the impact of Kern Fan and Willow Springs diversions of surplus flows and the relatively infrequent diversions of surplus flows. The mean annual pulse flow release throughout the simulation period is 16.5 TAF in April. The long-term monthly average cumulative effects of the three GW WSIP projects on Delta surplus and pulse flow release by water year type are shown in Figure 18 and in Tables 47 through 51.

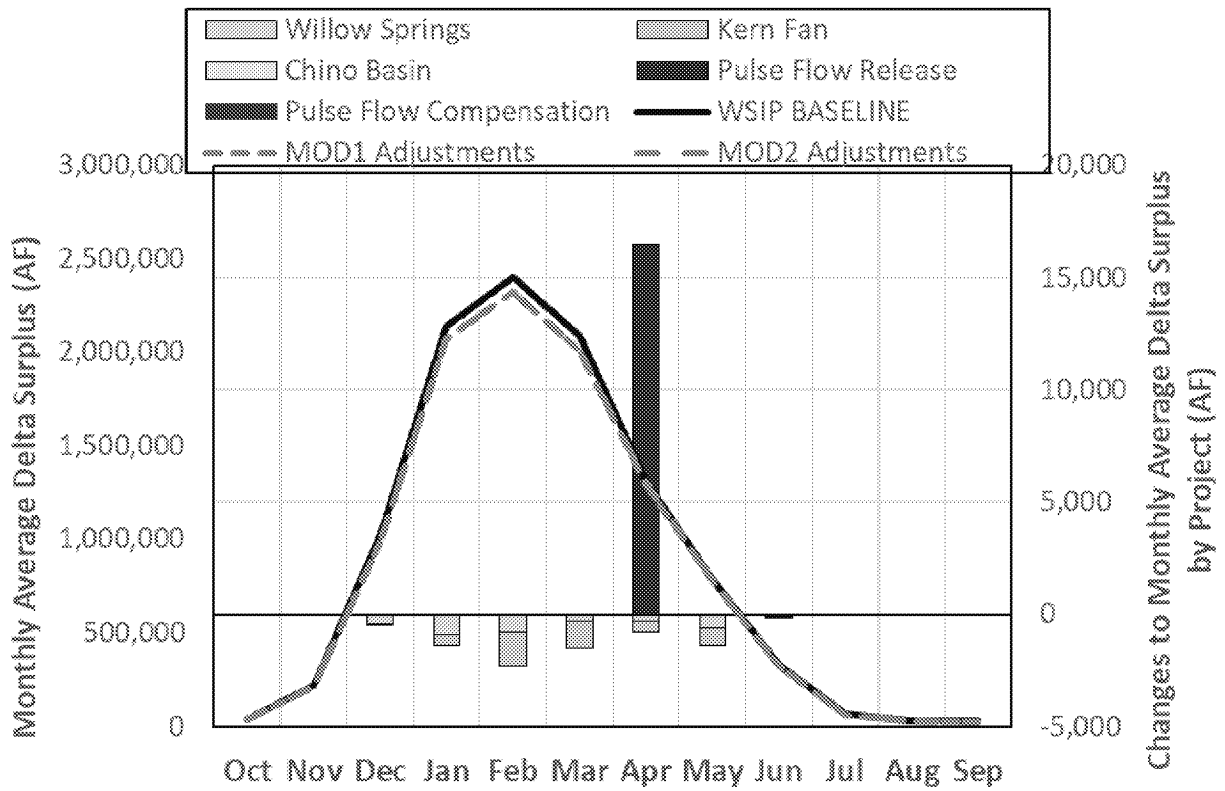


Figure 17. Monthly Average Delta Surplus for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Changes to Monthly Average Delta Surplus by Project, and Pulse Flow Release from Lake Oroville (in acre-feet)

How to interpret Tables that include both MOD1 and MOD2 adjustments: In Table 46 below, the first 2 lines are the same as in Table 3 that only analyze MOD1 projects. Similarly, the CALSIM II model calculates impacts from the MOD2 projects shown in data lines 3-6. The MOD1 change from WSIP Baseline (total and percent) is show in lines 8 and 9. The MOD2 change from MOD1 (total and percent) is shown in lines 10 and 11. The total MOD2 change from WSIP Baseline (total and percent) is shown in lines 12 and 13.

Table 46. Monthly Average Delta Surplus, Changes to Monthly Average Delta Surplus and Pulse Flow Release from Lake Oroville for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	38	224	1,031	2,140	2,401	2,088	1,307	787	332	64	34	28	10,473
MOD1 Adjustment	36	210	991	2,073	2,322	2,010	1,285	784	326	63	31	25	10,157
MOD2 Adjustment	36	210	991	2,072	2,319	2,009	1,301	782	326	63	31	25	10,165
MOD2 Adjustment by Willow Springs	0	0	0	-1	-1	0	0	-1	0	0	0	0	-3
MOD2 Adjustment by Kern Fan	0	0	0	-1	-2	-1	0	-1	0	0	0	0	-5
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	16.5	0	0	0	0	0	16.5
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-2	-14	-40	-67	-79	-78	-22	-3	-6	-1	-3	-3	-316
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-5%	-6%	-4%	-3%	-3%	-4%	-2%	0%	-2%	-2%	-9%	-11%	-3%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	-1	-3	-1	16	-2	0	0	0	0	8
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	-2	-14	-40	-68	-82	-79	-6	-5	-6	-1	-3	-3	-308
Percent Change (MOD2 Adjustment minus WSIP Baseline)	-5%	-6%	-4%	-3%	-3%	-4%	0%	-1%	-2%	-2%	-9%	-11%	-3%

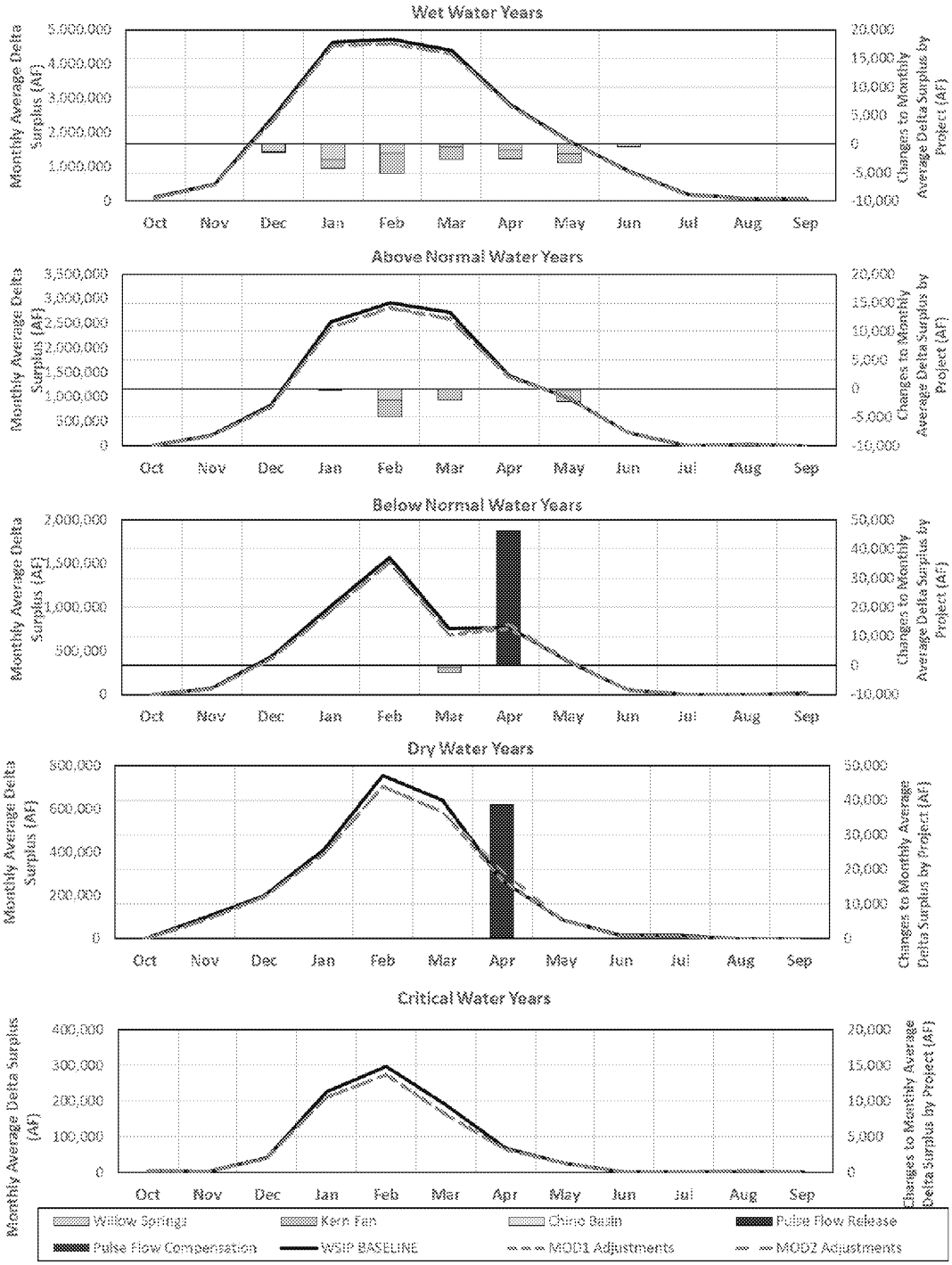


Figure 18. Monthly Average Delta Surplus for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, by MOD2 Project, and Pulse Flow Release from Lake Oroville, by Water Year Type (in acre-feet)

Table 47. Monthly Average Delta Surplus, Changes to Monthly Average Delta Surplus and Pulse Flow Release from Lake Oroville for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet), Wet Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	118	498	2,479	4,649	4,719	4,392	2,827	1,751	881	193	87	80	22,676
MOD1 Adjustment	110	477	2,392	4,547	4,593	4,295	2,775	1,736	867	188	77	72	22,130
MOD2 Adjustment	110	477	2,390	4,543	4,587	4,292	2,773	1,733	867	188	77	72	22,110
MOD2 Adjustment by Willow Springs	0	0	-1	-3	-2	-1	-1	-2	0	0	0	0	-9
MOD2 Adjustment by Kern Fan	0	0	0	-2	-3	-2	-2	-2	0	0	0	0	-10
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-8	-21	-87	-102	-126	-97	-52	-15	-14	-5	-10	-8	-546
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-7%	-4%	-4%	-2%	-3%	-2%	-2%	-1%	-2%	-3%	-11%	-10%	-2%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	-2	-4	-6	-3	-2	-3	0	0	0	0	-20
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	-8	-21	-89	-106	-132	-100	-54	-18	-14	-5	-10	-8	-566
Percent Change (MOD2 Adjustment minus WSIP Baseline)	-7%	-4%	-4%	-2%	-3%	-2%	-2%	-1%	-2%	-3%	-11%	-10%	-2%

Table 48. Monthly Average Delta Surplus, Changes to Monthly Average Delta Surplus and Pulse Flow Release from Lake Oroville for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet), Above Normal Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	1	223	831	2,531	2,922	2,715	1,433	979	275	0	42	0	11,950
MOD1 Adjustment	1	204	789	2,410	2,814	2,589	1,411	986	270	1	38	0	11,512
MOD2 Adjustment	1	204	789	2,410	2,809	2,587	1,411	984	270	1	38	0	11,503
MOD2 Adjustment by Willow Springs	0	0	0	0	-2	0	0	0	0	0	0	0	-3
MOD2 Adjustment by Kern Fan	0	0	0	0	-3	-2	0	-2	0	0	0	0	-7
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0	-19	-42	-121	-108	-126	-22	7	-5	1	-4	0	-438
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0%	-9%	-5%	-5%	-4%	-5%	-2%	1%	-2%	0%	-10%	0%	-4%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	-5	-2	0	-2	0	0	0	0	-9
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	0	-19	-42	-121	-113	-128	-22	5	-5	1	-4	0	-447
Percent Change (MOD2 Adjustment minus WSIP Baseline)	0%	-9%	-5%	-5%	-4%	-5%	-2%	1%	-2%	0%	-10%	0%	-4%

Table 49. Monthly Average Delta Surplus, Changes to Monthly Average Delta Surplus and Pulse Flow Release from Lake Oroville for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet), Below Normal Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	0	69	430	1,005	1,569	758	770	380	54	0	0	13	5,049
MOD1 Adjustment	0	60	408	949	1,518	686	758	384	52	2	0	12	4,828
MOD2 Adjustment	0	60	408	949	1,518	684	804	384	52	2	0	12	4,872
MOD2 Adjustment by Willow Springs	0	0	0	0	0	-1	0	0	0	0	0	0	-1
MOD2 Adjustment by Kern Fan	0	0	0	0	0	-2	0	0	0	0	0	0	-2
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	46	0	0	0	0	0	46
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0	-9	-22	-56	-51	-72	-12	4	-2	2	0	-1	-221
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0%	-13%	-5%	-6%	-3%	-9%	-2%	1%	-4%	0%	0%	-8%	-4%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	-2	46	0	0	0	0	0	44
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	6%	0%	0%	0%	0%	0%	1%
Total Change (MOD2 Adjustment minus WSIP Baseline)	0	-9	-22	-56	-51	-74	34	4	-2	2	0	-1	-177
Percent Change (MOD2 Adjustment minus WSIP Baseline)	0%	-13%	-5%	-6%	-3%	-10%	4%	1%	-4%	0%	0%	-8%	-4%

Table 50. Monthly Average Delta Surplus, Changes to Monthly Average Delta Surplus and Pulse Flow Release from Lake Oroville for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet), Dry Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	0	99	200	413	755	641	271	89	14	15	0	0	2,497
MOD1 Adjustment	0	85	193	393	704	587	273	90	11	13	1	0	2,350
MOD2 Adjustment	0	85	193	393	704	587	312	90	11	13	1	0	2,388
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	39	0	0	0	0	0	39
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0	-14	-7	-20	-51	-54	2	1	-3	-2	1	0	-147
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0%	-14%	-4%	-5%	-7%	-8%	1%	1%	-21%	-13%	0%	0%	-6%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	39	0	0	0	0	0	38
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	14%	0%	0%	0%	0%	0%	2%
Total Change (MOD2 Adjustment minus WSIP Baseline)	0	-14	-7	-20	-51	-54	41	1	-3	-2	1	0	-109
Percent Change (MOD2 Adjustment minus WSIP Baseline)	0%	-14%	-4%	-5%	-7%	-8%	15%	1%	-21%	-13%	0%	0%	-4%

Table 51. Monthly Average Delta Surplus, Changes to Monthly Average Delta Surplus and Pulse Flow Release from Lake Oroville for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet), Critical Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	3	2	41	225	297	189	67	25	0	0	0	0	850
MOD1 Adjustment	5	2	39	209	274	162	64	25	0	1	3	0	785
MOD2 Adjustment	5	2	39	209	274	162	64	25	0	1	3	0	785
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	2	0	-2	-16	-23	-27	-3	0	0	1	3	0	-65
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	67%	0%	-5%	-7%	-8%	-14%	-4%	0%	0%	0%	0%	0%	-8%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	2	0	-2	-16	-23	-27	-3	0	0	1	3	0	-65
Percent Change (MOD2 Adjustment minus WSIP Baseline)	67%	0%	-5%	-7%	-8%	-14%	-4%	0%	0%	0%	0%	0%	-8%

3.2.2 Banks Exports

The long-term monthly average cumulative effects of the three GW WSIP project export increases and pulse compensation export reductions are shown in Figure 19 and Table 52. Both Willow Springs and Kern Fan result in additional exports in December through May for filling operations. Chino Basin is filled with local treated water, resulting in no changes in Delta exports. The mean monthly increase in Banks exports due to MOD2 projects fill operations is 22 cfs (16.0 TAF). As a result of the pulse flow compensation, Banks exports are reduced in July through September. The total mean annual pulse flow compensation reduction in Banks exports is 16.5 TAF (reductions of 162 cfs, 80 cfs, and 26 cfs in July, August, and September, respectively), which is the same volume as the mean annual delivered pulse flow. The pulse flow compensation reduction from Banks is greater than the total mean annual increase in exports due to GW fill operations. The pulse flow compensation reduction accounts for the entire volume of the pulse flow, provided by Willow Springs, Kern Fan, and Chino Basin, but the increase in exports only go to Willow Springs and Kern Fan (Chino Basin fills with local supply). The mean annual volume of water exported to two GW banks is less than the required flow reduction needed to compensate for a pulse flow provided by three GW banks. The long term monthly average cumulative effects of the three GW projects on Banks exports and pulse flow compensation by water year type are shown in Figure 20 and in Tables 53 through 57.

The net change in exports is negative in March through July, November, and December (Table 52). In summer months, increased exports from Sites implementation were greater than export cuts for the pulse flow compensation, resulting in a net positive increase in Banks exports relative to the WSIP Baseline. Note that as previously mentioned, carriage water saving was not accounted for in the export reductions for pulse flow compensation, and thus the values likely overstate the export reductions that would occur, since a portion of the Delta inflow reductions due to Oroville release reductions would have gone towards carriage water.

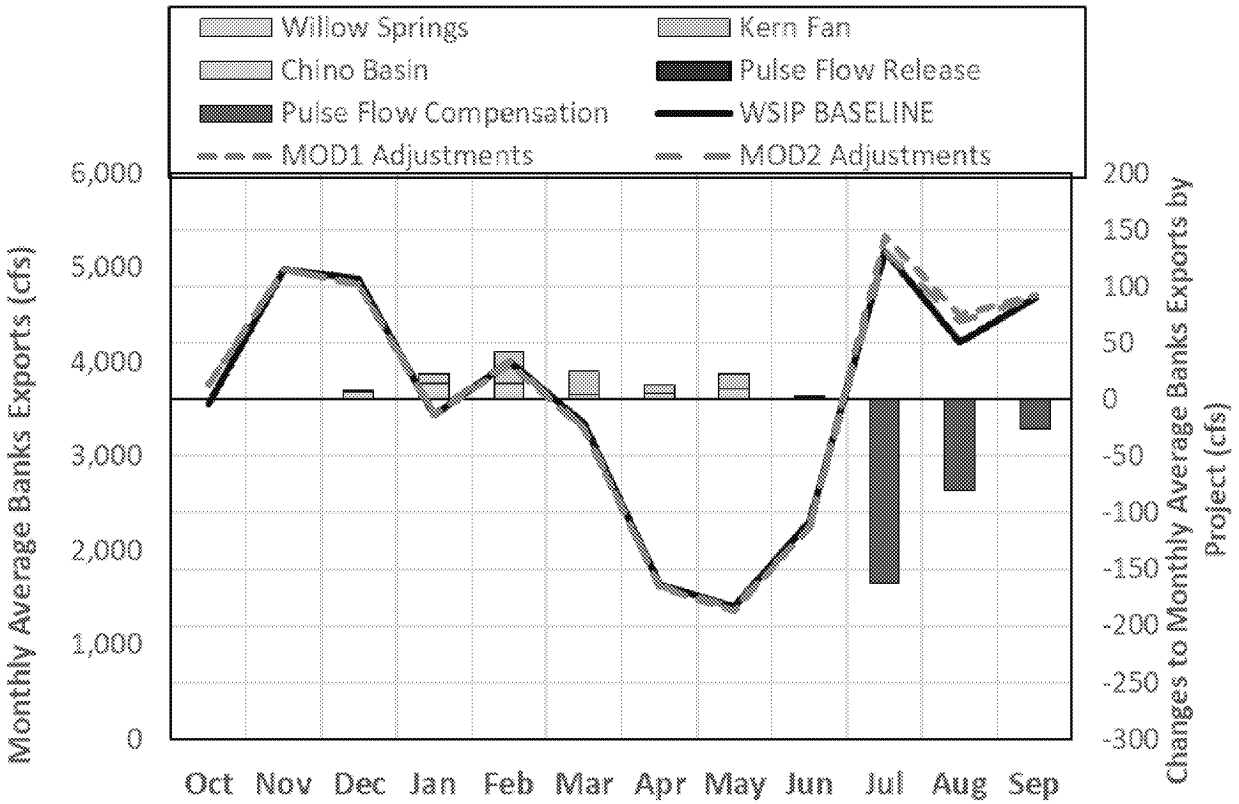


Figure 19. Monthly Average Banks Exports for WSIP Baseline and MOD2 Adjustments, Changes to Monthly Average Banks Exports by Project, and Pulse Flow Compensation (in cubic feet per second)

Table 52. Monthly Average Banks Exports, Changes to Monthly Average Banks Exports and Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,555	4,986	4,879	3,433	4,009	3,345	1,642	1,406	2,317	5,171	4,206	4,671	3,635
MOD1 Adjustment	3,750	4,981	4,818	3,435	3,970	3,286	1,614	1,364	2,256	5,330	4,505	4,710	3,668
MOD2 Adjustment	3,750	4,981	4,826	3,458	4,012	3,311	1,628	1,387	2,258	5,167	4,424	4,684	3,657
MOD2 Adjustment by Willow Springs	0	0	7	15	14	5	5	10	2	0	0	0	5
MOD2 Adjustment by Kern Fan	0	0	0	8	28	20	8	12	0	0	0	0	6
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	0	0	0	-162	-80	-26	-22
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	195	-5	-61	2	-39	-59	-28	-42	-61	159	299	39	33
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	5%	0%	-1%	0%	-1%	-2%	-2%	-3%	-3%	3%	7%	1%	1%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	8	23	42	25	14	23	2	-163	-81	-26	-11
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	1%	1%	1%	1%	2%	0%	-3%	-2%	-1%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	195	-5	-53	25	3	-34	-14	-19	-59	-4	218	13	22
Percent Change (MOD2 Adjustment minus WSIP Baseline)	5%	0%	-1%	1%	0%	-1%	-1%	-1%	-3%	0%	5%	0%	1%

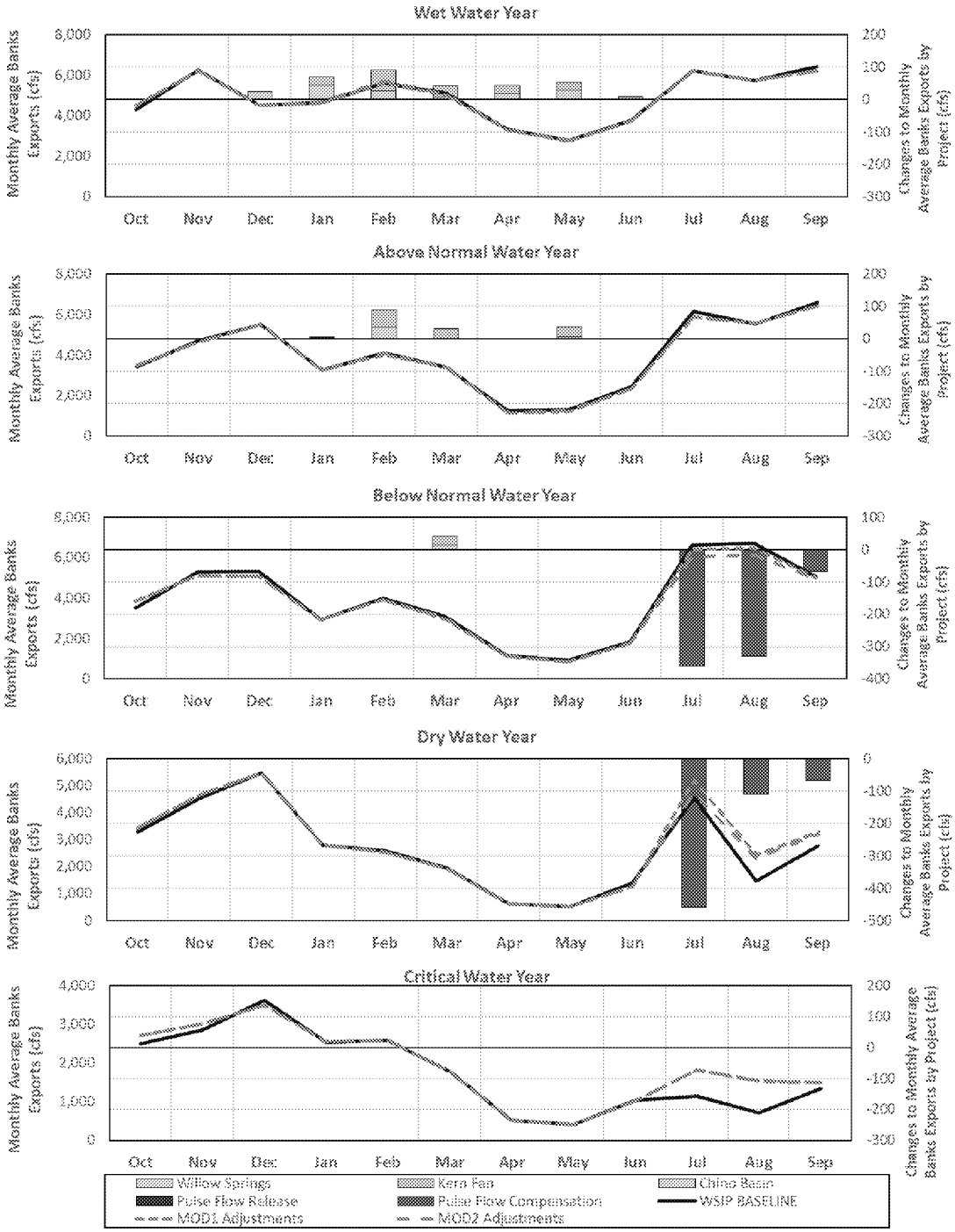


Figure 20. Monthly Average Banks Exports for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Changes to Monthly Average Delta Surplus by Project and Pulse Flow Compensation, by Water Year Type (in cubic feet per second)

Table 53. Monthly Average Banks Exports, Changes to Monthly Average Banks Exports and Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in cubic feet per second), Wet Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	4,309	6,239	4,515	4,638	5,609	5,124	3,311	2,773	3,756	6,220	5,740	6,420	4,888
MOD1 Adjustment	4,517	6,206	4,506	4,630	5,605	5,016	3,294	2,734	3,724	6,212	5,755	6,224	4,869
MOD2 Adjustment	4,517	6,206	4,529	4,700	5,696	5,059	3,337	2,787	3,731	6,212	5,755	6,224	4,896
MOD2 Adjustment by Willow Springs	0	0	23	45	28	8	17	29	8	0	0	0	13
MOD2 Adjustment by Kern Fan	0	0	0	25	63	35	26	25	0	0	0	0	14
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	208	-33	-9	-8	-4	-108	-17	-39	-32	-8	15	-196	-19
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	5%	-1%	0%	0%	0%	-2%	-1%	-1%	-1%	0%	0%	-3%	0%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	23	70	91	43	43	53	7	0	0	0	27
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	1%	2%	2%	1%	1%	2%	0%	0%	0%	0%	1%
Total Change (MOD2 Adjustment minus WSIP Baseline)	208	-33	14	62	87	-65	26	14	-25	-8	15	-196	8
Percent Change (MOD2 Adjustment minus WSIP Baseline)	5%	-1%	0%	1%	2%	-1%	1%	1%	-1%	0%	0%	-3%	0%

Table 54. Monthly Average Banks Exports, Changes to Monthly Average Banks Exports and Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in cubic feet per second), Above Normal Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,453	4,744	5,505	3,259	4,123	3,418	1,258	1,335	2,447	6,149	5,554	6,604	3,987
MOD1 Adjustment	3,496	4,649	5,507	3,258	4,022	3,419	1,161	1,238	2,362	5,891	5,566	6,438	3,917
MOD2 Adjustment	3,496	4,649	5,507	3,265	4,111	3,451	1,161	1,275	2,362	5,891	5,566	6,438	3,931
MOD2 Adjustment by Willow Springs	0	0	0	3	36	0	0	5	0	0	0	0	4
MOD2 Adjustment by Kern Fan	0	0	0	3	53	32	0	32	0	0	0	0	10
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	43	-95	2	-1	-101	1	-97	-97	-85	-258	12	-166	-70
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	1%	-2%	0%	0%	-2%	0%	-8%	-7%	-3%	-4%	0%	-3%	-2%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	7	89	32	0	37	0	0	0	0	14
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	2%	1%	0%	3%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	43	-95	2	6	-12	33	-97	-60	-85	-258	12	-166	-56
Percent Change (MOD2 Adjustment minus WSIP Baseline)	1%	-2%	0%	0%	0%	1%	-8%	-4%	-3%	-4%	0%	-3%	-1%

Table 55. Monthly Average Banks Exports, Changes to Monthly Average Banks Exports and Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in cubic feet per second), Below Normal Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,504	5,279	5,322	2,942	3,976	3,114	1,149	922	1,833	6,607	6,717	5,052	3,868
MOD1 Adjustment	3,847	5,104	5,086	2,935	3,926	2,982	1,110	856	1,776	6,399	6,481	5,017	3,793
MOD2 Adjustment	3,847	5,104	5,086	2,935	3,926	3,022	1,110	856	1,776	6,039	6,151	4,950	3,734
MOD2 Adjustment by Willow Springs	0	0	0	0	0	13	0	0	0	0	0	0	1
MOD2 Adjustment by Kern Fan	0	0	0	0	0	28	0	0	0	0	0	0	2
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	-360	-330	-67	-63
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	343	-175	-236	-7	-50	-132	-39	-66	-57	-208	-236	-35	-75
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	10%	-3%	-4%	0%	-1%	-4%	-3%	-7%	-3%	-3%	-4%	-1%	-2%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	40	0	0	0	-360	-330	-67	-59
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	1%	0%	0%	0%	-6%	-5%	-1%	-2%
Total Change (MOD2 Adjustment minus WSIP Baseline)	343	-175	-236	-7	-50	-92	-39	-66	-57	-568	-566	-102	-134
Percent Change (MOD2 Adjustment minus WSIP Baseline)	10%	-3%	-4%	0%	-1%	-3%	-3%	-7%	-3%	-9%	-8%	-2%	-3%

Table 56. Monthly Average Banks Exports, Changes to Monthly Average Banks Exports and Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in cubic feet per second), Dry Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,282	4,523	5,475	2,786	2,597	1,950	614	524	1,377	4,568	1,460	2,777	2,661
MOD1 Adjustment	3,420	4,647	5,484	2,797	2,532	1,929	611	506	1,259	5,183	2,427	3,269	2,839
MOD2 Adjustment	3,420	4,647	5,484	2,797	2,532	1,929	611	506	1,259	4,724	2,318	3,203	2,786
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	-459	-109	-67	-53
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	138	124	9	11	-65	-21	-3	-18	-118	615	967	492	178
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	4%	3%	0%	0%	-3%	-1%	0%	-3%	-9%	13%	66%	18%	7%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	0	0	0	-459	-109	-66	-53
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	0%	0%	0%	-9%	-4%	-2%	-2%
Total Change (MOD2 Adjustment minus WSIP Baseline)	138	124	9	11	-65	-21	-3	-18	-118	156	858	426	125
Percent Change (MOD2 Adjustment minus WSIP Baseline)	4%	3%	0%	0%	-3%	-1%	0%	-3%	-9%	3%	59%	15%	5%

Table 57. Monthly Average Banks Exports, Changes to Monthly Average Banks Exports and Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in cubic feet per second), Critical Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	2,495	2,864	3,633	2,542	2,582	1,781	525	407	1,043	1,146	722	1,348	1,757
MOD1 Adjustment	2,722	3,017	3,496	2,561	2,583	1,793	521	403	1,023	1,829	1,544	1,504	1,916
MOD2 Adjustment	2,722	3,017	3,496	2,561	2,583	1,793	521	403	1,023	1,829	1,544	1,504	1,916
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	227	153	-137	19	1	12	-4	-4	-20	683	822	156	159
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	9%	5%	-4%	1%	0%	1%	-1%	-1%	-2%	60%	114%	12%	9%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	227	153	-137	19	1	12	-4	-4	-20	683	822	156	159
Percent Change (MOD2 Adjustment minus WSIP Baseline)	9%	5%	-4%	1%	0%	1%	-1%	-1%	-2%	60%	114%	12%	9%

3.2.3 Delta Inflow from Sacramento River

The long-term monthly average cumulative effects of the three GW WSIP projects on Delta Inflow from Sacramento River is shown in Figure 21 and Table 58. Mean annual reductions in Delta Inflow from Sacramento River throughout the simulation period are 46 TAF, or 0.3% of the total 15,478 TAF of mean annual Delta Inflow from Sacramento River. Mean pulse flow release of 16.5 TAF occurs in April and the mean pulse flow compensation of 16.5 TAF occurs from July to September. The long-term monthly average cumulative effects of the three GW projects on Delta Inflow from the Sacramento River by water year type are shown in Figure 22 and in Tables 59 through 63.

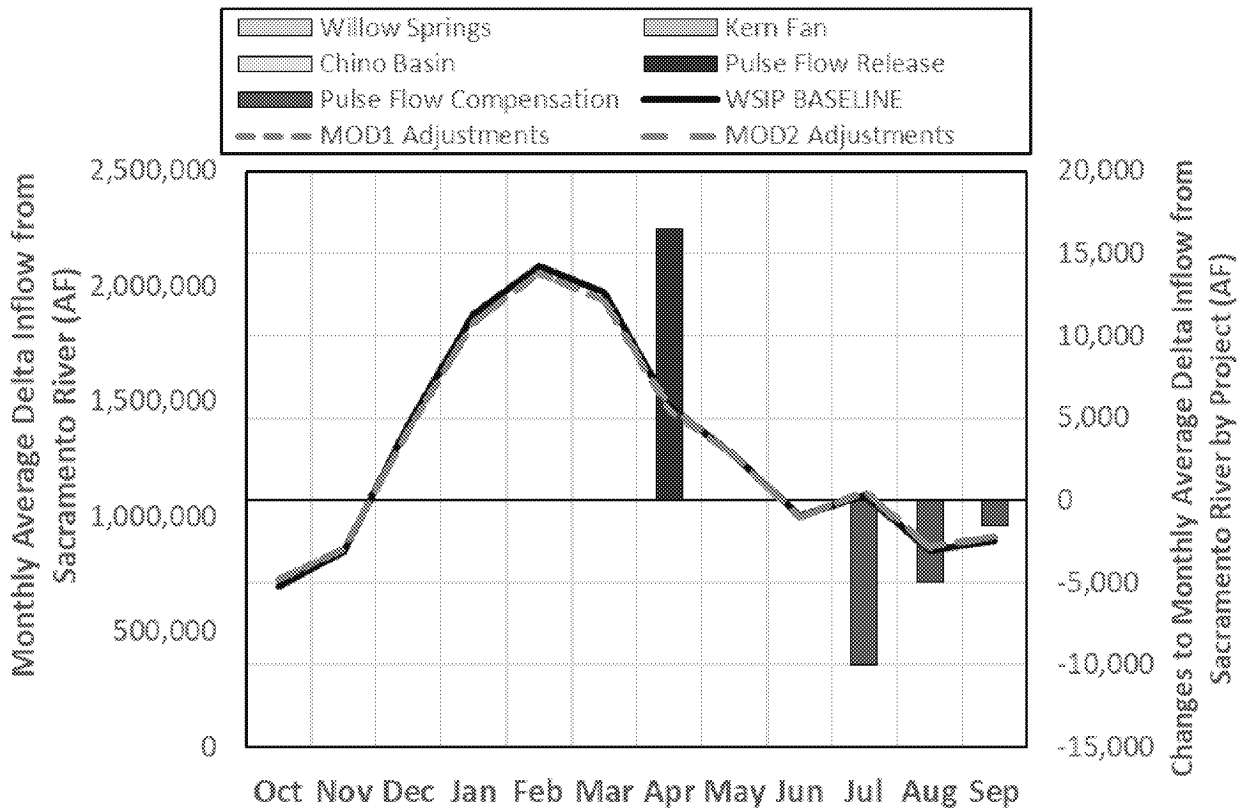


Figure 21. Monthly Average Delta Inflow from Sacramento River for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Changes to Monthly Average Delta Inflow from Sacramento River by Project, Pulse Flow Release from Lake Oroville, and Pulse Flow Compensation (in acre-feet)

Table 58. Monthly Average Delta Inflow from Sacramento River, Changes to Monthly Average Delta Inflow from Sacramento River, Pulse Flow Release from Lake Oroville, and Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	699	846	1,397	1,880	2,089	1,975	1,482	1,266	1,002	1,094	851	896	15,478
MOD1 Adjustment	728	861	1,377	1,842	2,058	1,938	1,466	1,266	996	1,113	874	913	15,432
MOD2 Adjustment	728	861	1,377	1,842	2,058	1,938	1,483	1,266	996	1,103	869	911	15,432
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	16	0	0	0	0	0	16.5
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	-10	-5	-2	-16.5
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	29	15	-20	-38	-31	-37	-16	0	-6	19	23	17	-46
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	4%	2%	-1%	-2%	-1%	-2%	-1%	0%	-1%	2%	3%	2%	0%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	17	0	0	-10	-5	-2	0
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	1%	0%	0%	-1%	-1%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	29	15	-20	-38	-31	-37	1	0	-6	9	18	15	-46
Percent Change (MOD2 Adjustment minus WSIP Baseline)	4%	2%	-1%	-2%	-1%	-2%	0%	0%	-1%	1%	2%	2%	0%

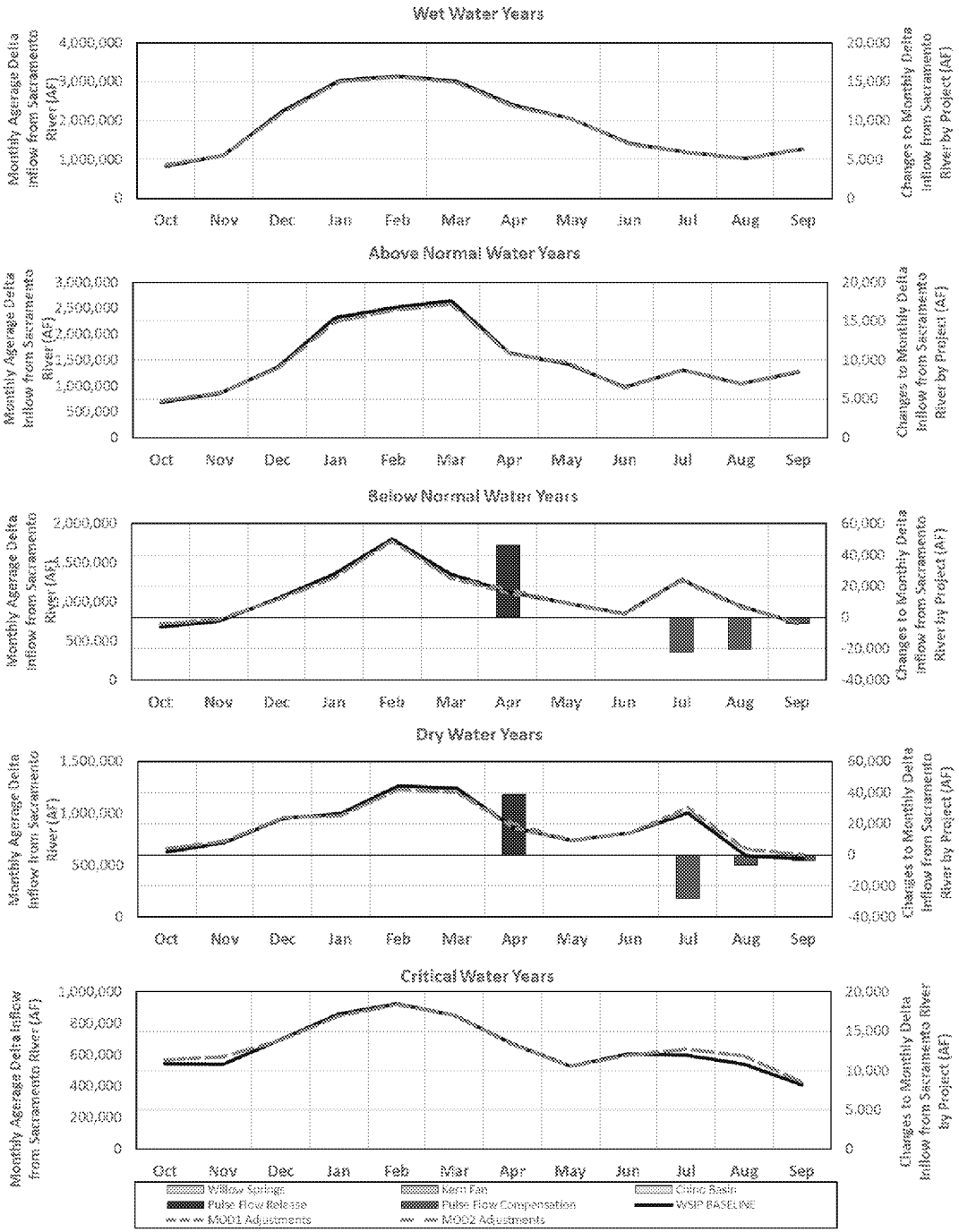


Figure 22. Monthly Average Delta Inflow from Sacramento River for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Changes to Monthly Average Delta Inflow from Sacramento River by Project, Pulse Flow Release from Lake Oroville, and Pulse Flow Compensation, by Water Year Type (in acre-feet)

Table 59. Monthly Average Delta Inflow from Sacramento River, Changes to Monthly Average Delta Inflow from Sacramento River, Pulse Flow Release from Lake Oroville, and Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet), Wet Water Years

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	836	1,117	2,238	3,045	3,153	3,028	2,405	2,047	1,409	1,179	1,021	1,274	22,751
MOD1 Adjustment	865	1,119	2,189	3,002	3,120	2,993	2,369	2,040	1,403	1,182	1,025	1,279	22,586
MOD2 Adjustment	865	1,119	2,189	3,002	3,120	2,993	2,369	2,040	1,403	1,182	1,025	1,279	22,586
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	29	2	-49	-43	-33	-35	-36	-7	-6	3	4	5	-165
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	3%	0%	-2%	-1%	-1%	-1%	-1%	0%	0%	0%	0%	0%	-1%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	29	2	-49	-43	-33	-35	-36	-7	-6	3	4	5	-165
Percent Change (MOD2 Adjustment minus WSIP Baseline)	3%	0%	-2%	-1%	-1%	-1%	-1%	0%	0%	0%	0%	0%	-1%

Table 60. Monthly Average Delta Inflow from Sacramento River, Changes to Monthly Average Delta Inflow from Sacramento River, Pulse Flow Release from Lake Oroville, and Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet), Above Normal Water Years

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	687	856	1,357	2,311	2,508	2,643	1,639	1,432	981	1,311	1,047	1,274	18,046
MOD1 Adjustment	716	868	1,335	2,237	2,461	2,578	1,633	1,449	969	1,316	1,047	1,277	17,887
MOD2 Adjustment	716	868	1,335	2,237	2,461	2,578	1,633	1,449	969	1,316	1,047	1,277	17,887
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	29	12	-22	-74	-47	-65	-6	17	-12	5	0	3	-159
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	4%	1%	-2%	-3%	-2%	-2%	0%	1%	-1%	0%	0%	0%	-1%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	29	12	-22	-74	-47	-65	-6	17	-12	5	0	3	-159
Percent Change (MOD2 Adjustment minus WSIP Baseline)	4%	1%	-2%	-3%	-2%	-2%	0%	1%	-1%	0%	0%	0%	-1%

Table 61. Monthly Average Delta Inflow from Sacramento River, Changes to Monthly Average Delta Inflow from Sacramento River, Pulse Flow Release from Lake Oroville, and Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet), Below Normal Water Years

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	680	753	1,037	1,358	1,810	1,353	1,130	988	847	1,290	957	725	12,928
MOD1 Adjustment	712	775	1,026	1,311	1,776	1,306	1,113	985	839	1,287	955	735	12,822
MOD2 Adjustment	712	775	1,026	1,311	1,776	1,306	1,160	985	839	1,265	935	731	12,822
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	46	0	0	0	0	0	46.4
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	-22	-20	-4	-46.4
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	32	22	-11	-47	-34	-47	-17	-3	-8	-3	-2	10	-106
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	5%	3%	-1%	-3%	-2%	-3%	-2%	0%	-1%	0%	0%	1%	-1%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	47	0	0	-22	-20	-4	0
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	4%	0%	0%	-2%	-2%	-1%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	32	22	-11	-47	-34	-47	30	-3	-8	-25	-22	6	-106
Percent Change (MOD2 Adjustment minus WSIP Baseline)	5%	3%	-1%	-3%	-2%	-3%	3%	0%	-1%	-2%	-2%	1%	-1%

Table 62. Monthly Average Delta Inflow from Sacramento River, Changes to Monthly Average Delta Inflow from Sacramento River, Pulse Flow Release from Lake Oroville, and Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet), Dry Water Years

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	629	721	955	998	1,264	1,243	858	738	815	1,005	597	558	10,380
MOD1 Adjustment	657	734	959	982	1,231	1,205	858	738	812	1,059	663	604	10,501
MOD2 Adjustment	657	734	959	982	1,231	1,205	897	738	812	1,031	656	600	10,501
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	39	0	0	0	0	0	38.9
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	-28	-7	-4	-38.9
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	28	13	4	-16	-33	-38	0	0	-3	54	66	46	121
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	4%	2%	0%	-2%	-3%	-3%	0%	0%	0%	5%	11%	8%	1%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	39	0	0	-28	-7	-4	0
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	5%	0%	0%	-3%	-1%	-1%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	28	13	4	-16	-33	-38	39	0	-3	26	59	42	121
Percent Change (MOD2 Adjustment minus WSIP Baseline)	4%	2%	0%	-2%	-3%	-3%	5%	0%	0%	3%	10%	8%	1%

Table 63. Monthly Average Delta Inflow from Sacramento River, Changes to Monthly Average Delta Inflow from Sacramento River, Pulse Flow Release from Lake Oroville, and Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet), Critical Water Years

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	544	542	696	859	927	851	670	528	605	598	542	409	7,770
MOD1 Adjustment	567	588	693	846	922	852	668	526	599	639	591	427	7,917
MOD2 Adjustment	567	588	693	846	922	852	668	526	599	639	591	427	7,917
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	23	46	-3	-13	-5	1	-2	-2	-6	41	49	18	147
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	4%	8%	0%	-2%	-1%	0%	0%	0%	-1%	7%	9%	4%	2%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	23	46	-3	-13	-5	1	-2	-2	-6	41	49	18	147
Percent Change (MOD2 Adjustment minus WSIP Baseline)	4%	8%	0%	-2%	-1%	0%	0%	0%	-1%	7%	9%	4%	2%

3.2.4 Feather River Flow

The long-term monthly average cumulative effects of three GW WSIP projects on Feather River flow from Thermalito Junction (CalSim II node C203) is shown in Figure 23 and Table 64. The mean monthly increase in Feather River flow throughout the simulation period is 1 cfs, or less than 0.1% of the total 3,984 cfs of mean monthly Feather River flow. The mean pulse flow release of 277 cfs occurs in April and the mean pulse flow compensation of 269 cfs occurs from July to September. The long-term monthly average cumulative effects of the three GW WSIP projects on Feather River flow from Thermalito Junction (C203) by water year type are shown in Figure 24 and in Tables 65 through 69.

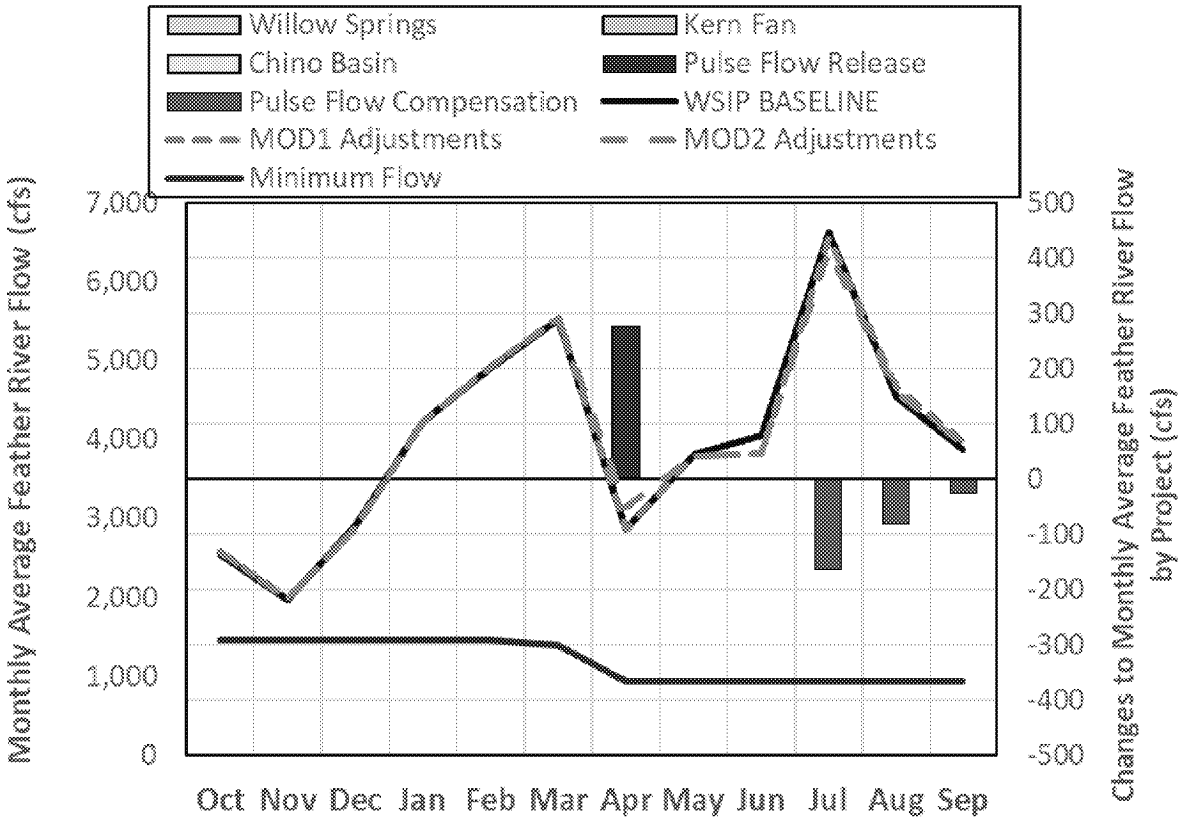


Figure 23. Monthly Average Feather River Flow from Thermalito Junction (C203) for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Changes to Monthly Average Feather River Flow by Project, Pulse Flow Release from Lake Oroville, Pulse Flow Compensation, and Minimum Flow Requirement (in cubic feet per second)

Table 64. Monthly Average Feather River Flow from Thermalito Junction (C203), Changes to Monthly Average Feather River Flow, Pulse Flow Release, Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	2,549	1,961	2,907	4,219	4,915	5,521	2,858	3,810	4,043	6,613	4,537	3,875	3,984
MOD1 Adjustment	2,584	1,992	2,870	4,230	4,930	5,530	2,867	3,784	3,826	6,550	4,665	3,977	3,984
MOD2 Adjustment	2,584	1,992	2,870	4,230	4,930	5,530	3,145	3,784	3,826	6,387	4,585	3,951	3,984
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	277	0	0	0	0	0	23
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	-163	-80	-26	-22
Minimum Flow Requirement	1,461	1,461	1,461	1,461	1,461	1,401	945	945	945	945	945	945	1,198
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	35	31	-37	11	15	9	9	-26	-217	-63	128	102	0
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	1%	2%	-1%	0%	0%	0%	0%	-1%	-5%	-1%	3%	3%	0%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	278	0	0	-163	-80	-26	0
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	10%	0%	0%	-2%	-2%	-1%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	35	31	-37	11	15	9	287	-26	-217	-226	48	76	0
Percent Change (MOD2 Adjustment minus WSIP Baseline)	1%	2%	-1%	0%	0%	0%	10%	-1%	-5%	-3%	1%	2%	0%

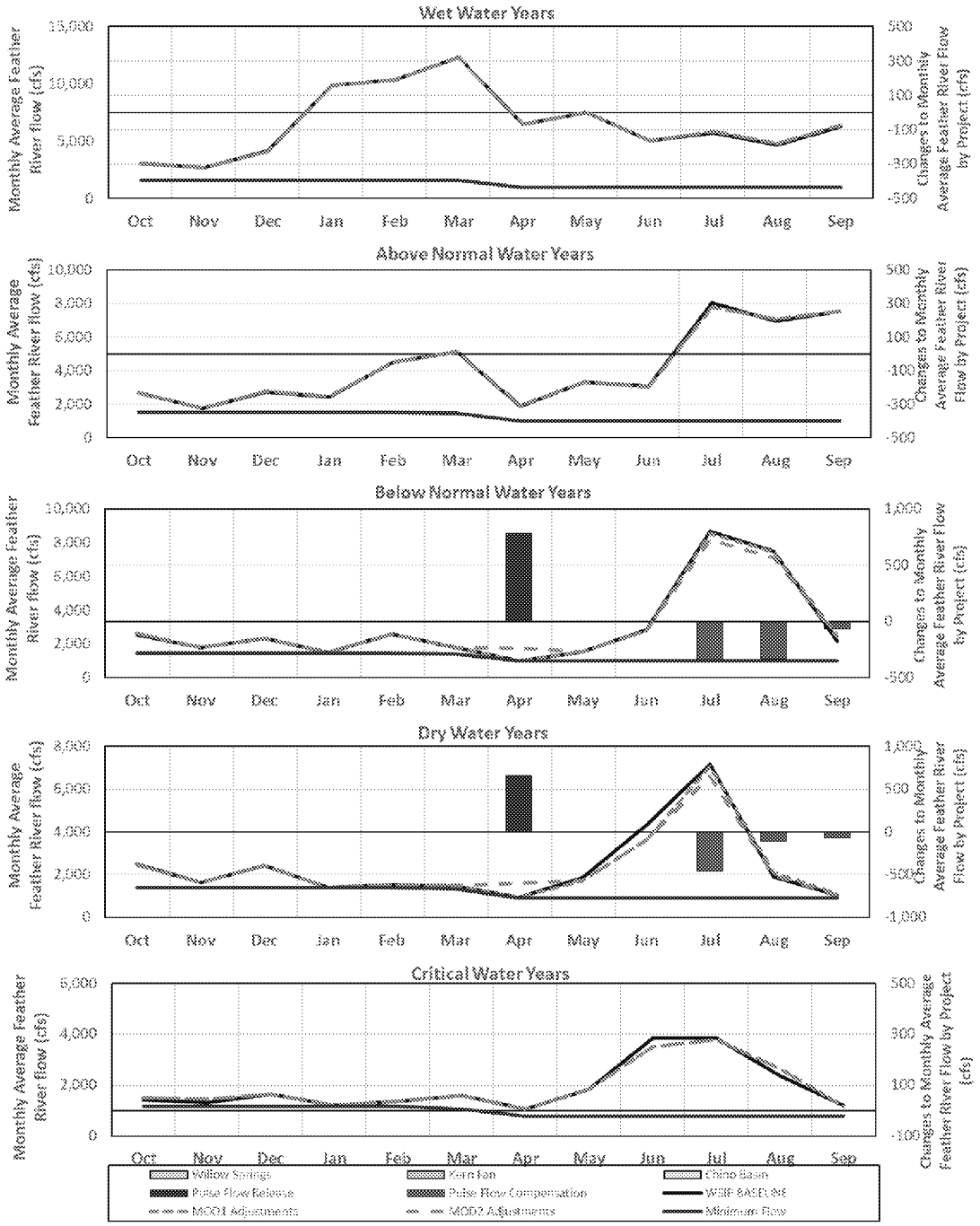


Figure 24. Monthly Average Feather River Flow from Thermalito Junction (C203) for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Changes to Monthly Average Feather River Flow by Project, Pulse Flow Release from Lake Oroville, and Pulse Flow Compensation, by Water Year Type (in cubic feet per second)

Table 65. Monthly Average Feather River Flow from Thermalito Junction (C203), Changes to Monthly Average Feather River Flow, Pulse Flow Release, Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Wet Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,042	2,693	4,195	9,862	10,347	12,325	6,486	7,521	5,052	5,752	4,661	6,297	6,519
MOD1 Adjustment	3,100	2,700	4,103	9,870	10,385	12,341	6,489	7,523	5,058	5,843	4,781	6,426	6,552
MOD2 Adjustment	3,100	2,700	4,103	9,870	10,385	12,341	6,489	7,523	5,058	5,843	4,781	6,426	6,552
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum Flow Requirement	1,612	1,612	1,612	1,612	1,612	1,583	1,000	1,000	1,000	1,000	1,000	1,000	1,303
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	58	7	-92	8	38	16	3	2	6	91	120	129	33
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	2%	0%	-2%	0%	0%	0%	0%	0%	0%	2%	3%	2%	1%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	58	7	-92	8	38	16	3	2	6	91	120	129	33
Percent Change (MOD2 Adjustment minus WSIP Baseline)	2%	0%	-2%	0%	0%	0%	0%	0%	0%	2%	3%	2%	1%

Table 66. Monthly Average Feather River Flow from Thermalito Junction (C203), Changes to Monthly Average Feather River Flow, Pulse Flow Release, Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Above Normal Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	2,682	1,746	2,742	2,444	4,489	5,126	1,871	3,335	3,062	8,034	6,947	7,540	4,168
MOD1 Adjustment	2,694	1,745	2,756	2,487	4,500	5,132	1,950	3,334	3,012	7,783	7,082	7,549	4,169
MOD2 Adjustment	2,694	1,745	2,756	2,487	4,500	5,132	1,950	3,334	3,012	7,783	7,082	7,549	4,169
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum Flow Requirement	1,525	1,525	1,525	1,525	1,525	1,483	1,000	1,000	1,000	1,000	1,000	1,000	1,259
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	12	-1	14	43	11	6	79	-1	-50	-251	135	9	1
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0%	0%	1%	2%	0%	0%	4%	0%	-2%	-3%	2%	0%	0%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	12	-1	14	43	11	6	79	-1	-50	-251	135	9	1
Percent Change (MOD2 Adjustment minus WSIP Baseline)	0%	0%	1%	2%	0%	0%	4%	0%	-2%	-3%	2%	0%	0%

Table 67. Monthly Average Feather River Flow from Thermalito Junction (C203), Changes to Monthly Average Feather River Flow, Pulse Flow Release, Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Below Normal Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	2,543	1,778	2,347	1,480	2,579	1,798	982	1,520	2,853	8,674	7,494	2,168	3,018
MOD1 Adjustment	2,615	1,805	2,313	1,492	2,579	1,798	982	1,531	2,775	8,529	7,435	2,495	3,029
MOD2 Adjustment	2,615	1,805	2,313	1,492	2,579	1,798	1,764	1,531	2,775	8,168	7,104	2,428	3,031
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	781	0	0	0	0	0	65
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	-361	-331	-67	-63
Minimum Flow Requirement	1,457	1,457	1,457	1,457	1,457	1,396	982	982	982	982	982	982	1,215
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	72	27	-34	12	0	0	0	11	-78	-145	-59	327	11
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	3%	2%	-1%	1%	0%	0%	0%	1%	-3%	-2%	-1%	15%	0%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	782	0	0	-361	-331	-67	2
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	80%	0%	0%	-4%	-4%	-3%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	72	27	-34	12	0	0	782	11	-78	-506	-390	260	13
Percent Change (MOD2 Adjustment minus WSIP Baseline)	3%	2%	-1%	1%	0%	0%	80%	1%	-3%	-6%	-5%	12%	0%

Table 68. Monthly Average Feather River Flow from Thermalito Junction (C203), Changes to Monthly Average Feather River Flow, Pulse Flow Release, Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Dry Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	2,500	1,617	2,431	1,397	1,534	1,479	938	1,855	4,297	7,148	1,904	1,047	2,346
MOD1 Adjustment	2,466	1,645	2,411	1,397	1,537	1,486	930	1,743	3,625	7,049	2,082	1,090	2,288
MOD2 Adjustment	2,466	1,645	2,411	1,397	1,537	1,486	1,585	1,743	3,625	6,588	1,973	1,023	2,290
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	655	0	0	0	0	0	55
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	-460	-110	-67	-53
Minimum Flow Requirement	1,394	1,394	1,394	1,394	1,394	1,319	903	903	903	903	903	903	1,142
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-34	28	-20	0	3	7	-8	-112	-672	-99	178	43	-58
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-1%	2%	-1%	0%	0%	0%	-1%	-6%	-16%	-1%	9%	4%	-2%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	655	0	0	-461	-109	-67	2
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	70%	0%	0%	-7%	-5%	-6%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	-34	28	-20	0	3	7	647	-112	-672	-560	69	-24	-56
Percent Change (MOD2 Adjustment minus WSIP Baseline)	-1%	2%	-1%	0%	0%	0%	69%	-6%	-16%	-8%	4%	-2%	-2%

Table 69. Monthly Average Feather River Flow from Thermalito Junction (C203), Changes to Monthly Average Feather River Flow, Pulse Flow Release, Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Critical Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	1,429	1,317	1,648	1,196	1,370	1,581	1,056	1,846	3,846	3,847	2,360	1,197	1,891
MOD1 Adjustment	1,496	1,442	1,652	1,196	1,370	1,591	1,044	1,824	3,500	3,790	2,641	1,156	1,892
MOD2 Adjustment	1,496	1,442	1,652	1,196	1,370	1,591	1,044	1,824	3,500	3,790	2,641	1,156	1,892
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum Flow Requirement	1,175	1,175	1,175	1,175	1,175	1,050	792	792	792	792	792	792	973
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	67	125	4	0	0	10	-12	-22	-346	-57	281	-41	1
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	5%	9%	0%	0%	0%	1%	-1%	-1%	-9%	-1%	12%	-3%	0%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	67	125	4	0	0	10	-12	-22	-346	-57	281	-41	1
Percent Change (MOD2 Adjustment minus WSIP Baseline)	5%	9%	0%	0%	0%	1%	-1%	-1%	-9%	-1%	12%	-3%	0%

The long-term monthly average cumulative effects of three GW WSIP projects on Feather River flow at Sacramento River Junction (CalSim II node C223) is shown in Figure 25 and Table 70. The mean monthly increase in Feather River flow throughout the simulation period is 1 cfs, or less than 0.1% of the total 7,418 cfs of mean monthly Feather River flow. The mean pulse flow release of 277 cfs occurs in April and the mean pulse flow compensation of 269 cfs occurs from July to September. The long-term monthly average cumulative effects of the three GW WSIP projects on Feather River flow at Sacramento River Junction (C223) by water year type are shown in Figure 26 and in Tables 71 through 75.

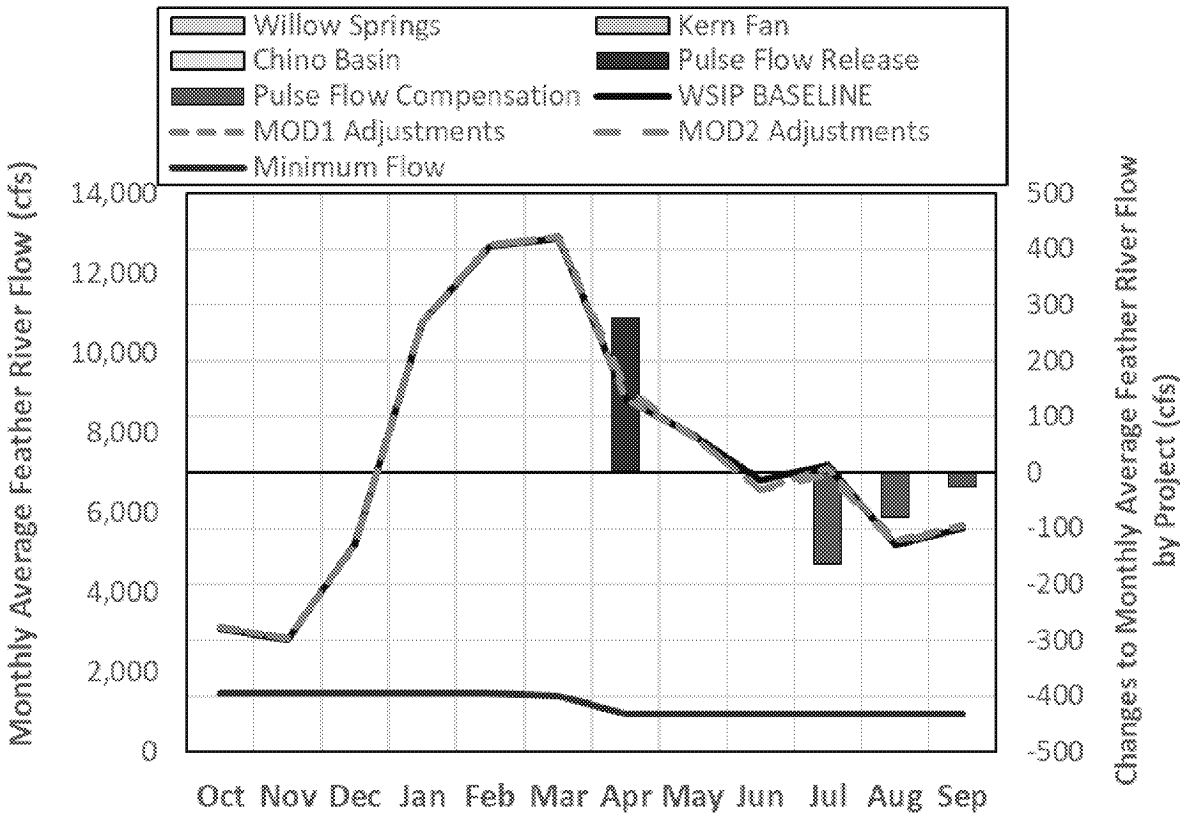


Figure 25. Monthly Average Feather River Flow at Sacramento River Junction (C223) for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Changes to Monthly Average Feather River Flow by Project, Pulse Flow Release from Lake Oroville, Pulse Flow Compensation, and Minimum Flow Requirement (in cubic feet per second)

Table 70. Monthly Average Feather River Flow at Sacramento River Junction (C223), Changes to Monthly Average Feather River Flow, Pulse Flow Release, Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,101	2,819	5,219	10,767	12,671	12,886	8,852	7,956	6,798	7,180	5,178	5,592	7,418
MOD1 Adjustment	3,135	2,850	5,182	10,781	12,688	12,897	8,861	7,929	6,577	7,112	5,311	5,688	7,417
MOD2 Adjustment	3,135	2,850	5,182	10,781	12,688	12,897	9,138	7,929	6,577	6,949	5,230	5,662	7,418
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	277	0	0	0	0	0	23
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	-163	-80	-26	-22
Minimum Flow Requirement	1,461	1,459	1,461	1,461	1,461	1,401	945	945	945	945	945	945	1,198
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	34	31	-37	14	17	11	9	-27	-221	-68	133	96	-1
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	1%	1%	-1%	0%	0%	0%	0%	0%	-3%	-1%	3%	2%	0%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	277	0	0	-163	-81	-26	1
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	3%	0%	0%	-2%	-2%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	34	31	-37	14	17	11	286	-27	-221	-231	52	70	0
Percent Change (MOD2 Adjustment minus WSIP Baseline)	1%	1%	-1%	0%	0%	0%	3%	0%	-3%	-3%	1%	1%	0%

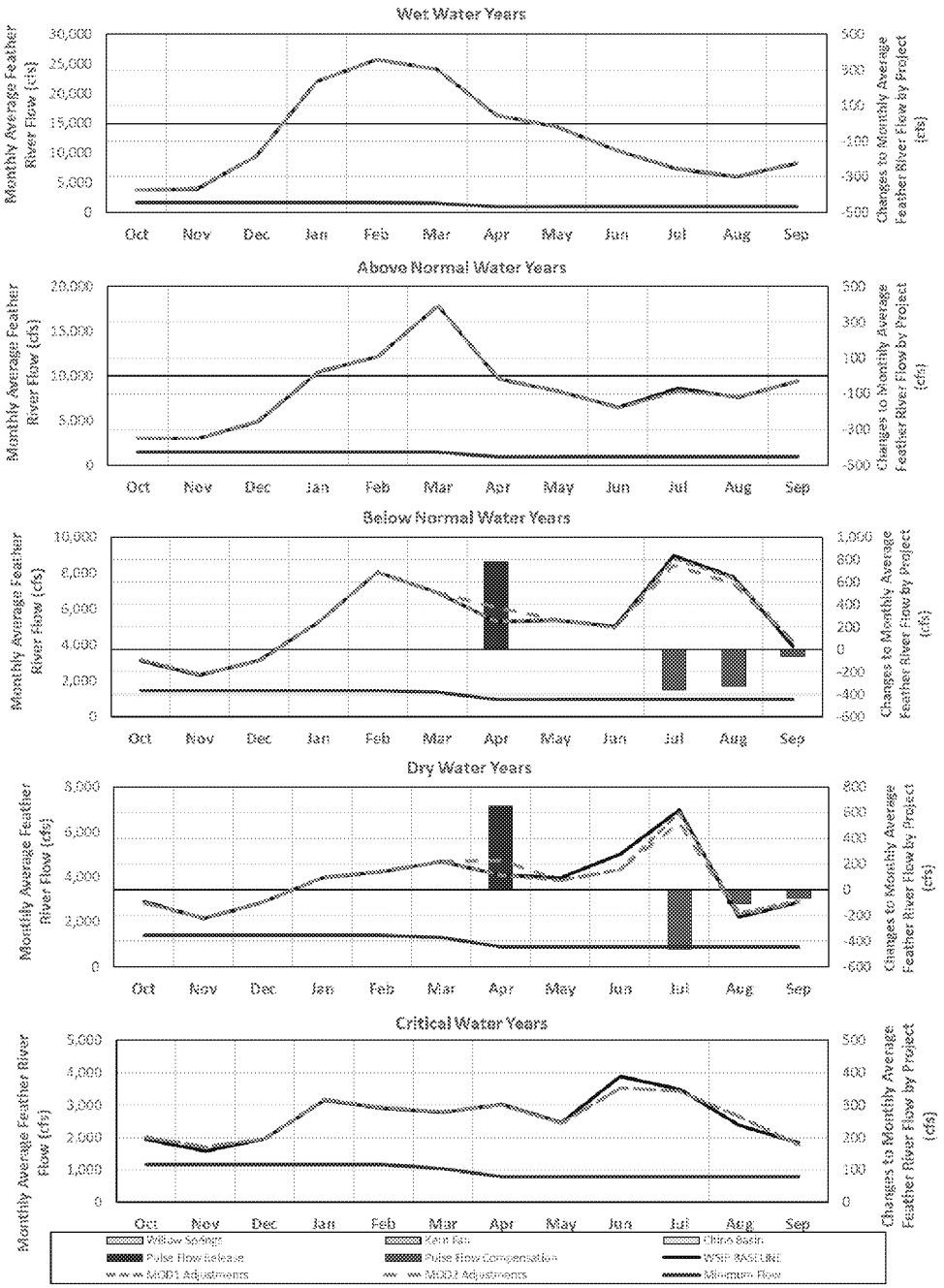


Figure 26. Monthly Average Feather River Flow at Sacramento River Junction (C203) for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Changes to Monthly Average Feather River Flow by Project, Pulse Flow Release from Lake Oroville, Pulse Flow Compensation, and Minimum Flow Requirement, by Water Year Type (in cubic feet per second)

Table 71. Monthly Average Feather River Flow at Sacramento River Junction (C223), Changes to Monthly Average Feather River Flow, Pulse Flow Release, Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Wet Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,798	3,993	9,571	22,085	25,734	24,148	16,345	14,467	10,476	7,416	5,988	8,326	12,695
MOD1 Adjustment	3,856	4,000	9,479	22,095	25,772	24,163	16,346	14,467	10,481	7,506	6,123	8,446	12,728
MOD2 Adjustment	3,856	4,000	9,479	22,095	25,772	24,163	16,346	14,467	10,481	7,506	6,123	8,446	12,728
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum Flow Requirement	1,612	1,605	1,612	1,612	1,612	1,583	1,000	1,000	1,000	1,000	1,000	1,000	1,303
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	58	7	-92	10	38	15	1	0	5	90	135	120	33
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	2%	0%	-1%	0%	0%	0%	0%	0%	0%	1%	2%	1%	0%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	58	7	-92	10	38	15	1	0	5	90	135	120	33
Percent Change (MOD2 Adjustment minus WSIP Baseline)	2%	0%	-1%	0%	0%	0%	0%	0%	0%	1%	2%	1%	0%

Table 72. Monthly Average Feather River Flow at Sacramento River Junction (C223), Changes to Monthly Average Feather River Flow, Pulse Flow Release, Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Above Normal Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,012	3,027	4,943	10,443	12,148	17,846	9,694	8,293	6,462	8,582	7,600	9,418	8,456
MOD1 Adjustment	3,024	3,026	4,957	10,487	12,159	17,853	9,774	8,292	6,413	8,326	7,737	9,424	8,456
MOD2 Adjustment	3,024	3,026	4,957	10,487	12,159	17,853	9,774	8,292	6,413	8,326	7,737	9,424	8,456
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum Flow Requirement	1,525	1,525	1,525	1,525	1,525	1,483	1,000	1,000	1,000	1,000	1,000	1,000	1,259
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	12	-1	14	44	11	7	80	-1	-49	-256	137	6	0
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0%	0%	0%	0%	0%	0%	1%	0%	-1%	-3%	2%	0%	0%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	12	-1	14	44	11	7	80	-1	-49	-256	137	6	0
Percent Change (MOD2 Adjustment minus WSIP Baseline)	0%	0%	0%	0%	0%	0%	1%	0%	-1%	-3%	2%	0%	0%

Table 73. Monthly Average Feather River Flow at Sacramento River Junction (C223), Changes to Monthly Average Feather River Flow, Pulse Flow Release, Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Below Normal Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	3,132	2,350	3,150	5,271	8,049	6,927	5,314	5,400	5,047	8,972	7,797	3,924	5,444
MOD1 Adjustment	3,203	2,377	3,117	5,286	8,055	6,930	5,314	5,410	4,968	8,815	7,735	4,251	5,455
MOD2 Adjustment	3,203	2,377	3,117	5,286	8,055	6,930	6,095	5,410	4,968	8,454	7,404	4,184	5,457
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	781	0	0	0	0	0	65
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	-361	-331	-67	-63
Minimum Flow Requirement	1,457	1,457	1,457	1,457	1,457	1,396	982	982	982	982	982	982	1,215
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	71	27	-33	15	6	3	0	10	-79	-157	-62	327	11
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	2%	1%	-1%	0%	0%	0%	0%	0%	-2%	-2%	-1%	8%	0%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	781	0	0	-361	-331	-67	2
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	15%	0%	0%	-4%	-4%	-2%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	71	27	-33	15	6	3	781	10	-79	-518	-393	260	13
Percent Change (MOD2 Adjustment minus WSIP Baseline)	2%	1%	-1%	0%	0%	0%	15%	0%	-2%	-6%	-5%	7%	0%

Table 74. Monthly Average Feather River Flow at Sacramento River Junction (C223), Changes to Monthly Average Feather River Flow, Pulse Flow Release, Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Dry Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	2,899	2,162	2,895	3,977	4,252	4,684	4,099	3,972	5,014	6,969	2,221	2,894	3,837
MOD1 Adjustment	2,863	2,191	2,875	3,980	4,258	4,693	4,092	3,860	4,329	6,867	2,408	2,933	3,779
MOD2 Adjustment	2,863	2,191	2,875	3,980	4,258	4,693	4,747	3,860	4,329	6,407	2,298	2,866	3,781
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	655	0	0	0	0	0	55
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	-460	-110	-67	-53
Minimum Flow Requirement	1,394	1,394	1,394	1,394	1,394	1,319	903	903	903	903	903	903	1,142
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-36	29	-20	3	6	9	-7	-112	-685	-102	187	39	-58
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-1%	1%	-1%	0%	0%	0%	0%	-3%	-14%	-1%	8%	1%	-2%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	655	0	0	-460	-110	-67	2
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	16%	0%	0%	-7%	-5%	-2%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	-36	29	-20	3	6	9	648	-112	-685	-562	77	-28	-56
Percent Change (MOD2 Adjustment minus WSIP Baseline)	-1%	1%	-1%	0%	0%	0%	16%	-3%	-14%	-8%	3%	-1%	-1%

Table 75. Monthly Average Feather River Flow at Sacramento River Junction (C223), Changes to Monthly Average Feather River Flow, Pulse Flow Release, Pulse Flow Compensation for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Critical Water Years (in cubic feet per second)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
WSIP Baseline	1,946	1,597	1,964	3,167	2,911	2,779	3,032	2,467	3,887	3,491	2,378	1,838	2,621
MOD1 Adjustment	2,011	1,721	1,967	3,173	2,918	2,800	3,020	2,440	3,532	3,425	2,654	1,782	2,620
MOD2 Adjustment	2,011	1,721	1,967	3,173	2,918	2,800	3,020	2,440	3,532	3,425	2,654	1,782	2,620
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum Flow Requirement	1,175	1,175	1,175	1,175	1,175	1,050	792	792	792	792	792	792	973
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	65	124	3	6	7	21	-12	-27	-355	-66	276	-56	-1
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	3%	8%	0%	0%	0%	1%	0%	-1%	-9%	-2%	12%	-3%	0%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	65	124	3	6	7	21	-12	-27	-355	-66	276	-56	-1
Percent Change (MOD2 Adjustment minus WSIP Baseline)	3%	8%	0%	0%	0%	1%	0%	-1%	-9%	-2%	12%	-3%	0%

3.2.5 Delta Outflow

The long-term monthly average cumulative effects of the three GW WSIP project Delta outflow decreases, and pulse flow release are shown in Figure 27 and Table 76. Mean annual reductions in Delta outflow throughout the simulation period are 308 TAF, or 2% of the total 15,539 TAF of mean annual Delta outflow. Note that MOD1 and MOD2 lines are almost equal because of the smaller magnitude of the impact of Kern Fan and Willow Springs diversions of surplus flows and the relatively infrequent diversions of surplus flows. The mean annual pulse flow release throughout the simulation period is 16.5 TAF in April. The long-term monthly average cumulative effects of the three GW WSIP projects on Delta surplus and pulse flow release by water year type are shown in Figure 28 and in Tables 77 through 81.

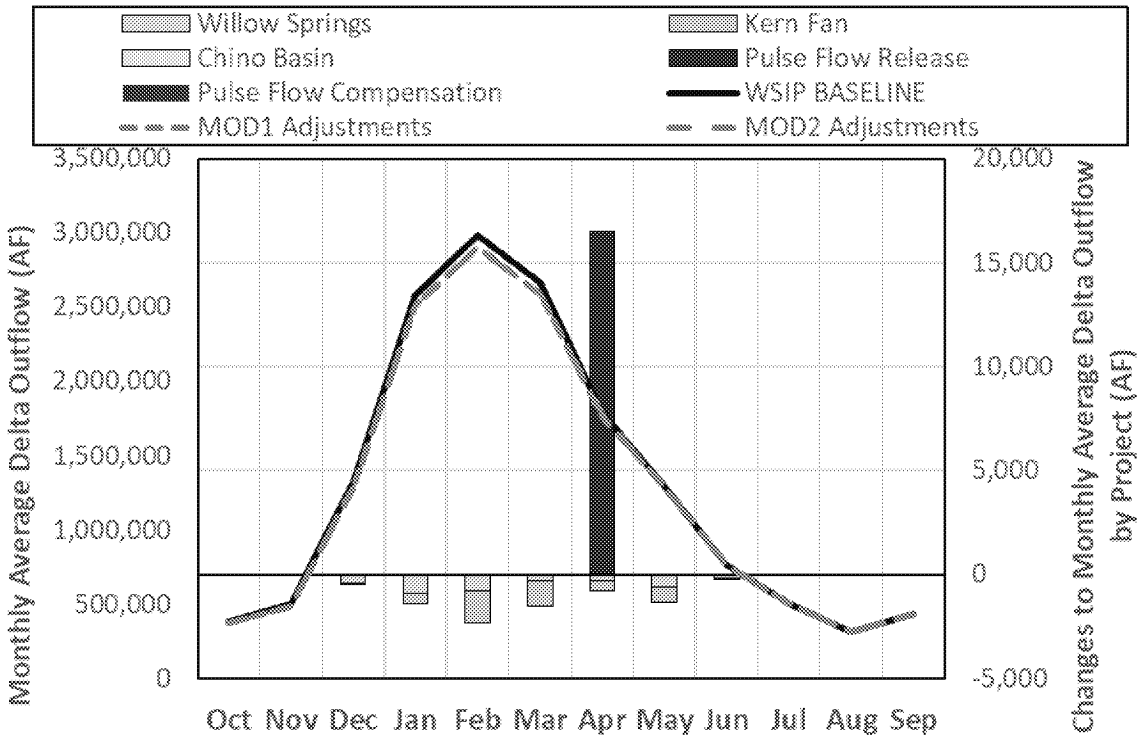


Figure 27. Monthly Average Delta Outflow for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, Changes to Monthly Average Delta Outflow by Project, and Pulse Flow Release from Lake Oroville (in acre-feet)

Table 76. Monthly Average Delta Outflow, Changes to Monthly Average Delta Outflow and Pulse Flow Release from Lake Oroville for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet)

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	380	501	1,331	2,576	2,983	2,664	1,794	1,292	766	501	315	436	15,539
MOD1 Adjustment	378	487	1,292	2,509	2,903	2,587	1,773	1,289	759	500	312	434	15,222
MOD2 Adjustment	378	487	1,291	2,508	2,901	2,585	1,789	1,287	759	500	312	434	15,231
MOD2 Adjustment by Willow Springs	0	0	0	-1	-1	0	0	-1	0	0	0	0	-3
MOD2 Adjustment by Kern Fan	0	0	0	-1	-2	-1	0	-1	0	0	0	0	-5
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	16	0	0	0	0	0	16
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-2	-14	-39	-67	-80	-77	-21	-3	-7	-1	-3	-2	-317
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-1%	-3%	-3%	-3%	-3%	-3%	-1%	0%	-1%	0%	-1%	0%	-2%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	-1	-1	-2	-2	16	-2	0	0	0	0	9
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	-2	-14	-40	-68	-82	-79	-5	-5	-7	-1	-3	-2	-308
Percent Change (MOD2 Adjustment minus WSIP Baseline)	-1%	-3%	-3%	-3%	-3%	-3%	0%	0%	-1%	0%	-1%	0%	-2%

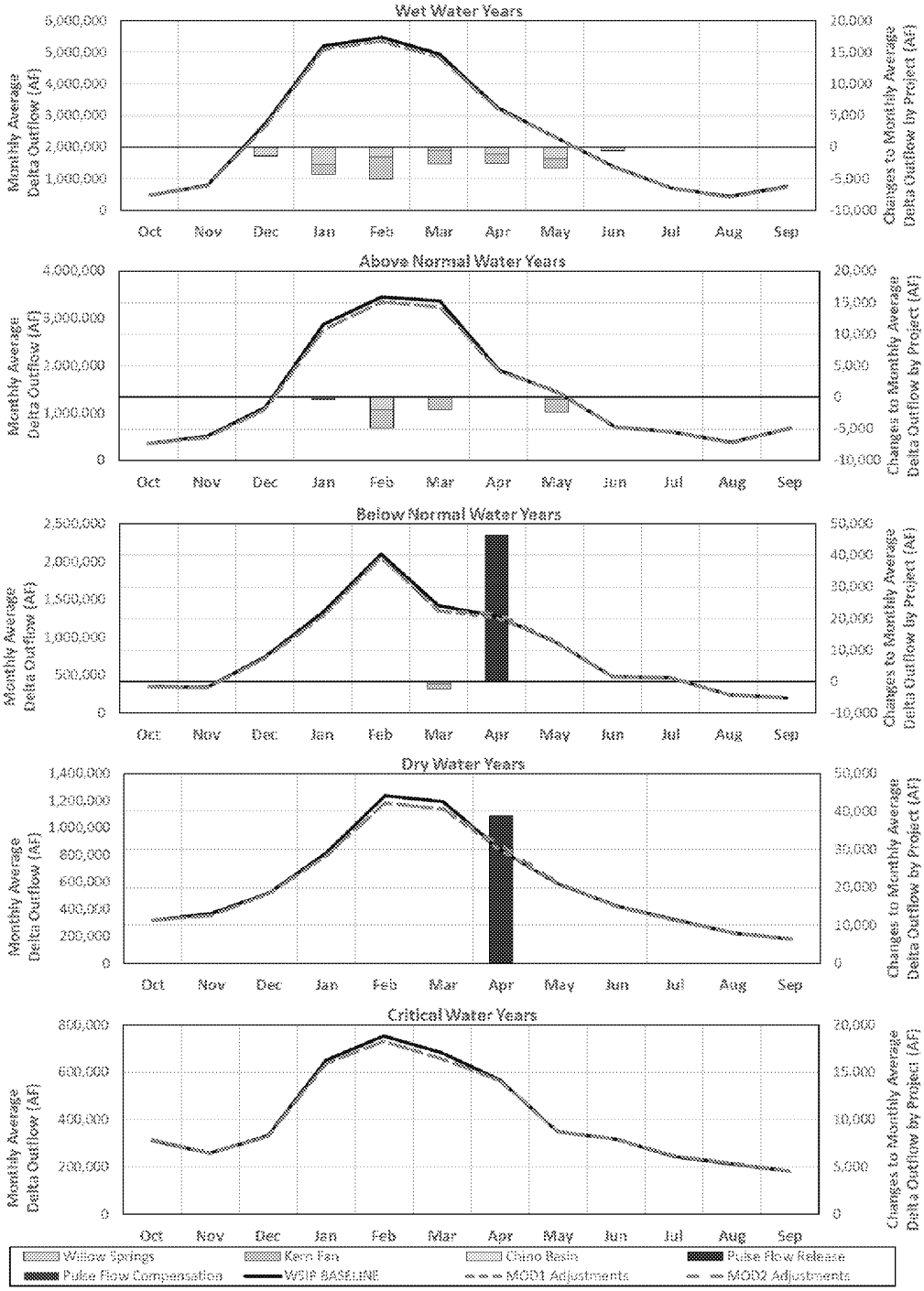


Figure 28. Monthly Average Delta Surplus for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments, by MOD2 Project, and Pulse Flow Release from Lake Oroville, by Water Year Type (in acre-feet)

Table 77. Monthly Average Delta Outflow, Changes to Monthly Average Delta Outflow and Pulse Flow Release from Lake Oroville for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet), Wet Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	477	789	2,768	5,214	5,477	4,943	3,257	2,331	1,387	720	431	745	28,539
MOD1 Adjustment	469	769	2,681	5,112	5,350	4,845	3,206	2,315	1,373	716	421	737	27,993
MOD2 Adjustment	469	769	2,679	5,107	5,345	4,843	3,203	2,312	1,373	716	421	737	27,974
MOD2 Adjustment by Willow Springs	0	0	-1	-3	-2	-1	-1	-2	0	0	0	0	-9
MOD2 Adjustment by Kern Fan	0	0	0	-2	-3	-2	-2	-2	0	0	0	0	-10
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-8	-20	-87	-102	-127	-98	-51	-16	-14	-4	-10	-8	-546
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	-2%	-3%	-3%	-2%	-2%	-2%	-2%	-1%	-1%	-1%	-2%	-1%	-2%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	-2	-5	-5	-2	-3	-3	0	0	0	0	-19
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	-8	-20	-89	-107	-132	-100	-54	-19	-14	-4	-10	-8	-565
Percent Change (MOD2 Adjustment minus WSIP Baseline)	-2%	-3%	-3%	-2%	-2%	-2%	-2%	-1%	-1%	-1%	-2%	-1%	-2%

Table 78. Monthly Average Delta Outflow, Changes to Monthly Average Delta Outflow and Pulse Flow Release from Lake Oroville for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet), Above Normal Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	355	507	1,120	2,873	3,454	3,369	1,904	1,444	712	595	380	681	17,394
MOD1 Adjustment	355	488	1,078	2,752	3,347	3,243	1,882	1,451	707	597	376	681	16,956
MOD2 Adjustment	355	488	1,078	2,752	3,342	3,241	1,882	1,449	707	597	376	681	16,947
MOD2 Adjustment by Willow Springs	0	0	0	0	-2	0	0	0	0	0	0	0	-3
MOD2 Adjustment by Kern Fan	0	0	0	0	-3	-2	0	-2	0	0	0	0	-7
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0	-19	-42	-121	-107	-126	-22	7	-5	2	-4	0	-438
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0%	-4%	-4%	-4%	-3%	-4%	-1%	0%	-1%	0%	-1%	0%	-3%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	-5	-2	0	-2	0	0	0	0	-9
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	0	-19	-42	-121	-112	-128	-22	5	-5	2	-4	0	-447
Percent Change (MOD2 Adjustment minus WSIP Baseline)	0%	-4%	-4%	-4%	-3%	-4%	-1%	0%	-1%	0%	-1%	0%	-3%

Table 79. Monthly Average Delta Outflow, Changes to Monthly Average Delta Outflow and Pulse Flow Release from Lake Oroville for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet), Below Normal Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	355	341	742	1,332	2,104	1,421	1,276	944	487	464	248	204	9,918
MOD1 Adjustment	355	332	719	1,275	2,053	1,348	1,264	948	485	466	248	203	9,698
MOD2 Adjustment	355	332	719	1,275	2,053	1,346	1,310	948	485	466	248	203	9,742
MOD2 Adjustment by Willow Springs	0	0	0	0	0	-1	0	0	0	0	0	0	-1
MOD2 Adjustment by Kern Fan	0	0	0	0	0	-2	0	0	0	0	0	0	-2
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	46	0	0	0	0	0	46
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0	-9	-23	-57	-51	-73	-12	4	-2	2	0	-1	-220
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0%	-3%	-3%	-4%	-2%	-5%	-1%	0%	0%	0%	0%	0%	-2%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	-2	46	0	0	0	0	0	44
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	4%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	0	-9	-23	-57	-51	-75	34	4	-2	2	0	-1	-176
Percent Change (MOD2 Adjustment minus WSIP Baseline)	0%	-3%	-3%	-4%	-2%	-5%	3%	0%	0%	0%	0%	0%	-2%

Table 80. Monthly Average Delta Outflow, Changes to Monthly Average Delta Outflow and Pulse Flow Release from Lake Oroville for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet), Dry Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	320	366	521	818	1,236	1,192	831	587	419	322	224	179	7,016
MOD1 Adjustment	320	352	514	797	1,185	1,138	834	588	416	320	225	179	6,868
MOD2 Adjustment	320	352	514	797	1,185	1,138	873	588	416	320	225	179	6,907
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	39	0	0	0	0	0	39
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0	-14	-7	-21	-51	-54	3	1	-3	-2	1	0	-148
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	0%	-4%	-1%	-3%	-4%	-5%	0%	0%	-1%	-1%	0%	0%	-2%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	39	0	0	0	0	0	39
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	5%	0%	0%	0%	0%	0%	1%
Total Change (MOD2 Adjustment minus WSIP Baseline)	0	-14	-7	-21	-51	-54	42	1	-3	-2	1	0	-109
Percent Change (MOD2 Adjustment minus WSIP Baseline)	0%	-4%	-1%	-3%	-4%	-5%	5%	0%	-1%	-1%	0%	0%	-2%

Table 81. Monthly Average Delta Outflow, Changes to Monthly Average Delta Outflow and Pulse Flow Release from Lake Oroville for WSIP Baseline, MOD1 Adjustments and MOD2 Adjustments (in thousand acre-feet), Critical Water Year Type

Scenario/Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
WSIP Baseline	312	258	332	651	753	682	566	350	317	246	213	181	4,860
MOD1 Adjustment	314	258	330	636	730	656	562	349	317	246	217	181	4,796
MOD2 Adjustment	314	258	330	636	730	656	562	349	317	246	217	181	4,796
MOD2 Adjustment by Willow Springs	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Kern Fan	0	0	0	0	0	0	0	0	0	0	0	0	0
MOD2 Adjustment by Chino Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Release from Lake Oroville	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulse Flow Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
Total **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	2	0	-2	-15	-23	-26	-4	-1	0	0	4	0	-64
Percent **MOD1** Change (MOD1 Adjustment minus WSIP Baseline)	1%	0%	-1%	-2%	-3%	-4%	-1%	0%	0%	0%	2%	0%	-1%
Total **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent **MOD2** Change (MOD2 Adjustment minus MOD1 Adjustment)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total Change (MOD2 Adjustment minus WSIP Baseline)	2	0	-2	-15	-23	-26	-4	-1	0	0	4	0	-64
Percent Change (MOD2 Adjustment minus WSIP Baseline)	1%	0%	-1%	-2%	-3%	-4%	-1%	0%	0%	0%	2%	0%	-1%

3.2.6 Groundwater Bank Storage

Annual and cumulative fill of the pulse flow account for each project is shown in the top of Figure 29 for the 82-year simulation period, and the annual fill of all accounts of Willow Springs and Kern Fan are shown in the bottom of Figure 29 along with MOD2 exportable Delta surplus as Article 21 (minimum of Delta surplus and regulatory/physical capacity at Banks).

Chino Basin fills with approximately 12 TAF per year of treated water. Willow Springs and Kern Fan only fill when Delta surplus is available, SWP San Luis Reservoir is full, and there is available permitted and regulatory capacity at Banks. This occurs only in four years prior to 1969, and in each instance, the Willow Springs pulse flow account fills with more Delta surplus than Kern Fan, for two primary reasons: (1) Willow Springs has significantly more storage capacity in the environmental account than Kern Fan and (2) Kern Fan exports are allocated to other storage accounts. Total exported Delta surplus is generally split between these two projects, except when Kern Fan has reached full capacity in all accounts and Willow Springs still has available capacity (e.g., bottom of Figure 29 in 1970 and 1984).

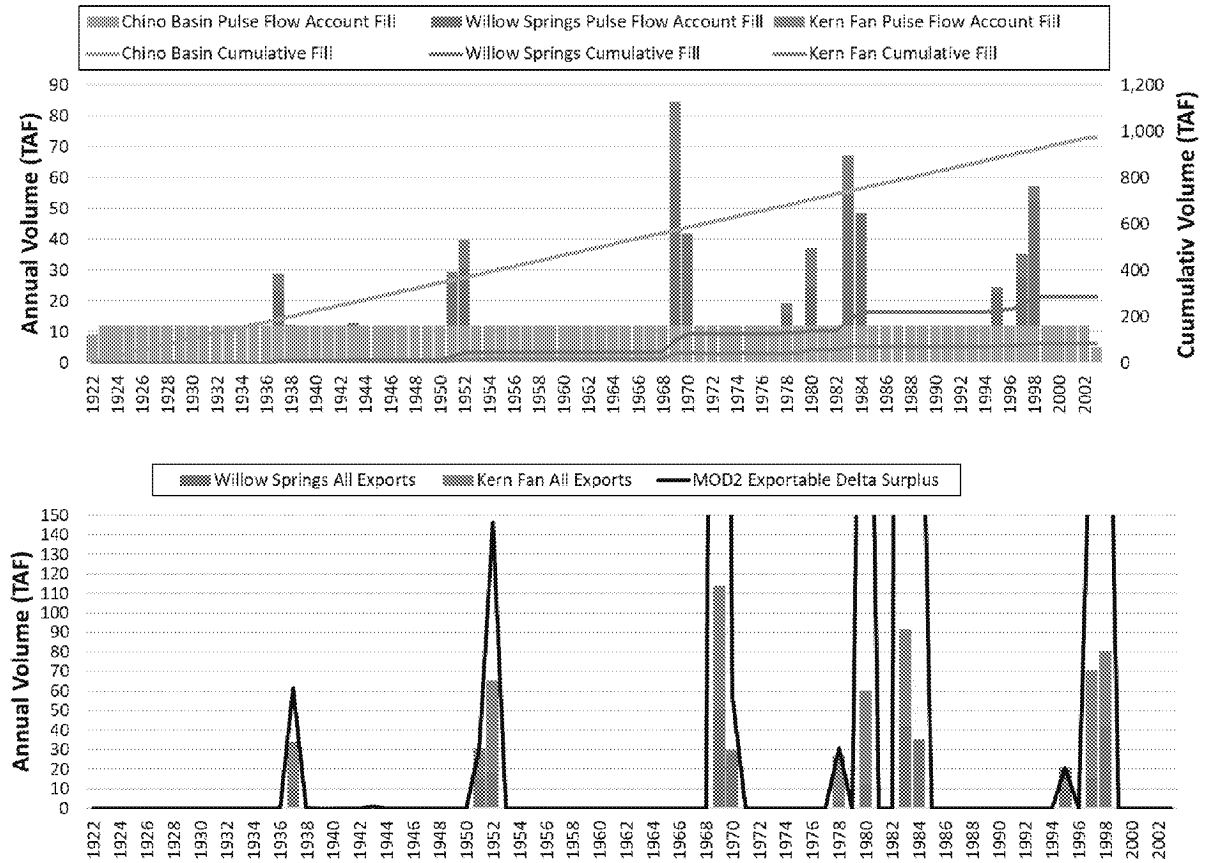


Figure 29. Top: Annual and Cumulative Fill of Each Groundwater Project Pulse Flow Account (in thousand acre-feet). Bottom: Annual Fill of Willow Springs and Kern Fan All Accounts and Exportable Delta Surplus.

Figures 30 through 32 show the total monthly storage in each GW bank for the 82-year simulation period. As shown in Figure 30, unlike the other two GW banks, Chino Basin does not maintain an explicit account for allowing pulse flows. Instead, consistent with their local agreement, total storage fluctuates between a maximum amount, which reflects the total capacity of the GW bank, and a negative minimum amount, which reflects borrowing from other Chino Basin groundwater. Storage increases continuously due to recharge from treated water and is reduced only when deliveries are made to Inland Empire Utility Agency (IEUA) or MWD. In a pulse flow year, MWD would reduce their SWP exports from Banks from April through December. As previously mentioned, because the pulse flow is decoupled from the compensation deliveries to IEUA and MWD, the reductions in total storage are independent from the pulse flow years (e.g., 1935 to 1937). The bottom portion of the figure shows the virtual storage account of Lake Oroville and the San Luis Reservoir storage account. In a pulse flow year, the Lake Oroville virtual account is debited 40 TAF in April when a pulse flow is made, and then credited 40 TAF in July when Lake Oroville releases and Banks exports are reduced. The San Luis Reservoir storage account accumulates supplies starting in April when MWD reduces their SWP deliveries. This account is reduced to a negative value in July to offset the Banks export reductions, then the account accumulates supplies through the remainder of the calendar year to return the account to 0.

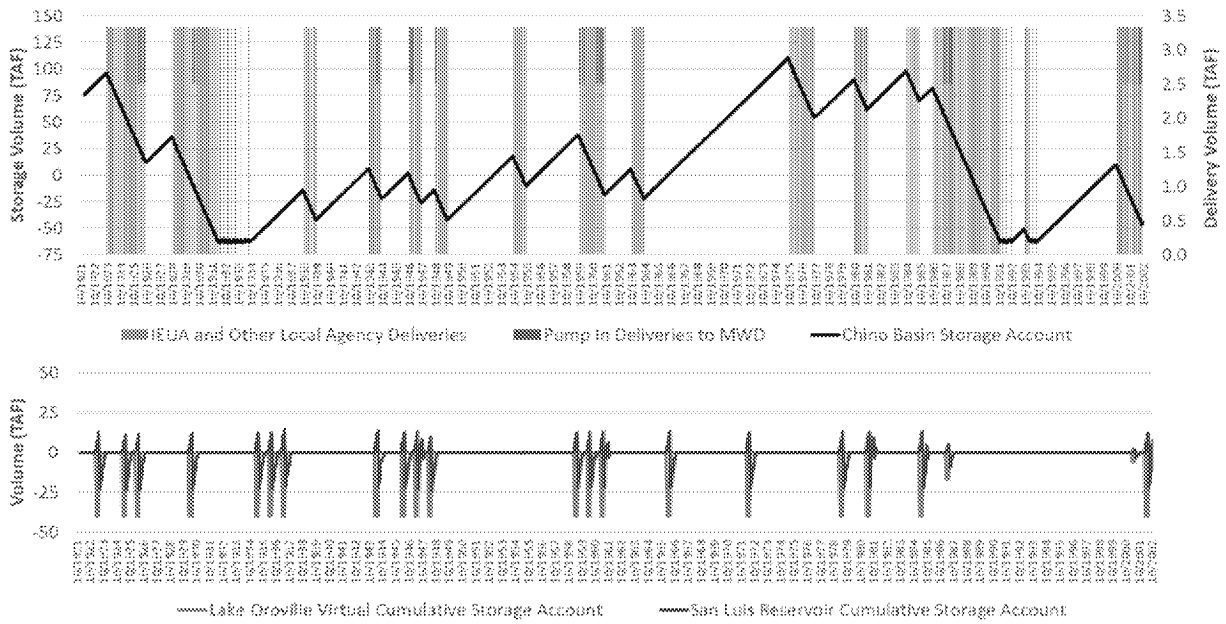


Figure 30. Top: Monthly Storage in and Deliveries from Chino Basin (in thousand acre-feet). Bottom: Storage Accounts to Track Pulse Flow and Compensation (in thousand acre-feet)

Shown in Figure 31, there are three storage accounts in Willow Springs: Pre-evacuation, Ecological Benefit Storage, and Table A. The Pre-evacuation storage account receives water that is moved from San Luis Reservoir in order to open up space for opportunistic pumping of Delta surplus, and that account

is always reduced back to zero by the end of the water year. The Ecological Benefit Storage account holds any additional yield generated by opportunistic pumping of Delta surplus, which is first stored in San Luis Reservoir and then transferred to this account. The Ecological Benefit Storage account can go slightly negative at times due to the leave-behind requirements when storing water in the underlying adjudicated groundwater basin, but this deficit must be paid off before water from that account can be used for pulse flow compensation. The Table A account holds a portion of AVEK's Table A allocated water that is in excess of their consumptive use demand, developing a backup supply for years when their Table A allocation is insufficient for their consumptive use demand. The Table A account does not have any effect on the pulse flow operation. It is managed in this simulation to store a reasonable volume of supplies for drought years but to not fill up the GW bank, a condition that could limit the operation of the Ecological Benefit Storage account and associated pulse flow operations.

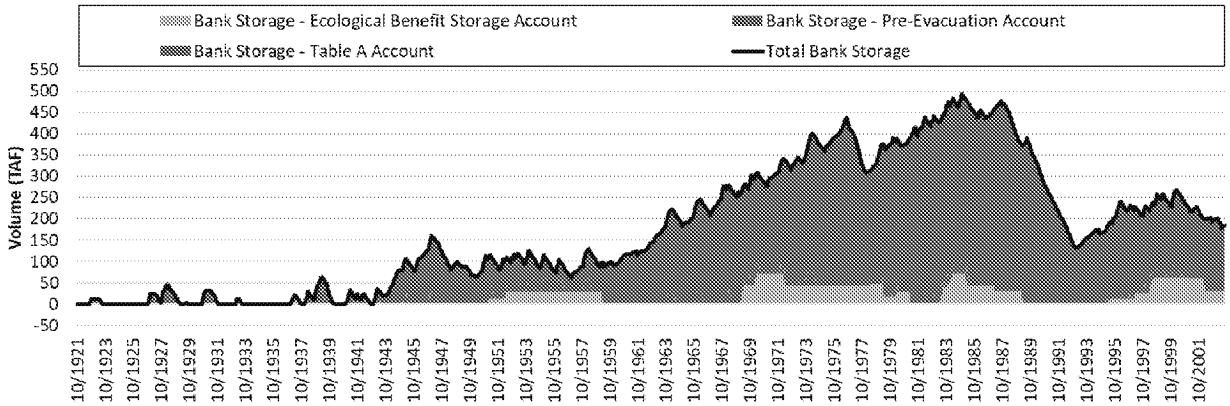


Figure 31. Monthly Storage for Willow Springs (in thousand acre-feet)

As shown in Figure 32, Kern Fan is composed of three accounts: environmental, IRWD, and RR. Available Article 21 supply is split between the three accounts, with 25% going to the environment account when storage capacity is available and 38% going to both the IRWD and RR accounts. The available storage in the environmental account is used to determine the pulse flow release. Even though there are some pulse flow years when Kern Fan has water stored in the environmental account, the original Kern Fan spreadsheet model does not allow partial delivery, so no water is contributed to the pulse flow operations.

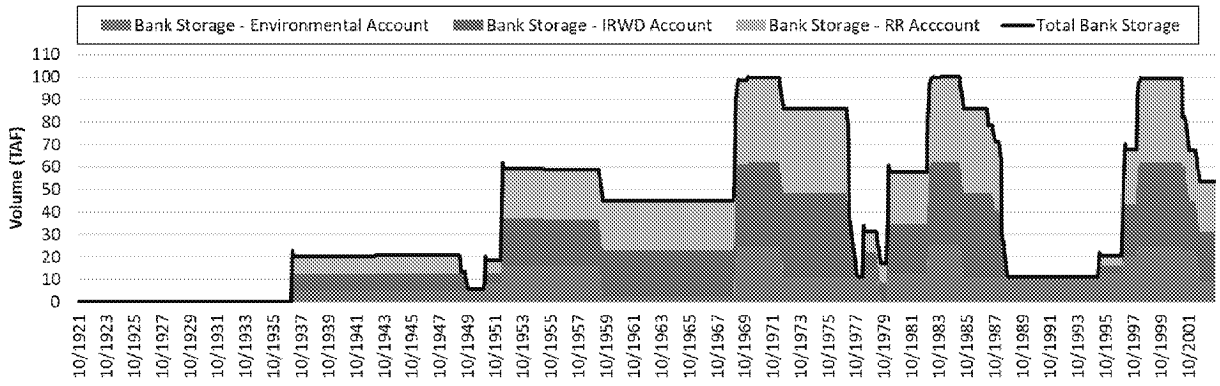


Figure 32. Monthly Storage for Kern Fan (in thousand acre-feet)

3.3 PULSE FLOW DELIVERY

For the cumulative analysis, a pulse flow was requested in April of Below Normal and Dry water year types, as defined by the Sacramento Valley Index, consistent with the water year types used by each groundwater bank in their WSIP application materials. The maximum requested pulse flow was 100 TAF; as previously mentioned, the combined storage volume for pulse flow exchange water of all GW banks is 97 TAF. The actual pulse flow request would be determined in real time subject to requests from CDFW.

The feasible pulse flow volume available to be delivered in MOD2 is based on the minimum of two values. The first value is the total volume of Lake Oroville flow release reductions, from July through September, that could be made while maintaining both the minimum flow threshold in the Feather River and the minimum Banks health and safety export (300 cfs). The second value is the total storage available for pulse flows in all GW banks in April. This value was assumed physically available to compensate Partner Contractors through the end of the year for any pulse flow made in April. The minimum of these two values was calculated and delivered as a pulse flow in April. An equivalent volume of pulse flow compensation reduction was made from July through September to ensure Lake Oroville storage levels in September matched those in the WSIP Baseline. Storage levels in SWP San Luis Reservoir were not analyzed, since compensatory releases from GW banks are always the same as the reductions in releases for exports from Lake Oroville. SWP San Luis Reservoir can be assumed to always have equivalent storage at the end of the year under the conditions when pulse flows are not implemented.

An annual time series of the pulse flow request, allowable pulse flow volume based on minimum flow or export constraints, and pulse flow delivery based on total GW storage available for pulse flows is shown in Figure 33. The pulse flow request is consistently set at 100 TAF (blue line). The pulse flow volume available due to MOD1 adjustments, i.e., after accounting for Feather River minimum flows and allowable Banks export adjustments, is reduced in three years: 1955, 1987, and 2001 (red dashed line). In these years, there is not enough volume in July through September above the Feather River minimum flow requirement or above the Banks health and safety minimum export limit to reduce Oroville releases, and in effect Delta inflows, by the full pulse request volume. Total pulse flow volume delivered through GW

bank exchange (green dashed line) averaged 46.4 TAF in Below Normal years and 38.9 TAF in Dry years, less than the pulse flow request, due to the lack of available GW storage during drought periods and certain limitations within each GW spreadsheet model as to when pulse flows could be delivered.

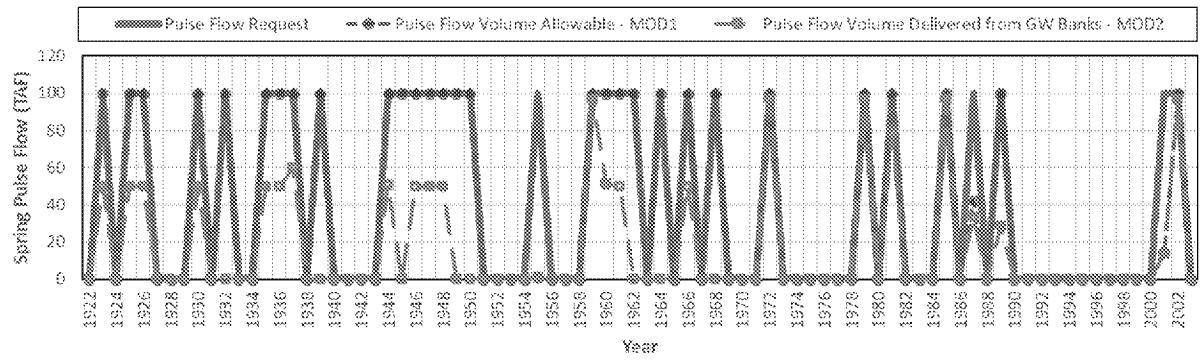


Figure 33. Annual Pulse Flow Time Series (in thousand acre-feet)

An annual time series of the pulse flow delivered by project is shown in Figure 34, and the pulse flow delivery by project is shown in Table 82. Chino Basin is most consistent in delivering a pulse flow when requested, as it remains relatively full due to the continuous fill operation from non-Delta sources. There are several instances when Chino Basin does not release a pulse flow due to the conservative assumption of limiting consecutive years of pulse flow delivery (no more than 3 consecutive or 4 out of 10 years). Constrained by the CalSim II hydrologic sequence, Willow Springs is limited in providing pulse flows prior to 1959, due to the lack of exportable surplus that can be used to generate additional yield, which in turn limits storage in the GW bank that can be used to compensate for pulse flows. Kern Fan does not provide a pulse flow consistently until 1959, 38 years into the simulation after sufficient water has accumulated in the environmental storage account. Even though Kern Fan partially fills prior to 1959, consistent with the project operations description, the post-processor does not allow a pulse flow to be made until 18 TAF is held in storage.

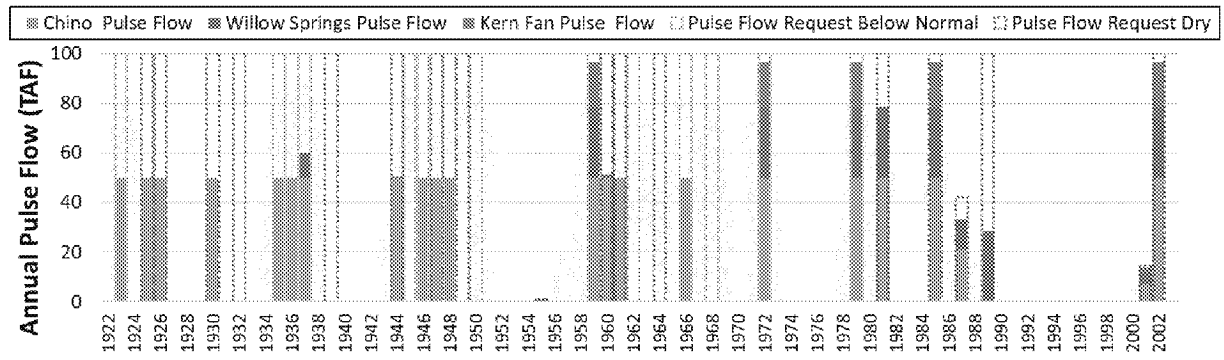


Figure 34. Annual Pulse Requested in Below Normal (dashed yellow line) and Dry (dashed red line) Years and Delivered by Each Groundwater Project (in thousand acre-feet)

Table 82. Average Pulse Flow Request and Delivery by Project by Water Year Type (in thousand acre-feet)

Water Year Type	Pulse flow request (TAF)	Chino Basin pulse flow delivered (TAF)	Kern Fan pulse flow delivered (TAF)	Willow Springs pulse flow delivered (TAF)	Total pulse flow delivered (TAF)
W	0.0	0.0	0.0	0.0	0.0
AN	0.0	0.0	0.0	0.0	0.0
BN	100.0	35.7	3.9	6.8	46.4
D	86.6	29.4	2.2	7.4	38.9
C	0.0	0.0	0.0	0.0	0.0
Average	**36.1**	**12.5**	**1.1**	**2.8**	**16.5**

The results of the analysis suggest the following two factors contribute to the pulse flow delivery:

1. **CalSim II hydrology and the assumption on initial storage.** The availability of Delta surplus is highly dependent on CalSim II hydrology, which is wetter in the latter half of the simulation period. The Delta surplus dependent GW banks, Willow Springs and Kern Fan, are set to an initial storage of 0 TAF, so no compensation for pulse flows can be provided until sufficient storage is accumulated. Starting each groundwater bank at 0 TAF initial storage may artificially suppress the GW bank availability for a pulse flow since the historical hydrology in CalSim II is relatively dry for the first few decades. Chino Basin is set to an initial storage of 75 TAF to be consistent with the project proposed operation. A value of 0 TAF was not used in the cumulative analysis because Chino Basin can leverage the basin agreement to allow borrowing from other groundwater accounts.

   The effect of initial storage used in the analysis was analyzed as a sensitivity. Starting Willow Springs with 50 TAF of initial storage and Kern Fan with 25 TAF of initial storage increases the annual pulse flow delivered from 16.5 TAF per year to 17.2 TAF per year and changes the number of pulses provided by Kern Fan (7 to 8) and Willow Springs (14 to 16). From a viewpoint of providing pulse flows, the initial storage seems to have limited effects. Other alternative approaches to reduce the effects of initial storage may be explored in the future if warranted; however, it is likely that the sequence of hydrology is more constraining than the assumed initial storage conditions for each groundwater banks.

2. **The assumption on allowing partial delivery.** There is no available Delta surplus that can be exported for Kern Fan or Willow Springs in the WSIP Baseline until 1936, 14 years into the simulation. Both Kern Fan and Willow Springs export surplus for fill at this time. Willow Springs can deliver a partial pulse flow in subsequent years with this volume, but the Kern Fan model only allows delivery of the full pulse volume, so it does not deliver a pulse flow until it fills more. The next time exportable surplus becomes available is 14 years later in 1951. At this point, Kern Fan begins accumulating sufficient storage to begin providing a pulse flow when requested. Kern

Fan total storage for pulse flows is 25 TAF, and the reduction in storage due to a delivered pulse flow is 14 TAF, so after one pulse flow is made the storage account must be refilled at least partially before making a subsequent release. This limits the ability of Kern Fan to deliver a pulse flow compared to the other two GW banks. Both Willow Springs and Chino Basin contain total storage for pulse flows greater than twice the pulse flow volume delivered, allowing them to deliver more frequent pulses without requiring a total refill.

4.0 PRELIMINARY SUMMARY OF FINDINGS

A post-processing tool was developed to analyze the cumulative effects of Sites, Harvest, LVE, Chino Basin, Kern Fan, and Willow Springs WSIP projects on Delta surplus and exports in a baseline CalSim II model. The tool integrated changes in Delta flows and exports from these projects, and assessed the ability of the three GW banks to make a coordinated pulse flow release from Lake Oroville. This section organizes and summarizes the preliminary findings.

4.1 ABILITY TO SUPPORT PULSE FLOW OPERATIONS

Out of 32 total Below Normal and Dry years in the 82-year simulation period (i.e., possible pulse flow delivery years), a full 97 TAF pulse flow is delivered in 5 years and a partial pulse flow averaging 43 TAF is delivered in 20 years. Two primary reasons limit the delivery of a pulse flow. First, for Willow Springs and Kern Fan, each GW bank fills using Delta surplus water that is subject to Delta operational constraints and only available in a limited number of years. These GW banks often do not have enough water accumulated in storage to deliver a full pulse flow. Kern Fan is particularly constrained since it cannot store more volume than what it delivers as a pulse flow in a single year. Willow Springs can fill to a much greater amount than the pulse flow volume, which enables a more reliable pulse flow delivery, especially later in the simulation period. Second, while Chino Basin is not subject to Delta operations, its pulse releases were assumed to be limited in frequency to 3 consecutive or 4 out of 10 years. There are several instances when the frequency of Below Normal and Dry years exceeds this limit, and Chino Basin does not release a pulse (e.g., 1942 to 1952). The cumulative implementation of all WSIP projects suggests pulse flows cannot be delivered during certain conditions, including relatively dry multi-decadal dry periods (e.g., 1920 – 1950) and dry decades following a wet period (e.g., 1960 – 1970).

An important limitation on simulated pulse flow deliveries is hydrologic sequencing in the CalSim II model. The existing conditions CalSim II hydrology begins with a relatively dry period and ends with a much wetter period. This hydrologic sequence results in a multi-decadal period before the GW banks can accumulate water supply and deliver a pulse flow. The GW banks can more consistently deliver a pulse flow from 1970 to the late 1980s, when the sequencing of wet to dry years allows the GW banks to fill, empty, and refill more frequently. Despite each GW bank accumulating storage during the relatively wet 1990s, each GW bank ends the simulation period with limited stored water supplies available for a pulse flow. For example. Willow Springs finishes the simulation with 30 TAF of stored water in the Ecological

Benefit Storage account (see Figure 31), enough to provide one more pulse in addition to the 14 already provided. Kern Fan finishes the simulation with approximately 10 TAF of stored water in the environmental account, which is not sufficient to provide another pulse flow. Chino Basin finishes the simulation with negative (i.e., borrowed) storage. A different hydrologic sequencing of dry and wet years could be assessed by randomly starting the models and post-processors in different years. It is likely, however, that there would still be years the pulse flow would not be provided. It is reasonable to infer that the limitation on providing pulse flows when requested in every Dry and Below Normal year is still likely to happen, even with a stochastic model or Monte Carlo-type approach to alleviate the limitations from a set hydrologic sequence.

Preliminary findings suggest Kern Fan may be the most sensitive to the cumulative implementation of the six WSIP projects relative to when the projects were simulated independently. Kern Fan and Willow Springs compete for available Delta surplus flows when SWP San Luis Reservoir is full. Willow Springs generates new water supplies by allowing for additional exports that are stored in space opened up in San Luis Reservoir through pre-evacuation, while Kern Fan is filled with additional Article 21 deliveries beyond those in MOD1. Since San Luis Reservoir filling is prioritized ahead of additional Article 21 deliveries, and the availability of Delta surplus and export capacity when San Luis Reservoir is full can be limited, Kern Fan is more constrained by the cumulative implementation of projects than Willow Springs. In addition, from a system-wide standpoint, Sites and LVE are reducing Delta surplus, and Harvest to a lesser extent, which could also reduce supplies for Willow Springs and Kern Fan.

The results from the cumulative analysis also suggest that the CVP, SWP, and Delta are tightly operated in the WSIP Baseline. There are limited opportunities when surplus is available, especially early in the 82-year simulation period that is historically dry. There are also limited opportunities when export capacity is available south of the Delta to take advantage of the available surplus. Kern Fan and Willow Springs are more reliably filled later in the 82-year simulation period, and are more consistent in providing a pulse flow when requested after 1969. Their ability to meet the pulse flow request is constrained by the availability of accumulated supplies. In the case of Chino Basin, it is not constrained by tight Delta operation but by certain release rules and assumptions. For example, currently, Chino Basin operations have a conservative assumption that it would only make a pulse release for either 3 consecutive or 4 out of 10 years, and only if Lake Oroville storage and San Luis Reservoir storage are within minimum and maximum threshold values.

4.2 EFFECTS OF CALSIM II BASELINE MODEL

It is also prudent to point out the effects of using the updated WSIP Baseline CalSim II model runs for the cumulative analysis. In reviewing the updated WSIP Baseline CalSim II model runs, it was noted that exportable Delta surplus is much less than that in the 2030 WSIP CalSim II model runs used by WSIP Projects for their original applications in 2017. This is especially apparent in the period prior to 1969. There is more exportable surplus in the prior model runs even though SWP share of the San Luis Reservoir is full more frequently in the more recent models, which should increase the frequency of opportunities for additional export. This reduction in exportable surplus could impose significant

constraints on the abilities of Willow Springs and Kern Fan to accumulate groundwater banking assets for pulse flow implementation, as demonstrated in the previously discussed results.

Stantec has investigated the reasons for the observed difference between these model runs and concluded with three contributing factors. First, Article 21 demands have increased in the updated WSIP Baseline compared to the 2017 WSIP models, reducing the remaining physical and regulatory capacity available for exporting additional Delta surplus. Second, the Old and Middle River flow standards are more restrictive in March in the updated WSIP Baseline, imposing additional restriction for additional exports. And third, for Willow Springs only, the CalSim II runs used in the original WSIP application for that project assumed a Delta operation that included the use of Jones Pumping Plant for SWP exports when Banks capacity is not available based on the Joint Point of Diversion under the Reclamation's and DWR's water rights for CVP and SWP operations. This assumption is not typically used in CalSim II applications for project evaluations and therefore, not used in the cumulative flow analysis presented here.

The sensitivity of the additional yield generated by Kern Fan and Willow Springs to Article 21 demand assumptions in the WSIP Baseline could be further investigated. The higher Article 21 demands and deliveries in the WSIP Baseline are contributing to lower additional yield in the current analysis compared to the 2017 modeling and hence lower pulse flow deliveries. This increase in Article 21 demands was due to an update to CalSim II demands conducted by DWR for the 2019 Delivery Capability Report. Based on documentation in CalSim II input files, the current annual Article 21 demand for each SWP contractor is based on the maximum of annual Article 21 deliveries during 2005-2018 and annual Article 21 requests in 2011, 2017, and 2019, then increased by 20% to represent future increases in demand. An evaluation could be conducted of the sensitivity of the pulse flow benefits by these two GW banks to Article 21 demand assumptions, and of the appropriateness of the current Article 21 demand assumptions for this analysis.

4.3 KNOWN LIMITATIONS

This section highlights known limitations that were encountered while developing the post-processing tool and analyzing the results.

Because the post-processing tool sequentially implements the operations of individual projects independently based on existing models with differing baselines, certain processes and interactions cannot be simulated or analyzed. This is a known limitation and deficiency of this approach. For example, use of San Luis Reservoir to hedge or backstop a pulse flow is not implemented or tracked cumulatively. With concurrence with DWR, Stantec also implemented a defined sequence for including likely project effects that resulted in implementation of the effects of Sites and LVE before any GW bank. It is possible one WSIP project may reduce the performance of another, but Stantec made no attempt to reconcile these potential consequences, if any.

It is possible the implementation of all projects cumulatively into a CalSim II model would reduce some limitations of the post-processor approach. However, this would be a significant undertaking that would

require consideration of the observations from this study before implementation. Any CalSim II model would still be dependent on the limited number of months and years when supply is available to divert for surface storage and to fill GW banks. There would likely still be situations when a pulse flow could not be provided unless DWR negotiated with member agencies to modify SWP Table A allocations for pulse flow compensation. To that effect, the post-processor provides a reasonable depiction of the general trends expected with cumulative implementation of WSIP projects, and there is no reason to believe a modified CalSim II model would produce significantly different results.

The post-processing tool combined information and results from many sources. The tool integrates results from different CalSim II baselines – the updated WSIP Baseline developed in 2021, the baseline used for the original WSIP applications, and 2022 models used for the Sites project. Some conflicts have been identified in certain periods (i.e., LVE exporting Delta surplus in the LVE Alternative CalSim II model when it is not available in the WSIP Baseline) and may be likely caused by incompatibilities between the two baselines. These conflicts could be reduced if all WSIP projects would redo their CalSim II modeling used the updated WSIP Baseline. However, this is subject to further directives from DWR or the California Water Commission and is outside of the current scope.

The post-processor incorporated the same assumptions as the GW bank spreadsheet models that were developed and optimized using a future conditions baseline (2030 conditions) instead of an existing baseline (as in the updated WSIP Baseline). The difference in baselines likely results in different yields for each project. For example, due to the reliable source of water for recharge, Chino Basin is the only GW bank that allows borrowing, or negative storage for the account offered for pulse flow use, at an amount that was determined based on optimizing the model for future conditions. The post-processor results show Chino Basin borrows capacity more frequently and for longer durations than what was shown in the original model, which results in greater deliveries to IEUA and MWD. These assumptions and the specific model thresholds determined based on future conditions should assessed with the project proponents to ensure the original assumptions are still valid.

The carriage water consideration was included in MOD1, but it was not explicitly considered in MOD2 when evaluating Banks export reductions in summer months due to pulse flow compensation reductions for Oroville releases. Our results likely overstate the export reductions required since some of the Delta inflow reductions would reduce carriage water instead. This is an area that can be refined in the future.

From the viewpoint of operations, it is critical to recognize that the WSIP projects are at different levels of approval for implementation. Some (e.g., LVE) have completed a federal feasibility study including environmental review, and some are still working on necessary environmental review. The permit acquisition process and schedule of these WSIP projects may differ further. Therefore, the preliminary results should be reviewed in consideration that not all assumed operations for each WSIP were approved by DWR or other appropriate entities. While the assumptions were consistent with the project proposal based on best available information, Stantec has not had direct communications with project proponents for questions and clarifications. Therefore, the CVP and SWP allocations and use of Article 21 for these projects may be subject to change, including the additional assumptions Stantec incorporated into the post-processing tool for prioritizing (or more specifically, deprioritizing) certain

operations. However, it is also important to note that the equal sharing principal currently imposed in the post processing tool for Kern Fan and Willow Springs only has a minor effect on the overall ability for the three GW banks to provide the Oroville pulse flow.

APPENDIX

Appendix A POST-PROCESSOR DETAILS

The following sections provide detailed descriptions of the assumptions laid out in the procedural summary. The analysis assumes the following:

- A post-processing tool has been developed to model and evaluate the cumulative implementation of six WSIP Projects: Sites, LVE, Harvest, Kern Fan, Willow Springs, and Chino Basin.
- The WSIP CalSim II existing conditions model provided by DWR serves as the baseline for the analysis. This is referred to as the WSIP Baseline.
- The first modification to the WSIP Baseline is to implement the cumulative operations of the three WSIP surface water diversion projects (Sites, Harvest, and Los Vaqueros). This first modified baseline is referred to as MOD1.
- MOD1 is then modified to implement the coordinated operations of the coordinated pulse flows from the three WSIP groundwater bank projects (Chino Basin, Kern Fan, and Willow Springs). This second modified baseline is referred to as MOD2.
- With the MOD1 and MOD2, changes are tracked and quantified for the following major variables:
  - Flows in the Feather River
  - Flows in the Sacramento River
  - Delta inflow from the Sacramento River
  - Delta inflow from Yolo Bypass
  - Delta surplus
  - Delta outflow
  - SWP Delta exports from Banks
  - GW bank account balances

A.1 SURFACE WATER DIVERSIONS, RELEASES, AND DELTA ASSUMPTIONS

The following sections provide detailed descriptions of the assumptions for the three WSIP surface water diversion projects (Sites, Harvest, and LVE) and Delta operations. The analysis assumes the following:

A.1.1 Main Assumptions

Projects are implemented from upstream to downstream based on how they impact Delta inflows, Delta surplus, and Delta exports. The simplified operations of the three WSIP surface water diversion projects are layered onto the WSIP Baseline in the following order:

1. Sites
2. Harvest
3. LVE

This modified baseline is referred to as MOD1. Each operation is layered onto the WSIP Baseline in series, i.e., first, changes from Sites operation are made, second, changes from Harvest operation are made, and third, changes from the LVE operation are applied.

- MOD1A – Sites operations applied
- MOD1B – Harvest operations added after Sites operations applied
- MOD1C – LVE operations added after Sites and Harvest operations applied

It is assumed that the Sites and LVE operations under the WSIP Baseline CalSim II existing condition model meet salinity operations standards,

Under the WSIP Baseline, Sites and LVE operations meet salinity operation standards. It is assumed that adding the three WSIP surface water diversion projects together onto the WSIP Baseline will not violate salinity standards as long as the post-processor recalculates surplus and exports to maintain Delta balance (see Delta Operations section for more detail). This assumption was made because salinity standards are too complex to model in the post-processor and a simplifying assumption is needed. As long as the Delta remains in balance, it is assumed Delta interior hydrodynamics are not modified significantly and Delta salinity standards are maintained.

A.1.2 Sites

The actual operational rules of Sites are not relevant to the analysis, only the effects of Sites operations on the Delta and SWP/CVP systems. The effects of Sites Reservoir operation are simulated by applying the change between the Sites Alternative 3 and the Sites No Action Alternative (NAA), referred to as the Sites Difference (Sites_D), to the WSIP Baseline at several CalSim II nodes. These changes are referred to as MOD1A. There are minimal changes between Sites Alt 3 and the NAA for major storage reservoirs and SWP and CVP allocations, so these are ignored. The focus of the analysis is on changes to Delta inflows, exports, and control.

Delta Inflow

Sites Reservoir operations primarily impacts flows in the Sacramento River (via diversions and releases) and Yolo Bypass (via releases). Delta inflow are modified by calculating the Sites_D at two locations: the Sacramento River at Hood (C400) and the Yolo Bypass at (C157). The Sites_D at these two locations are summed to produce a total change in Delta inflow.

Export Changes

The Sites_D of Banks exports (D419) in each month is added to the WSIP Baseline Banks exports to create a new variable, D419_MOD1A. This calculation is checked against Banks permit capacity (BANKSALLOWOUT), regulatory capacity, and health and safety minimums:

- Permit capacity
  - If D419_MOD1A is less than BANKSALLOWOUT, no additional action is taken.

  - If D419_MOD1A is greater than BANKSALLOWOUT, the additional exports above the export capacity for the month are tracked as 'infeasible', and no additional modifications are made.
- Regulatory capacity as defined as the minimum of flows available under the EI ratio export cap, Apr-May D-1641 export cap, D-1641 outflow control, D-1641 salinity control, OMR, and the SWP ITP export cut (April-May spring outflow).
  - If increases in exports are within regulatory capacity, no additional action is taken.
  - If increases in exports are not within regulatory capacity, exports are set to the regulatory capacity limit, and the additional exports above the limit are tracked as 'infeasible'.
- Health and safety minimum:
  - Any reductions in exports that reduce Banks monthly exports below 300 cfs are tracked as 'infeasible'.

There are only minor changes in Jones exports for Sites_D but large increases in summer exports at Banks. Additional Banks exports are tracked and implemented in MOD1A to further constrain export and conveyance capacity for the next project applied in the cumulative analysis.

Delta Outflow and Surplus Modifications and Delta Control

Changes to WSIP Baseline Delta surplus are calculated as the net change in Sites Delta inflow and Sites Banks exports (i.e., changes in Sites Delta inflows minus changes in Sites Banks exports). This net change is added to (if positive) or subtracted from (if negative) the WSIP Baseline Delta surplus flows (C407_SWP + C407_CVP), creating a new Delta surplus variable C407_MOD1A. The net change is also added to the WSIP Baseline Delta outflow (C407 + D407), creating a new Delta outflow variable CD407_MOD1A. The following actions are taken:

- If the net change is positive, no additional action is taken. WSIP Baseline Delta surplus (and outflow) flows have been increased, the Delta is in balance conditions, and C407_MOD1A is available to be exported for the next project.
- If the net change is negative:
  - If the resulting Delta surplus C407_MOD1A is still positive, WSIP Baseline Delta surplus (and outflow) flows have been decreased, and the reduced value is carried forward to cumulative projects.
  - If the resulting Delta surplus C407_MOD1A is negative, C407_MOD1A is set to 0 and no surplus flow is available for the next project. The negative amount is tracked as 'infeasible', i.e., a reduction in Sites yield due to conflicts with the WSIP Baseline. Delta outflow is only reduced by available Delta surplus, i.e., not reduced by the 'infeasible' reduction.

Additional Assumptions

There will be no assumed changes to the following in the WSIP Baseline based on the comparison between Sites Alternative 3 and Sites NAA. These variables were not changed significantly in the Sites alternative relative to the Sites baseline, and thus their inclusion in the post-processing tool is not warranted.

- Shasta storage (minor changes < 3% in all WY types)

- Oroville storage (minor changes < 1% in all WY types)
- Folsom storage (minor changes < 1% in all WY types)
- San Luis Reservoir CVP or SWP storage (minor changes < 4% in all WY types)
- SWP Table A allocations (minor changes < 2% in all WY types)
- CVP M&I and SOD M&I allocations (minor changes < 2% in all WY types)
- CVP Ag and Ag SOD allocations (minor changes < 4% in all WY types)
- Jones exports (minor changes < 1% in all WY types)
- Cross Valley Canal deliveries (minor changes < 2 cfs in all WY types))

A.1.3 Harvest

The effects of Harvest operation are simulated by applying a monthly reduction in flow in the Sacramento River at Hood (C400) and a monthly increase in flow in the Mokelumne River inflow to the Delta (C504). Conditions from the WSIP application will be used, reflecting 2030 conditions with climate change after twenty years of operations when groundwater return flows contribute to increases in surface water flows. These changes are referred to as MOD1B. Reductions in return flow to the Sacramento River of 50,000 AF per year was approved in the water rights Wastewater Petition WW0092. The WSIP application described additional return flows.

Sacramento River Flow Changes

The net difference between monthly waste-water discharge reductions into the Sacramento River and monthly increases in return flows to the Sacramento River is calculated and applied as a time series to reduce Delta inflows at the Sacramento River at Hood (C400):

- Annual discharge reductions into the Sacramento River are calculated as 42,850 AF per year. This value, reported in the WSIP application and consistent with the water rights Wastewater Petition WW0092, reflects a discharge reduction of 50,000 AF into the Sacramento River and a diversion reduction of 7,150 AF (due to future offsetting groundwater extractions). Monthly values are calculated based on the monthly discharge reduction percentages reported in the WSIP application (Table 2a in the application).
- Annual increases in Sacramento River are calculated as 1,744 AF per year, which is 5% of the total return flow increases in the Consumnes and Sacramento Rivers. Monthly values are calculated based on the monthly increase in streamflow percentages reported in the WSIP application (Table 5a in the application).
- The net change in annual flow at C400 is -41,106 AF (-42,850 AF + 1,744 AF), applied based on monthly percentages as a decrease in Delta surplus flow (C407_MOD1A).

Mokelumne River Flow Changes

The increase in monthly return flows into the Consumnes River is calculated and applied as a time series to increase Delta inflows at the Mokelumne River at Hood (C504), which increases flow available as Delta surplus:

- Annual increases in Mokelumne River are calculated as 33,133 AF per year, which is 95% of the total return flow increases in the Consumnes and Sacramento Rivers. Monthly values are calculated based on the monthly increase in streamflow percentages reported in the WSIP application (Table 5a in the application).
- The net change in annual flow at C504 is 33,133 AF, applied based on monthly percentages as an increase in Delta surplus flow (C407_MOD1A)

Delta Outflow and Surplus Modifications and Delta Controls

Harvest operations will change Delta inflows, which will change Delta outflow and surplus. Increases in Delta surplus would not influence any operations and needs no further action. Decreases in Delta surplus may require reductions in exports, especially if the reduction is greater than the surplus available.

Modifications to C407_MOD1A Delta surplus are calculated as the net change in Sacramento River flow and Mokelumne River flow. This change is added to (if positive) or subtracted from (if negative) the C407_MOD1A Delta surplus flows, creating a new Delta surplus variable C407_MOD1B. The net change is also added to the CD407_MOD1A Delta outflow, creating a new Delta outflow variable CD407_MOD1B. The following actions are taken:

Based on the net change to C407_MOD1A, Banks exports (D419_MOD1A) would be modified to a value of based on the following:

- If the net change is positive, no additional action is taken. C407_MOD1A Delta surplus (and outflow) flows have been increased, the Delta is in balance, and C407_MOD1B is available to be exported for the next project.
- If the net change is negative:
  - If the resulting Delta surplus C407_MOD1B is still positive, C407_MOD1A Delta surplus (and outflow) flows have been decreased, the Delta may no longer be in a balanced condition, and action would be needed to decrease exports depending on the controlling regulation in the Delta for that given month:
    - If the WSIP Baseline Delta condition is Surplus, no additional action is taken.
    - If the WSIP Baseline Delta is Surplus with restrictions or Balanced (see Delta Operations section), exports would need to be reduced to maintain Delta balance. The volume of export reductions are calculated as described in the Delta Operations section. A new export value is calculated as D419_MOD1B.
  - If the resulting Delta surplus C407_MOD1B is negative, C407_MOD1A Delta surplus flows have been decreased and the Delta is no longer in balance. The volume of export reductions would be calculated as described in the Delta Operations section depending on the WSIP Baseline Delta condition in that given month. The new export value will be calculated as D419_MOD1B. Delta outflow is not reduced since Delta inflow reductions were offset with Banks export cuts.

A.1.4 Los Vaqueros Expansion

The actual operational rules of LVE are not relevant to the analysis, only the effects of LVE operations on the Delta and SWP/CVP systems. There are minimal changes between LVE Alt 1B and the LVEEC for major storage reservoirs and SWP and CVP allocations, so these are ignored. The focus of the analysis is on changes to Delta surplus and exports. The effects of LVE Reservoir operation are simulated by applying the change between the LVE Alternative 1B and the LVE Existing Conditions (LVEEC), referred to as the LVE Difference (LVE_D), to MOD1B at several CalSim II nodes. These changes are referred to as MOD1C.

Delta Outflow and Surplus Modifications and Delta Control

The effect of LVE operations is primarily a reduction in Delta surplus flows. These reductions need to be checked against the cumulative surplus flows (those modified by Sites and Harvest).

The differences in Delta surplus flow (C407) in LVE_D are summed and added to (if sum is positive) or subtracted from (if sum is negative) Delta surplus flow (C407_MOD1B), creating a new Delta surplus variable C407_MOD1C. The net change is also added to the CD407_MOD1B Delta outflow, creating a new Delta outflow variable CD407_MOD1C. The following actions are taken:

- If the net change is positive, no additional action is taken. C407_MOD1B surplus (and outflow) flows have been increased, the Delta is in balance, and C407_MOD1C is available to be exported for the next project.
- If the net change is negative:
  - If the resulting Delta surplus C407_MOD1C is still positive, C407_MOD1B Delta surplus (and outflow) flows have been decreased, and the reduced value is carried forward to cumulative projects.
  - If the resulting Delta surplus C407_MOD1C is negative, C407_MOD1B is set to 0 and no surplus flow is available for the next project. The negative amount is tracked as 'infeasible', i.e., a reduction in LVE yield due to conflicts with the WSIP Baseline, Sites, and Harvest implementation. Delta outflow is only reduced by available Delta surplus, i.e., not reduced by the 'infeasible' reduction.

Export Changes

The LVE_D of LVE exports (D419) in each month is added to D419_MOD1B Banks exports to create a new variable, D419_MOD1C. This calculation is checked against Banks permit capacity (BANKSALLOWOUT), regulatory capacity, and health and safety minimums:

- Permit capacity
  - If D419_MOD1C is less than BANKSALLOWOUT, no additional action is taken.
  - If D419_MOD1C is greater than BANKSALLOWOUT, the additional exports above the export capacity for the month are tracked as 'infeasible', and no additional modifications are made.

- Regulatory capacity as defined as the minimum of flows available under the EI ratio export cap, Apr-May D-1641 export cap, D-1641 outflow control, D-1641 salinity control, OMR, and the SWP ITP export cut (April-May spring outflow), as reduced by Sites and Harvest.
  - If increases in exports are within regulatory capacity, no additional action is taken.
  - If increases in exports are not within regulatory capacity, exports are set to the regulatory capacity limit, and the additional exports above the limit are tracked as 'infeasible'.
- Health and safety minimum:
  - Any reductions in exports that reduce Banks monthly exports below 300 cfs are tracked as 'infeasible'.

Additional Assumptions

There will be no changes to the following based on the comparison of the LVE Alternative 1B to the LVEEC. These variables were not changed significantly in the LVE alternative relative to the LVE baseline, and thus their inclusion in the post-processing tool is not warranted.

- Shasta storage (minor changes < 2% in all WY types)
- Folsom storage (minor changes < 1% in all WY types)
- Delta inflow (minor changes < 0.5% in all WY types)
- San Luis Reservoir CVP or SWP storage (minor changes < 3% in all WY types)
- SWP Table A allocations (minor changes < 1% in all WY types)
- CVP M&I and SOD M&I allocations (minor changes < 1% in all WY types)
- CVP Ag allocations (minor changes < 1% in all WY types)
- Jones and Banks exports (minor changes < 1.5% in all WY types)

A.1.5 Delta Operations

The post-processor is not simulating Delta interior hydrodynamics or Delta control, so rules are needed to determine how to treat Delta surplus under the cumulative analysis based on the controlling regulation.

WSIP Baseline Delta Classification

In each month, a lookup of the WSIP Baseline variables classifies the Delta into one of the following conditions:

- Balanced
  - Delta surplus (C407 or MOD version) = 0 and a controlling regulation is identified
- Surplus with restrictions
  - Delta surplus (C407 or MOD version) >0 and a controlling regulation is identified
- Surplus (with no controlling regulations)
  - Delta surplus (C407 or MOD version) >0 with no controlling regulation

The lookup determined which of the following regulations is controlling Delta operations in the given month, if applicable, based on the CalSim II variable condition listed in parenthesis:

- EI ratio cap export control (EIEXPCTRL = C409)
- OMR control (C408_LBOUND = C408 = C409)
- D-1641 outflow control (C407_SWP + C407_CVP + C407_ANN = 0)
- D-1641 salinity control (C407_ANN > 0)
- D-1641 Apr-May export control (AprMayExpCtrl = ExportactualTD)
- SWP ITP export cut control (April-May spring outflow) (SWPITP_ExpCut_SJRIE_> 0)
- Surplus (none of the above equations are valid)

Delta control does not change based on modifications to inflows, exports, or surplus flows. The WSIP Baseline control is assumed to remain in control throughout all post-processor modifications. The only exception is if Delta surplus flow is reduced to 0 in any given month, it is assumed the Delta is under D-1641 outflow control.

Delta Control, Delta Surplus, and Export Reduction

When Delta surplus flows are reduced, the following actions occur based on the WSIP Baseline Delta classification for that month, and whether the modeled reduction in Delta surplus flows is greater than the Delta surplus flow available.

The table below summarizes the adjustments to surplus or SWP exports based on changes to Delta inflow. For all cases when SWP exports are reduced, export reductions are tracked monthly without cumulative effects, are not carried SOD, and do not have an impact on post-processed storage or allocations.

Controlling Regulation	Surplus with restrictions	Balanced[1]
EI ratio cap export control	Split reduction between SWP exports and Delta outflow by appropriate proportion to maintain EI ratio control. Track volume of required Delta outflow reductions.[1]	Split reduction between SWP exports and Delta outflow by appropriate proportion to maintain EI ratio control. Track volume of required Delta outflow reductions.
OMR control	Reduce surplus 1:1 to Delta inflow reduction until all surplus is eliminated, then refer to Balanced condition	Reduce SWP exports at a 1:1 ratio to Delta inflow reduction
D-1641 April-May export cap control	Reduce surplus 1:1 to Delta inflow reduction until all surplus is eliminated, then refer to Balanced condition	Reduce SWP exports at a 1:1 ratio to Delta inflow reduction
D-1641 outflow control	Not applicable	Reduce SWP exports at a 1:1 ratio to Delta inflow reduction
D-1641 salinity control	Not applicable	Split reduction between exports and Delta outflow based on carriage water requirements. Track volume of required Delta outflow reductions.
SWP ITP export cut (April-May spring outflow)	Reduce surplus 1:1 to Delta inflow reduction until all surplus is eliminated, then refer to Balanced condition	Not applicable unless all surplus has been reduced, then reduce SWP exports at a 1:1 ratio to Delta inflow reduction

[1] For Sites and LVE, these export cuts are tracked as 'infeasible' with the WSIP Baseline and are not cumulatively implemented.

Additional Assumptions

The following assumptions are inherent to the implications to Delta operations and control described above:

- No assessment is made of changes to Delta interior hydrodynamics
- Salinity changes associated with changes in inflows and exports are not accounted for
- No changes to OMR flows or assessment of when OMR may control based on changed Delta conditions

A.2 GROUNDWATER PROJECT COORDINATION

A.2.1 Main Assumptions

The simplified operations of each WSIP groundwater bank are layered onto MOD1 using the spreadsheet model provided by each project as part of the WSIP application (or an updated model as requested by DWR). Each spreadsheet model generally contains a water balance of inflows, outflows (for pulse exchange only) including losses, and change in GW storage (only the environmental storage account for pulse flows), with other changes to MOD1 as discussed below. The changes from GW banks layered onto MOD1 are referred to as MOD2.

A.2.2 Groundwater Bank Storage

The GW storage capacity of each GW bank available for storing environmental pulse flow volumes is the amount stated in the WSIP application

- Chino Basin: 50 TAF (50 TAF is released when called on for a pulse flow)
- Kern Fan: 25 TAF (18 TAF is released when called on for a pulse flow)
- Willow Springs: 28.6 TAF (annual pulse flows can be released up to 28.6 TAF)

Each GW bank has specific pulse flow volumes that are assumed released out of Oroville and specific volumes of water that are released to Partner Contractors to compensate for reduced exports from Banks. A smaller volume is used for compensation since carriage water was not needed to deliver water from Oroville to Banks. The assumed pulse flow and compensation flow are:

- Chino Basin: 50 TAF pulse flow release from Oroville, 40 TAF compensation flow (20% carriage water savings)
- Kern Fan: 18 TAF pulse flow release from Oroville, 14 TAF compensation flow (23% carriage water savings)
- Willow Springs: 28.6 TAF pulse flow release from Oroville, 28.6 TAF compensation flow (0% carriage water savings)

A.2.3 Groundwater Bank Filling

Each GW bank operates as a separate entity with independent filling operations. For the purposes of modeling, delivery of Delta surplus flow (C407_MOD1C) is split between Willow Springs and Kern Fan so as not to prioritize one GW bank over the other.

Chino Basin

Chino Basin is filled using a constant source of 15 TAF/year of treated water using a time series and magnitude of water consistent with what was used in the WSIP application. The proposed local fill to support Chino Basin operations is limited to the throughput of the proposed advanced water purification facilities (15 TAF/year). While not necessarily applicable to this cumulative flow analysis, the Chino Basin WSIP proposal also includes a limited term to support pulse flow operations of 25 years. In other words, as proposed, Chino Basin will support a total maximum volume of 375 TAF of pulse flows over 25 years of operations. This limited term for support of pulse flow operations over 25 years is not reflected in this cumulative flow analysis.

Kern Fan

Kern Fan is filled using unallocated SWP Article 21 supplies, consistent with the WSIP application. For modeling purposes, it is assumed additional exports could only occur when Delta surplus flow is available (C407_MOD1C > 0) and the Delta is in Surplus conditions (if the Delta is Surplus with restrictions or Balanced, there is no mechanism to increase Delta inflow and maintain Delta balance if exports are increased). A volume of water is assumed delivered to Kern Fan that is the minimum of the following in the given month:

- Delta surplus flows (C407_MOD1C)
- Banks export capacity (D419_MOD1C)
- Available storage capacity in Kern Fan
- Largest available conveyance capacity available in the California Aqueduct at key locations upstream of the Project:
  - C805 (capacity = 10,000 cfs)
  - C846 (capacity = 8100 cfs)
  - C865 (capacity = 4,480 cfs)
- Article 21 supplies based on contractor amount
- WSIP application identified conveyance capacity of 23.8 TAF per month (400 cfs).

Willow Springs

Fill occurs using opportunistically captured Delta surplus flow, which is stored in San Luis Reservoir in Pre-Evacuated Public Benefit Space that was created by moving water from San Luis Reservoir to the Water Bank earlier in the year. A simplified spreadsheet model of the Willow Springs operation, based on the April 6, 2022, Technical Memo from Willow Springs, determines the operation. Storage space in San Luis Reservoir made available by pre-evacuation can be filled by additional exports of Delta surplus from

MOD1 (as limited by permit/regulatory export capacity), thereby generating additional yield. This additional yield is then moved into the GW bank into an Ecological Benefit Storage account, which is used to compensate for pulse flow releases. The deficit in San Luis Reservoir due to pre-evacuation is always made up by the end of the water year, either by Antelope Valley-East Kern Water Agency (AVEK) taking its Table A allocation from, as the GW bank instead of San Luis Reservoir, or by returning pre-evacuated water to the California Aqueduct. Water stored in the GW bank is subject to a 10% leave-behind, removed from the Ecological Benefit Storage account, in two cases. First, when additional yield is moved into the Ecological Benefit Storage account, and second, when pre-evacuated water is returned to the California Aqueduct. .

A.2.4 Groundwater Bank Coordinated Pulse Flow Exchange with Oroville

Each GW bank is coordinated to exchange banked GW for storage in Oroville to enable a spring pulse flow release from Oroville and subsequent summer reduction in Oroville releases to the Feather River.

For modeling purposes, the following assumptions on pulse flow magnitude, source, triggers, and timing are proposed. If desired, a time series of years when pulse flows are requested could also be developed as a trigger :

- Pulse flow call magnitude, trigger, and timing
  - 100 TAF pulse flow call to occur in April of below normal and dry water year types
- Allowable pulse flow based on magnitude and timing of Feather River flow reductions and Banks export reductions in July through September:
  - Reductions to releases from Lake Oroville would be made in July - Sep of same year of pulse flow to compensate for the early release of the pulse flow and ensure storage at Sep EOM is equal to WSIP Baseline storage conditions
  - Reduced Oroville releases would result in reduced flow in the Feather and Sacramento Rivers. The magnitude of possible reductions, and thus the magnitude of the pulse flow, would be constrained by:
    - Meeting the monthly minimum flow in the Feather River (C203_MIF or C223_MIF, whichever is more restrictive). Reduced releases from Oroville due to Sites coordinated operation with Oroville are accounted for in this lookup (i.e., Sites difference in C203 and C223 is applied in the compensation lookup calculation).
    - The volume of flow, above the minimum flow requirement, provided by an Oroville release of 500 cfs for the Suisun Marsh in June and July of certain years cannot be cut (SMSCG_Oro_Rel_for_DO).
    - Reductions to Delta inflow resulting in reductions to Feather River flows must not cause Delta to be taken out of a balanced condition. The same rules developed for Sites and LVE Delta surplus modifications and Delta control are assessed to determine if the Delta was in surplus and inflow reductions could have occurred with no additional action, or if the Delta was controlled and reductions in exports would need to be assumed equivalent to reductions in inflows.

  - Feather River releases could be reduced across several months or could be reduced in some months and not others, depending on the constraints above. There is no priority to reduce flows evenly across months.
  - Banks SWP exports (D419_SWP and subsequent changes by cumulative projects) cannot be cut below the health and safety minimum of 300 cfs in any month.
- Delivered pulse flow magnitude and source (i.e., GW bank priority)
  - Capacity is combined from multiple GW banks to deliver a pulse flow with magnitude up to 97 TAF in any given year.
    - Capacity contributed by each GW bank is limited by how much each GW bank had in storage available to be used in that year for a pulse flow.
    - The entire capacity available in each GW bank pulse flow storage account is used for the pulse, except for Kern Fan, which does not allow a partial pulse flow.
  - To occur only if GW banks have water in storage available for use as a pulse flow (e.g., Willow Springs could not provide pulse using water in storage that was delivered in a year when pre-evacuation occurred).
  - Additional pulse flow constraints vary by project:
    - Based on the WSIP application, assume Chino Basin will only make a pulse flow for either 3 consecutive or 4 out of 10 years, and only if Lake Oroville storage and San Luis Reservoir storage are within minimum and maximum threshold values.
    - Kern Fan will only make a pulse flow if final SWP Table A allocations are greater than 20% and only if sufficient storage has accumulated in the account to deliver the full pulse flow requested (i.e., Kern Fan will not make partial delivery).
    - Willow Springs does not have an SWP Table A allocation threshold or minimum storage level for making a pulse flow.

WSIP CUMULATIVE FLOW ANALYSIS-NARRATIVE

(DWR – October 2022)

1. Introduction

The Water Storage Investment Program (WSIP) is a $2.7 billion program for investments in water storage projects in California, approved by the voters through Proposition 1 in 2014 and administered by the California Water Commission (CWC). Seven projects have been selected for funding consideration based on a rigorous review process. In addition to water storage benefits, the CWC selected projects that demonstrate an ability to provide public benefits related to flood control, ecosystem improvement, water quality improvement, recreation, and/or emergency response. The selected WSIP projects range from expanding existing reservoirs to boosting groundwater storage to building modern surface storage facilities. Once operational, the seven WSIP projects listed below would increase California's water storage capacity by 4.3 million acre-feet over the current (2021) baseline. The projects are listed below and are described in Section 2.

- Chino Basin Program (Chino Basin)
- Kern Fan Groundwater Storage Project (Kern Fan)
- Willow Springs Water Bank Conjunctive Use Project (WSWB)
- Los Vaqueros Reservoir Expansion Project (LVE)
- Sites Reservoir Project (Sites)
- Pacheco Reservoir Expansion Project (Pacheco)
- Harvest Water Program (Harvest Water)

The purpose of the cumulative flow analysis is to get a general sense of flow in the Feather River, Sacramento River, and Delta areas if all the WSIP projects were in operation. There has been no similar analysis done by any of the individual WSIP projects. The projects have evolved, and some are still evolving, since the CWC application stage.

The quantitative analysis is based on a CalSim II post processing study done by Stantec – "Cumulative Flow Effect Analysis of Water Storage Investment Program Projects" – October 2, 2022 (Stantec Report). The Stantec Report did not include the Pacheco project as that project has minimal impacts of the waterways studied in this flow analysis[1].

It is important to understand the limitations of the Stantec Report analysis. There are some simplifications and assumptions made that make results potentially not suitable for use in regulatory or water rights proceedings. The Stantec Report includes explanations of the simplifications and assumptions.

It is important to recognize that the regulatory conditions change over time and will impact the results of this analysis. Also, new facilities such as Delta Conveyance will change results.

[1] Draft EIR Pacheco Reservoir Expansion Project November 2021 Tables 3.12.33 and 3.12.34

This analysis is intended to assess potential cumulative hydraulic impacts to waterways and Delta exports and therefore does not attempt to assess potential cumulative impacts to aquatic or biological resources- as these impacts occur on a daily/short-term time step as compared to a monthly, annual, long-term timestep as evaluated here. The analysis does not address the environmental impacts of the WSIP projects pursuant to the California Environmental Quality Act (CEQA). Each WSIP project has either completed or is in the process of completing its own environmental documentation for CEQA compliance, including a discussion of cumulative effects as required by CEQA.

This paper helps interpret modeling results from the Stantec Report and includes WSIP project information from publicly available information. It summarizes anticipated changes in flows due to these projects including amounts, monthly variations, and year types. It also considers the magnitude of these changes compared to baseline flows and hydrologic conditions (i.e., excess, or balanced conditions) to provide context for the anticipated changes.

2. Background

This section provides background information on the State Water Project (SWP) and the seven WSIP projects.

The California Department of Water Resources (DWR) holds contracts with 29 public agencies for water supplies from the SWP. Key SWP facilities are Lake Oroville, the Harvey O. Banks Pumping Plant, and San Luis Reservoir. These facilities are operated and connected by a network of canals, aqueducts, and other facilities to deliver on average approximately 2.6 million acre-feet of contracted water supplies annually (Reclamation, 2019).

The U.S. Department of the Interior Bureau of Reclamation (Reclamation) also delivers water through the Delta at its Central Valley Project (CVP) pumping plant in the south Delta, Jones Pumping Plant, and either delivers it directly or stores water in San Luis Reservoir for later delivery to its contractors south of the Delta. DWR and Reclamation coordinate their operations on a daily basis. Some factors that DWR and Reclamation consider when coordinating their joint operations include required in-Delta flows, Delta outflow, water quality, fish species protections, schedules for the joint use facilities (e.g., San Luis Reservoir), pumping/wheeling arrangements,[2] and facility capacity limitations.

During balanced water conditions, DWR and Reclamation share a responsibility to meet in-basin uses and maintain a daily water accounting of the SWP and CVP obligations in conformance with the Coordinated Operation Agreement between the two projects. Balanced water conditions are defined as periods when it is mutually agreed that releases from upstream reservoirs plus unregulated flows approximately equal the water supply needed to meet Sacramento Valley in-basin uses plus exports. Excess water conditions are periods when it is mutually agreed that releases from upstream reservoirs plus unregulated flows exceed Sacramento Valley in-basin uses plus exports. The duration of balanced water conditions varies from year to year. While balanced conditions may never occur in some very wet years, some very dry years may have long continuous periods of balanced conditions, and still other years may have several periods of balanced conditions interspersed with excess water conditions. During excess water conditions, sufficient water is available to meet all beneficial uses, and the CVP and SWP are not required to supplement the supply with water from reservoir storage. As specified in the Coordinated Operation Agreement, DWR and Reclamation have the responsibility during excess water conditions to store and export as much water as possible within physical, legal, and contractual limits (Reclamation, 2019). If there is additional water supply beyond the capacity of

[2] Wheeling means using the water supply facilities by someone other than the owner or operator to transport water for a fee.

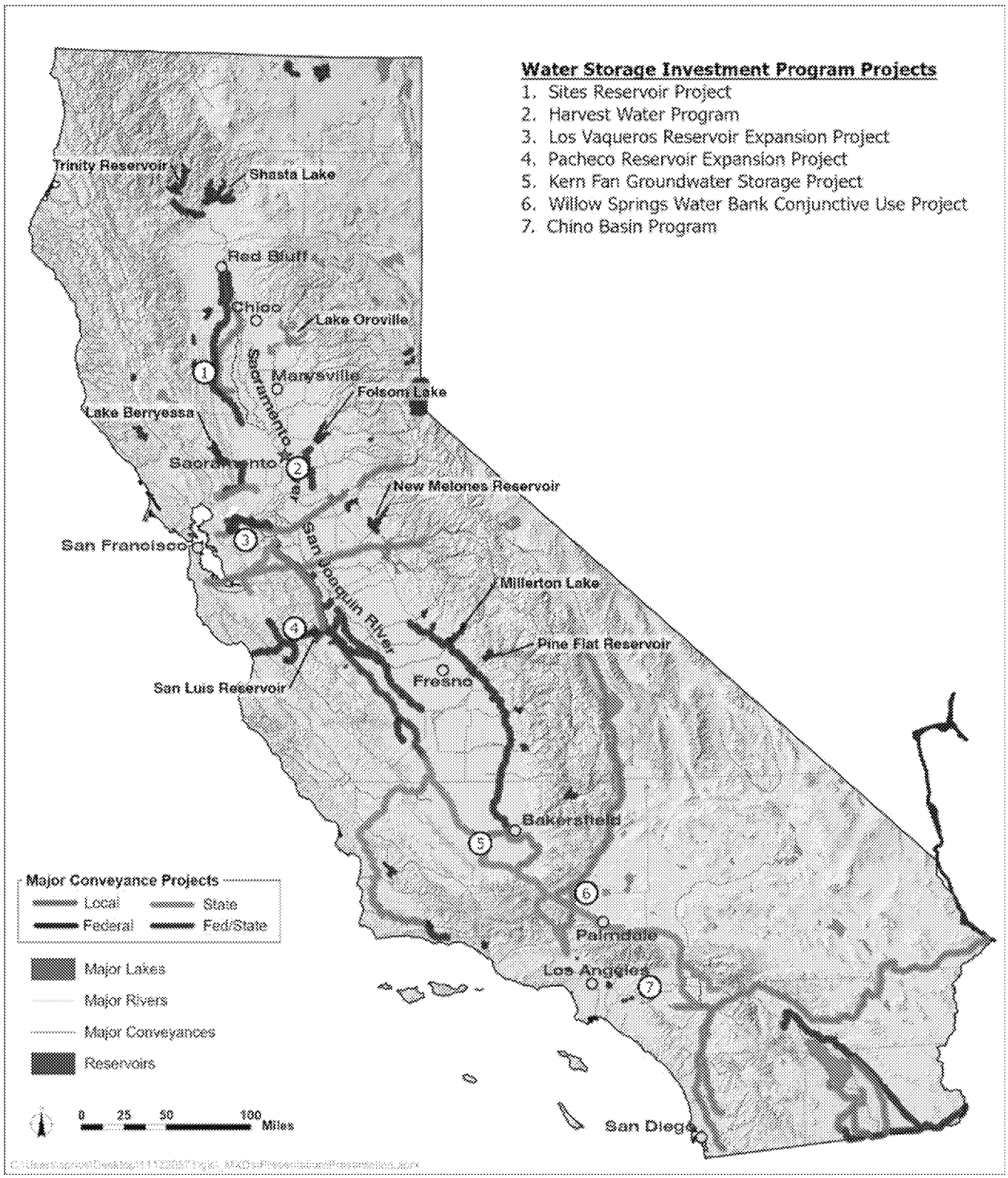
the SWP and CVP to store or deliver in excess conditions, that water can be made available to individual CVP and SWP contractors.

Article 21 water is one of several types of SWP water supply made available to the SWP contractors under the long-term water supply contracts between DWR and the SWP contractors. Unlike Table A water, which is the maximum allocated annual supply made available for scheduled delivery throughout the year, Article 21 water is made available only when certain conditions exist (which occur predominately in wet years). As with all SWP water, Article 21 water is supplied under existing SWP water rights permits and is pumped from the Delta under the same environmental, regulatory, and operational constraints that apply to all SWP supplies.

Article 21 water is typically offered to contractors on a weekly basis when all of the following conditions exist: (1) the SWP share of San Luis Reservoir is physically full, or projected to be physically full within approximately 1 week at permitted pumping rates; (2) other SWP reservoirs south of the Delta are at their storage targets or the conveyance capacity to fill these reservoirs is maximized; (3) the Delta is in excess condition; (4) current Table A demand is being fully met; and (5) Banks Pumping Plant has export capacity beyond that which is needed to meet current Table A and other SWP operational demands. The increment of available unused Banks Pumping Plant capacity is offered as the Article 21 delivery capacity (Reclamation, 2008).

The seven WSIP projects are described below. The location of each of the projects and how operations can affect hydrologic conditions are also described below. For the five WSIP projects that involve the SWP (Chino Basin, Kern Fan, WSWB, Sites and LVE), DWR has not yet approved operations of the projects, so the operations described below are subject to change.

The flow numbers in this paper come from several sources. Each WSIP project used flow models at various stages of project development (i.e., application, feasibility study and CEQA). The Stantec Report uses a 2021 version of CalSim II that includes up to date regulations and took the separate models prepared by the individual WSIP Projects and translated that to a new WSIP baseline. Adjustments had to be made in the process to account for variability in the models used. Adjustments included changes in baseline conditions including, but not limited to resulting flows, exports, availability of Article 21 and Delta conditions. Data sources are footnoted to show where data came from.



Pulse Flow Projects

The following are operations common to the three Pulse Flow Projects (Chino Basin, Kern Fan and WSWB),

In drier years, such as dry and below normal years, stored water from Lake Oroville would be used to provide pulse flow releases to enhance spring instream flows in the Feather River below Lake Oroville.

The amount of a pulse flow release in a given year will be determined by the availability of water in WSIP Exchange Storage Accounts of the three Pulse Flow Projects, California Department of Fish and Wildlife (CDFW) requests and DWR approval of a pulse flow. The modeling limits the amount of water in WSIP Exchange Storage Accounts to the maximum WSIP storage amounts for each project. A WSIP Operational Exchange process is required to replace water used for pulse flow releases with stored groundwater. This will require agreements with SWP Partner Contractors to forego SWP Table A deliveries equivalent to the pulse flow release amount in exchange for receiving an equivalent amount of WSIP In-Lieu Table A water from the groundwater bank. South-of-Delta exports needed to meet SWP Partner Contractor Table A demands would be reduced by the pulse flow release amount. A credit for a reduction of Delta carriage water requirements is being considered. Also required are agreements with DWR to implement the WSIP Operational Exchange resulting in a pulse flow release and with CDFW for administration of the pulse flow release benefits.

Chino Basin Program

Chino Basin would construct a new advanced water treatment facility and distribution facilities in western San Bernardino County that would store up to 15 thousand acre-feet (TAF) per year of treated wastewater in the Chino Basin (groundwater bank) for pulse flow releases. Chino Basin would be operated to dedicate blocks of water, assumed to be in increments of 50 TAF,[3] for Oroville pulse flow releases. The Partner Contractor will be the Metropolitan Water District of Southern California. After the estimated initial 25 years of operation and fulfilling ecosystem public benefits, pulse flow releases would cease, and Chino Basin would be operated for local water supply benefits.

Kern Fan Groundwater Storage Project

Kern Fan would develop a regional groundwater bank in Kern County, west of Bakersfield, that would store up to 100 TAF per year of Article 21 water and other available water supplies, including Federal Section 215 water. Kern Fan would be operated so that in wet years, the project would store these water supplies in the water bank. Twenty-five percent of the stored water, up to 25 TAF, would be stored in the WSIP Exchange Storage Account and would be dedicated for Oroville pulse flow releases in blocks of water assumed to be 18 TAF[4] each. The remaining water would be stored by the project participants for water supply reliability purposes. The Partner Contractors are anticipated to be Kern County Water Agency and Dudley Ridge Water District. After the estimated initial 50 years of operation and fulfilling ecosystem public benefits, pulse flow releases would cease, and Kern Fan would be operated for local water supply benefits.

Willow Springs Water Bank Conjunctive Use Project

WSWB would enhance the existing Willow Springs Water Bank located in southern Kern County, northwest of the City of Lancaster, in the adjudicated Antelope Valley Groundwater Basin. WSWB is a conjunctive use and reservoir reoperation project that would leverage 560 TAF of existing groundwater storage facilities at the Willow Springs Water Bank and High Desert Water Bank and operate conjunctively with the SWP.

WSWB will pre-position SWP water to WSWB between November and April in years when there is not a low volume concern in San Luis Reservoir. This SWP water would be "owned" by DWR and used in any SWP allocation calculation. Article 21 water would not be utilized. Pre-positioning SWP water in the groundwater bank reduces the amount of water stored in San Luis Reservoir, thus increasing available storage capacity in the reservoir to be filled during high flow events. "New" water is created when the pre-positioning allows SWP facilities to capture water that would otherwise not be pumped at Banks Pumping Plant due to storage capacity limitations. The new storage capacity created would be filled when there is excess pumping capacity at Banks beyond SWP needs and Article 21 allocations.

[3] Pulse flows are modeled as 50 TAF but may vary in amounts per CDFW requests.
[4] Pulse flows are modeled as 18 TAF but may vary in amounts per CDFW requests.

This operation could impact the availability of Article 21 by delaying conditions when Article 21 would be available. DWR is expected to mitigate this impact by allowing SWP contractors to take Article 21 before San Luis Reservoir fills to mimic conditions without WSWB.

WSWB would be operated to dedicate blocks of water assumed to be 28 TAF[5] for Oroville pulse flow releases. The Partner Contractor is anticipated to be Antelope Valley East Kern Water Agency. After the estimated initial 50 years of operation and fulfilling ecosystem public benefits, pulse flow releases would cease, and WSWB would be operated for local water supply benefits.

Los Vaqueros Reservoir Expansion Project

LVE is a surface storage project located in southeastern Contra Costa County that would enlarge the capacity of an existing off-stream reservoir by 115 TAF (from 160 TAF to 275 TAF). This project would also upgrade existing conveyance facilities, construct new conveyance, and re-operate existing facilities to develop water supplies for ecosystem public benefits and increased water supply reliability for project participants. LVE would divert water from the Delta at Rock Slough, Old River, and Middle River intakes that are operated by Contra Costa Water District, divert water from the Sacramento River at the Freeport Intake, and deliver water to project participants within Contra Costa Water District's service area, the Bay Area, the Delta, neighboring regions, and south-of-Delta wildlife refuges.

Diversions for LVE can be used for direct deliveries and for diversion to storage. Diversions would occur during excess and balanced conditions. During balanced conditions, total diversions at the Delta and Freeport intakes would increase by a long-term average of 58 TAF per year.[6] These diversions represent a reduction of about 0.5 percent or less of Delta outflow during dry and critical dry years[7]. During excess conditions total diversions at the Delta and Freeport intakes would increase by a long-term average of 69 TAF per year.[8] These diversions represent less than 0.3 percent reduction of Delta outflow during wet and above normal years.[9]

The maximum diversion rates at the intakes are 250 cubic feet per second (cfs) for the Old River Intake, 250 cfs for the Middle River Intake (320 cfs for the Old River and Middle River Intakes combined), 350 cfs for the Rock Slough Intake, and 155 cfs (of project supplies) at the Freeport Intake. Diversion to storage from all sources requires the use of the Transfer Pump Station, which has a pumping capacity of 200 cfs, so the rate of diversion to storage is limited to 200 cfs. Direct deliveries up to 300 cfs can be made to the California Aqueduct through the proposed Transfer-Bethany Pipeline.

Sites Reservoir Project

Sites is a new surface storage reservoir located in Colusa County in the Sacramento Valley west of the town of Maxwell. Sites would be an off-stream 1.5 million acre-feet (MAF) reservoir that would impound Funks Creek and Stone Coral Creek and provide storage capacity for Sacramento River diversions. This project also includes conveyance through the use of the existing Tehama Colusa (T-C) Canal and Glenn-Colusa Irrigation District Canal (GCID) diversion and conveyance facilities. Operation of the proposed reservoir would be in cooperation with the operations of existing CVP and SWP system facilities. Sites would release water to the GCID Canal and the T-C Canal. A new Dunnigan Pipeline will allow water in the T-C Canal to flow into the Colusa Basin Drain and ultimately

[5] Pulse flows are modeled as 28 TAF but may vary in amounts per CDFW requests.
[6] This value represents the difference between Alternative 1B with transfers and the no project/no action alternative under existing conditions (see Reclamation 2020, revised Table 4.2-6 in Appendix B-1, Updated Modeling Analysis).
[7] Long-term Delta outflow is estimated at 16.3 million acre-feet per year (MAF/yr), with an average of 28.7 MAF/yr in wet years, 17.7 MAF/yr in above normal years, 9.5 MAF/yr in below normal years, 9.5 MAF/yr in dry years, and 5.3 MAF/yr in critical dry years (Reclamation 2019, Appendix D – Modeling, Table 41-1, Current Operations).
[8] This value represents the difference between Alternative 1B and the no project/no action alternative under existing conditions (see Reclamation, 2020; Revised Table 4.2-8 in Appendix B-1, Updated Modeling Analysis).
[9] See footnote 6.

back into the Sacramento River. Using these facilities, Sites water would be delivered to participants within neighboring areas, to SWP and CVP contractors, to the Yolo Bypass and to north- and south-of-Delta wildlife refuges. The project also includes exchanges with upstream reservoirs to preserve cold water releases for fishery benefits.

Diversions would range from an average of 61 to 406 TAF per year, depending on water year type, availability of Sacramento River water, and diversion and conveyance facility capacities.[10] Diversions would occur only under excess conditions. The maximum Sacramento River diversion rate is 4,200 cfs (3,900 cfs into reservoir considering canal losses). Net contributions to storage are from the Red Bluff Pumping Plant (up to 2,100 cfs) and the Hamilton City Pump Station (up to 1,800 cfs) but Sacramento River diversions would be a combined 4,200 cfs. Modeling for the environmental documents show that the Sites Project diversions during wet years from January through March when excess conditions are expected shows a 3 to 4 percent reduction in flows in the Sacramento River downstream of Red Bluff Diversion Dam.

Excess condition diversions could occur anytime between September 1 to June 14, the timeframe that the Sacramento River is not fully appropriated; however, most diversions would occur from December through March during wet and above normal water years. Diversions are expected to decrease Sacramento River inflow to the Delta by approximately 2 percent (and less during wet water years), assuming an average diversion rate for above normal years of 406 TAF.[11]

Average annual releases from the Sites Project would range from 70 to 427 TAF per year, depending on water year type, with a long-term average annual release to Sacramento River or Yolo Bypass of 140 TAF (over all year types).[12] Water would be conveyed via existing waterways. The Dunnigan Pipeline diverts water released into the Tehama-Colusa Canal from Sites into the Colusa Basin Drain that eventually flows into the Sacramento River or the Yolo Bypass. Maximum releases to the Sacramento River would be 1,000 cfs. Releases would occur during balanced conditions.

Delta exports range from 13-203 TAF per year for Sites participants south of the Delta and for environmental water delivers to south of Delta refuges.

The table below summarizes the estimated Sites average diversions and releases by water year type[13].

Water Year Type (Sacramento Valley 40-30-30 Index)	Diversions to Storage (TAF)	Releases from Reservoir (TAF)	Releases through Dunnigan Pipeline to Sacramento River or Yolo Bypass (TAF)	Delta Exports for Sites Participants and Refuges (TAF)
Wet	361	81	72	2
Above Normal	488	324	102	2
Below Normal	285	285	132	55
Dry	177	440	247	210

[10] Sites Project Authority, 2021; Section 2.5.2.
[11] Long-term Sacramento River flow at Freeport is estimated at 15.5 MAF/yr, with an average of 22.4 MAF/yr in wet years, 18.2 MAF/yr in above normal years, 12.2 MAF/yr in below normal years, 11.5 MAF/yr in dry years, and 7.6 MAF/yr in critical dry years (Reclamation 2019, Appendix D – Modeling, Table 29-1, Current Operations).
[12] Sites Project Authority, 2020; Table 5-2 and 5-3 and Table B1-1.
[13] Alternative 3 from May 2022 model provided to Stantec.

Critically Dry	42	263	160	153
Average Annual	277	256	137	80

Sites operations also includes exchanges with State and Federal facilities. Exchanges with upstream reservoirs could occur to preserve cold water in the upstream reservoirs for fishery benefits, with most of the exchanges occurring in dry and critical water year types.[14] These releases from Sites for exchanges would typically occur in spring and early summer with the exchanges listed below occurring in late summer and fall. The following exchanges would occur during balanced conditions, however alternative time windows could be considered.

- Shasta Lake exchanges would result in Sites releasing water in the spring in exchange for Shasta Lake releases in August and September.
- Lake Oroville exchanges would result in Sites releasing water in June and July in exchange for Lake Oroville releases in August through November.
- Folsom Lake exchanges would result in Sites releasing water in the spring and early summer in exchange for Folsom Lake releases in late summer and fall.
- Real-time exchanges with local participants would result in deliveries from Sites to CVP partner contractors in lieu of direct diversions from the Sacramento River.

Pacheco Reservoir Expansion Project

Pacheco is a surface storage project located in southeast Santa Clara County that would enlarge an existing reservoir by 136 TAF (from 6 TAF to 142 TAF). The project would construct new conveyance infrastructure to the CVP San Felipe Division in Santa Clara County and deliver water supply to up to eight south-of-Delta wildlife refuges in Merced County. Pacheco benefits include increased delivery of water to south-of-Delta wildlife refuges, improved local habitat for threatened South-Central California Coast Steelhead, and emergency water storage. The primary water sources to fill the expanded reservoir would be natural inflows from the North and East Forks of Pacheco Creek and imported water from San Luis Reservoir. Supplemental flows to the expanded reservoir would arrive from Valley Water's and the San Benito County Water District's share of contracted CVP pumped water from San Luis Reservoir as well as water from excess condition diversions, when available.

San Luis Reservoir stored water is expected to decrease due to transfers to Pacheco Reservoir. This would increase the amount of available San Luis Reservoir storage that can be used by the SWP and CVP. South-of-Delta diversions could increase in both excess and balanced conditions. Valley Water has simulated SWP exports from Banks Pumping Plant by water year type[15]. This analysis shows a percent change in Banks exports ranging from -0.5% to +0.2%. Simulated SWP south of Delta allocations by water year type shows a range of -1% to +1% change.[16] Operation of Pacheco could impact the availability of Article 21 by delaying conditions when Article 21 would be available. DWR is expected to mitigate this impact, if significant, by allowing SWP contractors to take Article 21 before San Luis spills to mimic conditions without Pacheco.

Pacheco was not modeled in the Stantec Report because it has minimal effects on the waterways included in that analysis.

[14] Sites Project Authority, 2020; Section 5.2.
[15] Draft EIR Pacheco Reservoir Expansion Project November 2021 Table 3.12.33
[16] Draft EIR Pacheco Reservoir Expansion Project November 2021 Table 3.12.34

Harvest Water Program

Harvest Water is a conjunctive use project in Sacramento County. Harvest Water would store and manage groundwater via in lieu recharge during the irrigation season and passive recharge by applying recycled water to sandhill crane habitat in the winter while improving stream flow, enhancing groundwater dependent riparian habitats, sustaining prime agricultural lands, and improving regional water supply reliability. Sources of water would be up to 50 TAF per year of tertiary-treated recycled water produced by Sacramento Regional County Sanitation District (Regional San) and diverted from discharge into the Sacramento River. Water produced from Harvest Water would be used to irrigate up to 16,000 acres of agriculture and habitat lands in Sacramento County near the lower Cosumnes River and Stone Lakes National Wildlife Refuge.

Up to 50 TAF per year of recycled water would be applied to lands in lieu of groundwater pumped from the South American Subbasin portion of the Sacramento Valley groundwater basin. An estimated 32.5 TAF per year of recycled water would be used for irrigation during the growing season (April through October). In a dry year, irrigation demands could be as much as 37.5 TAF per year. An additional 8.75 to 17.5 TAF per year of recycled water would be applied to lands during the non-growing season for wildlife enhancement. The recycled water for wildlife enhancement does not reduce groundwater pumping but does provide passive recharge of groundwater. Return flows from irrigation are assumed to be minimal. In theory, reuse of up to 50 TAF per year of recycled water could potentially result in a reduction of up to 50 TAF per year in wastewater outflow to the Sacramento River. The flow rate of the reduction will vary over the year based on annual pattern of wastewater generation. In any event, this represents a relatively small change in Sacramento River flow – less than a 0.7 % decrease in Sacramento River inflow to the Delta.[17] The amount of water that is sent to the project area rather than to the Sacramento River (i.e., the flow rate of the reduction) is not based upon wastewater supply at the recycled water treatment plant. Rather, the flow rate of the reduction depends upon demand for recycled water by users in the project area (i.e., agricultural and habitat lands). Therefore, reductions in Sacramento River flow may be greater during periods of high demand (e.g., in drier years and in summertime when farmers need more recycled water) than the calculated average (0.7%).

However, after 20 years, as documented in reference 2 (Modeling TM) and reference 6 (Implementation Water Rights TM) in the Harvest Water list of references, the net outflow to the Sacramento River and the downstream Delta environment, is projected to be reduced by approximately 25 TAF per year (50% of the 50 TAF per year remains in the groundwater basin and 50% returns to the Delta). This is from the result of projections of the groundwater basin filling. This represents an even smaller change in Sacramento River flow – less than a 0.4 percent decrease in Sacramento River inflow to the Delta. By the end of the 84-year modeling period, 80% of the flow eventually returns to the Delta. To mitigate this potential affect during the first 20 years, Regional San has agreed through its Wastewater Petition for Change (SWRCB Order No. 0092) negotiation process to cut back recycled water deliveries in Shasta Critical and in Critically Dry years by 50% (of the 32.5-37.5 TAF per year) and 25% respectively. These cutbacks sunset only after the 50% threshold described above is reached as demonstrated by the latest calibrated groundwater-surface water model maintained by Regional San.

3. Analysis

This section describes the individual effects of each of the WSIP projects, considers how they interact, and addresses cumulative changes to Delta, Feather River, and Sacramento River flows, and other

[17] See Footnote 11.

parts of the SWP system. Table 1 provides a summary of expected changes from each of the WSIP projects. The following is a summary of Hydrology Changes for Individual WSIP Projects.

Chino Basin Program

- Project Additional Groundwater Storage: 15 TAF/year stored in a WSIP Exchange Storage Account dedicated for ecosystem benefits.
- Feather River pulse flow releases: up to 50 TAF in selected years
- Reduced Delta Exports: up to 50 TAF in pulse flow years,
- Additional Delta Outflow: up to 50 TAF in pulse flow years

Kern Fan Groundwater Storage Project

- Project Additional Groundwater Storage: up to 100 TAF/year, with up to 25 TAF stored in a WSIP Exchange Storage Account dedicated for ecosystem benefits.
- Feather River pulse flow releases: up to 18 TAF in selected years
- Delta Exports, Excess Conditions: up to 100 TAF/year when Article 21 water is available under excess conditions
- Reduced Delta Exports: up to 18 TAF in pulse flow years
- Additional Delta Outflow: up to 18 TAF in pulse flow years

Willow Springs Water Bank Conjunctive Use Project

- Project Additional Groundwater Storage: 34 TAF/yr w/ 2030 hydrology and 39.2 TAF/yr under 2070 hydrology[18] stored in a WSIP Exchange Storage Account dedicated for ecosystem benefits.
- Feather River pulse flow releases: up to 28 TAF in selected years
- Delta Exports: Pre-positioning of SWP Water to WSWB allows for additional Delta exports averaging about 8.4 TAF/year.
- Reduced Delta Exports: up to 28 TAF in pulse flow years
- Additional Delta Outflow: up to 28 TAF in pulse flow years.

Los Vaqueros Reservoir Expansion Project

- Additional Surface Water Storage: 115 TAF (reservoir increase)
- Sacramento River Diversions: up to 155 cfs at Freeport (long-term average up to 6 TAF/year[19])
- Delta Exports increase, Balanced Conditions: up to 500 cfs[20] (long term average 42 TAF/year)
- Delta Exports increase, Excess Conditions: up to 500 cfs (long term average 48 TAF/year)

Sites Reservoir Project

- Additional Surface Water Storage: 1,500 TAF (reservoir capacity)

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[18] WSWB 2019 and Table 1 of AVWS 2017

[19] Freeport diversions would occur during balanced and excess conditions. The long-term average Freeport diversions increased by 1 TAF/yr during balanced conditions, and by 6 TAF/yr during excess conditions.

[20] This represents the combination of diversion to storage (up to 200 cfs) and direct diversions made to the California Aqueduct (up to 300 cfs).

- Sacramento River Diversions: up to 4,200 cfs (average of 60 to 406 TAF/year) depending on year type during excess conditions. 4,200 cfs is diversion, 3,900 cfs to storage is net of canal losses.
- Sacramento River Releases: up to 1,000 cfs (70 to 254 TAF/year) from reservoir during balanced conditions (capacity of Dunnigan pipeline). Exchanges with Shasta and Oroville reservoirs would allow for greater movement of Sites water above 1000 cfs. This includes deliveries to local Sites participants or north-of-Delta refuges.
- Increased Delta Exports, Balanced Conditions: average of 203 TAF/year in critically dry years from deliveries pumped at Banks and Jones Pumping Plants

Pacheco Reservoir Expansion Project

- Additional Surface Water Storage: 136 TAF (reservoir increase)
- Delta Exports: Modeling shows changes in CVP and SWP exports to be minimal, within uncertainty ranges of models. San Luis Reservoir will have increased capacity due to the Pacheco project that will allow some additional SWP and CVP export from the Delta. These exports could occur in balanced or excess conditions.

Harvest Water Program

- Sacramento River discharge reductions: During first 20 years up to 50 TAF/year in both balanced and excess conditions. However, during Shasta Critical and in Critically Dry years, treated wastewater deliveries are reduced 50% and 25%, respectively. described in Section 2 above under balanced and excess conditions, thus reducing net decreases of flows into the Sacramento River.
- Project Additional Groundwater Storage: up to 50 TAF/year in lieu use except in "cutback years" as described in the point above.
- After the first 20 years, lower discharge reductions.

3.1 Cumulative Flows

This section summarizes the analysis done in the Stantec Report. See the Stantec Report for scope, limitations and assumptions made. The Stantec Report used a CalSim II post-processing technique to "layer" operations of each WSIP project to show cumulative changes. Pacheco was not included in the Stantec Report because it has a minimal effect on the waterways included in this analysis.

The Stantec Report modeling analyzes flows at the following locations:

-Delta Surplus Flows

-Banks Pumping Plant

-Delta Inflow from Sacramento River

-Delta Inflow from the Yolo Bypass

-Feather River (at Thermalito outfall)

-Feather River (at Sacramento River junction)

-Delta Outflow

-Groundwater Bank Storage

CalSim II simulates water project operations over an 82-year hydrologic period (1921-2002). For each location a long-term monthly average is shown that includes applicable WSIP projects. Not all WSIP projects impact all locations. This set of data is followed by the same data by water year type: wet, above normal, below normal, dry and critical. Data is shown as plotted and in tabular form. The Stantec Report analyzes Sites, LVE and Harvest Water (Upstream Projects), then separately analyzes impacts from Kern Fan, Chino and WSWB (Groundwater Projects). The data from both analyses are used to show combined effects.

The following is a summary of the Stantec Report analysis organized by location.

Delta Surplus (or Surplus Delta Outflow)

This is a measure of flows in the Delta that are in excess of what is needed to meet all other regulatory requirements and in excess of SWP and CVP diversions. It indicates the amount of additional water in the system. Those that have water rights junior to the SWP and CVP can divert this water. Surplus Delta outflow is a subset of Delta outflow described later. Delta outflow is the total flow exiting the Delta and can be categorized into components needed to meet regulatory water quality or outflow requirements, and surplus or excess flows above and beyond what is needed to meet those requirements.

Upstream Projects: The largest changes in Delta surplus are from Sites and LVE. These projects divert relatively large amounts of water under excess conditions when surplus flows are available. Under balanced conditions, these Upstream Projects are assumed to cease diversion of surplus flows. The exception is Harvest Water that is allowed by its water rights to reduce wastewater discharges to the Sacramento River under some balanced conditions.

Mean annual reductions in Delta surplus under excess conditions throughout the simulation period are 317 TAF, or 3% of the total 10,473 TAF of mean annual Delta surplus under excess conditions[21]. These reductions mainly occur in the months of January-March. Year type analysis shows that the largest reductions occur in wet and above normal years. In these types of years average monthly reductions in Delta surplus range from 97 TAF to 127 TAF[22]. This represents about 2-5% of Delta surplus in these years[23]. In drier years there are still some smaller opportunities to divert under excess conditions.

Groundwater Projects: Kern Fan and WSWB also impact Delta surplus by using surplus flows to add water to their WSIP Exchange Storage Accounts. This use of surplus flows by these projects are an order of magnitude smaller than the Upstream Projects mostly due to conveyance constraints. Mean annual reductions in Delta surplus (excluding pulse flows) under excess conditions throughout the simulation period are 8 TAF of the total 10,473 TAF of mean annual Delta surplus under excess conditions - less than 0.1%.[24] This occurs in Wet and Above Normal years.

A spring pulse flow release in Below Normal and Dry years adds to Delta outflow, but has little impact on Delta surplus, because in Below Normal and Dry years there are small amounts of Delta surplus in April when the pulse flow releases are simulated in the modeling. The analysis shows an average 39-46 TAF pulse flow release over a month, which is the modeled average pulse flow release magnitude provided in Below Normal and Dry years.

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[21] Stantec Report Table 3
[22] Stantec Report Tables 4 and 5
[23] ibid
[24] Stantec Report Table 46

Banks Pumping Plant (Banks)

Upstream Projects: Sites results in increases in pumping at Banks, mostly in Dry and Critical years in July-September from deliveries of stored water to SWP participants south of the Delta. Since these are deliveries of stored water, there is no impact on other water users. Carriage water assessments are applied to deliveries during this period. Year type analysis show that these deliveries mostly occur in Dry and Critical years. Monthly average delivery rates are 967 cfs or less[25]. During July-September of Dry and Critical years, these monthly average additional deliveries are modeled to be 12%-114% of WSIP Baseline pumping[26].

Groundwater Projects: Kern Fan and WSWB increase Banks pumping during excess conditions when pumping capacity exists by a monthly average of up to 91 cfs in January-May of Wet and Above Normal years.[27] Banks pumping is reduced by a monthly average of 66 to 459 cfs by all three Groundwater Projects to replenish Lake Oroville pulse flow releases by exchange during July-September in a pulse flow release year.[28]In July and August of pulse flow release years this is a monthly average reduction of 2% to 9% of WSIP Baseline pumping[29].

Combined Effect: The reduction in Banks pumping by the Groundwater Projects' WSIP Operational Exchange occurs in July-September in dryer years when a pulse flow release is made. This could be the same time period and year type where Sites is delivering stored water to participants south of the Delta. However, a pulse flow release will likely not occur in a critical year, but Sites deliveries are likely in critical years. These actions are of the same order of magnitude and may offset each other to some degree in dryer water years.[30]

Delta Inflow from Sacramento River

Upstream Projects: Sacramento River inflows to the Delta are mostly reduced by Sites diversions under excess conditions in wetter years[31]. There is a corresponding increase in inflow during the July-November transfer window in drier years when water is released from storage from Sites for delivery to participants south of the Delta. There is a small decrease in inflow from reduction of wastewater discharges from Harvest Water.

Year type analyses shows that in wetter years there are more reductions in inflow in the winter as would be expected with Sites diverting under excess conditions. The average monthly percent reduction for Upstream Projects in December-March of Wet and Above Normal years is 1%-3% with a maximum monthly average reduction of 74 TAF[32]. In Dry and Critical years Sites delivers mostly in the July through October time frame. Combined effects of Upstream Projects on Sacramento River inflow result in an increase of 0.4%-11%, as much as 67 TAF per month[33].

Groundwater Projects: A spring pulse flow release in Below Normal and Dry years adds to Delta inflow. The analysis shows an average 39-46 TAF pulse flow release over a month, which is the modeled average pulse flow release magnitude provided in Below Normal and Dry years [34]. Delta inflow from the Sacramento River is decreased during the summer months where Lake Oroville releases are decreased to replenish Lake Oroville from the spring pulse flow release. Delta inflow is

[25] Stantec Report Tables 13 and 14 and Figure 6
[26] Stantec Report Tables 13 and 14.
[27] Stantec Report Tables 53 and 54
[28] Stantec Report Tables 55 and 56
[29] ibid
[30] Stantec Report Table 56
[31] Stantec Report Figure 8
[32] Stantec Report Tables 17 and 18
[33] Stantec Report Tables 20 and 21
[34] Stantec Report Figure 20 and Tables 61 and 62

reduced by a monthly average of 4 TAF to 28 TAF during July-September of Below Normal and Dry years with the largest decrease being 3% of the WSIP Baseline[35].

Combined Effect: Oroville pulse flow releases are expected to occur in dry and below normal years while diversions to Upstream Projects that reduce Delta inflow from Upstream Projects will occur in wetter years under excess conditions. The reduction in Delta inflow from decreased Lake Oroville releases to replenish Lake Oroville pulse flow releases can occur the same months and year types as increases in stored water deliveries from Sites. These changes in flows can be of the same order of magnitude so there can be an offsetting effect. Tables 59 thorough 63 in the Stantec Report shows this relationship.

Delta Inflow from Yolo Bypass

This flow is measured where the Yolo Bypass feeds into the Sacramento River near Rio Vista. Only Sites impacts Yolo Bypass flows in any significant way. Since Sites diverts under excess conditions, there will be times when these diversions delay Sacramento River overflows into the Yolo Bypass and return flow back into the Sacramento River. In the summer months Sites is conveying stored water through the Yolo Bypass for environmental purposes. Other WSIP projects have no significant impact on the Yolo Bypass.

Year type analysis shows that the reductions in Yolo Bypass flows are mostly in wet and above normal years. Modeling shows a monthly average reduction in December through April of 7 TAF to 77 TAF in Wet and Above Normal years[36]. This is in approximately a 1% to 10% reduction in Yolo Bypass monthly flows[37]. Additions to the Yolo Bypass from Sites come in all years from August through October (minimal flow in critical years). These additions are a monthly average of 20 TAF or less[38].

Feather River below Thermalito Junction

Upstream Projects: This location is in the Feather River at the junction of the discharge of the Thermalito Afterbay. The low flow channel of the Feather River is upstream of this point. Apart from the pulse flow release operations, the only project that has significant impacts to the Feather River is Sites. As part of Delta and Feather River water management, in addition to the facilitation of Sites deliveries to south of Delta participants, Sites would exchange water with the SWP by providing Sacramento River flows in June and July to meet some of SWP flow obligations and in return have the SWP release the same amount of water mostly in August and September. Year type analysis shows that these exchanges occur mostly in in Dry and Critical years. The highest average monthly flow reduction in June and July of dry and critical years is 659 cfs and reduced flows are well above minimum flow standards in the Feather River.[39] These reductions can reduce average monthly Feather River flows 1% to 16% in these months.[40]

Groundwater Projects: The spring pulse flow releases in Below Normal and Dry years add to Feather River flows. Assuming a 100 TAF pulse flow release, the modeled flow was a pulse of 3,000 cfs over a 10-day period with a ramp down of 500 cfs per day. The analysis shows an average 700-800 cfs pulse flow release over a month because the 3,000 cfs pulse flow release is assumed to occur over a 10-day period (with an 8-day ramp down)[41]. Monthly baseline average monthly flows in this part of the Feather River during April in Below Normal and Dry years are in the range of 900-1000 cfs[42]. In a pulse flow release year, Lake Oroville releases are reduced in July through September to replenish Lake Oroville. The volume of the reduction match to pulse flow release amounts. The modeled

[35] Stantec Report Tables 61 and 62.
[36] Stantec Report Figure 10 and Tables 23 and 24
[37] Stantec Report Tables 23 and 24
[38] Stantec Report Figure 10 and Tables 23 through-27
[39] Stantec Report Figure 12
[40] Stantec Report Tables 31 and 32
[41] Stantec Report Figure 24
[42] Stantec Report Tables 67 and 68

reduction in Feather River flows range from a monthly average of 67 cfs to 459 cfs or from 3% to 7% of Feather River flows at this location[43].

Combined Effect: The cold water exchange between Sites and Lake Oroville occurs in June through September with the SWP releasing extra water into the Feather River mostly in August and September. August and September are some of the same months that the Groundwater Projects cause Lake Oroville to release less water to replenish storage from the spring pulse flow release. These flows are the same order of magnitude and can partially offset each other in some years if Sites is in operation.

Feather River at Sacramento River Junction

Flow patterns in the Feather River at the Junction of the Sacramento River approximately mirror those at the Thermalito Junction[44]. Baseline flows are higher in the Feather River at this point, due to inflows in the Feather River between Thermalito and the Sacramento River. Flow changes from the WSIP projects are the same, but the impacts are less due to the higher baseline flows.

Delta Outflow

Delta outflow differs from Delta surplus (surplus Delta outflow). Delta surplus is a measure of flows in the Delta that are in excess of what is needed to meet all other regulatory requirements and in excess of SWP and CVP diversions. Delta surplus indicates the amount of additional water in the system. Delta surplus can be diverted by those having appropriate water rights. Delta outflow includes Delta surplus, when it is available, but includes other flows such as water to meet regulatory water quality or outflow requirements. WSIP project diversions shown in this section are the same as shown in the Delta surplus section, but the WSIP baseline is different reflecting the difference between Delta surplus and Delta outflow.

Upstream Projects: The largest changes in Delta outflow are from Sites and LVE. These projects divert relatively large amounts of water under excess conditions. In balanced conditions, changes to Delta outflow are assumed to be unchanged by WSIP projects because of operational constraints to limit impacts to existing water users. The exception is Harvest Water that is allowed by its water rights to reduce wastewater discharges to the Sacramento River under some balanced conditions.

Mean annual reductions in Delta outflow throughout the simulation period are 317 TAF, or 2% of the total 15,539 TAF of mean annual Delta outflow[45]. These reductions mainly occur in the months of December-April. Year type analysis shows that the largest reductions occur in wet and above normal years. In these types of years average monthly reductions in Delta outflow range from 22 TAF to 127 TAF[46]. This represents about 2-4% of Delta outflow in these years[47]. In drier years there are still some smaller opportunities to divert.

Groundwater Projects: Kern Fan and WSWB also impact Delta outflow by using surplus flows to create water for their WSIP Exchange Storage Accounts. This use of surplus flows by these projects are an order of magnitude smaller than the Upstream Projects mostly due to conveyance constraints. Mean annual reductions in Delta outflow (excluding pulse flow releases) throughout the simulation period in Wet and Above Normal years are 9-19 TAF This represents - less than 0.1%.[48]

A spring pulse flow release in Below Normal and Dry years adds to Delta outflow in April when the pulse flow releases are simulated in the modeling. The analysis shows an average 39-46 TAF pulse

[43] Stantec Report Table 67 and 68
[44] Stantec Report Figure 26
[45] Stantec Report Table 40
[46] Stantec Report Tables 41 and 42
[47] ibid
[48] Stantec Report Table 78 and79

flow release over a month, which is the modeled average pulse flow release magnitude provided in Below Normal and Dry years.

Groundwater Banking Operations

The Stantec Report also analyzes how the three groundwater banks would add water to their WSIP Exchange Storage Accounts. Each project, in their application for Prop 1 funding and subsequent updates, made assumptions about the rate of input of water supplies into their groundwater banks and under what conditions they would provide water for pulse flow exchanges. These arrangements are expected to be specified in Contracts for Administration of Public Benefit with CDFW. It is the responsibility of the WSIP projects to meet environmental obligations in these contracts. The Stantec Report models how all three projects could contribute to pulse flows based on assumptions made by each project and historical hydrology included in CalSim II. This narrative report will not summarize this part of the Stantec Report. The Stantec Report generally shows that it is possible to meet the WSIP pulse flow obligations, but much depends on hydrology, particularly for Kern Fan and WSWB who depend on excess conditions water diversions to develop water to exchange for pulse flow releases.

The Stantec Report treats Article 21 availability different than what is contemplated in current draft operating agreements with DWR that are under development for Kern Fan and WSWB. The draft operating agreements assume that Article 21 water will come from Article 21 allocations of their Partner Contractors. The Stantec Report assumes that Article 21 water supplies for these projects are in addition to the Article 21 deliveries simulated in the WSIP Baseline. This may not make too much of a difference because Kern Fan and WSWB may increase allocated Article 21 demand above current levels.

The analysis does not include calculations for carriage water savings (also called Efficiency Credits) from delivery of water supplies from groundwater banks to Partner Contractors to replace Table A diverted from the Delta.

This section summarizes cumulative flows in the context of diversions, releases and exports.

Sacramento River Diversions

LVE (through use of the Freeport diversion) and Sites would increase Sacramento River diversions and Harvest Water would reduce inflow into the Sacramento River.

Sites is by far the largest Sacramento River diversion at 4,200 cfs, which would occur only during excess conditions. LVE Freeport diversion has a capacity of 155 cfs and may divert under excess conditions for LVE. Since the Harvest Water reduces Sacramento River inflows by 50 TAF per year on a continuous basis, that amount averages to a reduction of 69 cfs per day (or less as described in Section 2.2 above according to negotiated cutback in the first 20 years of operations).

The LVE Freeport diversion could also divert in balanced conditions such as for diverting SWP Table A supplies into LVE. This type of relatively small diversion would be scheduled and coordinated through the LVE operating agreements with the SWP and CVP to eliminate any adverse consequences and will be diverted in conformance with all permits and regulations. Any Harvest Water reductions in

balanced conditions are not substantial (less than 0.7 percent or less during Shasta Critical and Critically Dry cutback years).[49]

Summary: The largest diversion, Sites, occurs in excess conditions and is a relatively small percentage of Sacramento River flows during wet time periods. The LVE Freeport diversion is expected to be utilized less frequently than the LVE Delta diversion locations and is a relatively small diversion rate. Harvest Water reductions in discharges are relatively small given the volume of Sacramento River flows.

Sacramento River Releases

Sites would release flows back to the Sacramento River during balanced conditions. The releases from Sites to the Sacramento River are estimated to be a maximum of 1,000 cfs. The releases will be to local waterways eventually leading to the Sacramento River and the Delta. The releases would be scheduled and coordinated through the Sites operating agreements with the SWP and CVP to avoid any substantial adverse consequences and will be diverted in conformance with all permits and regulations.

Pulse flows from Lake Oroville into the Feather River will travel down the Sacramento River and through the Delta. The pulse flows will be protected from diversion through a SWRCB instream flow dedication (Water Code 1707). These flows are expected to occur, when requested by CDFW and approved by DWR, in the spring of Dry and Below Normal years. These flows could overlap with some other WSIP project operations but the pulse flows are considered environmentally beneficial "extra" flows above any regulatory flow requirements.

Summary: Releases in balanced conditions are coordinated with the SWP and CVP, so any WSIP operations should not impact other water users.

Delta Exports in Balanced Conditions

The Groundwater Projects do not increase Delta exports in balanced conditions. The Groundwater Projects reduce demand for Delta pumping for individual SWP Partner Contractors who receive their Table A deliveries by exchange with water recovered from the Groundwater Projects instead of the Delta or San Luis Reservoir. This reduced demand results in less pumping at Banks Pumping Plant in the summer of pulse flow release years.

Sites releases water from storage during balanced conditions for delivery to project participants and for exchanges with upstream SWP and CVP reservoirs. Most of the deliveries to project participants will be provided at SWP and CVP export facilities. LVE will also divert water from the Delta during balanced conditions. An example would be export of SWP Table A water for SWP South Bay Aqueduct contractors.

Pacheco results in increased available capacity in San Luis Reservoir that would allow a small amount of additional SWP and CVP export from the Delta in both balanced and excess conditions.

Combined Delta exports in balanced conditions for Sites and LVE are approximately 245 TAF per year.[50] For this analysis additional Delta exports resulting from the Pacheco project are not included. Note that these exports would occur under the same environmental, regulatory, and operational constraints that apply to all SWP supplies.

For the Groundwater Projects there are carriage water "credits" under discussion where the projects could be credited with water savings from not having to move Table A water through the Delta

[49] Average annual flow in the Sacramento River at Freeport is 10,400 to 30,900 cfs depending on year type (Reclamation 2019, Appendix D – Modeling, Table 29-1); a reduction of 69 cfs per day would decrease annual flow by no more than 0.7 percent.
[50] Assumed 203 TAF from the Sites Project and 42 TAF from the LVE Project.

(because water equivalent to Table A is provided by groundwater banks). The potential savings is because when water is moved through the Delta for export, a fraction of that export is used as Delta outflow to maintain Delta water quality standards. The carriage water savings matter is being discussed with SWP and CVP operators, but no final decision has been made. CalSim II modeling accounts for carriage water with changes in Delta exports. The carriage water credits would affect water accounting for the Groundwater Projects' obligations for providing water for the pulse flow releases.

Summary: Delta exports in balanced conditions are coordinated with the SWP and CVP, so any WSIP operations should not impact other water users.

Delta Exports in Excess Conditions

Kern Fan, WSWB, and the LVE would increase Delta exports during excess conditions. Pacheco results in increased available capacity in San Luis Reservoir that will allow some additional SWP and CVP exports from the Delta in both balanced and excess conditions. The exports during excess conditions would cause a small reduction in Delta outflow. Combined flows are expected to be a relatively small percentage of Delta outflow during excess conditions. These exports would occur under the same environmental, regulatory, and operational constraints that apply to all SWP supplies.

Summary: Delta diversions during excess conditions are a relatively small percentage of Delta outflow.

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Table 1. Resulting Changes from the WSIP Projects

Location or Type	Chino Basin Program	Kern Fan Project	WSWB Project	LVE Project	Sites Project	Pacheco Project	Harvest Water Program
Additional Surface Reservoir Storage	--	--	--	115 TAF	1,500 TAF	136 TAF	--
Additional Groundwater Storage	15 TAF/yr	up to 100 TAF/yr (up to 25 TAF/yr for ecosystem use)	34 TAF/yr	--	--	--	up to 50 TAF/yr in lieu use
Feather River Pulse Flows volumes	Up to 50 TAF	Up to 18 TAF	Up to 28 TAF	--	--	--	--
Sacramento River Diversions or Reductions	--	--	--	up to 155 cfs (7 TAF/yr average) in diversions @ Freeport	up to 4,200 cfs (60-406 TAF/yr average) diversions in excess conditions	--	up to 50 TAF/yr in reduced wastewater discharge (with reduced reductions in critically dry years and in later project operations)
Sacramento River Releases	--	--	--	--	up to 1,000 cfs (70-254 TAF/yr average) in balanced conditions. Plus local and environmental releases	--	--
Delta Exports, Balanced Conditions	Reduced export in pulse flow years of up to 50 TAF	Reduced export in pulse flow years up to 18 TAF	Reduced exports in pulse flow years up to 28 TAF. Average 8.4 TAF/yr increase in Delta exports in balanced and excess conditions	Increased exports up to 500 cfs (42 TAF/yr average)	Increased exports -avg of 203 TAF/yr in critical years from deliveries	some additional exports due to increased capacity available in San Luis Reservoir	--
Delta Export Increases, Excess Conditions	--	up to 100 TAF/yr	Average 8.4 TAF/yr increase in Delta exports in balanced and excess conditions	Up to 500 cfs (48 TAF/yr average)	--	some additional due to increased capacity available	--

Location or Type	Chino Basin Program	Kern Fan Project	WSWB Project	LVE Project	Sites Project	Pacheco Project	Harvest Water Program
						in San Luis Reservoir	

).

From: Micko, Steve [Steve.Micko@jacobs.com]
Sent: 11/1/2022 4:07:59 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]
CC: Angela Bezzone [bezzone@mbkengineers.com]; Leaf, Rob [Rob.Leaf@jacobs.com]
Subject: RE: Final Documents

Hi Ali,

The Table on page 7 in the WSIP Cumulative Flow Study presents values from Alt 3 of the Final EIR/EIS (ALT 3 051722). Those values are consistent with values in the trend report. Values in the Sites metrics (table below) will slightly differ by 1 to 2 TAF.

Jerry's comment is correct. Total deliveries are about 160 TAF.
However, the table on page 7 only considers Delta exports for South of Delta participants (70 TAF) and south of Delta IL4 refuges deliveries (12 TAF). In the trend report, these sum to 80 TAF.
The WSIP cumulative narrative paper does not consider NOD participants, CVP OpFlex, NOD IL4 Refuges, nor Yolo Bypass deliveries.

Hope this helps,
Steve

Authority Deliveries Table

Deliveries (TAF/year) (change from No Project Alternative conditions)[3]	ALT 1A 051722		ALT 1B 051722		ALT 2 051722		ALT 3 051722	
	Average	Dry and Critical	Average	Dry and Critical	Average	Dry and Critical	Average	Dry and Critical
	1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD) Historic Climate		1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD) Historic Climate		1.27 MAF Reservoir Dunnigan Pipeline (outlet to Sac R) Historic Climate		1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD) Historic Climate	
Authority PWA Deliveries	144	268	169	254	167	259	96	265
NOD	24	47	23	44	25	43	21	37
SOD	89	221	86	219	94	208	78	168
CVP Operational Flexibility	1	2	7	14	1	2	22	60
Sub-Total Supplemental Deliveries for Water Supply	115	276	116	268	108	251	112	266
Refuge Water Supply	16	32	18	29	19	33	16	28
NOD (Level 4)	3	5	4	5	4	5	4	5
SOD (Level 4)	14	26	14	24	15	28	12	23
Yolo Bypass Habitat Water Supply	36	10	34	9	40	14	33	10
Total Authority Deliveries	169	312	168	307	167	299	161	303
Percentage of Total Authority Deliveries								

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Tuesday, November 1, 2022 3:05 PM
To: Micko, Steve <Steve.Micko@jacobs.com>
Cc: Angela Bezzone <bezzone@mbkengineers.com>
Subject: [EXTERNAL] FW: Final Documents

Steve- See Jerry's message below. Can you verify that the Table on page 7 of the WSIP Cumulative Narrative Paper is correct?

I now cant remember if this report uses our RDEIR/SDEIS modeling or the BA modeling. But I think it was the RDEIR/SDEIS modeling.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Jerry Brown <jbrown@sitesproject.org>
Sent: Saturday, October 29, 2022 6:10 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Angela Bezzone <no-reply@sharepointonline.com>
Subject: FW: Final Documents

Please verify that the table on page 7 of the DWR report is correct for the delta exports. I believe the average annual amount of 80TAF shown is low and should be closer to 160TAF (~120taf for SOD Participants + ~40taf for P1 ecosystem water).

If 80taf is correct please explain what I'm missing and if it is incorrect please ask DWR to make a correction.

thanks

From: "Okita, David@DWR" <David.Okita@water.ca.gov>
Date: Friday, October 28, 2022 at 7:02 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>, Andrew Garcia <AndrewGarcia@valleywater.org>, Angela Bezzone <bezzone@mbkengineers.com>, "Boland-Brien, Samuel@Waterboards" <Samuel.Boland-Brien@waterboards.ca.gov>, Cindy Kao <ckao@valleywater.org>, Dana Jacobson <DJacobson@valleywater.org>, Dave Richardson <drichardson@woodardcurran.com>, Jerry Brown <jbrown@sitesproject.org>, Marguerite Patil <mpatil@ccwater.com>, Maureen Martin <mmartin@ccwater.com>, Michael Martin <MichaelMartin@valleywater.org>, "Riddle, Diane@Waterboards" <Diane.Riddle@waterboards.ca.gov>, "Sugar, Sarah@Waterboards" <Sarah.Sugar@Waterboards.ca.gov>, Terrie Mitchell <mitchellt@sacsewer.com>, "Young, Amy@DWR" <Amy.Young@water.ca.gov>
Subject: Final Documents

Attached are the final version of the WSIP Cumulative Flow Study. They are the Stantec Report and the DWR prepared Narrative. These have been revised based on comment received and some editorial updates. The main addition is a new section on Delta Outflow.

Note that the 3 WSIP Pulse Flow projects (and CDFW) are on a separate mailing list.

David Okita, PE
Department of Water Resources
530 902-7588

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From: Sara M. Katz [skatz@katzandassociates.com]
Sent: 11/2/2022 8:59:32 AM
To: Ann Newton [anewton@katzandassociates.com]
CC: Kevin Spesert [kspesert@sitesproject.org]; Sarah Rossetto [srossetto@katzandassociates.com]; kim@floydcommunications.com
Subject: Re: Sites Communications Meeting Agenda for 11/02/2022
Attachments: image001.png; Sites Virtual Toursmkedits11.01.22.docx; Sites Drought Video Outline 10.18.22.docx

Thanks Ann. Please be ready to show on the screen when we get to that agenda item. Thank you

Sent from my iPhone

On Nov 2, 2022, at 8:14 AM, Ann Newton <anewton@katzandassociates.com> wrote:

Hi All,

Attached are the two video outlines for discussion this morning – the drought video and the virtual tour. Talk soon.

Ann

From: Sara M. Katz <skatz@katzandassociates.com>
Sent: Tuesday, November 1, 2022 11:05 AM
To: Kevin Spesert <kspesert@sitesproject.org>; Ann Newton <anewton@katzandassociates.com>; Sarah Rossetto <srossetto@katzandassociates.com>; kim@floydcommunications.com
Subject: Sites Communications Meeting Agenda for 11/02/2022

1. Kevin Spesert update
2. Upcoming CWG tour details; Meeting #1 Summary Notes; other CWG details
3. Drought Video outline – review outline, discuss, next steps
4. Sites Virtual Tour Video outline – review outline, discuss, next steps
5. Year-End planning, contracting issues, 2023 budget discussions
6. Other

K&A
KATZ & ASSOCIATES
Sara M. Katz
Founder/CEO
mobile: 619.813.9551
San Diego · Los Angeles · San Francisco

Sites Virtual Tour Videos

1. **Maxwell/Community Intro**
   - Brief history of the project
   - Beyond an ideal reservoir location, Maxwell represents the rural farming communities that are so critical to California—communities that need this water to sustain our food supply.
   - When farms are hurting, the surrounding communities feel it as well because farms drive the economic health of rural America.
   - Sites is a statewide project with statewide participation and benefits, but has always been a locally led project.
   - Brief overview of Authority board structure, public agency involvement, statewide collaboration.

   On Camera Narrator: Fritz Dust

   Visuals: Maxwell sign, Sites JPA office door, community images, farming, family eating dinner, b-roll of local community services (police, education etc.), animation

2. **GCID Canal; TRR Reservoir**
   - History on GCID canal—built in the 1920's, runs about 100 or so miles, critical infrastructure that stands the test of time, pulls water from Sac River
   - Unique opportunity for Sites to utilize existing infrastructure
   - How it will operate - Water moves in and out of the river through this canal
   - Water from this canal will go into the TRR—a forebay for the Sites project. To get the volume we need, we need TRR. Water is then pumped 3.5 miles from TRR into Sites.
   - Water from Sac River – pumped into TRR – pumped into Sites. When it's released from Sites, it is pumped back into TRR from pipeline and then into the canal to be sent to water users south of GCI location.
   - We can use the canal when it is not being used for delivery to GCID customers
   - This infrastructure allows us to control how much and when we move water.
   - Fish screens provide crucial environmental protection
   - Why GCID is involved in Sites

   On Camera Narrator: Thad Bettner

   Visuals: GCID canal, fish screens, map of GCID canal location in relation to Sites reservoir, and drone footage

3. **Funks Reservoir/ TC Canal**
   - History of TC – how it operates, water moves in and out; another example of utilizing existing infrastructure
   - How it ties into TRR and TC system, how water flows in and out of the reservoir, state of the art fish screen.

DRAFT

- TC is the longer of the two canals—greater capacity. Water comes thru the fish screens, pumped into Sites Reservoir from the canal. Siphoned all the way down to Dunnigan Pipeline and then back into the Sac River at Knight's Landing.
- What Funks is going to look like
- Overview of construction,
- Why they are involved in Sites.

On Camera Narrator: Jeff Sutton

Visuals: TC Canal, Funks Reservoir view, map of location in relation to Sites, potential animation showing TC and TRR, fish screens, footage of farms

4. **Sites dam/Golden Gate dam**
   - Sites does not dam a river but the project will include construction of small dams to help hold water supplies in the reservoir and allow for controlled released in and out of the reservoir.
   - Critical entry points on the east side of the reservoir, allows us to manage water coming into Sites
   - Funks Reservoir behind Golden Gate dam
   - Need data points on these—fact and figures.

   On Camera Narrator: **JP Robinette**

   Visuals: View of dam locations, map view, mostly pictures and drone footage

5. **Reservoir Footprint**
   - Location is a natural reservoir.
   - Standing at the bottom of the reservoir, here we would be 250 feet underwater
   - The space here will hold up to xx acre-feet of water
   - It stretches xx long and xx wide
   - This is also the future site of new recreation opportunities—boating, waterskiing, fishing, camping, hiking. Sites Reservoir is a value add for residents throughout the Sac Valley.

   On Camera Narrator: **Jamie Traynam (TBD)**

   Visuals: Perspective from inside reservoir footprint, 360 views, aerial map view showing location in perspective, animation of reservoir filling, recreation animation, drone footage

6. **Dunnigan pipeline/Colusa Basin Drain**
   - Overview of how the water comes out from the reservoir, down Dunnigan pipeline and back into the river for delivery to south of delta participants
   - Portion of the environmental water will be delivered thru the pipeline

   On Camera Narrator: **TBD – Local board member or south of delta participant?**

   Visuals: Dunnigan pipeline/CB drain location, Sacramento River, urban and environmental b-roll

DRAFT

7. **Saddle Dams**
    - Saddle dams are small dams/dykes to top off the ridges that allows us to hold the water at the level we need. Built to help hold the water in the reservoir where the topography is lower.
    - Need stats/facts
    - Number of saddle dams, size

    On Camera Narrator: **JP Robinette**

    Visuals: View from reservoir footprint of where the saddle dams would be, map overview, animation to show the saddle dams in operation

8. **Sites Reservoir: The Big Picture**
    - Tying it all together.
    - Unique location
    - Meaningful use of existing infrastructure
    - Efficient engineering
    - Environmentally sound/protections and enhancements in place
    - Possible animated overview of how the reservoir would actually function with the canals, reservoir, dams and pipelines.

    Visuals: Reservoir aerial view, animated overview of how the infrastructure ties together (water going into TC and GCID canals, Funks and TRR reservoirs, released into Sites, back out to water users etc.). **Close from Jerry or Fritz.**

DRAFT

From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 11/2/2022 10:52:15 AM
To: Jacobson, Allison M [ajacobson@usbr.gov]; Dekar, Melissa D [mdekar@usbr.gov]; Brick, David A [dbrick@usbr.gov]; Hunt, Shane D [shunt@usbr.gov]; Lecky, Jim [jim.lecky@icf.com]; Greenwood, Marin [Marin.Greenwood@icf.com]; Pitts, Adrian [Adrian.Pitts@icf.com]; Hendrick, Mike [mike.hendrick@icf.com]; Moderan, Julien [Julien.Moderan@icf.com]; Alicia Forsythe [aforsythe@sitesproject.org]; Berryman, Ellen (Ellen.Berryman@icf.com) [ellen.berryman@icf.com]; Hassrick, Jason (Jason.Hassrick@icf.com) [jason.hassrick@icf.com]; Unger, Sophie [Sophie.Unger@icf.com]; Schoenberg, Steven [steven_schoenberg@fws.gov]
CC: steve.micko@jacobs.com; Angela Bezzone [bezzone@mbkengineers.com]; Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Subject: RE: PAM Meeting #3
Attachments: Sites YBCC analysis Summary_PAM_10-2022.docx

Sorry for the last minute addition here, attached is a brief write-up for the Yellow-billed Cuckoo analysis. Ellen will discuss this today.

John Spranza

D 916.679.8858 M 818.640.2487

-----Original Appointment-----
From: Spranza, John
Sent: Wednesday, October 26, 2022 2:19 PM
To: Spranza, John; Jacobson, Allison M; Melissa Dekar (mdekar@usbr.gov); Brick, David A; shunt@usbr.gov; jim.lecky@icf.com; Greenwood, Marin; Pitts, Adrian; Hendrick, Mike (Mike.Hendrick@icf.com); Moderan, Julien; aforsythe (aforsythe@sitesproject.org); Berryman, Ellen (Ellen.Berryman@icf.com); Hassrick, Jason (Jason.Hassrick@icf.com); Unger, Sophie; Schoenberg, Steven
Cc: Micko, Steve/SAC (Steve.Micko@jacobs.com); Angela Bezzone; Laurie Warner Herson
Subject: PAM Meeting #3
When: Wednesday, November 2, 2022 11:00 AM-12:00 PM (UTC-08:00) Pacific Time (US & Canada).
Where: Microsoft Teams Meeting

Hello, this is a follow-up meeting from the 8/29 meeting and the proposed agenda is below, please let me know if you have an additions or edits.

1. Ellen to review SacEFT used in the cottonwood analysis and questions on Attachment 8A - Sedimentation and River Hydraulics Modeling (SRH) that was sent to Steve on 10/4/22
2. Discuss the WUA information that Steve sent links to and discuss ICF WUA concerns response (See attached)
   a. https://www.tandfonline.com/doi/abs/10.1577/M10-020.1
   b. https://www.tandfonline.com/doi/full/10.1080/00288330.2015.1040424
   c. https://www.tandfonline.com/doi/abs/10.1577/1548-8675(1996)016%3C0154%3AASATEO%3E2.3.CO%3B2
3. Incremental Level 4 water estimate that would bracket best and worst case scenario of average amount of water provided (See attached)
4. Provide an estimate of near-bank inundation with and w/o diversion – If data available
   a. Acers
   b. Stream length
   c. Other

Microsoft Teams meeting

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Write-up on Sites ReservoireWestern Yellow-billed Cuckoo Analysis

10/31/2022

Introduction

Flow regulation resulting from off-stream storage north of the Delta has the potential to adversely affect western yellow-billed cuckoo by reducing the dynamic process that shapes the species' habitat (Fremier et al. 2014, Larsen et al. 2006). The maintenance of western yellow-billed cuckoo habitat is dependent on a meandering riparian system that is frequently eroding and depositing soil and creating young riparian habitat (Laymon 1998, Greco 2013, Greco and Larsen 2014). The reduction of large flood events and stream power reduces the potential for this process. ICF reviewed studies related to anticipated flow regimes resulting from diversions for off-stream storage and evaluated potential effects of the current proposed Sites Reservoir project on western yellow-billed cuckoo in light of these studies. This document provides a summary of the evaluation.

Western Yellow-billed Cuckoo Habitat Requirements Along the Sacramento River

Within the study area along the Sacramento River between Red Bluff and Colusa Drain, the riparian vegetation supports a population of the federally listed western yellow-billed cuckoo, and formally designated critical habitat for this species. This population is in decline, and although this decline is not likely attributable to the amount of riparian vegetation available (Dettling et al. 2015), maintenance of suitable habitat conditions is important to sustaining the population, and ensuring critical habitat is not adversely modified.

Recent studies have demonstrated that occasional flooding and gap-forming disturbance is important to sustaining western yellow-billed cuckoo habitat – otherwise forests become senescent and young tree recruitment necessary for healthy western yellow-billed cuckoo habitat is suppressed by older trees (Wohner et. al 2021). Western yellow-billed cuckoos require young, dense, early successional stands in association with older trees, forming habitat with both dense canopy and dense understory (Wohner et al l 2021,Johnson et al. 2017). The young stands are formed from establishment of seedlings in dynamic parts or river systems, particularly meandering river systems. Pioneer riparian forests have high growth rates along floodplains created by channel cut-offs in areas subject to frequent flooding, erosion, and depositional processes, and these areas provide prime habitat for western yellow-billed cuckoos (Wohner et al. 2021).

Young tree recruitment along many California riparian systems, including the Sacramento River, has been adversely affected by water impoundment, flow regulation, channel bank recruitment, bank revetment, and surface water diversions, potentially contributing to the decline of western yellow-billed cuckoos even while restoration efforts have increased the extent of riparian forests (Wohner et al 2021).

The analysis below looks at how the project potentially effects young tree recruitment and river meander migration, both of which are important aspects of maintain western yellow-billed cuckoo habitat in the study area.

Young Tree Recruitment

The Nature Conservancy and ESSA Technologies Limited developed the Sacramento River Ecological Flow Too. **Attachment 1** provides the methods and results of the SacEFT analysis and **Attachment 2**, the Record of Design, provides a complete description of the model performance measures and assumptions.

SacEFT incorporated The Unified Gravel Sand (TUGS) model that simulates how bed mobilization and scour affects grain size distribution, including the fraction of sand in both the surface and subsurface layers. SacEFT also evaluated bank erosion, channel movement, and reworking of the floodplain. Factors incorporated into the model for Fremont cottonwood included changes in the timing of flows and water surface elevations, and biological parameters such as taproot growth rate, seed dispersal timing, capillary fringe, drought tolerance and viable root depth.

The SacEFT evaluated existing conditions in Sacramento River and three project alternatives in terms of Fremont cottonwood initiation success. As shown in Table XX of Attachment 1, negligible change was found between the action alternatives and the no action alternative in terms of Fremont cottonwood initiation success. The proposed project is most similar to Alternative B in that it does not include a Delevan pipeline. However, diversion criteria for the old Alternative B required at least 5,000 CFS over a 3-day average, whereas for the proposed project, diversion criteria require at least 10,700 CFS at any point during the months of October to June. With significantly more flows in the river where river meander is most likely to occur in the proposed alternative, the proposed project is expected to have effects somewhere between the no action alternative and the old Alternative B, there no significant change is anticipated in terms of Fremont cottonwood recruitment.

River Meander

A river meandering model was previously utilized in the 2017 Draft EIR/EIS for a 1.8-MAF reservoir with a Delevan Intake location on the Sacramento River. The previous modeled results are valid for the geographic scale of the whole of the upper Sacramento River at which impacts on fluvial geomorphology are being considered for Alternatives 1, 2, and 3. The previous modeling results are generally conservative (i.e., higher in volume) relative to the amount of diverted water (and sediment) being considered under Alternatives 1, 2, and 3.

SRH-Meander was used to predict the channel alignments in 2030 based on 2009 channel alignment and modeling 20 years of hydrology from October 1, 2010, to September 30, 2030, using USRDOM flows. The effects on natural river meandering, bank erosion, and deposition in the Sacramento River channel between Red Bluff and Colusa was modeled using the model. Inputs to the model included USRDOM model daily flows, streambank erodibility, and channel hydraulic characteristics.

With respect to the SRH-Meander model, the authors of the modeling effort suggested that the tendency for meander and the difference between Alternatives 1 and 3 is not considered significant considering the inherent variability in the system. The river meandering, bank erosion, and deposition modeling concluded that there were no significant differences between

the channel alignments between existing conditions and the modeled alternatives (FEIR/S page 7-12).

Conclusion

Fremont cottonwood establishes in riparian areas where young seedlings require a continuous supply of groundwater to their growing tap root in order to survive during their first spring and summer (seedling initiation). Groundwater moisture is driven by the water table of the adjacent river, and successful initiation depends on a stage recession rate that matches the seedling's ability to grow a tap root. Historically, good initiation years happen about once or twice in every ten years, and SacEFT records and reports the number of successful initiation events at selected index cross sections along the Sacramento River.

The SacEFT study shows negligible difference between Alternative B and NAA in terms of both cottonwood initiation success, and since the proposed project is expected to have less impact on hydrology than the old Alternative B, effects of the proposed project on initial success are expected to be negligible. Additionally river meander is an important factor in maintaining habitat conditions suitable for western yellow-billed cuckoo, and SRH-Meander model indicates that there is no significant difference between the proposed project and the no action alternative in terms of river meander. As such, the operation of the proposed project is not expected to adversely affect habitat conditions for western yellow-billed cuckoo.

From: Berryman, Ellen [Ellen.Berryman@icf.com]
Sent: 11/2/2022 10:56:15 AM
To: Spranza, John [john.spranza@hdrinc.com]; Jacobson, Allison M [ajacobson@usbr.gov]; Dekar, Melissa D [mdekar@usbr.gov]; Brick, David A [dbrick@usbr.gov]; Hunt, Shane D [shunt@usbr.gov]; Lecky, Jim [Jim.Lecky@icf.com]; Greenwood, Marin [Marin.Greenwood@icf.com]; Pitts, Adrian [Adrian.Pitts@icf.com]; Hendrick, Mike [Mike.Hendrick@icf.com]; Moderan, Julien [Julien.Moderan@icf.com]; Alicia Forsythe [aforsythe@sitesproject.org]; Hassrick, Jason [Jason.Hassrick@icf.com]; Unger, Sophie [Sophie.Unger@icf.com]; Schoenberg, Steven [steven_schoenberg@fws.gov]
CC: steve.micko@jacobs.com; Angela Bezzone [bezzone@mbkengineers.com]; Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Subject: RE: PAM Meeting #3
Attachments: Attachment 2.pdf; Attachment 1.pdf

Thanks John. Here are the attachments – I'll focus today on Attachment #2 to answer the question about what parameters went into the Fremont cottonwood initiation aspect of SacEFT model.

From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Wednesday, November 2, 2022 10:52 AM
To: Jacobson, Allison M <ajacobson@usbr.gov>; Dekar, Melissa D <mdekar@usbr.gov>; Brick, David A <dbrick@usbr.gov>; Hunt, Shane D <shunt@usbr.gov>; Lecky, Jim <Jim.Lecky@icf.com>; Greenwood, Marin <Marin.Greenwood@icf.com>; Pitts, Adrian <Adrian.Pitts@icf.com>; Hendrick, Mike <Mike.Hendrick@icf.com>; Moderan, Julien <Julien.Moderan@icf.com>; Alicia Forsythe <aforsythe@sitesproject.org>; Berryman, Ellen <Ellen.Berryman@icf.com>; Hassrick, Jason <Jason.Hassrick@icf.com>; Unger, Sophie <Sophie.Unger@icf.com>; Schoenberg, Steven <steven_schoenberg@fws.gov>
Cc: Micko, Steve/SAC <Steve.Micko@jacobs.com>; Angela Bezzone <bezzone@mbkengineers.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: RE: PAM Meeting #3

Sorry for the last minute addition here, attached is a brief write-up for the Yellow-billed Cuckoo analysis. Ellen will discuss this today.

John Spranza

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-----Original Appointment-----
From: Spranza, John
Sent: Wednesday, October 26, 2022 2:19 PM
To: Spranza, John; Jacobson, Allison M; Melissa Dekar (mdekar@usbr.gov); Brick, David A; shunt@usbr.gov; jim.lecky@icf.com; Greenwood, Marin; Pitts, Adrian; Hendrick, Mike (Mike.Hendrick@icf.com); Moderan, Julien; aforsythe (aforsythe@sitesproject.org); Berryman, Ellen (Ellen.Berryman@icf.com); Hassrick, Jason (Jason.Hassrick@icf.com); Unger, Sophie; Schoenberg, Steven
Cc: Micko, Steve/SAC (Steve.Micko@jacobs.com); Angela Bezzone; Laurie Warner Herson
Subject: PAM Meeting #3
When: Wednesday, November 2, 2022 11:00 AM-12:00 PM (UTC-08:00) Pacific Time (US & Canada).
Where: Microsoft Teams Meeting

Hello, this is a follow-up meeting from the 8/29 meeting and the proposed agenda is below, please let me know if you have an additions or edits.

1. Ellen to review SacEFT used in the cottonwood analysis and questions on Attachment 8A - Sedimentation and River Hydraulics Modeling (SRH) that was sent to Steve on 10/4/22

2. Discuss the WUA information that Steve sent links to and discuss ICF WUA concerns response (See attached)
a. https://www.tandfonline.com/doi/abs/10.1577/M10-020.1
b. https://www.tandfonline.com/doi/full/10.1080/00288330.2015.1040424
c. https://www.tandfonline.com/doi/abs/10.1577/1548-8675(1996)016%3C0154%3AASATEO%3E2.3.CO%3B2
3. Incremental Level 4 water estimate that would bracket best and worst case scenario of average amount of water provided (See attached)
4. Provide an estimate of near-bank inundation with and w/o diversion – If data available
a. Acers
b. Stream length
c. Other

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Sacramento River Ecological Flows Tool (SacEFT): Record of Design (v.2.00)

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Sacramento River Ecological Flows Tool (SacEFT): Record of Design (v.2.00)

Prepared for

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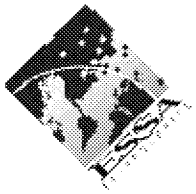
Prepared by



ESSA Technologies Ltd.
1765 West 8th Avenue, Suite 300
Vancouver, BC V6J 5C6

May 2011 Revision

Draft_0020254

Citation: **ESSA Technologies Ltd.** 2011. Sacramento River Ecological Flows Tool (SacEFT): Record of Design (v.2.00). Prepared by ESSA Technologies Ltd., Vancouver, BC for The Nature Conservancy, Chico, CA. 111 p. + appendices.

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Glossary

ATU	Accumulated Thermal Unit.
ADO.NET	The data-access component of the Microsoft .NET Framework.
Base Class Library (BCL)	An object oriented framework of reusable classes accessible from any .NET language.
BDCP	Bay Delta Conservation Plan.
Binary file	A file containing information that is in machine-readable form that can only be interpreted by a program that understands in advance exactly how it is formatted.
Binary object	A binary large object (BLOB) is a format of binary data stored in a relational database.
Business validation rules	A step or set of steps in a process or procedure or guide (algorithmic or heuristic) used by a customer for doing its business, work, or function, and often embodied in whole or in part in the software of a system.
CalSim II	A state-wide planning model which simulates operations of State Water Project and Central Valley Project facilities, under a Coordinated Operations Agreement, on a monthly time-step.
Cascade delete and update	A process that causes an action to be taken on rows in a database when another row is deleted.
CDWR	California Department of Water Resources.
Class	A template code file that can be used to create objects with a common definition and common properties, operations, and behavior. An object is an instance of a class.
COM components	A set of specification and services that facilitates a developer to create reusable objects and components for running various applications.
Compatibility list	A listing of imported physical model data instances that are allowed to be grouped together, based on having sufficiently similar embedded assumptions. Unless a data instance is part of the same "compatibility family", users cannot add it to a model scenario. This is the mechanism used to encourage use of apples and apples data instances.
Data instance	A SacEFT database concept for tracking imported datasets and their metadata using a unique identifier. Also used to tag information on non-imported (*i.e.*, local) generic rules/parameter values for focal species (*i.e.*, also used as a scenario identifier).
Database engine	The part of the database manager that provides the base functions and configuration files that are needed to use the database.
Desktop centered architecture	The majority of software application code is installed on individual workstations rather than accessed from a centralized server computer.
DOM	Daily Operations Model; a subsystem of CalSim which produces daily location-specific estimates of flow and temperature, while preserving the attributes of the monthly timestep model.
ERP	Ecological Restoration Program.
HEC-5Q	Alternate name for USBR Temperature Model.
IEM	Import/Export Manager – an envisioned SacEFT component for importing external datasets to the SacEFT relational database, using a combination of Excel templates, wrapper code for COM components that may be provided by USACE HEC programmers (for DSS files) and web services.
Metadata	The set of characteristics that describe the underlying assumptions and other major properties of a dataset or model.

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NODOS	North of Delta Offstream Storage.
NWIS	USGS National Water Information System.
OOD	Object-Oriented Design. OOD is a design method in which a system is modeled as a collection of cooperating objects and individual objects are treated as instances of a class within a class hierarchy.
PM	Performance Measure.
RBDD	Red Bluff Diversion Dam.
RM	River Mile; a historical (but not rigorously quantitative) system of assigning locations along the Sacramento River Ecol according to early survey work. The benchmark location for RM is located at Chipps Island.
R/Y/G	The Red/Yellow/Green categorical indicator rating system used by EFT. It may sometimes be referred to by the values that define the breakpoints between categories: Hazard Thresholds or Indicator Breakpoints.
SacEFT	Sacramento River Ecological Flows Tool.
SOAP	A lightweight, XML-based protocol for exchanging information in a decentralized, distributed environment. SOAP can be used to query and return information and invoke services across the Internet.
SQL Server 2005 Express	A free, redistributable version of SQL Server 2005 designed for building simple data-driven applications.
SRWQM	Sacramento River Water Quality Model; a subsystem of the CalSim model which predicts water temperature (among other variables).
SSURGO	Soil Survey Geographic.
Structured error handling	An approach for signaling and responding to unexpected problems while a software program is running.
Thick-client architecture	Where application-specific code runs on and processes data on the client, rather than merely rendering data which has been processed by a server.
TNC	The Nature Conservancy.
TUGS	The Unified Gravel-Sand model.
USBR Temperature Model	Occasionally referred to as USBR TMS/HEC-5Q or HEC-5Q; and more recently the USBR Upper Sacramento River Temperature Model.
USFWS	United State Fish and Wildlife Service.
USGS	United States Geological Survey.
USRDOM	Upper Sacramento River Daily Operations Model.
USRWQM	Upper Sacramento River Water Quality Model; a subsystem of the CalSim model which predicts water temperature (among other variables).
Windows event log	The event logs contain the most important information for diagnosing application and operating system failures, determining the health and status of a system and verifying that system and applications are operating properly.
Wrapper	A program or script that sets the stage and makes possible the running of another, more important program.
WUA	Weighted Usable Area.

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1. Decision Analysis Tool: Overview

1.1 Background and Goals

With over 50 years of international concern about the effects of flow alteration on ecosystems, the continued advancement of scientifically based tools to quantify the ecological effects of flow regulation and river channel alterations has become a prominent research activity (*e.g.*, Stalnaker 1994; Bunn and Arthington 2002; Annear *et al.* 2004; Veldkamp and Verburg 2004; Arthington *et al.* 2006; Poff *et al.* 1997; Petts 2009; Poff and Zimmerman 2010). Process-based models constitute one powerful and efficient tool for comparing the effects of alternative flow and river channel change scenarios. The Sacramento River Ecological Flows Tool (SacEFT) is a decision support tool emphasizing clear communication of trade-offs for key ecosystem targets associated with alternative conveyance, water operations and climate futures in the Sacramento River eco-region. The vision for SacEFT, one we believe we have achieved, is to create software that makes it easy for non-specialists to expand the ecological considerations and science foundation used to evaluate water management alternatives on the Sacramento River.

Practical integration of multi-species, multi-habitat needs in the evaluation of water operation scenarios is challenging. In SacEFT, we more transparently relate additional attributes of the flow regime to multiple species' life-history needs, thereby contributing to a more effective understanding of water operations on representative sets of focal species and their habitats (Chinook salmon, steelhead, green sturgeon, bank swallows, channel erosion/migration, Fremont cottonwoods, and large woody debris recruitment). Scientifically, SacEFT takes a bottom-up, process-based approach to the relationship between flow and related aquatic habitat variables, and looks at how these variables are tied to key species life-stages and ecosystem functions. Our work and the input of many expert contributors develops a more complete understanding of the flow regime and its relation to natural processes and species' requirements, so as to identify the critical attributes of the flow regime necessary to maintain ecosystem function. The multi-species, multi-indicator paradigm provides a "portfolio" approach for assessing how different flow and habitat restoration combinations suit the different life stages of desired species. In so doing, SacEFT transparently relates additional attributes of the flow regime to multiple species' life-history needs in an overall effort at careful organization of representative functional flow needs. This provides a robust scientific framework to focus the definition of ecological flow guidelines and contribute to the understanding of water operation effects on focal species and their habitats.

The performance indicators and functional relationships built into SacEFT were vetted through two multi-disciplinary workshops and numerous design document reviews. The recommendations of these technical design workshops and subsequent peer reviews provide the basis for the indicators and models described in this document. Collectively, the constituent focal species "submodels" provide twelve (12) performance measures which vary in spatial scale, temporal scale, and levels of reliability. Multi-year roll-ups allow users to quickly zoom in on the much smaller set of performance measures which differ significantly across management scenarios. With the completion of SacEFT v.2, the decision analysis tool provides the ability to:

1. improve the basis for evaluating flow alternatives on the Sacramento River from Keswick to Colusa (*e.g.*, Bay-Delta Conservation Plan flows, North-of-Delta Off-Stream Storage Investigation, Shasta Lake Water Resources Investigation, and other future diversions and water transfers);
2. evaluate a variety of management actions' affects (*e.g.,* gravel augmentation and bank protection alternatives) on ecosystem targets for the five Sacramento River focal species;

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3. provide multiple levels of communication of information ranging from simplified formats for managers and decision-makers to in-depth displays of detailed functional relationships and transparent assumptions for review by technical experts;
4. leverage existing systems and data sources (CalSim /USRWQM/USRDOM, historical gauging station records, the Meander Migration Model, and TUGS, a new sediment transport model); and
5. catalyze exploration of new alternatives as data sets become available (*e.g.*, climate change) and help promote the development of needed flexibility in the water management system.

By leveraging many of the same planning models used in existing socioeconomic evaluations in California (e.g., CalSim, USRDOM, USRWQM), SacEFT provides an "eco plug-in" for water operation studies based on use of these physical hydrologic/water balance models. SacEFT advances and enables ecological flow (e-Flow) science by linking these physical models to a representative set of individual ecosystem components inside an overall compressed, cross-disciplinary synthesis tool for evaluating conveyance operation alternatives in the Sacramento River eco-region.

Lastly, SacEFT's output interface and reports for trade-off analyses make it clear how actions implemented for the benefit of one area or focal species may affect (both positive and negative) another area or focal species. For example, we can show how altering Sacramento River flows to meet export pumping schedules in the Delta affects focal species' performance measures in the Upper and Middle Sacramento River. One of the biggest challenges in the practical implementation of ecological flow guidelines is the wide range of objectives, focal species and habitat types that need to be considered. Our work to date has brought into focus how these various objectives cannot all be simultaneously met. In nature, conditions often benefit one target or species to the potential detriment of another in any given year. Fortunately, flow characteristics that benefit the various ecological targets investigated are usually required on a periodic basis and not every single year. EFT studies simplify communication of these trade-offs, and catalyze definition of state-dependent management practices that promote the development of needed flexibility in the water management system.

Building a tool that makes accurate future predictions of ecosystem behavior is challenging and usually not possible in complex, open natural systems (Oreskes *et al.* 1994). SacEFT's main purpose is to characterize and explore important ecological trade-offs and inform managers and decision makers about the relative impacts of various flow management alternatives. The system can also act as a catalyst for exploring deliberate or opportunistic adaptive management experiments (Murray and Marmorek 2003) that assess actual ecological responses on a variety of spatial/temporal scales. This approach (model exploration of management alternatives and adaptive management experiments) will ultimately help water resource managers and stakeholders converge on options that best strike a balance among various of conflicting objectives.

1.1.1 History

Between 2004 and 2008 the Sacramento River Ecological Flows Study team developed a decision analysis tool that incorporates physical models of the Sacramento River with biophysical habitat models for six Sacramento River species (see: www.dfg.ca.gov/ERP/signature_sacriverecoflows.asp). The resultant tool, the Sacramento River Ecological Flows Tool (SacEFT), is a database-centered software system that links flow management actions to focal species outcomes on the mainstem Sacramento River. SacEFT allows: (1) the evaluation of ecosystem responses to alternative scenarios of discharge, water temperature, gravel augmentation, and channel revetment (rock removal) actions, and (2) water operations managers to significantly expand their ecological considerations when evaluating water management projects for the Sacramento River. The SacEFT software leverages considerable previous investment by utilizing data sets from commonly used models, such as CalSim II, USRWQM and

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USRDOM, which evaluate statewide water management operations. SacEFT v.2 is now fully operational, and herein we describe its focal species performance indicators and its utility to Sacramento River water management planning processes.

One of the main tasks of the SacEFT project was to create an integrated cross-disciplinary tool to characterize ecological trade-offs that result from the implementation of alternative water management scenarios. We undertook the Sacramento River Ecological Flows Study after noting challenges facing management agencies within existing water management planning efforts for the Central Valley that if addressed could greatly enhance these efforts. First, upon reviewing Sacramento River planning efforts, we noted that ecological considerations included in water management planning were generally narrow in scope and detail (esp. prior to 2008). Ecological considerations were limited to meeting some static minimum in-stream flow targets, meeting basic temperature requirements, or limiting periods of pumping (in the Delta) during times when sensitive species are present. Although these considerations are among the highest management priorities, they are often focused on single species management.

Prior to SacEFT, much of the important information on focal species existed in stacks of separate reports, independent conceptual models, and unconnected modeling tools. SacEFT has synthesized much of this disparate information, linking ecological submodels to existing physical planning models, and providing a major advance in the region's capabilities for rapidly assessing ecological trade-offs. In addition to integrating disparate sources of information, the second challenge we overcame in constructing SacEFT was translating analyses of this information into easily understandable results for managers. Practical synthesis and integration is challenging when considering multiple ecological targets, complex physical models, and multiple audiences (*i.e.*, high level managers as well as technical level staff). In keeping with the design principle of making it easy for non-specialists to understand the model's results, SacEFT creates output that can span the range from high-overview to high-resolution. The output interface makes extensive use of a "traffic light" paradigm that juxtaposes performance measure (PM) results and scenarios to provide an intuitive overview of whether a given year's PMs are healthy (Green), of some concern (Yellow), or of serious concern/poor ([redacted]).

DECEMBER 2005 INITIAL DESIGN WORKSHOP (SACEFT V.1)

On December 5 and 6 2005, ESSA Technologies Ltd., in partnership with The Nature Conservancy and Stillwater Sciences, held a model design workshop to evaluate a preliminary conceptual design of the Sacramento River Ecological Flows Tool (SacEFT). Forty scientists and other technical experts (see Appendix A), each having expertise with one of the focal species or physical submodels on the Sacramento River, were invited to attend the workshop to discuss and *prioritize* aspects of these submodels. Prior to their attendance a backgrounder on the SacEFT tool was provided to workshop participants which described the candidate submodels that would be evaluated at the workshop (ESSA Technologies Ltd. 2005).

Four criteria guided the technical review and prioritization of indicators **for SacEFT v.1**. First, experts assessed whether proposed indicators were directly *relevant* to the Sacramento River – *i.e.*, whether relationships were derived from data on the focal species or physical habitat attribute of interest, or whether indicators were developed using data collected within the study area during recent conditions. Second, scientists evaluated the *clarity* of functional relationships to ensure that they are not contested or confounded by other information. To the extent possible, we wanted to avoid functional relationships predicting species responses to flow that may be confounded by other factors not modeled in SacEFT (*e.g.,* changes in adjacent land uses). Third, participants discussed the level of *rigor* underlying functional relationships. That is, whether the evidence supporting a functional relationship was either: (1) well established, generally accepted, or from peer reviewed empirical studies; (2) strong but not fully conclusive; (3) theoretical support with some evidence; or (4) hypothesized based purely on theory and

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professional judgment. Finally, recognizing our inability to "include everything", we facilitated a discussion regarding the *feasibility* of integrating the proposed performance measures, ensuring SacEFT reflects both a reasonable level of breadth and depth across the five focal species present in SacEFT v.1.

DECEMBER 2008 REVIEW WORKSHOP (SACEFT V.1 → SACEFT V.2)

Building a software system of this magnitude is an iterative process. Previous steps included preparation of a workshop background document (ESSA Technologies Ltd. 2005), holding a technical design workshop on December 5 and 6 2005 in Davis, CA, and developing and applying SacEFT v.1. Usually, the first iteration of a decision support tool has data and conceptual gaps that are filled by estimates. To improve on the initial version of SacEFT, on October 7 and 8 2008, ESSA Technologies Ltd., in partnership with The Nature Conservancy, held a model review workshop to improve Version 1 of the Sacramento River Ecological Flows Tool. This technical workshop had two goals:

1. Through peer review, ensure credibility in SacEFT's existing focal species' indicators; and
2. Ensure the model's outputs remain clear and directly relevant to water managers.

Over 30 experienced biologists and water managers participated in discussions on how to improve the Sacramento River Ecological Flows Tool (see Appendix A). During the technical review workshop we solicited feedback (both in plenary and subgroups) on the following topics to help define improvements to the initial version of SacEFT:

i) A peer review of critical uncertainties in existing SacEFT functional relationships.

ii) A peer review of SacEFT hazard thresholds. (While SacEFT calculates performance measures in their native units, it uses a tri-state "traffic light" system of R/Y/G zones to rapidly communicate the desirability of flow/temperature/sediment transport outcomes. In the current version of SacEFT, the hazard threshold boundaries between Red/Yellow and Yellow/Green and are based on tercile break points determined by sorting performance measure values from our default water operation scenario based on the 66-year historical time series (1939-2004).)

iii) Discussion of additional/new indicators for SacEFT v.2.

iv) A discussion of how to enhance Excel report model output to show the assumptions associated with each model run.

v) Water manager advice was sought on SacEFT's key synthesis concept of "target and avoidance flow envelopes". This output concept is promising for translating SacEFT's "green" (good) traffic light results emerging from the model into multi-species flow operating rules for dam operators. However, while it may be desirable to satisfy certain ecological objectives every year (*e.g.,* temperature criteria) other objectives may only be satisfied occasionally (*e.g.,* cottonwood recruitment every 5-10 years). Technical discussions were held on how to convert SacEFT target and avoidance flows for multiple focal species into water year specific criteria and constraints to support the vision that this information feed back into other planning tools as new constraints and improved formulations in tools such as CalSim.

Table 1.1 summarizes the priority performance indicators that were identified by workshop participants, and distinguishes indicators developed for SacEFT v.1 that are unchanged in SacEFT v.2 from new indicators or existing indicators that received a significant overhaul in Version 2. The intention was to

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identify a finite number of priority performance measures per focal species to integrate into SacEFT v.2. *Ideally*, performance measures should be directly relevant to the Sacramento River conditions, very clear and uncontested by technical or non-technical audiences, be supported by a high level of evidence, and manageable to implement. Of course, few performance measures will meet all of these criteria. Four criteria guided the technical review and prioritization of indicators **for SacEFT v.2** (Table 2.3). These revised criteria were based on lessons learned in the subsequent development of design guidelines for DeltaEFT (ESSA Technologies Ltd. 2008b). This updated indicator classification and prioritization system (Table 2.3) is used from this point forwards in this document.

Table 1.1 Summary of the performance measures (PMs), selection criteria ratings (H = High, M = Moderate, L = Low), and priorities following the SacEFT v.2 model design workshop. Note the following PM abbreviations: CS – Chinook salmon or Steelhead trout, GS – green sturgeon, BASW – bank swallow, FC – Fremont cottonwood, and LWD – large woody debris. PMs marked with a red dot in the ver. 2 column are pre-existing indicators that were not significantly modified as a consequence of the December 2008 SacEFT v.1 review workshop. Those marked in green are pre-existing indicators that have been significantly changed; those marked in blue are new indicators created for SacEFT Version 2. Definitions of relevance, clarity, rigor and feasibility are provided later in Table 2.3.

Focal species and performance measure	Relevance	Clarity	Rigor	Feasibility	Priority	Ver. 2	Comments
CS = Chinook/Steelhead							
CS1 - Area of suitable spawning habitat	Direct	H	H	H	H	●	5 aggregate reaches, 4 run types, side channel included; gravel augmentation-sediment requires additional data
CS2 - Area of suitable rearing habitat	Direct	H	H	H	H	●	3 aggregate reaches, 4 run types
CS3 - Egg-to-fry survival rate	Direct	H	L	H	H	●	5 reaches, Bureau of Reclamation model
CS4 - Index of juvenile stranding	Direct	H	H	H	H	●	Daily flow; relationships from Gard (United States Fish and Wildlife Service (USFWS)
CS5 - Redd scour	Direct	M	L	H	M	●	Max flow during incubation
CS6 - Redd dewatering	Direct	M	M	H	M	●	Stage recession during incubation
GS1 – Green Sturgeon Egg-to-larvae survival rate	Direct	M	M	H	H	●	Laboratory studies for temperature tolerance
BASW1 – Bank swallow habitat potential	Direct	H	M	M	H	●	Only considering length of suitable banks within appropriate soils. Not feasible to assess suitability relative to other variables: bank height and bank slope.
BASW2 – Ramping rates during bank swallow nesting	Direct	M	M	M	H	●	Used findings in Linkages report to develop an indicator of bank sloughing due to flows during nesting
FC1 – Successful cottonwood initiation	Direct	H	H	M	H	●	Highly relevant issue, box model has been developed, and data are available at 3 locations. Relevant data (stage-discharge and x-sections) are not available for other locations.
FC2 – Cottonwood seedling scour	Direct	M	H	M - L	H	●	Highly relevant PM to FC. If seedlings are scoured out in year 2 and 3, actions taken in year 1 (FC1) become moot.
LWD1 – Large Woody Debris recruitment		M	M	L/M	L/M	●	Data may not be available, not feasible

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1.1.2 Related component in development: DeltaEFT

Early in the project development phase of SacEFT, the project team specifically excluded Delta considerations when bounding the limits of the SacEFT decision analysis tool. We sought to first achieve proof of concept in one location (*e.g.,* the Sacramento River eco-region) prior to expanding efforts to other CALFED Ecological Restoration Program (ERP) eco-regions. We now have a significant foundation of existing work to build upon in light of progress with the Delta Regional Ecosystem Restoration Implementation Plan process, the Bay Delta Conservation Plan (BDCP) process, new Operations Criteria and Plan biological options, Public Policy Institute of California initiatives, State Water Resource Control Board criteria development efforts, and Pelagic Organism Decline research. As of 2010, the timing and information sources were significantly more appropriate to address Delta specific needs in a similar fashion. Incorporation of Delta considerations into the existing EFT framework will provide managers with the ability to better inform Delta management actions for ecological affects, as well as evaluate a management action's affects in the two inseparable ERP eco-regions of the Sacramento River and Delta.

Under the grant ERP-07D-P06 - DFG# E0720044, ESSA Technologies Ltd., in continuing partnership with The Nature Conservancy, is developing the Delta Ecological Flows Tool, which is expected to be completed in the late fall of 2011.

1.1.3 How it will be used

EFT is intended to provide a framework for collaboration and integration that leverages existing tools focused on the human need aspects of water deliveries in northern California (*e.g.*, CalSim II). EFT users are able to download the model from the internet (www.essa.com/tools/EFT/download.html) and immediately work with pre-defined scenarios. In the context of specific water gaming environments, EFT combines outputs generated by existing water planning models with others to illuminate the anticipated ecological tradeoffs. Prior to these gaming sessions, EFT users can verify that the assumptions embedded in its physical submodels (*e.g.*, meander migration, TUGS) are *sufficiently* consistent with those in the primary water planning tools (*e.g.*, CalSim II, USBR Upper Sacramento River Temperature Model). Once a qualified EFT database administrator has imported external datasets and verified submodel compatibility, EFT scenarios can then be configured and run to give immediate feedback on ecological performance and tradeoffs. The efficiency of gaming exercises depends largely on how quickly EFT's external physical submodels can be configured and run, and their results imported into EFT. Once external datasets are imported and configured, and focal species submodels run, gaming and trade-off analysis are instantaneous.

EFT can provide valuable results to two groups of users. Scientists can supply their core data and metadata to EFT for ecological evaluation. Managers and decision makers are able to quickly review "traffic light" (dashboard) summary reports that illuminate the overall balance of performance across ecological indicators. Advanced tools also exist within the EFT relational database to perform further diagnostic and summary level analyses (*e.g.*, identify target and avoidance flows, exceedance plots, *etc.*).

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2. Scope and Bounding

2.1 Ecological objectives and performance measures

Complex decisions and associated trade-offs are easier when structured using formal approaches to evaluate management alternatives. SacEFT encourages a PrOACT approach (Hammond *et al.* 1999) to evaluate trade-offs among different ecological objectives and help managers choose amongst water management alternatives. PrOACT is a simplified form of multi-objective decision analysis that provides a framework for decision making in the face of a large number of objectives and uncertainties. PrOACT is a five-step process: (1) define the **Pr**oblem; (2) determine the **O**bjectives; (3) develop **A**lternative actions; (4) assess the **C**onsequences associated with each alternative across the set of objectives; and (5) evaluate **T**radeoffs across alternatives and the range of objectives being considered. This framework is described in more detail in ESSA's (2005) workshop backgrounder. SacEFT is designed with this framework in mind, and can be useful for completing most aspects of PrOACT, particularly steps 4 & 5.

Ecological objectives are statements describing the desired condition or state of the system that decision makers want to achieve. Clear objectives are needed to evaluate alternative management scenarios and help distinguish which among them is the best alternative. The purpose of SacEFT is to evaluate management alternatives on the basis of *fundamental objectives* – what do managers want to achieve? – not *means objectives* – how do decision makers plan to achieve it? With the list of fundamental objectives in mind, we then attribute consequences caused by various alternative actions through predictive performance measures (PMs).

SacEFT v.2's priority objectives and performance indicators – discussed in detail later in this document – are listed in Table 2.1.

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Table 2.1 Ecological objectives and performance measures found in EFT Version 2. PMs marked in green have been significantly modified from Version 1; those marked in blue are new PMs.

Focal Species	Ecological Objectives	Performance Measures
Fremont cottonwood (FC)	Maximize areas available for riparian initiation, and rates of initiation success at individual index sites.	FC1 – Successful Fremont cottonwood initiation (incidence of cottonwoods initiated along a given cross section, at end of seed dispersal period) FC2 – Cottonwood seedling scour. Following years that have fair to good initiation success, evaluate the risk of seedling scour during the first year following successful initiation.
Bank swallow (BASW)	Maximize availability of suitable nesting habitat	BASW1 – Habitat potential/suitability. BASW2 – Risk of nest inundation and bank sloughing during nesting
Western pond turtle (WPT)	Maximize availability of habitat for foraging, basking, and predator avoidance	LWD1 – Index of old vegetation recruited to the Sacramento River mainstem.
Green sturgeon (GS)	Maximize quality of habitat for egg incubation	GS1 – Egg-to-larvae survival
Chinook salmon, Steelhead trout (CS)	Maximize quality of habitat for adult spawning	CS1 – Area of suitable spawning habitat (ft²)
	Maximize quality of habitat for egg incubation	CS3 – Egg-to-fry survival (proportion) CS5 – Redd scour (Red/Yellow/Green hazard zones) CS6 – Redd dewatering (proportion)
	Maximize availability and quality of habitat for juvenile rearing	CS2 – Area of suitable rearing habitat (ft²) CS4 – Juvenile stranding (index)

Relationships between physical datasets (described in section 4.1), submodels and focal species PMs are summarized in Table 2.2.

Table 2.2. Physical datasets that potentially impact focal species and focal habitat performance in SacEFT. Only those species and habitats that are currently expected to be included in SacEFT Version 2 are shown.

Focal Species Performance Measures	Physical datasets and submodels				
	Flow	Stage - Discharge	Temperature	Sediment Transport	Meander Migration
Fremont cottonwood (FC)	●	●			
Bank swallow (BASW)	●				●
Green sturgeon (GS)			●		
Chinook, steelhead (CS)	●		●	●[1]	
Large Woody Debris (LWD) recruitment	●				●

[1] Certain indicators only. The linkage between channel bed conditions and Chinook and steelhead is restricted to weighted useable area for spawning. According to source data from Mark Gard (USFWS), rearing habitat is unaffected by substrate conditions. We relate substrate suitability curves taken from *River-2D* with substrate conditions predicted by the TUGS sediment transport model.

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2.1.1 Revised indicator classification and prioritization

Keeping in mind the criteria and priorities stated above, the ecological objectives and performance measures proposed in the backgrounder were reviewed at the December 2005 model design workshop. In SacEFT v.1, these Performance Measures were prioritized based on relevance, clarity, rigor and technical feasibility. Using lessons learned in the subsequent development of design guidelines for DeltaEFT (ESSA Technologies Ltd. 2008b), these categories have been updated so that they are more consistent with the classification scheme used for DeltaEFT (Table 2.3). The updated indicator classification and prioritization system is used from this point forwards in this document.

Table 2.3 Classification and prioritization concepts employed for the evaluation of SacEFT v.2 performance measures. Tables showing the strengths and weaknesses of PMs (Section 4.3) refer to these classification criteria using "I", "U", "R" and "F" to label each class.

Label	Explanation	Levels
I **Importance**	The degree to which a linkage (functional relationship) controls the outcome relative to other drivers and linkages affecting that same outcome.	**4 = High:** Expected sustained major population level effect, *e.g.*, the outcome addresses a key limiting factor, or contributes substantially to a species population's natural productivity, abundance, spatial distribution and/or diversity (both genetic and life history diversity) or has a landscape scale habitat effect, including habitat quality, spatial configuration and/or dynamics. **3 = Medium:** Expected sustained minor population effect or effect on large area or multiple patches of habitat. **2 = Low:** Expected sustained effect limited to small fraction of population, addresses productivity and diversity in a minor way, or limited spatial or temporal habitat effects. **1 = Minimal:** Conceptual model indicates little or no effect.
U **Understanding** ("Clarity")	The degree to which the performance indicator can be predicted from the defined linkage (functional relationship) and its driver(s).	**4 = High:** Understanding is high and nature of outcome is largely unconstrained by variability in ecosystem dynamics, other confounding external factors. **3 = Medium:** Understanding is high but nature of outcome is moderately dependent on other variable ecosystem processes or uncertain external confounding factors. **2 = Low:** Understanding is moderate or low and/or nature of outcome is greatly dependent on highly variable ecosystem processes or other external confounding factors. Many important aspects are subject of active ongoing research. **1 = Minimal:** Understanding is lacking. Mainly subject of active ongoing primary research.

This table continues on the next page.

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Label	Explanation	Levels
R **Rigor** ("Predictability")	The degree to which the scientific evidence supporting our understanding of a cause-effect relationship (linkage) is contested or confounded by other information.	**4 = High:** Is generally accepted, peer reviewed empirical evidence, strong predictive power and understanding, evidence not contested or confounded. Data in support of the functional relationship is derived from direct Bay-Delta field observations. **3 = Medium:** Strong evidence but not conclusive, only medium strength predictive power, some evidence for competing hypotheses and/or confounding factors. Data in support of the functional relationship is derived from direct Bay-Delta field observations OR from field observations outside the Bay-Delta estuary. **2 = Low:** Theoretical support with some evidence, semi-quantitative relationships, several alternative hypotheses and/or confounding factors. Data in support of the functional relationship is derived from lab or theoretical studies without field evidence. **1 = Minimal:** Hypothesized based on theory and/or professional judgment, purely qualitative predictions, many alternative hypotheses and/or confounding factors. Support for the functional relationship is largely hypothetical and based on first principles.
F **Feasibility**	The degree to which input data necessary to calculate the proposed performance measure can be delivered in a timely fashion (without external bottlenecks) and the amount of effort (relative to other possible indicators) needed to implement the cause-effect linkage in a computer model.	**4 = High:** Input data currently exists in a format easy to disseminate, can be delivered readily and the effort (time) associated with implementing the cause-effect linkage easily falls within project budget without sacrificing other indicators. **3 = Medium:** Input data currently exists (or can readily be generated by new model runs), and while it might need some additional formatting, can be delivered readily. The effort (time) associated with implementing the cause-effect linkage falls within project budget subject to prioritization decisions elsewhere that remove some other indicators from consideration. **2 = Low:** Input data does not currently exist, but can be generated through additional analyses or external model runs. The time before this external work could be completed is or may be uncertain. The effort (time) associated with implementing the cause-effect linkage could be accommodated within the project budget, but a number of other indicators would need to be eliminated from consideration. **1 = Minimal:** Input data does not currently exist, and it is not clear if it can be generated through additional analyses or external model runs. The time before this external work could be completed is unacceptably long. The effort (time) associated with implementing the cause-effect linkage would take up a disproportionately high amount of the project budget, and the majority of other indicators would need to be eliminated.
P **Priority**	Initial Priority Ranking	

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2.2 Spatial extent and temporal horizon

The spatial extent of SacEFT includes the mainstem Sacramento River at RM 301 (Keswick) downstream to RM 143 (Colusa) (Figure 2.1). Specific locations identified in SacEFT are chosen based on three factors:

1. their biological importance (*e.g.*, what is the current or historic range for a focal species?);
2. the areas where we have reliable *biological* relationships (focal species models); and
3. the feasibility of obtaining or producing the *physical* variables required for focal species submodels at these biologically relevant sites (*e.g.*, where have stage-discharge relations and channel cross-section profiles been developed?).

The overlap between these three considerations determines the spatial extent of performance measures throughout SacEFT's 158 mile study area.

The temporal horizon of SacEFT varies by submodel, ranging from specific events occurring at daily resolution (*e.g.*, changes in flow and stage) to performance measures that obtain their meaning when viewed over annual and longer time scales. In practice, we anticipate that the temporal horizon for a given SacEFT model run will be limited by the "weakest" (*i.e.*, shortest) dataset or submodel responsible for supplying inputs to other models. Depending on the purpose of a simulation, the *maximum* temporal horizon of a given SacEFT model run is expected to be in the neighborhood of 60 years.

2.3 Spatial and temporal resolution

Three **spatial** elements are used in SacEFT to describe specific locations:

- **points**;
- **cross-sections**; and
- **segments.**

A concrete example of a variable linked to a point would be a stream gauge. An example of a variable or relation associated with a cross-section is a stage-discharge relationship. The length of newly eroded bank at a particular river bend is well represented using the concept of a segment (*e.g.*, RM *X* to *Y*).

At the December 2005 model design workshop, considerable discussion occurred over the fact that the spatial localization and identification of certain variables changes over time. For example, a river center line determines river mile demarcations, and the center line of a river changes over time. On the Sacramento River, river miles (abbreviated "RM") have acquired a "cultural" significance, with many scientists/managers referring to river mile demarcations that are based on surveys performed decades ago (1950s). Today, these river miles are no longer technically accurate, but they are still commonly used and can be useful for clarifying which discharge or temperature gauge is closest to a biologically significant point or segment.

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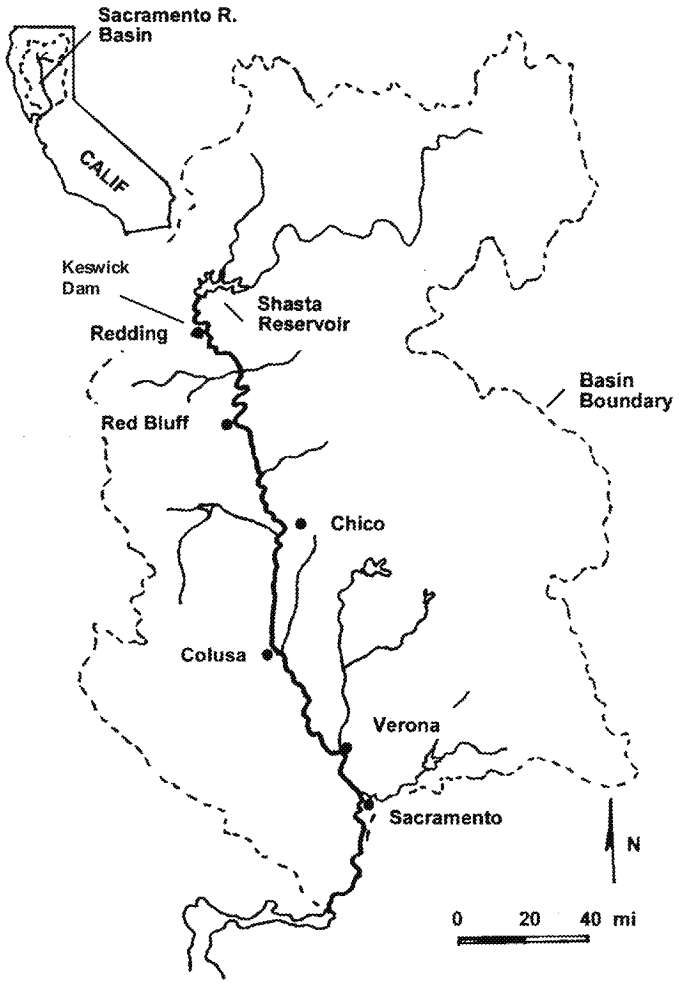

Figure 2.1. Map of the Sacramento River watershed and study area over which the SacEFT Version 2 can be applied – from Keswick Dam (RM 301) to Colusa (RM 143) (source of map: CALFED Bay-Delta Program 2000).

The underlying design of the SacEFT relational database supports spatial definition of points, cross sections and segments. However, focusing on the data needs of focal species and recognizing the relative predictive errors between physical and focal species submodels, SacEFT treats locations as being fixed over the course of a multi-decadal simulation. Conceptually, this introduces what we call a "zonal notion" of points and segments. For example, bank swallow colonies may exist between RM 202 and 183, and we may have a calibrated Meander Migration Model to provide information on the length of newly eroded bank in suitable soils in this region. Let's assume the river miles just mentioned were based on a 2004 river centerline survey. If the Meander Migration Model is run forward for 50 years (assuming some flow regime for that period), then the precise spatial location of the river miles on the landscape will shift. However, for purposes of determining the suitability of banks swallow nesting habitat, the locations of the individual bends of interest will still be in *approximately* the same zones. A dynamic bend at RM 191—while now technically at (say) RM 186.84—is still in *the same overall zone of interest to bank swallows*. The overall amount of suitable nest habitat for bank swallows is of interest, not its precise location. On this basis, SacEFT foregoes the costly overhead of precisely tracking fine spatial details such as these when this does not interfere with generating and interpreting focal species performance measures.

While SacEFT treats locations as fixed throughout model simulations for purposes of generating and summarizing focal species performance measures, certain inherently dynamic processes like center line

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change (from the Meander Migration Model output) are still being handled in a spatially explicit fashion. External simulations of centerline change using the Meander Migration Model are summarized and loaded into SacEFT according to the appropriate fixed zonal notion.

The **temporal** horizon of SacEFT varies by submodel, ranging from specific events at the daily scale, to longer duration events (*e.g.*, egg maturation) that may require months, to annual-scale events like channel migration. As well, there are some time periods within a year that are of greater interest for a focal species due to the life-history timing of specific biological processes. Differences in spatial and temporal resolution have implications on the way information is aggregated across the study area and presented to users for evaluation of alternative management actions. Table 2.4 summarizes both the spatial and temporal resolution of performance measures in SacEFT.

Table 2.7 summarizes the life-history timing that is relevant to the various focal species performance measures. In the case of Chinook and steelhead spawning time, closely follows the timing and spread used by Bartholow and Heasley (2006) for the SALMOD model; a distribution which is in turn based on Vogel and Marine (1991). When timing information was provided as a 3-part proportional distribution, the leading and trailing shoulders were each assigned one quarter of the spawning proportion, and the middle third of the distribution was assigned one half of the spawning proportion, divided over the number of days in the period.

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Table 2.4. Summary of the spatial location and extent of physical datasets, linked models and performance measures for the ***non-salmonid*** focal species. Performance measures (PMs) for the species are summarized in Table 2.1. Vertical bars denote PMs that are simulated for river segments; dots denote those that are simulated (measured in the case of gauges) at points along the river. Q = river discharge. T = water temperature. Annotation details are listed in Table 2.6.

		Physical Driving Variables						Linked Models		Biological Models					
		Historical [1]		NODOS [2]		BDCP Analysis [6]		TUGS [3]	Meander Migration	Fremont Cottonwood	Bank Swallow		Large Woody Debris	Green Sturgeon	
RM	Name	Q	T	Q	T	Q	T				1	2			RM
301	Keswick	•	•	•	•	•	•								301
298	ACID Dam		•												298
293	ACID Intake			•								◆			292
289	Clear Creek		•	•	•	•	•								289
281	Stillwater Creek			•	•										281
280	Cow Creek		•	•	•	•	•								280
278	Bear Creek			•	•										278
277	Ball's Ferry		•		•	•	•								277
275	Anderson Creek		•		•										275
273	Cottonwood Creek		•	•	•	•	•								273
272	Battle Creek		•	•	•										272
267	Jelly's Ferry		•		•	•	•								267
260	Bend Bridge A	•	•	•	•									◆	260
258	Bend Bridge B														258
252															252
243	Red Bluff	•			•	•	•								243
243	Red Bluff DD				•	•	•								243
230	Mill Creek			•	•										230
218	Vina	•		•	•										218
208										◆					208
207	GCID Pump									◆					207
201															201
199	Hamilton City	•		•	•	•	•			◆				◆	199
197												◆			197
196										◆					196
192										◆					192
190	Stony Creek														190
185										◆					185
183										◆					183
182															182
172										◆					172
170															170
168	Butte City	•		•	•							◆			168
165										◆					165
164										◆					164
159	Moulton Weir			•	•					◆					159
143	Colusa	•		•	•										143

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Table 2.5. Summary of the spatial location and extent of physical datasets, linked models and performance measures for the ***salmonid*** focal species. Performance measures (PMs) for the species are summarized in Table 2.1. Vertical bars denote PMs that are simulated for river segments; dots denote those that are simulated (measured in the case of gauges) at points along the river. Q = river discharge. T = water temperature. Annotation details are listed in Table 2.6.

		Physical Driving Variables						Linked Models		Biological Models									
										Chinook & Steelhead Spawning & Egg Stage PMs [4]					Chinook Steelhead Juvenile Rearing Stage PMs				
		Historical [1]		NODOS [2]		BDCP Analysis [5]		TUGS [3]	Meander Migration	*Spring*	*Fall*	*Late Fall*	*Winter*	*Steelhead*	*Spring*	*Fall*	*Late Fall*	*Winter*	*Steelhead*
RM	**Name**	***Q***	***T***	***Q***	***T***	***Q***	***T***												
301	Keswick	●	●	●	●	●	●												
298	ACID Dam		●																
293	ACID Intake			●															
289	Clear Creek		●	●	●	●	●												
281	Stillwater Creek			●	●														
280	Cow Creek		●	●	●	●	●												
278	Bear Creek			●	●														
277	Ball's Ferry		●		●	●	●												
275	Anderson Creek		●		●														
273	Cottonwood Creek		●	●	●	●	●												
272	Battle Creek		●	●	●														
267	Jelly's Ferry		●		●	●	●												
260	Bend Bridge A	●	●	●	●														
258	Bend Bridge B																		
252																			
243	Red Bluff	●			●	●	●												
243	Red Bluff DD				●	●	●												
230	Mill Creek			●	●														
218	Vina	●		●	●														
207	GCID Pump																		
201																			
199	Hamilton City	●		●	●	●	●												
197																			
192																			
190	Stony Creek																		
185																			
183																			
182																			
172																			
170																			
168	Butte City	●		●	●														
165																			
164																			
159	Moulton Weir			●	●														
143	Colusa	●		●	●														

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Table 2.6. Annotations for Table 2.4 and Table 2.5.

[1] The common time span of Historic discharge (Q) data is 1-Oct-1938 to 30-Sep-2004. The common time span of Historic temperature (T) data is 1-Jan-1970 to 31-Dec-2001.

[2] The common time span of the NODOS scenario analyses performed in April 2011 include discharge (Q) and temperature (T) data between 1-Oct-1921 to 30-Sep-2003.

[3] TUGS simulations (Cui 2007) shown in red actually comprise 5 distinct reaches between RM 301 and RM 289. TUGS results are not available downstream from Cow Creek but are necessary for linkage to Chinook and Steelhead spawning Weighted Usable Area (WUA) (CS1). TUGS relationships for these downstream segments (pink) are mapped from the nearest upstream location, as described in Section 4.2.3.

[4] Chinook and Steelhead *spawning* WUA relationships shown in pale blue are mapped from the closest downstream segment, as described in Section 4.2.3. Spring Chinook habitat preferences are assumed to follow those of fall Chinook. Chinook *rearing* WUA relationships shown in pale blue are mapped from the closest upstream section, as described in Section 4.2.4.

[5] The BDCP analysis performed in June of 2010 included a subset of PMs: Chinook, Steelhead and green sturgeon in the region from Keswick to Hamilton City only.

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Table 2.7. Summary of the life-history timing information relevant to the SacEFT focal species. Only those performance measures requiring information on life history timing are included here. Abbreviations of performance measures (PMs) are described in Table 2.1. Time intervals marked with heavy color denote periods of greater importance to focal species. In the case of the spawning PMs (CS-1), heavily shaded regions denote for each salmonid run-type/species the period between the 25th and 75th percentile, when half the spawning takes place. In the case of the other salmonid PMs, the heavily shaded regions denote the period between the 25th and 75th percentile of the population are present. Specific timing of CS-2, 3, 4, 5, 6 depends on ambient water temperature and varies with discharge scenario and year. Juvenile residency is defined by a fixed 90 day period following emergence for Chinook and a 365 day period for steelhead. This table is based on SALMOD (Bartholow and Heasley 2006, ultimately Vogel and Marine 1991). Salmonid timing values shown here are typical and may shift by as much as five days earlier or later, depending on year and reach. Timing values for green sturgeon, cottonwood and bank swallow are based on workshop discussions, and all values are under user control.

Performance Measure & Timing Relevance		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CS - 1	**Spring Chinook** Spawning												
CS - 3,5,6	Egg Development Period												
CS - 2,4	Juvenile Period												
CS - 1	**Fall Chinook** Spawning												
CS - 3,5,6	Egg Development Period												
CS - 2,4	Juvenile Period												
CS - 1	**Late fall Chinook** Spawning												
CS - 3,5,6	Egg Development Period												
CS - 2,4	Juvenile Period												
CS - 1	**Winter Chinook** Spawning												
CS - 3,5,6	Egg Development Period												
CS - 2,4	Juvenile Period												
CS - 1	**Steelhead** Spawning												
CS - 3,5,6	Egg Development Period												
CS - 2,4	Juvenile Period												
GS1	**Green Sturgeon Spawning**												
FC1	**Fremont Cottonwood** Seed Viability Date												
BASW1	**Bank Swallow** Habitat												
BASW2	Ramping Rates												

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Table 2.8. Summary of the spatial and temporal resolution of performance measures. Abbreviations of performance measure are described in Table 2.1. Physical submodels are abbreviated as: FLOW – Historical flow records and CalSim-USRWQM/USRDOM, STAGE – stage-discharge relations, TEMP – historical water temperatures and USBR Upper Sacramento River Temperature Model (HEC-5Q), TUGS – The Unified Gravel-Sand model, MEANDER – Meander Migration Model. Units describing spatial resolution are after Pasternack *et al.* (2004).

		Temporal resolution				
Spatial resolution		**Event-based**	**Daily**	**Seasonal**	**Annual**	**Decadal**
Hydraulic unit	Point or cross-section: micro habitat, 0.1 to 1 channel width	FC2 BASW2	FLOW STAGE TEMP	FC1		
Geomorphic unit	Segment: meso-habitat, 10 channel widths (100s feet - miles)				TUGS BASW1 LWD1	MEANDER
Reach unit	Segment: 100 to 1,000 channel widths (10 - 60 miles)		CS1-6 GS1		MEANDER BASW1 BASW2	

2.4 Management actions

The primary emphasis of SacEFT is to provide ecological trade-off information for alternative **flow operation alternatives** in water planning forums. Changes in flow will affect all focal species performance measures, either directly by influencing availability or suitability of physical habitats, or indirectly as mediated by outcomes from the physical submodels. Two classes of **channel actions** can be examined using SacEFT: (*i*) gravel augmentation, and (*ii*) channel revetment states (*e.g.*, rip-rap (rock) removal). Gravel augmentation and sediment transport will affect substrate conditions for spawning for Chinook salmon and steelhead. The revetment scenarios affect the amounts of new bank created annually, and thus can affect bank swallow nesting success.

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3. SacEFT Solution

3.1 Design principles

A main design aim for SacEFT is to allow exploration of trade-offs amongst key ecological components in a way that is clear to non-specialists. The main technical product is an integrated database, model engine, and user interface for presenting these ecological trade-offs for a defined set of management scenarios. Over time, this database, as well as the information management and reporting that it supports, will provide a foundation upon which additional scenarios can be configured and additional submodels added as new relationships are developed. Table 3.1 outlines some of the principles that underlie the design of SacEFT.

Table 3.1. SacEFT design principles. Various technical terms are defined in the glossary.

Prioritize, avoid being a jack of all trades, master of nothing	**Focus initially on a tight set of key ecosystem attributes**. Considering the scale of the mainstem Sacramento River, the many habitat units it encompasses, and the many species that it supports, it is necessary to focus on the most critical priority ecosystem attributes first. This allows the team to demonstrate how SacEFT can be used to identify and visualize key ecological trade-offs instead of spending all resources cataloguing the entire ecosystem and attempting to integrate everything. The 'integrate everything' approach usually results in having very little to show at the end in terms of actual scientific/management results because all resources will have been spent in data inventory activities.
Do not reinvent existing functionality	**Capitalize on existing tools and models.** To the extent possible, integrate existing quantitative models (including water operation planning tools such as the CalSim, USRWQM and USRDOM), followed by existing qualitative models or other decision support tools. Selectively analyze existing data to build new models (*e.g.*, regression relationships) for focal species, habitats, or habitat forming processes where appropriate and feasible. This principle also includes not spending effort coding custom graphical output controls. Instead, SacEFT leverages MS Excel, a widely held application with powerful graphing and analysis capabilities, when summarizing tabular and graphical outputs.
Generic, flexible relational data model	**Develop a custom relational database as the "glue" holding all submodel data together.** Linking together existing models with new ones to evaluate trade-offs for different scenarios requires a substantial level of planning. Given the large number of sites, variables and scenarios to be evaluated for a system as large as the mainstem Sacramento River, we need an infrastructure to organize and manage the large volume of data and to enable subsequent automation of trade-off analyses. This not only involves fundamental bookkeeping of the required information, but also supports core needs such as having a common way of defining locations and time-steps, linking output for submodels that are in common with a given point-of-interest, archiving metadata and running scenarios to give key output in a useable format. To achieve these and other needs, and to significantly reduce the likelihood of errors, a relational database is essential. The SacEFT database is the backbone of the software and it supports an information management engine used to automate ecological trade-off analysis to the greatest degree possible. Metadata on imported datasets are essential in the interpretation of model output.
Flexible, object-oriented design (OOD)	**Use a flexible model architecture and object-oriented design.** SacEFT incorporates software development strategies that maximize adaptability and ease of revision. The system architecture follows a tiered design that separates the database (first tier) from submodel logic (middle tier) and any user interface (third tier) components (*e.g.*, user reports). It also uses object-oriented design (OOD) within each of these components, which maximizes the reliability and flexibility of software development. However, SacEFT also relies on output from other models which may not have such flexible structures.
User friendly	**SacEFT should be designed for users of low to moderate computer literacy**. This includes the kinds of users who are comfortable building spreadsheets with formulas. The tool does not require power user skills, such as coding, or database design. For example, output reports are generated in Excel, a widely held application familiar to most users of computer models. Further, reporting in Excel typically reduces development costs associated with the alternative of tedious programming/customizing of third party reporting products.

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Number of users	The solution provides a desktop software application connected to a remote centralized database. Multiple users can interact with this central database simultaneously. In the future, individual users may obtain copies of the master database for their own analyses.
Database	SQL Server 2005 leveraging ADO.NET Version 2.0.
Client software	Windows®-based rich client application developed in Visual Studio .NET 2005 (.NET Framework v.2.0).
Use error handling and logging	Invisible to users, SacEFT application code uses structured error handling (Try...Catch) and by default log all moderate and severe errors to the Windows Event Log. This simple practice has been shown from experience to greatly simplify debugging and maintenance.
Role of Internet	SacEFT uses a thick-client, desktop centered architecture built around an internet accessible central database. Deployment needs and system help access web resources.
Avoid COM components and 3rd party controls	Use .NET Framework components in user interface to simplify deployment and maintenance. Consider COM components only if functionality cannot be reproduced by a .NET Framework component. The exception in SacEFT is MS Excel.
Installation, accessibility	Deployment needs are currently supported via: www.essa.com/tools/EFT/download.html The deployment model uses standard MSI and .EXE install packages generated by two Visual Studio 2005 setup and deployment projects.

3.1.1 Integration with external systems and data sources

A critical feature of SacEFT identified early in project planning was the need to leverage existing systems and data sources. Millions of dollars have already been spent developing and applying models like CalSim II, USRWQM and USRDOM. As most of these are road tested, commonly used and generally accepted tools, SacEFT does not reinvent their functionality. The Upper Sacramento River Daily Operations Model (USRDOM) was developed to simulate reservoir operations and hydrologic stream routing in the upper Sacramento River from Keswick Dam to Knights Landing on a daily timescale. The simulated daily flows from USRDOM can be used as inputs to SacEFT. The Upper Sacramento Water Quality Model (USRWQM) was developed to simulate daily temperature conditions in the Sacramento River based on the daily flow conditions. The geographical extent of the model is similar to the USRDOM. The simulated daily water temperatures from USRWQM are used as inputs to SacEFT.

Rather than attempt to replicate this functionality, SacEFT instead makes it easy to link with and import external datasets and enter critical summary metadata. Thus, SacEFT's database contains a mix of imported datasets derived from external models while other components—usually its focal species algorithms—are embedded within SacEFT software itself. Importing of external datasets is performed manually though one-time data preparation and import. As much as possible, we attempt to make use of pre-defined Excel templates to streamline this process. Future versions of SacEFT may provide automated import routines for external data sources (*e.g.*, DSS output files).

In addition to analyzing alternative (CalSim/USRDOM) flow and water temperature (USRWQM) regimes, SacEFT enables comparisons of gravel augmentation and rock removal restoration actions. SacEFT requires annual estimates of the gravel grain size-distribution at each of 5 river segments in order to calculate the weighted useable area available for spawning (ST1/CH1). This habitat estimate is then used as one of the inputs to calculate subsequent performance measures for egg maturation, survival, and juvenile rearing. In the absence of gravel data, no calculations are possible for these linked components. SacEFT was designed to leverage grain-size specific sediment transport results from The Unified Gravel & Sand (TUGS) model (Cui 2007). TUGS simulates changes in grain size of the river by accounting for how its sediment flux interacts with sediment in both the surface and subsurface of the channel bed. Results of a default historical sediment scenario analysis are described in Stillwater Sciences (2007).

Likewise, SacEFT studies can also evaluate alternative bank erosion modeling, e.g., for (a) the existing channel armoring and (b) selected rip-rap (rock) removal scenarios. Bank erosion modeling is informed

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by the Meander Migration model developed by Eric Larsen and associates at UC Davis (see Larsen 2007). Channel armoring conditions have a direct bearing on riparian model performance measures (bank swallows and LWD recruitment). Conversely, these assumptions do not influence SacEFT's aquatic performance measure results. SacEFT results including the label "NoRipRapRemoval" refer to the existing 2004 channel and existing 2004 revetment (no change to bank protection) while scenarios with the label "RipRapRemoval" refer to selected removal of rock at specific locations (Larsen 2007).

3.1.2 Indicator thresholds and rating system

The SacEFT output interface makes extensive use of a "traffic light" paradigm that juxtaposes performance measure (PM) results and scenarios to provide an intuitive overview of whether a given year's PMs are experiencing favorable conditions (Green), are performing only fairly (Yellow), or are experiencing unfavorable conditions (Red). For all twelve (12) performance measures, annual cumulative weighted performance measure values are calculated for our default historical water operation scenario based on the 66-year historical time series of observed flows and water temperatures from 1938 to 2003. These "annual roll-up" values for each performance measure (e.g., average over days and locations with applicable biological distributions) are then assigned a "Good" (Green), "Fair" (Yellow) or "Poor" (Red) performance measure rating (*e.g.*, Figure 3.1). The *default* threshold boundaries between Yellow/Green and Red/Yellow are based on tercile break points determined by sorting the annual weighted performance measure values from the default historical water operation scenario.

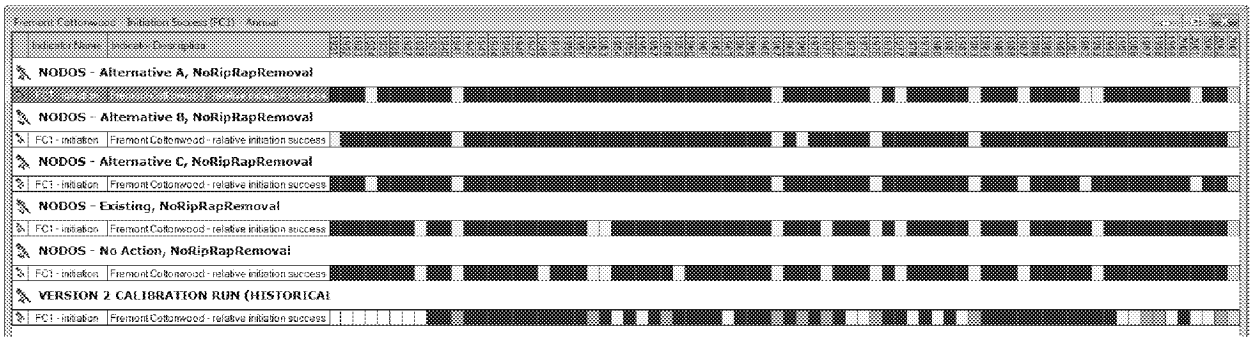

Figure 3.1: Typical SacEFT output showing annual roll-up results for the Fremont cottonwood initiation (FC1) performance measure. Analogous plots are available for all of the tools' focal species and performance measures.

These annual performance measure ratings are based on thresholds[1] defined by sorting cumulative annual results produced by SacEFT for historic observed flows and water temperatures between calendar years 1938 and 2003 (*e.g.*, Figure 3.2). The "units" of these plots vary with the performance measure. *In this way, historic observed flows/temperatures provide the de facto "calibration scenario" for SacEFT's twelve (12) focal species performance measures.*

[1] Indicator thresholds in SacEFT are fully configurable via settings found in the SacEFT relational database.

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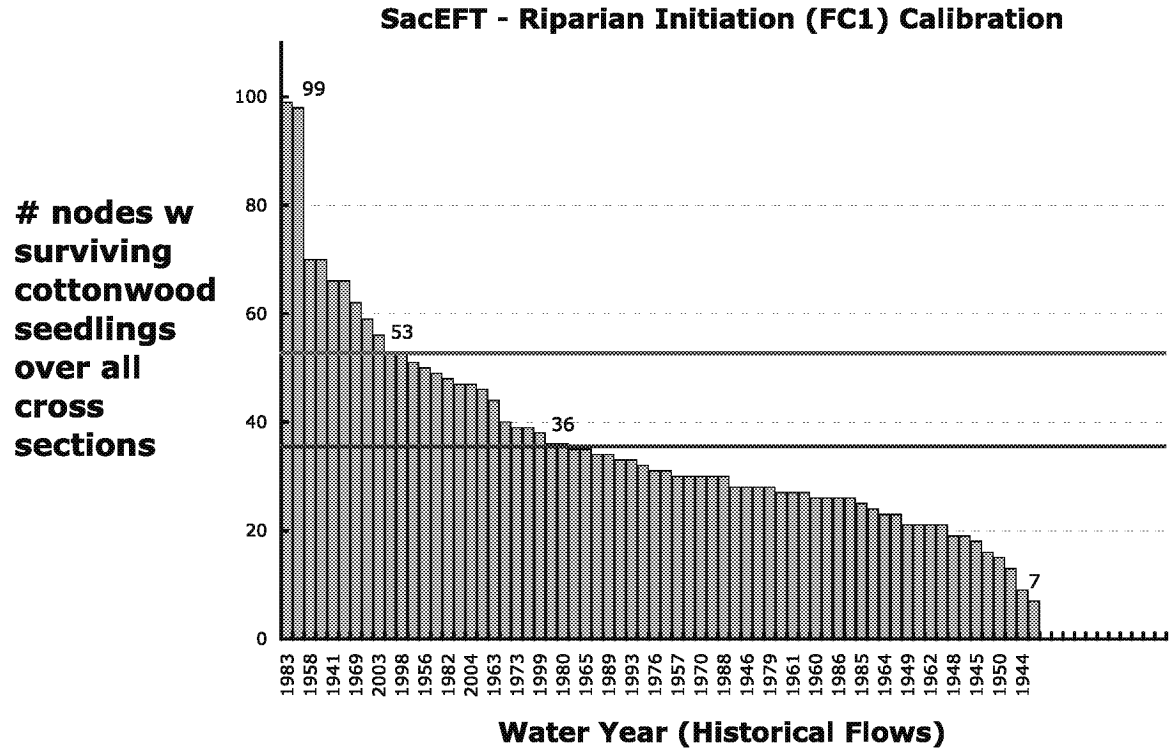

Figure 3.2: Annual roll-up results for the SacEFT Fremont cottonwood initiation (FC1) performance measure run using historic observed flows (1938–2003). This calibration also takes into consideration comparisons with aerial photographs of historically strong Cottonwood recruitment at study sites vs. model results.

Our concept of indicator threshold calibration in SacEFT focuses on historical data (rather than a future no action alternative or an existing condition based on present or future constraints). From an ecological standpoint, aquatic and riparian species are adapted to a historical range and frequency of variations in their habitats. Taken to the extreme, historical conditions would ideally include pre-settlement (natural) flows/water temperatures that represented 'typical' conditions experienced over evolutionarily significant windows of time. The closest flow/temperature time series that we have available to this evolutionarily representative condition is the range of variation in historical observed flows/temperatures (approx. 66 years). It is recognized that during 1938–2003 the Sacramento River experienced a number of waves of human and structural development and operational changes to the hydrosystem. Nevertheless, these flows and temperatures, derived from measurements, actually occurred in recent history and encompass repeat episodes of multiple water year types. Calibrating SacEFT indicator thresholds to a future no action or 'existing' scenario that includes a fixed set of hydrosystem features, constraints, operating regulations and assumed human demands would create a "self-fulfilling prophecy" inconsistent with SacEFT's underlying natural flow regime science foundation.

The highest level synthesis concept in SacEFT is that of a "multi-year roll-up". This is the percentage of years in the simulation having favorable (Green), fair (Yellow), and poor ( ) conditions (*e.g.*, Figure 3.3).

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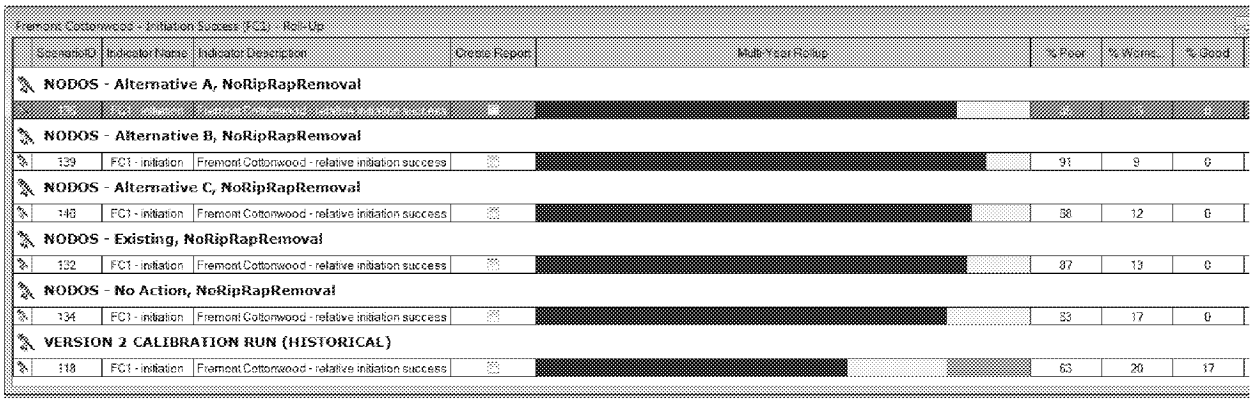

Figure 3.3: Typical SacEFT output showing multi-year roll-up results for the Fremont cottonwood initiation (FC1) performance measure. Analogous plots are available for all of the tools' focal species and performance measures.

The preferred method for calibrating the indicator thresholds is to identify historical years for each performance measure that were known (in nature) to have experienced 'good' or 'poor' performance. Unfortunately, our repeat survey efforts of fisheries experts (e.g., Mark Gard, USFWS, *pers. comm.*2011; Matt Brown, USFWS, *pers. comm.* 2011) and a questionnaire sent to fisheries biologists prior to the 2008 SacEFT v.1 review workshop revealed there are no known synoptic studies of this kind for many of the indicators in SacEFT. Because of this gap and the hesitancy of experts to reveal their opinions, we instead defaulted to the distribution of sorted weighted annual results and selected tercile break-points (the lower-, middle- and upper thirds of the sorted distribution) to categorize results into "Good" (Green), "Fair" (Yellow) or "Poor" (Red) categories. **While this method provides a fully internally consistent method of comparing scenario results (*i.e.*, will always provide an accurate picture of which water management scenarios are "better" than another), it does not *necessarily* provide a concrete inference about the biological significance** of being a "Poor" (Red) or "Good" (Green) category. For example, it is possible that a year that ranks as "Good" (Green) with this method may still be biologically suboptimal. Conversely, a year that ranks as "Poor" (Red) *may* be biologically insignificant (*i.e.*, *not* biologically 'unacceptable'). In the focal species/habitat performance indicator calibration summary tables in section 4.3 we flag cases where there are major gradients in performance indicator thresholds.

The challenge of identifying "acceptable" and "unacceptable" changes in habitat conditions or focal species performance measures confronts all biological effects analysis methods. SacEFT makes these inherent value judgments explicit in the model's summary outputs. Future analyses using SacEFT look forward to ecological effects analysis experts themselves providing clearer guidance on the (readily configurable) thresholds in the SacEFT modeling system.

3.2 Application overview

SacEFT uses a thick-client architecture driven by a desktop relational database. The goal is to combine external model datasets and focal species rules/hypotheses in a single client database that facilitates generation of focal species performance measures (via the SacEFT Analysis Engine) over time and space to evaluate ecological trade-offs associated with alternative flow, water temperature, gravel augmentation and channel revetment scenarios.

Snapshots of external data are imported into the SacEFT database where they are stored in an integrated system of related tables that standardize the spatial definition of variables and capture key metadata. Likewise, focal species rules/parameter values/hypotheses are stored in their own system of related tables.

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At the time of data import or focal species rule specification, available metadata is specified according to a pre-defined standard. In addition to standard metadata, each imported data instance is allowed to have one or more binary objects (files) associated with it. This allows further flexibility for associating metadata with each dataset. Binary fields can be used for single files (*e.g.*, source reports in Word or PDF), digital images, or even WinZip archives containing a set of model input or configuration parameters.

To carry out ecological trade-off analyses, end users install the client SacEFT software and database on their desktop computers. At the time of writing, the software is available from:

http://www.essa.com/tools/EFT/download.html.

3.2.1 Technology platform

SacEFT uses the Microsoft .NET Framework (Version 2.0) as its software development platform. .NET is a Microsoft technology that allows cross-language development and provides a very large standard library of components and functionality. The .NET Framework includes a Base Class Library (BCL) of types and classes available to all languages which encapsulate a large number of common functions such as file reading and writing, graphic rendering, database interaction, XML document manipulation, and so forth. The BCL is much larger than other libraries, and provides a very large breadth of functionality in one package. The .NET platform also greatly simplifies deployment. For these and other reasons, the majority of future Microsoft-based development will have a .NET foundation, ensuring SacEFT will be supportable well into the future.

The specific .NET Framework 2.0[1] technologies that are used in SacEFT Version 2 include:

- **Windows Forms**: the portion of the .NET Framework that provides managed wrappers for the user interface controls contained in the existing Win32 API.
- **VB.NET 2005**: a fully object-oriented computer language backed by the .NET Framework some view as an evolution of Microsoft's Visual Basic (VB6) though with significant changes that ultimately render it a new language.
- **ADO.NET**: the primary relational data access model for Microsoft .NET-based applications. It is used to access data sources for which there is a specific .NET Provider, or via a .NET Bridge Provider.

The database platform chosen is Microsoft SQL Server 2005. The master EFT database is hosted on a central server, and remote connections from the EFTReader software (www.essa.com/tools/EFT/download.html) are supported. SQL Server 2005 provides high-value database functionality including: stored procedures, triggers, transact-SQL (which supports conditional logic, such as if/then and case blocks), integrated XML and an integrated security model.

[1] The EFT development team plans to upgrade the application to the .NET Framework 3.x later in 2011.

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3.3 System architecture

SacEFT's component architecture is illustrated in Figure 3.4 and described in the sections that follow.

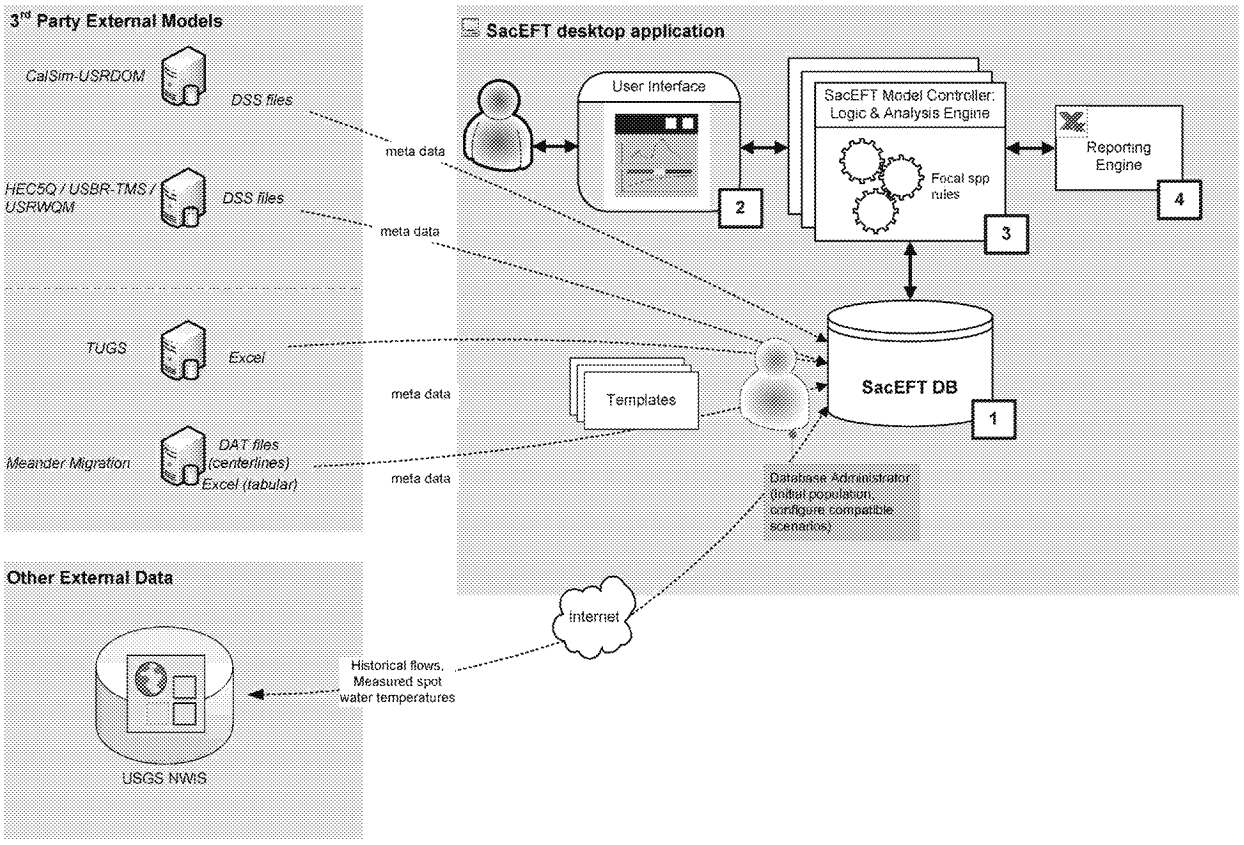

Figure 3.4. SacEFT component architecture.

3.3.1 External physical submodels

The physical input variables required by SacEFT's focal species submodels are derived from several external models or systems (see Figure 3.4, "3rd Party External Models"). These models vary in terms of sophistication, physical location, data formats and documentation. Many of them depend on the same kinds of input data. For example, the temperature simulation component of the US Bureau of Reclamation's Water Quality Model (USRWQM) depends on many of the same hydro system operation assumptions that are central configuration properties of CalSim II, as does a sediment transport model (TUGS) and a Meander Migration Model (because these assumptions affect Sacramento River flow). The datasets of results from these models must be accessed and imported to the SacEFT database. In so doing, **SacEFT addresses two issues at the time of data import**:

1. Identifying output variables (daily average flows, daily average water temperatures, sediment transport variables, river bend erosion variables) within a common spatial identification system.
2. Tagging imported data instances with key metadata that allows non-specialist users to: (a) determine whether that given instance should be combined with a dataset that was imported from another related model; and (b) understand a model run's assumptions and limitations.

Spatial harmonization is simply managed through the common concept of river miles. This includes making assumptions about the river segment that a particular node link in CalSim-USRWQM represents,

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even though it is recognized that as a node link it has no *precise* spatial meaning. We nevertheless must make explicit all the assumptions required to link different models together. The linkage process requires maturity surrounding the relative errors between physical and focal species submodels as well as a realization that even though a high level of detail may be possible, it is not always useful. As stated earlier, SacEFT is not an attempt to make precise predictions of ecosystem behavior or outcomes. The main purpose is to characterize and explore important ecological trade-offs and inform managers and decision makers about the *relative* impacts of various flow management alternatives.

Details of external physical models are described in more detail in Section 4.

3.3.2 Database

SacEFT is built around a single master relational database (Blue box labeled "1" in the upper right portion of Figure 3.4). The SacEFT Graphical User Interface (Box "2" in Figure 3.4), Model Controller & Analysis Engine (Box "3" in Figure 3.4) and Excel Reporting Service (Box "4" in Figure 3.4) connect to and interact with this database.

The SacEFT database contains seven important classes of related tables (Table 3.2). The SacEFT v.2 relational database schema is illustrated in Figure 3.5.

Table 3.2. The seven major classes of SacEFT database table, and their general role.

Table Family	Role
(1) Spatial_	▪ Tables under the Spatial namespace are responsible for holding all information related to the spatial definition of locations. This information is managed as points, cross-sections and segments.
(2) Data_Instances	▪ The key generic concept for tracking imported datasets and their metadata ▪ Also used to (optionally) tag information on non-imported (*i.e.*, local) generic rules/parameter values for focal species.
(3) Data_MetaData	▪ Data.Metadata provide a standard set of fields to capture metadata for all submodels. This information, along with optional model reviews, would be inspected by users when building compatibility lists for structuring unified, "apples and apples" SacEFT model runs.
(4) Data_Review	▪ Further comments, opinions regarding Data_Instances and model results can be provided by data reviews, which characterize applicability, relevance and rigor, and allow for general comments.
(5) ModelRun._	▪ Tables under the ModelRun namespace unify the concept of a model scenario, identifying all the associated data instances (imported data sets to be used, and focal species submodel rules) that are to be used within a single model run.
(6) DataImport.<Model>	▪ The DataImport namespace is used to structure how data imported from external physical models are stored. Typically, the variables of interest are arrayed by a DataInstanceID, a LocationID and a date (at the appropriate temporal resolution). ▪ These tables store the physical data itself – the streamflow, water temperatures, model results, *etc.*
(7) FS_ and FSOut_	▪ This family of tables hold the lookup data, rules and parameter values for focal species and their associated model results generated internally by SacEFT code.

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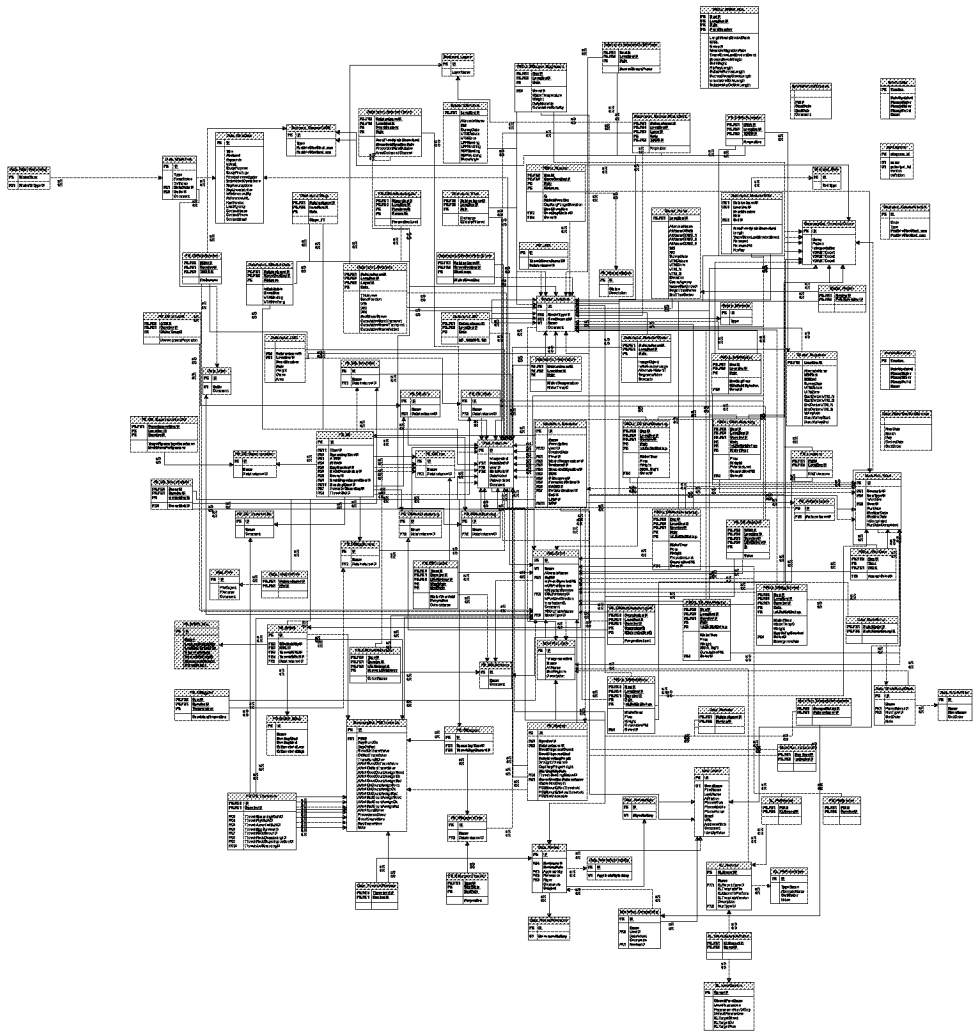

Figure 3.5. SacEFT v.2 relational database entity relationship diagram. DeltaEFT database components are also included in the same master database. PK = part of the primary key. FK = foreign key. U = unique index (values cannot repeat in the table). C = cascading referential action (delete and updates). Not shown are dozens of stored procedures, functions and views that leverage these user tables. (Note: This diagram has not been layout- or print-optimized).

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DATABASE CONFIGURATION

As discussed above, a critical feature of SacEFT is the need to leverage existing systems and data sources. This requires import of components of these datasets from these external models, into the SacEFT database. Presently in v.2.00, a database administrator who understands the SacEFT database schema is required to populate the SacEFT database.

DATAMASTER

Data-driven applications require a considerable amount of interaction with their underlying data store(s). Code is required to move data from the physical database tables to: a) the presentation layer (user interface), and b) in-memory datasets, arrays and variables used by indicator algorithms. Different commands are needed to retrieve, add, delete and update.

This functionality is the responsibility of SacEFT's DataMaster project, an ADO.NET wrapper for encapsulating all connection and command-based operations vs. SacEFT's SQL Server 2005 database. The DataMaster also interacts with a wide range of calculation specific SQL functions and stored procedures stored in the SacEFT database.

3.3.3 Model controller and analysis engine

FOCAL SPECIES SUBMODELS (PERFORMANCE INDICATOR ALGORITHMS)

This is the component of the system that is of the most interest to biologists. Unlike external physical submodels, the SacEFT code base is largely comprised of *in-situ* focal species rules and algorithms for the tool's various indicators. This includes, in several cases, porting lookup tables and even code from other studies or external models where this is efficient. These classes house all of the logic necessary to take physical inputs, and translate them into various focal species performance measures.

COMPATIBILITY LISTS AND SCENARIOS

Before a model run, the database administrator must have ensured physical datasets and focal species rules are internally consistent and compatible. This includes review of metadata and user reviews (optional) for the candidate data instances.

ANALYSIS ENGINE

The final job of the ModelController occurs at run-time, once a compatible scenario is established and run. During a SacEFT model run, the ModelController organizes calls to physical and focal species components in the required sequence, ensures that variables are packaged correctly for transfer between submodels. In essence, the ModelController is the thing that ensures performance measures are calculated in an orderly, sensible manner and the appropriate outputs written to the SacEFT database.

When combined with ADO.NET data transfer responsibilities in the DataMaster, the ModelController and focal species components make up the bulk of code in SacEFT.

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3.3.4 Excel reporting

As identified earlier, SacEFT uses MS Excel for reporting detailed outputs in tabular and graphical format. MS Excel is a well-established software tool widely used at one time or another by the majority of scientists and planners in the field of water operation planning. SacEFT's Excel Reporting engine involves designing Excel templates, and using them in a "just in time" fashion as the target of a specific set of stored procedure calls. For example, an Excel template may have a "flow" and "temperature" worksheet, and two embedded line graphs that expect this data in a specific location and format. Excel macros (VBA code) are optionally used to further extend the features of these reports.

The unique and intuitive manner in which this reporting feature is integrated into the SacEFT User Interface is highly extensible and customizable.

3.3.5 User interface

Figure 3.6, Figure 3.7 and Figure 3.8 illustrate three of the main screens or views provided by SacEFT v.2.00. This user interface was developed using Windows Forms with Visual Studio 2005 and the Visual Basic 2005 programming language.

SacEFT v.2.00 emphasizes display of output rather than dialogue-intensive database editing features. In our experience, it is more important to demonstrate results and iterate on how this is best presented before investing resources in a user interface for editing and configuring all aspects of the underlying database. Typically, database editing capability and the associated myriad of dialogue forms required eats up considerable time without fundamentally enabling users to access modeling results or appreciate the merits of the system.

Readers are referred to the EFTReader on-line User Guide for operational details on the SacEFT user interface, see: www.essa.com/tools/EFT/Help/index.html.

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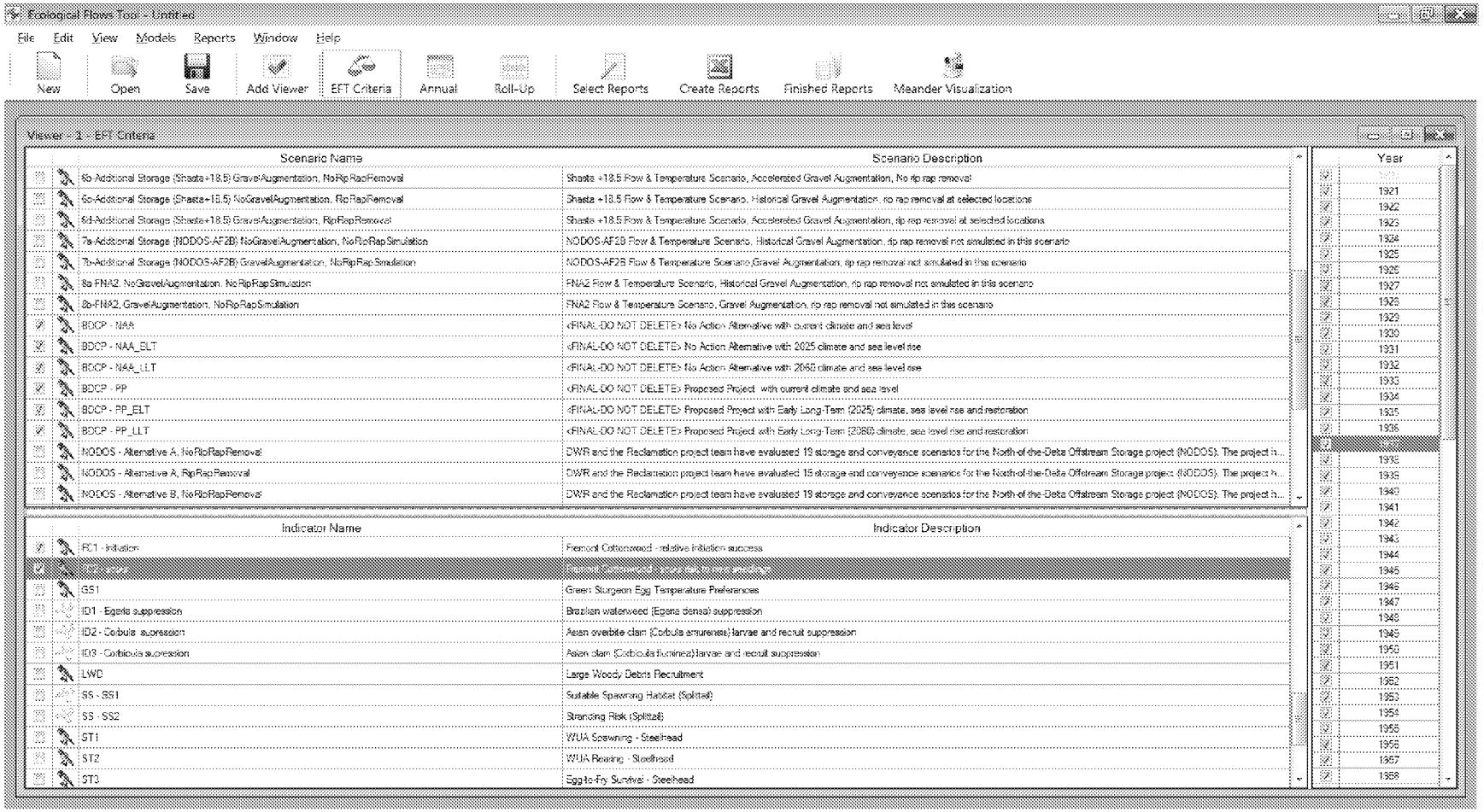

Figure 3.6: EFT's main screen, showing the Criteria selection dialogue used for choosing scenarios, indicators and simulation years.

Figure 3.7: An example of EFT's Output Viewer screen in Annual View, showing a multi-scenario comparison for two performance measures and the tool's signature "traffic light" hazard assessment or indicator rating system over multiple years. The hazard assessment tool provides a rapid visual summary of a scenarios' overall ecological performance, and can be used as a navigational aid to drill into the details.

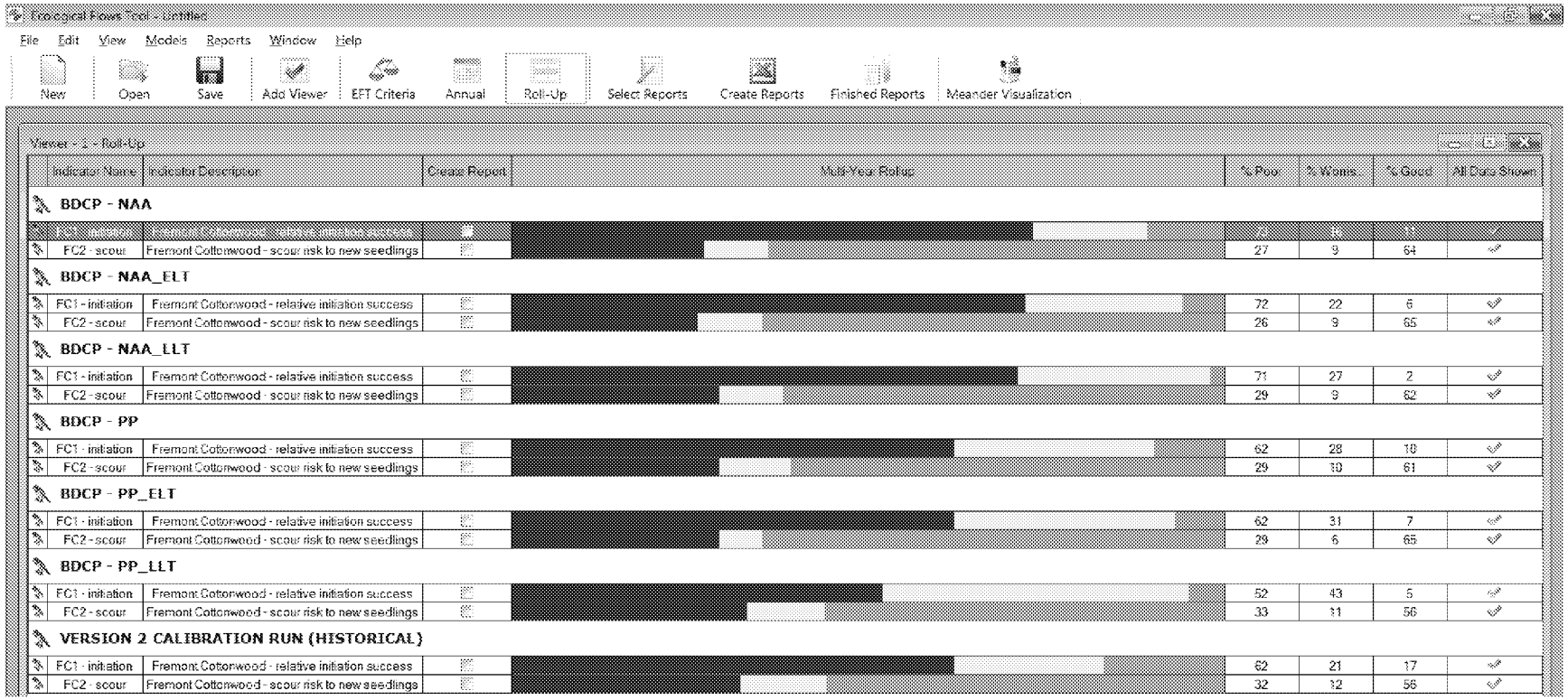

Figure 3.8: An example of EFT's Output Viewer screen, showing the same information as Figure 3.7, but in multi-year Rollup View. This is the best view for quickly assessing the relative differences in performance among scenarios.

EXCEL OUTPUT REPORTS

MS Excel graphs and tables serve as the primary method for delivering detailed outputs. An example of SacEFT's v.2.00 Fremont Cottonwood initiation model is given in Figure 3.9.

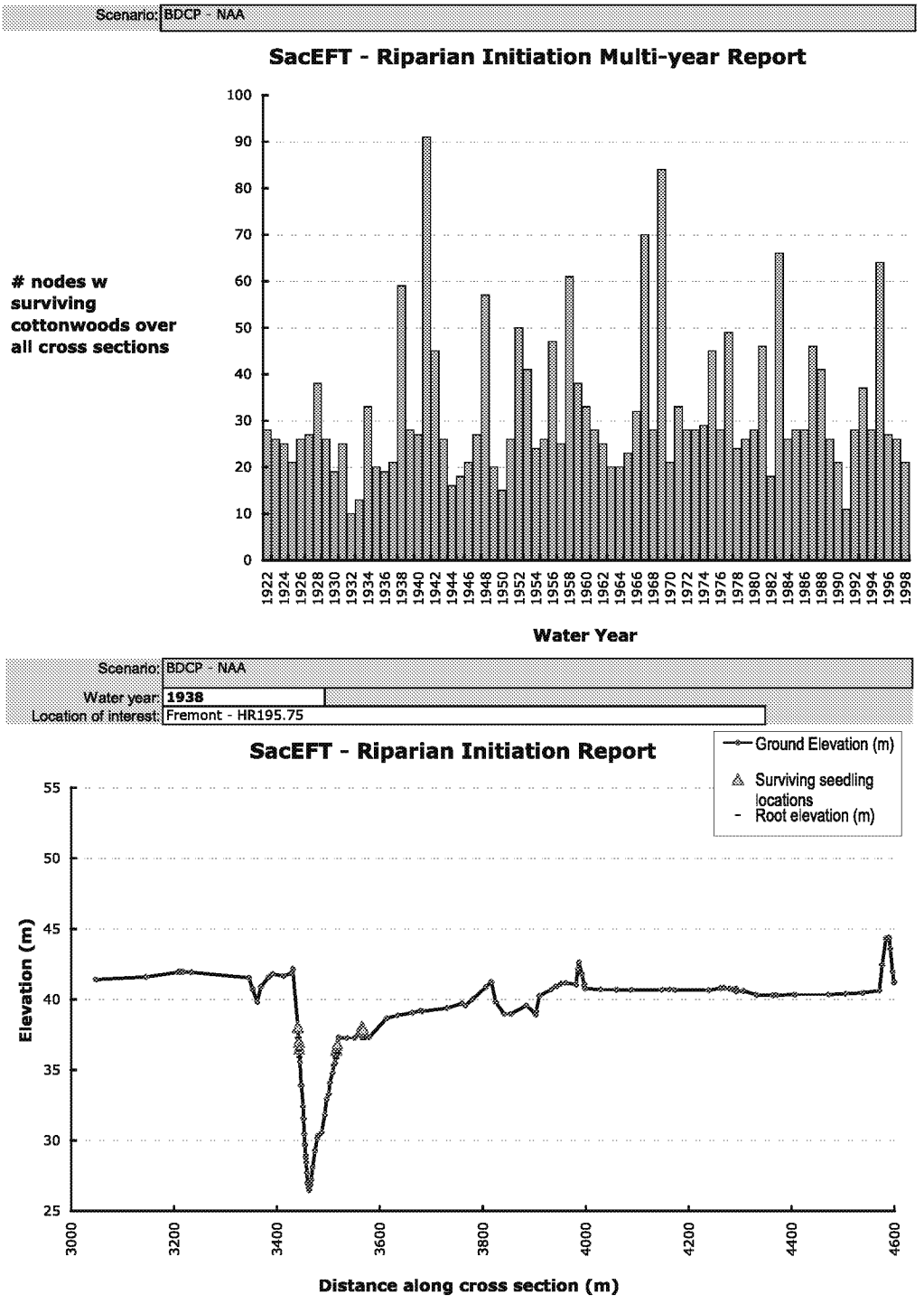

Figure 3.9: EFT provides detailed output on a scenario × year × performance measure basis in Excel. Refer back to Figure 3.7 for context.

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SCENARIO DETAILS AND METADATA

SacEFT provides a Scenario Details and Reviews feature to allow users to find additional information on a given scenario or model component (Figure 3.10).

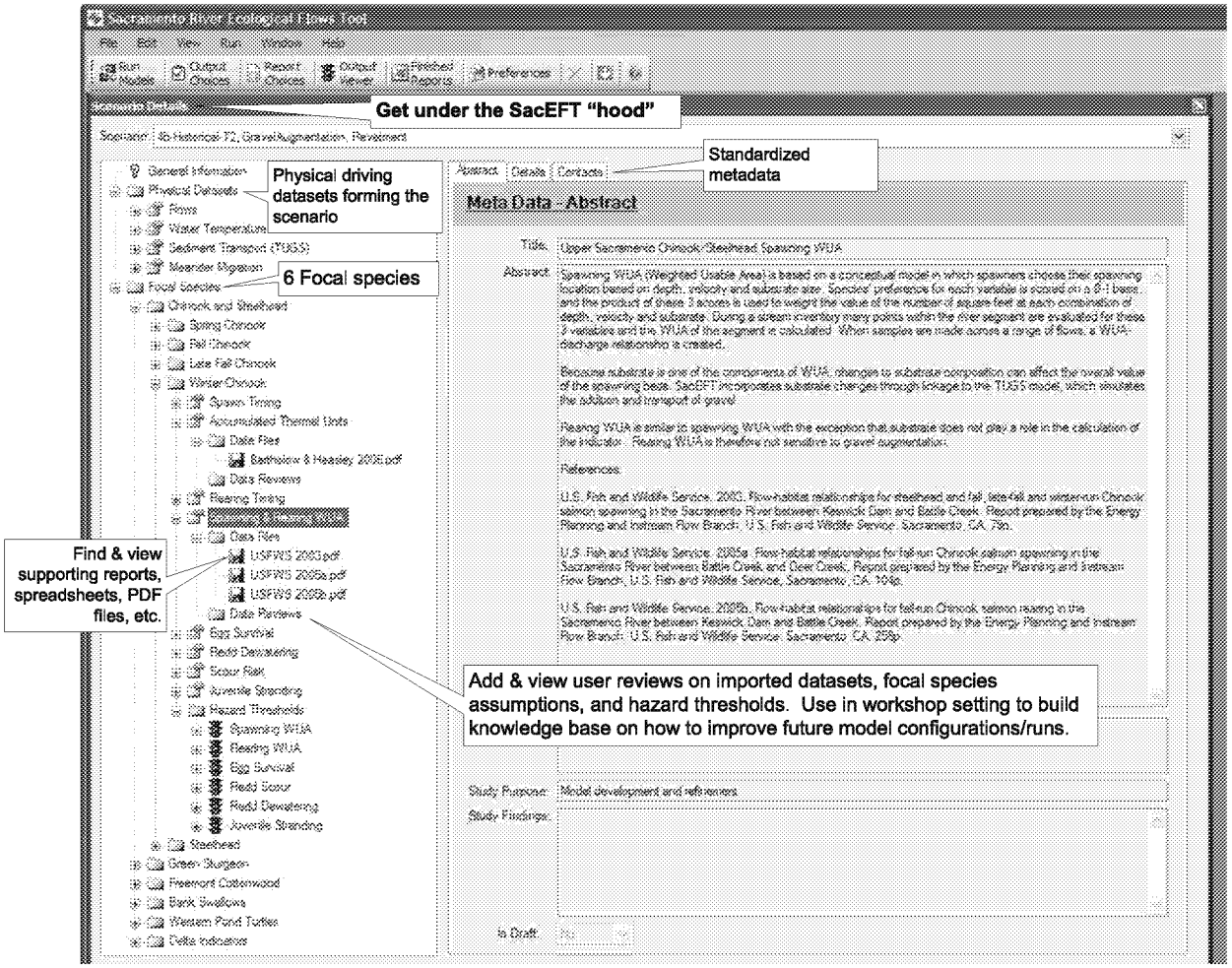

Figure 3.10: EFT's Scenario Details and Reviews dialogue for learning more about imported datasets and focal species assumptions.

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4. SacEFT Submodels: Functional Details

4.1 Physical driving submodels

The physical data sets used by SacEFT originate with several high-profile planning models. The intent of SacEFT is to leverage the extensive existing efforts made to develop, maintain and calibrate these systems, to supply key inputs necessary to calculate focal species performance measures. In addition to these models, selected mainstem Sacramento River gauging records have been used for river discharge and water temperatures. Using data from both models and stream gauges permits a mix of prospective and retrospective analyses.

4.1.1 Flow / hydrology

HISTORICAL/ACTUAL FLOWS: STREAM GAUGES

Table 4.1 lists the *historical* Sacramento River stream gauge records that have been imported into the SacEFT database. The finest temporal resolution of these historical records is the daily average.

Table 4.1. An example of the mainstem Sacramento River United States Geological Survey (USGS) stream gauges included in SacEFT. These gauges were selected because each provides a lengthy and complete or nearly-complete record of average daily flow. *Source:* The USGS surface water data web site (waterdata.usgs.gov/usa/nwis) and related web service (river.sdsc.edu/NWISTS/nwis.asmx).

Native Site Code	Name	UTM Zone	UTM Datum	UTM_N	UTM_E	RM	Elev (ft)	Owner Agency
11370500	SACRAMENTO R A KESWICK CA	10T	NAD27	4,494,415.947	547,098.993	301	479.8	USGS
11377100	SACRAMENTO R AB BEND BRIDGE NR RED BLUFF CA	10T	NAD27	4,459,898.695	569,229.379	260		USGS
11378000	SACRAMENTO R NR RED BLUFF CA	10T	NAD27	4,443,331.523	569,713.045	243	253.6	USGS
11383730	SACRAMENTO R A VINA BRIDGE NR VINA CA	10S	NAD27	4,417,891.359	577,616.258	218	197.0	USGS
11383800	SACRAMENTO R NR HAMILTON CITY CA	10S	NAD27	4,400,469.206	586,147.110	199	145.0	USGS
11389000	SACRAMENTO R A BUTTE CITY CA	10S	NAD27	4,367,853.628	586,631.562	168		USGS
11389500	SACRAMENTO R A COLUSA CA	10S	NAD27	4,340,812.116	586,405.165	143		USGS

Approximately 66 years of daily historical records were gathered in this manner and used in retrospective and calibration scenarios. This historical gauging data includes use of pre-existing data files supplied by project contributors.

Note: an extensive survey of the NWIS web service showed a total of 28 stations with some data, but many of these had incomplete time series. Even the 10 gauges with reasonably complete series (Table 4.1) had some gaps in daily average flow. Two missing data segments at VINA (1/Oct/1938 to 12/Apr/1945; 1/Oct/1978 to 30/Sep/2004) were interpolated by linear regression of the incomplete "SACRAMENTO R A VINA BRIDGE NR VINA CA" vs. complete "SACRAMENTO R AB BEND

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BRIDGE NR RED BLUFF CA": (1.2459 x BendBridge – 1364.5) (Yantao Cui, Stillwater Sciences, *pers. comm.*). Three missing data segments at this station (1/Oct/1938 to 20/Apr/1945; 15/Jan/1956 to 18/Jun/1956; 3/Oct/1980 to 30/Sep/2004) were interpolated by linear regression of incomplete "SACRAMENTO R NR HAMILTON CITY CA" vs. complete "SACRAMENTO R AB BEND BRIDGE NR RED BLUFF CA": (1.2047 x BendBridge – 1987.4) (Yantao Cui, Stillwater Sciences, *pers. comm.*). Finally, numerous winter gaps (typically Nov–May; 1921–1940) in COLUSA R A COLUSA CA were imputed using a nonlinear relationship with SACRAMENTO R AB BEND BRIDGE NR RED BLUFF CA discharge, even though that station is >100mi upstream. The best predictive relationship obtained for Colusa discharge day on day ***t*** was found to be given by Bend Bridge on day ***t-1*** (*i.e.,* a 1 day lag). Loess smoothing with a span of 2.5% was used to develop a fairly smooth predictive relationship, which was applied to the missing Colusa dates.

With these gaps filled, the available historical flow data span a continuous common period from 1/Oct/1938 to 30/Sep/2004: Water Years 1939-2004, a minimum of 24,107 historical records for each location.

FUTURE/PROSPECTIVE FLOWS AND WATER TEMPERATURES: UPPER SACRAMENTO WATER QUALITY MODEL (USRWQM) / UPPER SACRAMENTO RIVER DAILY OPERATIONS MODEL (USRDOM)

SacEFT prospective daily flow datasets are dependent on the input data provided to them. The Upper Sacramento River Daily Operations Model (USRDOM) was developed to simulate reservoir operations and hydrologic stream routing in the upper Sacramento River from Keswick Dam to Knights Landing on a daily timescale. The simulated daily flows from USRDOM can be used as inputs to several biological and habitat models. Upper Sacramento Water Quality Model (USRWQM) was developed to simulate daily temperature conditions in the Sacramento River based on the daily flow conditions. The geographical extent of the model is similar to the USRDOM. The simulated daily temperatures from USRWQM can be used as inputs to biological and habitat models. Both of these models depend on CalSim.

CalSim is a generalized water resource planning tool developed jointly by CWDR and the US Bureau of Reclamation Mid-Pacific Region. The primary purpose of the CalSim II model is to evaluate the performance of Central Valley Project (CVP) and State Water Project (SWP) at current and prospective future levels of water supply and demand. A mass balance model, CalSim is used as a framework to evaluate water delivery scenarios associated with expansion of project facilities as well as changes in hydrosystem operation criteria. Water routing and operational decisions are formalized into algorithms that include subjective judgments, rules and weights on various objectives. Explicit operating rules define what action is to be taken at each time-step given the state of the hydrosystem.

METADATA NEEDED TO DEVELOP SCENARIO COMPATIBILITY LISTS

By design, SacEFT requires no pre-requisite knowledge or experience in the operation of CalSim, USRDOM and USRWQM. Rather than become CalSim – USRDOM – USRWQM experts, SacEFT users are tasked with aligning model assumptions between a given imported dataset and other related physical models (TUGS, Meander Migration). This requires the ability to quickly summarize the key embedded assumptions, inputs, and other important characteristics of a CalSim – USRDOM – SRWQM DSS database in a format that non-CalSim experts can understand. To achieve this, we apply the metadata standard shown in Figure 4.1 to all physical submodel datasets that are imported into SacEFT.

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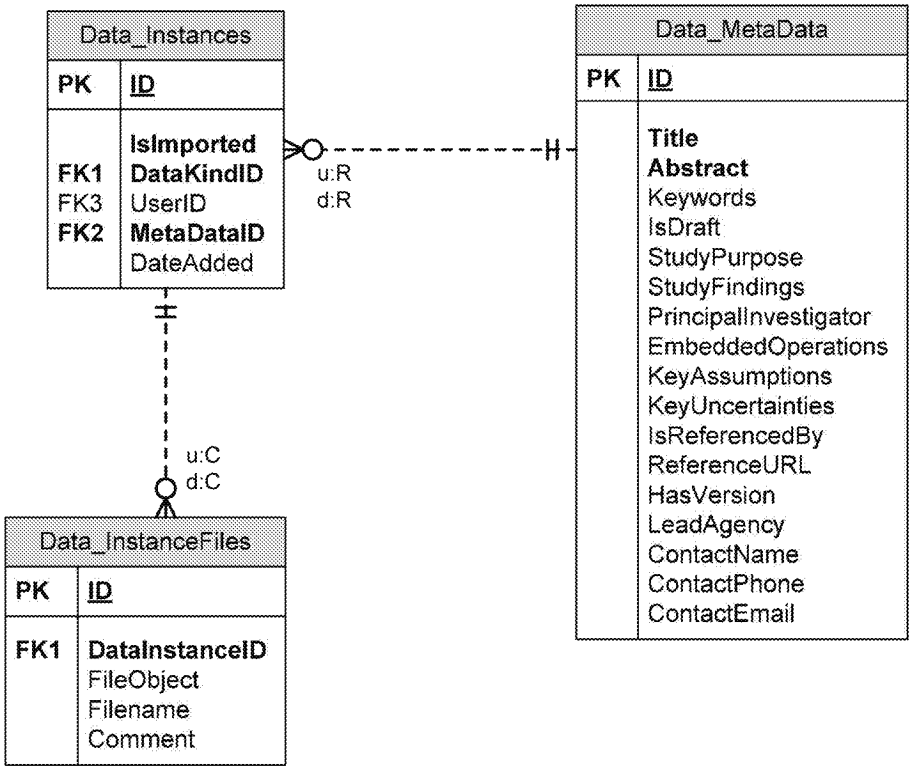

Figure 4.1. Underlying database design showing how each imported DSS file from CalSim (and any other data from an external physical model) is associated with a DataInstance and a set of MetaData. A considerable number of the fields in Data_MetaData are optional.

Note: **The metadata standard shown in Figure 4.1 is also applied to focal species submodels in SacEFT**. In other words, the concept of a DataInstance refers both to *imported data sets*, as well as *resident generic rules* for a particular focal species submodel. For example, one riparian submodel scenario may use a different tap-root growth rate from another riparian scenario. While this does not require nearly as great a level of detail in metadata documentation as a CalSim DataInstance, the rationale for one growth rate over another is the kind of information that can be tracked using the metadata standard.

4.1.2 Water temperature

HISTORICAL/ACTUAL WATER TEMPERATURES: GAUGES

The same USGS stream gauges listed in Table 4.1 were polled for water temperature information. These records can also be accessed using the NWIS web service, using a method call along the following lines:

```
oNWIS.GetWQValues(sUSGSStatCode, sWaterTempCode[1], "1880-01-01", "2008-11-25")
```

We attempted to use this data source to gather historical water temperature records but found that the existing historical temperature records are ephemeral. There are no temperature data corresponding to the

[1] The parameter code for water temperature in NWIS is: "00010"

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long continuous records available for discharge. Instead, Table 2.4 shows the 10 gauge locations (themselves modeled) between Bend Bridge and Keswick (RM 260-301) over the period 1-Jan-1970 to 31-Dec-2001.

SPATIAL RESOLUTION AND INTERPRETATION OF NODE LINKS

SacEFT treats USRWQM water temperatures as adequately representative of defined segments using a fixed river mile start and end value. Of the approximately 159 mile mainstem Sacramento River study area, the USBR model provides 10 nodes/arcs of interest (Table 4.2). The approximate river miles shown in the table are based on the U.S Army Corps of Engineers (1991). Additional nodes of interest can be provided, requiring only minor modifications to the software.

Table 4.2. USBR Temperature Model spatial nodes of interest on mainstem Sacramento River.

USBR Temperature Model Node / Arc Name	River mile
KESWICK	301
SAC_AT_COW_CR	280
BALLS_FERRY	277
JELLYS_FERRY	267
BEND_BR	260
RED_BLUFF	243
WOODSON_BR	218
HAMILTON_CITY	199
BUTTE_CITY	168
COLUSA	143

METADATA NEEDED TO DEVELOP SCENARIO COMPATIBILITY LISTS

As with CalSim – USRDOM results, SacEFT users must align model assumptions between a given USRWQM run and other related physical models (USRDOM, TUGS, Meander Migration). This requires the ability to quickly summarize the key embedded assumptions, inputs, and other important characteristics of a USBR Temperature Model DSS database in a form that non-USBR experts can understand. As described earlier in Section 4.1.1, we apply a metadata standard to document the context for all imported data (see Figure 4.1).

4.1.3 Stage-discharge

Some focal species submodels require information on water surface elevation (stage) at specific points along a cross-section, as a function of river discharge. These stage-discharge relationships are site specific and dependent on numerous variables that govern hydraulic behavior. Cross-sections themselves, that is – ground surface elevation profiles as a function of distance along a transect – are typically surveyed in the field by some means of bathymetric observation. The process of collecting this information from direct field measurement is time consuming, and often the flows of interest are not presented in a timely or predictable fashion. For these reasons, hydraulic simulation models have become widely used, especially tools developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center (HEC).

A variety of groups have used HEC software or UNET models on the Sacramento River (*e.g.*, California Department of Water Resources Comprehensive Study, U.S. Geological Survey, U.S. Fish and Wildlife Service, Ayers and Associates consultants, and The Nature Conservancy. Unfortunately, many of these

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studies only consider large flood recurrence discharges (50-, 100-, and 200-year events) and largely ignore lower-magnitude discharges needed to study in-channel and near-bank dynamics. Other academic researchers have developed detailed elevation models that provide stage-elevation and wetted area relations, but the output of these models is not readily available.

It is important to understand that in SacEFT, this information **is only needed where**:

1. A focal species submodel needs to know this information; and
2. Where geometric data and HEC (or other model) implementations already exist or can readily supply the ground surface profile and an in-channel stage-discharge relationship.

SITES OF INTEREST AND SPATIAL RESOLUTION

Cottonwood initiation is currently the only consideration in SacEFT driving the choice of matched stage-discharge and ground surface elevation data. During our reconnaissance leading up to the model design workshop in December 2005, three sites at RM 172, 183 and 192 – examined during the 2003 Beehive Bend study (Roberts *et al.* 2002, Roberts 2003) met the two criteria above. These sites were assumed to be representative of the Colusa to Red Bluff section of the Sacramento River, and SacEFT's riparian initiation submodel is therefore applied to these 3 sites. In subsequent development work additional locations have been added, so that Version 2 contains cross sections from these 10 locations: RM 164, 165, 172, 183, 185.5, 192, 195.75, 199.75, 206 and 208.25.

METADATA NEEDED

As with any other dataset in SacEFT, these manually imported data are tagged with a DataInstance ID, which allows key background information to be tracked using SacEFT's metadata standard.

4.1.4 Sediment transport and bed composition

Stillwater Sciences has developed The Unified Gravel-Sand (TUGS) model to simulate how bed mobilization and scour affect grain size distribution, including the fraction of sand in both the surface and subsurface layers. The model can be used to assess the effects of different management scenarios (*e.g.*, gravel augmentation, flow releases to increase the frequency of bed mobilization and scour, reduction in fine sediment supply) on salmonid spawning habitat.

Though existing bedload transport models can predict sediment transport rates and bed surface/subsurface textures as a function of sediment supply and routing, they generally have ignored the presence of sand. Including fractions of sand in surface and subsurface grain size distributions is of interest for evaluating the extent and quality of salmonid spawning habitat. Surface grain size distributions can support estimates of available spawning habitat in terms of the availability of spawning-sized gravel, and subsurface grain size distributions, especially the fraction of sand, can support estimates of spawning gravel quality. The TUGS model is designed to fulfill this need by simulating how bed mobilization and scour affect grain size distribution, including the fraction of sand, in both the surface and subsurface.

As described in Cui (2007), The Unified Gravel-Sand (TUGS) Model employs:

a) the surface-based bedload equation of Wilcock and Crowe (2003);
b) a combination of the backwater equation and the quasi-normal flow assumption for flow;
c) Exner equations for sediment continuity on a fractional basis, including both gravel and sand, and the process of gravel abrasion;

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d) the bedload, surface layer, and subsurface gravel transfer function of Hoey and Ferguson (1994) and Toro-Escobar *et al.* (1996); and

e) a hypothetical surface-subsurface sand transfer function.

The Wilcock and Crowe (2003) sediment transport equation calculates the transport rate of both coarse sediment (gravel and coarser) and sand based on the surface grain size distribution and on local shear stress. The Wilcock and Crowe equation assumes no relationship among surface, subsurface, and bedload grain size, which limits the application of the equation to field conditions. However, the research of Toro-Escobar *et al.* (1996) and Hoey and Ferguson (1994) identified a correlation among subsurface, surface, and bedload grain size distributions for coarse sediment, and Cui and Parker (1998) showed that the subsurface sand fraction is strongly correlated with the standard deviation of the grain size distribution of the coarse sediment. It is therefore possible to hypothesize a relation among the subsurface, surface, and bedload grain size distributions, and to combine these relations with the Wilcock and Crowe sediment transport equation to develop a numerical model that can be applied to field conditions. The hypothetical surface-subsurface sand transfer function is structured so that the subsurface sand fraction increases with the increase in the surface sand fraction and decreases with the increase in the subsurface gravel geometric standard deviation. Comparison with field data from several rivers indicates that the hypothetical surface-subsurface sand transfer function produces estimates of subsurface sand fraction within the general range measured in the field. Simulation of the Sandy River produced reasonable trend for surface/subsurface sand fractions under various hypothetical management scenarios.

The TUGS model was developed using a dataset developed in the Sandy River in Oregon. It is a one-dimensional model that predicts reach-average channel bed elevation and grain size distribution variations. A reach is defined as a length equal to a few channel widths. Because of limitations in current sediment transport modeling theories and techniques, TUGS model cannot simulate grain size distributions at the scale of local channel features, such as alternate bars or pool-riffle sequences. As with any sediment transport model, TUGS model results are most useful for comparing different management alternatives to assess their effectiveness in achieving defined goals (*e.g.*, increasing gravel deposition, reducing fine sediment, *etc.*). The model also uses existing cross-sections developed by the Army Corps of Engineers and CDWR as part of the Comprehensive Study.

SPATIAL HORIZON AND RESOLUTION

The TUGS model can be applied to any reach of the Sacramento River for which channel cross-sections and surface and subsurface grain size data are available, and has been calibrated for the Sacramento River using existing bulk sampling data collected by CDWR in 1980, 1984, and 1994. Stillwater Sciences has added to the dataset by collecting new bulk samples in the upper and middle Sacramento River in 2005, at locations sampled previously by CDWR. Table 4.3 displays the river miles where the CDWR bulk samples and Stillwater 2005 bulk samples were collected. Generally, sediment transport and routing models including TUGS require a very high initial effort to calibrate.

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Table 4.3. Bulk sampling sites in the Sacramento River where surface and subsurface grain size distribution data are available.

Upper Sacramento River	
RM	**Site Name**
298.3	Caldwell Park
296.9	Turtle Bay Upstream
292.7	Golf Course
291.3	Below Tobiasson
289.1	Clear Creek confluence
288.1	Above I-5 embankment
287.3	At I-5 embankment
286.3	n/a
282.6	Anderson outfall
281.1	Stillwater Creek
280.2	Cow Creek
279.1	Below Cow Creek
278.3	Above Bear Creek
275.7	Anderson Creek
273.3	Cottonwood Creek

Middle Sacramento River	
RM	**Site Name**
242.7	Red Bluff Diversion Dam
240.4	Above Blackberry Island
238.5	Above Todd Island
236.1	Below Todd Island
233.0	Oat Creek
228.3	Tehama
225.6	Thomes Creek
221.2	Copeland Bar
218.6	Woodson Bar
215.3	Above Cutoff
211.6	Upstream of Foster Island
208.9	Upstream of Shaded Slough
201.8	McIntosh Landing
197.9	Upstream of Pine Creek
163.5	Princeton

FORM OF TUGS OUTPUT TO BE ACCESSED AND IMPORTED: EXCEL

TUGS is capable of providing a variety of grain size specific transport estimates for gravel and sand, and of tracking these two classes of sediment by their proportions in surface and subsurface layers. The current output format for the model is shown in Figure 4.2.

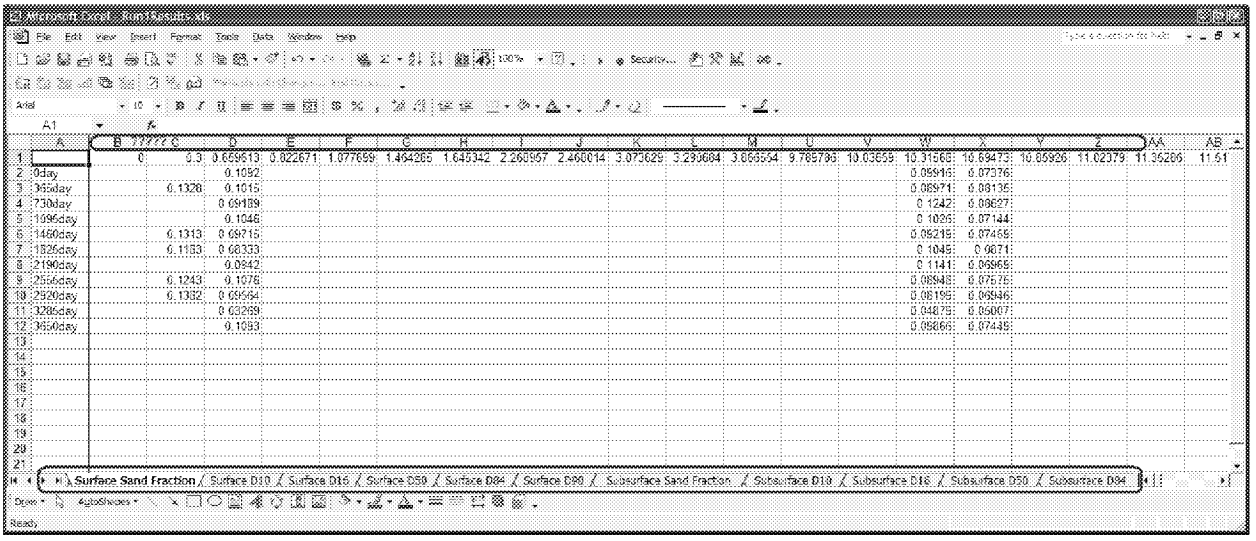

Figure 4.2. Current raw output from TUGS model. Numerous worksheets contain results for specific performance measures. As shown, it is not always clear what distance (location) or time period is associated with a particular value. An Excel template was developed to better organize and streamline this information for orderly import into the SacEFT database.

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With the benefit of a new Excel template, TUGS output is bulk loaded into SacEFT's database in the relational form shown in Figure 4.3.

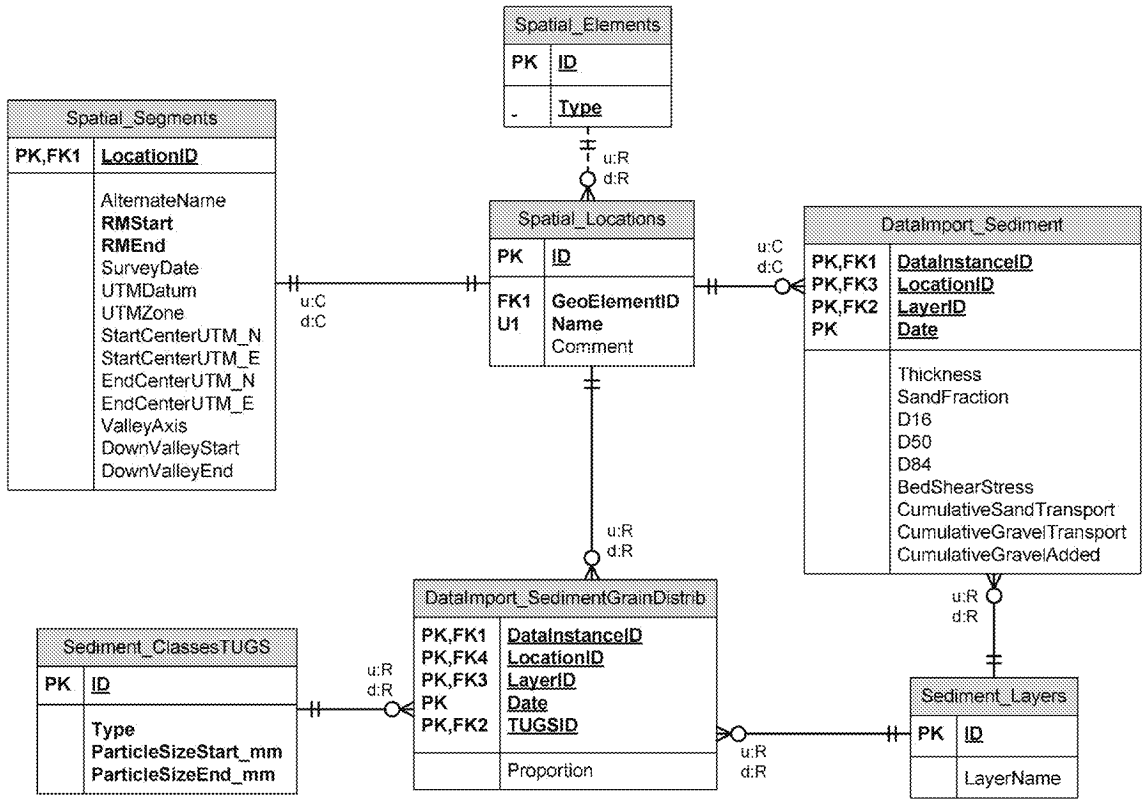

Figure 4.3. Relational database design used by SacEFT for storing TUGS model output.

After consultations between Stillwater Sciences and TNC, two scenarios were incorporated into SacEFT for **v.2.00**: a "No Gravel" scenario that assumes no gravel injection to the rivers, although small amounts of natural sand and gravel are present. The second scenario "Gravel Injection" contains a single gravel injection in Water Year 1940, with no subsequent additions. The scenarios were simulated using historical, NODOS and Shasta discharges at Keswick (RM 301) and implemented over 5 reaches as shown in Table 4.4. The results of the TUGS scenarios are incorporated into the calculation of Spawning WUA (Weighted Usable Area) for Chinook and steelhead, as described in Section 4.2.5.

Table 4.4. Location of TUGS simulation segments and amount of supplementary gravel added for "Gravel Injection" scenarios.

Upper RM	Lower RM	Gravel Injection (m^3) (when present)
301.956	299.800	
299.800	297.000	179,423[δ] (234,677 yd^3)
297.000	295.600	
295.600	292.400	188,662[δ] (246,760 yd^3)
292.400	289.375	

[δ] These are bulk amounts, assuming a gravel porosity of 0.4.

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Note: As part of the TUGS calibration process a third "zero gravel" scenario was also developed using historical flow at Keswick and *historical* gravel additions from 1981-2006.

4.1.5 Meander migration

UC Davis researchers have developed a Meander Migration Model (Larsen 1995, Larsen and Greco 2002, Larsen *et al.* 2006b) using MATLAB software, that calculates channel migration using a simplified form of equations for fluid flow and sediment transport developed by Johannesson and Parker (1989). One version of the Meander Migration Model predicts meander migration as a function of a single, representative, geomorphically effective discharge ("characteristic discharge"). The model has been modified to consider the effects of a variable hydrograph on meander migration rates. This is believed to provide a more accurate depiction of the conditions in which meander migration occurs. The underlying hypothesis is that the bank migration rate, when thresholds are excluded, in a specified time interval is linearly related to the sum of the cumulative excess stream power in the same time interval (Larsen *et al.* in review).

The meander migration MATLAB code that is used to assess ecological flows is similar to the code used in other applications (*i.e.,* Larsen and Greco 2002) but incorporates a variable flow, where channel migration in yearly time steps is a function of annual flow rates, through the measure of scaled annual cumulative excess stream power (Larsen *et al.* 2006a).

The migration model requires the following six input values, which reflect the hydrology of the watershed and the hydraulic characteristics of the channel: initial channel planform location, "characteristic discharge", reach-average median particle size of the bed material, reach-average width, depth, and slope. The crux of the model is the calculation of the velocity field. The analytic solution for the velocity results from the simultaneous solution of six partial differential equations representing fluid flow and bedload transport. An initial calibration also plays a critical role. To calibrate the model, researchers use the channel planform centerline from two years for which centerlines can be accurately delineated from digitized aerial photos. The calibration process consists of adjusting the erosion and hydraulic parameters, in the Meander Migration Model until the simulated migration closely matches the observed migration. The erosion potential map is initially determined from GIS coverages and delineates areas of higher and lower erosion potential due to differences in land cover, soil, and geology. The erosion potential map is then adjusted in the near-channel-bank areas by calibrating the channel centerlines between the two time periods. See Larsen and Greco 2002 for details.

Conceptually, the Meander Migration Model produces a temporal series of channel centerlines that are imported into ArcInfo where bends and lateral change polygons are defined and studied for movement in terms of progressive migration (Larsen and Greco 2002, Larsen *et al.* 2006). GIS tools are used to automate the spatially explicit measurements.

SPATIAL HORIZON AND RESOLUTION

As applied and configured for SacEFT, the Meander Migration Model focuses on three river segments located between RM 170-185, 185-201, and 201-218. The model has also been previously applied in various locations between Red Bluff (RM 243) and Colusa (RM 143).

The finest unit of resolution of interest in SacEFT is **a bend**. We apply a fixed zonal concept based on segments, using the locally well-known concept of river miles to reference these bends. While we recognize the channel alignment has changed significantly since the U.S. Army Corps of Engineers 1964 centerline survey, the critical consideration is that these locations be "well-known" and consistent across

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SacEFT's submodels. This in no way inhibits the spatial accuracy of meander migration calculations, just simplifies the manner in which specific bends are identified. As described earlier, for purposes of determining the suitability of bank swallow nesting habitat, the exact locations of individual bends of interest is still in *approximately* the same zones whether at RM 191 or RM 208. Knowing ***exactly*** where it is does not help us answer questions about bank swallow nesting habitat.

While SacEFT treats locations as fixed throughout model simulations for purposes of generating focal species performance measures, variables like centerline change, which are inherently spatial, may still be handled in a fully spatially explicit fashion. The distinction we draw is one of a need for "visualization" vs. an empirical summary performance measure that is transferred to a submodel of lower resolution and precision. Highly visual, dynamic map-based outputs usually require spatially explicit treatment; other variables do not.

4.1.6 Bank erosion model

ESSA has developed a GIS-based erosion model that allows users to combine the predictions from the Meander Migration Model with other spatial information, such as soil and vegetation information. Each year, the model simulates the location of the river channel, the area of eroded banks and the location of the banks at the end of the year. The location of the river channel is calculated from the centerline using two simplifying assumptions regarding the river channel: (1) that it is symmetrical around the centerline; and (2) that the local channel width for a given section of the river is unchanged during the simulation. The eroded area for each year is defined as the channel area overlapping the previous year's banks. The river banks at the end of the year are calculated by subtracting the eroded area from the banks at the start of the year. Figure 4.4 shows an example of change of centerlines simulated by the Meander Migration Model over a period of 56 years.

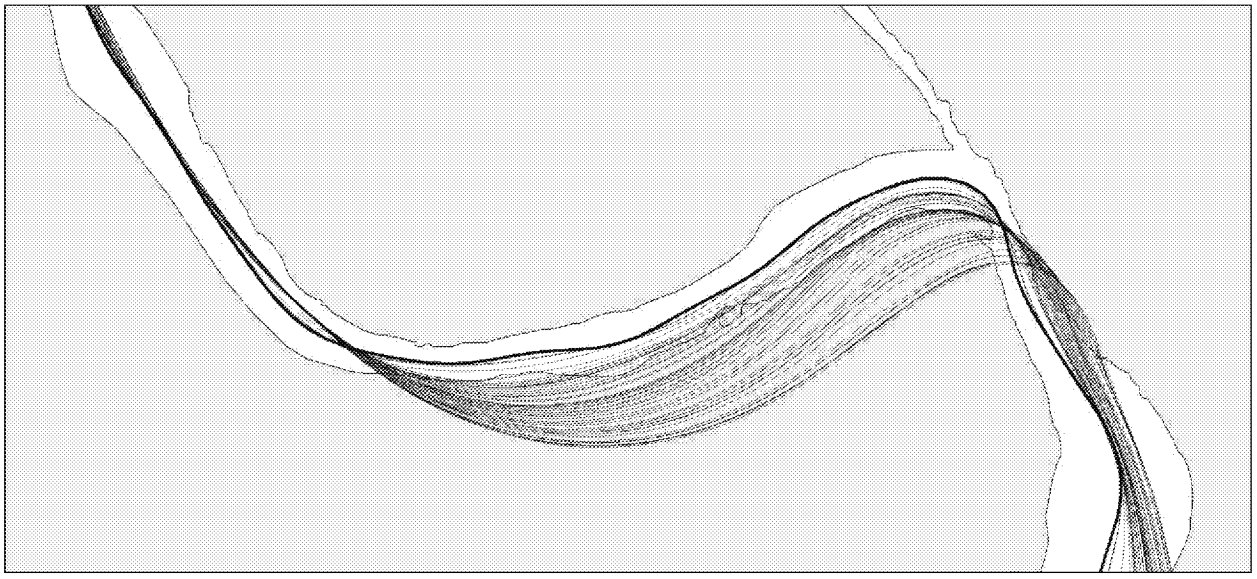

Figure 4.4. Example of centerlines for 56 years for one scenario.

The initial simplified channel is based on the measured location of banks in 2004. The centerline was divided into segments and the local channel was determined as the distance to the nearest bank. Then, a simplified channel was created by buffering each centerline segment by the local channel width (Figure 4.5).

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Figure 4.5. Simplified channel for initial conditions.

Each future channel is simulated based on the previous centerline and on the local channel width for each centerline segment. The new centerline is then divided into segments based on the proximity to the segment of the previous year's centerline. Next, the channel for the year is created by buffering the new centerline by the channel width for the closest location matching the previous year's centerline. Finally, the locations of eroded bank are defined as the area of the new channel that overlap the previous year's bank. Finally, the new bank locations are used to calculate the next year's erosion.

FORM OF EROSION OUTPUT TO BE ACCESSED AND IMPORTED: SHAPE FILE AND EXCEL

The erosion model produces three outputs: (1) GIS layers with eroded area for each year, (2) the vegetation for the eroded areas and (3) the soil composition of the eroded areas. The soil composition is divided into 4 types based on bank swallow preference and prevalence in the eroded areas. The eroded areas are overlaid on the amalgamated Soil Survey Geographic (SSURGO) soil data to derive soils data for the bank swallow model (Figure 4.6). The eroded areas are also overlaid on vegetation data to provide input to the large woody debris indicator (Figure 4.7).

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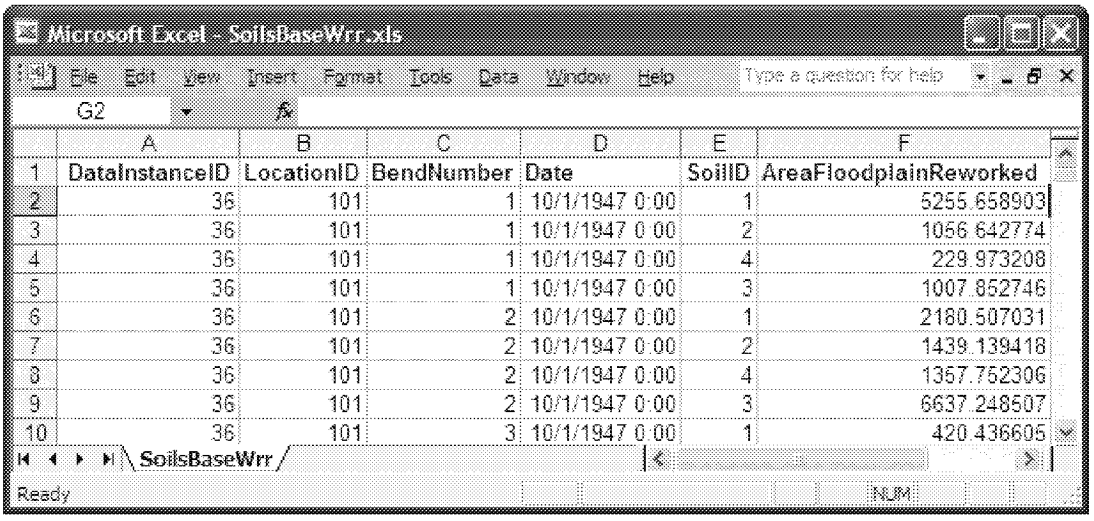
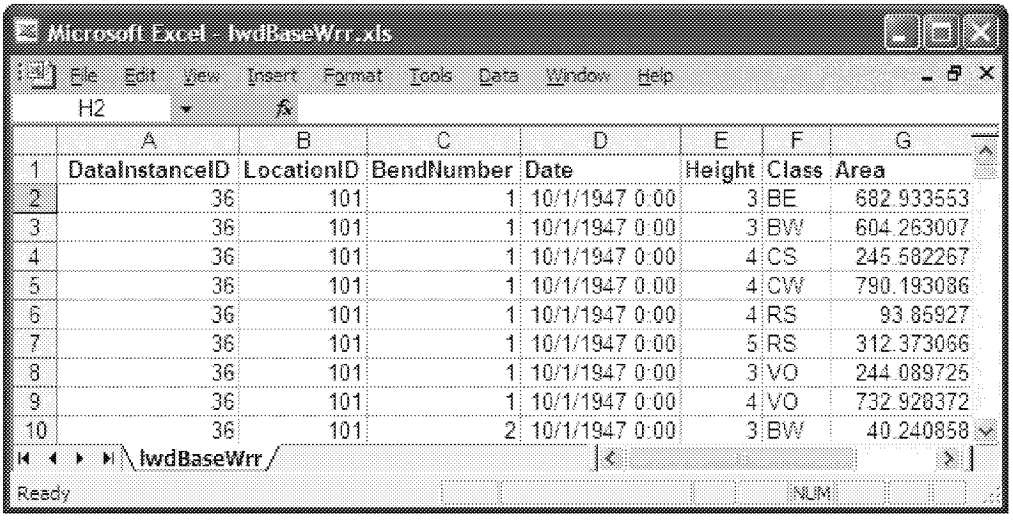


	A	B	C	D	E	F
1	DataInstanceID	LocationID	BendNumber	Date	SoilID	AreaFloodplainReworked
2	36	101	1	10/1/1947 0:00	1	5255.658903
3	36	101	1	10/1/1947 0:00	2	1056.642774
4	36	101	1	10/1/1947 0:00	4	229.973208
5	36	101	1	10/1/1947 0:00	3	1007.852746
6	36	101	2	10/1/1947 0:00	1	2160.507031
7	36	101	2	10/1/1947 0:00	2	1439.139418
8	36	101	2	10/1/1947 0:00	4	1367.752306
9	36	101	2	10/1/1947 0:00	3	6637.248507
10	36	101	3	10/1/1947 0:00	1	420.436605

Figure 4.6. Example of soil composition data for eroded areas in Excel.



	A	B	C	D	E	F	G
1	DataInstanceID	LocationID	BendNumber	Date	Height	Class	Area
2	36	101	1	10/1/1947 0:00	3	BE	682.933553
3	36	101	1	10/1/1947 0:00	3	BW	604.263007
4	36	101	1	10/1/1947 0:00	4	CS	245.582267
5	36	101	1	10/1/1947 0:00	4	CW	790.193086
6	36	101	1	10/1/1947 0:00	4	RS	93.85927
7	36	101	1	10/1/1947 0:00	5	RS	312.373066
8	36	101	1	10/1/1947 0:00	3	VO	244.089725
9	36	101	1	10/1/1947 0:00	4	VO	732.928372
10	36	101	2	10/1/1947 0:00	3	BW	40.240858

Figure 4.7. Example of vegetation data for eroded areas in Excel.

4.2 Integration of physical data, linked models and SacEFT submodels

4.2.1 Water year conventions for simulations and outputs

By convention, SacEFT uses the Water Year (WY) as its annual simulation framework. Each Water Year (*y*) begins on October 1 of calendar year (*y-1*) and ends on September 30 of calendar year (*y*). Spring-run Chinook salmon spawn across the (*y-1*):(*y*) boundary, and are accounted for with the run-types spawning in WY *y*.

4.2.2 Matching physical variables to focal species locations of interest

The model underlying each PM is designed to accommodate the temporal framework of its input data: daily for flow and temperature and annual for TUGS and Meander Migration data. SacEFT accepts inputs

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that may be point-based (*e.g.,* discharge and temperature) or segment-based (*e.g.*, TUGS data). It links these inputs to PMs that may themselves be point-based (*e.g.,* GS1 – Green Sturgeon spawning locations) or segment-based (*e.g.,* CS1 – Chinook spawning WUA).

The guiding principle for this linkage is to first fill gaps that may be present in the input data. The second principle is to use the input data that are nearest to the location where the PM is modeled. To do this, SacEFT uses the concept of a neighbor zone: any input data located within a user-defined river mile tolerance zone are considered a perfect match. Failing a match within the tolerance zone, the nearest upstream data are usually selected. In some cases, such as the riparian initiation submodel, flows are interpolated based on the nearest available upstream and downstream source of flow data for the cross-section of interest.

Some matches require overlaying segment-based data from multiple sources (*e.g.,* TUGS data and salmonid spawning segments). When this occurs, segments that are completely-contained and segments that overlap are weighted by the proportion of their length contained in the common segment. For example, if a short TUGS segment is completely contained in a longer spawning segment along with an adjacent TUGS segment that is half in the spawning segment, the sediment data from the first segment are given a weight of 1.0 and the data from the second segment a weight of 0.5.

In the unique case of salmonid rearing habitat, there are some rearing-reaches without spawning and therefore without any natural way to predict the egg-emergence that eventually follows spawning and marks the initiation of rearing. In these cases, the average emergence of the *upstream* segments is used to create an egg-emergence distribution for the downstream rearing segment.

Finally, in cases where there are multiple data sources within a salmonid reach segment for flow or temperature, those data are averaged to provide a single pooled estimate for the reach-based calculations.

4.2.3 Extending TUGS locations to Chinook and steelhead locations

The initial surface substrate conditions for TUGS simulations consisted of the substrate size categories in two river segments (see Section 4.2.5). Changes to these initial distributions were then modeled over time with the two gravel scenarios.

When applying TUGS data for Chinook and steelhead spawning WUA, it was generally necessary to apply annual location-based TUGS results to portions of the river that are outside the area where TUGS was calibrated (compare red and pink segments in Table 2.5). In accordance with our nearest-neighbor principle, the predicted substrate composition of the most downstream of the five TUGS simulation segments (near RM 289) is mapped to the downstream segments used by the Chinook and steelhead submodels each year for each of the combinations of flow scenarios and gravel scenarios. In the case of fall Chinook, the most distant segment can extend downstream over 70 miles to Vina (RM 218), implying that the distribution of surface substrate size classes (sand through boulder) is comparable across this entire range. It also assumes that gravel injection simulations at upstream locations can be plausibly extended at the downstream locations. The further the spatial extrapolation, the more tenuous this assumption becomes. The solution to this extrapolation problem can be resolved by obtaining TUGS simulation results calibrated and tested for these more downstream reaches of the Sacramento River.

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4.2.4 Extending Chinook and steelhead WUA relationships across locations and run-types

Chinook and steelhead spawning and rearing WUA performance measures (CS1, CS2) are parameterized for three upstream reaches only. The detailed empirical substrate information required to estimate site-specific spawning WUA (and its relationship to gravel injection) is not available at the 2 downstream segments. This is shown graphically in Table 2.5 where parameterized reaches are shown in dark blue and mapped reaches in light blue. The parameterization methodology developed and applied at the 2 downstream reaches is described more fully in Section 4.2.5.

Similarly, spawning and rearing WUA relationships (when they exist) have been parameterized for steelhead and for fall-, late fall- and winter- Chinook run-types. Habitat preferences for spring Chinook are not available and we assumed they follow those of fall Chinook (Mark Gard, USFWS, *pers. comm.*).

4.2.5 Linking Chinook and steelhead WUA relationships to TUGS substrate classes

The Chinook and steelhead spawning Weighted Usable Area (WUA) models are based on Gard's habitat preference models (U.S. Fish and Wildlife Service 2003, 2005a, 2005b). These models assume that spawners prefer habitats with optimal combinations of depth, velocity and gravel size, and that given an environment in which all three of the characteristics vary, their overall preference can be empirically modeled as the product of 0-1 preferences for each of these 3 variables. When one square foot of habitat is optimal (1.0) for all 3 preferences, it has a weighted usable area (WUA) of 1.0 ft^2; otherwise it has some smaller value. Gard's results are based on the River-2D hydrodynamic model (Steffler and Blackburn 2002, U.S. Fish and Wildlife Service 2006a), a 2-dimensional hydrodynamic simulation of river segments. River-2D takes as input discharge at the upstream segment transect and surface elevation at the downstream transect, along with empirical measurements of the river bottom topography and composition, and estimates the velocity field over the points of the segment's triangular irregular network (TIN), producing an estimate of WUA for each node of the TIN. When these TIN nodes are summed up, an estimate for the reach is produced and finally, when the reaches are summed in proportion to their presence in the entire segment, an overall segment WUA is obtained.

Using original data provided by Gard, we re-ran all the River-2D analyses and used raw River-2D output to determine $\boldsymbol{a_s}$, the proportional area contribution of each of the 11 substrate size categories in each river reach, across a range of discharges. When $\boldsymbol{A_i}$ is the absolute area in any substrate size class, $\boldsymbol{a_s}$ is:

$$a_s = \frac{A_s}{\sum_{s=1}^{11} A_i}$$

The $\boldsymbol{a_s}$ vector was found to be fairly insensitive to discharge, and we therefore took the average a-vector across the full range of flows (3,250 to 31,000 cfs), allowing us to develop a relationship that was independent of discharge. This calculation implicitly collapses two-dimensional information about substrate size categories across each reach into a one-dimensional summary. To provide a consistent set of size categories, the $\boldsymbol{a_s}$ vector calculated by River-2D was transformed to the 8 size categories ($\boldsymbol{a_8}$) used by TUGS by linear interpolation between overlapping size classes. After this operation, the $\boldsymbol{a_8}$ vector was provided as an initial condition for the TUGS simulations.

In SacEFT model runs, along with the actual surface substrate size distribution $\boldsymbol{a^*_s}$ predicted annually by TUGS gravel augmentation scenarios, the reference size distribution vector $\boldsymbol{a_s}$ is combined with substrate preference $\boldsymbol{p_{r,s}}$ to modify Gard's reference spawning discharge relationship $\boldsymbol{WUA_{r,Q}}$ for each species $\boldsymbol{r}$. The

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actual WUA available each day to spawners $WUA^*_{r,Q}$ is computed by the ratio of the reference conditions (denominator) to the current conditions (numerator), making WUA sensitive to changes in substrate:

$$WUA^*_{r,Q} = WUA_{r,Q} \times \frac{\sum_{s=1}^{8} p_{r,s}\, a^*_s}{\sum_{s=1}^{8} p_{r,s}\, a_s}$$

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4.3 Focal species submodels

4.3.1 Chinook salmon & steelhead trout

The salmonid conceptual model is shown in Figure 4.8. Readers are referred to ESSA Technologies Ltd. (2005) for details on the development of this model and the decisions that led to its current structure.

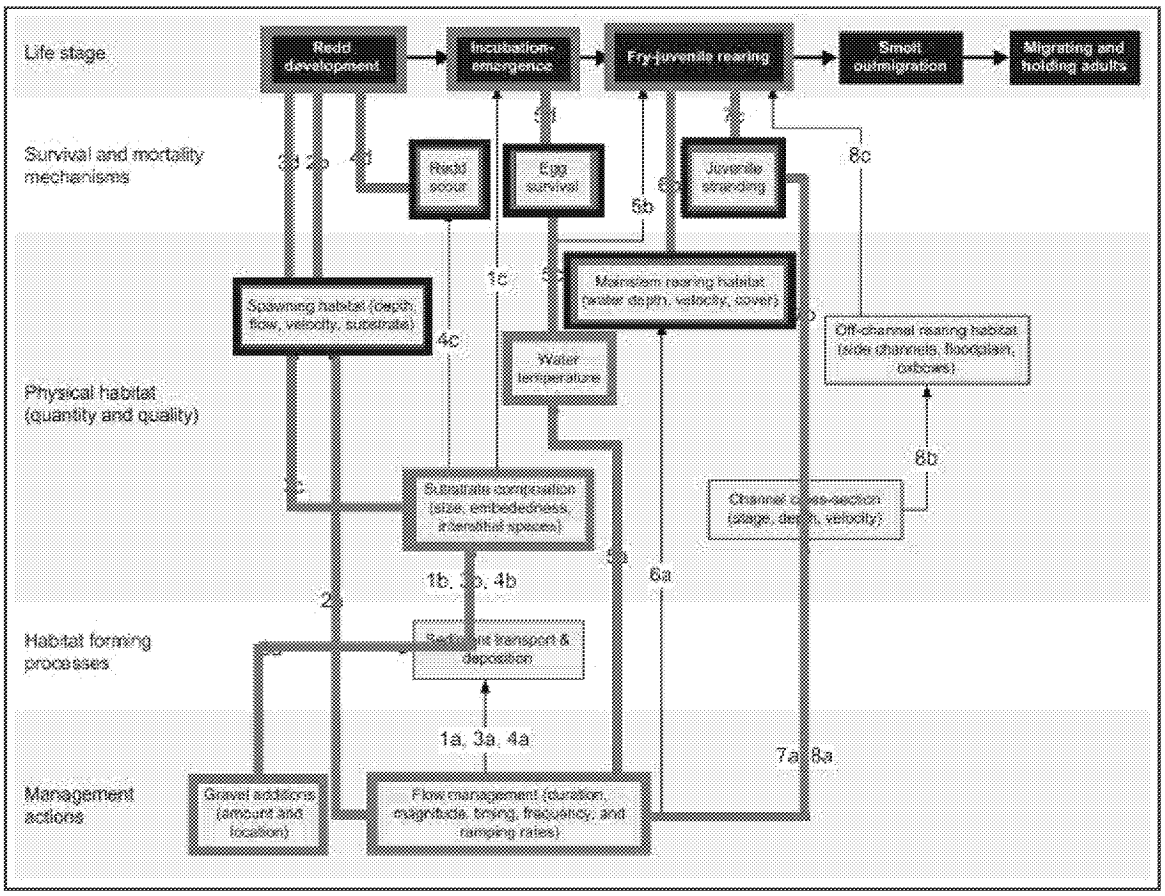

Figure 4.8. The salmonid conceptual model. Heavy lines show the processes and linkages that are currently implemented. See ESSA Technologies Ltd. (2005) for additional context and detail on processes and linkages shown here.

SacEFT includes six performance measures (PMs) that describe changes in the physical habitat available for salmonid spawning and rearing. These performance measures are shown in Table 4.5.

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Table 4.5. Performance Measures (PMs) for Chinook salmon and steelhead trout.

Performance Measure	Synonyms	PM code	Units
Weighted Usable Area for Spawning	Spawning WUA	CS1	Square feet
Redd Dewatering		CS6	Proportion
Redd Scour Potential		CS5	Hazard category
Egg-to-Fry Thermal Mortality	Egg Survival	CS3	Proportion
Weighted Usable Area for Rearing	Rearing WUA	CS2	Square feet
Juvenile Stranding Potential		CS4	Index

Steelhead trout and four Chinook salmon run-types are modeled using the common modeling framework described in this section. Our approach and data are largely based on research results provided by Mark Gard of the U.S. Fish and Wildlife Service in Sacramento (U.S. Fish and Wildlife Service 2003, 2005a, 2005b). As described below, additional temperature-emergence and temperature-mortality data have been provided from relationships published for the SALMOD model (Bartholow and Heasley 2006) and by Crisp (1981).

The salmonid performance measures broadly cover key features of the spawning and rearing portions of the juvenile life history, and are simulated in up to 5 segments of the mainstem, as shown in Table 2.5 and Table 4.5. Because parameterized relationships were not always available for every location and PM, relationship mapping was carried out by assuming that relationships parameterized for a run-type or location could be applied to another run-type or location (Mark Gard, USFWS, *pers. comm.*).[1] For example, based on U.S. Fish and Wildlife Service (1995), the distribution of rearing habitat for *spring-run* Chinook is almost entirely concentrated below Battle Creek but uses *fall-run* rearing WUA relationships. Likewise, rearing WUA relationships are not available for locations *downstream* from Battle Creek, and currently make use of *upstream* WUA relationships.

SacEFT presents the results for each PM at up to 3 scales. First, at the system-wide resolution (which we term the *rollup*), each annual PM is evaluated by comparing the results against those of a benchmark historical run scenario (historical flow and temperature, no gravel augmentation, no bank revetment). The distribution range of the benchmark annual PM is used, employing obvious discontinuities in the distribution to create a heuristic R/Y/G classification called the *Indicator Rating*. (If there are no obvious discontinuities, the tercile points – measurements taken at the 1/3 and 2/3 points of the sorted PM distribution – are used to assign the Indicator Rating.) At the *Annual* scale (not graphed in v.2.00) the terciles of the annual average for the PM are used to create indicator ratings. At the *Daily* scale, the indicator rating is represented using horizontal color bars on some Excel reports. This scale of indicator uses the terciles of the *daily* historic flow and temperature to assign a daily R/Y/G indicator rating.

Although each model operates internally on the basis of a daily cohort, the distributional and cumulative results shown on the Excel report often portray the cumulative (summed) distribution of all day-cohorts each day. This way it is possible to see daily changes to the entire population in the face of fluctuations in flow and temperature, even though internally, each day-cohort is tracked separately.

[1] One reviewer of Version 1 documentation noted that "the conventional wisdom is that rearing above Battle Creek is insignificant" and that "in-river rearing for all four named varieties of Chinook extends at least down to Ord Bend." (Andrew Hamilton, *pers. comm.*). If additional rearing WUA estimates are available for downstream locations, they can easily be accommodated in subsequent versions.

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Table 4.6. Reaches with calibrated or mapped spawning (CS1) and rearing (CS2) WUA relationships. Spawning WUA-substrate relationships for some reaches (light blue) are based on parameterizations (dark blue) from the nearest segment. Rearing relationships downstream from Battle Creek are based on WUA-Flow relationships from the nearest upstream segment (abstracted from Table 2.5).

		Spawning PMs					Rearing PMs				
Upstream	**Downstream**	***Spring***	***Fall***	***Late Fall***	***Winter***	***Steelhead***	***Spring***	***Fall***	***Late Fall***	***Winter***	***Steelhead***
Keswick	ACID		■	■	■	■		■	■	■	■
ACID	Cow Creek	■	■	■	■	■	■	■	■	■	■
Cow Creek	Battle Creek	■	■	■	■	■	■	■	■	■	■
Battle Creek	Red Bluff		■				■	■	■	■	
Red Bluff	Deer Creek		■				■	■	■	■	

In developing the initial design for SacEFT, our intention was that each PM be a measure of habitat suitability *only*, and that for consistency with the PMs of other species, we try to avoid designs where one PM depended on another and which can therefore resemble population-based models. In general we have adhered to this principle; but where the linkage between closely related PMs seemed robust, we have in one case allowed WUA Spawning (CS1) to affect a subsequent indicator.

In addition to modeling each PM at specific locations, each species spawns according to a timing-relationship developed at the design workshop (Table 2.7). The duration and amounts shown in this table strongly resemble the timing relationships used by SALMOD (Figure 3 in Bartholow and Heasley (2006), derived from Vogel and Marine (1991)). Rearing relationships were originally part of the design, but these became superfluous once we incorporated temperature-based egg maturation from SALMOD. As a result of this emergence relationship, eggs from each day-cohort remain in the gravel until the temperature-driven emergence relationship predicts their maturation. The relationship we adopted is not strictly egg-maturation, but covers the period to free swimming emergence.

The six performance measures described here are necessarily simplistic and generally do not attempt to account for interactions that naturally occur. For example, redd dewatering, temperature-driven egg mortality and redd scour risk all occur during the incubation period and the processes together would predict a different outcome than each process taken alone. Additionally, the cross-sectional data used to parameterize the models of WUA-based performance measures are a snapshot in time of conditions in the mainstem, and mainstem habitat locations may change slowly or episodically as a result of meanders. Habitat is therefore assumed to be in an equilibrium state in which the spatial arrangement of particular habitats may change, but the segment-wide non-spatial proportions do not.

Calibrating the Chinook and Steelhead Models

To calibrate SacEFT Version 2 we used the same historical data used for the Version 1 calibration: empirically measured historical flow data and a mix of empirical and modelled upstream temperature data. These provide about 30 years (WY 1971-2003) of paired observations that are required to calibrate all the models, some of which depend on temperature (the shorter time series) which drives the timing of egg maturation for later life history PMs.

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Using these empirical historical data, up to 3 calibration measures are computed for some CS1, CS3, CS4 and CS6 (Spawning and Rearing WUA, Juvenile Stranding and Redd Dewatering) indicators:

1. **Daily Indicator Rating** – Daily ratings are computed separately for each run-type, making use of daily values from all reaches and years for the run-type. The PM values are then sorted from largest to smallest (*e.g.,* the population-proportion weighted square feet of Rearing WUA on each day in the case of CS2). Values that define the upper third and lower thirds of the sorted values are termed daily Hazard Threshold boundaries and are shown as horizontal [redacted]/Y/G lines on some of the Excel Reports. They give a system-wide daily comparison of how the PM score compares to other days and reaches. Consistently high (Green) days in a reach show that the reach contributes strongly to the PM's performance in a given year. Daily indicator ratings are never weighted across multiple reaches. Because they are close to raw measurements, intrinsic differences between reaches need to be considered when looking at daily ratings. For example, a reach may have intrinsically low Rearing WUA simply because it is shorter than another reach, and could show a lower (Yellow or [redacted]) daily rating compared to a reach with higher Rearing WUA.

2. Annual Indicator Rating – Annual summaries of the PM are computed separately for each run-type, pooling the daily values into combinations of year and reach for the reach-type. These values are sorted from largest to smallest and the terciles computed. This provides each reach with a Hazard Threshold boundary; a ranking of its PM relative to other reaches and years. These ranking data are stored as output, but are not currently used.

3. **Annual Rollup Indicator Rating** – Annual summaries of the PM are computed separately for each run type, taking the average value of all reaches within the year. These data are sorted and then graphed to create a cumulative distribution. Generally the distributions are fairly uniform and taking terciles is a reasonable default approach. In some situations there may be a marked discontinuity in the distribution and in these cases the discontinuity may be used as an alternative breakpoint. These alternative distributions can be seen by examining the annual roll-ups for the calibration data sets. In cases that use the tercile approach, the [redacted]/Y/G bars are evenly divided (or nearly so, given round-off). In cases that use discontinuities, the division is not even. In both cases however, comparison across matched scenarios (*e.g.*, calibration versus a management scenario) will show differences in the distribution of years. These differences can be used to infer changes in the system, relative to the calibration.

An example of the approach for the Annual Rollup Indicator is shown below (Figure 4.9) for steelhead CS6 – Redd Dewatering. The sorted distribution of the annual average of all reaches shows a fairly even slope with the possibility of some discontinuities. However, the terciles have been used to select the Indicator Rating boundaries.

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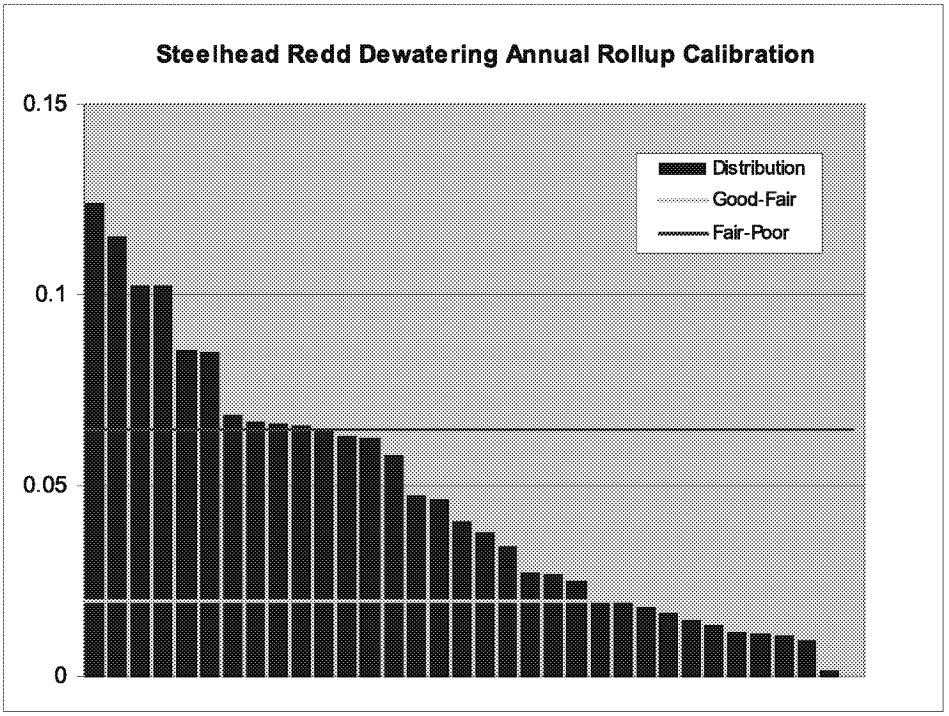

Figure 4.9. An example showing the distribution of the Redd Dewatering (CS6) index for steelhead trout based on the average annual value for all reaches, sorted by year from largest to smallest value. Similar graphs are created for all 3 temporal resolutions (daily, annual, and annual rollup) for 5 salmonid run-types for CS1, CS2 and CS6, a total of 60 graphs. Note that for this PM a lower value indicates a better condition: the green line is lower than the red line. For some PMs "more is better" and the lines are reversed.

Calibration of the CS3 and CS5 (Egg-to-Fry Thermal Mortality and Redd Scour) indicators follows a slightly different logic than the calibration of Spawning and Rearing WUA, Juvenile Stranding and Redd Dewatering. CS3 and CS5 are based on fixed Indicator Threshold boundaries such as % survival or 1-in-10 year flood flows. These differences are noted below in the descriptions of the individual PMs.

The calibration exercise affects the interpretation of all SacEFT outputs and assumes that the calibration period is the norm for the Sacramento system. While it provides a necessary benchmark, it should be borne in mind that if the calibration period is somehow abnormal ("very good", "very bad" "a time of extreme change," *etc.*), conclusions based on the benchmark will need to be critically examined. For PMs which are cued to absolute values like % survival, a poor benchmark causes fewer problems than PMs like redd dewatering which are often analyzed in a comparative way that hinges on the correct interpretation of changes in relative distributions.

CS1 – WEIGHTED USABLE AREA FOR SPAWNING

Spawning WUA is calculated using daily cohorts of spawners for each run-type and river segment. The historical or simulated gauges provide daily average flow *(Q)* over the spawning period *D* for each location *(l)* and run-type *(r)* combination[1].

[1] 'Run-types' are sometimes referred to as 'races.' We recognize four Chinook run-types and Steelhead trout as separate salmonid species.

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The *daily* performance measure is computed each day by interpolating the WUA-flow relationship – possibly modified by changes in substrate size composition from the TUGS model – $f(l,r,Q^*)$ to predict Weighted Usable Area (WUA, square feet). The PM accounts for spawning area only, and subsequent exposure to thermal mortality or redd dewatering is not included. Linear interpolation is used to calculate WUAs between the tabular values found in Gard's studies of spawning WUA (U.S. Fish and Wildlife Service 2003, 2005a).

The *rollup* PM is computed by averaging across all locations (L). It uses a 1/L average rather than a sum, so that system-wide thresholds are more meaningful should the number of locations vary across years and/or run-types, based upon the availability of the underlying flow and water temperature data.

$$CS1_r = \frac{1}{L}\sum_{l=1}^{L}\left(\frac{1}{D}\sum_{d=1}^{D} f(l,r,Q_d^*)\,w_d\right)$$

During the model review leading up to the release of Version 2, we considered using empirically driven measures of reach-usage (see "Field" columns in Table 4.7) to add further realism to the rollup. But a re-reading of U.S. Fish and Wildlife Service (2005b) makes it clear that this is not necessary: reach-weights from U.S. Fish and Wildlife Service (2003) were ***already*** incorporated in the study which produced WUA Spawning estimates for SacEFT Version 1. Moreover, estimates shown in Table 4.7 are based on 1989-1994 redd counts that preceded two very high flood events, and the WUA estimates developed by Gard (U.S. Fish and Wildlife Service 2005b) represent post-flooding conditions that changed substantially in the more downstream reaches, with downgraded habitat availability below Battle Creek.

Whichever WUA prediction model is incorporated, SacEFT assumes that WUA predictions are statistically stationary over time, an assumption that loses strength as simulation time periods move away from the time period of the field assessments that generated the underlying WUA curves. A comparison of "Field" and "SacEFT" Spawning WUA for three run-types shown in Table 4.7 shows fair agreement in most situations. SacEFT estimates reflect the dramatic change in available habitat below Battle Creek. No matching estimates are available for Spring Chinook or steelhead.

Table 4.7. 1989-1994 observations of field redd distribution (%) compared to simulated SacEFT Version 2 Spawning WUA (%) for three run-types.

Segment		Fall (%)		Late Fall (%)		Winter (%)	
Upper boundary	Lower boundary	Field	SacEFT	Field	SacEFT	Field	SacEFT
Keswick	ACID	9	8	24	20	2	25
ACID	Cow Creek	38	21	52	48	80	62
Cow Creek	Battle Creek	13	5	8	33	3	12
Battle Creek	Red Bluff	16	39	7	-	9	-
Red Bluff	Deer Creek	25	27	8	-	6	-

Breakpoints for the R/Y/G Indicator Ratings are taken using terciles of the sorted river-segment distribution for the daily and annual results, using discontinuities in the annual distribution for the rollup where those exist.

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Indicator Reliability

The indicator credibility rankings for CS1 are shown in Table 4.8.

Table 4.8. CS1 - Spawning WUA indicator credibility assignments following the workshop.

	Category				
	I	U	R	F	P
Winter-run Chinook		H	H	H	H
Spring-run Chinook		M	M	H	M
Fall-run Chinook		H	H	H	H
Late-fall-run Chinook		H	H	H	H
Steelhead		M	H	M	M/H

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Excel Reports

An example of the Version 2 Excel report is shown in Figure 4.10.

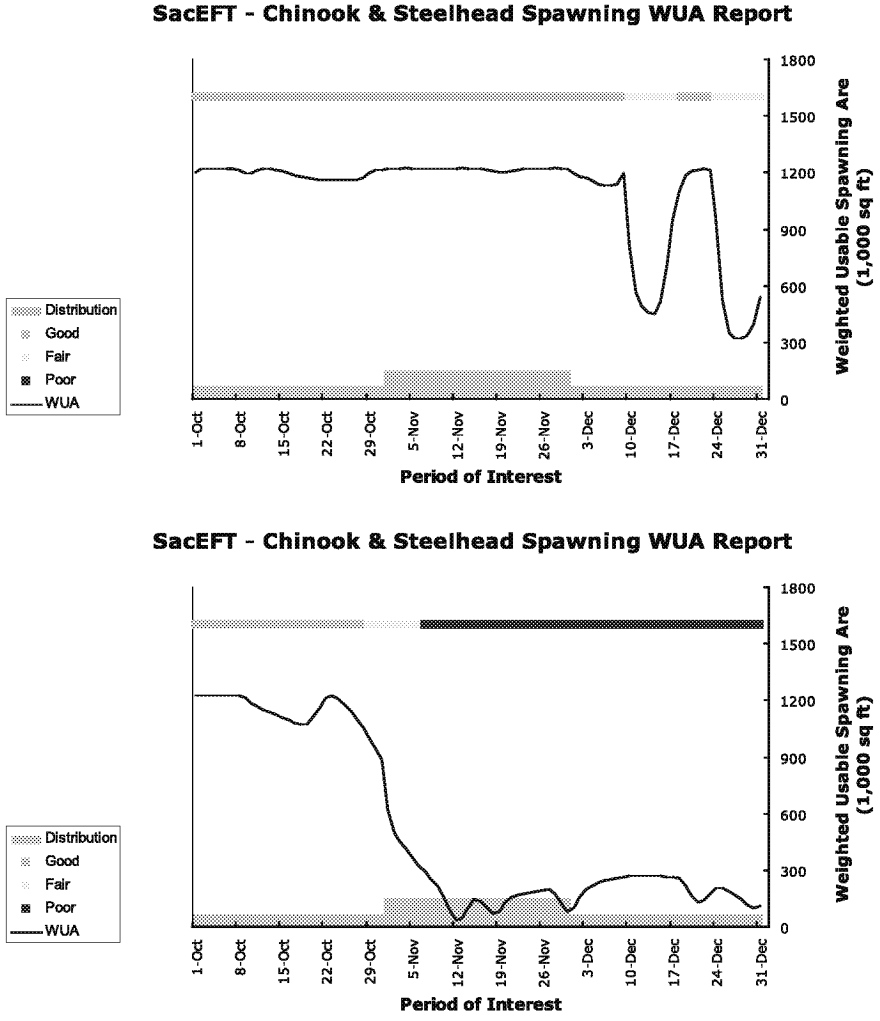

Figure 4.10. The CS1 – Spawning WUA daily Performance Measure as implemented in SacEFT Version 2. The upper and lower panels show results for fall-run Chinook in Reach 2 in 1969 and 1974: Good and Bad years respectively. In each panel, the horizontal R/Y/G bar shows the scoring of daily cohorts relative to the distribution of all day-cohorts over all years. To save space, the figure excludes a comparative graph of discharge which is produced as part of the Excel report. It also excludes an additional graph of field data showing redd proportion by reach for the period 1989-1994.

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Indicator Threshold Calibration

Based on model behavior using historical flow and temperature, the indicator rating thresholds for Spawning WUA are shown in Table 4.9. The indicator and its rating calibration have units of square feet of spawning habitat. The breakpoints for the *Daily Indicator* rating for each run-type are based on the estimated daily WUA over all reaches over all days of the spawning period, over all years. Typically, several thousand simulation observations contribute to the sorted daily WUA distribution. Run-types with longer spawning periods have a longer period to accumulate WUA and therefore have more observations and higher breakpoint values, other conditions being equal. The primary *Rollup Indicator* rating is based on a daily average across all reaches over all years, and there are typically a few dozen simulated observations for the distribution of this indicator; one for each simulation year.[1]

In the case of Spawning WUA, differences between the indicator rating breakpoints of the five run-types are notable, and can vary by a factor of 50. Besides differences in flow regime and substrate preferences, this large range is due to differences in the number of reaches and the length of the spawning periods amongst the run-types. The great difference in scales among run-types is part of the rationale for using independent breakpoints for each run. Readers are also reminded that the indicator is a measure of habitat potential (availability) and not a population of spawners or number of redds.

A preferred method for calibrating the indicator and categorizing annual variation across different hydrosystem scenarios is to identify historical years and run-types with Good or Poor performance. However, our repeated survey efforts of fisheries experts (e.g., Mark Gard, USFWS, *pers. comm.*; Matt Brown, USFWS, *pers. comm.*) and a questionnaire sent to fisheries biologists prior to the 2008 SacEFT Version 1 review workshop, revealed that there were no known synoptic studies of this kind for Spawning WUA. Because of this gap and the hesitancy of experts to reveal their opinions, we instead calculated the sorted distribution of weighted annual results and selected terciles (the lower-, middle- and upper thirds of the sorted distribution) as an initial reference to categorize the results.

Although this method provides an internally consistent way to compare results (*i.e.*, it will always provide a consistent ranking of which water management scenarios are "better" than others), it does not provide any concrete inferences about the biological significance of the three categories. For example, it is possible that a year that ranks as "Good" (Green)) with this method may still be biologically suboptimal. Conversely, a year that ranks as "Poor" ([redacted]) may be biologically insignificant. In the last column of Table 4.9 we attempt to flag cases where there are major gradients in performance indicator thresholds.

[1] We have also defined and calibrated an ***Annual Indicator*** rating based on calculating an average daily value for each reach. This indicator is calculated in SacEFT Version 2 and results are stored in the database, but are not currently presented in any of the output reports. For the Annual Indicator, the contribution of each daily value to the average is weighted by the proportion of the spawning population present on each day. Since a typical spawning period is about 100 days (see Table 2.7 for details), Annual Indicator thresholds for Spawning WUA are about 1% of the Daily Indicator thresholds, and there are typically about 100 simulated observations in the distribution, depending on the number of years and reaches available for simulation. The Annual and Rollup indicator ratings have a similar numerical ranges for each run-type, but are not identical, since the calculated breakpoints use observations of simulation results which are near, but hardly ever exactly identical for the 33% and 67% percentiles of the two sorted distributions.

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Table 4.9. CS1 - Spawning WUA indicator rating breakpoints used for Version 2.

	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Winter-run Chinook	430060	195486	2880	2475	• Criteria: statistical distribution, terciles, "more" is better • Units: square feet • Flow, spawning period, habitat preferences, affect distribution
Spring-run Chinook	607975	217913	5825	4775	
Fall-run Chinook	1006472	29967	8470	5500	
Late-fall-run Chinook	520424	280581	4250	2760	
Steelhead	18692	13447	135	106	

CS2 – WEIGHTED USABLE AREA FOR REARING

Rearing WUA is calculated using daily cohorts of juveniles after emergence, for each run-type and river segment. The historical or simulated gauges provide daily average flow (*Q*) and daily average temperature over the rearing residency period (*D*) for each location *(l)* and run-type *(r)* combination.

Daily juvenile rearing weights are notably different from daily spawning weights. In the case of rearing weight, each day-cohort is the result of the temperature-driven egg-emergence function instead of a deterministic spawning-calendar. This creates a linkage to the spawning performance measures CS1, with a delay between the day on which a cohort of eggs is spawned and the day on which the cohort emerges. Over the year the juvenile distribution is created by adding each daily juvenile cohort (c_e) from its date of emergence (e) using a run-type-dependent residence period (r) after emergence, with the variable r set to 90 days for all Chinook run-types and 365 days for steelhead. The proportion of juveniles (w_d) present on any given day (d) is therefore given as the sum of all emerged day-cohorts less than r days old:

$$w_d = \sum c_e \quad where\ (e \le d),\ and\ ((e + r - 1) \le d)$$

The emergence function makes it possible to have multiple spawning day cohorts emerge on the same day, particularly during periods of warming water. After emergence, each juvenile day-cohort is followed for a residency period of r days, providing an internally consistent way of evaluating both juvenile rearing WUA and juvenile stranding (CS4). Since emergence is driven by Accumulated Thermal Units (ATUs; see the CS3 description on pg. 63 for further information), this distribution will vary across locations and years due to location and temperature variations. After r days have elapsed, the day-cohort is no longer tracked. SacEFT does not track movement of cohorts between reaches, and during their residence period they are assumed to remain in the reach they were spawned.

The *daily* PM is computed by interpolating the WUA-flow relationship *f(l,r,Q)* (which for rearing does *not* vary with substrate composition) to predict Weighted Usable Area for rearing (WUA, square feet). Prior events such as thermal mortality or redd dewatering are not accounted for by this PM, which measures rearing area only. Linear interpolation is used to calculate rearing WUAs between the tabular values found in Gard's studies (U.S. Fish and Wildlife Service 2005b). As already noted, while each model operates internally on the basis of a daily cohort, the distributional and cumulative results shown in the Excel report portray the aggregated juvenile day-cohorts present each day and use that proportion to scale the Indicator Rating assigned to the WUA. This makes it possible to see daily changes to the entire population in the face of fluctuations in flow and temperature (see Figure 4.11), even though internally, each day-cohort is tracked separately.

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The *rollup* PM is computed by averaging across all locations (L). An average is used rather than a sum, so that thresholds are more meaningful should the number of locations vary across years and/or run-types, based upon the availability of the underlying flow and water temperature data.

$$CS2_r = \frac{1}{L}\sum_{l=1}^{L}\left(\sum_{d=1}^{D} f(l,r,Q_d)\,w_d\right)$$

Breakpoints for the R/Y/G Indicator Ratings are taken using terciles of the sorted river-segment distribution for the daily and annual results, and using discontinuities in the annual distribution for the rollup.

Indicator Reliability

The indicator credibility rankings for CS2 are shown in Table 4.10.

Table 4.10. CS2 – Rearing WUA indicator credibility assignments following the workshop. These ratings apply to those reaches of the Sacramento River where data have been directly acquired for the indicated run types (*i.e.,* depth, velocity, preference curves). If relationships derived from one reach are applied to another reach, both the U and R scores reduced, since the channel cross-section could lead to different curves of Rearing WUA vs. flow.

	Category			
	U	R	F	P
Winter-run Chinook	H	H	H	H
Spring-run Chinook	M	M	H	M
Fall-run Chinook	H	H	H	H
Late-fall-run Chinook	H	H	H	H
Steelhead	M	M	H	M

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Excel Reports

An example of the Version 2 Excel report is shown in Figure 4.11. The relative performance of a specific reach year can a compared with the historical range of Rearing WUA, by comparing the purple cumulative PM line to the vertical R/Y/G bar on the right of each graph. The vertical R/Y/G bar shows the distribution of annual rollup values across all years and reaches. The daily distribution is shown by the horizontal R/Y/G bar at the top of each pane.

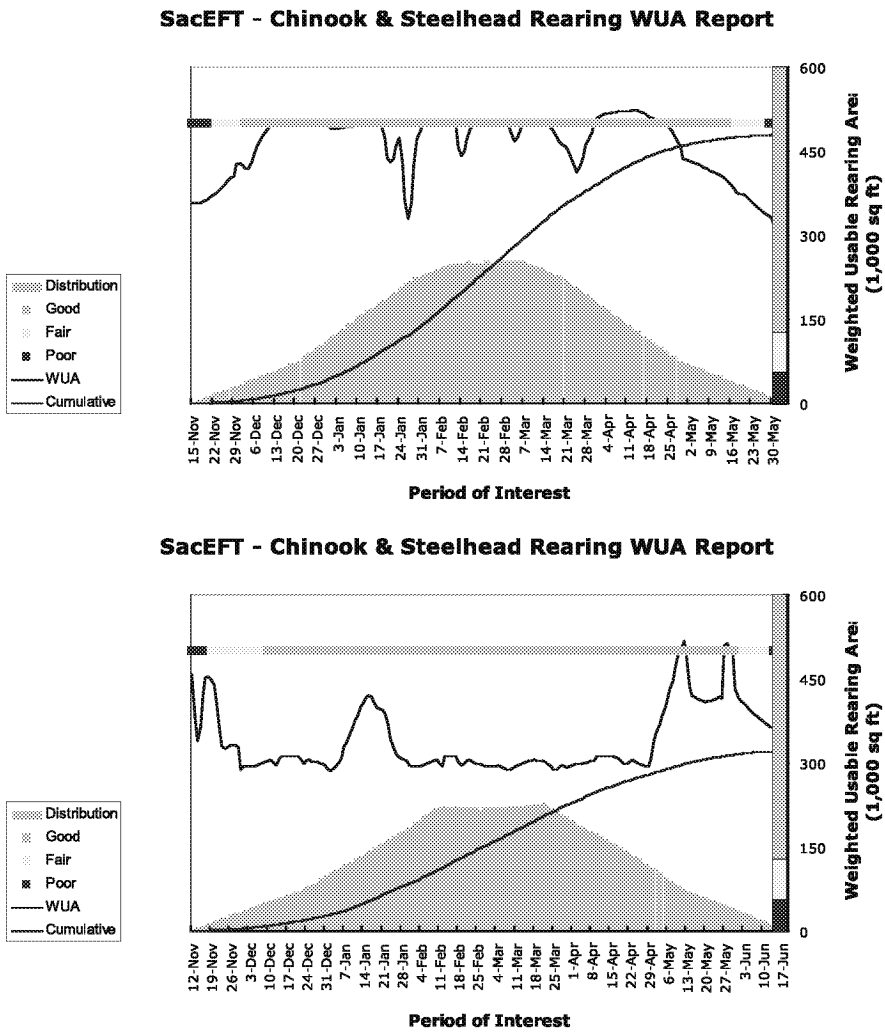

Figure 4.11. An example of the Version 2 Excel report for CS2 – Chinook juvenile rearing WUA using fall-run Chinook from Reach 5 in 1981 and 1982 in the upper and lower panels, respectively. The purple cumulative distribution lines show that Reach 5 receives a Good (Green) ranking relative to all reaches in both years. But because some other reaches scored poorly in one of the two years, ***system-wide*** 1981 was a Good (Green), while 1982 was a Bad (Red) year. To save space, the figure excludes a comparative graph of discharge which is produced as part of the Excel report.

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Indicator Threshold Calibration

Based on model behavior using historical flow and temperature, the indicator rating thresholds for Rearing WUA are shown in Table 4.11. The indicator and its rating calibration have units of square feet of rearing habitat. The breakpoints for the *Daily Indicator* rating for each run-type are based on the estimated daily WUA over all reaches over all days of the juvenile rearing period, over all years. For Rearing WUA, the observation for each simulation day is weighted by the proportion of the total population present in each day-cohort, meaning that days with more emerging juveniles are given more importance, but longer spawning and residency periods do not contribute to the magnitude of the indicator. Typically, several thousand simulation observations contribute to this sorted daily distribution. The primary *Rollup Indicator* rating has units of "sum of daily square feet" and is based on calculating a *cumulative* daily value for each reach, over the residency period (typically 90 days for Chinook and 365 days for steelhead (see Table 2.7 for details)) for each simulation year, and then taking the average value over all the reaches to produce an annual average value. The practice of using a cumulative total for this indicator leads to much larger indicator values for the Rollup, and there are typically a few dozen simulated observations for the distribution of this indicator; one for each simulation year.

In the case of Rearing WUA, there is about a two-fold range among the breakpoints of the five run-types. These differences are due to differences in the flow regime and number of reaches for each run-type. Difference in scales among run-types is part of the rationale for using independent breakpoints for each run. Readers are also reminded that the indicator is a measure of potential habitat (availability) and not a population of juveniles.

A preferred method for calibrating the indicator and categorizing annual variation across different hydrosystem scenarios is to identify historical years and run-types with Good or Poor performance. However, our repeated survey efforts of fisheries experts (e.g., Mark Gard, USFWS, *pers. comm.*; Matt Brown, USFWS, *pers. comm.*) and a questionnaire sent to fisheries biologists prior to the 2008 SacEFT Version 1 review workshop, revealed that there were no known synoptic studies of this kind for Rearing WUA. Because of this gap and the hesitancy of experts to reveal their opinions, we instead calculated the sorted distribution of weighted annual results and selected terciles (the lower-, middle- and upper thirds of the sorted distribution) as an initial reference to categorize the results.

Although this method provides an internally consistent way to compare results (*i.e.*, it will always provide a consistent ranking of which water management scenarios are "better" than others), it does not provide any concrete inferences about the biological significance of the three categories. For example, it is possible that a year that ranks as "Good" (Green)) with this method may still be biologically suboptimal. Conversely, a year that ranks as "Poor" ([redacted]) may be biologically insignificant. In the last column of Table 4.11 we attempt to flag cases where there are major gradients in performance indicator thresholds.

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Table 4.11. CS2 – Rearing WUA indicator rating breakpoints.

	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Winter-run Chinook	39675	10987	10250137	9997544	• Criteria: statistical distribution, terciles, "more" is better • Daily units: square feet • Rollup units: cumulative square feet • Flow, number of reaches affect distribution
Spring-run Chinook	109294	33678	24800719	19200148	
Fall-run Chinook	51872	20539	18341766	14048587	
Late-fall-run Chinook	47481	18283	13306025	11936239	
Steelhead	49501	14292	18160595	16361215	

CS3 – EGG-TO-FRY THERMAL MORTALITY

Temperature contributes to two opposing processes in SacEFT. Warmer water makes development faster through the temperature-maturation relationship discussed below, reducing the period of exposure to thermal (and other sources of) mortality. At the same time, development in warmer water produces higher thermal mortality.

Maturation is driven by Accumulated Thermal Units (ATUs) calculated from daily temperature. Following the model review workshop we enhanced the ATU calculation originally derived from SALMOD. Based on a review of Myrick and Cech (2010), Version 2 uses Chinook and rainbow trout (*Salmo gairdneri* = *O. mykiss*) relationships developed by Crisp (1981). Besides providing a unique set of steelhead coefficients, the coefficients adopted for Version 2 are also improved for Chinook, since those in Version 1 were interpolated from enlarged drawings found in the SALMOD documentation (Bartholow and Heasley 2006)[1], and those in Version 2 are taken directly from Crisp's models, where δ is the total days of egg development time at temperature T (°C) (see Figure 4.12):

$$\log_{10}\delta = -1.8126 \times \log_{10}(T+6) + 3.9166 \qquad \textbf{Chinook}$$

$$\log_{10}\delta = -2.0961 \times \log_{10}(T+6) + 4.0313 \qquad \textbf{Steelhead}$$

Proportion maturation per day is then the reciprocal of δ. The original SALMOD functions remain in the EFT model and can be used in a run scenario, if desired.

Given a development period determined by temperature, daily egg survival is calculated using daily egg cohorts over their development period (δ) following spawning, for each combination of location *(l)* and run-type *(r)*. Survival *s(T)* declines at warmer temperature (Table 11, Bartholow and Heasley 2006; see Figure 4.13). Chinook and steelhead use a ***common*** thermal mortality relationship, following Myrick and Cech (2010; see Figure TT.5 and TT.6), who conclude that any notion of run-type-specific mortality for steelhead is more closely related to what they term "genetic strains", and that the very wide range in mortality makes it very difficult to predict steelhead egg mortality with any precision.

[1] ***Note:*** Over the course of model development we also evaluated the USBR egg mortality model but later adopted SALMOD models since that model corrected some mathematical errors present in the USBR model we examined.

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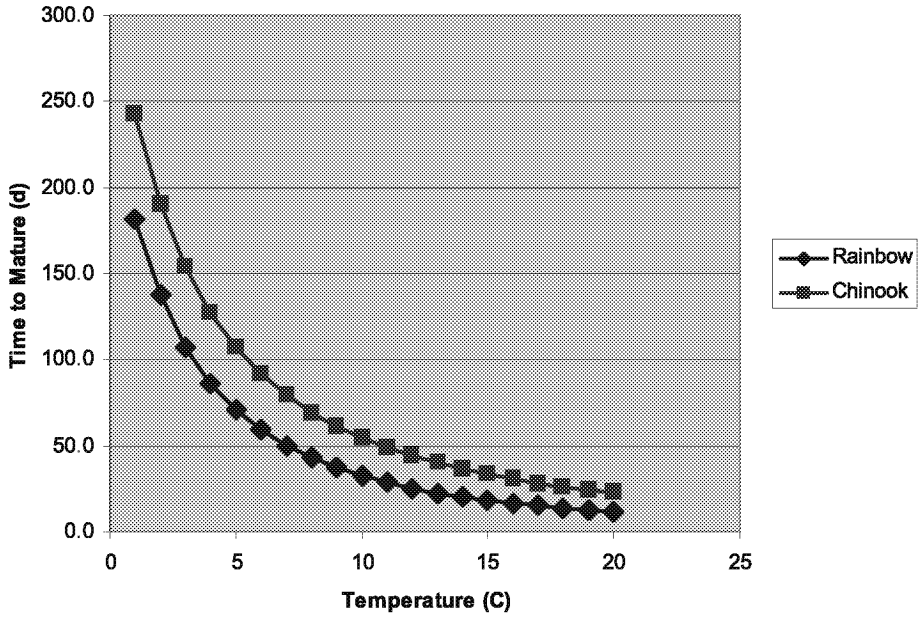

Figure 4.12 Based on relationships developed by Crisp (1981) for Chinook salmon and rainbow trout (= steelhead), eggs at a given temperature will mature in a corresponding number of days. The reciprocal of the number of days is the proportion of maturation occurring over one day, and the maturation period (δ) is complete when the cumulative proportion of daily maturation reaches 1.0.

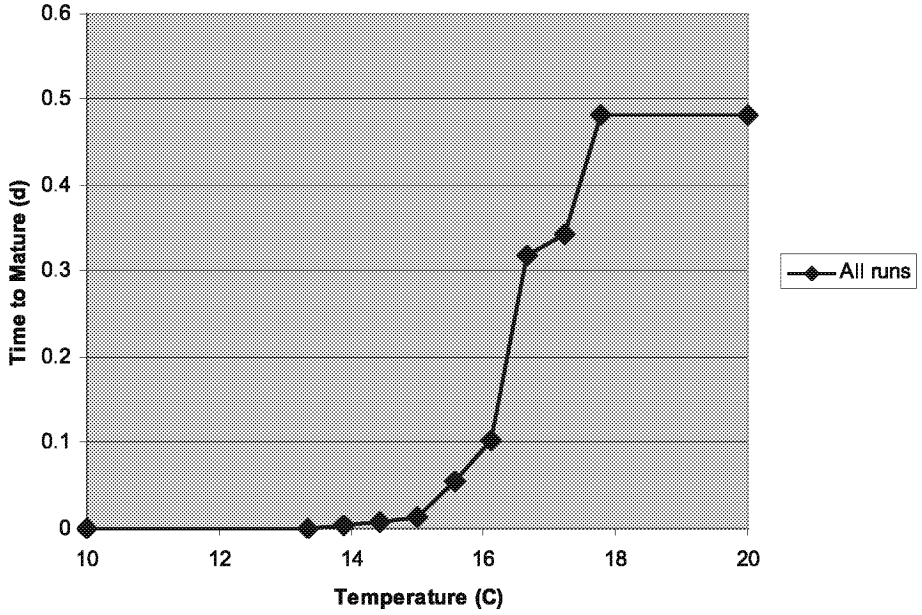

Figure 4.13 Daily thermal mortality is based on SALMOD relationships for all species (Bartholow and Heasley, 2006).

As noted above, longer egg development in colder water also increases the cumulative exposure to other potential mortality sources, a set of processes not accounted for in SacEFT. The influence of each day-cohort is expressed as the proportion (w_d) spawning each day over the egg development period. Unlike the Rearing WUA performance measure, which shows relative abundance of rearing salmonids, the Excel

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Report for egg survival portrays the spawning-day distribution only and not the relative abundance of in-gravel eggs.

The *daily* PM is calculated by following each spawning day-cohort over the course of its development up to emergence, evaluating its daily survival *s(T)* as a function of water temperature and taking the product of daily survival. Exposure to events such as redd dewatering are not accounted for by this PM, which calculates thermal mortality only:

$$CS3_{l,r,d} = \prod_{\delta} s(T)$$

The *rollup* PM is calculated by averaging over all river segments (L), weighting each segment by the using the average proportion of total spawning WUA (CS1) for the segment relative to the river-wide average Spawning WUA.

$$CS3_r = \sum_{l=1}^{L} \left(\frac{\overline{CS1}_{x,l}}{\overline{CS1}_x} \right) \left(\sum_{d=1}^{D} w_d \prod_{\delta} s(T) \right)$$

Indicator Reliability

The indicator credibility rankings for CS3 are shown in Table 4.12.

Table 4.12. CS3 – Egg thermal mortality indicator credibility assignments following the workshop.

	Category[1]				
	I	U	R	F	P
Winter-run Chinook		H	H	H	H
Spring-run Chinook		H	H	H	H
Fall-run Chinook		H	H	H	H
Late-fall-run Chinook		H	H	H	H
Steelhead		H	M	H	M/H

[1] see Table 2.3 for category definitions.

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Excel Reports

The Excel Report for Egg-to-fry Thermal Mortality (CS3) follows the style of the Rearing WUA (CS2) report shown in Figure 4.14, using a vertical bar to show the distribution of the annual rollup for the PM. Note that the orientation of the vertical [redacted]/Y/G bars are reversed in these two reports, since "more Rearing WUA" is better, but "more Thermal Mortality" is worse. The report shows two graphs. The upper panel shows the spawning-day distribution in gray, the incubation period mortality for each day cohort and the cumulative population mortality across all cohorts. The lower graph shows daily temperatures and R and Y thresholds for daily mortality. The x-axes are identical and span the first day of spawning to the last date of emergence. Note that the incubation period for a day-cohort is typically around 100 days and therefore the mortality for a day-cohort spawned on day *t* (and graphed on day *t*) can be high due to increased temperatures and higher mortality at a later date (for example day *t+50*).

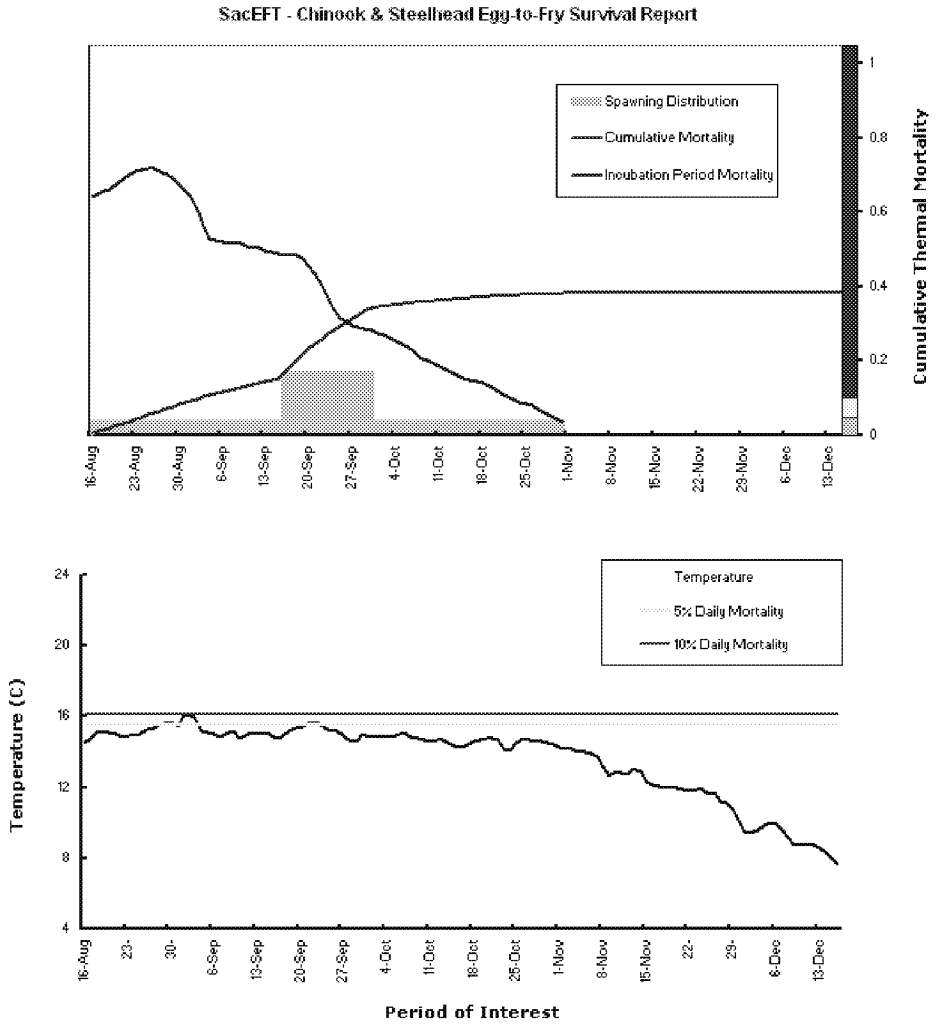

Figure 4.14. An example of the Version 2 Excel Report for CS3 – Egg-to-fry thermal mortality using spring-run Chinook from Reach 4 in 1988. System-wide this year was reported as a [redacted] year. To save space, the figure excludes some of the additional explanatory text that accompanies the Excel report.

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Indicator Threshold Calibration

Based on absolute mortality values of 5% and 10%, the Indicator Rating boundaries for Egg-to-fry thermal mortality are shown in Table 4.13. The same units and values are used for *Daily* and *Rollup* indicator ratings. The rationale for this choice of indicator at all scales is that it has an unambiguous meaning, in contrast to other indicators which are either more abstract, or are unit-free indices. Readers should note that 5% mortality at the Daily indicator scale means that 5% of the eggs spawned on that day and in that reach will die because of elevated temperature. At the Rollup level, the same number means that 5% of the entire multi-reach population of eggs will die in that year, due to elevated temperature.

The *Daily* indicator is calculated by accumulating thermal mortality over the egg-development period, which is determined by spawning day and water temperature, and differs for Chinook and steelhead. The *Rollup* indicator has the same units as the Daily rating, goes one step further and calculates an annual average across all reaches, using the relative amount of Spawning WUA in each reach to calculate a weighted average. There are typically a few dozen simulated observations for the distribution of this indicator.

A preferred method for calibrating the indicator and categorizing annual variation across different hydrosystem scenarios is to identify historical years and run-types with Good or Poor performance. However, our repeated survey efforts of fisheries experts (e.g., Mark Gard, USFWS, *pers. comm.*; Matt Brown, USFWS, *pers. comm.*) and a questionnaire sent to fisheries biologists prior to the 2008 SacEFT Version 1 review workshop, revealed that there were no known synoptic studies of this kind for Egg-to-fry thermal mortality. Neither are there universally accepted mortality levels – conceptually similar to LD_{50} values for pollutants – for measuring the impact of thermal mortality. Because of this gap and the hesitancy of experts to reveal their opinions, we instead chose arbitrary mortality breakpoints of 5% and 10% as initial reference points to categorize the results.

Although this method provides an internally consistent way to compare results (*i.e.*, it will always provide a consistent ranking of which water management scenarios are "better" than others), it does not provide any concrete inferences about the biological significance of the three categories. For example, it is possible that a year that ranks as "Good" (Green) with this method may still be biologically suboptimal. Conversely, a year that ranks as "Poor" ([redacted]) may be biologically insignificant. In the last column of Table 4.13 we attempt to flag cases where there are major gradients in performance indicator thresholds.

Table 4.13. CS3 – Egg-to-fry Thermal Mortality indicator rating breakpoints.

	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Winter-run Chinook	5	10	5	10	• Criteria: absolute values, "less" is better • Units: % mortality • Common threshold for all run-types
Spring-run Chinook	5	10	5	10	
Fall-run Chinook	5	10	5	10	
Late-fall-run Chinook	5	10	5	10	
Steelhead	5	10	5	10	

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CS4 – JUVENILE STRANDING

Juvenile stranding is modeled using daily declining changes in discharge *(Q)* over the juvenile rearing period *(D)* for each location *(l)* and run-type *(r)* combination. The daily distribution of rearing juveniles is based on the emergence function and the distribution (c_e) derived for juvenile rearing WUA (*i.e.*, from CS2). In the case of juvenile stranding the daily weight (w_d) is conditioned on events that take place as the cohort ages through the subsequent juvenile residency period. In particular, a daily cohort may experience losses (as described in the next section) when the flow declines from one day to the next. The cohort weight on a given day $c_{e,d}$ becomes:

$$c_{e,d} = \begin{cases} c_e \quad when\ (e \le d < (e+1)) \\ c_e\left(1 - \sum_{i=e+1}^{d-1} f(l, Q_{i-1}, Q_i)\right) \quad when\ (e < (d-1))\ and\ \ ((e+j-1) \le d) \\ 0.0 \quad otherwise,\ e.g.\ when\ ((e+j-1) < d < e) \end{cases}$$

By definition, no losses occur on the day a cohort emerges. If a drop occurs on the second day the loss is accounted for at the end of the second day, causing the cohort weight to decline on the third day (*e=1, d=3*). In SacEFT Version 2, Chinook juveniles reside in their natal reach for 90 days; steelhead for 365 days. Over this residency period, declining flows affect each day-cohort in a cumulative fashion. Based upon the formula above, the weight (w_d) for any given day is then assigned to the sum of all the cohort weights that are present on that day:

$$w_d = \sum c_{e,d}$$

The *Daily* indicator uses Gard's juvenile stranding research (U.S. Fish and Wildlife Service 2006b) to estimate the proportional decrease in habitat over the period between juvenile emergence and the end of the juvenile residence period. Mark Gard kindly made his raw results available to us so that his system-level tables could be disaggregated to the reach level used by SacEFT. Gard's results do not include time explicitly. Rather, his model estimates the proportion of rearing WUA lost (if any) at each location (*l*) between the day of emergence and the end of the residency period. Although run-types are modeled separately in SacEFT, they all use a single all-species flow-decline relationship. Based on discussions with Gard, we adapted this relationship in a way that is mathematically consistent with the original results, but which can be disaggregated to the daily scale of the juvenile stranding model. To calculate the daily PM, the model compares the previous day's flow, Q_{d-1}, and the flow on day Q_d. If there is a drop, then some proportion of juveniles are potentially stranded: $f(l,Q_{d-1},Q_d)$, and bilinear interpolation is used to calculate proportional losses between the tabular values found in Gard's tables (U.S. Fish and Wildlife Service 2006b).

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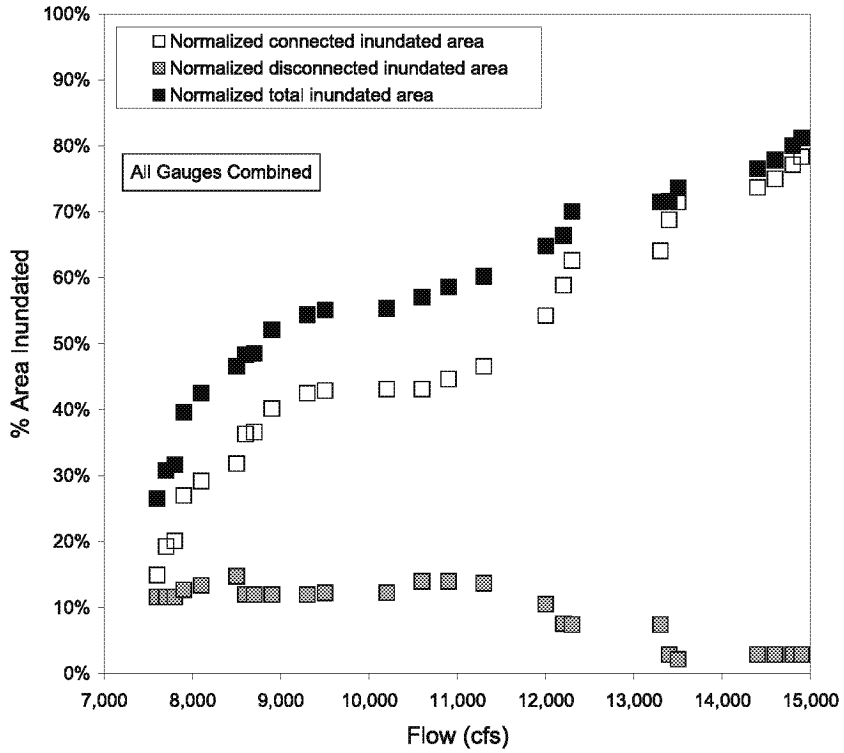

Figure 4.15. Normalized connected (white symbols), disconnected (gray symbols), and total inundated area (black symbols) averaged over all study sites for varying flows on the Sacramento River. Each site is normalized by the maximum potential inundated area, such that they each have equal weight in determining average percent inundated area. The stepped pattern of area versus flow highlights what appears to be a significant river-wide increase in inundated area at about 12,000 cfs. A significant decrease in inundated area appears to occur at roughly 8,500 cfs (Stillwater Sciences 2007; p. 33).

During the Version 1 model review workshop, the salmon sub-group agreed that while the structure of the indicator is good, its usefulness is constrained by the absence of stranding relationships ***below Red Bluff Diversion Dam***. Many juveniles are known to rear in these lower portions of the river and it would be useful to have stranding relationships for these locations as well as the more upstream segments. We explored pre-existing datasets from side channel studies described in the Stillwater Sciences (2007) (Figure 4.15). Mark Gard (USFWS, *pers. comm.*) has suggested that these might be adapted to the tabular model structure adopted for the U.S. Fish and Wildlife Service (2006b) report, and that the "normalized disconnected inundated area" from this figure corresponds most closely to the methodology used to estimate stranding at upstream locations. We compared the Stillwater range of data to Gard's and found that the flows shown in the Stillwater results are much higher than those measured in Gard's studies. This discontinuity makes it hard to see how downstream locations could be included in a comparable way. Even if this were possible, there is an additional data gap between 3,750 cfs (below which stranding will never be a problem) and 7,500 cfs, the lowest flow value shown in Figure 4.15. Thus, stranding relationships below Red Bluff Diversion Dam remain a model gap.

The daily proportional changes to rearing habitat create an *index* of stranding potential which is calculated by using the sum of proportions lost over the residency period, but which is not synonymous with the proportion of the juveniles lost. Because juveniles are mobile and may possess behaviors that help them avoid stranding (unlike eggs in redds), the use of an index of stranding potential is more appropriate, even though the underlying model measures declining fluctuations in rearing WUA.

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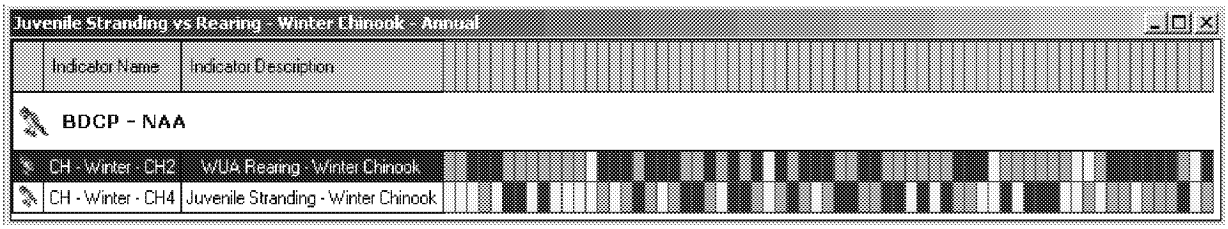
The *Rollup* indicator for juvenile stranding is calculated by taking the average across locations (L). An average is used rather than a sum, so that thresholds are more meaningful should the number of locations vary across years and/or run-types, based upon the availability of the underlying flow and water temperature data.

$$CS4_r = \frac{1}{L}\sum_{l=1}^{L}\sum_{i=1}^{D}(c_{i,D+1} - c_{i,D})$$

Breakpoints for the R/Y/G Indicator Ratings are taken using terciles of the sorted river-segment distribution for the daily and annual results, and using discontinuities in the annual distribution for the rollup.

Comment on Correlated CS2 and CS4 Behavior

In a review of 6 BDCP scenarios carried out with Version 2, an apparent negative correlation between juvenile rearing (CS2) and juvenile stranding (CS4) was reported for some run-types:



Our analysis found that the negative correlation arises from the fact that the amount of potential rearing habitat is used as an **input** to weight the impact of juvenile stranding, making it inevitable that as more habitat is created (regardless of the details of the daily flow regime and the exact nature of the flow-stage recession relationship) it exposes proportionally more juveniles to stage-flow recession events when they inevitably occur. Since increased WUA Rearing area results in a Green Indicator Rating while an increased Stranding Index results in a Red Indicator Rating, the two measures become negatively correlated. A more complete analysis of this negative correlation is found in Robinson (2010).

Indicator Reliability

The indicator credibility rankings for CS1 are shown in Table 4.14.

Table 4.14. CS4 – Juvenile stranding indicator credibility assignments following the workshop.

	Category			
	I	U	R	F	P
Winter-run Chinook		M/H	H	H	M/H
Spring-run Chinook		M/H	H	H	M/H
Fall-run Chinook		M/H	H	H	M/H
Late-fall-run Chinook		M/H	H	H	M/H
Steelhead		M/H	H	H	M/H

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Excel Reports

An example of the Version 2 Excel report is shown in Figure 4.16. The relative performance of a specific reach and year can a compared with the historical range of the Juvenile Stranding index, by comparing the purple cumulative PM line to the vertical R/Y/G bar on the right of each graph. The vertical R/Y/G bar shows the distribution of annual rollup Stranding values across all years and reaches. The daily distribution is shown by the horizontal R/Y/G bar at the top of each pane.

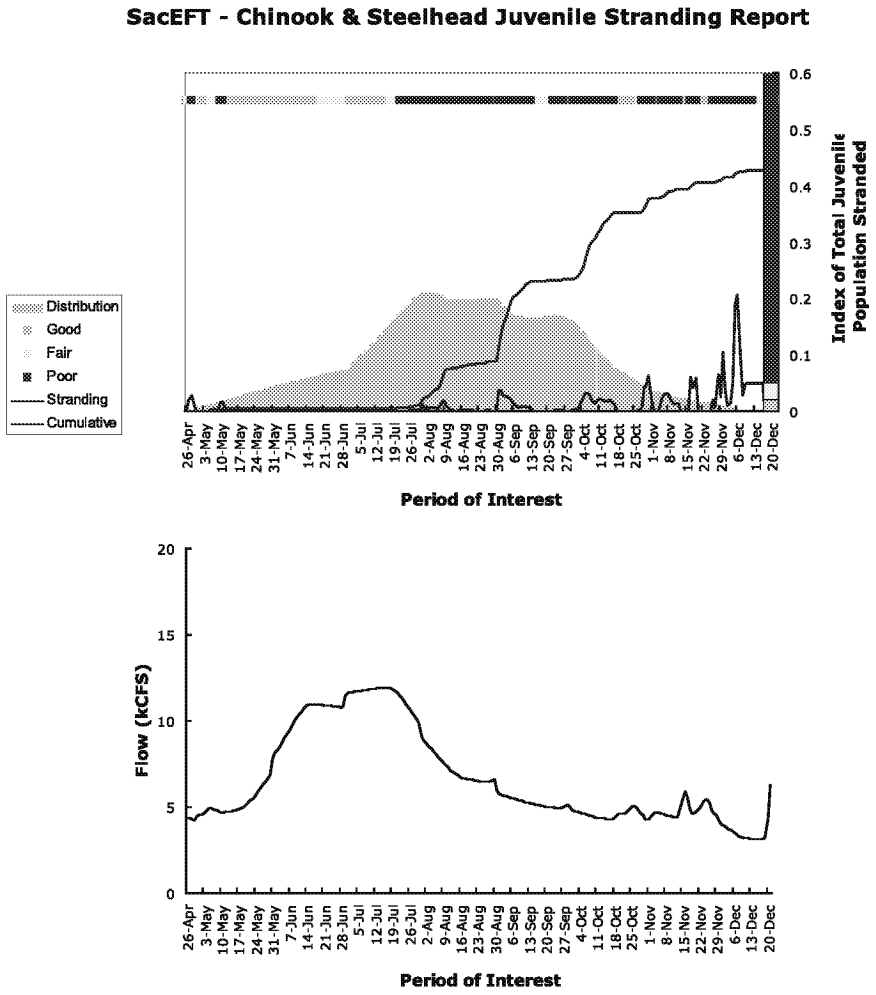

Figure 4.16. Excel Report for CS4 – Juvenile Stranding, showing winter-run Chinook in Reach 5 for 1979. The index is very sensitive to declining changes in flow, even though the discharge is quite low. The upper horizontal bar shows the index R/Y/G score relative to the daily scoring across all reaches and years; the vertical horizontal R/Y/G shows the cumulative distribution of the reach and year relative to the annual rollup distribution. The impact of stranding index upon the juvenile distribution can be seen in the quick declines of the bell-shaped gray distribution that accompany drops in flow, coupled to a sharp jump in the Stranding index.

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Indicator Threshold Calibration

Based on model behavior using historical flow and temperature, the indicator rating thresholds for Juvenile Stranding are shown in Table 4.15. The indicator and its rating calibration are treated as dimensionless index, although technically it is a sum of proportional changes in rearing area. The breakpoints for the *Daily Indicator* rating for each run-type are based on the estimated daily proportional change in rearing area over all reaches over all days of the juvenile rearing period, over all years. Each simulation day's observation is weighted by the proportion of the total rearing population present in each day-cohort, meaning that days with more juveniles are given more importance, with longer residency periods also contributing to the magnitude of the indicator. Typically, several thousand simulation observations contribute to this sorted daily distribution. The primary *Rollup Indicator* rating is also a dimensionless index, and is based on calculating a *cumulative* daily value for each reach, over the residency period (typically 90 days for Chinook and 365 days for steelhead (see Table 2.7 for details)) for each simulation year, and then taking the average value over all the reaches to produce an annual average value. The practice of using a cumulative total for this indicator leads to much larger indicator values for the Rollup, and there are typically a few dozen simulated observations for the distribution of this indicator; one for each simulation year.

In the case of Juvenile Stranding, there is about a two-fold range among the breakpoints of the five run-types. These differences are due to differences in the flow regime and number of reaches for each run-type. There are also some notable differences within run-types. For example, most run-types have lower and upper rollup thresholds that differ by about a factor of two (*e.g.,* 0.08 and 0.16 for winter-run Chinook). But in the case of late-fall Chinook, the difference in thresholds is much smaller (0.06 and 0.08), making the assignment more sensitive to small changes. The biological importance of this difference is unknown: it is simply a measure of the narrower historical range of fluctuations during the late-fall Chinook juvenile residence period. Difference in scales among run-types is part of the rationale for using independent breakpoints for each run. Readers are reminded that the indicator is a measure of potential habitat change (availability) and not a measure of actual stranding.

A preferred method for calibrating the indicator and categorizing annual variation across different hydrosystem scenarios is to identify historical years and run-types with Good or Poor performance. However, our repeated survey efforts of fisheries experts (e.g., Mark Gard, USFWS, *pers. comm.*; Matt Brown, USFWS, *pers. comm.*) and a questionnaire sent to fisheries biologists prior to the 2008 SacEFT Version 1 review workshop, revealed that there were no known synoptic studies of this kind for Juvenile Stranding. Because of this gap and the hesitancy of experts to reveal their opinions, we instead calculated the sorted distribution of weighted annual results and selected terciles (the lower-, middle- and upper thirds of the sorted distribution) as an initial reference to categorize the results.

Although this method provides an internally consistent way to compare results (*i.e.*, it will always provide a consistent ranking of which water management scenarios are "better" than others), it does not provide any concrete inferences about the biological significance of the three categories. For example, it is possible that a year that ranks as "Good" (Green)) with this method may still be biologically suboptimal. Conversely, a year that ranks as "Poor" ([redacted]) may be biologically insignificant. In the last column of Table 4.15 we attempt to flag cases where there are major gradients in performance indicator thresholds.

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Table 4.15. CS4 – Juvenile Stranding indicator rating breakpoints.

	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Winter-run Chinook	4.517E-05	3.528E-04	0.0804	0.1622	• Criteria: statistical distribution, terciles, "less" is better • Daily units: index • Rollup units: cumulative index • Flow, number of reaches affect distribution • *Late-fall-run may be more sensitive-responsive*
Spring-run Chinook	1.483E-04	8.852E-04	0.1472	0.2738	
Fall-run Chinook	1.083E-04	5.476E-04	0.1299	0.2161	
Late-fall-run Chinook	6.330E-05	2.249E-04	0.0654	0.0814	
Steelhead	9.964E-05	1.202E-03	0.1255	0.1845	

CS5 – REDD SCOUR

Redd scour risk is modeled using the daily proportion of eggs present by run type (r) and location (l) coupled to categorical hazard classes at times when flow exceeds user-configured threshold values. Threshold values that correspond to the 90th percentile of 10-year peak flow (75,000 cfs) and 80th percentile of 5-year peak flow (55,000 cfs) define the Fair/Poor and Good/Fair thresholds, respectively. The model couples these thresholds to each run-type's spawning distribution and uses the ATU-driven emergence function (see Figure 4.12) to create an aggregated egg distribution based on day-cohorts. In a final step, the daily weight is scaled by the relative daily proportion of spawning WUA at the given location, as is done for CS3. Thus, the daily proportion of redds (w_d) exposed to scour incorporates the joint influence of the original spawning distribution, temperature driven egg-development distribution and the proportion of total spawning WUA available in the reach.

Daily indicator values are calculated by multiplying the population-proportion weighted by daily flow. If flow is below the 55,000 cfs threshold, the daily indicator is given a value of zero. If flow exceeds the lower threshold, then the daily indicator is the product of the flow and the value (w_d) of the incubation distribution for that day and reach. Annual *Rollup* values are calculated by using a WUA-weighted average of the cumulative sum of daily weights across all reaches, for each simulation year.

Indicator Reliability

The PM scores shown in are generally lower than other salmonid PMs because they are based on more subjective opinions about scouring flow thresholds with no direct evidence. These scores are themselves only moderately quantitative, and are open to revision.

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Table 4.16. CS5 – Redd scour indicator credibility assignments following the workshop.

	Category				
	I	U	R	F	P
Winter-run Chinook		L/M	M	H	M
Spring-run Chinook		L/M	M	H	M
Fall-run Chinook		L/M	M	H	M
Late-fall-run Chinook		L/M	M	H	M
Steelhead		L/M	M	H	M

Excel Reports

An example of the Version 2 Excel report is shown in

Figure 4.17.

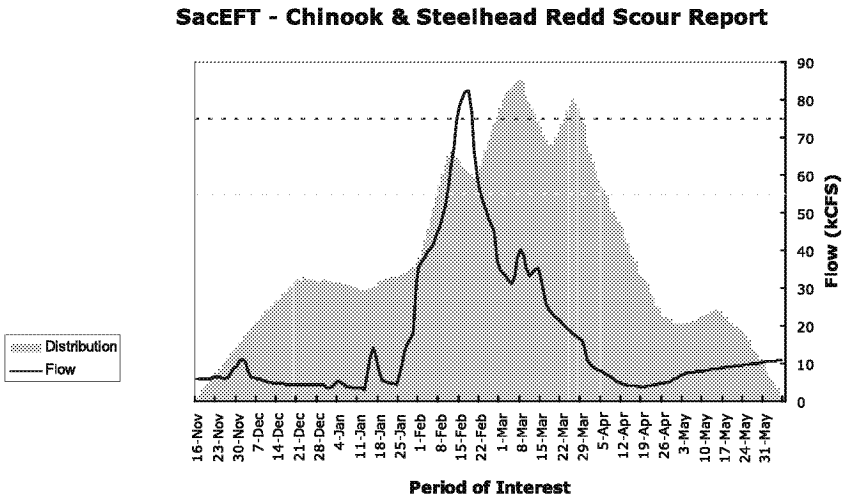

Figure 4.17. Excel Report for CS5 – Redd Scour risk, showing steelhead in Reach 4 for 1986. The Fair/Poor and Good/Fair thresholds are shown by dotted lines. System-wide, 1986 was a Poor year for steelhead scour risk.

Indicator Threshold Calibration

Based on model behavior using historical flow and temperature, the indicator rating thresholds for Redd scour are shown in Table 4.17. The units of the *Rollup* indicators are flow (cfs)[1]. The calibration process for the Redd Scour indicator is based on critical flow threshold values suggested by the salmonid subgroup at the Version 1 review workshop, of 55,000 cfs and 75,000 cfs. These two flows represent the 80th percentile of 5-year peak main stem flow and the 90th percentile of 10-year peak main stem flow respectively. When daily flow is less than 55,000 cfs, the indicator is given a value of zero. On days when eggs are present and flows exceed this lower threshold, the daily indicator is the product of the flow and a weight given by the proportion of the total egg population present in each day-cohort. In this way, days with a higher proportion of eggs are given more importance, and longer spawning runs can potentially

[1] A *Daily* indicator is calculated for Redd Scour is calculated and stored in the SacEFT database, but is not currently displayed. This indicator is derived from the terciles of the sorted daily distribution of weighted flow, over all run-types, reaches and years.

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expose the run-type to a wider range of flows. Daily weighted flows are subsequently processed using a set of flow-based rules. At the peak of the egg-distribution, a flow event above 75,000 cfs (*i.e.*, with a high daily indicator value from the product of flow and weight) is sufficient to give a Poor assignment to the year. In addition, years with more than 2 days of flow between 55,000 and 75,000 cfs are also assigned to the Poor class. Years with high flows in the tails of the distribution are assigned as Fair years, and all other years are considered Good. By iteratively adjusting the thresholds and evaluating the frequency of Bad years, rollup thresholds were set to 5,000 (Good/Fair) and 10,000 (Fair/Poor) cfs.

Historical - Redd Scour - Roll-Up

Indicator Name	Indicator Description	Create Report	Multi-Year Rollup	% Poor	% Worrisome	% Good	All Data Shown
VERSION 2 CALIBRATION RUN (HISTORICAL)							
CH - Fall - CH5	Redd Scour - Fall Chinook	☐		33	0	61	✓
CH - Late Fall - CH5	Redd Scour - Late Fall Chinook	☐		26	0	74	✓
CH - Spring - CH5	Redd Scour - Spring Chinook	☐		0	0	100	✓
CH - Winter - CH5	Redd Scour - Winter Chinook	☐		3	3	94	✓
ST5	Redd Scour - Steelhead	☐		22	0	78	✓

Figure 4.18. Annual Rollup report for CS5 – Redd Scour risk, showing results for all calibration years (1970-2001) and all run-types.

The Redd Scour risk indicator has no threshold differences among run-types at the Rollup scale. The rationale for this behavior is that scour is a physical process; that run-types which spawn during periods of high flow are likely to experience greater exposure to scour, and that these inherent physical risks should be reflected in the indicator, much the same way that thermal mortality should affect some run-types more than others. Using these thresholds, results for the historical scenario are shown in Figure 4.18. They shows that Spring-run Chinook are intrinsically less sensitive to redd scour compared to Fall-run Chinook, which experience high risk flows about every 3 years. Averaged over all run-types, 81% of years are Good, fewer than 1% are Fair, and 18% are Poor. A preferred method for calibrating the indicator and categorizing annual variation across different hydrosystem scenarios is to identify historical years and run-types with Good or Poor performance. However, our repeated survey efforts of fisheries experts (e.g., Mark Gard, USFWS, *pers. comm.*; Matt Brown, USFWS, *pers. comm.*) and a questionnaire sent to fisheries biologists prior to the 2008 SacEFT Version 1 review workshop, revealed that there were no known synoptic studies of this kind for Redd Scour risk. Because of this gap and the hesitancy of experts to reveal their opinions, we instead adopted the heuristic indicator described above, to categorize years with extreme flow events.

Although this method provides an internally consistent way to compare results (*i.e.*, it will always provide a consistent ranking of which water management scenarios are "better" than others), it does not provide any concrete inferences about the biological significance of the three categories. For example, it is possible that a year that ranks as "Good" (Green)) with this method may still be biologically suboptimal. Conversely, a year that ranks as "Poor" (Red) may be biologically insignificant.

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Table 4.17. CS5 – Redd scour indicator rating breakpoints.

	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Winter-run Chinook	N/A	N/A	5000	10000	• Criteria: calibrated to 80% Good years, "less" is better • Units: index flow (cfs) • No daily estimate • Common physical threshold for all run-types • *Very low risk for spring-, winter-runs*
Spring-run Chinook	N/A	N/A	5000	10000	
Fall-run Chinook	N/A	N/A	5000	10000	
Late-fall-run Chinook	N/A	N/A	5000	10000	
Steelhead	N/A	N/A	5000	10000	

CS6 – REDD DEWATERING

Redd dewatering is modeled using daily declining changes in discharge *(Q)* over the egg development period for each location *(l)* and run-type *(r)* combination to calculate estimates of proportional redd losses. The dewatering model tracks the daily proportion of spawned eggs based on each spawning day cohort (c_s) up to the day of its temperature-driven emergence (e). The weight of a spawning day cohort on any day ($c_{s,d}$) is based upon the original spawning cohort weight, c_s, conditioned on dewatering events that may take place as the egg-cohort matures through the egg development period and as flow may decline from one day to the next. The cohort weight on a given day $c_{s,d}$ becomes:

$$c_{s,d} = \begin{cases} c_s \quad when\ (s \le d < (s+1)) \\ c_s\left(1 - f(l,r,Q_s,Q_{d-1})\right) \quad when\ (s < (d-1))\ and\ up\ to\ emergence\ (d < e) \\ 0.0 \quad otherwise,\ e.g.\ when\ (d < s)\ or\ (d \ge e) \end{cases}$$

By definition, no losses occur on the day an egg cohort is spawned. If a drop occurs on the second day the loss is accounted for at the end of the second day, causing the cohort weight to decline on the third day ($e=1,d=3$). Over the egg-development period, declining flows affect each spawning day-cohort in a cumulative fashion. Based upon this formula above, the river-segment weight (w_d) for any given day is the sum of all the cohort weights present on that day:

$$w_d = \sum c_{s,d}$$

In a final step, the daily weight is further scaled by the relative daily proportion of spawning WUA at the given location. Thus, the weight (w_d) incorporates the joint influence of the original spawning distribution, temperature driven egg-development distribution and the proportion of total spawning WUA available in the river segment.

The model makes use of Gard's redd dewatering research (U.S. Fish and Wildlife Service 2006b), which estimates proportional decrease in redds over the period between spawning and the emergence of juveniles. Mark Gard kindly made his raw results available to us so that his system-level tables could be disaggregated to the segment level used by SacEFT. Gard's results do not include time explicitly. Rather, his model estimates the proportion of spawning redds lost (if any) at each location (l) between the time a day-cohort is spawned (c_s) and the end of the cohort's egg development period. Gard's tabular results include fall- and winter-Chinook salmon and steelhead trout only, and relationships for spring- and late-

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fall Chinook salmon are mapped from fall-run Chinook. Based on discussions with Gard, we adapted this relationship in a way that is mathematically consistent with the original results, but which can be disaggregated to the daily scale of the dewatering model. If there is no decline in flow then no loss occurs. To calculate the daily PM, the model compares the previous day's flow, Q_{d-1}, and the flow on day Q_d. If there is a drop, then some proportion of eggs are potentially dewatered: $f(l,Q_{d-1},Q_d)$, and bilinear interpolation is used to calculate proportional loss the tabular values found in Gard's tables (U.S. Fish and Wildlife Service 2006b).

To calculate a *Daily* performance measure, the model finds the proportion of incubating eggs lost to declines in flow during the egg-development phase of each spawning day cohort, summing all of the cohort's individual losses occurring on that day:

$$CS6_{l,r,d} = \sum_{i=1}^{d} (c_{i,d+1} - c_{i,d})$$

Summing losses on previous days gives cumulative losses up to and including day (d):

$$CS6_{l,r,d} = \sum_{p=1}^{d} \sum_{i=1}^{d} (c_{i,p+1} - c_{i,p})$$

The *Rollup* indicator is based on taking the cumulative loss, summed across locations (L). Because of the way that the cohort weight incorporates the proportional spawning WUA, the rollup PM represents the percentage of redds dewatered for all reaches:

$$CS6_{r} = \sum_{l=1}^{L} \sum_{p=1}^{D} \sum_{i=1}^{D} (c_{i,p+1} - c_{i,p})$$

Breakpoints for the R/Y/G Indicator Ratings are taken using terciles of the sorted river-segment distribution for the daily and annual results, sometimes using discontinuities in the annual distribution for the rollup.

Indicator Reliability

The PM reliability rating for redd dewatering is shown in Table 4.18. The lower rating for spring and late fall Chinook is due to the absence of direct observation for those run-types. Reliability scores are equally high because the data are drawn from studies that have been subject to peer review, and because the functional relationships are being applied within the same reaches, but to different runs.

Table 4.18. CS6 – Redd dewatering indicator credibility assignments following the workshop.

	Category			
	I	U	R	F	P
Winter-run Chinook		H	H	H	H
Spring-run Chinook		M	H	H	M/H
Fall-run Chinook		H	H	H	H
Late-fall-run Chinook		M	H	H	M/H
Steelhead		H	H	H	H

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Excel Reports

An example of the Version 2 Excel report for Redd Dewatering is shown in Figure 4.19. The amount of dewatering in a specific reach and year can be compared with the historical range of redd dewatering by comparing the purple cumulative PM line to the vertical R/Y/G bar on the right of each graph. The vertical R/Y/G bar shows the distribution of annual rollup values across all years and reaches. The daily distribution is shown by the horizontal R/Y/G bar at the top of each pane.

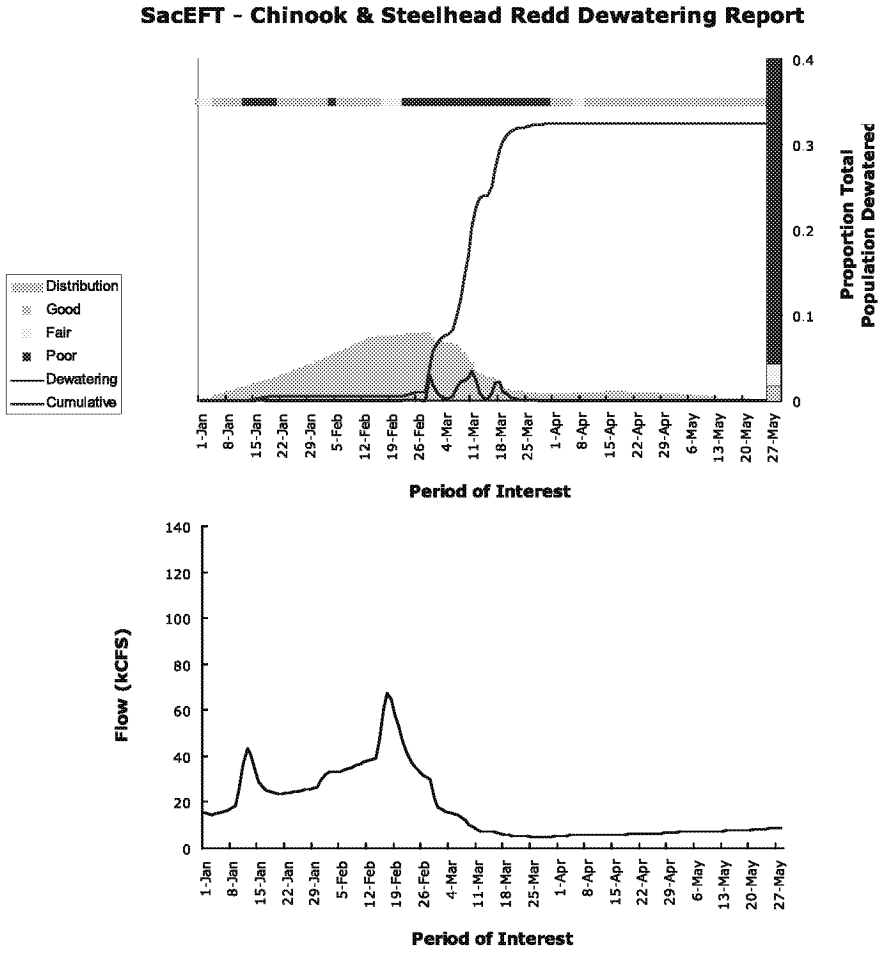

Figure 4.19. Excel Report for CS6 – Redd dewatering showing late-fall-run Chinook in Reach 4 for 1980. The index is sensitive to declining changes in flow. The upper horizontal bar shows the index R/Y/G score relative to the daily scoring across all reaches and years; the vertical horizontal R/Y/G shows the cumulative distribution of the reach and year relative to the annual rollup distribution. The impact of dewatering upon the egg distribution can be seen in the decline of the bell-shaped gray distribution that accompanies drops in flow and the sharp pulse of high dewatering index.

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Indicator Threshold Calibration

Based on model behavior using historical flow and temperature, the indicator rating thresholds for Redd Dewatering are shown in Table 4.19. The indicator and its rating calibration are treated as dimensionless index, although technically it is a sum of proportional changes in spawning area. The breakpoints for the *Daily Indicator* rating for each run-type are based on the estimated daily proportional change in WUA spawning area over all reaches over all days of the egg development period, over all years. Redd dewatering is similar in some ways to juvenile stranding, but because eggs remain fixed in the spawning redd and are not mobile, the details of the calculation of cumulative dewatering differ slightly from the calculation of juvenile stranding (CS4). Each simulation day's observation is weighted by the proportion of the total egg population present in each day-cohort, meaning that days with more developing eggs present are given more importance, with longer spawning periods and development times also contributing to the magnitude of the indicator. Typically, several thousand simulation observations contribute to this sorted daily distribution. The primary *Rollup Indicator* rating is also a dimensionless index correlated with mortality risk, and is based on calculating a *cumulative* daily value for each reach, over the egg development period for each simulation year, and then taking the average value over all the reaches to produce an annual average value. The practice of using a cumulative total for this indicator leads to much larger indicator values for the Rollup, and there are typically a few dozen simulated observations for the distribution of this indicator; one for each simulation year.

A preferred method for calibrating the indicator and categorizing annual variation across different hydrosystem scenarios is to identify historical years and run-types with Good or Poor performance. However, our repeated survey efforts of fisheries experts (e.g., Mark Gard, USFWS, *pers. comm.*; Matt Brown, USFWS, *pers. comm.*) and a questionnaire sent to fisheries biologists prior to the 2008 SacEFT Version 1 review workshop, revealed that there were no known synoptic studies of this kind for Redd Dewatering. Because of this gap and the hesitancy of experts to reveal their opinions, we instead calculated the sorted distribution of weighted annual results and selected terciles (the lower-, middle- and upper thirds of the sorted distribution) as an initial reference to categorize the results.

Within run-types, the lower and upper rollup thresholds differ by about a factor of two (*e.g.,* 0.05 and 0.09 for the fall-run Chinook rollup). These differences are due to differences in the flow regime and number of reaches for each run-type. But comparison across run-types shows that there is about a five-fold range among the breakpoints of the five run-types. Comparison across run-types shows an obvious limitation of the statistical approach to creating threshold boundaries. For example, the Good/Fair rollup boundary for winter-run Chinook is about 15% that of steelhead: 0.015 compared to 0.10.

Since the Redd Dewatering indicator is an index that should be highly correlated with potential egg loss, it might be more sensible to establish indicator rating thresholds that are mortality-like and not distributional. Reasonable choices for such boundaries remain an open question, however. Although the distributional method provides an internally consistent way to compare results (*i.e.*, it will always provide a consistent ranking of which water management scenarios are "better" than others), it does not provide any concrete inferences about the biological significance of the three categories. For example, it is possible that a year that ranks as "Good" (Green)) with this method may still be biologically suboptimal. Conversely, a year that ranks as "Poor" ([redacted]) may be biologically insignificant. In the last column of Table 4.19 we attempt to flag cases where there are major gradients in performance indicator thresholds.

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Table 4.19. CS6 – Redd dewatering indicator rating breakpoints. Units are population-proportion-weighted redd dewatering index for Daily resolution; cumulative for the Annual and Rollup scales

	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Winter-run Chinook	3.976E-06	4.042E-05	0.02	0.03	• Criteria: statistical distribution, terciles, "less" is better • Daily units: proportion stranded • Rollup units: cumulative proportion stranded • Flow, spawning period, habitat preferences, affect distribution • *Very low risk for winter-run* • *Higher sensitivity for Late-fall run Chinook*
Spring-run Chinook	6.184E-05	7.333E-04	0.07	0.13	
Fall-run Chinook	1.597E-05	1.910E-04	0.05	0.09	
Late-fall-run Chinook	1.336E-05	1.846E-04	0.12	0.22	
Steelhead	1.181E-05	1.428E-04	0.10	0.17	

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4.3.2 Green sturgeon

The salmonid conceptual model is shown in Figure 4.20. Readers are referred to ESSA Technologies Ltd. (2005) for details on the development of this model and the decisions that led to its current structure.

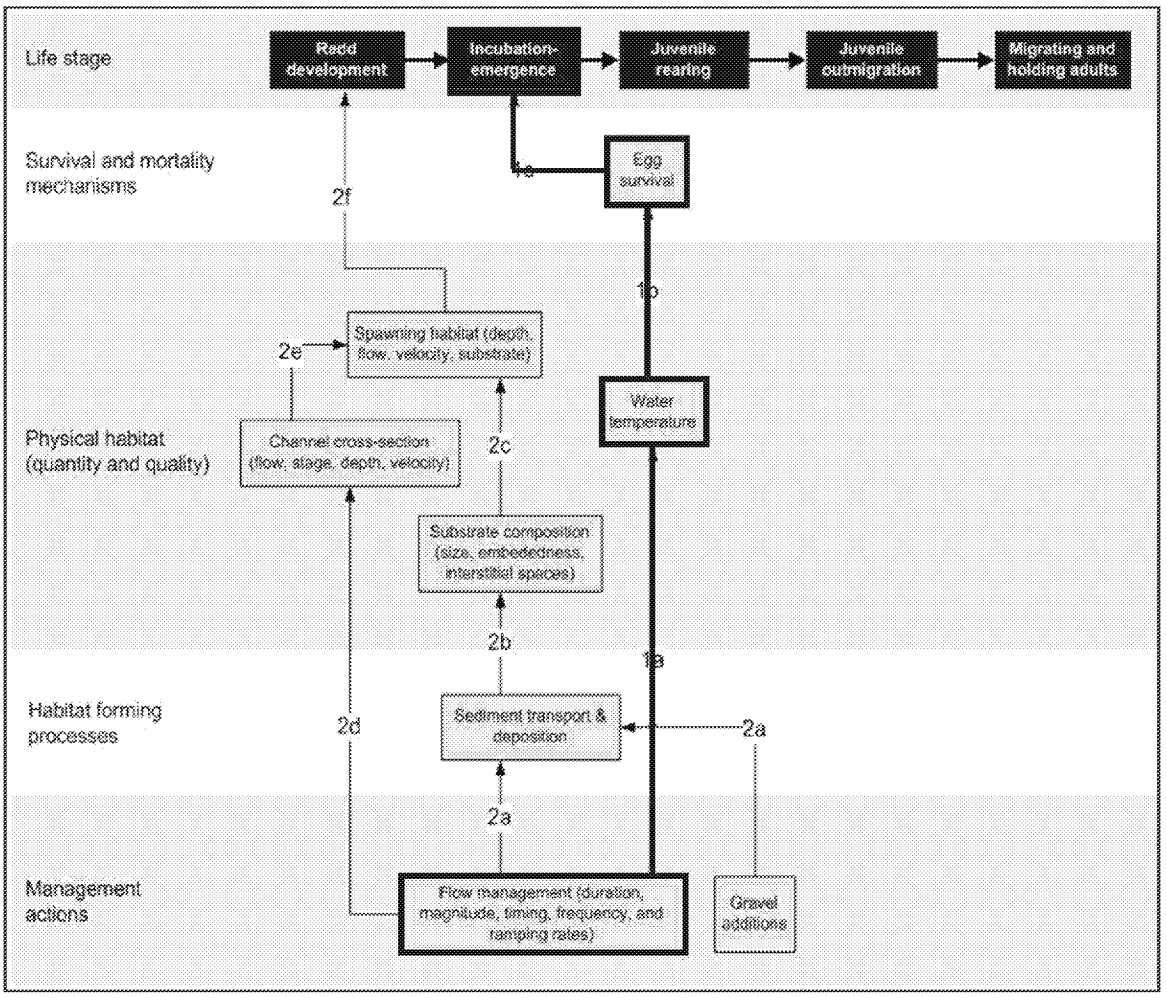

Figure 4.20. The green sturgeon conceptual model. Heavy lines show the processes and linkages that are currently implemented. See ESSA Technologies Ltd. (2005) for additional context and detail on processes and linkages shown here.

The impact of water temperature on green sturgeon eggs is modeled using daily changes in temperature over the egg development period at each location. From the daily average temperature, estimates of exposure to the hazard of warm water are modeled using two temperature breakpoints: 17^0C and 20^0C, to mark temperature excursions into zones of moderate and high risk. Each day the model tracks spawned eggs over a fixed development period of 14 days, tracking each day-cohort separately. The simplicity of the model stems from the lack of information about temperature-based mortality and uses the categorical grouping created by Cech *et al.* (2000) to assign "healthy", "moderate" and "lethal" outcomes. Other measures of green sturgeon life history (*e.g.*, flow-habitat; juvenile entrainment; fishing and poaching, discharge-migration cues) were found to be lacking in quantitative knowledge and therefore are not included in SacEFT v.2.00.

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Following the model review workshop the habitat scoring rule was modified so that it approximates a temperature-mortality relationship with full survival below 17°C and complete mortality above 20°C, with linear interpolation between these two temperatures. Daily cohort survival above 95% is scored as Good for the year-cohort; survival between 90-95% is scored as Fair, and survival lower than 90% is ranked as 'Poor.' A recommendation that Vina be included as a third possible spawning location was deferred, since simulated temperature data below RBDD were not yet considered reliable.

The *annual* PM at each location is the most frequent outcome for each location, with each day's Indicator Rating contribution weighted by the spawning distribution weight (w_d) for the day.

The *rollup* PM is calculated by combining the daily PMs across all locations over the spawning and development period, with the contribution of each day's Indicator Rating weighted by the spawning distribution weight (w_d) for the day.

Indicator Reliability

The PM reliability rating for green sturgeon thermal egg mortality is shown in Table 4.20. The low ratings reflect the uncertain linkage between laboratory studies of egg maturation with field observations of larval development.

Table 4.20. GS1 – Green sturgeon indicator credibility assignments following the workshop.

	Category				
	I	U	R	F	P
GS1 – Thermal Egg Mortality		M	M	H	M

Excel Reports

The Excel Report for Green Sturgeon thermal egg mortality (GS1) follows the style of the style of the Salmonid thermal mortality (CS3) report, using a vertical bar to show the distribution of the annual rollup for the PM (Figure 4.21). The report shows two graphs: the upper panel shows the spawning distribution in gray, the incubation period mortality for each day-cohort and the cumulative population mortality across all cohorts. The lower graph shows daily temperatures and R and Y thresholds for daily mortality. The x-axes are identical and span the first day of spawning to the last date of emergence.

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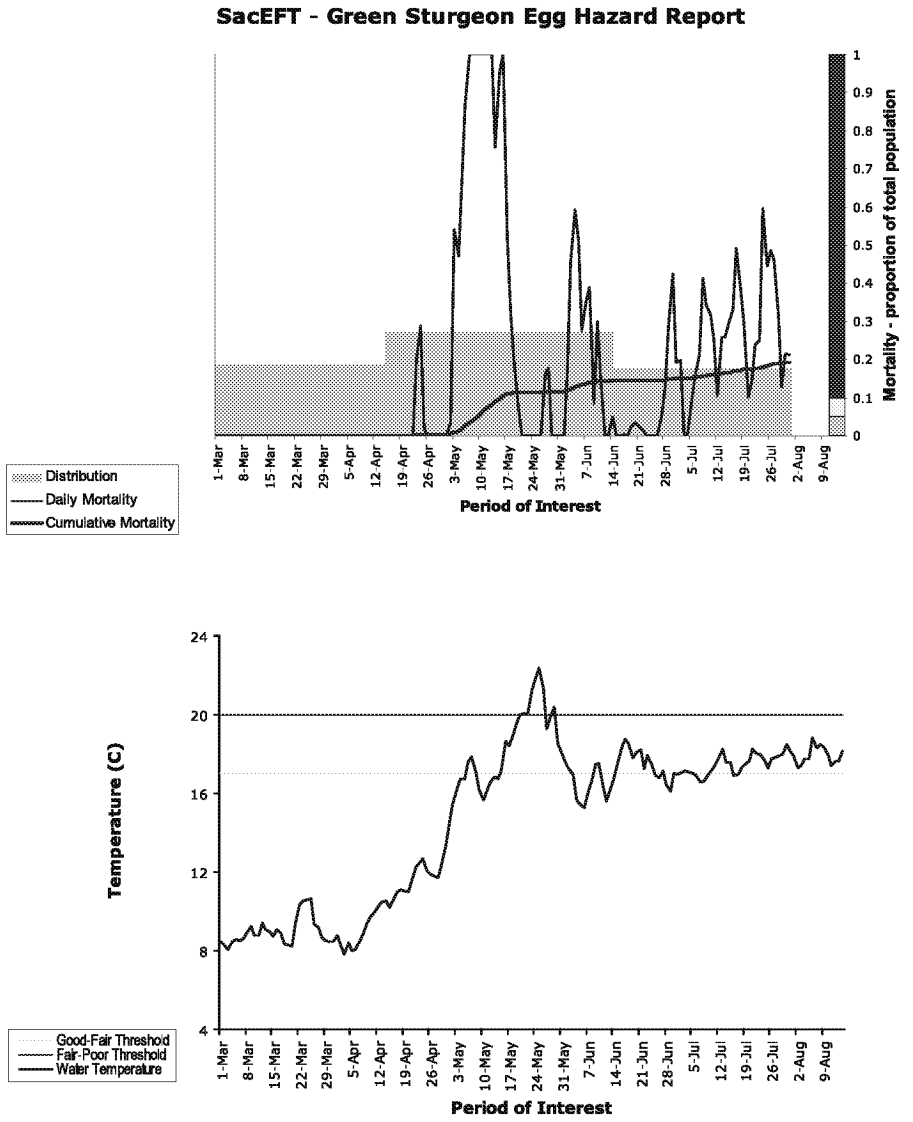

Figure 4.21. Excel Report for GS1 – Green sturgeon egg hazard for location GS1 (Hamilton City) in 1982. The vertical horizontal R/Y/G shows the cumulative mortality. The lower panel shows water temperature with the Good-Fair and Fair-Poor thresholds.

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Indicator Threshold Calibration

Based on absolute mortality values of 5% and 10%, the Indicator Rating boundaries for thermal egg mortality are shown in Table 4.21. The same units and values are used for *Daily* and *Rollup* indicator ratings. The rationale for this choice of indicator at all scales is that it has an unambiguous meaning, in contrast to other indicators which are either more abstract, or are unit-free indices. Readers should note that 5% mortality at the Daily indicator scale means that 5% of the eggs spawned on that day and location will die because of elevated temperature over their 14 day development period. At the Rollup level, the same number means that 5% of the entire multi-reach population of eggs will die in that year, due to elevated temperature.

The *Daily* indicator is calculated by accumulating thermal mortality over the 14 day egg-development period, which is determined by spawning day and water temperature. The *Rollup* indicator has the same units as the Daily rating, goes one step further and calculates an annual average across all reaches, for all simulation years, using the equal weighting for all locations to calculate a weighted average. There are typically a few dozen simulated observations for the distribution of this indicator.

A preferred method for calibrating the indicator and categorizing annual variation across different hydrosystem scenarios is to identify historical years and run-types with Good or Poor performance, or to include robust studies of temperature-based mortality. Our efforts of survey fisheries experts through a questionnaire sent to fisheries biologists prior to the 2008 SacEFT Version 1 review workshop, revealed that there were no known synoptic studies of this kind for green sturgeon thermal mortality. Neither are there universally accepted field mortality levels – conceptually similar to LD_{50} values for pollutants – for measuring the impact of thermal mortality. The best information we were able to use is based on *in vitro* studies (Cech *et al.* 2000) of larval development, which we adapted to create a quasi-mortality model in which larvae experience no mortality at temperatures below 17°C and complete mortality at temperatures at and above 20°C. Added to this simple model and the hesitancy of experts to reveal their opinions, we instead chose arbitrary mortality breakpoints of 5% and 10% as initial reference points to categorize the results.

Although this method provides an internally consistent way to compare results (*i.e.*, it will always provide a consistent ranking of which water management scenarios are "better" than others), it does not provide any concrete inferences about the biological significance of the three categories. For example, it is possible that a year that ranks as "Good" (Green) with this method may still be biologically suboptimal. Conversely, a year that ranks as "Poor" ([redacted]) may be biologically insignificant. In the last column of Table 4.13 we attempt to flag cases where there are major gradients in performance indicator thresholds.

Table 4.21. GS1 – Thermal egg mortality indicator rating breakpoints. Units are % Mortality and are intentionally held constant across all temporal scales. Annual and Rollup scales incorporate population-proportion weights.

	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Thermal Egg Mortality	5	10	5	10	• Criteria: absolute values, "less" is better • Units: % mortality

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4.3.3 Bank swallow

The bank swallow conceptual model is shown in Figure 4.22 . Readers are referred to ESSA Technologies Ltd. (2005) for details on the development of this model and the decisions that led to its current structure.

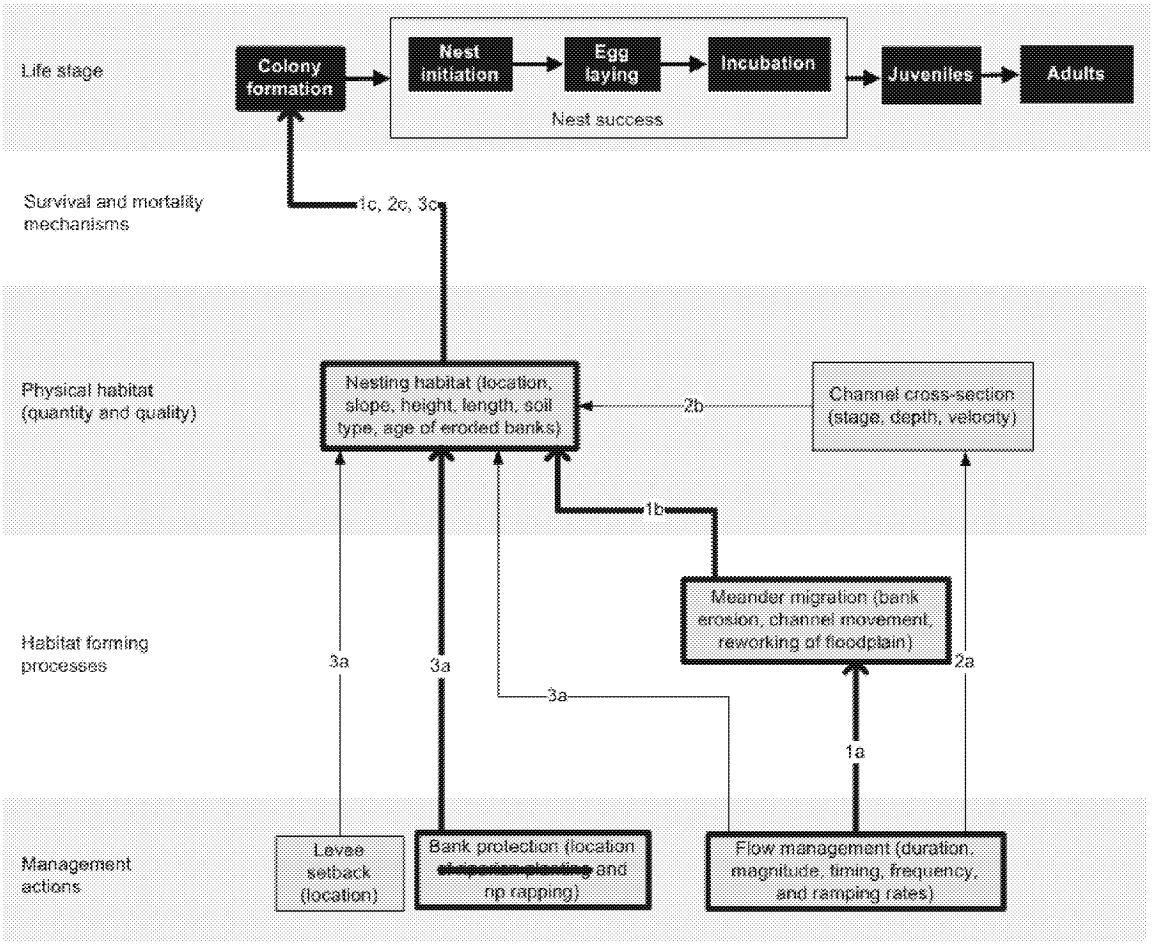

Figure 4.22. The bank swallow conceptual model. Blue heavy lines show the processes and linkages that are currently implemented.

SacEFT includes two performance measures (PMs) that describe changes in the physical habitat available for bank swallow nesting success. Prime bank swallow nesting habitat is limited to friable soils in vertical bank faces (Garrison 1998a, 1999). These bank and soil characteristics render nesting habitat susceptible to collapse when undercut by the river during high flows. Minor bank sloughing can degrade habitat quality by reducing bank slope and creating debris piles below nesting sites. Erosive processes such as lateral river migration are therefore periodically necessary in order to create new nesting habitat with steep slopes and fresh surfaces for new nests (Garrison 1999). Two performance measures describe changes in the physical habitats available for bank swallow. The first of these (BASW1) provides an annual estimate of the weighted useable length of newly eroded bank for nesting. The second of these provides daily estimates of the potential for bank sloughing during the nesting period, with high flows creating a high potential for bank failure (BASW2).

The models used to generate BASW1 and BASW2 are based on Garrison's (1989) habitat suitability index (HSI) model and refinements proposed by Stillwater Sciences (SWS) in its Sacramento River

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Linkages Report (Stillwater Sciences 2007). Of the four variables identified in Garrison's model – soil texture, bank slope, bank height, and bank length – and the additional four variables identified by Stillwater Sciences (2007) – distance to nearest grassland, bank age, peak flow during nesting period, and stage increase above base flow during the nesting period – only **newly eroded bank length** and **peak flow during nesting** were available for incorporation into SacEFT v.2.00, and are the key components of the BASW1 and BASW2 performance measures.

Although they reflect the best available information at SacEFT's spatial scale, it is clear that these two PMs are a very simplified picture of the factors affecting the quality and quantity of bank swallow habitat. For example, because the model has no memory of flow over time, the BASW2 indicator is not able to capture the possible cumulative effects of changes in discharge, nor the role of bank height in predicting bank sloughing.

BASW1 – Bank Swallow Habitat Potential/Suitability

Based on previous studies (*e.g.*, references cited in Stillwater Sciences 2007), the functional relationship for Bank Swallow habitat potential is based on three factors:

1. the length of bank erosion;
2. time since a major erosion event (defined as horizontal erosion ≥1m); and
3. the length of this erosion that is in soils of suitable type.

Based on feedback from the Bank Swallow Technical Advisory Committee[1] regarding the observation of bank length of less than 10 m being important habitat, it was decided to model only the second and third factors. Consequently, a weighted useable length (WUL, measured in meters) – or habitat potential – is calculated for each bank segment based on two weighting factors: years since last major erosion event (w_e) and soil suitability (w_s):

$$WUL_b = w_e \times w_s \times L_b$$

A conceptual example for the BASW1 Habitat Potential indicator is shown in Figure 4.23.

[1] February 2011 review presentation

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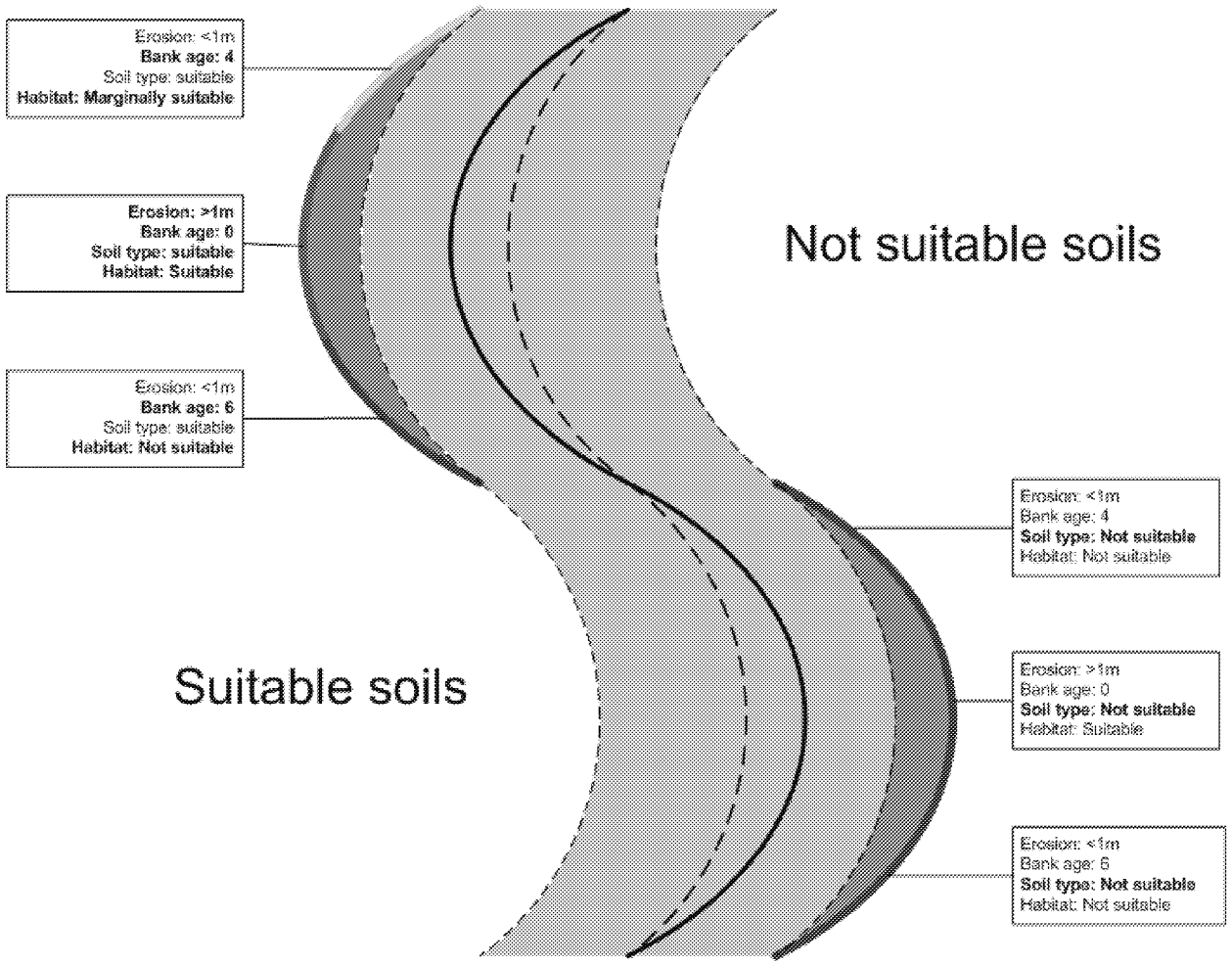

Figure 4.23. Conceptual example for the BASW1 Habitat Potential (or WUL) indicator. Note that all banks on the right hand side are not suitable because of soils, whereas the bank of the left hand side illustrates the effect of different bank ages. See text for details.

Biophysically, the need for periodic renewal of nesting habitat is dictated by the progressive decline in burrow quality due to erosion that reduces bank slopes (and thus provides easier access for predators) and infestation by fleas and other nest ectoparasites. Most of the colonies in the Sacramento valley are used for no more than 7 consecutive years in the absence of a major erosion event (see Stillwater Sciences 2007). After three years, habitat suitability drops rapidly because of high levels of ectoparasites and little room for new nests (Stillwater Sciences 2007). Recent research (Heneberg 2009) suggests that bank swallows will also abandon soils that become too hard to penetrate due to increased soil compactness with age.

The desired frequency of horizontal erosive events ≥1m for habitat renewal is about once every 3 years (*i.e.*, it does not need to occur annually). The SacEFT *BASW1* habitat potential indicator also takes into consideration that burrows can be reused for up to 3 years without significant renewal taking place. Additionally, the model is capable of accounting for cumulative erosion events over multiple years. Based on discussions at the SacEFT refinements workshop (ESSA Technologies Ltd. 2008a), the functional relationship for habitat potential in response to depth of horizontal erosion is a linear decay function where newly eroded banks (*i.e.,* horizontal erosion ≥ 1m) receive a habitat suitability index of 1. Habitat potential declines linearly each year until year 3, after which habitat potential/suitability is zero for those bank areas that have not experienced a major erosion event (see Figure 4.24).

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A major erosion event is defined as a horizontal erosion depth ≥1m. Erosion less than 1m deep is considered contributing to reduced bank slopes by bank sloughing. The time since last major erosion event ($t_{erosion}$) is defined as the number of years since the bank was eroded to a depth of at least 1m within a single year.

The weighting scheme for the time component reflects habitat degradation in the absence of a major erosion event:

$$w_e = \begin{cases} 1 & when\ (t_{erosion} < 3 years) \\ 1 - \dfrac{t_{erosion} - 3}{2} & when\ (3 years \le t_{erosion} < 5 years) \\ 0 & when\ (t_{erosion} \ge 5 years) \end{cases}$$

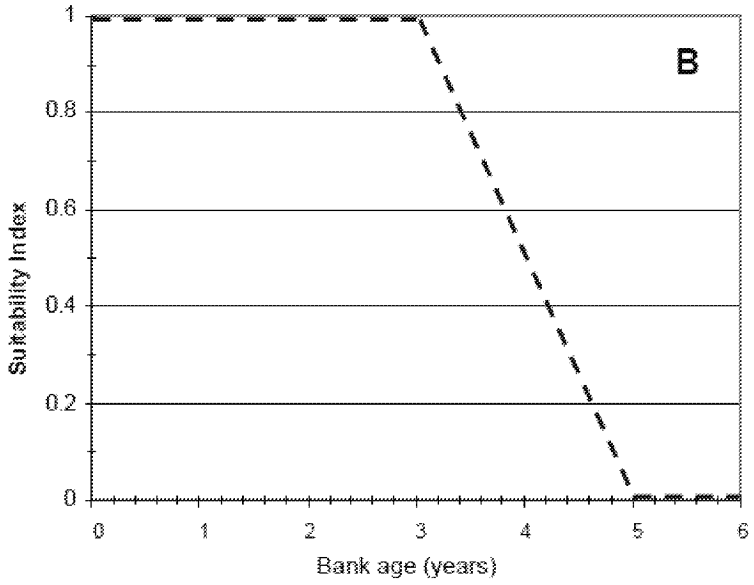

Figure 4.24. Habitat Potential vs. bank age (time since last major bank erosion event). Habitat decreases rapidly after 3 years because of ectoparasites. Most of the colonies in the Sacramento valley are used for no more than 7 consecutive years in the absence of erosion (see Stillwater Sciences 2007).

The bank age ($t_{erosion}$) is calculated based on the location of the current and the previous year's banks as simulated by the bank erosion model (see Section 4.1.6). Any bank segments that are more than 1m away from the previous year's banks are considered renewed in the current year and are assigned a bank age of zero. If the bank segment has not been renewed, the bank age is calculated as the age of the nearest banks from the previous year plus one year (see Figure 4.25 for an example).

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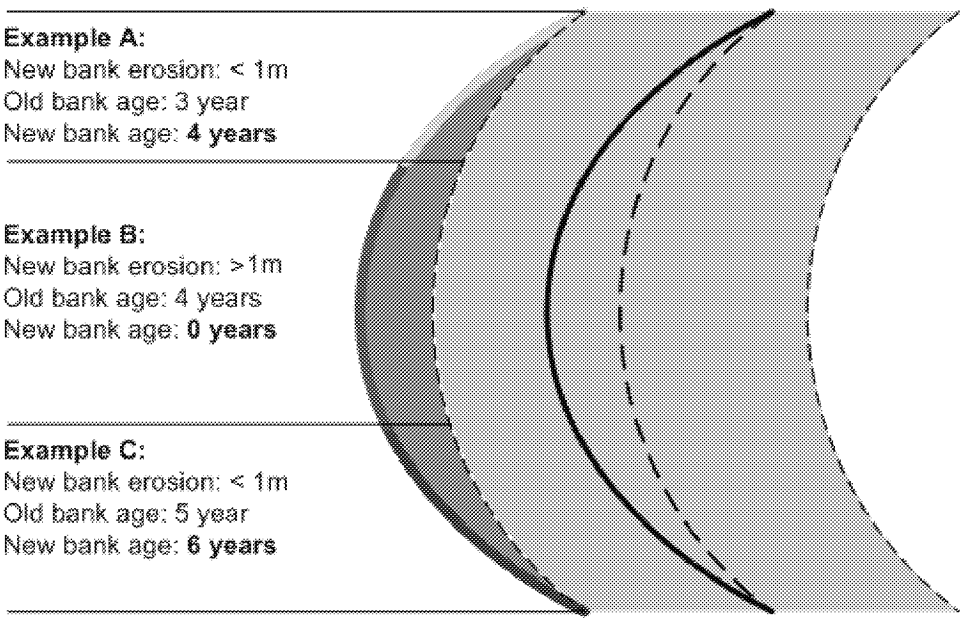

Figure 4.25. Bank age example. If the bank segment has been eroded more than 1m, the new bank age is always 0, see 'B'. If the bank segment has not been eroded this year, the new bank age is calculated as age of the nearest old bank + 1 year, see 'A' and 'C'. Note that the new bank segment in 'A' is now considered marginal habitat according to the weighting scheme, whereas the bank segment in 'C' is no longer suitable.

Not all soils are suitable for bank swallow burrows. Bank swallows prefer banks with soft sand or sandy loam soil (Garrison 1999). Furthermore, recent fieldwork has indicated that Bank swallows may also utilize the local vertical bank stratification to select favorable burrow location, *e.g.,* Bank swallows have been found in the field to burrow into coarse soils between lenses of silt that then function as the 'roof' and 'ceiling' of the burrow (Dean Burkett, Natural Resources Conservation Service, *pers. comm.* 2011). SacEFT's BASW1 soil suitability component is based on SSURGO soil data (Natural Resources Conservation Service 2011). The soils were divided into 4 categories based on the dominant soils near the Sacramento River: Gianella loams, Columbia loam, Riverwash and other soils. Based on communication with Dean Burkett, highlighting some of the limitations in the resolution of SSURGO soil data, it was decided that it is not currently possible to assign different weights to these four soil types with the current data, and it would be preferable to consider only 2 classes: suitable ($w_s = 1$) and unsuitable ($w_{est} = 0$). Based on field observations, Columbia Loam and Gianella Loams are considered suitable ($w_{Columbia}$, $w_{Gianella} = 1$) and riverwash and other soils are considered unsuitable ($w_{Riverwash}$, $w_{Others} = 0$). We recognize that soil data give only a snapshot in time, *i.e.,* they represent the river banks in a single year, whereas the bank observations cover almost a decade, during which the river banks have moved.

The length of bank in each soil type is determined in a GIS by overlying the bank locations simulation by the bank erosion model with the soil data (see Figure 4.26).

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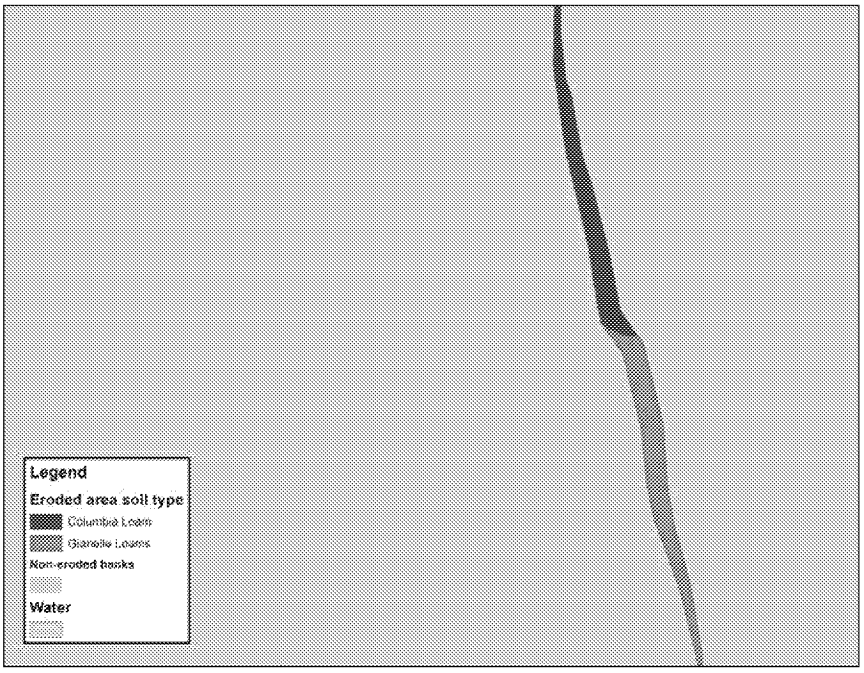

Figure 4.26. Conceptual example of eroded bank area divided into soil types.

The *annual* PM for BASW1 sums the weighted length of eroded bank across all river segments (***S***) and bends (***B***).

$$BASW1 = \sum_{i=1}^{S} \sum_{b=1}^{B} w_e \times w_s \times L_b$$

The *rollup* PM is based on the terciles of total length taken from a historical run with no bank revetment. These terciles determine set the thresholds for performance of BASW1 in any given year (*i.e.*, assignment of [redacted]/Y/[redacted] to BASW1).

Indicator Reliability

The indicator credibility rankings for BASW1 are shown in Table 4.22.

Table 4.22. BASW1 – Habitat Potential/Suitability - indicator credibility assignments following the workshop. These ratings apply to those reaches of the Sacramento River where it is possible to have estimates of floodplain area reworked from the Meander Migration Model.

	Category				
	I	U	R	F	P
BASW1 – Habitat potential/suitability	H	H	H	M	H

BASW1 received a score of Medium for feasibility because the performance measure only captures some of the important characteristics with respect to nest habitat suitability.

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Excel Reports

An example of an Excel report for BASW1 is shown in Figure 4.27. The habitat potential (weighted useable length (WUL)) for each year in a specific location is shown in kilometers.

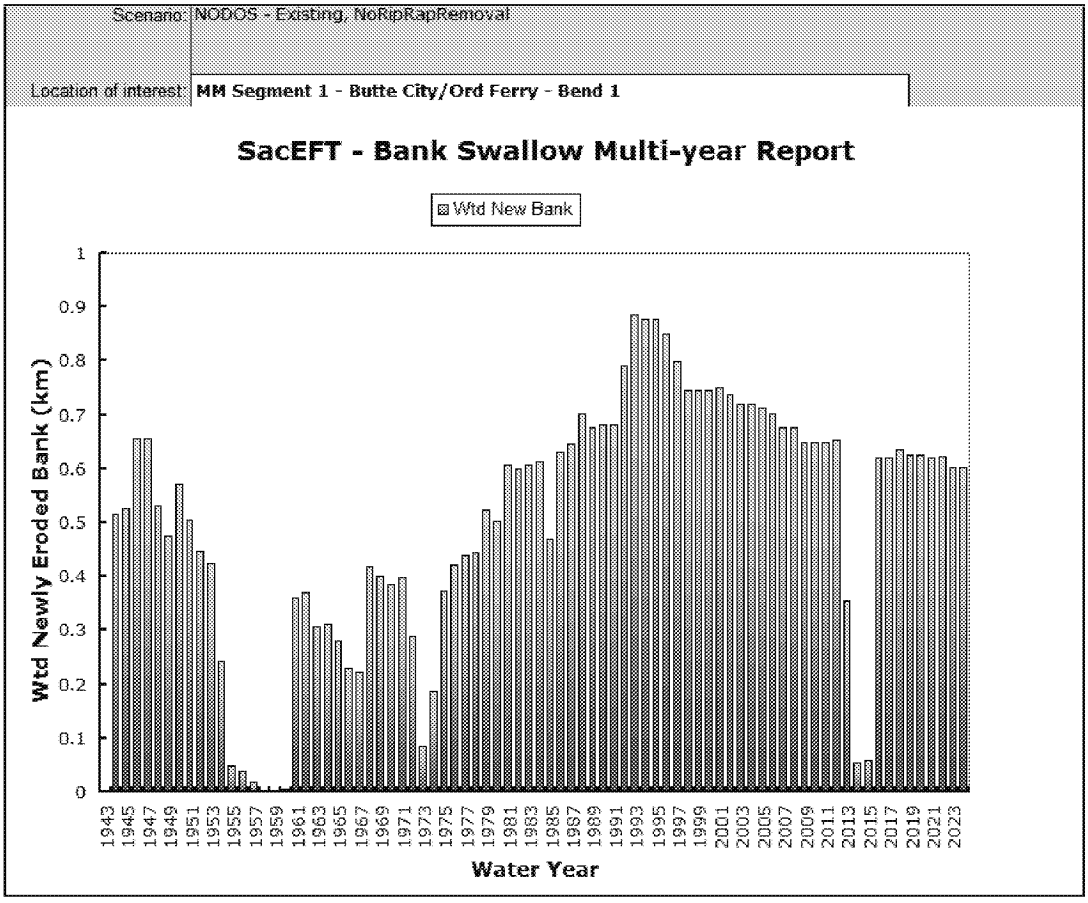

Figure 4.27. An example of an Excel report for BASW1 – Habitat potential/Suitability. This example shows the Weighted Useable Length (WUL; km)) for each year for Bend 1 in the Butte City/Ord Ferry segment.

Indicator Threshold Calibration

To calibrate the BASW1 indicator, we used empirically measured historical flow data with no rip-rap removal. Annual BASW1 weighted useable length was summed across all locations for each year and the PM values sorted from largest to smallest. Discontinuities (and not exact terciles) of the sorted values were used to establish the roll-up Hazard Threshold boundaries (see Figure 4.28 and Table 4.23).

A preferred method for calibrating the indicator and categorizing annual variation across different hydrosystem scenarios is to identify historical years with Good or Poor performance. It is possible that Bank Swallow Experts can create a list of years with Good or Poor performance based on field surveys of bank swallow burrows, including abandoned burrows. However, at the time of this report, we are not aware of a suitable processed dataset.

Although this method provides an internally consistent way to compare results (*i.e.*, it will always provide a consistent ranking of which water management scenarios are "better" than others), it does not provide any concrete inferences about the biological significance of the three categories. For example, it is

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possible that a year that ranks as "Good" (Green) with this method may still be biologically suboptimal. Conversely, a year that ranks as "Poor" ( ) may be biologically insignificant.

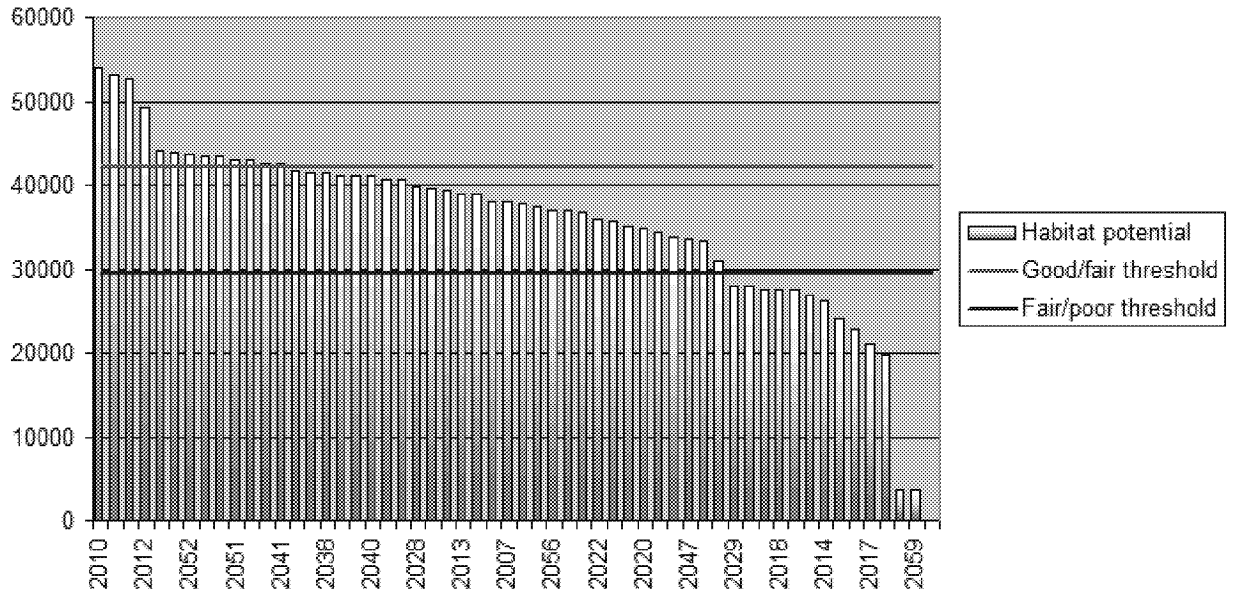

Figure 4.28. Calibration results for BASW1. Bars are the sorted total weighted length of newly eroded bank for each year of the Historical simulation.

Table 4.23. BASW1 – Length of newly eroded bank indicator rating breakpoints. Units are weighted useable length (WUL) in meters.

	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Habitat potential	N/A	N/A	42200	29500	• Criteria: statistical distribution using discontinuities, "more" is better • Units: meters suitable habitat • No daily estimate

BASW2 – PEAK FLOW DURING NESTING PERIOD

High flows during nesting have the potential to adversely affect bank swallow colonies through two mechanisms: inundation of nests and bank sloughing/collapse (Garrison 1998b; Moffatt *et al.* 2005). The exact magnitude of flow required to initiate bank sloughing is not definitively known. However, growing evidence suggests that flows in the range of 20,000 cfs to 50,000 cfs will typically erode some banks, causing partial collapse. Flows above 50,000 cfs are more than likely to cause widespread erosion leading to widespread colony failure at many sites if breeding swallows are present (Stillwater Sciences 2007).

During the SacEFT refinements workshop we were informed that about half of all nest burrows are located in the upper one quarter of the bank. Hence, the flow that is observed to reach this point should be the natural flow threshold for high risk. Informal observations at Hamilton City suggest that all nests at

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that location that are ≤ 3m above a stage of 130.19 feet (flow of 7,250 cfs)[1] would be inundated at 50,000 cfs, which corresponds to a stage of about 139 feet. Extrapolating the Hamilton city rating curve to the larger area between Red Bluff and Colusa, approximately 50% of nests are ≤ 3m above stage (130.19 feet), and would consequently be at least partially inundated at 50,000 cfs. This is likely a conservative estimate because the rating curve at Hamilton City is steeper than at most nesting sites. The specifics of the stage-discharge relationship for other bank swallow nesting sites are still unavailable. Consequently, the current value of 50,000 cfs appears to be a reasonable threshold.

The impact of peak flow during the nesting period is calculated using daily average flow (Q) coupled to estimates of exposure to the hazard of bank-sloughing flows in three river segments (see Table 2.4) during the April 15 to July 31 (Table 2.7) nesting period (ESSA Technologies Ltd. 2008a). Hazard is modeled using two flow breakpoints: 20,000 cfs and 50,000 cfs, to provide estimates of risk during flow excursions into zones of moderate and high flow, respectively.

The *daily* performance measure is calculated by an indicator that assigns an influence to the day's flow at each location, based on the breakpoint values:

$$BASW2 = \begin{cases} 1 & when\ (Q < 20kCFS) \\ 1 - \left(\dfrac{Q-20}{30}\right) & when\ (20kCFS \le Q < 50kCFS) \\ 0 & when\ (Q \ge 50kCFS) \end{cases}$$

The R/Y/G Indicator Ratings for BASW2 are based on a heuristic developed from the distribution of the BASW2 indicator, using a historical flow scenario across all river locations. Based on the flow thresholds, Q < 20,000 cfs is considered low risk and receives a score of 1, whereas $Q \ge$ 50,000 cfs is considered [redacted] and receives a score of 0. BASW2 is calculated at three locations along the river. Because of the fast ramping of flooding flows during the nesting period, days assigned a Yellow Indicator rating are infrequent.

Indicator Reliability

The indicator credibility rankings for BASW2 are shown in Table 4.24.

Table 4.24. BASW2 – Peak flow during nesting period - indicator credibility assignments following the workshop. These ratings apply to those reaches of the Sacramento River where it is possible to have estimates of floodplain area reworked from the Meander Migration Model.

	Category				
	I	U	R	F	P
BASW2 – Peak flow during nesting periods	H	M	M	M	H

With respect to understanding and rigor, BASW2 receives a score of Medium. Although there is strong evidence to support the flow threshold values for moderate and high risk, there remains some uncertainty around the exact magnitude of flow required to initiate substantial bank erosion, and hence bank collapse during nesting periods. Feasibility receives a score of Medium because the input data required to create more representative flow thresholds for high risk are not currently available.

[1] A rating table for Sacramento at Hamilton City showing the relationship between flow and stage is available at: http://cdec.water.ca.gov/rtables/HMC1.html.

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Excel reports

The Version 2 Excel report is shown in Figure 4.29 using a vertical bar to show the annual rollup for the PM.

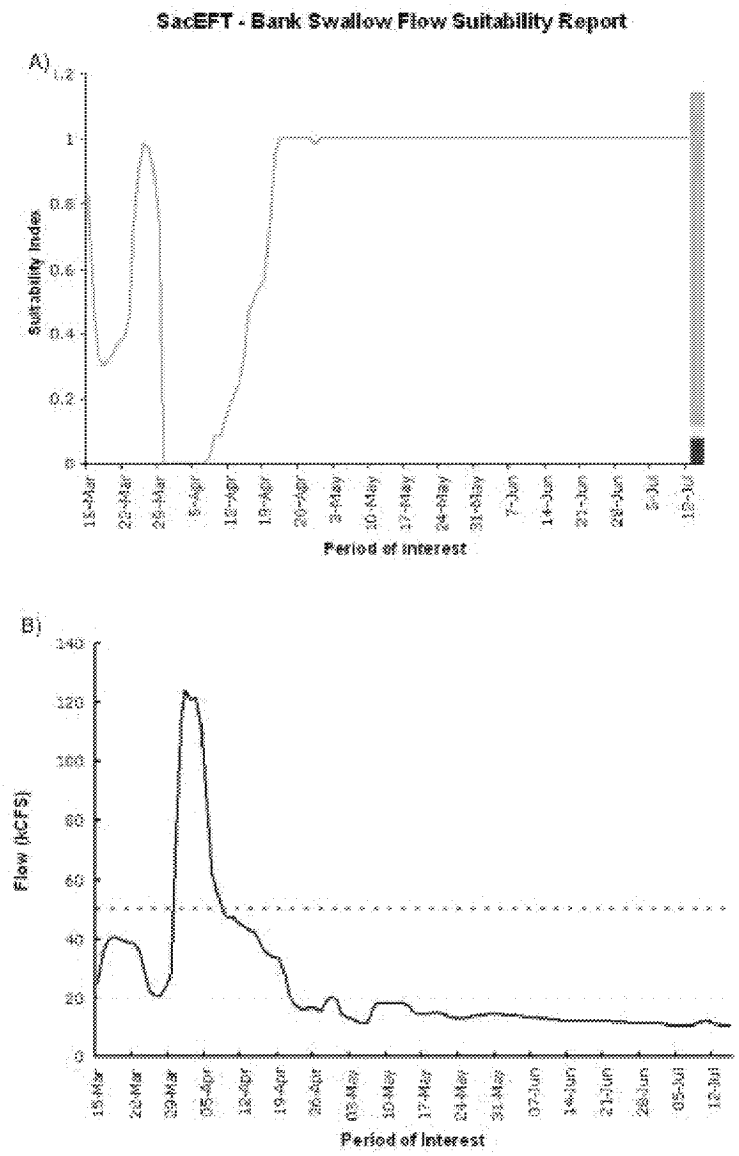

Figure 4.29 A) Daily roll up for BASW2 during the nesting period (April 15 to July 31). A suitability index score ≥ 0.1 is ranked as Good. A suitability score between 0.01 and 0.1 is ranked as Fair, and a suitability score ≤ 0.01 is ranked as Poor. B) Maximum daily flow during the nesting period. Flows ≥ 50,000 cfs (red dashed line) are automatically assigned a suitability index of 0 (Poor). Flows < 20,000 cfs are automatically assigned a suitability index of 1 (Good).

Indicator Threshold Calibration

Based on model behavior using historical flow and temperature, the indicator rating thresholds for peak flow during nesting period are shown in Table 4.25. *Daily* suitability indices of BASW2 are assigned based on a heuristic developed from the historical distribution of the BASW2 indicator across all river locations:

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$$BASW2 \quad suitability \quad index = \begin{cases} green & when\ (BASW2 \geq 0.1; [Q \leq 20kcfs]) \\ yellow & when\ (BASW2 > 0.01; [20kcfs < Q < 50kcfs]) \\ red & when\ (BASW2 \leq 0.01; [Q \geq 50kcfs]) \end{cases}$$

The *Rollup* PM for BASW2 is based on a similar heuristic that aggregates the annual PM across all locations based on peak flow during nesting. Using the same flow thresholds as the daily indicator, peak flow is used to assign an annual value for each nesting location. The rollup indicator is assigned a Good rating if 2 or more locations have a Good indicator rating for the year. The annual rollup is assigned a [redacted] rating if no locations are ranked as Good.

A preferred method for calibrating the indicator and categorizing annual variation across different hydrosystem scenarios is to identify historical years with Good or Poor performance. It is possible that Bank Swallow Experts can create a list of years with Good or Poor performance based on field surveys of inundated bank swallow burrows, however at the time of this report, we are not aware of a suitable processed dataset.

Although this method provides an internally consistent way to compare results (*i.e.*, it will always provide a consistent ranking of which water management scenarios are "better" than others) and is based on discussions at the Version 1 review workshop, it does not provide any concrete inferences about the biological significance of the three categories. For example, it is possible that a year that ranks as "Good" (Green) with this method may still be biologically suboptimal. Conversely, a year that ranks as "Poor" ([redacted]) may be biologically insignificant.

Table 4.25. BASW2 – Peak flow during nesting. Units are flow (cfs), weighted 1 below 20,000 cfs and 0 above 50,000 cfs.

	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Nesting Peak Flow	47000	49700	≥ 2	< 1 (zero)	• Criteria: flow thresholds based on expert opinion, "less" is better • Daily units: flow (cfs) • Rollup units: count of Good locations

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4.3.4 Fremont cottonwood

The Fremont cottonwood conceptual model is shown in Figure 4.30. Readers are referred to ESSA Technologies Ltd. (2007) or details on the development of this model and the decisions that led to its current structure.

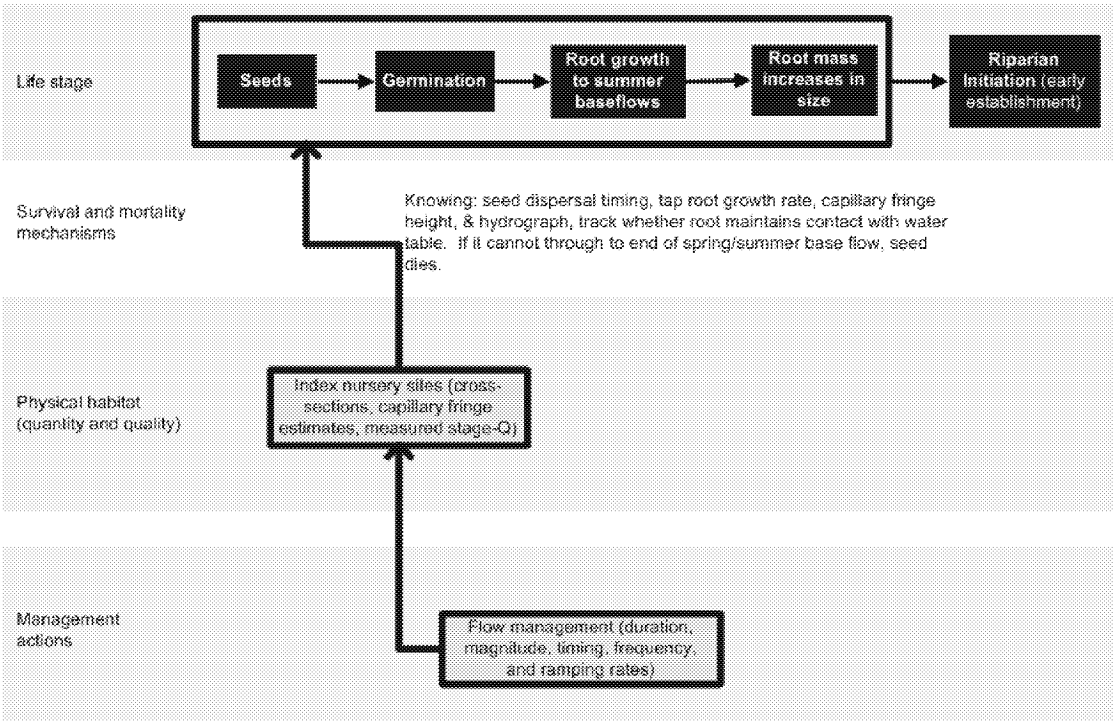

Figure 4.30 The Fremont cottonwood conceptual model. Blue heavy lines show the processes and linkages that are currently implemented.

SacEFT includes one performance measure (PM) that describes the potential for successful Fremont cottonwood initiation, along with a second performance measure designed to capture changes in the physical habitat that could negate successful initiation.

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RIPARIAN INITIATION (FC1)

A single performance measure predicts the biological response of seedling Fremont cottonwood to changes in flow management at eleven (11) index locations along the Sacramento River. The FC1 indicator is based on Mahoney and Rood's (1998) recruitment box model, which predicts the success of riparian initiation as a function of changes in the timing of flows and water surface elevations. Important biological parameters, such as taproot growth rate, seed dispersal timing, capillary fringe, drought tolerance and viable root depths are also integrated. As summarized in Table 4.26, two field studies (Roberts *et al.* 2002; Roberts 2003) provide the bulk of the data necessary to apply this model to eleven index locations on the Sacramento River. These cross sections are located at RM159, 164, 165, 172, 183, 185.5, 192, 195.75, 199.75, 206 and 208.25.

Table 4.26. Data requirements for FC1 – a measure of successful riparian initiation.

Focal species performance measure	Required input	Data source
FC1	Daily average flow hydrograph	Hydrological data from historical discharge and USRDOM
	Stage-discharge relations	Roberts *et al.* 2002; Roberts 2003 (RM 192, 183, and 172); HEC-RAS
	Channel cross-sections	Roberts *et al.* 2002; Roberts 2003 (RM 192, 183, and 172); HEC-RAS
	Capillary fringe height = 30 cm	FC experts
	Seed dispersal timing (start and end) Apr-15 to 21-June	FC experts
	Seedling tap root growth rate = 22 mm/d	Roberts *et al.* 2002; Roberts 2003 (based on actual field observations)
	Drought tolerance = 5 days	FC experts
	Viable rooting depth = 50 cm	FC experts
	Other assumptions: Standard recruitment box model Sampled cross section nodes, if non-uniform, are representative of the overall cross-sectional characteristics. ▪ Drought tolerance of 5 days (roots can be out of contact with water table for 5 continuous days without being declared dead) ▪ Cottonwood seedlings whose roots reach a depth of 50 cm are assumed to be successful in reaching some type of ephemeral groundwater moisture sufficient to keep them alive through the remainder of their first year (based on dialogue with John Bair, McBain and Trush, *pers. comm.*). **Note**: all these assumptions are fully configurable in the SacEFT database.	

An adapted version of the TARGETS model (Alexander 2004) is used to determine whether cottonwood seedlings will successfully initiate at a given node along a cross section. Cottonwood seeds are released within a dispersal window (April 15 to June 21, as shown in Table 2.7). Seeds that land on non-inundated ground[1] begin to grow roots downward from the elevation at which they were deposited. While accounting for optional capillary fringe height along the cross section (*e.g.*, 30 cm), the rate of stage decline determines whether the cottonwood's root is able to maintain contact with the water table. As soon as the root depth is above the surface elevation + capillary fringe height, the seedling becomes non-viable (dies). Hence for successful initiation, the rate of stage decline cannot occur at a rate faster than the taproot growth rate (we use a taproot growth rate of 22 mm/day). Cottonwood seedlings whose roots

[1] Seeds/seedlings that are submerged are not declared "dead" but instead the process of tap-root growth is suspended.

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reach a depth of 50 cm are assumed to be successful in reaching some type of ephemeral groundwater moisture sufficient to keep them alive through the remainder of their first year. ***Note:*** All these assumptions are configurable in the SacEFT database.

The cottonwood performance measure tallies the number of initiation successes and failures across years and across the three cross-sections used in the model. Based on inspection of the all year results, counts of successfully initiating nodes are used to assign R/Y/G indicator ratings.

The **node concept** is important and sometimes confuses investigators interpreting the model's cross-section specific results (Figure 4.31). *SacEFT's riparian initiation model does not provide a count of surviving stems or seedlings. Rather, based on the inherent spatial resolution present for each cross-section dataset, every survey point (whether real or interpolated) is treated as/called a '"node". The model calculates whether a single seedling in the center of each of these "nodes" would or would not survive.* The node count of surviving seedlings is then used as an index of seedling initiation success (more being better). Any change in the number of cross sections evaluated or the resolution of existing cross-sections would result in requiring re-calibration of R/Y/G threshold cut-offs.

Indicator Reliability

The indicator credibility rankings for FC1 are shown in Table 4.27.

Table 4.27. FC1 – Riparian initiation - indicator credibility assignments following the workshop. These ratings apply to those point bars in the Sacramento River that have detailed stage-discharge relationships available.

	Category				
	I	U	R	F	P
FC1 – Riparian initiation	H	M	H	H	H

FC1 scores High with respect to rigor because the model is based on field observation data derived for the Sacramento River. Understanding is scored as Medium ("strong evidence but not conclusive, only medium strength predictive power, some evidence for competing hypotheses and/or confounding factors"). Riparian initiation is a site specific process, influenced by local factors such as substrate soil characteristics, presence of ephemeral water and other site specific factors that influence initial seed viability.

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Excel reports

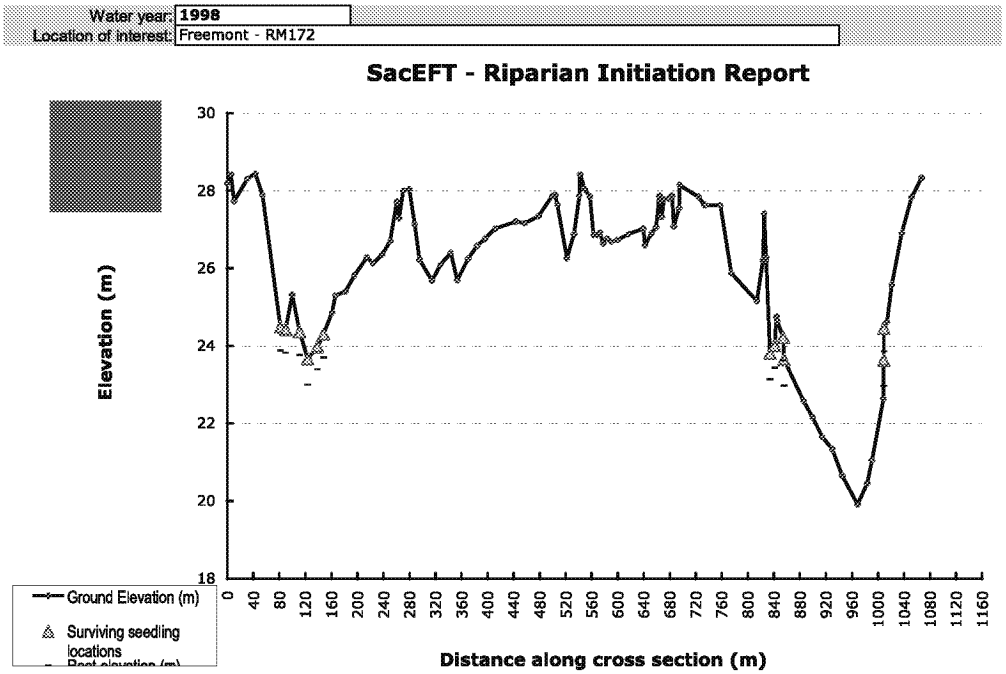

Figure 4.31: SacEFT Fremont Cottonwood seedling initiation success: 1998 (good year).

Indicator Threshold Calibration

The cottonwood performance measure tallies the number of initiation successes and failures across years and across the three cross-sections used in the model. Based on inspection of the all year results, counts of successfully initiating nodes are used to assign R/Y/G indicator ratings. SacEFT's riparian initiation model calculates whether a single seedling in the center of each of these "nodes" would or would not survive. **The node count of surviving seedlings** is then used as an index of seedling initiation success (more being better).

In making R/Y/G assignments for a particular water year, the value in the *ARollGoodCountAssignGood* field in the SacEFT database (*SummaryOut_PMThresholds* table) represents a count of cross-sectional nodes, **in the target zone for initiation** (*i.e.*, anything above 8,500 cfs elevation + 3ft), where surviving seedlings were found. At present, with the existing eleven cross-sections, the value 53 was found by visual inspection to represent "good" (*i.e.*, Green) initiation success, from historical flow data sorted descending (best to worst counts for each year) over the 66 year historical record. Likewise, *ARollGoodCountAssignBad* represents the equivalent information, defining the lower bound on successfully initiating nodes before the color Red is assigned (node count ≤ 36) (see Figure 4.32 and Table 4.28).

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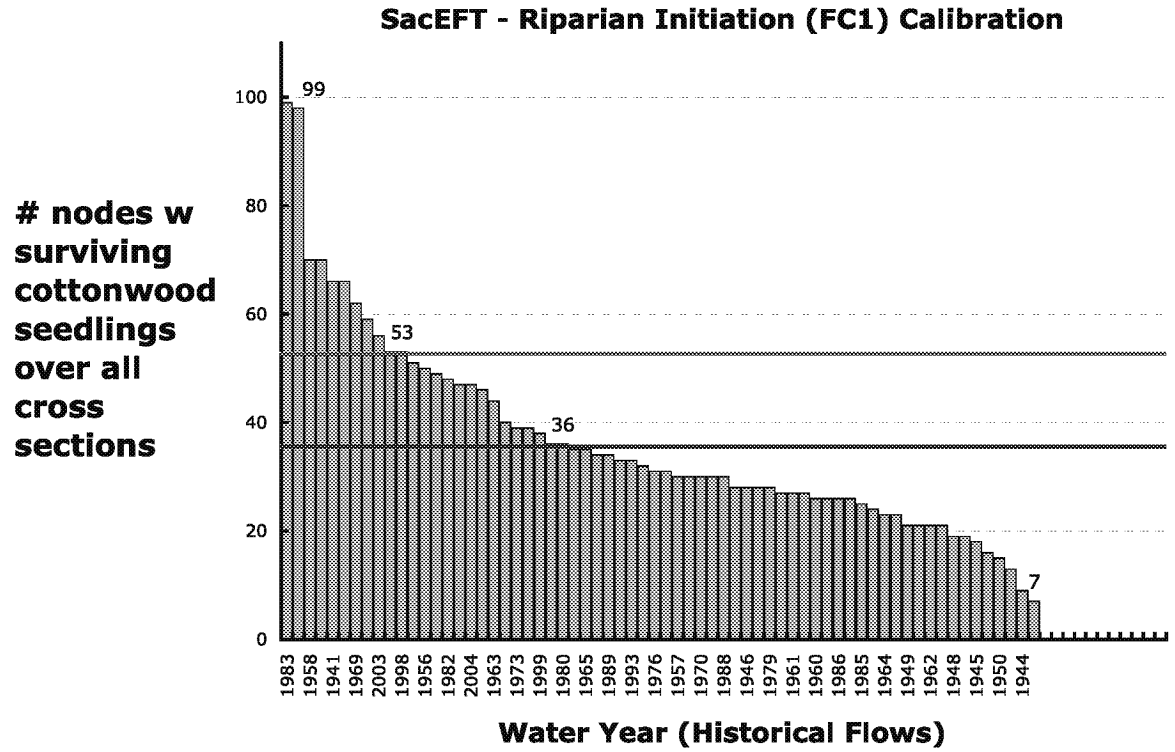

Figure 4.32: Annual roll-up results for the SacEFT Fremont cottonwood initiation (FC1) performance measure run using historic observed flows (1938–2003).

This indicator threshold calibration also takes into consideration comparisons with aerial photographs of historically strong Cottonwood recruitment at study sites vs. model results. At present, years revealed by SacEFT as having the potential for strong riparian initiation success are: 1941, 1952, 1952, 1958, 1967, 1969, 1971, 1975, 1983, 1997, 1999 and 2003 (historical data in SacEFT currently do not extend beyond 2004). However, after considering riparian scour potential (FC2), only **1958, 1967, 1971, 1975, 1999 and 2003** are predicted to show strong initiating cohorts of riparian seedlings (1941, 1952, 1969, 1983, 1997 predicted to suffer high risk of seedling scour following successful initiation).

Note: Any change in the number of cross sections evaluated or the resolution of existing cross-sections would result in requiring re-calibration of R/Y/G threshold cut-offs.

Table 4.28. FC1 – Riparian initiation success. Units are counts of successful initiation at the index nodes.

	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Riparian Initiation Success	N/A	N/A	53	36	• Criteria: thresholds based on expert opinion and observation of Good initiation years, "more" is better • Units: count of cross section nodes with surviving stems or seedlings. • No daily estimate

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RIPARIAN SCOUR (FC2)

Based on recommendations from the SacEFT refinements workshop, a second performance measure has been included in SacEFT v.2 to capture the effects of scour events following riparian initiation. The rationale for including this second performance measure is that gains made after successful riparian initiation are moot if the seedlings are scoured out in the following year, *i.e.*, there is no point expending large volumes of water to achieve riparian initiation, and then wiping out these benefits in year t+1 with a scouring flow (Figure 4.33).

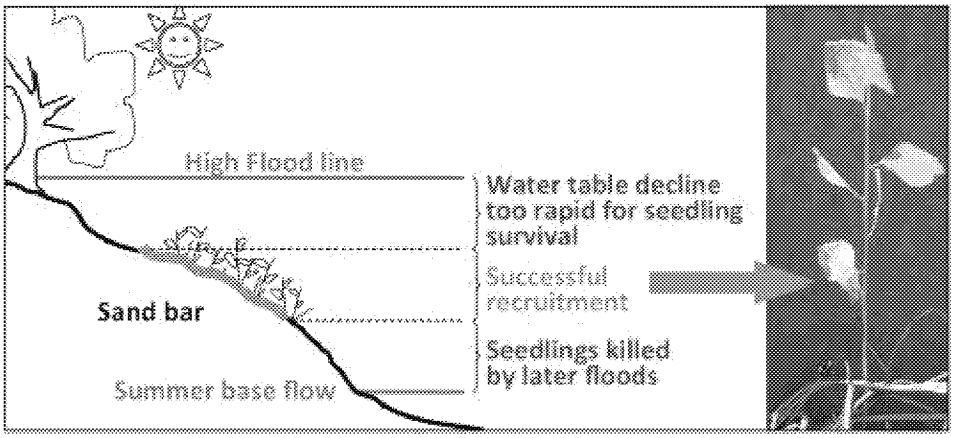

Figure 4.33. Generalized pattern of successful seedling initiation observed for cottonwoods along alluvial rivers. Seedlings that germinate too high on the bank cannot grow roots fast enough to keep up with the receding water table and soil moisture level during the hot summer months, while seedlings that initiate too low on the bank are removed by scour during high flow events during the subsequent winter or spring. Seedlings in the target initiation zone may also be scoured and killed by high flows. *Source*: Stillwater Sciences poster presentation, Calfed Science Conference (2008).

This performance measure is by design only calculated in years following Fair (Yellow) or Good (Green) FC1 initiation success. Considering riparian scour potential (FC2), the following strong initiating cohorts of riparian seedlings (FC1) are predicted to suffer high (Red) rates of scour following successful initiation: 1941, 1952, 1969, 1983, 1997 (*i.e.*, approx. 5 in 11 years successfully initiating cohorts may be wiped out by subsequent high flows).

Indicator Reliability

The indicator credibility rankings for FC2 are shown in Table 4.29.

Table 4.29. FC2 – Riparian scour - indicator credibility assignments following the workshop. These ratings apply to those point bars in the Sacramento River that have stage-discharge relationships and scour depth as a function of flow.

	Category				
	I	U	R	F	P
FC2 – Riparian scour risk	H	M	M/L	H	H

The FC2 indicator scores Medium on understanding because the sensitivity of this measure and its stability across multiple sites is theoretical, and alternative hypotheses and confounding factors will exist.

Excel Reports

None.

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Indicator Threshold Calibration

Initial scour thresholds for assignment of R/Y/G proposed by riparian subgroup participants were identified as follows. A flow of ≥ 90,000 cfs would *ensure* 100% scour mortality of riparian seedlings ≤ 1 years (*i.e.*, = R classification), wiping out recruitment success of the previous year. Flows of ≥ 90,000 cfs are expected to generate gravel mobilization down to 2 feet or more, based on scour chain observations. Flows of ≥ 80,000 cfs (and < 90,000 cfs) are expected to generate gravel mobilization producing a Yellow classification risk for seedling scour.

Note: these thresholds are readily configurable in the SacEFT database.

Table 4.30. FC2 – Riparian scour risk. Units are threshold flows (cfs) for bank mobilization events.

	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Riparian Scour Risk	N/A	N/A	80000	90000	• Criteria: thresholds based on expert opinion of scour events, "less" is better • Units: flow (cfs) • No daily estimate

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4.3.5 Large woody debris recruitment to mainstem Sacramento River

Large Woody Debris recruitment (LWD) is a proxy indicator for Western Pond Turtle (WPT) habitat quality. The indicator is based on the assumption provided by professional herpetologists at SacEFT design workshops that recruitment of LWD into the main channel of the Sacramento River will create more hospitable habitat conditions for WPT. To estimate LWD recruitment to the main channel, the area eroded with older forest vegetation is used as a measurement of how much potential large woody debris is recruited each year.

A GIS layer representing mature vegetation was created from the 2007 Riparian vegetation data for the Sacramento River; obtained from the Sacramento River GIS portal[1]. The GIS dataset includes vegetation class and height category. For the purpose of the recruitment of LWD, forests taller than 34 ft (height class 4 or higher) are considered old forest. The vegetation class itself is not used in this version of the LWD model as it is not clear whether WPT would preferentially use different types of LWD. An important simplifying caveat is that the LWD model assumes that the distribution of forest size classes is static during SacEFT simulations, *i.e.,* the vegetation cover map input at the start of the model simulation does not or change in species composition.

The performance measure for this indicator is computed for each location as the area eroded with old vegetation. The area is found in a GIS by overlaying the predicted eroded areas from the bank erosion model (see Section 4.1.6) with the old growth GIS layer (see Figure 4.34). Areas where the eroded area and the old vegetation locations overlap are considered to be the sources of LWD. Finally, the old vegetation areas are divided into 38 bends located in 3 different river segments for reporting purposes.

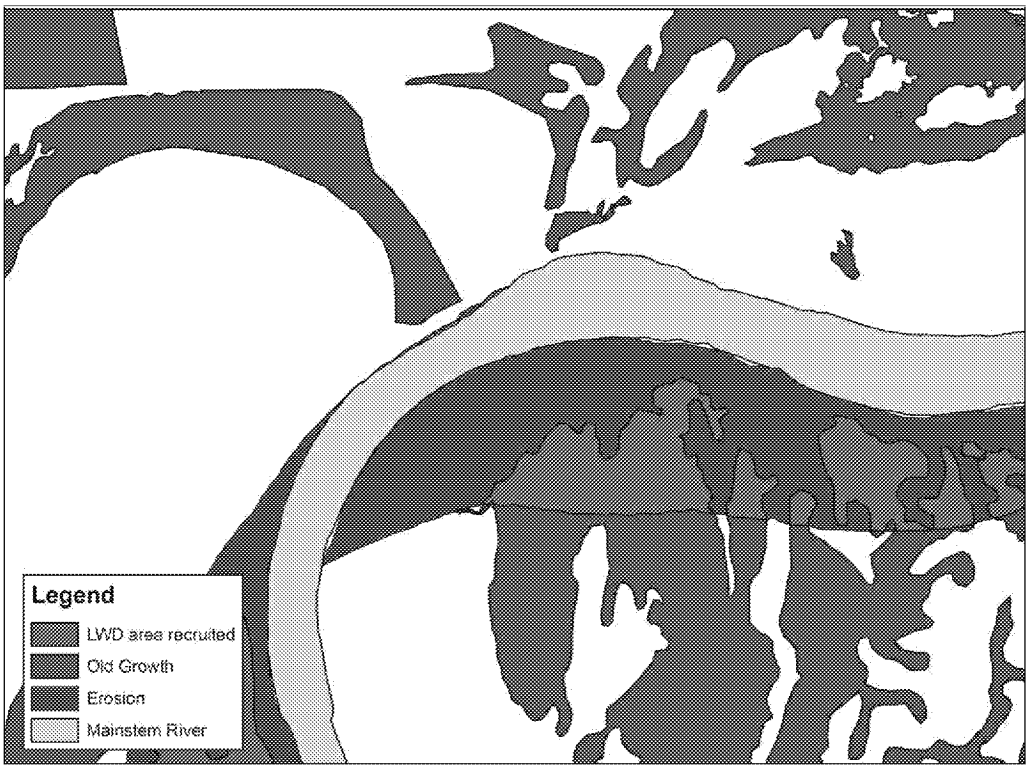

Figure 4.34: Map illustrating vegetation classes used to compute LWD recruitment for SacEFT.

[1] http://www.sacramentoriver.org/srcaf/index.php?id=data

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The *Rollup* indicator is then computed by summing the area eroded in old growth forest across all locations (L):

$$LWD = \sum_{l=1}^{L} LWD_l$$

Indicator Reliability

LWD is assigned the reliability shown in Table 4.31. This is a semi-quantitative proxy performance indicator reliant on the results of the Meander Migration Model, which are post-processed to create the Bank Erosion model.

Table 4.31. Credibility assignment for LWD – Large woody debris recruitment.

	Category				
	I	U	R	F	P
Large woody debris recruitment		M	M	L/M?	L/M

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Excel Reports

An example of a SacEFT v.2 Excel report for LWD is shown in Figure 4.35.

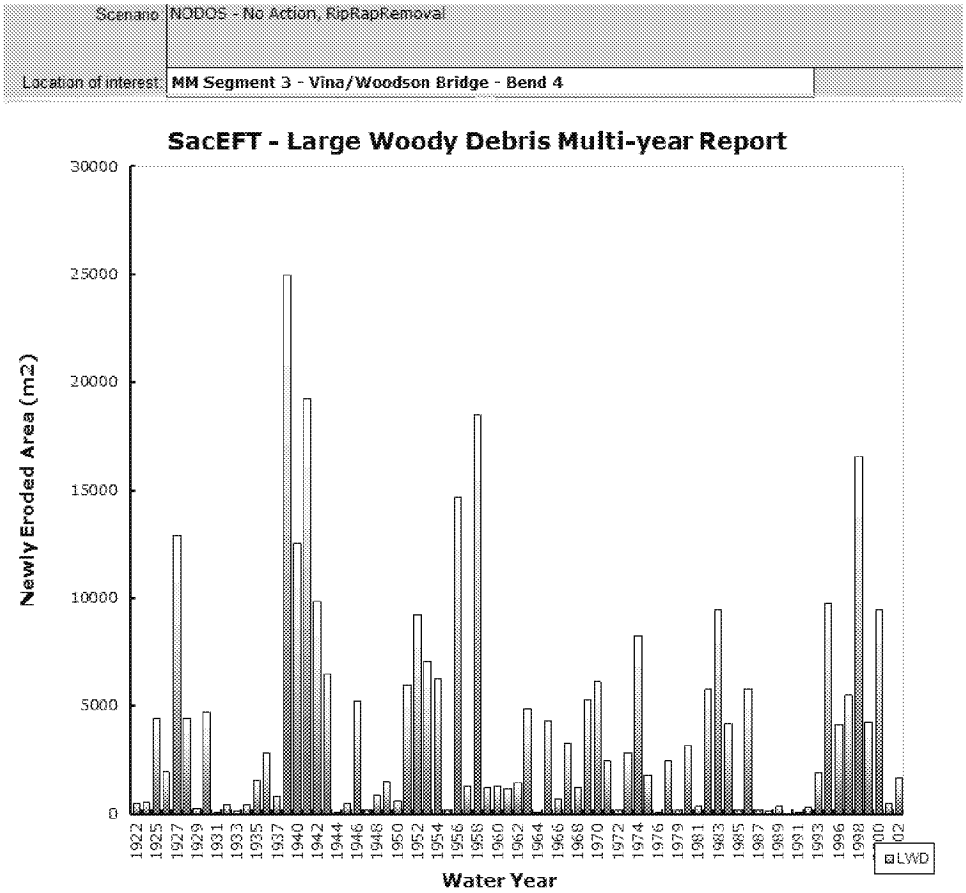

Figure 4.35. An example of an Excel report for LWD – Large Woody Debris recruitment. This example shows the square meters eroded each year for Bend 4 in the Vina/Woodson Bridget segment, as a proxy for WPT habitat.

Indicator Threshold Calibration

To calibrate the LWD indicator, we used empirically measured historical flow data with no rip-rap removal. LWD areas are summed for all locations for each year and the PM values were sorted from largest to smallest. Values that define the upper-, middle and lower thirds (terciles) of the sorted values are termed roll-up Hazard Threshold boundaries (see Figure 4.36 and Table 4.32).

Although this method provides an internally consistent way to compare results (*i.e.*, it will always provide a consistent ranking of which water management scenarios are "better" than others), it does not provide any concrete inferences about the biological significance of the three categories. For example, it is possible that a year that ranks as "Good" (Green)) with this method may still be biologically suboptimal. Conversely, a year that ranks as "Poor" ([redacted]) may be biologically insignificant.

A preferred method for calibrating the indicator and categorizing annual variation across different hydrosystem scenarios is to identify historical years with Good or Poor performance. However, to our knowledge, there does not exist a dataset that estimate the amount of LWD recruited to the main-stem Sacramento River, so it is not currently possible to evaluate year with Good or Poor performance.

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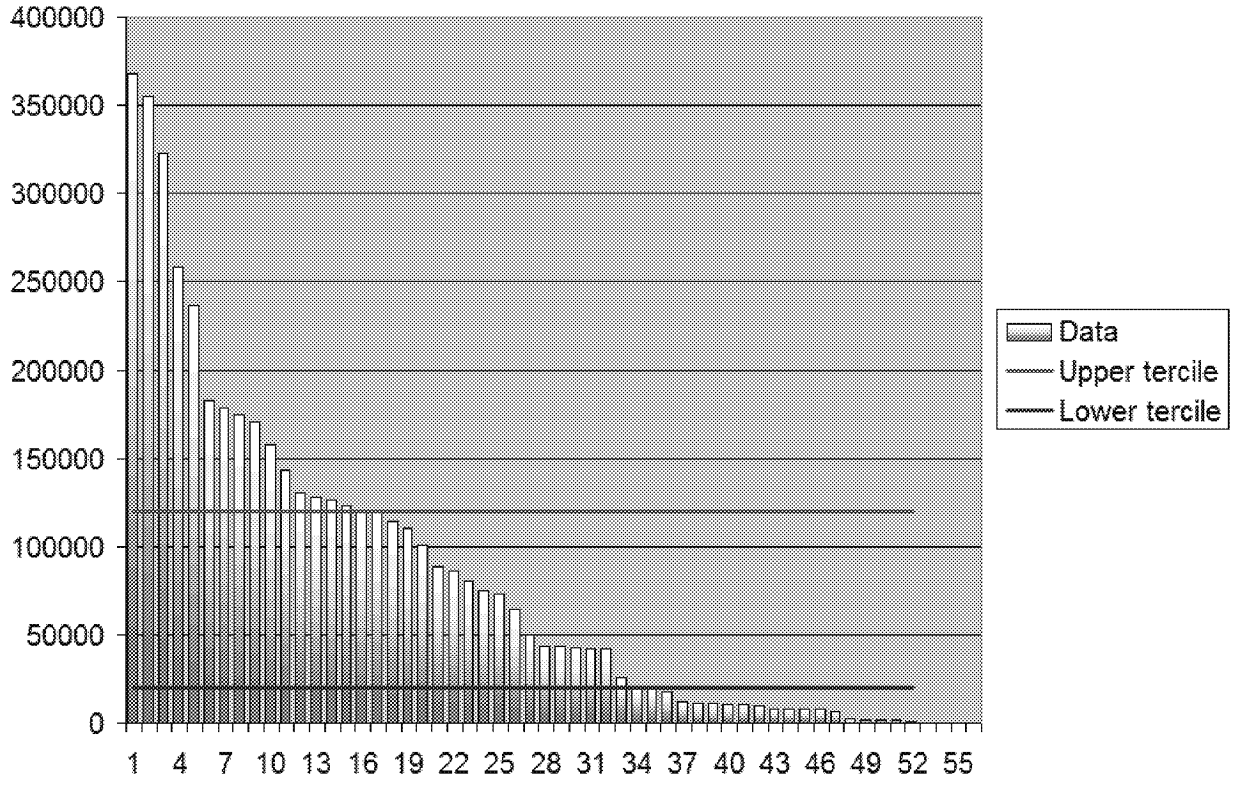

Figure 4.36. Calibration assumptions for LWD. Units on the y-axis are square meters riparian forest eroded to mainstem Sacramento River having forests taller than 34 ft (height class 4 or higher).

Table 4.32. LWD – Large Woody Debris indicator rating breakpoints, in units of square meters.

	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Large Woody Debris recruitment	N/A	N/A	120000	20000	• Criteria: statistical distribution, terciles, "more" is better • Units: square meters riparian forest eroded to mainstem Sacramento River having forests taller than 34 ft (height class 4 or higher). • No daily estimate

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Appendix A – Invited Workshop Participants

SacEFT v.1 design workshop (Dec. 5-6, 2005 Davis, CA):

Name	Subgroup	Area of Expertise	Organization	Phone / Fax	Email
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SacEFT v.2 design workshop (October 7-8 2008, Chico CA):

Invited water managers for Day 1: October 7		
Ron Ganzfried	Campbell Ingram	Sean Sou
Maurice Hall	Aric Lester	Joseph Terry
John Hannon	Tom Morstein-Marx	Jim Weiking
Derek Hilts	Steve Roberts	
Buford Holt	Anthony Saracino	
Invited biologists for Days 1 and 2: October 7 and 8		
Colleen Harvey Arrison	Chris Eilers	Bruce Oppenheim
Don Ashton	Tag Engstrom	Bruce Orr
John Bair	Mark Gard	Steve Lindley
Ed Ballard	Dave Germano	Keith Marine
Randy Benthin	Adam Henderson	Nadav Nur
Mike Berry	Josh Israel	Bill Poytress
Tricia Brachter	Doug Killam	Bruce Ross
Howard Brown	Jason Kindopp	Ron Schlorff
Larry Brown	Peter Klimley	Joe Silveira
Matt Brown	Ryan Kurtis	Jim Smith
Daniel Burmester	Eric Larsen	Alicia Steinholz
Bruce Bury	Alice Low	Rob Titus
Bradley Cavallo	Dennis McEwan	Mike Tucker
Richard Corwin	Tracy McReynolds	Dave Vogel
Yantao Cui	Rod McInnis	Dave Zezulack

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Appendix 8B
Analysis of the North-of-the-Delta Offstream Storage Investigation (SacEFT)

Prepared by:
Sacramento River Ecological Flows Tool

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SacEFT
Sacramento River Ecological Flows Tool

Analysis of the North-of-the-Delta Offstream Storage Investigation

Prepared for

CALIFORNIA DEPARTMENT OF WATER RESOURCES

Statewide Infrastructure Investigations Branch

Prepared by

The Nature Conservancy
Protecting nature. Preserving life.

Sacramento River Project
500 Main St.
Chico, CA 95928

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Canada V6H 3H4

October 4, 2012

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1. Introduction

Report Purpose

This report is intended to provide technical information to inform the evaluation of the North-of-the-Delta Offstream Storage (NODOS) Investigation (hereafter, the Investigation). Alternatives will be evaluated in detail in the NODOS EIS/EIR and Feasibility Report. The intended audience of this report is the set of resource specialists and decision makers associated with the Investigation that are evaluating the environmental effects and feasibility of alternatives. More specifically, this report presents detailed modeling results on how a set of focal species associated with the Sacramento River may be impacted (negatively and positively) by the Investigation's alternatives. Consistent with the design intent of the Sacramento River Ecological Flows Tool (SacEFT), this report will also inform interested stakeholders, decision makers, and the public of environmental trade-offs associated with the alternatives. Analyses included in this report are not strictly limited to the Investigation's alternatives. The Nature Conservancy has also reported on scenarios that include measures (rip rap removal and gravel augmentation) that are not included in the NODOS alternatives. These scenario features are intended to be informative and are not specific features of the Investigation's alternatives.

SacEFT Background

Between 2004 and 2008 the Sacramento River Ecological Flows Study team developed a decision analysis tool that incorporates physical models of the Sacramento River with biophysical habitat models for six Sacramento River species (see: www.dfg.ca.gov/ERP/signature_sacriverecoflows.asp). The Ecological Flows Study treats flow as the "master" variable regulating the form and function of riverine habitats. The Study included development of a decision-analysis tool, the "Sacramento River Ecological Flows Tool" (SacEFT) to evaluate the ecological consequences of management-related changes in flow regime and channel restoration activities (*e.g.*, gravel augmentation and selected removal of bank armoring) (ESSA 2011). The SacEFT decision support tool emphasizes the clear communication of trade-offs for key ecosystem targets associated with alternative conveyance, water operations, and climate futures in the Sacramento River ecoregion.

In SacEFT, we chose representative performance measures for multiple focal species. SacEFT includes flow and habitat relationships for six different focal species/habitats (Chinook salmon, steelhead, green sturgeon, bank swallows, channel erosion/migration (large woody debris and western pond turtle), and Fremont cottonwood). Standardized visualization interfaces allow cross-walking of ecological consequences over different water operation and channel management alternatives.

Scientifically, SacEFT takes a bottom-up, process-based approach to the relationship between flow and related aquatic habitat variables and looks at how these variables are tied to key species life-stages and ecosystem functions. Our work and the input of many expert contributors develops a more complete understanding of the flow regime and its relation to natural processes and species' requirements so as to identify the critical attributes of the flow regime necessary to maintain ecosystem function. The multi-species, multi-performance measure paradigm provides a "portfolio" approach for assessing how different flow and habitat restoration combinations suit the different life stages of desired species. In so doing, SacEFT transparently relates additional attributes of the flow regime to multiple species' life-history needs in an overall effort at careful organization of *representative* functional flow needs. This provides a robust scientific framework to focus the definition of ecological flow guidelines and contributes to the understanding of water operation effects on focal species and their habitats.

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The performance measures and functional relationships built into SacEFT were vetted through multi-disciplinary workshops and numerous design document reviews. The recommendations of these technical design workshops and subsequent peer reviews provide the basis for the performance measures and models that have been developed. Specific details on SacEFT submodels and performance measures are beyond the scope of this document. Readers are referred to ESSA (2011) for detailed descriptions of submodels, performance measures and related rules and assumptions. Collectively, the constituent focal species "submodels" provide twelve (12) performance measures (Table 2-A). Multi-year roll-ups of annual performance allow users to quickly zoom in on the much smaller set of performance measures which differ significantly across management scenarios.

A design principle of SacEFT is to leverage existing systems and data sources such as CALSIM II, USRWQM, USRDOM, historical gauging station records, Meander Migration Model outputs of bank erosion, and sediment-grain size specific sediment transport models. By leveraging many of the same physical planning models used in existing environmental, socioeconomic, and water resources planning evaluations in California, SacEFT provides an "eco plug-in" for water operation studies based on use of these physical hydrologic/water balance models.

As shown in this report, model outputs include an annual summary view for each water year and a multiple year "roll-up" view which summarizes results across all years. Both views incorporate a good-fair-poor performance measure ranking system shown with green, yellow and red colors. Daily site-specific data that produce the annual roll-up rankings are recorded in database output tables, and can be used for further analyses. Additionally, more detailed daily and site-specific data are also available for the different focal species performance measures through Excel output reports in the form of raw data, tables and graphs. SacEFT's output interface and reports for trade-off analyses make it clear how actions implemented for the benefit of one area or focal species may affect (both positively and negatively) another area or focal species. For example, we can show how altering Sacramento River flows to meet export pumping schedules in the Delta affects focal species' performance measures in the Upper and Middle Sacramento River.

1.1 Complementary Modeling Paradigms

Many agencies and organizations (*e.g.,* The Nature Conservancy (TNC), Bureau of Reclamation (USBR), Department of Water Resources (DWR), the US Geological Survey (USGS,) and the US Army Corps of Engineers (USACE)) have all developed flow modeling tools in response to a need to understand how flow and riparian land-use changes impact ecosystems. The modeling of ecosystem relationships is often used to assess ecosystem health or in the case of flow regime assessments, determine trade-offs between human water uses and ecological needs (Rapport *et al.* 1998).

Unlike physical modeling, attempting to build detailed ecological models that make accurate predictions of ecosystem behavior is challenging and usually not possible in complex, open natural systems (Oreskes *et al.* 1994). Because of the high uncertainty and incomplete understanding surrounding the complex interactions of communities of species with their physical environments (*e.g.*, time-lagged compensatory density-dependent survival mechanisms) modeling tools like SacEFT emphasize a specific set of species and life-stage linkages with physical habitat variables. The SacEFT approach does not consider detailed life-cycle modeling of a single species in an effort to predict precise numbers of emigrating smolts or returning adult spawners. As with the other modeling tools used in the Investigation, the focus of SacEFT is determining comparative effects on specific performance indicators. The assumption implicit in SacEFT is that flows and habitat conditions that generate better outcomes for discrete life-stage performance measures should – all else being equal – enable the species to support higher adult abundances. SacEFT also embeds a preferential emphasis on freshwater flow management where

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resource managers have more influence over conditions, than is practical in the case of marine conditions and processes (which usually exert a strong influence on adult abundance in salmonids).

In the case of fish species it is recognized that due to compensatory dynamics that can drive population level responses, that more high-quality habitat at a particular (usually freshwater juvenile) life-stage does not always translate to a higher abundance of adults. For this reason other modeling efforts pursue full life-cycle population representations that aim to evaluate the space-time abundance of a particular species (*e.g.*, Winter-Run Chinook Life Cycle Model (WRCLCM), also known as Winter-run Chinook IOS/DPM Model or SALMOD). By tracking the abundance and survival of salmon through successive life-stages, cumulative effects on specific run-types of Chinook salmon populations are simulated.

Given the accepted challenges of "validating" ecological models (Oreskes *et al.* 1994) many modeling practitioners favor a weight of evidence approach whereby directional trends in model predictions are compared across alternative (independently developed) models. Where multiple models determine the same rank-order results and trends, the strength of the evidence, or degree of belief in those evaluations increases. Hence, the relative trends in evaluations from life-cycle models provide an important and complementary line of evidence to SacEFT (and *vice versa*) in the assessment of flow management effects. For example, target flows identified by SacEFT could be simulated with IOS/DPM to determine the expected increase (if any) in total outmigrating winter-run Chinook smolts leaving the Sacramento River.

1.1.1 Classes of eFlow Assessment Tools

The Winter-run Chinook IOS/DPM, SALMOD and SacEFT all represent tools that fall in the **process-based** causal linkage category (Figure 1.1). Process-based models simulate linkages between flow, in-channel and riparian habitat changes through to a specific change in the survival or productivity of a particular focal species and life-stage (*e.g.*, success index of Fremont cottonwood (*Populus fremontii*) seedling initiation, Chinook salmon (*Oncorhynchus tshawytscha*) redd de-watering risk). In process-based models mathematical algorithms are used to describe the time-varying amount and relative suitability of habitat by drawing empirical relationships between species and environmental variables. These bio-physical relationships can for example be used to produce a habitat suitability index. Such indices can then be used to rank flow management alternatives or in the case of the Investigation, make comparisons with a baseline scenario.

A more widespread class of ecological flow assessment tools emphasizes generalized hydrologic indices and targets (Figure 1.1). These generalized hydrologic models analyze the changes in flow metrics themselves and leave it up to the user, outside of the tool, to infer the resultant habitat suitability changes or otherwise interpret how changes in the hydrologic index might potentially influence a particular species of concern. Both approaches for assessing and/or prescribing ecological flows are based on the idea that biological responses are adapted to and shaped by a river basin's natural hydrologic flow regime (inter- and intra-annual variability of flow levels and sequences of events) of a river (Poff *et al.* 1997). Early work in this area led to a definition of a collection of simple statistical metrics to quantify change in flow regime, typically after flow regulation (Richter *et al.* 1996). In an effort to assess how much a flow regime has been altered, indices of a natural (pre-regulation historical) regime can be compared with the indices of an altered flow regime. Further research proposed the idea that such statistical indices naturally have a range of variability, which led to the Range of Variability Analysis (RVA) approach, which can be used to compare different flow regimes. For these generalized hydrologic models – while there is a great deal of technical judgment required to interpret the biological significance of performance measure changes – they provide the advantage of offering simple/readily available input data. Thus, these methods can be more readily applied in other river basins with lower cost.

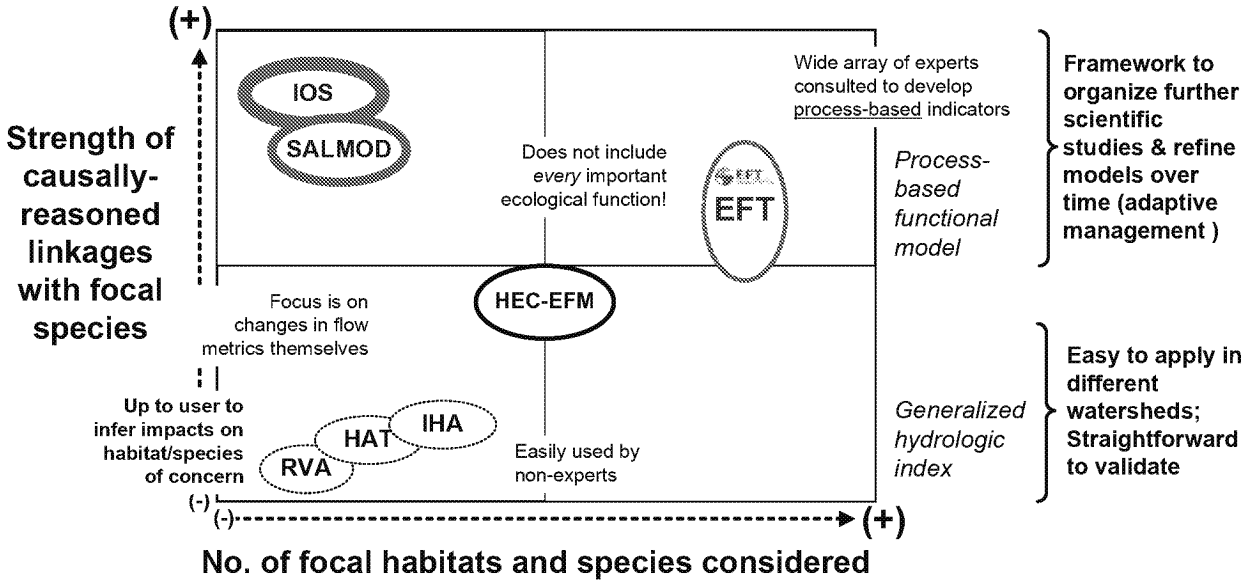


Figure 1.1: Attributes of alternative ecological flow assessment tools showing placement of the Sacramento River Ecological Flows Tool (SacEFT; ESSA (2011)). IHA = Indicators of Hydrologic Alteration (Mathews and Richter 2007). HAT = Hydrologic Assessment Tool (Kennen *et al.* 2009). RVA = Range of Variability Analysis (Mathews and Richter 2007). HEC-EFM = Hydrologic Engineering Center Ecosystem Functions Model (USACE 2002). IOS = Winter-run Chinook IOS/DPM. SALMOD = Salmonid Population Model (Bartholow *et al.* 2002).

1.2 North-of-the-Delta Offstream Storage Investigation

(a)

(b)

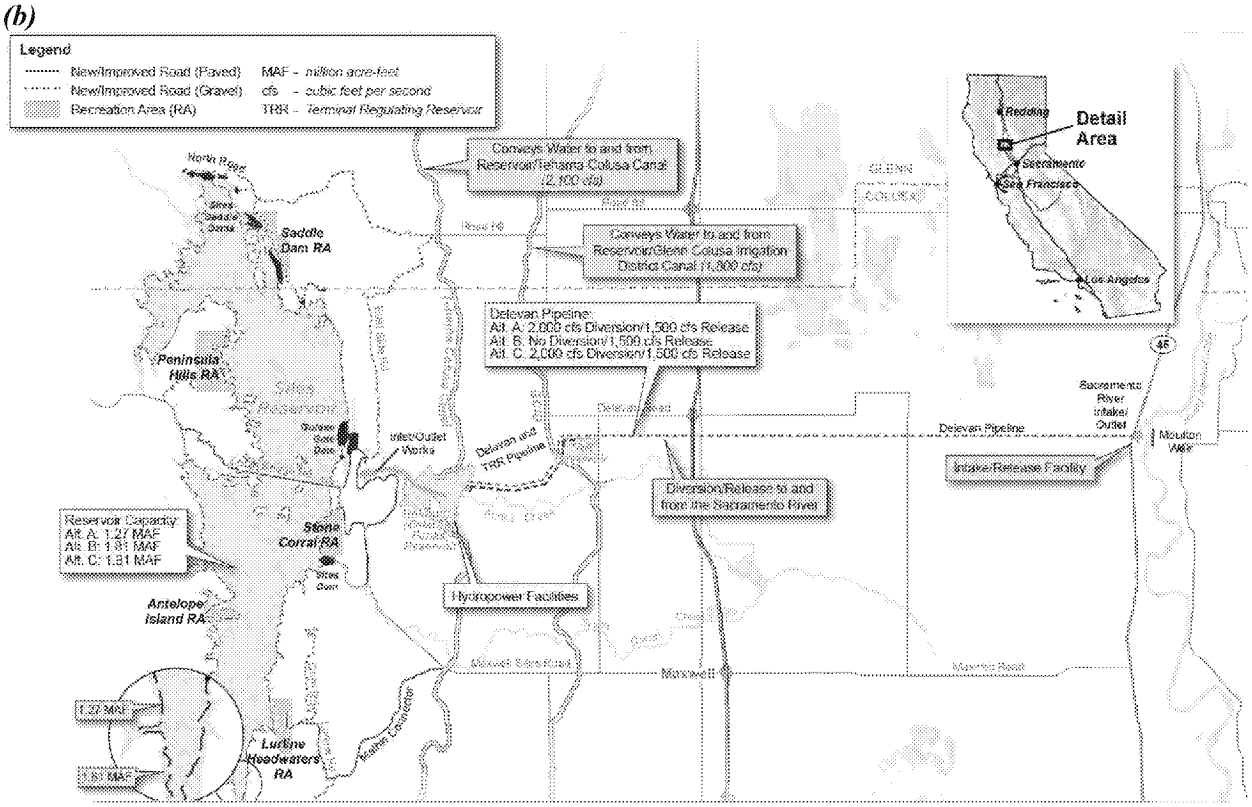


Figure 1.2: Artist's rendition of Sites Reservoir (a) and its location relative to the Sacramento River (b). Note: bottom panel (b) is for illustration purposes only, and is not intended to represent the final or preferred Plan Alternative. NODOS alternatives all include three conveyance facilities: TC Canal, GCID Canal and Delevan pipeline.

The North-of-the-Delta Offstream Storage (NODOS) Investigation is evaluating potential offstream surface water storage by constructing Sites Reservoir (pictured above) near the Sacramento River, downstream from Shasta Dam and west of Maxwell. The high-level project objectives are to:

- Improve water supply reliability for agricultural, urban, and environmental uses;
- Improve drinking, agricultural and environmental water quality in the Delta;
- Provide flexible hydropower generation to support integration of renewable energy sources; and
- Increase survival of anadromous and endemic fish populations.

The alternatives considered in this document are summarized in an October 1, 2010 memorandum, "Assumptions for Existing and Future No Action Alternative Conditions CALSIM II and DSM2 Models." The assumptions for the NODOS Alternatives are summarized in a January 5, 2011 document, "Definition of Proposed Alternatives for Evaluation in the North-of-the-Delta Offstream Storage Administrative Draft Environmental Impact Report and Statement." High level summaries of major alternatives are provided in Table 1-A.

Table 1-A: Interim Plan Formulation Alternatives – NODOS Investigation. Details subject to change. Information provided by the NODOS investigation planning team, DWR (August 2011).

Alternative	A	B	C
Storage Capacity			
Sites Reservoir	1.27 MAF	1.81 MAF	1.81 MAF
Conveyance Capacities *(to Sites Reservoir)*[1]			
Tehama-Colusa Canal	2,100 cfs	2,100 cfs	2,100 cfs
Glenn Colusa Irrigation District Canal	1,800 cfs	1,800 cfs	1,800 cfs
New Delevan Pipeline[2] Diversion Release	 2,000 cfs 1,500 cfs	 0 cfs[3] 1,500 cfs	 2,000 cfs 1,500 cfs
Operations Priorities *(Primary Planning Objectives)*			
Long Term *(all years)*	EESA[4] Power[5]	EESA[4] Power[5]	EESA[4] Power[5]
Driest Periods *(drought years)*	M&I	M&I	M&I
Average to Wet Periods *(non-drought years)*	Water Quality Level 4 Refuge Agricultural	Water Quality Level 4 Refuge Agricultural	Water Quality Level 4 Refuge Agricultural

Notes:
1. Diversions through the TC Canal, GCID Canal, and Delevan Pipeline are allowed in any month of the year.
2. New Delevan Pipeline can be operated June through March (April and May are reserved for maintenance).
3. A pump station, intake, and fish screens are not included for the Delevan Pipeline for Alternative B. For Alternative B, the Delevan Pipeline will be operated for releases only from Sites Reservoir to the Sacramento River year round.
4. Ecosystem Enhancement Storage Account (EESA) related operations are a function of specific conditions, and operating criteria that are defined uniquely for each action.
5. Includes dedicated pump/generation facilities with an additional dedicated after-bay/fore-bay (enlarged Funks Reservoir) used for managing conveyance of water between Sites Reservoir and river diversion locations.

Key:
cfs = cubic feet per second
CVP = Central Valley Project
EESA = ecosystem enhancement storage account
MAF = million acre-feet
M&I = municipal and industrial
SWP = State Water Project
TAF = thousand acre-feet

1.2.1 Ecosystem Enhancement Actions

The proposed NODOS alternatives include the following Ecosystem Enhancement Actions (EEAs):

Action 1. Improve the reliability of coldwater pool storage in Shasta Lake to increase the US Bureau of Reclamation's operational flexibility to provide suitable water temperatures in the Sacramento River (see Action 2 below). This action would operationally translate into the increase of Shasta Lake May storage

levels, and increased coldwater pool in storage, with particular emphasis on Below Normal, Dry and Critical water year types.

Action 2. Provide releases from Shasta Dam of appropriate water temperatures, and subsequently from Keswick Dam, to maintain mean daily water temperatures year-round at levels suitable for all species and life-stages of anadromous salmonids in the Sacramento River between Keswick Dam and Red Bluff Diversion Dam, with particular emphasis on the months of highest potential water temperature-related impacts (*i.e.*, July through November) during Below Normal, Dry and Critical water year types.

Action 3. Increase the availability of coldwater pool storage in Folsom Reservoir, by increasing May storage and coldwater pool storage, to allow the U.S. Bureau of Reclamation additional operational flexibility to provide suitable water temperatures in the lower American River. This action would utilize additional coldwater pool storage by providing releases from Folsom Dam (and subsequently from Nimbus Dam) to maintain mean daily water temperatures at levels suitable for juvenile steelhead over-summer rearing and fall-run Chinook salmon spawning in the lower American River from May through November during all water year types (not explicitly modeled in CALSIM II).

Action 4. Provide supplemental Delta outflow during summer and fall months (*i.e.*, May through December) to improve X2 (if possible, west of Collinsville, 81 km) and increase estuarine habitat, reduce entrainment, and improve food availability for anadromous fishes and other estuarine-dependent species (*e.g.*, delta smelt, longfin smelt, Sacramento splittail, starry flounder, and the shrimp *Crangon franciscorum*).

Action 5. Improve the reliability of coldwater pool storage in Lake Oroville to improve water temperature suitability for juvenile steelhead and spring-run Chinook salmon over-summer rearing and fall-run Chinook salmon spawning in the lower Feather River from May through November during all water year types. Provide releases from Oroville Dam to maintain mean daily water temperatures at levels suitable for juvenile steelhead and spring-run Chinook salmon over-summer rearing, and fall-run Chinook salmon spawning in the lower Feather River. Stabilize flows in the lower Feather River to minimize redd dewatering, juvenile stranding and isolation of anadromous salmonids.

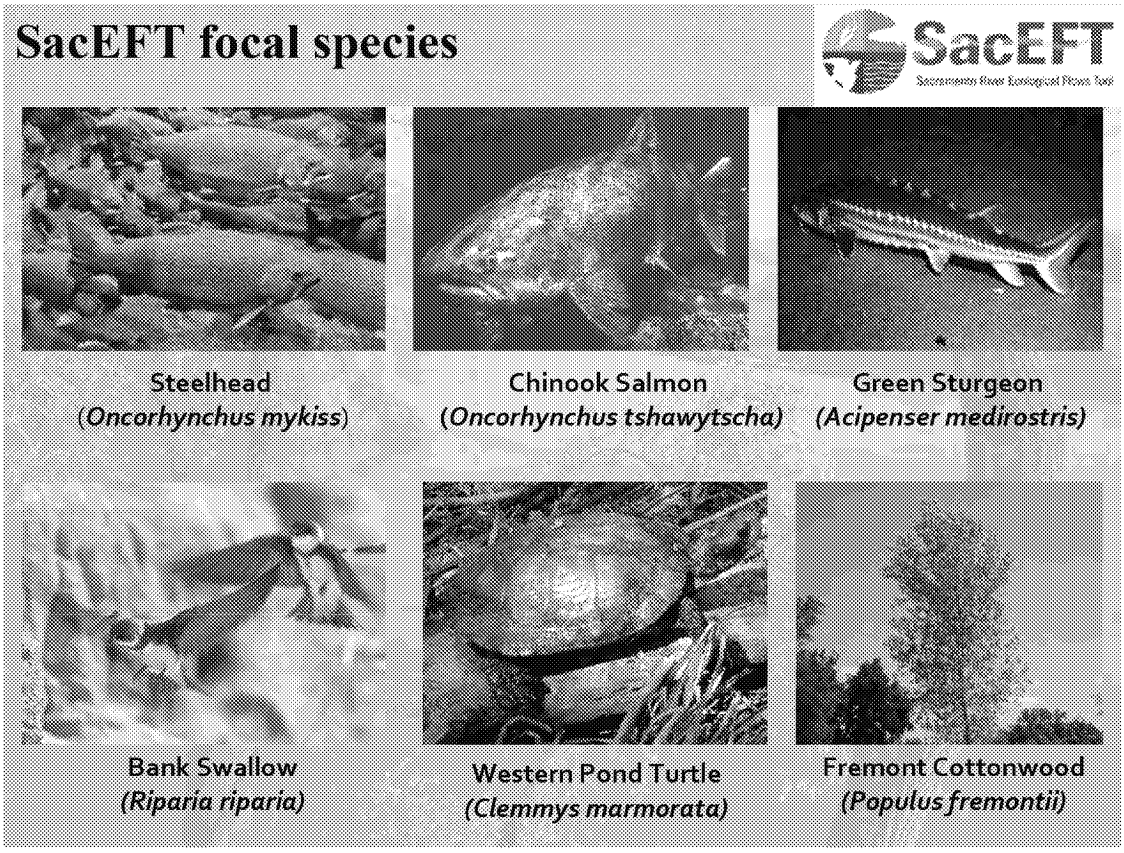
Action 6. Stabilize flows in the Sacramento River between Keswick Dam and the Red Bluff Diversion Dam to minimize dewatering of fall-run Chinook salmon redds (for the spawning and embryo incubation life-stage periods extending from October through March), particularly during fall months.

Action 7. Provide increased flows from spring through fall in the lower Sacramento River by reducing diversions at Red Bluff Diversion Dam (into the Tehama-Colusa Canal) and at Hamilton City (into the Glenn-Colusa Irrigation District Canal), and by providing supplemental flows (at Delevan). This action will provide multiple benefits to riverine and estuarine habitats, and to anadromous fishes and estuarine-dependent species (*e.g.*, delta smelt, splittail, longfin smelt, Sacramento splittail, starry flounder, and the shrimp *Crangon franciscorum*) by reducing entrainment, providing or augmenting transport flows, increasing habitat availability, increasing productivity, and improving nutrient transport and food availability.

2. Methodology and Assumptions

Details on SacEFT performance measure algorithms and their science foundation are beyond the scope of this document. Please refer to the SacEFT Record of Design for a complete description of model performance measures and assumptions (ESSA 2011).

2.1 SacEFT's Focal Species and Performance Measures



SacEFT's focal species and performance measures – discussed in detail in ESSA (2011) – are listed in Table 2-A. The sections that follow below provide a brief summary of SacEFT's focal species and performance measures.

Table 2-A: SacEFT focal species, ecological objectives, and performance measures.

Focal Species	Ecological Objectives	Performance Measures
Fremont cottonwood (FC)	Maximize areas available for riparian initiation, and rates of initiation success at individual index sites.	FC1 – Successful Fremont cottonwood initiation (incidence of cottonwoods initiated along a given cross section, at end of seed dispersal period) FC2 – Cottonwood seedling scour. Following years that have fair to good initiation success, evaluate the risk of seedling scour during the first year following successful initiation.
Bank swallow (BASW)	Maximize availability of suitable nesting habitats	BASW1 – Habitat potential/suitability. BASW2 – Risk of nest inundation and bank sloughing during nesting
Western pond turtle (WPT)	Maximize availability of habitats for foraging, basking, and predator avoidance	LWD1 – Index of old vegetation recruited to the Sacramento River mainstem.
Green sturgeon (GS)	Maximize quality of habitats for egg incubation	GS1 – Egg-to-larvae survival
Chinook salmon, Steelhead trout (CS)	Maximize quality of habitats for adult spawning	CS1 – Area of suitable spawning habitat (ft^2)
	Maximize quality of habitats for egg incubation	CS3 – Egg-to-fry survival (proportion) CS5 – Redd scour (Red/Yellow/Green hazard zones) CS6 – Redd dewatering (proportion)
	Maximize availability and quality of habitats for juvenile rearing	CS2 – Area of suitable rearing habitat (ft^2) CS4 – Juvenile stranding (index)

In addition to the SacEFT v.2 Record of Design (ESSA 2011), the Sacramento River Ecological Flows Study Final Report[1] (TNC *et al.* 2008) provides further background on hypotheses and linkages between riverine processes and biological responses for these species in SacEFT.

2.1.1 Aquatic Species and Performance Measures

Green Sturgeon Egg Survival (GS1)

Green sturgeon (*Acipenser medirostris*) eggs are susceptible to overheating during the April-July spawning and larval development period. Warm water temperatures during egg incubation increase the number of embryos that develop abnormally and reduce hatching success. Specifically, water temperatures above 17°C reduce egg survival and are lethal above 20°C. SacEFT uses daily water temperature at spawning index locations to simulate the proportion of survival for the larval young of year. Performance measure details and science foundation references are provided in the SacEFT v.2 Record of Design (ESSA 2011).

Chinook & Steelhead Spawning Habitat (ST1 / CH1)

Salmonids (4 seasonal run-types of Chinook (*Oncorhynchus tshawytscha*) plus steelhead trout (*Oncorhynchus mykiss*)) prefer to spawn in streams with a specific combination of water depth, velocity and gravel composition. SacEFT incorporates these preferences based on the River2D model and combines them with daily flow during the spawning period to calculate and report the weighted available habitat area for spawning, at up to 5 index sections of the Upper Sacramento River. The performance

[1] Available here: www.dfg.ca.gov/ERP/signature_sacriverecoflows.asp.

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measure is weighted by the relative density of adult spawners present throughout the species and run-specific spawning period. Performance measure details and science foundation references are provided in the SacEFT v.2 Record of Design (ESSA 2011).

There is a common misperception that habitat potential is equivalent to spawning abundance. This is not the case. In SacEFT, spawning habitat quality (ST1 / CH1) is indexed by Weighted Usable Area (WUA); which is derived from the River2D simulation model, fitted to data obtained and parameterized by Mark Gard (USFWS) (USFWS 2005a). River2D's calculations depend on spatially explicit measurements of velocity, depth and gravel size; laboriously measured over survey grids located on 5 index reaches of the Sacramento River. WUA is therefore a quantitative measure that incorporates location-specific quality (*e.g.*, preferred depth, velocity, gravel). Although River2D uses velocity and depth internally, both of those variables are parameterized so that only flow is required as input.

None of the Chinook or Steelhead performance measures in SacEFT include explicit treatment of spawning populations: they are measures of habitat potential only (not how many actual spawning Chinook/steelhead make use of this potential habitat). Further, although there are several linkages between some performance measures, there is no linkage between redd dewatering and spawning WUA: they are completely independent in their calculation. It is up to biologists to interpret the relative effects on overall smolt production associated with directional changes in the different spawning/egg/fry performance measures available in SacEFT. The idea being that "more good" is always better than "more bad" when integrated over multiple simulation years and performance measures. SacEFT allows users to pull out what attributes of the flow regime specifically generate "more good" (or "more bad") and then feedback those flow regime attributes as new/revised constraints to CalSim/USRDOM modellers for inclusion in the upfront hydrosystem models. We are able to do this for multiple focal species, fish and riparian performance measures.

Chinook & Steelhead Egg-to-Fry Survival (ST3 / CH3)

The developing eggs of salmonids (4 seasonal run-types of Chinook (*Oncorhynchus tshawytscha*) plus steelhead trout (*Oncorhynchus mykiss*)) have specific water temperature requirements to successfully mature. SacEFT uses relationships from the SALMOD model, along with daily water temperature at up to 5 index sections to simulate the maturation and proportional survival of developing eggs. The performance measure is weighted by the relative density of eggs present in spawning redds. Performance measure details and science foundation references are provided in the SacEFT v.2 Record of Design (ESSA 2011).

Chinook & Steelhead Redd Dewatering (ST6 / CH6)

Spawning redds contain the developing eggs of salmonids (4 seasonal run-types of Chinook (*Oncorhynchus tshawytscha*) plus steelhead trout (*Oncorhynchus mykiss*)) and are susceptible to declining flows that expose and desiccate the redds. SacEFT incorporates empirical relationships developed from GIS models to calculate the proportion of redd habitat exposed during periods of declining flows. Performance measure details and science foundation references are provided in the SacEFT v.2 Record of Design (ESSA 2011).

Chinook & Steelhead Redd Scour (ST5 / CH5)

Spawning redds contain the developing eggs of the 4 season run-types of Chinook (*Oncorhynchus tshawytscha*) in SacEFT plus steelhead (*Oncorhynchus mykiss*) and are susceptible to extremely high flow events that mobilize the gravel of the redd, killing portions of the developing eggs/embryos. SacEFT combines these high flow events with the species and run-type specific spawning and egg development calendar to calculate and report the frequency of high flow events at times and locations when the

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developing embryos are most sensitive. Performance measure details and science foundation references are provided in the SacEFT v.2 Record of Design (ESSA 2011).

Chinook & Steelhead Juvenile Stranding (ST4 / CH4)

Free swimming juvenile salmonids (4 seasonal run-types of Chinook (*Oncorhynchus tshawytscha*) plus steelhead trout (*Oncorhynchus mykiss*)) typically reside in their natal stream for 3 to 12 months after emerging from the gravel. During this period they are susceptible to declining flows that may strand them in side channels exposing them to high water temperatures, desiccation and other factors heightening rates of mortality. SacEFT incorporates empirical relationships developed from GIS bathymetric models to calculate an index at up to 5 sections of the Sacramento River of the proportion of juveniles exposed to stranding during periods of declining flow. The performance measure is weighted by the relative density of juvenile fish present during the species and run-specific rearing period. Performance measure details and science foundation references are provided in the SacEFT v.2 Record of Design (ESSA 2011).

Chinook & Steelhead Juvenile Rearing Habitat (ST2 / CH2)

Juvenile salmonids (4 seasonal run-types of Chinook (*Oncorhynchus tshawytscha*) plus steelhead trout (*Oncorhynchus mykiss*)) prefer to rear in streams with a specific combination of water depth and velocity. SacEFT incorporates these preferences from the River2D model and combines them with daily flow during the rearing period to calculate and report the weighted available habitat area for rearing, at up to 5 index sections of the Upper Sacramento River. The performance measure is weighted by the relative density of juvenile fish present during the species and run-specific rearing period. Performance measure details and science foundation references are provided in the SacEFT v.2 Record of Design (ESSA 2011).

2.1.2 Riparian Species and Performance Measures

Fremont Cottonwood Initiation (FC1)

Fremont cottonwood (*Populus fremontii*) establishes in riparian areas where young seedlings require a continuous supply of groundwater to their growing tap root in order to survive during their first spring and summer (seedling initiation). Groundwater moisture is driven by the water table of the adjacent river, and successful initiation depends on a stage recession rate that matches the seedling's ability to grow a tap root. Historically, good initiation years happen about once or twice in every ten years, and SacEFT records and reports the number of successful initiation events at selected index cross sections along the Sacramento River. Performance measure details and science foundation references are provided in the SacEFT v.2 Record of Design (ESSA 2011).

Fremont Cottonwood Scour (FC2)

Newly initiated (but not yet "established") Fremont cottonwoods (*Populus fremontii*) seedlings are susceptible to high flow events that inundate the seedlings and mobilize the gravel and sand containing their root system. In SacEFT, scour risk is quantified by determining whether flow thresholds are exceeded in the first following fair or good initiation (FC1) years. Performance measure details and science foundation references are provided in the SacEFT v.2 Record of Design (ESSA 2011).

Bank Swallow Habitat Potential (BASW1)

Bank swallows (*Riparia riparia*) nest and rear their young in burrows along the river banks and prefer soils with particular characteristics, burrowing depth, and burrow age. Burrows remain habitable for about 3 years and are abandoned after that, due to ectoparasites and other factors which degrade the quality of burrows over time). The meandering of (unrocked) rivers occurs naturally during high flow events, which renews old and creates new bank swallow burrowing/nesting areas. Coupled to a river Meander Migration

model, SacEFT simulates and reports the length of suitable bank habitat areas produced annually, at a number of representative index locations. Performance measure details and science foundation references are provided in the SacEFT v.2 Record of Design (ESSA 2011).

Bank Swallow Nest Inundation (BASW2)

During their spring and early summer nesting period, bank swallows (*Riparia riparia*) and their young are susceptible to extremely high flows that can inundate their nesting burrows drowning the nestlings. SacEFT tracks high flow events known to be associated with dangerously high river stage elevations. During the nesting period these flows and water levels, while potentially creating future nesting sites, will induce high mortality for the current year's cohort of nesting bank swallows. Performance measure details and science foundation references are provided in the SacEFT v.2 Record of Design (ESSA 2011).

Large Woody Debris Recruitment (LWD1)

Large woody debris is an important habitat requirement for western pond turtles (*Actinemys marmorata*) and is used as a proxy measurement for potential habitat quality in the mainstem Sacramento River. While western pond turtles utilize oxbow habitats and sloughs, they are also capable of utilizing the mainstem Sacramento River under appropriate conditions. To calculate the amount of Large Woody Debris recruited to the mainstem Sacramento River, SacEFT incorporates results from its spatially explicit bank erosion model combined with GIS mapping of mature forest vegetation, to provide a calculation of the amount of older vegetation added to the river each year. As with the BASW1 performance measure, bank erosion calculations are driven by the Meander Migration model. Performance measure details and science foundation references are provided in the SacEFT v.2 Record of Design (ESSA 2011).

2.2 Ecological Flows Tool – Core Concepts

Scientifically, SacEFT takes a bottom-up, process-based approach to the relationship between flow and related aquatic habitat variables, and looks at how these variables are tied to key species life-stages and ecosystem functions. SacEFT focal species and performance measures were selected using a rigorous vetting model combined with expert workshops and reviews (ESSA 2011). Each focal species has a defined conceptual model, within which specific biophysical linkages (performance measure algorithms) were selected for inclusion in SacEFT (ESSA 2011). This provides a multi-species, multi-performance measure approach for assessing how different flow and habitat restoration combinations suit the different life stages of desired species. In so doing, SacEFT transparently relates additional attributes of the flow regime to multiple species' life-history needs in an overall effort at careful organization of *representative* functional flow needs.

Most of SacEFT's 12 performance measures are calculated on a daily time-step at several index locations/river segments. Naturally, these daily calculations come in many different units appropriate to the performance measure (*e.g.*, square feet of suitable habitat, survival rates, counts of surviving cottonwood seedlings, *etc.*). The daily calculations for most aquatic performance measures (see above) are weighted by the appropriate life-history distribution as well as differences in habitat quantity/quality amongst the modeled index sites. For example, if a sudden dramatic low flow event occurs at the very beginning or very end of the egg incubation period for a particular run of Chinook, the weighted effect on the overall cumulative redd dewatering performance measure (ST6/CH6) will be negligible.

The SacEFT model is intended to be applied in multi-decadal simulations. For all 12 performance measures, annual cumulative weighted performance measure values are calculated for historic (observed) flows and water temperatures from WY1938–2003. These "annual roll-up" values for each performance

measure are then assigned a "good" (green), "fair" (yellow), or "poor" (red) performance measure rating (*e.g.*, Figure 2.1).

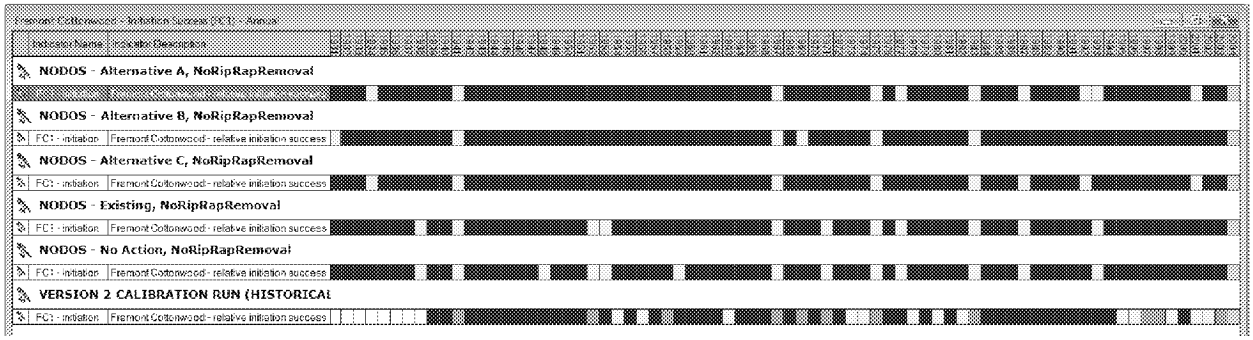

Figure 2.1: Typical SacEFT output showing annual roll-up results for the Fremont cottonwood initiation (FC1) performance measure. Analogous plots are available for all of the tools' focal species and performance measures.

These annual performance measure ratings are based on thresholds[1] defined by sorting cumulative annual results produced by SacEFT for historic observed flows and water temperatures between WY1938 and 2003 (*e.g.*, Figure 2.2). The "units" of these plots vary with the performance measure (see ESSA 2011). In this way, historic observed flows/temperatures provide the de facto "calibration scenario" for SacEFT's 12 focal species performance measures.

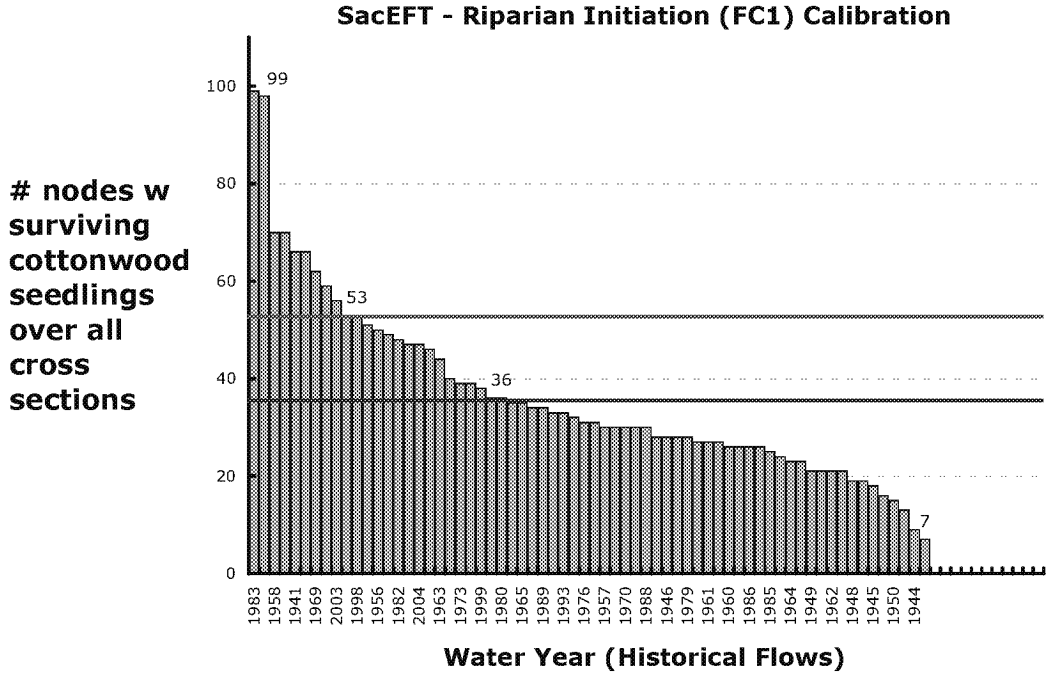

Figure 2.2: Annual roll-up results for the SacEFT Fremont cottonwood initiation (FC1) performance measure run using historic observed flows (WY1938–2003). This calibration also takes into consideration comparisons with aerial photographs of historically strong Cottonwood recruitment at study sites *vs.* model results.

[1] Indicator thresholds in SacEFT are fully configurable via settings found in the SacEFT relational database.

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Our concept of indicator threshold calibration in SacEFT focuses on historical data. From an ecological standpoint, aquatic and riparian species are adapted to a historical range and frequency of variations in their habitats. Taken to the extreme, historical conditions would ideally include pre-settlement (natural) flows/water temperatures that represented 'typical' conditions experienced over evolutionarily significant windows of time. The closest flow/temperature time series that we have available to this evolutionarily representative condition is the range of variation in historical observed flows/temperatures (approximately 66 years). It is recognized that during WY1938–2003 the Sacramento River experienced a number of waves of human and structural development and operational changes to the hydrosystem. Nevertheless, these flows and temperatures, derived from measurements, actually occurred in recent history and encompass repeat episodes of multiple water year types. Calibrating SacEFT indicator thresholds to a future no action or 'existing' scenario that includes a fixed set of hydrosystem features, constraints, operating regulations and assumed human demands would create a "self-fulfilling prophecy" inconsistent with SacEFT's underlying natural flow regime science foundation. In general, all of the models used in the NODOS Investigation are calibrated based on historical information.

The preferred method for calibrating the indicator thresholds is to identify historical years for each performance measure that were known (in nature) to have experienced 'good' or 'poor' performance. Unfortunately, our *repeat* survey efforts of fisheries experts (*e.g.*, Mark Gard, USFWS, *pers. comm.*2011; Matt Brown, USFWS, *pers. comm.* 2011 amongst many others) and a questionnaire sent to fisheries biologists prior to the 2008 SacEFT v.1 review workshop revealed there are no known synoptic studies of this kind for many of the indicators in SacEFT. Because of this gap and the hesitancy of experts to reveal their opinions, we instead defaulted to the distribution of sorted weighted annual results and selected tercile break-points (the lower-, middle- and upper thirds of the sorted distribution) to categorize results into "Good" (Green), "Fair" (Yellow) or "Poor" (Red) categories. While this method provides a fully internally consistent method of comparing scenario results (*i.e.*, will always provide an accurate picture of which water management scenarios are "better" than another), it does not *necessarily* provide a concrete inference about the biological significance of being a "Poor" (Red) or "Good" (Green) category. For example, it is possible that a year that ranks as "Good" (Green) with this method may still be biologically suboptimal. Conversely, a year that ranks as "Poor" (Red) may be biologically insignificant (*i.e.*, not biologically unacceptable).

The challenge of identifying "acceptable" and "unacceptable" changes in habitat conditions or focal species performance measures confronts all biological effects analysis methods. SacEFT makes these inherent value judgments explicit in the model's summary outputs. Future analyses using SacEFT look forward to ecological effects analysis experts themselves providing clearer guidance on the (readily configurable) thresholds in the SacEFT modeling system. Readers interested in further details on SacEFT indicator thresholds are directed to Appendix B.

We note that none of the NODOS Investigation alternative modelling results are compared against the historical calibration due to the focus of CEQA/NEPA which emphasizes isolating project alternative effects as compared to a no action reference or existing condition comparison. Comparisons that include historical data reveal different information in a different context that does not address a specific project effect relative to the no action alternative or existing condition reference case. Comparisons that include historic calibration data identify the ecological effects of the future system operations and constraints relative to historic conditions. In fully considering ecological flow needs, the magnitude of departure from these historic conditions may reveal important information on how future constraints, climate and/or hydrosystem operational modifications are influencing preferred ecological flow targets.

The highest level synthesis concept in SacEFT is that of a "multi-year roll-up". This is the percentage of years in the simulation having favorable (green), fair (yellow), and poor (red) conditions (*e.g.*, Figure 2.3).

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Fremont Cottonwood - Initiation Success (FC1) - Roll-Up

ScenarioID	Indicator Name	Indicator Description	Cross Passed	Multi Year Rollup	% Poor	% Marg.	% Good
NODOS - Alternative A, NoRipRapRemoval							
NODOS - Alternative B, NoRipRapRemoval							
139	FC1 - initiation	Fremont Cottonwood - relative initiation success	20		91	9	0
NODOS - Alternative C, NoRipRapRemoval							
140	FC1 - initiation	Fremont Cottonwood - relative initiation success	20		88	12	0
NODOS - Existing, NoRipRapRemoval							
132	FC1 - initiation	Fremont Cottonwood - relative initiation success	20		87	13	0
NODOS - No Action, NoRipRapRemoval							
134	FC1 - initiation	Fremont Cottonwood - relative initiation success	20		83	17	0
VERSION 2 CALIBRATION RUN (HISTORICAL)							
118	FC1 - initiation	Fremont Cottonwood - relative initiation success	20		63	20	17

Figure 2.3: Typical SacEFT output showing multi-year roll-up results for the Fremont cottonwood initiation (FC1) performance measure. Analogous plots are available for all of the tools' focal species and performance measures.

SacEFT also provides daily results within individual years at the specific index locations for the majority of its performance measures (*e.g.*, Figure 2.4). A variety of other forms of detailed daily results are contained in SacEFT's relational database tables.

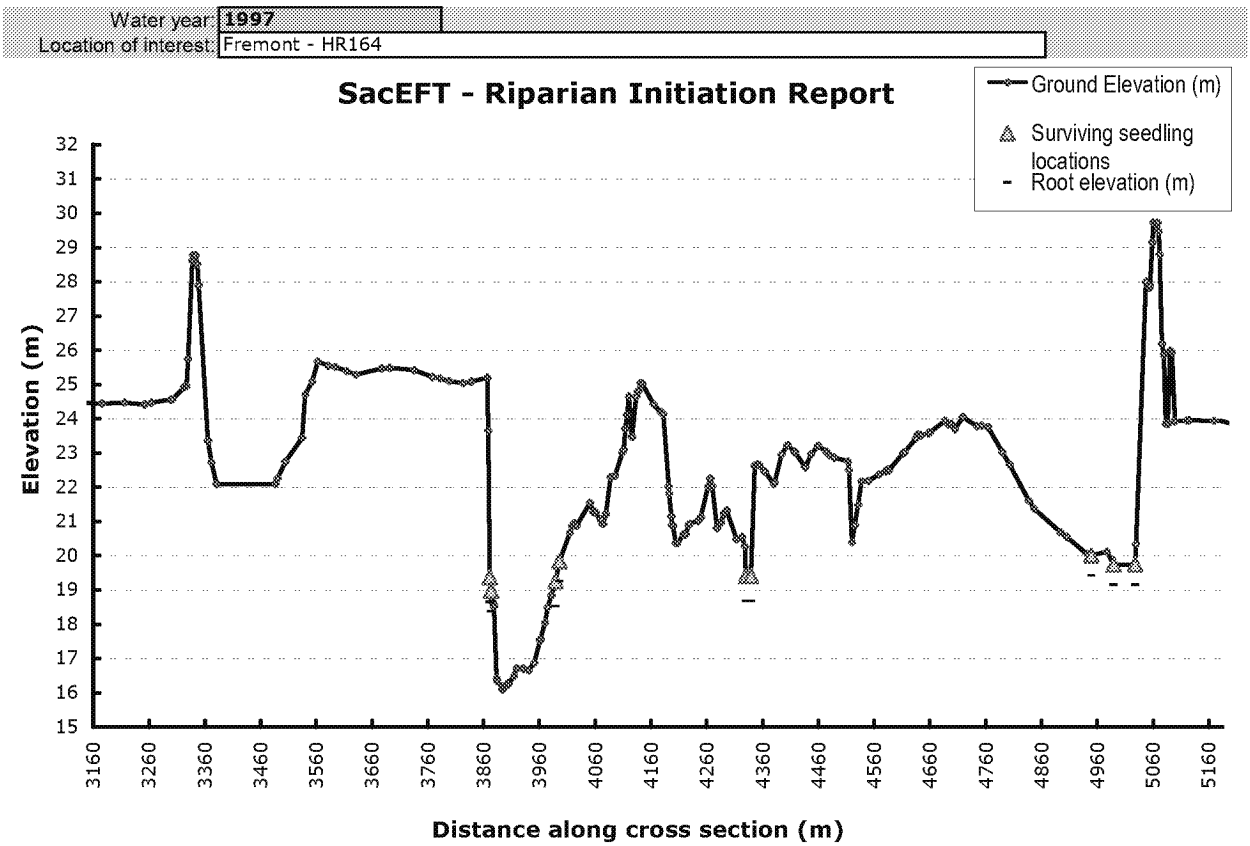

Figure 2.4: Example SacEFT output report showing results for the Fremont cottonwood initiation (FC1) performance measure at a specific cross-section at the conclusion of the seed dispersal period in WY1997.

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2.3 Locations of Interest and Life-History Timing Assumptions

The spatial extent of SacEFT includes the mainstem Sacramento River at RM 301 (Keswick) downstream to RM 143 (Colusa) (Figure 2.5). Specific locations identified in SacEFT are chosen based on three factors:

1. their biological importance (*e.g.*, what is the current or historic range for a focal species?);
2. the areas where we have reliable *biological* relationships (focal species models); and
3. the feasibility of obtaining or producing the *physical* variables required for focal species submodels at these biologically relevant sites (*e.g.*, where have stage-discharge relations and channel cross-section profiles been developed?).

The overlap between these three considerations determines the spatial extent of performance measures throughout SacEFT's 158 mile study area.

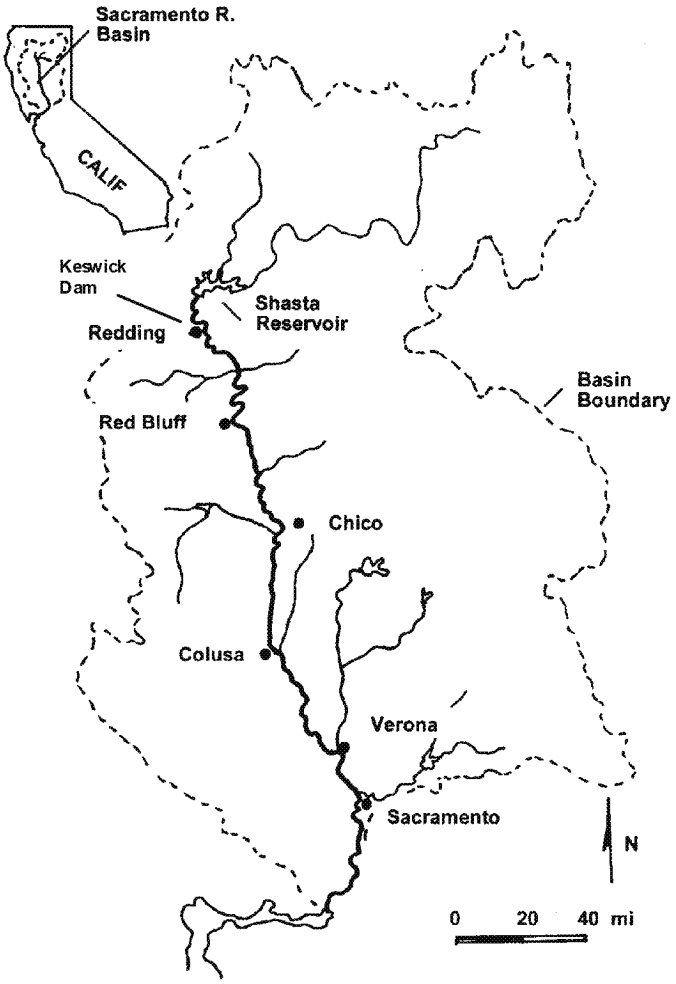

Figure 2.5: Map of the Sacramento River watershed and study area over which the SacEFT will be applied, from Keswick Dam (RM 301) to Colusa (RM 143) (CALFED Bay-Delta Program 2000).

Table 2-B provides a summary of the spatial locations for non-salmonid performance measures and the extent of linked physical datasets and external models. Performance measures for the species are summarized in Table 2-A. The analogous summary for salmonid performance measures is provided in

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Table 2-C. Performance measure location details are provided in the SacEFT v.2 Record of Design (ESSA 2011).

The temporal resolution of SacEFT varies by submodel, ranging from specific events occurring at daily resolution (*e.g.*, changes in flow and stage) to performance measures that obtain their meaning when viewed over annual and longer time scales. Typical SacEFT simulations run between 65 and 82 years.

Table 2-E summarizes the life-history timing that is relevant to the various focal species performance measures. In the case of Chinook and steelhead spawning time, closely follows the timing and spread used by Bartholow and Heasley (2006) for the SALMOD model; a distribution which is in turn based on Vogel and Marine (1991). Performance measure timing details are provided in the SacEFT v.2 Record of Design (ESSA 2011).

Table 2-B: Spatial location and extent of physical datasets, linked models and performance measures for the non-salmonid focal species. Performance measures (PMs) for the species are summarized in Table 2-A. Vertical bars denote PMs that are simulated for river segments; dots denote those that are simulated (measured in the case of gauges) at points along the river. Q = river discharge. T = water temperature. Annotation details are listed in Table 2-D.

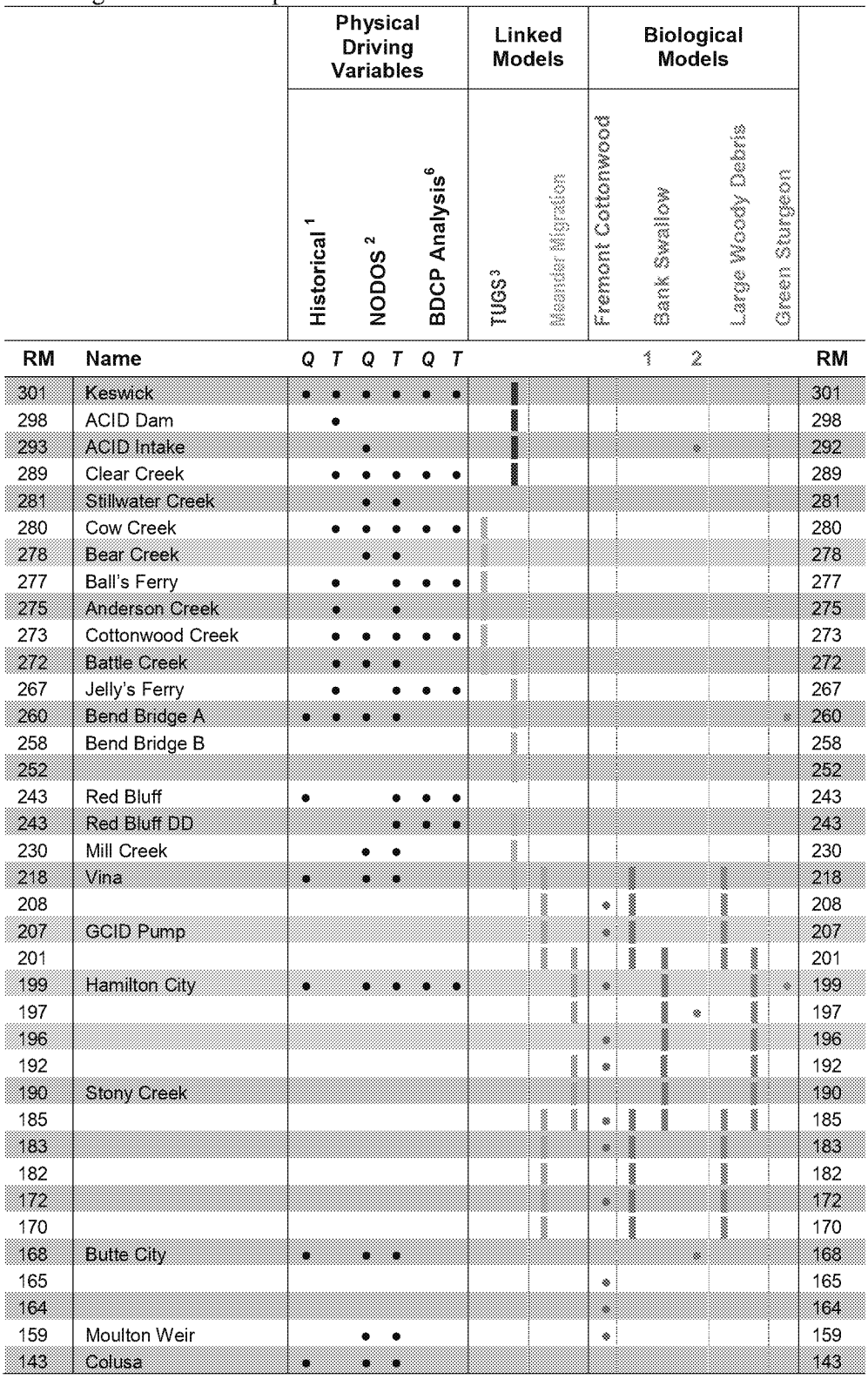

Table 2-C: Spatial location and extent of physical datasets, linked models and performance measures for the salmonid focal species. Performance measures (PMs) for the species are summarized in Table 2-A. Vertical bars denote PMs that are simulated for river segments; dots denote those that are simulated (measured in the case of gauges) at points along the river. Q = river discharge. T = water temperature. Annotation details are listed in Table 2-D.

		Physical Driving Variables						Linked Models		Biological Models									
										Chinook & Steelhead Spawning & Egg Stage PMs [4]					Chinook Steelhead Juvenile Rearing Stage PMs				
		Historical [1]		NODOS [2]		BDCP Analysis [5]		TUGS [3]	Meander Migration	*Spring*	*Fall*	*Late Fall*	*Winter*	*Steelhead*	*Spring*	*Fall*	*Late Fall*	*Winter*	*Steelhead*
RM	**Name**	*Q*	*T*	*Q*	*T*	*Q*	*T*												
301	Keswick	•	•	•	•	•	•												
298	ACID Dam		•																
293	ACID Intake			•															
289	Clear Creek		•	•	•	•	•												
281	Stillwater Creek			•	•														
280	Cow Creek		•	•	•	•	•												
278	Bear Creek			•	•														
277	Ball's Ferry		•		•	•	•												
275	Anderson Creek		•		•														
273	Cottonwood Creek		•	•	•	•	•												
272	Battle Creek		•	•	•														
267	Jelly's Ferry		•		•	•	•												
260	Bend Bridge A	•	•	•	•														
258	Bend Bridge B																		
252																			
243	Red Bluff	•			•	•	•												
243	Red Bluff DD				•	•	•												
230	Mill Creek			•	•														
218	Vina	•		•	•														
207	GCID Pump																		
201																			
199	Hamilton City	•		•	•	•	•												
197																			
192																			
190	Stony Creek																		
185																			
183																			
182																			
172																			
170																			
168	Butte City	•		•	•														
165																			
164																			
159	Moulton Weir			•	•														
143	Colusa	•		•	•														

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Table 2-D: Annotations for Table 2-B and Table 2-C.

[1] The common time span of Historic discharge (Q) data is 1-Oct-1938 to 30-Sep-2004. The common time span of Historic temperature (T) data is 1-Jan-1970 to 31-Dec-2001.

[2] The common time span of the NODOS scenario analyses performed in April 2011 include discharge (Q) and temperature (T) data between 1-Oct-1921 to 30-Sep-2003.

[3] TUGS simulations (Cui 2007) shown in red actually comprise 5 distinct reaches between RM 301 and RM 289. TUGS results are not available downstream from Cow Creek but are necessary for linkage to Chinook and Steelhead spawning Weighted Usable Area (WUA) (CS1). TUGS relationships for these downstream segments (pink) are mapped from the nearest upstream location, as described in ESSA (2011).

[4] Chinook and Steelhead *spawning* WUA relationships shown in pale blue are mapped from the closest downstream segment, as described in ESSA (2011). Spring Chinook habitat preferences are assumed to follow those of fall Chinook. Chinook *rearing* WUA relationships shown in pale blue are mapped from the closest upstream section, as describe in ESSA (2011).

[5] The BDCP analysis performed in June of 2010 included a subset of PMs: Chinook, Steelhead and green sturgeon in the region from Keswick to Hamilton City only.

The Meander Migration model is based on empirical river centerlines measured in 2004. For the meander (and bank erosion) simulations, WY1922 NODOS flows were applied starting with the 2004 river centerlines and this centerline run forwards for 82 years. Note that the first year of the simulation results (WY1922) was not included in SacEFT due to numerical instability of the meander migration results prior to burn-in. As a result, SacEFT results for NODOS are displayed beginning in WY1923. For the historical case, results are run forward for 65 years beginning in WY1939.

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Table 2-E: Summary of the life-history timing information relevant to the SacEFT focal species. Only those performance measures requiring information on life history timing are included here. Abbreviations of performance measures (PMs) are described in Table 2-A. Time intervals marked with heavy color denote periods of greater importance to focal species. In the case of the spawning PMs (CS-1), heavily shaded regions denote for each salmonid run-type/species the period between the 25th and 75th percentile, when half the spawning takes place. In the case of the other salmonid PMs, the heavily shaded regions denote the period between the 25th and 75th percentile of the population are present. Specific timing of CS-2, 3, 4, 5, 6 depends on ambient water temperature and varies with discharge scenario and year. Juvenile residency is defined by a fixed 90 day period following emergence for Chinook and a 365 day period for steelhead. This table is based on SALMOD (Bartholow and Heasley 2006, ultimately Vogel and Marine 1991). Salmonid timing values shown here are typical and may shift by as much as five days earlier or later, depending on year and reach. Timing values for green sturgeon, cottonwood and bank swallow are based on workshop discussions, and all values are under user control.

Performance Measure & Timing Relevance		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CS - 1	**Spring Chinook** Spawning												
CS - 3,5,6	Egg Development Period												
CS - 2,4	Juvenile Period												
CS - 1	**Fall Chinook** Spawning												
CS - 3,5,6	Egg Development Period												
CS - 2,4	Juvenile Period												
CS - 1	**Late fall Chinook** Spawning												
CS - 3,5,6	Egg Development Period												
CS - 2,4	Juvenile Period												
CS - 1	**Winter Chinook** Spawning												
CS - 3,5,6	Egg Development Period												
CS - 2,4	Juvenile Period												
CS - 1	**Steelhead** Spawning												
CS - 3,5,6	Egg Development Period												
CS - 2,4	Juvenile Period												
GS1	**Green Sturgeon Spawning**												
FC1	**Fremont Cottonwood** Seedling initiation												
BASW1	**Bank Swallow** Habitat												
BASW2	Ramping Rates												

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2.4 Special Conditions and Limitations

Although the NODOS Investigation alternatives provide daily flow and temperature data for the WY1922–2003 period, most of the salmonid results from SacEFT in this analysis are unavailable prior to WY1939. This gap is a consequence of the required linkage between the calculation of spawning habitat and streambed gravel grain size-distribution. SacEFT requires annual estimates of the gravel grain size-distribution at each of 5 river segments in order to calculate the weighted useable area available for spawning (ST1/CH1). This habitat estimate is then used as one of the inputs to calculate subsequent performance measures for egg maturation, survival, and juvenile rearing. In the absence of gravel data, no calculations are possible for these linked components. For previous model analyses using SacEFT, colleagues at Stillwater Sciences calibrated and ran The Unified Gravel & Sand (TUGS) model (Cui 2007) over the WY1939-2004 period and provided this information for input to a number of SacEFT scenarios that all used this common time-frame. TUGS simulates changes in grain size of the river by accounting for how its sediment flux interacts with sediment in both the surface and subsurface of the channel bed. Time constraints for the current investigation prevented this level of engagement with Stillwater Sciences, and we were therefore required to re-use the "default historical gravel" scenario data (Stillwater Sciences 2007). This data was applied starting in WY1939 in the NODOS alternatives to ensure that the time series lengths matched. This is a known limitation of the results for the ST1/CH1 performance measures in this analysis, but does not have a significant bearing on the other 5 ST/CH performance measures.

2.5 Focal Comparisons

DWR and the US Bureau of Reclamation NODOS Investigation team have defined the storage and conveyance alternatives for evaluation in the North-of-the-Delta Offstream Storage Draft Environmental Impact Report and Statement (DEIR/EIS). These alternatives are described in section 1.2. Results of the SacEFT ecological effects analysis are organized by species for the following eight comparisons:

Comparison	NODOS Alternative (SacEFT ID)	Compared to (SacEFT ID)
1	No Action Alternative (134)	Existing Conditions (132)
2	A (136)	Existing Conditions (132)
3	A (136)	No Action Alternative (134)
4	B (139)	Existing Conditions (132)
5	B (139)	No Action Alternative (134)
6	C (140)	Existing Conditions (132)
7	C (140)	No Action Alternative (134)
8*	No Action Alternative (134)	Historic conditions (118)

*This is not a recognized EIS/EIR comparison. CEQA/NEPA which emphasize isolating project alternative effects as compared to a No Action reference or Existing condition comparison.

Comparison 8 is not used in our report to assess NODOS effects. Instead, it provides an essential reference case illustrating how SacEFT's various performance measures have performed under historic flows and water temperatures from WY1938–2003. Relative to future hydrosystem operations, these flows represent more natural patterns of variation in flow and water temperature that have occurred historically.

2.5.1 SacEFT Gravel Augmentation and Bank Protection Alternatives

In addition to analyzing the NODOS alternative flow and water temperature regimes, SacEFT enables comparisons of gravel augmentation and rock removal restoration actions. The NODOS alternatives, including the No Action Alternative, do not include gravel augmentation or bank protection

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modifications. SacEFT scenarios shown in this report that involve these modifications are for demonstration purposes only and will not be considered in the EIS/EIR or Feasibility Report.

For the current SacEFT NODOS effects analysis, we used the "No Gravel" TUGS dataset developed using historical flow data at Keswick (RM 301) to define how substrate composition changes in the simulations. This scenario involves modest historical gravel injections and assumptions about the initial sediment storage (Stillwater Sciences 2007)[1]. The TUGS dataset for the historical gravel injection case then evolves according to the inherent grain-size specific sediment transport calculations contained in the TUGS model (Cui 2007).

Likewise, for the present SacEFT NODOS study, bank erosion modeling repeated both (a) the existing channel armoring (Figure 2.6 to Figure 2.8) and (b) the selected rip-rap removal alternative defined during the Flows Study project (Larsen 2007). Five sites (2-6) that fall within the SacEFT study area were identified as good candidates for revetment removal. Again, the NODOS alternatives, including the No Action Alternative, do not include rip rap removal and are shown for demonstration purposes only and will not be considered in the EIS/EIR or Feasibility Report. Table 2-F includes descriptions of the criteria used to choose the sites, relevant studies related to the sites. These conditions have a direct bearing on riparian model performance measures (bank swallow and LWD recruitment). Conversely, these assumptions do not influence SacEFT's aquatic performance measure results. SacEFT results including the label "NoRipRapRemoval" refer to the existing 2004 channel and existing 2004 revetment (no change to bank protection) while scenarios with the label "RipRapRemoval" refer to selected removal of rock at specific locations (Larsen 2007).

[1] See Gravel Study Final Report (available at www.dfg.ca.gov/ERP/signature_sacriverecoflows.asp), Sections 2.5 and 3.5 for details.

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Table 2-F: Potential revetment removal sites on the middle Sacramento River. Sites 2-6 define the "rip rap removal" scenario in SacEFT. For details see Larsen (2007).

POTENTIAL REVETMENT REMOVAL SITES ON THE MIDDLE SACRAMENTO RIVER								
Site No.	**Site Name**	**River Mile**	**Length (meters +/-)**	**Adjoining Landowner**	**Revetment Material**	**Description / Notes**	**Relevant Meander Analysis**	**Data Number on Google Earth File**
1	La Barranca	240.5R	550	USFWS - La Barranca Unit, Sacramento River NWR	Medium rock	Lower 1/3 of a larger revetment area is adjacent to La Barranca Unit, removal would also take pressure of rock at 240L	A	Reach 2 - 981
2	Kopta Slough	220-222R	1775	State Controller's Trust (TNC is lessee)	Medium rock	Area is being converted to habitat, removal would help redirect erosion from State Recreation Area and County bridge, substantial planning work has occurred	A, B	Reach 2 - 5819
3	Rio Vista	216-217L	1425	USFWS - Rio Vista Unit, Sacramento River NWR	Large rock, privately installed	Rock was installed to protect agriculture, the area is now converted to habitat	A	Reach 2 - 1069, 1183, 4674
4	Brayton	197-198R	600	CDPR, Bidwell-Sac River St Park, Brayton property	Large rubble, privately installed	Rock was installed to protect agriculture, the area is planned to be converted to habitat, consider effect on the road to the east but geologic control should limit meander	A, C	Reach 2 - 2007
5	Phelan island	191-192R	1410	USFWS, Phelan Island Unit and Sac & San Joaquin Drainage Dist.	Medium rock, USACE installed in 1988	Area has been converted to habitat, consider possible Murphy's Slough cutoff / flood relief structure concerns	A, C, E	Reach 3 - 4626
6	Llano Seco Riparian Sanctuary	179R	1300	USFWS, Phelan Island Unit and Sac & San Joaquin Drainage District and small area of private property	Medium rock, USACE installed in 1985 & 87	Rock removal potential identified as part of Lano Seco Riparian Sanctuary planning project as part of a solution to fish screen concerns at Princeton, Codora/ Provident pumping plant at RM 178R	D	Reach 3 - 2805, 1422
	Initial screening and review included staff from DWR Northern District, Sacramento River Conservation Area Forum and The Nature Conservancy							
	Criteria for Revetment Removal Identification							
	1. Revetment is adjacent to public or conservation ownership land							
	2. Revetment is not protecting important public infrastructure							
	3. Revetment removal does not create an obvious flood hazard							
	4. Revetment is currently limiting meander on lands in the historic meander belt							
	5. Revetment removal could result in ecosystem benefit: land reworking/creation of riparian habitat, creation of new bank swallow habitat, recruitment of spawning gravel, new shaded riverine aquatic habitat, etc.							
	5. Revetment removal could help direct meander to protect public infrastructure (if applicable)							
	Relevant Meander Analysis References							
	A. Department of Water Resources, Northern District, 1991, 25 and 50-year erosion projections for the Sacramento River.							
	B. Larsen, Eric, 2002. Modeling Channel Management Impacts on River Migration: A Case Study of Woodson Bridge state Recreation Area, Sacramento River, USA. University of California, Davis, Davis, California.							
	C. Larsen, Eric, 2002. The Control and Evolution of Channel Morphology of the Sacramento River: A Case Study of River Miles 201-185. University of California, Davis, Davis, California.							
	D. Larsen, Eric, 2004. Meander Bend Migration near River Mile 178 of the Sacramento River. University of California, Davis, Davis, California.							
	E. Larsen, Eric, 2005. Future Meander Bend Migration and Floodplain Development Patterns near River Miles 200 to 191 of the Sacramento River. University of California, Davis, Davis, California.							

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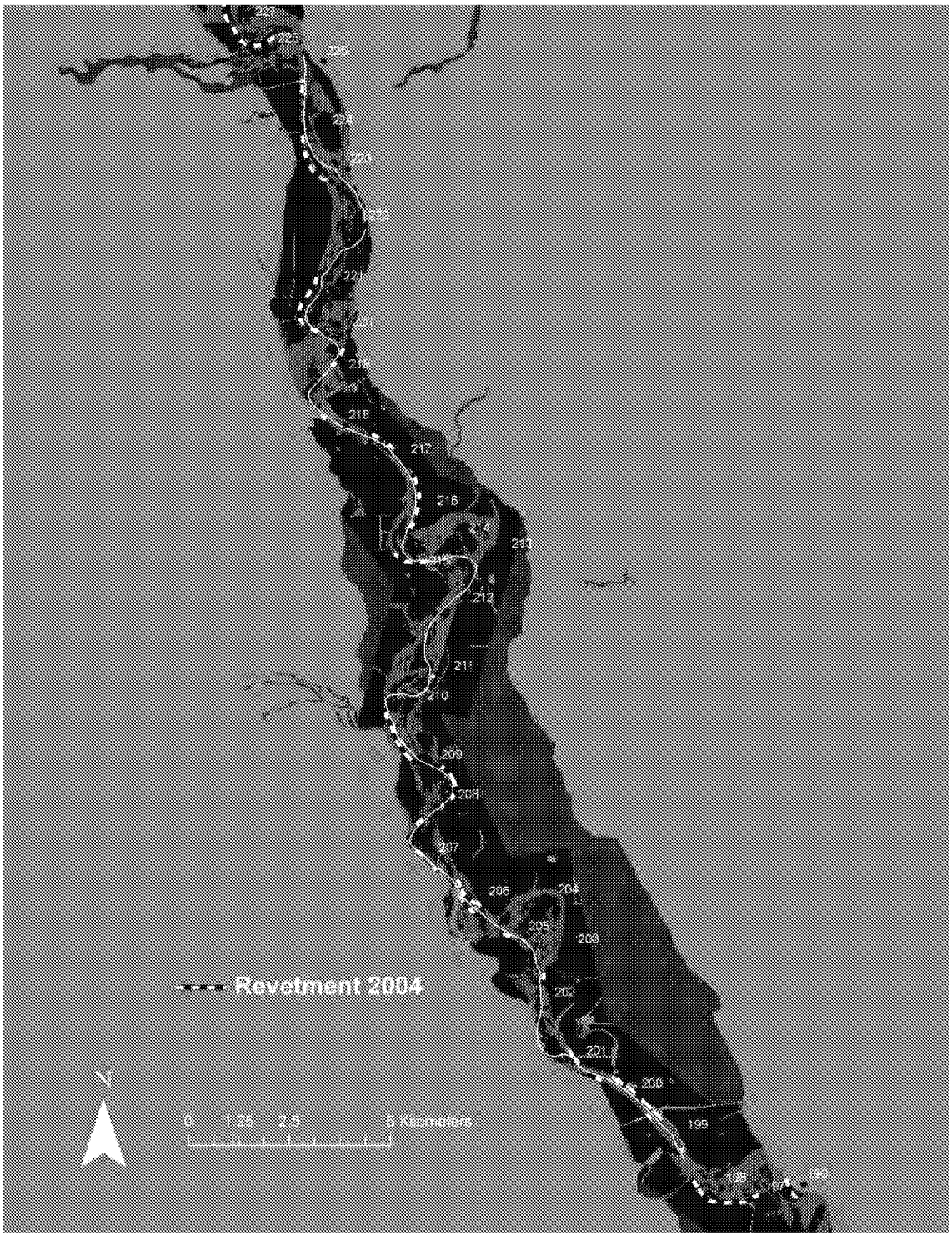

Figure 2.6: Meander Migration/Bank Erosion Model, Woodson Bridge segment showing 2004 revetment coverage (= SacEFT "no rip rap removal").

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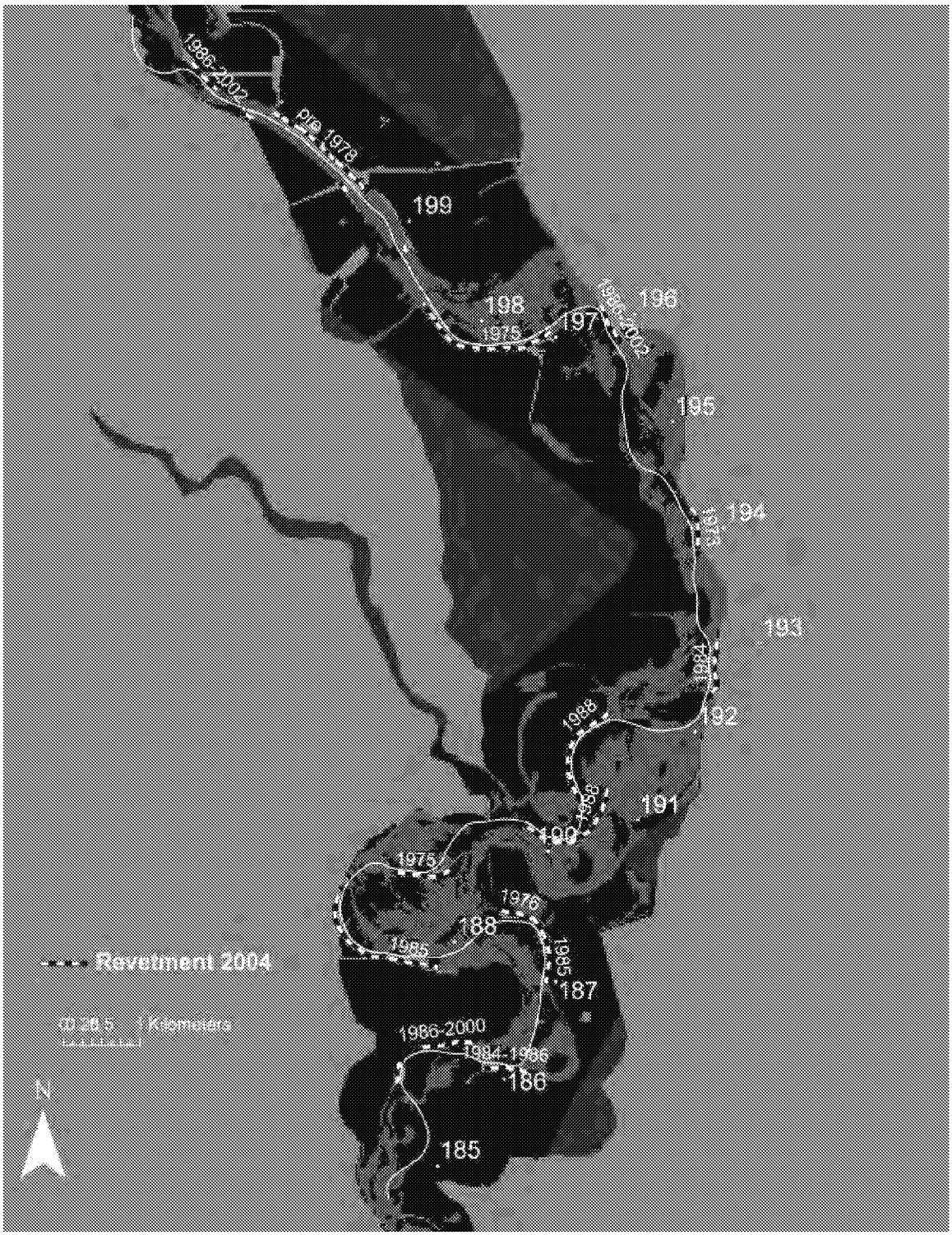

Figure 2.7: Meander Migration/Bank Erosion Model; Hamilton City segment showing 2004 revetment coverage (= SacEFT "no rip rap removal").

Figure 2.8: Meander Migration/Bank Erosion Model; Ord Ferry segment showing 2004 revetment coverage (= SacEFT "no rip rap removal").

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3. Results and Discussion

3.1 Study Flows and Water Temperatures

The purpose of the EIS/EIR feasibility documents is to describe differences between No Action / Existing Conditions and the Action Alternatives which all reflect 2030 conditions, constraints, and operations. Figure 3.1 to Figure 3.4 provide flow exceedance probability summaries at selected river miles measured over the full water year for each of the 5 major NODOS alternatives plus historical flows. These plots illustrate relatively minor differences in flow exceedance probabilities at these locations between the NODOS alternatives.

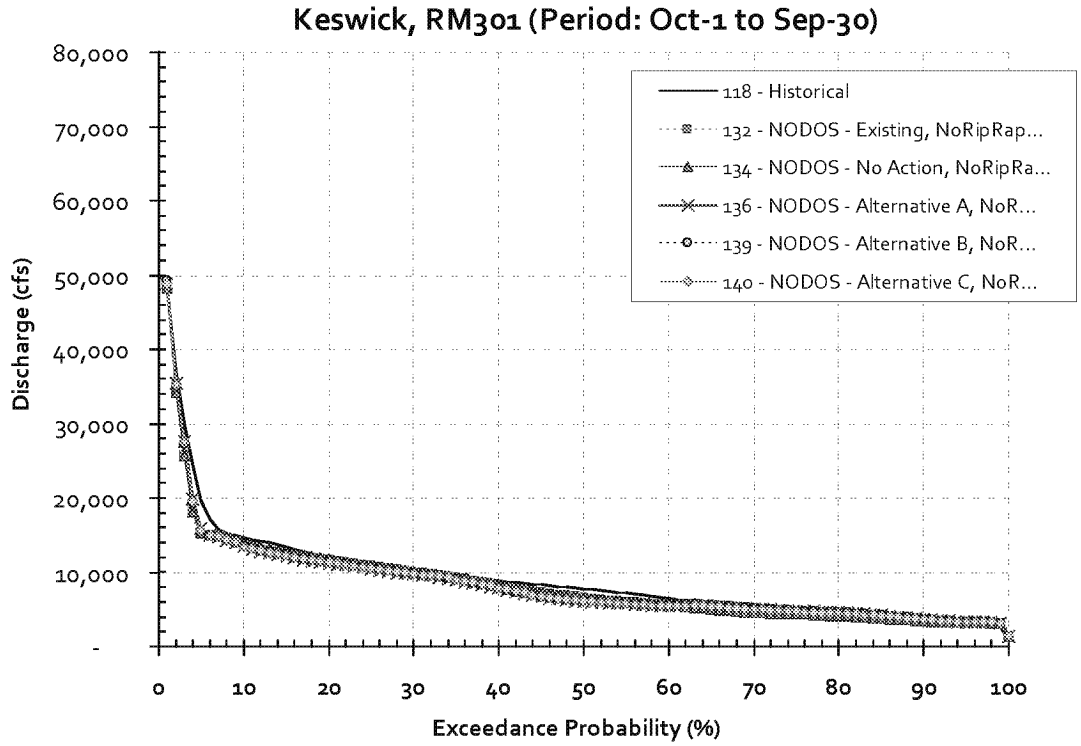

Figure 3.1: Flow exceedance plots at Keswick, RM301 (Oct-1 to Sep-30) for NODOS alternatives relative to historical flows.

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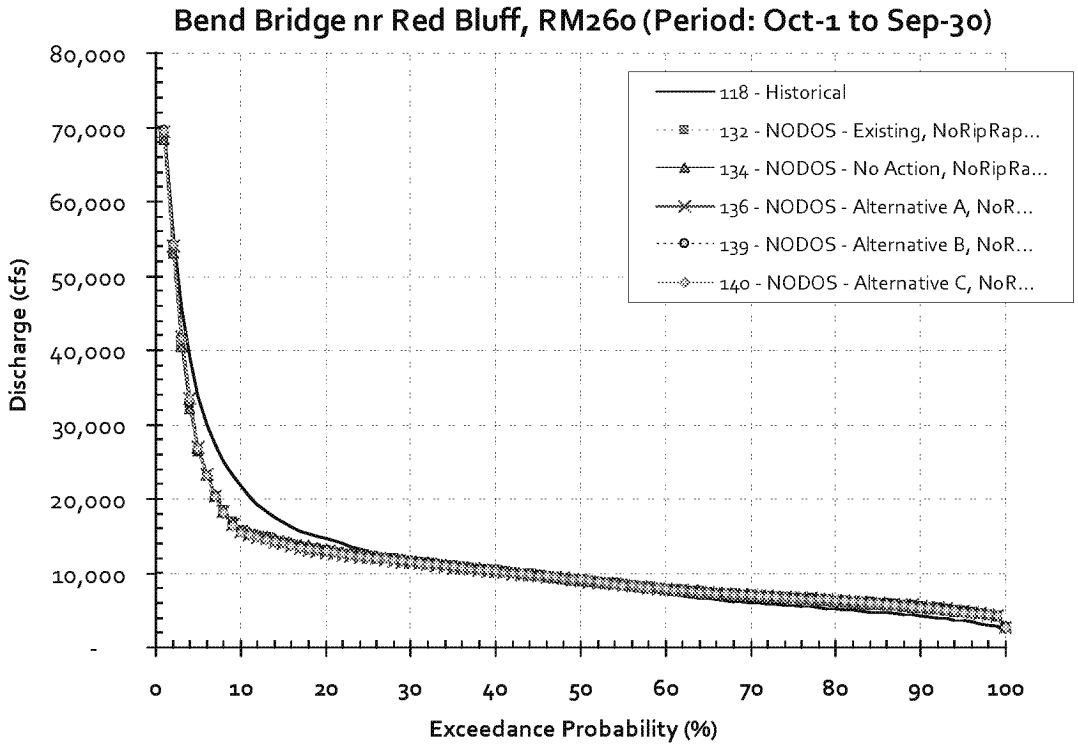

Figure 3.2: Flow exceedance plots at Bend Bridge near Red Bluff, RM260 (Oct-1 to Sep-30) for NODOS alternatives relative to historical flows.

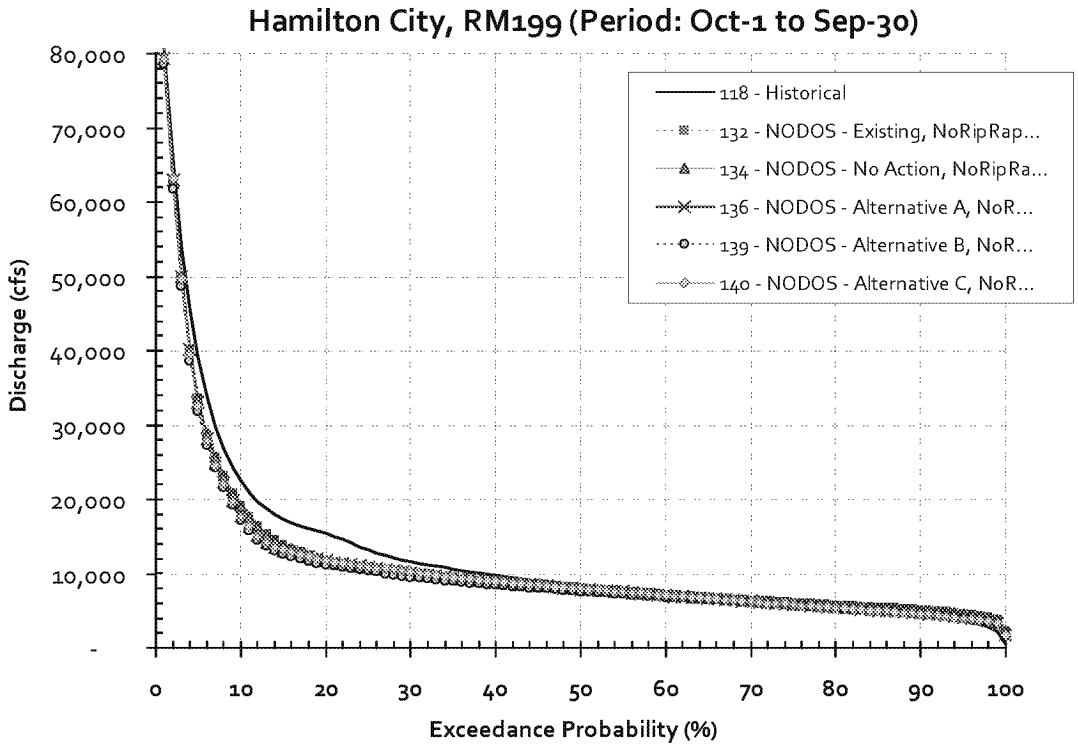

Figure 3.3: Flow exceedance plots near Hamilton City, RM199 (Oct-1 to Sep-30) for NODOS alternatives relative to historical flows.

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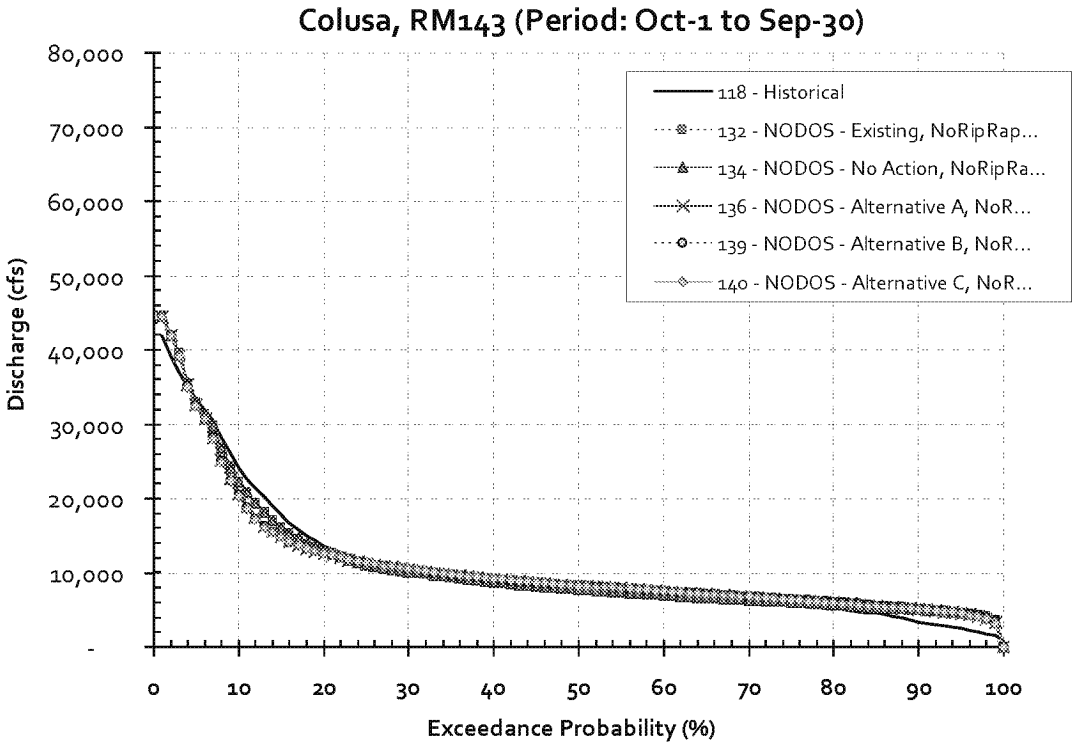

Figure 3.4: Flow exceedance plots near Colusa, RM143 (Oct-1 to Sep-30) for NODOS alternatives relative to historical flows.

Figure 3.5 to Figure 3.8 provide water temperature exceedance probability summaries at selected river miles measured over the full water year for each of the 5 major NODOS alternatives plus historical temperatures. These plots illustrate relatively minor differences in exceedance probabilities at these locations between the NODOS alternatives. Consistent with Ecosystem Enhancement Action #2, NODOS water temperatures in the upper Sacrament River are cooler than historical water temperatures.

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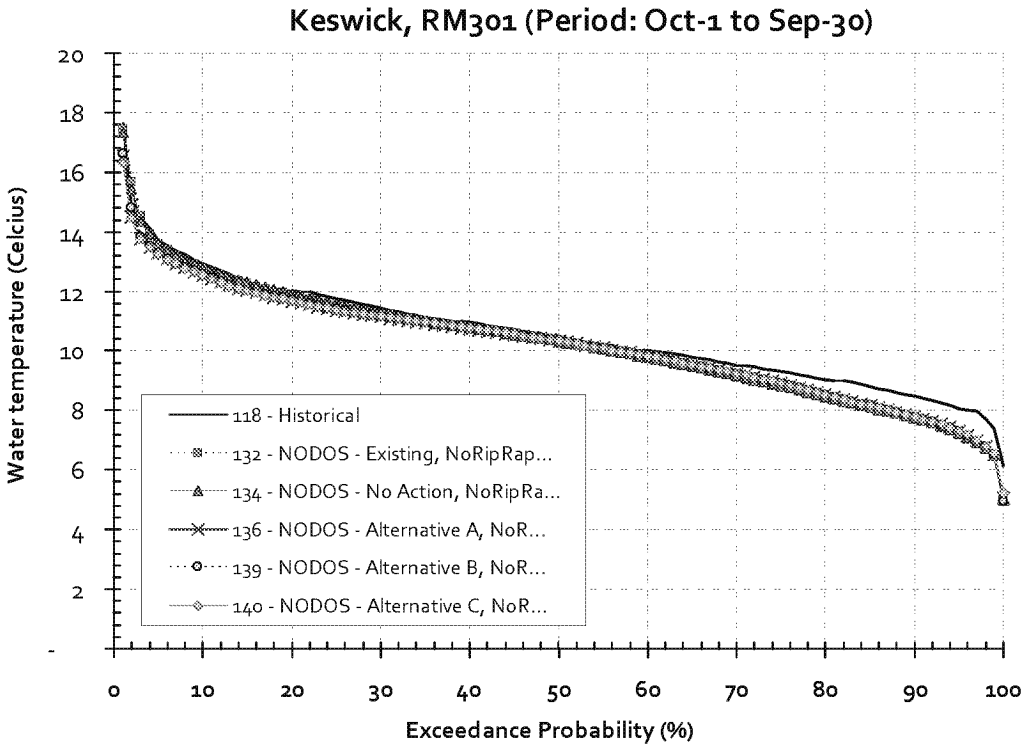

Figure 3.5: Water temperature exceedance plots at Keswick, RM301 (Oct-1 to Sep-30) for NODOS alternatives relative to historical temperatures.

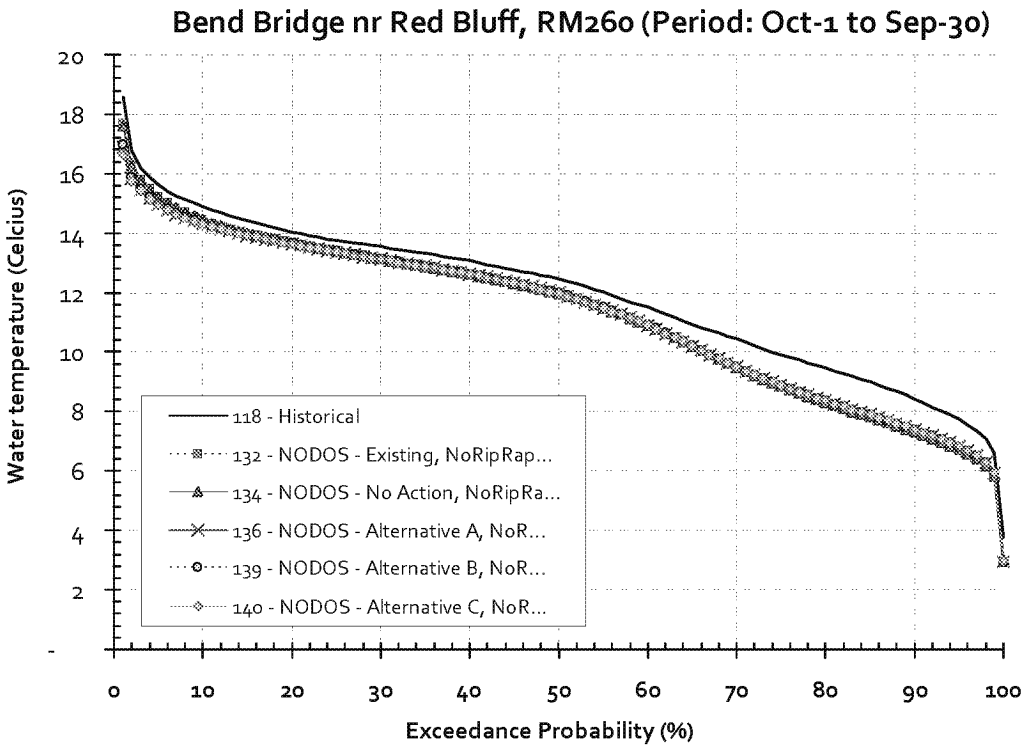

Figure 3.6: Water temperature exceedance plots at Bend Bridge near Red Bluff, RM260 (Oct-1 to Sep-30) for NODOS alternatives relative to historical temperatures.

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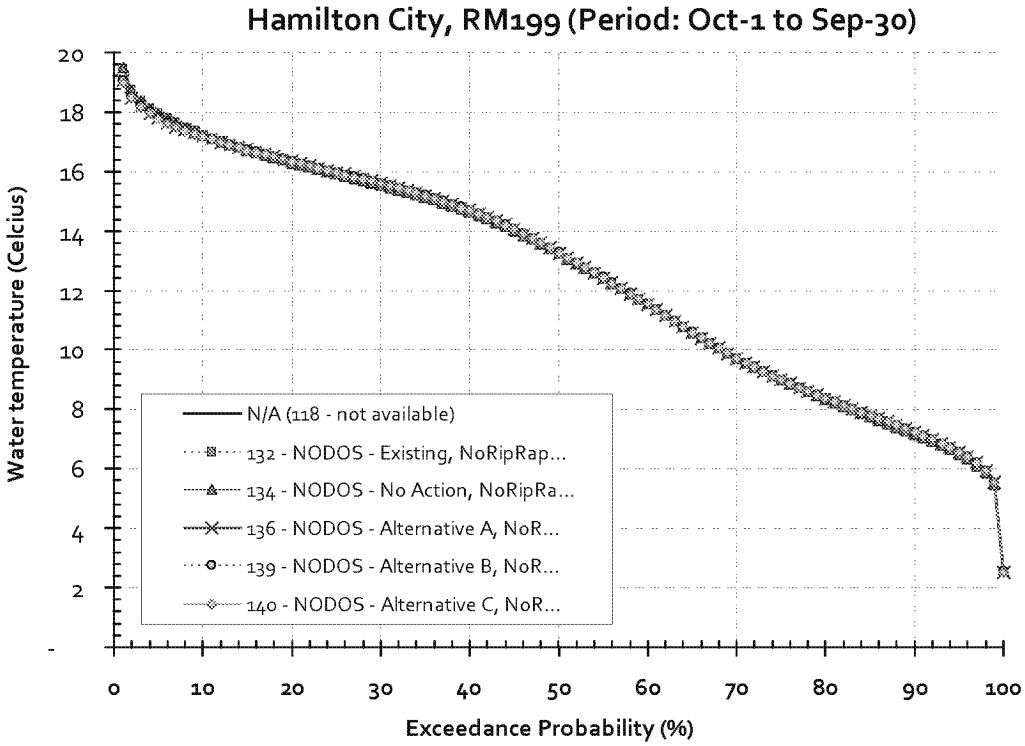

Figure 3.7: Water temperature exceedance plots near Hamilton City, RM199 (Oct-1 to Sep-30) for NODOS alternatives.

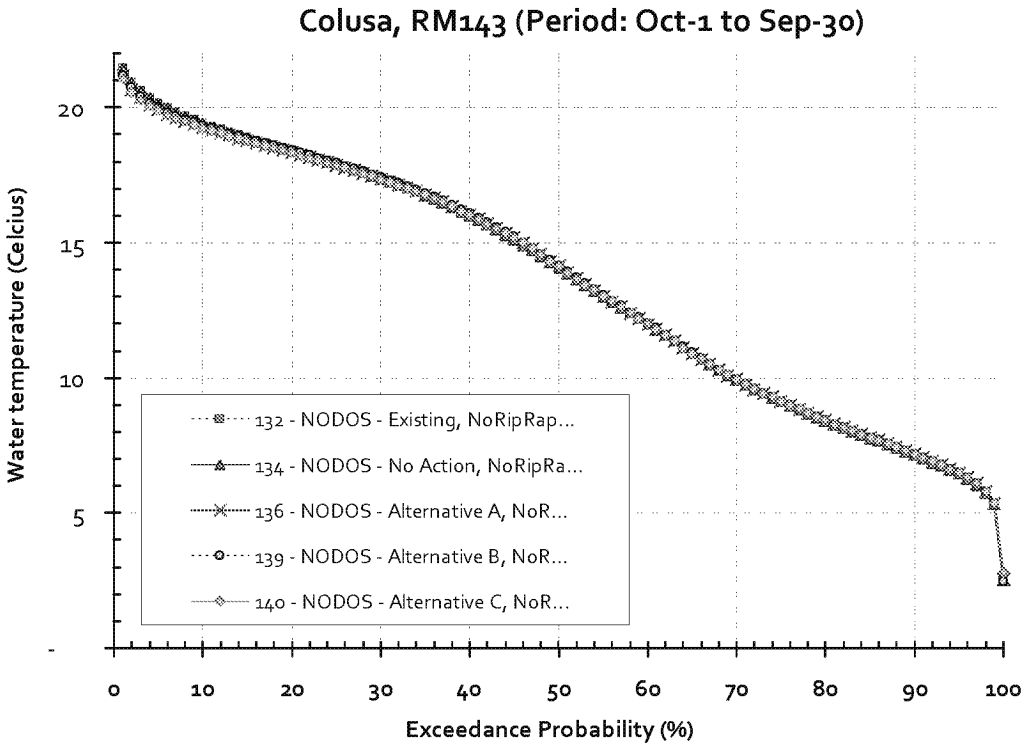

Figure 3.8: Water temperature exceedance plots near Colusa, RM143 (Oct-1 to Sep-30) for NODOS alternatives.

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3.2 Performance of Alternatives: Overall Synthesis

Relative to the NODOS existing conditions alternative, study comparisons #1, #2, #4 and #6 reveal mixed results depending on the species and performance measure (Table 3-B). Species specific findings are provided in later sections. In all cases, performance measures relating to thermally modulated egg mortality (GS1, ST3, CH4) show either no appreciable impact owing to any of the NODOS Investigation alternatives (A, B, C) or a small beneficial impact. Relative to steelhead and Chinook salmon, green sturgeon eggs (GS1) received the largest benefits in terms of thermal egg mortality reduction (Table 3-B).

Overall, Steelhead appears to be most favored by NODOS Alternative B (Table 3-B). NODOS Alternative A favors fall Chinook, followed closely by NODOS Alternative B. Late-fall Chinook are least impacted by NODOS Alternative B. Spring Chinook clearly encounter a higher proportion of favorable conditions under NODOS Alternative B. Acknowledging the downward performance of rearing WUA (CH2), winter-run Chinook experience the highest proportion of favorable conditions under NODOS alternative C. NODOS alternative A is the next most favorable for winter-run Chinook.

Overall, riparian focal species performance measures (FC1, FC2, BASW2 and BASW1) appear to be most favored by NODOS Alternative C, followed by NODOS Alternative A (Table 3-B).

For Steelhead and winter-run Chinook, juvenile stranding changes (ST4/CH4) were inversely related relative to rearing WUA (ST2/CH2) (Table 3-B). These effects are partially offsetting, but the exact outcome depends on the response of Steelhead and winter-run Chinook to stage recession events (worse during day than at night) and on the survival benefits attributable to better rearing habitat conditions (see Appendix A for a deeper exploration of this inverse correlation).

Overall, the rank order preferred NODOS action alternative (*i.e.*, highest proportion of favored conditions / least impact across all performance measures) by focal species group is provided in Table 3-A. Table 3-A also illustrates that as currently defined; **no single NODOS alternative favors all SacEFT focal species**.

Table 3-A: Rank order of preferred NODOS alternative by focal species or group based on synthesis results in Table 3-B.

Focal Species (group)	Most favorable NODOS alternative	Next most favorable NODOS alternative
Riparian focal species	NODOS Alternative C	NODOS Alternative A
Green Sturgeon	No significant difference in performance amongst NODOS A, B or C	
Steelhead	NODOS Alternative B	n/a
Fall Chinook	NODOS Alternative A	n/a
Late Fall Chinook	NODOS Alternative B	n/a
Spring Chinook	NODOS Alternative B	
Winter Chinook	NODOS Alternative C	NODOS Alternative A

Table 3-B: High-level summary of the relative direction of change in performance measures between existing conditions and the different alternatives. Numbers in brackets refer to the increased percentage of simulation years having a favorable rating. **Results of these meander/erosion model dependent performance measures are for the Sacramento River channel with existing revetment (no revetment removal).

Focal species	Performance measure	Action Alternatives vs. Existing Conditions			
		NAA (comparison 1)	Alt A (comparison 2)	Alt B (comparison 4)	Alt C (comparison 6)
Fremont Cottonwood	Initiation success (FC1)	ni (+/-0)	ni (+/-0)	ni (+/-0)	ni (+/-0)
	Post-initiation scour risk (FC2)	+ (+9)	++ (+20)	ni (+2)	++ (+25)
Bank Swallows	Habitat potential/suitability (BASW1)**	ni (+/-0)	- (-4)	- (-5)	ni (- 3)
	Peak flow during nesting period (BASW2)	ni (+/-0)	ni (+/-0)	ni (+/-0)	ni (+/-0)
Western Pond Turtles	Large Woody Debris Recruitment (LWD)**	ni (-3)	ni (-3)	ni (-3)	ni (-3)
Green Sturgeon	Egg temperature preferences (GS1)	ni (+1)	+ (+6)	+ (+8)	+ (+8)
Steelhead	Spawning WUA (ST1)	ni (+/- 0)	ni (+2)	ni (+2)	ni (+2)
	Thermal egg mortality (ST3)	ni (+/-0)	ni (+/-0)	ni (+/-0)	ni (+/-0)
	Redd Dewatering (ST6)	ni (+/-0)	+ (+5)	+ (+6)	+ (+5)
	Redd Scour (ST5)	ni (+/-0)	ni (+/-0)	ni (+/-0)	ni (+/-0)
	Juvenile Stranding (ST4)	ni (+/-0)	- (-6)	- (-4)	- (-7)
	Rearing WUA (ST2)	ni (-3)	+ (+5)	+ (+5)	+ (+5)
Fall Chinook	Spawning WUA (CH1)	ni (+2)	ni (-2)	ni (-2)	- (-5)
	Thermal egg mortality (CH3)	ni (+1)	ni (+3)	ni (+1)	ni (+3)
	Redd Dewatering (CH6)	ni (+/-0)	+ (+4)	ni (+2)	+ (+4)
	Redd Scour (CH5)	ni (+/-0)	ni (+/-0)	ni (-1)	ni (-1)
	Juvenile Stranding (CH4)	ni (+/-0)	ni (-3)	- (-4)	- (-4)
	Rearing WUA (CH2)	ni (+/-0)	+(+7)	+ (+7)	+ (+7)
Late Fall Chinook	Spawning WUA (CH1)	ni (+/-0)	ni (-3)	ni (-3)	ni (-3)
	Thermal egg mortality CH3)	ni (+/-0)	ni (+/-0)	ni (+/-0)	ni (+/-0)
	Redd Dewatering (CH6)	ni (+/-0)	ni (+2)	ni (+3)	ni (+2)
	Redd Scour (CH5)	ni (+/-0)	ni (+2)	ni (+/-0)	ni (+/-0)
	Juvenile Stranding (CH4)	ni (-3)	- (-9)	- (-6)	- (-9)
	Rearing WUA (CH2)	ni (-1)	ni (+3)	+ (+5)	ni (+2)
Spring Chinook	Spawning WUA (CH1)	ni (+/-0)	ni (+3)	ni (+3)	ni (+2)
	Thermal egg mortality (CH3)	ni (-2)	ni (+3)	+ (+4)	ni (+3)
	Redd Dewatering (CH6)	ni (-1)	++ (+11)	++ (+12)	+ (+9)

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Focal species	Performance measure	Action Alternatives vs. Existing Conditions			
		NAA (comparison 1)	Alt A (comparison 2)	Alt B (comparison 4)	Alt C (comparison 6)
	Redd Scour (CH5)	ni (+2)	ni (+/-0)	ni (+/-0)	ni (+/-0)
	Juvenile Stranding (CH4)	ni (-1)	ni (+2)	ni (+2)	ni (+2)
	Rearing WUA (CH2)	ni (+1)	- (-6)	- (-6)	- (-6)
Winter Chinook	Spawning WUA (CH1)	- (-5)	++ (+10)	+ (+9)	++ (+10)
	Thermal egg mortality (CH3)	ni (+/-0)	ni (+/-0)	ni (+/-0)	ni (+2)
	Redd Dewatering (CH6)	ni (-1)	+ (+4)	+ (+4)	+ (+4)
	Redd Scour (CH5)	ni (+/-0)	ni (+/-0)	ni (+/-0)	ni (+/-0)
	Juvenile Stranding (CH4)	+ (+4)	ni (+3)	ni (+3)	+ (+8)
	Rearing WUA (CH2)	- (-8)	- (-4)	- (-8)	- (-5)

Legend

++	strong beneficial impact owing to project alternative
+	small beneficial impact owing to project alternative
ni	negligible detected impact owing to project alternative
-	small negative impact owing to project alternative
--	strong negative impact owing to project alternative

Table 3-C: High-level summary of the relative direction of change in performance measures between the No Action Alternative and the different alternatives. Numbers in brackets refer to the increased percentage of simulation years having a favorable rating. **Results of these meander/erosion model dependent performance measures are for the Sacramento River channel with existing revetment (no revetment removal).

Focal species	Performance measure	Action Alternatives vs. No Action Alternative			
		Existing (comparison 1)	Alt A (comparison 3)	Alt B (comparison 5)	Alt C (comparison 7)
Fremont Cottonwood	Initiation success (FC1)	ni (+/-0)	ni (+/-0)	ni (+/-0)	ni (+/-0)
	Post-initiation scour risk (FC2)	+ (+9)	++ (+11)	+ (+7)	++ (+16)
Bank Swallows	Habitat potential/suitability (BASW1)**	ni (+/-0)	- (-4)	- (-5)	ni (-3)
	Peak flow during nesting period (BASW2)	ni (+/-0)	ni (+/-0)	ni (+/-0)	ni (+/-0)
Western Pond Turtles	Large Woody Debris Recruitment (LWD)**	ni (+3)	ni (+/-0)	ni (+/-0)	ni (+/-0)
Green Sturgeon	Egg temperature preferences (GS1)	ni (-1)	+ (+5)	+ (+7)	+ (+7)
Steelhead	Spawning WUA (ST1)	ni (+/- 0)	ni (+2)	ni (+2)	ni (+2)
	Thermal egg mortality (ST3)	ni (+/-0)	ni (+/-0)	ni (+/-0)	ni (+/-0)
	Redd Dewatering (ST6)	ni (+/-0)	+ (+5)	+ (+6)	+ (+5)
	Redd Scour (ST5)	ni (+/-0)	ni (+/-0)	ni (+/-0)	ni (+/-0)
	Juvenile Stranding (ST4)	ni (+/-0)	- (-6)	- (-4)	- (-7)
	Rearing WUA (ST2)	ni (+3)	+ (+8)	+ (+8)	+ (+8)
Fall Chinook	Spawning WUA (CH1)	ni (-2)	- (-4)	- (-4)	- (-7)
	Thermal egg mortality (CH3)	ni (-1)	ni (+2)	ni (+/-0)	ni (+2)
	Redd Dewatering (CH6)	ni (+/-0)	+ (+4)	ni (+2)	+ (+4)
	Redd Scour (CH5)	ni (+/-0)	ni (+/-0)	ni (-1)	ni (-1)
	Juvenile Stranding (CH4)	ni (+/-0)	ni (-3)	- (-4)	- (-4)
	Rearing WUA (CH2)	ni (+/-0)	+ (+7)	+ (+7)	+ (+7)
Late Fall Chinook	Spawning WUA (CH1)	ni (+/-0)	ni (-3)	ni (-3)	ni (-3)
	Thermal egg mortality (CH3)	ni (+/-0)	ni (+/-0)	ni (+/-0)	ni (+/-0)
	Redd Dewatering (CH6)	ni (+/-0)	ni (+2)	ni (+3)	ni (+2)
	Redd Scour (CH5)	ni (+/-0)	ni (+2)	ni (+/-0)	ni (+/-0)
	Juvenile Stranding (CH4)	ni (+3)	- (-6)	ni (-3)	- (-6)
	Rearing WUA (CH2)	ni (+1)	+ (+4)	+ (+6)	ni (+3)
Spring Chinook	Spawning WUA (CH1)	ni (+/-0)	ni (+3)	ni (+3)	ni (+2)
	Thermal egg mortality (CH3)	ni (+2)	+ (+5)	+ (+6)	+ (+5)
	Redd Dewatering (CH6)	ni (+1)	++ (+12)	++ (+13)	++ (+10)
	Redd Scour (CH5)	ni (-2)	ni (-2)	ni (-2)	ni (-2)
	Juvenile Stranding (CH4)	ni (+1)	ni (+3)	ni (+3)	ni (+3)
	Rearing WUA (CH2)	ni (-1)	- (-9)	- (-9)	- (-9)

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Focal species	Performance measure	Action Alternatives vs. No Action Alternative			
		Existing (comparison 1)	**Alt A** (comparison 3)	**Alt B** (comparison 5)	**Alt C** (comparison 7)
Winter Chinook	Spawning WUA (CH1)	+ (+5)	++ (+15)	++ (+14)	++ (+15)
	Thermal egg mortality (CH3)	ni (+/-0)	ni (+/-0)	ni (+/-0)	ni (+2)
	Redd Dewatering (CH6)	ni (-1)	+ (+5)	+ (+5)	+ (+5)
	Redd Scour (CH5)	ni (+/-0)	ni (+/-0)	ni (+/-0)	ni (+/-0)
	Juvenile Stranding (CH4)	- (-4)	ni (-1)	ni (-1)	+ (+4)
	Rearing WUA (CH2)	+ (+8)	+ (+4)	ni (+/-0)	ni (+3)

Legend		
	++	strong beneficial impact owing to project alternative
	+	small beneficial impact owing to project alternative
	ni	negligible detected impact owing to project alternative
	-	small negative impact owing to project alternative
	--	strong negative impact owing to project alternative

Table 3-D: High-level summary of the relative direction of change in performance measures between the No Action Alternative (which reflects 2030 conditions, constraints and operations) and historical flows. Numbers in brackets refer to the increased percentage of simulation years having a favorable rating. **Results of these meander/erosion model dependent performance measures are for the Sacramento River channel with existing revetment (no revetment removal).

Focal species	Performance measure	NAA vs. Historic Conditions (Comparison 8)
Fremont Cottonwood	Initiation success (FC1)	-- (-17)
	Post-initiation scour risk (FC2)	++ (+10)
Bank Swallows	Habitat potential/suitability (BASW1)**	ni (+1)
	Peak flow during nesting period (BASW2)	+ (+4)
Western Pond Turtles	Large Woody Debris Recruitment (LWD)**	-- (-29)
Green Sturgeon	Egg temperature preferences (GS1)	n/a
Steelhead	Spawning WUA (ST1)	++ (+14)
	Thermal egg mortality (ST3)	ni (+/-0)
	Redd Dewatering (ST6)	+ (+9)
	Redd Scour (ST5)	-- (-16)
	Juvenile Stranding (ST4)	-- (-24)
	Rearing WUA (ST2)	++ (+13)
Fall Chinook	Spawning WUA (CH1)	-- (-15)
	Thermal egg mortality (CH3)	+ (+8)
	Redd Dewatering (CH6)	+ (+4)
	Redd Scour (CH5)	- (-5)
	Juvenile Stranding (CH4)	-- (-25)
	Rearing WUA (CH2)	ni (+1)
Late Fall Chinook	Spawning WUA (CH1)	++ (+11)
	Thermal egg mortality (CH3)	ni (+/-0)
	Redd Dewatering (CH6)	+ (+6)
	Redd Scour (CH5)	-- (-14)
	Juvenile Stranding (CH4)	-- (-11)
	Rearing WUA (CH2)	++ (+20)
Spring Chinook	Spawning WUA (CH1)	ni (-2)
	Thermal egg mortality (CH3)	+ (+8)
	Redd Dewatering (CH6)	++ (+35)
	Redd Scour (CH5)	ni (+/-0)
	Juvenile Stranding (CH4)	-- (-29)
	Rearing WUA (CH2)	-- (-14)
Winter Chinook	Spawning WUA (CH1)	-- (-12)
	Thermal egg mortality (CH3)	ni (+1)
	Redd Dewatering (CH6)	ni (-3)
	Redd Scour (CH5)	- (-5)

Focal species	Performance measure	NAA vs. Historic Conditions (Comparison 8)
	Juvenile Stranding (CH4)	+ (+7)
	Rearing WUA (CH2)	ni (+/-0)

Legend		
	++	strong beneficial impact owing to project alternative
	+	small beneficial impact owing to project alternative
	ni	negligible detected impact owing to project alternative
	-	small negative impact owing to project alternative
	--	strong negative impact owing to project alternative

The purpose of the environmental and feasibility documents is to describe the difference between No Action / Existing Conditions and the Action Alternatives which all reflect 2030 conditions, constraints and operations. Typically, none of the NODOS Investigation alternative modelling results are compared against the historical calibration due to the focus of CEQA/NEPA which emphasizes isolating project alternative effects as compared to a no action reference or existing condition comparison.

Comparison #8 (see Section 2.5; The NAA, relative to Actual Historic Conditions) is **not** used in our report to assess NODOS effects. Instead, it provides an essential reference case illustrating how SacEFT's various performance measures have performed under historic flows and water temperatures from 1938 – 2003 relative to the future 2030 conditions, constraints and hydrosystem operations in the NAA. Historic flows represent less constrained, more natural patterns of variation in flow and water temperature that have occurred in the past. Comparisons that include historical data reveal different information in a different context that does not address a specific project effect relative to the no action alternative or existing condition reference case. These comparisons identify the ecological effects of the future system operations and constraints relative to historic conditions. In fully considering ecological flow needs, the magnitude of departure from these historic conditions may reveal important information on how future constraints, climate and/or hydrosystem operational modifications are influencing preferred ecological flow targets. Historic flows represent less constrained, more natural patterns of variation in flow and water temperature that have occurred in the past.

Table 3-D shows that relative to historic flows and water temperatures, conditions associated with the NAA (comparison 8) generate a strong negative effect on Fremont Cottonwood initiation success (FC1), Large Woody Debris recruitment (LWD) and Steelhead/fall Chinook/late fall Chinook/spring Chinook juvenile stranding risk (ST4/CH4). For case #8, fall Chinook spawning WUA (CH1) performance declined, as it did for winter-run Chinook. Likewise, redd scour risk is increased for Steelhead (ST5) and late fall Chinook (CH5). Rearing WUA (CH2) habitat conditions were also lower in the case of spring run Chinook

The following performance measures showed a strong positive effect owing to the NAA relative to actual historic conditions: Steelhead and late fall Chinook spawning WUA (ST1 and CH1). Also improved were rearing WUA for late fall Chinook (CH2). Notably, as with NODOS alternatives A, B and C, spring Chinook redd dewatering risk (CH6) was markedly reduced by conditions present in the NAA vs. actual historic.

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3.3 Aquatic Species and Performance Measures

3.3.1 Green Sturgeon

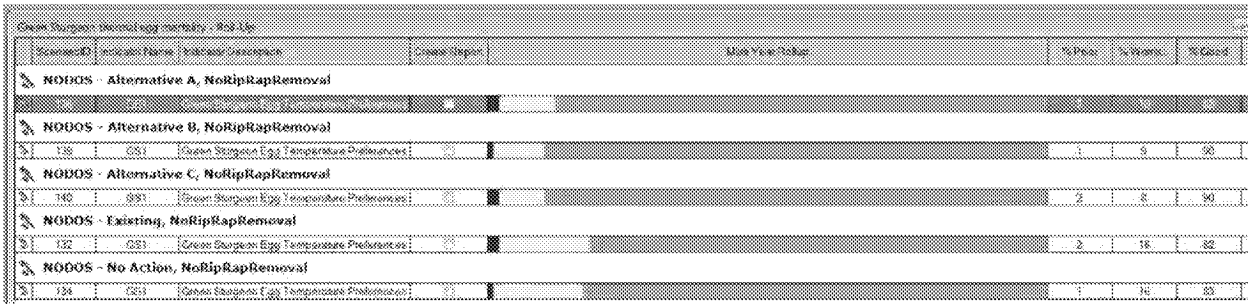

Figure 3.9: Multi-year roll-up results for green sturgeon thermal egg mortality (GS1).

Figure 3.9 and Figure 3.10 show the percentage of years in each NODOS simulation having favorable (green) conditions for green sturgeon thermal egg mortality (GS1). SacEFT predicts that green sturgeon eggs (GS1) would receive benefits (+5% to +8% of years with better conditions) from all three of the NODOS Investigation alternatives in terms of reduction of thermal egg mortality (GS1) (Figure 3.10).

Figure 3.11 shows the number of days in each simulation that water temperatures are above the 20°C lethal threshold for green sturgeon egg development. Consistent with SacEFT preferred condition roll-up results, the NODOS Investigation alternatives all reduce the number of days green sturgeon eggs are exposed to lethal water temperatures.

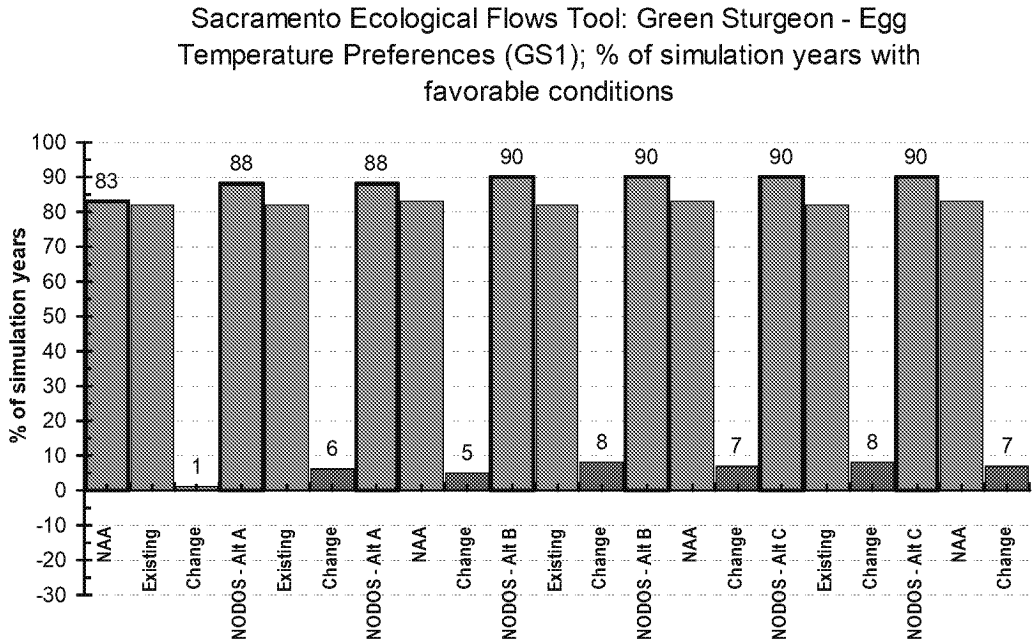

Figure 3.10: The percentage of years in each NODOS simulation having favorable (green) conditions for green sturgeon thermal egg mortality (GS1). Bars labeled with "Change" refer to the % change between the simulated alternative and the reference condition (either Existing conditions or the No Action Alternative (NAA)).

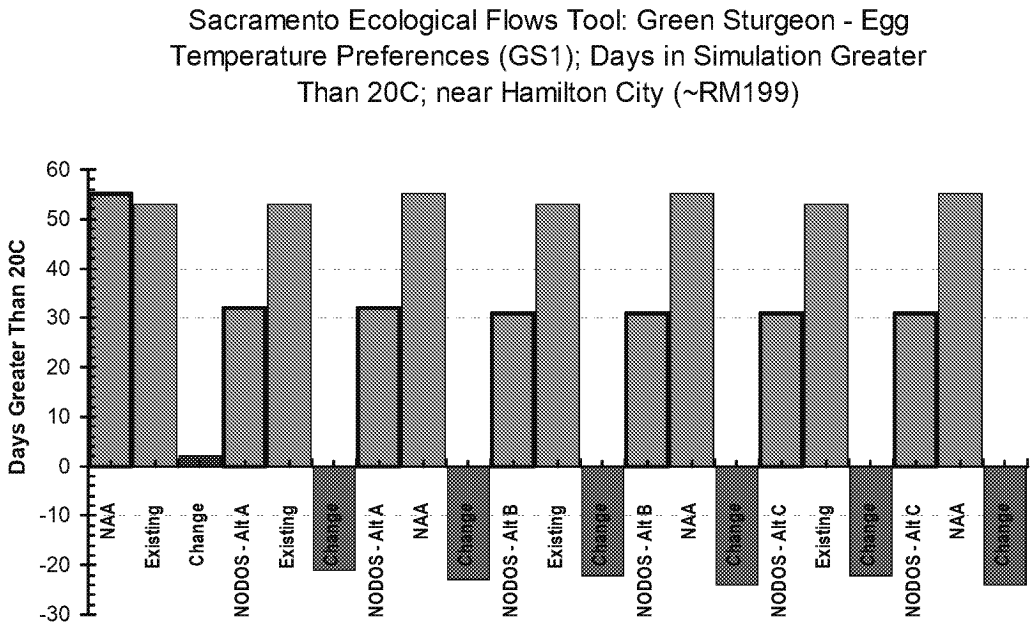

Figure 3.11: Number of days in each simulation where water temperatures near Hamilton City (RM199) are greater than 20ºC. Bars labeled with "Change" refer to the change in number of days greater than 20ºC between the simulated alternative and the reference condition (either Existing conditions or the No Action Alternative (NAA)).

SacEFT Target and Avoidance Flows for Green Sturgeon Egg Development

Figure 3.12 shows the SacEFT target/favorable water temperature profiles and the median target water temperature at the Sacramento River near Red Bluff (RM260) and Hamilton City (RM199) during the critical period for green sturgeon egg development.

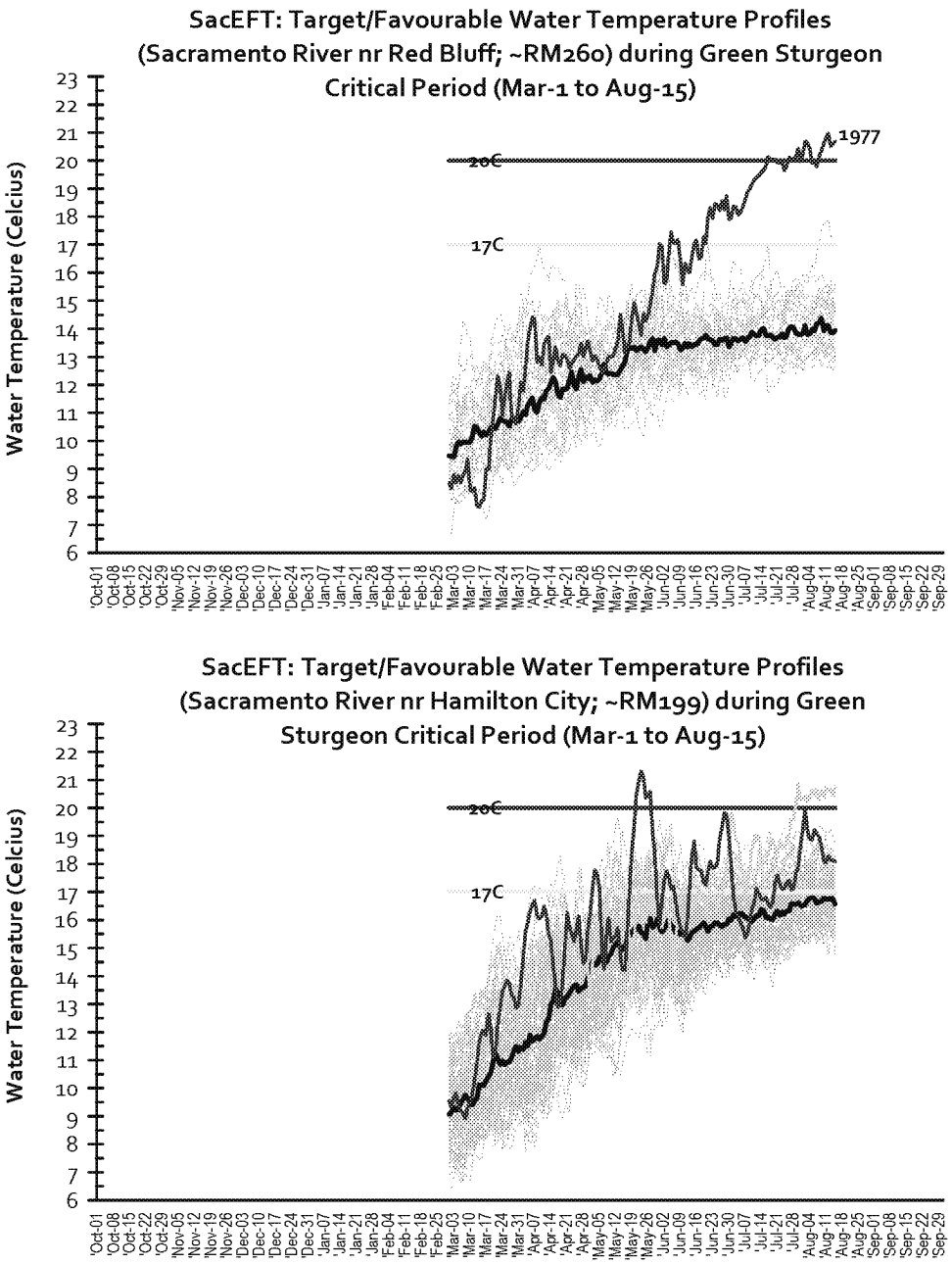

Figure 3.12: Target/favorable water temperature profiles (green) for minimizing green sturgeon thermal egg mortality (GS1) at two index locations (RM260 and RM199). Water temperature profiles in green refer to years where SacEFT's annual performance measure rating was assessed as good/favorable. The heavy black line provides the median of the all year favorable water temperature profiles. Lines in red show example years rated as poor by SacEFT (*i.e.*, highest category of egg mortality). Horizontal lines at 17ºC and 20ºC are important thresholds that affect green sturgeon egg development (GS1). [Note: this figure is designed for color printing].

Figure 3.13 provides an example of detailed daily output available from SacEFT for a poor year like 1977.

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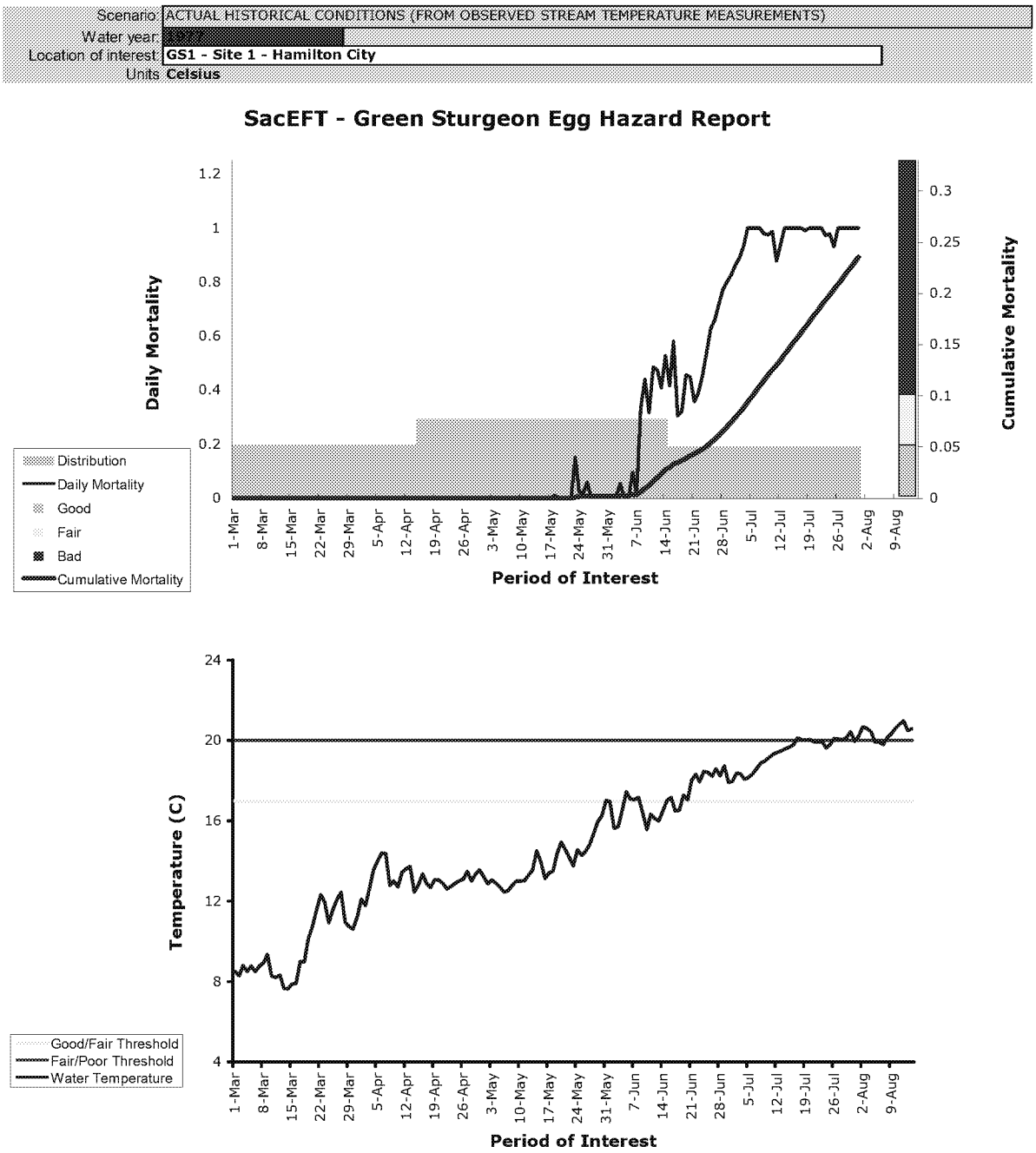

Figure 3.13: SacEFT detailed output report for a specific water year (1977) showing daily results for green sturgeon thermal egg mortality (GS1) at a specific index location (Hamilton City).

3.3.2 Steelhead Trout

Figure 3.14 to Figure 3.18 show the percentage of years in each NODOS simulation having favorable (green) conditions for the six independent Steelhead trout performance measure in SacEFT (ST3 omitted as SacEFT rates all scenarios as 100% favorable). SacEFT predicts that Steelhead would receive benefits in terms of reduced redd dewatering (ST6) (+5% to +6% of years with better conditions) from all three of the NODOS Investigation alternatives (Figure 3.15) as well as improvements to rearing conditions (ST2) (+5% to +8% of years with more favorable conditions) (Figure 3.18). Conversely the NODOS

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Investigation alternatives increase juvenile stranding risks (ST4) over both existing conditions and NAA (approx. –4% to –7% reduction in years with favorable conditions) (Figure 3.17). Stranding risk increases (ST4) are particularly apparent when compared to rates of stranding found with historical flows (Figure 3.17). Likewise, redd scour risks are higher in all NODOS alternatives relative to historic conditions (Figure 3.16).

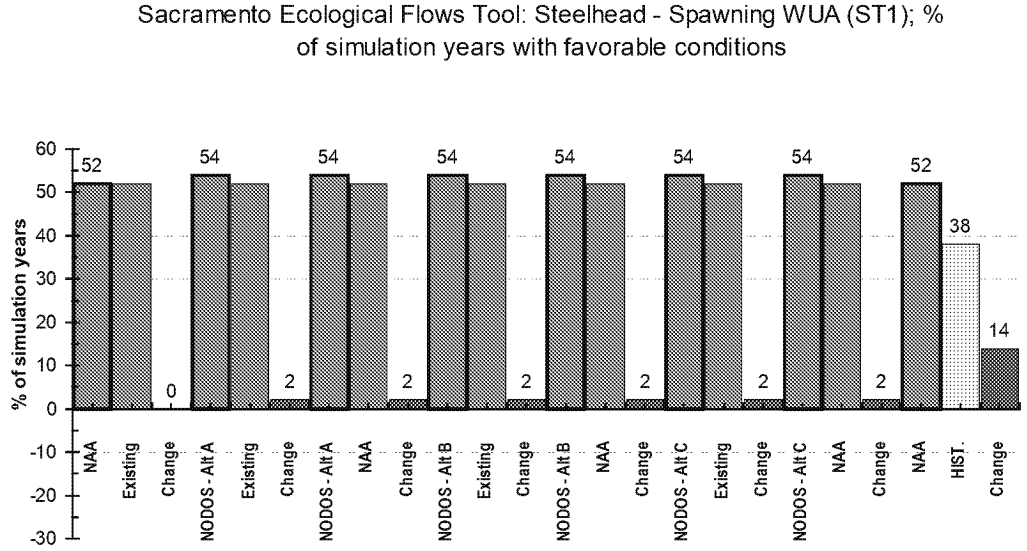

Figure 3.14: The percentage of years in each NODOS simulation having favorable (green) conditions for Steelhead spawning WUA (ST1). Bars labeled with "Change" refer to the % change between the simulated alternative and the reference condition (either Existing conditions or the No Action Alternative (NAA)).

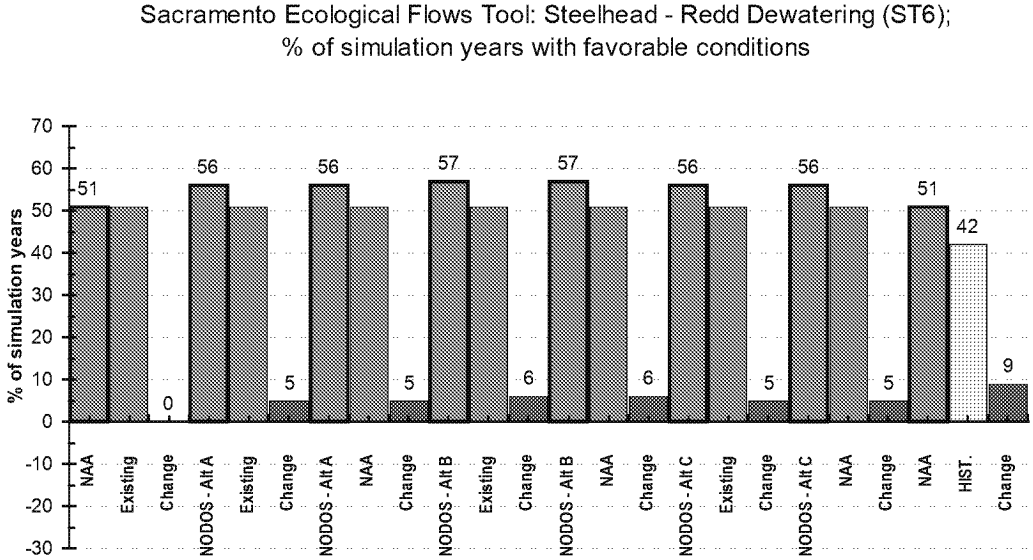

Figure 3.15: The percentage of years in each NODOS simulation having favorable (green) conditions for Steelhead redd dewatering (ST6). Bars labeled with "Change" refer to the % change between the simulated alternative and the reference condition (either Existing conditions or the No Action Alternative (NAA)).

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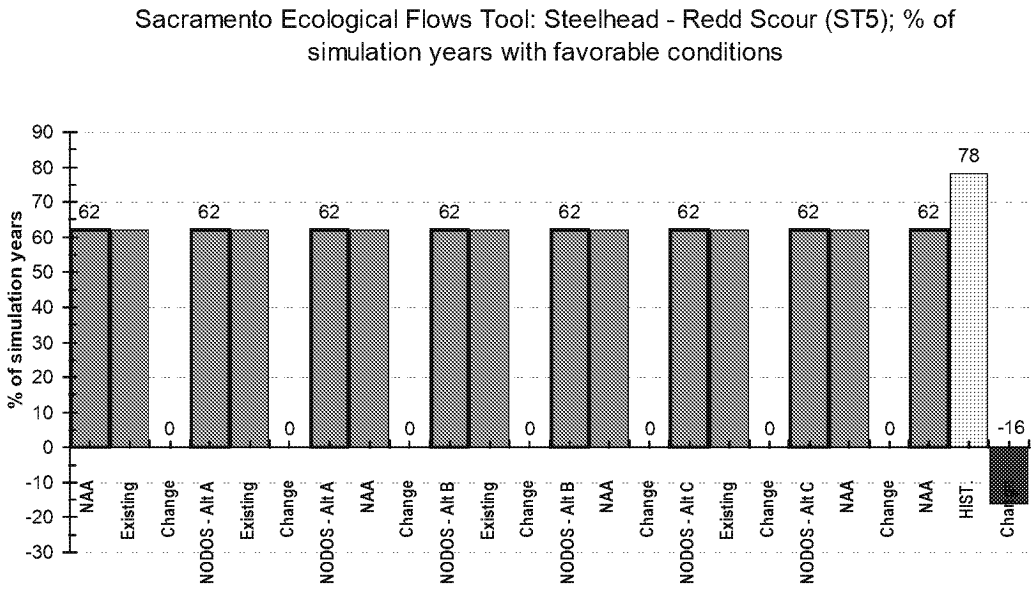

Figure 3.16: The percentage of years in each NODOS simulation having favorable (green) conditions for Steelhead redd scour (ST5). Bars labeled with "Change" refer to the % change between the simulated alternative and the reference condition (either Existing conditions or the No Action Alternative (NAA)).

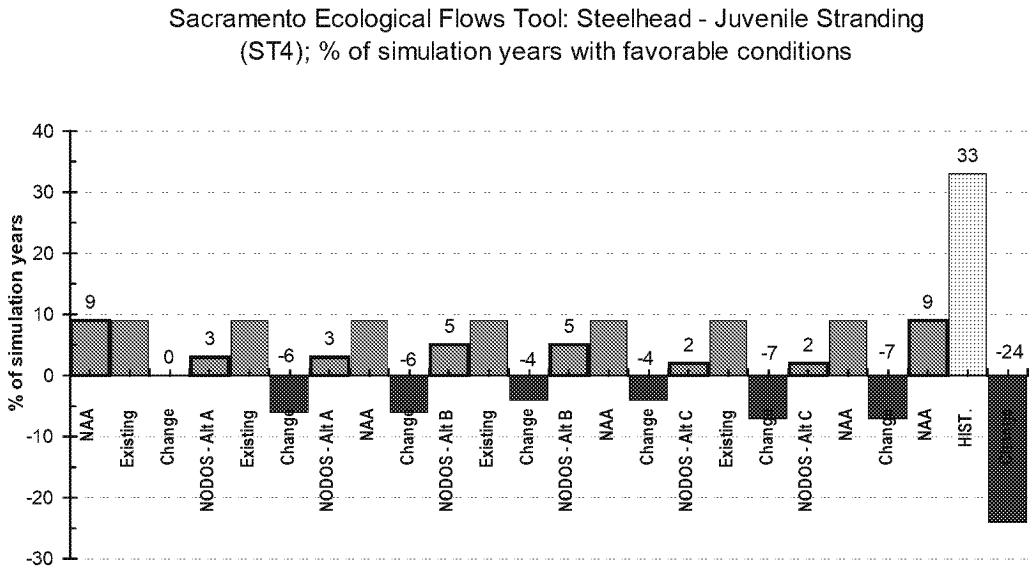

Figure 3.17: The percentage of years in each NODOS simulation having favorable (green) conditions for Steelhead juvenile stranding (ST4). Bars labeled with "Change" refer to the % change between the simulated alternative and the reference condition (either Existing conditions or the No Action Alternative (NAA)).

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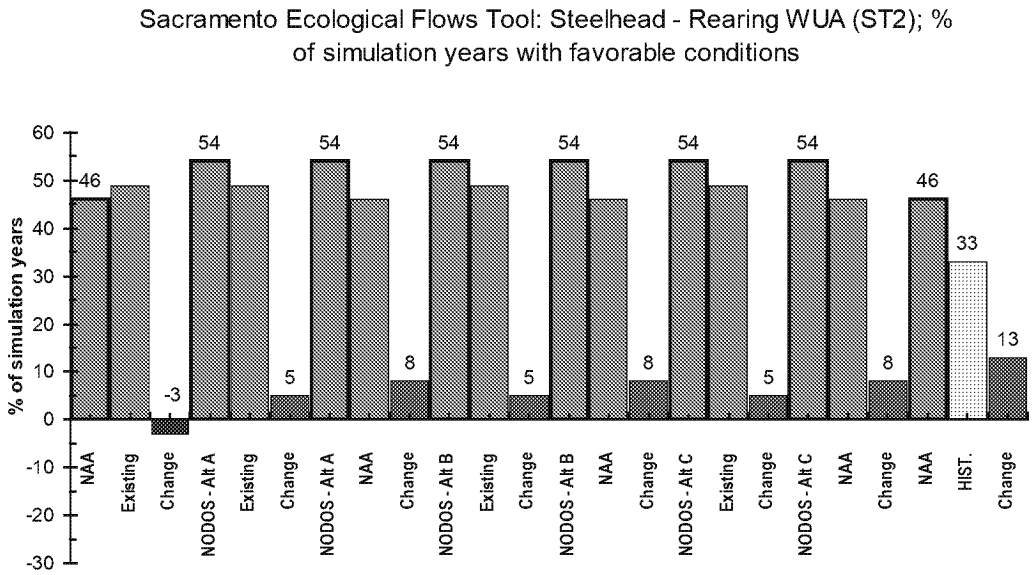

Figure 3.18: The percentage of years in each NODOS simulation having favorable (green) conditions for Steelhead rearing WUA (ST2). Bars labeled with "Change" refer to the % change between the simulated alternative and the reference condition (either Existing conditions or the No Action Alternative (NAA)).

Readers are referred to Appendix C for raw data for the results presented above, as well as all relevant SacEFT multi-year roll-up screen shot images.

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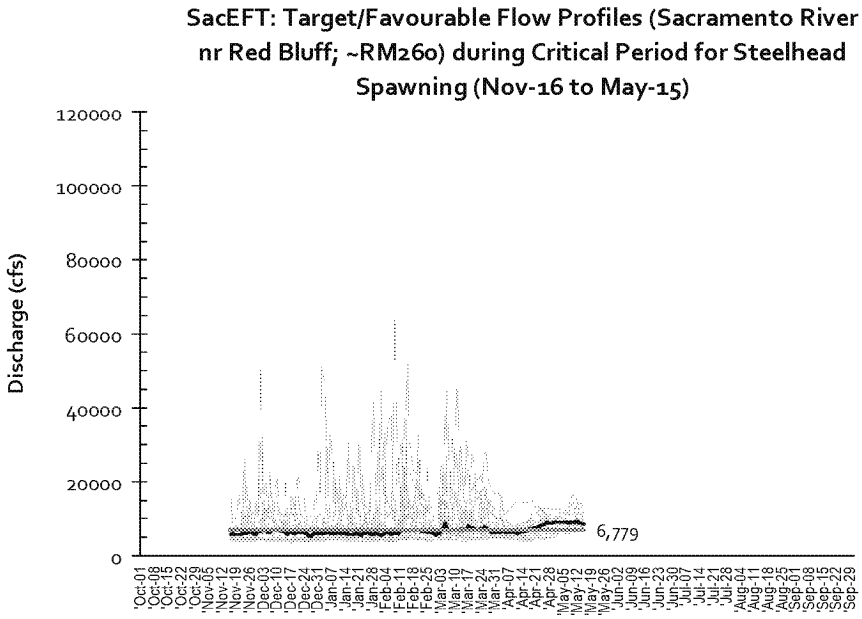
SacEFT Target and Avoidance Flows and Water Temperatures for Steelhead Trout

Figure 3.19 shows the SacEFT target/favorable flow profiles and the median target flow at the Sacramento River near Red Bluff (RM260) during the critical period for Steelhead trout spawning as found using the spawning WUA performance measure (ST1).

(a)



(b)

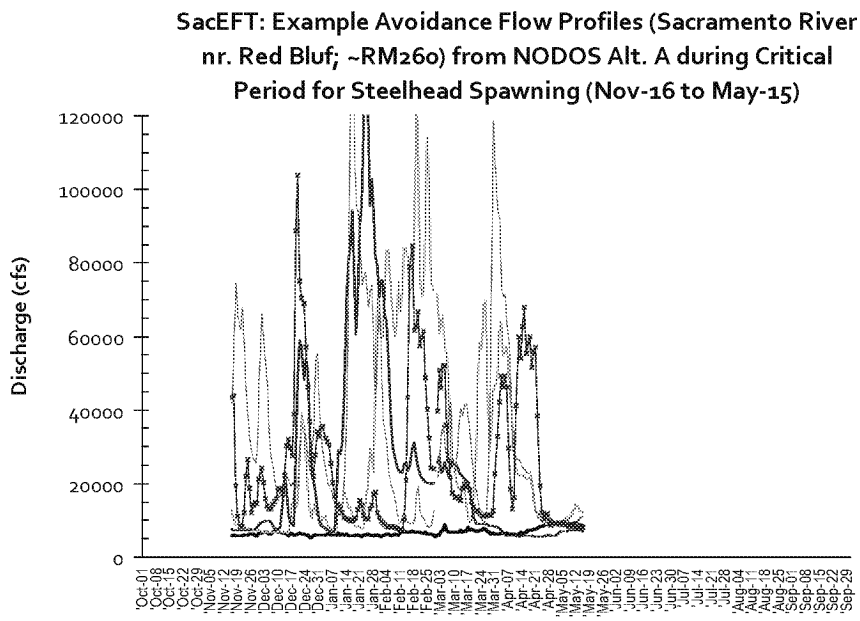


Figure 3.19: Target/favorable flow profiles (green) for steelhead spawning WUA (ST1) at Sacramento River near Red Bluff (RM260). Flow profiles in green refer to years where SacEFT's annual performance measure rating was assessed as good/favorable. The heavy black line provides the median of the all year favorable flow profiles. The grey horizontal line (panel a) is the average of the median target flow. Flow traces in red (panel b) are examples of typical years rated poor by SacEFT (*i.e.*, least cumulative spawning habitat potential). [Note: this figure is designed for color printing].

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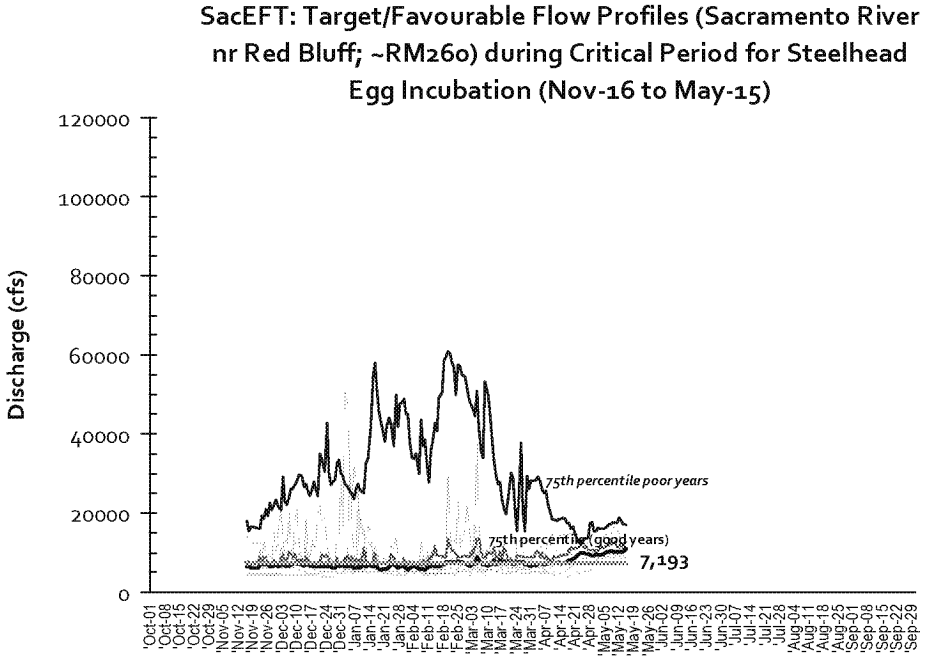
Figure 3.20 shows the SacEFT target/favorable flow profiles and the median target flow at the Sacramento River near Red Bluff (RM260) during the critical period for Steelhead trout egg incubation as found using the redd dewatering performance measure (ST6).

(a)



(b)

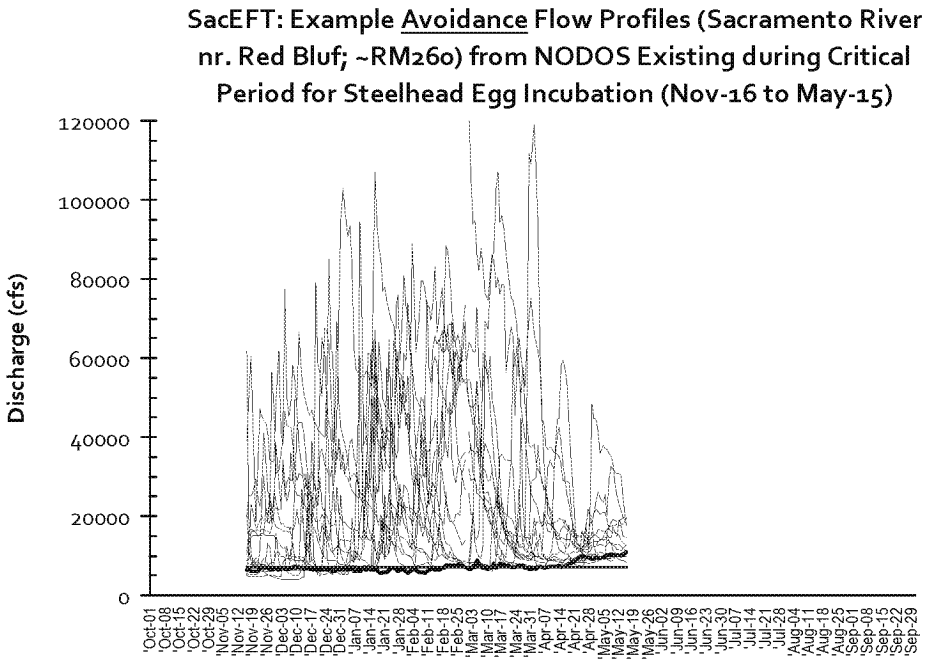


Figure 3.20: Example target/favorable flow profiles (green) for steelhead redd dewatering (ST6) at Sacramento River near Red Bluff (RM260) (panel a). Flow profiles in green refer to years where SacEFT's annual performance measure rating was assessed as good/favorable. Example flow traces in red (panel b) are examples of typical years rated poor by SacEFT (*i.e.*, highest values of redd dewatering).

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Steelheed redd de-watering risk is driven primarily by the presence of high flows during spawning, which contributes to a higher percentage of redds being spawned at higher elevations. This is apparent when comparing the 75th percentile flows between low de-watering years and high de-watering years in panel a of Figure 3.20. Hence, the de-watering threshold is dynamic, *and will be higher the higher average flows during the steelhead spawning period.*

Figure 3.21 shows the SacEFT target/favorable flow profiles and the median target flow at the Sacramento River near Red Bluff (RM260) during the critical period for Steelhead trout egg incubation as found using the redd scour performance measure (ST5).

Figure 3.22 shows the SacEFT target/favorable flow profiles and the median target flow at the Sacramento River near Red Bluff (RM260) during the critical period for Steelhead trout juvenile rearing as found using the juvenile stranding performance measure (ST4).

Figure 3.23 shows the SacEFT target/favorable flow profiles and the median target flow at the Sacramento River near Red Bluff (RM260) during the critical period for Steelhead trout juvenile rearing as found using the juvenile rearing WUA performance measure (ST2).

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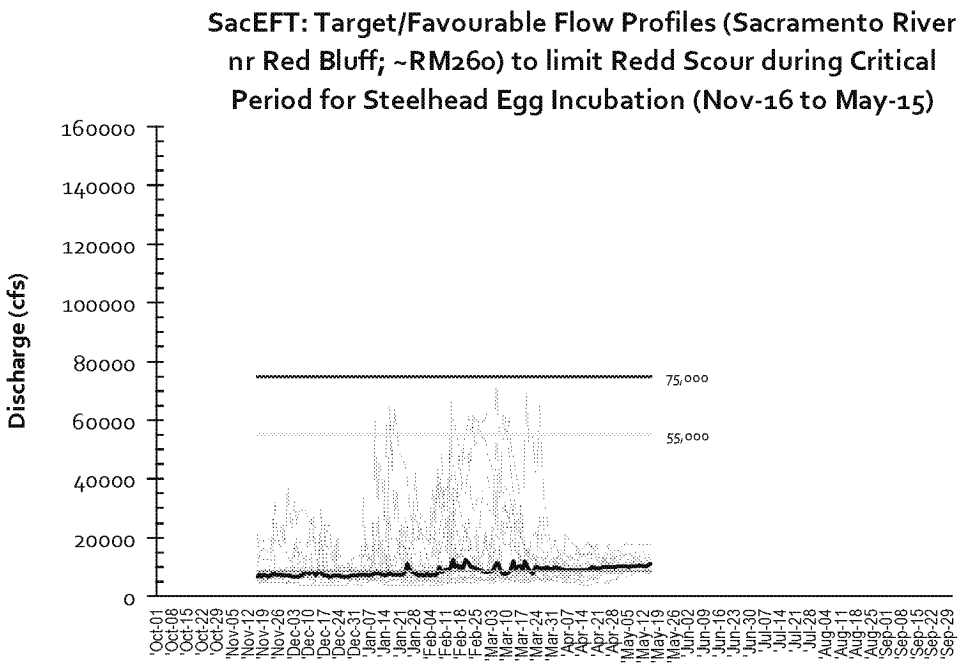
(a)



(b)

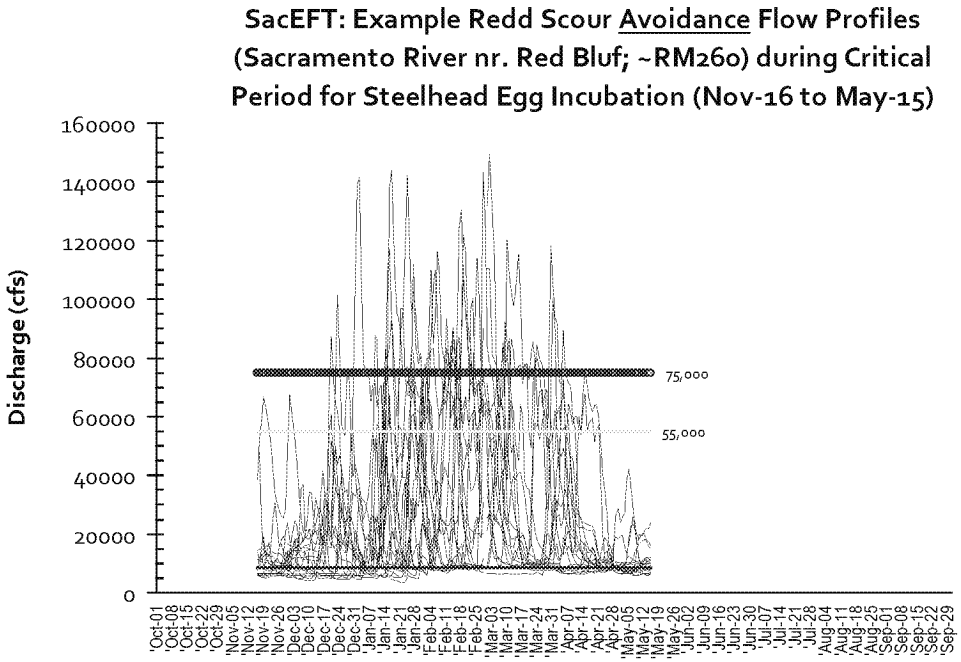


Figure 3.21: Target/favorable flow profiles (green) for minimizing steelhead egg scour mortality (ST5) at Sacramento River near Red Bluff (RM260) (panel a). Flow profiles in green refer to years where SacEFT's annual performance measure rating was assessed as good/favorable. The heavy black line (panel a) provides the median of the all year favorable flow profiles. Example flow traces in red (panel b) are examples of typical years rated poor by SacEFT (*i.e.*, highest values of redd scour). Horizontal lines at 55,000 cfs and 75,000 cfs are important thresholds that affect steelhead egg scour mortality rates (ST5).

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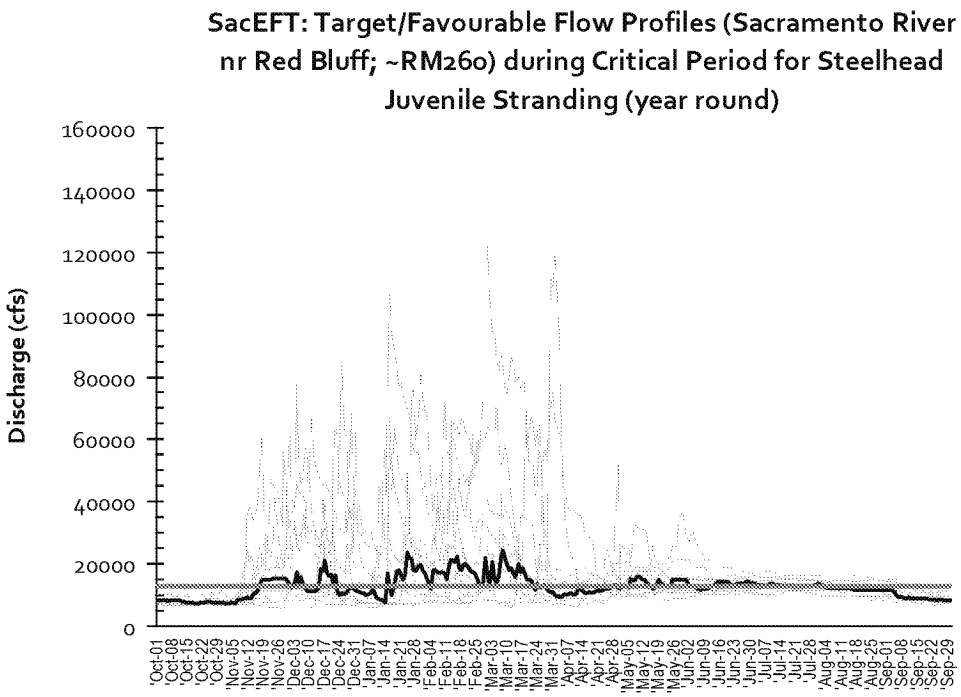
(a)



(b)

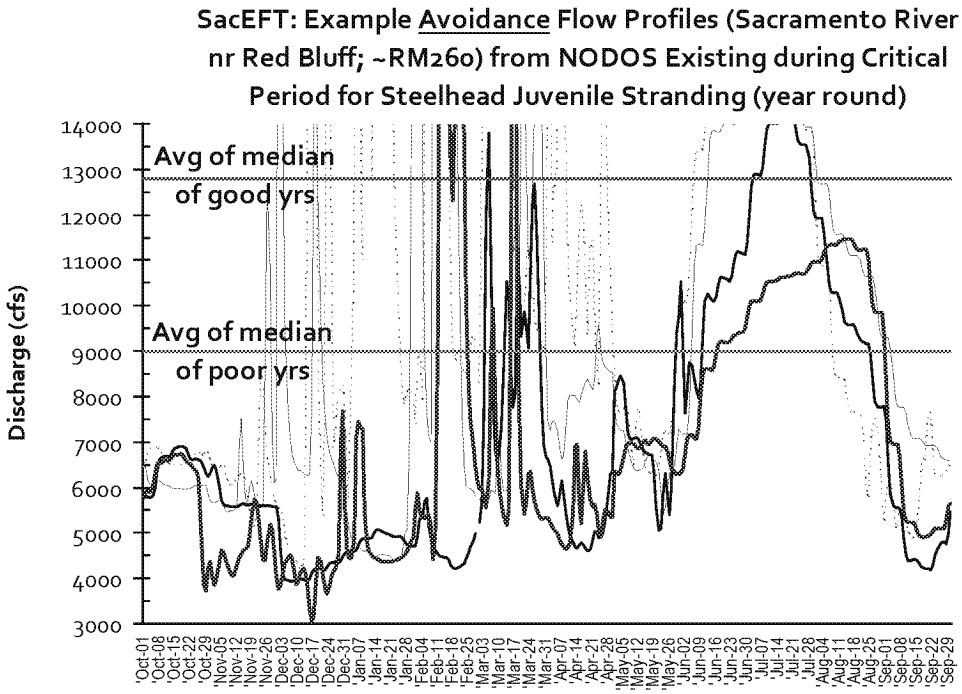
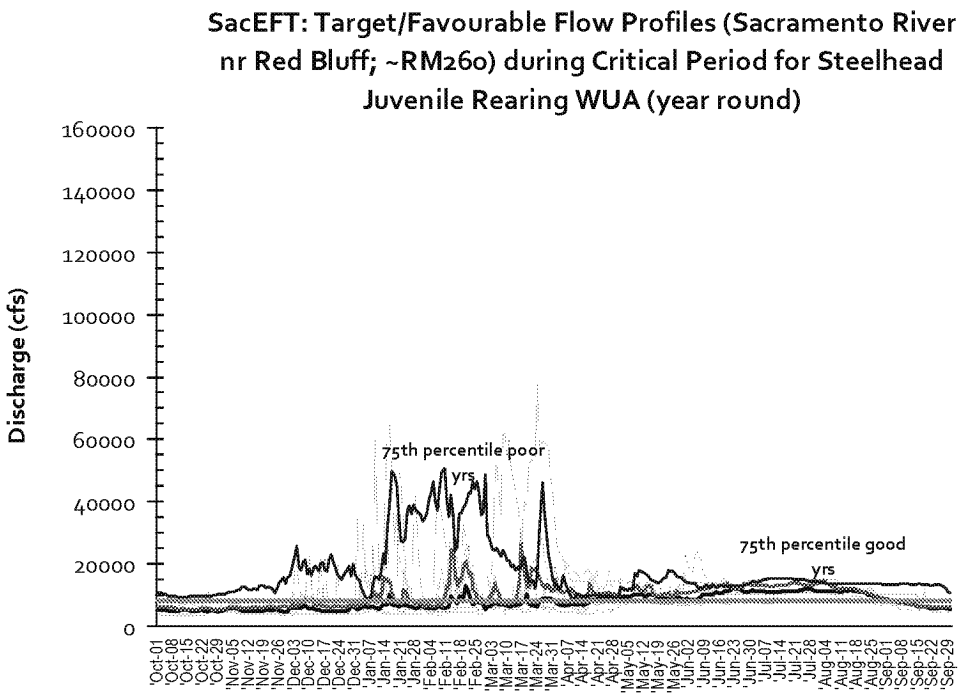


Figure 3.22: Target/favorable flow profiles (green) for minimizing juvenile steelhead stranding mortality (ST4) at Sacramento River near Red Bluff (RM260) (panel a). Flow profiles in green refer to years where SacEFT's annual performance measure rating was assessed as good/favorable. The heavy black line (panel a) provides the median of the all year favorable flow profiles. Example flow traces in red (panel b) are examples of typical years rated poor by SacEFT (*i.e.*, highest values of juvenile stranding). [Note: this figure is designed for color printing].

(a)



(b)

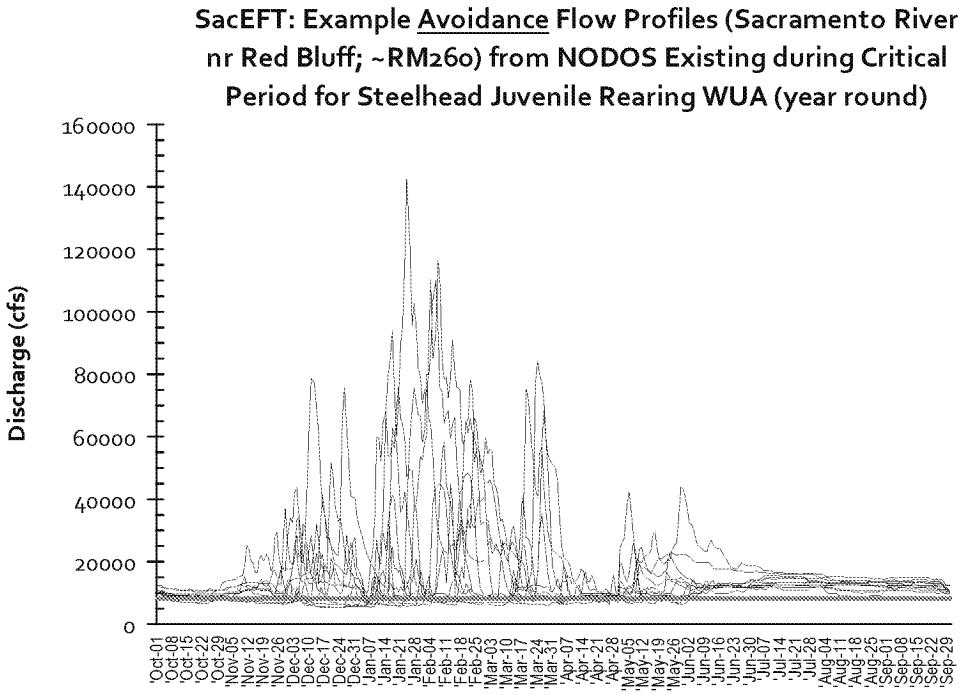


Figure 3.23: Target/favorable flow profiles (green) for maximizing juvenile steelhead rearing WUA (ST2) at Sacramento River near Red Bluff (RM260) (panel a). Flow profiles in green refer to years where SacEFT's annual performance measure rating was assessed as good/favorable. The heavy black line (panel a) provides the median of the all year favorable flow profiles. Example flow traces in red (panel b) are examples of typical years rated poor by SacEFT (*i.e.*, poorest values for juvenile rearing WUA). [Note: this figure is designed for color printing].

3.3.3 Fall Chinook

Readers are referred to Appendix C (FALL Chinook worksheet) for fall Chinook results for the six independent salmonid performance measures in SacEFT (CH1, CH3, CH6, CH5, CH4, CH2).

Section 3.2 summarizes the performance of the NODOS alternatives for fall Chinook (Table 3-B).

Using the same methods applied to Steelhead trout, it is possible to use SacEFT to quantify target and avoidance flows at index locations for fall Chinook critical periods.

3.3.4 Late Fall Chinook

Readers are referred to Appendix C (LFALL Chinook worksheet) for late fall Chinook results for the six independent salmonid performance measures in SacEFT (CH1, CH3, CH6, CH5, CH4, CH2).

Section 3.2 summarizes the performance of the NODOS alternatives for late fall Chinook (Table 3-B).

Using the same methods applied to Steelhead trout, it is possible to use SacEFT to quantify target and avoidance flows at index locations for late-fall Chinook critical periods.

3.3.5 Spring Chinook

Readers are referred to Appendix C (SPRING Chinook worksheet) for late fall Chinook results for the six independent salmonid performance measures in SacEFT (CH1, CH3, CH6, CH5, CH4, CH2).

Section 3.2 summarizes the performance of the NODOS alternatives for spring Chinook (Table 3-B).

Using the same methods applied to Steelhead trout, it is possible to use SacEFT to quantify target and avoidance flows at index locations for spring Chinook critical periods.

3.3.6 Winter Chinook

Readers are referred to Appendix C (WINTER Chinook worksheet) for winter-run Chinook results for the six independent salmonid performance measures in SacEFT (CH1, CH3, CH6, CH5, CH4, CH2).

Section 3.2 summarizes the performance of the NODOS alternatives for winter-run Chinook (Table 3-B).

Using the same methods applied to Steelhead trout, it is possible to use SacEFT to quantify target and avoidance flows at index locations for winter-run Chinook critical periods.

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3.4 Riparian Species and Performance measures

3.4.1 Fremont Cottonwood Initiation

Fremont Cottonwood - Initiation Success (FC1) - Roll-Up

Scenario ID	Indicator Name	Indicator Description	Create Report	Multi Year Rating	% Poor	% Fair	% Good
NODOS - Alternative A, NoRipRapRemoval							
NODOS - Alternative B, NoRipRapRemoval							
139	FC1 - Initiation	Fremont Cottonwood - relative initiation success			91	9	0
NODOS - Alternative C, NoRipRapRemoval							
140	FC1 - Initiation	Fremont Cottonwood - relative initiation success			88	12	0
NODOS - Existing, NoRipRapRemoval							
132	FC1 - Initiation	Fremont Cottonwood - relative initiation success			87	13	0
NODOS - No Action, NoRipRapRemoval							
134	FC1 - Initiation	Fremont Cottonwood - relative initiation success			83	17	0
VERSION 2 CALIBRATION RUN (HISTORICAL)							
115	FC1 - Initiation	Fremont Cottonwood - relative initiation success			63	20	17

Figure 3.24: Multi-year roll-up results for Fremont cottonwood seedling initiation success (FC1).

Figure 3.24 and Figure 3.25 show the percentage of years in each NODOS simulation having favorable (green) conditions for Fremont cottonwood seedling initiation (FC1). SacEFT predicts that Fremont cottonwood initiation (FC1) would not be impacted by any of the NODOS Investigation alternatives when compared with the existing conditions or NAA (Figure 3.25). However, results indicate that all of the NODOS alternatives are expected to generate unfavorable Cottonwood initiation conditions.

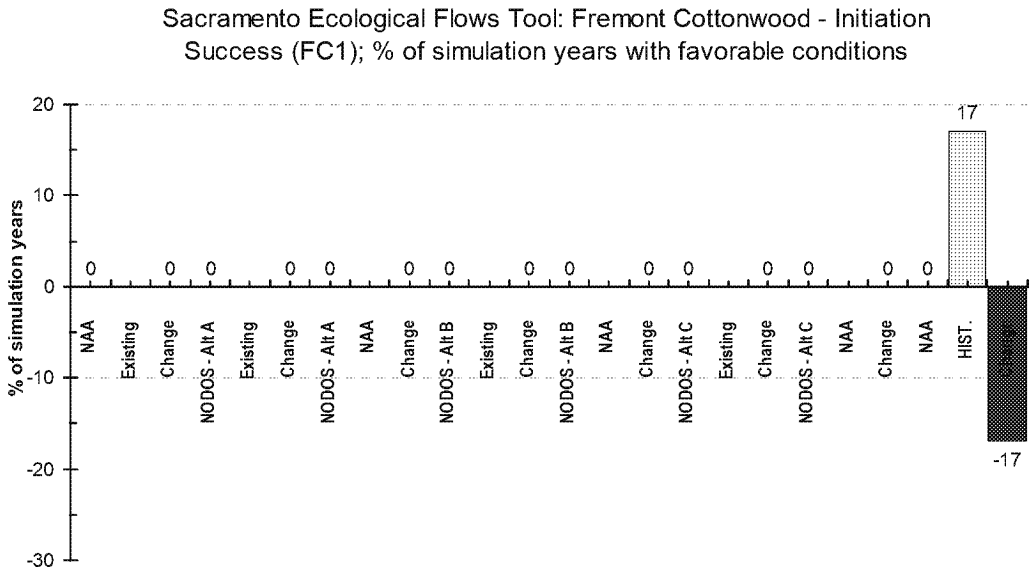

Figure 3.25: The percentage of years in each NODOS simulation having favorable (green) conditions for Fremont cottonwood seedling initiation (FC1). Bars labeled with "Change" refer to the % change between the simulated alternative and the reference condition (either Existing conditions or the No Action Alternative (NAA)).

It is noted that scour risk (FC2) is reduced under the NODOS alternatives, especially alternative C and A (Figure 3.26). However, this reduction in scour risk is in part due to the reduction in number of years with successful initiation (FC1). The FC2 performance measure in SacEFT is only relevant/calculated in years with successful Fremont cottonwood initiation (FC1).

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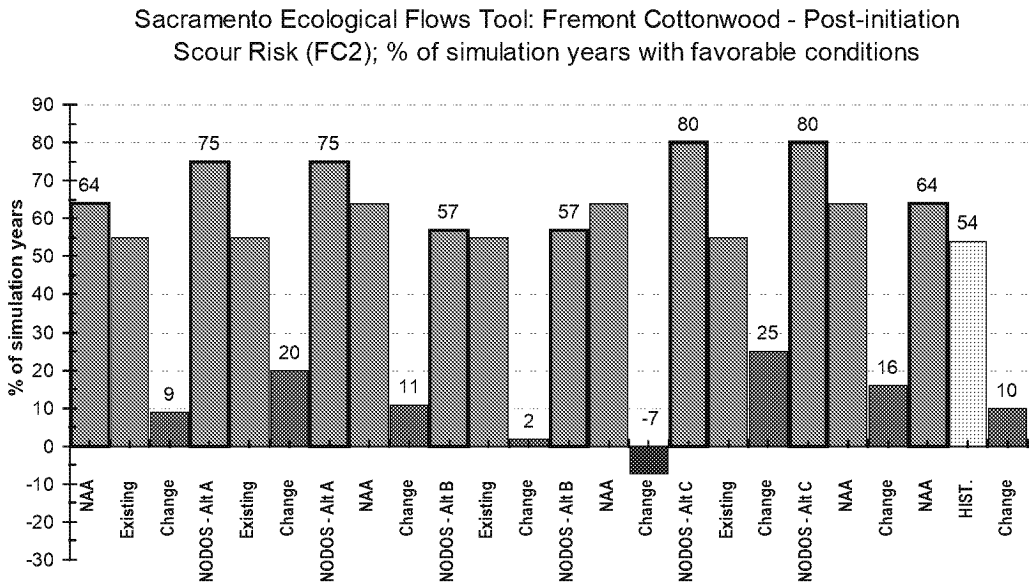

Figure 3.26: The percentage of years in each NODOS simulation having favorable (green) conditions for Fremont cottonwood seedling scour (FC2). Bars labeled with "Change" refer to the % change between the simulated alternative and the reference condition (either Existing conditions or the No Action Alternative (NAA)). Note: The FC2 performance measure in SacEFT is only relevant/calculated in years with successful Fremont cottonwood initiation (FC1).

In terms of Fremont cottonwood initiation, all NODOS alternative flows eliminate strong initiation events (see Figure 3.27).

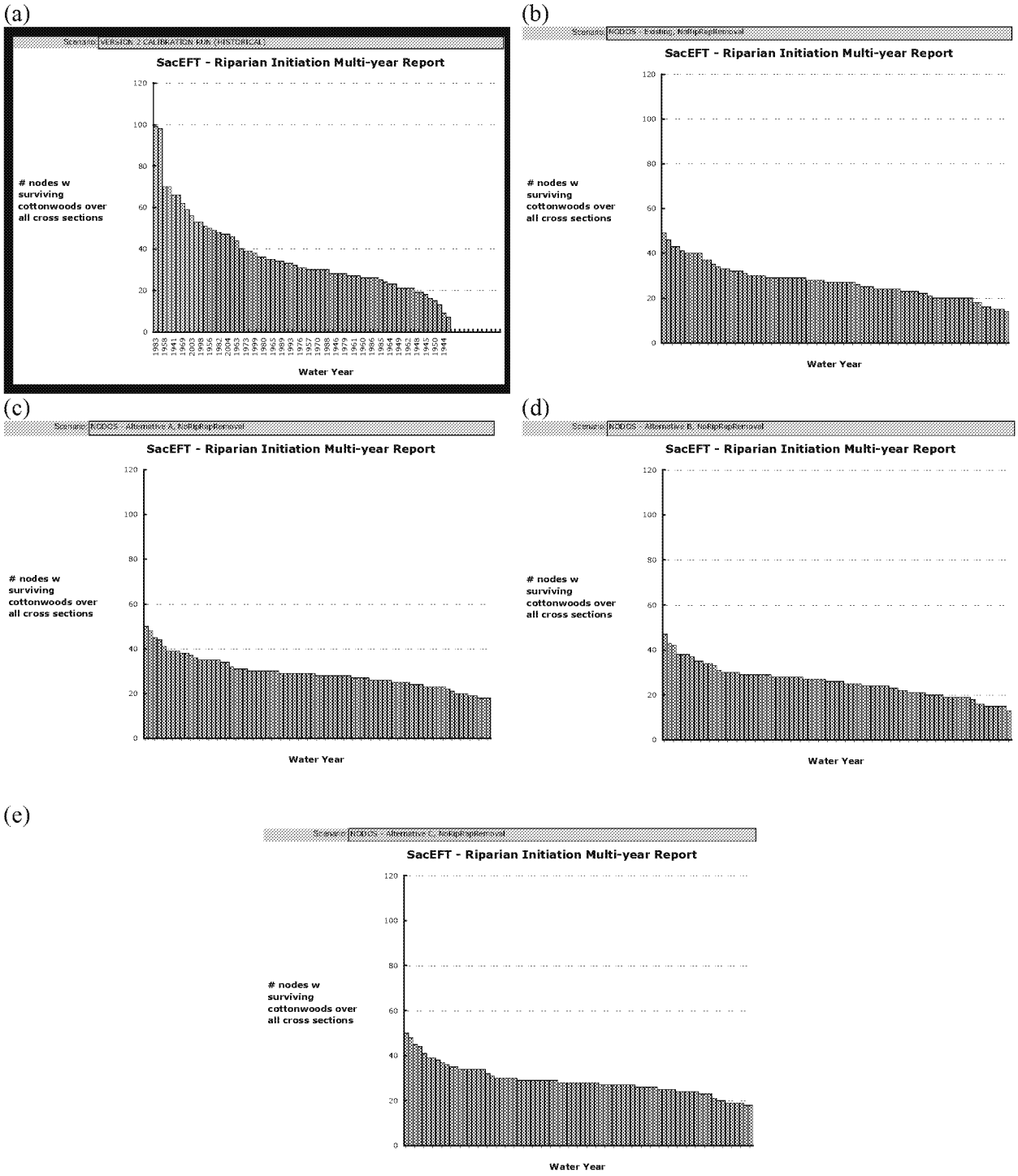

Figure 3.27: Annual index of total number of SacEFT cross-section nodes (entire study area) with successfully initiating Fremont cottonwood seedlings (FC1). These annual results are sorted in descending order. Panel (a) shows results for historical flows from 1938 to 2004. Green shaded bars refer to initiation totals that if met or exceeded, receive a favorable (green) rating in SacEFT. Panel (b) is for the NODOS existing conditions alternative. Panel (c) gives results for NODOS Investigation alternative A. Panel (d) shows results for NODOS Investigation alternative B. Finally, panel (e) shows results for NODOS Investigation alternative C.

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Figure 3.28, Figure 3.29 and Figure 3.30 show the SacEFT target/favorable flow profiles and target flow recession rate at several index locations along the Sacramento River during the critical period for Fremont cottonwood seedling initiation (FC1).

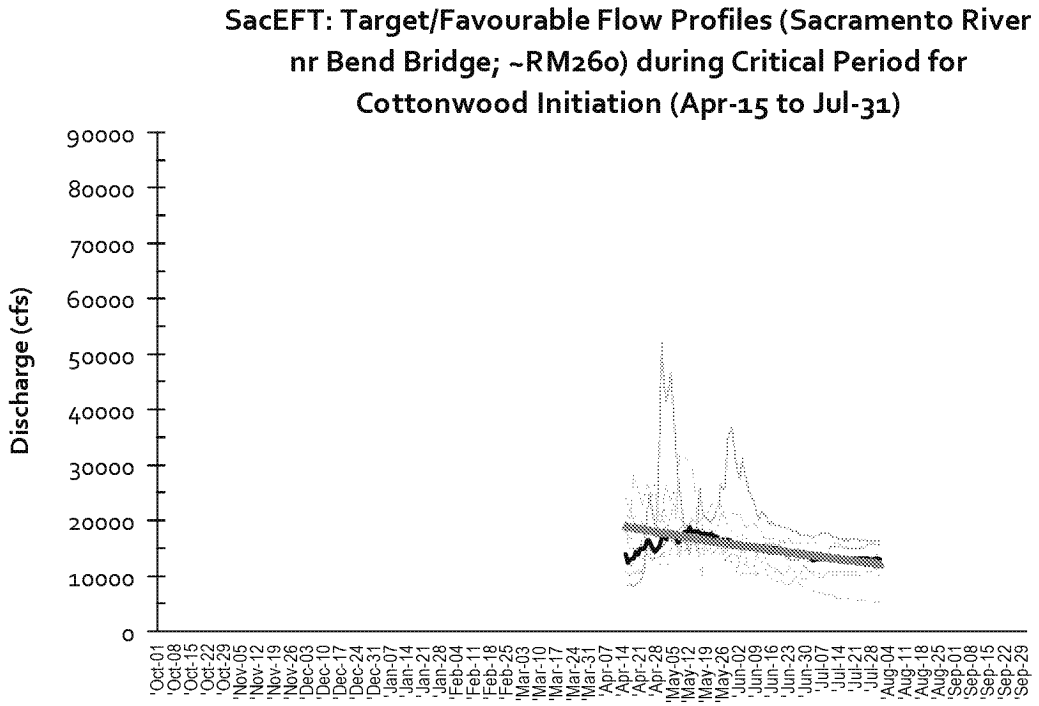

Figure 3.28: Target/favorable flow profiles (green) needed to deliver downstream successful Fremont cottonwood initiation (FC1) as measured at Sacramento River near Red Bluff (RM260). Flow profiles in green refer to years where SacEFT's annual performance measure rating was assessed as good/favorable. [Note: this figure is designed for color printing].

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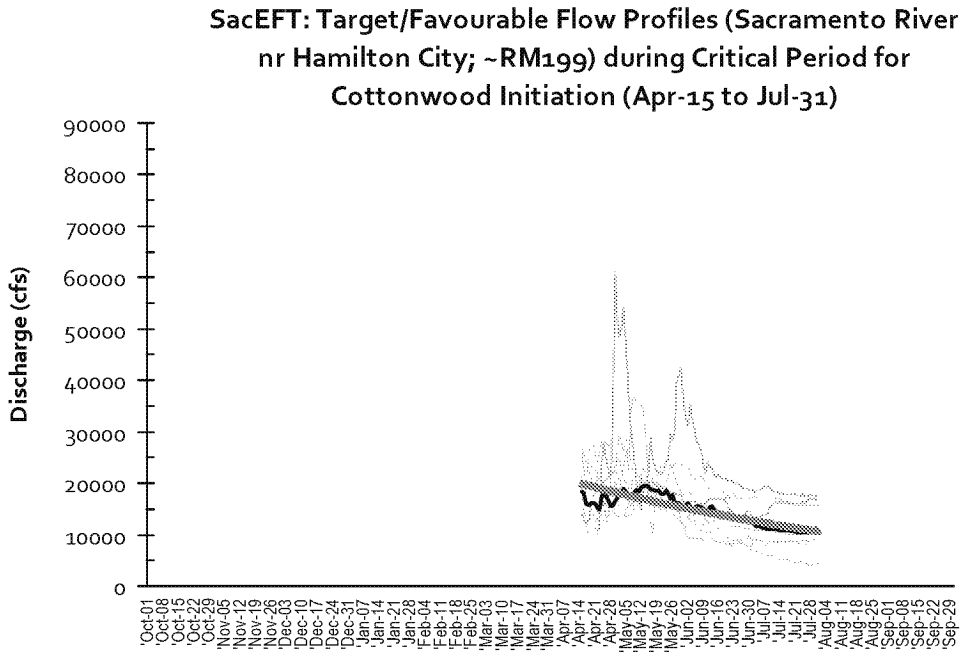

Figure 3.29: Target/favorable flow profiles (green) for successful Fremont cottonwood initiation (FC1) at Sacramento River near Hamilton City (RM199). Flow profiles in green refer to years where SacEFT's annual performance measure rating was assessed as good/favorable. [Note: this figure is designed for color printing].

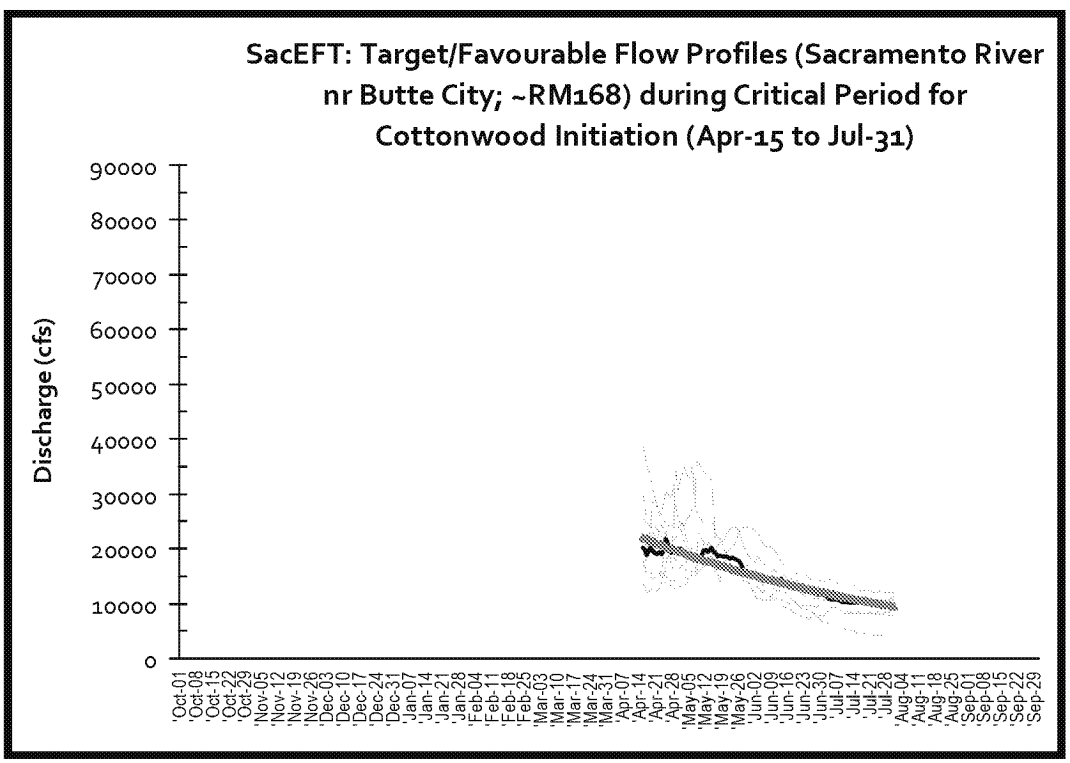

Figure 3.30: Target/favorable flow profiles (green) for successful Fremont cottonwood initiation (FC1) at Sacramento River near Butte City (RM168). Flow profiles in green refer to years where SacEFT's annual performance measure rating was assessed as good/favorable. [Note: this figure is designed for color printing].

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The frequency and pattern in which favorable Fremont cottonwood initiation flows are missed along the Sacramento River near Butte City is clearly shown in Figure 3.32.

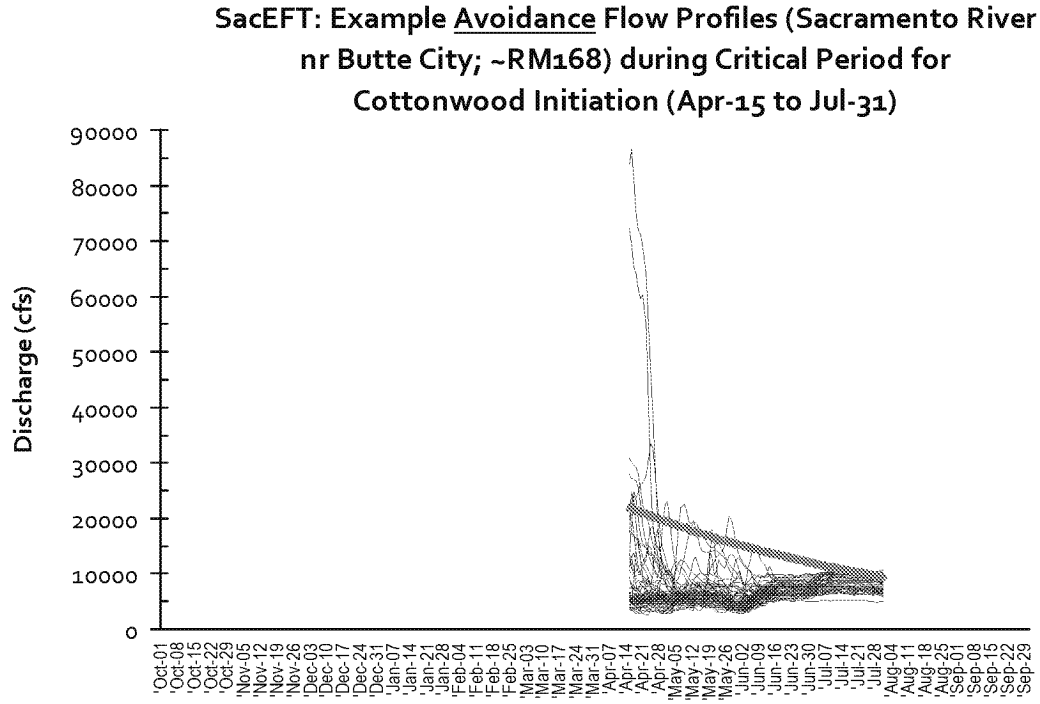

Figure 3.31: Avoidance flow profiles (red) for failed Fremont cottonwood initiation (FC1) at Sacramento River near Butte City (RM168) relative to the target flow and recession rate. [Note: this figure is designed for color printing].

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3.4.2 Bank Swallow Habitat Potential and Nest Inundation

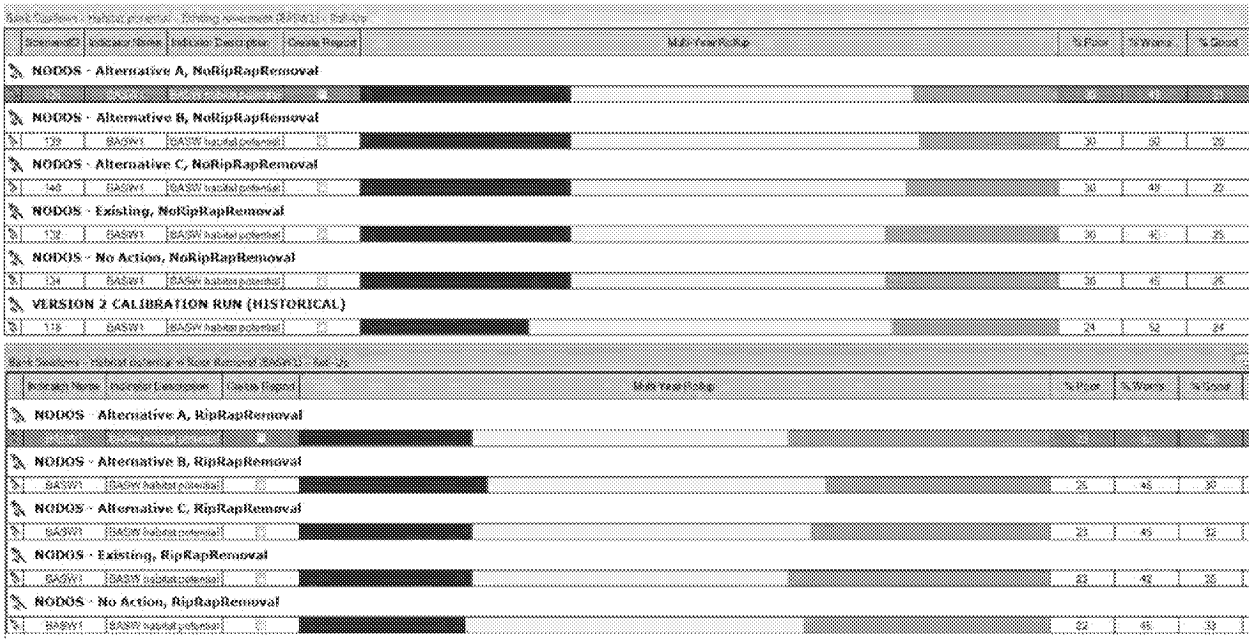

Figure 3.32: Multi-year roll-up results for Bank swallow habitat potential (BASW1). The top panel shows results for all NODOS alternatives under existing revetment. The bottom panel shows results with select rock removal (as defined in section 2.5.1).

Figure 3.32 and Figure 3.33 show the percentage of years in each NODOS simulation having favorable (green) conditions for Bank swallow habitat potential/suitability (BASW1). SacEFT predicts that Bank swallow habitat suitability (BASW1) would not be appreciably impacted by any of the NODOS Investigation alternatives when compared with the existing conditions or NAA (Figure 3.33). Results point to the stronger, more important effect of **rock removal** for improving habitat suitability and potential for Bank swallow nesting habitat.

Bank swallow nest inundation is not appreciably different amongst any of the NODOS alternatives (Figure 3.34).

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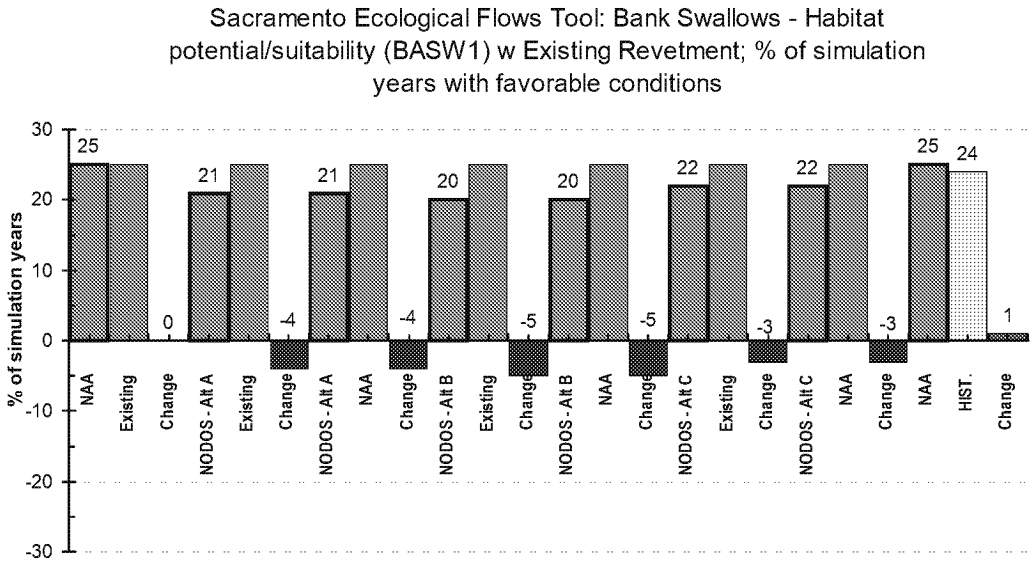
(a)



(b)

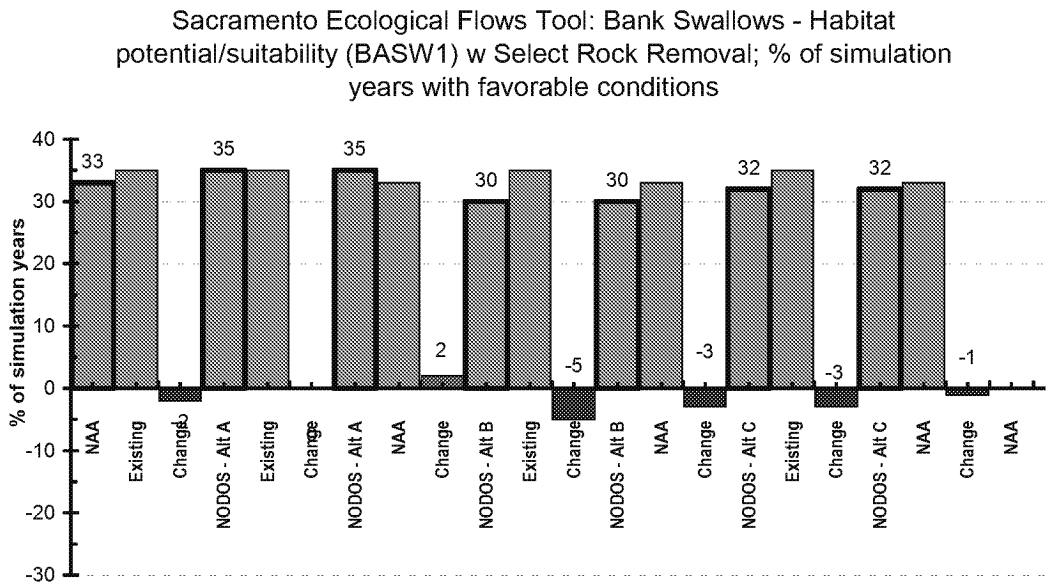


Figure 3.33: The percentage of years in each NODOS simulation having favorable (green) conditions for Bank swallow habitat potential/suitability (BASW1). Panel (a) provides results under existing revetment. Panel (b) shows results with selected rock removal (as defined in section 2.5.1). Bars labeled with "Change" refer to the % change between the simulated alternative and the reference condition (either Existing conditions or the No Action Alternative (NAA)).

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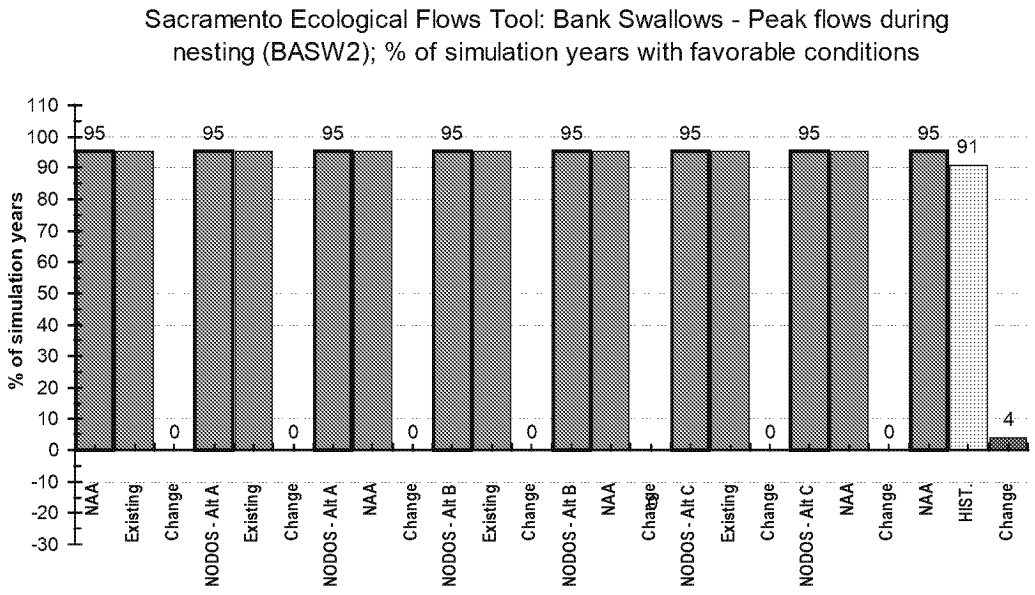

Figure 3.34: The percentage of years in each NODOS simulation having favorable (green) conditions for Bank swallow nest inundation (BASW1). Bars labeled with "Change" refer to the % change between the simulated alternative and the reference condition (either Existing conditions or the No Action Alternative (NAA)).

3.4.3 Large Woody Debris Recruitment

Figure 3.35: Multi-year roll-up results for Large Wood Debris recruitment (LWD) to the mainstem Sacramento River. The top panel shows results for all NODOS alternatives under existing revetment. The bottom panel shows results with select rock removal (as defined in section 2.5.1).

Figure 3.35 and Figure 3.36 show the percentage of years in each NODOS simulation having favorable (green) conditions for Large Wood Debris recruitment (LWD) to the mainstem Sacramento River. Amongst NODOS alternatives, SacEFT predicts LWD would not be appreciably impacted by any of the

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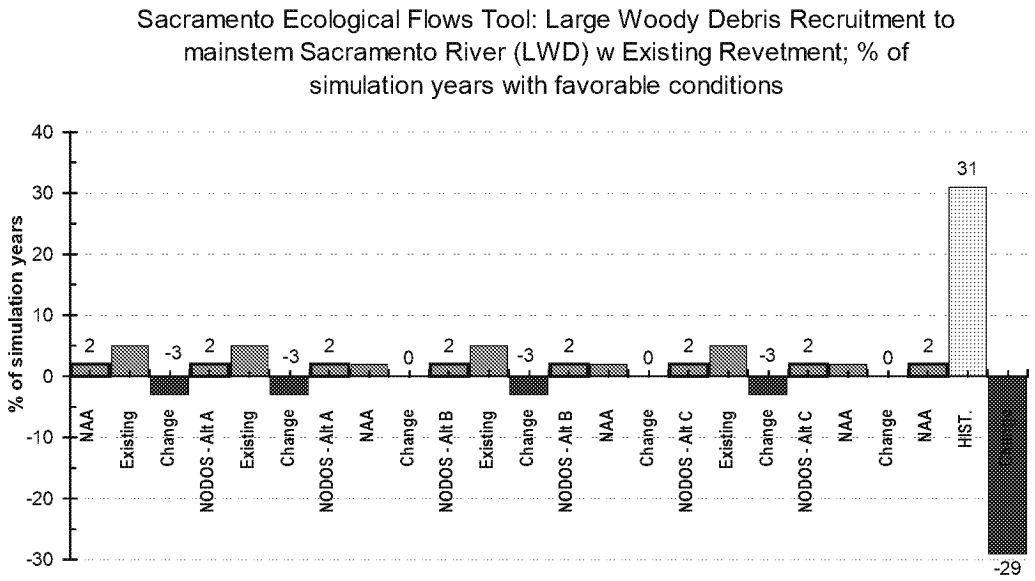
Investigation alternatives when compared with the existing conditions or NAA (Figure 3.36). Notably, LWD recruitment was significantly improved by conditions present in actual historic flows. Lastly, as with Bank Swallows, results point the important effect of rock removal for improving natural stream bank erosion and channel migration.

(a)



(b)

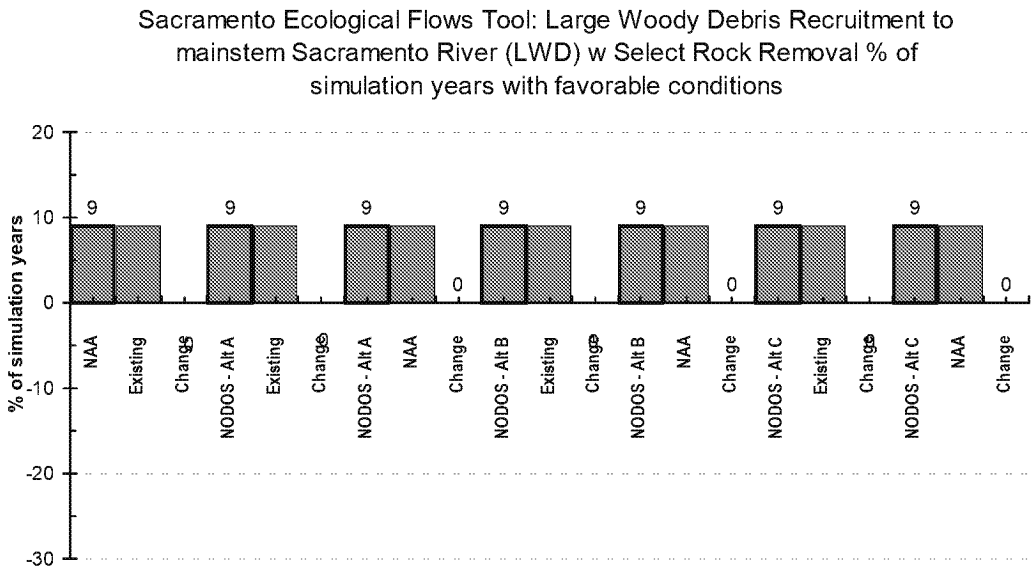


Figure 3.36: The percentage of years in each NODOS simulation having favorable (green) conditions for Large Woody Debris recruitment (LWD) to the mainstem Sacramento River. Panel (a) provides results under existing revetment. Panel (b) shows results with selected rock removal (as defined in section 2.5.1). Bars labeled with "Change" refer to the % change between the simulated alternative and the reference condition (either Existing conditions or the No Action Alternative (NAA)).

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3.5 Integrated SacEFT Target and Avoidance Flows

One of the unique features of SacEFT is the ability to quantify varied functional flow needs. This can be done on the basis of focal species, performance measure by performance measure. Combining *representative* ecological functional flow needs across species and performance measures is the next level of target and avoidance flow synthesis sought in SacEFT studies. As a starting point, Figure 3.37 shows the integrated SacEFT target and avoidance flows for Fremont Cottonwood initiation and Steelhead trout. Using SacEFT, it is possible to add additional functional flow targets for other species and performance measures to this type of graph.

When interpreting SacEFT target and avoidance flow plots such as Figure 3.37, it is important to recognize that short-term deviations below the low- and above the high-flow targets are acceptable. Previous examples of flow traces reveal that cumulative weighted performance measures may be viewed favorably over the course of a year despite modest variations above and below these targets. In practical terms, an integrated evaluation would consider the number of days in the simulation that a given water management alternative generated flows (or water temperatures) outside these targets (Figure 3.38).

Lastly, while some do, not all functional flow needs are required to be met every year. Certain functional flow characteristics are required on a periodic basis and not every single year. Fremont cottonwood initiation (FC1) flow requirements are perhaps the best example, and most ecologists would consider strong recruitment cohorts two to three times in 10 years to be adequate.

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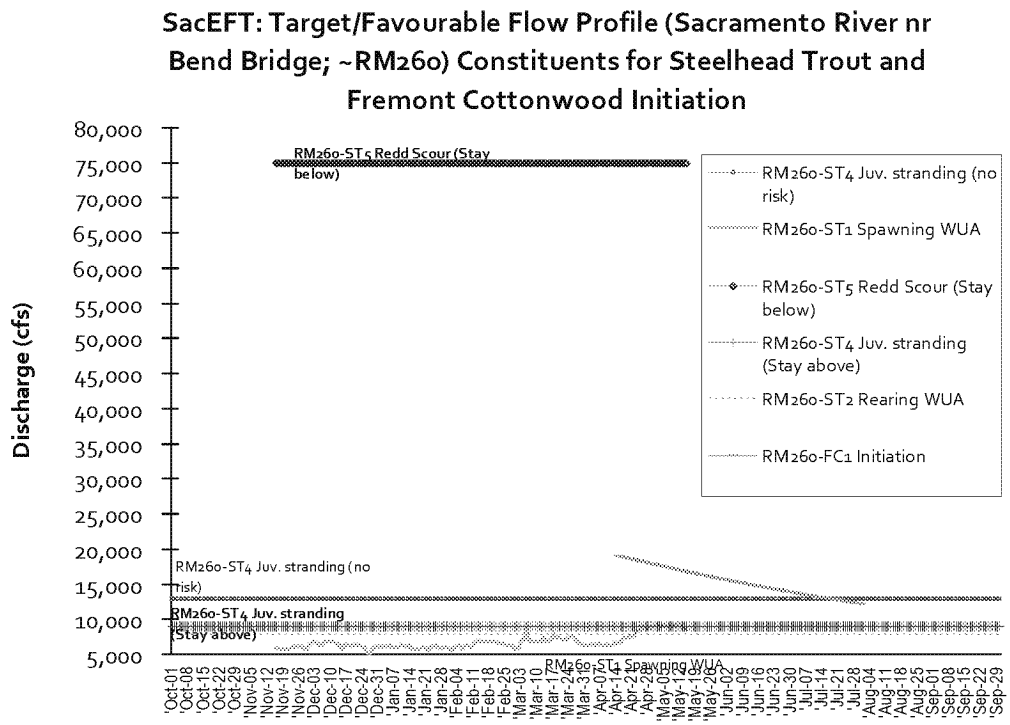
(a)



(b)

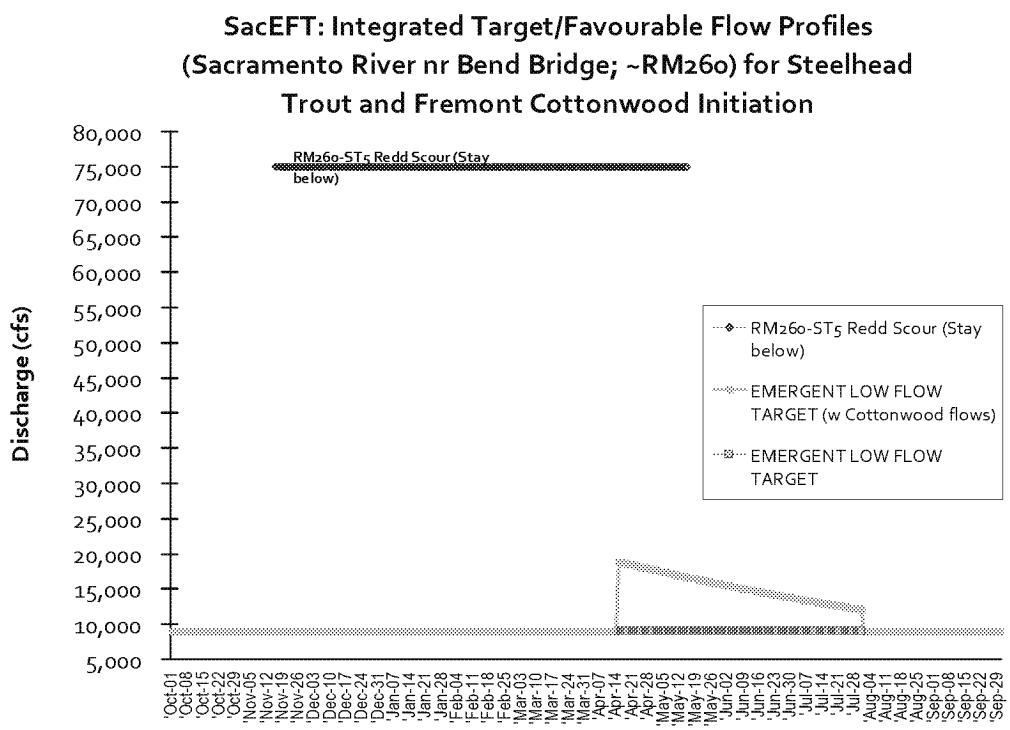


Figure 3.37: Constituent functional flow targets (panel (a)) used to derive integrated target flows (panel (b)) for Steelhead trout and Fremont cottonwood initiation referenced to flows at Sacramento River near Red Bluff (RM260). Using SacEFT, it is possible to add additional functional flow targets for other species and performance measures to this type of graph. [Note: this figure is designed for color printing].

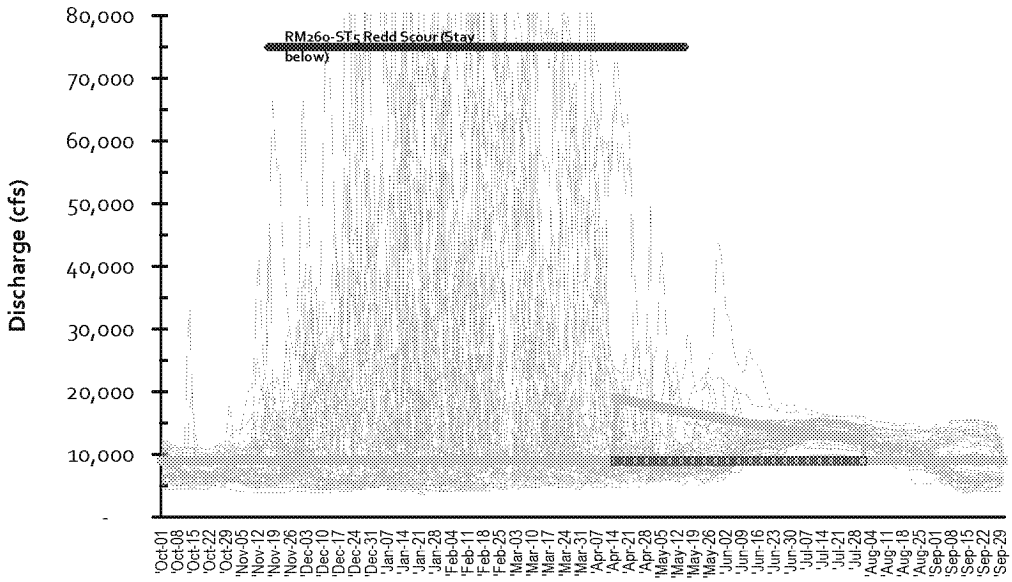


Figure 3.38: Flow traces for the NAA vs. SacEFT target flows for Steelhead trout and Fremont Cottonwood initiation as indexed at the Sacramento River near Red Bluff (RM260). Using SacEFT, it is possible to add additional functional flow targets for other species and performance measures to this type of graph.

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4. Conclusions

Our analyses of the ecosystem consequences of the proposed NODOS alternatives demonstrate that no one alternative is beneficial for all focal species considered in SacEFT. This is not surprising, given that different species, and even different life stages of a given species, are responsive to different conditions and habitat attributes.

With respect to fisheries resources, we recommend that the detailed results presented in this report, and summarized in Table 3-B and Table 3-C (pp. 34-36), be considered in conjunction with the results from other modeling exercises (*e.g.*, IOS, SALMOD).

For terrestrial species, which are being given less consideration outside of our analyses, we are concerned with Alternative B which, according to our analyses, has the most negative impacts as compared to Alternatives A and C. Alternative B, which does not include the construction of a pumping station and the Delevan Pipeline, is expected to adversely impact Bank Swallows and not yield the benefits to Cottonwood that are found in Alternatives A and C.

These results suggest that from an ecosystem management standpoint, it is favorable to include a diversion point that is far downstream of the GCID diversion. Doing so would allow water to be routed through a relatively longer reach of the Middle Sacramento River before being withdrawn for the new storage facility. Allowing water to remain in the river as long as possible before diverting it to the storage facility would enhance geomorphic processes such as bank erosion and sediment deposition, both of which are important for creating nesting cutbanks for swallows and appropriate recruitment sites for cottonwoods.

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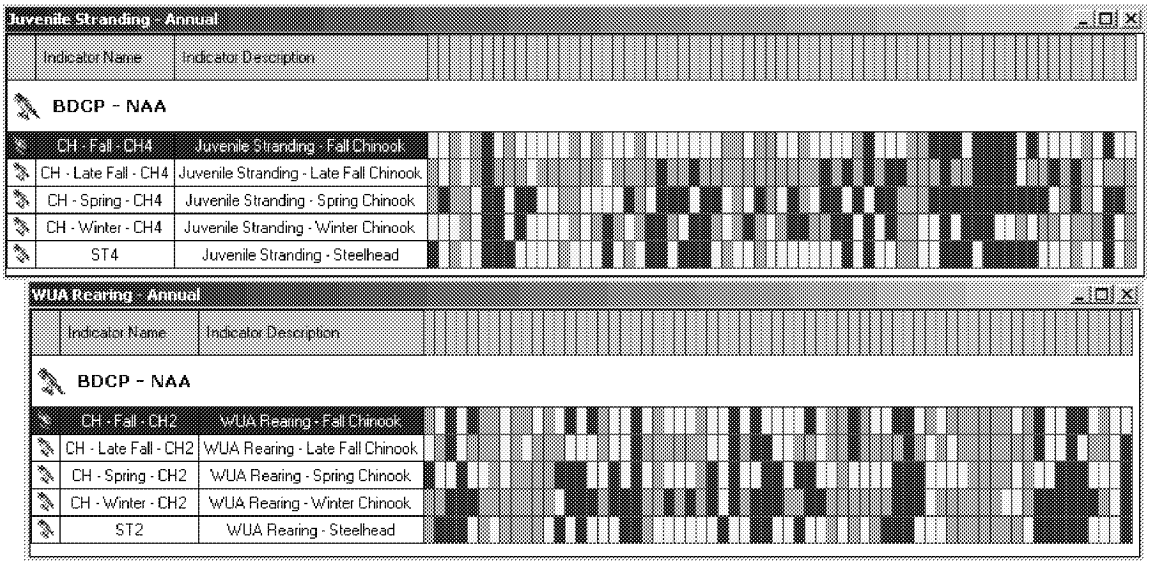
Appendix A – Inverse Correlation between Juvenile Stranding and Juvenile Rearing in SacEFT

SacEFT has six performance measures (PMs) related to the early life history of Chinook salmon and Steelhead trout. Positive and negative correlations between some of the PMs can often be seen. The example below compares juvenile Stranding (top panel) for all 5 run-types and WUA Rearing (bottom panel) for the run types. Each individual coloured cell represents the aggregated annual value beginning in Water Year (WY) 1939 and continuing until WY 2003. Separate rows show the different run types.

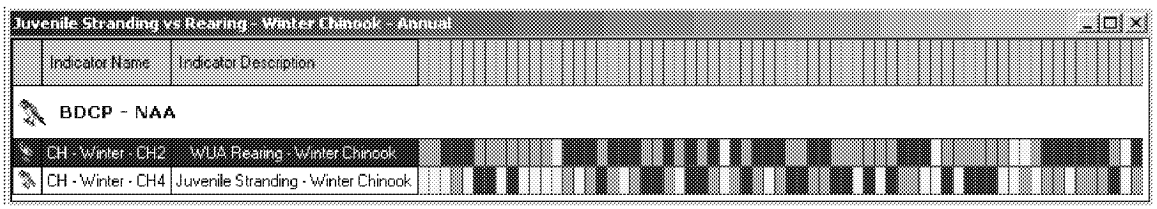


These high level summaries use the default SacEFT traffic light performance measure rating approach described earlier in the main body of this report.

One relationship that is particularly evident and appears to be counter-intuitive is the **negative** correlation between:

- ∞ juvenile rearing habitat ("WUA Rearing") and
- ∞ the index of juvenile stranding.

The figure below shows this for winter-run Chinook and gives a clear impression that good years (green) for WUA Rearing (ST2/CH2) are matched by fair (yellow) or poor (red) years for juvenile stranding (ST4/CH4) and *vice versa*.



To explore this result in more depth, we examined this run type using a draft BDCP-NAA scenario provided in the spring of 2010. The assumptions embedded in this scenario are immaterial to the current exploration of the inverse relationship between WUA rearing and juvenile stranding.

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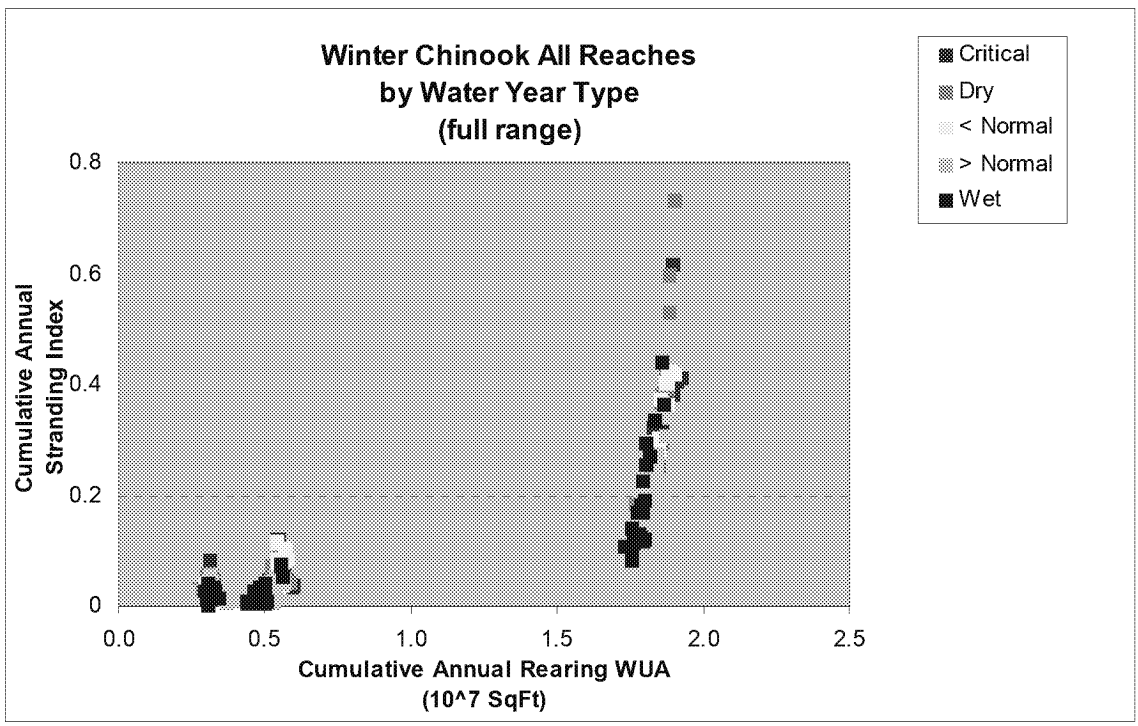
We plotted the annual summary data for WUA rearing against juvenile stranding, colouring each water year using the customary 5-level assignment used for the Sacramento River. Winter-run Chinook spawn from March 1 to August 15 with egg development typically continuing until early November. The Juvenile period begins in mid-June when the first-spawned eggs emerge and extends to early March of the following year. In SacEFT, all reports for year-cohorts are presented in the originating year of the cohort, even if the life stage continues into the next water year.

A plot of the full range of results is shown below, with water year strata coloured from very dry (red) to wet (blue). The upper panel shows the full range of the WUA rearing (ST2/CH2) and the juvenile stranding (ST4/CH4) index, and the lower panel expands the lower left corner of the upper panel to improve visibility of data points in that corner. It is very clear that the observations from all kinds of water years fall into three groups or clusters. There is also a trend for wet years (blue) to have lower rearing WUA and a lower stranding index.



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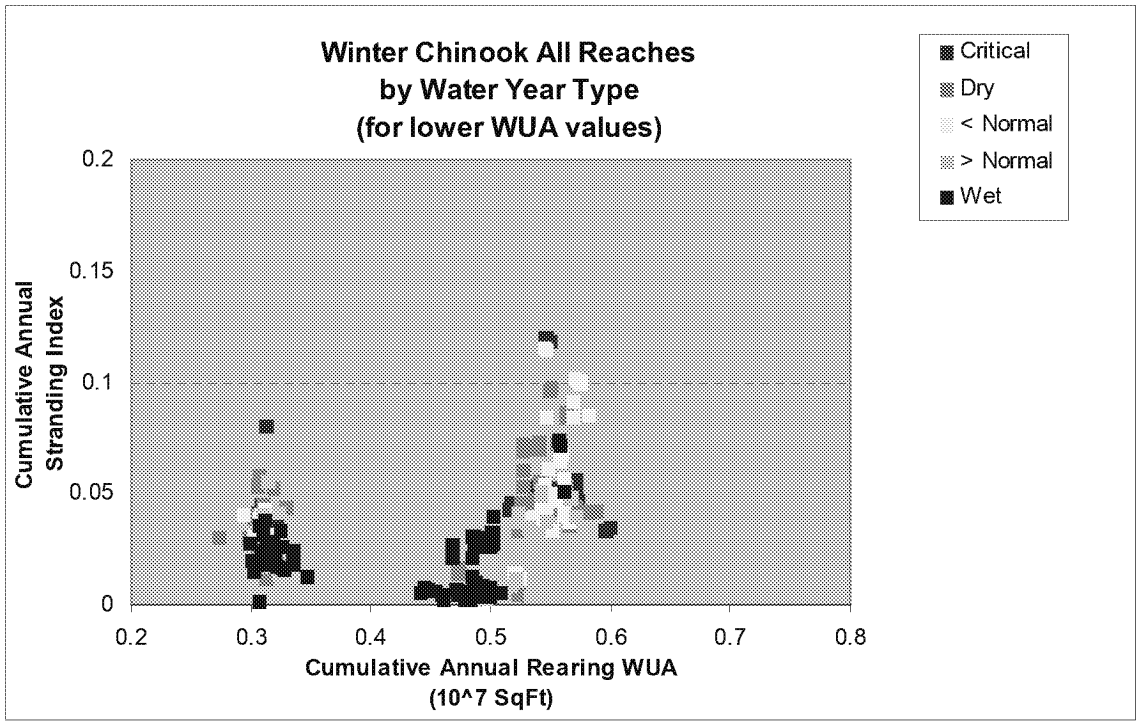
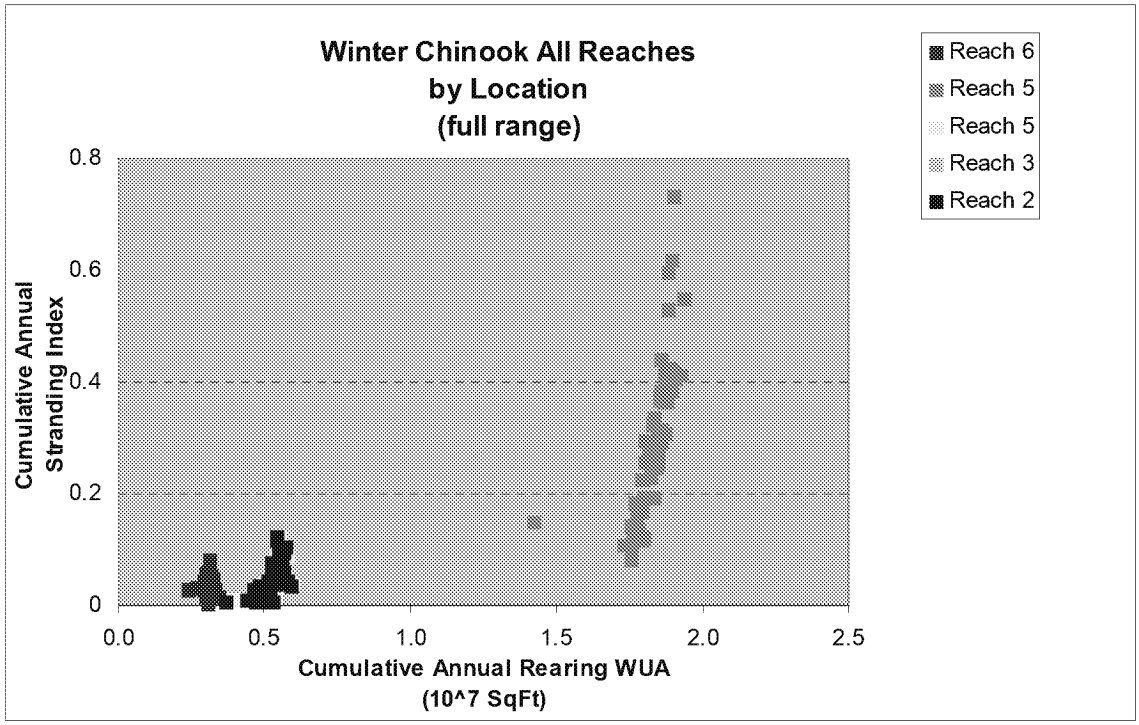
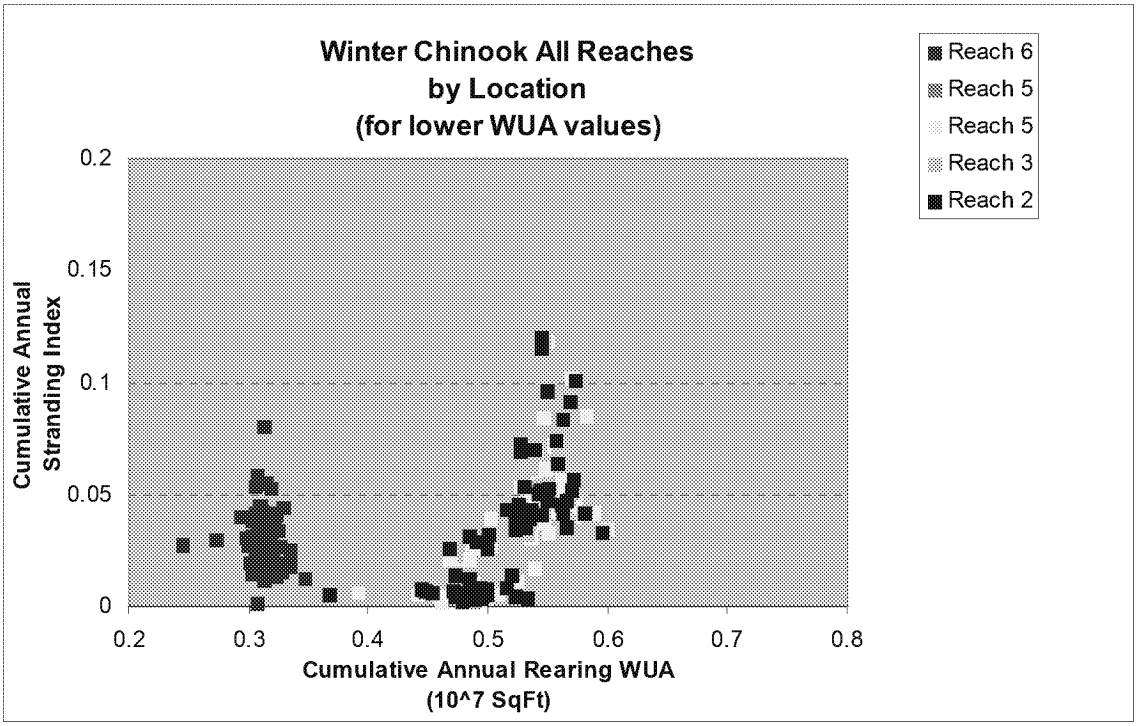


The different data cluster groups correspond to very different amounts of rearing WUA (x-axis) and to a lesser extent stranding index (y-axis) in the 5 reaches which are modelled by SacEFT's steelhead and Chinook submodels. This is made clear in the results stratified by location, plotted below.



Reach 5 (which begins downstream from Battle Creek and is coloured orange in the upper panel) has more than three times the potential rearing habit of the other reaches. The upper boundary of Reach 6 is at Keswick and the lower boundary of Reach 2 is at Vina.



The consistent and steep positive relationship between Rearing WUA and Stranding Index is clear for most of the reaches: **more rearing WUA produces more potential stranding.** The relationship also gives the impression of being slightly curved.

The relationship stems from the fact that the amount of potential rearing habitat is used as an input to weight the impact of juvenile stranding, making it inevitable that as more habitat is created (regardless of the details of the daily flow regime and the exact nature of the flow-stage recession relationship) it exposes proportionally more juveniles to stage-flow recession events when they inevitably occur. Since increased rearing WUA area results in a Good/Green performance measure rating while an increased stranding index results in a Poor/Red performance measure rating, the two measures become negatively correlated.

At the suggestion of Dr. David Swank (Fisheries Biologist, NMFS, Sacramento) we reviewed three articles relating to behavioral responses to stage recession and stranding.[1] These papers all conclude that fish will migrate in response to recession, given sufficient time. SacEFT operates at a daily timescale, while the real-world biological response to stage recession risk (in the context of these papers) is hourly. In general, trout and salmon are less likely to move during daylight hours, presumably to avoid predation. There are also species and seasonal differences in behavior. I could see no indication that juveniles will not use wetted habitat when it is present.

[1] **Halleraker, J.H., Saltveit, S.J., Harby, A., Arnekliev, J.V., Fjeldstad, H.-P. And B. Kohler.** 2003. Factors influencing stranding of wild juvenile Brown trout (*Salmo trutta*) during rapid and frequent flow decreases in an artificial stream. River Research and Applications 19:589-603.

Scruton, D.A., Ollerhead, L.M.N., Clarke, K.D., Pennell, C., Alfredsen, K., Harby, A. and D. Kelley. 2003. The behavioral response of juvenile Atlantic salmon (*Salmo salar*) and Brook trout (*Salvelinus fontinalis*) to experimental hydropeaking on a Newfoundland (Canada) river. River Research and Applications 19:577-587.

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Dr. Swank suggested that we might find some gauges with hourly (or shorter) stage measurements and see how the high-resolution values are distributed, then compare that distribution to our daily resolution data, creating a relationship between daily recession and the distribution of hourly recession. It might then be possible to link the probability of a high-resolution rapid recession rate (*e.g.*, exceeding 10cm hr^{-1} as a threshold for "high risk") derived from the literature with our daily recession. This could be a fairly involved analysis, and our modelers do not believe it would fundamentally remove the inverse correlation since the (potentially more accurate) hourly risk would still be weighted by rearing WUA in our model.

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Appendix B – Indicator Thresholds and Rating System[1]

The SacEFT output interface makes extensive use of a "traffic light" paradigm that juxtaposes performance measure (PM) results and scenarios to provide an intuitive overview of whether a given year's PMs are experiencing favorable conditions (Green), are performing only fairly (Yellow), or are experiencing unfavorable conditions (Red). For all twelve (12) performance measures, annual cumulative weighted performance measure values are calculated for our default historical water operation scenario based on the 66-year historical time series of observed flows and water temperatures from 1938 to 2003. These "annual roll-up" values for each performance measure (*e.g.*, average over days and locations with applicable biological distributions) are then assigned a "good" (Green), "fair" (Yellow) or "poor" (Red) performance measure rating (*e.g.*, Figure B.1). The *default* threshold boundaries between Yellow/Green and Red/Yellow are based on tercile break points determined by sorting the annual weighted performance measure values from the default historical water operation scenario.

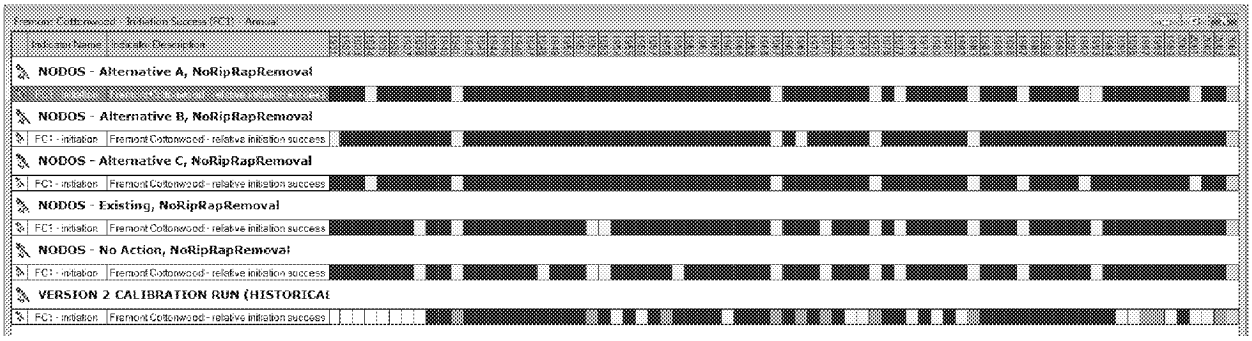

Figure B.1: Typical SacEFT output showing annual roll-up results for the Fremont cottonwood initiation (FC1) performance measure. Analogous plots are available for all of the tools' focal species and performance measures.

These annual performance measure ratings are based on thresholds[2] defined by sorting cumulative annual results produced by SacEFT for historic observed flows and water temperatures between calendar years 1938 and 2003 (*e.g.*, Figure B.2). The "units" of these plots vary with the performance measure. In this way, historic observed flows/temperatures provide the de facto "calibration scenario" for SacEFT's twelve (12) focal species performance measures.

[1] This introduction is drawn *verbatim* from Section 3.1.2 of:

ESSA Technologies Ltd. 2011. Sacramento River Ecological Flows Tool (SacEFT): Record of Design (v.2.00). Prepared by ESSA Technologies Ltd., Vancouver, BC for The Nature Conservancy, Chico, CA. 111 p. + appendices.

[2] Indicator thresholds in SacEFT are fully configurable via settings found in the SacEFT relational database.

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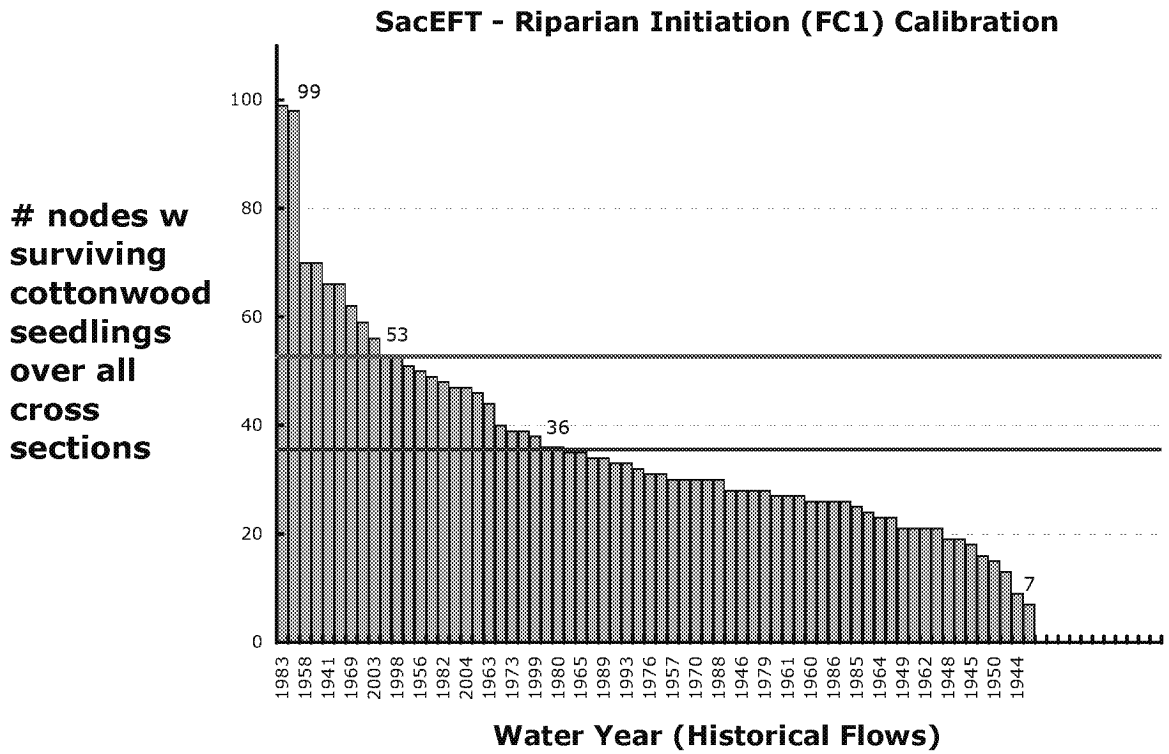

Figure B.2: Annual roll-up results for the SacEFT Fremont cottonwood initiation (FC1) performance measure run using historic observed flows (1938–2003). This calibration also takes into consideration comparisons with aerial photographs of historically strong Cottonwood recruitment at study sites vs. model results.

Our concept of indicator threshold calibration in SacEFT focuses on historical data. From an ecological standpoint, aquatic and riparian species are adapted to a historical range and frequency of variations in their habitats. Taken to the extreme, historical conditions would ideally include pre-settlement (natural) flows/water temperatures that represented 'typical' conditions experienced over evolutionarily significant windows of time. The closest flow/temperature time series that we have available to this evolutionarily representative condition is the range of variation in historical observed flows/temperatures (approximately 66 years). It is recognized that during 1938–2003 the Sacramento River experienced a number of waves of human and structural development and operational changes to the hydrosystem. Nevertheless, these flows and temperatures, derived from measurements, actually occurred in recent history and encompass repeat episodes of multiple water year types. Calibrating SacEFT indicator thresholds to a future no action or 'existing' scenario that includes a fixed set of hydrosystem features, constraints, operating regulations and assumed human demands would create a "self-fulfilling prophecy" inconsistent with SacEFT's underlying natural flow regime science foundation. In general, all of the models used in the NODOS investigation are calibrated based upon historical information.

Typically, none of the NODOS investigation project alternative modelling results are compared against the historical calibration due to the focus of CEQA/NEPA which emphasizes isolating project alternative effects as compared to a no action reference or existing condition comparison. Comparisons that include historical data reveal different information in a different context that does not address a specific project effect relative to the no action alternative or existing condition reference case. Comparisons that include historic calibration data identify the ecological effects of the future system operations and constraints relative to historic conditions. In fully considering ecological flow needs, the magnitude of departure from

these historic conditions may reveal important information on how future constraints, climate and/or hydrosystem operational modifications are influencing preferred ecological flow targets.

The highest level synthesis concept in SacEFT is that of a "multi-year roll-up". This is the percentage of years in the simulation having favorable (Green), fair (Yellow), and poor (Red) conditions (*e.g.*, Figure 2.3).

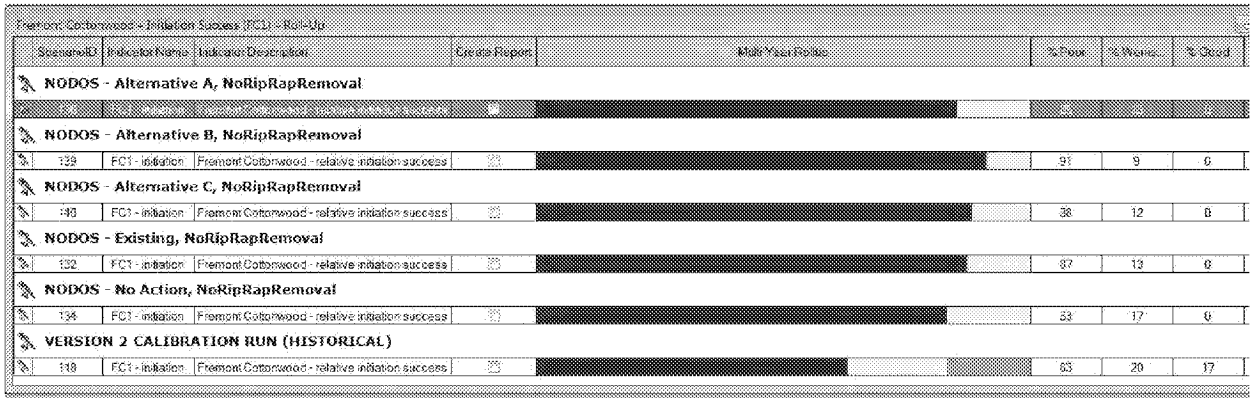

Figure B.3: Typical SacEFT output showing multi-year roll-up results for the Fremont cottonwood initiation (FC1) performance measure. Analogous plots are available for all of the tools' focal species and performance measures.

The preferred method for calibrating the indicator thresholds is to identify historical years for each performance measure that were known (in nature) to have experienced 'good' or 'poor' performance. Unfortunately, our *repeat* survey efforts of fisheries experts (*e.g.*, Mark Gard, USFWS, *pers. comm.*2011; Matt Brown, USFWS, *pers. comm.* 2011 amongst many others) and a questionnaire sent to fisheries biologists prior to the 2008 SacEFT v.1 review workshop revealed there are no known synoptic studies of this kind for many of the indicators in SacEFT. Because of this gap and the hesitancy of experts to reveal their opinions, we instead defaulted to the distribution of sorted weighted annual results and selected tercile break-points (the lower-, middle- and upper thirds of the sorted distribution) to categorize results into "Good" (Green), "Fair" (Yellow) or "Poor" (Red) categories. **While this method provides a fully internally consistent method of comparing scenario results (*i.e.*, will always provide an accurate picture of which water management scenarios are "better" than another), it does not *necessarily* provide a concrete inference about the biological significance** of being a "Poor" (Red) or "Good" (Green) category. For example, it is possible that a year that ranks as "Good" (Green) with this method may still be biologically suboptimal. Conversely, a year that ranks as "Poor" (Red) *may* be biologically insignificant (*i.e.*, *not* biologically 'unacceptable').

The challenge of identifying "acceptable" and "unacceptable" changes in habitat conditions or focal species performance measures confronts all biological effects analysis methods. SacEFT makes these inherent value judgments explicit in the model's summary outputs. Future analyses using SacEFT look forward to ecological effects analysis experts themselves providing clearer guidance on the (readily configurable) thresholds in the SacEFT modeling system.

On the following pages, Table B.1 provides all indicator rating threshold values for the Daily and Annual Rollup indicators. These are drawn from indicator threshold calibration descriptions in ESSA Technologies (2011). In Table B.1, we flag cases where there are major gradients in performance indicator thresholds. For detailed information on these thresholds, readers should refer to ESSA Technologies (2011).

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Table B.1: Indicator rating threshold breakpoints for the 12 Performance Measures found in SacEFT Version 2. For detailed information on these thresholds, readers should refer to ESSA Technologies (2011).

Chinook/Steelhead 1 – Spawning WUA					
	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Winter-run Chinook	430060	195486	2880	2475	∞ Criteria: statistical distribution, terciles, "more" is better ∞ Units: square feet ∞ Flow, spawning period, habitat preferences, affect distribution
Spring-run Chinook	607975	217913	5825	4775	
Fall-run Chinook	1006472	29967	8470	5500	
Late-fall-run Chinook	520424	280581	4250	2760	
Steelhead	18692	13447	135	106	

Chinook/Steelhead 2 – Rearing WUA					
	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Winter-run Chinook	39675	10987	10250137	9997544	∞ Criteria: statistical distribution, terciles, "more" is better ∞ Daily units: square feet ∞ Rollup units: cumulative square feet ∞ Flow, number of reaches affect distribution
Spring-run Chinook	109294	33678	24800719	19200148	
Fall-run Chinook	51872	20539	18341766	14048587	
Late-fall-run Chinook	47481	18283	13306025	11936239	
Steelhead	49501	14292	18160595	16361215	

Chinook/Steelhead 3 – Egg-to-Fry Thermal Mortality					
	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Winter-run Chinook	5	10	5	10	∞ Criteria: absolute values, "less" is better ∞ Units: % mortality ∞ Common threshold for all run-types
Spring-run Chinook	5	10	5	10	
Fall-run Chinook	5	10	5	10	
Late-fall-run Chinook	5	10	5	10	
Steelhead	5	10	5	10	

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Chinook/Steelhead 4 – Juvenile Stranding Risk					
	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Winter-run Chinook	4.517E-05	3.528E-04	0.0804	0.1622	∞ Criteria: statistical distribution, terciles, "less" is better ∞ Daily units: index ∞ Rollup units: cumulative index ∞ Flow, number of reaches affect distribution ∞ *Late-fall-run may be more sensitive-responsive*
Spring-run Chinook	1.483E-04	8.852E-04	0.1472	0.2738	
Fall-run Chinook	1.083E-04	5.476E-04	0.1299	0.2161	
Late-fall-run Chinook	6.330E-05	2.249E-04	0.0654	0.0814	
Steelhead	9.964E-05	1.202E-03	0.1255	0.1845	

Chinook/Steelhead 5 – Redd Scour Risk					
	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Winter-run Chinook	N/A	N/A	5000	10000	∞ Criteria: calibrated to 80% Good years, "less" is better ∞ Units: index flow (cfs) ∞ No daily estimate ∞ Common physical threshold for all run-types ∞ *Very low risk for spring- , winter-runs*
Spring-run Chinook	N/A	N/A	5000	10000	
Fall-run Chinook	N/A	N/A	5000	10000	
Late-fall-run Chinook	N/A	N/A	5000	10000	
Steelhead	N/A	N/A	5000	10000	

Chinook/Steelhead 6 – Redd Dewatering Risk					
	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Winter-run Chinook	3.976E-06	4.042E-05	0.02	0.03	∞ Criteria: statistical distribution, terciles, "less" is better ∞ Daily units: proportion stranded ∞ Rollup units: cumulative proportion stranded ∞ Flow, spawning period, habitat preferences, affect distribution ∞ *Very low risk for winter-run* ∞ *Higher sensitivity/risk for Late-fall run Chinook.*
Spring-run Chinook	6.184E-05	7.333E-04	0.07	0.13	
Fall-run Chinook	1.597E-05	1.910E-04	0.05	0.09	
Late-fall-run Chinook	1.336E-05	1.846E-04	0.12	0.22	
Steelhead	1.181E-05	1.428E-04	0.10	0.17	

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Green Sturgeon 1 – Thermal Egg Mortality					
	Daily		**Rollup**		**Notes**
	Good-Fair	**Fair-Poor**	**Good-Fair**	**Fair-Poor**	
Thermal Egg Mortality	5	10	5	10	∞ Criteria: absolute values, , "less" is better ∞ Units: % mortality

Bank Swallow 1 – Habitat Potential/Suitability					
	Daily		**Rollup**		**Notes**
	Good-Fair	**Fair-Poor**	**Good-Fair**	**Fair-Poor**	
Habitat potential	N/A	N/A	42200	29500	∞ Criteria: statistical distribution using discontinuities, "more" is better ∞ Units: meters suitable habitat ∞ No daily estimate

Bank Swallow 2 – Peak Flow During Nesting Period					
	Daily		**Rollup**		**Notes**
	Good-Fair	**Fair-Poor**	**Good-Fair**	**Fair-Poor**	
Nesting Peak Flow	47000	49700	≥ 2	< 1 (zero)	∞ Criteria: flow thresholds based on expert opinion, "less" is better ∞ Daily units: flow (cfs) ∞ Rollup units: count of locations assigned Good rating within a year.

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Fremont Cottonwood 1 – Riparian Initiation					
	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Riparian Initiation Success	N/A	N/A	53	36	∞ Criteria: thresholds based on expert opinion and observation of Good initiation years, "more" is better ∞ Units: count of cross section nodes with surviving stems or seedlings. ∞ No daily estimate

Fremont Cottonwood 2 – Riparian Scour					
	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Riparian Scour Risk	N/A	N/A	80000	90000	∞ Criteria: thresholds based on expert opinion of scour events, "less" is better ∞ Units: flow (cfs) ∞ No daily estimate

Large Woody Debris 1 – Large Woody Debris Recruitment					
	Daily		Rollup		Notes
	Good-Fair	Fair-Poor	Good-Fair	Fair-Poor	
Large Woody Debris recruitment	N/A	N/A	120000	20000	∞ Criteria: statistical distribution, terciles, "more" is better ∞ Units: square meters riparian forest eroded to mainstem Sacramento River having forests taller than 34 ft (height class 4 or higher). ∞ No daily estimate

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Appendix C – Additional Chinook Reports

C.1 Steelhead

Steelhead

	Comparison 1			Comparison 2			Comparison 3			Comparison 4			Comparison 5			Comparison 6			Comparison 7			Comparison 8		
ScenarioID	134	132		136	132		136	134		139	132		139	134		140	132		140	134		134	118	
Scenario Name	NAA	Existing	Change	NODOS - Alt A	Existing	Change	NODOS - Alt A	NAA	Change	NODOS - Alt B	Existing	Change	NODOS - Alt B	NAA	Change	NODOS - Alt C	Existing	Change	NODOS - Alt C	NAA	Change	NAA	HIST.	Change
	No Action Alternative	Existing conditions		NODOS - Alt A	Existing conditions		NODOS - Alt A	No Action Alternative		NODOS - Alt B	Existing conditions		NODOS - Alt B	No Action Alternative		NODOS - Alt C	Existing conditions		NODOS - Alt C	No Action Alternative		No Action Alternative	ACTUAL HISTORIC CONDITIONS	
Spawning WUA (ST1)	52	52	0	54	52	2	54	52	2	54	52	2	54	52	2	54	52	2	54	52	2	52	38	14
Thermal Egg Mortality (ST3)	100	100	0	100	100	0	100	100	0	100	100	0	100	100	0	100	100	0	100	100	0	100	100	0
Redd Dewatering (ST6)	51	51	0	56	51	5	56	51	5	57	51	6	57	51	6	56	51	5	56	51	5	51	42	9
Redd Scour (ST5)	62	62	0	62	62	0	62	62	0	62	62	0	62	62	0	62	62	0	62	62	0	62	78	-16
Juvenile Stranding (ST4)	9	9	0	3	9	-6	3	9	-6	5	9	-4	5	9	-4	2	9	-7	2	9	-7	9	33	-24
Rearing WUA (ST2)	46	49	-3	54	49	5	54	46	8	54	49	5	54	46	8	54	49	5	54	46	8	46	33	13

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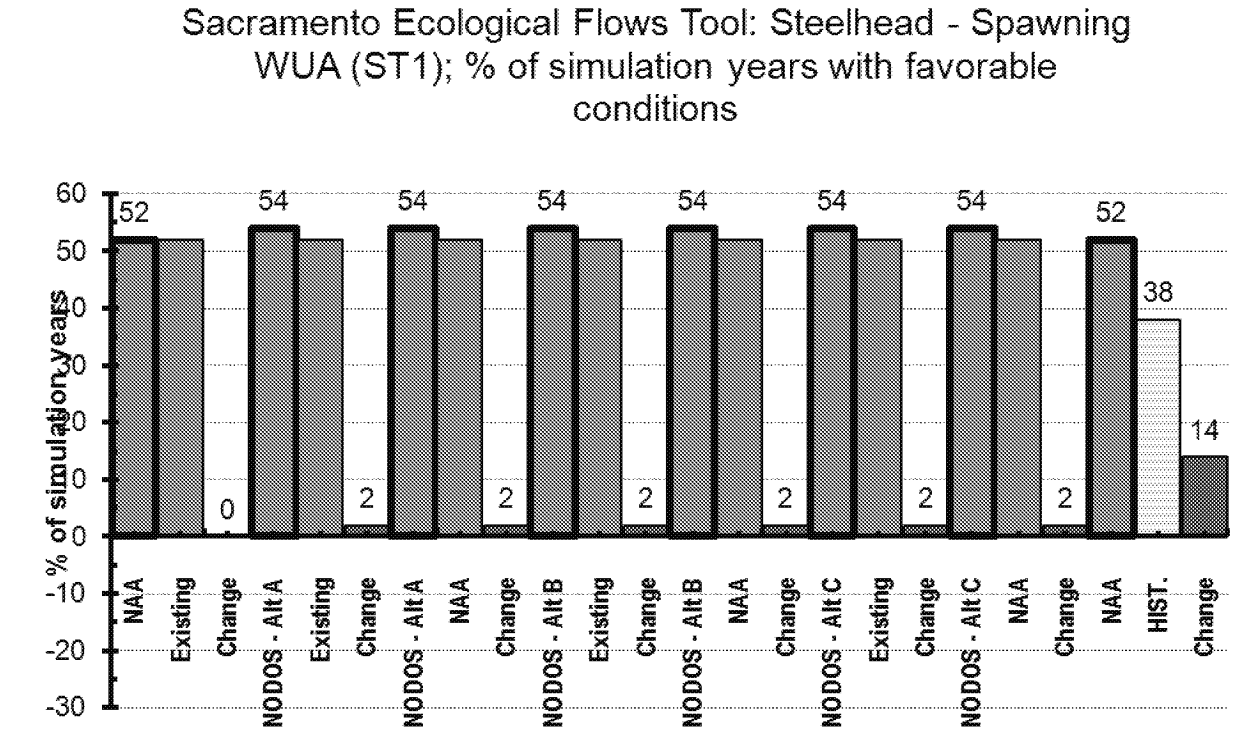

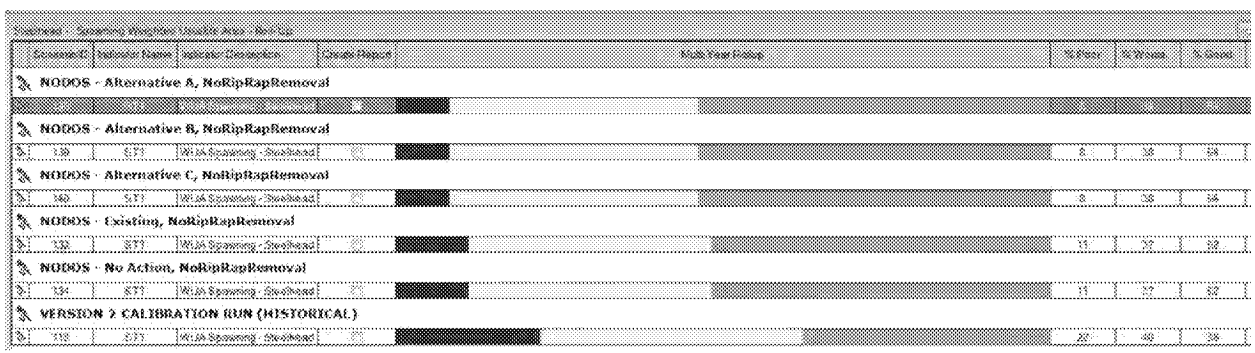

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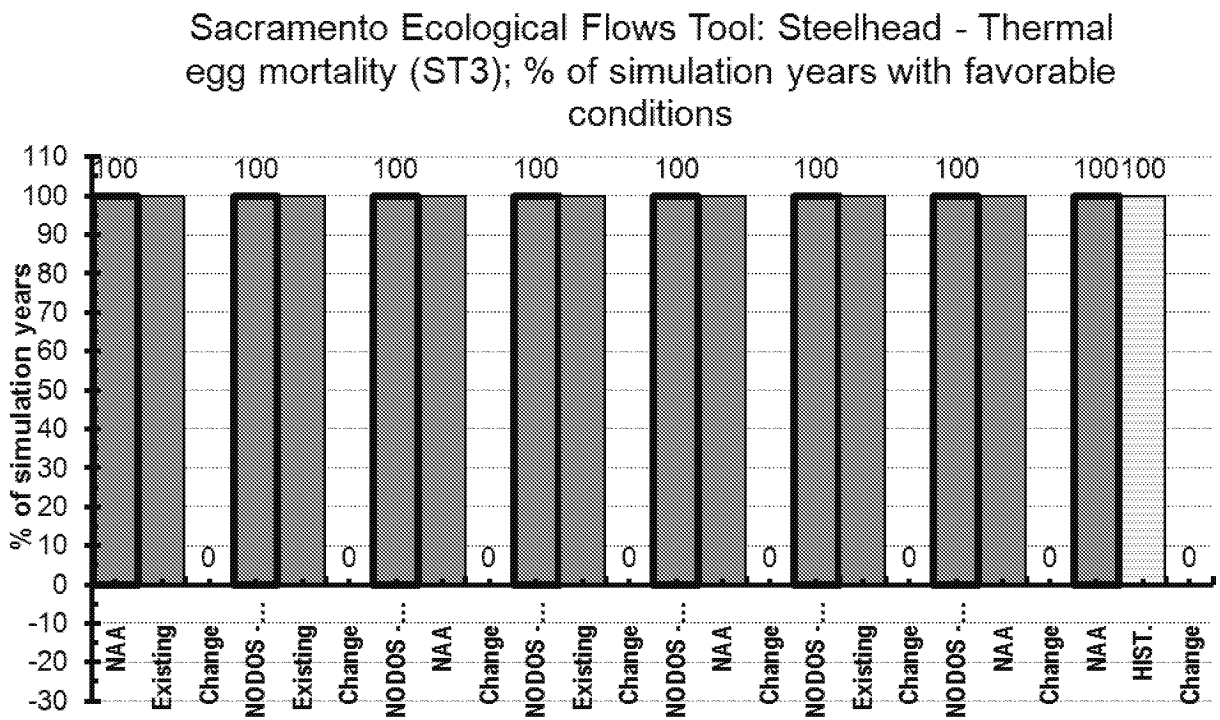

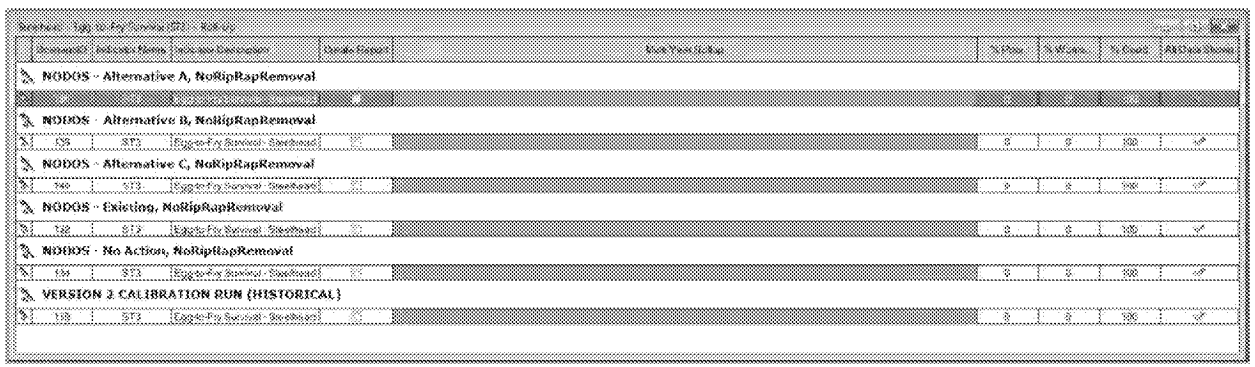

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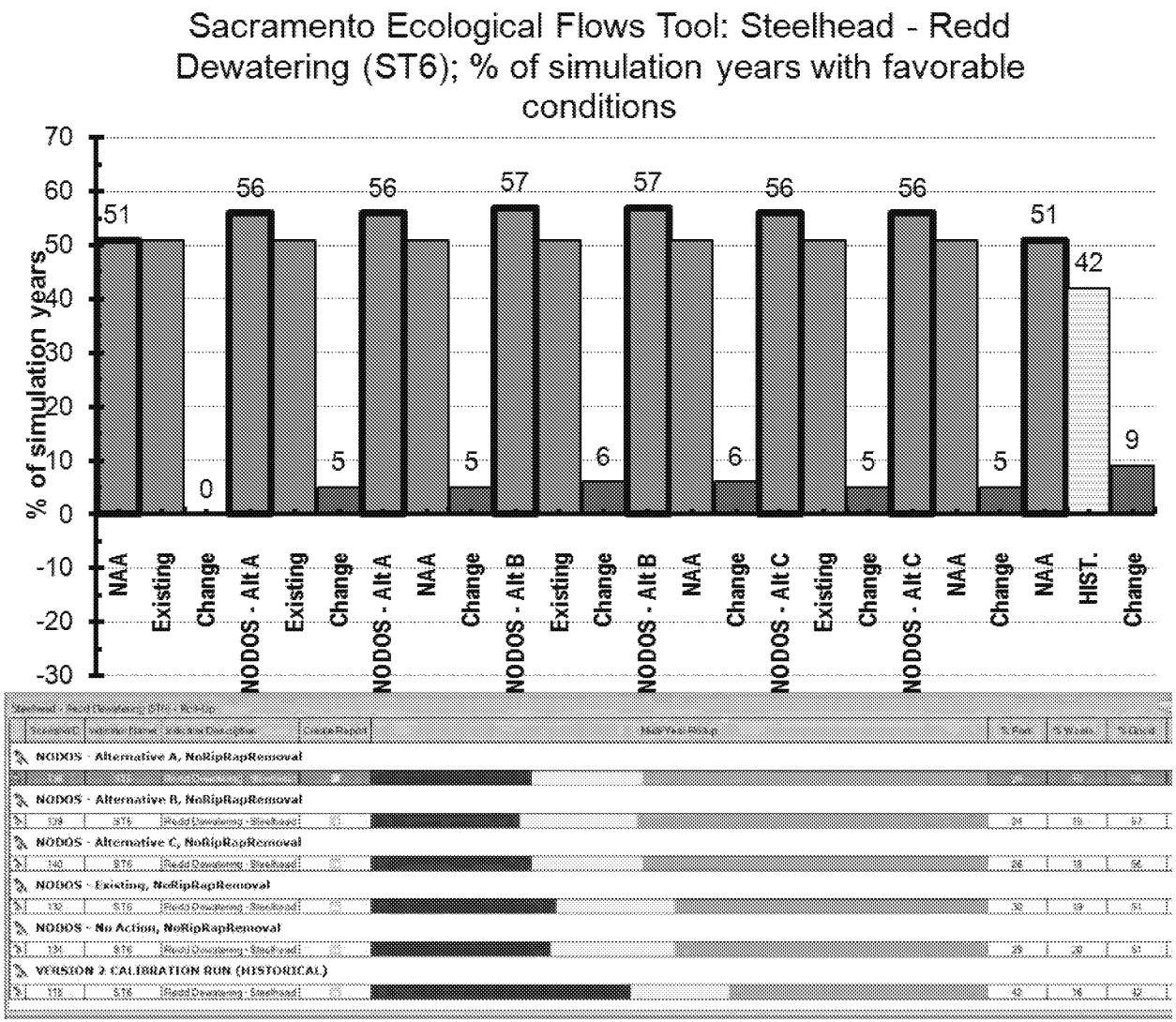

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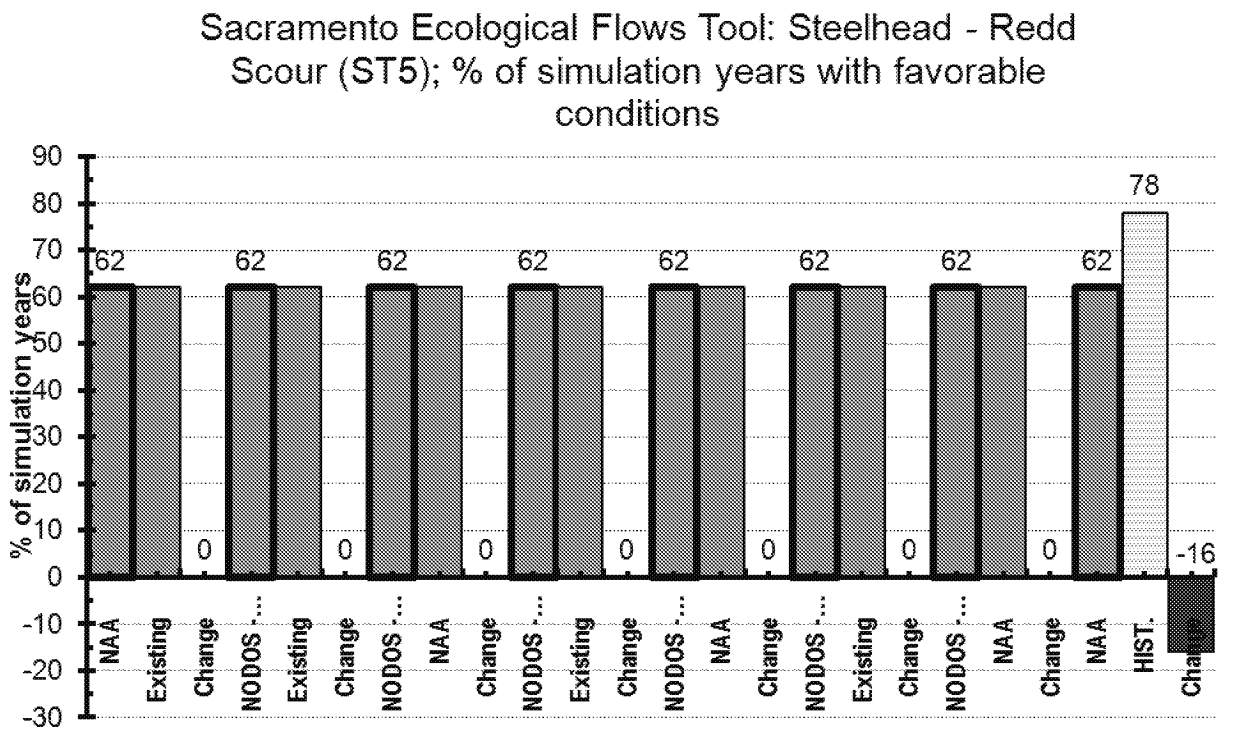

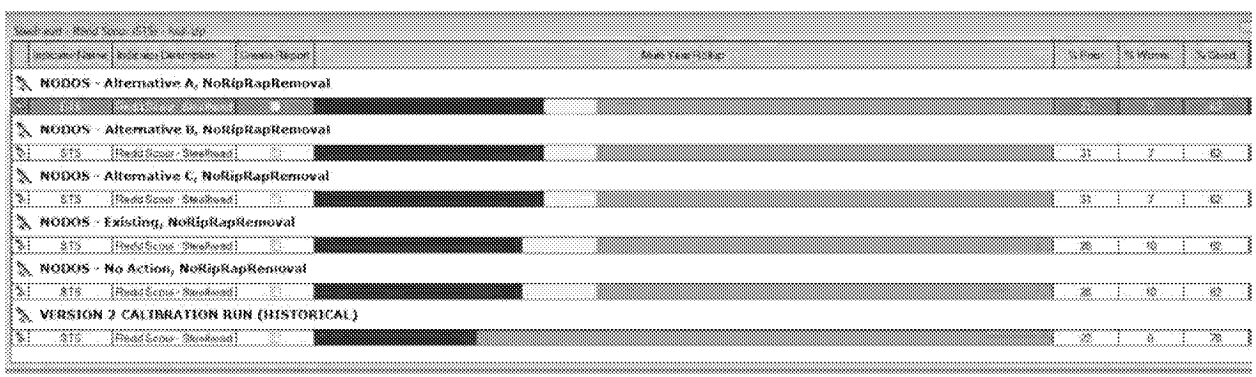

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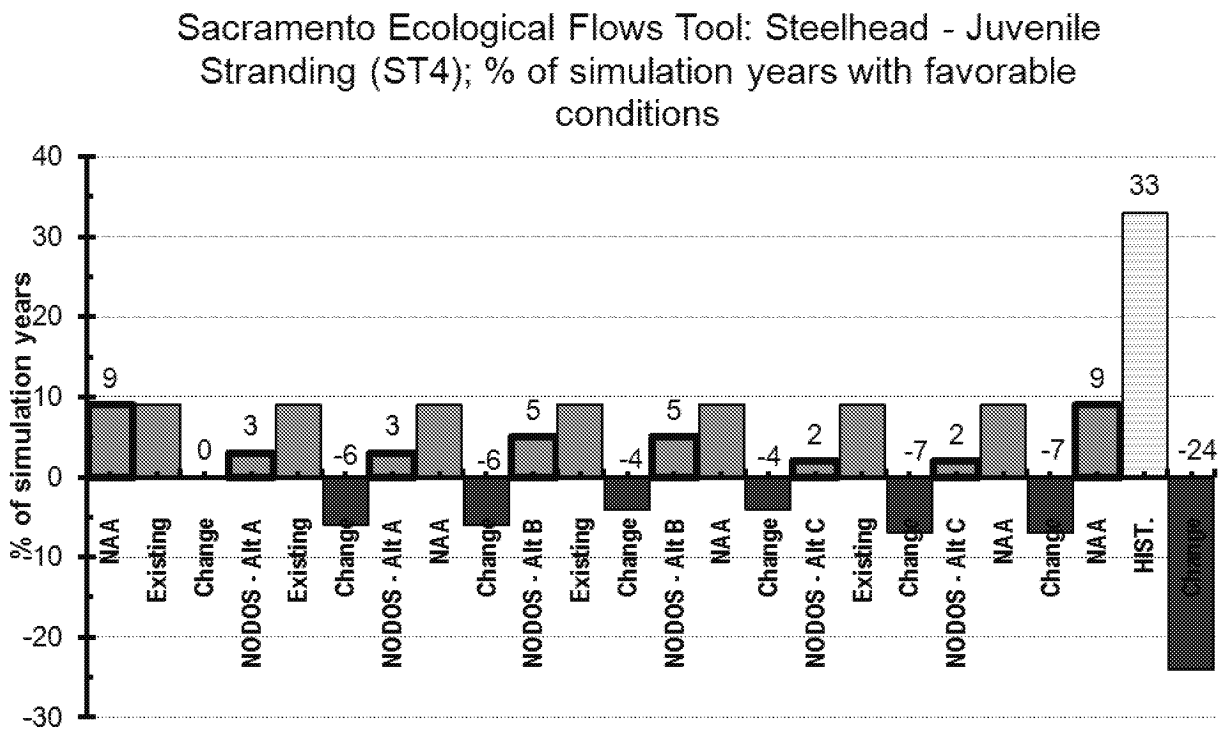

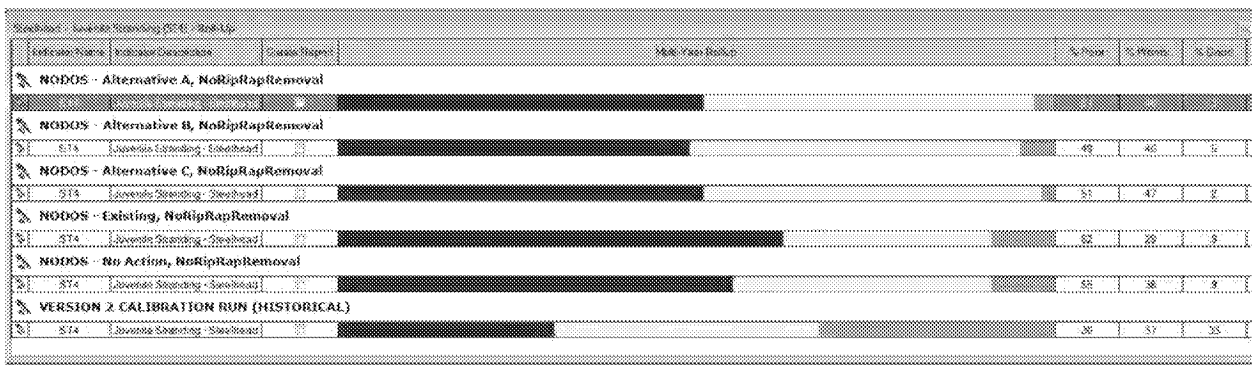

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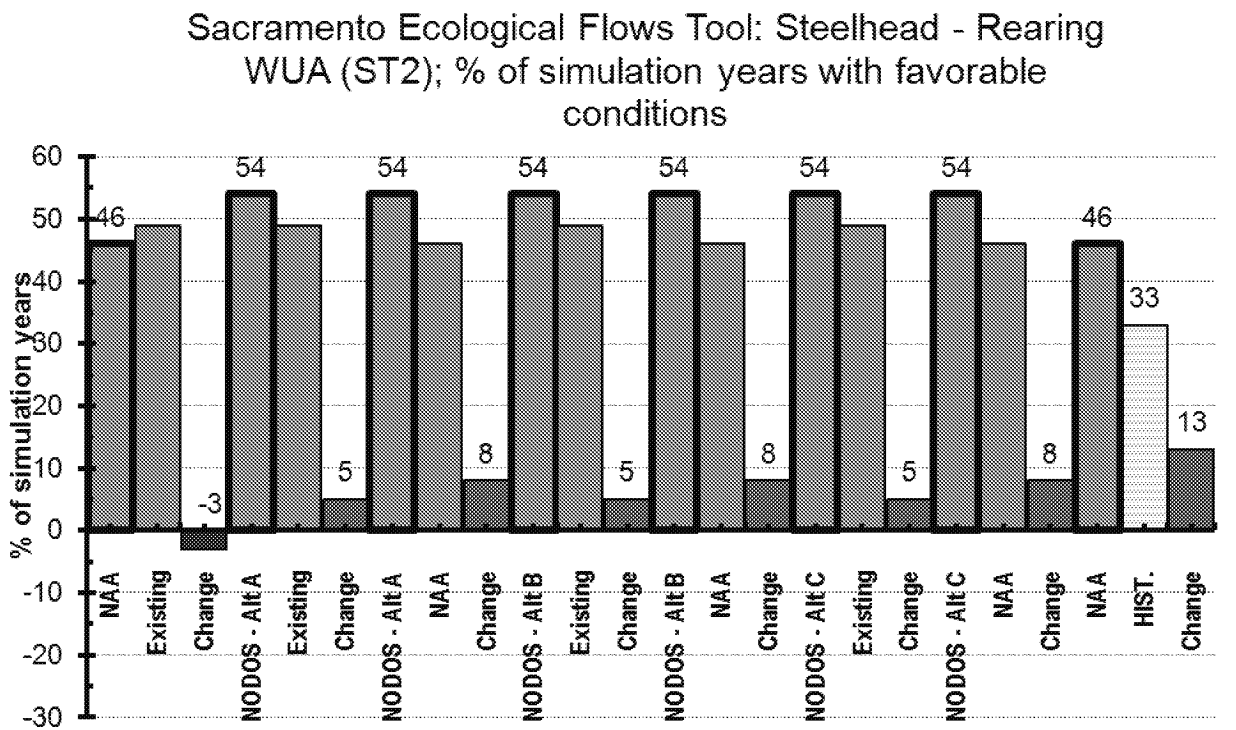

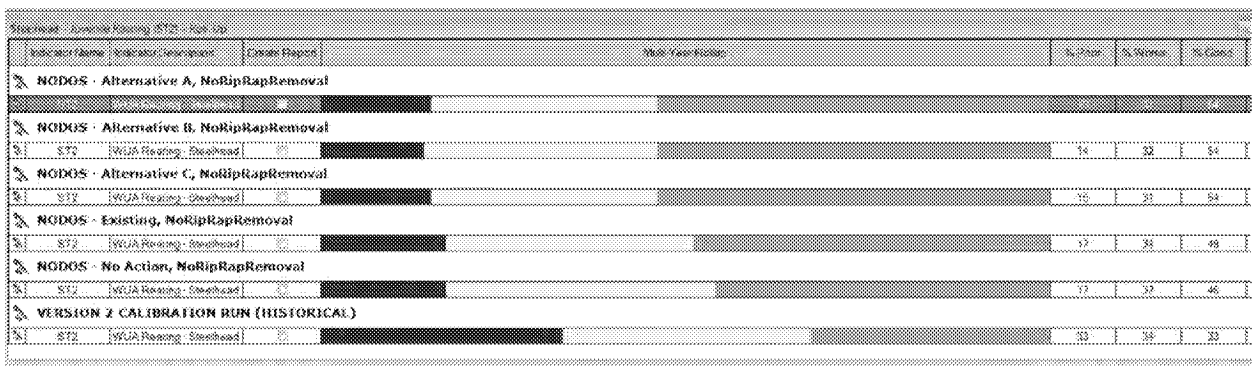

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C.2 Fall Chinook

FALL CHINOOK

				Comparison 2			Comparison 3			Comparison 4			Comparison 5			Comparison 6			Comparison 7			Comparison 8		
ScenarioID	134	132		135	132		136	134		139	132		139	134		140	132		140	134		134	18	
Scenario Name	NAA	Existing	Change	NODOS - Alt A	Existing	Change	NODOS - Alt A	NAA	Change	NODOS - Alt B	Existing	Change	NODOS - Alt B	NAA	Change	NODOS - Alt C	Existing	Change	NODOS - Alt C	NAA	Change	NAA	HIST.	Change
	No Action Alternative	Existing conditions		NODOS - Alt A	Existing conditions		NODOS - Alt A	No Action Alternative		NODOS - Alt B	Existing conditions		NODOS - Alt B	No Action Alternative		NODOS - Alt C	Existing conditions		NODOS - Alt C	No Action Alternative		No Action Alternative	ACTUAL HISTORIC CONDITIONS	
Spawning WUA (CH1)	42	40	2	38	40	-2	38	42	-4	36	40	-2	38	42	-4	35	40	-5	35	42	-7	42	57	-15
Thermal Egg Mortality (CH3)	92	91	1	94	91	3	94	92	2	92	91	1	92	92	0	94	91	3	94	92	2	92	84	8
Redd Dewatering (CH6)	26	26	0	30	26	4	30	26	4	28	26	2	28	26	2	30	26	4	30	26	4	26	22	4
Redd Scour (CH5)	56	56	0	56	56	0	56	56	0	55	56	-1	55	56	-1	55	56	-1	55	56	-1	56	61	-5
Juvenile Stranding (CH4)	6	6	0	3	6	-3	3	6	-3	2	6	-4	2	6	-4	2	6	-4	2	6	-4	6	31	-25
Rearing WUA (CH2)	35	35	0	42	35	7	42	35	7	42	35	7	42	35	7	42	35	7	42	35	7	35	34	1

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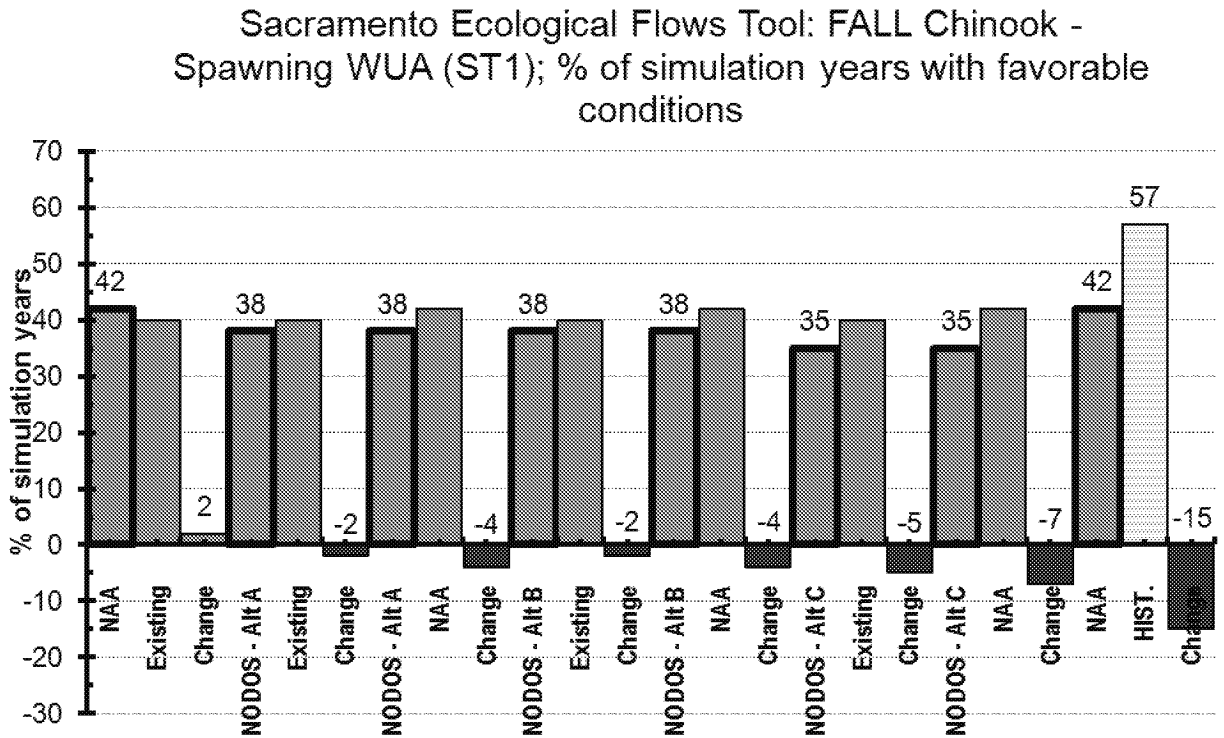

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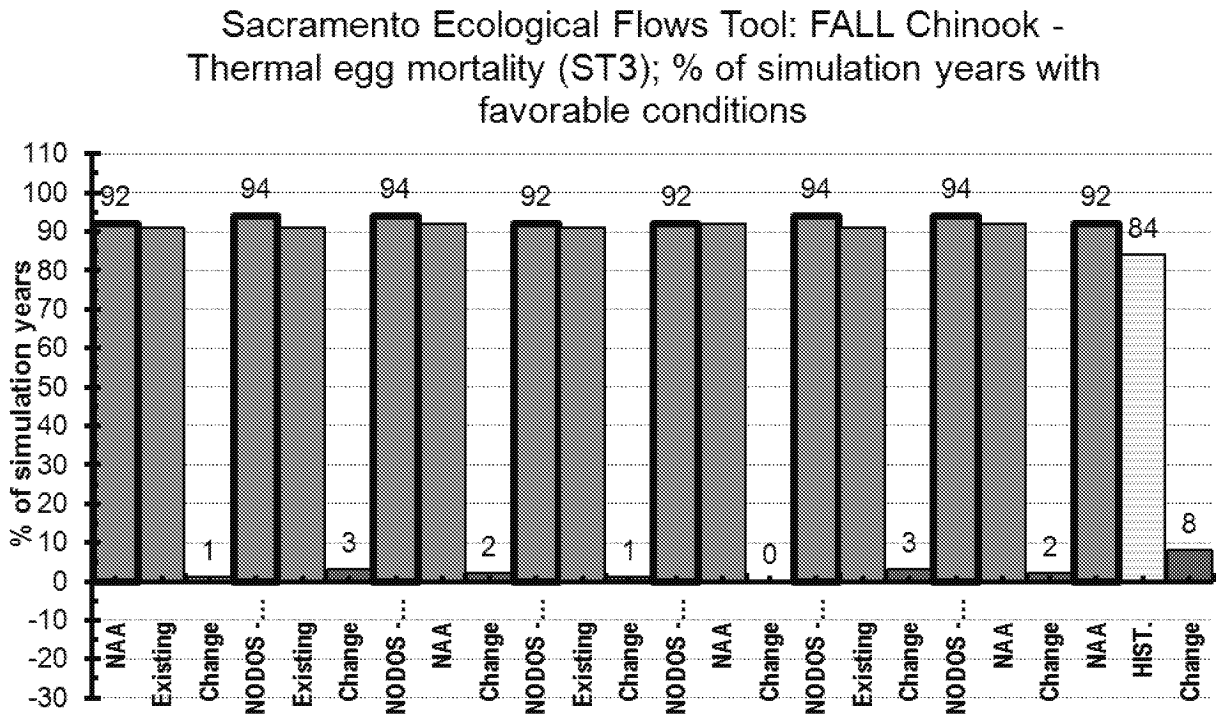

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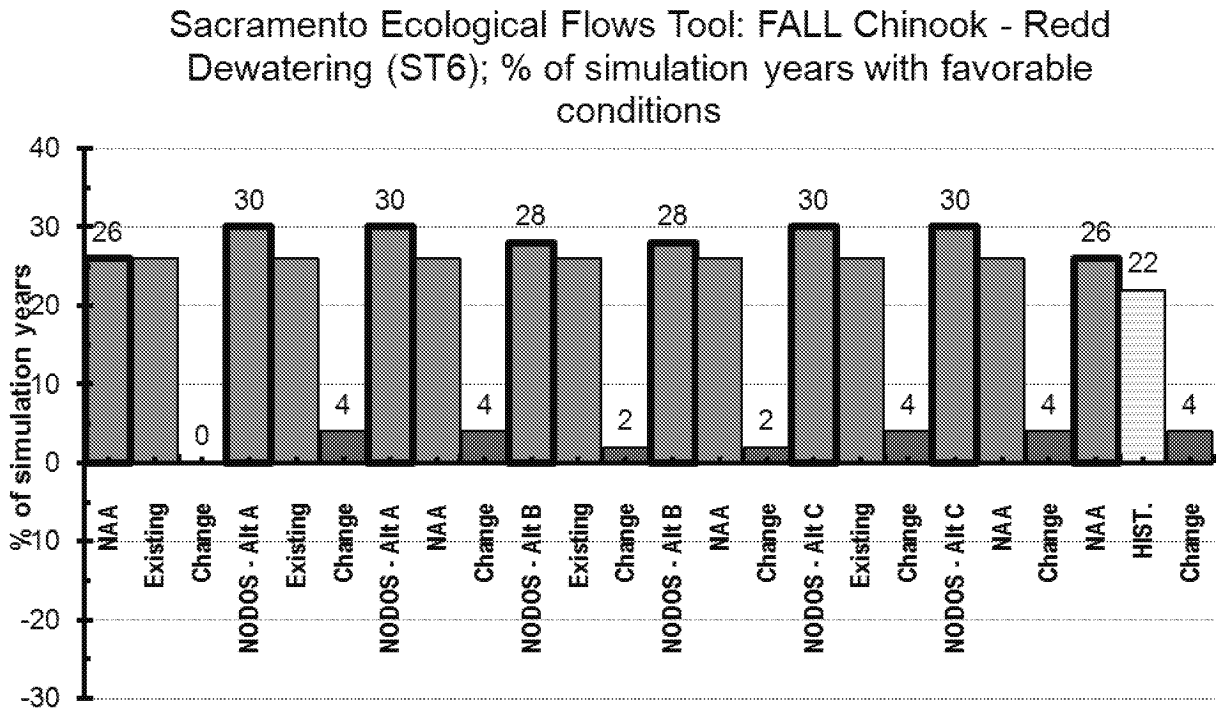

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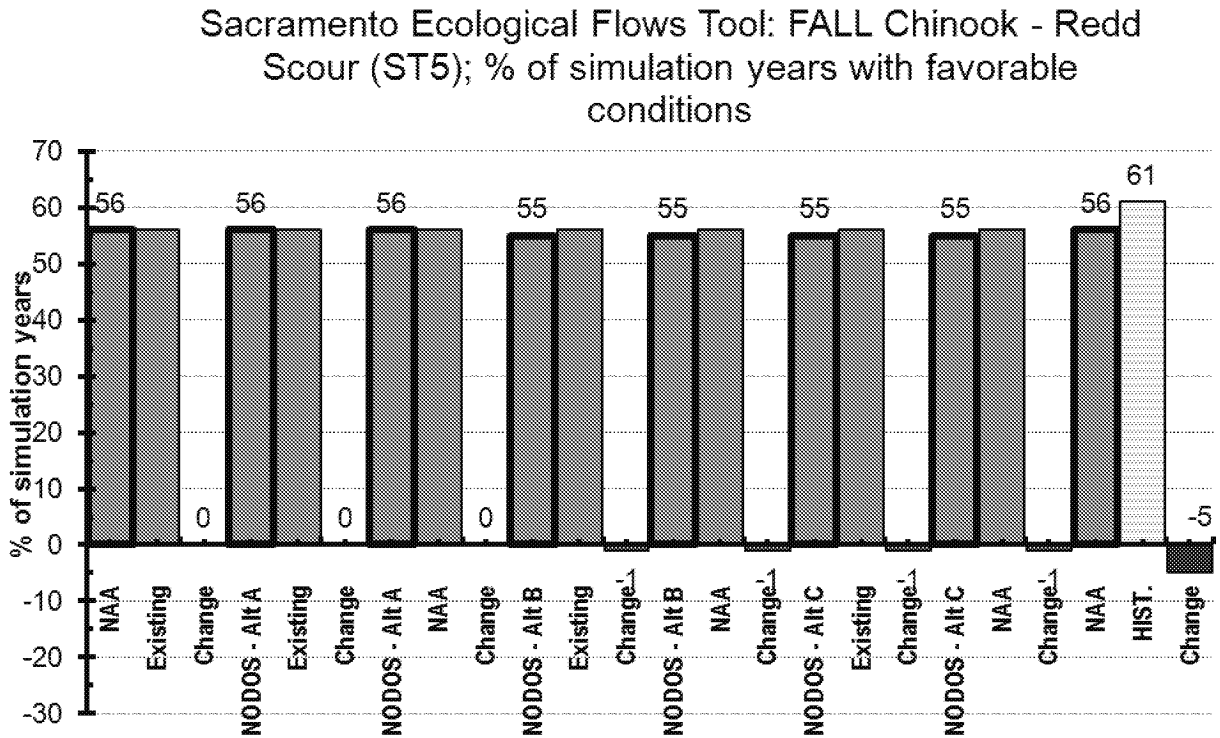

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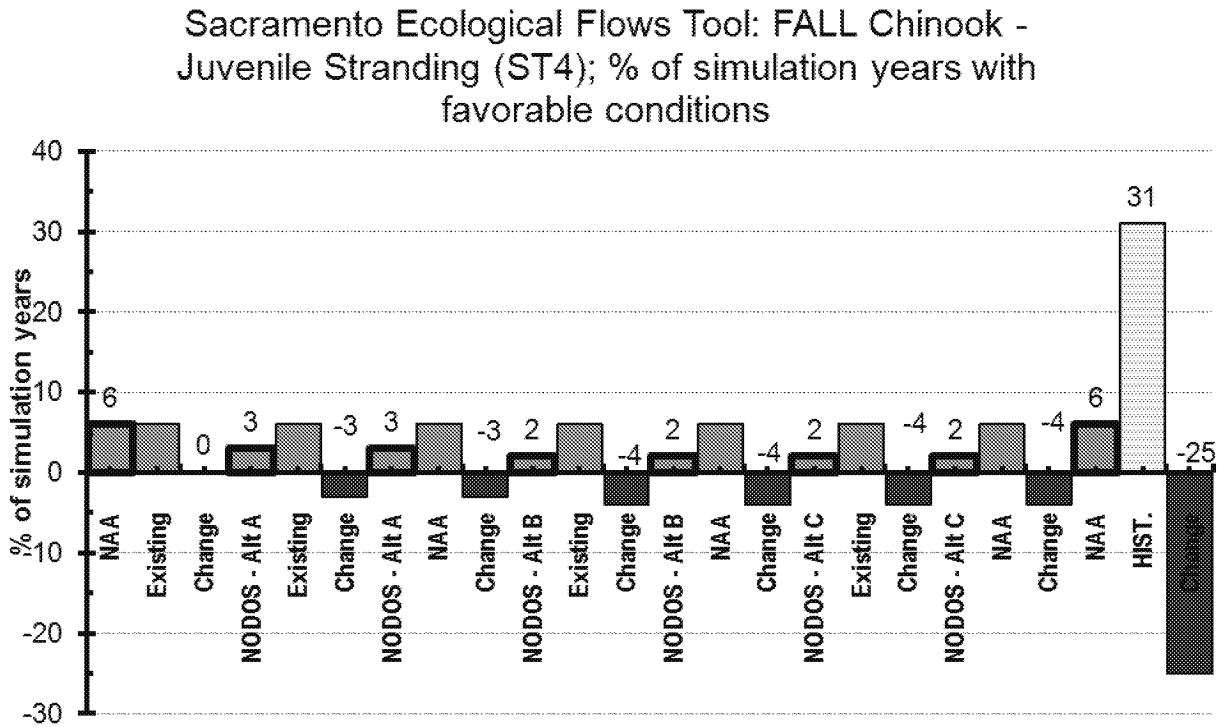

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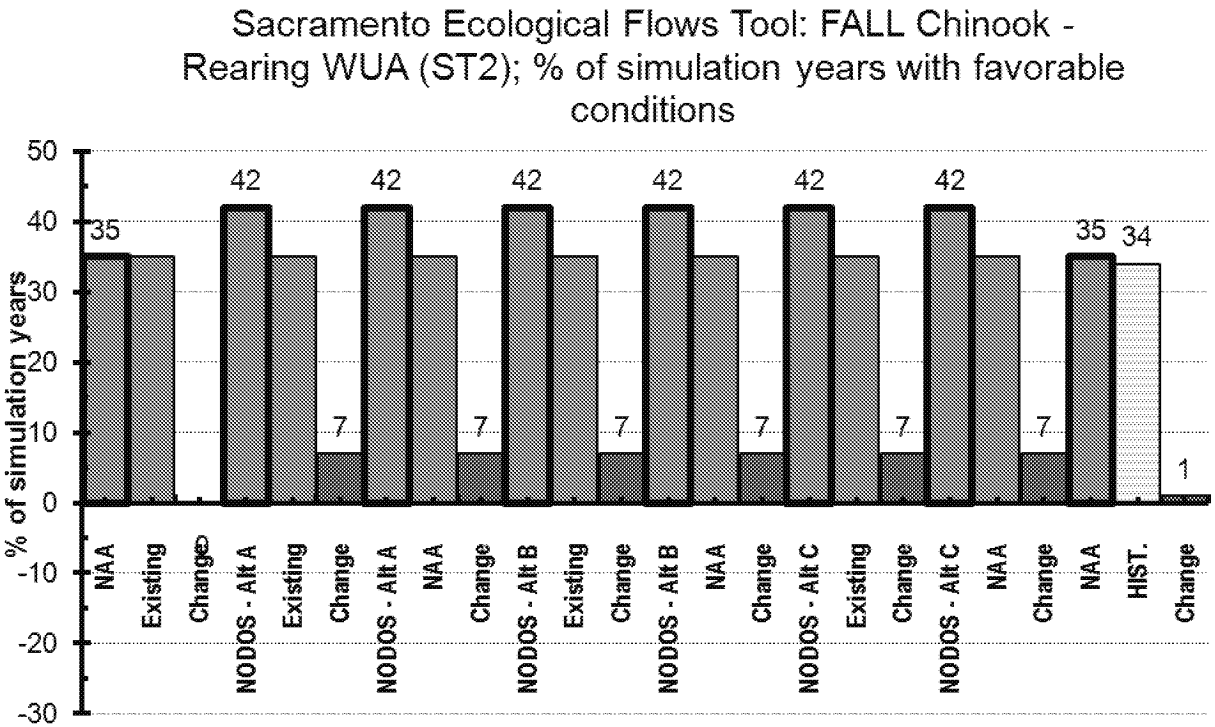

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C.3 Late Fall Chinook

LATE FALL CHINOOK

			Comparison 2			Comparison 3			Comparison 4			Comparison 5			Comparison 6			Comparison 7			Comparison 8		
ScenarioID	134	132	136	132		136	134		139	132		139	134		140	132		140	134		134	18	
Scenario Name	NAA	Existing	NODOS - Alt A	Existing	Change	NODOS - Alt A	NAA	Change	NODOS - Alt B	Existing	Change	NODOS - Alt B	NAA	Change	NODOS - Alt C	Existing	Change	NODOS - Alt C	NAA	Change	NAA	HIST	Change
	No Action Alternative	Existing conditions	NODOS - Alt A	Existing conditions		NODOS - Alt A	No Action Alternative		NODOS - Alt B	Existing conditions		NODOS - Alt B	No Action Alternative		NODOS - Alt C	Existing conditions		NODOS - Alt C	No Action Alternative		No Action Alternative	ACTUAL HISTORIC CONDITIONS	
Spawning %UA (CH1)	54	54	0	51	54	-3	51	54	-3	51	54	-3	51	54	-3	51	54	-3	51	54	-3	54	43	11
Thermal Egg Mortality (CH3)	100	100	0	100	100	0	100	100	0	100	100	0	100	100	0	100	100	0	100	100	0	100	100	0
Redd Dewatering (CH6)	59	59	0	61	59	2	61	59	2	62	59	3	62	59	3	61	59	2	61	59	2	59	53	6
Redd Scour (CH5)	61	61	0	63	61	2	63	61	2	61	61	0	61	61	0	61	61	0	61	61	0	61	74	-13
Juvenile Stranding (CH4)	23	26	-3	17	26	-9	17	23	-6	20	26	-6	20	23	-3	17	26	-9	17	23	-6	23	34	-11
Rearing %UA (CH2)	54	55	-1	59	55	3	58	54	4	60	55	5	60	54	6	57	55	2	57	54	3	54	34	20

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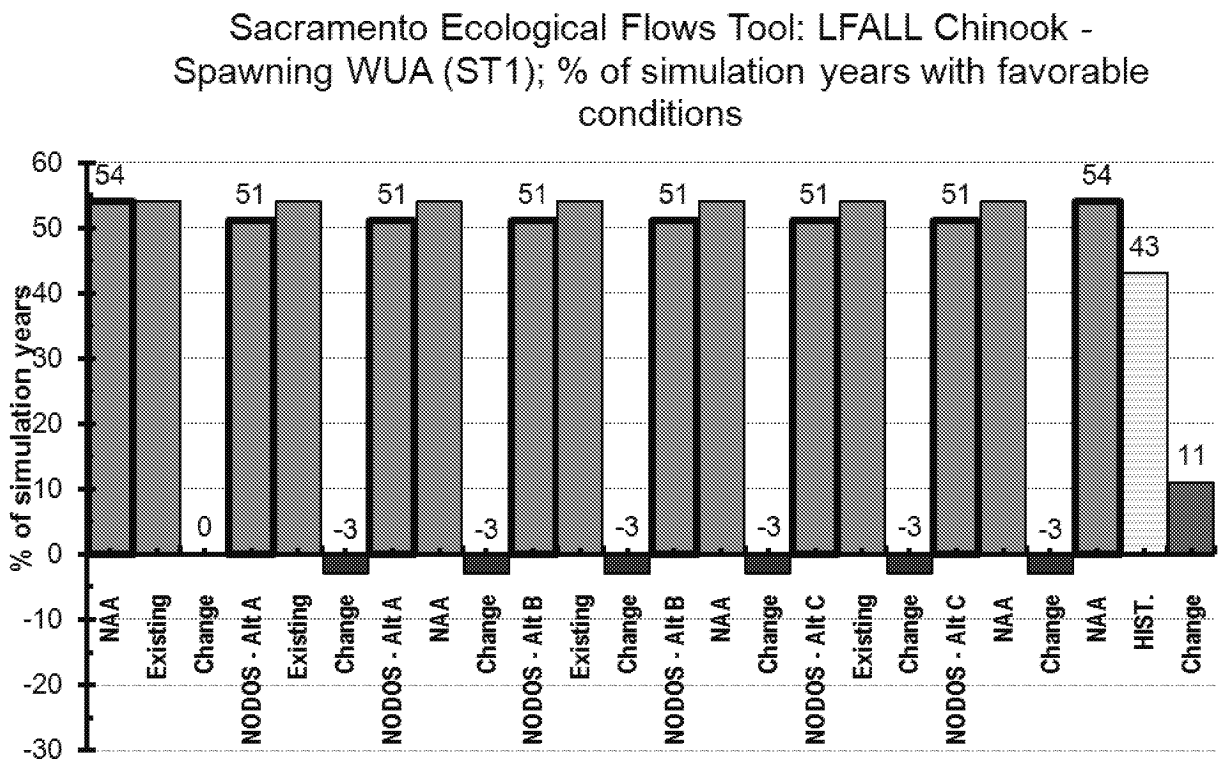

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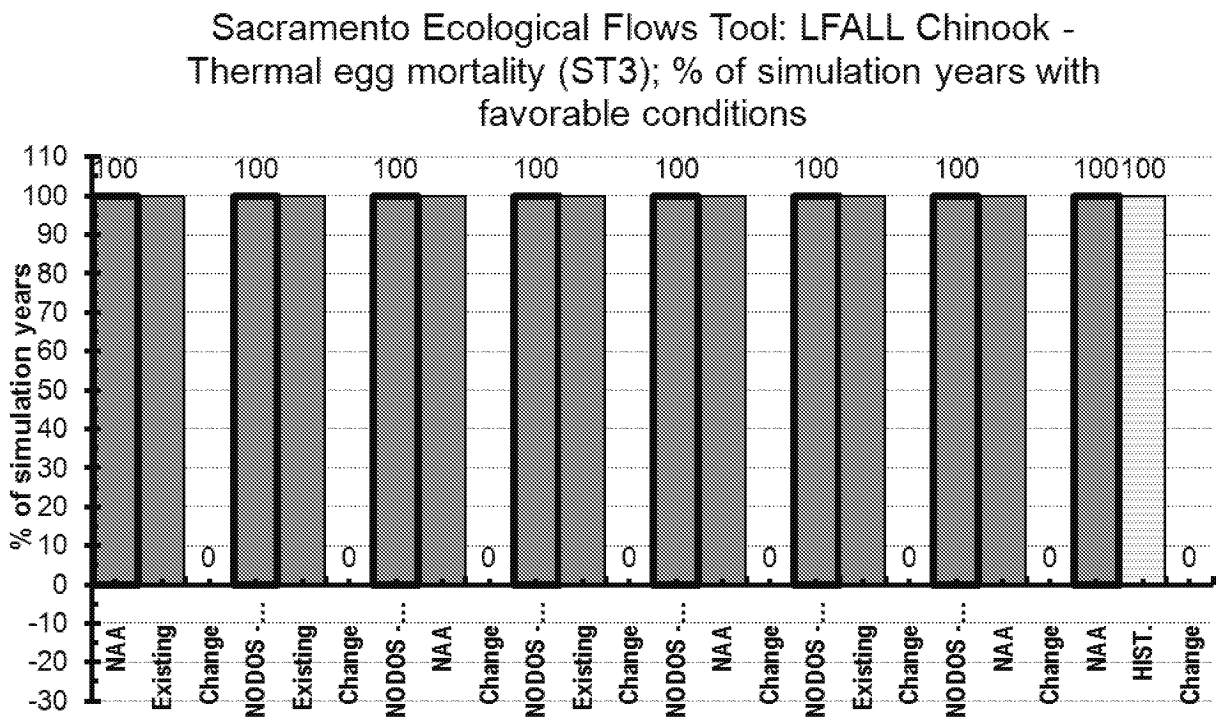

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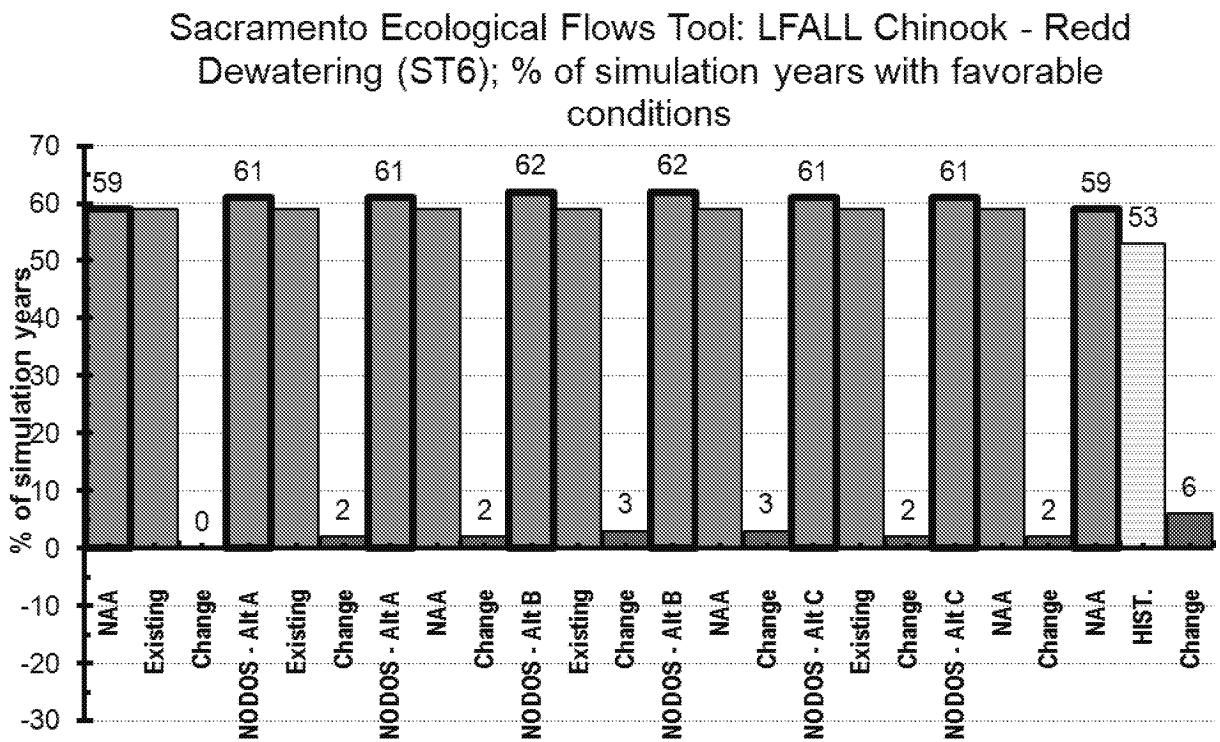

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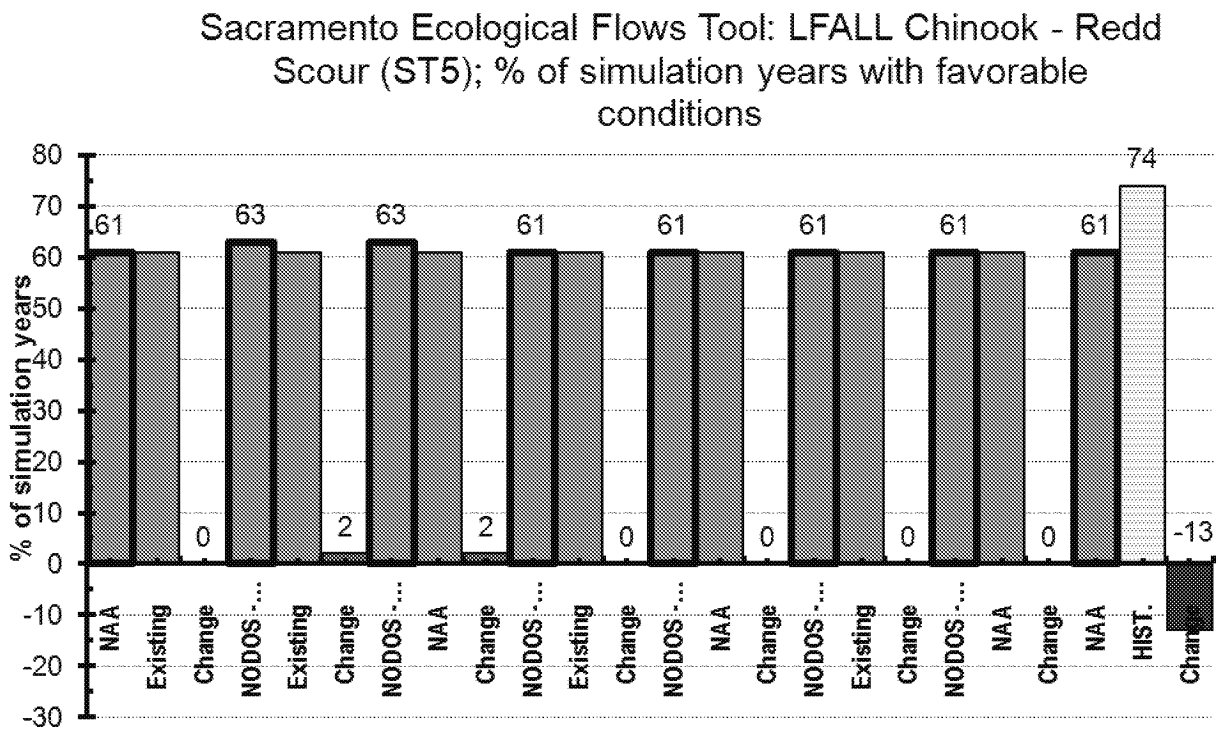

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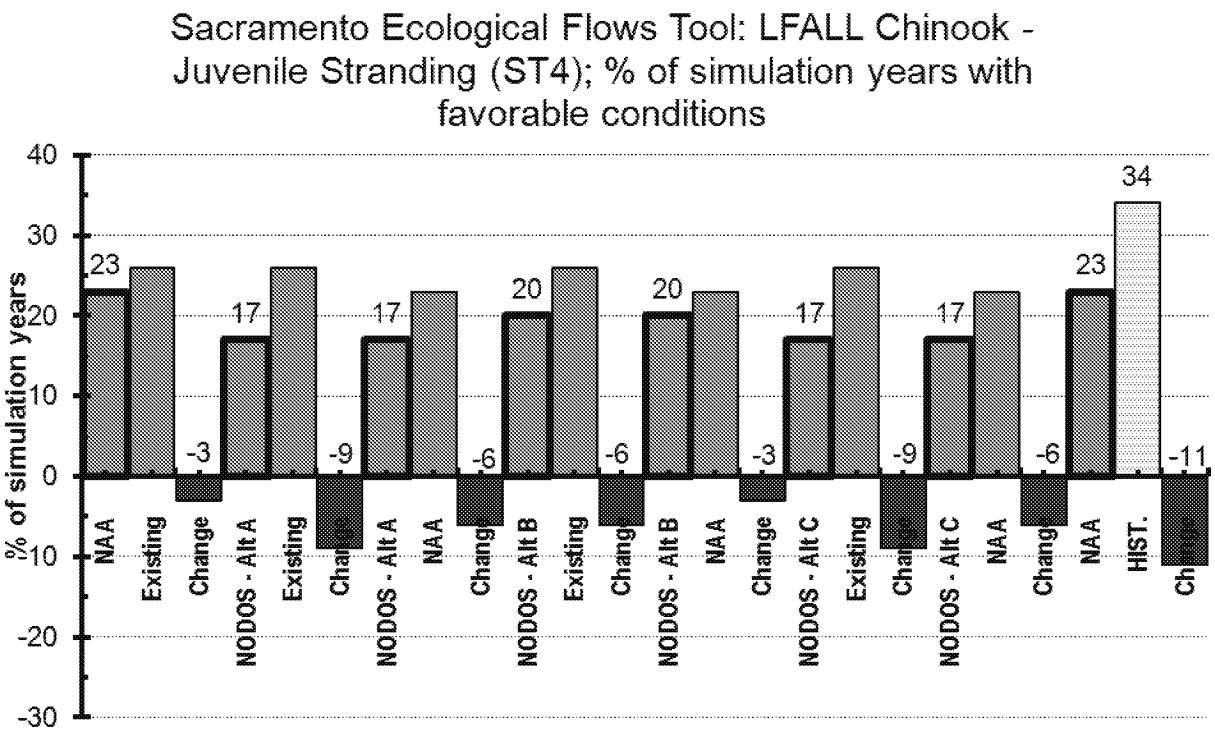

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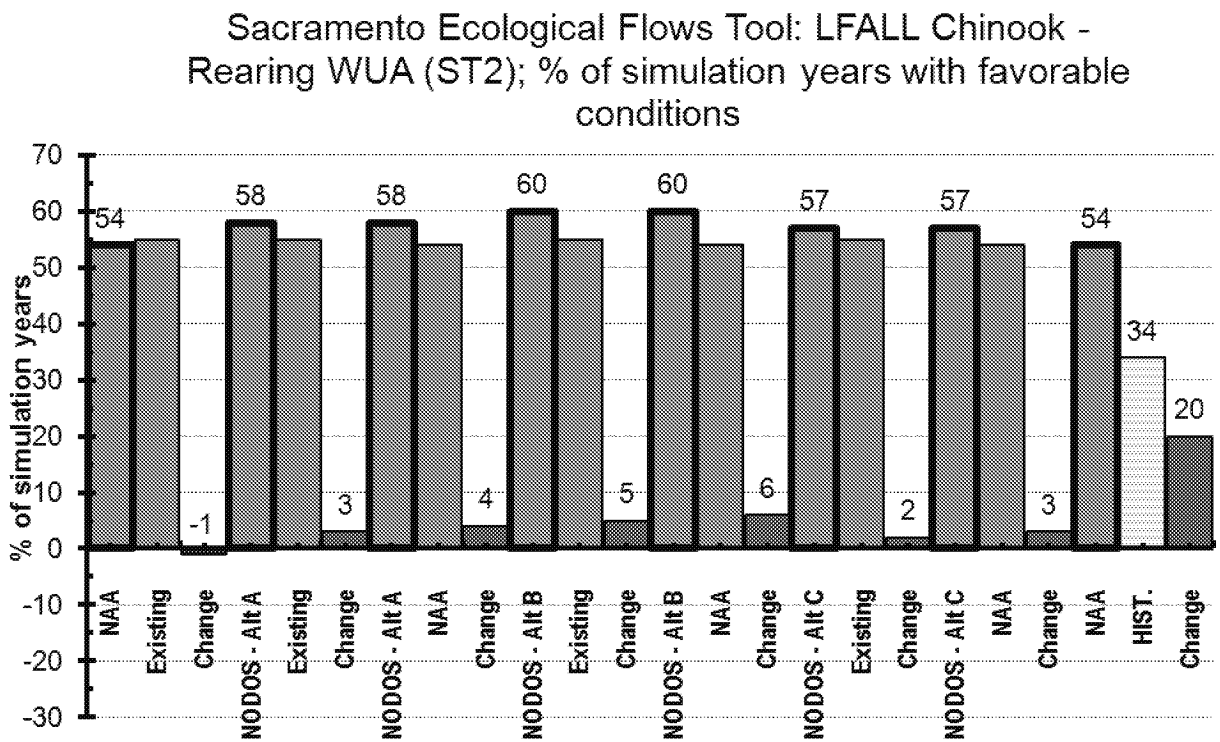

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C.4 Spring Chinook

SPRING CHINOOK

				Comparison 2			Comparison 3			Comparison 4			Comparison 5			Comparison 6			Comparison 7			Comparison 8		
ScenarioID	134	132		135	132		136	134		139	132		139	134		140	132		140	134		134	18	
Scenario Name	NAA	Existing	Change	NODOS - Alt A	Existing	Change	NODOS - Alt A	NAA	Change	NODOS - Alt B	Existing	Change	NODOS - Alt B	NAA	Change	NODOS - Alt C	Existing	Change	NODOS - Alt C	NAA	Change	NAA	HIST.	Change
	No Action Alternative	Existing conditions		NODOS - Alt A	Existing conditions		NODOS - Alt A	No Action Alternative		NODOS - Alt B	Existing conditions		NODOS - Alt B	No Action Alternative		NODOS - Alt C	Existing conditions		NODOS - Alt C	No Action Alternative		No Action Alternative	ACTUAL HISTORIC CONDITIONS	
Spawning WUA (CH1)	56	56	0	59	56	3	59	56	3	59	56	3	59	56	3	58	56	2	58	56	2	56	58	-2
Thermal Egg Mortality (CH3)	80	82	-2	85	82	3	85	80	5	86	82	4	86	80	6	85	82	3	85	80	5	80	72	8
Redd Dewatering (CH6)	48	49	-1	60	49	11	60	48	12	61	49	12	61	48	13	58	49	9	58	48	10	48	13	35
Redd Scour (CH5)	100	98	2	98	98	0	98	100	-2	98	98	0	98	100	-2	98	98	0	98	100	-2	100	100	0
Juvenile Stranding (CH4)	5	6	-1	8	6	2	8	5	3	8	6	2	8	5	3	8	6	2	8	5	3	5	34	-29
Rearing WUA (CH2)	18	17	1	9	17	-8	9	18	-9	9	17	-8	9	18	-9	9	17	-8	9	18	-9	18	31	-13

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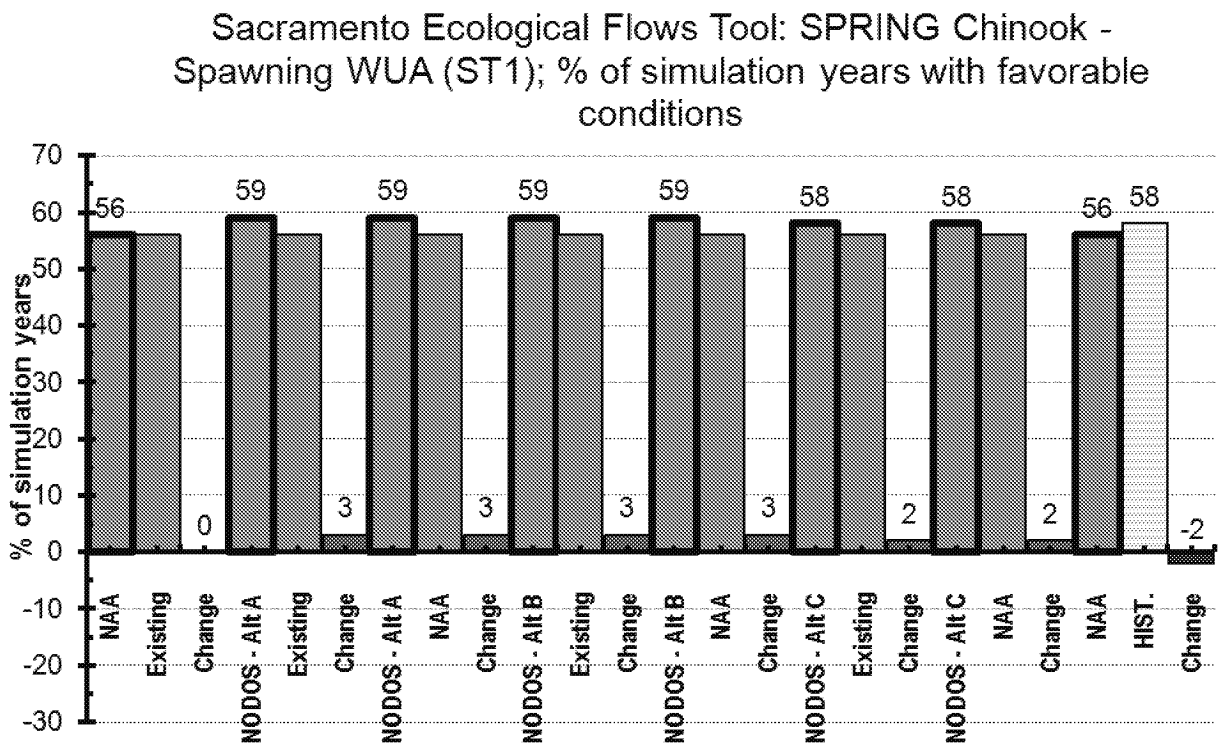

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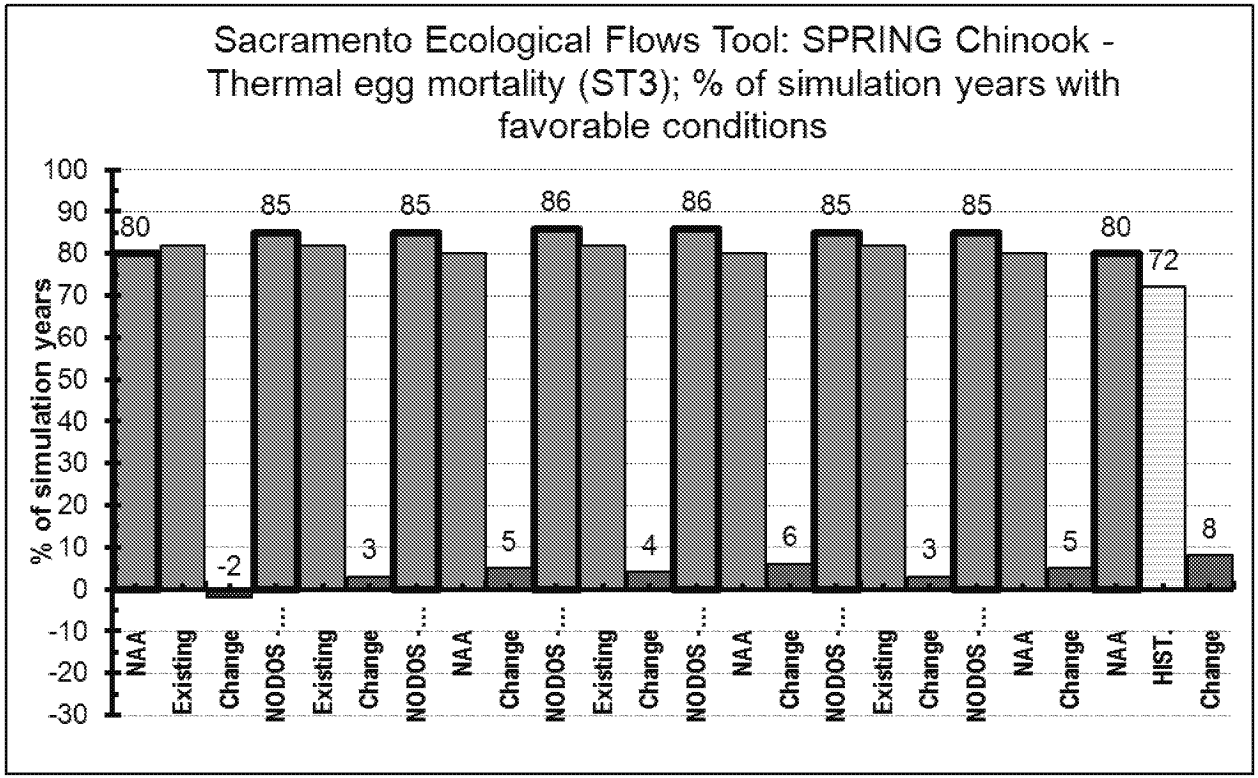

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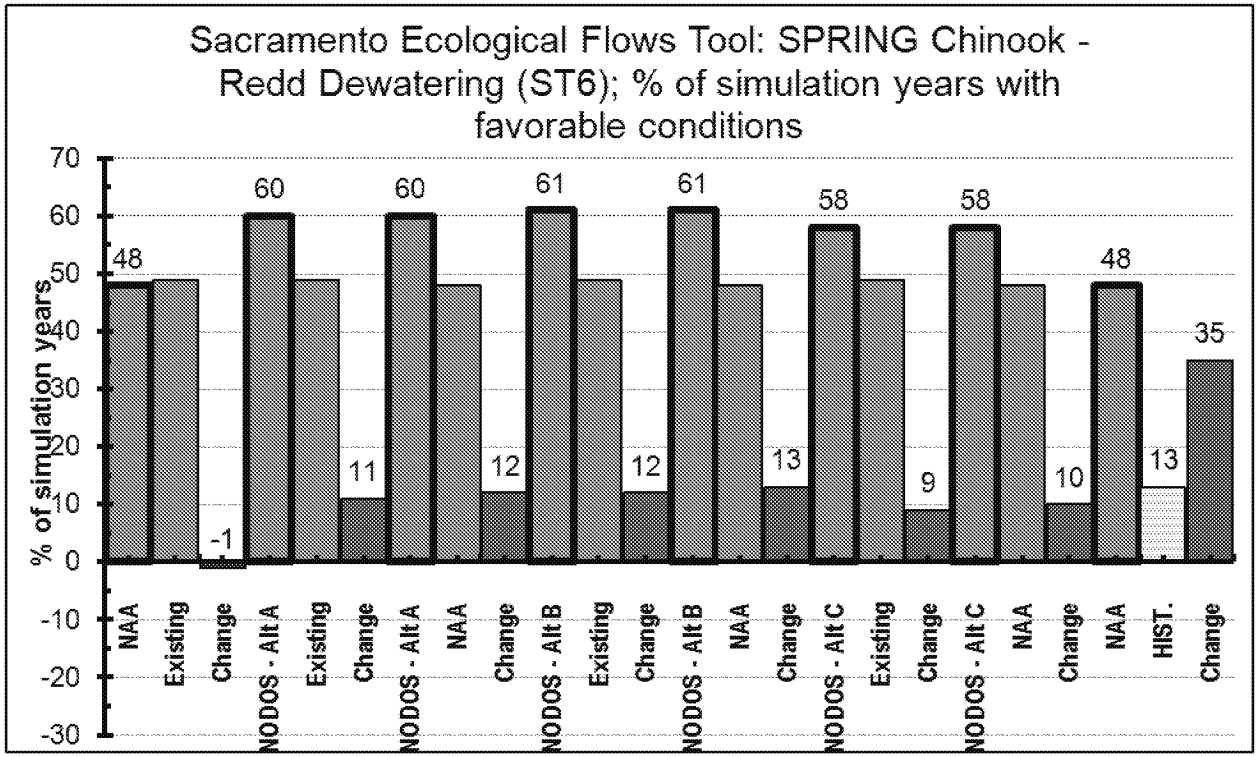

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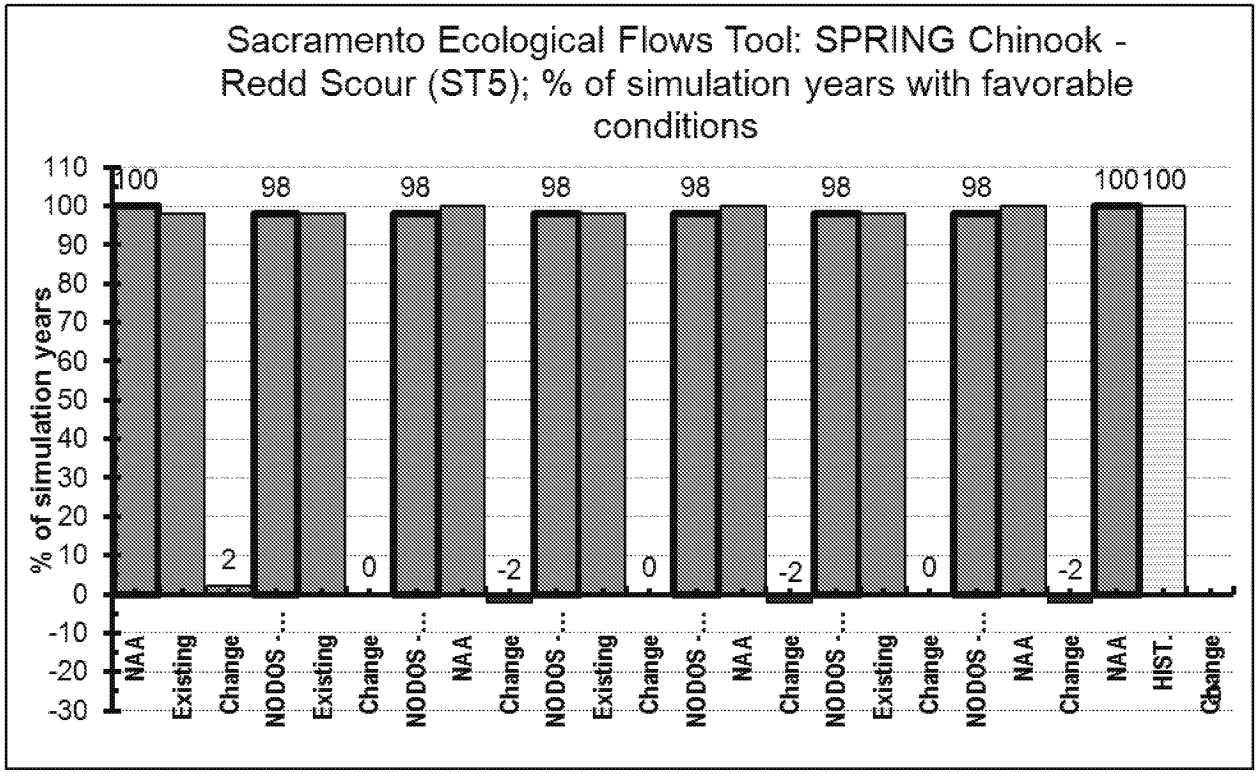

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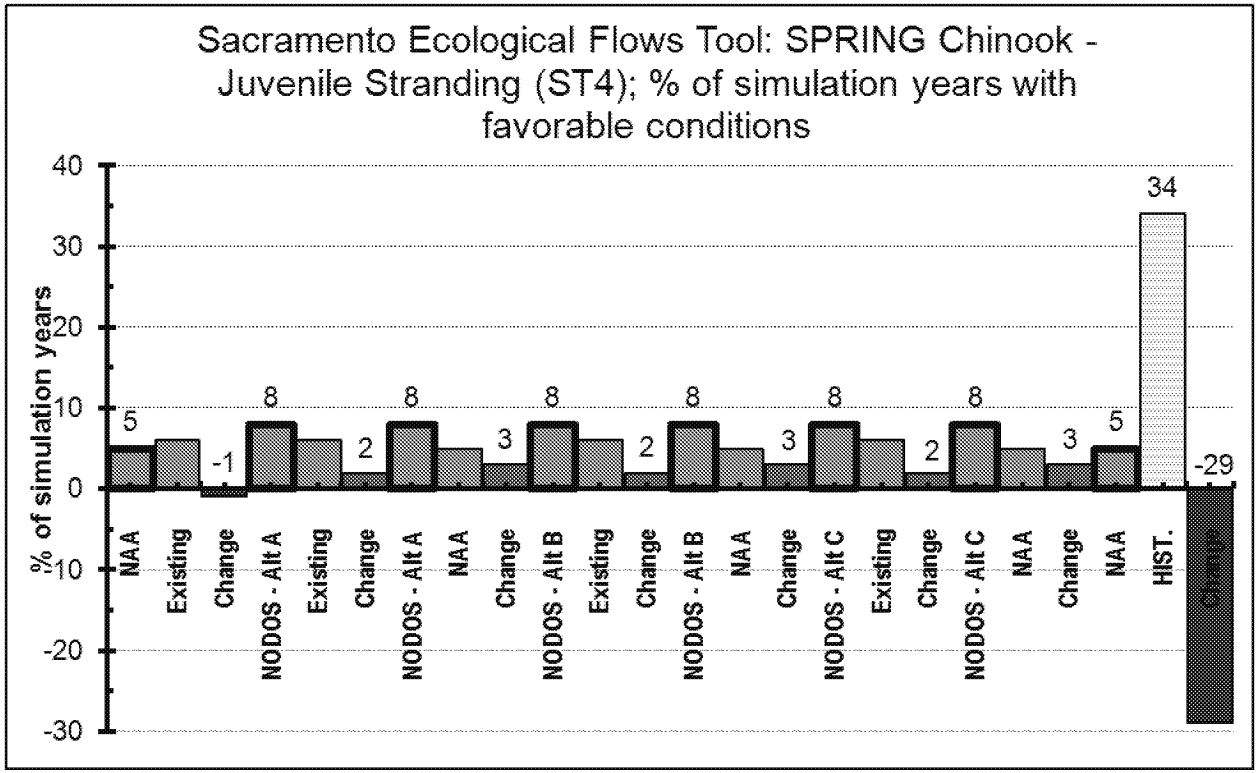

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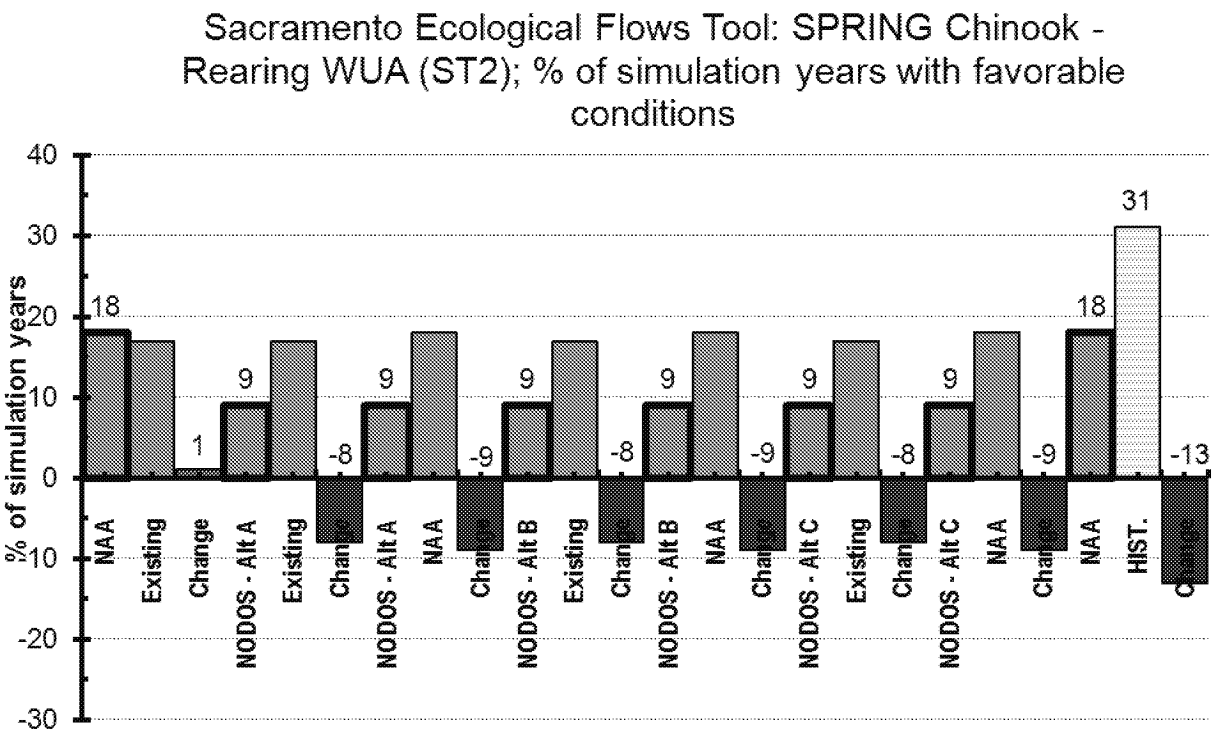

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C.5 Winter Chinook

WINTER CHINOOK

	Comparison 2						Comparison 3						Comparison 4						Comparison 5						Comparison 6						Comparison 7						Comparison 8					
ScenarioID	134	132		136	132		136	134		139	132			139	134			140	132			140	134			134	18													
Scenario Name	NAA	Existing	Change	NODOS - Alt A	Existing	Change	NODOS - Alt A	NAA	Change	NODOS - Alt B	Existing	Change		NODOS - Alt B	NAA	Change		NODOS - Alt C	Existing	Change		NODOS - Alt C	NAA	Change		NAA	HIST.	Change													
	No Action Alternative	Existing conditions		NODOS - Alt A	Existing conditions		NODOS - Alt A	No Action Alternative		NODOS - Alt B	Existing conditions			NODOS - Alt B	No Action Alternative			NODOS - Alt C	Existing conditions			NODOS - Alt C	No Action Alternative			No Action Alternative	ACTUAL HISTORIC CONDITIONS													
Spawning %UA (CH1)	40	45	-5	55	45	10	55	40	15	54	45	9		54	40	14		55	45	10		55	40	15		40	52	-12													
Thermal Egg Mortality (CH3)	95	95	0	95	95	0	95	95	0	95	95	0		95	95	0		97	95	2		97	95	2		95	94	1													
Redd Dewatering (CH6)	22	23	-1	27	23	4	27	22	5	27	23	4		27	22	5		27	23	4		27	22	5		22	25	-3													
Redd Scour (CH5)	89	89	0	89	89	0	89	89	0	89	89	0		89	89	0		89	89	0		89	89	0		89	94	-5													
Juvenile Stranding (CH4)	38	34	4	37	34	3	37	38	-1	37	34	3		37	38	-1		42	34	8		42	38	4		38	31	7													
Rearing %UA (CH2)	34	42	-8	38	42	-4	38	34	4	34	42	-8		34	34	0		37	42	-5		37	34	3		34	34	0													

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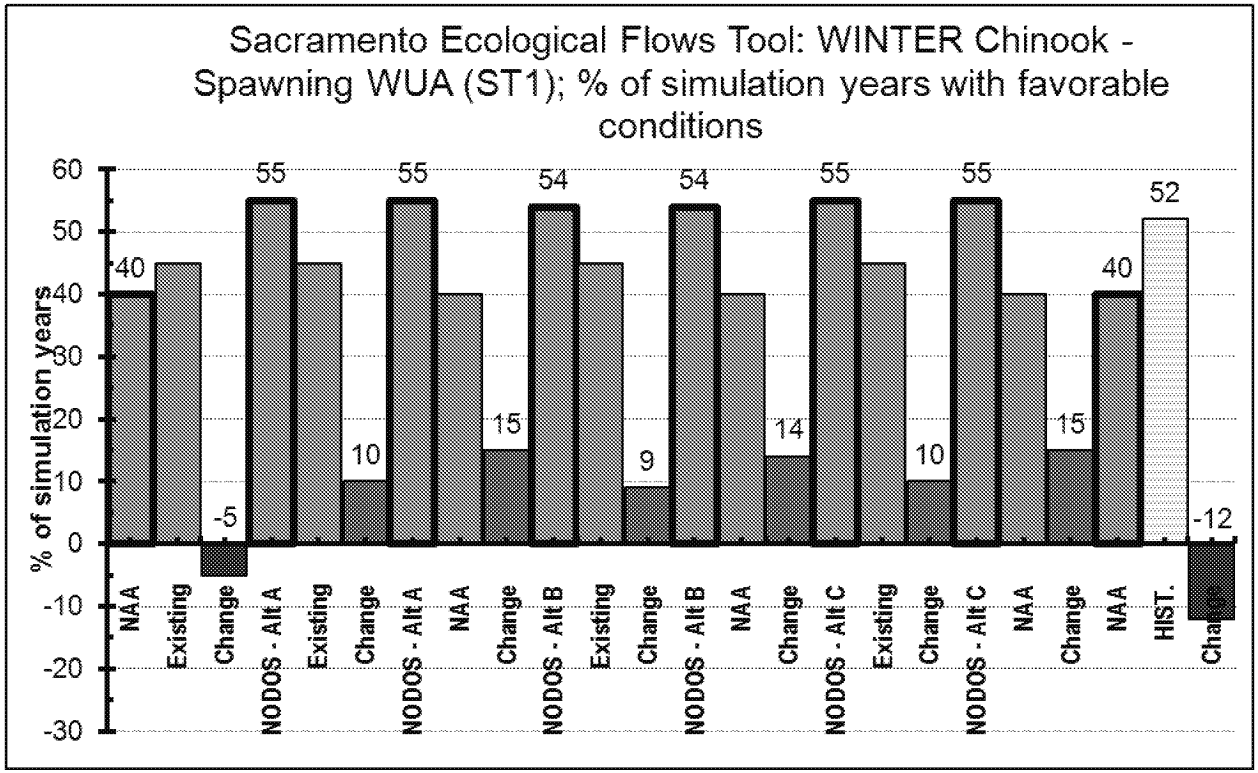

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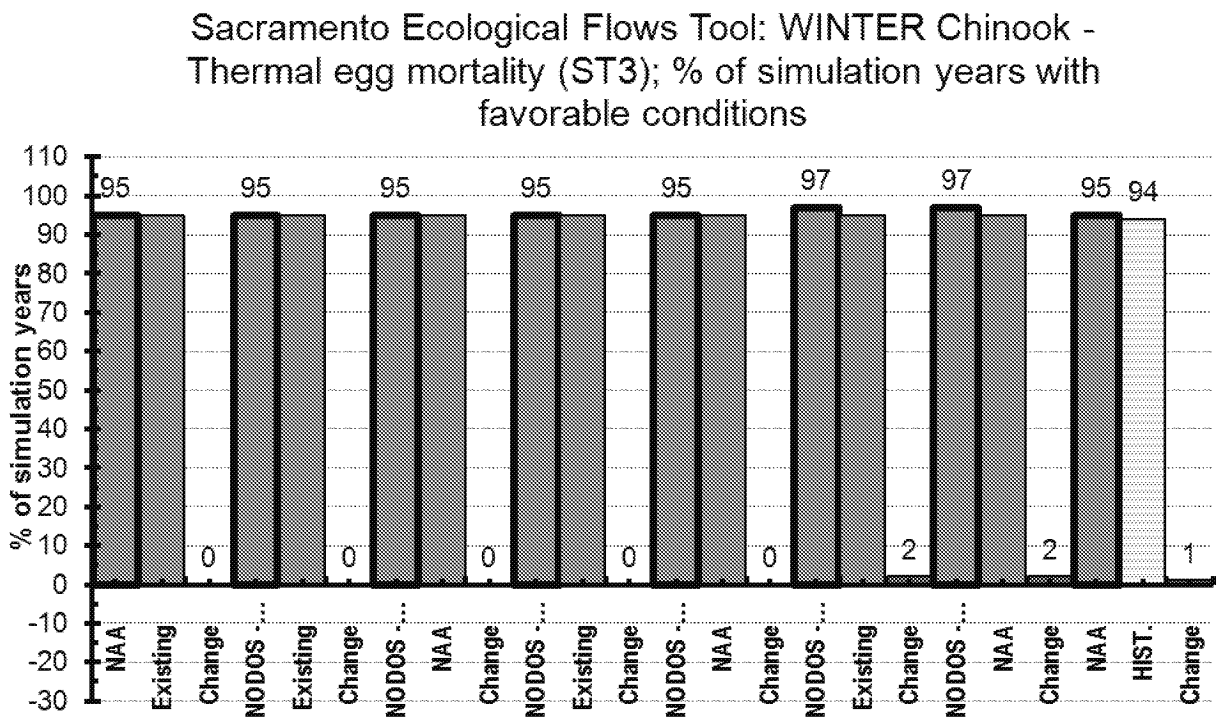

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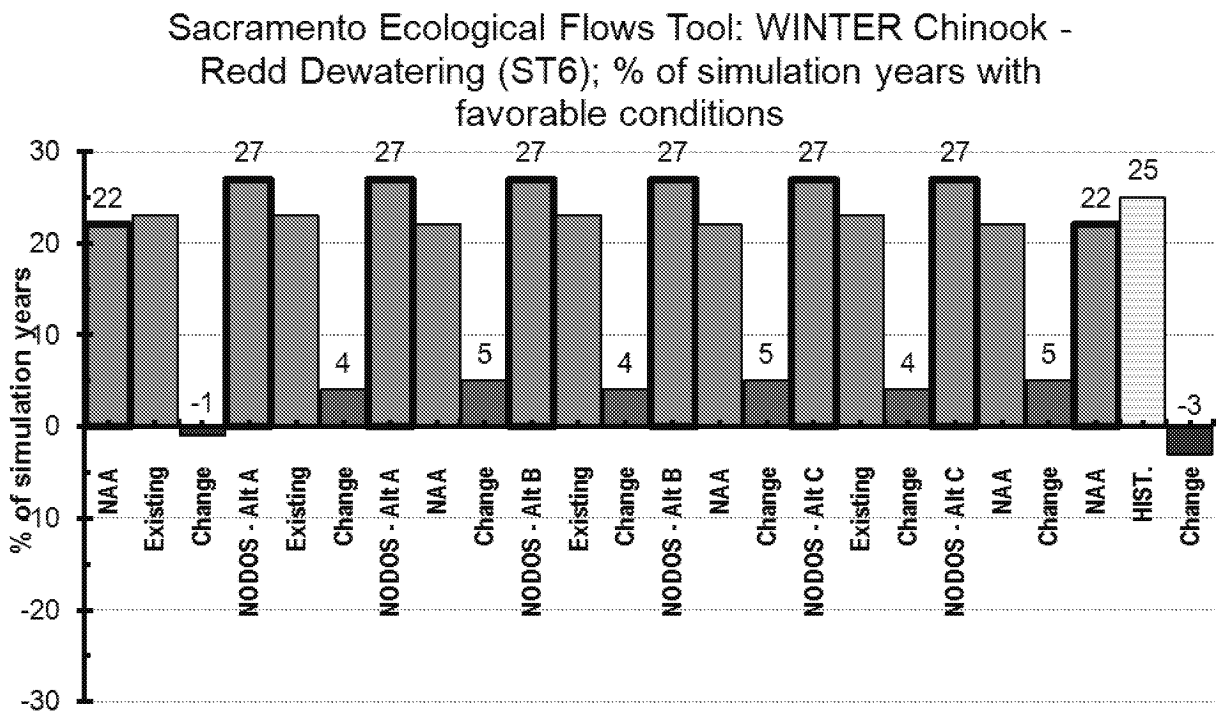

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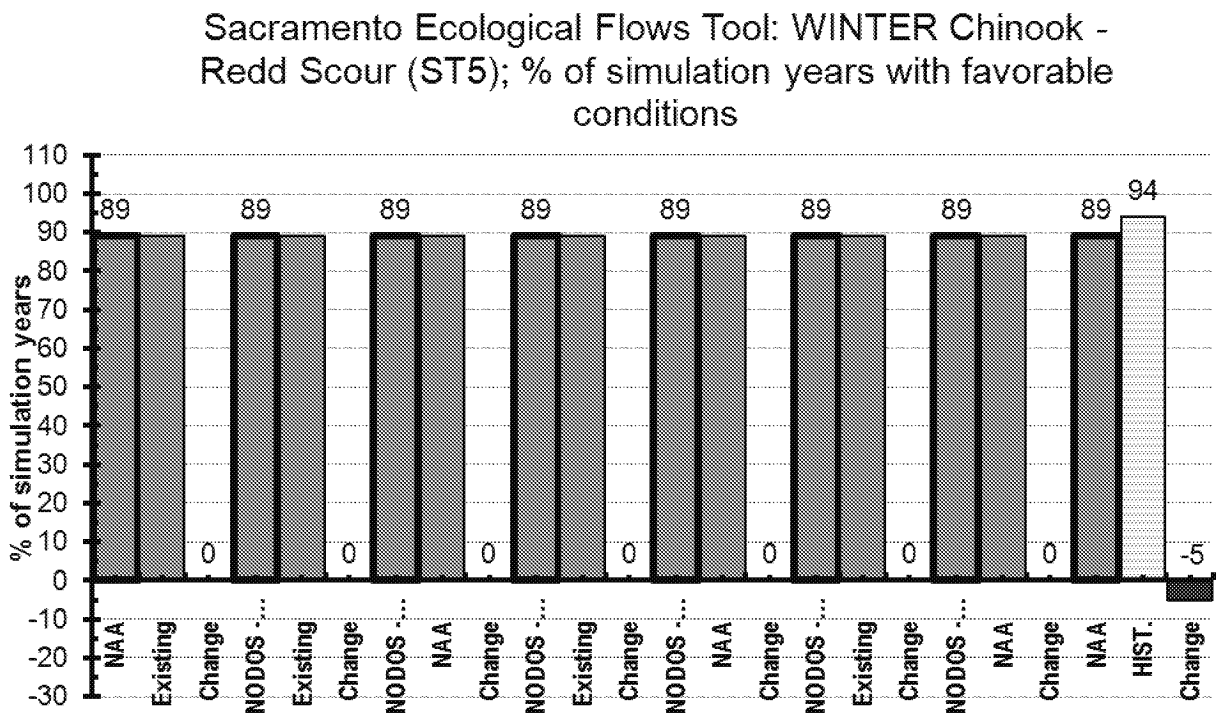

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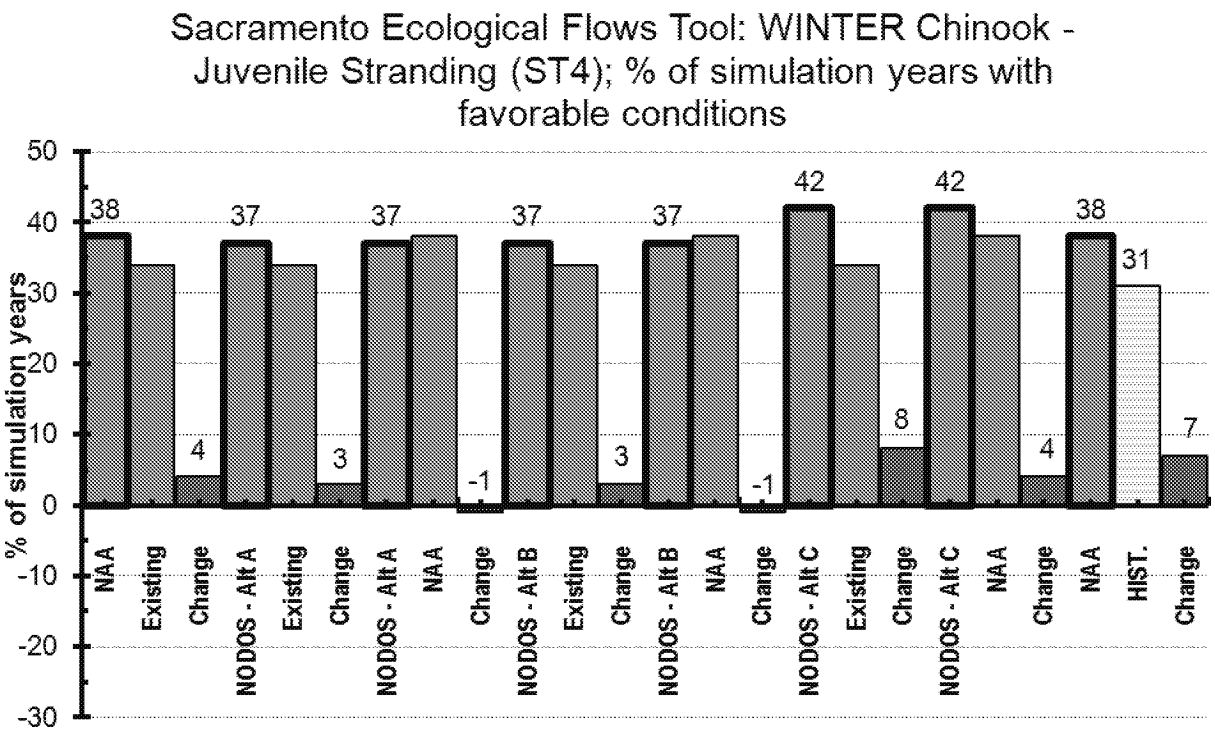

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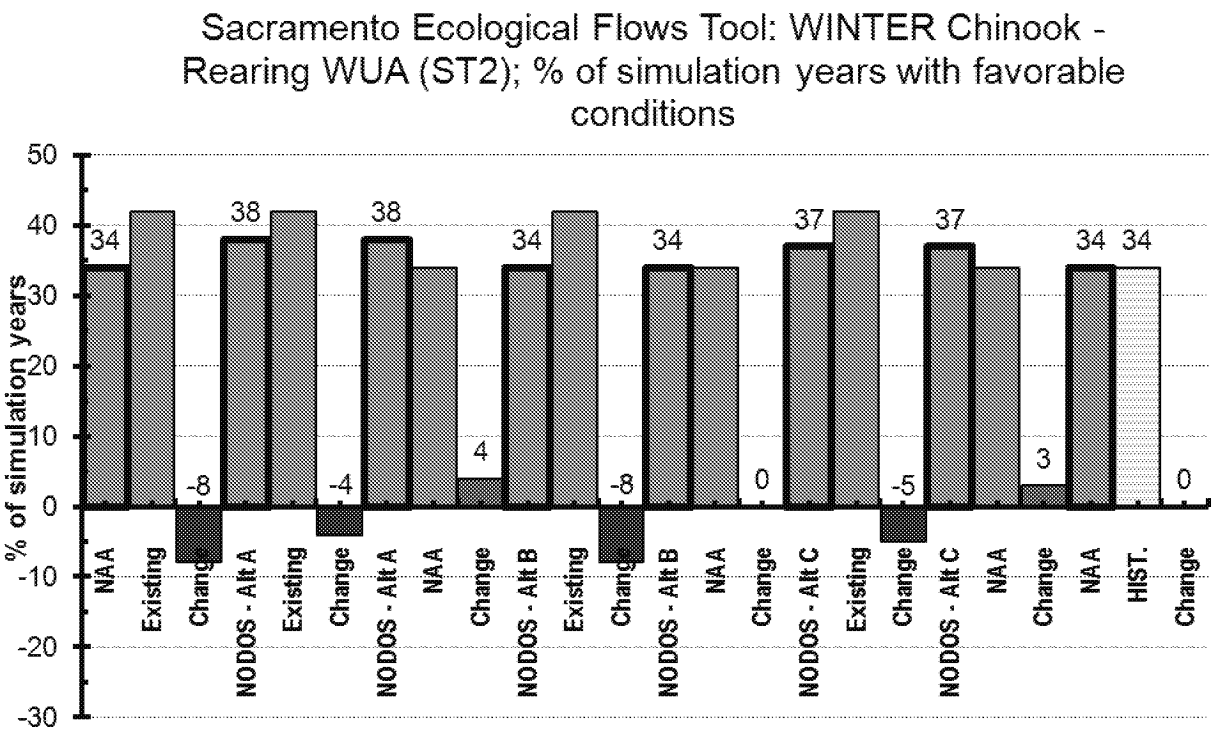
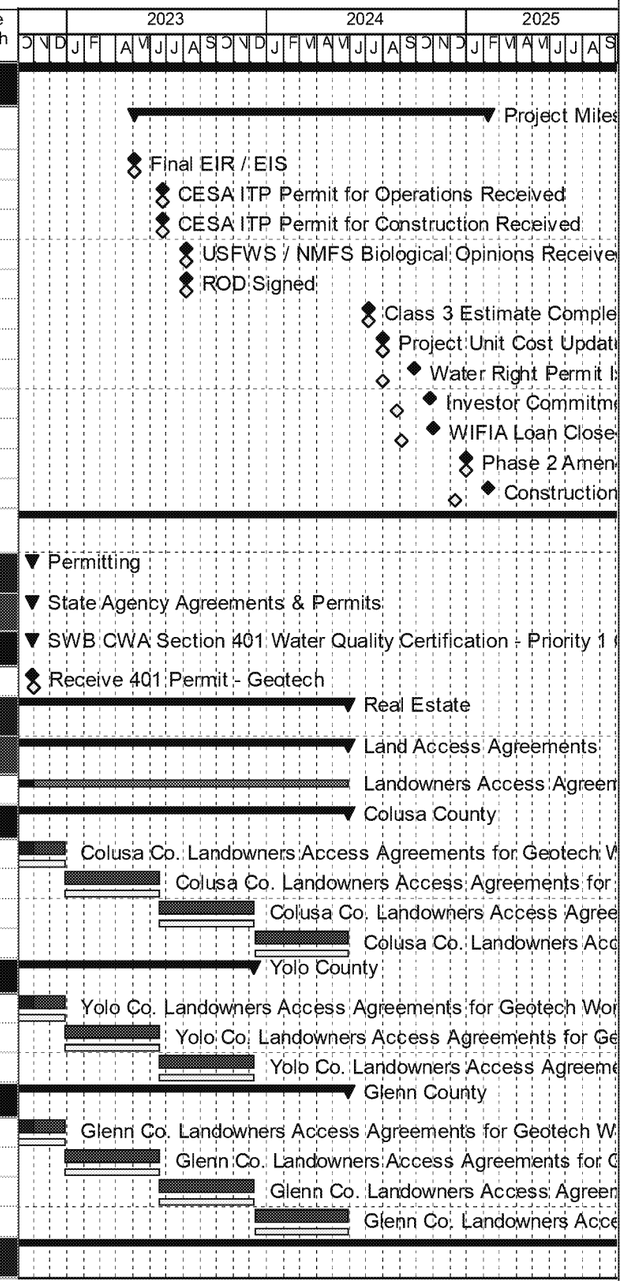


Sites Reservoir Project

Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
1	**Sites Reservoir Project DD: 01-Nov-2022**		01-Sep-20 A	17-Apr-36	3487	01-Sep-20	26-Mar-36	-16
2	**Project Milestones**		05-May-23	10-Feb-25	442	05-May-23	31-Dec-24	-29
3	MS-1200	Final EIR / EIS		05-May-23	0		05-May-23	0
4	MS-1320	CESA ITP Permit for Operations Received		26-Jun-23	0		26-Jun-23	0
5	MS-1340	CESA ITP Permit for Construction Received		26-Jun-23	0		26-Jun-23	0
6	MS-1150	USFWS / NMFS Biological Opinions Received		07-Aug-23	0		07-Aug-23	0
7	MS-1300	ROD Signed		07-Aug-23	0		07-Aug-23	0
8	MS-1700	Class 3 Estimate Complete		05-Jul-24	0		05-Jul-24	0
9	MS-1450	Project Unit Cost Update Complete		30-Jul-24	0		30-Jul-24	0
10	MS-1400	Water Right Permit Issued		26-Sep-24	0		30-Jul-24	-41
11	MS-1500	Investor Commitment		24-Oct-24*	0		27-Aug-24	-41
12	MS-1600	WIFIA Loan Closed		31-Oct-24	0		04-Sep-24	-41
13	MS-5000	Phase 2 Amendment 3 Complete		31-Dec-24*	0		31-Dec-24	0
14	MS-3000	Construction Groundbreaking	10-Feb-25		0	11-Dec-24		-41
15	**Geotech Program**		22-Mar-22 A	30-Sep-26	997	22-Mar-22	04-Aug-26	-41
16	**Permitting**		31-Oct-22 A	31-Oct-22 A	0	31-Oct-22	31-Oct-22	1
17	**State Agency Agreements & Permits**		31-Oct-22 A	31-Oct-22 A	0	31-Oct-22	31-Oct-22	1
18	**SWB CWA Section 401 Water Quality Certification - Priority 1 Geotech**		31-Oct-22 A	31-Oct-22 A	0	31-Oct-22	31-Oct-22	1
19	401-120	Receive 401 Permit - Geotech		31-Oct-22 A	0		31-Oct-22	1
20	**Real Estate**		22-Mar-22 A	30-May-24	394	22-Mar-22	30-May-24	0
21	**Land Access Agreements**		22-Mar-22 A	30-May-24	394	22-Mar-22	30-May-24	0
22	A1250	Landowners Access Agreements for Geotech	22-Mar-22 A	30-May-24	394	22-Mar-22	30-May-24	0
23	**Colusa County**		22-Mar-22 A	30-May-24	399	22-Mar-22	30-May-24	0
24	LAAC-1200	Colusa Co. Landowners Access Agreements for Geotech Work Pkg #2	22-Mar-22 A	29-Dec-22	39	22-Mar-22	29-Dec-22	0
25	LAAC-1300	Colusa Co. Landowners Access Agreements for Geotech Work Pkg #3	30-Dec-22	19-Jun-23	120	30-Dec-22	19-Jun-23	0
26	LAAC-1400	Colusa Co. Landowners Access Agreements for Geotech Work Pkg #4	20-Jun-23	08-Dec-23	120	20-Jun-23	08-Dec-23	0
27	LAAC-1500	Colusa Co. Landowners Access Agreements for Geotech Work Pkg #5	11-Dec-23	30-May-24	120	11-Dec-23	30-May-24	0
28	**Yolo County**		22-Mar-22 A	08-Dec-23	279	22-Mar-22	08-Dec-23	0
29	LAAY-1200	Yolo Co. Landowners Access Agreements for Geotech Work Pkg #2	22-Mar-22 A	29-Dec-22	39	22-Mar-22	29-Dec-22	0
30	LAAY-1300	Yolo Co. Landowners Access Agreements for Geotech Work Pkg #3	30-Dec-22	19-Jun-23	120	30-Dec-22	19-Jun-23	0
31	LAAY-1400	Yolo Co. Landowners Access Agreements for Geotech Work Pkg #4	20-Jun-23	08-Dec-23	120	20-Jun-23	08-Dec-23	0
32	**Glenn County**		22-Mar-22 A	30-May-24	399	22-Mar-22	30-May-24	0
33	LAAG-1200	Glenn Co. Landowners Access Agreements for Geotech Work Pkg #2	22-Mar-22 A	29-Dec-22	39	22-Mar-22	29-Dec-22	0
34	LAAG-1300	Glenn Co. Landowners Access Agreements for Geotech Work Pkg #3	30-Dec-22	19-Jun-23	120	30-Dec-22	19-Jun-23	0
35	LAAG-1400	Glenn Co. Landowners Access Agreements for Geotech Work Pkg #4	20-Jun-23	08-Dec-23	120	20-Jun-23	08-Dec-23	0
36	LAAG-1500	Glenn Co. Landowners Access Agreements for Geotech Work Pkg #5	11-Dec-23	30-May-24	120	11-Dec-23	30-May-24	0
37	**Geotechnical Engineering**		06-Sep-22 A	30-Sep-26	997	06-Sep-22	04-Aug-26	-41



Remaining Level of Effort
Actual Level of Effort
Primary Baseline
Actual Work
Remaining Work
Critical Remaining Work
Baseline Milestone
Milestone
Summary

Project ID: Sites November 2022 / Project Name: Sites Reservoir Project DD: 01-Nov-2022
Layout Name: Sites Comp vs Prior Month / TASK filter: Less than 100%.
Data Date: 01-Nov-22 / Print Date: 03-Nov-22

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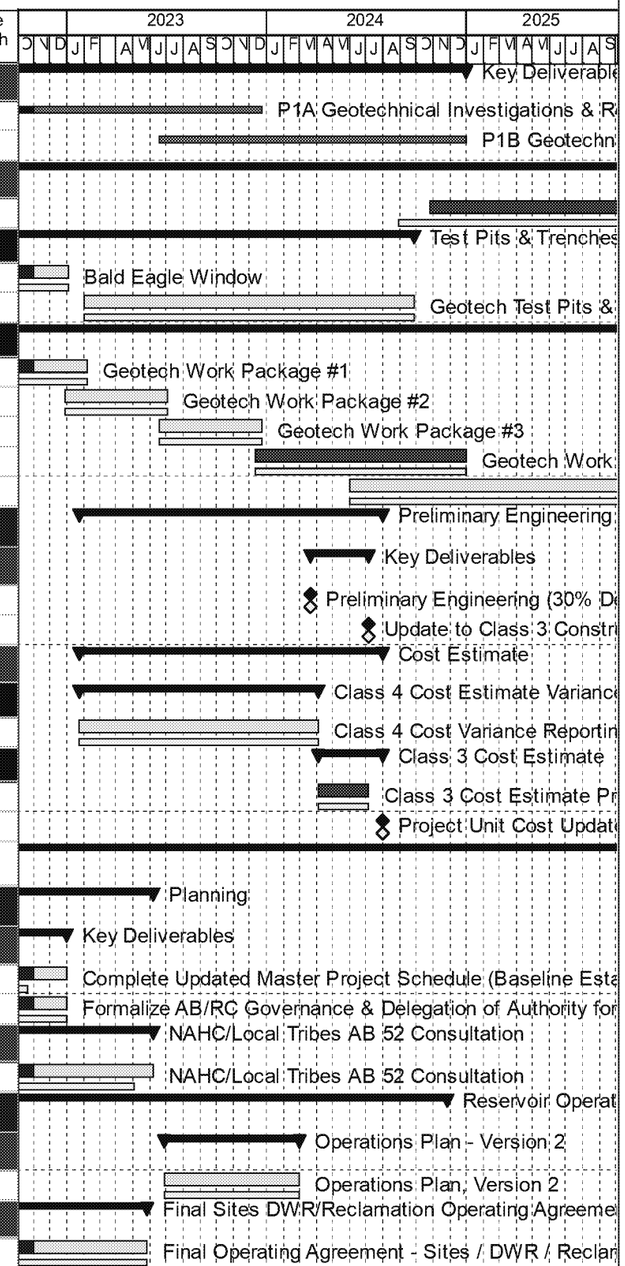
Sites Reservoir Project

Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
38	**Key Deliverables**		06-Sep-22 A	31-Dec-24	546	06-Sep-22	31-Dec-24	0
39	KD-2015	P1A Geotechnical Investigations & Reports	06-Sep-22 A	22-Dec-23	289	06-Sep-22	22-Dec-23	0
40	KD-2025	P1B Geotechnical Investigations & Reports	20-Jun-23	31-Dec-24	387	20-Jun-23	31-Dec-24	0
41	**Geotechnical Investigations**		06-Sep-22 A	30-Sep-26	997	06-Sep-22	04-Aug-26	-41
42	A1560	P2 Geotech for Final Design	25-Oct-24	30-Sep-26	500	28-Aug-24	04-Aug-26	-41
43	**Test Pits & Trenches**		06-Sep-22 A	26-Sep-24	482	06-Sep-22	26-Sep-24	0
44	TPT-1100	Bald Eagle Window	06-Sep-22 A	03-Jan-23	41	06-Sep-22	03-Jan-23	0
45	TPT-1200	Geotech Test Pits & Trenches - Short Term Pemit Window	02-Feb-23	26-Sep-24	420	02-Feb-23	26-Sep-24	0
46	**Work Packages**		06-Sep-22 A	31-Dec-25	799	06-Sep-22	31-Dec-25	0
47	GWP-1100	Geotech Work Package #1	06-Sep-22 A	06-Feb-23	65	06-Sep-22	06-Feb-23	0
48	GWP-1200	Geotech Work Package #2	30-Dec-22	03-Jul-23	130	30-Dec-22	03-Jul-23	0
49	GWP-1300	Geotech Work Package #3	20-Jun-23	22-Dec-23	130	20-Jun-23	22-Dec-23	0
50	GWP-1400	Geotech Work Package #4	11-Dec-23	31-Dec-24	267	11-Dec-23	31-Dec-24	0
51	GWP-1500	Geotech Work Package #5 (need for Sites Lodoga Rd. Realignment Cost Certainty)	31-May-24	31-Dec-25	400	31-May-24	31-Dec-25	0
52	**Preliminary Engineering**		24-Jan-23	30-Jul-24	386	24-Jan-23	30-Jul-24	0
53	**Key Deliverables**		20-Mar-24	05-Jul-24	75	20-Mar-24	05-Jul-24	0
54	KD-1180	Preliminary Engineering (30% Design Level)		20-Mar-24	0		20-Mar-24	0
55	KD-1190	Update to Class 3 Construction Cost Estimate		05-Jul-24	0		05-Jul-24	0
56	**Cost Estimate**		24-Jan-23	30-Jul-24	386	24-Jan-23	30-Jul-24	0
57	**Class 4 Cost Estimate Variance Reporting**		24-Jan-23	03-Apr-24	304	24-Jan-23	03-Apr-24	0
58	C4E-1000	Class 4 Cost Variance Reporting (rolling Class 4)	24-Jan-23	03-Apr-24	304	24-Jan-23	03-Apr-24	0
59	**Class 3 Cost Estimate**		04-Apr-24	30-Jul-24	82	04-Apr-24	30-Jul-24	0
60	C3E-1000	Class 3 Cost Estimate Preparation (Capital Cost)	04-Apr-24	05-Jul-24	65	04-Apr-24	05-Jul-24	0
61	CU-1000	Project Unit Cost Update		30-Jul-24	0		30-Jul-24	0
62	**Project Development**		01-Sep-20 A	27-Apr-29	1669	01-Sep-20	27-Apr-29	0
63	**Planning**		01-Sep-20 A	06-Jun-23	150	01-Sep-20	05-May-23	-21
64	**Key Deliverables**		24-Jan-22 A	30-Dec-22	40	24-Jan-22	30-Dec-22	0
65	KD-1130	Complete Updated Master Project Schedule (Baseline Established)	24-Jan-22 A	30-Dec-22	40	24-Jan-22	21-Oct-22	-46
66	KD-1290	Formalize AB/RC Governance & Delegation of Authority for Phase 3 (JBrown)	06-Sep-22 A	30-Dec-22	40	06-Sep-22	30-Dec-22	0
67	**NAHC/Local Tribes AB 52 Consultation**		01-Sep-20 A	06-Jun-23	150	01-Sep-20	05-May-23	-21
68	STA-120	NAHC/Local Tribes AB 52 Consultation	01-Sep-20 A	06-Jun-23	150	01-Sep-20	05-May-23	-21
69	**Reservoir Operations & Modeling**		03-Jan-22 A	25-Nov-24	524	03-Jan-22	25-Oct-24	-21
70	**Operations Plan - Version 2**		27-Jun-23	01-Mar-24	172	27-Jun-23	01-Mar-24	0
71	KD-1510	Operations Plan, Version 2	27-Jun-23	01-Mar-24	172	27-Jun-23	01-Mar-24	0
72	**Final Sites DWR/Reclamation Operating Agreement**		19-Apr-22 A	26-May-23	144	19-Apr-22	26-May-23	0
73	OP-1005	Final Operating Agreement - Sites / DWR / Reclamation	19-Apr-22 A	26-May-23	144	19-Apr-22	26-May-23	0



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Sites Reservoir Project

Schedule Comparison to Prior Month

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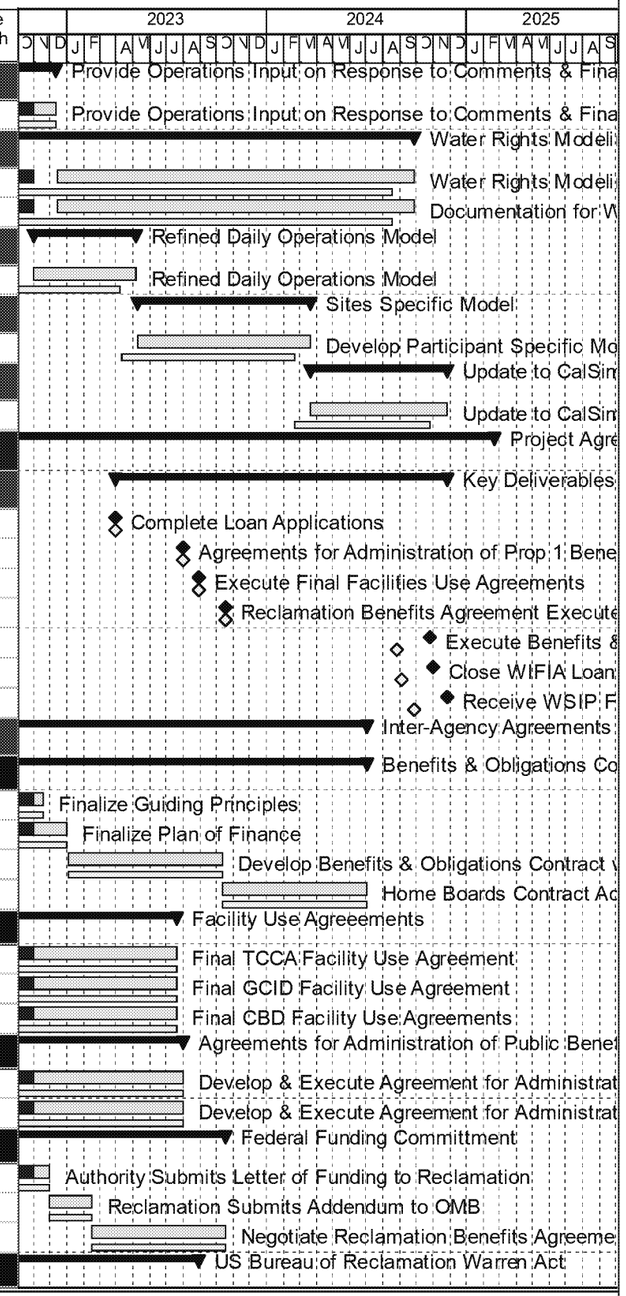
74	**Provide Operations Input on Response to Comments & Final EIR/EIS**		24-May-22 A	12-Dec-22	28	24-May-22	12-Dec-22	0
75	FO-1080	Provide Operations Input on Response to Comments & Final EIR/EIS	24-May-22 A	12-Dec-22	28	24-May-22	12-Dec-22	0
76	**Water Rights Modeling**		03-Jan-22 A	26-Sep-24	454	03-Jan-22	16-Aug-24	-28
77	A1200	Water Rights Modeling Support	03-Jan-22 A	26-Sep-24	454	03-Jan-22	16-Aug-24	-28
78	A1210	Documentation for Water Rights	03-Jan-22 A	26-Sep-24	454	03-Jan-22	16-Aug-24	-28
79	**Refined Daily Operations Model**		01-Nov-22	08-May-23	130	03-Oct-22	07-Apr-23	-21
80	A1220	Refined Daily Operations Model	01-Nov-22	08-May-23	130	03-Oct-22	07-Apr-23	-21
81	**Sites Specific Model**		09-May-23	21-Mar-24	220	10-Apr-23	21-Feb-24	-21
82	OS-1150	Develop Participant Specific Model	09-May-23	21-Mar-24	220	10-Apr-23	21-Feb-24	-21
83	**Update to CalSim 3**		22-Mar-24	25-Nov-24	174	22-Feb-24	25-Oct-24	-21
84	A1230	Update to CalSim 3	22-Mar-24	25-Nov-24	174	22-Feb-24	25-Oct-24	-21
85	**Project Agreements & Funding**		01-Jun-21 A	20-Feb-25	578	01-Jun-21	20-Dec-24	-42
86	**Key Deliverables**		29-Mar-23	25-Nov-24	422	29-Mar-23	27-Sep-24	-41
87	KD-1255	Complete Loan Applications		29-Mar-23	0		29-Mar-23	0
88	KD-1520	Agreements for Administration of Prop 1 Benefits Executed		31-Jul-23	0		31-Jul-23	0
89	KD-1230	Execute Final Facilities Use Agreements		29-Aug-23	0		29-Aug-23	0
90	KD-1260	Reclamation Benefits Agreement Executed		17-Oct-23	0		17-Oct-23	0
91	KD-1300	Execute Benefits & Obligations Contracts with Participants		24-Oct-24	0		27-Aug-24	-41
92	KD-2600	Close WIFIA Loan		31-Oct-24	0		04-Sep-24	-41
93	KD-1310	Receive WSIP Final Award from CWC		25-Nov-24	0		27-Sep-24	-41
94	**Inter-Agency Agreements**		01-Jun-21 A	02-Jul-24	417	01-Jun-21	02-Jul-24	0
95	**Benefits & Obligations Contract with Participants**		01-Mar-22 A	02-Jul-24	417	01-Mar-22	02-Jul-24	0
96	BO-1100	Finalize Guiding Principles	01-Mar-22 A	18-Nov-22	14	01-Mar-22	18-Nov-22	0
97	BO-1200	Finalize Plan of Finance	01-Mar-22 A	30-Dec-22	40	01-Mar-22	30-Dec-22	0
98	BO-1300	Develop Benefits & Obligations Contract with Participants	03-Jan-23	12-Oct-23	200	03-Jan-23	12-Oct-23	0
99	BO-1400	Home Boards Contract Actions	13-Oct-23	02-Jul-24	180	13-Oct-23	02-Jul-24	0
100	**Facility Use Agreeements**		27-Aug-21 A	21-Jul-23	182	27-Aug-21	21-Jul-23	0
101	FO-1020	Final TCCA Facility Use Agreement	27-Aug-21 A	21-Jul-23	182	27-Aug-21	21-Jul-23	0
102	FO-1030	Final GCID Facility Use Agreement	27-Aug-21 A	21-Jul-23	182	27-Aug-21	21-Jul-23	0
103	FO-1040	Final CBD Facility Use Agreements	27-Aug-21 A	21-Jul-23	182	27-Aug-21	21-Jul-23	0
104	**Agreements for Administration of Public Benefits**		31-Mar-22 A	31-Jul-23	188	31-Mar-22	31-Jul-23	0
105	PB-1100	Develop & Execute Agreement for Administration of Public Benefits with DWR (ali/chey)	31-Mar-22 A	31-Jul-23	188	31-Mar-22	31-Jul-23	0
106	PB-1200	Develop & Execute Agreement for Administration of Public Benefits with CDFW (ali/chey)	31-Mar-22 A	31-Jul-23	188	31-Mar-22	31-Jul-23	0
107	**Federal Funding Committment**		19-Sep-22 A	17-Oct-23	243	19-Sep-22	17-Oct-23	0
108	WIIN-1160	Authority Submits Letter of Funding to Reclamation	19-Sep-22 A	30-Nov-22	20	19-Sep-22	30-Nov-22	0
109	WIIN-1180	Reclamation Submits Addendum to OMB	01-Dec-22	16-Feb-23	53	01-Dec-22	16-Feb-23	0
110	WIIN-1170	Negotiate Reclamation Benefits Agreement	17-Feb-23	17-Oct-23	170	17-Feb-23	17-Oct-23	0
111	**US Bureau of Reclamation Warren Act**		01-Jun-21 A	29-Aug-23	209	01-Jun-21	29-Aug-23	0



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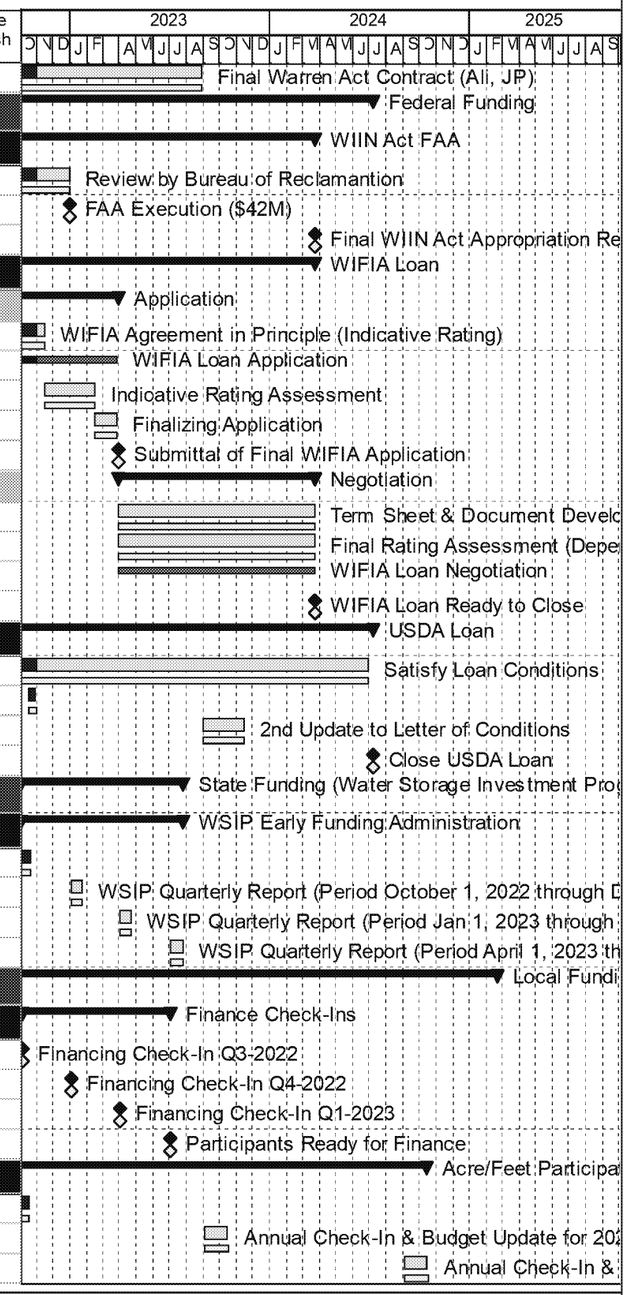
Sites Reservoir Project

Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
112	FED-090	Final Warren Act Contract (Ali, JP)	01-Jun-21 A	29-Aug-23	209	01-Jun-21	29-Aug-23	0
113	**Federal Funding**		10-Jun-22 A	08-Jul-24	420	10-Jun-22	08-Jul-24	0
114	**WIIN Act FAA**		10-Jun-22 A	25-Mar-24	347	10-Jun-22	25-Mar-24	0
115	WIIN-1190	Review by Bureau of Reclamantion	10-Jun-22 A	31-Dec-22	61	10-Jun-22	31-Dec-22	0
116	WIIN-1210	FAA Execution ($42M)		31-Dec-22	0		31-Dec-22	0
117	WIIN-1200	Final WIIN Act Appropriation Received		25-Mar-24	0		25-Mar-24	0
118	**WIFIA Loan**		05-Jul-22 A	25-Mar-24	347	05-Jul-22	25-Mar-24	0
119	**Application**		05-Jul-22 A	29-Mar-23	100	05-Jul-22	29-Mar-23	0
120	WIFIA-110	WIFIA Agreement in Principle (Indicative Rating)	05-Jul-22 A	15-Nov-22	11	05-Jul-22	15-Nov-22	0
121	WIFIA-300	WIFIA Loan Application	05-Jul-22 A	28-Mar-23	99	05-Jul-22	28-Mar-23	0
122	WIFIA-120	Indicative Rating Assessment	16-Nov-22	14-Feb-23	60	16-Nov-22	14-Feb-23	0
123	WIFIA-130	Finalizing Application	15-Feb-23	28-Mar-23	30	15-Feb-23	28-Mar-23	0
124	WIFIA-140	Submittal of Final WIFIA Application		29-Mar-23	0		29-Mar-23	0
125	**Negotiation**		30-Mar-23	25-Mar-24	247	30-Mar-23	25-Mar-24	0
126	WIFIA-210	Term Sheet & Document Development	30-Mar-23	25-Mar-24	250	30-Mar-23	25-Mar-24	0
127	WIFIA-220	Final Rating Assessment (Depends on Final Rebalancing)	30-Mar-23	25-Mar-24	250	30-Mar-23	25-Mar-24	0
128	WIFIA-240	WIFIA Loan Negotiation	30-Mar-23	25-Mar-24	247	30-Mar-23	25-Mar-24	0
129	WIFIA-230	WIFIA Loan Ready to Close		25-Mar-24	0		25-Mar-24	0
130	**USDA Loan**		02-Sep-22 A	08-Jul-24	420	02-Sep-22	08-Jul-24	0
131	USDA-1060	Satisfy Loan Conditions	02-Sep-22 A	28-Jun-24	420	02-Sep-22	28-Jun-24	0
132	USDA-1040	USDA Status Update Report (May 2022 - Oct 2022)	19-Oct-22 A	31-Oct-22 A	0	19-Oct-22	01-Nov-22	2
133	USDA-1080	2nd Update to Letter of Conditions	01-Sep-23	14-Nov-23	50	01-Sep-23	14-Nov-23	0
134	USDA-1070	Close USDA Loan		08-Jul-24	0		08-Jul-24	0
135	**State Funding (Water Storage Investment Program, WSIP)**		03-Oct-22 A	25-Jul-23	144	03-Oct-22	25-Jul-23	0
136	**WSIP Early Funding Administration**		03-Oct-22 A	25-Jul-23	144	03-Oct-22	25-Jul-23	0
137	WSIP-1230	WSIP Quarterly Report (Period July 1, 2022 through September 30, 2022)	03-Oct-22 A	21-Oct-22 A	0	03-Oct-22	21-Oct-22	1
138	WSIP-1240	WSIP Quarterly Report (Period October 1, 2022 through December 31, 2022)	03-Jan-23	23-Jan-23	15	03-Jan-23	23-Jan-23	0
139	WSIP-1250	WSIP Quarterly Report (Period Jan 1, 2023 through March 31, 2023)	03-Apr-23	21-Apr-23	15	03-Apr-23	21-Apr-23	0
140	WSIP-1260	WSIP Quarterly Report (Period April 1, 2023 through June 30, 2023)	05-Jul-23	25-Jul-23	15	05-Jul-23	25-Jul-23	0
141	**Local Funding**		06-Sep-22 A	20-Feb-25	538	06-Sep-22	20-Dec-24	-42
142	**Finance Check-Ins**		07-Oct-22 A	03-Jul-23	126	07-Oct-22	03-Jul-23	0
143	FC-1260	Financing Check-In Q3-2022		07-Oct-22 A	0		07-Oct-22	1
144	FC-1270	Financing Check-In Q4-2022		03-Jan-23	0		03-Jan-23	0
145	FC-1280	Financing Check-In Q1-2023		03-Apr-23	0		03-Apr-23	0
146	FC-1290	Participants Ready for Finance		03-Jul-23	0		03-Jul-23	0
147	**Acre/Feet Participation (Reservoir Committee Cash Calls)**		06-Sep-22 A	15-Oct-24	283	06-Sep-22	16-Oct-24	1
148	AF-1100	Annual Check-In & Budget Update for 2023	06-Sep-22 A	17-Oct-22 A	0	06-Sep-22	17-Oct-22	1
149	AF-1200	Annual Check-In & Budget Update for 2024	05-Sep-23	16-Oct-23	30	06-Sep-23	17-Oct-23	1
150	AF-1300	Annual Check-In & Budget Update for 2025	04-Sep-24	15-Oct-24	30	05-Sep-24	16-Oct-24	1



Remaining Level of Effort · Actual Work · Baseline Milestone
Actual Level of Effort · Remaining Work · Milestone
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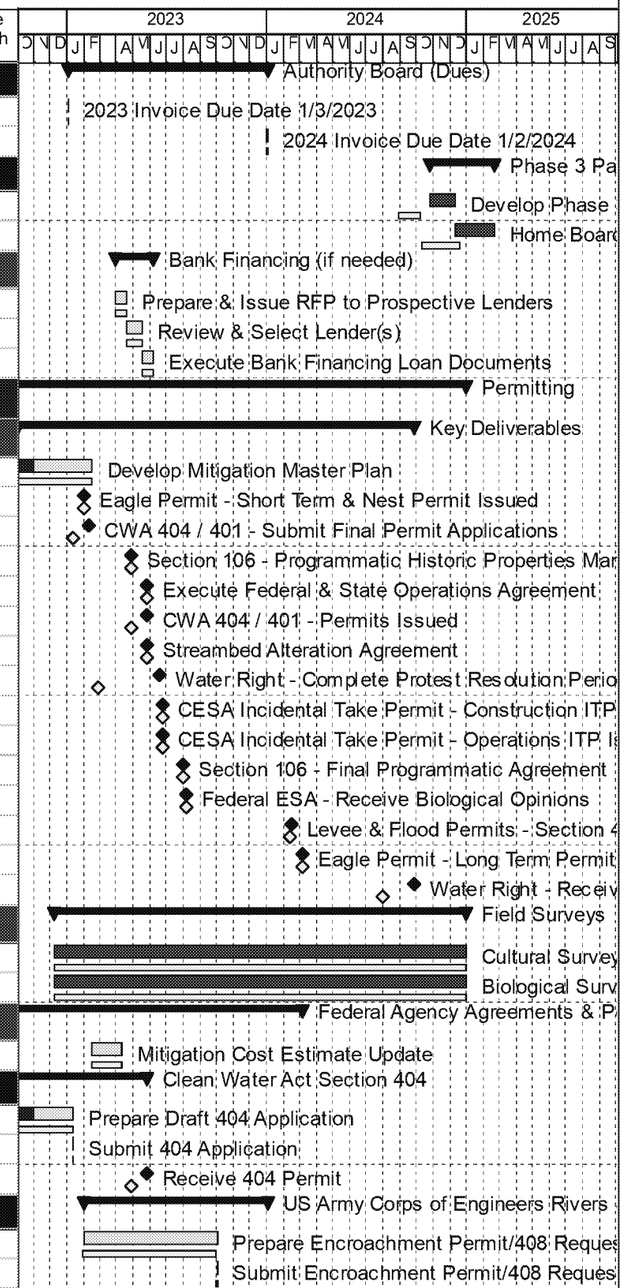
Sites Reservoir Project

Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
151	**Authority Board (Dues)**		03-Jan-23	02-Jan-24	253	03-Jan-23	02-Jan-24	0
152	AB-2200	2023 Invoice Due Date 1/3/2023	03-Jan-23	03-Jan-23*	1	03-Jan-23	03-Jan-23	0
153	AB-2300	2024 Invoice Due Date 1/2/2024	02-Jan-24	02-Jan-24*	1	02-Jan-24	02-Jan-24	0
154	**Phase 3 Participation Agreement (if needed)**		25-Oct-24	20-Feb-25	80	28-Aug-24	20-Dec-24	-41
155	PA-1100	Develop Phase 3 Participation Agreement	25-Oct-24	09-Dec-24	30	28-Aug-24	09-Oct-24	-41
156	PA-1200	Home Board Execution & Final Rebalancing	10-Dec-24	20-Feb-25	50	10-Oct-24	20-Dec-24	-41
157	**Bank Financing (if needed)**		30-Mar-23	08-Jun-23	50	30-Mar-23	08-Jun-23	0
158	BF-1100	Prepare & Issue RFP to Prospective Lenders	30-Mar-23	19-Apr-23	15	30-Mar-23	19-Apr-23	0
159	BF-1200	Review & Select Lender(s)	20-Apr-23	17-May-23	20	20-Apr-23	17-May-23	0
160	BF-1300	Execute Bank Financing Loan Documents	18-May-23	08-Jun-23	15	18-May-23	08-Jun-23	0
161	**Permitting**		04-Jan-21 A	31-Dec-24	541	04-Jan-21	31-Dec-24	0
162	**Key Deliverables**		03-Oct-22 A	26-Sep-24	482	03-Oct-22	30-Jul-24	-41
163	KD-1460	Develop Mitigation Master Plan	03-Oct-22 A	15-Feb-23	72	03-Oct-22	15-Feb-23	0
164	KD-1430	Eagle Permit - Short Term & Nest Permit Issued		01-Feb-23	0		01-Feb-23	0
165	KD-1390	CWA 404 / 401 - Submit Final Permit Applications		10-Feb-23	0		13-Jan-23	-20
166	KD-1360	Section 106 - Programmatic Historic Properties Management Plan Development		28-Apr-23	0		28-Apr-23	0
167	KD-1240	Execute Federal & State Operations Agreement		26-May-23	0		26-May-23	0
168	KD-1400	CWA 404 / 401 - Permits Issued		26-May-23	0		28-Apr-23	-20
169	KD-1420	Streambed Alteration Agreement		26-May-23	0		26-May-23	0
170	KD-1320	Water Right - Complete Protest Resolution Period & Resolve as Many Protests as Possible		20-Jun-23	0		27-Feb-23	-80
171	KD-1370	CESA Incidental Take Permit - Construction ITP Issued		26-Jun-23	0		26-Jun-23	0
172	KD-1380	CESA Incidental Take Permit - Operations ITP Issued		26-Jun-23	0		26-Jun-23	0
173	KD-1350	Section 106 - Final Programmatic Agreement		01-Aug-23	0		01-Aug-23	0
174	KD-1340	Federal ESA - Receive Biological Opinions		07-Aug-23	0		07-Aug-23	0
175	KD-1410	Levee & Flood Permits - Section 408 & CVFPB Encroachment Permits Issued		15-Feb-24	0		13-Feb-24	-2
176	KD-1440	Eagle Permit - Long Term Permit Issued		06-Mar-24	0		06-Mar-24	0
177	KD-1330	Water Right - Receive Water Right Order & Permit		26-Sep-24	0		30-Jul-24	-41
178	**Field Surveys**		09-Dec-22	31-Dec-24	520	09-Dec-22	31-Dec-24	0
179	RE-1030	Cultural Surveys	09-Dec-22	31-Dec-24	520	09-Dec-22	31-Dec-24	0
180	RE-1040	Biological Surveys	09-Dec-22	31-Dec-24	520	09-Dec-22	31-Dec-24	0
181	**Federal Agency Agreements & Permits**		11-Jan-21 A	06-Mar-24	339	11-Jan-21	06-Mar-24	0
182	CE-1570	Mitigation Cost Estimate Update	16-Feb-23	12-Apr-23	40	16-Feb-23	12-Apr-23	0
183	**Clean Water Act Section 404**		04-Feb-21 A	26-May-23	144	04-Feb-21	28-Apr-23	-20
184	404-050	Prepare Draft 404 Application	04-Feb-21 A	12-Jan-23	48	04-Feb-21	12-Jan-23	0
185	404-120	Submit 404 Application	13-Jan-23	13-Jan-23	1	13-Jan-23	13-Jan-23	0
186	404-130	Receive 404 Permit		26-May-23	0		28-Apr-23	-20
187	**US Army Corps of Engineers Rivers & Harbors Act Section 14, Section 408**		31-Jan-23	02-Jan-24	233	30-Jan-23	29-Dec-23	-1
188	408-150	Prepare Encroachment Permit/408 Request	31-Jan-23	02-Oct-23	172	30-Jan-23	29-Sep-23	-1
189	408-160	Submit Encroachment Permit/408 Request	03-Oct-23	03-Oct-23	1	02-Oct-23	02-Oct-23	-1



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Sites Reservoir Project

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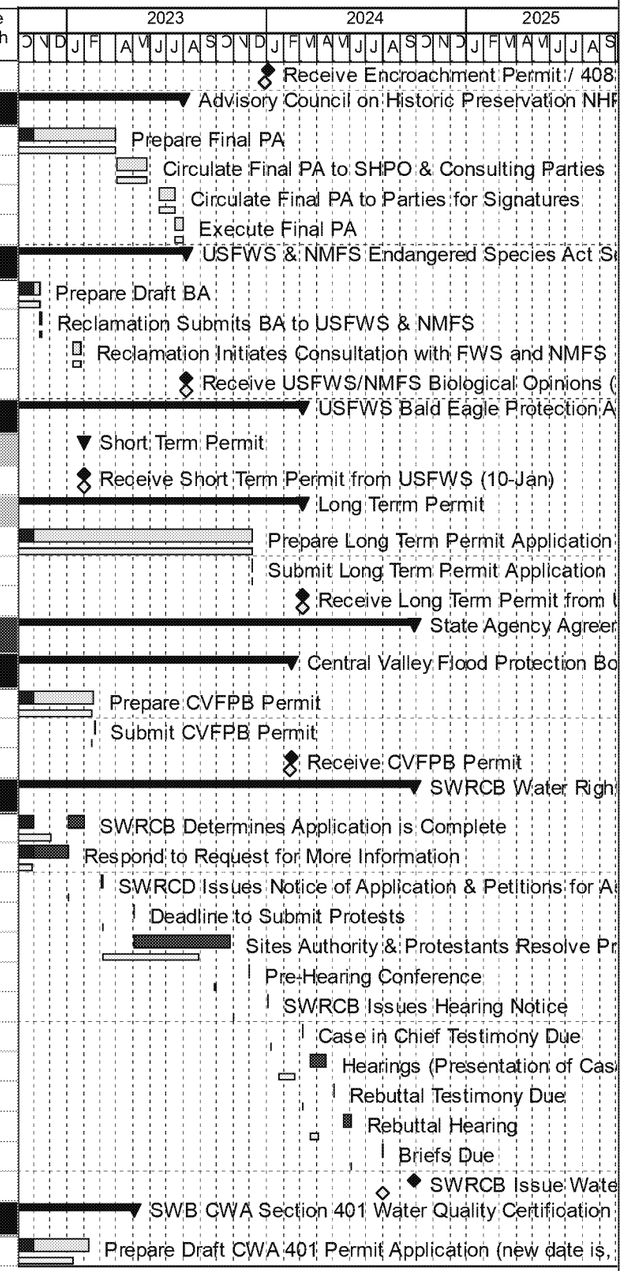
190	408-170	Receive Encroachment Permit / 408 Permit		02-Jan-24	0		29-Dec-23	-1
191	**Advisory Council on Historic Preservation NHPA Section 106**		14-Mar-22 A	01-Aug-23	189	14-Mar-22	01-Aug-23	0
192	106-081	Prepare Final PA	14-Mar-22 A	31-Mar-23	104	14-Mar-22	31-Mar-23	0
193	106-092	Circulate Final PA to SHPO & Consulting Parties	03-Apr-23	26-May-23	40	03-Apr-23	26-May-23	0
194	106-096	Circulate Final PA to Parties for Signatures	20-Jun-23	18-Jul-23	20	20-Jun-23	18-Jul-23	0
195	106-102	Execute Final PA	19-Jul-23	01-Aug-23	10	19-Jul-23	01-Aug-23	0
196	**USFWS & NMFS Endangered Species Act Section 7**		11-Jan-21 A	07-Aug-23	193	11-Jan-21	07-Aug-23	0
197	BA-200	Prepare Draft BA	11-Jan-21 A	11-Nov-22	9	11-Jan-21	11-Nov-22	0
198	BA-210	Reclamation Submits BA to USFWS & NMFS	14-Nov-22	14-Nov-22	1	14-Nov-22	14-Nov-22	0
199	BA-215	Reclamation Initiates Consultation with FWS and NMFS	13-Jan-23	26-Jan-23	10	13-Jan-23	26-Jan-23	0
200	BA-220	Receive USFWS/NMFS Biological Opinions (Incidental Take Authorizations)		07-Aug-23	0		07-Aug-23	0
201	**USFWS Bald Eagle Protection Act**		27-Jul-22 A	06-Mar-24	339	27-Jul-22	06-Mar-24	0
202	**Short Term Permit**		01-Feb-23	01-Feb-23	0	01-Feb-23	01-Feb-23	0
203	USFWS-130	Receive Short Term Permit from USFWS (10-Jan)		01-Feb-23	0		01-Feb-23	0
204	**Long Terrm Permit**		27-Jul-22 A	06-Mar-24	339	27-Jul-22	06-Mar-24	0
205	USFWS-140	Prepare Long Term Permit Application	27-Jul-22 A	04-Dec-23	275	27-Jul-22	04-Dec-23	0
206	USFWS-150	Submit Long Term Permit Application	05-Dec-23	05-Dec-23	1	05-Dec-23	05-Dec-23	0
207	USFWS-160	Receive Long Term Permit from USFWS		06-Mar-24	0		06-Mar-24	0
208	**State Agency Agreements & Permits**		04-Jan-21 A	26-Sep-24	477	04-Jan-21	30-Jul-24	-41
209	**Central Valley Flood Protection Board (CVFPB) Levee Encroachment**		13-Dec-21 A	15-Feb-24	325	13-Dec-21	13-Feb-24	-2
210	CVFPB-200	Prepare CVFPB Permit	13-Dec-21 A	17-Feb-23	74	13-Dec-21	15-Feb-23	-2
211	CVFPB-210	Submit CVFPB Permit	20-Feb-23	20-Feb-23	1	16-Feb-23	16-Feb-23	-2
212	CVFPB-220	Receive CVFPB Permit		15-Feb-24	0		13-Feb-24	-2
213	**SWRCB Water Right Permit**		12-May-22 A	26-Sep-24	477	12-May-22	30-Jul-24	-41
214	WRP-115a	SWRCB Determines Application is Complete	12-May-22 A	02-Feb-23	21	12-May-22	02-Dec-22	-41
215	WRP-115ac	Respond to Request for More Information	29-Aug-22 A	03-Jan-23	41	29-Aug-22	28-Oct-22	-42
216	WRP-115b	SWRCD Issues Notice of Application & Petitions for Assignmentt & Releases from Priority	06-Mar-23	06-Mar-23	1	04-Jan-23	04-Jan-23	-41
217	WRP-115c	Deadline to Submit Protests	04-May-23	04-May-23	1	08-Mar-23	08-Mar-23	-41
218	WRP-116	Sites Authority & Protestants Resolve Protests 122	05-May-23	27-Oct-23	122	09-Mar-23	29-Aug-23	-41
219	WRP-117a	Pre-Hearing Conference	01-Dec-23	01-Dec-23	1	29-Sep-23	29-Sep-23	-41
220	WRP-117b	SWRCB Issues Hearing Notice	04-Jan-24	04-Jan-24	1	01-Nov-23	01-Nov-23	-41
221	WRP-117c	Case in Chief Testimony Due	07-Mar-24	07-Mar-24	1	08-Jan-24	08-Jan-24	-41
222	WRP-117d	Hearings (Presentation of Cases-in-Chief)	22-Mar-24	18-Apr-24	20	24-Jan-24	21-Feb-24	-41
223	WRP-117e	Rebuttal Testimony Due	03-May-24	03-May-24	1	07-Mar-24	07-Mar-24	-41
224	WRP-117f	Rebuttal Hearing	20-May-24	03-Jun-24	10	22-Mar-24	04-Apr-24	-41
225	WRP-117g	Briefs Due	31-Jul-24	31-Jul-24	1	03-Jun-24	03-Jun-24	-41
226	WRP-120	SWRCB Issue Water Right Permit (original estimate of 28-Dec-23)		26-Sep-24	0		30-Jul-24	-41
227	**SWB CWA Section 401 Water Quality Certification**		04-Jan-21 A	05-May-23	129	04-Jan-21	07-Apr-23	-20
228	401-200	Prepare Draft CWA 401 Permit Application (new date is, Ali?)	04-Jan-21 A	09-Feb-23	68	04-Jan-21	12-Jan-23	-20



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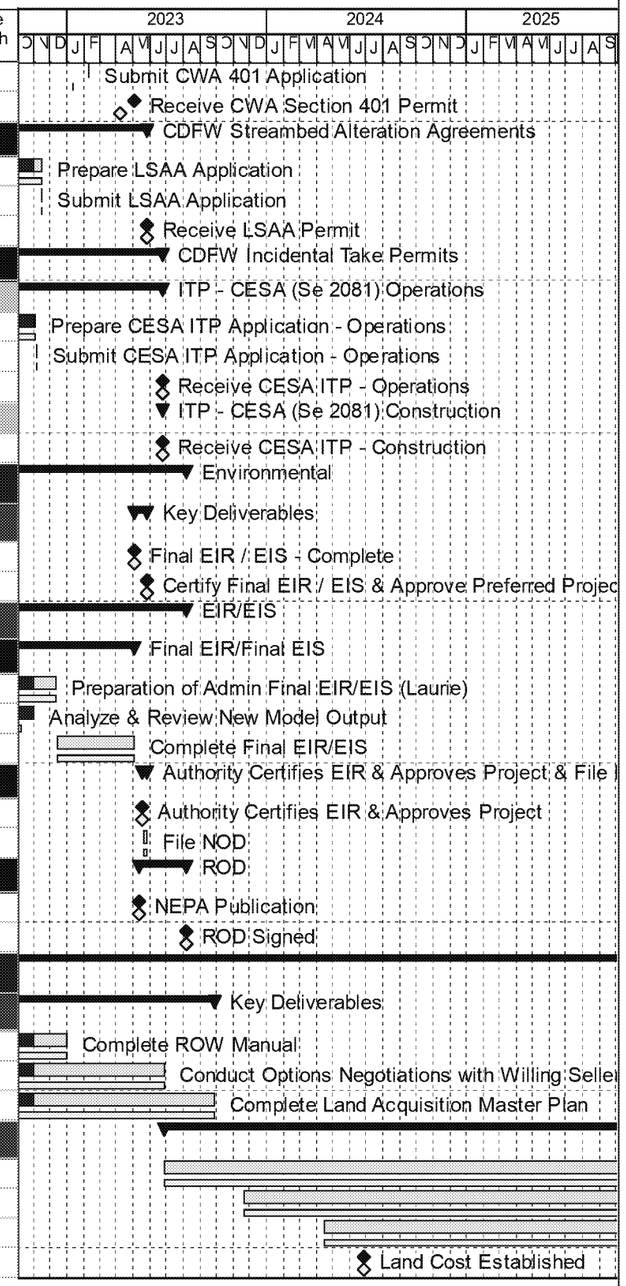
229	401-210	Submit CWA 401 Application	10-Feb-23	10-Feb-23	1	13-Jan-23	13-Jan-23	-20
230	401-220	Receive CWA Section 401 Permit		05-May-23	0		07-Apr-23	-20
231	**CDFW Streambed Alteration Agreements**		10-Jan-22 A	26-May-23	144	10-Jan-22	26-May-23	0
232	1600-200	Prepare LSAA Application	10-Jan-22 A	14-Nov-22	10	10-Jan-22	14-Nov-22	0
233	1600-210	Submit LSAA Application	15-Nov-22	15-Nov-22	1	15-Nov-22	15-Nov-22	0
234	1600-220	Receive LSAA Permit		26-May-23	0		26-May-23	0
235	**CDFW Incidental Take Permits**		11-Jan-21 A	26-Jun-23	164	11-Jan-21	26-Jun-23	0
236	**ITP - CESA (Se 2081) Operations**		11-Jan-21 A	26-Jun-23	164	11-Jan-21	26-Jun-23	0
237	2081-100	Prepare CESA ITP Application - Operations	11-Jan-21 A	04-Nov-22	4	11-Jan-21	04-Nov-22	0
238	2081-110	Submit CESA ITP Application - Operations	07-Nov-22	07-Nov-22	1	07-Nov-22	07-Nov-22	0
239	2081-120	Receive CESA ITP - Operations		26-Jun-23	0		26-Jun-23	0
240	**ITP - CESA (Se 2081) Construction**		26-Jun-23	26-Jun-23	0	26-Jun-23	26-Jun-23	0
241	2081-220	Receive CESA ITP - Construction		26-Jun-23	0		26-Jun-23	0
242	**Environmental**		03-Jan-22 A	07-Aug-23	193	03-Jan-22	07-Aug-23	0
243	**Key Deliverables**		05-May-23	26-May-23	15	05-May-23	26-May-23	0
244	KD-1470	Final EIR / EIS - Complete		05-May-23	0		05-May-23	0
245	KD-1480	Certify Final EIR / EIS & Approve Preferred Project & MMRP		26-May-23	0		26-May-23	0
246	**EIR/EIS**		03-Jan-22 A	07-Aug-23	193	03-Jan-22	07-Aug-23	0
247	**Final EIR/Final EIS**		03-Jan-22 A	05-May-23	129	03-Jan-22	05-May-23	0
248	EIR-210	Preparation of Admin Final EIR/EIS (Laurie)	03-Jan-22 A	12-Dec-22	28	03-Jan-22	12-Dec-22	0
249	EIR-220	Analyze & Review New Model Output	06-Sep-22 A	01-Nov-22	0	06-Sep-22	10-Oct-22	-15
250	EIR-250	Complete Final EIR/EIS	13-Dec-22	05-May-23	101	13-Dec-22	05-May-23	0
251	**Authority Certifies EIR & Approves Project & File NOD**		19-May-23	26-May-23	5	19-May-23	26-May-23	0
252	EIR-370	Authority Certifies EIR & Approves Project		19-May-23	0		19-May-23	0
253	EIR-380	File NOD	22-May-23	26-May-23	5	22-May-23	26-May-23	0
254	**ROD**		12-May-23	07-Aug-23	59	12-May-23	07-Aug-23	0
255	EIR-440	NEPA Publication		12-May-23	0		12-May-23	0
256	EIR-450	ROD Signed		07-Aug-23	0		07-Aug-23	0
257	**Real Estate**		02-Nov-20 A	27-Apr-29	1666	02-Nov-20	27-Apr-29	0
258	**Key Deliverables**		03-Jan-22 A	28-Sep-23	230	03-Jan-22	27-Sep-23	-1
259	KD-1495	Complete ROW Manual	03-Jan-22 A	30-Dec-22	40	03-Jan-22	30-Dec-22	0
260	KD-1500	Conduct Options Negotiations with Willing Seller Properties	01-Jul-22 A	28-Jun-23	166	01-Jul-22	28-Jun-23	0
261	KD-1490	Complete Land Acquisition Master Plan	03-Oct-22 A	28-Sep-23	229	03-Oct-22	27-Sep-23	-1
262	**Land Acquisition**		29-Jun-23	27-Apr-29	1500	29-Jun-23	27-Apr-29	0
263	RE-1060	Construction Package 1 - Land Acquisition	29-Jun-23	27-Apr-29	1500	29-Jun-23	27-Apr-29	0
264	RE-1070	Construction Package 2 - Land Acquisition	20-Nov-23	27-Apr-29	1400	20-Nov-23	27-Apr-29	0
265	RE-1080	Construction Package 3 - Land Acquisition	15-Apr-24	27-Apr-29	1300	15-Apr-24	27-Apr-29	0
266	RE-1050	Land Cost Established		27-Jun-24	0		27-Jun-24	0



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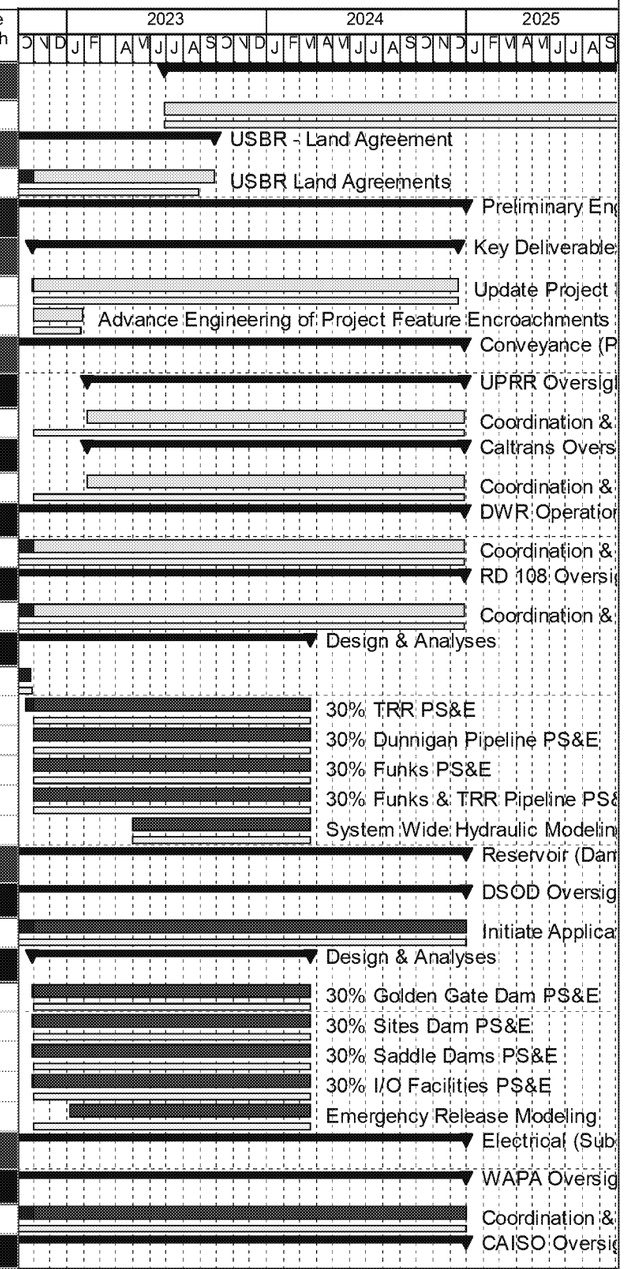
267	**Relocation**		29-Jun-23	27-Apr-29	1500	29-Jun-23	27-Apr-29	0
268	RE-1100	Relocation Assistance, as Needed	29-Jun-23	27-Apr-29	1500	29-Jun-23	27-Apr-29	0
269	**USBR - Land Agreement**		02-Nov-20 A	28-Sep-23	230	02-Nov-20	29-Aug-23	-21
270	FED-100	USBR Land Agreements	02-Nov-20 A	28-Sep-23	230	02-Nov-20	29-Aug-23	-21
271	**Preliminary Engineering**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
272	**Key Deliverables**		31-Oct-22 A	16-Dec-24	537	31-Oct-22	16-Dec-24	0
273	KD-1210	Update Project Risk Assessments (ongoing) (Risk Mgr Bob Beduhn & Henry Luu)	31-Oct-22 A	16-Dec-24	537	31-Oct-22	16-Dec-24	0
274	KD-1110	Advance Engineering of Project Feature Encroachments to 65% Design Level in Support of Per	01-Nov-22	30-Jan-23	60	31-Oct-22	27-Jan-23	-1
275	**Conveyance (Pipelines, Pump Stations, Canals)**		03-Jan-22 A	27-Dec-24	544	03-Jan-22	27-Dec-24	0
276	**UPRR Oversight & Review**		06-Feb-23	27-Dec-24	480	31-Oct-22	27-Dec-24	0
277	A1110	Coordination & Oversight with UPRR	06-Feb-23	27-Dec-24	480	31-Oct-22	27-Dec-24	0
278	**Caltrans Oversight & Review**		06-Feb-23	27-Dec-24	480	31-Oct-22	27-Dec-24	0
279	A1120	Coordination & Oversight with Caltrans	06-Feb-23	27-Dec-24	480	31-Oct-22	27-Dec-24	0
280	**DWR Operations Oversight & Review (KLOG)**		03-Jan-22 A	27-Dec-24	544	03-Jan-22	27-Dec-24	0
281	A1130	Coordination & Oversight with Department of Water Resources	03-Jan-22 A	27-Dec-24	544	03-Jan-22	27-Dec-24	0
282	**RD 108 Oversight & Review**		03-Jan-22 A	27-Dec-24	544	03-Jan-22	27-Dec-24	0
283	A1140	Coordination & Oversight with Reclamation District 108	03-Jan-22 A	27-Dec-24	544	03-Jan-22	27-Dec-24	0
284	**Design & Analyses**		01-Feb-22 A	20-Mar-24	349	01-Feb-22	20-Mar-24	0
285	KD-1140	Create Master Survey & Topo Map	01-Feb-22 A	27-Oct-22 A	0	01-Feb-22	28-Oct-22	2
286	KD-2020	30% TRR PS&E	18-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
287	KD-1630	30% Dunnigan Pipeline PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
288	KD-2010	30% Funks PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
289	KD-2030	30% Funks & TRR Pipeline PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
290	KD-2080	System Wide Hydraulic Modeling	01-May-23	20-Mar-24	225	01-May-23	20-Mar-24	0
291	**Reservoir (Dams, Tunnels)**		01-Feb-22 A	30-Dec-24	545	01-Feb-22	30-Dec-24	0
292	**DSOD Oversight & Review**		01-Feb-22 A	30-Dec-24	545	01-Feb-22	30-Dec-24	0
293	KD-1100	Initiate Application for Permit to Construct from DSOD	01-Feb-22 A	30-Dec-24	545	01-Feb-22	30-Dec-24	0
294	**Design & Analyses**		31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
295	KD-1660	30% Golden Gate Dam PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
296	KD-2040	30% Sites Dam PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
297	KD-2050	30% Saddle Dams PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
298	KD-2060	30% I/O Facilities PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
299	KD-2070	Emergency Release Modeling	05-Jan-23	20-Mar-24	307	31-Oct-22	20-Mar-24	0
300	**Electrical (Substation, Switchyard, Transmission Line)**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
301	**WAPA Oversight & Review**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
302	A1150	Coordination & Oversight with WAPA	03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
303	**CAISO Oversight & Review**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0



Remaining Level of Effort
Actual Level of Effort
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Actual Work
Remaining Work
Critical Remaining Work
Baseline Milestone
Milestone
Summary

Project ID: Sites November 2022 / Project Name: Sites Reservoir Project DD: 01-Nov-2022
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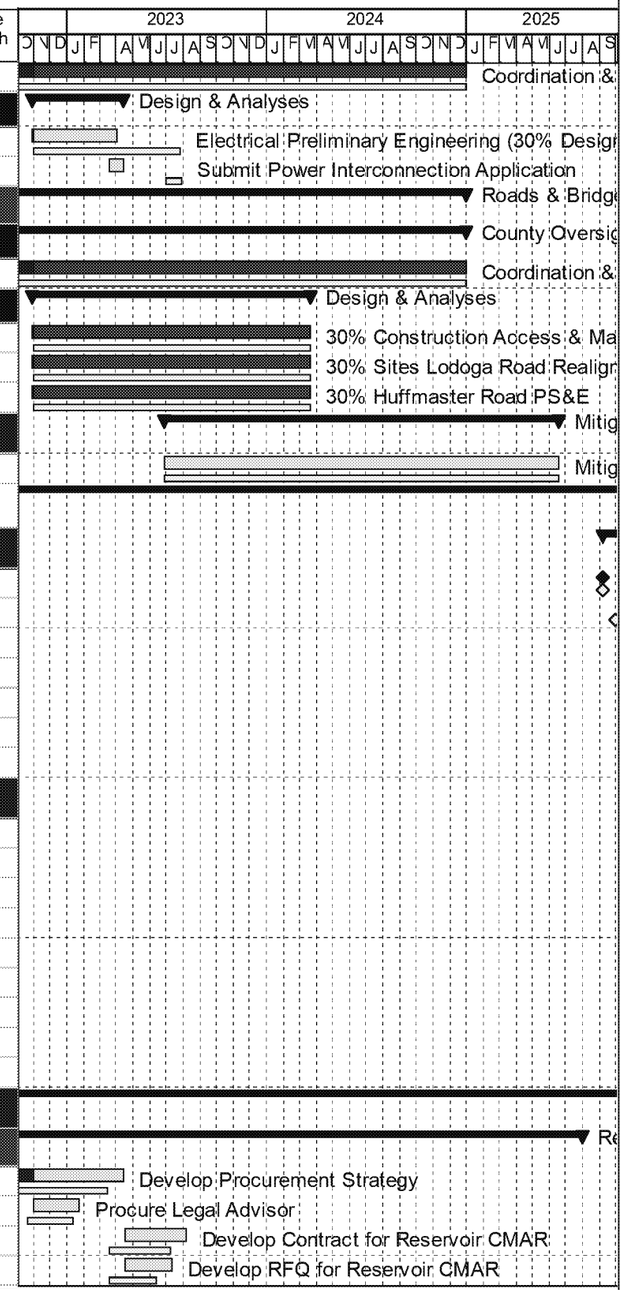
Sites Reservoir Project

Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
304	A1160	Coordination & Oversight with CAISO	03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
305	**Design & Analyses**		31-Oct-22 A	14-Apr-23	114	31-Oct-22	28-Jul-23	73
306	KD-1640	Electrical Preliminary Engineering (30% Design Level)	31-Oct-22 A	03-Apr-23	105	31-Oct-22	25-Jul-23	79
307	KD-1200	Submit Power Interconnection Application	20-Mar-23	14-Apr-23	20	30-Jun-23	28-Jul-23	73
308	**Roads & Bridges**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
309	**County Oversight & Review**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
310	A1170	Coordination & Oversight with County Authorities	03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
311	**Design & Analyses**		31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
312	KD-1650	30% Construction Access & Maintenance Roads PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
313	KD-2090	30% Sites Lodoga Road Realignment PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
314	KD-2100	30% Huffmaster Road PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
315	**Mitigation Implementation**		29-Jun-23	19-Jun-25	500	29-Jun-23	19-Jun-25	0
316	MI-1100	Mitigation Implementation (more information needed to expand detail)	29-Jun-23	19-Jun-25	500	29-Jun-23	19-Jun-25	0
317	**Project Delivery**		03-Jan-22 A	17-Apr-36	3487	03-Jan-22	26-Mar-36	-16
318	**Design Milestones**		05-Sep-25	23-Jan-30	1143	05-Sep-25	23-Jan-30	0
319	MS-6300	Conveyance Design Complete		05-Sep-25	0		05-Sep-25	0
320	MS-6510	Construction Access Roads Design Complete		21-Oct-25	0		29-Sep-25	-16
321	MS-6400	Reservoir / Dams Design Complete		25-Nov-26	0		29-Sep-26	-41
322	MS-6200	Lodoga Bridge & Road Design Complete		29-Jun-27	0		29-Jun-27	0
323	MS-6500	Maxwell-Sites Pumping & Generating Design Complete		25-Feb-28	0		30-Dec-27	-41
324	MS-6100	Dunnigan Pipeline Upstream Design Complete		23-Jan-30	0		23-Jan-30	0
325	MS-6600	Dunnigan Pipeline Downstream Design Complete		23-Jan-30	0		23-Jan-30	0
326	**Construction Milestones**		28-Jun-28	17-Apr-36	2035	06-Jun-28	26-Mar-36	-16
327	MS-8110	Construction Access Roads Complete		28-Jun-28	0		06-Jun-28	-16
328	MS-8510	Huffmaster Road Construction Complete		24-Aug-28	0		24-Aug-28	0
329	MS-8610	O&M Roads Complete		04-Apr-29	0		13-Mar-29	-16
330	MS-8200	Conveyance Construction Complete		25-Sep-29	0		30-Jul-29	-41
331	MS-8100	Lodoga Bridge & Road Construction Complete		03-Sep-30	0		03-Sep-30	0
332	MS-8500	Dunnigan Pipeline Construction Complete		12-May-32	0		12-May-32	0
333	MS-8300	MSPG Construction Complete		21-Jan-33	0		25-Nov-32	-41
334	MS-8400	Reservoir / Dams Construction Complete		20-Apr-33	0		29-Mar-33	-16
335	MS-8600	Reservoir Filled & Operational		17-Apr-36	0		26-Mar-36	-16
336	**Reservoir Package**		03-Jan-22 A	13-Jul-33	2767	03-Jan-22	21-Jun-33	-16
337	**Reservoir CMAR Procurement**		07-Sep-22 A	30-Jul-25	692	07-Sep-22	03-Jun-25	-41
338	RP-1100	Develop Procurement Strategy	07-Sep-22 A	14-Apr-23	112	07-Sep-22	17-Mar-23	-20
339	RP-1210	Procure Legal Advisor	01-Nov-22	24-Jan-23	55	20-Oct-22	11-Jan-23	-8
340	RP-1200	Develop Contract for Reservoir CMAR	17-Apr-23	07-Aug-23	79	20-Mar-23	10-Jul-23	-20
341	RP-1300	Develop RFQ for Reservoir CMAR	17-Apr-23	11-Jul-23	60	20-Mar-23	12-Jun-23	-20



Remaining Level of Effort | Actual Work | Baseline Milestone
Actual Level of Effort | Remaining Work | Milestone
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Sites Reservoir Project

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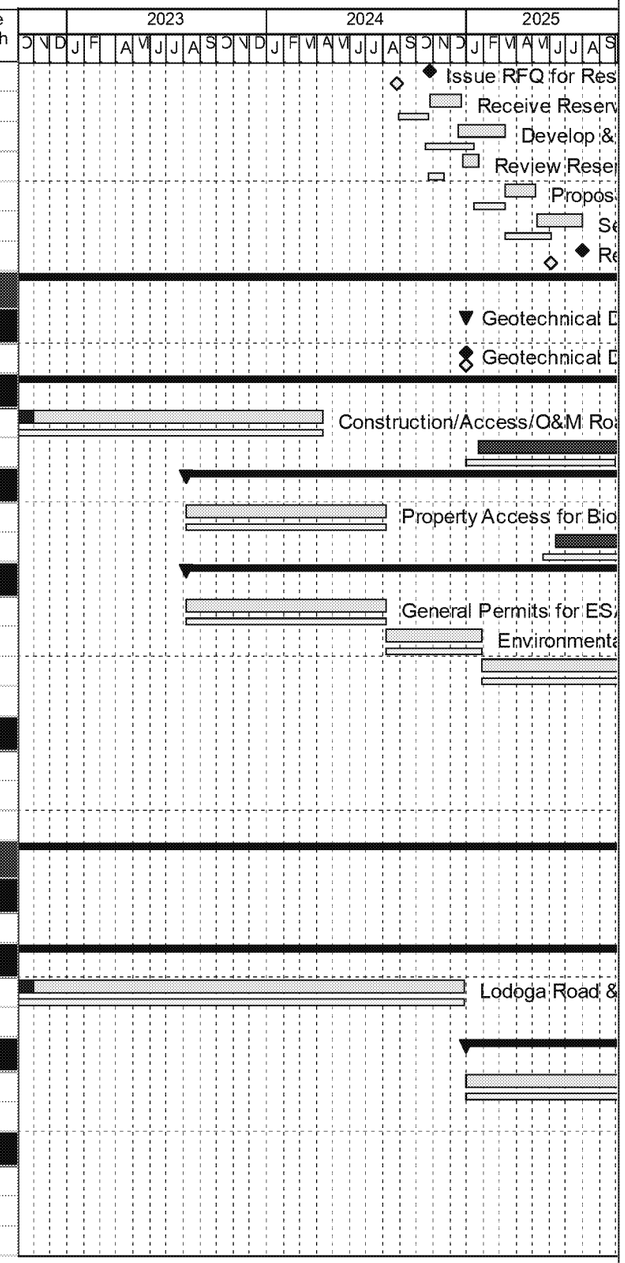
342	RP-1400	Issue RFQ for Reservoir CMAR		24-Oct-24	0		27-Aug-24	-41
343	RP-1500	Receive Reservoir CMAR SOQ's	25-Oct-24	23-Dec-24	40	28-Aug-24	23-Oct-24	-41
344	RP-1700	Develop & Issue RFP to Reservoir CMARs	17-Dec-24	12-Mar-25	60	17-Oct-24	14-Jan-25	-41
345	RP-1600	Review Reservoir CMAR SOQ's & Shortlist	24-Dec-24	22-Jan-25	20	24-Oct-24	20-Nov-24	-41
346	RP-1800	Proposals Prepared & Submitted by Reservoir CMARs	13-Mar-25	07-May-25	40	15-Jan-25	11-Mar-25	-41
347	RP-1900	Select & Execute Reservoir CMAR Contract	08-May-25	30-Jul-25	60	12-Mar-25	03-Jun-25	-41
348	RP-1980	Reservoir CMAR Contract Award		30-Jul-25	0		03-Jun-25	-41
349	**Construction/Access/O&M Roads**		03-Jan-22 A	04-Apr-29	1652	03-Jan-22	13-Mar-29	-16
350	**Geotechnical Data**		31-Dec-24	31-Dec-24	0	31-Dec-24	31-Dec-24	0
351	A1570	Geotechnical Data - Construction/Access/O&M Roads		31-Dec-24	0		31-Dec-24	0
352	**Design**		03-Jan-22 A	21-Oct-25	751	03-Jan-22	29-Sep-25	-16
353	RD-1410	Construction/Access/O&M Roads Preliminary Design	03-Jan-22 A	12-Apr-24	361	03-Jan-22	12-Apr-24	0
354	RD-1420	Construction/Access/O&M Roads Final Design	23-Jan-25	21-Oct-25	194	01-Jan-25	29-Sep-25	-16
355	**Real Estate**		08-Aug-23	26-Nov-25	586	08-Aug-23	04-Nov-25	-16
356	DP-2160	Property Access for Bio/CR Field Surveys - Construction/Access/O&M Roads	08-Aug-23	06-Aug-24	250	08-Aug-23	06-Aug-24	0
357	LP-1110	Property Rights for Construction Access Roads	12-Jun-25	26-Nov-25	120	21-May-25	04-Nov-25	-16
358	**Environmental Permitting & Mitigation**		08-Aug-23	05-May-27	961	08-Aug-23	13-Apr-27	-16
359	A1260	General Permits for ESA; 404/401; Cultural Resources	08-Aug-23	06-Aug-24	250	08-Aug-23	06-Aug-24	0
360	A1410	Environmental Surveys - Construction/Access/O&M Roads	07-Aug-24	28-Jan-25	120	07-Aug-24	28-Jan-25	0
361	A1420	Regulatory Reviews - Construction/Access/O&M Roads	29-Jan-25	04-Nov-25	200	29-Jan-25	04-Nov-25	0
362	A1430	Mitigation - Construction/Access/O&M Roads	27-Nov-25	05-May-27	375	05-Nov-25	13-Apr-27	-16
363	**Construction**		06-May-27	04-Apr-29	500	14-Apr-27	13-Mar-29	-16
364	DC-1310	Construction/Access/O&M Roads Mobilization	06-May-27	02-Jun-27	20	14-Apr-27	11-May-27	-16
365	DC-1320	Construction/Access Roads Construction	03-Jun-27	28-Jun-28	280	12-May-27	06-Jun-28	-16
366	DC-1350	O&M Roads Construction	29-Jun-28	04-Apr-29	200	07-Jun-28	13-Mar-29	-16
367	**Lodoga Road & Bridge**		03-Jan-22 A	03-Sep-30	2021	03-Jan-22	03-Sep-30	0
368	**Geotechnical Data**		31-Dec-25	31-Dec-25	0	31-Dec-25	31-Dec-25	0
369	A1580	Geotechnical Data - Lodoga Road & Bridge		31-Dec-25	0		31-Dec-25	0
370	**Design**		03-Jan-22 A	29-Jun-27	1191	03-Jan-22	29-Jun-27	0
371	RD-1450	Lodoga Road & Bridge Preliminary Design	03-Jan-22 A	27-Dec-24	539	03-Jan-22	27-Dec-24	0
372	RD-1460	Lodoga Road & Bridge Final Design	01-Jan-26	29-Jun-27	389	01-Jan-26	29-Jun-27	0
373	**Real Estate**		30-Dec-24	14-Dec-27	772	30-Dec-24	14-Dec-27	0
374	DP-2170	Property Access for Bio/CR Field Surveys - Lodoga Road & Bridge	30-Dec-24	12-Dec-25	250	30-Dec-24	12-Dec-25	0
375	LP-1120	Property Rights - Lodoga Road & Bridge	30-Jun-27	14-Dec-27	120	30-Jun-27	14-Dec-27	0
376	**Environmental Permitting & Mitigation**		15-Dec-27	13-Aug-30	695	15-Dec-27	13-Aug-30	0
377	A1440	Environmental Surveys - Lodoga Road & Bridge	15-Dec-27	30-May-28	120	15-Dec-27	30-May-28	0
378	A1450	Regulatory Reviews - Lodoga Road & Bridge	31-May-28	06-Mar-29	200	31-May-28	06-Mar-29	0
379	A1460	Mitigation - Lodoga Road & Bridge	07-Mar-29	13-Aug-30	375	07-Mar-29	13-Aug-30	0



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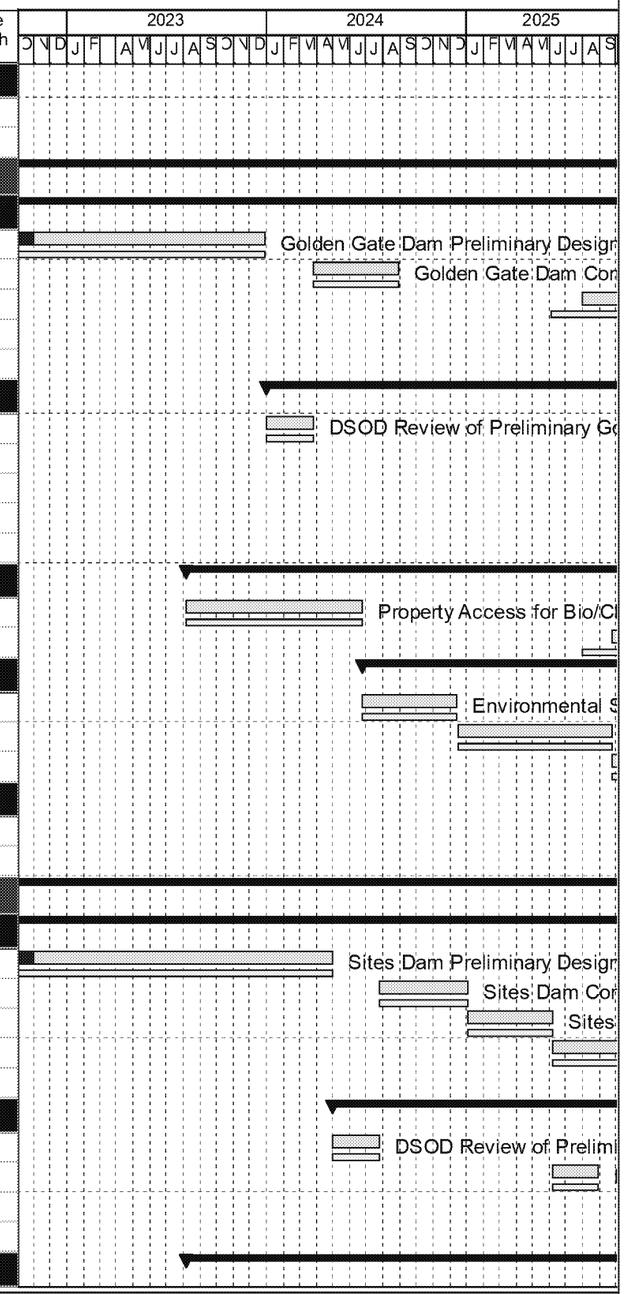
380	**Construction**		15-Dec-27	03-Sep-30	710	15-Dec-27	03-Sep-30	0
381	DC-1330	Lodoga Road & Bridge Construction Mobilization	15-Dec-27	25-Jan-28	30	15-Dec-27	25-Jan-28	0
382	DC-1340	Lodoga Road & Bridge Construction	26-Jan-28	03-Sep-30	680	26-Jan-28	03-Sep-30	0
383	**Golden Gate Dam**		03-Jan-22 A	13-Jul-33	2767	03-Jan-22	21-Jun-33	-16
384	**Design**		03-Jan-22 A	25-Nov-26	1037	03-Jan-22	29-Sep-26	-41
385	RD-1100	Golden Gate Dam Preliminary Design for DSOD Review	03-Jan-22 A	29-Dec-23	289	03-Jan-22	29-Dec-23	0
386	RD-1210	Golden Gate Dam Complete Design to 30%	28-Mar-24	30-Aug-24	110	28-Mar-24	30-Aug-24	0
387	RD-1200	Golden Gate Dam Design to 60%	31-Jul-25	31-Dec-25	110	04-Jun-25	04-Nov-25	-41
388	RD-1300	Golden Gate Dam Design to 90%	01-Jan-26	03-Jun-26	110	05-Nov-25	07-Apr-26	-41
389	RD-1400	Golden Gate Dam Design to 100%	27-Aug-26	25-Nov-26	65	01-Jul-26	29-Sep-26	-41
390	**DSOD Reviews**		02-Jan-24	13-Jul-33	2478	02-Jan-24	21-Jun-33	-16
391	RR-1100	DSOD Review of Preliminary Golden Gate Dam Design	02-Jan-24	27-Mar-24	60	02-Jan-24	27-Mar-24	0
392	RR-1200	DSOD Review of 60% Golden Gate Dam Design	01-Jan-26	25-Mar-26	60	05-Nov-25	27-Jan-26	-41
393	RR-1300	DSOD Review of 90% Golden Gate Design	04-Jun-26	26-Aug-26	60	08-Apr-26	30-Jun-26	-41
394	RR-1400	DSOD Approval of 100% Goldent Gate Design		25-Nov-26	0		29-Sep-26	-41
395	RR-1500	DSOD Approval of Completed Reservoir Construction	21-Apr-33	13-Jul-33	60	30-Mar-33	21-Jun-33	-16
396	**Real Estate**		08-Aug-23	03-Jun-26	721	08-Aug-23	07-Apr-26	-41
397	DP-2180	Property Access for Bio/CR Field Surveys - Golden Gate Dam	08-Aug-23	24-Jun-24	220	08-Aug-23	24-Jun-24	0
398	LP-1130	Property Rights - Golden Gate Dam	25-Sep-25	03-Jun-26	180	30-Jul-25	07-Apr-26	-41
399	**Environmental Permitting & Mitigation**		25-Jun-24	02-Mar-27	695	25-Jun-24	02-Mar-27	0
400	A1470	Environmental Surveys - Golden Gate Dam	25-Jun-24	13-Dec-24	120	25-Jun-24	13-Dec-24	0
401	A1480	Regulatory Reviews - Golden Gate Dam	16-Dec-24	23-Sep-25	200	16-Dec-24	23-Sep-25	0
402	A1490	Mitigation - Golden Gate Dam	24-Sep-25	02-Mar-27	375	24-Sep-25	02-Mar-27	0
403	**Construction**		29-Jun-28	20-Apr-33	1255	07-Jun-28	29-Mar-33	-16
404	DC-1200	Goldent Gate Dam Construction Mobilization	29-Jun-28	20-Sep-28	60	07-Jun-28	29-Aug-28	-16
405	DC-1300	Goldent Gate Dam Construction	21-Sep-28	20-Apr-33	1195	30-Aug-28	29-Mar-33	-16
406	**Sites Dam**		03-Jan-22 A	22-Mar-30	1904	03-Jan-22	22-Mar-30	0
407	**Design**		03-Jan-22 A	30-Apr-26	888	03-Jan-22	30-Apr-26	0
408	RD-1470	Sites Dam Preliminary Design for DSOD Review	03-Jan-22 A	30-Apr-24	373	03-Jan-22	30-Apr-24	0
409	RD-1510	Sites Dam Complete Design to 30%	26-Jul-24	02-Jan-25	110	26-Jul-24	02-Jan-25	0
410	RD-1480	Sites Dam Design to 60%	03-Jan-25	05-Jun-25	110	03-Jan-25	05-Jun-25	0
411	RD-1490	Sites Dam Design to 90%	06-Jun-25	06-Nov-25	110	06-Jun-25	06-Nov-25	0
412	RD-1500	Sites Dam Design to 100%	30-Jan-26	30-Apr-26	65	30-Jan-26	30-Apr-26	0
413	**DSOD Reviews**		01-May-24	30-Apr-26	515	01-May-24	30-Apr-26	0
414	RR-1510	DSOD Review of Preliminary Sites Dam Design	01-May-24	25-Jul-24	60	01-May-24	25-Jul-24	0
415	RR-1520	DSOD Review of 60% Sites Dam Design	06-Jun-25	28-Aug-25	60	06-Jun-25	28-Aug-25	0
416	RR-1530	DSOD Review of 90% Sites Dam Design	07-Nov-25	29-Jan-26	60	07-Nov-25	29-Jan-26	0
417	RR-1540	DSOD Approval of 100% Sites Dam Design		30-Apr-26	0		30-Apr-26	0
418	**Real Estate**		08-Aug-23	06-Nov-25	572	08-Aug-23	06-Nov-25	0



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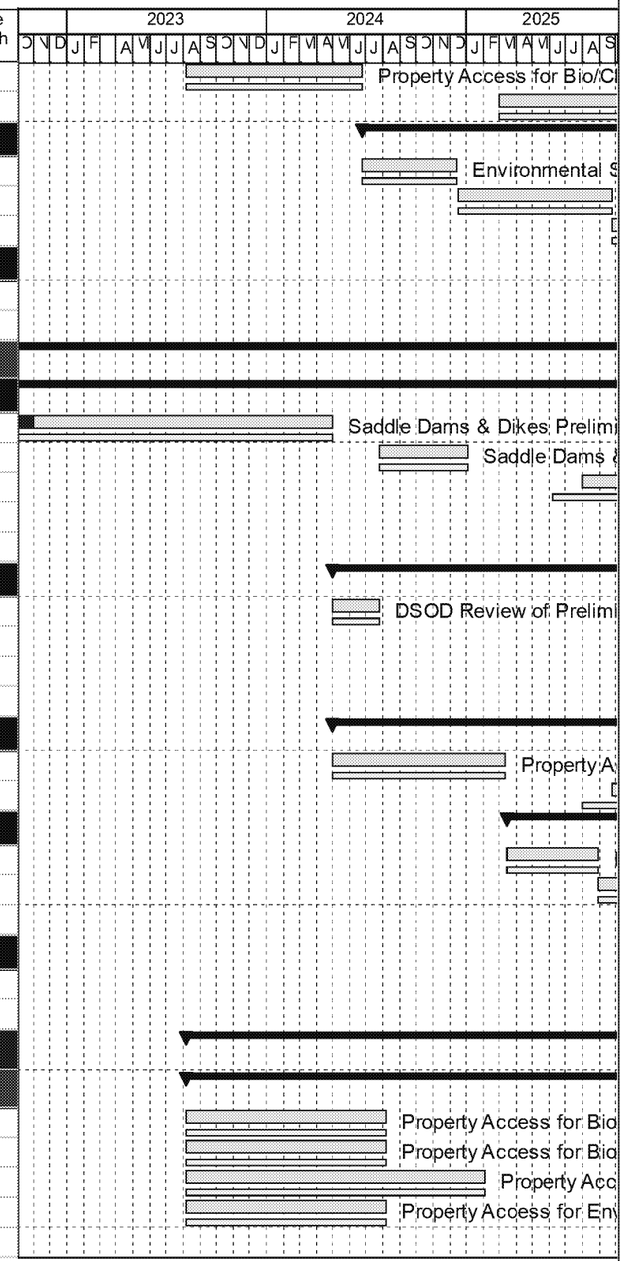
419	DP-2190	Property Access for Bio/CR Field Surveys - Sites Dam	08-Aug-23	24-Jun-24	220	08-Aug-23	24-Jun-24	0
420	LP-1140	Property Rights - Sites Dam	28-Feb-25	06-Nov-25	180	28-Feb-25	06-Nov-25	0
421	**Environmental Permitting & Mitigation**		25-Jun-24	02-Mar-27	695	25-Jun-24	02-Mar-27	0
422	A1500	Environmental Surveys - Sites Dam	25-Jun-24	13-Dec-24	120	25-Jun-24	13-Dec-24	0
423	A1510	Regulatory Reviews - Sites Dam	16-Dec-24	23-Sep-25	200	16-Dec-24	23-Sep-25	0
424	A1520	Mitigation - Sites Dam	24-Sep-25	02-Mar-27	375	24-Sep-25	02-Mar-27	0
425	**Construction**		01-May-26	22-Mar-30	1016	01-May-26	22-Mar-30	0
426	DC-1360	Sites Dam Construction Mobilization	01-May-26	23-Jul-26	60	01-May-26	23-Jul-26	0
427	DC-1370	Sites Dam Construction	24-Jul-26	22-Mar-30	956	24-Jul-26	22-Mar-30	0
428	**Saddle Dams & Dikes**		03-Jan-22 A	02-Jan-30	1847	03-Jan-22	08-Nov-29	-39
429	**Design**		03-Jan-22 A	25-Nov-26	1037	03-Jan-22	01-Oct-26	-39
430	RD-1520	Saddle Dams & Dikes Preliminary Design for DSOD Review	03-Jan-22 A	30-Apr-24	373	03-Jan-22	30-Apr-24	0
431	RD-1560	Saddle Dams & Dikes Complete Design to 30%	26-Jul-24	02-Jan-25	110	26-Jul-24	02-Jan-25	0
432	RD-1530	Saddle Dams & Dikes Design to 60%	31-Jul-25	31-Dec-25	110	06-Jun-25	06-Nov-25	-39
433	RD-1540	Saddle Dams & Dikes Design to 90%	01-Jan-26	03-Jun-26	110	07-Nov-25	09-Apr-26	-39
434	RD-1550	Saddle Dams & Dikes Design to 100%	27-Aug-26	25-Nov-26	65	03-Jul-26	01-Oct-26	-39
435	**DSOD Reviews**		01-May-24	25-Nov-26	664	01-May-24	01-Oct-26	-39
436	RR-1550	DSOD Review of Preliminary Saddle Dams & Dikes Design	01-May-24	25-Jul-24	60	01-May-24	25-Jul-24	0
437	RR-1560	DSOD Review of 60% Saddle Dams & Dikes Design	01-Jan-26	25-Mar-26	60	07-Nov-25	29-Jan-26	-39
438	RR-1570	DSOD Review of 90% Saddle Dams & Dikes Design	04-Jun-26	26-Aug-26	60	10-Apr-26	02-Jul-26	-39
439	RR-1580	DSOD Approval of 100% Saddle Dams & Dikes Design		25-Nov-26	0		01-Oct-26	-39
440	**Real Estate**		01-May-24	03-Jun-26	539	01-May-24	09-Apr-26	-39
441	DP-2200	Property Access for Bio/CR Field Surveys - Saddle Dams & Dikes	01-May-24	13-Mar-25	220	01-May-24	13-Mar-25	0
442	LP-1150	Property Rights - Saddle Dams & Dikes	25-Sep-25	03-Jun-26	180	01-Aug-25	09-Apr-26	-39
443	**Environmental Permitting & Mitigation**		14-Mar-25	11-Nov-27	695	14-Mar-25	11-Nov-27	0
444	A1530	Environmental Surveys - Saddle Dams & Dikes	14-Mar-25	28-Aug-25	120	14-Mar-25	28-Aug-25	0
445	A1540	Regulatory Reviews - Saddle Dams & Dikes	29-Aug-25	04-Jun-26	200	29-Aug-25	04-Jun-26	0
446	A1550	Mitigation - Saddle Dams & Dikes	05-Jun-26	11-Nov-27	375	05-Jun-26	11-Nov-27	0
447	**Construction**		26-Nov-26	02-Jan-30	810	02-Oct-26	08-Nov-29	-39
448	DC-1380	Saddle Dams & Dikes Construction Mobilization	26-Nov-26	17-Feb-27	60	02-Oct-26	24-Dec-26	-39
449	DC-1390	Saddle Dams & Dikes Construction	18-Feb-27	02-Jan-30	750	25-Dec-26	08-Nov-29	-39
450	**Real Estate**		08-Aug-23	25-Jan-30	1673	08-Aug-23	29-Nov-29	-41
451	**Property Access**		08-Aug-23	15-Nov-28	1361	08-Aug-23	15-Nov-28	0
452	DP-2110	Property Access for Bio/CR Field Surveys Reservoir Package	08-Aug-23	06-Aug-24	250	08-Aug-23	06-Aug-24	0
453	DP-2120	Property Access for Bio/CR Field Surveys MSPG Package	08-Aug-23	06-Aug-24	250	08-Aug-23	06-Aug-24	0
454	DP-2130	Property Access for Environmental Surveys Reservoir Clearing & Demo	08-Aug-23	04-Feb-25	375	08-Aug-23	04-Feb-25	0
455	DP-2140	Property Access for Environmental Surveys Dunnigan PL Upstream Segment	08-Aug-23	06-Aug-24	250	08-Aug-23	06-Aug-24	0
456	DP-2150	Property Access for Environmental Surveys Dunnigan PL Downstream Segment	02-Dec-27	15-Nov-28	250	02-Dec-27	15-Nov-28	0



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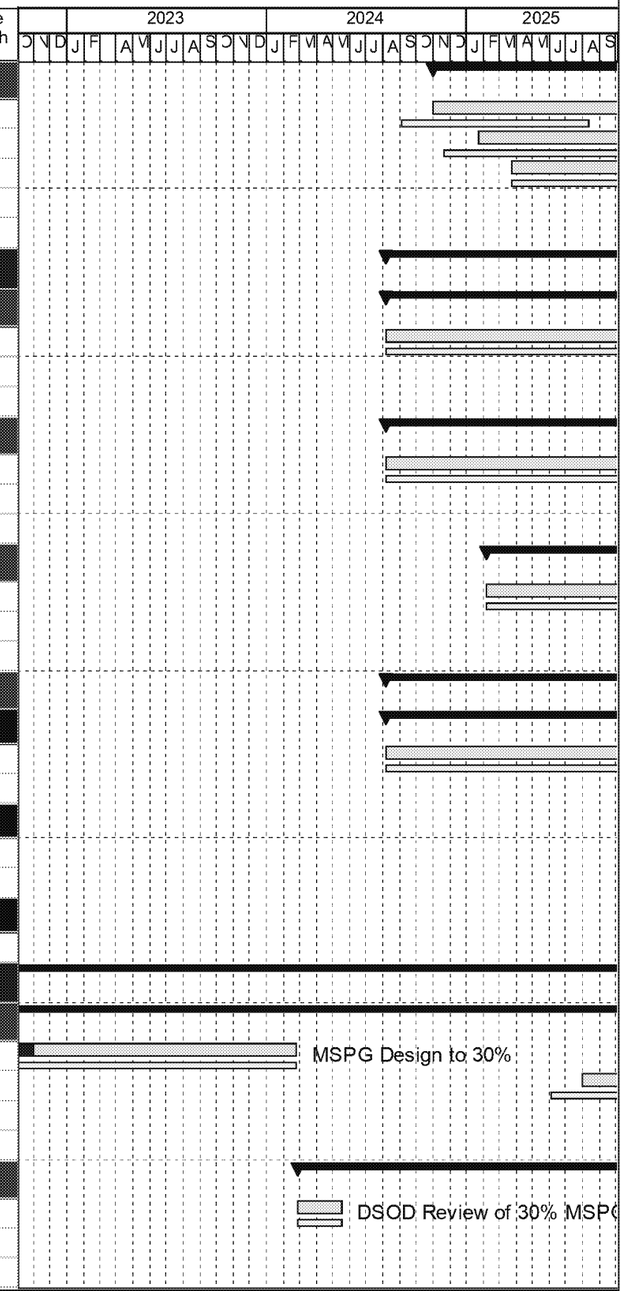
457	**Property Rights**		01-Nov-24	25-Jan-30	1362	05-Sep-24	29-Nov-29	-41
458	DP-2100	Obtain Property Rights for Dunnigan Pipeline Construction	01-Nov-24	08-Oct-25	240	05-Sep-24	12-Aug-25	-41
459	DC-1100	Obtain Property Rights for Reservoir / Dams Construction	23-Jan-25	23-Dec-26	500	21-Nov-24	27-Oct-26	-41
460	LP-1100	Obtain Property Rights for Huffmaster Road Construction	24-Mar-25	11-Feb-27	494	24-Mar-25	11-Feb-27	0
461	RCD-1100	Obtain Property Rights for Reservoir Clearing & Demolition	26-Nov-26	29-Aug-29	720	30-Sep-26	03-Jul-29	-41
462	IP-1100	Obtain Property Rights for MSPG Construction	28-Feb-28	25-Jan-30	500	31-Dec-27	29-Nov-29	-41
463	**Environmental Permitting**		07-Aug-24	23-Jul-31	1811	07-Aug-24	23-Jul-31	0
464	**Environmental Permitting Reservoir Package**		07-Aug-24	26-Sep-28	1075	07-Aug-24	26-Sep-28	0
465	A1270	Environmental Surveys Reservoir Package	07-Aug-24	14-Jul-26	500	07-Aug-24	14-Jul-26	0
466	A1280	Regulatory Reviews Reservoir Package	15-Jul-26	20-Apr-27	200	15-Jul-26	20-Apr-27	0
467	A1290	Mitigation for Reservoir Package	21-Apr-27	26-Sep-28	375	21-Apr-27	26-Sep-28	0
468	**Environmental Permitting Maxwell-Sites Pumping & Generating**		07-Aug-24	04-Apr-28	950	07-Aug-24	04-Apr-28	0
469	A1300	Environmental Surveys MSPG Package	07-Aug-24	14-Jul-26	500	07-Aug-24	14-Jul-26	0
470	A1310	Regulatory Reviews MSPG Package	15-Jul-26	20-Apr-27	200	15-Jul-26	20-Apr-27	0
471	A1320	Mitigation for MSPG Package	21-Apr-27	04-Apr-28	250	21-Apr-27	04-Apr-28	0
472	**Environmental Permitting Reservoir Clearing & Demolition**		05-Feb-25	26-Sep-28	950	05-Feb-25	26-Sep-28	0
473	A1330	Environmental Surveys Reservoir Clearing & Demo	05-Feb-25	05-Jan-27	500	05-Feb-25	05-Jan-27	0
474	A1340	Regulatory Reviews Reservoir Clearing & Demo	06-Jan-27	12-Oct-27	200	06-Jan-27	12-Oct-27	0
475	A1350	Mitigation for Reservoir Clearing & Demo	13-Oct-27	26-Sep-28	250	13-Oct-27	26-Sep-28	0
476	**Environmental Permitting Dunnigan Pipeline**		07-Aug-24	23-Jul-31	1811	07-Aug-24	23-Jul-31	0
477	**Upstream Segment**		07-Aug-24	20-Apr-27	700	07-Aug-24	20-Apr-27	0
478	A1360	Environmental Surveys Dunnigan Pipeline Upstream Segment	07-Aug-24	14-Jul-26	500	07-Aug-24	14-Jul-26	0
479	A1370	Regulatory Reviews Dunnigan Pipeline Upstream Segment	15-Jul-26	20-Apr-27	200	15-Jul-26	20-Apr-27	0
480	**Downstream Segment**		16-Nov-28	07-Aug-30	450	16-Nov-28	07-Aug-30	0
481	A1380	Environmental Surveys Dunnigan Pipeline Downstream Segment	16-Nov-28	31-Oct-29	250	16-Nov-28	31-Oct-29	0
482	A1390	Regulatory Reviews Dunnigan Pipeline Downstream Segment	01-Nov-29	07-Aug-30	200	01-Nov-29	07-Aug-30	0
483	**Both Segments**		08-Aug-30	23-Jul-31	250	08-Aug-30	23-Jul-31	0
484	A1400	Mitigation for Dunnigan Pipeline	08-Aug-30	23-Jul-31	250	08-Aug-30	23-Jul-31	0
485	**Maxwell-Sites Pumping & Generating**		03-Jan-22 A	15-Apr-33	2704	03-Jan-22	17-Feb-33	-41
486	**MSPG Design**		03-Jan-22 A	25-Feb-28	1364	03-Jan-22	30-Dec-27	-41
487	MD-1100	MSPG Design to 30%	03-Jan-22 A	23-Feb-24	326	03-Jan-22	23-Feb-24	0
488	MD-1200	MSPG Design to 60%	31-Jul-25	26-May-26	214	04-Jun-25	30-Mar-26	-41
489	MD-1300	MSPG Design to 90%	27-May-26	26-Mar-27	218	31-Mar-26	28-Jan-27	-41
490	MD-1400	MSPG Design to 100%	29-Mar-27	25-Feb-28	240	29-Jan-27	30-Dec-27	-41
491	**MSPG DSOD Reviews**		26-Feb-24	15-Apr-33	2378	26-Feb-24	17-Feb-33	-41
492	MR-1100	DSOD Review of 30% MSPG Design	26-Feb-24	17-May-24	60	26-Feb-24	17-May-24	0
493	MR-1200	DSOD Review of 60% MSPG Design	27-May-26	18-Aug-26	60	31-Mar-26	22-Jun-26	-41
494	MR-1300	DSOD Review of 90% MSPG Design	29-Mar-27	18-Jun-27	60	29-Jan-27	22-Apr-27	-41



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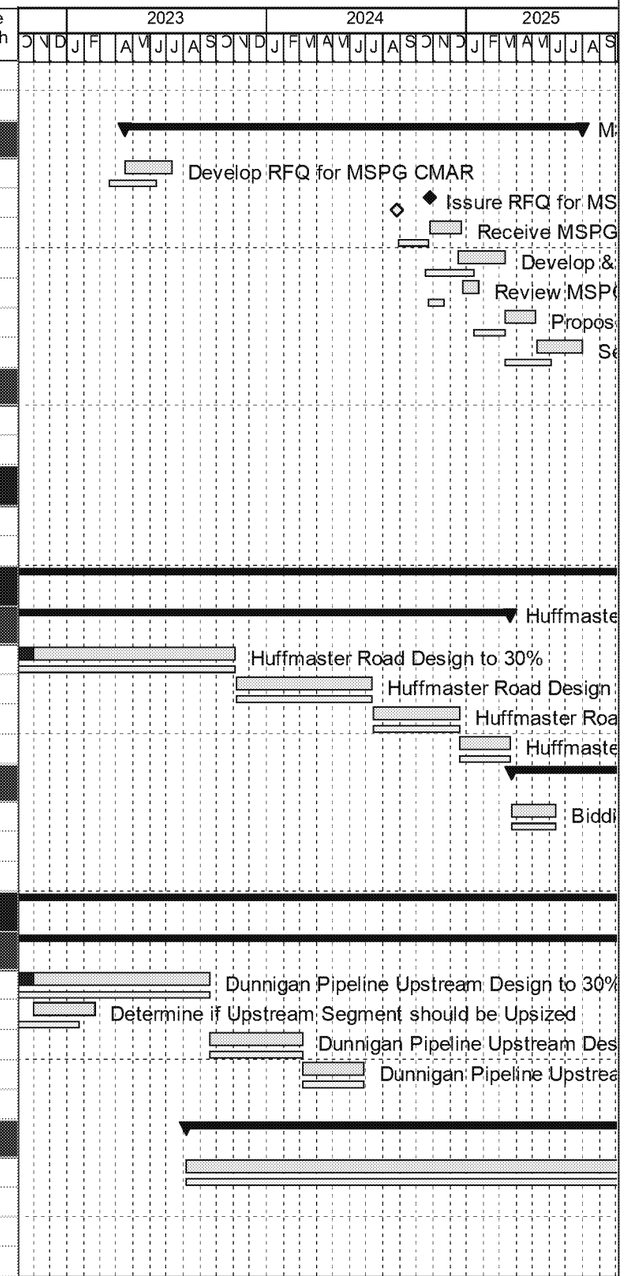
495	MR-1400	DSOD Approval of 100% MSPG Design	28-Feb-28	19-May-28	60	31-Dec-27	23-Mar-28	-41
496	MR-1410	DSOD Approval of Completed MSPG Construction	24-Jan-33	15-Apr-33	60	26-Nov-32	17-Feb-33	-41
497	**MSPG CMAR Procurement**		17-Apr-23	30-Jul-25	580	20-Mar-23	03-Jun-25	-41
498	RP-1910	Develop RFQ for MSPG CMAR	17-Apr-23	11-Jul-23	60	20-Mar-23	12-Jun-23	-20
499	RP-1920	Issure RFQ for MSPG CMAR		24-Oct-24	0		27-Aug-24	-41
500	RP-1930	Receive MSPG CMAR SOQ's	25-Oct-24	23-Dec-24	40	28-Aug-24	23-Oct-24	-41
501	RP-1950	Develop & Issue RFP to MSPG CMARs	17-Dec-24	12-Mar-25	60	17-Oct-24	14-Jan-25	-41
502	RP-1940	Review MSPG CMAR SOQ's & Shortlist	24-Dec-24	22-Jan-25	20	24-Oct-24	20-Nov-24	-41
503	RP-1960	Proposals Prepared & Submitted by MSPG CMARs	13-Mar-25	07-May-25	40	15-Jan-25	11-Mar-25	-41
504	RP-1970	Select & Execute MSPG CMAR Contract	08-May-25	30-Jul-25	60	12-Mar-25	03-Jun-25	-41
505	**MSPG Construction**		28-Jan-30	21-Jan-33	780	30-Nov-29	25-Nov-32	-41
506	IC-1200	MSPG Mobilization	28-Jan-30	19-Apr-30	60	30-Nov-29	21-Feb-30	-41
507	IC-1300	MSPG Construction	22-Apr-30	21-Jan-33	720	22-Feb-30	25-Nov-32	-41
508	**Reservoir Clearing & Demolition**		30-Aug-29	17-Dec-31	600	04-Jul-29	21-Oct-31	-41
509	RCD-1200	Reservoir Clearing & Demo	30-Aug-29	02-Jul-31	480	04-Jul-29	06-May-31	-41
510	RCD-1300	Cemetery Relocation	30-Aug-29	17-Dec-31	600	04-Jul-29	21-Oct-31	-41
511	**Huffmaster Road**		03-Jan-22 A	24-Aug-28	1493	03-Jan-22	24-Aug-28	0
512	**Huffmaster Road Design**		03-Jan-22 A	21-Mar-25	599	03-Jan-22	21-Mar-25	0
513	HRD-1100	Huffmaster Road Design to 30%	03-Jan-22 A	03-Nov-23	253	03-Jan-22	03-Nov-23	0
514	HRD-1200	Huffmaster Road Design to 60%	06-Nov-23	12-Jul-24	171	06-Nov-23	12-Jul-24	0
515	HRD-1300	Huffmaster Road Design to 90%	15-Jul-24	18-Dec-24	110	15-Jul-24	18-Dec-24	0
516	HRD-1400	Huffmaster Road Design to 100%	19-Dec-24	21-Mar-25	65	19-Dec-24	21-Mar-25	0
517	**Huffmaster Road Construction**		24-Mar-25	24-Aug-28	894	24-Mar-25	24-Aug-28	0
518	HRC-1100	Bidding & Contract Execution for Huffmaster Road	24-Mar-25	13-Jun-25	60	24-Mar-25	13-Jun-25	0
519	HRC-1200	Huffmaster Road Mobilization	12-Feb-27	08-Apr-27	40	12-Feb-27	08-Apr-27	0
520	HRC-1300	Huffmaster Road Construction	09-Apr-27	24-Aug-28	360	09-Apr-27	24-Aug-28	0
521	**Dunnigan Pipeline**		03-Jan-22 A	12-May-32	2462	03-Jan-22	12-May-32	0
522	**Dunnigan Pipeline Upstream Design**		03-Jan-22 A	23-Jan-30	1862	03-Jan-22	23-Jan-30	0
523	DPU-1100	Dunnigan Pipeline Upstream Design to 30%	03-Jan-22 A	19-Sep-23	221	03-Jan-22	19-Sep-23	0
524	DPU-1200	Determine if Upstream Segment should be Upsized	01-Nov-22	22-Feb-23	75	03-Oct-22	24-Jan-23	-20
525	DPU-1300	Dunnigan Pipeline Upstream Design to 60%	20-Sep-23	05-Mar-24	112	20-Sep-23	05-Mar-24	0
526	DPU-1400	Dunnigan Pipeline Upstream Design to 90%	06-Mar-24	26-Jun-24	80	06-Mar-24	26-Jun-24	0
527	DPU-1500	Dunnigan Pipeline Upstream Design to 100%	01-Nov-29	23-Jan-30	60	01-Nov-29	23-Jan-30	0
528	**Dunnigan Pipeline Downstream Design**		08-Aug-23	23-Jan-30	1671	08-Aug-23	23-Jan-30	0
529	DPD-1100	Determine Discharge Location for Downstream Segment (Colusa Basin Drain or Sac River)	08-Aug-23	01-Dec-27	1111	08-Aug-23	01-Dec-27	0
530	DPD-1200	Dunnigan Pipeline Downstream Design to 30%	02-Dec-27	24-Jan-29	300	02-Dec-27	24-Jan-29	0
531	DPD-1300	Dunnigan Pipeline Downstream Design to 60%	25-Jan-29	11-Jul-29	120	25-Jan-29	11-Jul-29	0
532	DPD-1400	Dunnigan Pipeline Downstream Design to 90%	12-Jul-29	31-Oct-29	80	12-Jul-29	31-Oct-29	0



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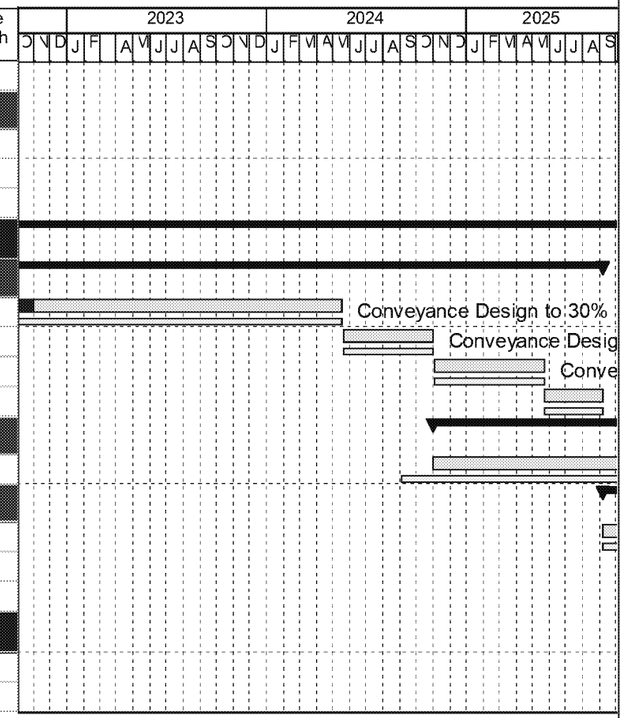
533	DPD-1500	Dunnigan Pipeline Downstream Design to 100%	01-Nov-29	23-Jan-30	60	01-Nov-29	23-Jan-30	0
534	**Dunnigan Pipeline Construction**		24-Jan-30	12-May-32	600	24-Jan-30	12-May-32	0
535	DPC-5100	Bidding & Contract Execution for Dunnigan Pipeline	24-Jan-30	15-May-30	80	24-Jan-30	15-May-30	0
536	DPC-5200	Dunnigan Pipeline Mobilization	16-May-30	10-Jul-30	40	16-May-30	10-Jul-30	0
537	DPC-5300	Dunnigan Pipeline Construction	11-Jul-30	12-May-32	480	11-Jul-30	12-May-32	0
538	**Tehama Colusa Canal Authority**		03-Jan-22 A	25-Sep-29	1776	03-Jan-22	30-Jul-29	-41
539	**Conveyance Design**		03-Jan-22 A	05-Sep-25	719	03-Jan-22	05-Sep-25	0
540	CD-1100	Conveyance Design to 30%	03-Jan-22 A	17-May-24	386	03-Jan-22	17-May-24	0
541	CD-1200	Conveyance Design to 60%	20-May-24	01-Nov-24	117	20-May-24	01-Nov-24	0
542	CD-1300	Conveyance Design to 90%	04-Nov-24	22-May-25	140	04-Nov-24	22-May-25	0
543	CD-1400	Conveyance Design to 100%	23-May-25	05-Sep-25	76	23-May-25	05-Sep-25	0
544	**Conveyance Property Rights**		01-Nov-24	29-Sep-26	494	05-Sep-24	03-Aug-26	-41
545	CP-1100	Obtain Property Rights for Conveyance Construction	01-Nov-24	29-Sep-26	494	05-Sep-24	03-Aug-26	-41
546	**Conveyance Construction**		08-Sep-25	25-Sep-29	1057	08-Sep-25	30-Jul-29	-41
547	CC-1100	Bidding & Contract Execution for Conveyance Package	08-Sep-25	26-Dec-25	80	08-Sep-25	26-Dec-25	0
548	CC-1200	Conveyance Mobilization	30-Sep-26	22-Dec-26	60	04-Aug-26	26-Oct-26	-41
549	CC-1300	Conveyance Construction	23-Dec-26	25-Sep-29	720	27-Oct-26	30-Jul-29	-41
550	**Reservoir Filling & Commissioning**		14-Jul-33	17-Apr-36	720	22-Jun-33	26-Mar-36	-16
551	RF-1100	Reservoir Filling & Commissioning	14-Jul-33	16-Apr-36	720	22-Jun-33	25-Mar-36	-16
552	RF-5100	Initiate Reservoir Operations	17-Apr-36		0	26-Mar-36		-16



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From: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Sent: 11/3/2022 3:00:27 PM
To: Spranza, John [john.spranza@hdrinc.com]; Arsenijevic, Jelica [jelica.arsenijevic@hdrinc.com]; Edwards, Dawn [Dawn.Edwards@hdrinc.com]; Risse, Danielle [danielle.risse@hdrinc.com]
CC: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: RE: Permit Amendment Slide

Thanks for doing this John. Quick comment – CEQA and NEPA are not permits so not sure those processes fit within your flowchart. I think we need a separate graphic or a separate section of this graphic that covers how the Authority (and Reclamation) will review project changes and determine whether the changes fall within the scope of the analysis of the Final EIR/EIS and the appropriate documentation needed.

From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Thursday, November 3, 2022 2:27 PM
To: Arsenijevic, Jelica <jelica.arsenijevic@hdrinc.com>; Edwards, Dawn <Dawn.Edwards@hdrinc.com>; Risse, Danielle <danielle.risse@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Cc: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: RE: Permit Amendment Slide

Slight update, please use this one.

John Spranza

D 916.679.8858 M 818.640.2487

From: Spranza, John
Sent: Thursday, November 3, 2022 2:21 PM
To: Arsenijevic, Jelica <jelica.arsenijevic@hdrinc.com>; Edwards, Dawn <Dawn.Edwards@hdrinc.com>; Risse, Danielle <danielle.risse@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Cc: aforsythe (aforsythe@sitesproject.org) <aforsythe@sitesproject.org>
Subject: Permit Amendment Slide

HI,
I wanted to circulate this around for your review and edit. The goal is to show this to the design and engineering team so they understand any change in the project description needs to be reviewed (e.g., random road movement) and could result in additional permitting steps/time. It's not meant to be perfect or all encompassing, but a general example.

Thanks,
John

John Spranza, MS, CCN
Senior Ecologist / Regulatory Specialist

HDR
2379 Gateway Oaks Drive, Suite 200
Sacramento, CA 95833
D 916.679.8858 M 818.640.2487
john.spranza@hdrinc.com

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hdrinc.com/follow-us

From: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Sent: 11/3/2022 3:58:08 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]; Kevin Spesert [kspesert@sitesproject.org]
CC: Janis Offermann (Janis@Horizonh2o.com) [janis@horizonh2o.com]
Subject: Yocha Dehe Meeting Notes
Attachments: 2022_1031_Yocha Dehe_meeting minutes.docx

Hi Ali and Kevin,

Janis prepared these notes from our meeting with the Yocha Dehe on Monday. Please review and let us know if there are any changes needed. I will file on SharePoint once these are finalized.

Thanks,

Laurie

Laurie Warner Herson
Principal/Owner

Phenix
Environmental Planning

916.201.3935
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State of California Small Business (#1796182)
Supplier Clearinghouse Women Business Enterprise (#16000323)

http://phenixenv.com/

AB 52 Sites Reservoir Project Update Meeting Minutes

Sites Reservoir Project

Meeting Information:			
Date:	October 31, 2022	**Location:**	Virtual
Start Time:	11:00 p.m.	**Finish Time:**	12:05 p.m.
Notes By:	Janis Offermann	**Reviewed By:**	Laurie Warner Herson
Purpose:	Meeting with Yocha Dehe for Sites Reservoir		

Meeting Participants (indicate absent invitees):

Laverne Bill, Yocha Dehe	Kevin Spesert, Sites Authority	Name
Yvonne Perkins, THPO, Yocha Dehe	Laurie Warner Herson, Integration	Name
Diamond Lomeli, Yocha Dehe	Janis Offermann, Horizon	Name
Paula Lorenzo Tackett, Yocha Dehe		
Alicia Forsythe, Sites Authority		

Key Takeaways/Decisions/Action Items:

Takeaways: Yocha Dehe will continue to consider the proposed use of an MOA to solidify a partnership with the Authority.

Decisions: The Authority will send updated outreach letters to the other tribes affiliated with the project. Yocha Dehe will prepare and submit commits on the REIR/S.

Action Items:

Action Item	Owner	Deadline	Notes
Complete review of the REIR/S and provide comments	**Yocha Dehe**	**Mid-January 2023, at the latest**	
Consider MOA elements and discuss with tribal leaders	**Laverne, Cultural Resources Committee**	**Before next meeting on December 9, 2022**	
Send updated outreach letters to Cachil Dehe, Kletsel Dehe, Grindstone, and Paskenta	**Janis to draft/Authority**	**ASAP**	

Agenda:

1. Introductions
2. Current Status of the Final EIR/EIS
3. MOA
4. Tribal Working Group
5. Geotechnical Work

6. Action Items/Follow Up

Meeting Minutes (issues discussed and decisions made):

Laverne invited three members of Yocha Dehe's (YD) Cultural Resources Committee to the meeting today, so introductions were made all around.

Ali then provided a brief overview of the status of the Final Environmental Impact Report/Statement (FEIR/S), which is now anticipated to be completed in late April 2023 and approved by the Sites Project Authority board in May 2023. Laverne asked if the tribe could still comment on the draft document, as it was still under review by the tribal attorneys and council members. Ali responded that it would be preferable to get comments by the end of November, but that comments could probably still be accepted as late as mid-January 2023 in order to be addressed in the FEIR/S.

Talk then turned to the possibility of a Memorandum of Agreement (MOA). Ali described the purpose of the MOA, noting that it would solidify the Authority's commitment to work with YD during project construction and operations, and Janis briefly discussed some of the potential components, emphasizing that draft outline provided to the tribe was very preliminary and it was expected that YD would have a lot to bring to the table for inclusion in the document. The following lists concerns or comments from YD:

- Laverne noted that Grindstone and Paskenta need to be brought into the discussion due to their ancestral lands in the northern part of the reservoir.
- Laverne wondered how the MOA would address the unknown. For example, what if there are a lot more burials to be moved than anticipated? The MOA would have to make sure those kinds of issues were covered. Ali responded that the Authority is very flexible on addressing this issue.
- Laverne wondered what co-management with the Authority would look like.
- Laverne reported that he didn't know if the Tribe was for or against the project, but appreciated the Authority's acknowledgement that they want to collaborate with the Tribe notwithstanding their official stand about the project.

Ali and Kevin discussed formation of a Tribal Working Group, which would include the five tribes with a direct ancestral affiliation with the project area, along with some Sites Reservoir Project board members. It would be up to the group to determine the topics to be discussed and the meeting schedule. The Group would identify and work through challenges created by the project, but would also seek opportunities to the benefit of the tribes, as well as the Authority. Laverne briefly referred to a concern about including discussion of cultural sensitive information in the group format.

Discussion briefly turned to the ongoing and upcoming geotechnical work. Ali acknowledged the comments YD provided on the Post Review Discovery Plan and noted that the comments would be incorporated into other project cultural resources documents, as well. Also, the Authority is getting ready to start the trenching portion of the geotechnical studies, which would likely begin in January 2023. The Authority is working on revising the existing contract with the tribe to accommodate monitoring for this next phase.

Lastly, Laverne suggested that the Authority reach out to the Cachil Dehe, Kletsel Dehe (Cortina), Grindstone, and Paskenta again to bring them up to date about the project, including the MOA and Tribal Working Group, as the tribes are getting back up to speed again after the COVID pandemic. He noted that Cachil Dehe and Kletsel Dehe are under reorganization.

The next meeting is scheduled for December 9, 2022, at 1:00pm.

From: Kim Floyd [kim@floydcommunications.com]
Sent: 11/4/2022 9:54:32 AM
To: Denise Sagara [denise@yolofarmbureau.org]; info@colusachamber.org; jgarofalo@colusasheriff.com; kanawhachief80@gmail.com; keli.teuscher@yolocounty.org; lisa@glennfarmbureau.com; Anastacia Allen [mallen@countyofcolusa.com]; maxwellfire@frontiernet.net; maxwellinnbg@gmail.com; Marcie Skelton [mskelton@countyofglenn.net]; Nadine Bailey [nadine@familywateralliance.com]; ppw@yolocounty.org; Stephanie Cormier [stephanie.cormier@yolocounty.org]; summershadley@maxwell.k12.ca.us; thewillowschamber@gmail.com; tom.arnold@countyofglenn.net; Wendy Tyler [wtyler@countyofcolusa.com]; wtyler@countyofcolusa.org; yolocountysheriffs@yolocounty.org; Juleah Cordi [juleah.cordi@ca.nacdnet.net]; cldudley41@gmail.com; alice.bennett@asm.ca.gov; breyden.coma@sen.ca.gov; rita.durgan@asm.ca.gov; brenda.haynes@mail.house.gov; Mo Sankey [monica@colusafarmbureau.com]
CC: Kevin Spesert [kspesert@sitesproject.org]
Subject: Fwd: Sites Community Working Group Follow Up - Nov. 12 Tour Reminder
Attachments: Sites_Community Work Group_06Oct2022_FINAL.pdf

All:

Thanks to all who have RSVP'd for the Sites Reservoir Project tour, which is scheduled for 9 a.m. on Saturday, November 12 (starting at the Sites Project Authority office, 122 Old Hwy 99W, Maxwell)! If you'd like to attend, but haven't RSVP'd yet, please reply to this email by noon on Monday, November 7. Tour transportation will be provided. We're planning for three stops, including the Sites Valley, and expect to return to the Sites Project Authority office by 11:30 a.m.

Please let me know if you have any questions, and have a great weekend!

Thanks,

Kim

Kim Floyd
Sac Valley Outreach Manager
Sites Project Authority
(916) 838-2666 (c)
kim@floydcommunications.com

---------- Forwarded message ---------
From: **Kim Floyd** <kim@floydcommunications.com>
Date: Mon, Oct 10, 2022 at 11:49 AM
Subject: Sites Community Working Group Follow Up - Nov. 12 Tour Reminder
To: Denise Sagara <denise@yolofarmbureau.org>, <info@colusachamber.org>, <jgarofalo@colusasheriff.com>, <kanawhachief80@gmail.com>, <keli.teuscher@yolocounty.org>, <lisa@glennfarmbureau.com>, Anastacia Allen <mallen@countyofcolusa.com>, <maxwellfire@frontiernet.net>, <maxwellinnbg@gmail.com>, <mskelton@countyofglenn.net>, <nadine@familywateralliance.com>, <ppw@yolocounty.org>, <stephanie.cormier@yolocounty.org>, <summershadley@maxwell.k12.ca.us>, <thewillowschamber@gmail.com>, <tom.arnold@countyofglenn.net>, Wendy Tyler <wtyler@countyofcolusa.com>, <wtyler@countyofcolusa.org>, <yolocountysheriffs@yolocounty.org>
Cc: Kevin Spesert <kspesert@sitesproject.org>

All:

Thanks to all who participated in last week's kickoff meeting for the Sites Project Authority's Community Working Group. I've attached a copy of the meeting presentation for your files/information. If you missed the first meeting, we hope to see you at our next meeting in January (date and time below)!

The Project Site Tour is scheduled for 9 a.m. to noon on Saturday, November 12 (starting at the Sites Project Authority office, 122 Old Hwy 99W, Maxwell). Please RSVP to me no later than Friday, November 4, if you plan to attend. Transportation will be provided.

As per the working group's agreement, our next meeting will be scheduled from 2-4 p.m., Thursday, January 19, and our first topics for discussion will be traffic, public safety and related community impacts. I'll follow up with an appointment notice for that session. Please feel free to reach out to me in the meantime if you have any questions.

Thank you again, and have a great week!

Kim

Kim Floyd
Sac Valley Outreach Manager
Sites Project Authority
(916) 838-2666 (c)
kim@floydcommunications.com

Sites Reservoir Project Overview

Community Work Group

October 6, 2022

Sites

Meeting Overview

- Welcome & Introductions
- Community Working Group Overview
- Sites Reservoir Project Update
- Identification of Community Issues/Concerns/Opportunities
- Future Meetings
- Other Discussion/Public Comment
- Adjourn

Working Group Introductions

- Members & Sites Representatives
- Review of meeting materials
  - Binder organization
    - Working Group information
    - Sites Reservoir Project information
    - Project FAQs
    - Project Progress Report
    - Meeting agendas & materials

Working Group: Purpose & Scope

- Identify and prioritize issues for discussion
- Discuss/recommend solutions to issues of local concern
- Inform project planning/development
- Focus on areas that can be influenced
- Involve local government, public safety, business, civic groups
- Meet bi-monthly in 2023, proposed tour in November 2022

Questions

Sites Project History

- **1957** - DWR Bulletin 3 identifies Sites Reservoir as a proposed project in the 1957 California Water Plan
- **1997** – Project is evaluated as part of the CALFED water management framework for ecosystem restoration
- **2010** – Sites Joint Powers Authority is formed to serve as the lead local agency to advance the project
- **2014** – California passes Proposition 1 that provides $2.7 billion for water storage projects, dams and reservoirs.

Sites Project History

- **2016** – Sites Project Reservoir Committee formed, and Draft EIR/EIS released
- **2018** – Project is awarded $816 million from Proposition 1 and a $449 million construction loan from USDA
- **2019** – The Sites Project goes through an extensive value planning process to make the project more affordable, permittable, and buildable
- **2021** –California Water Commission certifies that the project is technically feasible, and the Authority releases a revised Draft EIR/EIS
- **2022** – The Sites Project is invited to apply for a $2.2 billion federal loan from the WIFIA program and submits its Water Rights Application

Sites Project Authority

- Joint Powers Authority established under California law
- Authority member agencies located in the Sacramento Valley
- Reservoir Committee made up statewide agencies investing in the Sites Project
- The Sites Project Authority will own and operate Sites Reservoir

Board of Directors:
Colusa County
Colusa County Water District
Glenn County
Glenn-Colusa Irrigation District
Placer County Water Agency/City of Roseville
Reclamation District 108
Sacramento/Sac County Water Agency
Tehama-Colusa Canal Authority
Westside Water District

Our Strength is in Our Broad Statewide Participation

Sacramento Valley

City of American Canyon

Colusa County

Colusa County Water Agency

Cortina Water District

Davis Water District

Dunnigan Water District

Glenn County

Glenn-Colusa Irrigation District

LaGrande Water District

Placer County Water Agency

Reclamation District 108

City of Roseville

Sacramento County Water Agency

City of Sacramento

Tehama-Colusa Canal Authority

Westside Water District

Western Canal Water District

Bay Area

Santa Clara Valley Water District

Zone 7 Water Agency

San Joaquin Valley

Wheeler Ridge-Maricopa Water Storage District

Rosedale-Rio Bravo Water Storage District

Southern California

Antelope Valley – East Kern Water Agency

Coachella Valley Water District

Desert Water Agency

Irvine Ranch Water District

Metropolitan Water District

San Bernardino Valley Municipal Water District

San Gorgonio Pass Water Agency

Santa Clarita Valley Water Agency

Waiting List

Cal-Am Sacramento
City of Napa
Delta View WUA
Glenn County
La Cumbre MWC
Madera County
Pacific Resources MWC
Santa Clara Valley WD
Westlands WD
Wheeler Ridge Maricopa WSD
Woodland Davis CWA

Sites

Sites Reservoir

- Off-stream reservoir
- Utilizing existing infrastructure to divert water from the Sacramento River in higher flow conditions
- Store water in the new Sites Reservoir for later use by farms, cities, and the environment
- Funded by State and Federal governments and local public water agencies
- A key tool to help the state restore flexibility, reliability, and resilience to our statewide water supply

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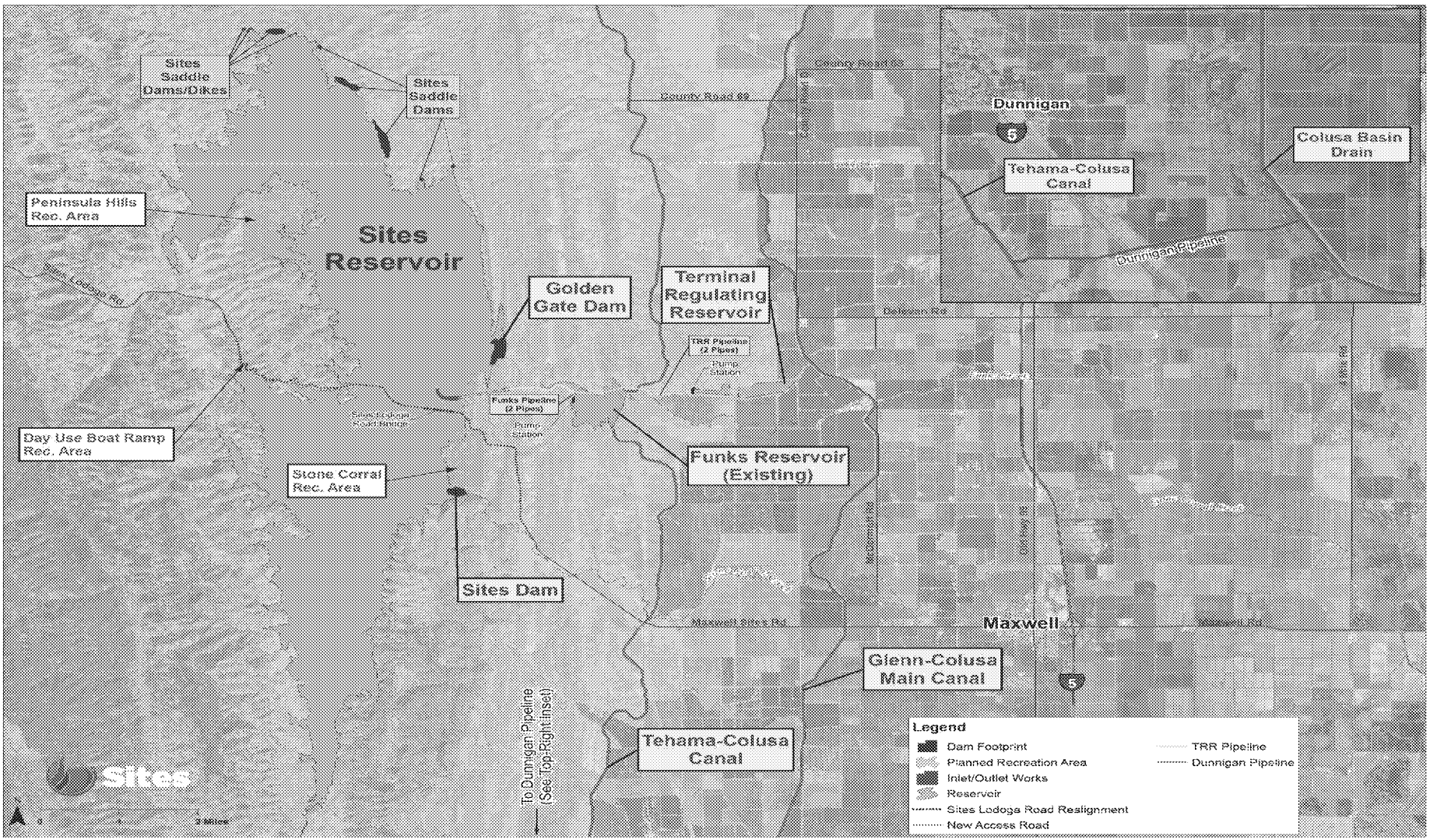
Affordable, Permittable, Buildable

Sites underwent a rigorous value planning effort that resulted in a "right-sized" project. The Sites Reservoir of today:

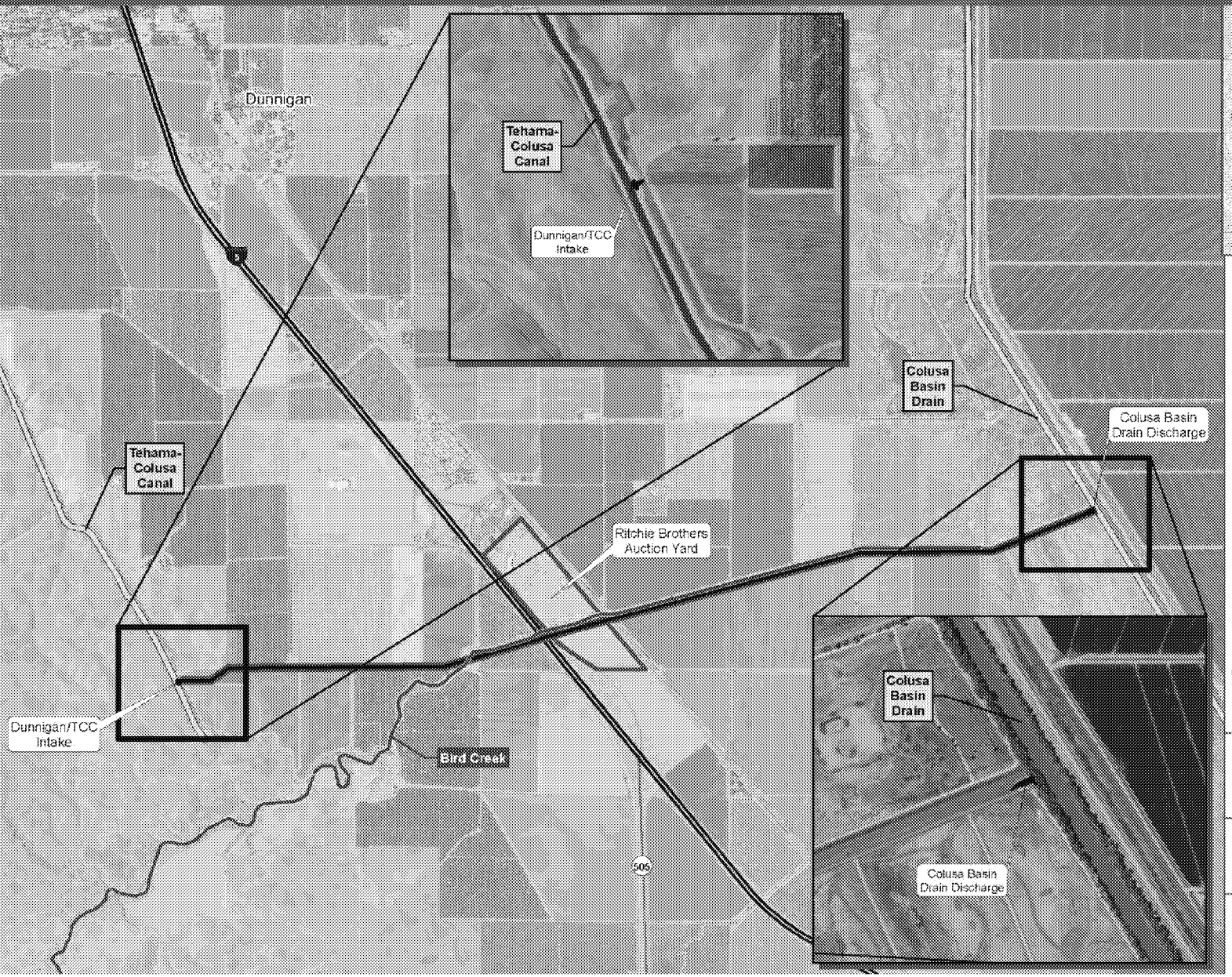
- Has a smaller footprint - less environmental effects
- Eliminates controversial conveyance infrastructure
- Meets the water supply needs of participants
- Is more affordable for local agencies
- Accommodates a range of federal investment from 7%-25%
- Continues to support the State's basis of MCED
- Performs under most challenging climate change scenarios

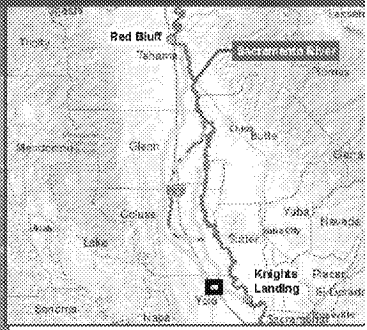
Sites

Project Facilities



Project Facilities





LEGEND

- City/Town/Community
- Bird Creek
- Dunnigan Underground Pipeline

DATA SOURCES: CityTown - ESRI, 2020; Project Features - AECOM, 2020; Canals/DWCA - USGS, 2018; Aerial Imagery (NAIP) - USDA, 2020.

DISCLAIMER: This exhibit is preliminary and is subject to change.

MAP DATE: 6/22/2021

FIGURE 2-2

ALTERNATIVES 1 AND 3
CONVEYANCE TO SACRAMENTO
RIVER COMPONENTS

N

0 0.5 1
MILES

Sites

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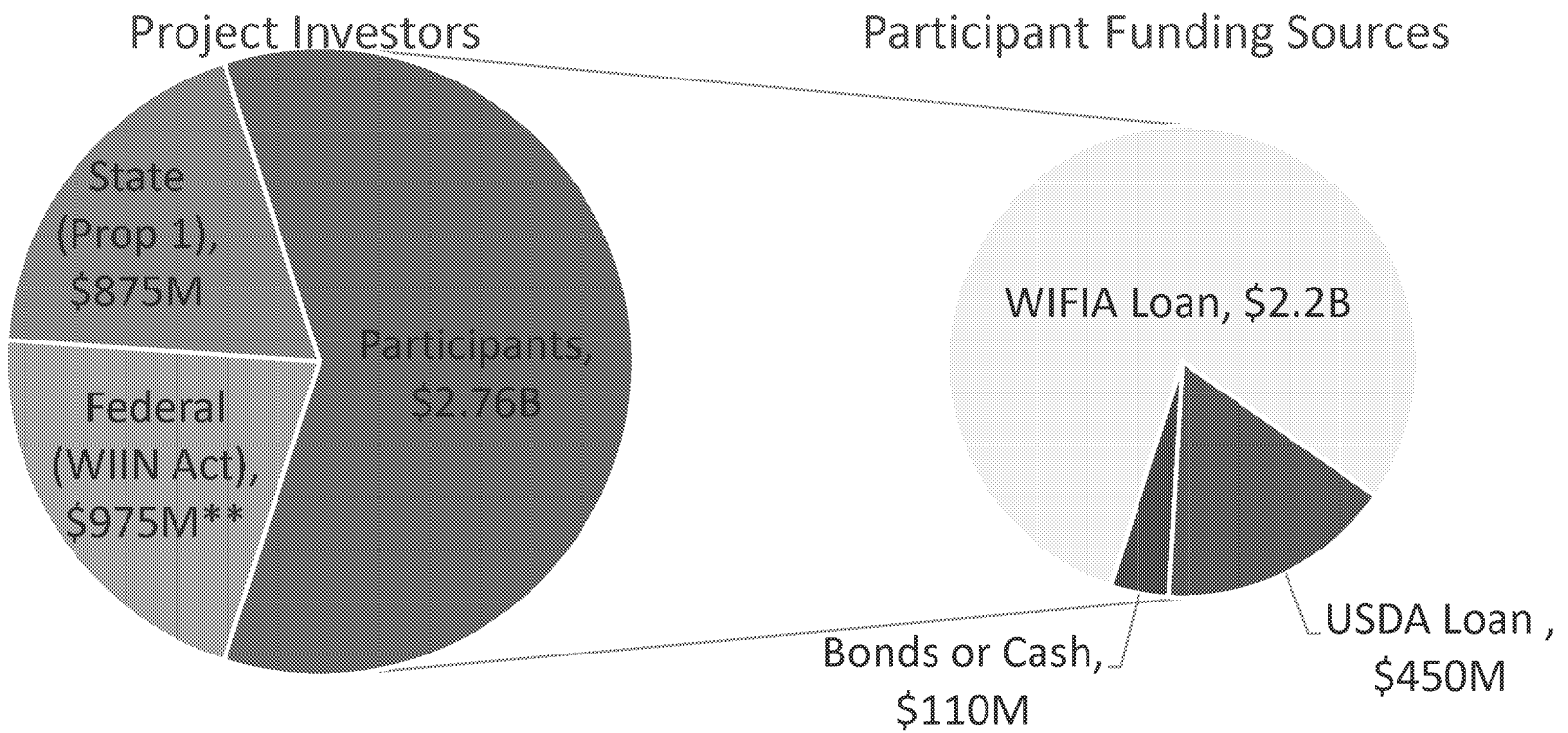
Project Funding Sources



**WIIN Act funding is based on Reclamation investment under Alternative 3 (Preferred Project) and is reported in 2021 dollars.

Environmental Planning & Permitting Update

- Environmental Impact Report
  - Draft document
    - Released for public review in November 2021
    - Comment period closed in January 2022
  - Final document
    - Expected in early 2023
    - Revisions to draft to address concerns raised
    - Response to comments received on the draft document
- Water Right Permit
  - Submitted application to State Board in May
  - Expect Board to complete review in coming month(s) and notice for public review/protests

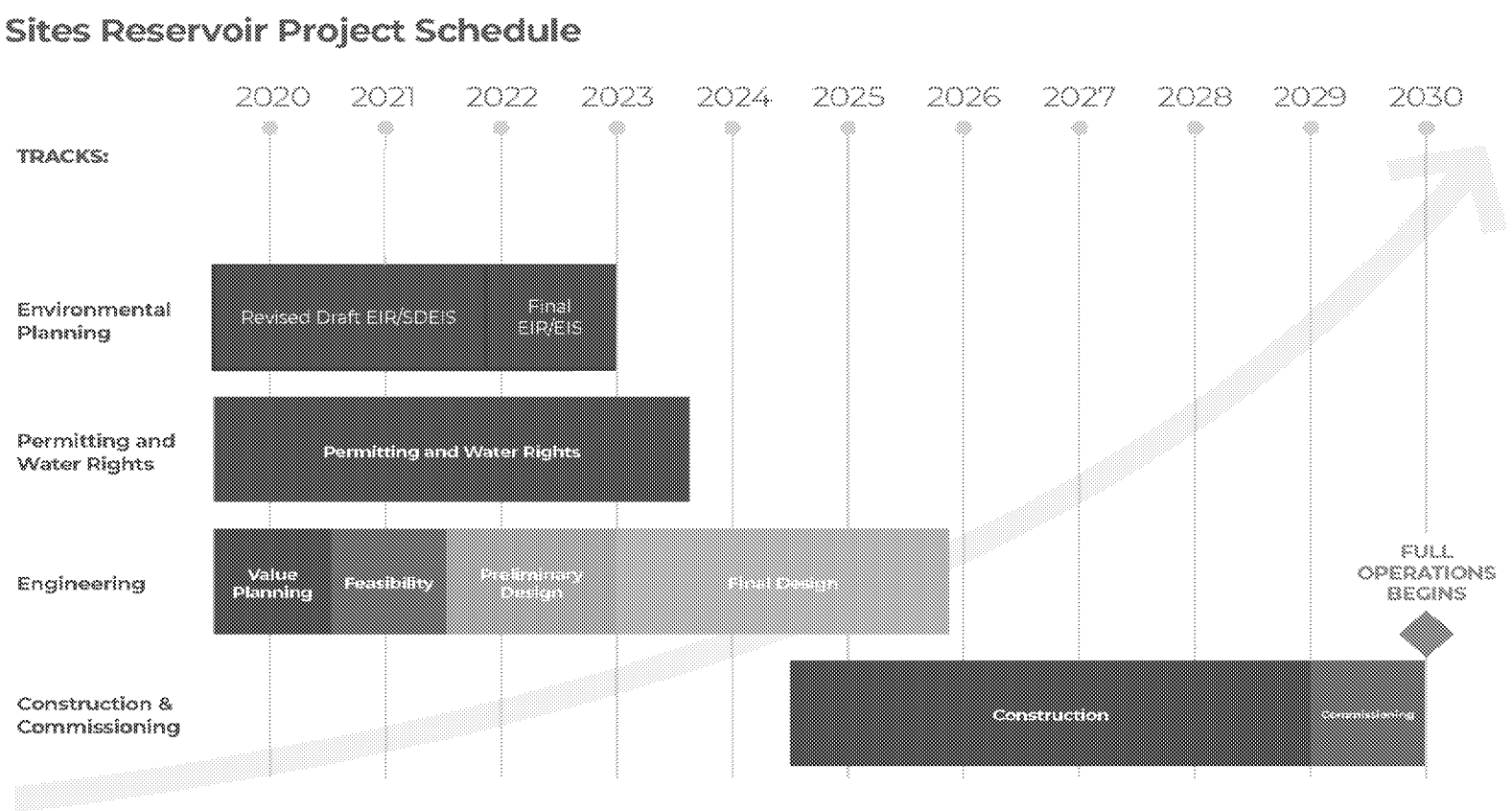
Engineering Update

- 2021 – Completed the Feasibility Analysis
  - The California Water Commission Determined the Project is Feasible
- 2022-2024 – Initiate Field Studies
  - Survey Mapping & Geotechnical Investigations to Inform Preliminary Engineering Analysis and Design
- 2024 – Complete Preliminary Engineering
  - Update Project Cost Estimate
- 2024 and Beyond – Key Agency Reviews and Approvals and begin Construction

Real Estate Update

- Soliciting Landowner feedback on the project design
- Ongoing coordination with Landowners regarding the anticipated land needs for the project
- Securing Temporary Rights of Entry (TROE) and other agreements to conduct necessary technical field activities
- Discussions with Landowners regarding potential early real estate actions on key project parcels or parcels associated with major project infrastructure

Project Schedule



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Project Next Steps/Goals: 2022 – 2024

- Secure Final Prop 1 Funding award with CWC
- Execute Final Operations Agreement
- Secure WIIN and BIL Federal Funding
- Complete WIFIA/USDA Loan Agreements
- Execute Benefits and Obligations Contracts
- Complete Final EIR/EIS
- Obtain Critical Environmental Permits (BO, ITP, 404)
- Receive Water Right Order and Permit
- Obtain Local Agency Agreements and Permits
- Execute Benefits Contracts with DWR and CDFW

Sites

Project Next Steps/Goals: 2022 – 2024

- Develop Mitigation Acquisition Master Plan
- Initiate Application for DSOD Permit to Construct
- Advance Engineering Design to achieve Level 3 cost estimate
- Determine Procurement and Delivery Strategy
- Determine Overall Project Schedule
- Develop and Implement Land Acquisition Master Plan
- Conduct Geotech Investigations and Evaluations
- Perform Geotech Evaluation of all “Willing Seller” Properties
- Determine Organization Structure and Governance

Sites

Questions

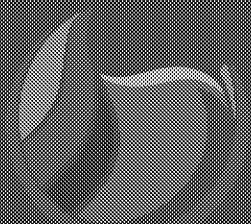
Identification of Community Concerns

- Traffic
- Public safety
- Community “preservation”
- Workforce development/jobs
- Recreation
- Sites Project Authority/Community partnerships
- Others?

Future Meetings

- Project site tour (November)
- Bi-monthly, beginning January 2023
- 3-5 p.m., third Thursday of the month, starting in January
- Priority issue(s) for January meeting

Questions/Other Discussion



Sites

From: Micko, Steve [Steve.Micko@jacobs.com]
Sent: 11/4/2022 4:12:24 PM
To: Angela Bezzone [bezzone@mbkengineers.com]
CC: Alicia Forsythe [aforsythe@sitesproject.org]; Leaf, Rob [Rob.Leaf@jacobs.com]; Thayer, Reed [Reed.Thayer@jacobs.com]
Subject: RE: Modeled Average Releases
Attachments: Sites_A2 Ecosystem Documentation.pdf; Sites_CDFW_REV.pdf

Hi Angela – Nice chatting with you today. See draft notes for your questions in orange. I'll keep thinking on the storage accounts and Yolo Bypass benefits.

Have a good weekend,
Steve

From: Angela Bezzone <bezzone@mbkengineers.com>
Sent: Thursday, November 3, 2022 3:45 PM
To: Micko, Steve <Steve.Micko@jacobs.com>
Cc: Alicia Forsythe <aforsythe@sitesproject.org>; Leaf, Rob <Rob.Leaf@jacobs.com>; Thayer, Reed <Reed.Thayer@jacobs.com>
Subject: [EXTERNAL] RE: Modeled Average Releases

Let's meet tomorrow afternoon. That way there's time if we need to do any follow up. I will send a Teams invite to the group on this email. (Ali – I will include you as optional)

Thanks for sharing the Alt 3A/3B information! I knew it was somewhere… I just couldn't find it.

Thanks,
Angela

From: Micko, Steve <Steve.Micko@jacobs.com>
Sent: Thursday, November 3, 2022 3:10 PM
To: Angela Bezzone <bezzone@mbkengineers.com>
Cc: Alicia Forsythe <aforsythe@sitesproject.org>; Leaf, Rob <Rob.Leaf@jacobs.com>; Thayer, Reed <Reed.Thayer@jacobs.com>
Subject: RE: Modeled Average Releases

CAUTION - EXTERNAL SENDER: This email originated from outside of the organization. Only open links from **TRUSTED** sources.

Hi Angela,

Thanks for the detailed notes and questions!

I'm happy to talk through these tomorrow from 2 PM to 3 PM, or Monday from 10 AM to 11 AM.
Let me know what works best for you.

In the meantime, I'll work to draft responses to your questions.

Best,
Steve

PS You can find a similar "Sites Metrics" for the BA Alternatives (Alt 3A and 3B) here: SitesMetrics_rev28_2scn__ALT3A_041122_2035CT_ALT3B_041122_2035CT.pdf. Please note that these results reflect modeling at 2035 CT climate hydrology. (The Sites Metrics referenced in your email below presents modeling at historical climate hydrology.)

From: Angela Bezzone <bezzone@mbkengineers.com>
Sent: Thursday, November 3, 2022 2:15 PM
To: Micko, Steve <Steve.Micko@jacobs.com>
Cc: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: [EXTERNAL] Modeled Average Releases

Hi Steve,

I would find time to meet with you about Reclamation participation and Yolo Bypass flows.

Reclamation Participation: I have been looking into Reclamation participation and annual releases for members with Jerry and have a few questions. My review has been focused on the summary information in this table: SitesMetrics_rev32_5scn__ALT1A_051722_ALT1B_051722_ALT2_051722_ALT3_051722.pdf. My observations and questions I'd like to discuss are below.

- Is there similar information available for Alt 3B?
- Current local participation is 167,320 AF. In reviewing the Sites Releases Table, the average release for PWA Deliveries and assumed transfer from NOD to SOD, are all below this participation volume. While, the Dry and Critical year releases are all above the 167 TAF. I'd like to discuss the average and Dry/Critical year releases, and how they relate (or maybe do not relate) to the participation level.

Participation in the CalSim II model is storage-based. With a given reservoir size (e.g. 1.5 MAF), we calculate CalSim II storage accounts with the following steps:

1. Prop 1 account size is constant: Refuge L4 is 124 TAF and Yolo Bypass is 120 TAF
   a. These account sizes are required to meet the physical benefits that Prop 1 funds
2. Federal Participation is a proportion of the active storage
   a. For Alt 3, active storage is 1440 TAF (1.5 MAF minus 60 TAF of deadpool); 25% of 1440 TAF is 360 TAF
3. Remaining volume (836 TAF in Alt 3) is split amongst remaining storage partners

- In 2021, a storage equation was established so that Storage Allocation = Existing Participation x 6.234. Jerry and I are reviewing the 6.234 ratio, along with the local participation levels under a 16% and 25% Reclamation participation. To maintain this ratio, local participation would need to be decreased by 12,373 AF and 33,526 AF, respectively. I'd like to discuss if it's appropriate to use the modeled release values to inform whether the 6.234 ratio is still appropriate.

The 6.234 ratio was based on using the storage balancing approach (above) and comparing the remaining volume in Alt 1B (preferred alternative in the RDEIR/SDEIS). This ratio would adjust to 4.99 and 5.76 under Alts 3A and 3B, respectively.

Yolo Bypass Flows: I spent more time with the information you sent over on this topic. Looking at Yolo Bypass release and Sites exports on a calendar year basis, it looks like these releases occur during the same years as Sites exports only 37% of the time. With this in mind, Jerry and I started talking about ideas of how to put the Yolo Bypass flows to use for members after they reach the Delta. Some concepts and questions I'd like to discuss are below.

- How was the timing of releases for the Yolo Bypass flows determined? Was this directed by CDFW? I'd like to talk better understand the assumptions.

I believe the timing of the releases was determined by the latest science of the time. The Sites Prop 1 Application specifies that releases would be provided in August through October. One reference is provided in the attached pdf (Sites Prop 1 Application: Attachment 2 to the Physical Public Benefits Tab); you can see a slide deck prepared by Ted

Sommer (DWR) about potential benefits of pulse flows through Yolo Bypass in the late-Summer. In CDFW's review, they concur that the Aug – Oct release period is consistent with the Delta Smelt Resiliency Strategy, 2016. The CDFW review of the Sites WSIP Application noted that the average Sites releases to Yolo Bypass varied by water year type. Therefore, there may be insufficient water available in some years to provide the flows necessary to generate food product benefits (pg 12 of 22 in Sites_CDFW_REV.pdf).

Prop 1 Yolo Bypass water is released through the Dunnigan Pipeline during summer and fall months (August through October) of all water year types. As soon as water is available in the Sites Prop 1 account, it is released for Yolo Bypass benefits. Hence, the high frequency of releases in wetter year types.

- Does the model only include exports at Banks? Or do exports at Banks and Jones generally occur during the same months? I'm wondering if this may change the frequency of overlap.

The model includes Banks and Jones operations. For the purposes of conveying Sites SOD participant water, only Banks is assumed.

- Similar to the above, I'm also interested in exports at the North Bay Aqueduct and if there may be opportunities to redivert the water at this location after it enters the Delta.

Good catch! The model assumes Sites exports at Barker Slough Pumping Plant for delivery to North Bay storage partners. I'll get the results timeseries for these. However, I anticipate they'll align with Sites exports through Banks.

- More conceptual ideas include: potential to redivert at the Contra Costa facility, potential for rediversion at the DCP facility (obviously far down the road and would also require a change to the water right), an exchange concept where the known Yolo Bypass could be diverted upstream (e.g., if Yolo Bypass is going to contribute 100 AF to Delta inflow, that water will enter the Delta and 100 AF would be rediverted at the Freeport Facility), a true exchange would occur with DWR or Reclamation where they take the additional Delta inflow and backup a like amount into Shasta or Oroville. I'd like to brainstorm with you to see if any other concepts come up, or if there are any major flows in any of these concepts.

I'm hoping to meet with you (and any others you think should be included) before Tuesday, when I have my next meeting with Jerry. I can meet anytime tomorrow 11:00 and later (I'm hoping to wrap up my work day around 3:00, but I'm happy to meet after 3:00 if that works best with your schedule), or on Monday 10:00-1:00 and 2:00-5:00. I think we need at least an hour.

Ali – I've cc'd you in case you would like to participate in the discussion and/or provide any input on the above! This may take some additional group discussions to make sure that everyone is on the same page.

Thanks!

Angela Bezzone, P.E.

MBK Engineers
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Sacramento, CA 95825

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(916) 456-0253 – Fax

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Physical Public Benefits Tab

Attachment 2: Ecosystem Documentation Priorities 1, 2, 10, 14, 15, and 16

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Acronyms and Abbreviations

°F	Fahrenheit
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
CV	Central Valley
CVP	Central Valley Project
DCH	Designated Critical Habitat
EFH	Essential Fish Habitat
GCID	Glenn Colusa Irrigation District
IEP	Interagency Ecological Program
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NWR	National Wildlife Refuge
PCE	primary constituent elements
PFMC	Pacific Fishery Management Council
RECTEMP	U.S. Bureau of Reclamation Temperature Model
RM	River Mile
SWRCB	State Water Resources Control Board
TCCA	Tehama-Colusa Canal Authority
USRWQM	Upper Sacramento River Water Quality Model

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Ecosystem Priority 1: Provide cold water at times and locations to increase the survival of salmonid eggs and fry

Improved Temperatures

Cold water benefits will be realized by operating Sites Reservoir and Shasta Lake in cooperation to preserve a greater volume of coldwater pool storage in Shasta Lake. This will be accomplished by substituting water from Sites Reservoir to meet a portion of the CVP water demand from Shasta (especially in the lower GCID and TCCA service areas) thus allowing cold water to be conserved in storage in Shasta Reservoir to benefit anadromous fish. This water will be released to maintain appropriate water temperatures in the Sacramento River, with particular emphasis on the months of highest potential water temperature related impacts. The area of temperature improvement for the Sacramento River resulting from the Project is shown in Figure A2-1 below and temperature improvements in Critical water years are shown in Table A2-1. Shasta Lake average end-of-month storage in May under simulated current, 2030, and 2070 dry water year conditions increases by 90 thousand acre feet (TAF) to 100 TAF above the respective without-project conditions.

Table A2-1. Temperature (°F) Improvements in Critical Water Years (July through September Period)

Sacramento River Location	Current Condition without Project (°F)	Current Condition with Project (°F)	Difference (°F)	WSIP 2030 without Project (°F)	WSIP 2030 with Project (°F)	Difference (°F)
Bonnyview	56.5	55.1	-1.4	56.5	55.9	-0.6
Balls Ferry	58.0	56.6	-1.4	58.1	57.5	-0.6
Jellys Ferry	59.2	57.9	-1.3	59.4	58.8	-0.6
Bend Bridge	60.1	58.9	-1.2	60.3	59.7	-0.6

Through releases from Sites Reservoir to meet TCCA and GCID irrigation diversions and equivalent reductions in CVP Shasta Lake releases, demands on Shasta Lake storage could be reduced and the coldwater pool maintained for a longer time at higher levels than are currently achievable. Shasta Lake release patterns could be shifted in season and between adjacent years to improve coldwater storage and flow management for salmon and other species using the portion of the Sacramento River between Keswick Dam and the Red Bluff Pumping Plant as habitat. Similar increases in storage can be achieved in Lake Oroville (average end-of-May increases of 25 to 35 TAF).

The operation of Sites Reservoir also provides opportunity for improved temperature conditions in the American River. Results for the American River at Watt Avenue are provided in Table A2-2 and the area of temperature improvement for the American River is shown in Figure A2-2.

Table A2-2. American River Temperature (°F) Improvement at Watt Avenue (July to September)

Year Type	2015 without Project	2015 with Project	Difference	WSIP 2030 without Project	WSIP 2030 with Project	Difference
Average	66.7	65.8	-0.9	70.6	69.9	-0.6
Dry	68.0	67.2	-0.8	70.7	70.5	-0.2
Critical	71.6	70.2	-1.4	73.6	73.1	-0.5

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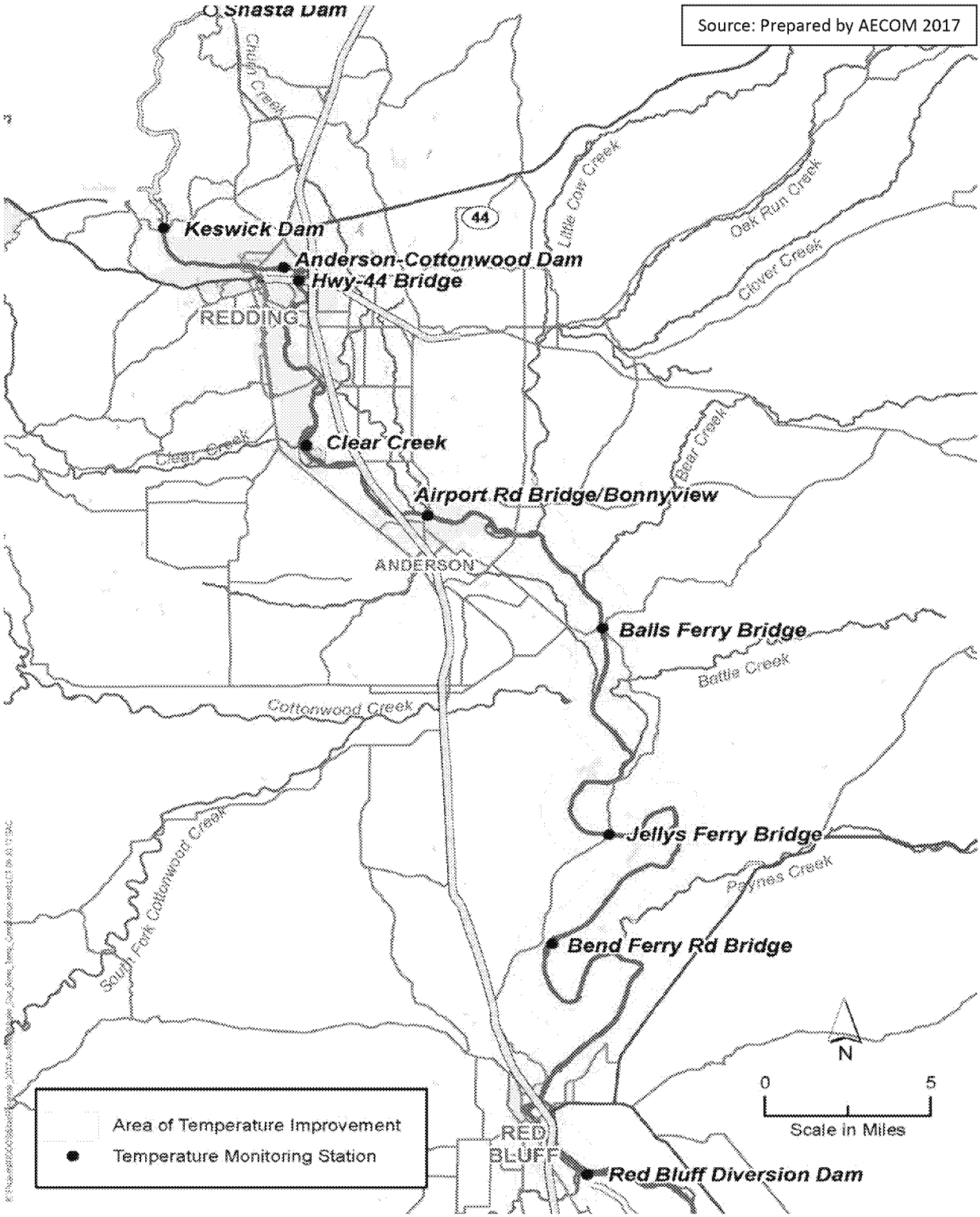

Figure A2-1: Area of Temperature Improvement for the Sacramento River

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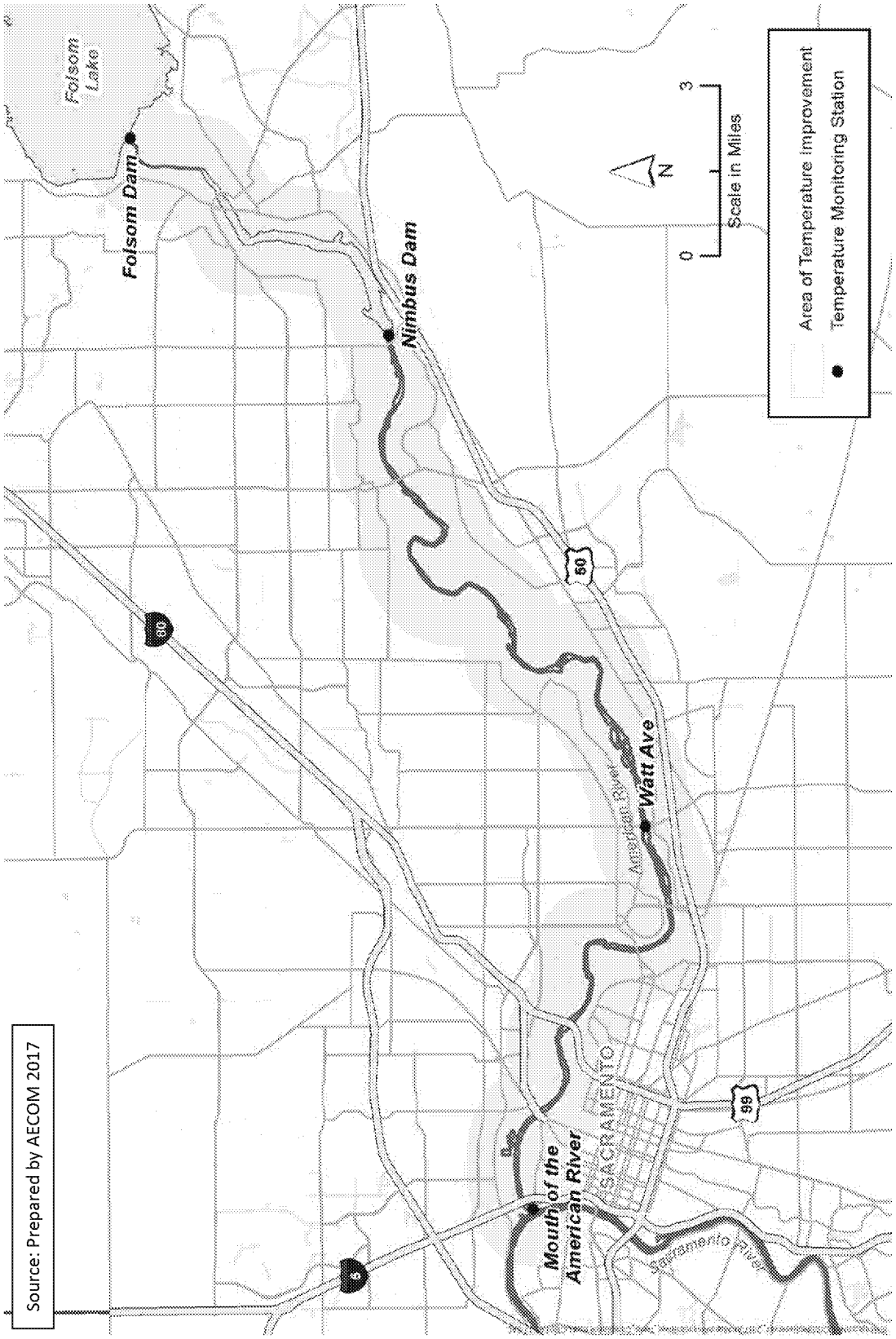

Figure A2-2: Area of Temperature Improvement for the American River

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Reduction in Sacramento River Winter-run Chinook Salmon Mortality

The estimated percent reduction in mortality to Winter-run Chinook salmon eggs and fry due to thermal benefits of the project are summarized in Table A2-3, separated by location and water year type.

Table A2-3. Estimated Percent Reduction in Mortality Due to Thermal Benefits of Project to Salmonid Eggs and Fry

Winter-run Chinook							
Locations along the Sacramento River	**Keswick**	**Bonnyview Bridge**	**Balls Ferry**	**Jellys Ferry**	**Bend Bridge**	**Red Bluff**	**Below Red Bluff**
Eggs							
Dry Water Years							
August	-	-	-	-	-	-	-
September	-	-	**8%**	-	-	-	-
October	-	-	-	-	-	-	-
Critical Water Years (15% of total water years)							
August	-	-	**15%**	-	-	-	-
September	**8%**	**7%**	**25%**	-	-	-	-
October	-	-	-	-	-	-	-
Fry (Alevins)							
Dry Water Years							
August	-	-	-	-	-	-	-
September	-	-	**25%**	-	-	-	-
October	-	-	-	-	-	-	-
Critical Water Years (15% of total water years)							
August	-	-	-	-	-	-	-
September	-	-	**15%**	-	-	-	-
October	-	-	-	-	-	-	-

Beginning at Keswick Dam and continuing in a downstream direction the results were:

Sacramento River Below Keswick Dam (RM 302.0) (Table SQ2-1a)

Critical water years only (15% of total water years): During September 2030 without the project the mean monthly water temperature is projected to be 57°F, thus exceeding the upper water temperature optimum of 56°F for egg incubation, but less than the upper water temperature of 58°F for pre-emergent alevins. At this temperature it is expected that egg mortality will increase by 8 percent after 24 days of exposure. No increase in mortality for pre-emergent alevins will occur (Vogel 2015, Table 3, page 10). With the project in place 56°F will not be exceeded in September, and egg and alevin mortality will not increase over natural levels. Therefore, the project would reduce egg mortality during September by approximately 8 percent for those eggs remaining in redds. In October 2030 both with and without the project the mean monthly water temperature will rise to 58°F, thereby increasing egg mortality by 15 percent over 22 days of exposure for any remaining incubating eggs. The number of incubating eggs in October is expected to be small. There would be no increase in alevin mortality with or without the project (Vogel 2015, Table 3, page 10). Both operating scenarios would have similar results by increasing egg mortality during October. During November only pre-emergent fry remain in

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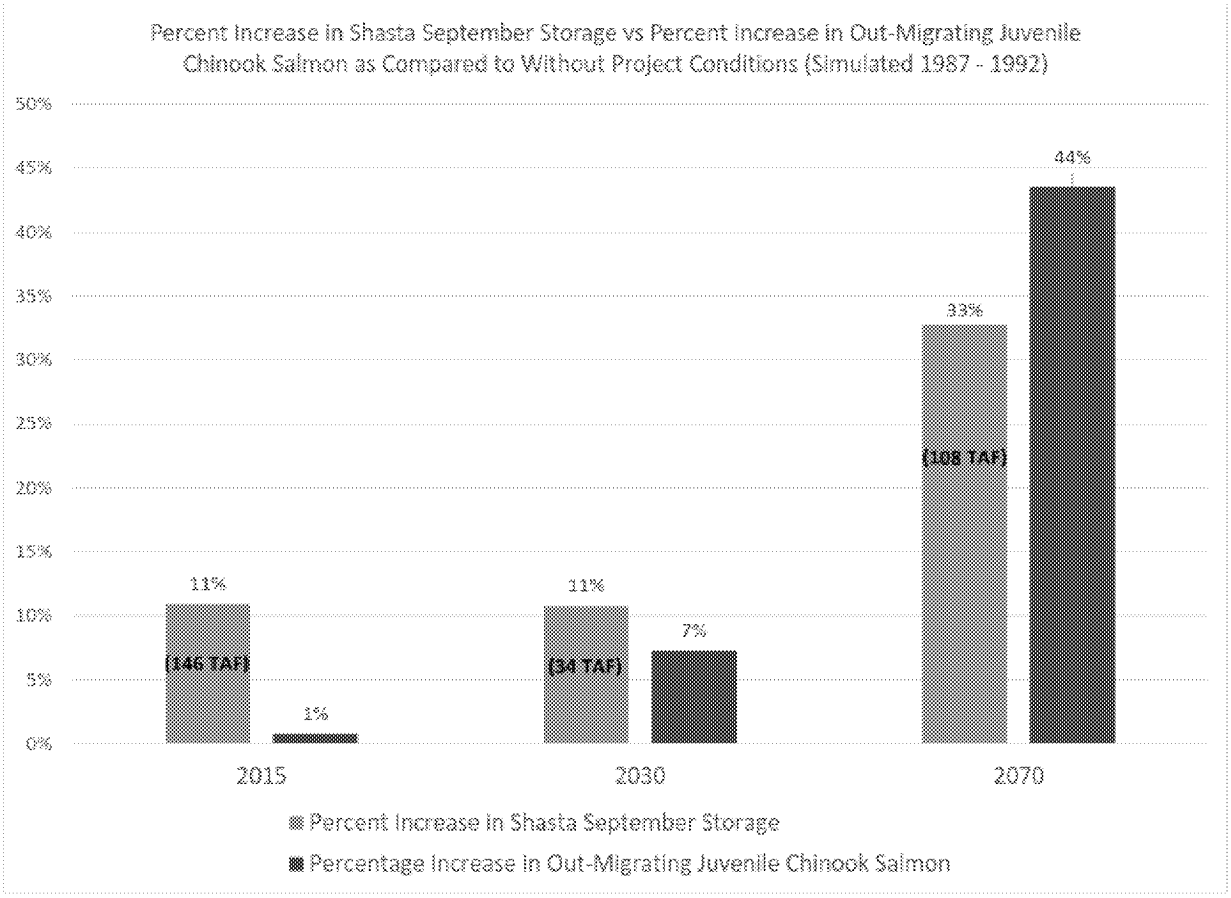
the spawning gravels and water temperatures with and without the project remain less than 58°F, indicating no increase in mortality with or without the project over natural levels.



*Values presented in TAF represent increases in Shasta September Storage as Compared to Without Project Conditions

Sacramento River at Bonnyview Bridge, Redding (RM 291.8) (Table SQ3-1a)

Note that most Winter-run spawning occurs (greater than 90 percent) upstream of this location which is 10.2 miles downstream of Keswick Dam.

Critical water years only (15% of total water years): During September 2030 the mean monthly water temperature without the project is projected to be 58°F, thus exceeding the upper water temperature optimum of 56°F for egg incubation, but not exceeding the thermal optimum of 58°F for pre-emergent alevins. The 58°F water temperature would result in an estimated 15 percent increase in egg mortality over a 22 day period for those eggs still incubating. With the project in place, egg mortality would decline to 8 percent over a 24-day exposure period (Vogel 2015, Table 3, page 10). Thus, the project would reduce egg mortality during September by approximately 7 percent. Pre-emergent alevins would not be exposed to greater mortality than natural levels with or without the project during September. During October 2030 egg mortality without the project is projected to be 59°F, thus exceeding the upper water temperature optimum of 56°F for egg incubation. This temperature would result in an estimated 25 percent increase in mortality over natural levels if exposed for 20 days for those eggs remaining. The number of incubating eggs in October is expected to be small. During October 2030 with the project the

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mean monthly water temperature is projected to be 58°F which would result in a 15 percent increase in egg mortality over natural levels if exposed for 22 days for those eggs remaining. Therefore, the project would reduce egg mortality by 10 percent at this location during October. Without the project pre-emergent alevins would be exposed to a 10 percent higher mortality rate if exposed for 14 days. With the project, no increase in mortality would occur. Therefore, the project would reduce pre-emergent alevin mortality by 10 percent over the without project scenario. During November only pre-emergent fry remain in the spawning gravels and water temperatures with and without the project remain less than 58°F, indicating no increase in mortality with or without the project.

Sacramento River at Balls Ferry (RM 276.0) (Table SQ4-1a)

Note that all Winter-run spawning occurs 13 miles or further upstream of this location. Balls Ferry is 26 miles downstream of Keswick Dam. No redds with incubation eggs and pre-emergent alevins would be located at Balls Ferry. Balls Ferry is a water temperature compliance point with a target water mean daily water temperature of 56°F (State Water Resources Control Board WR 90-5 [1990]).

Dry water years only (22% of total water years): During September of 2030 mean monthly water temperature is projected to reach 57°F, thus exceeding the upper water temperature optimum of 56°F for egg incubation, but not exceeding the thermal optimum of 58°F for pre-emergent alevins. At this temperature it is expected that egg mortality would increase by 8 percent after 24 days of exposure, if eggs were actually present at this location. No increase in mortality for pre-emergent alevins would occur if alevins were actually present (Vogel 2015, Table 3, page 10). With the project in place 56°F would not be exceeded in September, and egg and alevin mortality would not increase over natural levels were eggs and alevins actually present at this location. Therefore, the project would reduce egg mortality during September by approximately 8 percent for those eggs remaining in redds if eggs were actually present at Balls Ferry. In October 2030 the opposite is true, with the project resulting in a mean monthly water temperature of 57°F and without the project a projected 56°F. Therefore, the theoretical increase in egg mortality would be 8 percent with the project and no increase without the project. No impact to pre-emergent alevins would occur with and without the project if alevins were actually present at this location.

Critical water years only (15% of total water years): The mean monthly water temperature index of 56°F for egg incubation is exceeded from July through October 2030 both with and without the project. In July the mean monthly water temperature with and without the project is 57°F which would result in an 8 percent increase in mortality over natural levels if exposed for 24 days (Vogel 2015, Table 3, page 10). In August this value would increase to 58°F without the project, but remain at 57°F with the project. Therefore, in August, the project would reduce egg mortality by 15 percent if exposed for 22 days. During September the mean monthly water temperature would increase to 60°F without the project and 59°F with the project. Thus, egg mortality would increase by 50 percent without the project over a 12-day exposure and 25 percent with the project over a 20 day exposure. Therefore the project would reduce egg mortality by 25% in September. During October the mean monthly water temperature both with and without the project is 59°F, resulting in an increase in egg mortality of 25 percent for a 20 day exposure for those few eggs still incubating. Pre-emergent alevins would not be exposed to increased mortality until September 2030. During September the mean monthly water temperature is projected to reach 60°F without the project and 59°F with the project. The respective increases in alevin mortality greater than natural levels are 25 percent over a 14-day exposure period and 10 percent over the same period (Vogel 2015, Table 3, page 10). Therefore the project would reduce alevin mortality by 15% in September. During October 2030, the mean monthly water temperature is 59°F with and without the project resulting in a 10 percent increase in mortality over a 14-day period for remaining alevins had

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they actually been present at Balls Ferry. Alevin mortality would not increase above natural levels during November 2030 for any fish remaining in redds.

In summary, in the reach of the Sacramento River used by spawning Winter-run Chinook salmon from Keswick Dam to Clear Creek, the proposed project in 2030 will reduce the percentage of egg mortality in September and October of critically dry water years from 7 to 10 percent depending on location. In the spawning reach pre-emergent fry (alevins) would not be impacted adversely by water temperature with or without the project.

Species Conservation Plans

The ecosystem improvement is consistent with two recovery actions of National Oceanic and Atmospheric Administration (NOAA) Fisheries Recovery Plan for Winter-run Chinook salmon, Spring-run Chinook salmon, and Central Valley steelhead in the mainstem Sacramento River (National Marine Fisheries Service [NMFS] 2014). The actions in the NOAA Fisheries that will be met are: (1) to develop and apply alternative diversion technologies that reduce entrainment, and (2) evaluate and reduce stranding of juvenile chinook salmon in the channels from Keswick Dam to Colusa, due to flow reductions from Keswick Reservoir, by increasing or stabilizing releases from the reservoir. The ecosystem improvement is also consistent with three of the proposed actions listed in the Sacramento Valley Salmon Resiliency Strategy. These actions are: (1) increase productivity by improving spawning and incubation conditions (habitat and water quality); (2) increase productivity by increasing juvenile salmonid survival; and (3) support the full range of juvenile and adult migration conditions to maintain life history diversity. The project will meet these actions by providing increased flows and management of intake diversions to benefit salmonids in the Sacramento River below Keswick Dam. With improved flows, the project will also enhance and improve the quality of Essential Fish Habitat (EFH) and Designated Critical Habitat (DCH). Essential Fish Habitat is defined in the Magnuson-Stevens Act (MSA) as the waters and substrate necessary for fish spawning, breeding, feeding, or growth until maturity (MSA § 3(10)). The project will improve EFH for Pacific Coast Salmon (all four runs of Chinook included) by providing enhanced thermal refugia, floodplain habitats, and spawning habitat which included in the habitat areas of particular concern for Pacific Coast Salmon (Pacific Fishery Management Council [PFMC] and NMFS 2014). The US Fish and Wildlife Service defines DCH by considering those physical or biological features that are essential to the conservation of a given species, and designating specific areas within the geographic area occupied by the species at the time of listing. The project will provide enhanced DCH's primary constituent elements (PCE) as defined in 70 FR 52488 for steelhead. These PCEs are as follow: more suitable flow conditions, additional rearing sites, and increase in downstream passage.

Ecosystem Priority 2: Provide flows to improve habitat conditions for in-river rearing and downstream migration of juvenile salmonids

The additional water stored in Shasta Reservoir will be released to augment Sacramento River flows downstream from Keswick Dam. These flows will simulate punctuated high flow events that would trigger increased activity in downstream movement of juvenile Chinook Salmon. The greatest value in providing increase in flows in the Sacramento River below Keswick Dam is to emigrating juvenile Winter-run, Fall-run, and Late fall-run Chinook salmon. Similarly, increased water stored from Lake Oroville and Folsom Lake will also be released to benefit habitat conditions for in-river rearing and downstream emigration of juvenile Chinook salmon in the Feather and American rivers.

Sites Reservoir would provide a 4.2% (338 cubic feet per second [cfs]) long term average increase in flows in the Sacramento River between Keswick Dam and the Red Bluff Diversion Dam (Table A2-4). Model results using different water year types show that there is a 7.0% (380 cfs) increase in flows in below normal water years and a 7.6% (334 cfs) increase in flows in dry water years. In 2030, there is a 2.5% (209 cfs) long term average increase in flows, a 3.4% (169 cfs) increase in below normal water years, and a 10.8% (495 cfs) increase in dry water year flows.

Table A2-4. Stabilize Sacramento River Fall Flows

Flow Increase (Nov-Feb)	Current Condition Increase (cfs)	Current Condition Increase (%)	2030 Increase (cfs)	2030 Increase (%)	2070 Increase (cfs)	2070 Increase (%)
Long Term Avg	338	4.2	209	2.5	93	1.1
Below Normal	380	7.0	169	3.4	127	2.2
Dry	334	7.6	495	10.8	163	3.8

Flow augmentation in the Sacramento River was estimated using the WSIP and provided CALSIM model that showed benefits to fall-run and late fall-run Chinook salmon productions (Table A2-5).

Table A2-5. Increased Juvenile Production Compared to Without Project (SALMOD 2030)

Year Type	Fall-run	Late fall-run
Long Term Avg	435,000	70,188
Wet	28,401	37,827
Above Normal	1,338,057	61,484
Below Normal	118,225	37,207
Dry	19,886	57,277
Critical	1,493,425	208,800

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SWC Briefing:
North Delta Food Web Study
March 2017

Ted Sommer and Jared Frantzich
Department of Water Resources

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PURPOSE:	PHYSICAL PUBLIC BENEFITS ECOSYSTEM PRIORITIES A2	CHECKER:	J HERRIN	DATE:	2017 AUGUST
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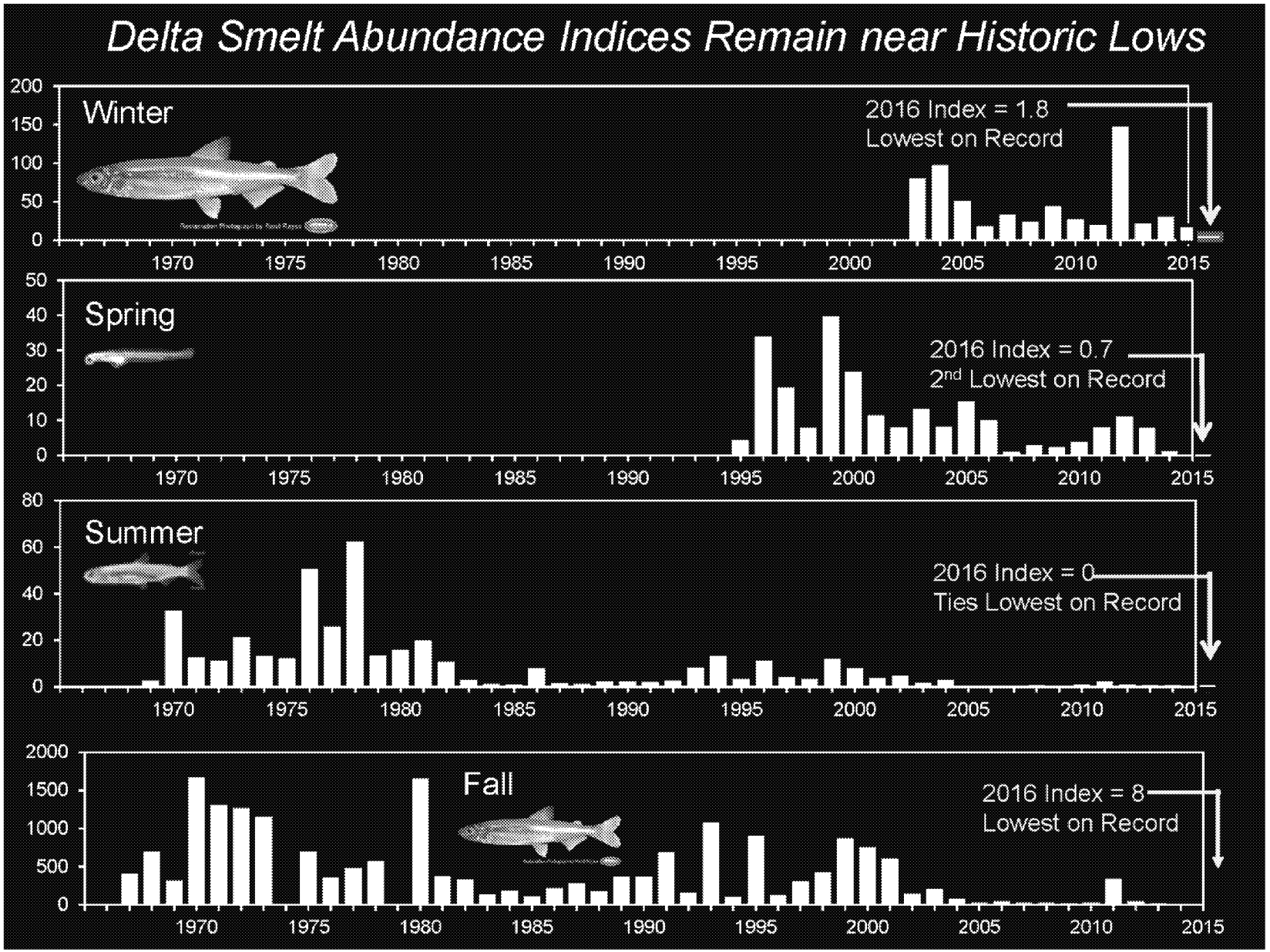

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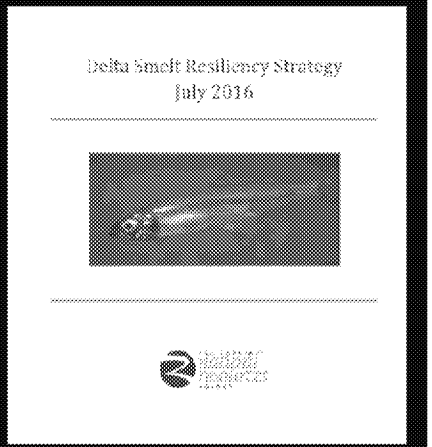
Delta Smelt Resilience Strategy

13 Proposed Actions



- Aquatic Weed Control
- North Delta Food Web Adaptive Management Projects
- Outflow Augmentation
- Reoperation of the Suisun Marsh Salinity Control Gates
- Sediment Supplementation in the Low Salinity Zone
- Spawning Habitat Augmentation
- Roaring River Distribution System Food Production
- Coordinate Managed Wetland Flood and Drain Operations in Suisun Marsh
- Adjust Fish Salvage Operations during Summer and Fall
- Storm water Discharge Management
- Rio Vista Research Station and Fish Technology Center
- Near-term Delta Smelt Habitat Restoration
- Franks Tract Restoration Feasibility Study

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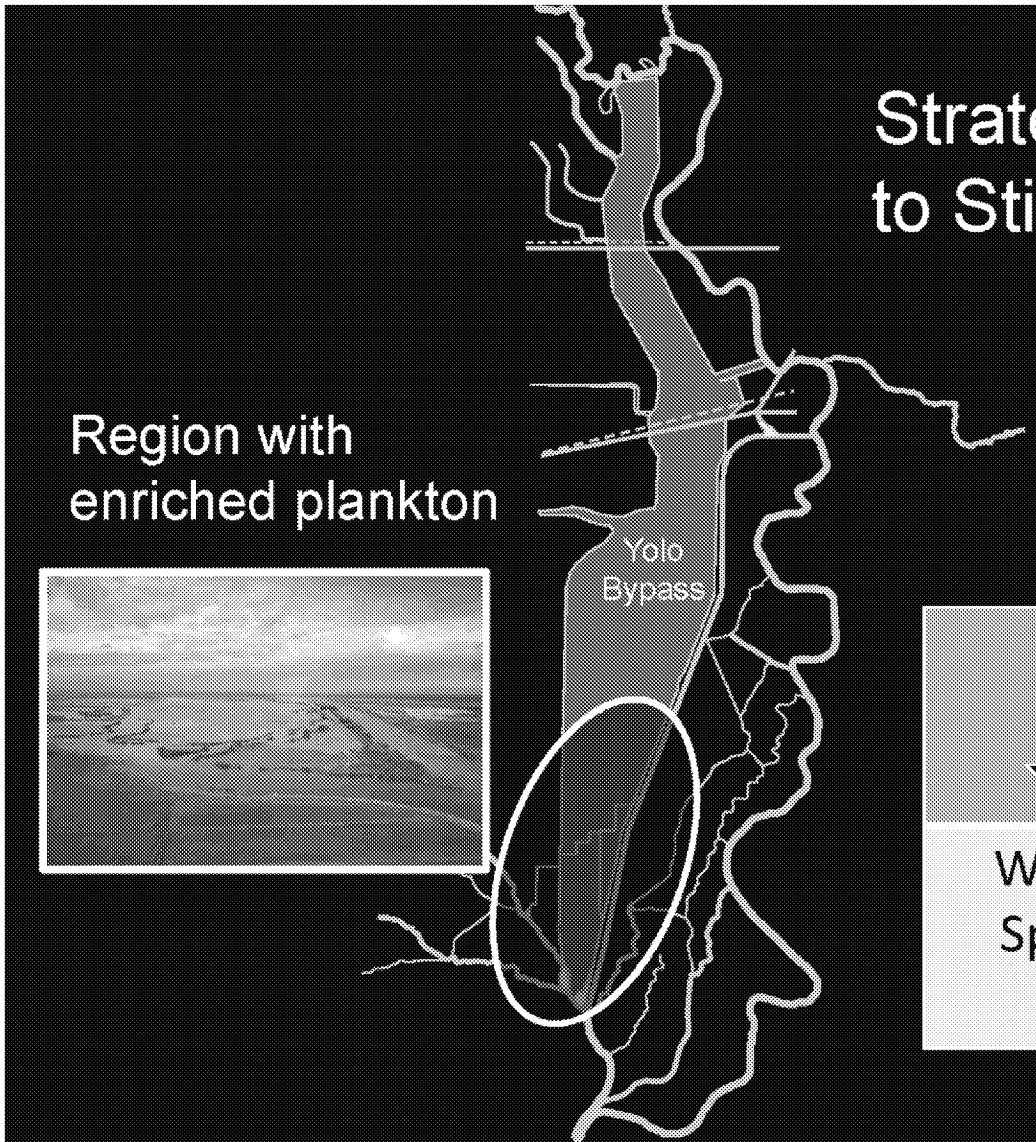
Strategic Use of Flow to Stimulate the Delta Food Web?



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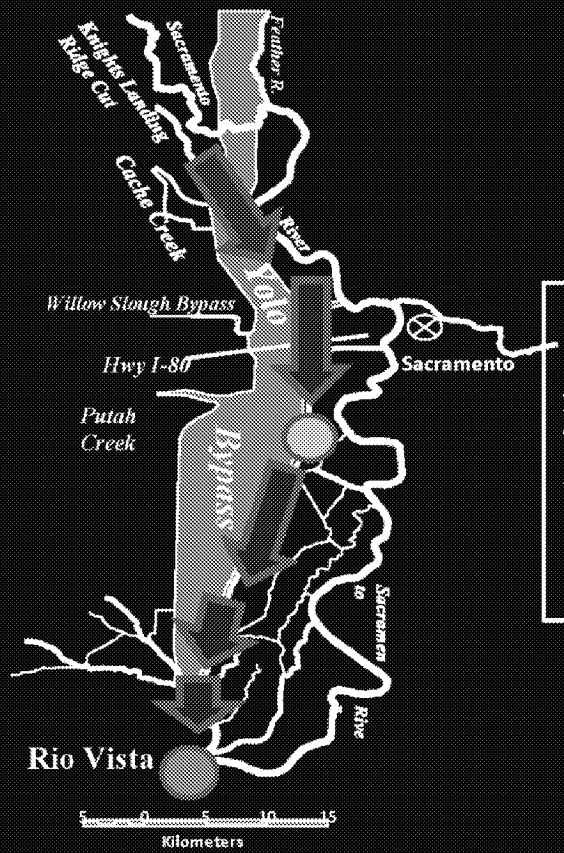
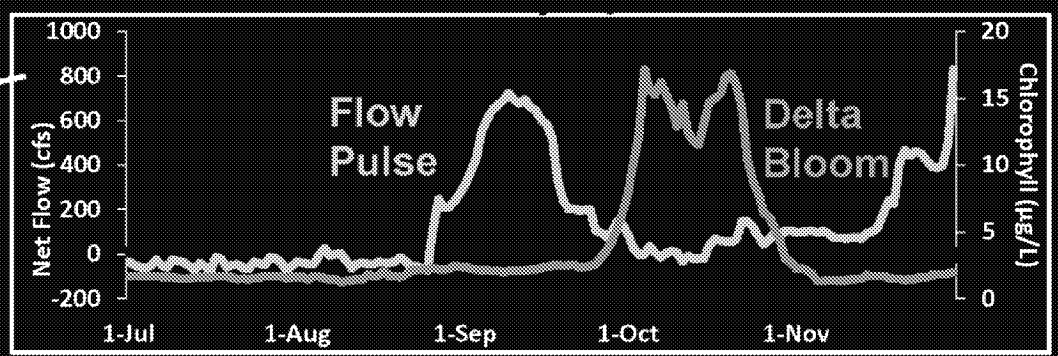
Evidence That Enhancing Flows Might Help

Unusually High Fall Yolo Flows = Delta Bloom



2012 North Delta Phytoplankton Bloom



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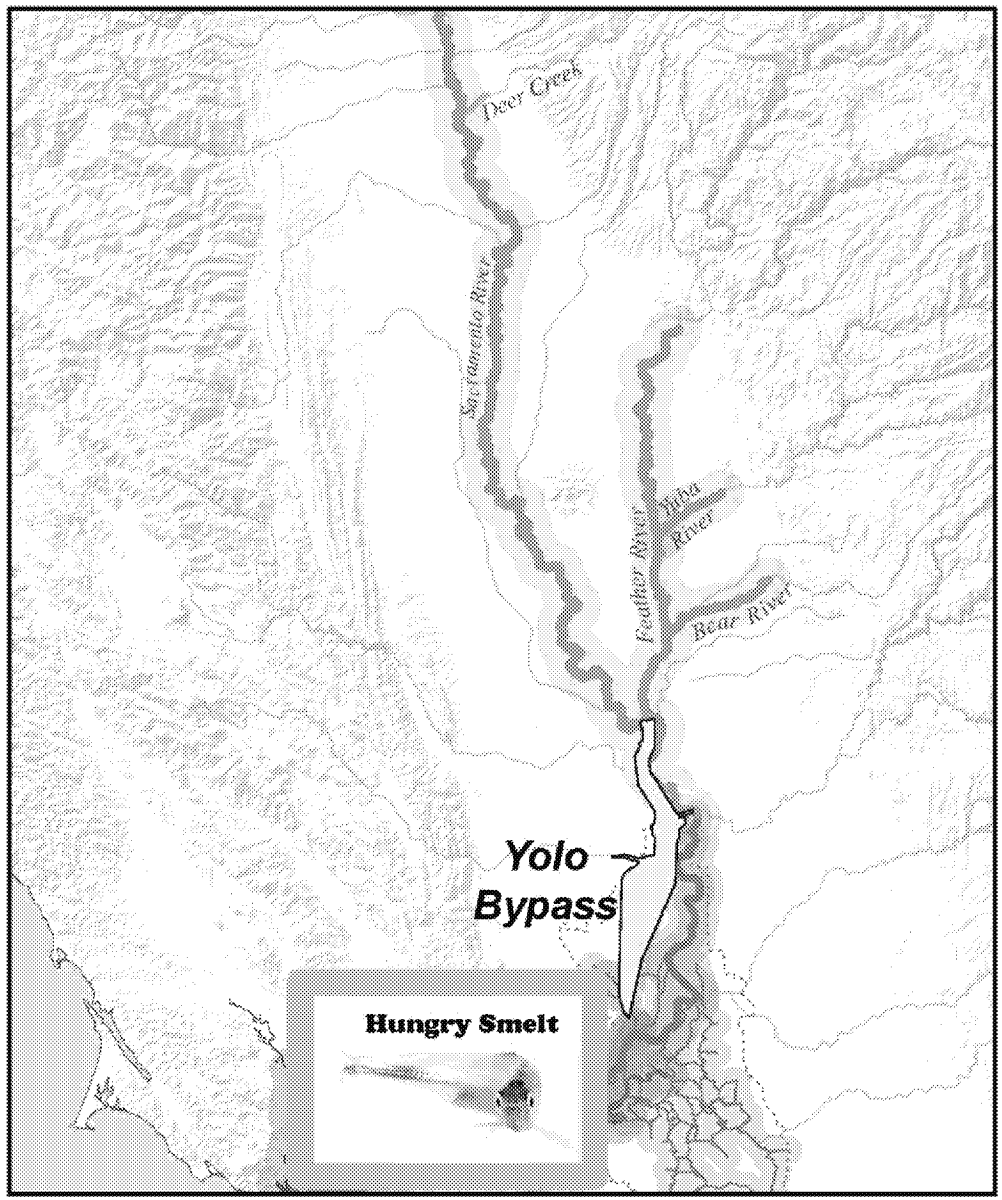

Delta Smelt Food Web Flow Action – Summer 2016

Project Coordination

Base map courtesy of NOAA Fisheries

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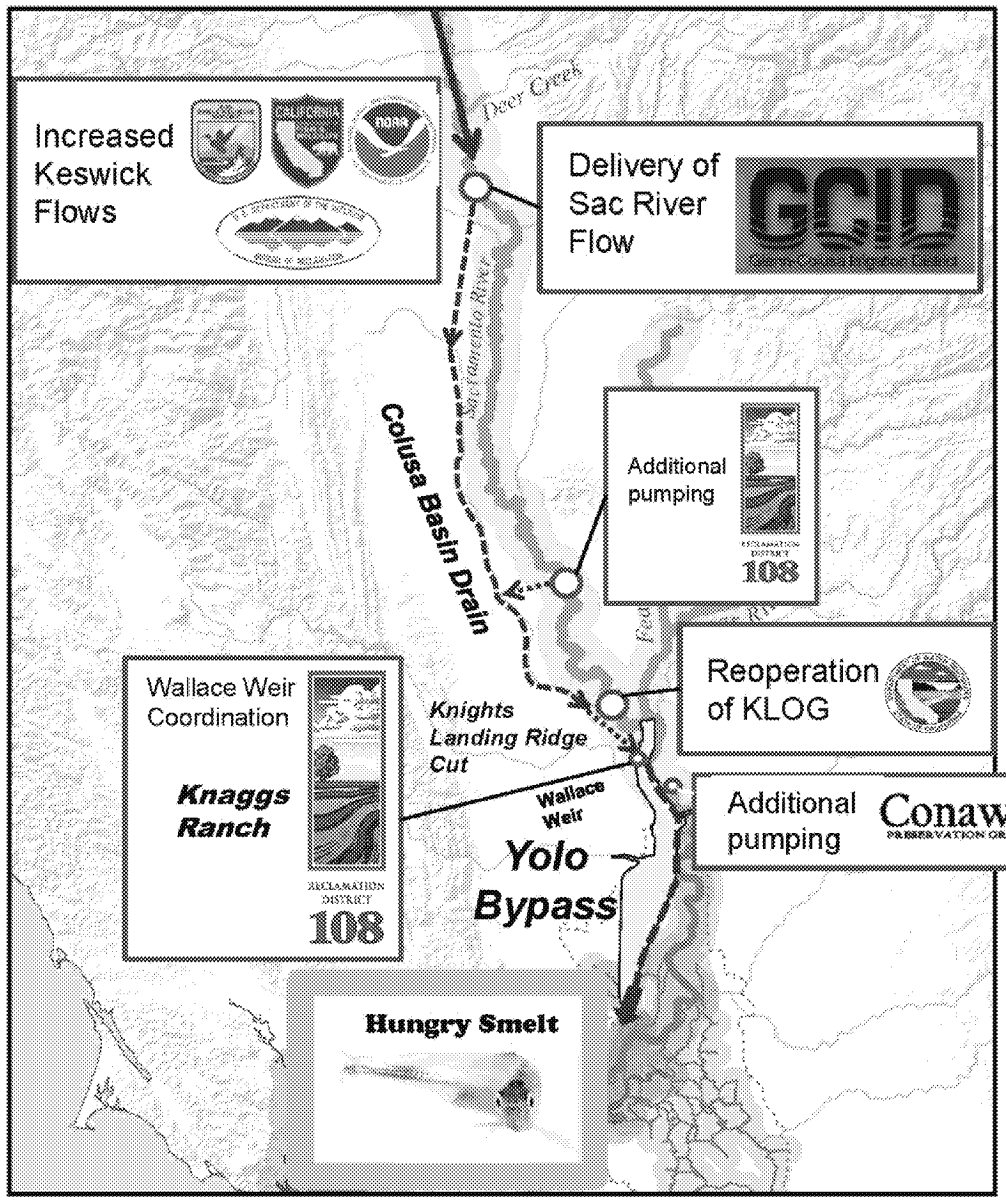

Delta Smelt Food Web Flow Action – Summer 2016

Project Coordination

Base map courtesy of NOAA Fisheries

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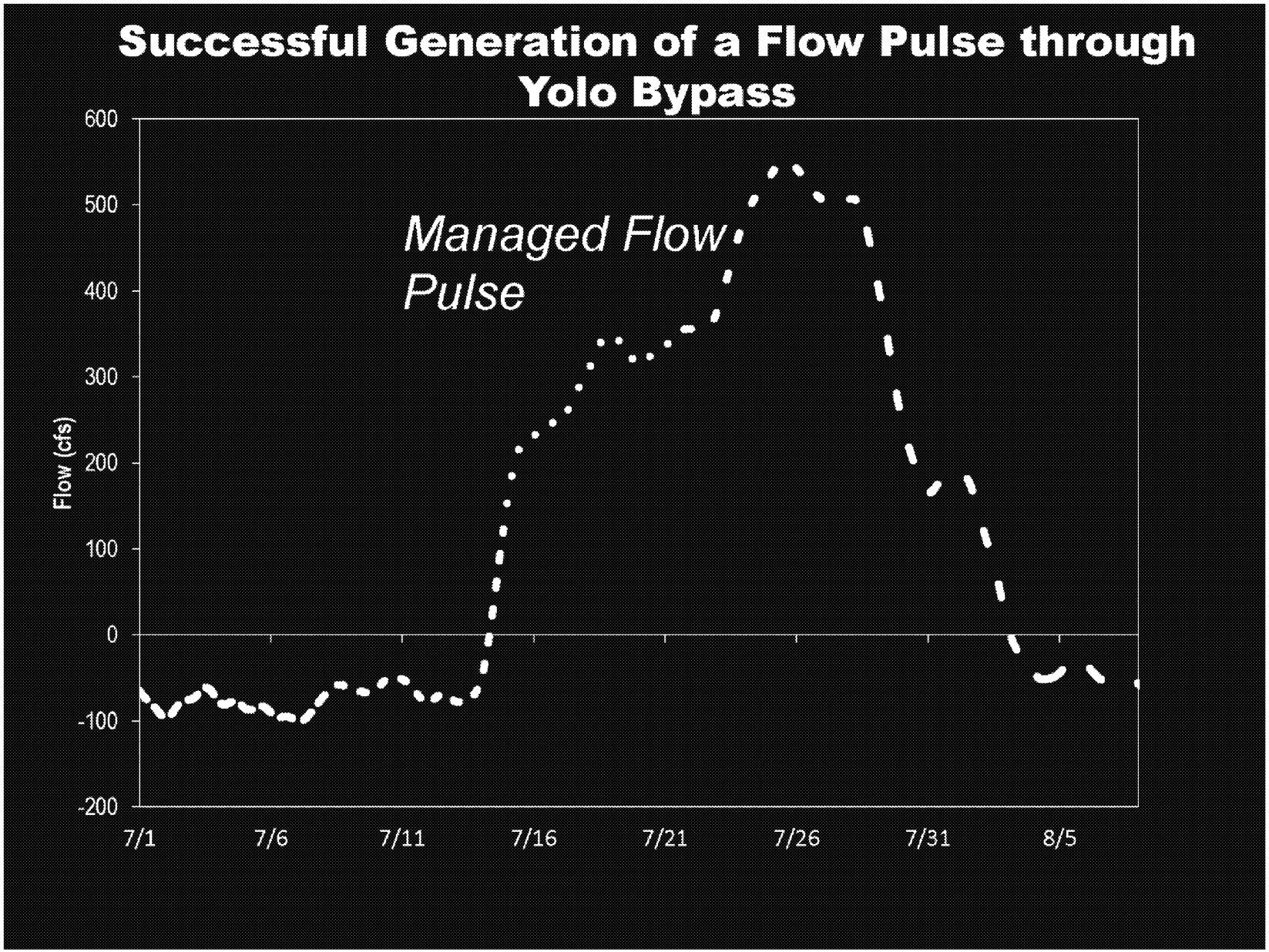

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Delta Smelt Flow Action: Study Team

Zooplankton: Kimmerer

Field Coordination: Jared Frantzich
Flow
Water quality
Plankton

Water quality: Bergamaschi, Downing
Invertebrates: Feyrer
Contaminants: Orlando
Benthos: Thompson

Funding
Dept Fish and Wildlife
Dept Water Resources
US Bureau of Reclamation
State and Federal Water Contractors Association

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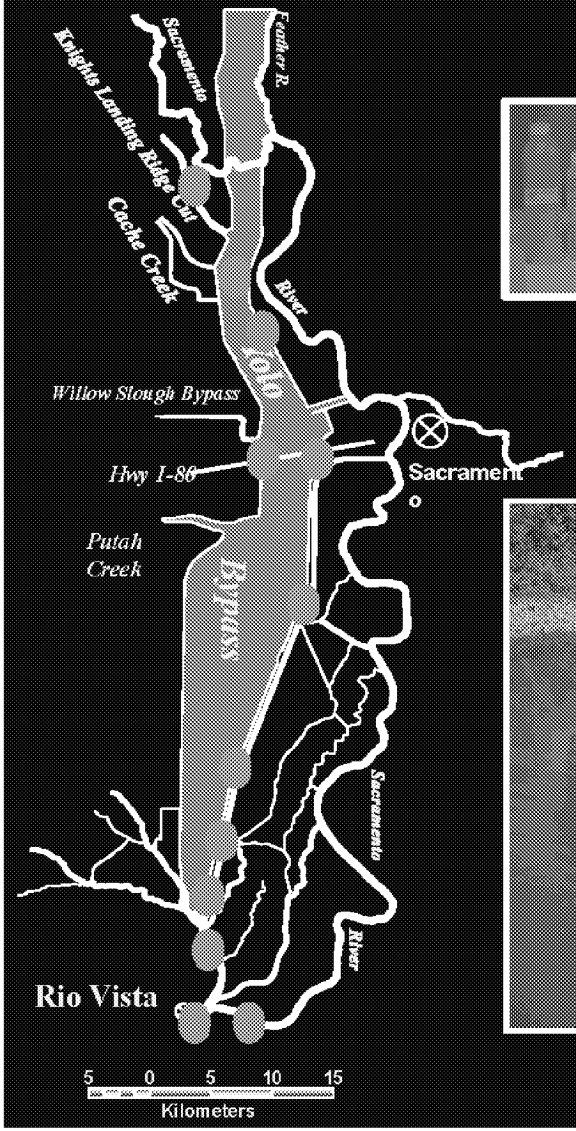
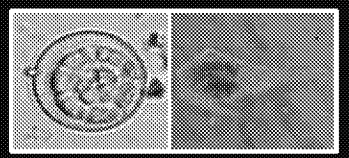
Extensive Sampling to Evaluate Flow Pulse



Nutrients

WQ Monitoring



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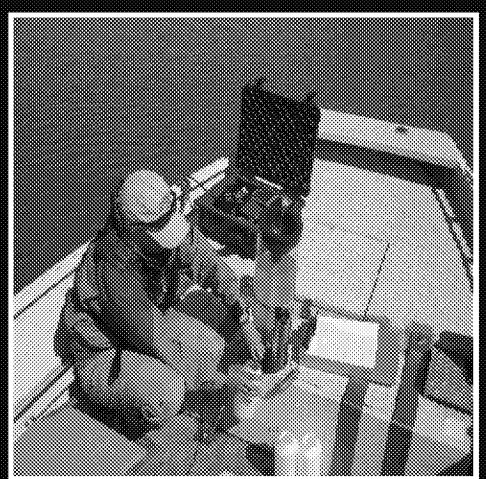

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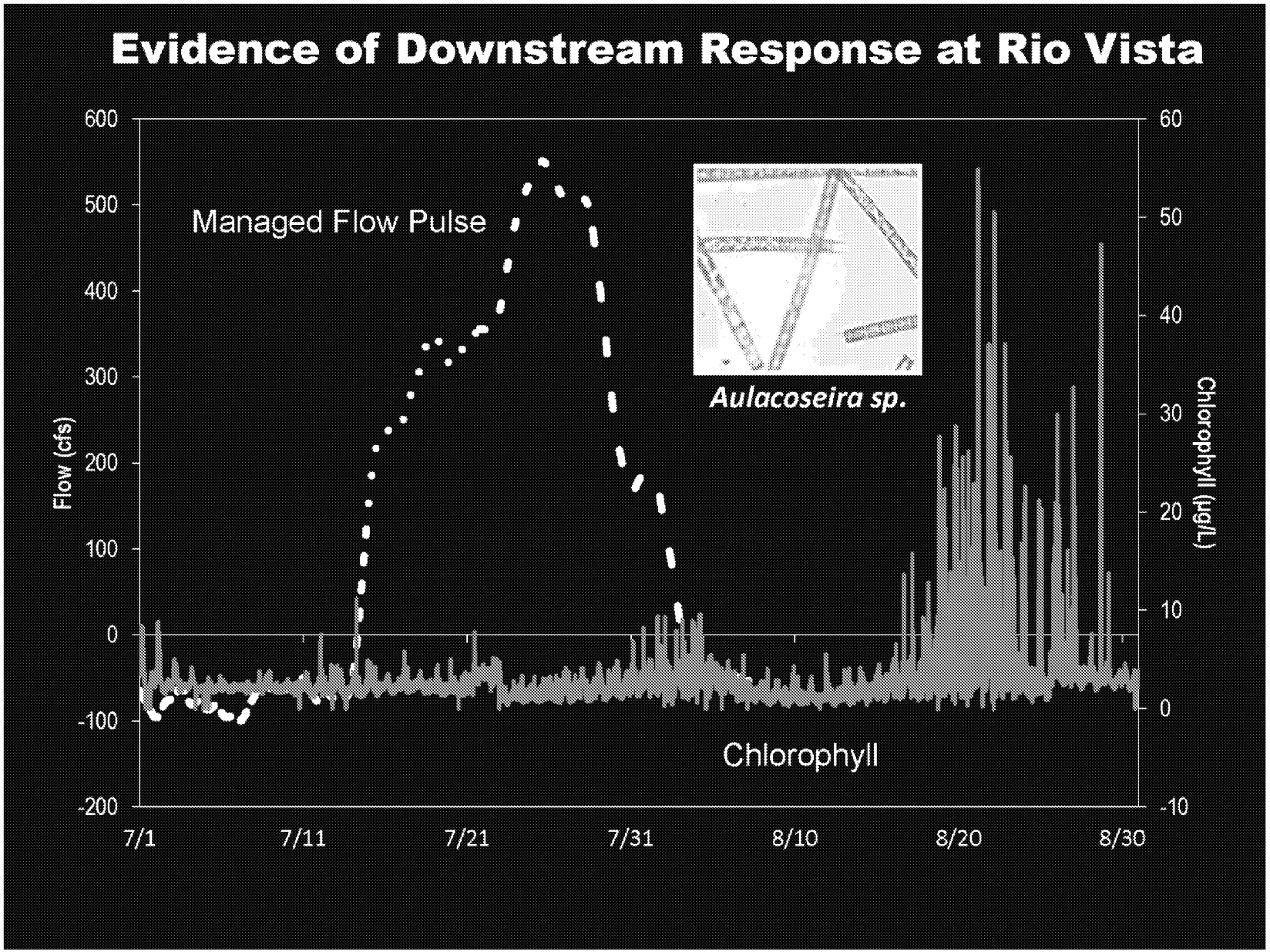
Evidence of Downstream Response at Rio Vista



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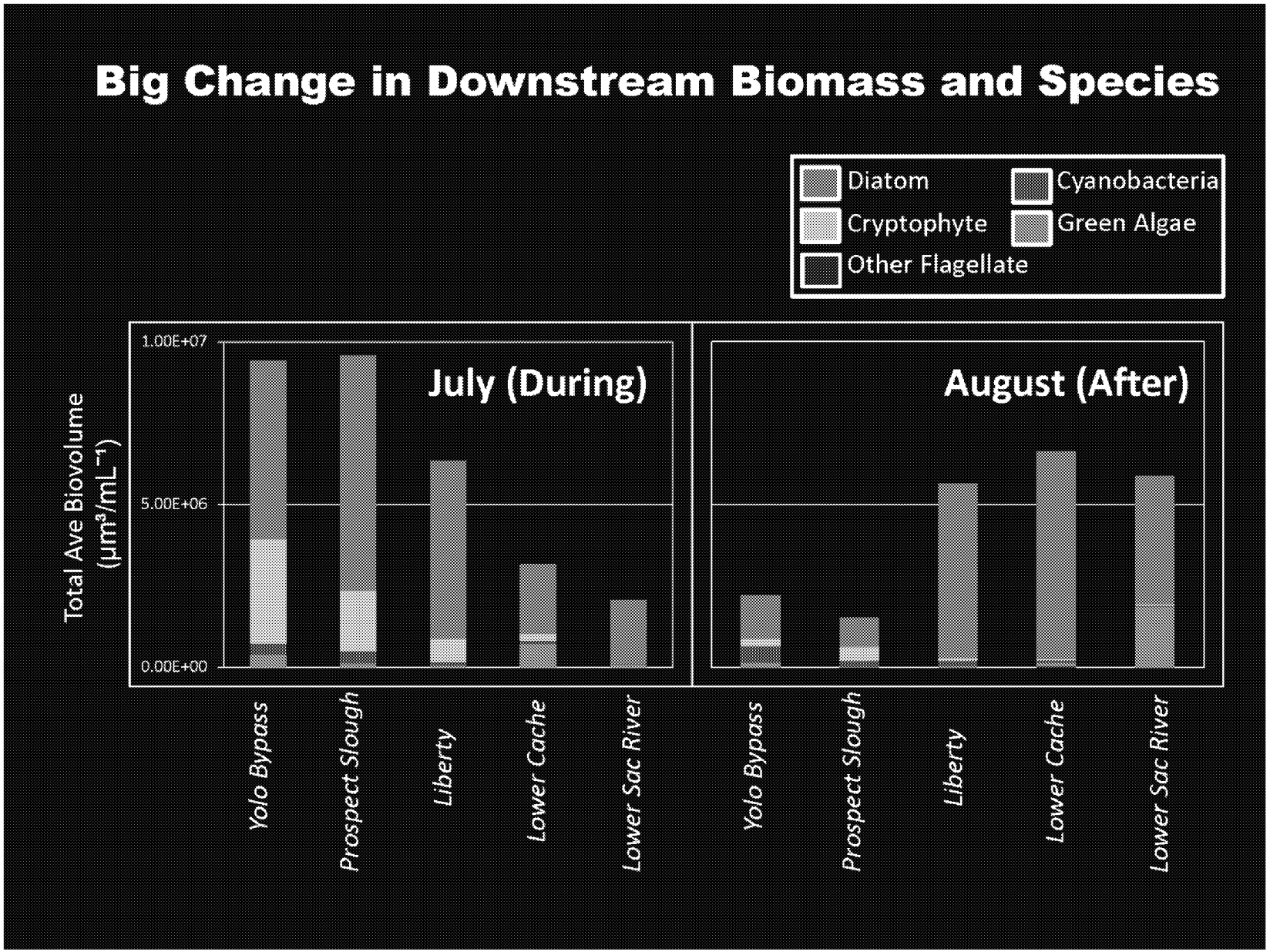
Big Change in Downstream Biomass and Species



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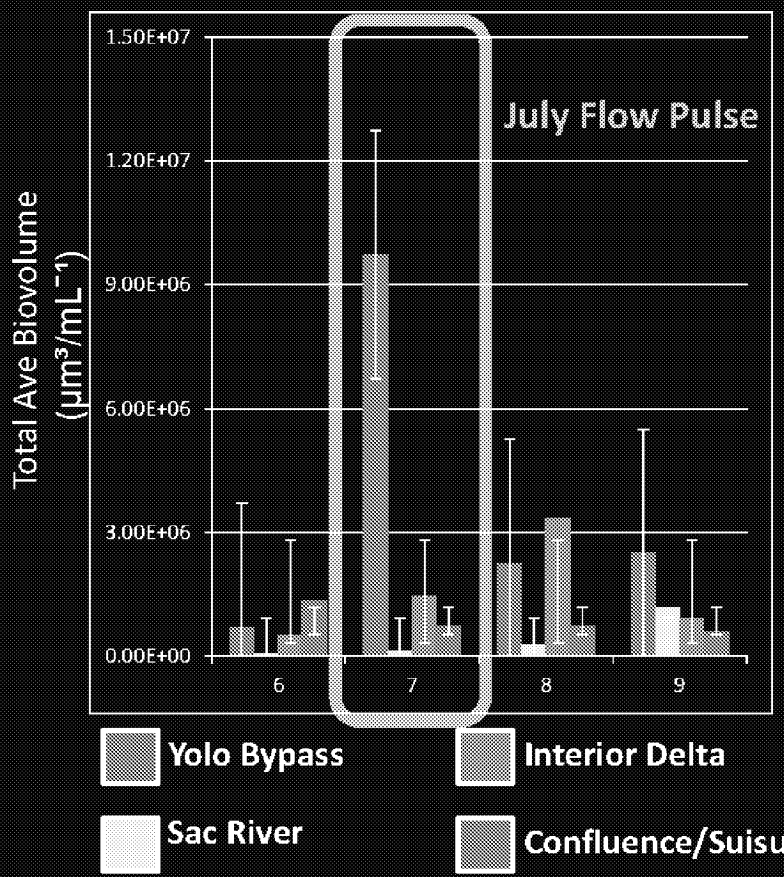
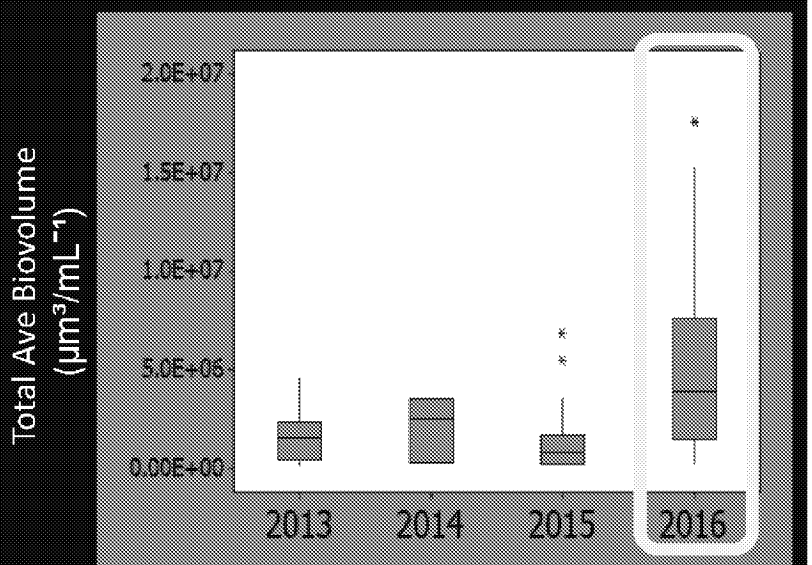
Response in Yolo Bypass Was Impressive

Higher than other Delta Regions



Higher Than Prior Years



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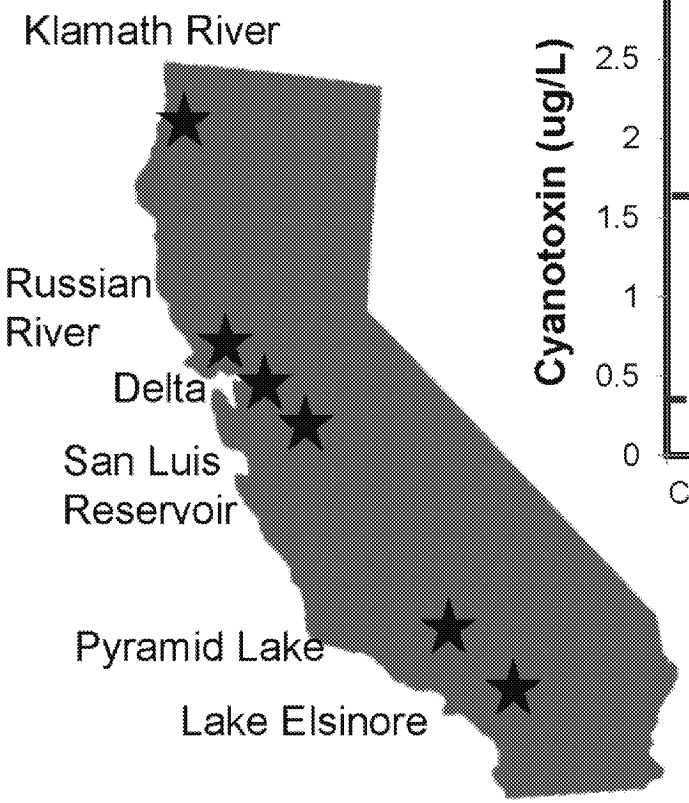
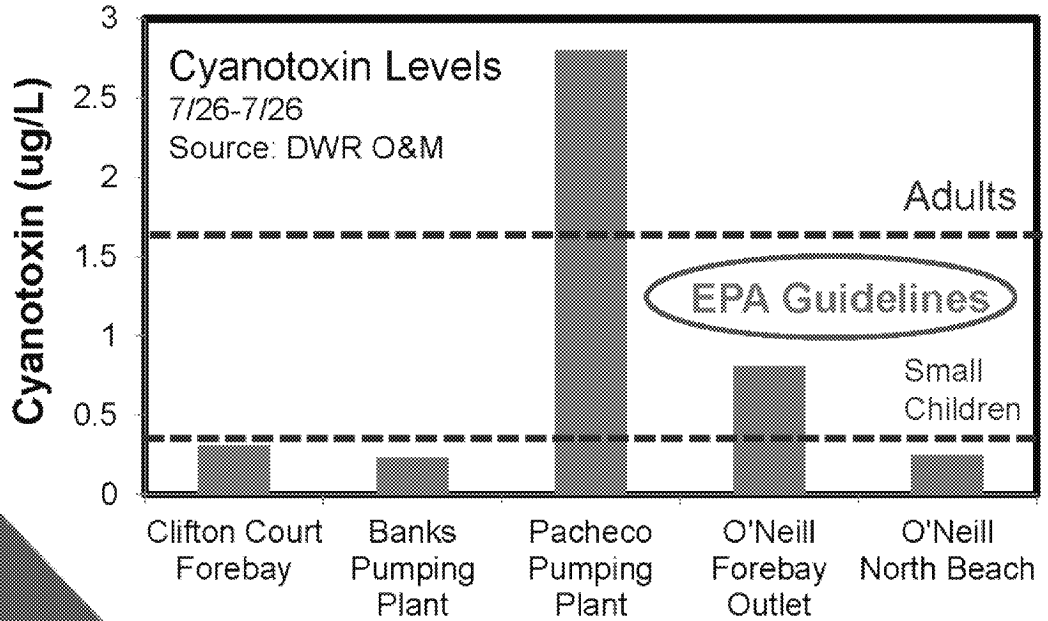
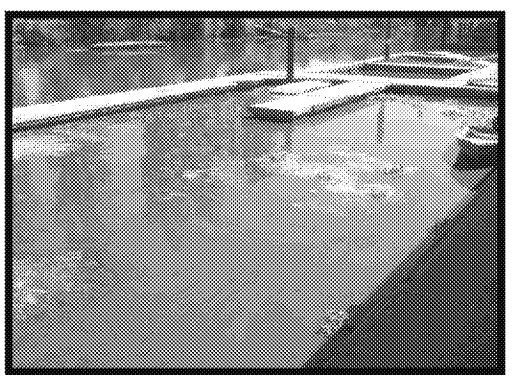
Contrast With Harmful Algal Blooms Elsewhere







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PURPOSE:	PHYSICAL PUBLIC BENEFITS ECOSYSTEM PRIORITIES A2	CHECKER:	J HERRIN	DATE:	2017 AUGUST
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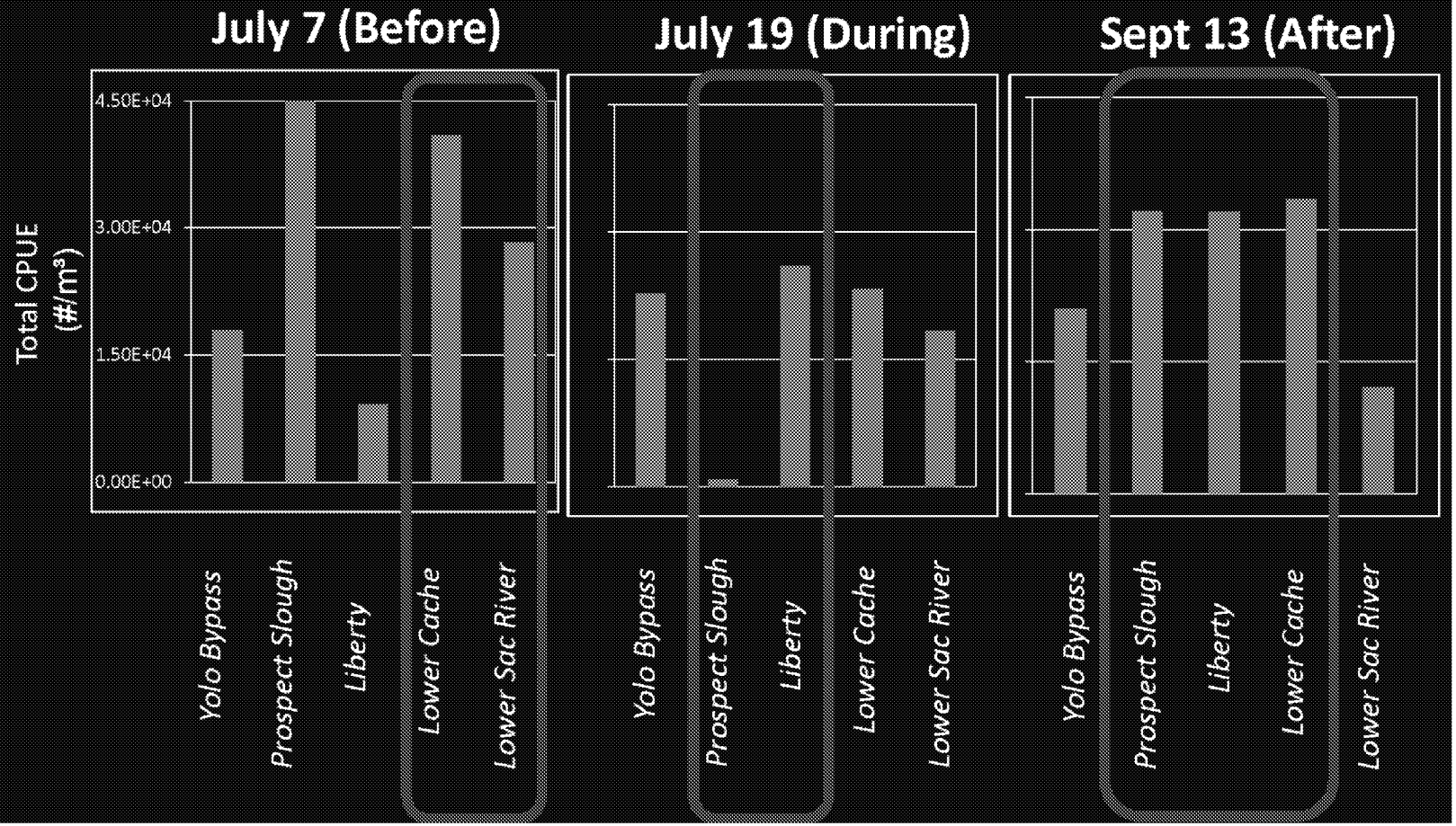
NOTES:				PAGE: 28	OF 44

Copepod Response Less Apparent

*High Downstream Abundance

*Downstream Export?

*Downstream Abundance Increase



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PURPOSE:	PHYSICAL PUBLIC BENEFITS ECOSYSTEM PRIORITIES A2	CHECKER:	J HERRIN	DATE:	2017 AUGUST
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But… Evidence That Food Increased Copepod Egg Production

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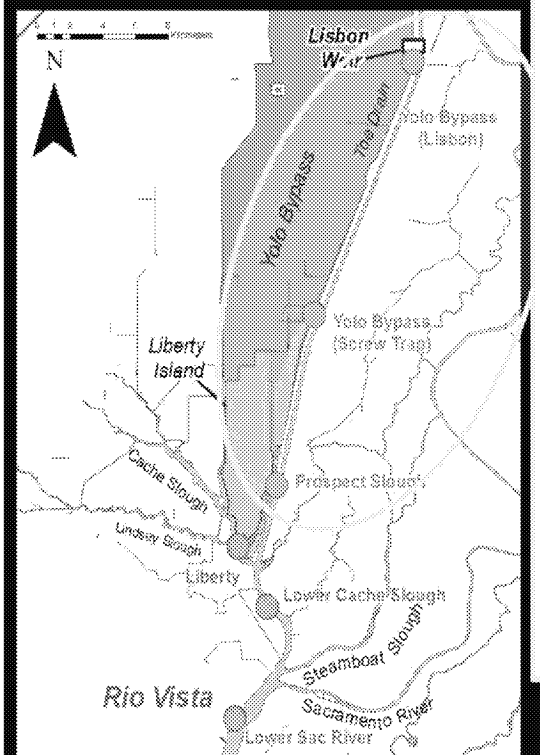

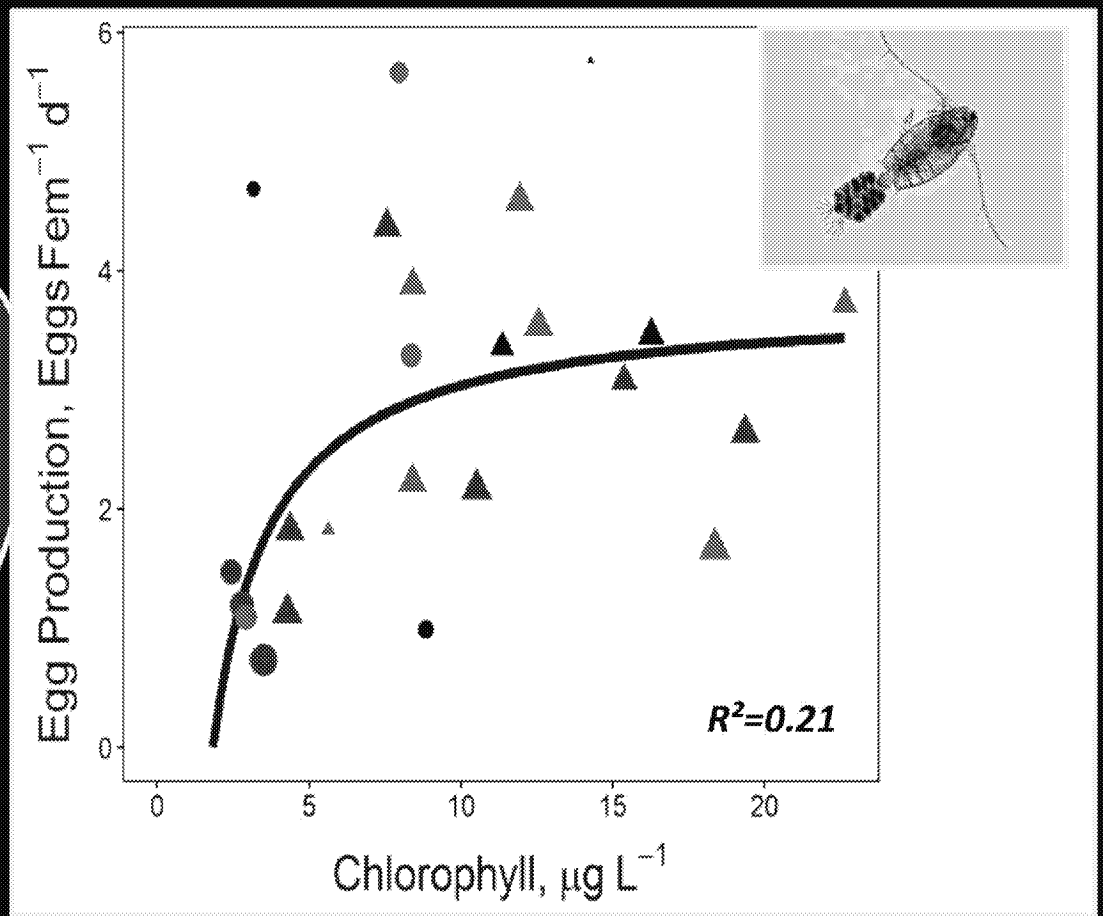

2015 & 2016 Results

STATUS:	FINAL	PREPARER:	N PONFERRADA	PHASE: 1	VERSION: A
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Good Media Coverage of the Action

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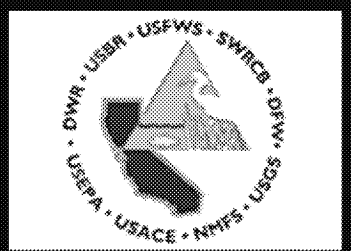
Future Plans

- Planning Efforts for 2017 Summer/Fall Flow Pulse



- Increased Project Funds for FY 2017 and 2018

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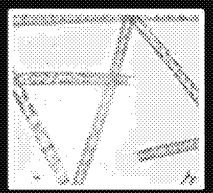
Summary

-Positive downstream plankton response



-Solid relationships for the future

-Successful Adaptive Management

Science → Managed Action → Future Management Strategy

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Ecosystem Priority 14: Ecosystem Priorities Application Worksheet– Terrestrial

Effects of Water Reductions at Refuges:

Reduction in water allocations of 50% to 25% of normal deliveries at Sacramento, Colusa and Delevan NWRs during dry or critically dry years would have the following impacts on wetland habitat and wetland dependent species (source: Drought Contingency Plans for Sacramento, Colusa and Delevan NWRs - USFWS 2011a, 2011b, 2011c).

For 50% of normal deliveries, wetland acreage at the three refuges would be reduced by 30–50%. Composite acreages of seasonal and permanent wetlands at all three refuges totals 15,525 acres (based on 2010 data), which includes 13,722 acres of seasonal wetlands (timothy grass and water grass) and 1,803 acres of permanent and semi-permanent wetland/brood ponds. A 30–50% reduction for permanent and seasonal wetlands would amount to a loss of 4,658 to7,762 acres. For 25% of normal deliveries, total wetland acreage at the three refuges would be reduced by 60-70%, amounting to loss of 9,315 to 10,867 acres. In addition to the direct loss of wetlands, longer term impacts would also occur to future wetland habitat quality throughout the refuges. Loss of permanent pond acreage would be 80% for both the 50% and 25% reductions of normal deliveries. Other impacts on wildlife of reductions to 50 to 25% of normal deliveries include:

- Very early spring draw-downs of wetlands which severely limits shorebird habitat and results in poor germination for important wildlife and waterfowl plants.
- Loss of permanent pond acreage adversely affects habitat for special-status species such as giant garter snakes, tricolored blackbirds, western pond turtles, and for duck broods.
- Complete elimination of irrigation for annual food plants and control of invasive species such as cocklebur, resulting in increased mowing/diesel fuel consumption to mitigate.
- Flood-ups delayed on remaining acreage, resulting in widespread crop depredation in nearby agricultural lands.
- Extreme waterfowl crowding and disease risk (avian botulism (Type C) and avian cholera).
- Reduced public use on all refuge habitats reduced (or eliminated for 25% of water delivery scenario) other than having the Sacramento National Wildlife Refuge (NWR) visitor center open, and visitor use would decrease to a fraction of normal.

Value of Ricelands to Wildlife

The Central Valley of California supports one of the largest concentrations of wintering waterfowl in the world, despite loss of 90% of its historic wetlands. The 6–7 million waterfowl that winter annually in the Central Valley rely upon a mix of wetland and agricultural food resources to meet their energetic needs (Eadie et al. 2008, Petrie et al. 2016). Flooded rice fields and surrounding refuge wetlands in the Sacramento-San Joaquin Valley function as some of the most important waterfowl wintering habitat on the Pacific Flyway, supporting the majority of Flyway population in some years (Migratory Bird Conservation Partnership 2014). Ricelands are indispensable components of waterbird habitat; residual rice, weed seeds, and invertebrates provide food for many avian species during fall and winter (Eadie et al. 2008). Ricelands also provide breeding habitat for a variety of birds, and rice fields that are flooded after harvest (i.e., winter flooded) to decompose rice straw provide many of the same habitat values for

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waterfowl as the wetlands that they replaced. Droughts adversely affect foraging habitat for wildlife that depend on Central Valley seasonal wetlands and ricelands. An analysis by Petrie et al. (2016) found that in droughts food supplies could be exhausted for ducks by mid- to late winter and by late winter or early spring for geese. For ducks, these results were strongly related to projected declines in winter-flooded rice fields that provide 45% of all the food energy available to ducks in the Central Valley in non-drought water years (Petrie et al. 2016).

CalSim Model Runs - Refuges

Table A2-6 summarizes CalSim II Model Runs conducted on June 21, 2017 and show the net increase in water supply available for all refuges with implementation of the project.

Table A2-6. Difference: WSIP 2030 With Project minus WSIP 2030 Without Project, Refuge Water Supplies (Central Valley Project [CVP] Contract, Sites and Acquisitions Supplies), Long-term Average and Average by Water Year Type

	Total Refuge L2 (Mar–Feb TAF)	Total Refuge L4 (Mar–Feb TAF)
Long-term		
Full Simulation Period[1]	8	35
Water Year Types[2]		
Wet (30%)	3	53
Above Normal 15%	3	47
Below Normal 21%	9	38
Dry 20%	14	21
Critical 15%	11	1

[1] Based on the 82-year simulation period

[2] As defined by the Sacramento Valley 40-30-30 Index Water Year

Deliveries of additional Level 2 and Level 4 water during dry and critically dry years would avoid loss of up to 10,867 acres of wetland habitat on the Sacramento, Colusa, and Delevan NWRs, and the other direct and indirect impacts of reduced water availability described above.

Refuges in the Mendota Pool and the Tulare Basin could also benefit from additional deliveries from the Sites Project. Refuges in these areas include the Kern and Pixley NWR and the CDFW Mendota Wildlife Area. Additional water supply is needed to meet the goals and objectives outlined in the Comprehensive Conservation Plan for Kern and Pixley National Wildlife Refuges (USFWS 2005) and also to improve management of seasonal and permanent wetlands in the Mendota Wildlife Area. Table A2-7 summarizes the results of CalSim II Model Runs that shows the average increased availability of water for refuges and other beneficiaries in the Mendota Pool and Tulare Basin in 2030 with the project, and also the increased water supply available during dry and critically dry years.

Table A2-7. Difference: WSIP 2030 With Project minus WSIP 2030 Without Project for Sites Deliveries of Incremental Level 4 Refuge

Modeled Beneficiaries	Average Increase in Deliveries (TAF/yr)	Dry and Critical Increase in Deliveries (TAF/yr)
Mendota Pool	28	10
Tulare Basin	6	2

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CalSim Model Runs - Ricelands

As shown in Table A2-8 and Table A2-9, additional water would be available to support rice plantings in dry and critically dry years with the project. Table A2-8 and Table A2-9 summarize CalSim II Model Runs conducted on June 21, 2017 and show the net increase in water supply available for agricultural users in the Central Valley with implementation of the project.

Table A2-8. Difference: WSIP 2030 With Project minus WSIP 2030 Without Project Sites Deliveries to Sacramento Valley Members: Long-term Average and Average by Water Year Types

Analysis Period[1]	Sacramento Valley (Mar–Feb TAF)
Long Term	
Full Simulation Period	129
Water Year Type	
Wet (30%)	62
Above Normal 15%	118
Below Normal 21%	155
Dry 20%	186
Critical 15%	165

Table A2-9. Difference: WSIP 2030 With Project minus WSIP 2030 Without Project Sites Deliveries to South of Delta Members for Agriculture: Long-term Average and Average by Water Year Types

Analysis Period[1]	Jan-Dec, TAF)
Long Term	
Full Simulation Period	23
Water Year Type	
Wet (30%)	2
Above Normal 15%	-1
Below Normal 21%	23
Dry 20%	52
Critical 15%	50

[1] Based on the 82-year simulation period

[2] As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (State Water Resources Control Board [SWRCB] D-1641, 1999)

[3] Includes Sites delivery to Tehama-Colusa Canal Authority (TCCA) members, Glenn Colusa Irrigation District (GCID), RD108, County of Colusa, and Western Canal Water District

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Ecosystem Priority 15: Develop and Implement Invasive Species Management Plans

Consistent with this priority, the Authority will create habitat in the vicinity of reservoir on lands that are not accessible to the public. This area is currently covered with yellow star thistle (*Centaurea solstitialis*) and goatgrass (*Aegilops triuncialis*). The yellow star thistle will be eliminated and replaced with species characteristic of native California prairie.

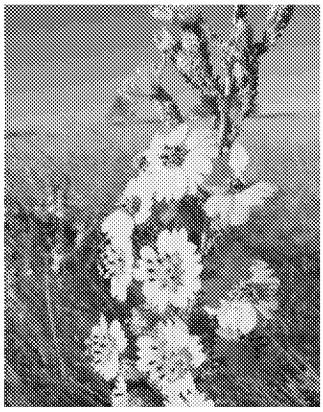

Figure A2-3: Virgate tarplant

Central Valley Prairie

Plant Composition: Burcham (1957) mapped most of "pristine California Prairie" in the Central Valley before agriculture had converted most of this habitat to cropland. His mapping matches the early Valley's accounts by John Muir who described the California Central Valley (CV) Prairie as a sea of wildflowers with little grass. He identified numerous colorful forbs from the genera of Layia, Lasthenia, Lupinus, and Eschscholzia dominating the prairie in spring, and a second late summer domination by flowering forbs like virgate tarplant (*Holocarpha virgata*) and its other Asteraceae relatives. Additionally, there are summer blooming perennials like narrow-leaved mule's ears (*Wyethia angustifolia*) and perennial lupine (*Lupinus formosus*) that survive in CV Prairie relic areas where purple needlegrass (*Stipa pulchra*) would be expected.

Extent: Since Burcham's mapping, much of the CV Prairie habitat was lost to urbanization and cultivation. The CV Prairie closely corresponds with the extent of California Grassland habitat in the Central Valley.

Soils: Prairie soils do not support trees and shrubs because their hardpans and clay horizons keep most water too close the soil surface. Some believe California prairie was once covered by bunchgrasses (which are now uncommon), but there is little documentation or evidence for this belief. In fact annual wildflowers covered the floor of the Valley. California Central Valley Prairie typically occurs on alluvial valley soils that favor herbaceous vegetation because of their fine texture and often abundant clay. Before urbanization and cultivation, CV Prairie primarily occurred on "*recent alluvium*", so named by geologists because it was deposited during the 10,000 years since the last Ice Age. However, because of the high fertility and low relief, this soil type became the prime land for agriculture and development. Currently the last extant areas of CV Prairie are now found on "*older alluvium*" that was formed from 10,000 to 2 million years ago. Soils in these areas are coarser, less fertile, hillier, and farther from the Valley center. As a result of that, these areas are less often cultivated or urbanized and are very often used for grazing, a land use that in some cases preserves native prairie plants.

The CV Prairie fine and clayey soils are a great substrate for rhizomatous grasses and shallow rooted annual species because they can densely cover its moist and fertile surface. In contrast, coarse and sandy soils favor deep and wide extending roots of bunch grasses, trees and shrubs because water and air can penetrate freely, however, water and nutrients are scarce near the surface.

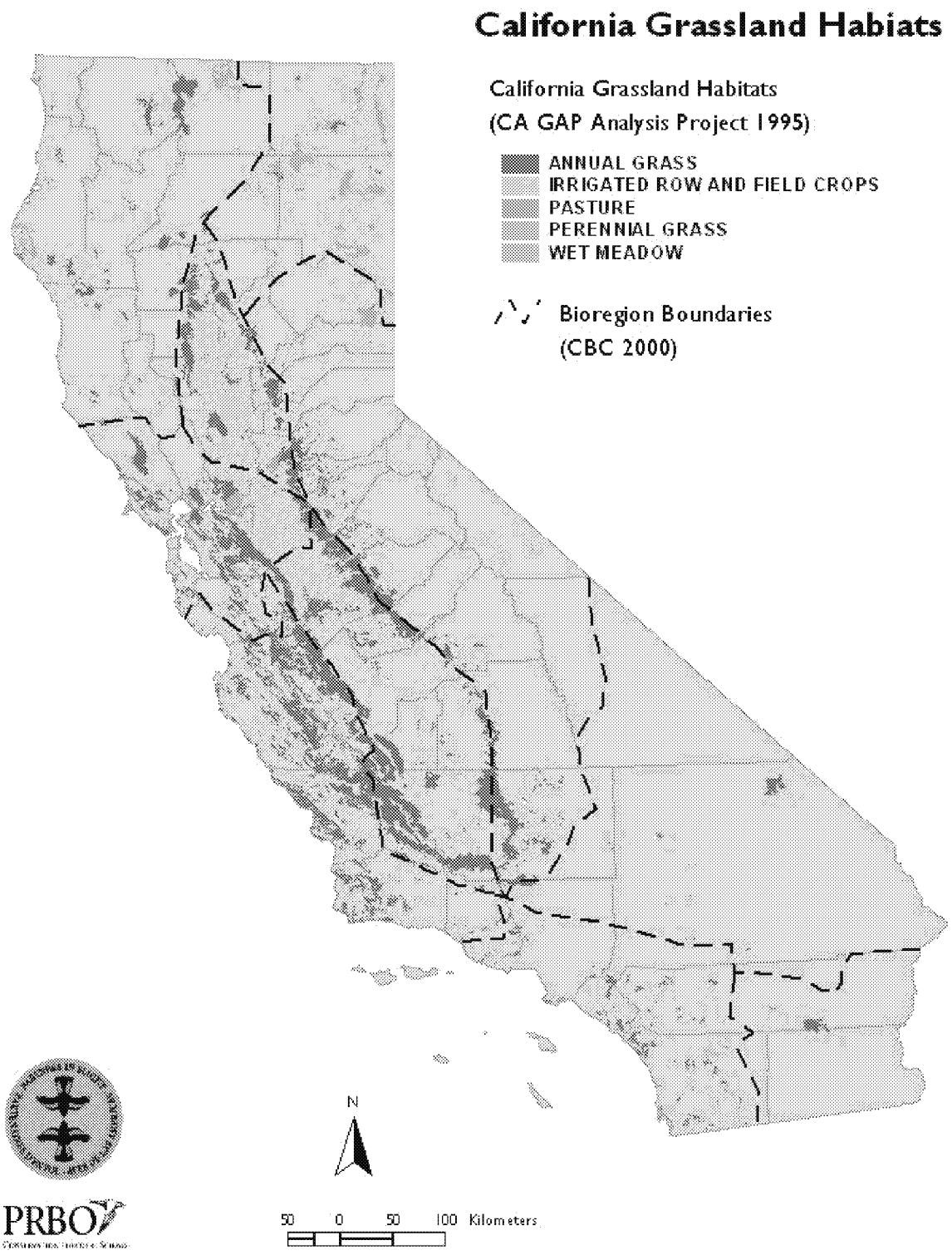

Figure A2-4 California Grassland Habitats mapped in 1995 by the GAP Analysis Project

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Plants: The CV Prairie differs from other prairies of the world in both identity of the perennial species and the larger number and the importance of annuals (Beetle 1947). Typical fine clayey soils of the CV Prairie would have the creeping wildrye (*Leymus triticoides*) as a dominant grass species along with large number of annual forbs such as California poppy (*Eschscholzia californica*), purple owl clover (*Orthocarpus purpurascens*), virgate tarplant, tidytips (*Layia platyglossa*), narrowleaved mule's ears (*Wyethia angustifolia*), perennial lupine (*Lupinus formosus*), Ithuriel's spear (*Triteleia laxa*), tomcat clover (*Trifolium willdenovii*), gilia (Gilia tricolor), (*Orthocarpus erianthus*), blue-eyed grass (*Sisyrinchium bellum*), and various other species of the genera *Layia*, *Brodiaea*, *Calandrinia*, *Nemophila*, *Castilleja*, and *Lupinus*. On the marginal coarse soils along the edges of the valley, bunchgrasses such as purple needlegrass (*Stipa pulchra*), and nodding needlegrass (*Stipa cernua*), were dominant along with important associates such as blue wildrye (*Elymus glaucus*), pine bluegrass (*Poa scabrella*), and deergrass (*Muhlenbergia rigens*).

Central Valley Prairie Importance

Despite the fact that the CV Prairie provides critical foraging habitat for the golden eagle, nesting and feeding habitat for native bees, refuge borrows for amphibians, and habitat for rich native flora and fauna, CV Prairie does not receive as much attention as the often adjacent vernal pool and riparian habitats for which it serves as an important buffer.

Habitat for Native Plant Diversity: The CV Prairie provides the optimal habitat for hundreds of native plant species that have adapted to the fine clayey soils and high water table in these areas.

Golden Eagle Foraging Habitat: Golden Eagles live in open and semi-open country featuring native vegetation across most of the Northern Hemisphere.

Plant Pollinator Habitat: The spring growth of native forbs represents a tremendous food resource for pollinators. Bees, bumblebees, beetles, hummingbirds, bats, butterflies, moths, and flies are some of the pollinators needed by 90% of flowering plants and over 30% of food crops (Pollinator Partnership 2010). CV Prairie provides food and shelter for bees and other insects that pollinate our food crops. The importance of these native pollinators, especially ground and twig nesting bees, is increasing due to the current collapse of populations of the European honeybee.

Central Valley Prairie Creation Approach

Site Preparation: In areas where residual native species cover is present, it will be preserved. At the same time invasive species will be controlled and additional native species seeded. However, very often, there are virtually no residual native plants at heavily grazed sites and the "blank slate" restoration approach will be adopted if that is the case at the Sites Reservoir restoration areas. The soil texture, compaction, profile and chemistry, as well as hydrology will be closely analyzed during this phase to determine the best composition of native plant species to be seeded.

Existing Weed and Weed Seedbank Removal: Non-native vegetation eradication involves removal of the existing exotic species to the greatest extent possible (including the seed bank) and installing a native plant community from seed. Typically, existing vegetation eradication consists of three to four times repeated shallow tilling and irrigation cycles to exhaust the seed bank followed by re-seeding with native vegetation. Hard to eradicate weed species such as the yellow star thistle (*Centaurea solstitialis*) and goatgrass (*Aegilops triuncialis*) a more intense eradication methods such as burning, solarization and as a last resort herbicide spraying may be used. It will be also very important to control these invasive species in weed infested areas adjacent to and up-wind of the project. Increasing the cover and diversity of native forbs - either by actively planting them or by removing the invasive species with which

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they compete— will greatly contribute to the restoration success. As one example, hayfield tarplant (*Hemizonia congesta*) is often added to a native bunchgrass seed mix specifically to armor restored grasslands against re-invasion by yellow star thistle because it is the greatest impediment to successful grass establishment. Annual applications of a broadleaf herbicide are also often necessary to keep it at bay. While herbicides are effective, an ecosystem that depends on regular herbicide application does not meet the definition of self-sustaining. A promising technique for providing natural invasion resistance to restored grasslands is to select native species that compete strongly for the same resources as likely invaders (Young et al. 2009). Native tarplants are among the grassland species most analogous to yellow star thistle in the timing of growth and seed set. These late-season annual forbs germinate with the first fall rains and spend the winter and spring developing a tap root. Doing so allows them to take advantage of deep soil moisture in the summer and to flower and set seed long after the majority of annuals have completed their life cycle. Yellow star thistle is more effectively eliminated if a diversity of native late season forbs is planted that compete for resources with the thistle in slightly different ways. As another example, effective control of the invasive annual barbed goatgrass (*Aegilops triuncialis*) with analogous native species results in a natural resurgence of native forbs and a corresponding increase in the activity of native bees.

Seed Collection and Seeding: Because disturbed CV Prairie usually lacks any significant native seed bank, restoring prairie will require the reseeding of native species. Native species should be collected from the nearest vicinity around Sites Reservoir and can be seeded either manually with belly grinders, by the hydro-mulching method or with seed-drillers if the amounts of seed are small. Seed collection should be initiated immediately after project start so that sufficient seed amounts and diversity are available at the time of installation. The traditional approach to prairie restoration emphasizes the establishment of native bunch grasses. Following site preparation, a seed mix of up to seven native grass species is applied.

Ecosystem Priority 16: Ecosystem Priorities Application Worksheet– Terrestrial

CalSim Model Runs - Refuges

Table A2-10 summarizes CalSim II Model Runs conducted on June 21, 2017 and show the net increase in water supply available for all refuges with implementation of the project.

Table A2-10. Difference: WSIP 2030 With Project minus WSIP 2030 Without Project, Refuge Water Supplies (CVP Contract, Sites and Acquisitions Supplies), Long-term Average and Average by Water Year Type

	Total Refuge L2 (Mar–Feb TAF)	Total Refuge L4 (Mar–Feb TAF)
Long-term		
Full Simulation Period[1]	8	35
Water Year Types[2]		
Wet (30%)	3	53
Above Normal 15%	3	47
Below Normal 21%	9	38
Dry 20%	14	21
Critical 15%	11	1

[1] Based on the 82-year simulation period

[2] As defined by the Sacramento Valley 40-30-30 Index Water Year

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Native Species Benefiting from Implementation of the Project

The following native species occur on the Sacramento NWR Complex refuges and have commercial, recreational, scientific, or educational uses and values, and would benefit from implementation of the project:

Table A2-11. Waterfowl

Common Name	*Scientific Name*
Ross's Goose	*Chen rossii*
Snow Goose	*Chen caerulescens*
Green-winged Teal	*Anas crecca*
Gadwall	*Anas strepera*
Cinnamon Teal	*Anas cyanoptera*
Northern Shoveler	*Anas clypeata*
Greater White-fronted Goose	*Anser albifrons*
Northern Pintail	*Anas acuta*
Western Meadowlark	*Sturnella neglecta*
Ruddy Duck	*Oxyura jamaicensis*
American Wigeon	*Anas americana*
Mallard	*Anas platyrhynchos*
Ring-necked Duck	*Aythya collaris*
Lesser Scaup	*Aythya affinis*
Bufflehead	*Bucephala albeola*
Common Goldeneye	*Bucephala clangula*
American Green-winged Teal	*Anas crecca carolinensis*
Canada Goose	*Branta canadensis*
Blue-winged Teal	*Anas discors*

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Table A2-12. Shorebirds/Egrets/Other Wetland-Dependent Species

Common Name	*Scientific Name*
American Bittern	*Botaurus lentiginosus*
Common Snipe	*Gallinago gallinago*
Eared Grebe	*Podiceps nigricollis*
Great Egret	*Ardea alba*
American White Pelican	*Pelecanus erythrorhynchos*
Black-necked Stilt	*Himantopus mexicanus*
White-faced Ibis	*Plegadis chihi*
Double-crested Cormorant	*Phalacrocorax auritus*
Great Blue Heron	*Ardea herodias*
Marsh Wren	*Cistothorus palustris*
Western Pond Turtle	*Actinemys marmorata*
Snowy Egret	*Egretta thula*
American Avocet	*Recurvirostra americana*
Killdeer	*Charadrius vociferus*
Common Gallinule	*Gallinula galeata*
Pied-billed Grebe	*Podilymbus podiceps*
Ring-billed Gull	*Larus delawarensis*
Long-billed Curlew	*Numenius americanus*
North American River Otter	*Lontra canadensis*
Greater Yellowlegs	*Tringa melanoleuca*
Virginia Rail	*Rallus limicola*
Clark's Grebe	*Aechmophorus clarkii*
Caspian Tern	*Hydroprogne caspia*
Wilson's Snipe	*Gallinago delicata*
American Herring Gull	*Larus argentatus smithsonianus*

Table A2-13. Special-Status Species

Common Name	*Scientific Name*
Peregrine Falcon	*Falco peregrinus*
Northern Harrier	*Circus cyaneus*
American White Pelican	*Pelecanus erythrorhynchos*
White-faced Ibis	*Plegadis chihi*
Greater Sandhill Crane	*Grus canadensis*
Bald Eagle	*Haliaeetus leucocephalus*
Double-crested Cormorant	*Phalacrocorax auritus*
Tricolored Blackbird	*Agelaius tricolor*
Loggerhead Shrike	*Lanius ludovicianus*
Cooper's Hawk	*Accipiter cooperii*
White-tailed Kite	*Elanus leucurus*
Western Pond Turtle	*Actinemys marmorata*
Giant garter snake	*Thamnophis gigas*

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EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

May 23, 2018

Joseph Yun
Executive Officer
California Water Commission
P.O. Box 942836
Sacramento, CA 94236-0001

Dear Mr. Yun:

RELATIVE ENVIRONMENTAL VALUE OF WATER STORAGE INVESTMENT PROGRAM PROJECTS AND DEPARTMENT FINDINGS

Thank you for your leadership during this process. As you know, the California Department of Fish and Wildlife (Department) is tasked with the responsibility of making recommendations to the California Water Commission (Commission). I acknowledge the complexity of the process has been challenging for you, Commissioners, the reviewing agencies, and each applicant. No one has tried a competitive approach to water storage on such a scale before. The good news is that the Commission and applicants are as close as ever to adding much needed water storage capacity through a portfolio of different types of projects across a diverse geography.

This competitive approach must adhere to the controlling statute and the implementing regulations. At each step of your process, our Department has always based our recommendations on the plain instructions in the statute and the regulations. All of the current applicants, as members of a broad-based stakeholder advisory group, helped develop these regulations during a two-year dialogue. At the last Commission meeting, the Department's recommendations to the Commission on monetized ecosystem benefits to include in the public benefit ratio calculations were discussed. This package contains our next assignment under the regulations related to our calculation of relative environmental value for the ecosystem improvements of a project and preliminary findings. However, as I describe at the end of this letter, each applicant retains an important obligation to complete due diligence for their projects promptly.

Pursuant to the Water Storage Investment Program (WSIP) regulations, this letter and attachments transmit to California Water Commission (Commission) staff (1) the relative environmental value scores calculated by the California Department of Fish and Wildlife (Department) and (2) the Department's findings on the public benefits claimed by each WSIP project. The WSIP regulations require the Department to calculate a relative environmental value for ecosystem improvements, based on information supplied in each project's application. (Cal. Code Regs. tit. 23, § 6007, subd. (c).) Additionally, if the Department "finds the public benefits as described in a project's application meet all of the requirements of Water Code section 79750 *et seq.* for which the reviewing

agency is responsible, the reviewing agency shall provide to the Commission a written statement confirming the finding." (Cal. Code Regs., tit. 23, § 6012, subd. (d).) This finding is a "preliminary assessment of public benefits based on information supplied in the application that indicates that a project's public benefits meet the requirements of Water Code section 79750 *et seq.*" (Cal. Code Regs., tit. 23, § 6012, subd. (a).)

For each ecosystem benefit quantified, project applications were required to identify at least one applicable ecosystem priority listed in section 6007, subdivision (c), of the WSIP regulations. (Cal. Code Regs., tit. 23, § 6003, subd. (a)(1)(Q).) The Department applied the 10 relative environmental value criteria outlined in Table 2 of section 6007, subdivision (c)(1)(A)(1), to score each of the ecosystem priorities identified by the applicant. Based on information supplied in the application, the Department considered information supporting ecosystem benefits including the analytical methods, modeling results, and physical, chemical, or biological information. (Cal. Code Regs., tit. 23, § 6007, subd. (c)(1)(A)(1).) Section 6007, subdivision (c)(1)(A)(2), states the score shall be assigned by evaluating the degree of change between with- and without-project conditions, and the degree to which ecosystem improvements associated with each claimed priority would be provided by a project.

The relative environmental value scores reflect the Department's critical and thorough evaluations of project applications and include comments to the Commission and its staff that address the many aspects of the projects as proposed. The Department's analysis contained in this package is consistent with our analysis related to public benefits.

The Department recognizes that the projects in many cases have a long history in water management planning in California, and have additional steps in front of them that will refine the projects, reduce uncertainties, and further inform the Commission's decisionmaking. The regulations emphasize the preliminary nature of the findings submitted to you today, and the fact that changes may occur after a reviewing agency's findings. (Cal. Code Regs., tit. 23, § 6012(g).) Moreover, prior to the Commission encumbering funding, each successful applicant must enter into enforceable contracts for public benefits and non-public benefit cost shares, complete feasibility studies and environmental documentation, obtain all required federal, state, and local approvals, and provide extensive additional information to the Commission, as applicable, on items including labor compliance, urban water management plans, agricultural water management plans, and groundwater management plans or GSP(s). (Cal. Code Regs., tit. 23, § 6013(a)(1), (c).)

This letter and attachments represent the completion of the Department's technical review of WSIP projects for the purpose of contributing toward the maximum conditional eligibility determination of each project that the Commission must make. The Department looks forward to continuing to work with the Commission and project

applicants in the next phase of the WSIP.

Sincerely,

Charlton H. Bonham
Director

Encl: CDFW Findings on WSIP Public Benefits, Relative Environmental Value Scores, Technical Review Comments

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Sites Project – Relative Environmental Value Score

Project Overview

The Sites Project Authority (Applicant) proposes the Sites Project (Project) that includes a new 1.8 million acre-foot (MAF) reservoir off-stream of the Sacramento River. It would be filled by diverting excess flows from the Sacramento River at existing diversions facilities in Red Bluff and Hamilton City, and a new diversion near Delevan. The primary ecosystem benefits proposed derive from coordinated operations of Sites Reservoir, Shasta Lake, Lake Oroville, and Folsom Lake. Through the use of water stored in Sites Reservoir in substitution for releases from these other reservoirs, storage could be conserved in Shasta Lake, Lake Oroville, and Folsom Lake to increase operational flexibility and to improve river water temperatures for anadromous fish survival. Utilizing this operational design the Applicant claims temperature improvements to the upper Sacramento River that would result in higher rates of salmon survival. Similarly, the Applicant states there would be temperature improvements derived from added water stored in Oroville. The Applicant is also proposing to deliver water to the Yolo Bypass, in order to propagate nutrient rich water lower in the bypass system that would later be flushed to the Delta where smelt could benefit from increased food productivity. Lastly, the Applicant is proposing deliveries of Incremental Level 4 refuge water to National Wildlife Refuges, State Wildlife Areas, and privately managed wetlands in order to improve wetland habitat and provide benefits to species utilizing these habitats.

Ecosystem Priorities Identified by the Applicant

The Applicant has identified the following ecosystem priorities:

- Priority 1 – Provide cold water at times and locations to increase the survival of salmonid eggs and fry.
- Priority 2 – Provide flows to improve habitat conditions for in-river rearing and downstream migration of juvenile salmonids.
- Priority 3 – Maintain flows and appropriate ramping rates at times and locations that will minimize dewatering of salmonid redds and prevent stranding of juvenile salmonids in side channel habitat.
- Priority 4 – Improve ecosystem water quality.
- Priority 5 – Provide flows that increase dissolved oxygen and lower water temperatures to support anadromous fish passage.
- Priority 10 – Enhance the frequency, magnitude, and duration of floodplain inundation to enhance primary and secondary productivity and the growth and survival of fish.
- Priority 11 – Enhance the temporal and spatial distribution and diversity of habitats to support all life stages of fish and wildlife species.
- Priority 14 – Provide water to enhance seasonal wetlands, permanent wetlands, and riparian habitat for aquatic and terrestrial species on State and Federal wildlife refuges and on other public and private lands.
- Priority 15 – Develop and implement invasive species management plans utilizing techniques that are supported by best available science to enhance habitat and increase the survival of native species.
- Priority 16 – Enhance habitat for native species that have commercial, recreational, scientific, or educational uses.

The California Code of Regulations requires the California Department of Fish and Wildlife (Department) to apply 10 Relative Environmental Value (REV) criteria to score each of the priorities that an applicant claims would be provided by a project. (Cal. Code Regs., tit. 23, § 6007, subd. (c)(1)(A)(1).) Based on the information provided in the application, the Department scored each ecosystem priority listed above to determine the ecosystem REV score shown below. To implement REV Criterion 1, the Department has developed a standard calculation to assign points based on the number of ecosystem priorities a project has claimed. For each priority claimed, the Department added 0.375% to a project's final ecosystem REV score. REV Criterion 2 through 10 were each scored on a scale of 0 to 6. Detailed scores are provided in Table 1. A summary of comments for each Priority-REV combination is provided in Sites Project – Technical Review Comments.

REV Score Summary

Total Points Possible	540
Total Points Received	198.4
Additional % for Number of Ecosystem Priorities (REV Criterion 1)	3.8%
Total REV Score	**40.5%**

Sites Project – Technical Review Comments

REV Criterion 1 (Number of different ecosystem priorities claimed)

To implement Relative Environmental Value (REV) Criterion 1, the California Department of Fish and Wildlife (Department) has developed a standard calculation to assign points based on the number of ecosystem priorities a project has claimed. For each priority claimed, the Department added 0.375% to a project's final ecosystem REV score. The Department has applied the standard calculation to each of the projects.

In its application for funding under the Water Storage Investment Program, the Sites Project Authority (applicant) identified ten ecosystem priorities for the Sites Project (Project). The calculation described above resulted in an increase of 3.8% for the Project's ecosystem REV score. The Department applied the other nine REV criteria to each priority identified by the applicant. The Department's evaluation of each priority is described below.

Priority 1: Provide cold water at times and locations to increase the survival of salmonid eggs and fry.
Priority 1 – REV Criterion 2 (Magnitude of Ecosystem Improvements) Score = 2.3

Under this priority the applicant proposed coldwater improvements on the Sacramento River, Feather River, and the American River. The applicant used CALSIM and various temperature models to generate flow and temperature benefits in each of the rivers.

The magnitude of cold water benefits on the Sacramento River were calculated using SALMOD model results. The applicant used the HEC-5Q temperature model to generate temperature data for the Upper Sacramento River, and applied this data as an input into SALMOD. The applicant then used SALMOD to generate annual average production outputs. SALMOD is not a life cycle model and does not account for population changes over time. Rather, the model resets the starting population of fish for each modeled year using the programmed starting populations of each run to calculate production numbers. Because the model does not account for variations in starting populations there is low confidence in the magnitude of the ecosystem improvement as demonstrated by the SALMOD production outputs.

The applicant also identified water temperature improvements on the Feather and American Rivers as a result of the with-Project scenario increasing retained water stored in Lake Oroville and Folsom Reservoir, respectively. The applicant used the RecTemp model to generate temperature data for the Feather River. The modeled temperature improvements generally occur within a currently suitable temperature range for salmonids. As such, the modeled Feather River temperature improvements do not provide any additional benefit. When temperatures without-Project exceed temperature targets, the modeled operations do not decrease temperatures in order to meet established targets and indicate increased temperatures in the summer months across multiple year types and under all climate conditions. The applicant used the American River CE QUAL-W2 Model to generate temperature data for the American River. The modeled temperature improvements indicate a relatively small change of less than 1 degree Fahrenheit across the full simulation period. This change in temperature could potentially benefit steelhead. However, the application does not substantiate or quantify how these changes will benefit the targeted salmonids.

Priority 1 – REV Criterion 3 (Spatial and temporal scale of ecosystem improvements) Score = 3.0

The applicant targets temperature improvements for the Sacramento River in the upper portion of the Sacramento River, where the majority of salmonid spawning and egg incubation occurs. The modeled temperature improvements are most prevalent in the driest months of dry and critical years during time periods that may benefit winter run salmon. However, SALMOD outputs also indicate impacts to all runs of salmon depending on the water year type and life stage present due to flow and temperature fluctuations resulting from Project operations.

The applicant proposes the temperature changes on the Feather River in the May to November period will benefit spawning conditions for salmonids. However, the modeled results show that Project operations would not decrease temperatures to within established temperature targets from without-Project scenarios where temperatures fall outside the optimal range for Chinook salmon. Additionally, the modeling results indicate with-Project conditions result in increased temperatures in the summer months across multiple year types and under all climate conditions, in comparison to the without-Project condition.

Proposed American River temperature improvements would affect locations downstream of Nimbus Dam to Watt Avenue and could potentially provide benefits to steelhead during the targeted July through September period. However, the application does not substantiate or quantify how these changes will benefit the targeted salmonids.

Priority 1 – REV Criterion 4 (Inclusion of an adaptive management and monitoring program that includes measurable objectives, performance measures, thresholds, and triggers for managing ecosystem benefits) Score = 3.0

The applicant intends to develop an adaptive management program in partnership with state and federal agencies and utilize existing monitoring programs to collect data. The application describes a general framework to develop specific measures, targets, and thresholds. The application states that potential funding sources for adaptive management and monitoring include revenue generated from water delivery contracts. It is not clear how operational decisions would be made if physical parameters and biological responses fall outside the range of anticipated benefits.

Priority 1 – REV Criterion 5 (Immediacy of ecosystem improvement actions and realization of benefits) Score = 2.5

The applicant estimates that temperature benefits would begin to accrue in 2028 and would reach full achievement by 2030. The realization of benefits will not be measurable until 2033-2034 when the cohorts that would benefit from reduced temperatures in 2030 return to spawn. The immediacy and realization of the ecosystem improvement is dependent upon Sites' ability to deliver water in lieu of Shasta Reservoir. In order for in lieu water deliveries out of Sites, the reservoir must have sufficient storage. There is concern that the reservoir may take longer than expected to reach sufficient capacity in order to make deliveries in lieu of Shasta, which could delay the immediacy and realization of benefits.

Priority 1 – REV Criterion 6 (Duration of ecosystem improvements) Score = 3.3

The modeling results indicate the proposed temperature changes will continue over the 92 years projected. However, because there is low confidence in this ecosystem improvement, there is low confidence in the duration of the ecosystem improvement.

Priority 1 – REV Criterion 7 (Consistency with species recovery plans and strategies, initiatives, and conservation plans) Score = 2.8

The application identified several plans, strategies, initiatives, and conservation plans with which the applicant states the Project is consistent, including Action SAR-1.4 of the NOAA Fisheries Salmon Recovery Plan and three actions specified in the Sacramento Valley Salmon Resiliency Strategy (SVSRS). The SVSRS actions are: (1) increase productivity by improving spawning and incubation conditions (habitat and water quality); (2) increase productivity by increasing juvenile salmonid survival; and (3) support the full range of juvenile and adult migration conditions to maintain life history diversity. The applicant also states the Project would improve the quality of Essential Fish Habitat (EFH). The benefits identified by the applicant under this priority are consistent with the temperature objectives of the NOAA SAR-1.4 action. The first two SVSRS actions are applicable to the water temperature improvements of this priority. The last SVSRS action is associated with juvenile and adult migration conditions and appears to be more applicable to other priorities. The proposed water temperature improvements would potentially contribute to the quality of EFH. However, the ability of the Project to meet the aforementioned actions and objectives is unclear given the low confidence in the ecosystem benefit.

Priority 1 – REV Criterion 8 (Location of ecosystem improvements and connectivity to areas already being protected or managed for conservation values) Score = 2.8

Sacramento River cold water benefits are targeted to the Upper Sacramento River, where salmonid spawning and incubation is concentrated. The application stated that the ecosystem improvements are adjacent to or hydrologically connected to Turtle Bay Exploration Park East and Anderson River Park, which are located geographically along the Sacramento River. The applicant did not further describe how the proposed ecosystem benefit is hydrologically connected to the conservation areas identified. Proposed cold water improvements on the Feather and American Rivers would occur in the areas where salmonids could benefit; however, the application does not substantiate or quantify how these changes will benefit the targeted salmonids in these respective rivers. No areas managed for conservation values were identified along the Feather or American Rivers.

Priority 1 – REV Criterion 9 (Efficient use of water to achieve multiple ecosystem benefits) Score = 1.8

The Project intends to release water stored primarily in Shasta to benefit priorities related to temperature and flow (Priorities 1, 2, 3, 4, 5, and 11). The application describes the potential for the Project to capture and store water that was previously released for ecosystem benefits. According to the application, this water could be stored in an Ecosystem Enhancement Storage Account (EESA) or potentially sold to other water users in order to generate funds to maintain and operate public benefits, including ecosystem benefits. However, there is uncertainty associated with the efficiency and efficacy of recapturing water, because these flows may be required to meet ecosystem needs or downstream regulatory requirements.

Priority 1 – REV Criterion 10 (Resilience of ecosystem improvements to the effects of changing environmental conditions, including hydrologic variability and climate change) Score = 2.7

The application states that the Project's primary environmental uncertainty is climate change, which was assessed using the California Water Commission (CWC) 2030 and 2070 climate assumptions. No further discussion was provided in the application that elucidates how climate change, relevant to this priority, was incorporated into the Project siting, design, or operations.

Priority 2: Provide flows to improve habitat conditions for in-river rearing and downstream migration of juvenile salmonids.

Priority 2 – REV Criterion 2 (Magnitude of Ecosystem Improvements) Score = 1.8

Proposed flow improvements described in the application amount to approximately a 1.1 - 4.2% change in long term average flow from without-Project conditions depending on the modeled scenario (current, 2030, 2070), and would primarily benefit fall and late-fall run salmon. Ecosystem improvements were quantified using SALMOD, which incorporates the changes in flow proposed by the applicant. SALMOD is not a life cycle model and does not account for population changes over time. Rather, it resets each year using the programmed starting populations of each run to calculate production numbers. For this reason, there is low confidence in the magnitude of the ecosystem improvement as demonstrated by SALMOD production outputs. In addition, SALMOD does not account for impacts resulting from Project-related reductions in Sacramento River flow, downstream of Red Bluff (where the SALMOD modeling domain ends). To account for potential flow-related impacts to salmonids downstream of Red Bluff, the applicant conducted a flow-survival effects analysis. The analysis did not account for cumulative effects of Project diversions on the Sacramento River that may impact migrating salmonids, nor did it account for the variability in survival from reduced flows as presented in the appeal material submitted by the applicant.

Priority 2 – REV Criterion 3 (Spatial and temporal scale of ecosystem improvements) Score = 1.7

The applicant proposes to provide flow improvements between November and February in the upper 59 miles of the Sacramento River. The applicant states that the timing of the proposed flow improvements would primarily benefit fall and late-fall run Chinook salmon. The 59-mile extent described is the same spatial extent used in SALMOD. Geographically, this area between Keswick and the Red Bluff Diversion Dam is an appropriate range where fall and late-fall run Chinook salmon could potentially benefit from flow related improvements. However, the Project operations would reduce flows downstream of Red Bluff. These reduced flows may reduce salmon survival and negatively affect in-river rearing and migration.

Priority 2 – REV Criterion 4 (Inclusion of an adaptive management and monitoring program that includes measurable objectives, performance measures, thresholds, and triggers for managing ecosystem benefits) Score = 2.3
See comment for Priority 1 – REV Criterion 4.

Priority 2 – REV Criterion 5 (Immediacy of ecosystem improvement actions and realization of benefits) Score = 2.0

The applicant estimates that flow benefits would begin to accrue in 2028 and would reach full achievement by 2030. The realization of benefits would not be measurable until 2033-2034 when the cohorts that benefit from flow improvements in 2030 return to spawn. The immediacy and realization of the ecosystem improvement is dependent upon Sites' ability to deliver water in lieu of Shasta Reservoir. In order for in lieu water deliveries out of Sites, the reservoir must have sufficient storage. There is concern that the reservoir may take longer than expected to reach sufficient capacity in order to make deliveries in lieu of Shasta, which could delay the immediacy and realization of benefits.

Priority 2 – REV Criterion 6 (Duration of ecosystem improvements) Score = 2.7

The modeling results demonstrate flow changes would occur as proposed over the 92 years projected. However, the flows provided by the Project would diminish over time (long-term average of 372 cubic feet per second [cfs] under current conditions; 228 cfs in 2030; and 157 cfs in 2070). Moreover, because there is low confidence in the ecosystem improvement, there is lower confidence in the duration of the ecosystem improvement.

Priority 2 – REV Criterion 7 (Consistency with species recovery plans and strategies, initiatives, and conservation plans) Score = 2.3
See comment for Priority 1 – REV Criterion 7.

Priority 2 – REV Criterion 8 (Location of ecosystem improvements and connectivity to areas already being protected or managed for conservation values) Score = 2.4

The applicant targets Sacramento River flow benefits at the upper 59 miles of the Sacramento River. However, Project operations will reduce flow downstream of this extent. The application states that water from the Project could be exchanged with other reservoirs to enhance the reservoir operators' ability to provide quality habitat. The application stated that the ecosystem improvements are adjacent to conservation areas or are hydrologically connected to the Sacramento River Wildlife Area, Nimbus and American River Hatcheries, American River Parkway, and Colusa-Sacramento River State Recreation Area. Geographically, the Sacramento River Wildlife Areas and Colusa-Sacramento River State Recreation Area occur along the Sacramento River while the Nimbus and American River Hatcheries and American River Parkway occur along the American. The applicant provided no further information regarding how the proposed ecosystem benefit is hydrologically connected to the conservation areas identified. Additionally, there are concerns that reductions in flow due to Project operations, could negatively affect hydrologic connectivity along the Sacramento River, potentially reducing floodplain inundation and spill events at various locations, such as the Sutter and Yolo Bypasses, downstream of Project diversions.

Priority 2 – REV Criterion 9 (Efficient use of water to achieve multiple ecosystem benefits) Score = 1.3
See comment for Priority 1 – REV Criterion 9.

Priority 2 – REV Criterion 10 (Resilience of ecosystem improvements to the effects of changing environmental conditions, including hydrologic variability and climate change) Score = 1.8
See comment for Priority 1 – REV Criterion 10.

Priority 3: Maintain flows and appropriate ramping rates at times and locations that will minimize dewatering of salmonid redds and prevent stranding of juvenile salmonids in side channel habitat
Priority 3 – REV Criterion 2 (Magnitude of Ecosystem Improvements) Score = 1.7

Proposed flow improvements presented in the application show approximately a 1.1-4.2% change in the long term average flow from without-Project conditions depending on the modeled scenario (current, 2030, 2070), and would primarily benefit fall and late-fall run salmon. Under this priority, the applicant proposes that the added flows would benefit egg incubation by preventing the dewatering of redds and preventing juvenile stranding in side channel habitats during rearing. Although the proposed flow improvements were incorporated into SALMOD and could positively affect the salmon production numbers, the claimed benefits associated with reductions to redd dewatering and stranding could not be accounted for in SALMOD and are therefore the applicant did not quantify them. The applicant states in its Draft EIR/EIS that the river's weighted usable area (WUA), which is the relationship between streamflow and habitat availability for each life stage of salmon, is derived from the Project's CALSIM II modeling. The WUA is calculated by disaggregating CALSIM's monthly flows into average daily flows. This disaggregation of data does not capture the daily variability or change in variability that might otherwise indicate a point in time where a reduction in flow is extreme enough to contribute to redd dewatering or stranding. Because the flow data input into SALMOD is not provided at a scale fine enough to capture potential dewatering or stranding conditions SALMOD is unable to show benefits claimed under this priority. No other modeling or analysis was provided to quantify reductions in redd dewatering or stranding; therefore, the Project-related water elevation of the Sacramento River and its contribution to reductions in redd dewatering and juvenile stranding cannot be substantiated.

Priority 3 – REV Criterion 3 (Spatial and temporal scale of ecosystem improvements) Score = 1.7
The applicant proposes to provide flow improvements between November and February in the upper 59 miles of the Sacramento River. The applicant states that the timing of the proposed flow improvements would primarily benefit fall and late-fall run Chinook salmon. The 59-mile extent described is the same spatial extent used in SALMOD. Geographically this is an appropriate range where flows could benefit egg incubation by preventing the dewatering of redds and preventing juvenile stranding in side channel habitats during rearing. However, the application did not demonstrate how Project flows would affect the river elevation and reduce the risk of dewatering or stranding. Additionally, the Project operations would reduce flows downstream of Red Bluff. Reduced flows downstream of Red Bluff may reduce salmon survival and negatively affect rearing and migration.

Priority 3 – REV Criterion 4 (Inclusion of an adaptive management and monitoring program that includes measurable objectives, performance measures, thresholds, and triggers for managing ecosystem benefits) Score = 2.3
See comment for Priority 1 – REV Criterion 4.

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Priority 3 – REV Criterion 5 (Immediacy of ecosystem improvement actions and realization of benefits) Score = 1.8
See comment for Priority 2 – REV Criterion 5.

Priority 3 – REV Criterion 6 (Duration of ecosystem improvements) Score = 2.3
See comment for Priority 2 – REV Criterion 6.

Priority 3 – REV Criterion 7 (Consistency with species recovery plans and strategies, initiatives, and conservation plans) Score = 2.0
See comment for Priority 1 – REV Criterion 7.

Priority 3 – REV Criterion 8 (Location of ecosystem improvements and connectivity to areas already being protected or managed for conservation values) Score = 2.0

The applicant targets the proposed flow benefits at the upper 59 miles of the Sacramento River. Geographically, this is an appropriate range where flows could benefit egg incubation by preventing the dewatering of redds and preventing juvenile stranding in side channel habitats during rearing.

The applicant states that water from the Project could be exchanged with other reservoirs to enhance the reservoir operators' ability to provide quality habitat. The application states that the ecosystem improvements are adjacent to conservation areas or are hydrologically connected to the Sacramento River Wildlife Areas, Nimbus and American River Hatcheries, and the Colusa-Sacramento River State Recreation Area. Geographically, the Sacramento River Wildlife Areas and Colusa-Sacramento River State Recreation Area occur along the Sacramento River, while the Nimbus and American River Hatcheries occur along the American. The applicant did not provide further information regarding how the proposed ecosystem benefit is hydrologically connected with the conservation areas identified.

Priority 3 – REV Criterion 9 (Efficient use of water to achieve multiple ecosystem benefits) Score = 1.2
See comment for Priority 1 – REV Criterion 9.

Priority 3 – REV Criterion 10 (Resilience of ecosystem improvements to the effects of changing environmental conditions, including hydrologic variability and climate change) Score = 1.5
See comment for Priority 2 – REV Criterion 10.

Priority 4: Improve ecosystem water quality

Priority 4 – REV Criterion 2 (Magnitude of Ecosystem Improvements) Score = 2.3

The application states that temperature improvements would be realized in the Sacramento, Feather, and American Rivers as a result of conservation of water (primarily in Shasta Lake) facilitated by cooperative operations with Sites Reservoir. The application states that the Project would increase coldwater pool conservation in Shasta Lake, Lake Oroville, and Folsom Reservoir, allowing for improved river temperatures during certain months at specific compliance points, particularly in below normal, dry, and critical water years. Temperature improvements were estimated using the Upper Sacramento River HEC-5Q model for the Sacramento River, the American River CE QUAL-W2 Model for the American River, and the Reclamation Temperature Model (RecTemp) for the Feather River.

The applicant used the HEC-5Q model to demonstrate the proposed temperature improvements generated from the additional storage in Shasta Reservoir. Between Bonnyview and Bend Bridge, during the July through September period in critically dry years, the modeled Sacramento River temperature projections indicate a 0.6 °F change from without- to with-Project conditions under 2030 conditions. The applicant also analyzed a study by Vogel (2015)[1] under this priority and Priority 1, which correlates temperature effects on salmonid eggs and pre-emergent alevins, at various temperature thresholds. The applicant's analysis estimates improved survival of salmonids at various locations within the Upper Sacramento River due to the Project when temperature thresholds have been compromised in dry and critical years. Based on the results of this analysis, the applicant concludes that winter-run Chinook salmon egg and fry mortality between Keswick Dam and Ball Ferry Bridge would be reduced by 7 – 25 percent between September and October of critically dry water years (depending on the location). The relationship between water temperature and mortality of Chinook salmon eggs and pre-emergent fry presented in the Vogel study and used in the applicant's analysis, presents changes in mortality by whole degrees Fahrenheit, which is the level of precision for the model. There is uncertainty in the reduction in mortality due to a change in temperature of less than a whole degree Fahrenheit. Additionally, the Vogel study is specific to winter-run and may not be applicable to fall-run and late-fall-run, which are targeted to benefit under this Priority. The greatest reduction in mortality (25 percent) is shown at the Balls Ferry Bridge location. The application notes this location is 13 miles downstream of where spawning occurs and that no redds with incubating eggs or pre-emergent alevins would be present at this location.

The application proposes American River temperature improvements based on increased water retained in Folsom Reservoir because of Project operations. American River temperature improvements at Watt Avenue, during the July through September Period (in critical years), indicate a -1.4 °F and -0.5 °F change from without- to with-Project conditions under current and 2030 conditions, respectively. The proposed American River temperature improvements could potentially benefit steelhead. However, the application does not substantiate or quantify how these changes would benefit the targeted salmonids.

The application proposes Feather River temperature improvements based on increased water retained in Lake Oroville through Project operations. Oroville's average end-of-May storage is estimated to be improved by 26 and 31 thousand acre feet (TAF) under 2030 and 2070 conditions, respectively. Proposed temperature improvements generated from the additional storage were modeled using RecTemp. Between the Low Flow Channel and Gridley, during the May through November Period in critical years, the modeled Feather River temperature projections indicate a range of change between -0.1 °F to -0.6 °F over the life of the Project. During the October through November Period in critical years, the modeled Feather River temperature projections indicate a range of change between -0.2 °F to -1.1 °F over the life of the Project. The modeled Feather River temperature improvements fall within the existing protective temperature targets for anadromous fish that are met under without-Project conditions, and do not provide any additional benefit.

Priority 4 – REV Criterion 3 (Spatial and temporal scale of ecosystem improvements) Score = 3.2

The application targets proposed Sacramento River temperature improvements to occur in the upper portion of the Sacramento River, where the large majority of spawning and egg incubation occurs. The

[1] Vogel, D. 2015. Potential Effects of Central Valley Project Operations on Winter-Run Chinook Salmon Egg Incubation in 2015: A Preliminary Analysis. April.

applicant states that the modeled temperature improvements are most prevalent in dry and critical years during time periods that will most likely benefit winter-run salmon. However, there is low confidence in the percent change in mortality from temperature improvements as discussed under REV Criterion 2.

Temperature modeling results target areas of the Feather River that may benefit salmonids. The modeled temperature improvements generally occur within a currently suitable temperature range for salmonids. As such, the modeled Feather River temperature improvements do not provide any additional benefit. When temperatures without-Project exceed temperature targets, the modeled operations do not decrease temperatures in order to meet established targets and indicate increased temperatures in the summer months across multiple year types and under all climate conditions.

Proposed American River temperature improvements would affect locations downstream of Nimbus Dam to Watt Avenue and could potentially provide benefits to steelhead during the targeted July through September period. However, the application does not substantiate or quantify how these changes would benefit the targeted salmonids.

Priority 4 – REV Criterion 4 (Inclusion of an adaptive management and monitoring program that includes measurable objectives, performance measures, thresholds, and triggers for managing ecosystem benefits) Score = 2.8
See comment for Priority 1 – REV Criterion 4.

Priority 4 – REV Criterion 5 (Immediacy of ecosystem improvement actions and realization of benefits) Score = 2.6
See comment for Priority 1 – REV Criterion 5.

Priority 4 – REV Criterion 6 (Duration of ecosystem improvements) Score = 3.3
See comment for Priority 1 – REV Criterion 6.

Priority 4 – REV Criterion 7 (Consistency with species recovery plans and strategies, initiatives, and conservation plans) Score = 2.8
See comment for Priority 1 – REV Criterion 7.

Priority 4 – REV Criterion 8 (Location of ecosystem improvements and connectivity to areas already being protected or managed for conservation values) Score = 2.8

The proposed Sacramento River cold water benefits are targeted to occur in the Upper Sacramento River, where spawning and incubation is concentrated. Proposed cold water benefits on the Feather and American Rivers would occur in the areas where salmonids could benefit; however, the application does not substantiate or quantify how these changes would benefit the targeted salmonids in these respective rivers. The application states that water from the Project can be exchanged with other reservoirs to enhance the reservoir operators' ability to provide quality habitat. The application states that the ecosystem improvements are adjacent to or hydrologically connected to the Turtle Bay Exploration Park East, Anderson River Park, Sacramento River Wildlife Areas, Nimbus and American River Hatcheries, American River Parkway, Effie Yeaw Nature Center, and the Colusa-Sacramento River State Recreation Area. Geographically, the Turtle Bay Exploration Park East, Anderson River Park, Sacramento River Wildlife Areas, and Colusa-Sacramento River State Recreation Area occur along the Sacramento River while the Nimbus and American River Hatcheries and American River Parkway, and

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Effie Yeaw Nature Center, occur along the American. The applicant did not provide further information regarding how the proposed ecosystem benefit is hydrologically connected to the conservation areas identified. The applicant did not identify any areas managed for conservation values along the Feather River.

Priority 4 – REV Criterion 9 (Efficient use of water to achieve multiple ecosystem benefits) Score = 1.8
See comment for Priority 1 – REV Criterion 9.

Priority 4 – REV Criterion 10 (Resilience of ecosystem improvements to the effects of changing environmental conditions, including hydrologic variability and climate change) Score = 2.7
See comment for Priority 1 – REV Criterion 10.

Priority 5: Provide flows that increase dissolved oxygen and lower water temperatures to support anadromous fish passage

Priority 5 – REV Criterion 2 (Magnitude of Ecosystem Improvements) Score = 1.0

The application states the Project's flow management would promote more suitable water temperatures and provide increased dissolved oxygen levels for rearing salmonids in the Sacramento River below Keswick Dam. The application states the Project's proposed flow releases, occurring between October and March, would increase dissolved oxygen levels in the upper portion of the Sacramento River. The applicant did not quantify or analyze the change in dissolved oxygen levels resulting from the proposed flows. The applicant references the temperature benefits as described in Priority 1 to support the lowered temperatures under this priority. As discussed in Priority 1 above, there is low confidence in the temperature benefit to salmonids. The application did not include discussion of how the proposed temperature and dissolved oxygen changes would support fish passage.

Priority 5 – REV Criterion 3 (Spatial and temporal scale of ecosystem improvements) Score = 1.0

The proposed temperature improvements resulting from the Project's flow management target the upper portion of the Sacramento River. As described in Priority 1 the applicant's modeled temperature improvements are most prevalent in dry and critical years. The applicant associates dissolved oxygen improvements during the periods when flow and temperature benefits are scheduled to occur (primarily between the months of October and March). The timing of proposed flow (and associated water quality benefits) are planned to occur when spawning and egg development life stages are expected in the Upper Sacramento River. By targeting these life stages the benefits to fish passage (as described in this priority) are less impactful because passage benefits could be realized at different times of the year and could encompass the entirety of the river. Because oxygen improvements were not quantified it is not possible to substantiate the spatial or temporal extent of claimed oxygen benefits.

Priority 5 – REV Criterion 4 (Inclusion of an adaptive management and monitoring program that includes measurable objectives, performance measures, thresholds, and triggers for managing ecosystem benefits) Score = 1.2

The applicant intends to develop an adaptive management program in partnership with State and Federal agencies and utilize existing monitoring programs to collect data. The application describes a general framework to develop specific measures, targets, and thresholds. There is no discussion in the application regarding monitoring dissolved oxygen and water temperature and how they would be

adaptively managed. The application states that potential funding sources for adaptive management and monitoring include revenue generated from water delivery contracts. It is not clear how operational decisions would be made if physical parameters and biological responses fall outside the range of anticipated benefits.

Priority 5 – REV Criterion 5 (Immediacy of ecosystem improvement actions and realization of benefits) Score = 1.5

The applicant estimates that temperature benefits will begin to accrue in 2028 and will reach full achievement by 2030. The realization of benefits will not be measurable until 2033-2034 when the cohorts that benefit from reduced temperatures in 2030 will return to spawn. The realization of proposed dissolved oxygen level improvements are not described independently from the proposed temperature improvements and cannot be assessed. The immediacy and realization of the ecosystem improvement is dependent upon Sites' ability to deliver water in lieu of Shasta Reservoir. In order for in lieu water deliveries out of Sites, the reservoir must have sufficient storage. There is concern that the reservoir may take longer than expected to reach sufficient capacity in order to make deliveries in lieu of Shasta, which could delay the immediacy and realization of benefits.

Priority 5 – REV Criterion 6 (Duration of ecosystem improvements) Score = 1.8

The modeling results demonstrate temperature and flow changes will occur as proposed over the 92 years projected; however, the magnitude of flows will diminish over time. The Department was unable to evaluate the duration of proposed dissolved oxygen benefits because dissolved oxygen levels were not quantified.

Priority 5 – REV Criterion 7 (Consistency with species recovery plans and strategies, initiatives, and conservation plans) Score = 1.2
See comment for Priority 1 – REV Criterion 7.

Priority 5 – REV Criterion 8 (Location of ecosystem improvements and connectivity to areas already being protected or managed for conservation values) Score = 1.5

The Project targets the proposed Sacramento River temperature and dissolved oxygen improvements to occur in the Upper Sacramento River. Although this location would likely benefit from reduced temperatures and increased dissolved oxygen it is not an area that would significantly contribute to fish passage. Fish passage benefits could be realized anywhere in the Sacramento River, yet the Project focuses on the upper 59 miles. The application state that the ecosystem improvements are adjacent to conservation areas or hydrologically connected to the Sacramento River Wildlife Areas, Nimbus and American River Hatcheries, American River Parkway, Stone Lakes National Wildlife Refuge, Vic Fazio Yolo Wildlife Area, Bidwell-Sacramento River State Park, Colusa-Sacramento River State Recreation Area, Brannan Island State Recreation Area and Delta Meadows. Geographically, the Sacramento River Wildlife Areas, Stone Lakes National Wildlife Refuge, Vic Fazio Yolo Wildlife Area, Bidwell-Sacramento River State Park, Colusa-Sacramento River State Recreation Area, Brannan Island State Recreation Area, and Delta Meadows occur along the Sacramento River, while the Nimbus and American River Hatcheries and American River Parkway occur along the American. The applicant provided no further discussion regarding how the proposed ecosystem benefit is hydrologically connected with the conservation areas identified. There is some concern that the Project could negatively affect hydrologic connectivity with certain conservation areas located along the Sacramento River, because reductions in Sacramento River

flows associated with the filling of Sites Reservoir would likely reduce the amount of floodplain inundation and spill events at various bypass locations such as Yolo and Sutter Bypasses.

Priority 5 – REV Criterion 9 (Efficient use of water to achieve multiple ecosystem benefits) Score = 1.0
See comment for Priority 1 – REV Criterion 9.

Priority 5 – REV Criterion 10 (Resilience of ecosystem improvements to the effects of changing environmental conditions, including hydrologic variability and climate change) Score = 1.5
See comment for Priority 1 – REV Criterion 10.

Priority 10: Enhance the frequency, magnitude, and duration of floodplain inundation to enhance primary and secondary productivity and the growth and survival of fish.

Priority 10 – REV Criterion 2 (Magnitude of Ecosystem Improvements) Score = 2.1

The applicant proposes to release 40 TAF of water to the Yolo Bypass between August and October in order to increase food production for Delta smelt. Based on the best available science, this proposed action would likely benefit Delta smelt and is consistent with the Delta Smelt Resiliency Strategy (DSRS). The modeled hydrologic data shows the quantity of water available for this benefit could fluctuate dramatically depending on the water year type, and could be as little as 5 TAF in critical years. Therefore, there may be insufficient water available in some years to provide the flows necessary to generate food production benefits. Additionally, the modeling shows a net loss of flows through the Yolo Bypass in all other months outside of the proposed August-October period. There are concerns that the net reduction in flows through the Yolo Bypass may impact the ability for salmon to enter the bypass and could reduce their ability to utilize the bypass for feeding and improved growth.

Priority 10 – REV Criterion 3 (Spatial and temporal scale of ecosystem improvements) Score = 2.3

The proposed Yolo Bypass flows would be delivered between August and October through the Colusa Basin Drain, near the Knights Landing Ridge Cut. The timing and location of deliveries are consistent with the DSRS. However, there is concern that in some years there may be insufficient water available to provide the flows necessary to generate food production benefits. The applicant proposes that the benefits of these flow releases would occur as far as the tip of Sherman Island. However, no information is provided to support the spatial extent of claimed benefits.

Priority 10 – REV Criterion 4 (Inclusion of an adaptive management and monitoring program that includes measurable objectives, performance measures, thresholds, and triggers for managing ecosystem benefits) Score = 2.4
See Priority 1 – REV Criterion 4.

Priority 10 – REV Criterion 5 (Immediacy of ecosystem improvement actions and realization of benefits) Score = 2.8

The immediacy and realization of the ecosystem improvement is dependent upon Sites Reservoir's ability to deliver water in lieu of Shasta Reservoir. In order for in lieu water deliveries out of Sites, the reservoir must have sufficient storage. There is concern that the reservoir may take longer than expected to reach sufficient capacity in order to make deliveries in lieu of Shasta, which could delay the immediacy and realization of benefits. Specifically, the Project relies on excess rainwater (primarily

occurring during wet years) in order to fill the Reservoir. If climate conditions generate little rainfall, it may take longer than expected for the reservoir to fill and provide the benefits proposed.

The applicant estimates that the proposed Yolo Bypass flow benefits would begin to accrue in 2026 and would reach full achievement by 2030. Because the proposed benefits would be delivered via the existing Colusa Basin drainage canal, these benefits could potentially be delivered prior to the full completion and operation of the Project. However, benefits may not be realized in some year types when available flows are projected to be low.

Priority 10 – REV Criterion 6 (Duration of ecosystem improvements) Score = 2.7

The application states that the duration of benefits is expected to be 90 years. No additional information is provided to support the duration of the ecosystem improvement.

Priority 10 – REV Criterion 7 (Consistency with species recovery plans and strategies, initiatives, and conservation plans) Score = 2.1

The application states the proposed benefit is consistent with the DSRS. No additional information regarding the proposed benefit's consistency with species recovery plans and strategies, initiatives, and conservation plans was provided. The proposed benefit is consistent with the North Delta Food Web Adaptive Management Project, one of the 13 proposed actions in the DSRS. The reduced flows through the Yolo Bypass could be counterproductive to the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project objectives.

Priority 10 – REV Criterion 8 (Location of ecosystem improvements and connectivity to areas already being protected or managed for conservation values) Score = 2.9

The location of proposed Yolo Bypass flow releases is consistent with similar actions conducted recently in furtherance of the DSRS. Similarly, the location of food production benefits and food delivery areas are also consistent with previous actions. Although it is possible that proposed benefits could reach as far as the tip of Sherman Island, this occurrence is uncertain due to tidal fluctuations in Cache Slough. No modeling was provided to support the spatial distribution of the food dispersal benefits.

The proposed pulses would flow through several areas adjacent to, and hydrologically connected to, areas protected and managed for conservation values. However, the CALSIM modeling shows a net loss of flows through the Yolo Bypass. There are concerns that the net reduction in flows through the Yolo Bypass may impact the ability for salmon to enter the bypass and could reduce their ability to utilize the bypass for feeding and improved growth, thus negatively influencing connectivity.

The application identified the proposed ecosystem improvement is adjacent to Liberty Island Ecological Reserve, Miner Slough Wildlife Area, Prospect Island, and Brannan Island State Recreation Area.

Priority 10 – REV Criterion 9 (Efficient use of water to achieve multiple ecosystem benefits) Score = 1.6

The application states that "this management strategy may not be able to occur annually due to varying water year types." The applicant did not identify any additional ecosystem benefits that could be achieved through the use of this water.

Priority 10 – REV Criterion 10 (Resilience of ecosystem improvements to the effects of changing environmental conditions, including hydrologic variability and climate change) Score = 1.9
See comment for Priority 1 – REV Criterion 10.

Priority 11: Enhance the temporal and spatial distribution and diversity of habitats to support all life stages of fish and wildlife species.

Priority 11 – REV Criterion 2 (Magnitude of Ecosystem Improvements) Score = 1.9

The applicant proposes to improve the spatial distribution and diversity of habitats of native fishes in the Sacramento River and Yolo Bypass. Sacramento River habitat improvements consist of temperature and flow improvements targeting the Upper Sacramento River. The application states the Project would provide a long-term average increase in flow of 4.4% (372 cfs) near the Colusa diversion. The applicant states that this increase in flow would provide more suitable water temperatures for egg incubation and fry, leading to higher survival rates of these stages. Fall-run, late fall-run, and winter-run Chinook salmon would be the primary beneficiaries of the proposed temperature and flow improvements. Yolo Bypass habitat improvements would be realized from the average annual flow of 42 thousand acre-feet, delivered to the bypass between August and October. The applicant proposes these flows would allow for better growth rates of native fish due to increased food availability.

The Project's operational changes to water temperature and flow could benefit some runs and/or life stages of salmonids, while impacting other runs and/or life stages. As discussed under Priority 2 - REV Criterion 2, SALMOD results may indicate benefits to some runs in the upper portion of the Sacramento River watershed; however, there may be impacts to other runs downstream of Red Bluff associated with reduced river flows resulting from Project operations. Additionally, the SALMOD modeling outputs indicate reductions in salmon production numbers for some runs of salmon, in varying water year types, associated with changes in both temperature and flow from with Project operations. For example, the SALMOD results indicate that there are net impacts to fall-run Chinook salmon under 2015 climate conditions and to spring-run Chinook salmon under 2030 climate conditions.

Priority 11 – REV Criterion 3 (Spatial and temporal scale of ecosystem improvements) Score = 1.9

The proposed temperature and flow improvements target the upper portion of the Sacramento River where the large majority of spawning and egg incubation occurs. The modeled temperature improvements are most prevalent in dry and critical years during time periods that will most likely benefit winter-run Chinook salmon. However, due to potential impacts associated with both temperature and flow changes from Project operations, there is low confidence in the ecosystem improvement.

The proposed Yolo Bypass flows would be delivered between August and October through the Colusa Basin Drain, near the Knights Landing Ridge Cut. The timing and location of deliveries are both appropriate to achieve food production benefits. However, there is concern that in some years there

may be insufficient water available to provide the flows necessary to generate food production benefits. The applicant proposes that the benefits of these flow releases would occur as far as the tip of Sherman Island/San Joaquin River. However, the application included no modeling to support the spatial distribution of these benefits.

Priority 11 – REV Criterion 4 (Inclusion of an adaptive management and monitoring program that includes measurable objectives, performance measures, thresholds, and triggers for managing ecosystem benefits) Score = 2.3
See Priority 1 – REV Criterion 4.

Priority 11 – REV Criterion 5 (Immediacy of ecosystem improvement actions and realization of benefits) Score = 2.2

The applicant estimates that temperature benefits would begin to accrue in 2028 and would reach full achievement by 2030. The application describes proposed Yolo Bypass flow benefits as beginning to accrue in 2026 with full achievement by 2030. The realization of benefits would not be measurable until 2033-2034 when the cohorts that benefit from flow improvements in 2030 would return to spawn. The immediacy and realization of the ecosystem improvement is dependent upon Sites' ability to deliver water in lieu of Shasta Reservoir. In order for in lieu water deliveries out of Sites, the reservoir must have sufficient storage. There is concern that the reservoir may take longer than expected to reach sufficient capacity in order to make deliveries in lieu of Shasta, which could delay the immediacy and realization of benefits. In addition, modeling data provided by the applicant shows that flows delivered to the Yolo Bypass would be substantially reduced in some year types; therefore, proposed benefits may not be realized.

Priority 11 – REV Criterion 6 (Duration of ecosystem improvements) Score = 2.9

The modeling results demonstrate flow changes would occur as proposed over the 92 years projected. However, as discussed in previous REV criteria, the flows provided by the project would diminish over time. The application states that the duration of Yolo Bypass flow benefits is expected to be 90 years. Due to low confidence in the realization of flow-related benefits from the Project and related impacts to salmonids, there is not high confidence in the duration of flow related ecosystem improvements.

Priority 11 – REV Criterion 7 (Consistency with species recovery plans and strategies, initiatives, and conservation plans) Score = 2.6

The application identified several plans, strategies, initiatives, and conservation plans in which they believe their Project is consistent with, including Action SAR-2.17 and SAR-1.4 of the NOAA Fisheries Salmon Recovery Plan, three actions specified in the SVSRS, and the DSRS. The SVSRS actions are: (1) increase productivity by improving spawning and incubation conditions (habitat and water quality); (2) increase productivity by increasing juvenile salmonid survival; and (3) support the full range of juvenile and adult migration conditions to maintain life history diversity. The applicant also states its Project would improve the quality of EFH. The benefits identified by the applicant under this priority are consistent with habitat and distribution components of the NOAA SAR-2.17 and SAR-1.4 actions. Similarly, the actions identified in the SVSRS are applicable to the habitat distribution components of this priority. The proposed food production targets proposed under this priority are consistent with portions of the DSRS. The proposed water temperature and flow improvements would potentially contribute to the quality of EFH. However, the ability of the Project to meet the aforementioned actions

and objectives is unclear given the low magnitude of this ecosystem benefit, as discussed under other REV criteria. There are concerns that reduced flows through the Yolo Bypass could be counterproductive to the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project objectives.

Priority 11 – REV Criterion 8 (Location of ecosystem improvements and connectivity to areas already being protected or managed for conservation values) Score = 2.7

The Project targets proposed flow and temperature benefits in the upper 59 miles of the Sacramento River, where the large majority of spawning and egg incubation occurs. The location of proposed Yolo Bypass flow releases is consistent with similar actions completed in recent history in furtherance of the DSRS. Similarly, the location of food production benefits and food delivery areas are also consistent with previous actions in the Bypass. The application states that locations downstream from Shasta, Oroville, and Folsom dams have known salmonid populations and that water from Sites Reservoir can be exchanged with these other reservoirs to provide water for habitat improvements. The application stated that the ecological improvements are adjacent to conservation areas or are hydrologically connected to Sacramento River Wildlife Areas, Nimbus and American River Hatcheries, American River Parkway, Effie Yeaw Nature Center, Folsom Lake State Recreation Area, Mather Regional Park, Isenberg Crane Service, Cosumnes River Preserve, Stone Lakes National Wildlife Refuge, Laguna Creek Parkway, Vic Fazio Yolo Wildlife Area, Grizzly Island Wildlife Area, Gray Lodge Wildlife Area, Bobelaine Audubon Sanctuary, Bidwell Mansion State Historic Park, Butte City project, Clay Pit State Vehicular Recreation Area, Lake Oroville State Recreation Area, Bidwell-Sacramento River State Park, Colusa-Sacramento River State Recreation Area, Brannan Island State Recreation Area, and Delta Meadows. The applicant did not provide further information regarding how the proposed ecosystem benefit is hydrologically connected to the conservation areas identified or would augment existing efforts. There are concerns that reductions in flow from the Project's Sacramento River diversions could negatively affect hydrologic connectivity along the Sacramento River and potentially reduce floodplain inundation at various locations downstream of Project diversions, including the Sutter and Yolo Bypasses.

Priority 11 – REV Criterion 9 (Efficient use of water to achieve multiple ecosystem benefits) Score = 1.7
See comment for Priority 1 – REV Criterion 9.

Priority 11 – REV Criterion 10 (Resilience of ecosystem improvements to the effects of changing environmental conditions, including hydrologic variability and climate change) Score = 2.1
See comment for Priority 1 – REV Criterion 10.

Priority 14: Provide water to enhance seasonal wetlands, permanent wetlands, and riparian habitat for aquatic and terrestrial species on State and Federal wildlife refuges and on other public and private lands.

Priority 14 – REV Criterion 2 (Magnitude of Ecosystem Improvements) Score = 3.0

The applicant proposes to deliver Incremental Level 4 (IL4) water to various wildlife refuges and State Wildlife Areas (SWAs) in the Central Valley. According to modeled projections, the volume of available water for refuges and wildlife areas would vary from 6 TAF to 54 TAF, depending on the water year type and future climate conditions. The Project would primarily benefit the Sacramento, Colusa, and Delevan National Wildlife Refuges (NWRs). The applicant identified several other refuges and wildlife areas as potential recipients. The application provides supporting documentation regarding the effects of water deliveries on refuges. This material states that a 50% reduction in deliveries to the Sacramento, Colusa,

and Delevan NWRs occurring in dry and critically dry years would amount to a loss of 4,658 to 7,762 acres of permanent and seasonal wetlands.

The application states the Project would provide ecosystem benefits associated with increased rice land production. Additional rice land production would result from the availability of Sites agricultural water primarily in dry and critically dry years (approximately 175 TAF). Although rice lands may provide potential ecosystem benefits to waterfowl and giant garter snake, these would only accrue if farmers utilize the agricultural water for rice production. The information in the application does not commit to this use of Project deliveries and the proposed ecosystem benefits in comparison to without-Project conditions were not quantified.

Priority 14 – REV Criterion 3 (Spatial and temporal scale of ecosystem improvements) Score = 4.0

According to the applicant, most benefits would occur at the Sacramento, Colusa, and Delevan NWRs, which total 21,382 acres. Refuges in the Mendota Pool and the Tulare Basin could also benefit from deliveries from the Project, as documented in the modeling submitted by the applicant. Deliveries would be made year-round, and the modeling shows allocations in all months except February. The priority worksheet submitted by the applicant states that water for agricultural users would be provided in dry and critically dry years, primarily in April and May, which is consistent with the timing of rice field inundation needs. Ricelands inundation at this time could provide GGS foraging habitat (if GGS are present). Typically, rice is harvested in the fall. If farmers maintain field inundation longer into the season, or refill their fields after harvesting (to aid in the breakdown of vegetation), they could provide waterfowl foraging habitat in the winter when it is most needed. However, it is uncertain how many farmers would utilize the available water for rice production.

Priority 14 – REV Criterion 4 (Inclusion of an adaptive management and monitoring program that includes measurable objectives, performance measures, thresholds, and triggers for managing ecosystem benefits) Score = 2.8

The applicant intends to develop an adaptive management program in partnership with State and Federal agencies and utilize existing monitoring programs to collect data. The application describes a general framework to develop specific measures, targets, and thresholds. The application states that potential funding sources for adaptive management and monitoring include revenue generated from water delivery contracts. It is not clear how operational decisions would be made if physical parameters and biological responses fall outside the range of anticipated benefits. Under this priority, the application indicates that the NWR inventory data collected annually, including bird counts, would be utilized to assess and manage delivery adjustments. Additionally, refuge managers may have some flexibility in the timing of water, which could be incorporated into the adaptive management plan. The application states that the Project would conduct an annual assessment of the acreage of rice planted, in dry and critically dry years. However, there is no discussion on how this information would be applied to inform adaptive management strategies.

Priority 14 – REV Criterion 5 (Immediacy of ecosystem improvement actions and realization of benefits) Score = 3.3

See Priority 1 - REV Criterion 5.

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Priority 14 – REV Criterion 6 (Duration of ecosystem improvements) Score = 2.3

The proposed refuge benefits are modeled to occur for a duration of 92 years. The application states that the duration of benefits would be observed for the duration of the Sacramento, Colusa, and Delevan NWRs' existence. However, the applicant's modeling shows that deliveries may be reduced depending on the water year type and future climate conditions. Similarly, the application states the duration of rice land benefits derived from Sites' water supply would be observed as long as rice production occurs in the Central Valley. However, this statement is based on the assumption that Sites agricultural water would be used primarily for rice production.

Priority 14 – REV Criterion 7 (Consistency with species recovery plans and strategies, initiatives, and conservation plans) Score = 4.0

Improving water supply to refuges during dry years is consistent with several recovery plans, strategies, initiatives, and conservation plans identified by the applicant. These plans include the Migratory Habitat Enhancement Plan, North American Waterfowl Management Plan, U.S. Shorebird Conservation Plan, Central Valley Joint Venture Implementation Plan, California Wildlife Action Plan, Draft Recovery Plan for the Giant Garter Snake, and the Conservation Plan for the Tricolored Blackbird. Improving water supply to rice lands during dry years is also consistent with many of these plans. Water provided to refuge habitats could potentially provide supplementary benefits linked to many species recovery plans and could also apply to multiple components of specific NWR management plans.

Priority 14 – REV Criterion 8 (Location of ecosystem improvements and connectivity to areas already being protected or managed for conservation values) Score = 5.3

The application identifies multiple refuges to which the Project could provide with IL4 water deliveries. Refuge water deliveries provide improved habitat for multiple species of plants and wildlife and can improve habitat functionality of adjacent areas due to their hydrologic and spatial proximity to refuge water applications. The refuges identified by the applicant are areas managed for conservation values.

Priority 14 – REV Criterion 9 (Efficient use of water to achieve multiple ecosystem benefits) Score = 3.8

In general, water deliveries to refuges can generate multiple habitat and species-specific benefits. The application indicates that there is flexibility available in the timing of refuge deliveries, allowing refuges to target other conservation goals that may occur later in the season. The applicant did not support the assumption that regional water supply provided by the Project would be used to irrigate ricelands.

Priority 14 – REV Criterion 10 (Resilience of ecosystem improvements to the effects of changing environmental conditions, including hydrologic variability and climate change) Score = 3.5

The modeling results demonstrate refuge delivery benefits would occur through the year 2122. However, the magnitude of deliveries would decrease slightly in the future. Although deliveries in dry and critical years are reduced relative to other water year types, these deliveries could still prevent the loss of refuge wetland acreage when other sources of refuge water also reduced due to dry year water demands. Besides climate change, the applicant did not discuss any of the other environmental uncertainties identified in the Department's ecosystem priority worksheet under this priority.

Priority 15: Develop and implement invasive species management plans utilizing techniques that are supported by best available science to enhance habitat and increase the survival of native species.
Priority 15 – REV Criterion 2 (Magnitude of Ecosystem Improvements) Score = 1.5

Yellow star thistle is an invasive plant present in the Project area and the primary target of this priority. The applicant intends to remove these plants and reestablish native species in an estimated 90 acres between the Golden Gate Dam to Funks Reservoir. There is no baseline mapping of the invasive plant, its density, or the topography of the environment in which it occurs. Without this data, no quantification of the ecosystem improvement between without- and with-Project conditions has been substantiated. The application also states the proposed invasive species management plan will benefit golden eagle. However, no method of quantifying the benefits to eagles was presented in the application.

Priority 15 – REV Criterion 3 (Spatial and temporal scale of ecosystem improvements) Score = 1.1

The spatial extent of the ecosystem improvement identified under this priority could not be assessed from the information provided in the application. The application states the estimated 90 acres refers to "the approximate acreage of the valley extending from Golden Gate Dam to Funks Reservoir". Baseline mapping of existing vegetation was not provided. Similarly, the timing of invasive species removal practices was not provided in the application.

Priority 15 – REV Criterion 4 (Inclusion of an adaptive management and monitoring program that includes measurable objectives, performance measures, thresholds, and triggers for managing ecosystem benefits) Score = 1.5

The application states that the 90 acres would be surveyed monthly during the initial establishment of native prairie and then surveyed annually. No discussion is provided on how this information will be applied to inform measureable objectives, thresholds, or adaptive management strategies. The application states that potential funding sources for adaptive management and monitoring include revenue generated from water delivery contracts.

Priority 15 – REV Criterion 5 (Immediacy of ecosystem improvement actions and realization of benefits) Score = 1.0

The application states that the ecosystem benefit would be complete nine years after grant encumbrance. For realization, the application states that "once the area is reseeded the benefit is immediate." The applicant did not point to supporting documentation. Successful reseeding may take more time than expected due to several potential factors such as weather, irrigation, slope, erosion, wind, or animal disturbance.

Priority 15 – REV Criterion 6 (Duration of ecosystem improvements) Score = 2.3

The application states the invasive species management benefits would be maintained for the project life (100 years), and that funding for this ecosystem improvement may come from budgeted mitigation funds or be obtained through grants. There is no additional information provided in the application to support the duration of this improvement.

Priority 15 – REV Criterion 7 (Consistency with species recovery plans and strategies, initiatives, and conservation plans) Score = 0.5

The application does not identify any recovery plans, initiatives, or conservation plans with which this proposed benefit would be consistent.

Priority 15 – REV Criterion 8 (Location of ecosystem improvements and connectivity to areas already being protected or managed for conservation values) Score = 1.1

The application provides a 1995 state map of California grassland habitats, which does not provide any information on the distribution of invasive species targeted for removal. The application states the Project is near the proposed Stone Corral recreation area that will be managed for conservation values. However, there is no map or description of this recreation area in relation to the area that would benefit from invasive species control.

Priority 15 – REV Criterion 9 (Efficient use of water to achieve multiple ecosystem benefits) Score = 0.0

The application states "Water for establishing native vegetation will most likely be taken from Holthouse Reservoir, which is a project facility." The applicant did not point to supporting documentation.

Priority 15 – REV Criterion 10 (Resilience of ecosystem improvements to the effects of changing environmental conditions, including hydrologic variability and climate change) Score = 1.0

In response to this ecosystem priority worksheet question, the application states, "Affects choice of native species for re-seeding". The applicant did not discuss the proposed ecosystem improvement's resilience nor point to supporting documentation to demonstrate the resilience of this ecosystem improvement.

Priority 16: Enhance habitat for native species that have commercial, recreational, scientific, or educational uses.

Priority 16 – REV Criterion 2 (Magnitude of Ecosystem Improvements) Score = 2.3

The application states that the Project's drought contingency actions for the Sacramento, Colusa and Delevan NWRs during dry and critically dry years vary depending on the severity of the reduced water allocations and the timing within the water year when the cutback is finalized. The application states that in recent history (2005-2014), only 43% of Level 2 and Level 4 refuge water was delivered in dry and critical years. These reductions in refuge deliveries have negative impacts on wetland habitats and the species that utilize these habitats. The application states a 50% reduction in deliveries to the Sacramento, Colusa, and Delevan NWRs would amount to a loss of up to 10,867 acres of wetland habitat.

The applicant proposes to provide additional water, with the highest deliveries in wet, above normal, and below normal years, to reduce adverse impacts to seasonal and permanent wetlands and to wetland-dependent wildlife on refuges. According to modeled projections, the volume of available water for refuges and wildlife areas will vary from 6 TAF to 54 TAF, depending on the water year type and future climate conditions. The Project would primarily benefit the Sacramento, Colusa, and Delevan NWRs. However, several other refuges and wildlife areas have been identified as potential targets.

The applicant did not demonstrate how these deliveries will enhance habitat for native species that have commercial, recreational, scientific, or educational uses. The application provides a list of species that occur in the Sacramento NWR Complex refuges that have commercial, recreational, scientific, or educational uses and values. However, the applicant did not point to supporting documentation to establish the commercial, recreational, scientific, or educational use of any of the identified species.

Priority 16 – REV Criterion 3 (Spatial and temporal scale of ecosystem improvements) Score = 2.5

Several potential NWRs and SWAs were identified in the application, and most benefits would occur at the Sacramento, Colusa, and Delevan NWRs. Refuges in the Mendota Pool and the Tulare Basin could also benefit from deliveries from the Project, as documented in the modeling. The timing of deliveries would be year-round, and the modeling shows allocations in all months except February. However, the applicant did not point to supporting documentation that establishes the commercial, recreational, scientific, or educational use of any species or habitat under this priority.

Priority 16 – REV Criterion 4 (Inclusion of an adaptive management and monitoring program that includes measurable objectives, performance measures, thresholds, and triggers for managing ecosystem benefits) Score = 2.3
See Priority 1 – REV Criterion 4

Priority 16 – REV Criterion 5 (Immediacy of ecosystem improvement actions and realization of benefits) Score = 2.3
See Priority 1 – REV Criterion 5

Priority 16 – REV Criterion 6 (Duration of ecosystem improvements) Score = 1.8

The proposed refuge benefits are modeled for 92 years. However, the application states that the duration of benefits will be observed for the duration of the Sacramento, Colusa, and Delevan NWRs' existence. Deliveries may be reduced depending on the water year type and future climate conditions. The applicant did not point to supporting documentation to explain how the duration of this benefit is linked to any commercial, recreational, scientific, or educational uses.

Priority 16 – REV Criterion 7 (Consistency with species recovery plans and strategies, initiatives, and conservation plans) Score = 2.0

The application identified several recovery plans, strategies, initiatives, and conservation plans that are consistent with improving water supply to refuges during dry years, including the Migratory Habitat Enhancement Plan, North American Waterfowl Management Plan, U.S. Shorebird Conservation Plan, California Wildlife Action Plan, Draft Recovery Plan for the Giant Garter Snake, Conservation Plan for the Tricolored Blackbird, and the Central Valley Joint Venture Implementation Plan. The water provided to refuge habitats could potentially deliver supplementary benefits that can be linked to many species recovery plans and apply to multiple components of specific NWR management plans. However, the applicant did not describe how the ecosystem changes proposed by this Project relevant to this priority are consistent with these plans.

Priority 16 – REV Criterion 8 (Location of ecosystem improvements and connectivity to areas already being protected or managed for conservation values) Score = 2.5

The application documents multiple refuges that could be provided with IL4 water deliveries. Several potential NWRs and SWAs were identified in the application with most benefits occurring at the Sacramento, Colusa, and Delevan NWRs. Refuges in the Mendota Pool and the Tulare Basin could also benefit from deliveries from the Project as documented in the modeling. Refuge water deliveries provide improved habitat for multiple species of plants and wildlife and can improve habitat functionality of adjacent areas due to their hydrologic and spatial proximity to refuge water applications. The refuges identified are managed for conservation values. Several of the NWRs are hydrologically connected to the Sacramento River, which provides beneficial pathways for water and species movement. The application states that seasonal and permanent wetlands in the Sacramento NWR are managed specifically for habitat enhancement and for the benefit of native species that have commercial, recreational, scientific, or educational uses (including waterfowl, shorebirds, and special-status wildlife species). However, no documentation was provided that quantifies what the added commercial, recreational, scientific, or educational value of any species or habitat would be.

Priority 16 – REV Criterion 9 (Efficient use of water to achieve multiple ecosystem benefits) Score = 2.8

In general, water deliveries to refuges can generate multiple habitat and species specific benefits. The application indicates that there is flexibility in the timing of refuge deliveries, allowing refuges to target other conservation goals that may occur later in the season. The application did not describe how the water efficiencies of this benefit are linked to any commercial, recreational, scientific, or educational uses.

Priority 16 – REV Criterion 10 (Resilience of ecosystem improvements to the effects of changing environmental conditions, including hydrologic variability and climate change) Score = 1.8

The application states that Project modeling indicates that dry, and critically dry, years will occur 34-38% of time in the Sacramento Valley and 66-69% of time in the San Joaquin Valley. The applicant associates this frequency with the potential wetland losses in the future due to reduced refuge deliveries under without Project conditions. The proposed benefits discussed under this priority indicate the Project's ability to potentially reduce the impacts associated with these reductions. The application states that climate change and associated increased frequency of dry and critically dry years is the primary source of uncertainty. However, the application did not describe how this linked to any commercial, recreational, scientific, or educational uses is resilient.

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Table 1. Relative Environmental Value Scores for the Sites Project												
Priority	REV2	REV3	REV4	REV5	REV6	REV7	REV8	REV9	REV10	REV1	Points Possible	Points Received
P 1	2.3	3.0	3.0	2.5	3.3	2.8	2.8	1.8	2.7	X	54	24.2
P 2	1.8	1.7	2.3	2.0	2.7	2.3	2.4	1.3	1.8	X	54	18.3
P 3	1.7	1.7	2.3	1.8	2.3	2.0	2.0	1.2	1.5	X	54	16.5
P 4	2.3	3.2	2.8	2.6	3.3	2.8	2.8	1.8	2.7	X	54	24.3
P 5	1.0	1.0	1.2	1.5	1.8	1.2	1.5	1.0	1.5	X	54	11.7
P 10	2.1	2.3	2.4	2.8	2.7	2.1	2.9	1.6	1.9	X	54	20.8
P 11	1.9	1.9	2.3	2.2	2.9	2.6	2.7	1.7	2.1	X	54	20.3
P 14	3.0	4.0	2.8	3.3	2.3	4.0	5.3	3.8	3.5	X	54	32.0
P 15	1.5	1.1	1.5	1.0	2.3	0.5	1.1	0.0	1.0	X	54	10.0
P 16	2.3	2.5	2.3	2.3	1.8	2.0	2.5	2.8	1.8	X	54	20.3
TOTAL										REV1 = [1] 3.8%	540	198.4
										TOTAL REV SCORE[2]		40.5%

[1] Additional 0.375 percent applied to total REV score for each priority claimed

[2] Total REV Score equals total points received divided by total points possible, plus REV1 percentage addition

Meeting: **Sites Reservoir Committee's Coordination Workgroup**

Locations: Maxwell Project Office, 122 Old Highway 99W, Maxwell, CA 95955
See below for alternate meeting locations.

Call in: **1-916-538-7066** Code: **372 979 656#** Click here to join the meeting

Workgroup Chair: Thad Bettner (RC Chair/Glenn-Colusa Irrigation District)

Workgroup Vice-Chair: Valerie Pryor (RC Vice-Chair/Zone 7 Water Agency)

Staff Lead: Jerry Brown, Executive Director

AGENDA

Thursday, November 10, 2022 9:00 – 10:00 am

NO ACTION or DECISION WILL BE TAKEN

ROLL CALL & CALL TO ORDER:

- Introductions
- Period for Public Comment

PERIOD OF PUBLIC COMMENT: Any person may speak about any subject of concern, provided it is within the jurisdiction of the workgroup. The time allotted for receiving such public communication shall be limited to 3 minutes per person or group and not exceed 10 minutes per issue. Note: No action shall be taken on comments made during this period.

1. Discussion and Information Items:

1.1 Board Meeting Agenda Planning

1.1.1 Effect of AB2449

1.2 General Coordination Among Committees and Workgroups

1.2.1 ACWA meetings

1.2.2 Consider Joint Coordination Meetings

2. Closed Session:

2.1 Potential Litigation – Gov. Code Sec. 54956.9(d)(3)

3. Upcoming Meetings:

Reservoir Committee
Friday, November 18, 2022 (9:00 am – 12:00 pm)

Authority Board Meeting
Monday, November 21, 2022 (1:30 – 4:00 pm)

Coordination Workgroup
Thursday, December 8, 2022 (9:00 – 10:00 am)

Virtual Information will be provided before all meetings at Sitesproject.org.

ADJOURN

ADA COMPLIANCE: Upon request, agendas will be made available in alternative formats to accommodate persons with disabilities. In addition, any person with a disability who requires a modification or accommodation to participate or attend this meeting may request necessary accommodation. Please make your request to the Board Clerk, specifying your disability, the format in which you would like to receive this Agenda and any other accommodation required no later than 24 hours before the start of the meeting.

Alternate Meeting Locations:

Coachella Valley Water District, 51501 Tyler Street, Coachella, CA 92236

Davis Water District, 6505 Hillgate Road, Arbuckle, CA 95912

Glenn-Colusa Irrigation District, 344 East Laurel Street, Willows, CA 95988

San Bernardino Valley Municipal WD, 380 E. Vanderbilt Way, San Bernardino, CA 92408

Wheeler Ridge-Maricopa Water Storage District, 12109 Hwy 166, Bakersfield, CA 93313

Zone 7 Water Agency, 100 North Canyons Parkway, Livermore, CA 94551

Model Description for the Sacramento River Winter-run Chinook Salmon Life Cycle Model: an implementation for the Delta Conveyance Project

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October 19, 2022

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I. Background and Model Structure

Given the goals of improving the reliability of water supply and improving the ecosystem health in California's Central Valley, NMFS-SWFSC is developing simulation models to evaluate the potential effects of water project operations and habitat restoration on the dynamics of Chinook salmon populations in the Central Valley. These life cycle models (LCMs) couple water planning models (CALSIM II), physical models (HEC-RAS, DSM2, DSM2-PTM, USBR river temperature model, etc.) and Chinook salmon life cycle models to predict how various salmon populations will respond to suites of management actions, including changes to flow and export regimes, modification of water extraction facilities, and large-scale habitat restoration. In this document, we describe a winter-run Chinook salmon life cycle model (WRLCM). In the following sections, we provide the general model structure, the transition equations that define the movement and survival throughout the life cycle, the life cycle model inputs that are calculated by external models for capacity and smolt survival, and the steps to calibrate the WRLCM.

Winter-run Life Cycle Model (WRLCM)

The WRLCM is structured spatially to include several habitats for each of the life history stages of spawning, rearing, smoltification (physiological and behavioral process of preparing for seaward migration as a smolt), outmigration, and ocean residency. We use discrete geographic regions of Upper River, Lower River, Floodplain, Delta, Bay, and Ocean (Figure 1). The temporal structure of winter-run Chinook is somewhat unique, with spawning occurring in the late spring and summer, the eggs incubating over the summer, emerging in the fall, rearing through the winter and outmigrating in the following spring (Figure 2). We capture these life-history stages within the WRLCM by using developmental stages of eggs, fry, smolts, ocean sub-adults, and mature adults (spawners). The goal of the WRLCM is consistent with that of Hendrix et al. (2014); that is, to quantitatively evaluate how Federal Central Valley Project (CVP) and California State Water Project (SWP) management actions affect Central Valley Chinook salmon populations.

In 2015, the WRLCM was reviewed by the Center for Independent Experts (CIE). In response to recommendations from the CIE, the following modifications were implemented in the WRLCM: 1) divided the River habitat to encompass above Red Bluff Diversion Dam (Upper River) and below Red Bluff Diversion Dam (Lower River); 2) incorporated hatchery fish into the WRLCM; 3) used 95% of observed density as an upper bound for calculation of habitat capacity; 4) re-parameterized the Beverton-Holt function; 5) used appropriate spawner sex-ratios for model calibration to account for bias in Keswick trap capture; 6) modified the WRLCM to a state-space form to incorporate measurement error and process noise; and 7) designed metrics and simulation studies to evaluate model performance. In addition, Hendrix et al. (2014) indicated that future work would use DSM2's enhanced particle tracking model to track salmon survival, which has now been implemented.

Additional comments received in the CIE review that have not been incorporated yet include: 1) expanding spatial structure for spring and fall-run; 2) tracking additional categories of juveniles (e.g., yearling) for applying an LCM to spring-run Chinook; 3) implementing shared capacity for fall and spring-run Chinook; 5) tracking monthly cohorts through the model; and 6) evaluating multiple model structural forms. We are actively working on improving the WRLCM and developing the spring-run LCM (SRLCM) and fall-run LCM (FRLCM). Many of the CIE recommendations will be implemented with subsequent versions of these models.

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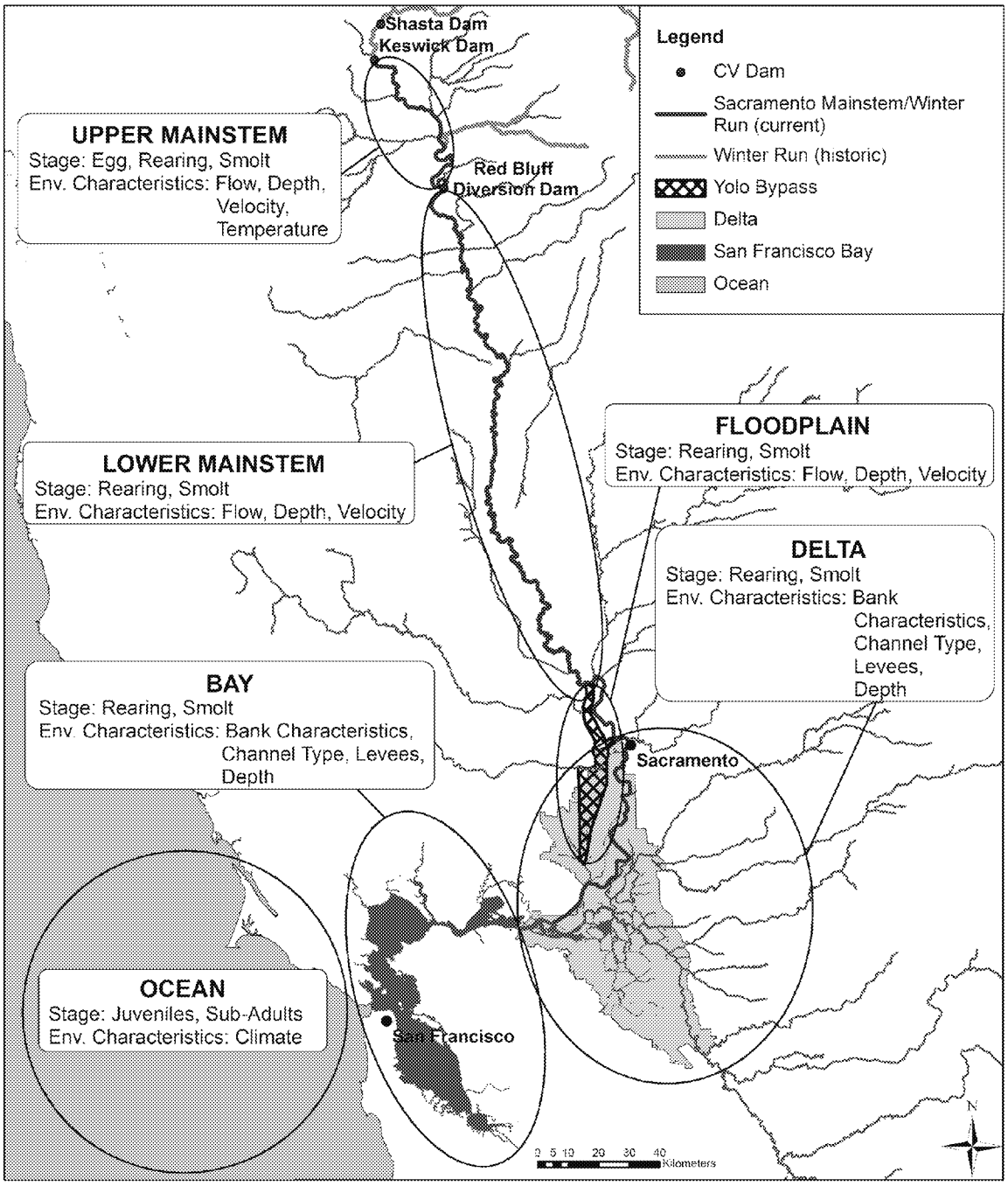

Figure 1. Geographic distribution of Chinook life stages and examples of environmental characteristics that influence survival.

The quantity and quality of rearing and migratory habitat are viewed as key drivers of reproduction, survival, and migration of freshwater life stages. Various life stages have velocity, depth, and temperature preferences and tolerances, and these factors are influenced by water project operations and climate.

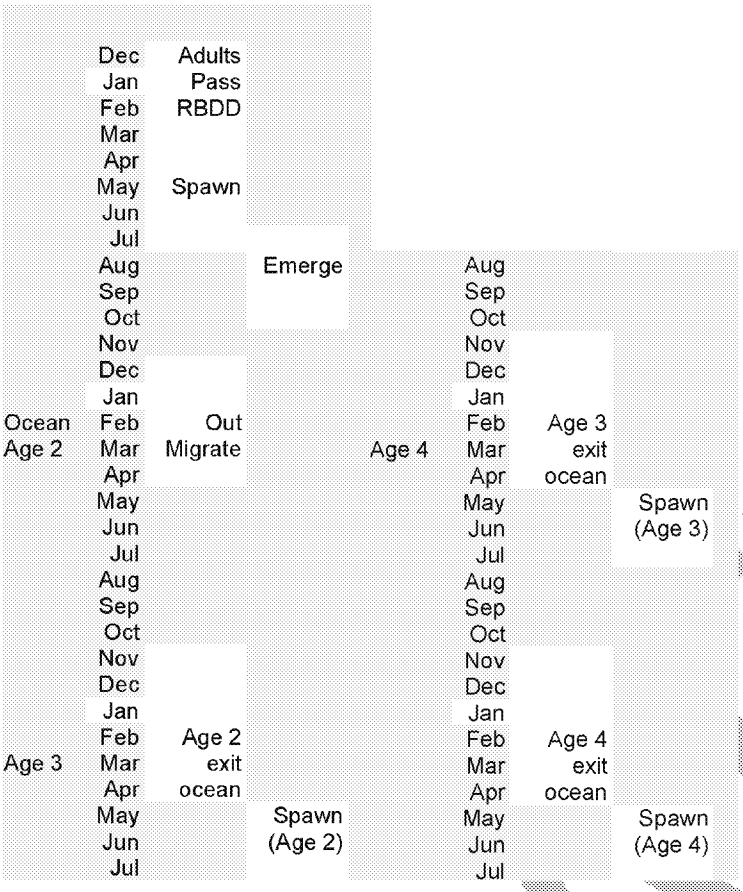

Figure 2. Temporal structure of the winter-run Chinook salmon. Each cohort begins in March of the brood year. Figure from Grover et al. (2004).

Hydrology (the amount and timing of flows) is modeled with the California Simulation Model II (CALSIM II). Hydraulics (depth and velocity) and water quality is modeled with the Delta Simulation Model II (DSM2) and its water quality sub-model QUAL, the Hydrologic Engineering Centers River Analysis System (HEC-RAS), the U.S. Bureau of Reclamation's (USBR) Sacramento River Water Quality Model (SRWQM), and other temperature models. The enhanced particle tracking model (ePTM) makes use of many of these DSM2 related products to calculate survival of outmigrating smolts originating from Lower River, Delta, and Floodplain habitats. Many of the stage transition equations describing the salmon life cycle are directly or indirectly functions of water quality, depth, or velocity, thereby linking management actions to the salmon life cycle. The combination of models and the linkages among them form a framework for analyzing alternative management scenarios (Figure 3).

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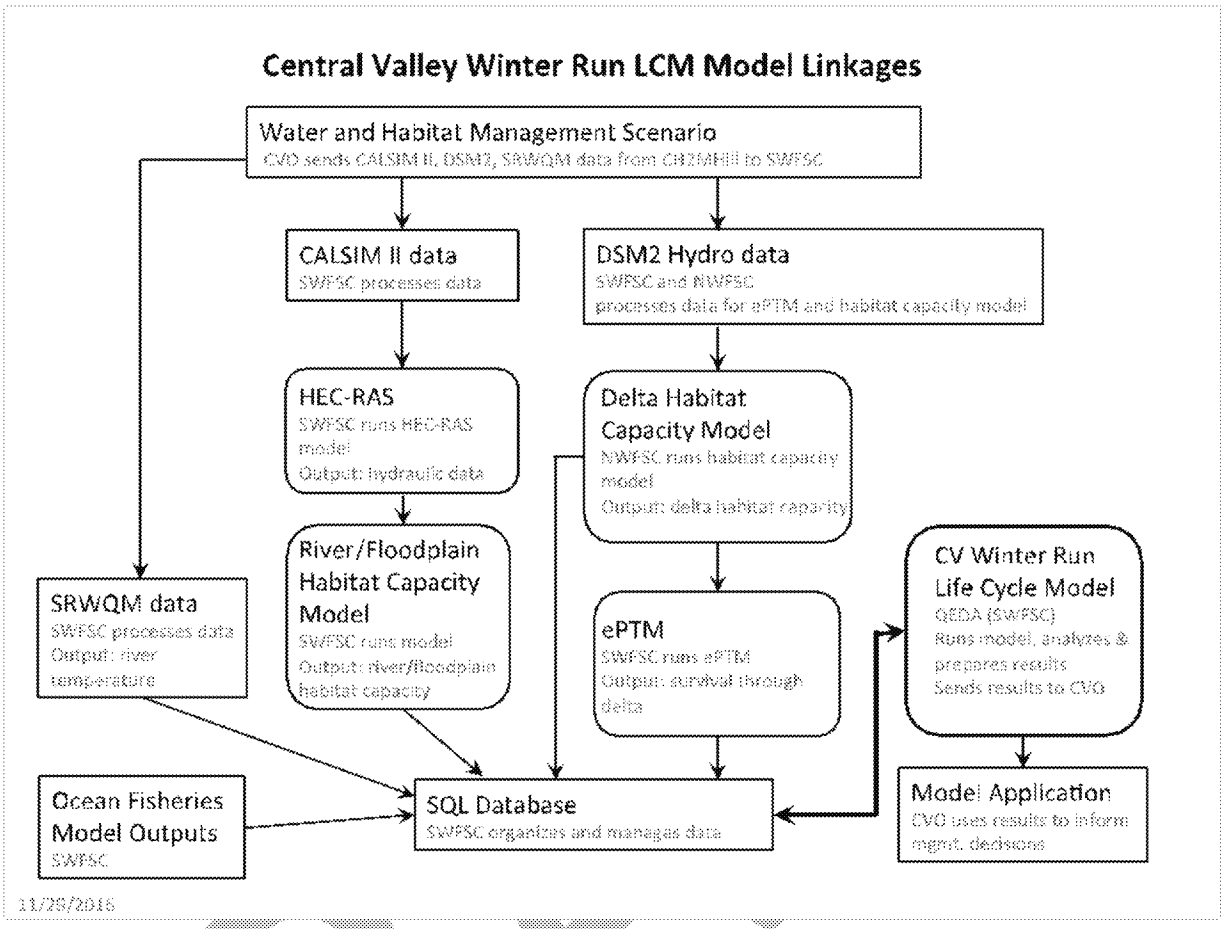

Figure 3. Submodels that support and provide parameter inputs that feed into the life cycle model.

The life cycle model is a stage-structured, stochastic life cycle model. Stages are defined by development and geography (Figure 1), and each stage transition is assigned a unique number (Figure 4).

II. Model Transition Equations

This section is divided into two parts. In the first part, we explain each of the transitions for the natural origin winter-run Chinook, which are described by the life cycle diagram (Figure 4). In the second part, we explain the transitions for hatchery origin fish. The transitions are described for an annual cohort; however, in most cases we have not included a subscript for the cohort brood year to simplify the equations. For those transitions in which there are multiple cohorts, such as the production of eggs in transition 22, a subscript to distinguish cohort is included in the equation.

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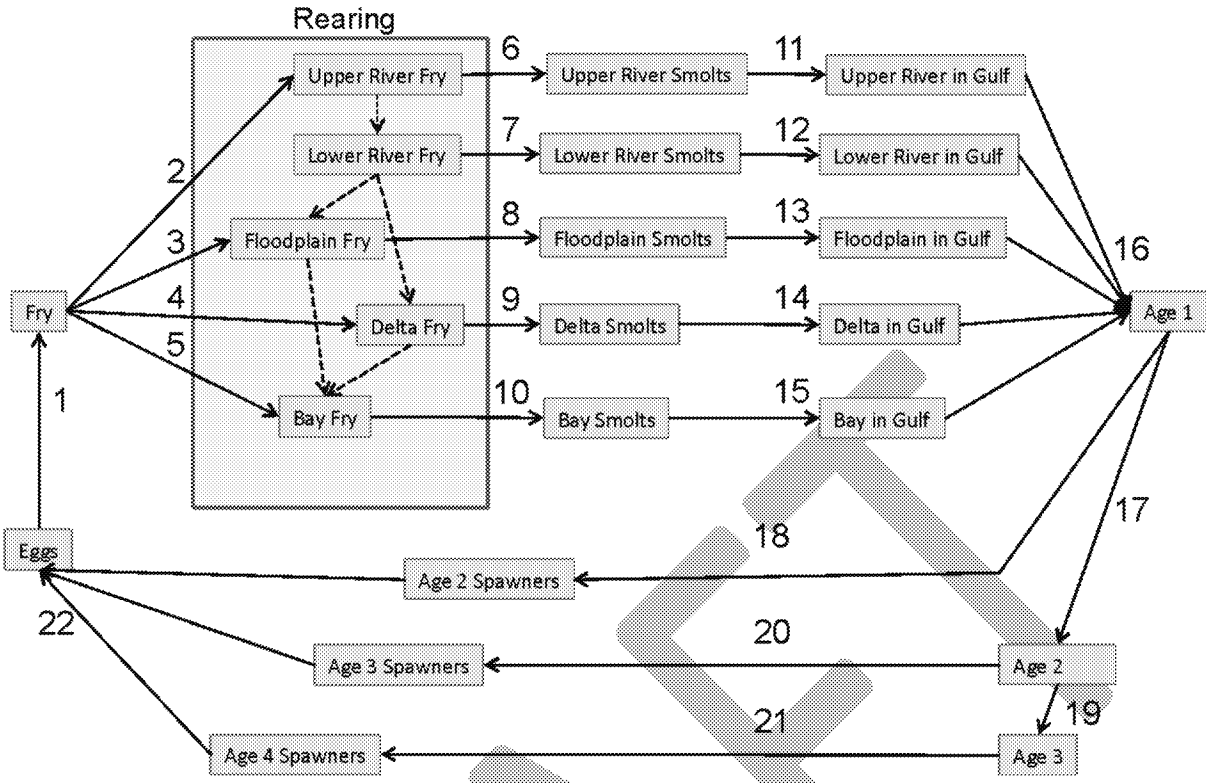

Figure 4. Central Valley Chinook transition stages. Each number represents a transition equation through which we can compute the survival probability of Chinook salmon moving from one life stage in a particular geographic area to another life stage in another geographic area.

Natural Origin Chinook

Transition 1

Definition: Survival from Egg to Fry

$Fry_{m+2} = Eggs_m * S_{eggs,m}$

$$logit(S_{eggs,m}) = \begin{cases} B0_1, & TEMP \leq t.crit \\ B0_1 + B1_1(TEMP_m - t.crit), & TEMP > t.crit \end{cases}$$

where $S_{eggs,m}$ is the survival rate of fry as a function of the coefficients $B0_1$, $B1_1$ and *t.crit* (model parameter representing the critical temperature at which egg survival begins to be decline), logit(x) = log(x/[1-x]) is a function that ensures that the survival rate is within the interval [0,1], for months m = (2, …, 6) corresponding to April to August.

Factors affecting baseline survival $B0_1$

$B0_1 = B0a + B1a * X1$

Where B0a is the intercept and B1a is the slope of the regression relating the covariate X1 to the background survival rate. This formulation provides the ability to incorporate the influence of Thiamine deficiency, for example, which may affect the survival of eggs. In addition, this term could also be used to reflect density dependent mortality of eggs, which was identified as a possible factor

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in Martin et al. (2017). The covariate $TEMP_m$ is defined as the equally weighted average of the month of spawning m and the following 2 months.

Transitions 2 - 5

Definition: Dispersal from fry in the natal reaches as tidal fry to the h habitats = Lower River (LR), Floodplain (FP), Delta (DE), and Bay (BA) in months m = (5, ..., 10) corresponding to July to December. Fry that remain (in contrast to those that are tidal fry) rear in the Upper River (UR).

Tidal Fry and Upper River Rearing Fry (Transition 2)

$TidalFry_{m,} = P_{TF,} * Fry_m$

$RearFry_{UR,m} = (1 - P_{TF}) * Fry_m$

where P_{TF} is the proportion of fry moving out of the Upper River as tidal fry, and $RearFry_{UR,m}$ are the number remaining in the Upper River habitat (UR) as rearing fry.

Floodplain Tidal Fry (Transition 3)

Whenever there are flows into the Yolo Bypass, a proportion of the Tidal Fry move into the floodplain habitat:

$TidalFry_{FP,m} = S_{TF,FP} * TidalFry_m * P_{FP,m}$

where $P_{FP,\,m}$ is the proportion of fry that move into the Floodplain habitat, and $S_{TF,FP}$ is the monthly survival of tidal fry in the floodplain.

For the 2020 scenario evaluations, the $P_{FP,m}$ is modeled as a function of the flow at Verona. To reflect the historical dynamics of access to the Floodplain habitat (Yolo bypass), the following transition equation was used to describe the proportion of Tidal Fry that enter the floodplain habitat ($P_{FP,m}$)

$P_{FP,m} = B1_{FP} * \mathrm{I}(Q_{Verona,m} > 991.1\ \mathrm{m^3 s^{-1}})$

where $Q_{Verona,m}$ was the Sacramento River flow at Verona in month m, I( ) is an indicator function that equates to 1 when the condition in the parenthesis is met, and $B1_{FP}$ is the proportion of fry that enter the Yolo under flooding conditions.

For the 2040 scenario evaluation, the $P_{FP,m}$ is modeled as a function of the expected flow onto the Floodplain habitat due to proposed modifications of the Fremont Weir.

$$P_{FP,m} = \begin{cases} min.p, & y.flow_m < 100 \\ min.p + \dfrac{(y.flow_m - 100) * (0.5 - min.p)}{5900}, & 100 \le y.flow_m \le 6000 \\ inv.logit\left(\dfrac{p.rate * (y.flow_m - 6000)}{1000}\right), & y.flow_m > 6000 \end{cases}$$

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where $P_{FP,m}$ is the proportion of fry moving into the Floodplain as a function of the coefficients $min.p$ (0.05) and $p.rate$ (1.1), and the covariate $y.flow_m$. The function inv.logit(x) = $e^x/(1+ e^x)$ ensures that the proportion of fry moving into the Floodplain is within the interval [0,1]. The covariate $y.flow_m$ represents the monthly average flow rate (cfs) at the entrance to Yolo Bypass (CALSIM node D160). The relationship between $P_{FP,m}$ and flow is depicted in Figure 5.

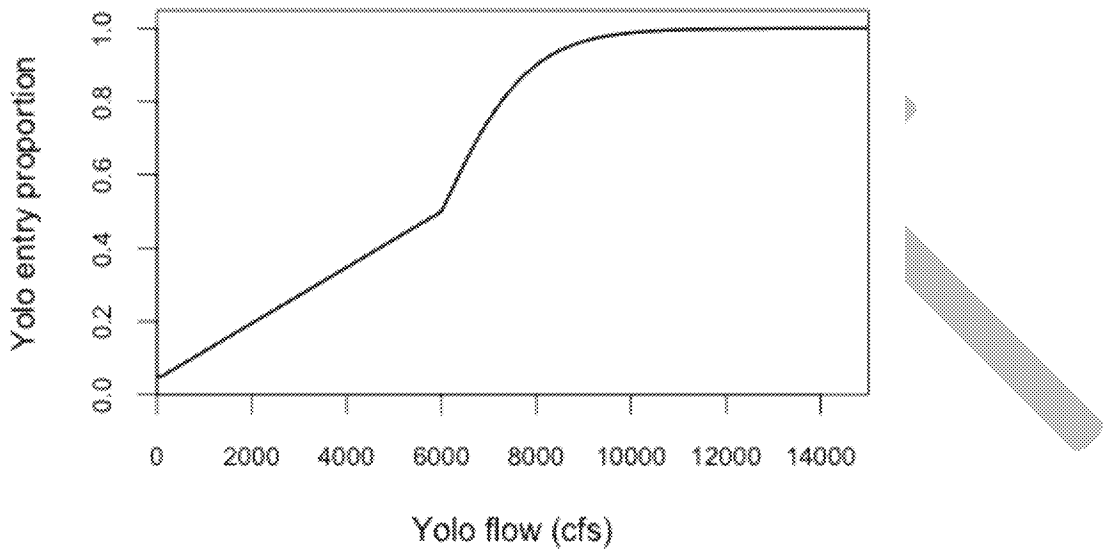

Figure 5. The relationship of Floodplain entry (Yolo bypass) entry proportion (P_{FP}) as a function of Yolo flow.

Delta and Bay Tidal Fry (Transition 4 and 5)

$$TidalFry_{DE,m} = TidalFry_m * (1- P_{FP,m}) * (1 - P_{TF, BA,m}) * S_{TF,DE,m}$$

$$TidalFry_{BA,m} = TidalFry_m * (1- P_{FP, m}) * P_{TF, BA,m} * S_{TF,DE,m} * S_{TF,DE-BA}$$

where $S_{TF,DE,m}$ is the survival to the Delta by Tidal Fry.

$$\text{logit}(S_{TF,DE,m}) = B0_4 + B1_4 * DCC_m$$

where $B0_4$ and $B1_4$ are model parameters, and DCC_m is the proportion of the transition month that the DCC gate is open.

$P_{TF,Bay,m}$ is the proportion of fish moving to the Bay from the Delta

$$\text{logit}(P_{TF,Bay,m}) = B0_5 + B1_5 * Q_{RioVista,m}$$

where $B0_5$ and $B1_5$ are model parameters, and $Q_{RioVista,m}$ is the flow anomaly (subtract mean and divide by standard deviation). The mean and standard deviation were calculated from 1970-2014 data at Rio Vista (mean = 11,360, standard deviation = 12166.73).

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Rearing

Definition: Fry rear among Upper River, Lower River, Floodplain, Delta, and Bay habitats according to a density dependent movement function in months m = (5, …, 10) corresponding to July to December.

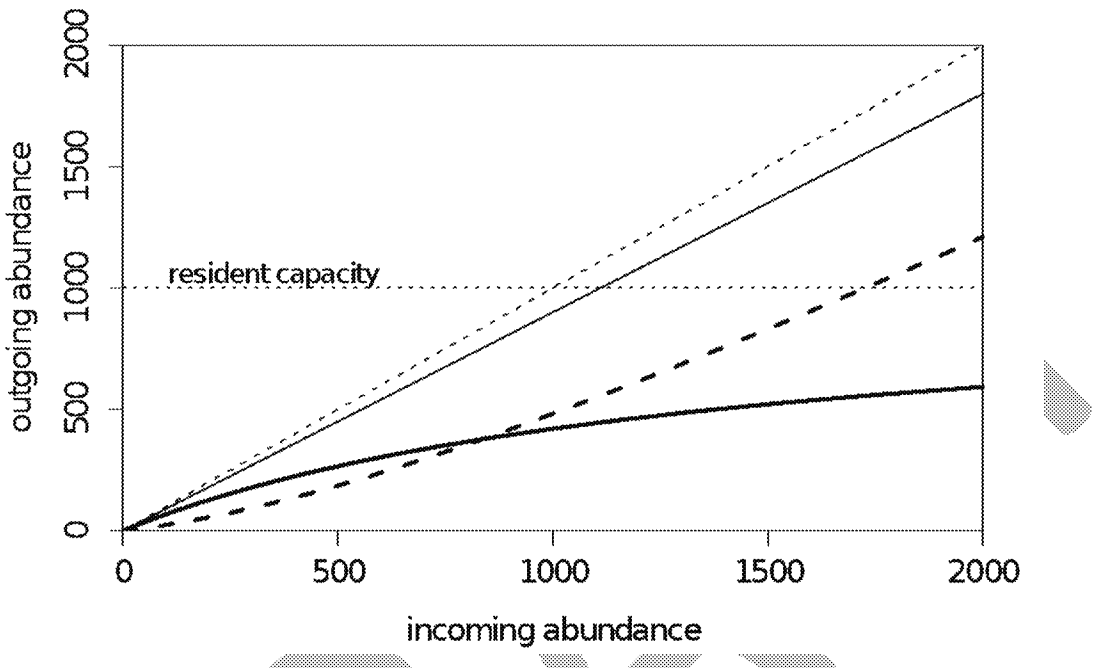

Figure 6. Example of the Beverton-Holt movement function in which the outgoing abundance (thin solid black line) is split between migrants (thick dashed line) and residents (solid dark line), that are affected by the resident capacity (thin dotted line). The 1:1 line (thin dashed line) is also plotted for reference. Parameter values used in the plotted relationship are survival, S = 0.90; migration, m = 0.2; and capacity, K= 1000.

The number fry that remain as residents in the month is calculated from the following equation (Figure 6):

$$Residents_{h,m} = S_{FRY,h,m} * (1 - mig_{h,m}) * N_{h,m} / (1 + S_{FRY,h,m} * [1 - mig_{h,m}] * N_{h,m}/K_{h,m})$$

$$Migrants_{h,m} = S_{FRY,h,m} * N_{h,m} - Residents_{h,m}$$

where $S_{FRY,h,m}$ is the survival rate in the absence of density dependence, $N_{h,m}$ is the pre-transition abundance composed of $Migrants$ from upstream habitats in m-1 and $Residents$ from the current habitat (Figure 7) in m-1, $K_{h,m}$ is the capacity for habitat type h and $mig_{h,m}$ is the migration rate in the absence of density dependence in month m.

The migration rate in the Upper River, $mig_{UR,m}$, is unique and is estimated by using the temporal patterns in fry abundance estimated at Red Bluff Diversion Dam (Poytress et al. 2014).

The migration rate in the Lower River, $mig_{LR,m}$, is modeled as a function of a flow threshold at Wilkins Slough

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$\text{logit}(mig_{LR,m}) = B0_M + B1_M * I(Q_{Wilkins,\,m} > 400\ m^3s^{-1})$

whereas in all other habitats and months the migration rate $mig_{h,m}$ is a constant value (e.g., movement from the floodplain to the delta, the delta to the bay, and the bay to the gulf).

Survival of fry

Survival of resident and migrant fry $S_{FRY,h,m}$ are modeled as a function of a covariate $X_{h,m}$ that can vary for each habitat and month. The monthly survival rate of fry in habitat *h* and month *m* is modeled as

$\text{logit}(S_{FRY,h,y,m}) = B0_F + B1_{F,h} * X_{h,y,m}$

Smolting

Transitions 6 - 10

Definition: Smolting of *Residents* in the Upper River, Lower River, Floodplain, Delta, and Bay rearing habitats in months m = (11, … ,17) corresponding to January to July in the calendar year after spawning.

$Smolts_{h,m} = P_{SM,m} * Residents_{h,m-1}$

where $P_{SM,m}$ is the probability of smolting in month m which is assumed to be the same across habitats, by the *Residents* from the previous month (m-1) in that habitat.

The probability of smolting is modeled as a proportion ordered logistic regression model of the form:

$\text{logit}(P_{SM,\,m}) = Z_k$

where $-\infty < Z_1 < Z_2 \ldots < Z_k < \infty$ are the monthly rates of smoltification based on photoperiod (k = 1, …, 7 encompassing January to July).

The model performs the following steps during the months in which smoltification occurs:

1. Smoltification of Resident fry
2. Accumulation of the Migrant fry from the upstream habitats and Resident fry from the current habitat remaining from the previous month that did not smolt
3. Survival and movement of the fry calculated in step 2

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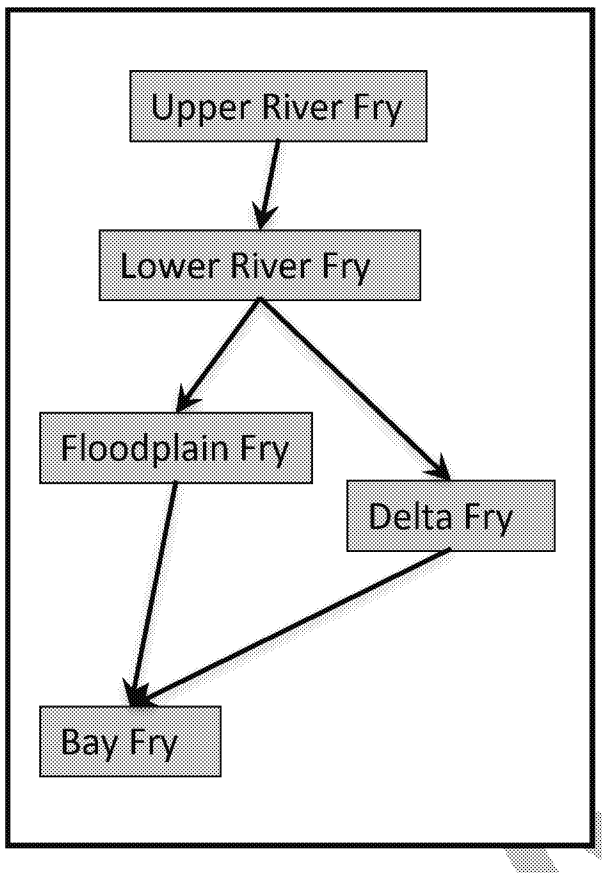

Figure 7. Connectivity among habitats for winter-run Chinook fry. Connections between the Lower River and Floodplain occur due to flooding of the Yolo bypass and are thus ephemeral.

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Transitions 11 – 14

These transitions use a Smolt Survival Model (SSM) to calculate the smolt survival through the delta portion of their outmigration. Different models may be used to calculate this survival including Newman (2003) based on an analysis of coded wire tag recoveries, estimates of acoustically tagged survival rates analyzed by Perry et al. (2018) and given the name STARS, and an enhanced particle tracking model (ePTM version 2) that simulates smolt movement at fine temporal (15 min) and spatial (DSM2 8.2 grid structure) resolution. We have described the transition equations generically to be able to use the survival estimates in month *m* and habitat *h* from any of the above survival models using the acronym $SSM_{h,m}$ in the descriptions below.

Transitions 11 & 12

Definition: Smolts that reared in the Upper River and Lower River habitats migrate to the Golden Gate and thus end the freshwater phase of their life cycle in months *m* = (12, … ,18) corresponding to February to August.

Upper River smolt outmigration (Transition 11)

$Gate_{UR,m} = S_{11,UR,m-1} * Smolts_{UR,m-1}$

Lower River smolt outmigration (Transition 12)

$Gate_{LR,m} = S_{12,LR,m-1} * Smolts_{LR,m-1}$

where survival $S_{T,h,m}$ is the smolt survival rate from transition T (11, ..., 15) in habitat h (*UR, LR, FP, DE, BA*) in month m. The rates $S_{11.UR,m}$ and $S_{12,LR,m}$ are composed of three components: A) survival rate from the Upper or Lower River to the Sacramento River near Sacramento; B) survival through the Delta to Chipps Island; and C) survival from Chipps Island to Golden Gate.

$S_{11.UR,m} = {}^{A}S_{11,UR,m} * {}^{B}S_{12,LR,m} * {}^{C}S_{11}$
$S_{12,LR,m} = {}^{A}S_{12,LR,m} * {}^{B}S_{12,LR,m} * {}^{C}S_{11}$

The first smolt survival component is modeled as a function of flow at Bend Bridge

$\text{logit}({}^{A}S_{11,UR,m}) = B0_{11,UR} + B1_{11} * q.bb_m$
$\text{logit}({}^{A}S_{12,LR,m}) = B0_{12,LR} + B1_{11} * q.bb_m$

where $B0_{11,UR}$, $B0_{12,LR}$ and $B1_{11}$ are model parameters, and $q.bb_m$ is monthly flow at Bend Bridge which is the closest station to the Red Bluff Diversion Dam standardized relative to historic Bend Bridge flows from 1970-2014 (mean = 14593.96, standard deviation = 10984.20).

${}^{B}S_{12.LR,m} = SSM_{LR,m}$

where $SSM_{LR,m}$ is a survival rate for smolts originating from the Sacramento River through the Delta to Chipps Island as calculated by the Smolt Survival Model. The value ${}^{C}S_{11}$ is a model parameter representing survival from Chipps Island to Golden Gate, and it was applied to smolts originating from all habitats.

Transition 13

Definition: Smolts that reared in the Floodplain migrate to the Golden Gate arriving in months m = (12, ... ,18) corresponding to February to August.

$Gate_{FP,m} = S_{13,FP,m-1} Smolts_{FP,m-1}$

The rate $S_{13,FP,m}$ is composed of three components: A) survival rate through the Floodplain to the Delta; B) survival through the Delta to Chipps Island; and C) survival from Chipps Island to Golden Gate.

$S_{13,FP,m} = {}^{A}S_{13,FP,m} * {}^{B}S_{13,FP,m} * {}^{C}S_{11}$

where ${}^{A}S_{12,FP,m}$ is survival in the Floodplain until the Smolt Survival Model estimate is applied for survival through the Delta.

${}^{B}S_{13.FP,m} = SSM_{FP,m}$

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Transition 14

Definition: Smolts that reared in the Delta migrate to the Golden Gate arriving in months m = (12, ... ,18) corresponding to February to August.

$Gate_{DE,m} = S_{14,DE,m-1} * Smolts_{DE,m-1}$

The rate $S_{14,DE,m}$ is composed of two components: survival through the Delta to Chipps Island ($^{A}S_{14,DE,m}$) and survival from Chipps Island to Golden Gate ($^{C}S_{11}$).

$S_{14,DE,m} = {}^{A}S_{14,DE,m} * {}^{C}S_{11}$

where $^{A}S_{14,DE,m} = SSM_{DE,m}$

Transition 15

Definition: Smolts that reared in the Bay migrate to the Golden Gate with an associated migration survival in months m = (12, ... ,18) corresponding to February to August.

$Gate_{BA,m} = S_{15,BA} * Smolts_{BA,m-1}$

where $S_{15,BA}$ is the survival from the Bay habitat to the Golden Gate.

Transition 16

Definition: Smolts that reach the Golden Gate transition to the Gulf of the Farallones and the numbers in each month accumulate as a combination of the smolts in the Gulf the previous month and smolts that passed the Golden Gate in months m = (12, ... ,20) corresponding to February to September.

$Gulf_{h,m} = Gate_{h,m-1} * S_{ENTRY,\,m-1} + Gulf_{h,m-1} * S_{GULF,\,m-1}$

Where the survival rate $S_{ENTRY,\,m}$ is the survival rate during the month of ocean entry in the Gulf of the Farallones and the survival rate $S_{GULF,m}$ is the subsequent survival rate in month m after ocean entry.

The period of ocean entry can be a critical period of transition for salmonids and lack of available resources can have strong detrimental effects on the year class (Lindley et al. 2009). We therefore model the survival at ocean entry by using an indicator of ocean productivity as

$$\text{logit}(S_{ENTRY,m}) = B0_{ENTRY} + B1_{ENTRY} * OPI_{,m}$$

where $B0_{ENTRY}$ is a parameter describing the average survival rate , $OPI_{,m}$ is the ocean productivity index, and $B1_{ENTRY}$ is the coefficient describing the strength of the ocean productivity effect on ocean entry survival.

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Finally, the transition to the ocean from all habitats includes a random effect term ε_y that is specific to each year y and is distributed as a normal random variable, that is $\varepsilon_y \sim N(0, \sigma_\varepsilon^2)$. The formulation used here is a biased-corrected form so the expected value of the random effects equals 0.

The total number of Age 1 fish entering the Gulf of the Farallones from all habitats arriving in a given month can be calculated by summing across each of the individual rearing areas. Furthermore, earlier arriving fish are retained in the Age 1 stage and an ocean survival rate is applied to those fish that were already in the Age 1 stage in the previous month. Fish arrive into the Age 1 stage in months m = (12, ..., 20) corresponding to February through October.

$$Age1_m = Gulf_{UR,m} + Gulf_{LR,m} + Gulf_{FP,m} + Gulf_{DE,m} + Gulf_{BA,m} + Age1_{m-1} * S_{17}^{1/4}$$

Transition 17

Definition: Survival in the ocean from Age 1 to Age 2 (for Chinook that remain in the ocean)

$$Age2 = Age1_{m=21} * (1 - M_2) * S_{17}$$

where S_{17} is a model parameter representing the survival rate of Age 1 fish in the ocean to Age 2 and M_2 is a model parameter representing the maturation rate that leads to 2-year old spawners. The model transitions from a monthly time step (used for months 1 through 20) to an annual time step (used for Age 2, Age 3 and Age 4 fish) in this transition, thus the S_{17} survival represents a 4-month survival rate from 21 months to 24 months (November to February).

Transition 18

Definition: Maturation and migration for Age 2 males and females that will spawn as 2-year olds

$$Sp_{2,F} = Age1_{m=21} * S_{17} * M_2 * Fem_{Age2} * S_{sp2}$$
$$Sp_{2,M} = Age1_{m=21} * S_{17} * M_2 * (1 - Fem_{Age2}) * S_{sp2}$$

where S_{17} and M_2 are model parameters for maturation and survival as described in Transition 17. Fem_{Age2} is a model parameter representing the proportion of Age 2 spawners that are female, and S_{sp2} is a model parameter representing the natural survival rate of Age 2 spawners from the ocean to the spawning grounds.

Transition 19

Definition: Survival in the ocean from Age 2 to Age 3 (for Chinook that remain in the ocean)

$$Age3 = Age2 * (1 - I_3) * S_{19} * (1 - M_3)$$

where I_3 is the fishery impact rate for Age 3 fish, S_{19} is a model parameter representing natural survival rate for fish between Age 2 and Age 3, and M_3 is a model parameter representing maturation rate of Age 3 fish.

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Transition 20

Definition: Maturation and migration for Age 3 males and females that will spawn as 3-year olds

$Sp_{3,F} = Age2 * (1- I_3) * S_{19} * M_3 * Fem_{Age3} * S_{sp3}$
$Sp_{3,M} = Age2 * (1- I_3) * S_{19} * M_3 * (1 - Fem_{Age3}) * S_{sp3}$

where I_3 is the Age 3 fishery impact rate, and M_3 and S_{19} are the Age 3 maturation and survival rates as described in Transition 19. Fem_{Age3} is a model parameter representing the proportion of Age 3 and 4 spawners that are female, and S_{sp3} is a model parameter representing the natural survival rate of Age 3 spawners from the ocean to the spawning grounds.

Transition 21

Definition: Maturation and migration for Age 3 males and females that will spawn as 4-year olds

$Sp_{4,F} = Age3 * (1- I_4) * S_{21} * Fem_{Age3} * S_{sp4}$
$Sp_{4,M} = Age3 * (1- I_4) * S_{21} * (1 - Fem_{Age3}) * S_{sp4}$

where I_4 is the Age 4 fishery impact rate, S_{21} is a model parameter representing survival rate from Age 3 to Age 4, Fem_{Age3} is a model parameter representing the proportion of Age 3 and 4 spawners that are female, and S_{sp4} is a model parameter representing the natural survival rate of Age 4 spawners from the ocean to the spawning grounds.

Transition 22

Definition: Number of eggs produced by spawners of Ages 2 – 4 in months m = (2, ..., 6) corresponding to April to August.

$$Eggs_m = \frac{\sum_{j=2}^{4}(TSp_{j,F} - hat.f_j)P_{SP,m}V_{eggs,j}}{1 + \frac{\sum_{j=2}^{4}(TSp_{j,F} - hat.f_j)\,P_{SP,m}V_{eggs,j}}{K_{Sp,m}}}$$

where TSp_j are the total number of female spawners of age j = 2, 3, 4 (composed of both natural and hatchery origin), $V_{eggs,j}$ is the number of eggs per spawner of age j = 2, 3, 4, $K_{Sp,m}$ is the capacity of eggs in the spawning grounds per month, and $P_{SP,m}$ is the proportion of spawning that occurs in month m and is a function of April average temperature at Keswick Dam. Because the April temperature can vary among years, the monthly distribution varies as well to reflect observed patterns in spawn timing among the years from 1999 to 2012. Please see Appendix A for description of the analysis of historical patterns in spawn timing.

$TSp_{2,F} = Sp_{2,F}$

$TSp_{3,F} = Sp_{3,F} - hat.f$

$TSp_{4,F} = Sp_{4,F}$

$hat.f = 0.15 * Sp_3 \quad (\min = 10; \max = 60)$

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where $hat.f$ is the number of age-3 spawning females removed for use as hatchery broodstock, and $Sp_{j,Hatchery}$ for $j = (2,3,4)$ is the spawners of age j hatchery origin, which are described below in the *Hatchery Origin Chinook* section.

Hatchery Origin Chinook

Transition 1H

Definition: Survival of hatchery fish from eggs to Age 2

$$Age2_{Hatchery} = hat.f * 3000 * H_{S1}$$

$$H_{S1} = 2.3 * Age2_{Natural} / Fry_{Natural}$$

where H_{S1} is the hatchery-origin survival rate from pre-smolt at release to Age 2 in the ocean, $Age2_{Natural}$ is the number of natural-origin Chinook that survived to Age 2 and remained in the ocean, and $Fry_{Natural}$ is the number of natural origin emerging Fry (see Transition 1 for Natural Origin Chinook). The multiplier of 3000 hatchery smolts per spawner was obtained from Winship et al. (2014). The multiplier of 2.3 was used to equate hatchery origin survival to the end of age 2 to natural origin survival to the end of age 2 as described in Winship et al. (2014).

Transition 2H

Definition: Maturation and spawning for hatchery origin Age 2

$$Sp_{2,F,Hatchery} = Age2_{Hatchery} * M_2 * Fem_{Age2} * S_{sp2}$$
$$Sp_{2,M,Hatchery} = Age2_{Hatchery} * M_2 * (1 - Fem_{Age2}) * S_{sp2}$$

where the coefficients are described under Transition 18.

Transition 3H

Definition: Survival of hatchery origin fish in the ocean from Age 2 to Age 3 (for Chinook that remain in the ocean)

$$Age3_{Hatchery} = Age2_{Hatchery} * (1 - I_3) * S_{19} * (1 - M_3)$$

where the coefficients are described under Transition 19.

Transition 4H

Definition: Maturation and spawning for hatchery origin Age 3

$$Sp_{3,F,Hatchery} = Age2_{Hatchery} * (1 - I_3) * S_{19} * M_3 * Fem_{Age3} * S_{sp3}$$
$$Sp_{3,M,Hatchery} = Age2_{Hatchery} * (1 - I_3) * S_{19} * M_3 * (1 - Fem_{Age3}) * S_{sp3}$$

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where the coefficients are described under Transition 20.

Transition 5H

Definition: Survival and maturation rate for hatchery origin Age 4

$$Sp_{4,F,\,Hatchery} = Age3_{Hatchery} * (1- I_4) * S_{21} * Fem_{Age3} * S_{sp4}$$
$$Sp_{4,M,\,Hatchery} = Age_{Hatchery}\,3\ (1- I_4) * S_{21} * (1 - Fem_{Age3}) * S_{sp4}$$

where the coefficients are described under Transition 21.

Fishery Dynamics

To simulate the winter-run population dynamics under alternative hydrologic scenarios, we include fishery dynamics that are consistent with a NMFS fishery control rule (NMFS 2012) (Figure 8). For each year of the simulation, the impact rate for age 3 (I_3) was calculated from the control rule by obtaining the 3-year trailing geometric average of spawner abundance. The age-4 impact rate (I_4) in that year was calculated as double the instantaneous age-3 impact rate (Winship et al. 2014).

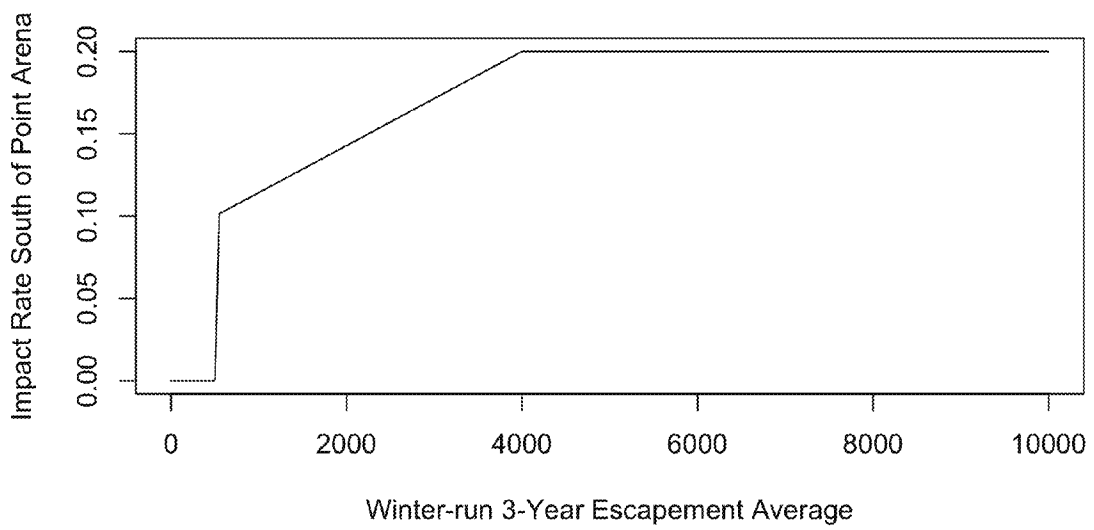

Figure 8. Fishery control rule determining the level of Age 3 impact rate as a function of trailing 3-year geometric mean in winter-run escapement.

III. Inputs to the Winter-run life-cycle model

Water Temperature

The life cycle model (LCM) incorporates monthly average temperature below Keswick Dam into the definition of egg to fry survival. The water temperature can be obtained from water quality gages

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on the Sacramento River (for model calibration) or from a forecasted water temperature model, such as the the Sacramento River Water Quality Model (SRWQM).

Fisheries

Estimates of impact rates on vulnerable age classes of Chinook salmon are computed as part of the Pacific Fisheries Management Council (PFMC) annual forecast of harvest rates and review of previous years' observed catch rates. For runs that are not actively targeted, such as winter-run and spring-run Chinook, analyses of coded wire tag (CWT) groups are used to infer impact rates for these races (e.g., O'Farrell et al. 2012).

Habitat Capacity

Juvenile salmonids rear in the mainstem Sacramento River, delta, floodplain, and bay habitats (Figure 1). The model incorporates the dynamics of rearing by using density-dependent movement out of habitats as a function of capacity for juvenile Chinook. The capacities of each of the habitats are calculated in each month using a series of habitat-specific models that relate habitat quality to a spatial capacity estimate for rearing juvenile Chinook salmon. Habitat quality is defined uniquely for each habitat type (mainstem, delta, etc.) with the goal of reflecting the unique habitat attributes in that specific habitat type. For example, the mainstem habitat quality is a function of velocity and depth (Beechie et al. 2005). Areas with vegetated cover along banks are preferred in other systems by Chinook salmon (Beamer et al. 2005, Semmens 2008), and areas associated with cover in the delta were assumed to be higher quality habitats because they provide protection from predators (Semmens 2008) and offer subsidies of terrestrial insect prey. In the bay, salinity is a factor that predicts suitable habitat, as fish monitoring data in both Skagit River and San Francisco Bay have shown high likelihood of fry presence in water with salinity less than 10 ppt. Higher quality habitats are capable of supporting higher densities of rearing Chinook salmon, with the range of densities being determined from studies in the Central Valley and in river systems in the Pacific Northwest where appropriate. Note, the current version of the model uses densities from the Skagit River, Washington, which are shown in Figure 9.

Defining habitat capacity. For each habitat type (mainstem, delta, and bay), capacity was calculated each month as:

$$K_i = \sum_{j=1}^{n} A_j d_j$$

where K_i is the capacity for a given habitat type i, n is the total number of categories describing habitat variation, A_j is the total habitat area for a particular category, and d_j is the maximum density attributable to a habitat of a specific category. Three variables were determined for each habitat, the ranges of each were divided into high and low quality, and all combinations were examined, resulting in a total of eight categories (2 x 2 x 2) of habitat quality for each habitat type (Table 1). The exception was mainstem habitats (Upper River, Lower River, and Yolo Bypass), which were subdivided into 4 (2x2) bins of habitat quality. Ranges of high and low habitat quality were based on

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published studies of habitat use by Chinook salmon fry across their range and examination of data collected by USFWS within the Sacramento-San Joaquin Delta and San Francisco Bay.

Defining maximum densities. Determining maximum densities for each combination of habitat variables is complicated by the fact that most river systems in the Central Valley are now hatchery-dominated with fish primed for outmigration. In addition, the Central Valley river system is at historically low natural abundance levels compared to expected or potential density levels. Because of this deficiency in the Central Valley system, salmon fry density data from the Skagit River system were used, which in contrast has very low hatchery inputs, has been monitored in mainstem, delta, and bay habitats, and exhibits evidence of reaching maximum density in years of high abundance (Greene et al. 2005; Beamer et al. 2005). These data from the Skagit River were compared with Central Valley density estimates calculated by USFWS. For each of these data sets, the upper 95 percentile levels of density defined a range of maximum density levels, assuming that the highest five percentile of density levels were sampling outliers. The comparison indicated that Skagit River values represented conservative estimates of maximum density (Figure 9).

Table 1. Habitat variables influencing capacity for each habitat type.

Habitat type	Variable	Habitat quality	Variable range
Mainstem & Bypass	Velocity	High	<= 0.15 m/s
		Low	> 0.15 m/s
	Depth	High	> 0.2 m, <= 1 m
		Low	<= 0.2 m, > 1 m
Delta	Channel type	High	Blind channels
		Low	Mainstem, distributaries, open water
	Depth	High	> 0.2 m, <= 1.5 m
		Low	<= 0.2 m, > 1.5 m
	Cover	High	Vegetated
		Low	Not vegetated

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Habitat type	Variable	Habitat quality	Variable range
Bay	Shoreline type	High	Beaches, marshes, vegetated banks, tidal flats
		Low	Riprap, structures, rocky shores, exposed habitats
	Depth	High	> 0.2 m, <= 1.5 m
		Low	<= 0.2 m, > 1.5 m
	Salinity	High	< 10 ppt
		Low	>= 10 ppt

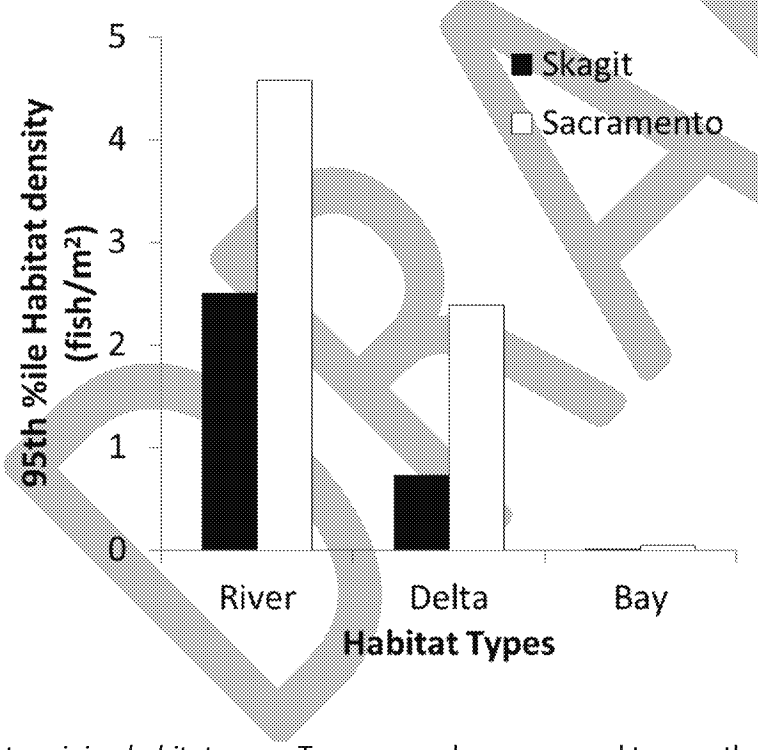

Figure 9. 95th percentile values of densities in river, delta, and bay habitats in the Skagit and Sacramento Rivers. Skagit data are based on electroshocking in mainstems and beach seining in delta and bay habitats (Beamer et al. 2005), while Sacramento data are based on beach seining across all habitat types (USFWS 2007).

Determining habitat areas. Two approaches were used to map the spatial extents of different combinations of habitat variables. To estimate river and Yolo Bypass capacities based on channel velocity and depth, a suite of HEC-RAS models at varying discharge values (2,000-200,000 ft^3/sec) were simulated on the Sacramento River and Yolo Bypass. The HEC-RAS geometry was based on a series of cross-sections that define locations surveyed in the mid-1990s at longitudinal intervals of approximately 500m. From the HEC-RAS output, the cross-sectional width of a given river reach was broken up into 45 lateral sections (i.e., cells), with the main channel composed of 25 cells and the banks composed of 20 cells (10 left and 10 right bank; example shown in Figure 10). Main channel

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and bank stations are defined in the original HEC-RAS model and denoted in Figure 10 with red cross-section stations. To estimate depth and velocity in each cell, we used the flow distribution methods outlined by HEC, which can be found at: https://www.hec.usace.army.mil/confluence/rasdocs/ras1dtechref/latest/overview-of-optional-capabilities/flow-distribution-calculations

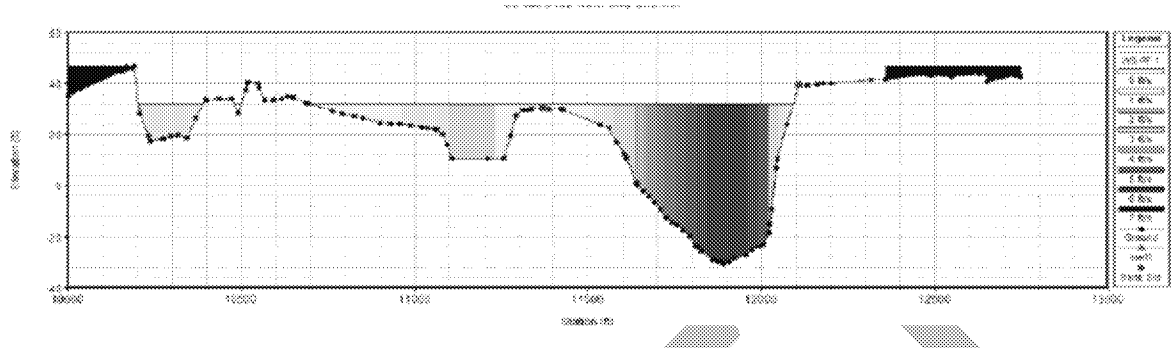

Figure 10: Example of method used to split up a HEC-RAS cross-sectional output into 45 lateral sections. Note that main channel locations are within the red cross-sections stations and bank locations are outside of the red cross-sections stations

At each lateral cell, the HEC-RAS simulated channel depth and velocity were grouped into one of the four habitat capacity categories described above. Each cell in the cross-section has a depth and velocity, and altering the flow changes the depth and velocity of a particular cell. The area of each cell that corresponded to a specific combination of velocity and depth category was tabulated for each mean monthly flow (extracted from CalSim results) associated with a cross-section. The appropriate density of Chinook salmon for each of the four categories was applied to each lateral cell by taking the product of area for a given preference and the 95th percentile density estimate for that preference. To arrive at a monthly capacity estimate for the Sacramento River and Yolo Bypass habitats, we summed the capacity estimates for each lateral and longitudinal cell in each habitat. Figure 11 shows how habitat capacity changes as a function of flow for the Sacramento River and Yolo Bypass.

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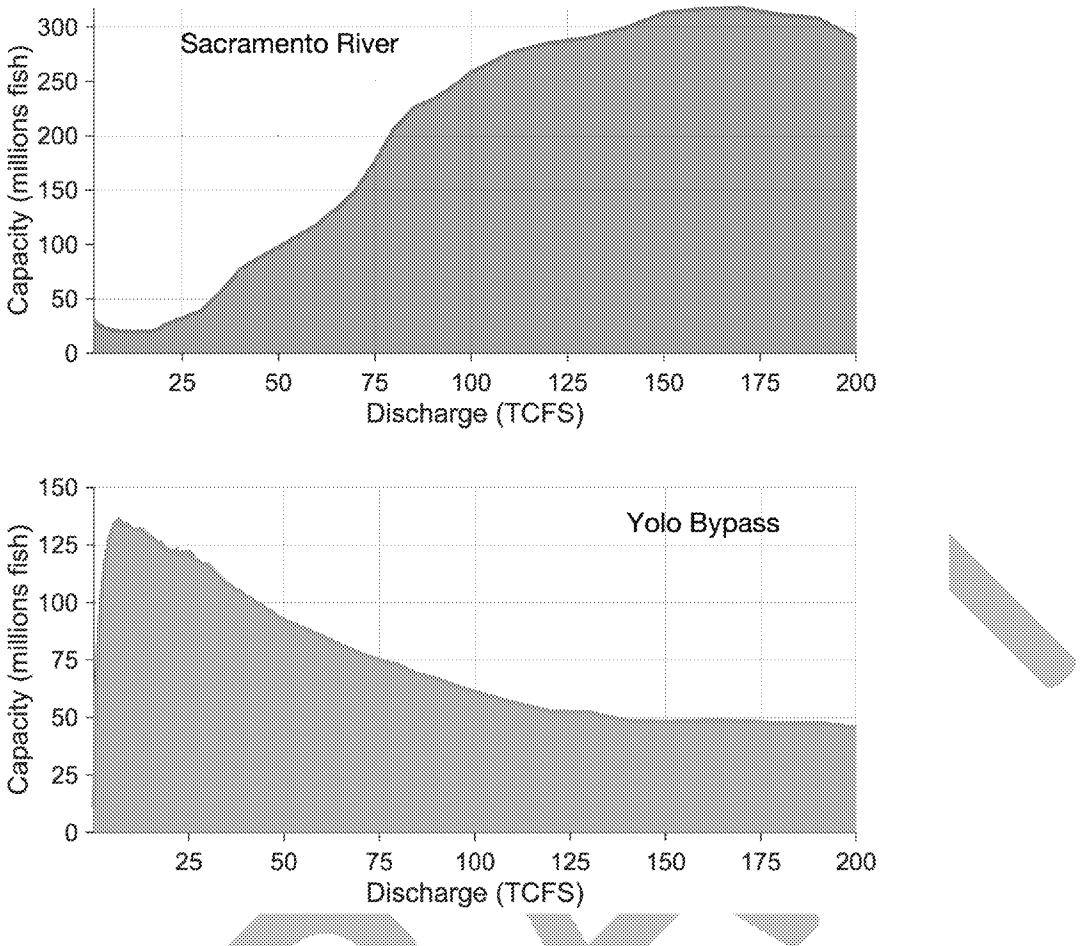

Figure 11: Habitat capacity to flow (thousand cfs) relationship for the Sacramento River and Yolo Bypass under the 95th percentile density estimate.

For the delta and bay, geographic data products were used to map habitat variables, including cover, shoreline type, salinity, and depth. Vector GIS files were converted to raster, and all habitat variables were mapped onto a common $10m^2$ grid. To obtain the spatial extent of channels and wetlands, National Wetland Inventory (NWI) data (USFWS 2006) were used in the delta, and Bay Area Aquatic Resource Inventory (BAARI) v 2.1 data (SFEI ASC 2017) were used in the bay. A geographic buffer was applied where required to ensure that the full extent of the channels were included, and a levee file (DWR 2018) was utilized to ensure that no inaccessible areas were included. For each cell, the habitat variables listed in Table 1 above were determined to be of high or low quality. Cover data were obtained from the Coastal Change Analysis Program (C-CAP) (NOAA OCM 2017). Areas that had vegetation (forested areas, scrub/shrub area, etc.) were considered high quality cover, and cells within 30 meters were marked as high quality cover. Shoreline data were obtained from BAARI v 2.1 (SFEI ASC 2017) and the Environmental Sensitivity Index (NOAA OR&R 2017). Cells within marshes, tidal flats, and vegetated areas, and cells within 30 meters were marked as high quality, whereas areas near rip-rap, rocky areas, and exposed areas were marked as low quality.

For salinity, monthly X2 values, representing the distance from the Golden Gate Bridge to the 2 ppt isohaline position (Jassby et al. 1995), were obtained from CalSim simulations. X10 values were calculated as 75% of X2 values (Monismith et al. 2002, Jassby et al. 1995). Distance to the Golden Gate was mapped, and cells upstream of the X10 value were marked as high quality.

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Water depth was calculated from bathymetric data (Wang et al. 2018) and water level from DSM2 simulations. Each cell was assigned to its corresponding DSM2 channel, and for each DSM2 channel, monthly median water level was calculated. This value was subtracted from the bathymetric measurement in order to obtain monthly water depth for each cell.

Blind tidal channels within wetland areas were not able to be mapped directly with the available data. Therefore, we estimated these areas using allometric relationships between tidal wetland areas and blind tidal channel areas. We tested allometric equations developed in the Skagit River by Beamer et al. (2005) and Hood (2007) to determine which equations were best suited to apply to the Central Valley and chose an allometric equation that returned conservative estimation results:

$$A_{btc} = 0.0024 * A_w{}^{1.56}$$

where A_{btc} is blind tidal channel area in hectares and A_w is wetland area in hectares. We also applied the minimum area requirement (0.94 ha) to form blind tidal channels in a wetland from Hood (2007). To ensure that habitat area was not double counted in wetland areas through the previously described mapping methods and the blind tidal channel calculation, the habitat area of each cell in tidal wetlands was reduced by the proportion of the area of the wetland that is blind tidal channel. Finally, the habitat areas from all cells, along with the habitat area from blind tidal channels, was summed in order to get the total monthly habitat areas for each of the eight habitat quality categories.

Enhanced Particle Tracking Model

The survival rate of juvenile Chinook salmon within and migrating through the Delta is modeled using the Enhanced Particle Tracking Model (ePTM) version 2.0 (Hereafter, ePTM v2). This rate is defined as the survival at Chipps Island of simulated juvenile salmon released at any location within the Delta. The ePTM v2 survival computation includes movement, orientation, holding and routing behaviors and predation mortality (Sridharan et al., in prep.). The ePTM v2 is based on the Delta Simulation Model II Particle Tracking Model (DSM2 PTM) developed by the Department of Water Resources (DWR), California. Model code and documentation for the ePTM v2 is hosted at https://github.com/cvclcm/ePTM_v2.

DSM2

The DSM2 PTM transports particles on a one-dimensional network representation of the Delta, driven by the flows computed by HYDRO, the hydrodynamic module of DSM2 written in FORTRAN (Anderson and Mierzwa, 2002). The DSM2 HYDRO module computes the flow and stage at different locations in the Delta by solving the cross-sectionally averaged one-dimensional shallow water wave equations on a network of links, continuously stirred tank reactors (CSTR) and nodes which respectively represent channels, flooded and leveed islands, floodplains and forebays, and channel junctions (Figure 12). River inflows and in-delta consumptive use flows are estimated from CALSIM, a water budget model for California. Gate operations are provided by DWR. Details of the numerical solution method can be found in DeLong et al. (1997) and a peer review of the model can be found in Sridharan et al. (2018). DSM2 HYDRO is typically run with a time step of 15 minutes to one hour.

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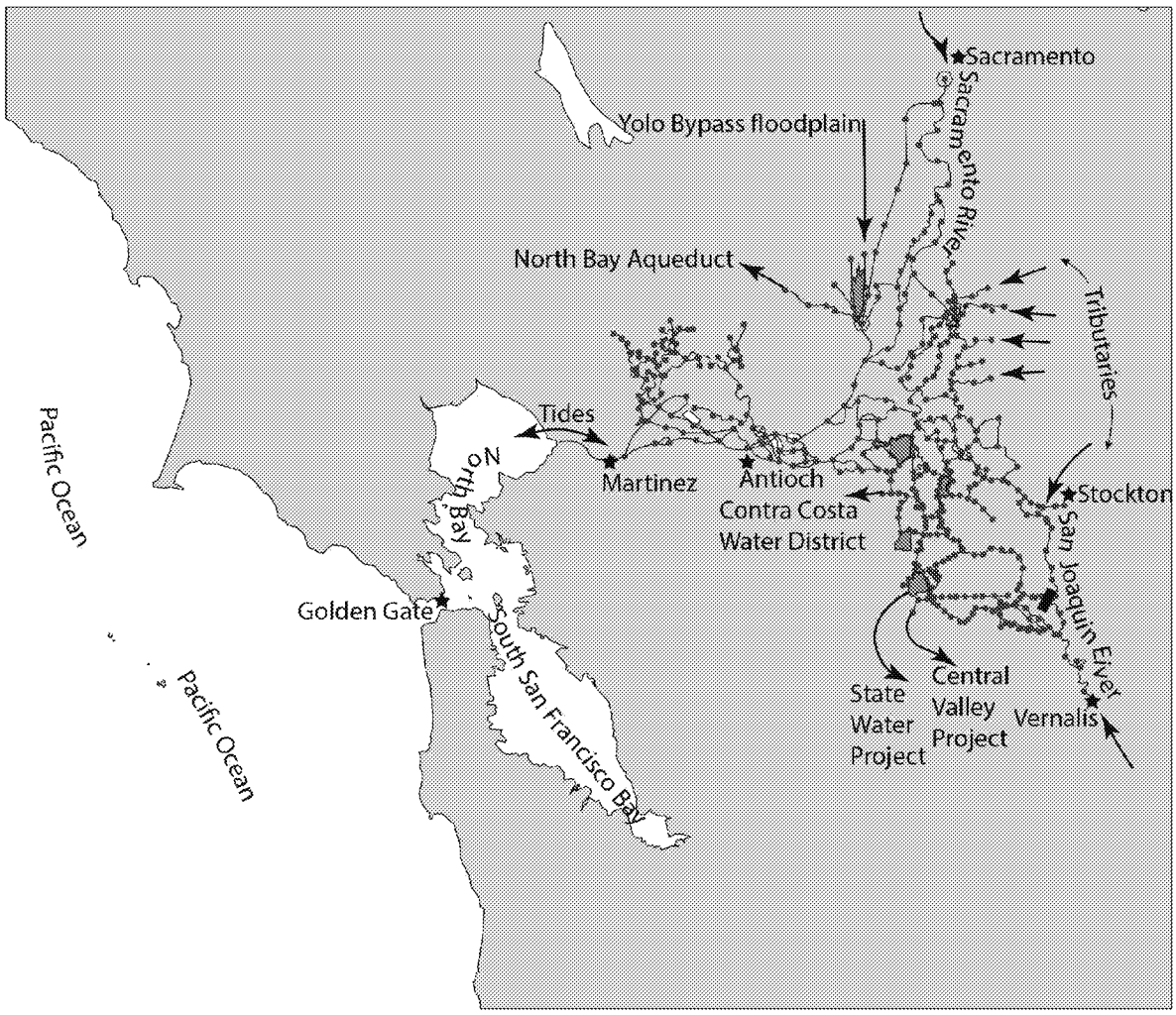

Figure 12. The Sacramento-San Joaquin Delta and the DSM2 grid. Arrows represent inflows and outflows. Grey lines, dark grey shaded regions and red dots respectively represent DSM2 channels, reservoirs and nodes. The Hatched box, crossed out circle and solid box respectively represent the Delta Cross Channel, the salinity control gate in Montezuma Slough and the temporary salmon passage barrier in Mossdale. The blue boxes represent nodes in which fry rearing in the Sacramento River and the Yolo Bypass floodplain are seeded as simulated smolts into the ePTM v2. Simulated smolt seeded in all other nodes represent fry rearing within the Delta.

The DSM2 PTM module, written in JAVA, is a pseudo three-dimensional model with a turbulent law of the wall logarithmic vertical velocity (Prandlt 1935) and a fourth order polynomial transverse velocity profile (Wilbur 2000) imposed onto the solved mean flows through a cross-section. The links are represented as rectangular prismoids whose cross-sections preserve the hydraulic radii and water column depth in the channels they represent. It uses constant cross-sectional eddy diffusivities in a zeroth-order turbulence closure to move particles laterally and vertically. Particles are advected in the streamwise direction with the hydrodynamic velocity at their locations and moved randomly in the lateral and vertical direction with the diffusivities at their locations using Forward Euler numerical integration. DSM2 PTM is capable of modeling about 5,000 particles (Kimmerer and Nobriga, 2008). It does not have any temporal interpolation of hydrodynamic quantities between DSM2 HYDRO time steps, and randomizes particles arriving at nodes and assigns them to new links based on the flow splits at the nodes. Their new cross-sectional positions are also

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randomized. ePTM v2 builds on the basic framework of the DSM2 PTM by adopting conceptual and performance updates described in Sridharan et al. (2017) and adds behavior to simulated particles.

ePTM v2

The ePTM v2 adds juvenile salmon swimming behavior and predation mortality to the DSM2 PTM (Sridharan et al. in prep.). Apart from these additions, the ePTM v2 linearly interpolates all hydraulic and hydrodynamic quantities between DSM2 HYDRO time steps to account for simulated salmon movement within an ePTM v2 time substep. Broadly, the scope of the ePTM v2 can be summarized into its representation of the hydrodynamics, the fish behavior, and the mortality of simulated salmon.

Hydrodynamics

Simulated smolt trajectories are given by (Visser 1997)

$$\frac{dx}{dt} = u + u_S;\ \frac{dy}{dt} = R_y\sqrt{\frac{2}{r}\frac{\varepsilon_H}{\Delta t}} + \frac{d\varepsilon_H}{dy};\frac{dz}{dt} = R_z\sqrt{\frac{2}{r}\frac{\varepsilon_V}{\Delta t}} + \frac{d\varepsilon_V}{dz}$$

where u is the hydrodynamic velocity at the particle position, u_s is the swimming velocity, ε_H and ε_V are the lateral and vertical eddy diffusivities, Δt is the ePTM v2 timestep, R_Y and R_Z are uniform random variables between -1 and 1, r is the variance of a standard normal distribution and is equal to 1. In order to realistically represent fish movements, channel curvature has been included in ePTM v2.

The curvature of a channel is determined by fitting both a Theil-Sen robust linear regressor (Gilbert 1987), as well as a Chernov-Lesort robust circular regressor (Chernov, 2010). If the Pearson correlation coefficient value of the linear fit exceeds that of the circular fit, or if the estimated radius of curvature exceeds 10 Km, the channel is assumed as straight. The bend angle is computed as the ratio of the total distance along the river and the radius of curvature. Meanders occurring on a scale smaller than the channel length can be incorporated by refining the DSM2 model grid as needed.

For straight channels, we have (DWR, 1998):

$$u = Uf_Vf_H$$

$$f_V = 1 + \left(\frac{0.1}{\kappa}\right)\left[1 + ln\left(\frac{z}{H}\right)\right];\frac{z}{H} \geq 0.01 \text{ and } f_V = 0;\frac{z}{H} < 0.01$$

$$f_H = A + B\left(\frac{2y}{W}\right)^2 + C\left(\frac{2y}{W}\right)^4$$

where f_V and f_H are the water velocity profiles in the lateral and vertical dimensions, W and H are respectively the width and depth of the channel, U is the mean streamwise velocity, A, B and C are constants that can vary with the river, κ=0.41 is von Karman's constant, and the diffusion coefficients in the lateral and vertical dimension are

$$\varepsilon_H = C_THu^*;\ u^* = 0.1U$$

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$$\varepsilon_V = \kappa \frac{z}{H}\left(1 - \frac{z}{H}\right)$$

$$\frac{d\varepsilon_V}{dz} = \frac{\kappa}{H}\left(1 - 2\frac{z}{H}\right)$$

where C_T=0.6 is a constant and u^* is the friction velocity.

For curved channels, the experimental results of Gandhi et al. (2016) of turbulent open rectangular channel flow in around bends of varying curvature from a straight channel to up to 90° are used. For angles beyond 90°, we assume that the flow adjustment will not be significantly different (Blanckaert and De Vriend, 2004), and so we use the distribution at 90° itself. We use the best-fit regression of Gandhi et al. (2016) to their data to generate the flow profiles. Using the force balance between the turbulent eddy diffusivity and the shear stress by assuming a linear decay of the shear stress from its peak value at the channel banks to zero at the lateral position of peak flow defined from the left bank, y_{Max} (and similarly for the right bank),

$$\varepsilon_H \frac{du}{dy} = u^{*2}\left(1 - 2\frac{y}{y_{Max}}\right)$$

where $\frac{du}{dy}$ is obtained from the data, and smoothing the resulting profile of ε_H to remove spurious discontinuities, we get profiles of the flow and mixing terms. A mixed layer is implemented near the channel banks that is 20% of the width of the channel (Ross and Sharples 2004).

Time substeps are chosen to be 20 seconds. A simulated salmon leaves a given channel through its upstream or downstream end when its streamwise displacement during a time step exceeds the distance between its current position and the end of the channel. The channel bottom, banks and free surface are treated as fully reflecting boundaries.

Simulated salmon that enter reservoirs or flooded islands are held there over a random period between 0 and 24 hours and subsequently randomly released depending on the flow into a connecting channel.

Behavior

ePTM v2 is a spatially explicit model, in that behaviors of fish are allowed to vary spatially through the Delta domain. Such spatial variability is supported by numerous reports from the literature, and observations within the Delta that migrating smolts vary their behavior as they move closer to the ocean (McCleave 1978; Solomon 1978; Healey 1980; Moser et al. 1991; Lacroix and McCurdy 1996; McCormick et al. 1998; Moore et al. 1998; Miller and Sadro 2003; Lacroix et al. 2005; Hedger et al. 2008; Kelly and Klimley 2012; Chapman et al. 2013; DWR 2015; DWR 2016). The ePTM v2 incorporates five behaviors based on literature reviews and observations in the data (Sridharan et al. In prep) that include:

(i) active swimming,

(ii) orientation towards or away from the ocean,

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(iii) Holding against the flow,

(iv) routing at channel junctions, and

(v) mortality due to predation.

All these behaviors are allowed to vary at the scale of the regions defined in Figure 13.

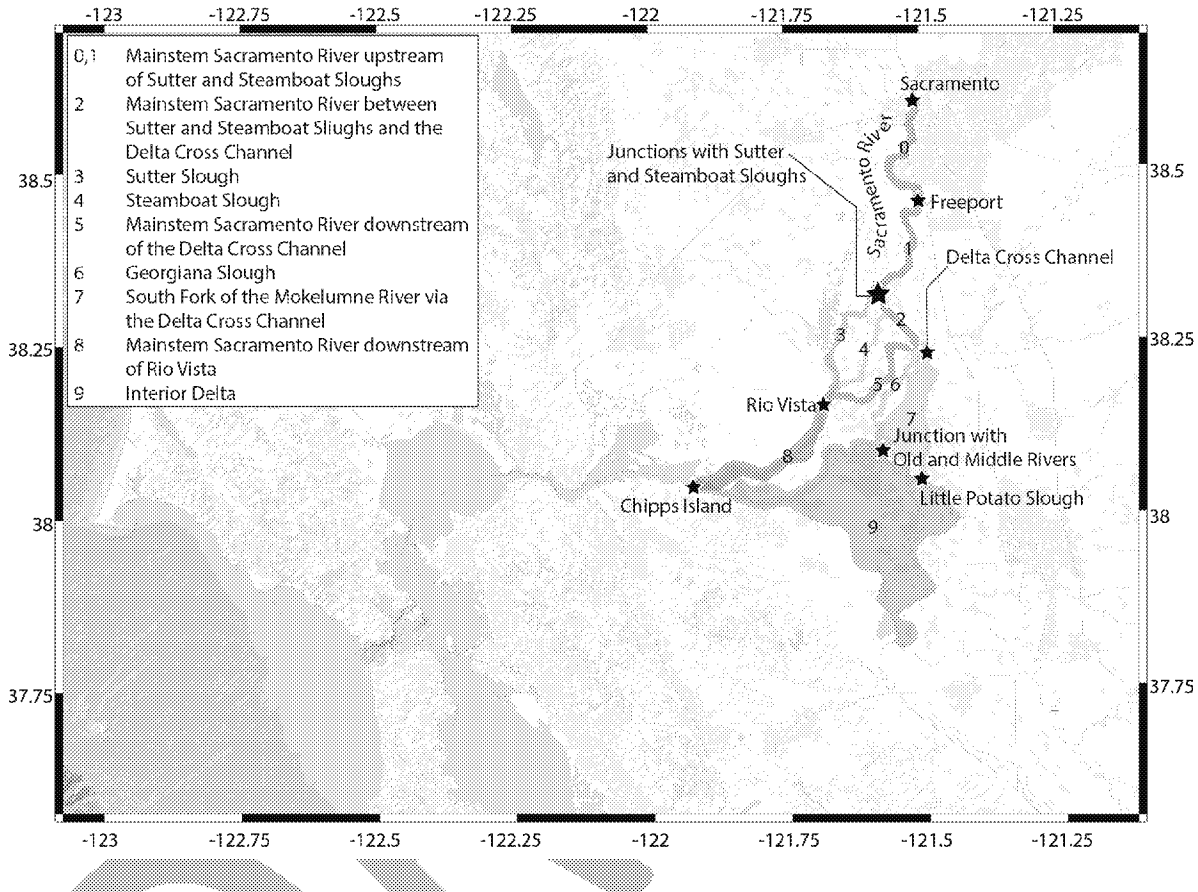

Figure 13. Calibration regions for ePTM v2 behaviors. Colors uniquely identify the different calibration regions. All blue colored regions indicate the mainstem Sacramento River.

Active swimming

A biological swimming velocity is added to the water velocity at the location of the simulated salmon at each time step. Simulated salmon can swim in the along stream direction with swimming speeds that are drawn from a lognormal distribution $lnN(\mu, \sigma)$ in which

$$\mu = 2ln(U_S) - \frac{1}{2}ln(\sigma_s^2 + U_S^2) \text{ and } \sigma = \sqrt{ln(\sigma_s^2 + U_S^2) - 2ln(U_S)}.$$

Here, the mean and standard deviation of observed swimming speeds are respectively U_S and σ_s. To ensure that randomly drawn swimming speeds remain within the range of biologically plausible speeds, the log-normal distribution is truncated at the 95th percentile and rescaled appropriately.

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Orientation

In the *ePTM v2*, a probabilistic swimming direction rule determines each simulated salmon's swimming direction at each timestep. The swimming direction is influenced by the migrant's previous swimming direction, as well as the flow it experiences as follows. If a Bernoulli draw to determine persistence results in a zero, the fish's swimming direction is determined by a stochastic decision based on the flow it experiences, $\frac{|u|}{|U|}$, during the current timestep as

$$p_{SWF} = 0.5 + (p_{Rheo} - 0.5)\left[\frac{1}{1 + e^{-\left(c + b\ln\frac{|u|}{|U|}\right)}}\right]$$

Here, U is the mean flow observed in the Delta from 1962 to 2014, and is used to simply normalize the values of u. There is no assumption that the fish somehow knows what U is. p_{SWF} is the probability of orienting with the flow, and p_{Rheo}, c and b are calibration constants.

For positive values of c and small values of b, fish response to flow signals is sluggish in that only at very strong water speeds will fish make decisions that are not random. For negative values of c and large values of b, fish responses to small changes in the flow will be very sharp, i.e., decisions will be nonrandom even for weak flows. The p_{Rheo} parameter determines if the fish is likely to orient with or against the flow. If $p_{Rheo} \approx 0$, then as flows become stronger, fish will have a tendency to orient against the flow. If $p_{Rheo} \approx 0.5$, orientation decisions will be random. If 1, then as flows become stronger, fish will have a tendency to orient with the flow.

Holding Position Relative to Flow

The simulated salmon also holds position via Selective Tidal-Stream Transport (STST) (Gibson 2003), a hypothesis for optimal energy expenditure while achieving average travel speeds greater than the average flow velocity in tidal regions. During the ebb phase of the tide, the simulated salmon allow themselves to be advected. On a flood tide, when the upstream flow exceeds some threshold, they hold position with a certain probability (Liao, 2007). The ePTM v2 also parameterizes diel swimming behavior (Chapman et al. 2013) by assigning a probability of swimming during the light hours.

Routing at Channel Junctions

Anadromous salmonids often make decisions on which route to adopt (Gleichauf et al. 2014; Perry et al. 2014; Hance et al. 2021). Sridharan et al. (2017) demonstrated the importance of correctly representing the movement of simulated fish through channel junctions. In the ePTM v2, we allow fish to move into downstream channels at junctions depending on their lateral position relative to the critical streakline (Perry et al. 2014), also known as the bifurcating streamline.

When a simulated migrant reaches the end of a channel within a sub-timestep, the routing process is invoked, and it is moved into a downstream channel or open water body. Subsequently, the remaining trajectory computation is completed for that sub-timestep in the new channel beginning from a random cross-sectional position in the new channel. If the fish enters an open water body, it waits for a random length of time between zero seconds and one day and then leaves the open water body

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randomly into a connecting downstream channel. This mechanism ensures that fish move through the system in a manner consistent with the critical streakline hypothesis, while allowing for random lateral and vertical movements to occur within the time taken to move through the junction.

When a simulated fish reaches a channel junction, it is assigned to one channel or the other based on its lateral location relative to the location of the critical streakline (see Perry et a. 2018 or Sridharan et al. 2017 for an explanation of how the location of the critical streakline is calculated). Thus, the routing module does not contain any fitted free parameters. When there are junctions with more than three channels, a tree-search algorithm is implemented in which the junction is dynamically deconstructed into a sequence of bifurcations with two downstream channels from the point of view of the channel from which the fish enters the junction. Recently, nonphysical barriers and fish guidance mechanisms such as bubble curtains and strobe lights have been investigated to steer fish into favorable migration routes in the Delta (Perry et al. 2014; DWR 2015; DWR 2016). Such mechanisms can be represented in the model as a "particle filter," which restricts a fraction of fish from entering a specific waterbody. Any number of filters can be applied at any junction in the system domain with specified efficiencies. Such filters will simply divert the fraction of fish into the next nearest downstream channel that does not have a filter.

Predation Mortality

The ePTM v2 adds predator-induced mortality according to the XT model (Anderson et al. 2005). The probability of a simulated salmon surviving passage through a region, S, is as follows:

$$S = e^{-\left(\frac{1}{\lambda}\sqrt{x^2+\omega^2 t^2}\right)}$$

where x is the distance traveled and t is the travel time. The mean free path, λ, is

$$\lambda = \frac{1}{\rho \pi r^2}$$

where ρ is the density of predators and r is the encounter distance. The term ω is the random component of prey speed. The implementation of the XT model in the ePTM v2 involves recording the x and t for each channel that a simulated salmon traverses in a given 15-minute time step. A survival probability for each of these sub time steps is then calculated using the λ values for the individual channels. The overall probability that the simulated salmon survives the 15-minute time step is the product of the survival probabilities of the sub time steps, i.e.:

$$S = \prod_{i=1}^{n} e^{-\left(\frac{1}{\lambda_i}\sqrt{x_i^2+\omega_i^2 t_i^2}\right)}$$

where n is the number of channels that the simulated salmon traversed during the time step, x_i is the distance traveled in channel i, t_i is the time spent in channel i, and λ_i and ω_i are the channel-specific mortality parameters. In the ePTM v2, only the parameters λ_i and ω_i are specified explicitly (Table 2).

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Model Calibration and Validation

The parameters of the ePTM v2 were estimated from tagging studies of late Fall-run Chinook salmon (2006-2010) released in the Sacramento River and passing through the Delta (Perry et al. 2010). This tagging study included a total of 1,591 tagged late-Fall juveniles that were released in the Sacramento River in eight release groups over the five year period. These fish were tagged with VEMCO V5 acoustic tags and were tracked through the system at hydroacoustic receiver arrays (Figure 13). By tracking fish through these receiver arrays, their passage through the Delta could be naturally quantified along the nine regions connected by key river junctions (Figure 13). A Cormack-Jolly-Seber (CJS) mark-recapture model was fit within a hierarchical Bayesian framework to concurrently estimate detection, routing and survival probabilities through the different regions (Perry et al. 2010; Perry et al. 2018). In addition to the region-scale survival estimates, the data was also processed (Russ Perry, personal communication) to include fist detection times for each fish whenever it was detected at a receiver array.

To estimate all 99 ePTM v2 parameters (11 parameters in each of the nine calibration regions) from the calibration data described above, the following steps were applied. First, for each parameter, bounds were identified on the permissible range of parameter values to constrain the parameter search space. These bounds were set based on a thorough review of the literature including laboratory experiments and field data, and reasonable biological expectations when insights could not be gained from the literature. Then, a four-stage calibration process was incorporated. In this process, first, it was determined that the movement (swimming, orientation and holding) parameters could be fit independently of the survival parameters (Sridharan et al. In prep.). Second, a coarse grid search on a large number of movement parameter values was performed to narrow in on the best local optima defined within a multiobjective optimization framework. Third, the parameter space was zoomed into in the neighborhoods of the best local optima to perform a fine grid search using the multiobjective optimization framework to identify the global optimum movement parameter values. Fourth, the movement parameters were held at their optimum values and performed a grid search over the survival parameters to find the optimum values of these parameters. These values are listed in Table 2. In lieu of an uncertainty analysis, a sensitivity analysis was performed on the parameters (Sridharan et al. In prep.). The calibrated model was also validated with out-of-sample data using Juvenile Salmon Acoustic Telemetry System (JSATS) tagged Chinook smolts (see Sridharan et al. In prep.). Both the calibration and validation results are archived in the ePTM v2 GitHub repository.

Table 2. ePTM v2 model parameters

Behavior	Description	Parameter	Search bounds	Optimal value	Evidence
Swimming	Mean swimming speed	U_S	[0,0.5m/s]	region 1: 0.50 m/s region 2: 0.37 m/s region 3: 0.32 m/s region 4: 0.43 m/s region 5: 0.50 m/s region 6: 0.15 m/s region 7: 0.35 m/s	Swimming speeds observed by Dougan 1993; Anglea et al. 2004; Brown et al. 2006;

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Behavior	Description	Parameter	Search bounds	Optimal value	Evidence
				region 8: 0.39 m/s region 9: 0.33 m/s	Walker et al. 2016; Lehman et al. 2017
	Standard deviation of swimming speed	σ_S	[0,0.5m/s]	region 1: 0.16 m/s region 2: 0.47 m/s region 3: 0.45 m/s region 4: 0.43 m/s region 5: 0.01 m/s region 6: 0.32 m/s region 7: 0.01 m/s region 8: 0.43 m/s region 9: 0.44 m/s	Swimming speeds observed by Dougan 1993; Anglea et al. 2004; Brown et al. 2006; Walker et al. 2016; Lehman et al. 2017
Orientation	Probability of memory persistence	$p_{Persistence}$	[0,1]	region 1: 0.81 region 2: 0.97 region 3: 0.86 region 4: 0.78 region 5: 0.61 region 6: 0.87 region 7: 0.37 region 8: 0.32 region 9: 0.71	Normal probability range
	Probability of rheotaxis	p_{Rheo}	[0,1]	region 1: 0.38 region 2: 0.15 region 3: 0.05 region 4: 0.17 region 5: 0.03 region 6: 0.40 region 7: 0.11 region 8: 0.90 region 9: 0.41	Normal probability range
	Half-saturation point of logistic function	c	[-10,10]	region 1: 7.55 region 2: 5.91 region 3: 2.09 region 4: 8.19 region 5: -0.19 region 6: 0.91 region 7: 2.68 region 8: -2.53 region 9: -0.55	Encompassing various shapes of logistic curve for 95% of flows observed in the Delta
	Slope of logistic function	b	[0,10]	region 1: 5.89 region 2: 5.34 region 3: 0.88 region 4: 6.40	Encompassing various shapes of logistic curve for 95%

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Behavior	Description	Parameter	Search bounds	Optimal value	Evidence
				region 5: 5.77 region 6: 6.02 region 7: 4.47 region 8: 7.16 region 9: 8.56	of flows observed in the Delta
Holding	Landward holding threshold water velocity	u_H	[0,1.5m/s]	region 1: 0.70 m/s region 2: 1.44 m/s region 3: 1.17 m/s region 4: 1.26 m/s region 5: 0.70 m/s region 6: 0.67 m/s region 7: 1.48 m/s region 8: 1.13 m/s region 9: 1.14 m/s	0 to peak tidal water velocity computed by DSM2 between 1962 and 2014
	Holding probability	p_H	[0,1]	region 1: 0.80 region 2: 0.58 region 3: 0.65 region 4: 0.33 region 5: 0.60 region 6: 0.66 region 7: 0.96 region 8: 0.73 region 9: 0.32	Normal probability range
	Daytime swimming probability	p_{DS}	[0,1]	region 1: 0.63 region 2: 0.11 region 3: 0.62 region 4: 0.01 region 5: 0.70 region 6: 0.00 region 7: 0.16 region 8: 0.62 region 9: 0.68	Probabilities reported in Chapman et al. (2013)
Mortality	Mean free path length	λ	[10,1000Km]	region 1: 753 Km region 2: 629 Km region 3: 1000 Km region 4: 876 Km region 5: 1000 Km region 6: 794 Km region 7: 711 Km region 8: 918 Km region 9: 753 Km	Synthetic survival model predictions encompassing range of survivals predicted in Perry et al. (2018)
	Random prey speed	ω	[0,2m/s]	region 1: 0.58 m/s region 2: 0.92 m/s region 3: 1.42 m/s	Synthetic survival model predictions

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Behavior	Description	Parameter	Search bounds	Optimal value	Evidence
				region 4: 0.08 m/s region 5: 0.08 m/s region 6: 0.75 m/s region 7: 0.50 m/s region 8: 0.00 m/s region 9: 0.00 m/s	encompassing range of survivals predicted in Perry et al. (2018)

Spatial Patterns in Calibrated Model Parameters

A detailed analysis of the spatial patterns in the calibrated behaviors will be presented in Sridharan et al. (In prep.); here we merely present a synopsis.

For the active swimming component of the model, in the North Delta regions upstream of Rio Vista (regions 1 to 5) and the confluence of Georgiana Slough with the San Joaquin River (region 6), simulated salmon actively swim against strong non-reversing riverine flows. In the more tidally reversing Central (region 7), Western (region 8) and South Delta (region 9), fish execute either movements that are directed weakly with or against the flow. Together, these parameters result in actions by the fish that increase migration rate and dispersion with increasing proximity to the ocean, as is observed in the acoustic telemetry datasets.

The orientation and holding parameters allow simulated fish to hold position against the flow, and even swim against the flow during the landward flood phase of the tide. In the regions where the oceanward flow does not reverse, the net effect is to orient fish against the flow much more often than with the flow. In the parts of the system where the flow reverses tidally, fish orientations are more likely to switch between with and against the flow. During strong landward flow reversals, fish approximately maintain position relative to the flow. The probability of swimming during the day is consistent with the values obtained in this region from acoustic telemetry experiments reported in Chapman et al. (2013).

The mean-free path length and random prey speed result in an overall increasing likelihood of survival through the downstream regions of the system. In the Delta, predator densities are generally higher in the fresh Sacramento and San Joaquin River waters than in the Western, more salty parts of the system (Michel 2020). The spatial distribution of the mortality parameters thus mirror a lower likelihood of predation in the Western Delta than in the Eastern Delta.

ePTM v2 Application

For a given climate change, water operations or restoration scenario, ePTM v2 is used in conjunction with the habitat capacity model, and the USGS juvenile Chinook beach seine abundance model (Perry et al. 2016) to predict mean and variance in monthly survivals for fish rearing in the Sacramento River, the Yolo Bypass floodplain, and in the interior Delta. In a multi-year scenario, 50 simulated salmon are released uniformly over the first month of each simulation at each DSM2 node East of Chipps Island and the survivals estimated from each of these releases is bootstrapped into 1,000 survival samples. Each ePTM v2 simulation for fish released in a given month is run for three

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months to allow fish to reach their ultimate fate, and survival is reported based on fish that arrive at Chipps Island. River- and floodplain-rearing smolt survivals are reported as the survivals estimated by releasing fish at the relevant nodes (Figure 12), while Delta-rearing smolt survivals are reported by reweighting the survivals in the target month estimated from in-Delta node releases using the carrying capacity associated with each Delta node three months prior to the release month. The carrying capacities are estimated three months prior to the release month to reflect the fact that rearing juveniles would have selected a habitat patch to rear based on the conditions at the time that they arrived there. This reweighting assumes an ideal free distribution of fish in the Delta. The reweighting is done as follows:

First, the density of smolt abundance per unit area in four different regions representing the Delta [regions 2 through 5 in Figure 14 adapted from an United States Fish and Wildlife Service memo (Barnard 2019)] are estimated using the USGS abundance model for each month in each year between 2000 and 2020.

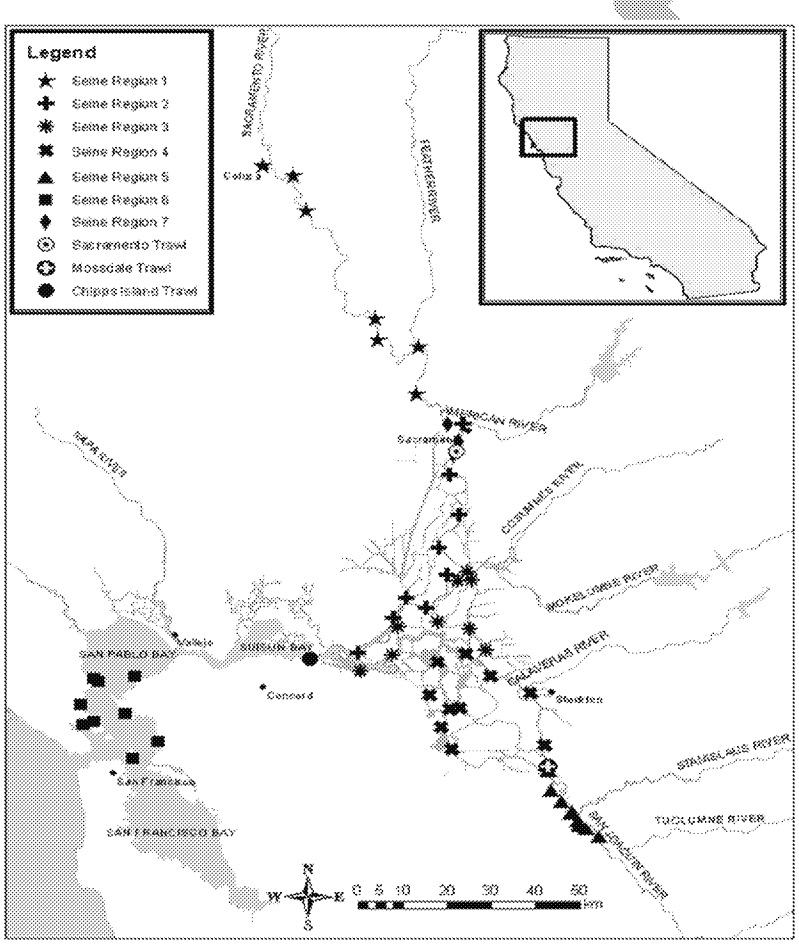

Figure 14. Beach-seine based abundance density model regions. Regions 2, 3, 4 and 5 are used in the habitat capacity-based reweighting scheme. From Barnard 2019.

Then, for each month in each year in the scenario that is being evaluated, the density in each region is estimated by using a K-nearest neighbors model which sets the abundance in a given month as

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$$d_{m,r} = \frac{\sum_{j=1}^{K} d_{j,Historical,i}}{K}$$

where $d_{m,i}$ is the density in region r in month m of the scenario, $d_{j,Historical,i}$ is the density in that region in the jth month of K months within the historical period that are within the cluster of months closest to the mth month hydrologically. The hydrological similarity index used to cluster historical months is given by the Euclidean distance between the hydrologic conditions representative of a given region, which are

Region 1 based on Sacramento River flow: $\sqrt{(Q_{Sac,m} - Q_{Sac,j})^2}$

Region 2 based on Sacramento River flow and Delta Cross Channel operation:
$\sqrt{(Q_{Sac,m} - Q_{Sac,j})^2 + (Q_{DCC,m} - Q_{DCC,j})^2}$

Region 3 based on Sacramento River flow and Delta Cross Channel operation:
$\sqrt{(Q_{Sac,m} - Q_{Sac,j})^2 + (Q_{DCC,m} - Q_{DCC,j})^2}$

Region 4 based on San Joaquin River flow: $\sqrt{(Q_{SJR,m} - Q_{SJR,j})^2}$

and, w_j is the inverse Euclidean distance between the hydrologic conditions representative of a given region within the cluster of points closest to the month m. The number of clusters is dynamically determined by minimizing the sum of squared errors obtained by successively leaving one month out of the historical dataset. These errors are the sum of the Euclidean separation between a training point and the sum of other points in a cluster weighted by the inverse Euclidean separation between those points and the training point.

Second, the area within each of the eight habitat classes, c, associated with a node, i, with l connecting channels is given by

$$a_{i,c} = \frac{1}{2}\sum_{j=1}^{l} a_{i,c}$$

The density associated with each habitat class is given by d_c.

Third, the weight associated with each region in the Delta is estimated as

$$w_r = \frac{\sum_{c=1}^{8} d_c\left(\sum_{i=1}^{n} a_{i,c}\right)}{\sum_{r=1}^{4} w_r}$$

This formula ensures that regions with predominantly poor habitats are weighted lower as locations where fish would likely rear. As the USGS density model collapses beach seine data into the four regions depicted in Figure 15 and finer resolution is not possible, the assumption here is that the carrying capacity associated with each node within a given region is identical.

Fourth, the carrying capacity (K) of each region is then given by

$$K_{m,r} = w_r d_{m,r}$$

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Finally, the reweighted survival from a given DSM2 node i in month m is given as

$$S_{m,i,Reweighted} = \frac{K_{m-3,r}}{\sum_{r=1}^{4} K_{m-3,r}} S_{m,i}$$

Caveats

Currently, the ePTM v2 can represent either the current geomorphology and hydrology of the Delta (Current), a historic representation of the Delta before Liberty Island flooded (Historic), or any other configuration representing restoration actions or other water operations. We note that in order to investigate these alternate configurations, some effort would be required to set up the overarching CALSIM simulations and the Delta hydrodynamics DSM2 model. The development of these models for specific scenarios is currently beyond the scope of the LCM team. The ePTM v2 results are based on a simplified one-dimensional network representation of the Delta, and hence do not account for complex geo-morphological and hydrodynamic transport and mixing phenomena such as tide induced chaotic dispersion, wind generated transport and gravitational circulation. The ePTM v2 results do not include the effects of environmental stressors such as water quality, temperature, nutrients, channel scale, temporal variability in predation dynamics, and foraging behavior or energy management dynamics. There is a significant data gap in addressing more complex spatio-temporal patterns in biological behavior and habitat interactions, as well as a need for easy model deployment and speed, so the ePTM v2 parameterizes only simple hypotheses about these effects.

Cloud-based Implementation of ePTM v2 for Tractable Scenario Evaluation

In a typical application of the WRLCM for evaluation of a proposed project or water management scenario, the ePTM v2 is used to generate monthly survival estimates across multiple decades. The resampling procedure described above requires survival estimates for smolts originating throughout the Delta for every year and month, which implies that a large number of ePTM v2 simulations are required for a single scenario evaluation.

For example, a typical scenario evaluation could span 90 years and eight months per year, for a total of 720 year-month combinations. The exact number of ePTM v2 insertion nodes depends on the DSM2 grid, which may vary by scenario, but there are approximately 370 relevant insertion nodes east of Chipps Island. Therefore, the example scenario evaluation would require approximately 266,400 simulations (90 years x 8 months x 370 simulations/year-month). A single ePTM v2 simulation with 50 SJS requires on the order of one minute to complete. Performing all of the required simulations on a single machine would take approximately 1.65 X 10^7 seconds, or 190 days.

Given that the elapsed real time required to complete these ePTM v2 simulations on a single machine would be prohibitive, we have deployed the ePTM v2 on the Amazon Web Services (AWS) cloud computing platform to allow for massively parallel computation. Using AWS, we are able to distribute the ePTM v2 simulations across hundreds of instances (virtual machines), allowing completion of a scenario evaluation in less than a day of elapsed real time.

We employed three primary components of AWS to implement the cloud-based ePTM v2 workflow. Simulations are performed using Elastic Cloud Compute (EC2) instances. Communication between a local machine and the EC2 instances (e.g., for scheduling jobs and downloading metadata for the

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completed jobs) is implemented via the Simple Queue Service (SQS). ePTM v2 outputs from the EC2 instances are stored using Simple Storage Service (S3) buckets.

Creating virtual machines on EC2 requires an Amazon Machine Image (AMI), which is essentially a template that can be used to spawn one or more EC2 instances. It can be thought of as an image of a single computer that can be copied any number of times to create multiple, identical, virtual computers running in the cloud. The AMI specifies the operating system, all of the installed software, and other software configuration details. The same AMI can be used to launch EC2 instances with a variety of hardware configurations, meaning that a more or less powerful hardware configuration can be selected as needed at runtime.

For the ePTM v2, we created a custom AMI based on Windows and the x86_64 platform with the ePTM v2 and all required supporting software installed. The AMI was configured to automatically log in and begin polling SQS for available jobs upon launch, and to automatically terminate after a set period of time with no new jobs. For typical applications, we use the c5.large EC2 instance type, which is a compute-optimized instance with 2 virtual CPUs (vCPUs) and 4 GiB of memory.

We used a series of Python scripts, running on both a local machine and the cloud instances, to implement the workflow. The workflow includes scheduling the jobs from the local machine, polling the job queues on the cloud instances, downloading the ePTM v2 outputs to the local machine, and post-processing the results. Interaction with AWS is accomplished using the Boto3 AWS Software Development Kit (SDK) for Python.

Each ePTM v2 simulation provides a survival estimate for SJS inserted into a particular DSM2 node for a given year and month. To obtain survival estimates representing the entire month, we insert 50 SJS with insertion dates and times distributed uniformly throughout the specified month. For each SJS, the ePTM v2 calculates a survival probability in each time step, so the cumulative survival probability from the insertion location to the Delta exit at Chipps Island is the product of the survival probabilities for the individual time steps. Survival probabilities for SJS that did not pass Chipps Island are assumed to be zero.

Summarizing, the standard workflow for running the ePTM v2 on AWS includes the following steps:

- use a Python script on a local machine to post jobs on SQS for all years, months, and insertion nodes required for the scenario evaluation

- launch up to hundreds of c5.large EC2 instances using a custom Windows-based AMI configured to automatically log in, poll the SQS job queue, claim a particular job, perform the ePTM v2 simulation, save the run metadata to the SQS queue, and save the raw ePTM v2 outputs to an S3 bucket

- after all scheduled simulations are complete, use a Python script to download the raw ePTM v2 outputs to a local machine for post-processing

- run a Python post-processing script to quality assure (QA) the ePTM v2 outputs and perform bootstrap resampling

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IV. Model Calibration

The WRLCM framework is flexible in that it may be used to generate many different trajectories of abundance and spatial patterns of habitat use by varying the parameters of the model. The WRLCM should reflect historical trends and spatial patterns in abundance, however. As a result, we calibrated the WRLCM to multiple winter-run abundance indices by fixing some model parameters and estimating other parameters with a statistical fitting algorithm.

One goal of the WRLCM was to construct a model that was sensitive to alternative hydro management actions in the Central Valley; thus the model was structured such that it is sensitive to hydrologic drivers. An unintended consequence of this approach is that the statistical properties of the model are not optimal. In particular, some model parameters are not uniquely identifiable; that is, the same abundance can occur through several different parameter combinations. Because this property of the LCM makes statistical estimation difficult, the values of some parameters must be constrained using biological information, previous studies, or expert opinion, so that other parameters can be estimated. We provide the parameters that were constrained and provide justification for their values before moving to the statistical estimation of the remaining parameters.

Fixed Parameters and Their Justifications

Spawn Timing Parameters

Historically, the spawning of winter-run Chinook has not been uniform among the months April to August. Instead, higher proportions of winter-run spawned in June and July relative to April, May, and August. In addition, the proportions of winter-run that spawned in each month were not constant across years, but instead varied yearly. We analyzed the historical proportion of spawning among each month from 2003 – 2014 using carcass counts (assuming a 2 week period between spawning and senescence), and estimated the proportion of winter-run spawning in each month as a function of April temperatures at Keswick (Appendix A). We compared this model to one that used a static proportion among years, and found that the model based on April temperatures outperformed the static model. The general relationship identified through this multinomial regression model was that hotter April temperatures caused later initiation of spawning in winter-run Chinook. This may be explained mechanistically if the female spawners were laying their eggs to target an emergence time. Hotter temperatures in April indicated that a shorter incubation window was needed, whereas cooler temperatures indicated a longer incubation window. Please see Appendix A for additional information on this analysis.

These equations provided a method of shifting spawning distribution among months as a function of April temperatures (Table 3 and Appendix A). The April water temperatures were standardized in the analysis and thus need to be standardized for use in the simulation model (mean = 10.00 C, standard deviation = 0.70).

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Table 3. Parameter values related to monthly spawn timing (SD = standard deviation).

Parameter	Mean	SD	Description
$B0_{Apr}$	-4.145	0.060	Intercept for proportion of spawners in April
$B1_{Apr}$	0.0538	0.062	Effect of temperature on proportion of spawners in April
$B0_{May}$	-1.796	0.020	Intercept for proportion of spawners in May
$B1_{May}$	-0.2031	0.020	Effect of temperature on proportion of spawners in May
$B0_{Jul}$	-0.332	0.012	Intercept for proportion of spawners in July
$B1_{Jul}$	0.3852	0.012	Effect of temperature on proportion of spawners in July
$B0_{Aug}$	-3.443	0.044	Intercept for proportion of spawners in August
$B1_{Aug}$	0.7921	0.045	Effect of temperature on proportion of spawners in August

Tidal Fry and Fry Related Parameters

Winter-run Chinook generally have not had a high tidal fry proportion (on the order of less than 5%). Furthermore, the location of tidal fry has varied among years, and they have been susceptible to movement downstream in the Sacramento River under high flow conditions (Pat Brandes, USFWS *personal communication*). The WRLCM parameters for the tidal fry and fry stages reflected these assumptions (Table 4).

Table 4. Fixed parameter values related to the tidal fry and fry stage.

Parameter	Value	Description
$t.crit$	12.0	Temperature at which thermal morality initiates in the egg to emerging fry survival in Transition 1. Value of 12.0 obtained from Martin et al. (2017).
$B1_A$	0.0	Effect of covariate on background survival in egg to emerging fry survival in Transition 1. A value of 0 indicates no annual variability in background survival.
$P_{TF,m}$	0.047	Proportion tidal fry
$S_{TF,FP}$	0.731	Survival tidal fry in floodplain
$P_{FP,m}$	0.88	Proportion entering Floodplain if flooding (Pope et al. 2018)
$B0_4$	0.5	Average survival tidal fry to delta intercept
$B1_4$	-1.0	Effect of DCC gate (value is in logit space)*
$B0_5$	0.5	Average proportion of tidal fry to bay intercept
$B1_5$	2.0	Effect of Rio Vista flow (value is in logit space)*

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Parameter	Value	Description
$B0_M$	0.003	Proportion of fry moving from the Lower River to the Delta in the absence of density dependence when Wilkins Slough Flows are < 400 cms.
$B1_M$	0.377	Proportion of fry moving from the Lower River to the Delta in the absence of density dependence when Wilkins Slough Flows are ≥ 400 cms.

Smoltification Timing Parameters

The timing of smoltification of winter-run Chinook salmon historically begins in January with a majority of winter-run sized smolts outmigrating by March (delRosario et al. 2013). In the WRLCM, all fry are assumed to have smolted by April and migrated in May (Table 5). The timing of smoltification in the WRLCM has been parameterized to coincide with winter-run sized Chinook salmon in Chipps Island trawl data (delRosario et al. 2013) and by using Chipps Island abundance indices as described below in the *Parameter Estimation* section.

Table 5. Smoltification timing parameters for winter-run Chinook.

Parameter	Value	Description
Z_1	0.269	January smolt probability
Z_2	0.5	February smolt probability
Z_3	0.953	March smolt probability
Z_4	0.999	April smolt probability
Z_5	1	May smolt probability
Z_6	1	June smolt probability
Z_7	1	July smolt probability

Maturation Rate Probabilities

The age-specific maturation probabilities for winter-run Chinook salmon were fixed to values based on analysis of coded wire tagged hatchery fish (Grover et al. 2004). The probability of maturation of age 2 fish was 0.10 (M_2), the conditional probability of maturation at age 3 was 0.90 (M_3), and the conditional probability of maturation at age 4 was 1.0.

Age-specific sex ratios were applied to obtain age and sex specific escapement values. Males dominate age-2 escapement, thus the female sex ratio for age-2 fish (Fem_{Age2}) was set at 0.01. Estimates of the proportion of age-3 female spawners (Fem_{Age3}) may vary among years, and we accounted for this historical annual variability by using an annual sex spawner ratio value calculated from Keswick trap counts 2001 – 2014 (mean = 0.595, sd = 0.077). These values were also used in the annual calculation of natural origin escapement from carcass surveys over the period 2001 –

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2014 (Doug Killam, CDFW Redding, CA, *personal communication*). In the absence of an estimate of the age-3 sex ratio, a value of 0.5 was assumed for 1970 – 2000.

Egg production per age-2 female ($V_{eggs,2}$) was 3000 for age 2 females (3200 reported in Newman and Lindley, 2006) and production per age-3 and age-4 female ($V_{eggs,3}$ and $V_{eggs,4}$) was 5000 (Winship et al. 2014).

Smolt Survival

The ePTM v2 calculates month and year-specific smolt survival probabilities; however, some survival probabilities were needed to move the smolts from their areas of rearing to the location in which the ePTM v2 survival rates were applied. Smolt survival from the Lower River to the Delta ($B0_{11,LR}$) was fixed at 0.8 (estimates of survival ranged from 0.73 - 0.875 Colusa to Sacramento in the 2012-2015 WR acoustic tag data, Arnold Ammann, SWFSC NMFS Santa Cruz *personal communication*). Smolt survival from the Upper River to the Delta ($B0_{10,UR}$) was fixed at 0.4 (estimates of survival averaged 0.456 from release to Sacramento in the 2012-2015 WR acoustic tag data, Arnold Ammann, SWFSC NMFS Santa Cruz *personal communication*). Smolt survival from the Yolo bypass to insertion into the DSM2 grid for incorporation into the ePTM v2 ($^{A}S_{13,FP}$) was assumed to be 1.0 per month.

Survival of smolts from Chipps Island to the Golden Gate bridge ($^{c}S_{11}$) was incorporated into the survival during early ocean survival (described below) and therefore assumed to be 1.0. Survival of smolts that reared in the Bay to the Golden Gate bridge ($S_{15,BA}$) was assumed to be 0.8.

Ocean Survival

Survival of smolts that reared in the Upper River, Lower River, Delta, Yolo, and Bay habitats (S_{G1}) have the same gulf survival, which was estimated through statistical fitting (see below in the *Parameter Estimation* section).

Survival during the first four months in the ocean (S_{17}) was assumed to have a rate of 0.79, which equates to an annual survival of 0.5, whereas annual survival in the ocean for age-3 and age-4 (S_{19} and S_{21}) was assumed to be 0.8. These annual natural survival rates are consistent with winter-run reconstruction conducted annually as part of the fishery management of Sacramento River salmon (Grover et al. 2004, O'Farrell et al. 2012).

Statistical Estimation

One of our objectives is to ensure that the WRLCM can reflect the historical patterns in winter-run Chinook population dynamics in the Sacramento River. In order to meet this objective, we calibrated the LCM to observe winter-run indices of abundance throughout the life cycle (Table 6). Not all indices of abundance were available for the entire period of model calibration of 1970-2014. This data limitation is not a problem for fitting the WRLCM, however. The WRLCM can be fitted to the specific indices of abundance for the period over which they were available by pairing observed indices of abundance with WRLCM predictions over the appropriate period. Then, the sampling

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distribution provided a likelihood function by which the model predictions were statistically evaluated given the observed data (Hilborn and Mangel 1997).

This type of model, in which multiple data sources are used to inform multiple life-history stages, is called an integrated population model and has notable advantages over piecewise model composition (Newman et al. 2014). In particular, the model parameter estimates can utilize all of the available data simultaneously, which can improve the parameter estimates by allowing the model to "fill in the gaps" over portions of the life cycle that are unobserved (Newman et al. 2014).

Table 6. Indices of abundance used to calibrate the winter-run life cycle model.

Data	Date	Standard Deviation	Sampling Distribution	Data time step
Natural	1970-2002	0.25	lognormal	Annual
Escapement				
Escapement by sex and jack/jill vs adult	2003-2016	0.25	lognormal	Annual
RBDD monthly juvenile counts	1996-1999, 2002-2016	0.8	lognormal	Monthly
Chipps Island monthly juvenile abundance	2008 - 2011	0.9	lognormal	Monthly

Modification of the WRLCM for Estimating Parameters

Annual impact rates of age-3 (I_3) and age-4 (I_4) were obtained from estimated harvest rates over the 1970- 2014 period (O'Farrell and Satterthwaite 2015). Survival of age-2 (S_{sp2}), age-3 (S_{sp3}), and age-4 (S_{sp4}) through the freshwater prior to spawning is assumed to be 0.9 to incorporate in-river harvest, which historically included levels of approximately 7 percent (Grover et al. 2004) and pre-spawn mortality.

To reflect the historical dynamics of access to the Floodplain habitat (Yolo bypass), the following transition equation was used to describe the proportion of Tidal Fry that enter the floodplain habitat ($P_{FP,m}$)

$$P_{FP,m} = B1_{FP} * \mathrm{I}(Q_{Verona,m} > 991.1 \text{ m}^3\text{s}^{-1})$$

where $Q_{Verona,m}$ was the Sacramento River flow at Verona in month m, $\mathrm{I}(\,)$ is an indicator function that equates to 1 when the condition in the parenthesis is met, and $B1_{FP}$ is the proportion of fry that enter the Yolo under flooding conditions, which was 0.8.

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Bayesian Estimation

Given the fixed parameter values described above, the remaining parameters were estimated in a Bayesian statistical fitting framework. An initial evaluation of model complexity (not shown) indicated that approximately 10 parameters were identifiable in the mechanistic portion of the model, depending upon which parameters were chosen. We estimated 8 parameters in addition to 45 annual random effects (i.e, the ε_y) in the model calibration.

These parameters were estimated by sampling from the posterior distribution (the combination of the likelihood specified by the sampling distribution and the prior distribution for model parameters) of observing the winter-run abundance indices (Hilborn and Mangel 1997, Gelman et al. 2013). That is, parameter combinations can be used to make predictions on the escapement in each year, the number of juveniles passing RBDD in each month, and monthly abundance estimates at Chipps Island (Table 6). Some parameter combinations provide predictions that are closer to the observed abundance indices than others. The parameter combinations that provide the closest fit to the observed indices are retained in the Markov Chain Monte Carlo (MCMC) sampling algorithm, leading to a set of samples from the posterior distribution of the model parameters. The MCMC algorithm also provides estimates of the state variables, which include the abundance at each sampling location at the appropriate time scale (Table 6) for comparison of the model predictions to the observed abundance data.

Model parameters were estimated by implementing the Bayesian statistical fitting in the programming language NIMBLE (de Valpine et al. 2017, deValpine et al. 2022a). In order to implement the MCMC algorithm, the WRLCM had to be written into the NIMBLE language as NIMBLE uses a specific syntax that it subsequently converts to C++ code so that the MCMC algorithm can be implemented in a fast computational environment. All life stages of the WRLCM were coded into the NIMBLE version of the WRLCM with the exception of tidal fry. Tidal fry compose a small portion of the overall dynamics of winter-run (~5.0%) and field data have not been collected for this life stage. As a result, the NIMBLE model has no observations on which to evaluate this life stage, and therefore tidal fry were not included in the NIMBLE code; however, their dynamics were included in the evaluation of the projects using the fixed parameter values described above. More details on the NIMBLE programming language can be found at de Valpine et al. (2022b).

Fits to Abundance Indices

Fits to the abundance indices generally followed patterns in the observed data. Annual patterns in natural origin escapement were well estimated by the model (Figure 15), as were monthly patterns in juvenile abundance estimates at RBDD (Figure 16).

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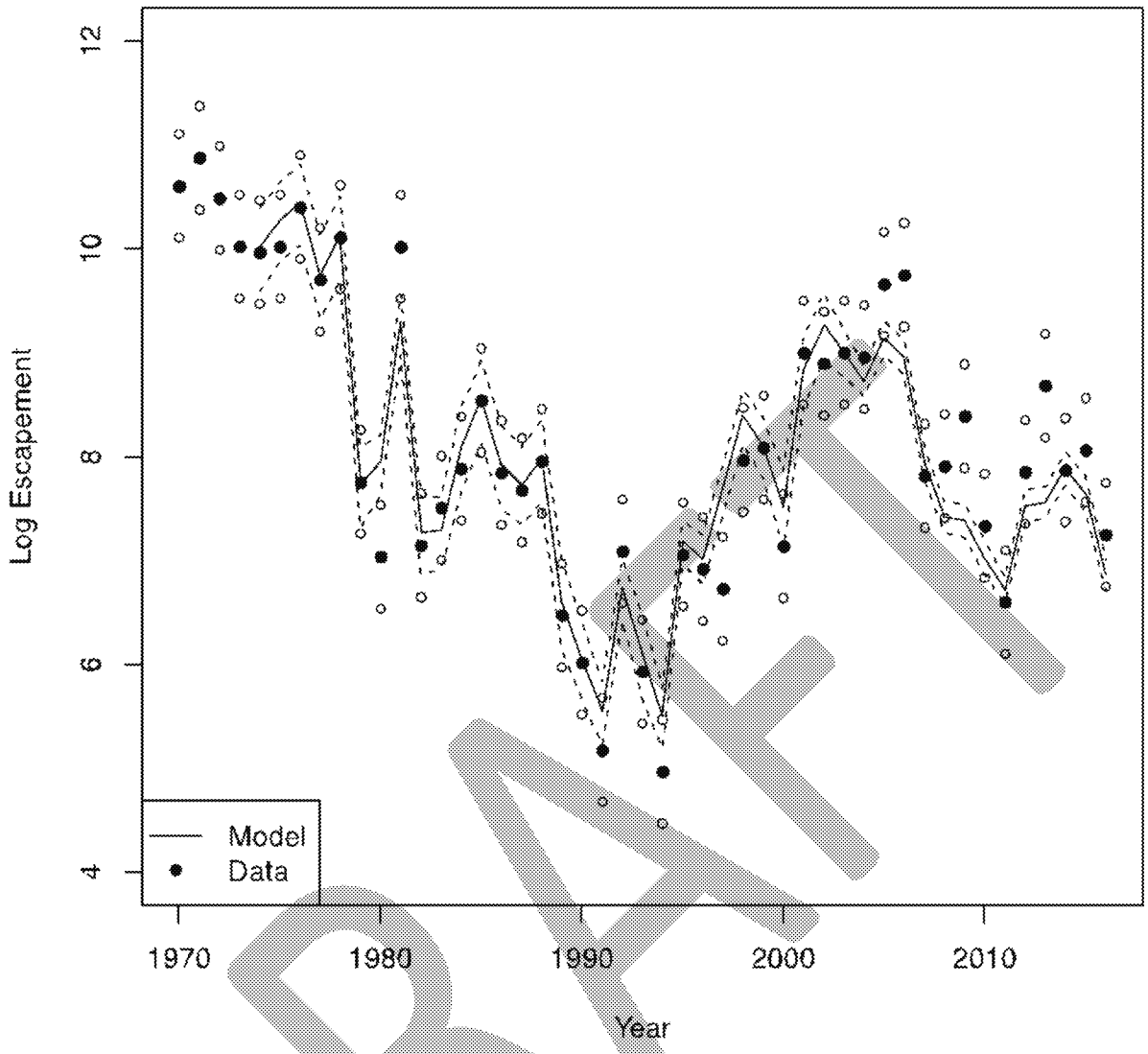

Figure 15. Model fit (line) with 95% credible intervals on model predictions (dashed line) to log natural origin escapement data (solid circles) with 95% interval on measurement error (open circles).

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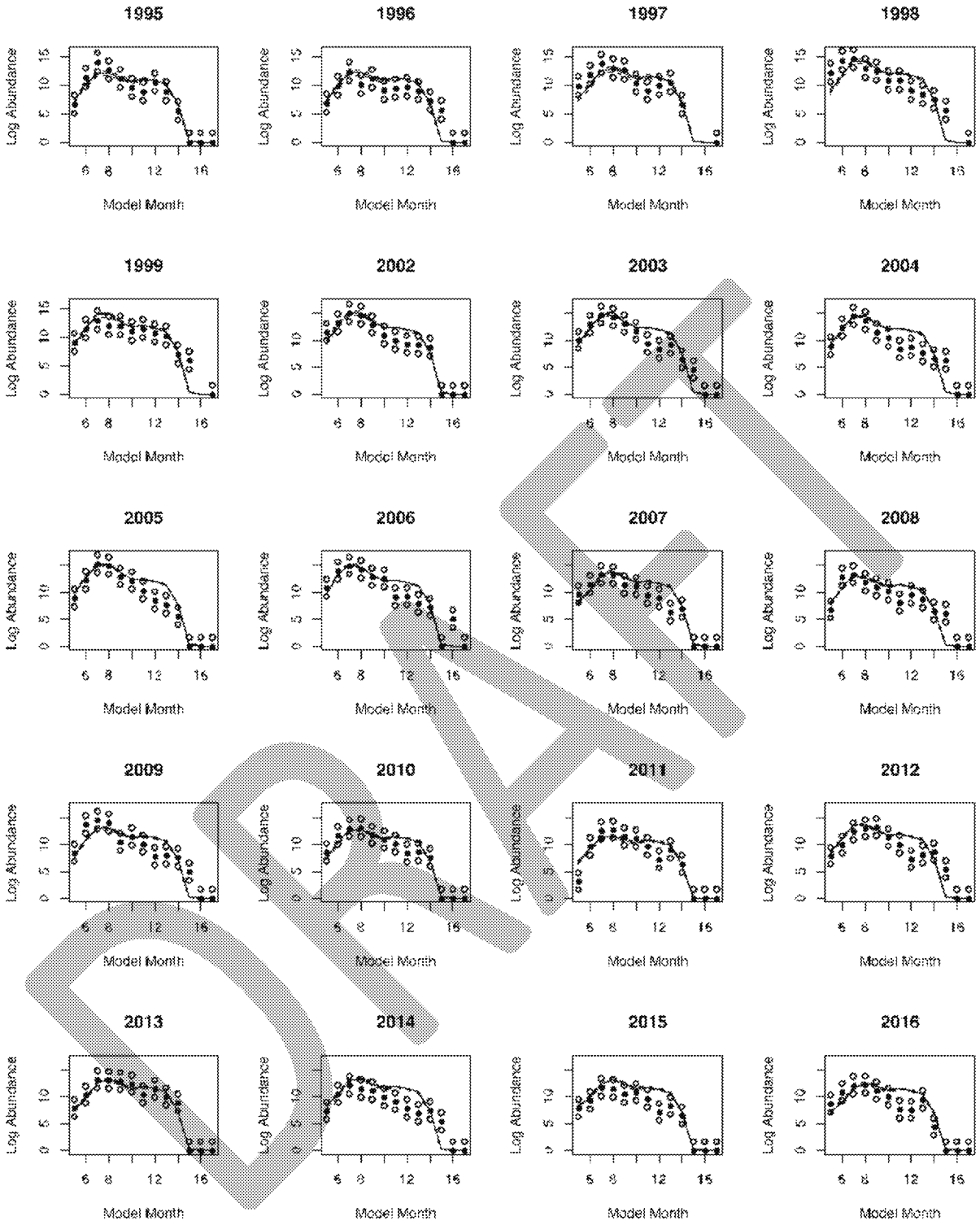

Figure 16. Model fit (line) with 95% credible intervals on model predictions (dashed line) to log juvenile abundance at Red Bluff Diversion Dam (solid circles) with 95% interval on measurement error (open circles).

Finally, the WRLCM was able to capture the monthly patterns in Chipps Island abundance trends from 2008 – 2011, reflecting the outmigration patterns of winter-run from each of the rearing habitats (Figure 17).

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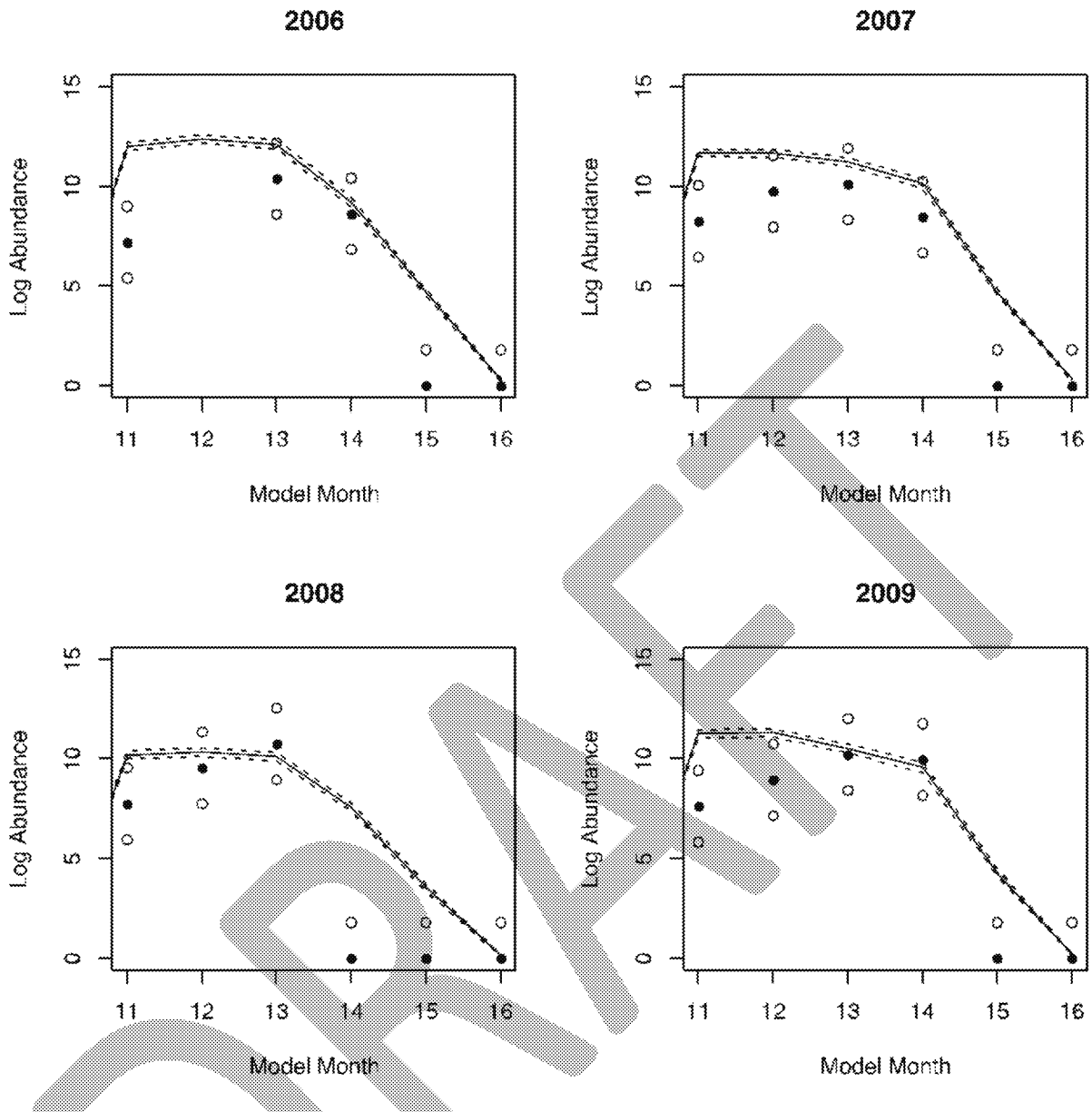

Figure 17. Model fit (line) with 95% credible intervals on model predictions (dashed line) to log juvenile abundance at Chipps Island (solid circles) with 95% interval on measurement error (open circles).

The estimated parameter values from the MCMC algorithm are provided in Table 7. The table provides the parameter estimate, the standard deviation of the estimate (SD), a transformed value of the parameter estimate, and a note defining the parameter. We attempted to estimate all parameters of the survival of egg to fry as a function of temperature (Transition 1); however, there was strong correlation among the three parameters that caused problems with parameter identifiability. We assumed that the critical temperature at which thermal mortality starts to affect egg to fry survival was 12.0 C, which is the value determined from an analysis of egg to fry survival by Martin et al. (2017). The survival of egg to fry below this critical temperature was a value (logit(BO_1)) for the 3-month period, whereas above this threshold the survival was reduced for every degree above the critical temperature.

mig_m is a constant value (e.g., movement from the floodplain to the delta, the delta to the bay, and the bay to the gulf).

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The other parameter value that was set was the variance on the random effect in process noise (σ_{ε}^2), and it was set to have a value of 1. This variance allowed the model to estimate the annual random effect parameters (ε_y) to have values of approximately $\pm$ 2. These parameter values corresponded to a range in annual variability in survival of (0.17, 7.4) due to the lognormal structure of the random effects.

Table 7. WRLCM parameter estimates from the model calibration to winter-run indices of abundance (Table 6).

Parameter	mean	sd	2.50%	97.50%	Rhat	Description
$B0_A$	0.95	0.096	0.764	1.139	1.00	Survival below critical temperature value
$B1_1$	-1.11	0.144	-1.412	-0.847	1.09	Rate of reduction in egg to fry survival (logit space)
S_{FRY}	0.872	0.062	0.758	0.997	1.00	Winter run fry survival (logit space)
mig_m	0.224	0.126	0.017	0.486	1.00	Proportion migrating per month from floodplain, delta, and bay in absence of density dependence
$mig_{UR,m}$	0.128	0.012	0.105	0.153	1.00	Proportion of fry in upper river migrating to lower river per month in absence of density dependence
S_{G0}	-3.165	0.297	-3.723	-2.557	1.02	Average survival during gulf entry (logit space)
S_{G1}	-0.338	0.233	-0.786	0.144	1.04	Effect of upwelling index on survival during gulf entry (logit space)
σ_{ε}	1.645	0.194	1.255	1.974	1.01	Standard deviation of random effects during gulf entry

Using 1500 samples from the posterior, we calculated the correlation among estimated model parameters (Table 8). In general, the absolute value in correlations among parameters was less than 0.6. Parameters with absolute correlations greater than 0.5 included the standard deviation in the random effects (σ_{ε}) and the average ocean entry survival (S_{G0}), which were negatively related, and the effect of thermal mortality ($B1_1$) and the ocean entry average ocean entry survival (S_{G0}), which was also negatively related. These negative correlations reflect the lack of observations on winter-run between Chipps Island (in a few years) and spawner escapement. As a result, the observed patterns in abundance can be explained by having high thermal mortality and low gulf entry survival (and vice versa). Likewise, the abundance data can be explained by allowing the annual variability in gulf survival to be more variable if the thermal mortality rate is low and less variable if the thermal mortality rate is high. These correlations reflect unknown relationships due to limited data; that is, we do not have data sets that can determine the specific rates and thus multiple combinations of these parameters can produce the same patterns in abundance. This is an important aspect to the model fitting in that the correlations in posterior draws can be passed to the evaluation of the project effects.

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Table 8. Correlation matrix for estimated parameters in the WRLCM calibration.

	mig_m	$mig_{UR,m}$	S_{G0}	S_{G1}	$B0_A$	S_{FRY}	$B1_1$	σ_ε
mig_m	1	0.152	-0.08	-0.009	0.083	0.279	0.023	-0.09
$mig_{UR,m}$	0.152	1	-0.102	-0.062	-0.228	0.442	-0.01	-0.014
S_{G0}	-0.08	-0.102	1	0.172	-0.081	-0.232	-0.564	0.353
S_{G1}	-0.009	-0.062	0.172	1	0.024	-0.091	-0.259	0.262
$B0_A$	0.083	-0.228	-0.081	0.024	1	-0.25	-0.035	-0.063
S_{FRY}	0.279	0.442	-0.232	-0.091	-0.25	1	-0.071	-0.031
$B1_1$	0.023	-0.01	-0.564	-0.259	-0.035	-0.071	1	-0.564
σ_ε	-0.09	-0.014	0.353	0.262	-0.063	-0.031	-0.564	1

Incorporating Uncertainty in the Analysis of Hydrologic Alternatives

Our goal is to be able to account for multiple sources of uncertainty in the analysis of the proposed alternatives relative to the existing condition (or baseline). We incorporated three forms of uncertainty in the DCP analysis: 1) parameter uncertainty, 2) natural variability in cohort productivity, and 3) model uncertainty in the smolt survival function (ePTMv2). We then used Monte Carlo simulation to incorporate all three sources of uncertainty in the WRLCM outputs.

To incorporate parameter uncertainty, we used 1000 posterior samples from the parameters estimated via MCMC. With two exceptions, we used the draws that were defined by the posterior credible intervals described in Table 7. The two parameters that used different values were the standard deviation in the random effects (σ_ε) and the ocean entry survival (S_{G0}). The ocean entry survival was fixed at a value of 0.12 for gulf entry survival (corresponding to an inverse logit transformed value of -2), because the estimated value of 0.043 (corresponding to an inverse logit transformed value of -3.1) was leading to extremely low population sizes given the survival rates in the other parts of the life cycle. We also fixed the standard deviation in the random effects (σ_ε) to its mean value (1.645).

To incorporate natural variability in cohort productivity, we incorporated a unique random effect for each cohort in the 92-year time series. We repeated this 92-year series over 1000 iterations to simulate a set of 1000 x 92 random effects that corresponded to 1000 iterations and 92 years of the time series. The random effects were bias corrected random variables (to ensure that when they were exponentiated they retained a mean of 1) from a normal distribution with mean = 0 and standard deviation = 1.645.

Finally, to incorporate uncertainty in the smolt survival model (ePTMv2), we used 1000 bootstrapped samples of survival rates estimated for each model month 11 to 17 (January to July) and the Lower River, Floodplain, and Delta rearing habitats. These 1000 samples by month and habitat were calculated for each alternative and the baseline existing condition. Within each scenario, we ordered the survival estimates within each month and rearing habitat such that the first value was the lowest survival rate for that month and habitat and the last value was the highest survival rate for that month and habitat. We then used the ordered smolt survival rates in the effects analysis, which ensured that the lowest monthly survival for a given habitat under the existing condition was being paired with the lowest monthly survival for the same habitat under the

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alternative. This ordering also ensured that this comparison was made for the second lowest survival and through to the highest survival.

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Appendix A. Analysis of winter-run monthly spawn timing

To estimate the proportion of winter-run spawning among the months of April to August, we conducted an analysis of the numbers of winter-run carcasses detected in each of the months April to August. We were interested in understanding whether the proportions spawning among months were static across all years, or alternatively, whether the proportions varied among years due to the environmental conditions in that year. That is, whether there were some environmental conditions that caused shifts to earlier spawning in some years.

Data

Winter-run carcass observations by date were shifted two weeks earlier to generate "observed" number of fish spawning by date. These spawning numbers by date were coalesced by month to form $N.spawn_{m,t}$ the observed (based on carcass counts) number of winter-run Chinook spawning in month m in year t.

To evaluate annual variability in the proportion spawning in a given month, we calculated a spawning proportion anomaly as the standardized proportion of fish spawning each month ($SPr_{m,t}$). For example, the values of the standardized April values were

$$SP_{Apr,t} = \frac{P.spawn_{Apr,t} - mean(P.spawn_{Apr})}{std\ dev(P.spawn_{Apr})}$$

where the proportion spawning in each month for a given year t (subscript suppressed) was calculated as

$$P.spawn_m = \frac{N.spawn_m}{\sum_m N.spawn_m}.$$

To understand how these annual anomalies varied as a function of water temperature, we calculated the Pearson's correlation coefficient between mean monthly temperature below Keswick Dam between January and June and the standardized proportions (Figure A1).

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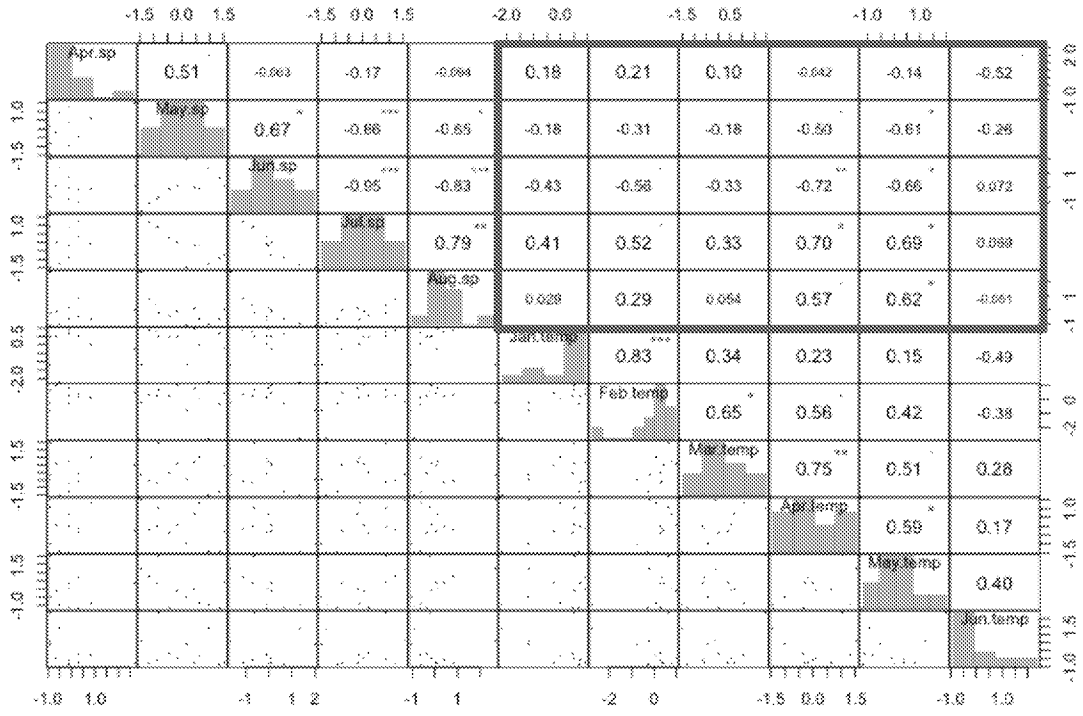

Figure A1. Pearson correlation coefficients (upper triangle), histograms (diagonal) and scatter plots (lower triangle) for all combinations of monthly spawning proportion anomalies and Keswick water temperatures. The red box indicates the month by temperature correlations, and red asterisks indicate significant correlation coefficients.

Statistical Analysis

We fit a multinomial logistic regression using the *multinom* function from the *nnet* package in R to the number of winter-run Chinook spawning in each month, $N.spawn_{m,t}$. We evaluated the ability of April Keswick temperatures to explain annual variability in the spawning timing. We focused on April temperatures because April is the first month of spawning, and April would allow this physical variable to be used as a predictor of spawn timing for future years. The monthly average April temperatures at Keswick were standardized (subtracted mean and divided by standard deviation) for use in the multinomial model.

We fit a base model without the April temperature effect and we fit the model with the April effect and used Akaike Information Criterion (AIC) to compare the models. The AIC value for the base multinomial model was 75822, whereas the value for the multinomial model including April temperature as a covariate was 74209. The difference in AIC was 1613, providing strong support for the model with the April temperature covariate.

The model coefficients for the multinomial model with April covariate indicated increasing spawning in July and August (positive coefficient values) when April temperatures increased (Table A1 and Figure A2). The model coefficients (Table A1) can thus be used for making predictions of spawning proportions using standardized April temperatures as displayed in Figure A2.

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Table A1. Coefficient estimates of the multinomial model including April covariate. The effect of the April covariate is reflected in the B1 coefficient estimate.

	Estimate		Standard Error	
Month	B0	B1	B0	B1
Apr	-4.145	0.054	0.06	0.062
May	-1.796	-0.203	0.02	0.02
Jul	-0.332	0.385	0.012	0.012
Aug	-3.443	0.792	0.044	0.045

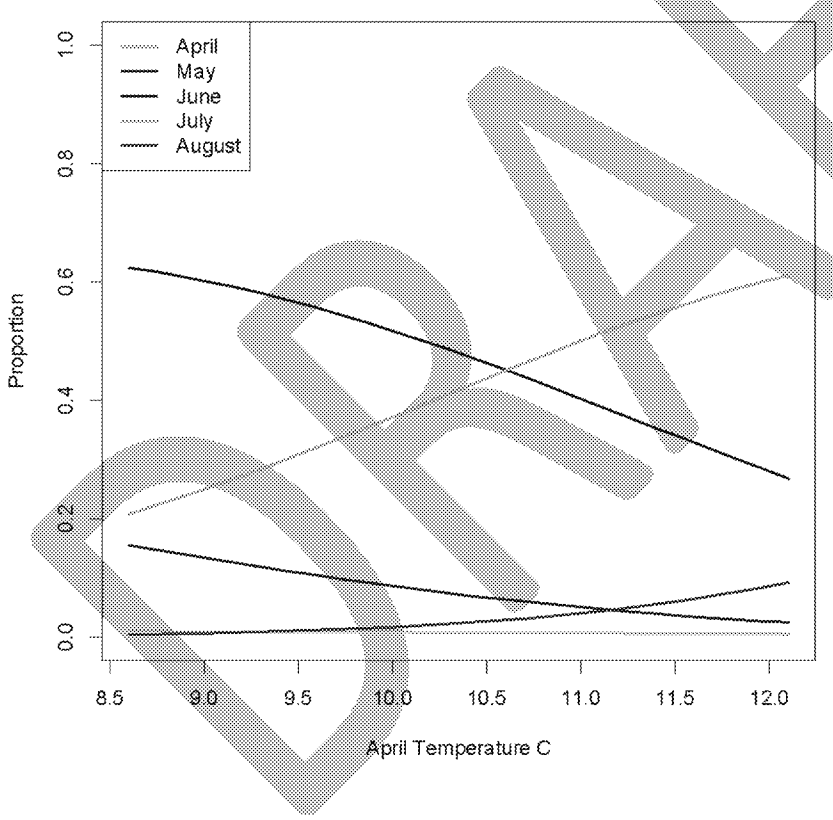

Figure A2. Predictions of the proportion of winter-run Chinook spawning from the multinomial regression model using April temperatures at Keswick Dam as a predictor variable.

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Appendix B. Table of parameter values for WRLCM

Table B1. Parameter values, standard deviation (SD), transformed values, transition numbers in which parameters are found and brief description of parameters.

Name	Value	SD*	Transformed Value	Transition	Description
t.crit	12.0	0	12.0	1	Critical temperature (C) at which egg to fry survival is reduced
BO_1	0.95	0.096	0.72	1	Survival below critical temperature value (logit space)
$B1_1$	-1.11	0.144	NA	1	Rate of reduction in egg to fry survival (logit space)
$P_{TF,m}$	-3	0	0.047	2	Proportion tidal fry
$S_{TF,FP}$	1	0	0.731	3	Survival tidal fry in floodplain
min.p	0.05	0	0.05	3	Minimum proportion entering Yolo bypass under flow < 100 cfs under modified design
p.rate	1.1	0	NA	3	Rate of increase in proportion entering Yolo bypass for flows > 6000 cfs under modified design
BO_4	0	0	0.5	4	Average survival tidal fry to delta intercept
$B1_4$	-1	0	NA	4	Effect of DCC gate (value is in logit space)*
BO_5	0	0	0.5	5	Average proportion of tidal fry to bay intercept
$B1_5$	2	0	NA	5	Proportion tidal fry to bay - flow at Rio Vista effect
$S_{TF,DE-BA}$	-1	0	0.269	5	Survival of tidal fry from delta to bay
S_{FRY}	0.872	0.062	0.705	Rearing	Winter run fry survival
$mig_{UR,m}$	0.128	0.012	0.128	Rearing	Proportion of fry in upper river migrating from upper river to lower river per month
BO_M	-6.0	0	0.002	Rearing	Wilkins slough movement without trigger (value is in logit space)

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Name	Value	SD*	Transformed Value	Transition	Description
$B1_M$	5.5	0	0.377	Rearing	Wilkins slough movement with flow trigger (value is in logit space), movement rate under flow trigger is 0.377
mig_m	0.224	0.126	0.224	Rearing	Probability of migration from habitats
$S_{FRY,BA}$	-7	0	0.001	Rearing	Survival of bay rearing fry pushed to gulf
Z_1	-1	0	0.269	11 to 15	January smolt probability
Z_2	0	0	0.5	11 to 15	February smolt probability
Z_3	3	0	0.953	11 to 15	March smolt probability
Z_4	8	0	1	11 to 15	April smolt probability
Z_5	10	0	1	11 to 15	May smolt probability
Z_6	10	0	1	11 to 15	June smolt probability
Z_7	10	0	1	11 to 15	July smolt probability
$BO_{11,LR}$	1.39	0	0.801	12	Smolt survival lower river to delta
$BO_{10,UR}$	-0.4	0	0.401	11	Survival of upper river fish to lower river
$B1_{10}$	0.3	0.053	NA	11,12	River smolt survival from flow effect
$C_{S_{11}}$	12	0	0.999	11 to 14	Survival smolt chipps to ocean – survival captured in gulf survival
$A_{S_{13,FP,m}}$	12	0	0.999	13	survival from Yolo until Delta, assume 0.999 since Yolo nodes being captured in ePTMv2
$S_{15,BA}$	0	0	0.5	15	Survival of smolts bay to ocean

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Name	Value	SD*	Transformed Value	Transition	Description
S_{G0}	-2.0	0	0.12	16	Average survival of smolts entering the gulf
S_{G1}	-0.338	0.233	0.157	11, 12, 13	Gulf entry covariate effect (PCUI) for all rearing areas in logit space
σ_{ε}	1.6	0	1	16	Standard deviation of annual random effects in process noise
S_{17}	1.35	0	0.794	17, 18	Probability of survival age 1 to age 2 over 4 months
M_2	-2.2	0	0.1	17,18	Probability of maturation age 2
S_{sp2}	2.2	0	0.9	18	Survival ocean exit to spawning ground age 2
S_{19}	1.4	0	0.802	19	Probability of survival age 2 to age 3
M_3	2.2	0	0.9	19, 20	Conditional probability of maturation at age 3
S_{sp3}	2.2	0	0.9	20	Survival ocean exit to spawning ground age 3
S_{21}	1.4	0	0.802	21	Survival age 3 to age 4
S_{sp4}	2.2	0	0.9	21	Survival ocean exit to spawning ground age 4
$V_{eggs,2}$	3000	0	3000	22	Eggs per spawner age 2
$V_{eggs,3}$	5000	0	5000	22	Eggs per spawner age 3
$V_{eggs,4}$	5000	0	5000	22	Eggs per spawner age 4
$B0_{Apr}$	-4.145	0.060	NA	22	Intercept for proportion of spawners in April
$B1_{Apr}$	0.0538	0.062	NA	22	Effect of temperature on proportion of spawners in April
$B0_{May}$	-1.796	0.020	NA	22	Intercept for proportion of spawners in May

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Name	Value	SD*	Transformed Value	Transition	Description
$B1_{May}$	-0.2031	0.020	NA	22	Effect of temperature on proportion of spawners in May
$B0_{Jul}$	-0.332	0.012	NA	22	Intercept for proportion of spawners in July
$B1_{Jul}$	0.3852	0.012	NA	22	Effect of temperature on proportion of spawners in July
$B0_{Aug}$	-3.443	0.044	NA	22	Intercept for proportion of spawners in August
$B1_{Aug}$	0.7921	0.045	NA	22	Effect of temperature on proportion of spawners in August
Fem_{Age2}	0.01	0	0.01	18	Proportion of age 2 spawners that are female
Fem_{Age3}	0.5	0	0.5	20	Proportion of age 3 and 4 that are female
$K_{Sp,m}$	9000	0	9000	22	Capacity of female age -3 spawners in the spawning reaches by month

*Estimated parameter values have associated standard deviations (SD)

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From: Katherine Li [katherine_li@berkeley.edu]
Sent: 11/7/2022 10:45:18 AM
To: Sites Project [info@sitesproject.org]
CC: Hanisha Harjani [hharjani@berkeley.edu]
Subject: Press Document Request

Flag: Flag for follow up

Dear Sites Authority Team,

Hello, my name is Katherine Li, and I'm a journalism graduate student at UC Berkeley. We are currently working on a research project regarding water sustainability and droughts in Northern California.

We are aware that the Sites Reservoir has been on the drawing board for decades, and that multiple state and federal agencies, especially the USEPA, CDFW, and CWC, are responsible for making comments and recommendations on your most recent 2020 draft and 2021 revised draft environmental impact report (EIS/EIR). We would like to ask if there is one place where we could view these recommendation documents, or if you know where to find them. Some of the recommendation and comment documents we have located are regarding the original EIR from back in 2018, but plenty has changed regarding the size and design of your project since then. It would be great if you could show us these new documents so we could have the most accurate and updated information. Thank you so much!

Regards,
Katherine Li

Katherine Li (she/her)
UC Berkeley Graduate School of Journalism
(510) 363 6496
https://twitter.com/Katherineli_

From: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Sent: 11/7/2022 11:03:50 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: RE: Sites Project - Review of DCP EIR
Attachments: DCP Draft EIR Review

Sure, I can expand on my initial review. I sent an earlier email regarding my preliminary review (attached). My comments at the time were:

I did a search of the document and key appendices and came up with limited specific references to Sites. Most were in the scoping comment letters which I included in the attached table for informational purposes. Otherwise, the project is addressed in the context of the cumulative analysis. Of interest is that they still reference the project as NODOS and in the Groundwater chapter they also include DWR as the lead agency and cite the 2017 Draft EIR/EIS and not the most recent RDEIR/SDEIS.

I'll put this on my list of tasks this month.

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Monday, November 7, 2022 9:20 AM
To: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: Sites Project - Review of DCP EIR

Hi Laurie – I wanted to close the loop on this. Can you review the document from the Sites perspective and let me know what you think? I think they address us in cumulative. So its reviewing that but also looking at how they addressed key things and what precedent, etc that might set for us.

I don't see us making public comments on the document, so I don't see a huge rush on this. Maybe try to get back to me by early December.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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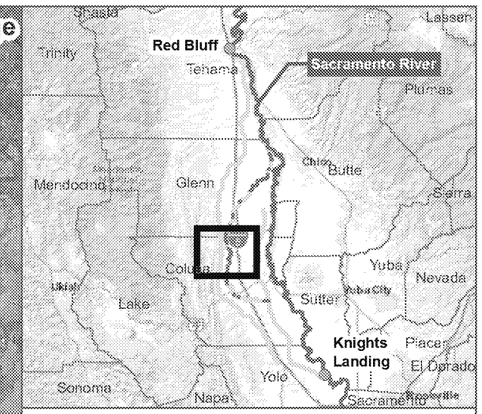
Preliminary Draft - Subject To Change



LEGEND

- Project Area
- Rice Growing Land
- Monitoring Sites

DATA SOURCES: HDR (2022), Sacramento Valley Water Quality Coalition (2018).

DISCLAIMER: This exhibit is preliminary and is subject to change.

MAP DATE: 10/24/2022

RICE LANDS

N

0 5 10

MILES

Sites

PATH: G:\PROJECTS\SITES_RESERVOIR\PROGRAMMANAGEMENT\7.2_WORKING\MAP_DOCS\WATER_QUALITY\ATTACHMENT_RICE_LANDS.MXD - USER: SETHOMAS - DATE: 10/24/2022

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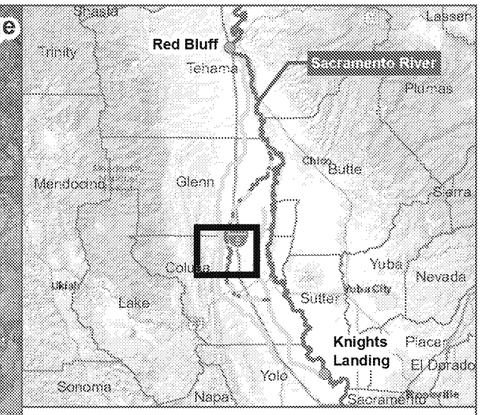
Preliminary Draft - Subject To Change



LEGEND

Project Area

SVWQC

Monitoring Sites

Drainage Areas

* Entire area within map view is within the SVWQC watershed boundary.

DATA SOURCES: HDR (2022), Sacramento Valley Water Quality Coalition (2018).

DISCLAIMER: This exhibit is preliminary and is subject to change.

MAP DATE: 10/24/2022

SACRAMENTO VALLEY WATER QUALITY COALITION - MONITORING

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MILES

Sites

PATH: G:\PROJECTS\SITES_RESERVOIR\PROGRAMMANAGEMENT\7.2_WORKING\MAP_DOCS\WATER_QUALITY\ATTACHMENT_SVWQC_MONITORING.MXD - USER: SETHOMAS - DATE: 10/24/2022

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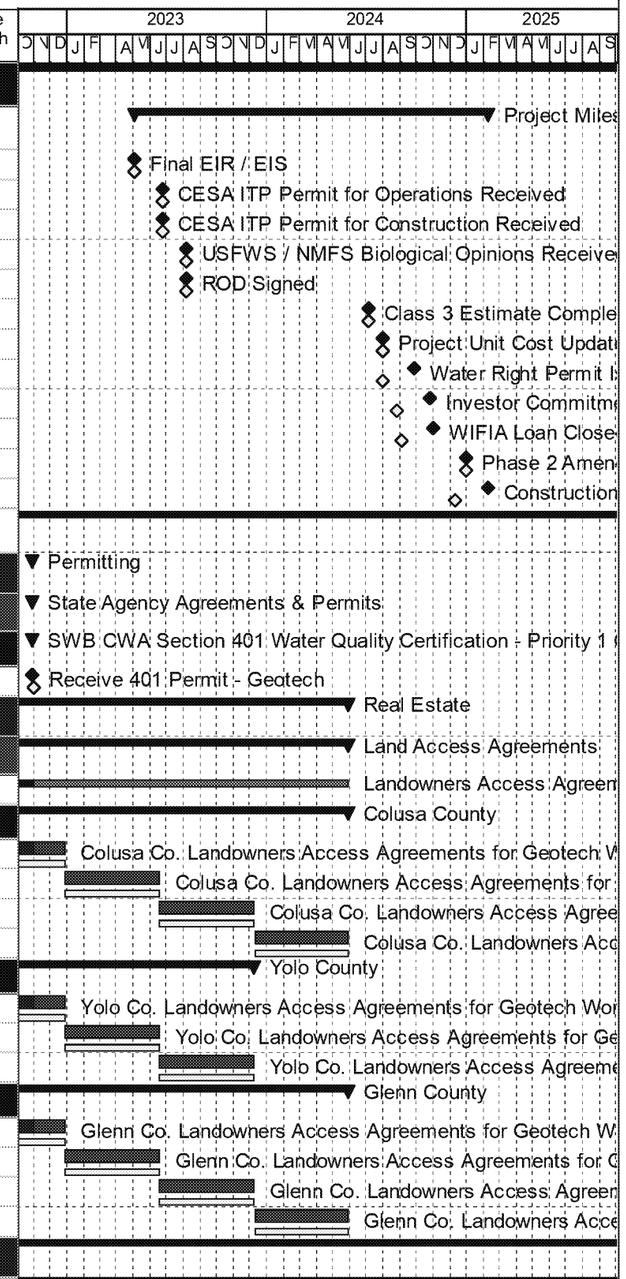
Sites Reservoir Project

Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
1	**Sites Reservoir Project DD: 01-Nov-2022**		01-Sep-20 A	17-Apr-36	3487	01-Sep-20	26-Mar-36	-16
2	**Project Milestones**		05-May-23	10-Feb-25	442	05-May-23	31-Dec-24	-29
3	MS-1200	Final EIR / EIS		05-May-23	0		05-May-23	0
4	MS-1320	CESA ITP Permit for Operations Received		26-Jun-23	0		26-Jun-23	0
5	MS-1340	CESA ITP Permit for Construction Received		26-Jun-23	0		26-Jun-23	0
6	MS-1150	USFWS / NMFS Biological Opinions Received		07-Aug-23	0		07-Aug-23	0
7	MS-1300	ROD Signed		07-Aug-23	0		07-Aug-23	0
8	MS-1700	Class 3 Estimate Complete		05-Jul-24	0		05-Jul-24	0
9	MS-1450	Project Unit Cost Update Complete		30-Jul-24	0		30-Jul-24	0
10	MS-1400	Water Right Permit Issued		26-Sep-24	0		30-Jul-24	-41
11	MS-1500	Investor Commitment		24-Oct-24*	0		27-Aug-24	-41
12	MS-1600	WIFIA Loan Closed		31-Oct-24	0		04-Sep-24	-41
13	MS-5000	Phase 2 Amendment 3 Complete		31-Dec-24*	0		31-Dec-24	0
14	MS-3000	Construction Groundbreaking	10-Feb-25		0	11-Dec-24		-41
15	**Geotech Program**		22-Mar-22 A	30-Sep-26	997	22-Mar-22	04-Aug-26	-41
16	**Permitting**		31-Oct-22 A	31-Oct-22 A	0	31-Oct-22	31-Oct-22	1
17	**State Agency Agreements & Permits**		31-Oct-22 A	31-Oct-22 A	0	31-Oct-22	31-Oct-22	1
18	**SWB CWA Section 401 Water Quality Certification - Priority 1 Geotech**		31-Oct-22 A	31-Oct-22 A	0	31-Oct-22	31-Oct-22	1
19	401-120	Receive 401 Permit - Geotech		31-Oct-22 A	0		31-Oct-22	1
20	**Real Estate**		22-Mar-22 A	30-May-24	394	22-Mar-22	30-May-24	0
21	**Land Access Agreements**		22-Mar-22 A	30-May-24	394	22-Mar-22	30-May-24	0
22	A1250	Landowners Access Agreements for Geotech	22-Mar-22 A	30-May-24	394	22-Mar-22	30-May-24	0
23	**Colusa County**		22-Mar-22 A	30-May-24	399	22-Mar-22	30-May-24	0
24	LAAC-1200	Colusa Co. Landowners Access Agreements for Geotech Work Pkg #2	22-Mar-22 A	29-Dec-22	39	22-Mar-22	29-Dec-22	0
25	LAAC-1300	Colusa Co. Landowners Access Agreements for Geotech Work Pkg #3	30-Dec-22	19-Jun-23	120	30-Dec-22	19-Jun-23	0
26	LAAC-1400	Colusa Co. Landowners Access Agreements for Geotech Work Pkg #4	20-Jun-23	08-Dec-23	120	20-Jun-23	08-Dec-23	0
27	LAAC-1500	Colusa Co. Landowners Access Agreements for Geotech Work Pkg #5	11-Dec-23	30-May-24	120	11-Dec-23	30-May-24	0
28	**Yolo County**		22-Mar-22 A	08-Dec-23	279	22-Mar-22	08-Dec-23	0
29	LAAY-1200	Yolo Co. Landowners Access Agreements for Geotech Work Pkg #2	22-Mar-22 A	29-Dec-22	39	22-Mar-22	29-Dec-22	0
30	LAAY-1300	Yolo Co. Landowners Access Agreements for Geotech Work Pkg #3	30-Dec-22	19-Jun-23	120	30-Dec-22	19-Jun-23	0
31	LAAY-1400	Yolo Co. Landowners Access Agreements for Geotech Work Pkg #4	20-Jun-23	08-Dec-23	120	20-Jun-23	08-Dec-23	0
32	**Glenn County**		22-Mar-22 A	30-May-24	399	22-Mar-22	30-May-24	0
33	LAAG-1200	Glenn Co. Landowners Access Agreements for Geotech Work Pkg #2	22-Mar-22 A	29-Dec-22	39	22-Mar-22	29-Dec-22	0
34	LAAG-1300	Glenn Co. Landowners Access Agreements for Geotech Work Pkg #3	30-Dec-22	19-Jun-23	120	30-Dec-22	19-Jun-23	0
35	LAAG-1400	Glenn Co. Landowners Access Agreements for Geotech Work Pkg #4	20-Jun-23	08-Dec-23	120	20-Jun-23	08-Dec-23	0
36	LAAG-1500	Glenn Co. Landowners Access Agreements for Geotech Work Pkg #5	11-Dec-23	30-May-24	120	11-Dec-23	30-May-24	0
37	**Geotechnical Engineering**		06-Sep-22 A	30-Sep-26	997	06-Sep-22	04-Aug-26	-41



Remaining Level of Effort
Actual Level of Effort
Primary Baseline
Actual Work
Remaining Work
Critical Remaining Work
Baseline Milestone
Milestone
Summary

Project ID: Sites November 2022 / Project Name: Sites Reservoir Project DD: 01-Nov-2022
Layout Name: Sites Comp vs Prior Month / TASK filter: Less than 100%.
Data Date: 01-Nov-22 / Print Date: 03-Nov-22

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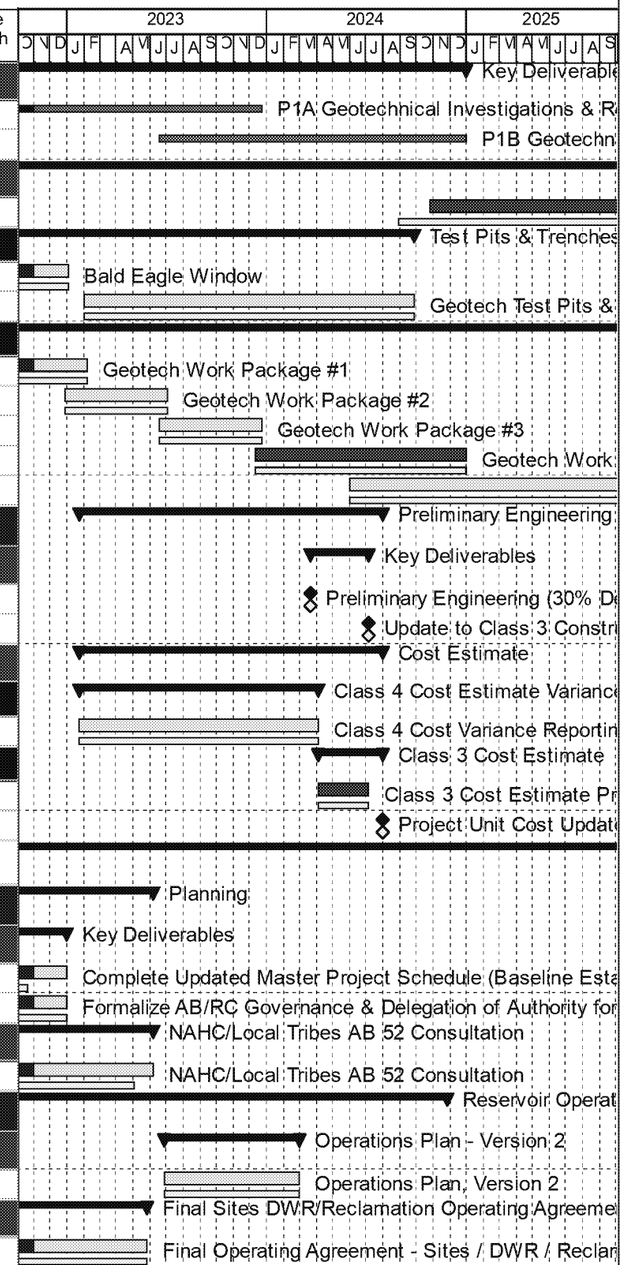
Sites Reservoir Project

Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
38	**Key Deliverables**		06-Sep-22 A	31-Dec-24	546	06-Sep-22	31-Dec-24	0
39	KD-2015	P1A Geotechnical Investigations & Reports	06-Sep-22 A	22-Dec-23	289	06-Sep-22	22-Dec-23	0
40	KD-2025	P1B Geotechnical Investigations & Reports	20-Jun-23	31-Dec-24	387	20-Jun-23	31-Dec-24	0
41	**Geotechnical Investigations**		06-Sep-22 A	30-Sep-26	997	06-Sep-22	04-Aug-26	-41
42	A1560	P2 Geotech for Final Design	25-Oct-24	30-Sep-26	500	28-Aug-24	04-Aug-26	-41
43	**Test Pits & Trenches**		06-Sep-22 A	26-Sep-24	482	06-Sep-22	26-Sep-24	0
44	TPT-1100	Bald Eagle Window	06-Sep-22 A	03-Jan-23	41	06-Sep-22	03-Jan-23	0
45	TPT-1200	Geotech Test Pits & Trenches - Short Term Pemit Window	02-Feb-23	26-Sep-24	420	02-Feb-23	26-Sep-24	0
46	**Work Packages**		06-Sep-22 A	31-Dec-25	799	06-Sep-22	31-Dec-25	0
47	GWP-1100	Geotech Work Package #1	06-Sep-22 A	06-Feb-23	65	06-Sep-22	06-Feb-23	0
48	GWP-1200	Geotech Work Package #2	30-Dec-22	03-Jul-23	130	30-Dec-22	03-Jul-23	0
49	GWP-1300	Geotech Work Package #3	20-Jun-23	22-Dec-23	130	20-Jun-23	22-Dec-23	0
50	GWP-1400	Geotech Work Package #4	11-Dec-23	31-Dec-24	267	11-Dec-23	31-Dec-24	0
51	GWP-1500	Geotech Work Package #5 (need for Sites Lodoga Rd. Realignment Cost Certainty)	31-May-24	31-Dec-25	400	31-May-24	31-Dec-25	0
52	**Preliminary Engineering**		24-Jan-23	30-Jul-24	386	24-Jan-23	30-Jul-24	0
53	**Key Deliverables**		20-Mar-24	05-Jul-24	75	20-Mar-24	05-Jul-24	0
54	KD-1180	Preliminary Engineering (30% Design Level)		20-Mar-24	0		20-Mar-24	0
55	KD-1190	Update to Class 3 Construction Cost Estimate		05-Jul-24	0		05-Jul-24	0
56	**Cost Estimate**		24-Jan-23	30-Jul-24	386	24-Jan-23	30-Jul-24	0
57	**Class 4 Cost Estimate Variance Reporting**		24-Jan-23	03-Apr-24	304	24-Jan-23	03-Apr-24	0
58	C4E-1000	Class 4 Cost Variance Reporting (rolling Class 4)	24-Jan-23	03-Apr-24	304	24-Jan-23	03-Apr-24	0
59	**Class 3 Cost Estimate**		04-Apr-24	30-Jul-24	82	04-Apr-24	30-Jul-24	0
60	C3E-1000	Class 3 Cost Estimate Preparation (Capital Cost)	04-Apr-24	05-Jul-24	65	04-Apr-24	05-Jul-24	0
61	CU-1000	Project Unit Cost Update		30-Jul-24	0		30-Jul-24	0
62	**Project Development**		01-Sep-20 A	27-Apr-29	1669	01-Sep-20	27-Apr-29	0
63	**Planning**		01-Sep-20 A	06-Jun-23	150	01-Sep-20	05-May-23	-21
64	**Key Deliverables**		24-Jan-22 A	30-Dec-22	40	24-Jan-22	30-Dec-22	0
65	KD-1130	Complete Updated Master Project Schedule (Baseline Established)	24-Jan-22 A	30-Dec-22	40	24-Jan-22	21-Oct-22	-46
66	KD-1290	Formalize AB/RC Governance & Delegation of Authority for Phase 3 (JBrown)	06-Sep-22 A	30-Dec-22	40	06-Sep-22	30-Dec-22	0
67	**NAHC/Local Tribes AB 52 Consultation**		01-Sep-20 A	06-Jun-23	150	01-Sep-20	05-May-23	-21
68	STA-120	NAHC/Local Tribes AB 52 Consultation	01-Sep-20 A	06-Jun-23	150	01-Sep-20	05-May-23	-21
69	**Reservoir Operations & Modeling**		03-Jan-22 A	25-Nov-24	524	03-Jan-22	25-Oct-24	-21
70	**Operations Plan - Version 2**		27-Jun-23	01-Mar-24	172	27-Jun-23	01-Mar-24	0
71	KD-1510	Operations Plan, Version 2	27-Jun-23	01-Mar-24	172	27-Jun-23	01-Mar-24	0
72	**Final Sites DWR/Reclamation Operating Agreement**		19-Apr-22 A	26-May-23	144	19-Apr-22	26-May-23	0
73	OP-1005	Final Operating Agreement - Sites / DWR / Reclamation	19-Apr-22 A	26-May-23	144	19-Apr-22	26-May-23	0



Remaining Level of Effort
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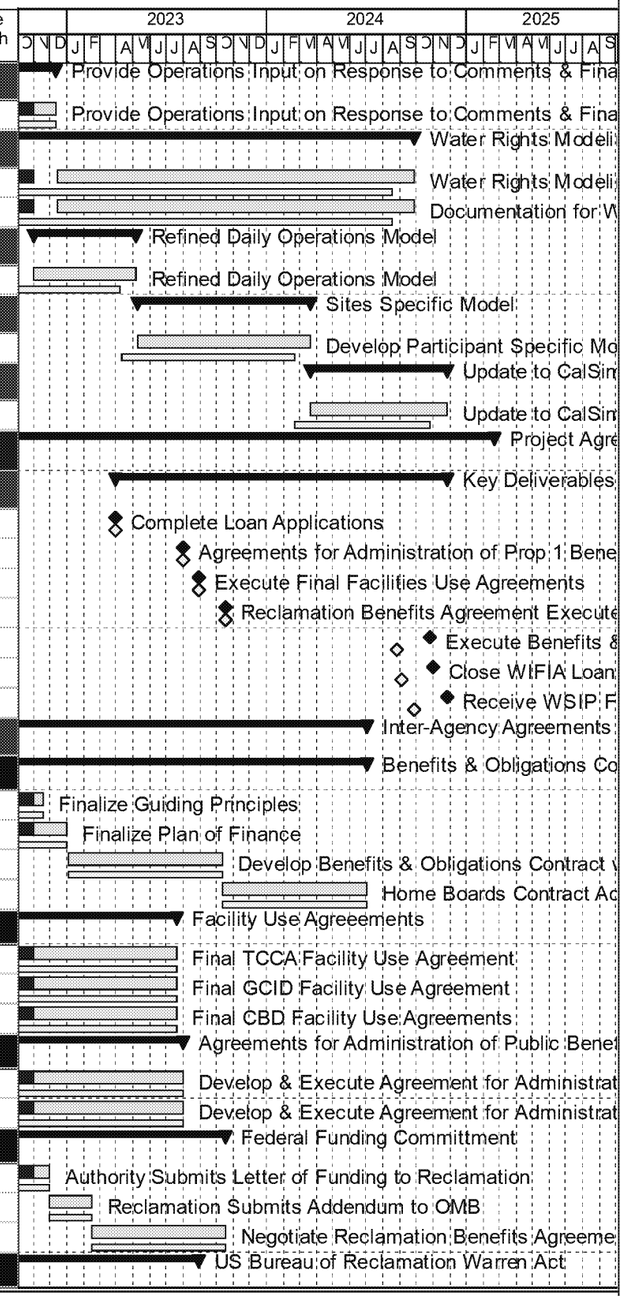
Sites Reservoir Project

Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
74	**Provide Operations Input on Response to Comments & Final EIR/EIS**		24-May-22 A	12-Dec-22	28	24-May-22	12-Dec-22	0
75	FO-1080	Provide Operations Input on Response to Comments & Final EIR/EIS	24-May-22 A	12-Dec-22	28	24-May-22	12-Dec-22	0
76	**Water Rights Modeling**		03-Jan-22 A	26-Sep-24	454	03-Jan-22	16-Aug-24	-28
77	A1200	Water Rights Modeling Support	03-Jan-22 A	26-Sep-24	454	03-Jan-22	16-Aug-24	-28
78	A1210	Documentation for Water Rights	03-Jan-22 A	26-Sep-24	454	03-Jan-22	16-Aug-24	-28
79	**Refined Daily Operations Model**		01-Nov-22	08-May-23	130	03-Oct-22	07-Apr-23	-21
80	A1220	Refined Daily Operations Model	01-Nov-22	08-May-23	130	03-Oct-22	07-Apr-23	-21
81	**Sites Specific Model**		09-May-23	21-Mar-24	220	10-Apr-23	21-Feb-24	-21
82	OS-1150	Develop Participant Specific Model	09-May-23	21-Mar-24	220	10-Apr-23	21-Feb-24	-21
83	**Update to CalSim 3**		22-Mar-24	25-Nov-24	174	22-Feb-24	25-Oct-24	-21
84	A1230	Update to CalSim 3	22-Mar-24	25-Nov-24	174	22-Feb-24	25-Oct-24	-21
85	**Project Agreements & Funding**		01-Jun-21 A	20-Feb-25	578	01-Jun-21	20-Dec-24	-42
86	**Key Deliverables**		29-Mar-23	25-Nov-24	422	29-Mar-23	27-Sep-24	-41
87	KD-1255	Complete Loan Applications		29-Mar-23	0		29-Mar-23	0
88	KD-1520	Agreements for Administration of Prop 1 Benefits Executed		31-Jul-23	0		31-Jul-23	0
89	KD-1230	Execute Final Facilities Use Agreements		29-Aug-23	0		29-Aug-23	0
90	KD-1260	Reclamation Benefits Agreement Executed		17-Oct-23	0		17-Oct-23	0
91	KD-1300	Execute Benefits & Obligations Contracts with Participants		24-Oct-24	0		27-Aug-24	-41
92	KD-2600	Close WIFIA Loan		31-Oct-24	0		04-Sep-24	-41
93	KD-1310	Receive WSIP Final Award from CWC		25-Nov-24	0		27-Sep-24	-41
94	**Inter-Agency Agreements**		01-Jun-21 A	02-Jul-24	417	01-Jun-21	02-Jul-24	0
95	**Benefits & Obligations Contract with Participants**		01-Mar-22 A	02-Jul-24	417	01-Mar-22	02-Jul-24	0
96	BO-1100	Finalize Guiding Principles	01-Mar-22 A	18-Nov-22	14	01-Mar-22	18-Nov-22	0
97	BO-1200	Finalize Plan of Finance	01-Mar-22 A	30-Dec-22	40	01-Mar-22	30-Dec-22	0
98	BO-1300	Develop Benefits & Obligations Contract with Participants	03-Jan-23	12-Oct-23	200	03-Jan-23	12-Oct-23	0
99	BO-1400	Home Boards Contract Actions	13-Oct-23	02-Jul-24	180	13-Oct-23	02-Jul-24	0
100	**Facility Use Agreeements**		27-Aug-21 A	21-Jul-23	182	27-Aug-21	21-Jul-23	0
101	FO-1020	Final TCCA Facility Use Agreement	27-Aug-21 A	21-Jul-23	182	27-Aug-21	21-Jul-23	0
102	FO-1030	Final GCID Facility Use Agreement	27-Aug-21 A	21-Jul-23	182	27-Aug-21	21-Jul-23	0
103	FO-1040	Final CBD Facility Use Agreements	27-Aug-21 A	21-Jul-23	182	27-Aug-21	21-Jul-23	0
104	**Agreements for Administration of Public Benefits**		31-Mar-22 A	31-Jul-23	188	31-Mar-22	31-Jul-23	0
105	PB-1100	Develop & Execute Agreement for Administration of Public Benefits with DWR (ali/chey)	31-Mar-22 A	31-Jul-23	188	31-Mar-22	31-Jul-23	0
106	PB-1200	Develop & Execute Agreement for Administration of Public Benefits with CDFW (ali/chey)	31-Mar-22 A	31-Jul-23	188	31-Mar-22	31-Jul-23	0
107	**Federal Funding Committment**		19-Sep-22 A	17-Oct-23	243	19-Sep-22	17-Oct-23	0
108	WIIN-1160	Authority Submits Letter of Funding to Reclamation	19-Sep-22 A	30-Nov-22	20	19-Sep-22	30-Nov-22	0
109	WIIN-1180	Reclamation Submits Addendum to OMB	01-Dec-22	16-Feb-23	53	01-Dec-22	16-Feb-23	0
110	WIIN-1170	Negotiate Reclamation Benefits Agreement	17-Feb-23	17-Oct-23	170	17-Feb-23	17-Oct-23	0
111	**US Bureau of Reclamation Warren Act**		01-Jun-21 A	29-Aug-23	209	01-Jun-21	29-Aug-23	0



Remaining Level of Effort · Actual Work · Baseline Milestone
Actual Level of Effort · Remaining Work · Milestone
Primary Baseline · Critical Remaining Work · Summary

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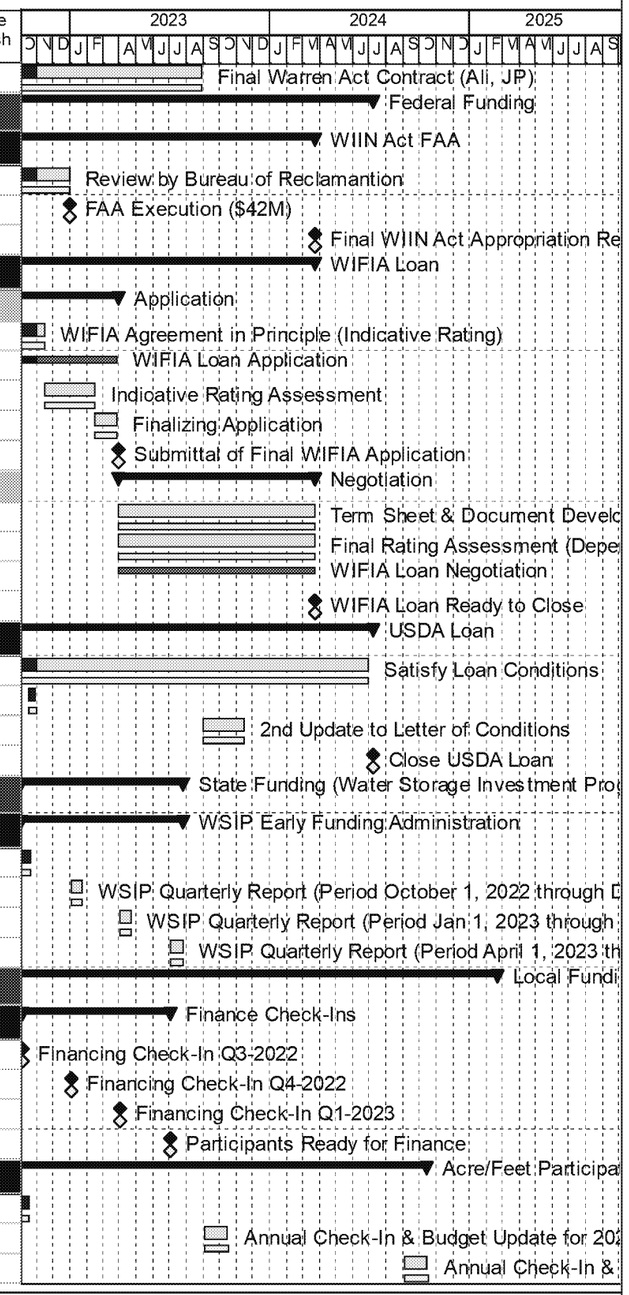
Sites Reservoir Project

Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
112	FED-090	Final Warren Act Contract (Ali, JP)	01-Jun-21 A	29-Aug-23	209	01-Jun-21	29-Aug-23	0
113	**Federal Funding**		10-Jun-22 A	08-Jul-24	420	10-Jun-22	08-Jul-24	0
114	**WIIN Act FAA**		10-Jun-22 A	25-Mar-24	347	10-Jun-22	25-Mar-24	0
115	WIIN-1190	Review by Bureau of Reclamantion	10-Jun-22 A	31-Dec-22	61	10-Jun-22	31-Dec-22	0
116	WIIN-1210	FAA Execution ($42M)		31-Dec-22	0		31-Dec-22	0
117	WIIN-1200	Final WIIN Act Appropriation Received		25-Mar-24	0		25-Mar-24	0
118	**WIFIA Loan**		05-Jul-22 A	25-Mar-24	347	05-Jul-22	25-Mar-24	0
119	**Application**		05-Jul-22 A	29-Mar-23	100	05-Jul-22	29-Mar-23	0
120	WIFIA-110	WIFIA Agreement in Principle (Indicative Rating)	05-Jul-22 A	15-Nov-22	11	05-Jul-22	15-Nov-22	0
121	WIFIA-300	WIFIA Loan Application	05-Jul-22 A	28-Mar-23	99	05-Jul-22	28-Mar-23	0
122	WIFIA-120	Indicative Rating Assessment	16-Nov-22	14-Feb-23	60	16-Nov-22	14-Feb-23	0
123	WIFIA-130	Finalizing Application	15-Feb-23	28-Mar-23	30	15-Feb-23	28-Mar-23	0
124	WIFIA-140	Submittal of Final WIFIA Application		29-Mar-23	0		29-Mar-23	0
125	**Negotiation**		30-Mar-23	25-Mar-24	247	30-Mar-23	25-Mar-24	0
126	WIFIA-210	Term Sheet & Document Development	30-Mar-23	25-Mar-24	250	30-Mar-23	25-Mar-24	0
127	WIFIA-220	Final Rating Assessment (Depends on Final Rebalancing)	30-Mar-23	25-Mar-24	250	30-Mar-23	25-Mar-24	0
128	WIFIA-240	WIFIA Loan Negotiation	30-Mar-23	25-Mar-24	247	30-Mar-23	25-Mar-24	0
129	WIFIA-230	WIFIA Loan Ready to Close		25-Mar-24	0		25-Mar-24	0
130	**USDA Loan**		02-Sep-22 A	08-Jul-24	420	02-Sep-22	08-Jul-24	0
131	USDA-1060	Satisfy Loan Conditions	02-Sep-22 A	28-Jun-24	420	02-Sep-22	28-Jun-24	0
132	USDA-1040	USDA Status Update Report (May 2022 - Oct 2022)	19-Oct-22 A	31-Oct-22 A	0	19-Oct-22	01-Nov-22	2
133	USDA-1080	2nd Update to Letter of Conditions	01-Sep-23	14-Nov-23	50	01-Sep-23	14-Nov-23	0
134	USDA-1070	Close USDA Loan		08-Jul-24	0		08-Jul-24	0
135	**State Funding (Water Storage Investment Program, WSIP)**		03-Oct-22 A	25-Jul-23	144	03-Oct-22	25-Jul-23	0
136	**WSIP Early Funding Administration**		03-Oct-22 A	25-Jul-23	144	03-Oct-22	25-Jul-23	0
137	WSIP-1230	WSIP Quarterly Report (Period July 1, 2022 through September 30, 2022)	03-Oct-22 A	21-Oct-22 A	0	03-Oct-22	21-Oct-22	1
138	WSIP-1240	WSIP Quarterly Report (Period October 1, 2022 through December 31, 2022)	03-Jan-23	23-Jan-23	15	03-Jan-23	23-Jan-23	0
139	WSIP-1250	WSIP Quarterly Report (Period Jan 1, 2023 through March 31, 2023)	03-Apr-23	21-Apr-23	15	03-Apr-23	21-Apr-23	0
140	WSIP-1260	WSIP Quarterly Report (Period April 1, 2023 through June 30, 2023)	05-Jul-23	25-Jul-23	15	05-Jul-23	25-Jul-23	0
141	**Local Funding**		06-Sep-22 A	20-Feb-25	538	06-Sep-22	20-Dec-24	-42
142	**Finance Check-Ins**		07-Oct-22 A	03-Jul-23	126	07-Oct-22	03-Jul-23	0
143	FC-1260	Financing Check-In Q3-2022		07-Oct-22 A	0		07-Oct-22	1
144	FC-1270	Financing Check-In Q4-2022		03-Jan-23	0		03-Jan-23	0
145	FC-1280	Financing Check-In Q1-2023		03-Apr-23	0		03-Apr-23	0
146	FC-1290	Participants Ready for Finance		03-Jul-23	0		03-Jul-23	0
147	**Acre/Feet Participation (Reservoir Committee Cash Calls)**		06-Sep-22 A	15-Oct-24	283	06-Sep-22	16-Oct-24	1
148	AF-1100	Annual Check-In & Budget Update for 2023	06-Sep-22 A	17-Oct-22 A	0	06-Sep-22	17-Oct-22	1
149	AF-1200	Annual Check-In & Budget Update for 2024	05-Sep-23	16-Oct-23	30	06-Sep-23	17-Oct-23	1
150	AF-1300	Annual Check-In & Budget Update for 2025	04-Sep-24	15-Oct-24	30	05-Sep-24	16-Oct-24	1



Remaining Level of Effort · Actual Work · Baseline Milestone
Actual Level of Effort · Remaining Work · Milestone
Primary Baseline · Critical Remaining Work · Summary

Project ID: Sites November 2022 / Project Name: Sites Reservoir Project DD: 01-Nov-2022
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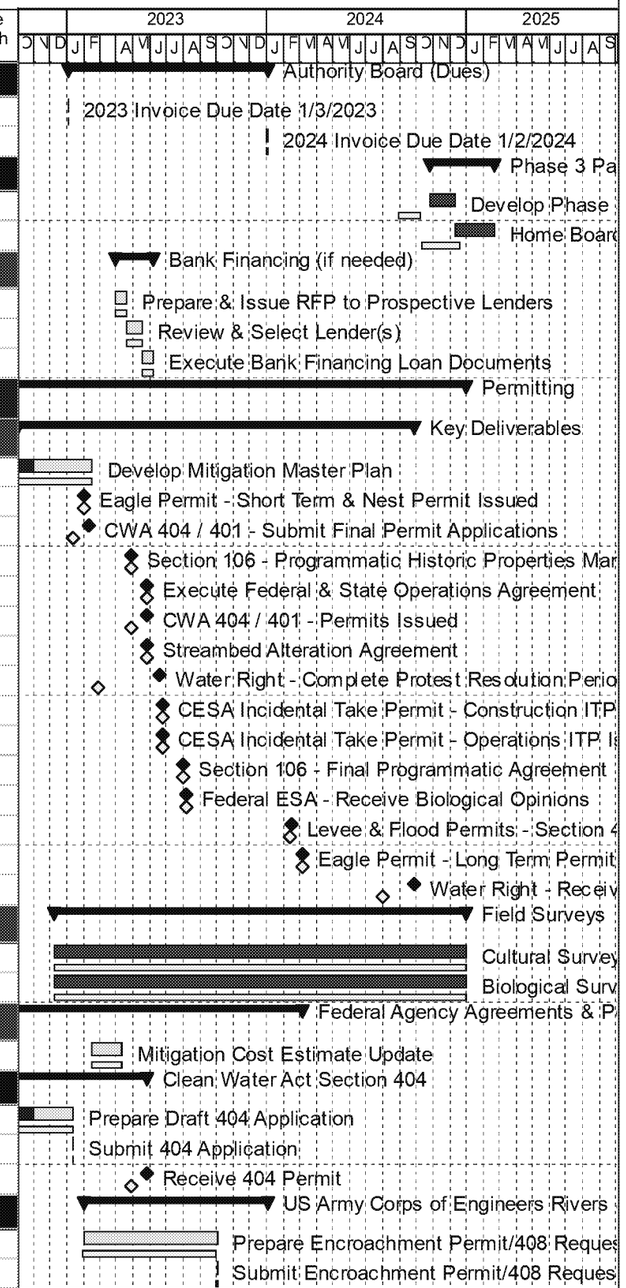
Sites Reservoir Project

Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
151		**Authority Board (Dues)**	03-Jan-23	02-Jan-24	253	03-Jan-23	02-Jan-24	0
152	AB-2200	2023 Invoice Due Date 1/3/2023	03-Jan-23	03-Jan-23*	1	03-Jan-23	03-Jan-23	0
153	AB-2300	2024 Invoice Due Date 1/2/2024	02-Jan-24	02-Jan-24*	1	02-Jan-24	02-Jan-24	0
154		**Phase 3 Participation Agreement (if needed)**	25-Oct-24	20-Feb-25	80	28-Aug-24	20-Dec-24	-41
155	PA-1100	Develop Phase 3 Participation Agreement	25-Oct-24	09-Dec-24	30	28-Aug-24	09-Oct-24	-41
156	PA-1200	Home Board Execution & Final Rebalancing	10-Dec-24	20-Feb-25	50	10-Oct-24	20-Dec-24	-41
157		**Bank Financing (if needed)**	30-Mar-23	08-Jun-23	50	30-Mar-23	08-Jun-23	0
158	BF-1100	Prepare & Issue RFP to Prospective Lenders	30-Mar-23	19-Apr-23	15	30-Mar-23	19-Apr-23	0
159	BF-1200	Review & Select Lender(s)	20-Apr-23	17-May-23	20	20-Apr-23	17-May-23	0
160	BF-1300	Execute Bank Financing Loan Documents	18-May-23	08-Jun-23	15	18-May-23	08-Jun-23	0
161		**Permitting**	04-Jan-21 A	31-Dec-24	541	04-Jan-21	31-Dec-24	0
162		**Key Deliverables**	03-Oct-22 A	26-Sep-24	482	03-Oct-22	30-Jul-24	-41
163	KD-1460	Develop Mitigation Master Plan	03-Oct-22 A	15-Feb-23	72	03-Oct-22	15-Feb-23	0
164	KD-1430	Eagle Permit - Short Term & Nest Permit Issued		01-Feb-23	0		01-Feb-23	0
165	KD-1390	CWA 404 / 401 - Submit Final Permit Applications		10-Feb-23	0		13-Jan-23	-20
166	KD-1360	Section 106 - Programmatic Historic Properties Management Plan Development		28-Apr-23	0		28-Apr-23	0
167	KD-1240	Execute Federal & State Operations Agreement		26-May-23	0		26-May-23	0
168	KD-1400	CWA 404 / 401 - Permits Issued		26-May-23	0		28-Apr-23	-20
169	KD-1420	Streambed Alteration Agreement		26-May-23	0		26-May-23	0
170	KD-1320	Water Right - Complete Protest Resolution Period & Resolve as Many Protests as Possible		20-Jun-23	0		27-Feb-23	-80
171	KD-1370	CESA Incidental Take Permit - Construction ITP Issued		26-Jun-23	0		26-Jun-23	0
172	KD-1380	CESA Incidental Take Permit - Operations ITP Issued		26-Jun-23	0		26-Jun-23	0
173	KD-1350	Section 106 - Final Programmatic Agreement		01-Aug-23	0		01-Aug-23	0
174	KD-1340	Federal ESA - Receive Biological Opinions		07-Aug-23	0		07-Aug-23	0
175	KD-1410	Levee & Flood Permits - Section 408 & CVFPB Encroachment Permits Issued		15-Feb-24	0		13-Feb-24	-2
176	KD-1440	Eagle Permit - Long Term Permit Issued		06-Mar-24	0		06-Mar-24	0
177	KD-1330	Water Right - Receive Water Right Order & Permit		26-Sep-24	0		30-Jul-24	-41
178		**Field Surveys**	09-Dec-22	31-Dec-24	520	09-Dec-22	31-Dec-24	0
179	RE-1030	Cultural Surveys	09-Dec-22	31-Dec-24	520	09-Dec-22	31-Dec-24	0
180	RE-1040	Biological Surveys	09-Dec-22	31-Dec-24	520	09-Dec-22	31-Dec-24	0
181		**Federal Agency Agreements & Permits**	11-Jan-21 A	06-Mar-24	339	11-Jan-21	06-Mar-24	0
182	CE-1570	Mitigation Cost Estimate Update	16-Feb-23	12-Apr-23	40	16-Feb-23	12-Apr-23	0
183		**Clean Water Act Section 404**	04-Feb-21 A	26-May-23	144	04-Feb-21	28-Apr-23	-20
184	404-050	Prepare Draft 404 Application	04-Feb-21 A	12-Jan-23	48	04-Feb-21	12-Jan-23	0
185	404-120	Submit 404 Application	13-Jan-23	13-Jan-23	1	13-Jan-23	13-Jan-23	0
186	404-130	Receive 404 Permit		26-May-23	0		28-Apr-23	-20
187		**US Army Corps of Engineers Rivers & Harbors Act Section 14, Section 408**	31-Jan-23	02-Jan-24	233	30-Jan-23	29-Dec-23	-1
188	408-150	Prepare Encroachment Permit/408 Request	31-Jan-23	02-Oct-23	172	30-Jan-23	29-Sep-23	-1
189	408-160	Submit Encroachment Permit/408 Request	03-Oct-23	03-Oct-23	1	02-Oct-23	02-Oct-23	-1



Remaining Level of Effort
Actual Level of Effort
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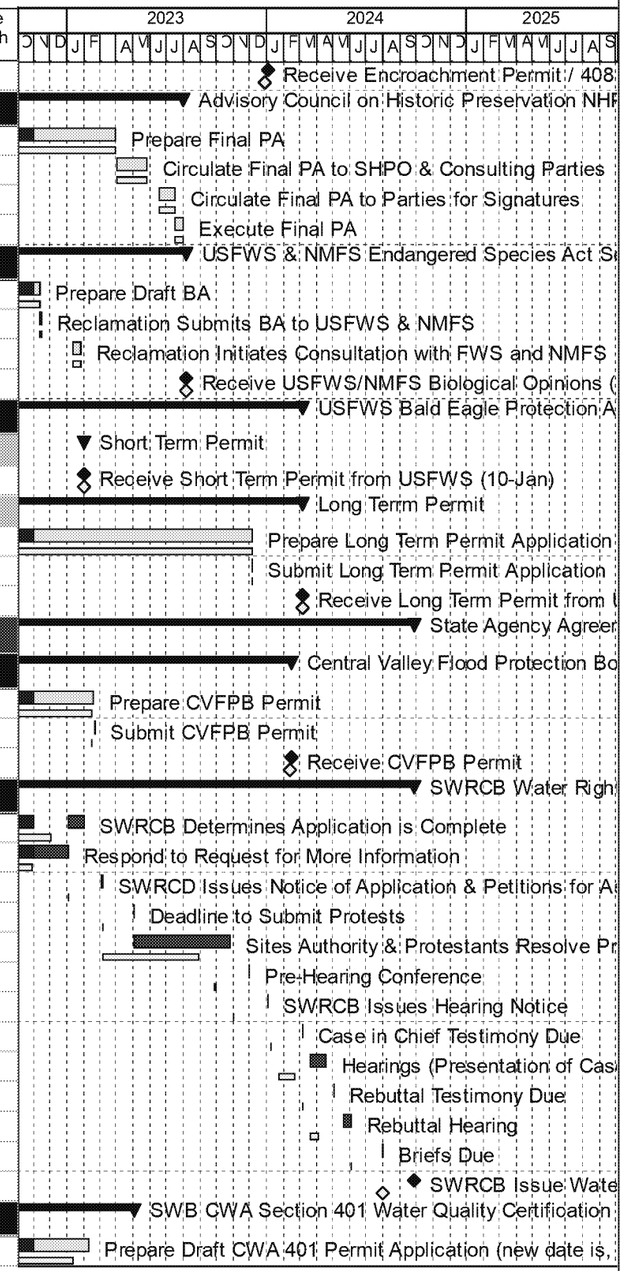
Sites Reservoir Project

Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
190	408-170	Receive Encroachment Permit / 408 Permit		02-Jan-24	0		29-Dec-23	-1
191	**Advisory Council on Historic Preservation NHPA Section 106**		14-Mar-22 A	01-Aug-23	189	14-Mar-22	01-Aug-23	0
192	106-081	Prepare Final PA	14-Mar-22 A	31-Mar-23	104	14-Mar-22	31-Mar-23	0
193	106-092	Circulate Final PA to SHPO & Consulting Parties	03-Apr-23	26-May-23	40	03-Apr-23	26-May-23	0
194	106-096	Circulate Final PA to Parties for Signatures	20-Jun-23	18-Jul-23	20	20-Jun-23	18-Jul-23	0
195	106-102	Execute Final PA	19-Jul-23	01-Aug-23	10	19-Jul-23	01-Aug-23	0
196	**USFWS & NMFS Endangered Species Act Section 7**		11-Jan-21 A	07-Aug-23	193	11-Jan-21	07-Aug-23	0
197	BA-200	Prepare Draft BA	11-Jan-21 A	11-Nov-22	9	11-Jan-21	11-Nov-22	0
198	BA-210	Reclamation Submits BA to USFWS & NMFS	14-Nov-22	14-Nov-22	1	14-Nov-22	14-Nov-22	0
199	BA-215	Reclamation Initiates Consultation with FWS and NMFS	13-Jan-23	26-Jan-23	10	13-Jan-23	26-Jan-23	0
200	BA-220	Receive USFWS/NMFS Biological Opinions (Incidental Take Authorizations)		07-Aug-23	0		07-Aug-23	0
201	**USFWS Bald Eagle Protection Act**		27-Jul-22 A	06-Mar-24	339	27-Jul-22	06-Mar-24	0
202	**Short Term Permit**		01-Feb-23	01-Feb-23	0	01-Feb-23	01-Feb-23	0
203	USFWS-130	Receive Short Term Permit from USFWS (10-Jan)		01-Feb-23	0		01-Feb-23	0
204	**Long Terrm Permit**		27-Jul-22 A	06-Mar-24	339	27-Jul-22	06-Mar-24	0
205	USFWS-140	Prepare Long Term Permit Application	27-Jul-22 A	04-Dec-23	275	27-Jul-22	04-Dec-23	0
206	USFWS-150	Submit Long Term Permit Application	05-Dec-23	05-Dec-23	1	05-Dec-23	05-Dec-23	0
207	USFWS-160	Receive Long Term Permit from USFWS		06-Mar-24	0		06-Mar-24	0
208	**State Agency Agreements & Permits**		04-Jan-21 A	26-Sep-24	477	04-Jan-21	30-Jul-24	-41
209	**Central Valley Flood Protection Board (CVFPB) Levee Encroachment**		13-Dec-21 A	15-Feb-24	325	13-Dec-21	13-Feb-24	-2
210	CVFPB-200	Prepare CVFPB Permit	13-Dec-21 A	17-Feb-23	74	13-Dec-21	15-Feb-23	-2
211	CVFPB-210	Submit CVFPB Permit	20-Feb-23	20-Feb-23	1	16-Feb-23	16-Feb-23	-2
212	CVFPB-220	Receive CVFPB Permit		15-Feb-24	0		13-Feb-24	-2
213	**SWRCB Water Right Permit**		12-May-22 A	26-Sep-24	477	12-May-22	30-Jul-24	-41
214	WRP-115a	SWRCB Determines Application is Complete	12-May-22 A	02-Feb-23	21	12-May-22	02-Dec-22	-41
215	WRP-115ac	Respond to Request for More Information	29-Aug-22 A	03-Jan-23	41	29-Aug-22	28-Oct-22	-42
216	WRP-115b	SWRCD Issues Notice of Application & Petitions for Assignmentt & Releases from Priority	06-Mar-23	06-Mar-23	1	04-Jan-23	04-Jan-23	-41
217	WRP-115c	Deadline to Submit Protests	04-May-23	04-May-23	1	08-Mar-23	08-Mar-23	-41
218	WRP-116	Sites Authority & Protestants Resolve Protests 122	05-May-23	27-Oct-23	122	09-Mar-23	29-Aug-23	-41
219	WRP-117a	Pre-Hearing Conference	01-Dec-23	01-Dec-23	1	29-Sep-23	29-Sep-23	-41
220	WRP-117b	SWRCB Issues Hearing Notice	04-Jan-24	04-Jan-24	1	01-Nov-23	01-Nov-23	-41
221	WRP-117c	Case in Chief Testimony Due	07-Mar-24	07-Mar-24	1	08-Jan-24	08-Jan-24	-41
222	WRP-117d	Hearings (Presentation of Cases-in-Chief)	22-Mar-24	18-Apr-24	20	24-Jan-24	21-Feb-24	-41
223	WRP-117e	Rebuttal Testimony Due	03-May-24	03-May-24	1	07-Mar-24	07-Mar-24	-41
224	WRP-117f	Rebuttal Hearing	20-May-24	03-Jun-24	10	22-Mar-24	04-Apr-24	-41
225	WRP-117g	Briefs Due	31-Jul-24	31-Jul-24	1	03-Jun-24	03-Jun-24	-41
226	WRP-120	SWRCB Issue Water Right Permit (original estimate of 28-Dec-23)		26-Sep-24	0		30-Jul-24	-41
227	**SWB CWA Section 401 Water Quality Certification**		04-Jan-21 A	05-May-23	129	04-Jan-21	07-Apr-23	-20
228	401-200	Prepare Draft CWA 401 Permit Application (new date is, Ali?)	04-Jan-21 A	09-Feb-23	68	04-Jan-21	12-Jan-23	-20



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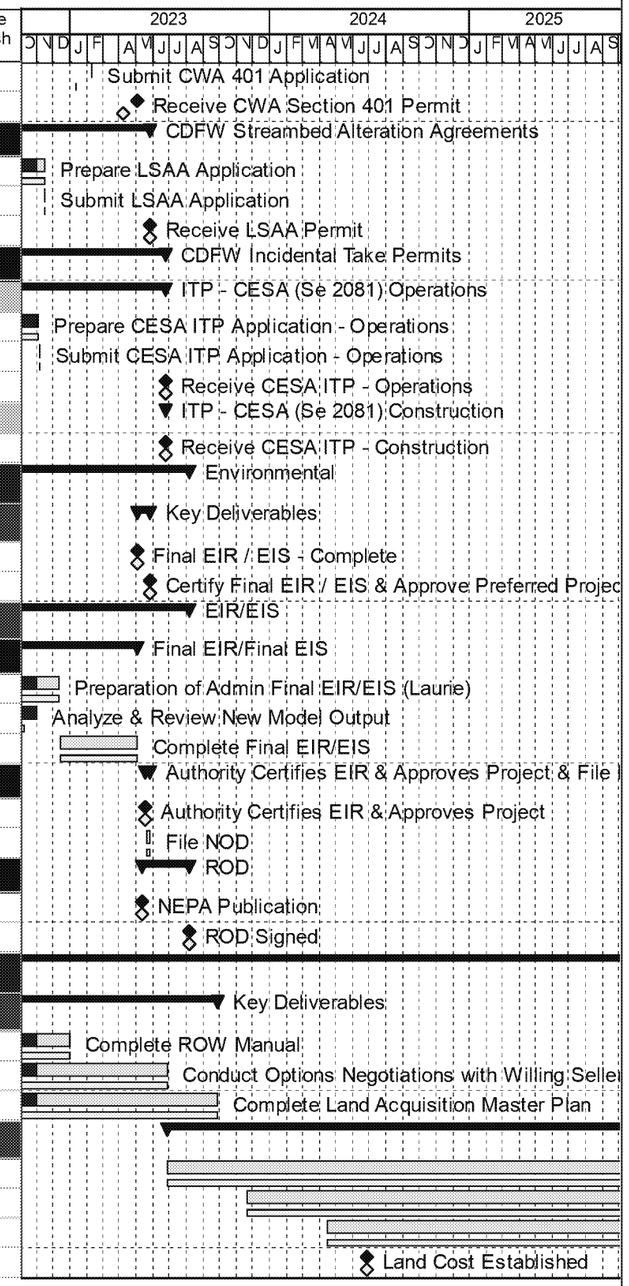
229	401-210	Submit CWA 401 Application	10-Feb-23	10-Feb-23	1	13-Jan-23	13-Jan-23	-20
230	401-220	Receive CWA Section 401 Permit		05-May-23	0		07-Apr-23	-20
231	**CDFW Streambed Alteration Agreements**		10-Jan-22 A	26-May-23	144	10-Jan-22	26-May-23	0
232	1600-200	Prepare LSAA Application	10-Jan-22 A	14-Nov-22	10	10-Jan-22	14-Nov-22	0
233	1600-210	Submit LSAA Application	15-Nov-22	15-Nov-22	1	15-Nov-22	15-Nov-22	0
234	1600-220	Receive LSAA Permit		26-May-23	0		26-May-23	0
235	**CDFW Incidental Take Permits**		11-Jan-21 A	26-Jun-23	164	11-Jan-21	26-Jun-23	0
236	**ITP - CESA (Se 2081) Operations**		11-Jan-21 A	26-Jun-23	164	11-Jan-21	26-Jun-23	0
237	2081-100	Prepare CESA ITP Application - Operations	11-Jan-21 A	04-Nov-22	4	11-Jan-21	04-Nov-22	0
238	2081-110	Submit CESA ITP Application - Operations	07-Nov-22	07-Nov-22	1	07-Nov-22	07-Nov-22	0
239	2081-120	Receive CESA ITP - Operations		26-Jun-23	0		26-Jun-23	0
240	**ITP - CESA (Se 2081) Construction**		26-Jun-23	26-Jun-23	0	26-Jun-23	26-Jun-23	0
241	2081-220	Receive CESA ITP - Construction		26-Jun-23	0		26-Jun-23	0
242	**Environmental**		03-Jan-22 A	07-Aug-23	193	03-Jan-22	07-Aug-23	0
243	**Key Deliverables**		05-May-23	26-May-23	15	05-May-23	26-May-23	0
244	KD-1470	Final EIR / EIS - Complete		05-May-23	0		05-May-23	0
245	KD-1480	Certify Final EIR / EIS & Approve Preferred Project & MMRP		26-May-23	0		26-May-23	0
246	**EIR/EIS**		03-Jan-22 A	07-Aug-23	193	03-Jan-22	07-Aug-23	0
247	**Final EIR/Final EIS**		03-Jan-22 A	05-May-23	129	03-Jan-22	05-May-23	0
248	EIR-210	Preparation of Admin Final EIR/EIS (Laurie)	03-Jan-22 A	12-Dec-22	28	03-Jan-22	12-Dec-22	0
249	EIR-220	Analyze & Review New Model Output	06-Sep-22 A	01-Nov-22	0	06-Sep-22	10-Oct-22	-15
250	EIR-250	Complete Final EIR/EIS	13-Dec-22	05-May-23	101	13-Dec-22	05-May-23	0
251	**Authority Certifies EIR & Approves Project & File NOD**		19-May-23	26-May-23	5	19-May-23	26-May-23	0
252	EIR-370	Authority Certifies EIR & Approves Project		19-May-23	0		19-May-23	0
253	EIR-380	File NOD	22-May-23	26-May-23	5	22-May-23	26-May-23	0
254	**ROD**		12-May-23	07-Aug-23	59	12-May-23	07-Aug-23	0
255	EIR-440	NEPA Publication		12-May-23	0		12-May-23	0
256	EIR-450	ROD Signed		07-Aug-23	0		07-Aug-23	0
257	**Real Estate**		02-Nov-20 A	27-Apr-29	1666	02-Nov-20	27-Apr-29	0
258	**Key Deliverables**		03-Jan-22 A	28-Sep-23	230	03-Jan-22	27-Sep-23	-1
259	KD-1495	Complete ROW Manual	03-Jan-22 A	30-Dec-22	40	03-Jan-22	30-Dec-22	0
260	KD-1500	Conduct Options Negotiations with Willing Seller Properties	01-Jul-22 A	28-Jun-23	166	01-Jul-22	28-Jun-23	0
261	KD-1490	Complete Land Acquisition Master Plan	03-Oct-22 A	28-Sep-23	229	03-Oct-22	27-Sep-23	-1
262	**Land Acquisition**		29-Jun-23	27-Apr-29	1500	29-Jun-23	27-Apr-29	0
263	RE-1060	Construction Package 1 - Land Acquisition	29-Jun-23	27-Apr-29	1500	29-Jun-23	27-Apr-29	0
264	RE-1070	Construction Package 2 - Land Acquisition	20-Nov-23	27-Apr-29	1400	20-Nov-23	27-Apr-29	0
265	RE-1080	Construction Package 3 - Land Acquisition	15-Apr-24	27-Apr-29	1300	15-Apr-24	27-Apr-29	0
266	RE-1050	Land Cost Established		27-Jun-24	0		27-Jun-24	0



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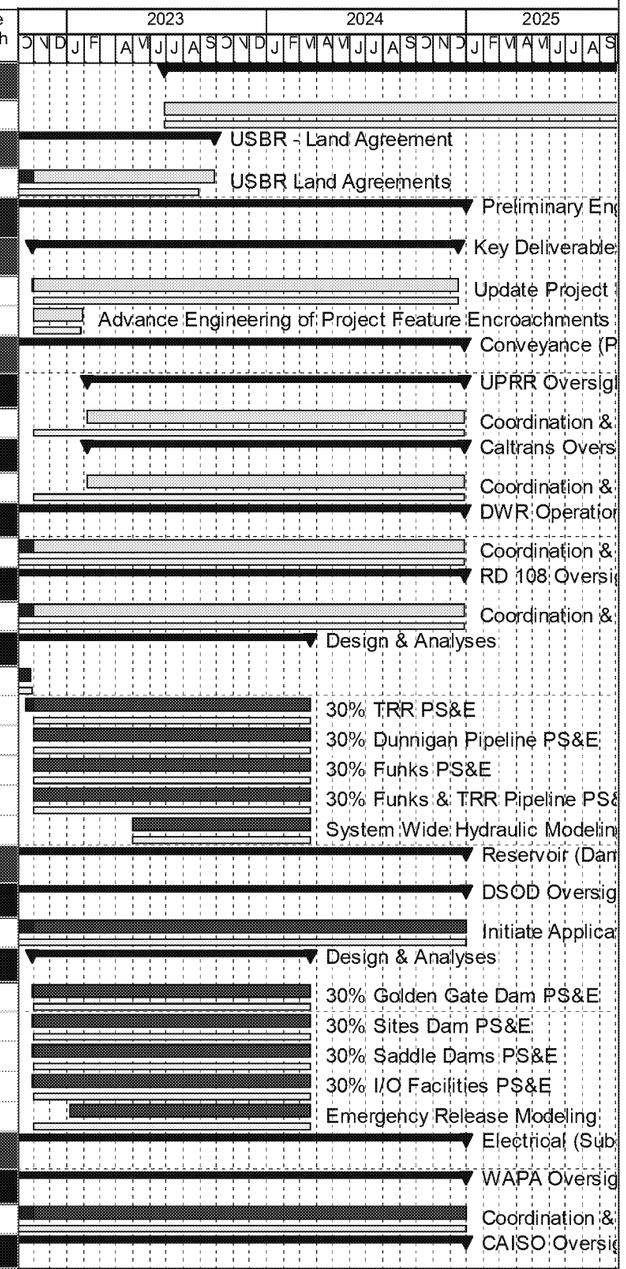
267	**Relocation**		29-Jun-23	27-Apr-29	1500	29-Jun-23	27-Apr-29	0
268	RE-1100	Relocation Assistance, as Needed	29-Jun-23	27-Apr-29	1500	29-Jun-23	27-Apr-29	0
269	**USBR - Land Agreement**		02-Nov-20 A	28-Sep-23	230	02-Nov-20	29-Aug-23	-21
270	FED-100	USBR Land Agreements	02-Nov-20 A	28-Sep-23	230	02-Nov-20	29-Aug-23	-21
271	**Preliminary Engineering**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
272	**Key Deliverables**		31-Oct-22 A	16-Dec-24	537	31-Oct-22	16-Dec-24	0
273	KD-1210	Update Project Risk Assessments (ongoing) (Risk Mgr Bob Beduhn & Henry Luu)	31-Oct-22 A	16-Dec-24	537	31-Oct-22	16-Dec-24	0
274	KD-1110	Advance Engineering of Project Feature Encroachments to 65% Design Level in Support of Per	01-Nov-22	30-Jan-23	60	31-Oct-22	27-Jan-23	-1
275	**Conveyance (Pipelines, Pump Stations, Canals)**		03-Jan-22 A	27-Dec-24	544	03-Jan-22	27-Dec-24	0
276	**UPRR Oversight & Review**		06-Feb-23	27-Dec-24	480	31-Oct-22	27-Dec-24	0
277	A1110	Coordination & Oversight with UPRR	06-Feb-23	27-Dec-24	480	31-Oct-22	27-Dec-24	0
278	**Caltrans Oversight & Review**		06-Feb-23	27-Dec-24	480	31-Oct-22	27-Dec-24	0
279	A1120	Coordination & Oversight with Caltrans	06-Feb-23	27-Dec-24	480	31-Oct-22	27-Dec-24	0
280	**DWR Operations Oversight & Review (KLOG)**		03-Jan-22 A	27-Dec-24	544	03-Jan-22	27-Dec-24	0
281	A1130	Coordination & Oversight with Department of Water Resources	03-Jan-22 A	27-Dec-24	544	03-Jan-22	27-Dec-24	0
282	**RD 108 Oversight & Review**		03-Jan-22 A	27-Dec-24	544	03-Jan-22	27-Dec-24	0
283	A1140	Coordination & Oversight with Reclamation District 108	03-Jan-22 A	27-Dec-24	544	03-Jan-22	27-Dec-24	0
284	**Design & Analyses**		01-Feb-22 A	20-Mar-24	349	01-Feb-22	20-Mar-24	0
285	KD-1140	Create Master Survey & Topo Map	01-Feb-22 A	27-Oct-22 A	0	01-Feb-22	28-Oct-22	2
286	KD-2020	30% TRR PS&E	18-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
287	KD-1630	30% Dunnigan Pipeline PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
288	KD-2010	30% Funks PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
289	KD-2030	30% Funks & TRR Pipeline PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
290	KD-2080	System Wide Hydraulic Modeling	01-May-23	20-Mar-24	225	01-May-23	20-Mar-24	0
291	**Reservoir (Dams, Tunnels)**		01-Feb-22 A	30-Dec-24	545	01-Feb-22	30-Dec-24	0
292	**DSOD Oversight & Review**		01-Feb-22 A	30-Dec-24	545	01-Feb-22	30-Dec-24	0
293	KD-1100	Initiate Application for Permit to Construct from DSOD	01-Feb-22 A	30-Dec-24	545	01-Feb-22	30-Dec-24	0
294	**Design & Analyses**		31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
295	KD-1660	30% Golden Gate Dam PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
296	KD-2040	30% Sites Dam PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
297	KD-2050	30% Saddle Dams PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
298	KD-2060	30% I/O Facilities PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
299	KD-2070	Emergency Release Modeling	05-Jan-23	20-Mar-24	307	31-Oct-22	20-Mar-24	0
300	**Electrical (Substation, Switchyard, Transmission Line)**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
301	**WAPA Oversight & Review**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
302	A1150	Coordination & Oversight with WAPA	03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
303	**CAISO Oversight & Review**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0



Remaining Level of Effort
Actual Level of Effort
Primary Baseline
Actual Work
Remaining Work
Critical Remaining Work
Baseline Milestone
Milestone
Summary

Project ID: Sites November 2022 / Project Name: Sites Reservoir Project DD: 01-Nov-2022
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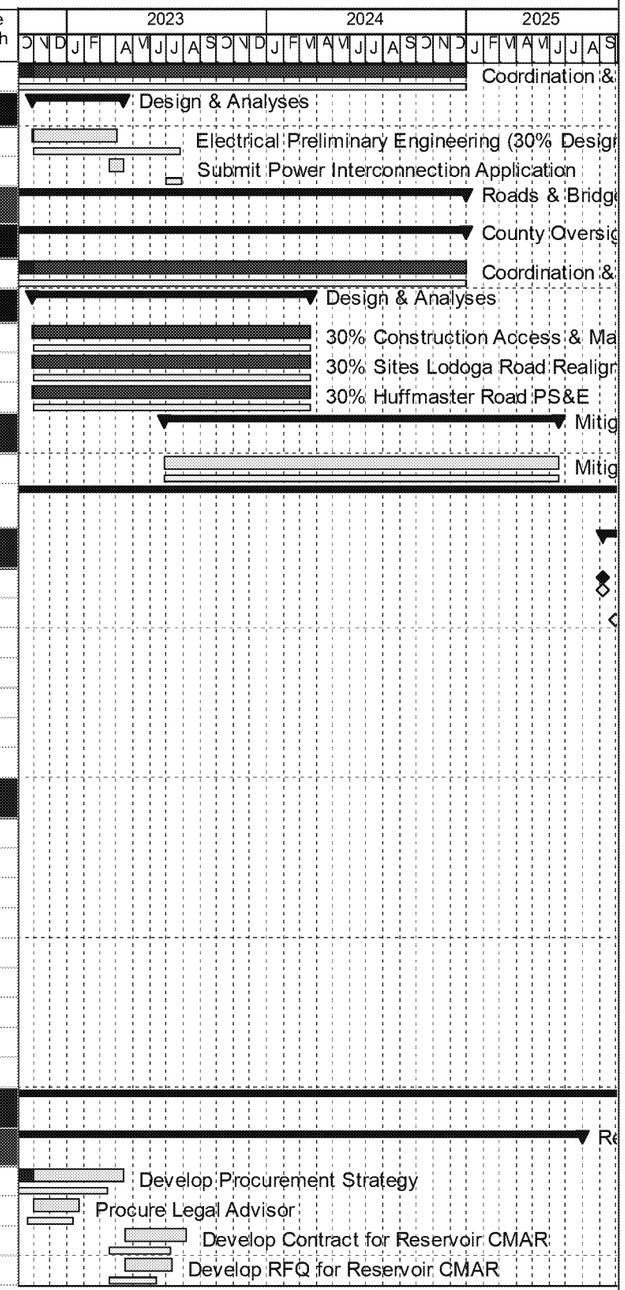
Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
304	A1160	Coordination & Oversight with CAISO	03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
305	**Design & Analyses**		31-Oct-22 A	14-Apr-23	114	31-Oct-22	28-Jul-23	73
306	KD-1640	Electrical Preliminary Engineering (30% Design Level)	31-Oct-22 A	03-Apr-23	105	31-Oct-22	25-Jul-23	79
307	KD-1200	Submit Power Interconnection Application	20-Mar-23	14-Apr-23	20	30-Jun-23	28-Jul-23	73
308	**Roads & Bridges**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
309	**County Oversight & Review**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
310	A1170	Coordination & Oversight with County Authorities	03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
311	**Design & Analyses**		31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
312	KD-1650	30% Construction Access & Maintenance Roads PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
313	KD-2090	30% Sites Lodoga Road Realignment PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
314	KD-2100	30% Huffmaster Road PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
315	**Mitigation Implementation**		29-Jun-23	19-Jun-25	500	29-Jun-23	19-Jun-25	0
316	MI-1100	Mitigation Implementation (more information needed to expand detail)	29-Jun-23	19-Jun-25	500	29-Jun-23	19-Jun-25	0
317	**Project Delivery**		03-Jan-22 A	17-Apr-36	3487	03-Jan-22	26-Mar-36	-16
318	**Design Milestones**		05-Sep-25	23-Jan-30	1143	05-Sep-25	23-Jan-30	0
319	MS-6300	Conveyance Design Complete		05-Sep-25	0		05-Sep-25	0
320	MS-6510	Construction Access Roads Design Complete		21-Oct-25	0		29-Sep-25	-16
321	MS-6400	Reservoir / Dams Design Complete		25-Nov-26	0		29-Sep-26	-41
322	MS-6200	Lodoga Bridge & Road Design Complete		29-Jun-27	0		29-Jun-27	0
323	MS-6500	Maxwell-Sites Pumping & Generating Design Complete		25-Feb-28	0		30-Dec-27	-41
324	MS-6100	Dunnigan Pipeline Upstream Design Complete		23-Jan-30	0		23-Jan-30	0
325	MS-6600	Dunnigan Pipeline Downstream Design Complete		23-Jan-30	0		23-Jan-30	0
326	**Construction Milestones**		28-Jun-28	17-Apr-36	2035	06-Jun-28	26-Mar-36	-16
327	MS-8110	Construction Access Roads Complete		28-Jun-28	0		06-Jun-28	-16
328	MS-8510	Huffmaster Road Construction Complete		24-Aug-28	0		24-Aug-28	0
329	MS-8610	O&M Roads Complete		04-Apr-29	0		13-Mar-29	-16
330	MS-8200	Conveyance Construction Complete		25-Sep-29	0		30-Jul-29	-41
331	MS-8100	Lodoga Bridge & Road Construction Complete		03-Sep-30	0		03-Sep-30	0
332	MS-8500	Dunnigan Pipeline Construction Complete		12-May-32	0		12-May-32	0
333	MS-8300	MSPG Construction Complete		21-Jan-33	0		25-Nov-32	-41
334	MS-8400	Reservoir / Dams Construction Complete		20-Apr-33	0		29-Mar-33	-16
335	MS-8600	Reservoir Filled & Operational		17-Apr-36	0		26-Mar-36	-16
336	**Reservoir Package**		03-Jan-22 A	13-Jul-33	2767	03-Jan-22	21-Jun-33	-16
337	**Reservoir CMAR Procurement**		07-Sep-22 A	30-Jul-25	692	07-Sep-22	03-Jun-25	-41
338	RP-1100	Develop Procurement Strategy	07-Sep-22 A	14-Apr-23	112	07-Sep-22	17-Mar-23	-20
339	RP-1210	Procure Legal Advisor	01-Nov-22	24-Jan-23	55	20-Oct-22	11-Jan-23	-8
340	RP-1200	Develop Contract for Reservoir CMAR	17-Apr-23	07-Aug-23	79	20-Mar-23	10-Jul-23	-20
341	RP-1300	Develop RFQ for Reservoir CMAR	17-Apr-23	11-Jul-23	60	20-Mar-23	12-Jun-23	-20



Remaining Level of Effort | Actual Work | Baseline Milestone
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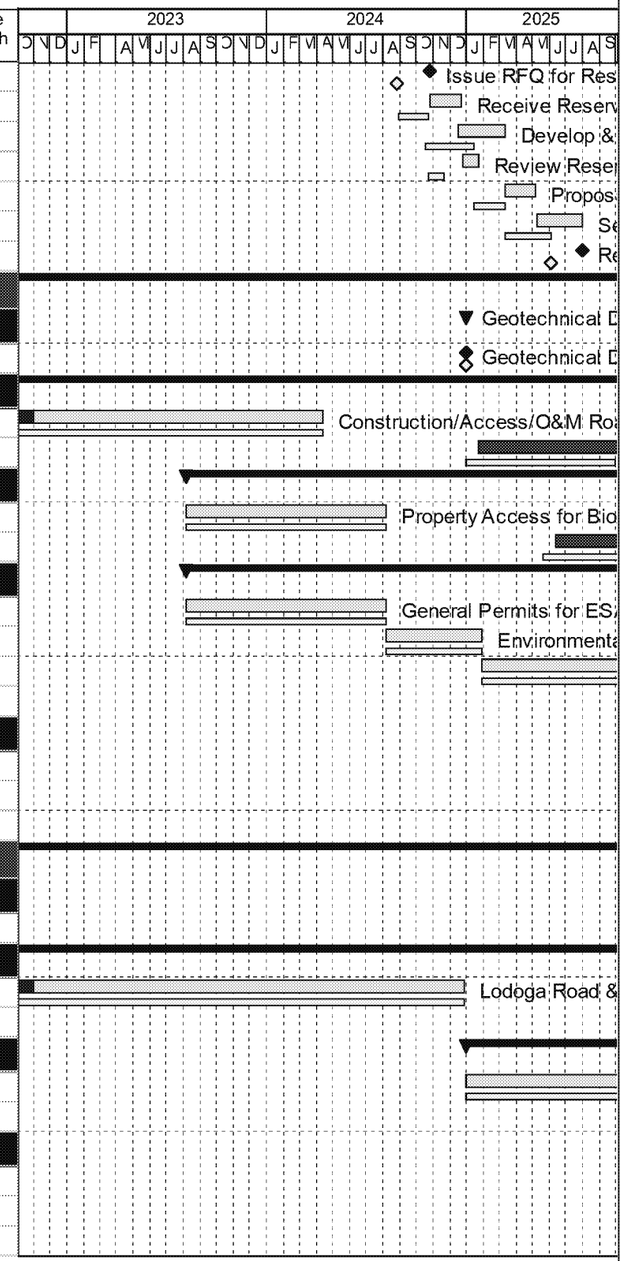
342	RP-1400	Issue RFQ for Reservoir CMAR		24-Oct-24	0		27-Aug-24	-41
343	RP-1500	Receive Reservoir CMAR SOQ's	25-Oct-24	23-Dec-24	40	28-Aug-24	23-Oct-24	-41
344	RP-1700	Develop & Issue RFP to Reservoir CMARs	17-Dec-24	12-Mar-25	60	17-Oct-24	14-Jan-25	-41
345	RP-1600	Review Reservoir CMAR SOQ's & Shortlist	24-Dec-24	22-Jan-25	20	24-Oct-24	20-Nov-24	-41
346	RP-1800	Proposals Prepared & Submitted by Reservoir CMARs	13-Mar-25	07-May-25	40	15-Jan-25	11-Mar-25	-41
347	RP-1900	Select & Execute Reservoir CMAR Contract	08-May-25	30-Jul-25	60	12-Mar-25	03-Jun-25	-41
348	RP-1980	Reservoir CMAR Contract Award		30-Jul-25	0		03-Jun-25	-41
349	**Construction/Access/O&M Roads**		03-Jan-22 A	04-Apr-29	1652	03-Jan-22	13-Mar-29	-16
350	**Geotechnical Data**		31-Dec-24	31-Dec-24	0	31-Dec-24	31-Dec-24	0
351	A1570	Geotechnical Data - Construction/Access/O&M Roads		31-Dec-24	0		31-Dec-24	0
352	**Design**		03-Jan-22 A	21-Oct-25	751	03-Jan-22	29-Sep-25	-16
353	RD-1410	Construction/Access/O&M Roads Preliminary Design	03-Jan-22 A	12-Apr-24	361	03-Jan-22	12-Apr-24	0
354	RD-1420	Construction/Access/O&M Roads Final Design	23-Jan-25	21-Oct-25	194	01-Jan-25	29-Sep-25	-16
355	**Real Estate**		08-Aug-23	26-Nov-25	586	08-Aug-23	04-Nov-25	-16
356	DP-2160	Property Access for Bio/CR Field Surveys - Construction/Access/O&M Roads	08-Aug-23	06-Aug-24	250	08-Aug-23	06-Aug-24	0
357	LP-1110	Property Rights for Construction Access Roads	12-Jun-25	26-Nov-25	120	21-May-25	04-Nov-25	-16
358	**Environmental Permitting & Mitigation**		08-Aug-23	05-May-27	961	08-Aug-23	13-Apr-27	-16
359	A1260	General Permits for ESA; 404/401; Cultural Resources	08-Aug-23	06-Aug-24	250	08-Aug-23	06-Aug-24	0
360	A1410	Environmental Surveys - Construction/Access/O&M Roads	07-Aug-24	28-Jan-25	120	07-Aug-24	28-Jan-25	0
361	A1420	Regulatory Reviews - Construction/Access/O&M Roads	29-Jan-25	04-Nov-25	200	29-Jan-25	04-Nov-25	0
362	A1430	Mitigation - Construction/Access/O&M Roads	27-Nov-25	05-May-27	375	05-Nov-25	13-Apr-27	-16
363	**Construction**		06-May-27	04-Apr-29	500	14-Apr-27	13-Mar-29	-16
364	DC-1310	Construction/Access/O&M Roads Mobilization	06-May-27	02-Jun-27	20	14-Apr-27	11-May-27	-16
365	DC-1320	Construction/Access Roads Construction	03-Jun-27	28-Jun-28	280	12-May-27	06-Jun-28	-16
366	DC-1350	O&M Roads Construction	29-Jun-28	04-Apr-29	200	07-Jun-28	13-Mar-29	-16
367	**Lodoga Road & Bridge**		03-Jan-22 A	03-Sep-30	2021	03-Jan-22	03-Sep-30	0
368	**Geotechnical Data**		31-Dec-25	31-Dec-25	0	31-Dec-25	31-Dec-25	0
369	A1580	Geotechnical Data - Lodoga Road & Bridge		31-Dec-25	0		31-Dec-25	0
370	**Design**		03-Jan-22 A	29-Jun-27	1191	03-Jan-22	29-Jun-27	0
371	RD-1450	Lodoga Road & Bridge Preliminary Design	03-Jan-22 A	27-Dec-24	539	03-Jan-22	27-Dec-24	0
372	RD-1460	Lodoga Road & Bridge Final Design	01-Jan-26	29-Jun-27	389	01-Jan-26	29-Jun-27	0
373	**Real Estate**		30-Dec-24	14-Dec-27	772	30-Dec-24	14-Dec-27	0
374	DP-2170	Property Access for Bio/CR Field Surveys - Lodoga Road & Bridge	30-Dec-24	12-Dec-25	250	30-Dec-24	12-Dec-25	0
375	LP-1120	Property Rights - Lodoga Road & Bridge	30-Jun-27	14-Dec-27	120	30-Jun-27	14-Dec-27	0
376	**Environmental Permitting & Mitigation**		15-Dec-27	13-Aug-30	695	15-Dec-27	13-Aug-30	0
377	A1440	Environmental Surveys - Lodoga Road & Bridge	15-Dec-27	30-May-28	120	15-Dec-27	30-May-28	0
378	A1450	Regulatory Reviews - Lodoga Road & Bridge	31-May-28	06-Mar-29	200	31-May-28	06-Mar-29	0
379	A1460	Mitigation - Lodoga Road & Bridge	07-Mar-29	13-Aug-30	375	07-Mar-29	13-Aug-30	0



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Sites Reservoir Project

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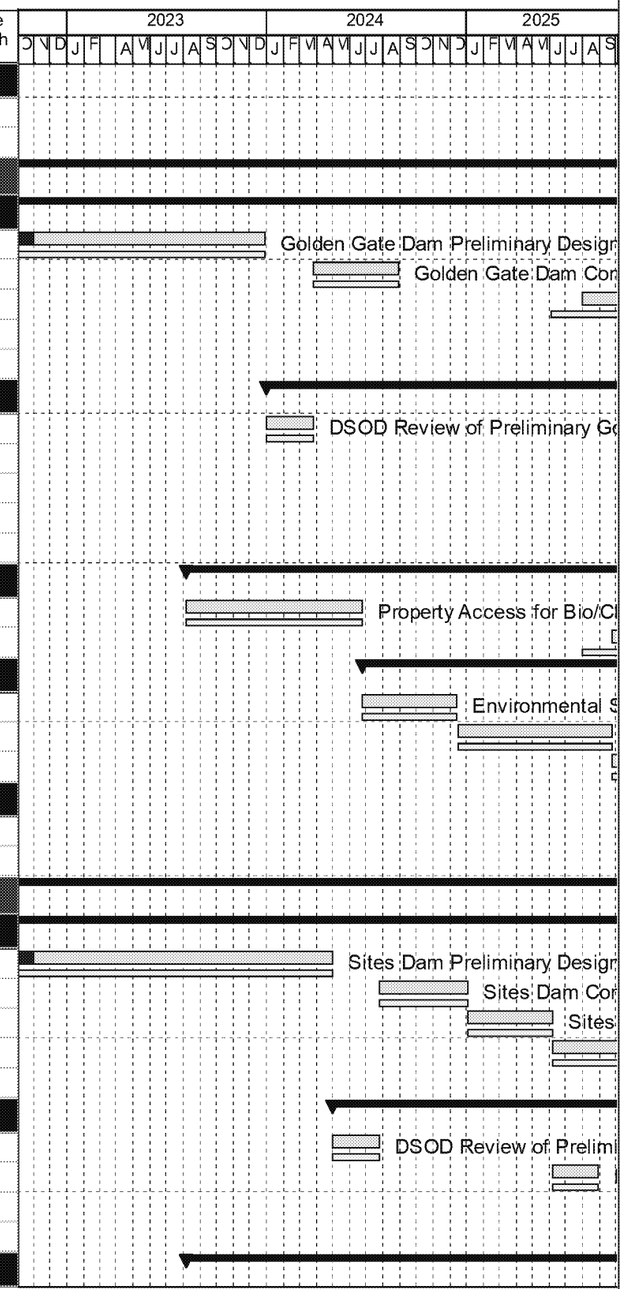
380	**Construction**		15-Dec-27	03-Sep-30	710	15-Dec-27	03-Sep-30	0
381	DC-1330	Lodoga Road & Bridge Construction Mobilization	15-Dec-27	25-Jan-28	30	15-Dec-27	25-Jan-28	0
382	DC-1340	Lodoga Road & Bridge Construction	26-Jan-28	03-Sep-30	680	26-Jan-28	03-Sep-30	0
383	**Golden Gate Dam**		03-Jan-22 A	13-Jul-33	2767	03-Jan-22	21-Jun-33	-16
384	**Design**		03-Jan-22 A	25-Nov-26	1037	03-Jan-22	29-Sep-26	-41
385	RD-1100	Golden Gate Dam Preliminary Design for DSOD Review	03-Jan-22 A	29-Dec-23	289	03-Jan-22	29-Dec-23	0
386	RD-1210	Golden Gate Dam Complete Design to 30%	28-Mar-24	30-Aug-24	110	28-Mar-24	30-Aug-24	0
387	RD-1200	Golden Gate Dam Design to 60%	31-Jul-25	31-Dec-25	110	04-Jun-25	04-Nov-25	-41
388	RD-1300	Golden Gate Dam Design to 90%	01-Jan-26	03-Jun-26	110	05-Nov-25	07-Apr-26	-41
389	RD-1400	Golden Gate Dam Design to 100%	27-Aug-26	25-Nov-26	65	01-Jul-26	29-Sep-26	-41
390	**DSOD Reviews**		02-Jan-24	13-Jul-33	2478	02-Jan-24	21-Jun-33	-16
391	RR-1100	DSOD Review of Preliminary Golden Gate Dam Design	02-Jan-24	27-Mar-24	60	02-Jan-24	27-Mar-24	0
392	RR-1200	DSOD Review of 60% Golden Gate Dam Design	01-Jan-26	25-Mar-26	60	05-Nov-25	27-Jan-26	-41
393	RR-1300	DSOD Review of 90% Golden Gate Design	04-Jun-26	26-Aug-26	60	08-Apr-26	30-Jun-26	-41
394	RR-1400	DSOD Approval of 100% Goldent Gate Design		25-Nov-26	0		29-Sep-26	-41
395	RR-1500	DSOD Approval of Completed Reservoir Construction	21-Apr-33	13-Jul-33	60	30-Mar-33	21-Jun-33	-16
396	**Real Estate**		08-Aug-23	03-Jun-26	721	08-Aug-23	07-Apr-26	-41
397	DP-2180	Property Access for Bio/CR Field Surveys - Golden Gate Dam	08-Aug-23	24-Jun-24	220	08-Aug-23	24-Jun-24	0
398	LP-1130	Property Rights - Golden Gate Dam	25-Sep-25	03-Jun-26	180	30-Jul-25	07-Apr-26	-41
399	**Environmental Permitting & Mitigation**		25-Jun-24	02-Mar-27	695	25-Jun-24	02-Mar-27	0
400	A1470	Environmental Surveys - Golden Gate Dam	25-Jun-24	13-Dec-24	120	25-Jun-24	13-Dec-24	0
401	A1480	Regulatory Reviews - Golden Gate Dam	16-Dec-24	23-Sep-25	200	16-Dec-24	23-Sep-25	0
402	A1490	Mitigation - Golden Gate Dam	24-Sep-25	02-Mar-27	375	24-Sep-25	02-Mar-27	0
403	**Construction**		29-Jun-28	20-Apr-33	1255	07-Jun-28	29-Mar-33	-16
404	DC-1200	Goldent Gate Dam Construction Mobilization	29-Jun-28	20-Sep-28	60	07-Jun-28	29-Aug-28	-16
405	DC-1300	Goldent Gate Dam Construction	21-Sep-28	20-Apr-33	1195	30-Aug-28	29-Mar-33	-16
406	**Sites Dam**		03-Jan-22 A	22-Mar-30	1904	03-Jan-22	22-Mar-30	0
407	**Design**		03-Jan-22 A	30-Apr-26	888	03-Jan-22	30-Apr-26	0
408	RD-1470	Sites Dam Preliminary Design for DSOD Review	03-Jan-22 A	30-Apr-24	373	03-Jan-22	30-Apr-24	0
409	RD-1510	Sites Dam Complete Design to 30%	26-Jul-24	02-Jan-25	110	26-Jul-24	02-Jan-25	0
410	RD-1480	Sites Dam Design to 60%	03-Jan-25	05-Jun-25	110	03-Jan-25	05-Jun-25	0
411	RD-1490	Sites Dam Design to 90%	06-Jun-25	06-Nov-25	110	06-Jun-25	06-Nov-25	0
412	RD-1500	Sites Dam Design to 100%	30-Jan-26	30-Apr-26	65	30-Jan-26	30-Apr-26	0
413	**DSOD Reviews**		01-May-24	30-Apr-26	515	01-May-24	30-Apr-26	0
414	RR-1510	DSOD Review of Preliminary Sites Dam Design	01-May-24	25-Jul-24	60	01-May-24	25-Jul-24	0
415	RR-1520	DSOD Review of 60% Sites Dam Design	06-Jun-25	28-Aug-25	60	06-Jun-25	28-Aug-25	0
416	RR-1530	DSOD Review of 90% Sites Dam Design	07-Nov-25	29-Jan-26	60	07-Nov-25	29-Jan-26	0
417	RR-1540	DSOD Approval of 100% Sites Dam Design		30-Apr-26	0		30-Apr-26	0
418	**Real Estate**		08-Aug-23	06-Nov-25	572	08-Aug-23	06-Nov-25	0



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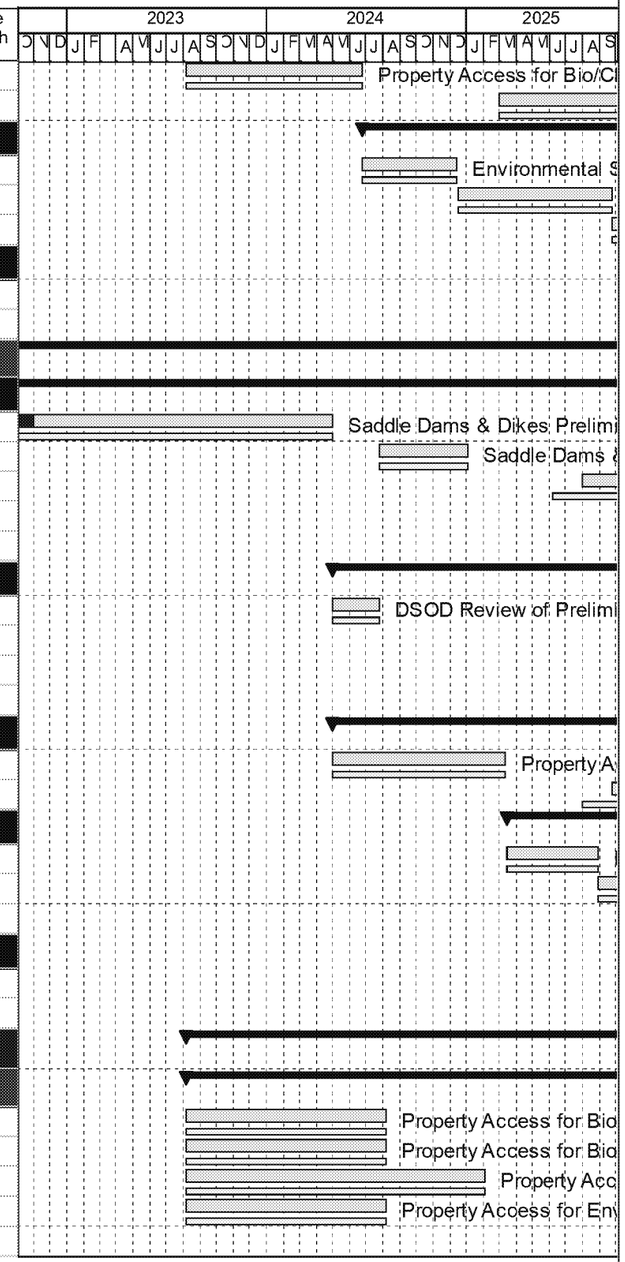
419	DP-2190	Property Access for Bio/CR Field Surveys - Sites Dam	08-Aug-23	24-Jun-24	220	08-Aug-23	24-Jun-24	0
420	LP-1140	Property Rights - Sites Dam	28-Feb-25	06-Nov-25	180	28-Feb-25	06-Nov-25	0
421	**Environmental Permitting & Mitigation**		25-Jun-24	02-Mar-27	695	25-Jun-24	02-Mar-27	0
422	A1500	Environmental Surveys - Sites Dam	25-Jun-24	13-Dec-24	120	25-Jun-24	13-Dec-24	0
423	A1510	Regulatory Reviews - Sites Dam	16-Dec-24	23-Sep-25	200	16-Dec-24	23-Sep-25	0
424	A1520	Mitigation - Sites Dam	24-Sep-25	02-Mar-27	375	24-Sep-25	02-Mar-27	0
425	**Construction**		01-May-26	22-Mar-30	1016	01-May-26	22-Mar-30	0
426	DC-1360	Sites Dam Construction Mobilization	01-May-26	23-Jul-26	60	01-May-26	23-Jul-26	0
427	DC-1370	Sites Dam Construction	24-Jul-26	22-Mar-30	956	24-Jul-26	22-Mar-30	0
428	**Saddle Dams & Dikes**		03-Jan-22 A	02-Jan-30	1847	03-Jan-22	08-Nov-29	-39
429	**Design**		03-Jan-22 A	25-Nov-26	1037	03-Jan-22	01-Oct-26	-39
430	RD-1520	Saddle Dams & Dikes Preliminary Design for DSOD Review	03-Jan-22 A	30-Apr-24	373	03-Jan-22	30-Apr-24	0
431	RD-1560	Saddle Dams & Dikes Complete Design to 30%	26-Jul-24	02-Jan-25	110	26-Jul-24	02-Jan-25	0
432	RD-1530	Saddle Dams & Dikes Design to 60%	31-Jul-25	31-Dec-25	110	06-Jun-25	06-Nov-25	-39
433	RD-1540	Saddle Dams & Dikes Design to 90%	01-Jan-26	03-Jun-26	110	07-Nov-25	09-Apr-26	-39
434	RD-1550	Saddle Dams & Dikes Design to 100%	27-Aug-26	25-Nov-26	65	03-Jul-26	01-Oct-26	-39
435	**DSOD Reviews**		01-May-24	25-Nov-26	664	01-May-24	01-Oct-26	-39
436	RR-1550	DSOD Review of Preliminary Saddle Dams & Dikes Design	01-May-24	25-Jul-24	60	01-May-24	25-Jul-24	0
437	RR-1560	DSOD Review of 60% Saddle Dams & Dikes Design	01-Jan-26	25-Mar-26	60	07-Nov-25	29-Jan-26	-39
438	RR-1570	DSOD Review of 90% Saddle Dams & Dikes Design	04-Jun-26	26-Aug-26	60	10-Apr-26	02-Jul-26	-39
439	RR-1580	DSOD Approval of 100% Saddle Dams & Dikes Design		25-Nov-26	0		01-Oct-26	-39
440	**Real Estate**		01-May-24	03-Jun-26	539	01-May-24	09-Apr-26	-39
441	DP-2200	Property Access for Bio/CR Field Surveys - Saddle Dams & Dikes	01-May-24	13-Mar-25	220	01-May-24	13-Mar-25	0
442	LP-1150	Property Rights - Saddle Dams & Dikes	25-Sep-25	03-Jun-26	180	01-Aug-25	09-Apr-26	-39
443	**Environmental Permitting & Mitigation**		14-Mar-25	11-Nov-27	695	14-Mar-25	11-Nov-27	0
444	A1530	Environmental Surveys - Saddle Dams & Dikes	14-Mar-25	28-Aug-25	120	14-Mar-25	28-Aug-25	0
445	A1540	Regulatory Reviews - Saddle Dams & Dikes	29-Aug-25	04-Jun-26	200	29-Aug-25	04-Jun-26	0
446	A1550	Mitigation - Saddle Dams & Dikes	05-Jun-26	11-Nov-27	375	05-Jun-26	11-Nov-27	0
447	**Construction**		26-Nov-26	02-Jan-30	810	02-Oct-26	08-Nov-29	-39
448	DC-1380	Saddle Dams & Dikes Construction Mobilization	26-Nov-26	17-Feb-27	60	02-Oct-26	24-Dec-26	-39
449	DC-1390	Saddle Dams & Dikes Construction	18-Feb-27	02-Jan-30	750	25-Dec-26	08-Nov-29	-39
450	**Real Estate**		08-Aug-23	25-Jan-30	1673	08-Aug-23	29-Nov-29	-41
451	**Property Access**		08-Aug-23	15-Nov-28	1361	08-Aug-23	15-Nov-28	0
452	DP-2110	Property Access for Bio/CR Field Surveys Reservoir Package	08-Aug-23	06-Aug-24	250	08-Aug-23	06-Aug-24	0
453	DP-2120	Property Access for Bio/CR Field Surveys MSPG Package	08-Aug-23	06-Aug-24	250	08-Aug-23	06-Aug-24	0
454	DP-2130	Property Access for Environmental Surveys Reservoir Clearing & Demo	08-Aug-23	04-Feb-25	375	08-Aug-23	04-Feb-25	0
455	DP-2140	Property Access for Environmental Surveys Dunnigan PL Upstream Segment	08-Aug-23	06-Aug-24	250	08-Aug-23	06-Aug-24	0
456	DP-2150	Property Access for Environmental Surveys Dunnigan PL Downstream Segment	02-Dec-27	15-Nov-28	250	02-Dec-27	15-Nov-28	0



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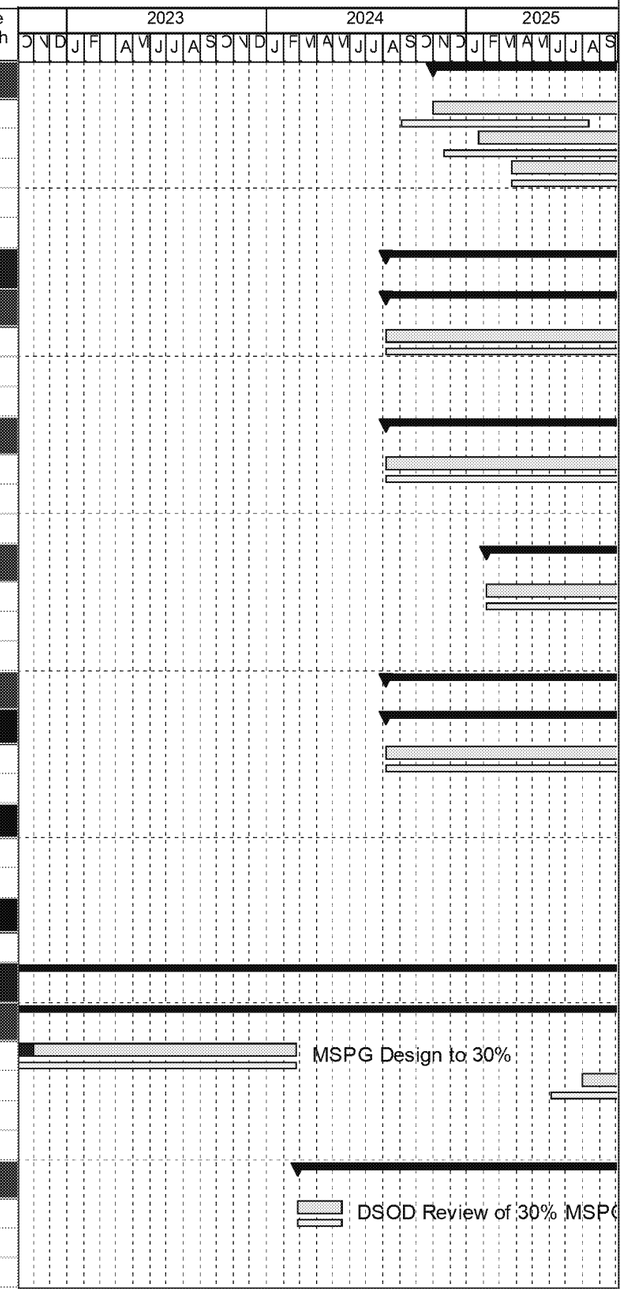
457	**Property Rights**		01-Nov-24	25-Jan-30	1362	05-Sep-24	29-Nov-29	-41
458	DP-2100	Obtain Property Rights for Dunnigan Pipeline Construction	01-Nov-24	08-Oct-25	240	05-Sep-24	12-Aug-25	-41
459	DC-1100	Obtain Property Rights for Reservoir / Dams Construction	23-Jan-25	23-Dec-26	500	21-Nov-24	27-Oct-26	-41
460	LP-1100	Obtain Property Rights for Huffmaster Road Construction	24-Mar-25	11-Feb-27	494	24-Mar-25	11-Feb-27	0
461	RCD-1100	Obtain Property Rights for Reservoir Clearing & Demolition	26-Nov-26	29-Aug-29	720	30-Sep-26	03-Jul-29	-41
462	IP-1100	Obtain Property Rights for MSPG Construction	28-Feb-28	25-Jan-30	500	31-Dec-27	29-Nov-29	-41
463	**Environmental Permitting**		07-Aug-24	23-Jul-31	1811	07-Aug-24	23-Jul-31	0
464	**Environmental Permitting Reservoir Package**		07-Aug-24	26-Sep-28	1075	07-Aug-24	26-Sep-28	0
465	A1270	Environmental Surveys Reservoir Package	07-Aug-24	14-Jul-26	500	07-Aug-24	14-Jul-26	0
466	A1280	Regulatory Reviews Reservoir Package	15-Jul-26	20-Apr-27	200	15-Jul-26	20-Apr-27	0
467	A1290	Mitigation for Reservoir Package	21-Apr-27	26-Sep-28	375	21-Apr-27	26-Sep-28	0
468	**Environmental Permitting Maxwell-Sites Pumping & Generating**		07-Aug-24	04-Apr-28	950	07-Aug-24	04-Apr-28	0
469	A1300	Environmental Surveys MSPG Package	07-Aug-24	14-Jul-26	500	07-Aug-24	14-Jul-26	0
470	A1310	Regulatory Reviews MSPG Package	15-Jul-26	20-Apr-27	200	15-Jul-26	20-Apr-27	0
471	A1320	Mitigation for MSPG Package	21-Apr-27	04-Apr-28	250	21-Apr-27	04-Apr-28	0
472	**Environmental Permitting Reservoir Clearing & Demolition**		05-Feb-25	26-Sep-28	950	05-Feb-25	26-Sep-28	0
473	A1330	Environmental Surveys Reservoir Clearing & Demo	05-Feb-25	05-Jan-27	500	05-Feb-25	05-Jan-27	0
474	A1340	Regulatory Reviews Reservoir Clearing & Demo	06-Jan-27	12-Oct-27	200	06-Jan-27	12-Oct-27	0
475	A1350	Mitigation for Reservoir Clearing & Demo	13-Oct-27	26-Sep-28	250	13-Oct-27	26-Sep-28	0
476	**Environmental Permitting Dunnigan Pipeline**		07-Aug-24	23-Jul-31	1811	07-Aug-24	23-Jul-31	0
477	**Upstream Segment**		07-Aug-24	20-Apr-27	700	07-Aug-24	20-Apr-27	0
478	A1360	Environmental Surveys Dunnigan Pipeline Upstream Segment	07-Aug-24	14-Jul-26	500	07-Aug-24	14-Jul-26	0
479	A1370	Regulatory Reviews Dunnigan Pipeline Upstream Segment	15-Jul-26	20-Apr-27	200	15-Jul-26	20-Apr-27	0
480	**Downstream Segment**		16-Nov-28	07-Aug-30	450	16-Nov-28	07-Aug-30	0
481	A1380	Environmental Surveys Dunnigan Pipeline Downstream Segment	16-Nov-28	31-Oct-29	250	16-Nov-28	31-Oct-29	0
482	A1390	Regulatory Reviews Dunnigan Pipeline Downstream Segment	01-Nov-29	07-Aug-30	200	01-Nov-29	07-Aug-30	0
483	**Both Segments**		08-Aug-30	23-Jul-31	250	08-Aug-30	23-Jul-31	0
484	A1400	Mitigation for Dunnigan Pipeline	08-Aug-30	23-Jul-31	250	08-Aug-30	23-Jul-31	0
485	**Maxwell-Sites Pumping & Generating**		03-Jan-22 A	15-Apr-33	2704	03-Jan-22	17-Feb-33	-41
486	**MSPG Design**		03-Jan-22 A	25-Feb-28	1364	03-Jan-22	30-Dec-27	-41
487	MD-1100	MSPG Design to 30%	03-Jan-22 A	23-Feb-24	326	03-Jan-22	23-Feb-24	0
488	MD-1200	MSPG Design to 60%	31-Jul-25	26-May-26	214	04-Jun-25	30-Mar-26	-41
489	MD-1300	MSPG Design to 90%	27-May-26	26-Mar-27	218	31-Mar-26	28-Jan-27	-41
490	MD-1400	MSPG Design to 100%	29-Mar-27	25-Feb-28	240	29-Jan-27	30-Dec-27	-41
491	**MSPG DSOD Reviews**		26-Feb-24	15-Apr-33	2378	26-Feb-24	17-Feb-33	-41
492	MR-1100	DSOD Review of 30% MSPG Design	26-Feb-24	17-May-24	60	26-Feb-24	17-May-24	0
493	MR-1200	DSOD Review of 60% MSPG Design	27-May-26	18-Aug-26	60	31-Mar-26	22-Jun-26	-41
494	MR-1300	DSOD Review of 90% MSPG Design	29-Mar-27	18-Jun-27	60	29-Jan-27	22-Apr-27	-41



Remaining Level of Effort
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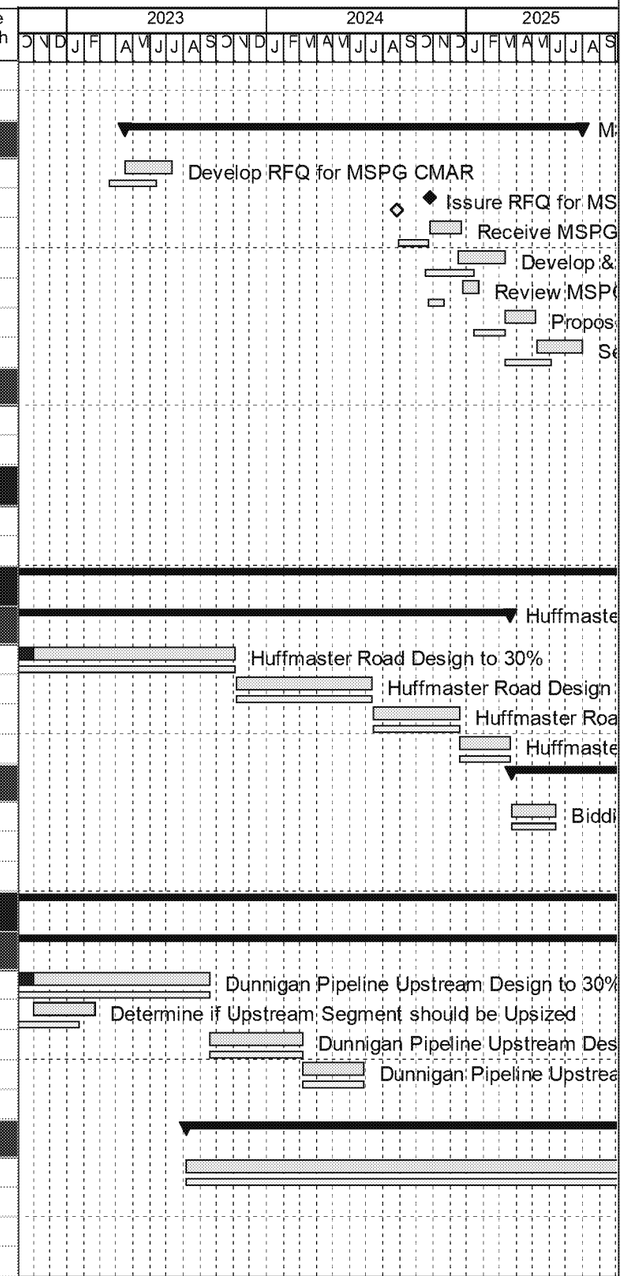
Sites Reservoir Project

Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
495	MR-1400	DSOD Approval of 100% MSPG Design	28-Feb-28	19-May-28	60	31-Dec-27	23-Mar-28	-41
496	MR-1410	DSOD Approval of Completed MSPG Construction	24-Jan-33	15-Apr-33	60	26-Nov-32	17-Feb-33	-41
497	**MSPG CMAR Procurement**		17-Apr-23	30-Jul-25	580	20-Mar-23	03-Jun-25	-41
498	RP-1910	Develop RFQ for MSPG CMAR	17-Apr-23	11-Jul-23	60	20-Mar-23	12-Jun-23	-20
499	RP-1920	Issure RFQ for MSPG CMAR		24-Oct-24	0		27-Aug-24	-41
500	RP-1930	Receive MSPG CMAR SOQ's	25-Oct-24	23-Dec-24	40	28-Aug-24	23-Oct-24	-41
501	RP-1950	Develop & Issue RFP to MSPG CMARs	17-Dec-24	12-Mar-25	60	17-Oct-24	14-Jan-25	-41
502	RP-1940	Review MSPG CMAR SOQ's & Shortlist	24-Dec-24	22-Jan-25	20	24-Oct-24	20-Nov-24	-41
503	RP-1960	Proposals Prepared & Submitted by MSPG CMARs	13-Mar-25	07-May-25	40	15-Jan-25	11-Mar-25	-41
504	RP-1970	Select & Execute MSPG CMAR Contract	08-May-25	30-Jul-25	60	12-Mar-25	03-Jun-25	-41
505	**MSPG Construction**		28-Jan-30	21-Jan-33	780	30-Nov-29	25-Nov-32	-41
506	IC-1200	MSPG Mobilization	28-Jan-30	19-Apr-30	60	30-Nov-29	21-Feb-30	-41
507	IC-1300	MSPG Construction	22-Apr-30	21-Jan-33	720	22-Feb-30	25-Nov-32	-41
508	**Reservoir Clearing & Demolition**		30-Aug-29	17-Dec-31	600	04-Jul-29	21-Oct-31	-41
509	RCD-1200	Reservoir Clearing & Demo	30-Aug-29	02-Jul-31	480	04-Jul-29	06-May-31	-41
510	RCD-1300	Cemetery Relocation	30-Aug-29	17-Dec-31	600	04-Jul-29	21-Oct-31	-41
511	**Huffmaster Road**		03-Jan-22 A	24-Aug-28	1493	03-Jan-22	24-Aug-28	0
512	**Huffmaster Road Design**		03-Jan-22 A	21-Mar-25	599	03-Jan-22	21-Mar-25	0
513	HRD-1100	Huffmaster Road Design to 30%	03-Jan-22 A	03-Nov-23	253	03-Jan-22	03-Nov-23	0
514	HRD-1200	Huffmaster Road Design to 60%	06-Nov-23	12-Jul-24	171	06-Nov-23	12-Jul-24	0
515	HRD-1300	Huffmaster Road Design to 90%	15-Jul-24	18-Dec-24	110	15-Jul-24	18-Dec-24	0
516	HRD-1400	Huffmaster Road Design to 100%	19-Dec-24	21-Mar-25	65	19-Dec-24	21-Mar-25	0
517	**Huffmaster Road Construction**		24-Mar-25	24-Aug-28	894	24-Mar-25	24-Aug-28	0
518	HRC-1100	Bidding & Contract Execution for Huffmaster Road	24-Mar-25	13-Jun-25	60	24-Mar-25	13-Jun-25	0
519	HRC-1200	Huffmaster Road Mobilization	12-Feb-27	08-Apr-27	40	12-Feb-27	08-Apr-27	0
520	HRC-1300	Huffmaster Road Construction	09-Apr-27	24-Aug-28	360	09-Apr-27	24-Aug-28	0
521	**Dunnigan Pipeline**		03-Jan-22 A	12-May-32	2462	03-Jan-22	12-May-32	0
522	**Dunnigan Pipeline Upstream Design**		03-Jan-22 A	23-Jan-30	1862	03-Jan-22	23-Jan-30	0
523	DPU-1100	Dunnigan Pipeline Upstream Design to 30%	03-Jan-22 A	19-Sep-23	221	03-Jan-22	19-Sep-23	0
524	DPU-1200	Determine if Upstream Segment should be Upsized	01-Nov-22	22-Feb-23	75	03-Oct-22	24-Jan-23	-20
525	DPU-1300	Dunnigan Pipeline Upstream Design to 60%	20-Sep-23	05-Mar-24	112	20-Sep-23	05-Mar-24	0
526	DPU-1400	Dunnigan Pipeline Upstream Design to 90%	06-Mar-24	26-Jun-24	80	06-Mar-24	26-Jun-24	0
527	DPU-1500	Dunnigan Pipeline Upstream Design to 100%	01-Nov-29	23-Jan-30	60	01-Nov-29	23-Jan-30	0
528	**Dunnigan Pipeline Downstream Design**		08-Aug-23	23-Jan-30	1671	08-Aug-23	23-Jan-30	0
529	DPD-1100	Determine Discharge Location for Downstream Segment (Colusa Basin Drain or Sac River)	08-Aug-23	01-Dec-27	1111	08-Aug-23	01-Dec-27	0
530	DPD-1200	Dunnigan Pipeline Downstream Design to 30%	02-Dec-27	24-Jan-29	300	02-Dec-27	24-Jan-29	0
531	DPD-1300	Dunnigan Pipeline Downstream Design to 60%	25-Jan-29	11-Jul-29	120	25-Jan-29	11-Jul-29	0
532	DPD-1400	Dunnigan Pipeline Downstream Design to 90%	12-Jul-29	31-Oct-29	80	12-Jul-29	31-Oct-29	0



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Sites Reservoir Project

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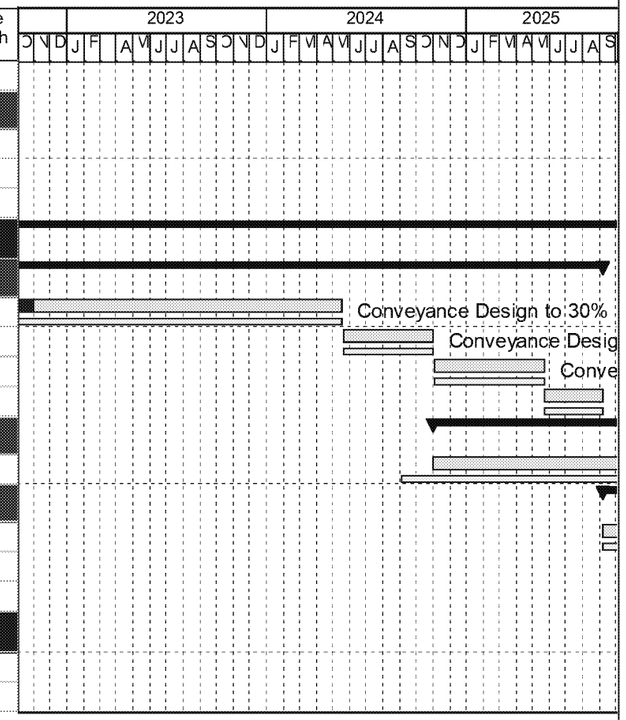
533	DPD-1500	Dunnigan Pipeline Downstream Design to 100%	01-Nov-29	23-Jan-30	60	01-Nov-29	23-Jan-30	0
534	**Dunnigan Pipeline Construction**		24-Jan-30	12-May-32	600	24-Jan-30	12-May-32	0
535	DPC-5100	Bidding & Contract Execution for Dunnigan Pipeline	24-Jan-30	15-May-30	80	24-Jan-30	15-May-30	0
536	DPC-5200	Dunnigan Pipeline Mobilization	16-May-30	10-Jul-30	40	16-May-30	10-Jul-30	0
537	DPC-5300	Dunnigan Pipeline Construction	11-Jul-30	12-May-32	480	11-Jul-30	12-May-32	0
538	**Tehama Colusa Canal Authority**		03-Jan-22 A	25-Sep-29	1776	03-Jan-22	30-Jul-29	-41
539	**Conveyance Design**		03-Jan-22 A	05-Sep-25	719	03-Jan-22	05-Sep-25	0
540	CD-1100	Conveyance Design to 30%	03-Jan-22 A	17-May-24	386	03-Jan-22	17-May-24	0
541	CD-1200	Conveyance Design to 60%	20-May-24	01-Nov-24	117	20-May-24	01-Nov-24	0
542	CD-1300	Conveyance Design to 90%	04-Nov-24	22-May-25	140	04-Nov-24	22-May-25	0
543	CD-1400	Conveyance Design to 100%	23-May-25	05-Sep-25	76	23-May-25	05-Sep-25	0
544	**Conveyance Property Rights**		01-Nov-24	29-Sep-26	494	05-Sep-24	03-Aug-26	-41
545	CP-1100	Obtain Property Rights for Conveyance Construction	01-Nov-24	29-Sep-26	494	05-Sep-24	03-Aug-26	-41
546	**Conveyance Construction**		08-Sep-25	25-Sep-29	1057	08-Sep-25	30-Jul-29	-41
547	CC-1100	Bidding & Contract Execution for Conveyance Package	08-Sep-25	26-Dec-25	80	08-Sep-25	26-Dec-25	0
548	CC-1200	Conveyance Mobilization	30-Sep-26	22-Dec-26	60	04-Aug-26	26-Oct-26	-41
549	CC-1300	Conveyance Construction	23-Dec-26	25-Sep-29	720	27-Oct-26	30-Jul-29	-41
550	**Reservoir Filling & Commissioning**		14-Jul-33	17-Apr-36	720	22-Jun-33	26-Mar-36	-16
551	RF-1100	Reservoir Filling & Commissioning	14-Jul-33	16-Apr-36	720	22-Jun-33	25-Mar-36	-16
552	RF-5100	Initiate Reservoir Operations	17-Apr-36		0	26-Mar-36		-16



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From: Briard, Monique [Monique.Briard@icf.com]
Sent: 11/8/2022 9:01:06 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]; Laurie Warner Herson (Laurie.Warner.Herson@phenixenv.com) [laurie.warner.herson@phenixenv.com]
CC: Harris, Melissa [Melissa.Harris@icf.com]
Subject: RE: Providing excerpts on juvenile stranding analysis from Final EIR/S to Josh Israel

Thank you!

Monique Briard
916.231.9551 (direct) | 916.842.0894 (mobile)

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Tuesday, November 8, 2022 8:59 AM
To: Briard, Monique <Monique.Briard@icf.com>; Laurie Warner Herson (Laurie.Warner.Herson@phenixenv.com) <laurie.warner.herson@phenixenv.com>
Cc: Harris, Melissa <Melissa.Harris@icf.com>
Subject: RE: Providing excerpts on juvenile stranding analysis from Final EIR/S to Josh Israel

Sounds good. Go ahead and send to Reclamation. Sophie can copy Laurie.

Thanks!

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Briard, Monique <Monique.Briard@icf.com>
Sent: Tuesday, November 8, 2022 8:50 AM
To: Laurie Warner Herson (Laurie.Warner.Herson@phenixenv.com) <laurie.warner.herson@phenixenv.com>; Alicia Forsythe <aforsythe@sitesproject.org>
Cc: Harris, Melissa <Melissa.Harris@icf.com>
Subject: FW: Providing excerpts on juvenile stranding analysis from Final EIR/S to Josh Israel

Laurie and Ali,

Below is the clarification that we received about the request to send Sophie's write up on the Feather River redd dewatering and juvenile stranding analysis. He wants to review it to determine if Reclamation should use the same approach for their new long-term operations of the CVP analysis.

Please let us know if it is okay for us to forward it to Josh and if you'd like us to include one of you on the submittal. We will include the caveat that the write up has not been reviewed yet by the Authority and that this is a draft analysis for the Sites Project.

Thanks,
Monique

Monique Briard
916.231.9551 (direct) | 916.842.0894 (mobile)

From: Wilder, Rick <Rick.Wilder@icf.com>
Sent: Monday, November 7, 2022 4:51 PM
To: Unger, Sophie <Sophie.Unger@icf.com>; Harris, Melissa <Melissa.Harris@icf.com>
Cc: Hendrick, Mike <Mike.Hendrick@icf.com>; Moderan, Julien <Julien.Moderan@icf.com>
Subject: RE: Providing excerpts on juvenile stranding analysis from Final EIR/S to Josh Israel

Sophie is only asking if there are any issues from your perspective with sharing this yet-to-be-publicly-released section of the Sites Final EIS/R with Reclamation. Reclamation wants to evaluate whether to use the approach we used in the Sites Final EIS/R for their project.

Thanks,
Rick

From: Harris, Melissa <Melissa.Harris@icf.com>
Sent: Monday, November 7, 2022 3:44 PM
To: Unger, Sophie <Sophie.Unger@icf.com>
Cc: Hendrick, Mike <Mike.Hendrick@icf.com>; Wilder, Rick <Rick.Wilder@icf.com>; Moderan, Julien <Julien.Moderan@icf.com>
Subject: RE: Providing excerpts on juvenile stranding analysis from Final EIR/S to Josh Israel

Hi Sophie,

Is this for the BA or the EIR/EIS?

Melissa

Melissa Harris, PMP
916.210.5916 (direct)
980 9th Street Suite 1200, Sacramento, CA, 95814, USA

From: Unger, Sophie <Sophie.Unger@icf.com>
Sent: Monday, November 7, 2022 3:14 PM
To: Harris, Melissa <Melissa.Harris@icf.com>
Cc: Hendrick, Mike <Mike.Hendrick@icf.com>; Wilder, Rick <Rick.Wilder@icf.com>; Moderan, Julien

<Julien.Moderan@icf.com>
Subject: Providing excerpts on juvenile stranding analysis from Final EIR/S to Josh Israel

Hi Melissa,

I just learned that Josh Israel from Reclamation would like to see my writeup on juvenile stranding in addition to the redd dewatering analyses I mentioned during our meeting this morning. The material in the Draft EIR/S on juvenile stranding is more limited and difficult to understand than my revisions for the Final EIR/S, so I would like to send him the material from the Final EIR/S if that is OK with Reclamation. In addition, the Final, but not the Draft, has material on Feather River redd dewatering that I'd like to provide. Could you please check with Reclamation if it would be OK to provide him with these writeups?

Many thanks,
Sophie

From: Sara M. Katz [skatz@katzandassociates.com]
Sent: 11/9/2022 4:53:47 PM
To: Kevin Spesert [kspesert@sitesproject.org]; Ann Newton [anewton@katzandassociates.com]; Sarah Rossetto [srossetto@katzandassociates.com]; kim@floydcommunications.com
Subject: Notes of 11/9/22 Sites Comms Team Meeting

1. General discussion of final prep for Sites CWG tour set for 9am at Maxwell Sites office on Saturday, 11/12.
2. Confirmed **Kevin has final draft for** review and consideration of CWG Meeting Summary from 10/06/22's kick-off meeting.
3. Discussed Forbes article, solid coverage, but one inaccurate claim. Agreed **Ann would reach out to reporter**; express thanks for positive coverage; offer for call to learn more about operations of Sites; determine if he may be writing on this topic again in the future.
4. Confirmed **Kevin received and is to review** revised/updated draft copy for **Wikipedia** regarding Sites.
5. Discussed drought video outline. Conversation re appropriate individual/NGO etc. to consider as the environmental voice. **Ann to advance revisions to video outline** and pass along to Kevin and others. **Sara to call Ali F** and/or Jerry re ideas for environmental voice/participation.
6. **Sarah Rossetto** let Kevin know she **will advance a request for two staff additions**, both at the "Sharon Han" already approved rate. Want to get Quin La Capra started sooner than later given various initiatives and possibility of increased scope/budget in FY 23.
7. Meeting turned to discussion on presentation to Sites Legislative and Communications Committee – Monday, November 14th @11am. **Kevin and Sara to tag-team** comms presentation. **Ann to work with Sara and Kevin to get presentation finalized.**

Future discussions to include:
- Set aside of time to discuss both drought video and virtual Sites Project tour

K&A
KATZ & ASSOCIATES
Sara M. Katz
Founder/CEO
mobile: 619.813.9551
San Diego · Los Angeles · San Francisco

Meeting: **Sites Authority Board's Coordination Committee**

Locations: Maxwell Project Office, 122 Old Highway 99W, Maxwell, CA 95955
See below for alternate meeting locations.

Call in: **1-213-379-5743** Code: **703 288 727#** Click here to join the meeting

Committee Chair: Fritz Durst (AB Chair/Reclamation District 108)

Committee Vice-Chair: Jeff Sutton (AB Vice-Chair/Tehama-Colusa Canal Authority)

Staff Lead: Jerry Brown, Executive Director

AGENDA

Monday, November 14, 2022 3:00 – 4:00 pm

NO ACTION or DECISION WILL BE TAKEN

ROLL CALL & CALL TO ORDER:

- Introductions
- Period for Public Comment

PERIOD OF PUBLIC COMMENT: Any person may speak about any subject of concern, provided it is within the jurisdiction of the workgroup. The time allotted for receiving such public communication shall be limited to 3 minutes per person or group and not exceed 10 minutes per issue. Note: No action shall be taken on comments made during this period.

1. Discussion and Information Items:

1.1 Board Meeting Agenda Planning

1.1.1 Effect of AB2449

1.2 General Coordination Among Committees and Workgroups

1.2.1 ACWA meetings

1.2.2 Consider Joint Coordination Meetings

2. Closed Session:

2.1 Potential Litigation – Gov. Code Sec. 54956.9(d)(3)

3. Upcoming Meetings:

Reservoir Committee
Friday, November 18, 2022 (9:00 am – 12:00 pm)

Authority Board Meeting
Monday, November 21, 2022 (1:30 – 4:00 pm)

Coordination Committee
Monday, December 5, 2022 (3:00 – 4:00 pm)

Virtual Information will be provided before all meetings at Sitesproject.org.

ADJOURN

ADA COMPLIANCE: Upon request, agendas will be made available in alternative formats to accommodate persons with disabilities. In addition, any person with a disability who requires a modification or accommodation to participate or attend this meeting may request necessary accommodation. Please make your request to the Board Clerk, specifying your disability, the format in which you would like to receive this Agenda and any other accommodation required no later than 24 hours before the start of the meeting.

Alternate Meeting Locations:

Davis Water District, 6505 Hillgate Road, Arbuckle, CA 95912

Glenn-Colusa Irrigation District, 344 East Laurel Street, Willows, CA 95988

Reclamation District 108, 975 Wilson Bend Road, Grimes, CA 95950

Tehama-Colusa Canal Authority, 5513 Highway 162, Willows, CA 95987

Video Summary

Interview-heavy video describing ongoing impacts of drought on California communities. These impacts underscore how important it is to capture water when it's abundant. And there ARE times when it is abundant.

Video Outline

Key Points for Voiceover

- Drought is ravaging California communities.
- Farmers are fallowing their fields.
- Rural communities no longer have reliable, clean drinking water.
- Towns that rely heavily on revenue from agriculture are cutting back on basic community services.

Interview #1

Family farmer speaking directly to impacts – acres fallowed, describing impacts to their production, to their families, to their employees, etc.

Commented [AN1]: Hal Charter, Logan Denis

Visuals: View of farm, farmer's home, close up of face – need to show human aspect of the drought

Interview #2

Farm worker describing how their day to day has changed as drought continues, importance of farming/food production to their families, communities.

Commented [AN2]: Anastasia Allen? Possible for interview 2 or 3

Visuals: Family eating meal at table, view of fallowed fields, working with hands, view of crops/food

Interview #3

Commented [AN3]: CAO of Colusa Co.

Agricultural community firefighter/police officer/teacher speaking to what they are seeing in their community, loss of tax revenue and the impacts that has on basic social services/public safety etc., fire suppression concerns.

Visuals: Community/town, schools, firetruck. Show individual being interviewed in their uniform or professional attire.

Key Points for Voiceover

- This is not just a rural issue, or even just a California issue. Over a third of the country's vegetables and three-quarters of the country's fruits and nuts are grown in California.
- Food security
- And across California, the landscape is changing as water supplies dwindle.

Interview #4

Urban water agency describing their impacts. Water comes out of the tap when customers turn it but cities are not without impacts. Need specific impacts noted.

Commented [AN4]: Robert Chang/CVWD

Visuals: Depends on agency and content.

Key Points for Voiceover

- Because of these devastating impacts, California MUST capture water when it is abundant
- And the ARE times when there is simply more water than our current system can handle

Visuals: Footage of high flows, flooding (could we show Oroville??)

Interview #5

Sites board member speaking to how we've seen incredibly high flows on the Sacramento River, but today it's barely moving. They water is there, but we need to be able to capture it. That's where Sites comes in.

Visuals: High flows and then current footage

Commented [AN5]: Add environmental impacts (e.g. refuge water/birds)

Commented [AN6R5]: Rice Commission

Key Points for Voiceover:

- Sites Reservoir will store water from these high flow periods and save it for dry years, like the one we are in now.
- The water will go to people, the environment and farms.
- We don't have any storage like Sites Reservoir today. This is a new way of preparing for droughts.
- And as climate change worsens, Sites will provide even more benefit.

To learn more, visit www.sitesproject.org.

From: Briard, Monique [Monique.Briard@icf.com]
Sent: 11/11/2022 1:53:27 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: RE: Sites - Someone to Help Reclamation Review of Batch 3

Hi Ali,

I've spoken with Suzanne and she is fully booked working on ReRoc with Reclamation so she isn't a good choice for this task. I do have someone in mind though who is an oncall with ICF – a retired NMFS/DOJ employee who has a lot of years of experience as a NEPA compliance reviewer, including the EIS for Lower Bois d/Arc Creek Reservoir with Gregg Roy for USACE. We can chat more when we talk next week.

Have a great weekend,
Monique

P.S. I started this email first thing this morning and had to remove Good Morning from my salutation. It's been one of those days.

Monique Briard
916.231.9551 (direct) | 916.842.0894 (mobile)

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Thursday, November 3, 2022 2:09 PM
To: Briard, Monique <Monique.Briard@icf.com>
Subject: RE: Sites - Someone to Help Reclamation Review of Batch 3

Someone to do an independent review of all of the Batch 3 RTC tables and Master Responses – with Reclamation's interests in mind. This might be someone who would lead the review and they may need to pull in a fish or aquatic biologist for the details.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Briard, Monique <Monique.Briard@icf.com>
Sent: Thursday, November 3, 2022 12:28 PM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: RE: Sites - Someone to Help Reclamation Review of Batch 3

Are looking for someone to do an independent review of all of the Batch 3 RTC tables and Master Responses or, are you just looking for someone to review Master Response 5, Aquatic Biological Resources, and associated individual comment tables? If it's the latter, it seems like you are looking for a Fish and Aquatics Sr Biologist or are you thinking of a NEPA practitioner?

Monique Briard
916.231.9551 (direct) | 916.842.0894 (mobile)

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Thursday, November 3, 2022 10:47 AM
To: Briard, Monique <Monique.Briard@icf.com>
Subject: Sites - Someone to Help Reclamation Review of Batch 3

Hi Monique – We're looking to help Reclamation's BDO team in their review of the Final EIR/EIS Batch 3 comments. Does ICF have someone in house or as a sub on the Sites contract that has been involved in the Reconsultation effort with Reclamation but NOT involved in Sites? Looking for someone that is a bit independent of Sites, in tune with the reconsultation, and could review the documents from Reclamation's perspective. I realize we would need to add this person into the Sites contract. Looking for someone fairly senior – that Reclamation would be comfortable with this.

ICF should continue on the Final EIR/EIS Batch 3 work. This will run in parallel if we end up doing this for Reclamation.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: JP Robinette [jrobinette@sitesproject.org]
Sent: 11/14/2022 12:07:47 PM
To: Kevin Spesert [kspesert@sitesproject.org]
CC: Luu, Henry [henry.luu@hdrinc.com]
Subject: Fw: Sites LMC 202211 Item 1.1 Considerations for establishing a project baseline schedule - Presentation
Attachments: 202211_LMC Item 1.1_Considerations for Establishing Baseline Schedule.pptx

Kevin,

Here are our slides for the LMC Friday.

Thanks,

JP

From: Luu, Henry <Henry.Luu@hdrinc.com>
Sent: Monday, November 14, 2022 10:51 AM
To: JP Robinette <jrobinette@sitesproject.org>
Subject: Sites LMC 202211 Item 1.1 Considerations for establishing a project baseline schedule - Presentation

JP,

Attached are slides from the O&E presentation with minor word-smith edits to bullet 3 on slide 9 (on SharePoint @202211_LMC Item 1.1_Considerations for Establishing Baseline Schedule.pptx).

Henry H. Luu, PE
D 916.679.8857 M 916.754.7566

hdrinc.com/follow-us

Agenda Item 1.1:
Considerations for Establishing a Project Baseline Schedule

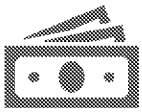
JP Robinette

Sites

Amendment 3 Main Goals and Objectives

Obtain key permits

Obtain water rights



Secure project financing

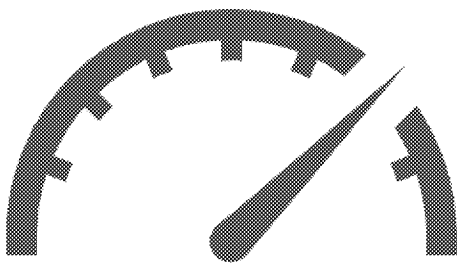
Draft - Predecisional Working Document - For Discussion Purposes Only

Only one of the 3 goals is completely within the Authority's control – secure project financing. Regulators control the schedule for obtaining key permits and water rights. All 3 define the project schedule and timing of investor commitment, i.e. 'Go'.

Schedule Moves the Cost Needle

Fixed Costs

- Interest rates (financing participants)
- Pace (schedule)
- Controlling construction costs (delivery method & risk allocation)
- Bifurcated costs
- Extreme market conditions



Variable Costs

- Power
- Losses (evaporation and seepage)

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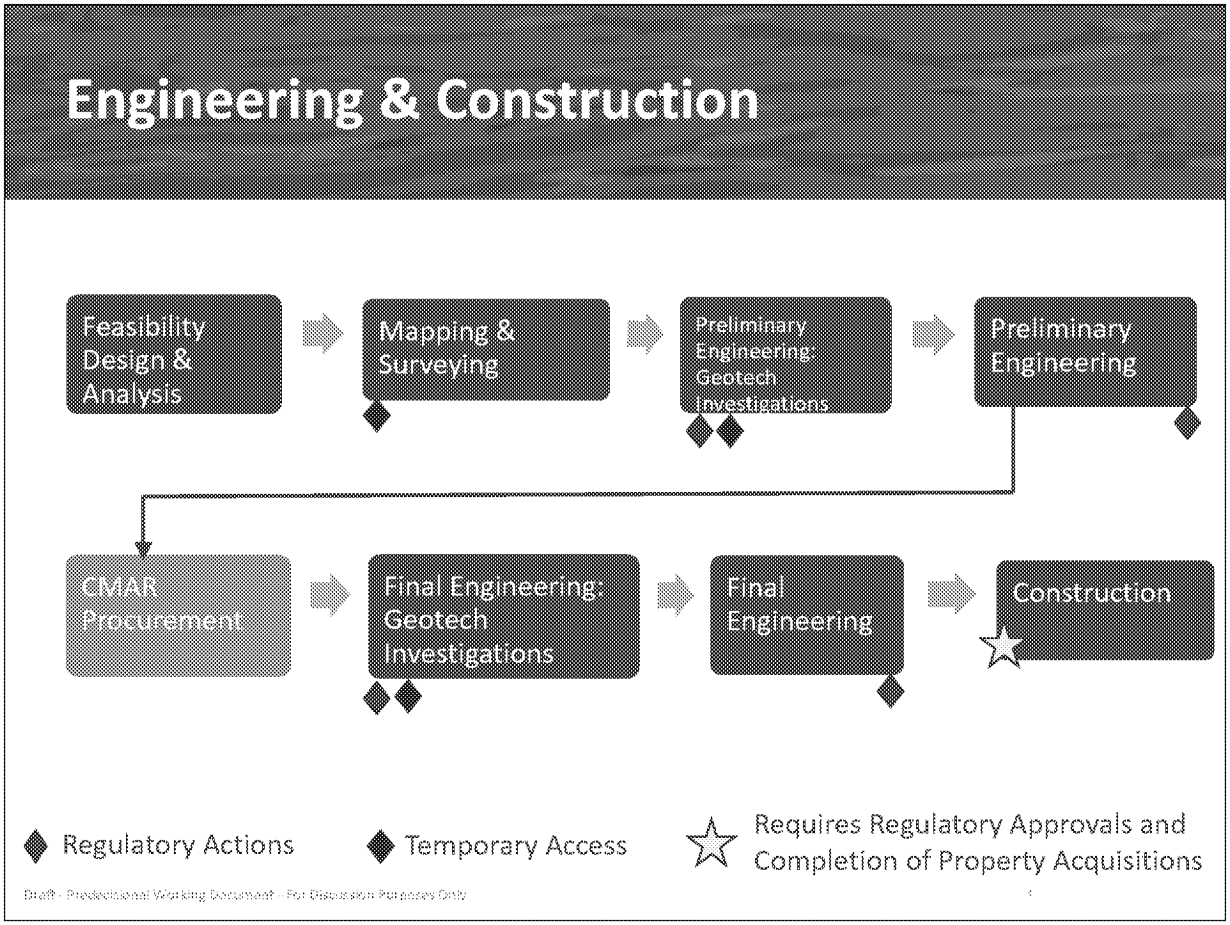
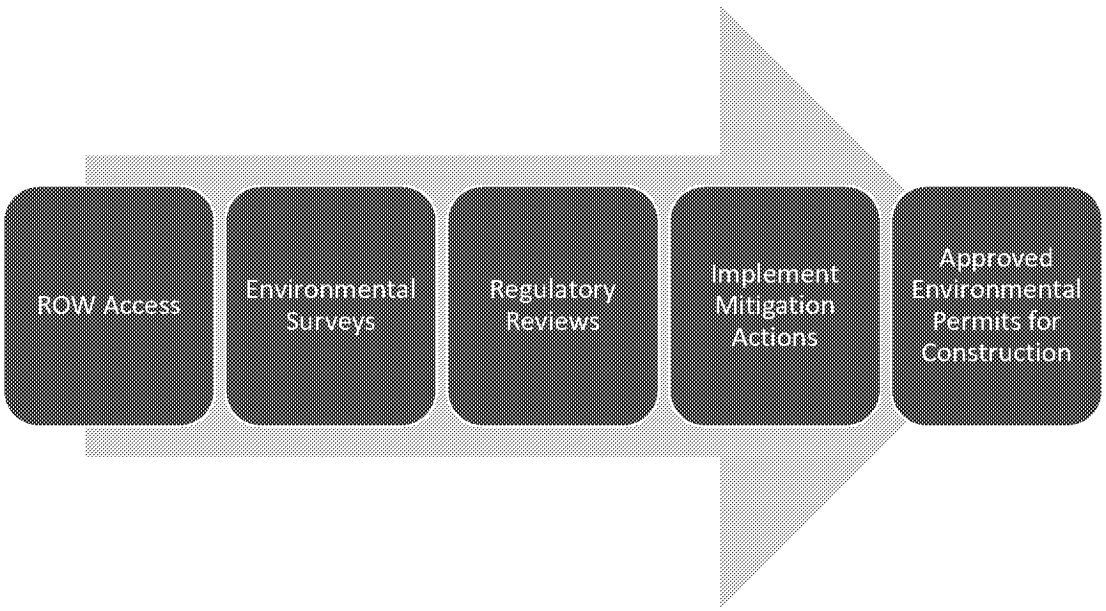


Talking schedule requires a lot of discussion around process. The engineering and construction process is mapped out here and forms the skeleton of our master schedule.

Temporary access and completion of property acquisition is within the Authority's control

Environmental Permitting & Mitigation Process for getting to Construction



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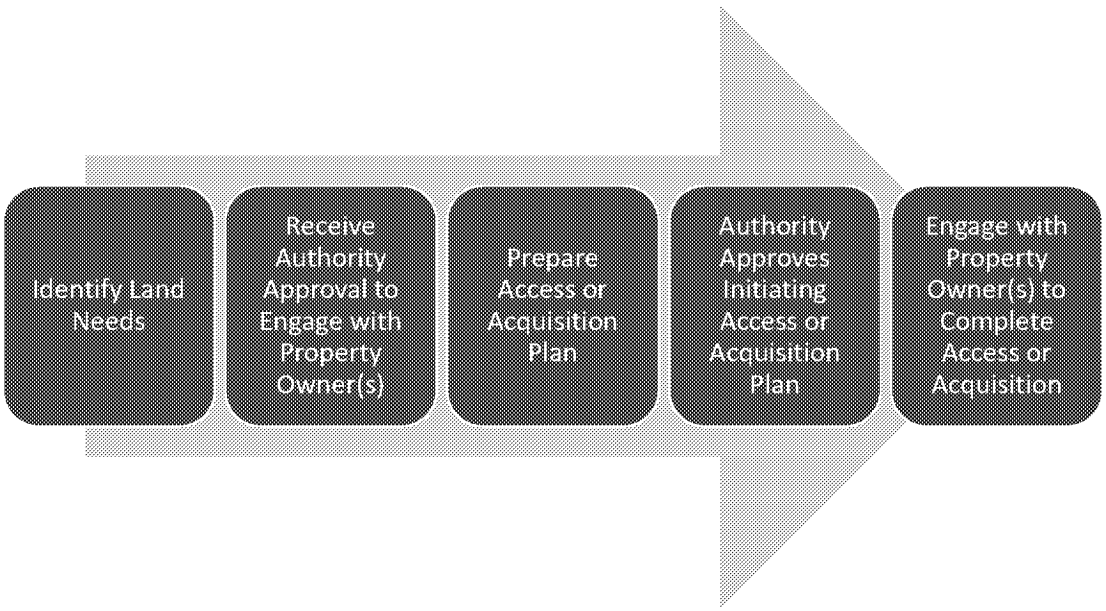
Real Estate Process for getting to Construction



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Opportunities to Influence Schedule

- **Real Estate** – initiate acquisitions prior to obtaining key permits and/or water rights (after certified EIR/EIS)
  - Supports required environmental surveys
  - Supports geotechnical investigations
  - Potential schedule/time savings by eliminating a need for two separate negotiation actions: temporary access and permanent acquisition
  - *Risk: the Authority owns and is responsible for the acquired properties regardless of Project status*
  - *Risk: expenditures related to initiating real estate acquisitions have not been accounted for within the Amendment 3 budget*

Draft_0020732

Opportunities to Influence Schedule

- **Contracting and Procurement** – initiate CMAR procurement prior to investor commitment
  - Benefits in having insight on potential construction schedule efficiencies, value engineering, and material handling
  - Potential cost saving strategies and cost certainty
  - *Risk: CMAR procurement and engagement is an additional expense that is not accounted for within the Amendment 3 budget*
- **Construction Phasing** – balancing resources based on the critical path of construction packages
  - Greater assurance of balancing expenditures vs. revenue
  - *Risk: potential for critical path changes that may impact Program Schedule*

Draft_0020733

Next Steps

- Continue coordination with real estate and permitting teams in preparation of the Baseline Program Schedule
- Focus on managing costs and risk, while remaining aggressive with overall schedule
- Complete analyses and identify staff recommendations for the Baseline Program Schedule early next year (January 2023 timeframe)

Draft_0020734

Discussion

What assurances are required to initiate early real estate acquisitions (before obtaining key permits and water rights)?

What type of risks should staff consider with regards to an accelerated schedule? (ex: Project reputation)

What analyses would be helpful for understanding schedule opportunities and risks? (ex: cost/benefit assessment)

Draft_0020735

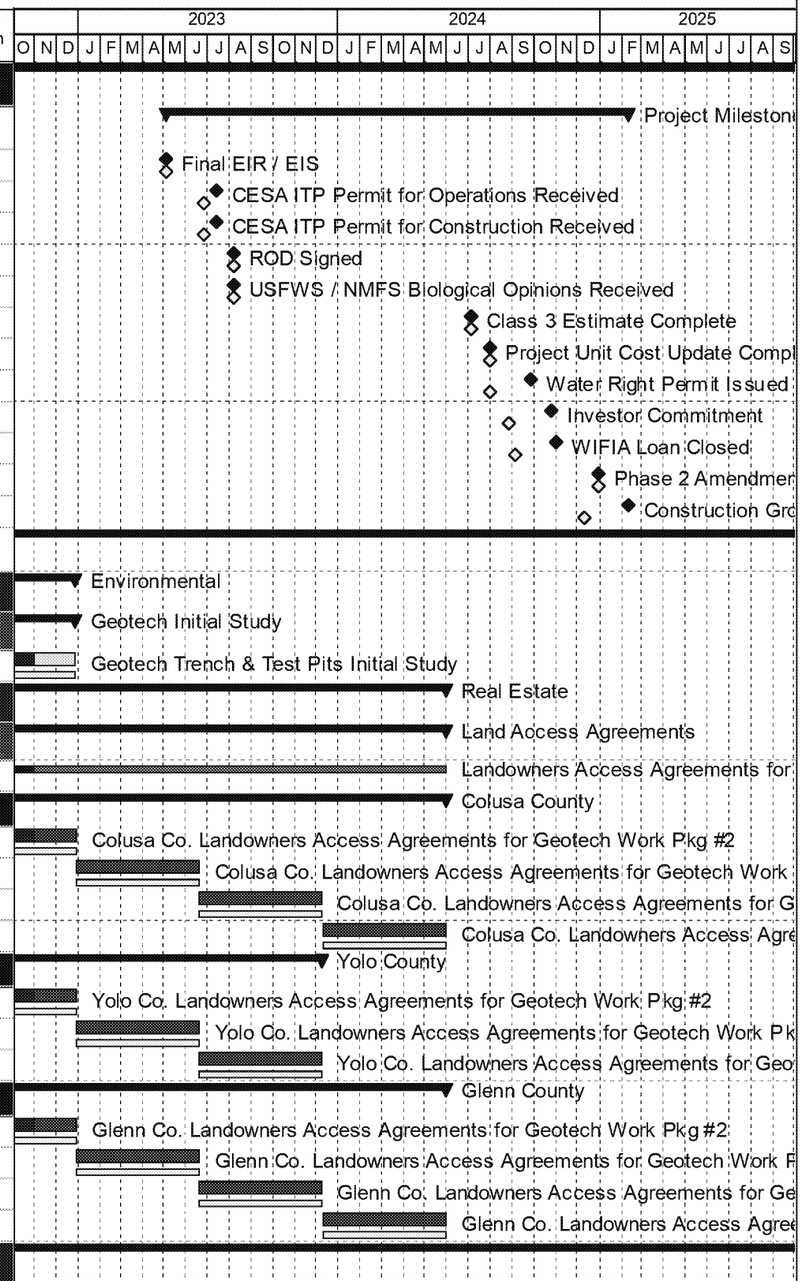
Questions?

Sites

Sites Reservoir Project

Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
1	**Sites Reservoir Project DD: 01-Nov-2022**		01-Sep-20 A	24-Sep-36	3601	01-Sep-20	26-Mar-36	-130
2	**Project Milestones**		05-May-23	10-Feb-25	442	05-May-23	31-Dec-24	-29
3	MS-1200	Final EIR / EIS		05-May-23	0		05-May-23	0
4	MS-1320	CESA ITP Permit for Operations Received		14-Jul-23	0		26-Jun-23	-13
5	MS-1340	CESA ITP Permit for Construction Received		14-Jul-23	0		26-Jun-23	-13
6	MS-1300	ROD Signed		07-Aug-23	0		07-Aug-23	0
7	MS-1150	USFWS / NMFS Biological Opinions Received		07-Aug-23	0		07-Aug-23	0
8	MS-1700	Class 3 Estimate Complete		05-Jul-24	0		05-Jul-24	0
9	MS-1450	Project Unit Cost Update Complete		30-Jul-24	0		30-Jul-24	0
10	MS-1400	Water Right Permit Issued		26-Sep-24	0		30-Jul-24	-41
11	MS-1500	Investor Commitment		24-Oct-24*	0		27-Aug-24	-41
12	MS-1600	WIFIA Loan Closed		31-Oct-24	0		04-Sep-24	-41
13	MS-5000	Phase 2 Amendment 3 Complete		31-Dec-24*	0		31-Dec-24	0
14	MS-3000	Construction Groundbreaking	10-Feb-25		0	11-Dec-24		-41
15	**Geotech Program**		22-Mar-22 A	30-Sep-26	997	22-Mar-22	04-Aug-26	-41
16	**Environmental**		20-Jun-22 A	27-Dec-22	37	20-Jun-22	27-Dec-22	0
17	**Geotech Initial Study**		20-Jun-22 A	27-Dec-22	37	20-Jun-22	27-Dec-22	0
18	IS-205	Geotech Trench & Test Pits Initial Study	20-Jun-22 A	27-Dec-22	37	20-Jun-22	27-Dec-22	0
19	**Real Estate**		22-Mar-22 A	30-May-24	394	22-Mar-22	30-May-24	0
20	**Land Access Agreements**		22-Mar-22 A	30-May-24	394	22-Mar-22	30-May-24	0
21	A1250	Landowners Access Agreements for Geotech	22-Mar-22 A	30-May-24	394	22-Mar-22	30-May-24	0
22	**Colusa County**		22-Mar-22 A	30-May-24	399	22-Mar-22	30-May-24	0
23	LAAC-1200	Colusa Co. Landowners Access Agreements for Geotech Work Pkg #2	22-Mar-22 A	29-Dec-22	39	22-Mar-22	29-Dec-22	0
24	LAAC-1300	Colusa Co. Landowners Access Agreements for Geotech Work Pkg #3	30-Dec-22	19-Jun-23	120	30-Dec-22	19-Jun-23	0
25	LAAC-1400	Colusa Co. Landowners Access Agreements for Geotech Work Pkg #4	20-Jun-23	08-Dec-23	120	20-Jun-23	08-Dec-23	0
26	LAAC-1500	Colusa Co. Landowners Access Agreements for Geotech Work Pkg #5	11-Dec-23	30-May-24	120	11-Dec-23	30-May-24	0
27	**Yolo County**		22-Mar-22 A	08-Dec-23	279	22-Mar-22	08-Dec-23	0
28	LAAY-1200	Yolo Co. Landowners Access Agreements for Geotech Work Pkg #2	22-Mar-22 A	29-Dec-22	39	22-Mar-22	29-Dec-22	0
29	LAAY-1300	Yolo Co. Landowners Access Agreements for Geotech Work Pkg #3	30-Dec-22	19-Jun-23	120	30-Dec-22	19-Jun-23	0
30	LAAY-1400	Yolo Co. Landowners Access Agreements for Geotech Work Pkg #4	20-Jun-23	08-Dec-23	120	20-Jun-23	08-Dec-23	0
31	**Glenn County**		22-Mar-22 A	30-May-24	399	22-Mar-22	30-May-24	0
32	LAAG-1200	Glenn Co. Landowners Access Agreements for Geotech Work Pkg #2	22-Mar-22 A	29-Dec-22	39	22-Mar-22	29-Dec-22	0
33	LAAG-1300	Glenn Co. Landowners Access Agreements for Geotech Work Pkg #3	30-Dec-22	19-Jun-23	120	30-Dec-22	19-Jun-23	0
34	LAAG-1400	Glenn Co. Landowners Access Agreements for Geotech Work Pkg #4	20-Jun-23	08-Dec-23	120	20-Jun-23	08-Dec-23	0
35	LAAG-1500	Glenn Co. Landowners Access Agreements for Geotech Work Pkg #5	11-Dec-23	30-May-24	120	11-Dec-23	30-May-24	0
36	**Geotechnical Engineering**		06-Sep-22 A	30-Sep-26	997	06-Sep-22	04-Aug-26	-41



Remaining Level of Effort · Actual Work · Baseline Milestone
Actual Level of Effort · Remaining Work · Milestone
Primary Baseline · Critical Remaining Work · Summary

Project ID: Sites November 2022 / Project Name: Sites Reservoir Project DD: 01-Nov-2022
Layout Name: Sites Comp vs Prior Month / TASK filter: Less than 100%.
Data Date: 01-Nov-22 / Print Date: 10-Nov-22

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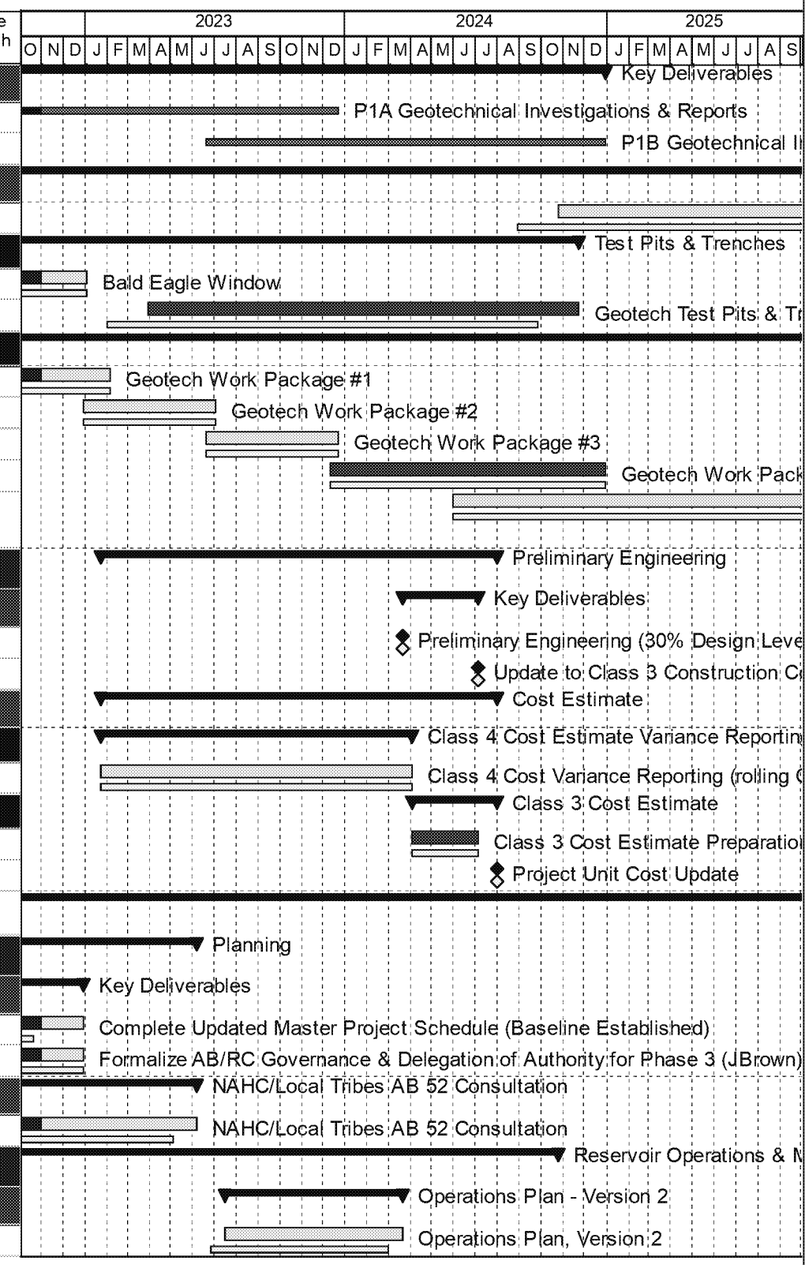
Sites Reservoir Project

Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
37	**Key Deliverables**		06-Sep-22 A	31-Dec-24	546	06-Sep-22	31-Dec-24	0
38	KD-2015	P1A Geotechnical Investigations & Reports	06-Sep-22 A	22-Dec-23	289	06-Sep-22	22-Dec-23	0
39	KD-2025	P1B Geotechnical Investigations & Reports	20-Jun-23	31-Dec-24	387	20-Jun-23	31-Dec-24	0
40	**Geotechnical Investigations**		06-Sep-22 A	30-Sep-26	997	06-Sep-22	04-Aug-26	-41
41	A1560	P2 Geotech for Final Design	25-Oct-24	30-Sep-26	500	28-Aug-24	04-Aug-26	-41
42	**Test Pits & Trenches**		06-Sep-22 A	22-Nov-24	523	06-Sep-22	26-Sep-24	-41
43	TPT-1100	Bald Eagle Window	06-Sep-22 A	03-Jan-23	41	06-Sep-22	03-Jan-23	0
44	TPT-1200	Geotech Test Pits & Trenches - Short Term Pemit Window	31-Mar-23	22-Nov-24	420	02-Feb-23	26-Sep-24	-41
45	**Work Packages**		06-Sep-22 A	31-Dec-25	799	06-Sep-22	31-Dec-25	0
46	GWP-1100	Geotech Work Package #1	06-Sep-22 A	06-Feb-23	65	06-Sep-22	06-Feb-23	0
47	GWP-1200	Geotech Work Package #2	30-Dec-22	03-Jul-23	130	30-Dec-22	03-Jul-23	0
48	GWP-1300	Geotech Work Package #3	20-Jun-23	22-Dec-23	130	20-Jun-23	22-Dec-23	0
49	GWP-1400	Geotech Work Package #4	11-Dec-23	31-Dec-24	267	11-Dec-23	31-Dec-24	0
50	GWP-1500	Geotech Work Package #5 (need for Sites Lodoga Rd. Realignment Cost Certainty)	31-May-24	31-Dec-25	400	31-May-24	31-Dec-25	0
51	**Preliminary Engineering**		24-Jan-23	30-Jul-24	386	24-Jan-23	30-Jul-24	0
52	**Key Deliverables**		20-Mar-24	05-Jul-24	75	20-Mar-24	05-Jul-24	0
53	KD-1180	Preliminary Engineering (30% Design Level)		20-Mar-24	0		20-Mar-24	0
54	KD-1190	Update to Class 3 Construction Cost Estimate		05-Jul-24	0		05-Jul-24	0
55	**Cost Estimate**		24-Jan-23	30-Jul-24	386	24-Jan-23	30-Jul-24	0
56	**Class 4 Cost Estimate Variance Reporting**		24-Jan-23	03-Apr-24	304	24-Jan-23	03-Apr-24	0
57	C4E-1000	Class 4 Cost Variance Reporting (rolling Class 4)	24-Jan-23	03-Apr-24	304	24-Jan-23	03-Apr-24	0
58	**Class 3 Cost Estimate**		04-Apr-24	30-Jul-24	82	04-Apr-24	30-Jul-24	0
59	C3E-1000	Class 3 Cost Estimate Preparation (Capital Cost)	04-Apr-24	05-Jul-24	65	04-Apr-24	05-Jul-24	0
60	CU-1000	Project Unit Cost Update		30-Jul-24	0		30-Jul-24	0
61	**Project Development**		01-Sep-20 A	27-Apr-29	1669	01-Sep-20	27-Apr-29	0
62	**Planning**		01-Sep-20 A	06-Jun-23	150	01-Sep-20	05-May-23	-21
63	**Key Deliverables**		24-Jan-22 A	30-Dec-22	40	24-Jan-22	30-Dec-22	0
64	KD-1130	Complete Updated Master Project Schedule (Baseline Established)	24-Jan-22 A	30-Dec-22	40	24-Jan-22	21-Oct-22	-46
65	KD-1290	Formalize AB/RC Governance & Delegation of Authority for Phase 3 (JBrc	06-Sep-22 A	30-Dec-22	40	06-Sep-22	30-Dec-22	0
66	**NAHC/Local Tribes AB 52 Consultation**		01-Sep-20 A	06-Jun-23	150	01-Sep-20	05-May-23	-21
67	STA-120	NAHC/Local Tribes AB 52 Consultation	01-Sep-20 A	06-Jun-23	150	01-Sep-20	05-May-23	-21
68	**Reservoir Operations & Modeling**		03-Jan-22 A	25-Oct-24	503	03-Jan-22	25-Oct-24	0
69	**Operations Plan - Version 2**		17-Jul-23	20-Mar-24	172	27-Jun-23	01-Mar-24	-13
70	KD-1510	Operations Plan, Version 2	17-Jul-23	20-Mar-24	172	27-Jun-23	01-Mar-24	-13



Remaining Level of Effort
Actual Level of Effort
Primary Baseline
Actual Work
Remaining Work
Critical Remaining Work
Baseline Milestone
Milestone
Summary

Project ID: Sites November 2022 / Project Name: Sites Reservoir Project DD: 01-Nov-2022
Layout Name: Sites Comp vs Prior Month / TASK filter: Less than 100%.
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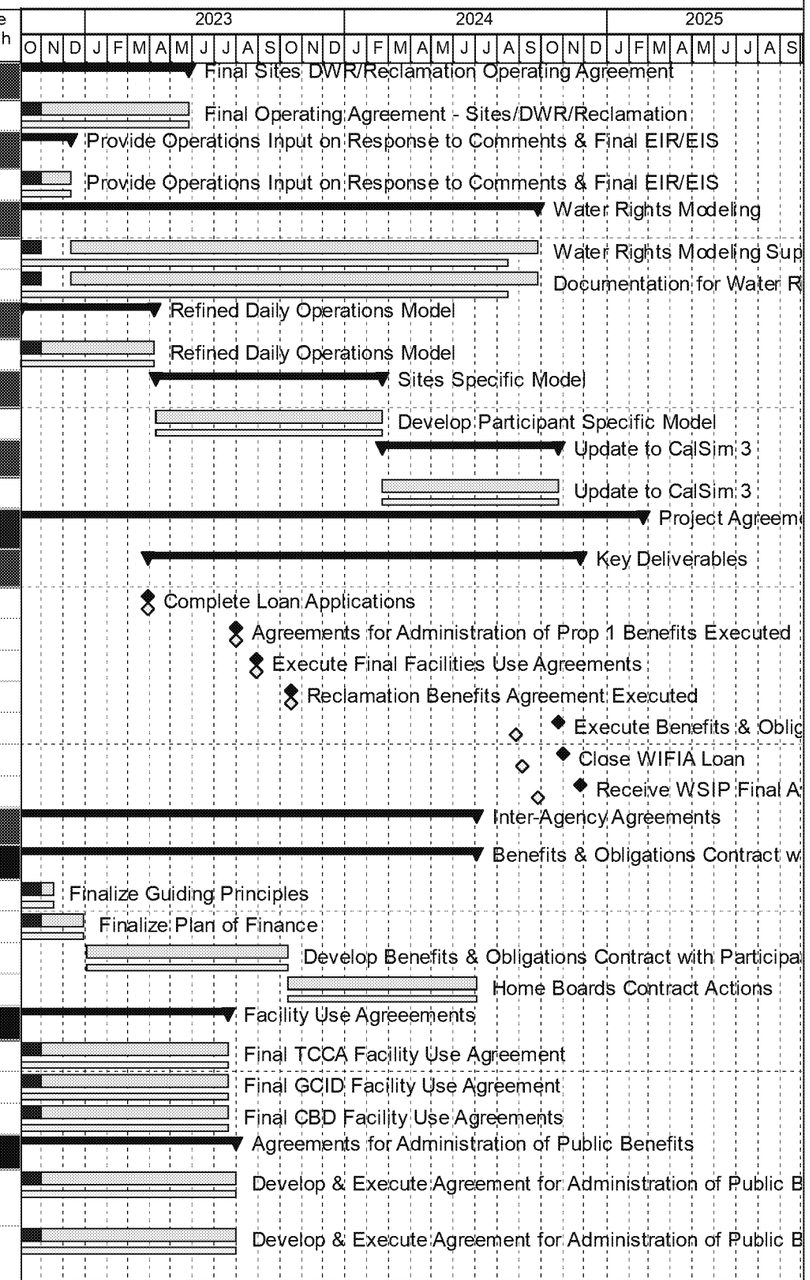
Sites Reservoir Project

Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
71	**Final Sites DWR/Reclamation Operating Agreement**		19-Apr-22 A	26-May-23	144	19-Apr-22	26-May-23	0
72	OP-1005	Final Operating Agreement - Sites/DWR/Reclamation	19-Apr-22 A	26-May-23	144	19-Apr-22	26-May-23	0
73	**Provide Operations Input on Response to Comments & Final EIR/EIS**		24-May-22 A	12-Dec-22	28	24-May-22	12-Dec-22	0
74	FO-1080	Provide Operations Input on Response to Comments & Final EIR/EIS	24-May-22 A	12-Dec-22	28	24-May-22	12-Dec-22	0
75	**Water Rights Modeling**		03-Jan-22 A	26-Sep-24	454	03-Jan-22	16-Aug-24	-28
76	A1200	Water Rights Modeling Support	03-Jan-22 A	26-Sep-24	454	03-Jan-22	16-Aug-24	-28
77	A1210	Documentation for Water Rights	03-Jan-22 A	26-Sep-24	454	03-Jan-22	16-Aug-24	-28
78	**Refined Daily Operations Model**		03-Oct-22 A	07-Apr-23	109	03-Oct-22	07-Apr-23	0
79	A1220	Refined Daily Operations Model	03-Oct-22 A	07-Apr-23	109	03-Oct-22	07-Apr-23	0
80	**Sites Specific Model**		10-Apr-23	21-Feb-24	220	10-Apr-23	21-Feb-24	0
81	OS-1150	Develop Participant Specific Model	10-Apr-23	21-Feb-24	220	10-Apr-23	21-Feb-24	0
82	**Update to CalSim 3**		22-Feb-24	25-Oct-24	174	22-Feb-24	25-Oct-24	0
83	A1230	Update to CalSim 3	22-Feb-24	25-Oct-24	174	22-Feb-24	25-Oct-24	0
84	**Project Agreements & Funding**		01-Jun-21 A	20-Feb-25	578	01-Jun-21	20-Dec-24	-42
85	**Key Deliverables**		29-Mar-23	25-Nov-24	422	29-Mar-23	27-Sep-24	-41
86	KD-1255	Complete Loan Applications		29-Mar-23	0		29-Mar-23	0
87	KD-1520	Agreements for Administration of Prop 1 Benefits Executed		31-Jul-23	0		31-Jul-23	0
88	KD-1230	Execute Final Facilities Use Agreements		29-Aug-23	0		29-Aug-23	0
89	KD-1260	Reclamation Benefits Agreement Executed		17-Oct-23	0		17-Oct-23	0
90	KD-1300	Execute Benefits & Obligations Contracts with Participants		24-Oct-24	0		27-Aug-24	-41
91	KD-2600	Close WIFIA Loan		31-Oct-24	0		04-Sep-24	-41
92	KD-1310	Receive WSIP Final Award from CWC		25-Nov-24	0		27-Sep-24	-41
93	**Inter-Agency Agreements**		01-Jun-21 A	02-Jul-24	417	01-Jun-21	02-Jul-24	0
94	**Benefits & Obligations Contract with Participants**		01-Mar-22 A	02-Jul-24	417	01-Mar-22	02-Jul-24	0
95	BO-1100	Finalize Guiding Principles	01-Mar-22 A	18-Nov-22	14	01-Mar-22	18-Nov-22	0
96	BO-1200	Finalize Plan of Finance	01-Mar-22 A	30-Dec-22	40	01-Mar-22	30-Dec-22	0
97	BO-1300	Develop Benefits & Obligations Contract with Participants	03-Jan-23	12-Oct-23	200	03-Jan-23	12-Oct-23	0
98	BO-1400	Home Boards Contract Actions	13-Oct-23	02-Jul-24	180	13-Oct-23	02-Jul-24	0
99	**Facility Use Agreeements**		27-Aug-21 A	21-Jul-23	182	27-Aug-21	21-Jul-23	0
100	FO-1020	Final TCCA Facility Use Agreement	27-Aug-21 A	21-Jul-23	182	27-Aug-21	21-Jul-23	0
101	FO-1030	Final GCID Facility Use Agreement	27-Aug-21 A	21-Jul-23	182	27-Aug-21	21-Jul-23	0
102	FO-1040	Final CBD Facility Use Agreements	27-Aug-21 A	21-Jul-23	182	27-Aug-21	21-Jul-23	0
103	**Agreements for Administration of Public Benefits**		31-Mar-22 A	31-Jul-23	188	31-Mar-22	31-Jul-23	0
104	PB-1100	Develop & Execute Agreement for Administration of Public Benefits with DWR (ali/chey)	31-Mar-22 A	31-Jul-23	188	31-Mar-22	31-Jul-23	0
105	PB-1200	Develop & Execute Agreement for Administration of Public Benefits with CDFW (ali/chey)	31-Mar-22 A	31-Jul-23	188	31-Mar-22	31-Jul-23	0



Remaining Level of Effort
Actual Level of Effort
Primary Baseline
Actual Work
Remaining Work
Critical Remaining Work
Baseline Milestone
Milestone
Summary

Project ID: Sites November 2022 / Project Name: Sites Reservoir Project DD: 01-Nov-2022
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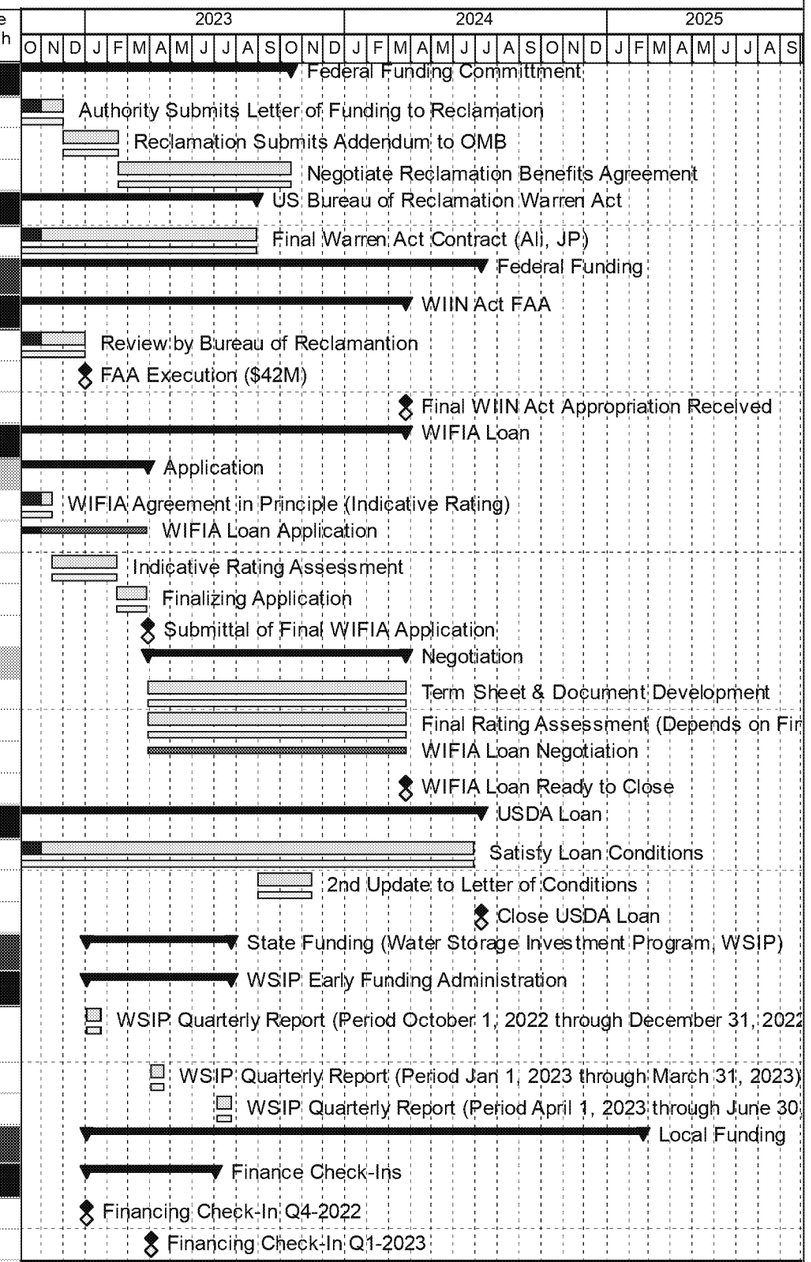
Sites Reservoir Project

Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
106	**Federal Funding Committment**		19-Sep-22 A	17-Oct-23	243	19-Sep-22	17-Oct-23	0
107	WIIN-1160	Authority Submits Letter of Funding to Reclamation	19-Sep-22 A	30-Nov-22	20	19-Sep-22	30-Nov-22	0
108	WIIN-1180	Reclamation Submits Addendum to OMB	01-Dec-22	16-Feb-23	53	01-Dec-22	16-Feb-23	0
109	WIIN-1170	Negotiate Reclamation Benefits Agreement	17-Feb-23	17-Oct-23	170	17-Feb-23	17-Oct-23	0
110	**US Bureau of Reclamation Warren Act**		01-Jun-21 A	29-Aug-23	209	01-Jun-21	29-Aug-23	0
111	FED-090	Final Warren Act Contract (Ali, JP)	01-Jun-21 A	29-Aug-23	209	01-Jun-21	29-Aug-23	0
112	**Federal Funding**		10-Jun-22 A	08-Jul-24	420	10-Jun-22	08-Jul-24	0
113	**WIIN Act FAA**		10-Jun-22 A	25-Mar-24	347	10-Jun-22	25-Mar-24	0
114	WIIN-1190	Review by Bureau of Reclamantion	10-Jun-22 A	31-Dec-22	61	10-Jun-22	31-Dec-22	0
115	WIIN-1210	FAA Execution ($42M)		31-Dec-22	0		31-Dec-22	0
116	WIIN-1200	Final WIIN Act Appropriation Received		25-Mar-24	0		25-Mar-24	0
117	**WIFIA Loan**		05-Jul-22 A	25-Mar-24	347	05-Jul-22	25-Mar-24	0
118	**Application**		05-Jul-22 A	29-Mar-23	100	05-Jul-22	29-Mar-23	0
119	WIFIA-110	WIFIA Agreement in Principle (Indicative Rating)	05-Jul-22 A	15-Nov-22	11	05-Jul-22	15-Nov-22	0
120	WIFIA-300	WIFIA Loan Application	05-Jul-22 A	28-Mar-23	99	05-Jul-22	28-Mar-23	0
121	WIFIA-120	Indicative Rating Assessment	16-Nov-22	14-Feb-23	60	16-Nov-22	14-Feb-23	0
122	WIFIA-130	Finalizing Application	15-Feb-23	28-Mar-23	30	15-Feb-23	28-Mar-23	0
123	WIFIA-140	Submittal of Final WIFIA Application		29-Mar-23	0		29-Mar-23	0
124	**Negotiation**		30-Mar-23	25-Mar-24	247	30-Mar-23	25-Mar-24	0
125	WIFIA-210	Term Sheet & Document Development	30-Mar-23	25-Mar-24	250	30-Mar-23	25-Mar-24	0
126	WIFIA-220	Final Rating Assessment (Depends on Final Rebalancing)	30-Mar-23	25-Mar-24	250	30-Mar-23	25-Mar-24	0
127	WIFIA-240	WIFIA Loan Negotiation	30-Mar-23	25-Mar-24	247	30-Mar-23	25-Mar-24	0
128	WIFIA-230	WIFIA Loan Ready to Close		25-Mar-24	0		25-Mar-24	0
129	**USDA Loan**		02-Sep-22 A	08-Jul-24	420	02-Sep-22	08-Jul-24	0
130	USDA-1060	Satisfy Loan Conditions	02-Sep-22 A	28-Jun-24	420	02-Sep-22	28-Jun-24	0
131	USDA-1080	2nd Update to Letter of Conditions	01-Sep-23	14-Nov-23	50	01-Sep-23	14-Nov-23	0
132	USDA-1070	Close USDA Loan		08-Jul-24	0		08-Jul-24	0
133	**State Funding (Water Storage Investment Program, WSIP)**		03-Jan-23	25-Jul-23	144	03-Jan-23	25-Jul-23	0
134	**WSIP Early Funding Administration**		03-Jan-23	25-Jul-23	144	03-Jan-23	25-Jul-23	0
135	WSIP-1240	WSIP Quarterly Report (Period October 1, 2022 through December 31, 2022)	03-Jan-23	23-Jan-23	15	03-Jan-23	23-Jan-23	0
136	WSIP-1250	WSIP Quarterly Report (Period Jan 1, 2023 through March 31, 2023)	03-Apr-23	21-Apr-23	15	03-Apr-23	21-Apr-23	0
137	WSIP-1260	WSIP Quarterly Report (Period April 1, 2023 through June 30, 2023)	05-Jul-23	25-Jul-23	15	05-Jul-23	25-Jul-23	0
138	**Local Funding**		03-Jan-23	20-Feb-25	538	03-Jan-23	20-Dec-24	-42
139	**Finance Check-Ins**		03-Jan-23	03-Jul-23	126	03-Jan-23	03-Jul-23	0
140	FC-1270	Financing Check-In Q4-2022		03-Jan-23	0		03-Jan-23	0
141	FC-1280	Financing Check-In Q1-2023		03-Apr-23	0		03-Apr-23	0



Remaining Level of Effort
Actual Level of Effort
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Sites Reservoir Project

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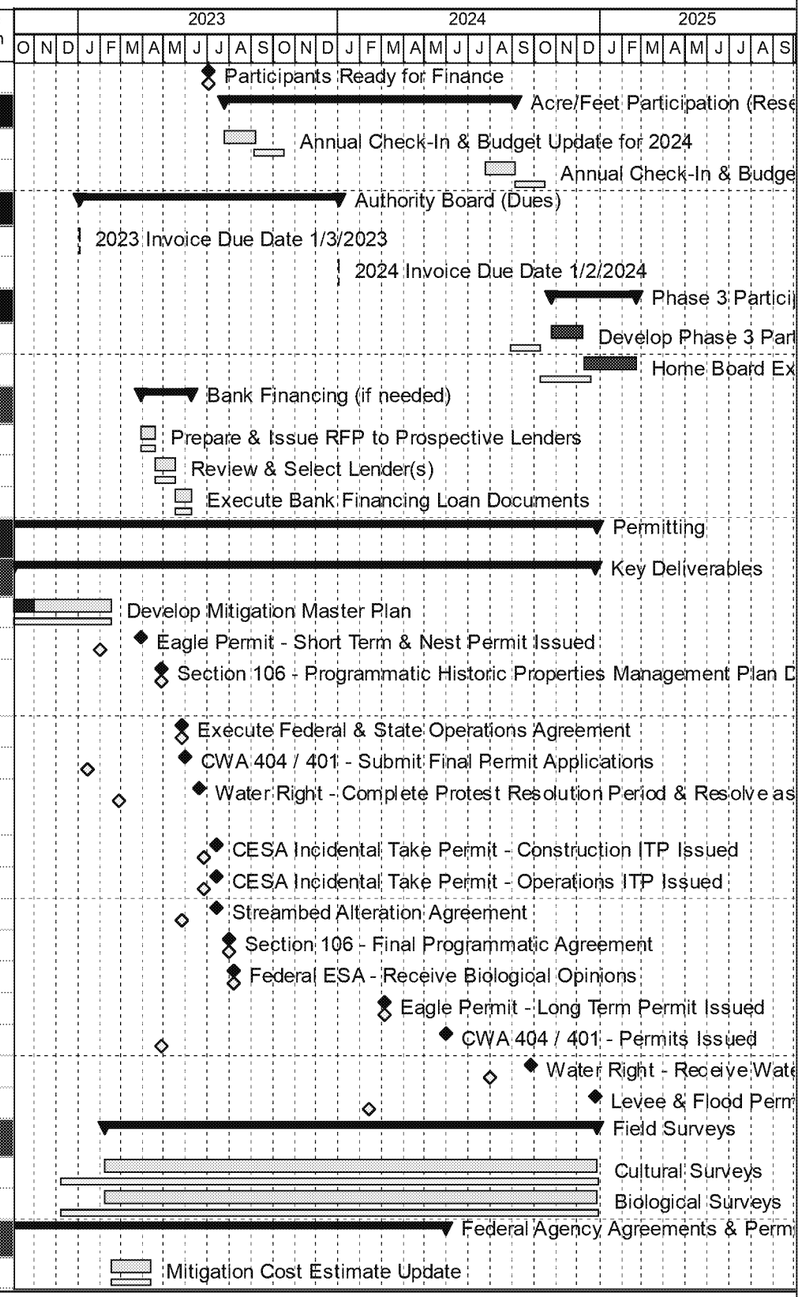
142	FC-1290	Participants Ready for Finance		03-Jul-23	0		03-Jul-23	0
143	**Acre/Feet Participation (Reservoir Committee Cash Calls)**		26-Jul-23	05-Sep-24	283	06-Sep-23	16-Oct-24	29
144	AF-1200	Annual Check-In & Budget Update for 2024	26-Jul-23	06-Sep-23	30	06-Sep-23	17-Oct-23	29
145	AF-1300	Annual Check-In & Budget Update for 2025	25-Jul-24	05-Sep-24	30	05-Sep-24	16-Oct-24	29
146	**Authority Board (Dues)**		03-Jan-23	02-Jan-24	253	03-Jan-23	02-Jan-24	0
147	AB-2200	2023 Invoice Due Date 1/3/2023	03-Jan-23	03-Jan-23*	1	03-Jan-23	03-Jan-23	0
148	AB-2300	2024 Invoice Due Date 1/2/2024	02-Jan-24	02-Jan-24*	1	02-Jan-24	02-Jan-24	0
149	**Phase 3 Participation Agreement (if needed)**		25-Oct-24	20-Feb-25	80	28-Aug-24	20-Dec-24	-41
150	PA-1100	Develop Phase 3 Participation Agreement	25-Oct-24	09-Dec-24	30	28-Aug-24	09-Oct-24	-41
151	PA-1200	Home Board Execution & Final Rebalancing	10-Dec-24	20-Feb-25	50	10-Oct-24	20-Dec-24	-41
152	**Bank Financing (if needed)**		30-Mar-23	08-Jun-23	50	30-Mar-23	08-Jun-23	0
153	BF-1100	Prepare & Issue RFP to Prospective Lenders	30-Mar-23	19-Apr-23	15	30-Mar-23	19-Apr-23	0
154	BF-1200	Review & Select Lender(s)	20-Apr-23	17-May-23	20	20-Apr-23	17-May-23	0
155	BF-1300	Execute Bank Financing Loan Documents	18-May-23	08-Jun-23	15	18-May-23	08-Jun-23	0
156	**Permitting**		04-Jan-21 A	27-Dec-24	539	04-Jan-21	31-Dec-24	2
157	**Key Deliverables**		03-Oct-22 A	26-Dec-24	543	03-Oct-22	30-Jul-24	-102
158	KD-1460	Develop Mitigation Master Plan	03-Oct-22 A	15-Feb-23	72	03-Oct-22	15-Feb-23	0
159	KD-1430	Eagle Permit - Short Term & Nest Permit Issued		30-Mar-23	0		01-Feb-23	-41
160	KD-1360	Section 106 - Programmatic Historic Properties Management Plan Development		28-Apr-23	0		28-Apr-23	0
161	KD-1240	Execute Federal & State Operations Agreement		26-May-23	0		26-May-23	0
162	KD-1390	CWA 404 / 401 - Submit Final Permit Applications		31-May-23	0		13-Jan-23	-97
163	KD-1320	Water Right - Complete Protest Resolution Period & Resolve as Many Protests as Possible		20-Jun-23	0		27-Feb-23	-80
164	KD-1370	CESA Incidental Take Permit - Construction ITP Issued		14-Jul-23	0		26-Jun-23	-13
165	KD-1380	CESA Incidental Take Permit - Operations ITP Issued		14-Jul-23	0		26-Jun-23	-13
166	KD-1420	Streambed Alteration Agreement		14-Jul-23	0		26-May-23	-33
167	KD-1350	Section 106 - Final Programmatic Agreement		01-Aug-23	0		01-Aug-23	0
168	KD-1340	Federal ESA - Receive Biological Opinions		07-Aug-23	0		07-Aug-23	0
169	KD-1440	Eagle Permit - Long Term Permit Issued		06-Mar-24	0		06-Mar-24	0
170	KD-1400	CWA 404 / 401 - Permits Issued		31-May-24	0		28-Apr-23	-276
171	KD-1330	Water Right - Receive Water Right Order & Permit		26-Sep-24	0		30-Jul-24	-41
172	KD-1410	Levee & Flood Permits - Section 408 & CVFPB Encroachment Permits Is		26-Dec-24	0		13-Feb-24	-220
173	**Field Surveys**		07-Feb-23	27-Dec-24	479	09-Dec-22	31-Dec-24	2
174	RE-1030	Cultural Surveys	07-Feb-23	27-Dec-24	479	09-Dec-22	31-Dec-24	2
175	RE-1040	Biological Surveys	07-Feb-23	27-Dec-24	479	09-Dec-22	31-Dec-24	2
176	**Federal Agency Agreements & Permits**		11-Jan-21 A	31-May-24	400	11-Jan-21	06-Mar-24	-61
177	CE-1570	Mitigation Cost Estimate Update	16-Feb-23	12-Apr-23	40	16-Feb-23	12-Apr-23	0



Remaining Level of Effort | Actual Work | Baseline Milestone
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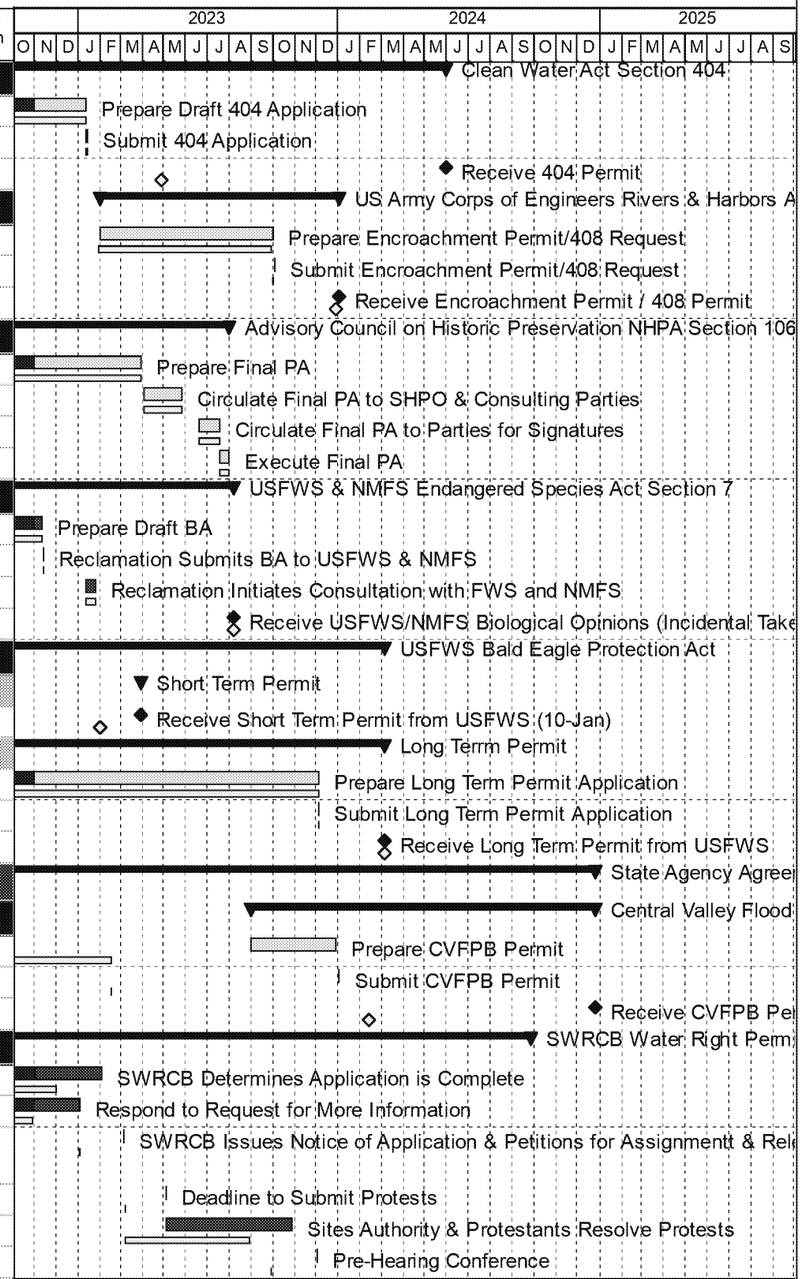
178	**Clean Water Act Section 404**		04-Feb-21 A	31-May-24	400	04-Feb-21	28-Apr-23	-276
179	404-050	Prepare Draft 404 Application	04-Feb-21 A	12-Jan-23	48	04-Feb-21	12-Jan-23	0
180	404-120	Submit 404 Application	13-Jan-23	13-Jan-23	1	13-Jan-23	13-Jan-23	0
181	404-130	Receive 404 Permit		31-May-24	0		28-Apr-23	-276
182	**US Army Corps of Engineers Rivers & Harbors Act Section 14, Section 408**		31-Jan-23	02-Jan-24	233	30-Jan-23	29-Dec-23	-1
183	408-150	Prepare Encroachment Permit/408 Request	31-Jan-23	02-Oct-23	172	30-Jan-23	29-Sep-23	-1
184	408-160	Submit Encroachment Permit/408 Request	03-Oct-23	03-Oct-23	1	02-Oct-23	02-Oct-23	-1
185	408-170	Receive Encroachment Permit / 408 Permit		02-Jan-24	0		29-Dec-23	-1
186	**Advisory Council on Historic Preservation NHPA Section 106**		14-Mar-22 A	01-Aug-23	189	14-Mar-22	01-Aug-23	0
187	106-081	Prepare Final PA	14-Mar-22 A	31-Mar-23	104	14-Mar-22	31-Mar-23	0
188	106-092	Circulate Final PA to SHPO & Consulting Parties	03-Apr-23	26-May-23	40	03-Apr-23	26-May-23	0
189	106-096	Circulate Final PA to Parties for Signatures	20-Jun-23	18-Jul-23	20	20-Jun-23	18-Jul-23	0
190	106-102	Execute Final PA	19-Jul-23	01-Aug-23	10	19-Jul-23	01-Aug-23	0
191	**USFWS & NMFS Endangered Species Act Section 7**		11-Jan-21 A	07-Aug-23	193	11-Jan-21	07-Aug-23	0
192	BA-200	Prepare Draft BA	11-Jan-21 A	11-Nov-22	9	11-Jan-21	11-Nov-22	0
193	BA-210	Reclamation Submits BA to USFWS & NMFS	14-Nov-22	14-Nov-22	1	14-Nov-22	14-Nov-22	0
194	BA-215	Reclamation Initiates Consultation with FWS and NMFS	13-Jan-23	26-Jan-23	10	13-Jan-23	26-Jan-23	0
195	BA-220	Receive USFWS/NMFS Biological Opinions (Incidental Take Authorizatio		07-Aug-23	0		07-Aug-23	0
196	**USFWS Bald Eagle Protection Act**		27-Jul-22 A	06-Mar-24	339	27-Jul-22	06-Mar-24	0
197	**Short Term Permit**		30-Mar-23	30-Mar-23	0	01-Feb-23	01-Feb-23	-41
198	USFWS-130	Receive Short Term Permit from USFWS (10-Jan)		30-Mar-23	0		01-Feb-23	-41
199	**Long Terrm Permit**		27-Jul-22 A	06-Mar-24	339	27-Jul-22	06-Mar-24	0
200	USFWS-140	Prepare Long Term Permit Application	27-Jul-22 A	04-Dec-23	275	27-Jul-22	04-Dec-23	0
201	USFWS-150	Submit Long Term Permit Application	05-Dec-23	05-Dec-23	1	05-Dec-23	05-Dec-23	0
202	USFWS-160	Receive Long Term Permit from USFWS		06-Mar-24	0		06-Mar-24	0
203	**State Agency Agreements & Permits**		04-Jan-21 A	26-Dec-24	538	04-Jan-21	30-Jul-24	-102
204	**Central Valley Flood Protection Board (CVFPB) Levee Encroachment**		01-Sep-23	26-Dec-24	332	13-Dec-21	13-Feb-24	-220
205	CVFPB-200	Prepare CVFPB Permit	01-Sep-23	29-Dec-23	81	13-Dec-21	15-Feb-23	-220
206	CVFPB-210	Submit CVFPB Permit	02-Jan-24	02-Jan-24	1	16-Feb-23	16-Feb-23	-220
207	CVFPB-220	Receive CVFPB Permit		26-Dec-24	0		13-Feb-24	-220
208	**SWRCB Water Right Permit**		12-May-22 A	26-Sep-24	477	12-May-22	30-Jul-24	-41
209	WRP-115a	SWRCB Determines Application is Complete	12-May-22 A	02-Feb-23	60	12-May-22	02-Dec-22	-41
210	WRP-115ac	Respond to Request for More Information	29-Aug-22 A	03-Jan-23	41	29-Aug-22	28-Oct-22	-42
211	WRP-115b	SWRCB Issues Notice of Application & Petitions for Assignmentt & Releases from Priority	06-Mar-23	06-Mar-23	1	04-Jan-23	04-Jan-23	-41
212	WRP-115c	Deadline to Submit Protests	04-May-23	04-May-23	1	08-Mar-23	08-Mar-23	-41
213	WRP-116	Sites Authority & Protestants Resolve Protests	05-May-23	27-Oct-23	122	09-Mar-23	29-Aug-23	-41
214	WRP-117a	Pre-Hearing Conference	01-Dec-23	01-Dec-23	1	29-Sep-23	29-Sep-23	-41



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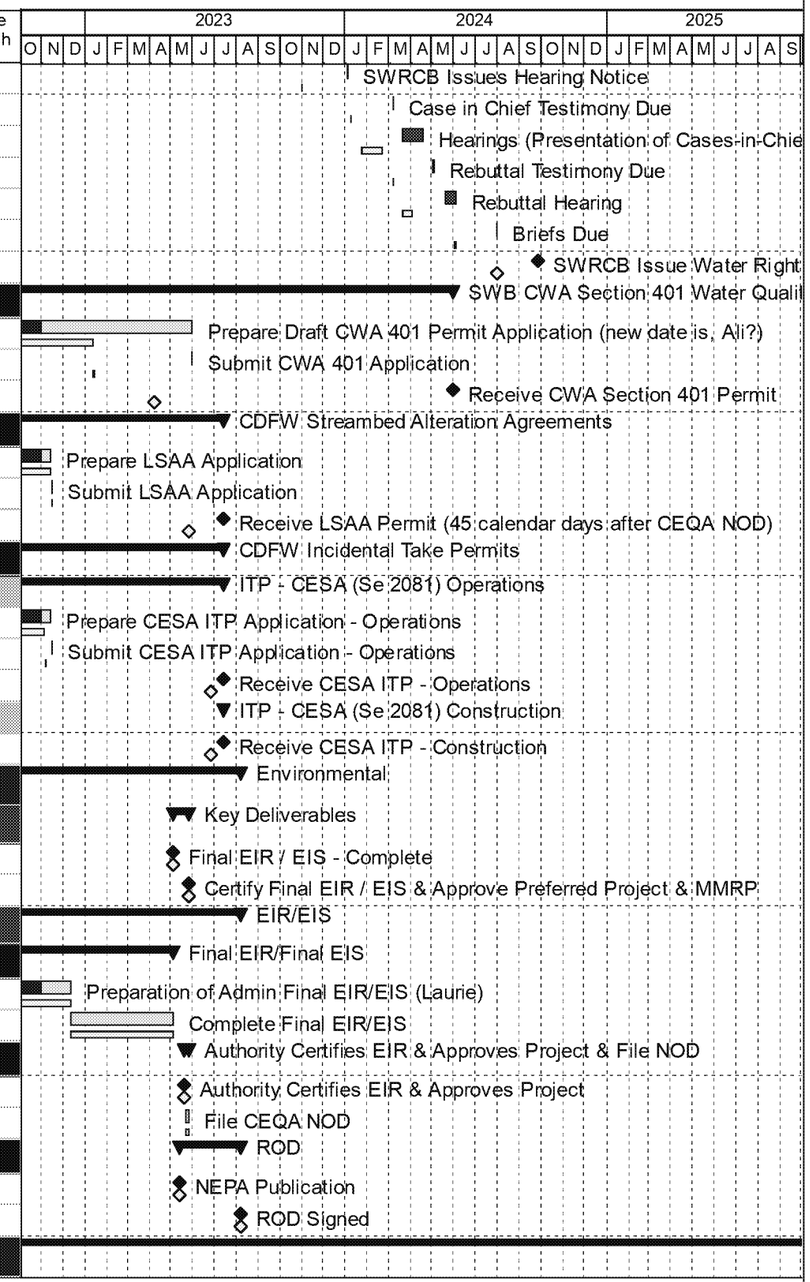
#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
215	WRP-117b	SWRCB Issues Hearing Notice	04-Jan-24	04-Jan-24	1	01-Nov-23	01-Nov-23	-41
216	WRP-117c	Case in Chief Testimony Due	07-Mar-24	07-Mar-24	1	08-Jan-24	08-Jan-24	-41
217	WRP-117d	Hearings (Presentation of Cases-in-Chief)	22-Mar-24	18-Apr-24	20	24-Jan-24	21-Feb-24	-41
218	WRP-117e	Rebuttal Testimony Due	03-May-24	03-May-24	1	07-Mar-24	07-Mar-24	-41
219	WRP-117f	Rebuttal Hearing	20-May-24	03-Jun-24	10	22-Mar-24	04-Apr-24	-41
220	WRP-117g	Briefs Due	31-Jul-24	31-Jul-24	1	03-Jun-24	03-Jun-24	-41
221	WRP-120	SWRCB Issue Water Right Permit		26-Sep-24	0		30-Jul-24	-41
222	**SWB CWA Section 401 Water Quality Certification**		04-Jan-21 A	31-May-24	400	04-Jan-21	07-Apr-23	-291
223	401-200	Prepare Draft CWA 401 Permit Application (new date is, Ali?)	04-Jan-21 A	30-May-23	145	04-Jan-21	12-Jan-23	-97
224	401-210	Submit CWA 401 Application	31-May-23	31-May-23	1	13-Jan-23	13-Jan-23	-97
225	401-220	Receive CWA Section 401 Permit		31-May-24	0		07-Apr-23	-291
226	**CDFW Streambed Alteration Agreements**		10-Jan-22 A	14-Jul-23	177	10-Jan-22	26-May-23	-33
227	1600-200	Prepare LSAA Application	10-Jan-22 A	14-Nov-22	10	10-Jan-22	14-Nov-22	0
228	1600-210	Submit LSAA Application	15-Nov-22	15-Nov-22	1	15-Nov-22	15-Nov-22	0
229	1600-220	Receive LSAA Permit (45 calendar days after CEQA NOD)		14-Jul-23	0		26-May-23	-33
230	**CDFW Incidental Take Permits**		11-Jan-21 A	14-Jul-23	177	11-Jan-21	26-Jun-23	-13
231	**ITP - CESA (Se 2081) Operations**		11-Jan-21 A	14-Jul-23	177	11-Jan-21	26-Jun-23	-13
232	2081-100	Prepare CESA ITP Application - Operations	11-Jan-21 A	14-Nov-22	10	11-Jan-21	04-Nov-22	-6
233	2081-110	Submit CESA ITP Application - Operations	15-Nov-22	15-Nov-22	1	07-Nov-22	07-Nov-22	-6
234	2081-120	Receive CESA ITP - Operations		14-Jul-23	0		26-Jun-23	-13
235	**ITP - CESA (Se 2081) Construction**		14-Jul-23	14-Jul-23	0	26-Jun-23	26-Jun-23	-13
236	2081-220	Receive CESA ITP - Construction		14-Jul-23	0		26-Jun-23	-13
237	**Environmental**		03-Jan-22 A	07-Aug-23	193	03-Jan-22	07-Aug-23	0
238	**Key Deliverables**		05-May-23	26-May-23	15	05-May-23	26-May-23	0
239	KD-1470	Final EIR / EIS - Complete		05-May-23	0		05-May-23	0
240	KD-1480	Certify Final EIR / EIS & Approve Preferred Project & MMRP		26-May-23	0		26-May-23	0
241	**EIR/EIS**		03-Jan-22 A	07-Aug-23	193	03-Jan-22	07-Aug-23	0
242	**Final EIR/Final EIS**		03-Jan-22 A	05-May-23	129	03-Jan-22	05-May-23	0
243	EIR-210	Preparation of Admin Final EIR/EIS (Laurie)	03-Jan-22 A	12-Dec-22	28	03-Jan-22	12-Dec-22	0
244	EIR-250	Complete Final EIR/EIS	13-Dec-22	05-May-23	101	13-Dec-22	05-May-23	0
245	**Authority Certifies EIR & Approves Project & File NOD**		19-May-23	26-May-23	5	19-May-23	26-May-23	0
246	EIR-370	Authority Certifies EIR & Approves Project		19-May-23	0		19-May-23	0
247	EIR-380	File CEQA NOD	22-May-23	26-May-23	5	22-May-23	26-May-23	0
248	**ROD**		12-May-23	07-Aug-23	59	12-May-23	07-Aug-23	0
249	EIR-440	NEPA Publication		12-May-23	0		12-May-23	0
250	EIR-450	ROD Signed		07-Aug-23	0		07-Aug-23	0
251	**Real Estate**		02-Nov-20 A	27-Apr-29	1666	02-Nov-20	27-Apr-29	0



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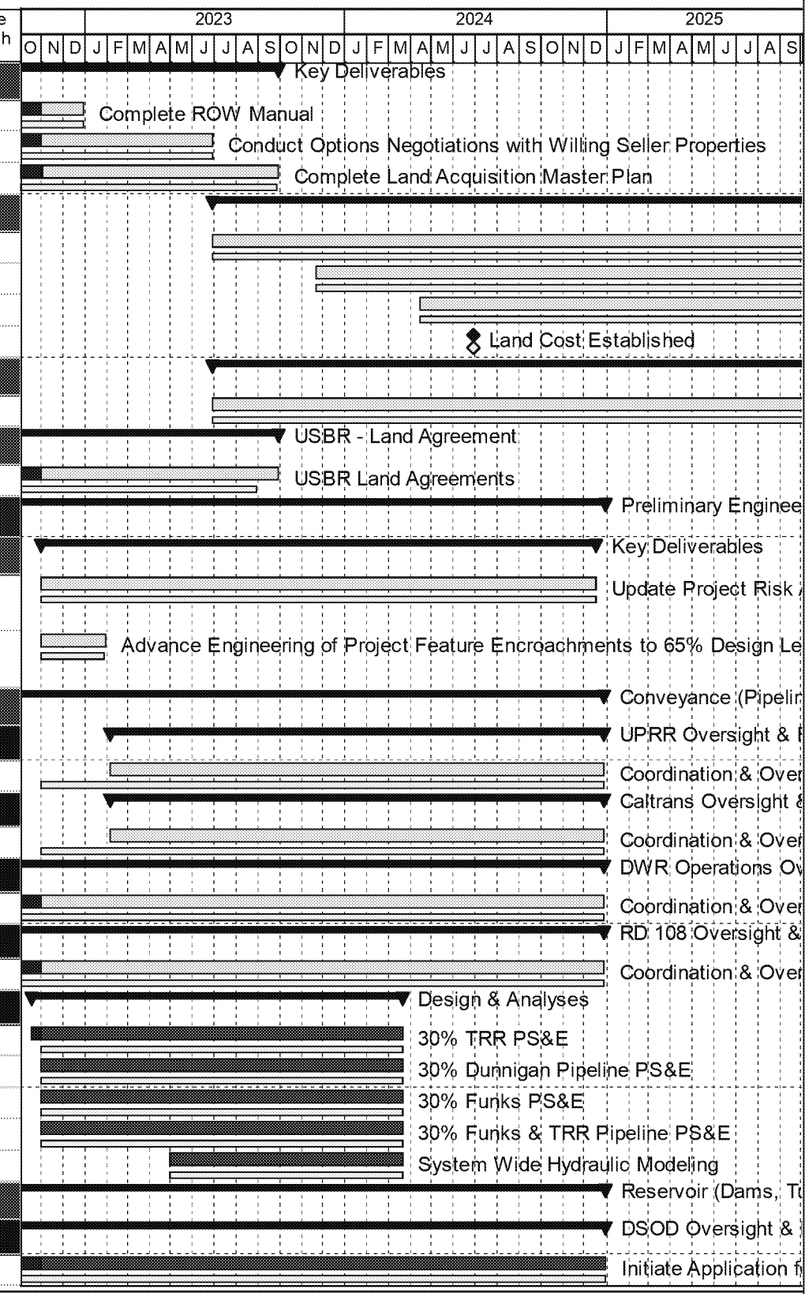
#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
252	**Key Deliverables**		03-Jan-22 A	28-Sep-23	230	03-Jan-22	27-Sep-23	-1
253	KD-1495	Complete ROW Manual	03-Jan-22 A	30-Dec-22	40	03-Jan-22	30-Dec-22	0
254	KD-1500	Conduct Options Negotiations with Willing Seller Properties	01-Jul-22 A	28-Jun-23	166	01-Jul-22	28-Jun-23	0
255	KD-1490	Complete Land Acquisition Master Plan	03-Oct-22 A	28-Sep-23	229	03-Oct-22	27-Sep-23	-1
256	**Land Acquisition**		29-Jun-23	27-Apr-29	1500	29-Jun-23	27-Apr-29	0
257	RE-1060	Construction Package 1 - Land Acquisition	29-Jun-23	27-Apr-29	1500	29-Jun-23	27-Apr-29	0
258	RE-1070	Construction Package 2 - Land Acquisition	20-Nov-23	27-Apr-29	1400	20-Nov-23	27-Apr-29	0
259	RE-1080	Construction Package 3 - Land Acquisition	15-Apr-24	27-Apr-29	1300	15-Apr-24	27-Apr-29	0
260	RE-1050	Land Cost Established		27-Jun-24	0		27-Jun-24	0
261	**Relocation**		29-Jun-23	27-Apr-29	1500	29-Jun-23	27-Apr-29	0
262	RE-1100	Relocation Assistance, as Needed	29-Jun-23	27-Apr-29	1500	29-Jun-23	27-Apr-29	0
263	**USBR - Land Agreement**		02-Nov-20 A	28-Sep-23	230	02-Nov-20	29-Aug-23	-21
264	FED-100	USBR Land Agreements	02-Nov-20 A	28-Sep-23	230	02-Nov-20	29-Aug-23	-21
265	**Preliminary Engineering**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
266	**Key Deliverables**		31-Oct-22 A	16-Dec-24	537	31-Oct-22	16-Dec-24	0
267	KD-1210	Update Project Risk Assessments (ongoing) (Risk Mgr Bob Beduhn & Henry Luu)	31-Oct-22 A	16-Dec-24	537	31-Oct-22	16-Dec-24	0
268	KD-1110	Advance Engineering of Project Feature Encroachments to 65% Design Level in Support of Permitting	01-Nov-22	30-Jan-23	60	31-Oct-22	27-Jan-23	-1
269	**Conveyance (Pipelines, Pump Stations, Canals)**		03-Jan-22 A	27-Dec-24	544	03-Jan-22	27-Dec-24	0
270	**UPRR Oversight & Review**		06-Feb-23	27-Dec-24	480	31-Oct-22	27-Dec-24	0
271	A1110	Coordination & Oversight with UPRR	06-Feb-23	27-Dec-24	480	31-Oct-22	27-Dec-24	0
272	**Caltrans Oversight & Review**		06-Feb-23	27-Dec-24	480	31-Oct-22	27-Dec-24	0
273	A1120	Coordination & Oversight with Caltrans	06-Feb-23	27-Dec-24	480	31-Oct-22	27-Dec-24	0
274	**DWR Operations Oversight & Review (KLOG)**		03-Jan-22 A	27-Dec-24	544	03-Jan-22	27-Dec-24	0
275	A1130	Coordination & Oversight with Department of Water Resources	03-Jan-22 A	27-Dec-24	544	03-Jan-22	27-Dec-24	0
276	**RD 108 Oversight & Review**		03-Jan-22 A	27-Dec-24	544	03-Jan-22	27-Dec-24	0
277	A1140	Coordination & Oversight with Reclamation District 108	03-Jan-22 A	27-Dec-24	544	03-Jan-22	27-Dec-24	0
278	**Design & Analyses**		18-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
279	KD-2020	30% TRR PS&E	18-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
280	KD-1630	30% Dunnigan Pipeline PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
281	KD-2010	30% Funks PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
282	KD-2030	30% Funks & TRR Pipeline PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
283	KD-2080	System Wide Hydraulic Modeling	01-May-23	20-Mar-24	225	01-May-23	20-Mar-24	0
284	**Reservoir (Dams, Tunnels)**		01-Feb-22 A	30-Dec-24	545	01-Feb-22	30-Dec-24	0
285	**DSOD Oversight & Review**		01-Feb-22 A	30-Dec-24	545	01-Feb-22	30-Dec-24	0
286	KD-1100	Initiate Application for Permit to Construct from DSOD	01-Feb-22 A	30-Dec-24	545	01-Feb-22	30-Dec-24	0



Remaining Level of Effort
Actual Level of Effort
Primary Baseline
Actual Work
Remaining Work
Critical Remaining Work
Baseline Milestone
Milestone
Summary

Project ID: Sites November 2022 / Project Name: Sites Reservoir Project DD: 01-Nov-2022
Layout Name: Sites Comp vs Prior Month / TASK filter: Less than 100%.
Data Date: 01-Nov-22 / Print Date: 10-Nov-22

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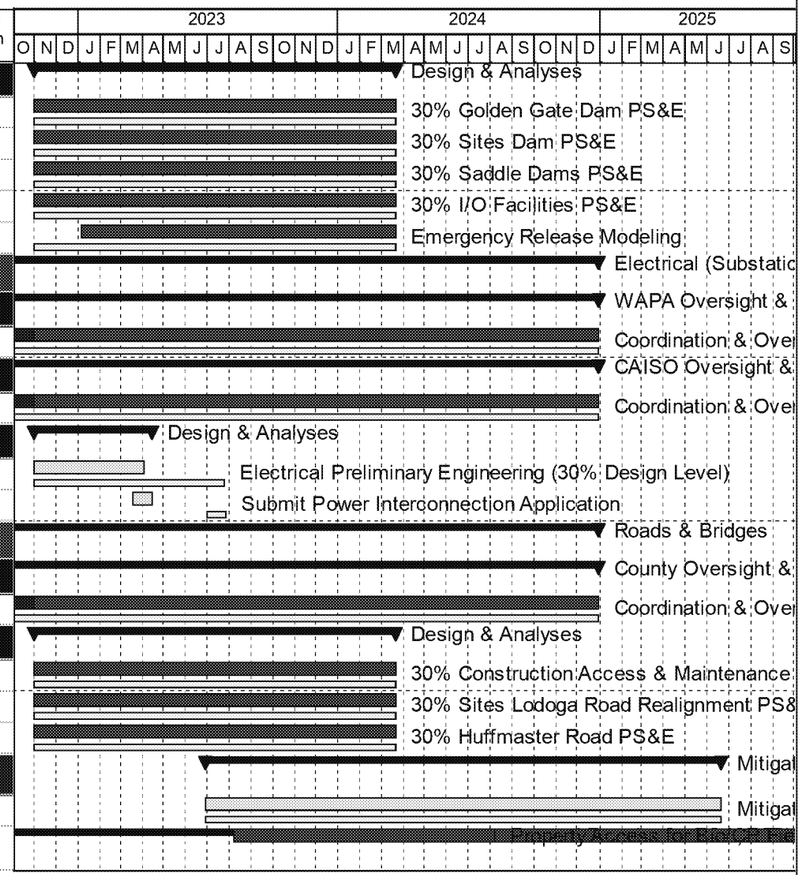
Sites Reservoir Project

Schedule Comparison to Prior Month

#	Activity ID	Activity Name	Start	Finish	Remaining Duration	Last Month Start	Last Month Finish	Variance LM Finish
287	**Design & Analyses**		31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
288	KD-1660	30% Golden Gate Dam PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
289	KD-2040	30% Sites Dam PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
290	KD-2050	30% Saddle Dams PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
291	KD-2060	30% I/O Facilities PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
292	KD-2070	Emergency Release Modeling	05-Jan-23	20-Mar-24	307	31-Oct-22	20-Mar-24	0
293	**Electrical (Substation, Switchyard, Transmission Line)**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
294	**WAPA Oversight & Review**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
295	A1150	Coordination & Oversight with WAPA	03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
296	**CAISO Oversight & Review**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
297	A1160	Coordination & Oversight with CAISO	03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
298	**Design & Analyses**		31-Oct-22 A	14-Apr-23	114	31-Oct-22	28-Jul-23	73
299	KD-1640	Electrical Preliminary Engineering (30% Design Level)	31-Oct-22 A	03-Apr-23	105	31-Oct-22	25-Jul-23	79
300	KD-1200	Submit Power Interconnection Application	20-Mar-23	14-Apr-23	20	30-Jun-23	28-Jul-23	73
301	**Roads & Bridges**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
302	**County Oversight & Review**		03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
303	A1170	Coordination & Oversight with County Authorities	03-Jan-22 A	30-Dec-24	545	03-Jan-22	30-Dec-24	0
304	**Design & Analyses**		31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
305	KD-1650	30% Construction Access & Maintenance Roads PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
306	KD-2090	30% Sites Lodoga Road Realignment PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
307	KD-2100	30% Huffmaster Road PS&E	31-Oct-22 A	20-Mar-24	349	31-Oct-22	20-Mar-24	0
308	**Mitigation Implementation**		29-Jun-23	19-Jun-25	500	29-Jun-23	19-Jun-25	0
309	MI-1100	Mitigation Implementation (more information needed to expand detail)	29-Jun-23	19-Jun-25	500	29-Jun-23	19-Jun-25	0
310	**Project Delivery**		03-Jan-22 A	24-Sep-36	3601	03-Jan-22	26-Mar-36	-130



Remaining Level of Effort
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Project ID: Sites November 2022 / Project Name: Sites Reservoir Project DD: 01-Nov-2022
Layout Name: Sites Comp vs Prior Month / TASK filter: Less than 100%.
Data Date: 01-Nov-22 / Print Date: 10-Nov-22

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From: Chandra Chilmakuri [cchilmakuri@swc.org]
Sent: 11/15/2022 9:29:50 AM
To: Rob Kunde [rkunde@wrmwsd.com]; Rob Cooke (rcooke1956@gmail.com) [rcooke1956@gmail.com]; Okita, David@DWR [David.Okita@water.ca.gov]
CC: Jeff Davis [jdavis@ppeng.com]; Alicia Forsythe [aforsythe@sitesproject.org]
Subject: RE: Proposed Brief Meeting Wed Nov 16 on Sites EIR topics for DWR Briefing

Hi Rob,
I have a conflict tomorrow. We can have a separate discussion.
Thanks,
Chandra

Chandra Sekhar Chilmakuri, Ph.D., P.E.
State Water Contractors
P: 916.562.2583 | M: 916.335.3017 | **cchilmakuri@swc.org**

From: Rob Kunde <rkunde@wrmwsd.com>
Sent: Tuesday, November 15, 2022 9:16 AM
To: Rob Cooke (rcooke1956@gmail.com) <rcooke1956@gmail.com>; Okita, David@DWR <David.Okita@water.ca.gov>; Chandra Chilmakuri <cchilmakuri@swc.org>
Cc: Jeff Davis <jdavis@ppeng.com>; Alicia Forsythe <aforsythe@sitesproject.org>
Subject: Proposed Brief Meeting Wed Nov 16 on Sites EIR topics for DWR Briefing

Gentlemen:

Are you available for ½ hour tomorrow Wed Nov 16 between 4 and 5 pm? Ali Forsythe, Environmental Planning and Permitting Manager for the Sites Project, is working on a briefing to DWR regarding the relevant content of the Sites draft EIR. The focus is to be on whether that content is sufficient for DWR to rely on the Sites EIR (when adopted) to then execute a Sites Contract Amendment. But if DWR has specific topics, we want to include them in the briefing. So, for Wed:
a. what information does DWR want to be briefed on? e.g. modeling assumptions, impacts to the SWP and/or how such impacts are avoided, growth-inducing impacts, place of use, etc.
b. should the briefing include the non-Sites SWC, or hold a separate briefing for the non-Sites SWC? I am inclined toward the latter because a trial run with DWR could be helpful, and the SWC may have a somewhat different issue list e.g. perceived SLR impacts. Chandra's input here would be helpful.

Jeff Davis: Your participation is optional.

Robert J. Kunde, P.E.
Retired Annuitant
Wheeler Ridge-Maricopa Water Storage District
cell: 661-345-3719 email: rkunde@wrmwsd.com

From: Jeff Davis [JDavis@ppeng.com]
Sent: 11/15/2022 12:04:36 PM
To: rkunde [rkunde@wrmwsd.com]; Rob Cooke (rcooke1956@gmail.com) [rcooke1956@gmail.com]; Okita, David@DWR [David.Okita@water.ca.gov]; Chandra Chilmakuri [cchilmakuri@swc.org]
CC: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: RE: Proposed Brief Meeting Wed Nov 16 on Sites EIR topics for DWR Briefing

Rob, I am available Wednesday the 16th between 4 and 5.

From: Rob Kunde <rkunde@wrmwsd.com>
Sent: Tuesday, November 15, 2022 9:16 AM
To: Rob Cooke (rcooke1956@gmail.com) <rcooke1956@gmail.com>; Okita, David@DWR <David.Okita@water.ca.gov>; Chandra Chilmakuri <cchilmakuri@swc.org>
Cc: Jeff Davis <JDavis@ppeng.com>; Alicia Forsythe <aforsythe@sitesproject.org>
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Gentlemen:

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Jeff Davis: Your participation is optional.

Robert J. Kunde, P.E.
Retired Annuitant
Wheeler Ridge-Maricopa Water Storage District
cell: 661-345-3719 email: rkunde@wrmwsd.com

Sites WAA: CalSim II Unimpaired Flow Requirement Analysis

Working Draft – For Discussion Purposes Only

Outline

Overview of ROC on LTO Alternative 4 Model

Applicability of using a CalSim model for an UIF analysis

UIF Sites WAA Post-Processor

Results

Draft_0020749

ROConLTO Alt 4 CalSim Modeling

2030 Climate Change hydrology

- Including adjustments to UIF

High level assumptions

- Same "baseline" changes as Alt 1 (2019 BiOp)
- 55% UIF requirement year-round
  - Sacramento at Red Bluff / Clear Creek at Whiskeytown
  - Sacramento above Feather Confluence (i.e. Upper Sac Valley Tributaries)
  - Feather below Thermalito
  - American at Fair Oaks
- March-May Outflow Objective
  - Positive OMR March-May
  - "Surrogate for reducing Delta exports and increasing Delta outflow as a complementary action to the 55% UIF objective"

Draft_0020750

ROConLTO Alt 4 CalSim Modeling

Sacramento River / Shasta Specific Requirements

- Offramps
  - Shasta Critical Years
  - Prior to June, previous month storage < 1.6 MAF
  - Weir Spills on Sac River > 5,000 cfs
- UIF at Red Bluff
  - Deficits shared 50/50 between additional Keswick release and local diverters
    - UIF requirement adjusted based on final deficit
  - Similar logic applied to Sac River above Feather Confluence

Delta Outflow

- Includes increment of added UIF release to D-1641 outflow requirement

Draft_0020751

Using CalSim to evaluate water availability under UIF Requirement

Similar to climate change, CalSim II is used to evaluate a potential future condition at a planning level of analysis

- A monthly time step is appropriate for environmental flow and water supply planning purposes

Through operation of the reservoirs in CalSim II, the actual effects and potential volumes of water available can be evaluated, as opposed to a spreadsheet analysis

Draft_0020752

UIF WAA Post Processor

Overall Availability based on availability at 5 locations
- Minimum across the locations at each time step is the water available

Red Bluff (TCCA POD)
- Flow at Red Bluff vs. Adjusted UIF Bypass Req

Hamilton City (GCID POD)
- Flow at Hamilton City vs. Adjusted/Calculated UIF Bypass Req

Wilkins Slough
- Flow at Wilkins vs. 10,700 cfs (Oct-Jun) & 5,000 cfs (Jul-Sep)

Upper Sac Valley
- Flow at Sacramento River abv Feather Confluence vs. Adjusted UIF Bypass Req

Delta
- Balanced / Excess
- Delta Outflow vs. "UIF Outflow" Requirement
- Mar-May Outflow Objective

Draft_0020753

Results: Water Availability

WY Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	16	73	424	449	380	81	60	9	5	0	0	39	1,537
AN	0	28	171	234	305	0	1	0	0	0	0	0	739
BN	0	43	37	67	166	0	0	0	0	0	0	0	313
D	0	6	22	22	19	0	0	0	0	0	0	0	68
C	0	0	0	0	7	0	0	0	0	0	0	0	7
Avg	5	35	172	194	197	26	19	3	2	0	0	12	664

Values in 1,000 acre-feet

Draft_0020754

Results Comparison: Water Availability

WY Type	Sites Alt 3A_2035	Alternative 4	Difference
W	2,524	1,537	-987 (-39%)
AN	1,443	739	-704 (-49%)
BN	578	313	-265 (-46%)
D	401	68	-333 (-83%)
C	78	7	-71 (-91%)
Average	1,212	664	-548 (-45%)

Values in 1,000 acre-feet

Draft_0020755

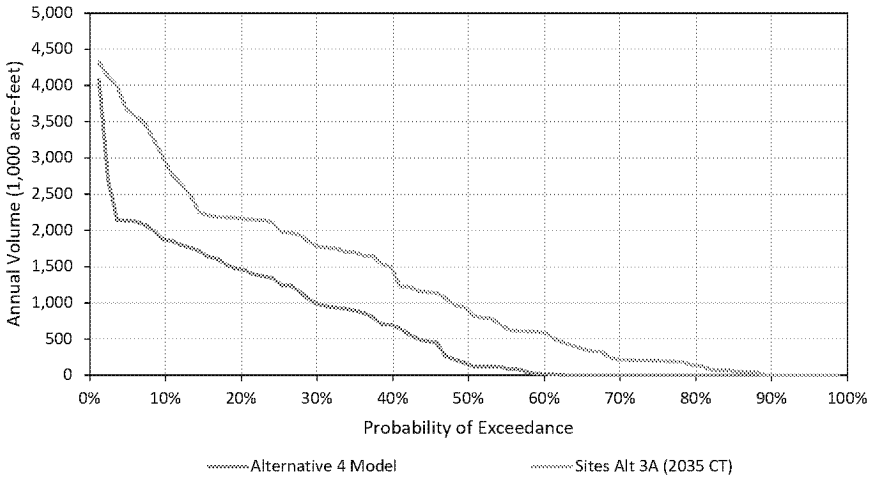
Results Comparison: Diversions

WY Type	Sites Alt 3A_2035	Alternative 4	Difference
W	492	729	237 (48%)
AN	457	364	-93 (-20%)
BN	228	199	-29 (-13%)
D	162	63	-99 (-61%)
C	51	7	-44 (-86%)
Average	303	332	29 (10%)

Values in 1,000 acre-feet

** Please note diversion values from Alt 3A are actual modeled values, whereas the ROC on LTO Alternative 4 values are estimated by the post-processor and do not consider available reservoir capacity due to reservoir operations.*

Results Comparison



Max 3821 WAA Max was

Conclusions

ROConLTO Alt 4 provides the only recent modeling of Phase II requirements

WAA shows water available for appropriation by Sites

Limitations of ROConLTO Alt 4 modeling limit any further or more specific conclusions

Draft_0020758

From: Janis Offermann [janis@horizonh2o.com]
Sent: 11/15/2022 4:34:28 PM
To: Kevin Spesert [kspesert@sitesproject.org]; Alicia Forsythe [aforsythe@sitesproject.org]; Laurie Warner Herson [laurie.warner.herson@phenixenv.com]; Risse, Danielle [Danielle.Risse@hdrinc.com]
Subject: RE: [EXTERNAL] RE: first draft TWG letter
Attachments: final draft_TWG_notification letter_11152022.docx

Thanks for all of the comments and edits. I have accepted the changes, as attached. **Ali**, will you take it up the chain for further review and approvals?

Also, I wanted to let you know that I heard from Laverne today; he was in the process of reviewing the MOA brief that we provided to him. However, his question for me was about the status of Section 106 consultation. I reminded him that Reclamation is responsible for Section 106 and that Yocha Dehe had received an invitation to consult from them some months ago. I also told him that the SHPO is currently reviewing the PA and that Reclamation had also sent the PA to the Tribe for review. He was able to locate both the letter and the draft PA in his files. He said he "would have to take care of that," so I expect Reclamation will be hearing from Yocha Dehe soon, with a request to consult under Section 106. I am happy to see this, as the Tribe now appears to be more fully engaged in the project.

Ali, at our last Section 106 meeting we mentioned that we were moving forward with the TWG and Mark Carper mentioned that he would like to attend, just to listen, not to participate, so that he would be familiar with issues that might carry over into the PA and Section 106 issues. Not sure how you feel about that. We said we would bring his request to your attention, and this seems to be the perfect opportunity to do that.

Thanks, all
janis

From: Kevin Spesert <kspesert@sitesproject.org>
Sent: Tuesday, November 15, 2022 10:36 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Janis Offermann <janis@horizonh2o.com>; Risse, Danielle <Danielle.Risse@hdrinc.com>
Subject: [EXTERNAL] RE: first draft TWG letter

The letter looks good…no changes on my end

I think the bullets are good…and cover the topics that I think the tribes can really help us with.

Kevin

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Tuesday, November 15, 2022 10:21 AM
To: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Janis Offermann <janis@horizonh2o.com>; Kevin Spesert <kspesert@sitesproject.org>; Risse, Danielle <Danielle.Risse@hdrinc.com>
Subject: RE: first draft TWG letter

Hi all – Attached are some minor changes to the letter. Once we have a final document, I'll put this into the Sites template.

Kevin, take a close look at the bullets. We should characterize these carefully and make sure we are really willing to talk about these items in a meaningful way. Let me know what you think.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Sent: Monday, November 14, 2022 4:33 PM
To: Janis Offermann <janis@horizonh2o.com>; Alicia Forsythe <aforsythe@sitesproject.org>; Kevin Spesert <kspesert@sitesproject.org>; Risse, Danielle <Danielle.Risse@hdrinc.com>
Subject: RE: first draft TWG letter

Hi all –

I have reviewed the draft letter and provided a few comments/suggested edits to content. I think Kevin and Ali will have to review for style and tone since it will be signed by Fritz.

Thanks,

Laurie

From: Janis Offermann <janis@horizonh2o.com>
Sent: Tuesday, November 8, 2022 12:07 PM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Kevin Spesert <kspesert@sitesproject.org>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Risse, Danielle <Danielle.Risse@hdrinc.com>
Subject: first draft TWG letter

Hi, All
Here is my first stab at a letter to send out about the Tribal Working Group. I expect that you will have quite a few edits. I wasn't sure how much detail you wanted to include. 😊

Kevin, did you find the charter for the other working group you are working with? I would be interested in seeing that.

Thanks
janis

Janis Offermann, MA, RPA
Cultural Resources Practice Lead
Horizon Water and Environment
1801 7th Street, Suite 100
Sacramento, CA 95811
530.220.4918

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you are not the intended recipient, you are hereby notified that any disclosure, use, dissemination, copying, or storage of this message or its attachments is strictly prohibited.

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From: Rob Kunde [rkunde@wrmwsd.com]
Sent: 11/15/2022 8:45:48 PM
To: Okita, David@DWR [David.Okita@water.ca.gov]; Rob Cooke (rcooke1956@gmail.com) [rcooke1956@gmail.com]; Chilmakuri, Chandra@SWC [cchilmakuri@swc.org]
CC: Jeff Davis [jdavis@ppeng.com]; Alicia Forsythe [aforsythe@sitesproject.org]
Subject: Re: Proposed Brief Meeting Wed Nov 16 on Sites EIR topics for DWR Briefing

All:

Ali and I spoke today. She will send out an invitation ([possibly via Marcia Kivett) for a Wednesday 4:00 pm - 4:30 pm meeting. Chandra has a conflict and cannot attend. She will also work on getting a current Project Description to David Okita; David is welcome to participate if he chooses.

At the Wednesday meeting, we will focus on any additional DWR feedback from Rob C, and identify the information needed for a future EIR presentation to the non-participating SWC. I will pull in Chandra's input through a separate call.

Robert J. Kunde, P.E.
Retired Annuitant
Wheeler Ridge-Maricopa Water Storage District
cell: 661-345-3719 email: rkunde@wrmwsd.com

From: Rob Kunde <rkunde@wrmwsd.com>
Sent: Tuesday, November 15, 2022 9:27 AM
To: Okita, David@DWR <David.Okita@water.ca.gov>; Rob Cooke (rcooke1956@gmail.com) <rcooke1956@gmail.com>; Chilmakuri, Chandra@SWC <cchilmakuri@swc.org>
Cc: Jeff Davis <jdavis@ppeng.com>; Alicia Forsythe <aforsythe@sitesproject.org>
Subject: Re: Proposed Brief Meeting Wed Nov 16 on Sites EIR topics for DWR Briefing

David:

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I ask Rob Cooke for his perspective on this.

Robert J. Kunde, P.E.
Retired Annuitant
Wheeler Ridge-Maricopa Water Storage District
cell: 661-345-3719 email: rkunde@wrmwsd.com

From: Okita, David@DWR <David.Okita@water.ca.gov>
Sent: Tuesday, November 15, 2022 9:20 AM
To: Rob Kunde <rkunde@wrmwsd.com>; Rob Cooke (rcooke1956@gmail.com) <rcooke1956@gmail.com>; Chilmakuri,

Chandra@SWC <cchilmakuri@swc.org>
Cc: Jeff Davis <jdavis@ppeng.com>; Alicia Forsythe <aforsythe@sitesproject.org>
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Department of Water Resources
530 902-7588

From: Rob Kunde <rkunde@wrmwsd.com>
Sent: Tuesday, November 15, 2022 9:15 AM
To: Rob Cooke (rcooke1956@gmail.com) <rcooke1956@gmail.com>; Okita, David@DWR <David.Okita@water.ca.gov>; Chilmakuri, Chandra@SWC <cchilmakuri@swc.org>
Cc: Jeff Davis <jdavis@ppeng.com>; Alicia Forsythe <aforsythe@sitesproject.org>
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Jeff Davis: Your participation is optional.

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---

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Rob Kunde <rkunde@wrmwsd.com>
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To: Okita, David@DWR <David.Okita@water.ca.gov>; Rob Cooke (rcooke1956@gmail.com) <rcooke1956@gmail.com>; Chilmakuri, Chandra@SWC <cchilmakuri@swc.org>
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Subject: Re: Proposed Brief Meeting Wed Nov 16 on Sites EIR topics for DWR Briefing

All:

Ali and I spoke today. She will send out an invitation ([possibly via Marcia Kivett) for a Wednesday 4:00 pm - 4:30 pm meeting. Chandra has a conflict and cannot attend. She will also work on getting a current Project Description to David Okita; David is welcome to participate if he chooses.

At the Wednesday meeting, we will focus on any additional DWR feedback from Rob C, and identify the information needed for a future EIR presentation to the non-participating SWC. I will pull in Chandra's input through a separate call.

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Stone Corral Creek and Funks Creek Aquatic Study Plan

November 15, 2022

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Acronyms and Abbreviations

°F	degrees Fahrenheit
ADCP	acoustic Doppler current profiler
AFDM	ash-free dry mass
Aquatic Study Plan	Stone Corral Creek and Funks Creeks Aquatic Study Plan
ASCI	Algae Stream Condition Index
Authority	Sites Project Authority
cfs	cubic feet per second
CDFW	California Department of Fish and Wildlife
CFGC	California Fish and Game Code
Chico ABL	Chico Aquatic Bioassessment Laboratory
CPUE	catch per unit effort
CSCI	California Stream Condition Index
CVRWQCB	Central Valley Regional Water Quality Control Board
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
GCID	Glenn-Colusa Irrigation District
GIS	geographic information system
GPS	global positioning system
LiDAR	light detection and ranging
MPSL-MLML	Marine Pollution Studies Laboratory at Moss Landing Marine Laboratories
PHAB	physical habitat
Project	Sites Reservoir Project
QA/QC	quality assurance/quality control
SQL	Structured Query Language
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
TC Canal	Tehama-Colusa Canal
TCCA	Tehama-Colusa Canal Authority
USGS	U.S. Geological Survey

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1.0 Introduction and Purpose

1.1 Introduction

This Stone Corral Creek and Funks Creek Aquatic Study Plan (Aquatic Study Plan) has been prepared for the Sites Project Authority (Authority) to guide fisheries technical studies to be conducted prior to and during operation of the Sites Reservoir Project (Project), as well as ongoing monitoring during Project operations. The Project is a proposed offstream storage project located on the west side of the Sacramento Valley in Glenn and Colusa Counties, approximately 10 miles west of the community of Maxwell. It is designed to store unappropriated water from winter and spring storm events in the northern Sacramento River watershed. The Project would impound a maximum of 1.5 million acre-feet of water in a reservoir. The reservoir would be created by building Sites Dam on Stone Corral Creek, Golden Gate Dam on Funks Creek, and a series of saddle dams on the northeastern rims of Antelope Valley. While a portion of naturally occurring seasonal flows in Stone Corral Creek and Funks Creek would be retained in the reservoir, the primary source of water for the reservoir would be diversions from the Sacramento River. These diversions would be up to 4,200 cubic feet per second (cfs) via two existing facilities: the Red Bluff fish screen and pumping plant (operated by the Tehama-Colusa Canal Authority [TCCA]) and the Glenn-Colusa Irrigation District's (GCID) fish screen and pumping plant near Hamilton City.

1.2 Purpose of Aquatic Study Plan

As part of the Project alternatives development, the Authority has committed in the Project's Revised Draft Environmental Impact Report/Supplemental Draft Environmental Impact Statement (RDEIR/SDEIS), as well as in the Project's application to appropriate water, to prepare this Aquatic Study Plan and conduct technical studies on Stone Corral Creek and Funks Creek.[2] The Authority is proposing the following special water right term to be included in its water right permit.

Within 1 year of issuance of this permit and prior to impoundments to storage of flows from Stone Corral Creek and Funks Creek under this permit, Permittee shall develop a Technical Studies Plan in accordance with Section 2.5.2.1. and Appendix D, Section 2D.4 of the Project's RDEIR/SDEIS to guide studies in Stone Corral Creek and Funks Creek that shall be implemented prior to and during construction activities to collect information necessary to address California Fish and Game Code Section (CFGC) 5937. The Technical Studies Plan shall include, but may not be limited to, assessment of fish assemblage and available habitat, flow characteristics, water temperatures, bioassessment monitoring, and method for reporting data. The Technical Studies Plan shall be developed in consultation with the California Department of Fish and Wildlife (CDFW), the U.S. Fish and Wildlife Service (USFWS), and Colusa County. Permittee shall implement the Technical Studies Plan.

Using the results of the technical studies, within 5 years of issuance of this permit and prior to impoundments to storage of flows from Stone Corral Creek and Funks Creek under this permit, the Permittee shall develop a Stone Corral Creek and Funks Creek Operations Plan (Operations Plan) in

[1] See Section 2.5.2.1. and Appendix D, Section 2D.4 of the RDEIR/SDEIS.

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accordance with Section 2.5.2.1. and Appendix D, Section 2D.4 of the Authority is proposing the following special water right term to be included in its water right permit.

The Operations Plan shall describe Permittee's approach to address CFGC Section 5937 requirements, if any, resulting from impoundments to storage of flows from those creeks under this permit, while also ensuring that the Project's flood protection benefits are realized. The Operations Plan shall include, but may not be limited to, the approach for reservoir releases into Stone Corral Creek and Funks Creek, including release schedules and volumes and a monitoring plan. The Operations Plan shall be developed in consultation with CDFW, USFWS, and Colusa County, and approved by the Deputy Director for Water Rights.

Together, these studies would document the two creeks' existing hydrology, assess flow levels needed to maintain fluvial geomorphic processes, and update information on aquatic species presence and habitat use in the reaches downstream of the dams to establish aquatic baseline information that would be used to determine and subsequently manage environmental releases from the Project into the creeks. As part of the Aquatic Study Plan, studies would be initiated once access permission to the creeks through private property is obtained. The studies would also be used to inform final design for the proposed Sites Dam and Golden Gate Dam release facilities and operational requirements. The Aquatic Study Plan includes fish monitoring, a Surface Water Ambient Monitoring Program (SWAMP) bioassessment study, a hydrogeomorphic study, and a temperature study. Specific details for the field studies would be designed and conducted in collaboration with CDFW, USFWS and Colusa County.

The objectives of these studies are as follows.

- Determine existing fish assemblages in these creeks, including fish species presence and habitat use.
- Characterize habitats available (e.g., spawning, rearing, foraging, and sheltering habitats) at varying flow levels, including the presence or absence of pools that persist through summer.
- Characterize flows, including assessing the baseflow during summer and conducting a fluvial geomorphologic study to characterize habitat conditions, substrate compositions, and flow levels.
- Conduct a SWAMP technical study (i.e., a stream bioassessment) that focuses on relationships between physical habitat (PHAB), water quality, and benthic macroinvertebrates.
- Implement hydrological studies to define flow temperature relationships.

This Aquatic Study Plan summarizes the methods and reporting strategies for the reaches downstream of the proposed impoundments on Stone Corral Creek and Funks Creek. Using information obtained from these field studies, along with currently available information, the Authority would develop a schedule of releases for Stone Corral Creek and Funks Creek to be incorporated into the Operations Plan. Flow releases into these creeks would be made to maintain flood control benefits of the Project and would not overtop streambanks or flood downstream areas. The release schedule would also account for meeting demands of senior water right holders on Stone Corral Creek and Funks Creek that are downstream from the proposed dams. Appendix 2D, *Best Management Practices, Management Plans, and Technical Studies* of the *Sites Reservoir Project Revised Draft Environmental Impact Report/Supplemental Draft Environmental Impact Statement* (Sites Project Authority and Bureau of Reclamation 2021) describes the purpose, objectives, content, and timing of the field studies identified above.

Furthermore, if flows in Stone Corral Creek and Funks Creek are needed to maintain fish in good condition in compliance with CFGC Section 5937, then the Authority would adapt this study program into an operations monitoring program with a duration of 5 to 10 years to document and adaptively

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manage the timing and magnitude of flow releases to maintain fish in good condition below the dams along with the habitats upon which they depend. Performance standards would be developed in conjunction with the Authority and the relevant agencies (CDFW, USFWS, and Colusa County) prior to the start of operations monitoring.

1.2.1 Integration of Fish Monitoring with Aquatic Habitat Survey Methods

Aquatic habitat survey methods for sampling are described below. Note that the field observations and results from other studies (i.e., the stream bioassessment study and hydrogeomorphic study) would aid in the assessment of aquatic habitat and are referenced where applicable.

An initial reconnaissance survey would provide information on existing habitat and inform the selection of sampling stations within the Stone Corral Creek and Funks Creek drainages. Stations would initially be set at fixed distances apart to accommodate between 10 and 15 sampling stations within each drainage. Stations would be mapped prior to going into the field and then field-verified during the reconnaissance survey. Some leeway would be given to adjust locations to prioritize reaches containing optimal fish habitat. Stations that fell within dry or sub-optimal aquatic habitat for fish survival would be de-prioritized or curtailed.

As part of the pre-operation sampling for fish community and aquatic habitat, the following data would be collected and/or integrated into the fish study.

- **Fish community.** Surveys would characterize local fish communities using methods described below. As feasible and appropriate, methods would be consistent with those used in previous and ongoing fish community survey efforts (e.g., methods accepted as standard practice for sampling aquatic systems; Meador et al. 1993). (Fish Study)
- **Substrate composition.** Surveys would document stream bed substrate particle size using Wolman pebble counts (Wolman 1954; Kondolf and Li 1992), gravelometer, substrate facies mapping, or similar methods. (Hydrogeomorphic Study)
- **Riparian vegetation cover.** Surveys would measure the relative amount (e.g., percent cover) of riparian vegetation cover over aquatic habitat to document conditions. Riparian vegetation cover would be monitored using the California Rapid Assessment Method (Brown 2013), or similar method. (Hydrogeomorphic Study)
- **Benthic macroinvertebrate presence.** A SWAMP bioassessment that focuses on the relationships between PHAB, water quality, benthic macroinvertebrates, and algal communities would be conducted on the reaches downstream of the proposed impoundments on Stone Corral Creek and Funks Creek. The bioassessment study would be conducted using the methods described in the SWRCB's SWAMP protocols (Ode et al. 2016a, 2016b). (SWAMP Bioassessment Study)
- **Water quality.** Monitoring for general water quality parameters (e.g., temperature, turbidity, pH, conductivity, salinity, dissolved oxygen) would be conducted to assess surface water quality. Water quality monitoring would be conducted using methods described in the State Water Board's SWAMP protocols (Ode et al. 2016a, 2016b). (SWAMP Bioassessment Study and Fish Study)
- **Water temperature.** Water temperature profiles for Stone Corral Creek and Funks Creek would be developed. These water temperature profiles would be used to inform decisions about which tiers of the inlet/outlet (I/O) tower to use when conducting releases into downstream water bodies. The goal would be to mimic existing temperature profiles in Funks Creek.

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1.3 Applicable Methods for Determining Operational Streamflows

After baseline hydrogeomorphic conditions are obtained and evaluated in context with the studies from other disciplines (i.e., Fish Assemblage Study and SWAMP Bioassessment Study), various approaches for estimation of minimum streamflows to maintain ecosystem and geomorphic function would be reviewed, such as "the functional flow" approach suggested by Yarnell et al. (2015), the Instream Flow Incremental Methodology (National Biological Service, U.S. Department of the Interior 1995), the CDFW Instream Flow Program,[3] the California Environmental Flows Framework,[4] and the Richter et al. (2011) approach. These methods would be investigated for their applicability to determine appropriate streamflows on Stone Corral Creek and Funks Creek to maintain fish in good condition. Coordination with CDFW, USFWS, and Colusa County would be required before a method is selected.

[3] https://wildlife.ca.gov/Conservation/Watersheds/Instream-Flow

[4] https://ceff.ucdavis.edu/

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2.0 Environmental Setting

2.1 Environmental Setting of Stone Corral Creek and Funks Creek

Stone Corral Creek and Funks Creek are both small watersheds originating below the snowline on the eastern foothills of the California Coast Range at elevations of 700 to 850 feet. Consequently, they do not receive cold snowmelt water. Rather, they respond rapidly to significant rainfall events and flow intermittently, mostly during winter and early spring. From their origins, they flow through low foothills, across Antelope Valley (the proposed location of Sites Reservoir), through a series of shallow canyons and eventually spill onto the Sacramento Valley floor (Figure 1). For much of their course on the valley floor, they are confined to narrow channels between berms along the edge of agricultural fields and road prisms. While the stream channels of these creeks are not actively managed, their straight alignment and angular turns around agricultural fields and along roads indicate that they were modified from their natural historic channels. In the upper parts of the watersheds just above the dam locations, these streams are largely devoid of riparian cover resulting from livestock use (Bureau of Reclamation and California Department of Water Resources 2008:3-20). In the lower reaches where the streams run through and around agricultural fields, shaded riparian habitat is sparse and consists mostly of low shrubs, grasses, and occasional oaks (*Quercus* sp.) and cottonwood (*Populus* sp.) trees.

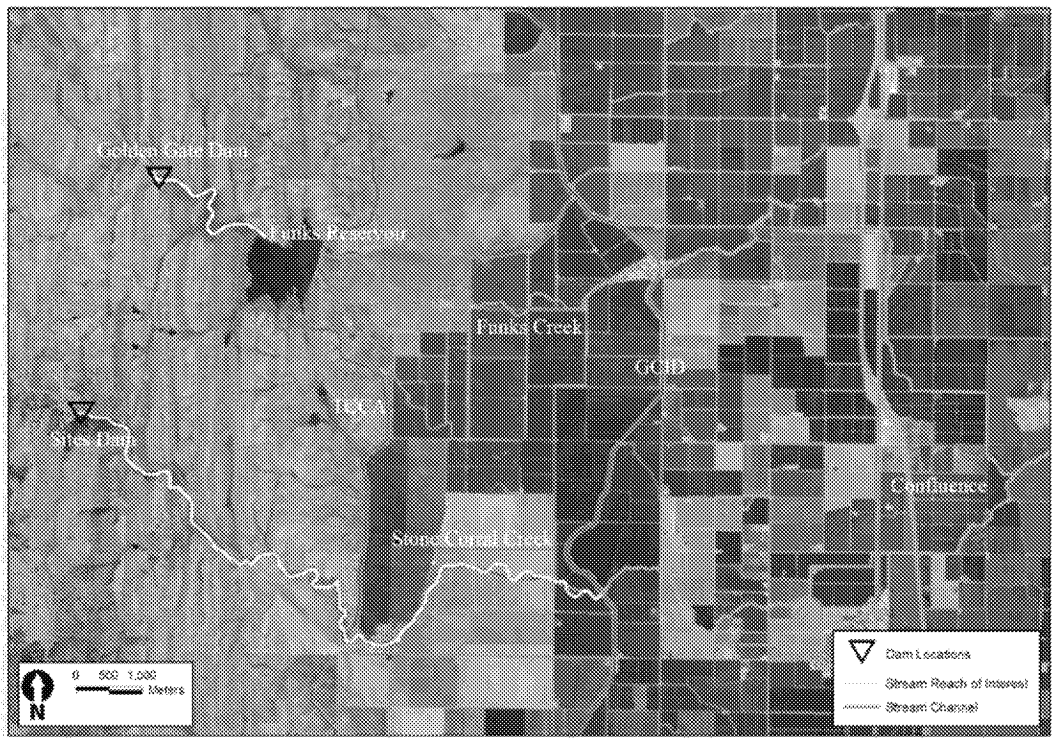

Figure 1. Stone Corral Creek and Funks Creek Reaches of Interest and Downstream Reaches

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2.1.1 Stone Corral Creek

Stone Corral Creek has a drainage area of 38 square miles upstream of the proposed Sites Dam. From the proposed location of the Sites Dam, Stone Corral Creek meanders through a shallow canyon onto the valley floor, where it flows through an incised channel across grazing lands. At 4.6 miles from the Sites Dam location, Stone Corral Creek crosses over a siphon in the Tehama-Colusa Canal (TC Canal) and begins to travel through agricultural lands. About 3 miles below the TC Canal siphon, Stone Corral Creek crosses the GCID Main Canal. Although most of the water in the canal passes under Stone Corral Creek in a siphon, GCID releases water from the canal into Stone Corral Creek for delivery to agricultural fields downstream. About 5.5 miles below the GCID Main Canal, Funks Creek flows into Stone Corral Creek, and then Stone Corral Creek flows an additional 5 miles to the Colusa Basin Drain. Refer to Figure 2 for a figure showing these various elements.

The U.S. Geological Survey (USGS) collected 27 years of discharge measurements at USGS Gage No. 11390672, in Stone Corral Creek near the community of Sites, California, from 1958 through 1985 (Figure 3). The data demonstrate a high variability of flow over the period of record, and there were 3 years of zero flow: 1972, 1976, and 1977 (Figure 4). Yates (1989) estimated the recurrence interval of a winter without flow at 12 to 14 years. The maximum annual discharge during the period of record was 39.9 thousand acre-feet (TAF) in 1983. Based on the USGS period of record, mean annual daily discharge for the period of record was calculated as 9.02 cfs (SD of 67.5, median is 0) and annual average discharge was 6.5 TAF per year.

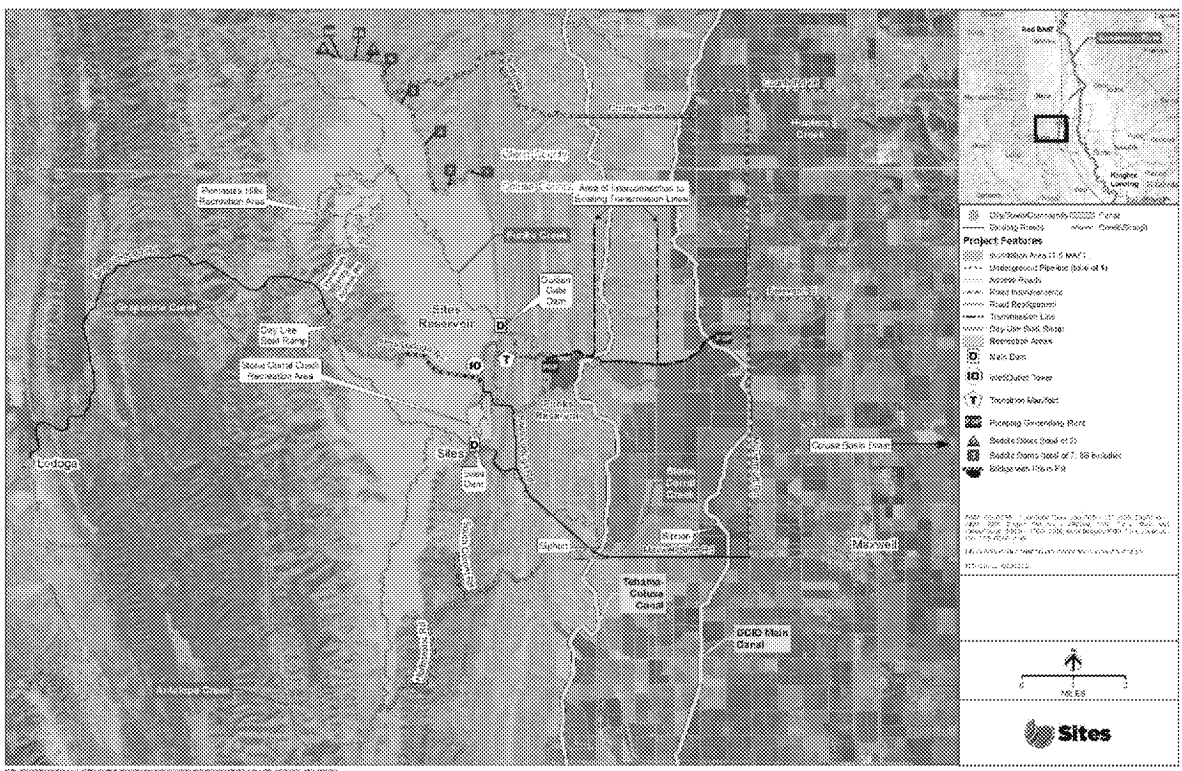

Figure 2. Project Area Overview

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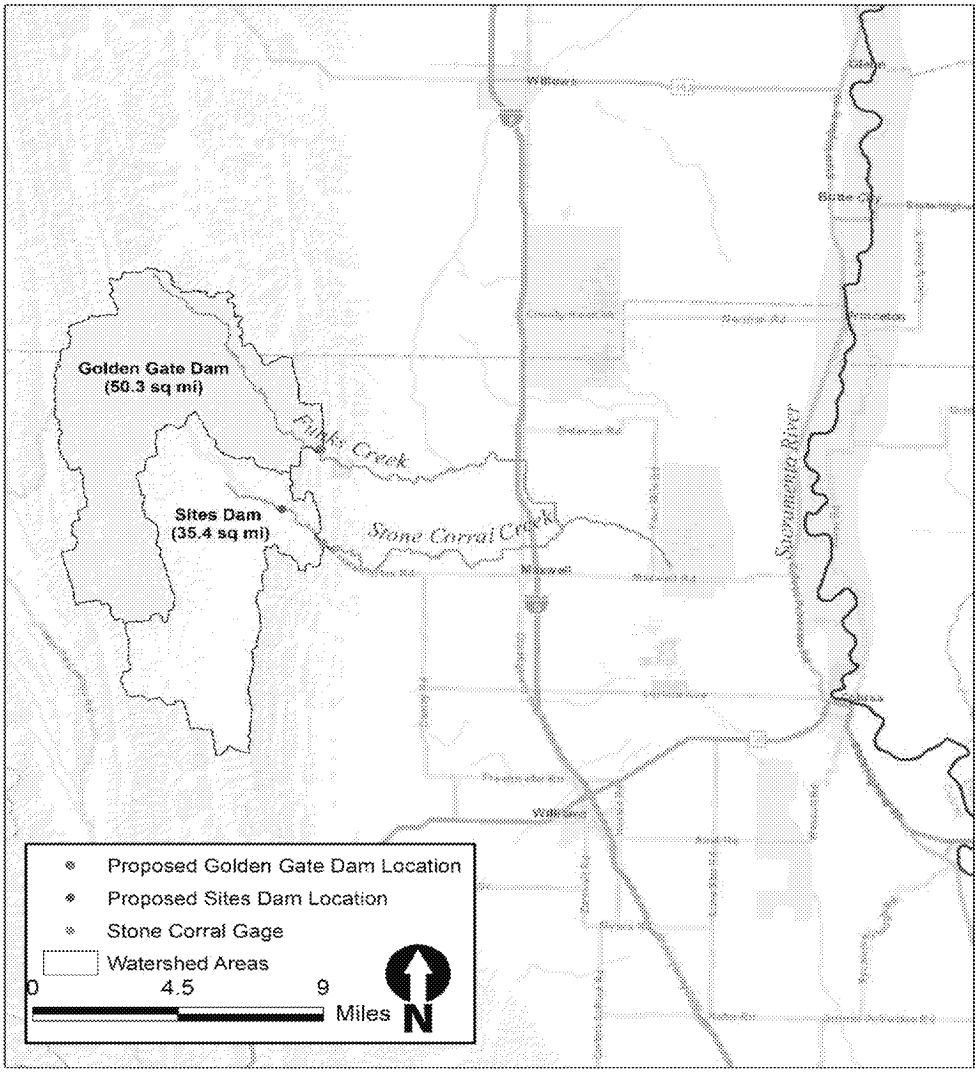

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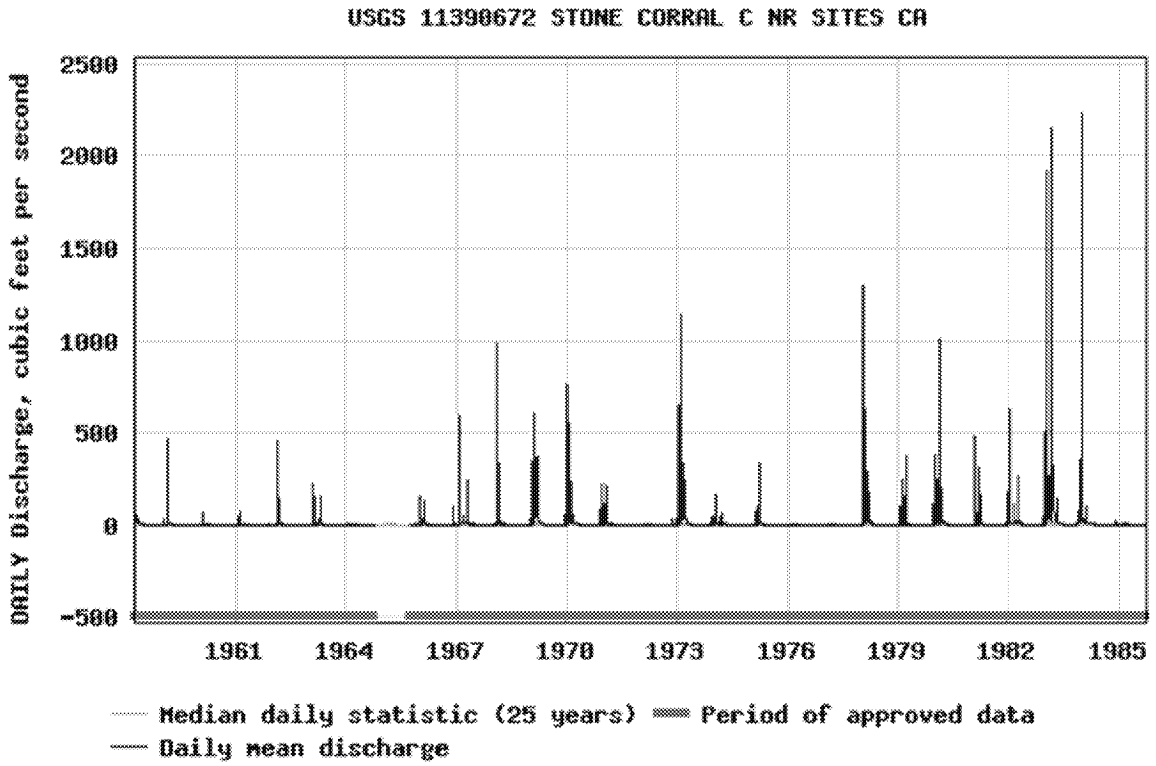

Source: U.S. Geological Survey stream gage 11390672

Figure 4. Mean Daily Flow in Stone Corral Creek near Sites (cfs)

Because the historical gage record for Stone Corral Creek is limited and Funks Creek is not gaged, historical stream gage data from Elder Creek was used to produce a longer-term estimate of streamflow on Stone Corral Creek and Funks Creek. The Elder Creek gage was chosen because it was the nearest gage on the valley floor with a long record of data available. It was assumed that Elder Creek has relatively similar precipitation and runoff patterns to Stone Corral Creek and Funks Creek. The streamflow of Elder Creek, located in Tehama County, has been measured since 1948 (USGS Gage No. 11379500). The gage site is approximately 49 miles northwest of the proposed Sites Reservoir, and has a drainage area upstream of the gage of 92.4 square miles (Attachment 1- MBK Engineers 2022). The overlapping period of gage records for Stone Corral Creek and Elder Creek (1958–1985) was used to determine a logarithmic correlation between the two gages for each month of the year. The developed streamflow timeseries was then further adjusted to account for the difference in watershed areas upstream of the old USGS Stone Corral Creek gage and the proposed location of Sites Dam. Tables 1a and 1b provide the results of this analysis, which shows the average monthly flow volume in acre feet per year and cubic feet per second for each water year type (MBK Engineers 2022). The average monthly volumes are calculated using the gage record for October 1958 through August 1985 with logarithmic monthly correlations for September 1985 through September 2021. Results are summarized by Sacramento Valley Water Year Type: wet, above normal, below normal, dry, and critical.

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Table 1a. Stone Corral Creek at Proposed Sites Dam Average Monthly Flow Volume (ac-ft) by Water Year Type (1958–2021)

Month	Wet	Above Normal	Below Normal	Dry	Critical	Average of All Years
Oct	0	0	0	0	0	0
Nov	42	11	2	5	0	17
Dec	872	242	29	47	54	336
Jan	3,365	2,825	711	345	171	1,663
Feb	4,487	4,667	1,283	135	307	2,317
Mar	2,135	1,522	407	264	179	1,039
Apr	901	319	114	25	35	375
May	136	119	15	7	9	65
Jun	20	8	2	1	1	8
Jul	1	0	0	0	0	0
Aug	0	0	0	0	0	0
Sep	0	0	0	0	0	0
WY Total	**11,959**	**9,713**	**2,562**	**828**	**757**	**5,827**

Table 1b. Stone Corral Creek at Proposed Sites Dam Average Monthly Flow (cfs) by Water Year Type (1958–2021)

Month	Wet	Above Normal	Below Normal	Dry	Critical	Average of All Years
Oct	0	0	0	0	0	0
Nov	0.7	0.2	0	0.1	0	0.3
Dec	14.2	3.9	0.5	0.8	0.9	5.5
Jan	54.7	45.9	11.6	5.6	2.8	27
Feb	80.8	84	23.1	2.4	5.5	41.7
Mar	34.7	24.8	6.6	4.3	2.9	16.9
Apr	15.1	5.4	1.9	0.4	0.6	6.3
May	2.2	1.9	0.2	0.1	0.1	1.1
Jun	0.3	0.1	0	0	0	0.1
Jul	0	0	0	0	0	0
Aug	0	0	0	0	0	0
Sep	0	0	0	0	0	0
WY Average	**17**	**14**	**4**	**1**	**1**	**8**

2.1.2 Funks Creek

Funks Creek, a tributary to Stone Corral Creek, has a drainage area of 50.3 square miles upstream of the proposed Golden Gate Dam. From the proposed location of Golden Gate Dam, Funks Creek meanders through a series of low ridges and grazing lands for about 1.8 miles to Funks Reservoir. Funks Reservoir

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is a re-regulating reservoir on the TC Canal and is created by a low dam on Funks Creek. Funks Dam is operated by TCCA to manage water levels within the TC Canal. The Funks Dam gates are opened during large storm events to pass flood waters through Funks Reservoir and down Funks Creek to avoid compromising the TC Canal and its operations. With the exception of passing flood waters, the Funks Dam gates are operated in the closed position, but seepage through the dam gates maintains perennial flow for a short distance below the dam in Funks Creek.

Below Funks Dam, Funks Creek travels 3.9 miles through agricultural fields in a combination of natural and straightened channels to where it crosses the GCID Main Canal. While the GCID Main Canal passes under Funks Creek in a siphon, GCID releases water from the canal to Funks Creek. Similar to Stone Corral Creek, GCID uses the downstream portions of Funks Creek as part of its conveyance system to deliver water to agricultural fields. Approximately 2 miles northeast of Maxwell and 1 mile east of Interstate 5, Funks Creek flows into Stone Corral Creek.

There is no flow record for Funks Creek, but given the comparable size, geology, and topography of the two watersheds and their proximity to each other, Funks Creek seasonal flow patterns and flow magnitudes are likely similar to Stone Corral Creek.

The same correlation approach used to estimate streamflow in Stone Corral Creek cannot be followed to estimate streamflow in Funks Creek because there are no streamflow data available for Funks Creek. Therefore, flow in Funks Creek was estimated by prorating monthly Stone Corral Creek streamflow data by the ratio of Stone Corral Creek's and Funks Creek's watershed areas upstream of the proposed dam locations (MBK Engineers 2022). Tables 2a and 2b provide the results of this analysis and identify the average monthly flow volume in acre feet per year and cubic feet per second foreach water year type.

Table 2a. Funks Creek Average Monthly Flow Volume (ac-ft) by Water Year Type (1958–2021)

Month	Wet	Above Normal	Below Normal	Dry	Critical	Average of All Years
Oct	0	0	0	0	0	0
Nov	60	16	3	7	1	24
Dec	1,239	343	41	66	77	485
Jan	4,778	4,011	1,010	489	243	2,362
Feb	6,372	6,628	1,822	192	436	3,290
Mar	3,031	2,161	578	375	255	1,475
Apr	1,280	453	162	36	49	553
May	193	169	21	9	13	93
Jun	28	11	2	1	2	12
Jul	2	0	0	0	0	1
Aug	0	0	0	0	0	0
Sep	0	0	0	0	0	0
WY Total	**16,984**	**13,793**	**3,638**	**1,176**	**1,075**	**8,275**

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Table 2b. Funks Creek Average Monthly Flow (cfs) by Water Year Type (1958–2021)

Month	Wet	Above Normal	Below Normal	Dry	Critical	Average of All Years
Oct	0	0	0	0	0	0
Nov	1.0	0.3	0.1	0.1	0	0.4
Dec	20.2	5.6	0.7	1.1	1.3	7.9
Jan	77.7	65.2	16.4	8.0	4.0	38.4
Feb	114.7	119.3	32.8	3.5	7.9	59.2
Mar	49.3	35.1	9.4	6.1	4.1	24.0
Apr	21.5	7.6	2.7	0.6	0.8	9.3
May	3.1	2.7	0.3	0.1	0.2	1.5
Jun	0.5	0.2	0	0	0	0.2
Jul	0	0	0	0	0	0
Aug	0	0	0	0	0	0
Sep	0	0	0	0	0	0
WY Average	**24**	**20**	**5**	**2**	**2**	**12**

2.1.3 Physical Characteristics

The only drainages that exit Antelope Valley are Stone Corral Creek and Funks Creek. Each creek continues through the steeper, foothill environments and then transitions to the Sacramento Valley floor, where each is generally shallow and highly altered, primarily for water conveyance and agricultural purposes. Straight channels and angular turns associated with agricultural fields and roads indicate that natural channels have been at least partially modified. Along their reaches on the valley floor, these creeks are mostly confined to narrow channels between berms adjacent to agricultural fields and road prisms.

Stone Corral Creek and Funks Creek are largely devoid of riparian habitat in their upper reaches (foothill environments) due to heavy livestock use. In the lower reaches where the creeks run through and around agricultural fields, riparian habitat is variable and consists mostly of low shrubs, grasses, and occasional oak and cottonwood trees; however, some segments of Stone Corral Creek possess dense stands of mature riparian vegetation.

Although the reaches of interest have been modified by livestock grazing, channelization, irrigation conveyance systems and minor diversions, they are still expected to have available aquatic habitat (i.e., benthic macroinvertebrate [BMI]). They also both experience much of their natural hydrograph (albeit altered due to local conveyance) and fluvial geomorphic processes and provide water and sediment that ultimately flows into the Colusa Basin Drain during rain events.

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3.0 Fish Monitoring

3.1 Purpose of Fish Monitoring Program

The purpose of a fish monitoring program in Stone Corral Creek and Funks Creek downstream of Sites Reservoir is to establish a pre-project baseline and post-operation assessment of the fish species present to determine the existing state of the fish population and whether it is maintained in good condition consistent with CFGC Section 5937 after project construction and operation.

3.2 Overview of Proposed Methods

Assessment of the goal to maintain fish in good condition in these ephemeral creeks consistent with CFGC Section 5937 would be made using a Before-After-Control-Impact experimental study design, using the reach with perennial flow below Funks Reservoir as a control. Sampling would be conducted to assess fish community and habitat present in the study area for up to 5 years prior to operation of the Project. Following completion of the pre-operation survey, fish communities and aquatic habitats in the study area would be monitored in a similar fashion for a 5-to-10-year period after the Project is operational. Fish community and habitat data that showed statistically significant negative departures from baseline data would trigger reassessment of downstream flow management under a proposed adaptive management plan.

3.2.1 Pre-operation Baseline Monitoring

Pre-operation baseline monitoring would be conducted within the study area to identify, quantify, and map habitats (Chapter 4, *SWAMP Bioassessment Study Designs and Methodology*), document aquatic species distribution and population characteristics (e.g., relative abundance, diversity), and identify triggers (e.g., decrease in relative abundance) for adaptive management actions. This monitoring establishes a baseline condition from which success criteria are measured and includes initial reconnaissance and pre-operation sampling.

The pre-operation surveys would first involve a reconnaissance survey to observe and record variables that may affect sampling efforts and establish monitoring stations. Data collection would include information about the site, habitat, and fauna that are observed during site visits. Aquatic habitat and fish species sampling would be conducted once the reconnaissance is complete and sampling stations have been established. Data would be collected via standardized electronic or paper forms by experienced biologists during assessments and sampling. Data collected as part of pre-operation efforts would be summarized into yearly reports and a final pre-operation baseline report to the Authority at the end of the pre-operation survey period. Surveys would provide the information required to characterize baseline conditions of the fisheries resources, as well as threats and stressors to fish species and habitat in the pre-operation conditions.

3.2.2 Operations Monitoring

Operations monitoring would occur periodically at the intervals specified herein. Operations sampling would document fish abundance, condition, and distribution and compare the results with data collected on habitat area, location, and changes in habitat characteristics over time. Data from the fish study would be used in documenting compliance with CFGC Section 5937 with data from the SWAMP assessments providing additional details on overall stream status.

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Operations sampling methods would be identical to the pre-operation sampling, including returning to established stations and tracking fish abundance, diversity, and distribution through time. Threats and stressors identified in the pre-operation survey would be assessed during operations surveys to differentiate changes in habitat or fish communities not related to the operation of the Project. Data collected as part of the operations sampling effort would be compared against the baseline data, as well as previous years' data and summarized into interim and final reports.

3.2.3 Fish Sampling Methods

Beach Seining

Seining is a low cost, low impact method for capturing aquatic organisms. The size of the seines used for sampling would depend on the size of the habitat being sampled. Larger seines may be up to 30 feet long, 6 feet high, with a mesh size of 0.25 inch and a pocket size of 5 feet by 5 feet. Smaller seines used for small pools and ponds may be 12 feet long, 4 feet high, with a mesh size of 3/16 inch and a pocket that is 5 feet by 5 feet. Seines would be used or deployed in conjunction with block nets to prevent fish from moving out of the area prior to being sampled. Captured specimens would be held in floating net pens or large aerated containers, based on site conditions, prior to being processed. Specimens would be identified to species, and the first 20 of each species would be measured for fork length to the nearest millimeter before being released at the capture site. Additional specimens would be tallied and released. Representative specimens would be photographed for positive identification.

Circumstances that may affect efficacy include the amount or type of benthic structure, presence/absence of aquatic vegetation, water clarity, flow rate, and water depth. Seining is most effective in smooth bottom habitats free of aquatic debris or vegetation, with elevated turbidity, and are shallow enough for biologists to wade in. When benthic structure is complex, water clarity is high, and habitats contain extremely deep, shallow, or rapidly moving water that may exclude biologists from deploying nets, efficacy is dramatically decreased.

Seines with a "bag" to minimize aquatic organism handling stress are preferred. Seines with a bag are also preferred where obstructions make access to the water (or deployment/retrieval of the seine) difficult (U.S. Fish and Wildlife Service 2012). Blocking nets typically improve efficacy by reducing opportunities for target species to move out of the area being seined. Where the area to be isolated for sampling includes culverts, deep pools, undercut banks, or other cover attractive to fish (e.g., thick overhanging vegetation, root wads, logjams) it may be appropriate to isolate a portion or portions of the study area in phases, rather than attempting to herd fish from the entirety of the work area in a single downstream pass.

Electrofishing with Block Nets

Previous work in Stone Corral Creek and Funks Creek indicates that total dissolved solids are high enough to prevent the use of electrofishing as a means of sampling (California Department of Fish and Game and California Department of Water Resources 2000). During reconnaissance surveys, basic water quality measurements would be taken to confirm this observation. If total dissolved solids values are above levels known to interfere with electrofishing, the method would be curtailed in favor of seining. If employed, electrofishing would be done with a Smith-Root type backpack electrofisher. Sections of creeks would be isolated using blocking nets before biologists wade into them, starting from the upstream net and moving downstream. Captured specimens would be held in buckets, floating net pens, or large aerated containers prior to being identified and measured as above for seine sampling. Effort

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would be calculated using shock time. If fish exhibit signs of stress, including symptoms of tetany or bruising, electrofisher settings would be adjusted accordingly to reduce impacts.

Visual Surveys

Any visual observations by biologists during reconnaissance and sampling of stream fauna would be systematically recorded based on pre-determined reach locations. This would include documenting amphibians and reptiles that may be observed incidentally during fish sampling efforts.

General Water Quality

Water quality data would be measured at every fish sampling location using a YSI Pro DSS unit (or similar collection device), following Chapter 3 of the 2016 version of the SWAMP *Standard Operating Procedures for the Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat* (SWAMP 2016 SOP) (Ode et al. 2016a) and recorded on standard SWAMP data forms. Water quality data obtained would include temperature, specific conductivity, salinity, dissolved oxygen, turbidity, and pH.

3.2.4 Fish Response

Abundance

All sampling efforts would be quantified using catch per unit effort (CPUE). The CPUE would be computed for each sample method and assessed once multiple data sets are available for comparison. Numbers of individuals, weight, and area sampled would be recorded. A decline in CPUE, in comparison to baseline values and accounting for threats and stressors, would reflect a potential adaptive management trigger.

Condition

Condition factor (K) would be calculated for all fish specimens for which length and weight have been recorded. The condition factor of fish reflects environmental and biological circumstances and fluctuations in feeding conditions and physiological factors (Le Cren 1951). The condition factor also indicates changes in food reserves and can be used as an indicator of the general condition of aquatic organisms. Therefore, information on condition factor can be used to assess biological health of monitored organisms because the measure provides information about the specific condition under which organisms are developing (Araneda et al. 2008).

A decline in condition factor, in comparison to baseline values and accounting for threats and stressors, would reflect a potential adaptive management trigger.

Distribution

Fish presence would be recorded and tracked through the study area. Fish distribution would be determined through reconnaissance and pre-operation surveys, known distributions, and incidental observations made during other sampling efforts. Records may be kept as count data and volumetric data but would ultimately be provided as presence or absence of fish species within sampling reaches.

3.3 Timing and Frequency

The schedule and effort for the pre-operation and operation portions of the proposed study are detailed below. The pre-operation surveys would be five consecutive annual visits staged at any point prior to

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start of operation and within the seasonal restrictions indicated below. Monitoring efforts would be one-per-year visits each year following initiation of operation up to a 5- or 10-year timeline as determined by the Authority. For the purposes of this Aquatic Study Plan, it is assumed that sufficient access to the study area would be available in 2023.

Pre-Project implementation:

- Desktop scoping effort: lay out sampling reaches using geographic information system (GIS) data overlaid on aerial imagery, organize data sheets, and coordinate with water quality and SWAMP efforts. Spring 2022
- Initial reconnaissance: 2 days with 2-person crew; ideal timing would be when water levels are most restricted, which is typically in autumn.
- Pre-operation effort 1: 14 days with 4-person crew. 2023
- Pre-operation effort 2: 14 days with 4-person crew. 2024
- Pre-operation effort 3: 14 days with 4-person crew. 2025
- Pre-operation effort 4: 14 days with 4-person crew. 2026
- Pre-operation effort 5: 14 days with 4-person crew. 2027

Post-Project implementation:

- Operation effort 1: 14 days with 4-person crew. 2030
- Operation effort 2: 14 days with 4-person crew. 2031
- Operation effort 3: 14 days with 4-person crew. 2032
- Operation effort 4: 14 days with 4-person crew. 2033
- Operation effort 5: 14 days with 4-person crew. 2034
- Additional efforts up to 10 years after initial operation would be determined by the Authority.

The post-Project implementation schedule may be adjusted based on the Project construction schedule and construction completion.

Permitting Requirements

A CDFW Scientific Collecting Permit (Specific Use) or Memorandum of Understanding permit would be required to complete the study design as proposed. BMI samples would be the only collected species.

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4.0 SWAMP Bioassessment Study Designs and Methods

4.1 Purpose of Bioassessment Monitoring Program

Stream bioassessment monitoring is a method of evaluating and monitoring the environmental health and integrity of freshwater wadeable streams by using BMI, water quality parameters, and PHAB conditions indicators of stream condition. Bioassessments are especially useful in tracking the aquatic conditions before and after a project is implemented to determine the project effects on aquatic communities. A SWAMP bioassessment that focuses on the relationships between PHAB, water quality, BMI, and algal communities would be conducted on the reaches downstream of the proposed impoundments on Stone Corral Creek and Funks Creek.

This information, along with the other studies (i.e., Fish Monitoring and Hydrogeomorphic Study), would help to inform the type of flow releases that should be made to the creeks under various operating conditions.

4.2 Overview of Proposed Methods

The bioassessment effort would be conducted using the methods described in the SWAMP 2016 SOP (Ode et al. 2016a, 2016b), or any updated version thereof. The reach-wide benthos method, which requires collection from each of 11 designated major transects across the sampling reach regardless of stream habitat type (e.g., riffle, run, pool), would be employed.

The ultimate number of individual sites, herein referred to as sampling reaches, on each creek would be based on access and safety; however, it is anticipated that five sampling reaches would be located on Funks Creek and that six sampling reaches would be located on Stone Corral Creek (Figure 5). Since there is no stringent guidance on establishing the number of bioassessment sampling reaches for a project such as this (Rehn pers. comm.), the number of sampling reaches was chosen to both best capture and quantify the two different elevational gradients within the study area (i.e., foothill and valley floor environments), and to have adequate spacing/distance between the sampling reaches (approximately 500 meters apart on Funks Creek above Funks Reservoir and approximately 2 kilometers apart elsewhere). Field and laboratory methods would be fully described in an associated Quality Assurance Project Plan.

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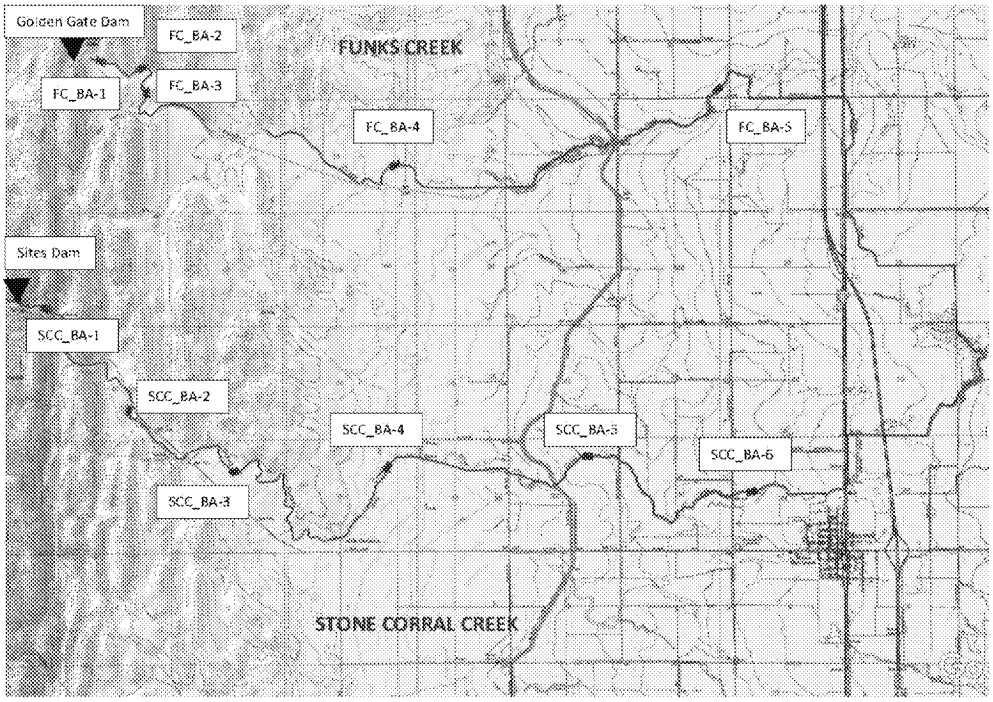

Figure 5. Potential Bioassessment Sampling Reaches, Stone Corral Creek and Funks Creek

4.3 Field Methods

This section summarizes the methods that would be used to collect all bioassessment data. All surveys would be performed by a qualified team of a biologist or biologists and a geomorphologist with expertise in benthic macroinvertebrate and algae collection, water quality monitoring, and PHAB data collection.

4.3.1 Sampling Reach Delineation

As described in Chapter 2 of the SWAMP 2016 SOP, the average wetted width of each sampling reach would be used to determine the sampling reach length (Ode et al. 2016a). The SWAMP 2016 SOP specifies standard sampling reach lengths that are based on wetted width (150 meters for sampling reaches with average wetted widths less than or equal to 10 meters, and 250 meters for sampling reaches with average wetted widths greater than 10 meters).

After the sampling reach length is determined, it would be laid out using marked surveyor's flags for transect identification and transects would be labeled according to the SWAMP 2016 SOP (main transects A–K and inter-transects AB, BC, etc.) for a total of 11 main transects and 10 inter-transects.

4.3.2 Basic Data Collection

Basic information collected at each sampling site would include project name, sampling reach name, time and date of survey, stream/watershed name, global positioning system (GPS) coordinates, and the names of the survey crew members. GPS coordinates would be recorded with an appropriate collection device (e.g., hand-held GPS receiver or iPad). Data collected at the sampling reaches would include water quality and stream discharge measurements, PHAB, and BMI and algae sample collections. The

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most recent version of the SWAMP *Stream Habitat Characterization Form Full Version* field forms would be used to enter data in the field.

4.3.3 Water Quality and Discharge Measurements

Water quality data would be measured using a YSI Pro DSS unit (or similar collection device), following Chapter 3 of the SWAMP 2016 SOP (Ode et al. 2016a) and recorded on standard SWAMP data forms. Water quality data obtained would include temperature, specific conductivity, salinity, dissolved oxygen, alkalinity, turbidity, and pH.

To determine alkalinity (which is a standard YSI is not capable of doing), a water sample would be collected at each sampling reach. The sample would be taken at approximately 10 to 15 centimeters below the water surface. Using gloves, collectors would fill the water sample bottles to the brim to ensure that air bubbles would not get trapped in the sample bottle. The bottle would then be placed on ice in a cooler until all field data collections were completed. In the evening following each day's sample collection, the water samples would be removed from the coolers and allowed to warm to room temperature. Alkalinity would then be determined by the double endpoint titration method using a Hach Digital Titrator.

Stream discharge would be measured using a Marsh-McBirney Flo-Mate Model 2000 flow meter and following the Velocity Area Method (Module O in Chapter 8 of the SWAMP 2016 SOP (Ode et al. 2016a, 2016b). Efforts would be made to select a stream transect with a relatively uniform cross section and laminar flow, and at least 20 equally spaced data points would be used to estimate streamflow.

4.3.4 Physical Habitat Assessment and Photo-Documentation

As required by the SWAMP 2016 SOP, PHAB information would be collected at the sampling reaches at each transect and inter-transect location. At the 11 main transects, the full measurements listed in Chapter 6 of the SWAMP 2016 SOP would be taken (Ode et al. 2016a, 2016b). At the 10 inter-transects, fewer measurements would be taken per the SWAMP *Stream Habitat Characterization Form Full Version* field forms.

Digital photo documentation for each sampling reach would consist of upstream and downstream views at transects A, F, and K (i.e., the downstream, middle, and upstream portions of the sampling reach). Incidental observations such as recent rainfall, fire effects, flooding, and other disturbances would also be recorded.

At each sampling reach, reach-wide PHAB conditions relative to three Rapid Bioassessment Protocol (RBP) habitat parameters would be evaluated based on visual observations. These observations would include epifaunal substrate/cover, sediment deposition, and channel alteration. Each of these parameters would be scored using the following numeric value and ranked using the following 20-point scale, per the SWAMP 2016 SOP.

- 1–5 rank as poor
- 6–10 rank as marginal
- 11–15 rank as suboptimal
- 16–20 rank as optimal

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4.3.5 Benthic Macroinvertebrate Sample Collection

BMI collection would be conducted according to the SWAMP 2016 SOP, using the reach-wide benthos method, which requires collection from each of the 11 major transects across the sampling reach regardless of stream habitat type (e.g., riffle, run, and pool). The BMI samples would be collected 1 meter downstream of each major transect by sampling a 1-foot-square area using a D-frame net. The sampling would begin at transect A (the downstream end) and continue upstream to transect K, with the sample location alternating from left (25% of width), to center (50% of width), to right (75% of width) on each subsequent transect.

All collections from the 11 major transects would be composited into a single sample and transferred into a 1-liter, wide-mouth plastic jar and preserved with 95% ethanol, following the SWAMP 2016 SOP. Samples would be labeled with collection site, time, and collector's name; and a chain-of-custody form would be filled out to accompany the samples on their way to the laboratory for identification. Replicate samples would be collected according to the SWAMP 2016 SOP at one sampling reach for quality assurance/quality control (QA/QC) purposes.

4.3.6 Algae Sample Collection

Algae would be collected in the same manner as the BMI samples, except that the algae would be collected 25 centimeters above the location where the BMI sample would be located. Algae samples would be collected using the sampling tools identified in the SWAMP 2016 SOP, which vary according to the substrate being sampled. A rubber delimiter would be used for large gravel and cobble; a PVC delimiter would be used for fines and gravels; and a syringe scrubber would be used for bedrock and large boulders (if present).

Similar to the BMI sampling, each algae sample collected at the 11 major transects would be composited into a single sample for processing. The processing of the algae would follow the SWAMP 2016 SOP, which would involve removal of algae from the substrates collected and processing the sample for the four algae analyses: quantitative soft-bodied algae, quantitative diatoms, ash-free dry mass (AFDM), and chlorophyll a. A soft-bodied algae qualitative sample would also be collected from each sampling reach by collecting a composite of all types of soft-bodied algae observed within the sampling reach into a single sample. This sample would aid in the identification of soft-bodied algae in the quantitative sample and would be used in the calculation of some of the algae metrics. Replicate algae samples would be collected at the same sampling reaches where replicate BMI samples would be collected.

4.4 Laboratory Processing

This section summarizes the methods that would be used to process all bioassessment data.

4.4.1 Water Quality

Water samples would be collected at each sampling reach to determine total nitrogen and total phosphorus, constituents necessary for helping to determine algal results. Samples would be sent to a local water quality processing laboratory in northern California. The water quality analyses would be consistent with SWAMP protocols for water chemistry. Total nitrogen would be analyzed according to U.S. Environmental Protection Agency Method 351.2, and total phosphorous would be analyzed according to Standard Methods 4500-P B and 4500-P E.

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4.4.2 Benthic Macroinvertebrate Sample Processing

BMI sample taxa identification would be conducted by an outside laboratory (most likely by the Chico Aquatic Bioassessment Laboratory [Chico ABL] in Chico, California). BMI samples would be picked, sorted, and identified completely or until a 600 count (SAFIT Level 2) is reached. Chico ABL follows QA/QC procedures developed under the SWAMP program.

4.4.3 Algae Sample Processing

Five types of algae would be collected and processed: qualitative grab, soft-bodied algae, diatoms, AFDM, and chlorophyll a. The qualitative grab, soft algae, and diatom samples would be sent to the CDFW Group at the Marine Pollution Studies Laboratory at Moss Landing Marine Laboratories (MPSL-MLML). MPSL-MLML would report the data in SWAMP template formats. MPSL-MLML would calculate the Algae Stream Condition Index (ASCI) from the data. The samples of AFDM and chlorophyll a would also be sent to MPSL-MLML, who would report the data in California Environmental Data Exchange Network template formats. PSL-MLML follows the QA/QC procedures developed under the SWAMP.

4.5 Data Analysis

PHAB information would be entered using the SWAMP Version 2.5 bioassessment data entry forms (Marine Pollution Studies Laboratory 2022) and then loaded into the Microsoft Structured Query Language (SQL) Server database of the MPSL-MLML. BMI and algae taxonomy data, as well as water chemistry data would be loaded from Microsoft Excel templates into the same Microsoft SQL Server database. The data entry forms and templates would be obtained from the MPSL-MLML Data Center website. All data would be verified and checked for completeness after input into the database.

4.5.1 Physical Habitat Information

PHAB data would be entered by the MPSL-MLML using the SWAMP Bioassessment Field Form Microsoft Access database, and then loaded into the MPSL-MLML's Microsoft SQL Server database. After loading, additional error and completeness checks would be run following SWAMP business rules. The data would be sent to the California Environmental Data Exchange Network, where it would be available to the public for viewing and download.

PHAB metrics would be calculated using the SWAMP Bioassessment Reporting Module. The SWAMP protocol contains a subset of parameters measured within the U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program for freshwater wadeable streams; therefore, many of their metrics described in Kaufmann et al. (1999) form the basis of the SWAMP Bioassessment Reporting Module output.

SWAMP has developed a PHAB Index similar to the California Stream Condition Index (CSCI) (Section 4.5.3, *Benthic Macroinvertebrates*) for BMI data. The PHAB Index (called the *IPI*) combines eight GIS-calculated metrics with 12 PHAB metrics to produce one IPI value (Rehn et al. 2018). For the purposes of statewide assessments, the IPI has thresholds of physical condition: greater than or equal to 0.94 indicates likely intact condition; 0.93 to 0.84 indicates possibly altered condition; 0.83 to 0.71 indicates likely altered condition; and less than or equal to 0.70 indicates very likely altered condition.

In addition, the results would be compared to key stressor thresholds that best highlight the conditions at the sampling reaches identified in *Ecological Condition Assessment of California's Perennial Wadeable Streams: Highlights from the Surface Water Ambient Monitoring Program's Perennial Stream*

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Assessment (PSA) (2000–2007) (Ode et al. 2011). These select stressor thresholds are not regulatory limits set by SWRCB; rather, they are biology-based stressor thresholds developed by researchers as an objective means to set meaningful, regionally appropriate water quality standards. Two statewide and regional PHAB biological stressor thresholds, the Percent Fines and Sand and Mean Embeddedness thresholds, are examples of biological stressor thresholds that would be appropriate to analyze for this Project.

4.5.2 Water Quality

Similar to the PHAB analysis described above, water quality results would be compared to key stressor thresholds that best highlight the conditions at the sampling reaches identified in *Ecological Condition Assessment of California's Perennial Wadeable Streams: Highlights from the Surface Water Ambient Monitoring Program's Perennial Stream Assessment (PSA) (2000–2007)* (Ode et al. 2011).

4.5.3 Benthic Macroinvertebrates

MPSL-MLML would be contracted to assist in the analysis of the BMI data. MPSL-MLML would use the BMI taxonomic data obtained from Chico ABL to calculate CSCI scores for each sampling reach. The CSCI is a statewide biological scoring tool that translates complex data about individual BMIs found living in a stream into an overall measure of stream health (Rehn et al. 2015).

CSCI scores and output would be calculated using R scripts defined in Mazor et al. (2017). CSCI score categories would be applied as defined in Rehn et al. (2015).

- Less than or equal to 0.62: very likely altered
- 0.63–0.79: likely altered
- 0.80–0.91: possibly altered
- Greater than or equal to 0.92: likely intact

MPSL-MLML would also calculate several BMI metrics from the taxonomic data for each sampling reach. These individual metrics would be reviewed to discuss the individual results for each sampling reach and event. Representative metrics may include measures of taxa richness, composition, tolerance, functional feeding groups, and habit measures. These other metrics may be more insightful for determining the biological integrity of the BMI communities than the CSCI scores alone (at least in the valley floor sampling reaches), as valley floor reference sites (the sites used in the CSCI calculations) are relatively limited in abundance (Rehn pers. Comm.).

4.5.4 Algae

Diatoms and Soft Algae

MPSL-MLML would be contracted to calculate the statewide diatom, soft algae, and hybrid ASCI and associated metrics. These predictive biological indices replace past regional indices with a statewide index allowing for improved comparisons across diverse landscapes in a consistent and comparable manner. While ASCI can be calculated for soft algae and diatoms separately, the hybrid ASCI produces stronger species distribution models for more accurate and integrative assessments of biological condition.

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Chlorophyll *a* and Ash-Free Dry Mass

Ode et al. (2011) in their analysis of the results from the statewide Perennial Stream Assessment between 2000 and 2007, have included stressor thresholds for chlorophyll *a* and AFDM. These thresholds are more protective than levels proposed by previous authors, which were 100 milligrams per square meter for chlorophyll *a* and 50 grams per square meter for AFDM (Barbour et al. 1999, Welch et al. 1988, Dodds et al. 1998, Sosiak 2002, Dodds and Welch 2000, U.S. Environmental Protection Agency 2000, Biggs 2000). The thresholds proposed by Ode et al. (2011) are not regulatory limits or requirements but rather recommendations. The chlorophyll *a* and AFDM stressor thresholds (statewide and regional) would be evaluated for each sampling reach by MPSL-MLML.

4.6 Timing and Frequency

The bioassessment surveys would be conducted during the appropriate index period for Central Valley streams (June through August), which is typically 4 to 6 weeks following the last winter storm event. Depending on stream conditions, however, bioassessment surveys may need to be performed prior to the appropriate index period to ensure adequate flow for benthic and algal sampling is present. Baseline (pre-operation monitoring) would occur in the spring for (possibly) 5 years prior to project operation. Follow-up (baseline) surveys would be conducted on an annual basis during the same period for up to 10 years after operation activities are initiated. The Authority and the relevant agencies (CDFW, USFWS, and Colusa County) would be consulted if the frequency of monitoring would be shortened after 5 years.

4.6.1 Permitting Requirements

A CDFW Scientific Collecting Permit (Specific Use) or Memorandum of Understanding permit would be required to complete the study design as proposed. BMI samples would be the only collected species.

4.7 Additional Water Quality Measurements

In addition to the standard water quality measurements included in the SWAMP bioassessment as described above, samples would be collected for additional laboratory measurements. The objectives for taking these additional measurements would be to compare pre-Project and Project values, determine any effect of operational adjustments on sampled water quality constituents, and compare measurement values to key stressor thresholds. These additional measurements include:

- **A suite of total and dissolved metals and metalloids**. The suite includes aluminum, arsenic, cadmium, chromium (total), chromium, copper, iron, lead, manganese, mercury, methylmercury, nickel, selenium, silver, and zinc.
- **Cyanobacteria and cyanotoxins**. The cyanobacteria water samples would be collected for the purpose of laboratory analysis for cyanobacteria presence and density and the presence of cyanotoxins (specifically microcystins, anatoxin-a, and cylindrospermopsin).
- **Methymercury in fish tissue**. Level I trophic level fish would likely be more abundant than higher trophic level fish, so the measurements of methylmercury concentrations in fish tissue would focus on these fish. Higher trophic level fish would be sampled intermittently as available. To assess methylmercury in fish tissue, sampling would be conducted using the SWAMP protocol for California rivers and streams (California Water Boards 2011 or most current).

When these additional water quality samples and fish are collected, the following basic survey information and data described above would be collected: project name, sampling reach name, time

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and date of survey, stream/watershed name, and the names of the survey crew members. Incidental observations such as recent rainfall, fire effects, flooding, and other disturbances would also be recorded. Basic data collected at the sampling sites would include stream discharge measurements, temperature, specific conductivity, dissolved oxygen, turbidity, pH, and water samples for total nitrogen and total phosphorus laboratory measurements. In addition, water samples would be collected for laboratory measurements of dissolved organic carbon and hardness as these parameters influence water quality standards for aquatic life protection for some metals.

These measurements would be taken twice a year, once during a high flow period and once during a low flow period, at the upstream and downstream bioassessment sampling locations on each creek. Sampling would occur during the same years as the rest of the bioassessment studies.

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5.0 Hydrogeomorphic Study

5.1 Purpose of Study

The overall purpose of the Hydrogeomorphic Study would be to characterize historical and present-day streamflows, including baseflow during the spring and summer months, on Stone Corral Creek and Funks Creek; the relevant geomorphic characteristics of each creek (herein called *geomorphic indicators*); and flow levels necessary for channel maintenance of geomorphic processes required to maintain the channels in their current condition.

A Hydrogeomorphic Study with quantitative and qualitative monitoring data to fully characterize the existing hydrologic regime of Stone Corral Creek and Funks Creek, as well as the overall type and abundance of sediment available for aquatic organisms, would be developed. To inform the appropriate streamflows for the creeks under inquiry, a geomorphic assessment of the reaches of interest (i.e., the stream reaches below the dams) would constitute the first step in the analysis. The channel segments upstream of the dams would also be rapidly assessed to provide a greater understanding of the local watershed geomorphic characteristics. The focus of the geomorphic assessment would be to determine the dominant geomorphic processes, document the surrounding landforms and channel bed topography, and to determine how the observed morphology of each creek is influenced by the hydrologic regime and the surrounding land uses. Likewise, collection of geomorphic information would aid in the determination of overall channel stability for each creek, which has important implications for the proposed releases.

The Hydrogeomorphic Study to examine the hydrologic regime of Stone Corral Creek and Funks Creek would include a desktop modeling exercise, as well as installation of stilling wells, staff gages, and real-time water surface level collection devices. The goal of the Hydrogeomorphic Study would be to evaluate the physical and hydrologic condition of the reaches of interest within both Stone Corral Creek and Funks Creek. This information, along with the other required studies as discussed in previous chapters (i.e., Fish Assemblage Study and SWAMP bioassessment study), would help to inform the type of flow releases that should be made to the creeks under various Project operating conditions.

After completion of the baseline studies, consideration would be given to when and how flows would be released and whether a portion of these flows are needed to maintain fluvial geomorphic processes (based on the findings from the geomorphic assessment).

5.2 Study Design

The (baseline) Hydrogeomorphic Study components are discussed below. *Field site locations* are applicable to the geomorphic component of the Hydrogeomorphic Study; *hydrologic monitoring locations* represent the potential locations where stilling wells, staff gages, and real-time water surface level collection devices would be installed (i.e., the hydrologic component of the Hydrogeomorphic Study). The ultimate number of field site locations on each creek would be based on access and safety; however, it is anticipated that five sites would be located on Funks Creek and that six would be located on Stone Corral Creek. The locations for the geomorphic component of the Hydrogeomorphic Study would presumably be the same as the bioassessment sampling reaches as part of the SWAMP bioassessment study as described in Chapter 4 (Figure 5). The ultimate number of hydrologic monitoring locations on each creek would primarily be based on access, due to the need for monitoring during and

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after precipitation events. It is anticipated that two sites would be located on each creek: one in the foothills and one on the valley floor as shown on Figure 6.

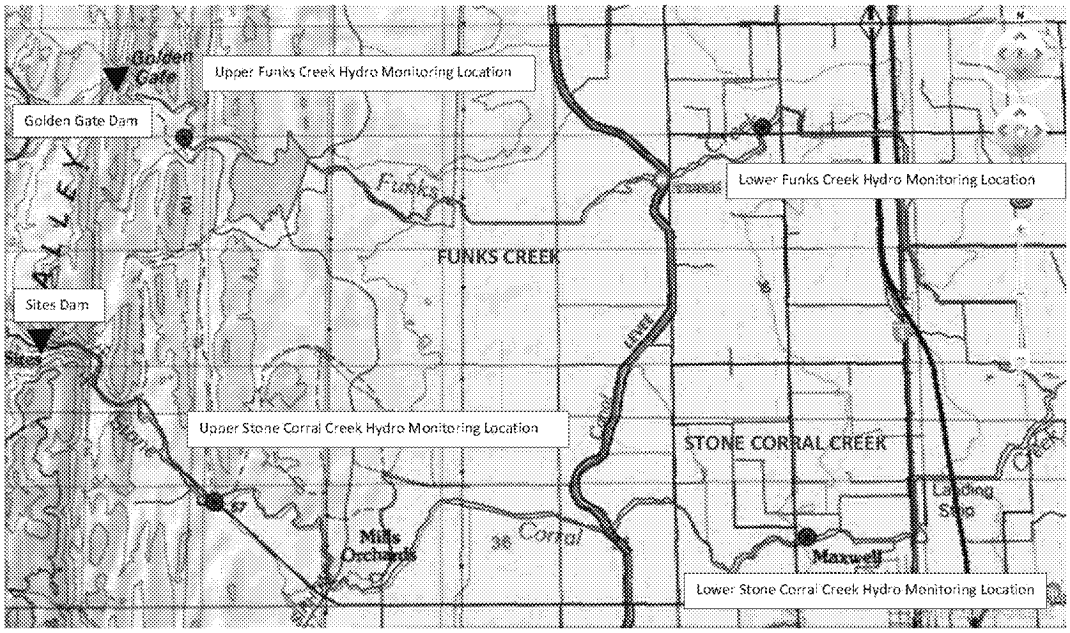

Figure 6. Potential Hydrologic Monitoring Locations, Stone Corral Creek and Funks Creek

5.2.1 Geomorphic Conditions

Data collected during the geomorphic component of the Hydrogeomorphic Study (geomorphic assessment) would include a host of geomorphic attributes, or indicators, as described below. Topographic data (longitudinal profile and cross sections) needed for the hydrologic model (further described below) would also be collected during the geomorphic assessment. The geomorphic assessment would be conducted by a geomorphologist with expertise in channel and floodplain dynamics, channel stability analyses, and topographic surveying techniques.

The geomorphic assessment would include evaluation of the following indicators.

- Channel classification
- Local watershed inputs
- Hydrologic and flow patterns
- Riparian vegetation condition
- Bankfull width and depth and wetted width
- Bank instability and bank characteristics
- Channel bed substrate composition and embeddedness
- Channel complexity
- Degree of channel incision
- Stage of channel evolution

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- Cross section and longitudinal profile surveys

These indicators would be assessed for each field site location (Figure 5). In addition, at least three permanent cross sections would be established within each field site location and within each hydrologic monitoring location (Figure 6) for collection of quantitative channel morphology information and required modeling input. Evaluation methods for these indicators are described below.

Channel Classification

Stream and river segments can be grouped into three generalized classifications based on their position in the watershed and the relative balance of transport capacity to sediment supply (Montgomery and Buffington 1998). Headwater source areas are typically transport-limited (often due to limited channel runoff) but do offer sediment storage that is intermittently initiated under large flow events, debris flows, or other gravitational events. Transport segments are composed of morphologically resilient, supply-limited reaches (e.g., bedrock, cascade, and step-pool) that rapidly convey increased sediment inputs. Response segments consist of lower-gradient, more transport-limited depositional reaches (e.g., plane-bed, pool-riffle) where channel adjustments occur in response to changes in sediment supply delivered from upstream.

Based on field observations and the stream classification methodology of Montgomery and Buffington (1998), each field site location would be classified accordingly. The classification would aid in the determination of the sediment regime and bedform morphology, which would help characterize the stream habitat and function of each field site location on the reaches of interest.

Local Watershed Inputs

Any major inputs of sediment and runoff into the field site locations (e.g., landslides or other mass wasting features, recent burn scars) would be summarized. The objective would be to identify any land use changes that could alter the balance of sediment supply and runoff that could lead to future instability (e.g., channel aggradation of degradation) within the reaches of interest. This would aid in the determination of channel stability and the potential for available habitat to be disrupted or altered in the vicinity of the field site locations.

Hydrologic and Flow Patterns

The hydrologic pattern would be determined throughout the length of the field site locations and would include identification of whether streamflow is perennial, intermittent, or ephemeral. Perennial streams are those which flow year-round; intermittent streams are those which flow for only certain times of the year and receive water from both surface water and groundwater; and ephemeral streams are those which have their channels above the water table year-round and only receive water from surface runoff. This geomorphic indicator would rely on the field-based hydrologic component of the overall Hydrogeomorphic Study, as described below.

Riparian Vegetation Condition

Riparian vegetation is an important indicator for overall stream habitat and function as it serves to stabilize streambanks and allows for canopy cover to create suitable water temperatures for aquatic species. Riparian condition refers to a description of the general health of the riparian area, focusing on the amount and type of vegetative cover.

Within each field site location, riparian condition would be described as low (0–25 % vegetative cover), moderate (25–50 % vegetative cover), high (50–75 % vegetative cover), or very high (75–100 %

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vegetative cover). The size and approximate age of any riparian vegetation growing in the channel bed would be documented because this is evidence of channel adjustment and possible re-stabilization from a prior disturbance.

Bankfull Width and Depth and Wetted Width

Bankfull width and depth measurements would be recorded to assess the hydraulic capacity of the channel in the field site locations. Specifically, a geomorphic or effective bankfull surface would be identified in the field. The geomorphic bankfull or effective surface is the surface that gets inundated by the discharge that performs the most geomorphic work on a system, typically a flow that occurs every 1.5 to 2 years (Knighton 1999). This discharge, known as the geomorphic bankfull discharge, is defined as that water discharged when stream water just begins to overflow into the active floodplain. The geomorphic bankfull or effective surface would be identified based on the methodology of Harrelson et al. (1994) and Hauer and Lamberti (1996). Once this surface is recognized, width and depth measurements would be recorded.

Like bankfull width and depth measurements, wetted width and depth measurements would be recorded. Specifically, the wetted surface would be identified in the field and width and depth measurements would be recorded.

Bankfull and wetted width and depth data collection would help to determine the size of the channel, which would help in assessing overall available habitat conditions in the field site locations and reaches of interest.

In addition, the "active channel" width would be identified, which typically represents a typical low to moderate flow regime and is usually bounded by the width of the in-channel vegetation.

Bank Instability and Bank Characteristics

The term *bank instability* refers to streambanks that are either actively retreating or have the potential to retreat soon. In brief, weakening processes are any bank or near-bank processes that act to erode or prepare streambanks for further erosion (Lawler 1992). The purpose of assessing this indicator would be to identify fluvial erosion (erosion associated with flowing water) and bank failure (erosion associated with gravitational forces and weakening processes). Fluvial erosion is closely related to boundary shear stress, which can be loosely approximated by unit stream power variations, and bank failure is collapse of all or part of the streambank in situ (Lawler 1995).

Bank stability would be defined as the natural streambank that has stable groundcover. Stable ground cover includes rooted trees, shrubs, herbaceous plants, and naturally occurring rocky substrates. Bank composition and bank height/angle would also be determined. The results, in conjunction with the other indicators, can be used to detect where the channel may be downcutting as suggested by over-steepened banks, and can also be used to describe the potential for the channel to potentially laterally migrate and increase the risk of bank instability.

Bank stability analyses would aid in determination of the sediment regime and bedform morphology, which would help characterize the stream habitat and function of the field site locations, as well as the determination of channel stability and the potential for available habitat to be disrupted or altered in the field site locations.

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Channel Bed Substrate Composition and Embeddedness

Substrate composition and embeddedness refer to the size of the substrate materials on the channel bed, and the degree to which these materials are embedded. These conditions indicate how frequently the channel substrate is mobilized. Substrate composition and embeddedness would be measured using the methods described by Bunte and Abt (2001). Substrate composition would identify the available substrate (overall type and abundance) for aquatic species in the vicinity of each field site location.

Channel Complexity

The presence or absence of gravel bar development and evidence of scour and/or deposition would be determined throughout the length of each field site location. Pool and riffle habitats containing in-channel structures (e.g., instream woody material) that create complexity and habitat niches for aquatic organisms would also be documented. Basic channel or habitat units (e.g., pool, riffle, and flatwater) would be delineated according to standard habitat mapping descriptions in each field site location. A rough proportion of unit types would be calculated.

Channel or habitat units would be defined as follows.

- **Pool.** Slow water, length, and width at least one-half the bankfull channel width, and a 10-inch minimum residual pool depth. Subcategories define the general type of pool and include scour (lateral, channel, channel confluence, plunge), dam, and backwater, as defined by Overton et al. (1997).
- **Riffle.** Swiftly flowing, turbulent water, some partially exposed substrate, substrate cobble, and/or boulder dominated (McCain et al. 1990).
- **Flatwater.** Wide, uniform channel bottom, low to moderate water velocity, and little surface agitation. Encompasses any areas that do not qualify as pool or riffle (McCain et al. 1990).

If appropriate (i.e., if the habitat diversity merits such a method), the field site locations would be habitat typed to provide a more detailed stream habitat inventory. Stream habitats would be delineated into one of the six Level-III habitat classification types (Flosi et al. 2010) based on morphological characteristics. These include overall channel gradient, water velocity and depth, substrate, and, where applicable, the channel features (e.g., boulder, bedrock, woody material, converging flow) causing the formation of the habitat unit through scour and sediment deposition (Flosi et al. 2010). Channel/habitat type determination would allow for identification of available habitat types for aquatic species.

Degree of Channel Incision

The degree to which the channel is incised would be recorded as negligible, low, moderate, high, or very high. The degree of incision would be qualitatively analyzed using the following criteria.

- **Identification of any Quaternary landforms on the floodplain (e.g., terraces, low floodplain, fan, etc.).** Terraces typically have steep streambanks, and the channel may not necessarily be incised. Steep, unstable streambanks adjacent to a low floodplain surface, however, typically indicate incision.
- **Identification of bedforms downstream of the site where and if the channel is less incised.** Bed and streambank material from incised channels would typically be deposited downstream in somewhat uncharacteristically large deposits on the channel bed (downstream aggradation).

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- **Recognition of base level changes downstream.** Dams and other barriers can create upstream changes in channel bed elevation (i.e., headward migration of incision).
- **Visual survey of channel bed at the field site location.** Channel or habitat sequences, such as pool-riffle sequences, are rare in incised channels, and those that do exist do so for only limited time intervals. Additionally, the increased depth of flow associated with incision, coupled with an increased flashy regime, results in bed armoring and a decreased frequency of bed mobilization.
- **Determination of the health of the riparian and floodplain plant species.** Plants that are found in similar, un-incised reaches are usually not present in incised reaches. No vegetation at all is an indicator of no hydrologic interaction between the floodplain and the channel and, therefore, incision.
- **Identification of recent evidence of overbank deposition of fine sediment, plant debris, or other organic matter.** A channel that floods its streambanks frequently would typically have splay (i.e., sand) deposits and vegetation with a smoothed, flooded appearance in the downstream direction. Natural levee development is also an indication of frequent flooding.

Stage of Channel Evolution

A stream evolution model (Cluer and Thorne 2013) would be applied to the entirety of the reaches of interest on Stone Corral Creek and Funks Creek to provide a template for understanding geomorphic responses and processes within the immediate watershed. The stream evolution model of Cluer and Thorne (2013) revisits and updates two well-established channel evolution models (Schumm et al. 1984, Simon and Hupp 1987) in light of recent research and the authors' practical experiences.

In addition, a channel stability analysis would be conducted at each field site location. The chosen methodology would be dictated by site conditions but could include the methods as presented in the modified Pfankuch procedure (Pfankuch 1975) as described by Rosgen (2001), Simon and Down (1995), Bledsoe et al. (2010), or other applicable method. The stream evolution model and the channel stability analyses would aid in the determination of how on Stone Corral Creek and Funks Creek may evolve (e.g., deepen/widen) or remain in a state of equilibrium in the future, thus, having implications for the available habitat within the channels.

Cross Section and Longitudinal Profile Surveys

As mentioned above, at least three permanent cross sections would be established within each field site location (Figure 5) and within each hydrologic monitoring location (Figure 6) for collection of quantitative channel morphology information and required modeling input. Permanent cross sections would be established perpendicular to the primary channel following the methodology of Harrelson et al. (1994). Each transect would be surveyed using ground-based surveying equipment to capture and track channel morphology. Elevations along the cross sections would be collected at intervals close enough to capture slope breaks and distinct morphological features within the floodplain (if present), and along the channel sides and bottom.

The location of each cross section would be permanently marked in the field using 4-foot-tall metal t-posts or wooden lathes (to easily find the general transect location) and with rebar driven vertically into the ground surface, capped with an appropriate cover (to establish known permanent elevations [permanent monuments or benchmarks] on each side of the transect). The permanent benchmarks for each transect would be placed in a stable location above the active channel on the left and right (as viewed facing downstream) banks or terraces of the channel. Transect endpoints (i.e., the permanent

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monuments) would be documented using a GPS receiver. Representative photographs would be taken at each cross section.

In addition to the cross sections, a longitudinal profile would be surveyed throughout the length of the channel within a field site location. The spacing between channel bed data points would vary depending on the complexity of the channel bed characteristics. Digital photographs would be taken in the upstream and downstream directions at various locations throughout the longitudinal profile. The location(s) of each cross section would be surveyed on the longitudinal profile for graphical plotting purposes.

Channel Geometry Metrics

As mentioned previously, bankfull width and depth measurements would be recorded to assess the hydraulic capacity of the channels. This would be completed at the cross sections measured in the field. In addition to bankfull, wetted, and active channel width and depth measurements, the bankfull and entire channel width-to-depth ratio would be calculated for each cross section, and sinuosity and gradient of the longitudinal profile would be determined.

5.2.2 Hydrologic Conditions

The hydrologic component of the Hydrogeomorphic Study would consist of both desktop (modeling and historical conditions review) and field-based efforts (generation of stage-discharge relationships), both of which are summarized below. The desktop effort would provide detailed information on various (modeled) flows of interest (i.e., the 2-year, 5-year, 10-year, 50-year, and 100-year flow events), while the field-based efforts would validate/calibrate the modeling results via collection of real-time streamflow data, especially for smaller streamflow events (the flows that are expected to occur most of the time on each creek).

Summary of Modeling Approach

A HEC-HMS rainfall-runoff-routing watershed hydrology model would be created to generate hydrographs for both Stone Corral Creek and Funks Creek. Inputs into the hydrology model would include watershed land use, percent impervious inputs, soil types, precipitation and evapotranspiration, drainage network characteristics, and topography (which would be generated from available light detection and ranging [LiDAR] technology).

The topographic surveys as described above would also serve to augment the existing LiDAR data with on-the-ground data to better capture topography in areas requiring additional detail (such as densely vegetated areas). The topographic surveys would be tied into the State Plane Coordinate System and would be sufficient to generate contours at a 1-foot interval. The data collected via the topographic surveys would also be required for generation of stage discharge relationships, as described below.

It should be noted that HEC-HMS rainfall-runoff-routing watershed hydrology model constitutes the first (somewhat exploratory) step in the hydrologic analysis. As discussed in the RDEIR/SDEIS, any releases into Funks Creek would be made through the transition manifold at the base of Golden Gate Dam and a new pipeline that terminates at Funks Creek below the dam. These facilities would carry up to 100 cfs with a release range of 0 to 100 cfs into Funks Creek. Any releases into Stone Corral Creek would be made through the permanent outlet at Sites Dam. This outlet would have a release range of 0 to 100 cfs, with an emergency release capacity of up to 2,500 cfs. The modeling effort would be the first step in determining if a range in flows, as described in the RDEIR/SDEIS, would be needed to meet the purpose of CFGC Section 5937 given the modeled hydrology.

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Summary of Field-Based Analysis

The primary objective of the field investigation would be to provide an accurate description of the existing watershed hydrology and variations in streamflow and water surface elevations (i.e., stage) on both Stone Corral Creek and Funks Creek. Periodic streamflow measurements (depth and velocity measurements) would be taken to develop stage-discharge relationships (rating curves) to translate the continuous water depth measurements measured with continuous stage recorders (i.e., HOBO water level loggers [Onset Computer Corporation]) into continuous estimates of flow. These measurements would occur at the hydrologic monitoring locations as shown on Figure 6.

To determine continuous estimates for streamflow, the stage recorders, which measure water temperature and pressure, and vertical stilling wells would be installed in relatively deep portions of the creeks at the locations as shown on Figure 6. The HOBO water level loggers would be set to monitor water depth every 15 or 30 minutes. Additional HOBO water level loggers would also be installed to monitor barometric pressure every 15 or 30 minutes for the purpose of calibrating the depth (water pressure) measurements, which are also affected by barometric pressure. These additional data loggers would be secured to upland surfaces (e.g., trees). Streamflow measurements would be collected to develop equations to convert the continuous stage recorder data into estimated streamflows (discharge). During variable discharge conditions, streamflows would be estimated using a Marsh-McBirney Flo-Mate Model 2000 flow meter and top-setting rod following the procedures described in Module O in Chapter 8 of the SWAMP 2016 SOP (Ode et al. 2016a, 2016b).

Daily precipitation data obtained from the California Data Exchange Center or the PRISM Climate Group would be used to characterize the rainfall patterns during the study period. Rainfall patterns would be displayed concurrently with the measured streamflow data.

If necessary, acoustic Doppler current profiler (ADCP) technology could be used to capture high flow events. ADCP equipment is particularly useful for collecting accurate and precise water depth and 2-D/3-D velocity data, especially at high flows when other standard surveying techniques as described above are impractical or unsafe. ADCP technology also offers the advantage of detecting bed elevation change resulting from high flow events that would be useful for evaluating sediment mobility in the reaches of interest. The applicability of ADCP would be investigated during the first season of hydrologic monitoring (once field conditions at the field site locations are ascertained).

5.3 Timing, Frequency, and Operation Monitoring

5.3.1 Pre-Operations Monitoring

The baseline geomorphic component of the Hydrogeomorphic Study would first be conducted during the winter/spring of 2023. It is anticipated that all relevant geomorphic indicators could be collected during one field trip. Additional baseline geomorphic data collection during subsequent years would be conducted if high precipitation patterns/high flow events occur during the pre-operation period.

The desktop hydrologic component of the Hydrogeomorphic Study would occur during 2023. The field-based hydrologic component of the Hydrogeomorphic Study would occur at the locations as shown on Figure 6 until the dams are constructed.

5.3.2 Operations Monitoring

Follow-up geomorphic and hydrologic surveys would be conducted on a regular (pre-approved) basis for up to 10 years after operations begin. The Authority would consult with the relevant agencies (CDFW,

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USFWS, and Colusa County) if the frequency of monitoring would be shortened after 5 years. Additional information on each component of is provided below.

Geomorphic Stability Monitoring Plan

Operations geomorphic monitoring would generally be like the pre-operation efforts, including returning to established field site locations and collecting information on geomorphic indicators by performing a geomorphic assessment as described above. Data collected as part of the operations geomorphic monitoring effort would be compared against the baseline data and summarized into interim and final reports to the Authority.

The focus of the operations geomorphic monitoring effort, however, would be geomorphic stability monitoring. As such, the primary survey components of monitoring would include cross section and longitudinal profile surveys, channel bed substrate composition determination, and channel stability evaluations. All methods for these efforts would be identical to those described above. The objectives of these monitoring elements and their relevance to geomorphic stability are summarized below.

Cross Section and Longitudinal Profile Surveys

The objectives of collecting data at the cross sections would be to collect primarily lateral stability information to determine the rate of lateral migration through bank erosion and overall cross-sectional area change. The rate, magnitude, and direction of lateral change and area change would be determined over time using repeat longitudinal profile surveys.

The objective of collecting data at the longitudinal profiles would be to collect primarily vertical stability information to determine rates of aggradation or degradation (whether the stream is downcutting [degrading], filling [aggrading], or remaining static). The rate, magnitude, and direction of vertical change would be determined over time using repeat longitudinal profile surveys.

Channel Bed Substrate Composition and Embeddedness

The objectives of collecting channel bed substrate composition and embeddedness information would be to observe potential shifts in bed material size-frequency distribution, which can be determined over time. Collected grain size information would aid in interpretation in specific geomorphic changes if they occur (such as any changes identified via the cross-sectional and longitudinal profile analyses above).

Channel Stability Evaluations

The chosen methodology for channel stability evaluations would be dictated by site conditions but could include the methods as presented in the modified Pfankuch procedure (Pfankuch 1975) as described by Rosgen (2001), Simon and Down (1995), Bledsoe et al. (2011), or other applicable method. Together with the stream evolution model (Cluer and Thorne 2013), the channel stability analyses would aid in the determination of how Stone Corral Creek and Funks Creek may continue to evolve (e.g., deepen/widen) or remain in a state of equilibrium in the future, thus having implications for the available habitat within the channels.

Hydrologic Monitoring Plan

Operations hydrologic monitoring would be like the pre-operation field-based efforts, including returning to established hydrologic monitoring locations, monitoring stage and stream discharge over time. Data collected as part of the operation hydrologic monitoring effort would be compared against the baseline data and summarized into interim and final reports.

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The level of effort of the operations Hydrologic Monitoring Plan, however, would be considerably less than for the pre-operation effort because, depending on the streamflow and precipitation patterns during the pre-operation time-period, there would presumably already be numerous years of pre-operations hydrologic monitoring data at the hydrologic monitoring locations (in other words, a robust data set with multiple discharge measurements and associated stages would be available). The operation hydrologic monitoring effort would, therefore, primarily consist of measuring streamflow values that were not obtained during the pre-operation monitoring effort (presumably higher flow events) and conducting routine field maintenance activities such as periodic downloads of the HOBO water level loggers and upkeep of field equipment.

6.0 Temperature Study Design and Methods

6.1 Overview of Proposed Methods

A temperature study would be conducted to characterize temperatures under existing conditions and determine flow and storage effects on temperature in Stone Corral Creek and Funks Creek under operating conditions. The study would involve evaluating temperatures in the creeks before and after initiation of Project operation and would include consideration of the effects of creek flow and reservoir storage on temperature.

The study would assess the following.

- The temperatures that support the aquatic community under existing conditions.
- Reservoir discharge needed to maintain appropriate temperatures to maintain fish in good condition in Stone Corral Creek and Funks Creek downstream of Sites Reservoir after the start of operation.

6.2 Study Design

Once access to Stone Corral Creek is obtained, a temperature probe would be installed in Stone Corral Creek at the location of Sites Dam release, and four additional probes would be installed downstream by approximately 0.5 mile, 1 mile, 2.4 miles (near where Stone Corral Creek goes under Maxwell Sites Road), and 4.4 miles (near where TC Canal goes under Stone Corral Creek).

Once access to Funks Creek is obtained, a temperature probe would be installed in Funks Creek at the location of the I/O tower release to Funks Creek, and two additional probes would be installed downstream by approximately 0.5 mile and 1 mile (far enough upstream of Funks Reservoir to be unaffected by it). In addition, probes would be installed at the TC Canal inlet to Funks Reservoir, at the TC Canal outlet from Funks Reservoir, and at the Funks Creek outlet from Funks Reservoir.

As described in the draft Reservoir Management Plan included in Appendix 2D of the RDEIR/SDEIS, once operation has commenced, water temperature profiles would be measured near Golden Gate Dam once every 2 weeks at 5-feet depth intervals to inform decisions about which ports of the I/O tower to use for any required flow releases under 5937. The temperature probes in the creeks would continuously record hourly temperatures. These temperatures would be used along with specific fish requirements to develop target temperature ranges for operation conditions.

Temperatures recorded after Sites Reservoir is operational would be used in conjunction with flow and storage data to determine flow and storage effects on creek temperatures. If creek temperatures cannot

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be accurately estimated with flow, storage, meteorology, and the reservoir temperature profiles, water temperature modeling could be performed for Sites Reservoir, Stone Corral Creek, and Funks Creek. If modeling is necessary, models would be calibrated with the measured flow, storage, and temperature data.

Water released into Stone Corral Creek would originate from the lower half of Sites Reservoir and would likely be cooler than equilibrium values during months when the reservoir is stratified. The biggest differential between release temperatures and equilibrium values would occur when the reservoir is full and ambient air temperature conditions are high. If it is determined that flow should be maintained in Stone Corral Creek at times when releases would be relatively cool compared to temperatures under existing conditions, lower flows would allow the water to warm farther upstream than higher flows.

Water released to Funks Creek would originate from the I/O tower and, when the reservoir is stratified, would be warmer than the water released to Stone Corral Creek. The temperatures would be warmer because the withdrawals would come from higher in the reservoir and, as described in the Reservoir Management Plan, the I/O tower port openings would be chosen to provide 65 degrees Fahrenheit (°F) or higher water temperatures during the rice growing season (May through September).

6.3 Timing and Frequency

Water temperature measurements would occur before and during operation. Measurements during the initial fill period would be useful for evaluating water temperature under low-storage conditions. Reservoir profile measurements and measurements at the Stone Corral Creek and Funks Creek releases may need to continue in the long term.

Measurements downstream of the release locations could be discontinued if the following conditions are met.

- Sites Reservoir has made releases for at least 2 years when the reservoir was at least 75% full.
- Temperature effects are found to have little effect on native fish (e.g., if only short sections of the creeks below the dams experience temperature effects) or if flow and storage effects on creek temperatures are understood well enough that average daily creek temperatures can be estimated within 3°F based on meteorological conditions, flow, reservoir storage, and reservoir temperature profiles.

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7.0 Reporting and Permit Requirements

7.1 Annual Reporting Requirements

Reporting requirements would be met through the preparation and submittal of annual and final reports as part of the Aquatic Study Plan that would be implemented as a part of the Authority's commitments and responsibilities to maintain fish in good condition consistent with CFGC Section 5937.

The first five annual reports would summarize the first 5 years of baseline conditions. All future (operation) reporting efforts would compare the conditions at that time to those collected during the baseline conditions.

The following information would be addressed in comprehensive annual reports with multiple chapters covering fish, bioassessment, hydrogeomorphic, and temperature study results.

- **Fish Study Results.** The annual report would include descriptions and locations of fish communities in Stone Corral Creek and Funks Creek, summarizing monitoring results in the study area. The report would document monitoring results and link results to objectives. The report would identify new or ongoing management issues, threats and stressors, and provide recommendations for future monitoring and management.
- **Bioassessment Results.** The annual reports would include BMI, algae, water quality, and PHAB output and results and a summary of each of these indicators. The most recent version of the SWAMP *Stream Habitat Characterization Form, Full Version* field forms would be provided in appendix format, along with representative photography of the sampling reaches.
- **Hydrogeomorphic Results.** The annual reports would include a summary of the monitoring methods; a summary and analysis of the hydrogeomorphic monitoring results, including an evaluation of site conditions in the context of the performance standards; a discussion of the monitoring results; a discussion of any modifications made to the monitoring methods; a discussion of the previous year's monitoring efforts; and photographs taken from the cross sections and longitudinal profiles.
- **Temperature Results.** The annual reports would include a summary of temperatures that support the aquatic community under existing conditions, and a recommendation of reservoir discharge needed to establish suitable temperatures in Stone Corral Creek downstream of Sites Dam and Funks Creek downstream of Golden Gate Dam after operation has commenced.
- **Monitoring Program Evaluation.** The annual reports would evaluate the Aquatic Study Plan to ensure that data (1) are collected efficiently, (2) address information needs, and (3) adequately assess resource responses to management actions. Changes in monitoring methods, protocols, or frequency would be summarized in the annual reports.
- **Objective Criteria Evaluation.** Annual reports during operations would evaluate whether management actions are meeting project objectives or performance standards (described below). An assessment would be made as to causal factors of observed declines, including the potential role of external stressors outside the parameters of Project effects.
- **Adaptive Management Thresholds.** The link between the technical and decision-making steps requires regular interaction and exchange of information between technical staff and decision-makers. This would be accomplished by annual meetings involving the Authority and the agencies where both regulatory and technical expertise can be integrated into revising goals and objectives,

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adjusting management and/or monitoring activities, or allocating funding. Meetings should be timed such that any new information discussed assists with the planning of upcoming seasonal work.

7.2 Performance Standards

Performance standards for the Aquatic Study Plan would be based on quantitative metrics. These performance standards would be designed specifically as a means of monitoring the progress and performance of the physical and biological conditions of the study reaches.

Fish community performance standards would include measures of community diversity and percent area occupied for both available and total reach distance within the study areas. BMI performance standards would likely include three main indicators—PHAB IPI scores, BMI CSCI scores, and algae ASCI scores. Geomorphic performance standards would focus on channel stability evaluations such as:(1) evidence of significant and detrimental morphologic changes at any of the cross sections; (2) evidence of channel headcutting; (3) significant loss of gravels via dam impoundment; and (4) significant decrease in the channel stability score during the duration of monitoring activities.

Performance standards would be developed in conjunction with the Authority and the relevant agencies (CDFW, USFWS, and Colusa County) prior to the start of operation monitoring.

7.3 Operations Plan

The Authority would use information from the results of implementation of this Aquatic Study Plan, including field studies described herein, to prepare the Operations Plan. The Operations Plan would describe the approach to address CFGC Section 5937 requirements, if any, resulting from impoundments to storage of flows from Stone Corral Creek and Funks Creek, while also ensuring that the Project's flood protection benefits are realized. Further, the Operations Plan would include, but would not be limited to, the approach for reservoir releases into Stone Corral Creek and Funks Creek, including release schedules and volumes. As stated in the Authority's application to appropriate water, the Operations Plan would be developed in consultation with CDFW, USFWS, and Colusa County, and approved by the Deputy Director for Water Rights.

7.4 Anticipated Schedule

The following schedule is anticipated to result in a reduced workload once a range of flows is encountered with representative variability of environmental conditions (Table 3). For example, the field-based Hydrologic Study could possibly occur over the course of the 5 years leading up to dam construction and could terminate once a suitable range of flows has been measured and analyzed. This could occur within 1 year if flow conditions are variable enough, but more than likely it will occur over a series of years.

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Table 3. Anticipated years that each study will be needed to acquire a representative range of environmental conditions for baseline and post operation periods.

Year	Fish Community	Bioassessment Study	Water Quality	Water Temp.	Geomorphic Study	Hydrologic Study (desktop)	Hydrologic Study (field)
Baseline							
2023	√	√	√	√	√	√	√
2024	√		√	√			√
2025	√	√	√	√			√
2026	√		√	√			√
2027	√	√	√	√			√
Post Operation							
2030	√	√	√	√	√		√
2031	√		√	√			
2032	√	√	√	√	√		√
2033	√		√	√			
2034	√	√	√	√	√		√

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8.2 Personal Communications

Rehn, Andrew. Biologist, California Department of Fish and Wildlife. April 6, 2022—Phone conversation with Jeff Peters of ICF and Marco Sigala at Moss Landing Marine Laboratories regarding a suitable number of bioassessment sampling reaches on Funks Creek and Stone Corral Creek for the Sites Reservoir Project.

From: Alicia Forsythe [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A6CDF06A7E904B65BAA21702A82AD329-AFORSYTHE]
Sent: 11/17/2022 7:47:49 AM
To: Cooke, Robert@DWR [Robert.Cooke@water.ca.gov]; Okita, David@DWR [David.Okita@water.ca.gov]; Rob Kunde [rkunde@wrmwsd.com]; Rob Cooke (rcooke1956@gmail.com) [rcooke1956@gmail.com]; Chilmakuri, Chandra@SWC [cchilmakuri@swc.org]; Jeff Davis [jdavis@ppeng.com]
Subject: RE: Sites Project - Discussion on EIR Presentation

Hi all – I was completely out of pocket yesterday on a site visit with Reclamation management so apologies for the really late response. I will catch up with Rob Kunde tomorrow and we'll figure out where to go from here in terms of a call.

I am working with ICF to get the current version of the Project Description. David and Rob Cooke, I've read through your emails and David's prior email (from many months ago about DWR's needs for the project description). I'll confirm all of this in there and will get a document to you all to take a quick look at. It may take me about a week to get all of this done and out to you all. The entire Admin Final EIR/EIS will be out for CEQA Responsible Agency review in January (still working on exact date) so DWR will also have a chance to review the entire document at that time.

Hope this all helps and apologies about the mix up and being out of pocket yesterday.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Cooke, Robert@DWR <Robert.Cooke@water.ca.gov>
Sent: Wednesday, November 16, 2022 6:43 PM
To: Okita, David@DWR <David.Okita@water.ca.gov>; Rob Kunde <rkunde@wrmwsd.com>; Alicia Forsythe <aforsythe@sitesproject.org>; Rob Cooke (rcooke1956@gmail.com) <rcooke1956@gmail.com>; Chilmakuri, Chandra@SWC <cchilmakuri@swc.org>; Jeff Davis <jdavis@ppeng.com>
Subject: Re: Sites Project - Discussion on EIR Presentation

Thanks for the clarification David.

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From: Okita, David@DWR <David.Okita@water.ca.gov>
Sent: Wednesday, November 16, 2022 6:40:08 PM
To: Cooke, Robert@DWR <Robert.Cooke@water.ca.gov>; Rob Kunde <rkunde@wrmwsd.com>; Alicia Forsythe

<aforsythe@sitesproject.org>; Rob Cooke (rcooke1956@gmail.com) <rcooke1956@gmail.com>; Chilmakuri, Chandra@SWC <cchilmakuri@swc.org>; Jeff Davis <jdavis@ppeng.com>
Subject: Re: Sites Project - Discussion on EIR Presentation

No - DWR is only doing a Supplemental EIR for the pulse flow projects. We will be relying on individual WSIP CEQA documents for Sites and LVE. We have reviewed both CEQA documents and the only thing we need is for Sites CEQA to reference the documents that DWR will be approving for the project - this is the list I gave to Ali earlier and we just need to see how this is described in the project description - really just a list of actions.

We did do a cumulative flow study of all WSIP projects, but that is not a CEQA document.

David Okita, PE
Department of Water Resources
530 902-7588

From: Cooke, Robert@DWR <Robert.Cooke@water.ca.gov>
Sent: Wednesday, November 16, 2022 3:32 PM
To: Rob Kunde <rkunde@wrmwsd.com>; Alicia Forsythe <aforsythe@sitesproject.org>; Okita, David@DWR <David.Okita@water.ca.gov>; Rob Cooke (rcooke1956@gmail.com) <rcooke1956@gmail.com>; Chilmakuri, Chandra@SWC <cchilmakuri@swc.org>; Jeff Davis <jdavis@ppeng.com>
Subject: Re: Sites Project - Discussion on EIR Presentation

My message to Ali is DWR plans to sign the Amendment, B&O agreement, Article 55 agreement, and the Operations Agreement. We need CEQA coverage. DWR plans to prepare a cumulative CEQA document for the Prop 1 projects.

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From: Rob Kunde <rkunde@wrmwsd.com>
Sent: Wednesday, November 16, 2022 2:16:24 PM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Okita, David@DWR <David.Okita@water.ca.gov>; Rob Cooke (rcooke1956@gmail.com) <rcooke1956@gmail.com>; Chilmakuri, Chandra@SWC <cchilmakuri@swc.org>; Jeff Davis <jdavis@ppeng.com>; Cooke, Robert@DWR <Robert.Cooke@water.ca.gov>
Subject: Re: Sites Project - Discussion on EIR Presentation

Lady and Gentlemen:

This was supposed to be a 4:00 pm Teams call for TODAY, Wednesday (not Thursday). Ali is available for this time per a prior email from her. I emailed her earlier requesting a change to 4pm today but have not heard back. If there is no further notice, I suggest trying to use the Thursday 4pm link for today's call. Chandra is not available today, and David indicated he did not need to attend. Ali is working on getting a Project Description to him per his request.

Robert J. Kunde, P.E.
Retired Annuitant
Wheeler Ridge-Maricopa Water Storage District
cell: 661-345-3719 email: rkunde@wrmwsd.com

From: Alicia Forsythe
Sent: Wednesday, November 16, 2022 8:29 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Rob Kunde <rkunde@wrmwsd.com>; Okita, David@DWR <David.Okita@water.ca.gov>; Rob Cooke (rcooke1956@gmail.com) <rcooke1956@gmail.com>; Chilmakuri, Chandra@SWC <cchilmakuri@swc.org>; Jeff Davis <jdavis@ppeng.com>; Cooke, Robert@DWR <Robert.Cooke@water.ca.gov>
Subject: Sites Project - Discussion on EIR Presentation
When: Thursday, November 17, 2022 4:00 PM-4:30 PM.
Where: Microsoft Teams Meeting

focus on any additional DWR feedback from Rob C, and identify the information needed for a future EIR presentation to the non-participating SWC

Microsoft Teams meeting

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From: Alicia Forsythe [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A6CDF06A7E904B65BAA21702A82AD329-AFORSYTHE]
Sent: 11/17/2022 8:06:57 AM
To: Rob Kunde [rkunde@wrmwsd.com]
Subject: RE: Sites EIR discussion with DWR

Ha ha ha! I always knew that a focused group could solve all of California's water problems in 20 minutes. Nice job!

Monday, November 21 is already packed with meeting with GCID in the morning on operations and then AB meeting in the afternoon.
Tuesday, November 22 is pretty packed also with just everyone trying to jamb in meetings prior to the holiday and ACWA. I am available from 8 to 9 AM and then after 2 PM.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Rob Kunde <rkunde@wrmwsd.com>
Sent: Wednesday, November 16, 2022 4:32 PM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: Re: Sites EIR discussion with DWR

Ali:

Jeff Davis and I used the Thursday meeting link to meet for 20 minutes today. We solved all of California's water problems.

Is your availability for Mon, Nov 21 or Tues, Nov 22 from 2pm to 3pm? That would be the best next date.

Rob K.

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Tuesday, November 15, 2022 5:55 AM
To: Rob Kunde <rkunde@wrmwsd.com>
Subject: RE: Sites EIR discussion with DWR

Hi Rob – Great chatting with you yesterday. Below are some dates/times for a discussion on a DWR EIR presentation.

Wednesday, Nov 16 – 4 to 5 PM
Thursday, Nov 17 – Noon to 1 PM; 2 to 3 PM and 4 to 5 PM
Tuesday, Nov 21 – 2 to 3 PM
Monday, Nov 28 – 11 am to 1 PM
Friday, Dec 2 – 11 AM to 1 PM; 2:30 to 5 PM

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Rob Kunde <rkunde@wrmwsd.com>
Sent: Friday, November 4, 2022 11:46 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: Sites EIR discussion with DWR

Ali:

Per our discussion at the RPC meeting, I am checking in on how preparation for the DWR presentation on the Sites EIR is going. I suggest a call with you, me and Rob Cooke to make sure we cover the matters of importance to DWR.

Robert J. Kunde, P.E.
Retired Annuitant
Wheeler Ridge-Maricopa Water Storage District
cell: 661-345-3719 email: rkunde@wrmwsd.com

From: Rob Kunde [rkunde@wrmwsd.com]
Sent: 11/17/2022 8:52:10 AM
To: Okita, David@DWR [David.Okita@water.ca.gov]; Rob Cooke (rcooke1956@gmail.com) [rcooke1956@gmail.com]; Jeff Davis [jdavis@ppeng.com]; Chandra Chilmakuri [cchilmakuri@swc.org]
CC: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: Tues, Nov 22 Call to plan next Sites Briefing to SWC and/or DWR on EIR and other matters
Attachments: Sites Proposed Briefings to SWC_Planning_11.14.2022.doc

Gentlemen:

Please advise regarding your availability for the subject call between 2-5pm on Tues, Nov 22. We would schedule for a 1 hour meeting during that time. Based on feedback from Okita and Cooke, there may not be a need to brief DWR on the EIR. Per David Okita's suggestion, we may also discuss his next SWC briefing proposal, to wit:

1. *Basic Sites operations - diversions and deliveries: Aaron Miller*
2. *Outline of SPA/DWR/USBR Operations agreement: Aaron Miller*
   a. *Excess condition diversions*
   b. *Sites/Oroville exchange*
   c. *Coordination with SWP/CVP*
3. *Sites Water rights - ?*
4. *San Luis Impacts: Rob Cooke*

Also attached is an updated version (11-14) of my draft SWC /Sites briefing outline.

Robert J. Kunde, P.E.
Retired Annuitant
Wheeler Ridge-Maricopa Water Storage District
cell: 661-345-3719 email: rkunde@wrmwsd.com

Sent: 11/17/2022 8:55:25 AM
To: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Subject: Sites - DWR request for project description

Hi Laurie - I've been working with Rob Kunde on a couple of items for DWR. DWR wants to make sure that their actions are addressed in the Final EIR\EIS so they can rely on the document as their CEQA compliance for amending the SWP contracts and signing the operations agreement.

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

From: Alicia Forsythe [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A6CDF06A7E904B65BAA21702A82AD329-AFORSYTHE]
Sent: 11/17/2022 12:15:36 PM
To: Jerry Brown [jbrown@sitesproject.org]
Subject: RE: Final EIR May 2023 Approval

I know. I am going to add this to our 1 on 1 as I think we need to strategize a bit on this. And I likely need you to talk to Chris Elliot. We are just super tight on the schedule and its going to take a village to pull this off.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Jerry Brown <jbrown@sitesproject.org>
Sent: Thursday, November 17, 2022 10:18 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: Final EIR May 2023 Approval

I think there may be some misunderstanding going around about the schedule for the final EIR/EIS. There should be no discussion about missing the May 2023 approval date since this already incorporates the 4 month delay previously authorized for everything we had up to that point and there has been nothing that has occurred since then or is anticipated that would cause further delay. Just want to make sure we're on the same page. thanks

From: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Sent: 11/17/2022 1:52:24 PM
To: steve.micko@jacobs.com; Angela Bezzone [bezzone@mbkengineers.com]
CC: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: FW: Sites - EO 13112 Invasive Species

Hi Steve and Angela –

Reclamation would like to get the Alternative 2 modeling results. Ali has agreed to send the files but I will need your help to make sure they get the correct and complete set of files. I'm hoping Steve can send directly to Reclamation and just copy us on any email. Please confirm.

Thank you !

Laurie

From: Dekar, Melissa D <mdekar@usbr.gov>
Sent: Thursday, November 17, 2022 1:21 PM
To: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Cc: Brick, David A <dbrick@usbr.gov>; Hunt, Shane D <shunt@usbr.gov>; Jacobson, Allison M <ajacobson@usbr.gov>
Subject: RE: Sites - EO 13112 Invasive Species

Hi Laurie,

The last we spoke, you mentioned that Sites developed a memo regarding the Chinese Mystery Snail. Could you please send that over? Also, could you provide the Alternative 2 modeling results?

Thanks,

Melissa

From: Dekar, Melissa D
Sent: Wednesday, November 9, 2022 7:43 AM
To: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Cc: Brick, David A <dbrick@usbr.gov>; Hunt, Shane D <shunt@usbr.gov>
Subject: Sites - EO 13112 Invasive Species

Good morning, Laurie,

This is a follow up to our discussion on the Chinese Mystery Snail and what should be included in the environmental document to comply with EO 13112. The final EIS/R should:

- disclose whether our action is one that may affect the status of the invasive species. (Section 2(a)(1))
- disclose if Reclamation would implement measures to achieve any of goals listed in the EO ((Section 2(a)(2)(i-ix))
- conclude whether the proposed action would promote the introduction/spread of invasive species and if it does, the document should provide support that the benefits of the action outweigh the potential harm and document all the feasible/prudent measures to minimize risk of harm associated w/ the action. (Section 2(a)(3))

Please let us know if you have questions.

Sec. 3. *Federal Agency Duties.* Section 2 of Executive Order 13112 is amended to read as follows:

"Sec. 2. *Federal Agency Duties.*

(a) Each Federal agency for which that agency's actions may affect the introduction, establishment, or spread of invasive species shall, to the extent practicable and permitted by law,

(1) identify such agency actions;

(2) subject to the availability of appropriations, and within administrative, budgetary, and jurisdictional limits, use relevant agency programs and authorities to:

(i) prevent the introduction, establishment, and spread of invasive species;

(ii) detect and respond rapidly to eradicate or control populations of invasive species in a manner that is cost-effective and minimizes human, animal, plant, and environmental health risks;

(iii) monitor invasive species populations accurately and reliably;

(iv) provide for the restoration of native species, ecosystems, and other assets that have been impacted by invasive species;

(v) conduct research on invasive species and develop and apply technologies to prevent their introduction, and provide for environmentally sound methods of eradication and control of invasive species;

(vi) promote public education and action on invasive species, their pathways, and ways to address them, with an emphasis on prevention, and early detection and rapid response;

(vii) assess and strengthen, as appropriate, policy and regulatory frameworks pertaining to the prevention, eradication, and control of invasive species and address regulatory gaps, inconsistencies, and conflicts;

(viii) coordinate with and complement similar efforts of States, territories, federally recognized American Indian tribes, Alaska Native Corporations, Native Hawaiians, local governments, nongovernmental organizations, and the private sector; and

(ix) in consultation with the Department of State and with other agencies as appropriate, coordinate with foreign governments to prevent the movement and minimize the impacts of invasive species; and

(3) refrain from authorizing, funding, or implementing actions that are likely to cause or promote the introduction, establishment, or spread of invasive species in the United States unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions.

(c) Federal agencies shall pursue the duties set forth in this section in coordination, to the extent practicable, with other member agencies of the Council and staff, consistent with the National Invasive Species Council Management Plan, and in cooperation with State, local, tribal, and territorial governments, and stakeholders, as appropriate, and in consultation with the Department of State when Federal agencies are working with international organizations and foreign nations.

(d) Federal agencies that are members of the Council, and Federal interagency bodies working on issues relevant to the prevention, eradication, and control of invasive species, shall provide the Council with annual information on actions taken that implement these duties and identify barriers to advancing priority actions.

(e) To the extent practicable, Federal agencies shall also expand the use of new and existing technologies and practices; develop, share, and utilize similar metrics and standards, methodologies, and databases and, where relevant, platforms for monitoring invasive species; and, facilitate the interoperability of information systems, open data, data analytics, predictive modeling, and data reporting necessary to inform timely, science-based decision making.

Thanks,

Melissa

Melissa Dekar (she/her)

Natural Resources Specialist
Environmental Compliance and Conservation Branch, CGB-152
2800 Cottage Way, Sacramento, CA, 95825
Interior Region 10, Bureau of Reclamation
916-978-6153 mdekar@usbr.gov

From: Alicia Forsythe [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A6CDF06A7E904B65BAA21702A82AD329-AFORSYTHE]
Sent: 11/17/2022 4:06:07 PM
To: Spranza, John [John.Spranza@hdrinc.com]
Subject: RE: Sites Preliminary Construction Sequencing

These are good John. I like these a lot and I think this makes sense and is what CDFW is asking for. Two things –

1. A narrative around this would be helpful – what is generally happening each year. And then tables showing impact acres by land type and species habitat.
2. We end on year 8 and haven't showed full completion of construction. I wonder if there should be a year 9 showing everything completed?

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Tuesday, November 15, 2022 9:29 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: FW: Sites Preliminary Construction Sequencing

John Spranza

D 916.679.8858 M 816.640.2487

From: Luu, Henry <Henry.Luu@hdrinc.com>
Sent: Monday, November 14, 2022 3:16 PM
To: Spranza, John <John.Spranza@hdrinc.com>
Cc: Edwards, Dawn <Dawn.Edwards@hdrinc.com>
Subject: Sites Preliminary Construction Sequencing

John, can you let me know if the attached are sufficient for permitting assessment?

Thanks,

Henry H. Luu, PE
D 916.679.8857 M 916.754.7566

hdrinc.com/follow-us

From: Sara M. Katz [skatz@katzandassociates.com]
Sent: 11/17/2022 4:18:06 PM
To: Jerry Brown [jbrown@sitesproject.org]; Kevin Spesert [kspesert@sitesproject.org]; Ann Newton [anewton@katzandassociates.com]
Subject: FW: 2022 Heal the Bay: ONE Water Day!

Team Sites: Heal the Bay is a very large and well regarded LA based environmental NGO. They have been advocates for the City of LA's and now MWD's One Water initiatives. Mark Gold, current CA Coastal Commissioner and UCLA PhD in Environmental Science/Engineering, was the President of Heal the Bay for more than 20-years. He was also a City of LA MWD Board member from 2016 – 2019. Heal the Bay is getting into telling the story about drought too. Not sure we could get his "support" for Sites, and it's not directly part of his "portfolio", but he is someone that commands significant attention and respect in the NGO community, especially in the greater LA area. Thinking about his quals and credentials as it relates to the Sites opposition voices of So Cal Sierra Club.

FYI only.

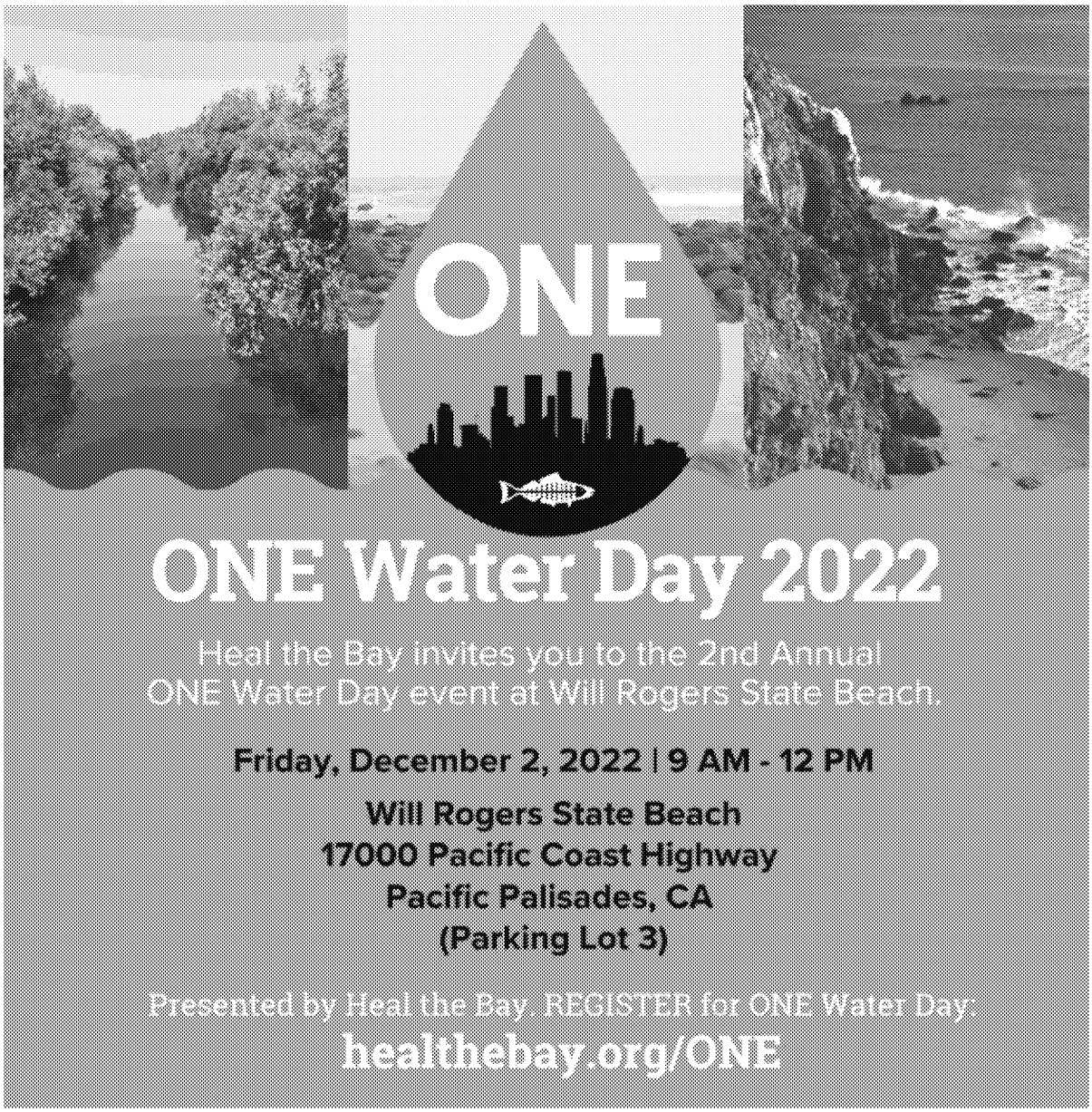
K&A
KATZ & ASSOCIATES
Sara M. Katz
Founder/CEO
mobile: 619.813.9551
San Diego · Los Angeles · San Francisco

From: Britta Bucholz <bbucholz@healthebay.org>
Sent: Thursday, November 17, 2022 3:14 PM
To: Britta Bucholz <bbucholz@healthebay.org>
Subject: 2022 Heal the Bay: ONE Water Day!

Heal the Bay

ONE

You are invited to ONE Water Day 2022


ONE
ONE Water Day 2022
Heal the Bay invites you to the 2nd Annual
ONE Water Day event at Will Rogers State Beach.
Friday, December 2, 2022 | 9 AM - 12 PM
Will Rogers State Beach
17000 Pacific Coast Highway
Pacific Palisades, CA
(Parking Lot 3)
Presented by Heal the Bay. REGISTER for ONE Water Day:
healthebay.org/ONE

ONE Water Day 2022

Special Guests

Adel Hagekhalil, General Manager, Metropolitan Water District of Southern California
Barbara Romero, Director and General Manager, Los Angeles Sanitation and Environment
Martin Adams, General Manager and Chief Engineer, Los Angeles Department Water and Power
David Pedersen, Las Virgenes Municipal Water District
Robert Ferrante, Chief Engineer and General Manager, Los Angeles County Sanitation Districts
Mark Pestrella, Director, Los Angeles County Public Works

Presenting Sponsor ($25,000)

- Name as presenting sponsor (O.N.E. Beach Clean-up presented by [name])
- 20 Tickets to the Event
- 20 Pre-Paid Parking Passes
- Logo Placement as Presenting Sponsor on event website
- Recognition in Event Press Release and Social Media Announcements
- Recognition by moderator from the podium
- Exclusive office "Lunch and Learn" by Heal the Bay CEO, Tracy Quinn at your offices

Ocean Sponsor ($15,000)

- 20 Tickets to the Event
- 20 Pre-Paid Parking Passes
- Name/logo branding at the event
- Logo Placement on event website
- Recognition in Event Press Release and Social Media Announcements

Environment Sponsor ($10,000)

- 12 Tickets to the Event
- 12 Pre-Paid Parking Passes
- Name/logo branding at the event
- Logo Placement on event website
- Recognition in Event Press Release and Social Media Announcements

Partner Sponsor ($5,000)

- 8 Tickets to the Event
- 8 Pre-Paid Parking Passes
- Logo Placement on event website and printed materials

Friendship Sponsor ($2,500)

- 4 Tickets to the Event

Presented by Heal the Bay. REGISTER for ONE Water Day

healthebay.org/ONE

ONE Water Day brings together people who share a passion for a sustainable water future, and are committed to protecting and conserving water in Los Angeles. On December 2, 2022, local water leaders from some of Los Angeles' most influential environmental agencies will gather to share their vision, and support our common goal and purpose. Join us in celebrating all we have accomplished and be a part of the plan for L.A.'s water future.

RSVP To ONE Water Day

See the ONE Water Day 2021 Event Pictures

healthebay.org
310.451.1500

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View this email online.

1444 9th Street
Santa Monica, CA | 90401 US

This email was sent to jmarshall@healthebay.org.
To continue receiving our emails, add us to your address book.

From: Alicia Forsythe [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A6CDF06A7E904B65BAA21702A82AD329-AFORSYTHE]
Sent: 11/18/2022 8:46:32 AM
To: Craig Tucker [craig@suitsandsigns.com]
CC: Jerry Brown [jbrown@sitesproject.org]
Subject: Sites Project - Possible Trinity River Water Right Term
Attachments: 20221118_Trinity River Language Comparison_Revisions V5.docx

Hi Craig – Nadine emailed you a bit ago on this. You and I chatted over a year ago now on the Sites Reservoir Project, planned in the Sacramento Valley near the town of Maxwell. At that time, we were talking about how the Project was planning to approach its water right application and working on ways to provide firm assurances to the Trinity River interests that we would not impact the Trinity River.

The Project has continued to spend a good amount of time in working through these firm assurances for the Trinity River. We have developed a proposed term that would be included in our water right permit that we believe accomplished the firm assurances to not impact the Trinity River. The proposed term is attached.

I'd be happy to schedule a call for us to discuss the term and get your thoughts on it. Jerry Brown (no relation to the former governor), our Executive Director and I are also working to schedule some time to come up to visit with the Yurok on the proposed term. We are happy to meet with you in person also.

I hope you are doing well!

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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Sites Reservoir Project – Trinity River Discussions
November 11, 2022

Humboldt County Proposed Term[i]:

> Trinity River water shall not be used to fill Sites Reservoir unless the Trinity River Division of the Central Valley Project is releasing water as a result of storage conditions requiring "Safety of Dams" releases beyond normal operating plans and concurrently when Shasta Reservoir is making flood control releases.
>
> Furthermore, Humboldt County's 1959 water contract with the Bureau of Reclamation, Trinity River Record of Decision (ROD) flows, and releases to implement the Bureau of Reclamation's Long-Term Plan to Protect Adult Salmon in the Lower Klamath River shall not be reduced or negatively impacted in any way as a result of any Sites Reservoir decisions, modeling, operational plans, and water right petitions.

Revised Term[ii]:

> The Sites Project's diversions to storage under this Permit shall not include the diversion or rediversion of Trinity River water (water diverted by the Bureau of Reclamation from the Trinity River watershed into the Sacramento River watershed pursuant to its water rights) unless the Trinity River water is abandoned in the Sacramento River and all other diversion criteria in this Permit are met.
>
> Furthermore, the Sites Project's diversions to storage under this Permit shall not negatively impact Trinity River obligations of the Bureau of Reclamation, including but not limited to those obligations specified in the 1959 Contract between the United States and Humboldt County, the Trinity River Mainstem Fishery Restoration Record of Decision, and the Long-Term Plan to Protect Adult Salmon in the Lower Klamath River, and related obligations in the Bureau of Reclamation's water right permits 11966, 11967, 11968, 11969, 11970, 11971, 11972, and 11973.

---

[i] From letter sent to the Sites Project Authority from County of Humboldt, Board of Supervisors. Received by Sites on December 17, 2019. Letter is not dated.

[ii] The Sites Authority Board has not reviewed or approved this possible revised term. Staff has provided this language for discussion purposes only.

From: Micko, Steve [Steve.Micko@jacobs.com]
Sent: 11/18/2022 2:02:15 PM
To: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]; Angela Bezzone [bezzone@mbkengineers.com]
CC: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: RE: Sites - EO 13112 Invasive Species

Will do!

Best,

Steve

From: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Sent: Thursday, November 17, 2022 1:52 PM
To: Micko, Steve <Steve.Micko@jacobs.com>; Angela Bezzone <bezzone@mbkengineers.com>
Cc: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: [EXTERNAL] FW: Sites - EO 13112 Invasive Species

Hi Steve and Angela –

Reclamation would like to get the Alternative 2 modeling results. Ali has agreed to send the files but I will need your help to make sure they get the correct and complete set of files. I'm hoping Steve can send directly to Reclamation and just copy us on any email. Please confirm.

Thank you !

Laurie

From: Dekar, Melissa D <mdekar@usbr.gov>
Sent: Thursday, November 17, 2022 1:21 PM
To: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Cc: Brick, David A <dbrick@usbr.gov>; Hunt, Shane D <shunt@usbr.gov>; Jacobson, Allison M <ajacobson@usbr.gov>
Subject: RE: Sites - EO 13112 Invasive Species

Hi Laurie,

The last we spoke, you mentioned that Sites developed a memo regarding the Chinese Mystery Snail. Could you please send that over? Also, could you provide the Alternative 2 modeling results?

Thanks,

Melissa

From: Dekar, Melissa D
Sent: Wednesday, November 9, 2022 7:43 AM
To: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Cc: Brick, David A <dbrick@usbr.gov>; Hunt, Shane D <shunt@usbr.gov>
Subject: Sites - EO 13112 Invasive Species

Good morning, Laurie,

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- disclose whether our action is one that may affect the status of the invasive species. (Section 2(a)(1))
- disclose if Reclamation would implement measures to achieve any of goals listed in the EO ((Section 2(a)(2)(i-ix))
- conclude whether the proposed action would promote the introduction/spread of invasive species and if it does, the document should provide support that the benefits of the action outweigh the potential harm and document all the feasible/prudent measures to minimize risk of harm associated w/ the action. (Section 2(a)(3))

Please let us know if you have questions.

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(1) identify such agency actions;

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(ii) detect and respond rapidly to eradicate or control populations of invasive species in a manner that is cost-effective and minimizes human, animal, plant, and environmental health risks;

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(vi) promote public education and action on invasive species, their pathways, and ways to address them, with an emphasis on prevention, and early detection and rapid response;

(vii) assess and strengthen, as appropriate, policy and regulatory frameworks pertaining to the prevention, eradication, and control of invasive species and address regulatory gaps, inconsistencies, and conflicts;

(viii) coordinate with and complement similar efforts of States, territories, federally recognized American Indian tribes, Alaska Native Corporations, Native Hawaiians, local governments, nongovernmental organizations, and the private sector; and

(ix) in consultation with the Department of State and with other agencies as appropriate, coordinate with foreign governments to prevent the movement and minimize the impacts of invasive species; and

(3) refrain from authorizing, funding, or implementing actions that are likely to cause or promote the introduction, establishment, or spread of invasive species in the United States unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions.

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in cooperation with State, local, tribal, and territorial governments, and stakeholders, as appropriate, and in consultation with the Department of State when Federal agencies are working with international organizations and foreign nations.

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Thanks,

Melissa

Melissa Dekar (she/her)
Natural Resources Specialist
Environmental Compliance and Conservation Branch, CGB-152
2800 Cottage Way, Sacramento, CA, 95825
Interior Region 10, Bureau of Reclamation
916-978-6153 mdekar@usbr.gov

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From: Micko, Steve [Steve.Micko@jacobs.com]
Sent: 11/18/2022 2:12:08 PM
To: Melissa Dekar (mdekar@usbr.gov) [mdekar@usbr.gov]
CC: Alicia Forsythe [aforsythe@sitesproject.org]; Angela Bezzone [bezzone@mbkengineers.com]; Laurie Warner Herson [laurie.warner.herson@phenixenv.com]; Leaf, Rob [Rob.Leaf@jacobs.com]; Thayer, Reed [Reed.Thayer@jacobs.com]
Subject: Sites Final EIR/EIS Alternative 2 Models

Hi Melissa,

I've posted the CalSim II models and results trend report spreadsheet for the Sites Final EIR/EIS here:
20221011_Final_EIRS_CalSimII
This includes the CalSim II model and results for Alternative 2.

Let me know if you'd like any additional Alternative 2 models/results.
I'll happily post them too.

Best.
Steve

Steve Micko, PE (he/him) | Jacobs | Project Manager and Water Group Leader
O:916.286.0358 | M:408.834.6614 | Steve.Micko@jacobs.com
2485 Natomas Park Drive Suite 600 | Sacramento, CA 95833

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From: Joe Trapasso [jtrapasso@sitesproject.org]
Sent: 11/21/2022 8:13:48 AM
To: Rebekah Canavesio [rcanavesio@yochadehe.gov]; Laverne Bill [LBill@yochadehe-nsn.gov]
CC: Alicia Forsythe [aforsythe@sitesproject.org]; Kevin Spesert [kspesert@sitesproject.org]; Arsenijevic, Jelica [Jelica.Arsenijevic@hdrinc.com]
Subject: Amendment #1 to Yocha Dehe Wintun Nation Agreement with the SPA
Attachments: Amendment #1 to Yocha Dehe Wintun Nation Agreemen with Sites.pdf

Rebekah/Laverne,

The Authority put together the attached draft amendment to the Yocha Dehe Wintun Nation Agreement with the Sites Project Authority to include additional scope of work. Please review and let me know if you have any comments to the draft amendment. Please sign the Amendment if you agree with it and the Authority will also sign to execute the amendment.

Thanks,

Joe

Joe Trapasso
Program Operations Manager
Sites Reservoir Project
Phone: 530.387.1102
Email: jtrapasso@sitesproject.org
Web: www.SitesProject.org
P.O. Box 517
122 Old Highway 99 West
Maxwell, CA 95955

Amendment No. 1 To
Yocha Dehe Wintun Nation
Standard Monitoring Agreement
With the Sites Project Authority

Yocha Dehe Wintun Nation's Amendment No. 1 to the Standard Monitoring Agreement between Yocha Dehe Wintun Nation and Sites Project Authority, executed on 3/1/22, is agreed to by the Yocha Dehe Wintun Nation and the Sites Project Authority, as follows:

Scope of Services

Yocha Dehe Wintun Nation's Scope of Services is amended as described in Attachment 1 hereto.

Schedule

The Agreement schedule is not modified as part of this Amendment.

Yocha Dehe Wintun Nation is authorized to proceed with modification set forth in this amendment effective on the date of this executed Amendment.

Budget

Compensation for the Services of this Amendment shall be calculated on the same basis as in the Standard Monitoring Agreement between Yocha Dehe Wintun Nation and Sites Project Authority.

Except as expressly provided for in this Amendment, all terms and conditions of the Agreement and any amendments thereto remain unchanged.

This amendment is hereby executed by duly authorized representatives of the parties.

Yocha Dehe Wintun Nation	**Sites Project Authority**
By: _____	By: _____
Printed Name: _____	Printed Name: _____
Date: _____	Date: _____

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Attachment 1 To
Amendment No. 1 To
Yocha Dehe Wintun Nation Agreement
With the Sites Project Authority
Scope of Services
November 1, 2022

This amended Scope of Services is for the Yocha Dehe Wintun Nation to provide additional support to the Sites Project Authority (Authority) for continued tribal monitoring for Proposed Sites Reservoir Test Pits, Fault Studies and Quarry Studies. Changes are shown in ~~strike-out~~ for deletions and underline for additions.

A. Subject Matter

This Agreement concerns the use and/ or development of real property located within the areas of Glenn, Colusa, and Yolo Counties, and which is the subject of development by the Authority. The development is commonly known as Sites Reservoir Geotechnical Activities, hereinafter referenced as the Activities and is described in Attachment IA, ~~and~~ IB, and IC of this Agreement. As used herein, the Area of Potential Effect includes approximately 500 geotechnical investigation areas throughout Glenn, Colusa, and Yolo Counties (see Attachment IA, ~~and~~ IB, and IC).

C. Scope of Services and Specifications

Given the nature and sensitivity of archaeological sites and cultural resources that are or may be within the Project area (a map of which is shown and attached hereto as Attachments IA, ~~and~~ IB, and IC). Yocha Dehe shall provide tribal monitoring and consultation for the Project during the archaeological investigations and all ground disturbing activities required for the Project. Yocha Dehe monitors will work in collaboration with the archaeologists, inspectors, project managers and other consultants hired/employed/ retained by the Authority.

Attachment IC

Added to the Standard Monitoring Agreement between Yocha Dehe Wintun Nation and Sites Project Authority.

Attachment IC

2023 – 2024 Proposed Sites Reservoir Test Pits, Fault Studies and Quarry Studies

1.1 Introduction

The Sites Project Authority (Authority) is proposing to conduct field investigations ("investigations") using test pit and trench excavations in Glenn, Colusa, and Yolo Counties. The purpose of these investigations is to obtain information necessary to support the ongoing engineering evaluations and design development for the proposed Sites Reservoir and associated facilities. Specifically, test pits would provide information regarding the quantity and quality of borrow materials at proposed quarry locations, as well as information regarding pipeline trench stability; fault studies would provide information in areas of suspected and known fault traces/zones; and quarry studies would provide information on quantity and quality of borrow materials. Both fault and quarry studies would be conducted using trench excavations, which is further described in the *Subsurface Investigations* section.

1.2 Project Location

The Proposed Project is located in Colusa, Glenn, and Yolo Counties in Northern California. The Proposed Project vicinity is shown in Figure 1 and locations of investigations are shown in Figure 2. The Proposed Project would be implemented generally in and near the Antelope Valley in Colusa and Glenn Counties where the dams, reservoirs, pipelines, and related facilities could be located for the proposed Sites Reservoir, along with areas near the town of Dunnigan in Yolo County where pipelines and related facilities could be located for the proposed Sites Reservoir ("Project Area").

Figure 1. Proposed Project Vicinity

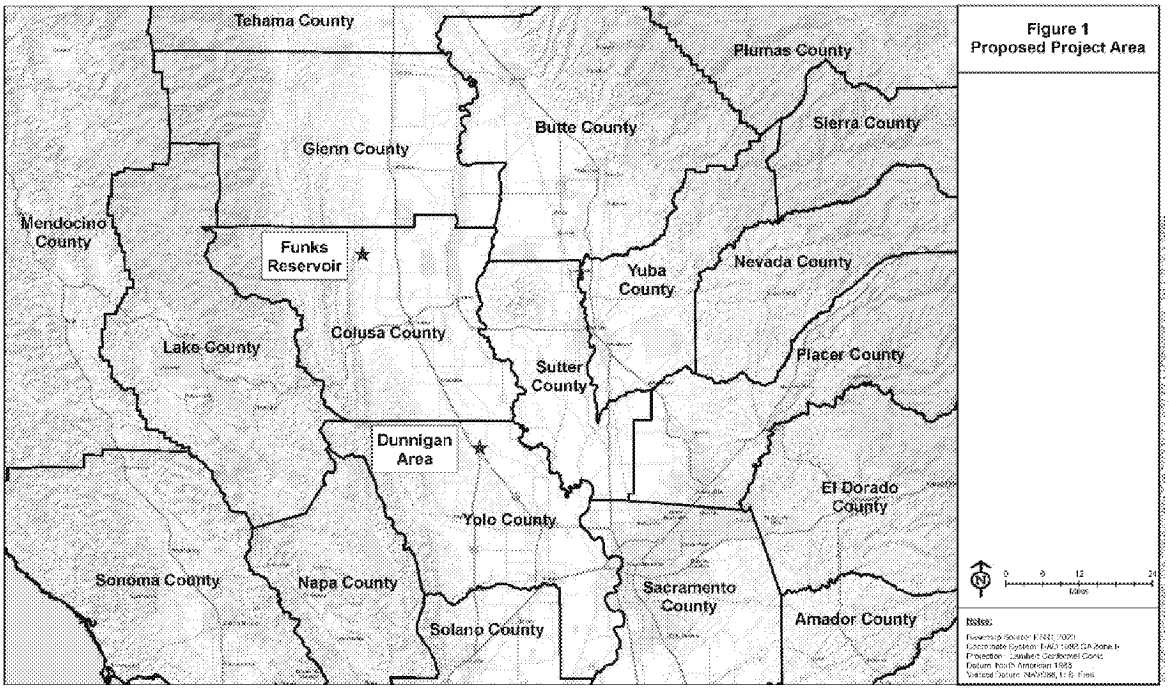
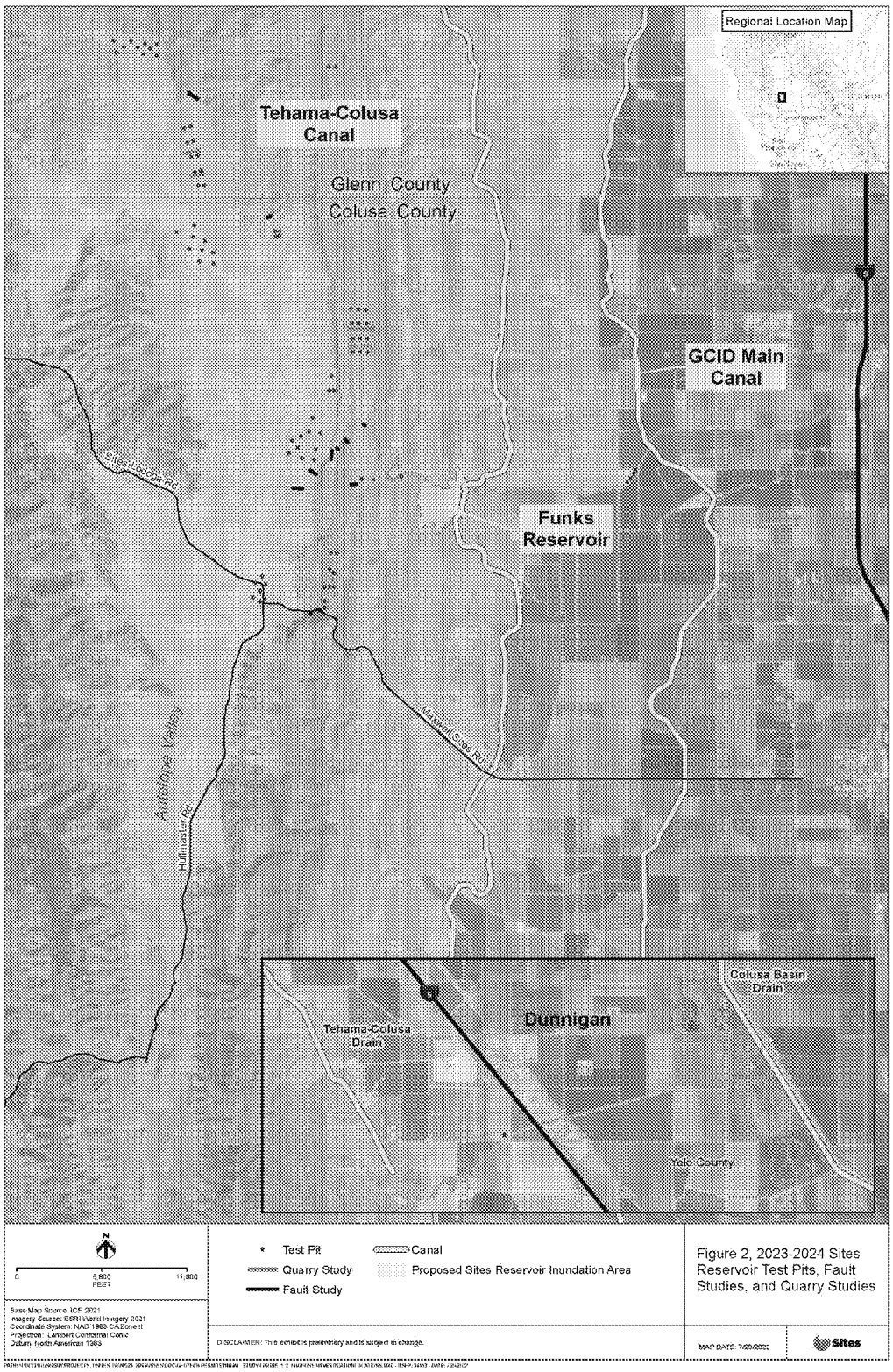


Figure 2. Investigation Locations



1.3 Project Background

The proposed Sites Reservoir would include construction and operation of a new offstream storage reservoir with a capacity of approximately 1.3-1.5 million acre-feet and associated water management facilities. The reservoir would be located approximately 10 miles west of the town of Maxwell, in both Glenn and Colusa Counties. Other proposed Sites Reservoir facilities would be located in Colusa, Glenn, Tehama, and Yolo Counties.

The proposed Sites Reservoir would use existing infrastructure to divert unappropriated flow from the Sacramento River at Red Bluff and Hamilton City and convey the water to a new offstream reservoir. New and existing facilities would move water into and out of the reservoir, with ultimate release back to the Sacramento River system via existing canals and a new pipeline proposed near Dunnigan, California. The proposed Sites Reservoir would require modifications to the Glenn-Colusa Irrigation District (GCID) system and the Tehama-Colusa (TC) Canal to move water into and out of the reservoir. Water conveyance between the proposed Sites Reservoir and the canals and Dunnigan pipeline would be facilitated by the existing Funks Reservoir and a new Terminal Regulating Reservoir (TRR) and two new associated pumping/generating plants.

Under the Proposed Project, the Authority is proposing to conduct investigations to provide technical information to assist in formulating and refining the engineering design and assist in the preparation of permit applications for the proposed Sites Reservoir. Numerous geotechnical studies have been conducted in the vicinity of the proposed Sites Reservoir since the late 1950s to evaluate the feasibility of Sites Reservoir. Previous investigations generated general stratigraphic data suitable for project feasibility assessments, but insufficient for design. New field and laboratory data needs to be collected specifically in the footprint of each planned facility to: 1) further refine the understanding of geologic structure and faulting activity, 2) further refine the understanding of the strength and consistency of the soil and rock which will provide the structural support of the new facilities, 3) to evaluate the suitability of local materials for use as construction materials, and 4) provide data to support selection of construction means and methods.

The number, type, and location of investigation points were selected based on experience of the project design engineers who are knowledgeable in complying with the design investigation requirements of various regulatory agencies, including the California Division of Safety of Dams.

1.4 Project Description

The purpose of the Proposed Project is to conduct investigations by test pits and trench excavations (for the fault and quarry studies) in order to obtain information necessary to support the ongoing engineering evaluations and design development for the proposed Sites Reservoir and associated facilities. In particular, many of the planned excavations would be completed at proposed quarry locations to gather information regarding the quantity and quality of borrow materials proposed for dam and reservoir feature construction fill, as well as assessing means and methods for excavation effort required. Other planned excavations would be used to gather

information regarding the location and stratigraphy (study of the strata, or rock layers, that were deposited over time) in areas of suspected and known fault traces/zones and to further evaluate the areas for evidence of last movement. Finally, excavations at other feature locations would provide information for pipeline trench stability analysis.

Generally, the investigations would provide information on subsurface conditions up to 20 feet below grade at specific locations. A list of the Proposed Project's investigations, and the corresponding proposed Sites Reservoir feature to which the investigations pertain, is included in Table 1. All investigations, except for the one test pit in the Dunnigan area, would be in grasslands, open areas of oak savannas, and hayfields located north and east of the town of Sites. The Dunnigan area is generally agricultural, but the test pit would be in an area identified as disturbed habitat and is adjacent to ruderal habitat. No tree removal or trimming is included in the Proposed Project.

Table 1. Investigation Types, Approximate Numbers, and Approximate Depths by Proposed Sites Reservoir Feature

Proposed Sites Reservoir Feature	**Approximate Numbers, Investigation Types, and Approximate Depths**
Sites Reservoir	Up to 76 test pits, 18 to 20 feet below grade Up to 9 fault studies, 10 to 15 feet below grade Up to 7 quarry studies, 15 to 20 feet below grade
Funks Reservoir	Up to 3 test pits, 18 to 20 feet below grade Up to 2 fault studies, 10 to 15 feet below grade
Terminal Regulating Reservoir and Pipeline	Up to 4 test pits, 18 to 20 feet below grade
Dunnigan Pipeline	Up to 1 test pit, 18 to 20 feet below grade
Total	**Up to 84 test pits, 18 to 20 feet below grade** **Up to 11 fault studies, 10 to 15 feet below grade** **Up to 7 quarry studies, 15 to 20 feet below grade**

The investigations are scheduled to occur between January 2023 and December 2024. The sequence would depend on site and seasonal conditions, as well as landowner access. All proposed investigations would be conducted during daylight hours and would be limited to the times allowed by the applicable local noise ordinance. Each investigation would take 1-2 days to complete for a test pit, up to 4 days for a quarry study, and up to 25 days for a fault study.

Project planning involved an extensive review of desktop aerial imagery and geographic information system (GIS) data with a goal of selecting investigation locations that would avoid potential sensitive resources to the extent possible, in light of the limited field survey documentation that is available. As noted in the discussion of Section 2.2 *Project Background* of the CEQA Initial Study prepared for the proposed Project, CDFW and DWR conducted biological and cultural surveys in much of the proposed Sites Reservoir footprint in Colusa and Glenn Counties in 2000. The results of these previous surveys were obtained and reviewed to identify and propose investigation locations outside of identified sensitive habitats and known cultural sites. In addition, preliminary wetland and waters mapping has been completed as part of

the proposed Sites Reservoir permitting efforts; this data was also used to determine the Project Area. As such, the proposed investigation locations have been selected to avoid all potentially jurisdictional wetlands or regulated waters of the U.S./State and known cultural sites.

In addition to siting the investigation locations to avoid potential sensitive resources, access to the locations was examined during the desktop evaluation process. Though existing roads are the primary and more desired option, numerous investigation locations are anticipated to require overland access in areas where no roads exist or where existing roads are inaccessible. With avoidance of impacts to sensitive resources a key consideration in developing an overland access plan, engineers, cultural and biological specialists, and land access managers met multiple times to refine overland access routes. This process made it possible for the Authority to identify access routes which would avoid known culturally sensitive locations, known biological resources (e.g., wetland features, beds and banks of streams, creeks, channels), and areas that were expected to cause increased landowner sensitivity (e.g., active orchards, grazing pastures).

1.4.1 Subsurface Investigations

The Proposed Project includes conducting subsurface investigations consisting of 84 test pits and trenches for 11 fault studies and 7 quarry studies throughout Colusa, Glenn, and Yolo counties (Table 1).

Descriptions for each subsurface investigation type are provided below.

Test Pits

Test pits would be used at proposed quarry locations to gather information regarding the quantity and quality of borrow materials proposed for dam and reservoir feature construction fill. In addition, test pits at other locations would provide information regarding pipeline trench stability analysis. Test pit locations were selected to provide sufficient assessment of feature footprints and would allow collection of soil samples for engineering and laboratory analysis. Work areas, which include equipment and vehicle staging areas, would be up to approximately 50 feet wide by 50 feet long for each test pit. Proposed test pit work areas would consist of the smallest footprint necessary to complete the investigations and would avoid or minimize impacts to biological resources, cultural resources, and any other sensitive resources. Using an excavator or backhoe, a rectangular hole with an approximate footprint of 18 feet by 18 feet would be excavated within the identified work area and samples would then be collected. Test pits would be approximately 18 to 20 feet deep, and excavation and sampling would take up to 1 day to complete at each location. Stockpiling of excavated materials would occur adjacent to the hole within the established 50-foot-wide work area. Test pits would be backfilled with the excavated material on the same day as they are excavated with the stockpiled soil placed and compacted in thin, moisture conditioned layers to the surface and the area restored, as closely as possible, to its pre-project or better conditions.

Fault Studies

Fault trenches would be used to gather information regarding the location and stratigraphy in areas of suspected and known fault traces/zones and to further evaluate the areas for evidence of last movement. Fault trenches have been sited at specific existing and suspected fault line locations in proximity to proposed Sites Reservoir features. Each trench would be approximately 5 feet wide and range from 200 to 600 feet long, and would vary from 10 to 15 feet deep. Work areas for fault trenches, which include equipment and vehicle staging areas, would be up to approximately 40 feet wide and range from 100 to 1,000 feet long. Proposed trench work areas would consist of the smallest footprint necessary to complete the investigations and would avoid or minimize impacts to biological resources, cultural resources, and any other sensitive resources. The trenches would be excavated using a conventional backhoe and be fitted with temporary shoring to prevent sidewall collapse. This would allow safety-trained geologists to enter the trench and observe exposed subsurface materials to study fault activity and stratigraphy contacts over a maximum 25-day period at each location. Stockpiling of excavated materials would occur adjacent to the trench within the established 40-foot-wide work area. Trenches would be temporarily covered with heavy duty plywood sheets (3/4 inch or thicker sheets) at the end of each workday. The ends of the trenches would be sloped and benched, as needed, to provide safe ingress and egress for workers. Once the trenching and mapping are complete, the trenches would be backfilled with excavated materials placed in thin lifts and tamped in place by the backhoe bucket and roller attachments, before a subsequent lift of material is placed as backfill. Lifts, or fill layers, will not exceed about 8 inches thick and allow for material to be replaced consistent with previous conditions. Upon completion of each proposed investigation, the area would be returned to pre-project or better conditions.

Quarry Studies

Quarry study trenches would be used to gather information regarding the quantity and quality of borrow materials proposed for dam and reservoir feature construction fill and to assess the means and methods needed to remove overburden and rock materials during construction. These investigations would be conducted by trenching in areas of planned quarries for the proposed Sites Reservoir. Each trench would be up to 20 feet wide and range from 300 to 1,500 feet long, would vary from 15 to 20 feet deep, and would be excavated using a bulldozer. Work areas for the quarry studies, which would include equipment and vehicle staging areas, would be approximately 40 feet wide and range from 1,000 to 2,300 feet long. Proposed trench work areas would consist of the smallest footprint necessary to complete the investigations and would avoid or minimize impacts to biological resources, cultural resources, and any other sensitive resources. Stockpiling would occur adjacent to each trench within the established 40-foot-wide work area. Investigations at a quarry study site would occur in sections to minimize the length of trench open at any given time. Open portions of the trenches would be backfilled at the end of each day by track-walking excavated materials back into place by the dozer. Each quarry study trench will take up to 2 days to complete. Upon completion of work at a quarry study area, the area would be returned to pre-project or better conditions.

1.4.2 Investigation Equipment, Personnel, and Site Access

Activities at each investigation location would require up to 10 to 15 personnel, including equipment operators and assistants, a utility locator, a geologist/engineer to document conditions encountered, biological, cultural, and tribal monitors, project managers, and safety staff. It is anticipated that one team would be in the field at any given time.

Equipment, vehicles, and materials would be temporarily staged within each designated investigation work area. Equipment use would be planned to optimize onsite staging and reduce offsite traffic and travel. All staging areas would be located outside of wetlands and other aquatic resources and adhere to species-specific buffer zones. Workers in remote areas would be provided necessary onsite amenities (e.g., waste and sanitary facilities). All wastewater generated during implementation of the Proposed Project would be hauled off-site and disposed of at an approved facility that is permitted to receive wastewater in the quantities anticipated. Crew vehicles and equipment would access the investigation areas daily over the Proposed Project duration; carpooling would be encouraged to the extent feasible. Flaggers, cones, and other measures would be used to control the flow of traffic near active roadways, where necessary, and neighbors would be notified prior to commencement of Proposed Project activities in their area. Table 2 provides the estimated number of each type of equipment required by field team to complete the investigations included in the Proposed Project.

Table 2. Proposed Project Equipment and Anticipated Duration of Use

Equipment	Estimated Maximum Pieces of Equipment	Maximum Work Hours per Day
Skid Steer	2	12
Backhoe	2	12
Bulldozer	1	12
Water Trucks	2 (included for dust suppression)	12
ATV and Trailers	4	12
Pickup Trucks/Sport Utility Vehicles	4	12

Low-lying vegetation removal is anticipated within the footprint of the excavations and would be conducted with biological, cultural, and tribal resource monitors present. Vegetation removal would be completed in stages as excavation progresses using the planned excavation equipment. No tree removal or trimming is included in the Proposed Project.

Access to the proposed investigation areas would include vehicle travel via existing roadways and overland access routes. Access would use existing public and private roads to the extent possible. Minor maintenance, such as repairing potholes or impassable portions of roads, could occur, as necessary, for safe vehicle access. If required, the maintenance would be completed according to the applicable county standards. Where roads do not exist, some of the proposed investigation locations would require overland access through portions of grasslands and woodland open areas. No trees would be trimmed or removed for vehicle access.

Overland access routes would be as direct as possible. Minor drainage crossings, if necessary, will adhere to the following process:

1. Where possible, all drainage crossings would be avoided, and vehicles would go around any waterways so as to avoid entirely;
2. If avoidance is not entirely possible, crossing areas that are dry will be identified and used for vehicles;
3. Where avoidance or crossing-in-the-dry are not possible, field personnel would be required to use clean, contained, temporary cover such as steel plates or hard density plastic mats and place them over the drainage, in an area where no impacts would occur to the banks, for temporary vehicular access. No fill would be placed within any active waterway, and waterway crossings would be avoided to the extent possible.

Preferred access routes would be determined in the field during the pre-investigation siting surveys with biological, cultural, and tribal monitors present to avoid sensitive resources and finalized following Sites real estate team's coordination with landowners.

BEFORE THE BOARD OF DIRECTORS OF THE SITES PROJECT AUTHORITY

RESOLUTION NO. 2022-03

In the Matter of:

SITES PROJECT AUTHORITY RESOLUTION PROVIDING FOR THE PRIORITIZATION OF USE FOR SITES PROJECT REVENUES

WHEREAS, the Board of Directors of the Sites Project Authority (the "Board" and the "Sites Authority," respectively), pursuant to the Sites Authority's procedures and the California Government Code, from time to time, may adopt policy for the administration of the Sites Authority;

WHEREAS, the Sites Authority is developing a water supply and storage project commonly referred to as the "Sites Reservoir Project" and related facilities;

WHEREAS, the Sites Authority expects to receive certain revenues (as further defined below, the "Revenues") from water supply and storage contractors, the California Department of Water Resources, the United States Bureau of Reclamation and others; and

WHEREAS, the Board, by adoption of this Master Resolution, desires to adopt guidance providing for the prioritization of use for such Revenues.

NOW, THEREFORE BE IT RESOLVED, by this Board of Directors:

Section 1. **Recitals**. The facts stated in the recitals above are true and correct, and the Board so finds and determines.

Section 2. **Definitions.** Unless the context otherwise requires, the terms defined in this section shall for all purposes hereof and of any amendment hereof or supplement hereto and of any opinion or report or other document mentioned herein or therein have the meanings defined herein. Such definitions are equally applicable to both the singular and plural forms of any of the terms defined herein:

(a) Authorized Officer. "Authorized Officer" means (i) the Executive Director of the Sites Authority or, if there is no officer designated as the Executive Director, the Treasurer of the Sites Authority or (ii) the highest ranking member of the finance staff of the Sites Authority; and, in each case, the written designee thereof.

(b) Benefits and Obligations Contracts. "Benefits and Obligations Contracts" means water supply and water storage contracts entered into by the Sites Authority with agricultural, municipal and/or industrial water providers with respect to the Project but shall not include any agreement or arrangement for water service or water storage with DWR or Reclamation.

(c) Board. "Board" means the Board of Directors of the Sites Authority.

(d) DWR. "DWR" means the California Department of Water Resources, including any successor thereto.

(e) Fiscal Year. "Fiscal Year" means the period beginning on January 1 of each year and ending on the last day of December of such year, or any other accounting period hereafter selected and designated by the Board as the Fiscal Year of the Sites Authority.

(f) Fixed Operation and Maintenance Costs. "Fixed Operation and Maintenance Costs" mean Operation and Maintenance Costs which do not vary by the amount of water diverted, stored or released from the Project, as more particularly determined in accordance with the Benefits and Obligations Contracts.

(g) Fixed Project Costs. "Fixed Project Costs" mean capital costs, including debt service on Project Obligations, reserves established for the payment of debt service on Project Obligations, other amounts due under the Project Obligations and other payments under the Benefits and Obligations Contracts other than payments constituting Fixed Operation and Maintenance Costs and Variable Operation and Maintenance Costs of the Project, as more particularly determined in accordance with the Benefits and Obligations Contracts.

(h) Joint Powers Agreement. "Joint Powers Agreement" means the Fourth Amended and Restated Joint Exercise of Powers Agreement, effective March 23, 2017, by and among the parties set forth on the execution page thereof, as amended and supplemented from time-to-time in accordance therewith.

(i) Liquidity Reserve. "Liquidity Reserve" means "Fund _____" maintained by the Sites Authority in accordance with Section 3.5 hereof.

(j) Liquidity Reserve Requirement. "Liquidity Reserve Requirement" means, for any Fiscal Year, an amount equal to (i) 10% of the debt service payable during such Fiscal Year with respect to all Project Obligations outstanding on the first day of such Fiscal Year, plus (ii) 10% of total Fixed Operation and Maintenance Costs payable during such Fiscal Year.

(k) Master Resolution. "Master Resolution" means this resolution as this resolution may be amended from time-to-time in accordance with Section 4.3 hereof.

(l) Net Revenues. "Net Revenues" means, for any Fiscal Year, Revenues minus Operation and Maintenance Costs.

(m) Operation and Maintenance Costs. "Operation and Maintenance Costs" means costs spent or incurred for operation and maintenance of the Project, calculated in accordance with Generally Accepted Accounting Principles; but excluding in all cases depreciation, replacement and obsolescence charges or reserves therefor and amortization of intangibles, including amortization of water rights, unrealized losses on investments, write offs of the value

of impaired assets and bookkeeping entries of similar nature as well as any other non-cash expenses.

(n) Project. "Project" means a water supply and storage project commonly referred to as the Sites Reservoir Project, the entire physical infrastructure and capital improvements to be designed, constructed, commissioned, and completed by the Sites Authority.

(o) Project Obligations. "Project Obligations" means any bonds, notes, loans or other evidences of indebtedness issued or incurred by or on behalf of the Sites Authority with respect to the Project.

(p) Reclamation. "Reclamation" means the United States of America, Department of the Interior, Bureau of Reclamation, including any successor thereto.

(q) Revenue Fund. "Revenue Fund" means the "Fund __-_____" maintained by the Sites Authority in accordance with Section 3.1 hereof, and including any other funds and accounts into which the Sites Authority deposits Revenues.

(r) Revenues. "Revenues" means, with respect to any Fiscal Year, all amounts received by the Sites Authority with respect to the Project, including but not limited to (i) (A) amounts received by the Sites Authority in connection with water supply and storage contracts with respect to the Project, including the Benefits and Obligations Contracts, (B) amounts received by the Sites Authority in connection with agreements or other arrangements entered into with DWR and Reclamation with respect to the Project, (C) other amounts received by the Sites Authority related to the operation of the Project, (D) transfers from the Liquidity Reserve as provided in Section 3.5 hereof and (E) other amounts received by the Sites Authority to the extent designated by the Board as "Revenues", and (ii) all income from the investment of any Revenues in the (A) Revenue Fund, (B) Liquidity Reserve, and (C) any other fund or account created with respect to any Project Obligation to the extent investment earnings thereon are required by the terms of such Project Obligation to be transferred to the Revenue Fund or the Liquidity Reserve.

(s) Sites Authority. "Sites Authority" means the Sites Project Authority, an independent joint powers authority established pursuant to the Joint Exercise of Powers Agreement to exercise powers common to the Sites Authority members to, among other things, effectively study, promote, develop, design, finance, acquire, construct, manage, and operate the Project and related facilities such as recreation and power generation.

(t) Variable Operation and Maintenance Costs. "Variable Operation and Maintenance Costs" means Operation and Maintenance Costs which vary by the amount of water diverted, stored or released from the Project, as more particularly determined in accordance with the Benefits and Obligations Contracts.

Section 3. Prioritization of Use for Revenues.

Section 3.1. Revenue Fund.

The Sites Authority hereby continues and agrees to maintain, so long as any Project Obligations remain unpaid, the Revenue Fund to be held by the Sites Authority. Amounts in the Revenue Fund shall be disbursed, allocated and applied solely to the uses and purposes hereinafter described in this Master Resolution, and shall be accounted for separately and apart from all other accounts, funds, money or other resources of the Sites Authority.

All Revenues and all amounts on deposit in the Revenue Fund are hereby allocated to the payment of the Operation and Maintenance Costs, Project Obligations and other costs as set forth in Section 3.2. The Revenues and all amounts on deposit in the Revenue Fund shall not be used for any other purpose while any Project Obligations remain unpaid. Any investment earnings on amounts on deposit in the Revenue Fund shall be retained in the Revenue Fund.

Section 3.2. Prioritization of Use for Revenues.

All Revenues received by the Sites Authority shall be deposited into the Revenue Fund established and held by the Sites Authority pursuant to Section 3.1 hereof and allocated in the following priority:

a. to the payment of Operation and Maintenance Costs;

b. to the payment of senior lien Project Obligations;

c. to replenish bond reserve funds established for senior lien Project Obligations, if any;

d. to the payment of subordinate lien Project Obligations;

e. to replenish bond reserve funds established for subordinate lien Project Obligations, if any;

f. to restore the amount on deposit in the Liquidity Reserve to the Liquidity Reserve Requirement; and

g. as long as the Sites Authority determines there will be sufficient Revenues to make the payments set forth in (a) through (f) above, to pay any other Project costs, including Fixed Project Costs not previously paid under (b) through (e) above, permitted by law, under the Joint Powers Agreement and the Benefits and Obligations Contracts.

Section 3.3. Project Obligations. The Sites Authority shall not issue or incur any additional Project Obligations unless the Sites Authority has certified that (i) no material event of default has occurred under any Project Obligations and is continuing, (ii) each of the Benefits

and Obligations Contracts is in full force and effect, and (iii) such additional Project Obligation is entitled to the benefits this Master Resolution.

Section 3.4. Rate Sufficiency. (a) The Sites Authority hereby covenants to establish charges under the Benefits and Obligations Contracts at the beginning of each Fiscal Year which, together with Revenues billed and collected with respect to such Fiscal Year prior to the commencement of such Fiscal Year and with other Revenues, are reasonably expected to be at least sufficient to yield Net Revenues, together with amounts on deposit in the Liquidity Reserve, of at least 1.00 times Project Obligation debt service payable during such Fiscal Year.

(b) So long as the Sites Authority has complied with its obligations set forth in subsection (a) above, the failure of Net Revenues to meet the threshold in the prior subsection (a) with respect to a Fiscal Year shall not constitute a default or an event of default hereunder so long as the Authority has complied with its obligation set forth in subsection (a) above with respect to the following Fiscal Year.

Section 3.5. Liquidity Reserve. The Sites Authority hereby covenants and agrees to maintain, so long as any Project Obligations remain outstanding, the Liquidity Reserve to be held by the Sites Authority. Amounts in the Liquidity Reserve shall be disbursed, allocated and applied solely to the uses and purposes hereinafter described in this Master Resolution, and shall be accounted for separately and apart from all other accounts, funds, money or other resources of the Sites Authority.

So long as any Project Obligations remain outstanding, the Sites Authority shall maintain in the Liquidity Reserve an amount equal to the Liquidity Reserve Requirement. On or prior to the date of incurrence of any Project Obligations, the Sites Authority shall deposit to the Liquidity Reserve an amount necessary, if any, to increase the amount on deposit in the Liquidity Reserve to the Liquidity Reserve Requirement, including in the calculation of the Liquidity Reserve Requirement any debt service payable during the then-current Fiscal Year with respect to such Project Obligations.

In the event of any deficiency in the Liquidity Reserve, the Sites Authority shall replenish such deficiency in accordance with Section 3.2 hereof.

Amounts in the Liquidity Reserve shall be withdrawn by the Sites Authority upon the written direction of an Authorized Officer solely for the purposes set forth in Sections 3.2(a) through (e) hereof. Any amounts withdrawn from the Liquidity Reserve shall be deposited into the Revenue Fund and applied pursuant to Section 3.2 hereof. Any amounts in the Liquidity Reserve in excess of the Liquidity Reserve Requirement on the last day of any Fiscal Year may be transferred in accordance with the written direction of an Authorized Officer from the Liquidity Reserve to the Revenue Fund and applied pursuant to Section 3.2 hereof. Any investment earnings on amounts on deposit in the Liquidity Reserve shall be transferred on the last day of any Fiscal Year into the Revenue Fund and applied pursuant to Section 3.2 hereof unless such transfer would cause the amount on deposit in the Liquidity Reserve to be less than the Liquidity Reserve Requirement.

Section 3.6. Enforcement Provisions. The Sites Authority hereby covenants to enforce the Benefits and Obligations Contracts and other agreements pursuant to which the Sites Authority receives Revenues with other parties, including Reclamation and DWR, to the fullest extent necessary to assure sufficient Revenues will be available to pay all amounts with respect to Operation and Maintenance Costs and Project Obligations when due.

Section 3.7. Billing Provisions. The Sites Authority hereby covenants to bill (i) all amounts payable as Fixed Operation and Maintenance Costs under the Benefits and Obligations Contracts annually in advance in accordance with the Benefits and Obligations Contracts, (ii) all amounts payable as Variable Operation and Maintenance Costs semi-annually in advance in accordance with the Benefits and Obligations Contracts, (iii) all amounts due under Project Obligations annually in advance in accordance with the Benefits and Obligations Contracts, and (iv) all Fixed Project Costs, other than amounts due under Project Obligations, semi-annually in advance in accordance with the Benefits and Obligations Contracts.

Section 3.8. Investment. All amounts on deposit in the Revenue Fund and the Liquidity Reserve shall be invested in accordance with the Sites Authority investment policy as in effect from time-to-time.

Section 4. Miscellaneous.

Section 4.1. Benefits of this Master Resolution Limited to Certain Parties. Nothing contained herein, expressed or implied, is intended to give any person other than the Sites Authority or the parties to a Project Obligation any right, remedy or claim under or pursuant hereto, and any agreement or covenant required herein to be performed by or on behalf of the Sites Authority shall be for the sole and exclusive benefit of such other parties.

Section 4.2. Successor is Deemed Included in all References to Predecessor. Whenever the Sites Authority is named or referred to herein, such reference shall be deemed to include the successor to the powers, duties and functions that are presently vested in the Sites Authority, and all agreements and covenants required hereby to be performed by or on behalf of the Sites Authority shall bind and inure to the benefit of the successors thereof whether so expressed or not.

Section 4.3. Amendments. Except as may be otherwise provided in a Project Obligation, the Sites Authority may amend the provisions of this Master Resolution in accordance with the provisions of the Joint Powers Agreement and the bylaws of the Sites Authority in effect from time-to-time.

Section 4.4. Partial Invalidity. If any one or more of the agreements or covenants or portions thereof required hereby to be performed by or on the part of the Sites Authority shall be contrary to law, then such agreement or agreements, such covenant or covenants or such portions thereof shall be null and void and shall be deemed separable from the remaining agreements and covenants or portions thereof and shall in no way affect the validity hereof. The Sites Authority hereby declares that it would have adopted this Master Resolution, and

each and every other article, section, paragraph, subdivision, sentence, clause and phrase hereof irrespective of the fact that any one or more articles, sections, paragraphs, subdivisions, sentences, clauses or phrases hereof or the application thereof to any person or circumstance may be held to be unconstitutional, unenforceable or invalid.

Section 4.5. Repeal of Inconsistent Resolutions. Any resolution of the Sites Authority and any part of any resolution inconsistent herewith is hereby repealed to the extent of such inconsistency.

Section 4.6. Additional Covenants. Nothing in this Master Resolution shall prohibit the Sites Authority from entering into additional covenants with or for the benefit of the owners of Project Obligations.

Section 4.7. Effect. This Master Resolution shall take effect immediately.

PASSED, APPROVED AND ADOPTED by the Board of Directors of the Sites Project Authority this 21st day of November 2022 by the following vote:

AYES:

NOES:

ABSENT:

ABSTAIN:

I, Fritz Durst, Chair Authority Board of the Sites Project Authority, do hereby certify that the resolution set forth above is true and accurate copy of the resolution adopted by the Board of Directors of the Sites Project Authority at a duly called meeting of the Board on November 21, 2022 and that said resolution has not been rescinded, amended or modified and is in full force and effect as of the date hereof.

In Witness Whereof, I have executed this certificate this 21st day of November 2022.

_____

Fritz Durst, Chair Authority Board, Sites Project Authority

BEFORE THE BOARD OF DIRECTORS OF THE SITES PROJECT AUTHORITY

RESOLUTION NO. 2022-03

In the Matter of:

SITES PROJECT AUTHORITY RESOLUTION PROVIDING FOR THE PRIORITIZATION OF USE FOR SITES PROJECT REVENUES

WHEREAS, the Board of Directors of the Sites Project Authority (the "Board" and the "Sites Authority," respectively), pursuant to the Sites Authority's procedures and the California Government Code, from time to time, may adopt policy for the administration of the Sites Authority;

WHEREAS, the Sites Authority is developing a water supply and storage project commonly referred to as the "Sites Reservoir Project" and related facilities;

WHEREAS, the Sites Authority expects to receive certain revenues (as further defined below, the "Revenues") from water supply and storage contractors, the California Department of Water Resources, the United States Bureau of Reclamation and others; and

WHEREAS, the Board, by adoption of this Master Resolution, desires to adopt guidance providing for the prioritization of use for such Revenues.

NOW, THEREFORE BE IT RESOLVED, by this Board of Directors:

Section 1. **Recitals**. The facts stated in the recitals above are true and correct, and the Board so finds and determines.

Section 2. **Definitions.** Unless the context otherwise requires, the terms defined in this section shall for all purposes hereof and of any amendment hereof or supplement hereto and of any opinion or report or other document mentioned herein or therein have the meanings defined herein. Such definitions are equally applicable to both the singular and plural forms of any of the terms defined herein:

(a) Authorized Officer. "Authorized Officer" means (i) the Executive Director of the Sites Authority or, if there is no officer designated as the Executive Director, the Treasurer of the Sites Authority or (ii) the highest ranking member of the finance staff of the Sites Authority; and, in each case, the written designee thereof.

(b) Benefits and Obligations Contracts. "Benefits and Obligations Contracts" means water supply and water storage contracts entered into by the Sites Authority with agricultural, municipal and/or industrial water providers with respect to the Project but shall not include any agreement or arrangement for water service or water storage with DWR or Reclamation.

(c) Board. "Board" means the Board of Directors of the Sites Authority.

(d) DWR. "DWR" means the California Department of Water Resources, including any successor thereto.

(e) Fiscal Year. "Fiscal Year" means the period beginning on January 1 of each year and ending on the last day of December of such year, or any other accounting period hereafter selected and designated by the Board as the Fiscal Year of the Sites Authority.

(f) Fixed Operation and Maintenance Costs. "Fixed Operation and Maintenance Costs" mean Operation and Maintenance Costs which do not vary by the amount of water diverted, stored or released from the Project, as more particularly determined in accordance with the Benefits and Obligations Contracts.

(g) Fixed Project Costs. "Fixed Project Costs" mean capital costs, including debt service on Project Obligations, reserves established for the payment of debt service on Project Obligations, other amounts due under the Project Obligations and other payments under the Benefits and Obligations Contracts other than payments constituting Fixed Operation and Maintenance Costs and Variable Operation and Maintenance Costs of the Project, as more particularly determined in accordance with the Benefits and Obligations Contracts.

(h) Joint Powers Agreement. "Joint Powers Agreement" means the Fourth Amended and Restated Joint Exercise of Powers Agreement, effective March 23, 2017, by and among the parties set forth on the execution page thereof, as amended and supplemented from time-to-time in accordance therewith.

(i) Liquidity Reserve. "Liquidity Reserve" means "Fund _____" maintained by the Sites Authority in accordance with Section 3.5 hereof.

(j) Liquidity Reserve Requirement. "Liquidity Reserve Requirement" means, for any Fiscal Year, an amount equal to (i) 10% of the debt service payable during such Fiscal Year with respect to all Project Obligations outstanding on the first day of such Fiscal Year, plus (ii) 10% of total Fixed Operation and Maintenance Costs payable during such Fiscal Year.

(k) Master Resolution. "Master Resolution" means this resolution as this resolution may be amended from time-to-time in accordance with Section 4.3 hereof.

(l) Net Revenues. "Net Revenues" means, for any Fiscal Year, Revenues minus Operation and Maintenance Costs.

(m) Operation and Maintenance Costs. "Operation and Maintenance Costs" means costs spent or incurred for operation and maintenance of the Project, calculated in accordance with Generally Accepted Accounting Principles; but excluding in all cases depreciation, replacement and obsolescence charges or reserves therefor and amortization of intangibles, including amortization of water rights, unrealized losses on investments, write offs of the value

of impaired assets and bookkeeping entries of similar nature as well as any other non-cash expenses.

(n) Project. "Project" means a water supply and storage project commonly referred to as the Sites Reservoir Project, the entire physical infrastructure and capital improvements to be designed, constructed, commissioned, and completed by the Sites Authority.

(o) Project Obligations. "Project Obligations" means any bonds, notes, loans or other evidences of indebtedness issued or incurred by or on behalf of the Sites Authority with respect to the Project.

(p) Reclamation. "Reclamation" means the United States of America, Department of the Interior, Bureau of Reclamation, including any successor thereto.

(q) Revenue Fund. "Revenue Fund" means the "Fund __-_____" maintained by the Sites Authority in accordance with Section 3.1 hereof, and including any other funds and accounts into which the Sites Authority deposits Revenues.

(r) Revenues. "Revenues" means, with respect to any Fiscal Year, all amounts received by the Sites Authority with respect to the Project, including but not limited to (i) (A) amounts received by the Sites Authority in connection with water supply and storage contracts with respect to the Project, including the Benefits and Obligations Contracts, (B) amounts received by the Sites Authority in connection with agreements or other arrangements entered into with DWR and Reclamation with respect to the Project, (C) other amounts received by the Sites Authority related to the operation of the Project, (D) transfers from the Liquidity Reserve as provided in Section 3.5 hereof and (E) other amounts received by the Sites Authority to the extent designated by the Board as "Revenues", and (ii) all income from the investment of any Revenues in the (A) Revenue Fund, (B) Liquidity Reserve, and (C) any other fund or account created with respect to any Project Obligation to the extent investment earnings thereon are required by the terms of such Project Obligation to be transferred to the Revenue Fund or the Liquidity Reserve.

(s) Sites Authority. "Sites Authority" means the Sites Project Authority, an independent joint powers authority established pursuant to the Joint Exercise of Powers Agreement to exercise powers common to the Sites Authority members to, among other things, effectively study, promote, develop, design, finance, acquire, construct, manage, and operate the Project and related facilities such as recreation and power generation.

(t) Variable Operation and Maintenance Costs. "Variable Operation and Maintenance Costs" means Operation and Maintenance Costs which vary by the amount of water diverted, stored or released from the Project, as more particularly determined in accordance with the Benefits and Obligations Contracts.

Section 3. Prioritization of Use for Revenues.

Section 3.1. Revenue Fund.

The Sites Authority hereby continues and agrees to maintain, so long as any Project Obligations remain unpaid, the Revenue Fund to be held by the Sites Authority. Amounts in the Revenue Fund shall be disbursed, allocated and applied solely to the uses and purposes hereinafter described in this Master Resolution, and shall be accounted for separately and apart from all other accounts, funds, money or other resources of the Sites Authority.

All Revenues and all amounts on deposit in the Revenue Fund are hereby allocated to the payment of the Operation and Maintenance Costs, Project Obligations and other costs as set forth in Section 3.2. The Revenues and all amounts on deposit in the Revenue Fund shall not be used for any other purpose while any Project Obligations remain unpaid. Any investment earnings on amounts on deposit in the Revenue Fund shall be retained in the Revenue Fund.

Section 3.2. Prioritization of Use for Revenues.

All Revenues received by the Sites Authority shall be deposited into the Revenue Fund established and held by the Sites Authority pursuant to Section 3.1 hereof and allocated in the following priority:

a. to the payment of Operation and Maintenance Costs;

b. to the payment of senior lien Project Obligations;

c. to replenish bond reserve funds established for senior lien Project Obligations, if any;

d. to the payment of subordinate lien Project Obligations;

e. to replenish bond reserve funds established for subordinate lien Project Obligations, if any;

f. to restore the amount on deposit in the Liquidity Reserve to the Liquidity Reserve Requirement; and

g. as long as the Sites Authority determines there will be sufficient Revenues to make the payments set forth in (a) through (f) above, to pay any other Project costs, including Fixed Project Costs not previously paid under (b) through (e) above, permitted by law, under the Joint Powers Agreement and the Benefits and Obligations Contracts.

Section 3.3. Project Obligations. The Sites Authority shall not issue or incur any additional Project Obligations unless the Sites Authority has certified that (i) no material event of default has occurred under any Project Obligations and is continuing, (ii) each of the Benefits and Obligations Contracts is in full force and effect, and (iii) such additional Project Obligation is entitled to the benefits this Master Resolution.

Section 3.4. Rate Sufficiency. (a) The Sites Authority hereby covenants to establish charges under the Benefits and Obligations Contracts at the beginning of each Fiscal Year which, together with Revenues billed and collected with respect to such Fiscal Year prior to the commencement of such Fiscal Year and with other Revenues, are reasonably expected to be at least sufficient to yield Net Revenues, together with amounts on deposit in the Liquidity Reserve, of at least 1.00 times Project Obligation debt service payable during such Fiscal Year.

(b) So long as the Sites Authority has complied with its obligations set forth in subsection (a) above, the failure of Net Revenues to meet the threshold in the prior subsection (a) with respect to a Fiscal Year shall not constitute a default or an event of default hereunder so long as the Authority has complied with its obligation set forth in subsection (a) above with respect to the following Fiscal Year.

Section 3.5. Liquidity Reserve. The Sites Authority hereby covenants and agrees to maintain, so long as any Project Obligations remain outstanding, the Liquidity Reserve to be held by the Sites Authority. Amounts in the Liquidity Reserve shall be disbursed, allocated and applied solely to the uses and purposes hereinafter described in this Master Resolution, and shall be accounted for separately and apart from all other accounts, funds, money or other resources of the Sites Authority.

So long as any Project Obligations remain outstanding, the Sites Authority shall maintain in the Liquidity Reserve an amount equal to the Liquidity Reserve Requirement. On or prior to the date of incurrence of any Project Obligations, the Sites Authority shall deposit to the Liquidity Reserve an amount necessary, if any, to increase the amount on deposit in the Liquidity Reserve to the Liquidity Reserve Requirement, including in the calculation of the Liquidity Reserve Requirement any debt service payable during the then-current Fiscal Year with respect to such Project Obligations.

In the event of any deficiency in the Liquidity Reserve, the Sites Authority shall replenish such deficiency in accordance with Section 3.2 hereof.

Amounts in the Liquidity Reserve shall be withdrawn by the Sites Authority upon the written direction of an Authorized Officer solely for the purposes set forth in Sections 3.2(a) through (e) hereof. Any amounts withdrawn from the Liquidity Reserve shall be deposited into the Revenue Fund and applied pursuant to Section 3.2 hereof. Any amounts in the Liquidity Reserve in excess of the Liquidity Reserve Requirement on the last day of any Fiscal Year may be transferred in accordance with the written direction of an Authorized Officer from the Liquidity Reserve to the Revenue Fund and applied pursuant to Section 3.2 hereof. Any investment earnings on amounts on deposit in the Liquidity Reserve shall be transferred on the last day of any Fiscal Year into the Revenue Fund and applied pursuant to Section 3.2 hereof unless such transfer would cause the amount on deposit in the Liquidity Reserve to be less than the Liquidity Reserve Requirement.

Section 3.6. Enforcement Provisions. The Sites Authority hereby covenants to enforce the Benefits and Obligations Contracts and other agreements pursuant to which the Sites

Authority receives Revenues with other parties, including Reclamation and DWR, to the fullest extent necessary to assure sufficient Revenues will be available to pay all amounts with respect to Operation and Maintenance Costs and Project Obligations when due.

Section 3.7. Billing Provisions. The Sites Authority hereby covenants to bill (i) all amounts payable as Fixed Operation and Maintenance Costs under the Benefits and Obligations Contracts annually in advance in accordance with the Benefits and Obligations Contracts, (ii) all amounts payable as Variable Operation and Maintenance Costs semi-annually in advance in accordance with the Benefits and Obligations Contracts, (iii) all amounts due under Project Obligations annually in advance in accordance with the Benefits and Obligations Contracts, and (iv) all Fixed Project Costs, other than amounts due under Project Obligations, semi-annually in advance in accordance with the Benefits and Obligations Contracts.

Section 3.8. Investment. All amounts on deposit in the Revenue Fund and the Liquidity Reserve shall be invested in accordance with the Sites Authority investment policy as in effect from time-to-time.

Section 4. Miscellaneous.

Section 4.1. Benefits of this Master Resolution Limited to Certain Parties. Nothing contained herein, expressed or implied, is intended to give any person other than the Sites Authority or the parties to a Project Obligation any right, remedy or claim under or pursuant hereto, and any agreement or covenant required herein to be performed by or on behalf of the Sites Authority shall be for the sole and exclusive benefit of such other parties.

Section 4.2. Successor is Deemed Included in all References to Predecessor. Whenever the Sites Authority is named or referred to herein, such reference shall be deemed to include the successor to the powers, duties and functions that are presently vested in the Sites Authority, and all agreements and covenants required hereby to be performed by or on behalf of the Sites Authority shall bind and inure to the benefit of the successors thereof whether so expressed or not.

Section 4.3. Amendments. Except as may be otherwise provided in a Project Obligation, the Sites Authority may amend the provisions of this Master Resolution in accordance with the provisions of the Joint Powers Agreement and the bylaws of the Sites Authority in effect from time-to-time.

Section 4.4. Partial Invalidity. If any one or more of the agreements or covenants or portions thereof required hereby to be performed by or on the part of the Sites Authority shall be contrary to law, then such agreement or agreements, such covenant or covenants or such portions thereof shall be null and void and shall be deemed separable from the remaining agreements and covenants or portions thereof and shall in no way affect the validity hereof. The Sites Authority hereby declares that it would have adopted this Master Resolution, and each and every other article, section, paragraph, subdivision, sentence, clause and phrase hereof irrespective of the fact that any one or more articles, sections, paragraphs, subdivisions,

sentences, clauses or phrases hereof or the application thereof to any person or circumstance may be held to be unconstitutional, unenforceable or invalid.

Section 4.5. Repeal of Inconsistent Resolutions. Any resolution of the Sites Authority and any part of any resolution inconsistent herewith is hereby repealed to the extent of such inconsistency.

Section 4.6. Additional Covenants. Nothing in this Master Resolution shall prohibit the Sites Authority from entering into additional covenants with or for the benefit of the owners of Project Obligations.

Section 4.7. Effect. This Master Resolution shall take effect immediately.

PASSED, APPROVED AND ADOPTED by the Board of Directors of the Sites Project Authority this 21st day of November 2022 by the following vote:

AYES: Colusa County, Glenn-Colusa Irrigation District, Reclamation District 108, Placer County Water Agency, Tehama-Colusa Canal Authority, City of Sacramento, Westside Water District.

NOES: None.

ABSENT: Colusa County Water District, Glenn County

ABSTAIN: None.

I, Fritz Durst, Chair Authority Board of the Sites Project Authority, do hereby certify that the resolution set forth above is true and accurate copy of the resolution adopted by the Board of Directors of the Sites Project Authority at a duly called meeting of the Board on November 21, 2022 and that said resolution has not been rescinded, amended or modified and is in full force and effect as of the date hereof.

In Witness Whereof, I have executed this certificate this 21st day of November 2022.

_____

Fritz Durst, Chair Authority Board, Sites Project Authority

Biweekly EIR/EIS Meeting - Agenda

Affordable Water, Sustainably Managed

Our Core Values – Safety, Trust and Integrity, Respect for Local Communities, Environmental Stewardship, Shared Responsibility and Shared Benefits, Accountability and Transparency, Proactive Innovation, Diversity and Inclusivity
Our Commitment – To live up to these values in everything we do

Meeting Information:

Date:	November 22, 2022	**Location:**	Webex
Start Time:	3:30 p.m.	**Finish Time:**	4:30 p.m.
Purpose:	RDEIR/SDEIS Status and Coordination		

Meeting Participants:

Monique Briard, ICF	Melissa Harris, ICF
Ali Forsythe, Sites Authority	Laurie Warner Herson, Integration

Agenda:

Discussion Topic	Topic Leader	Time Allotted
1. Outstanding Questions a. Removal of Folsom exchanges - changes in storage seen in modeling, just modeling noise? b. Oroville exchanges removed from ITP and BA - remove from EIR/EIS?	Melissa	10 min
2. Admin Final EIR/EIS Preparation a. Format of next deliverable: • All changes/comments; just the changes/no comments, or "clean"? • No figure or section numbers b. Assistance from Integration • Master Response 8, Trinity • Update project description in Chapter 2 and MR2 c. Schedule	Melissa	30 min
3. Reclamation Coordination a. FPPA data and coordination with Conner b. 2017 RTCs c. Next meeting - schedule and agenda items	Laurie	10 min

Draft_0020864

4. Reschedule Next Biweekly Meeting	All	5 min

Draft_0020865

From: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Sent: 11/22/2022 12:20:57 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]; Kevin Spesert [kspesert@sitesproject.org]
Subject: School District Concerns

Hi Ali and Kevin,

I had a brief discussion with Kevin this morning about our current draft responses to school district comments and whether we need to do more in the context of the Final EIR/EIS. He suggested that we meet and discuss this issue.

Let me know if you would like me to set something up in the next few weeks. We still have time to develop some additional language to add to the administrative Final EIR/EIS in January.

Thanks,

Laurie

Laurie Warner Herson
Principal/Owner

Phenix
Environmental Planning

916.201.3935
laurie.warner.herson@phenixenv.com
State of California Small Business (#1796182)
Supplier Clearinghouse Women Business Enterprise (#16000323)

http://phenixenv.com/

Sites Reservoir Project

HC Design and Construction Schedule - Overview

November 28, 2022

Sites

Agenda

- Objectives for Workshop
- Objectives of Construction Sequencing Plan/Schedule
- Conveyance Contract Packages
- Contract Package No. 2 Facilities
- Engineering Phases
- CP No. 2 Schedule – walk-through
- Next Steps

Sites

Workshop Objectives

- Understand HC-Conveyance Scope
- Identify critical path items in schedule
- Identify key milestones in schedule that impact critical path
- Identify items that may change that would impact schedule

Draft_0020869

Objectives of Construction Sequencing Plan (CSP)/ Schedule

- CSP will be integrated into the Master Project Schedule
  - CSP is presented for comment
- CSP can be used to show when predecessor activities will need to occur to achieve the targeted project completion in 2031
  - Currently identify Permitting & Environmental milestones through 2024
  - Real Estate access granted on private land for design effort is obtained by December 2024
  - Geotechnical investigations
    - Phase 1 is completed during 30% design schedule by December 2024
    - Phase 2 is completed by December 2025
- CSP identifies critical path
  - Through the Inlet/Outlet Facilities as part of CP No. 2
  - CAISO process, PG&E point of interconnections and providing power to PGP's
  - Funks Reservoir final sediment removal

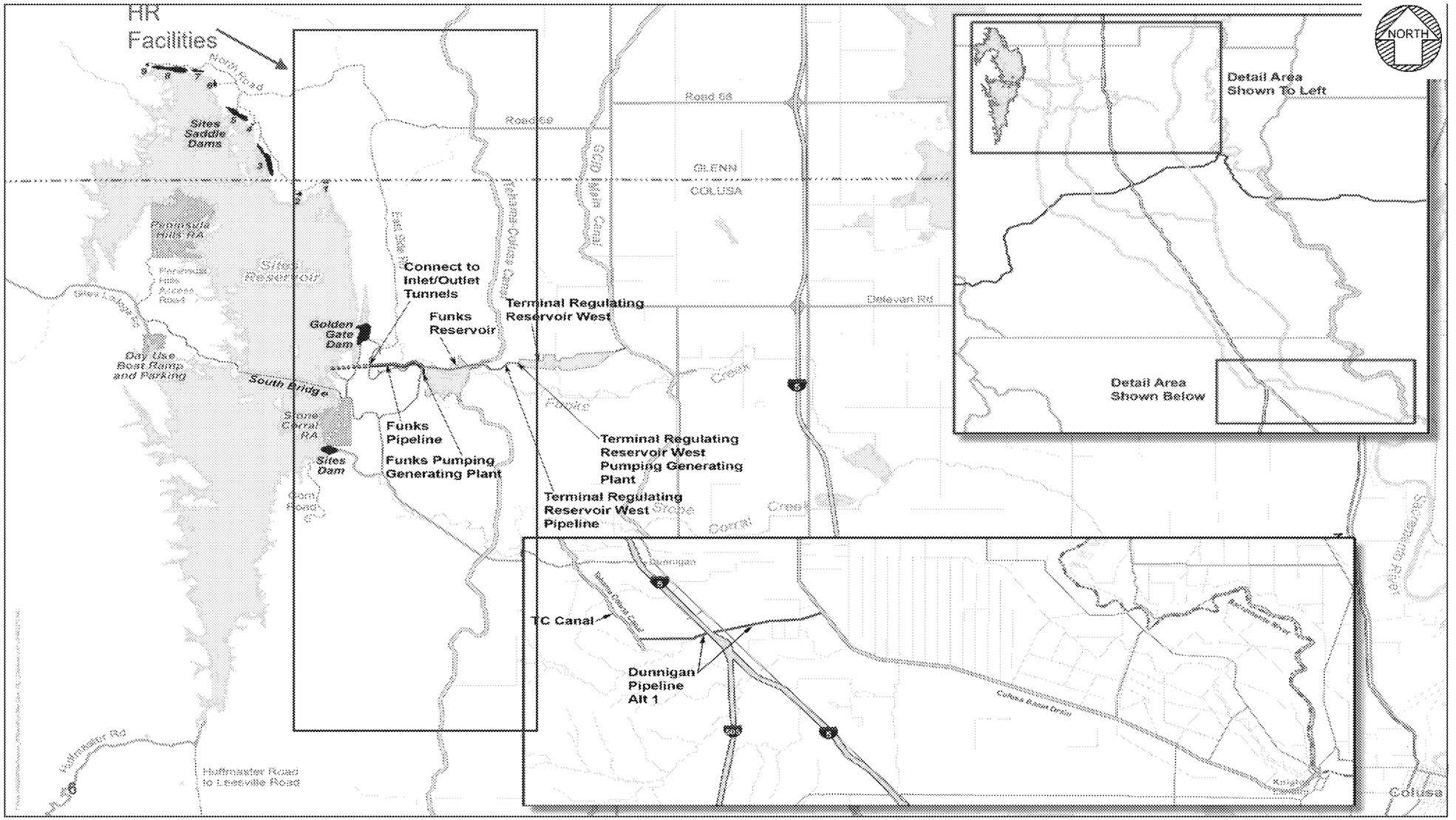
Draft_0020870

Conveyance Contract Packages

- Contract packages:
  - CP No. 2 – Maxwell Sites Pumping and Generating Facilities (MSPG) Facilities – Includes Inlet/Outlet Works - CMAR
  - CP No. 5 – Dunnigan Pipeline Alt 1 - DBB
  - CP No. 6 – Red Bluff Pumping Plant Improvements (By TCCA and USBR)
  - CP No. 7 – GCID Improvements (By GCID)
- Today we are focusing on CP No. 2

Draft_0020871

Contract Package No. 2 - Site Plan



Sites

CP No. 2 - Facilities

- Terminal Regulating Reservoir (TRR) -West
- TRR Pumping Generating Plant (PGP)
- TRR Pipelines
- Inlet/Outlet Facilities
- Funks Reservoir Improvements
- Funks PGP
- Funks Pipelines
- PG&E Point of Interconnection
- 230 kV Power Transmission Lines and Substation at each PGP
- Administration and Operations Building (Part of Funks PGP)
- Maintenance and Storage Building (Part of Funks PGP)
- Access Roads
- Electrical Overhead from Funks PGP to Sites Dam & I/O Control Building

Sites

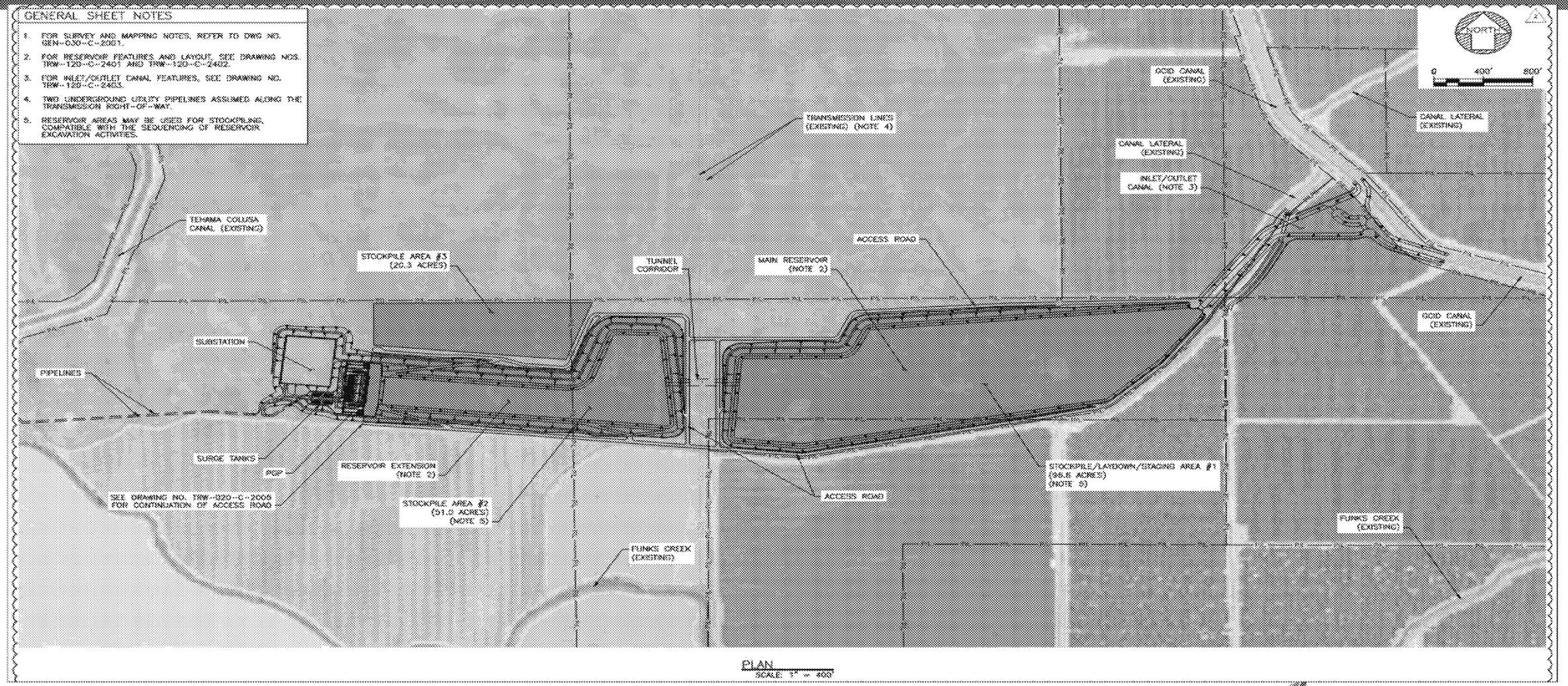
Draft_0020873

CP No. 2 Facilities Eliminated that are in Draft EIR/EIS

- Terminal Regulating Reservoir (TRR)-East
- WAPA point of interconnection and associated power transmission line facilities
- Dunnigan Pipeline (Alternative 2) – extends from Colusa Basin Drain to the Sacramento River

Draft_0020874

TRR – West



Sites

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TRR – West

- New reservoir on the western side of GCID Main Canal
- Footprint: approximately 140 acre
- Estimated Storage Volume: 600 ac-ft
- Will be hydraulically connected to the GCID Main Canal through several gate structures
- Currently working with GCID to optimize the size
- Will be constructed via primarily mass excavation – so potentially not Division of Safety of Dams (DSOD) jurisdictional

Sites

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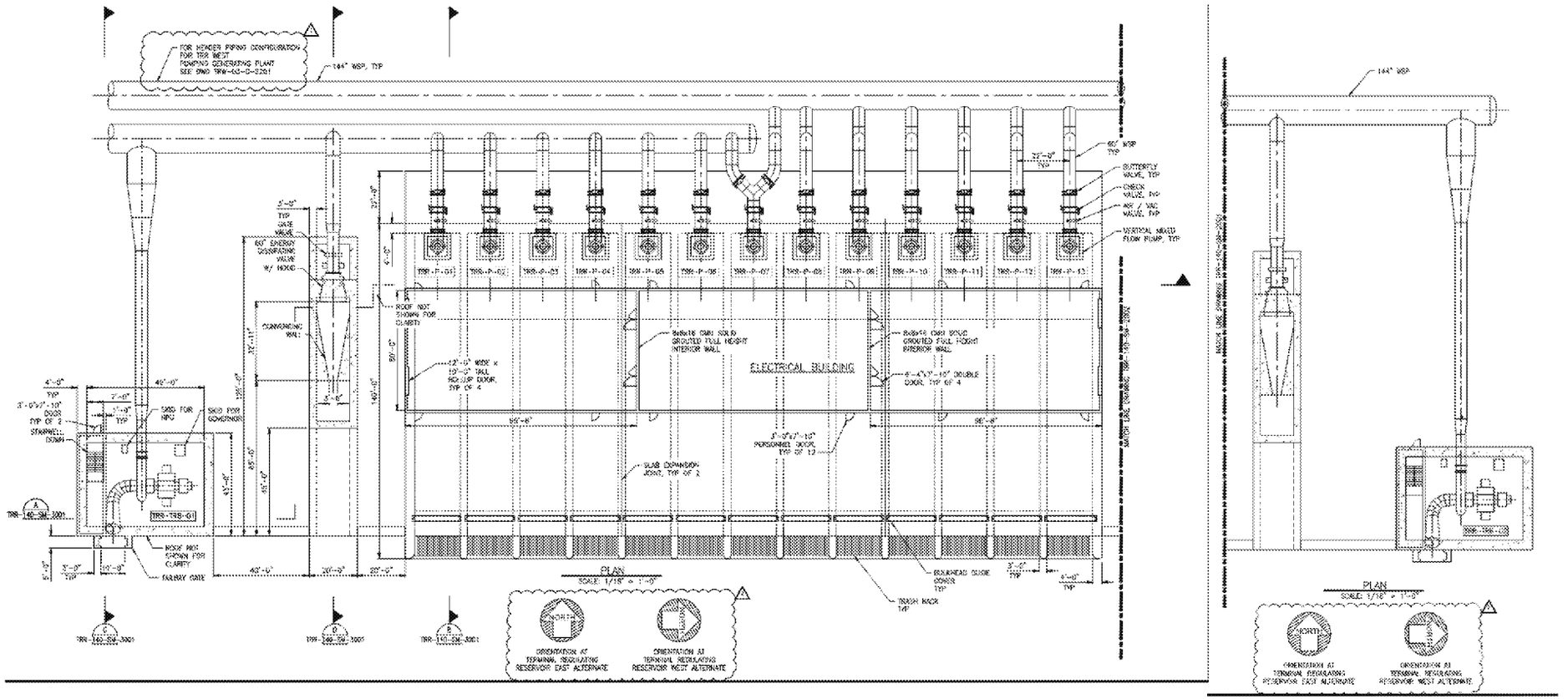
TRR West – PGP (600-ft x 200-ft)



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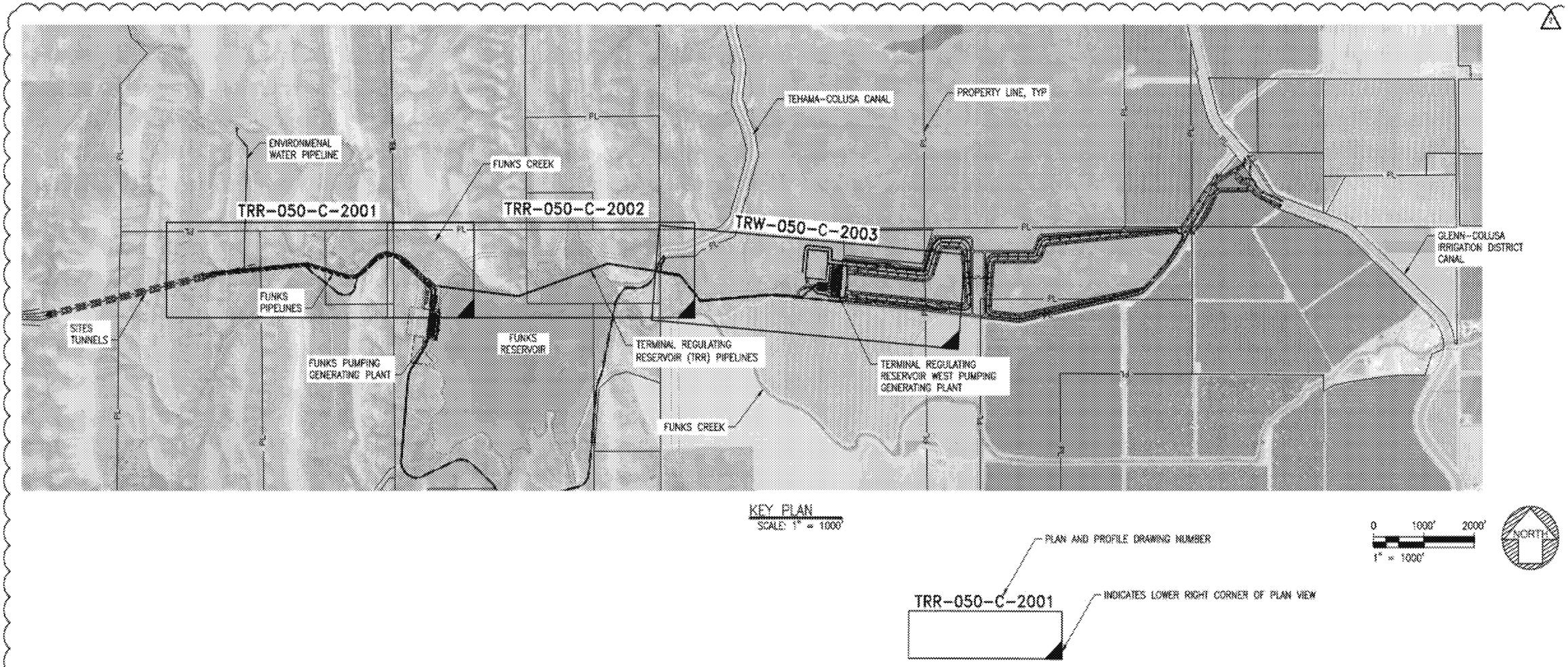
TRR West – PGP

- Pumping and generating plant that will be used to pump water from TRR West to Sites Reservoir
- Pumping station will consist of 13 pumps (9,000 hp each), 12 duty and one standby
- Includes two hydroelectric turbines (11.5 MW each) to generate electricity when flow is released from Sites Reservoir to the TRR and GCID Main Canal
- Includes several (?)energy-dissipation valves/facilities that will allow releases back to the TRR as backup to the turbines & provide reservoir emergency flow
- Pumping plant capacity: 1,800 cfs
- Generating plant: 1,000 cfs (2 turbines at 500 cfs each)

Sites

Draft_0020878

TRR – West Pipelines & Environmental Pipeline



Sites

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TRR Pipelines & Environmental Pipeline

- Two parallel 12-foot diameter pipelines intended to convey water between the TRR PGP and the Sites Reservoir
- Ties into the 32-foot-diameter tunnel connected to the Sites Reservoir inlet/outlet structure
- TRR-West pipelines approximate length would be 2.5 miles each
- There is a 42-inch-diameter Environmental Water Pipe (200 cfs) tying into one of the TRR pipelines and discharges into Funks Creek above Funks Reservoir. Pipeline is 2,550-ft long.

Sites

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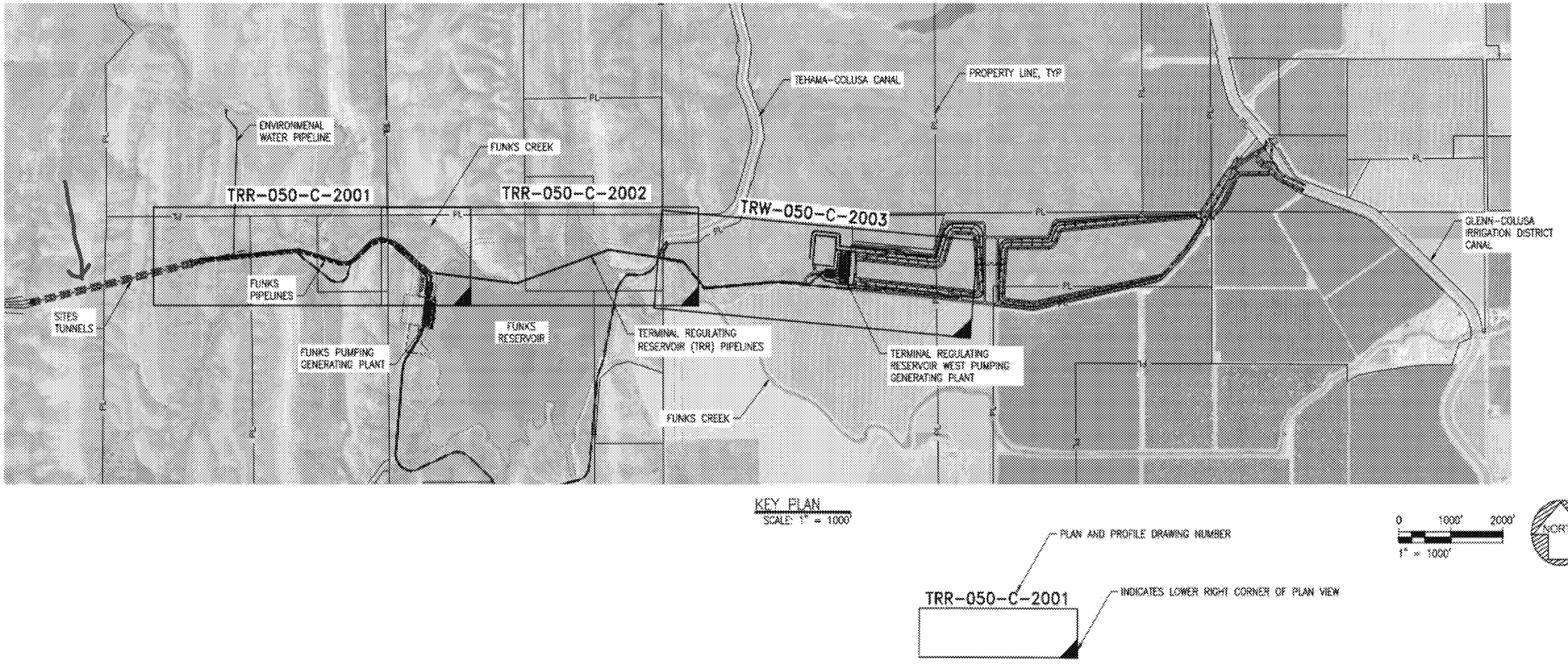
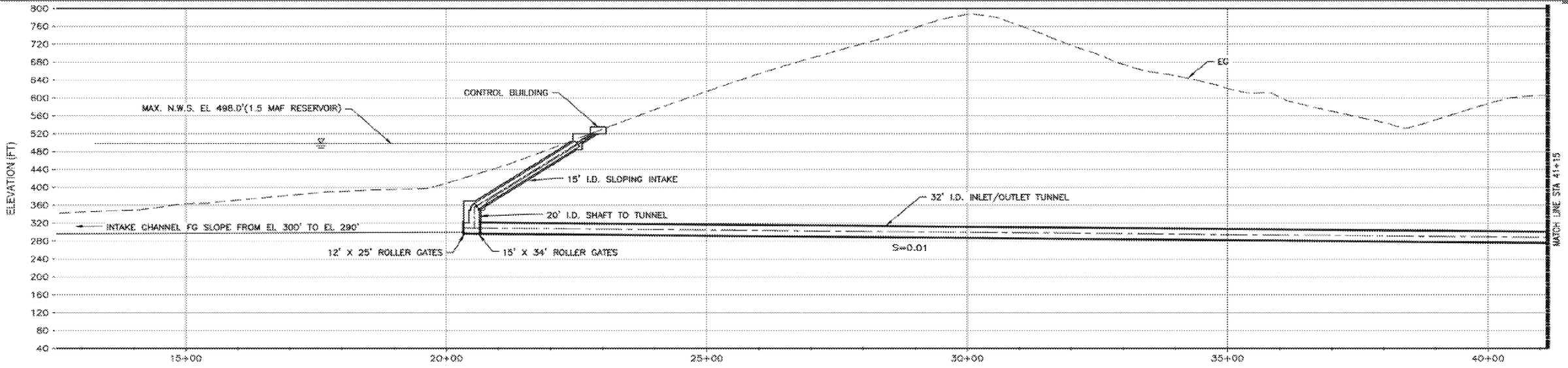
Inlet/Outlet Facility



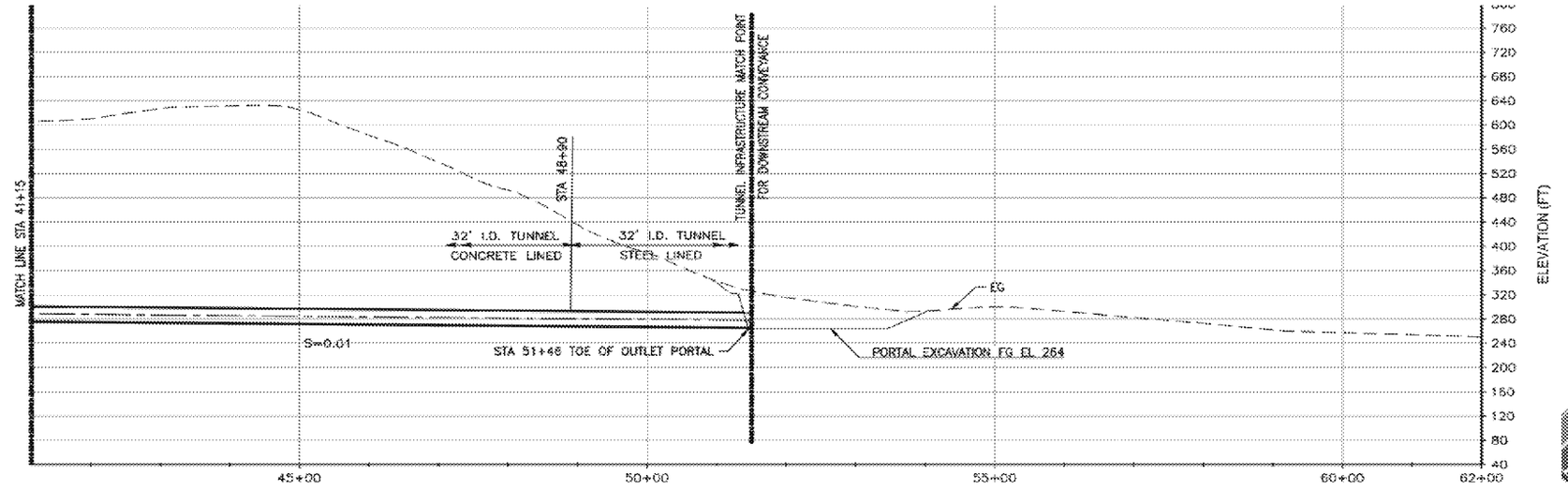
Sites

Draft_0020881

Inlet/Outlet Facility Profile



PROFILE STA 14+50 TO STA 40+20



PROFILE STA 40+20 TO 62+00
SCALE: 1" = 100'

Sites

Draft_0020882

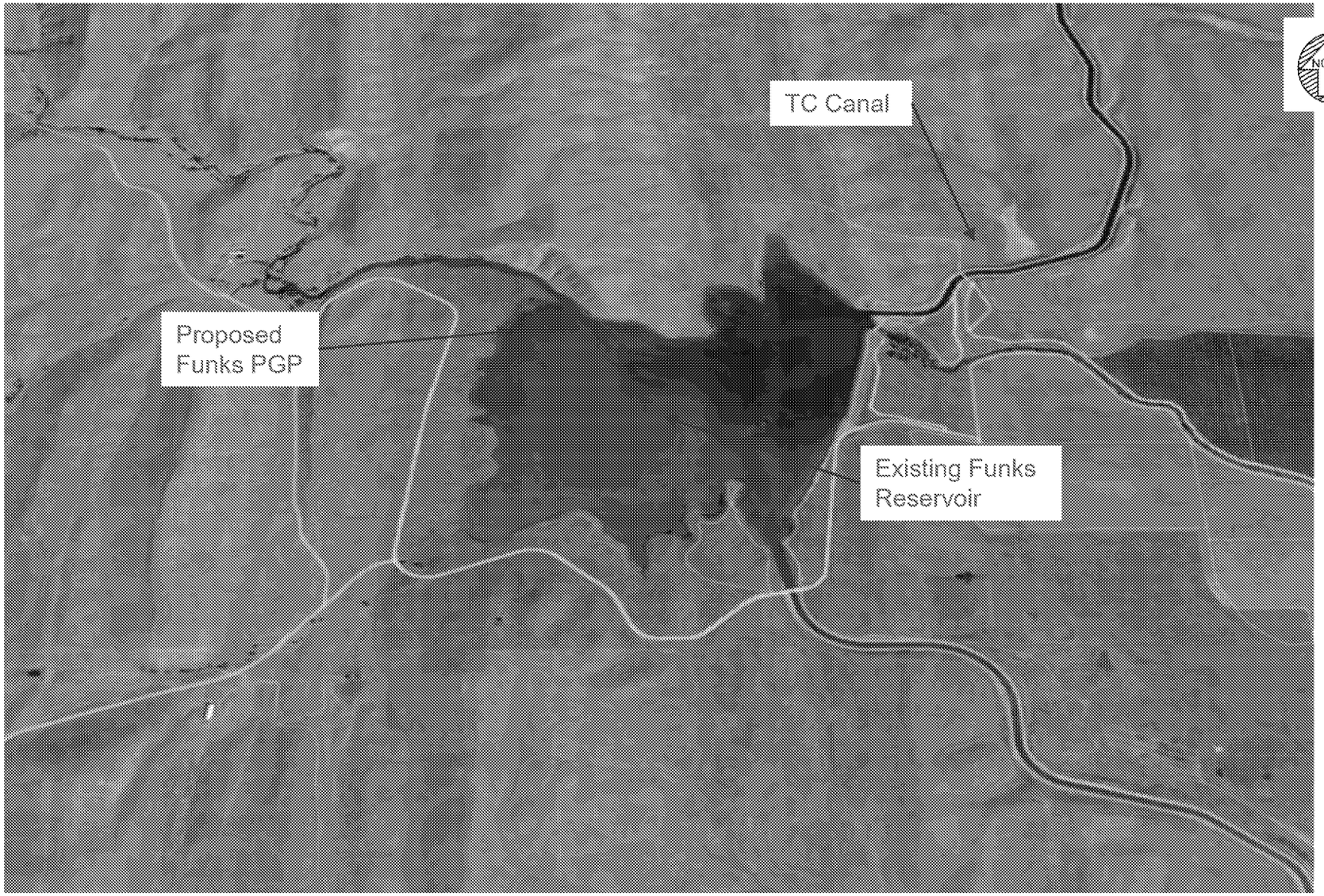
Inlet/Outlet Facility

- A sloping inlet/outlet structure with multiple gates on eastern bank of Sites Reservoir
- A 32-foot-diameter tunnel connecting Sites Reservoir inlet/outlet structure to the 4 pipes from TRR PGP and Funks PGP
- Tunnel is approximately 3,100 feet long

Sites

Draft_0020883

Funks Reservoir Site Plan



Sites

Draft_0020884

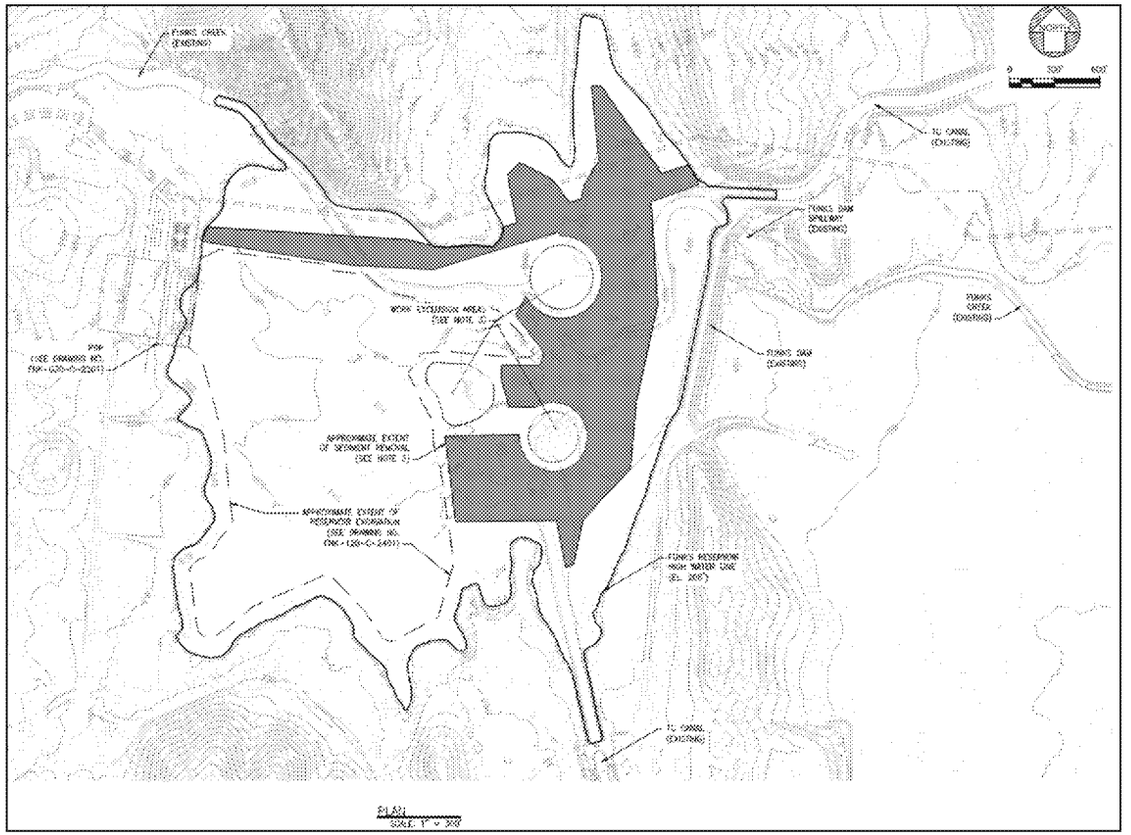
Funks Reservoir and Improvements

- Existing reservoir off the TC Canal to be used as a source of water to pump and receive discharged water from Sites Reservoir
- Total Reservoir Volume: 2,250 ac-ft
- Current Usable Storage Volume within TCC Operating Range: 1,100 ac-ft
- Improvements include reshaping the shoreline to accommodate PGP, excavating a channel to PGP, constructing a temporary cofferdam to construct TRR pipelines, and remove sediment to regain design storage capacity

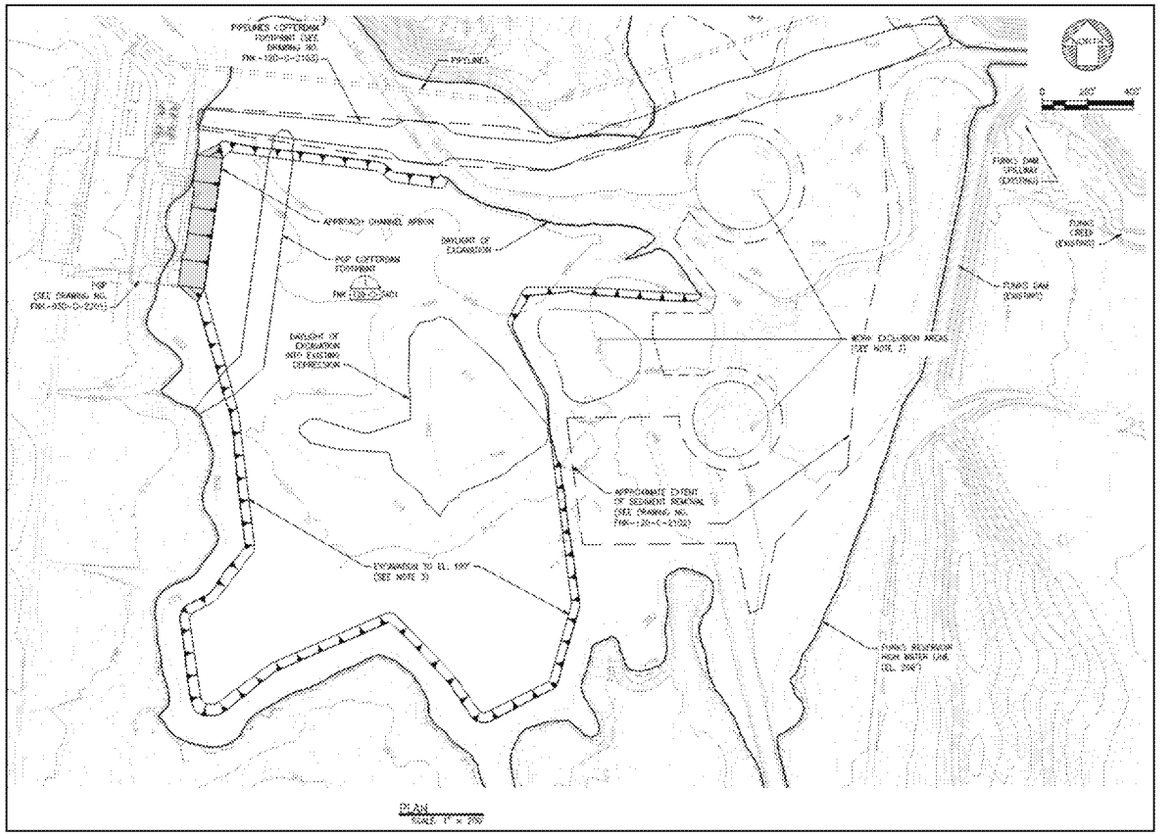
Sites

Draft_0020885

Funks Reservoir Improvements (Cultural Resource areas highlighted)



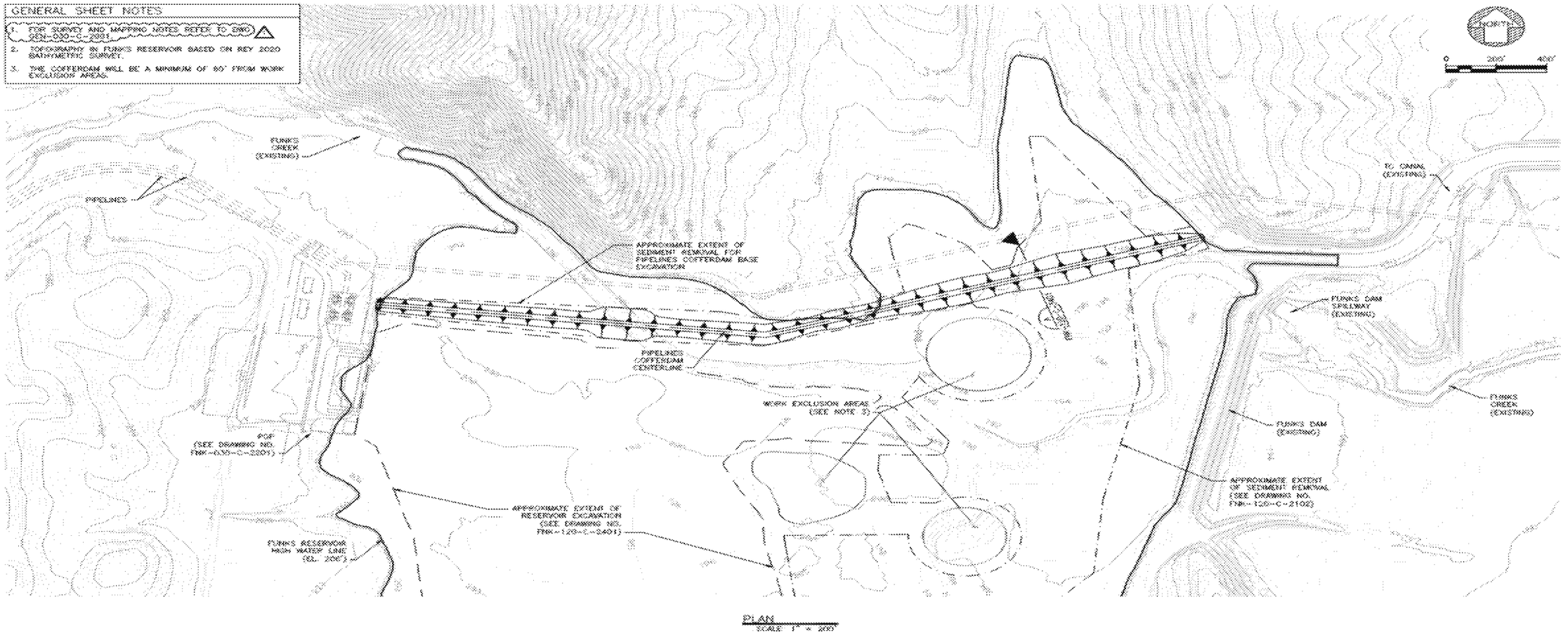
Sediment Removal Plan



Excavation and Approach Channel Plan

Sites

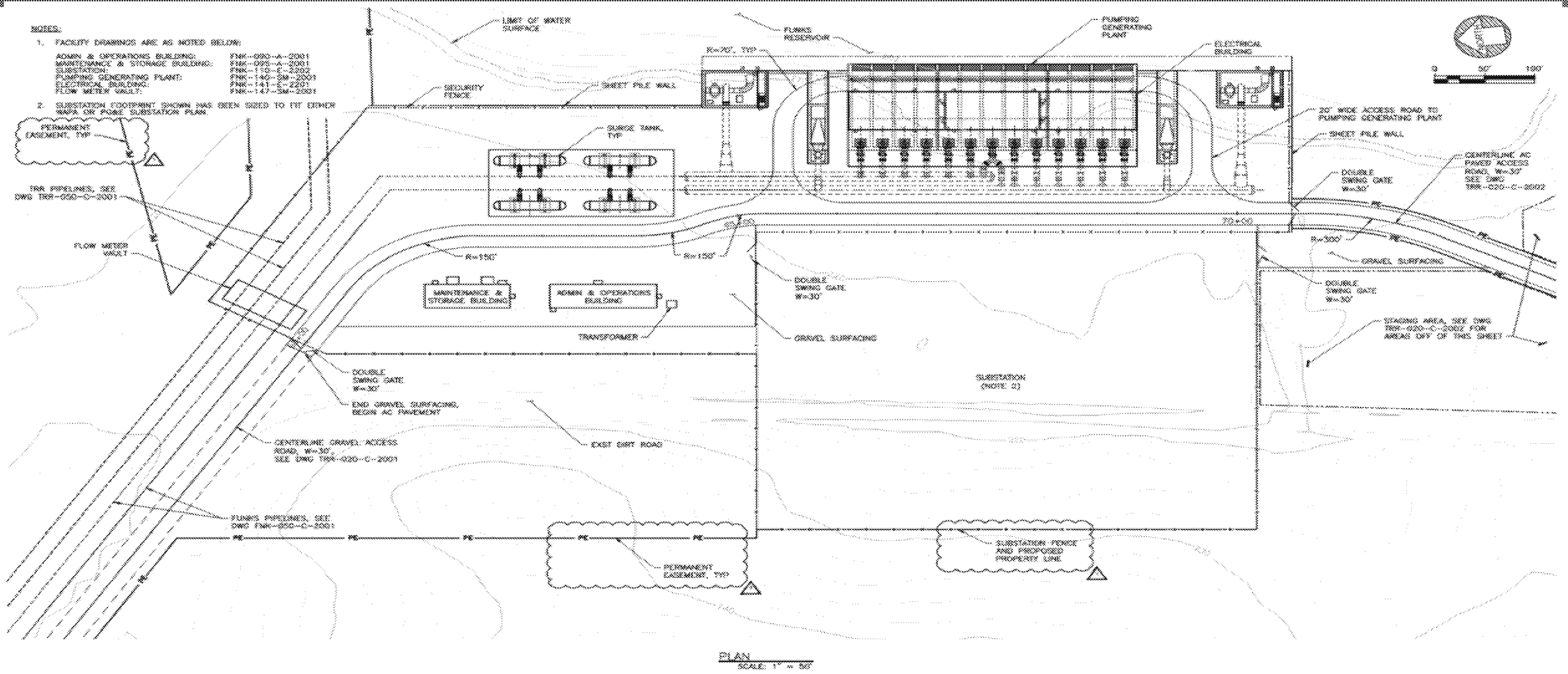
Funks Reservoir Improvements



Temporary TRR Pipeline Cofferdam Plan

Sites

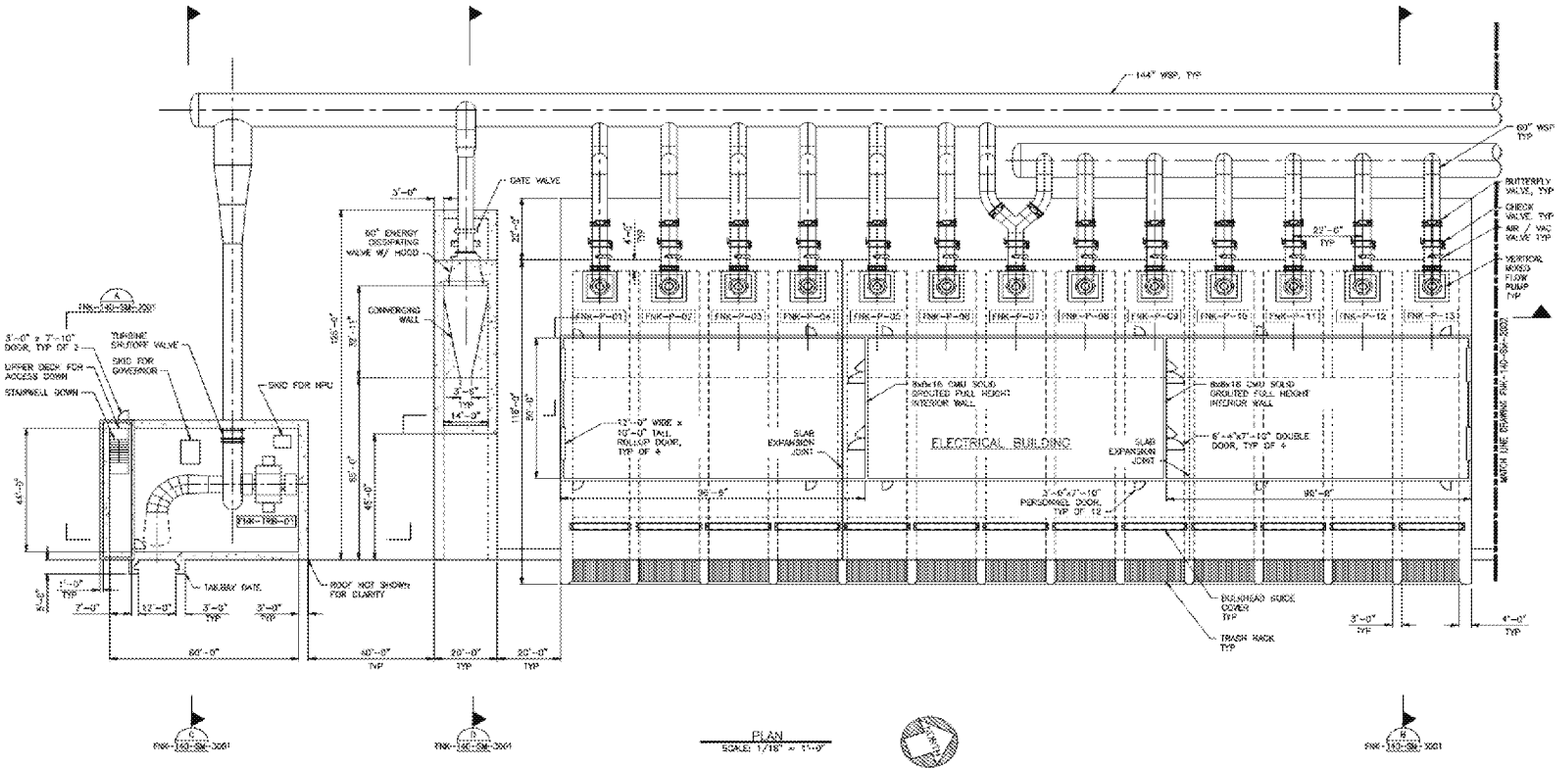
Funks PGP Site Plan (about 15-acres)

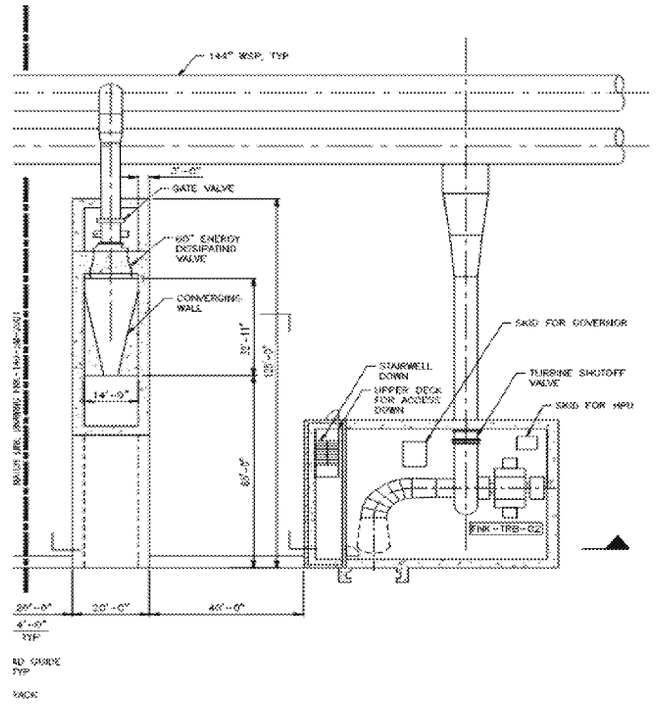


Sites

Draft_0020888

Funks PGP





Sites

Draft_0020889

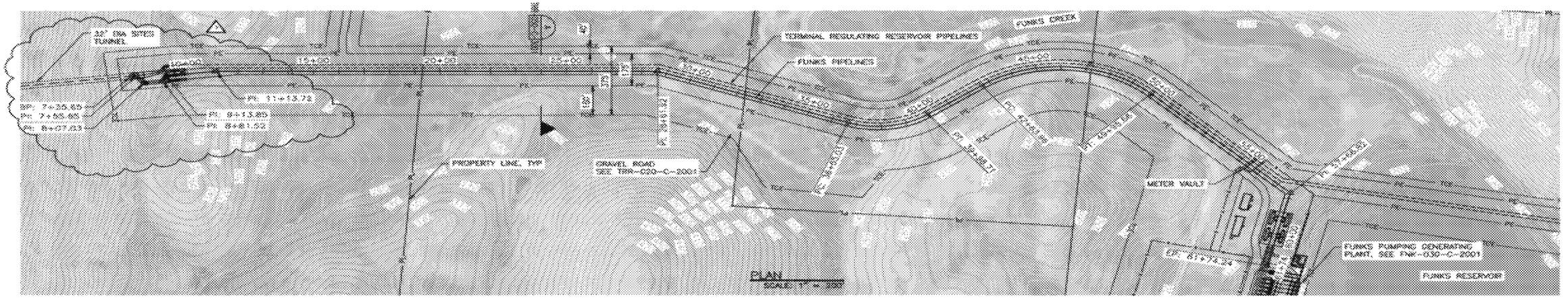
Funks PGP

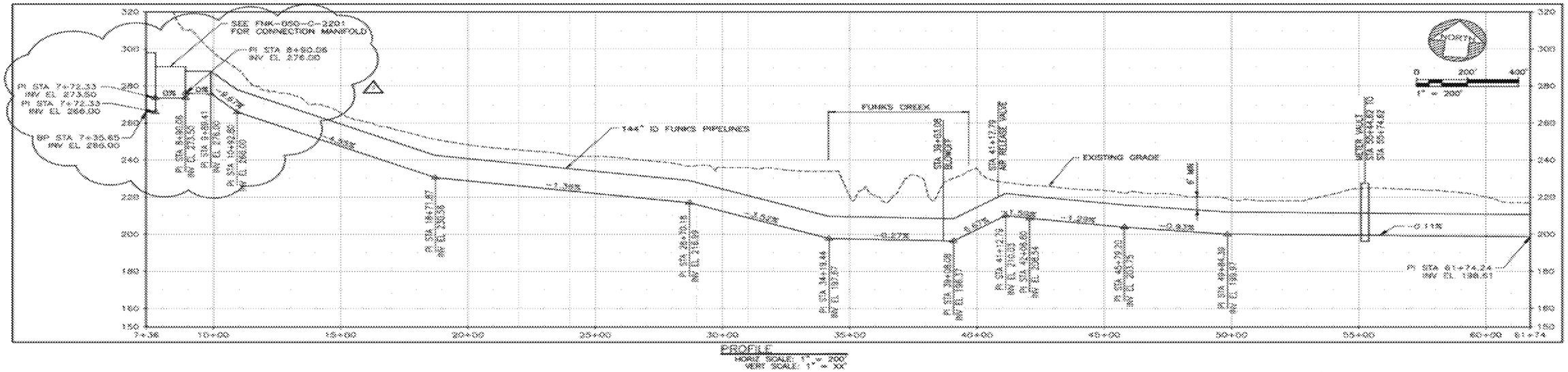
- Intended to pump water from Funks Reservoir to Sites Reservoir
- Pumping Plant includes 13 pumps (8,000 hp each) 12 Duty and 1 standby.
- Includes two hydroelectric turbines (14.5 MW each)to generate electricity when flow is released from the Sites Reservoir to Funks Reservoir, to the TC Canal and ultimately to the Sacramento River
- Includes several (?)energy-dissipation valves/facilities that will allow releases back to Funks as backup to the turbines & provide reservoir emergency flow
- Pumping plant capacity: 2,100 cfs
- Generating plant capacity: 2,000 cfs (1,000 cfs per turbine for redundancy)

Sites

Draft_0020890

Funks Pipelines





Sites

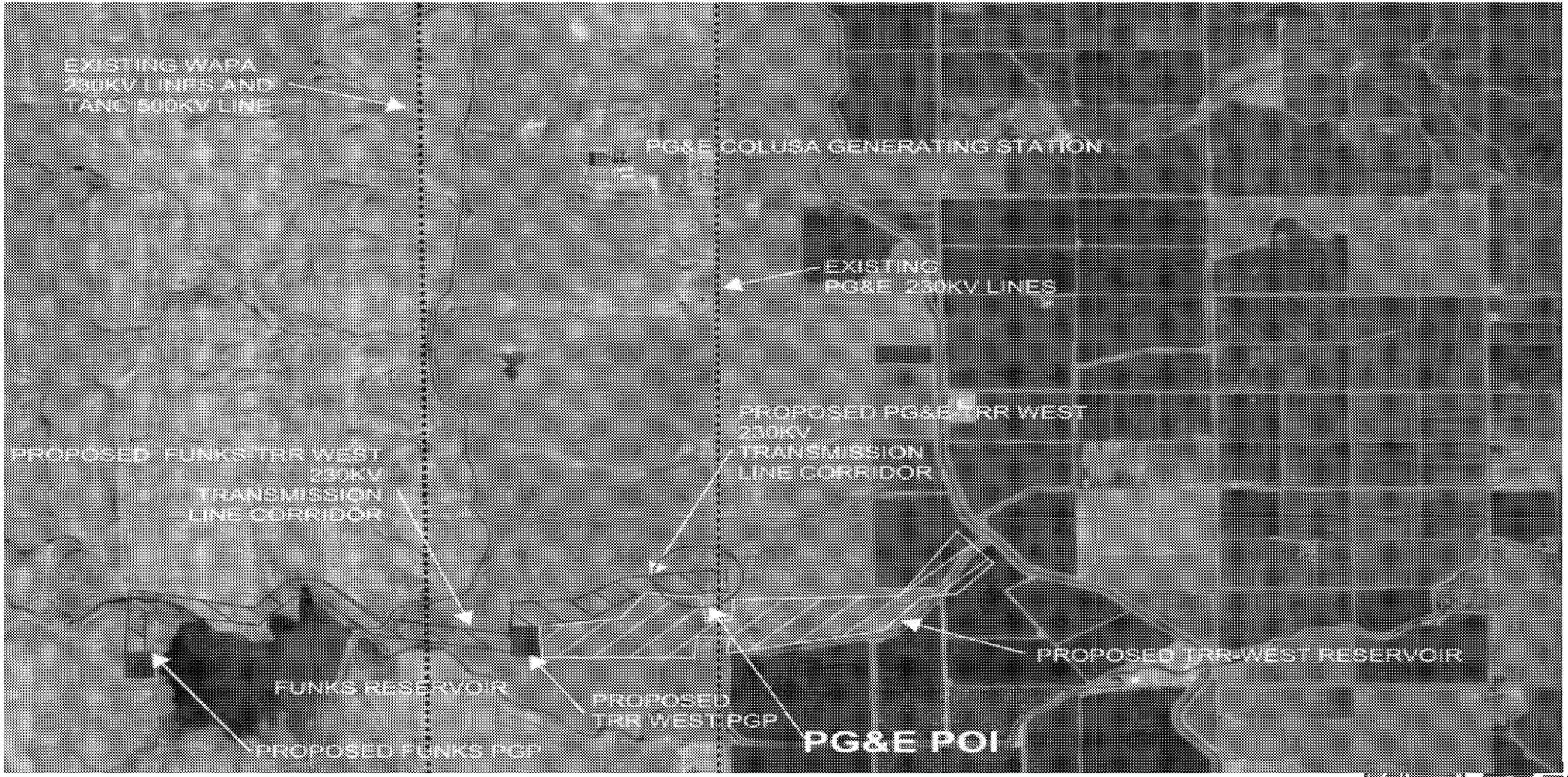
Draft_0020891

Funks Pipelines

- Two parallel 12-foot diameter pipelines intended to convey water between Funks PGP and Sites Reservoir
- Ties into a 32-foot-diameter tunnel connected to the Sites Reservoir inlet/outlet structure
- Appx. Length of each Pipeline: 1 mi (5,200 ft)
- Valve between one Funks Pipeline and one TRR Pipeline acts as the Maxwell Intertie (allowing flow from TC Canal to GCID Canal without going to Sites Reservoir)

Draft_0020892

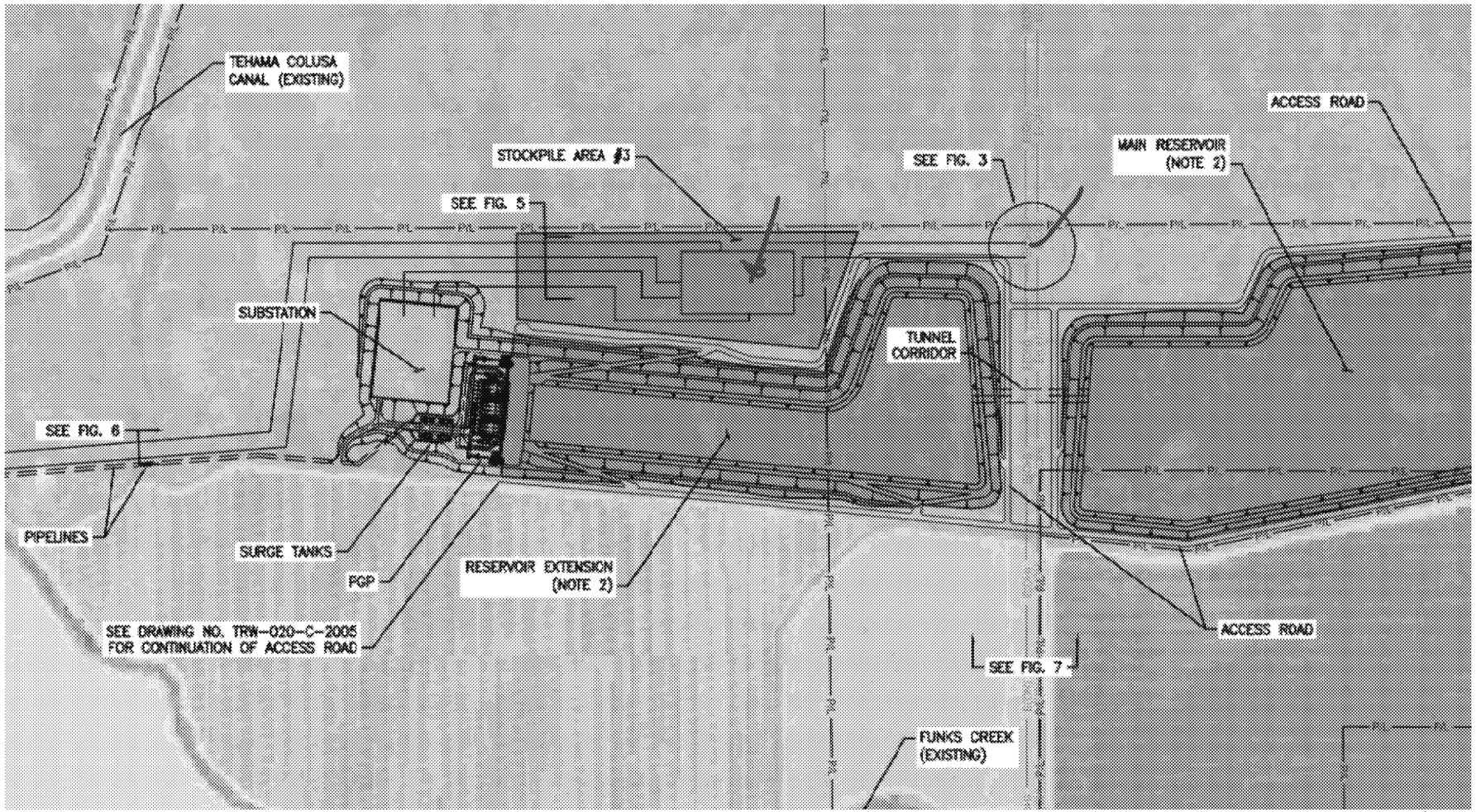
PG&E Point of Interconnection



Sites

Draft_0020893

PG&E Point of Interconnection and Substation



Sites

PG&E Point of Interconnection & Substations

- Will serve as the primary source of power for the Project
- Will have ability to receive generated electrical power from the hydroelectric turbines
- The substations will be designed for the total pumping power requirements (import) or total generation requirements (export)
- 230 kV to 13.8 kV substations at TRR PGP and Funks PGP

Draft_0020895

Power Transmission Lines

- A point of interconnect to the PG&E high-voltage transmission line will provide power to operate the pumps at the Funks PGP, and the TRR PGP.
- Power will be delivered between TRR and Funks substations via looped (two circuits) 230 kV to the supply power to pumps.
- The looped circuits would also receive power from the Funks PGP and TRR PGP when the turbine/generators are operating.

Sites

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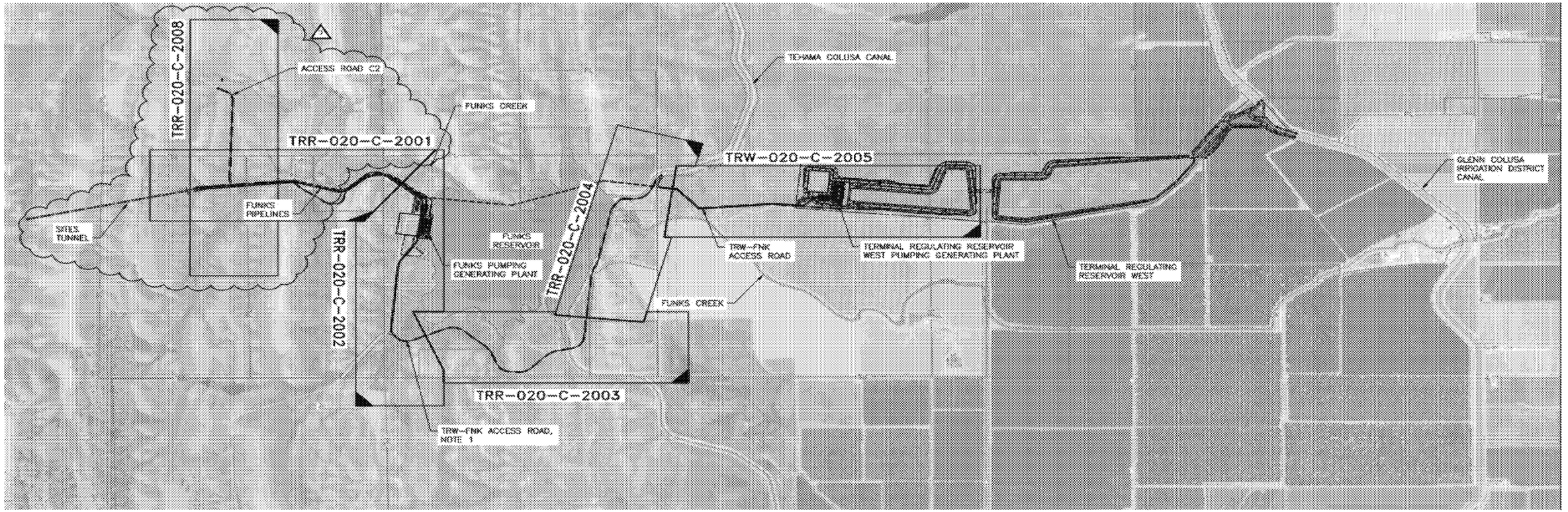
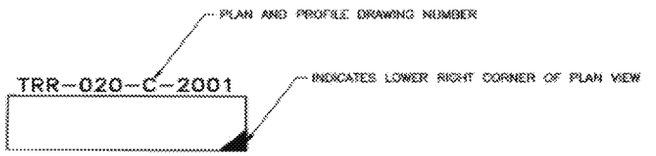
TRR West & Funks Access Roads



NOTE:

1. TRW-FNK ROAD IS THE SAME AS TRR-FNK ROAD FROM BEGIN STA 10+00 TO STA 192+00, SHOWN ON DWGS TRR-020-C-2021 THROUGH 2004.

KEY PLAN
SCALE: 1" = 1000'



0 1000' 2000'
1" = 1000'

NORTH

Sites

Draft_0020897

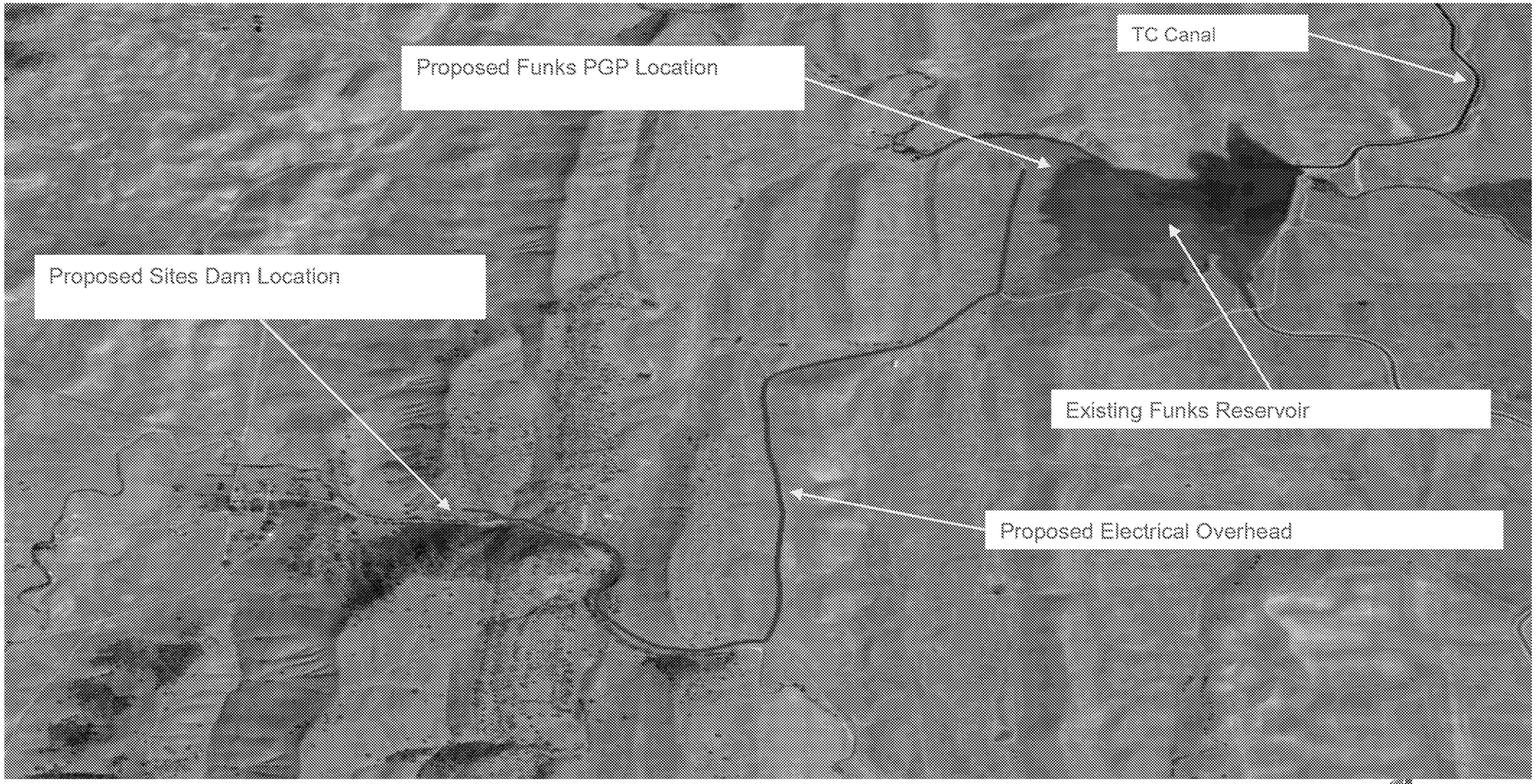
Access Roads

- A new access road will be required that allows larger equipment and year-round access to all project facilities
- Access to the Funks complex (PGP and Reservoir) will be along a current private road coming off the Maxwell-Sites Road.
- Will need permanent easement along USBR Road around Funks Reservoir
- Secondary access roads will be constructed within TRR-West and Funks pipeline easements for access to pipelines and electrical transmission lines

Sites

Draft_0020898

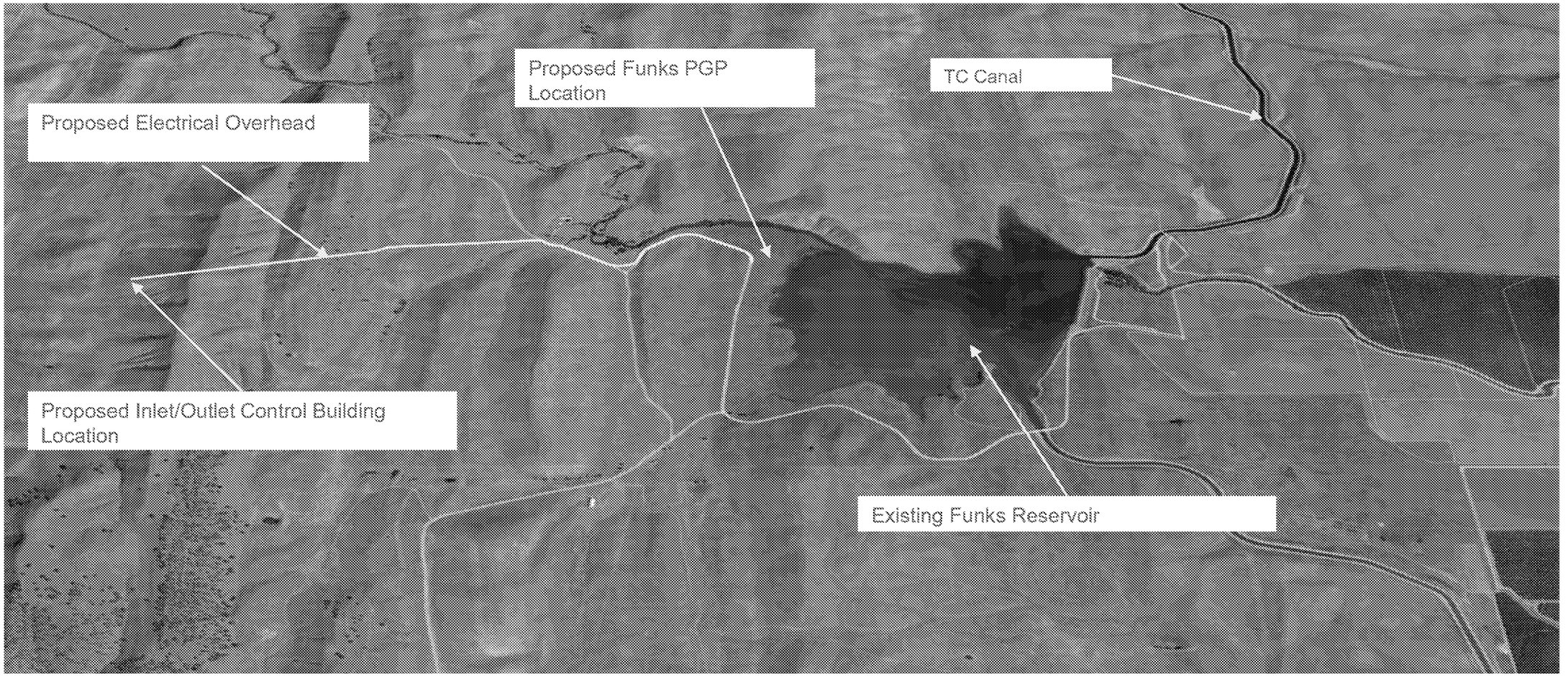
Electrical Overhead from Funks PGP to Sites Dam



Sites

Draft_0020899

Electrical Overhead from Funks PGP to Inlet/Outlet Control Building



Sites

Draft_0020900

Engineering Phases - Iterative Process/Reviews
Aligned with Contract Packages

- Geotechnical investigations
- Engineering
  - 30% design for DSOD jurisdictional features (TRR and Funks Pipelines and maybe TRR)
  - Design continues while DSOD reviews taking place (30, 60, 90%)
  - Design continues while reviews taking place
- DSOD reviews/approval
  - 3 months each for 30, 60, 90% reviews
  - 3 months for 100% approval
  - DSOD staffing and ability is assumed not to affect schedule; communication with DSOD is needed to confirm this

Draft_0020901

CP No. 2 - Schedule Considerations

- DSOD Jurisdiction on TRR West is unknown and DSOD impact on TRR and Funks pipelines (both are jurisdictional) unknown
- Geotechnical data
  - P1 completed by December 2024
  - P2 completed by December 2025
- CAISO application submitted April 15, 2023
- Further schedule iterations to be developed as more information is received.
  - Schedule to be shared with CMAR - CMAR would confirm, modify, and improve schedule, and adding more detail
- Optimization of this draft preliminary schedule was not attempted

CP No. 2 - Schedule

- Walk–through in Microsoft Project
- Highlight Critical Path through Inlet/Outlet Works
- Highlight potential Critical Path through CA ISO and PG&E
- Funks Reservoir final sediment removal

Draft_0020903

Items That Would Impact Schedule

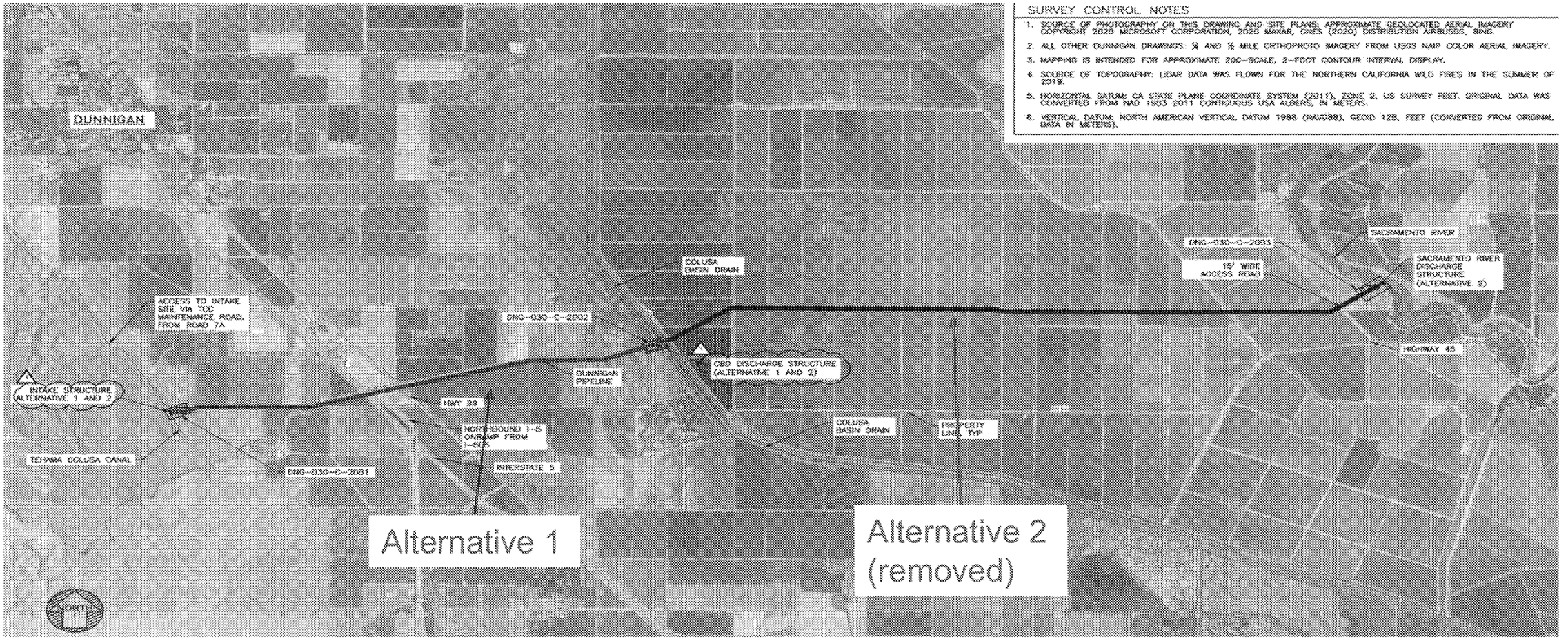
- Identify key milestones in schedule that impact critical path
  - DSOD review and Geotechnical Investigations for Inlet/Outlet Works
  - CA ISO April 15, 2023 application – if this is deemed a “Super Cluster” like 2021, then the CA ISO process is extended an additional year, which extends PG&E POI and substation and becomes Critical Path
- Identify items that may change that would impact schedule
  - Unsure of DSOD review times for design of TRR and Funks Pipelines
  - Unsure if Ca Public Utilities Commission is involved with CAISO process – checking with Z Global
  - Geotech investigations completions
  - Environmental/Permitting constraints during design
  - Environmental/Permitting constraints during construction

Next Steps

- HR Schedule Workshop on December 15 – schedule input from Environmental, Permitting & Real Estate
- Revise HC Schedule based input from HR Schedule Workshop
- Hold HC Schedule Workshop with input from Environmental, Permitting & Real Estate
- Revise HC Schedule to be incorporated into Baseline Schedule
- JP Present Baseline Schedule to Operations & Engineering Work Group
- JP Present to Reservoir Committee/Board

Thank You

Dunnigan Pipeline Alt 1 – CP No. 5



PLAN
SCALE: 1" = 2000'

Sites

Dunnigan Pipeline Alt 1 - CP No. 5

- Pipeline that connects to intake structure at TCC and flows to an outlet structure at CBD, which flows to Sacramento River
- Requires tunneled crossings under I-5 and Hwy 99/railroad with 10.5-foot casing
- Fixed-cone valves will be placed at the discharge stilling basin to dissipate energy and adjust the flow.
- Flow: 1,000 cfs, based on gravity head from TCC
- Pipe Diameter: 9 feet
- Appx Length: 4 miles (20,900 feet)
- May includes West levee improvements on CBD downstream of discharge point

Sites

Sites Reservoir
Sites

Our Strength is in Our Broad Statewide Participation

Sacramento Valley

City of American Canyon
Colusa County
Colusa County Water Agency
Cortina Water District
Davis Water District
Dunnigan Water District
Glenn County
Glenn-Colusa Irrigation District
LaGrande Water District
Placer County Water Agency
Reclamation District 108
City of Roseville
Sacramento County Water Agency
City of Sacramento
Tehama-Colusa Canal Authority
Westside Water District
Western Canal Water District

Bay Area

Santa Clara Valley Water District
Zone 7 Water Agency

San Joaquin Valley

Wheeler Ridge-Maricopa WSD
Rosedale-Rio Bravo WSD

Southern California

Antelope Valley-East Kern Water Agency
Coachella Valley Water District
Desert Water Agency
Irvine Ranch Water District
Metropolitan Water District
San Bernardino Valley Municipal Water District
San Gorgonio Pass Water Agency
Santa Clarita Valley Water Agency

Waiting List

Cal-Am Sacramento
City of Napa
Delta View WUA
Glenn County
La Cumbre MWC
Madera County
Pacific Resources MWC
Palmdale Water District
Santa Clara Valley WD
Westlands WD
Wheeler Ridge-Maricopa WSD
Woodland Davis CWA

Sites

Current Participation Mix (Based on Allocation of Storage Capacity)

Participant Name	2021 Participation Level	Estimated Storage Capacity (AF) 1.5 MAF Reservoir	% Local Participation	% Total Active Storage
Antelope Valley-East Kern WA	500	3,117	0.3%	0.2%
Carter MWC	300	1,870	0.2%	0.1%
City of American Canyon	4,000	24,937	2.4%	1.8%
Coachella Valley WD	10,000	62,343	6.0%	4.5%
Colusa County	10,000	62,343	6.0%	4.5%
Colusa County WD	10,073	62,799	6.0%	4.6%
Cortina WD	450	2,805	0.3%	0.2%
Davis WD	2,000	12,469	1.2%	0.9%
Desert WA	6,500	40,523	3.9%	2.9%
Dunnigan WD	2,972	18,528	1.8%	1.3%
Glenn-Colusa ID	5,000	31,172	3.0%	2.3%
Irvine Ranch WD	1,000	6,234	0.6%	0.5%
LaGrande WD	1,000	6,234	0.6%	0.5%
Metropolitan Water District of SC	50,000	311,717	29.8%	22.6%
Reclamation District 108	4,000	24,937	2.4%	1.8%
Rosedale-Rio Bravo WD	500	3,117	0.3%	0.2%
San Bernardino Valley Municipal WD	21,400	133,415	12.8%	9.7%
San Gorgonio Pass WA	14,000	87,281	8.4%	6.3%
Santa Clara Valley WD	500	3,117	0.3%	0.2%
Santa Clarita Valley WA	5,000	31,172	3.0%	2.3%
Westside WD	5,375	33,510	3.2%	2.4%
Wheeler Ridge - Maricopa WSD	3,050	19,015	1.8%	1.4%
Zone 7 WA	10,000	62,343	6.0%	4.5%
State of California - Ecosystem Benefit		244,000		17.7%
State of California - Recreation and Flood Control		0		0.0%
State of California - Total		244,000		17.7%
Reclamation		91,000		6.6%
Subtotal	167,620	1,380,000	100%	100.0%

Dead Storage = 120 TAF

Sites

Angela – add the table showing storage/annual supply with Reclamation @ 7%. Do not show storage conversation factor

Affordable, Permittable, Buildable

Sites underwent a rigorous value planning effort that resulted in a "right-sized" project. The Sites Reservoir of today:

- Has a smaller footprint than the previous iteration
- Meets the water supply needs of current participants
- Comes at a lower cost
- Supports State's environmental goals
- Creates flexibility for participants
- Performs under most challenging climate change scenarios

The right-sized project cuts roughly $2 billion from the original proposal.

Sites is now more affordable, permittable, and buildable.

Sites

Provides Climate Change Resiliency

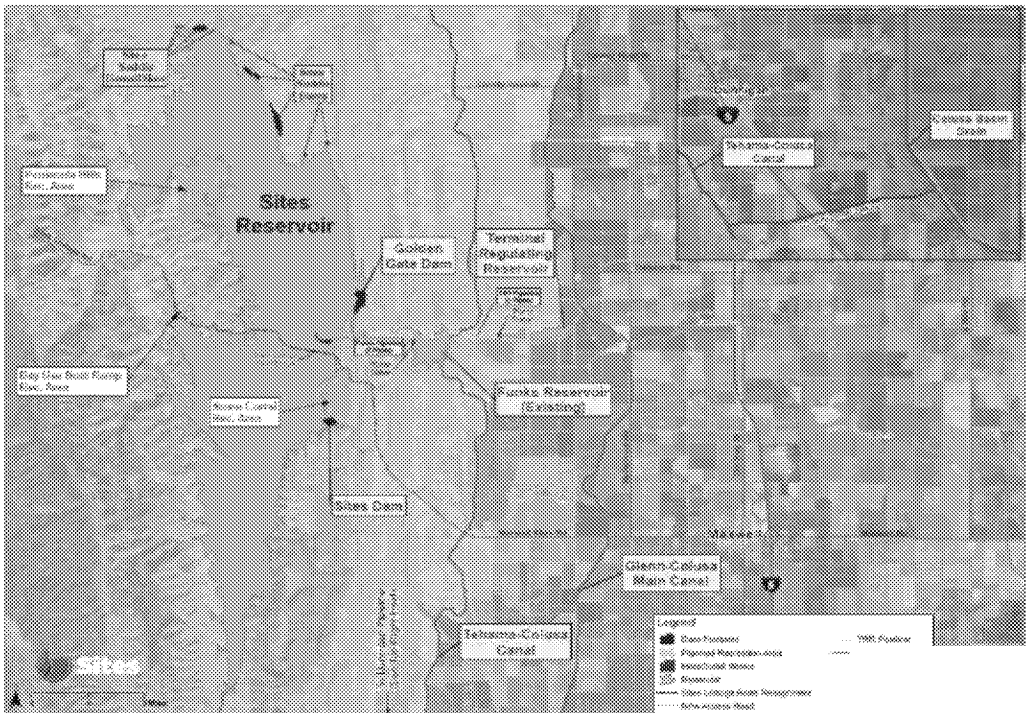
How does Sites Reservoir address these challenges?

- Captures excess flows from Sacramento River – rain instead of snowmelt
- Off-river storage increases environmental benefits by not damming major river system
- Adds 1.5 million acre-feet of water into the statewide system, easing pressure on other sources during droughts
- Supplies water for people, farms and environment during the longer dry spells California experiences
- Allows other reservoirs, like Shasta, Oroville and Folsom to conserve more cold water during dry periods in order to benefit fisheries

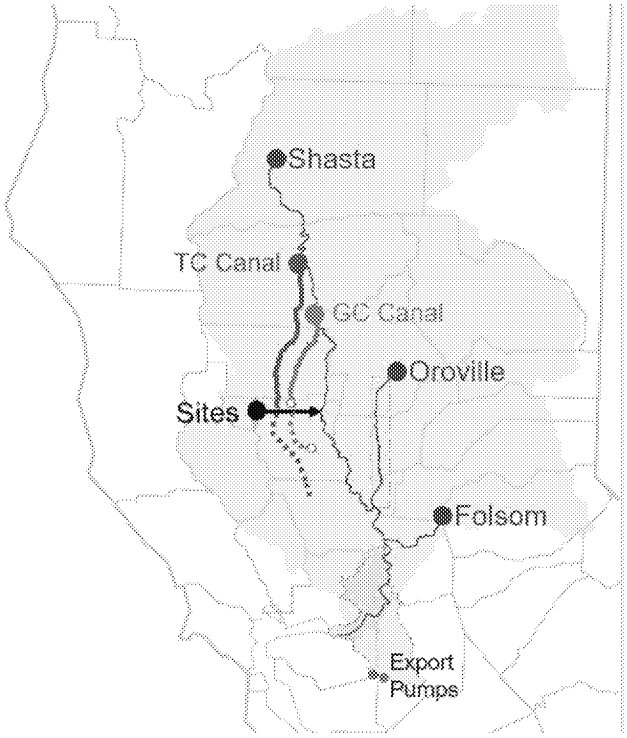
Project performance is expected to improve by approximately 5%-10% under anticipated climate change conditions

Sites

Affordable, Permittable, Buildable



Sites is Perfectly Located Relative to Existing State and Federal Facilities for Complementary Operations



Provides a Resilient, New Supply of Dry Year Water

SITES PROJECT NEW WATER SUPPLY

Year Type	Water Supply (thousand acre-feet)*
Wet	80-120
Above Normal	130-390
Below Normal	170-330
Dry	375-440
Critically Dry	265-315
Long-Term Average	208-280

*Ranges depict differences in selected project alternative and hydrology

One thousand acre-feet of water supply can serve about 2,000-3,000 households for one year, or 200-500 acres of productive California agriculture

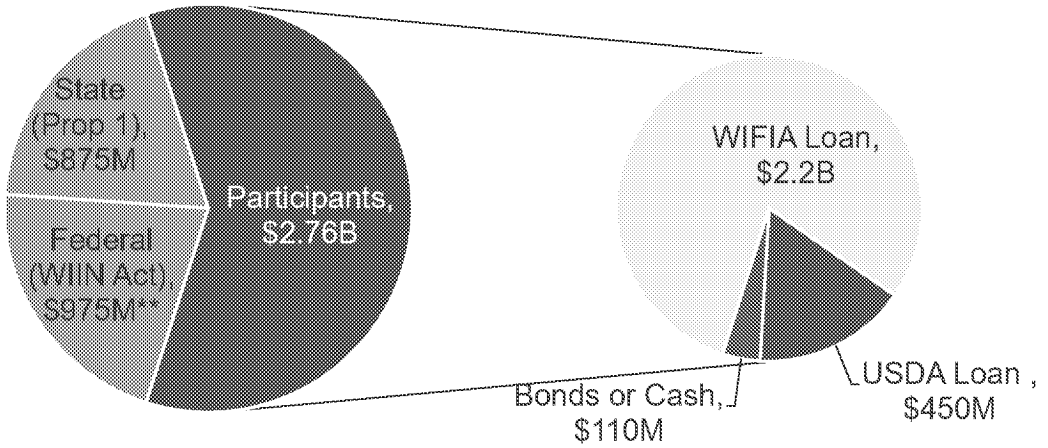
Sites

EIR Project Alternatives

Facilities / Operations	Alternative 1	Alternative 2	Alternative 3
Reservoir Size	1.5 MAF	1.3 MAF	1.5 MAF
Hydropower	Incidental upon release	Same as Alt 1	Same as Alt 1
Diversion Locations	Red Bluff Pumping Plant and Hamilton City	Same as Alt 1	Same as Alt 1
Conveyance Release / Dunnigan Release	1,000 cubic feet per second (cfs) into new Dunnigan Pipeline to Colusa Basin Drain	1,000 cfs into new Dunnigan Pipeline to Sacramento River. Partial release into the Colusa Basin Drain	Same as Alt 1
Reclamation Involvement	1. Funding Partner of 7% 2. Operational Exchanges a. Within Year Exchanges b. Real-time Exchanges	Operational Exchanges a. Within Year Exchanges b. Real-time Exchanges	Same as Alt 1, but up to 25% storage allocation
DWR Involvement	Operational Exchanges with Oroville and use of SWP facilities South-of-Delta	Same as Alt 1	Same as Alt 1
Route to West Side of Reservoir	Bridge across reservoir	Paved road around southern end of reservoir	Same as Alt 1

Sites is a WIIN State-Led Project under the Sites Project Authority

100% of local financing for the project is secured.



Sites

State Investment Provides Badly Needed Environmental Benefits

Sites Reservoir provides water dedicated to environmental use

Approximately 20% of the **Sites Reservoir Project's annual water supplies will be dedicated to ecosystem "public" benefits:**

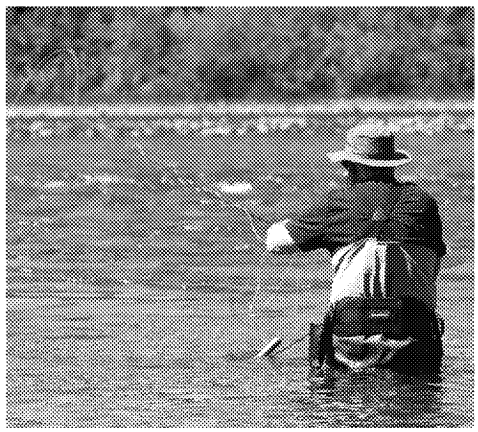
State Prop 1

- Provide a **reliable supply of refuge water** to improve **Pacific Flyway** habitat for **migratory birds** and other **native species**
- Improve **water flows in the Delta** to help improve conditions for the **Delta Smelt**

Federal WIIN/BIL

- **Preserve cold-water** pool for later use during dry years in summer months to support **salmon development, spawning and rearing**

Water and Storage Space dedicated for the environment - Sites Reservoir creates a water asset for the state that **does not currently exist.**



Sites

Environmental & Regulatory Considerations

- **Water Rights Protections** – Withdrawing from the River only during excess conditions, when **all senior water rights and Delta flows/water quality conditions are met**
- **Multi Barrier Intake Protections** – Limited withdrawal periods, diverting while certain **bypass flow conditions exist**, River pulse protections, all diversions through **state-of-the-art fish screens**
- **Water Quality and Delta Flows Protected** – **Returning additional water** to the River/Delta during dry periods of dry years, water quality continuously monitored
- **Future Water Availability Analyzed** – **Evaluating multiple scenarios** under differing Bay Delta and climate conditions; all find sufficient water being available to support the project
- **Terrestrial Effects Fully Mitigated** – Project relying heavily on **existing infrastructure, limiting construction impacts**, opportunities for environmental enhancements with mitigation

Sites

Mostly a Large Earthwork Project Because of the Heavy Dependence on Existing Pumping and Conveyance Features

Serving California's environment, families, and farms takes:

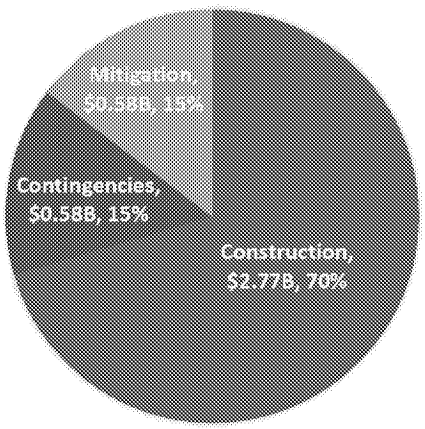
1.5 million acre-ft of storage

2 new large dams and several smaller saddle dams

11 miles of big pipes (9-12ft)

20 million cubic yards of fill

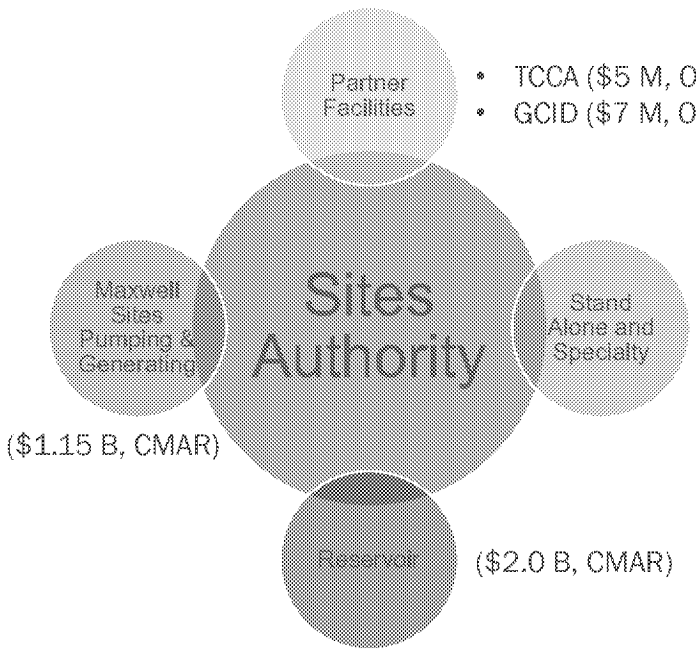
ESTIMATED PROJECT COSTS
($3.9B, 2021$)



Estimated construction costs are based on the class 4 cost estimate for Alternative 1 approved by the Reservoir Committee and Authority Board in June 2021

Sites

Authority's Current Contracting Strategy adopted July 2022 (costs in 2021$)



- TCCA ($5 M, Owner Agreements)
- GCID ($7 M, Owner Agreements)

($1.15 B, CMAR)

- Dunnigan Pipeline ($100 M, DBB)
- Huffmaster Road ($50 M, DBB)
- Reservoir Clearing ($35 M, DBB)
- Mitigation ($600 M, various)
- Recreation ($35 M, DBB or DBO)

($2.0 B, CMAR)

Sites

Project Costs and Affordability

Reservoir Size (MAF)	Alternative 3 (1.5 MAF)
Total Project Cost (2021$, billions)	$3.93
Annualized AF/year release (AFY)	250,000
Range of Annual Costs During Repayment With WIFIA Loans (2021$, $/AF)	~$760

F.O.B Origin

Sites

Looking Ahead - Sites Reservoir Near Term Project Schedule

Sites

Sites Reservoir Project

Work Plan Progress Reporting

#	Activity Name	Start	Finish
1	**What do we get?**	19-Apr-22 A	26-Sep-24
2	Final Operating Agreement - Sites/DWR/Reclamation	19-Apr-22 A	26-May-23
3	Submit Water Right Permit Application		11-May-22 A
4	Develop Participant Specific Model	10-Apr-23	21-Feb-24
5	Final EIR / EIS		05-May-23
6	CWA 404 / 401 - Submit Final Permit Applications		31-May-23
7	Receive CESA ITP - Operations		14-Jul-23
8	Receive CESA ITP - Construction		14-Jul-23
9	Operations Plan, Version 2	17-Jul-23	26-Mar-24
10	Federal ESA - Receive Biological Opinions		07-Aug-23
11	Water Right Permit Issued		26-Sep-24
12	**What does it cost?**	03-Jan-22 A	31-Dec-24
13	Geotech EA#5	03-Jan-22 A	28-Jul-22 A
14	Landowners Access Agreements for Geotech	22-Mar-22 A	30-May-24
15	Geotech Work Package #1	08-Sep-22 A	06-Feb-25
16	Geotech Work Package #2	30-Dec-22	03-Jul-23
17	Mitigation Cost Estimate Update	19-Feb-23	12-Apr-23
18	Geotech Work Package #3	20-Jun-23	22-Dec-23
19	Geotech Work Package #4	19-Dec-23	31-Dec-24
20	Land Cost Established		27-Jun-24
21	Project Unit Cost Update Complete		30-Jul-24
22	**How do we pay?**	01-Jul-22 A	25-Mar-24
23	Financing Check-In Q2-2022		01-Jul-22 A
24	WIFIA Loan Application	05-Jul-22 A	28-Mar-23
25	Financing Check-In Q3-2022		07-Oct-22 A
26	Financing Check-In Q4-2022		03-Jan-23
27	Submittal of Final WIFIA Application		25-Mar-25
28	WIFIA Loan Negotiation	30-Mar-23	25-Mar-24
29	Financing Check-In Q1-2023		03-Apr-23
30	Participants Ready for Finance		03-Jul-23
31	**Investor Commitment**	24-Oct-24	24-Oct-24
32	Investor Commitment		24-Oct-24*
33	**Construction**	19-Feb-25	19-Feb-25
34	Construction Groundbreaking	19-Feb-25	

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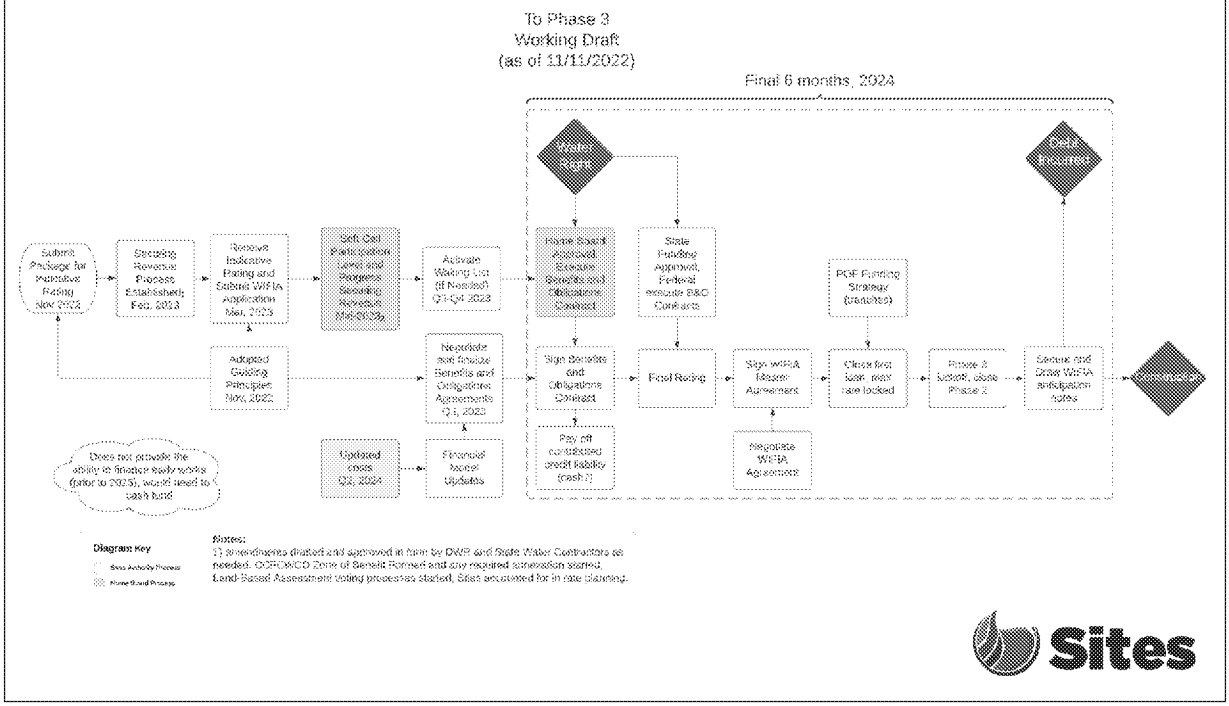
Data Date: 21-Nov-22 / Print Date: 10-Nov-22

Getting to Construction in 2 Years Requires Nailing Down Reclamation Investment Now



Sites

Key Elements of Three Party Ops Agreement Reclamation/DWR/Sites

Roles and Responsibilities/Operations Principles: Describes how the parties will coordinate to implement the Sites Reservoir Project in a way that is mutually beneficial while avoiding negative effects to the CVP, SWP, and Sites

Stored Water Exchanges: Either Reclamation uses its Sites storage or other Participants release their stored Sites water that allows modifying the timing, location, and/or quantity of releases from Shasta to provide additional anadromous fish benefits

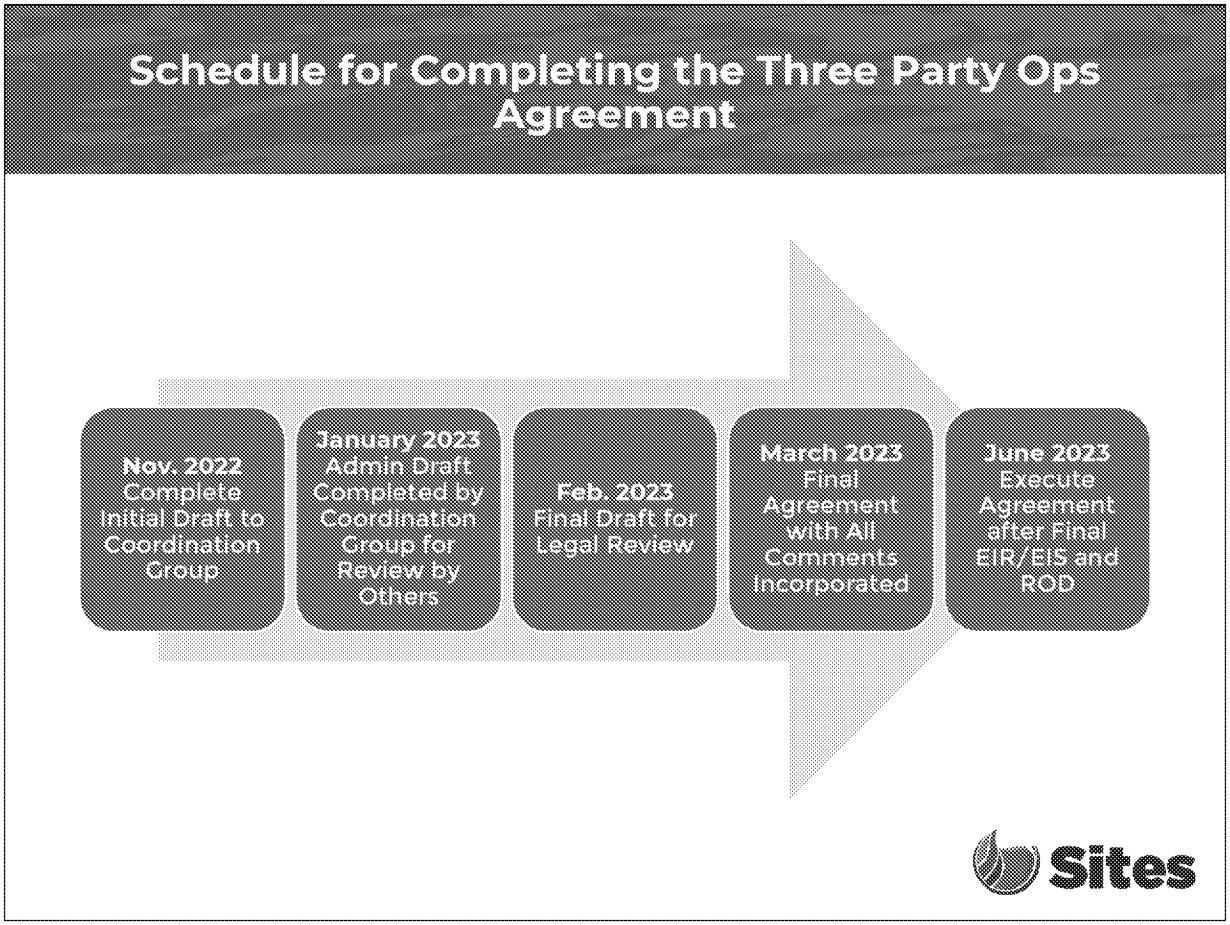
Diversions to Storage: Sites will not divert when the Delta is in a Balanced condition, and diversions will be closely coordinated with DWR and Reclamation to avoid negative effects to CVP, SWP, and Sites operations

Releases of Sites Water: Releases will also be coordinated to ensure facility capacity for movement of Sites Water to the Sacramento River, and as needed, rediversion of Sites Water to Participants

Conveyance of Site Water through Delta: The volume of water to be exported will be coordinated prior to July each year; carriage water will be required for Sites Water conveyed through the Delta

Sites

Angela – summarize the key elements of the Ops Agreement. We are trying to emphasize how Reclamation's CVP ops are not impacted.



Angela – show a bullet point milestone schedule with the agreement competing in March 2023 but not being signed until after the May EIR and after the ROD.

INFO@SITESPROJECT.ORG
SITESPROJECT.ORG
Sites

Hypothetical Participation Mix for Reclamation Increase to 16% (based on proportional reallocation of storage capacity)

Participant Name	2021 Participation Level	Estimated Storage Capacity (AF) 1.5 MAF Reservoir	% Local Participation	% Total Active Storage
Antelope Valley-East Kern WA	500	2,885	0.3%	0.2%
City of American Canyon	4,000	23,084	2.4%	1.6%
Coachella Valley WD	10,000	57,710	6.0%	4.0%
Colusa County	10,000	57,710	6.0%	4.0%
Colusa County WD	10,073	58,131	6.0%	4.0%
Cortina WD	450	2,597	0.3%	0.2%
Davis WD	2,000	11,542	1.2%	0.8%
Desert WA	6,500	37,511	3.9%	2.6%
Dunnigan WD	2,972	17,151	1.8%	1.2%
Glenn-Colusa ID	5,000	28,855	3.0%	2.0%
Irvine Ranch WD	1,000	5,771	0.6%	0.4%
LaGrande WD	1,000	5,771	0.6%	0.4%
Metropolitan Water District of SC	50,000	288,549	29.9%	20.0%
Reclamation District 108	4,000	23,084	2.4%	1.6%
Rosedale-Rio Bravo WD	500	2,885	0.3%	0.2%
San Bernardino Valley Municipal WD	21,400	123,499	12.8%	8.6%
San Gorgonio Pass WA	14,000	80,794	8.4%	5.6%
Santa Clara Valley WD	500	2,885	0.3%	0.2%
Santa Clarita Valley WA	5,000	28,855	3.0%	2.0%
Westside WD	5,375	31,019	3.2%	2.2%
Wheeler Ridge - Maricopa WSD	3,050	17,601	1.8%	1.2%
Zone 7 WA	10,000	57,710	6.0%	4.0%
State of California - Ecosystem Benefit*		244,000		16.9%
State of California - Recreation and Flood Control		0		0.0%
State of California - Total		244,000		16.9%
Reclamation**		230,400		16.0%
Subtotal	167,320	1,440,000	100%	100.0%

Dead Storage = 60 TAF

Sites

Angela – add the table showing storage/annual supply with Reclamation @ 16%. Everyone takes a haircut. Do not show storage conversation factor

From: Celina Horbat [chorbat@kearnswest.com]
Sent: 11/28/2022 7:30:25 PM
To: Rafael Silberblatt [rsilberblatt@kearnswest.com]
CC: Mark Tompkins [mtompkins@flowwest.com]; Noble Hendrix [noble@qedaconsulting.com]; Sadie Gill [sgill@flowwest.com]; Maddee Rubenson [mrubenson@flowwest.com]; Ann Marie Osterback - NOAA Affiliate [annmarie.osterback@noaa.gov]; Erin Cain [ecain@flowwest.com]; Alison L Collins [acollins@mwdh2o.com]; Brian Crawford [bcrawford@compassrm.com]; Gary Bobker [bobker@sbcglobal.net]; Natalie Stauffer-Olsen [Natalie.Stauffer-Olsen@tu.org]; Frances Brewster [FBrewster@valleywater.org]; Rene Henery [Rene.Henery@tu.org]; Bruce DiGennaro (bruce@essexpartnership.com) [bruce@essexpartnership.com]; sherri@cieaweb.org; Michelle Rivera [micheller.ciea@gmail.com]; Celina Horbat [chorbat@kearnswest.com]
Subject: REMINDER: Salmonid Recovery Forum December Workshop Series
Attachments: Central Valley Salmonid Recovery: Forum Workshop Day 1; R2R_Values_11-28-2022.xlsx; Values Memo from Storytelling Workshop_11.28.2022.pdf

Hello Everyone,

We're looking forward to connecting with you for the upcoming Salmonid Recovery: Forum Workshops starting this Thursday, December 1st.

This will be a great opportunity to learn about and provide feedback on the work we've undertaken since we last met in June and our plans for the work ahead, including:

- Day 1 (12/1, 10am-2pm)
  - Review the initial baseline scenario
  - Introduce the Science Integration Team (SIT) model and how it will be used in this effort
  - Preview SDM Working Group
  - Preview values
- Day 2 (12/6, 12-4pm)
  - Correlate value metrics with model inputs/outputs
- Day 3 (12/12, 11am-3pm)
  - Wrap up values exercise
  - Introduce the Winter Run Life Cycle Model (WRLCM)
  - Review model sensitivity
  - Next Steps

Attached, please find a spreadsheet containing the salmonid recovery related values we've collected thus far and a memo describing their refinement. I've also attached a calendar invite for the first workshop – please let me know if you have not received an invite to the other two workshops and/or if you have any questions.

Thank you and looking forward to meeting with you soon!

CeCe and the Salmonid Recovery Planning Team

Celina (CeCe) Horbat
Associate
Kearns & West
p: (415) 674-5572
w: www.kearnswest.com
Pronouns: she/her/they/them

File Provided Natively

Memo

Initial summary of values related to salmon recovery in the Central Valley

From: The Reorienting to Recovery Project Planning Team

Prepared by: Brian Crawford, Compass Resource Management

Date: November 28, 2022

In a nutshell:

- The Reorienting to Recovery Project has begun broad engagement of interested parties across the Central Valley and to solicit social, cultural, ecological, and economic values that could be affected by potential salmon recovery actions.
- We have collected >550 "value statements" from participants through online questionnaires and a remote Storytelling Workshop series in June 2022.
- We synthesized these statements into a smaller set of draft values that captured common themes.
- We identified 34 "decision values" that can be affected by different recovery scenarios (Table 1) and sorted these into five categories: (1) salmon (biological); (2) access to lands, (3) economics, (4) water, and (5) ecosystem values.
- Additionally, 15 "process values" can be affected by and shape the overall process (Table 2).
- The list of values can be reviewed by all interested parties and further discussed, revised, added to, and condensed as the Project progresses, and will ultimately help us evaluate, compare, and identify broadly supported salmon recovery scenarios.

1 Overview: The Reorienting to Recovery Project and values

The Reorienting to Recovery Project ("Project") was initiated in 2020 by members of the Collaborative Science and Adaptive Management Program (CSAMP), a consortium of State of California and federal resource management agencies, Public Water Agencies, and Non-Governmental Organizations. The Project's purpose is to develop an effective and implementable strategy for recovering listed and non-listed salmonids in California's Central Valley while balancing other social, ecological, and economic interests in the region.

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Phase 1 of the Project engaged scientists to develop a draft Salmon Recovery Definition Framework, which included measurable biological objectives for salmon recovery, quantitative metrics that can be used to track the degree objectives are being met, and targets or benchmarks that define the numerical values of desired future conditions.

Phase 2 (still in progress) seeks to broaden engagement with all interested parties in the Central Valley, solicit input on other ecological, social, cultural, and economic values/interests that relate to salmon recovery efforts, and solicit information/data needed to model consequences of recovery efforts across Central Valley watersheds.

Phase 3 will use a structured decision making (SDM) approach with interested parties and modelers across the Central Valley to collectively assess different combinations of management actions (referred to as draft recovery scenarios) and evaluate their effects on the set of salmon, ecological, social, cultural, and economic values identified in previous phases. The process will allow interested parties to discuss potential tradeoffs across these values and work towards identifying a broadly supported draft recovery strategy.

More information about the Reorienting to Recovery Project can be found on the project website, hosted by CSAMP.

2 Soliciting and synthesizing initial values related to salmon recovery

This memo provides an overview of values related to salmon recovery efforts shared by interested parties across the Central Valley to date in the Project. The Project Planning Team solicited people's values through two avenues: (1) a "Values Questionnaire" distributed broadly over email to interested parties, and (2) discussions at a Storytelling Workshop series on June 7, 8, and 16, 2022. A total of 106 people responded to the questionnaire, and 117 people from state and federal agencies, PWAs, NGOs, Tribes, and other interested parties attended at least one day of the workshop series. The workshop series had three key objectives:

1) Build understanding, trust, and buy-in to the Project that facilitates further engagement with interested parties across the Central Valley;
2) Share stories and perspectives related to salmon recovery to build understanding of shared and competing values (also known as interests or objectives in this process) among participants; and
3) Distill people's stories into ecological, social, cultural, and economic values and begin discussing translation of values into quantitative metrics for the purpose of evaluating various potential recovery actions.

Through the questionnaire and workshops, we collected and reviewed over 550 distinct value statements (see the accompanying Excel Workbook). Following the workshop, we synthesized these value statements into a smaller set of initial, draft, refined value statements that captured common themes represented in the original list. We highlight that there is unavoidable subjectivity in refining complex values, but multiple Project Planning Team members independently reviewed and categorized original value statements to strive for consistency in how they were being interpreted.

We sorted value statements into two broad categories at first: "decision values" and "process values." These concepts were discussed during the Storytelling Workshop. These are defined in the graphic below.

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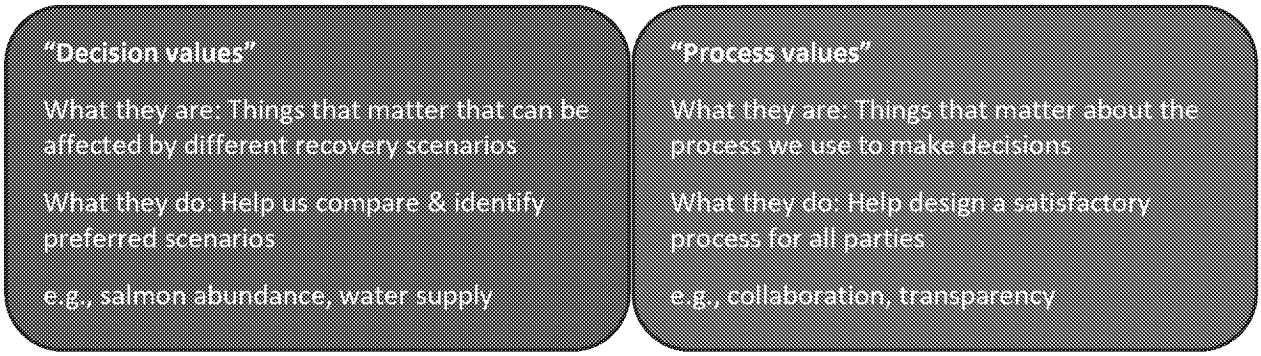

We sorted 34 initial ***decision values*** into five categories (Table 1): (1) Salmon (biological) values that were developed in Phase 1 with additional salmon-based values proposed after Phase 1; (2) access to lands and waters for engagement with salmon and the environment, (3) economics (e.g., jobs, agriculture production, power generation), (4) water (e.g., supply volume and reliability), and (5) ecosystem values (e.g., river structure and function, flood risk). Additionally, we identified at least 15 ***process values*** that represent distinct themes heard in the set of original value statements (Table 2). We include one or more representative statements (taken from the original list of value statements) for each refined value in Table 1 and 2 to provide more detailed examples of the value and track how original statements were interpreted.

It is impossible to capture all people's values that could be impacted by salmon recovery efforts, and we heard many value statements that were more vague or difficult to categorize but nonetheless important. Examples of these statements include, "time spent in nature," "health for people," "sharing salmon with kids," "psychological benefits of nature and salmon," "connection to place," "concern about setting unachievable goals that will set us up for failure," and "feelings of alarm, urgency." Again, see the accompanying Excel Workbook for a complete list of original value statements received.

However, this synthesized list of values likely captures many key interests that can be used as a starting point when evaluating and comparing salmon recovery scenarios. Next steps in the Project will:

a) Use this preliminary list of values to develop quantitative metrics (e.g., based on the number and distribution of salmon) that can be predicted for an initial set of recovery scenarios, which will be coordinated by the Project Team, salmon modelers, and an independent Science Advisory Team,
b) Work with all interested parties to review these predicted outcomes and discuss tradeoffs across the preliminary set of values and scenarios – highlighting any additional values that are important but missing, can be measured, and can help differentiate between scenarios,
c) Revise, add to, and condense the list of values based on preferences and insights that emerge; develop and refine quantitative metrics; and predict outcomes for another set of recovery scenarios,
d) Repeat rounds of discussion with all interested parties, refinement of values and recovery scenarios, and evaluation of those scenarios by salmon modelers and an independent Science Team.

We would like to thank all who have participated in the Project so far, and we look forward to any and all feedback.

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Disclaimer: This memo describes initial statements of people's values across the Central Valley that were shared through the Values Questionnaire and the Storytelling Workshop series in the Reorienting to Recovery Project. Project participants will discuss and refine these values and their groupings as the Project progresses.

Table 1. Initial draft *decision values* expressed so far in the Reorienting to Recovery Project that could be affected by different salmon recovery actions. Decision values are grouped into general categories (light blue rows) to aid interpretation.

Decision value	Representative statement(s) from participants
Salmon (biological)	
Abundance and spatial structure	Abundance sufficient to support viable populations that result in low extinction risk, abundant natural origin spawners, a full range of ecological roles; Representation and redundancy of populations across the Central Valley sufficient to support local adaptation, minimize risk of extinction from catastrophes, and support natural levels of connectivity between populations
Abundance and spatial structure equivalent to historic reference	Traditional/historic geographic range of salmon distribution
Abundance, productivity, and distribution at levels that support ecosystem health	Ecosystem benefits – salmon provide nutrients across the food web
Biological recovery objectives met by certain time	Productivity sufficient to support viability (as defined by VSP guidelines) and broad-sense recovery; Recovery and preserve life history diversity, including achieving diversity in habitat use, migration and spawning timing, and age distribution of spawning adults
Harvest – Indigenous/cultural	Maintaining and preserving indigenous culture around salmon, including use of salmon as food
Harvest – Recreational	Increased recreational opportunities for fishing and sharing this with my children, connecting with nature
Harvest – Commercial	The ability to support sustainable long-term commercial (and recreational) harvest levels that are both ecologically sound and economically viable for the fishing industry
Hatchery production	Meeting annual salmonid escapement targets and hatchery egg take goals
Access to land and water	
Land/water access – Indigenous/cultural	Maintaining and preserving indigenous culture around salmon, including increasing access and rights to lands/rivers
Land/water access – Recreational	Recreation in watersheds with salmon; being able to experience the outdoors and the water
Land/water access – Commercial	Increased fisheries benefits, i.e., opportunities and regions to fish for salmon, increased season lengths, increased harvest quotas
Non-salmon wilderness	Concerned about constraints on access to wild places

Decision value	Representative statement(s) from participants
Economic	
Maintain or increase value of salmon	Concerned that salmon recovery may lead to short term reduction in consumption
Salmon-related jobs	More people employed in salmon related jobs
Water cost	Concerned about the increased cost of water and economic cascade
Food cost	Concerned that water management may reduce yields leading to higher ag prices
Relative cost in the context of limited resources	Concerned about the cost and opportunity cost of salmon recovery (i.e., less money available for other things I value)
Agriculture – irrigation diversion sustainability	Allow irrigated ag to continue to produce food in the Valley
Agriculture – farm-associated professions	Concerned about reduced farming
Power generation ability	Concerned that salmon recovery may impact the economical and environmentally-sound generation of power and delivery of water
Regulatory extent and compliance	Concerned that salmon recovery may curtail hatchery operations leading to mitigation requirements that are difficult to achieve (which might in turn necessitate re-negotiating/re-writing licenses, agreements and permits)
Water	
Supply and delivery – agriculture	Concerned about reducing water supply to farms that grow the food my family eats
Human use	Livable water supply
Non-salmon-oriented recreation	Impacts to recreational waterfowl hunting; recreational opportunities including fishing, boating, and hiking
Environmental water reliability	Better reliability of water for salmon; Improved habitat quality and connectivity
Water rights	Maintenance of water rights through recovery of fisheries
Groundwater sustainability	Concerned about significant water supply from irrigation diverters to groundwater pumping will have a negative impact on groundwater sustainability
Managed wetlands	Concerned about impacts to managed wetlands throughout the valley
Land/ecosystem	
Food production and availability	Allow irrigated ag to continue to produce food in the Valley
Flood risk and safety	Concerned that removing dams could potentially cause increased flooding
Condition and maintenance of existing property and natural landscape features	Integrating urban framework of human communities with natural processes, ecosystems, and species

Decision value	Representative statement(s) from participants
Infrastructure and operations costs	Minimizing interventions and regulations that come at the expense of water project operation flexibility
Preservation of natural habitats	Healthier, complex and dynamic freshwater, estuarine and ocean environments and riparian areas; improved habitat quality
Riverine structure and physical and ecological processes	Increased water quality, flow; freedom of rivers, integrity of waterways

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Table 2. Initial draft *process values* expressed so far in the Reorienting to Recovery Project that relate to things that matter about the overall process and inform the design of a satisfactory process.

Process value	Representative statement(s) from participants
Bookends (best- and worst-case scenario) development	What does the best-case scenario related to abundance look like?
Lessons/ learnings from other places, systems	Borrowing/leveraging/sharing information from other systems outside the Central Valley
Coordinated, integrated planning, funding, and implementation	Concerned that planning be coordinated across efforts
Optimism, hope, vision, imagination, novelty, experimentation, risk	Openness to environmental recovery, new ideas/new modes, making progress; need for collective creativity and hopeful mindset
Time spent in nature	Time spent in wilderness is important to frame our paradigm for sustainability
Science and structured approach (transparency, clear objectives, testable hypotheses, performance indicators, measuring success)	Improved scientific understanding and information to inform rational policy
Climate change consideration and integration	Need to recognize climate change
Indigenous knowledge and wisdom	The value/elevation of situated, place-based knowledge
Other processes and plans proceeding unencumbered	Concerned that the Reorienting to Recovery project may be slow and thereby delay implementation of the Bay Delta Plan
Salmon education (ecological, cultural, connectivity, indicator) including place-based and experiential	Educational opportunities for children; raising public awareness and need for recovery
Equitable, inclusive orientation and process - Tribal Inclusion and engagement	Concerned that Tribal communities be engaged in this process; Community and collaboration to work together towards common goals
Potential for success	Concerned about setting overly ambitious objectives given the factors beyond our control (e.g., drought years, ocean conditions, factors outside our geographic region of concern)
Equitable, inclusive orientation and process including honesty, transparency, care, orientation	Speaking to each other's interests; Valuing different perspectives
Equitable, inclusive orientation and process - cost, responsibility, scale	Concerned about equitably assigning financial and regulatory responsibility
Scientific integrity	Science as an important tool for understanding and supporting the process; use of best available science that is not misrepresented to promote a particular set of values

Draft_0020938

From: Sandra Yarbrough [syarbrough@sitesproject.org]
Sent: 11/29/2022 7:21:23 AM
To: Marcia Kivett [MKivett@sitesproject.org]

I received an email asking for EIR/EIS info for a college student. Do you want me to forward it to you or discuss it when we meet today? My first thought was Ali or Cheyanne but I thought I better check with you to see how I should approach it for PRR.

From: Sandra Yarbrough [syarbrough@sitesproject.org]
Sent: 11/29/2022 8:30:19 AM
To: Marcia Kivett [MKivett@sitesproject.org]

We would also love to know if a Statement of Overriding Considerations (SOOC) has been prepared for the Sites, or if there is a plan to do so. The California Water Commission had recommended that the Sites prepare such a statement as the lead agency under CEQA, to overcome wildlife protection and water quality regulations. This recommendation was mentioned in a December 2021 CWC continuing eligibility and feasibility determination document, and we would like to know if the Sites have taken action regarding this recommendation.

From: Sandra Yarbrough [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=1D27A6F32C7E4F5683D274124179A7A3-SYARBROUGH]
Sent: 11/29/2022 11:41:45 AM
To: laurie.warner.herson [laurie.warner.herson@phenixenv.com]
CC: Lori Jones [ljones@brwncald.com]
Subject: FW: Press Inquiries

Sorry I sent this to the wrong Laurie. Lori, you can disregard it. Laurie, I meant for you to be included in this email.

Thank You,
Sandra

From: Sandra Yarbrough
Sent: Tuesday, November 29, 2022 8:47 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Lori Jones <ljones@brwncald.com>; Cheyanne Harris <charris@brwncald.com>
Cc: Joe Trapasso <jtrapasso@sitesproject.org>; Jerry Brown <jbrown@sitesproject.org>
Subject: FW: Press Inquiries

Good morning,

Please see the email below that I received. I know we can send the link to the EIR/EIS from our website, but I wasn't sure about the last paragraph.

Thank You,
Sandra

From: Katherine Li <katherine_li@berkeley.edu>
Sent: Monday, November 28, 2022 8:00 AM
To: Board Clerk <boardclerk@sitesproject.org>
Cc: Hanisha Harjani <hharjani@berkeley.edu>
Subject: Press Inquiries

Dear Sites Authority Board,

Hello, my name is Katherine Li, and I'm a journalism graduate student at UC Berkeley. We are currently working on a research project regarding water sustainability and droughts in Northern California.

We are aware that the Sites Reservoir has been on the drawing board for decades, and that multiple state and federal agencies, especially the USEPA, CDFW, and CWC, are responsible for making comments and recommendations on your most recent 2020 draft and 2021 revised draft environmental impact report (EIS/EIR). We would like to ask if there is one place where we could view these recommendation documents, or if you know where to find them. Some of the recommendation and comment documents we have located are regarding the original EIR from back in 2018, but plenty has changed regarding the size and design of your project since then. It would be great if you could show us these new documents so we could have the most accurate and updated information.

We would also love to know if a Statement of Overriding Considerations (SOOC) has been prepared for the Sites, or if there is a plan to do so. The California Water Commission had recommended that the Sites prepare such a statement as the lead agency under CEQA, to overcome wildlife protection and water quality regulations. This recommendation was

mentioned in a December 2021 CWC continuing eligibility and feasibility determination document, and we would like to know if the Sites have taken action regarding this recommendation.

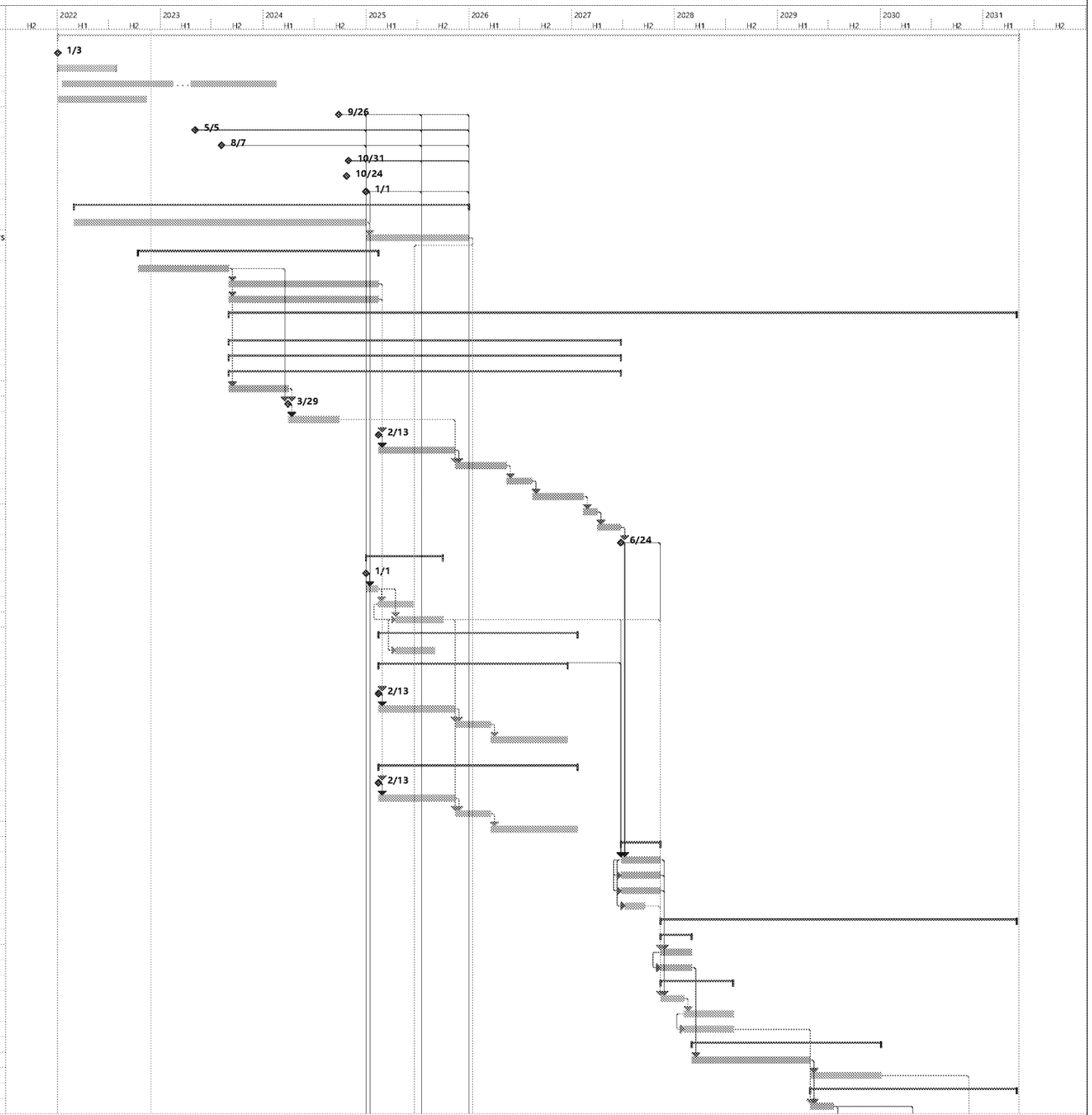
Thank you so much!

Regards,
Katherine Li

Katherine Li (she/her)
UC Berkeley Graduate School of Journalism
(510) 365 6496
https://twitter.com/Katherineli

Sites Reservoir
Preliminary Construction Schedule
Maxwell - Sites Pumping and Generating (MSPG) Facilities
November 2022

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Successors
0		**Maxwell Sites Pumping and Generating Facilities CP2**	**2439 days**	**Mon 1/3/22**	**Thu 5/8/31**		
1		Start Task Order 3 - Preliminary Engineering	0 days	Mon 1/3/22	Mon 1/3/22		
2		Determine Construction Packaging & Delivery Methods	149 days	Mon 1/3/22	Thu 7/28/22		
3		Real Estate Team Gain Access for Surveying & Geotech Investiga	500 days	Mon 1/17/22	Fri 2/16/24		
4		Topographic Survey and Mapping	225 days	Mon 1/3/22	Fri 11/11/22		
5		Water Rights Permit Issued	0 days	Thu 9/26/24	Thu 9/26/24		114,178,224,129,160,206,236
6		Final EIR / EIS	0 days	Fri 5/5/23	Fri 5/5/23		114,178,224,129,160,206,236
7		ROD Signed	0 days	Mon 8/7/23	Mon 8/7/23		114,178,224,129,160,206,236
8		WIFEA EPA Loan Closed	0 days	Thu 10/31/24	Thu 10/31/24		114,178,224,129,160,206,236
9		Investor Commitment	0 days	Thu 10/24/24	Thu 10/24/24		
10		NTP for 60% Design Activities	0 days	Wed 1/1/25	Wed 1/1/25		114,144,178,191,224,129,160,206,236
11		**Geotech Investigations MSPG Investigations**	**1002 days**	**Tue 3/1/22**	**Wed 12/31/25**		
12		Phase 1 Geotech investigation for Preliminary (30%) Design	741 days	Tue 3/1/22	Tue 12/31/24		13
13		Phase 2 Geotech Investigation for All MSPG Design	261 days	Wed 1/1/25	Wed 12/31/25	12	191,129,160FS-120 days,144,206FS-120 days
14		**Sites Reservoir Geotechnical Investigations**	**610 days**	**Fri 10/14/22**	**Thu 2/13/25**		
15		P1 Geotech Investigation (30% Cutoff)	230 days	Fri 10/14/22	Thu 8/31/23		16,17,22,23
16		P2a Geotech Investigation (Dam Foundations & Grouting)(an	76 wks	Fri 9/1/23	Thu 2/13/25	15	25
17		P2a Geotech Investigation (Roads)	76 wks	Fri 9/1/23	Thu 2/13/25	15	41,46
18		**CONSTRUCTION PACKAGE #1 - RESERVOIR FACILITIES (Rev 7 10-25-22)**	**1999 days**	**Fri 9/1/23**	**Wed 4/30/31**		
19		**Engineering - Dams**	**995 days**	**Fri 9/1/23**	**Thu 6/24/27**		
20		**Inlet-Outlet Design**	**995 days**	**Fri 9/1/23**	**Thu 6/24/27**		
21		**Inlet-Outlet Design (CP#2 - MSPG)**	**995 days**	**Fri 9/1/23**	**Thu 6/24/27**		
22		Inlet-Outlet 30% Design	151 days	Fri 9/1/23	Fri 3/29/24	15	23
23		Inlet-Outlet Package Submittal	0 days	Fri 3/29/24	Fri 3/29/24	22,15	24
24		DSOD Review of Inlet-Outlet 30% Design	26 wks	Mon 4/1/24	Fri 9/27/24	23	27
25		Inlet-Outlet Geotech Data	0 days	Thu 2/13/25	Thu 2/13/25	16	26
26		Inlet-Outlet 60% Design	39 wks	Fri 2/14/25	Thu 11/13/25	25	27
27		DSOD Review of Inlet-Outlet 60% Design	26 wks	Fri 11/14/25	Thu 5/14/26	24,26	28
28		Inlet-Outlet 90% Design	13 wks	Fri 5/15/26	Thu 8/13/26	27	29
29		DSOD Review of Inlet-Outlet 90% Design	26 wks	Fri 8/14/26	Thu 2/11/27	28	30
30		Inlet-Outlet 100% Design	7 wks	Fri 2/12/27	Thu 4/1/27	29	31
31		DSOD Review of Inlet-Outlet 100% Design Package	12 wks	Fri 4/2/27	Thu 6/24/27	30	32
32		Inlet-Outlet DSOD Approval Received	0 days	Thu 6/24/27	Thu 6/24/27	31	57,51,60
33		**CMAR Procurement**	**195 days**	**Wed 1/1/25**	**Tue 9/30/25**		
34		Award CMAR Contract	0 days	Wed 1/1/25	Wed 1/1/25		35
35		Notice to Proceed	6 wks	Wed 1/1/25	Tue 2/11/25	34	37,36
36		Early Submittals And Approvals - Dams and I/O	90 days	Wed 2/12/25	Tue 6/17/25	35	37SS+45 days
37		CMAR Mobilization	6 mons	Wed 4/16/25	Tue 9/30/25	35,36SS+45 days	43,39SS,48,57,51,60
38		**Roads, Bridges, Access, and Site Development**	**505 days**	**Thu 2/13/25**	**Thu 1/21/27**		
39		Early Site Access and Staging Development	100 days	Wed 4/16/25	Tue 9/2/25	37SS	
40		**Southern Construction Access Roads (Maxwell-Sites, Shoo-fly, A-1)**	**480 days**	**Thu 2/13/25**	**Thu 12/17/26**		**51**
41		Geotechnical Data	0 days	Thu 2/13/25	Thu 2/13/25	17	42
42		Final Design	39 wks	Fri 2/14/25	Thu 11/13/25	41	43
43		Procurement and NTP	90 days	Fri 11/14/25	Thu 3/19/26	37,42	44
44		Southern Construction Access Roads (Maxwell-Sites, Shoo-fly, A-1)	195 days	Fri 3/20/26	Thu 12/17/26	43	
45		**Ancillary Roads B1, B2, C1, C2, Comm N., Comm South**	**505 days**	**Thu 2/13/25**	**Thu 1/21/27**		
46		Geotechnical Data	0 days	Thu 2/13/25	Thu 2/13/25	17	47
47		Final Design	39 wks	Fri 2/14/25	Thu 11/13/25	46	48
48		Procurement and NTP	90 days	Fri 11/14/25	Thu 3/19/26	37,47	49
49		Ancillary Roads B1, B2, C1, C2, Comm N., Comm South	220 days	Fri 3/20/26	Thu 1/21/27	48	
50		**Inlet-Outlet Preliminary Work (CP#2 - MSPG)**	**100 days**	**Fri 6/25/27**	**Thu 11/11/27**		
51		Inlet-Outlet Access and Staging	100 days	Fri 6/25/27	Thu 11/11/27	32,37,40	52SS,54SS+10 days,53SS,57,60
52		Erosion and Sediment Control	100 days	Fri 6/25/27	Thu 11/11/27	51SS	57
53		Clearing / Grubbing Topsoil Salvage from Work Areas	100 days	Fri 6/25/27	Thu 11/11/27	51SS	57
54		Demolition	50 days	Fri 7/9/27	Thu 9/16/27	51SS+10 days	57
55		**Inlet Outlet Facilities (CP#2 - MSPG)**	**904 days**	**Fri 11/12/27**	**Wed 4/30/31**		
56		**Develop Downstream Portal**	**80 days**	**Fri 11/12/27**	**Thu 3/2/28**		
57		Downstream Portal Excavation	80 days	Fri 11/12/27	Thu 3/2/28	32,37,51,52,53,54	58SS
58		Downstream Portal Rock Bolting	80 days	Fri 11/12/27	Thu 3/2/28	57SS	64
59		**Develop Upstream Portal**	**185 days**	**Fri 11/12/27**	**Thu 7/27/28**		
60		Intake Channel Excavation	60 days	Fri 11/12/27	Thu 2/3/28	32,37,51	61
61		Upstream Portal Excavation	125 days	Fri 2/4/28	Thu 7/27/28	60	62SS
62		Upstream Portal Rock Bolting	125 days	Fri 2/4/28	Thu 7/27/28	61SS	67
63		**Tunnels Excavation and Lining (Double Shift)**	**480 days**	**Fri 3/3/28**	**Thu 1/3/30**		
64		Tunnel Excavation - Double Shift	300 days	Fri 3/3/28	Thu 4/26/29	58	65,67
65		Tunnel Lining	180 days	Fri 4/27/29	Thu 1/3/30	64	71
66		**Intake and Outlet Structures**	**524 days**	**Fri 4/27/29**	**Wed 4/30/31**		
67		Intake Structure Foundation	60 days	Fri 4/27/29	Thu 7/19/29	62,64	68,69



Project: Maxwell Sites Pumping
Date: Tue 11/29/22

Task · Split · Milestone · Summary · Project Summary · Inactive Task · Inactive Milestone · Inactive Summary · Manual Task · Duration-only · Manual Summary Rollup · Manual Summary · Start-only · Finish-only · External Tasks · External Milestone · Deadline · Critical · Critical Split · Progress · Manual Progress

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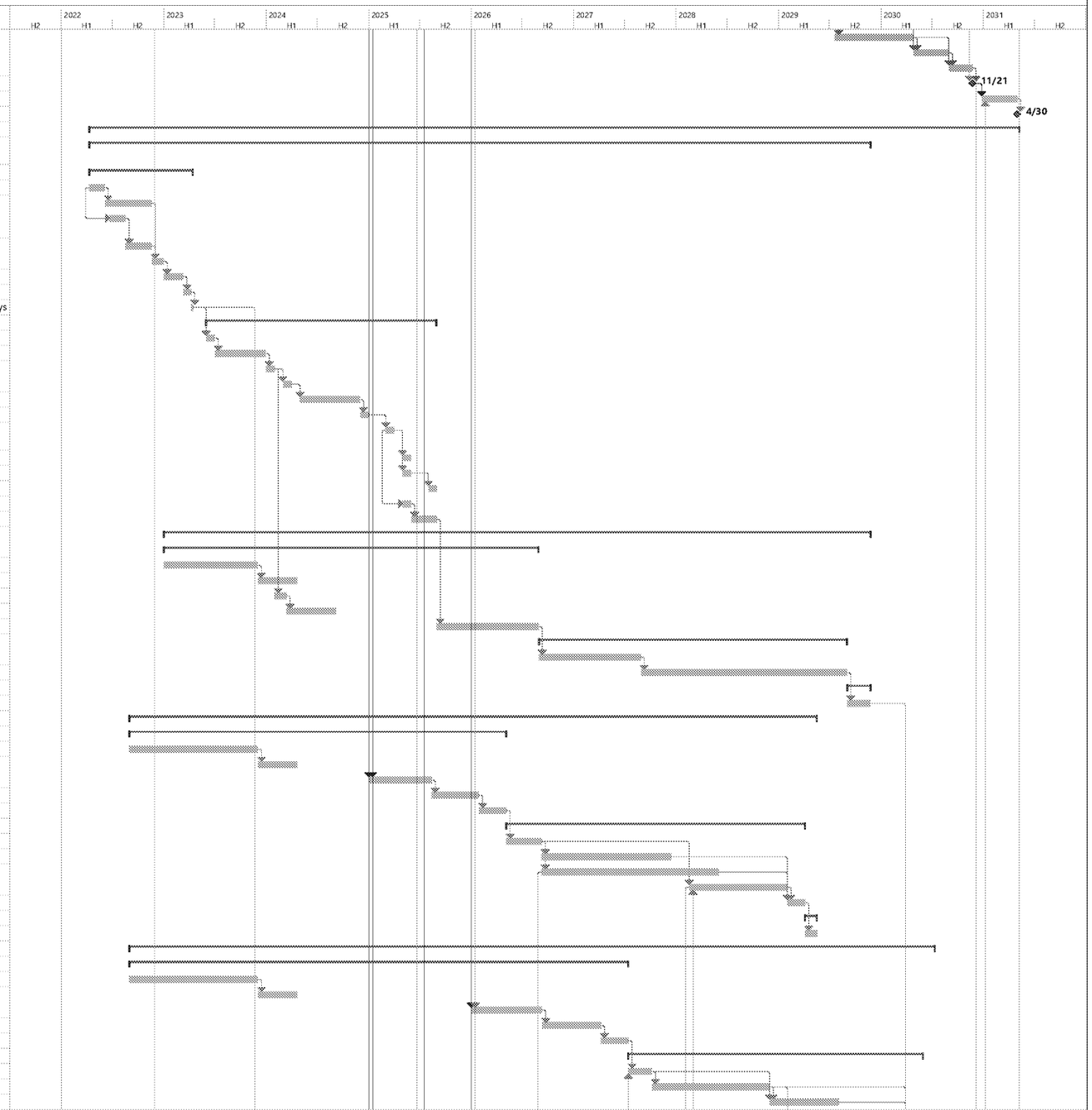
Sites Reservoir
Preliminary Construction Schedule
Maxwell - Sites Pumping and Generating (MSPG) Facilities
November 2022

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Successors
68		Intake Structure Concrete	200 days	Fri 7/20/29	Thu 4/25/30	67	70,69
69		Intake Structure Gates and Mechanical	90 days	Fri 4/26/30	Thu 8/29/30	67,68	70
70		I/O Completion and Restoration	60 days	Fri 8/30/30	Thu 11/21/30	68,69	71,153
71		Inlet-Outlet Ready for Commissioning	0 days	Thu 11/21/30	Thu 11/21/30	65,70	72
72		Inlet-Outlet Startup and Commissioning	90 days	Thu 12/26/30	Wed 4/30/31	71,186	73
73		Inlet-Outlet Completion	0 days	Wed 4/30/31	Wed 4/30/31	72	
74		**CONSTRUCTION PACKAGE #2 - MSPG FACILITIES**	**2369 days**	**Mon 4/11/22**	**Thu 5/8/31**		
75		**POWER INTERCONNECTION (CAISO / PG&E DESIGN AND CONSTRUCTION)**	**1990 days**	**Mon 4/11/22**	**Fri 11/23/29**		
76		**Prepare & Submit CAISO Package**	**265 days**	**Mon 4/11/22**	**Fri 4/14/23**		
77		Prepare Pump/Motor Package for Vendors to obtain Dat	40 days	Mon 4/11/22	Fri 6/3/22		78,79SS
78		Pump Vendors Prepare & Send Data	120 days	Mon 6/6/22	Fri 11/18/22	77	81
79		Prepare Hydropower Generator/Turbine Package for Vendors to Obtain Data	40 days	Wed 6/22/22	Tue 8/16/22	77SS	80
80		Generator/Turbine Vendors Prepare & Send Data	68 days	Wed 8/17/22	Fri 11/18/22	79	81
81		HC Engineering Team provide info to ZGlobal	30 days	Mon 11/21/22	Fri 12/30/22	78,80	82
82		ZGlobal run models and prepare CAISO package	50 days	Mon 1/2/23	Fri 3/10/23	81	83
83		Sites Review CAISO Package & Approve	20 days	Mon 3/13/23	Fri 4/7/23	82	84
84		ZGlobal Submit CAISO Package	5 days	Mon 4/10/23	Fri 4/14/23	83	86FS+33 days,222FF+30 days,176FF+30 days
85		**Respond to CAISO**	**587 days**	**Thu 6/1/23**	**Fri 8/29/25**		
86		Scoping Meeting	22 days	Thu 6/1/23	Fri 6/30/23	84FS+33 days	87
87		Phase 1 Study	130 days	Mon 7/3/23	Fri 12/29/23	86	88
88		Phase 1 Results Meeting	22 days	Mon 1/1/24	Tue 1/30/24	87	89FS+22 days,102
89		First Finanical Security Posting	21 days	Fri 3/1/24	Fri 3/29/24	88FS+22 days	90FS+22 days
90		Phase II Study	153 days	Wed 5/1/24	Fri 11/29/24	89FS+22 days	91
91		Phase II Results Meeting	22 days	Mon 12/2/24	Tue 12/31/24	90	92FS+43 days
92		Transmission Plan Deliverability (Resource Adequacy Process)	21 days	Mon 3/3/25	Mon 3/31/25	91FS+43 days	93FS+22 days,94FS+22 days,96SS+43 days
93		Second Financial Security Posting	22 days	Thu 5/1/25	Fri 5/30/25	92FS+22 days	
94		Draft Impact Analysis Issues	22 days	Thu 5/1/25	Fri 5/30/25	92FS+22 days	95FS+44 days
95		Reassessment Results	21 days	Fri 8/1/25	Fri 8/29/25	94FS+44 days	
96		Receive Draft Interconnection Agreement from CAISO	22 days	Thu 5/1/25	Fri 5/30/25	92SS+43 days	97
97		Negotiate Interconnection Agreement	65 days	Mon 6/2/25	Fri 8/29/25	96	104
98		**PG&E Point of Interconnection Substation**	**1800 days**	**Mon 1/2/23**	**Fri 11/23/29**		
99		**Engineering**	**955 days**	**Mon 1/2/23**	**Fri 8/28/26**		
100		Preliminary Design 30% (by HC)	240 days	Mon 1/2/23	Fri 12/1/23		101
101		Class 3 Cost Estimate (by HC)	100 days	Mon 12/4/23	Fri 4/19/24	100	
102		Establish E&P Agreement with PG&E	30 days	Wed 1/31/24	Tue 3/12/24	88	103
103		Preliminary Design (30%)	125 days	Wed 3/13/24	Tue 9/3/24	102	
104		Final 60%, 90%, 100% Design - by PG&E	260 days	Mon 9/1/25	Fri 8/28/26	97	106
105		**Construction - by PG&E**	**785 days**	**Mon 8/31/26**	**Fri 8/31/29**		
106		Procure Equipment	260 days	Mon 8/31/26	Fri 8/27/27	104	107
107		Construction	525 days	Mon 8/30/27	Fri 8/31/29	106	109
108		**Commissioning**	**60 days**	**Mon 9/3/29**	**Fri 11/23/29**		
109		Commission	60 days	Mon 9/3/29	Fri 11/23/29	107	137
110		**Funks/TRR Pipelines (DSOD Jurisdictional)**	**1750 days**	**Thu 9/1/22**	**Wed 5/16/29**		
111		**Engineering**	**959 days**	**Thu 9/1/22**	**Tue 5/5/26**		
112		Preliminary (30%)	327 days	Thu 9/1/22	Fri 12/1/23		113
113		Class 3 Cost Estimate	100 days	Mon 12/4/23	Fri 4/19/24	112	
114		Final 60% Design	160 days	Wed 1/1/25	Tue 8/12/25	5,7,8,6,10	115
115		Final 90% Design	120 days	Wed 8/13/25	Tue 1/27/26	114	116
116		Final 100% Design	70 days	Wed 1/28/26	Tue 5/5/26	115	118
117		**Construction**	**761 days**	**Wed 5/6/26**	**Wed 4/4/29**		
118		Submittals	90 days	Wed 5/6/26	Tue 9/8/26	116	119,120,121
119		Structures	330 days	Wed 9/9/26	Tue 12/14/27	118	122
120		Pipelines	450 days	Wed 9/9/26	Tue 5/30/28	118	122,136SS+250 days
121		Pipelines in Reservoir	250 days	Thu 2/17/28	Wed 1/31/29	118,152	122,136SS+250 days
122		Testing	45 days	Thu 2/1/29	Wed 4/4/29	119,120,121	124
123		**Commissioning**	**30 days**	**Thu 4/5/29**	**Wed 5/16/29**		
124		Commission	30 days	Thu 4/5/29	Wed 5/16/29	122	
125		**Transmission Powerlines**	**2050 days**	**Thu 9/1/22**	**Wed 7/10/30**		
126		**Engineering**	**1270 days**	**Thu 9/1/22**	**Wed 7/14/27**		
127		Preliminary (30%)	327 days	Thu 9/1/22	Fri 12/1/23		128
128		Class 3 Cost Estimate	100 days	Mon 12/4/23	Fri 4/19/24	127	
129		Final 60% Design	180 days	Thu 1/1/26	Wed 9/9/26	13,5,7,8,6,10	130
130		Final 90% Design	150 days	Thu 9/10/26	Wed 4/7/27	129	131
131		Final 100% Design	70 days	Thu 4/8/27	Wed 7/14/27	130	133
132		**Construction**	**750 days**	**Thu 7/15/27**	**Wed 5/29/30**		
133		Submittals	60 days	Thu 7/15/27	Wed 10/6/27	131,162	134,135
134		Procurement	300 days	Thu 10/7/27	Wed 11/29/28	133	135,137,136
135		Towers/Powerlines to POI	175 days	Thu 11/30/28	Wed 8/1/29	133,134	137



Project: Maxwell Sites Pumping
Date: Tue 11/29/22

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Critical | Critical Split | Progress | Manual Progress

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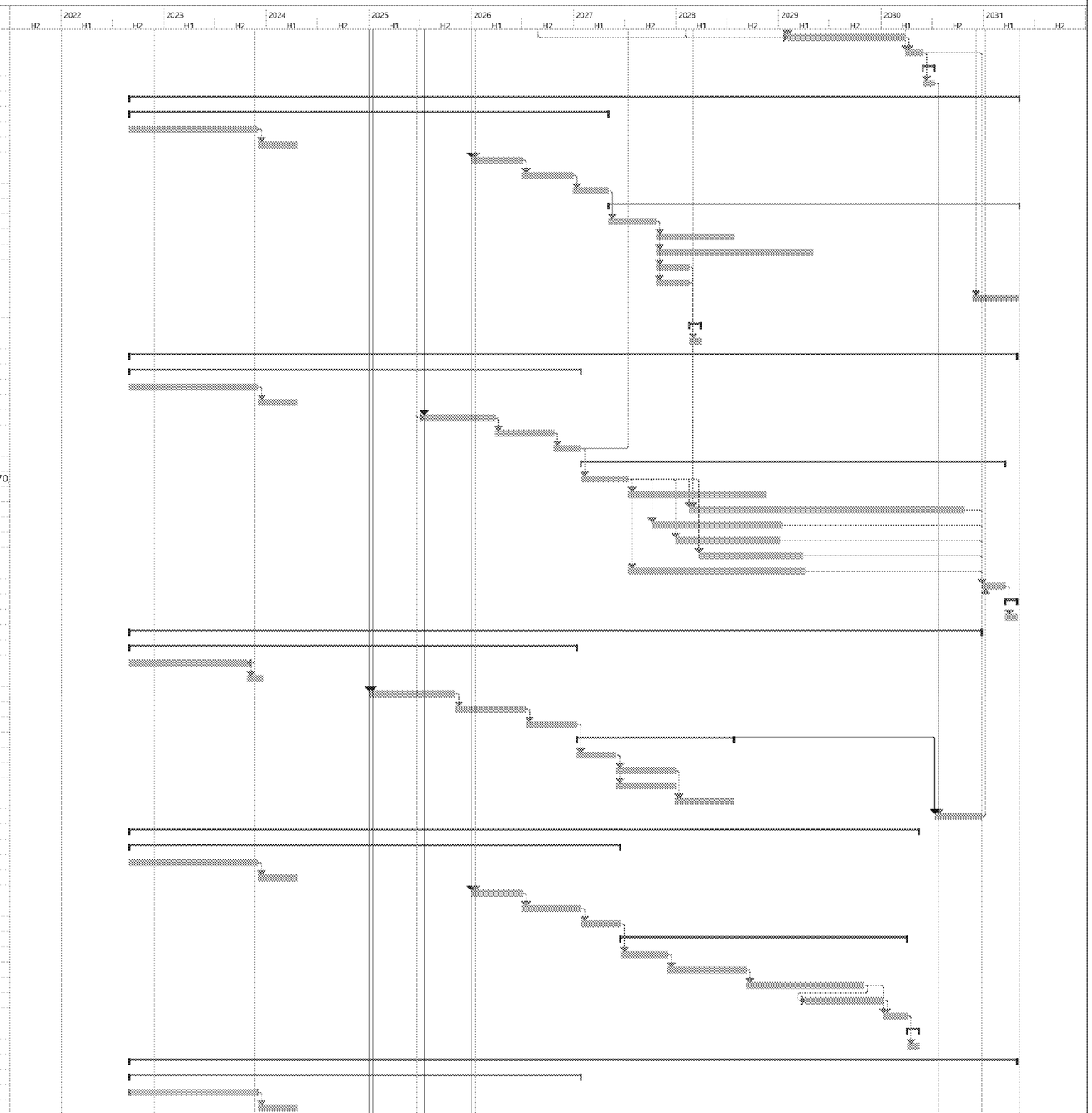
Sites Reservoir
Preliminary Construction Schedule
Maxwell - Sites Pumping and Generating (MSPG) Facilities
November 2022

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Successors
136		Towers/Powerlines Funks/TRR	300 days	Thu 2/1/29	Wed 3/27/30	120SS+250 days,134,121SS+250 da	137
137		Testing	45 days	Thu 3/28/30	Wed 5/29/30	134,135,136,109	139,217,171
138		**Commissioning**	**30 days**	**Thu 5/30/30**	**Wed 7/10/30**		
139		Commission	30 days	Thu 5/30/30	Wed 7/10/30	137	186,231
140		**Funks Reservoir**	**2266 days**	**Thu 9/1/22**	**Thu 5/8/31**		
141		**Engineering**	**1220 days**	**Thu 9/1/22**	**Wed 5/5/27**		
142		Preliminary Design (30%)	327 days	Thu 9/1/22	Fri 12/1/23		143
143		Class 3 Cost Estimate	100 days	Mon 12/4/23	Fri 4/19/24	142	
144		Final 60% Design	130 days	Thu 1/1/26	Wed 7/1/26	10,13	145
145		Final 90% Design	130 days	Thu 7/2/26	Wed 12/30/26	144	146
146		Final 100% Design	90 days	Thu 12/31/26	Wed 5/5/27	145	148
147		**Construction**	**1046 days**	**Thu 5/6/27**	**Thu 5/8/31**		
148		Submittals	120 days	Thu 5/6/27	Wed 10/20/27	146	149,150,151,152
149		Haulroads	200 days	Thu 10/21/27	Wed 7/26/28	148	
150		Initial Sediment Removal	400 days	Thu 10/21/27	Wed 5/2/29	148	
151		PGP Cofferdams (build)	85 days	Thu 10/21/27	Wed 2/16/28	148	166
152		Pipeline Cofferdams (build)	85 days	Thu 10/21/27	Wed 2/16/28	148	155,121
153		Final Sediment Removal (After I/O and Golden Gate Dam nearly complete)	120 days	Fri 11/22/30	Thu 5/8/31	70	
154		**Commissioning**	**30 days**	**Thu 2/17/28**	**Wed 3/29/28**		
155		Commission	30 days	Thu 2/17/28	Wed 3/29/28	152	
156		**Funks Pumping Generating Plant**	**2260 days**	**Thu 9/1/22**	**Wed 4/30/31**		
157		**Engineering**	**1150 days**	**Thu 9/1/22**	**Wed 1/27/27**		
158		Preliminary (30%)	327 days	Thu 9/1/22	Fri 12/1/23		159
159		Class 3 Cost Estimate	100 days	Mon 12/4/23	Fri 4/19/24	158	
160		Final 60% Design	180 days	Thu 7/17/25	Wed 3/25/26	13FS-120 days,5,7,8,6,10	161
161		Final 90% Design	150 days	Thu 3/26/26	Wed 10/21/26	160	162
162		Final 100% Design	70 days	Thu 10/22/26	Wed 1/27/27	161	133,164
163		**Construction**	**1080 days**	**Thu 1/28/27**	**Wed 3/19/31**		
164		Submittals	120 days	Thu 1/28/27	Wed 7/14/27	162	165,166,167FS+60 days,168FS+120 days,170
165		Large Equipment Procurement	350 days	Thu 7/15/27	Wed 11/15/28	164	
166		Pump Generating Plant Structure	700 days	Thu 2/17/28	Wed 10/23/30	164,151	171
167		Turbine Structure	330 days	Thu 10/7/27	Wed 1/10/29	164FS+60 days	171
168		Energy Dissipation Valve Structure	265 days	Thu 12/30/27	Wed 1/3/29	164FS+120 days	171
169		Electrical Building	265 days	Thu 3/23/28	Wed 3/28/29	164FS+180 days	171
170		Site Electrical and PGP Sitework	450 days	Thu 7/15/27	Wed 4/4/29	164	171
171		Testing	60 days	Thu 12/26/30	Wed 3/19/31	170,166,167,169,168,137,186	173
172		**Commissioning**	**30 days**	**Thu 3/20/31**	**Wed 4/30/31**		
173		Commission	30 days	Thu 3/20/31	Wed 4/30/31	171	
174		**Funks Substation**	**2170 days**	**Thu 9/1/22**	**Wed 12/25/30**		
175		**Engineering (Excludes PG&E]**	**1139 days**	**Thu 9/1/22**	**Tue 1/12/27**		
176		Design 30%	300 days	Thu 9/1/22	Wed 10/25/23	84FF+30 days	177
177		Class 3 Cost Estimate	40 days	Thu 10/26/23	Wed 12/20/23	176	
178		Final 60% Design	220 days	Wed 1/1/25	Tue 11/4/25	10,5,6,7,8	179
179		Final 90% Design	180 days	Wed 11/5/25	Tue 7/14/26	178	180
180		Final 100% Design	130 days	Wed 7/15/26	Tue 1/12/27	179	182
181		**Construction**	**400 days**	**Wed 1/13/27**	**Tue 7/25/28**		**186**
182		Submittals	100 days	Wed 1/13/27	Tue 6/1/27	180	184,183
183		Earthwork/Pad Prep	150 days	Wed 6/2/27	Tue 12/28/27	182	185
184		Large Equipment Procurement	150 days	Wed 6/2/27	Tue 12/28/27	182	
185		Breaker Substation	150 days	Wed 12/29/27	Tue 7/25/28	183	
186		Commissioning	120 days	Thu 7/11/30	Wed 12/25/30	181,139	171,72
187		**TRR West Reservoir**	**2010 days**	**Thu 9/1/22**	**Wed 5/15/30**		
188		**Engineering**	**1250 days**	**Thu 9/1/22**	**Wed 6/16/27**		
189		Preliminary (30%)	327 days	Thu 9/1/22	Fri 12/1/23		190
190		Class 3 Cost Estimate	100 days	Mon 12/4/23	Fri 4/19/24	189	
191		Final 60% Design	130 days	Thu 1/1/26	Wed 7/1/26	13,10	192
192		Final 90% Design	150 days	Thu 7/2/26	Wed 1/27/27	191	193
193		Final 100% Design	100 days	Thu 1/28/27	Wed 6/16/27	192	195
194		**Construction**	**730 days**	**Thu 6/17/27**	**Wed 4/3/30**		
195		Submittals	120 days	Thu 6/17/27	Wed 12/1/27	193	196
196		Haulroads	200 days	Thu 12/2/27	Wed 9/6/28	195	197
197		Earthwork/Structures	300 days	Thu 9/7/28	Wed 10/31/29	196	198FS-1200 hrs,199
198		Subgrade and Liner	200 days	Thu 4/5/29	Wed 1/9/30	197FS-1200 hrs	199
199		Testing	60 days	Thu 1/10/30	Wed 4/3/30	197,198	201
200		**Commissioning**	**30 days**	**Thu 4/4/30**	**Wed 5/15/30**		
201		Commission	30 days	Thu 4/4/30	Wed 5/15/30	199	
202		**TRR West Pumping Generating Plant**	**2260 days**	**Thu 9/1/22**	**Wed 4/30/31**		
203		**Engineering**	**1150 days**	**Thu 9/1/22**	**Wed 1/27/27**		
204		Preliminary (30%)	327 days	Thu 9/1/22	Fri 12/1/23		205
205		Class 3 Cost Estimate	100 days	Mon 12/4/23	Fri 4/19/24	204	



Project: Maxwell Sites Pumping
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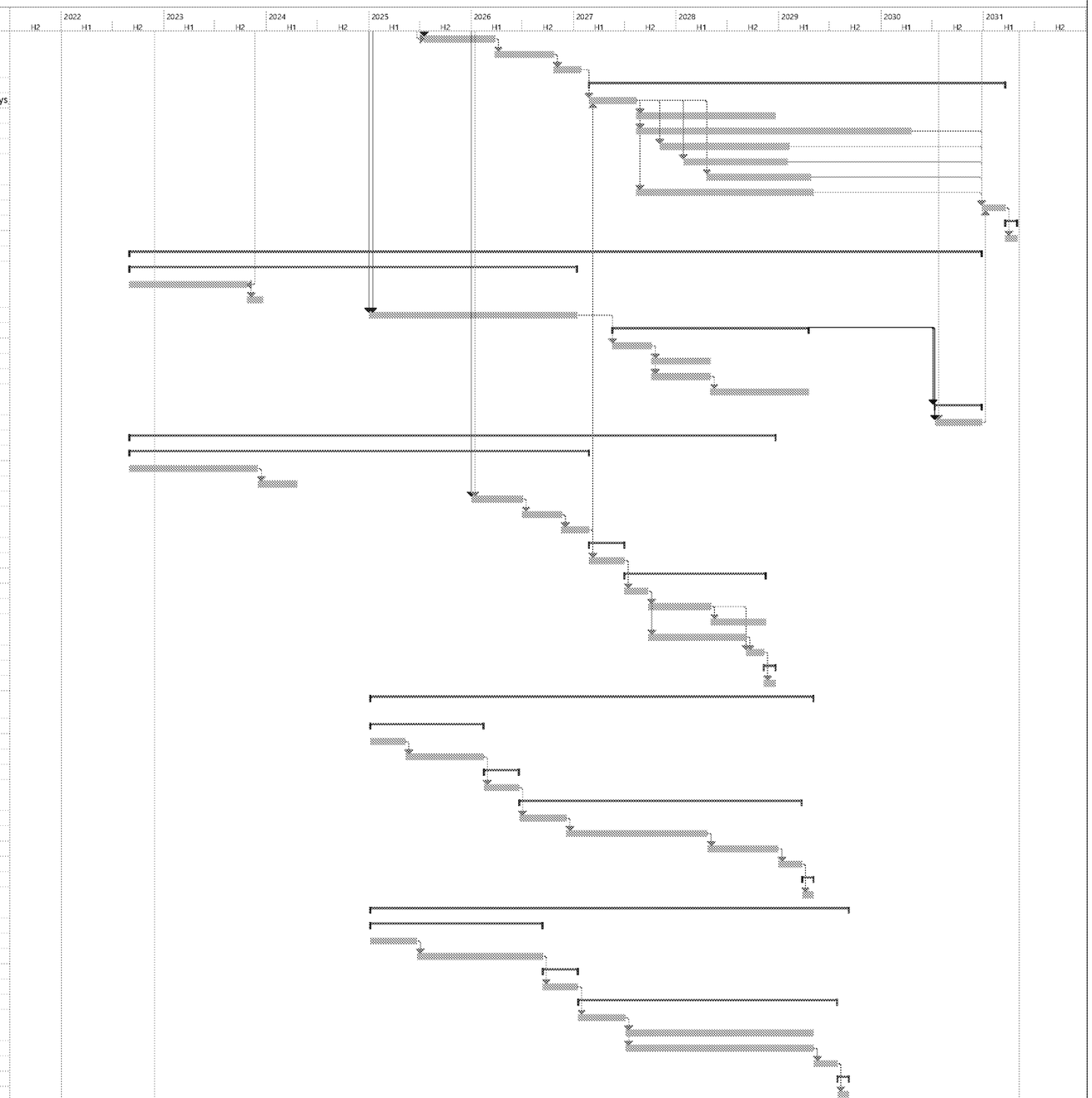
Sites Reservoir
Preliminary Construction Schedule
Maxwell - Sites Pumping and Generating (MSPG) Facilities
November 2022

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Successors
206		Final 60% Design	180 days	Thu 7/17/25	Wed 3/25/26	13FS-120 days,5,7,8,6,10	207
207		Final 90% Design	150 days	Thu 3/26/26	Wed 10/21/26	206	208
208		Final 100% Design	70 days	Thu 10/22/26	Wed 1/27/27	207	210
209		**Construction**	**1060 days**	**Thu 2/25/27**	**Wed 3/19/31**		
210		Submittals	120 days	Thu 2/25/27	Wed 8/11/27	208,238	211,212,213FS+60 days,216,214FS+120 days
211		Large Equipment Procurement	355 days	Thu 8/12/27	Wed 12/20/28	210	
212		Pump Generating Plant Structure	700 days	Thu 8/12/27	Wed 4/17/30	210	217
213		Turbine Structure	330 days	Thu 11/4/27	Wed 2/7/29	210FS+60 days	217
214		Energy Dissipation Valve Structure	265 days	Thu 1/27/28	Wed 1/31/29	210FS+120 days	217
215		Electrical Building	265 days	Thu 4/20/28	Wed 4/25/29	210FS+180 days	217
216		Site Electrical and PGP Sitework	450 days	Thu 8/12/27	Wed 5/2/29	210	217
217		Testing	60 days	Thu 12/26/30	Wed 3/19/31	137,215,212,213,214,216,231	219
218		**Commissioning**	**30 days**	**Thu 3/20/31**	**Wed 4/30/31**		
219		Commission	30 days	Thu 3/20/31	Wed 4/30/31	217	
220		**TRR West Substation**	**2170 days**	**Thu 9/1/22**	**Wed 12/25/30**		
221		**Engineering [excludes PG&E]**	**1139 days**	**Thu 9/1/22**	**Tue 1/12/27**		
222		Preliminary (30%)	300 days	Thu 9/1/22	Wed 10/25/23	84FF+30 days	223
223		Class 3 Cost Estimate	40 days	Thu 10/26/23	Wed 12/20/23	222	
224		Design (60%, 90%, 100%)	530 days	Wed 1/1/25	Tue 1/12/27	10,5,6,7,8	226FS+90 days
225		**Construction**	**500 days**	**Wed 5/19/27**	**Tue 4/17/29**		**230,231**
226		Submittals	100 days	Wed 5/19/27	Tue 10/5/27	224FS+90 days	228,227
227		Earthwork/Pad Prep	150 days	Wed 10/6/27	Tue 5/2/28	226	
228		Large Equipment Procurement	150 days	Wed 10/6/27	Tue 5/2/28	226	229
229		Structures	250 days	Wed 5/3/28	Tue 4/17/29	228	
230		**Commissioning**	**120 days**	**Thu 7/11/30**	**Wed 12/25/30**	**225**	
231		Commission	120 days	Thu 7/11/30	Wed 12/25/30	225,139	217
232		**CONSTRUCTION PACKAGE #5 - DUNNIGAN PIPELINE (ALT 1)**	**1645 days**	**Thu 9/1/22**	**Wed 12/20/28**		
233		**Engineering**	**1170 days**	**Thu 9/1/22**	**Wed 2/24/27**		
234		Preliminary (30%)	327 days	Thu 9/1/22	Fri 12/1/23		235
235		Class 3 Cost Estimate	100 days	Mon 12/4/23	Fri 4/19/24	234	
236		Final 60% Design	130 days	Thu 1/1/26	Wed 7/1/26	13,5,7,8,6,10	237
237		Final 90% Design	100 days	Thu 7/2/26	Wed 11/18/26	236	238
238		Final 100% Design	70 days	Thu 11/19/26	Wed 2/24/27	237	210,240
239		**Bid and Award**	**90 days**	**Thu 2/25/27**	**Wed 6/30/27**		
240		Bid and Award	90 days	Thu 2/25/27	Wed 6/30/27	238	242
241		**Construction**	**360 days**	**Thu 7/1/27**	**Wed 11/15/28**		
242		Submittals	60 days	Thu 7/1/27	Wed 9/22/27	240	243,245
243		TCC Intake Structure	160 days	Thu 9/23/27	Wed 5/3/28	242	246,244
244		CBD Discharge Structure	140 days	Thu 5/4/28	Wed 11/15/28	243	
245		Pipeline	250 days	Thu 9/23/27	Wed 9/6/28	242	246
246		Testing	45 days	Thu 9/7/28	Wed 11/8/28	243,245	248
247		**Commissioning**	**30 days**	**Thu 11/9/28**	**Wed 12/20/28**		
248		Commission	30 days	Thu 11/9/28	Wed 12/20/28	246	
249		**CONSTRUCTION PACKAGE #6 - RED BLUFF PUMPING PLANT (BY TCCA)**	**1130 days**	**Mon 1/6/25**	**Fri 5/4/29**		
250		**Engineering**	**290 days**	**Mon 1/6/25**	**Fri 2/13/26**		
251		Preliminary (30%)	90 days	Mon 1/6/25	Fri 5/9/25		252
252		Final (60%, 90%, 100%)	200 days	Mon 5/12/25	Fri 2/13/26	251	254
253		**Bid and Award**	**90 days**	**Mon 2/16/26**	**Fri 6/19/26**		
254		Bid and Award	90 days	Mon 2/16/26	Fri 6/19/26	252	256
255		**Construction**	**720 days**	**Mon 6/22/26**	**Fri 3/23/29**		
256		Submittals	120 days	Mon 6/22/26	Fri 12/4/26	254	257
257		Pump Procurement	18 mons	Mon 12/7/26	Fri 4/21/28	256	258
258		Mechanical/Electrical	180 days	Mon 4/24/28	Fri 12/29/28	257	259
259		Testing	60 days	Mon 1/1/29	Fri 3/23/29	258	261
260		**Commissioning**	**30 days**	**Mon 3/26/29**	**Fri 5/4/29**		
261		Commission	30 days	Mon 3/26/29	Fri 5/4/29	259	
262		**CONSTRUCTION PACKAGE #7 - GCID IMPROVMENTS (BY GCID)**	**1220 days**	**Mon 1/6/25**	**Fri 9/7/29**		
263		**Engineering**	**440 days**	**Mon 1/6/25**	**Fri 9/11/26**		
264		Preliminary (30%)	120 days	Mon 1/6/25	Fri 6/20/25		265
265		Final (60%, 90%, 100%)	320 days	Mon 6/23/25	Fri 9/11/26	264	267
266		**Bid and Award**	**90 days**	**Mon 9/14/26**	**Fri 1/15/27**		
267		Bid and Award	90 days	Mon 9/14/26	Fri 1/15/27	265	269
268		**Construction**	**660 days**	**Mon 1/18/27**	**Fri 7/27/29**		
269		Submittals	120 days	Mon 1/18/27	Fri 7/2/27	267	270,271
270		Structures	24 mons	Mon 7/5/27	Fri 5/4/29	269	
271		Earthwork	24 mons	Mon 7/5/27	Fri 5/4/29	269	272
272		Testing	60 days	Mon 5/7/29	Fri 7/27/29	271	274
273		**Commissioning**	**30 days**	**Mon 7/30/29**	**Fri 9/7/29**		
274		Commission	30 days	Mon 7/30/29	Fri 9/7/29	272	



Project: Maxwell Sites Pumping
Date: Tue 11/29/22

Task, Split, Milestone, Summary, Project Summary, Inactive Task, Inactive Milestone, Inactive Summary, Manual Task, Duration-only, Manual Summary Rollup, Manual Summary, Start-only, Finish-only, External Tasks, External Milestone, Deadline, Critical, Critical Split, Progress, Manual Progress

Draft_0020946

File Provided Natively

Sites Reservoir Project

HC Design and Construction Schedule - Overview

November 28, 2022

Agenda

- Objectives for Workshop
- Objectives of Construction Sequencing Plan/Schedule
- Conveyance Contract Packages
- Contract Package No. 2 Facilities
- Engineering Phases
- CP No. 2 Schedule – walk-through
- Next Steps

Sites

Workshop Objectives

- Understand HC-Conveyance Scope
- Identify critical path items in schedule
- Identify key milestones in schedule that impact critical path
- Identify items that may change that would impact schedule

Draft_0020950

Objectives of Construction Sequencing Plan (CSP)/ Schedule

- CSP will be integrated into the Master Project Schedule
  - CSP is presented for comment
- CSP can be used to show when predecessor activities will need to occur to achieve the targeted project completion in 2031
  - Currently identify Permitting & Environmental milestones through 2024
  - Real Estate access granted on private land for design effort is obtained by December 2024
  - Geotechnical investigations
    - Phase 1 is completed during 30% design schedule by December 2024
    - Phase 2 is completed by December 2025
- CSP identifies critical path
  - Through the Inlet/Outlet Facilities as part of CP No. 2
  - CAISO process, PG&E point of interconnections and providing power to PGP's
  - Funks Reservoir final sediment removal

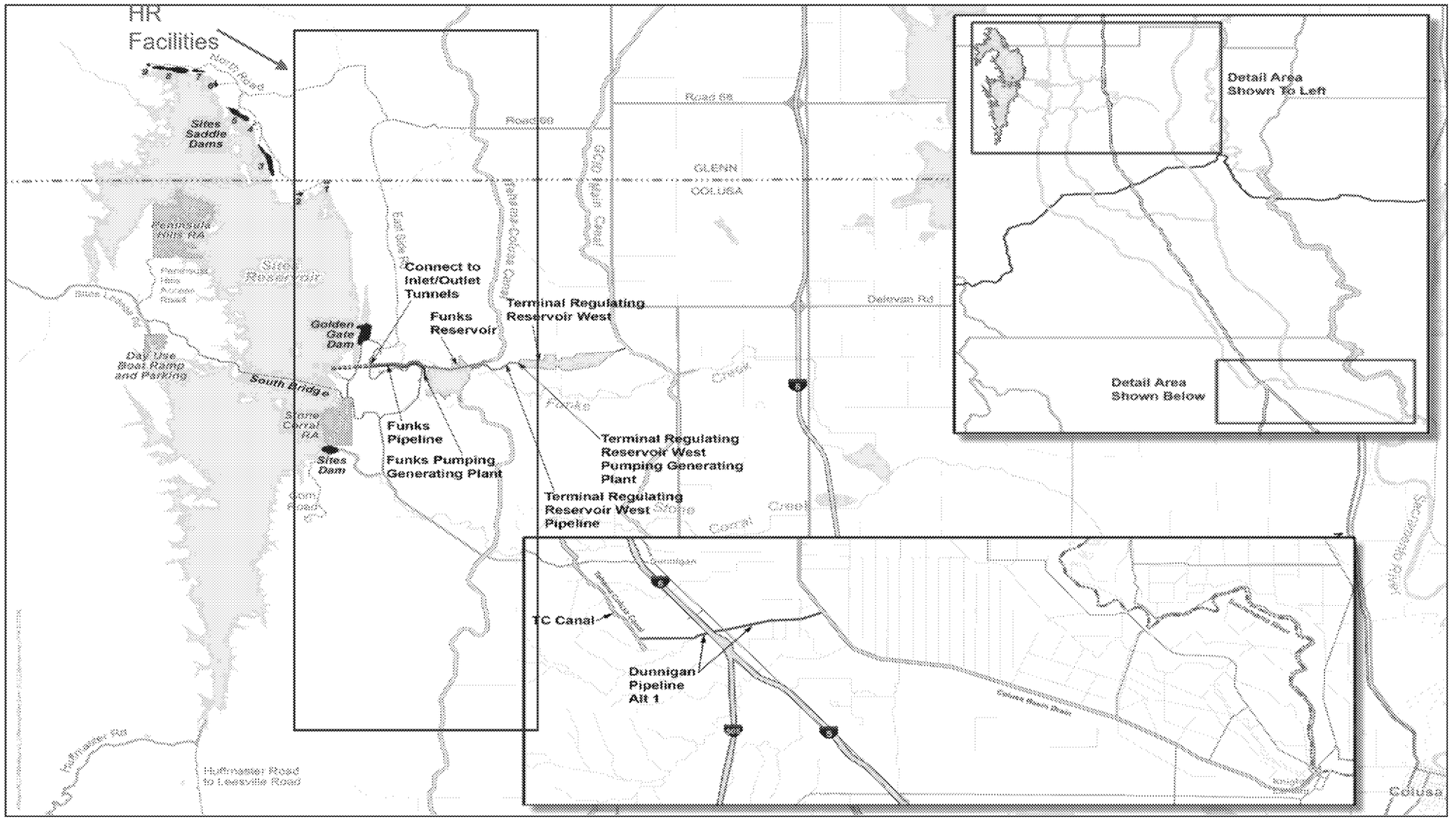
Draft_0020951

Conveyance Contract Packages

- Contract packages:
  - CP No. 2 – Maxwell Sites Pumping and Generating Facilities (MSPG) Facilities – Includes Inlet/Outlet Works - CMAR
  - CP No. 5 – Dunnigan Pipeline Alt 1 - DBB
  - CP No. 6 – Red Bluff Pumping Plant Improvements (By TCCA and USBR)
  - CP No. 7 – GCID Improvements (By GCID)
- Today we are focusing on CP No. 2

Draft_0020952

Contract Package No. 2 - Site Plan



CP No. 2 - Facilities

- Terminal Regulating Reservoir (TRR) -West
- TRR Pumping Generating Plant (PGP)
- TRR Pipelines
- Inlet/Outlet Facilities
- Funks Reservoir Improvements
- Funks PGP
- Funks Pipelines
- PG&E Point of Interconnection
- 230 kV Power Transmission Lines and Substation at each PGP
- Administration and Operations Building (Part of Funks PGP)
- Maintenance and Storage Building (Part of Funks PGP)
- Access Roads
- Electrical Overhead from Funks PGP to Sites Dam & I/O Control Building

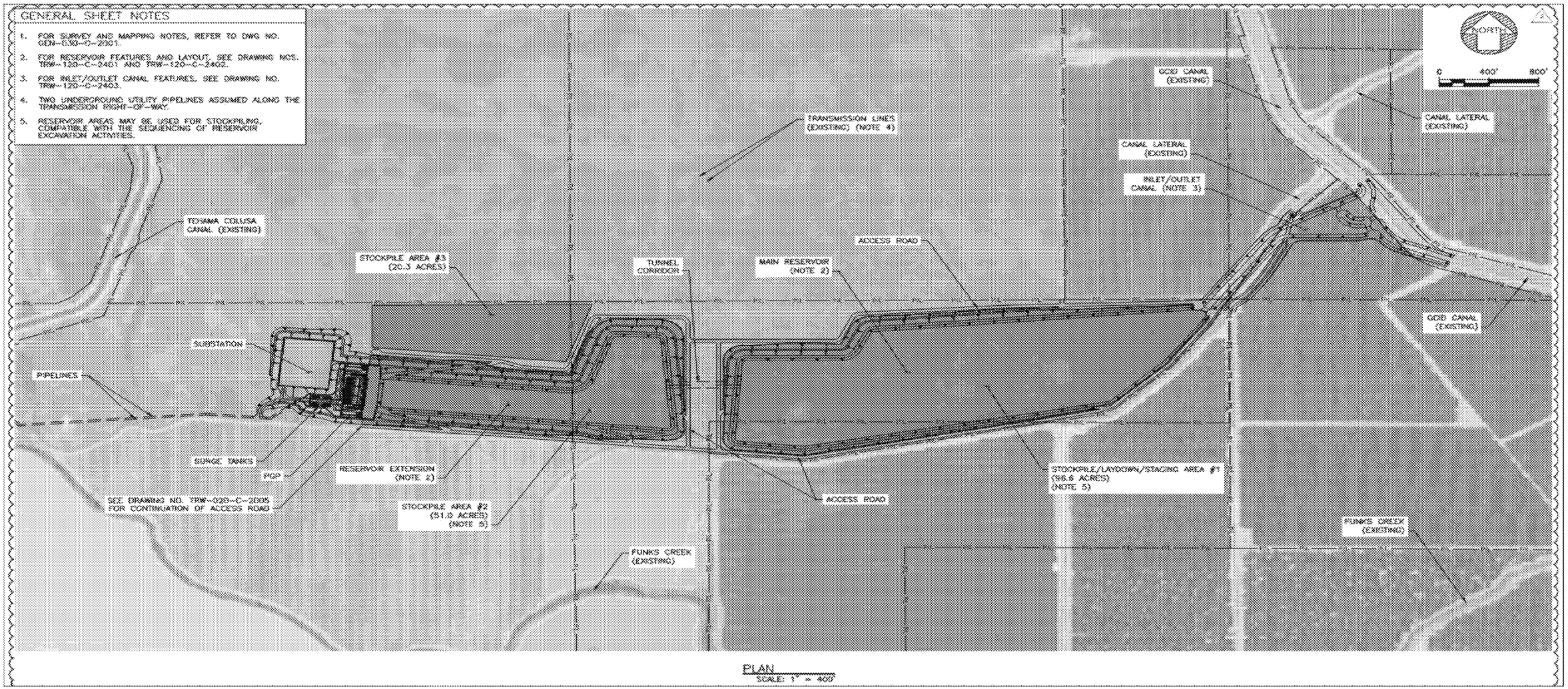
Draft_0020954

CP No. 2 Facilities Eliminated that are in Draft EIR/EIS

- Terminal Regulating Reservoir (TRR)-East
- WAPA point of interconnection and associated power transmission line facilities
- Dunnigan Pipeline (Alternative 2) – extends from Colusa Basin Drain to the Sacramento River. This alternative is not advancing but its not eliminated – the Sites Board can decide in the future if they want this alternative to advance.

Draft_0020955

TRR – West



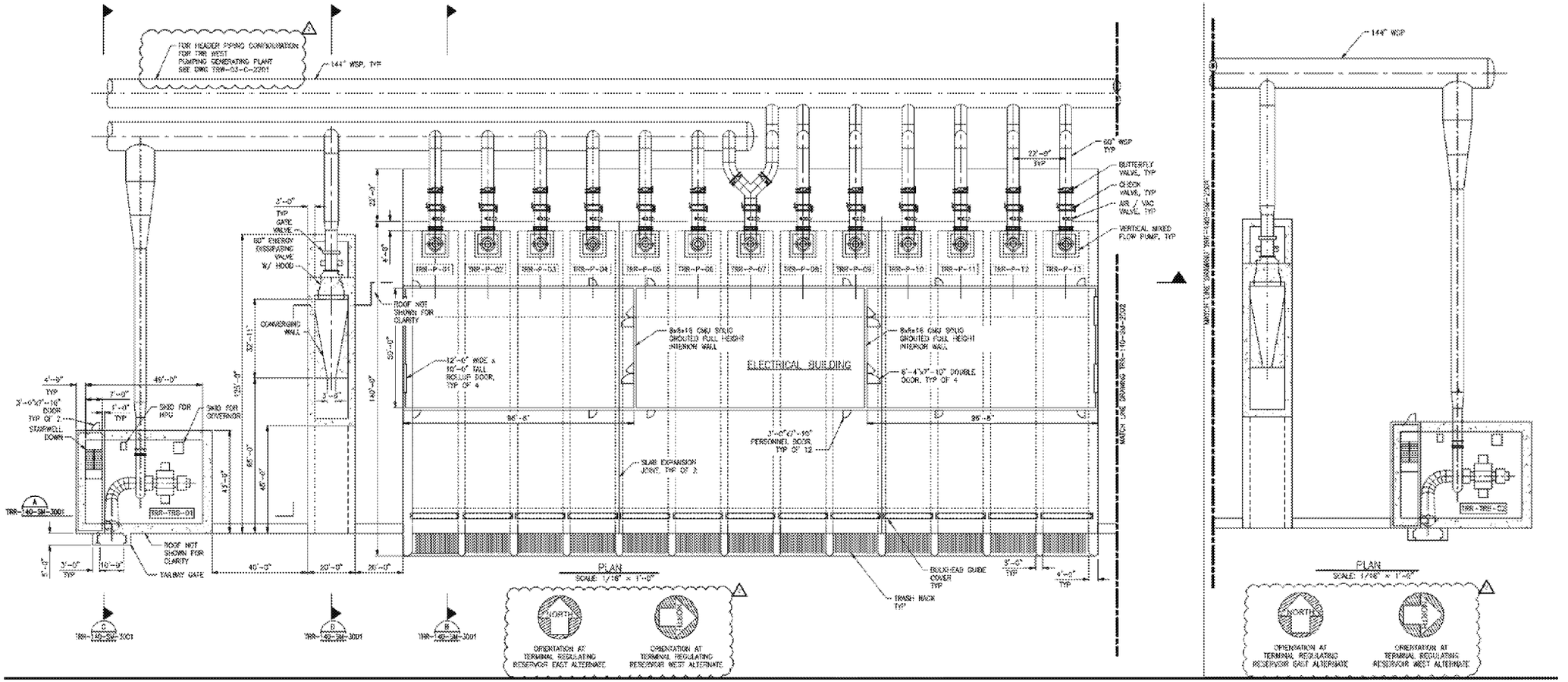
Draft_0020956

TRR – West

- New reservoir on the western side of GCID Main Canal
- Footprint: approximately 140 acre
- Estimated Storage Volume: 600 ac-ft
- Will be hydraulically connected to the GCID Main Canal through several gate structures
- Currently working with GCID to optimize the size
- Will be constructed via primarily mass excavation – so potentially not Division of Safety of Dams (DSOD) jurisdictional

Draft_0020957

TRR West – PGP (600-ft x 200-ft)

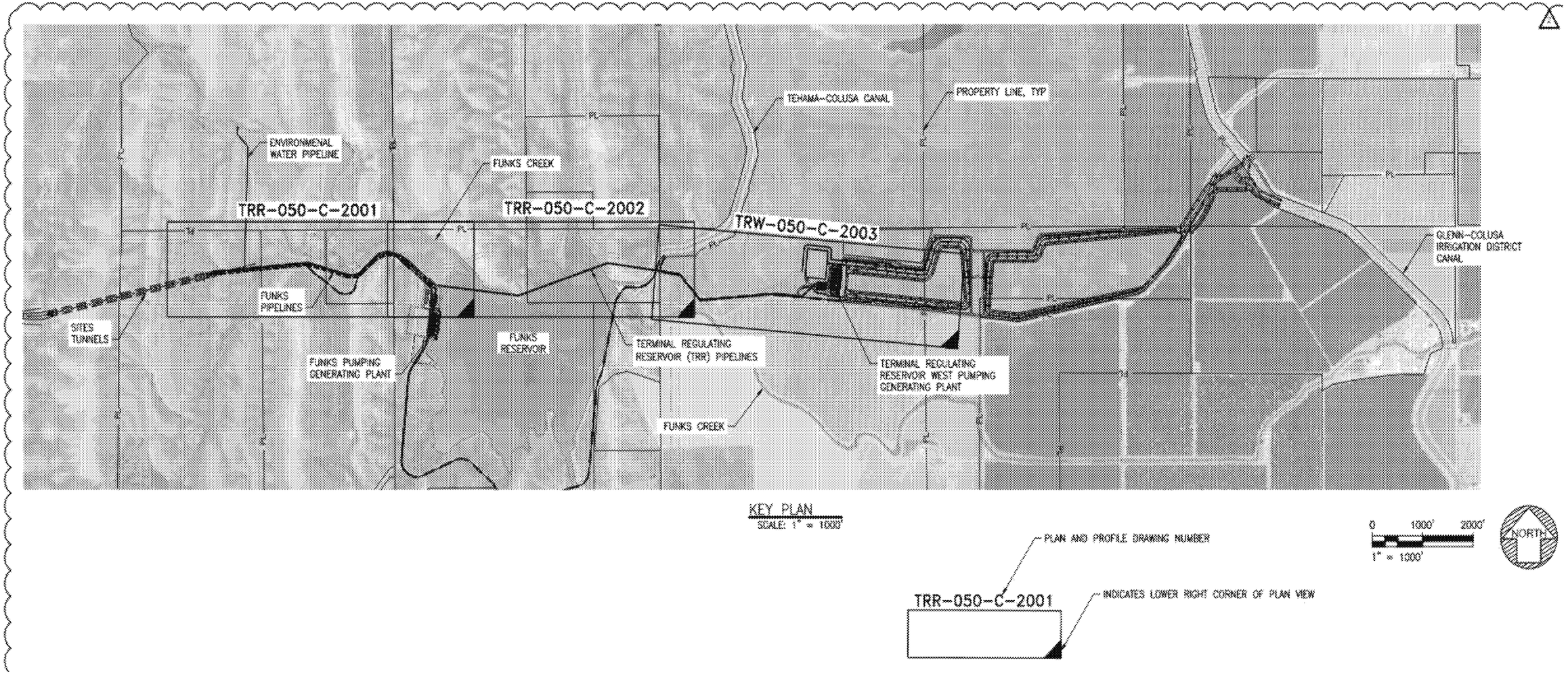


TRR West – PGP

- Pumping and generating plant that will be used to pump water from TRR West to Sites Reservoir
- Pumping station will consist of 13 pumps (9,000 hp each), 12 duty and one standby
- Includes two hydroelectric turbines (11.5 MW each) to generate electricity when flow is released from Sites Reservoir to the TRR and GCID Main Canal
- Includes several (?)energy-dissipation valves/facilities that will allow releases back to the TRR as backup to the turbines & provide reservoir emergency flow
- Pumping plant capacity: 1,800 cfs
- Generating plant: 1,000 cfs (2 turbines at 500 cfs each)

Draft_0020959

TRR – West Pipelines & Environmental Pipeline

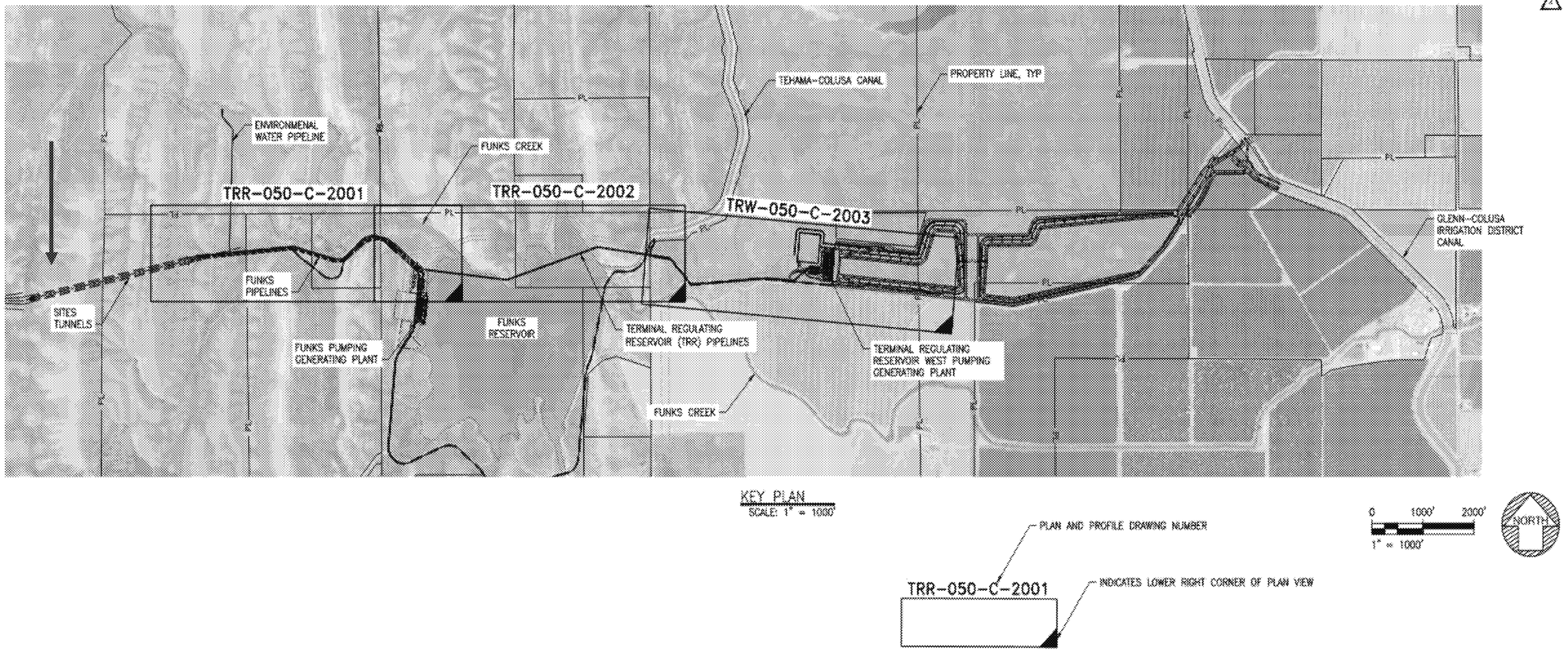


TRR Pipelines & Environmental Pipeline

- Two parallel 12-foot diameter pipelines intended to convey water between the TRR PGP and the Sites Reservoir
- Ties into the 32-foot-diameter tunnel connected to the Sites Reservoir inlet/outlet structure
- TRR-West pipelines approximate length would be 2.5 miles each
- There is a 42-inch-diameter Environmental Water Pipe (200 cfs) tying into one of the TRR pipelines and discharges into Funks Creek above Funks Reservoir. Pipeline is 2,550-ft long.

Draft_0020961

Inlet/Outlet Facility



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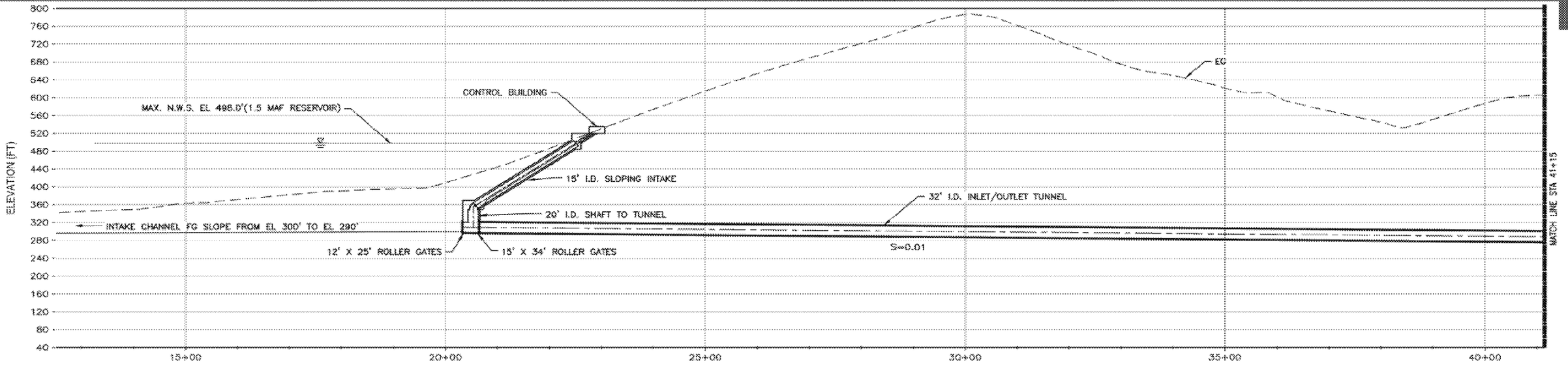
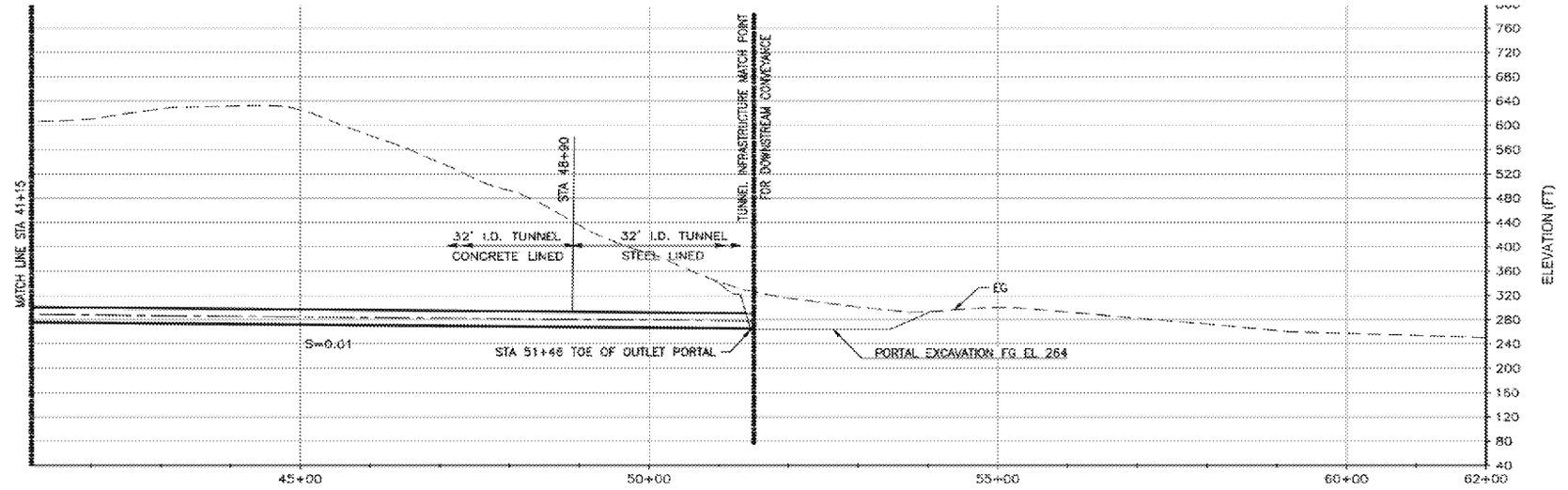
Inlet/Outlet Facility Profile



PROFILE STA 14+50 TO STA 40+20



PROFILE STA 40+20 TO 62+00

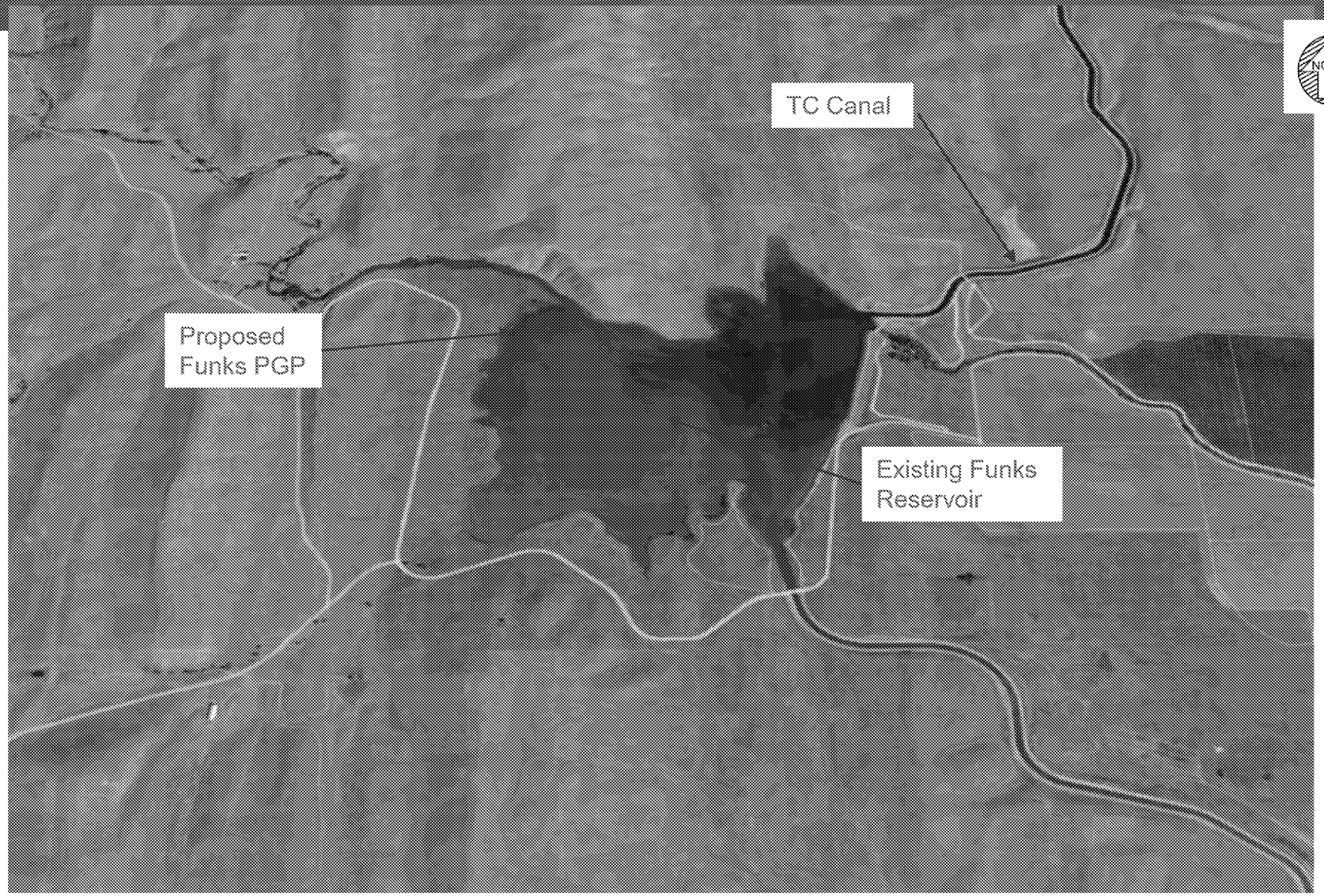
SCALE: 1" = 100'

Inlet/Outlet Facility

- A sloping inlet/outlet structure with multiple gates on eastern bank of Sites Reservoir
- A 32-foot-diameter tunnel connecting Sites Reservoir inlet/outlet structure to the 4 pipes from TRR PGP and Funks PGP
- Tunnel is approximately 3,100 feet long

Draft_0020964

Funks Reservoir Site Plan



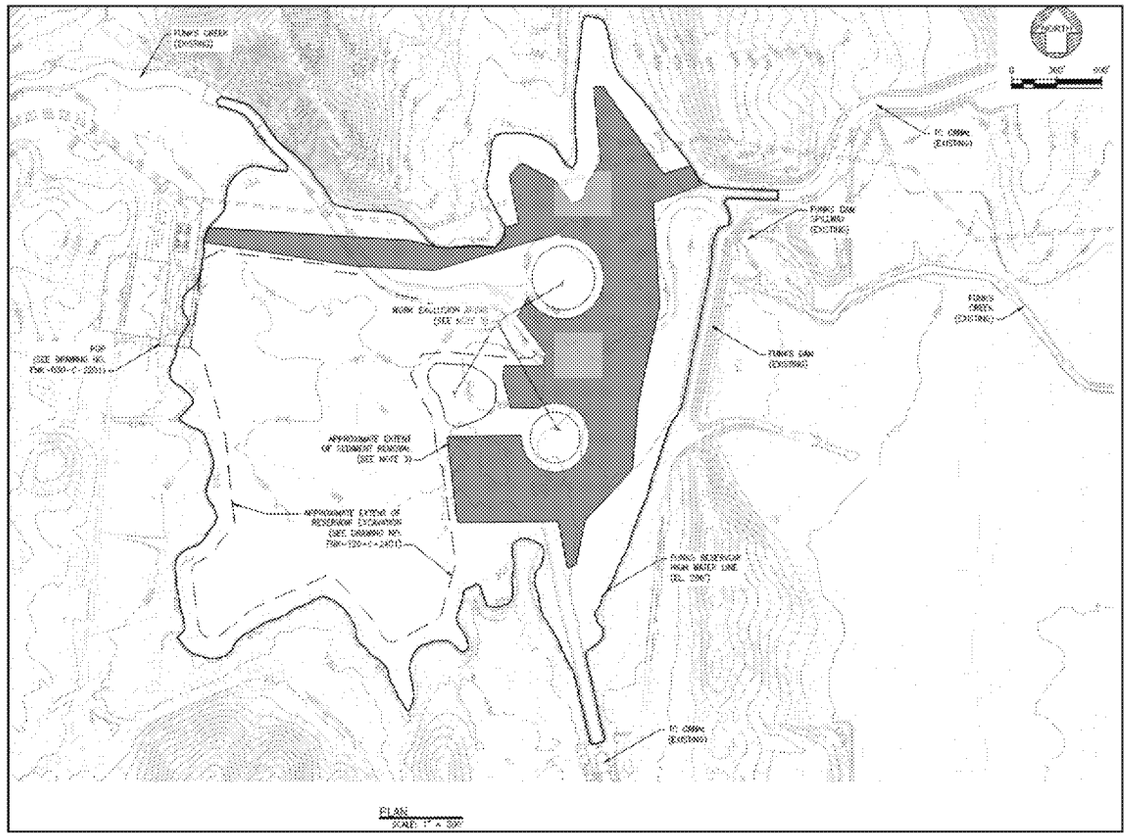
Draft_0020965

Funks Reservoir and Improvements

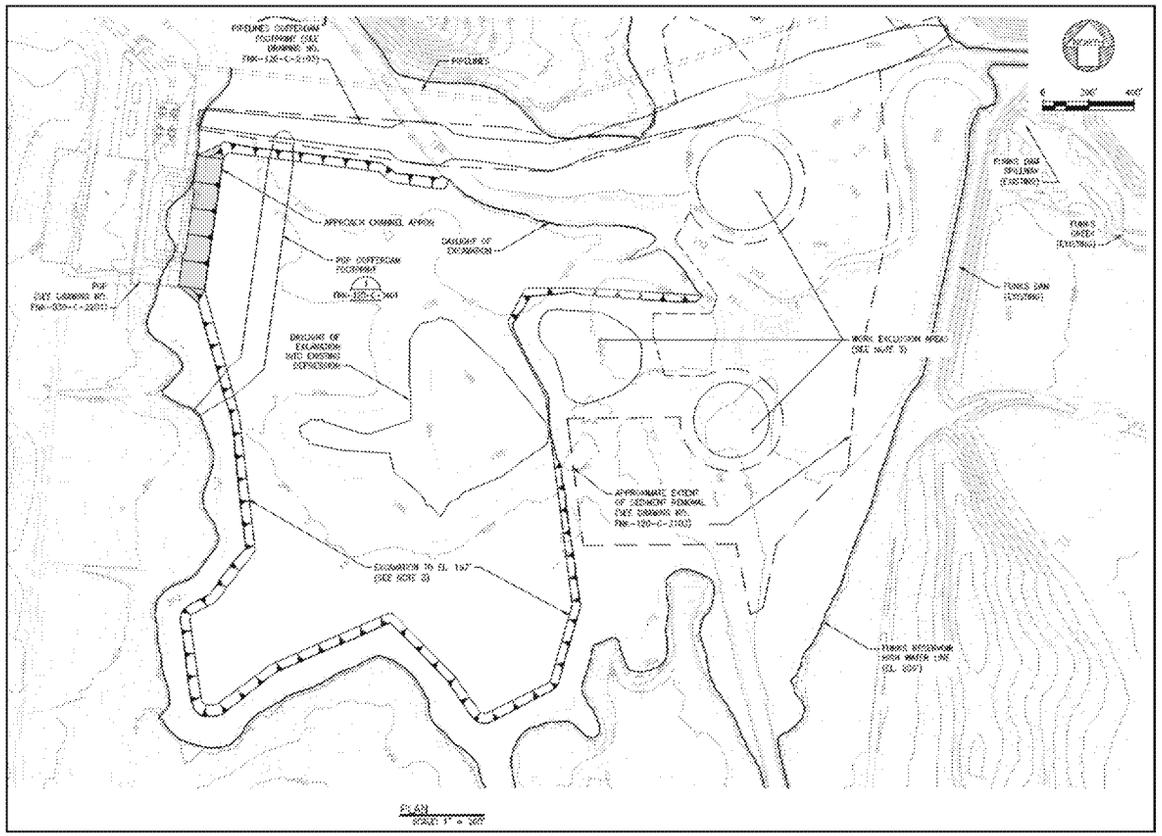
- Existing reservoir off the TC Canal to be used as a source of water to pump and receive discharged water from Sites Reservoir
- Total Reservoir Volume: 2,250 ac-ft
- Current Usable Storage Volume within TCC Operating Range: 1,100 ac-ft
- Improvements include reshaping the shoreline to accommodate PGP, excavating a channel to PGP, constructing a temporary cofferdam to construct TRR pipelines, and remove sediment to regain design storage capacity

Draft_0020966

Funks Reservoir Improvements (Cultural Resource areas highlighted)



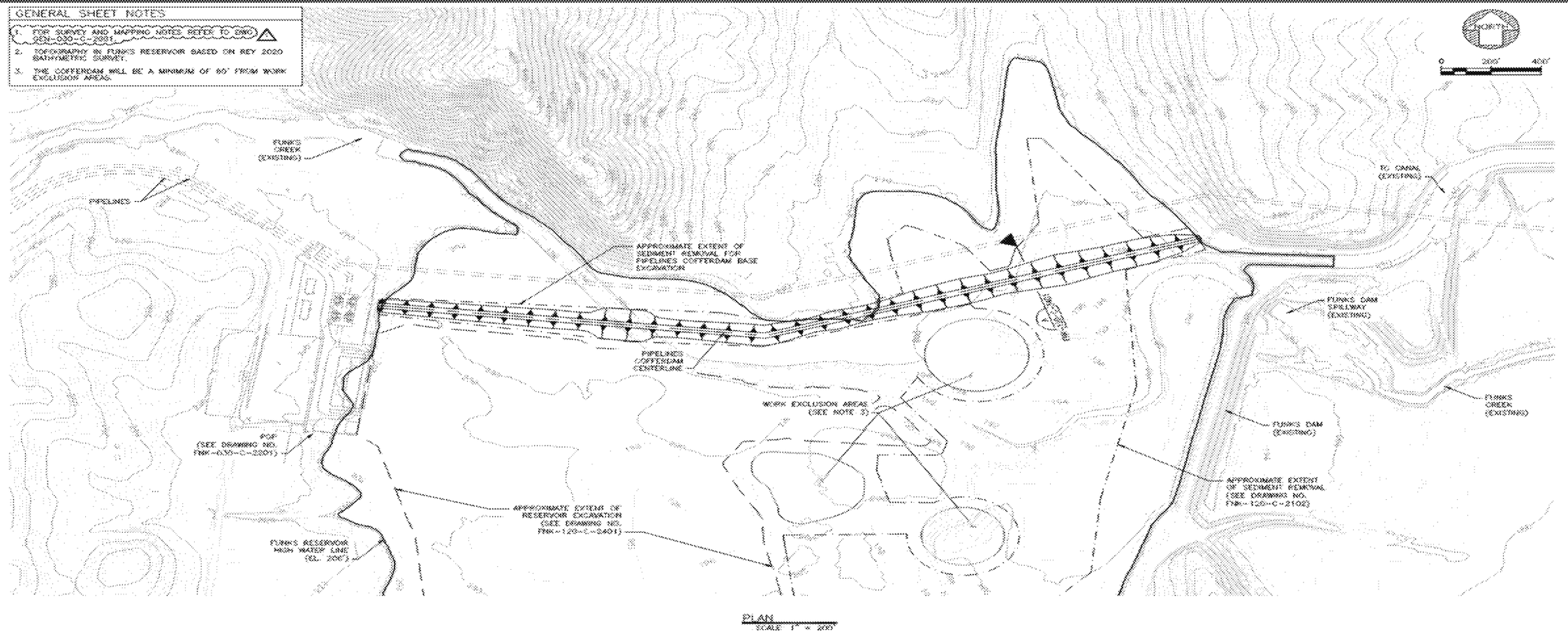
Sediment Removal Plan



Excavation and Approach Channel Plan

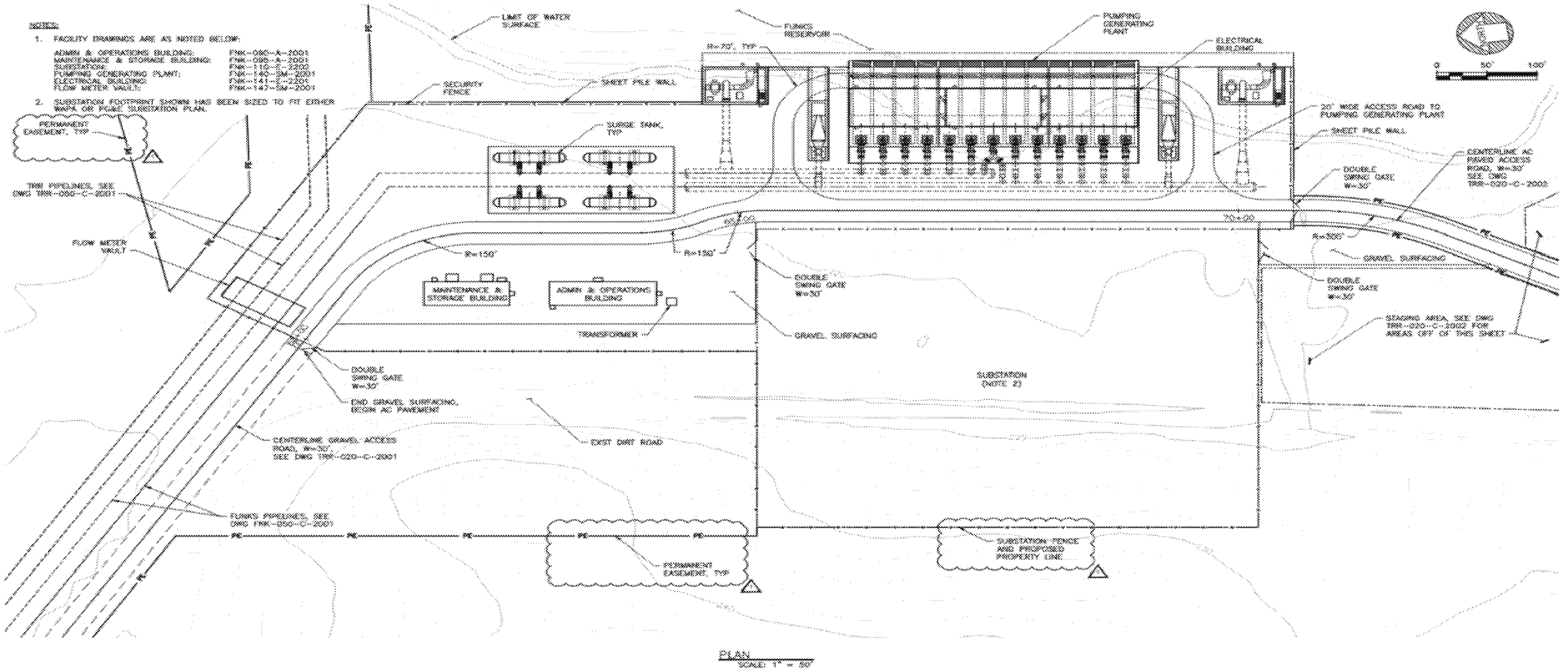
Draft_0020967

Funks Reservoir Improvements



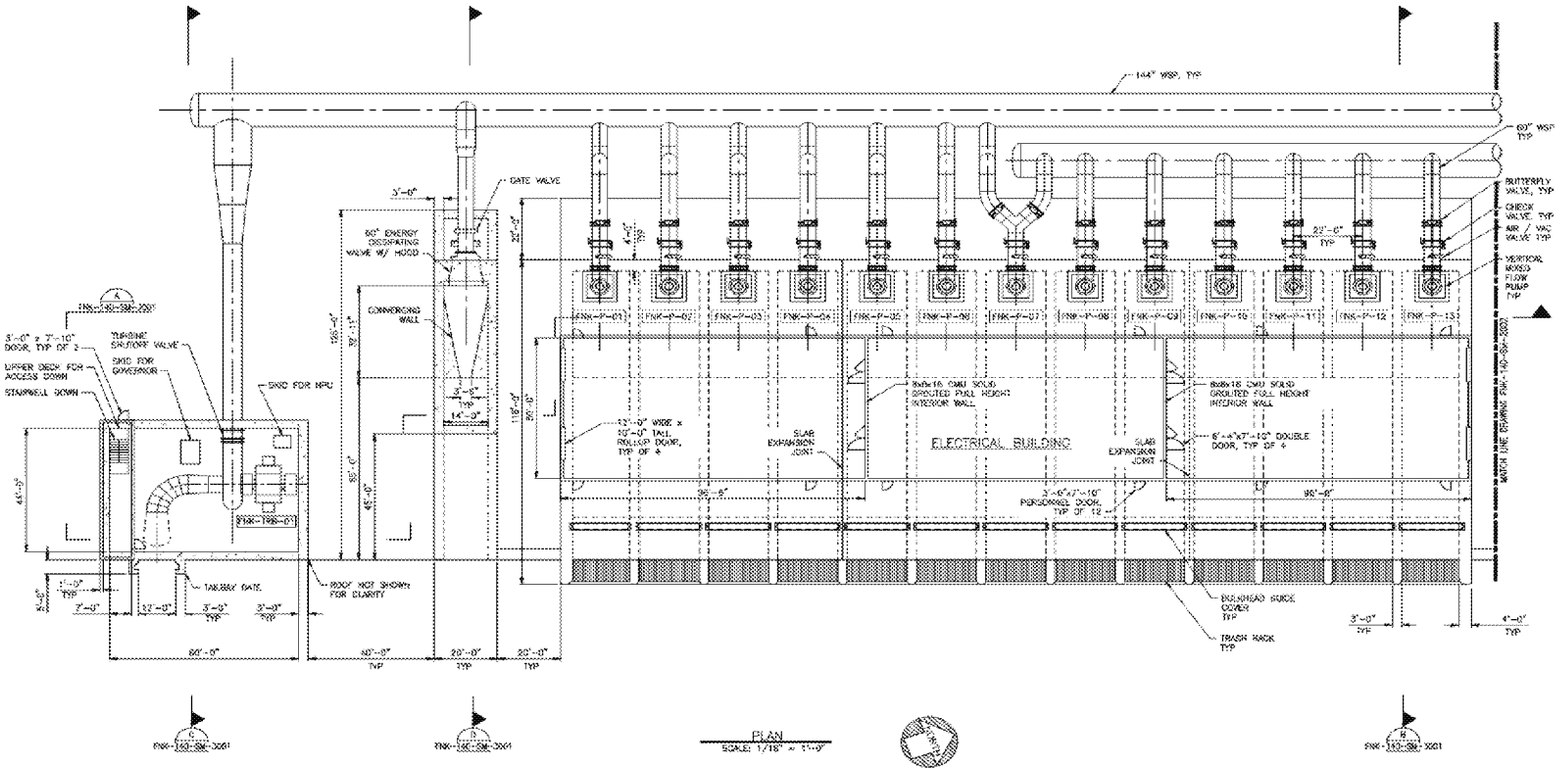
Temporary TRR Pipeline Cofferdam Plan

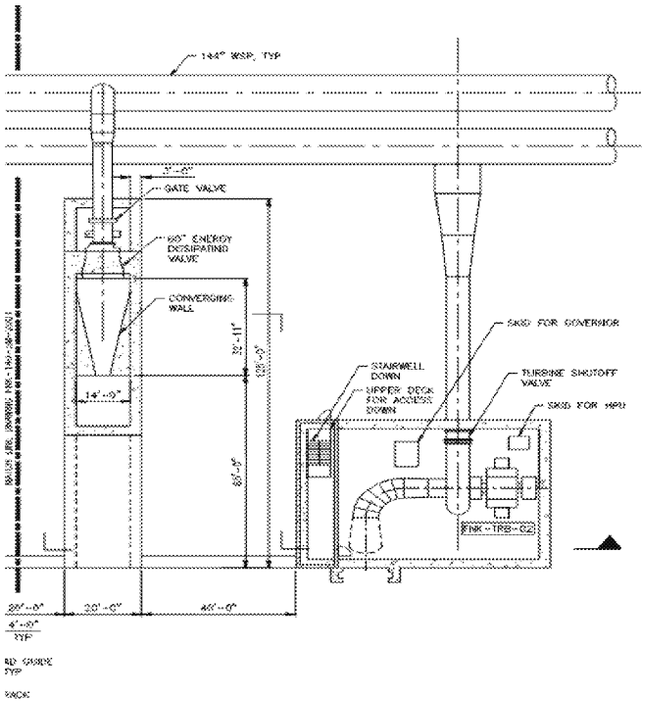
Funks PGP Site Plan (about 15-acres)



Draft_0020969

Funks PGP





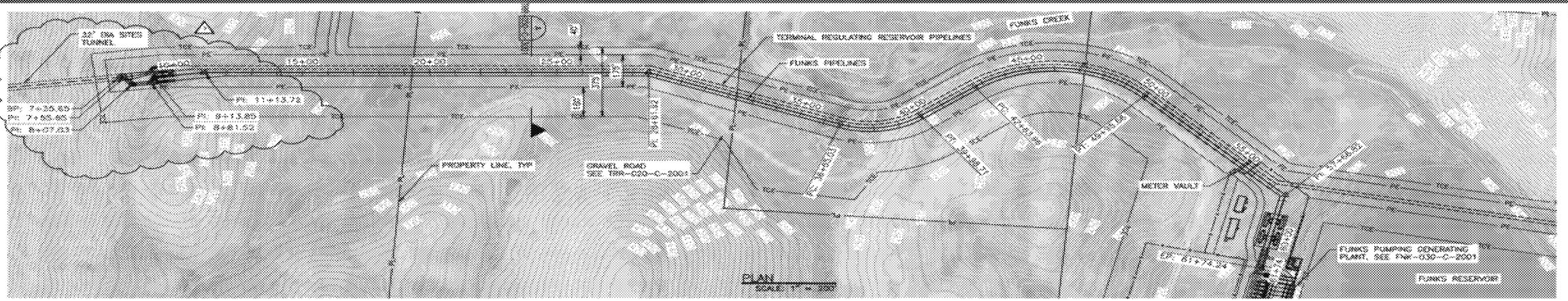
Draft_0020970

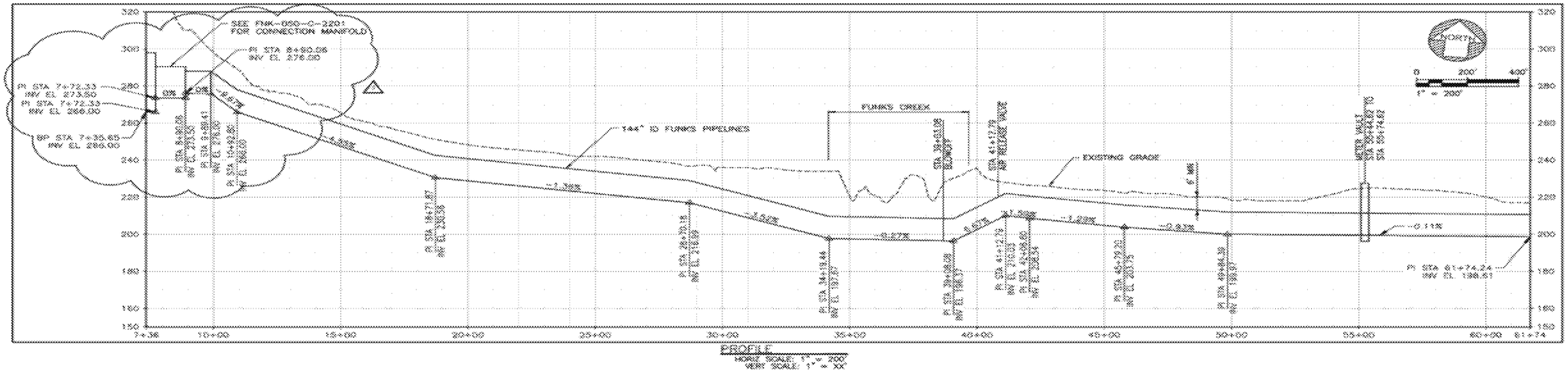
Funks PGP

- Intended to pump water from Funks Reservoir to Sites Reservoir
- Pumping Plant includes 13 pumps (8,000 hp each) 12 Duty and 1 standby.
- Includes two hydroelectric turbines (14.5 MW each)to generate electricity when flow is released from the Sites Reservoir to Funks Reservoir, to the TC Canal and ultimately to the Sacramento River
- Includes several (?)energy-dissipation valves/facilities that will allow releases back to Funks as backup to the turbines & provide reservoir emergency flow
- Pumping plant capacity: 2,100 cfs
- Generating plant capacity: 2,000 cfs (1,000 cfs per turbine for redundancy)

Draft_0020971

Funks Pipelines





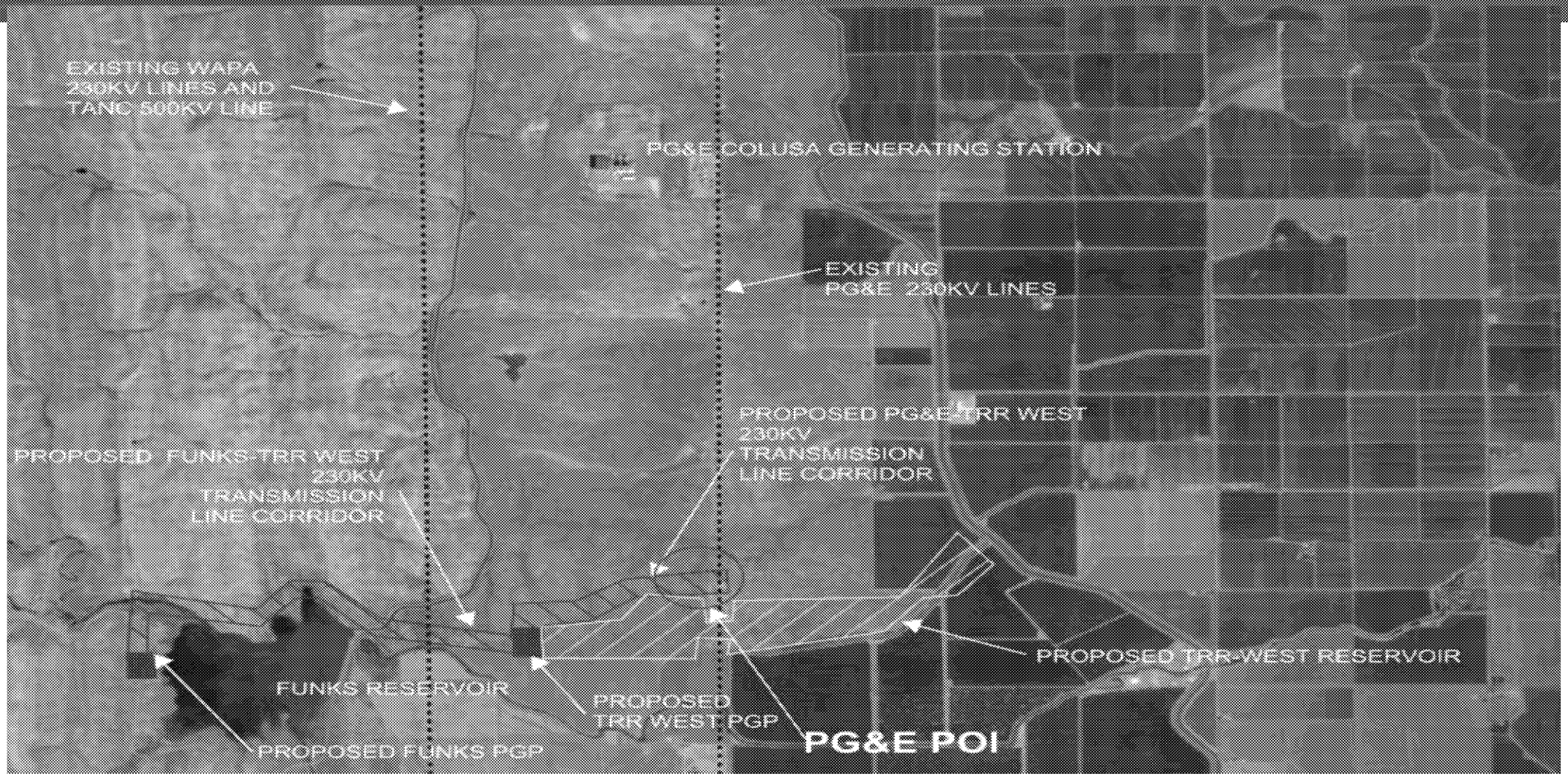
Draft_0020972

Funks Pipelines

- Two parallel 12-foot diameter pipelines intended to convey water between Funks PGP and Sites Reservoir
- Ties into a 32-foot-diameter tunnel connected to the Sites Reservoir inlet/outlet structure
- Appx. Length of each Pipeline: 1 mi (5,200 ft)
- Valve between one Funks Pipeline and one TRR Pipeline acts as the Maxwell Intertie (allowing flow from TC Canal to GCID Canal without going to Sites Reservoir)

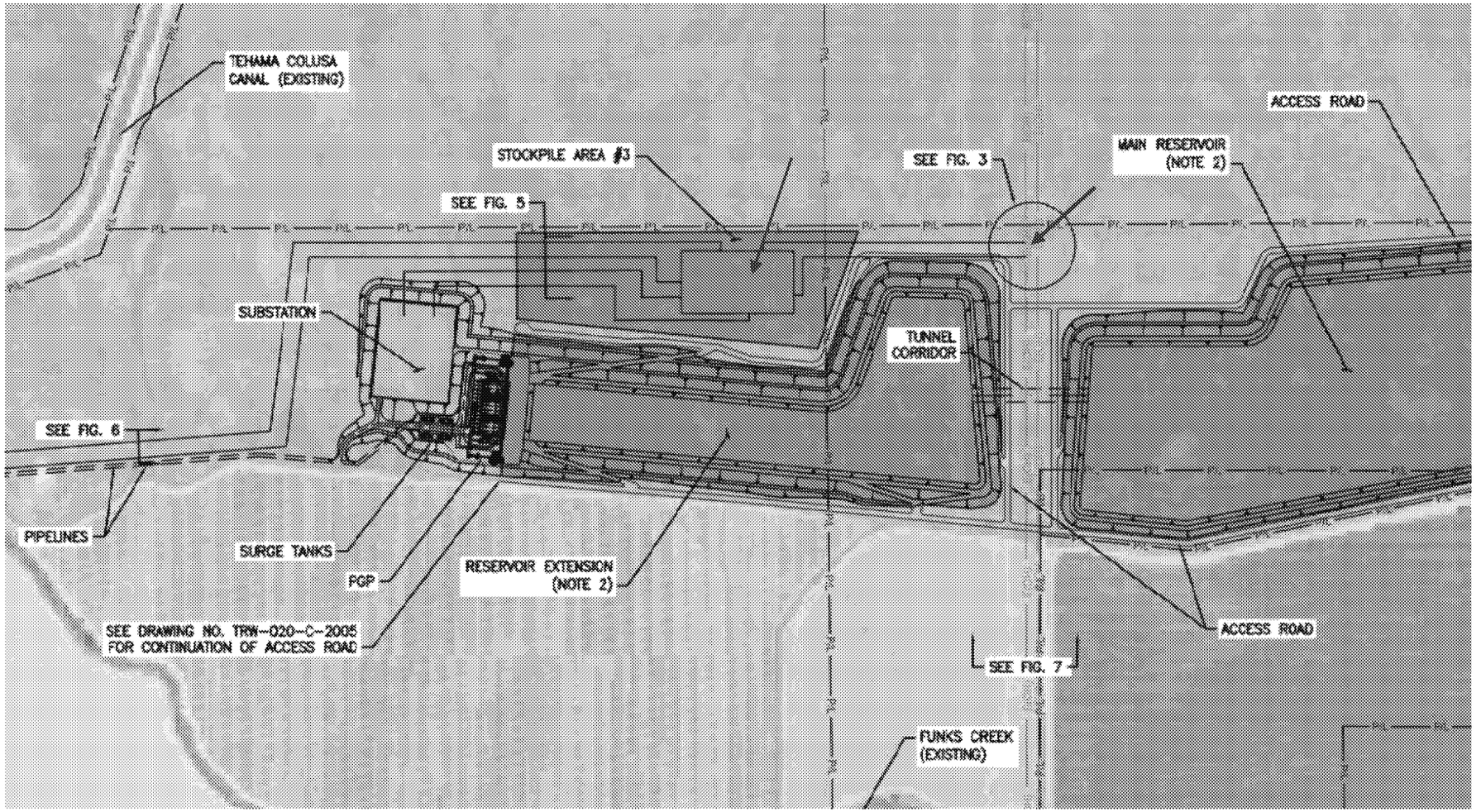
Draft_0020973

PG&E Point of Interconnection



Draft_0020974

PG&E Point of Interconnection and Substation



PG&E Point of Interconnection & Substations

- Will serve as the primary source of power for the Project
- Will have ability to receive generated electrical power from the hydroelectric turbines
- The substations will be designed for the total pumping power requirements (import) or total generation requirements (export)
- 230 kV to 13.8 kV substations at TRR PGP and Funks PGP

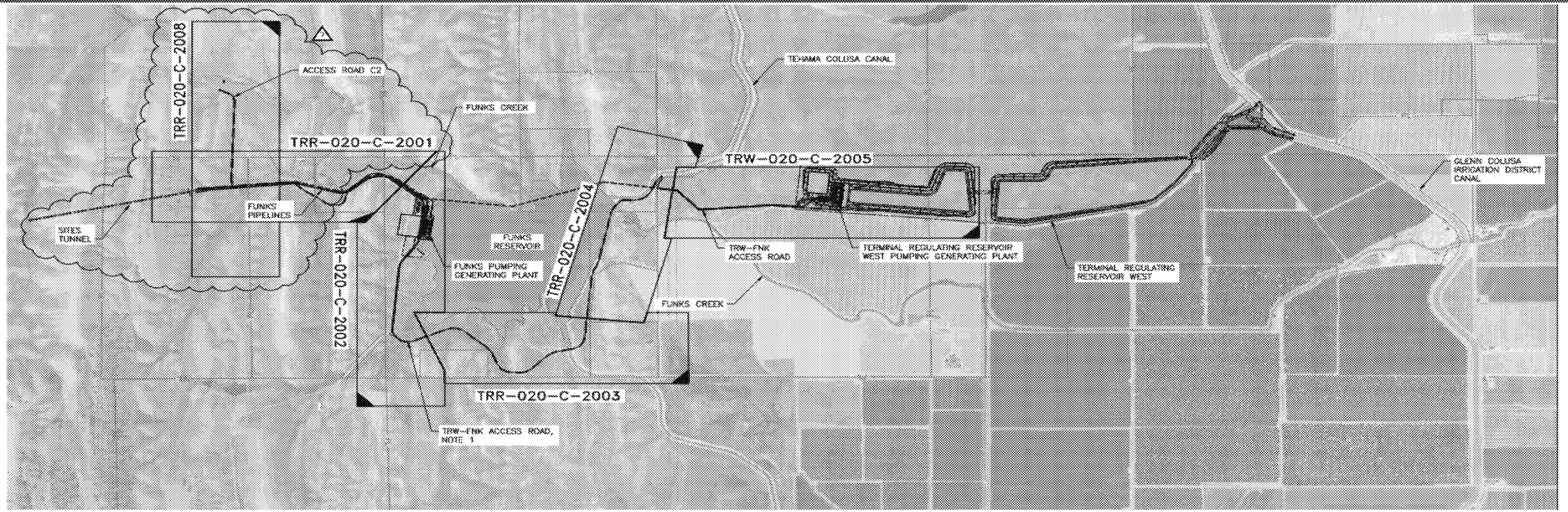
Draft_0020976

Power Transmission Lines

- A point of interconnect to the PG&E high-voltage transmission line will provide power to operate the pumps at the Funks PGP, and the TRR PGP.
- Power will be delivered between TRR and Funks substations via looped (two circuits) 230 kV to the supply power to pumps.
- The looped circuits would also receive power from the Funks PGP and TRR PGP when the turbine/generators are operating.

Draft_0020977

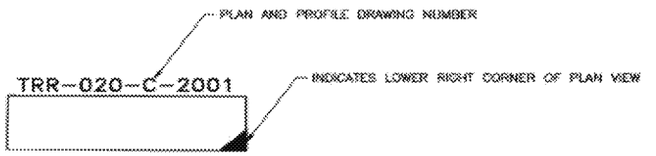
TRR West & Funks Access Roads



NOTE:

1. TRW-FNK ROAD IS THE SAME AS TRR-FNK ROAD FROM BEGIN STA 10+00 TO STA 192+00, SHOWN ON DWGS TRR-020-C-2021 THROUGH 2004.

KEY PLAN
SCALE: 1" = 1000'



0 1000' 2000'
1" = 1000'

NORTH

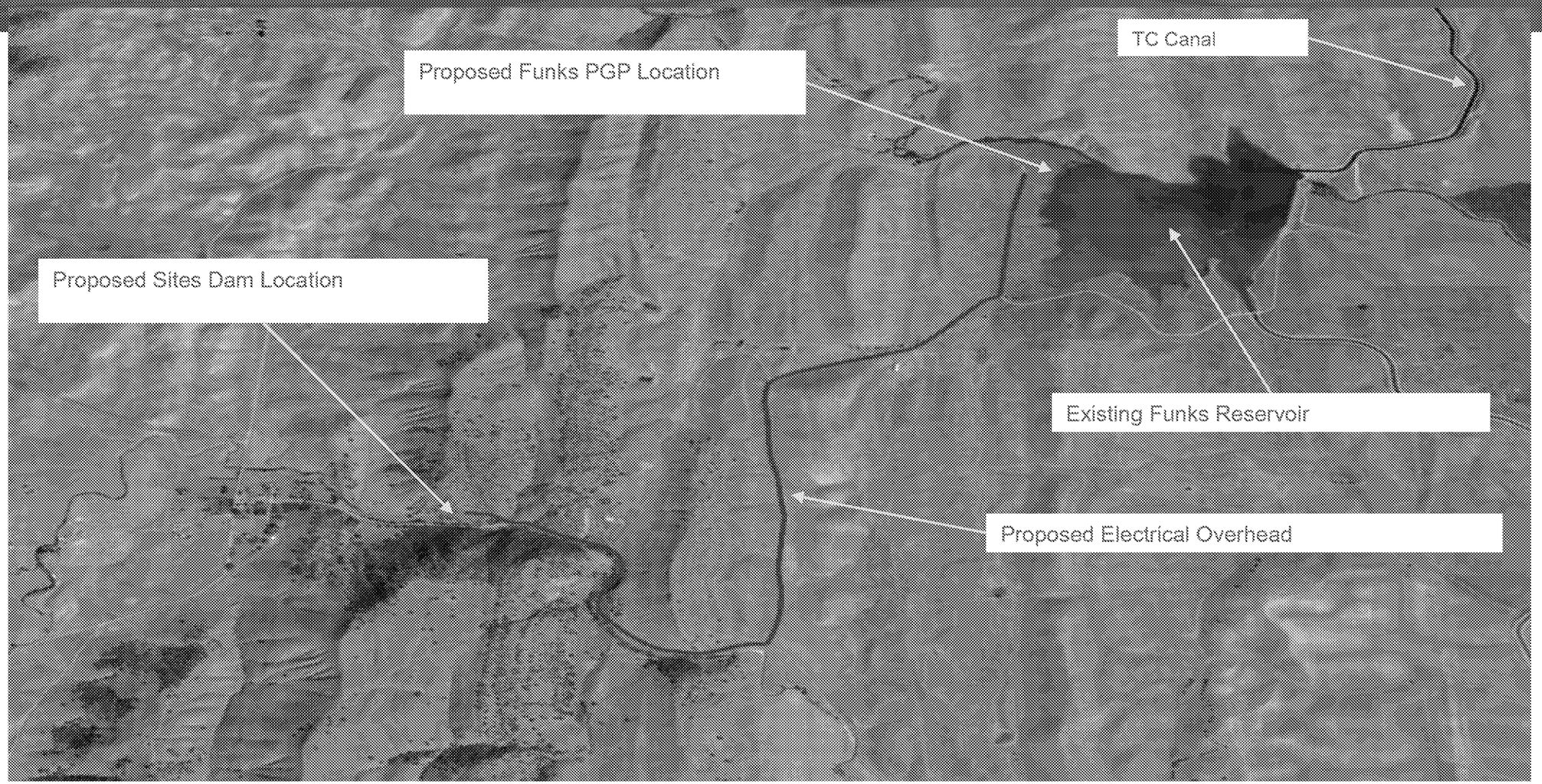
Draft_0020978

Access Roads

- A new access road will be required that allows larger equipment and year-round access to all project facilities
- Access to the Funks complex (PGP and Reservoir) will be along a current private road coming off the Maxwell-Sites Road.
- Will need permanent easement along USBR Road around Funks Reservoir
- Secondary access roads will be constructed within TRR-West and Funks pipeline easements for access to pipelines and electrical transmission lines

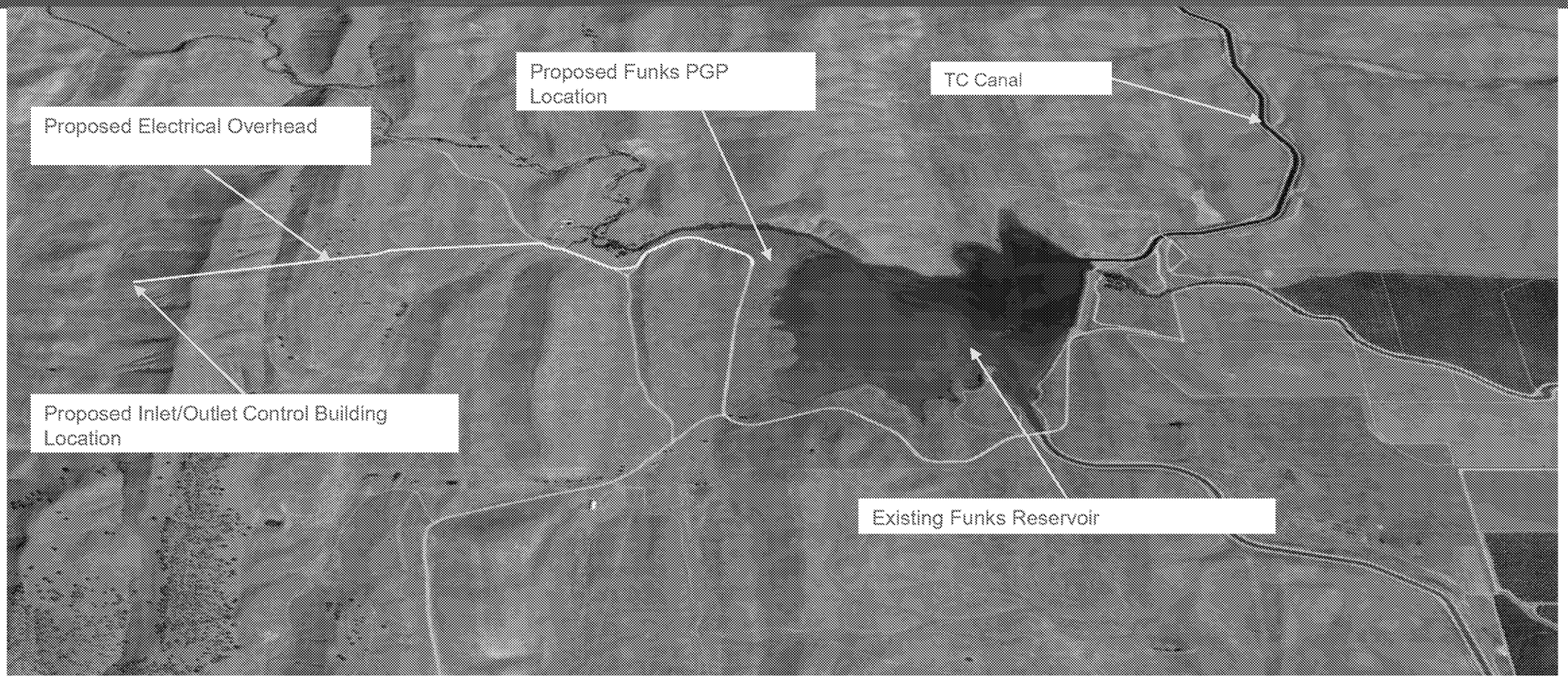
Draft_0020979

Electrical Overhead from Funks PGP to Sites Dam



Draft_0020980

Electrical Overhead from Funks PGP to Inlet/Outlet Control Building



Draft_0020981

Engineering Phases - Iterative Process/Reviews
Aligned with Contract Packages

- Geotechnical investigations
- Engineering
  - 30% design for DSOD jurisdictional features (TRR and Funks Pipelines and maybe TRR)
  - Design continues while DSOD reviews taking place (30, 60, 90%)
  - Design continues while reviews taking place
- DSOD reviews/approval
  - 3 months each for 30, 60, 90% reviews
  - 3 months for 100% approval
  - DSOD staffing and ability is assumed not to affect schedule; communication with DSOD is needed to confirm this

Draft_0020982

CP No. 2 - Schedule Considerations

- DSOD Jurisdiction on TRR West is unknown and DSOD impact on TRR and Funks pipelines (both are jurisdictional) unknown
- Geotechnical data
  - P1 completed by December 2024
  - P2 completed by December 2025
- CAISO application submitted April 15, 2023
- Further schedule iterations to be developed as more information is received.
  - Schedule to be shared with CMAR - CMAR would confirm, modify, and improve schedule, and adding more detail
- Optimization of this draft preliminary schedule was not attempted

Draft_0020983

CP No. 2 - Schedule

- Walk–through in Microsoft Project
- Highlight Critical Path through Inlet/Outlet Works
- Highlight potential Critical Path through CA ISO and PG&E
- Funks Reservoir final sediment removal

Draft_0020984

Items That Would Impact Schedule

- Identify key milestones in schedule that impact critical path
  - DSOD review and Geotechnical Investigations for Inlet/Outlet Works
  - CA ISO April 15, 2023 application – if this is deemed a “Super Cluster” like 2021, then the CA ISO process is extended an additional year, which extends PG&E POI and substation and becomes Critical Path
- Identify items that may change that would impact schedule
  - Unsure of DSOD review times for design of TRR and Funks Pipelines
  - Unsure if Ca Public Utilities Commission is involved with CAISO process – checking with Z Global
  - Geotech investigations completions
  - Environmental/Permitting constraints during design
  - Environmental/Permitting constraints during construction

Draft_0020985

Next Steps

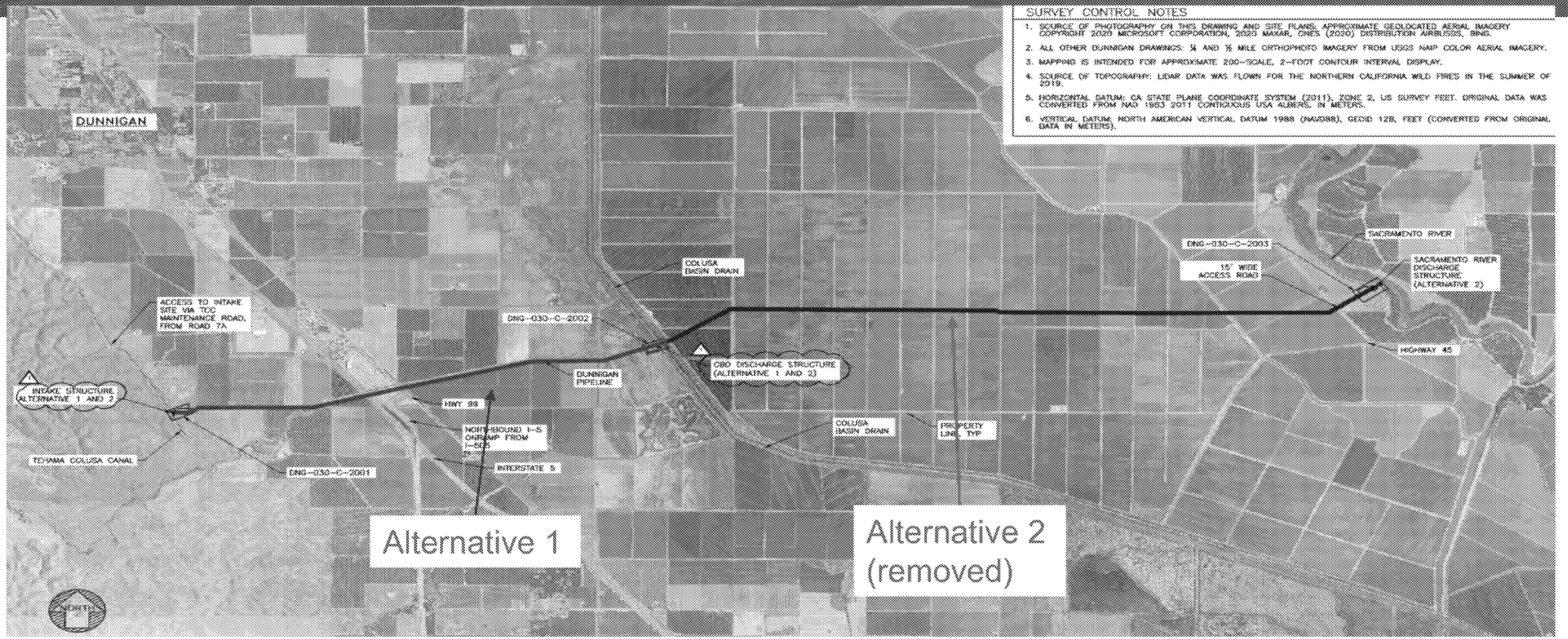
- HR Schedule Workshop on December 15 – schedule input from Environmental, Permitting & Real Estate
- Revise HC Schedule based input from HR Schedule Workshop
- Hold HC Schedule Workshop with input from Environmental, Permitting & Real Estate
- Revise HC Schedule to be incorporated into Baseline Schedule
- JP Present Baseline Schedule to Operations & Engineering Work Group
- JP Present to Reservoir Committee/Board

Draft_0020986

Thank You

Sites

Dunnigan Pipeline Alt 1 – CP No. 5



PLAN
SCALE: 1" = 2000'

Draft_0020988

Dunnigan Pipeline Alt 1 - CP No. 5

- Pipeline that connects to intake structure at TCC and flows to an outlet structure at CBD, which flows to Sacramento River
- Requires tunneled crossings under I-5 and Hwy 99/railroad with 10.5-foot casing
- Fixed-cone valves will be placed at the discharge stilling basin to dissipate energy and adjust the flow.
- Flow: 1,000 cfs, based on gravity head from TCC
- Pipe Diameter: 9 feet
- Appx Length: 4 miles (20,900 feet)
- May includes West levee improvements on CBD downstream of discharge point

Draft_0020989

From: Alicia Forsythe [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A6CDF06A7E904B65BAA21702A82AD329-AFORSYTHE]
Sent: 11/29/2022 6:30:44 PM
To: Spranza, John [John.Spranza@hdrinc.com]
Subject: RE: Sites Preliminary Construction Sequencing

Thanks John. This looks good to me. I cant seem to find the graphics on my computer but I know I have them – but we just want to use similar language for new and ongoing so the graphics and the table correspond. And we should double check that we have all of these roads and things in our project description. So if they "search" the project description, we're using similar terminology and phrasing and all of the facilities mentioned in the table are also described/included in the project description.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Tuesday, November 29, 2022 10:29 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: FW: Sites Preliminary Construction Sequencing

Here is the descriptions that Henry sent over. As I mentioned, very brief but component specific. Please let me know what you think.
Thanks,
John

John Spranza

D 916.679.8858 M 818.640.2487

From: Luu, Henry <Henry.Luu@hdrinc.com>
Sent: Tuesday, November 22, 2022 1:06 PM
To: Spranza, John <John.Spranza@hdrinc.com>; Thomas, Sean <Sean.Thomas@hdrinc.com>
Subject: RE: Sites Preliminary Construction Sequencing

Sean, please confirm if the shape files corresponding to the construction phasing figures are available and provide a link to the source.

John, are the following descriptions sufficient?

Year	Activity
1	Improve existing roads to accommodate construction vehicles: Huffmaster Rd (Peterson Rd), Maxwell Sites Rd, McDermott Rd, Delevan Rd, Sutton Rd, Wadleigh Rd, and Old Hwy 99W.

	Construct new roads: Sites Lodoga Rd, Maxwell Sites Rd Detour, and access/construction road to Golden Gate Dam vicinity.
2	Continue constructing: Sites Lodoga Rd and access/construction road to Golden Gate Dam vicinity. Improve existing roads to accommodate construction vehicles: County Rd 68, County Rd 69, and Peterson Rd. Construct new roads: North Rd, Huffmaster Rd Re-alignment, and Comm Rd. Construct mobilization/labor camp area.
3	Continue constructing: Sites Lodoga Rd. Begin construction of Golden Gate Dam (including onsite access roads and borrow/material processing facilities). Construct new access/construction road to Funks Reservoir and power interconnection facilities (i.e. electrical substations and powerlines).
4	Continue constructing: Sites Lodoga Rd, Golden Gate Dam, and power interconnection facilities. Begin construction of Sites Dam (including onsite access roads and borrow/material processing facilities) and I/O Works.
5	Continue constructing: Golden Gate Dam, Sites Dam, I/O Works, and power interconnection facilities. Begin construction of Saddle Dams (including onsite access roads and borrow/material processing facilities) and Funks Reservoir improvements/facilities.
6	Continued constructing: Golden Gate Dam, Sites Dam, I/O Works, Saddle Dams, Funks Reservoir improvements/facilities, and recreational areas. Begin construction of TRR and Dunnigan Pipeline facilities. Begin reservoir footprint clearing.
7	Continue constructing: Golden Gate Dam, Sites Dam, Saddle Dams, Funks Reservoir and TRR improvements/facilities, Dunnigan Pipeline, recreational areas, and reservoir footprint clearing. Begin construction of GCID Main Canal headwork.
8	Complete remaining portions of construction of Sites Reservoir Project by the end of year 8 (i.e. Golden Gate Dam, Sites Dam, Saddle Dams, Funks Reservoir and TRR improvements/facilities, Dunnigan Pipeline, recreational areas, and reservoir footprint clearing)

Thanks,

Henry N. Luu, PE
D 916.679.8857 M 916.754.7566

hdrinc.com/follow-us

From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Friday, November 18, 2022 9:40 AM
To: Luu, Henry <henry.luu@hdrinc.com>
Subject: FW: Sites Preliminary Construction Sequencing

Henry, Ali has a few additional items.

Can you help me with the description of activities for # 1? I'll work with ICF to get the landcover. Did you happen to create these figures using a shapefile that I could send over to ICF?

John Spranza

D 916.679.8858 M 818.640.2487

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Thursday, November 17, 2022 4:06 PM
To: Spranza, John <john.spranza@hdrinc.com>
Subject: RE: Sites Preliminary Construction Sequencing

CAUTION: [EXTERNAL] This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

These are good John. I like these a lot and I think this makes sense and is what CDFW is asking for. Two things –

1. A narrative around this would be helpful – what is generally happening each year. And then tables showing impact acres by land type and species habitat.
2. We end on year 8 and haven't showed full completion of construction. I wonder if there should be a year 9 showing everything completed?

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Tuesday, November 15, 2022 9:29 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: FW: Sites Preliminary Construction Sequencing

John Spranza

D 916.679.8858 M 818.640.2487

From: Luu, Henry <Henry.Luu@hdrinc.com>
Sent: Monday, November 14, 2022 3:16 PM
To: Spranza, John <John.Spranza@hdrinc.com>
Cc: Edwards, Dawn <Dawn.Edwards@hdrinc.com>
Subject: Sites Preliminary Construction Sequencing

John, can you let me know if the attached are sufficient for permitting assessment?

Thanks,

Henry N. Luu, PE
D 916.679.8857 M 916.754.7566

hdrinc.com/follow-us

From: Sandra Yarbrough [syarbrough@sitesproject.org]
Sent: 11/30/2022 7:14:14 AM
To: Marcia Kivett [MKivett@sitesproject.org]
Subject: FW: Press Inquiries

Well here is the response

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Tuesday, November 29, 2022 7:57 PM
To: Sandra Yarbrough <syarbrough@sitesproject.org>; Lori Jones <ljones@brwncald.com>; Cheyanne Harris <charris@brwncald.com>; Kevin Spesert <kspesert@sitesproject.org>
Cc: Joe Trapasso <jtrapasso@sitesproject.org>; Jerry Brown <jbrown@sitesproject.org>
Subject: RE: Press Inquiries

Hi all – Below is a proposed response for your review and input. This does not include providing them the comment letters as these are typically provided with the release of the Final EIR/EIS – and typically not made available earlier than the release. Let me check with Jerry tomorrow on his thoughts on this and we can send the response later this week.

Ali

Katherine – Thank you for your email. The Sites Authority and the Bureau of Reclamation released a Revised Draft Environmental Impact Report / Supplemental Draft Environmental Impact Statement (RDEIR/SDEIS) in November 2021. The public comment period closed in January 2022. Based on your email, I think you have found the link to the document, but just in case, it is available here (scroll to the bottom of the page): Environmental Review - Sites Reservoir (sitesproject.org). As part of the environmental review process, the Authority and Reclamation are reviewing all of the comments received, preparing responses to those comments and revising the document. The responses to comments and any revisions to the document will be released in the Final Environment Impact Report/Environmental Impact Statement (Final EIR/EIS). We expect to complete and release the Final EIR/EIS in May 2023. This Final EIR/EIS will include all of the comment letters received with the responses to the comments.

In general, a Statement of Overriding Considerations is required under the California Environmental Quality Act when an agency approves a project that includes significant and unavoidable environmental impacts. The Statement of Overriding Considerations is made when the agency approves the project – which happens after issuance and certification of the Final EIR. If the Authority Board chooses to approve the project, the Board will also need to make a Statement of Overriding Considerations as the RDEIR/SDEIS had, and Final EIR/EIS is expected to continue to have significant and unavoidable environmental impacts. We expect the Authority Board to consider approving the project and making a Statement of Overriding Considerations shortly after release of the Final EIR/EIS.

I will also note that the Statement of Overriding Considerations does not overcome wildlife protections or water quality regulations – meaning it does not waive statutory requirements or regulations. It would provide justification, in the view of the Authority, on how the benefits of the project outweigh the significant and

unavoidable environmental impacts. However, the Authority will continue to meet all applicable statutory requirements and regulations for the project and obtain all necessary permits and approvals.

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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Sent: Tuesday, November 29, 2022 8:47 AM
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Cc: Joe Trapasso <jtrapasso@sitesproject.org>; Jerry Brown <jbrown@sitesproject.org>
Subject: FW: Press Inquiries

Good morning,

Please see the email below that I received. I know we can send the link to the EIR/EIS from our website, but I wasn't sure about the last paragraph.

Thank You,
Sandra

From: Katherine Li <katherine_li@berkeley.edu>
Sent: Monday, November 28, 2022 8:00 AM
To: Board Clerk <boardclerk@sitesproject.org>
Cc: Hanisha Harjani <hharjani@berkeley.edu>
Subject: Press Inquiries

Dear Sites Authority Board,

Hello, my name is Katherine Li, and I'm a journalism graduate student at UC Berkeley. We are currently working on a research project regarding water sustainability and droughts in Northern California.

We are aware that the Sites Reservoir has been on the drawing board for decades, and that multiple state and federal agencies, especially the USEPA, CDFW, and CWC, are responsible for making comments and recommendations on your most recent 2020 draft and 2021 revised draft environmental impact report (EIS/EIR). We would like to ask if there is one place where we could view these recommendation documents, or if you know where to find them. Some of the recommendation and comment documents we have located are regarding the original EIR from back in 2018, but plenty has changed regarding the size and design of your project since then. It would be great if you could show us these new documents so we could have the most accurate and updated information.

We would also love to know if a Statement of Overriding Considerations (SOOC) has been prepared for the Sites, or if there is a plan to do so. The California Water Commission had recommended that the Sites prepare such a statement as the lead agency under CEQA, to overcome wildlife protection and water quality regulations. This recommendation was

mentioned in a December 2021 CWC continuing eligibility and feasibility determination document, and we would like to know if the Sites have taken action regarding this recommendation.

Thank you so much!

Regards,
Katherine Li

Katherine Li (she/her)
UC Berkeley Graduate School of Journalism
(510) 365 6496
https://twitter.com/Katherineli

From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 11/30/2022 8:08:49 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: RE: Sites Preliminary Construction Sequencing

Sounds good. I'll get the PD searched.

John Spranza

D 916.679.8858 M 818.640.2487

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Tuesday, November 29, 2022 6:31 PM
To: Spranza, John <john.spranza@hdrinc.com>
Subject: RE: Sites Preliminary Construction Sequencing

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Thanks John. This looks good to me. I cant seem to find the graphics on my computer but I know I have them – but we just want to use similar language for new and ongoing so the graphics and the table correspond. And we should double check that we have all of these roads and things in our project description. So if they "search" the project description, we're using similar terminology and phrasing and all of the facilities mentioned in the table are also described/included in the project description.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Tuesday, November 29, 2022 10:29 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: FW: Sites Preliminary Construction Sequencing

Here is the descriptions that Henry sent over. As I mentioned, very brief but component specific. Please let me know what you think.
Thanks,
John

John Spranza

D 916.679.8858 M 818.640.2487

From: Luu, Henry <Henry.Luu@hdrinc.com>
Sent: Tuesday, November 22, 2022 1:06 PM
To: Spranza, John <John.Spranza@hdrinc.com>; Thomas, Sean <Sean.Thomas@hdrinc.com>
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Thanks,
Henry H. Luu, PE
D 916.679.8857 M 916.754.7566

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Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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John, can you let me know if the attached are sufficient for permitting assessment?

Thanks,
Henry H. Luu, PE
D 916.679.8857 M 916.754.7566

hdrinc.com/follow-us

Progress Report

Life Cycle Modeling for the Sites Reservoir Project

Agreement number A22-0879

September 2022 - October 2022

General Project Updates

Task 1:

During this reporting period, UCSC completed and delivered draft results for Task 1 scenarios and completed an associated WRLCM Model Description. During a meeting with Sites Authority on October 11th to discuss draft results, we discussed the need to re-run the WRLCM using modified Bend Bridge flows to better represent outmigration survival from the Sacramento River. Steve Micko (Jacobs Consulting) provided updated Bend Bridge flows to UCSC/QEDA on October 25th. UCSC/QEDA plan to provide updated WRLCM results using modified Bend Bridge flows in late November.

Task 2:

Task 2 scenarios will be dependent on review of Task 1 results which will require a shift in the deliverable schedule (Ann-Marie Osterback, PI at UCSC, sent an example updated deliverable schedule during the last reporting period). This shift will likely require a No Cost Time Extension for the contract to accommodate model runs for all 3 tasks before the contract ends.

Subtask 1: Project Management

Dr. Ann-Marie Osterback served as the primary contact for this reporting period. She coordinated project timeline and work products between Sites Authority, UCSC, and QEDA, and also held monthly internal meetings with UCSC and QEDA to discuss project timeline and deliverables. Dr. Osterback also coordinated deliverables between QEDA, UCSC and Sites Authority, and communicated any changes to the deliverable timeline to Sites Authority.

Subtask 2: Database Management

During this reporting period, Sara John updated the SQLite covariate database to include modified Bend Bridge flows provided by Steve Micko (Jacobs Consulting) for Task 1.

Subtask 3: Generate Habitat Capacity Estimates

Sara John and Dr. Miles Daniels generated final figures for Task 1 scenarios using the specified formatting requested by Sites Authority. They improved graphical representation of figures, and included additional information on yolo access to aid in interpreting results.

Both Ms. John and Dr. Daniels met with team members regularly to discuss interpretation of results and improve graphical presentation of habitat capacity outputs.

Subtask 4: Generate Delta Smolt Survival Estimates

Part A (QEDA Consulting):
No work was conducted under Subtask 4 during this reporting period.

Part B (UC Santa Cruz):
Dr. Simone Olivetti generated final figures for Task 1 scenarios using the specified formatting requested by Sites Authority and improved graphical representation of figures.

Both Dr. Jackson and Dr. Olivetti met with team members regularly to discuss results and improve graphical presentation of ePTMv2 outputs.

Subtask 5: Generate WRLCM results

During the reporting period, Doug Jackson and Noble Hendrix completed the initial round of Sites alternatives using a 2035 climate scenario and evaluating the no action alternative (NAA), alternative Alt3A, and alternative Alt3B. They generated draft figures and reports summarizing results. Noble Hendrix conducted additional analysis to evaluate the role of underlying physical drivers (flow, temperature) in affecting WRLCM results. Dr. Hendrix and Dr. Jackson attended several internal meetings to discuss Task 1 deliverables.

Dr. James Gilbert provided CalSim expertise to interpret how proposed scenarios would contribute to changes in flow dynamics and affect WRLCM submodel and WRLCM results.

Subtask 6: Communicating WRLCM results

On October 11th, Dr. Noble Hendrix, Dr. Ann-Marie Osterback, Dr. Simone Olivetti, and Dr. Eric Danner presented WRLCM and submodel results for Task 1 scenarios to Sites Authority. During that meeting, there was discussion about the need to re-run the WRLCM using modified Bend Bridge flows to better represent outmigration survival from the Sacramento River. Steve Micko (Jacobs Consulting) provided updated Bend Bridge flows to UCSC/QEDA on October 25th. Dr. Noble Hendrix and Dr. Doug Jackson began a second round of WRLCM model runs using modified flows that incorporate Sites Diversions on flows below Bend Bridge, which affect the flow-survival relationship of smolts originating from the upper river and lower river rearing habitats.

UCSC/QEDA plan to provide updated WRLCM results using modified Bend Bridge flows in late November.

Completed Deliverables

UCSC-01-02: Provide summary of WRLCM population metrics (e.g. CRR and escapement), Delta smolt survival by month, and habitat capacity by month for Task 1 scenarios

On September 21st, Dr. Osterback (PI) emailed John Spranza (HDR) the WRLCM and submodel draft results for Task 1 scenarios.

UCSC-01-04: Provide WRLCM model description (e.g. description of model structure and assumptions)

On October 10th, Dr. Osterback (PI) emailed John Spranza (HDR) the WRLCM Model Description that describes the model transition equations, parameter estimates, and the assumptions used within the WRLCM.

Project Expenditures

We spent a total of $32,647.76 during this reporting period.

Expense Category	***Expenditures***
Salaries	$3,944.97
Benefits	$1,254.68
Subcontracts (QEDA)	$23,963.00
Indirect Costs	$3,485.11
Total	**$32,647.76**

From: Lori Jones [LJones@BrwnCald.com]
Sent: 11/30/2022 8:47:23 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: RE: Press Inquiries

Alicia:

The response is well worded. My suggestions are noted below.

Thank you,
Lori

Lori Jones, P.E., PMP
Brown and Caldwell | Walnut Creek, CA
LJones@brwncald.com
T 925.210.2272 | **C** 707.761.4242

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Tuesday, November 29, 2022 7:57 PM
To: Sandra Yarbrough <syarbrough@sitesproject.org>; Lori Jones <LJones@BrwnCald.com>; Cheyanne Harris <CHarris@BrwnCald.com>; Kevin Spesert <kspesert@sitesproject.org>
Cc: Joe Trapasso <jtrapasso@sitesproject.org>; Jerry Brown <jbrown@sitesproject.org>
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Ali

Katherine – Thank you for your email. The Sites Authority and the Bureau of Reclamation released a Revised Draft Environmental Impact Report / Supplemental Draft Environmental Impact Statement (RDEIR/SDEIS) in November 2021. The public comment period closed in January 2022. Based on your email, I think you have found the link to the document, but just in case, it is available here (scroll to the bottom of the page): Environmental Review - Sites Reservoir (sitesproject.org). As part of the environmental review process, the Authority and Reclamation are reviewing all of the comments received, preparing responses to those comments and revising the document. The responses to comments and any revisions to the document will be released in the Final Environment Impact Report/Environmental Impact Statement (Final EIR/EIS). We expect to complete and release the Final EIR/EIS in May 2023. This Final EIR/EIS will include all of the comment letters received with the responses to the comments.

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~~expected to continue to have significant and unavoidable environmental impacts.~~ We expect the Authority Board to consider approving the project and making a Statement of Overriding Considerations shortly after release of the Final EIR/EIS.

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Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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Good morning,

Please see the email below that I received. I know we can send the link to the EIR/EIS from our website, but I wasn't sure about the last paragraph.

Thank You,
Sandra

From: Katherine Li <katherine_li@berkeley.edu>
Sent: Monday, November 28, 2022 8:00 AM
To: Board Clerk <boardclerk@sitesproject.org>
Cc: Hanisha Harjani <hharjani@berkeley.edu>
Subject: Press Inquiries

Dear Sites Authority Board,

Hello, my name is Katherine Li, and I'm a journalism graduate student at UC Berkeley. We are currently working on a research project regarding water sustainability and droughts in Northern California.

We are aware that the Sites Reservoir has been on the drawing board for decades, and that multiple state and federal agencies, especially the USEPA, CDFW, and CWC, are responsible for making comments and recommendations on your most recent 2020 draft and 2021 revised draft environmental impact report (EIS/EIR). We would like to ask if there is

one place where we could view these recommendation documents, or if you know where to find them. Some of the recommendation and comment documents we have located are regarding the original EIR from back in 2018, but plenty has changed regarding the size and design of your project since then. It would be great if you could show us these new documents so we could have the most accurate and updated information.

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Thank you so much!

Regards,
Katherine Li

Katherine Li (she/her)
UC Berkeley Graduate School of Journalism
(510) 365 6496
https://twitter.com/Katherineli