Fish and Aquatic Habitat Collaborative Effort

Final Program Environmental Impact Report

Appendix Volume II

Santa Clara Valley Water District

State Clearinghouse #2015022008

Santa Clara County, California

June 30, 2023

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Appendix Volume II – Contents

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Appendix G

Valley Water Daily WEAP Model Technical Memorandum

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VALLEY WATER DAILY WEAP MODEL TECHNICAL MEMORANDUM

Valley Water

Clean Water • Healthy Environment • Flood Protection

VALLEY WATER
DAILY WEAP MODEL

SUBMITTED TO SUPPORT THE EIR SUBMISSION

Submitted to:

Valley Water

Prepared by:

The Stockholm Environmental Institute and Valley Water

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DISCLAIMER:

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I. Introduction and Purpose

The Fisheries and Aquatic Habitat Collaborative Effort ("FAHCE") Modeling Study Plan is intended to address regulatory and stakeholder concerns about the methods and information used to evaluate the effects of the FAHCE Reservoir Re-operation Rules as required by CEQA. Based on these concerns, the parties to the FAHCE Agreement committed to an effort to: evaluate options to refine the temporal and spatial resolution of the flow and temperature modeling of the Three Creeks (Coyote Creek, Guadalupe River, and Stevens Creek), decide on the best approaches to improve the flow modeling, and implement such modifications (see Activities 2, 3, 5 and 7 of the FAHCE Modeling Study Plan).

This technical memorandum fulfills the requirements of Activities 2, 3, 5 and 7 of the FAHCE Modeling Study Plan and documents a new daily model developed with WEAP to support the CEQA analysis. As part of the FAHCE Modeling Study Plan, the Technical Working Group (TWG) decided to pursue disaggregation of the monthly model to a daily time step, which is better suited to evaluate the effects of water supply operations on key variables related to fish habitat.

The purpose of this memorandum is to document the work done in developing a daily model to provide spatially disaggregated information of ecological relevance at the defined POIs. It describes the development and calibration of the model for the period 1990-2014, the assumptions and sources of uncertainty of the model, metrics assessing the ability of the model to produce results consistent with historically observed river flows and reservoir storage values, development of model alternatives, and the results of model that support the evaluation of alternatives as part of the FAHCE-related CEQA analysis.

As part of the FAHCE Modeling Study Plan, the FAHCE Technical Working Group identified reaches of interest (ROI), which establish a life-stage specific framework to guide the location of Points of Interest (POI). The details of the definition of the ROIs and POIs can be found in the "Methods for Establishing Reaches of Interest and Points of Interest" EIR Appendix H, and the location of the 39 POIs where the TWG felt that habitat metrics should be assessed is shown in Figure 1. This memo describes the data processing required to spatially disaggregate areas adjacent to the ROIs in order to simulate runoff at the POIs by modeling the storm-water runoff process within the WEAP model. Modeling these spatially disaggregated processes required data on temperature, precipitation, and percent of pervious area, and the calibration of the hydrological model used to simulate urban storm-water hydrology.

This report also discusses how the base case and FAHCE alternative scenarios were built, based on the calibrated historical WEAP model and for the time frame of 1990-2014. While the historically calibrated WEAP model contains operations that may change from one year to the next based on known historical conditions (for example, changes in reservoir storage capacity due to dam seismic safety concerns), the operations in the base case and FAHCE alternatives do not change on a year-to-year basis. In this process, iterative feedback from the District on several rounds of modeled output (reservoir volumes, inflows, and discharges; transfer volumes; and groundwater storage) helped refine the base case operations and the implementation of FAHCE rule curves in the WEAP model to better match the District's expectations and understanding of the Three Creeks system. The FAHCE Plus scenarios were designed to address this feedback.

This final section of this report contains key model results and graphs of hydrologic and hydraulic WEAP outputs that feed into habitat metrics (depth, velocity, temperature). Given that the full set of model outputs that feed into habitat metrics is extensive, only a sample of results are included in this report~~; full results are available on a Tableau Platform, and are reflected in EIR Appendix R, “Model Outputs”~~.

Note that results and outputs from modeling of Coyote Creek are excluded, as a separate environmental impact study will be conducted for the Anderson Dam Seismic Retrofit Project (ADSRP). However, information on Coyote Creek related to model development necessary to understand the development of the larger Three Creeks System was retained, given that the system is interconnected via pipelines, canals and groundwater aquifers.

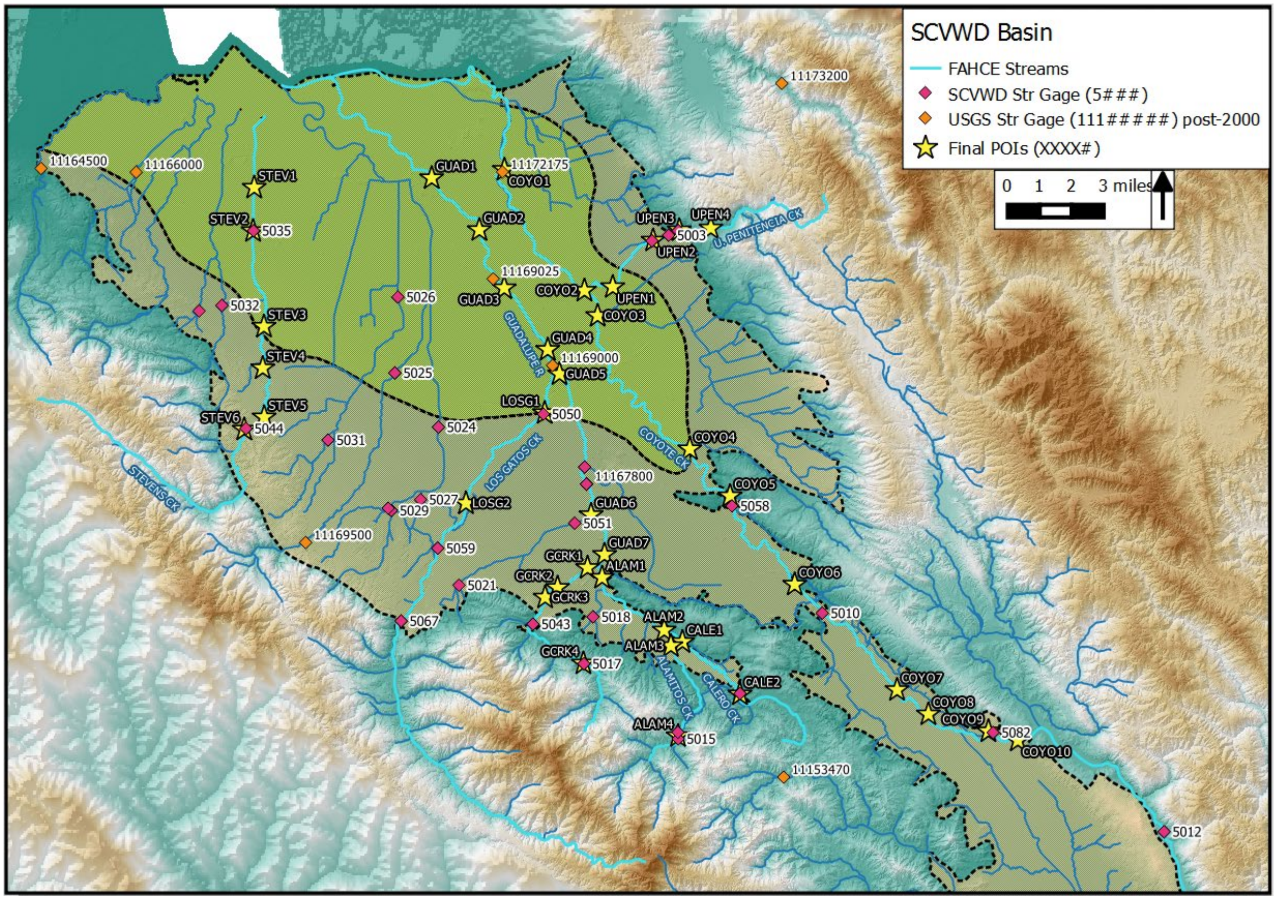

Figure 1. Extent of storm-water accretion assessment and representation in WEAP

II. Modeling Approach

In this section, we describe the original monthly Valley Water WEAP planning model and the steps required to disaggregate it into a daily time step model with higher spatial resolution in order to obtain flow and other relevant habitat characteristics at the POIs.

A. Model Time Horizon

The model time horizon was set to 1990-2010; a period for which sufficient data was available to implement the daily model, and a period comprised of an interesting variation of water year types, varying from critically dry to wet, in a historically representative order, such that the results of alternative scenarios could be compared under a variety of conditions (*Appendix 1. Water Year Types in the 1990-2010 period*).

B. Monthly Model

The Valley Water WEAP monthly model, used as a basis for development of the daily model, is the result of a modeling endeavor that started in the mid-1990s. The initial version of the model used for FAHCE was based on Lotus 1-2-3 spreadsheets and code that were then converted to Excel spreadsheets. The models used a monthly time step and included a representation of reservoir rule curves. An earlier water supply planning model used by Valley Water (which included mainframe computer models and desktop models programmed using Extend) had an annual time step. In the early 2000s, Valley Water water supply planning staff began using the WEAP platform as a data repository and analysis tool. In the following years, continuous improvements of WEAP followed, which led to the completion of a robust model at a monthly time step that included imported water allocations from CalSim II, monthly local supplies, monthly local demands, and, for some particular years, restrictions on reservoir storage due to dam seismic safety concerns. In addition to the input data, the model also covered current operations focused on supplying retailers' demands and the delivery of water to groundwater recharge facilities (grey boxes in Figure 2). The main outputs extracted from the model were focused on water supply reliability and demand coverage. A detailed description of the pre-existing model is found in Appendix N of the EIR, the "Water Supply Planning Modeling Technical Memorandum"[1] , which is a compilation of information about the hydrology, facilities, and the system operations that are built into the monthly model.

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[1] Water Supply Planning Modeling Technical Memorandum Santa Clara Valley Water District Fish and Aquatic Habitat Collaborative Effort Program and Fish Habitat Restoration Plan EIR Environmental Impact Report Santa Clara County, August 27, 2015

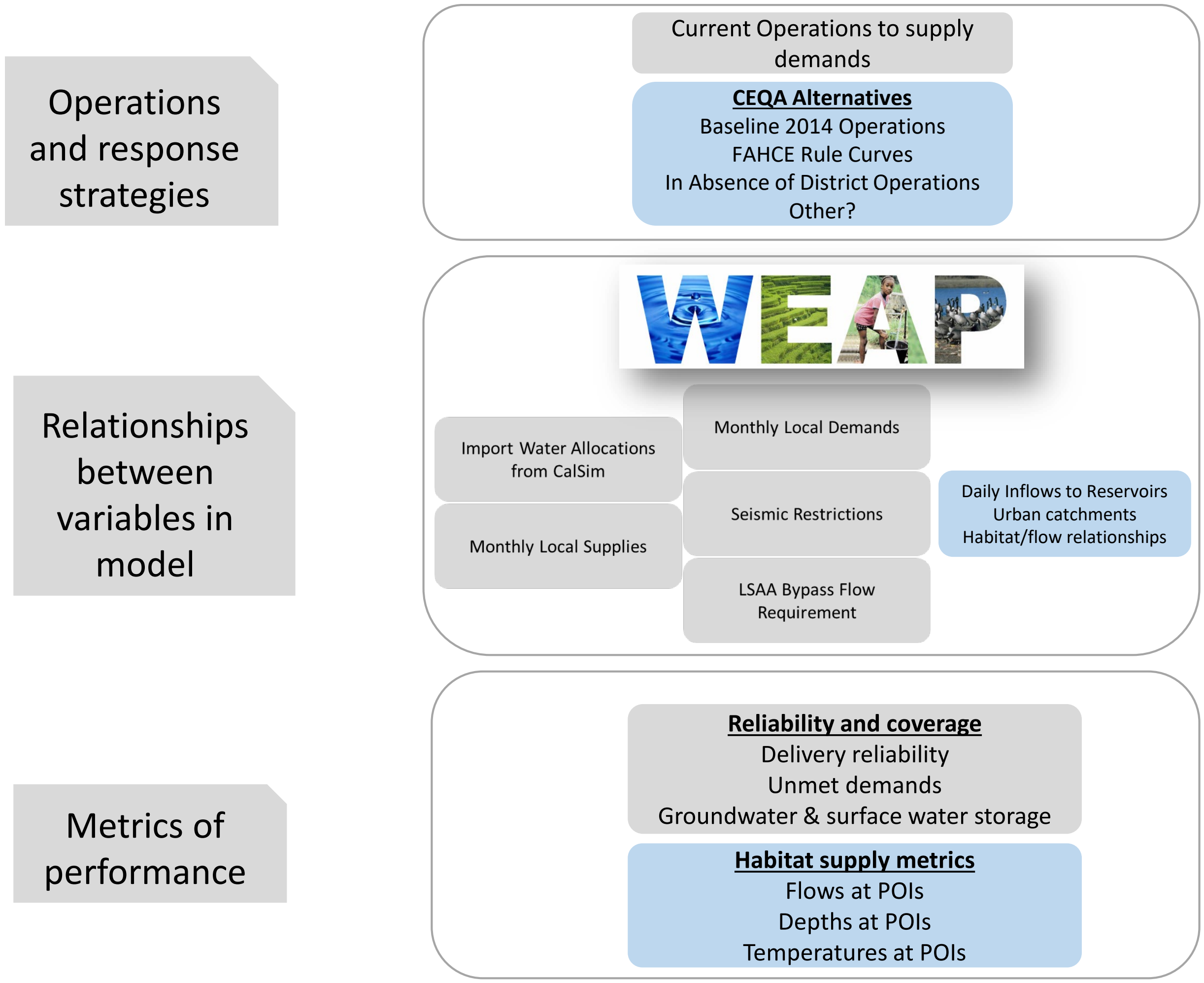

Figure 2. WEAP model data input and relationships
Including operations and metrics of performance included in the monthly model (in gray),
and expected to be obtained through the FAHCE Modeling Study Plan (in blue)

C. Daily Model

The primary objective of disaggregating the existing monthly Valley Water WEAP model was to simulate flow conditions at specific POIs with sufficient temporal variability to reasonably assess habitat variables as they would be experienced by steelhead trout and Chinook salmon during three life stages (migration, spawning and rearing) in a stream network with a flashy hydrological regime. The TWG decided to shift to a daily model in light of the inability of monthly average data to represent actual river conditions. This decision was facilitated by the fact that data analysis carried out early in the FAHCE Modeling Study Plan implementation indicated that there was sufficient data to make this shift. Data sets analyzed included information on climate, reservoir storage, streamflow, and precipitation. In addition to temporal disaggregation, a spatial disaggregation was deemed both feasible and necessary, based on data available from storm drain outfalls and in order to assess flow conditions at specific POIs. Other datasets associated with habitat metrics at the POIs, such as stage-discharge relationships and water temperature regressions, were also gathered and entered into the modified WEAP model. The temporal and spatial disaggregation of the monthly model, including the possibility of implementing depth and temperature simulation, required four main activities:

Disaggregate monthly to daily time step

This activity, focused on time step disaggregation, required estimating daily values for the following key elements of the model: Recharge Pond Operation Rules, water retailer demands, treated water demands, treated water supplies, recycled water supplies, surface water supplies, and imported water supplies from the Sacramento-San Joaquin Delta. The time disaggregation of these elements is described in detail in the section "Disaggregation of Monthly Input Files".

Model urban catchments for storm water disaggregation

Data gathered to represent contributing areas to storm drains discharging to FAHCE streams showed the feasibility of preparing a spatially and temporally disaggregated model that includes urban storm-water runoff. Such disaggregation can be useful to estimate inflows from urban areas, which in turn allows for the estimation of other ecological variables at POI locations. This approach required the creation of WEAP catchment objects to represent urban accretions and the processing of precipitation data to be entered into the Valley Water WEAP daily model. This procedure is described in detail in the section "Urban Catchments".

Estimate reservoir inflows

Because observed continuous and complete reservoir inflow volumes were not available, inflows to reservoirs were calculated based on a mass balance approach, which required estimating evaporation and other losses. Sources of data uncertainty in this approach came from errors in reservoir elevation data, evaporation loss estimates and other losses not directly accounted for (e.g. seepage). The process associated with this method is described in the section "Inflows to Reservoirs".

Incorporate HEC-RAS modeled stage-discharge relationships into WEAP

Since flow depth is a key output for ecological metrics, stage-discharge curves to obtain depth outputs from flow estimates within WEAP were included. Using available HEC-RAS models, updated based on surveys conducted at the POIs, updated stage-discharge curves were generated, as described in Appendix J of the EIR "White Paper on Work Flow of the HEC-RAS Cross Section Analysis"; these were included in WEAP to streamline the calculations required to turn WEAP flow estimates into depths. This is described in more detail in the section "Stage-Discharge Relationships".

Incorporate water temperature correlations into WEAP

Water temperature correlations were developed for historical conditions by the HDR team based on available data (see Appendix I of the EIR). These correlations were refined for a daily time step in order to be included in the daily time step WEAP model. These correlation functions were incorporated at the POIs using coefficients defined for each site. A brief description of how the correlations were incorporated into WEAP is included in the section "Water Temperature".

The following sub-sections of this memo include descriptions of the five main activities outlined above.

D. Disaggregation From a Monthly to a Daily Time Step

The disaggregation of the Valley Water monthly model required the identification of monthly data that was read into the model using the "*ReadFromFile" or* "*MonthlyValues"* functions and of model logic that assumed that the model was running on a monthly time step. The "*ReadFromFile"* function in WEAP is used to input data from CSV-type files stored in the model directory. These files contain data from 1990-2015 (the time horizon of the monthly model), out of which we used 1990-2010 (the period defined for the daily model).

1. *Disaggregation of Files and Operation Functions*

Table 1 shows examples of the data files identified in the disaggregation process and the disaggregation approach used. For instance, agriculture demands were presented in the CSV files as Acre-Feet per month, and to disaggregate the monthly value, each cell was divided by the corresponding number of days in each month. Other data, such as the artificial recharge, was in AF per day in the CSV files, so the corresponding value was repeated for all days. Since the "*ReadFromFile"* function uses columns to read in variables, the column for each variable was preserved, maintaining the syntax of the functions in the monthly time step WEAP.

Table 1. Characteristics of the Valley Water WEAP model input files and disaggregation method

CSV File Name	Variable in WEAP	Unit	Disaggregation method
ag_Demand2010, ag_Demand2015, ag_Demand2020, ag_Demand2025, ag_Demand2030, ag_Demand2035, ag_Demand2040,	Agricultural water demand	AF per month	Divided by the number of days
recharge_data	Artificial recharge	AF per day	Repeat
mi_Demand2010, mi_Demand2015, mi_Demand2020, mi_Demand2025, mi_Demand2030, mi_Demand2035, mi_Demand2040,	Water demand	AF per month	Divided by the number of days
Ngwy	Natural groundwater recharge	AF per month	Divided by the number of days
rainfall	Rainfall	Inches per month	Divided by the number of days
res_inflow	Reservoir inflow	AF per month	Divided by the number of days
recycled, recycled2010, recycled2015, recycled2020, recycled2025, recycled2030, recycled35, recycled2040	Projected recycled water supplies	AF per month	Divided by the number of days

The WEAP function "*MonthlyValues"* is used to enter data directly without making reference to an external CSV file. In the case of the Valley Water WEAP monthly model, this function is used for data associated with "*Flood Rule Curves*" and "*Transfer Rule Curve*" in reservoirs. Table 2 shows examples of disaggregation to daily time step using logic conditionals such as *"If"*, *"And"* and *"TS",* the latter being used to make reference to a particular time step. The syntax uses the monthly values, making them applicable to the time step of the year that the values are valid within each month. Table 2 shows the syntax used for two different types of disaggregation: for the flood rule curve, and for the accretion flow use factor.

Table 2. Disaggregation of the data input as "MonthlyValues"

Example	Expression in monthly model	Expression in daily model
1. Lexington flood rule curve	*MonthlyValues(Jan, 16.1, Feb, 17.8, Mar, 18.933, Apr, 19.044, May, 19.044, Jun, 19.044, Jul, 19.044, Aug, 19.044, Sep, 17.363, Oct, 15.681, Nov, 14, Dec, 14)*	*If(And(TS>=Jan 1,TS<=Jan 31),16.1,And(TS>=Feb 1,TS<=Feb 29),17.8,And(TS>=Mar 1,TS<=Mar 31),18.933,And(TS>=Apr 1,TS<=Apr 30),19.044,And(TS>=May 1,TS<=May 31),19.044,And(TS>=Jun 1,TS<=Jun 30),19.044,And(TS>=Jul 1,TS<=Jul 31),19.044,And(TS>=Aug 1,TS<=Aug 31),19.044,And(TS>=Sep 1,TS<=Sep 30),17.363,And(TS>=Oct 1,TS<=Oct 31),15.681,And(TS>=Nov 1,TS<=Nov 30),14,And(TS>=Dec 1,TS<=Dec 31),14)*
2. Accretion flows utilization factor	*MonthlyValues(* ***Jan***, *0.25,* ***Feb***, *0.25,* ***Mar***, *0.25,* ***Apr***, *0.25,* ***May***, *0.75,* ***Jun***, *1,* ***Jul***, *1,* ***Aug***, *1,* ***Sep***, *1,* ***Oct***, *1,* ***Nov***, *0.75,* ***Dec***, *0.25)*	*If(And(TS>=Jan 1,TS<=Jan 31),0.25,And(TS>=Feb 1,TS<=Feb 29),0.25,And(TS>=Mar 1,TS<=Mar 31),0.25,And(TS>=Apr 1,TS<=Apr 30),0.25,And(TS>=May 1,TS<=May 31),0.75,And(TS>=Jun 1,TS<=Jun 30),1,And(TS>=Jul 1,TS<=Jul 31),1,And(TS>=Aug 1,TS<=Aug 31),1,And(TS>=Sep 1,TS<=Sep 30),1,And(TS>=Oct 1,TS<=Oct 31),1,And(TS>=Nov 1,TS<=Nov 30),0.75,And(TS>=Dec 1,TS<=Dec 31),0.25)*

Note: ***TS:*** *Time step*

2. Verification of Daily Disaggregation

Whether the base model is run at a monthly time step or a daily time step, it is the same system being modeled. Therefore, one would expect that the overall system response be similar once the monthly model hydrology and operating logic have been disaggregated to a daily time step. To test the veracity of this expectation, both monthly and daily models were run for the 1990-2010 time period before additional modifications were made to the daily model (i.e. variable storm-water inflows). The results of the two runs were then compared to ensure that the disaggregated daily model successfully preserved the overall behavior of the monthly model. Note that with this step, no conclusion about the validity of either model is made nor sought; instead, this comparison serves to instill confidence that the monthly to daily disaggregation of various expressions and datasets was done correctly and are functional at the daily time step. This assessment was done by looking at specific model outputs, such as inflows to reservoirs, water demand, reservoir storage, reservoir outflow, groundwater storage, recharge, demand coverage and streamflow at existing POIs. The daily model behavior should nearly match that of the monthly model for these variables, with slight differences being acceptable due to an understanding that daily streamflow may fluctuate more than monthly average streamflow. The other reason why one should not necessarily expect the model output to match perfectly is because much of the model logic is based on the application of if-then threshold logic. Obviously the moment at which such thresholds are encountered in a monthly model can only be the beginning of the month, while it could realistically happen within a month or a daily time step. In these types of comparisons, however, it is always good to see that the output match up at call conditions as this is where physical constraints defining call/not call conditions control model output.

Table 3 shows the criteria used to compare the monthly vs daily results.

Table 3. Criteria for comparing results of monthly and daily models after input files disaggregation

Performance measure	Monthly model	Daily Model
Reservoir inflow	Streamflow in CFS	Monthly average streamflow in CFS
Reservoir storage volume	Storage volume in AF	Storage volume of the last day of the month in AF
Volume release	Discharge volume in AF	Daily sum of discharge water in a month in AF
Water demand	Demand volume in AF	Daily sum of water demand in a month in AF
Demand coverage	Percentage coverage	Monthly average of daily coverage in percentage
Groundwater storage	Storage AF	Storage volume of the last day of the month in AF
Recharge	Recharge volume in AF	Daily sum of recharge water in a month in AF

Figure 3 shows the comparison of the monthly and daily model results in terms of the simulated reservoir storage. Note that the results for both the monthly and daily models shown here are from model versions that were current at the time of verification of the disaggregation process (July 2016).

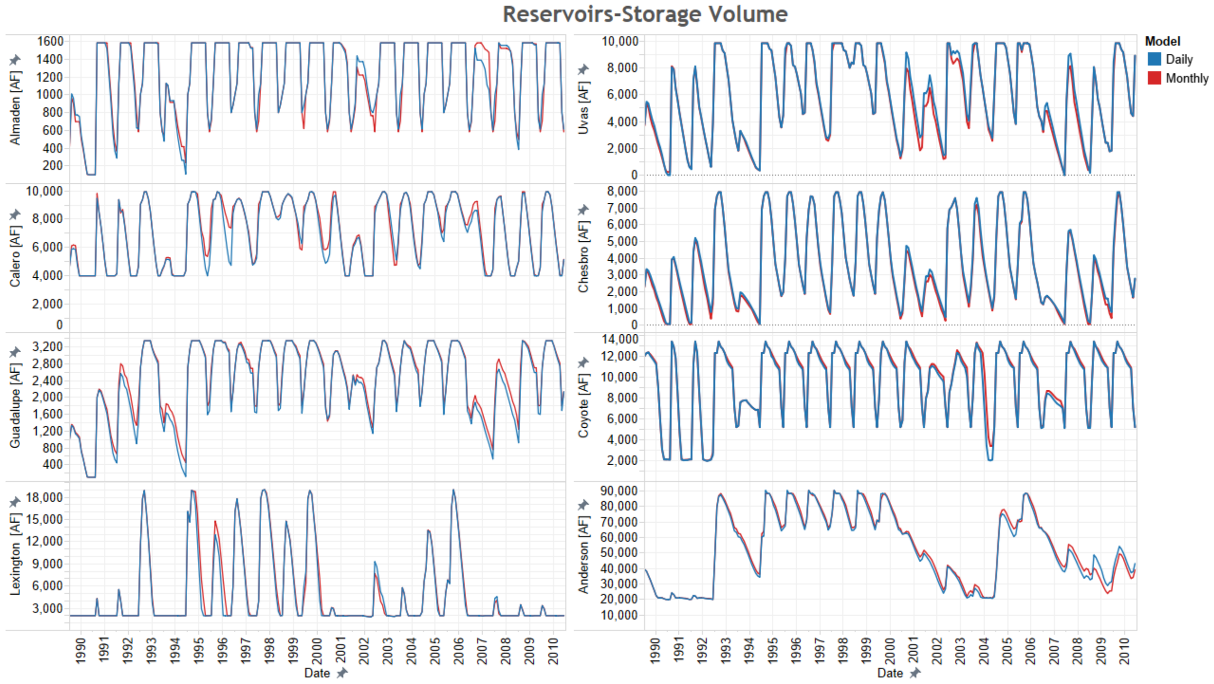

Figure 3. Reservoir storage volume of Valley Water WEAP daily vs monthly models

The daily model reservoir storage volume has a similar trace as the monthly model, which means that the disaggregation process for files and operation rules in WEAP is reliable. Groundwater storage offers another way to verify the disaggregated model; Figure 4 shows a comparison between the results of the daily model and the monthly model (July 2016). Again, the results seem to be similar, despite the fact that the daily model slightly underestimates the stored volume in relation to the monthly model in the two FAHCE relevant aquifers during the 1993-1996 interval. These deviations, which are likely related to the assumed timing of stream accretions in the winter months in the monthly model, were deemed acceptable. In conclusion, the daily model captures the baseline operations of the Valley Water system in a manner consistent with the representation contained in the monthly model. This is an important conclusion as in the effort to produce a daily model suitable to support the FAHCE analysis, we are assuming that the District's monthly model represents the best description of the District's current operations. That these operations are captured when the identical model is at a daily time step creates a point of departure for the modification of the daily model as imagined in the FAHCE Modeling Study Plan.

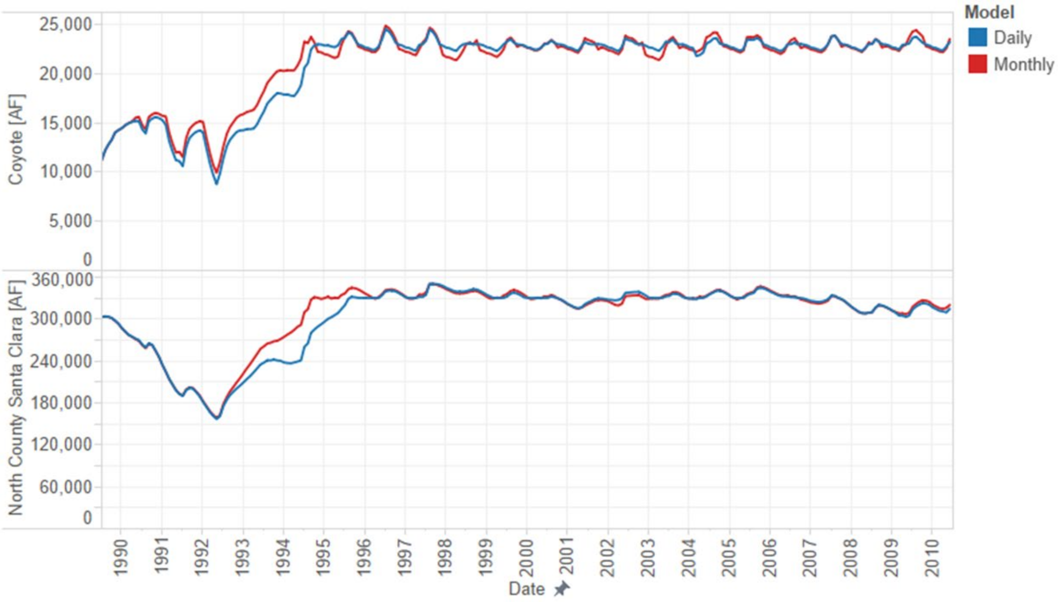

Figure 4. Daily and monthly model aquifer storage after input files disaggregation

E. Modeling Urban Catchments

To expand the spatial scope of the existing WEAP model and ensure storm-water accretions to FAHCE steams are well-represented, it was deemed necessary to model storm-water runoff from surrounding urban catchments. In the monthly model, such accretions are crudely represented in reaches of major streams, upstream of the unconfined/confined groundwater zone boundary (i.e., the zone available for aquifer recharge). This simplification is due to the fact that these storm-water accretions occur downstream of major reservoirs, and therefore do not bear significant implications upon District operations, which focus on delivering water to treatment plants and to recharge ponds located in the unconfined zone. However, the influence of these storm-water accretions can greatly affect streamflow at the POIs, especially at the daily time step, and therefore they needed to be represented in the Valley Water WEAP daily model as part of the FAHCE modeling.

Accretions from storm-water were evaluated between the furthest downstream POIs in the FAHCE streams and the nearest major upstream dam, which constitutes the majority of the study area.

1. Data Utilized

Unique storm-water runoff zones were delineated upstream of each POI using GIS data provided by the District. This data consists of both the network of storm drains and storm drain outfall points, and their corresponding contributing areas, which constitute 1624 polygons or sections of the storm-water system that drain to streams (each of the red polygons in Figure 5). The location of storm-water outfall as well as approximations of the percentage of impervious area of each of these catchments was also calculated.

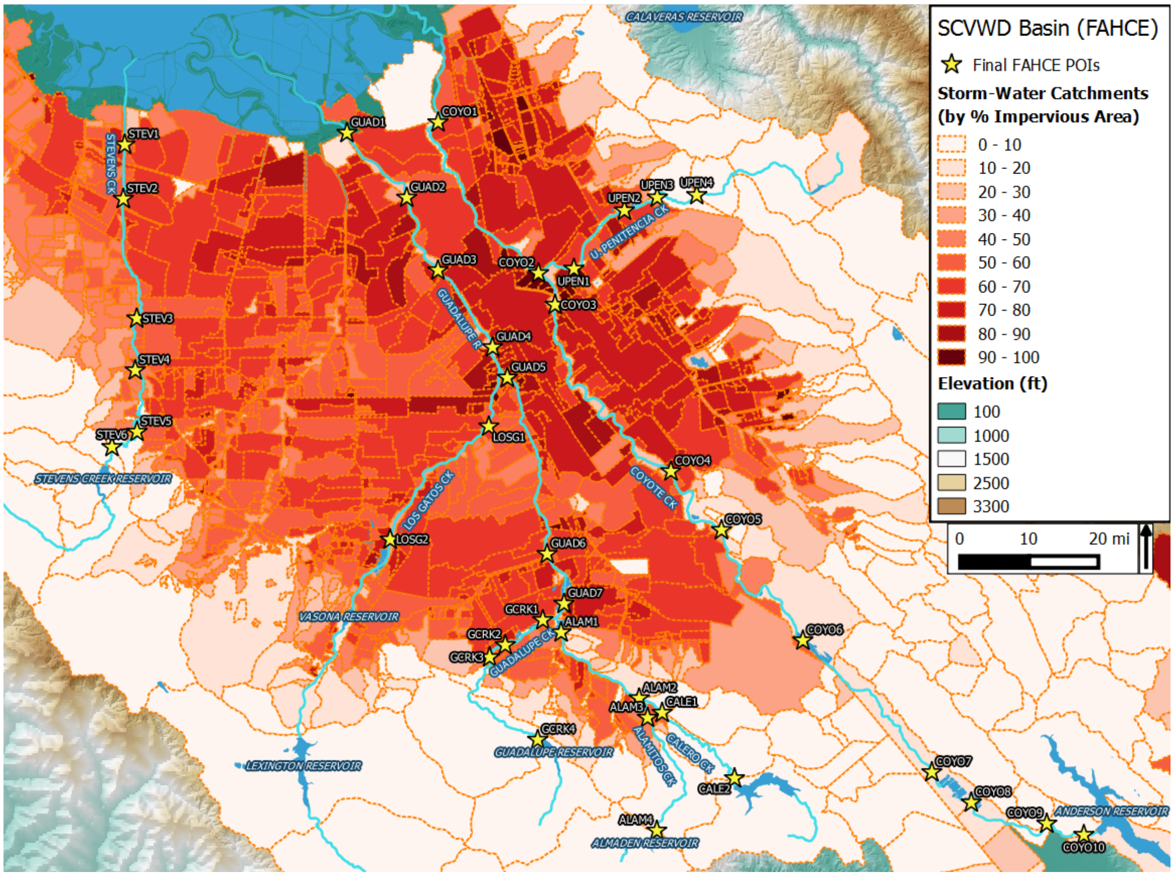

Figure 5. Storm-water catchments by percent of impervious area

The urban storm-water polygons whose runoff contributes to FAHCE streams/tributaries below major dams were identified. Among 1624 total polygons, the 750 highlighted in yellow in Figure 6 were selected to be included in the daily WEAP model.

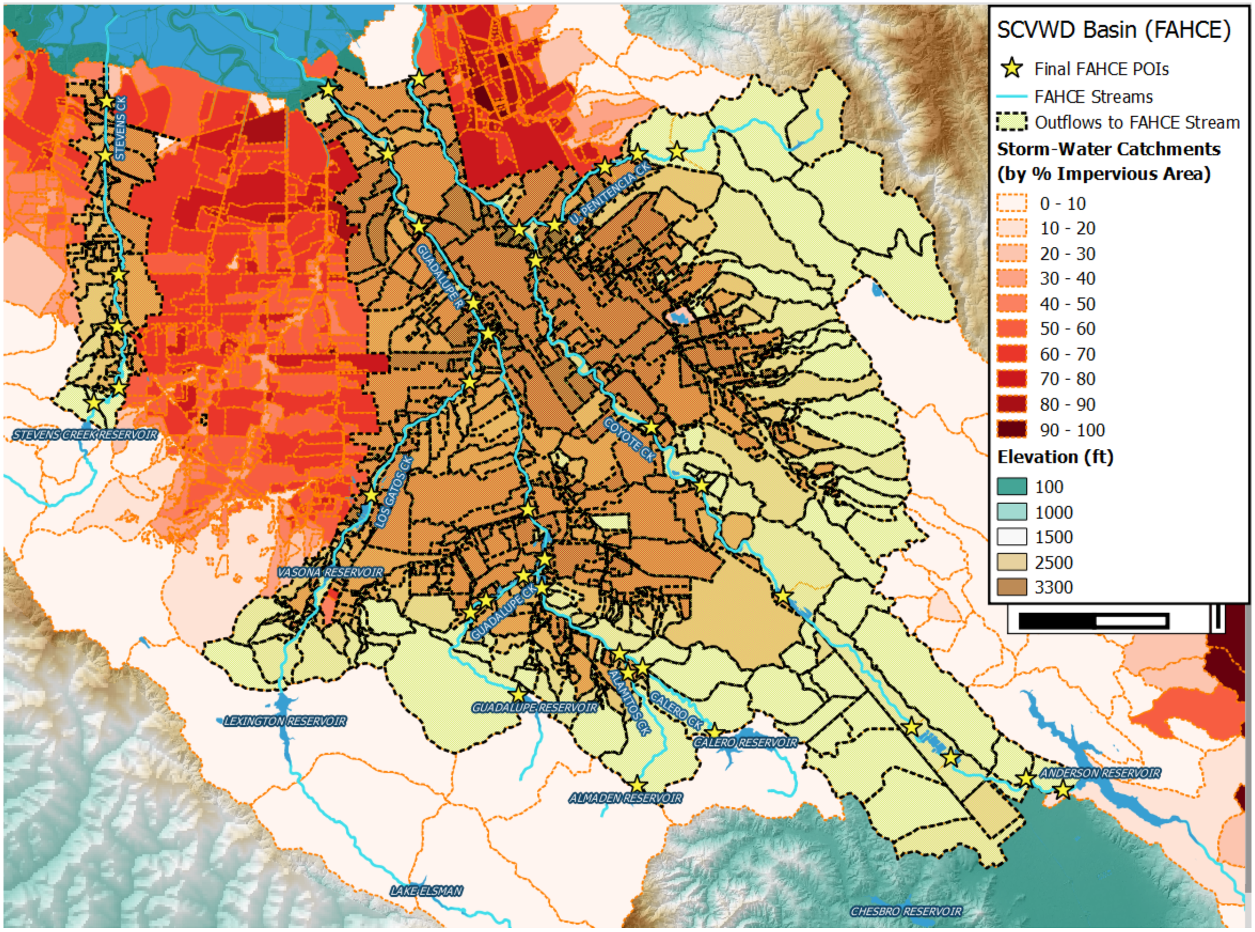

Figure 6. Storm-water catchments that drain to FAHCE streams

Precise storm-water outfall points were collected from various municipal databases[2], and used to understand the runoff routing network in order to identify the specific stream reaches to which each urban storm-water polygon contributes runoff. A close-up example of a storm drain basin, collector network, and outfall points along a portion of Stevens Creek is shown below in Figure 7.

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[2] Databases for storm drain data were collected from various sources, and summarized for the purpose of this model update by Jack Xu, Associate Civil Engineer, Hydrology, Hydraulics, and Geomorphology Unit from Valley Water in January, 2016

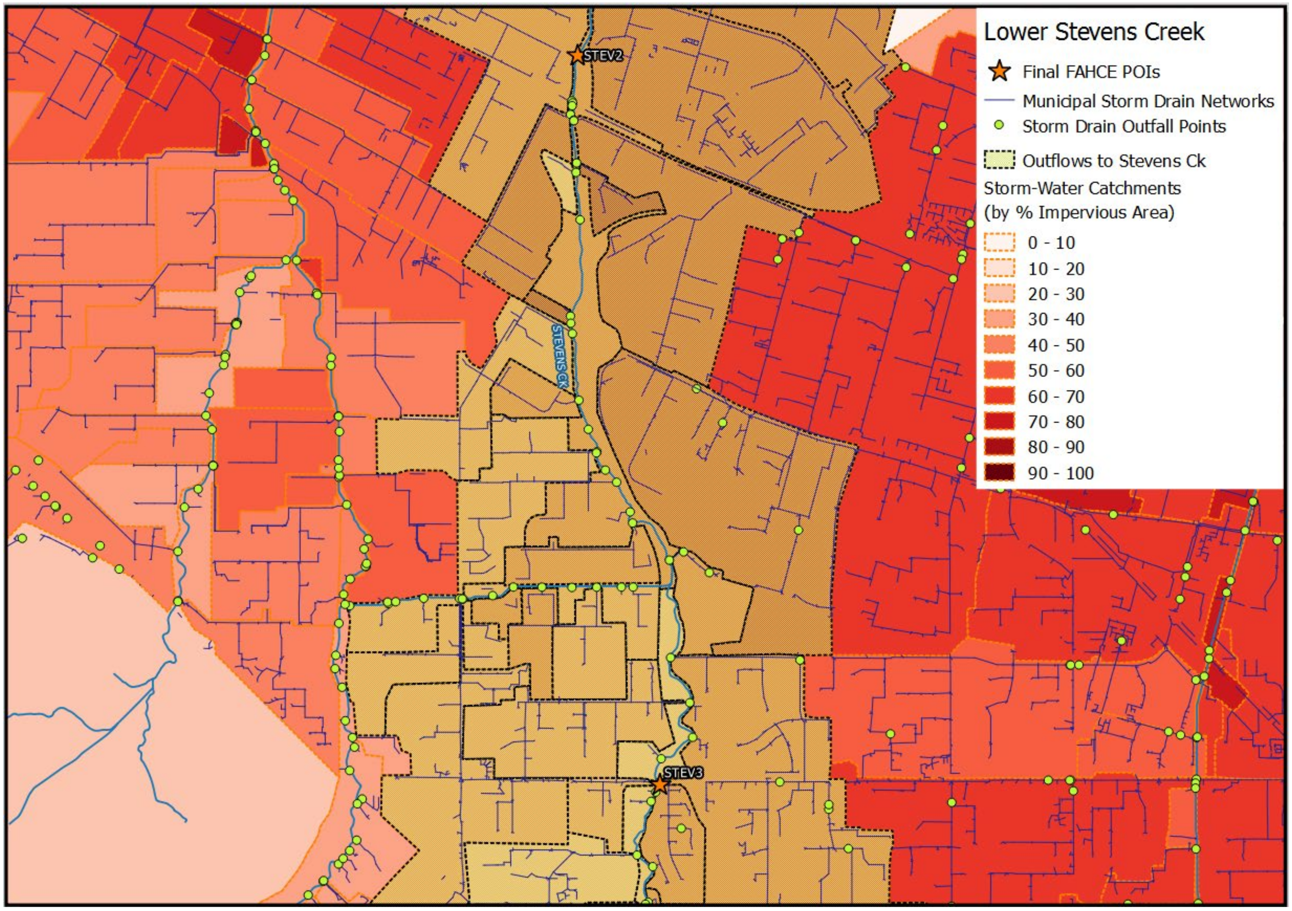

Figure 7. Outflows catchment aggregation in the Lower Stevens Creek

The delineation of the boundaries of the 750 FAHCE-relevant urban storm-water polygons with respect to each POI was implemented by a manual process of tracing each polygon's drain pipe network to its respective outfall point into a FAHCE creek/stream, and identifying within which reach between two POIs this outfall point fell. Storm-water polygons where then combined to obtain one aggregated contributing area for the interval between two POIs. In addition to these completely urban catchments, five additional catchments were delineated to represent storm-water accumulation upstream of the first POI and downstream of the reservoirs in each FAHCE Creek (Figure 8). This process resulted in 33 unique urban "catchments" or hydrologic units – one for each POI reach.

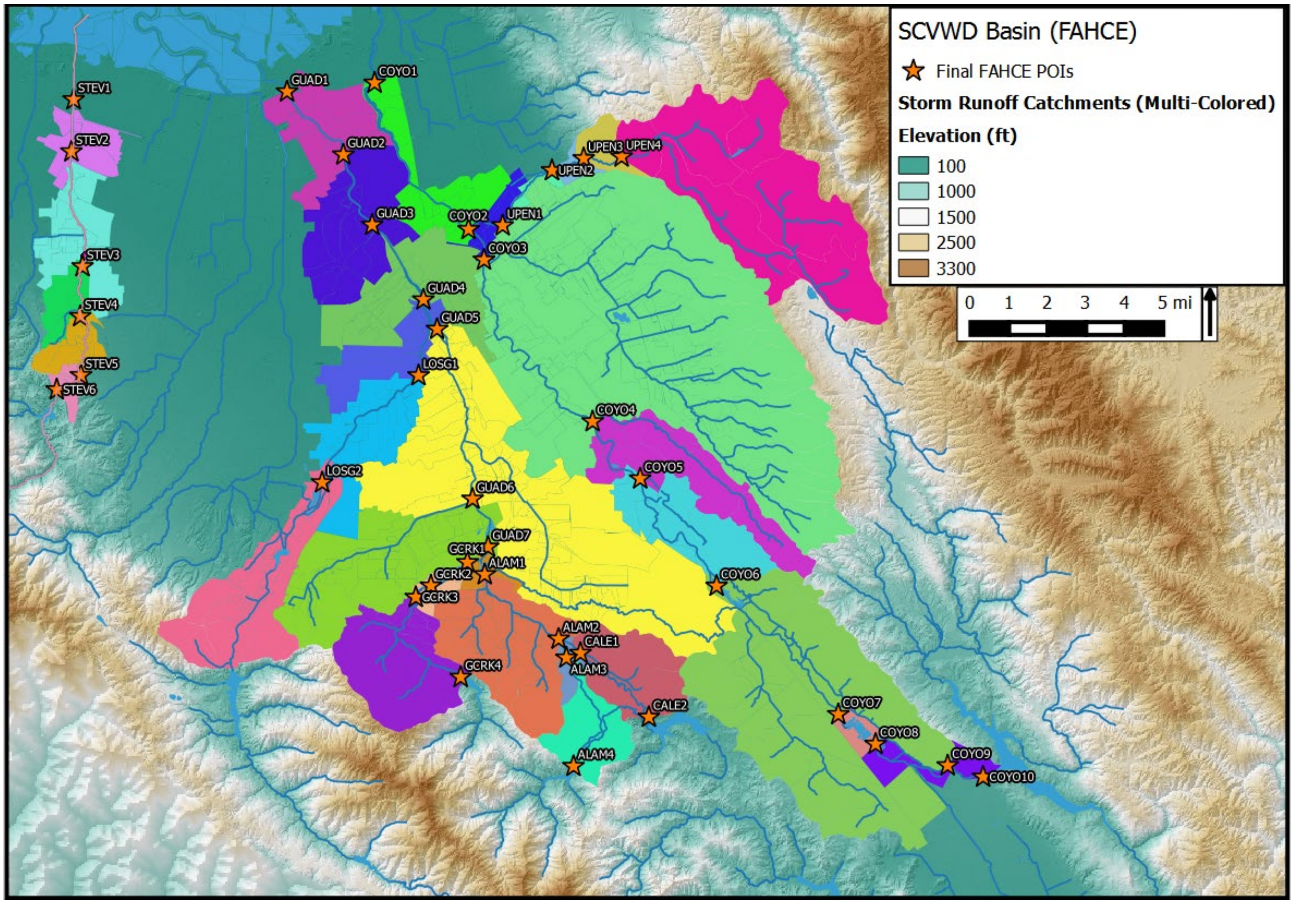

Figure 8. Storm runoff catchments

2. *Runoff in Urban Catchments and Calibration Parameters*

In order to ensure that the amount of storm runoff being modeled by the urban storm-water catchments is realistic, a uniform methodology of parameter creation and calibration was applied to each catchment. The calibration exercise involved comparing model results to observed flows at various gauge sites throughout the system from January 1991- December 1999. The hydrology module in WEAP is spatially continuous, with a study area represented as a contiguous set of catchments that cover the entire spatial extent of the river basin in question. This continuous representation of the river basin is overlaid with a water management network topology of rivers, canals, reservoirs, demand centers, aquifers and other features[3]. Each catchment is fractionally subdivided into a unique set of independent land use/land cover classes that are defined by their area within the catchment rather than their location, such that they sum to 100% of the catchment's area. A unique climate-forcing data set of precipitation, temperature, relative humidity, and wind speed was uniformly prescribed across each catchment.

A one-dimensional, physical water balance model depicts the hydrologic response of each fractional area within a catchment and partitions water into surface runoff, infiltration, evapotranspiration, interflow, percolation, and baseflow components. Runoff values from each fractional area within the

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[3] See: Yates, D., Purkey, D., Sieber, J., Huber-Lee, A., Galbraith, H., 2005. WEAP 21--A Demand, Priority, and Preference-Driven Water Planning Model: Part 2, Aiding Freshwater Ecosystem Service Evaluation. Water Int. 30, 501–502.

catchment are then summed to represent the lumped hydrologic response, with the surface runoff, interflow and base flow being linked to a river element; deep percolation being linked to a groundwater element where prescribed; and evapotranspiration being lost from the system (Figure 9).

At each time step, WEAP first computes the hydrologic flux, which it passes to the relevant river and groundwater objects. The water allocation is then carried out for the given time step, where constraints related to the characteristics of reservoirs and the distribution network, environmental regulations, and the priorities and preferences assigned to points of demands are used to condition a linear programming optimization routine that maximizes, in order of priority, the demand “satisfaction” to the greatest extent possible[4]. All flows are assumed to occur instantaneously; thus a demand site can withdraw water from the river, consume some, and optionally return the remainder to a receiving water body in the same time step.

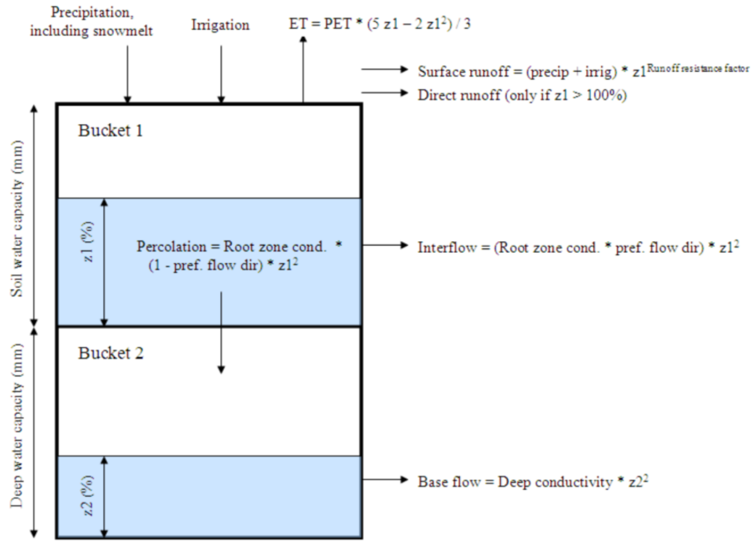

Figure 9. Diagram of the two-bucket WEAP hydrology model (From Yates et al., 2005)

The WEAP catchment objects require the following input data:

1) ***Area***
   Estimated areas by storm runoff catchment are listed below in Table 4. These areas were calculated using GIS analysis for the areas visualized in Figure 8.

Table 4. Urban Catchment Input Data

POI Catchment	Area (Ha)	Paired Rain Gauge	Impervious Area (%)
ALAM1	2397	6037	28.8
ALAM2	168	6037	37.6
ALAM3	944	6128	3.0
CALE1	1312	6037	4.4
COYO1	1297	6086	67.6
COYO2	311	6086	62.5

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[4] Yates, D., Purkey, D., Sieber, J., Huber-Lee, A., Galbraith, H., 2005. WEAP 21--A Demand, Priority, and Preference-Driven Water Planning Model: Part 2, Aiding Freshwater Ecosystem Service Evaluation. Water Int. 30, 501–502.

COYO3	14004	6132	42.3
COYO4	1931	6132	20.3
COYO5	1527	6132	36.4
COYO6	6741	6037	6.2
COYO7	233	6037	10.6
COYO8	528	6041	6.6
GCRK1	273	6001	48.7
GCRK2	2	6001	9.4
GCRK3	1988	6036	17.1
GUAD1	1393	6086	59.6
GUAD2	2054	6086	69.6
GUAD3	1956	6086	69.1
GUAD4	995	6086	72.8
GUAD5	7586	6001	55.6
GUAD6	5426	6125	63.8
GUAD7	185	6001	33.6
LOSG1	1529	6086	61.9
LOSG2	2336	6125	53.0
STEV1	658	6121	61.2
STEV2	1236	6048	53.7
STEV3	463	6053	38.6
STEV4	439	6053	37.2
STEV5	210	6100	15.1
UPEN1	129	6099	45.1
UPEN2	145	6099	52.2
UPEN3	355	6099	6.6
UPEN4	5285	6034	2.7

2) Temperature and Daily Observed Precipitation

Regarding temperature, the San Jose Airport station was used for the storm runoff catchments in the model. In terms of precipitation, each catchment was paired with a nearby rain gauge, with that station’s rainfall data used as the precipitation input in WEAP (Figure 10). To assign a rain gauge to each catchment, the list of candidate Valley Water rain gauges was first filtered to those that had complete records or the 1991–2010 period. Priority was then given to gauges falling within the catchment areas themselves, as long as they were at an elevation that roughly corresponded to the average elevation of the catchment. In instances where no rain gauges fell within the catchment or were not at an elevation representative of the catchment area, the nearest rain gauge at a reasonably similar elevation was used, due to the fact that average annual rainfall is strongly correlated to elevation in the Santa Clara basin.

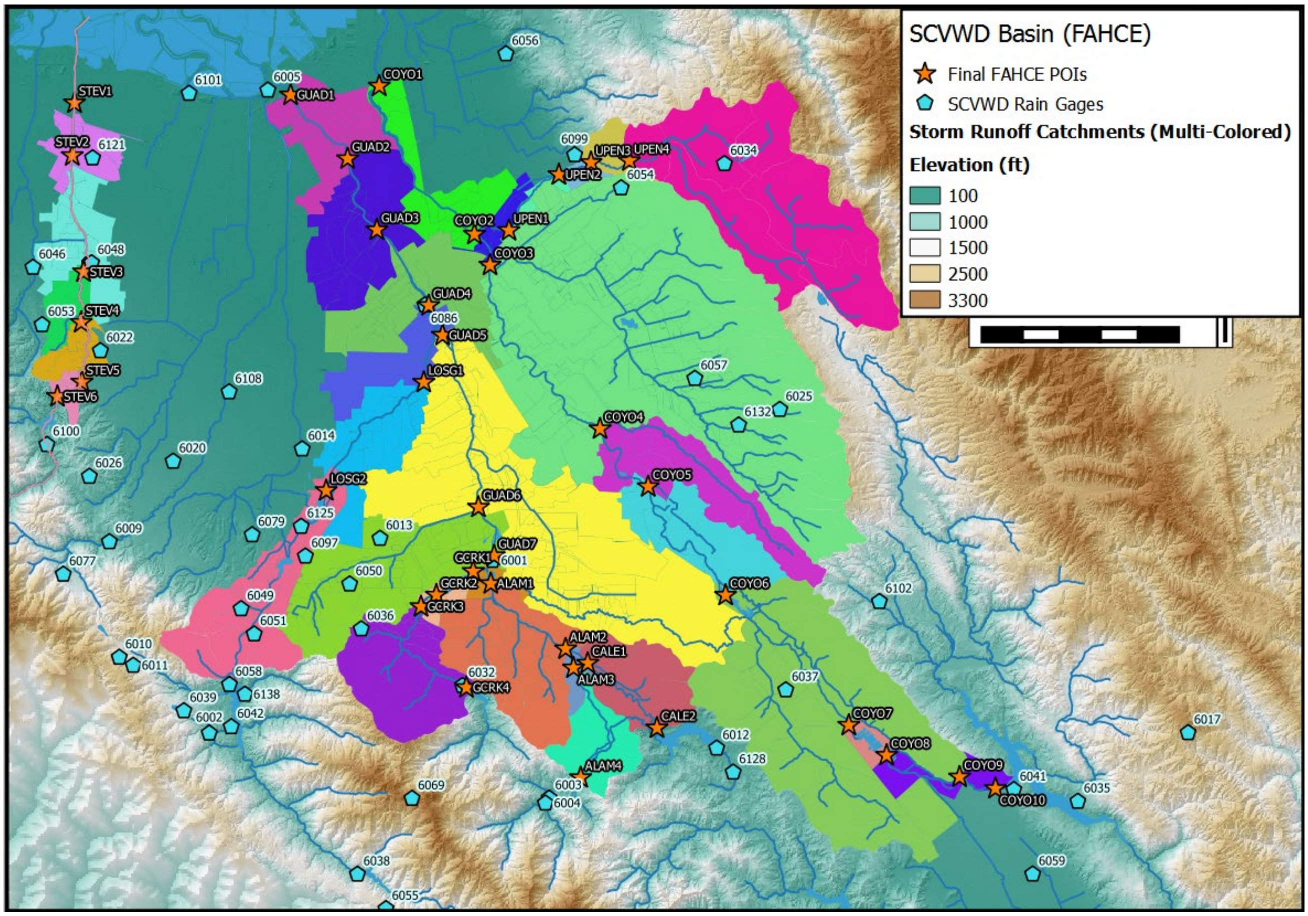


Figure 10. Storm Runoff Catchments with Rain Gauges

An example of this process is shown in Figure 11 below, in which the CALE1 storm runoff catchment (rose-colored on the left) contains no rain gauge, and therefore station 6037 (right) was selected to represent the catchment's rainfall.

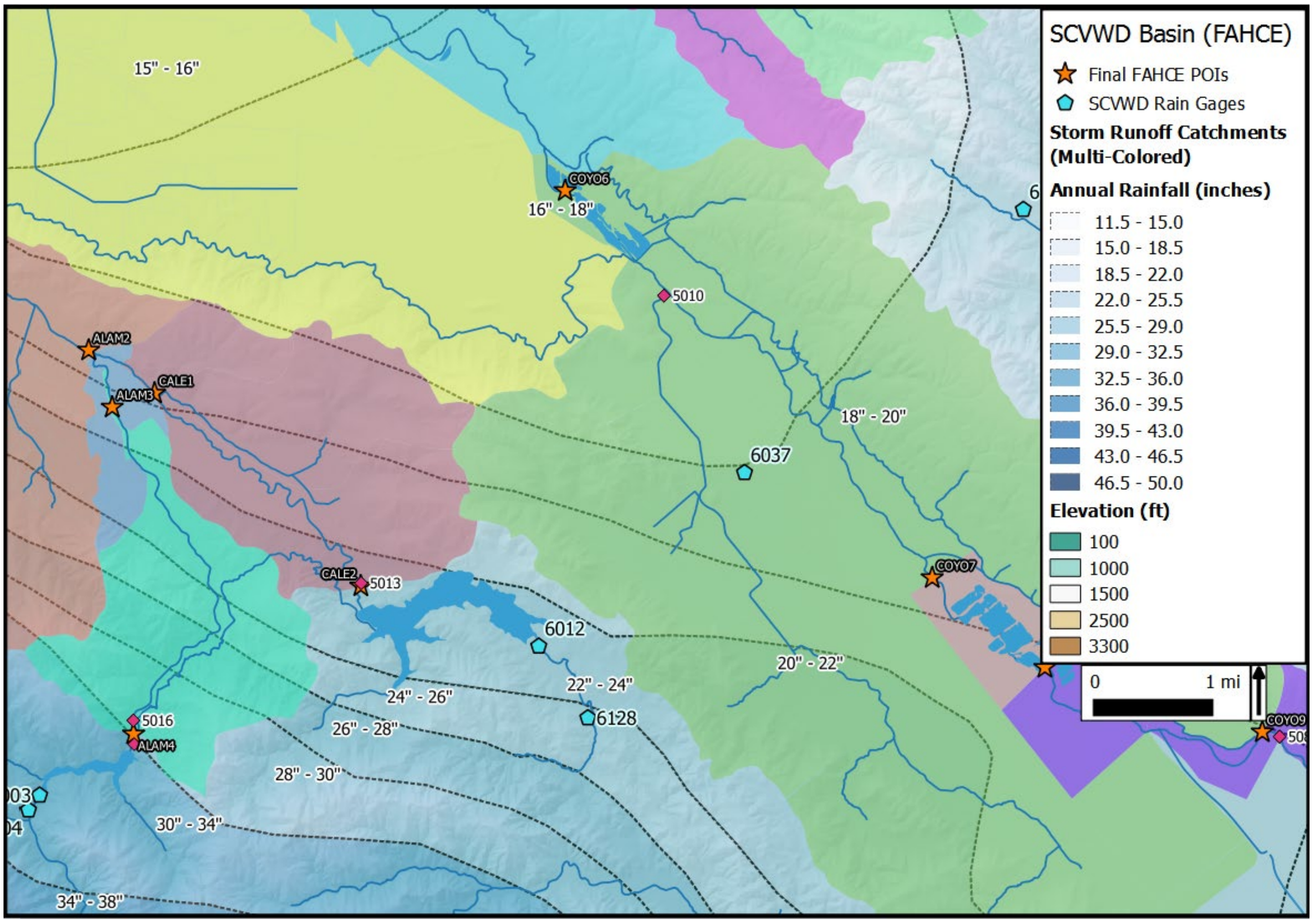
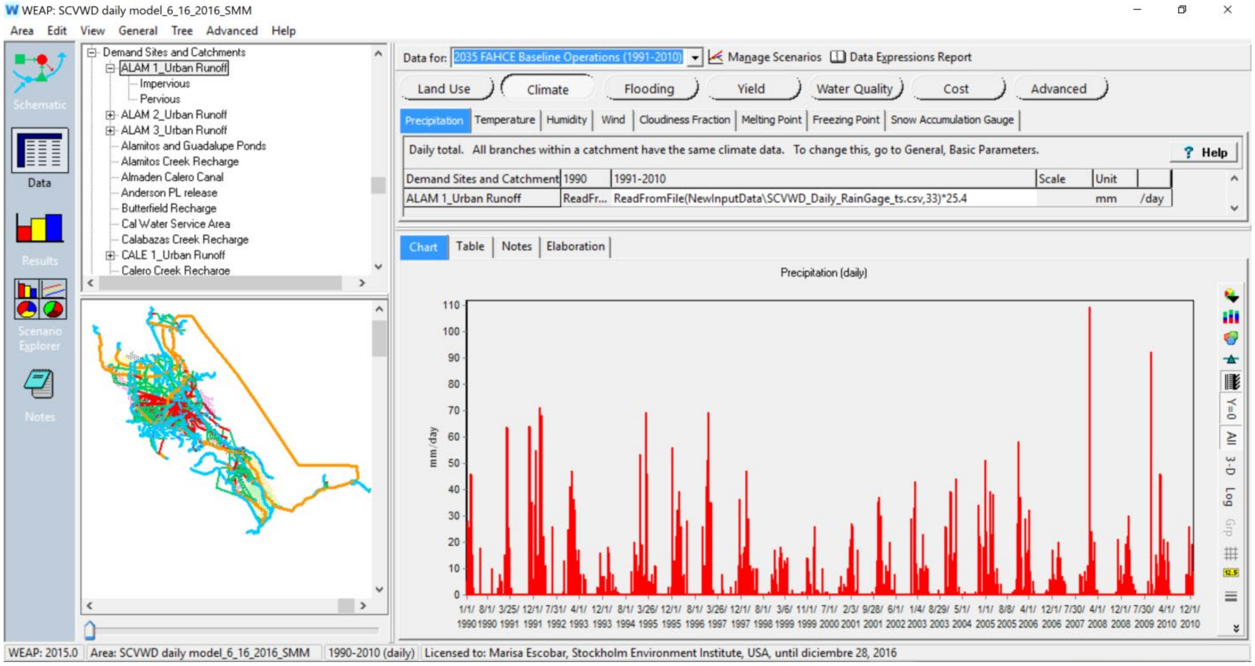


Figure 11. See CALE1 Urban Catchment (Rose-Colored on left) with its paired rain gauge, 6037 (right)

The complete list of catchment-rain gauge pairs is shown in Table 4 above. An example of precipitation data input into the urban runoff catchment for the STEV1 POI in WEAP is shown in Figure 12. (In this image, the data is read from the file named SCVWD_Daily_RainGauge.csv, with the associated ALAM1 station located in column 33. A conversion factor from inches to millimeters is also included.)



WEAP: SCVWD daily model_6_16_2016_SMM

Data for: 2035 FAHCE Baseline Operations (1991-2010)

Daily total. All branches within a catchment have the same climate data. To change this, go to General, Basic Parameters.

Demand Sites and Catchment	1990	1991-2010	Scale	Unit	
ALAM 1_Urban Runoff	ReadFr...	ReadFromFile(NewInputData\SCVWD_Daily_RainGage_ts.csv,33)*25.4		mm	/day

WEAP: 2015.0 | Area: SCVWD daily model_6_16_2016_SMM | 1990-2010 (daily) | Licensed to: Marisa Escobar, Stockholm Environment Institute, USA, until diciembre 28, 2016

Figure 12. Local Rain Gauge Data Input into WEAP Storm Runoff Catchment

3) *Percentage Share of Impervious vs. Pervious Area*

The GIS data of the storm-water runoff zones provided by Valley Water also contained information regarding the estimated percentage of impervious area in each zone. In the process of constructing the final urban catchments associated with each POI, the area-weighted average percentage of impervious area per catchment was calculated. The remainder of the area was assumed to be pervious area. The percentages of impervious areas by storm-water catchment are listed above in Table 4.

This input data was used to parameterize the storm-water runoff model in WEAP. The final set of soil and surface-related parameters obtained after calibrating the rainfall-runoff routines (a process summarized in the following section) is presented in Table 5.

Table 5. Calibration parameters for the rainfall-runoff routine in WEAP

Parameter	Impervious	Pervious	Unit
Sw – Soil water capacity	50	300	mm
Dw – Deep water capacity	500	500	mm
Kc – crop coefficient for evaporation	0.9	0.85	
Ks – conductivity of the upper bucket	12	10	mm/day
Kd – conductivity of the lower bucket	5	5	mm/day
f - Preferred flow direction	0.85	0.5	
RRF – runoff resistance factor	3	6	

3. Urban Storm-Runoff Calibration

Once calibrated, the urban catchments produced flows for their corresponding areas, which contributed accretions at each of the POIs. The calibration process consisted of comparing the observed flows at gauges as compared to modeled flows until the calibration statistics of Nash-Sutcliffe Efficiency (NSE – unit-less), the normalized Root Mean Square Error (RMSE – %), and the Bias (%) fell within acceptable values. Acceptable values of NSE are above 0.7, of RMSE are below 50%, and of Bias are within +- 20%. The key points for comparison are gauges 5035 in Stevens Creek, 5050 in Los Gatos Creek, 5023 in Guadalupe Creek, and 1116900 in Guadalupe River (Figure 13), for which the current results are shown (Figure 14).

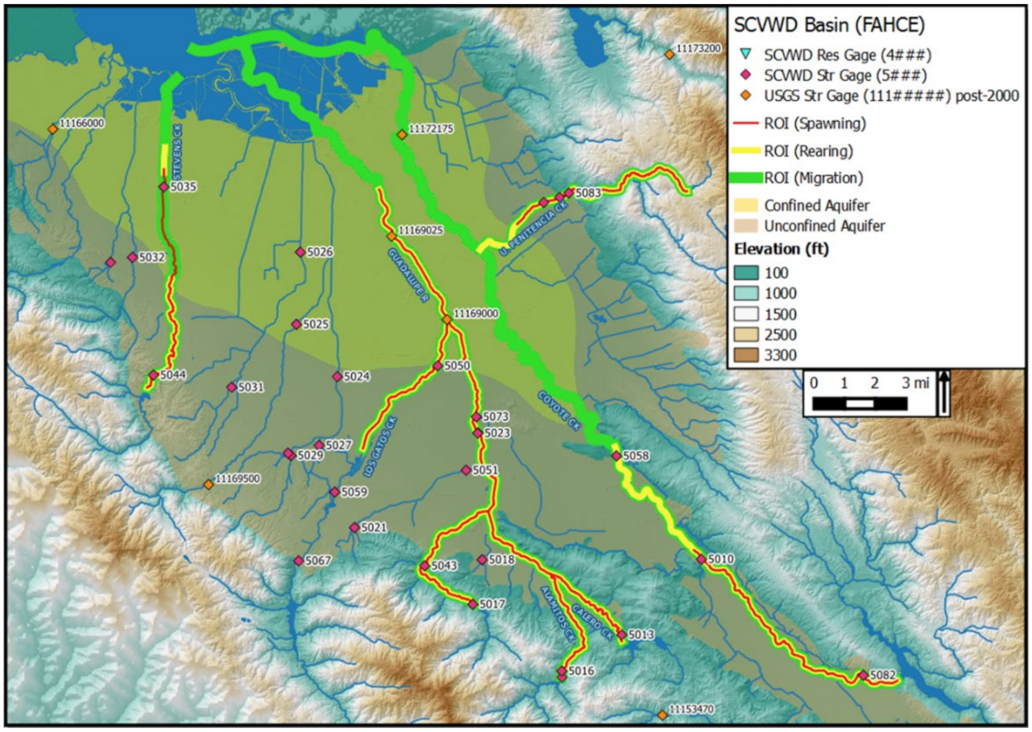
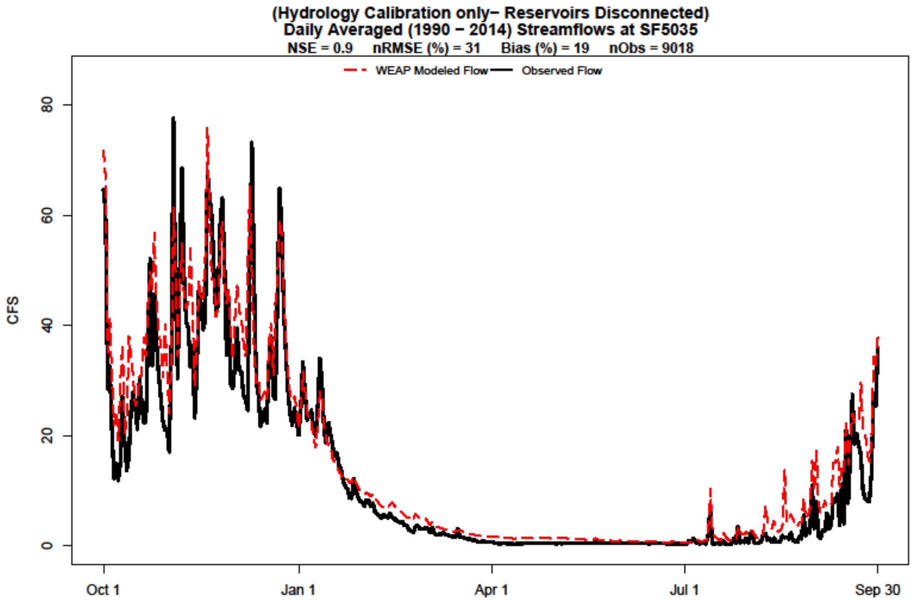


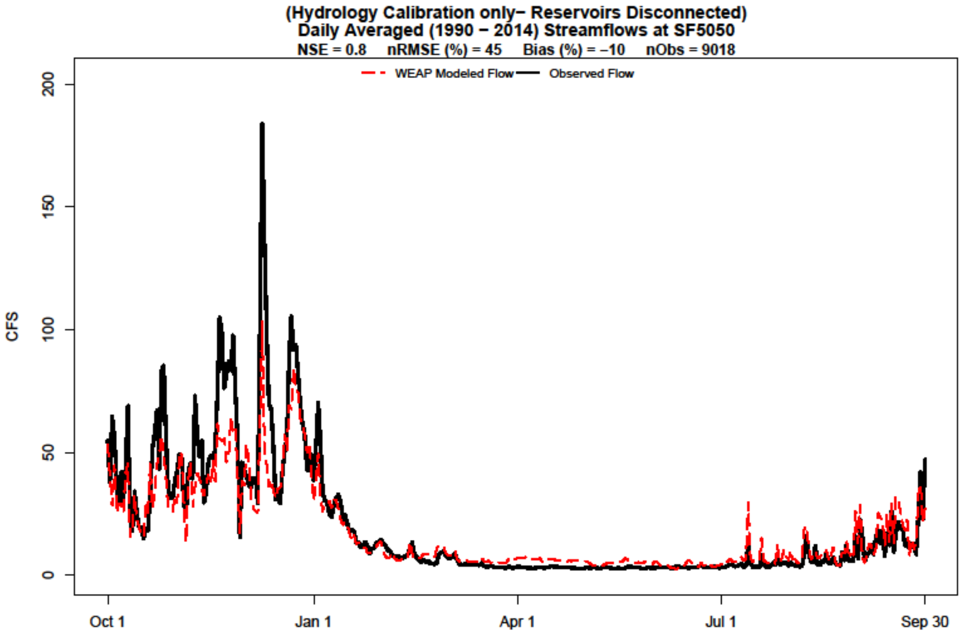
Figure 13. Streamflow gauges used to compare urban catchments calibration

The following set of plots shows the daily average calibration for the 1990-2014 period, and associated statistics for the key gauges mentioned (Figure 14). To perform this calibration, actual observed time series from gauges located downstream of reservoirs were used as input. This way, we controlled for possible model errors related to modeling reservoir operations and releases which also contribute to the flows observed at each point, allowing us to exclusively focus on the performance of the urban storm-water model during the calibration exercise. The resulting graphs and statistics indicate very acceptable model performance, with NSE values over 0.8 for all gauges except gauge 5023 in Guadalupe River, with an NSE value of 0.61, and a bias of within 20% for all gauges.

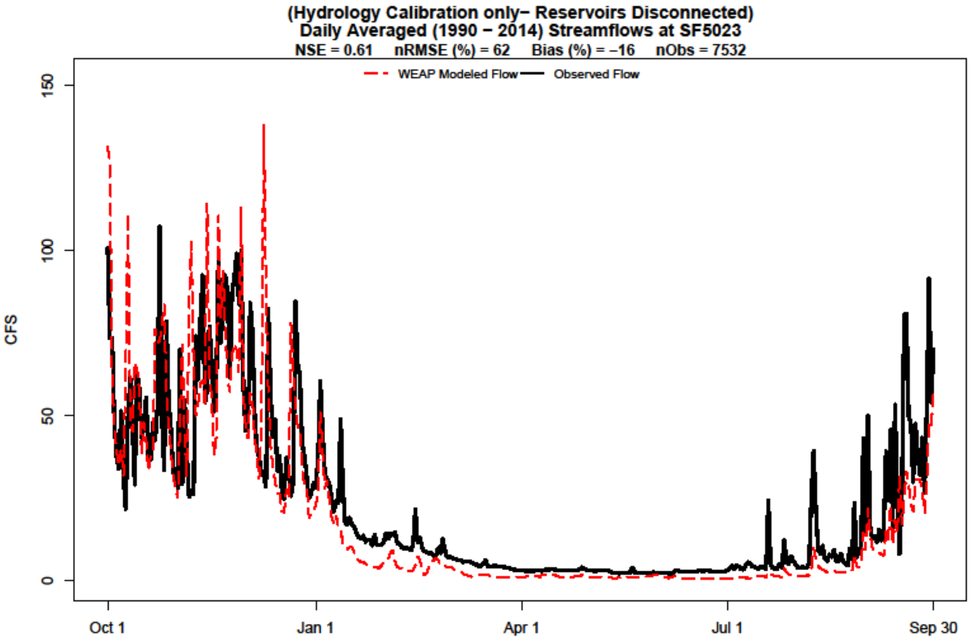
a)


(Hydrology Calibration only– Reservoirs Disconnected)
Daily Averaged (1990 – 2014) Streamflows at SF5035
NSE = 0.9 nRMSE (%) = 31 Bias (%) = 19 nObs = 9018
WEAP Modeled Flow
Observed Flow
CFS
0
20
40
60
80
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30

b)


(Hydrology Calibration only– Reservoirs Disconnected)
Daily Averaged (1990 – 2014) Streamflows at SF5050
NSE = 0.8 nRMSE (%) = 45 Bias (%) = –10 nObs = 9018
WEAP Modeled Flow
Observed Flow
CFS
0
50
100
150
200
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30

c)



d)

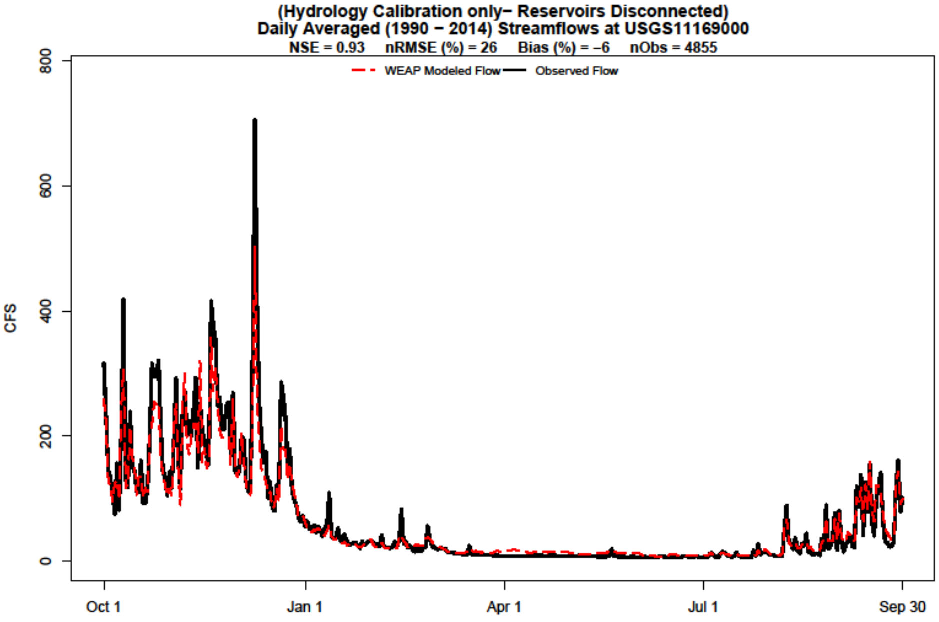


Figure 14. Daily average calibration figures and statistics for gauges a) 5035 in Stevens Creek, b) 5050 in Los Gatos Creek, c) 5023 in Guadalupe Creek, and d) 1116900 in Guadalupe River

F. Estimation of Inflows to Reservoirs

Obtaining daily inflow values for all reservoirs on the FAHCE Creeks consisted of a process of back-calculating flows from existing daily records of observed reservoir storage volume, reservoir releases, and transfers in and out of the reservoirs. Estimates of evaporation and precipitation on the reservoir surface were included in this daily water balance, resulting in daily estimates of inflows. The basic water balance equation is shown below:

$$\mathit{Inflow}_i = (\mathit{Vol}_{i+1} - \mathit{Vol}_i) + \mathit{Evap}_i + \mathit{Releases}_i - \mathit{Precip}_i \pm \mathit{Transfers}_i$$

Where ***i*** signifies a given day ***i***

Vol$_i$ is the observed reservoir volume at the start of day ***i***. Therefore, the change in storage during day ***i*** is defined as $\mathit{Vol}_{i+1} - \mathit{Vol}_i$.

Evap$_i$ is the estimated evaporation losses over the surface of the reservoir. These values in inches were taken from the evaporation pan values, corrected for water bodies, at the Alamitos evaporation pond site. Daily values of reservoir surface area were provided by Valley Water.

Releases$_i$ is the amount of water released from the reservoir as measured by the nearest downstream gauge[5].

Precip$_i$ Is the estimated amount of precipitation falling on the reservoir surface, calculated using the daily rainfall values from the nearest rainfall gauge and the estimated reservoir surface area, as with the estimation of evaporation.

Transfers$_i$ Represent any other water flowing in/out of the reservoir due to transfers via pipelines or canals. Transfers occur in Almaden, Calero, and Anderson reservoirs.

1. Mass Balances for Reservoirs

The following equations show the mass balance used to calculate the daily inflows for each reservoir, using the correct reservoir, streamflow, and rainfall station IDs. Station IDs numbered **4###** are reservoir volumes, **5###** are streamflow, and **6###** are rainfall. Also, note that some of the station IDs start with **SF##** which is a nomenclature used by the District to refer to some of the stations, which is equivalent to the 4### or 5###, in which the two last numbers of the station ID is used in the SF## nomenclature (i.e. station 5067 is also SF67). All equation components are in units of AF/day. Evaporation and Precipitation records were converted to volumes using the time-series of daily reservoir surface areas.

<u>Almaden:</u>

$$\mathit{Inflow}_i = (4001_{i+1} - 4001_i) + \mathit{Evap}_i + 5016_i + 5015(\text{Transfers Out via Canal to Calero Reservoir})_i - 6004_i$$

---

[5] Most reservoirs have streamflow gauges with daily records immediately downstream that can be assumed to reflect reservoir releases. Exceptions to this are Lexington, Calero, and Anderson reservoirs, whose nearest downstream flow gauge is also downstream of some other significant source of inflow downstream of the reservoir, making it difficult to discern what portion of recorded streamflow represents reservoir releases.

Anderson [6]:

$$\text{Inflow}_i = (4002_{i+1} - 4002_i) + \text{Evap}_i + (5082_i - \text{San Felipe Pipeline Inflows})_i + (\text{Releases to Pipeline})_i - (\text{CVP Imports to Anderson})_i - 5012(\text{Coyote Reservoir Releases})_i - 6041_i$$

Calero:

$$\text{Inflow}_i = (4003_{i+1} - 4003_i) + \text{Evap}_i + 5013_i + (\text{Releases to Pipeline})_i - 5014(\text{Inflows from Almaden-Calero Canal})_i - (\text{CVP/Anderson Imports})_i - 6128_i$$

Coyote:

$$\text{Inflow}_i = (4005_{i+1} - 4005_i) + \text{Evap}_i + 5012_i - 6021_i$$

Guadalupe:

$$\text{Inflow}_i = (4006_{i+1} - 4006_i) + \text{Evap}_i + 5017_i - 6036_i$$

Lexington:

$$\text{Inflow}_i = (4007_{i+1} - 4007_i) + \text{Evap}_i + (5067 - \text{Accretions US SF67})_i - 6058_i$$

Stevens Creek:

$$\text{Inflow}_i = (4009_{i+1} - 4009_i) + \text{Evap}_i + 5044_i - 6100_i$$

In all reservoirs, evaporation was estimated using the daily average evapotranspiration values across the year as recorded at the San Jose CIMIS station (Figure 15).

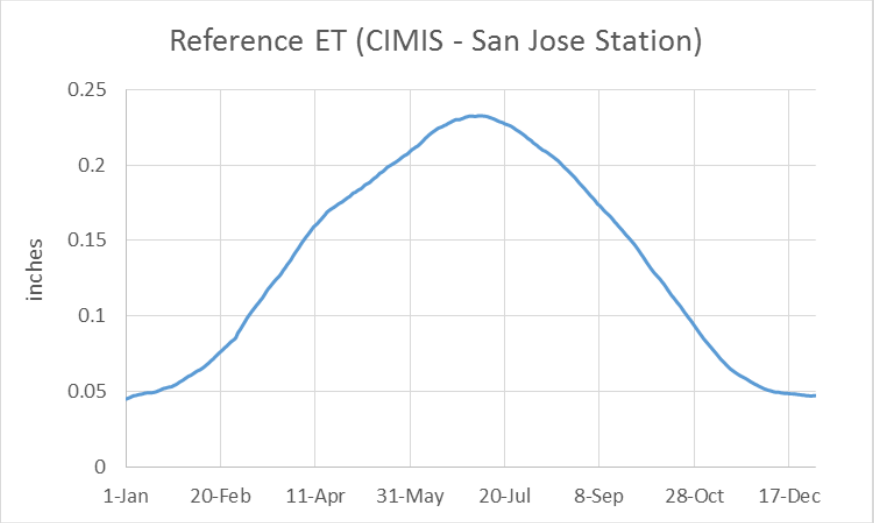


Figure 15. Reference ET values cycled yearly (daily averages from San Jose CIMIS station)

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[7] 2013 Best Research-Oriented Paper Award by ASCE-EWRI Journal of Water Resources Planning and Management selected this work

Oftentimes, the lack of complete data complicated the application of this methodology to FAHCE-relevant reservoirs. The only FAHCE-relevant reservoir to have a complete daily streamflow gauge record of inflows from the period 1990–2010 (SF77 & USGS station 11169800) (Figure 16) is Coyote Creek. The gauge on Coyote Creek is situated almost 2 miles upstream of the maximum extent of Coyote Reservoir. This means that the flows captured at this gauge do not represent all inflows to Coyote Reservoir. It was estimated that the contributing area to this gauge location is roughly 86.8% of the total contributing area to Coyote Reservoir. It was found that these streamflow records underestimate the calculated inflows to Coyote Reservoir by roughly 8%. Because the magnitude of this underestimation is similar to the percent area of the catchment contributing to Coyote located downstream of the gauge (100%-86.8% = 13%), it was deemed reasonable.

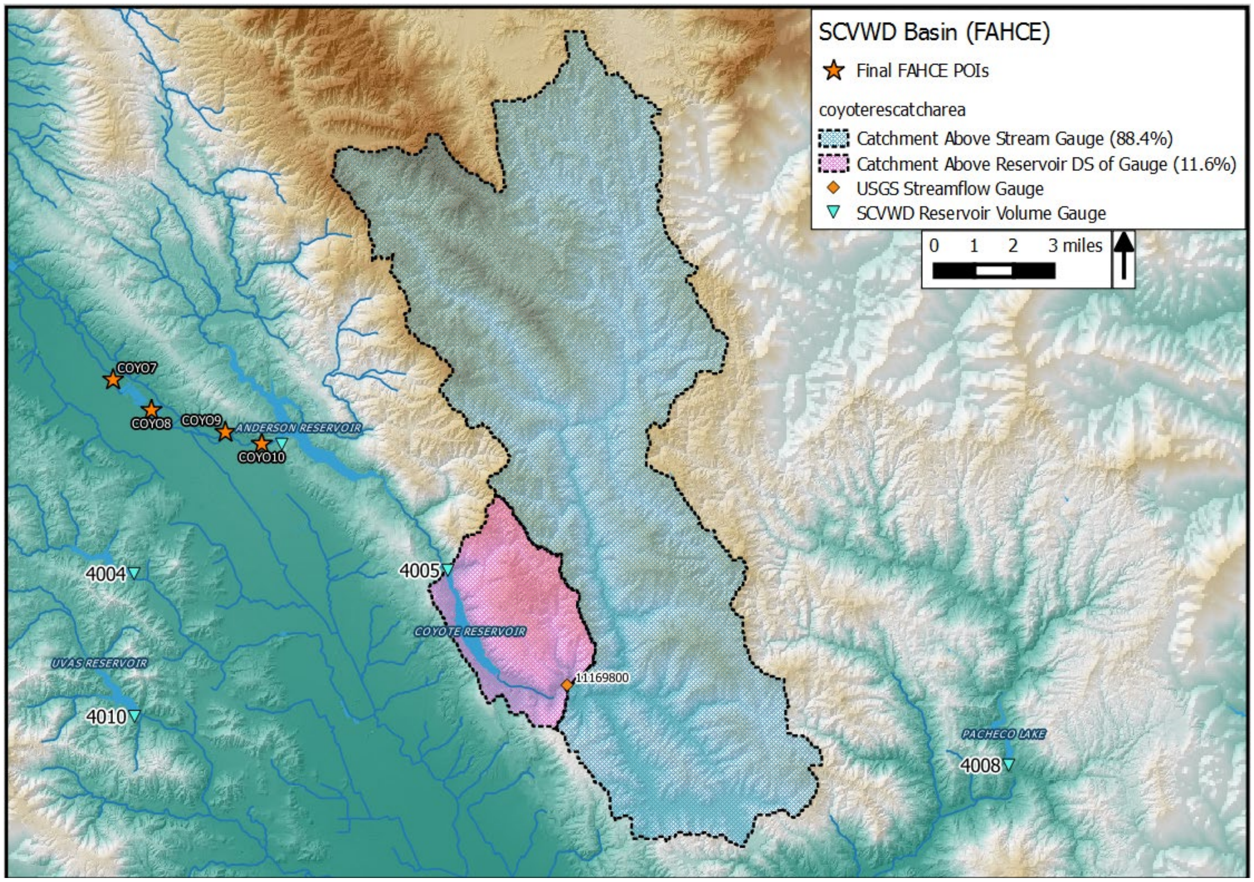


Figure 16. Contributing Area to Coyote Reservoir. DS gauge = 11.6% area. US gauge = 88.4% area.

Other reservoirs did not have as complete an accompanying dataset. At Lexington Reservoir, the nearest downstream gauge is SF67, which is downstream of a small tributary (Trout Creek) that flows into Los Gatos Creek just downstream of the reservoir, as well as additional various accretions upstream of SF67. Therefore, it was necessary to estimate these accretions, so that they could be subtracted from the SF67 records, theoretically leaving a streamflow record of only Lexington Reservoir releases. SCADA data that was recently processed for this model update offered observed volumes of controlled outflows from Lexington, and it was determined that from 9/20/2012 to 12/31/2014 there was a mostly continuous (a few missing values were filled via interpolation) and reliable record of the actual releases from Lexington Reservoir. During this period no spillway releases occurred from Lexington (observed volume was well below the storage capacity the entire period), meaning that in theory all releases from Lexington were captured by these SCADA records. Comparing this record with the values seen at SF67 illustrates the influence of the unmonitored accretions downstream of the reservoir, especially during storm events (Figure 17).

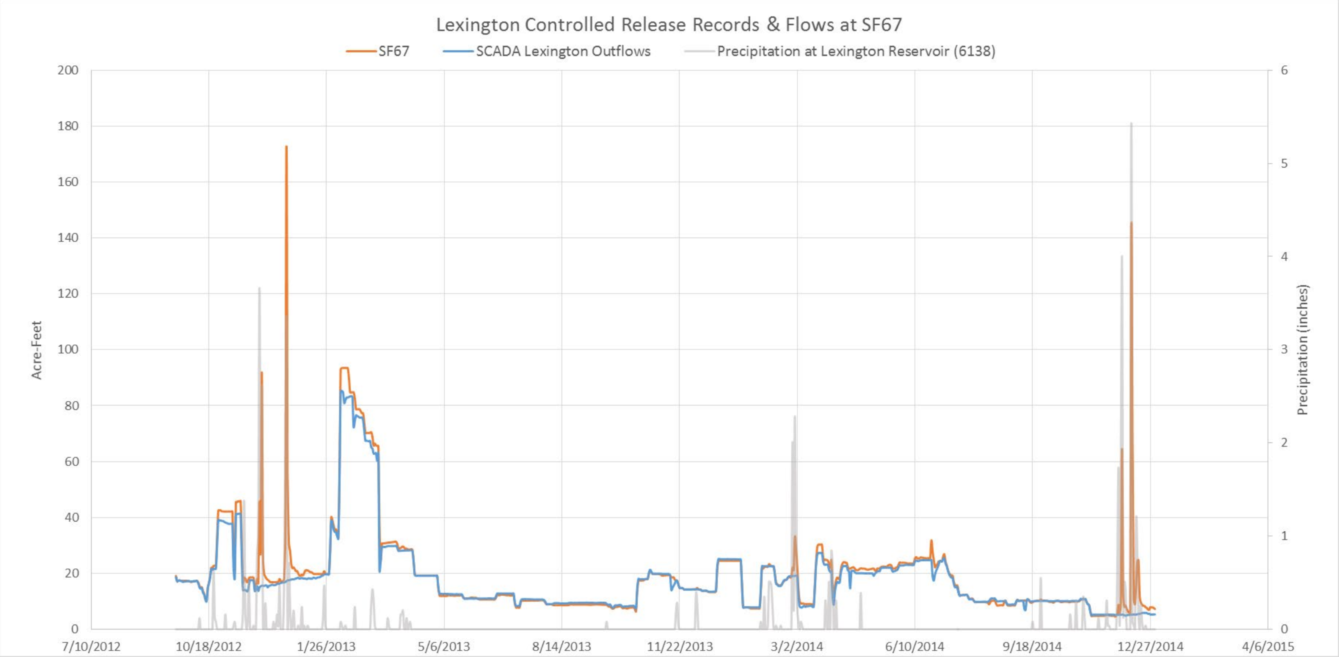


Figure 17. Lexington Reservoir Releases and SF67 flows

From this, the accretions upstream of the gauge (labeled “US SF67”) were assumed to be the difference between SF67 flows and the SCADA Lexington Release records for this period (Figure 18).

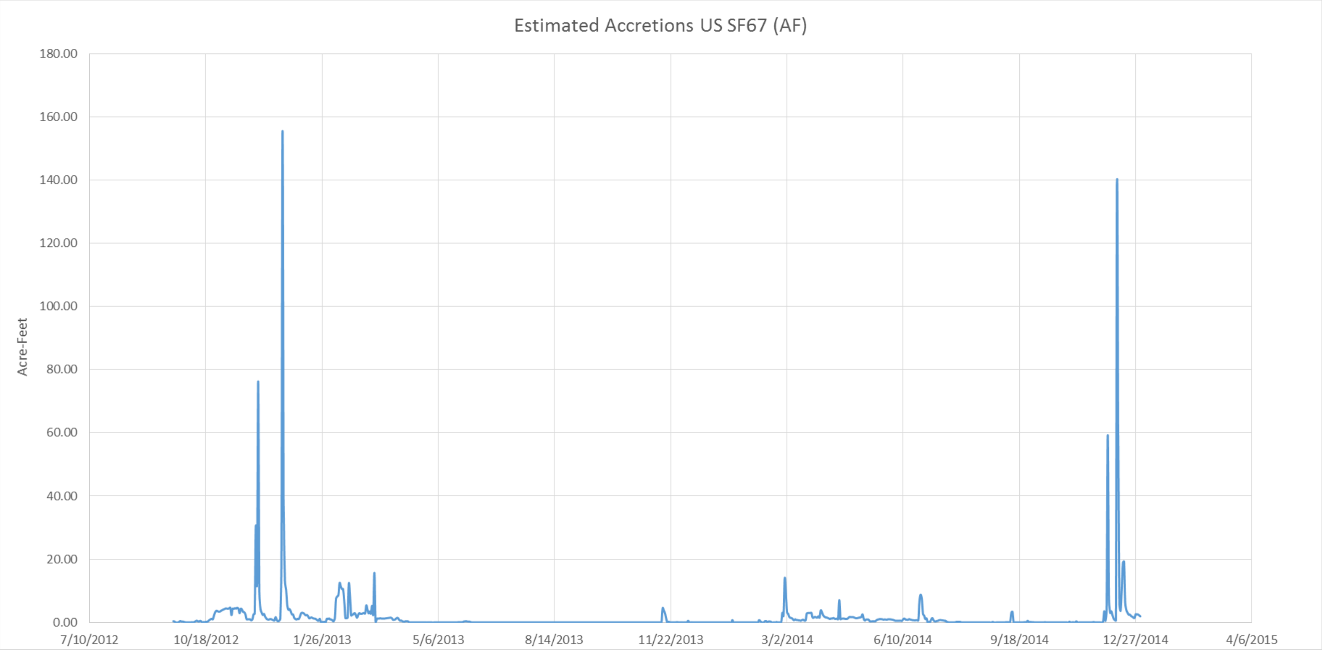


Figure 18. Estimated Trout Creek inflows to Los Gatos Creek

This was deemed the best method to estimate Trout Creek flows and other unknown accretions.

Extending the flow record of these accretions US SF67 backwards to 1990–2010 was done by determining a relationship between these "observed" accretions and rainfall at Lexington Reservoir for this period. Given the short period, a very strong relationship did not emerge ($R^2 = 0.64$), but it was deemed sufficient given the lack of additional data (Figure 19).

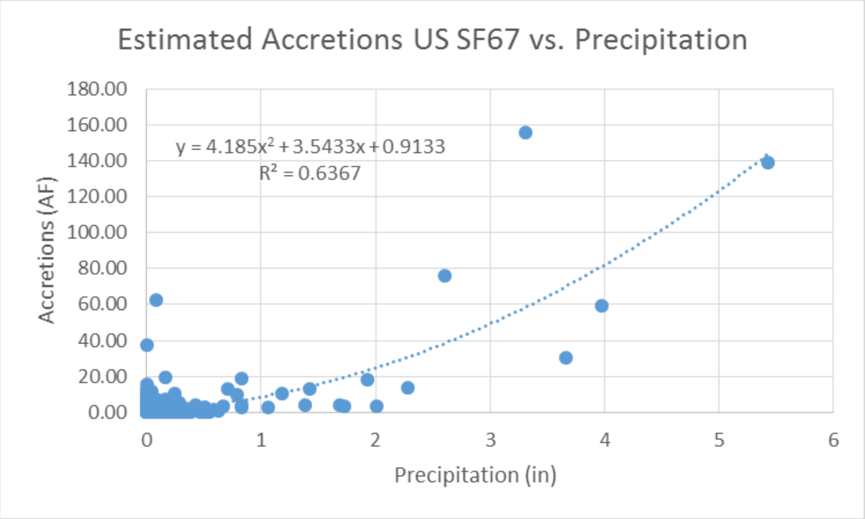


Figure 19. Scatter Plot and fit between Accretions US SF67 and Precipitation

The second-order relationship shown above was used to create a synthetic signal of accretions SF67 from 1990–2010, which was then subtracted from the SF67 records to obtain an estimated record of releases from Lexington reservoir.

Calero and Anderson reservoirs posed additional challenges. The nearest downstream gauges (SF13 & SF83, respectively) are downstream of the inflows of major pipelines, which discharge water directly into Calero Creek and Coyote Creek. Daily SCADA records exist for these pipeline inflows from 12/1/1994–present. Unfortunately, pipeline inflows are not available from 1/1/1990–11/30/1994. For these dates, the reservoir inflow to Calero Creek was based on the average daily inflows from 1995-2014 for the particular water year type. These records of the Calero and San Felipe pipeline inflows were subtracted from the SF13 & SF83 streamflow records, respectively, resulting in estimated records of reservoir releases.

2. Veracity of Back-Calculation Method

As mentioned above, the only existing streamflow gauge capturing reservoir inflows with some degree of accuracy is the 5077/11169800 gauge upstream of Coyote, and even this gauge is only capturing a portion of total inflows. As such, it was difficult to test the veracity of the daily inflow estimates we obtained by applying the mass balance equations at each reservoir. However, we did compare the daily inflow estimates for Coyote Reservoir from the entire period of 5077/11169800 record (1973–2014) with the observed values at station 5077/11169800 with the following result shown in Figure 20 and Figure 21 (for daily averages).

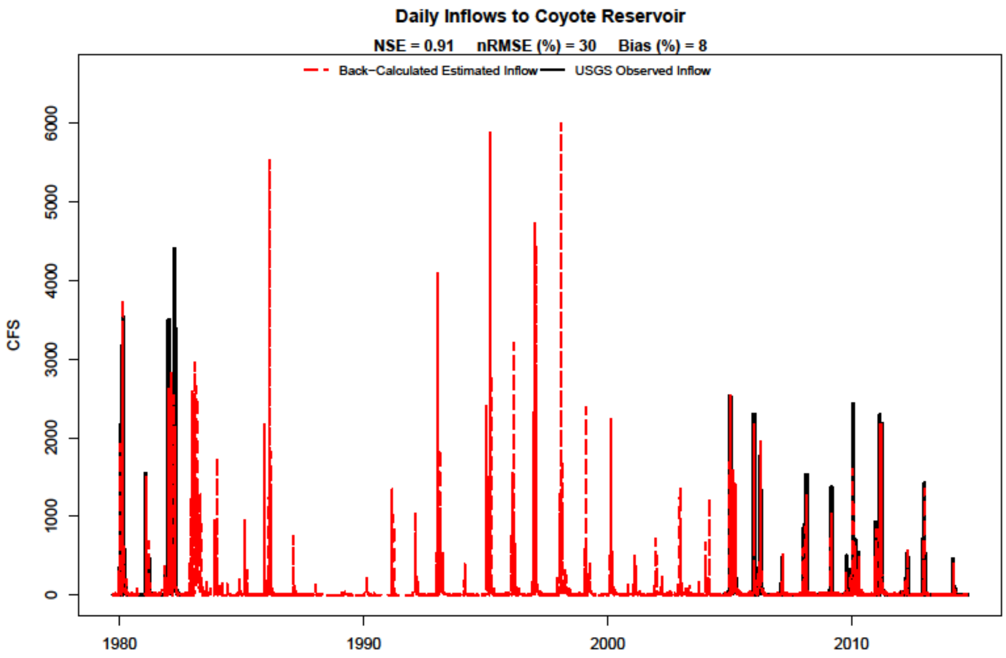


Figure 20. Daily back-calculated inflow to Coyote Reservoir compared to flows at SF77/11169800

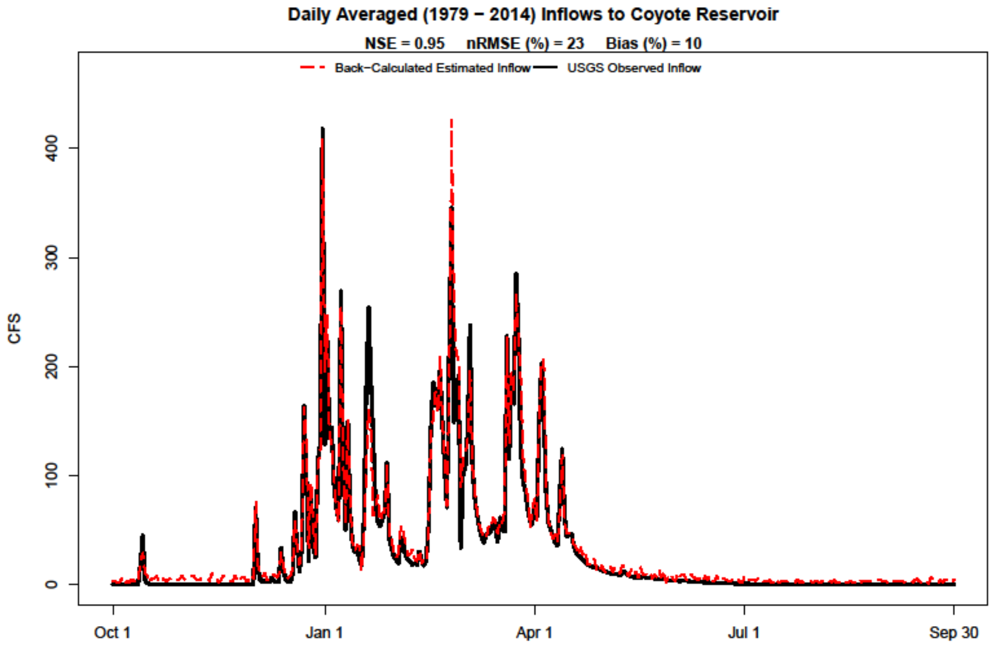


Figure 21. Daily Average back-calculated inflow to Coyote Reservoir compared to flows at SF77/11169800

The statistics reported in the heading of each graph are the NASH, nRMSE, and Bias. Notice that both the NSE and RMSE are fairly good, with the Bias showing the estimated inflows to be roughly 8% higher than those observed at station 5077/11169800.

However, as previously mentioned, due to the fact that this station does not capture all inflows to Coyote, we would expect the back-calculated estimates to be higher, to account for the inflows from the contributing area downstream of 5077/11169800. In fact, the total area downstream of the station totaled roughly 3,600 ha, while upstream totaled about 27,350 ha, meaning the downstream area is 13.2% of the total contributing area of the reservoir. Therefore, if we assume that the area to runoff ratio is roughly equivalent in all parts of the contributing area, we would expect our back-calculation estimates to be roughly 13-14% higher than observed. Our estimates were close to this (8% higher), giving us confidence that the back-calculation method is in fact producing reasonable inflow estimates. This supports the conclusion that the mass balance approach to estimate daily reservoir inflow from daily changes in reservoir storage is reasonable and appropriate. It is not perfect, however, and will introduce some error into the model.

G. Incorporation of Water Depth at POIs: Stage-Discharge Relationships

To determine water depth at each POI, stage-discharge rating curves were calculated for each POI using a combination of new field survey transects, preexisting survey transects, and estimations of transects from DEM data. Previous HEC-RAS models for each FAHCE-relevant stream were used as the platform for developing these rating curves. However, those models were generally constructed for flood-risk analysis, and therefore consist of fairly coarsely surveyed stream transects, oftentimes representing low-flow channels as simple trapezoids, and at times consisting of channel geometry values that have been interpolated between measured survey transects. In addition, those models did not extend all the way up to many of the FAHCE relevant reservoirs, excluding some POIs (Figure 22). Note that there are a total of 7 of 39 POIs that fell outside of previous HEC-RAS models (LOSG2, GCKR3, GCRK4, ALAM4, UPEN4, CALE2, STEV6).

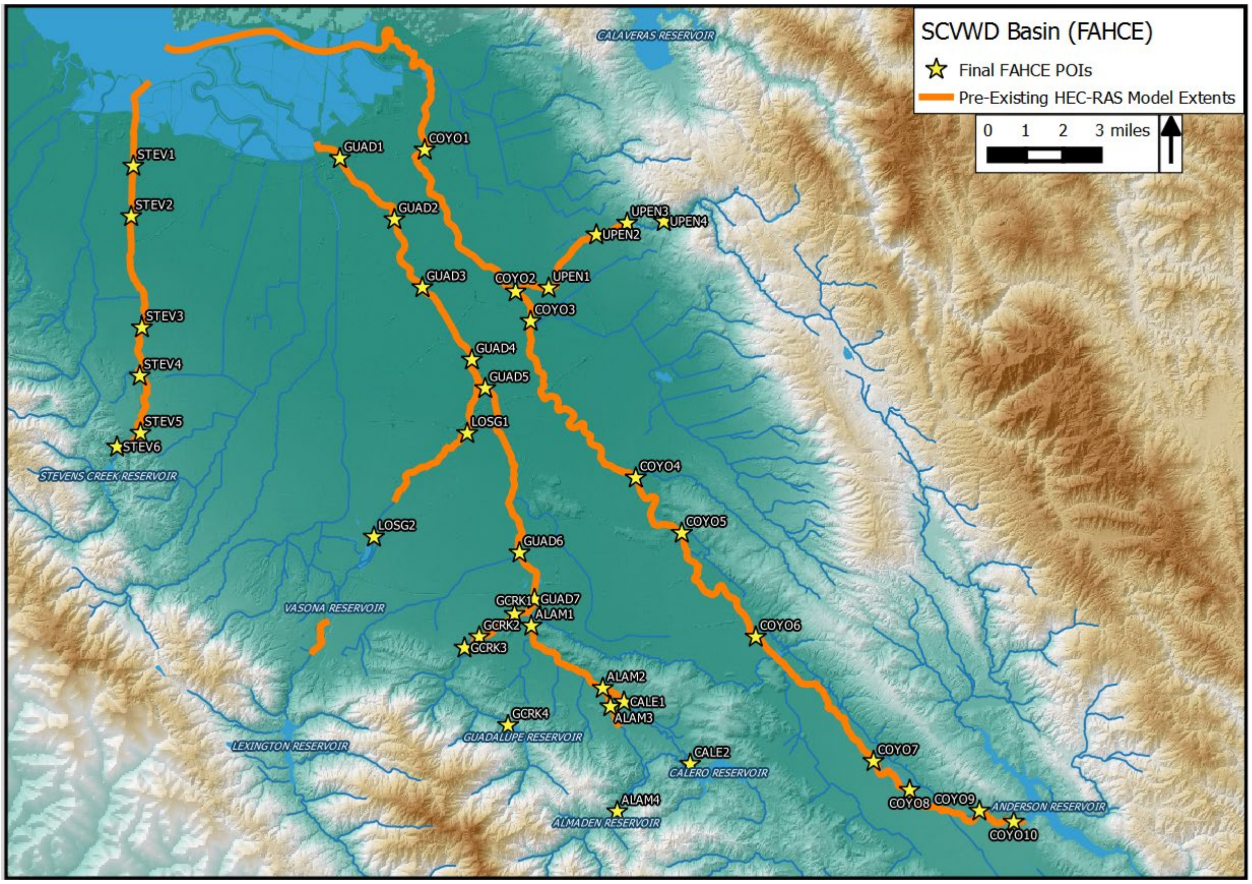


Figure 22. Extent of pre-existing HEC-RAS models

Given that the FAHCE effort is concerned with fish passage at low flows as one important habitat metric, it was deemed that a higher level of detail than offered by the previously existing HEC-RAS stream transects, or cross-sections (XSs), was needed at a selected set of POIs in order to accurately capture the geometry of critical riffles or other passage-barriers. Therefore, the District conducted a field survey to obtain stream transects at a total of 21 POIs for the Stevens Creek and Guadalupe River systems. These transects were developed with RTK (Real-Time Kinematic) GPS (Global Positioning System) stream transects conducted at the most prominent critical riffle or passage-barrier in the vicinity of each of the selected POIs (Figure 23). The remaining POIs did not receive new field surveys of riffles due to a variety of reasons, detailed in Table 6. Refer to “White Paper on Work Flow of the HEC-RAS Cross Section Analysis” for a full discussion of the process for refining these HEC-RAS transects.

Table 6. HEC-RAS Cross-Sections by POI.

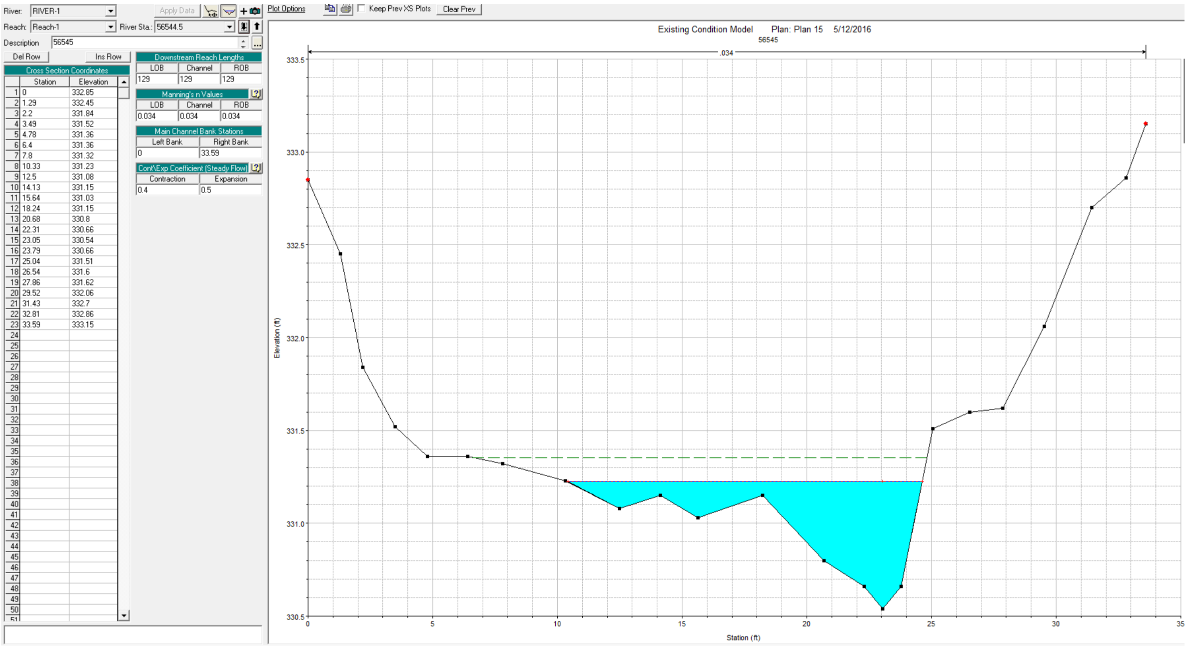
Note: The "Range of Flow" column in the table below signifies the flows captured by the field transect data. Many of the new transects do not have data points extending high up the river banks or out onto the floodplain, making them suited for low and intermediate flow analysis only. Green cells indicate that no field transect was surveyed, gold cells indicate that transects were newly surveyed, orange cells indicate that transects were taken from DEM, and yellow cells indicate that new surveyed cells were upstream of POI.

POI	HEC-RAS XS Type	Range of Flow (cfs)	Reason for no Field Survey
COYO1	No field transect, use existing XS	5-15000	Only deep, standing pools exist in vicinity
COYO2	New Field Survey. Stitched into internal bridge (Berryessa Rd) XS 15827 US & DS from sta 82 to 137 (US) & 68 to 123 (DS) to 1051.1	0-15000	
COYO3	New Field Survey. DS of XS 21400	0 -275	
COYO4	No field transect, use existing XS (DS Singleton Rd barrier)	0-15000	Singelton Road (Planned for Removal)
COYO5	New Field Survey. Stitched into internal bridge XS 139790 US & DS from sta 988.38 to 1051.1	0-15000	
COYO6	New Field Survey. Stitched into internal bridge XS 163780 US & DS from sta 965 to 1011.36	0-15000	
COYO7	No field transect, use existing XS	0-15000	Only deep, standing pools exist in vicinity
COYO8	New Field Survey DS of 201957	0-175	
COYO9	New Field Survey US of 220898	0-300	
COYO10	New Field Survey US of 222144	0-275	
UPEN1	No field transect, use existing XS	0-7500	Upper Pen was excluded from field surveys due to uncertainty surrounding the utility of such data on Upper Penitencia Creek, given the absence of District reservoirs on the creek
UPEN2	No field transect, use existing XS	0-15000	Upper Pen was excluded from field surveys due to uncertainty surrounding the utility of such data on Upper Penitencia Creek, given the absence of District reservoirs on the creek
UPEN3	No field transect, use existing XS	0-3500	Upper Pen was excluded from field surveys due to uncertainty surrounding the utility of such data on Upper Penitencia Creek, given the absence of District reservoirs on the creek
UPEN4	No field transect nor model (used DEM)	0-15000	Upper Pen was excluded from field surveys due to uncertainty surrounding the utility of such data on Upper Penitencia Creek, given the absence of District reservoirs on the creek
GUAD1	No field transect, use existing XS	0-4500	Only deep, standing pools exist in vicinity
GUAD2	No field transect, use existing XS	0-4500	Only deep, standing pools exist in vicinity
GUAD3	New Field Survey US of 15870	0-200	

POI	HEC-RAS XS Type	Range of Flow (cfs)	Reason for no Field Survey
GUAD4	New Field Survey DS of 19240	0-100	
GUAD5	New Field Survey DS of 20679	0-750	
GUAD6	New Field Survey DS of 95000	0-350	
GUAD7	New Field Survey DS of 102400	0-175	
LOSG1	New Field Survey Stitched into internal bridge XS 84.52499 US & DS from sta 21 to 71	0-4500	
LOSG2	New Field Survey US of all existing XSs	0-175	
GCRK1	New Field Survey just US of XS 1010 (intersects it)	0-325	
GCRK2	New Field Survey 28 ft DS of XS 1270	0-350	

Figure 23. Photo of a cross-section from new field survey. Shown here is STEV5.

The transect data obtained at each of these surveys was in turn built into the existing HEC-RAS models as new XSs (Figure 24).



River: RIVER-1
Reach: Reach-1
River Sta.: 56544.5
Description 56545

Cross Section Coordinates

	Station	Elevation
1	0	332.85
2	1.29	332.45
3	2.2	331.84
4	3.49	331.52
5	4.78	331.36
6	6.4	331.36
7	7.8	331.32
8	10.33	331.23
9	12.5	331.08
10	14.13	331.15
11	15.64	331.03
12	18.24	331.15
13	20.68	330.8
14	22.31	330.66
15	23.05	330.54
16	23.79	330.66
17	25.04	331.51
18	26.54	331.6
19	27.86	331.62
20	29.52	332.06
21	31.43	332.7
22	32.81	332.86
23	33.59	333.15

Downstream Reach Lengths

LOB	Channel	ROB
129	129	129

Manning's n Values

LOB	Channel	ROB
0.034	0.034	0.034

Main Channel Bank Stations

Left Bank	Right Bank
0	33.59

Cont\Exp Coefficient (Steady Flow)

Contraction	Expansion
0.4	0.5

Figure 24. Example of a newly field-surveyed critical riffle built into HEC-RAS as a new cross section. Shown here is STEV5. A flow of 10cfs is shown in blue.

To encompass the new surveys (LOSG2, GCRK3, GCRK4, ALAM4, STEV6) that were outside of the existing HEC-RAS model extents, the model domain required an upstream extension. To do this, a number of intermediate XSs were constructed into the HEC-RAS models between the upstream-most extent of the preexisting model and the new field transect, as well as upstream of the new transects, so that the flows modeled in HEC-RAS gradually transition to the field transect location. This helps to avoid large steps in flow, which could cause model instability (Figure 25). These intermediate transects were constructed using cut lines from a LiDAR-based digital elevation map (DEM) of Santa Clara County provided by the District. The resolution of this DEM is 30 ft, meaning the stream XSs constructed from the DEM itself are very coarse, and serving here only to aid in the transitioning of the HEC-RAS model towards the high-resolution field transects.

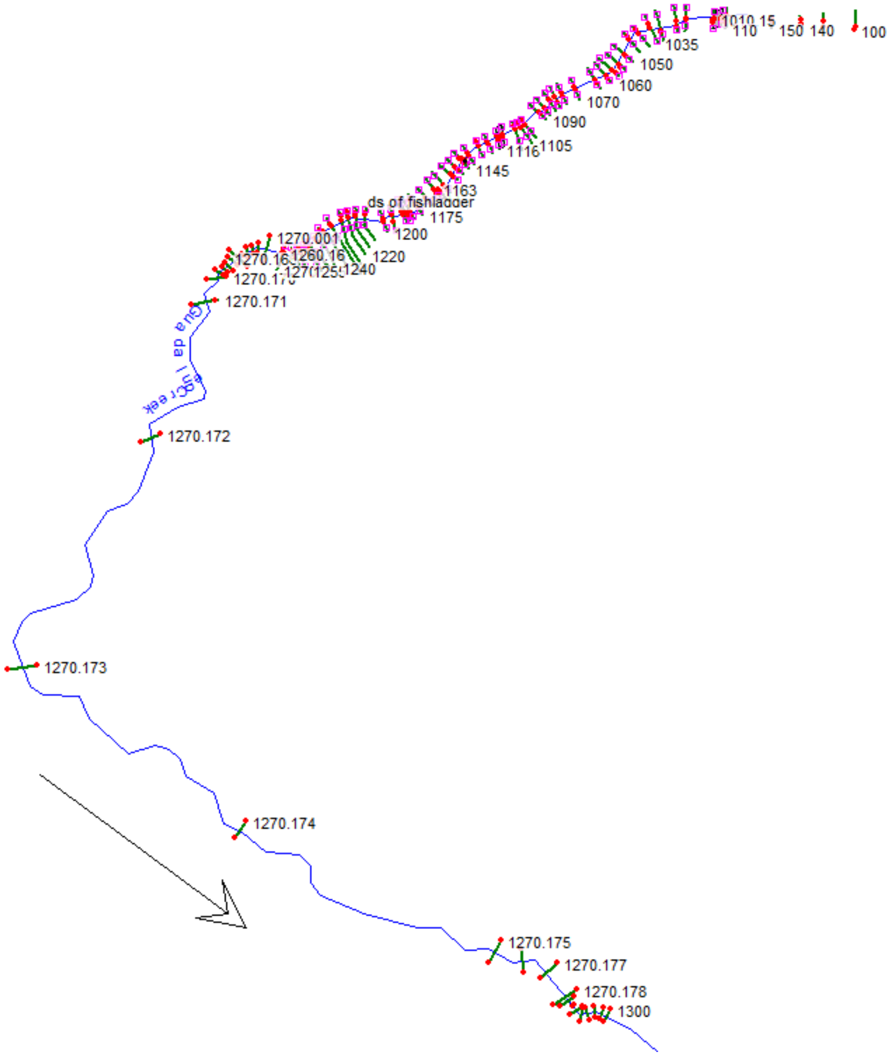


Figure 25. Example of HEC-RAS model extended upstream to encompass a new field transect.
The purple and green transects shown here in Guadalupe Creek previously ended around XS 1270.171. Additional XSs were added all the way up to the GCRK4 field transect (just upstream of 1270.178).

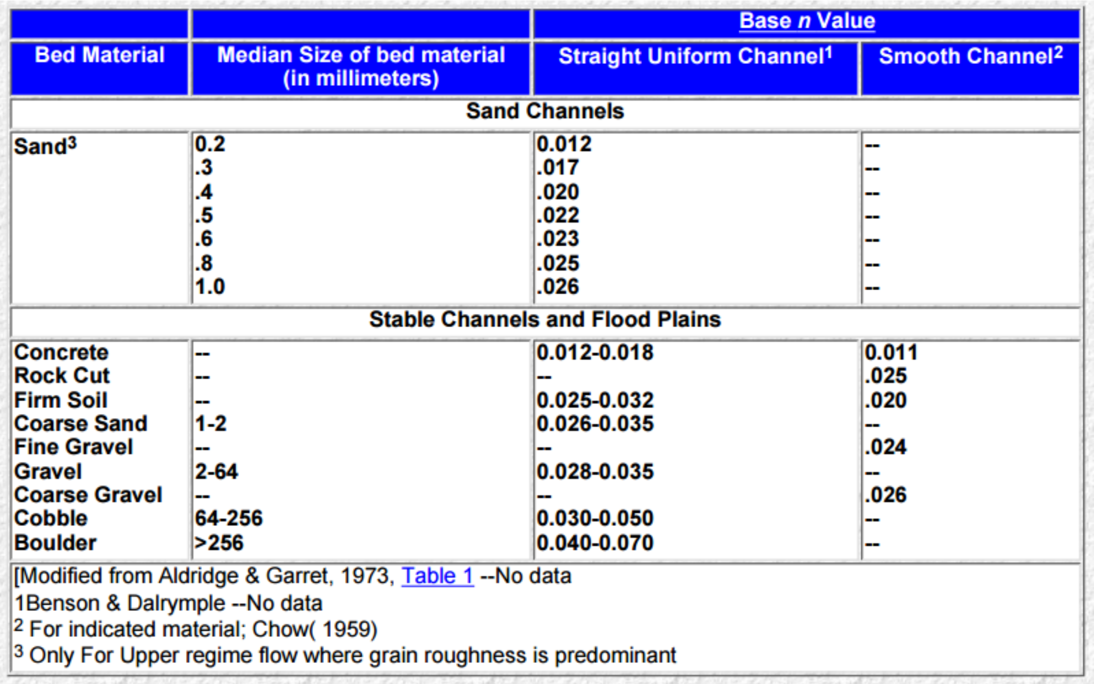
Of the 11 POIs that were not newly surveyed, nine fell within the extent of existing HEC-RAS models, and therefore the nearest pre-existing, field-surveyed cross section was assigned to each POI

For the two POIs falling outside of pre-existing HEC-RAS model extents, and which were not newly field-surveyed (CALE2), the crude DEM-based transects served as the only source of stream-channel data, and were therefore used. The rating curves determined from these XSs therefore are less sensitive to low flows and have a high level of uncertainty

Roughness Coefficient Estimation (Manning's n) for All New XSs

Using HEC-RAS to model channel hydraulics requires a number of parameter estimates and assumptions about the channel at each given point in order to successfully operate. One of the inputs required by HEC-RAS for all XSs is a value of the roughness coefficient, or "Manning's n". To estimate this for each new field transect XS, average sediment size measurements that the survey crew gathered at each field site were used with this table found in this USGS report on 'Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains (http://www.fhwa.dot.gov/bridge/wsp2339.pdf). Table 7 includes a summary of average sediment sizes and corresponding estimated Manning's n. These Manning's n values only represent the "base" value estimates, and ideally one would want comprehensive site data to estimate additional factors such as channel irregularities, obstructions, and vegetation, which could potentially add to the overall roughness value of the site. However, given the absence of highly detailed data regarding these variables; the fact that site photos reveal little in the way of irregularities, obstructions, or in-channel vegetation (most vegetation occurs along the banks); and that passage at riffles primarily occurs at below-bankfull flows, it was deemed sufficient to assume the base n value to be acceptably close to actual in-channel values at these riffles.

Table 7. Estimating Manning's n values for each new XS



		Base *n* Value	
Bed Material	**Median Size of bed material (in millimeters)**	**Straight Uniform Channel[1]**	**Smooth Channel[2]**
Sand Channels			
Sand[3]	**0.2**	**0.012**	**--**
	.3	**.017**	**--**
	.4	**.020**	**--**
	.5	**.022**	**--**
	.6	**.023**	**--**
	.8	**.025**	**--**
	1.0	**.026**	**--**
Stable Channels and Flood Plains			
Concrete	**--**	**0.012-0.018**	**0.011**
Rock Cut	**--**	**--**	**.025**
Firm Soil	**--**	**0.025-0.032**	**.020**
Coarse Sand	**1-2**	**0.026-0.035**	**--**
Fine Gravel	**--**	**--**	**.024**
Gravel	**2-64**	**0.028-0.035**	**--**
Coarse Gravel	**--**	**--**	**.026**
Cobble	**64-256**	**0.030-0.050**	**--**
Boulder	**>256**	**0.040-0.070**	**--**

[Modified from Aldridge & Garret, 1973, Table 1 --No data
1Benson & Dalrymple --No data
[2] For indicated material; Chow(1959)
[3] Only For Upper regime flow where grain roughness is predominant

The field sites were assumed to be at "stable channels", at least at the relatively low flows relevant to riffle passage. It's likely that at high flows there may be some movement of material, and channel instability, but for the purposes of low-flow riffle passage analysis, the channels were assumed to be "stable". This assumption of stability is also required in order to perform the modeling calculations within HEC-RAS. Table 8 lists the final estimates of Manning's n values for each field transect XS.

Table 8. Final Estimates of Manning's n values for each new field transect XS

POI	SUBSTRATE Diameter (IN)	mm	Manning's n
STEV1	1	25.4	0.031
STEV3	3	76.2	0.036
STEV4	2	50.8	0.034
STEV5	2	50.8	0.034
STEV6	2	50.8	0.034
GUAD3	36 (sacrete)	910.8	0.070
GUAD4	9	228.6	0.051
GUAD5	1	25.4	0.031
GUAD6	1	25.4	0.031
GUAD7	2	50.8	0.034
GCRK1	1	25.4	0.031
GCRK2	0.5	12.7	0.029
GCRK3	1	25.4	0.031
GCRK4	4	101.6	0.038
ALAM1	1	25.4	0.031
ALAM2	5	127	0.041
ALAM3	5	127	0.041
ALAM4	1	25.4	0.031
CALE1	1	25.4	0.031
LOSG1	3	76.2	0.036
LOSG2	0.5	12.7	0.029

Depth Estimate Validation

Unfortunately, there exist very few field measurements of water depth at the precise locations of each of the POI sites that can serve to validate estimated depth outputs from HEC-RAS. However, prior to the 28 RTK riffle surveys, there were a total of 11 critical riffle analysis (CRA) surveys carried out by the District, in which a riffle near a POI was identified and surveyed at 1 - 3 different flows, detailing the water depth along the survey transect. The POIs at which these CRA surveys were carried out are shown below in Table 9.

Table 9. Comparison of Average Depths as observed in CRA surveys with those modeled by HEC-RAS

		AVERAGE DEPTH			
POI	Q [cfs]	Observed (CRA) [ft]	HEC-RAS (RTK) [ft]	Sim - Obs [ft]	% Diff
ALAM2	11.4	0.39	0.32	-0.07	-18%
	14.9	0.38	0.36	-0.02	-5%
	26.5	0.49	0.48	-0.01	-2%
ALAM3	12.0	0.27	0.25	-0.02	-7%
	71.0	0.64	0.63	-0.01	-2%
CALE1	2.6	0.26	0.18	-0.08	-31%
	14.2	0.53	0.52	-0.01	-2%
	20.5	0.56	0.63	0.07	13%
GCRK1	20.8	0.50	0.46	-0.04	-8%
	22.3	0.49	0.47	-0.02	-4%
	31.7	0.58	0.58	0.00	0%
GCRK3	14.3	0.40	0.28	-0.12	-30%
	15.2	0.42	0.29	-0.13	-31%
	33.4	0.54	0.44	-0.10	-19%
GUAD3	25.62	0.65	0.62	-0.03	-5%
LOSG1*	5.6	0.22	0.27	0.05	23%
	20.4	0.41	0.46	0.05	12%
	52.2	0.75	0.64	-0.11	-15%
STEV1	1.0	0.11	0.18	0.07	64%
	11.2	0.38	0.56	0.18	47%
	37.1	0.62	0.98	0.36	58%
STEV2	8.4	0.45	0.47	0.02	4%
	11.7	0.44	0.56	0.12	27%
	73.4	1.10	1.43	0.33	30%
STEV4	1.4	0.16	0.22	0.06	38%
	2.8	0.19	0.29	0.10	53%
	13.1	0.45	0.52	0.07	16%
	14.9	0.46	0.56	0.10	22%
	16.5	0.49	0.59	0.10	20%
STEV5	2.4	0.26	0.19	-0.07	-27%
	18.2	0.58	0.46	-0.12	-21%
	36.9	0.75	0.65	-0.10	-13%
STEV6	2.5	0.20	0.15	-0.05	-25%
	15.9	0.51	0.53	0.02	4%
	41.4	0.80	0.92	0.12	15%
			Avg Model Bias:	0.02	5%

These 11 riffles are located at the same POIs that would later undergo RTK surveys, and therefore provide some opportunity to compare our estimates of depths from HEC-RAS (which utilizes the RTK survey data) with observed depths from the CRA analyses. It should be made clear, however, that the CRA survey transects were not necessarily linear and perpendicular to streamflow, as was the case with the RTK transects, but instead followed the course of the riffle crest, or the shallowest line along the riffle. Therefore, while both the CRA and RTK transects were done on the same riffles, they are not identical, with the RTK transects likely capturing more areas of deeper water due to the fact that they do not perfectly track the riffle crest. This incongruence makes a 1-to-1 comparison of modeled depths from the RTK transects with observed depths along the CRA depths impossible, but doing a rough comparison nonetheless provides reassurance that the HEC-RAS model is generally capturing similar magnitudes of average depths, as summarized above in Table 9.

It can be clearly seen in Figure 26 below that the differences between the CRA and RTK transect shapes will produce different average depth values, making a direct comparison between the two impossible, but nonetheless the similar magnitudes of values suggests the HEC-RAS models are at least reasonably well-calibrated.

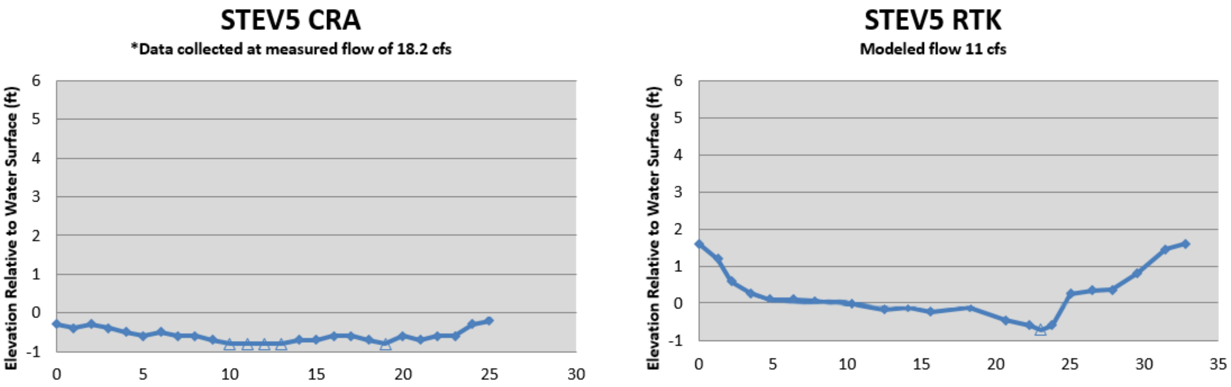
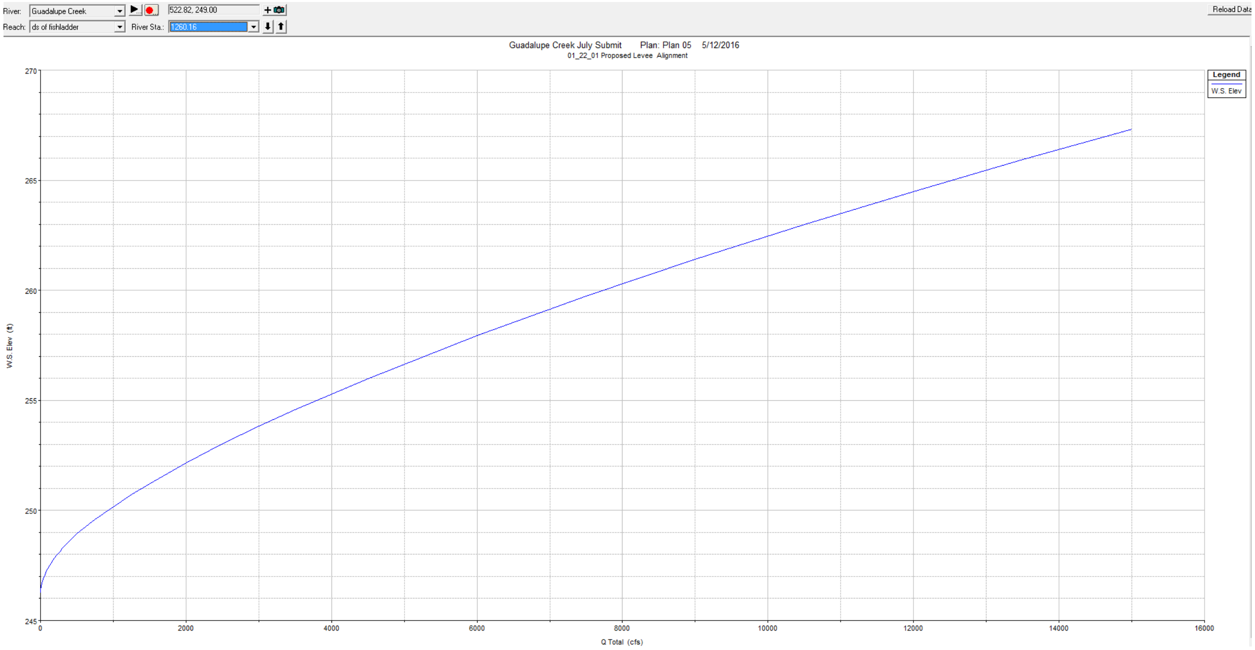


Figure 26. CRA and RTK transects at STEV5

Stage-Discharge Rating Curves

Rating curves relating discharge to water depth were calculated in HEC-RAS at each POI for 43 different flows from 0 to 15,000 cfs, with an emphasis on low and intermediate flows (seven flows from 0-10 cfs, and 22 flows from 10-1,000 cfs) (Figure 27). These rating curves were then built into WEAP using a lookup function in a user-defined variable, enabling WEAP to calculate daily depth at each POI from the modeled flow for that day (Figure 28).



River: Guadalupe Creek

Reach: ds of fishladder

River Sta.: 1260.16

522.82, 249.00

Figure 27. Rating Curve Output from HEC-RAS. Shown here is GCRK2

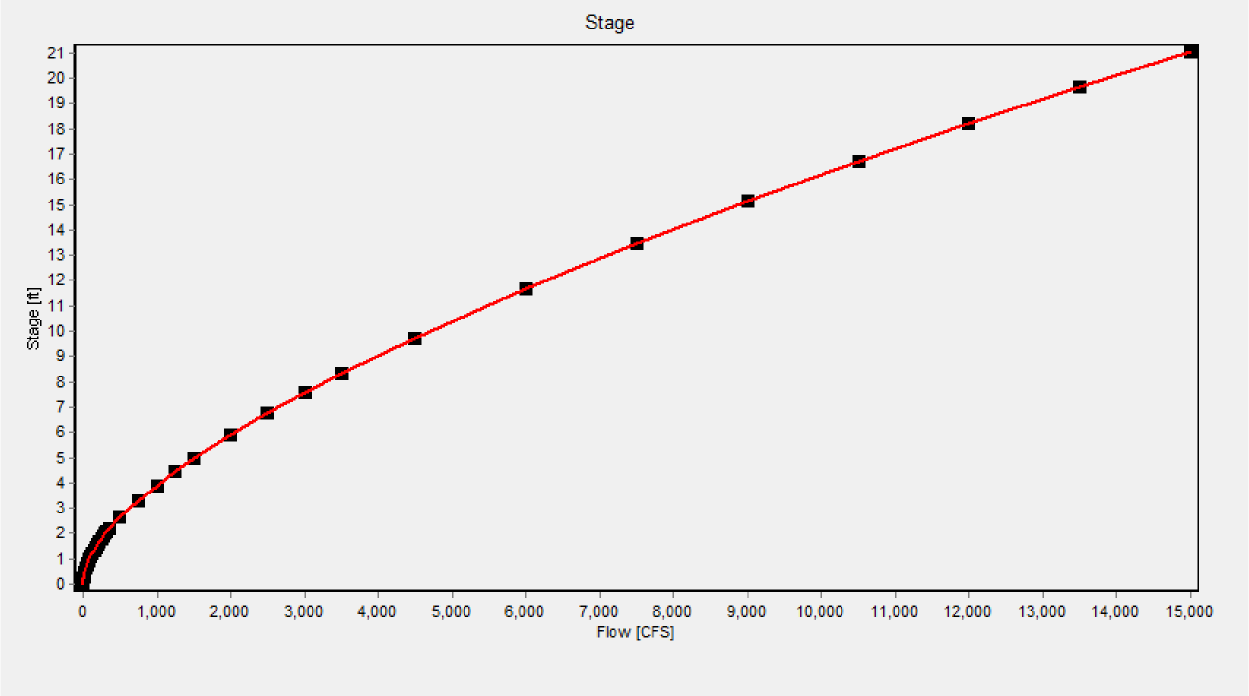


Figure 28. Rating Curve Input into WEAP. Shown here is GCRK2

H. Incorporation of Water Temperature Correlations

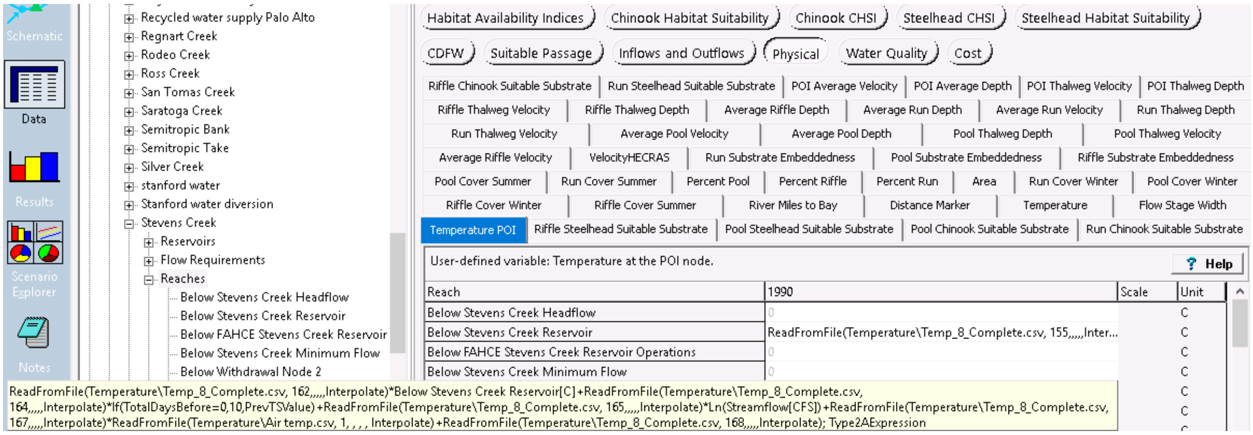
The full description of the procedure and technical approach for temperature correlations is described in EIR Appendix I, “Temperature Modeling Technical Memorandum”. To incorporate the temperature relationships into WEAP, the first step was to consolidate all the daily correlation coefficients in a csv file, and include the maximum daily temperature value as a ReadFromFile in WEAP. With these two input files, we created an equation that could estimate the correlations using the reservoir storage value for the POIs located just downstream of reservoirs, or the upstream reach temperature value for all other POIs, as indicated in HDRs correlation equations. The specific variables used in the correlation equations differ for each location. However, the generalized HDR correlation equations used are:

- Water Temperature, just downstream of Reservoir = A*Reservoir Storage + B*Previous Day Water Temperature + C* Reservoir Release + D * Daily Max Air Temperature + E(constant)
- Water Temperature, all other locations = A*Upstream Water Temperature + B* Previous Day Water Temperature + C * Flow + D * Daily Max Air Temperature + E (constant)

Below is an example expression used in WEAP to read the coefficients associated with upstream temperature (column 162), previous day water temperature (column 164), reservoir release (column 165), daily max air temperature (column 167) and the constant (column 168).

- *ReadFromFile(Temperature\Temp_8_Complete.csv, 162,,,,,Interpolate)*Below Stevens Creek Reservoir[C]+ReadFromFile(Temperature\Temp_8_Complete.csv, 164,,,,,Interpolate)*If(TotalDaysBefore=0,10,PrevTSValue)+ReadFromFile(Temperature\Temp_8_Complete.csv, 165,,,,,Interpolate)*Ln(Streamflow[CFS])+ReadFromFile(Temperature\Temp_8_Complete.csv, 167,,,,,Interpolate)*ReadFromFile(Temperature\Air temp.csv, 1, , , , Interpolate)+ReadFromFile(Temperature\Temp_8_Complete.csv, 168,,,,,Interpolate)*

For <u>temperatures at POIs</u>, these expressions were added in a user defined variable called Temperature POI in WEAP (Figure 29), while for <u>temperature along river reaches</u>, a separate user defined variable called Temperature calculates the average of the nearest upstream and downstream Temperature POI values (Figure 30).

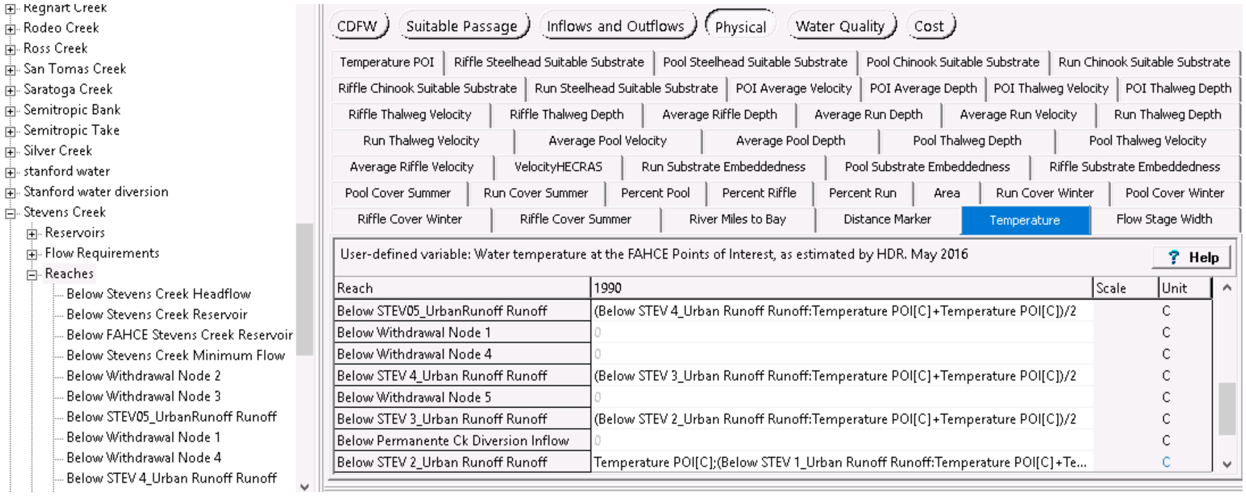


User-defined variable: Temperature at the POI node.

Reach	1990	Scale	Unit
Below Stevens Creek Headflow	0		C
Below Stevens Creek Reservoir	ReadFromFile(Temperature\Temp_8_Complete.csv, 155,,,,,Inter...		C
Below FAHCE Stevens Creek Reservoir Operations	0		C
Below Stevens Creek Minimum Flow	0		C

ReadFromFile(Temperature\Temp_8_Complete.csv, 162,,,,,Interpolate)*Below Stevens Creek Reservoir[C]+ReadFromFile(Temperature\Temp_8_Complete.csv, 164,,,,,Interpolate)*If(TotalDaysBefore=0,10,PrevTSValue)+ReadFromFile(Temperature\Temp_8_Complete.csv, 165,,,,,Interpolate)*Ln(Streamflow[CFS])+ReadFromFile(Temperature\Temp_8_Complete.csv, 167,,,,,Interpolate)*ReadFromFile(Temperature\Air temp.csv, 1, , , , Interpolate)+ReadFromFile(Temperature\Temp_8_Complete.csv, 168,,,,,Interpolate); Type2AExpression

Figure 29. River reach/physical/ temperature POI variable calculates temperature at POIs based on HDR correlation equations



User-defined variable: Water temperature at the FAHCE Points of Interest, as estimated by HDR. May 2016

Reach	1990	Scale	Unit
Below STEV05_UrbanRunoff Runoff	(Below STEV 4_Urban Runoff Runoff:Temperature POI[C]+Temperature POI[C])/2		C
Below Withdrawal Node 1	0		C
Below Withdrawal Node 4	0		C
Below STEV 4_Urban Runoff Runoff	(Below STEV 3_Urban Runoff Runoff:Temperature POI[C]+Temperature POI[C])/2		C
Below Withdrawal Node 5	0		C
Below STEV 3_Urban Runoff Runoff	(Below STEV 2_Urban Runoff Runoff:Temperature POI[C]+Temperature POI[C])/2		C
Below Permanente Ck Diversion Inflow	0		C
Below STEV 2_Urban Runoff Runoff	Temperature POI[C];(Below STEV 1_Urban Runoff Runoff:Temperature POI[C]+Te...		C

Figure 30. River reach/physical/ temperature variable calculates the reach temperature by taking the average of upstream and downstream POI temperatures

I. Habitat Metrics and Biological Evaluation Framework (BEF) Indicators

In the Valley Water system, as in other managed water systems in California and elsewhere, processes at different levels interact (Figure 31). The FAHCE WEAP model serves as an integrated platform to integrate key habitat metrics and tools at the broad hydrology scale, as it connects to the system operations scale and the smaller the fish habitat scale. Hydrologic and landscape processes are driven by watershed dynamics, but flow, temperature, and habitat suitability must be determined at the river, the reach and the habitat unit levels. To tackle this challenge, the team drew upon innovative work that connected a physical systems model with fish population dynamics to assess management adaptations for threatened species loss reduction (Thompson et al. 2012).[7] Importantly, in the Three Creeks system, the underlying system hydrology stems not only from the physical watershed processes, but from the operation of comprehensive water management systems of dams, diversions and groundwater recharge basins.

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[7] 2013 Best Research-Oriented Paper Award by ASCE-EWRI Journal of Water Resources Planning and Management selected this work

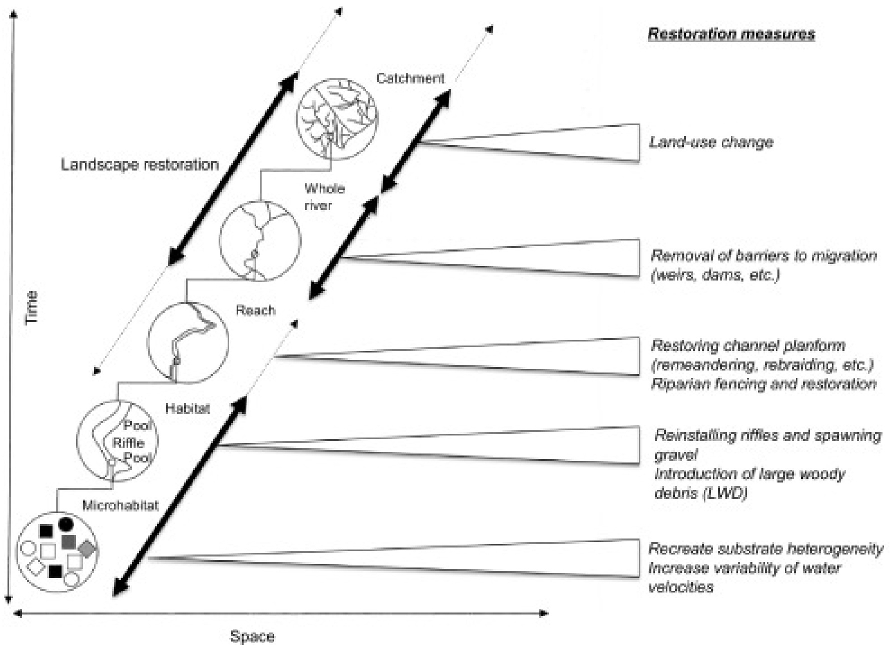

Figure 31. Scales of system restoration in time and space adapted from Figure 4 in Friberg et al., 2017

At the smaller scale of analysis required for FAHCE WEAP, creeks are delineated into physical habitat units. Each possess characteristic physical attributes related to how organisms interact with their physical habitat (Moyle and Cech 2004). The attributes of physical habitat stem from the interaction among hydrologic, hydraulic, and geomorphic processes (Poff et al. 1997). Watershed and stream processes determine transient ecologic functions at the habitat-unit scale that can be characterized with observable metrics (Maddock 1999). Existing approaches available for habitat functionality are adept at producing detailed characterizations of parameters representing one or two habitat functions. However, existing habitat assessment approaches lack an integrated understanding of hydraulic, geomorphic, and ecologic interactions of physical habitat (Clarke et al. 2003; Maddock 1999). The WEAP FAHCE framework connects a hydrologic model, water systems operation, and the conceptual ecological framework to offer a robust conceptual framework that can be used at the reach and basin scales to evaluate ecological functions and their relation to physical processes (Escobar-Arias and Pasternack 2010).

Biological Evaluation Framework (BEF) metrics were developed using a Tableau tool where threshold parameters by species can be set for adult immigration depth, adult immigration temperature, adult spawning depth, embryo incubation temperature, embryo incubation depth, fry rearing depth, fry rearing temperature, juvenile rearing depth, juvenile rearing temperature, juvenile emigration depth, juvenile emigration temperature, and percent of depth cross section passable for adult immigration and juvenile emigration. Based on these thresholds, Biological Evaluation Framework metrics are calculated, which include, by species: immigration depth, emigration depth, adult immigration passage extent, spawning combined habitat suitability indicator (CHSI), fry rearing CHSI, juvenile rearing CHSI, spawning habitat availability indicator (HAI), rearing HAI, juvenile emigration, effective incubation CHSI, effective spawning CHSI, and effective spawning HAI, as defined in EIR Appendix O “Fisheries Habitat Availability Estimation Methodology Technical Memorandum”.

Using the definition of scales and processes from Figure 31, key metrics required at each level which are outputs of the WEAP model are summarized in Table 10. The Biological Evaluation Framework (BEF), fills the gap to evaluate physical habitat unit suitability. With BEF, it became possible to generate a robust analysis platform in WEAP to obtain all required habitat metrics under different assumptions regarding the operation of the District's water management infrastructure.

Table 10. Scales of analysis, processes, habitat metrics, tools used

Scale	**Process**	**Example habitat metric**	**Tool**
Watershed	Hydrologic and Landscape	Flow, temperature and sediment inputs	WEAP
Whole river	Hydrologic and Fluvial Geomorphology	Passage conditions	WEAP/ HEC-RAS
Reach	Hydraulic, temperature	Depth, velocity, width, temperature	HEC-RAS, HDR temperature correlations
Habitat	Physical habitat units	CHSI and HAI by stage and species	Tableau/ BEF

III. Assumptions in Valley Water Daily Model

The full set of assumptions used in the final model are contained in the spreadsheet titled "Consolidated Revisions", available to the District.

A. Assumptions in Daily Disaggregation

The disaggregation of the monthly model required data processing as described in Figure 32, with disaggregation and review phases to lead to a complete daily model.

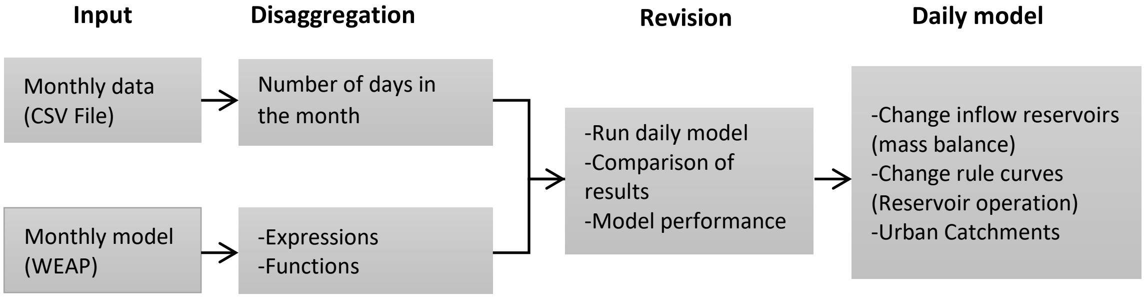

Figure 32. Disaggregation of monthly model into a daily model

The main assumptions that were required in this process include:

- Urban and agriculture water demand, water imports from the CVP and the SWP, and water evaporation were disaggregated by the number of days in each month. The disaggregation of monthly input values into daily data created discontinuities between the last and first days of each month.

- In the case of Transmission Links in the original monthly time step WEAP model, the Maximum Flow Volume was expressed as a monthly value that was constant value for each year. In order to obtain daily values, the constant value was multiplied by 12 months and then divided into 365 days. Implications of this assumption can be seen in Figure 33, where there is evidence of overestimation of the monthly model in the months with 31 days and underestimation in the months with lower number of days, indicating also the higher accuracy of the daily model.

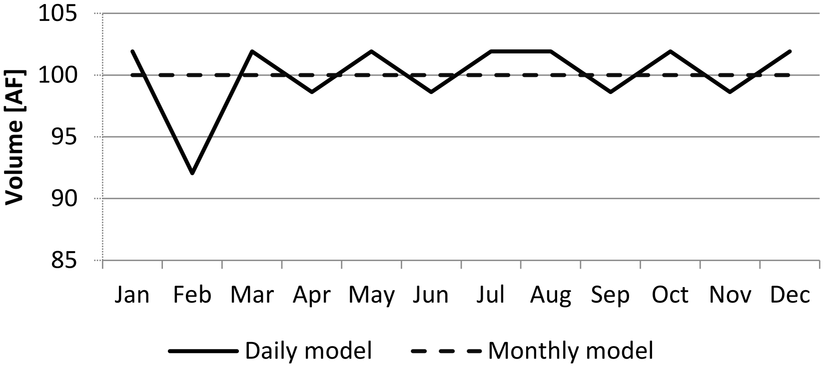

Figure 33. Implications of the volume disaggregation of constant monthly values.

B. Assumptions in Urban Catchments

Assumptions made in the process of developing urban catchments include those associated with the delineation of the catchments, and those associated with the calibration of the rainfall-runoff routines. The visual tracking of drainage networks to their respective outfall and identification within which reach between two POIs each outfall point discharged into may generate an error.

Regarding the data required for storm-water runoff modeling, another assumption in the catchments disaggregation was the pairing of each catchment with nearby rain gauges for rain input data. Many other assumptions pertaining to the implementation of the storm-water runoff routines had to do with the partitioning of area between pervious and impervious. Assigning Kc values for catchments was a key assumption in order to differentiate impervious and pervious sections of the catchments. Finally, runoff to groundwater from catchments was fine-tuned for each catchment based on monthly fluctuations of groundwater recharge driven by fluctuations in modeled soil moisture storage.

The resulting calibration of the urban catchments shows acceptable results at key POIs (as shown in the earlier Figure 14). The results indicate that the new Valley Water WEAP daily model represents the hydrology and operations of the system well enough to explore other alternative operations of the system that could improve habitat conditions.

C. Assumptions in Inflows to Reservoirs

The assumptions associated with the mass balances for inflows to reservoirs turned out to produce acceptable results based on the statistics of NSE, Bias, and RMSE at Coyote Reservoir. The main assumption is that the validity of the approach at Coyote Reservoir was extrapolated to all other reservoirs, which in many cases have additional mass balance terms. Each dataset used to complete the inflows to reservoirs mass balances contributes to the potential overall error. The ultimate estimate of the error associated with this assumption is reflected in the model performance statistics.

D. Assumptions in Stage-Discharge Data from HEC and WEAP

As described in the corresponding past section, the assumptions required to obtain stage-discharge relationships for the POIs include the fact that some of the cross sections were surveyed (23 POIs were newly surveyed and fell within existing HEC-RAS model domains), others needed to be obtained from existing HEC-RAS models cross sections (nine POIs fell within existing HEC-RAS model domains), others needed to be obtained from extensions of the existing HEC-RAS models (five POIs), and others were obtained based on existing DEMs (two POIs). The decision to use the existing models comes with all the assumptions associated with the physics of one-dimensional hydraulic modeling and those of the existing model calibration uncertainty, which is beyond the scope of this project. However, from our understanding of the source of the models, these HEC-RAS models are tools that were built for flooding analysis and are good representations of the system. Extending the model and using DEMs for cross sections representation adds additional assumptions to the calculation, which can induce additional error. In general, the greater assumption in using HEC-RAS for stage discharge data at the POIs, and that was under our control, had to do with the Manning's n roughness. Thanks to the collection of this data during the field campaign, it was possible to associate real observations with their respective Manning's n, which reduces the uncertainty on this aspect of the model.

E. Assumptions in Temperature Correlations in WEAP

The assumptions associated with the temperature relationships are described by HDR in EIR Appendix I: Temperature Modeling Technical Memorandum. Note that the correlation equations developed for reservoir outlet temperatures are the starting point for all three major creeks. Reservoir outlet temperature estimation accuracy is highly dependent on the accuracy of the modeled reservoir volume. The temperature correlation equations are not calibrated for conditions where reservoirs are not operating within historic volume ranges or if reservoir levels rare taken out of service completely.

IV. Model Uncertainty and Sensitivity

The daily Valley Water WEAP model is a complex model that, in addition to representing the Valley Water supply and demand system, includes disaggregated inflows to reservoirs, urban catchments, and functions to estimate salmonid habitat metrics at the POIs (POIs shown in Figure 1). Sources of uncertainty in this water resources planning model include model and parameter uncertainty, spatial and temporal variability of the system, and the uncertainty associated with systems operations, as described below. On June 30th, 2016, the Technical Working Group explored these sources of uncertainty and how they combine to impact the model output produced by the modified daily model.

A. Sources of uncertainty

In terms of **model uncertainty**, the Valley Water WEAP daily model is a water resources planning platform that brings together pieces of information about the system to represent them in an integrated assessment tool. WEAP is a priority-driven hydrologic modeling software that computes the system-wide water balance for each time step (daily in this case) and in turn allocates water to demands within the system based on their relative priorities. The principal elements of the Valley Water system have all been represented in the WEAP model. This includes reservoirs and their daily inflows, inter- and intra-basin transfers, urban runoff hydrology, and the wide diversity of demands within the system. Naturally the model is not perfectly representative of every nuance and minute detail of the complex system, and utilizes a multitude of generalized assumptions in order to emulate real-world hydrology and operations.

One example of such uncertainty is the conversion and integration of data from the previous monthly time-step WEAP model to the new daily time-step model. This was done for aspects of the system such as imported water allocations, various local supplies and demands, seismic restrictions on reservoirs, and bypass flow requirements, in which daily-specific estimates were unavailable. This disaggregation of monthly values generally entailed dividing the original monthly values by the number of days in each month to obtain “daily” estimates of these components of the system.

The modeling of urban runoff hydrology was represented using rainfall-runoff routines, which are based upon a multitude of physical parameters that introduce a level of **parameter uncertainty** to the model. In this particular case, parameters were defined based on a standard calibration procedure that yielded the optimal representation of the urban runoff as compared to gauge observations. However, it is well known that hydrological model parameters are not constants in dryland catchments. It was beyond the scope of this work to evaluate and incorporate unsteady parameters. Additionally, water system operations functions, such reservoir rule curves and stream-water diversions, were evaluated against historical observations to produce modeled operations reflective of real-world operations.

The **natural variability of the system** in a hydrologic and systems model is particularly relevant to the discussion of model uncertainty since it relates to the spatial and temporal resolution of the model. In this particular case, the monthly model was refined into a daily model for higher temporal resolution, and with newly integrated estimates of urban runoff hydrology in order to obtain a higher spatial resolution of in-stream flow estimates. This increased resolution was implemented in order to represent the natural fluctuations of the system, which are highly relevant for fish habitat conditions. As such, the current daily Valley Water WEAP model better captures the natural variability of the system than the monthly model. That being said, potentially significant sub-daily flow and temperature fluctuations remain un-captured by this daily model. Still, the current daily time step and spatial disaggregation of the urban catchments are an improvement over the monthly model resolution to represent natural variability, which is consistent with the objectives of the FAHCE Modeling Study Plan.

Regarding **system operations**, the model aims to represent the chief objectives of Valley Water in terms of fulfilling demands and groundwater storage requirements. The representation of these operations is based on complex algorithms that represent District priorities for water allocation and distribution. However, the human on-the-ground decisions made by the District on a daily basis were not driven by those algorithms.

The combined effect of uncertainty sources has an impact on the veracity of the final model outputs for habitat metrics at POIs. Therefore, WEAP model robustness, that is the ability of the WEAP model to handle variability and effectively represent the system, was analyzed, as well as the sensitivity of model outputs to input parameters. We present a set of graphical analytics to characterize the implications of uncertainty to guide users in the interpretation of model output.

B. Model sensitivity

1. Hydrologic model parameter sensitivity

The hydrologic model physical parameters associated with the rainfall-runoff routines that were used for the urban catchments were calibrated, and the sensitivity of model results to changes in these parameters was assessed. An initial manual calibration based on the physical process that the rainfall-runoff routines represent yielded a set of parameters that produced acceptable statistical model performance. Once this set of parameters for the rainfall-runoff routines was obtained, the PEST Parameter Estimation tool embedded in WEAP was employed to determine the sensitivity of model outputs to these parameter values[8]. PEST estimates model sensitivity to each parameter with respect to observations. The composite sensitivity estimated in PEST is normalized with respect to the number of observations, with "composite relative sensitivity" being defined as the composite sensitivity multiplied by the magnitude of the parameter value. According to the results in Table 11, the hydrologic model is not sensitive to the deep conductivity (Kd) and deep soil-water capacity (Dw) parameters, because of the generally low levels of deep percolation in urban zones where overland flow and interflow typify the hydrologic response (see Figure 9 where the soil model is originally illustrated). Therefore, the majority of the water remains in the upper soil layer, or the "upper bucket". However, this partitioning of water between the upper and lower soil layers, or "buckets", is largely dictated by preferred flow direction - the f parameter – which defines the proportion of water to be routed through the soil as interflow vs. deep percolation, meaning that the model is highly sensitive to this parameter. However, with the f parameter set so as to maintain the majority of runoff in the upper soil "bucket", the emphasis during calibration was on fine-tuning the upper soil water capacity (Sw), the runoff resistance factor (RRF) and the conductivity of the upper bucket (Ks), both of which are also sensitive parameters, though to a lesser degree than f. The model's sensitivity to these parameters is consistent with the expectation that in an urban zone, runoff is determined by the capacity of water to flow as surface runoff from dominantly impervious paved surfaces.

Table 11. Rainfall-runoff model parameter sensitivity

	Composite Sensitivity		**Relative Composite Sensitivity**	
Parameter Sensitivity	**Impervious**	**Pervious**	**Impervious**	**Pervious**
Sw – Soil water capacity (upper bucket)	1.76E-03	1.05E-03	0.35	0.39
Ks – conductivity of the upper bucket	2.83E-01	1.50E-01	0.28	0.15
Kd – conductivity of the lower bucket	1.24E-04	1.24E-04	0.01	0.01
f - Preferred flow direction	1.22E+00	5.17E-01	1.22	0.44
RRF – runoff resistance factor	1.05E-01	5.15E-01	0.28	0.52
Dw – deep water capacity (lower bucket)	3.74E-05	3.74E-05	0.02	0.02

Note: Number of observations with non-zero weight = 7670; and Kc values were set based on existing literature values, so sensitivity associated to these parameters was not estimated.

C. Metrics used to assess the effect of uncertainty on model performance

Although it is not appropriate to expect the same performance as from pure hydrology studies, the verified historical model nonetheless shows strong historical correspondence. In general, the verified historical model shows a good fit of representing the comprehensive system's historical conditions.

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[8] PEST: Model-Independent Parameter Estimation and Uncertainty Analysis, http://www.pesthomepage.org/

However, given that systems models must respond to a wide set of variables including water supply operation, it is not appropriate to expect the same historical correspondence as from pure hydrology studies (D. N. Moriasi et al. 2007). It is impossible to know the exact combination of factors that caused reservoir operators to operate the system in a particular way at some point in the past.

According to the literature, techniques for evaluation of model performance include graphical techniques and statistical estimates. The statistical estimates recommended include Nash-Sutcliffe efficiency (NSE), percent bias (%BIAS), and ratio of the root mean square error to the standard deviation of measured data (nRMSE). NSE indicates how well the plot of observed versus simulated data fits the 1:1 line, nRMSE indicates is an indicator of error in the model, and PBIAS indicates over or underestimation. For monthly timestep streamflow models, the following thresholds were established as satisfactory performance: NSE > 0.50, nRMSE < 70%, and PBIAS +/-25%.

The WEAP FAHCE model integrates effects of hydrology and water management operations on habitat variables on a daily time step. As can be understood intuitively, the literature concurs that model simulations are typically poorer for shorter time steps than for longer time steps, so acceptable model statistics will be less stringent for a daily versus a monthly time step. For example acceptable NSE values have established as 0.395 for daily and 0.656 for monthly streamflows and acceptable base flows as within 20% of those observed (D. N. Moriasi et al. 2007). Given the unique integrative nature of this modeling approach and its daily time step, the following thresholds were determined as acceptable: NSE > 0.36 and nRMSE < 80%, and if PBIAS +/-36% for streamflow. The graphical techniques used include visual comparison of simulated and measured model variables. These included hydrographs and percent exceedance probability curves (*Appendix 5. Streamflow exceedance figures*). The graphic evaluation of the model outputs, as well as the evaluation of these three statistics guided calibration, validation and verification.

The most significant factor of the operations verification process that took place after the initial review of this report in October 2016 until Feb 2017 was fine tuning as best as possible the logic of the current operations of the complex system of reservoirs and water transfers of Valley Water. This operations verification process involved several iterations in communication with the District staff in charge of the operations of reservoir and transfers, who provided feedback on the best approaches to represent these operations in the system through functions, rule curves, and priorities in WEAP. The set of interactions included multiple iterations of model outputs (reservoir volumes, inflows, and discharges; groundwater storage; and transfers in/out of Calero), and numerous meetings to review operation details. These iterations involved the generation of tables and graphs for Valley Water staff to review the outputs and to provide feedback, and the assimilation of this feedback into updated WEAP functions, rule curves and priorities. The purpose of this iterative process was to refine a) the current operations as represented by WEAP and as applied to the base case scenarios, and b) the implementation of FAHCE rule curves in the FAHCE alternatives, in order to best match the expectations and understanding of Valley Water staff. The process also served to inform the historical reservoir operations, and thus the verified model which represents historical conditions and – unlike the base case and FAHCE scenarios – produces flows and reservoir volumes directly comparable to historical observations. The model performance graphics from September 2019 was therefore a better representation of the system's historical conditions than previous iterations.

From upstream to downstream, the first set of graphs (Figure 34) show the performance of the model at the reservoirs in relation to observed values. These graphs show the correspondence between observed and modeled reservoir volumes, with model error being a product both of the error in estimated reservoir inflows as well as the operations and allocation priorities of the downstream demands. The R^2 estimates for reservoir storage are included in the graphs.

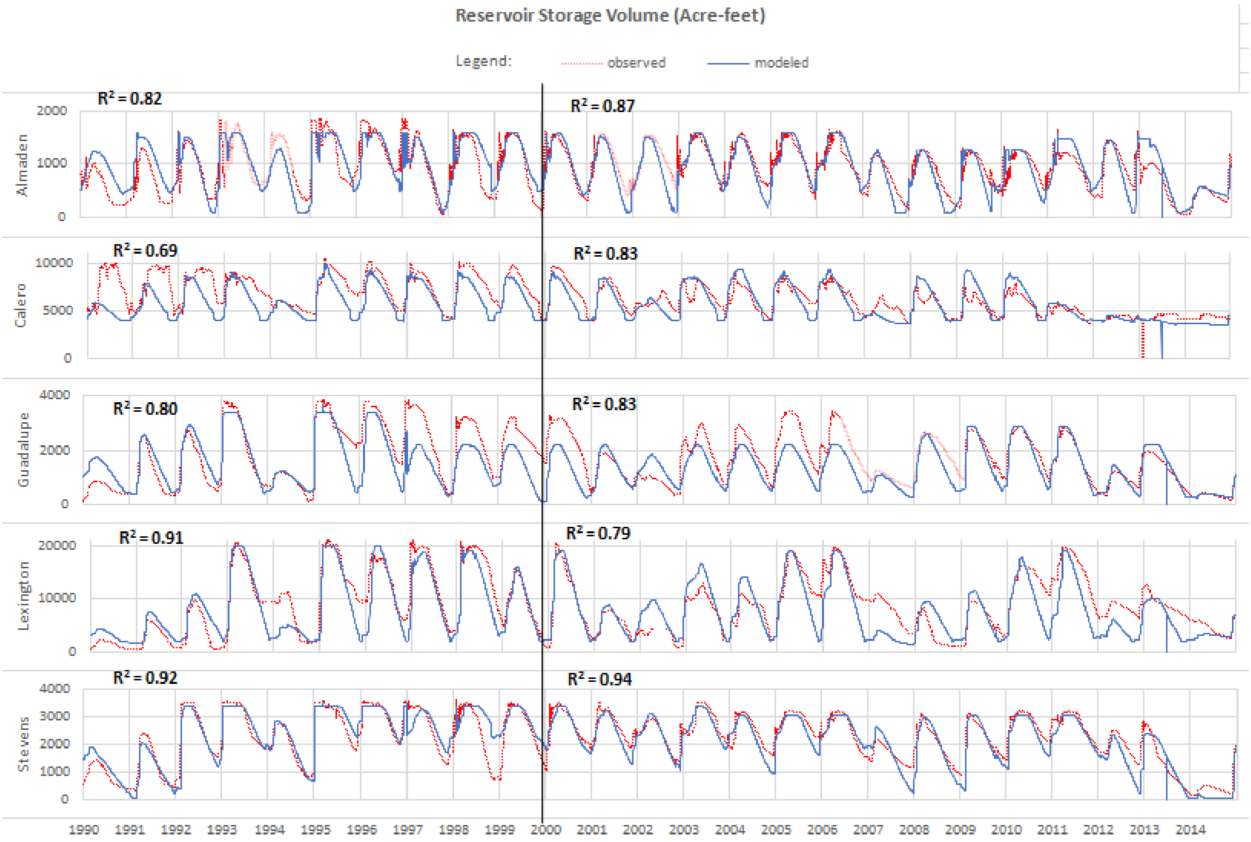


Figure 34. Observed vs modeled reservoir volume for Almaden, Calero, Guadalupe, Lexington, and Stevens reservoirs.

As seen in Figure 34, Almaden, Calero, Guadalupe, Stevens and Lexington all display general agreement between observed and modeled data to varying degrees of accuracy (R^2 between 0.69 and 0.92 for the calibration period and between 0.79 and 0.94 for the validation period). As noted in the images, there are particular breaks in 1993, 1997 and 2002, which respond to varying operation regimes and water year types. The modern-day "flood rule curves" for Almaden, Calero, Guadalupe, Lexington, and Stevens Creek reservoirs were adopted in 1997. Previously, the reservoirs were typically operated as "fill-and-spill" reservoirs, meaning releases were not typically made to provide flood-buffer storage space. Several of these reservoirs are subject to Division of Safety of Dams (DSOD) interim seismic storage restrictions, which constrain the operational releases until seismic retrofits are completed. These seismic restrictions on maximum allowable storage implied reduced reservoir storage over time, as shown in Table 12. Still, the exact implications of these restrictions on the daily decisions of operators two decades ago are neither known nor knowable. It is also difficult to capture decisions made by reservoir operators about the volumes of transfers in and out of Calero Reservoir from and to the Santa Clara Conduit, which carries imported supplies. Multi-layered decisions are impossible to capture in an automatic, modeled rule that can be carried into base case scenarios.

Table 12. Reservoir Storage Capacities and Seismic Restrictions for Historical Scenario

Facility	Stream	Storage Capacity	Seismic Storage Restriction
Almaden Reservoir	Alamitos Creek	1974 = 1,587 AF 2003 = 1,587 AF	2006 = 1,260 AF 2012 = 1,472 AF
Calero Reservoir	Calero Creek	1977 = 9.934 AF 2006 = 9,246 AF 2011 = 5,721 AF 2012 = 4.585 AF	2006 = 9,246 AF 2011 = 5,721 AF 2012 = 4,585 AF
Guadalupe Reservoir	Guadalupe Creek	1970 = 3,728 AF 1998 = 3,228 AF 2004 = 3,415 AF	2006 = 2,888 AF 2012 = 2,218 AF
Lexington Reservoir	Los Gatos Creek	1987 = 19,834 AF 2002 = 19,044 AF	None
Stevens Creek Reservoir	Stevens Creek	1988 = 3,465 AF 2004 = 3,138 AF	None

Key streamflow gauges along the FAHCE streams serve as an essential way to check the performance of the model as compared to the observed streamflows, using the same NSE, RMSE and Bias statistics. A summary for those key streamflow gauges is provided in Table 13. This table presents the performance of the modeled flows from the verified historical WEAP model for 1990-2014 compared to observed gauge data for two main river systems – Stevens Creek, and the Guadalupe River and its tributaries – and the POIs associated with these two systems. The thresholds for acceptable and unsatisfactory values of these calibration statistics have been defined according to literature standards and presented in the accompanying legend.

The statistics in Table 13 summarize model performance and improvement of model performance based on District input. The hydrology calibration results summarize statistics for the pure hydrological performance of the model, without the influence of reservoirs, for the calibration period of 1990-1999. Points just downstream of reservoirs are not included in the hydrology calibration results because these served as the starting point for calibration of urban inflows. In this way, errors in modeling reservoir operations were omitted from the results. The set of validation statistics, are for the validation period from 1990-2014, and include the influence of the reservoir operations, which are difficult to model. An accompanying set of graphs (*Appendix 3. Daily graphs and statistics of observed data and modeled output at gauges (1990-2014)* and *Appendix 4. Daily average graphs and statistics of observed data and modeled output at gauges (1990-2014)*) show the time series comparison of observed and final modeled flows for each of the gauges at the daily and daily average time scale, respectively, that are summarized in the set of statistics in Table 13.

Table 13. Summary of gauge statistics for observed vs modeled daily streamflow values.

River	Gauge	POI	1. Sep 2019			2. Validation/verification- Sep 2019		
			Hydrology Calibration (Reservoirs Disconnected) Daily 1990-1999			Daily 1990-2014		
			NSE	nRMSE [%]	Bias [%]	NSE	nRMSE [%]	Bias [%]
Stevens Cr	SF 5044	STEV6	.	.	.	0.75	50	-3
Stevens Cr	SF 5035	STEV2	0.81	43	17	0.72	53	12
Los Gatos Cr	SF 5067	NA	.	.	.	0.43	75	4
Los Gatos Cr	SF 5059	NA	0.93	27	-14	0.41	77	-12
Los Gatos Cr	SF 5050	LOSG1	0.66	59	-21	0.55	67	-16
Alamitos Cr	SF 5016	ALAM4	.	.	.	0.73	52	-9
Guadalupe Cr	SF 5017	GCRK4	.	.	.	0.24	87	3
Guadalupe Cr	SF 5043	GCRK3	0.75	50	-16	0.64	60	-7
Ross Cr	SF 5051	NA	0.82	43	16	0.78	47	22
Calero Cr	SF 5013	CALE2	.	.	.	-0.61	127	-18
Guadalupe R	SF 5023	GUAD5	0.85	39	-22	0.72	53	-33
Guadalupe R	SF 11169000	NA	0.89	33	-5	0.84	40	-10

Legend	Satisfactory	Not Satisfactory
NSE	> 0.36	<= 0.36
nRMSE (%)	< 80	>= 80
Bias (%)	< 35	>= 35

Statistics are color-coded according to the ranges for "satisfactory" and "not satisfactory" values identified in the legend.

At most gauge-locations, the model performance statistics are within acceptable thresholds, indicated by a green color in Table 13. Two sites exhibit lower performance (indicated by a red color) due to their location, various hard-to-quantify influencing factors, and/or the dubious quality of the original gauge data itself. Gauge 5013 in Calero, which exhibits poor model performance, includes the aggregated hydrologic and system operations response of the Calero reservoir, meaning that there are more modeling assumptions and accumulated uncertainties influencing the modeled flows at this site. Calero Reservoir transfers water in and out of the conduit carrying imported supplies, and receives a transfer from Almaden Reservoir. It is very difficult to model these transfers due to the variability and uncertainty in the year-by-year decisions taken by reservoir operators around the frequency and amount of these transfers. The transfer volumes have implications on creek hydrology downstream of Calero Reservoir because the reservoir is releasing water to satisfy demands that also receive water from Alamitos Creek, the conduit, and/or Guadalupe Creek. Modeled versus observed Gauge 5017 in Guadalupe Creek also displays poor performance, likely due to historical operations of Guadalupe Reservoir differing from the modeled algorithms.

The other gauges have performance that is considered acceptable for a complex hydrology and systems-operations model. The final set of statistics indicate an overall better performance in NSE, nRMSE and Bias as compared to the beginning of the validation and verification process. This representative set of gauges in the system provides the basis to assess the validity of the flow results in WEAP for different rivers and reaches within the river, which is the main building block for all other calculations of habitat availability as part of FAHCE. An overview of the model parameter sensitivity and uncertainty is provided in the next sections to describe the sources of error.

D. Implications of uncertainty for interpretation of model output

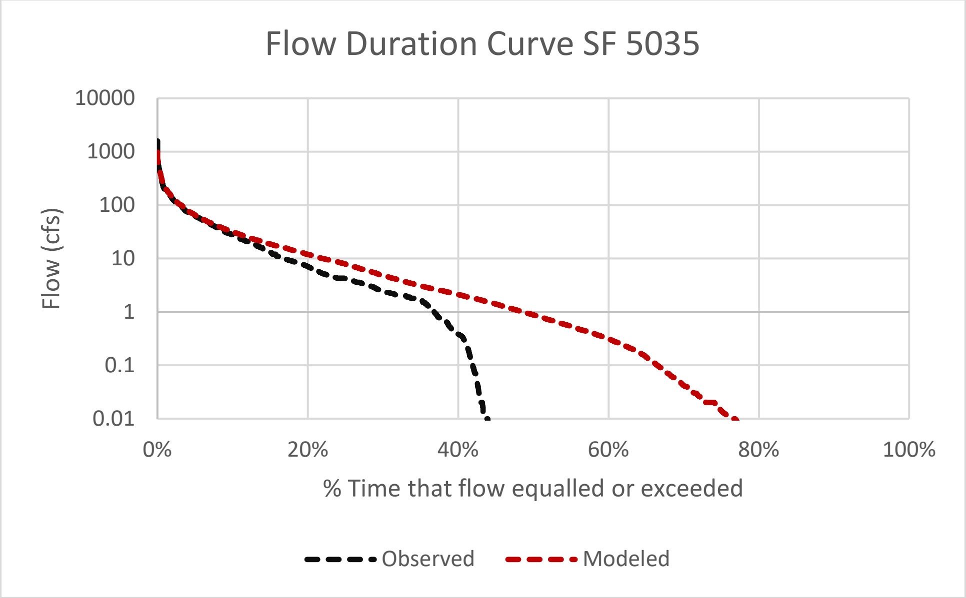
Uncertainty in model structure, input data, model parameters, system variability, and system operations create error in the model, resulting in different values of performance metrics as indicated in the sections above. The ultimate WEAP model outputs that relate to flow-dependent habitat metrics include this model uncertainty and error. The performance metrics of flow estimates (Nash, Bias and RMSE) provide information about the capacity of the model to represent the hydrologic conditions in an aggregated way. However, other types of analyses can help one understand different aspects of model performance and their implications for evaluating fish habitat at the 39 POIs.

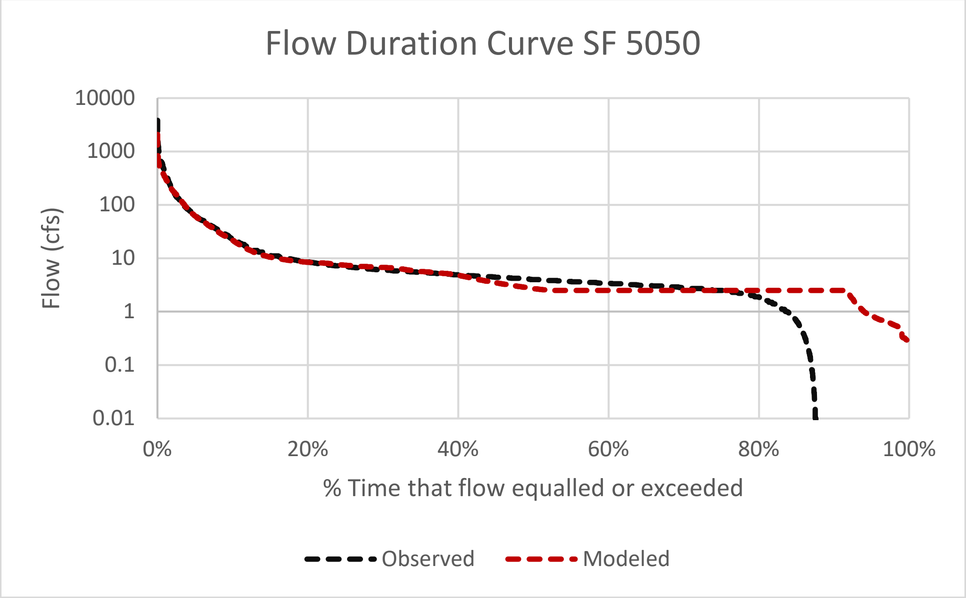
Understanding the implications of model uncertainty on the habitat conditions at each of the POIs is an essential task in order to draw meaningful conclusions about the various habitat metrics at each of these POIs. However, only 14 of the 39 POIs are spatially co-located with streamflow gauges where model performance was assessed. Therefore, the quality of model results with respect to real-world values at the other 25 POIs have to be inferred, using the model performance at the nearest up-stream and/or downstream gauge locations as points of reference.

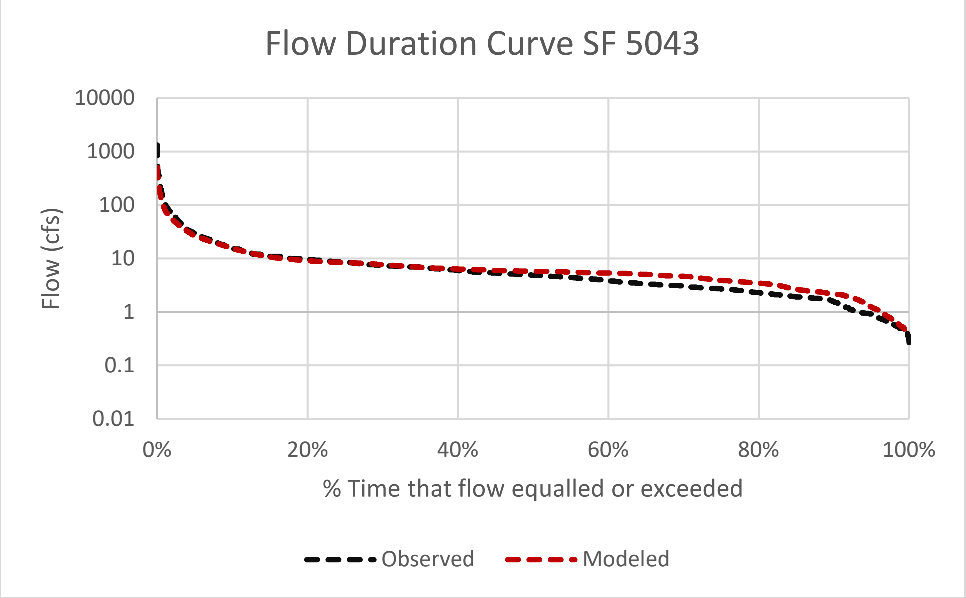
1. Exceedance curves of modeled vs observed flows

Another common way to assess modeled output uncertainty is with exceedance curves of modeled vs. observed flows (Figure 35). These graphs illustrate the flow regimes (high, moderate, low) during which the model tends to coincide closest with observed flows, conveyed as percent-exceedance values (x-axis values indicate the percentage of time in the observed or modeled flow data at which the corresponding flow value is equaled or exceeded). The exceedance graphs, with four examples shown in Figure 35 and the full set *(Appendix 5. Streamflow exceedance figures*), provide additional insight about the model's performance than merely assessing the statistical goodness-of-fit metrics (NSE, nRMSE, and Bias).

For instance, Figure 35 below shows that modeled flow estimates at SF 5035 are generally valid at all flows greater than approximately 10 cfs, with those below subject to the slight high bias. When looking at the difference between the red (modeled) and black (observed) curves, we can see that at 10 cfs, the modeled curve has an exceedance probability of roughly 22%, whereas the observed curve hits 10 cfs squarely at an exceedance probability of about 17%. Therefore, it can be discerned from this plot that modeled flows of 10 cfs occur about 5% more frequently than in reality, and therefore conditions for passage at flows near 10 cfs are prone to this slight high bias. Doing the same analysis for 5 cfs, the exceedance is roughly 22% of time for observed flows and about 30% of the time in the modeled flows, meaning the frequency of these flows in the model is about +5% biased. Furthermore, it can be seen that very low flows of less than 1cfs suffer a greater over-estimation by the model, with the exceedance probability values between the modeled and observed values widening to 22% at 0.2cfs.


Flow Duration Curve SF 5035
10000
1000
100
10
1
0.1
0.01
Flow (cfs)
0%
20%
40%
60%
80%
100%
% Time that flow equalled or exceeded
Observed
Modeled


Flow Duration Curve SF 5050
10000
1000
100
10
1
0.1
0.01
Flow (cfs)
0%
20%
40%
60%
80%
100%
% Time that flow equalled or exceeded
Observed
Modeled



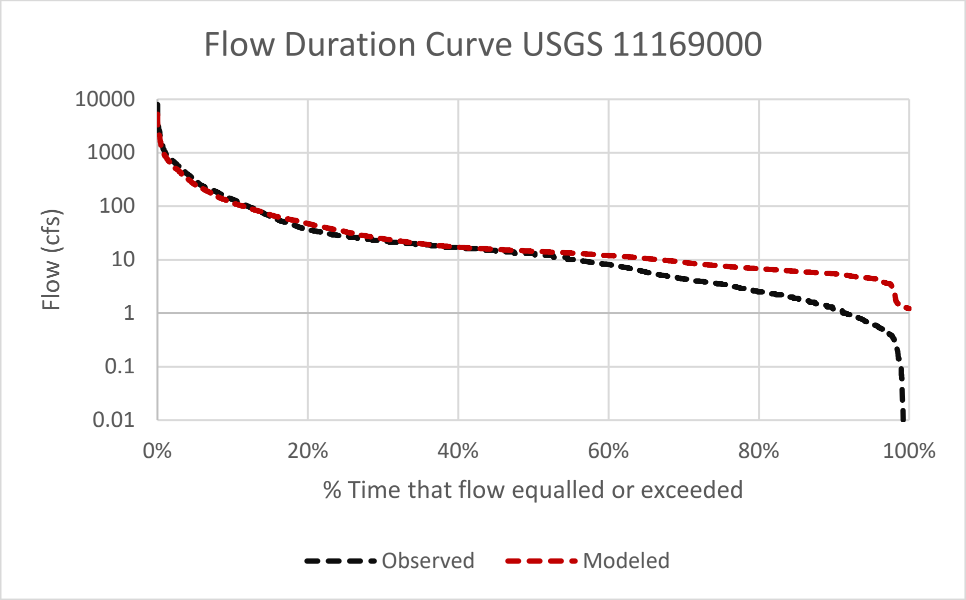


Figure 35. Exceedance curves of modeled and observed flows

V. Model Alternative Scenarios

A. Scenario Development Process

The implementation of the model alternatives in WEAP has been an iterative process. After finishing the verified model, SEI and Valley Water started a communication thread in order to produce a Base Case and a FAHCE alternative. The verified historical model was aimed at representing historical conditions, and captures any changes in operations over time from 1990-2014. The Base Case scenarios focused on assuming consistent reservoir operations for the 1990-2010 time frame, which serve as the reference to the FAHCE scenarios. Valley Water staff helped conceive of and verify the current reservoir operations as defined in WEAP.

B. Description of Scenarios

In the process of generating the alternatives, five management scenarios were defined and simulated in the model for the time frame of 1990-2010. Valley Water provided the data necessary to characterize and implement these alternatives. These included two base cases with current reservoir operation rules: one representing demand and import levels in 2015, with seismic restrictions on the reservoirs, and the other in 2035, without seismic restrictions on the reservoirs; and three additional alternatives with reservoir operations set according to the FAHCE Agreement. A final alternative with no district operations is also used in order to evaluate the Three Creeks under a completely natural flow regime. However this last alternative was not used to a great degree in the iterations since it will not be used in the habitat analysis given the fact that the temperature correlations developed under FAHCE are not valid for scenarios without reservoirs.

The key elements of the alternatives include the operation of reservoirs which can be either based on current conditions or FAHCE rule curves, the projected water demands level of demands and water imports from CALSIM which can 2015 or 2035, and the seismic restrictions which should not be valid in 2035 (Table 14). Ultimately, the alternatives that serve the purpose of evaluating the effect of the FAHCE rule curves are the 2035 Base Case, and the 2035 FAHCE because the lack of seismic restrictions in these two scenarios meant that the FAHCE rule curves were not restricted to behave on restricted reservoir volumes, and all others were used for reference in the evaluation of the model in relation to what the current operations could be if there are seismic restrictions and current levels of demands.

Table 14. Key elements of alternatives implemented in WEAP

	2015 Base Case	**2035 Base Case**	**2015 FAHCE**	**2015 FAHCE NSR**	**2035 FAHCE**	**2015 FAHCE Plus**	**2035 FAHCE Plus**	**No District Operations**
Reservoir Operation	Current	Current	FAHCE Rule Curves	FAHCE Rule Curves	FAHCE Rule Curves	FAHCE Plus Rule Curves	FAHCE Plus Rule Curves	No reservoirs, demand sites, artificial recharge, or imported water.
Water Demand	2015	2035	2015	2015	2035	2015	2035	
Imported Water (CALSIM)	2015	2035	2015	2015	2035	2015	2035	
Includes Seismic Restrictions	Yes	No	Yes	No	No	Yes	No	

C. Implementation of Scenarios in WEAP

One important capability of WEAP is to run an analysis on a large range of scenarios or alternatives. in WEAP, the scenario called “2035 Baseline Operations (1990-2010)” refers to the scenario containing historical data used for calibration and validation. The alternatives from Table 14 are evaluated for the 1990-2010, although some include projected data which is not in and of itself historical. For example, for the “2035 Base Case” alternative, the yearly water demand is defined as the water demand expected for 2035 and the volume of imported water varies based on the type of year, but the reservoir inflows do not change.

Seismic restrictions are implemented in the reservoir elements in WEAP using the top of conservation level and restrictions by year as indicated in Table 14. Water demands are included in the demand elements in WEAP, which in this case are represented by the treatment plants. The imported water is represented as a head flow of the water that comes into the reservoirs.

D. General Assumptions of the FAHCE Alternatives

The approach used to implement the FAHCE operational rules is based on the following:

- The reservoir outflows are limited by the “Maximum Hydraulic Outflow” variable In the WEAP reservoir object.
- WEAP “Flow Requirements” are installed downstream of the reservoirs to simulate required flows in the FAHCE Agreement.
- Demand priorities are assumed to be the same as in the monthly model.

E. Reservoir Operations in the FAHCE Alternatives

1. Winter Flow

The FAHCE Settlement Agreement Operational establishes operational rule curves for each of the reservoirs in the Valley Water system; for example, Figure 36 shows the FAHCE rule curves for Stevens Creek Reservoir. To simulate FAHCE alternatives in the model, the daily values of the rule curves were saved to a CSV file and imported into WEAP for each reservoir. The imported rule curves for Stevens Creek Reservoir are shown in Figure 37.

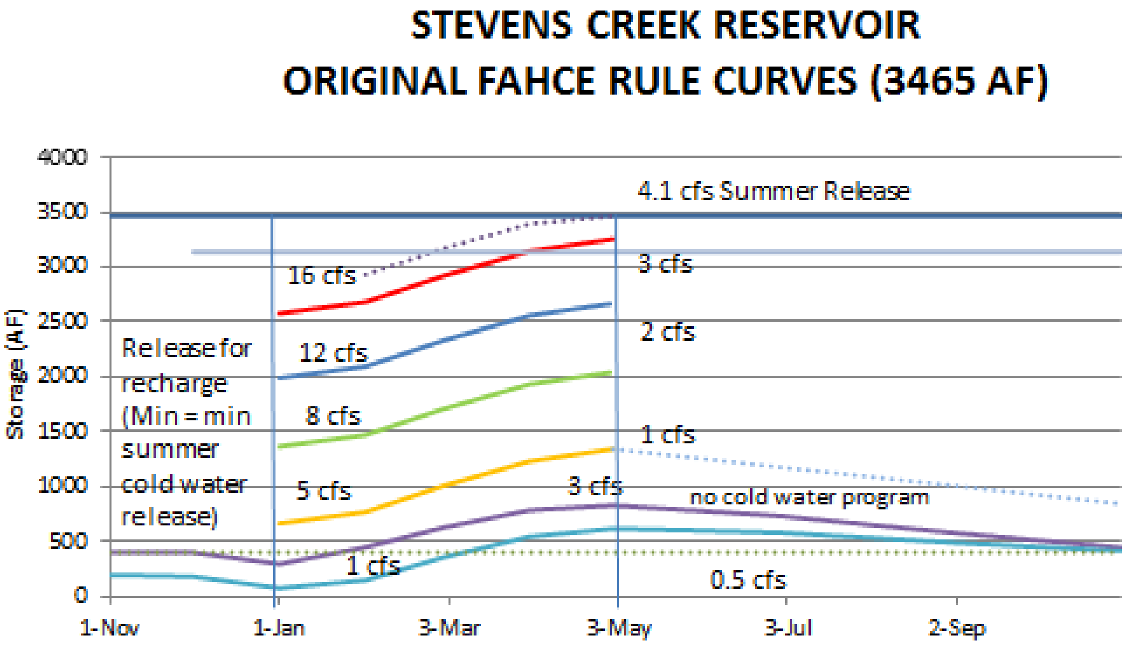
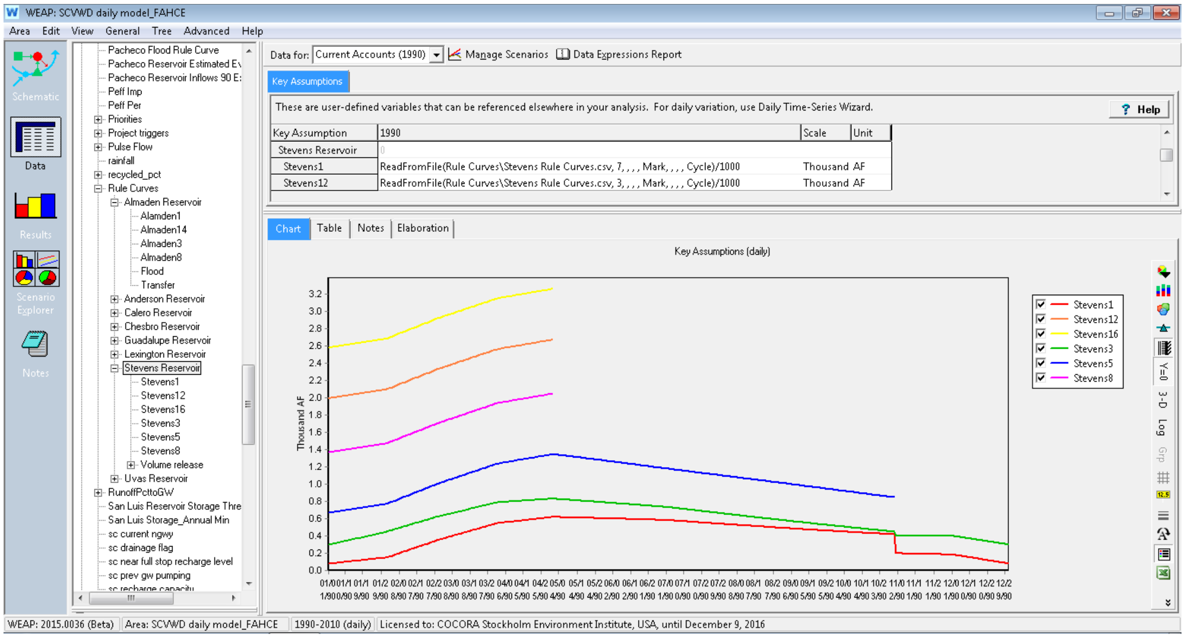


Figure 36. FAHCE Rule Curves for Stevens Creek Reservoir



Data for: Current Accounts (1990)

These are user-defined variables that can be referenced elsewhere in your analysis. For daily variation, use Daily Time-Series Wizard.

Key Assumption	1990	Scale	Unit
Stevens Reservoir	0		
Stevens1	ReadFromFile(Rule Curves\Stevens Rule Curves.csv, 7, , , , Mark, , , , Cycle)/1000	Thousand	AF
Stevens12	ReadFromFile(Rule Curves\Stevens Rule Curves.csv, 3, , , , Mark, , , , Cycle)/1000	Thousand	AF

WEAP: 2015.0036 (Beta) | Area: SCVWD daily model_FAHCE | 1990-2010 (daily) | Licensed to: COCORA Stockholm Environment Institute, USA, until December 9, 2016

Figure 37. FAHCE Rule Curves for Stevens Creek Reservoir, imported into WEAP.

Before calculating the discharge from each reservoir, an expression in WEAP calculates the operational volume, in function of storage volume, net evaporation, and inflow, as follows:

$$\text{Volume Operation}_{TS} = \text{Storage Volume}_{TS-1} - \text{Net Evaporation}_{TS} + \text{Headflow}_{TS}$$

Where:

$\text{Volume Operation}_{TS}$: Volume in the current time step
$\text{Storage Volume}_{TS-1}$: Storage volume in the previous time step
$\text{Net Evaporation}_{TS}$: Net evaporation in the current time step
Headflow_{TS}: Inflow into the reservoir in the current time step

If the operational volume falls on or above the rule curve, then the discharge released will be equal to the corresponding streamflow from the curve. Otherwise, the discharge is simply equal to the minimum required streamflow downstream of the reservoir. This is managed in the "Maximum Hydraulic Outflow" variable with the following expression:

If "$\text{Volume Operation}_{TS} >= \text{Rule Curves}$" then "*QRelease*" otherwise "*Minimum Flow*"

Where:

Rule Curves: The reservoir volumes in the FAHCE Rule Curves, entered in the "Top of Conservation" WEAP variable.
QRelease: The corresponding discharge on the rule curve.
Minimum Flow: Minimum flow required downstream of the reservoir.

2. Cold Water Management

The FAHCE Settlement Agreement outlines cold water management programs for Stevens Creek Reservoir, Guadalupe Creek Reservoir, and Anderson Reservoir. This program lasts from May to October (184 days). The criteria used to implement the cold water rule curves from FAHCE is the same as the one used in Valley Water's monthly model; that is, the volume of cold water available on the 1st of May. This is calculated as follows:

$$\text{Cold Water Volume} = \text{Storage Volume}_{TS-1} - \text{Top of Inactive} - \text{Depth Cold Water Volume}$$

Where:

Cold Water Volume: volume of cold water available
$\text{Storage Volume}_{TS-1}$: the storage volume from the previous time step
Top of inactive: inactive volume of the reservoir
Depth Cold Water Volume: the volume corresponding to the depth from the water surface, related to a temperature threshold

It's assumed that when the available cold water volume is larger than 360 AF (equal to 1 CFS discharge for 184 days), said volume is released in an equivalent manner throughout those 184 days, starting on May 1 and ending on October 31st. If the condition is not met, only enough cold water is released, via restrictions on the maximum hydraulic outflow and a downstream minimum flow requirement in the WEAP model, to meet the minimum temperature requirement downstream of the reservoir.

In reservoirs without cold water management, releases in the summer are operated by the FAHCE rule curves where appropriate, or by the summer release rule used in the current reservoir operations when no rule curves apply.

3. Pulse flows

The FAHCE Settlement Agreement indicates that up to two pulse flows are required between February and April. The following assumptions were made when implementing pulse flows in WEAP:

- If the reservoir both contains a volume equal or greater than the pulse flow (50 CFS) and is in a condition that could lead to spills on February 1st, the model is coded to wait for the spill to finish and check to see if the duration of the spill was 5 days; otherwise, the pulse flow is initiated according to what the FAHCE Agreement establishes.
- After the pulse flow is completed, the discharge is "ramped" down to return to the levels appropriate for winter base flow management.
- The second pulse flow is initiated 15 days after the first. Note that 15 days is an estimation; an appropriate time interval between the two pulse flows has yet to be determined.

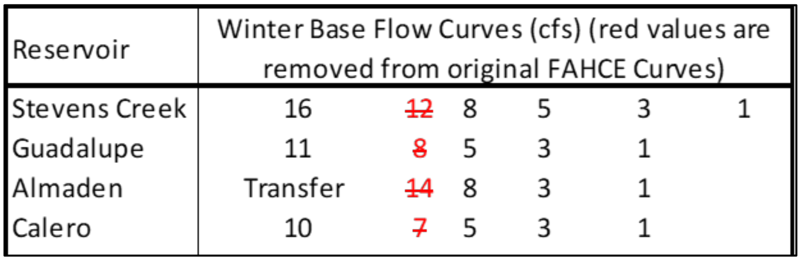
F. FAHCE Plus Scenarios

The FAHCE Plus scenarios represent modifications to the FAHCE scenarios to better support fish species viability in the District watershed. The FAHCE Plus scenarios were designed based on successes and feedback from previous model runs of the FAHCE and 4th Alternative scenarios. The FAHCE Plus operational rules are very similar to those for the FAHCE scenarios, with changes primarily to three areas:

- Cold-water management assumptions for Anderson, Guadalupe, and Stevens Creeks in FAHCE Plus differ from those in FAHCE. The depth from the water surface to top of cold water volume for these reservoirs are generally less in FAHCE Plus than in FAHCE. These changes are contained within the csv file, "Depth_Water_FAHCEPLus.csv". The other assumptions regarding cold-water management are the same as in the FAHCE Scenarios.

- FAHCE Plus also contains changes to the rule curves of Stevens, Guadalupe, Almaden, Calero, and Anderson Reservoirs. The major difference is in the winter base flow curves, with the FAHCE Plus rule curves generally releasing less water than FAHCE during the winter as shown in Table 15.

Table 15. Winter Base Flow Curves in FAHCE Plus Scenarios.



Reservoir	Winter Base Flow Curves (cfs) (red values are removed from original FAHCE Curves)					
Stevens Creek	16	~~12~~	8	5	3	1
Guadalupe	11	~~8~~	5	3	1	
Almaden	Transfer	~~14~~	8	3	1	
Calero	10	~~7~~	5	3	1	

- Finally, FAHCE Plus contains differences in the timing and discharge of pulse flows compared to the FAHCE scenario. Generally, the FAHCE Plus scenario initiates smaller and more frequent pulse flows compared to the FAHCE scenario. Under the FAHCE Plus scenarios, pulse flows may occur on the 1st and 15th of each month in the period between December 1st to April 1st to provide appropriate conditions for Chinook and Steelhead migration and outmigration. The pulses may last between 1 to 10 days depending on the purpose behind the pulse flow release and the creek. Table 16 demonstrates the magnitude and duration of pulse flows for different creeks. In addition to those pulse flows, a safeguard pulse flow on March 1st is considered if no pulse flows for the season have occurred yet prior that time. The triggers for pulse flows are shown in Table 17.

Table 16. Magnitude and Duration of Pulse Flow in the FAHCE Plus Scenario

Target	Time Frame	Guadalupe	Alamitos	Calero	Stevens
Adult Steelhead Up migration	Dec 1- Apr 1 (Mar 1: safeguard)	38 (cfs) for 2 days	50 (cfs) for 2 days	17 (cfs) for 2 days	38 (cfs) for 3 days
Chinook and Steelhead Outmigration	April 15	20 (cfs) for 5 days	18 (cfs) for 5 days	7 (cfs) for 5 days	20 (cfs) for 5 days

Table 17. Pulse Flow Triggers in FAHCE Plus

Target	Trigger
Adult Steelhead Up migration	Highest winter baseflow in FAHCE Plus rule curves; may be initiated 9 times on 1st and 15th of each month between December 1 to April 1st.
Chinook and Steelhead Outmigration	Sufficient water to support 2 cfs summer flow + carryover; may be initiated on April 15th.

VI. Summary and Conclusion

The current Valley Water WEAP daily model is the best available representation of the Three Creeks system hydrology and system operations to calculate metrics of daily habitat suitability. The model is a robust tool which integrates the complex hydrology and systems operations of Valley Water, achieved by disaggregating the monthly input files into a daily time-step, representing storm-runoff in the urban zone using a rainfall-runoff algorithm, and using daily reservoir levels and mass balances to estimate inflows to reservoirs. In addition, the model seamlessly allows for the study of habitat impacts in the same platform, achieved by including depth, velocity, and temperature correlations.

The model was first developed by disaggregating the previous monthly WEAP model from the District into a daily model. The daily model was then calibrated according to iterative steps, including the review of monthly data disaggregation, the adjustment of hydrology parameters, and the verification of the back-calculated reservoir inflows. Then, the modeled operations were refined with several months of iterative adjustments to the model scenarios, confirmed with Valley Water staff. Finally, the model performance was validated to obtain estimates of model error.

The estimated model error comes from sources that are common to hydrology and system operations models, including model uncertainty, parameter uncertainty, the natural variability of the system, and the challenge of modeling human behavior as it pertains to urban and agricultural water management operations. The figures of streamflow outputs in this memo were produced to help understand the effects of model error in the system. Despite model error and uncertainty, the validated and verified model is the current best representation of the system in order to assess the effects of changes in operations on downstream habitat suitability.

The final validated model provides the basis for the implementation of the Biological Evaluation Framework. The model results provide estimates of relative habitat conditions under the different scenarios of the existing operations and the FAHCE and FAHCE Plus alternatives. ~~The results are presented in a Tableau visualization available to the District, as well as in EIR Appendix R, “Model Outputs”.~~ This information has helped District staff and interested parties to refine and estimate the effectiveness of new reservoir operating rules to improve habitat conditions for Steelhead trout and Chinook salmon in the Three Creeks system.

VII. References

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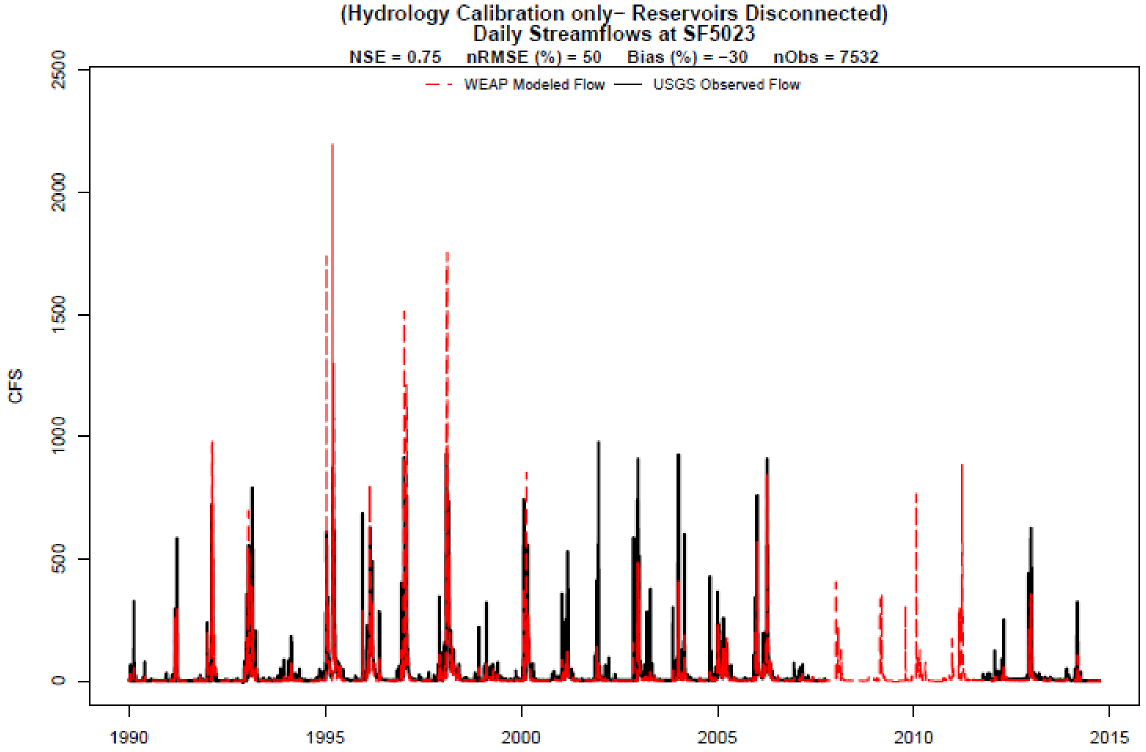
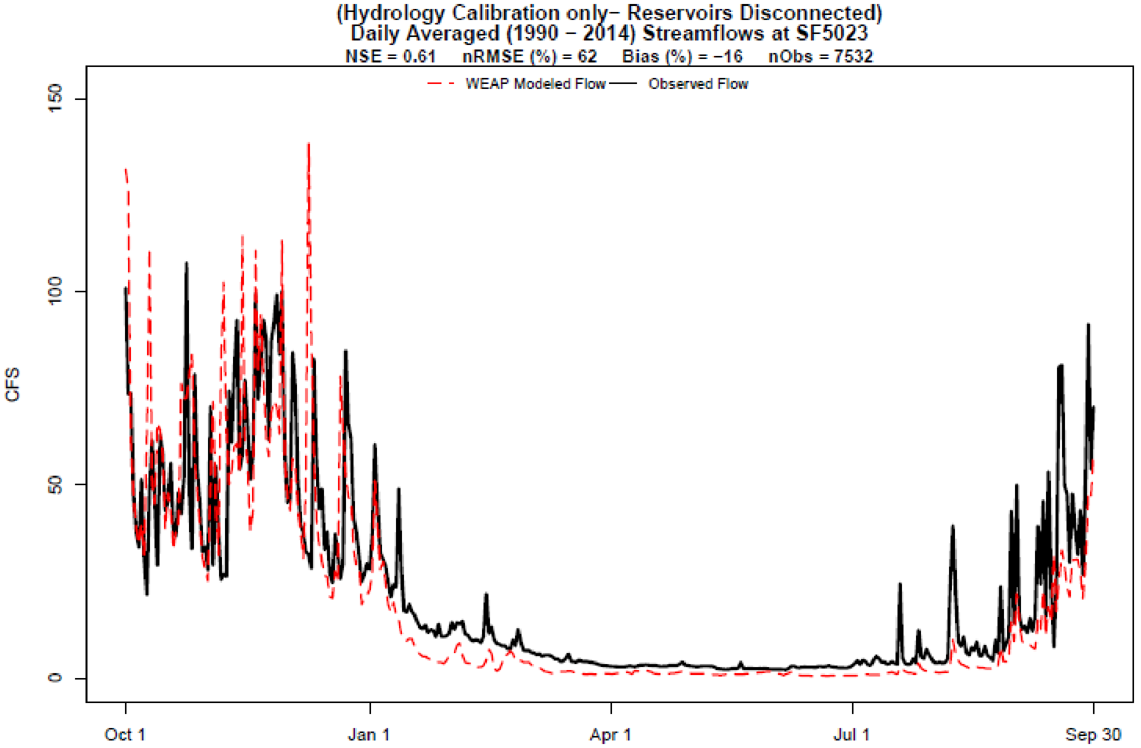
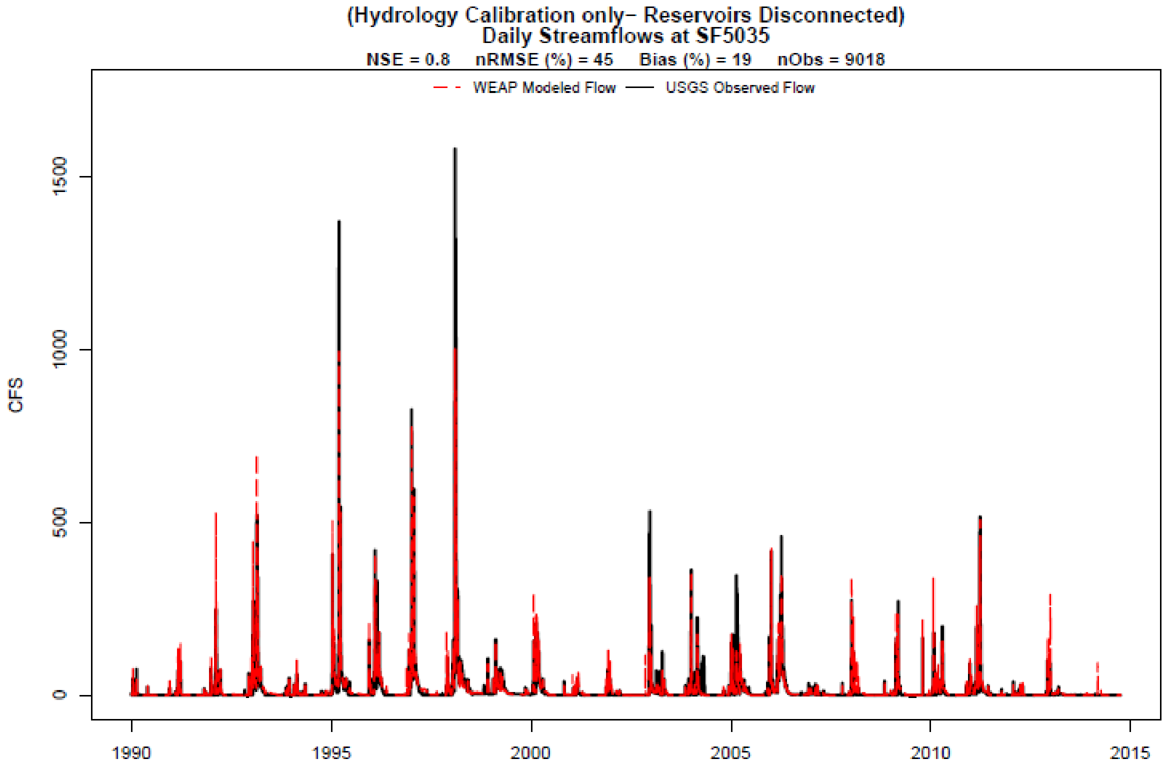
Appendix 1. Water Year Types in the 1990-2010 period

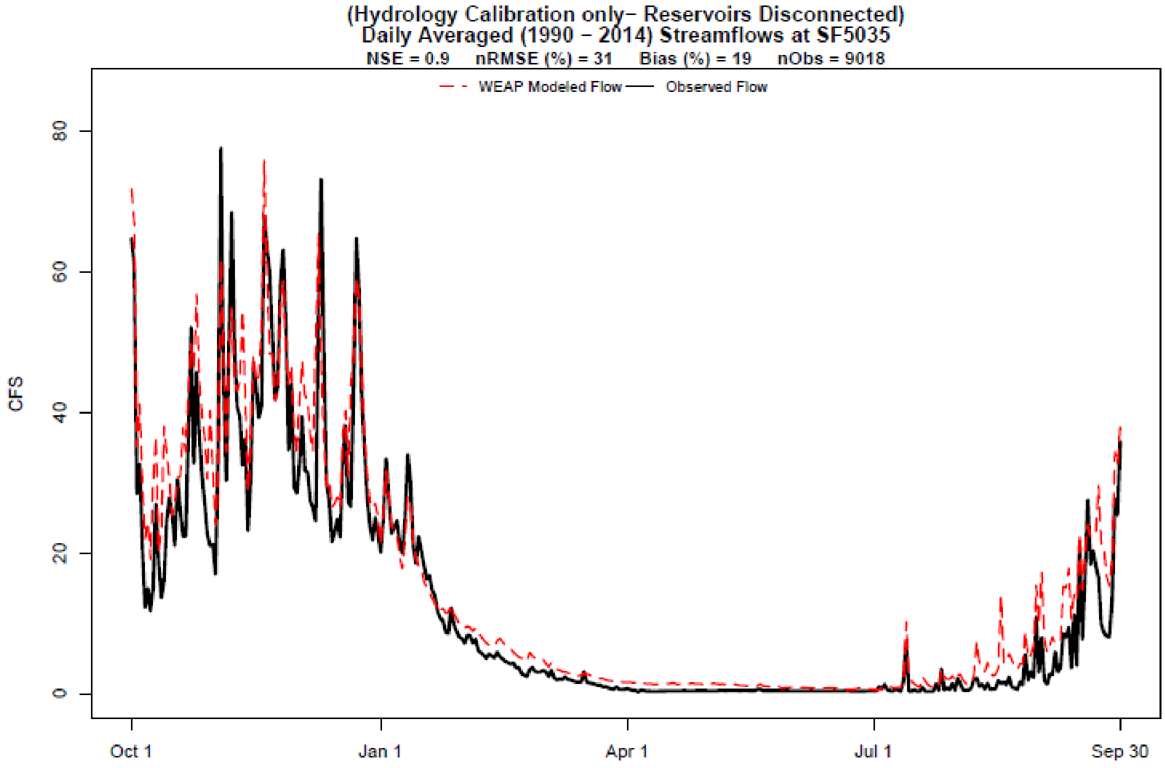
		Count			
C	Critical	5		1990	C
D	Dry	4		1991	C
BN	Below Normal	2		1992	C
AN	Above Normal	4		1993	AN
W	Wet	6		1994	C
		21		1995	W
				1996	W
				1997	W
				1998	W
				1999	W
				2000	AN
				2001	D
				2002	D
				2003	AN
				2004	BN
				2005	AN
				2006	W
				2007	D
				2008	C
				2009	D
				2010	BN

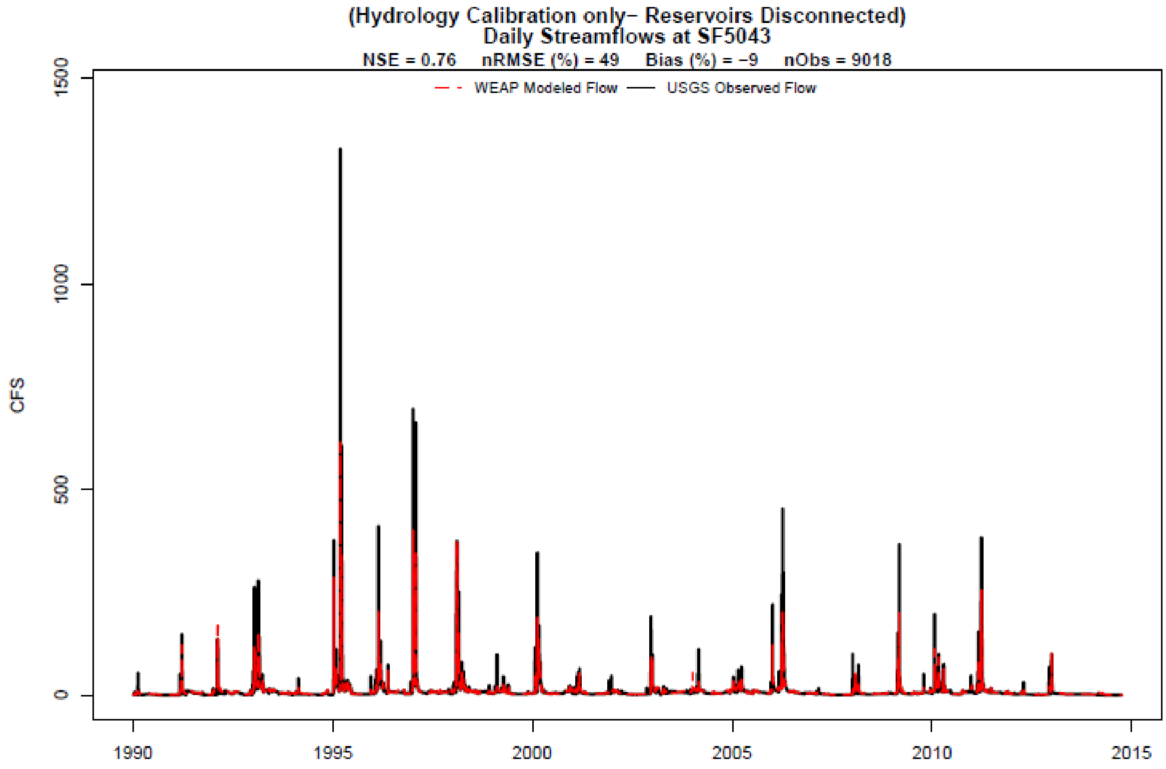
Appendix 2. Hydrology calibration graphs (Daily and Daily Average)

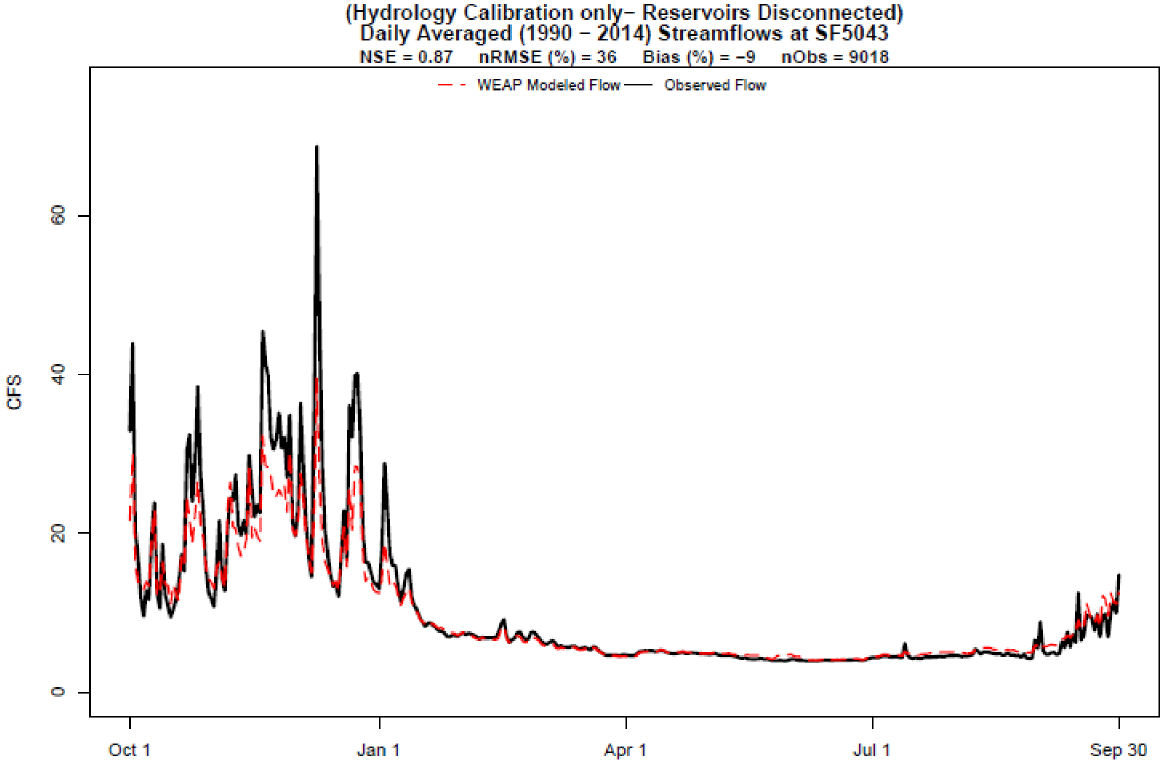


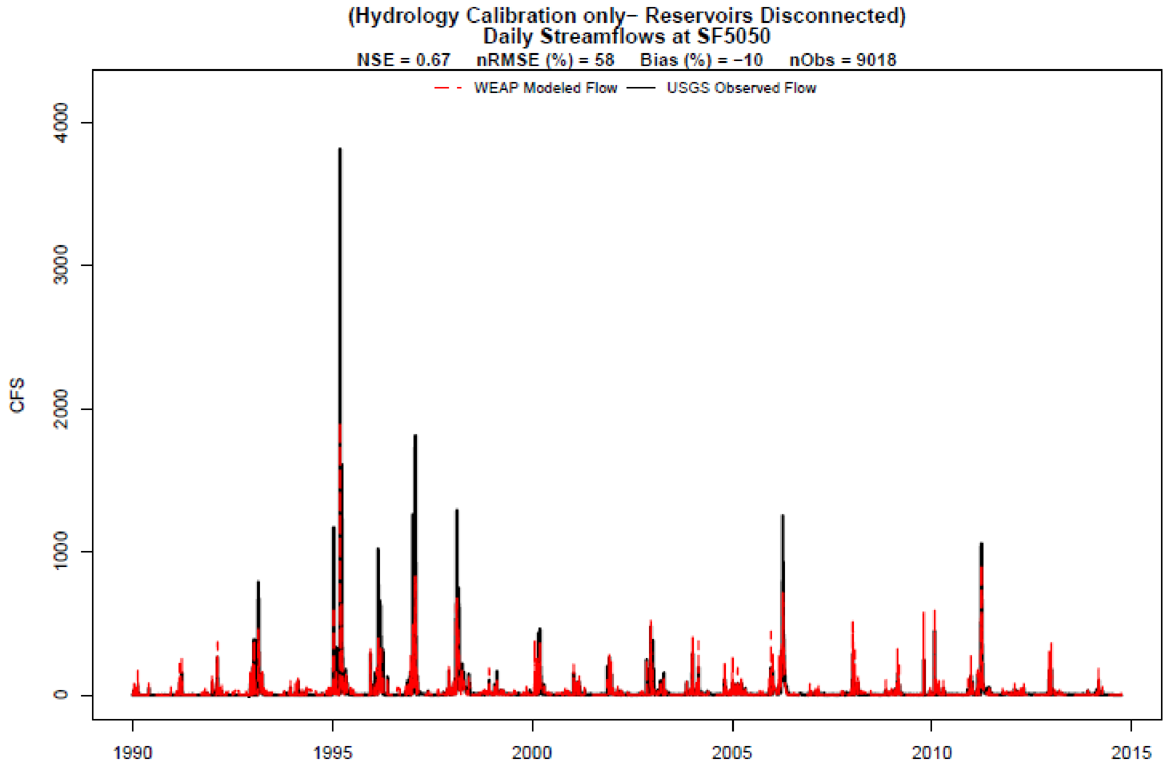



(Hydrology Calibration only– Reservoirs Disconnected)
Daily Streamflows at SF5035
NSE = 0.8 nRMSE (%) = 45 Bias (%) = 19 nObs = 9018
WEAP Modeled Flow
USGS Observed Flow
CFS
0
500
1000
1500
1990
1995
2000
2005
2010
2015


(Hydrology Calibration only– Reservoirs Disconnected)
Daily Averaged (1990 – 2014) Streamflows at SF5035
NSE = 0.9 nRMSE (%) = 31 Bias (%) = 19 nObs = 9018
WEAP Modeled Flow
Observed Flow
CFS
0
20
40
60
80
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30


(Hydrology Calibration only– Reservoirs Disconnected)
Daily Streamflows at SF5043
NSE = 0.76 nRMSE (%) = 49 Bias (%) = −9 nObs = 9018
WEAP Modeled Flow
USGS Observed Flow
CFS
0
500
1000
1500
1990
1995
2000
2005
2010
2015


(Hydrology Calibration only– Reservoirs Disconnected)
Daily Averaged (1990 − 2014) Streamflows at SF5043
NSE = 0.87 nRMSE (%) = 36 Bias (%) = −9 nObs = 9018
WEAP Modeled Flow
Observed Flow
CFS
0
20
40
60
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30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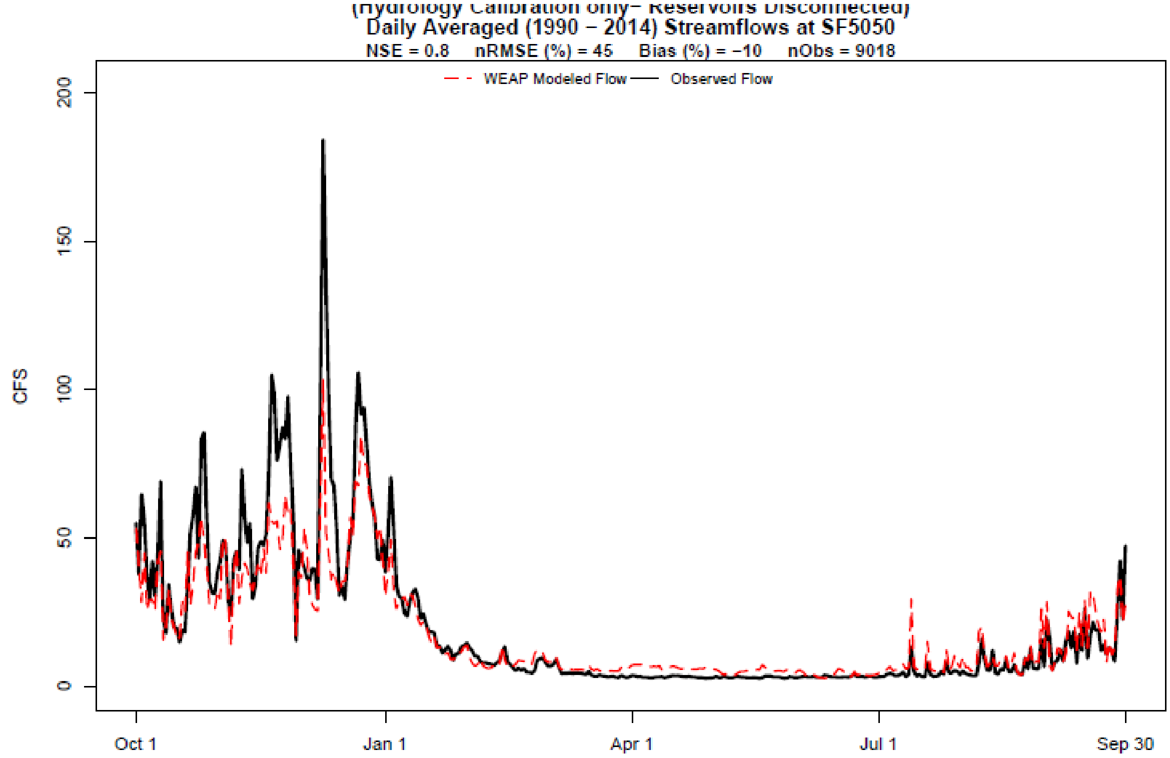
Daily Streamflows at SF5050
NSE = 0.67 nRMSE (%) = 58 Bias (%) = −10 nObs = 9018
WEAP Modeled Flow
USGS Observed Flow
CFS
0
1000
2000
3000
4000
1990
1995
2000
2005
2010
2015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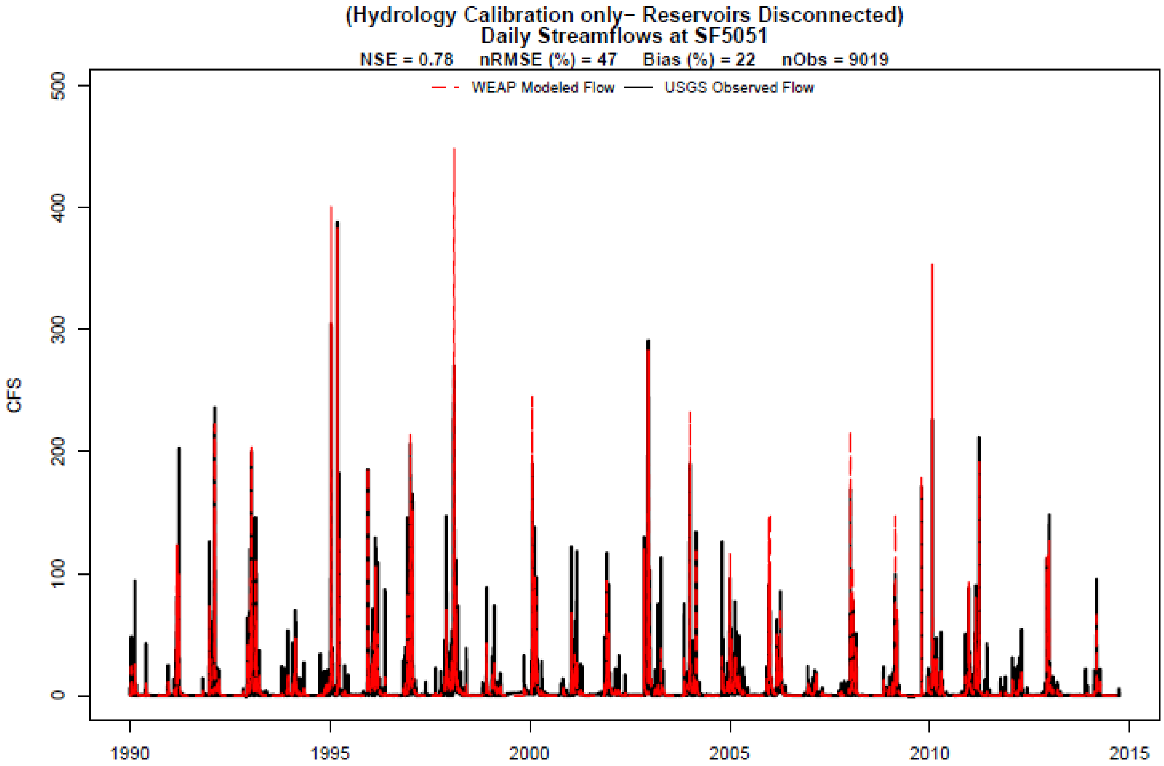
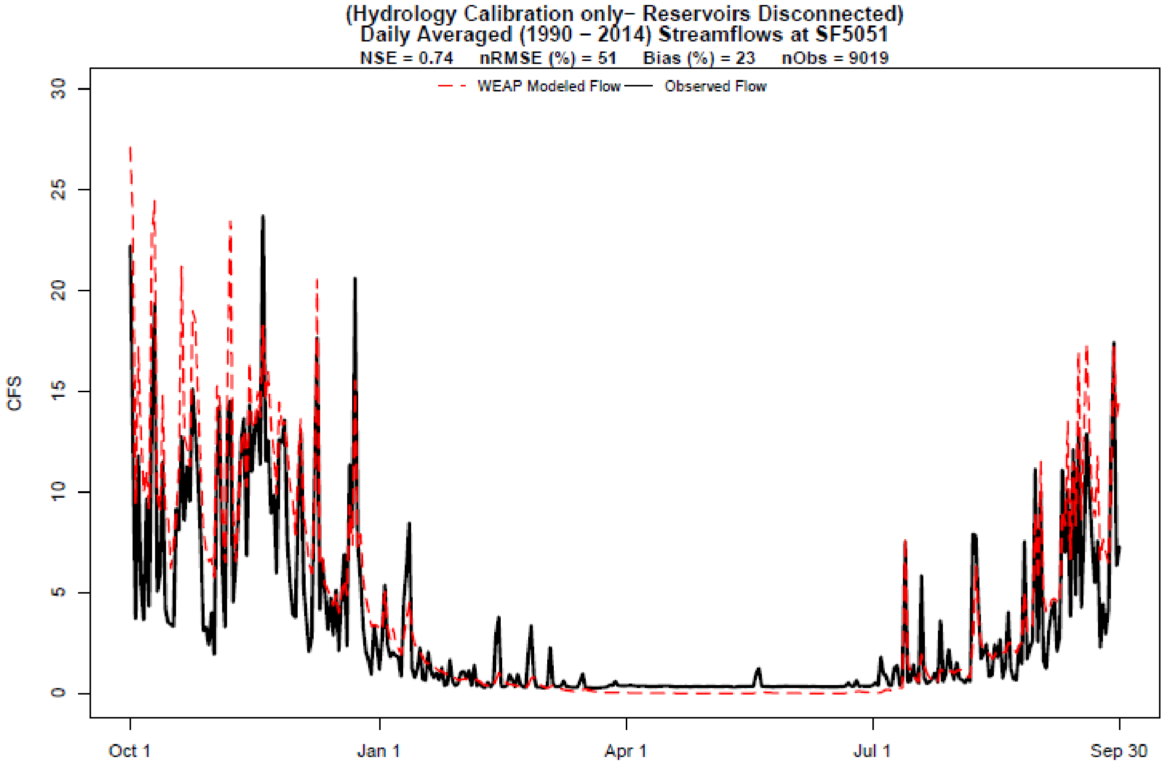
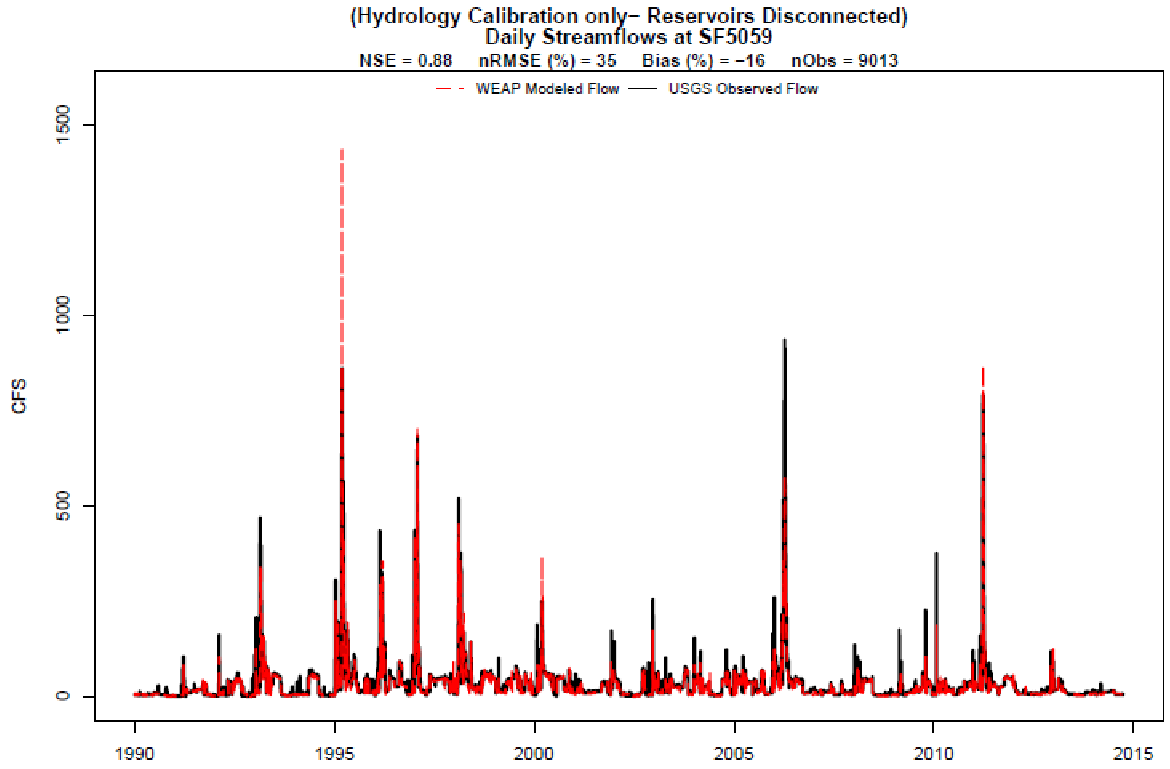
Daily Averaged (1990 – 2014) Streamflows at SF5050
NSE = 0.8 nRMSE (%) = 45 Bias (%) = −10 nObs = 9018
WEAP Modeled Flow
Observed Flow
CFS
0
50
100
150
200
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30


(Hydrology Calibration only– Reservoirs Disconnected)
Daily Streamflows at SF5051
NSE = 0.78 nRMSE (%) = 47 Bias (%) = 22 nObs = 9019
WEAP Modeled Flow
USGS Observed Flow
CFS
0
100
200
300
400
500
1990
1995
2000
2005
2010
2015


(Hydrology Calibration only– Reservoirs Disconnected)
Daily Averaged (1990 – 2014) Streamflows at SF5051
NSE = 0.74 nRMSE (%) = 51 Bias (%) = 23 nObs = 9019
WEAP Modeled Flow
Observed Flow
CFS
0
5
10
15
20
25
30
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30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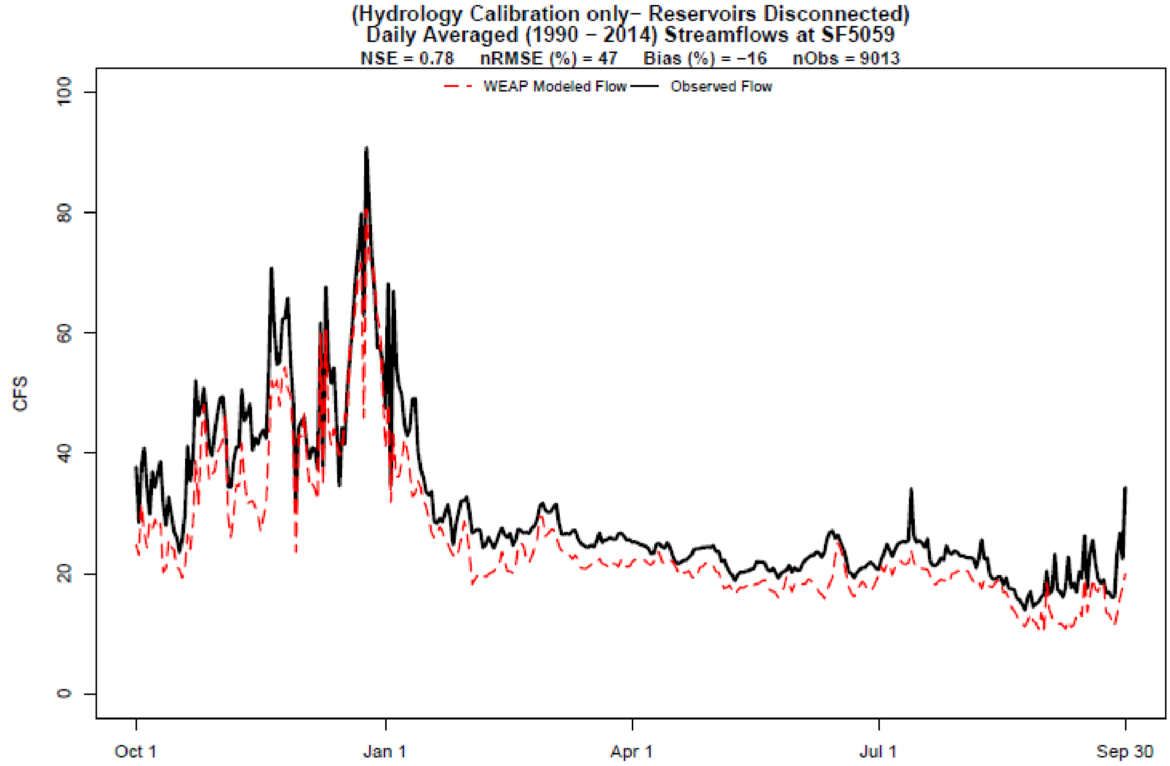
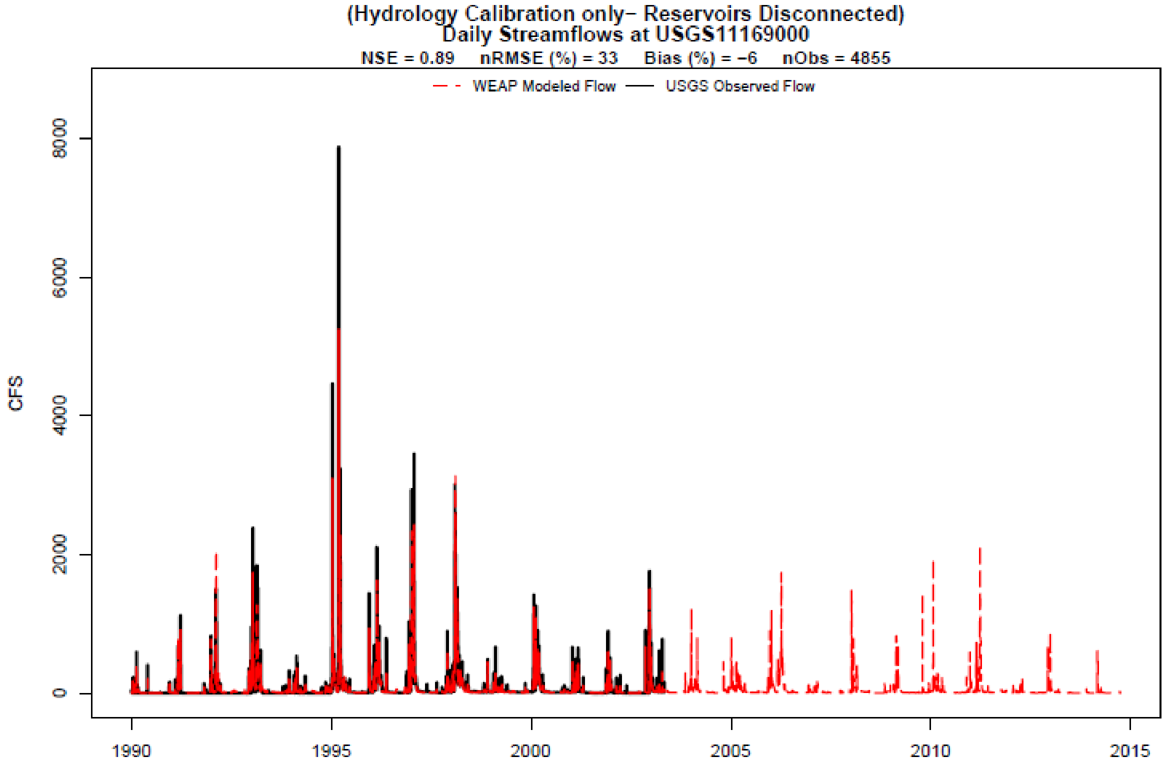
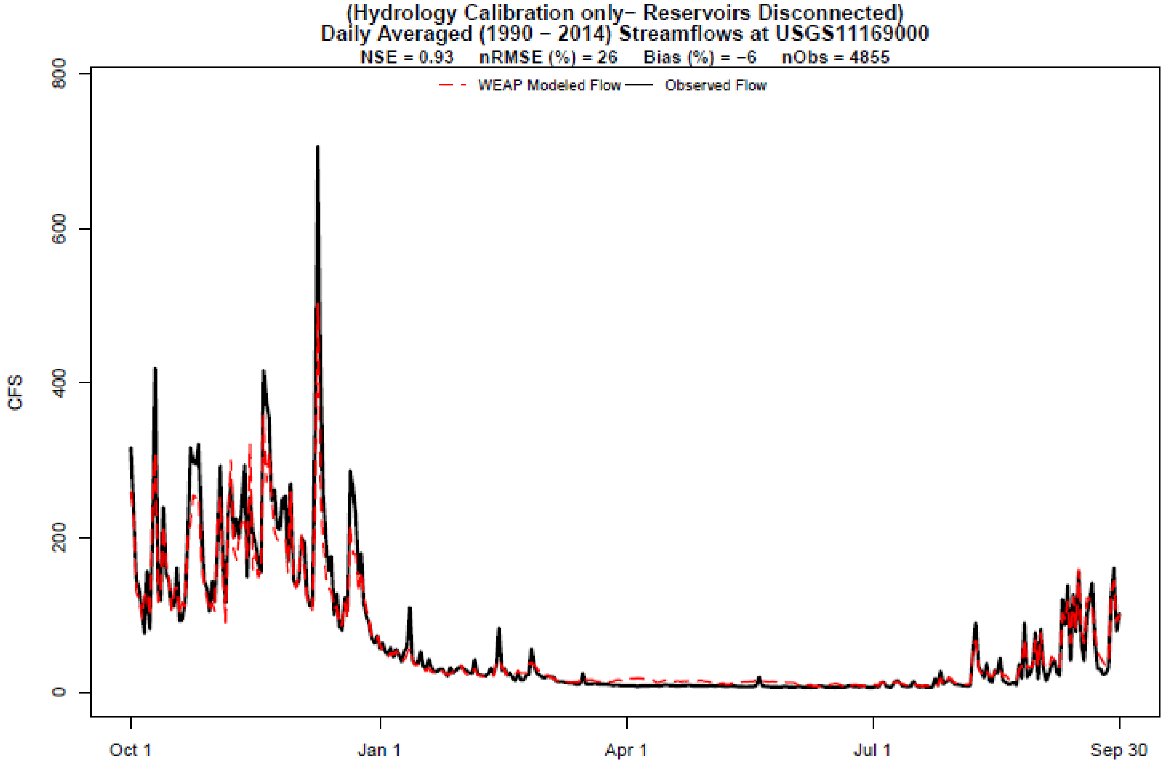
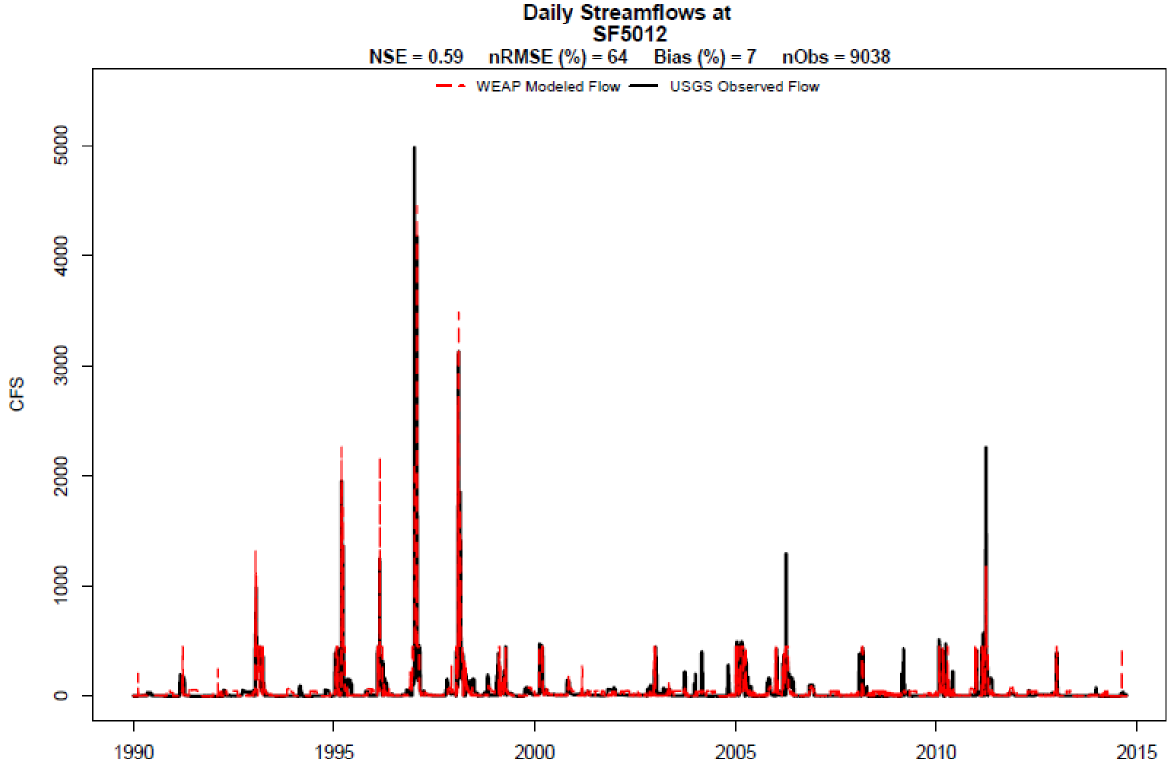
Daily Streamflows at SF5059
NSE = 0.88 nRMSE (%) = 35 Bias (%) = −16 nObs = 9013

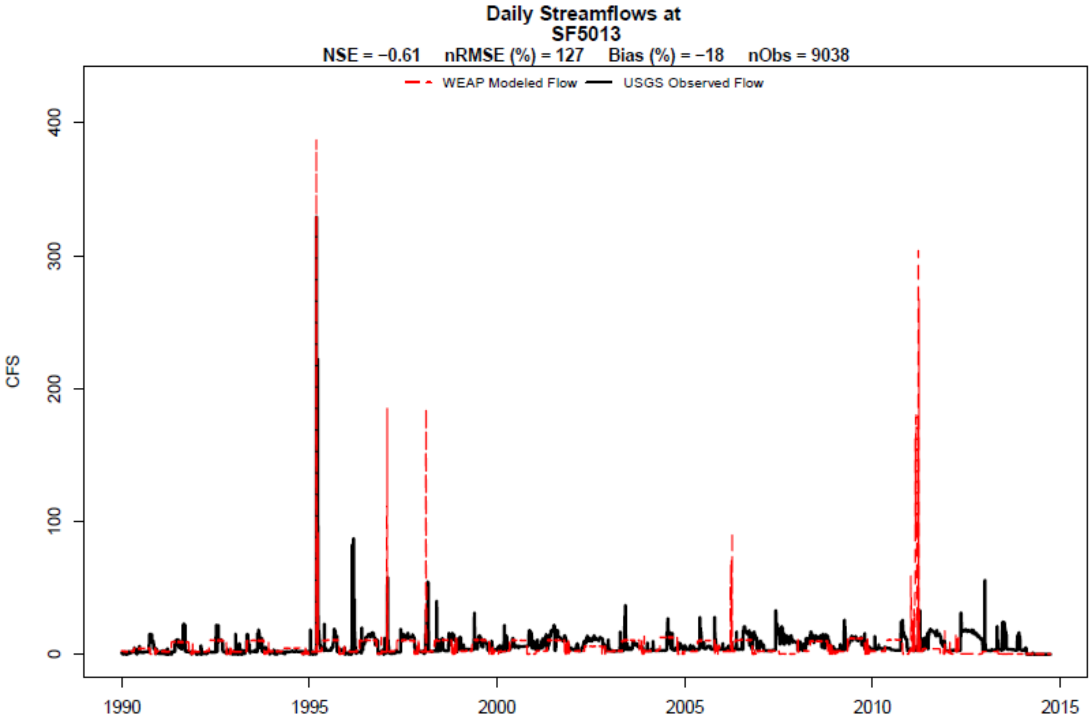

(Hydrology Calibration only– Reservoirs Disconnected)
Daily Averaged (1990 – 2014) Streamflows at SF5059
NSE = 0.78 nRMSE (%) = 47 Bias (%) = −16 nObs = 9013

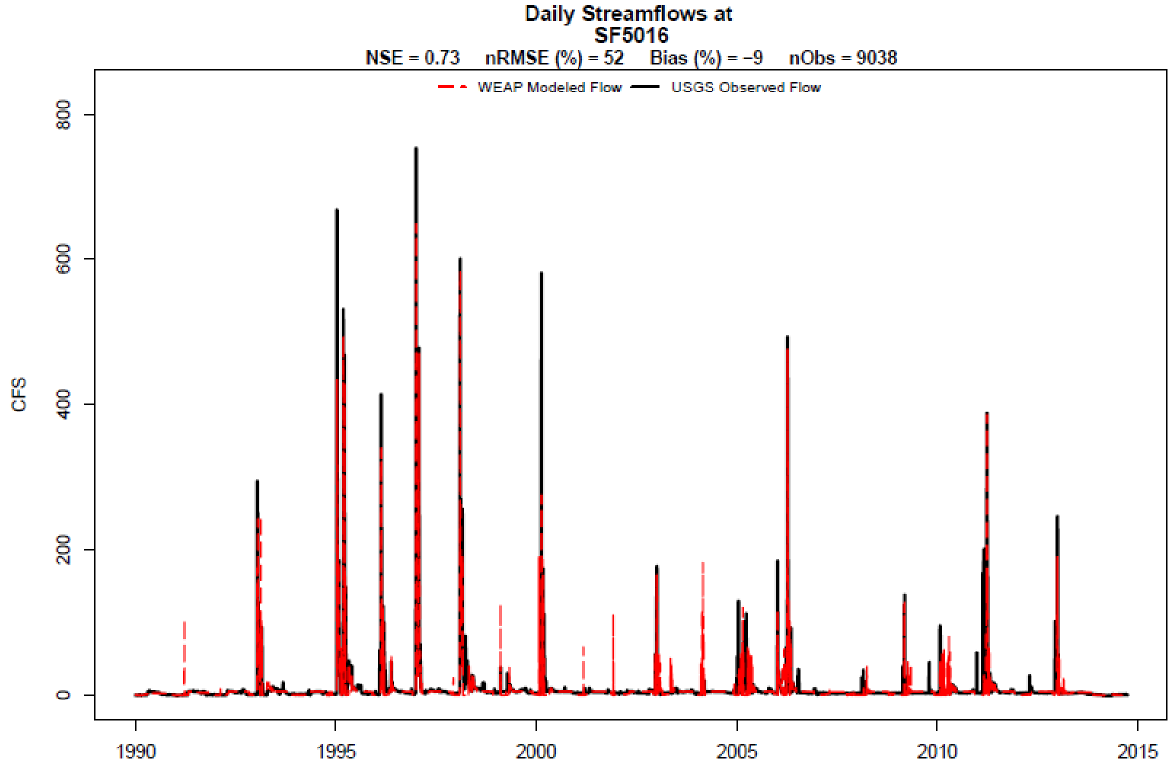

(Hydrology Calibration only– Reservoirs Disconnected)
Daily Streamflows at USGS11169000
NSE = 0.89 nRMSE (%) = 33 Bias (%) = −6 nObs = 4855
WEAP Modeled Flow
USGS Observed Flow
CFS
0
2000
4000
6000
8000
1990
1995
2000
2005
2010
2015


(Hydrology Calibration only– Reservoirs Disconnected)
Daily Averaged (1990 – 2014) Streamflows at USGS11169000
NSE = 0.93 nRMSE (%) = 26 Bias (%) = −6 nObs = 4855
WEAP Modeled Flow
Observed Flow
CFS
0
200
400
600
800
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30

Appendix 3. Daily graphs and statistics of observed data and modeled output at gauges (1990-2014)






Daily Streamflows at
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NSE = 0.73 nRMSE (%) = 52 Bias (%) = −9 nObs = 9038
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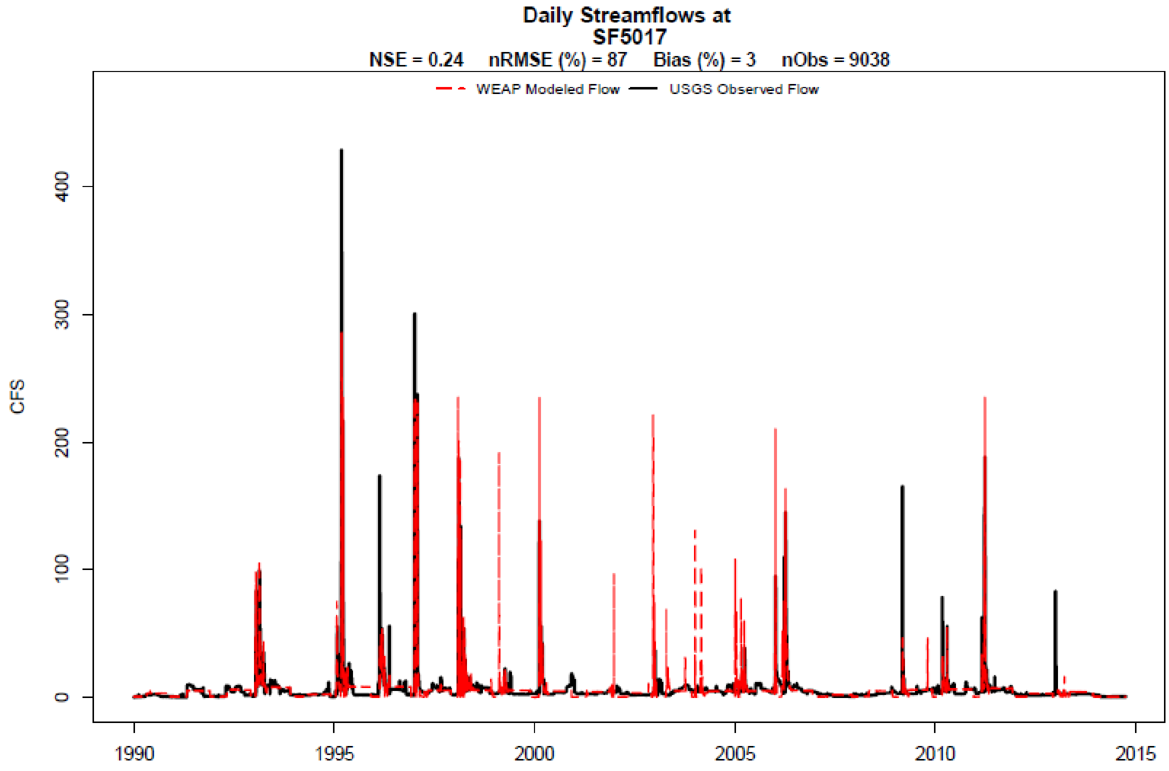
USGS Observed Flow
CFS
0
200
400
600
800
1990
1995
2000
2005
2010
2015


Daily Streamflows at
SF5017
NSE = 0.24 nRMSE (%) = 87 Bias (%) = 3 nObs = 9038
WEAP Modeled Flow
USGS Observed Flow
CFS
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100
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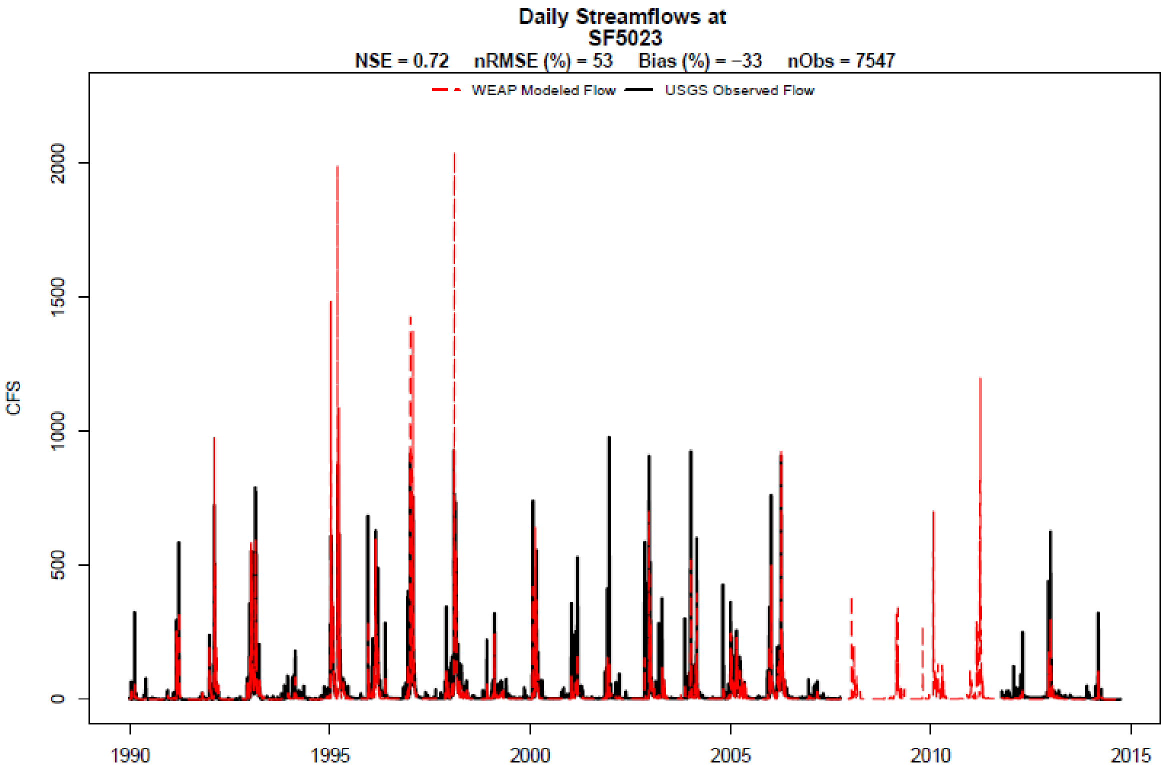
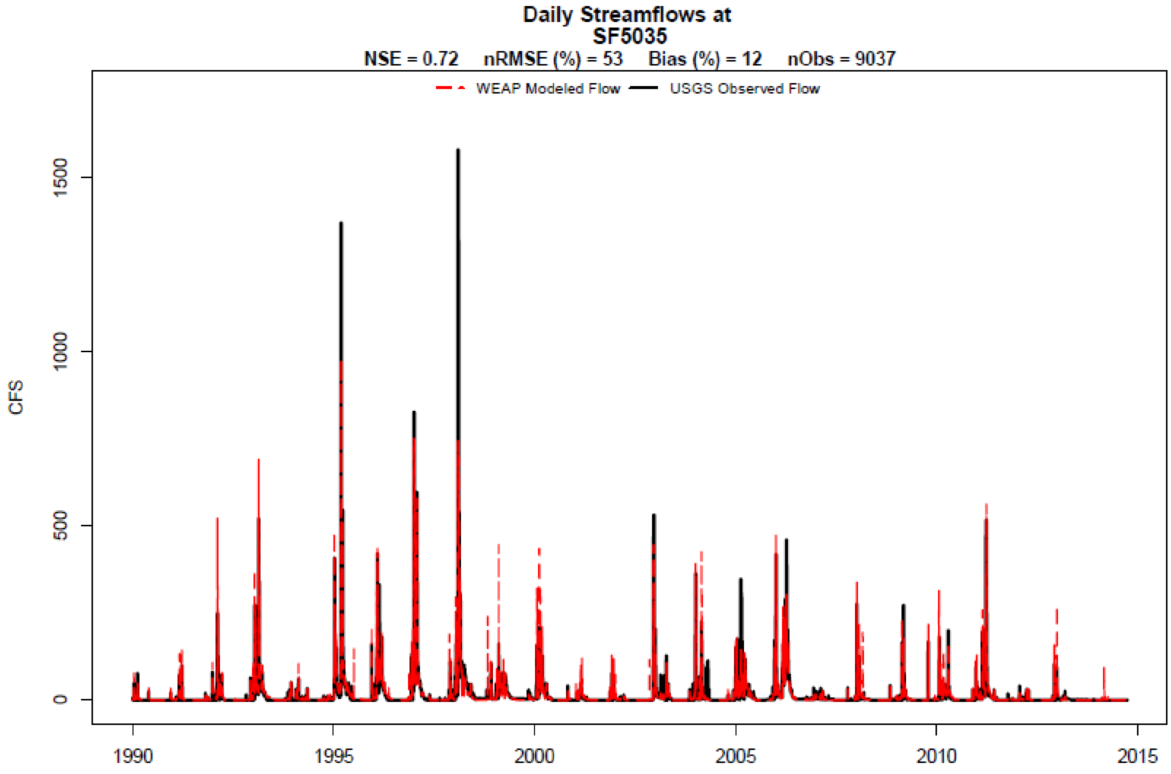
300
400
1990
1995
2000
2005
2010
2015


Daily Streamflows at
SF5023
NSE = 0.72 nRMSE (%) = 53 Bias (%) = −33 nObs = 7547
WEAP Modeled Flow
USGS Observed Flow
CFS
0
500
1000
1500
2000
1990
1995
2000
2005
2010
2015


Daily Streamflows at
SF5035
NSE = 0.72 nRMSE (%) = 53 Bias (%) = 12 nObs = 9037
WEAP Modeled Flow
USGS Observed Flow
CFS
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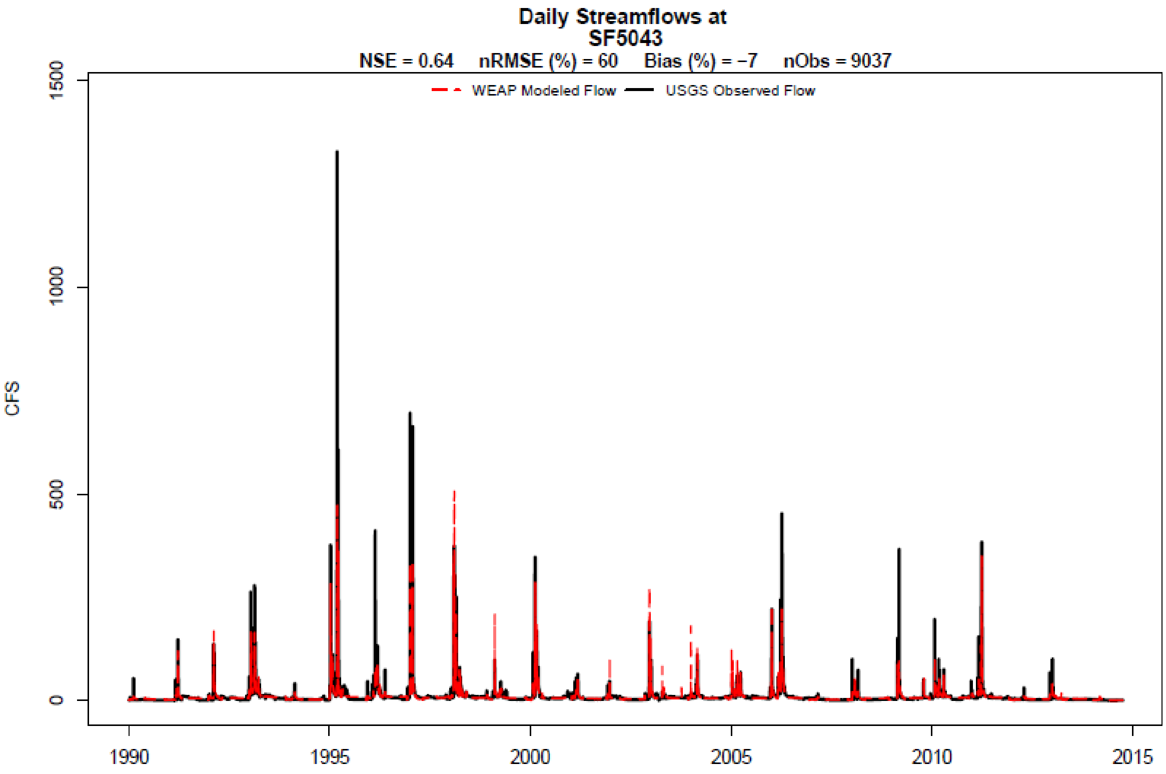
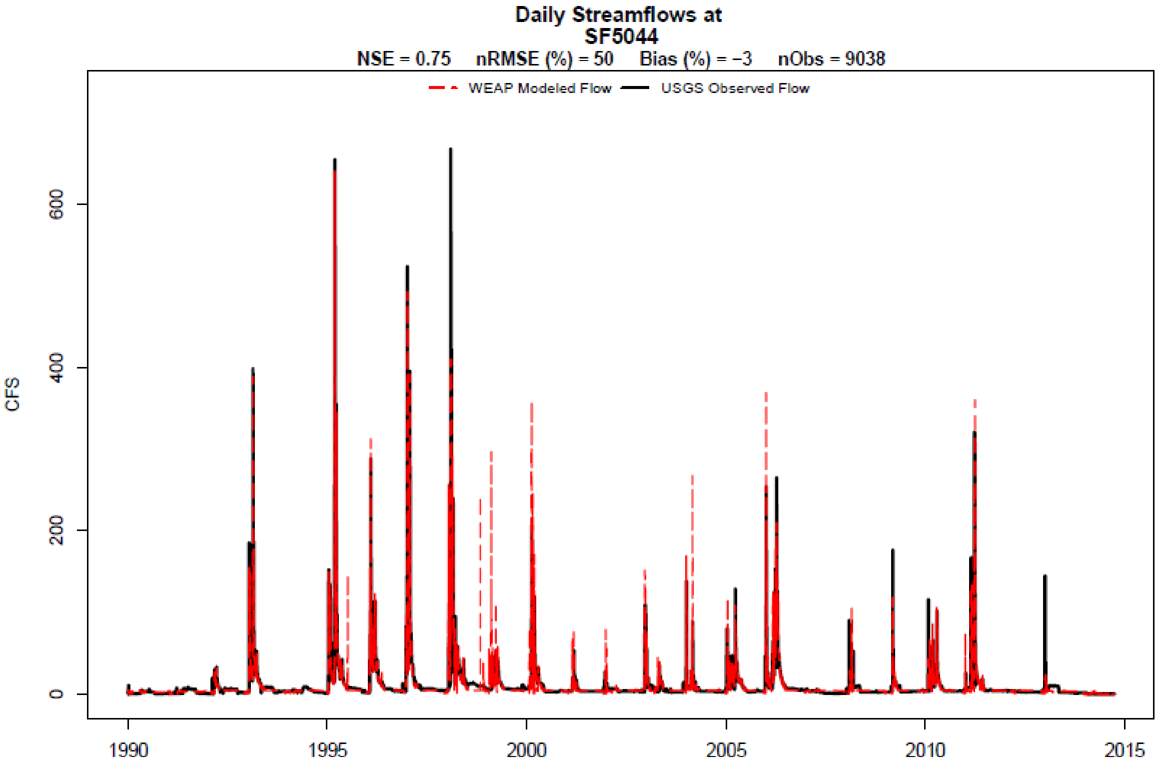
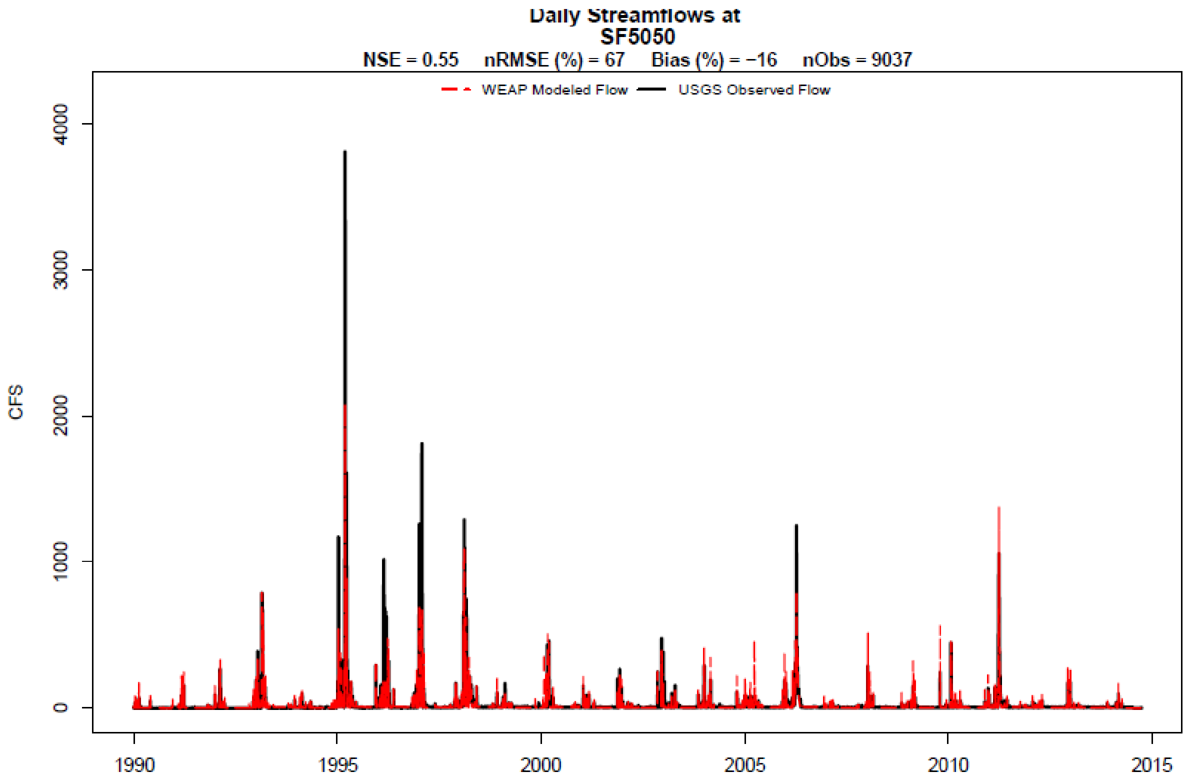
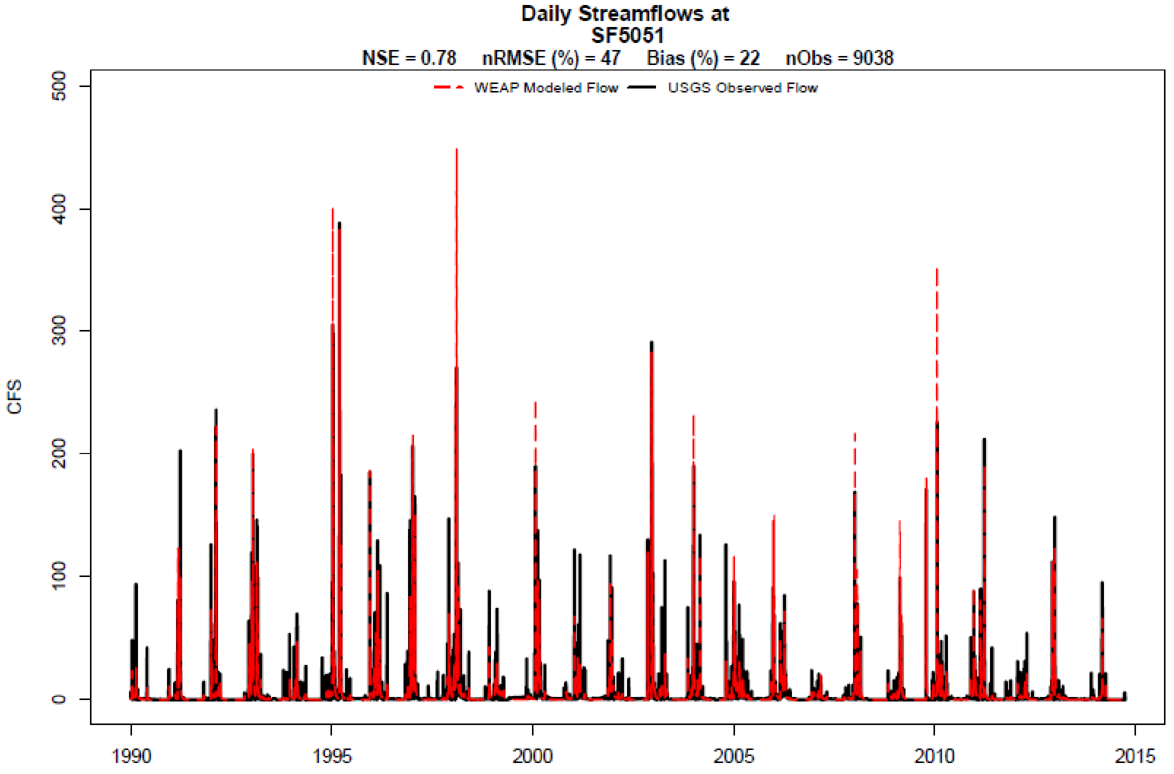
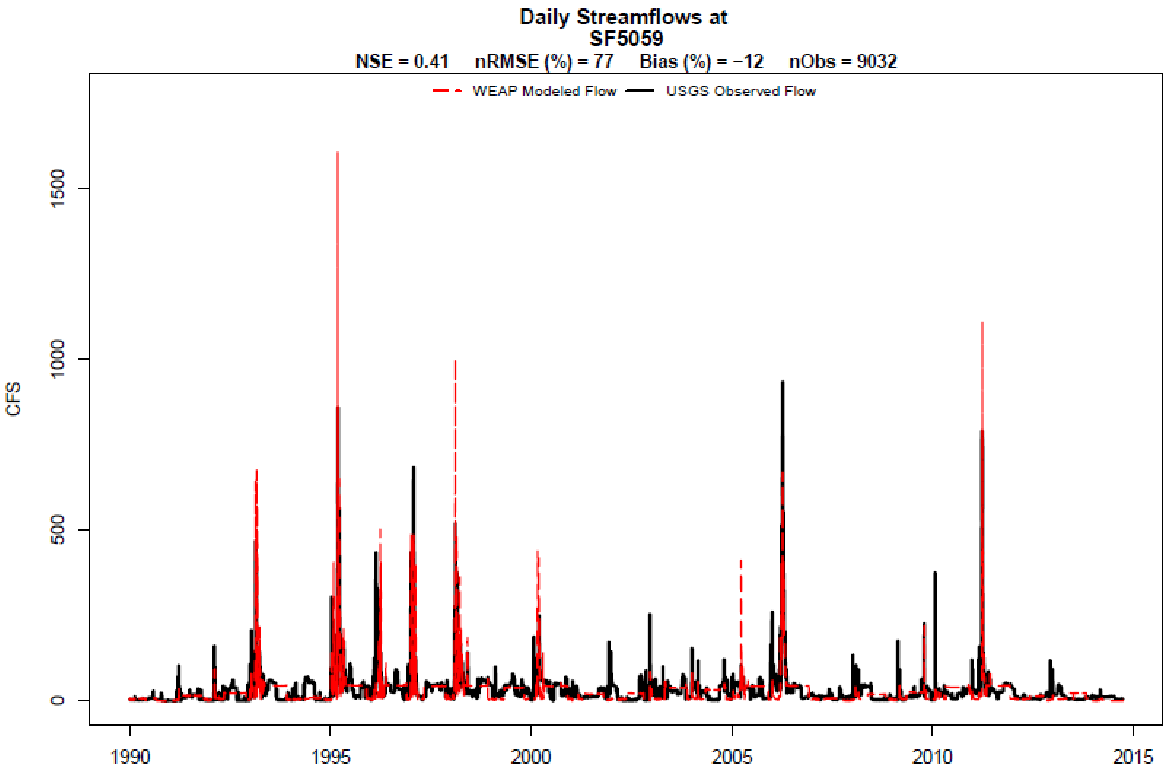
1000
1500
1990
1995
2000
2005
2010
2015

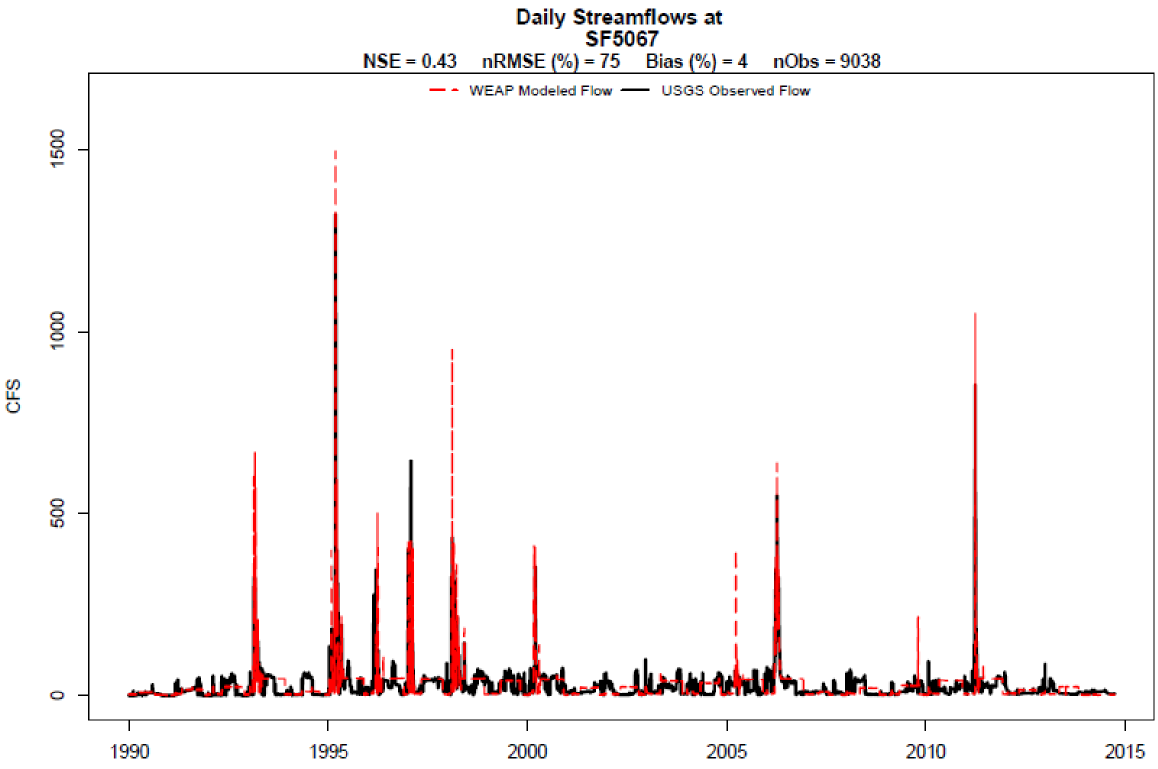

Daily Streamflows at
SF5043
NSE = 0.64 nRMSE (%) = 60 Bias (%) = −7 nObs = 9037
WEAP Modeled Flow
USGS Observed Flow
CFS
0
500
1000
1500
1990
1995
2000
2005
2010
2015

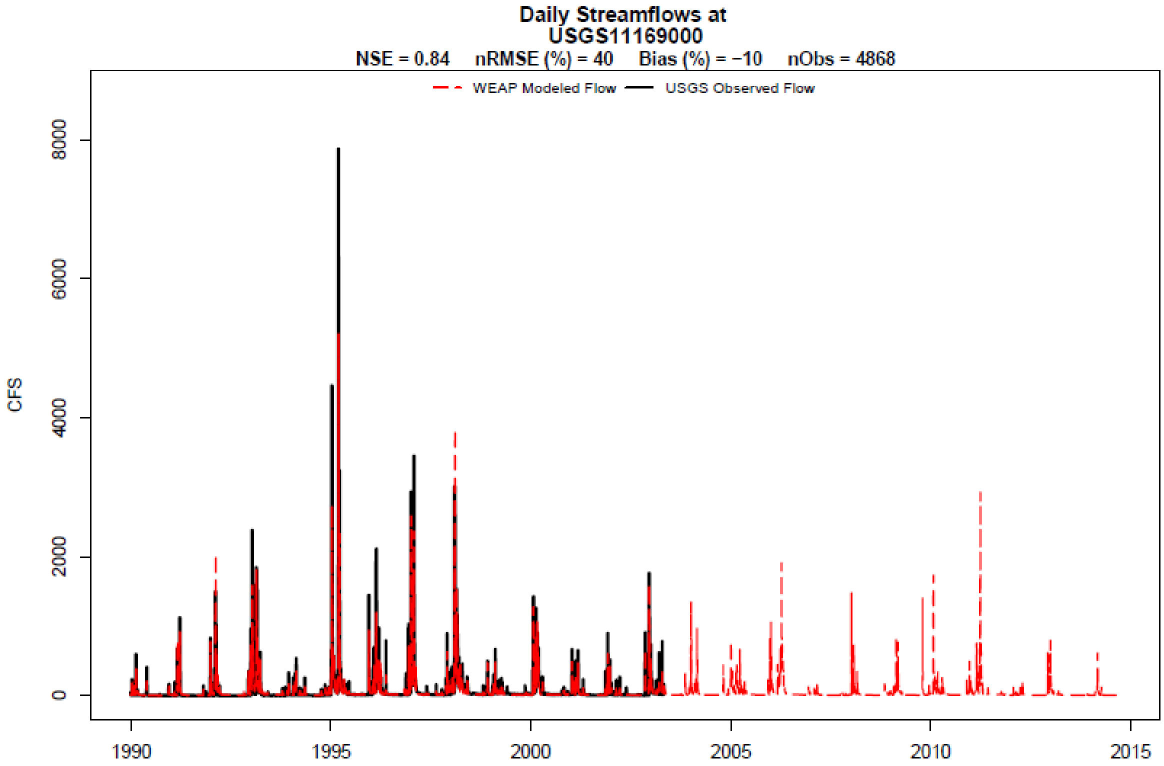

Daily Streamflows at
SF5044
NSE = 0.75 nRMSE (%) = 50 Bias (%) = −3 nObs = 9038
WEAP Modeled Flow
USGS Observed Flow
CFS
0
200
400
600
1990
1995
2000
2005
2010
2015


Daily Streamflows at
SF5050
NSE = 0.55 nRMSE (%) = 67 Bias (%) = −16 nObs = 9037
WEAP Modeled Flow
USGS Observed Flow
CFS
0
1000
2000
3000
4000
1990
1995
2000
2005
2010
2015

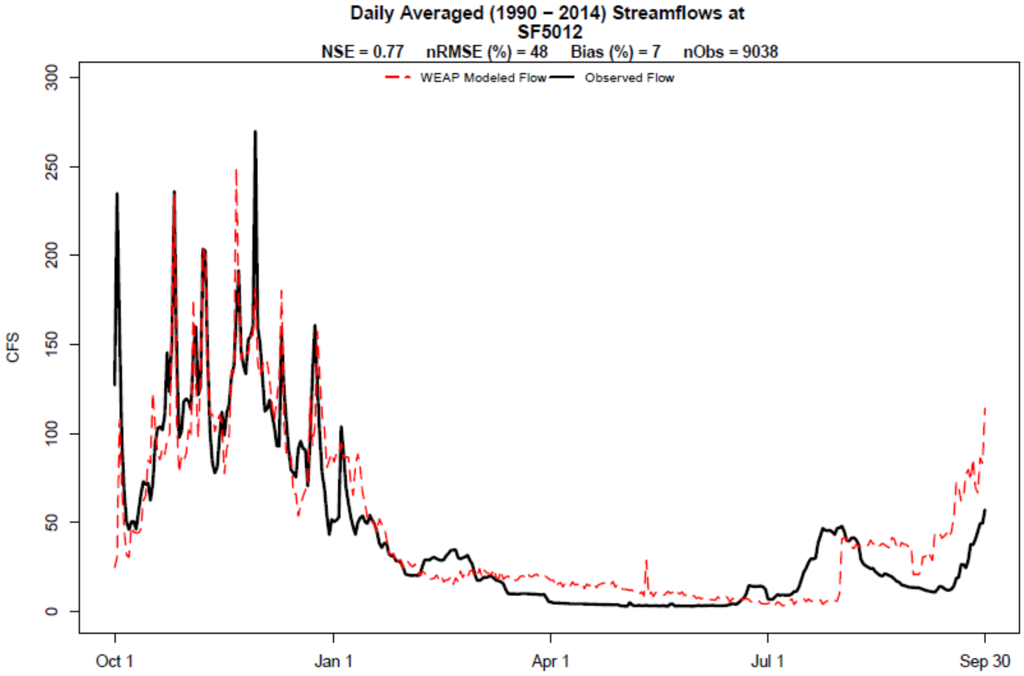

Daily Streamflows at
SF5051
NSE = 0.78 nRMSE (%) = 47 Bias (%) = 22 nObs = 9038
WEAP Modeled Flow
USGS Observed Flow
CFS
0
100
200
300
400
500
1990
1995
2000
2005
2010
2015

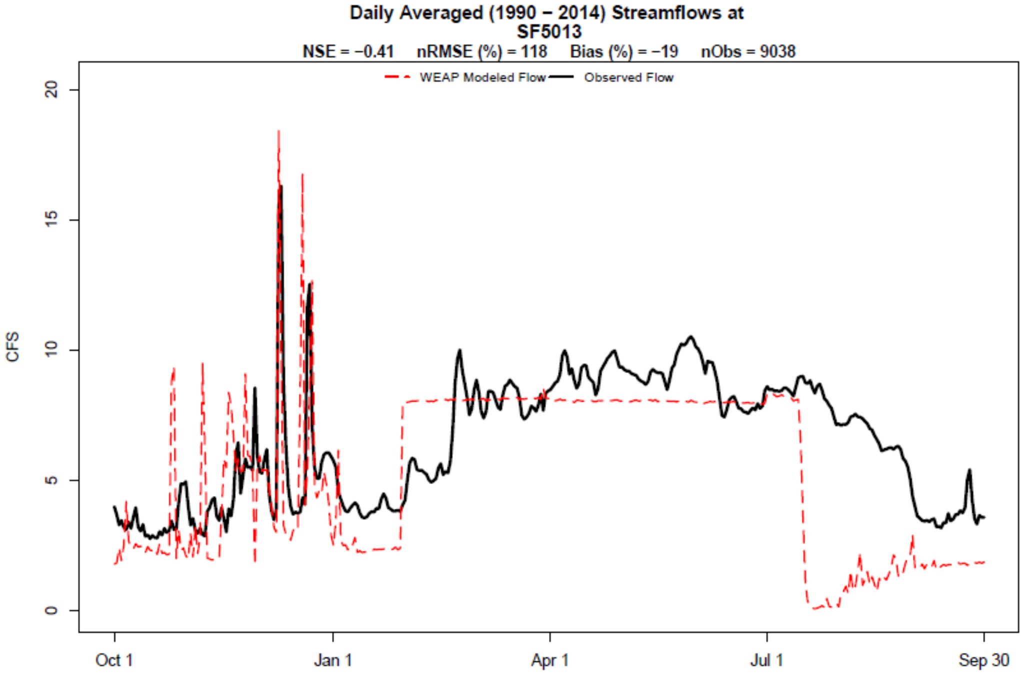

Daily Streamflows at
SF5059
NSE = 0.41 nRMSE (%) = 77 Bias (%) = −12 nObs = 9032
WEAP Modeled Flow
USGS Observed Flow
CFS
0
500
1000
1500
1990
1995
2000
2005
2010
2015

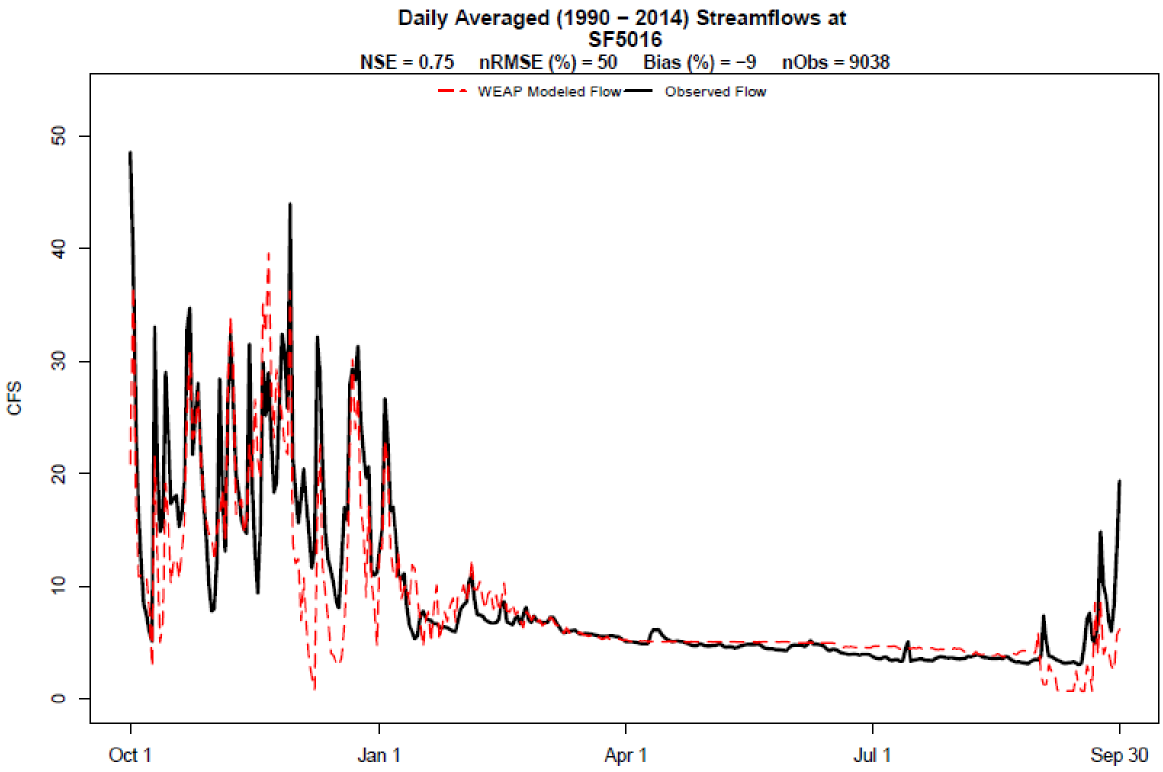

Daily Streamflows at
SF5067
NSE = 0.43 nRMSE (%) = 75 Bias (%) = 4 nObs = 9038
WEAP Modeled Flow
USGS Observed Flow
CFS
0
500
1000
1500
1990
1995
2000
2005
2010
2015

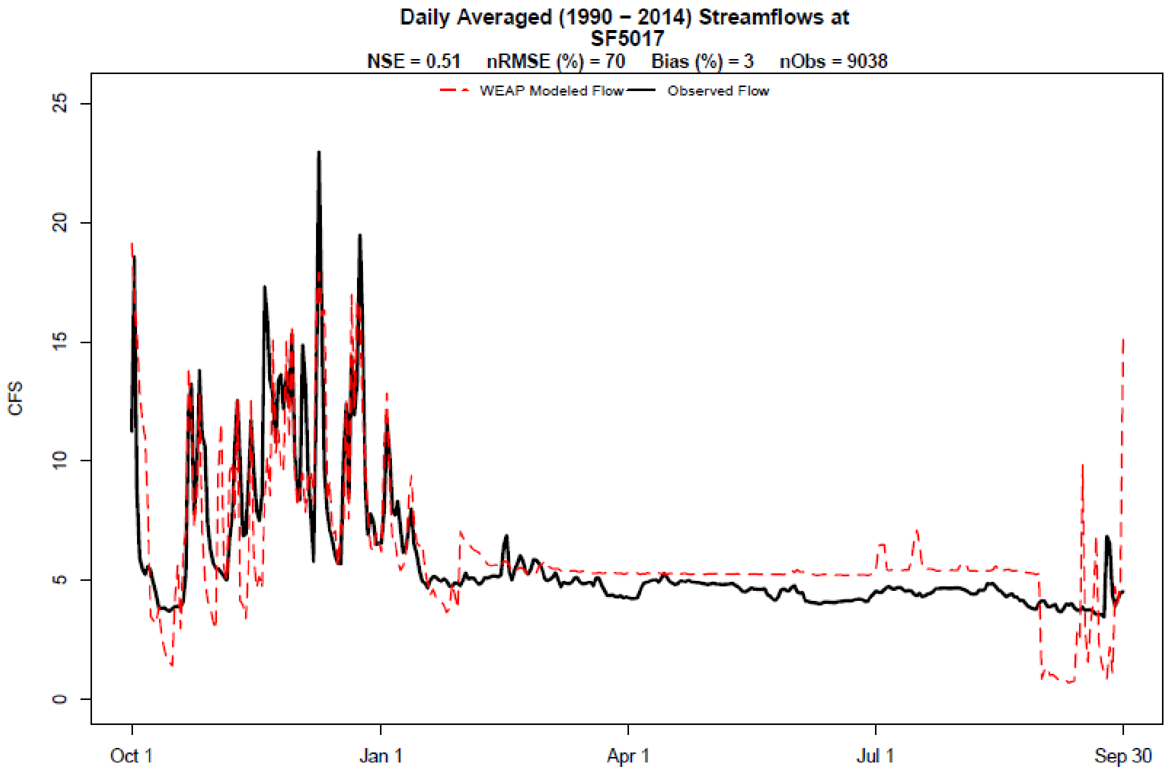

Daily Streamflows at
USGS11169000
NSE = 0.84 nRMSE (%) = 40 Bias (%) = −10 nObs = 4868
WEAP Modeled Flow
USGS Observed Flow
CFS
0
2000
4000
6000
8000
1990
1995
2000
2005
2010
2015

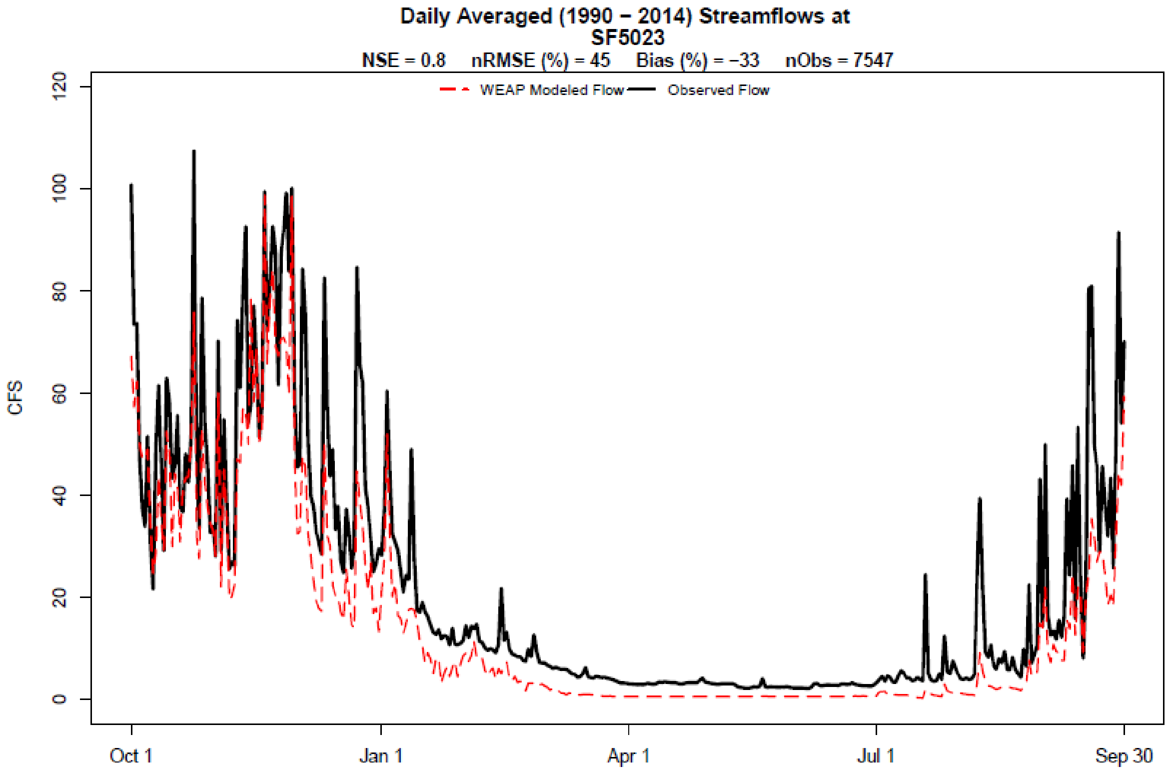
Appendix 4. Daily average graphs and statistics of observed data and modeled output at gauges (1990-2014)

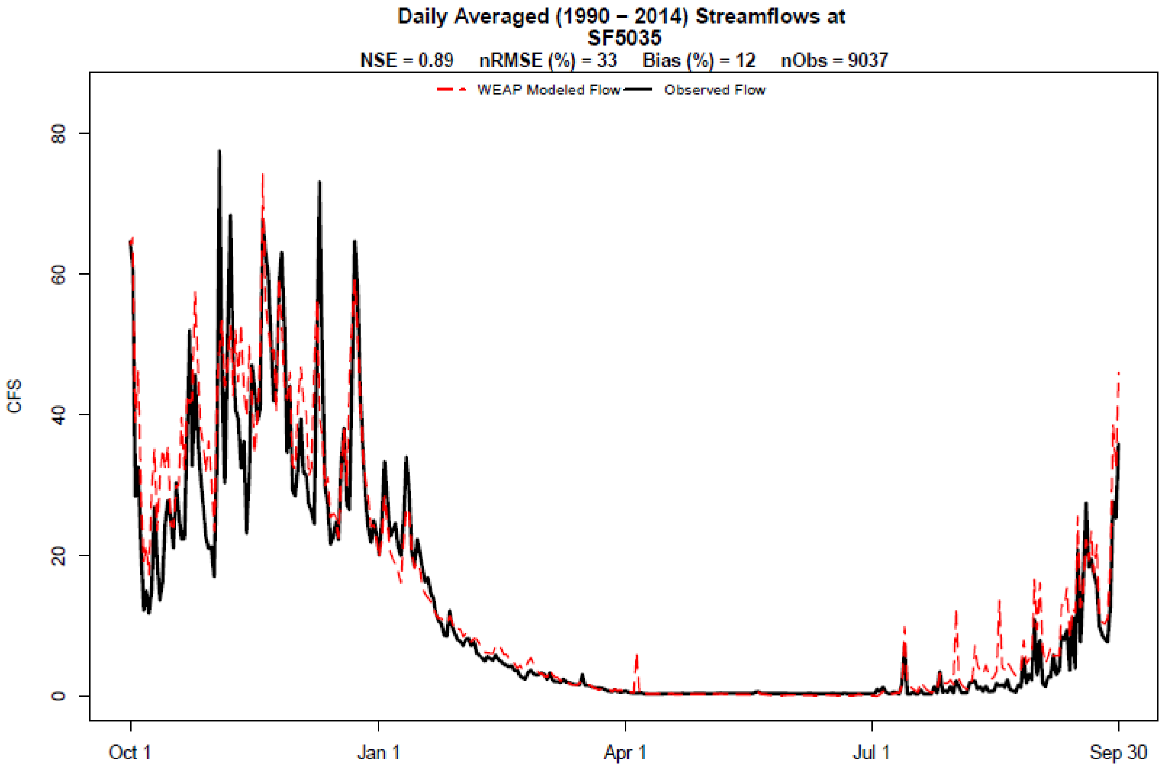





Daily Averaged (1990 – 2014) Streamflows at
SF5016
NSE = 0.75 nRMSE (%) = 50 Bias (%) = −9 nObs = 9038
WEAP Modeled Flow
Observed Flow
CFS
0
10
20
30
40
50
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30


Daily Averaged (1990 – 2014) Streamflows at
SF5017
NSE = 0.51 nRMSE (%) = 70 Bias (%) = 3 nObs = 9038
WEAP Modeled Flow
Observed Flow
CFS
0
5
10
15
20
25
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30


Daily Averaged (1990 – 2014) Streamflows at
SF5023
NSE = 0.8 nRMSE (%) = 45 Bias (%) = −33 nObs = 7547
WEAP Modeled Flow
Observed Flow
CFS
0
20
40
60
80
100
120
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30


Daily Averaged (1990 – 2014) Streamflows at
SF5035
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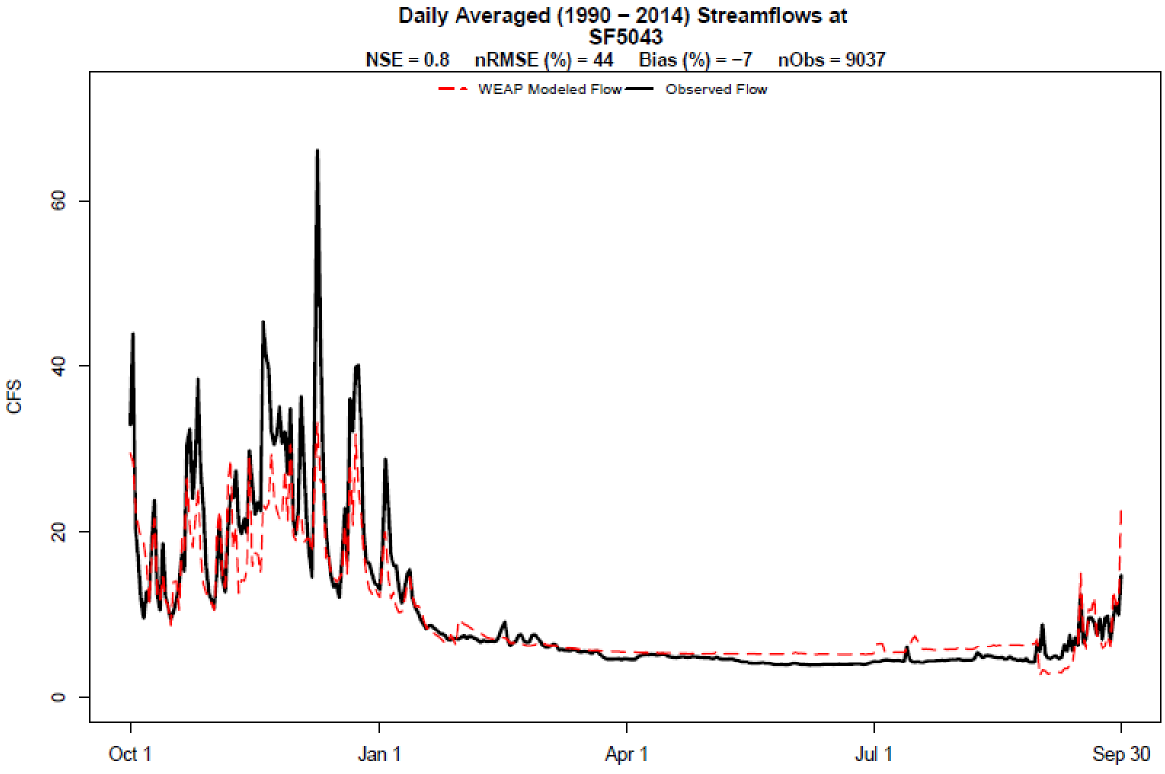
WEAP Modeled Flow
Observed Flow
CFS
0
20
40
60
80
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30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SF5043
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Observed Flow
CFS
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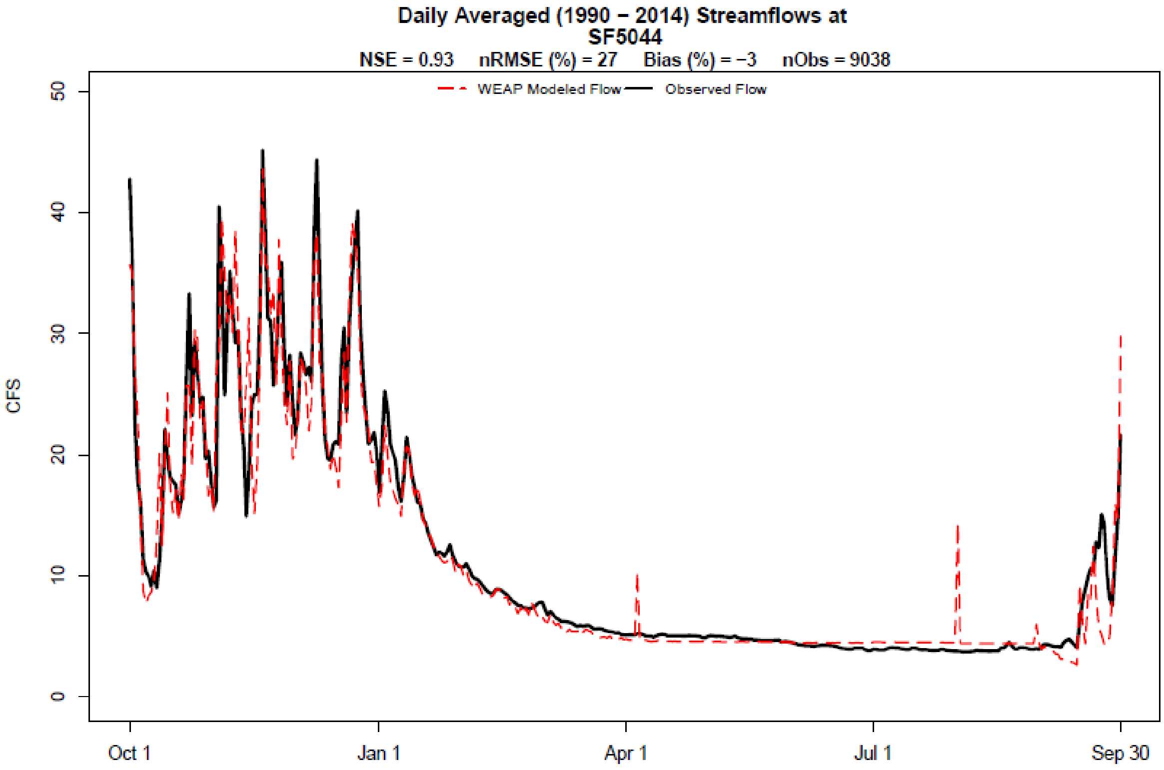
20
40
60
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30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CFS
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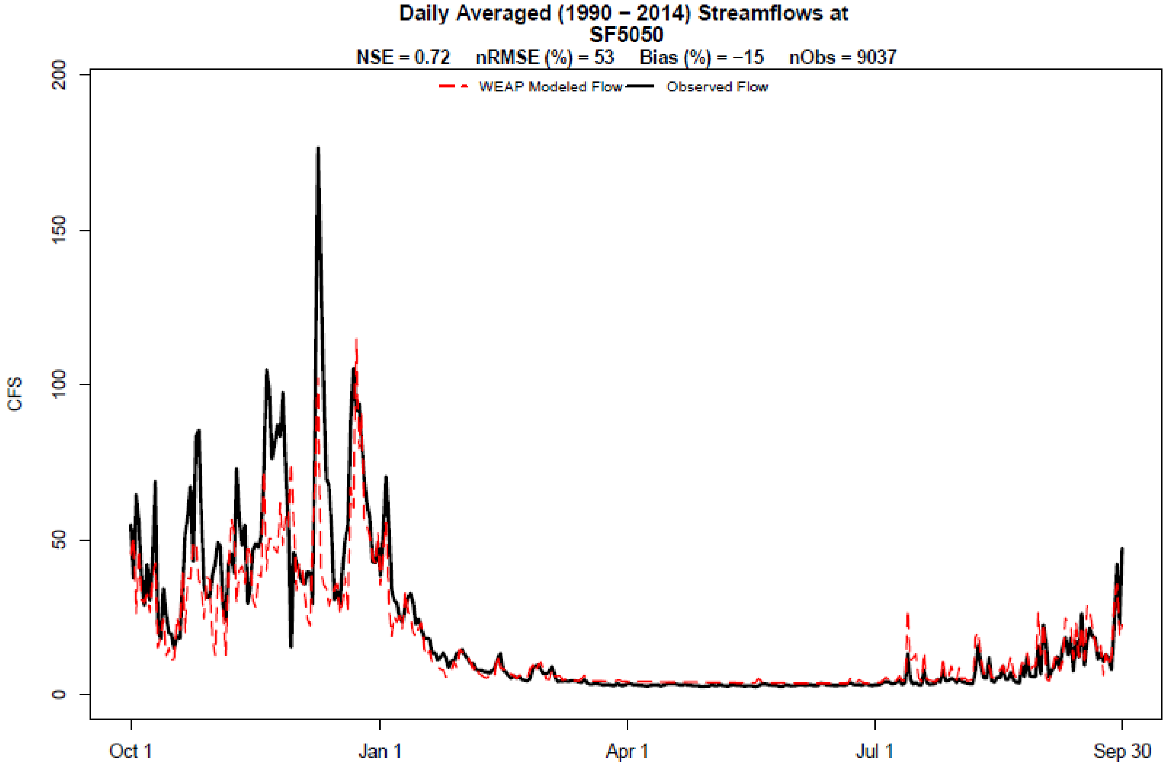
10
20
30
40
50
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30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SF5050
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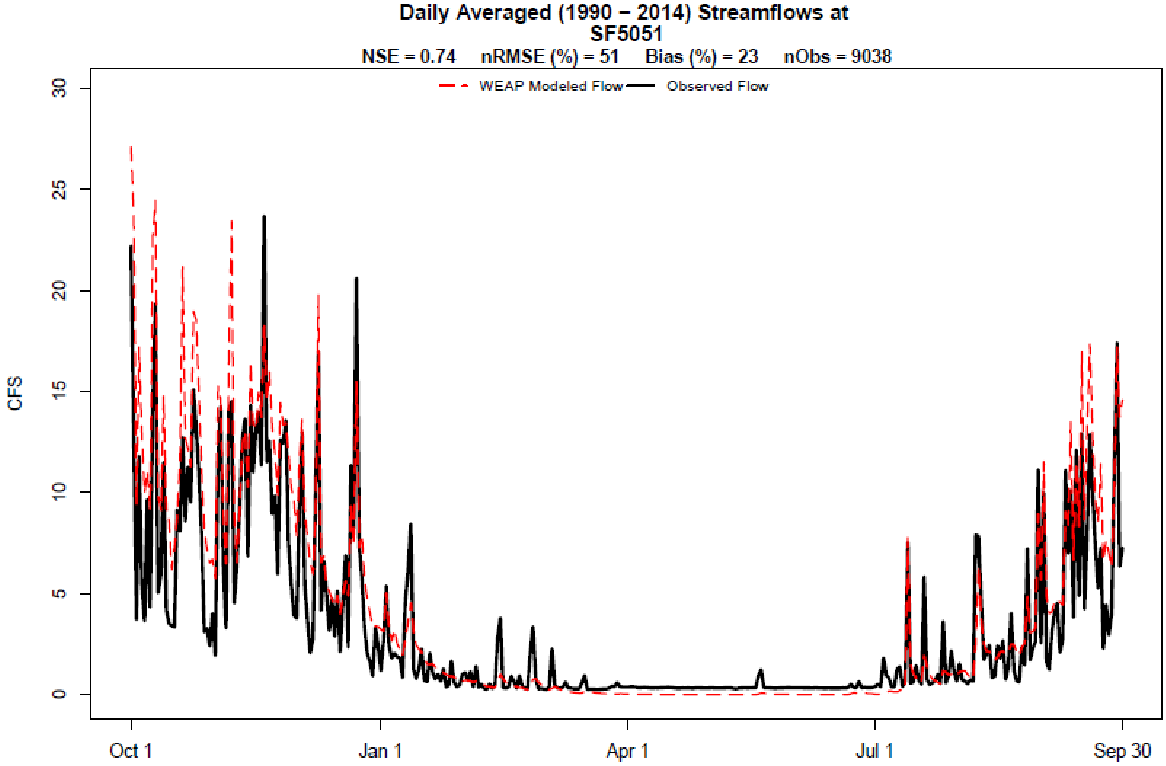
Observed Flow
CFS
0
50
100
150
200
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30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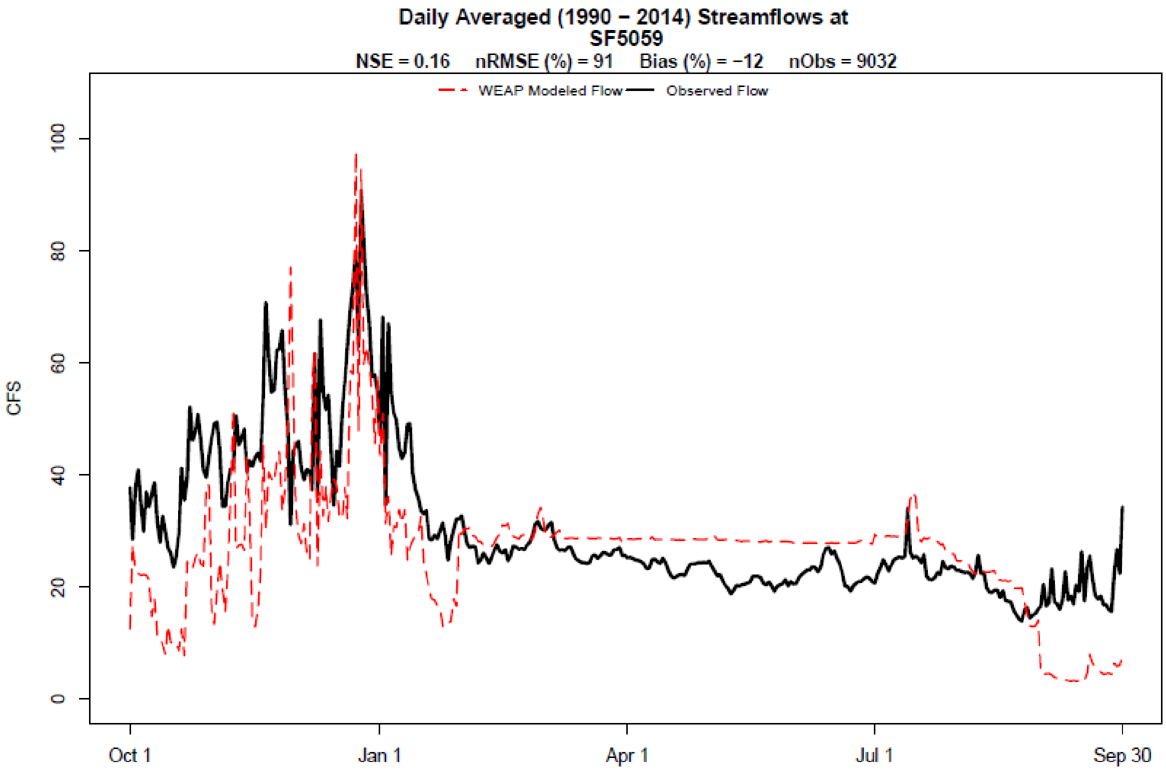
Observed Flow
CFS
0
5
10
15
20
25
30
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30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Observed Flow
CFS
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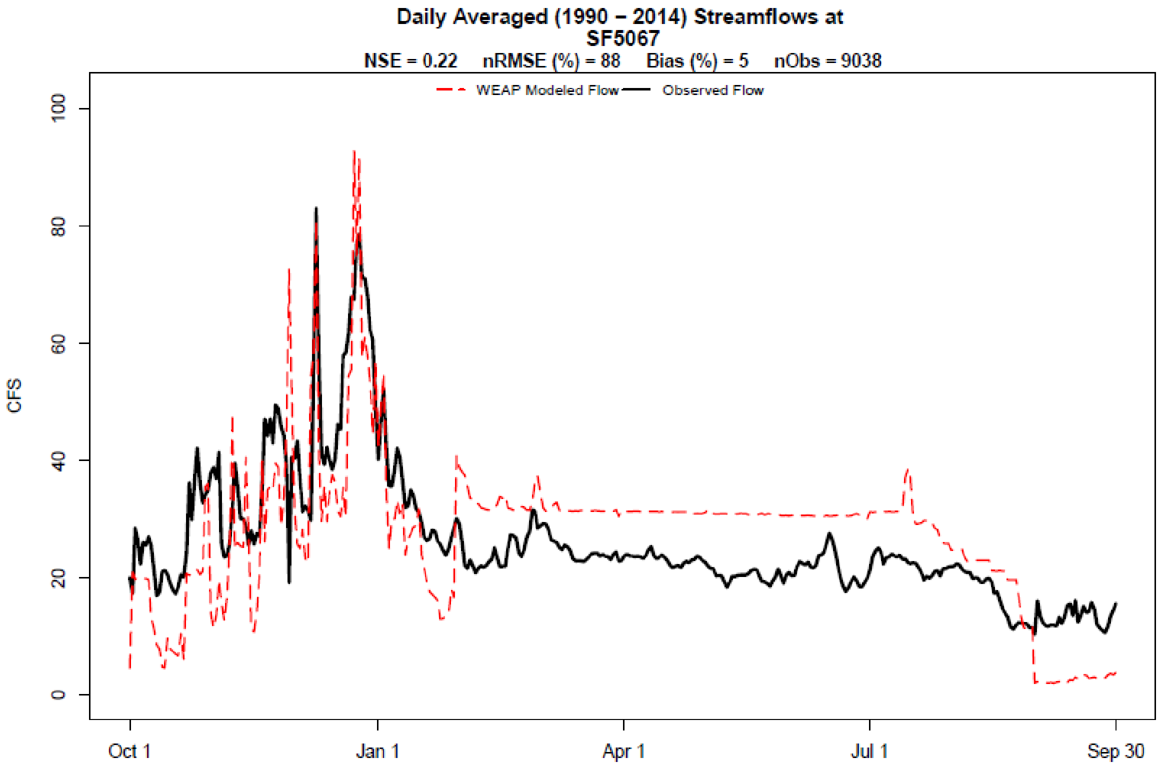
20
40
60
80
100
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30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CFS
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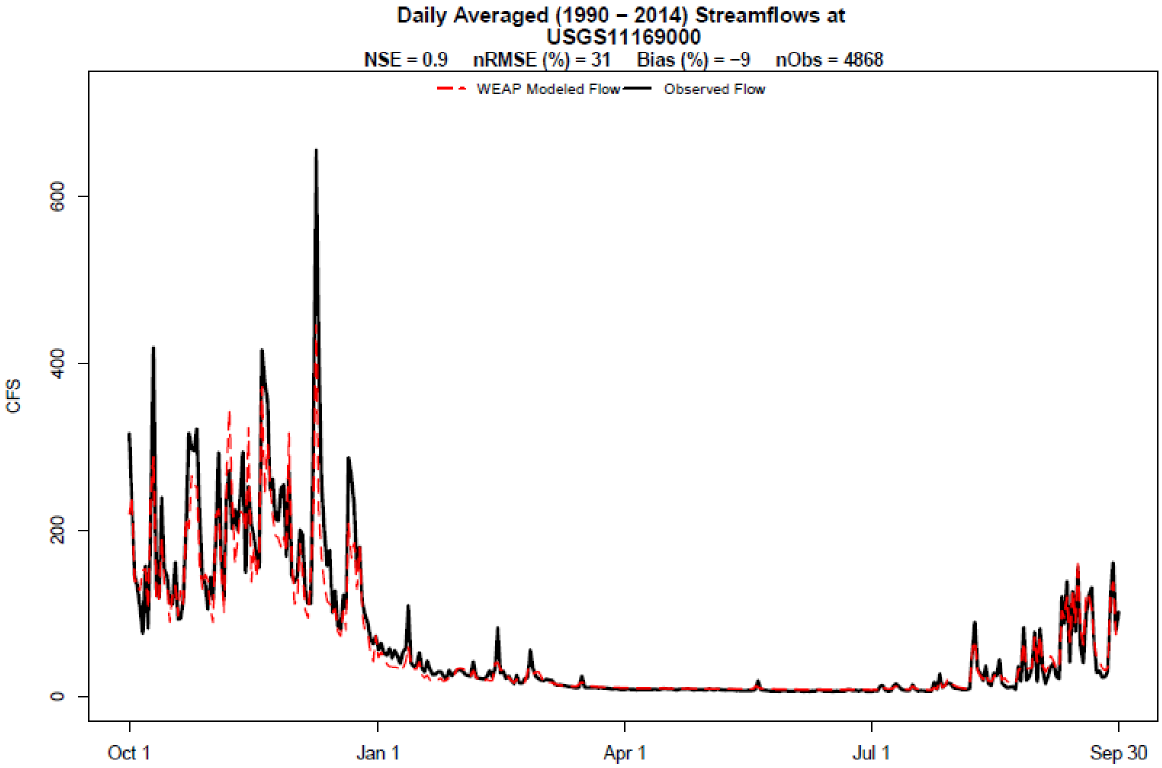
80
100
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30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CFS
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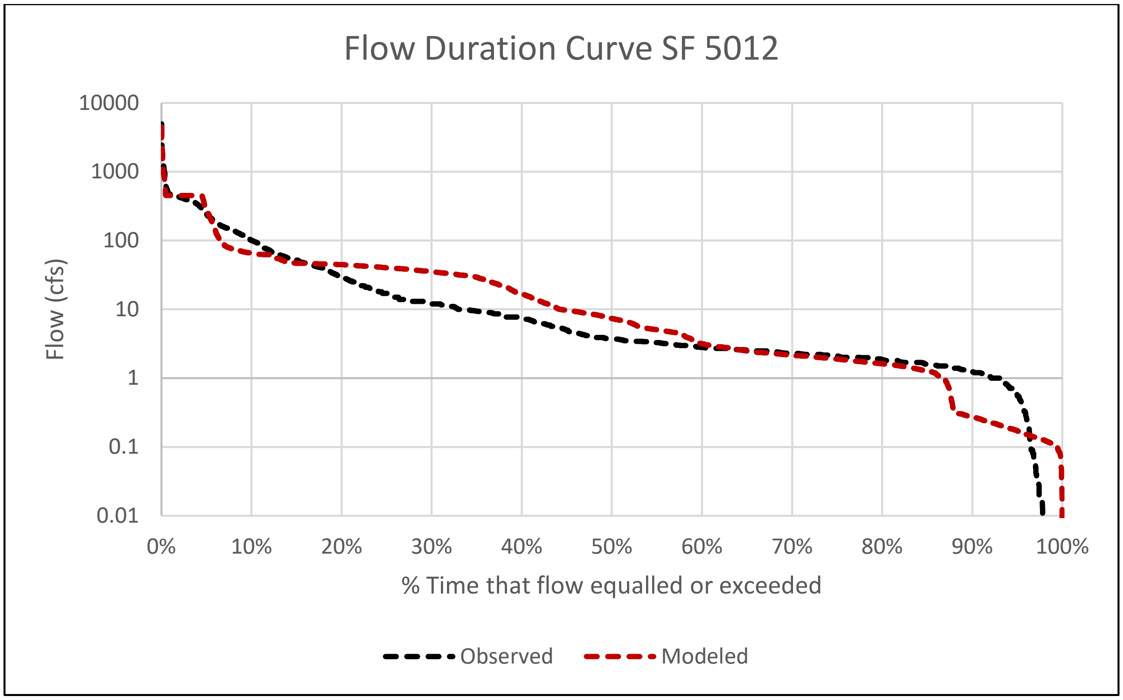
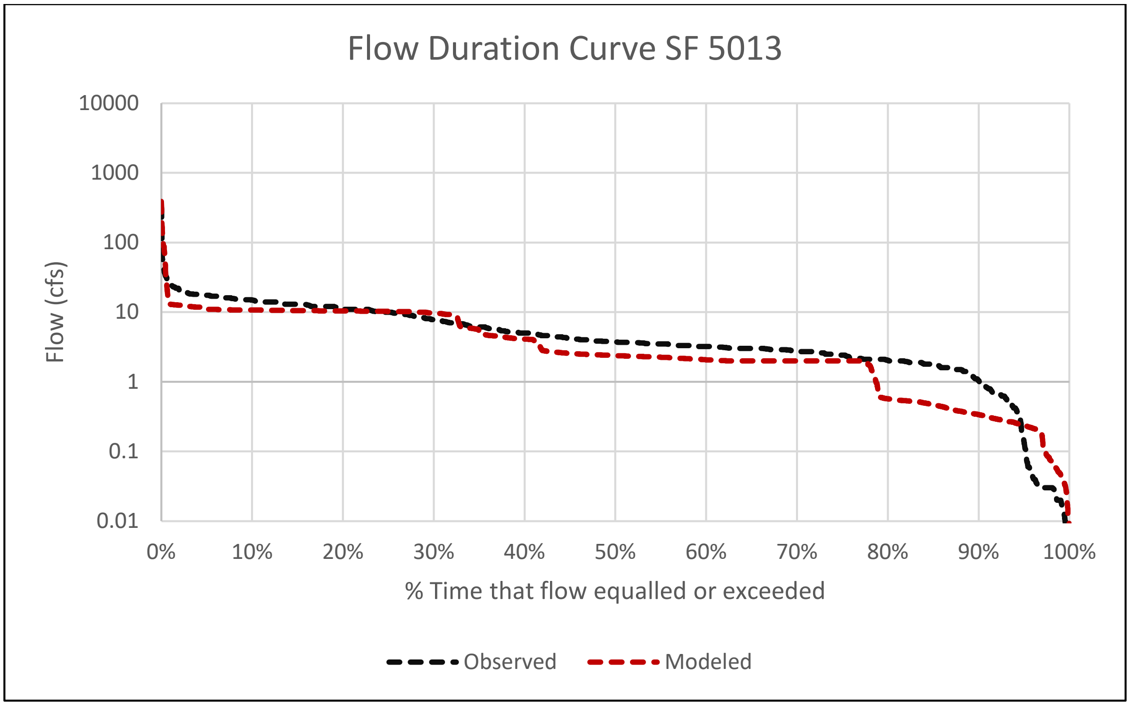
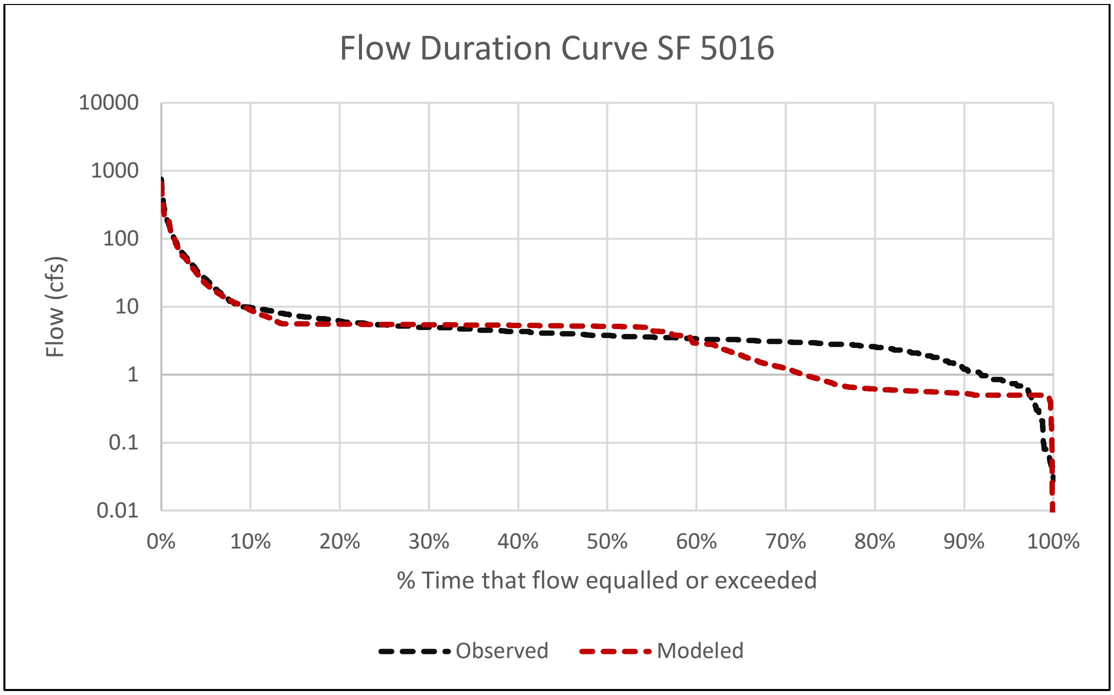
400
600
Oct 1
Jan 1
Apr 1
Jul 1
Sep 30

Appendix 5. Streamflow exceedance figures



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0.01
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30%
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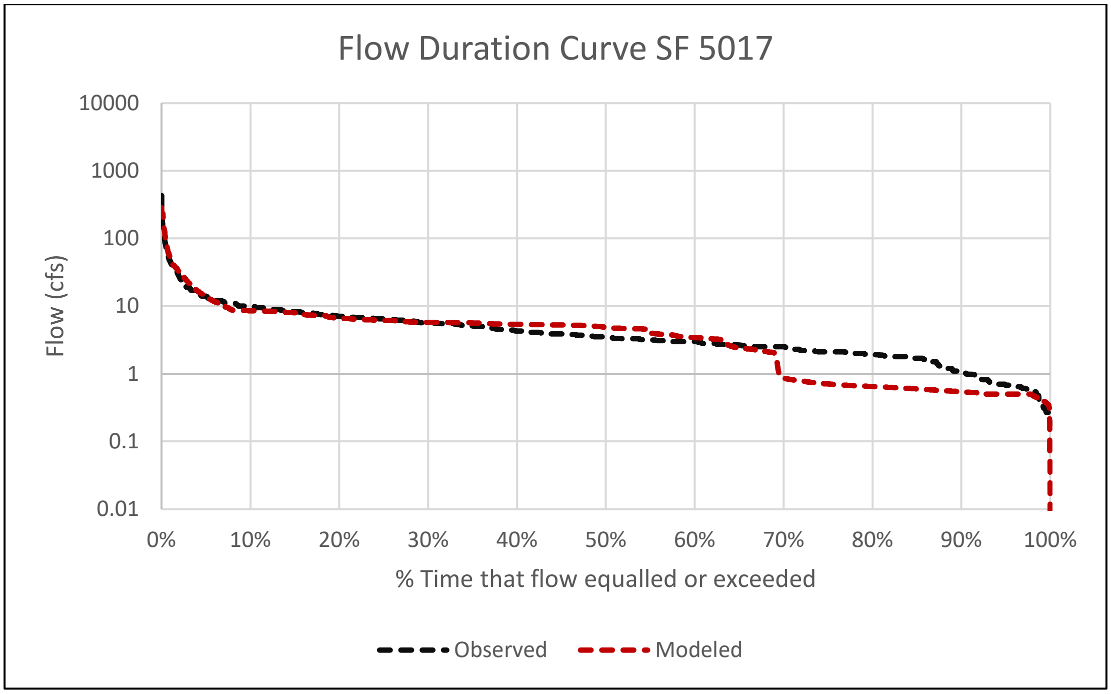
90%
100%
% Time that flow equalled or exceeded
Observed
Modeled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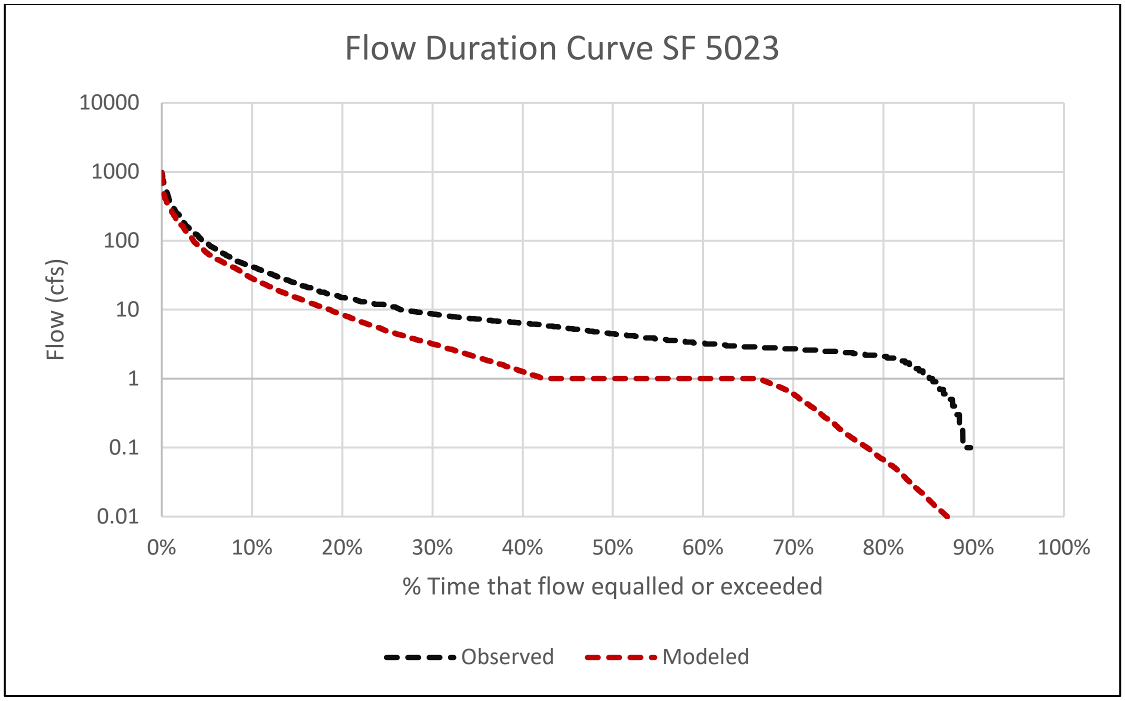
% Time that flow equalled or exceeded
Observed
Modeled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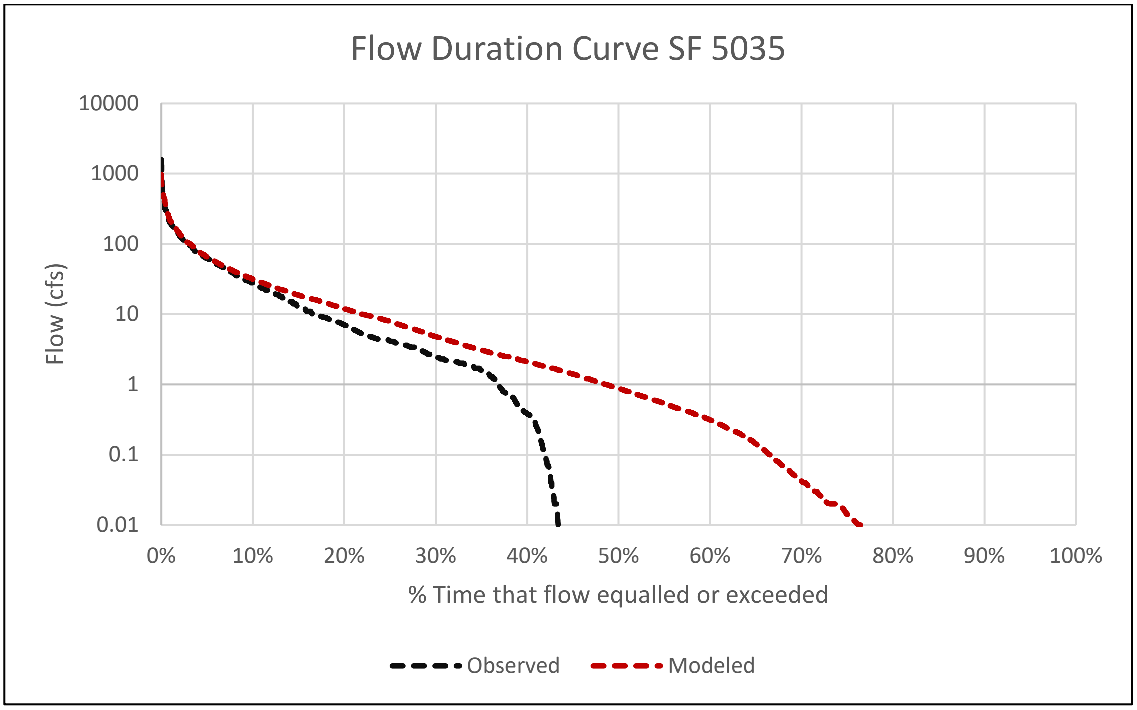
% Time that flow equalled or exceeded
Observed
Modeled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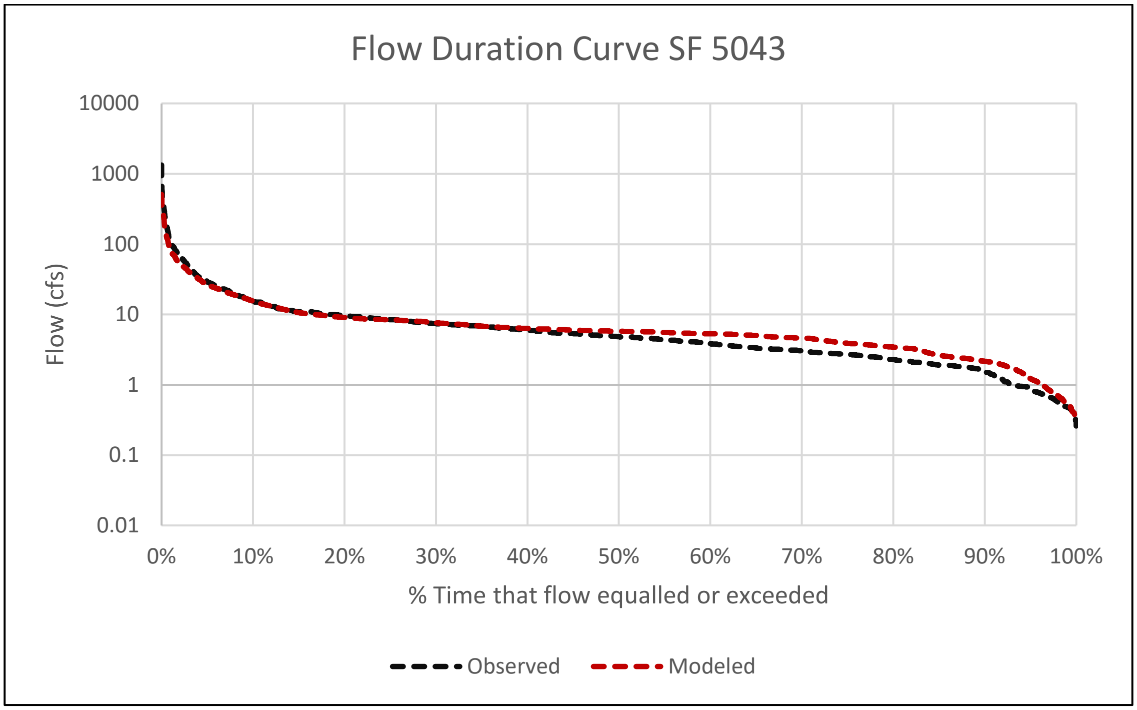
% Time that flow equalled or exceeded
Observed
Modeled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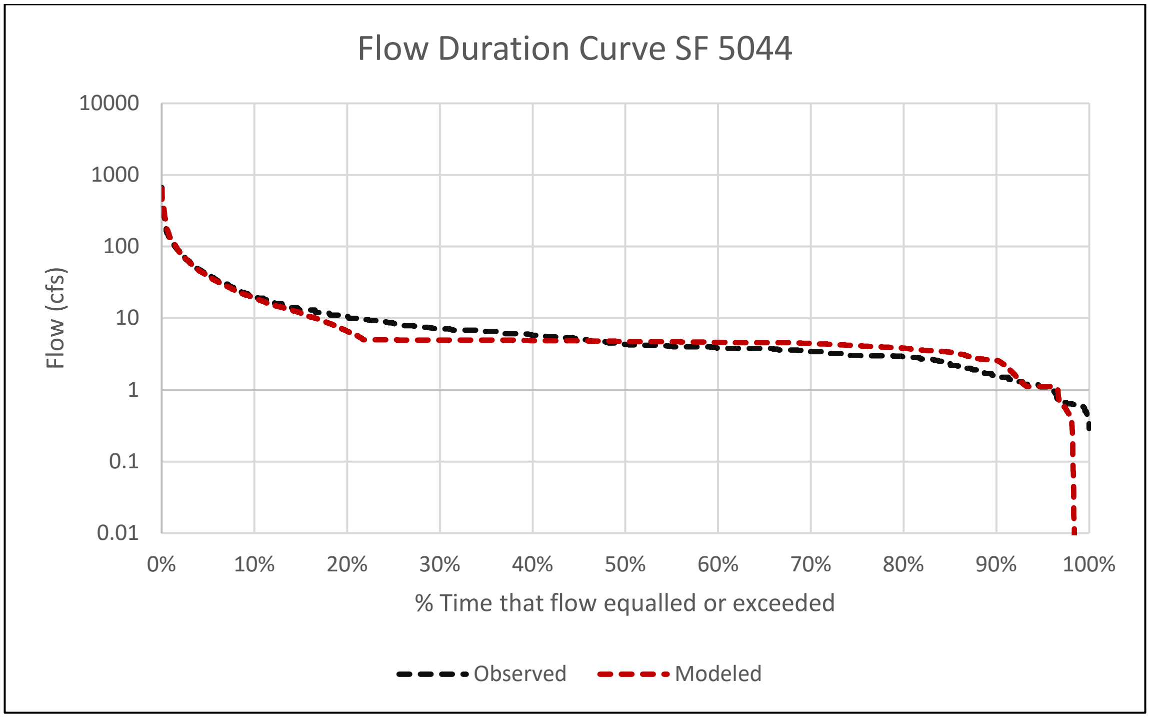
% Time that flow equalled or exceeded
Observed
Modeled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0.01
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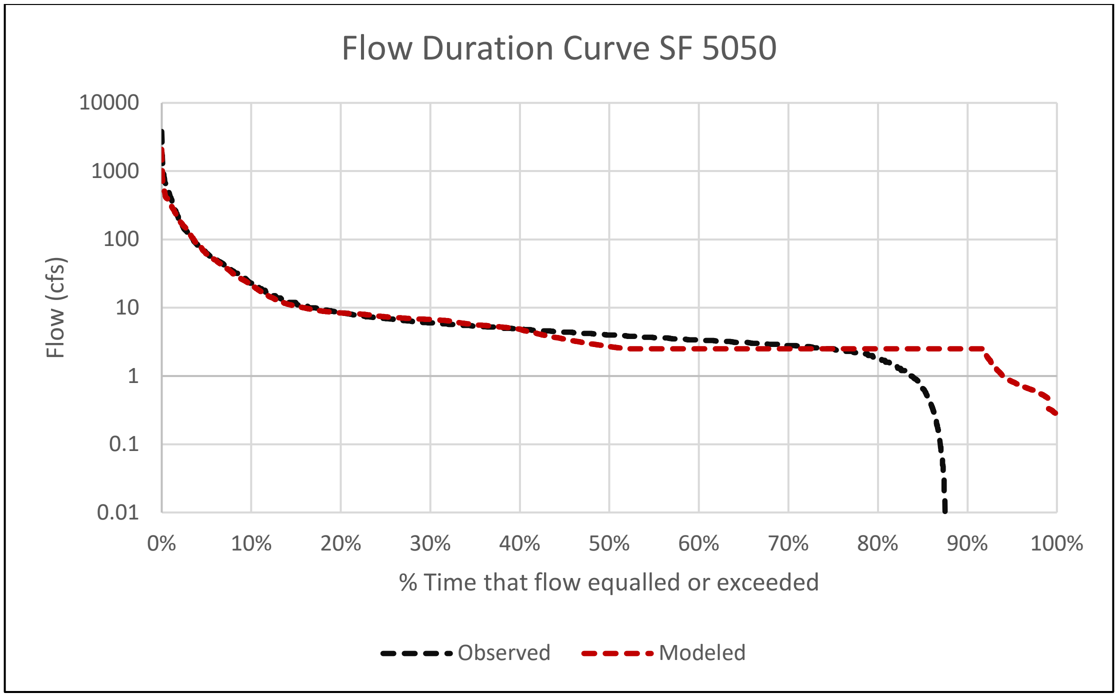
% Time that flow equalled or exceeded
Observed
Modeled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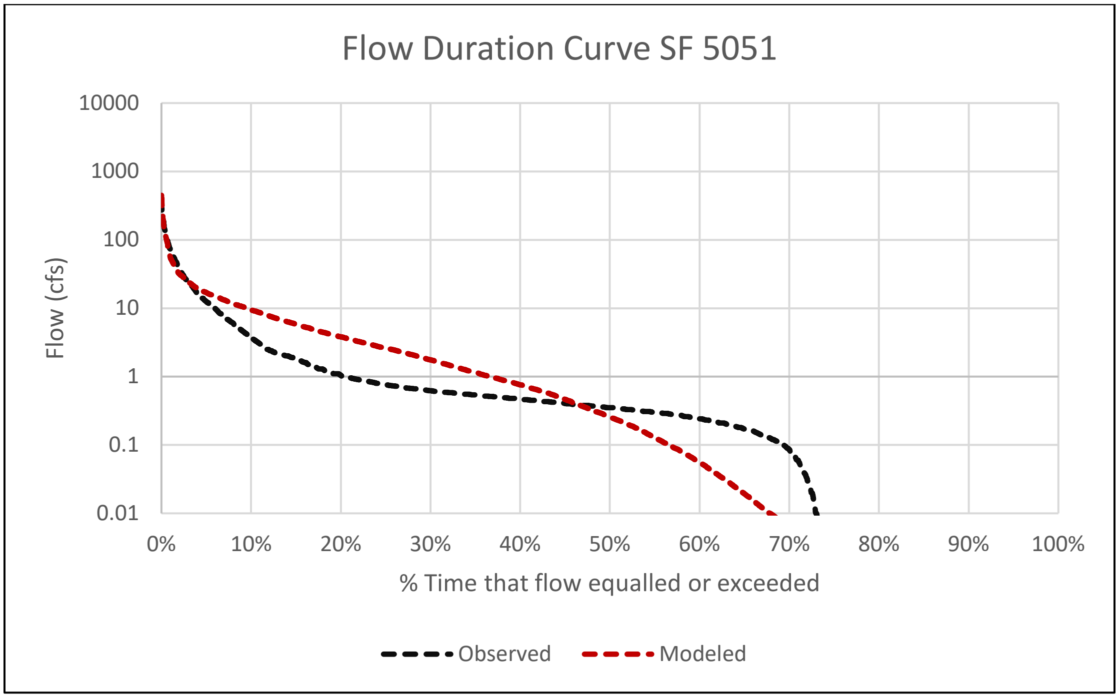
100%
% Time that flow equalled or exceeded
Observed
Modeled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0.01
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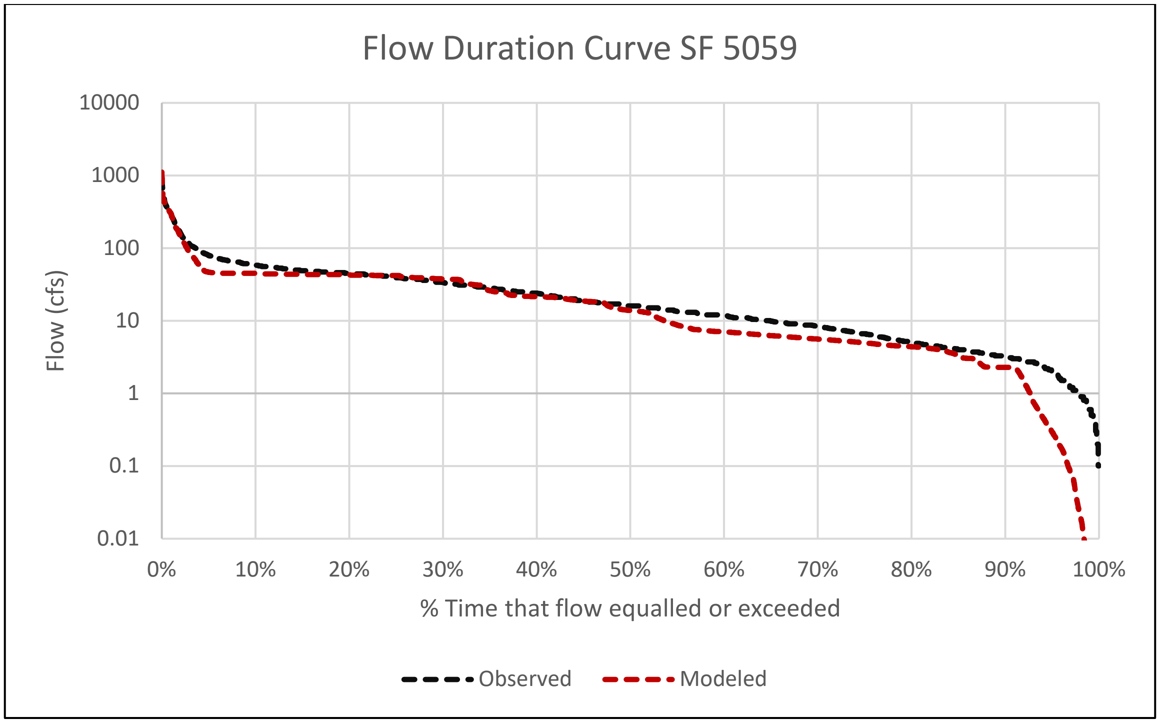
% Time that flow equalled or exceeded
Observed
Modeled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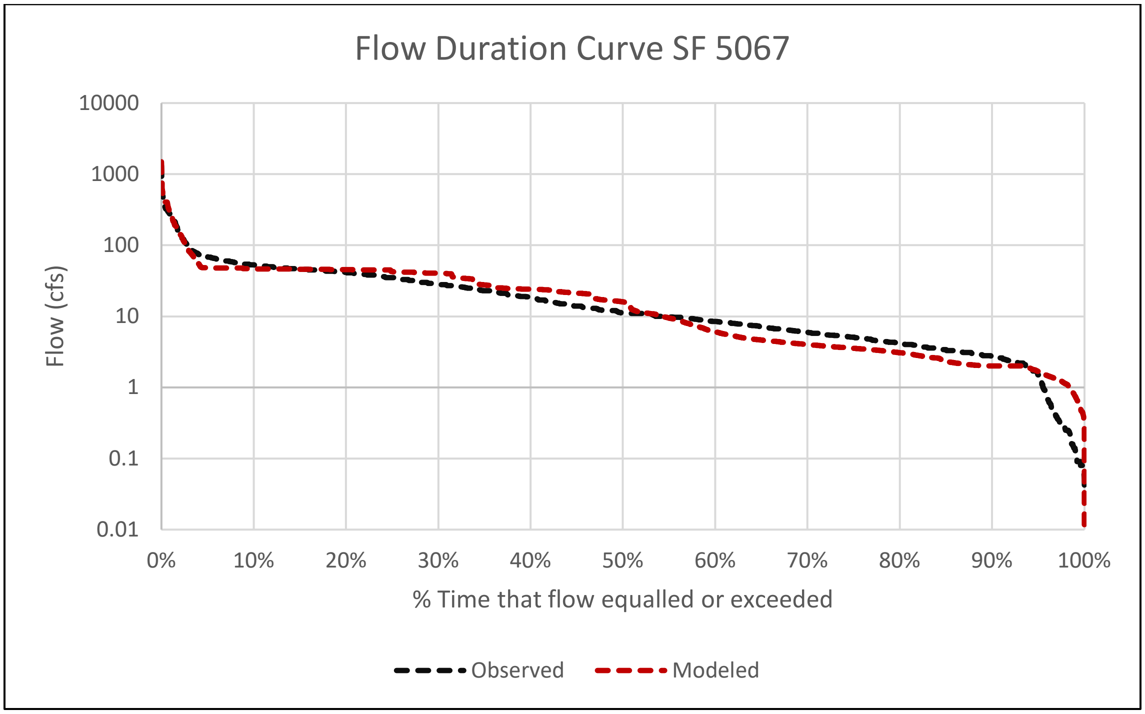
80%
90%
100%
% Time that flow equalled or exceeded
Observed
Modeled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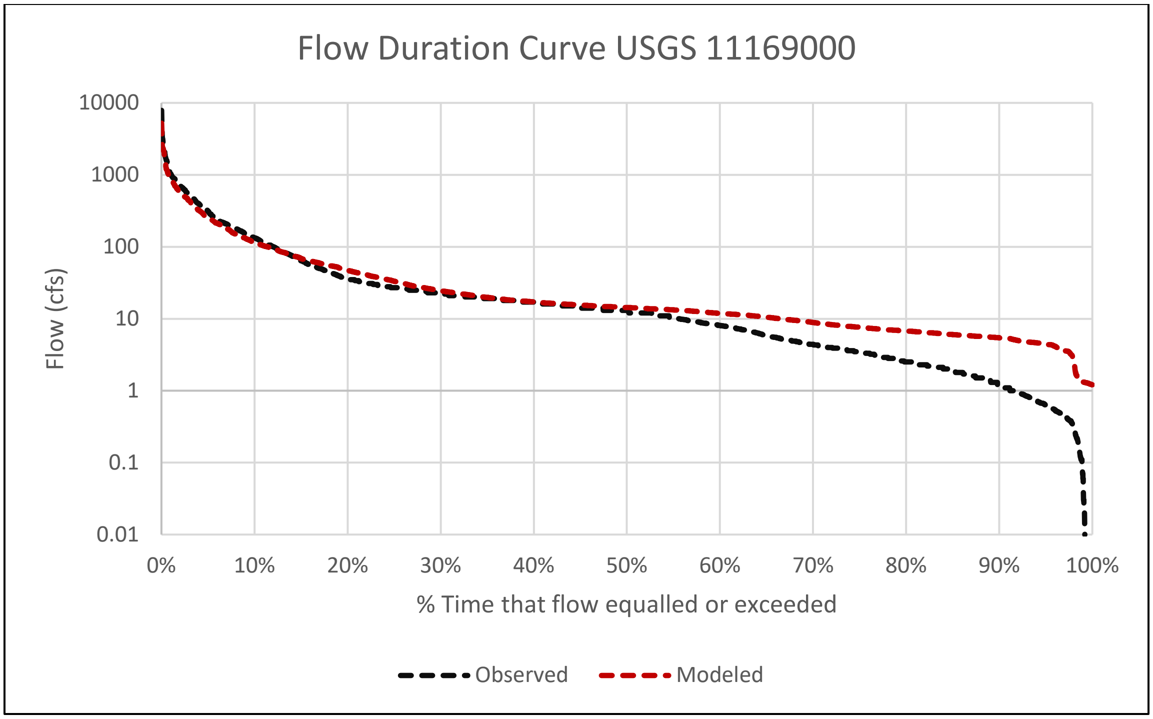
100%
% Time that flow equalled or exceeded
Observed
Modeled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Flow (cfs)
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0.01
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time that flow equalled or exceeded
Observed
Modeled

Appendix G – Valley Water Daily WEAP Model Technical Memorandum

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Appendix H

Methods for Establishing Reaches of Interest and Points of Interest Technical Memorandum

Appendix H – Methods for Establishing Reaches of Interest and Points of Interest Technical Memorandum

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FAHCE Technical Workgroup

Methods for Establishing Reaches of Interest and Points of Interest

September 2020

Introduction

As part of the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) Settlement Agreement, reservoir re-operation rule curves were developed to ensure the Santa Clara Valley Water District's (SCVWD) operations would "restore and maintain healthy steelhead trout and salmon populations as appropriate to each of the Two Creeks[1], by providing (A) suitable spawning and rearing habitat within each watershed, and (B) adequate passage for adult steelhead trout and salmon to reach suitable spawning and rearing habitat and for out-migration of juveniles". At the direction of initialing parties to the FAHCE Settlement Agreement in 2015, the FAHCE Technical Workgroup (formed to facilitate further analysis and development of the settlement agreement terms) is applying the Water Evaluation and Planning (WEAP) model to evaluate rule curve performance on instream flow and water temperatures pursuant to environmental analysis requirements defined in the California Environmental Quality Act (CEQA). WEAP is a distributed hydrologic model that produces flow and temperature estimates at select locations along stream networks. These points are called "WEAP nodes" and are based in part on where sufficient historic data have been collected to inform stream flow and water temperature.

To improve the analysis, the FAHCE Technical Workgroup is adding WEAP nodes at locations throughout the two creeks network that will yield the most ecologically relevant results for steelhead and Chinook salmon. Because the CEQA analysis will evaluate the effects of flow regimes outside the range of current operations, the group's approach to identifying node locations is focused not only on identifying areas that currently support steelhead and Chinook habitat, but also in areas with a reasonable potential to support these salmonids under all future scenarios being evaluated under CEQA.

Reach of Interest Development

To help identify these locations, the FAHCE Technical Workgroup has identified reaches of interest (ROI), which establish a life-stage specific framework to guide the placement of points of interest (POI). ROIs were defined broadly so as not to exclude analysis of any stream reach that may have present or future value to one or more salmonid life stages. ROIs are shown on the attached map.

ROIs are classified into three categories reflecting the flow-dependent life stages of Steelhead and Chinook salmon: Adult and juvenile migration; Adult spawning, and; Juvenile rearing.

- *Adult and juvenile migration:* These reaches include all areas adults pass through to reach spawning grounds during immigration. This typically occurs from October to December for Chinook salmon and January through April for steelhead. These reaches also include areas juveniles must pass through while emigrating from their natal rearing areas to the ocean. This usually occurs from the beginning of February through May for steelhead and beginning of

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[1] The two creeks are: Stevens Creek and Guadalupe River.

February through June for Chinook salmon. Since adult passage and juvenile emigration flows are required to pass fish throughout all anadromous reaches of stream, all reaches below major barriers (i.e., District dams) are considered adult passage and juvenile emigration (migration) ROIs.

- *Adult holding and spawning:* Adult holding and spawning reaches are defined as areas where salmonids would most likely be able to hold while completion of adult maturation or environmental conditions are met at spawning areas, build redds, incubate embryos, and successfully produce fry. Spawning habitat is typically associated with low gradient reaches with alluvial deposits of gravel (of sufficient size and quality), a relatively stable configuration of pools, riffles and runs, and suitable flow and temperature conditions to keep embryos wet and cool throughout the incubation period for Steelhead (January through April) and Chinook salmon (mid-October through February). Adults require deep pools with low velocities and sufficient cover in order to rest, mature, wait for appropriate migration flows to resume, and to avoid threats such as predation.
- *Juvenile rearing:* These reaches include areas that provide habitat for fry, sub-yearling, and yearling parr, as well as areas where juveniles move upstream during the hot and dry period. These juvenile life stages typically require cool temperatures, adequate dissolved oxygen, food and cover to survive. Optimal flow conditions in rearing reaches connect riffles and pools, which (when appropriate substrate conditions are present) support food production. As the summer progresses, streamflow typically declines and water temperatures increase. Juveniles that did not emigrate, must then redistribute themselves to more suitable habitat in order to persist through the remainder of the dry season. This requires sufficient flow to allow them to pass over riffles and other shallow water features during this transitional period. In addition, juveniles can survive and grow in warm stream reaches if sufficient food is available to compensate for the increased metabolic demands that high temperatures place on these fish. While the emphasis of the WEAP model for juvenile rearing is the summer period, juveniles may rear in streams year-around. In addition, they may be exposed to elevated turbidity events at any time of year, as a result of stormflows and/or from mobilization of fine sediment from behind dams. These additional considerations will therefore be addressed as part of the juvenile rearing ROI evaluation.

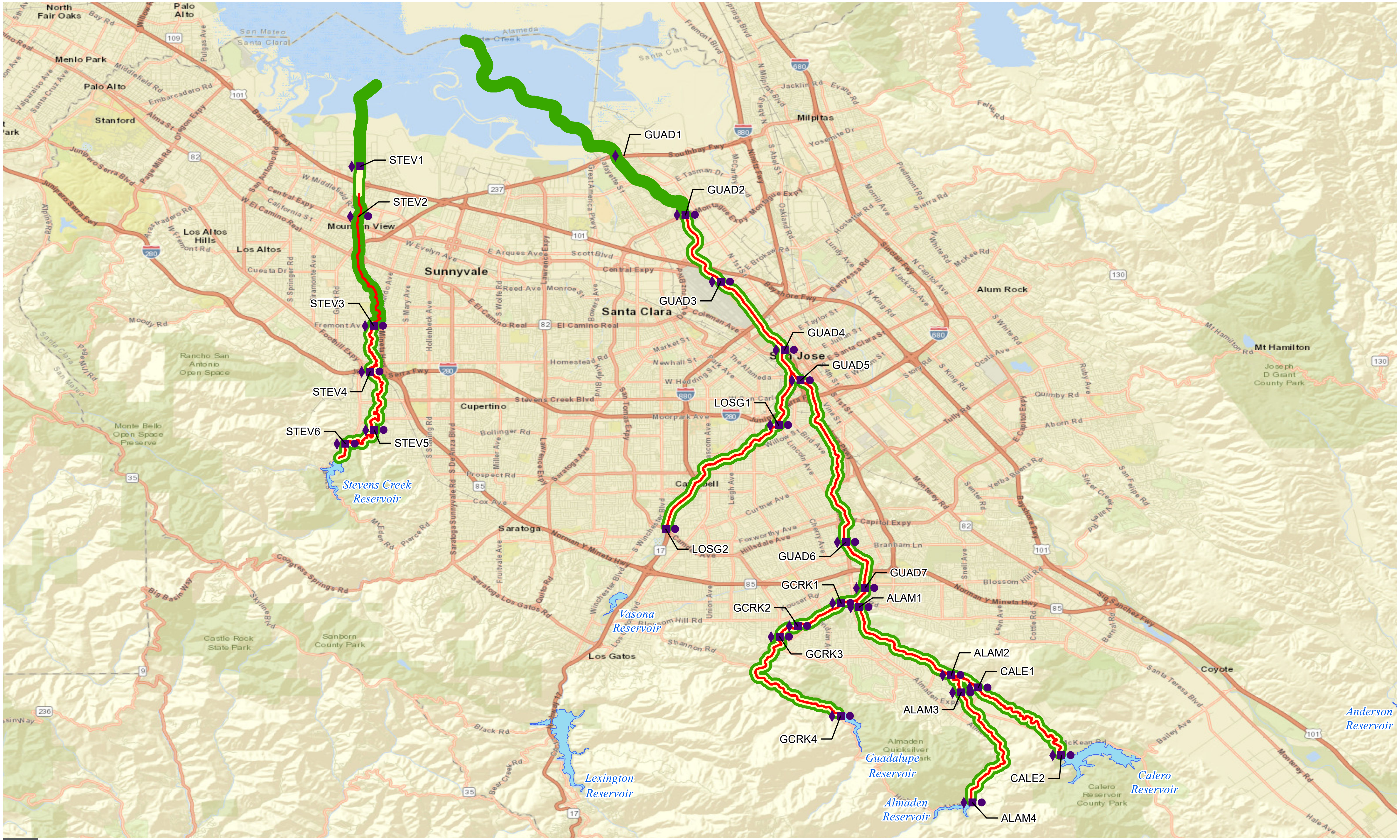
As shown on the map, there is considerable overlap among the three ROIs, indicating that many stream reaches serve as habitat for multiple life stages. Therefore, the WEAP model will produce flow and temperature metrics appropriate to each ROI-type upon which the POI lies. Because conditions are likely to vary by water year type, separate estimates will be produced for dry, normal and wet years.

Points of Interest Development

For our purposes, a POI is a discrete point within one or more ROIs where WEAP and temperature model results will be generated and evaluated. In addition to having pre-existing data at most of the POIs, all will have additional data collected at or near the point to support biological evaluation criteria. WEAP nodes (i.e. locations where the model produces flow estimates) will be placed at POIs, but POIs differ in that they will also become foci for future data collection efforts to support model calibration and adaptive management. POIs were applied liberally to ensure flow and temperature estimates would be available wherever the group needed to evaluate such conditions. This included placing POIs wherever substantial flow accretions and depletions were anticipated. For example, POIs were placed above and below water diversions and after transitions to reaches with groundwater accretion, groundwater percolation and at known storm-water discharge points. Rationale for selection and placement of each POI can be viewed in Appendix A.

Both ROIs and POIs were developed by consensus within the FAHCE Technical Workgroup and drafts were circulated to the FAHCE initialing parties. Workgroup members evaluated existing fisheries and habitat information and applied best professional judgment to delineate ROIs and POIs given their understanding of geologic, geomorphic, hydrologic and habitat conditions as well as recent and historical fisheries data.

ROIs and POIs are based on best available knowledge without the benefit of a more in depth analysis. We therefore recommend both ROIs and POIs be revised periodically as new information becomes available and our collective understanding of habitat conditions improve. This product was developed specifically to evaluate Santa Clara Valley Water District's operations and may not be appropriate to use for any other purpose.



● Spawning
■ Rearing
♦ Passage

🟥 Spawning Reach
🟨 Rearing Reach
🟩 Migration Reach

N

0 1 2 3
Miles

REACHES & POINTS OF INTEREST

FAHCE TECHNICAL WORKGROUP
OCTOBER 2020

PATH: G:\PROJECTS\SANTACLARAWATERDISTRICT\FAHCE_THREE_CREEKS_EIR\7.2_WORKING\MAP_DOCS\ATTACHMENT_ROI_AND_POI_METHODS_UPDATE.MXD - USER: KKEIGHTL - DATE: 10/9/2020

Appendix A

POI ID	Point of Interest	SPAWN	REAR	PASS	Rationale for inclusion	Lat	Long	Distance to SFB (ft)	Keep POI?
STEV1	Stevens Creek D/S of Hwy 101		✓	✓	Downstream extent of documented rearing; have CDFW summer rearing data (e-fishing) for 2010, 2013, 2014, 2015; HEC-RAS x-section; temperature data; can also check with Jae Abel's temperature data			13200	Y
STEV2	Stevens Creek at Central Ave	✓		✓	Location of Stream Gage SF35; called out as priority barrier in the FAHCE Settlement Agreement; stream at Central Avenue often dry so no rearing here typically; CDFW has temperature data from Moffett Blvd but can't infer conditions u/s using Moffett data due to Moffett being a site of ground water accretion; leave POI at Central Avenue but use temperature data from El Camino Avenue; District will be collecting spawning data at Central Ave as part of the Evelyn Avenue project so more data in coming years; HEC-RAS x-section			20000	Y
STEV3	Stevens Creek above Fremont Ave	✓	✓	✓	Called out as FAHCE priority barrier in FAHCE Settlement Agreement; typical downstream extent of water in summer months; this was an original point in analysis; temperature data; HEC-RAS x-section			38000	Y
STEV4	Stevens Creek above Hwy 280	✓	✓	✓	Hwy 280 is d/s of FAHCE Cold Water Management Zone (CWMZ); HEC-RAS x-section; District critical riffle transect at Hwy 280			47000	Move point on map from Stevens Creek Blvd to Hwy 280
STEV5	Stevens Creek above McClellan Rd	✓	✓	✓	FAHCE restoration area; important juvenile steelhead rearing reach; CDFW summer rearing data (e-fishing) for 2010, 2013, 2014, 2015; HEC-RAS x-section; just below Deep Cliff Golf Course diversion; temperature data (3 years at McClellan Road and 10 years from Deep Cliff so temperature regression analysis good here)			57500	Y
STEV6	Stevens Creek below Stevens Creek Reservoir	✓	✓	✓	Downstream of Reservoir; Location of Stream Gage SF44; just d/s reservoir so no need for passage; temperature data; District critical riffle transect (1-foot intervals)			64500	Y

Appendix A

POI ID	Point of Interest	SPAWN	REAR	PASS	Rationale for inclusion	Lat	Long	Distance to SFB (ft)	Keep POI?
GUAD1	Guadalupe River at Hwy 237			✓	HEC-RAS x-section; capture passage flows here			29000	Y
GUAD2	Guadalupe River at Montague Exp	✓	✓	✓	HEC-RAS x-section; District doesn't feel there is a passage issue here but may need to expand search for passage issues in area			41500	Y
GUAD3	Guadalupe River at SJ Airport	✓	✓	✓	Upstream of USGS Gage 11169025; HEC-RAS x-section; temperature data; data for passage depths across channel at 2-foot intervals for years 2001-2005; permanent grade control structure w/ multiple measurements of depth; radio telemetry for u/s passage; juvenile rearing sampling site			54000	Y
GUAD4	Guadalupe River above Los Gatos Creek	✓	✓	✓	Beginning of confined aquifer and accretive flow increases; HEC-RAS x-section; most years there is flow to the confluence; lot of historical USGS gauge data but gauge was removed in 2003; temperature data and flow data d/s of confluence; Jason noted that he cannot speak to acceptance of adding another POI			71500	Y*
GUAD5	Guadalupe River below Ross Creek	✓	✓	✓	Ross Creek has a significant flow signature (per Jae Abel via Michelle Leicester); don't need a POI above and below so keep this POI and eliminate POI above Ross Creek; can estimate but not validate temperature data due to only 3 months of data;			97000	Y
GUAD6	Guadalupe River above Ross Creek	✓	✓	✓	Eliminate POI			98000	N
GUAD7	Guadalupe River below Alamitos Drop Structure	✓	✓	✓	Understand effects of Alamitos Diversion; understand conditions downstream of Alamitos Drop Structure; remediated FAHCE priority barrier; important to evaluate the contributions of the two tributaries u/s; representative of the reach; temperature data; Vaki fish counter data for 3 years to verify passage; HEC-RAS x-section			101000	Y
LOSG1	Los Gatos Creek above the Guadalupe River confluence	✓	✓	✓	Stream Gage 50; HEC-RAS x-section; easily accessible			78000	Y
LOSG2	Los Gatos Creek below ~~Kirk Diversion~~ Lower Page Drop Structure	✓	✓		Ustream extent of anadromy in Los Gatos Creek; temperature data; older models of HEC-RAS but not georeferenced so problematic; need site visit			100000	Y
GCRK1	Guadalupe ~~River~~ Creek ~~at Guadalupe Creek~~ upstream of Lake Almaden	✓	✓	✓	HEC-RAS x-section; District has critical riffle transect; temperature data			108000	Y
GCRK2	Guadalupe Creek below Masson Dam	✓	✓	✓	Downstream of Masson Diversion; HEC-RAS x-section			114000	Y
GCRK3	Guadalupe Creek above Masson Dam	✓	✓	✓	Downstream of Camden Ave; Downstream of FAHCE CWMZ; above diversion; District has critical riffle transect; no HEC-RAS x-section so good candidate for field visit			116800	Y
GCRK4	Guadalupe Creek below Guadalupe Reservoir	✓	✓		Downstream of Reservoir so no passage needed; see what releases are; location of Stream Gage SF17; no HEC-RAS x-section below dam so good candidate for field visit			137800	Y
ALAM1	~~Guadalupe River at~~ Alamitos Creek above Lake Almaden	✓	✓	✓	Want a point u/s Lake Almaden			110500	Y
ALAM2	Alamitos Creek below Calero Creek	✓	✓	✓	Important juvenile rearing reach in Guadalupe Watershed; HEC-RAS x-section; temperature data			124000	Y
ALAM3	Alamitos Creek above Calero Creek	✓	✓	✓	Want a point u/s conflunce with Calero Creek; HEC-RAS x-section			127500	Y

Appendix A

POI ID	Point of Interest	SPAWN	REAR	PASS	Rationale for inclusion	Lat	Long	Distance to SFB (ft)	Keep POI?
ALAM4	Alamitos Creek below Almaden Reservoir	✓	✓		Downstream of Reservoir; location of Stream Gage SF16; no HEC-RAS x-section below dam so no passage but can be good candidate for field visit			147500	Y
CALE1	Calero Creek above Alamitos Creek	✓	✓	✓	Important juvenile steelhead rearing reach in Guadalupe Watershed; a few hundred feet u/s of HEC-RAS x-section so can move POI down to below confluence to match x-section; or can do a critical riffle transect if necessary			127500	move d/s below confluence
CALE2	Calero Creek below Calero Reservoir	✓	✓		Downstream of Reservoir; location of Stream Gage SF13; no HEC-RAS x-section below dam so no passage but can be good candidate for field visit			144000	Y

Request to add a POI at Coleman which is d/s of the confluence with Guadalupe River; St John weir is d/s of confluence and has good summer flow data; there is more data at Coleman but it is not year-around

Appendix I

Temperature Modeling Technical Memorandum

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Appendix I – Temperature Modeling Technical Memorandum

Fish and Aquatic Habitat Collaborative Effort
Draft Program Environmental Impact Report

Santa Clara Valley Water District

Santa Clara County, California

May 2021

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Appendix I – Temperature Modeling Technical Memorandum

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Appendix I – Temperature Modeling Technical Memorandum

1 Temperature Modeling

1.1 Introduction

The Fish and Aquatic Habitat Collaborative Effort (FAHCE) project involves development and implementation of a Fish Habitat Restoration Plan (FHRP) for two watersheds in the Santa Clara Valley of California. These two watersheds, the Guadalupe River and Stevens Creek (collectively referred to as the Two Creeks), are important elements of the Santa Clara Valley Water District's (Valley Water's or District's) water supply and flood management system. The FHRP is one component of the FAHCE Settlement Agreement, which was initialed in 2003 by the District, Guadalupe Coyote Resource Conservation District (GCRCD), California Department of Fish and Wildlife (CDFW), U.S. Fish and Wildlife Service (USFWS), and National Marine Fisheries Service (NMFS) (referred to as the Initialing Parties or IPs).

The FAHCE Project (Project) is subject to review pursuant to the California Environmental Quality Act (CEQA). The FAHCE Settlement Initialing Parties formed a technical workgroup that met regularly throughout the CEQA process to discuss the biological framework for the CEQA analyses and the modeling required to conduct the biological evaluations according to Settlement Agreement terms. Output from the District's Operations Model provides the base data for several of the impact areas evaluated pursuant to CEQA, including water supply, groundwater, and water quality. In order to evaluate key impact areas related to fisheries, it is necessary to estimate water temperature.

This Technical Memorandum provides information about the Project and methods used to simulate tributary water temperatures under Project operations. The memorandum is organized as follows:

- Section 1: Temperature Modeling
- Section 2: General Modeling Approach
- Section 3: Temperature Regression Methodology
- Section 4: Temperature Regression Results
- Section 5: Regression Limitations
- Section 6: Regression Application
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2 General Modeling Approach

This section provides a background for the overall temperature modeling approach, given the geographic scope of the project, resolution of modeled flows from the Operations Model, and the desired spatial and temporal resolution of fisheries analyses outlined in the *Methods for Establishing Reaches of Interest and Points of Interest Technical Memorandum* in Appendix H of this Environmental Impact Report (EIR).

2.1 WEAP Flow Model and Geographic Scope

The Project area includes two primary tributaries: Stevens Creek and Guadalupe River. Secondary tributaries include Calero Creek, Alamitos Creek, and Los Gatos Creek. The FAHCE technical workgroup selected Reaches of Interest (ROI) determined to be ecologically relevant for adult and smolt migration, adult spawning, and juvenile rearing. These ROI informed the overall geographic extent of the operations and temperature models.

The FAHCE Operations Model (Operations Model) is implemented using the Stockholm Environment Institute's (SEI) Water Evaluation and Planning (WEAP) System, with Microsoft Excel as a platform for input and output time series storage. The model simulates operations on a daily time step to determine the Project's response to changes in operations. The Operations Model period of record is 1922 to 2002. Once the geographic limits of the model were established, Points of Interest (POI) were selected to evaluate conditions at areas above and below flow changes, such as water diversions, groundwater accretion, and tributary inflows. WEAP model output nodes were placed at all POI to provide daily flows and end-of-day reservoir storages at biologically relevant locations along each of the Project tributaries. As a result, WEAP flow nodes are distributed along the tributaries at intervals ranging from a few hundred feet to several miles.

The WEAP Operations Model is further described in the *Valley Water Daily WEAP Model Technical Memorandum* in Appendix G of this EIR.

2.2 Temperature Model

Given the daily historical data resolution, daily operations model scale, and the spatial scale of the WEAP model output, a statistical model rather than a numerical model is expected to provide a sufficient level of detail for the temperature evaluation.

A least-squares regression was developed to estimate daily average water temperatures corresponding with daily project operations using historic flow, reservoir storage, water temperature, and air temperature daily data measured during the 2000 to 2014 calibration period. For the 1922 to 2002 Operations Model period of record, the resulting regression coefficients were applied using WEAP-modeled daily flow and storage data, and daily maximum historic temperature data to predict daily average water temperatures. Daily average water temperatures were summarized at selected locations corresponding to POI for each project alternative, starting with the Existing Conditions scenario.

3 Temperature Regression Methodology

This section provides an overview of the approach used to select locations for water temperature analysis and to estimate the water temperatures at these selected locations for each Project alternative.

Water temperature is influenced by a variety of factors, including reservoir storage, upstream water temperatures, previous day water temperatures, air temperatures, and flow. The relationship between these factors and water temperature is nonlinear, and changes throughout the year and throughout the project area. For this analysis, several simplifying assumptions were applied to these factors. Along several tributaries, neither historical reservoir water temperature profiles nor release water temperatures were available, so upstream reservoir storage was used, assuming a relatively strong correlation between reservoir storage and release temperature for a given month. Meteorological conditions were represented by maximum daily air temperatures, assuming maximum daily air temperatures were correlated to environmental heat flux. The magnitude of cooling and warming relative to upstream temperatures was represented by a constant component, and a component varying with flow. The constant was assumed to correlate with typical temperature changes from accretions and depletions between two points. The flow was assumed to be correlated to the relative stability against warming or cooling within a reach.

For locations directly downstream of a reservoir without historical water temperature profiles or release temperatures available, historical water temperature data in degrees Celsius, historical daily maximum air temperature data in degrees Celsius, closest historical flow data in cubic feet per second (cfs), and closest historical upstream reservoir storage data in acre-feet were used to compute regression coefficients A, B, C, D and E for the following equation:

$$T_{water} = A*Storage + B*\ln(flow) + C*T_{water,previous\ day} + D*T_{air} + E$$

For locations directly downstream from a reservoir with historical water temperature profiles available, a series of “representative” daily profiles were developed based on historically-measured water temperature profiles, and the simulated reservoir storage was converted to a water surface elevation, and the water temperature at the depth of the intake along the representative daily profile was used to represent water temperature at the inlet to the reservoir outlet. The computed inlet water temperature in degrees Celsius, historical water temperature data in degrees Celsius, historical daily maximum air temperature data in degrees Celsius, and closest historical flow data in cfs were used to compute regression coefficients A, B, C, D and E as follows:

$$T_{water} = A*\ T_{Reservoir\ Inlet} + B*\ln(flow) + C*T_{water,previous\ day} + D*T_{air} + E$$

For all locations not directly downstream of a reservoir, historical water temperature data in degrees Celsius, historical daily maximum air temperature data in degrees Celsius, and closest historical flow data in cfs were used to compute regression coefficients A, B, C, D and E as follows:

$$T_{water} = A*\ T_{water,upstream} + B*\ln(flow) + C*T_{water,previous\ day} + D*T_{air} + E$$

The least-squares method was used for this analysis. Coefficients A, B, C, D, and a constant E were optimized for each day of the year to minimize the sum of squared errors between the predicted water temperature and the measured water temperature. To allow water temperature to decrease asymptotically with flow, water temperature was assumed to vary with the natural log of flow. Water temperature was assumed to vary linearly with maximum air temperature, upstream water temperature, and upstream reservoir storage.

Calibration of regression parameters are limited by the availability of historical input data. Historical water temperature data availability typically limited the period of record for data used for calibration. Accordingly, flow, meteorological, and storage conditions represented by the regressions are limited to those observed within the available water temperature data period of record. Availability of historically measured data for storage, flow, air temperature, and water temperature are described below. Attachment A shows locations of available air and water temperature, flow, and storage data throughout the watershed. Additionally, the previous day water temperature is the calculated water temperature from the previous day, not the historical previous day temperature.

Daily maximum air temperature data were available at San Jose Airport from 1919 to 2015 from the National Climatic Data Center Climate Data Online (NCDC CDO, 2015). Daily maximum temperatures were used in the analysis due to the long, consecutive period of record available. Daily average observed air temperature values were not used in the analysis because the record was not continuous due to missing observations.

3.1 Historical Flow Data

Historical flow data were available at two USGS gages (USGS, 2015) and at fourteen District flow gages, beginning as early as 1979. Due to water temperature data availability, the period from 2000-2014 was used in model calibration and regression development. Table 3.1-1 lists locations of historical flow data, period of record, and the percentage of the calibration period for which each location has data. Most flow gages had 100% of data available for 2000-2014, but 3 gages were missing 27%-35% of the record in the calibration time period.

Table 3.1-1. Available Historical Flow Data

Location of Flow Data and Gage Number	Period of Record	Percentage of 2000–2014 Days with Data
Guadalupe River		
Above Almaden Expressway (SF23.2)	10/1/1979 - 12/31/2014	73%
At Highway 101 (USGS Gage 1169025)	5/21/2002 - 12/31/2014	84%
At St John (1169000)	10/1/1979 - 12/31/2014	65%
Guadalupe Creek		
Hicks Road (SF43)	10/1/1979 – 12/31/2014	100%
Below Guadalupe Reservoir (SF17)	10/1/1979 – 12/31/2014	100%
Los Gatos Creek		
Lark Avenue (SF59)	10/1/1979 – 12/31/2014	100%
Lincoln Avenue (SF50)	10/1/1979 – 12/31/2014	100%

Location of Flow Data and Gage Number	Period of Record	Percentage of 2000–2014 Days with Data
Alamitos Creek		
At Graystone Lane (SF70)	10/1/1979 – 12/31/2014	100%
Below Almaden Reservoir (SF16)	10/1/1979 – 12/31/2014	100%
Calero Creek		
Below Calero Reservoir (SF13)	10/1/1979 – 12/31/2014	100%
Stevens Creek		
Above Highway 85 (SF35)	10/1/1979 – 12/31/2014	100%
Below Stevens Creek Reservoir (SF44)	10/1/1979 – 12/31/2014	100%

3.2 Historical Reservoir Storage Data

Valley Water staff provided 15-minute reservoir storage data for Almaden, Calero, Lexington, Guadalupe, Anderson, and Stevens Creek reservoirs for the period October 1998 through September 2014. From these time series, end-of-day storages were used as inputs in the temperature regression. All locations had complete end-of-day storage records for the 2000-2014 time period.

3.3 Historical Water Temperature Data

District staff provided mean daily water temperature data beginning in 1997 through 2014 for selected locations throughout the study area. Within this time period, water temperature data were available for select years at certain locations. Additionally, loggers were deployed seasonally in Guadalupe and Los Gatos Creeks in late spring (April to June) and were removed each fall (October or November). As a result, many datasets had incomplete periods of record. The period between 2000 through 2014 was selected as the calibration period.

Mean daily water temperature data were used as inputs in the temperature regression. Table 3.3-1 lists locations for historical water temperature data and the percentage of days for which each location has data for the 2000-2014 calibration period. The percentage of available data points for the 2000-2014 calibration period ranged from 2% to 74%. Locations with lower data availability had only a few months to one full year of data. Locations with higher data availability had more continuous data available, but were missing data for some years or seasons.

Table 3.3-1. Locations of Historic Water Temperature Data

Location of Temperature Data	Period of Record	Percentage of 2000-2014 days with Data
Guadalupe River		
Almaden Expressway	7/13/2011 - 4/5/2013	5%
Upstream of 880	1/7/2002 - 10/15/2013	42%
Airport Parkway	4/1/2002 - 10/15/2013	32%
Downstream of Los Gatos Creek	5/1/2006 - 10/31/2007	7%
Julian	11/17/2005 - 2/23/2006	2%
Coleman	4/1/2002 - 10/15/2013	29%
St John	4/3/2010 - 10/23/2012	10%
Alamitos Drop Structure	4/1/2002 - 10/15/2013	32%
Streamgage 50	8/3/2012 - 5/13/2013	4%
Upstream of Los Gatos Creek	5/3/2002 - 10/15/2013	34%
Under Highway 85	12/16/2005 - 5/1/2006	3%
Willow Glen Way	4/1/2002 - 10/15/2013	42%
Virginia Street	12/12/2001 - 10/23/2012	49%
Woz Way	5/1/2006 - 10/15/2013	27%
Upstream of Lake Almaden	7/13/2011 - 5/13/2013	4%
Gage 23B	4/1/2003 - 10/15/2013	28%
Guadalupe Creek		
Downstream of Guadalupe Reservoir	5/3/2006 - 10/31/2007	7%
Downstream of Masson Dam	4/1/2002 - 10/15/2013	31%
Upstream of Masson Dam	5/2/2006 - 10/15/2013	27%
Gage 43	6/5/2013 - 9/8/2013	2%
Los Gatos Creek		
Downstream of Lark at JCC	7/6/2000 - 9/12/2012	59%
Upstream of Guadalupe River	4/1/2002 - 10/23/2012	28%
Campbell Avenue	1/1/2009 - 9/8/2013	20%
Lincoln Avenue	1/1/2009 - 12/31/2011	20%
Meridian	1/1/2009 - 12/31/2011	20%
Bascom	1/1/2009 - 12/31/2011	20%

Location of Temperature Data	Period of Record	Percentage of 2000-2014 days with Data
Camden	5/24/1998 - 12/31/2011	20%
Alamitos Creek		
Almaden Reservoir Outlet	6/29/2000 - 12/31/2011	58%
McKean Road Bridge	6/29/2000 -12/31/2011	30%
At Graystone Lane	4/25/2000 - 10/18/2000	3%
Upstream of Calero Confluence	6/29/2000 -12/18/2012	56%
Pfeiffer Ranch Road	6/29/2000 - 1/4/2012	46%
Downstream of Randol Creek	6/29/2000 -1/1/2012	45%
Mazzone Drive	6/29/2000 - 12/31/2011	35%
Calero Creek		
Calero Reservoir Outlet	4/22/1999 - 2/6/2008	14%
Fortini Road	4/27/1999 -2/6/2008	12%
Harry Road	6/16/2004 -2/8/2005	4%
Stevens Creek		
La Avenida	4/26/2000-3/10/2011	22%
Blackberry Farm	6/1/2009 - 5/31/2013	12%
Downstream of Fremont Avenue	6/16/2000 - 3/3/2011	46%
El Camino Real	4/26/2000 - 5/22/2013	30%
Downstream of Stevens Creek Road	4/26/2000 - 5/31/2013	73%
Upstream of Highway 280	6/16/2000- 5/31/2013	67%
Upstream of Deep Cliff	8/18/2000 - 7/13/2014	73%
SF44	6/17/2000-2/11/2013	61%
Stevens Creek Reservoir Outlet	4/26/2000 - 5/22/2014	74%

3.4 Historical Reservoir Water Temperature Profile Data

District staff provided historical reservoir profile data for Anderson, Guadalupe, and Stevens Creek reservoirs. Historical profiles were generally available for every two weeks between 2000 and 2013. Historically-measured water temperature profiles were used to generate monthly average water temperatures at discrete depths, and a time series of daily profiles was generated by applying the monthly average profile to the midpoint day of each month, and then linearly interpolating for intervening days. For example, all the historically measured profiles in June throughout the period of record for a given reservoir were used to create a single profile for June that was applied for each year on June 15. Corresponding profiles for May and July were used to linearly interpolate profiles for the other 29 days in June.

Specifics associated with each reservoir's water temperature, including depth range, intake elevation, and measurement period of record are described in Table 3.4-1.

Table 3.4-1. Summary of Historical Reservoir Water Temperature Profile Information

Reservoir	Period of Record	Maximum Measurement Depth (ft)[1]	Intake Elevation (ft)
Anderson Reservoir	6/6/2000-9/24/2013	75.5	525.0[2]
Guadalupe Reservoir	7/16/1999-2/6/2018	30.5	529.55
Stevens Creek Reservoir	5/25/1999-4/29/2009	79.2	463.77

[1] Reservoir profiles were measured in meters, but converted to feet for ease of use with reservoir water surface and elevations.

[2] Anderson Reservoir has three intakes, but a review of historical operations indicated that the middle intake at 525.0 was primarily used.

4 Temperature Regression Results

4.1 Results at Points of Interest

The ROI and POI Technical Memorandum (FAHCE Technical Workgroup, 2016) identified 35 Points of Interest (POI) where WEAP and temperature model results will be generated and evaluated. After calibrating daily regression coefficients for each location listed in Table 4.1-1, many were eliminated from further use in the analysis due to either insufficient data, poor regression fit, or redundancy with a location with more data or a better regression fit. Water temperature regressions at eliminated locations are not included in this report. POI and the gage regression assigned to that POI are listed in Table 4.1-1.

Table 4.1-1. Regressions Used in Analysis by POI

POI	POI Description	Historical Data Regression	Number of Days Used for Calibration
Guadalupe River			
GUAD7	Below Alamitos Drop Structure	Alamitos Drop Structure	1,027
GUAD6	Below Ross Creek	NO DATA AVAILABLE	
GUAD5	Above Los Gatos Creek	Virginia Street	1,348
GUAD4	At Coleman Avenue	Coleman Avenue	900
GUAD3	At San Jose Airport	Airport Parkway	1,269
GUAD2	At Montague Expressway	NO DATA AVAILABLE	
GUAD1	At Highway 237	NO DATA AVAILABLE	
Guadalupe Creek			
GCRK4	Below Guadalupe Reservoir	Downstream of Guadalupe Reservoir	2,549
GCRK3	Above Masson Dam	Upstream of Masson Dam	1,077
GCRK2	Below Masson Dam	Downstream of Masson Dam	713
GCRK1	Upstream of Lake Almaden	Upstream of Almaden Expressway	900
Los Gatos Creek			
LOSG2	Below Lower Page Drop Structure	Camden Avenue	1,094
LOSG1	Above Guadalupe River confluence	Lincoln Avenue	1,095
Alamitos Creek			
ALAM4	Below Almaden Reservoir	Almaden Reservoir Outlet	1,658
ALAM3	Above Calero Creek	Upstream of Calero Creek	1,658

POI	POI Description	Historical Data Regression	Number of Days Used for Calibration
ALAM2	Below Calero Creek	Downstream of Randol Creek	1,665
ALAM1	Above Lake Almaden	Mazzone Drive	1,657
Calero Creek			
CALE2	Below Calero Reservoir	Calero Reservoir Outlet	620
CALE1	Above Alamitos Creek	Fortini Road	528
Stevens Creek			
Outlet	Stevens Creek Reservoir	Stevens Creek Reservoir Outlet	2,675
STEV6	Below Stevens Creek Reservoir	SF44	2,160
STEV5	Above McClellan Road	Upstream of Deep Cliff	1,921
STEV4	Above Highway 280	Highway 280	2,434
STEV3	Above Fremont Avenue	Downstream of Fremont Avenue	2,115
STEV2	At Central Avenue	El Camino Real	269

Attachment B shows the locations of the historical water temperature monitoring locations used for analysis.

Several locations were missing temperature data at certain times of the year. To compensate for the missing temperature data, data from other locations were substituted to fill the gaps. Substituted data were chosen due to its similar geography and behavior to the available temperature data at the locations. Table 4.1-2 details all the data that was substituted and source of the substituted data.

Table 4.1-2. Substituted Data Used in Analysis by POI

POI	Regression Location	Dates Substituted	Data Source
Guadalupe River			
GUAD7	Alamitos Drop Structure	10/02/2009-4/23/2010 10/19/2010-4/29/2011	Los Gatos Creek-Downstream of Lark at LCC
GUAD5	Virginia Street	1/1/2009-4/2/2010 10/25/2010-4/29/2011	Los Gatos Creek- Lincoln Avenue
GUAD4	Coleman Ave	10/19/2009-4/2/2010 10/25/2010-4/29/2011	Guadalupe River upstream of Confluence with Los Gatos Creek
GUAD3	Airport Parkway	10/19/2009-4/2/2010 10/25/2010-4/29/2011 10/3/2011-4/30/2012	Coyote Creek-Mabury Road

POI	Regression Location	Dates Substituted	Data Source
Guadalupe Creek			
GCRK4	Downstream of Guadalupe Reservoir	11/1/2007-4/14/2009 10/19/2009-4/2/2010 10/25/2010-4/29/2011 10/3/2011-4/30/2012	Stevens Creek Reservoir Outlet
GCRK3	Upstream of Masson Dam	12/2/2008-4/17/2009 10/19/2009-4/4/2010	Alamitos Creek- Bertram Road
GCRK2	Downstream of Masson Dam	1. 10/19/2009-4/2/2010 2. 10/25/2010-4/29/2011	1. Alamitos Creek-Mazzone Drive minus 1°C 2. Alamitos Creek Pfeiffer Ranch Road minus 2°C
GCRK1	Upstream of Almaden Expressway	10/19/2009-4/23/2010 10/25/2010-5/23/2011	Upstream Calero Confluence
Calero Creek			
CALE2	Calero Reservoir Outlet	2/7/2008-6/30/2008	Almaden Reservoir Outlet
CALE1	Fortini Road	2/8/2005-6/30/2005	Alamitos Creek Pfeiffer Ranch Road minus 2°C
CALE2	Calero Reservoir Outlet	2/7/2008-6/30/2008	Almaden Reservoir Outlet

4.2 Temperature Regression Calibration and Uncertainty

The following section presents results of temperature regression calibrations selected for use in the POI temperature analysis, and the relative weighting of the calculation components throughout the year. The relative contribution of each of the independent variables was computed by multiplying each of the independent variables times the regression coefficient, taking the absolute value, and then dividing by the sum of all of the absolute values of the different components. For example, the storage contribution is computed as:

$$\text{Contribution}_{\text{storage}} = |A*\text{Storage}|/(|A*\text{Storage}| + |B*\ln(\text{flow})| + |C*T_{\text{water,prev day}}|+|D*T_{\text{air}}| + |E|)$$

The contribution was computed daily and then summarized to monthly for the available period of historic data.

To estimate the uncertainty inherent in the modeling assumptions, simulated water temperatures were then compared against available historic water temperature. Scatter plots of computed temperature versus measured temperature are plotted against a line with a slope of one. Points that are closer to the line have less error than points further away from the line. Uncertainty was assessed by computing the R^2, normalized root mean square error (nRMSE), and bias (or mean error).

4.2.1 Guadalupe River

Four water temperature gage locations were selected on Guadalupe River to represent seven POI. These locations were selected due to their proximity to key fisheries locations, the quantity of data available, and the quality of the fit of their regressions.

Daily regression coefficients for each POI are included in Attachment C.

4.2.1.1 GUAD7

The Guadalupe River below Alamitos Drop Structure was selected as the representative water temperature gage for GUAD7. Table 4.2-1 shows the relative contribution of each of the temperature regression components.

Table 4.2-1. Contribution of Regression Components for Guadalupe River below Alamitos Drop Structure, GUAD7

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Graystone Flow (% of Calculation)	0.02	0.03	0.02	0.03	0.00	0.00	0.02	0.01	0.02	0.01	0.01	0.01	0.01
Mazzone Temperature (% of Calculation)	0.24	0.32	0.39	0.28	0.26	0.22	0.10	0.09	0.11	0.27	0.27	0.40	0.22
Hicks Flow (% of Calculation)	0.01	0.01	0.04	0.02	0.01	0.00	0.01	0.01	0.04	0.03	0.01	0.01	0.02
Almaden Temperature (% of Calculation)	0.02	0.01	0.02	0.06	0.04	0.15	0.08	0.10	0.11	0.02	0.04	0.13	0.07
Previous Day Water Temperature (% of Calculation)	0.65	0.61	0.52	0.62	0.68	0.70	0.80	0.79	0.74	0.67	0.66	0.46	0.68
Air Temperature (% of Calculation)	0.08	0.02	0.01	0.01	0.03	0.01	0.05	0.07	0.05	0.02	0.04	0.03	0.04
Constant (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Since historical water temperature data were not available for December through April, data from Los Gatos Creek-downstream Lark Avenue were substituted from December 2008 to April 2009 and October 2009 to April 2011. Los Gatos Creek-downstream Lark Avenue was chosen due to its similar geography and behavior to the available temperature data for Guadalupe River below Alamitos Drop Structure. Additionally, Off Hicks Road (SF43) flows were used instead of Guadalupe Creek above Masson Dam (GCRK3) flows for regression development due to lack of sufficient data for GCRK3. SF43 was used due to its close proximity to GCRK3.

Overall, previous-day temperature has the highest contribution to the temperature calculations at this location. Previous day water temperature accounts for 46-80% of the temperature calculations. Mazzone upstream temperatures accounted for 9-40% of the temperature calculations. Almaden upstream temperatures accounts for 1-15% of the temperature calculations. The remaining components contribute less than 7% to the calculations throughout the year. Figure 4.2-1 shows the accuracy of the computed temperatures, relative to the measured temperatures for Guadalupe River below Alamitos Drop Structure. Table 4.2-2 shows the resulting coefficient of determination, mean error, and absolute mean error for the calibration period of record.

Figure 4.2-1. Accuracy of Computed Temperatures Relative to Measured Temperatures for Guadalupe River below Alamitos Drop Structure, GUAD7.

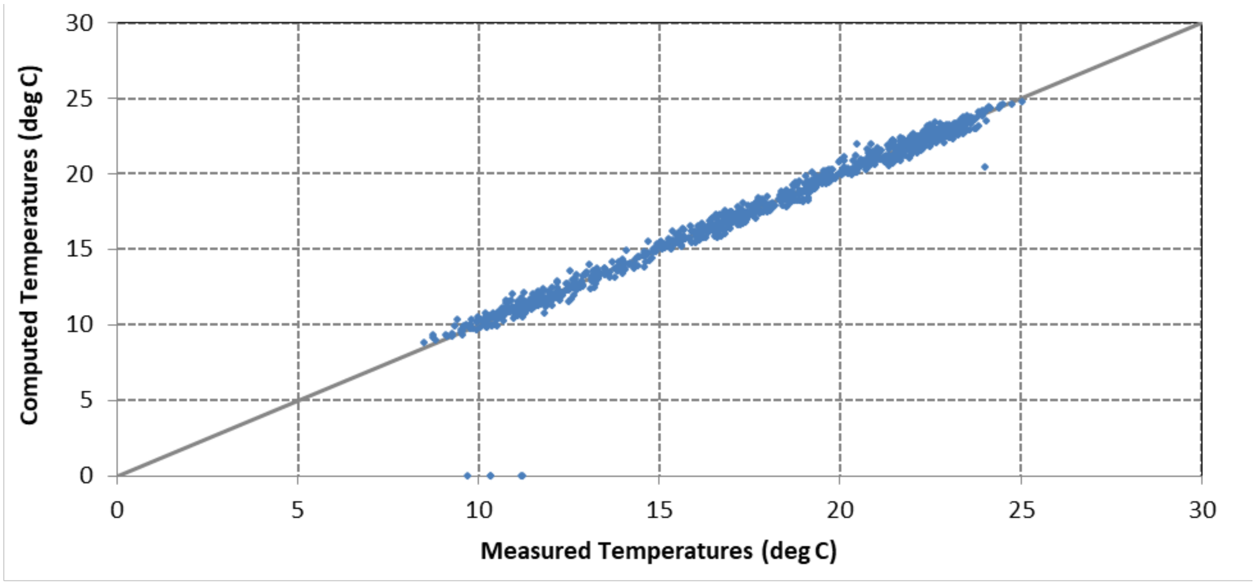
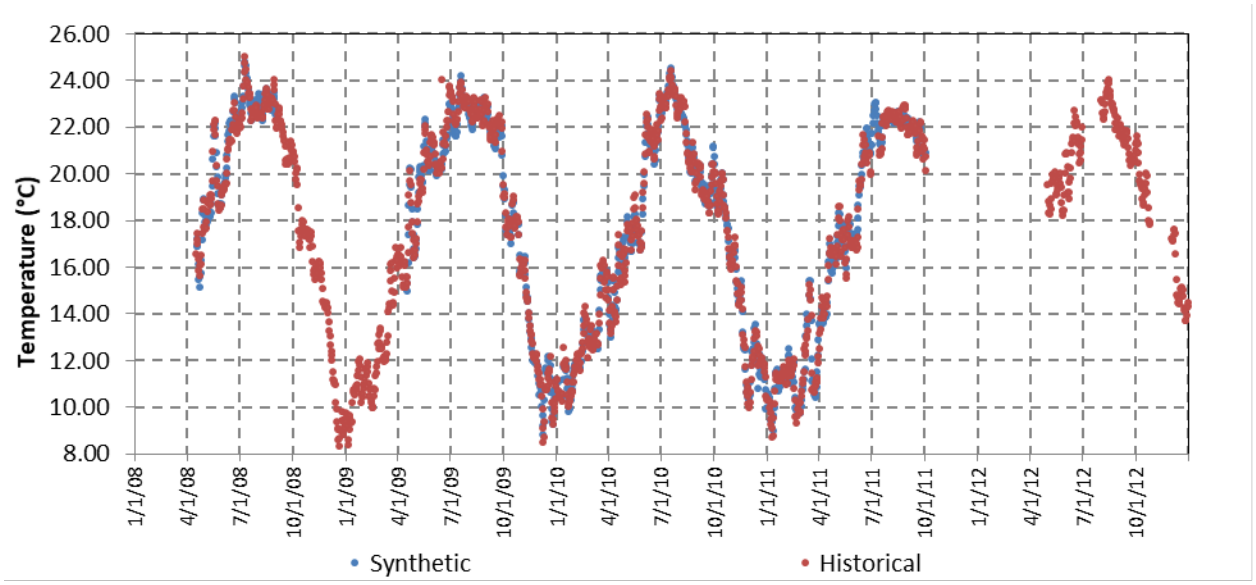


Table 4.2-2. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Guadalupe River below Alamitos Drop Structure, GUAD7, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Alamitos Drop Structure	0.98	0.02	0.32

Figure 4.2-2 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on Guadalupe River at GUAD7.

Figure 4.2-2. Guadalupe River Validation at GUAD7



Predictions of average daily temperatures on Guadalupe River at GUAD7 were within less than half a degree of measured temperatures, on average.

4.2.1.2 GUAD6

Insufficient historical water temperature data were available to estimate temperature changes near GUAD6. Regression coefficients were not developed.

4.2.1.3 GUAD5

The Guadalupe River at Virginia Street was selected as the representative water temperature location for GUAD5. Table 4.2-3 shows the relative contribution of each of the temperature regression components.

Table 4.2-3. Contribution of Regression Components for Guadalupe River above Los Gatos Creek, GUAD5

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Upstream Water Temp (% of Calculation)	0.86	0.81	0.82	0.51	0.71	0.50	0.09	0.05	0.19	0.45	0.78	0.83	0.51
Previous Day Water Temperature (% of Calculation)	0.10	0.13	0.10	0.35	0.20	0.40	0.80	0.89	0.70	0.52	0.20	0.07	0.41
Flow (% of Calculation)	0.00	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.02	0.01
Air Temperature	0.03	0.04	0.07	0.14	0.08	0.08	0.10	0.06	0.11	0.04	0.02	0.08	0.07

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
(% of Calculation)													
Constant (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Since historical water temperature data were not available for December through March, data from Los Gatos Creek-Lincoln Avenue were substituted from January 2009 to March 2010 and October 2010 to April 2011. Los Gatos Creek-Lincoln Avenue was chosen due to its similar geography and behavior to the available temperature data for Guadalupe River at Virginia Street.

Overall, upstream temperature has the highest contribution to the temperature calculations at this location. Upstream temperature accounts for 9-86% of the temperature calculations, and contribute significantly to the temperature calculations from November to April. Previous day water temperature accounts for 7-89% of the temperature calculations, and contribute significantly to the temperature calculations from June to October. Air temperature and flow typically contribute less than 14% to the calculations throughout the year. Figure 4.2-3 shows the accuracy of the computed temperatures, relative to the measured temperatures for Guadalupe River above Los Gatos Creek. Table 4.2-4 shows the resulting coefficient of determination, mean error, and absolute mean error for the calibration period of record.

Figure 4.2-3. Accuracy of Computed Temperatures Relative to Measured Temperatures for Guadalupe River above Los Gatos Creek, GUAD5

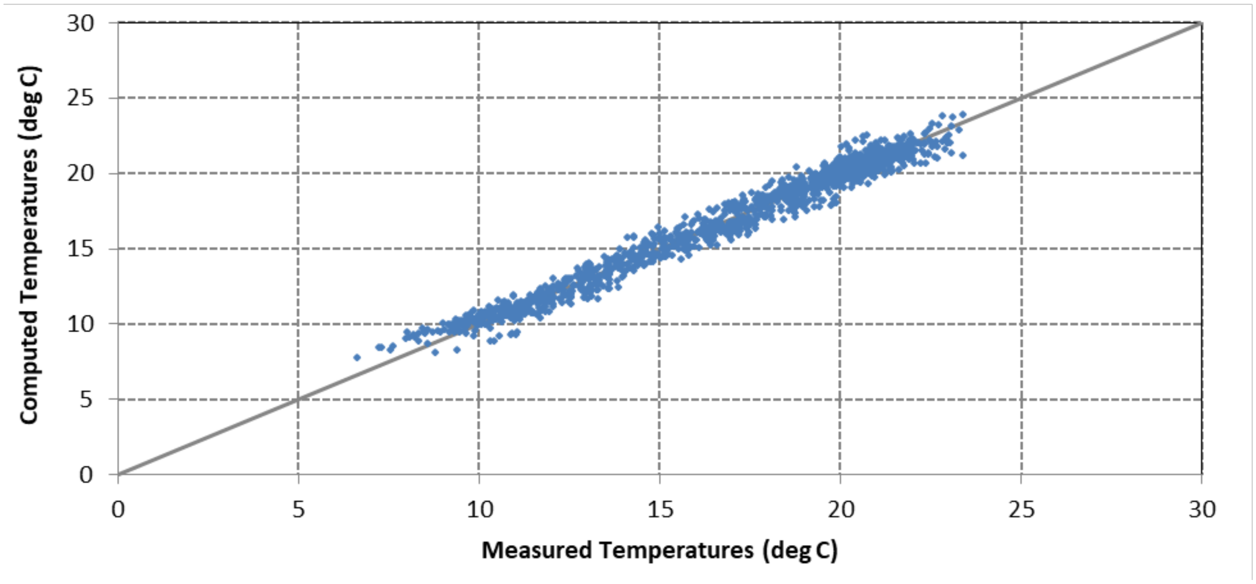
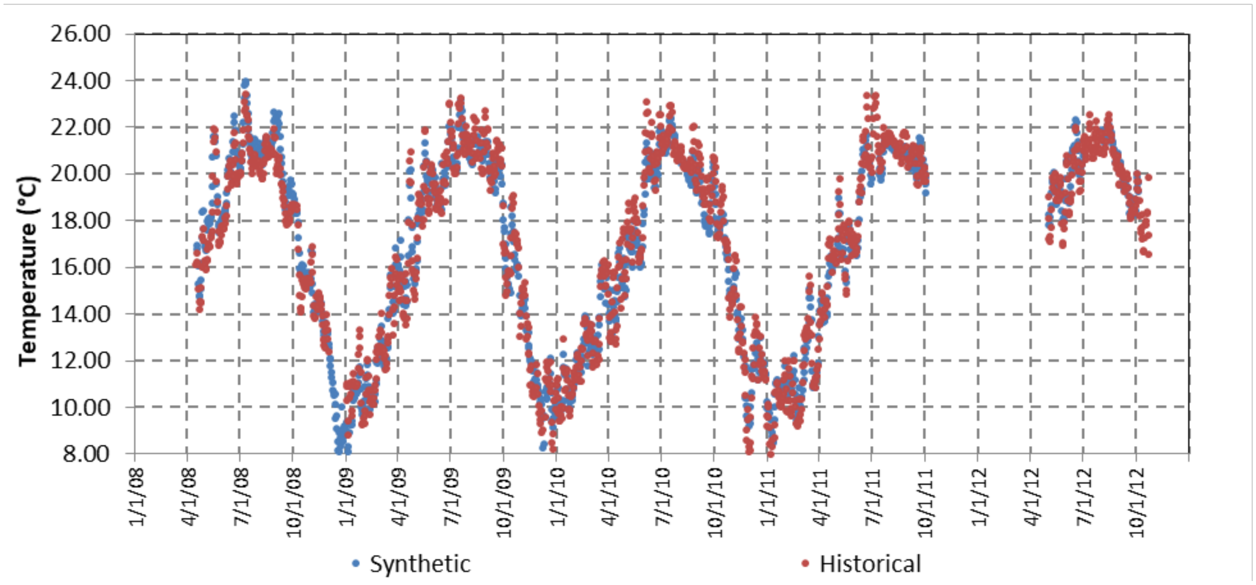


Table 4.2-4. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Guadalupe River above Los Gatos Creek, GUAD5, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Virginia Street	0.98	0.00	0.50

Figure 4.2-4 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on Guadalupe River at GUAD5

Figure 4.2-4. Guadalupe River Validation at GUAD5



Predictions of average daily temperatures on Guadalupe River at GUAD5 were within 0.5 degrees of measured temperatures, on average.

4.2.1.4 GUAD4

Guadalupe River at Coleman Avenue was selected as the representative water temperature gage for GUAD4. Table 4.2-5 shows the relative contribution of each temperature regression component.

Table 4.2-5. Contribution of Regression Components for Guadalupe River at Coleman Avenue, GUAD4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Virginia Temperature (% of Calculation)	0.09	0.15	0.28	0.41	0.25	0.70	0.84	0.80	0.22	0.03	0.12	0.05	0.37
Lincoln Temperature (% of Calculation)	0.51	0.30	0.58	0.56	0.67	0.25	0.09	0.12	0.68	0.86	0.58	0.44	0.45
Lincoln Flow (% of Calculation)	0.00	0.04	0.03	0.00	0.01	0.00	0.01	0.01	0.01	0.04	0.03	0.02	0.01
St John Flow (% of Calculation)	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Previous Day Water Temperature (% of Calculation)	0.32	0.35	0.06	0.02	0.06	0.04	0.06	0.05	0.07	0.05	0.21	0.37	0.12
Air Temperature (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Since historical water temperature data were not available for December through March, data from Los Gatos Creek-Guadalupe River upstream of Confluence with Los Gatos Creek were substituted from October 2009 to April 2010 and October 2010 to April 2011. Los Gatos Creek-Guadalupe River upstream of Confluence with Los Gatos Creek was chosen due to its similar geography and behavior to the available temperature data for Guadalupe River at Coleman Avenue.

Overall, upstream temperatures has the highest contribution to the temperature calculations at this location. Lincoln upstream temperature accounts for up to 86% of the temperature calculations. Virginia upstream temperature accounts for up to 84% of the temperature calculations. Previous day water temperature accounts for up to 37% of the temperature calculations. Air temperature and flow typically contribute less than 4% to the calculations throughout the year. Figure 4.2-5 shows the accuracy of the computed temperatures, relative to the measured temperatures for Guadalupe River at Coleman Avenue. Table 4.2-6 shows the resulting coefficient of determination, mean error and absolute mean error for the calibration period of record.

Figure 4.2-5. Accuracy of Computed Temperatures Relative to Measured Temperatures for Guadalupe River at Coleman Avenue, GUAD4

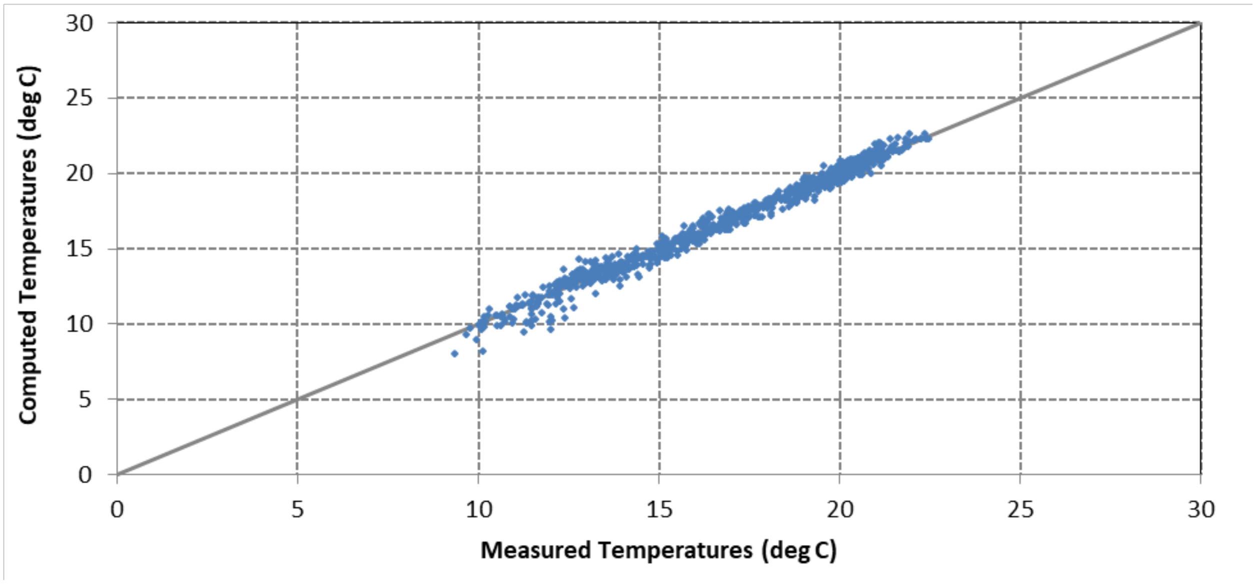
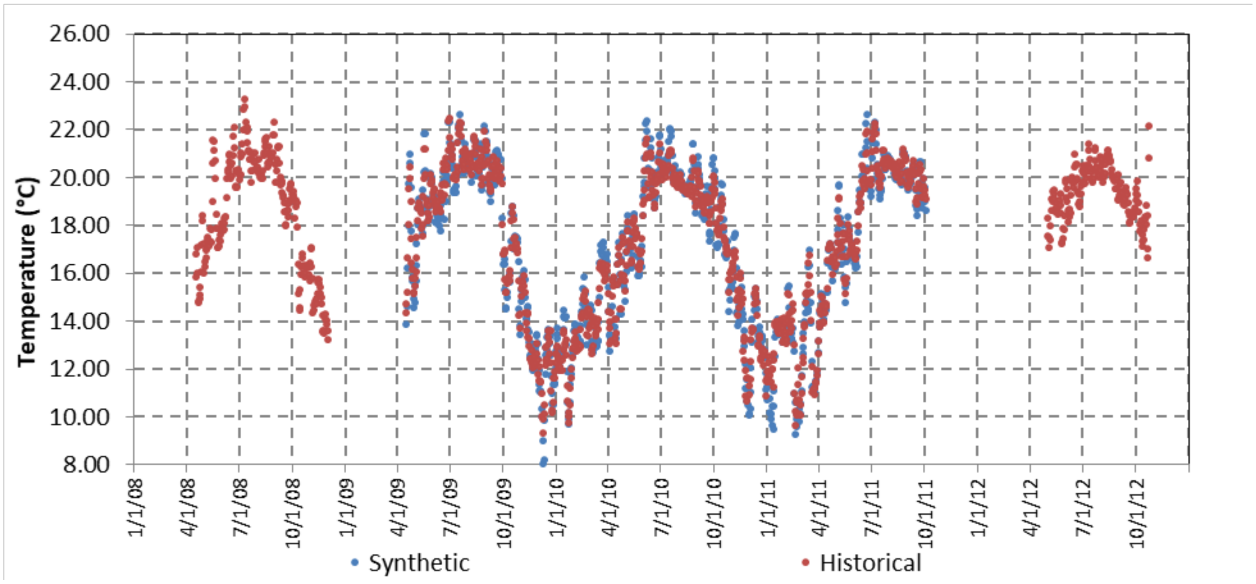


Table 4.2-6. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Guadalupe River at Coleman Avenue, GUAD4, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Coleman Avenue	0.98	-0.02	0.33

Figure 4.2-6 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on Guadalupe River at GUAD4.

Figure 4.2-6. Guadalupe River Validation at GUAD4



Predictions of average daily temperatures on Guadalupe River at GUAD4 were within 0.33 degrees of measured temperatures, on average.

4.2.1.5 GUAD3

Guadalupe River at Airport Parkway was selected as the representative water temperature gage for GUAD3. The monthly regression coefficients for GUAD3, Guadalupe River at San Jose Airport, are provided in Attachment C. Table 4.2-7 shows the relative contribution of each of the temperature regression components.

Table 4.2-7.Contribution of Regression Components for Guadalupe River at San Jose Airport, GUAD3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Upstream Water Temperature (% of Calculation)	0.73	0.78	0.54	0.77	0.88	0.86	0.82	0.78	0.66	0.84	0.41	0.65	0.75
Previous Day Water Temperature (% of Calculation)	0.17	0.09	0.34	0.17	0.05	0.05	0.13	0.10	0.28	0.13	0.48	0.28	0.17
Flow (% of Calculation)	0.07	0.05	0.05	0.03	0.03	0.06	0.02	0.10	0.05	0.02	0.09	0.05	0.05
Air Temperature (% of Calculation)	0.02	0.08	0.07	0.03	0.05	0.03	0.02	0.01	0.00	0.00	0.02	0.02	0.03
Constant (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Since historical water temperature data were not available for December through March, data from Coyote Creek-Mabury were substituted from October 2009 to April 2010, October 2010 to April 2011, and October 2011 to April 2012. Coyote Creek-Mabury was chosen due to its similar geography and behavior to the available temperature data for Guadalupe River at San Jose Airport.

Overall, upstream temperature has the highest contribution to the temperature calculations at this location. Upstream temperature accounts for 41-88% of the temperature calculations. Previous day water temperature accounts for up to 48% of the temperature calculation. Air temperature and flow contributes less than 10% to the calculations throughout the year. Figure 4.2-7 shows the accuracy of the computed temperatures, relative to the measured temperatures for Guadalupe River at San Jose Airport. Table 4.2-8 shows the resulting coefficient of determination, mean error and absolute mean error for the calibration period of record.

Figure 4.2-7. Accuracy of Computed Temperatures Relative to Measured Temperatures for Guadalupe River at San Jose Airport, GUAD3

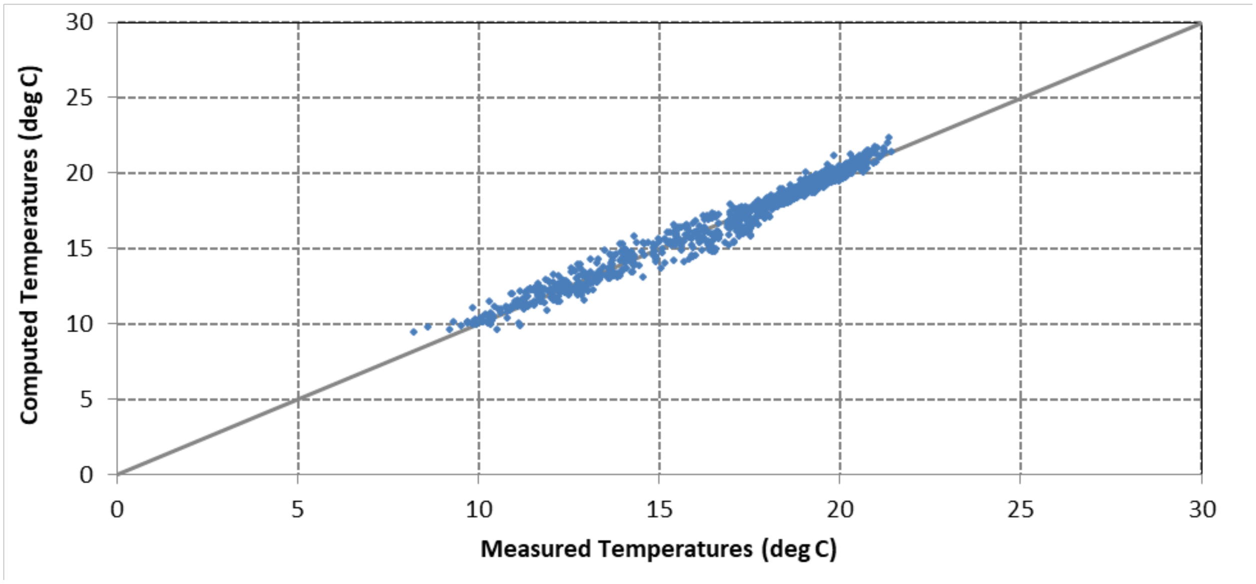
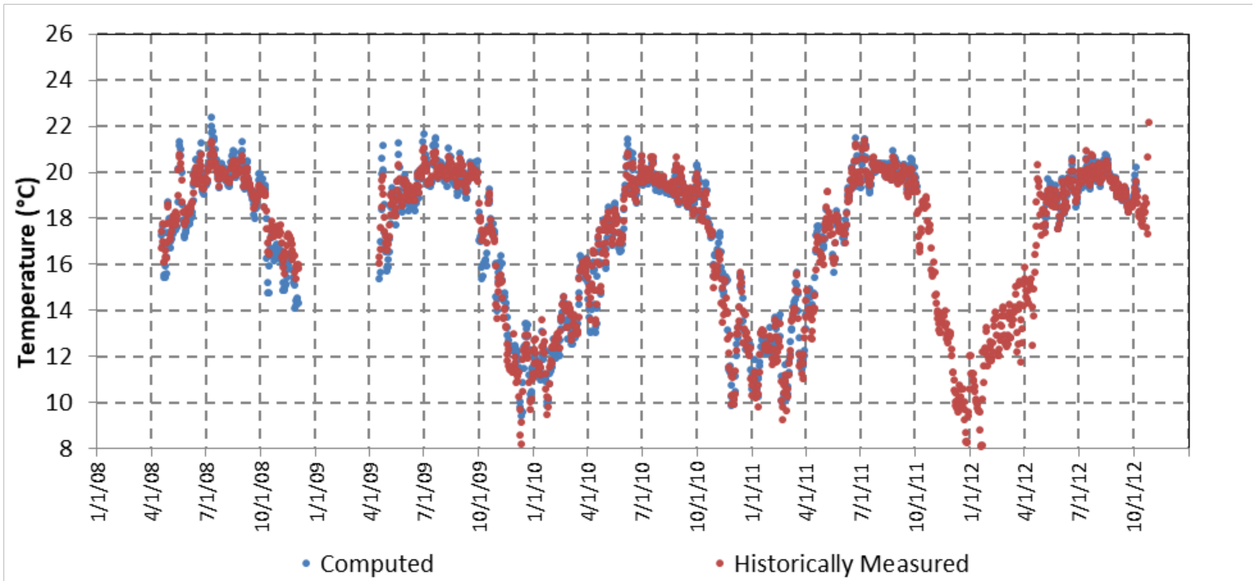


Table 4.2-8. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Guadalupe River at San Jose Airport, GUAD3, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
At Highway 237	0.98	-0.01	0.33

Figure 4.2-8 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on Guadalupe River at GUAD3.

Figure 4.2-8. Guadalupe River Validation at GUAD3



Predictions of average daily temperatures on Guadalupe River at GUAD3 were within less than 0.33 degrees of measured temperatures, on average.

4.2.1.6 GUAD2

Insufficient historical water temperature data were available to estimate temperature changes near GUAD2. Regression coefficients were not developed.

4.2.1.7 GUAD1

Insufficient historical water temperature data were available to estimate temperature changes near GUAD1. Regression coefficients were not developed.

4.2.1.8 Discussion

Since historical water temperature data were not available for December through March, data from Los Gatos Creek-Guadalupe River upstream of Confluence with Los Gatos Creek, Los Gatos Creek-Lincoln Avenue, and Coyote Creek-Mabury were substituted to fill gaps in the data.

Model uncertainty is relatively low, with R^2 of .98 at every location, bias less than +/- 0.02°C, and absolute mean error less than 0.5°C. Measured temperatures may be influenced by factors other than those modeled in the regression. Discrepancies between predicted and measured values could occur due to variables such as upstream storage in Lexington, Almaden, or Calero Reservoirs, or accretions in the vicinity of the San Jose Airport. Nevertheless, the regression for Highway 880 is expected to provide reasonable predictions for comparative purposes.

4.2.2 Guadalupe Creek

Three water temperature locations were selected on Guadalupe Creek to represent four POI: downstream of Guadalupe Reservoir, downstream of Masson Dam, and upstream of the Almaden Expressway. These three were selected due to their proximity to key fisheries locations, the quantity of data available at each location, and the quality of the fit of their respective regressions.

Daily regression coefficients for each POI are included in Attachment C.

4.2.2.1 GCRK4

Guadalupe Creek downstream of Guadalupe Reservoir was selected as the representative water temperature gage for GCRK4. Table 4.2-9 shows the relative contribution of each of the temperature regression components.

Table 4.2-9. Contribution of Regression Components for Guadalupe Creek at Guadalupe Reservoir, GCRK4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Intake Temperature (% of Calculation)	0.66	0.10	0.03	0.03	0.01	0.00	0.00	0.00	0.00	0.01	0.03	0.15	0.07
Previous Day Water Temperature (% of Calculation)	0.12	0.24	0.20	0.78	0.92	0.98	0.99	0.97	0.96	0.84	0.84	0.79	0.76
Flow (% of Calculation)	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Air Temperature (% of Calculation)	0.00	0.01	0.07	0.06	0.03	0.01	0.00	0.02	0.02	0.02	0.00	0.01	0.02
Constant (% of Calculation)	0.19	0.63	0.69	0.13	0.04	0.01	0.00	0.01	0.02	0.12	0.12	0.05	0.14

Since historical water temperature data were not available for January through March, data from Stevens Creek Outlet were substituted from November 2007 to April 2009, October 2009 to April 2010, October 2010 to April 2011, and October 2011 to April 2012. Stevens Creek Outlet was chosen due to its similar behavior to the available temperature data and reservoir characteristics.

Overall, previous day water temperature has the highest contribution to the temperature calculations at this location. Previous day temperature accounts for up to 99% of the temperature calculations. The constant accounts for 63% and 69% in February and March, and less than 19% the rest of the year. Reservoir storage, air temperature, and flow accounts for less than 15% of the temperature calculations; however, storage does account for 66% of the temperature calculation in January.

Figure 4.2-9 shows the accuracy of the computed temperatures, relative to the measured temperatures for Guadalupe Creek below Guadalupe Reservoir. Table 4.2-10 shows the resulting coefficient of determination, mean error, and absolute mean error for the calibration period of record.

Figure 4.2-9. Accuracy of Computed Temperatures Relative to Measured Temperatures for Guadalupe Creek below Guadalupe Reservoir, GCRK4

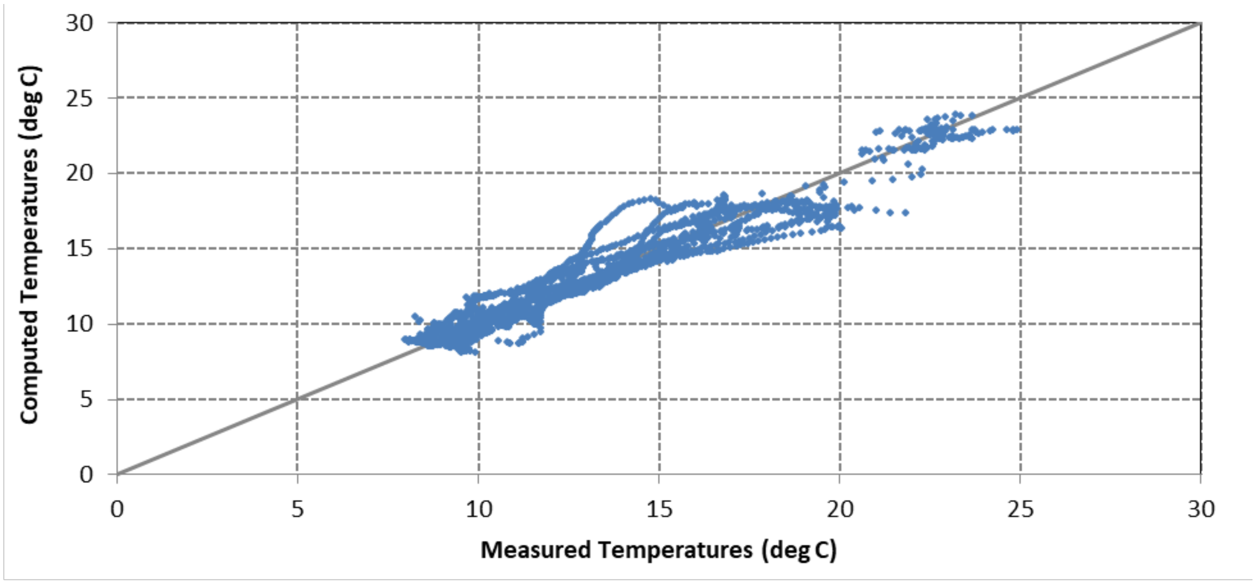
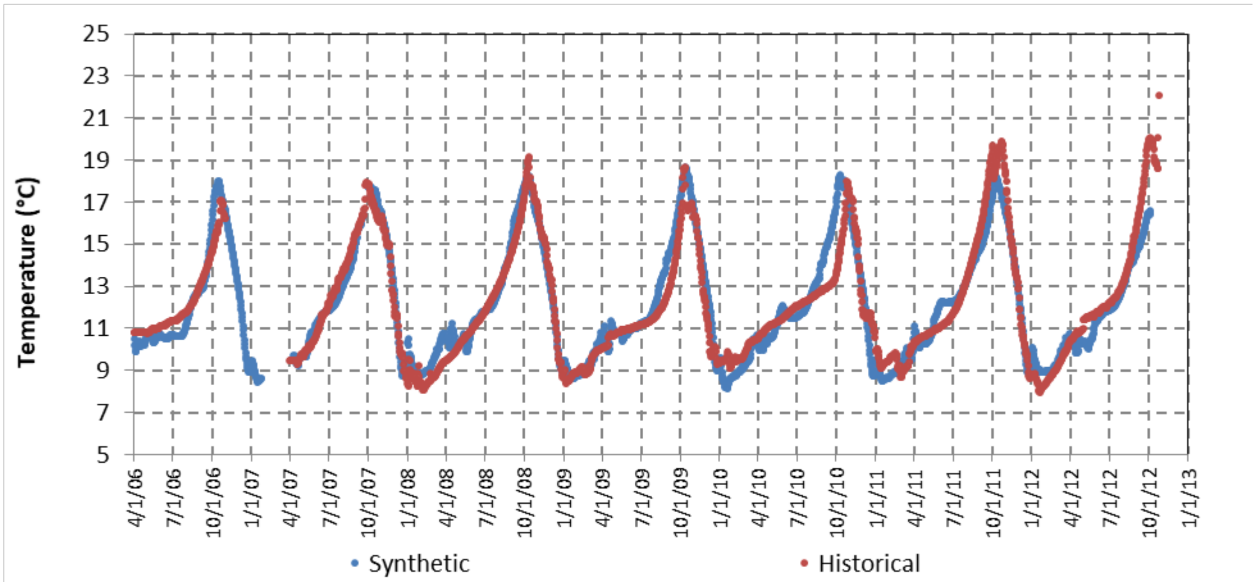


Table 4.2-10. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Guadalupe Creek below Guadalupe Reservoir, GCRK4, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Downstream of Guadalupe Reservoir	0.93	-0.01	0.68

Figure 4.2-10 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on Guadalupe Creek at GCRK4.

Figure 4.2-10. Guadalupe Creek Validation at GCRK4



Predictions for GCRK4 are within 0.68 degrees of measured values, on average.

4.2.2.2 GCRK3

Guadalupe Creek upstream of Masson Dam was selected as the representative water temperature gage for GCRK3. Table 4.2-11 shows the relative contribution of each of the temperature regression components.

Table 4.2-11. Contribution of Regression Components for Guadalupe Creek above Masson Dam, GCRK3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Upstream Water Temperature (% of Calculation)	0.66	0.15	0.67	0.47	0.23	0.32	0.65	0.89	0.60	0.51	0.78	0.72	0.56
Previous Day Water Temperature (% of Calculation)	0.23	0.73	0.15	0.29	0.49	0.46	0.07	0.03	0.06	0.03	0.05	0.10	0.21
Flow (% of Calculation)	0.10	0.04	0.01	0.05	0.06	0.08	0.11	0.04	0.05	0.27	0.14	0.02	0.08
Air Temperature (% of Calculation)	0.01	0.08	0.17	0.19	0.22	0.14	0.17	0.04	0.29	0.19	0.04	0.16	0.14
Constant (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Since historical water temperature data were not available for January through March, data from Alamitos Creek-Bertram Road were substituted from December 2008 to April 2009 and October 2009 to April 2010. Alamitos Creek-Bertram Road was chosen due to its similar geography and behavior to the available temperature data for Guadalupe Creek upstream Masson Dam.

Overall, upstream water temperature has the highest contribution to the calculations at this location. The temperature calculations are the most sensitive to previous day water temperature in January through June. Flow contributes less than 14% to the calculations throughout the year, however flow accounts for 27% of the temperature calculation in October. Air temperature accounts for 1-29% of the of the temperature calculations. Figure 4.2-11 shows the accuracy of the computed temperatures, relative to the measured temperatures for Guadalupe Creek upstream of Masson Dam. Table 4.2-12 shows the resulting coefficient of determination, mean error, and absolute mean error for the calibration period of record.

Figure 4.2-11. Accuracy of Computed Temperatures Relative to Measured Temperatures for Guadalupe Creek above Masson Dam, GCRK3

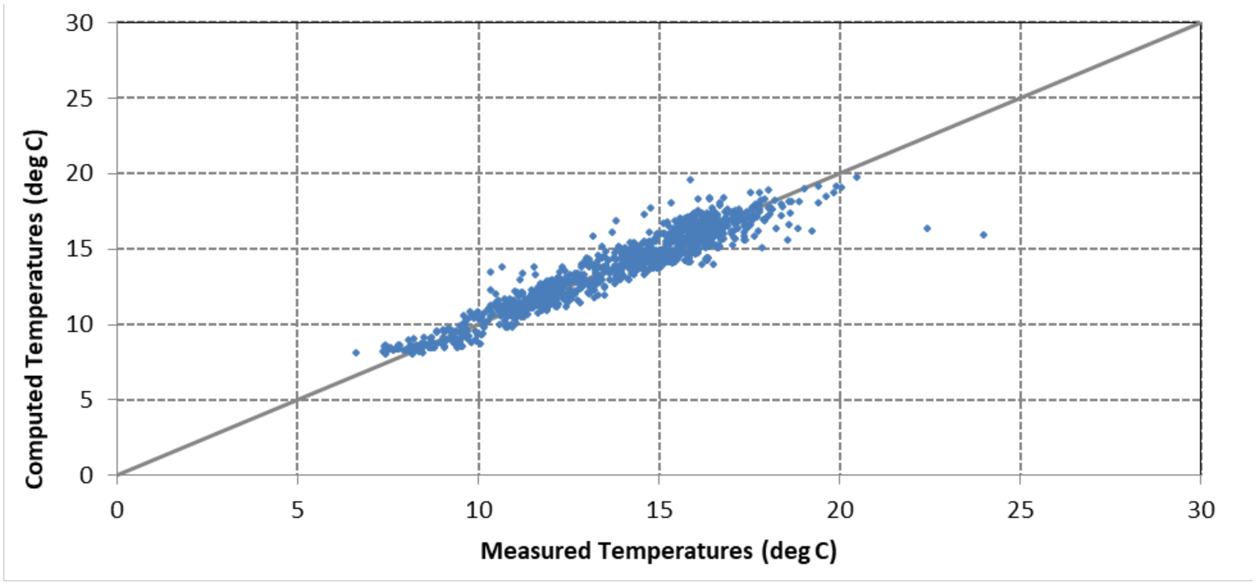
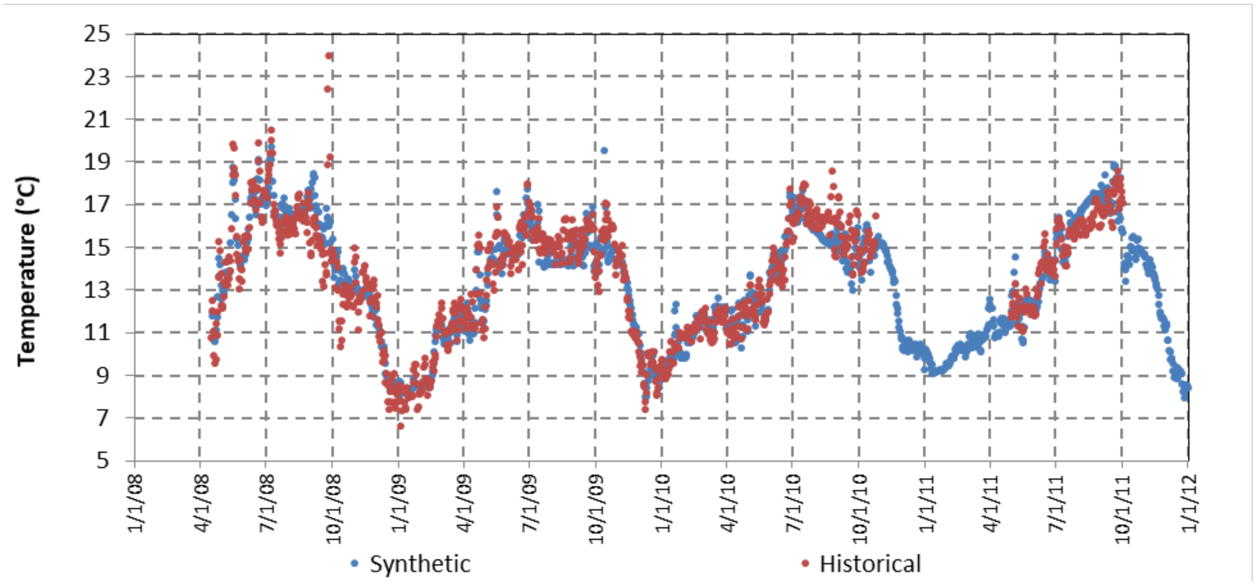


Table 4.2-12. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Guadalupe Creek above Masson Dam, GCRK3, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Upstream of Masson Dam	0.90	0.71	0.72

Figure 4.2-12 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on Guadalupe Creek at GCRK3.

Figure 4.2-12. Guadalupe Creek Validation at GCRK3



Average water temperature predictions were within 0.72 degrees of measured temperatures, on average. These discrepancies are likely due to the Masson diversion and groundwater recharge occurring between the flow node (Hicks Road, SF43) and the confluence with Alamitos.

4.2.2.3 GCRK2

Guadalupe Creek downstream of Masson Dam was selected as the representative water temperature gage for GCRK2. Table 4.2-13 shows the relative contribution of each of the temperature regression components.

Table 4.2-13. Contribution of Regression Components for Guadalupe Creek below Masson Dam, GCRK2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Upstream Water Temperature (% of Calculation)	0.81	0.77	0.76	0.95	0.98	0.96	0.96	0.98	0.97	0.95	0.81	0.89	0.93
Previous Day Water Temperature (% of Calculation)	0.05	0.12	0.07	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Flow (% of Calculation)	0.10	0.06	0.08	0.02	0.00	0.02	0.01	0.01	0.01	0.02	0.15	0.07	0.03
Air Temperature (% of Calculation)	0.01	0.05	0.09	0.02	0.01	0.02	0.02	0.01	0.02	0.03	0.04	0.03	0.02

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Constant (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Since historical water temperature data were not available for January through March, data from Alamitos Creek-Pfeiffer Ranch Road, was substituted from October 2009 to April 2010 and October 2010 to April 2011. The temperatures from Pfeiffer Ranch Road were subtracted by 2℃ to more accurately reflect downstream Masson Dam temperatures. Alamitos Creek- Pfeiffer Ranch Road was chosen due to its similar geography and behavior to the available temperature data for Guadalupe Creek downstream Masson Dam.

Overall, upstream water temperature has the highest contribution to the calculations at this location. Upstream water temperature accounts for 76-98% of the temperature calculations. Previous day water temperature, flow, and air temperature each contribute less than 15% to the temperature calculations throughout the year. The historic flow data used in the regression downstream of Masson Dam is the same as the historic flow data used upstream of Masson Dam, and therefore the flow term does not capture the differences in temperature between the two locations due to diversions.

Figure 4.2-13 shows the accuracy of the computed temperatures, relative to the measured temperatures for Guadalupe Creek below Masson Dam. Table 4.2-14 shows the resulting coefficient of determination, mean error, and absolute mean error for the calibration period of record.

Figure 4.2-13. Accuracy of Computed Temperatures Relative to Measured Temperatures for Guadalupe Creek below Masson Dam, GCRK2

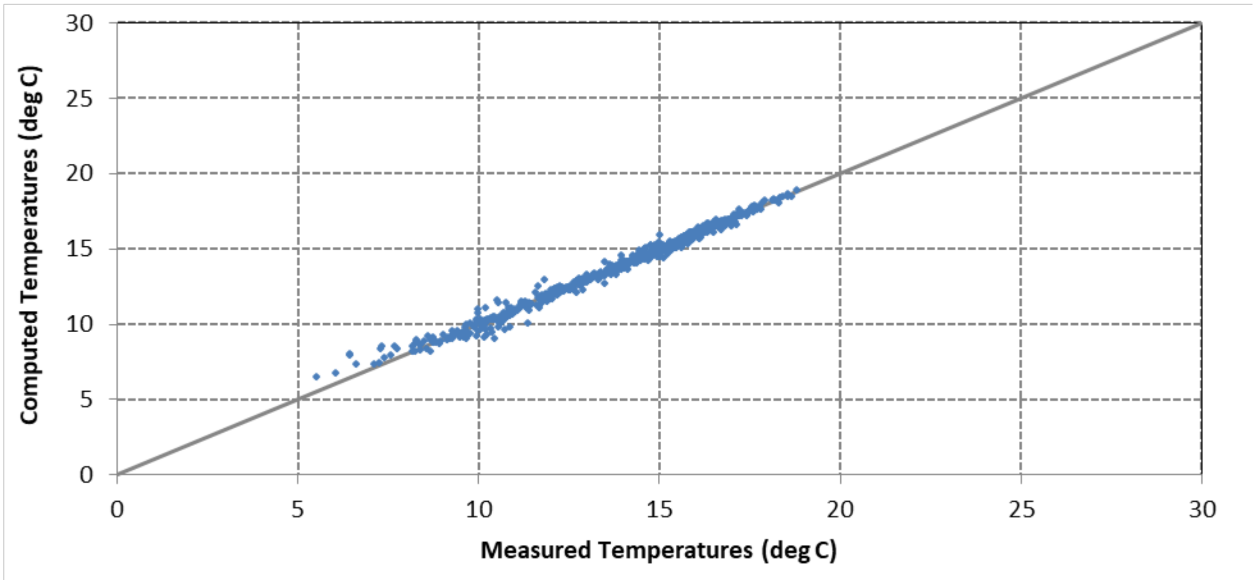
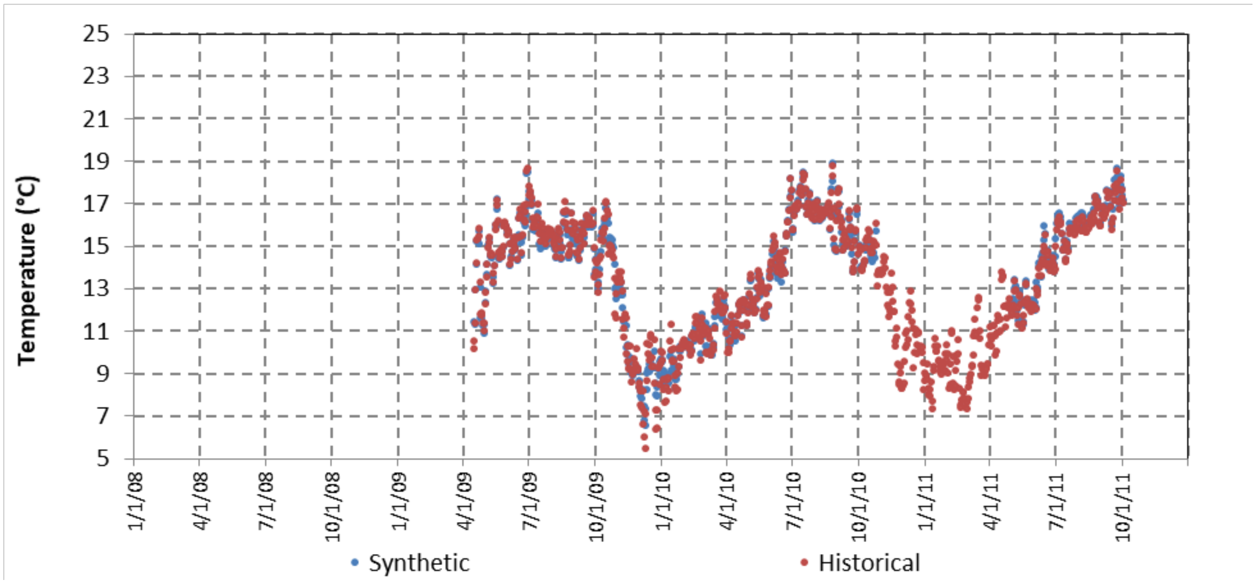


Table 4.2-14. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Guadalupe Creek below Masson Dam, GCRK2, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Downstream of Masson Dam	0.99	0.00	0.19

Figure 4.2-14 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on Guadalupe Creek at GCRK2

Figure 4.2-14. Guadalupe Creek Validation at GCRK2



Average daily water temperature predictions at GCRK2 are within 0.19 degrees of the measured water temperatures at GCRK2, on average.

4.2.2.4 GCRK1

Guadalupe Creek upstream of the Almaden Expressway was selected as the representative water temperature gage for GCRK1. Table 4.2-15 shows the relative contribution of each of the temperature regression components.

Table 4.2-15. Contribution of Regression Components for Guadalupe Creek upstream of Lake Almaden, GCRK1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Upstream Water Temperature (% of Calculation)	0.77	0.76	0.18	0.82	0.82	0.87	0.90	0.86	0.92	0.93	0.84	0.76	0.80
Previous Day Water Temperature (% of Calculation)	0.17	0.18	0.65	0.13	0.05	0.02	0.01	0.02	0.02	0.02	0.05	0.19	0.11
Flow (% of Calculation)	0.03	0.02	0.01	0.02	0.03	0.05	0.08	0.08	0.02	0.05	0.10	0.04	0.04

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Air Temperature (% of Calculation)	0.02	0.05	0.16	0.03	0.10	0.06	0.01	0.04	0.04	0.01	0.00	0.01	0.05
Constant (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Since historical water temperature data were not available for January through March, data from Alamitos Creek-Mazzone Drive were substituted from October 2009 to April 2010 and October 2010 to April 2011. The temperatures from Mazzone Drive were subtracted by 1℃ to more accurately reflect Almaden Expressway temperatures. Alamitos Creek-Mazzone Drive was chosen due to its similar geography and behavior to the available temperature data for Almaden Expressway.

Overall, upstream water temperature has the highest contribution to the calculations at this location, contributing 76-93% to the temperature calculations in most months. Previous day water temperature accounts for less than 19% of temperature calculations in most months; however, previous day temperatures account for 65% of the temperature calculations in March. Flow and air temperature each contribute less than 10% to the temperature calculations throughout the year. Air temperature influences 16% of the temperature calculations in March. The historic flow data used in the regression upstream of Lake Almaden is the same as the historic flow data used upstream and downstream of Masson Dam, and therefore the flow term does not capture the differences in temperature between the two locations due to accretions and depletions.

Figure 4.2-15 shows the accuracy of the computed temperatures, relative to the measured temperatures for Guadalupe Creek upstream of Lake Almaden. Table 4.2-16 shows the resulting coefficient of determination, mean error and absolute mean error for the calibration period of record.

Figure 4.2-15. Accuracy of Computed Temperatures Relative to Measured Temperatures for Guadalupe Creek upstream of Lake Almaden, GCRK1

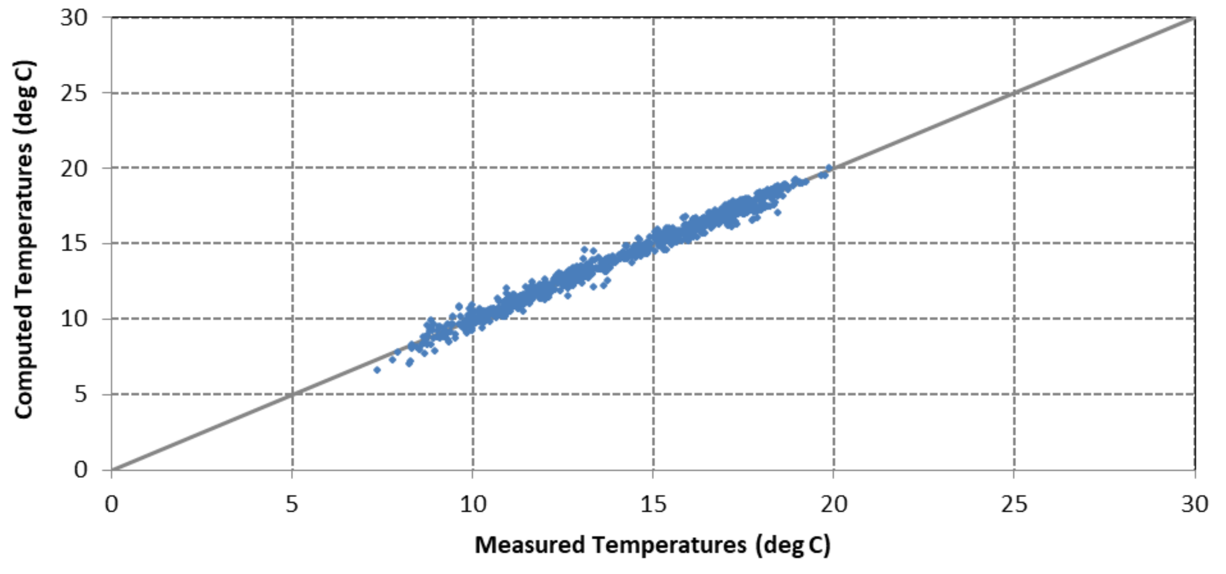
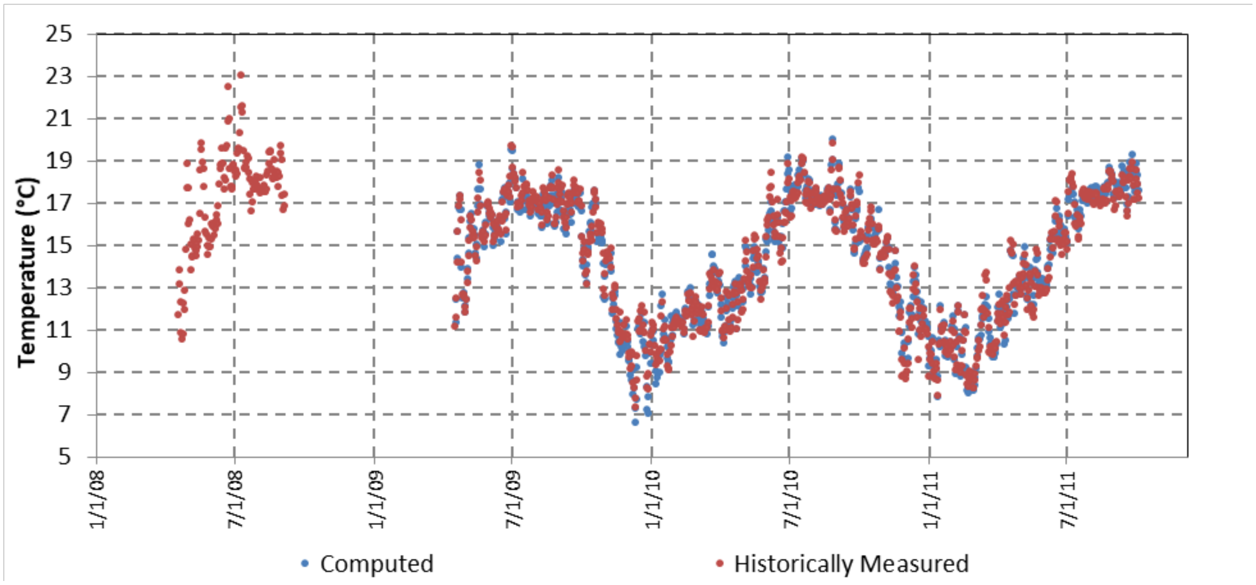


Table 4.2-16. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Guadalupe Creek upstream of Lake Almaden, GCRK1, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Upstream of Almaden Expressway	0.98	0.01	0.29

Figure 4.2-16 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on Guadalupe Creek at GCRK1

Figure 4.2-16. Guadalupe Creek Validation at GCRK1



Average water temperature predictions at GCRK1 were within 0.29 degrees of measured temperatures, on average. These discrepancies are likely due to the Masson diversion and groundwater recharge occurring between the flow node (Hicks Road, SF43) and the confluence with Alamitos.

4.2.2.5 Discussion

Nine years of water temperature data were collected on Guadalupe Creek, with no data available in November through March. Since historical water temperature data were not available for certain months, data from Alamitos Creek and Stevens Creek were substituted to fill gaps in the data.

Of the Guadalupe Creek regressions, the regression for GCRK2 (below Masson Dam) is the strongest, with R^2 of 0.99. Overall, Guadalupe Creek regressions have R^2 above 0.90. Major discrepancies in the temperature calculations are likely to occur in months where missing temperature data were substituted. Model uncertainty is relatively low, with all biases less than +/- 0.1°C and absolute mean errors less than 1°C.

4.2.3 Los Gatos Creek

Two water temperature gage locations were selected on Los Gatos Creek to represent two POI: Lincoln Avenue and Camden Avenue. These locations were selected due to their proximity to key fisheries locations LOSG2 and LOSG1, the quantity of data available at each location, and the quality of the fit of their respective regressions.

Daily regression coefficients for each POI are included in Attachment C.

4.2.3.1 LOSG2

Los Gatos Creek at Camden Avenue was selected as the representative water temperature gage for LOSG2. Table 4.2-17 shows the relative contribution of each of the temperature regression components.

Table 4.2-17. Contribution of Regression Components for Los Gatos Creek below the Lower Page Drop Structure, LOSG2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Previous Day Water Temperature (% of Calculation)	0.78	0.89	0.78	0.72	0.66	0.81	0.74	0.52	0.71	0.85	0.56	0.19	0.69
Flow (% of Calculation)	0.01	0.00	0.01	0.02	0.01	0.02	0.01	0.00	0.00	0.01	0.05	0.02	0.01
Air Temperature (% of Calculation)	0.05	0.04	0.16	0.10	0.19	0.12	0.07	0.02	0.09	0.11	0.11	0.32	0.11
Constant (% of Calculation)	0.16	0.06	0.05	0.16	0.13	0.05	0.18	0.46	0.19	0.03	0.28	0.47	0.18

Overall, the calculation at this location is driven primarily by previous day water temperature. Since this location is substantially downstream from Lexington Reservoir, and the intervening reservoir on Los Gatos Creek, Vasona Reservoir, is not operated in the WEAP model, there is no upstream water temperature or boundary condition for this location. Flow contributes 5% or less to the calculations throughout the year. Air temperature accounts for less than 19% for the majority of the year with contributions of 32% in December. The constant accounts for less than 19% of the temperature calculations throughout the year, however constants account for 46% and 47% of the calculations in August and December. Figure 4.2-17 shows the accuracy of the computed temperatures, relative to the measured temperatures for Los Gatos Creek below the Lower Page Drop Structure. Table 4.2-18 shows the resulting coefficient of determination, mean error and absolute mean error for the calibration period of record.

Figure 4.2-17. Accuracy of Computed Temperatures Relative to Measured Temperatures for Los Gatos Creek below the Lower Page Drop Structure, LOSG2

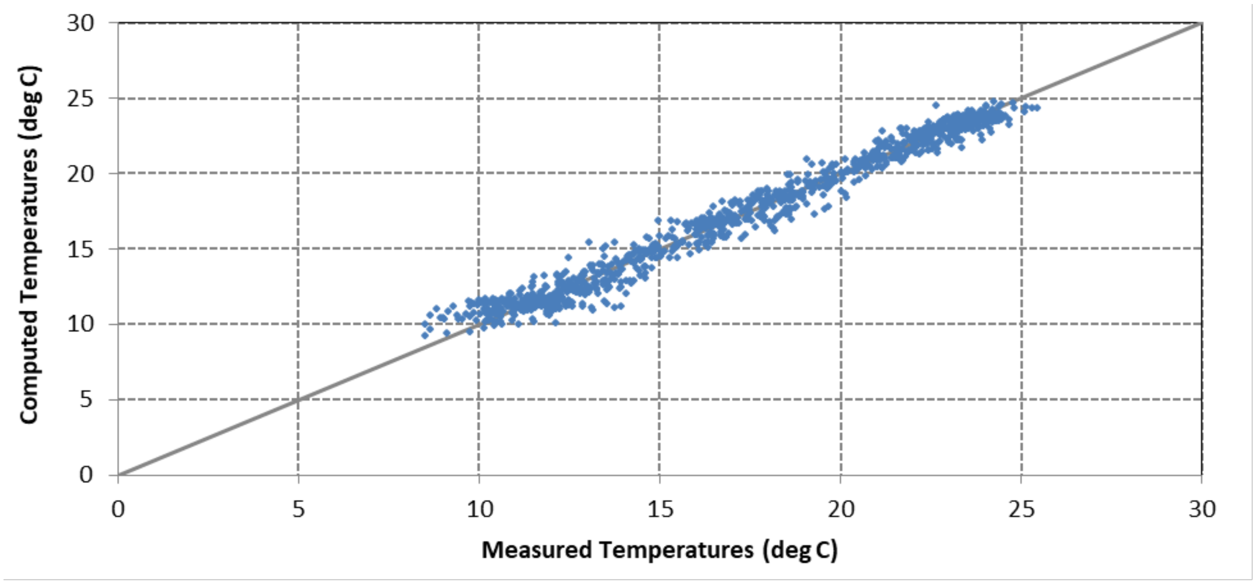
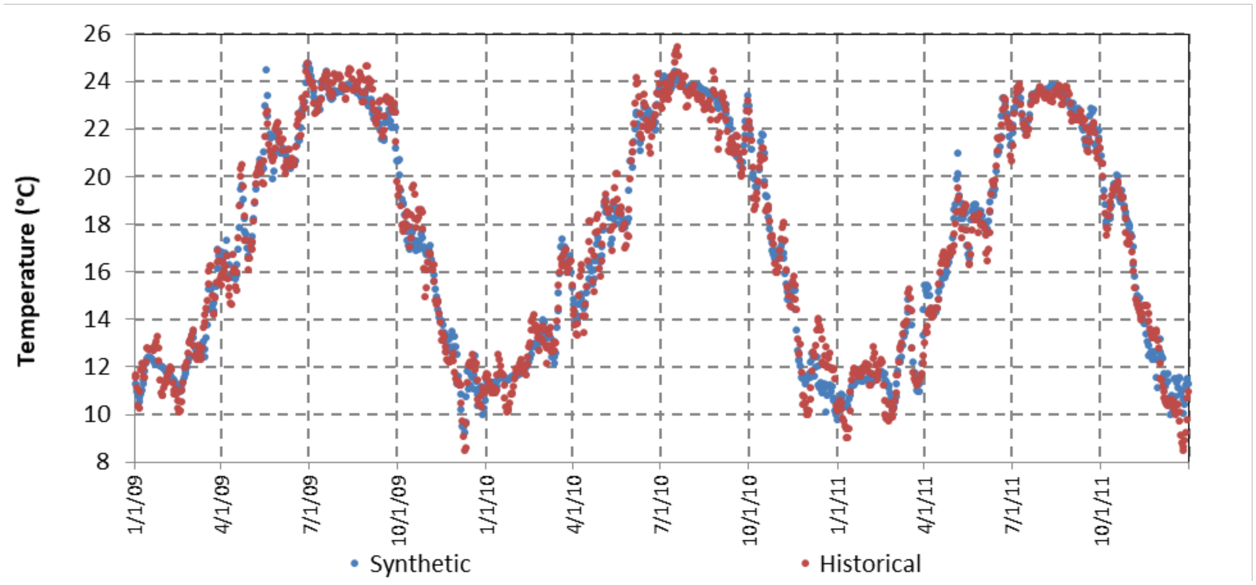


Table 4.2-18. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Los Gatos Creek below Lower Page Drop Structure, LOSG2, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Camden Avenue	0.98	0.00	0.54

Figure 4.2-18 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on Los Gatos Creek at LOSG2.

Figure 4.2-18. Los Gatos Creek Validation at LOSG2



Predictions of average daily temperatures at LOSG2 were within 0.54 degrees of measured temperatures, on average.

4.2.3.2 LOSG1

Los Gatos Creek at Lincoln Avenue was selected as the representative water temperature gage for LOSG1. Table 4.2-19 shows the relative contribution of each of the temperature regression components.

Table 4.2-19. Contribution of Regression Components for Los Gatos Creek below the Lower Page Drop Structure, LOSG2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Upstream Water Temp (% of Calculation)	0.75	0.83	0.84	0.44	0.54	0.22	0.39	0.80	0.72	0.85	0.81	0.73	0.66
Previous Day Water Temperature (% of Calculation)	0.15	0.10	0.12	0.39	0.27	0.55	0.45	0.15	0.24	0.11	0.14	0.16	0.24
Flow (% of Calculation)	0.02	0.02	0.01	0.03	0.03	0.04	0.04	0.03	0.03	0.02	0.01	0.02	0.03
Air Temperature (% of Calculation)	0.08	0.05	0.03	0.14	0.16	0.18	0.12	0.02	0.01	0.02	0.05	0.08	0.08
Constant (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Overall, upstream temperature has the highest contribution to the calculations at this location. Flow contributes 4% or less to the calculations throughout the year. Previous day water temperature accounts for 10-55% of the temperature calculations. Air temperature accounts for up to 18% of the calculations, with the highest contributions in April through July. Figure 4.2-19 shows the accuracy of the computed temperatures, relative to the measured temperatures for Los Gatos Creek above the Guadalupe River Confluence. Table 4.2-20 shows the resulting coefficient of determination, mean error and absolute mean error for the calibration period of record.

Figure 4.2-19. Accuracy of Computed Temperatures Relative to Measured Temperatures for Los Gatos Creek above the Guadalupe River Confluence, LOSG1

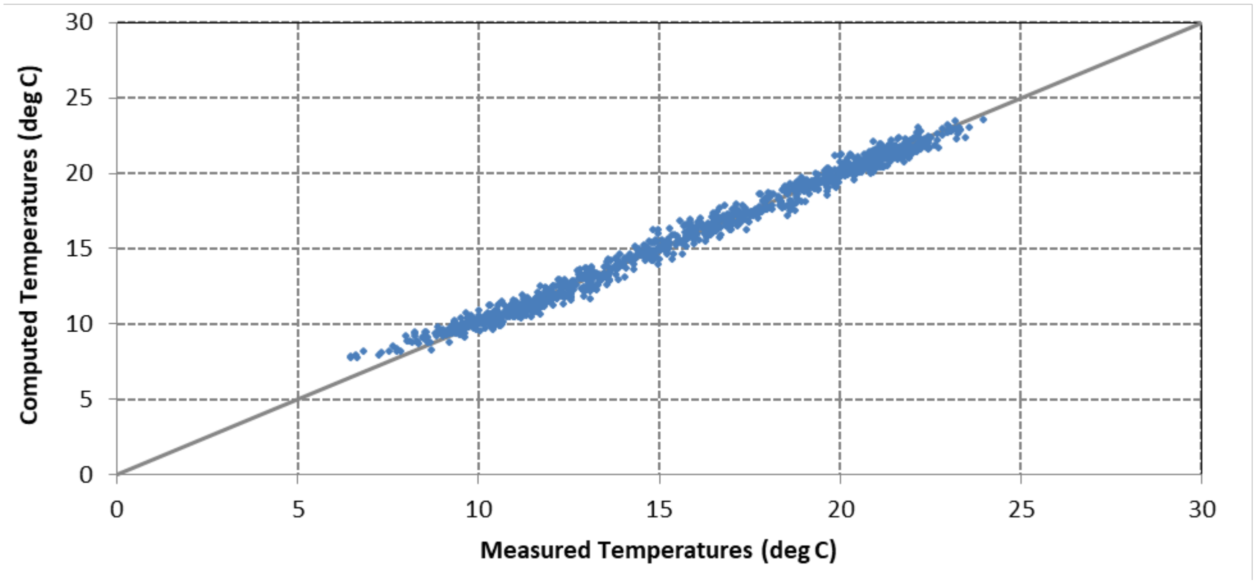
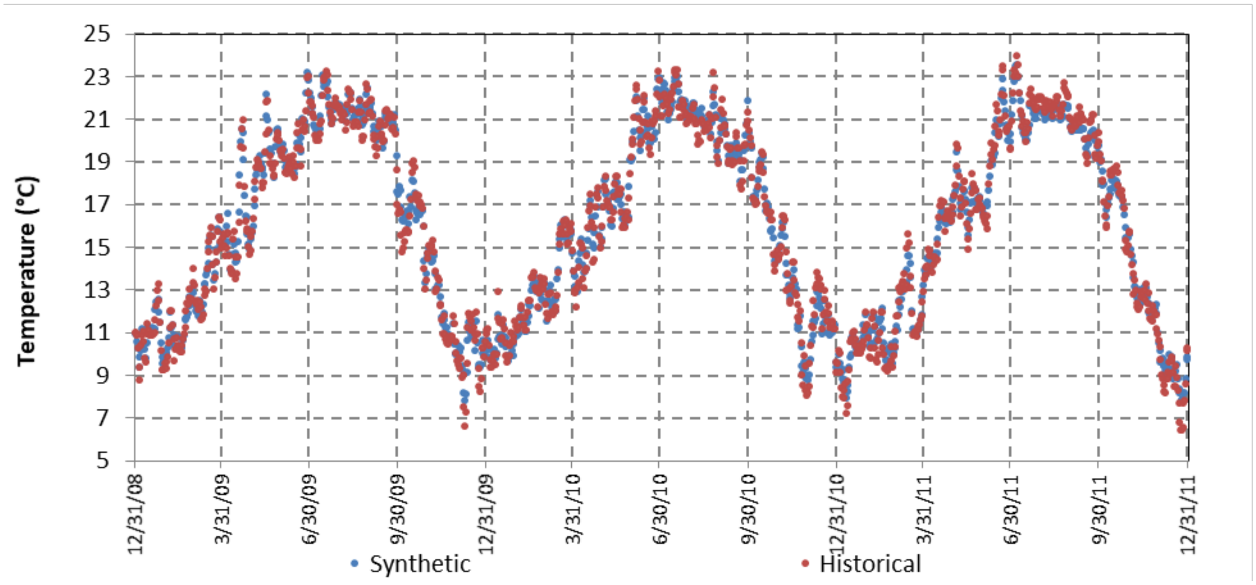


Table 4.2-20. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Los Gatos Creek above Guadalupe River confluence, LOSG1, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Lincoln Avenue	0.99	0.01	0.38

Figure 4.2-20 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on Los Gatos Creek at LOSG1

Figure 4.2-20. Los Gatos Creek Validation at LOSG1



Predictions of average daily temperatures at LOSG1 were within a half degree of measured temperatures, on average.

4.2.3.3 Discussion

The LOSG1 and LOSG2 regressions bias is low, less than +/- 0.1°C, and the absolute mean error is less than 1°C indicating a relatively low level of model uncertainty. Although there is no pronounced lower or upper limit, measured temperatures may be influenced by factors other than those modeled in the regression, including Vasona Reservoir, local accretions, and groundwater recharge. Nevertheless, the regressions for Los Gatos Creek are relatively strong, with R^2 of 0.98 to 0.99 and 4 to 7 years of data.

4.2.4 Alamitos Creek

Four temperature gages were selected on Alamitos Creek to represent four POI: the Almaden Reservoir outlet, Upstream of Calero Creek, Downstream of Randol Creek, and Mazzone Drive. These four were selected due to their proximity to key fisheries locations, the quantity of data available at each location, and the quality of the fit of their respective regressions. The gage Downstream of Randol Creek was selected to represent temperatures at ALAM2, Alamitos Creek below Calero Creek, and the gage at Mazzone Drive was selected to represent temperatures at ALAM1, Alamitos Creek above Lake Almaden.

Daily regression coefficients for each POI are included in Attachment C.

4.2.4.1 ALAM4

Alamitos Creek at the Almaden Reservoir Outlet was selected as the representative water temperature gage for ALAM4. Table 4.2-21 shows the relative contribution of each of the temperature regression components.

Table 4.2-21. Contribution of Regression Components for Alamitos Creek below Almaden Reservoir, ALAM4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Previous Day Water Temperature (% of Calculation)	0.98	0.97	0.96	0.95	0.91	0.45	0.04	0.17	0.72	0.96	0.92	0.91	0.72
Flow (% of Calculation)	0.01	0.00	0.00	0.00	0.00	0.05	0.07	0.18	0.05	0.01	0.01	0.00	0.04
Air Temperature (% of Calculation)	0.01	0.01	0.00	0.01	0.01	0.03	0.01	0.02	0.01	0.01	0.03	0.06	0.02
Constant (% of Calculation)	0.01	0.02	0.03	0.03	0.07	0.47	0.88	0.63	0.22	0.01	0.05	0.03	0.23

Overall, previous day water temperature has the highest contribution to the calculations at this location, and contributes up to 98% throughout the year. A review of the quality of fit of the regression with and without a storage term indicated a better, more resilient fit when storage was excluded, so there is no upstream water temperature or boundary condition for this location. Flow contributes to less than 7% to the temperature calculations throughout the year, but accounts for 18% of the calculations in August. Air temperature contributes less than 6% to the calculations. The constant accounts for less than 7% of the temperature calculations except in June through September when contributions range from 22-88%. Figure 4.2-21 shows the accuracy of the computed temperatures, relative to the measured temperatures for Alamitos Creek below Almaden Reservoir. Table 4.2-22 shows the resulting coefficient of determination, mean error, and absolute mean error for the calibration period of record.

Figure 4.2-21. Accuracy of Computed Temperatures Relative to Measured Temperatures for Alamitos Creek below Almaden Reservoir, ALAM4

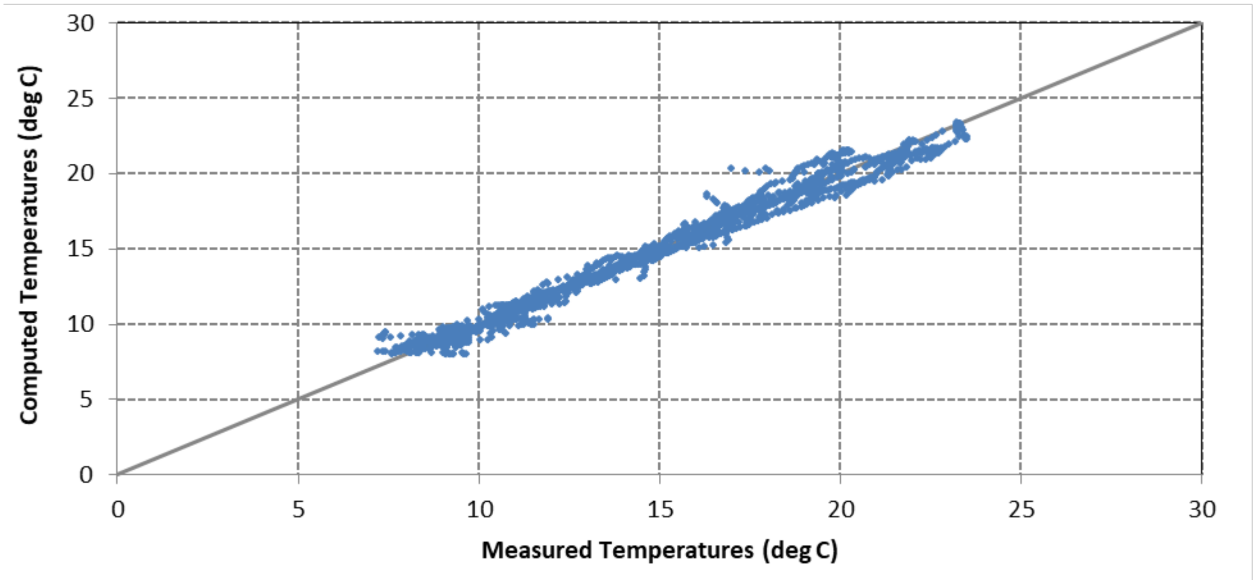
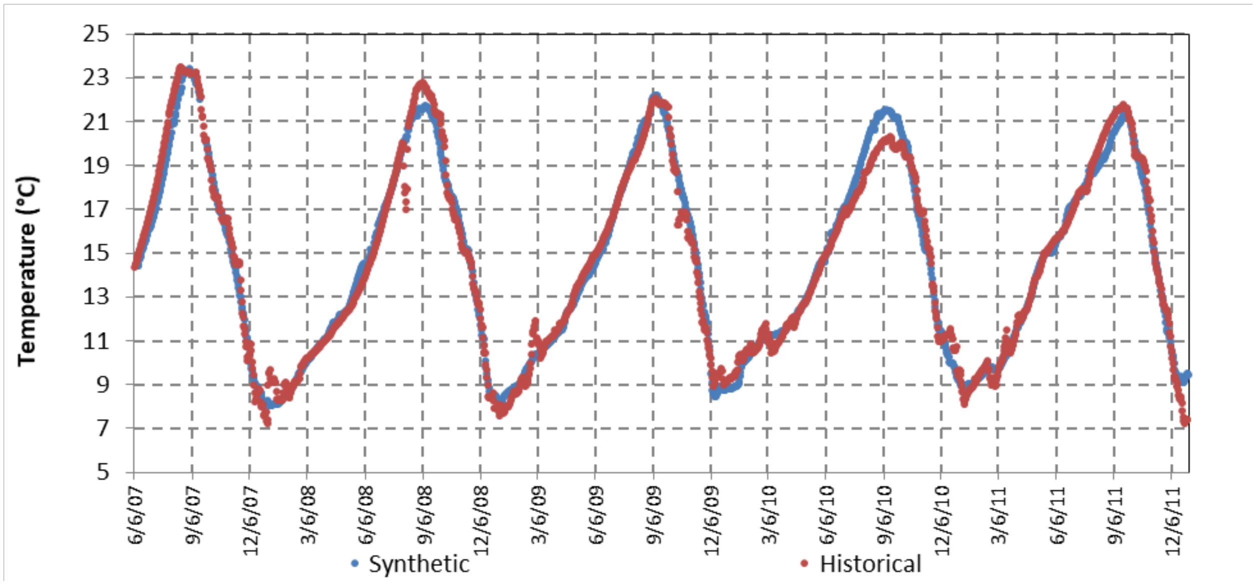


Table 4.2-22. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Alamitos Creek below Almaden Reservoir, ALAM4, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Almaden Reservoir Outlet	0.98	-0.02	0.45

Figure 4.2-22 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on Alamitos Creek downstream of Almaden Reservoir (ALAM4).

Figure 4.2-22. Alamitos Creek Validation at ALAM4



Predictions of average daily temperatures at Almaden Reservoir outlet were within 0.45 degrees of measured values, on average, but the predicted values showed slightly increased maximum temperatures and slightly decreased minimum temperatures. Differences in measured and predicted daily averages could be due to unaccounted-for bathymetric effects.

4.2.4.2 ALAM3

Alamitos Creek upstream of Calero Creek was selected as the representative water temperature gage for ALAM3. Table 4.2-23 shows the relative contribution of each of the temperature regression components.

Table 4.2-23. Contribution of Regression Components for Alamitos Creek Above Calero Creek, ALAM3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Upstream Water Temperature (% of Calculation)	0.02	0.15	0.26	0.05	0.01	0.01	0.01	0.01	0.00	0.01	0.03	0.01	0.04
Previous Day Water Temperature (% of Calculation)	0.97	0.81	0.62	0.93	0.94	0.94	0.98	0.98	0.97	0.98	0.94	0.97	0.93
Flow (% of Calculation)	0.00	0.02	0.03	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.01
Air Temperature (% of Calculation)	0.01	0.02	0.09	0.01	0.05	0.03	0.01	0.01	0.02	0.01	0.03	0.01	0.02

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Constant (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Overall, previous day water temperature component has the highest contribution to the calculations at this location, and contributes 62-92% throughout the year. Flow contributes less than 3% throughout the year. Air temperature contributes less than 9% throughout the year. The calculation is most sensitive to upstream water temperature in February and March. Figure 4.2-23 shows the accuracy of the computed temperatures, relative to the measured temperatures for Alamitos Creek above Calero Creek. Table 4.2-24 shows the resulting coefficient of determination, mean error, and absolute mean error for the calibration period of record.

Figure 4.2-23. Accuracy of Computed Temperatures Relative to Measured Temperatures for Alamitos Creek above Calero Creek, ALAM3

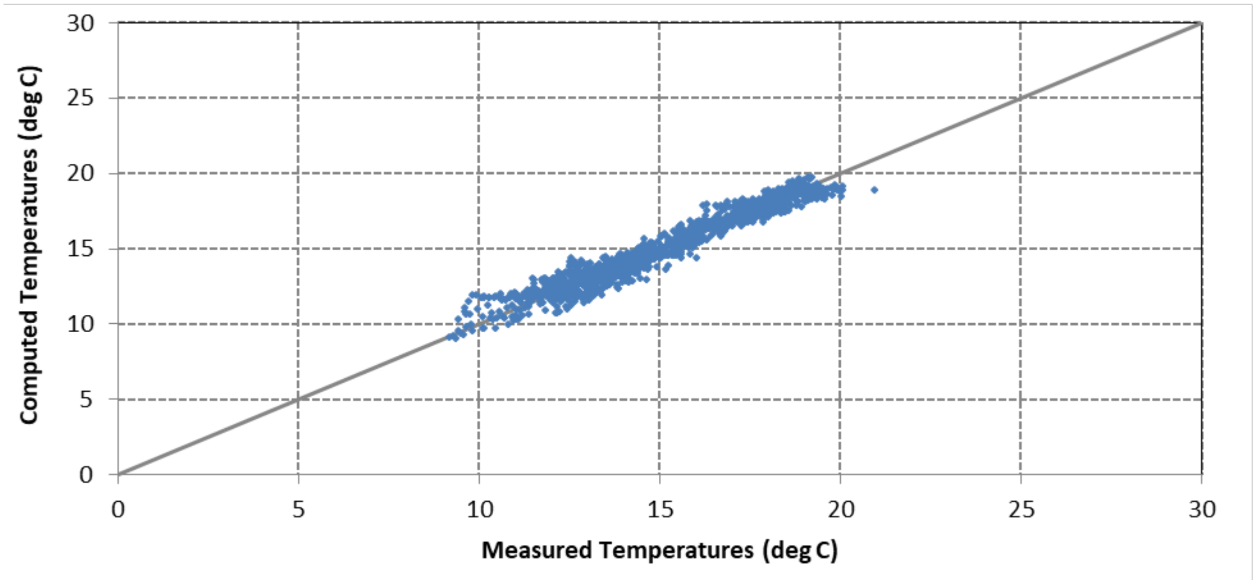
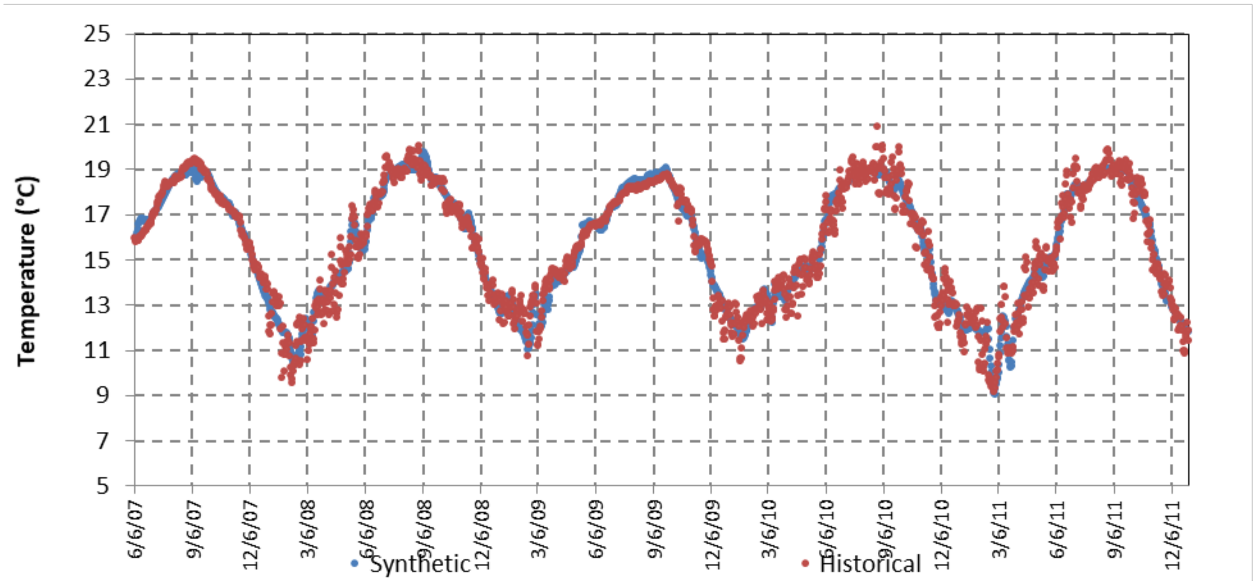


Table 4.2-24. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Alamitos Creek above Calero Creek, ALAM3, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Upstream of Calero Creek	0.96	0.00	0.42

Figure 4.2-24 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on Alamitos Creek above Calero Creek (ALAM3).

Figure 4.2-24. Alamitos Creek Validation at ALAM3



Predictions of average daily temperatures at ALAM3 were within 0.42 degree of measured temperatures, on average.

4.2.4.3 ALAM2

Alamitos Creek downstream of Randol Creek was selected as the representative water temperature gage for ALAM2. ALAM2 water temperatures reflect flow and water temperature contributions from both Alamitos Creek and Calero Creek. Table 4.2-25 shows the relative contribution of each of the temperature regression components.

Table 4.2-25. Contribution of Regression Components for Alamitos Creek Below Calero Creek, ALAM2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Almaden Temperature (% of Calculation)	0.51	0.07	0.58	0.37	0.16	0.75	0.15	0.14	0.13	0.20	0.55	0.50	0.34
Fortini Temperature (% of Calculation)	0.27	0.84	0.25	0.46	0.71	0.12	0.70	0.65	0.23	0.57	0.27	0.23	0.44
SF16 Flow (% of Calculation)	0.00	0.02	0.03	0.02	0.03	0.01	0.01	0.00	0.01	0.03	0.04	0.03	0.02
SF13 Flow (% of Calculation)	0.07	0.03	0.06	0.07	0.09	0.06	0.01	0.00	0.03	0.06	0.08	0.04	0.05

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Previous Day Water Temperature (% of Calculation)	0.14	0.03	0.05	0.06	0.01	0.06	0.12	0.19	0.55	0.13	0.04	0.16	0.13
Air Temperature (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Overall, the upstream water temperatures from Almaden and Fortini have the highest contribution to the calculations at this location, and contributes 23-84% at Fortini and 7-58% at Almaden throughout the year. Previous day water temperature account for less than 19% of the calculations for the majority of the year and 55% of the calculations in September. Flow contributes less than 9% to the calculations throughout the year. Figure 4.2-25 shows the accuracy of the computed temperatures, relative to the measured temperatures for Alamitos Creek below Calero Creek. Table 4.2-26 shows the resulting coefficient of determination, mean error, and absolute mean error for the calibration period of record.

Figure 4.2-25. Accuracy of Computed Temperatures Relative to Measured Temperatures for Alamitos Creek below Calero Creek, ALAM2

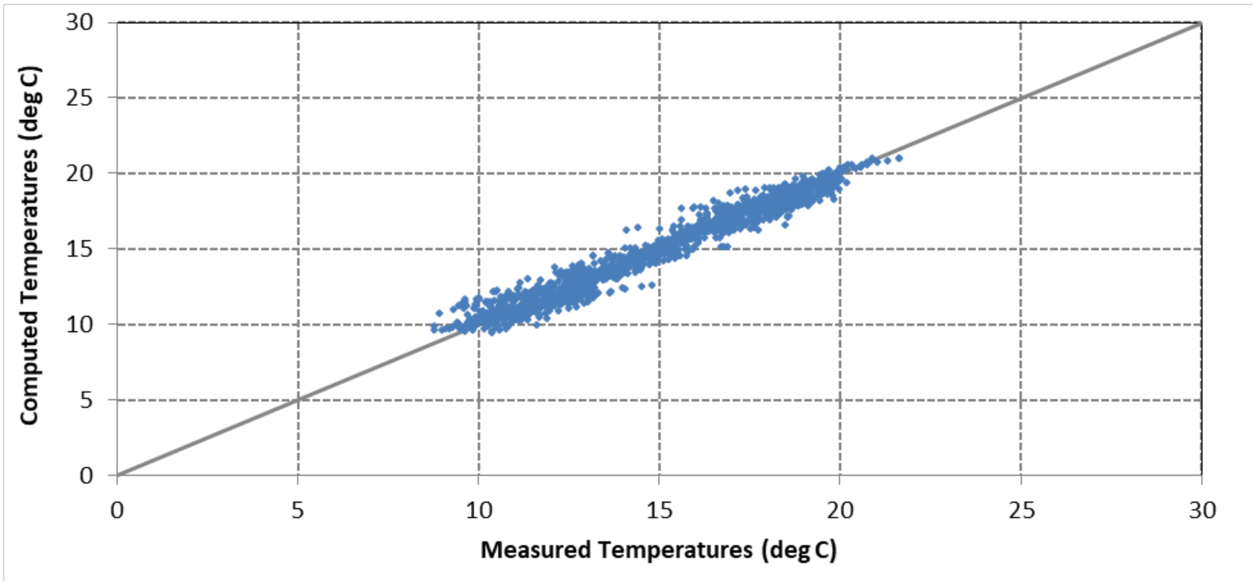
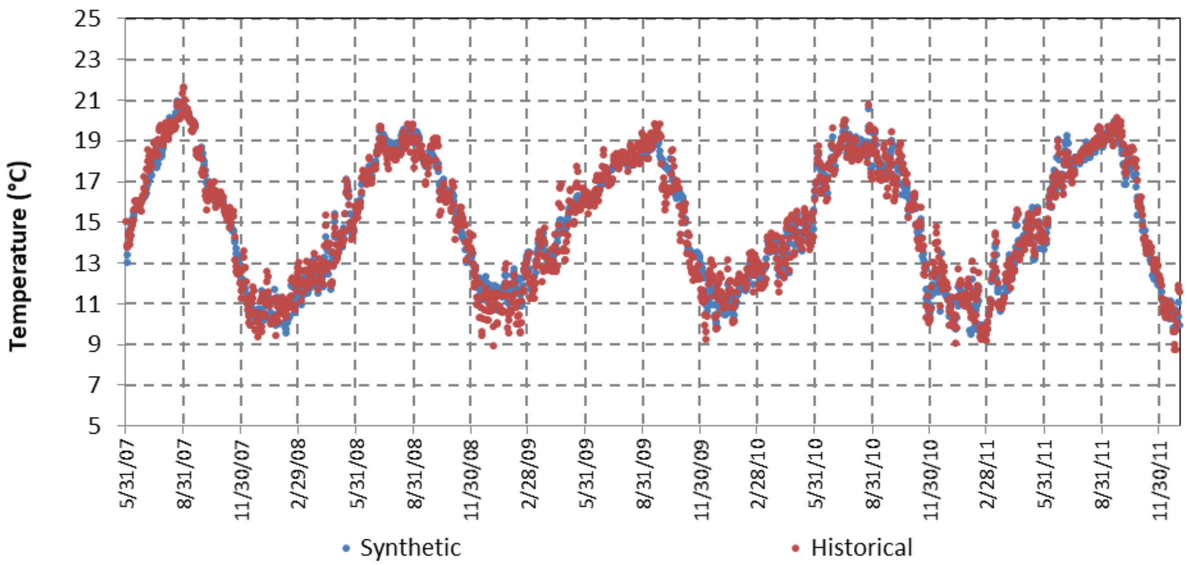


Table 4.2-26. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Alamitos Creek below Calero Creek, ALAM2, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Downstream of Randol Creek	0.96	0.00	0.43

Figure 4.2-26 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on Alamitos Creek below Calero Creek.

Figure 4.2-26. Alamitos Creek Validation at ALAM2



Predictions of average daily temperatures at ALAM3 were within 0.43 degrees of measured temperatures, on average.

4.2.4.4 ALAM1

Alamitos Creek at Mazzone Drive was selected as the representative water temperature gage for ALAM1. Table 4.2-27 shows the relative contribution of each of the temperature regression components.

Table 4.2-27. Contribution of Regression Components for Alamitos Creek above Lake Almaden, ALAM1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Upstream Water Temperature (% of Calculation)	0.95	0.98	0.96	0.95	0.90	0.88	0.91	0.93	0.95	0.90	0.89	0.86	0.92
Previous Day Water Temperature (% of Calculation)	0.03	0.01	0.01	0.01	0.01	0.07	0.04	0.02	0.02	0.08	0.08	0.11	0.04
Flow (% of Calculation)	0.02	0.00	0.01	0.04	0.07	0.04	0.05	0.05	0.02	0.00	0.02	0.02	0.03
Air Temperature (% of Calculation)	0.00	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
Constant (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Overall, the upstream water temperature component has the highest contribution to the calculations at this location, and contributes 86-98% throughout the year. Previous day water temperature accounts for less than 11% throughout the year. Flow accounts for less than 7% of the calculations throughout the year. Air temperature accounts for less than 2% of the calculations throughout the year. Figure 4.2-27 shows the accuracy of the computed temperatures, relative to the measured temperatures for Alamitos Creek above Lake Almaden. Table 4.2-28 shows the resulting coefficient of determination, mean error, and absolute mean error for the calibration period of record.

Figure 4.2-27. Accuracy of Computed Temperatures Relative to Measured Temperatures for Alamitos Creek above Lake Almaden, ALAM1

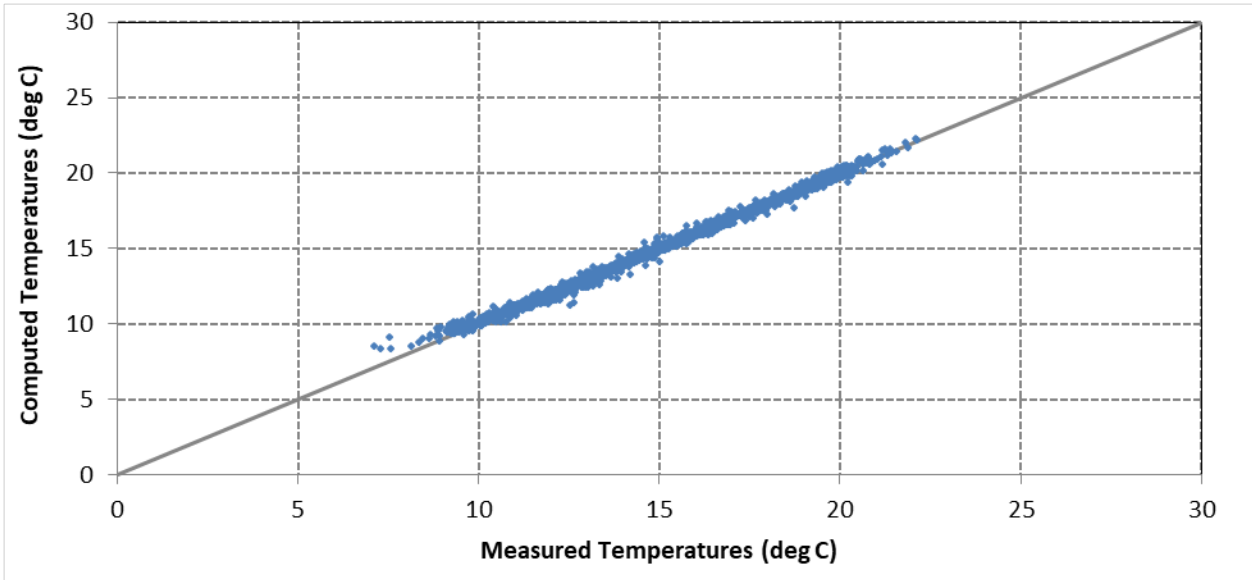
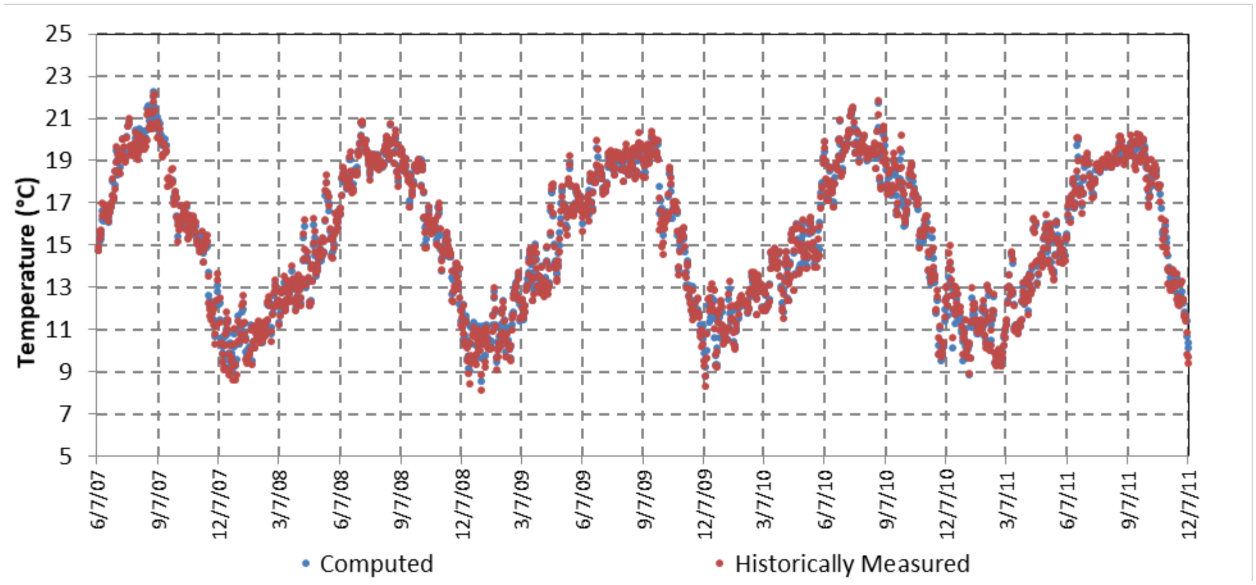


Table 4.2-28. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Alamitos Creek above Lake Almaden, ALAM1, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Above Lake Almaden	1.00	0.01	0.43

Figure 4.2-28 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on Alamitos Creek above Lake Almaden.

Figure 4.2-28. Alamitos Creek Validation at ALAM1



Predictions of average daily temperatures above Lake Almaden were within 0.17 degrees of measured values.

4.2.4.5 Discussion

The fit for Alamitos Creek locations on a month-to-month basis are comparable or higher than the fit for other regression locations. Model uncertainty for Alamitos Creek is relatively low with all biases below +/- 0.5°C and all absolute mean error below 1°C, and an R^2 for all locations ranging from 0.96 to 1.00, and 7 years of data above the confluence with Calero Creek.

4.2.5 Calero Creek

Two water temperature gage locations were selected on Calero Creek, Calero Creek at Calero Reservoir outlet and Calero Creek at Fortini Road, to represent the two POI. These two locations were selected due to their proximity to key fisheries locations CALE2 and CALE1, the quantity of data available at each location, and the quality of the fit of their respective regressions.

Daily regression coefficients for each POI are included in Attachment C.

4.2.5.1 CALE2

Calero Creek at Calero Reservoir Outlet was selected as the representative water temperature gage for CALE2. A review of the fit of the regressions with and without Calero Reservoir storage indicated a better, more resilient fit when storage was excluded from the regression. Accordingly, there is no upstream water temperature or boundary condition for CALE2. Table 4.2-29 shows the relative contribution of each of the temperature regression components.

Table 4.2-29. Contribution of Regression Components for Calero Creek at the Calero Reservoir Outlet, CALE2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Previous Day Water Temperature (% of Calculation)	0.94	0.99	0.99	0.99	0.95	0.94	0.95	0.98	0.99	0.98	0.94	0.88	0.96
Flow (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Air Temperature (% of Calculation)	0.01	0.00	0.00	0.00	0.03	0.03	0.02	0.01	0.00	0.02	0.02	0.01	0.01
Constant (% of Calculation)	0.05	0.00	0.01	0.00	0.02	0.02	0.03	0.01	0.00	0.01	0.04	0.11	0.03

Since historical water temperature data were not available for February through June, data from Almaden Reservoir Outlet were substituted from February 2007 to June 2008. Almaden Reservoir Outlet was chosen due to its similar geography and behavior to the available temperature data for the Calero Reservoir Outlet.

Overall, previous day temperature has the highest contribution to the calculations at this location, and contributes 88-99% throughout the year. Flow and air temperature have little to no contribution to the calculations. The constant accounts for less than 11% of the temperature calculations throughout the year. Figure 4.2-29 shows the accuracy of the computed temperatures, relative to the measured temperatures for Calero Creek at Calero Reservoir Outlet. Table 4.2-30 shows the resulting coefficient of determination, mean error, and absolute mean error for the calibration period of record.

Figure 4.2-29. Accuracy of Computed Temperatures Relative to Measured Temperatures for Calero Creek at Calero Reservoir Outlet, CALE2

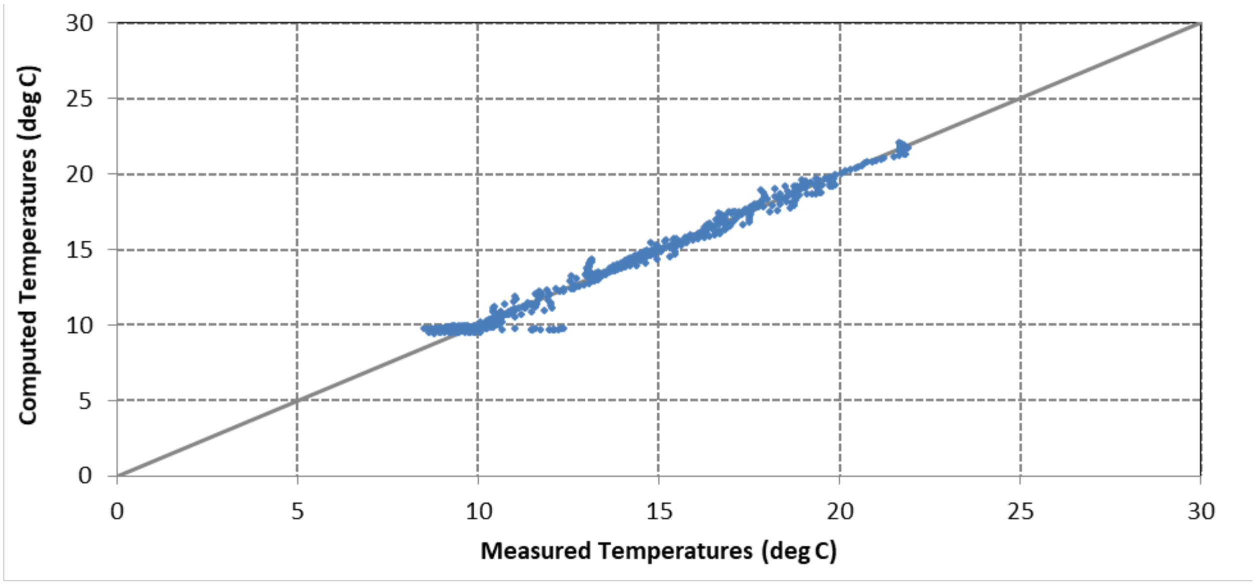
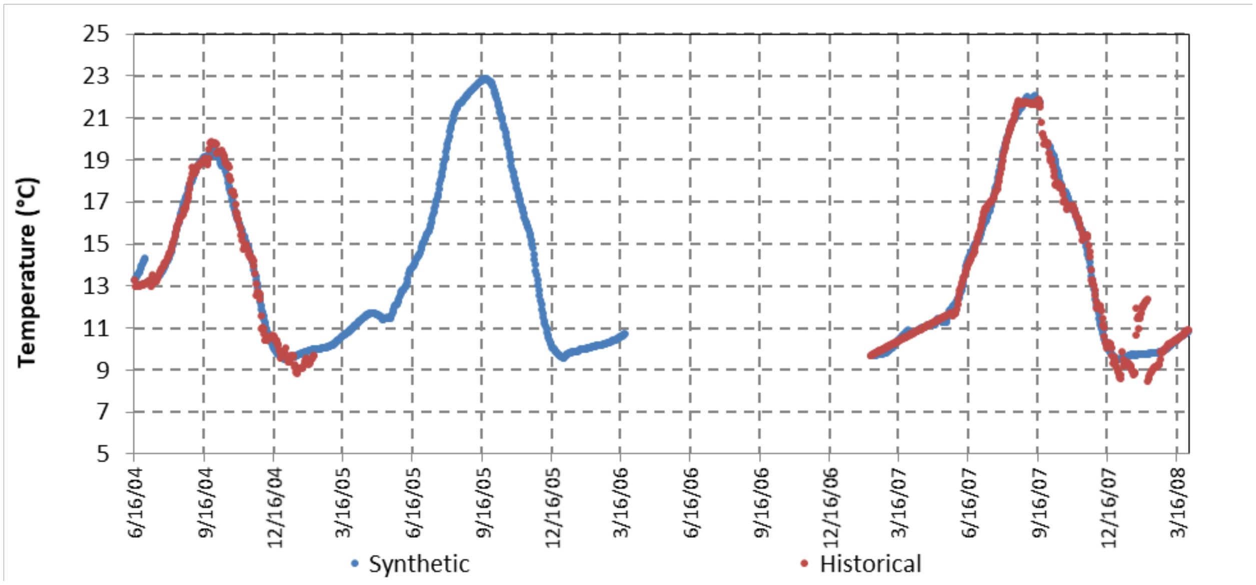


Table 4.2-30. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Calero Creek below Calero Reservoir, CALE2, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Calero Reservoir outlet	0.98	0.01	0.33

Figure 4.2-30 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on Calero Creek downstream of Calero Reservoir.

Figure 4.2-30. Calero Creek Validation at CALE2.



Predictions of average daily temperatures at Calero Reservoir outlet were within 0.33 degrees, on average.

4.2.5.2 CALE1

Calero Creek at Fortini Road was selected as the representative water temperature gage for CALE1. Table 4.2-31 shows the relative contribution of each of the temperature regression components.

Table 4.2-31. Contribution of Regression Components for Calero Creek at the Calero Reservoir Outlet, CALE2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Upstream Water Temperature (% of Calculation)	0.70	0.19	0.89	0.78	0.69	0.51	0.27	0.07	0.27	0.74	0.78	0.71	0.52
Previous Day Water Temperature (% of Calculation)	0.29	0.80	0.10	0.18	0.17	0.36	0.63	0.89	0.71	0.22	0.19	0.29	0.45
Flow (% of Calculation)	0.01	0.01	0.01	0.04	0.13	0.09	0.03	0.01	0.01	0.03	0.01	0.00	0.02
Air Temperature (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.03	0.01	0.01	0.02	0.00	0.02

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Constant (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Since historical water temperature data were not available for February through June, data from Alamitos Creek, Pfeiffer Ranch Road were substituted from February 2005 to June 2005 and February 2008 to June 2008. Alamitos Creek, Pfeiffer Ranch Road was chosen due to its similar geography and behavior to the available temperature data for Fortini Road.

Upstream temperature and previous day temperature contributes the most overall to the calculations at this location, with upstream temperature accounting for 7-89% and previous day temperature accounting for 10-80%. Flow and air temperature each contribute less than 13% to the temperature calculations. Figure 4.2-31 shows the accuracy of the computed temperatures, relative to the measured temperatures for Calero Creek above Alamitos Creek. Table 4.2-32 shows the resulting coefficient of determination, mean error, and absolute mean error for the calibration period of record.

Figure 4.2-31. Accuracy of Computed Temperatures Relative to Measured Temperatures for Calero Creek at Fortini Road, CALE1

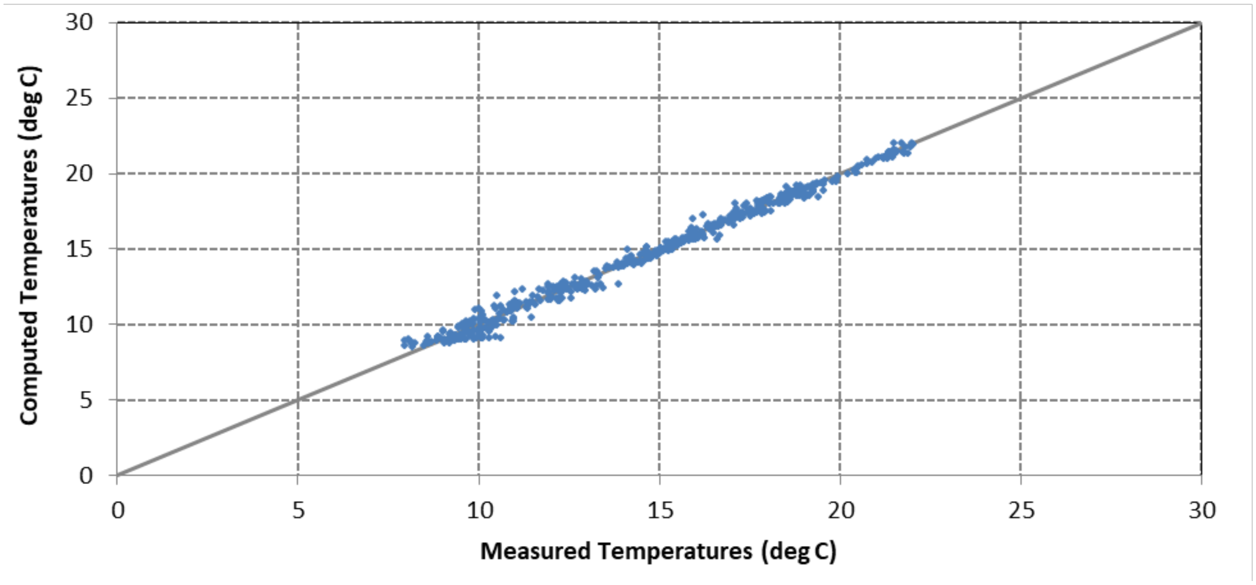
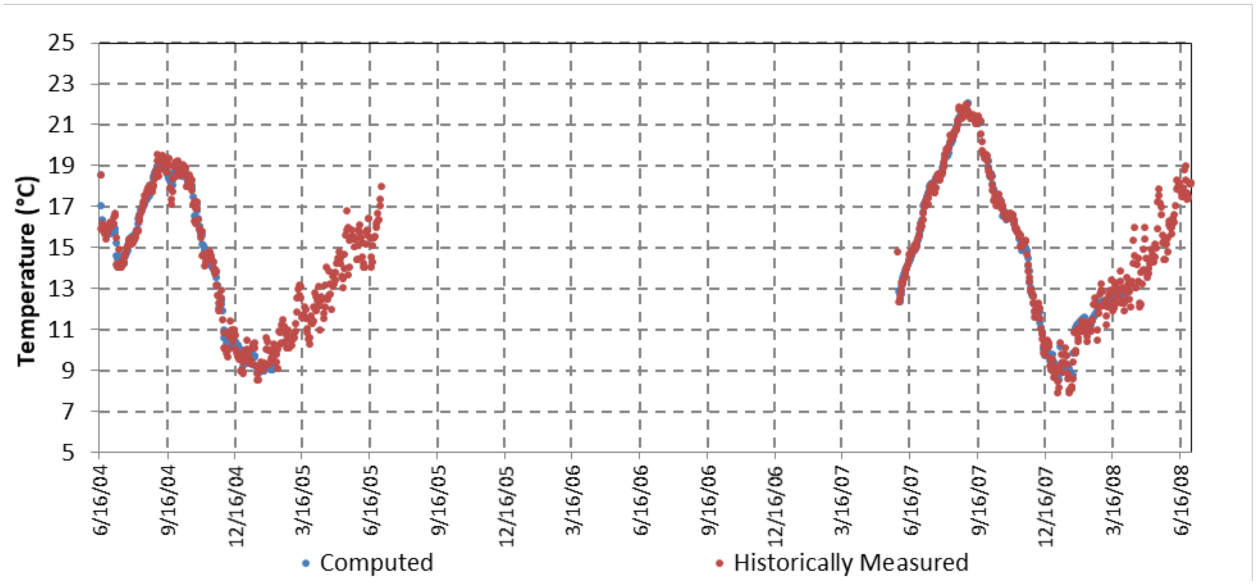


Table 4.2-32. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Calero Creek above Alamitos Creek, CALE1, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Fortini Road	0.99	0.00	0.29

Figure 4.2-32 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on Calero Creek at Fortini Road.

Figure 4.2-32. Calero Creek Validation at CALE1



Predictions of average daily temperatures at Fortini Road were within 0.29 degrees, on average.

4.2.5.3 Discussion

Four years of data were collected on Calero Creek. Since historical water temperature data were not available for certain months, data from Alamitos Creek and Almaden Reservoir Outlet were substituted.

Major discrepancies in the temperature calculations are likely to occur in months where missing temperature data were substituted. In the case of CALE1, the substituted data were more variable than the historically measured data at that location. Despite the close fit, it is again important to note that the predictions are only based on four years of data. Water temperature predictions based on air temperatures and flows that are higher or lower than those observed in the two years may not be as accurate. Major discrepancies in the temperature calculations are likely to occur in months where missing temperature data were substituted. However, based on available data, model uncertainty is relatively low, with a bias of 0.01°C, an absolute mean error of 0.3, and an R^2 for all locations ranging from 0.98 to 0.99.

4.2.6 Stevens Creek

Six water temperature gage locations were selected on Stevens Creek, corresponding with six POI. These temperature nodes were selected due to their proximity to key fisheries locations, the quantity of data available at each location, and the quality of the fit of their respective regressions.

Daily regression coefficients for each POI are included in Attachment C.

4.2.6.1 Stevens Creek Reservoir Outlet

Stevens Creek at Stevens Creek Reservoir Outlet was included as part of the Stevens Creek water temperature regressions. While not a POI, water temperatures at the Stevens Creek Reservoir Outlet serve as a boundary condition for downstream location, and reflect Stevens Creek Reservoir storage and water temperature profile. Monthly relative contributions of the regression terms for Stevens Creek Reservoir Outlet, are shown in Table 4.2-33.

Table 4.2-33. Contribution of Regression Components for Stevens Creek Reservoir Outlet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Inlet Temperature (% of Calculation)	0.95	1.00	0.96	0.85	0.84	0.88	0.93	0.95	0.99	0.93	0.96	0.91	0.93
Flow (% of Calculation)	0.05	0.00	0.05	0.15	0.16	0.12	0.07	0.05	0.01	0.07	0.04	0.09	0.07
Air Temperature (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Overall, inlet temperature, based on reservoir storage and water temperature profile, has the highest contribution to the calculations at this location, and contributes 84-100% throughout the year. Flow accounts for up to 16% of the calculations. Figure 4.2-33 shows the accuracy of the regression based computed temperatures, relative to the measured temperatures for Stevens Creek below Stevens Creek Reservoir. Table 4.2-34 shows the resulting coefficient of determination, mean error, and absolute mean error for the calibration period of record.

Figure 4.2-33. Accuracy of Computed Temperatures Relative to Measured Temperatures for Stevens Creek Reservoir Outlet

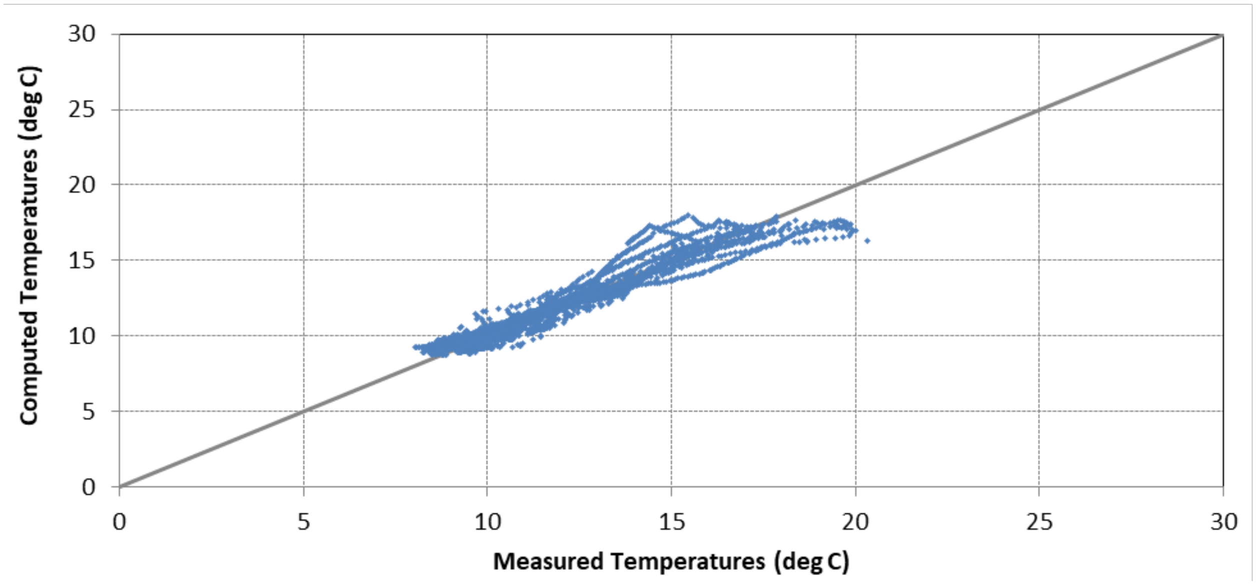
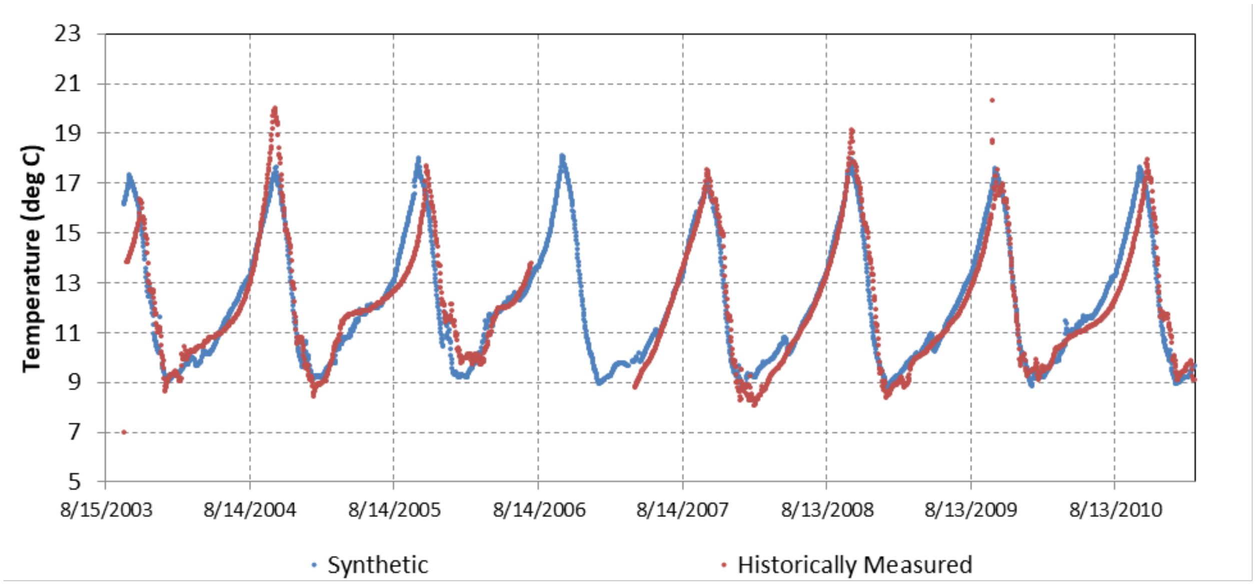


Table 4.2-34. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Stevens Creek Reservoir Outlet, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Stevens Creek Reservoir Outlet	0.92	0.00	0.53

Figure 4.2-34 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures at Stevens Creek Reservoir Outlet.

Figure 4.2-34. Stevens Creek Validation at Stevens Creek Reservoir Outlet.



Predictions of average daily temperatures on Stevens Creek Reservoir Outlet were within 0.53 degrees of measured temperatures, on average.

4.2.6.2 STEV6

Stevens Creek at Stevens Creek Reservoir Outlet was selected as the representative water temperature gage for STEV6. Monthly relative contributions of the regression terms for STEV6, Stevens Creek below Stevens Creek Reservoir, are shown in Table 4.2-35.

Table 4.2-35. Contribution of Regression Components for Stevens Creek below Stevens Creek Reservoir, STEV6

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Upstream Temperature (% of Calculation)	0.61	0.37	0.70	0.14	0.02	0.04	0.09	0.31	0.47	0.41	0.19	0.39	0.32

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Previous Day Water Temperature (% of Calculation)	0.37	0.61	0.26	0.84	0.97	0.95	0.88	0.67	0.47	0.55	0.78	0.56	0.65
Flow (% of Calculation)	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.03	0.01	0.01	0.01
Air Temperature (% of Calculation)	0.01	0.02	0.03	0.01	0.00	0.01	0.02	0.01	0.04	0.01	0.03	0.04	0.02
Constant (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Overall, previous day temperature has the highest contribution to the calculations at this location, and contributes 26-97% throughout the year. Upstream temperature accounts for up to 70% of the calculations in March. Daily maximum air temperature contributes less than 4% of the calculations throughout the year. Flow accounts for less than 3% of the calculations throughout the year. Figure 4.2-35 shows the accuracy of the regression based computed temperatures, relative to the measured temperatures for Stevens Creek below Stevens Creek Reservoir. Table 4.2-36 shows the resulting coefficient of determination, mean error, and absolute mean error for the calibration period of record.

Figure 4.2-35. Accuracy of Computed Temperatures Relative to Measured Temperatures for Stevens Creek below Stevens Creek Reservoir, STEV6

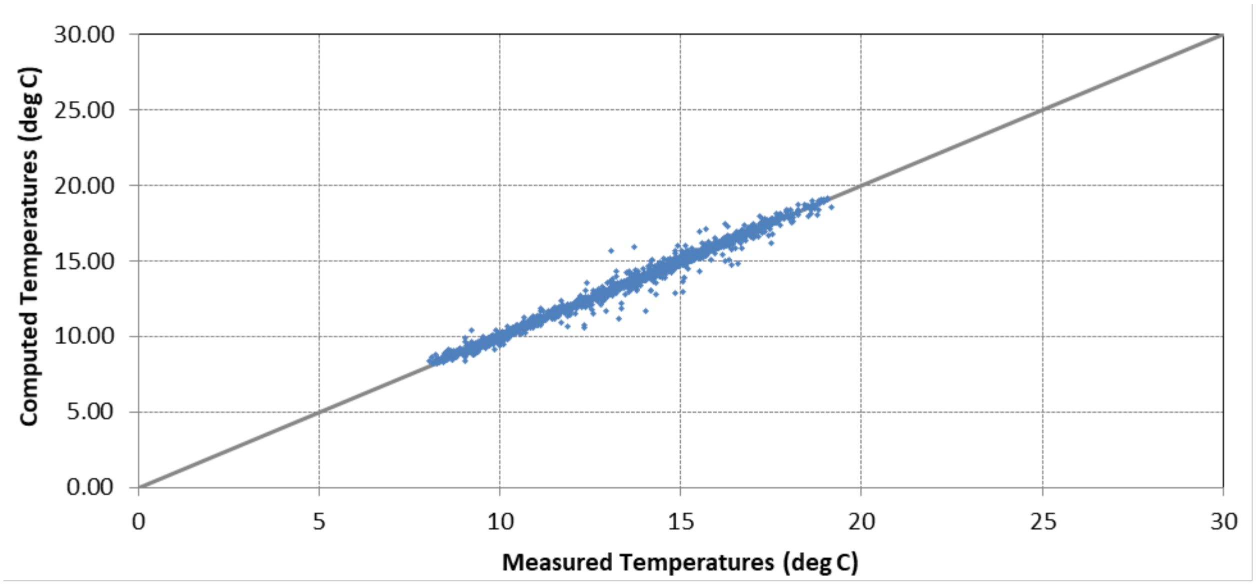
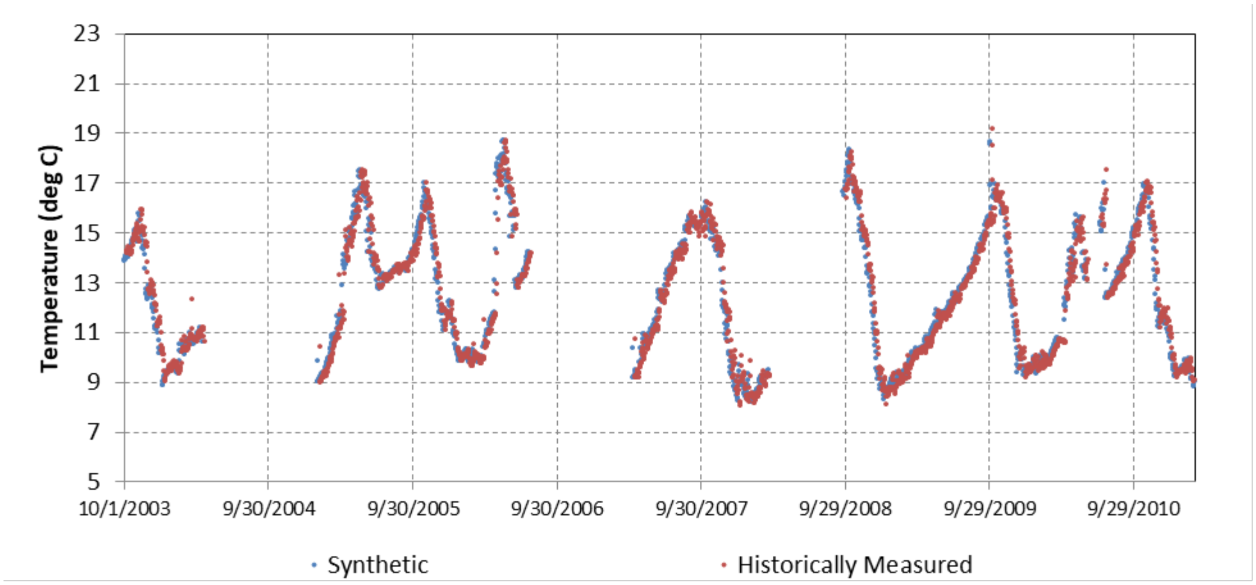


Table 4.2-36. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Stevens Creek below Stevens Creek Reservoir, STEV6, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Stevens Creek Reservoir Outlet	0.99	-0.01	0.17

Figure 4.2-36 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on STEV6 Stevens Creek below Stevens Creek Reservoir.

Figure 4.2-36. Stevens Creek Validation at STEV6



Predictions of average daily temperatures on Stevens Creek at STEV6 were within 0.17 degrees of measured temperatures, on average. For all of the final selected regression locations on Stevens Creek, the flow below Stevens Creek Reservoir (model location STEV6, gage SF44) was used because it was the only flow location available and because it was more representative of the flows at the desired temperature.

4.2.6.3 STEV5

Stevens Creek upstream of Deep Cliff was selected as the representative water temperature gage for STEV5. Monthly relative contributions of the regression terms for STEV5, Stevens Creek above McClellan Road, are shown in Table 4.2-37.

Table 4.2-37. Contribution of Regression Components for Stevens Creek above McClellan Road, STEV5

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Upstream Water Temperature (% of Calculation)	0.78	0.37	0.32	0.44	0.39	0.51	0.08	0.49	0.35	0.48	0.71	0.84	0.48
Previous Day Water Temperature (% of Calculation)	0.19	0.59	0.66	0.52	0.53	0.39	0.88	0.46	0.61	0.47	0.27	0.13	0.48
Flow (% of Calculation)	0.02	0.01	0.00	0.00	0.02	0.03	0.00	0.01	0.01	0.02	0.00	0.00	0.01
Air Temperature (% of Calculation)	0.01	0.04	0.01	0.04	0.05	0.07	0.03	0.03	0.02	0.03	0.01	0.03	0.03
Constant (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Overall, the upstream water temperature and previous day water temperature have the highest contribution to the calculations at this location. Air temperature contributes less than 7% to the calculation throughout the year. Flow contributes a relatively low percentage to the calculations throughout the year, contributing less than 3% throughout the year. Figure 4.2-37 shows the accuracy of the computed temperatures, relative to the measured temperatures for Stevens Creek above McClellan Road. Table 4.2-38 shows the resulting coefficient of determination, mean error, and absolute mean error for the calibration period of record.

Figure 4.2-37. Accuracy of Computed Temperatures Relative to Measured Temperatures for Stevens Creek above McClellan Road, STEV5

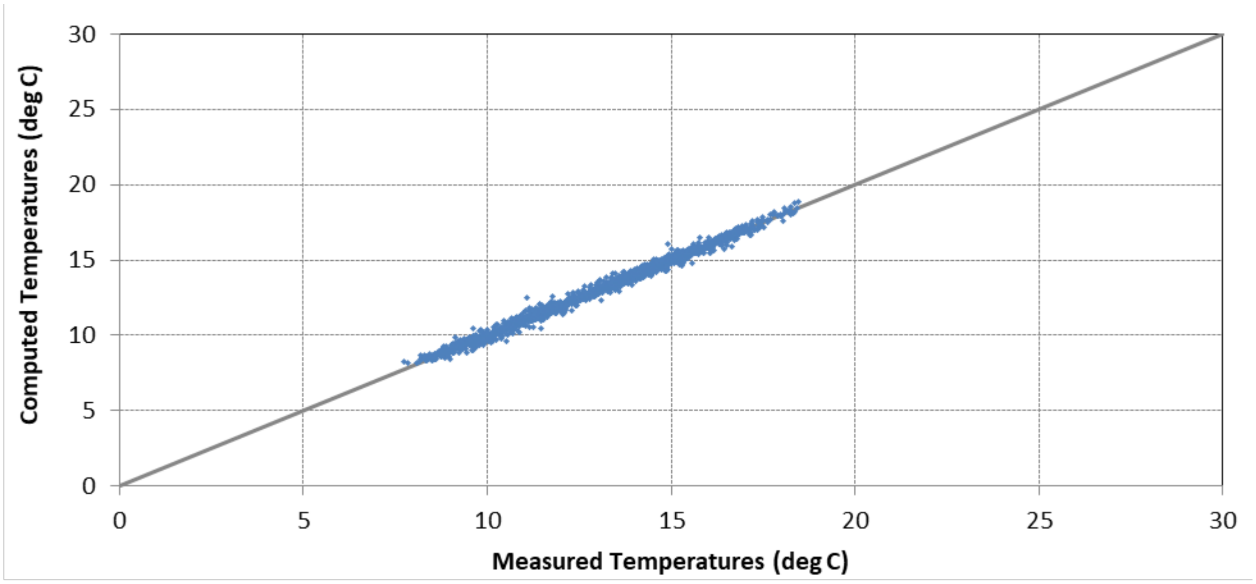
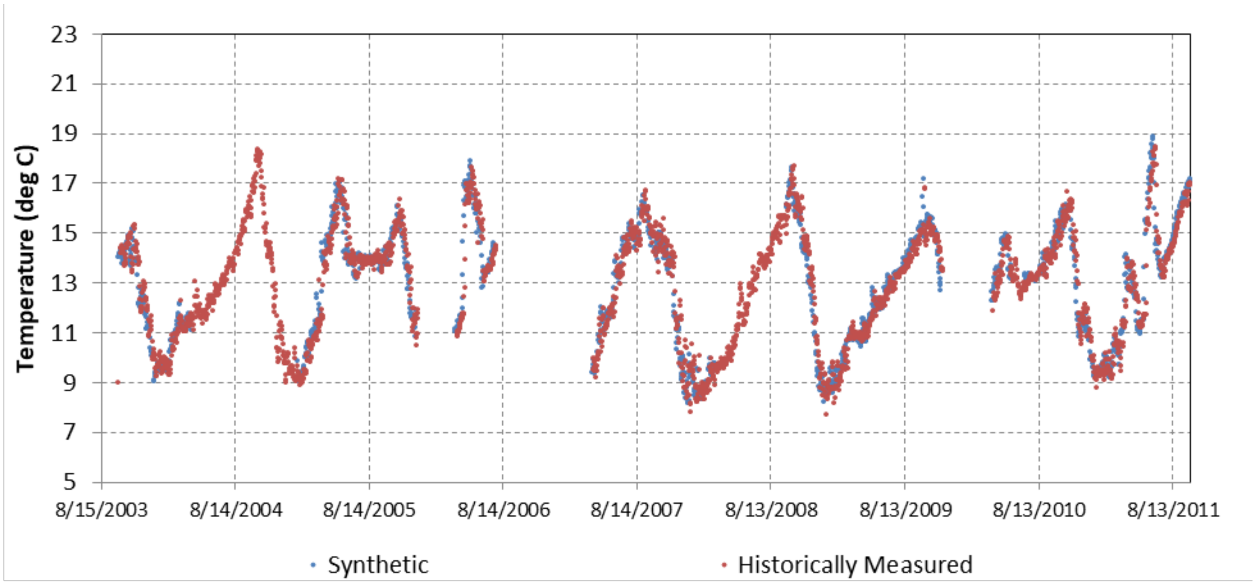


Table 4.2-38. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Stevens Creek Above McClellan Road, STEV5, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Upstream of Deep Cliff	0.99	0.00	0.16

Figure 4.2-38 shows a comparison of historical daily average water temperatures compared to the synthetic daily average water temperatures on Stevens Creek above McClellan Road.

Figure 4.2-38. Stevens Creek Validation at STEV5



Predictions of average daily temperatures on Stevens Creek at STEV5 were within 0.16 degrees of measured temperatures, on average. For all of the final selected regression locations on Stevens Creek, the flow below Stevens Creek Reservoir (model location STEV6, gage SF44) was used because it was the only flow location available and because it was more representative of the flows at the desired temperature locations than the downstream flow location SF35.

4.2.6.4 STEV4

Stevens Creek at Highway 280 was selected as the representative water temperature gage for STEV4. Monthly relative contributions of the regression terms for STEV4, Stevens Creek above Highway 280, are shown in Table 4.2-39.

Table 4.2-39. Contribution of Regression Components for Stevens Creek above Highway 280, STEV4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Upstream Water Temperature (% of Calculation)	0.59	0.48	0.46	0.51	0.33	0.26	0.26	0.27	0.22	0.27	0.49	0.55	0.37
Previous Day Water Temperature (% of Calculation)	0.37	0.46	0.45	0.38	0.50	0.57	0.60	0.62	0.67	0.64	0.46	0.39	0.52
Flow (% of Calculation)	0.01	0.02	0.04	0.02	0.05	0.04	0.04	0.03	0.01	0.01	0.01	0.04	0.03

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Air Temperature (% of Calculation)	0.03	0.04	0.05	0.09	0.12	0.13	0.10	0.09	0.09	0.08	0.04	0.03	0.08
Upstream Water Temperature (% of Calculation)	0.59	0.48	0.46	0.51	0.33	0.26	0.26	0.27	0.22	0.27	0.49	0.55	0.37

Overall, previous day temperature has the highest contribution to the calculations at this location, and contributes 37-67% to the calculations throughout the year. Upstream water temperature accounts for 26-59% of the calculations throughout the year. Air temperature contributes 3-13% of the calculations throughout the year. Flow contributes a relatively low percentage to the calculations throughout the year of less than 5%. Figure 4.2-39 shows the accuracy of the computed temperatures, relative to the measured temperatures for Stevens Creek above Highway 280. Table 4.2-40 shows the resulting coefficient of determination, mean error, and absolute mean error for the calibration period of record.

Figure 4.2-39. Accuracy of Computed Temperatures Relative to Measured Temperatures for Stevens Creek above Highway 280, STEV4

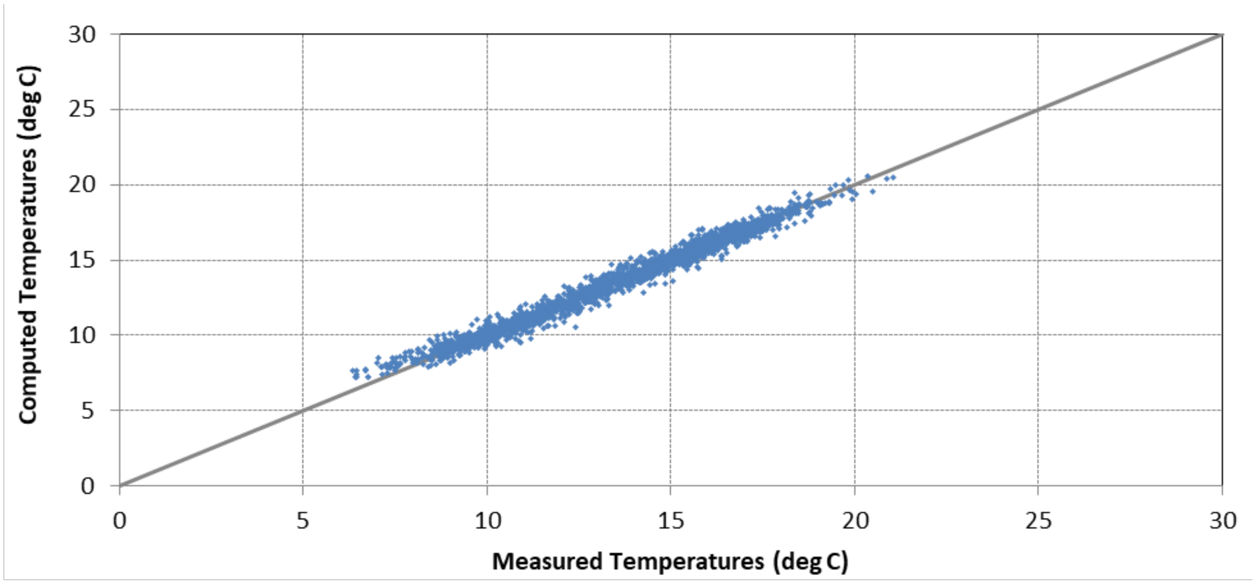
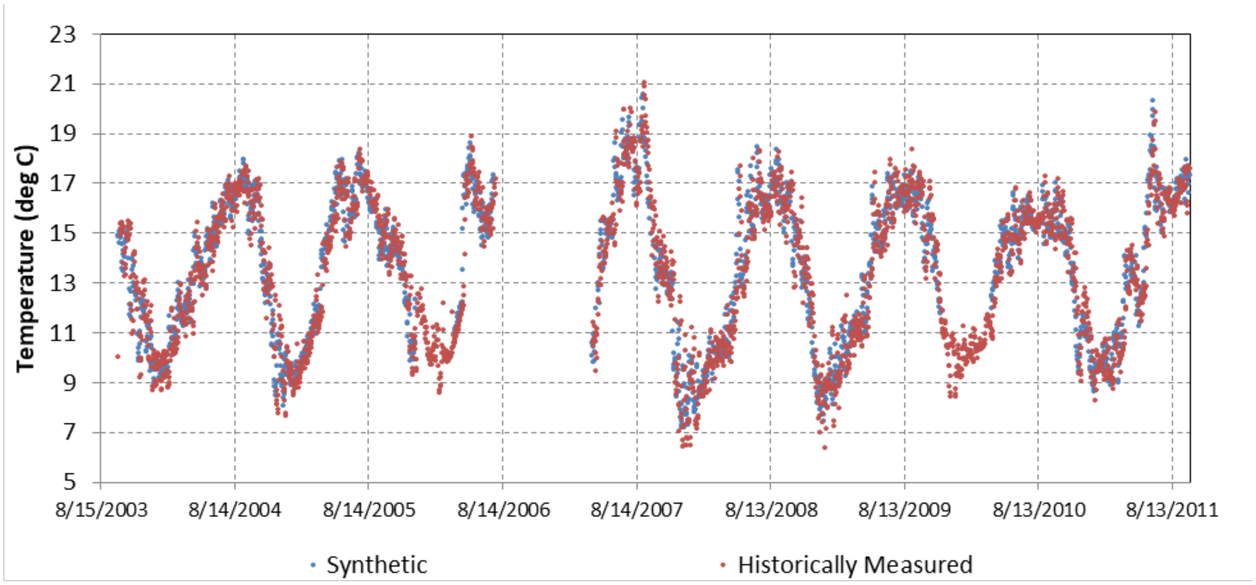


Table 4.2-40. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Stevens Creek Above Highway 280, STEV4, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Highway 280	0.98	0.00	0.31

Figure 4.2-40. Stevens Creek Validation at STEV4



Predictions of average daily temperatures on Stevens Creek at STEV4 were within 0.31 degrees of measured temperatures, on average. For all of the final selected regression locations on Stevens Creek, the flow below Stevens Creek Reservoir (model location STEV6, gage SF44) was used because it was the only flow location available and because it was more representative of the flows at the desired temperature locations than the downstream flow location SF35.

4.2.6.5 STEV3

Stevens Creek downstream of Fremont Avenue was selected as the representative water temperature gage for STEV3. Monthly relative contributions of the regression terms for STEV3, Stevens Creek above Fremont Avenue, are shown in Table 4.2-41.

Table 4.2-41. Contribution of Regression Components for Stevens Creek above Fremont Avenue, STEV3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Upstream Water Temperature (% of Calculation)	0.93	0.92	0.88	0.80	0.63	0.49	0.60	0.88	0.93	0.91	0.85	0.86	0.80
Previous Day Water Temperature (% of Calculation)	0.03	0.07	0.09	0.14	0.24	0.35	0.30	0.04	0.03	0.05	0.03	0.08	0.13
Flow (% of Calculation)	0.02	0.01	0.00	0.01	0.02	0.02	0.02	0.05	0.02	0.03	0.09	0.03	0.03
Air Temp (% of Calculation)	0.02	0.00	0.02	0.06	0.11	0.13	0.07	0.03	0.02	0.01	0.02	0.03	0.05

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Constant (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Overall, upstream water temperature has the highest contribution to the calculations at this location, and contributes 63-93% to the calculations throughout the year. Previous day temperature accounts for 3-35% of the temperature calculations throughout the year. Flow and air temperature contributes a relatively low percentage of less than 13%. Figure 4.2-41 shows the accuracy of the computed temperatures, relative to the measured temperatures for Stevens Creek above Fremont Avenue. Table 4.2-42 shows the resulting coefficient of determination, mean error, and absolute mean error for the calibration period of record.

Figure 4.2-41. Accuracy of Computed Temperatures Relative to Measured Temperatures for Stevens Creek above Fremont Avenue, STEV3

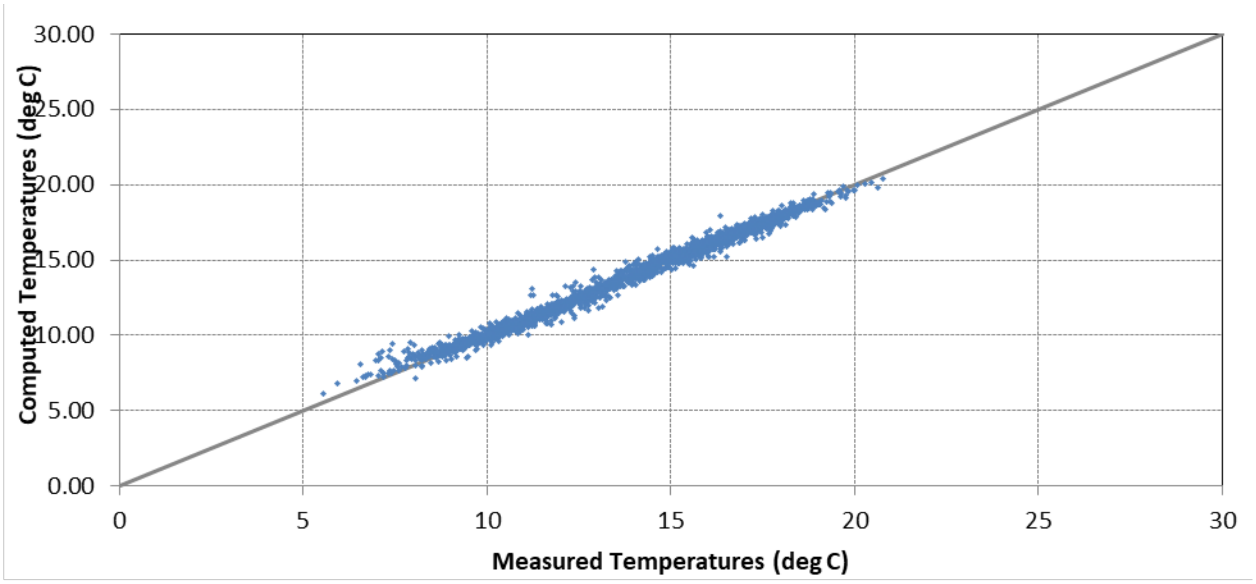
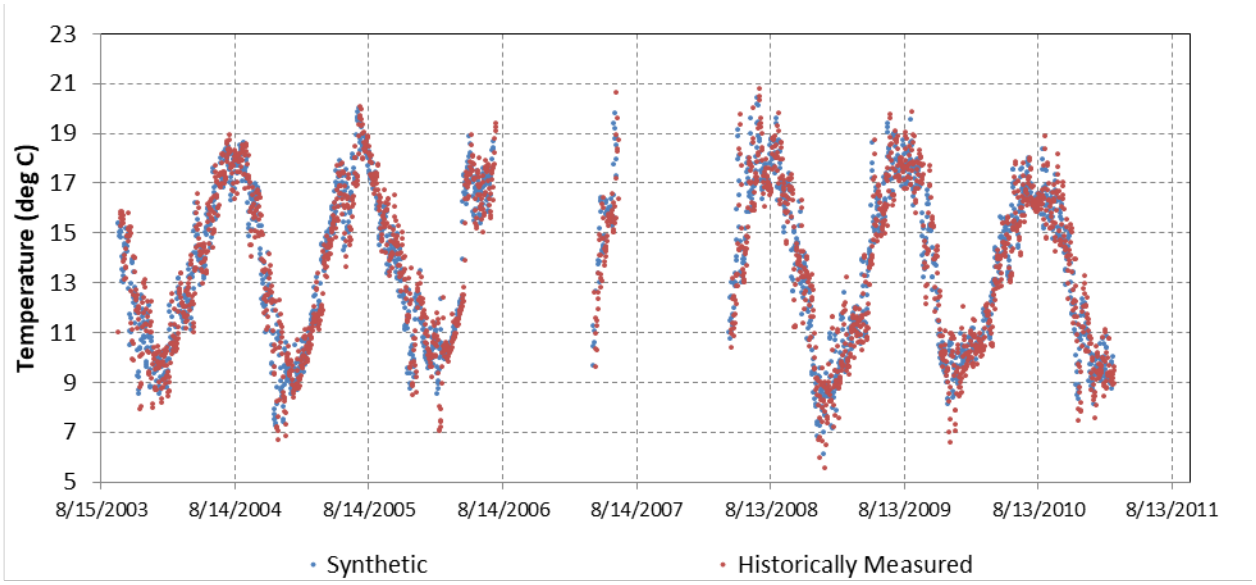


Table 4.2-42. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Stevens Creek Above Freemont Avenue, STEV3, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
Downstream of Freemont Avenue	0.99	0.01	0.26

Figure 4.2-42. Stevens Creek Validation at STEV3



Predictions of average daily temperatures on Stevens Creek at STEV3 were within 0.26 degrees of measured temperatures, on average. For all of the final selected regression locations on Stevens Creek, the flow below Stevens Creek Reservoir (model location STEV6, gage SF44) was used because it was the only flow location available and because it was more representative of the flows at the desired temperature locations than the downstream flow location SF35.

4.2.6.6 STEV2

Stevens Creek at El Camino Real was selected as the representative water temperature gage for STEV2. Monthly relative contributions of the regression terms for STEV2, Stevens Creek at Central Avenue are shown in Table 4.2-43.

Table 4.2-43. Contribution of Regression Components for Stevens Creek at Central Avenue, STEV2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Upstream Water Temperature (% of Calculation)	0.93	0.95	0.86	0.76	0.76	0.77	0.52	---	0.89	0.88	0.77	0.65	0.82
Previous Day Temperature (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow (% of Calculation)	0.02	0.02	0.02	0.01	0.01	0.07	---	0.00	0.11	0.29	0.04	0.03	0.02
Air Temperature (% of Calculation)	0.04	0.03	0.11	0.23	0.22	0.15	---	0.00	0.01	0.01	0.19	0.32	0.14

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Constant (% of Calculation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Overall, the upstream water temperature has the highest contribution to the calculation at this location, and contributes 52-79% to the calculations throughout the year. Air temperature accounts for up to 30% of the calculations, with the greatest contribution in December. Flow accounts for 1-29% of the calculations, with the greatest contribution in October. Figure 4.2-43 shows the accuracy of the computed temperatures, relative to the measured temperatures for Stevens Creek at Central Avenue. Table 4.2-44 shows the resulting coefficient of determination, mean error, and absolute mean error for the calibration period of record.

Figure 4.2-43. Accuracy of Computed Temperatures Relative to Measured Temperatures for Stevens Creek at Central Avenue, STEV2

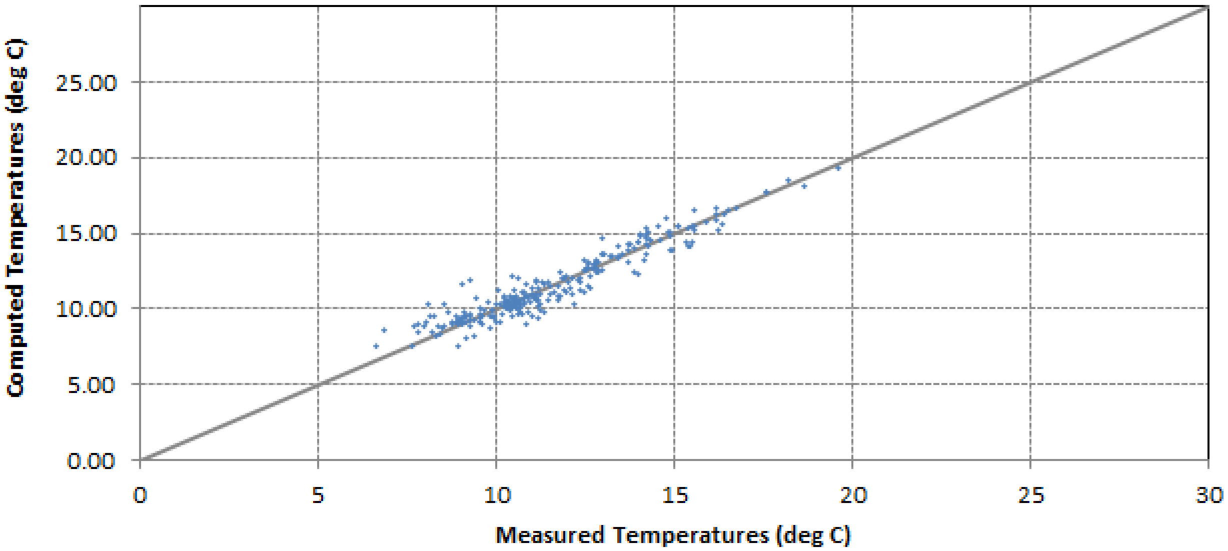
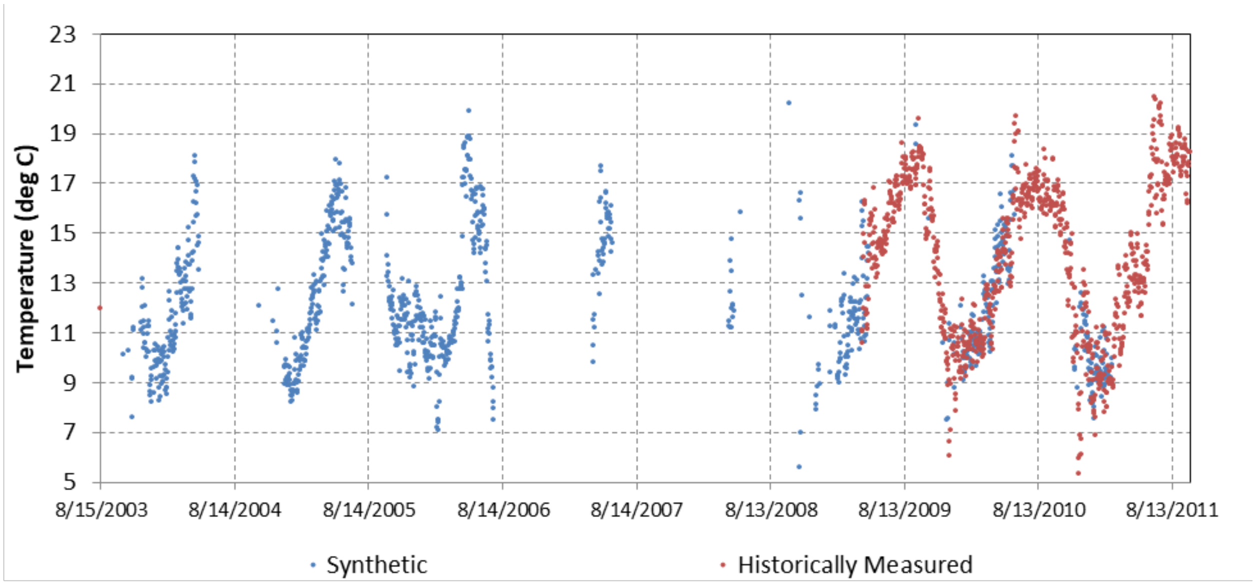


Table 4.2-44. Summary of the Coefficient of Determination, Mean Error and Absolute Mean Error for Stevens Creek at Central Avenue, STEV2, Water Temperature Regression

Water Temperature Regression Data Source	Coefficient of Determination (R-squared)	Mean Error (°C)	Absolute Mean Error (°C)
El Camino Real	0.91	-0.02	0.52

Figure 4.2-44. Stevens Creek Validation at STEV2



Predictions of average daily temperatures on Stevens Creek at STEV2 were within 0.52 degrees of measured temperatures, on average. Flows above Highway 85 (SF35) were used for STEV2 since it is the closest monitoring location, but there are extensive periods without any measured flows at this location, likely due to dry-backs; though upstream water temperatures are used as an input to this location's water temperature calculation, the disconnection to upstream water temperatures through the dry-backs means that correlation with upstream water temperatures may, at times, be coincidental rather than a real influence. Due to this, regressions from this location are unreliable.

4.2.6.7 STEV1

Locations like STEV1 are subject to dry-backs, or periods of time when the streambed is dry and influenced from the San Francisco Bay. Due to this, regressions from this location are highly unreliable and regression coefficients were not developed.

4.2.6.8 Discussion

The temperature regressions for Stevens Creek have low uncertainty: R^2 ranged from 0.91 to 0.99 and mean error was less than +/-.02°C.

There could be additional influences due to local inflows and corresponding local inflow temperatures downstream of Stevens Creek Reservoir that are not represented in the regression due to lack of information.

The flow below Stevens Creek Reservoir (SF44) was used for most of the locations because it was more representative of the flows at the desired temperature locations except STEV2 than the downstream flow location SF35. Therefore, the regressions could not represent the effect of any flow changes that may have occurred between SF44 and the points of interest. Locations like STEV2 are subject to dry-backs, or periods of time when the streambed is dry. Due to this, regressions from this location are unreliable.

5 Regression Limitations

Water temperature regressions assume that District operations are constant except for the changing rule curves. The regressions represent a mathematical model rather than a physical model, and are not intended to model the following:

- Changes in channel or reservoir geometry
- Substantial changes to water temperatures into or out of the reservoir
- Substantial changes to downstream flow patterns or diversions

Historical data were collected within a time period that was assumed to have negligible changes to channel geometry, reservoir bathymetry, and reservoir spillway geometry. Changes to these physical characteristics would change the temperature interactions in a reach or reservoir. Because the current model approach assumes these physical characteristics are constant, scenarios with substantial differences to these characteristics would have to be modeled using a physical model rather than the current model approach to achieve meaningful results.

In addition to the physical and geometric characteristics implicit in the modeling assumptions, certain implicit assumptions are also made about boundary conditions. Water temperatures are assumed to be cooler than the air temperature and warm towards equilibrium downstream of the reservoir. Applying the current regressions to substantially different boundary condition water temperatures is inadvisable. If the water temperature at the reservoir has already reached or neared equilibrium, water temperatures downstream will be less reactive to temperature changes upstream than currently represented in the model. A scenario with full or empty reservoirs year-round would alter the boundary condition as well as the timing and location of equilibrium. A spilling reservoir would withdraw warmer water from the top of the reservoir rather than near the bottom, as is currently represented, and would reach equilibrium with atmospheric conditions further upstream in the reach below the reservoir. An empty reservoir would behave more like stream temperatures than is currently represented, and more information about conditions further upstream would need to be known, invalidating the existing boundary condition assumptions.

Due to limited spatial availability of data, regressions assume a fixed relationship between flow at available locations and temperature at POI. Since flow data were not available at every POI, the flow coefficient in the regressions represents the effect of changing flow at a specific location where data were available, often upstream of the POI. In the historical data, significant accretions and depletions occurred between the gaged flow location and the temperature location. Therefore, the effects of any accretions and depletions between the POI and the flow gage are represented by the constant term in the regression rather than the flow coefficient. Because the term is constant and is not multiplied by anything, any changes to diversions or depletions between the flow point and the POI would not be accurately represented, although they may be represented in the WEAP operations model.

Regression equations developed in this analysis can be applied with high confidence over the historically-observed range of input data used to develop the regression coefficients. To some extent, the regression equations can be used outside this range, albeit with less confidence, but for the reasons listed in the above paragraphs there is some outer limit in which the results are no longer reasonable or valid. In Sections 4.2.1 through 4.2.7, the range of each input variable used to develop the regression coefficients is presented to identify the range of high confidence that the regression equations can be used. The 99% and 1% exceedances of upstream temperature, flow, and storage were used for an estimate of the outside range of less confidence. Values outside of this range (i.e. storages closer to empty or full reservoirs, flows far outside the observed range of district operations, and/or upstream reservoir temperatures warmer than the seasonally observed range) would no longer be deemed reasonable or meaningful.

The accuracy of predicted reservoir release temperatures at the head of each reach has lasting effects; temperatures are propagated downstream as the output from an upstream regression becomes the input for a downstream regression. Reservoir storage is a key variable in the prediction of reservoir release temperature. The model uses greatly simplified assumptions for reservoir outflow temperatures and stream temperatures. The relationship between outflow, storage, air temperature, and outflow temperature is assumed to be linear. In reality, reservoir warming may accelerate or decelerate as storage decreases or as water is drawn from different elevations in the reservoir. Variables that affect stream temperature such as wind, cloudiness, and shading are not modeled. Sub-daily or hourly flow and air temperature changes are not represented and could also add to the model uncertainty.

Some reaches did not have a full year of regression input data or measured water temperature data, in some cases leaving multi-month gaps. To compensate for the missing temperature data, data from other locations were substituted to fill the gaps. Substituted data were chosen due to its similar geography and behavior to the available temperature data at the locations. Daily regression coefficients were interpolated for data gaps of 30 days or less.

The following sections present haze charts of input data used to develop the daily regressions to highlight the range of high confidence over which the regressions can be used. The range of historical input data were truncated to show only times when overlapping flow data, downstream temperature data, and upstream temperature or storage data were available. In some locations, the availability of downstream temperature or upstream temperature limited the time period for which flow or storage could be used. Haze charts of maximum daily air temperature are not presented because air temperature is an independent variable and will not vary between modeled alternatives.

5.1 Guadalupe River

5.1.1 GUAD7

Figure 5.1-1 through Figure 5.1-4 and Table 5.1-1 through Table 5.1-4 show the range of historical upstream water temperatures and flows used in the regression at GUAD7, Guadalupe River below Alamitos Drop Structure. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.1-1. Range of High Confidence for Upstream Temperature at GUAD7 from Almaden Expressway

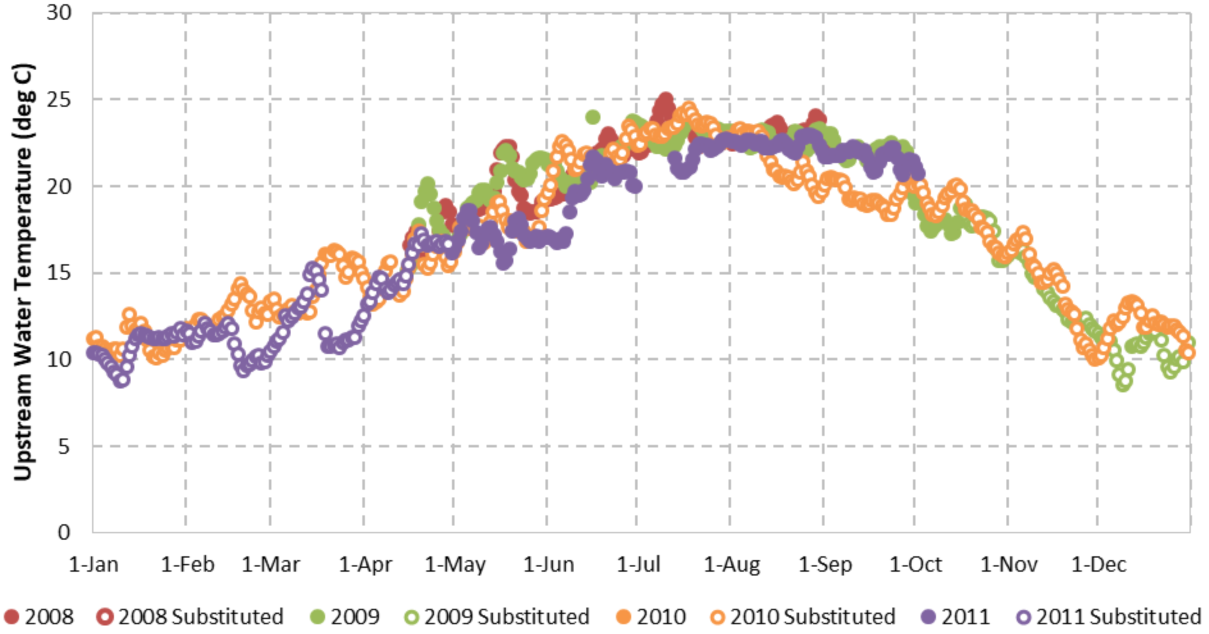


Table 5.1-1. Range of High Confidence for Upstream Temperature at GUAD7 from Almaden Expressway

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Temperature	10.1	9.2	10.7	10.6	12.5	12.8	15.3	15.7	14.3	13.2	12.0	11.4
1% Exceedance Temperature	12.9	12.4	13.8	18.9	19.9	22.5	23.1	19.9	18.9	18.2	18.6	14.8

Of the period used, 99% of the upstream water temperature data points from Almaden Expressway were above 9.2°C and 99% of the temperature data points were below 22.5°C. Temperature values based on modeled temperatures below 9.2°C or above 22.5°C cannot be predicted with high confidence. In addition, the haze chart above demonstrates the lack of data for this location. No historical temperature data were available for December through April. Temperatures in early December and late April were substituted with data from Upstream Calero Creek.

Figure 5.1-2. Range of High Confidence for Upstream Temperature at GUAD7 from Mazzone Drive

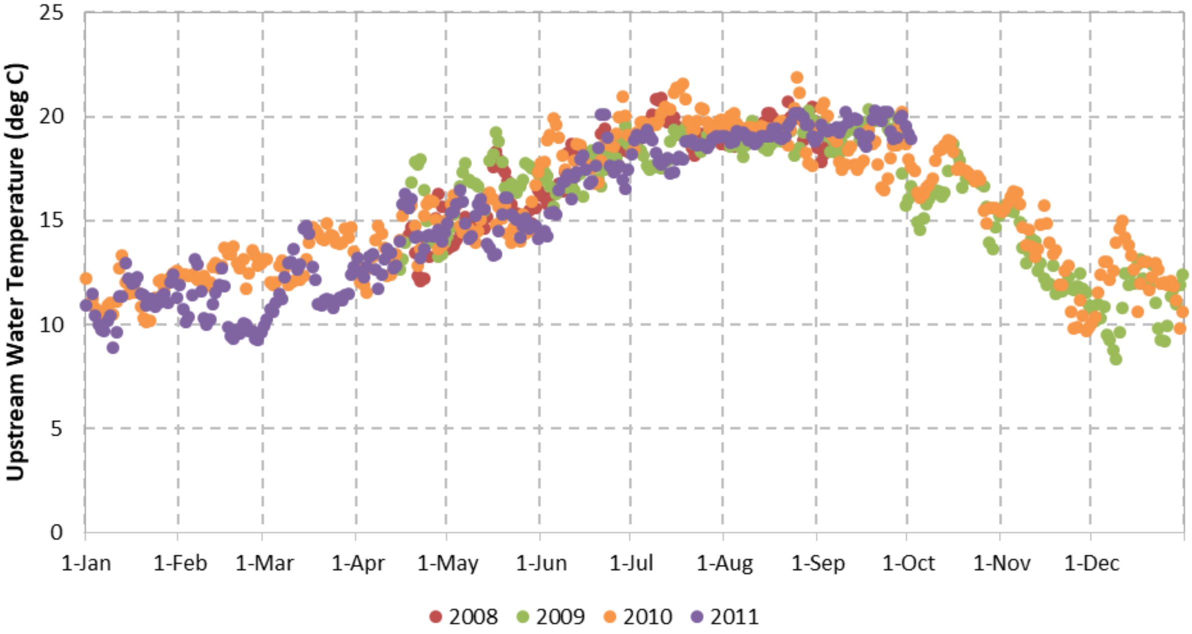


Table 5.1-2. Range of High Confidence for Upstream Temperature at GUAD7 from Mazzone Drive.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	8.9	9.3	9.9	11.5	13.4	14.3	17.3	17.7	15.7	13.6	9.7	8.3
1% Exceedance Flow	13.3	13.7	14.9	17.9	19.2	21.0	21.6	21.9	20.7	19.2	16.4	15.0

Of the period used, 99% of the upstream water temperature data points from Mazzone Drive were above 8.3°C and 99% of the temperature data points were below 21.9°C. Temperature values based on modeled temperatures below 8.3°C or above 21.9°C cannot be predicted with high confidence.

Figure 5.1-3. Range of High Confidence for Flows at GUAD7 from Graystone Lane (SF70)

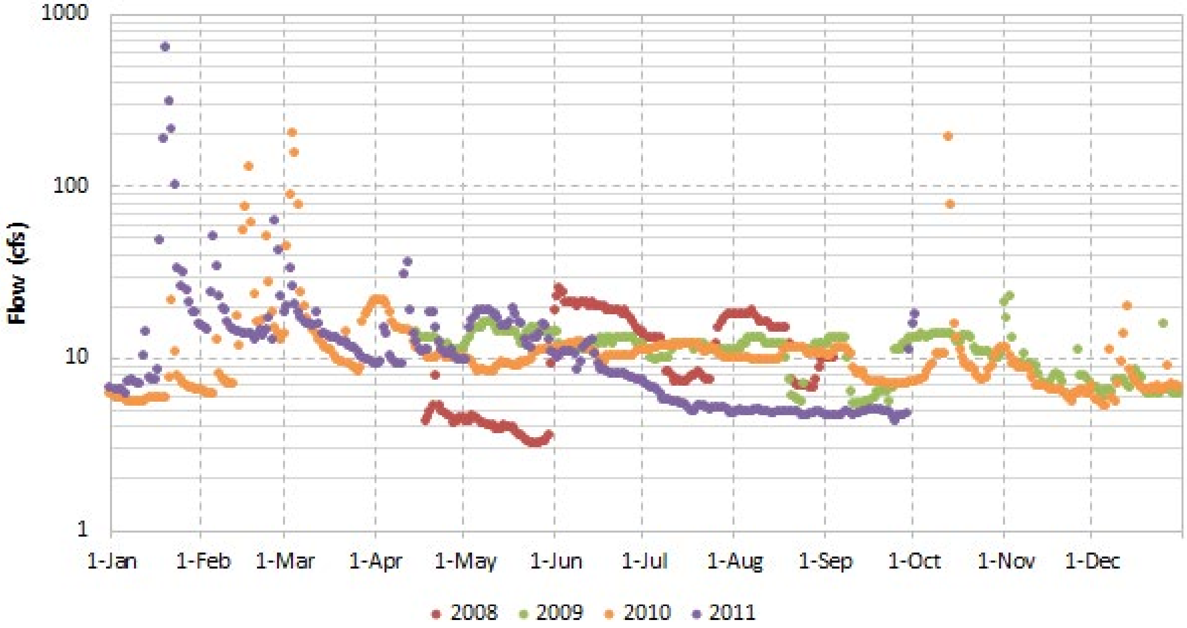


Table 5.1-3. Range of High Confidence for Flows at GUAD7 from Graystone Lane (SF70)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	5.6	6.1	8.2	4.2	3.2	7.4	4.8	4.6	4.3	7.3	5.6	5.3
1% Exceedance Flow	632.0	129.0	201.0	35.4	19.4	25.0	18.0	19.0	13.0	192.0	22.5	19.7

Of the period used, 99% of the flow data points from Graystone Lane (SF70) were above 3.2 cfs and 99% were below 632 cfs. For GUAD7, temperature values based on modeled flows below 3.2 cfs or above 632 cfs cannot be predicted with high confidence.

Figure 5.1-4. Range of High Confidence for Flows at GUAD7 from Off Hicks Road (SF43)

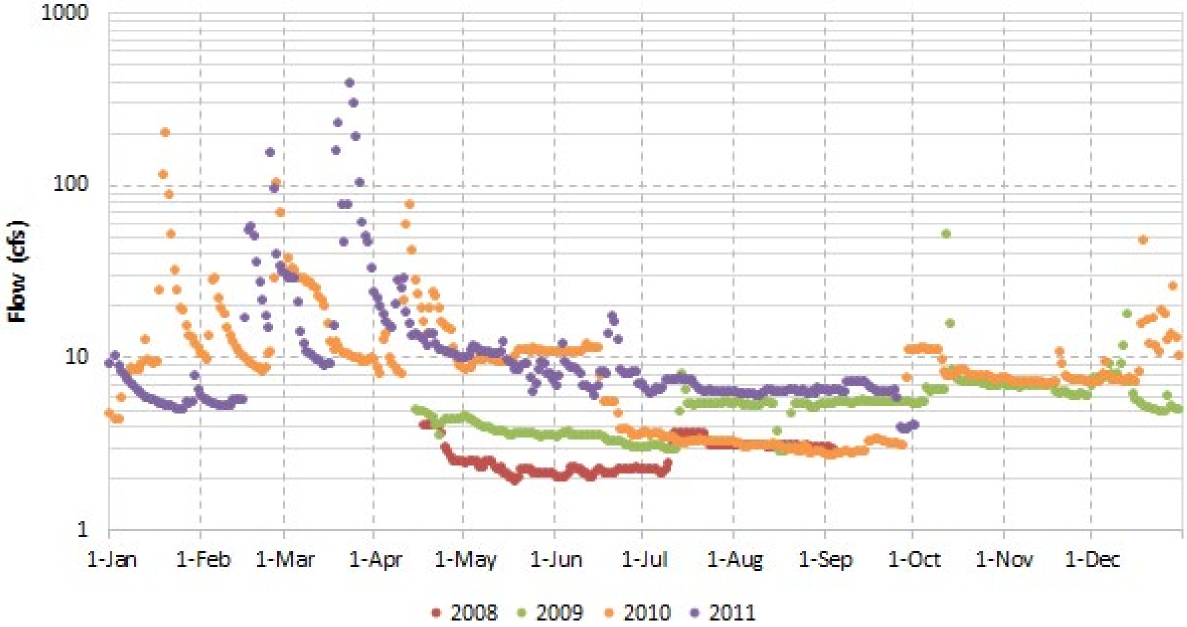


Table 5.1-4.Range of High Confidence for Flows at GUAD7 from Off Hicks Road (SF43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	4.4	5.2	8.8	2.5	1.9	2.0	2.1	2.8	2.7	3.9	6.0	4.8
1% Exceedance Flow	197.0	154.0	383.0	75.6	12.3	17.1	7.9	6.5	11.0	51.1	10.7	47.2

Of the period used, 99% of the flow data points from Off Hicks Road (SF43) were above 2.1 cfs and 99% were below 383 cfs. For GUAD7, temperature values based on modeled flows below 2.1 cfs or above 383 cfs cannot be predicted with high confidence.

5.1.2 GUAD5

Figure 5.1-5 and Figure 5.1-6 and Table 5.1-5 and Table 5.1-6 show the range of historical upstream water temperatures and flows used in the regression at GUAD5, Guadalupe River above Los Gatos Creek. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.1-5. Range of High Confidence for Upstream Temperature at GUAD5.

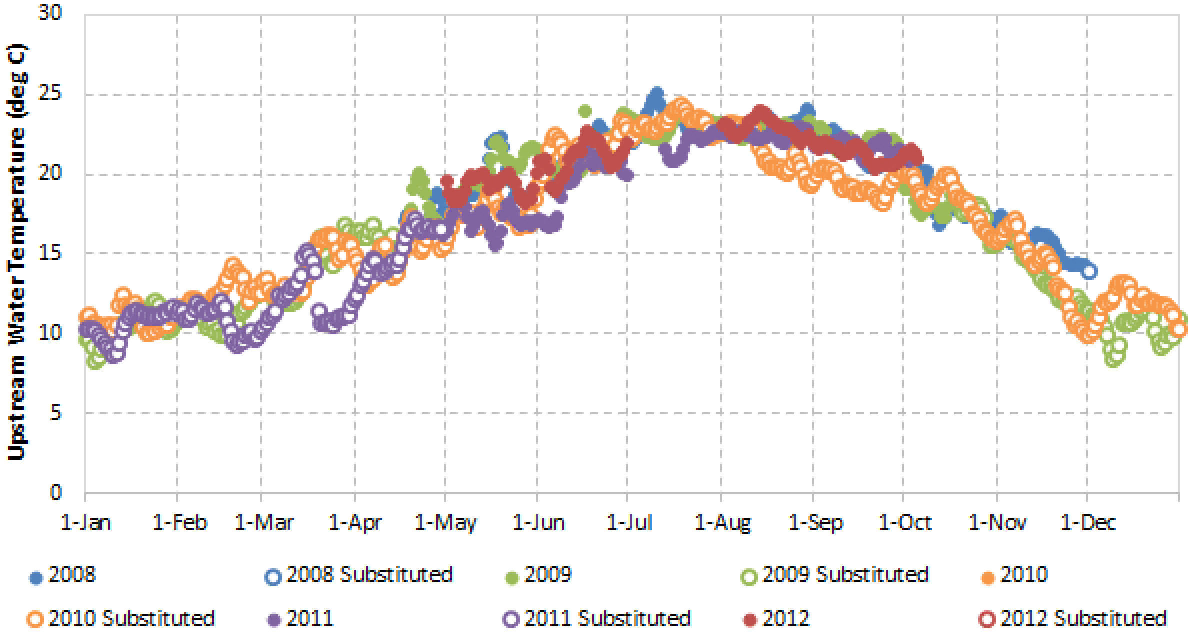


Table 5.1-5. Range of High Confidence for Upstream Temperature at GUAD5.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	8.4	9.3	10.5	12.5	15.5	16.7	20.8	19.3	18.3	15.7	10.0	8.5
1% Exceedance Flow	12.5	14.3	16.8	20.1	22.3	24.0	25.0	24.0	23.0	21.6	17.5	14.0

Of the period used, 99% of the upstream water temperature data points were above 8.4°C and 99% of the temperature data points were below 25°C. Temperature values based on modeled temperatures below 8.4°C or above 25°C cannot be predicted with high confidence. In addition, the haze chart above demonstrates the lack of data for this location. No historical temperature data were available for December through March. Temperatures in early December and late March were substituted with data from downstream Lark Avenue.

Figure 5.1-6. Range of High Confidence for Flows at GUAD5.

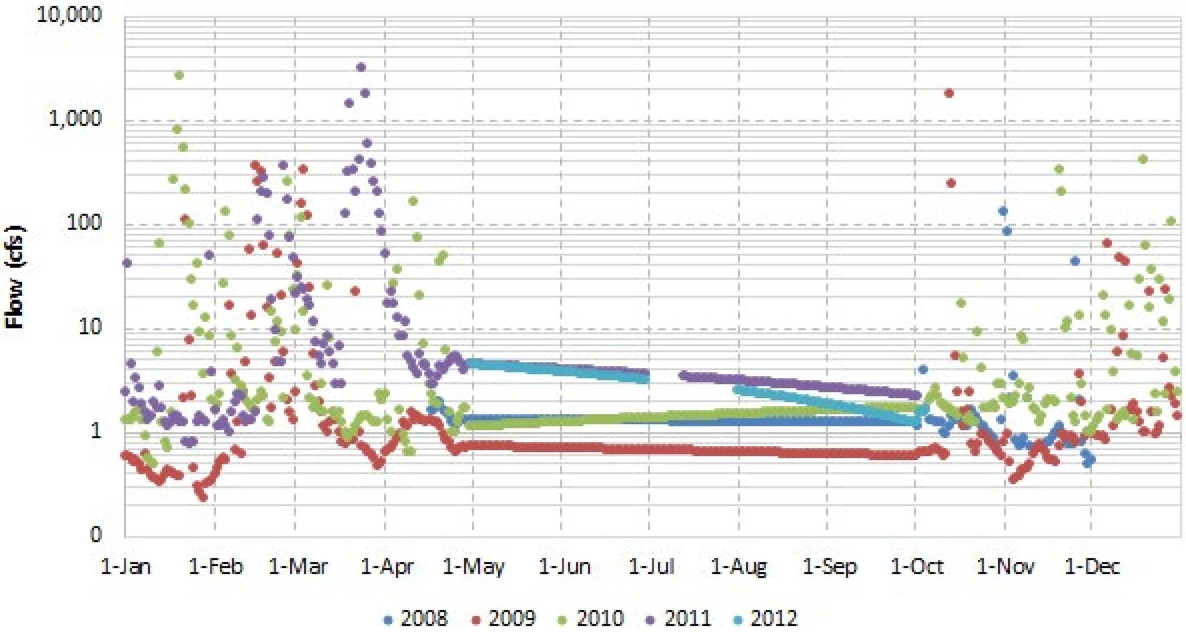


Table 5.1-6. Range of High Confidence for Flows at GUAD5.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	0.2	0.4	0.5	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.3	0.5
1% Exceedance Flow	2,620.0	361.0	3,080	162.0	4.4	3.9	3.3	3.1	2.6	1,780	319	407

Of the period used, 99% of the flow data points were above 0.2 cfs and 99% were below 3,080 cfs. For GUAD5, temperature values based on modeled flows below 0.2 cfs or above 3,080 cfs cannot be predicted with high confidence.

5.1.3 GUAD4

Figure 5.1-7 through Figure 5.1-10 and Table 5.1-7 through Table 5.1-10 show the range of historical upstream water temperatures and flows used in the regression at GUAD4, Guadalupe River at Coleman Avenue. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.1-7. Range of High Confidence for Upstream Temperature at GUAD4 from Virginia Street

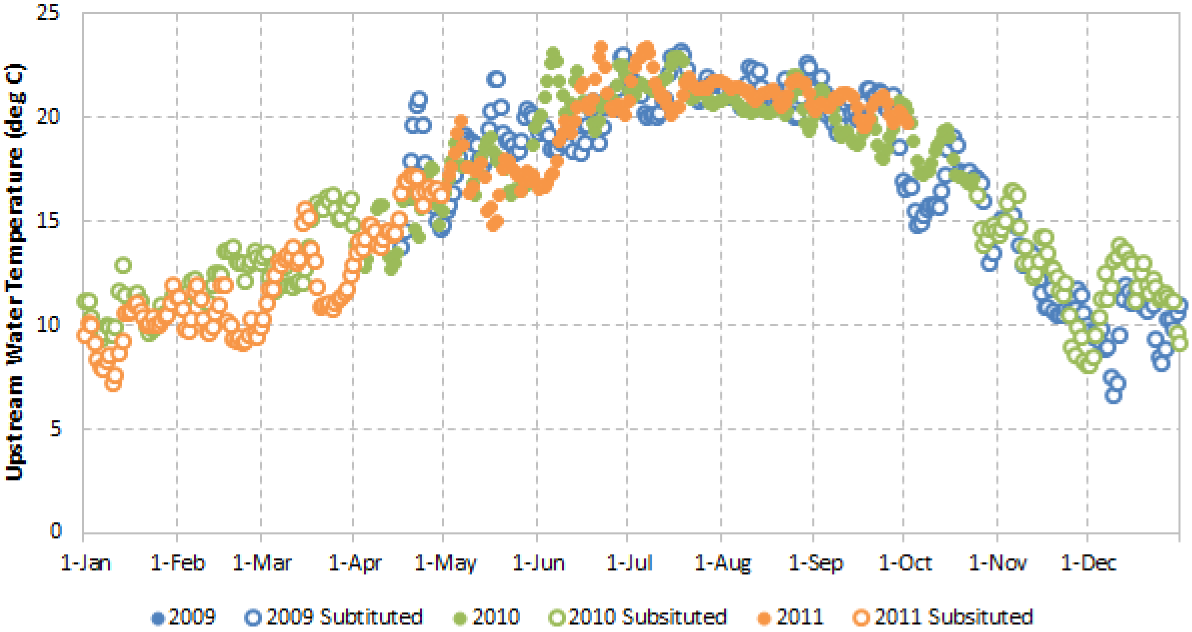


Table 5.1-7. Range of High Confidence for Upstream Temperature at GUAD4 from Virginia Street

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	7.2	9.2	10.4	12.7	14.8	16.6	20.0	19.3	17.0	13.0	8.1	6.6
1% Exceedance Flow	12.9	13.8	16.3	21.0	21.9	23.4	23.4	22.7	22.0	20.6	16.5	13.9

Of the period used, 99% of the upstream water temperature data points from Virginia Street were above 7.2°C and 99% of the temperature data points were below 23.4°C. Temperature values based on modeled temperatures below 7.2°C or above 23.4°C cannot be predicted with high confidence. In addition, the haze chart above demonstrates the lack of data for this location; for each day of year, only 2 to 3 data points are available. No historical temperature data were available for October through April. Temperatures in mid-October and late April were substituted with data from Los Gatos Creek-Lincoln Avenue.

Figure 5.1-8. Range of High Confidence for Upstream Temperature at GUAD4 from Lincoln Avenue (SF50)

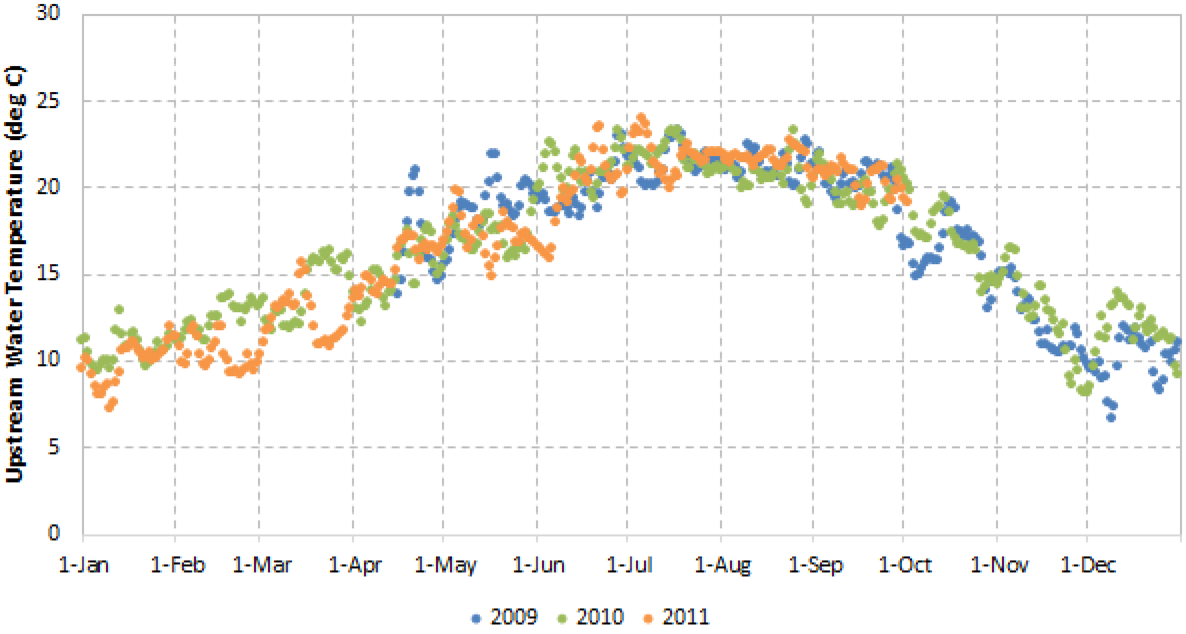


Table 5.1-8. Range of High Confidence for Upstream Temperature at GUAD4 from Lincoln Avenue (SF50).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	7.2	9.2	10.4	12.2	14.9	15.9	19.9	19.0	17.0	13.0	8.1	6.6
1% Exceedance Flow	12.9	13.8	16.3	21.0	21.9	23.5	24.0	23.2	22.0	20.5	16.5	13.9

Of the period used, 99% of the upstream water temperature data points from Lincoln Avenue were above 7.2°C and 99% of the temperature data points were below 24°C. Temperature values based on modeled temperatures below 7.2°C or above 24°C cannot be predicted with high confidence. In addition, the haze chart above demonstrates the lack of data for this location; for each day of year, only 2 to 3 data points are available.

Figure 5.1-9. Range of High Confidence for Flows at GUAD4 from St John

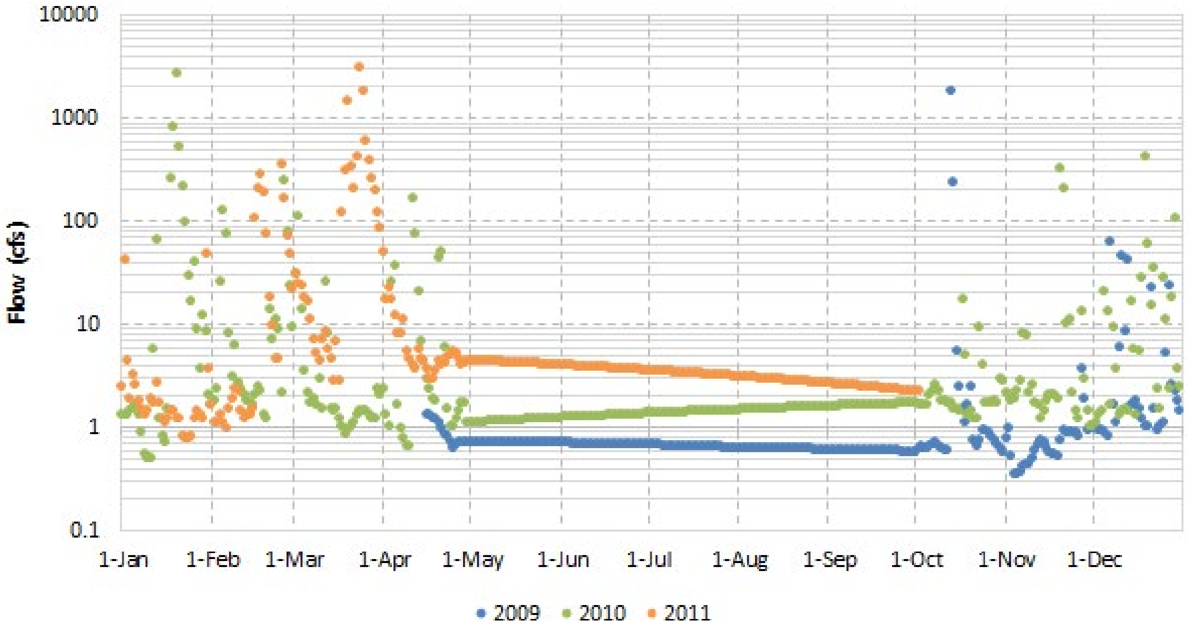


Table 5.1-9. Range of High Confidence for Flows at GUAD4 from St John

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	0.5	1.0	0.9	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.3	0.8
1% Exceedance Flow	2,620	355.0	3,080	162.0	4.4	3.9	3.5	3.1	2.6	1,780	319	407

Of the period used, 99% of the flow data points from St John were above 0.3 cfs and 99% were below 3,080 cfs. For GUAD4, temperature values based on modeled flows below 0.3 cfs or above 3,080 cfs cannot be predicted with high confidence. In addition, the haze chart above demonstrates the lack of data for this location; for each day of year, only 2 to 3 data points are available.

Figure 5.1-10. Range of High Confidence for Flows at GUAD4 from Lincoln Avenue (SF50)

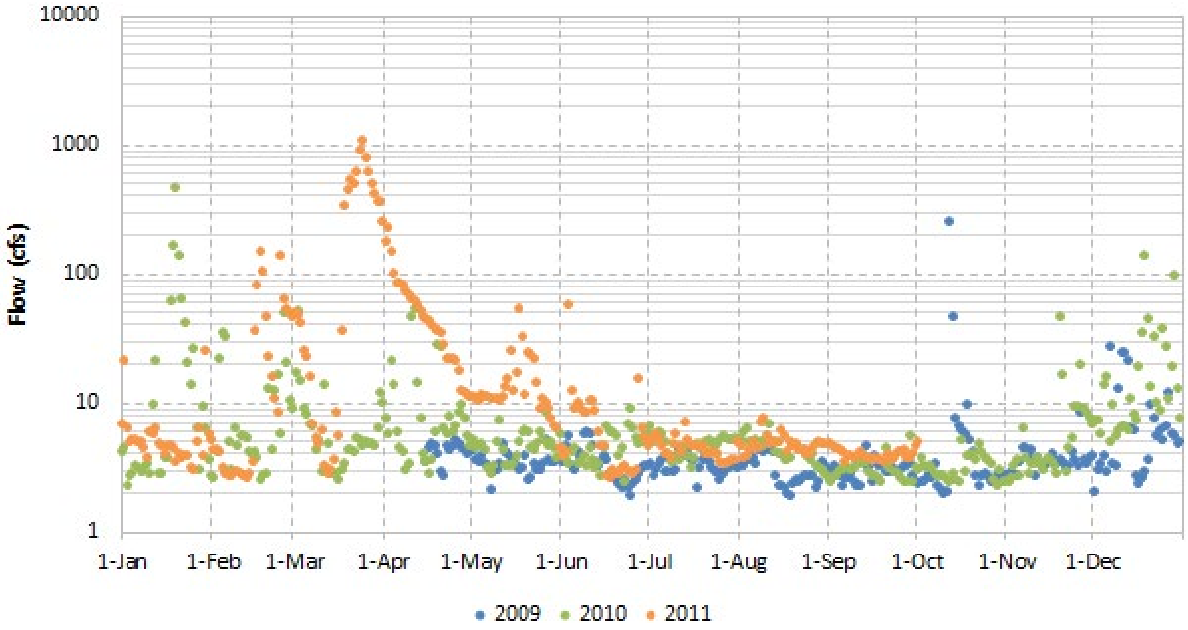


Table 5.1-10. Range of High Confidence for Flows at GUAD4 from Lincoln Avenue (SF50)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	2.2	2.5	2.5	2.6	2.1	1.9	2.2	1.9	2.2	1.9	2.3	2.0
1% Exceedance Flow	446.0	145.0	1,060	248.0	52.5	56.8	6.9	7.5	5.4	244.0	45.1	137

Of the period used, 99% of the flow data points from Lincoln Avenue (SF50) were above 1.9 cfs and 99% were below 1.9 cfs. For GUAD4, temperature values based on modeled flows below 2 cfs or above 223 cfs cannot be predicted with high confidence. In addition, the haze chart above demonstrates the lack of data for this location; for each day of year, only 2 to 3 data points are available.

5.1.4 GUAD3

Figure 5.1-11 and Figure 5.1-12 and Table 5.1-11 and Table 5.1-12 show the range of historical upstream water temperatures and flows used in the regression at GUAD3, Guadalupe River at San Jose Airport. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.1-11. Range of High Confidence for Upstream Temperature at GUAD3

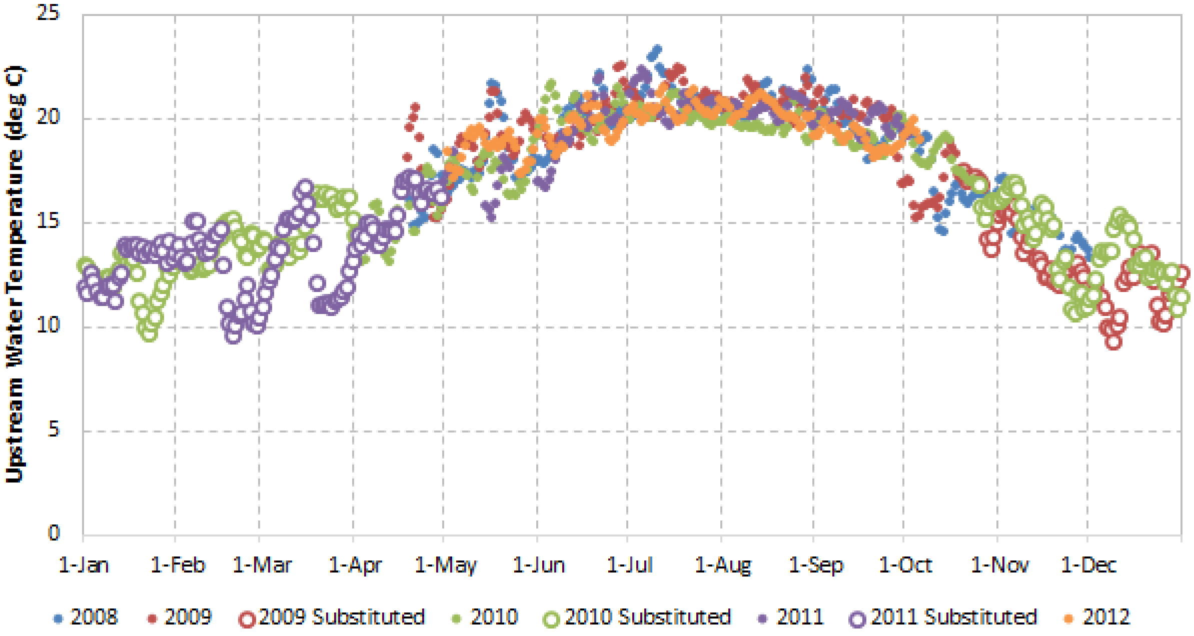


Table 5.1-11. Range of High Confidence for Upstream Temperature at GUAD3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	9.8	9.7	11.0	13.1	15.2	16.6	19.6	18.8	16.8	13.7	10.7	9.3
1% Exceedance Flow	14.2	15.2	16.8	20.4	21.6	22.5	23.3	22.3	21.4	19.8	17.1	15.4

Of the period used, 99% of the upstream water temperature data points were above 9.7°C and 99% of the temperature data points were below 23.3°C. Temperature values based on modeled temperatures below 9.7°C or above 23.3°C cannot be predicted with high confidence. In addition, the haze chart above demonstrates the lack of data for this location. No historical temperature data were available for October through April. Temperatures in mid-October and late April were substituted with data from Los Gatos Creek-Confluence with Guadalupe.

Figure 5.1-12. Range of High Confidence for Flows at GUAD3

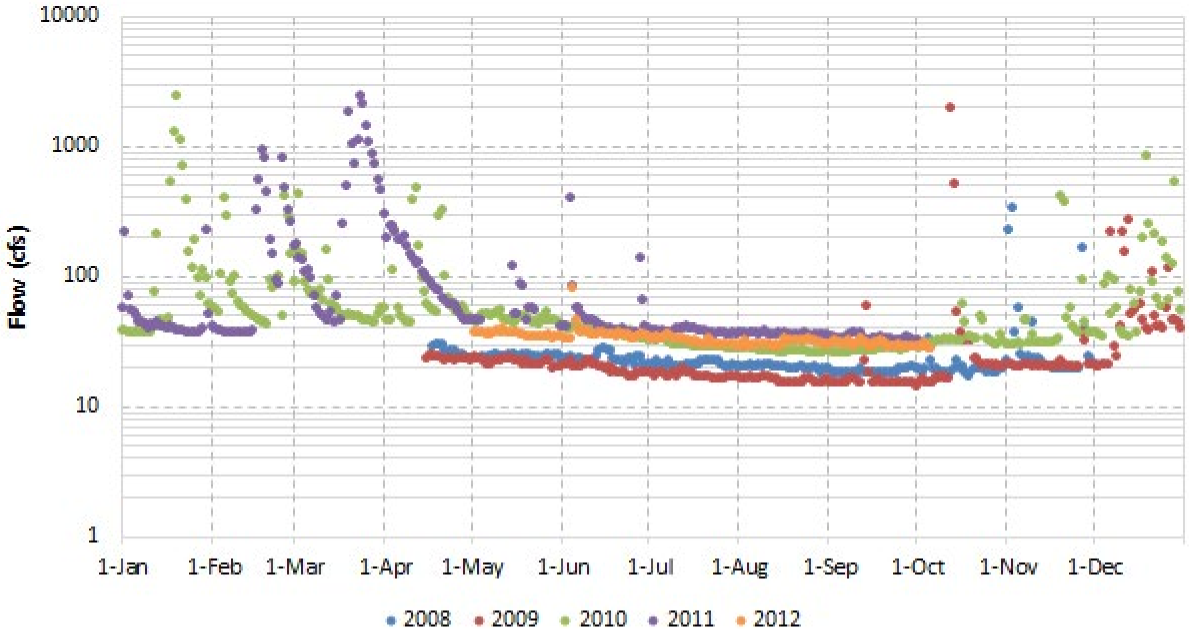


Table 5.1-12. Range of High Confidence for Flows at GUAD3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	36.0	36.0	44.0	22.0	19.0	17.0	16.0	15.0	15.0	14.0	19.0	20.0
1% Exceedance Flow	2,370	908.0	2,360	472.0	116	395	41.0	38.0	59.0	1,970	401	833

Of the period used, 99% of the flow data points were above 14 cfs and 99% were below 2,370 cfs. For GUAD3, temperature values based on modeled flows below 14 cfs or above 2,370 cfs cannot be predicted with high confidence.

5.2 Guadalupe Creek

5.2.1 GCRK4

Figure 5.2-1 and Figure 5.2-2 and Table 5.2-1 and Table 5.2-2 show the range of historical storages and flows used in the regression at GCRK4, Guadalupe Creek below Guadalupe Reservoir. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.2-1. Range of High Confidence for Upstream Storage at GCRK4

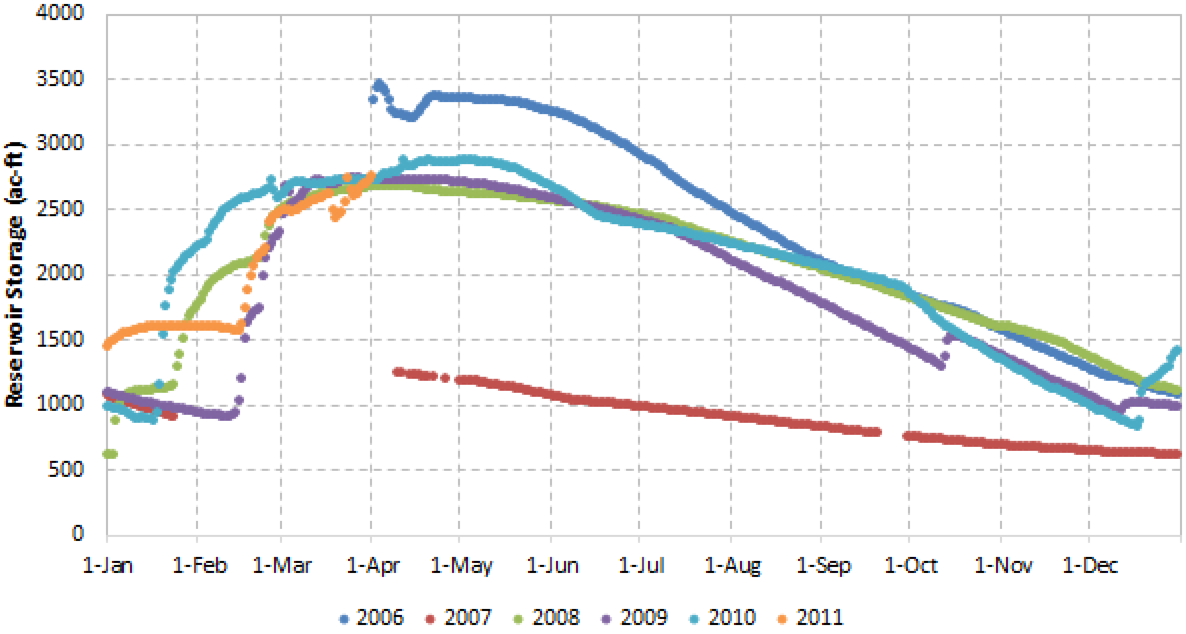


Table 5.2-1. Range of High Confidence for Upstream Storage at GCRK4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	603.8	905.2	2,311	1,194.2	1,069.2	980.0	905.1	827.2	750.1	686.3	639.8	609.3
1% Exceedance Flow	2,188.4	2,718.7	2,738	3,459.8	3,352.2	3,246.6	2,919.3	2,471.1	2,087.1	1,846.6	1,591.7	1,415.3

Of the period used, 99% of the storage data points were above 603.8 acre-feet and 99% were below 3,459.8 acre-feet. Values based on modeled storages below 603.8 acre-feet or above 3,459.8 acre-feet cannot be predicted with high confidence.

Figure 5.2-2. Range of High Confidence for Flows at GCRK4

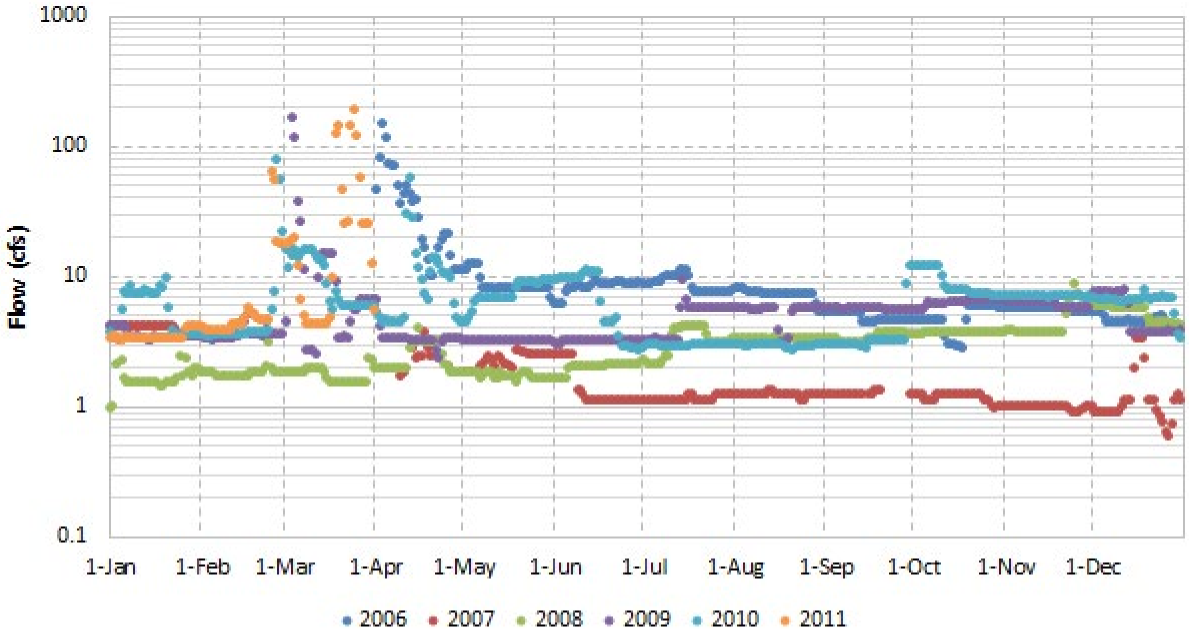


Table 5.2-2. Range of High Confidence for Flows at GCRK4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	0.9	1.7	1.5	1.7	1.5	1.1	1.1	1.1	1.2	0.9	0.9	0.6
1% Exceedance Flow	9.6	78.1	188.0	145.0	12.0	11.0	11.0	7.9	11.7	11.8	8.4	7.7

Of the period used, 99% of the flow data points were above 0.9 cfs and 99% were below 188 cfs. For GCRK4, temperature values based on modeled flows below 0.9 cfs or above 188 cfs cannot be predicted with high confidence.

5.2.2 GCRK3

Figure 5.2-3 and Figure 5.2-4 and Table 5.2-3 and Table 5.2-4 show the range of historical upstream water temperatures and flows used in the regression at GCRK3, Guadalupe Creek above Masson Dam. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.2-3. Range of High Confidence for Upstream Temperature at GCRK3

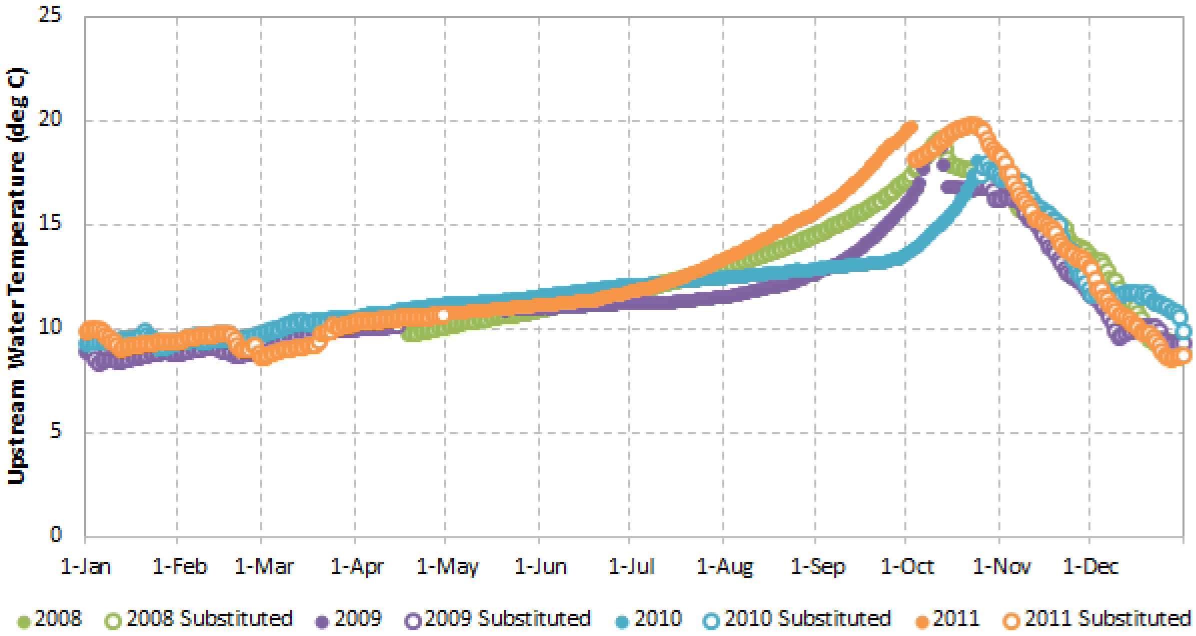


Table 5.2-3. Range of High Confidence for Upstream Temperature at GCRK3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	8.4	8.7	8.7	9.8	10.2	11.0	11.2	11.5	12.7	13.6	11.7	8.6
1% Exceedance Flow	10.0	9.9	10.5	11.2	11.5	12.1	13.3	15.5	19.4	19.9	18.3	13.3

Of the period used, 99% of the upstream water temperature data points were above 8.4°C and 99% of the temperature data points were below 19.9°C. Temperature values based on modeled temperatures below 8.4°C or above 19.9°C cannot be predicted with high confidence. In addition, the haze chart above demonstrates the lack of data for this location. No historical temperature data were available for late October through April. Temperatures in late October and late April were substituted with temperatures from Stevens Creek Reservoir Outlet.

Figure 5.2-4. Range of High Confidence for Flows at GCRK3

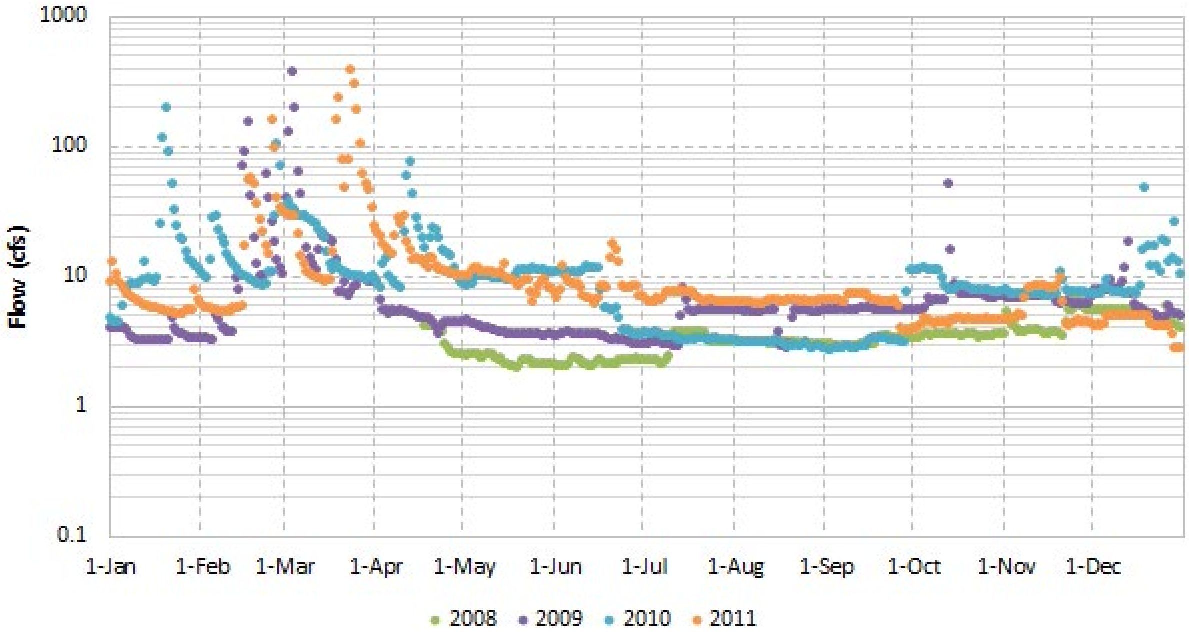


Table 5.2-4. Range of High Confidence for Flows at GCRK3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	3.2	3.2	7.0	2.5	1.9	2.0	2.1	2.8	2.7	3.3	3.5	2.8
1% Exceedance Flow	197.0	154.0	383.0	75.6	12.3	17.1	7.9	6.5	11.0	51.1	10.7	47.2

Of the period used, 99% of the flow data points were above 2 cfs and 99% were below 383 cfs. For GCRK3, temperature values based on modeled flows below 2 cfs or above 383 cfs cannot be predicted with high confidence.

5.2.3 GCRK2

Figure 5.2-5 and Figure 5.2-6 and Table 5.2-5 and Table 5.2-6 show the range of historical upstream water temperatures and flows used in the regression at GCRK2, Guadalupe Creek below Masson Dam. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.2-5. Range of High Confidence for Upstream Temperature at GCRK2

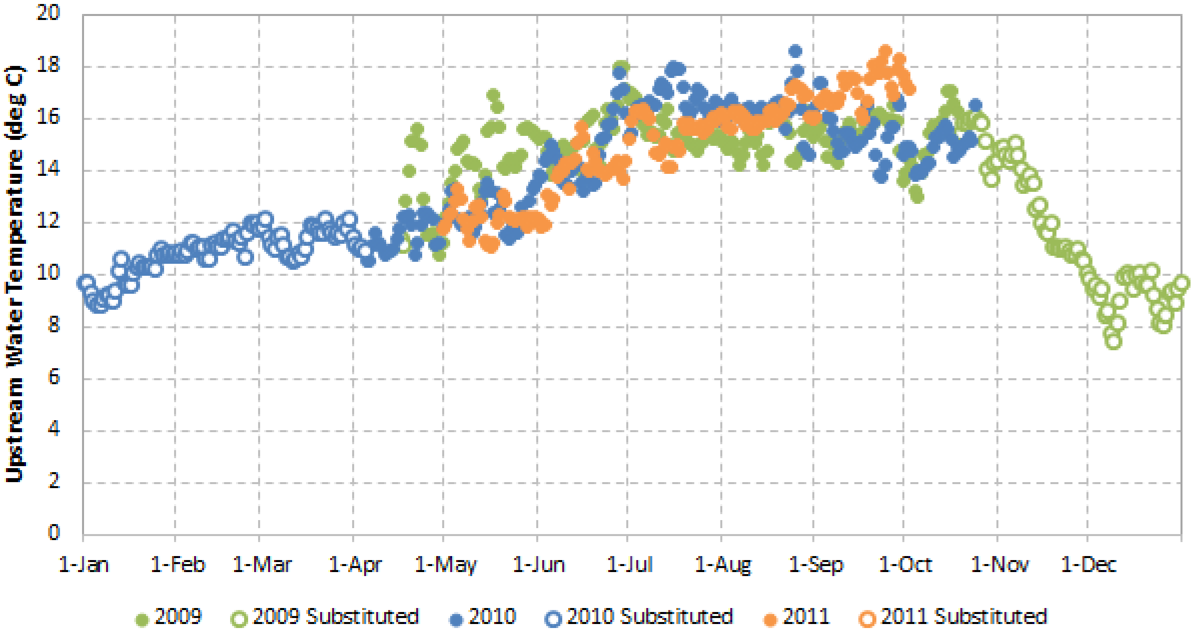


Table 5.2-5. Range of High Confidence for Upstream Temperature at GCRK2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	8.9	10.6	10.5	10.5	11.1	11.8	14.1	14.2	13.6	13.0	10.1	7.4
1% Exceedance Flow	11.0	12.0	12.2	15.6	16.9	18.0	18.0	18.6	18.6	17.3	15.1	10.1

Of the period used, 99% of the upstream water temperature data points were above 8.9°C and 99% of the temperature data points were below 18.6°C. Temperature values based on modeled temperatures below 8.9°C or above 18.6°C cannot be predicted with high confidence. In addition, the haze chart above demonstrates the lack of data for this location. No historical temperature data were available for late October through April. Temperatures in late October and April were substituted with temperatures from Alamitos Creek-Bertram Road.

Figure 5.2-6. Range of High Confidence for Flows at GCRK2

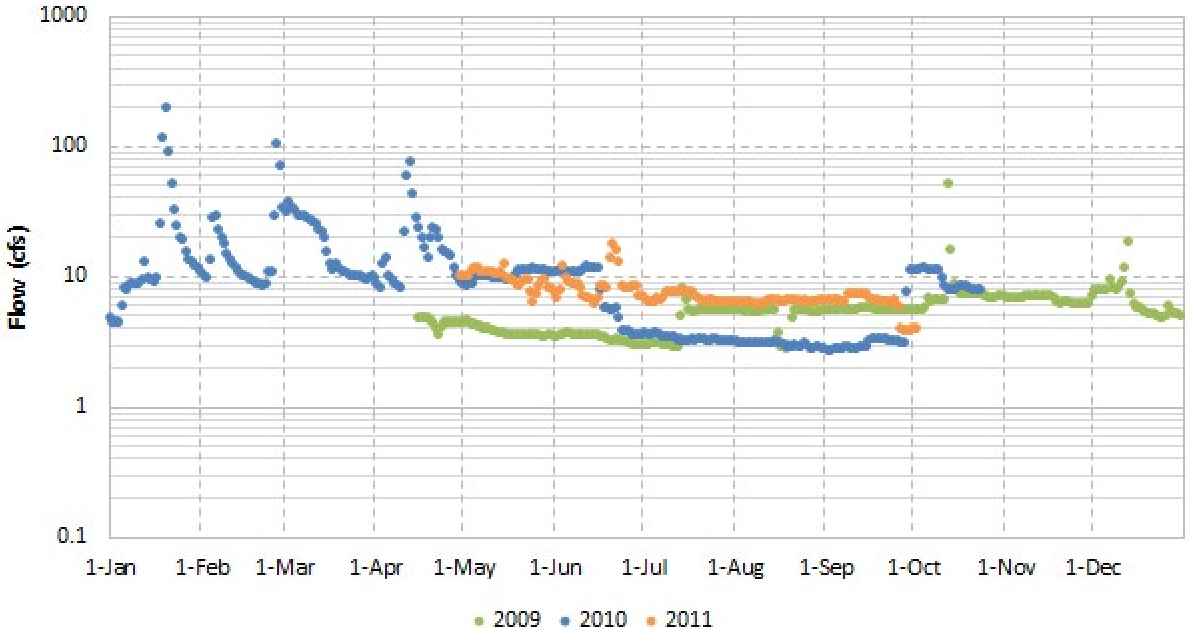


Table 5.2-6. Range of High Confidence for Flows at GCRK2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	4.4	8.2	9.3	3.5	3.4	2.9	2.9	2.8	2.7	3.9	6.0	4.8
1% Exceedance Flow	197.0	101.0	36.9	75.6	12.3	17.1	7.9	6.5	11.0	51.1	6.9	17.8

Of the period used, 99% of the flow data points were above 2.7 cfs and 99% were below 197 cfs. For GCRK2, temperature values based on modeled flows below 2.7 cfs or above 197 cfs cannot be predicted with high confidence.

5.2.4 GCRK1

Figure 5.2-7 and Figure 5.2-8 and Table 5.2-7 and Table 5.2-8 show the range of historical upstream water temperatures and flows used in the regression at GCRK1, Guadalupe Creek Upstream of Lake Almaden. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.2-7. Range of High Confidence for Upstream Temperature at GCRK1

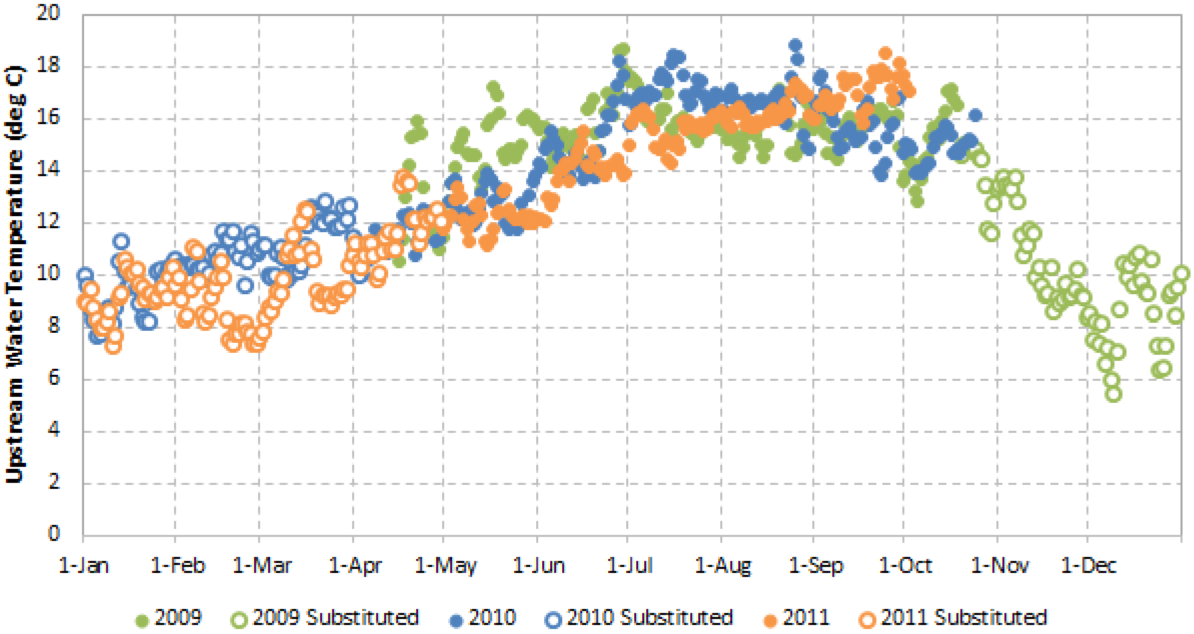


Table 5.2-7. Range of High Confidence for Upstream Temperature at GCRK1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	7.3	7.4	7.8	9.9	11.2	12.1	14.3	14.5	13.6	11.7	8.3	5.5
1% Exceedance Flow	11.3	11.7	12.9	15.9	17.2	18.7	18.4	18.8	18.5	17.3	14.5	12.9

Of the period used, 99% of the upstream water temperature data points were above 7.3°C and 99% of the temperature data points were below 18.8°C. Temperature values based on modeled temperatures below 7.3°C or above 18.8°C cannot be predicted with high confidence. In addition, the haze chart above demonstrates the lack of data for this location. No historical temperature data were available for late October through April. Temperatures in October and April were substituted with temperatures from Alamitos Creek-Mazzone minus 1°C and Alamitos Creek-Pfeiffer Ranch Road minus 2°C.

Figure 5.2-8. Range of High Confidence for Flows at GCRK1

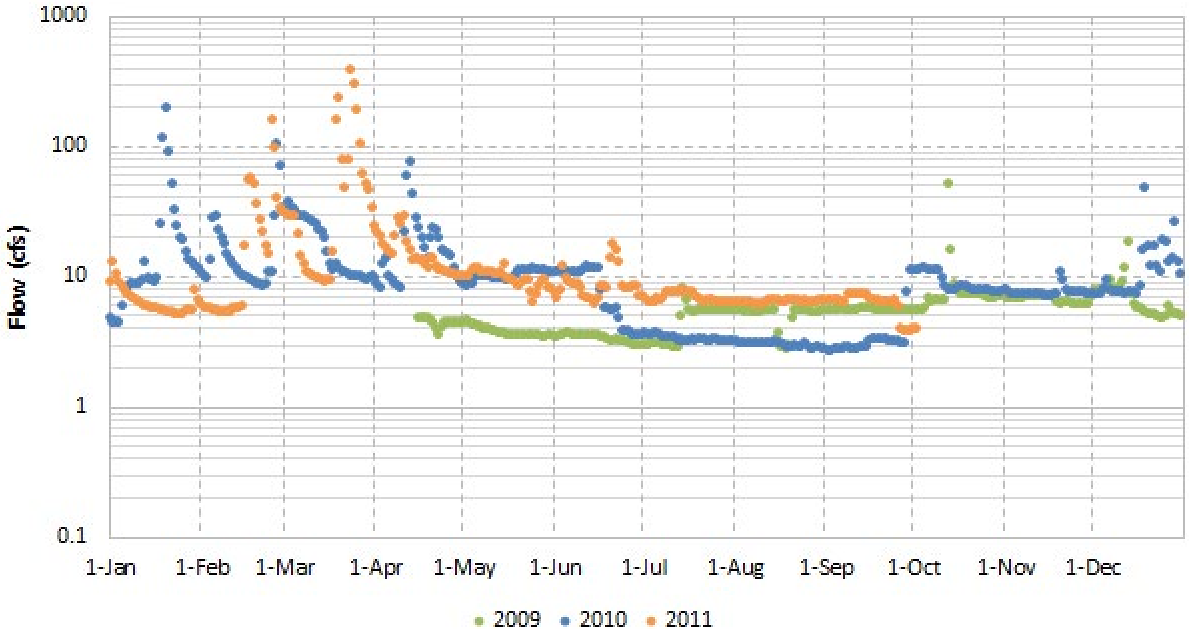


Table 5.2-8. Range of High Confidence for Flows at GCRK1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	4.4	5.2	8.8	3.5	3.4	2.9	2.9	2.8	2.7	3.9	6.0	4.8
1% Exceedance Flow	197.0	154.0	383.0	75.6	12.3	17.1	7.9	6.5	11.0	51.1	10.7	47.2

Of the period used, 99% of the flow data points were above 2.7 cfs and 99% were below 383 cfs. For GCRK1, temperature values based on modeled flows below 2.7 cfs or above 383 cfs cannot be predicted with high confidence.

5.3 Los Gatos Creek

5.3.1 LOSG2

Figure 5.3-1 and Figure 5.3-2 and Table 5.3-1 and Table 5.3-2 show the range of historical storages and flows used in the regression at LOSG2, Los Gatos Creek below Lower Page Drop Structure. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.3-1. Range of High Confidence for Upstream Temperature at LOSG2

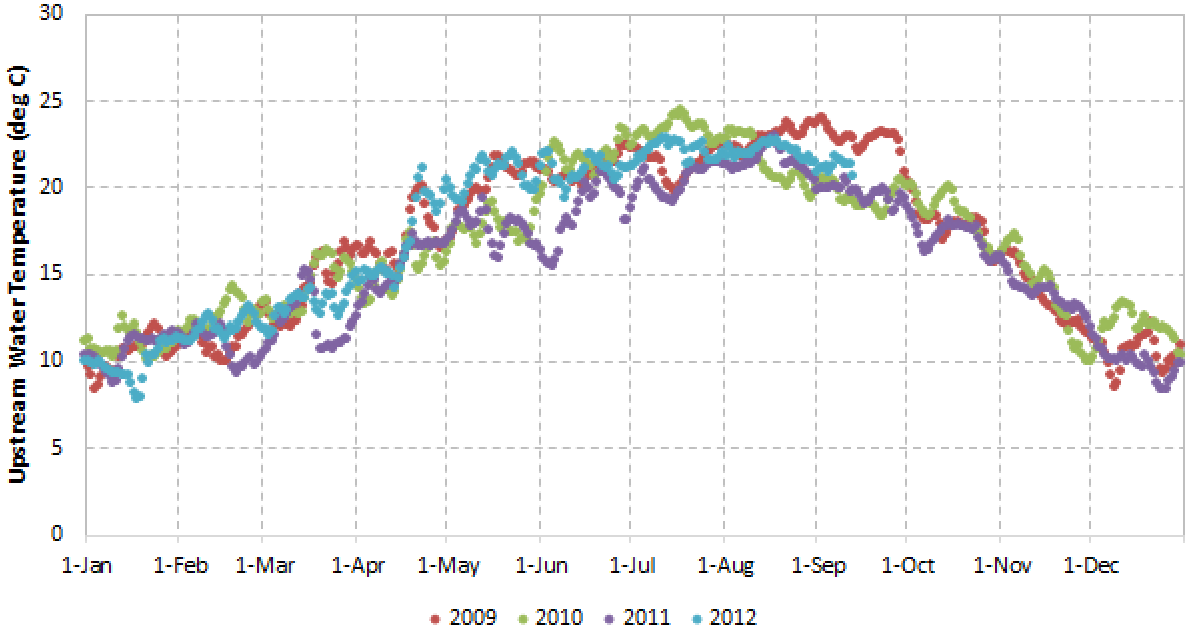


Table 5.3-1. Range of High Confidence for Upstream Temperature at LOSG2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	7.8	9.3	10.5	12.5	15.9	15.5	18.7	19.3	18.3	15.7	10.0	8.3
1% Exceedance Flow	12.5	14.3	16.8	21.1	22.1	23.4	24.4	23.8	23.9	20.4	17.3	13.3

Of the period used, 99% of the upstream temperature data points were above 7.8°C and 99% were below 24.4°C. Values based on modeled temperatures below 7.8°C or above 24.4°C cannot be predicted with high confidence.

Figure 5.3-2. Range of High Confidence for Flows at LOSG2

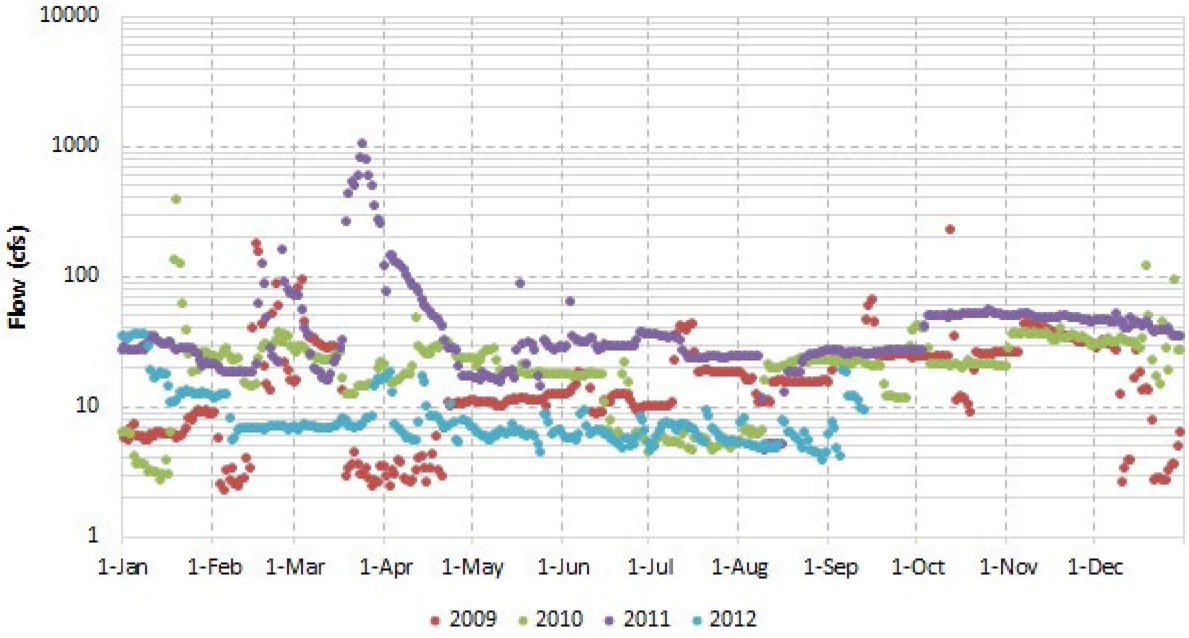


Table 5.3-2. Range of High Confidence for Flows at LOSG2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	2.7	2.3	2.4	2.4	4.4	4.7	4.4	3.7	4.0	8.9	20.2	2.6
1% Exceedance Flow	374.0	175.0	1,010	143.0	86.7	62.9	42.2	26.3	63.6	225.0	50.3	119

Of the period used, 99% of the flow data points were above 2.3 cfs and 99% were below 1,010 cfs. For LOSG2, temperature values based on modeled flows below 2.3 cfs or above 1,010 cfs cannot be predicted with high confidence.

5.3.2 LOSG1

Figure 5.3-3 and Figure 5.3-4 and Table 5.3-3 and Table 5.3-4 show the range of historical upstream water temperatures and flows used in the regression at LOSG1, Los Gatos Creek above Guadalupe River Confluence. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.3-3. Range of High Confidence for Upstream Temperature at LOSG1

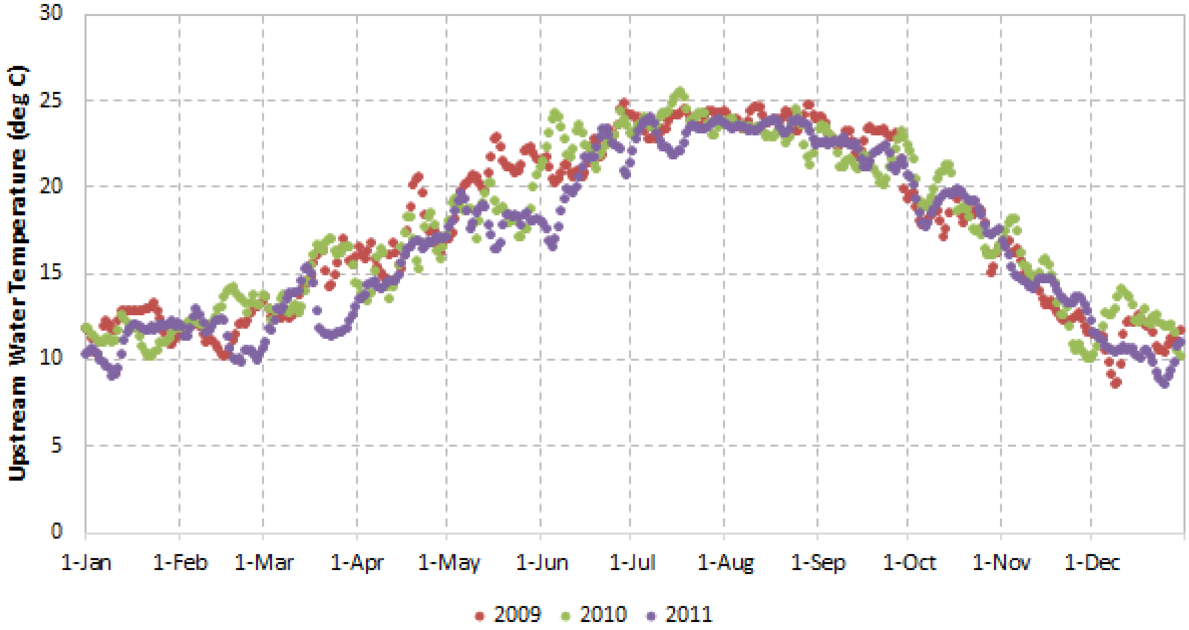


Table 5.3-3. Range of High Confidence for Upstream Temperature at LOSG1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	9.0	9.7	10.6	13.0	16.3	16.5	21.3	21.2	19.8	15.0	10.0	8.5
1% Exceedance Flow	13.3	14.2	16.9	20.5	22.8	24.8	25.4	24.7	24.0	22.4	18.1	14.1

Of the period used, 99% of the storage data points were above 9°C and 99% of the temperature data points were below 25.4°C. Values based on modeled temperatures below 9°C or above 25.4°C cannot be predicted with high confidence.

Figure 5.3-4. Range of High Confidence for Flows at LOSG1

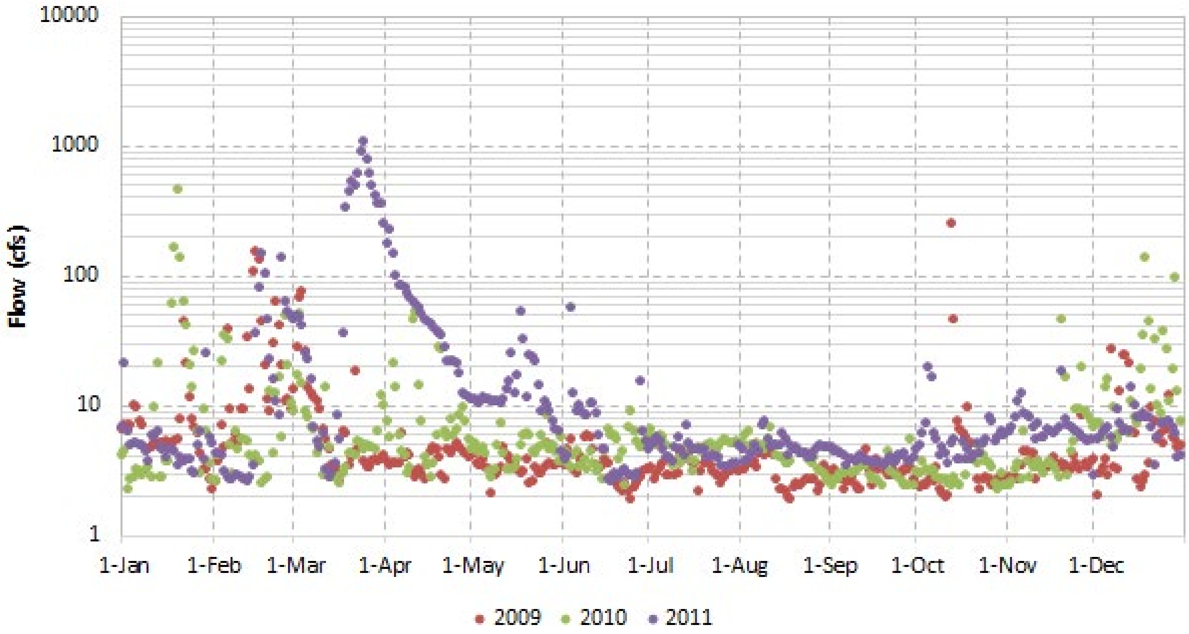


Table 5.3-4. Range of High Confidence for Flows at LOSG1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	2.2	2.3	2.5	2.6	2.1	1.9	2.2	1.9	2.2	1.9	2.3	2.0
1% Exceedance Flow	446.0	152.0	1,060	248.0	52.5	56.8	6.9	7.5	5.4	244.0	45.1	137

Of the period used, 99% of the flow data points were above 1.9 cfs and 99% were below 1,060 cfs. For LOSG1, temperature values based on modeled flows below 1.9 cfs or above 1,060 cfs cannot be predicted with high confidence.

5.4 Alamitos Creek

5.4.1 ALAM4

Figure 5.4-1 and Table 5.4-1 show the range of historical flows used in the regression at ALAM4, Alamitos Creek below Almaden Reservoir. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.4-1. Range of High Confidence for Flows at ALAM4

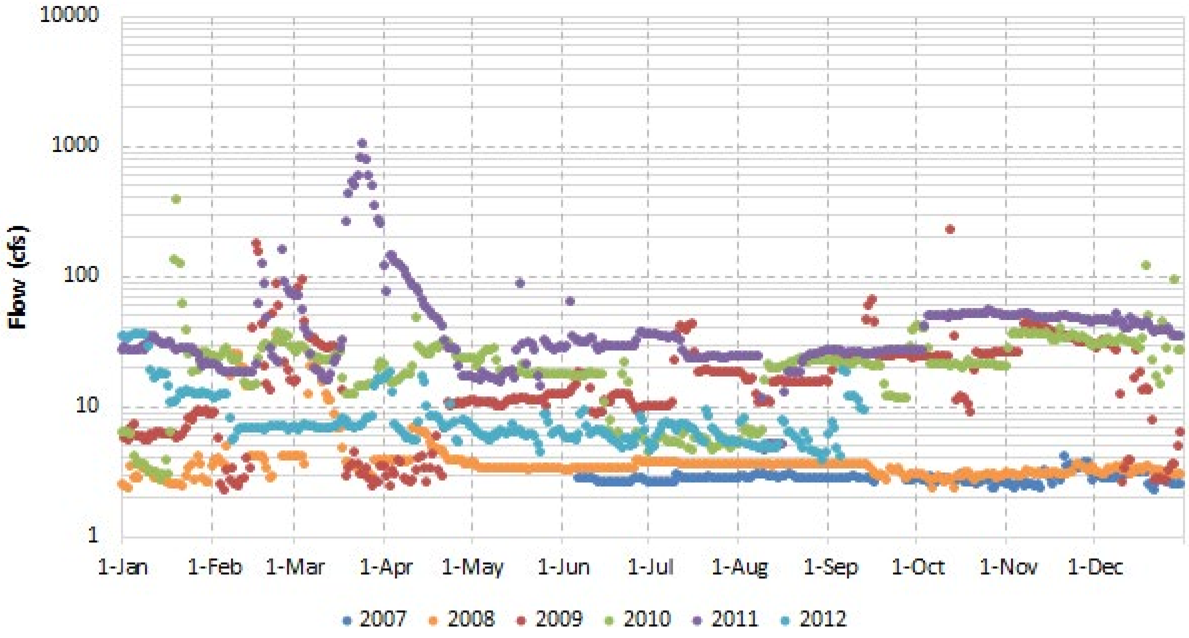


Table 5.4-1. Range of High Confidence for Flows at ALAM4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	2.3	2.5	2.3	2.7	3.0	2.6	2.6	2.8	2.6	2.3	2.3	2.2
1% Exceedance Flow	95.8	201.0	388.0	49.0	18.2	16.6	5.9	4.3	4.2	45.7	7.9	59.1

Of the period used, 99% of the flow data points were above 2.3 cfs and 99% were below 388 cfs. For ALAM4, temperature values based on modeled flows below 2.3 cfs or above 388 cfs cannot be predicted with high confidence.

5.4.2 ALAM3

Figure 5.4-2 and Figure 5.4-3 and Table 5.4-2 and Table 5.4-3 show the range of historical upstream water temperatures and flows used in the regression at ALAM3, Alamitos Creek above Calero Creek. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.4-2. Range of High Confidence for Upstream Temperature at ALAM3

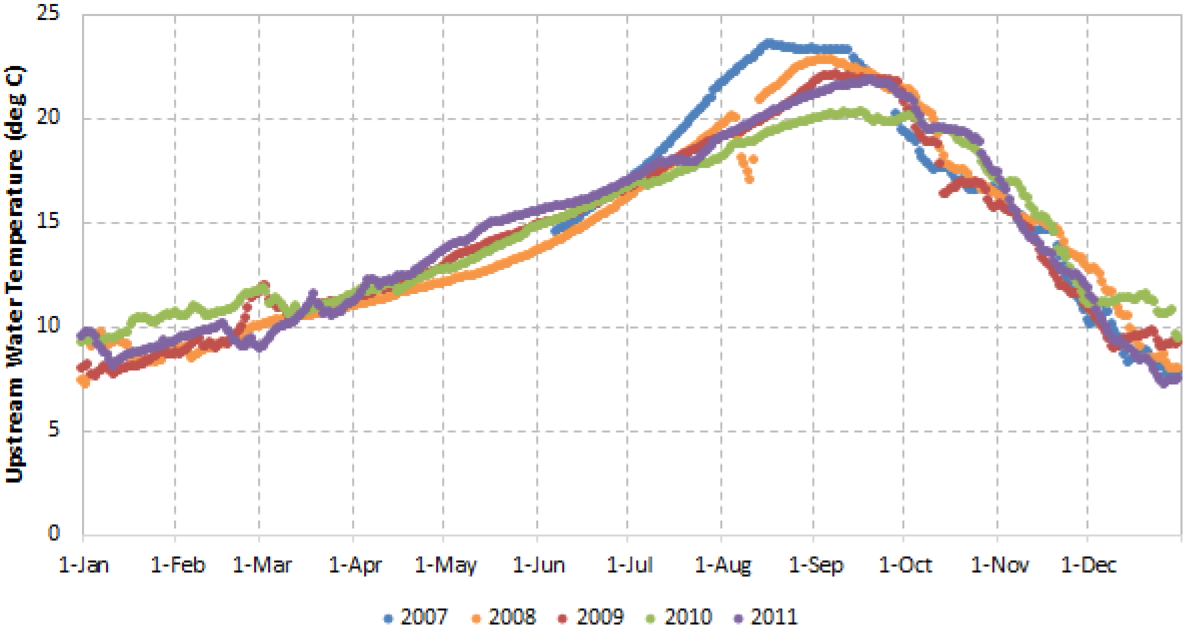


Table 5.4-2. Range of High Confidence for Upstream Temperature at ALAM3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	7.2	8.4	8.9	11.0	12.1	13.6	16.2	17.0	19.4	15.7	10.8	7.2
1% Exceedance Flow	10.6	11.6	11.9	13.5	15.4	16.9	21.5	23.5	23.2	21.3	17.4	12.7

Of the period used, 99% of the storage data points were above 7.2°C and 99% of the temperature data points were below 23.5°C. Values based on modeled temperatures below 7.2°C or above 23.5°C cannot be predicted with high confidence.

Figure 5.4-3. Range of High Confidence for Flows at ALAM3

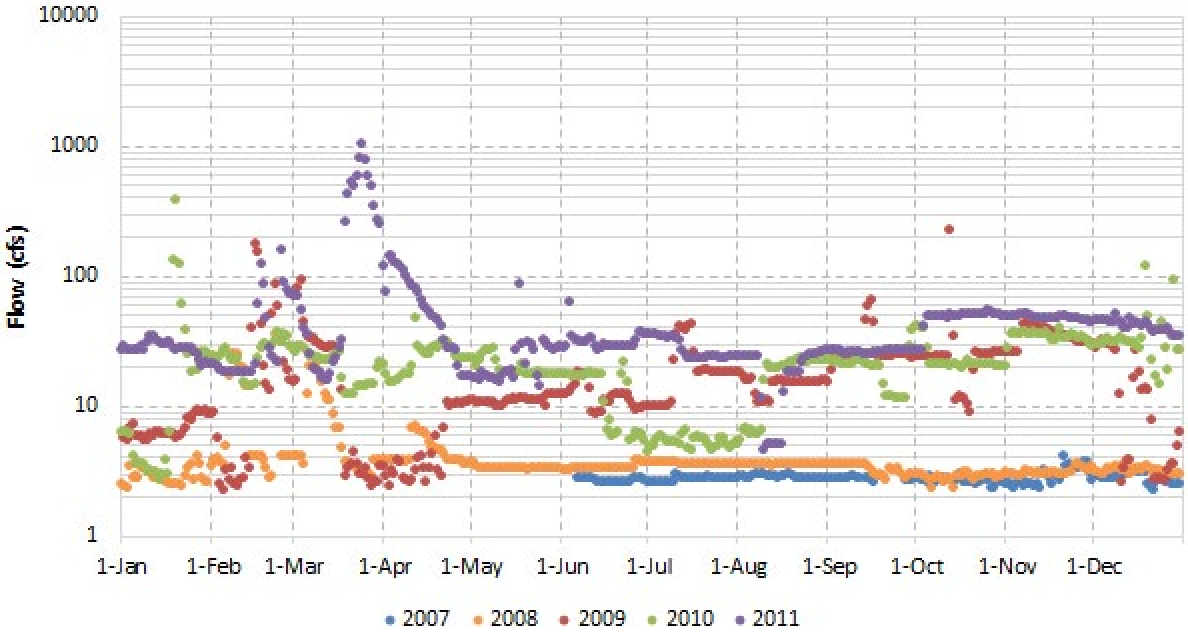


Table 5.4-3. Range of High Confidence for Flows at ALAM3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	2.3	2.7	2.8	2.7	3.0	2.6	2.6	2.8	2.6	2.3	2.3	2.2
1% Exceedance Flow	95.8	201.0	388.0	49.0	18.2	16.6	5.9	4.3	4.2	45.7	7.9	59.1

Of the period used, 99% of the flow data points were above 2.3 cfs and 99% were below 388 cfs. For ALAM3, temperature values based on modeled flows below 2.3 cfs or above 388 cfs cannot be predicted with high confidence.

5.4.3 ALAM2

Figure 5.4-4 through Figure 5.4-7 and Table 5.4-4 through Table 5.4-7 show the range of historical upstream water temperatures and flows used in the regression at ALAM2, Alamitos Creek below Calero Creek. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.4-4. Range of High Confidence for Upstream Temperature at ALAM2 from Upstream Calero Creek

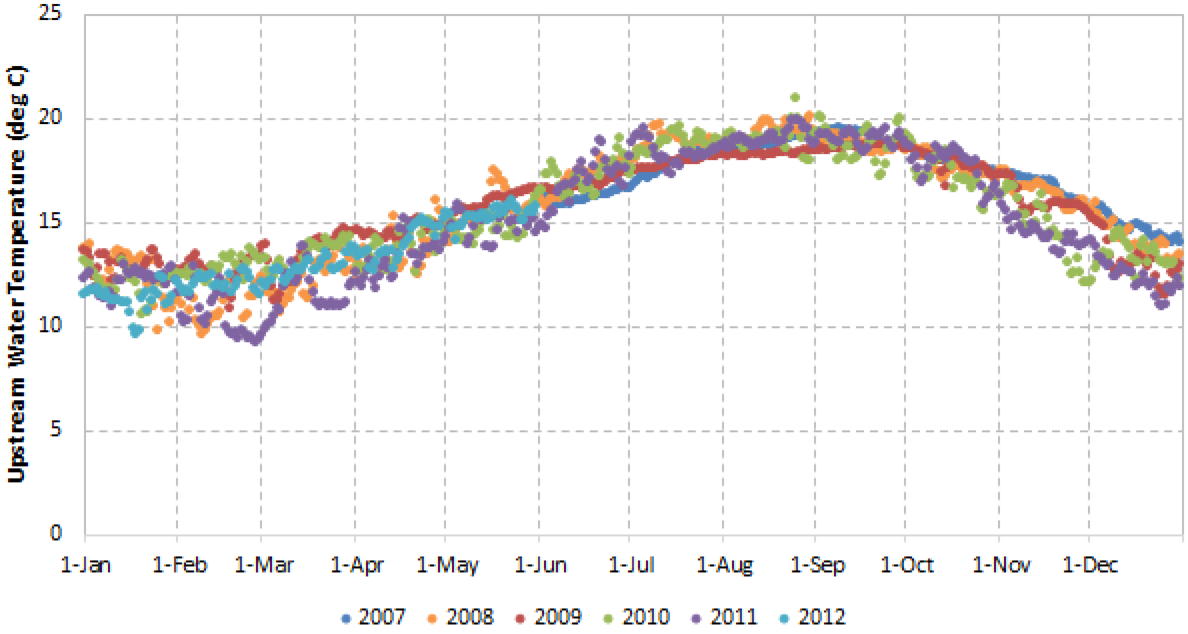


Table 5.4-4. Range of High Confidence for Upstream Temperature at ALAM2 from Upstream Calero Creek

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	9.6	9.2	9.6	11.8	13.7	14.7	16.6	17.9	17.2	15.6	12.0	10.9
1% Exceedance Flow	13.9	13.7	14.6	16.0	17.4	19.0	19.6	20.9	20.1	19.2	17.4	15.9

Of the period used, 99% of the upstream temperature data points from Upstream Calero Creek were above 9.2°C and 99% of the temperature data points were below 20.9°C. Values based on modeled temperatures below 9.2°C or above 20.9°C cannot be predicted with high confidence.

Figure 5.4-5. Range of High Confidence for Upstream Temperature at ALAM2 from Fortini Road

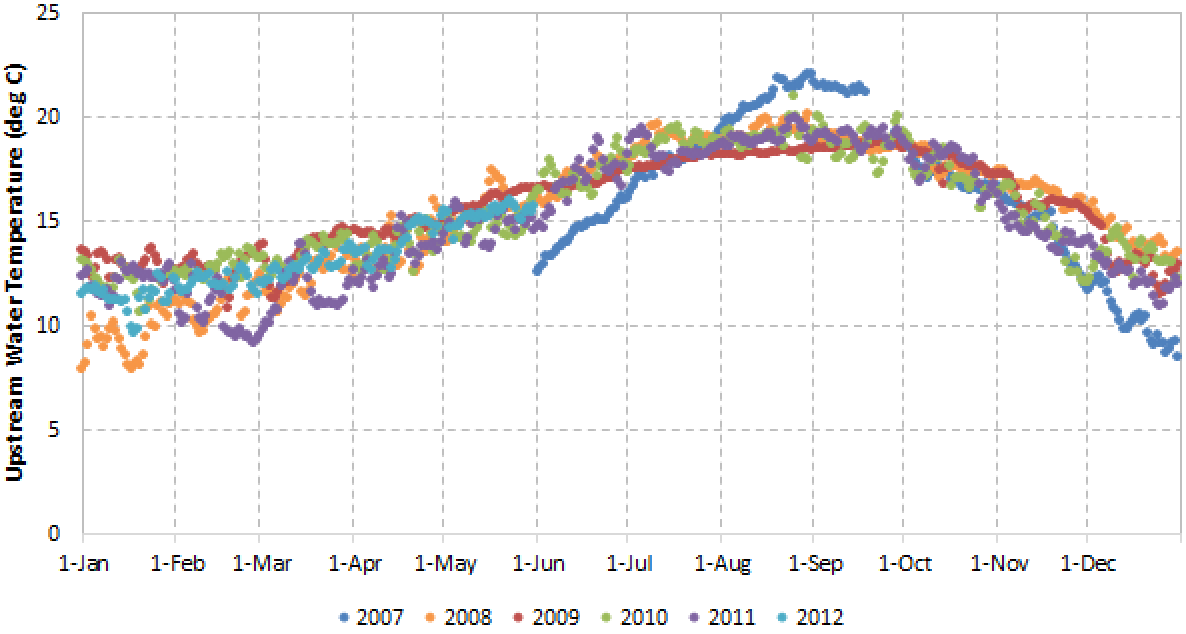


Table 5.4-5. Range of High Confidence for Upstream Temperature at ALAM2 from Fortini Road

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	7.9	9.2	9.6	11.8	13.7	12.5	16.0	17.9	17.2	15.6	11.9	8.5
1% Exceedance Flow	13.6	13.7	14.6	16.0	17.4	19.0	19.6	22.0	21.7	19.2	17.4	15.9

Of the period used, 99% of the upstream temperature data points from Fortini Road were above 7.9 C and 99% of the temperature data points were below 22 C. Values based on modeled temperatures below 7.9 C or above 22 C cannot be predicted with high confidence.

Figure 5.4-6. Range of High Confidence for Flows at ALAM2 from Below Almaden Reservoir (SF16)

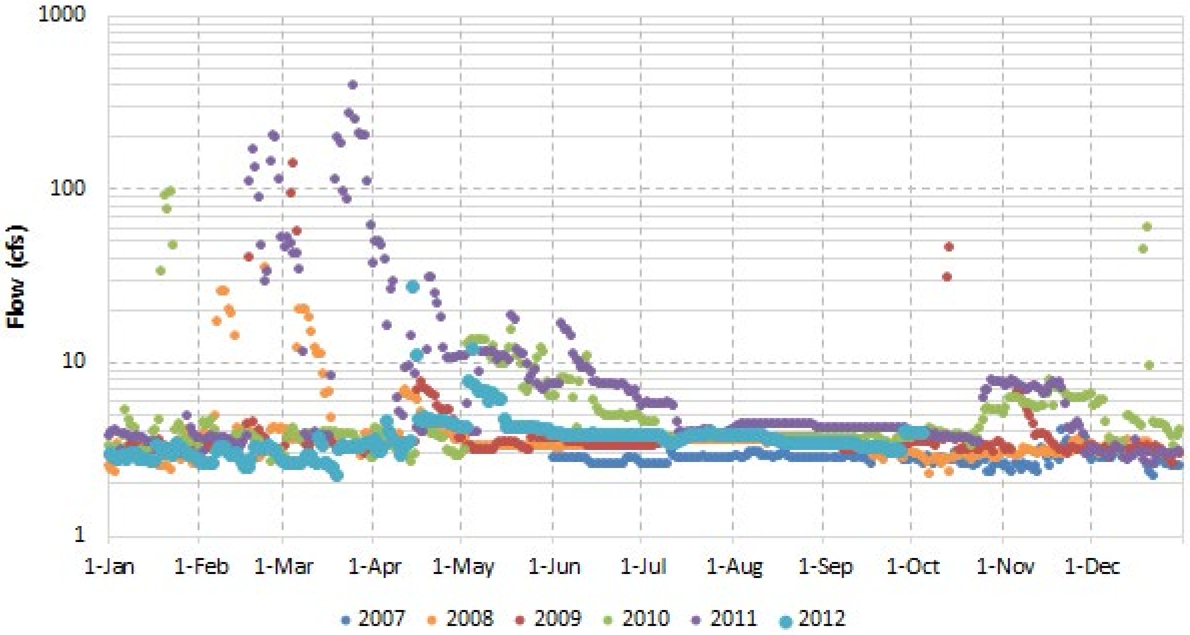


Table 5.4-6. Range of High Confidence for Flows at ALAM2 from Below Almaden Reservoir (SF16)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	2.3	2.5	2.3	2.7	3.0	2.6	2.6	2.8	2.6	2.3	2.3	2.2
1% Exceedance Flow	95.8	201.0	388.0	49.0	18.2	16.6	5.9	4.3	4.2	45.7	7.9	59.1

Of the period used, 99% of the flow data points from Below Almaden Reservoir were above 2.3 cfs and 99% were below 388 cfs. For ALAM2, temperature values based on modeled flows below 2.3 cfs or above 388 cfs cannot be predicted with high confidence.

Figure 5.4-7. Range of High Confidence for Flows at ALAM2 from Below Calero Reservoir (SF13)

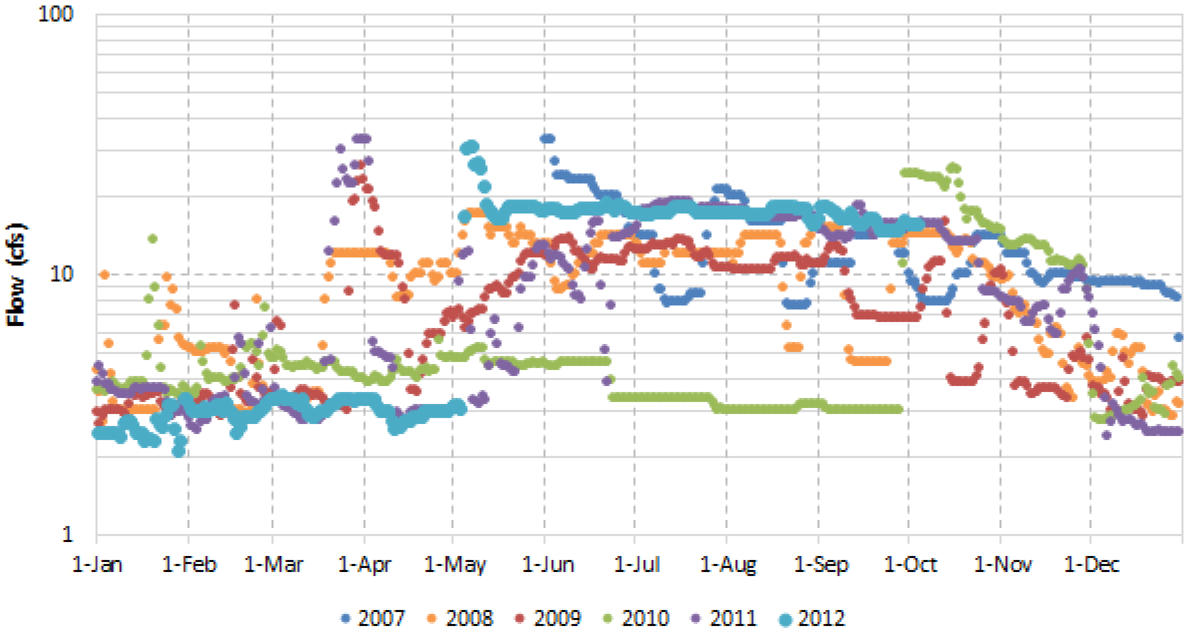


Table 5.4-7. Range of High Confidence for Flows at ALAM2 from Below Calero Reservoir (SF13)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	2.1	2.5	2.7	2.6	3.0	3.3	3.0	3.0	3.0	3.8	3.3	2.4
1% Exceedance Flow	13.6	7.9	33.1	33.1	31.3	33.0	21.0	21.0	24.1	25.8	14.9	9.4

Of the period used, 99% of the flow data points from Below Calero Reservoir were above 2.1 cfs and 99% were below 33.1 cfs. For ALAM2, temperature values based on modeled flows below 2.1 cfs or above 33.1 cfs cannot be predicted with high confidence.

5.4.4 ALAM1

Figure 5.4-8 and Figure 5.4-9 and Table 5.4-8 and Table 5.4-9 show the range of historical upstream water temperatures and flows used in the regression at ALAM1, Alamitos Creek above Lake Almaden. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.4-8. Range of High Confidence for Upstream Temperature at ALAM1

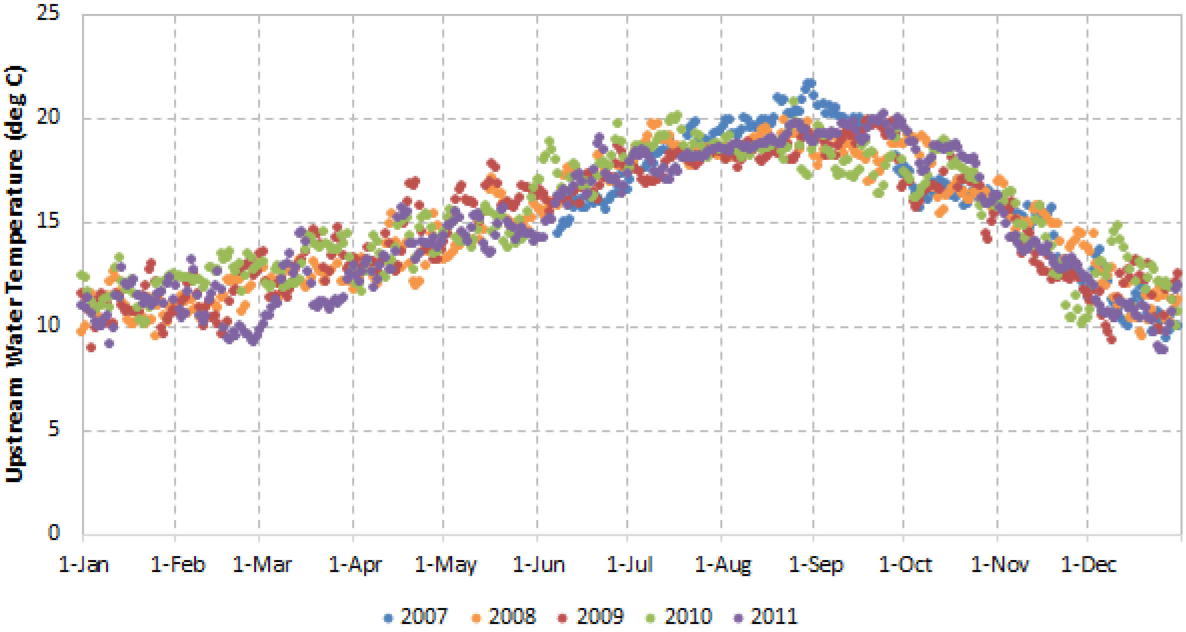


Table 5.4-8. Range of High Confidence for Upstream Temperature at ALAM1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	8.9	9.2	9.8	11.6	13.3	14.2	16.5	17.2	16.3	14.1	10.1	8.8
1% Exceedance Flow	13.2	13.5	14.7	16.9	17.7	19.6	20.0	21.6	21.0	19.4	17.0	14.8

Of the period used, 99% of the storage data points were above 8.9°C and 99% of the temperature data points were below 21.6°C. Values based on modeled temperatures below 8.9°C or above 21.6°C cannot be predicted with high confidence.

Figure 5.4-9. Range of High Confidence for Flows at ALAM1

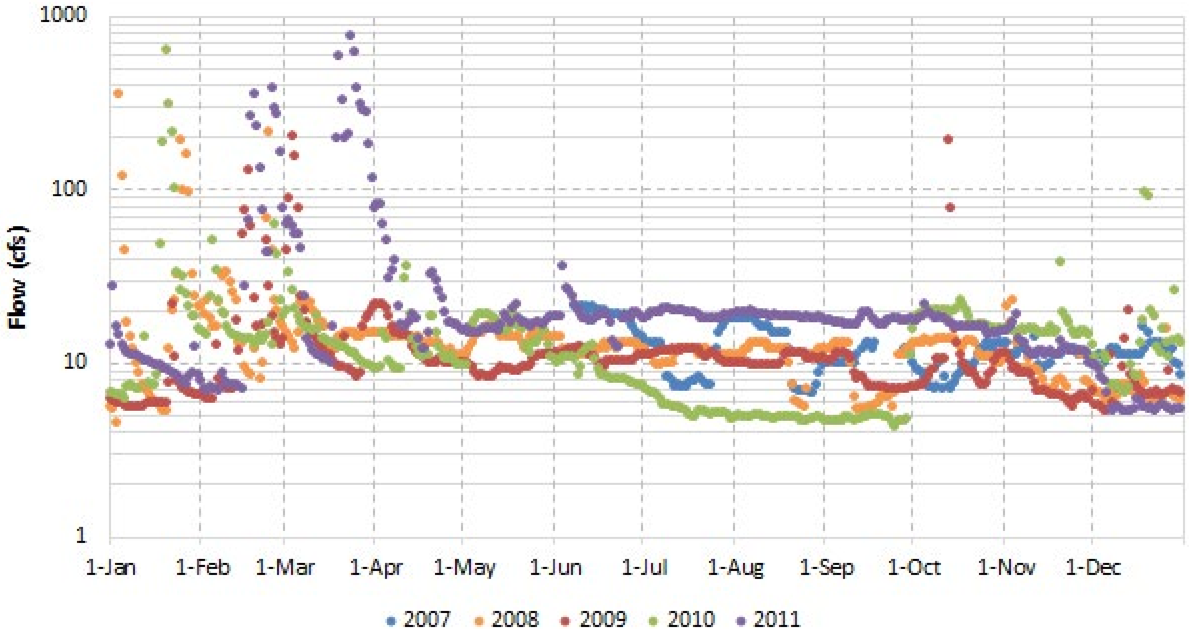


Table 5.4-9. Range of High Confidence for Flows at ALAM1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	4.5	6.1	8.2	9.1	8.2	7.4	4.8	4.6	4.3	7.1	5.6	5.3
1% Exceedance Flow	632.0	378.0	750.0	82.4	21.5	36.0	20.4	19.7	19.5	192.0	37.6	95.5

Of the period used, 99% of the flow data points were above 4.3 cfs and 99% were below 750 cfs. For ALAM1, temperature values based on modeled flows below 4.3 cfs or above 750 cfs cannot be predicted with high confidence.

5.5 Calero Creek

5.5.1 CALE2

Figure 5.5-1 and Table 5.5-1 show the range of historical flows used in the regression at CALE2, Calero Creek below Calero Reservoir. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.5-1. Range of High Confidence for Flows at CALE2

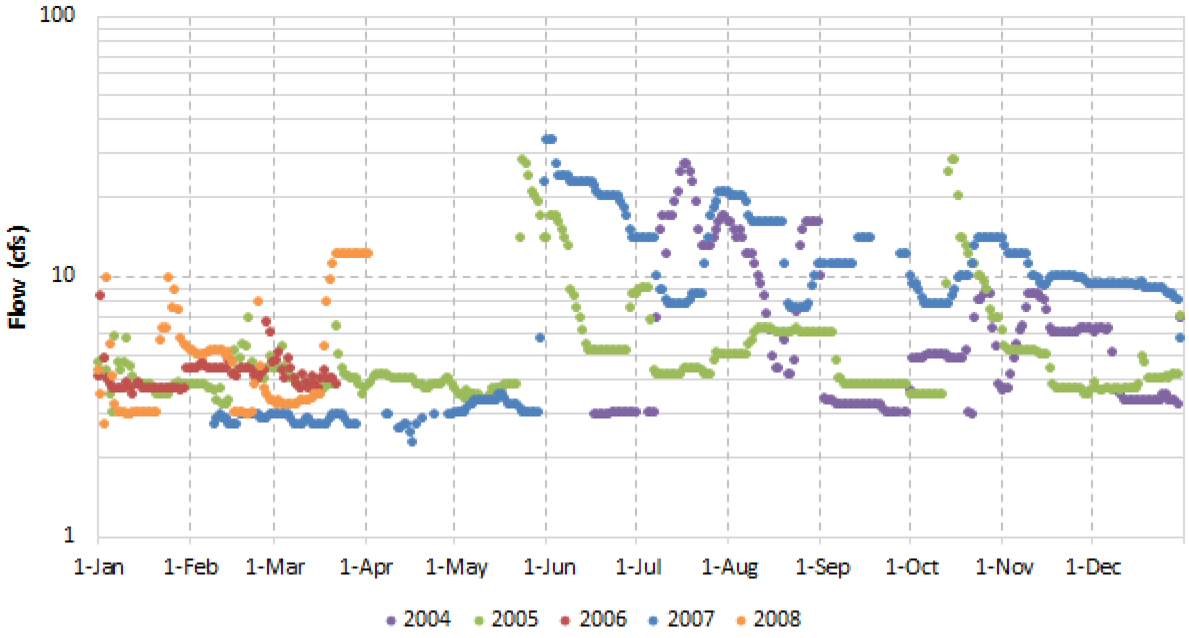


Table 5.5-1. Range of High Confidence for Flows at CALE2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	2.7	2.7	2.7	2.3	3.0	2.9	3.0	4.2	3.0	2.9	3.5	3.2
1% Exceedance Flow	9.8	7.9	12.0	12.0	28.0	33.0	27.0	21.0	14.0	28.0	14.0	9.4

Of the period used, 99% of the flow data points were above 2.3 cfs and 99% were below 33 cfs. For CALE2, temperature values based on modeled flows below 2.3 cfs or above 33 cfs cannot be predicted with high confidence.

5.5.2 CALE1

Figure 5.5-2 and Figure 5.5-3 and Table 5.5-2 and Table 5.5-3 show the range of historical upstream water temperatures and flows used in the regression at CALE1, Calero Creek above Alamitos Creek. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.5-2. Range of High Confidence for Upstream Temperature at CALE1

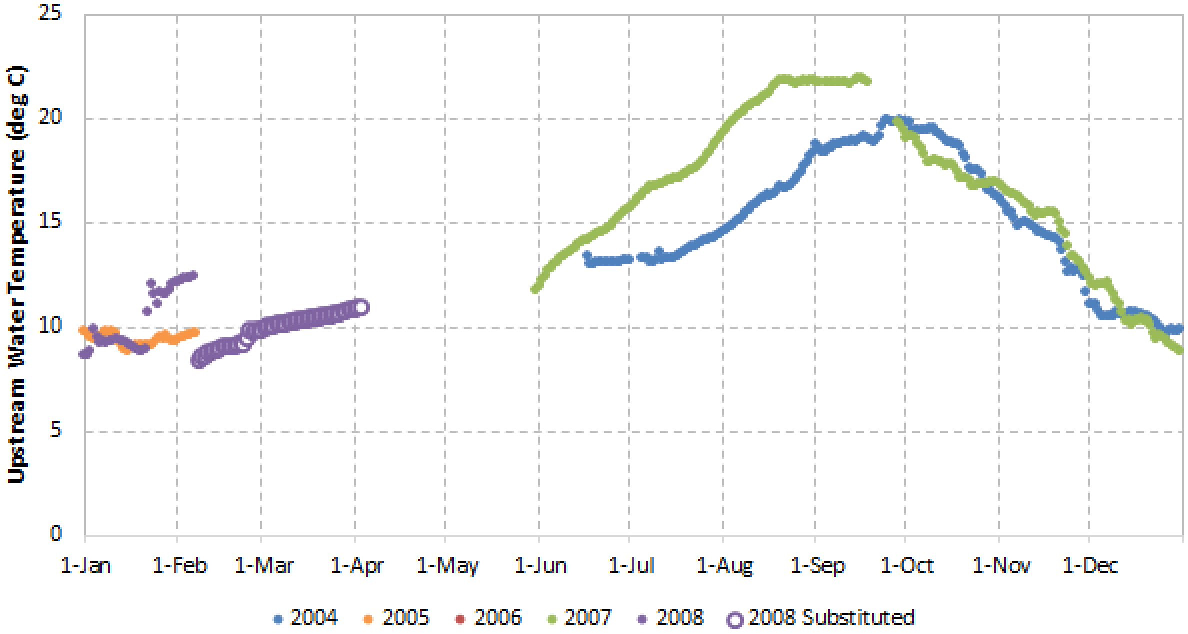


Table 5.5-2. Range of High Confidence for Upstream Temperature at CALE1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	8.6	8.5	10.1	11.0	11.7	11.9	13.0	14.6	18.4	16.2	11.0	8.8
1% Exceedance Flow	12.1	12.4	10.9	11.0	11.7	15.5	19.0	21.8	21.9	19.7	16.8	12.2

Of the period used, 99% of the storage data points were above 8.5°C and 99% of the temperature data points were below 21.9°C. Values based on modeled temperatures below 8.5°C or above 21.9°C cannot be predicted with high confidence. In addition, the haze chart above demonstrates the lack of data for this location; for each day of year, only one to three data points are available, which seasonally reduces the range of high confidence. The range of higher confidence for summer is smaller due to the smaller range of observed values. No data were available for February through April. Temperatures in early February and late April were substituted with temperatures from Almaden Reservoir Outlet.

Figure 5.5-3. Range of High Confidence for Flows at CALE1

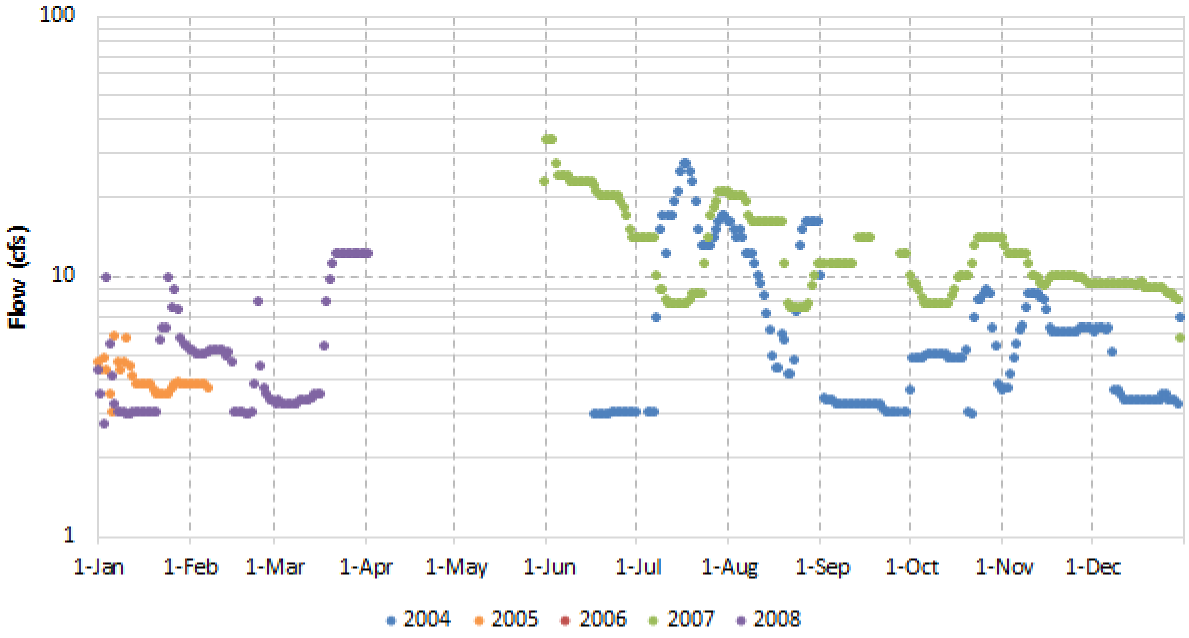


Table 5.5-3. Range of High Confidence for Flows at CALE1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	2.7	2.9	3.2	12.0	23.0	2.9	3.0	4.2	3.0	2.9	3.7	3.2
1% Exceedance Flow	9.8	7.9	12.0	12.0	23.0	33.0	27.0	21.0	14.0	14.0	14.0	9.4

Of the period used, 99% of the flow data points were above 2.7 cfs and 99% were below 33 cfs. For CALE1, temperature values based on modeled flows below 2.7 cfs or above 33 cfs cannot be predicted with high confidence. In addition, the haze chart above demonstrates the lack of data for this location; for each day of year, only two to three data points are available, which seasonally reduces the range of high confidence. The range of higher confidence for summer is smaller due to the smaller range of observed values. No data were available for February through April. Temperatures in early February and late April may be modeled by assuming some similarity to late January and early May values.

5.6 Stevens Creek

5.6.1 Stevens Creek Reservoir Outlet

Figure 5.6-1 and Figure 5.6-2 and Table 5.6-1 and Table 5.6-2 show the range of historical storages and flows used in the regression at Stevens Creek Reservoir Outlet. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.6-1. Range of High Confidence for Inlet Temperature at Stevens Creek Reservoir Outlet

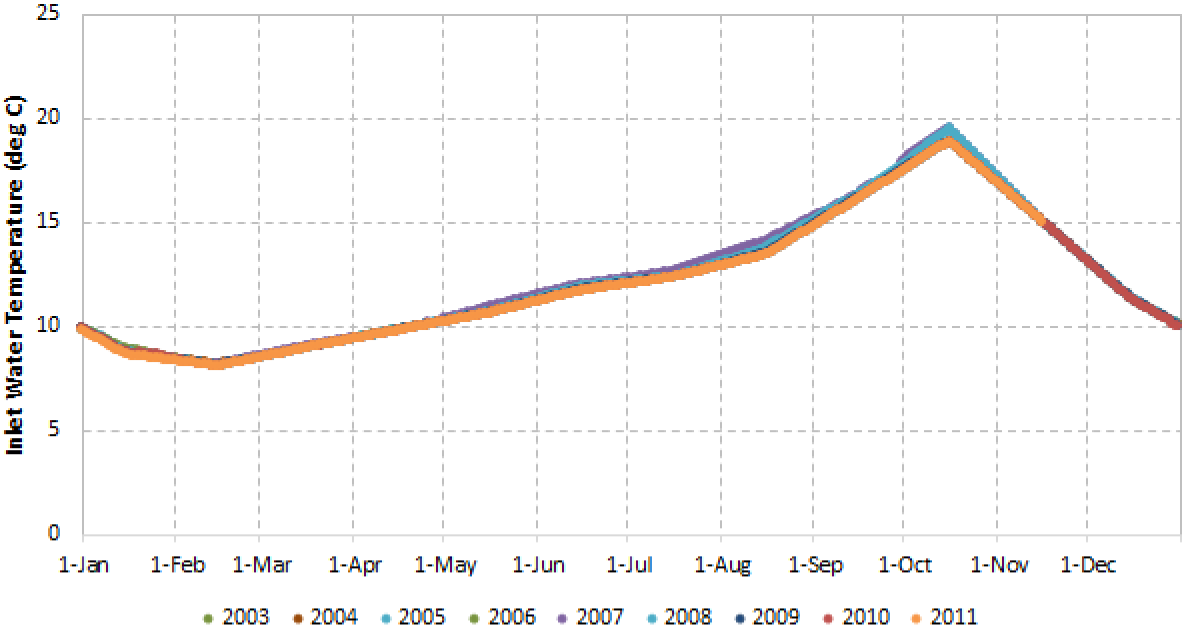


Table 5.6-1. Range of High Confidence for Inlet Temperature at Stevens Creek Reservoir Outlet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	8.3	8.0	8.5	9.3	10.2	11.1	12.0	12.9	14.8	16.9	13.1	9.9
1% Exceedance Flow	9.9	8.5	9.4	10.2	11.4	12.2	13.3	15.2	17.9	19.5	17.2	13.1

Of the period used, 99% of the inlet temperature data points were above 8°C and 99% were below 19.5°C. Values based on modeled storages below 8°C or above 19.5°C cannot be predicted with high confidence.

Figure 5.6-2. Range of High Confidence for Flows at Stevens Creek Reservoir Outlet.

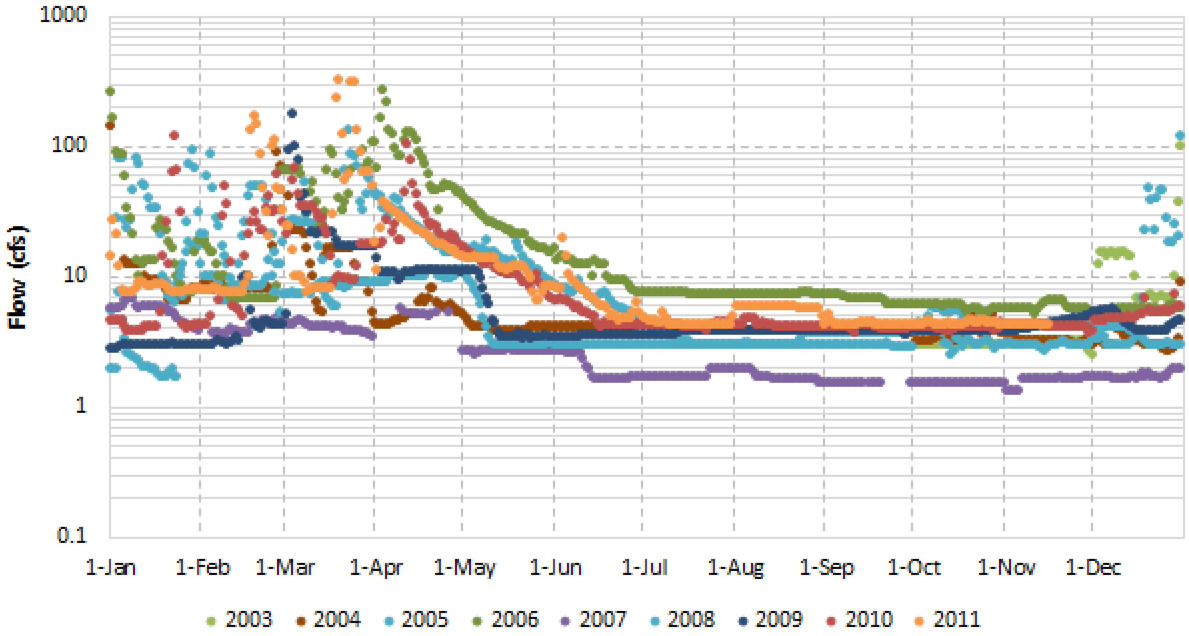


Table 5.6-2. Range of High Confidence for Flows at Stevens Creek Reservoir Outlet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	1.7	3.0	3.4	4.2	2.5	1.6	1.7	1.5	1.5	1.5	1.3	1.6
1% Exceedance Flow	254.0	167.0	321.0	265.0	40.0	19.3	7.5	7.4	7.1	6.1	6.5	119.0

Of the period used, 99% of the flow data points were above 1.5 cfs and 99% were below 321 cfs. For Stevens Creek Reservoir Outlet, temperature values based on modeled flows below 1.5 cfs or above 321 cfs cannot be predicted with high confidence.

5.6.2 STEV6

Figure 5.6-3 and Figure 5.6-4 and Table 5.6-3 and Table 5.6-4 show the range of historical storages and flows used in the regression at STEV6, Stevens Creek SF44. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.6-3. Range of High Confidence for Upstream Temperature at STEV6

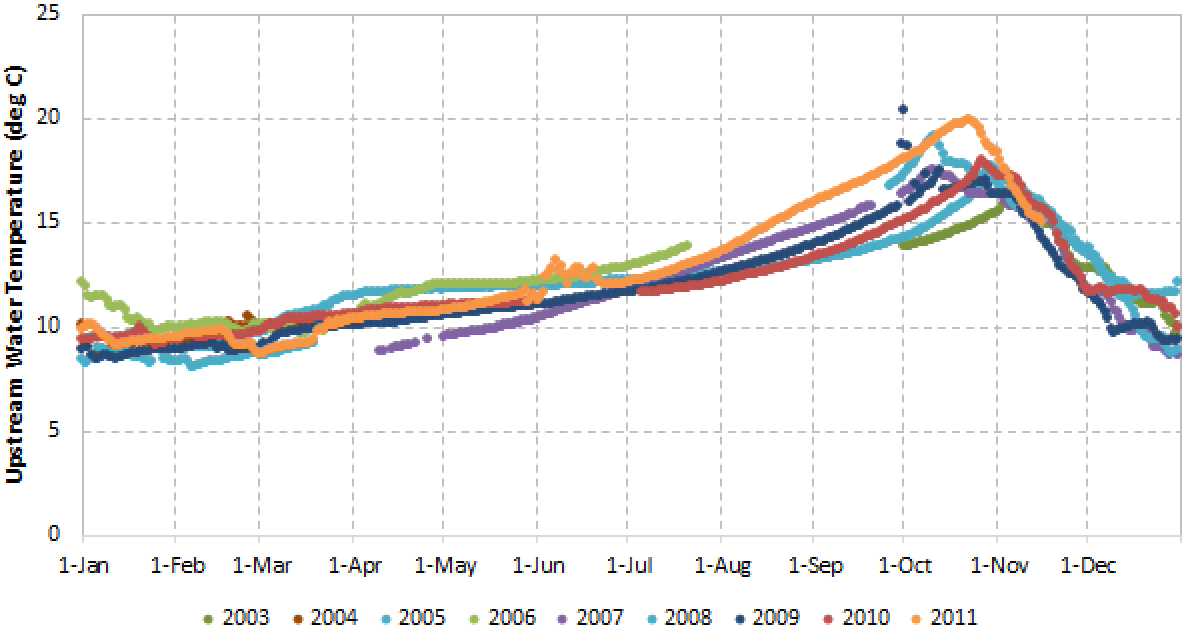


Table 5.6-3. Range of High Confidence for Upstream Temperature at STEV6

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	8.2	8.0	8.7	8.8	9.5	10.4	11.6	12.1	13.1	13.8	11.7	8.6
1% Exceedance Flow	12.1	10.4	11.4	12.0	12.1	13.1	13.8	15.9	18.7	20.3	18.3	13.7

Of the period used, 99% of the upstream temperature data points were above 8°C and 99% were below 20.3°C. Values based on modeled storages below 8°C or above 20.3°C cannot be predicted with high confidence.

Figure 5.6-4. Range of High Confidence for Flows at STEV6

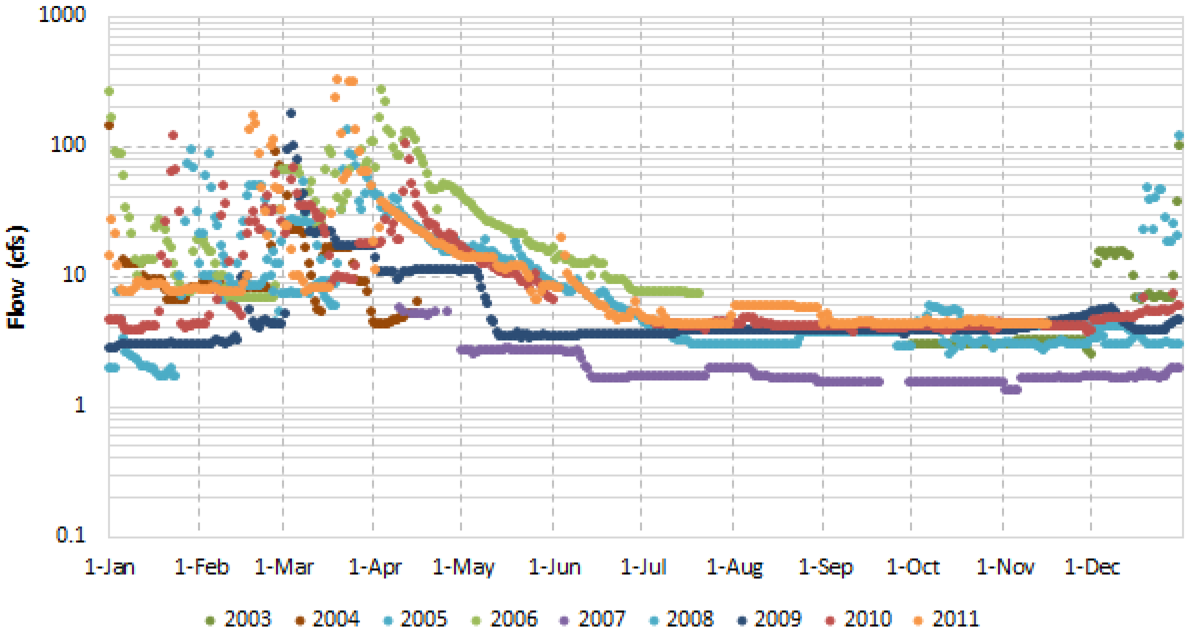


Table 5.6-4. Range of High Confidence for Flows at STEV6

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	1.7	3.0	4.3	4.2	2.5	1.6	1.7	1.5	1.5	1.5	1.3	1.6
1% Exceedance Flow	254.0	167.0	321.0	265.0	40.0	19.3	7.5	5.8	5.1	5.7	4.9	119

Of the period used, 99% of the flow data points were above 1.3 cfs and 99% were below 321 cfs. For STEV6, temperature values based on modeled flows below 1.3 cfs or above 321 cfs cannot be predicted with high confidence.

5.6.3 STEV5

Figure 5.6-5 and Figure 5.6-6 and Table 5.6-5 and Table 5.6-6 show the range of historical upstream water temperatures and flows used in the regression at STEV5, Stevens Creek above McClellan Road. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.6-5. Range of High Confidence for Upstream Temperature at STEV5

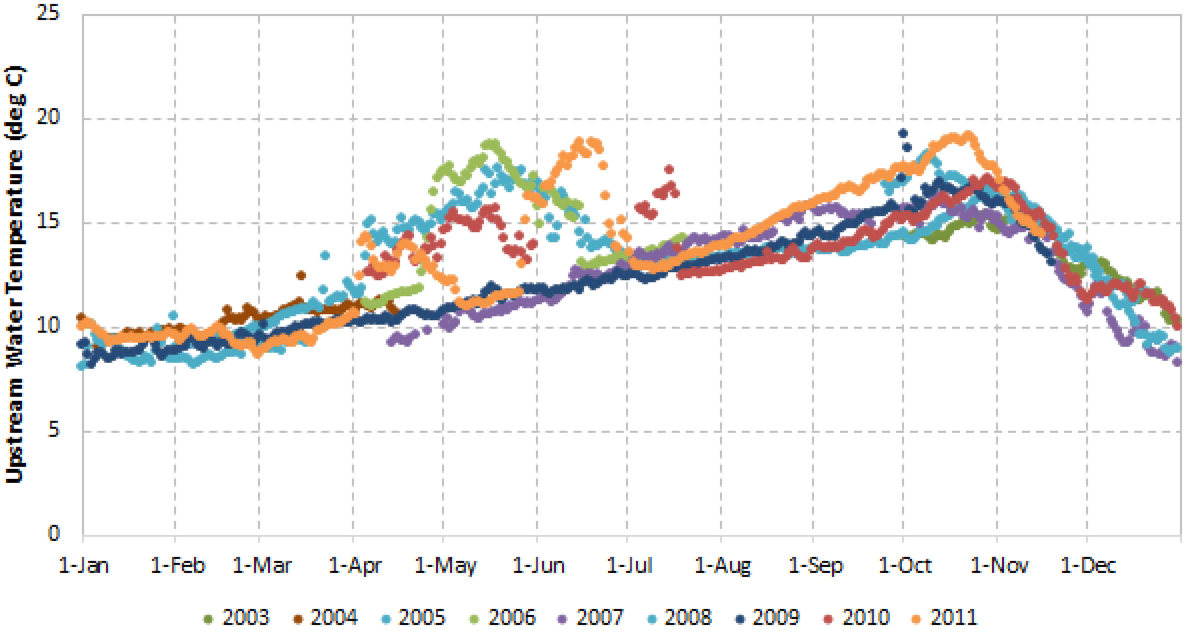


Table 5.6-5. Range of High Confidence for Upstream Temperature at STEV5

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	8.0	8.2	8.7	9.2	9.9	11.1	12.2	12.5	13.5	14.1	10.9	8.2
1% Exceedance Flow	10.4	10.9	13.3	17.3	18.7	18.8	17.5	15.8	17.6	19.2	17.4	13.7

Of the period used, 99% of the storage data points were above 8°C and 99% of the temperature data points were below 19.2°C. Values based on modeled temperatures below 8°C or above 19.2°C cannot be predicted with high confidence.

Figure 5.6-6. Range of High Confidence for Flows at STEV5

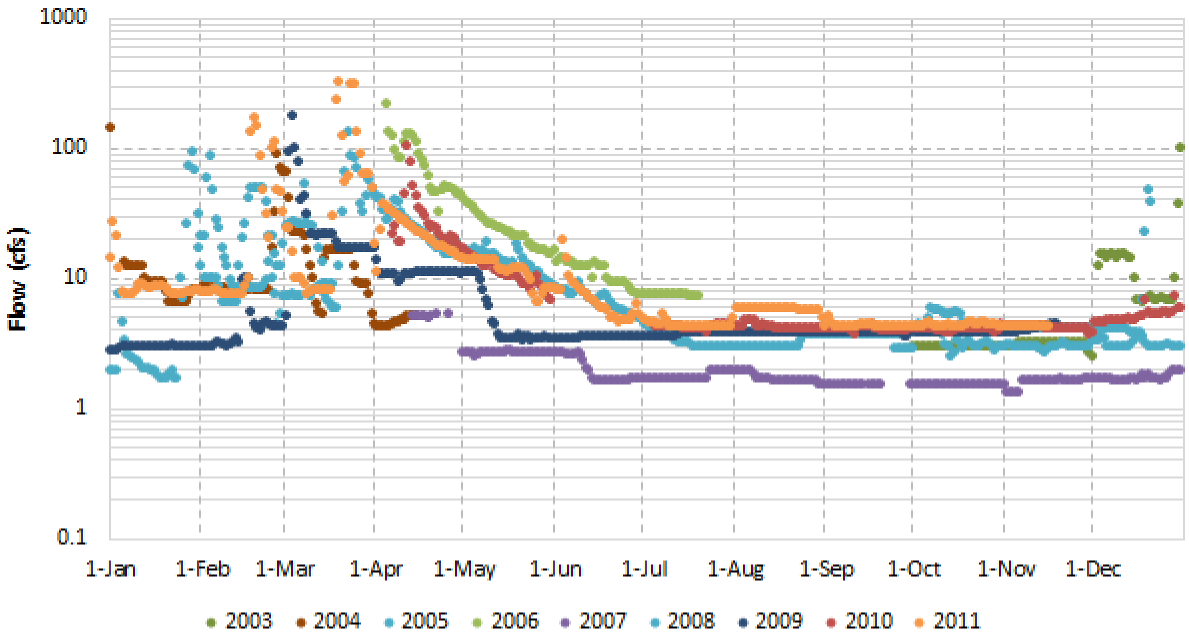


Table 5.6-6. Range of High Confidence for Flows at STEV5

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	1.7	3.0	4.3	4.2	2.5	1.6	1.7	1.5	1.5	1.5	1.3	1.6
1% Exceedance Flow	139.0	167.0	321.0	217.0	40.0	19.3	7.5	5.8	5.1	5.7	4.4	99.0

Of the period used, 99% of the flow data points were above 1.3 cfs and 99% were below 321 cfs. For STEV5, temperature values based on modeled flows below 1.3 cfs or above 321 cfs cannot be predicted with high confidence.

5.6.4 STEV4

Figure 5.6-7 and Figure 5.6-8 and Table 5.6-7 and Table 5.6-8 show the range of historical upstream water temperatures and flows used in the regression at STEV4, Stevens Creek above Highway 280. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.6-7. Range of High Confidence for Upstream Temperature at STEV4

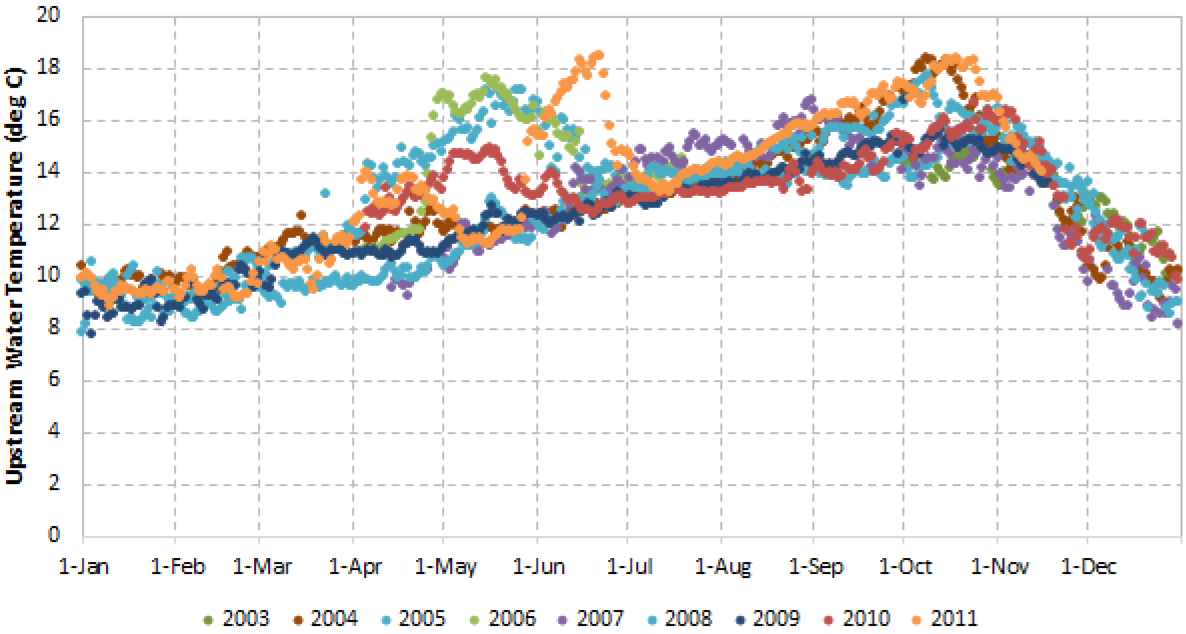


Table 5.6-7. Range of High Confidence for Upstream Temperature at STEV4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	7.7	8.3	8.9	9.2	10.2	11.6	12.7	13.1	13.4	13.4	10.2	8.1
1% Exceedance Flow	10.5	10.9	13.1	17.0	17.6	18.5	15.5	16.7	17.4	18.4	16.8	13.6

Of the period used, 99% of the storage data points were above 7.7°C and 99% of the temperature data points were below 18.5°C. Temperature values based on modeled temperatures below 7.7°C or above 18.5°C cannot be predicted with high confidence.

Figure 5.6-8. Range of High Confidence for Flows at STEV4

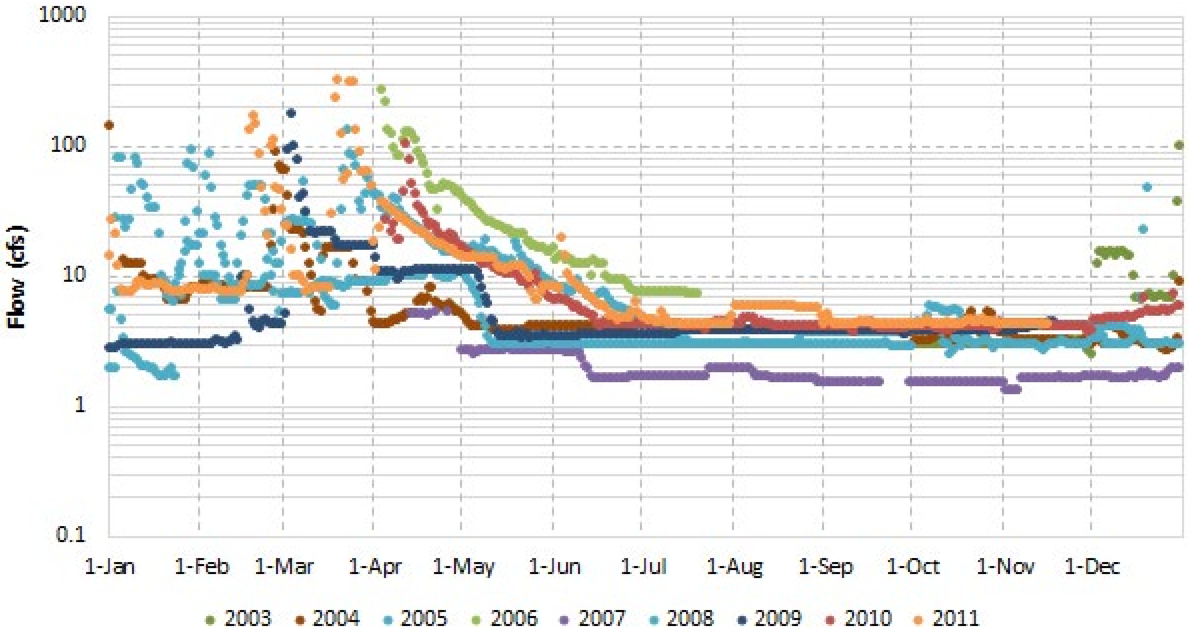


Table 5.6-8. Range of High Confidence for Flows at STEV4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	1.7	3.0	4.3	4.2	2.5	1.6	1.7	1.5	1.5	1.5	1.3	1.6
1% Exceedance Flow	139.0	167.0	321.0	265.0	40.0	19.3	7.5	5.8	5.1	5.7	4.3	99.0

Of the period used, 99% of the flow data points were above 1.3 cfs and 99% were below 321 cfs. For STEV4, temperature values based on modeled flows below 1.3 cfs or above 321 cfs cannot be predicted with high confidence.

5.6.5 STEV3

Figure 5.6-9 and Figure 5.6-10 and Table 5.6-9 and Table 5.6-10 show the range of historical upstream water temperatures and flows used in the regression at STEV3, Stevens Creek above Fremont Avenue. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.6-9. Range of High Confidence for Upstream Temperature at STEV3.

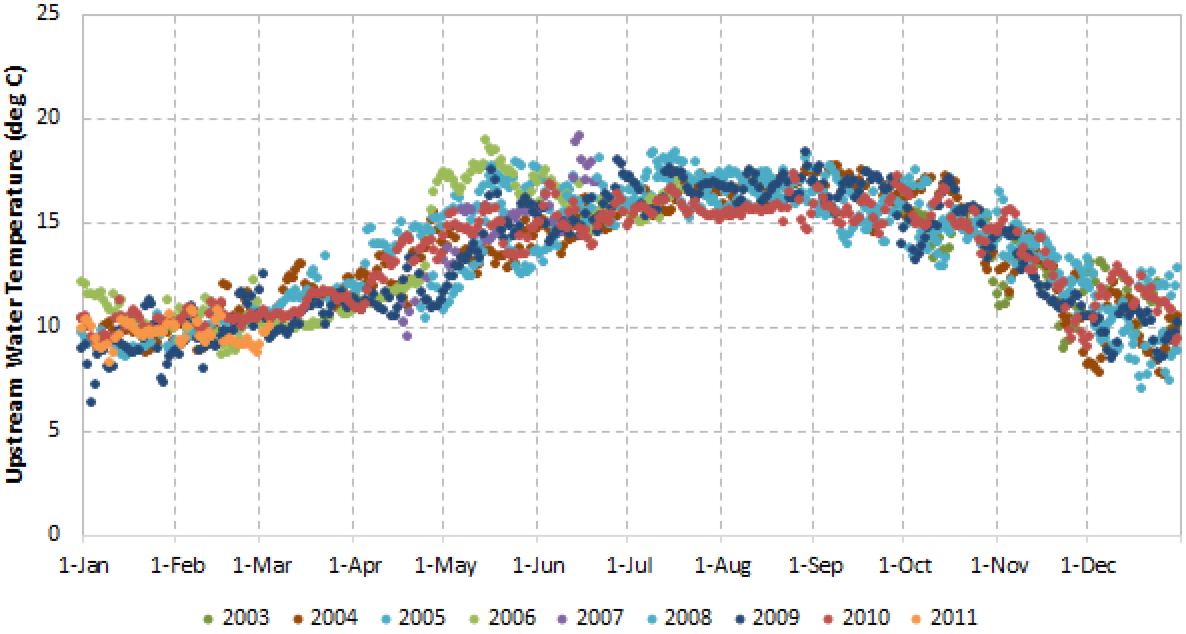


Table 5.6-9. Range of High Confidence for Upstream Temperature at STEV3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	6.3	8.0	9.1	9.4	11.0	13.1	14.8	14.6	13.9	12.1	8.1	7.0
1% Exceedance Flow	12.1	12.2	13.3	17.2	18.9	19.1	18.3	18.4	17.7	17.4	16.4	13.2

Of the period used, 99% of the storage data points were above 6.3°C and 99% of the temperature data points were below 19.1°C. Values based on modeled temperatures below 6.3°C or above 19.1°C cannot be predicted with high confidence.

Figure 5.6-10. Range of High Confidence for Flows at STEV3

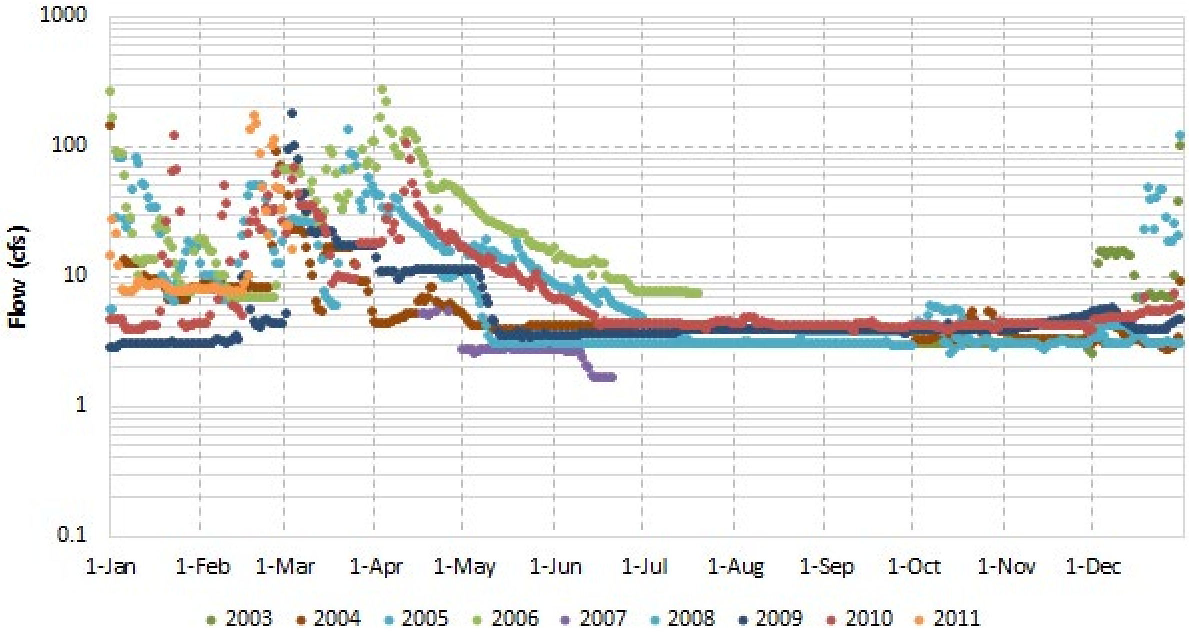


Table 5.6-10. Range of High Confidence for Flows at STEV3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	2.8	3.0	4.3	4.2	2.5	1.6	3.0	3.0	2.9	2.5	2.7	2.5
1% Exceedance Flow	254.0	167.0	177.0	265.0	40.0	16.0	7.5	4.7	4.3	5.7	4.9	119

Of the period used, 99% of the flow data points were above 1.6 cfs and 99% were below 265 cfs. For STEV3, temperature values based on modeled flows below 1.6 cfs or above 265 cfs cannot be predicted with high confidence.

5.6.6 STEV2

Figure 5.6-11 and Figure 5.6-12 and Table 5.6-11 and Table 5.6-12 show the range of historical upstream water temperatures and flows used in the regression at STEV2, Stevens Creek at Central Avenue. Temperature regressions can be applied at a high confidence for values within the historical range for each date.

Figure 5.6-11. Range of High Confidence for Upstream Temperature at STEV2.

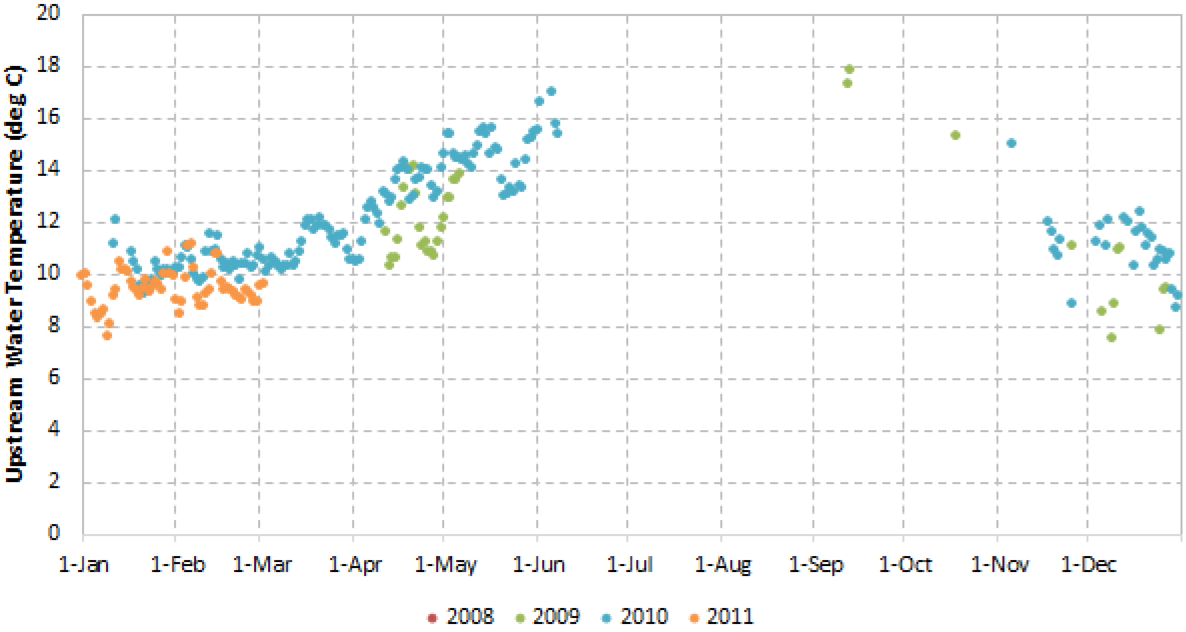


Table 5.6-11. Range of High Confidence for Upstream Temperature at STEV2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	7.6	8.5	9.5	10.3	12.1	15.3	--	--	17.3	15.3	8.8	7.5
1% Exceedance Flow	12.0	11.5	12.1	14.3	15.6	17.0	--	--	17.8	15.3	15.0	12.4

Of the period used, 99% of the storage data points were above 7.6°C and 99% of the temperature data points were below 17.8°C. Temperature values based on modeled temperatures below 7.6°C or above 17.8°C cannot be predicted with high confidence. In addition, the haze chart above demonstrates the lack of data for this location; for each day of year, only one to three data points are available, which seasonally reduces the range of high confidence. Additionally, no historical temperature data were available for June through November; values in June through November cannot be estimated with confidence.

Figure 5.6-12. Range of High Confidence for Flows at STEV2.

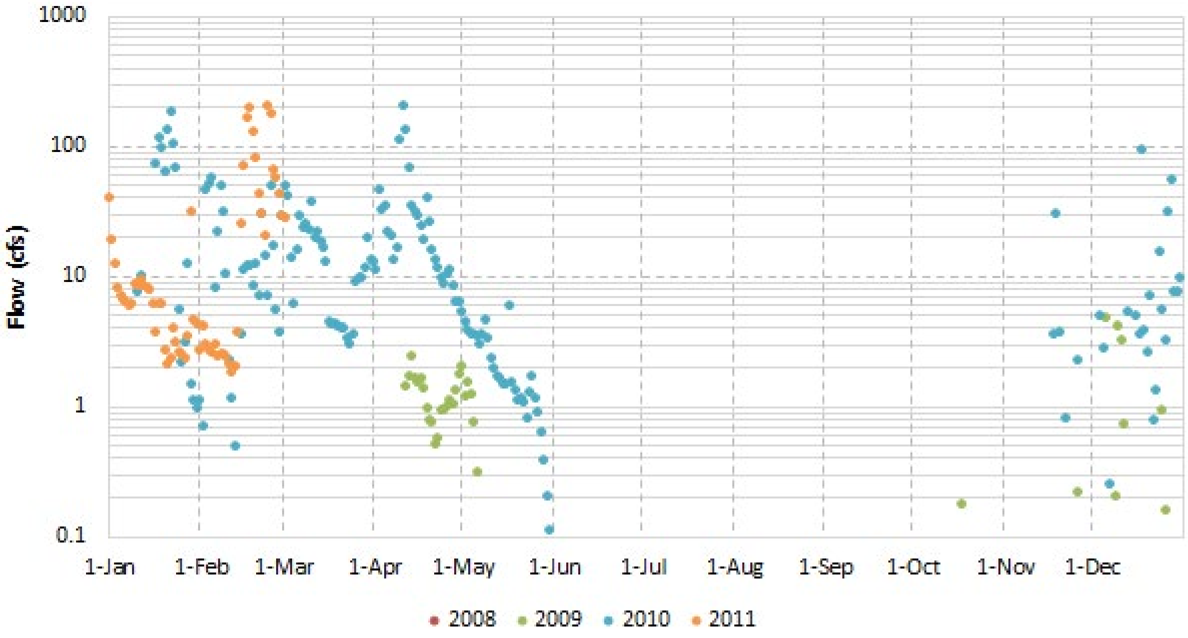


Table 5.6-12. Range of High Confidence for Flows at STEV2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99% Exceedance Flow	0.952	0.085	2.960	0.511	0.108	0.009	--	--	0.016	0.176	0.009	0.007
1% Exceedance Flow	181.0	200.0	48.8	198.0	5.9	0.1	--	--	0.1	0.2	29.8	91.7

Of the period used, 99% of the flow data points were above 0.009 cfs and 99% were below 200 cfs. For STEV2, temperature values based on modeled flows below 0.009 cfs or above 200 cfs cannot be predicted with high confidence. The range of higher confidence for summer is smaller due to the smaller range of observed values.

6 Regression Application

This section describes how the regressions described in Section 4 were applied to Operations Model output to compute water temperatures throughout the Project area for the January 1922 through December 2002 period of record.

6.1 Temperature Regression Inputs

For each alternative, the Operations Model provides time series of reservoir storages and tributary flows at discrete locations representative of tributary reaches. These flow and storage time series are used as inputs for the daily temperature regressions. Regressions were applied for the Operations Model period of record. Operations Model output locations are listed and described in Table 6.1-1.

Table 6.1-1. Operations Model Output Locations and Description.

Reservoirs	
Guadalupe Reservoir	Guadalupe Reservoir Storage
Vasona Reservoir	Vasona Reservoir Storage
Stevens Creek Reservoir	Stevens Creek Reservoir Storage
Calero Reservoir	Calero Reservoir Storage
Stevens Creek WEAP NODE	***Description***
Stevens Creek 2	STEV6 - Stevens Creek below Stevens Creek Reservoir
Stevens Creek 11	STEV5 - Stevens Creek below Stevens Creek Reservoir
Stevens Creek 17	STEV4 - Stevens Creek below Stevens Creek Reservoir
Stevens Creek 21	STEV3 - Stevens Creek above Hwy 280
Stevens Creek 25	STEV2 - Stevens Creek above Fremont Ave
Stevens Creek 2	STEV6 - Stevens Creek below Stevens Creek Reservoir
Stevens Creek 29	STEV 1 - Stevens Creek flow to the Bay
Alamitos Creek WEAP NODE	***Description***
Alamitos Creek 2	ALAM4 - Alamitos Creek below Almaden Reservoir
Alamitos Creek 9	ALAM3 - Alamitos Creek below Almaden Reservoir
Alamitos Creek 15	ALAM2 - Alamitos Creek below Almaden Reservoir
Alamitos Creek 17	ALAM1 - Alamitos Creek with Accretions
Calero Creek WEAP NODE	***Description***
Calero Creek 8	CALE2 - Calero Creek below Calero Reservoir
Calero Creek 15	CALE1 - Calero Creek below Calero Reservoir
Guadalupe Creek/River WEAP NODE	***Description***
Guadalupe Creek 2	GCRK4 - Guadalupe Creek below Guadalupe Reservoir

Reservoirs	
Guadalupe Creek 11	GCRK3 - Guadalupe Creek above Masson Dam
Guadalupe Creek 17	GCRK2 - Guadalupe Creek below Masson Dam
Guadalupe Creek 25	GCRK1 - Guadalupe Creek upstream of Lake Almaden
Guadalupe River 5	GUAD7 - Guadalupe River below Alamitos Drop Structure
Guadalupe River 13	GUAD6 - Guadalupe River below Ross Creek
Guadalupe River 17	GUAD5 - Guadalupe River above Los Gatos Creek
Guadalupe River 21	GUAD4 - Guadalupe River at Coleman Avenue
Guadalupe River 23	GUAD3 - Guadalupe River at San Jose Airport
Guadalupe River 25	GUAD2 - Guadalupe River at Montague Expressway
Guadalupe River 27	GUAD1 - Guadalupe River at Highway 237
Los Gatos Creek WEAP NODE	***Description***
Los Gatos Creek 23	LOSG2 - Los Gatos Creek below Lower Page Drop Structure
Los Gatos Creek 31	LOSG1 - Los Gatos Creek above Guadalupe River Confluence

To apply the regression for each temperature location, the Operations Model node closest to the historical flow node used for the regression was selected. Table 6.1-2 lists the Operations Model nodes selected.

Table 6.1-2. Operations Model Nodes Selected for Regression Application

Water Temperature Location	Operations Model Node Used for Flow	Operations Model Node Used for Storage	Operations Model Node used for Upstream Temperature	Notes
Stevens Creek				
STEV6	Stevens Creek 2 (STEV6)	Stevens Creek Reservoir	Outlet	Storage is converted to an inlet temperature using water temperature profiles
STEV5	Stevens Creek 2 (STEV6)	N/A	STEV6	
STEV4	Stevens Creek 2 (STEV6)	N/A	STEV5	
STEV3	Stevens Creek 2 (STEV6)	N/A	STEV4	

Water Temperature Location	Operations Model Node Used for Flow	Operations Model Node Used for Storage	Operations Model Node used for Upstream Temperature	Notes
STEV2	Stevens Creek 2 (STEV6)	N/A	STEV3	
Alamitos Creek				
ALAM4	Alamitos Creek 2 (ALAM4)	Almaden Reservoir	N/A	For Aug and Sep, min flow of 2.3 cfs.
ALAM3	Alamitos Creek 2 (ALAM4)	N/A	ALAM4	
ALAM2	Alamitos Creek 2 + Calero Creek 8 (ALAM4 + CALE2)	N/A	ALAM3 + CALE1	Min flow of 1.1 cfs (CALE2)
ALAM1	Alamitos Creek 15 (ALAM2)	N/A	ALAM2	Min flow of 1.1 cfs (ALAM2)
Calero Creek				
CALE2	Calero Creek 8 (CALE2)	Calero Reservoir	N/A	Min flow of 1.1 cfs (CALE2)
CALE1	Calero Creek 8 (CALE2)	N/A	CALE2	Min flow of 1.1 cfs (CALE2)
Los Gatos Creek				
LOSG2	Los Gatos Creek 23 (LOSG2)	Vasona Reservoir	N/A	
LOSG1	Los Gatos Creek 23 (LOSG2)	N/A	LOSG2	
Guadalupe Creek				
GCRK4	Guadalupe Creek 2 (GCRK4)	Guadalupe Reservoir		
GCRK3	Guadalupe Creek 11 (GCRK3)	N/A	GCRK4	Min flow of 1.1 cfs (GCRK3)
GCRK2	Guadalupe Creek 11 (GCRK3)	N/A	GCRK3	Min flow of 1.1 cfs (GCRK3)
GCRK1	Guadalupe Creek 11 (GCRK3)	N/A	GCRK2	Min flow of 1.1 cfs (GCRK3)
Guadalupe River				
GUAD7	Alamitos Creek 15 and Guadalupe Creek 11 (ALAM2 + GCRK3)	N/A	ALAM1 + GCRK1	Min flow of 1.1 cfs (GCRK3) & (ALAM2)
GUAD5	Guadalupe 17 (GUAD5)	N/A	GUAD7	Min flow of 1.1 cfs (GUAD5)

Water Temperature Location	Operations Model Node Used for Flow	Operations Model Node Used for Storage	Operations Model Node used for Upstream Temperature	Notes
GUAD4	Los Gatos Creek 31 and Guadalupe 17 (LOSG1 + GUAD5)	N/A	LOSG1+GUAD5	Min flow of 1.1 cfs (GUAD5)
GUAD3	Guadalupe River 23 (GUAD3)	N/A	GUAD4	

Historical daily maximum air temperature data from the San Jose Airport (NCDC CDO, 2015), was used to represent meteorological conditions at all regression locations.

At some locations, historically-measured data did not have minimums low enough to reflect minimums seen in the WEAP data. Due to this, a minimum flow of 1.1 cfs was applied to certain locations. Additionally, due to some WEAP flow data being unavailable at some locations at the time of regression testing, other locations were substituted in testing. For GUAD5 and GUAD4, GUAD5 flows were used to calculate the regression coefficients; however, the WEAP flow data for GUAD7 was all that was available at the time of the regression testing.

6.2 Temperature Regression Outputs

Model output is a daily average time series that can be used for comparative temperature and fisheries analyses. The regression will be applied four times for each location, once each to create a synthetic time series for the Existing Conditions analysis with present level of demand, Existing Conditions analysis with 2035 demands, the FAHCE Proposed Action, and the Alternative. An example of a synthetic time series is shown in Figure 6.2-1. Baseline temperature output is shown for all locations in Figure 6.2-2.

Figure 6.2-1. Simulated Daily Water Temperatures at Stevens Creek POI6

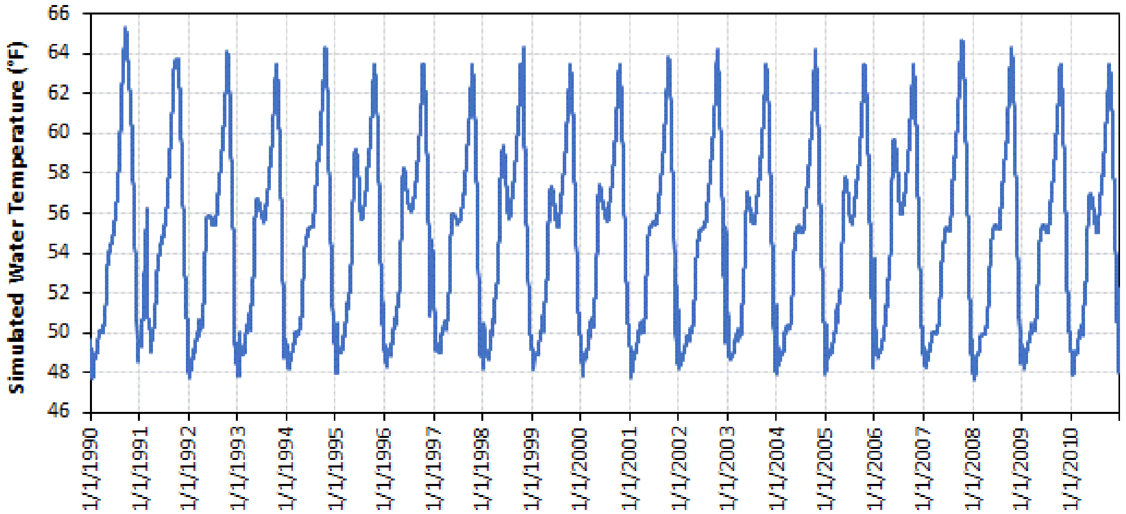


Figure 6.2-2. Baseline Temperature Output

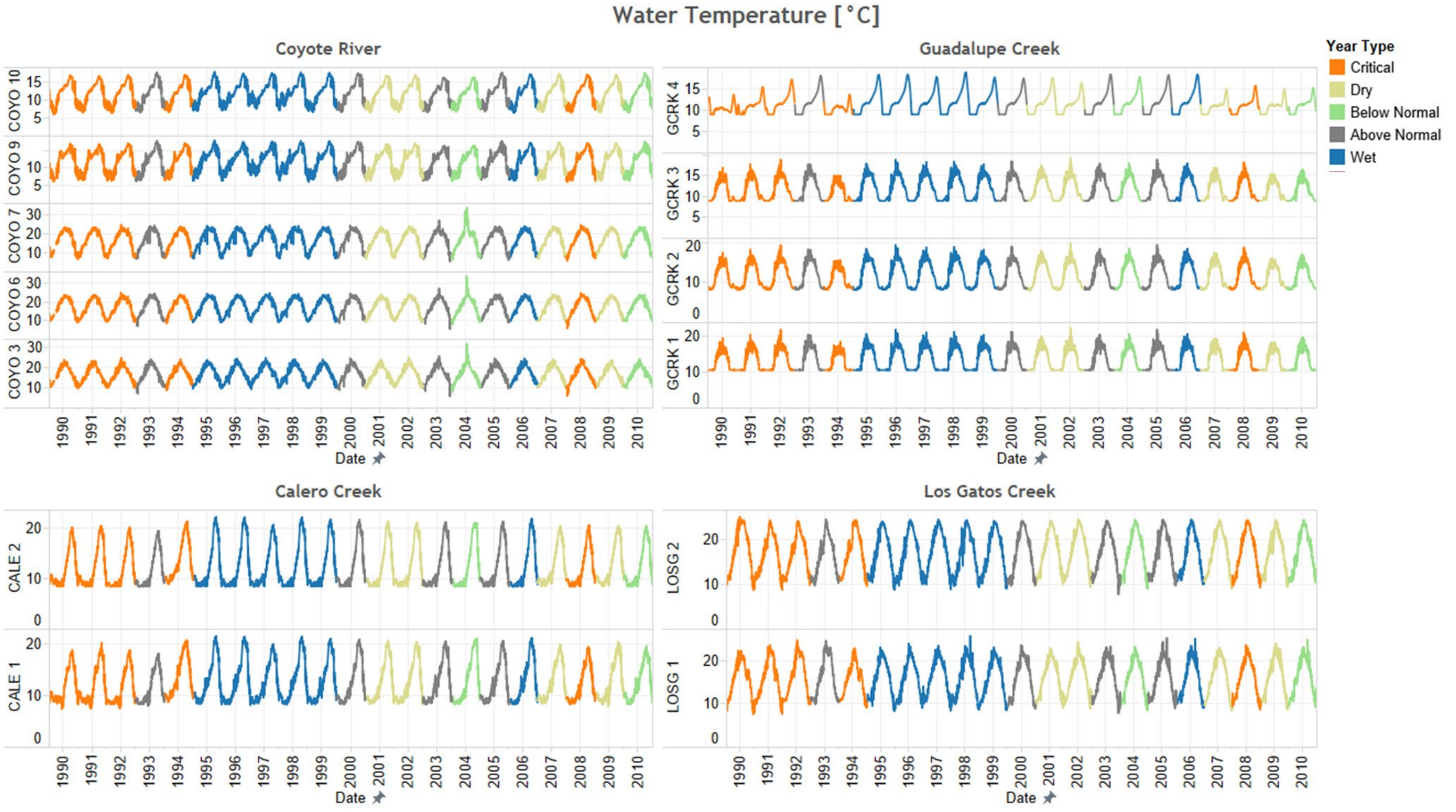
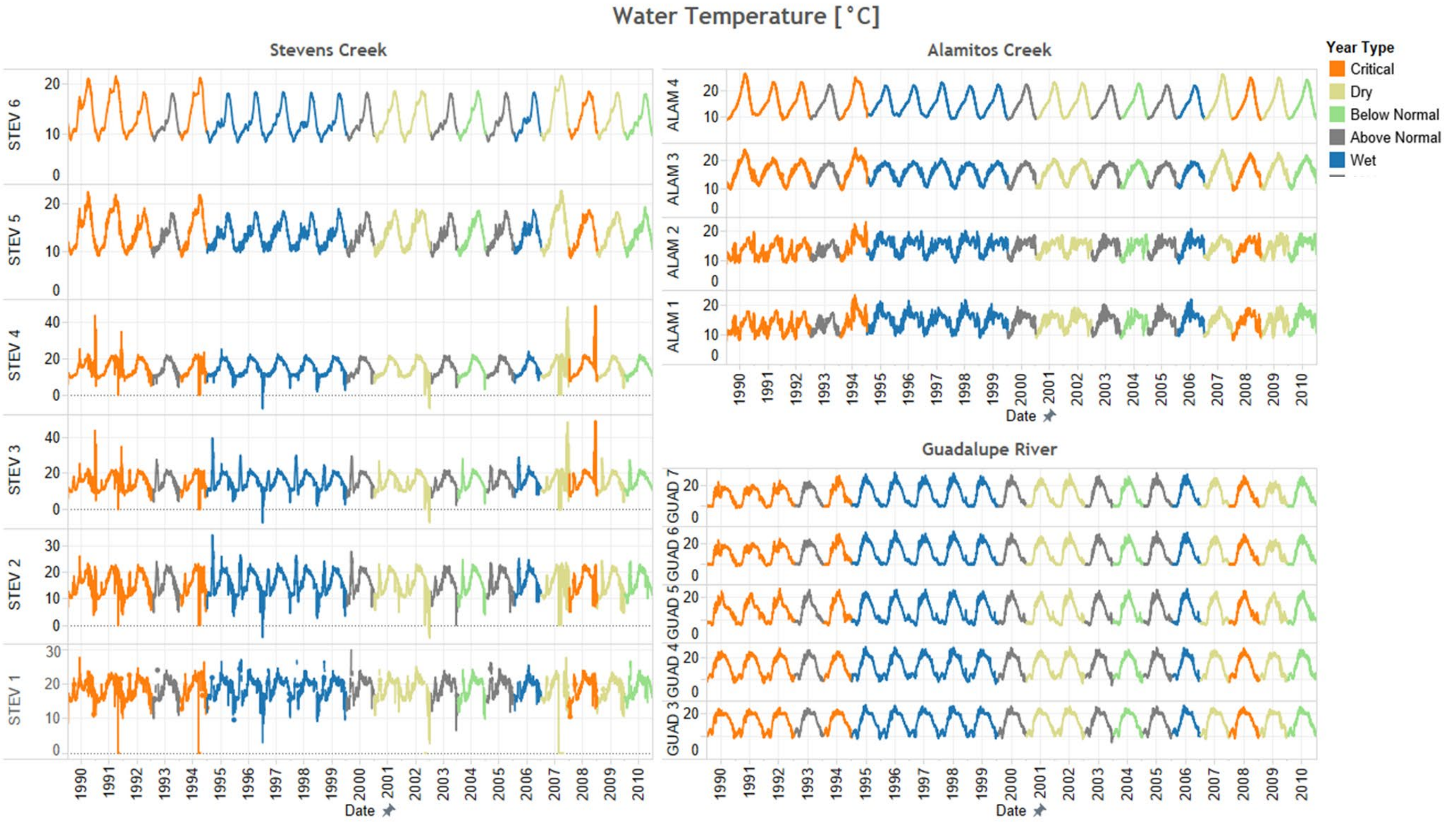


Figure 6.2-2 (continued). Baseline Temperature Output



6.3 Model Sensitivity to Flow Uncertainty

In addition to the uncertainty described in the above sections, which occurs as a result of the imperfect fit of the regressions compared to historical data, uncertainty can also propagate from the model inputs used to estimate temperature. Uncertainty in modeled flow and storage results contribute to uncertainty in the temperature model. To test the temperature model's sensitivity to flow uncertainty, temperature estimates were generated assuming a 10% increase in baseline flows at all locations and a 10% decrease in baseline flows at all locations. The results were then compared against the baseline operation temperatures to determine the average change in temperature, maximum temperature increase, and maximum temperature decrease for each reach.

The effect of flow uncertainty on temperature model performance was tested by computing temperatures based on a 10% decrease and a 10% increase in modeled flow at all locations. Table 6.3-1 and Table 6.3-2 show the results of that test.

Table 6.3-1. Sensitivity of Modeled Temperature to 10% Decrease In Flow

	Average Change, relative to Base Case Flow (°C)	Max Increase, relative to Base Case Flow (°C)	Max Decrease, relative to Base Case Flow (°C)
ALAM	+0.00	+0.39	-0.90
CALE	-0.01	+0.16	-0.22
GCRK	-0.04	+0.35	-0.37
GUAD	-0.02	+0.34	-0.63
LOSG	-0.01	+0.18	-0.16
STEV	-0.02	+0.27	-0.51

Table 6.3-2. Sensitivity of Modeled Temperature to 10% Increase In Flow

	Average Change, relative to Base Case Flow (°C)	Max Increase, relative to Base Case Flow (°C)	Max Decrease, relative to Base Case Flow (°C)
ALAM	+0.00	+0.81	-0.36
CALE	+0.01	+0.20	-0.14
GCRK	+0.04	+0.33	-0.32
GUAD	+0.02	+0.58	-0.31
LOSG	+0.01	+0.46	-0.25
STEV	+0.01	+0.30	-0.15

On average, a 10% decrease in flow resulted in an average temperature increase of -0.04℃ to 0.07℃ for Alamitos, Calero, Guadalupe, and Los Gatos Creeks and Guadalupe River. A 10% increase in flow resulted in an average temperature decrease of -0.04℃ to 0.03℃ for Alamitos, Calero, Guadalupe, and Los Gatos Creeks and Guadalupe River.

Based on maximum temperature increase and maximum temperature decrease for both the 10% increase in flow and the 10% decrease in flow, Alamitos Creek and Guadalupe River were the most sensitive to flow changes. Uncertainty in flows on Alamitos Creek could lead to an uncertainty of up to 0.9℃. Uncertainty in flows for Guadalupe River could lead to an uncertainty of up to 0.63℃. Uncertainty in flows on Stevens Creek could lead to an uncertainty of up to 0.51℃. Uncertainty in flows on Los Gatos Creek could lead to an uncertainty of up to 0.46℃. For Calero and Guadalupe Creeks, 10% uncertainty in the flow model could lead to an uncertainty of up to 0.37℃.

6.4 Conclusions

Regression calibrations were limited to the smallest available input data set. Temperature data, and therefore temperature regressions, were only available for a limited number of years, thus representing a limited range of flow and reservoir storage conditions. For Operations Model output above or below the range of measured conditions used for regression calibration, the regressions must extrapolate values, which could introduce uncertainty into the results. In addition, data were substituted for months in which no temperature data were recorded. As a result, predictions could not be made for some months of modeled WEAP data in some locations along Guadalupe River. Additionally, nonlinear effects due to changing bathymetry could affect the accuracy of the temperature results.

The models described are purely mathematical and not intended to compare scenarios with substantially different boundary conditions at the reservoir or temperature regimes within the reservoir; scenarios with substantial changes to downstream flow patterns or diversions; scenarios with full or empty reservoirs year-round; and scenarios with changes in channel or reservoir geometry.

Nonetheless, temperature model results remain useful for comparative purposes. It is important to differentiate between “absolute” or “predictive” modeling applications and “comparative” applications. In “absolute” applications, the model is run once to predict a future outcome; errors or assumptions for such factors as formulation, system representation, data, and operational criteria, all contribute to total error or uncertainty in model results. In “comparative” applications, the model is run twice, once to represent a base condition (Existing Condition) and a second time with a specific modification (Alternative) to assess the change in the outcome because of the input change.

In the comparative mode (the mode used for this study), the difference between the two simulations is of principal importance. Most potential errors or uncertainties affecting the Existing Condition simulation will also affect the Alternative simulation in a similar manner; as a result, the effect of errors and uncertainties on the difference between the simulations is reduced. However, not all limitations are fully eliminated by the comparative analysis approach; small differences between the alternatives and the bases of comparison are not considered to be indicative of an effect of the alternative.

7 References

[NCDC CDO] National Climatic Data Center Climate Data Online

2015 Daily Maximum Air Temperature, 1/1/19-9/30/2007. San Jose, CA, US. http://www.ncdc.noaa.gov/cdo-web/datatools/findstation. Retrieved June 19, 2015.

[USGS] U.S. Geological Survey

2015 Surface-water Historical Instantaneous Data. Gage 1169025 and 11172175. http://waterdata.usgs.gov/nwis/uv/?referred_module=sw. Retrieved June 2015.

Valley Water Daily WEAP Model Technical Memorandum (Valley Water, June 2016)

ROI and POI Technical Memorandum (FAHCE Technical Workgroup, 2016)

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Attachment A – Locations of Historic Water Temperature, Flow and Storage Data

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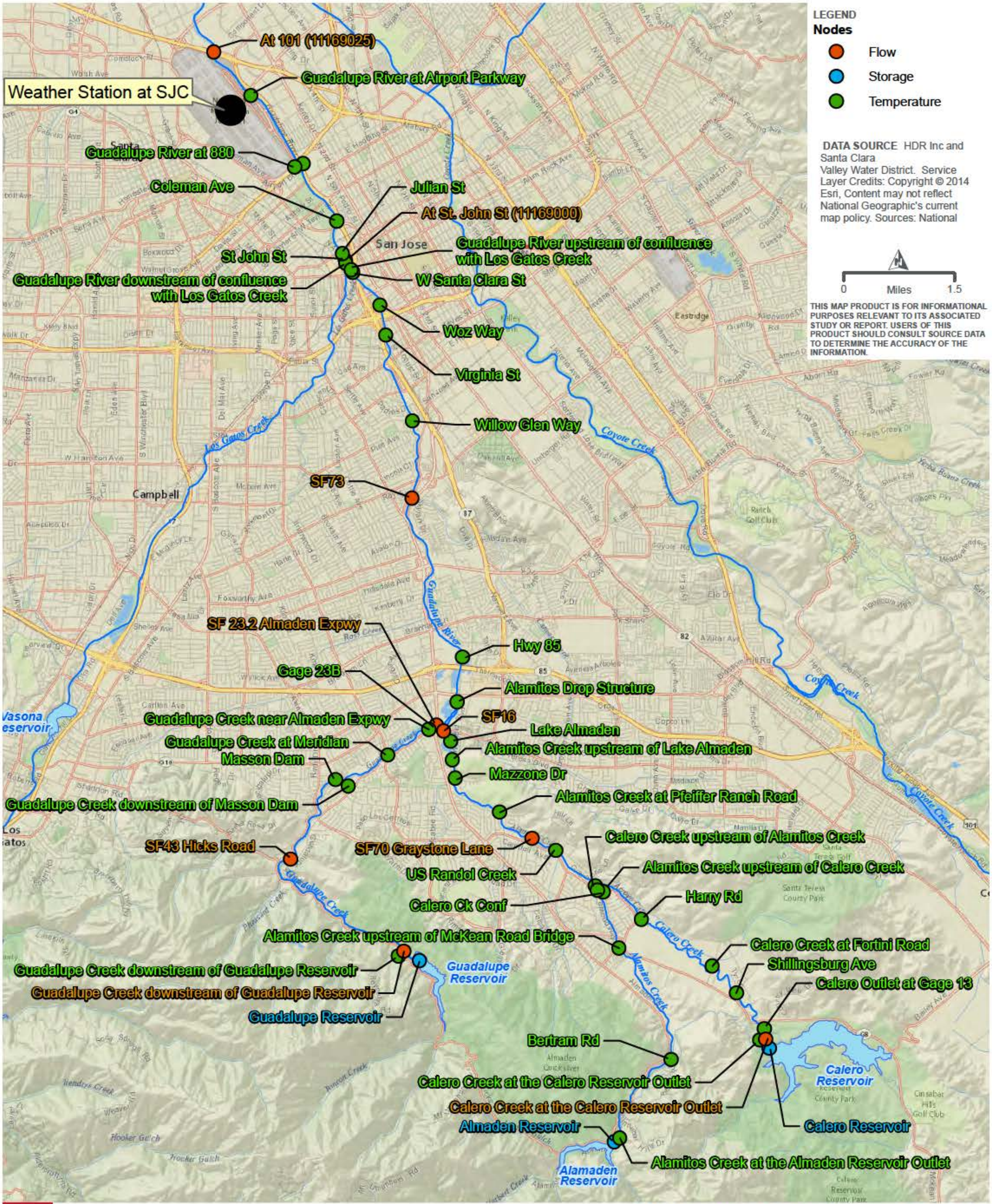

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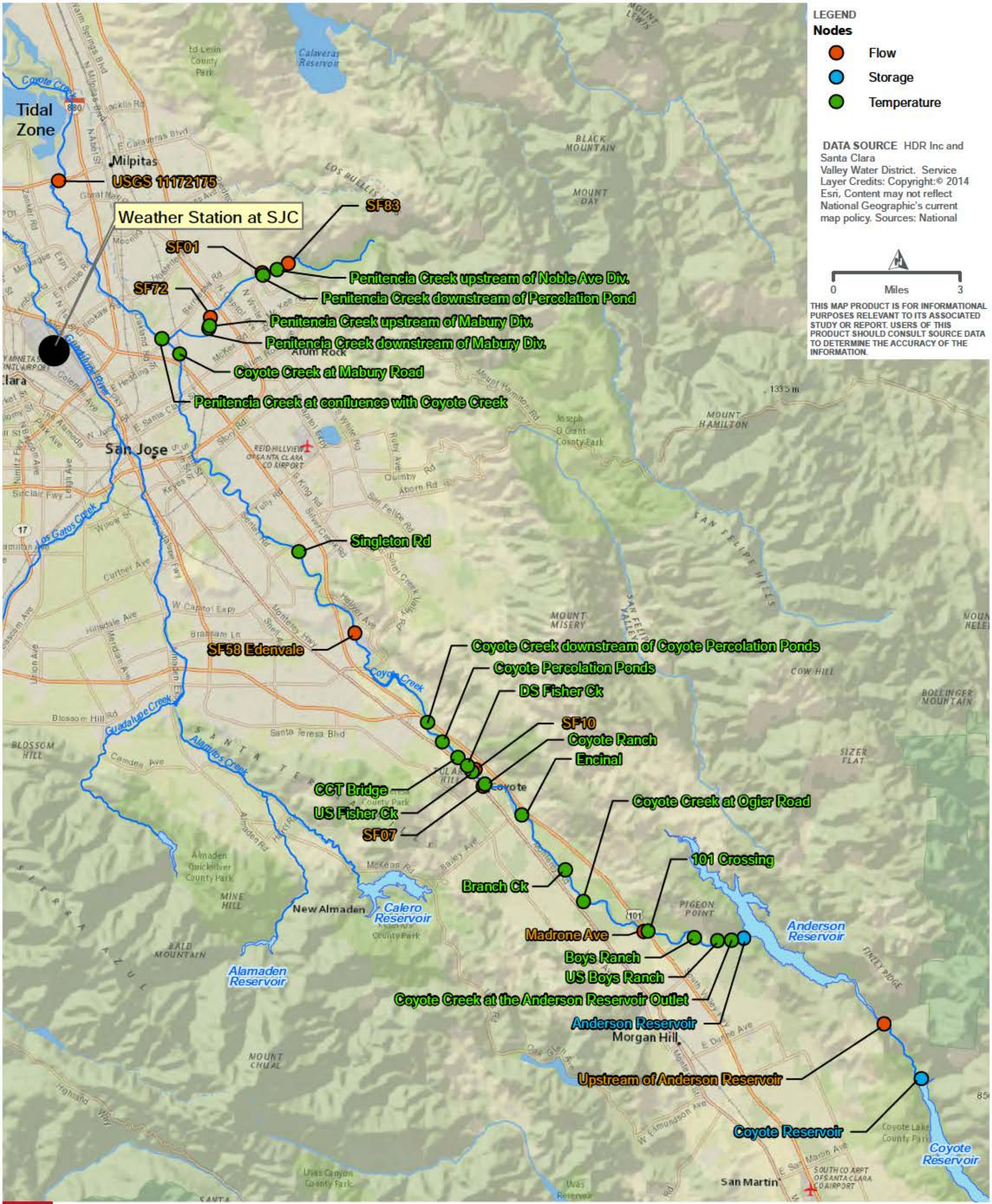
HDR

SANTA CLARA VALLEY WATER DISTRICT – FISH AND AQUATIC HABITAT COLLABORATIVE EFFORT (FAHCE)

A-1, LOCATIONS OF ALL AVAILABLE HISTORIC DATA

PATH: \\SAC SRV01\GIS\PROJECTS\SANTACLARAWATERDISTRICT\028_224745_SCVWD\MAP_DOCS\REPORT\REPORT_GUADALUPE_DECEMBER_ALLPTS.MXD USER: GPOPULIS DATE: 9/9/2016

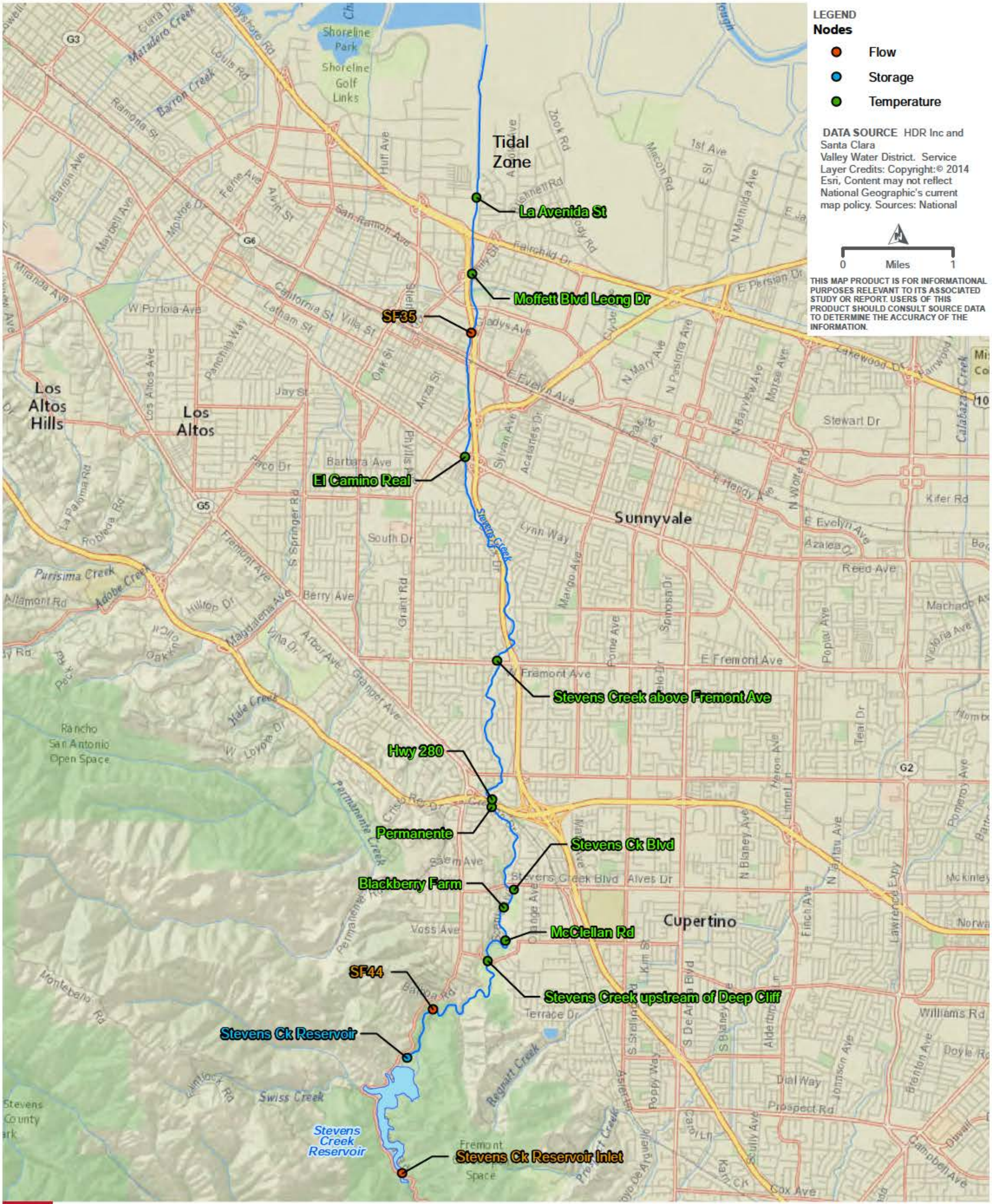


HDR

SANTA CLARA VALLEY WATER DISTRICT – FISH AND AQUATIC HABITAT COLLABORATIVE EFFORT (FAHCE)

A-2, LOCATIONS OF ALL AVAILABLE HISTORIC DATA

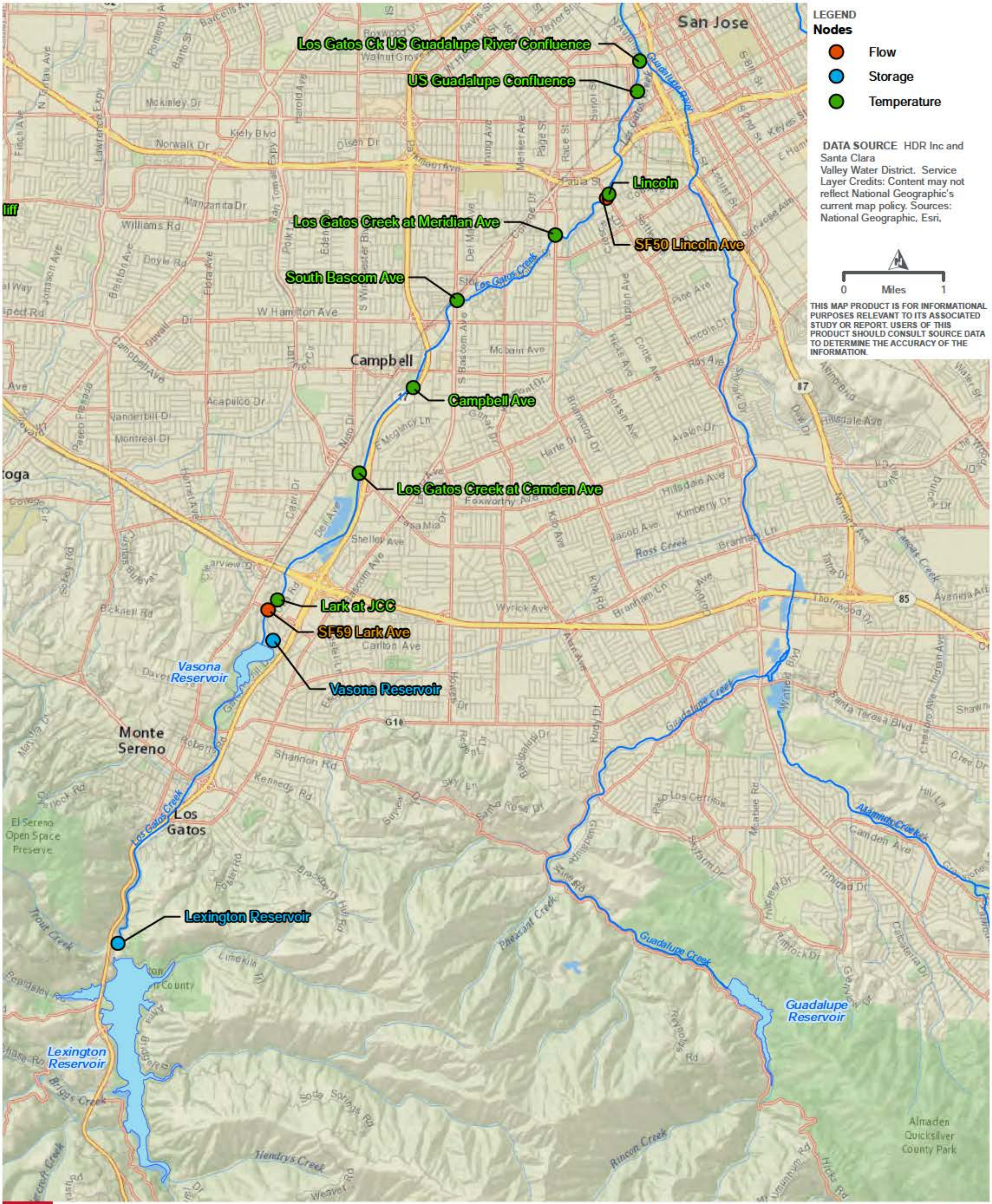
PATH: \\SAC SRV01\GIS\PROJECTS\SANTACLARAWATERDISTRICT\028_224745_SCVWD\MAP_DOCS\REPORT\REPORT_COYOTE_DECEMBER_ALLPTS.MXD USER: GPOPULIS DATE: 9/9/2016



SANTA CLARA VALLEY WATER DISTRICT – FISH AND AQUATIC HABITAT COLLABORATIVE EFFORT (FAHCE)

A-3, LOCATIONS OF ALL AVAILABLE HISTORIC DATA

PATH: \\SAC SRV01\GIS\PROJECTS\SANTACLARAWATERDISTRICT\028_224745_SCVWD\MAP_DOCS\REPORT\REPORT_STEVENS_DECEMBER_ALLPTS.MXD USER: GPOPULIS DATE: 9/9/2016



SANTA CLARA VALLEY WATER DISTRICT – FISH AND AQUATIC HABITAT COLLABORATIVE EFFORT (FAHCE)

A-4, LOCATIONS OF ALL AVAILABLE HISTORIC DATA

PATH: \\SAC SRV01\GIS\PROJECTS\SANTACLARAWATERDISTRICT\028_224745_SCVWD\MAP_DOCS\REPORT\REPORT_LOSGATOS_DECEMBER_ALLPTS.MXD USER: GPOPULIS DATE: 9/9/2016

Appendix I – Temperature Modeling Technical Memorandum

Attachment B – Final Regression and Input Data Locations

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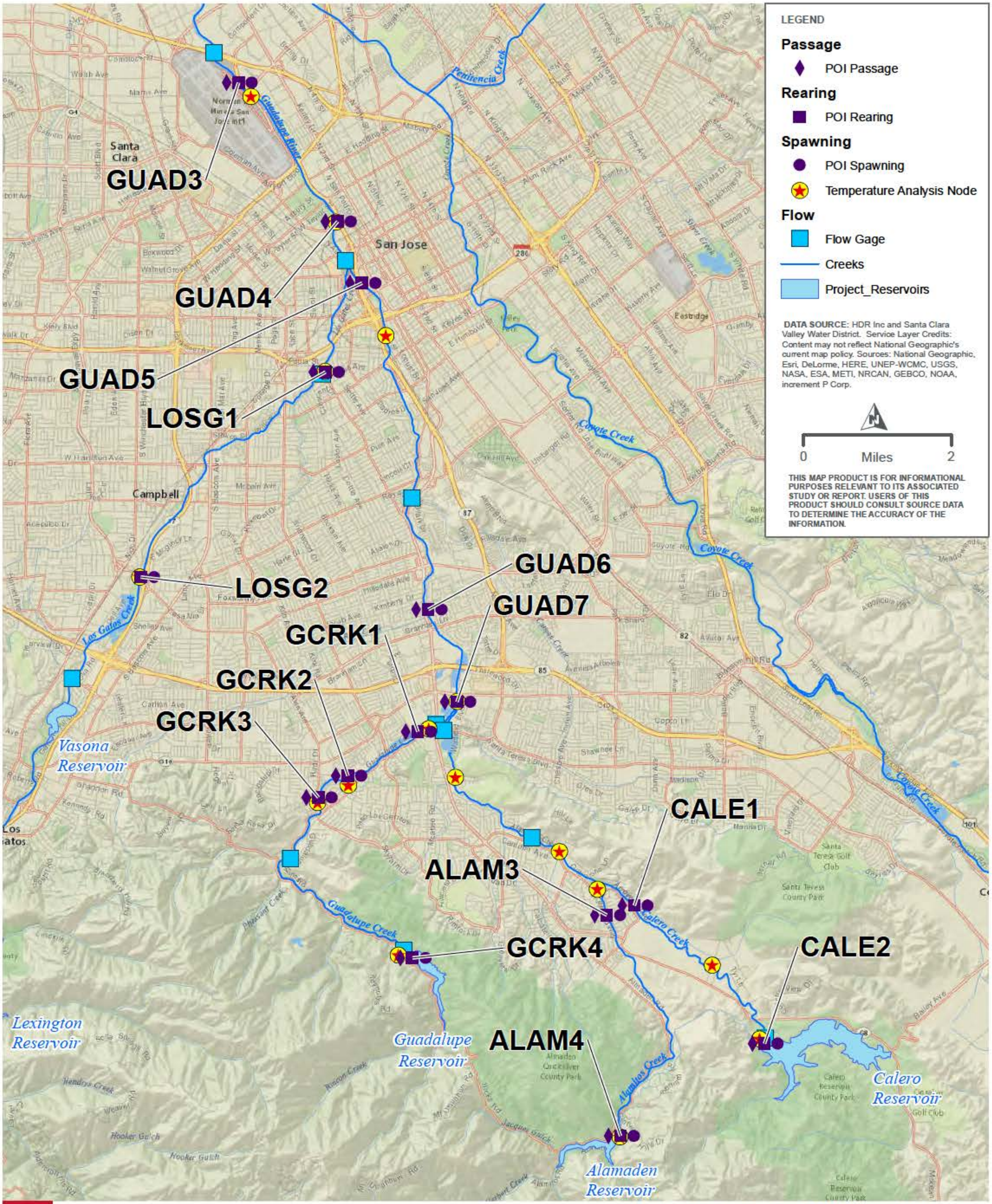

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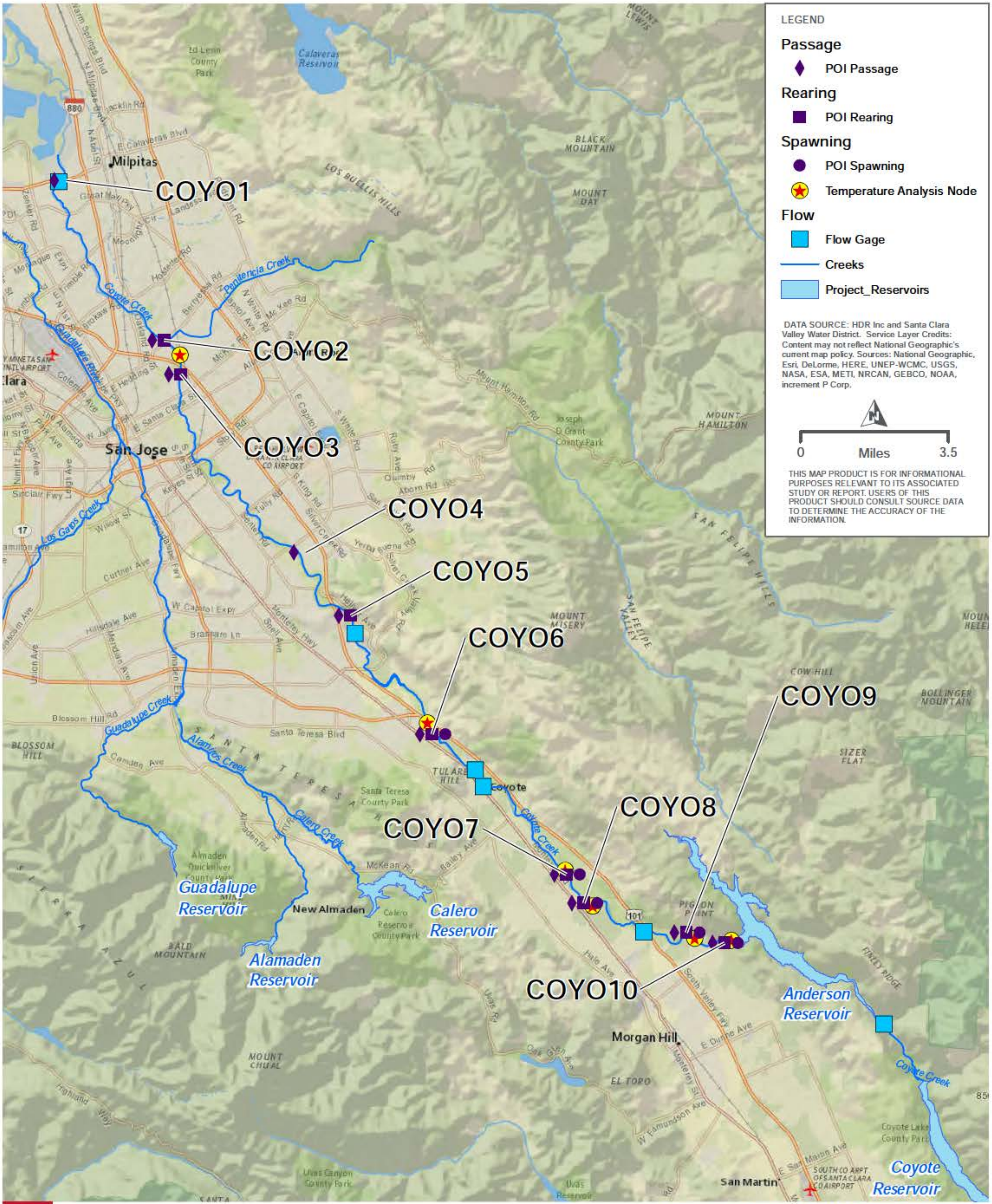
SANTA CLARA VALLEY WATER DISTRICT - FISH AND AQUATIC HABITAT COLLABORATIVE EFFORT (FAHCE)

B-1, FINAL REGRESSION AND INPUT DATA LOCATIONS

PATH: G:\PROJECTS\SANTACLARAWATERDISTRICT\028_224745_SCVWD\MAP_DOCS\REPORT\REPORT_POI_GUADALUPERIVER_8.5X11.MXD USER: RCARIADIKI DATE: 9/9/2016



DATA SOURCE: HDR Inc and Santa Clara Valley Water District. Service Layer Credits: Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

THIS MAP PRODUCT IS FOR INFORMATIONAL PURPOSES RELEVANT TO ITS ASSOCIATED STUDY OR REPORT. USERS OF THIS PRODUCT SHOULD CONSULT SOURCE DATA TO DETERMINE THE ACCURACY OF THE INFORMATION.

SANTA CLARA VALLEY WATER DISTRICT -
FISH AND AQUATIC HABITAT COLLABORATIVE EFFORT (FAHCE)

B-2, FINAL REGRESSION AND INPUT DATA LOCATIONS

PATH: G:\PROJECTS\SANTACLARAWATERDISTRICT\028 224745 SCVWD\MAP DOCS\REPORT\REPORT POI COYOTECREEK 8 5X11 MXD USER: RCARIADIKI DATE: 9/9/2016

SANTA CLARA VALLEY WATER DISTRICT -
FISH AND AQUATIC HABITAT COLLABORATIVE EFFORT (FAHCE)

B-3, FINAL REGRESSION AND INPUT DATA LOCATIONS

PATH: G:\PROJECTS\SANTACLARAWATERDISTRICT\028 224745 SCVWD\MAP DOCS\REPORT\REPORT POI STEVENSCREEK 8 5X11 MXD USER: RCARIADIKI DATE: 9/9/2016

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Appendix I – Temperature Modeling Technical Memorandum

Attachment C – Daily Regression Coefficients

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Temperature Modeling Technical Memorandum
Santa Clara Valley Water District FAHCE Project

Attachment C - Alamitos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.97	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
C. Reservoir Release (ALAM4)	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.07	0.07	0.07	0.07	0.07
D. Daily Max Air Temperature	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
E. Constant	-0.10	-0.09	-0.08	-0.07	-0.06	-0.05	-0.04	-0.03	-0.02	-0.01	0.00	0.01	0.01	0.02	0.03
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00
B. Previous day temp	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98
C. Flow (ALAM4)	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	-0.01	-0.01
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.90	0.90	0.90	0.90	0.89	0.89	0.88	0.88	0.87	0.85	0.84	0.82	0.80	0.78	0.76
B. Calero Temp (CALE1)	0.15	0.15	0.14	0.14	0.14	0.14	0.15	0.15	0.16	0.17	0.18	0.19	0.21	0.23	0.25
C. Alamitos Flow (ALAM4)	0.15	0.13	0.11	0.09	0.08	0.06	0.04	0.03	0.02	0.01	0.00	-0.01	-0.02	-0.03	-0.03
D. Calero Flow (CALE2)	0.44	0.50	0.55	0.61	0.66	0.70	0.74	0.78	0.82	0.85	0.88	0.91	0.93	0.94	0.96
E. Prev Day Temp	-0.28	-0.27	-0.27	-0.27	-0.26	-0.26	-0.26	-0.25	-0.25	-0.24	-0.24	-0.23	-0.23	-0.22	-0.22
F. Daily Max Air Temperature	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.02	1.01	1.01	1.01	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99
B. Prev Day Temp	-0.07	-0.07	-0.07	-0.06	-0.06	-0.05	-0.05	-0.05	-0.05	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03
C. Flow (ALAM2)	0.13	0.13	0.13	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.10
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
C. Reservoir Release (ALAM4)	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.04	0.04	0.04	0.03	0.03
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.11
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06
B. Previous day temp	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.97	0.96	0.96	0.96
C. Flow (ALAM4)	-0.01	-0.02	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.05
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.73	0.71	0.68	0.64	0.61	0.58	0.54	0.50	0.46	0.42	0.39	0.35	0.31	0.27	0.23
B. Calero Temp (CALE1)	0.27	0.30	0.33	0.36	0.39	0.42	0.46	0.49	0.53	0.56	0.60	0.64	0.67	0.71	0.75
C. Alamitos Flow (ALAM4)	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.02	-0.02	-0.01	-0.01	0.00	0.01
D. Calero Flow (CALE2)	0.96	0.97	0.97	0.96	0.95	0.94	0.93	0.91	0.89	0.86	0.83	0.81	0.77	0.74	0.70
E. Prev Day Temp	-0.21	-0.21	-0.20	-0.20	-0.19	-0.18	-0.18	-0.17	-0.16	-0.15	-0.15	-0.14	-0.13	-0.13	-0.12
F. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00
B. Prev Day Temp	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
C. Flow (ALAM2)	0.10	0.10	0.10	0.09	0.09	0.09	0.08	0.08	0.07	0.07	0.07	0.06	0.06	0.05	0.05
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Alamitos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
C. Reservoir Release (ALAM4)	0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.11	0.12	0.12	0.13	0.14	0.14	0.15	0.16	0.16	0.17	0.18	0.19	0.20	0.21	0.22
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	0.07	0.08	0.08	0.09	0.10	0.10	0.11	0.12	0.13	0.13	0.14	0.15	0.16	0.17	0.18
B. Previous day temp	0.95	0.95	0.95	0.94	0.94	0.93	0.93	0.92	0.91	0.91	0.90	0.89	0.88	0.87	0.86
C. Flow (ALAM4)	-0.05	-0.05	-0.05	-0.05	-0.06	-0.06	-0.06	-0.07	-0.07	-0.07	-0.08	-0.08	-0.08	-0.09	-0.09
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.19	0.16	0.12	0.09	0.06	0.03	0.00	-0.03	-0.05	-0.07	-0.09	-0.11	-0.12	-0.13	-0.13
B. Calero Temp (CALE1)	0.78	0.82	0.85	0.88	0.92	0.94	0.97	1.00	1.02	1.04	1.06	1.07	1.08	1.09	1.09
C. Alamitos Flow (ALAM4)	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.09	0.10	0.11	0.12	0.12	0.13
D. Calero Flow (CALE2)	0.67	0.63	0.59	0.55	0.50	0.46	0.42	0.38	0.33	0.29	0.24	0.20	0.16	0.12	0.08
E. Prev Day Temp	-0.11	-0.10	-0.10	-0.09	-0.08	-0.08	-0.07	-0.06	-0.06	-0.05	-0.04	-0.04	-0.03	-0.02	-0.02
F. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02	1.02	1.02
B. Prev Day Temp	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01
C. Flow (ALAM2)	0.05	0.04	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97
C. Reservoir Release (ALAM4)	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.23	0.24	0.26	0.27	0.28	0.30	0.31	0.33	0.34	0.36	0.37	0.38	0.40	0.41	0.42
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30	0.31	0.32	0.32
B. Previous day temp	0.85	0.84	0.83	0.82	0.81	0.80	0.78	0.77	0.76	0.75	0.73	0.72	0.71	0.70	0.69
C. Flow (ALAM4)	-0.10	-0.10	-0.11	-0.11	-0.12	-0.12	-0.13	-0.14	-0.14	-0.15	-0.15	-0.16	-0.16	-0.17	-0.18
D. Daily Max Air Temperature	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.05
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	-0.13	-0.13	-0.12	-0.11	-0.09	-0.07	-0.05	-0.03	0.00	0.03	0.06	0.09	0.13	0.16	0.20
B. Calero Temp (CALE1)	1.09	1.08	1.08	1.06	1.05	1.03	1.01	0.98	0.95	0.92	0.89	0.86	0.82	0.79	0.75
C. Alamitos Flow (ALAM4)	0.13	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
D. Calero Flow (CALE2)	0.04	0.00	-0.04	-0.07	-0.11	-0.14	-0.17	-0.20	-0.23	-0.26	-0.29	-0.31	-0.33	-0.36	-0.38
E. Prev Day Temp	-0.01	-0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
F. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.01	1.01	1.01	1.01	1.01	1.01	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.98
B. Prev Day Temp	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
C. Flow (ALAM2)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
C. Reservoir Release (ALAM4)	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.43	0.44	0.45	0.46	0.47	0.47	0.48	0.48	0.48	0.48	0.48	0.48	0.47	0.46	0.45
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	0.33	0.34	0.35	0.35	0.36	0.36	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
B. Previous day temp	0.67	0.66	0.65	0.64	0.64	0.63	0.62	0.62	0.61	0.61	0.61	0.60	0.60	0.61	0.61
C. Flow (ALAM4)	-0.18	-0.18	-0.19	-0.19	-0.20	-0.20	-0.20	-0.20	-0.21	-0.21	-0.21	-0.21	-0.21	-0.21	-0.20
D. Daily Max Air Temperature	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.24	0.28	0.32	0.35	0.39	0.43	0.47	0.51	0.55	0.58	0.62	0.65	0.68	0.71	0.73
B. Calero Temp (CALE1)	0.71	0.67	0.63	0.59	0.55	0.51	0.47	0.43	0.40	0.36	0.32	0.29	0.26	0.23	0.20
C. Alamitos Flow (ALAM4)	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.17	0.17	0.18	0.18	0.19	0.19
D. Calero Flow (CALE2)	-0.40	-0.42	-0.44	-0.45	-0.47	-0.48	-0.49	-0.51	-0.52	-0.53	-0.53	-0.54	-0.55	-0.55	-0.56
E. Prev Day Temp	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06
F. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
B. Prev Day Temp	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
C. Flow (ALAM2)	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Alamitos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**76**	**77**	**78**	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.96	0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.99
C. Reservoir Release (ALAM4)	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.44	0.42	0.41	0.39	0.37	0.35	0.32	0.30	0.27	0.24	0.22	0.19	0.15	0.12	0.09
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	0.36	0.35	0.35	0.34	0.33	0.32	0.31	0.30	0.29	0.28	0.27	0.25	0.24	0.23	0.21
B. Previous day temp	0.61	0.62	0.63	0.63	0.64	0.65	0.66	0.68	0.69	0.70	0.72	0.73	0.74	0.76	0.77
C. Flow (ALAM4)	-0.20	-0.20	-0.19	-0.19	-0.18	-0.18	-0.17	-0.16	-0.16	-0.15	-0.14	-0.14	-0.13	-0.12	-0.11
D. Daily Max Air Temperature	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.04
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.75	0.78	0.79	0.81	0.82	0.84	0.85	0.85	0.86	0.86	0.86	0.86	0.86	0.85	0.84
B. Calero Temp (CALE1)	0.18	0.15	0.13	0.11	0.10	0.09	0.07	0.07	0.06	0.06	0.05	0.05	0.06	0.06	0.07
C. Alamitos Flow (ALAM4)	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30	0.31	0.32	0.33	0.34
D. Calero Flow (CALE2)	-0.56	-0.56	-0.56	-0.56	-0.56	-0.56	-0.56	-0.56	-0.56	-0.55	-0.55	-0.55	-0.55	-0.54	-0.54
E. Prev Day Temp	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
F. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	0.97	0.97	0.98	0.98	0.98	0.99	0.99	0.99	1.00	1.00	1.01	1.01	1.02	1.02	1.03
B. Prev Day Temp	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
C. Flow (ALAM2)	0.01	0.01	0.00	0.00	0.00	-0.01	-0.02	-0.02	-0.03	-0.03	-0.04	-0.05	-0.06	-0.07	-0.07
D. Daily Max Air Temperature	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.99	0.99	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.02	1.02	1.02	1.02	1.03	1.03
C. Reservoir Release (ALAM4)	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.05	0.02	-0.02	-0.05	-0.09	-0.12	-0.16	-0.20	-0.24	-0.27	-0.31	-0.35	-0.38	-0.42	-0.46
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	0.20	0.19	0.17	0.16	0.15	0.13	0.12	0.11	0.10	0.09	0.07	0.06	0.05	0.04	0.04
B. Previous day temp	0.79	0.81	0.82	0.84	0.85	0.87	0.88	0.89	0.91	0.92	0.93	0.94	0.95	0.96	0.97
C. Flow (ALAM4)	-0.10	-0.09	-0.09	-0.08	-0.07	-0.06	-0.06	-0.05	-0.04	-0.03	-0.03	-0.02	-0.02	-0.01	-0.01
D. Daily Max Air Temperature	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.83	0.82	0.80	0.79	0.77	0.75	0.73	0.70	0.68	0.65	0.62	0.59	0.55	0.52	0.48
B. Calero Temp (CALE1)	0.08	0.09	0.11	0.12	0.14	0.17	0.19	0.22	0.24	0.28	0.31	0.35	0.38	0.42	0.47
C. Alamitos Flow (ALAM4)	0.34	0.35	0.35	0.36	0.36	0.36	0.36	0.36	0.35	0.35	0.34	0.33	0.32	0.31	0.29
D. Calero Flow (CALE2)	-0.54	-0.54	-0.54	-0.54	-0.54	-0.54	-0.54	-0.55	-0.55	-0.56	-0.57	-0.57	-0.58	-0.59	-0.61
E. Prev Day Temp	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.08
F. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.07	1.07	1.08	1.08	1.08	1.09	1.09	1.09
B. Prev Day Temp	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02
C. Flow (ALAM2)	-0.08	-0.09	-0.10	-0.11	-0.12	-0.13	-0.14	-0.15	-0.17	-0.18	-0.19	-0.20	-0.21	-0.23	-0.24
D. Daily Max Air Temperature	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
C. Reservoir Release (ALAM4)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	-0.49	-0.53	-0.56	-0.59	-0.62	-0.65	-0.67	-0.70	-0.72	-0.73	-0.75	-0.75	-0.76	-0.76	-0.75
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	0.03	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
B. Previous day temp	0.98	0.98	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99
C. Flow (ALAM4)	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.44	0.40	0.36	0.32	0.27	0.23	0.18	0.14	0.09	0.05	0.01	-0.03	-0.07	-0.11	-0.15
B. Calero Temp (CALE1)	0.51	0.56	0.61	0.66	0.71	0.76	0.82	0.87	0.92	0.98	1.03	1.08	1.13	1.18	1.23
C. Alamitos Flow (ALAM4)	0.27	0.25	0.23	0.21	0.18	0.15	0.12	0.09	0.06	0.03	0.00	-0.04	-0.07	-0.10	-0.14
D. Calero Flow (CALE2)	-0.62	-0.64	-0.66	-0.67	-0.69	-0.72	-0.74	-0.76	-0.78	-0.81	-0.83	-0.85	-0.88	-0.90	-0.93
E. Prev Day Temp	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.05	0.05	0.05
F. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.09	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
B. Prev Day Temp	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.01
C. Flow (ALAM2)	-0.25	-0.27	-0.28	-0.29	-0.31	-0.32	-0.33	-0.35	-0.36	-0.37	-0.38	-0.40	-0.41	-0.42	-0.43
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.01	1.00	1.00	0.99
C. Reservoir Release (ALAM4)	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
E. Constant	-0.74	-0.73	-0.71	-0.68	-0.64	-0.60	-0.55	-0.50	-0.43	-0.36	-0.28	-0.19	-0.10	0.01	0.13
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
B. Previous day temp	0.99	0.98	0.98	0.98	0.97	0.97	0.96	0.96	0.95	0.95	0.95	0.94	0.94	0.94	0.93
C. Flow (ALAM4)	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
D. Daily Max Air Temperature	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	-0.18	-0.22	-0.25	-0.27	-0.30	-0.32	-0.34	-0.35	-0.36	-0.36	-0.36	-0.36	-0.35	-0.33	-0.31
B. Calero Temp (CALE1)	1.27	1.31	1.35	1.39	1.42	1.45	1.48	1.50	1.51	1.52	1.53	1.53	1.53	1.52	1.50
C. Alamitos Flow (ALAM4)	-0.17	-0.20	-0.23	-0.26	-0.29	-0.32	-0.35	-0.37	-0.39	-0.41	-0.43	-0.45	-0.46	-0.47	-0.48
D. Calero Flow (CALE2)	-0.95	-0.97	-0.99	-1.02	-1.04	-1.05	-1.07	-1.09	-1.10	-1.12	-1.13	-1.14	-1.15	-1.15	-1.15
E. Prev Day Temp	0.04	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00
F. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
B. Prev Day Temp	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C. Flow (ALAM2)	-0.44	-0.46	-0.47	-0.48	-0.48	-0.49	-0.50	-0.51	-0.52	-0.52	-0.53	-0.53	-0.53	-0.54	-0.54
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.88	0.87	0.85	0.84	0.83	0.81
C. Reservoir Release (ALAM4)	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.08	0.09	0.10	0.11
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.25	0.39	0.54	0.69	0.85	1.03	1.21	1.39	1.59	1.79	2.00	2.22	2.45	2.68	2.91
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
B. Previous day temp	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.94	0.94
C. Flow (ALAM4)	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.07
D. Daily Max Air Temperature	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	-0.29	-0.25	-0.22	-0.18	-0.13	-0.08	-0.03	0.03	0.09	0.15	0.21	0.28	0.34	0.41	0.47
B. Calero Temp (CALE1)	1.47	1.44	1.41	1.37	1.32	1.27	1.21	1.15	1.09	1.03	0.96	0.89	0.82	0.75	0.68
C. Alamitos Flow (ALAM4)	-0.48	-0.49	-0.49	-0.48	-0.48	-0.47	-0.46	-0.44	-0.43	-0.41	-0.40	-0.38	-0.36	-0.34	-0.32
D. Calero Flow (CALE2)	-1.15	-1.15	-1.15	-1.14	-1.13	-1.12	-1.11	-1.09	-1.08	-1.06	-1.04	-1.02	-1.00	-0.98	-0.95
E. Prev Day Temp	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
F. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.11	1.11	1.11	1.11	1.12	1.12	1.12	1.13	1.13	1.13	1.14	1.14	1.15	1.15	1.15
B. Prev Day Temp	0.01	0.01	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03	-0.04	-0.04	-0.05
C. Flow (ALAM2)	-0.54	-0.54	-0.53	-0.53	-0.53	-0.52	-0.52	-0.51	-0.51	-0.50	-0.50	-0.49	-0.48	-0.47	-0.46
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Alamitos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**151**	**152**	**153**	**154**	**155**	**156**	**157**	**158**	**159**	**160**	**161**	**162**	**163**	**164**	**165**
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.79	0.78	0.76	0.74	0.73	0.71	0.69	0.67	0.65	0.64	0.62	0.60	0.58	0.56	0.54
C. Reservoir Release (ALAM4)	0.12	0.13	0.15	0.16	0.18	0.20	0.22	0.24	0.27	0.29	0.32	0.35	0.38	0.41	0.44
D. Daily Max Air Temperature	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
E. Constant	3.16	3.40	3.66	3.91	4.18	4.45	4.72	4.99	5.27	5.55	5.84	6.13	6.42	6.71	7.00
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
B. Previous day temp	0.94	0.94	0.94	0.95	0.95	0.95	0.95	0.96	0.96	0.96	0.97	0.97	0.97	0.97	0.98
C. Flow (ALAM4)	0.08	0.08	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
D. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.54	0.60	0.67	0.73	0.79	0.84	0.90	0.95	0.99	1.03	1.07	1.10	1.13	1.15	1.17
B. Calero Temp (CALE1)	0.61	0.54	0.47	0.40	0.33	0.26	0.20	0.14	0.09	0.03	-0.01	-0.06	-0.09	-0.13	-0.15
C. Alamitos Flow (ALAM4)	-0.29	-0.27	-0.25	-0.23	-0.21	-0.18	-0.16	-0.14	-0.12	-0.11	-0.09	-0.07	-0.06	-0.05	-0.04
D. Calero Flow (CALE2)	-0.93	-0.90	-0.88	-0.85	-0.82	-0.80	-0.77	-0.74	-0.71	-0.68	-0.66	-0.63	-0.60	-0.58	-0.55
E. Prev Day Temp	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.04	0.05	0.05
F. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.16	1.16	1.17	1.17	1.17	1.18	1.18	1.18	1.19	1.19	1.19	1.20	1.20	1.20	1.20
B. Prev Day Temp	-0.05	-0.06	-0.06	-0.06	-0.07	-0.07	-0.08	-0.08	-0.09	-0.09	-0.09	-0.10	-0.10	-0.10	-0.10
C. Flow (ALAM2)	-0.46	-0.45	-0.44	-0.43	-0.42	-0.41	-0.41	-0.40	-0.39	-0.38	-0.38	-0.37	-0.36	-0.36	-0.35
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.52	0.50	0.47	0.45	0.43	0.41	0.39	0.37	0.35	0.33	0.31	0.29	0.27	0.25	0.23
C. Reservoir Release (ALAM4)	0.48	0.52	0.56	0.60	0.64	0.69	0.73	0.77	0.80	0.84	0.87	0.90	0.92	0.94	0.96
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	7.30	7.60	7.90	8.20	8.50	8.81	9.11	9.42	9.73	10.04	10.36	10.68	11.00	11.32	11.65
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
B. Previous day temp	0.98	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00	1.00
C. Flow (ALAM4)	0.09	0.09	0.09	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.03	0.02	0.01	0.00	-0.01
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	1.17	1.18	1.17	1.16	1.14	1.11	1.09	1.05	1.01	0.97	0.93	0.88	0.83	0.77	0.72
B. Calero Temp (CALE1)	-0.17	-0.18	-0.19	-0.19	-0.18	-0.17	-0.15	-0.13	-0.10	-0.07	-0.03	0.01	0.05	0.10	0.15
C. Alamitos Flow (ALAM4)	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.03	-0.04	-0.05	-0.05	-0.06	-0.07	-0.09	-0.10
D. Calero Flow (CALE2)	-0.52	-0.50	-0.47	-0.45	-0.43	-0.41	-0.39	-0.37	-0.35	-0.33	-0.31	-0.29	-0.28	-0.26	-0.25
E. Prev Day Temp	0.06	0.07	0.08	0.09	0.10	0.10	0.11	0.12	0.13	0.14	0.15	0.15	0.16	0.17	0.17
F. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.19	1.19	1.19	1.19
B. Prev Day Temp	-0.10	-0.10	-0.11	-0.11	-0.11	-0.11	-0.11	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.09	-0.09
C. Flow (ALAM2)	-0.35	-0.34	-0.34	-0.34	-0.34	-0.34	-0.34	-0.34	-0.34	-0.34	-0.34	-0.34	-0.35	-0.35	-0.35
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Temperature Modeling Technical Memorandum
Santa Clara Valley Water District FAHCE Project

Attachment C - Alamitos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**181**	**182**	**183**	**184**	**185**	**186**	**187**	**188**	**189**	**190**	**191**	**192**	**193**	**194**	**195**
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.21	0.19	0.17	0.15	0.14	0.12	0.11	0.09	0.08	0.07	0.05	0.04	0.03	0.02	0.02
C. Reservoir Release (ALAM4)	0.96	0.97	0.96	0.95	0.93	0.90	0.86	0.81	0.75	0.67	0.59	0.50	0.39	0.27	0.13
D. Daily Max Air Temperature	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
E. Constant	11.98	12.31	12.65	12.99	13.33	13.68	14.03	14.39	14.74	15.11	15.48	15.85	16.22	16.60	16.99
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00
B. Previous day temp	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
C. Flow (ALAM4)	-0.01	-0.02	-0.03	-0.04	-0.05	-0.06	-0.06	-0.07	-0.07	-0.08	-0.08	-0.09	-0.09	-0.09	-0.09
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.66	0.60	0.54	0.48	0.42	0.37	0.31	0.25	0.20	0.15	0.10	0.05	0.01	-0.03	-0.07
B. Calero Temp (CALE1)	0.20	0.25	0.31	0.36	0.42	0.48	0.54	0.60	0.66	0.72	0.77	0.83	0.88	0.94	0.99
C. Alamitos Flow (ALAM4)	-0.11	-0.12	-0.14	-0.15	-0.16	-0.18	-0.19	-0.20	-0.21	-0.22	-0.23	-0.24	-0.25	-0.25	-0.25
D. Calero Flow (CALE2)	-0.23	-0.22	-0.21	-0.19	-0.18	-0.17	-0.16	-0.15	-0.14	-0.13	-0.12	-0.12	-0.11	-0.10	-0.10
E. Prev Day Temp	0.18	0.18	0.19	0.19	0.19	0.19	0.19	0.18	0.18	0.17	0.17	0.16	0.14	0.13	0.12
F. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.18	1.18	1.18	1.18	1.17	1.17	1.17	1.16	1.16	1.16	1.16	1.15	1.15	1.15	1.15
B. Prev Day Temp	-0.09	-0.09	-0.08	-0.08	-0.08	-0.07	-0.07	-0.07	-0.07	-0.06	-0.06	-0.06	-0.06	-0.05	-0.05
C. Flow (ALAM2)	-0.36	-0.36	-0.36	-0.37	-0.37	-0.38	-0.39	-0.39	-0.40	-0.40	-0.41	-0.41	-0.42	-0.43	-0.43
D. Daily Max Air Temperature	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Alamitos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**196**	**197**	**198**	**199**	**200**	**201**	**202**	**203**	**204**	**205**	**206**	**207**	**208**	**209**	**210**
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.01	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.03
C. Reservoir Release (ALAM4)	-0.02	-0.19	-0.36	-0.56	-0.76	-0.97	-1.19	-1.42	-1.66	-1.90	-2.14	-2.39	-2.63	-2.88	-3.12
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
E. Constant	17.38	17.78	18.18	18.58	18.98	19.37	19.77	20.16	20.54	20.91	21.28	21.63	21.97	22.29	22.59
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
B. Previous day temp	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
C. Flow (ALAM4)	-0.09	-0.09	-0.09	-0.09	-0.08	-0.08	-0.07	-0.07	-0.06	-0.05	-0.04	-0.04	-0.03	-0.02	-0.01
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	-0.10	-0.13	-0.15	-0.16	-0.18	-0.18	-0.19	-0.19	-0.19	-0.18	-0.17	-0.16	-0.15	-0.13	-0.11
B. Calero Temp (CALE1)	1.04	1.08	1.12	1.16	1.20	1.24	1.27	1.30	1.32	1.35	1.37	1.38	1.40	1.41	1.42
C. Alamitos Flow (ALAM4)	-0.26	-0.26	-0.26	-0.26	-0.25	-0.25	-0.24	-0.23	-0.22	-0.22	-0.21	-0.19	-0.18	-0.17	-0.16
D. Calero Flow (CALE2)	-0.09	-0.09	-0.08	-0.08	-0.08	-0.07	-0.07	-0.07	-0.07	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06
E. Prev Day Temp	0.10	0.08	0.06	0.03	0.01	-0.02	-0.05	-0.08	-0.11	-0.14	-0.17	-0.20	-0.23	-0.26	-0.28
F. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.15	1.15	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14
B. Prev Day Temp	-0.05	-0.05	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03
C. Flow (ALAM2)	-0.44	-0.45	-0.45	-0.46	-0.46	-0.47	-0.47	-0.48	-0.49	-0.49	-0.50	-0.50	-0.50	-0.51	-0.51
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Alamitos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.04	0.05	0.05	0.07	0.08	0.09	0.10	0.11	0.13	0.14	0.16	0.17	0.19	0.20	0.22
C. Reservoir Release (ALAM4)	-3.37	-3.60	-3.84	-4.06	-4.28	-4.49	-4.68	-4.87	-5.04	-5.20	-5.34	-5.46	-5.57	-5.65	-5.72
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
E. Constant	22.88	23.14	23.38	23.60	23.79	23.96	24.09	24.20	24.27	24.30	24.30	24.27	24.19	24.07	23.91
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
B. Previous day temp	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98
C. Flow (ALAM4)	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.09	0.10	0.11	0.11	0.12
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	-0.09	-0.07	-0.05	-0.03	0.00	0.02	0.04	0.07	0.09	0.12	0.14	0.16	0.19	0.21	0.23
B. Calero Temp (CALE1)	1.43	1.43	1.44	1.44	1.43	1.43	1.42	1.41	1.40	1.38	1.36	1.34	1.32	1.29	1.27
C. Alamitos Flow (ALAM4)	-0.15	-0.14	-0.12	-0.11	-0.10	-0.09	-0.08	-0.07	-0.06	-0.05	-0.04	-0.03	-0.03	-0.02	-0.02
D. Calero Flow (CALE2)	-0.06	-0.06	-0.06	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03
E. Prev Day Temp	-0.31	-0.34	-0.37	-0.39	-0.41	-0.43	-0.45	-0.47	-0.48	-0.49	-0.50	-0.51	-0.51	-0.50	-0.50
F. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.13	1.13	1.13	1.13
B. Prev Day Temp	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
C. Flow (ALAM2)	-0.52	-0.52	-0.52	-0.52	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53	-0.52	-0.52
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Temperature Modeling Technical Memorandum
Santa Clara Valley Water District FAHCE Project

Attachment C - Alamitos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**226**	**227**	**228**	**229**	**230**	**231**	**232**	**233**	**234**	**235**	**236**	**237**	**238**	**239**	**240**
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.24	0.25	0.27	0.29	0.31	0.32	0.34	0.36	0.38	0.40	0.42	0.44	0.45	0.47	0.49
C. Reservoir Release (ALAM4)	-5.76	-5.78	-5.77	-5.74	-5.69	-5.62	-5.52	-5.41	-5.28	-5.14	-4.98	-4.81	-4.62	-4.43	-4.22
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
E. Constant	23.70	23.45	23.15	22.80	22.41	21.98	21.51	21.01	20.47	19.91	19.32	18.70	18.06	17.41	16.74
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
B. Previous day temp	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.97
C. Flow (ALAM4)	0.12	0.13	0.13	0.13	0.13	0.14	0.14	0.13	0.13	0.13	0.13	0.12	0.12	0.12	0.11
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.24	0.26	0.27	0.28	0.29	0.29	0.30	0.30	0.30	0.30	0.30	0.30	0.29	0.29	0.28
B. Calero Temp (CALE1)	1.24	1.21	1.17	1.14	1.10	1.06	1.02	0.97	0.93	0.88	0.84	0.79	0.75	0.70	0.66
C. Alamitos Flow (ALAM4)	-0.02	-0.02	-0.02	-0.02	-0.03	-0.03	-0.04	-0.05	-0.06	-0.07	-0.08	-0.09	-0.10	-0.11	-0.12
D. Calero Flow (CALE2)	-0.02	-0.01	-0.01	0.00	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10
E. Prev Day Temp	-0.49	-0.47	-0.45	-0.43	-0.40	-0.37	-0.34	-0.30	-0.26	-0.22	-0.17	-0.12	-0.08	-0.03	0.02
F. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.13	1.12	1.12	1.12	1.11	1.11	1.11	1.10	1.10	1.09	1.09	1.09	1.08	1.08	1.07
B. Prev Day Temp	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
C. Flow (ALAM2)	-0.52	-0.51	-0.51	-0.50	-0.50	-0.49	-0.49	-0.48	-0.47	-0.46	-0.45	-0.44	-0.43	-0.42	-0.41
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.51	0.53	0.55	0.57	0.58	0.60	0.62	0.64	0.65	0.67	0.69	0.70	0.72	0.73	0.75
C. Reservoir Release (ALAM4)	-4.01	-3.79	-3.56	-3.33	-3.10	-2.87	-2.63	-2.40	-2.17	-1.94	-1.72	-1.50	-1.29	-1.09	-0.90
D. Daily Max Air Temperature	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	16.05	15.35	14.65	13.94	13.22	12.51	11.80	11.09	10.39	9.70	9.03	8.37	7.72	7.10	6.51
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
C. Flow (ALAM4)	0.11	0.10	0.10	0.09	0.08	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.02
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.27	0.26	0.25	0.24	0.23	0.22	0.21	0.20	0.19	0.18	0.17	0.16	0.15	0.14	0.13
B. Calero Temp (CALE1)	0.61	0.57	0.52	0.48	0.44	0.40	0.36	0.32	0.29	0.26	0.23	0.20	0.18	0.16	0.14
C. Alamitos Flow (ALAM4)	-0.13	-0.14	-0.15	-0.16	-0.17	-0.18	-0.19	-0.20	-0.20	-0.21	-0.21	-0.21	-0.21	-0.21	-0.21
D. Calero Flow (CALE2)	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.22	0.23	0.23
E. Prev Day Temp	0.07	0.12	0.17	0.22	0.27	0.32	0.37	0.41	0.46	0.50	0.54	0.57	0.61	0.63	0.66
F. Daily Max Air Temperature	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.07	1.06	1.06	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02
B. Prev Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (ALAM2)	-0.40	-0.39	-0.38	-0.37	-0.36	-0.35	-0.33	-0.32	-0.31	-0.30	-0.28	-0.27	-0.26	-0.25	-0.23
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Attachment C - Alamitos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**256**	**257**	**258**	**259**	**260**	**261**	**262**	**263**	**264**	**265**	**266**	**267**	**268**	**269**	**270**
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.76	0.78	0.79	0.80	0.81	0.82	0.84	0.85	0.85	0.86	0.87	0.88	0.89	0.90	0.90
C. Reservoir Release (ALAM4)	-0.72	-0.55	-0.40	-0.26	-0.13	-0.02	0.07	0.16	0.23	0.29	0.34	0.38	0.41	0.44	0.45
D. Daily Max Air Temperature	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	5.94	5.40	4.89	4.41	3.97	3.56	3.18	2.83	2.51	2.21	1.94	1.70	1.48	1.28	1.10
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
C. Flow (ALAM4)	0.02	0.01	0.01	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.12	0.11	0.10	0.10	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09
B. Calero Temp (CALE1)	0.13	0.12	0.11	0.11	0.11	0.12	0.13	0.14	0.16	0.17	0.19	0.22	0.24	0.27	0.30
C. Alamitos Flow (ALAM4)	-0.20	-0.19	-0.18	-0.17	-0.15	-0.13	-0.11	-0.09	-0.07	-0.04	-0.02	0.01	0.04	0.07	0.10
D. Calero Flow (CALE2)	0.24	0.24	0.25	0.25	0.25	0.25	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
E. Prev Day Temp	0.68	0.70	0.71	0.72	0.72	0.72	0.71	0.70	0.68	0.67	0.64	0.62	0.59	0.57	0.53
F. Daily Max Air Temperature	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.04	1.04	1.05	1.05
B. Prev Day Temp	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.03	-0.03	-0.04	-0.04	-0.05	-0.05
C. Flow (ALAM2)	-0.22	-0.21	-0.20	-0.18	-0.17	-0.16	-0.15	-0.14	-0.12	-0.11	-0.10	-0.09	-0.08	-0.07	-0.06
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.91	0.91	0.92	0.93	0.93	0.94	0.94	0.94	0.95	0.95	0.96	0.96	0.96	0.97	0.97
C. Reservoir Release (ALAM4)	0.46	0.46	0.45	0.43	0.42	0.39	0.37	0.34	0.30	0.27	0.23	0.19	0.16	0.12	0.08
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.94	0.80	0.68	0.57	0.47	0.39	0.33	0.27	0.22	0.19	0.15	0.13	0.11	0.09	0.08
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
C. Flow (ALAM4)	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.09	0.09	0.10	0.10	0.11	0.12	0.12	0.13	0.14	0.14	0.15	0.16	0.17	0.18	0.19
B. Calero Temp (CALE1)	0.32	0.35	0.39	0.42	0.45	0.48	0.51	0.54	0.57	0.59	0.62	0.65	0.67	0.69	0.71
C. Alamitos Flow (ALAM4)	0.13	0.16	0.19	0.22	0.25	0.28	0.31	0.34	0.37	0.40	0.43	0.45	0.48	0.50	0.52
D. Calero Flow (CALE2)	0.26	0.26	0.26	0.26	0.26	0.27	0.27	0.28	0.28	0.29	0.30	0.31	0.32	0.33	0.35
E. Prev Day Temp	0.50	0.47	0.43	0.40	0.36	0.32	0.28	0.24	0.21	0.17	0.13	0.10	0.07	0.03	0.00
F. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	-0.01	-0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.05	1.06	1.06	1.07	1.07	1.08	1.08	1.08	1.09	1.09	1.10	1.10	1.10	1.11	1.11
B. Prev Day Temp	-0.06	-0.06	-0.06	-0.07	-0.07	-0.08	-0.08	-0.09	-0.09	-0.09	-0.10	-0.10	-0.10	-0.11	-0.11
C. Flow (ALAM2)	-0.05	-0.05	-0.04	-0.03	-0.02	-0.02	-0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.97	0.97	0.98	0.98	0.98	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.01
C. Reservoir Release (ALAM4)	0.05	0.02	-0.01	-0.04	-0.06	-0.08	-0.10	-0.11	-0.12	-0.13	-0.13	-0.14	-0.14	-0.14	-0.13
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.06	0.05	0.03	0.02	-0.01	-0.03	-0.05	-0.08	-0.11	-0.14	-0.17	-0.20	-0.24	-0.27	-0.31
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02
B. Previous day temp	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
C. Flow (ALAM4)	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.05
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30	0.31	0.32	0.33	0.34
B. Calero Temp (CALE1)	0.72	0.73	0.74	0.75	0.75	0.75	0.75	0.74	0.73	0.72	0.71	0.69	0.68	0.66	0.64
C. Alamitos Flow (ALAM4)	0.54	0.56	0.57	0.58	0.59	0.60	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.60	0.60
D. Calero Flow (CALE2)	0.36	0.38	0.40	0.42	0.44	0.47	0.49	0.52	0.55	0.58	0.61	0.63	0.66	0.69	0.72
E. Prev Day Temp	-0.02	-0.05	-0.07	-0.09	-0.10	-0.12	-0.13	-0.14	-0.14	-0.15	-0.15	-0.15	-0.15	-0.14	-0.14
F. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.11	1.12	1.12	1.12	1.12	1.12	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.12
B. Prev Day Temp	-0.11	-0.11	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.11	-0.11	-0.11	-0.11	-0.11
C. Flow (ALAM2)	0.01	0.01	0.01	0.01	0.00	0.00	-0.01	-0.01	-0.02	-0.03	-0.03	-0.04	-0.05	-0.06	-0.07
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
C. Reservoir Release (ALAM4)	-0.13	-0.12	-0.12	-0.11	-0.10	-0.09	-0.08	-0.06	-0.05	-0.04	-0.03	-0.01	0.00	0.01	0.02
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
E. Constant	-0.34	-0.38	-0.41	-0.45	-0.48	-0.52	-0.55	-0.59	-0.62	-0.65	-0.68	-0.71	-0.73	-0.76	-0.78
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
B. Previous day temp	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99
C. Flow (ALAM4)	-0.05	-0.05	-0.05	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03
D. Daily Max Air Temperature	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.35	0.36	0.37	0.38	0.39	0.40	0.41	0.42	0.43	0.44	0.45	0.46	0.47	0.48	0.49
B. Calero Temp (CALE1)	0.61	0.59	0.57	0.54	0.52	0.49	0.47	0.44	0.42	0.39	0.37	0.35	0.32	0.30	0.28
C. Alamitos Flow (ALAM4)	0.59	0.58	0.57	0.56	0.55	0.54	0.53	0.52	0.51	0.50	0.49	0.48	0.47	0.46	0.46
D. Calero Flow (CALE2)	0.74	0.77	0.79	0.82	0.84	0.85	0.87	0.88	0.90	0.90	0.91	0.91	0.91	0.90	0.89
E. Prev Day Temp	-0.13	-0.13	-0.12	-0.11	-0.10	-0.09	-0.08	-0.07	-0.06	-0.05	-0.04	-0.03	-0.02	-0.01	-0.01
F. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.11	1.11	1.11	1.11	1.11	1.11	1.10	1.10
B. Prev Day Temp	-0.11	-0.10	-0.10	-0.10	-0.10	-0.10	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.08	-0.08
C. Flow (ALAM2)	-0.07	-0.08	-0.09	-0.10	-0.11	-0.11	-0.12	-0.13	-0.14	-0.14	-0.15	-0.15	-0.16	-0.16	-0.16
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.00	1.00	1.00	1.00	0.99
C. Reservoir Release (ALAM4)	0.04	0.05	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.09
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
E. Constant	-0.80	-0.81	-0.83	-0.84	-0.84	-0.85	-0.85	-0.85	-0.84	-0.84	-0.83	-0.82	-0.81	-0.79	-0.77
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03
B. Previous day temp	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
C. Flow (ALAM4)	-0.03	-0.02	-0.02	-0.02	-0.01	-0.01	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.04
D. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.50	0.51	0.52	0.53	0.54	0.55	0.56	0.56	0.57	0.58	0.59	0.60	0.60	0.61	0.62
B. Calero Temp (CALE1)	0.27	0.25	0.23	0.22	0.21	0.20	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.20
C. Alamitos Flow (ALAM4)	0.45	0.44	0.44	0.43	0.43	0.43	0.43	0.43	0.44	0.44	0.44	0.45	0.45	0.46	0.47
D. Calero Flow (CALE2)	0.87	0.85	0.83	0.80	0.76	0.72	0.68	0.63	0.57	0.52	0.46	0.40	0.33	0.27	0.20
E. Prev Day Temp	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	-0.01	-0.01	-0.02	-0.03	-0.04	-0.05	-0.06
F. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
B. Prev Day Temp	-0.08	-0.08	-0.08	-0.08	-0.08	-0.09	-0.09	-0.09	-0.09	-0.09	-0.10	-0.10	-0.10	-0.11	-0.11
C. Flow (ALAM2)	-0.17	-0.17	-0.17	-0.16	-0.16	-0.16	-0.15	-0.15	-0.14	-0.13	-0.13	-0.12	-0.11	-0.10	-0.09
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.96	0.96	0.96	0.96
C. Reservoir Release (ALAM4)	0.09	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.03
D. Daily Max Air Temperature	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
E. Constant	-0.76	-0.74	-0.71	-0.69	-0.67	-0.64	-0.62	-0.59	-0.57	-0.54	-0.52	-0.49	-0.46	-0.44	-0.41
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
B. Previous day temp	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
C. Flow (ALAM4)	0.05	0.05	0.06	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.11
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.62	0.63	0.64	0.64	0.65	0.66	0.66	0.67	0.67	0.68	0.68	0.69	0.69	0.70	0.70
B. Calero Temp (CALE1)	0.21	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.31	0.32	0.33	0.34	0.35
C. Alamitos Flow (ALAM4)	0.47	0.48	0.49	0.49	0.50	0.51	0.52	0.52	0.53	0.53	0.54	0.54	0.55	0.55	0.55
D. Calero Flow (CALE2)	0.13	0.06	-0.01	-0.08	-0.14	-0.21	-0.28	-0.34	-0.40	-0.46	-0.51	-0.57	-0.61	-0.66	-0.70
E. Prev Day Temp	-0.08	-0.09	-0.10	-0.12	-0.13	-0.15	-0.16	-0.17	-0.19	-0.20	-0.22	-0.23	-0.24	-0.26	-0.27
F. Daily Max Air Temperature	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
B. Prev Day Temp	-0.11	-0.11	-0.12	-0.12	-0.12	-0.13	-0.13	-0.13	-0.14	-0.14	-0.14	-0.15	-0.15	-0.15	-0.15
C. Flow (ALAM2)	-0.07	-0.06	-0.05	-0.04	-0.03	-0.01	0.00	0.01	0.02	0.04	0.05	0.06	0.07	0.08	0.09
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
Reservoir Outlet (ALAM4)															
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.96	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
C. Reservoir Release (ALAM4)	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Daily Max Air Temperature	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
E. Constant	-0.38	-0.36	-0.34	-0.31	-0.29	-0.27	-0.25	-0.23	-0.21	-0.20	-0.18	-0.17	-0.15	-0.14	-0.12
US Calero Creek (ALAM3)															
A Upstream Temp (ALAM4)	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
B. Previous day temp	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
C. Flow (ALAM4)	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.11
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)															
A. Alamitos Temp (ALAM3)	0.71	0.71	0.72	0.72	0.72	0.73	0.73	0.73	0.73	0.74	0.74	0.74	0.74	0.74	0.75
B. Calero Temp (CALE1)	0.36	0.36	0.37	0.38	0.38	0.39	0.39	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.39
C. Alamitos Flow (ALAM4)	0.55	0.55	0.55	0.55	0.54	0.54	0.53	0.52	0.51	0.50	0.49	0.47	0.46	0.44	0.43
D. Calero Flow (CALE2)	-0.73	-0.76	-0.78	-0.80	-0.81	-0.81	-0.81	-0.80	-0.78	-0.76	-0.74	-0.71	-0.67	-0.63	-0.58
E. Prev Day Temp	-0.28	-0.29	-0.30	-0.31	-0.32	-0.32	-0.33	-0.33	-0.34	-0.34	-0.34	-0.34	-0.34	-0.34	-0.34
F. Daily Max Air Temperature	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)															
A. Upstream Temp (ALAM2)	1.10	1.10	1.10	1.10	1.09	1.09	1.09	1.09	1.09	1.08	1.08	1.08	1.08	1.07	1.07
B. Prev Day Temp	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.14	-0.14	-0.14	-0.14
C. Flow (ALAM2)	0.10	0.11	0.12	0.13	0.14	0.14	0.15	0.15	0.16	0.16	0.16	0.17	0.17	0.17	0.17
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	361	362	363	364	365	366
Reservoir Outlet (ALAM4)						
A. Reservoir Storage (Almaden)	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.95	0.95	0.95	0.96	0.96	0.96
C. Reservoir Release (ALAM4)	0.01	0.01	0.01	0.02	0.02	0.02
D. Daily Max Air Temperature	0.04	0.04	0.03	0.03	0.03	0.03
E. Constant	-0.11	-0.10	-0.09	-0.08	-0.07	-0.06
US Calero Creek (ALAM3)						
A Upstream Temp (ALAM4)	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
B. Previous day temp	0.99	0.99	0.99	0.99	0.99	0.99
C. Flow (ALAM4)	0.10	0.10	0.09	0.09	0.08	0.08
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00
Randol (ALAM2)						
A. Alamitos Temp (ALAM3)	0.75	0.75	0.75	0.75	0.75	0.75
B. Calero Temp (CALE1)	0.39	0.39	0.38	0.38	0.37	0.37
C. Alamitos Flow (ALAM4)	0.41	0.39	0.37	0.35	0.33	0.31
D. Calero Flow (CALE2)	-0.53	-0.48	-0.42	-0.36	-0.29	-0.22
E. Prev Day Temp	-0.34	-0.34	-0.34	-0.33	-0.33	-0.32
F. Daily Max Air Temperature	0.04	0.04	0.04	0.04	0.04	0.03
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00
Mazzone (ALAM1)						
A. Upstream Temp (ALAM2)	1.07	1.06	1.06	1.06	1.05	1.05
B. Prev Day Temp	-0.13	-0.13	-0.12	-0.12	-0.11	-0.11
C. Flow (ALAM2)	0.17	0.17	0.17	0.17	0.16	0.16
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Calero Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Calero Res Outlet (CALE2)															
A. Prev Day Temp	0.90	0.91	0.91	0.91	0.91	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.93	0.94	0.94
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Constant	0.84	0.82	0.80	0.77	0.75	0.73	0.71	0.68	0.66	0.64	0.61	0.59	0.56	0.54	0.52
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	1.32	1.29	1.26	1.23	1.20	1.17	1.14	1.11	1.08	1.04	1.01	0.97	0.94	0.90	0.86
B. Previous day temp	-0.34	-0.31	-0.28	-0.25	-0.22	-0.19	-0.16	-0.12	-0.09	-0.06	-0.02	0.01	0.05	0.09	0.12
C. Flow (CALE2)	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Calero Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Calero Res Outlet (CALE2)															
A. Prev Day Temp	0.94	0.94	0.95	0.95	0.95	0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.98	0.98	0.98
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.49	0.47	0.44	0.42	0.39	0.37	0.34	0.32	0.29	0.27	0.24	0.22	0.20	0.18	0.15
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	0.82	0.78	0.74	0.70	0.66	0.61	0.57	0.53	0.49	0.45	0.41	0.37	0.34	0.30	0.27
B. Previous day temp	0.16	0.20	0.24	0.29	0.33	0.37	0.41	0.45	0.49	0.53	0.57	0.61	0.64	0.68	0.71
C. Flow (CALE2)	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Calero Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Calero Res Outlet (CALE2)															
A. Prev Day Temp	0.98	0.98	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.13	0.11	0.09	0.08	0.06	0.04	0.03	0.01	0.00	-0.01	-0.02	-0.03	-0.04	-0.04	-0.05
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	0.23	0.20	0.18	0.15	0.13	0.11	0.09	0.08	0.07	0.06	0.06	0.06	0.06	0.07	0.09
B. Previous day temp	0.75	0.78	0.80	0.83	0.85	0.88	0.90	0.91	0.92	0.93	0.94	0.94	0.94	0.94	0.93
C. Flow (CALE2)	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Calero Res Outlet (CALE2)															
A. Prev Day Temp	1.01	1.01	1.01	1.01	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	-0.05	-0.05	-0.05	-0.05	-0.05	-0.04	-0.04	-0.03	-0.02	-0.01	-0.01	0.00	0.01	0.03	0.04
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	0.11	0.13	0.16	0.19	0.23	0.27	0.31	0.35	0.40	0.45	0.50	0.56	0.61	0.66	0.72
B. Previous day temp	0.91	0.89	0.87	0.85	0.82	0.78	0.75	0.71	0.67	0.63	0.59	0.54	0.50	0.45	0.40
C. Flow (CALE2)	0.08	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.11	0.12	0.12	0.12
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**
Calero Res Outlet (CALE2)															
A. Prev Day Temp	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
B. Flow (CALE2)	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.13	0.14	0.15	0.15	0.15	0.16
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	0.77	0.83	0.88	0.93	0.98	1.03	1.07	1.11	1.15	1.19	1.22	1.25	1.27	1.29	1.30
B. Previous day temp	0.36	0.31	0.27	0.22	0.18	0.14	0.10	0.07	0.03	0.00	-0.02	-0.05	-0.07	-0.08	-0.09
C. Flow (CALE2)	0.12	0.12	0.13	0.13	0.13	0.12	0.12	0.12	0.12	0.11	0.11	0.10	0.09	0.09	0.08
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Calero Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Calero Res Outlet (CALE2)															
A. Prev Day Temp	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00
B. Flow (CALE2)	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.16	0.15	0.15	0.15	0.15	0.14	0.13	0.13	0.12	0.11	0.10	0.10	0.09	0.08	0.07
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	1.31	1.31	1.31	1.30	1.29	1.28	1.26	1.24	1.22	1.20	1.17	1.14	1.11	1.08	1.04
B. Previous day temp	-0.10	-0.10	-0.10	-0.09	-0.08	-0.07	-0.06	-0.04	-0.02	0.00	0.03	0.05	0.08	0.11	0.14
C. Flow (CALE2)	0.07	0.05	0.04	0.03	0.01	0.00	-0.02	-0.03	-0.05	-0.07	-0.09	-0.11	-0.12	-0.14	-0.16
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
Calero Res Outlet (CALE2)															
A. Prev Day Temp	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
B. Flow (CALE2)	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.06	0.05	0.04	0.03	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.03	-0.03	-0.04	-0.04	-0.04
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	1.01	0.98	0.94	0.91	0.88	0.85	0.81	0.78	0.76	0.73	0.71	0.69	0.67	0.65	0.64
B. Previous day temp	0.17	0.20	0.23	0.26	0.29	0.31	0.34	0.37	0.39	0.42	0.44	0.46	0.48	0.49	0.50
C. Flow (CALE2)	-0.18	-0.20	-0.22	-0.24	-0.26	-0.28	-0.30	-0.32	-0.34	-0.36	-0.37	-0.39	-0.41	-0.42	-0.44
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Calero Res Outlet (CALE2)															
A. Prev Day Temp	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.98
B. Flow (CALE2)	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
D. Constant	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.02	-0.01	-0.01	0.00	0.01	0.02	0.03
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	0.63	0.63	0.63	0.63	0.64	0.65	0.66	0.67	0.68	0.70	0.72	0.74	0.76	0.78	0.81
B. Previous day temp	0.51	0.52	0.52	0.52	0.51	0.51	0.50	0.49	0.48	0.47	0.45	0.44	0.42	0.40	0.39
C. Flow (CALE2)	-0.46	-0.47	-0.48	-0.50	-0.51	-0.52	-0.53	-0.54	-0.55	-0.56	-0.57	-0.58	-0.58	-0.59	-0.60
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**121**	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**	**131**	**132**	**133**	**134**	**135**
Calero Res Outlet (CALE2)															
A. Prev Day Temp	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.97	0.96	0.96	0.96	0.96	0.95	0.95	0.95
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
D. Constant	0.04	0.05	0.07	0.08	0.09	0.10	0.12	0.13	0.14	0.16	0.17	0.18	0.20	0.21	0.22
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	0.83	0.86	0.88	0.91	0.93	0.96	0.98	1.00	1.03	1.05	1.07	1.08	1.10	1.11	1.13
B. Previous day temp	0.37	0.35	0.33	0.31	0.29	0.27	0.25	0.23	0.21	0.20	0.18	0.17	0.15	0.14	0.13
C. Flow (CALE2)	-0.61	-0.61	-0.62	-0.62	-0.63	-0.64	-0.64	-0.65	-0.65	-0.66	-0.66	-0.67	-0.67	-0.68	-0.68
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**136**	**137**	**138**	**139**	**140**	**141**	**142**	**143**	**144**	**145**	**146**	**147**	**148**	**149**	**150**
Calero Res Outlet (CALE2)															
A. Prev Day Temp	0.95	0.95	0.95	0.95	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
D. Constant	0.24	0.25	0.26	0.28	0.29	0.30	0.31	0.32	0.33	0.34	0.35	0.36	0.37	0.37	0.38
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	1.14	1.14	1.15	1.15	1.15	1.15	1.15	1.15	1.14	1.13	1.12	1.11	1.10	1.09	1.07
B. Previous day temp	0.13	0.12	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.14	0.15	0.16	0.17	0.18	0.19
C. Flow (CALE2)	-0.69	-0.69	-0.70	-0.70	-0.71	-0.71	-0.72	-0.72	-0.73	-0.73	-0.74	-0.74	-0.74	-0.75	-0.75
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165
Calero Res Outlet (CALE2)															
A. Prev Day Temp	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.95	0.95	0.95	0.95	0.95	0.95	0.96	0.96
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
D. Constant	0.38	0.38	0.38	0.38	0.38	0.37	0.37	0.36	0.35	0.34	0.33	0.31	0.29	0.27	0.25
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	1.06	1.04	1.02	1.00	0.99	0.97	0.95	0.93	0.91	0.88	0.86	0.84	0.82	0.80	0.78
B. Previous day temp	0.20	0.21	0.23	0.24	0.26	0.27	0.29	0.30	0.32	0.33	0.35	0.37	0.38	0.40	0.41
C. Flow (CALE2)	-0.75	-0.75	-0.76	-0.76	-0.76	-0.76	-0.76	-0.76	-0.76	-0.76	-0.75	-0.75	-0.75	-0.74	-0.74
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Calero Res Outlet (CALE2)															
A. Prev Day Temp	0.96	0.96	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.99	0.99	0.99	1.00	1.00	1.00
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Constant	0.23	0.20	0.17	0.14	0.11	0.07	0.04	0.00	-0.04	-0.07	-0.11	-0.15	-0.19	-0.23	-0.27
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	0.76	0.74	0.72	0.70	0.68	0.66	0.65	0.63	0.61	0.60	0.58	0.56	0.55	0.53	0.52
B. Previous day temp	0.42	0.44	0.45	0.46	0.47	0.48	0.49	0.50	0.51	0.52	0.53	0.54	0.55	0.56	0.56
C. Flow (CALE2)	-0.73	-0.72	-0.72	-0.71	-0.70	-0.69	-0.68	-0.67	-0.65	-0.64	-0.63	-0.62	-0.60	-0.59	-0.57
D. Daily Max Air Temperature	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195
Calero Res Outlet (CALE2)															
A. Prev Day Temp	1.00	1.01	1.01	1.01	1.02	1.02	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.03
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Constant	-0.31	-0.35	-0.38	-0.42	-0.45	-0.49	-0.52	-0.55	-0.57	-0.60	-0.62	-0.64	-0.65	-0.67	-0.68
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	0.50	0.49	0.47	0.46	0.45	0.43	0.42	0.41	0.40	0.39	0.37	0.36	0.35	0.34	0.33
B. Previous day temp	0.57	0.58	0.58	0.59	0.60	0.60	0.61	0.61	0.62	0.63	0.63	0.64	0.64	0.65	0.65
C. Flow (CALE2)	-0.56	-0.54	-0.52	-0.51	-0.49	-0.47	-0.45	-0.44	-0.42	-0.40	-0.38	-0.36	-0.34	-0.33	-0.31
D. Daily Max Air Temperature	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
Calero Res Outlet (CALE2)															
A. Prev Day Temp	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Constant	-0.68	-0.68	-0.68	-0.67	-0.66	-0.65	-0.64	-0.62	-0.60	-0.58	-0.55	-0.53	-0.50	-0.47	-0.44
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	0.32	0.31	0.30	0.29	0.29	0.28	0.27	0.26	0.25	0.24	0.24	0.23	0.22	0.21	0.21
B. Previous day temp	0.66	0.66	0.67	0.67	0.68	0.69	0.69	0.70	0.70	0.71	0.72	0.72	0.73	0.74	0.74
C. Flow (CALE2)	-0.29	-0.27	-0.25	-0.23	-0.21	-0.19	-0.18	-0.16	-0.14	-0.12	-0.11	-0.09	-0.07	-0.06	-0.04
D. Daily Max Air Temperature	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225
Calero Res Outlet (CALE2)															
A. Prev Day Temp	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Constant	-0.40	-0.37	-0.34	-0.30	-0.27	-0.24	-0.20	-0.17	-0.13	-0.10	-0.07	-0.04	-0.01	0.02	0.04
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	0.20	0.19	0.18	0.18	0.17	0.16	0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.10	0.09
B. Previous day temp	0.75	0.76	0.77	0.77	0.78	0.79	0.80	0.81	0.81	0.82	0.83	0.84	0.85	0.86	0.87
C. Flow (CALE2)	-0.03	-0.01	0.00	0.01	0.03	0.04	0.05	0.06	0.07	0.08	0.08	0.09	0.09	0.10	0.10
D. Daily Max Air Temperature	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
Calero Res Outlet (CALE2)															
A. Prev Day Temp	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
D. Constant	0.07	0.09	0.11	0.12	0.14	0.15	0.16	0.17	0.18	0.18	0.19	0.19	0.19	0.19	0.19
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	0.08	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02	-0.03
B. Previous day temp	0.88	0.89	0.90	0.91	0.93	0.94	0.95	0.96	0.97	0.98	0.99	0.99	1.00	1.01	1.01
C. Flow (CALE2)	0.10	0.10	0.10	0.10	0.10	0.09	0.09	0.08	0.08	0.07	0.06	0.06	0.05	0.04	0.04
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255
Calero Res Outlet (CALE2)															
A. Prev Day Temp	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.18	0.18	0.17	0.17	0.16	0.15	0.15	0.14	0.13	0.12	0.11	0.10	0.09	0.08	0.08
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.01	0.00	0.01	0.02	0.04	0.05	0.08	0.10
B. Previous day temp	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.00	0.99	0.97	0.96	0.94	0.92	0.89
C. Flow (CALE2)	0.03	0.02	0.02	0.01	0.01	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.01
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Calero Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
Calero Res Outlet (CALE2)															
A. Prev Day Temp	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
D. Constant	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	0.12	0.15	0.18	0.22	0.25	0.29	0.34	0.38	0.42	0.47	0.52	0.57	0.62	0.67	0.72
B. Previous day temp	0.87	0.84	0.80	0.77	0.73	0.69	0.64	0.60	0.55	0.50	0.45	0.40	0.34	0.29	0.24
C. Flow (CALE2)	0.02	0.03	0.04	0.06	0.07	0.09	0.11	0.13	0.15	0.18	0.20	0.23	0.25	0.28	0.31
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285
Calero Res Outlet (CALE2)															
A. Prev Day Temp	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.97
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Constant	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	0.77	0.82	0.87	0.92	0.97	1.02	1.07	1.11	1.16	1.20	1.24	1.28	1.31	1.34	1.37
B. Previous day temp	0.18	0.13	0.07	0.02	-0.03	-0.08	-0.13	-0.18	-0.23	-0.28	-0.32	-0.36	-0.40	-0.43	-0.46
C. Flow (CALE2)	0.33	0.36	0.38	0.41	0.43	0.46	0.48	0.50	0.53	0.54	0.56	0.58	0.59	0.60	0.61
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Calero Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
Calero Res Outlet (CALE2)															
A. Prev Day Temp	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.96	0.96	0.96	0.96	0.96
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
D. Constant	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.19	0.20	0.21
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	1.40	1.42	1.44	1.45	1.46	1.47	1.48	1.48	1.47	1.47	1.46	1.45	1.44	1.43	1.41
B. Previous day temp	-0.49	-0.51	-0.53	-0.55	-0.56	-0.57	-0.57	-0.57	-0.57	-0.56	-0.56	-0.55	-0.53	-0.52	-0.51
C. Flow (CALE2)	0.62	0.63	0.63	0.63	0.62	0.62	0.61	0.59	0.58	0.57	0.55	0.53	0.51	0.48	0.46
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Calero Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315
Calero Res Outlet (CALE2)															
A. Prev Day Temp	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.94
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
D. Constant	0.23	0.24	0.26	0.28	0.29	0.31	0.33	0.35	0.37	0.39	0.41	0.43	0.45	0.47	0.49
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	1.40	1.38	1.36	1.34	1.33	1.31	1.29	1.27	1.25	1.24	1.22	1.21	1.19	1.18	1.17
B. Previous day temp	-0.49	-0.47	-0.45	-0.43	-0.41	-0.39	-0.37	-0.35	-0.33	-0.31	-0.30	-0.28	-0.27	-0.25	-0.24
C. Flow (CALE2)	0.44	0.41	0.38	0.36	0.33	0.30	0.28	0.25	0.22	0.19	0.17	0.14	0.12	0.09	0.07
D. Daily Max Air Temperature	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Calero Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330
Calero Res Outlet (CALE2)															
A. Prev Day Temp	0.94	0.94	0.94	0.94	0.93	0.93	0.93	0.93	0.92	0.92	0.92	0.91	0.91	0.91	0.91
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Constant	0.52	0.54	0.56	0.59	0.61	0.64	0.67	0.69	0.72	0.75	0.78	0.80	0.83	0.86	0.89
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	1.17	1.16	1.16	1.16	1.17	1.17	1.18	1.20	1.21	1.23	1.25	1.27	1.29	1.31	1.34
B. Previous day temp	-0.24	-0.23	-0.23	-0.23	-0.23	-0.24	-0.24	-0.26	-0.27	-0.29	-0.30	-0.32	-0.34	-0.37	-0.39
C. Flow (CALE2)	0.05	0.03	0.01	-0.01	-0.02	-0.04	-0.05	-0.06	-0.06	-0.07	-0.08	-0.08	-0.08	-0.08	-0.08
D. Daily Max Air Temperature	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Calero Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345
Calero Res Outlet (CALE2)															
A. Prev Day Temp	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.88	0.88	0.88	0.88	0.88	0.87	0.87	0.87
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Constant	0.91	0.94	0.96	0.99	1.01	1.03	1.06	1.08	1.10	1.11	1.13	1.15	1.16	1.17	1.18
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	1.36	1.39	1.42	1.44	1.47	1.50	1.52	1.55	1.57	1.60	1.62	1.64	1.66	1.68	1.69
B. Previous day temp	-0.42	-0.44	-0.47	-0.49	-0.52	-0.55	-0.57	-0.60	-0.62	-0.64	-0.67	-0.69	-0.71	-0.72	-0.74
C. Flow (CALE2)	-0.08	-0.08	-0.07	-0.07	-0.07	-0.06	-0.05	-0.05	-0.04	-0.03	-0.03	-0.02	-0.01	0.00	0.01
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Calero Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
Calero Res Outlet (CALE2)															
A. Prev Day Temp	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.88
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	1.19	1.20	1.20	1.20	1.20	1.20	1.20	1.19	1.18	1.17	1.16	1.15	1.13	1.11	1.09
Fortini Road (CALE1)															
A. Upstream Temp (CALE2)	1.70	1.72	1.72	1.73	1.73	1.73	1.73	1.72	1.71	1.70	1.69	1.67	1.65	1.63	1.61
B. Previous day temp	-0.75	-0.76	-0.77	-0.77	-0.77	-0.77	-0.77	-0.76	-0.75	-0.74	-0.73	-0.71	-0.69	-0.67	-0.64
C. Flow (CALE2)	0.01	0.02	0.03	0.03	0.04	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.08	0.08
D. Daily Max Air Temperature	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Temperature Modeling Technical Memorandum
Santa Clara Valley Water District FAHCE Project

Attachment C - Calero Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**361**	**362**	**363**	**364**	**365**	**366**
Calero Res Outlet (CALE2)						
A. Prev Day Temp	0.88	0.88	0.88	0.89	0.89	0.89
B. Flow (CALE2)	0.00	0.00	0.00	0.00	0.00	0.00
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	1.07	1.05	1.03	1.01	0.98	0.96
Fortini Road (CALE1)						
A. Upstream Temp (CALE2)	1.58	1.55	1.53	1.50	1.46	1.43
B. Previous day temp	-0.62	-0.59	-0.56	-0.53	-0.49	-0.46
C. Flow (CALE2)	0.08	0.08	0.08	0.09	0.09	0.09
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00

Temperature Modeling Technical Memorandum
Santa Clara Valley Water District FAHCE Project

Attachment C - Guadalupe Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	1.00	1.05	1.09	1.12	1.15	1.18	1.21	1.23	1.25	1.27	1.28	1.29	1.29	1.29	1.28
B. Previous day temp	0.45	0.42	0.39	0.36	0.33	0.30	0.26	0.23	0.20	0.17	0.14	0.11	0.08	0.05	0.02
C. Reservoir Release (GCRK4)	-0.38	-0.40	-0.41	-0.43	-0.44	-0.45	-0.46	-0.47	-0.48	-0.49	-0.49	-0.49	-0.50	-0.50	-0.49
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	-4.31	-4.42	-4.50	-4.56	-4.58	-4.58	-4.55	-4.48	-4.38	-4.25	-4.07	-3.86	-3.61	-3.32	-2.99
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	1.41	1.44	1.47	1.49	1.51	1.52	1.54	1.54	1.55	1.55	1.54	1.53	1.52	1.50	1.47
B. Prev Day Temp	-0.63	-0.66	-0.68	-0.70	-0.72	-0.73	-0.74	-0.75	-0.75	-0.74	-0.74	-0.72	-0.71	-0.68	-0.66
C. Flow (GCRK3)	0.77	0.81	0.84	0.88	0.90	0.93	0.96	0.98	1.00	1.01	1.02	1.03	1.04	1.04	1.03
D. Daily Max Air Temperature	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.10	1.11	1.11	1.11	1.11	1.12	1.12	1.12	1.12	1.13	1.13	1.13	1.13	1.14	1.14
B. Prev Day Temp	-0.02	-0.03	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.05	-0.05	-0.06	-0.06	-0.06	-0.07	-0.07
C. Flow (GCRK3)	-0.51	-0.52	-0.53	-0.54	-0.54	-0.55	-0.56	-0.56	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57
D. Daily Max Air Temperature	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
E. Constant	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	1.17	1.19	1.21	1.23	1.24	1.26	1.28	1.29	1.31	1.33	1.34	1.36	1.37	1.38	1.40
B. Previous day temp	-0.13	-0.14	-0.16	-0.18	-0.20	-0.21	-0.23	-0.24	-0.25	-0.26	-0.28	-0.29	-0.29	-0.30	-0.31
C. Flow (GCRK3)	0.28	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.27	0.26	0.26
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	1.27	1.25	1.23	1.21	1.18	1.15	1.11	1.07	1.03	0.99	0.94	0.89	0.84	0.79	0.74
B. Previous day temp	-0.02	-0.05	-0.08	-0.11	-0.14	-0.17	-0.20	-0.23	-0.25	-0.28	-0.31	-0.34	-0.36	-0.39	-0.41
C. Reservoir Release (GCRK4)	-0.49	-0.49	-0.48	-0.47	-0.46	-0.45	-0.44	-0.42	-0.41	-0.40	-0.38	-0.36	-0.35	-0.33	-0.31
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
E. Constant	-2.61	-2.20	-1.74	-1.25	-0.73	-0.18	0.39	0.99	1.61	2.25	2.89	3.55	4.22	4.89	5.56
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	1.44	1.41	1.37	1.33	1.28	1.23	1.17	1.12	1.06	1.00	0.94	0.87	0.81	0.75	0.68
B. Prev Day Temp	-0.62	-0.58	-0.54	-0.50	-0.45	-0.39	-0.34	-0.28	-0.21	-0.15	-0.09	-0.02	0.05	0.11	0.18
C. Flow (GCRK3)	1.03	1.02	1.00	0.99	0.97	0.95	0.92	0.89	0.86	0.83	0.80	0.76	0.73	0.69	0.65
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.14	1.14	1.15	1.15	1.15	1.15	1.15	1.16	1.16	1.16	1.16	1.16	1.16	1.17	1.17
B. Prev Day Temp	-0.08	-0.08	-0.09	-0.09	-0.10	-0.10	-0.11	-0.11	-0.12	-0.12	-0.13	-0.14	-0.14	-0.15	-0.15
C. Flow (GCRK3)	-0.57	-0.57	-0.56	-0.56	-0.55	-0.55	-0.54	-0.53	-0.52	-0.52	-0.51	-0.50	-0.49	-0.48	-0.47
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03
E. Constant	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	1.41	1.42	1.43	1.44	1.45	1.46	1.47	1.48	1.48	1.49	1.49	1.49	1.49	1.49	1.49
B. Previous day temp	-0.32	-0.32	-0.32	-0.33	-0.33	-0.33	-0.33	-0.33	-0.32	-0.32	-0.31	-0.31	-0.30	-0.29	-0.28
C. Flow (GCRK3)	0.25	0.24	0.22	0.21	0.20	0.18	0.17	0.15	0.14	0.12	0.11	0.09	0.07	0.06	0.04
D. Daily Max Air Temperature	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.03	-0.03	-0.04	-0.04	-0.04	-0.05	-0.05
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	0.69	0.64	0.58	0.53	0.48	0.43	0.38	0.33	0.28	0.23	0.19	0.14	0.10	0.06	0.03
B. Previous day temp	-0.43	-0.45	-0.47	-0.49	-0.51	-0.53	-0.54	-0.56	-0.57	-0.58	-0.59	-0.59	-0.60	-0.60	-0.60
C. Reservoir Release (GCRK4)	-0.29	-0.27	-0.26	-0.24	-0.22	-0.20	-0.18	-0.17	-0.15	-0.14	-0.12	-0.11	-0.10	-0.09	-0.08
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
E. Constant	6.24	6.90	7.56	8.21	8.85	9.47	10.07	10.65	11.20	11.72	12.21	12.67	13.09	13.47	13.81
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	0.62	0.55	0.49	0.43	0.38	0.32	0.27	0.22	0.17	0.13	0.09	0.06	0.03	0.00	-0.01
B. Prev Day Temp	0.25	0.31	0.38	0.44	0.50	0.56	0.61	0.66	0.71	0.76	0.80	0.83	0.86	0.89	0.91
C. Flow (GCRK3)	0.61	0.57	0.53	0.50	0.46	0.42	0.38	0.34	0.31	0.27	0.24	0.21	0.18	0.15	0.12
D. Daily Max Air Temperature	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
B. Prev Day Temp	-0.16	-0.16	-0.17	-0.17	-0.18	-0.18	-0.18	-0.19	-0.19	-0.19	-0.20	-0.20	-0.20	-0.20	-0.21
C. Flow (GCRK3)	-0.46	-0.45	-0.45	-0.44	-0.43	-0.42	-0.41	-0.41	-0.40	-0.39	-0.39	-0.38	-0.38	-0.38	-0.37
D. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	1.48	1.48	1.47	1.46	1.44	1.43	1.41	1.39	1.37	1.35	1.32	1.29	1.26	1.23	1.19
B. Previous day temp	-0.27	-0.26	-0.24	-0.23	-0.21	-0.19	-0.17	-0.15	-0.13	-0.11	-0.09	-0.06	-0.03	-0.01	0.02
C. Flow (GCRK3)	0.03	0.01	-0.01	-0.02	-0.03	-0.05	-0.06	-0.07	-0.08	-0.09	-0.10	-0.11	-0.11	-0.12	-0.12
D. Daily Max Air Temperature	-0.05	-0.05	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.05
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	0.00	-0.03	-0.05	-0.07	-0.09	-0.10	-0.12	-0.12	-0.13	-0.14	-0.14	-0.14	-0.14	-0.13	-0.13
B. Previous day temp	-0.60	-0.60	-0.59	-0.58	-0.57	-0.56	-0.55	-0.54	-0.52	-0.50	-0.48	-0.46	-0.44	-0.42	-0.39
C. Reservoir Release (GCRK4)	-0.07	-0.06	-0.05	-0.05	-0.05	-0.04	-0.04	-0.04	-0.04	-0.05	-0.05	-0.05	-0.06	-0.06	-0.06
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03
E. Constant	14.10	14.34	14.53	14.68	14.78	14.84	14.87	14.85	14.80	14.71	14.59	14.44	14.27	14.06	13.84
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	-0.02	-0.03	-0.03	-0.02	-0.01	0.01	0.03	0.06	0.09	0.12	0.16	0.20	0.24	0.28	0.33
B. Prev Day Temp	0.92	0.93	0.93	0.92	0.91	0.89	0.87	0.84	0.81	0.78	0.74	0.70	0.66	0.62	0.57
C. Flow (GCRK3)	0.10	0.08	0.07	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Daily Max Air Temperature	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.10	0.10
E. Constant	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.16	1.16	1.16	1.16	1.16	1.15	1.15	1.15	1.15	1.14	1.14	1.14	1.13	1.13	1.13
B. Prev Day Temp	-0.21	-0.21	-0.21	-0.21	-0.21	-0.21	-0.20	-0.20	-0.20	-0.20	-0.20	-0.19	-0.19	-0.19	-0.18
C. Flow (GCRK3)	-0.37	-0.37	-0.37	-0.38	-0.38	-0.38	-0.39	-0.39	-0.40	-0.40	-0.41	-0.42	-0.42	-0.43	-0.44
D. Daily Max Air Temperature	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	1.15	1.11	1.06	1.01	0.96	0.91	0.86	0.81	0.75	0.70	0.64	0.59	0.53	0.48	0.43
B. Previous day temp	0.06	0.09	0.12	0.16	0.19	0.23	0.26	0.30	0.34	0.37	0.41	0.44	0.48	0.51	0.55
C. Flow (GCRK3)	-0.12	-0.12	-0.12	-0.11	-0.11	-0.10	-0.09	-0.08	-0.07	-0.06	-0.05	-0.04	-0.03	-0.02	0.00
D. Daily Max Air Temperature	-0.05	-0.05	-0.04	-0.03	-0.03	-0.02	-0.01	-0.01	0.00	0.01	0.02	0.02	0.03	0.04	0.05
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	-0.12	-0.11	-0.11	-0.10	-0.09	-0.08	-0.07	-0.06	-0.05	-0.04	-0.03	-0.02	-0.01	0.00	0.01
B. Previous day temp	-0.37	-0.34	-0.31	-0.29	-0.26	-0.23	-0.20	-0.17	-0.14	-0.10	-0.07	-0.04	-0.01	0.02	0.06
C. Reservoir Release (GCRK4)	-0.07	-0.07	-0.08	-0.08	-0.09	-0.09	-0.10	-0.10	-0.11	-0.11	-0.12	-0.12	-0.12	-0.12	-0.12
D. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
E. Constant	13.59	13.32	13.03	12.72	12.40	12.07	11.72	11.37	11.01	10.64	10.27	9.90	9.53	9.16	8.80
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	0.38	0.43	0.47	0.52	0.57	0.62	0.66	0.71	0.75	0.79	0.83	0.86	0.89	0.92	0.95
B. Prev Day Temp	0.53	0.48	0.43	0.38	0.34	0.29	0.24	0.20	0.16	0.12	0.08	0.04	0.01	-0.01	-0.04
C. Flow (GCRK3)	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07
D. Daily Max Air Temperature	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.12
E. Constant	-0.02	-0.02	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.12	1.12	1.11	1.11	1.11	1.10	1.10	1.09	1.09	1.09	1.08	1.08	1.07	1.07	1.06
B. Prev Day Temp	-0.18	-0.18	-0.17	-0.17	-0.16	-0.16	-0.15	-0.15	-0.14	-0.14	-0.13	-0.13	-0.12	-0.12	-0.11
C. Flow (GCRK3)	-0.44	-0.45	-0.46	-0.46	-0.47	-0.47	-0.48	-0.48	-0.48	-0.48	-0.48	-0.48	-0.48	-0.48	-0.48
D. Daily Max Air Temperature	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	0.37	0.33	0.28	0.23	0.19	0.16	0.12	0.09	0.06	0.04	0.02	0.01	0.00	0.00	0.01
B. Previous day temp	0.58	0.61	0.64	0.66	0.69	0.71	0.73	0.75	0.76	0.77	0.78	0.79	0.79	0.78	0.78
C. Flow (GCRK3)	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.09	0.10	0.10	0.10	0.10	0.10
D. Daily Max Air Temperature	0.06	0.07	0.07	0.08	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.13	0.13	0.13	0.13
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02
B. Previous day temp	0.09	0.12	0.15	0.18	0.21	0.25	0.28	0.31	0.34	0.37	0.40	0.43	0.46	0.48	0.51
C. Reservoir Release (GCRK4)	-0.12	-0.12	-0.12	-0.11	-0.11	-0.11	-0.10	-0.10	-0.09	-0.08	-0.08	-0.07	-0.06	-0.06	-0.05
D. Daily Max Air Temperature	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
E. Constant	8.44	8.09	7.74	7.40	7.07	6.74	6.41	6.09	5.78	5.48	5.18	4.89	4.60	4.33	4.06
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	0.97	0.98	0.99	1.00	1.01	1.01	1.01	1.01	1.00	0.99	0.98	0.97	0.96	0.94	0.92
B. Prev Day Temp	-0.06	-0.07	-0.08	-0.09	-0.10	-0.10	-0.10	-0.09	-0.08	-0.08	-0.06	-0.05	-0.04	-0.02	0.00
C. Flow (GCRK3)	0.07	0.06	0.06	0.05	0.05	0.04	0.03	0.02	0.01	0.00	-0.01	-0.03	-0.04	-0.05	-0.07
D. Daily Max Air Temperature	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.11
E. Constant	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.06	1.06	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.01	1.01
B. Prev Day Temp	-0.10	-0.10	-0.09	-0.09	-0.08	-0.08	-0.07	-0.07	-0.06	-0.06	-0.05	-0.05	-0.04	-0.04	-0.03
C. Flow (GCRK3)	-0.47	-0.47	-0.46	-0.45	-0.44	-0.43	-0.42	-0.41	-0.40	-0.38	-0.37	-0.35	-0.34	-0.32	-0.31
D. Daily Max Air Temperature	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.06	0.06	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	0.02	0.03	0.05	0.08	0.11	0.14	0.18	0.22	0.26	0.31	0.36	0.41	0.46	0.51	0.57
B. Previous day temp	0.77	0.75	0.74	0.72	0.69	0.67	0.64	0.61	0.58	0.55	0.51	0.47	0.44	0.40	0.36
C. Flow (GCRK3)	0.09	0.09	0.08	0.07	0.06	0.05	0.04	0.02	0.01	0.00	-0.02	-0.03	-0.05	-0.06	-0.08
D. Daily Max Air Temperature	0.13	0.13	0.13	0.13	0.13	0.12	0.12	0.12	0.11	0.11	0.10	0.10	0.09	0.09	0.08
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	0.02	0.01	0.01	0.01	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03
B. Previous day temp	0.54	0.57	0.59	0.62	0.64	0.67	0.69	0.71	0.73	0.75	0.77	0.79	0.81	0.83	0.84
C. Reservoir Release (GCRK4)	-0.04	-0.04	-0.03	-0.02	-0.01	-0.01	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04
D. Daily Max Air Temperature	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04
E. Constant	3.80	3.55	3.31	3.07	2.85	2.63	2.43	2.23	2.04	1.87	1.70	1.55	1.40	1.27	1.14
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	0.90	0.88	0.86	0.84	0.82	0.79	0.77	0.74	0.72	0.69	0.67	0.65	0.62	0.60	0.58
B. Prev Day Temp	0.02	0.04	0.06	0.09	0.11	0.13	0.16	0.18	0.20	0.23	0.25	0.27	0.30	0.32	0.34
C. Flow (GCRK3)	-0.08	-0.10	-0.11	-0.13	-0.15	-0.16	-0.18	-0.20	-0.21	-0.23	-0.25	-0.26	-0.28	-0.30	-0.31
D. Daily Max Air Temperature	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.12
E. Constant	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.01	1.01	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
B. Prev Day Temp	-0.03	-0.02	-0.02	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02
C. Flow (GCRK3)	-0.29	-0.28	-0.26	-0.25	-0.23	-0.22	-0.20	-0.18	-0.17	-0.15	-0.14	-0.13	-0.11	-0.10	-0.09
D. Daily Max Air Temperature	0.05	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	0.62	0.68	0.73	0.79	0.84	0.89	0.94	0.99	1.04	1.09	1.13	1.17	1.20	1.23	1.26
B. Previous day temp	0.32	0.28	0.24	0.20	0.16	0.13	0.09	0.05	0.02	-0.01	-0.04	-0.07	-0.10	-0.12	-0.14
C. Flow (GCRK3)	-0.10	-0.11	-0.12	-0.14	-0.15	-0.16	-0.18	-0.19	-0.20	-0.20	-0.21	-0.22	-0.22	-0.22	-0.22
D. Daily Max Air Temperature	0.07	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03	-0.03
B. Previous day temp	0.86	0.87	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.95	0.96	0.97	0.97	0.98	0.98
C. Reservoir Release (GCRK4)	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03
D. Daily Max Air Temperature	0.04	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
E. Constant	1.03	0.93	0.84	0.76	0.69	0.63	0.58	0.53	0.49	0.46	0.44	0.42	0.41	0.40	0.40
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	0.56	0.54	0.52	0.51	0.49	0.48	0.46	0.45	0.44	0.43	0.42	0.41	0.40	0.39	0.38
B. Prev Day Temp	0.35	0.37	0.39	0.40	0.41	0.42	0.44	0.45	0.45	0.46	0.47	0.48	0.48	0.49	0.49
C. Flow (GCRK3)	-0.33	-0.34	-0.36	-0.37	-0.39	-0.40	-0.41	-0.43	-0.44	-0.45	-0.46	-0.47	-0.48	-0.49	-0.50
D. Daily Max Air Temperature	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.13	0.13	0.14	0.14	0.14	0.14	0.15	0.15
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00
B. Prev Day Temp	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
C. Flow (GCRK3)	-0.08	-0.07	-0.06	-0.05	-0.04	-0.03	-0.02	-0.02	-0.01	-0.01	0.00	0.00	0.00	0.01	0.01
D. Daily Max Air Temperature	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	1.28	1.30	1.31	1.32	1.33	1.33	1.33	1.33	1.32	1.31	1.30	1.29	1.27	1.25	1.23
B. Previous day temp	-0.16	-0.18	-0.19	-0.20	-0.21	-0.21	-0.21	-0.22	-0.21	-0.21	-0.21	-0.20	-0.20	-0.19	-0.18
C. Flow (GCRK3)	-0.22	-0.21	-0.20	-0.20	-0.19	-0.17	-0.16	-0.15	-0.13	-0.11	-0.10	-0.08	-0.06	-0.04	-0.02
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Temperature Modeling Technical Memorandum
Santa Clara Valley Water District FAHCE Project

Attachment C - Guadalupe Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00
B. Previous day temp	0.98	0.99	0.99	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
C. Reservoir Release (GCRK4)	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.02	-0.03	-0.03
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02
E. Constant	0.40	0.40	0.41	0.42	0.43	0.45	0.46	0.48	0.49	0.51	0.53	0.54	0.55	0.56	0.57
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	0.37	0.37	0.36	0.36	0.35	0.35	0.34	0.34	0.34	0.33	0.33	0.33	0.32	0.32	0.32
B. Prev Day Temp	0.50	0.50	0.51	0.51	0.51	0.52	0.52	0.52	0.52	0.53	0.53	0.53	0.54	0.54	0.54
C. Flow (GCRK3)	-0.51	-0.52	-0.53	-0.54	-0.54	-0.55	-0.56	-0.56	-0.57	-0.57	-0.57	-0.58	-0.58	-0.58	-0.58
D. Daily Max Air Temperature	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.00	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.03
B. Prev Day Temp	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (GCRK3)	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	1.21	1.19	1.17	1.15	1.12	1.10	1.08	1.05	1.03	1.01	0.99	0.97	0.95	0.93	0.92
B. Previous day temp	-0.17	-0.16	-0.14	-0.13	-0.12	-0.11	-0.09	-0.08	-0.07	-0.06	-0.04	-0.03	-0.02	-0.01	0.00
C. Flow (GCRK3)	0.00	0.02	0.04	0.07	0.09	0.11	0.13	0.15	0.17	0.19	0.21	0.23	0.24	0.26	0.27
D. Daily Max Air Temperature	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.08
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
B. Previous day temp	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
C. Reservoir Release (GCRK4)	-0.03	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01
E. Constant	0.57	0.57	0.57	0.56	0.56	0.55	0.53	0.52	0.50	0.48	0.46	0.44	0.42	0.40	0.37
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	0.32	0.32	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.32	0.32
B. Prev Day Temp	0.55	0.55	0.56	0.57	0.57	0.58	0.58	0.59	0.59	0.60	0.61	0.61	0.62	0.62	0.63
C. Flow (GCRK3)	-0.58	-0.58	-0.58	-0.58	-0.58	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.58
D. Daily Max Air Temperature	0.16	0.16	0.16	0.15	0.15	0.15	0.15	0.14	0.14	0.13	0.13	0.13	0.12	0.12	0.12
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.05	1.05	1.05	1.05	1.05	1.05
B. Prev Day Temp	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
C. Flow (GCRK3)	0.00	-0.01	-0.01	-0.02	-0.02	-0.02	-0.03	-0.03	-0.04	-0.04	-0.05	-0.05	-0.06	-0.06	-0.07
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	0.90	0.89	0.88	0.87	0.87	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.87	0.87
B. Previous day temp	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.03	0.03	0.03	0.03
C. Flow (GCRK3)	0.29	0.30	0.31	0.32	0.33	0.34	0.34	0.35	0.36	0.36	0.37	0.37	0.37	0.38	0.38
D. Daily Max Air Temperature	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00	1.00	1.00
C. Reservoir Release (GCRK4)	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.35	0.32	0.29	0.27	0.24	0.21	0.19	0.16	0.14	0.11	0.09	0.06	0.04	0.02	0.00
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	0.32	0.33	0.33	0.34	0.34	0.35	0.36	0.37	0.38	0.39	0.40	0.41	0.42	0.44	0.45
B. Prev Day Temp	0.63	0.63	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.63	0.63	0.62	0.61	0.61
C. Flow (GCRK3)	-0.58	-0.58	-0.59	-0.60	-0.61	-0.62	-0.63	-0.65	-0.66	-0.68	-0.70	-0.72	-0.75	-0.78	-0.81
D. Daily Max Air Temperature	0.11	0.11	0.10	0.10	0.10	0.10	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.08
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.06
B. Prev Day Temp	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (GCRK3)	-0.07	-0.08	-0.08	-0.09	-0.09	-0.10	-0.10	-0.11	-0.11	-0.12	-0.12	-0.13	-0.13	-0.14	-0.14
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	0.88	0.89	0.89	0.90	0.91	0.92	0.93	0.93	0.94	0.95	0.96	0.97	0.98	0.98	0.99
B. Previous day temp	0.03	0.02	0.02	0.02	0.01	0.01	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.02	-0.03
C. Flow (GCRK3)	0.38	0.38	0.38	0.39	0.39	0.39	0.39	0.39	0.40	0.40	0.40	0.41	0.41	0.42	0.42
D. Daily Max Air Temperature	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.04	0.04	0.04
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
C. Reservoir Release (GCRK4)	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	-0.01	-0.03	-0.04	-0.05	-0.06	-0.07	-0.08	-0.08	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	0.47	0.49	0.51	0.53	0.55	0.57	0.59	0.61	0.64	0.66	0.69	0.71	0.74	0.76	0.79
B. Prev Day Temp	0.60	0.58	0.57	0.56	0.54	0.53	0.51	0.49	0.47	0.45	0.43	0.41	0.39	0.37	0.35
C. Flow (GCRK3)	-0.84	-0.88	-0.92	-0.96	-1.00	-1.05	-1.09	-1.14	-1.19	-1.24	-1.29	-1.34	-1.38	-1.43	-1.48
D. Daily Max Air Temperature	0.08	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.11	0.12	0.12	0.13
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
B. Prev Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (GCRK3)	-0.15	-0.15	-0.15	-0.16	-0.16	-0.16	-0.17	-0.17	-0.17	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	1.00	1.00	1.01	1.01	1.01	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.03	1.03
B. Previous day temp	-0.03	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03
C. Flow (GCRK3)	0.43	0.43	0.44	0.45	0.46	0.47	0.48	0.49	0.51	0.52	0.53	0.55	0.56	0.58	0.59
D. Daily Max Air Temperature	0.04	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
C. Reservoir Release (GCRK4)	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	-0.09	-0.08	-0.08	-0.07	-0.07	-0.06	-0.05	-0.04	-0.04	-0.03	-0.02	-0.01	-0.01	0.00	0.01
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	0.81	0.84	0.86	0.89	0.91	0.94	0.96	0.99	1.01	1.04	1.06	1.08	1.10	1.12	1.14
B. Prev Day Temp	0.33	0.30	0.28	0.26	0.24	0.22	0.20	0.17	0.15	0.13	0.12	0.10	0.08	0.06	0.05
C. Flow (GCRK3)	-1.52	-1.57	-1.61	-1.65	-1.68	-1.71	-1.74	-1.77	-1.79	-1.81	-1.82	-1.83	-1.84	-1.84	-1.83
D. Daily Max Air Temperature	0.13	0.13	0.14	0.14	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.16	0.16
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
B. Prev Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (GCRK3)	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.18	-0.18	-0.18	-0.18
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.00	1.00	1.00	0.99	0.99	0.99
B. Previous day temp	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01
C. Flow (GCRK3)	0.61	0.63	0.64	0.66	0.68	0.70	0.71	0.73	0.75	0.77	0.79	0.81	0.83	0.85	0.87
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	1.01	1.01	1.01	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
C. Reservoir Release (GCRK4)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.01	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	1.16	1.18	1.19	1.21	1.22	1.24	1.25	1.26	1.27	1.28	1.29	1.29	1.30	1.31	1.31
B. Prev Day Temp	0.03	0.02	0.01	0.00	-0.01	-0.02	-0.03	-0.03	-0.04	-0.04	-0.05	-0.05	-0.05	-0.05	-0.05
C. Flow (GCRK3)	-1.82	-1.80	-1.77	-1.74	-1.70	-1.66	-1.62	-1.57	-1.52	-1.46	-1.40	-1.34	-1.28	-1.22	-1.15
D. Daily Max Air Temperature	0.16	0.15	0.15	0.15	0.14	0.14	0.13	0.13	0.12	0.11	0.11	0.10	0.09	0.09	0.08
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.05	1.05	1.05	1.05	1.05
B. Prev Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (GCRK3)	-0.18	-0.17	-0.17	-0.17	-0.16	-0.16	-0.16	-0.15	-0.15	-0.14	-0.14	-0.14	-0.13	-0.13	-0.12
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	0.98	0.98	0.98	0.97	0.97	0.97	0.96	0.96	0.96	0.96	0.95	0.95	0.95	0.95	0.94
B. Previous day temp	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (GCRK3)	0.89	0.91	0.93	0.96	0.98	1.00	1.02	1.03	1.05	1.07	1.09	1.10	1.12	1.13	1.14
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
C. Reservoir Release (GCRK4)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.06	0.06	0.05	0.05	0.05	0.04	0.03	0.03	0.02	0.01	0.00	-0.01	-0.02	-0.04	-0.05
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	1.31	1.32	1.32	1.32	1.32	1.32	1.32	1.31	1.31	1.30	1.30	1.29	1.28	1.28	1.27
B. Prev Day Temp	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03	-0.02	-0.02	-0.01
C. Flow (GCRK3)	-1.09	-1.03	-0.96	-0.90	-0.84	-0.78	-0.72	-0.67	-0.61	-0.57	-0.52	-0.48	-0.44	-0.41	-0.39
D. Daily Max Air Temperature	0.07	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03
B. Prev Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (GCRK3)	-0.12	-0.12	-0.11	-0.11	-0.11	-0.11	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	0.94	0.94	0.94	0.94	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.94	0.94	0.94	0.94
B. Previous day temp	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02
C. Flow (GCRK3)	1.15	1.16	1.17	1.18	1.18	1.18	1.18	1.18	1.18	1.17	1.16	1.15	1.13	1.12	1.10
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00	1.00
C. Reservoir Release (GCRK4)	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
E. Constant	-0.07	-0.08	-0.10	-0.12	-0.14	-0.16	-0.18	-0.20	-0.22	-0.24	-0.26	-0.28	-0.29	-0.31	-0.32
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	1.26	1.25	1.24	1.23	1.21	1.20	1.19	1.17	1.16	1.14	1.12	1.11	1.09	1.07	1.06
B. Prev Day Temp	-0.01	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.05
C. Flow (GCRK3)	-0.37	-0.36	-0.35	-0.35	-0.36	-0.37	-0.38	-0.40	-0.43	-0.45	-0.48	-0.51	-0.54	-0.58	-0.61
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.00	1.00
B. Prev Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (GCRK3)	-0.10	-0.11	-0.11	-0.11	-0.12	-0.12	-0.13	-0.13	-0.14	-0.14	-0.15	-0.16	-0.16	-0.17	-0.17
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	0.94	0.95	0.95	0.95	0.96	0.96	0.96	0.97	0.97	0.98	0.98	0.99	0.99	1.00	1.00
B. Previous day temp	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
C. Flow (GCRK3)	1.07	1.05	1.02	0.99	0.95	0.91	0.87	0.83	0.79	0.74	0.69	0.65	0.60	0.55	0.50
D. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
C. Reservoir Release (GCRK4)	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	-0.34	-0.35	-0.35	-0.36	-0.36	-0.36	-0.36	-0.35	-0.35	-0.33	-0.31	-0.29	-0.27	-0.24	-0.20
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	1.04	1.02	1.00	0.98	0.96	0.94	0.92	0.90	0.88	0.86	0.84	0.82	0.80	0.78	0.76
B. Prev Day Temp	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08
C. Flow (GCRK3)	-0.64	-0.67	-0.70	-0.73	-0.76	-0.78	-0.80	-0.81	-0.82	-0.82	-0.82	-0.81	-0.80	-0.78	-0.75
D. Daily Max Air Temperature	0.07	0.07	0.08	0.09	0.10	0.11	0.11	0.12	0.13	0.14	0.15	0.15	0.16	0.17	0.17
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
B. Prev Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (GCRK3)	-0.18	-0.18	-0.19	-0.19	-0.19	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.19	-0.19	-0.18
D. Daily Max Air Temperature	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.04	1.05	1.05	1.05	1.06	1.06	1.06	1.06
B. Previous day temp	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03
C. Flow (GCRK3)	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.11	0.07	0.02	-0.02	-0.05	-0.09	-0.12	-0.15
D. Daily Max Air Temperature	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
B. Previous day temp	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.96
C. Reservoir Release (GCRK4)	-0.01	-0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.04
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
E. Constant	-0.16	-0.11	-0.06	0.00	0.06	0.13	0.20	0.27	0.35	0.44	0.53	0.61	0.71	0.80	0.89
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	0.74	0.72	0.70	0.68	0.66	0.64	0.62	0.60	0.59	0.57	0.55	0.53	0.52	0.50	0.49
B. Prev Day Temp	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.06
C. Flow (GCRK3)	-0.71	-0.66	-0.60	-0.53	-0.45	-0.36	-0.27	-0.17	-0.06	0.06	0.18	0.31	0.44	0.57	0.70
D. Daily Max Air Temperature	0.18	0.18	0.19	0.19	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01
B. Prev Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (GCRK3)	-0.17	-0.16	-0.15	-0.14	-0.13	-0.11	-0.10	-0.08	-0.07	-0.05	-0.03	-0.01	0.00	0.02	0.03
D. Daily Max Air Temperature	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.05	1.05	1.05	1.04	1.04	1.03	1.03
B. Previous day temp	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00
C. Flow (GCRK3)	-0.18	-0.20	-0.22	-0.23	-0.24	-0.25	-0.25	-0.26	-0.25	-0.25	-0.24	-0.23	-0.22	-0.20	-0.18
D. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00
B. Previous day temp	0.96	0.96	0.95	0.95	0.94	0.94	0.94	0.93	0.93	0.92	0.92	0.91	0.91	0.90	0.90
C. Reservoir Release (GCRK4)	0.04	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
E. Constant	0.99	1.09	1.18	1.28	1.38	1.47	1.57	1.66	1.75	1.84	1.92	2.00	2.08	2.15	2.22
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	0.47	0.46	0.45	0.44	0.43	0.42	0.41	0.40	0.39	0.39	0.38	0.38	0.38	0.38	0.38
B. Prev Day Temp	0.06	0.06	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01
C. Flow (GCRK3)	0.84	0.98	1.12	1.25	1.39	1.52	1.66	1.78	1.91	2.03	2.14	2.25	2.35	2.44	2.53
D. Daily Max Air Temperature	0.20	0.20	0.19	0.19	0.19	0.19	0.18	0.18	0.17	0.17	0.16	0.16	0.15	0.15	0.14
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.01	1.01	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.03
B. Prev Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (GCRK3)	0.05	0.06	0.08	0.09	0.10	0.11	0.11	0.12	0.12	0.12	0.11	0.11	0.10	0.08	0.07
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	1.02	1.02	1.01	1.01	1.00	1.00	0.99	0.99	0.98	0.98	0.97	0.97	0.97	0.96	0.96
B. Previous day temp	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03
C. Flow (GCRK3)	-0.16	-0.14	-0.12	-0.09	-0.06	-0.04	-0.01	0.02	0.05	0.08	0.11	0.15	0.18	0.21	0.24
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
B. Previous day temp	0.90	0.89	0.89	0.88	0.88	0.87	0.87	0.87	0.86	0.86	0.85	0.85	0.85	0.84	0.84
C. Reservoir Release (GCRK4)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.06	0.06	0.06	0.05	0.05
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
E. Constant	2.29	2.35	2.40	2.45	2.49	2.52	2.55	2.58	2.60	2.61	2.62	2.63	2.63	2.62	2.62
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	0.38	0.38	0.39	0.39	0.40	0.41	0.42	0.43	0.44	0.45	0.47	0.48	0.50	0.51	0.53
B. Prev Day Temp	0.01	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.05
C. Flow (GCRK3)	2.60	2.67	2.73	2.77	2.80	2.83	2.84	2.84	2.84	2.82	2.80	2.77	2.74	2.69	2.64
D. Daily Max Air Temperature	0.14	0.13	0.13	0.12	0.12	0.11	0.10	0.10	0.09	0.09	0.08	0.08	0.07	0.06	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01
B. Prev Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (GCRK3)	0.05	0.02	-0.01	-0.04	-0.08	-0.12	-0.16	-0.21	-0.26	-0.31	-0.36	-0.42	-0.48	-0.53	-0.59
D. Daily Max Air Temperature	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	0.00	0.00	0.00
E. Constant	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	0.96	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.96	0.96	0.96
B. Previous day temp	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00
C. Flow (GCRK3)	0.27	0.30	0.33	0.36	0.39	0.42	0.45	0.47	0.50	0.52	0.54	0.56	0.59	0.60	0.62
D. Daily Max Air Temperature	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Temperature Modeling Technical Memorandum
Santa Clara Valley Water District FAHCE Project

Attachment C - Guadalupe Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**301**	**302**	**303**	**304**	**305**	**306**	**307**	**308**	**309**	**310**	**311**	**312**	**313**	**314**	**315**
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02
B. Previous day temp	0.84	0.84	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.84	0.84	0.84	0.84
C. Reservoir Release (GCRK4)	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.00	0.00	0.00	-0.01	-0.01	-0.01
D. Daily Max Air Temperature	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00
E. Constant	2.61	2.59	2.57	2.55	2.52	2.50	2.47	2.43	2.40	2.36	2.32	2.27	2.23	2.18	2.14
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	0.55	0.56	0.58	0.59	0.61	0.63	0.64	0.66	0.67	0.68	0.70	0.71	0.72	0.73	0.74
B. Prev Day Temp	-0.05	-0.05	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.05
C. Flow (GCRK3)	2.59	2.53	2.46	2.39	2.32	2.24	2.16	2.07	1.99	1.90	1.81	1.72	1.63	1.54	1.45
D. Daily Max Air Temperature	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.01	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98
B. Prev Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (GCRK3)	-0.65	-0.71	-0.77	-0.83	-0.88	-0.94	-0.99	-1.05	-1.10	-1.14	-1.19	-1.23	-1.26	-1.30	-1.33
D. Daily Max Air Temperature	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04
E. Constant	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	0.96	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
B. Previous day temp	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01
C. Flow (GCRK3)	0.64	0.66	0.67	0.68	0.70	0.71	0.72	0.72	0.73	0.74	0.74	0.74	0.74	0.74	0.74
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	0.01	0.01	0.01	0.00	-0.01	-0.01	-0.02	-0.02	-0.03	-0.04	-0.04	-0.05	-0.06	-0.06	-0.07
B. Previous day temp	0.85	0.85	0.86	0.87	0.87	0.88	0.89	0.90	0.91	0.91	0.92	0.93	0.94	0.95	0.96
C. Reservoir Release (GCRK4)	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.01	0.01
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	2.09	2.04	1.99	1.94	1.89	1.84	1.79	1.73	1.68	1.63	1.57	1.52	1.46	1.40	1.34
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	0.75	0.75	0.76	0.76	0.76	0.76	0.76	0.76	0.75	0.75	0.74	0.74	0.73	0.72	0.71
B. Prev Day Temp	-0.05	-0.05	-0.04	-0.03	-0.03	-0.02	-0.01	-0.01	0.00	0.01	0.02	0.03	0.04	0.05	0.06
C. Flow (GCRK3)	1.36	1.27	1.19	1.11	1.02	0.95	0.87	0.80	0.73	0.66	0.60	0.54	0.48	0.43	0.37
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.05	0.05
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.99	0.99	0.99	0.99
B. Prev Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
C. Flow (GCRK3)	-1.35	-1.37	-1.38	-1.39	-1.39	-1.39	-1.38	-1.37	-1.35	-1.33	-1.30	-1.27	-1.23	-1.20	-1.16
D. Daily Max Air Temperature	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.02
E. Constant	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	0.97	0.96	0.96	0.96	0.95	0.95	0.94	0.93	0.93	0.92	0.91	0.91	0.90	0.89	0.88
B. Previous day temp	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.09	0.10	0.11	0.12
C. Flow (GCRK3)	0.74	0.73	0.73	0.72	0.71	0.70	0.68	0.67	0.65	0.63	0.62	0.60	0.58	0.56	0.53
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	-0.08	-0.08	-0.09	-0.09	-0.09	-0.09	-0.10	-0.10	-0.09	-0.09	-0.09	-0.08	-0.08	-0.07	-0.06
B. Previous day temp	0.97	0.98	0.99	0.99	1.00	1.01	1.01	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
C. Reservoir Release (GCRK4)	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01
E. Constant	1.29	1.23	1.17	1.10	1.04	0.98	0.91	0.85	0.78	0.71	0.64	0.57	0.50	0.43	0.35
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	0.70	0.69	0.68	0.67	0.66	0.66	0.65	0.64	0.63	0.63	0.62	0.61	0.61	0.61	0.61
B. Prev Day Temp	0.07	0.08	0.09	0.09	0.10	0.11	0.11	0.12	0.13	0.13	0.13	0.14	0.14	0.14	0.14
C. Flow (GCRK3)	0.32	0.28	0.23	0.19	0.15	0.12	0.09	0.06	0.03	0.01	-0.01	-0.03	-0.05	-0.06	-0.07
D. Daily Max Air Temperature	0.06	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.12	0.12
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.02	1.02	1.02	1.03	1.03	1.04	1.04	1.04
B. Prev Day Temp	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C. Flow (GCRK3)	-1.12	-1.07	-1.02	-0.98	-0.93	-0.88	-0.83	-0.78	-0.73	-0.68	-0.63	-0.58	-0.53	-0.49	-0.45
D. Daily Max Air Temperature	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02
E. Constant	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	0.88	0.87	0.86	0.85	0.85	0.84	0.83	0.83	0.82	0.82	0.82	0.81	0.81	0.81	0.81
B. Previous day temp	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.23	0.24	0.24	0.25
C. Flow (GCRK3)	0.51	0.49	0.47	0.44	0.42	0.40	0.38	0.35	0.33	0.31	0.29	0.27	0.25	0.23	0.21
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
DS Guadalupe Res (GCRK4)															
A. Intake Temp (from Profile)	-0.05	-0.03	-0.02	0.00	0.02	0.04	0.07	0.09	0.12	0.15	0.18	0.21	0.25	0.29	0.32
B. Previous day temp	1.01	1.00	0.99	0.98	0.97	0.96	0.94	0.92	0.90	0.88	0.86	0.84	0.81	0.78	0.76
C. Reservoir Release (GCRK4)	0.02	0.02	0.02	0.01	0.00	0.00	-0.01	-0.02	-0.03	-0.04	-0.06	-0.07	-0.08	-0.10	-0.11
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.28	0.20	0.12	0.04	-0.04	-0.12	-0.21	-0.30	-0.38	-0.47	-0.56	-0.66	-0.75	-0.84	-0.94
US Masson Dam (GCRK3)															
A. Upstream Water Temperature (GCRK4)	0.61	0.61	0.61	0.62	0.63	0.64	0.65	0.66	0.68	0.70	0.71	0.73	0.76	0.78	0.80
B. Prev Day Temp	0.13	0.13	0.12	0.12	0.11	0.10	0.09	0.07	0.06	0.04	0.02	0.01	-0.01	-0.04	-0.06
C. Flow (GCRK3)	-0.07	-0.08	-0.08	-0.07	-0.07	-0.06	-0.05	-0.03	-0.01	0.01	0.03	0.05	0.08	0.11	0.14
D. Daily Max Air Temperature	0.12	0.12	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.12	0.12	0.12	0.12	0.11	0.11
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)															
A. Upstream Water Temperature (GCRK3)	1.05	1.05	1.05	1.06	1.06	1.06	1.07	1.07	1.07	1.08	1.08	1.08	1.08	1.09	1.09
B. Prev Day Temp	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01
C. Flow (GCRK3)	-0.41	-0.37	-0.33	-0.30	-0.27	-0.25	-0.23	-0.21	-0.20	-0.19	-0.18	-0.17	-0.17	-0.17	-0.18
D. Daily Max Air Temperature	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)															
A. Upstream Water Temperature (GCRK2)	0.81	0.81	0.82	0.82	0.83	0.83	0.84	0.85	0.86	0.87	0.89	0.90	0.91	0.93	0.95
B. Previous day temp	0.25	0.25	0.25	0.25	0.24	0.24	0.23	0.22	0.22	0.21	0.19	0.18	0.17	0.15	0.14
C. Flow (GCRK3)	0.19	0.18	0.16	0.15	0.14	0.13	0.12	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	361	362	363	364	365	366
DS Guadalupe Res (GCRK4)						
A. Intake Temp (from Profile)	0.36	0.40	0.45	0.49	0.53	0.58
B. Previous day temp	0.73	0.70	0.66	0.63	0.60	0.56
C. Reservoir Release (GCRK4)	-0.13	-0.14	-0.16	-0.17	-0.19	-0.21
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	-1.04	-1.13	-1.23	-1.33	-1.43	-1.53
US Masson Dam (GCRK3)						
A. Upstream Water Temperature (GCRK4)	0.83	0.85	0.88	0.91	0.94	0.97
B. Prev Day Temp	-0.08	-0.11	-0.13	-0.16	-0.18	-0.21
C. Flow (GCRK3)	0.17	0.21	0.24	0.28	0.32	0.36
D. Daily Max Air Temperature	0.11	0.10	0.10	0.09	0.09	0.08
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00
DS Masson Dam (GCRK2)						
A. Upstream Water Temperature (GCRK3)	1.09	1.10	1.10	1.10	1.10	1.11
B. Prev Day Temp	-0.01	-0.02	-0.02	-0.02	-0.02	-0.03
C. Flow (GCRK3)	-0.18	-0.19	-0.20	-0.21	-0.22	-0.24
D. Daily Max Air Temperature	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00
Almaden Expressway (GCRK1)						
A. Upstream Water Temperature (GCRK2)	0.96	0.98	1.00	1.02	1.04	1.06
B. Previous day temp	0.12	0.10	0.09	0.07	0.05	0.03
C. Flow (GCRK3)	0.10	0.10	0.11	0.11	0.12	0.12
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	-0.14	-0.14	-0.15	-0.16	-0.16	-0.16	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17	-0.16	-0.16	-0.15
B. Alamitos Temp (ALAM1)	0.32	0.31	0.29	0.28	0.27	0.26	0.25	0.24	0.23	0.23	0.22	0.21	0.21	0.20	0.20
C. Guad Creek Flow (GCRK3)	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.04
D. Guad Creek Temp (GCRK1)	0.06	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.00
E. Prev Day Temp	0.54	0.56	0.58	0.60	0.62	0.63	0.65	0.67	0.68	0.69	0.70	0.72	0.73	0.73	0.74
F. Daily Max Air Temperature	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.98	0.98	0.99	1.00	1.00	1.01	1.02	1.03	1.03	1.04	1.05	1.05	1.06	1.07	1.08
B. Previous day temp	-0.08	-0.08	-0.08	-0.09	-0.09	-0.10	-0.10	-0.11	-0.11	-0.11	-0.12	-0.12	-0.13	-0.13	-0.13
C. Flow (GUAD5)	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Daily Max Air Temperature	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	-0.17	-0.17	-0.18	-0.18	-0.19	-0.19	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.19	-0.19
B. Los Gatos Temp (LOSG1)	0.86	0.88	0.89	0.90	0.91	0.91	0.92	0.92	0.93	0.93	0.93	0.92	0.92	0.91	0.90
C. Los Gatos Flow (LOSG1)	-0.02	-0.01	-0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Guad River Flow (GUAD5)	-0.19	-0.21	-0.22	-0.22	-0.23	-0.24	-0.25	-0.25	-0.26	-0.26	-0.27	-0.27	-0.27	-0.27	-0.27
E. Previous day temp	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.40	0.40	0.40
F. Daily Max Air Temperature	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.95	0.97	0.98	0.99	1.01	1.02	1.03	1.04	1.05	1.07	1.08	1.09	1.10	1.11	1.12
B. Previous day temp	-0.12	-0.14	-0.16	-0.18	-0.20	-0.22	-0.23	-0.25	-0.26	-0.28	-0.29	-0.30	-0.31	-0.32	-0.33
C. Flow (GUAD3)	0.19	0.21	0.22	0.24	0.25	0.27	0.28	0.29	0.30	0.31	0.32	0.33	0.33	0.34	0.34
D. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	-0.15	-0.14	-0.13	-0.12	-0.11	-0.10	-0.09	-0.08	-0.07	-0.06	-0.04	-0.03	-0.02	0.00	0.01
B. Alamitos Temp (ALAM1)	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.20	0.20	0.20	0.21	0.21	0.22	0.22	0.23
C. Guad Creek Flow (GCRK3)	-0.04	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02
D. Guad Creek Temp (GCRK1)	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Prev Day Temp	0.75	0.75	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.75	0.75	0.74	0.74	0.73	0.72
F. Daily Max Air Temperature	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	1.08	1.09	1.10	1.11	1.11	1.12	1.13	1.14	1.14	1.15	1.16	1.17	1.17	1.18	1.18
B. Previous day temp	-0.14	-0.14	-0.15	-0.15	-0.15	-0.16	-0.16	-0.17	-0.17	-0.17	-0.18	-0.18	-0.18	-0.19	-0.19
C. Flow (GUAD5)	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.05	0.06	0.06	0.07	0.08	0.09	0.10
D. Daily Max Air Temperature	0.02	0.01	0.01	0.01	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.03	-0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	-0.18	-0.17	-0.17	-0.16	-0.15	-0.14	-0.12	-0.11	-0.10	-0.09	-0.07	-0.06	-0.04	-0.03	-0.01
B. Los Gatos Temp (LOSG1)	0.89	0.88	0.86	0.84	0.82	0.80	0.78	0.76	0.73	0.71	0.68	0.66	0.63	0.61	0.58
C. Los Gatos Flow (LOSG1)	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.03	-0.04	-0.05	-0.05	-0.06	-0.07	-0.08	-0.09	-0.10
D. Guad River Flow (GUAD5)	-0.27	-0.27	-0.27	-0.26	-0.26	-0.25	-0.24	-0.24	-0.23	-0.22	-0.21	-0.20	-0.19	-0.18	-0.17
E. Previous day temp	0.40	0.40	0.41	0.41	0.41	0.42	0.42	0.42	0.42	0.43	0.43	0.43	0.43	0.44	0.44
F. Daily Max Air Temperature	0.04	0.04	0.05	0.05	0.05	0.06	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.10
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	1.13	1.14	1.14	1.15	1.16	1.17	1.17	1.18	1.18	1.19	1.19	1.19	1.19	1.20	1.20
B. Previous day temp	-0.33	-0.34	-0.34	-0.34	-0.34	-0.34	-0.34	-0.33	-0.33	-0.32	-0.32	-0.31	-0.30	-0.29	-0.28
C. Flow (GUAD3)	0.34	0.34	0.34	0.34	0.34	0.34	0.33	0.33	0.32	0.32	0.31	0.30	0.29	0.29	0.28
D. Daily Max Air Temperature	0.00	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03	-0.04	-0.04	-0.05	-0.06	-0.06	-0.07	-0.07	-0.08
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	0.02	0.04	0.05	0.06	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.14	0.15	0.15	0.16
B. Alamitos Temp (ALAM1)	0.24	0.24	0.25	0.26	0.27	0.28	0.28	0.29	0.30	0.31	0.32	0.33	0.34	0.35	0.36
C. Guad Creek Flow (GCRK3)	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.03
D. Guad Creek Temp (GCRK1)	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
E. Prev Day Temp	0.72	0.71	0.70	0.69	0.68	0.67	0.67	0.66	0.65	0.64	0.63	0.62	0.61	0.60	0.59
F. Daily Max Air Temperature	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	1.19	1.20	1.20	1.20	1.21	1.21	1.22	1.22	1.22	1.23	1.23	1.23	1.23	1.23	1.23
B. Previous day temp	-0.19	-0.19	-0.20	-0.20	-0.20	-0.20	-0.20	-0.21	-0.21	-0.21	-0.21	-0.21	-0.21	-0.21	-0.21
C. Flow (GUAD5)	0.10	0.11	0.12	0.13	0.13	0.14	0.15	0.16	0.16	0.17	0.17	0.18	0.18	0.18	0.19
D. Daily Max Air Temperature	-0.03	-0.04	-0.04	-0.04	-0.04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.06	-0.06	-0.06	-0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	0.00	0.02	0.03	0.05	0.07	0.08	0.10	0.11	0.12	0.14	0.15	0.16	0.17	0.19	0.20
B. Los Gatos Temp (LOSG1)	0.56	0.53	0.51	0.48	0.46	0.44	0.42	0.40	0.38	0.36	0.35	0.33	0.32	0.32	0.31
C. Los Gatos Flow (LOSG1)	-0.11	-0.12	-0.13	-0.14	-0.15	-0.15	-0.16	-0.17	-0.18	-0.19	-0.20	-0.21	-0.21	-0.22	-0.22
D. Guad River Flow (GUAD5)	-0.16	-0.15	-0.14	-0.12	-0.11	-0.10	-0.09	-0.08	-0.07	-0.05	-0.04	-0.03	-0.02	-0.01	0.00
E. Previous day temp	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.43	0.43	0.42	0.42	0.41	0.41
F. Daily Max Air Temperature	0.11	0.11	0.12	0.12	0.13	0.13	0.13	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.15
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	1.20	1.19	1.19	1.19	1.18	1.18	1.17	1.16	1.15	1.14	1.13	1.12	1.10	1.09	1.07
B. Previous day temp	-0.27	-0.26	-0.24	-0.23	-0.22	-0.20	-0.19	-0.17	-0.15	-0.14	-0.12	-0.10	-0.09	-0.07	-0.05
C. Flow (GUAD3)	0.27	0.26	0.25	0.24	0.23	0.22	0.22	0.21	0.20	0.19	0.19	0.18	0.18	0.17	0.17
D. Daily Max Air Temperature	-0.08	-0.09	-0.09	-0.10	-0.10	-0.10	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.14	0.13	0.13	0.12	0.11	0.10	0.09
B. Alamitos Temp (ALAM1)	0.37	0.38	0.39	0.40	0.41	0.42	0.43	0.44	0.45	0.46	0.47	0.48	0.49	0.50	0.50
C. Guad Creek Flow (GCRK3)	-0.03	-0.04	-0.04	-0.05	-0.05	-0.06	-0.06	-0.07	-0.08	-0.09	-0.09	-0.10	-0.11	-0.12	-0.13
D. Guad Creek Temp (GCRK1)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Prev Day Temp	0.58	0.57	0.56	0.56	0.55	0.54	0.53	0.53	0.52	0.52	0.51	0.51	0.50	0.50	0.49
F. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	1.23	1.23	1.22	1.22	1.22	1.21	1.21	1.20	1.20	1.19	1.18	1.17	1.16	1.16	1.15
B. Previous day temp	-0.21	-0.21	-0.21	-0.20	-0.20	-0.20	-0.20	-0.19	-0.19	-0.19	-0.18	-0.18	-0.17	-0.17	-0.16
C. Flow (GUAD5)	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.18	0.18	0.18	0.17	0.17	0.16	0.16	0.15
D. Daily Max Air Temperature	-0.06	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.02	-0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	0.20	0.21	0.22	0.23	0.23	0.24	0.24	0.25	0.25	0.25	0.25	0.26	0.26	0.26	0.26
B. Los Gatos Temp (LOSG1)	0.31	0.31	0.31	0.32	0.32	0.33	0.34	0.36	0.37	0.39	0.41	0.42	0.44	0.46	0.48
C. Los Gatos Flow (LOSG1)	-0.23	-0.23	-0.24	-0.24	-0.25	-0.25	-0.25	-0.25	-0.25	-0.25	-0.25	-0.25	-0.25	-0.25	-0.25
D. Guad River Flow (GUAD5)	0.01	0.02	0.02	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.07	0.07	0.08
E. Previous day temp	0.40	0.39	0.38	0.37	0.36	0.35	0.34	0.32	0.31	0.30	0.28	0.27	0.25	0.24	0.23
F. Daily Max Air Temperature	0.15	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.13	0.13	0.12	0.12	0.11	0.11	0.10
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	1.05	1.03	1.01	0.99	0.97	0.94	0.92	0.89	0.87	0.84	0.81	0.79	0.76	0.74	0.71
B. Previous day temp	-0.03	-0.01	0.01	0.03	0.04	0.06	0.08	0.10	0.12	0.14	0.15	0.17	0.19	0.21	0.22
C. Flow (GUAD3)	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.17	0.17	0.17	0.18	0.18	0.18	0.19	0.19
D. Daily Max Air Temperature	-0.11	-0.11	-0.10	-0.10	-0.09	-0.09	-0.08	-0.08	-0.07	-0.06	-0.05	-0.05	-0.04	-0.03	-0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	0.08	0.07	0.05	0.04	0.03	0.02	0.00	-0.01	-0.02	-0.03	-0.05	-0.06	-0.07	-0.08	-0.09
B. Alamitos Temp (ALAM1)	0.51	0.52	0.52	0.53	0.54	0.54	0.54	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
C. Guad Creek Flow (GCRK3)	-0.13	-0.14	-0.15	-0.16	-0.17	-0.17	-0.18	-0.19	-0.19	-0.20	-0.21	-0.21	-0.22	-0.22	-0.22
D. Guad Creek Temp (GCRK1)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03
E. Prev Day Temp	0.49	0.49	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.49	0.49	0.49
F. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	1.13	1.12	1.11	1.10	1.09	1.07	1.06	1.04	1.03	1.01	1.00	0.98	0.96	0.94	0.93
B. Previous day temp	-0.15	-0.15	-0.14	-0.13	-0.12	-0.11	-0.10	-0.09	-0.08	-0.07	-0.06	-0.05	-0.03	-0.02	-0.01
C. Flow (GUAD5)	0.14	0.14	0.13	0.13	0.12	0.12	0.11	0.10	0.10	0.09	0.09	0.08	0.08	0.07	0.07
D. Daily Max Air Temperature	-0.02	-0.01	-0.01	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.05
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	0.26	0.26	0.26	0.26	0.27	0.27	0.27	0.27	0.27	0.27	0.28	0.28	0.28	0.29	0.29
B. Los Gatos Temp (LOSG1)	0.50	0.52	0.55	0.57	0.59	0.60	0.62	0.64	0.66	0.67	0.69	0.70	0.71	0.71	0.72
C. Los Gatos Flow (LOSG1)	-0.24	-0.24	-0.24	-0.23	-0.23	-0.22	-0.22	-0.21	-0.21	-0.20	-0.19	-0.19	-0.18	-0.17	-0.17
D. Guad River Flow (GUAD5)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.06	0.06	0.05
E. Previous day temp	0.21	0.20	0.18	0.17	0.15	0.14	0.13	0.12	0.10	0.09	0.08	0.07	0.06	0.05	0.05
F. Daily Max Air Temperature	0.10	0.09	0.08	0.08	0.07	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.02
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.68	0.66	0.64	0.61	0.59	0.57	0.55	0.53	0.51	0.50	0.49	0.47	0.46	0.46	0.45
B. Previous day temp	0.24	0.25	0.27	0.28	0.29	0.31	0.32	0.33	0.34	0.35	0.36	0.36	0.37	0.38	0.38
C. Flow (GUAD3)	0.19	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.21	0.20	0.20	0.20	0.19	0.18
D. Daily Max Air Temperature	-0.01	-0.01	0.00	0.01	0.02	0.03	0.03	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Temperature Modeling Technical Memorandum
Santa Clara Valley Water District FAHCE Project

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**76**	**77**	**78**	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	-0.11	-0.12	-0.13	-0.14	-0.15	-0.16	-0.16	-0.17	-0.18	-0.19	-0.19	-0.20	-0.21	-0.21	-0.22
B. Alamitos Temp (ALAM1)	0.55	0.55	0.54	0.54	0.53	0.53	0.52	0.51	0.51	0.50	0.49	0.48	0.47	0.47	0.46
C. Guad Creek Flow (GCRK3)	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.22
D. Guad Creek Temp (GCRK1)	0.03	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07
E. Prev Day Temp	0.50	0.50	0.51	0.51	0.52	0.52	0.53	0.54	0.54	0.55	0.56	0.57	0.57	0.58	0.59
F. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.91	0.89	0.87	0.85	0.82	0.80	0.78	0.76	0.74	0.72	0.70	0.68	0.66	0.64	0.62
B. Previous day temp	0.01	0.02	0.04	0.06	0.07	0.09	0.11	0.12	0.14	0.16	0.17	0.19	0.21	0.22	0.24
C. Flow (GUAD5)	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.06	0.06	0.06	0.06	0.06
D. Daily Max Air Temperature	0.05	0.05	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.10	0.10
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	0.30	0.31	0.31	0.32	0.33	0.34	0.34	0.35	0.36	0.37	0.38	0.39	0.40	0.40	0.41
B. Los Gatos Temp (LOSG1)	0.72	0.72	0.72	0.72	0.72	0.71	0.71	0.70	0.69	0.68	0.67	0.66	0.65	0.63	0.62
C. Los Gatos Flow (LOSG1)	-0.16	-0.15	-0.14	-0.14	-0.13	-0.12	-0.11	-0.10	-0.09	-0.09	-0.08	-0.07	-0.06	-0.06	-0.05
D. Guad River Flow (GUAD5)	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.00	0.00	-0.01	-0.01	-0.02	-0.03
E. Previous day temp	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
F. Daily Max Air Temperature	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.45	0.45	0.45	0.46	0.46	0.47	0.48	0.49	0.50	0.51	0.53	0.54	0.56	0.57	0.59
B. Previous day temp	0.38	0.38	0.39	0.38	0.38	0.38	0.38	0.38	0.37	0.37	0.36	0.36	0.35	0.34	0.33
C. Flow (GUAD3)	0.17	0.17	0.16	0.14	0.13	0.12	0.11	0.09	0.08	0.06	0.05	0.03	0.02	0.00	-0.01
D. Daily Max Air Temperature	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	-0.22	-0.23	-0.23	-0.23	-0.23	-0.24	-0.24	-0.24	-0.24	-0.24	-0.23	-0.23	-0.23	-0.23	-0.22
B. Alamitos Temp (ALAM1)	0.45	0.44	0.43	0.42	0.41	0.40	0.39	0.39	0.38	0.37	0.36	0.35	0.35	0.34	0.34
C. Guad Creek Flow (GCRK3)	-0.22	-0.22	-0.22	-0.21	-0.21	-0.21	-0.20	-0.20	-0.20	-0.20	-0.19	-0.19	-0.19	-0.19	-0.18
D. Guad Creek Temp (GCRK1)	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
E. Prev Day Temp	0.60	0.60	0.61	0.62	0.63	0.64	0.64	0.65	0.66	0.66	0.67	0.67	0.68	0.69	0.69
F. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.60	0.59	0.57	0.55	0.54	0.52	0.51	0.50	0.49	0.47	0.47	0.46	0.45	0.45	0.45
B. Previous day temp	0.25	0.27	0.28	0.30	0.31	0.32	0.33	0.34	0.35	0.36	0.37	0.38	0.38	0.39	0.39
C. Flow (GUAD5)	0.06	0.06	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.11
D. Daily Max Air Temperature	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.12
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	0.42	0.43	0.43	0.44	0.45	0.45	0.46	0.46	0.47	0.47	0.47	0.47	0.47	0.47	0.47
B. Los Gatos Temp (LOSG1)	0.61	0.60	0.59	0.57	0.56	0.55	0.54	0.53	0.53	0.52	0.51	0.51	0.51	0.51	0.51
C. Los Gatos Flow (LOSG1)	-0.04	-0.03	-0.03	-0.02	-0.02	-0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02
D. Guad River Flow (GUAD5)	-0.03	-0.03	-0.04	-0.04	-0.05	-0.05	-0.05	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06
E. Previous day temp	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
F. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.61	0.63	0.65	0.66	0.68	0.70	0.72	0.74	0.76	0.78	0.80	0.81	0.83	0.85	0.86
B. Previous day temp	0.33	0.32	0.31	0.30	0.29	0.28	0.27	0.26	0.26	0.25	0.24	0.23	0.22	0.21	0.20
C. Flow (GUAD3)	-0.03	-0.04	-0.06	-0.07	-0.09	-0.10	-0.11	-0.13	-0.14	-0.15	-0.16	-0.17	-0.17	-0.18	-0.18
D. Daily Max Air Temperature	0.06	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	-0.22	-0.21	-0.21	-0.20	-0.19	-0.19	-0.18	-0.17	-0.16	-0.15	-0.15	-0.14	-0.13	-0.12	-0.11
B. Alamitos Temp (ALAM1)	0.33	0.33	0.32	0.32	0.31	0.31	0.31	0.31	0.30	0.30	0.30	0.30	0.30	0.30	0.30
C. Guad Creek Flow (GCRK3)	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18
D. Guad Creek Temp (GCRK1)	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.05	0.05	0.05	0.04	0.04
E. Prev Day Temp	0.69	0.70	0.70	0.70	0.71	0.71	0.71	0.71	0.71	0.71	0.72	0.72	0.72	0.72	0.72
F. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.44	0.44	0.45	0.45	0.45	0.46	0.47	0.47	0.48	0.49	0.50	0.51	0.52	0.54	0.55
B. Previous day temp	0.39	0.39	0.39	0.39	0.38	0.38	0.37	0.37	0.36	0.35	0.35	0.34	0.33	0.32	0.31
C. Flow (GUAD5)	0.11	0.11	0.12	0.12	0.13	0.13	0.14	0.14	0.15	0.15	0.16	0.16	0.17	0.17	0.18
D. Daily Max Air Temperature	0.12	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.09
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	0.46	0.46	0.45	0.45	0.44	0.43	0.42	0.41	0.40	0.39	0.38	0.37	0.36	0.35	0.34
B. Los Gatos Temp (LOSG1)	0.51	0.52	0.52	0.53	0.54	0.55	0.56	0.58	0.59	0.61	0.62	0.64	0.65	0.67	0.69
C. Los Gatos Flow (LOSG1)	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.03	-0.04
D. Guad River Flow (GUAD5)	-0.06	-0.06	-0.05	-0.05	-0.04	-0.04	-0.03	-0.03	-0.02	-0.02	-0.01	0.00	0.00	0.01	0.02
E. Previous day temp	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.03
F. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.95	0.96	0.96	0.97	0.97	0.98	0.98
B. Previous day temp	0.20	0.19	0.18	0.18	0.17	0.16	0.16	0.15	0.15	0.14	0.14	0.13	0.13	0.12	0.12
C. Flow (GUAD3)	-0.19	-0.19	-0.19	-0.19	-0.19	-0.18	-0.18	-0.18	-0.17	-0.16	-0.15	-0.14	-0.13	-0.12	-0.11
D. Daily Max Air Temperature	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03	-0.04	-0.04
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	-0.10	-0.09	-0.08	-0.07	-0.07	-0.06	-0.05	-0.04	-0.04	-0.03	-0.02	-0.02	-0.01	-0.01	-0.01
B. Alamitos Temp (ALAM1)	0.30	0.30	0.30	0.30	0.30	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
C. Guad Creek Flow (GCRK3)	-0.18	-0.18	-0.18	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17	-0.16	-0.16
D. Guad Creek Temp (GCRK1)	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
E. Prev Day Temp	0.72	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.70	0.70	0.70	0.70	0.70
F. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.56	0.57	0.59	0.60	0.61	0.62	0.64	0.65	0.66	0.67	0.68	0.69	0.70	0.71	0.71
B. Previous day temp	0.30	0.29	0.28	0.27	0.26	0.25	0.24	0.23	0.22	0.21	0.20	0.20	0.19	0.18	0.18
C. Flow (GUAD5)	0.19	0.19	0.20	0.20	0.21	0.22	0.22	0.23	0.24	0.25	0.25	0.26	0.27	0.28	0.29
D. Daily Max Air Temperature	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	0.33	0.32	0.31	0.30	0.29	0.28	0.27	0.26	0.26	0.25	0.25	0.24	0.24	0.24	0.24
B. Los Gatos Temp (LOSG1)	0.70	0.72	0.74	0.75	0.77	0.78	0.79	0.81	0.82	0.83	0.84	0.84	0.85	0.85	0.86
C. Los Gatos Flow (LOSG1)	-0.04	-0.05	-0.05	-0.06	-0.06	-0.07	-0.07	-0.08	-0.08	-0.08	-0.09	-0.09	-0.09	-0.09	-0.09
D. Guad River Flow (GUAD5)	0.03	0.03	0.04	0.05	0.06	0.06	0.07	0.08	0.08	0.09	0.09	0.10	0.11	0.11	0.11
E. Previous day temp	-0.03	-0.04	-0.04	-0.05	-0.05	-0.06	-0.06	-0.07	-0.07	-0.07	-0.08	-0.08	-0.08	-0.08	-0.09
F. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98
B. Previous day temp	0.11	0.11	0.10	0.10	0.10	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.06	0.06	0.06
C. Flow (GUAD3)	-0.10	-0.08	-0.07	-0.06	-0.04	-0.02	-0.01	0.01	0.03	0.04	0.06	0.08	0.10	0.12	0.13
D. Daily Max Air Temperature	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01
B. Alamitos Temp (ALAM1)	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.30
C. Guad Creek Flow (GCRK3)	-0.16	-0.16	-0.15	-0.15	-0.15	-0.14	-0.14	-0.14	-0.13	-0.13	-0.12	-0.12	-0.11	-0.11	-0.10
D. Guad Creek Temp (GCRK1)	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.06
E. Prev Day Temp	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
F. Daily Max Air Temperature	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.72	0.72	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.72	0.72	0.71	0.71	0.70	0.70
B. Previous day temp	0.18	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.18	0.18	0.18	0.19	0.20	0.20	0.21
C. Flow (GUAD5)	0.29	0.30	0.31	0.32	0.33	0.34	0.35	0.36	0.37	0.37	0.38	0.39	0.40	0.41	0.41
D. Daily Max Air Temperature	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	0.24	0.25	0.25	0.26	0.26	0.27	0.28	0.29	0.30	0.32	0.33	0.35	0.36	0.38	0.39
B. Los Gatos Temp (LOSG1)	0.85	0.85	0.85	0.84	0.83	0.82	0.81	0.80	0.79	0.77	0.75	0.74	0.72	0.70	0.68
C. Los Gatos Flow (LOSG1)	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.08	-0.08	-0.08	-0.07	-0.07	-0.07	-0.06	-0.06	-0.05
D. Guad River Flow (GUAD5)	0.12	0.12	0.12	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.12	0.12	0.12
E. Previous day temp	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.08	-0.08	-0.08	-0.08	-0.08	-0.07
F. Daily Max Air Temperature	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.97	0.97	0.97
B. Previous day temp	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00
C. Flow (GUAD3)	0.15	0.17	0.19	0.21	0.23	0.25	0.26	0.28	0.30	0.32	0.33	0.35	0.36	0.38	0.39
D. Daily Max Air Temperature	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03	-0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01
B. Alamitos Temp (ALAM1)	0.30	0.30	0.30	0.30	0.29	0.29	0.29	0.29	0.28	0.28	0.28	0.28	0.27	0.27	0.27
C. Guad Creek Flow (GCRK3)	-0.09	-0.09	-0.08	-0.07	-0.07	-0.06	-0.05	-0.04	-0.04	-0.03	-0.02	-0.01	0.00	0.00	0.01
D. Guad Creek Temp (GCRK1)	0.06	0.07	0.07	0.07	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.11
E. Prev Day Temp	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.71	0.71	0.71
F. Daily Max Air Temperature	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.69	0.68	0.67	0.66	0.65	0.64	0.63	0.62	0.61	0.59	0.58	0.57	0.55	0.54	0.53
B. Previous day temp	0.22	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30	0.32	0.33	0.34	0.35	0.37
C. Flow (GUAD5)	0.42	0.43	0.43	0.44	0.44	0.45	0.45	0.45	0.46	0.46	0.46	0.46	0.46	0.45	0.45
D. Daily Max Air Temperature	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	0.41	0.43	0.45	0.47	0.49	0.51	0.53	0.55	0.57	0.59	0.61	0.63	0.66	0.68	0.70
B. Los Gatos Temp (LOSG1)	0.66	0.63	0.61	0.59	0.56	0.54	0.51	0.49	0.46	0.44	0.41	0.39	0.36	0.34	0.32
C. Los Gatos Flow (LOSG1)	-0.05	-0.05	-0.04	-0.04	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01
D. Guad River Flow (GUAD5)	0.12	0.11	0.11	0.10	0.10	0.09	0.09	0.08	0.08	0.07	0.06	0.06	0.05	0.04	0.04
E. Previous day temp	-0.07	-0.07	-0.07	-0.06	-0.06	-0.06	-0.06	-0.05	-0.05	-0.05	-0.05	-0.04	-0.04	-0.04	-0.04
F. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.97	0.97	0.97	0.97	0.96	0.96	0.96	0.95	0.95	0.95	0.94	0.94	0.94	0.93	0.93
B. Previous day temp	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.01	0.01
C. Flow (GUAD3)	0.40	0.41	0.42	0.43	0.44	0.45	0.45	0.46	0.46	0.46	0.46	0.46	0.46	0.45	0.44
D. Daily Max Air Temperature	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
E. Constant	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	0.00	0.01	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.10	0.11	0.12	0.13	0.14
B. Alamitos Temp (ALAM1)	0.26	0.26	0.26	0.25	0.25	0.25	0.24	0.24	0.24	0.23	0.23	0.22	0.22	0.22	0.21
C. Guad Creek Flow (GCRK3)	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.12	0.13	0.14	0.15
D. Guad Creek Temp (GCRK1)	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.09	0.09	0.09	0.08
E. Prev Day Temp	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.72	0.72	0.72	0.72	0.72	0.72	0.73	0.73
F. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.51	0.50	0.48	0.47	0.45	0.44	0.42	0.41	0.39	0.38	0.36	0.35	0.33	0.32	0.30
B. Previous day temp	0.38	0.39	0.41	0.42	0.43	0.45	0.46	0.47	0.49	0.50	0.52	0.53	0.54	0.56	0.57
C. Flow (GUAD5)	0.45	0.44	0.44	0.43	0.42	0.41	0.40	0.39	0.38	0.37	0.36	0.35	0.33	0.32	0.31
D. Daily Max Air Temperature	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	0.72	0.74	0.76	0.78	0.80	0.82	0.84	0.86	0.88	0.90	0.92	0.94	0.96	0.97	0.99
B. Los Gatos Temp (LOSG1)	0.29	0.27	0.25	0.23	0.21	0.18	0.16	0.15	0.13	0.11	0.09	0.07	0.06	0.04	0.03
C. Los Gatos Flow (LOSG1)	-0.02	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.04	-0.04	-0.05	-0.06	-0.06	-0.07	-0.08	-0.09
D. Guad River Flow (GUAD5)	0.03	0.02	0.01	0.00	0.00	-0.01	-0.02	-0.03	-0.04	-0.05	-0.06	-0.06	-0.07	-0.08	-0.09
E. Previous day temp	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.05	-0.05	-0.05
F. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.92	0.91	0.91	0.90	0.90	0.89	0.88	0.87	0.87	0.86	0.85	0.85	0.84	0.83	0.83
B. Previous day temp	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15
C. Flow (GUAD3)	0.43	0.42	0.41	0.39	0.38	0.36	0.34	0.32	0.30	0.28	0.26	0.24	0.22	0.19	0.17
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
E. Constant	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.21	0.22	0.22	0.22	0.23	0.23	0.23	0.22
B. Alamitos Temp (ALAM1)	0.21	0.20	0.20	0.19	0.18	0.18	0.17	0.17	0.16	0.15	0.15	0.14	0.13	0.13	0.12
C. Guad Creek Flow (GCRK3)	0.15	0.16	0.16	0.17	0.17	0.17	0.18	0.18	0.18	0.18	0.17	0.17	0.17	0.16	0.15
D. Guad Creek Temp (GCRK1)	0.08	0.08	0.07	0.07	0.07	0.06	0.06	0.06	0.05	0.05	0.05	0.04	0.04	0.04	0.04
E. Prev Day Temp	0.73	0.73	0.74	0.74	0.74	0.75	0.75	0.75	0.76	0.76	0.77	0.77	0.78	0.79	0.79
F. Daily Max Air Temperature	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.29	0.27	0.26	0.25	0.23	0.22	0.20	0.19	0.18	0.17	0.15	0.14	0.13	0.12	0.11
B. Previous day temp	0.59	0.60	0.61	0.63	0.64	0.65	0.67	0.68	0.70	0.71	0.72	0.73	0.75	0.76	0.77
C. Flow (GUAD5)	0.29	0.28	0.26	0.25	0.24	0.22	0.21	0.19	0.18	0.17	0.15	0.14	0.13	0.12	0.10
D. Daily Max Air Temperature	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	1.01	1.02	1.04	1.06	1.07	1.09	1.10	1.12	1.13	1.14	1.15	1.17	1.18	1.19	1.20
B. Los Gatos Temp (LOSG1)	0.01	0.00	-0.02	-0.03	-0.04	-0.05	-0.07	-0.08	-0.09	-0.10	-0.10	-0.11	-0.12	-0.13	-0.13
C. Los Gatos Flow (LOSG1)	-0.10	-0.10	-0.11	-0.12	-0.13	-0.14	-0.15	-0.16	-0.17	-0.18	-0.19	-0.20	-0.21	-0.22	-0.23
D. Guad River Flow (GUAD5)	-0.10	-0.10	-0.11	-0.12	-0.12	-0.13	-0.14	-0.14	-0.15	-0.15	-0.15	-0.16	-0.16	-0.16	-0.16
E. Previous day temp	-0.05	-0.05	-0.06	-0.06	-0.06	-0.06	-0.07	-0.07	-0.07	-0.07	-0.08	-0.08	-0.08	-0.09	-0.09
F. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.82	0.82	0.81	0.81	0.80	0.80	0.80	0.79	0.79	0.79	0.79	0.79	0.79	0.80	0.80
B. Previous day temp	0.16	0.17	0.18	0.18	0.19	0.20	0.20	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.20
C. Flow (GUAD3)	0.15	0.13	0.11	0.09	0.08	0.06	0.05	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.01
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
E. Constant	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	0.22	0.21	0.20	0.20	0.18	0.17	0.16	0.15	0.13	0.12	0.10	0.08	0.07	0.05	0.03
B. Alamitos Temp (ALAM1)	0.11	0.10	0.09	0.08	0.08	0.07	0.06	0.05	0.04	0.03	0.02	0.01	0.00	-0.01	-0.01
C. Guad Creek Flow (GCRK3)	0.15	0.14	0.13	0.11	0.10	0.09	0.07	0.06	0.04	0.03	0.01	0.00	-0.02	-0.03	-0.05
D. Guad Creek Temp (GCRK1)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
E. Prev Day Temp	0.80	0.81	0.82	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.88	0.89	0.90	0.91	0.92
F. Daily Max Air Temperature	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.02	0.01	0.01	0.01	0.00
B. Previous day temp	0.78	0.80	0.81	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.89	0.89	0.90	0.91	0.92
C. Flow (GUAD5)	0.09	0.08	0.07	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01
D. Daily Max Air Temperature	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	1.21	1.22	1.23	1.23	1.24	1.25	1.25	1.26	1.26	1.26	1.27	1.27	1.27	1.27	1.27
B. Los Gatos Temp (LOSG1)	-0.14	-0.15	-0.15	-0.15	-0.16	-0.16	-0.16	-0.16	-0.17	-0.17	-0.17	-0.16	-0.16	-0.16	-0.16
C. Los Gatos Flow (LOSG1)	-0.24	-0.25	-0.26	-0.27	-0.28	-0.29	-0.30	-0.31	-0.32	-0.33	-0.33	-0.34	-0.35	-0.35	-0.36
D. Guad River Flow (GUAD5)	-0.16	-0.16	-0.16	-0.16	-0.15	-0.15	-0.15	-0.14	-0.14	-0.13	-0.13	-0.12	-0.12	-0.11	-0.11
E. Previous day temp	-0.09	-0.09	-0.10	-0.10	-0.10	-0.10	-0.10	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.12	-0.12
F. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.81	0.81	0.82	0.83	0.83	0.84	0.85	0.86	0.88	0.89	0.90	0.91	0.92	0.93	0.94
B. Previous day temp	0.20	0.19	0.18	0.17	0.15	0.14	0.12	0.11	0.09	0.07	0.06	0.04	0.02	0.00	-0.01
C. Flow (GUAD3)	0.01	0.03	0.04	0.05	0.07	0.09	0.12	0.14	0.17	0.20	0.23	0.26	0.29	0.33	0.36
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.03	-0.04	-0.04	-0.05	-0.05	-0.06	-0.07	-0.08	-0.08

Temperature Modeling Technical Memorandum
Santa Clara Valley Water District FAHCE Project

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	0.02	0.00	-0.02	-0.04	-0.05	-0.07	-0.08	-0.09	-0.11	-0.12	-0.13	-0.14	-0.14	-0.15	-0.15
B. Alamitos Temp (ALAM1)	-0.02	-0.03	-0.04	-0.05	-0.05	-0.06	-0.07	-0.07	-0.08	-0.09	-0.09	-0.10	-0.10	-0.10	-0.11
C. Guad Creek Flow (GCRK3)	-0.06	-0.07	-0.09	-0.10	-0.11	-0.12	-0.12	-0.13	-0.13	-0.14	-0.14	-0.13	-0.13	-0.12	-0.11
D. Guad Creek Temp (GCRK1)	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06
E. Prev Day Temp	0.93	0.94	0.94	0.95	0.96	0.97	0.97	0.98	0.98	0.99	0.99	1.00	1.00	1.00	1.00
F. Daily Max Air Temperature	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.01
B. Previous day temp	0.92	0.93	0.93	0.94	0.94	0.94	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.94	0.94
C. Flow (GUAD5)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
D. Daily Max Air Temperature	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	1.27	1.26	1.26	1.26	1.25	1.24	1.24	1.23	1.22	1.20	1.19	1.18	1.16	1.15	1.13
B. Los Gatos Temp (LOSG1)	-0.15	-0.15	-0.14	-0.14	-0.13	-0.12	-0.12	-0.11	-0.10	-0.09	-0.08	-0.07	-0.05	-0.04	-0.03
C. Los Gatos Flow (LOSG1)	-0.37	-0.37	-0.37	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.37	-0.37	-0.37	-0.36	-0.35	-0.35
D. Guad River Flow (GUAD5)	-0.10	-0.10	-0.09	-0.09	-0.09	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08
E. Previous day temp	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.11	-0.11	-0.11	-0.11	-0.11	-0.10	-0.10	-0.10
F. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.95	0.96	0.97	0.98	0.99	1.00	1.00	1.01	1.01	1.01	1.02	1.02	1.01	1.01	1.00
B. Previous day temp	-0.03	-0.05	-0.06	-0.08	-0.09	-0.11	-0.12	-0.13	-0.14	-0.15	-0.16	-0.16	-0.16	-0.16	-0.16
C. Flow (GUAD3)	0.39	0.43	0.46	0.50	0.53	0.56	0.59	0.62	0.65	0.68	0.70	0.73	0.75	0.77	0.78
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	-0.09	-0.10	-0.11	-0.11	-0.12	-0.13	-0.14	-0.14	-0.15	-0.16	-0.17	-0.17	-0.18	-0.18	-0.19

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	-0.16	-0.16	-0.15	-0.15	-0.14	-0.14	-0.13	-0.12	-0.10	-0.09	-0.07	-0.06	-0.04	-0.03	-0.01
B. Alamitos Temp (ALAM1)	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.10	-0.10	-0.10	-0.09	-0.09	-0.08	-0.08	-0.07
C. Guad Creek Flow (GCRK3)	-0.10	-0.09	-0.07	-0.05	-0.03	0.00	0.02	0.05	0.08	0.12	0.15	0.18	0.22	0.25	0.29
D. Guad Creek Temp (GCRK1)	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
E. Prev Day Temp	1.00	1.00	1.00	1.00	0.99	0.99	0.98	0.98	0.97	0.96	0.96	0.95	0.94	0.93	0.92
F. Daily Max Air Temperature	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.06	0.07	0.08	0.09	0.09	0.10	0.11
B. Previous day temp	0.94	0.93	0.92	0.92	0.91	0.90	0.89	0.88	0.87	0.86	0.85	0.84	0.83	0.82	0.80
C. Flow (GUAD5)	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.08	0.08	0.09
D. Daily Max Air Temperature	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	1.11	1.09	1.07	1.05	1.02	1.00	0.97	0.95	0.92	0.89	0.86	0.83	0.80	0.77	0.74
B. Los Gatos Temp (LOSG1)	-0.01	0.00	0.02	0.04	0.05	0.07	0.09	0.11	0.13	0.15	0.17	0.19	0.21	0.24	0.26
C. Los Gatos Flow (LOSG1)	-0.34	-0.33	-0.31	-0.30	-0.29	-0.27	-0.26	-0.24	-0.22	-0.21	-0.19	-0.17	-0.16	-0.14	-0.12
D. Guad River Flow (GUAD5)	-0.09	-0.09	-0.10	-0.11	-0.12	-0.13	-0.14	-0.15	-0.16	-0.17	-0.19	-0.20	-0.21	-0.22	-0.24
E. Previous day temp	-0.09	-0.09	-0.08	-0.08	-0.07	-0.07	-0.06	-0.06	-0.05	-0.04	-0.04	-0.03	-0.02	-0.02	-0.01
F. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	1.00	0.99	0.98	0.96	0.95	0.93	0.91	0.89	0.87	0.85	0.83	0.80	0.78	0.76	0.73
B. Previous day temp	-0.15	-0.15	-0.14	-0.12	-0.11	-0.09	-0.07	-0.05	-0.02	0.00	0.03	0.05	0.08	0.11	0.13
C. Flow (GUAD3)	0.80	0.81	0.81	0.82	0.82	0.81	0.81	0.80	0.79	0.78	0.77	0.75	0.73	0.72	0.70
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	-0.20	-0.20	-0.21	-0.21	-0.22	-0.22	-0.22	-0.23	-0.23	-0.23	-0.24	-0.24	-0.24	-0.24	-0.24

Temperature Modeling Technical Memorandum
Santa Clara Valley Water District FAHCE Project

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**241**	**242**	**243**	**244**	**245**	**246**	**247**	**248**	**249**	**250**	**251**	**252**	**253**	**254**	**255**
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	0.01	0.03	0.05	0.07	0.09	0.10	0.12	0.14	0.16	0.17	0.19	0.20	0.22	0.23	0.24
B. Alamitos Temp (ALAM1)	-0.06	-0.06	-0.05	-0.04	-0.03	-0.02	-0.01	-0.01	0.00	0.01	0.02	0.03	0.04	0.05	0.07
C. Guad Creek Flow (GCRK3)	0.32	0.36	0.39	0.42	0.45	0.49	0.51	0.54	0.57	0.59	0.61	0.63	0.64	0.66	0.66
D. Guad Creek Temp (GCRK1)	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.06
E. Prev Day Temp	0.91	0.90	0.89	0.88	0.87	0.86	0.85	0.83	0.82	0.81	0.80	0.79	0.78	0.77	0.76
F. Daily Max Air Temperature	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.17	0.17	0.18	0.18	0.19	0.19	0.19	0.19
B. Previous day temp	0.79	0.78	0.77	0.76	0.75	0.74	0.73	0.72	0.71	0.70	0.69	0.69	0.68	0.68	0.67
C. Flow (GUAD5)	0.09	0.10	0.11	0.11	0.12	0.13	0.14	0.14	0.15	0.16	0.16	0.17	0.18	0.19	0.20
D. Daily Max Air Temperature	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	0.71	0.68	0.64	0.61	0.58	0.55	0.52	0.49	0.46	0.43	0.40	0.37	0.34	0.31	0.29
B. Los Gatos Temp (LOSG1)	0.28	0.31	0.33	0.35	0.38	0.40	0.42	0.45	0.47	0.49	0.52	0.54	0.56	0.59	0.61
C. Los Gatos Flow (LOSG1)	-0.11	-0.09	-0.08	-0.06	-0.05	-0.04	-0.03	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02
D. Guad River Flow (GUAD5)	-0.25	-0.26	-0.27	-0.28	-0.29	-0.30	-0.31	-0.31	-0.32	-0.32	-0.32	-0.32	-0.32	-0.32	-0.31
E. Previous day temp	0.00	0.00	0.01	0.02	0.02	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08
F. Daily Max Air Temperature	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.71	0.69	0.67	0.65	0.63	0.61	0.59	0.58	0.56	0.55	0.54	0.54	0.53	0.53	0.53
B. Previous day temp	0.16	0.19	0.21	0.24	0.26	0.29	0.31	0.33	0.35	0.37	0.38	0.40	0.41	0.41	0.42
C. Flow (GUAD3)	0.67	0.65	0.63	0.60	0.58	0.55	0.53	0.50	0.47	0.45	0.42	0.39	0.37	0.35	0.32
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.23	-0.23	-0.23	-0.22	-0.22	-0.22

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	0.25	0.26	0.26	0.27	0.27	0.27	0.27	0.27	0.26	0.26	0.25	0.25	0.24	0.23	0.22
B. Alamitos Temp (ALAM1)	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.20	0.21	0.22	0.23
C. Guad Creek Flow (GCRK3)	0.67	0.67	0.67	0.66	0.65	0.63	0.61	0.59	0.56	0.53	0.50	0.47	0.43	0.40	0.36
D. Guad Creek Temp (GCRK1)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05
E. Prev Day Temp	0.75	0.74	0.73	0.73	0.72	0.71	0.70	0.70	0.69	0.69	0.68	0.68	0.67	0.67	0.67
F. Daily Max Air Temperature	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.20	0.20	0.20	0.19	0.19	0.19	0.19	0.18	0.18	0.17	0.17	0.17	0.16	0.16	0.16
B. Previous day temp	0.67	0.67	0.67	0.67	0.67	0.67	0.68	0.68	0.68	0.69	0.70	0.70	0.71	0.71	0.72
C. Flow (GUAD5)	0.20	0.21	0.22	0.23	0.24	0.24	0.25	0.26	0.27	0.27	0.28	0.29	0.30	0.30	0.31
D. Daily Max Air Temperature	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	0.26	0.24	0.21	0.19	0.17	0.15	0.13	0.11	0.10	0.08	0.07	0.05	0.04	0.03	0.02
B. Los Gatos Temp (LOSG1)	0.63	0.65	0.68	0.70	0.72	0.74	0.76	0.78	0.80	0.81	0.83	0.85	0.87	0.88	0.90
C. Los Gatos Flow (LOSG1)	-0.02	-0.03	-0.05	-0.07	-0.08	-0.11	-0.13	-0.16	-0.19	-0.21	-0.25	-0.28	-0.31	-0.34	-0.38
D. Guad River Flow (GUAD5)	-0.31	-0.30	-0.29	-0.27	-0.26	-0.24	-0.22	-0.19	-0.17	-0.15	-0.12	-0.09	-0.06	-0.03	0.00
E. Previous day temp	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.08
F. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.54	0.54	0.55	0.57	0.59	0.61	0.63	0.66	0.69	0.72	0.75	0.79	0.82	0.86	0.90
B. Previous day temp	0.42	0.41	0.41	0.40	0.38	0.37	0.34	0.32	0.29	0.27	0.24	0.20	0.17	0.14	0.10
C. Flow (GUAD3)	0.30	0.28	0.26	0.24	0.22	0.21	0.19	0.18	0.17	0.16	0.14	0.13	0.13	0.12	0.11
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	-0.21	-0.21	-0.20	-0.20	-0.19	-0.18	-0.18	-0.17	-0.16	-0.16	-0.15	-0.14	-0.13	-0.13	-0.12

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	0.21	0.20	0.18	0.17	0.16	0.15	0.13	0.12	0.11	0.09	0.08	0.07	0.06	0.05	0.04
B. Alamitos Temp (ALAM1)	0.23	0.24	0.25	0.26	0.27	0.28	0.28	0.29	0.30	0.30	0.31	0.31	0.31	0.32	0.32
C. Guad Creek Flow (GCRK3)	0.32	0.28	0.24	0.19	0.15	0.11	0.07	0.03	-0.01	-0.05	-0.09	-0.13	-0.16	-0.19	-0.22
D. Guad Creek Temp (GCRK1)	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.02	0.02
E. Prev Day Temp	0.67	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.67	0.67	0.67	0.67	0.68
F. Daily Max Air Temperature	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.16	0.16	0.17	0.18	0.19	0.20	0.22	0.24
B. Previous day temp	0.72	0.73	0.73	0.74	0.74	0.74	0.74	0.74	0.74	0.73	0.72	0.72	0.71	0.69	0.68
C. Flow (GUAD5)	0.31	0.32	0.33	0.33	0.34	0.34	0.34	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
D. Daily Max Air Temperature	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.04	0.04	0.04	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	0.01	0.00	-0.01	-0.01	-0.02	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
B. Los Gatos Temp (LOSG1)	0.91	0.92	0.94	0.95	0.96	0.97	0.98	0.99	1.00	1.00	1.01	1.01	1.02	1.02	1.02
C. Los Gatos Flow (LOSG1)	-0.41	-0.44	-0.47	-0.51	-0.54	-0.57	-0.59	-0.62	-0.64	-0.66	-0.68	-0.70	-0.71	-0.72	-0.73
D. Guad River Flow (GUAD5)	0.03	0.06	0.09	0.11	0.14	0.17	0.20	0.23	0.25	0.28	0.30	0.32	0.34	0.36	0.38
E. Previous day temp	0.08	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05
F. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.93	0.97	1.01	1.05	1.08	1.12	1.15	1.19	1.22	1.25	1.27	1.30	1.32	1.34	1.35
B. Previous day temp	0.06	0.03	-0.01	-0.04	-0.08	-0.11	-0.14	-0.17	-0.20	-0.23	-0.26	-0.28	-0.30	-0.31	-0.32
C. Flow (GUAD3)	0.10	0.09	0.09	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.03	0.02	0.01	0.00	-0.01
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	-0.11	-0.10	-0.10	-0.09	-0.08	-0.07	-0.07	-0.06	-0.05	-0.04	-0.04	-0.03	-0.03	-0.02	-0.01

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	0.03	0.02	0.01	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01
B. Alamitos Temp (ALAM1)	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.31	0.31	0.30	0.30	0.30	0.29	0.29	0.28
C. Guad Creek Flow (GCRK3)	-0.25	-0.27	-0.30	-0.31	-0.33	-0.34	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.34	-0.33	-0.32
D. Guad Creek Temp (GCRK1)	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02
E. Prev Day Temp	0.68	0.69	0.69	0.70	0.70	0.71	0.71	0.72	0.73	0.73	0.74	0.74	0.75	0.75	0.76
F. Daily Max Air Temperature	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.26	0.28	0.30	0.33	0.36	0.39	0.43	0.46	0.50	0.54	0.58	0.62	0.66	0.70	0.75
B. Previous day temp	0.66	0.64	0.62	0.59	0.57	0.54	0.50	0.47	0.43	0.39	0.35	0.31	0.27	0.23	0.19
C. Flow (GUAD5)	0.35	0.35	0.35	0.34	0.34	0.33	0.33	0.32	0.31	0.30	0.29	0.29	0.28	0.27	0.26
D. Daily Max Air Temperature	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	-0.04	-0.03	-0.03	-0.03	-0.02	-0.02	-0.01	-0.01	0.00	0.01	0.01	0.02	0.03	0.04	0.04
B. Los Gatos Temp (LOSG1)	1.02	1.02	1.02	1.02	1.01	1.01	1.00	0.99	0.99	0.98	0.97	0.96	0.95	0.94	0.92
C. Los Gatos Flow (LOSG1)	-0.73	-0.73	-0.72	-0.71	-0.70	-0.68	-0.66	-0.63	-0.60	-0.57	-0.54	-0.50	-0.46	-0.42	-0.38
D. Guad River Flow (GUAD5)	0.39	0.40	0.41	0.42	0.42	0.42	0.42	0.41	0.41	0.40	0.39	0.38	0.36	0.35	0.33
E. Previous day temp	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07
F. Daily Max Air Temperature	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	1.36	1.37	1.37	1.37	1.37	1.36	1.34	1.33	1.31	1.28	1.26	1.23	1.20	1.17	1.13
B. Previous day temp	-0.33	-0.34	-0.34	-0.33	-0.32	-0.31	-0.29	-0.27	-0.24	-0.22	-0.19	-0.15	-0.12	-0.08	-0.04
C. Flow (GUAD3)	-0.02	-0.03	-0.05	-0.06	-0.08	-0.09	-0.11	-0.13	-0.15	-0.17	-0.19	-0.21	-0.23	-0.25	-0.27
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	-0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**301**	**302**	**303**	**304**	**305**	**306**	**307**	**308**	**309**	**310**	**311**	**312**	**313**	**314**	**315**
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	-0.01	-0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.05
B. Alamitos Temp (ALAM1)	0.27	0.27	0.26	0.26	0.25	0.25	0.25	0.24	0.24	0.24	0.24	0.23	0.23	0.23	0.24
C. Guad Creek Flow (GCRK3)	-0.31	-0.29	-0.28	-0.26	-0.25	-0.23	-0.21	-0.19	-0.17	-0.15	-0.13	-0.11	-0.09	-0.07	-0.05
D. Guad Creek Temp (GCRK1)	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
E. Prev Day Temp	0.76	0.77	0.77	0.77	0.78	0.78	0.78	0.78	0.78	0.78	0.77	0.77	0.76	0.76	0.75
F. Daily Max Air Temperature	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.79	0.83	0.88	0.92	0.96	1.00	1.04	1.08	1.12	1.15	1.19	1.22	1.25	1.27	1.30
B. Previous day temp	0.14	0.10	0.06	0.01	-0.03	-0.07	-0.11	-0.15	-0.19	-0.23	-0.26	-0.30	-0.33	-0.36	-0.38
C. Flow (GUAD5)	0.25	0.24	0.23	0.22	0.21	0.20	0.19	0.18	0.17	0.16	0.16	0.15	0.14	0.13	0.13
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	0.05	0.06	0.07	0.07	0.08	0.09	0.10	0.10	0.11	0.12	0.12	0.13	0.13	0.14	0.14
B. Los Gatos Temp (LOSG1)	0.91	0.90	0.88	0.87	0.86	0.84	0.83	0.81	0.80	0.78	0.77	0.75	0.74	0.72	0.71
C. Los Gatos Flow (LOSG1)	-0.34	-0.29	-0.25	-0.20	-0.16	-0.11	-0.07	-0.03	0.02	0.06	0.10	0.14	0.17	0.21	0.24
D. Guad River Flow (GUAD5)	0.32	0.30	0.28	0.26	0.24	0.22	0.20	0.18	0.16	0.14	0.12	0.10	0.08	0.06	0.04
E. Previous day temp	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.12	0.12	0.13	0.14	0.14	0.15	0.16	0.16
F. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	1.10	1.06	1.02	0.98	0.94	0.90	0.86	0.82	0.78	0.74	0.70	0.67	0.63	0.60	0.57
B. Previous day temp	0.00	0.04	0.09	0.13	0.18	0.22	0.27	0.31	0.35	0.40	0.44	0.48	0.52	0.55	0.59
C. Flow (GUAD3)	-0.29	-0.32	-0.34	-0.36	-0.38	-0.40	-0.42	-0.43	-0.45	-0.47	-0.49	-0.50	-0.51	-0.53	-0.54
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
E. Constant	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08
B. Alamitos Temp (ALAM1)	0.24	0.24	0.25	0.25	0.26	0.27	0.28	0.29	0.30	0.31	0.32	0.33	0.35	0.36	0.37
C. Guad Creek Flow (GCRK3)	-0.03	-0.02	0.00	0.02	0.03	0.04	0.06	0.07	0.08	0.08	0.09	0.10	0.10	0.11	0.11
D. Guad Creek Temp (GCRK1)	-0.03	-0.02	-0.02	-0.01	-0.01	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.04	0.05	0.06
E. Prev Day Temp	0.74	0.73	0.72	0.70	0.69	0.67	0.65	0.63	0.61	0.59	0.56	0.54	0.52	0.49	0.47
F. Daily Max Air Temperature	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	1.32	1.34	1.35	1.37	1.37	1.38	1.38	1.38	1.37	1.36	1.35	1.34	1.33	1.31	1.29
B. Previous day temp	-0.41	-0.43	-0.44	-0.46	-0.47	-0.47	-0.48	-0.48	-0.48	-0.47	-0.46	-0.45	-0.44	-0.43	-0.41
C. Flow (GUAD5)	0.12	0.12	0.11	0.11	0.11	0.11	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.12	0.12
D. Daily Max Air Temperature	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	0.15	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.15	0.14
B. Los Gatos Temp (LOSG1)	0.69	0.68	0.66	0.65	0.64	0.63	0.61	0.60	0.59	0.58	0.57	0.56	0.55	0.54	0.54
C. Los Gatos Flow (LOSG1)	0.26	0.29	0.31	0.32	0.34	0.35	0.35	0.35	0.35	0.35	0.34	0.33	0.32	0.30	0.28
D. Guad River Flow (GUAD5)	0.03	0.01	0.00	-0.01	-0.02	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
E. Previous day temp	0.17	0.18	0.19	0.20	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.26	0.27	0.28	0.29
F. Daily Max Air Temperature	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.54	0.51	0.48	0.46	0.44	0.43	0.41	0.40	0.39	0.39	0.39	0.38	0.39	0.39	0.39
B. Previous day temp	0.62	0.65	0.68	0.70	0.72	0.73	0.75	0.76	0.76	0.77	0.77	0.77	0.76	0.76	0.75
C. Flow (GUAD3)	-0.55	-0.55	-0.56	-0.57	-0.57	-0.57	-0.57	-0.57	-0.56	-0.56	-0.55	-0.54	-0.53	-0.52	-0.51
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.05	0.05	0.05
B. Alamitos Temp (ALAM1)	0.39	0.40	0.42	0.43	0.45	0.46	0.48	0.49	0.50	0.51	0.53	0.54	0.55	0.56	0.57
C. Guad Creek Flow (GCRK3)	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.10	0.10	0.09
D. Guad Creek Temp (GCRK1)	0.07	0.08	0.08	0.09	0.10	0.11	0.11	0.12	0.13	0.14	0.14	0.15	0.16	0.16	0.17
E. Prev Day Temp	0.44	0.42	0.39	0.37	0.34	0.32	0.30	0.27	0.25	0.23	0.21	0.19	0.18	0.16	0.15
F. Daily Max Air Temperature	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	1.27	1.25	1.23	1.20	1.18	1.15	1.13	1.10	1.08	1.05	1.03	1.00	0.98	0.95	0.93
B. Previous day temp	-0.39	-0.37	-0.35	-0.33	-0.31	-0.29	-0.26	-0.24	-0.21	-0.19	-0.17	-0.14	-0.12	-0.10	-0.08
C. Flow (GUAD5)	0.12	0.13	0.13	0.14	0.14	0.14	0.15	0.15	0.16	0.16	0.17	0.17	0.17	0.18	0.18
D. Daily Max Air Temperature	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.05	0.06	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	0.14	0.13	0.13	0.12	0.12	0.11	0.11	0.10	0.09	0.09	0.08	0.07	0.07	0.06	0.05
B. Los Gatos Temp (LOSG1)	0.53	0.52	0.52	0.51	0.51	0.50	0.50	0.50	0.49	0.49	0.49	0.49	0.49	0.49	0.50
C. Los Gatos Flow (LOSG1)	0.27	0.24	0.22	0.20	0.17	0.15	0.12	0.10	0.07	0.05	0.02	-0.01	-0.03	-0.06	-0.08
D. Guad River Flow (GUAD5)	-0.03	-0.03	-0.03	-0.02	-0.01	-0.01	0.00	0.00	0.01	0.01	0.02	0.03	0.03	0.04	0.04
E. Previous day temp	0.30	0.31	0.31	0.32	0.33	0.34	0.35	0.35	0.36	0.37	0.37	0.38	0.39	0.39	0.40
F. Daily Max Air Temperature	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.40	0.41	0.42	0.43	0.45	0.46	0.47	0.49	0.51	0.53	0.54	0.56	0.58	0.60	0.62
B. Previous day temp	0.74	0.72	0.71	0.69	0.67	0.66	0.63	0.61	0.59	0.57	0.54	0.52	0.49	0.46	0.44
C. Flow (GUAD3)	-0.50	-0.48	-0.47	-0.45	-0.44	-0.42	-0.40	-0.39	-0.37	-0.35	-0.33	-0.31	-0.29	-0.27	-0.25
D. Daily Max Air Temperature	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
E. Constant	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
Alamitos Drop Structure (GUAD7)															
A. Alamitos Flow (ALAM2)	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.00	0.00	-0.01	-0.01	-0.02	-0.03
B. Alamitos Temp (ALAM1)	0.57	0.58	0.58	0.59	0.59	0.59	0.59	0.59	0.58	0.58	0.57	0.57	0.56	0.55	0.54
C. Guad Creek Flow (GCRK3)	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.06	0.06	0.06	0.05	0.05	0.04	0.04	0.04
D. Guad Creek Temp (GCRK1)	0.17	0.17	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.17	0.17	0.17	0.16
E. Prev Day Temp	0.14	0.13	0.12	0.11	0.11	0.11	0.11	0.12	0.12	0.13	0.14	0.15	0.16	0.18	0.19
F. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)															
A. Upstream Water Temperature (GUAD7)	0.91	0.89	0.88	0.86	0.85	0.84	0.83	0.82	0.81	0.81	0.81	0.80	0.81	0.81	0.81
B. Previous day temp	-0.06	-0.04	-0.02	0.00	0.01	0.02	0.03	0.04	0.05	0.05	0.06	0.06	0.06	0.06	0.06
C. Flow (GUAD5)	0.18	0.18	0.19	0.19	0.19	0.19	0.19	0.18	0.18	0.18	0.18	0.17	0.17	0.17	0.16
D. Daily Max Air Temperature	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)															
A. Guad River Temp (GUAD5)	0.04	0.04	0.03	0.02	0.01	0.01	0.00	-0.01	-0.01	-0.02	-0.03	-0.04	-0.04	-0.05	-0.06
B. Los Gatos Temp (LOSG1)	0.50	0.50	0.50	0.51	0.51	0.52	0.53	0.54	0.54	0.55	0.56	0.57	0.58	0.59	0.60
C. Los Gatos Flow (LOSG1)	-0.10	-0.12	-0.14	-0.16	-0.17	-0.19	-0.20	-0.21	-0.21	-0.22	-0.22	-0.23	-0.23	-0.23	-0.22
D. Guad River Flow (GUAD5)	0.04	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.02	0.01	0.01	0.00
E. Previous day temp	0.40	0.41	0.41	0.42	0.42	0.42	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.44
F. Daily Max Air Temperature	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.10
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)															
A. US water temp (GUAD4)	0.64	0.66	0.68	0.70	0.72	0.73	0.75	0.77	0.78	0.80	0.82	0.83	0.85	0.86	0.88
B. Previous day temp	0.41	0.39	0.36	0.33	0.31	0.28	0.26	0.23	0.21	0.19	0.16	0.14	0.12	0.10	0.07
C. Flow (GUAD3)	-0.23	-0.21	-0.19	-0.17	-0.15	-0.13	-0.11	-0.09	-0.08	-0.06	-0.04	-0.02	0.00	0.01	0.03
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Guadalupe River

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	361	362	363	364	365	366
Alamitos Drop Structure (GUAD7)						
A. Alamitos Flow (ALAM2)	-0.03	-0.04	-0.04	-0.05	-0.06	-0.06
B. Alamitos Temp (ALAM1)	0.53	0.51	0.50	0.49	0.47	0.46
C. Guad Creek Flow (GCRK3)	0.03	0.03	0.03	0.02	0.02	0.01
D. Guad Creek Temp (GCRK1)	0.16	0.15	0.14	0.14	0.13	0.12
E. Prev Day Temp	0.21	0.23	0.25	0.27	0.30	0.32
F. Daily Max Air Temperature	0.04	0.04	0.04	0.04	0.04	0.04
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00
Virginia St. (GUAD5)						
A. Upstream Water Temperature (GUAD7)	0.82	0.82	0.83	0.84	0.85	0.86
B. Previous day temp	0.06	0.05	0.05	0.04	0.04	0.03
C. Flow (GUAD5)	0.15	0.15	0.14	0.14	0.13	0.12
D. Daily Max Air Temperature	0.07	0.07	0.07	0.06	0.06	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00
Coleman (GUAD4)						
A. Guad River Temp (GUAD5)	-0.06	-0.07	-0.08	-0.08	-0.09	-0.10
B. Los Gatos Temp (LOSG1)	0.62	0.63	0.64	0.65	0.67	0.68
C. Los Gatos Flow (LOSG1)	-0.22	-0.22	-0.21	-0.20	-0.20	-0.19
D. Guad River Flow (GUAD5)	-0.01	-0.02	-0.03	-0.04	-0.06	-0.07
E. Previous day temp	0.43	0.43	0.43	0.43	0.43	0.43
F. Daily Max Air Temperature	0.10	0.10	0.10	0.09	0.09	0.09
G. Constant	0.00	0.00	0.00	0.00	0.00	0.00
Airport Parkway (GUAD3)						
A. US water temp (GUAD4)	0.89	0.90	0.92	0.93	0.94	0.96
B. Previous day temp	0.05	0.03	0.01	-0.01	-0.03	-0.05
C. Flow (GUAD3)	0.05	0.06	0.08	0.10	0.11	0.13
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Los Gatos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.52	0.54	0.57	0.59	0.61	0.63	0.65	0.67	0.69	0.71	0.73	0.75	0.76	0.78	0.80
C. Flow (blw Vasona)	-0.05	-0.05	-0.05	-0.05	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02
D. Daily Max Air Temperature	0.12	0.11	0.10	0.09	0.09	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.03
E. Constant	3.71	3.58	3.46	3.34	3.21	3.09	2.96	2.84	2.71	2.58	2.46	2.33	2.20	2.08	1.95
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	1.32	1.32	1.32	1.32	1.32	1.31	1.31	1.31	1.31	1.30	1.30	1.29	1.29	1.28	1.28
B. Previous day temp	-0.34	-0.34	-0.34	-0.34	-0.34	-0.34	-0.34	-0.33	-0.33	-0.33	-0.32	-0.32	-0.31	-0.31	-0.30
C. Flow (LOSG1)	0.23	0.23	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.25	0.25	0.25	0.25	0.25
D. Daily Max Air Temperature	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.82	0.83	0.85	0.86	0.88	0.89	0.91	0.92	0.93	0.95	0.96	0.97	0.98	0.99	1.00
C. Flow (blw Vasona)	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02
D. Daily Max Air Temperature	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	1.82	1.69	1.57	1.44	1.31	1.19	1.06	0.94	0.82	0.69	0.58	0.46	0.34	0.23	0.12
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	1.27	1.26	1.26	1.25	1.24	1.23	1.23	1.22	1.21	1.20	1.19	1.18	1.18	1.17	1.16
B. Previous day temp	-0.29	-0.29	-0.28	-0.27	-0.26	-0.25	-0.25	-0.24	-0.23	-0.22	-0.21	-0.20	-0.19	-0.18	-0.18
C. Flow (LOSG1)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.24	0.24	0.24
D. Daily Max Air Temperature	-0.10	-0.10	-0.10	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.08	-0.08	-0.08	-0.08	-0.08
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	1.01	1.02	1.02	1.03	1.04	1.04	1.05	1.05	1.05	1.06	1.06	1.06	1.06	1.06	1.06
C. Flow (blw Vasona)	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02
E. Constant	0.02	-0.09	-0.19	-0.28	-0.38	-0.46	-0.55	-0.63	-0.70	-0.77	-0.84	-0.90	-0.95	-1.00	-1.04
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	1.15	1.15	1.14	1.13	1.13	1.12	1.12	1.12	1.11	1.11	1.11	1.11	1.11	1.11	1.11
B. Previous day temp	-0.17	-0.16	-0.15	-0.15	-0.14	-0.13	-0.13	-0.12	-0.12	-0.12	-0.12	-0.11	-0.11	-0.12	-0.12
C. Flow (LOSG1)	0.24	0.24	0.23	0.23	0.23	0.22	0.22	0.22	0.21	0.21	0.20	0.20	0.19	0.18	0.18
D. Daily Max Air Temperature	-0.07	-0.07	-0.07	-0.07	-0.07	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.05	-0.05	-0.05	-0.05
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.01	1.00	0.99	0.98	0.97	0.96	0.95
C. Flow (blw Vasona)	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.00	0.00	0.00	-0.01	-0.01
D. Daily Max Air Temperature	0.02	0.03	0.03	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08	0.09	0.09	0.10	0.10
E. Constant	-1.08	-1.11	-1.13	-1.15	-1.16	-1.17	-1.17	-1.16	-1.15	-1.14	-1.11	-1.09	-1.06	-1.02	-0.98
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	1.11	1.12	1.12	1.13	1.13	1.14	1.15	1.16	1.17	1.17	1.18	1.19	1.20	1.20	1.21
B. Previous day temp	-0.12	-0.12	-0.13	-0.14	-0.14	-0.15	-0.16	-0.17	-0.17	-0.18	-0.19	-0.20	-0.21	-0.22	-0.23
C. Flow (LOSG1)	0.17	0.16	0.16	0.15	0.14	0.13	0.12	0.11	0.11	0.10	0.09	0.08	0.07	0.06	0.05
D. Daily Max Air Temperature	-0.05	-0.05	-0.05	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03	-0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Los Gatos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.94	0.93	0.92	0.91	0.91	0.90	0.89	0.88	0.87	0.86	0.85	0.84	0.83	0.83	0.82
C. Flow (blw Vasona)	-0.02	-0.02	-0.02	-0.03	-0.03	-0.04	-0.04	-0.04	-0.05	-0.05	-0.06	-0.06	-0.06	-0.07	-0.07
D. Daily Max Air Temperature	0.11	0.11	0.12	0.12	0.13	0.13	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.15	0.15
E. Constant	-0.93	-0.88	-0.83	-0.77	-0.71	-0.64	-0.58	-0.50	-0.43	-0.35	-0.27	-0.18	-0.09	0.00	0.09
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	1.22	1.22	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.22	1.21	1.20	1.19	1.18	1.16
B. Previous day temp	-0.23	-0.24	-0.25	-0.25	-0.26	-0.26	-0.26	-0.26	-0.26	-0.26	-0.25	-0.25	-0.24	-0.23	-0.21
C. Flow (LOSG1)	0.05	0.04	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01
D. Daily Max Air Temperature	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.82	0.81	0.80	0.80	0.80	0.79	0.79	0.79	0.78	0.78	0.78	0.78	0.78	0.77	0.77
C. Flow (blw Vasona)	-0.07	-0.07	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09
D. Daily Max Air Temperature	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.14	0.13	0.13	0.12	0.12	0.12	0.11	0.11
E. Constant	0.19	0.29	0.38	0.49	0.59	0.69	0.80	0.90	1.01	1.11	1.22	1.32	1.43	1.53	1.63
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	1.14	1.12	1.10	1.07	1.05	1.02	0.99	0.96	0.93	0.90	0.86	0.83	0.80	0.76	0.73
B. Previous day temp	-0.20	-0.18	-0.16	-0.14	-0.12	-0.10	-0.07	-0.05	-0.02	0.01	0.03	0.06	0.09	0.12	0.15
C. Flow (LOSG1)	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.05	0.06	0.07	0.08	0.09
D. Daily Max Air Temperature	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.76	0.76	0.76	0.76	0.76	0.76	0.75	0.75
C. Flow (blw Vasona)	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09
D. Daily Max Air Temperature	0.10	0.10	0.10	0.09	0.09	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07
E. Constant	1.73	1.83	1.93	2.02	2.12	2.21	2.29	2.38	2.46	2.54	2.61	2.68	2.75	2.81	2.87
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	0.70	0.67	0.63	0.60	0.57	0.54	0.52	0.49	0.46	0.44	0.42	0.40	0.38	0.37	0.35
B. Previous day temp	0.17	0.20	0.23	0.26	0.28	0.31	0.33	0.35	0.37	0.39	0.41	0.43	0.44	0.45	0.46
C. Flow (LOSG1)	0.10	0.11	0.12	0.13	0.14	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.20	0.21	0.22
D. Daily Max Air Temperature	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.12
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Los Gatos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.75	0.75	0.74	0.74	0.73	0.73	0.73	0.72	0.72	0.71	0.71	0.70	0.70	0.70	0.69
C. Flow (blw Vasona)	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10
D. Daily Max Air Temperature	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.12
E. Constant	2.92	2.96	3.01	3.04	3.08	3.11	3.13	3.15	3.16	3.18	3.18	3.19	3.19	3.19	3.18
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	0.34	0.34	0.33	0.33	0.33	0.33	0.34	0.34	0.35	0.36	0.36	0.37	0.39	0.40	0.41
B. Previous day temp	0.47	0.47	0.47	0.47	0.47	0.47	0.46	0.46	0.45	0.44	0.43	0.42	0.40	0.39	0.38
C. Flow (LOSG1)	0.22	0.23	0.23	0.23	0.24	0.24	0.24	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.26
D. Daily Max Air Temperature	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Los Gatos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.69	0.68	0.68	0.68	0.67	0.67	0.67	0.67	0.66	0.66	0.66	0.66	0.66	0.66	0.67
C. Flow (blw Vasona)	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
D. Daily Max Air Temperature	0.13	0.13	0.14	0.14	0.15	0.15	0.16	0.16	0.17	0.17	0.18	0.18	0.18	0.18	0.19
E. Constant	3.17	3.16	3.14	3.12	3.10	3.07	3.04	3.01	2.98	2.95	2.91	2.87	2.83	2.78	2.74
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	0.42	0.44	0.45	0.46	0.48	0.49	0.50	0.51	0.52	0.53	0.54	0.55	0.55	0.56	0.56
B. Previous day temp	0.36	0.35	0.34	0.32	0.31	0.30	0.28	0.27	0.26	0.25	0.24	0.23	0.23	0.22	0.22
C. Flow (LOSG1)	0.26	0.26	0.26	0.26	0.26	0.26	0.27	0.27	0.27	0.27	0.28	0.28	0.29	0.29	0.30
D. Daily Max Air Temperature	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Los Gatos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.67	0.67	0.67	0.68	0.68	0.69	0.69	0.70	0.70	0.71	0.72	0.72	0.73	0.74	0.74
C. Flow (blw Vasona)	-0.11	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.13	-0.13	-0.13
D. Daily Max Air Temperature	0.19	0.19	0.19	0.19	0.19	0.18	0.18	0.18	0.18	0.18	0.17	0.17	0.17	0.16	0.16
E. Constant	2.69	2.64	2.59	2.54	2.49	2.43	2.38	2.32	2.27	2.21	2.15	2.10	2.04	1.98	1.92
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	0.56	0.56	0.56	0.55	0.55	0.54	0.53	0.52	0.51	0.50	0.49	0.47	0.46	0.44	0.43
B. Previous day temp	0.22	0.22	0.22	0.22	0.23	0.23	0.24	0.25	0.26	0.27	0.28	0.30	0.31	0.32	0.34
C. Flow (LOSG1)	0.30	0.31	0.32	0.32	0.33	0.34	0.35	0.36	0.37	0.38	0.39	0.40	0.41	0.42	0.43
D. Daily Max Air Temperature	0.12	0.12	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.14	0.14
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.75	0.76	0.77	0.77	0.78	0.79	0.80	0.80	0.81	0.82	0.82	0.83	0.84	0.84	0.85
C. Flow (blw Vasona)	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.14	-0.14	-0.14	-0.14	-0.14
D. Daily Max Air Temperature	0.16	0.15	0.15	0.14	0.14	0.14	0.13	0.13	0.12	0.12	0.12	0.11	0.11	0.11	0.10
E. Constant	1.87	1.81	1.75	1.70	1.64	1.59	1.54	1.48	1.43	1.38	1.34	1.29	1.25	1.20	1.16
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	0.41	0.40	0.38	0.36	0.35	0.33	0.31	0.30	0.28	0.26	0.25	0.23	0.22	0.21	0.19
B. Previous day temp	0.35	0.37	0.38	0.40	0.42	0.43	0.45	0.47	0.48	0.50	0.51	0.53	0.54	0.55	0.57
C. Flow (LOSG1)	0.44	0.45	0.46	0.47	0.48	0.49	0.50	0.51	0.52	0.52	0.53	0.54	0.55	0.56	0.56
D. Daily Max Air Temperature	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.85	0.86	0.86	0.87	0.87	0.87	0.87	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
C. Flow (blw Vasona)	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14
D. Daily Max Air Temperature	0.10	0.10	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08
E. Constant	1.13	1.09	1.06	1.03	1.00	0.98	0.96	0.95	0.95	0.95	0.96	0.98	1.00	1.03	1.08
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	0.18	0.17	0.16	0.15	0.14	0.14	0.13	0.13	0.12	0.12	0.12	0.12	0.12	0.12	0.13
B. Previous day temp	0.58	0.59	0.60	0.61	0.62	0.62	0.63	0.64	0.64	0.64	0.65	0.65	0.65	0.65	0.65
C. Flow (LOSG1)	0.57	0.57	0.58	0.58	0.59	0.59	0.59	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
D. Daily Max Air Temperature	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.14
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.88	0.87	0.87	0.87	0.86	0.86	0.85	0.85	0.84	0.84	0.83	0.82	0.82	0.81	0.80
C. Flow (blw Vasona)	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13
D. Daily Max Air Temperature	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07
E. Constant	1.13	1.19	1.26	1.35	1.45	1.55	1.68	1.81	1.96	2.12	2.30	2.50	2.71	2.93	3.18
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	0.13	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.19	0.21	0.22	0.24	0.25	0.27	0.29
B. Previous day temp	0.64	0.64	0.64	0.63	0.63	0.62	0.61	0.60	0.59	0.58	0.57	0.56	0.55	0.53	0.52
C. Flow (LOSG1)	0.60	0.60	0.60	0.60	0.60	0.59	0.59	0.59	0.59	0.58	0.58	0.58	0.58	0.57	0.57
D. Daily Max Air Temperature	0.14	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.12	0.12	0.12	0.11	0.11
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Camden (LOSG2) Day of Year ->	**196**	**197**	**198**	**199**	**200**	**201**	**202**	**203**	**204**	**205**	**206**	**207**	**208**	**209**	**210**
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.79	0.78	0.77	0.76	0.75	0.73	0.72	0.71	0.70	0.69	0.67	0.66	0.65	0.64	0.62
C. Flow (blw Vasona)	-0.12	-0.12	-0.12	-0.12	-0.11	-0.11	-0.11	-0.11	-0.10	-0.10	-0.10	-0.09	-0.09	-0.09	-0.08
D. Daily Max Air Temperature	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.03
E. Constant	3.44	3.72	4.02	4.33	4.65	4.99	5.33	5.69	6.04	6.41	6.78	7.14	7.51	7.88	8.24

Lincoln Ave (LOSG1) Day of Year ->	**196**	**197**	**198**	**199**	**200**	**201**	**202**	**203**	**204**	**205**	**206**	**207**	**208**	**209**	**210**
A. Upstream Water Temperature (LOSG2)	0.30	0.32	0.34	0.36	0.39	0.41	0.43	0.46	0.48	0.51	0.53	0.56	0.58	0.61	0.64
B. Previous day temp	0.50	0.48	0.46	0.45	0.43	0.41	0.38	0.36	0.34	0.32	0.29	0.27	0.24	0.22	0.19
C. Flow (LOSG1)	0.57	0.57	0.56	0.56	0.56	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
D. Daily Max Air Temperature	0.11	0.11	0.10	0.10	0.09	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.06	0.06	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**211**	**212**	**213**	**214**	**215**	**216**	**217**	**218**	**219**	**220**	**221**	**222**	**223**	**224**	**225**
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.61	0.60	0.59	0.58	0.57	0.56	0.55	0.54	0.53	0.52	0.51	0.51	0.50	0.49	0.49
C. Flow (blw Vasona)	-0.08	-0.08	-0.08	-0.07	-0.07	-0.07	-0.06	-0.06	-0.06	-0.06	-0.05	-0.05	-0.05	-0.05	-0.05
D. Daily Max Air Temperature	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	8.60	8.95	9.29	9.61	9.93	10.23	10.52	10.79	11.04	11.27	11.48	11.66	11.82	11.95	12.05
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	0.66	0.69	0.72	0.74	0.77	0.80	0.83	0.85	0.88	0.90	0.93	0.95	0.98	1.00	1.03
B. Previous day temp	0.17	0.14	0.12	0.09	0.07	0.04	0.02	-0.01	-0.03	-0.06	-0.08	-0.11	-0.13	-0.16	-0.18
C. Flow (LOSG1)	0.55	0.55	0.55	0.56	0.56	0.56	0.57	0.58	0.58	0.59	0.60	0.61	0.62	0.63	0.65
D. Daily Max Air Temperature	0.05	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Los Gatos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.49	0.49	0.48	0.48	0.49	0.49	0.49	0.49	0.50	0.50	0.51	0.52	0.52	0.53	0.54
C. Flow (blw Vasona)	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03
E. Constant	12.12	12.15	12.15	12.12	12.06	11.97	11.85	11.70	11.53	11.33	11.11	10.87	10.61	10.34	10.05
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	1.05	1.07	1.09	1.11	1.13	1.15	1.17	1.19	1.20	1.22	1.24	1.25	1.26	1.27	1.29
B. Previous day temp	-0.20	-0.23	-0.25	-0.27	-0.29	-0.31	-0.33	-0.34	-0.36	-0.38	-0.39	-0.41	-0.42	-0.44	-0.45
C. Flow (LOSG1)	0.66	0.68	0.69	0.71	0.73	0.75	0.77	0.79	0.81	0.83	0.85	0.87	0.90	0.92	0.94
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.55	0.56	0.57	0.58	0.59	0.60	0.61	0.62	0.63	0.64	0.65	0.66	0.67	0.68	0.69
C. Flow (blw Vasona)	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01
D. Daily Max Air Temperature	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07
E. Constant	9.74	9.42	9.09	8.75	8.40	8.04	7.68	7.31	6.94	6.58	6.21	5.84	5.48	5.12	4.77
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	1.30	1.31	1.31	1.32	1.33	1.33	1.34	1.34	1.34	1.35	1.35	1.35	1.35	1.34	1.34
B. Previous day temp	-0.46	-0.47	-0.48	-0.49	-0.50	-0.50	-0.51	-0.52	-0.52	-0.52	-0.52	-0.53	-0.52	-0.52	-0.52
C. Flow (LOSG1)	0.96	0.98	1.00	1.02	1.04	1.06	1.08	1.09	1.11	1.12	1.13	1.14	1.15	1.15	1.16
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Los Gatos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.70	0.71	0.72	0.73	0.74	0.75	0.76	0.77	0.77	0.78	0.79	0.79	0.80	0.81	0.81
C. Flow (blw Vasona)	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.05	0.06	0.07	0.07	0.08
D. Daily Max Air Temperature	0.07	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.10
E. Constant	4.43	4.10	3.78	3.48	3.18	2.90	2.63	2.38	2.14	1.91	1.69	1.49	1.29	1.12	0.95
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	1.33	1.33	1.32	1.31	1.31	1.30	1.28	1.27	1.26	1.25	1.23	1.22	1.21	1.19	1.18
B. Previous day temp	-0.52	-0.51	-0.51	-0.50	-0.49	-0.48	-0.47	-0.46	-0.45	-0.43	-0.42	-0.41	-0.39	-0.38	-0.36
C. Flow (LOSG1)	1.16	1.16	1.16	1.15	1.14	1.13	1.12	1.11	1.09	1.07	1.05	1.03	1.01	0.98	0.96
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Los Gatos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**271**	**272**	**273**	**274**	**275**	**276**	**277**	**278**	**279**	**280**	**281**	**282**	**283**	**284**	**285**
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.82	0.82	0.83	0.83	0.83	0.84	0.84	0.84	0.85	0.85	0.85	0.85	0.85	0.86	0.86
C. Flow (blw Vasona)	0.08	0.09	0.10	0.10	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
D. Daily Max Air Temperature	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
E. Constant	0.79	0.65	0.52	0.40	0.30	0.21	0.12	0.06	0.00	-0.05	-0.08	-0.10	-0.11	-0.11	-0.10
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	1.16	1.15	1.13	1.12	1.10	1.09	1.07	1.06	1.05	1.04	1.02	1.01	1.00	0.99	0.98
B. Previous day temp	-0.34	-0.33	-0.31	-0.30	-0.28	-0.26	-0.25	-0.23	-0.22	-0.20	-0.19	-0.18	-0.17	-0.15	-0.14
C. Flow (LOSG1)	0.93	0.90	0.87	0.84	0.81	0.78	0.75	0.71	0.68	0.65	0.61	0.58	0.54	0.51	0.48
D. Daily Max Air Temperature	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Los Gatos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.85	0.85	0.85	0.85	0.84	0.84
C. Flow (blw Vasona)	0.12	0.11	0.11	0.10	0.09	0.08	0.08	0.07	0.05	0.04	0.03	0.02	0.01	-0.01	-0.02
D. Daily Max Air Temperature	0.10	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07
E. Constant	-0.07	-0.04	0.01	0.07	0.14	0.22	0.31	0.41	0.52	0.64	0.76	0.89	1.03	1.17	1.32
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	0.98	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.97	0.97	0.98	0.98	0.99
B. Previous day temp	-0.13	-0.12	-0.12	-0.11	-0.11	-0.10	-0.10	-0.10	-0.09	-0.09	-0.09	-0.10	-0.10	-0.10	-0.10
C. Flow (LOSG1)	0.45	0.41	0.38	0.35	0.32	0.29	0.26	0.23	0.20	0.18	0.15	0.13	0.10	0.08	0.06
D. Daily Max Air Temperature	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Los Gatos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**301**	**302**	**303**	**304**	**305**	**306**	**307**	**308**	**309**	**310**	**311**	**312**	**313**	**314**	**315**
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.83	0.83	0.82	0.82	0.81	0.80	0.79	0.79	0.78	0.77	0.76	0.74	0.73	0.72	0.70
C. Flow (blw Vasona)	-0.04	-0.05	-0.06	-0.08	-0.09	-0.10	-0.12	-0.13	-0.14	-0.16	-0.17	-0.18	-0.19	-0.20	-0.21
D. Daily Max Air Temperature	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
E. Constant	1.47	1.63	1.79	1.95	2.12	2.29	2.46	2.63	2.80	2.97	3.14	3.31	3.47	3.64	3.80
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	1.00	1.01	1.02	1.02	1.03	1.04	1.05	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14
B. Previous day temp	-0.11	-0.11	-0.12	-0.12	-0.13	-0.14	-0.14	-0.15	-0.16	-0.17	-0.17	-0.18	-0.19	-0.20	-0.20
C. Flow (LOSG1)	0.04	0.02	0.00	-0.02	-0.04	-0.06	-0.07	-0.08	-0.10	-0.11	-0.12	-0.13	-0.13	-0.14	-0.15
D. Daily Max Air Temperature	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.05
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Los Gatos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.69	0.67	0.66	0.64	0.62	0.60	0.58	0.56	0.54	0.52	0.49	0.47	0.45	0.43	0.40
C. Flow (blw Vasona)	-0.22	-0.22	-0.23	-0.23	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.23	-0.23	-0.22	-0.22
D. Daily Max Air Temperature	0.07	0.07	0.07	0.08	0.08	0.09	0.10	0.10	0.11	0.12	0.12	0.13	0.14	0.15	0.16
E. Constant	3.95	4.11	4.25	4.40	4.53	4.66	4.79	4.91	5.02	5.13	5.23	5.33	5.42	5.50	5.57
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.22	1.22	1.23	1.24	1.25	1.25	1.26	1.26
B. Previous day temp	-0.21	-0.22	-0.23	-0.23	-0.24	-0.25	-0.25	-0.26	-0.26	-0.27	-0.27	-0.28	-0.28	-0.29	-0.29
C. Flow (LOSG1)	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.14	-0.14	-0.13	-0.12	-0.11	-0.10	-0.09	-0.08	-0.07
D. Daily Max Air Temperature	-0.05	-0.05	-0.05	-0.06	-0.06	-0.06	-0.07	-0.07	-0.07	-0.07	-0.08	-0.08	-0.08	-0.08	-0.08
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Los Gatos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.38	0.36	0.34	0.32	0.30	0.28	0.26	0.24	0.22	0.20	0.19	0.18	0.16	0.15	0.14
C. Flow (blw Vasona)	-0.21	-0.21	-0.20	-0.19	-0.18	-0.18	-0.17	-0.16	-0.15	-0.14	-0.13	-0.12	-0.11	-0.11	-0.10
D. Daily Max Air Temperature	0.17	0.17	0.18	0.19	0.20	0.21	0.21	0.22	0.23	0.24	0.24	0.25	0.25	0.26	0.26
E. Constant	5.64	5.71	5.77	5.82	5.86	5.90	5.93	5.96	5.98	5.99	6.00	5.99	5.99	5.97	5.95
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	1.27	1.27	1.28	1.28	1.29	1.29	1.30	1.30	1.30	1.30	1.31	1.31	1.31	1.31	1.31
B. Previous day temp	-0.30	-0.30	-0.30	-0.30	-0.31	-0.31	-0.31	-0.31	-0.32	-0.32	-0.32	-0.32	-0.32	-0.32	-0.33
C. Flow (LOSG1)	-0.05	-0.04	-0.02	-0.01	0.00	0.02	0.03	0.05	0.06	0.08	0.09	0.11	0.12	0.14	0.15
D. Daily Max Air Temperature	-0.08	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
Camden (LOSG2)															
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.14	0.15	0.16	0.17	0.19	0.20	0.22	0.24
C. Flow (blw Vasona)	-0.09	-0.08	-0.07	-0.07	-0.06	-0.06	-0.05	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03	-0.02	-0.02
D. Daily Max Air Temperature	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.26	0.26	0.25	0.25	0.24	0.24
E. Constant	5.92	5.89	5.85	5.80	5.74	5.68	5.61	5.54	5.46	5.37	5.28	5.18	5.07	4.97	4.85
Lincoln Ave (LOSG1)															
A. Upstream Water Temperature (LOSG2)	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.31
B. Previous day temp	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33
C. Flow (LOSG1)	0.16	0.18	0.19	0.20	0.21	0.22	0.23	0.23	0.24	0.25	0.25	0.26	0.26	0.27	0.27
D. Daily Max Air Temperature	-0.10	-0.10	-0.10	-0.10	-0.10	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Temperature Modeling Technical Memorandum
Santa Clara Valley Water District FAHCE Project

Attachment C - Los Gatos Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**361**	**362**	**363**	**364**	**365**	**366**
Camden (LOSG2)						
A. Upstream Temp (N/A)	0.00	0.00	0.00	0.00	0.00	0.00
B. Previous day temp	0.26	0.28	0.30	0.32	0.35	0.37
C. Flow (blw Vasona)	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01
D. Daily Max Air Temperature	0.23	0.22	0.21	0.20	0.20	0.19
E. Constant	4.74	4.61	4.49	4.36	4.23	4.09
Lincoln Ave (LOSG1)						
A. Upstream Water Temperature (LOSG2)	1.31	1.31	1.31	1.31	1.31	1.31
B. Previous day temp	-0.32	-0.32	-0.32	-0.32	-0.32	-0.32
C. Flow (LOSG1)	0.27	0.27	0.27	0.28	0.28	0.28
D. Daily Max Air Temperature	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.92	0.92	0.92	0.93	0.93	0.94	0.94	0.95	0.95	0.96	0.96	0.97	0.97	0.98	0.98
B. Reservoir Release (STEV6)	0.43	0.41	0.40	0.38	0.36	0.35	0.33	0.32	0.30	0.29	0.27	0.26	0.25	0.23	0.22
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.65	0.66	0.67	0.68	0.69	0.69	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.69	0.68
B. Previous Day Temp	0.32	0.31	0.31	0.30	0.30	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.30	0.30	0.31
C. Reservoir Release (STEV6)	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
D. Daily Max Air Temperature	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	1.04	1.03	1.02	1.01	1.00	0.99	0.98	0.96	0.95	0.94	0.93	0.91	0.90	0.88	0.87
B. Previous Day Temp	-0.02	-0.01	0.00	0.02	0.03	0.04	0.06	0.07	0.08	0.10	0.11	0.13	0.14	0.16	0.17
C. Flow (STEV6)	-0.09	-0.09	-0.10	-0.10	-0.11	-0.11	-0.11	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.58	0.58	0.58	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
B. Previous Day Temp	0.37	0.37	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.37	0.37
C. Flow (STEV6)	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.00	-0.01
D. Daily Max Air Temperature	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.08	0.09	0.10	0.10	0.10	0.11
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.91	0.92	0.94	0.95	0.96	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.04	1.04	1.05
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	-0.13	-0.12	-0.12	-0.12	-0.12	-0.12	-0.11	-0.11	-0.11	-0.11	-0.11	-0.10	-0.10	-0.10	-0.10
D. Daily Max Air Temperature	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.02	0.01	0.01	0.00	0.00	-0.01	-0.01	-0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.99	1.00	1.00	1.01	1.01	1.02	1.03	1.03	1.04	1.05	1.05	1.06	1.07	1.07	1.08
B. Reservoir Release (STEV6)	0.21	0.19	0.18	0.17	0.16	0.15	0.14	0.12	0.11	0.10	0.09	0.09	0.08	0.07	0.06
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.68	0.66	0.65	0.64	0.62	0.61	0.59	0.58	0.56	0.54	0.52	0.50	0.48	0.46	0.45
B. Previous Day Temp	0.32	0.33	0.35	0.36	0.38	0.39	0.41	0.43	0.44	0.46	0.48	0.50	0.52	0.54	0.55
C. Reservoir Release (STEV6)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
D. Daily Max Air Temperature	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.85	0.84	0.82	0.80	0.78	0.77	0.75	0.73	0.71	0.69	0.67	0.65	0.64	0.62	0.60
B. Previous Day Temp	0.19	0.20	0.22	0.23	0.25	0.26	0.28	0.29	0.31	0.32	0.34	0.35	0.37	0.38	0.40
C. Flow (STEV6)	-0.12	-0.12	-0.11	-0.11	-0.10	-0.10	-0.09	-0.09	-0.08	-0.08	-0.07	-0.07	-0.06	-0.05	-0.05
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.59	0.59	0.59	0.59	0.59	0.58	0.58	0.58	0.58	0.58	0.57	0.57	0.57	0.57	0.56
B. Previous Day Temp	0.37	0.37	0.37	0.38	0.38	0.38	0.38	0.39	0.39	0.39	0.40	0.40	0.41	0.41	0.41
C. Flow (STEV6)	-0.01	-0.02	-0.02	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.05	-0.05	-0.05	-0.05	-0.06	-0.06
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.09	0.09	0.09	0.08	0.07	0.07	0.06
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	1.05	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.05	1.05
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	-0.09	-0.09	-0.09	-0.09	-0.09	-0.08	-0.08	-0.08	-0.08	-0.07	-0.07	-0.07	-0.07	-0.07	-0.06
D. Daily Max Air Temperature	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Temperature Modeling Technical Memorandum
Santa Clara Valley Water District FAHCE Project

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	1.08	1.09	1.09	1.10	1.11	1.11	1.12	1.12	1.12	1.13	1.13	1.13	1.14	1.14	1.14
B. Reservoir Release (STEV6)	0.05	0.05	0.04	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.43	0.41	0.39	0.38	0.36	0.35	0.34	0.33	0.32	0.31	0.31	0.30	0.30	0.30	0.31
B. Previous Day Temp	0.57	0.59	0.61	0.62	0.63	0.65	0.66	0.67	0.68	0.69	0.69	0.69	0.69	0.69	0.69
C. Reservoir Release (STEV6)	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.58	0.56	0.54	0.52	0.51	0.49	0.47	0.46	0.44	0.42	0.41	0.40	0.38	0.37	0.36
B. Previous Day Temp	0.41	0.43	0.44	0.46	0.47	0.49	0.50	0.51	0.53	0.54	0.55	0.56	0.57	0.59	0.60
C. Flow (STEV6)	-0.04	-0.03	-0.03	-0.02	-0.01	-0.01	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04
D. Daily Max Air Temperature	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.56	0.56	0.55	0.55	0.55	0.54	0.54	0.54	0.54	0.53	0.53	0.53	0.52	0.52	0.52
B. Previous Day Temp	0.42	0.42	0.43	0.43	0.44	0.44	0.45	0.45	0.46	0.46	0.46	0.47	0.47	0.48	0.48
C. Flow (STEV6)	-0.06	-0.06	-0.06	-0.06	-0.06	-0.07	-0.07	-0.07	-0.07	-0.07	-0.08	-0.08	-0.08	-0.08	-0.09
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.02
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	0.06	0.05	0.04	0.04	0.03	0.02	0.02	0.01	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.03
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.01	1.01	1.01	1.00	1.00	1.00
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.06
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	1.14	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.14	1.14	1.14	1.14	1.14	1.13
B. Reservoir Release (STEV6)	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.01
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.31	0.32	0.33	0.35	0.36	0.38	0.40	0.42	0.44	0.47	0.49	0.51	0.54	0.56	0.59
B. Previous Day Temp	0.68	0.67	0.66	0.64	0.63	0.61	0.59	0.57	0.55	0.52	0.50	0.47	0.45	0.42	0.40
C. Reservoir Release (STEV6)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.35	0.34	0.33	0.32	0.31	0.31	0.30	0.30	0.29	0.29	0.29	0.29	0.28	0.28	0.28
B. Previous Day Temp	0.61	0.62	0.63	0.63	0.64	0.65	0.66	0.67	0.67	0.68	0.68	0.69	0.69	0.70	0.70
C. Flow (STEV6)	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.03	0.03
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.52	0.51	0.51	0.51	0.51	0.50	0.50	0.50	0.50	0.50	0.49	0.49	0.49	0.49	0.49
B. Previous Day Temp	0.49	0.49	0.49	0.50	0.50	0.50	0.51	0.51	0.51	0.52	0.52	0.52	0.52	0.52	0.52
C. Flow (STEV6)	-0.09	-0.10	-0.10	-0.11	-0.11	-0.12	-0.12	-0.13	-0.13	-0.14	-0.14	-0.15	-0.16	-0.16	-0.17
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03
D. Daily Max Air Temperature	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	-0.06	-0.06	-0.06	-0.06	-0.06	-0.07	-0.07	-0.07	-0.07	-0.08	-0.08	-0.08	-0.09	-0.09	-0.09
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Temperature Modeling Technical Memorandum

Santa Clara Valley Water District FAHCE Project

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	1.13	1.13	1.12	1.12	1.12	1.11	1.11	1.10	1.10	1.09	1.09	1.08	1.08	1.07	1.07
B. Reservoir Release (STEV6)	0.01	0.02	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.61	0.64	0.66	0.68	0.71	0.73	0.75	0.76	0.78	0.79	0.80	0.81	0.81	0.82	0.81
B. Previous Day Temp	0.37	0.35	0.32	0.30	0.28	0.26	0.24	0.22	0.20	0.19	0.18	0.17	0.17	0.17	0.17
C. Reservoir Release (STEV6)	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.28	0.29	0.29	0.29	0.29	0.30	0.30	0.30	0.31	0.31	0.32	0.32	0.33	0.33	0.34
B. Previous Day Temp	0.70	0.70	0.70	0.71	0.71	0.71	0.70	0.70	0.70	0.70	0.70	0.69	0.69	0.68	0.68
C. Flow (STEV6)	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.50	0.50
B. Previous Day Temp	0.52	0.53	0.53	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.51	0.51	0.51	0.50
C. Flow (STEV6)	-0.17	-0.18	-0.18	-0.18	-0.19	-0.19	-0.19	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.19	-0.19
D. Daily Max Air Temperature	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	1.01	1.01	1.01	1.01	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.96	0.96	0.96	0.96	0.95	0.95
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	-0.09	-0.10	-0.10	-0.10	-0.11	-0.11	-0.11	-0.11	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12
D. Daily Max Air Temperature	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	1.06	1.06	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.01	1.01	1.00	0.99	0.99	0.98
B. Reservoir Release (STEV6)	0.15	0.16	0.17	0.19	0.20	0.22	0.23	0.25	0.26	0.28	0.29	0.31	0.33	0.34	0.36
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.81	0.80	0.79	0.78	0.76	0.75	0.73	0.71	0.68	0.66	0.63	0.60	0.58	0.55	0.52
B. Previous Day Temp	0.17	0.18	0.19	0.20	0.22	0.24	0.26	0.28	0.30	0.33	0.35	0.38	0.41	0.44	0.47
C. Reservoir Release (STEV6)	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.35	0.35	0.36	0.37	0.37	0.38	0.39	0.39	0.40	0.41	0.41	0.42	0.42	0.43	0.44
B. Previous Day Temp	0.67	0.66	0.66	0.65	0.64	0.63	0.63	0.62	0.61	0.60	0.59	0.58	0.58	0.57	0.56
C. Flow (STEV6)	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.50	0.50	0.51	0.51	0.51	0.52	0.52	0.52	0.53	0.53	0.53	0.54	0.54	0.54	0.55
B. Previous Day Temp	0.50	0.49	0.49	0.48	0.48	0.47	0.47	0.46	0.46	0.45	0.44	0.44	0.43	0.43	0.42
C. Flow (STEV6)	-0.19	-0.18	-0.18	-0.17	-0.17	-0.16	-0.15	-0.15	-0.14	-0.13	-0.12	-0.12	-0.11	-0.10	-0.09
D. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.95	0.94	0.94	0.93	0.93	0.92	0.92	0.91	0.91	0.90	0.89	0.89	0.88	0.87	0.87
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	-0.13	-0.13	-0.13	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.11	-0.11	-0.11	-0.10	-0.10	-0.09
D. Daily Max Air Temperature	0.07	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.11
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Temperature Modeling Technical Memorandum
Santa Clara Valley Water District FAHCE Project

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.98	0.97	0.97	0.96	0.96	0.95	0.95	0.94	0.94	0.93	0.93	0.92	0.92	0.92	0.91
B. Reservoir Release (STEV6)	0.37	0.39	0.41	0.42	0.44	0.46	0.47	0.49	0.50	0.52	0.53	0.55	0.56	0.58	0.59
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.48	0.45	0.42	0.39	0.36	0.33	0.30	0.27	0.24	0.21	0.18	0.15	0.13	0.11	0.08
B. Previous Day Temp	0.50	0.54	0.57	0.60	0.63	0.66	0.70	0.73	0.76	0.79	0.81	0.84	0.87	0.89	0.91
C. Reservoir Release (STEV6)	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.44	0.45	0.45	0.45	0.46	0.46	0.46	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.46
B. Previous Day Temp	0.55	0.54	0.54	0.53	0.52	0.52	0.51	0.51	0.50	0.50	0.50	0.49	0.49	0.49	0.49
C. Flow (STEV6)	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.55	0.55	0.56	0.56	0.56	0.56	0.56	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
B. Previous Day Temp	0.41	0.41	0.40	0.40	0.39	0.39	0.39	0.38	0.38	0.38	0.38	0.38	0.37	0.37	0.38
C. Flow (STEV6)	-0.09	-0.08	-0.07	-0.07	-0.06	-0.06	-0.06	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.06	-0.06
D. Daily Max Air Temperature	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-0.01	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03	-0.04	-0.04	-0.05	-0.05	-0.06	-0.07	-0.07	-0.08
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.86	0.86	0.85	0.84	0.84	0.83	0.82	0.82	0.81	0.81	0.80	0.80	0.79	0.79	0.78
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	-0.09	-0.08	-0.07	-0.07	-0.06	-0.05	-0.04	-0.03	-0.02	-0.01	0.00	0.01	0.02	0.04	0.05
D. Daily Max Air Temperature	0.11	0.12	0.12	0.12	0.13	0.13	0.13	0.13	0.14	0.14	0.14	0.14	0.15	0.15	0.15
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.91	0.91	0.90	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.89	0.89	0.88	0.88	0.88
B. Reservoir Release (STEV6)	0.60	0.62	0.63	0.64	0.65	0.67	0.68	0.69	0.70	0.71	0.72	0.73	0.74	0.75	0.76
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.06	0.05	0.03	0.02	0.00	-0.01	-0.02	-0.02	-0.03	-0.04	-0.04	-0.04	-0.05	-0.05	-0.05
B. Previous Day Temp	0.93	0.95	0.96	0.98	0.99	1.00	1.01	1.02	1.03	1.03	1.04	1.04	1.04	1.04	1.04
C. Reservoir Release (STEV6)	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.46	0.46	0.45	0.45	0.44	0.44	0.43	0.42	0.42	0.41	0.40	0.40	0.39	0.38	0.38
B. Previous Day Temp	0.49	0.50	0.50	0.51	0.51	0.52	0.52	0.53	0.54	0.54	0.55	0.56	0.57	0.57	0.58
C. Flow (STEV6)	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03	-0.03	-0.04	-0.04
D. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.57	0.56	0.56	0.56	0.56	0.55	0.55	0.54	0.54	0.53	0.53	0.52	0.52	0.51	0.51
B. Previous Day Temp	0.38	0.38	0.38	0.38	0.39	0.39	0.40	0.40	0.41	0.42	0.42	0.43	0.44	0.44	0.45
C. Flow (STEV6)	-0.07	-0.08	-0.09	-0.09	-0.11	-0.12	-0.13	-0.14	-0.16	-0.17	-0.19	-0.20	-0.22	-0.24	-0.25
D. Daily Max Air Temperature	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-0.09	-0.09	-0.10	-0.11	-0.12	-0.13	-0.13	-0.14	-0.15	-0.16	-0.17	-0.18	-0.19	-0.20	-0.21
D. Daily Max Air Temperature	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.78	0.78	0.77	0.77	0.77	0.77	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	0.06	0.08	0.09	0.11	0.13	0.14	0.16	0.17	0.19	0.20	0.21	0.22	0.23	0.24	0.25
D. Daily Max Air Temperature	0.15	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Temperature Modeling Technical Memorandum
Santa Clara Valley Water District FAHCE Project

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**121**	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**	**131**	**132**	**133**	**134**	**135**
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.88	0.88	0.88	0.88	0.88	0.88	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
B. Reservoir Release (STEV6)	0.77	0.77	0.78	0.79	0.80	0.81	0.82	0.83	0.83	0.84	0.85	0.86	0.87	0.88	0.88
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	-0.05	-0.05	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.02	-0.02	-0.01	-0.01	0.00	0.00	0.00
B. Previous Day Temp	1.04	1.04	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.01	1.01	1.00	1.00	0.99	0.99
C. Reservoir Release (STEV6)	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.37	0.37	0.36	0.36	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.36	0.37
B. Previous Day Temp	0.59	0.59	0.60	0.61	0.61	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.61	0.61
C. Flow (STEV6)	-0.05	-0.05	-0.06	-0.07	-0.07	-0.08	-0.09	-0.09	-0.10	-0.11	-0.12	-0.13	-0.13	-0.14	-0.15
D. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.50	0.49	0.49	0.48	0.47	0.47	0.46	0.45	0.45	0.44	0.44	0.43	0.42	0.42	0.41
B. Previous Day Temp	0.46	0.47	0.47	0.48	0.49	0.50	0.51	0.51	0.52	0.53	0.54	0.54	0.55	0.56	0.56
C. Flow (STEV6)	-0.27	-0.29	-0.30	-0.32	-0.34	-0.35	-0.37	-0.38	-0.40	-0.41	-0.42	-0.43	-0.44	-0.45	-0.46
D. Daily Max Air Temperature	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.96	0.96	0.96	0.96
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-0.22	-0.23	-0.24	-0.25	-0.26	-0.26	-0.27	-0.28	-0.29	-0.30	-0.31	-0.32	-0.33	-0.34	-0.35
D. Daily Max Air Temperature	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.07
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.76	0.76	0.76	0.76	0.76	0.76	0.77	0.77	0.77	0.77	0.78	0.78	0.78	0.78	0.79
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	0.26	0.26	0.27	0.27	0.26	0.26	0.26	0.25	0.23	0.22	0.20	0.18	0.16	0.13	0.10
D. Daily Max Air Temperature	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.15
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.87	0.87	0.87	0.87	0.87	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
B. Reservoir Release (STEV6)	0.89	0.90	0.91	0.92	0.93	0.93	0.94	0.95	0.96	0.97	0.97	0.98	0.99	0.99	1.00
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04
B. Previous Day Temp	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96
C. Reservoir Release (STEV6)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.38	0.38	0.40	0.41	0.42	0.43	0.45	0.46	0.48	0.49	0.51	0.53	0.54	0.56	0.57
B. Previous Day Temp	0.60	0.59	0.58	0.57	0.55	0.54	0.53	0.51	0.50	0.48	0.46	0.45	0.43	0.42	0.40
C. Flow (STEV6)	-0.16	-0.17	-0.18	-0.20	-0.21	-0.22	-0.23	-0.24	-0.25	-0.26	-0.27	-0.28	-0.29	-0.30	-0.31
D. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.41	0.40	0.39	0.39	0.38	0.38	0.37	0.37	0.37	0.36	0.36	0.35	0.35	0.35	0.34
B. Previous Day Temp	0.57	0.57	0.58	0.58	0.59	0.59	0.59	0.60	0.60	0.60	0.60	0.61	0.61	0.61	0.61
C. Flow (STEV6)	-0.47	-0.48	-0.48	-0.49	-0.49	-0.49	-0.50	-0.50	-0.50	-0.50	-0.50	-0.49	-0.49	-0.49	-0.49
D. Daily Max Air Temperature	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-0.35	-0.36	-0.37	-0.38	-0.39	-0.39	-0.40	-0.41	-0.41	-0.42	-0.42	-0.43	-0.43	-0.43	-0.44
D. Daily Max Air Temperature	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.79	0.79	0.80	0.80	0.81	0.81	0.81	0.82	0.82	0.82	0.83	0.83	0.83	0.83	0.83
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	0.06	0.02	-0.02	-0.06	-0.10	-0.15	-0.19	-0.24	-0.28	-0.32	-0.36	-0.39	-0.42	-0.45	-0.47
D. Daily Max Air Temperature	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.12
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.87
B. Reservoir Release (STEV6)	1.00	1.01	1.01	1.01	1.01	1.02	1.02	1.02	1.01	1.01	1.01	1.00	1.00	0.99	0.99
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
B. Previous Day Temp	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
C. Reservoir Release (STEV6)	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.59	0.60	0.61	0.62	0.63	0.64	0.65	0.66	0.66	0.67	0.67	0.67	0.66	0.66	0.65
B. Previous Day Temp	0.39	0.37	0.36	0.35	0.33	0.32	0.32	0.31	0.30	0.30	0.30	0.30	0.30	0.31	0.31
C. Flow (STEV6)	-0.32	-0.33	-0.33	-0.34	-0.35	-0.35	-0.36	-0.36	-0.36	-0.36	-0.37	-0.37	-0.36	-0.36	-0.36
D. Daily Max Air Temperature	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.34	0.34	0.33	0.33	0.33	0.33	0.33	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.31
B. Previous Day Temp	0.61	0.61	0.61	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
C. Flow (STEV6)	-0.48	-0.48	-0.48	-0.47	-0.47	-0.46	-0.46	-0.46	-0.45	-0.45	-0.44	-0.44	-0.44	-0.44	-0.43
D. Daily Max Air Temperature	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.97	0.97
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-0.44	-0.44	-0.44	-0.44	-0.44	-0.44	-0.43	-0.43	-0.43	-0.42	-0.41	-0.41	-0.40	-0.39	-0.38
D. Daily Max Air Temperature	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.84	0.84	0.84	0.84	0.83	0.83	0.83	0.83	0.82	0.82	0.81	0.81	0.80	0.79	0.78
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	-0.48	-0.49	-0.49	-0.49	-0.47	-0.45	-0.42	-0.37	-0.32	-0.25	-0.17	-0.08	0.02	0.14	0.28
D. Daily Max Air Temperature	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.09	0.09	0.09	0.09
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.87	0.87	0.87	0.87	0.87	0.88	0.88	0.88	0.88	0.89	0.89	0.89	0.89	0.90	0.90
B. Reservoir Release (STEV6)	0.98	0.97	0.96	0.94	0.93	0.92	0.90	0.89	0.87	0.85	0.84	0.82	0.80	0.79	0.77
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
B. Previous Day Temp	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
C. Reservoir Release (STEV6)	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.64	0.63	0.61	0.59	0.57	0.55	0.53	0.50	0.48	0.45	0.42	0.39	0.36	0.33	0.30
B. Previous Day Temp	0.32	0.34	0.35	0.37	0.39	0.41	0.43	0.46	0.48	0.51	0.54	0.57	0.60	0.63	0.66
C. Flow (STEV6)	-0.35	-0.34	-0.34	-0.33	-0.32	-0.31	-0.29	-0.28	-0.27	-0.25	-0.24	-0.22	-0.21	-0.19	-0.17
D. Daily Max Air Temperature	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
B. Previous Day Temp	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
C. Flow (STEV6)	-0.43	-0.43	-0.43	-0.43	-0.43	-0.43	-0.43	-0.44	-0.44	-0.44	-0.44	-0.45	-0.45	-0.45	-0.46
D. Daily Max Air Temperature	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.08
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.99	0.99	0.99	1.00	1.00	1.00	1.01	1.01
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-0.37	-0.36	-0.34	-0.33	-0.31	-0.30	-0.28	-0.26	-0.25	-0.23	-0.22	-0.20	-0.18	-0.17	-0.15
D. Daily Max Air Temperature	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.77	0.76	0.75	0.74	0.72	0.71	0.69	0.68	0.66	0.64	0.62	0.61	0.59	0.57	0.55
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	0.43	0.59	0.77	0.97	1.17	1.39	1.61	1.84	2.08	2.32	2.56	2.80	3.05	3.29	3.52
D. Daily Max Air Temperature	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Temperature Modeling Technical Memorandum

Santa Clara Valley Water District FAHCE Project

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**181**	**182**	**183**	**184**	**185**	**186**	**187**	**188**	**189**	**190**	**191**	**192**	**193**	**194**	**195**
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.90	0.91	0.91	0.91	0.91	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.93	0.93	0.93
B. Reservoir Release (STEV6)	0.75	0.74	0.72	0.70	0.69	0.68	0.66	0.65	0.64	0.63	0.62	0.61	0.60	0.60	0.59
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.08
B. Previous Day Temp	0.94	0.94	0.94	0.94	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.91	0.91	0.91	0.90
C. Reservoir Release (STEV6)	-0.05	-0.05	-0.05	-0.05	-0.06	-0.06	-0.06	-0.06	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.08
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.27	0.24	0.21	0.19	0.16	0.13	0.11	0.08	0.06	0.04	0.03	0.01	0.00	-0.01	-0.02
B. Previous Day Temp	0.69	0.72	0.75	0.78	0.81	0.83	0.86	0.88	0.90	0.92	0.94	0.96	0.97	0.98	0.99
C. Flow (STEV6)	-0.16	-0.14	-0.13	-0.11	-0.10	-0.08	-0.07	-0.06	-0.04	-0.03	-0.02	-0.01	0.00	0.00	0.01
D. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.32	0.32	0.32	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.34	0.34	0.34	0.34	0.34
B. Previous Day Temp	0.63	0.63	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.65	0.65
C. Flow (STEV6)	-0.46	-0.46	-0.47	-0.47	-0.47	-0.48	-0.48	-0.48	-0.49	-0.49	-0.49	-0.50	-0.50	-0.50	-0.50
D. Daily Max Air Temperature	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	1.01	1.02	1.02	1.02	1.03	1.03	1.03	1.04	1.04	1.05	1.05	1.05	1.06	1.06	1.06
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-0.14	-0.13	-0.11	-0.10	-0.10	-0.09	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.09	-0.10	-0.11
D. Daily Max Air Temperature	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.53	0.51	0.49	0.47	0.45	0.43	0.41	0.39	0.37	0.35	0.33	0.32	0.30	0.28	0.27
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	3.75	3.98	4.19	4.40	4.59	4.78	4.94	5.09	5.23	5.34	5.44	5.51	5.56	5.58	5.58
D. Daily Max Air Temperature	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.93	0.93	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.93	0.93	0.93	0.93	0.93	0.93
B. Reservoir Release (STEV6)	0.59	0.59	0.59	0.59	0.60	0.60	0.61	0.62	0.63	0.63	0.64	0.65	0.66	0.67	0.68
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.08	0.09	0.09	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.17	0.18
B. Previous Day Temp	0.90	0.89	0.89	0.89	0.88	0.88	0.87	0.87	0.86	0.85	0.85	0.84	0.84	0.83	0.82
C. Reservoir Release (STEV6)	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	-0.02	-0.02	-0.02	-0.01	0.00	0.01	0.02	0.04	0.06	0.08	0.10	0.12	0.14	0.17	0.20
B. Previous Day Temp	0.99	0.99	0.99	0.99	0.98	0.97	0.96	0.94	0.92	0.90	0.88	0.86	0.84	0.81	0.79
C. Flow (STEV6)	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.00	0.00	-0.01	-0.02	-0.03	-0.04	-0.05	-0.06
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.34	0.34	0.34	0.34	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
B. Previous Day Temp	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
C. Flow (STEV6)	-0.50	-0.50	-0.50	-0.50	-0.50	-0.50	-0.50	-0.50	-0.50	-0.49	-0.49	-0.49	-0.49	-0.48	-0.48
D. Daily Max Air Temperature	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	1.07	1.07	1.07	1.08	1.08	1.08	1.08	1.09	1.09	1.09	1.09	1.10	1.10	1.10	1.10
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-0.13	-0.15	-0.17	-0.19	-0.22	-0.25	-0.28	-0.31	-0.34	-0.38	-0.41	-0.45	-0.49	-0.53	-0.57
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.25	0.24	0.22	0.21	0.20	0.19	0.18	0.17	0.16	0.15	0.14	0.14	0.14	0.13	0.13
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	5.54	5.48	5.39	5.28	5.14	4.98	4.79	4.59	4.37	4.14	3.89	3.63	3.36	3.08	2.80
D. Daily Max Air Temperature	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.92	0.92	0.92	0.92	0.92	0.93
B. Reservoir Release (STEV6)	0.69	0.70	0.70	0.71	0.71	0.72	0.72	0.72	0.72	0.72	0.72	0.71	0.70	0.69	0.68
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.19	0.20	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.26	0.27	0.28	0.29	0.30	0.31
B. Previous Day Temp	0.82	0.81	0.80	0.80	0.79	0.78	0.78	0.77	0.76	0.75	0.75	0.74	0.73	0.72	0.71
C. Reservoir Release (STEV6)	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.10	-0.10	-0.10	-0.10
D. Daily Max Air Temperature	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.22	0.25	0.28	0.31	0.33	0.36	0.39	0.41	0.44	0.46	0.49	0.51	0.53	0.55	0.56
B. Previous Day Temp	0.76	0.74	0.71	0.68	0.66	0.63	0.60	0.58	0.55	0.53	0.51	0.49	0.47	0.45	0.43
C. Flow (STEV6)	-0.07	-0.08	-0.09	-0.10	-0.11	-0.12	-0.13	-0.14	-0.15	-0.16	-0.17	-0.18	-0.18	-0.19	-0.20
D. Daily Max Air Temperature	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
B. Previous Day Temp	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
C. Flow (STEV6)	-0.48	-0.47	-0.47	-0.46	-0.46	-0.46	-0.45	-0.45	-0.44	-0.44	-0.43	-0.43	-0.43	-0.42	-0.42
D. Daily Max Air Temperature	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-0.61	-0.65	-0.69	-0.73	-0.77	-0.80	-0.84	-0.88	-0.91	-0.94	-0.97	-1.00	-1.03	-1.05	-1.07
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.13	0.13	0.13	0.14	0.14	0.15	0.16	0.17	0.18	0.19	0.21	0.22	0.24	0.26	0.28
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	2.51	2.22	1.93	1.63	1.34	1.06	0.78	0.51	0.25	0.00	-0.23	-0.45	-0.65	-0.84	-1.00
D. Daily Max Air Temperature	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**226**	**227**	**228**	**229**	**230**	**231**	**232**	**233**	**234**	**235**	**236**	**237**	**238**	**239**	**240**
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.94	0.94	0.94	0.94	0.94	0.95	0.95	0.95
B. Reservoir Release (STEV6)	0.66	0.64	0.62	0.59	0.57	0.54	0.50	0.47	0.44	0.40	0.36	0.33	0.29	0.25	0.21
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.32	0.32	0.33	0.34	0.35	0.35	0.36	0.37	0.38	0.38	0.39	0.40	0.40	0.41	0.41
B. Previous Day Temp	0.71	0.70	0.69	0.68	0.67	0.66	0.65	0.65	0.64	0.63	0.62	0.61	0.60	0.60	0.59
C. Reservoir Release (STEV6)	-0.10	-0.10	-0.10	-0.10	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.58	0.59	0.60	0.61	0.61	0.61	0.61	0.61	0.61	0.60	0.59	0.59	0.58	0.57	0.55
B. Previous Day Temp	0.42	0.41	0.40	0.39	0.39	0.39	0.39	0.39	0.39	0.40	0.40	0.41	0.42	0.43	0.44
C. Flow (STEV6)	-0.20	-0.21	-0.21	-0.21	-0.21	-0.21	-0.21	-0.21	-0.20	-0.20	-0.19	-0.19	-0.18	-0.17	-0.17
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.33	0.33	0.33	0.33	0.33	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31	0.30	0.30
B. Previous Day Temp	0.65	0.65	0.65	0.65	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.67	0.67
C. Flow (STEV6)	-0.41	-0.41	-0.41	-0.40	-0.40	-0.40	-0.39	-0.39	-0.39	-0.38	-0.38	-0.38	-0.37	-0.37	-0.37
D. Daily Max Air Temperature	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	1.12	1.12	1.12	1.12	1.12	1.12	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.10	1.10
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-1.09	-1.11	-1.12	-1.13	-1.14	-1.14	-1.14	-1.14	-1.13	-1.12	-1.11	-1.10	-1.09	-1.07	-1.05
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.30	0.33	0.35	0.38	0.41	0.44	0.48	0.51	0.54	0.58	0.61	0.65	0.69	0.72	0.76
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	-1.14	-1.26	-1.35	-1.42	-1.46	-1.48	-1.48	-1.46	-1.43	-1.38	-1.31	-1.23	-1.14	-1.04	-0.93
D. Daily Max Air Temperature	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.95	0.95	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
B. Reservoir Release (STEV6)	0.18	0.14	0.10	0.07	0.04	0.01	-0.02	-0.05	-0.07	-0.09	-0.11	-0.12	-0.14	-0.14	-0.14
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.42	0.43	0.43	0.44	0.44	0.45	0.45	0.46	0.46	0.46	0.47	0.47	0.48	0.48	0.48
B. Previous Day Temp	0.58	0.57	0.56	0.55	0.55	0.54	0.53	0.52	0.52	0.51	0.50	0.50	0.49	0.49	0.48
C. Reservoir Release (STEV6)	-0.11	-0.11	-0.11	-0.11	-0.11	-0.10	-0.10	-0.09	-0.09	-0.08	-0.07	-0.07	-0.06	-0.05	-0.04
D. Daily Max Air Temperature	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.54	0.53	0.51	0.50	0.48	0.47	0.45	0.44	0.42	0.41	0.39	0.38	0.37	0.36	0.34
B. Previous Day Temp	0.45	0.47	0.48	0.49	0.51	0.52	0.54	0.55	0.57	0.58	0.59	0.60	0.62	0.63	0.64
C. Flow (STEV6)	-0.16	-0.15	-0.14	-0.13	-0.12	-0.11	-0.09	-0.08	-0.07	-0.06	-0.04	-0.03	-0.02	-0.01	0.01
D. Daily Max Air Temperature	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.30	0.29	0.29	0.29	0.29	0.28	0.28	0.28	0.27	0.27	0.27	0.26	0.26	0.26	0.25
B. Previous Day Temp	0.67	0.67	0.67	0.67	0.67	0.67	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.69
C. Flow (STEV6)	-0.36	-0.36	-0.35	-0.35	-0.34	-0.33	-0.33	-0.32	-0.31	-0.30	-0.30	-0.29	-0.28	-0.26	-0.25
D. Daily Max Air Temperature	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	1.10	1.10	1.10	1.09	1.09	1.09	1.09	1.08	1.08	1.08	1.07	1.07	1.07	1.06	1.06
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-1.03	-1.01	-0.98	-0.96	-0.93	-0.90	-0.87	-0.84	-0.81	-0.77	-0.74	-0.70	-0.67	-0.63	-0.59
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.80	0.83	0.87	0.90	0.94	0.97	1.00	1.03	1.06	1.09	1.11	1.14	1.16	1.18	1.19
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	-0.82	-0.70	-0.57	-0.44	-0.31	-0.18	-0.06	0.07	0.19	0.30	0.41	0.50	0.59	0.67	0.73
D. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Temperature Modeling Technical Memorandum

Santa Clara Valley Water District FAHCE Project

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**256**	**257**	**258**	**259**	**260**	**261**	**262**	**263**	**264**	**265**	**266**	**267**	**268**	**269**	**270**
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.96	0.96	0.96	0.95	0.95	0.95	0.94	0.94	0.94	0.93	0.93	0.92	0.92	0.91	0.91
B. Reservoir Release (STEV6)	-0.14	-0.13	-0.12	-0.10	-0.08	-0.05	-0.02	0.01	0.05	0.09	0.14	0.18	0.23	0.29	0.34
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.49	0.49	0.49	0.49	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
B. Previous Day Temp	0.48	0.47	0.47	0.46	0.46	0.46	0.45	0.45	0.45	0.45	0.45	0.44	0.44	0.44	0.44
C. Reservoir Release (STEV6)	-0.02	-0.01	0.00	0.02	0.03	0.05	0.07	0.09	0.11	0.13	0.15	0.17	0.19	0.21	0.23
D. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.33	0.32	0.32	0.31	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.31	0.31	0.32
B. Previous Day Temp	0.65	0.65	0.66	0.66	0.67	0.67	0.67	0.67	0.66	0.66	0.66	0.65	0.65	0.64	0.63
C. Flow (STEV6)	0.02	0.03	0.05	0.06	0.07	0.09	0.10	0.11	0.12	0.13	0.15	0.16	0.17	0.18	0.19
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.25	0.25	0.25	0.24	0.24	0.24	0.23	0.23	0.23	0.23	0.22	0.22	0.22	0.22	0.22
B. Previous Day Temp	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
C. Flow (STEV6)	-0.24	-0.23	-0.21	-0.20	-0.18	-0.16	-0.15	-0.13	-0.11	-0.09	-0.07	-0.05	-0.04	-0.02	0.00
D. Daily Max Air Temperature	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	1.06	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.01	1.01
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-0.55	-0.52	-0.48	-0.44	-0.40	-0.36	-0.33	-0.29	-0.25	-0.22	-0.18	-0.15	-0.11	-0.08	-0.05
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	1.21	1.22	1.23	1.23	1.24	1.24	1.23	1.23	1.22	1.21	1.20	1.19	1.17	1.16	1.14
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	0.77	0.80	0.82	0.81	0.79	0.74	0.69	0.62	0.53	0.43	0.32	0.21	0.08	-0.06	-0.20
D. Daily Max Air Temperature	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**271**	**272**	**273**	**274**	**275**	**276**	**277**	**278**	**279**	**280**	**281**	**282**	**283**	**284**	**285**
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.90	0.90	0.89	0.89	0.88	0.88	0.87	0.87	0.87	0.86	0.86	0.86	0.85	0.85	0.85
B. Reservoir Release (STEV6)	0.39	0.45	0.50	0.56	0.61	0.66	0.72	0.77	0.82	0.86	0.91	0.95	0.99	1.02	1.06
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.50	0.50	0.50	0.50	0.50	0.49	0.49	0.49	0.48	0.48	0.47	0.47	0.46	0.46	0.45
B. Previous Day Temp	0.44	0.45	0.45	0.45	0.45	0.45	0.46	0.46	0.47	0.47	0.48	0.48	0.49	0.49	0.50
C. Reservoir Release (STEV6)	0.25	0.27	0.29	0.31	0.33	0.35	0.37	0.38	0.40	0.41	0.43	0.44	0.45	0.46	0.47
D. Daily Max Air Temperature	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.32	0.33	0.34	0.34	0.35	0.36	0.37	0.38	0.39	0.40	0.40	0.41	0.42	0.43	0.44
B. Previous Day Temp	0.62	0.61	0.61	0.60	0.59	0.58	0.57	0.56	0.54	0.53	0.52	0.51	0.50	0.49	0.49
C. Flow (STEV6)	0.20	0.21	0.21	0.22	0.23	0.23	0.24	0.24	0.25	0.25	0.25	0.26	0.26	0.26	0.25
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.22	0.22	0.21	0.21	0.21	0.21	0.21	0.21	0.22	0.22	0.22	0.22	0.22	0.22	0.23
B. Previous Day Temp	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.68	0.68	0.68	0.68	0.67	0.67	0.67	0.66
C. Flow (STEV6)	0.02	0.04	0.06	0.07	0.09	0.11	0.12	0.13	0.15	0.16	0.17	0.18	0.18	0.19	0.19
D. Daily Max Air Temperature	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	1.01	1.01	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-0.02	0.01	0.03	0.06	0.08	0.10	0.12	0.13	0.15	0.16	0.17	0.17	0.18	0.18	0.17
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	1.12	1.10	1.08	1.06	1.03	1.01	0.99	0.97	0.94	0.92	0.90	0.88	0.86	0.83	0.82
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	-0.35	-0.50	-0.65	-0.81	-0.97	-1.12	-1.28	-1.43	-1.58	-1.72	-1.86	-1.99	-2.11	-2.23	-2.33
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.85	0.85	0.85	0.85	0.85	0.86	0.86	0.86	0.87	0.87	0.87	0.88	0.88	0.89	0.89
B. Reservoir Release (STEV6)	1.08	1.10	1.12	1.13	1.14	1.14	1.14	1.13	1.12	1.11	1.09	1.07	1.04	1.02	0.99
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.44	0.43	0.43	0.42	0.41	0.40	0.39	0.38	0.37	0.36	0.35	0.33	0.32	0.31	0.30
B. Previous Day Temp	0.51	0.52	0.53	0.53	0.54	0.55	0.57	0.58	0.59	0.60	0.61	0.62	0.63	0.65	0.66
C. Reservoir Release (STEV6)	0.47	0.47	0.48	0.48	0.47	0.47	0.46	0.45	0.44	0.43	0.42	0.41	0.39	0.38	0.36
D. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.45	0.46	0.46	0.47	0.48	0.48	0.49	0.49	0.50	0.50	0.51	0.51	0.51	0.52	0.52
B. Previous Day Temp	0.48	0.47	0.46	0.46	0.45	0.44	0.44	0.44	0.43	0.43	0.43	0.42	0.42	0.42	0.42
C. Flow (STEV6)	0.25	0.25	0.24	0.24	0.23	0.22	0.22	0.21	0.20	0.19	0.17	0.16	0.15	0.14	0.12
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.23	0.23	0.24	0.24	0.25	0.25	0.26	0.27	0.27	0.28	0.29	0.29	0.30	0.31	0.32
B. Previous Day Temp	0.66	0.66	0.65	0.65	0.64	0.63	0.63	0.62	0.62	0.61	0.60	0.60	0.59	0.58	0.57
C. Flow (STEV6)	0.20	0.20	0.20	0.19	0.19	0.18	0.17	0.16	0.15	0.14	0.13	0.11	0.10	0.08	0.07
D. Daily Max Air Temperature	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	0.98	0.98	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.01
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	0.17	0.16	0.14	0.12	0.10	0.08	0.05	0.02	-0.01	-0.04	-0.08	-0.12	-0.16	-0.20	-0.24
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.80	0.78	0.77	0.75	0.74	0.73	0.72	0.71	0.71	0.70	0.70	0.69	0.69	0.69	0.69
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	-2.42	-2.49	-2.56	-2.60	-2.64	-2.66	-2.66	-2.65	-2.64	-2.61	-2.57	-2.52	-2.46	-2.39	-2.32
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.90	0.91	0.91	0.92	0.92	0.93	0.93	0.94	0.94	0.95	0.95	0.96	0.96	0.96	0.97
B. Reservoir Release (STEV6)	0.96	0.93	0.89	0.86	0.82	0.79	0.75	0.72	0.68	0.65	0.61	0.58	0.55	0.52	0.49
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.29	0.28	0.27	0.26	0.24	0.23	0.22	0.22	0.21	0.20	0.19	0.18	0.17	0.17	0.16
B. Previous Day Temp	0.67	0.68	0.69	0.70	0.71	0.72	0.73	0.74	0.75	0.76	0.77	0.78	0.78	0.79	0.79
C. Reservoir Release (STEV6)	0.35	0.33	0.31	0.29	0.27	0.25	0.23	0.21	0.20	0.18	0.16	0.14	0.13	0.11	0.09
D. Daily Max Air Temperature	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.53	0.53	0.54	0.54	0.55	0.55	0.56	0.56	0.57	0.58	0.58	0.59	0.60	0.61	0.62
B. Previous Day Temp	0.41	0.41	0.41	0.41	0.40	0.40	0.39	0.39	0.39	0.38	0.37	0.37	0.36	0.35	0.34
C. Flow (STEV6)	0.11	0.10	0.08	0.07	0.06	0.04	0.03	0.02	0.01	-0.01	-0.02	-0.03	-0.04	-0.05	-0.06
D. Daily Max Air Temperature	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.33	0.33	0.34	0.35	0.36	0.37	0.38	0.38	0.39	0.40	0.41	0.42	0.42	0.43	0.44
B. Previous Day Temp	0.57	0.56	0.55	0.55	0.54	0.53	0.52	0.52	0.51	0.50	0.50	0.49	0.48	0.48	0.47
C. Flow (STEV6)	0.05	0.03	0.02	0.00	-0.02	-0.03	-0.05	-0.06	-0.08	-0.09	-0.10	-0.11	-0.12	-0.13	-0.14
D. Daily Max Air Temperature	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	1.01	1.01	1.01	1.02	1.02	1.02	1.03	1.03	1.04	1.04	1.04	1.05	1.05	1.05	1.06
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-0.28	-0.33	-0.37	-0.42	-0.46	-0.50	-0.55	-0.59	-0.63	-0.68	-0.72	-0.75	-0.79	-0.82	-0.86
D. Daily Max Air Temperature	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.69	0.69	0.69	0.69	0.70	0.70	0.70	0.71	0.71	0.72	0.72	0.72	0.73	0.73	0.74
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	-2.24	-2.15	-2.06	-1.96	-1.86	-1.76	-1.66	-1.55	-1.44	-1.33	-1.22	-1.12	-1.01	-0.91	-0.81
D. Daily Max Air Temperature	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.08
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Temperature Modeling Technical Memorandum
Santa Clara Valley Water District FAHCE Project

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.96	0.96	0.96	0.95	0.95	0.94	0.94
B. Reservoir Release (STEV6)	0.47	0.45	0.43	0.41	0.40	0.39	0.38	0.38	0.38	0.38	0.39	0.40	0.41	0.42	0.43
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.16	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.16	0.16	0.17	0.17	0.18	0.18
B. Previous Day Temp	0.80	0.80	0.80	0.81	0.81	0.81	0.80	0.80	0.80	0.79	0.79	0.78	0.78	0.77	0.76
C. Reservoir Release (STEV6)	0.08	0.07	0.06	0.04	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.63	0.64	0.66	0.67	0.69	0.70	0.72	0.73	0.75	0.77	0.79	0.81	0.83	0.85	0.87
B. Previous Day Temp	0.33	0.32	0.31	0.29	0.28	0.26	0.25	0.23	0.21	0.19	0.17	0.15	0.13	0.11	0.09
C. Flow (STEV6)	-0.06	-0.07	-0.08	-0.08	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.08	-0.08	-0.08	-0.07
D. Daily Max Air Temperature	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.44	0.45	0.46	0.46	0.47	0.47	0.48	0.48	0.49	0.49	0.50	0.50	0.50	0.50	0.51
B. Previous Day Temp	0.47	0.46	0.46	0.45	0.45	0.44	0.44	0.44	0.43	0.43	0.43	0.43	0.43	0.42	0.42
C. Flow (STEV6)	-0.14	-0.14	-0.14	-0.14	-0.14	-0.13	-0.12	-0.11	-0.10	-0.09	-0.07	-0.06	-0.04	-0.02	0.00
D. Daily Max Air Temperature	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	1.06	1.06	1.07	1.07	1.07	1.08	1.08	1.08	1.08	1.08	1.09	1.09	1.09	1.09	1.09
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-0.89	-0.91	-0.94	-0.96	-0.98	-0.99	-1.00	-1.01	-1.01	-1.02	-1.01	-1.01	-1.00	-0.99	-0.98
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.74	0.74	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.74	0.74	0.74
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	-0.72	-0.63	-0.55	-0.47	-0.40	-0.34	-0.28	-0.23	-0.19	-0.15	-0.11	-0.08	-0.06	-0.04	-0.03
D. Daily Max Air Temperature	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.13	0.13	0.14	0.15	0.15	0.16
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Temperature Modeling Technical Memorandum
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Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	**331**	**332**	**333**	**334**	**335**	**336**	**337**	**338**	**339**	**340**	**341**	**342**	**343**	**344**	**345**
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.93	0.93	0.92	0.92	0.91	0.91	0.90	0.90	0.89	0.88	0.88	0.88	0.87	0.87	0.86
B. Reservoir Release (STEV6)	0.44	0.46	0.47	0.49	0.51	0.53	0.55	0.57	0.58	0.60	0.62	0.64	0.66	0.67	0.68
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30	0.31	0.32	0.33
B. Previous Day Temp	0.75	0.74	0.74	0.73	0.72	0.71	0.69	0.68	0.67	0.66	0.65	0.64	0.63	0.62	0.60
C. Reservoir Release (STEV6)	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.06	0.06	0.07	0.07	0.08	0.08
D. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	0.89	0.91	0.93	0.95	0.97	0.98	1.00	1.02	1.04	1.05	1.07	1.09	1.10	1.11	1.13
B. Previous Day Temp	0.06	0.04	0.02	0.00	-0.02	-0.04	-0.06	-0.08	-0.10	-0.12	-0.14	-0.15	-0.17	-0.18	-0.20
C. Flow (STEV6)	-0.07	-0.06	-0.05	-0.05	-0.04	-0.03	-0.03	-0.02	-0.01	-0.01	0.00	0.01	0.01	0.02	0.02
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.51	0.51	0.51	0.52	0.52	0.52	0.52	0.52	0.52	0.53	0.53	0.53	0.53	0.53	0.53
B. Previous Day Temp	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
C. Flow (STEV6)	0.02	0.04	0.06	0.09	0.11	0.13	0.15	0.17	0.20	0.22	0.24	0.26	0.28	0.29	0.31
D. Daily Max Air Temperature	0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.08	1.08	1.08	1.08	1.07	1.07
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-0.96	-0.94	-0.92	-0.90	-0.87	-0.84	-0.81	-0.78	-0.74	-0.70	-0.66	-0.62	-0.57	-0.53	-0.48
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.74	0.73	0.73	0.72	0.72	0.71	0.71	0.70	0.70	0.69	0.69	0.68	0.67	0.67	0.66
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	-0.01	-0.01	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.03	-0.04	-0.05	-0.07	-0.08	-0.09	-0.11
D. Daily Max Air Temperature	0.16	0.17	0.17	0.18	0.19	0.19	0.20	0.20	0.21	0.22	0.22	0.23	0.23	0.24	0.25
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
Outlet - DS Stevens Creek Reservoir															
A. Intake Temp (from profile)	0.86	0.86	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.86	0.86
B. Reservoir Release (STEV6)	0.70	0.71	0.72	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.72	0.71	0.70	0.69	0.68
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44															
A. Upstream Temp (Outlet)	0.34	0.36	0.37	0.38	0.39	0.40	0.41	0.42	0.43	0.44	0.45	0.46	0.47	0.48	0.49
B. Previous Day Temp	0.59	0.58	0.57	0.56	0.55	0.54	0.53	0.52	0.51	0.50	0.49	0.48	0.47	0.46	0.46
C. Reservoir Release (STEV6)	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.10
D. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff															
A. Upstream Temp (STEV6)	1.14	1.15	1.15	1.16	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.16	1.16	1.15
B. Previous Day Temp	-0.21	-0.22	-0.23	-0.23	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.23	-0.22	-0.22	-0.21	-0.20
C. Flow (STEV6)	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03
D. Daily Max Air Temperature	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280															
A. Upstream Temp (STEV5)	0.53	0.53	0.53	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.55	0.55	0.55	0.55	0.55
B. Previous Day Temp	0.42	0.42	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.40
C. Flow (STEV6)	0.32	0.34	0.35	0.36	0.37	0.37	0.38	0.38	0.38	0.38	0.37	0.37	0.36	0.36	0.35
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave															
A. Upstream Temp (STEV4)	1.06	1.06	1.05	1.04	1.04	1.03	1.02	1.01	1.01	1.00	0.99	0.98	0.97	0.96	0.94
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	-0.42	-0.37	-0.32	-0.26	-0.20	-0.14	-0.08	-0.02	0.05	0.11	0.18	0.25	0.32	0.39	0.46
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real															
A. Upstream Temp (STEV3)	0.65	0.65	0.64	0.63	0.62	0.62	0.61	0.60	0.60	0.59	0.58	0.57	0.57	0.56	0.55
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	-0.12	-0.13	-0.15	-0.16	-0.17	-0.17	-0.18	-0.18	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.18
D. Daily Max Air Temperature	0.25	0.26	0.26	0.27	0.28	0.28	0.29	0.30	0.30	0.31	0.31	0.32	0.33	0.33	0.34
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Attachment C - Stevens Creek

DAILY REGRESSION COEFFICIENTS FOR TEMPERATURE MODEL

Day of Year ->	361	362	363	364	365	366
Outlet - DS Stevens Creek Reservoir						
A. Intake Temp (from profile)	0.87	0.87	0.88	0.88	0.89	0.89
B. Reservoir Release (STEV6)	0.66	0.65	0.63	0.61	0.59	0.57
C. Daily Max Air Temperature	0.00	0.00	0.00	0.00	0.00	0.00
D. Constant	0.00	0.00	0.00	0.00	0.00	0.00
STEV6 - SF44						
A. Upstream Temp (Outlet)	0.50	0.51	0.52	0.53	0.54	0.55
B. Previous Day Temp	0.45	0.44	0.43	0.42	0.42	0.41
C. Reservoir Release (STEV6)	0.10	0.10	0.09	0.09	0.09	0.08
D. Daily Max Air Temperature	0.02	0.02	0.02	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00
STEV5 - US Deep Cliff						
A. Upstream Temp (STEV6)	1.14	1.13	1.12	1.11	1.10	1.09
B. Previous Day Temp	-0.19	-0.17	-0.16	-0.15	-0.13	-0.11
C. Flow (STEV6)	0.02	0.02	0.01	0.01	0.00	-0.01
D. Daily Max Air Temperature	0.03	0.03	0.03	0.02	0.02	0.02
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00
STEV4 - US 280						
A. Upstream Temp (STEV5)	0.55	0.56	0.56	0.56	0.56	0.56
B. Previous Day Temp	0.40	0.40	0.40	0.40	0.40	0.39
C. Flow (STEV6)	0.34	0.33	0.32	0.30	0.29	0.27
D. Daily Max Air Temperature	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00
STEV3 - Fremont Ave						
A. Upstream Temp (STEV4)	0.93	0.92	0.91	0.90	0.88	0.87
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV6)	0.54	0.61	0.69	0.77	0.84	0.92
D. Daily Max Air Temperature	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00
STEV2 - El Camino Real						
A. Upstream Temp (STEV3)	0.54	0.54	0.53	0.52	0.51	0.51
B. Previous Day Temp	0.00	0.00	0.00	0.00	0.00	0.00
C. Flow (STEV2)	-0.18	-0.17	-0.17	-0.16	-0.15	-0.15
D. Daily Max Air Temperature	0.34	0.35	0.36	0.36	0.37	0.38
E. Constant	0.00	0.00	0.00	0.00	0.00	0.00

Appendix J

White Paper on Work Flow of the HEC-RAS Cross Section Analysis

Appendix J – White Paper on Work Flow of the HEC-RAS Cross Section Analysis

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WHITE PAPER ON WORK FLOW OF THE HEC-RAS CROSS SECTION ANALYSIS

Valley Water

Clean Water • Healthy Environment • Flood Protection

WHITE PAPER ON WORKFLOW OF HEC-RAS CROSS SECTION ANALYSIS

SUBMITTED TO SUPPORT THE EIR SUBMISSION

Submitted to:

Valley Water

Prepared by:

The Stockholm Environmental Institute

Language:

The document is in English

Date:

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DISCLAIMER:

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I. Introduction

This documents presents the work flow followed in order to use the existing HEC-RAS cross section data that Valley Water has developed over the years as input data for the habitat analysis being performed as part of the Fisheries and Aquatic Habitat Collaborative Effort ("FAHCE") Modeling Study Plan. The document incudes a description of the HEC-RAS models, the field data collected in early 2016 and the integration of this data into HEC-RAS to obtain relationships between flow and depth, with and velocity which are necessary of the habitat analysis. The document also presents a description of the theory used for the geomorphic analysis of the HEC-RAS cross sections, and how this information was used to select representative cross sections for the Three Creeks (Coyote Creek, Guadalupe River, and Stevens Creek). The final sections of the report include the final results of the habitat classification of the reaches, and the incorporation of the field based structural metrics into the implementation of the habitat analysis in WEAP.

Note a separate environmental impact study for the Coyote Creek system will be conducted for the Anderson Dam Seismic Retrofit Project (ADSRP). Only the data related to the cluster analysis for the Three Creek Systems has been included for Coyote Creek in this submission, with the remainder of the information for Coyote Creek to be included in the future ADSRP submission.

II. HEC-RAS Models

Numerous pre-existing HEC-RAS models of Santa Clara rivers and creeks were provided by Valley Water for use in this analysis. The models are comprised of past field surveys of various ages and sources, and therefore there is no complete, up-to-date single model of the entire system. The models, characteristics, and their applicability to this effort are listed in Table 1.

Table 1. Summary of Existing HEC-RAS Models

Model	Model Extent	Date of Surveys	Notes
Alamitos Creek	Lake Almaden to ~3mi below Almaden Res. Also includes lower part of Calero Ck	2013 – 2014	Used in Analysis (Extended extent up to reservoir)
Lower Coyote Ck	SF Bay to Montague Bridge	2011	Used in Analysis
Mid Coyote	Montague Bridge to Hwy 280	2014 – 2015	Used in Analysis
Upper Coyote	Hwy 280 to Anderson Res.	2014	Used in Analysis
Guadalupe Ck	Confluence with Guad R. to ~3mi beneath Guadalupe Res.	1999	Used in Analysis (Extended extent up to reservoir)
Guadalupe River	Entire river, lower 2 miles of Los Gatos Creek	1999	Used in Analysis
Los Gatos Creek Partial	Middle portion of Los Gatos Creek	1978	Not used in analysis due to age of surveys
ESA_LosGatosCk	Confluence with Guadalupe R. to Vasona Res.	2015	Used in Analysis
ESA_StevensCk	SF Bay to Hwy 101	2009	Used in Analysis
ESA_StevensCk	Hwy 101 to Hwy 237	2008 – 2009, 2014	Used in Analysis
ESA_StevensCk	Hwy 237 to Stevens Ck Rsrvr	2015	Used in Analysis
Stevens Creek	SF Bay to ~1mi below Stevens Ck Res.	1982	Only used for STEV3 passage XS which is on the concrete apron below the Fremont Ave. fish ladder, and assumed to have stayed hydraulically constant since 1982
Upper Penitencia Creek		2012	Used in Analysis

III. RTK GPS Low-Flow Stream Surveys (2016)

The stream surveys conducted by Valley Water meant to capture the low-flow hydraulic conditions near the POIs are listed in Table 2. All orange and yellow cells indicate the locations at which these surveys were conducted, and which HEC-RAS models they were stitched into.

Table 2. HEC-RAS Cross Sections used for POIs

POI	**HEC-RAS XS Type**	**Range of Flow (cfs)**	**Reason for no Field Survey**
COYO1	No field transect, use existing XS	5-15000	Only deep, standing pools exist in vicinity
COYO2	New Field Survey. Stitched into internal bridge (Berryessa Rd) XS 15827 US & DS from sta 82 to 137 (US) & 68 to 123 (DS) to 1051.1	0-15000	
COYO3	New Field Survey. DS of XS 21400	0 -275	
COYO4	No field transect, use existing XS (DS Singleton Rd barrier)	0-15000	Singelton Road (Planned for Removal)
COYO5	New Field Survey. Stitched into internal bridge XS 139790 US & DS from sta 988.38 to 1051.1	0-15000	
COYO6	New Field Survey. Stitched into internal bridge XS 163780 US & DS from sta 965 to 1011.36	0-15000	
COYO7	No field transect, use existing XS	0-15000	Only deep, standing pools exist in vicinity
COYO8	New Field Survey DS of 201957	0-175	
COYO9	New Field Survey US of 220898	0-300	
COYO10	New Field Survey US of 222144	0-275	
UPEN1	No field transect, use existing XS	0-7500	Upper Pen was excluded from field surveys due to uncertainty surrounding the utility of such data on Upper Penitencia Creek, given the absence of District reservoirs on the creek
UPEN2	No field transect, use existing XS	0-15000	Upper Pen was excluded from field surveys due to uncertainty surrounding the utility of such data on Upper Penitencia Creek, given the absence of District reservoirs on the creek
UPEN3	No field transect, use existing XS	0-3500	Upper Pen was excluded from field surveys due to uncertainty surrounding the utility of such data on Upper Penitencia Creek, given the absence of District reservoirs on the creek
UPEN4	No field transect nor model (used DEM)	0-15000	Upper Pen was excluded from field surveys due to uncertainty surrounding the utility of such data on Upper Penitencia Creek, given the absence of District reservoirs on the creek
GUAD1	No field transect, use existing XS	0-4500	Only deep, standing pools exist in vicinity
GUAD2	No field transect, use existing XS	0-4500	Only deep, standing pools exist in vicinity

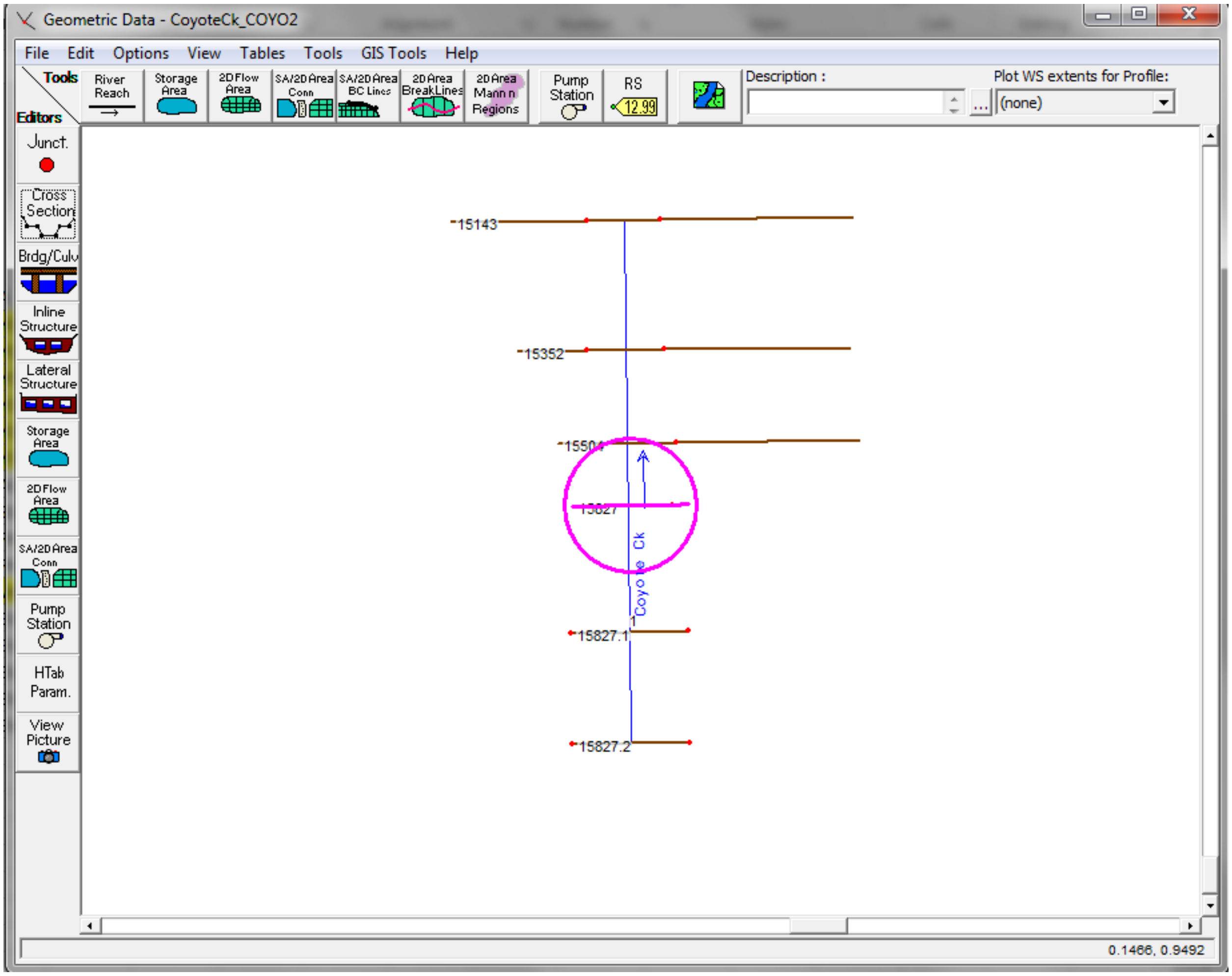
GUAD3	New Field Survey US of 15870	0-200	
GUAD4	New Field Survey DS of 19240	0-100	
GUAD5	New Field Survey DS of 20679	0-750	
GUAD6	New Field Survey DS of 95000	0-350	
GUAD7	New Field Survey DS of 102400	0-175	
LOSG1	New Field Survey Stitched into internal bridge XS 84.52499 US & DS from sta 21 to 71	0-4500	
LOSG2	New Field Survey US of all existing XSs	0-175	
GCRK1	New Field Survey just US of XS 1010 (intersects it)	0-325	
GCRK2	New Field Survey 28 ft DS of XS 1270	0-350	
GCRK3	New Field Survey US of all existing XSs	0-1000	
GCRK4	New Field Survey US of all existing XSs (out of model extent)	0-350	
ALAM1	New Field Survey US of 636.6389 (intersects it)	0-40	
ALAM2	New Field Survey US of 14839.1*	0-225	
ALAM3	New Field Survey US of 16737.4*	0-2000	
ALAM4	New Field Survey US of 21469.59 (out of model extent)	0-250	
CALE1	New Field Survey US of 1547.48*	0-100	
CALE2	No field transect nor model (use DEM)	0-350	Only deep, standing pools exist in vicinity
STEV1	New Field Survey US of 13220	0-500	
STEV2	New Field Survey Stitched into internal bridge XS 21131.5 US & DS from sta 981.1 to 1019.1	0-4500	
STEV3	No field transect, use existing XS (Fremont Denil Fish Ladder Barrier)	0-10500	Fremont Ave Fish Ladder here is the primary barrier, not riffles
STEV4	New Field Survey US of 45979	0-350	
STEV5	New Field Survey DS of 56545	0-300	
STEV6	New Field Survey US of last XS 62725	0-150	

IV. Integration of RTK Surveys into HEC-RAS models

The fact that many of the RTK surveys at the various POIs were done in 2016, and the pre-existing HEC-RAS models were originally constructed anywhere between 1999 – 2015 meant that oftentimes attempting to stitch the new stream cross-section (XS) into the pre-existing model would result in abrupt changes in stream-bed elevation. It should also be noted that the pre-existing models were constructed for use in flood risk analysis primarily and therefore are also generally lacking in low-flow stream-bed topographic resolution. As a result, smaller topographic features are often smoothed out in the pre-existing XSs, contributing to the incongruence between the new high-resolution RTK surveys and the pre-existing ones. Therefore, in hindsight, it would have been worthwhile to obtain current RTK surveys not just at the locating of interest, but also at multiple locations up and down-stream of each location of interest to assist in the embedding of these new surveyed XSs in the older and larger models.

However, a work-around employed was to isolate the area of concern surrounding each new RTK survey and construct a “mini” HEC-RAS models of just that small stretch of river, generally 1000-2000 feet in length. This process was done to produce stable hydraulic conditions at the locations of the new surveys. However, this process was subject to speculation regarding the situation and selection of neighboring XSs up and down-stream and therefore is a source of uncertainty regarding the hydraulic conditions at the POIs.

Table 3., Example of the mini model constructed for COYO2 on Coyote Creek (RTK survey circled)



Description :

Plot WS extents for Profile: (none)

Generally, the procedure of constructing these mini models consisted of taking the nearest 3-4 XSs from the previous HEC-RAS model and smoothing out any drastic, unrealistic jump in bed elevation from one XS to the next. The original bed slope was maintained. The following POIs were subject to this mini model construction (Table 4)

Table 4. POIs where mini HEC-RAS models where constructed

COYO2
COYO3
COYO5
COYO6
COYO8
COYO9
GUAD5
LOSG1
GCRK1
GCRK2
ALAM3
STEV1
STEV2
STEV4
STEV5
STEV6

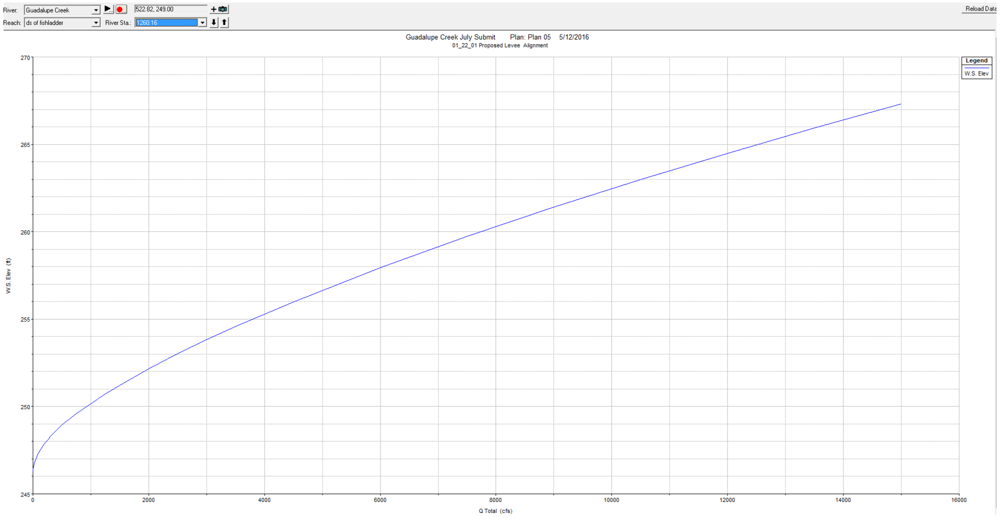
V. HEC-RAS Model Results

All HEC-RAS models were run for 42 different flows ranging from 0.1 to 15000cfs. These flows were arbitrarily chosen, but ensured that the full range of low, moderate, and high flow hydraulics were captured at each POI. Due to the fact that this analysis is more greatly concerned with studying low-flow hydraulics, a greater frequency of low flows was represented in this flow regime, with 15 flow values represented between 0.1 and 100cfs. Many XSs, especially those newly surveyed RTK surveys only have topography which captures flows of a certain discharge. These flow limits can be seen in Table 1.

The model results at each of these flows for every XS consisted of water surface, main channel average velocity, cross-sectional flow area, wetted width, top water surface area between current XS and next downstream XS, and the portion of discharge occurring outside of the main channel.

However, there was need to calculate certain hydraulic variables at smaller increments along the XSs than merely just the XS-wide (i.e. the thalweg). Therefore, after calculating the results from HEC-RAS, the data was imported in R to emulate hydraulic calculations carried out by HEC-RAS, but at smaller 2-ft intervals along each XS. From these outputs, it was possible to choose the depths and velocities at the deepest 2-ft slice (deemed to be the thalweg), and also any other desired metrics for biological fish assessment.

Rating curves for all of these variables were produced and input into WEAP.



River: Guadalupe Creek

Reach: ds of fishladder

River Sta.: 1260.16

Figure 1. Rating Curves from HEC-RAS input into WEAP

A. Depth Estimate Validation

One way to verify the validity of using HEC-RAS outputs for habitat variables estimates is to compare the results of depths from the model to observations. Unfortunately, there exist very few field measurements of water depth at the precise locations of each of the POI sites that can serve to validate estimated depth outputs from HEC-RAS. However, prior to the 28 RTK riffle surveys, there were a total of 11 critical riffle analysis (CRA) surveys carried out by the District, in which a riffle near a POI was identified and surveyed at 1 - 3 different flows, detailing the water depth along the survey transect. The POIs at which these CRA surveys were carried out are shown below in Table 5. These 11 riffles are located at the same POIs that would later undergo RTK surveys, and therefore provide some opportunity to compare our estimates of depths from HEC-RAS (which utilizes the RTK survey data) with observed depths from the CRA analyses. It should be made clear, however, that the CRA survey transects were not necessarily linear and perpendicular to streamflow, as was the case with the RTK transects, but instead followed the course of the riffle crest, or the shallowest line along the riffle. Therefore, while both the CRA and RTK transects were done on the same riffles, they are not identical, with the RTK transects likely capturing more areas of deeper water due to the fact that they do not perfectly track the riffle crest. This incongruence makes a 1-to-1 comparison of modeled depths from the RTK transects with observed depths along the CRA depths impossible, but doing a rough comparison nonetheless provides reassurance that the HEC-RAS model is generally capturing similar magnitudes of average depths, as summarized below (Table 5). Note that Coyote Creek is absent from Table 5, as a separate environmental impact study will be conducted for the Anderson Dam Seismic Retrofit Project (ADSRP).

Table 5. Comparison of Average Depths as observed in CRA surveys with those modeled by HEC-RAS

		AVERAGE DEPTH			
POI	**Q [cfs]**	**Observed (CRA) [ft]**	**HEC-RAS (RTK) [ft]**	**Sim - Obs [ft]**	**% Diff**
ALAM2	11.4	0.39	0.32	**-0.07**	**-18%**
	14.9	0.38	0.36	**-0.02**	**-5%**
	26.5	0.49	0.48	**-0.01**	**-2%**
ALAM3	12.0	0.27	0.25	**-0.02**	**-7%**
	71.0	0.64	0.63	**-0.01**	**-2%**
CALE1	2.6	0.26	0.18	**-0.08**	**-31%**
	14.2	0.53	0.52	**-0.01**	**-2%**
	20.5	0.56	0.63	**0.07**	**13%**
GCRK1	20.8	0.50	0.46	**-0.04**	**-8%**
	22.3	0.49	0.47	**-0.02**	**-4%**
	31.7	0.58	0.58	**0.00**	**0%**
GCRK3	14.3	0.40	0.28	**-0.12**	**-30%**
	15.2	0.42	0.29	**-0.13**	**-31%**
	33.4	0.54	0.44	**-0.10**	**-19%**
GUAD3	25.62	0.65	0.62	**-0.03**	**-5%**
LOSG1*	5.6	0.22	0.27	**0.05**	**23%**
	20.4	0.41	0.46	**0.05**	**12%**
	52.2	0.75	0.64	**-0.11**	**-15%**
STEV1	1.0	0.11	0.18	**0.07**	**64%**
	11.2	0.38	0.56	**0.18**	**47%**
	37.1	0.62	0.98	**0.36**	**58%**
STEV2	8.4	0.45	0.47	**0.02**	**4%**
	11.7	0.44	0.56	**0.12**	**27%**
	73.4	1.10	1.43	**0.33**	**30%**
STEV4	1.4	0.16	0.22	**0.06**	**38%**
	2.8	0.19	0.29	**0.10**	**53%**
	13.1	0.45	0.52	**0.07**	**16%**
	14.9	0.46	0.56	**0.10**	**22%**
	16.5	0.49	0.59	**0.10**	**20%**
STEV5	2.4	0.26	0.19	**-0.07**	**-27%**
	18.2	0.58	0.46	**-0.12**	**-21%**
	36.9	0.75	0.65	**-0.10**	**-13%**
STEV6	2.5	0.20	0.15	**-0.05**	**-25%**
	15.9	0.51	0.53	**0.02**	**4%**
	41.4	0.80	0.92	**0.12**	**15%**
			Avg Model Bias:	**0.02**	**5%**

As is evident from Table 5, the HEC-RAS estimates of average depths along the RTK transects at these 11 POIs are fairly similar to the average depths along the corresponding CRA transects. Some estimates are higher, and others lower, but again it is difficult to draw conclusions about model accuracy at these locations, due to the incongruence between the CRA and RTK transects. The fact that overall, there is a slight high average bias (5%) is sensible, due to the fact that we would expect the CRA average depths to reflect the shallowest possible depths within the riffle, with the RTK transects prone to capturing a higher diversity of depths, likely leading to a slightly higher average depth. Using STEV5 as an example, the difference in shape of the CRA and RTK transects at the same riffle is illustrated in Figure 2.

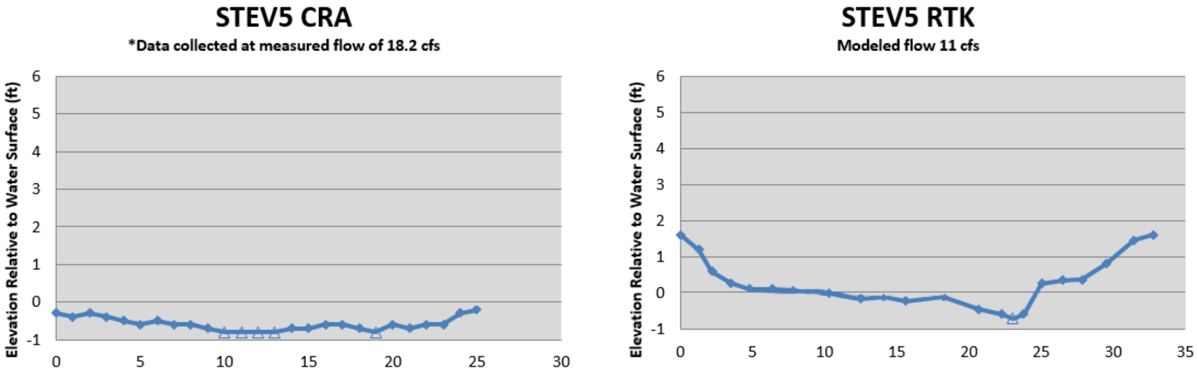


Figure 2. CRA and RTK transects at STEV5

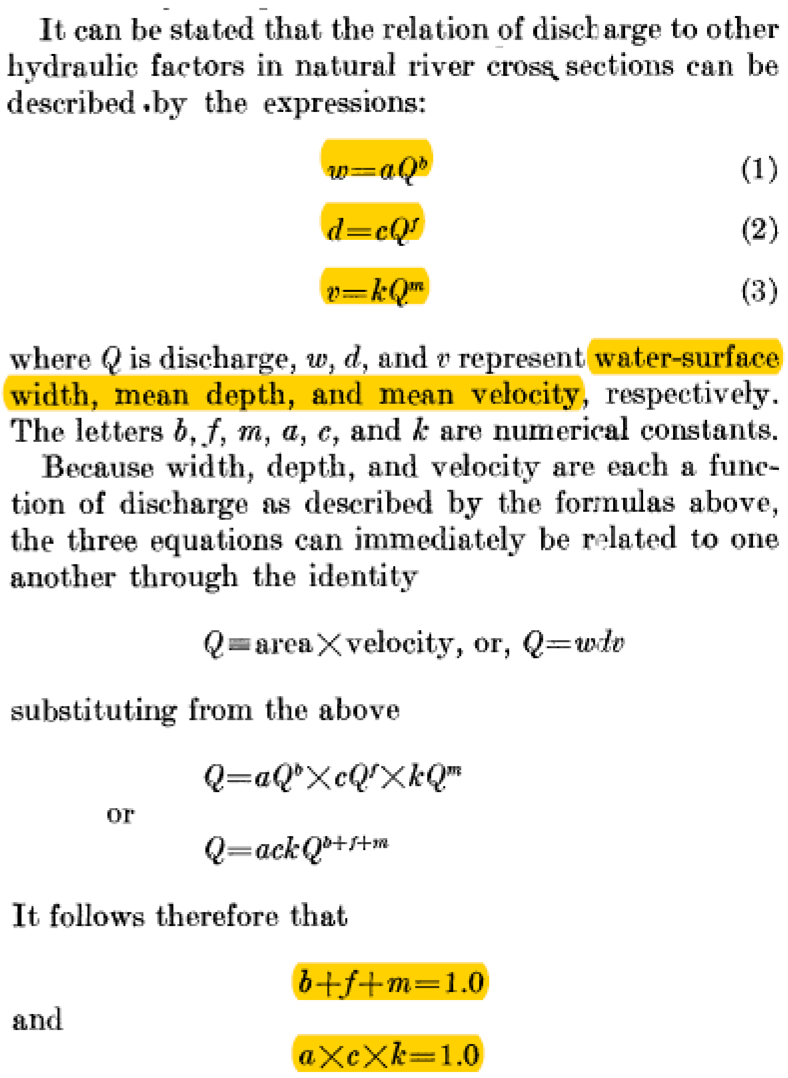
It can be clearly seen from Figure 2 that the differences between the CRA and RTK transect shapes will produce different average depth values, making a direct comparison between the two impossible, but nonetheless the similar magnitudes of values suggests the HEC-RAS models are at least reasonably well-calibrated. Additional field data collected can be used to further verity these relationships.

VI. Geomorphic Analysis from HEC-RAS Results

With these flow-depth, flow-velocity, and flow-width relationships at all XSs in the HEC-RAS models, it was possible to conduct some exploratory analysis to discern geomorphic groupings and trends of these XSs. This consisted of the following steps:

A. Initial Analysis and Scientific Context

Fitting each of these ratings curves for every XS to power law functions as described by Leopold (1953):



It can be stated that the relation of discharge to other hydraulic factors in natural river cross sections can be described by the expressions:

$$w=aQ^{b} \quad (1)$$

$$d=cQ^{f} \quad (2)$$

$$v=kQ^{m} \quad (3)$$

where Q is discharge, w, d, and v represent water-surface width, mean depth, and mean velocity, respectively. The letters b, f, m, a, c, and k are numerical constants.

Because width, depth, and velocity are each a function of discharge as described by the formulas above, the three equations can immediately be related to one another through the identity

$$Q=\text{area}\times\text{velocity, or, } Q=wdv$$

substituting from the above

$$Q=aQ^{b}\times cQ^{f}\times kQ^{m}$$

or

$$Q=ackQ^{b+f+m}$$

It follows therefore that

$$b+f+m=1.0$$

and

$$a\times c\times k=1.0$$

Therefore, at every XS, exponent values of b, f, m and constant values of a, c, k, for width, depth, and velocity, respectively, were obtained. The objective was to identify XSs with similar values of these variables, which would indicate that they are geomorphically similar. In general, for fish habitat, identifying morphological units (MUs) along a river or stream is essential for assessing habitat and passage. Such MUs of concern are riffles, pools, and runs/glides/flatwater units. These MUs and their depth and velocity characteristics at base flow in the Lower Yuba River are depicted by Pasternack et al. (2012) (Figure 3):

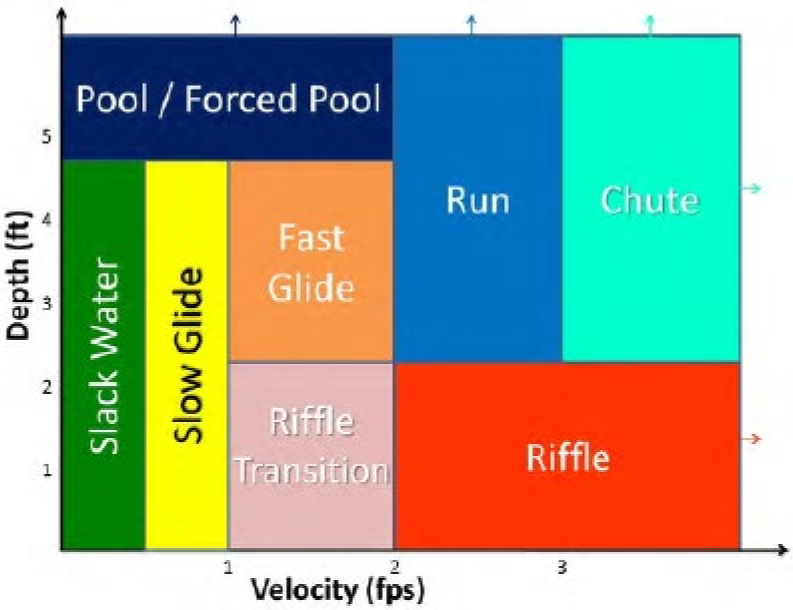


Figure 3. Classification of MUs based on velocity and depth (from Wyrick and Pasternack 2012)

The exponent values b,f, and m indicate the *rate* at which the width, depth, and velocity, respectively, are increasing for a given XS, while the coefficient values a, c, and k are more representative of the initial width, depth, and velocity conditions at each XS. In fact, the a, c, and k values themselves are the actual width, depth, and velocity values when Q = 1cfs.

In general, the following is understood to be typical behavior of these three major MUs:

Table 6. Typical Behavior of MUs

MU	**Velocity**	**Depth**
Riffle	High initial value, slow rate of increase as flow increases (high k, low m)	Low initial value, high rate of depth increase as flow increases (low c, high f)
Run/Glide	Moderate initial value, moderate rate of increase (moderate k, moderate m)	Moderate initial value, moderate rate of increase (moderate c, moderate f)
Pool	Low initial value, high rate of increase (low k, high m)	High initial value, slow rate of increase (high c, low f)

It should be noted that the classification of MUs is more strongly dictated by depth and velocity generally than by XS width, which is why in this analysis emphasis is placed on depth and velocity characteristics and classification. The next step was to verify if this behavior was being reflected by the actual XS data, and if there were evident groupings of XSs that may allow for generalized MU classification based solely upon these b,f,m and a,c,k values

B. Cluster Analysis of XS data - Theory

Once all of these b,f,m and a,c,k values were found for each HEC-RAS XS, they could be visualized in various ways. The b,f,m exponent values can be plotted on a ternary plot due to the fact that they sum to 1. The ternary plot of all the b,f,m values of the roughly 2650 XSs across all the HEC-RAS models below in Figure 4:

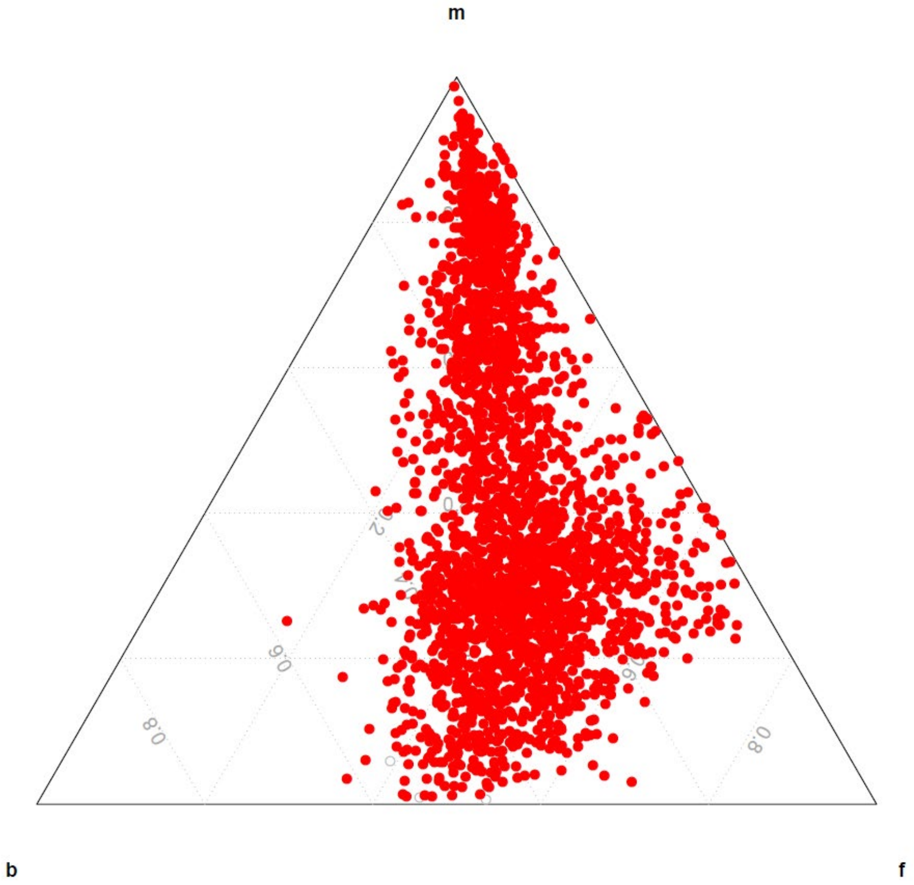


Figure 4. Ternary Plot of all HEC-RAS Cross Sections

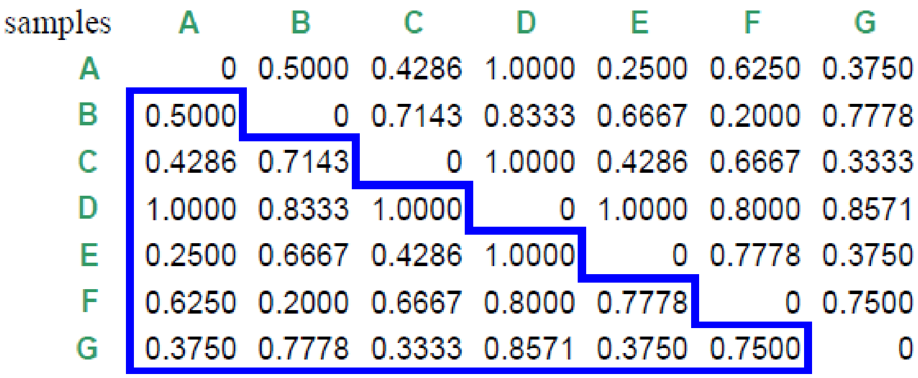
The question is then whether or not these XSs can be delineated into some natural groupings according to commonalities of these b,f,m values as well as the a,c,k values. This meant performing a hierarchical cluster analysis upon these XSs based on these values in order to discover any naturally occurring groups or “clusters” that may be reflective of riffle, run, pool behavior amongst the XSs.

Briefly, cluster analysis consists of selecting a number of characteristic variables for each sample site (in this case stream XSs) which are shared by all sites. In this case the variables selected initially were all six b,f,m and a,c,k values. However, following some analysis of results, it was deemed that the width-related variables were less pertinent to MU clustering and therefore were removed, leaving the 4 variables of f,m,c,k. Therefore, each XS has 4 potential variables to exhibit similarities or difference with other XSs. Cluster analysis requires that one measure of “similarity” between each sample site be computed, which entails aggregating all 4 variables of the sites into one "distance" matrix, where the Euclidean distance between all four variables is computed for each pair of sites.

Equation 1: $$d(XS_1, XS_2) = \sqrt{(f_1 - f_2)^2 + (m_1 - m_2)^2 + (c_1 - c_2)^2 + (k_1 - k_2)^2}$$

- Where XS_1 and XS_2 are two given XSs
- f, m are the exponent power-law fit values for those two XSs
- c, k are log-normalized values (in order to get these values on a scale between 0 and 1 like the f and m values) of the original c, and k power-law fit coefficients

The resultant "distance" or "dissimilarity" value computed between each pair of XSs is then used to begin the clustering process. The resultant matrix of distance between XSs may look something like this:



samples	A	B	C	D	E	F	G
A	0	0.5000	0.4286	1.0000	0.2500	0.6250	0.3750
B	0.5000	0	0.7143	0.8333	0.6667	0.2000	0.7778
C	0.4286	0.7143	0	1.0000	0.4286	0.6667	0.3333
D	1.0000	0.8333	1.0000	0	1.0000	0.8000	0.8571
E	0.2500	0.6667	0.4286	1.0000	0	0.7778	0.3750
F	0.6250	0.2000	0.6667	0.8000	0.7778	0	0.7500
G	0.3750	0.7778	0.3333	0.8571	0.3750	0.7500	0

Figure 5. Example of Distance Matrix in Cluster Analysis (Greenacre 2014)

In the above Figure 5 the samples A – G can be thought of as 7 different XSs. The d(A,B) distance value computed from Equation 1 between XSs A and B is 0.5, while between A and E is it 0.25 and so forth for all possible combinations. Therefore, the resultant distance (again not geographical distance, but distance between this suite of physical variables) matrix mirrors itself along the identity diagonal. In order to begin clustering these XSs into groups, the first step is to identify which XS pair exhibits the lowest distance value, or are the most "similar". In the above case, that would be XSs B and F which only exhibit a distance value of 0.2. Therefore, XSs B and F are joined into the same initial cluster.

The following steps to continue the cluster analysis can be done in a number of ways, and requires choosing one of a number of "linkage methods". These various linkage methods determine how the next sample site will be grouped with respect to this first grouped pair. Regardless of what linkage method is chosen, the above first step is uniform across all of them. There are three common "linkage" methods: *complete, average, and single* linkage. Each of them employs a different method of choosing which XS should be next included in the cluster along with the first pair. As the number of XSs in the cluster grows, the number of different distance values from all other outside XSs grows as well.

For example, now that B and F are in a cluster, there are two distance values from this cluster to all other XSs. B and A has a distance of 0.5 and F and A has a difference of 0.625. Therefore, what should be considered as the singular distance from the B,F cluster and A?

- *Complete Linkage* defines this distance as the **maximum** distance encountered between any of the member XSs in the given cluster and an outside XS. Therefore, in the B,F to A case, the distance would be defined as 0.625
- *Average Linkage* defines this distance as the **average** value of member XS distances to the given outside XS. In this case this would be the average of 0.5 and 0.625, or 0.561.
- *Single Linkage* defines this distance and the **minimum** distance encountered between any member XS and the given outside XS. In this case this would be 0.5

C. Cluster Analysis of XS data – Initial Cluster Results

All three methods of cluster linkage were tested when analyzing the Santa Clara XS data. The objective was to identify a method which produced discernible clusters which may reflect various in-stream MUs encompassed by the XSs. It was found that the *complete linkage* method was most effective in creating a well-populated cluster grouping which reflected trends in f,m,c,k values that aligned roughly with expectant values of riffles, runs, and pools.

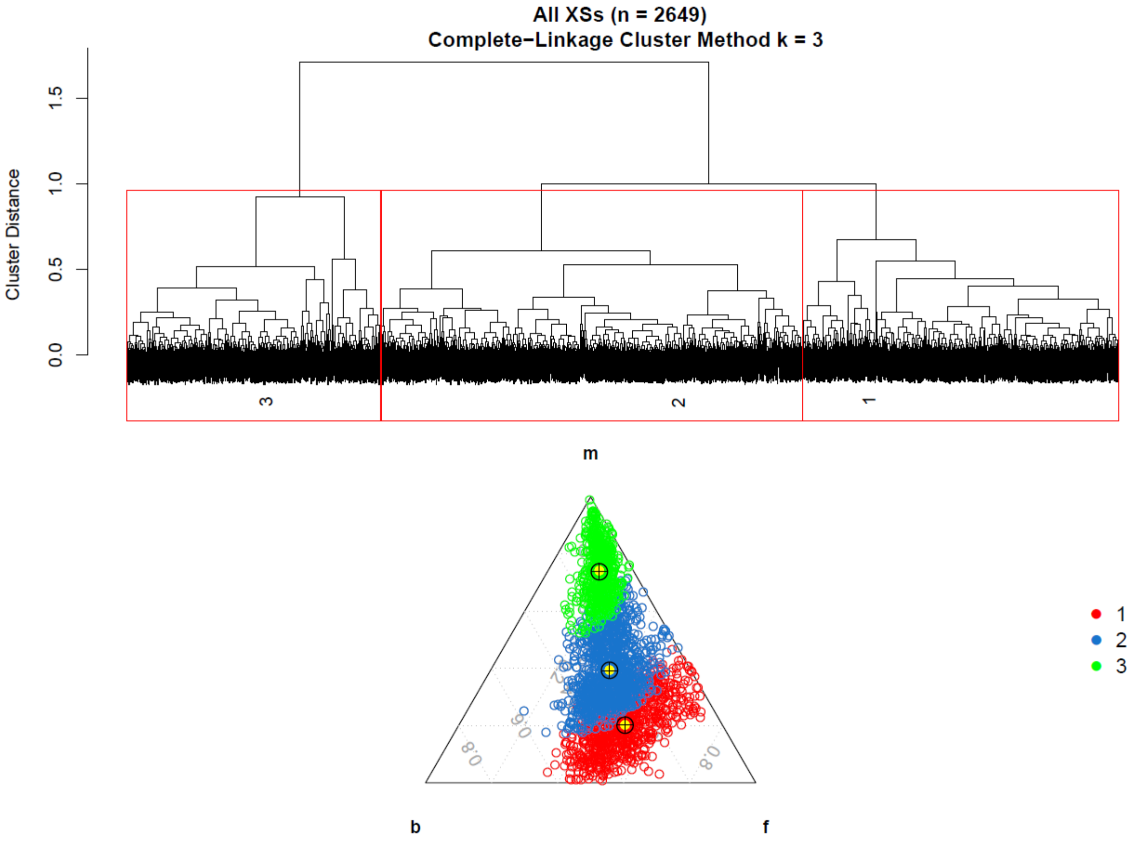


Figure 6. Complete Linkage Clustering of all 2649 XSs. (Above) The cluster tree dendrogram showing the grouping sequences, along with the delineations of the three major cluster boundaries. (Below) b,f,m ternary diagram of the XSs grouped by the bins in the dend

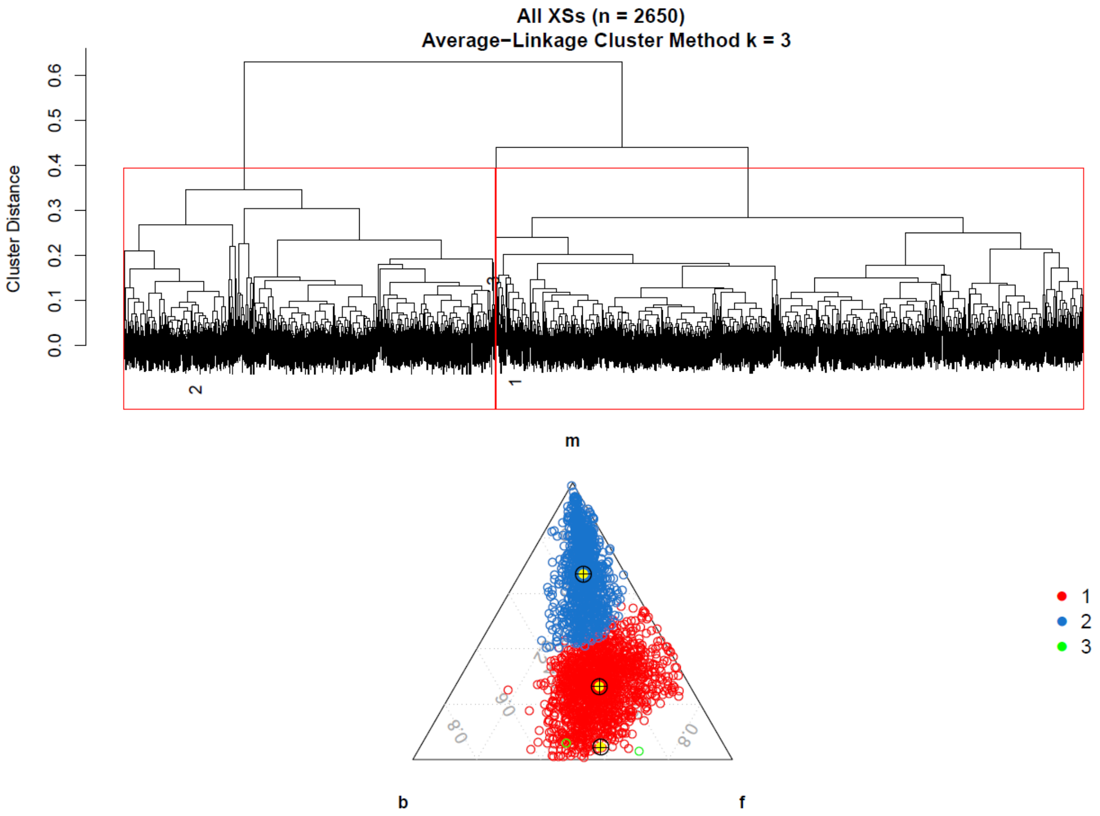


Figure 7. Average Linkage Clustering of all 2649 XSs.

It can be seen from comparing Figure 6 and Figure 7 that the complete linkage clustering method produced much more discernible groupings at the 3-cluster phase, whereas the average linkage was more prone to producing small clusters of only a couple of XSs (see the pair of green dots at the bottom of the ternary plot). This behavior was reflected at higher clustering numbers. See the results with 6 clusters below in Figure 8 and Figure 9.[1]

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[1] The single linkage method only exhibiting more dramatic behavior similar to the average linkage method, and is therefore not shown here.

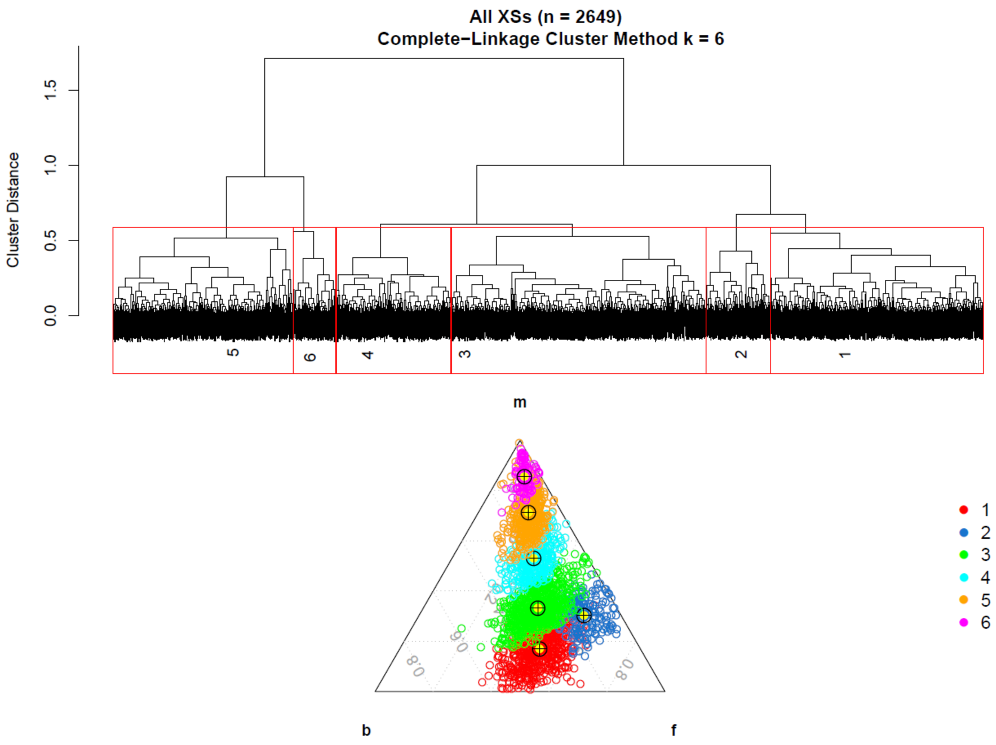


Figure 8. Complete linkage clustering with 6-clusters

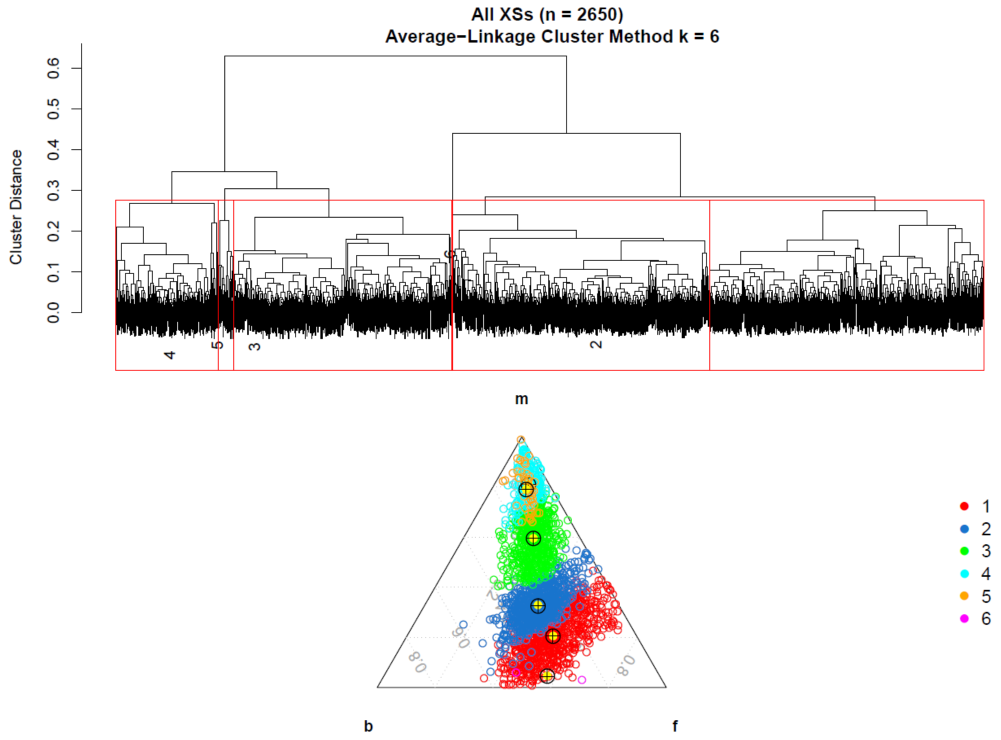


Figure 9. Average linkage clustering with 6-clusters

Again, the average linkage clustering method produces more clusters of very few members, whereas the complete linkage method produces more well-populated and discernible clusters, which seem to better reflect the various regions of the ternary plot. Therefore, the complete linkage method was selected for further analysis.

D. Cluster Analysis of XS data – Initial MU Identification

In following with the desire to identify three major MU groups (riffle, run/glide/flatwater, and pool), the 3-cluster group of the complete linkage clustering was selected to potentially represent these MU groups.

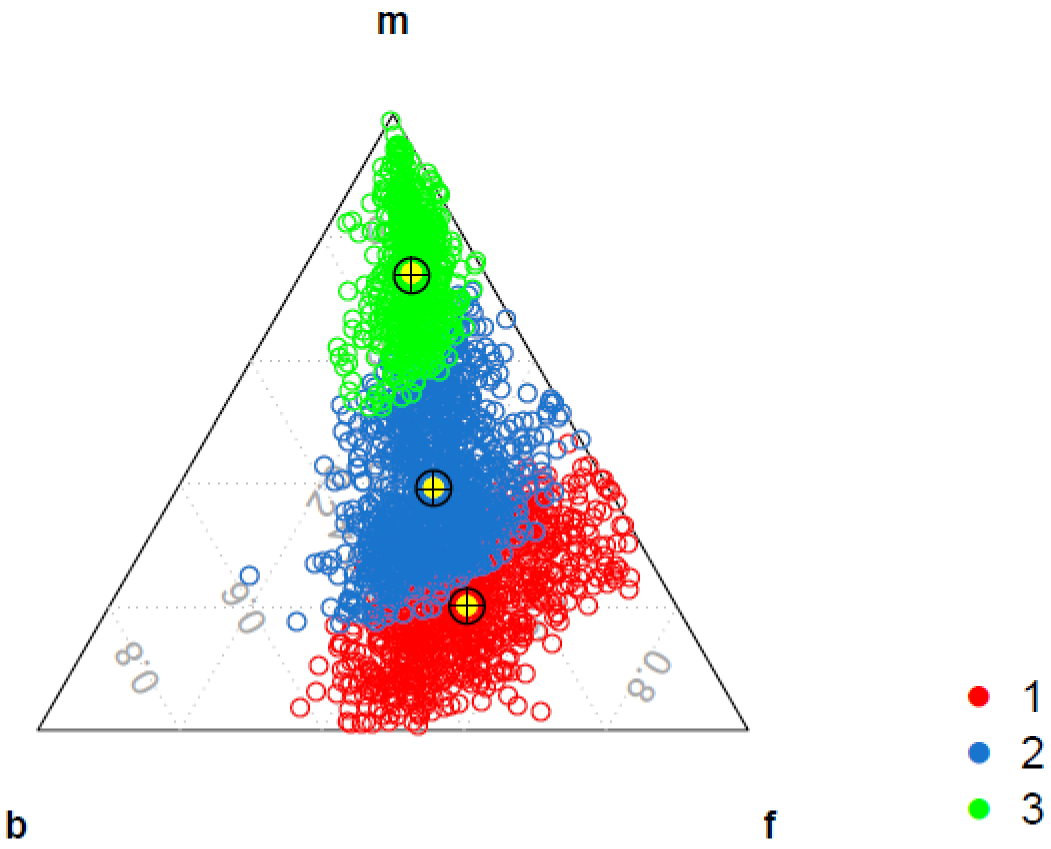


Figure 10. Complete 3-cluster results for all XSs where 1 = Riffles, 2 = Run/Glide/Flatwater, 3 = Pool

These MU assignments were made based on the expected b,f,m values and which clusters reflected these values. For example, riffles are expected to exhibit high rates of depth increase (high f), low rates of velocity increase (low m), high initial velocity (high k) and low initial depth (low c). Figure 11 illustrated the c and k values as relating to their corresponding exponent values.

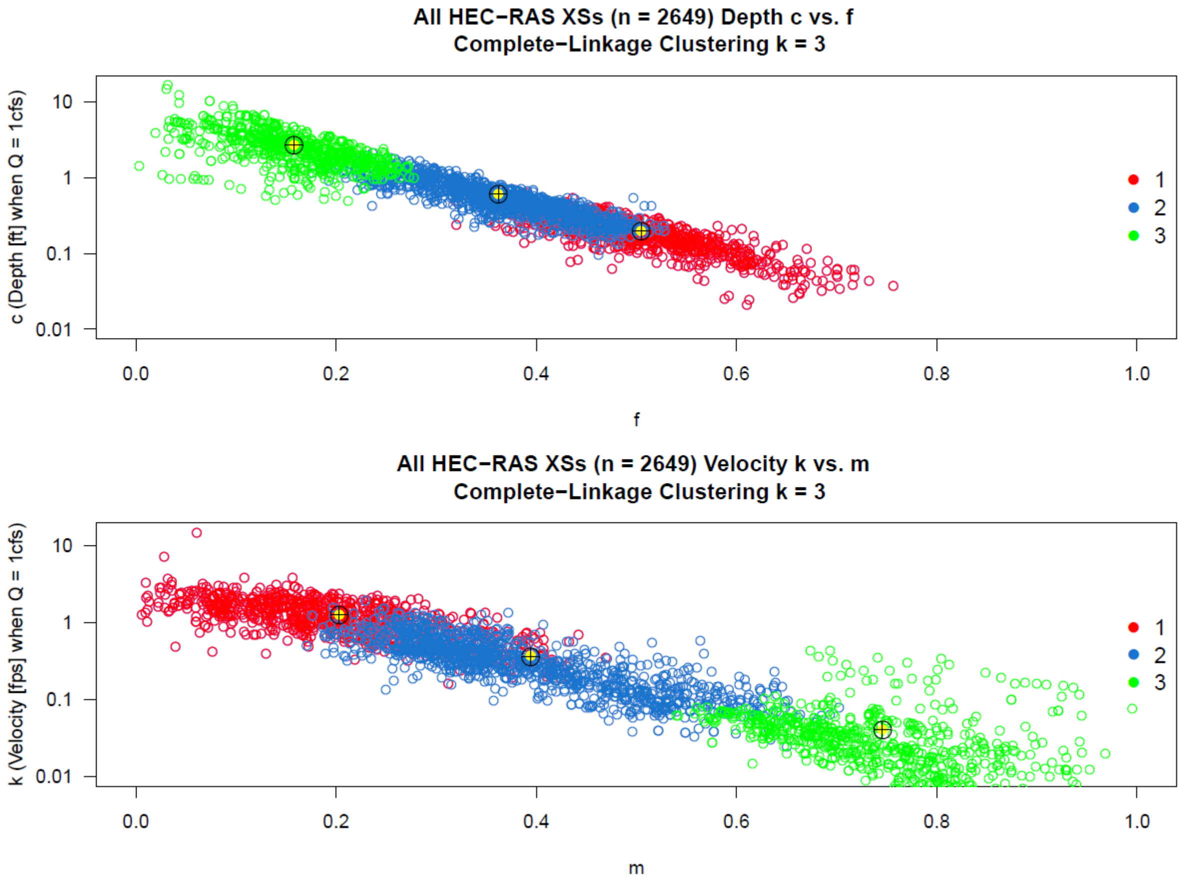


Figure 11. c vs. f and k vs. m values for each of the 3 cluster groups. These reflect the trends expected of riffles, runs, and pools, and reinforced the MU assignment decision to each of the groups

E. Field Survey Data – Attempt to Find MU Classification System without Cluster Analysis

However, just because the complete cluster 3-group scheme produced groups which exhibit hydraulic characteristics expected of distinct MUs, does not mean that it can be said with certainty that all XSs falling into one of these groups can then be assumed to definitively be located at one of these MUs in the reality.

The ultimate objective is to be able to use this method to classify thousands of XSs as certain MUs without doing comprehensive field surveys of all of them to verify as being that MU. Still, before this can be done, some validation must be conducted with a sub-sample of XS sites which were assessed and manually classified as a certain MU in the field. Therefore, a number of visual surveys were conducted at random locations throughout the basin to classify roughly 5-10% of the study area in MU-terms. From these regions of classification, it was then possible to identify which HEC-RAS XSs fell into these regions, and in turn what MU they should in theory reflect with their b,f,m and a,c,k values.

Following the analysis of this visual survey data throughout the study area, it was identified that a total of 226 pre-existing HEC-RAS XSs were encompassed in this visually surveyed area. Combining these XSs with the 28 newly RTK-surveyed riffle locations near the POIs yielded a total of 254 XSs with field-classified MU assignments. It was initially thought that perhaps this would be sufficient data to identify clear regions of grouping in the ternary plot of b,f,m values and the c and k graphs between XSs of different MUs to arrive at a classification system independent of the cluster analysis. However, the lack of comprehensive representation of runs and intermediate hydraulic MUs in the sub-sampled XS set made this classification difficult.

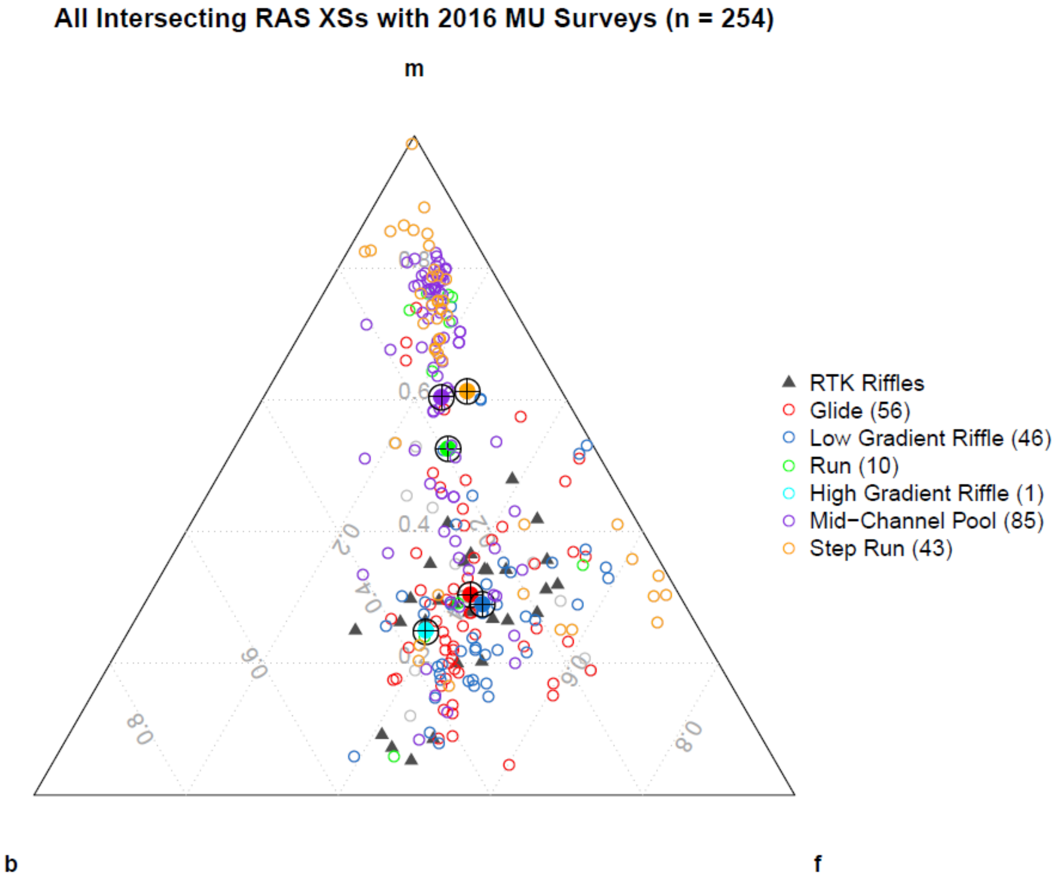


Figure 12. XSs and their corresponding visually-classified approximate MU field-assignments

It can be seen in the above ternary diagram in Figure 12 that while there is clear distinction between the group of Step Run, Mid-Channel Pool, and Run XSs (as shown by their centroids depicted in orange, purple, and green solid circles) and the group of Glide, High Gradient Riffle, and Low Gradient Riffle XSs (as shown by their centroids depicted in red, light blue and dark blue solids circles), there is a paucity of XSs represented in the intermediate range of the ternary diagram, and with certain flatwater MUs such and step run and run exhibiting characteristics somewhat akin to pools, with glides behaving similarly to riffles. Therefore, had there been more XSs in the middle range, it may have been more evident where the general "flatwater" region lay. It can be seen, however, that the RTK-surveyed riffles (depicted in solid black triangles) are more or less in the expected lower right riffle region of the ternary diagram (low m, high f).

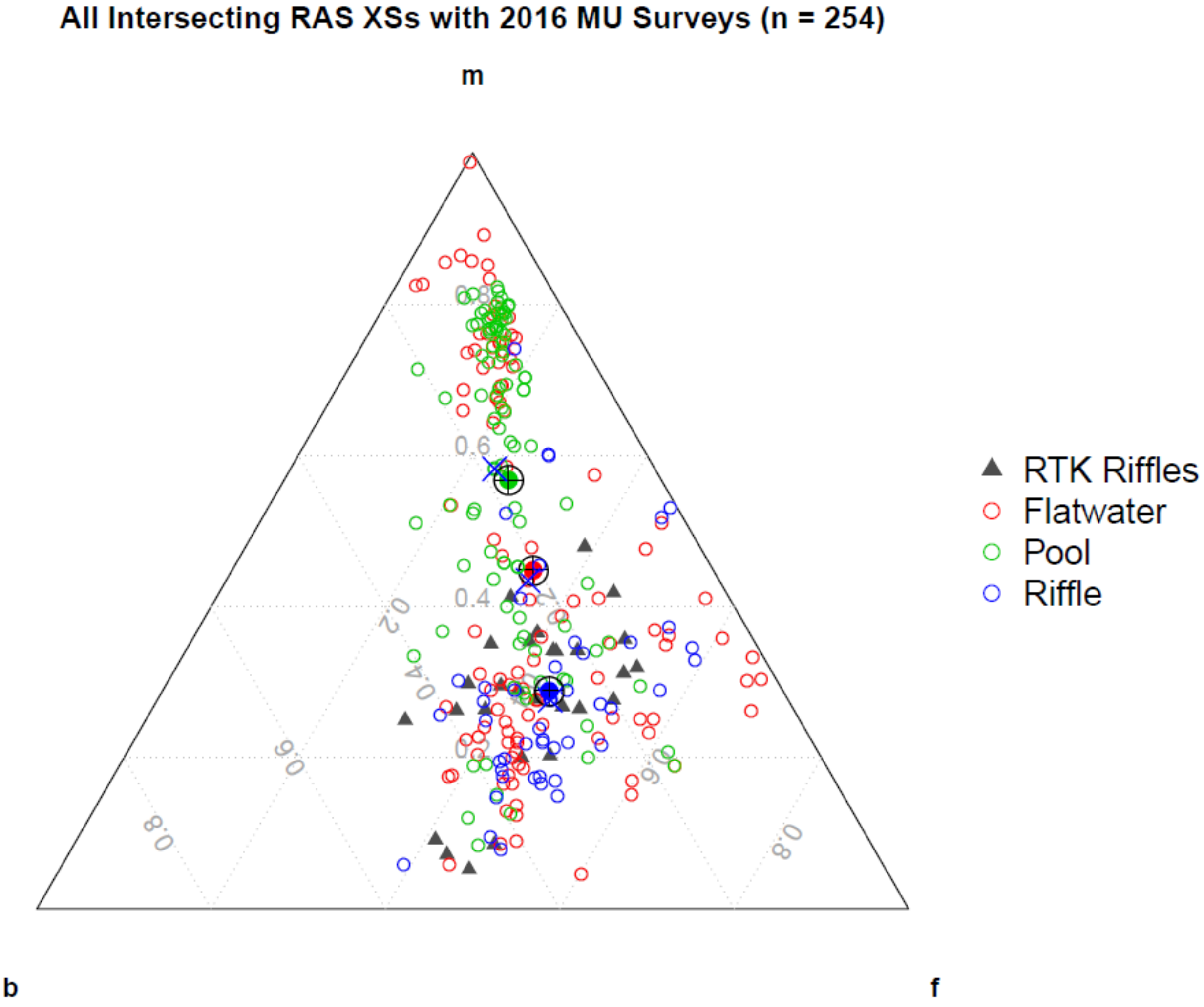


Figure 13. 3-MU class of field sub-sampled XSs

Reducing these MU assignments to a 3-MU system yields the following (Figure 13). In this 3-MU classification system, the average values of the groups display well-distinguished behavior between riffle, flatwater, and pool, similar to the 3-cluster grouping seen in the complete linkage clustering scenario. However, there is still lots of overlap of the flatwater XSs with both the riffle and pool groups, and relatively few actually nearby its centroid on the ternary plot. Therefore, it was deemed too difficult given this small sub-sampling of XS data to derive definitive MU regions from using only these 254 points.

Various attempts were made to sub-divide the flatwater MUs into run and glide, and group the glides with riffles given their similar behavior in these points. Initially b,f,m and a,c,k thresholds were defined to create a generalized classification system, such as f > 0.3 & m < 0.55 = Riffle/Glide, and of those remaining, those with a k < 0.04 = Pool, and all remaining classified as Run. The rationale for the use of k as a classification between pool and run is illustrated below (Figure 14).

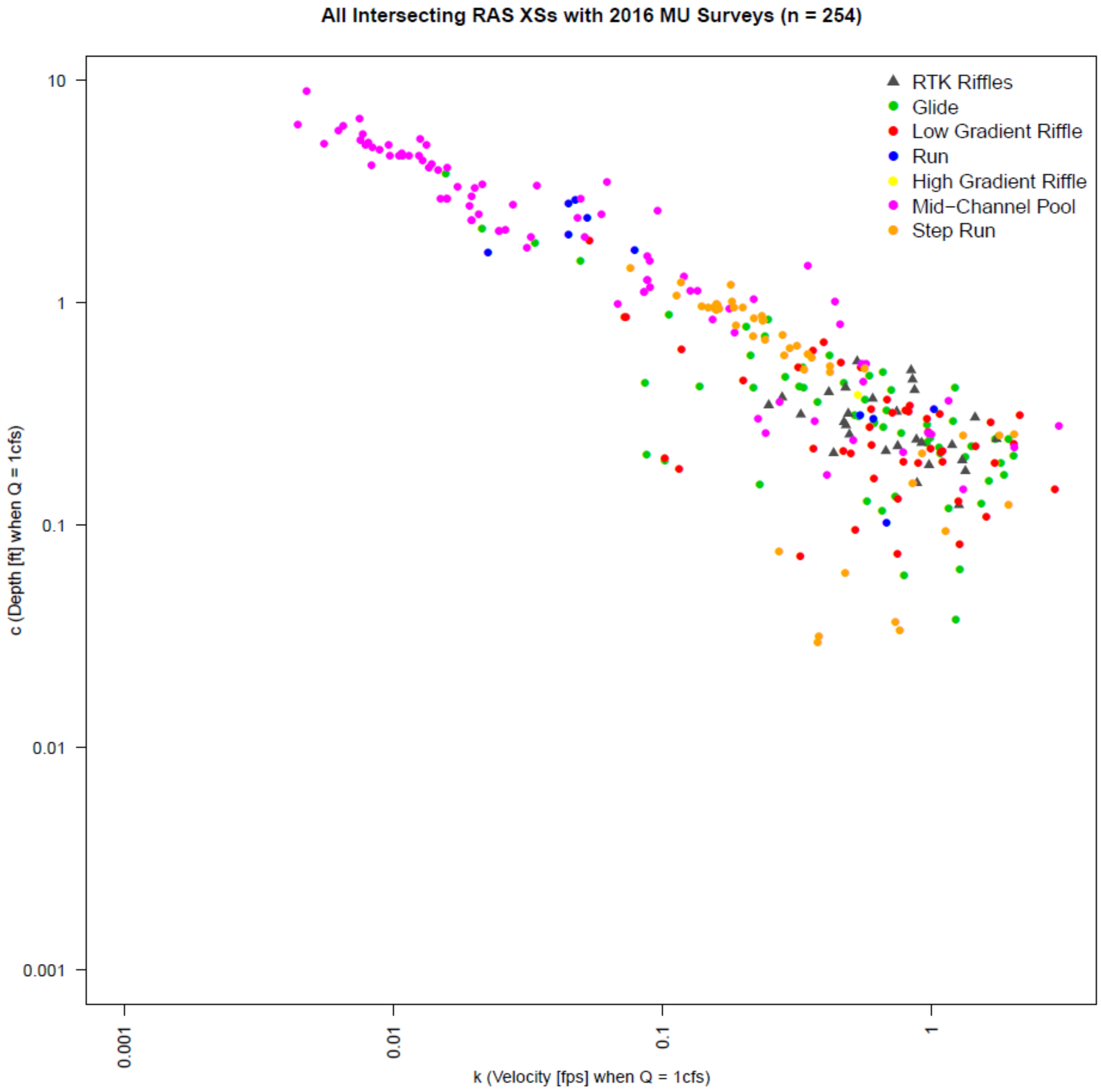


Figure 14. c vs. k of the 254 sub-sampled XSs by MU classifications. Note the preponderance of pools less than k = 0.04 and of runs right of k = 0.04.

However, this classification system, when applied to the entire 2649 XS data set yielded a very large riffle/glide "binning", underrepresentation of pools and runs, and significant overlap of pools and runs.

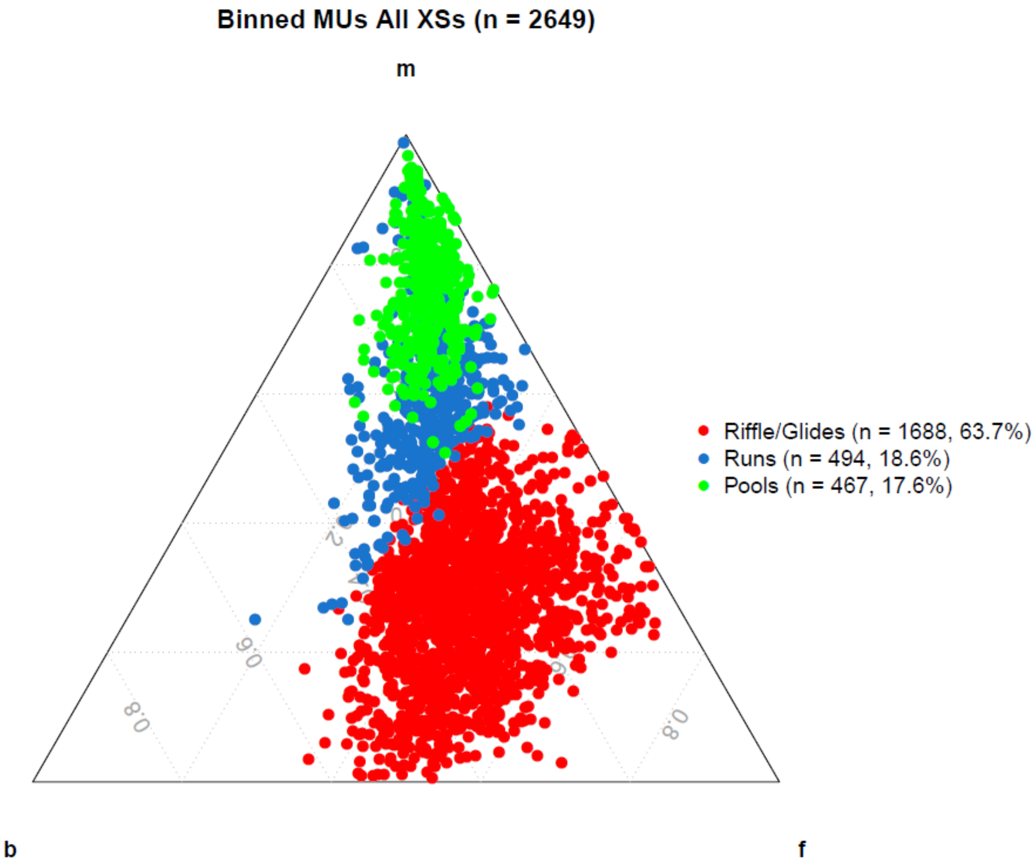


Figure 15. The groupings produced with using the manual binning (non-cluster analysis) method described above based solely on trends observed between the 254 field sub-sampled XSs. This was NOT USED in the end.

Therefore, it was determined to revert to the original complete linkage 3-group cluster scheme explained above and shown in Figure 10, using this sub-sampled field data merely to validate general trends observed and reflected by these clusters as shown in Figure 12 and Figure 13.

VII. Selection of Representative XSs for each MU

Given the objective of selecting a single XS for each POI for each MU-type, the next step was to determine which XSs to choose. The MUs of consideration for habitat and passage analysis are riffles, runs/flatwaters, and pools. However, riffles must be considered both for their potential to provide spawning habitat, and well as their potential to serve as barriers to passage for migrating fish. In general terms, this means that the task at hand was to select 4 XSs (passage riffle, habitat riffle, flatwater, pool) for all 39 POIs, meaning 4 x 39, or 156 XSs were to be selected.

The selected XSs would then have their rating curves of various habitat metrics (depth, velocity, thalweg depth, thalweg velocity etc.) embedded into the WEAP model at each POI.

A. Selection of Passage Riffle XSs

The majority (28 of 39) of the potential passage barrier riffles were identified and RTK-surveyed in the field prior to this cluster analysis, and serve as the passage riffle XSs for most cases. However, of the 11 out of 39 POIs which did not receive a passage-riffle RTK survey, 5 of those were deemed to only consist of deep pools in their vicinity, and therefore not likely to have any nearby passage barriers. Of the remaining 6 POIs, STEV3 and COYO4 were specially selected just downstream of major in-stream barriers (STEV3 on the concrete apron just downstream of the Fremont Ave. fish ladder, and COYO4 just downstream of the Singleton Rd. obstruction) to try and capture the immediate downstream hydraulics of these barriers. The passage-riffle XSs for the remaining 4 POIs (all on Upper Penitencia Ck which received no field surveys) were selected by analyzing which XSs in the reach downstream of each POI exhibited the lowest c coefficient value, and therefore is assumed to have the lowest depth at low flows, making them most likely to serve as passage barriers.

Table 7. Passage Riffle XS Final Selection

POI	XS	Selection Method
ALAM1	637.19	RTK GPS Field Survey (2016)
ALAM2	14840.20	RTK GPS Field Survey (2016)
ALAM3	16738.22	RTK GPS Field Survey (2016)
ALAM4	21470.23	RTK GPS Field Survey (2016)
CALE1	1548.21	RTK GPS Field Survey (2016)
CALE2	Deep Pools Only	Deep Pools Only
COYO1	Deep Pools Only	Deep Pools Only
COYO2	15827 US	RTK GPS Field Survey (2016)
COYO3	21399.27	RTK GPS Field Survey (2016)
COYO4	128921	XS Selected Just DS of Singleton Rd.
COYO5	139790 US	RTK GPS Field Survey (2016)
COYO6	163780 US	RTK GPS Field Survey (2016)
COYO7	Deep Pools Only	Deep Pools Only
COYO8	201956	RTK GPS Field Survey (2016)
COYO9	220899	RTK GPS Field Survey (2016)
COYO10	222145	RTK GPS Field Survey (2016)
GCRK1	1010.15	RTK GPS Field Survey (2016)
GCRK2	1260.16	RTK GPS Field Survey (2016)

GCRK3	1270.017	RTK GPS Field Survey (2016)
GCRK4	1270.18	RTK GPS Field Survey (2016)
GUAD1	Deep Pools Only	Deep Pools Only
GUAD2	Deep Pools Only	Deep Pools Only
GUAD3	15870.9	RTK GPS Field Survey (2016)
GUAD4	19239.39	RTK GPS Field Survey (2016)
GUAD5	20678.12	RTK GPS Field Survey (2016)
GUAD6	94999.13	RTK GPS Field Survey (2016)
GUAD7	102399	RTK GPS Field Survey (2016)
LOSG1	84.52499 DS	RTK GPS Field Survey (2016)
LOSG2	245	RTK GPS Field Survey (2016)
STEV1	12800	RTK GPS Field Survey (2016)
STEV2	21283.2	RTK GPS Field Survey (2016)
STEV3	35110	XS Selected Just DS of Fremont Fish Ladder
STEV4	45979.4	RTK GPS Field Survey (2016)
STEV5	56544.5	RTK GPS Field Survey (2016)
STEV6	62725.6	RTK GPS Field Survey (2016)
UPEN1	4122.831	XS with Lowest c-value in POI reach
UPEN2	14291.01	XS with Lowest c-value in POI reach
UPEN3	19966.67	XS with Lowest c-value in POI reach
UPEN4	22406.66	XS with Lowest c-value in POI reach

The passage-riffle XSs as represented in the ternary diagram are shown below in Figure 16.

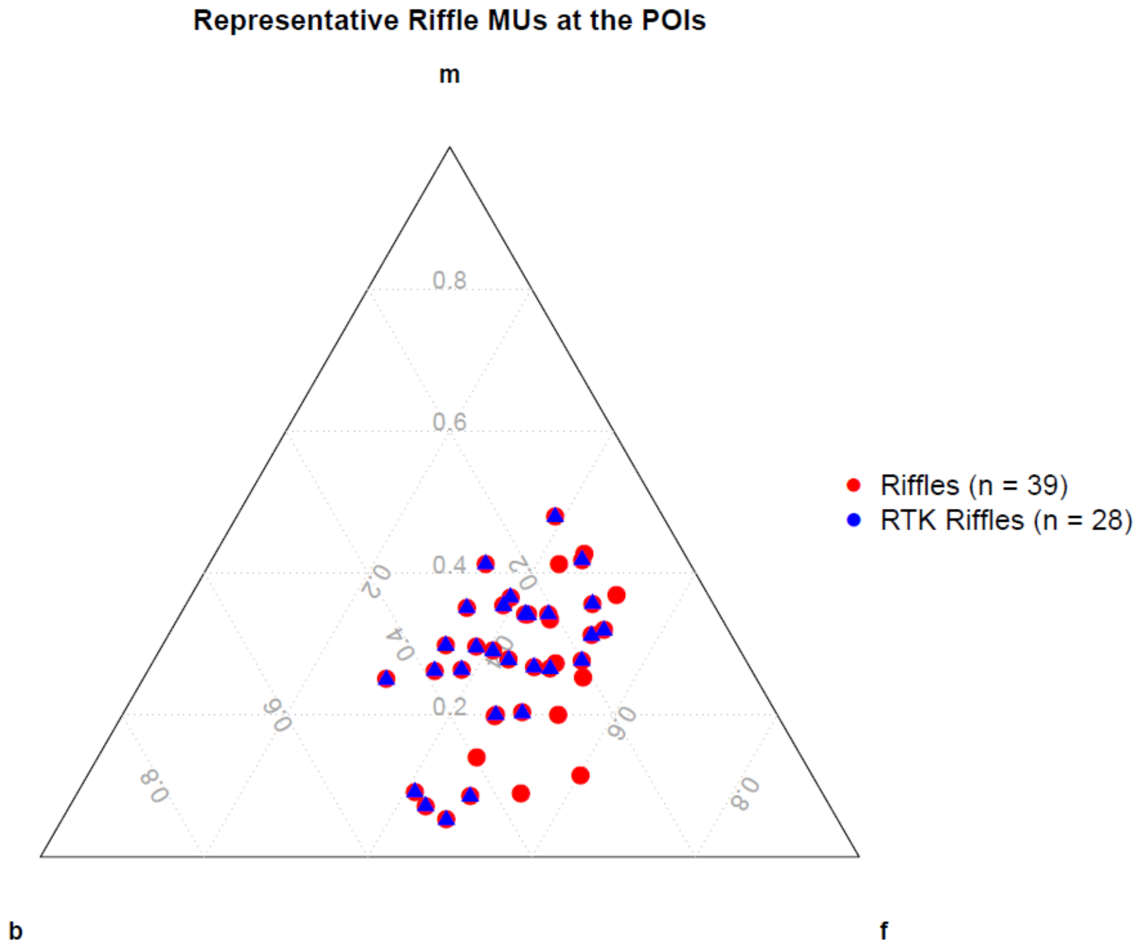


Figure 16. Passage Riffle XSs

A. Selection of Habitat Riffle, Flatwater, and Pool XSs

For the selection of the remaining XSs for habitat riffle, Flatwater, and Pool XSs, the downstream reaches of each POI (defined as the reach between the given POI and the next one downstream, or of a stream or SF bay confluence) were defined and all XSs in each of these reaches were identified. The XSs belonging to each cluster group were grouped, their centroid found, and the nearest XS to this centroid was selected as the representative XS. Cluster 1 (red) is representative of riffles, cluster 2 (blue) of flatwaters, and cluster 3 (green) of pools. An example of this process is shown below in Figure 17.

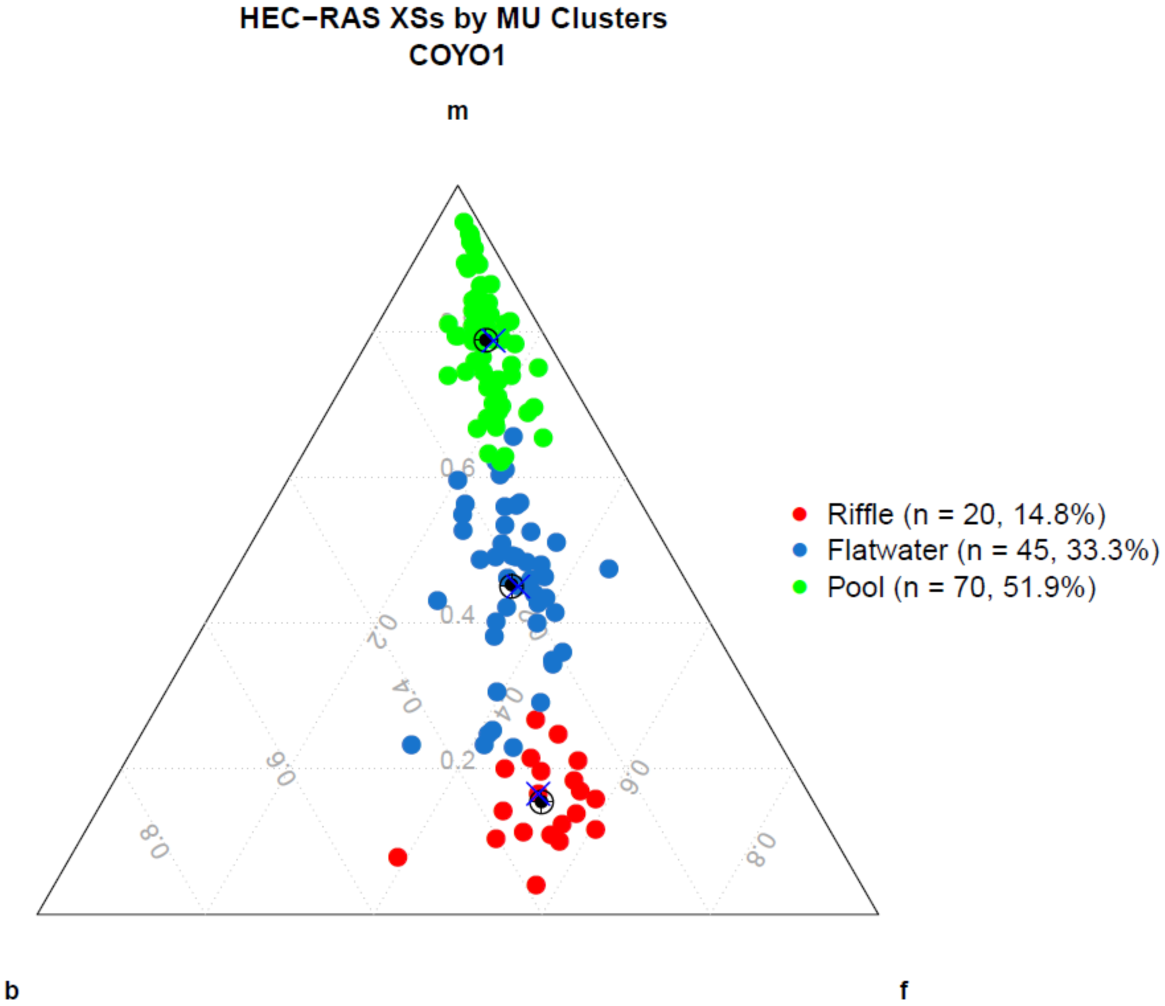


Figure 17. Representative XSs shown as blue Xs near the MU centroids at COYO1

While this example at COYO1 shows a good diversity of riffle, flatwater, and pool XSs, not all POI reaches consisted of all MUs, meaning it was impossible to have a representative XS of that given MU for that POI (Figure 18).

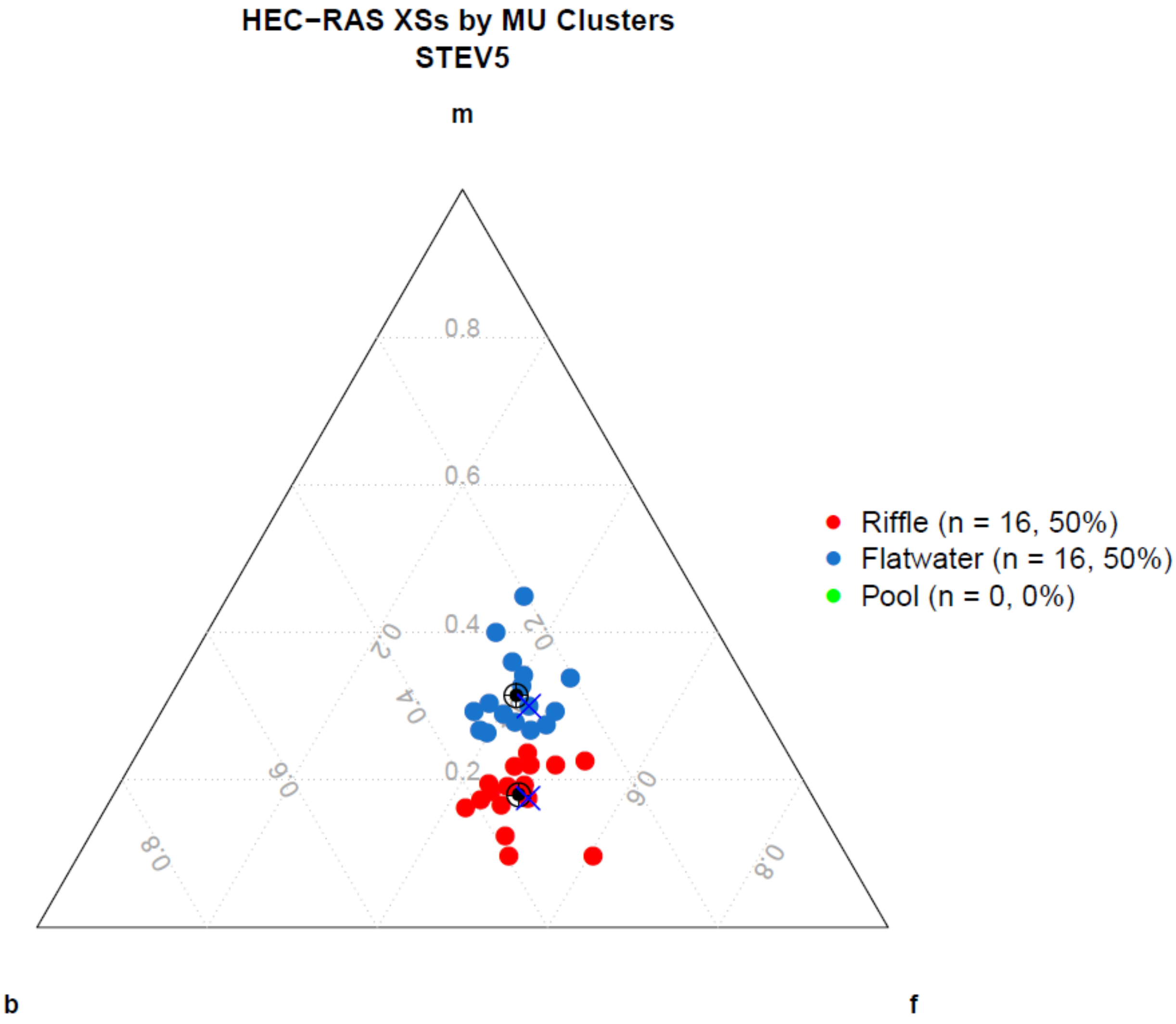


Figure 18. STEV5 only has XSs reflecting Flatwaters and Riffles, making the selection of a representative pool XS impossible.

Table 8. The final XS selection for all POIs for all MUs

POI	Riffle (Habitat)	Flatwater	Pool
ALAM1	Lake Almaden	Lake Almaden	Lake Almaden
ALAM2	Alamitos Creek 13847.14	Alamitos Creek 480.7332	Alamitos Creek 5215.715
ALAM3	Alamitos Creek 17214.15	Alamitos Creek 16873.8	No XSs of this MU
ALAM4	No XSs of this MU	Alamitos Creek 21469.59	No XSs of this MU
CALE1	Calero Creek 1729.591	Calero Creek 2632.513	No XSs of this MU
CALE2	No HEC-RAS Model	No HEC-RAS Model	No HEC-RAS Model
COYO1	Coyote Creek 37730	Coyote Creek 38059.95	Coyote Creek 49801.21
COYO2	Coyote Creek 9451	Coyote Creek 68997.43	Coyote Creek 9917
COYO3	Coyote Creek 18336	Coyote Creek 20407	Coyote Creek 20243
COYO4	Coyote Creek 121500	Coyote Creek 108000	Coyote Creek 27796
COYO5	Coyote Creek 134655	Coyote Creek 138974	Coyote Creek 131080
COYO6	Coyote Creek 159719	Coyote Creek 160804	Coyote Creek 157975
COYO7	Coyote Creek 182105	Coyote Creek 187483	Coyote Creek 188473
COYO8	Coyote Creek 200498	Coyote Creek 194957	Coyote Creek 198218
COYO9	Coyote Creek 213963	Coyote Creek 207950	Coyote Creek 209060
COYO10	Coyote Creek 220235	Coyote Creek 220898	Coyote Creek 217772.5
GCRK1	Guadalupe Creek 1010	Guadalupe Creek 1020	No XSs of this MU
GCRK2	Guadalupe Creek 1075	Guadalupe Creek 1077	Guadalupe Creek 1170
GCRK3	Guadalupe Creek 1250	Guadalupe Creek 1245	Guadalupe Creek 1260
GCRK4	No HEC-RAS Model	No HEC-RAS Model	No HEC-RAS Model
GUAD1	No XSs of this MU	Guadalupe River 7710	Guadalupe River 7890
GUAD2	Guadalupe River 9090	Guadalupe River 11790	Guadalupe River 10620
GUAD3	Guadalupe River 15030	Guadalupe River 13080	Guadalupe River 12780
GUAD4	Guadalupe River 17220	Guadalupe River 16650	Guadalupe River 17010
GUAD5	Guadalupe River 20439	Guadalupe River 19746	Guadalupe River 20111

GUAD6	Guadalupe River 88100	Guadalupe River 85300	Guadalupe River 71347.49
GUAD7	Guadalupe River 100400	Guadalupe River 96900	Guadalupe River 94700
LOSG1	Los Gatos Creek 58	Los Gatos Creek 1484.654	Los Gatos Creek 41.37
LOSG2	Los Gatos Creek 22922.82	Los Gatos Creek 93.35	Los Gatos Creek 87.38
STEV1	Stevens Creek 8953.68	Stevens Creek 8997.48	No XSs of this MU
STEV2	Stevens Creek 12816.38	Stevens Creek 15606.18	Stevens Creek 19692.38
STEV3	Stevens Creek 23599.89	Stevens Creek 24620.18	Stevens Creek 21378.59
STEV4	Stevens Creek 41572.1	Stevens Creek 40994.55	No XSs of this MU
STEV5	Stevens Creek 57468.26	Stevens Creek 51485.82	No XSs of this MU
STEV6	Stevens Creek 60426.55	Stevens Creek 64743.96	Stevens Creek 64569.67
UPEN1	Upper Penitencia Creek 4170.517	Upper Penitencia Creek 5463.898	No XSs of this MU
UPEN2	Upper Penitencia Creek 6207.995	Upper Penitencia Creek 16463.63	No XSs of this MU
UPEN3	Upper Penitencia Creek 20681.31	Upper Penitencia Creek 21642.71	No XSs of this MU
UPEN4	Upper Penitencia Creek 22406.66	No XSs of this MU	No XSs of this MU

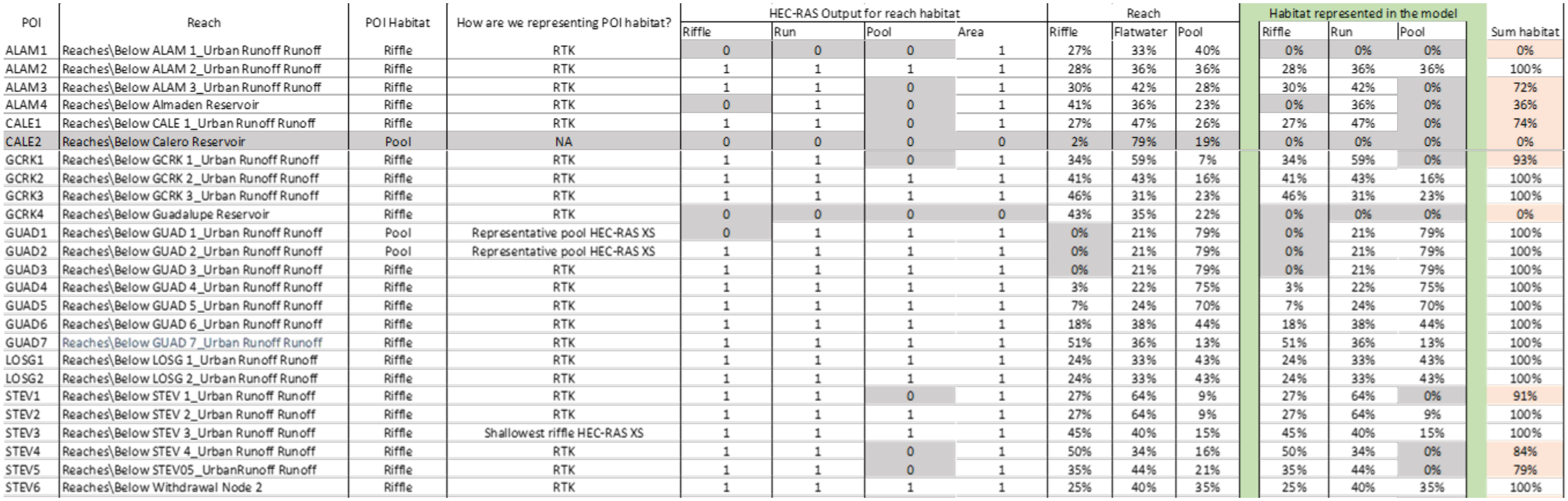
As can be seen, the most common MU to lack XS representation was pools (11 POIs lacked pool XSs), which is understandable, especially in smaller, steep streams. There were also 2 instances in which riffles lacked XS representation, and 1 where flatwater lacked representation. Also 3 POIs lacked representation altogether due to either the absence of any HEC-RAS XSs in the POI reach (GCRK4 & CALE2), or because it was located directly upstream of a non-stream object (ALAM1 just above Lake Almaden).

It should also be noted that the majority of the UPEN4 reach was outside of the scope of the Upper Penitencia Ck HEC-RAS model, and therefore only has 3 XSs (riffles) to choose from, and may be better to be excluded from analysis due to this lack of data.

VIII. Habitat Type Proportions and of Structural Habitat Data from the Field

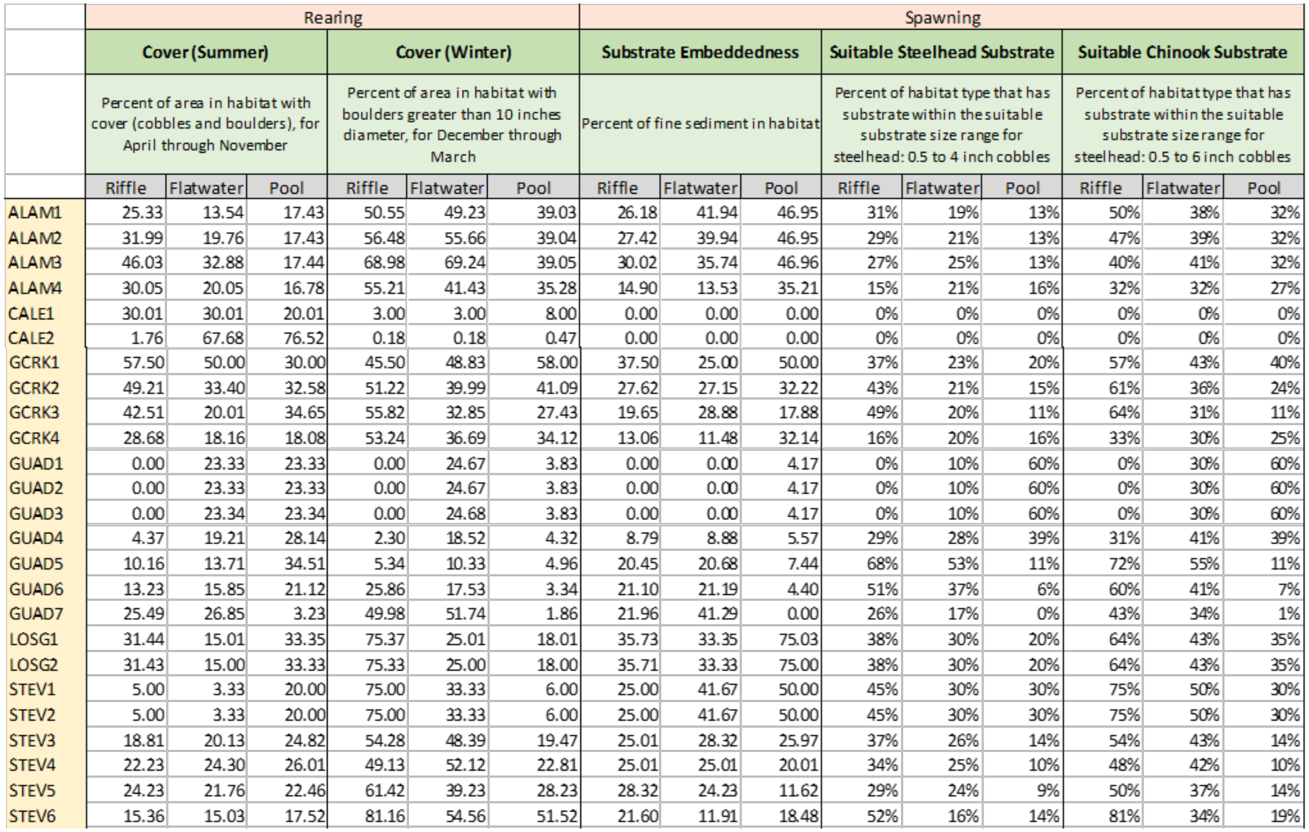
The previous analysis was used to select representative cross sections for habitat types in the stream reaches. Table 9 shows the final estimate of habitat type proportions and the existence of HEC-RAS Cross Sections for each MU in each POI and POI reach. Also, Table 10 shows the final structural habitat data collected from the field and extrapolated to POI reaches as requested by the Biological Evaluation Framework from HDR. Note that the habitat type proportions are excluded for the Coyote Creek system, as a separate environmental impact study will be conducted for the Anderson Dam Seismic Retrofit Project (ADSRP).

Table 9. Habitat types proportions in WEAP



POI	Reach	POI Habitat	How are we representing POI habitat?	HEC-RAS Output for reach habitat				Reach			Habitat represented in the model			Sum habitat
				Riffle	Run	Pool	Area	Riffle	Flatwater	Pool	Riffle	Run	Pool	
ALAM1	Reaches\Below ALAM 1_Urban Runoff Runoff	Riffle	RTK	0	0	0	1	27%	33%	40%	0%	0%	0%	0%
ALAM2	Reaches\Below ALAM 2_Urban Runoff Runoff	Riffle	RTK	1	1	1	1	28%	36%	36%	28%	36%	36%	100%
ALAM3	Reaches\Below ALAM 3_Urban Runoff Runoff	Riffle	RTK	1	1	0	1	30%	42%	28%	30%	42%	0%	72%
ALAM4	Reaches\Below Almaden Reservoir	Riffle	RTK	0	1	0	1	41%	36%	23%	0%	36%	0%	36%
CALE1	Reaches\Below CALE 1_Urban Runoff Runoff	Riffle	RTK	1	1	0	1	27%	47%	26%	27%	47%	0%	74%
CALE2	Reaches\Below Calero Reservoir	Pool	NA	0	0	0	0	2%	79%	19%	0%	0%	0%	0%
GCRK1	Reaches\Below GCRK 1_Urban Runoff Runoff	Riffle	RTK	1	1	0	1	34%	59%	7%	34%	59%	0%	93%
GCRK2	Reaches\Below GCRK 2_Urban Runoff Runoff	Riffle	RTK	1	1	1	1	41%	43%	16%	41%	43%	16%	100%
GCRK3	Reaches\Below GCRK 3_Urban Runoff Runoff	Riffle	RTK	1	1	1	1	46%	31%	23%	46%	31%	23%	100%
GCRK4	Reaches\Below Guadalupe Reservoir	Riffle	RTK	0	0	0	0	43%	35%	22%	0%	0%	0%	0%
GUAD1	Reaches\Below GUAD 1_Urban Runoff Runoff	Pool	Representative pool HEC-RAS XS	0	1	1	1	0%	21%	79%	0%	21%	79%	100%
GUAD2	Reaches\Below GUAD 2_Urban Runoff Runoff	Pool	Representative pool HEC-RAS XS	1	1	1	1	0%	21%	79%	0%	21%	79%	100%
GUAD3	Reaches\Below GUAD 3_Urban Runoff Runoff	Riffle	RTK	1	1	1	1	0%	21%	79%	0%	21%	79%	100%
GUAD4	Reaches\Below GUAD 4_Urban Runoff Runoff	Riffle	RTK	1	1	1	1	3%	22%	75%	3%	22%	75%	100%
GUAD5	Reaches\Below GUAD 5_Urban Runoff Runoff	Riffle	RTK	1	1	1	1	7%	24%	70%	7%	24%	70%	100%
GUAD6	Reaches\Below GUAD 6_Urban Runoff Runoff	Riffle	RTK	1	1	1	1	18%	38%	44%	18%	38%	44%	100%
GUAD7	Reaches\Below GUAD 7_Urban Runoff Runoff	Riffle	RTK	1	1	1	1	51%	36%	13%	51%	36%	13%	100%
LOSG1	Reaches\Below LOSG 1_Urban Runoff Runoff	Riffle	RTK	1	1	1	1	24%	33%	43%	24%	33%	43%	100%
LOSG2	Reaches\Below LOSG 2_Urban Runoff Runoff	Riffle	RTK	1	1	1	1	24%	33%	43%	24%	33%	43%	100%
STEV1	Reaches\Below STEV 1_Urban Runoff Runoff	Riffle	RTK	1	1	0	1	27%	64%	9%	27%	64%	0%	91%
STEV2	Reaches\Below STEV 2_Urban Runoff Runoff	Riffle	RTK	1	1	1	1	27%	64%	9%	27%	64%	9%	100%
STEV3	Reaches\Below STEV 3_Urban Runoff Runoff	Riffle	Shallowest riffle HEC-RAS XS	1	1	1	1	45%	40%	15%	45%	40%	15%	100%
STEV4	Reaches\Below STEV 4_Urban Runoff Runoff	Riffle	RTK	1	1	0	1	50%	34%	16%	50%	34%	0%	84%
STEV5	Reaches\Below STEV05_UrbanRunoff Runoff	Riffle	RTK	1	1	0	1	35%	44%	21%	35%	44%	0%	79%
STEV6	Reaches\Below Withdrawal Node 2	Riffle	RTK	1	1	1	1	25%	40%	35%	25%	40%	35%	100%

Table 10. Structural Habitat in WEAP



	Rearing						Spawning								
	Cover (Summer)			**Cover (Winter)**			**Substrate Embeddedness**			**Suitable Steelhead Substrate**			**Suitable Chinook Substrate**		
	Percent of area in habitat with cover (cobbles and boulders), for April through November			Percent of area in habitat with boulders greater than 10 inches diameter, for December through March			Percent of fine sediment in habitat			Percent of habitat type that has substrate within the suitable substrate size range for steelhead: 0.5 to 4 inch cobbles			Percent of habitat type that has substrate within the suitable substrate size range for steelhead: 0.5 to 6 inch cobbles		
	Riffle	Flatwater	Pool	Riffle	Flatwater	Pool	Riffle	Flatwater	Pool	Riffle	Flatwater	Pool	Riffle	Flatwater	Pool
ALAM1	25.33	13.54	17.43	50.55	49.23	39.03	26.18	41.94	46.95	31%	19%	13%	50%	38%	32%
ALAM2	31.99	19.76	17.43	56.48	55.66	39.04	27.42	39.94	46.95	29%	21%	13%	47%	39%	32%
ALAM3	46.03	32.88	17.44	68.98	69.24	39.05	30.02	35.74	46.96	27%	25%	13%	40%	41%	32%
ALAM4	30.05	20.05	16.78	55.21	41.43	35.28	14.90	13.53	35.21	15%	21%	16%	32%	32%	27%
CALE1	30.01	30.01	20.01	3.00	3.00	8.00	0.00	0.00	0.00	0%	0%	0%	0%	0%	0%
CALE2	1.76	67.68	76.52	0.18	0.18	0.47	0.00	0.00	0.00	0%	0%	0%	0%	0%	0%
GCRK1	57.50	50.00	30.00	45.50	48.83	58.00	37.50	25.00	50.00	37%	23%	20%	57%	43%	40%
GCRK2	49.21	33.40	32.58	51.22	39.99	41.09	27.62	27.15	32.22	43%	21%	15%	61%	36%	24%
GCRK3	42.51	20.01	34.65	55.82	32.85	27.43	19.65	28.88	17.88	49%	20%	11%	64%	31%	11%
GCRK4	28.68	18.16	18.08	53.24	36.69	34.12	13.06	11.48	32.14	16%	20%	16%	33%	30%	25%
GUAD1	0.00	23.33	23.33	0.00	24.67	3.83	0.00	0.00	4.17	0%	10%	60%	0%	30%	60%
GUAD2	0.00	23.33	23.33	0.00	24.67	3.83	0.00	0.00	4.17	0%	10%	60%	0%	30%	60%
GUAD3	0.00	23.34	23.34	0.00	24.68	3.83	0.00	0.00	4.17	0%	10%	60%	0%	30%	60%
GUAD4	4.37	19.21	28.14	2.30	18.52	4.32	8.79	8.88	5.57	29%	28%	39%	31%	41%	39%
GUAD5	10.16	13.71	34.51	5.34	10.33	4.96	20.45	20.68	7.44	68%	53%	11%	72%	55%	11%
GUAD6	13.23	15.85	21.12	25.86	17.53	3.34	21.10	21.19	4.40	51%	37%	6%	60%	41%	7%
GUAD7	25.49	26.85	3.23	49.98	51.74	1.86	21.96	41.29	0.00	26%	17%	0%	43%	34%	1%
LOSG1	31.44	15.01	33.35	75.37	25.01	18.01	35.73	33.35	75.03	38%	30%	20%	64%	43%	35%
LOSG2	31.43	15.00	33.33	75.33	25.00	18.00	35.71	33.33	75.00	38%	30%	20%	64%	43%	35%
STEV1	5.00	3.33	20.00	75.00	33.33	6.00	25.00	41.67	50.00	45%	30%	30%	75%	50%	30%
STEV2	5.00	3.33	20.00	75.00	33.33	6.00	25.00	41.67	50.00	45%	30%	30%	75%	50%	30%
STEV3	18.81	20.13	24.82	54.28	48.39	19.47	25.01	28.32	25.97	37%	26%	14%	54%	43%	14%
STEV4	22.23	24.30	26.01	49.13	52.12	22.81	25.01	25.01	20.01	34%	25%	10%	48%	42%	10%
STEV5	24.23	21.76	22.46	61.42	39.23	28.23	28.32	24.23	11.62	29%	24%	9%	50%	37%	14%
STEV6	15.36	15.03	17.52	81.16	54.56	51.52	21.60	11.91	18.48	52%	16%	14%	81%	34%	19%

IX. References

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Appendix K

Fisheries and Aquatic Habitat Technical Memorandum

Appendix K – Fisheries and Aquatic Habitat Technical Memorandum

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Appendix K – Fisheries and Aquatic Habitat Technical Memorandum

Fish and Aquatic Habitat Collaborative Effort
Draft Program Environmental Impact Report

Santa Clara Valley Water District

Santa Clara County, California

May 2023

Prepared by Stillwater Sciences

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Appendix K – Fisheries and Aquatic Habitat Technical Memorandum

Contents

Figures

Tables

Attachments

List of Acronyms and Abbreviations

°F	degrees Fahrenheit
°C	degrees Celsius
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CWMZ	Cold Water Management Zone
DPS	Distinct Population Segment
DSOD	Division of Safety of Dams
EIR	Environmental Impact Report
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FAHCE	Fish and Aquatic Habitat Collaborative Effort
FHRP	Fish Habitat Restoration Plan
feet/sec	feet per second
FR	*Federal Register*
HAI	habitat availability index
HEC-RAS	Hydrologic Engineering Center's River Analysis System
HSI	Habitat Suitability Index
in	inches
IRWM	Integrated Regional Water Management
m	meter
mm	millimeter
MWAT	Mean Weekly Average Temperature
NMFS	National Marine Fisheries Service
PLCI	Pacific Lamprey Conservation Initiative
POI	Points of Interest
sq ft	square feet
TWG	technical working group
TRT	Technical Recovery Team
USFWS	United States Fish and Wildlife Service
UWMP	Urban Water Management Plan
Valley Water	Santa Clara Valley Water District
WEAP Model	Water Evaluation and Planning Model
YOY	young-of-the-year

Glossary

anadromous	Pertaining to fish species that spend part of their life cycle in the ocean and return to freshwater streams to spawn.
Cold-Water Management Zone	The *Settlement Agreement Regarding Water Rights of the Santa Clara Valley Water District on Coyote, Guadalupe, and Stevens Creeks* initialed by the Initialing Parties on May 27, 2003 (FAHCE Settlement Agreement) identifies Cold Water Management Zones to provide suitable spawning and rearing habitat for steelhead in Stevens Creek, Coyote Creek and Guadalupe Creek (Coyote Creek is not included in this EIR so is not detailed below). **Stevens Creek** – From May 1 to October 31, Valley Water is to maintain water temperatures not to exceed 66.2°F throughout as much of the Cold Water Management Zone (the 3.8-mile reach from the outlets of Stevens Creek Dam to approximately Highway 280) as available cold-water supply will allow. Valley Water is to make these releases in accordance with the reservoir operations rule curves. **Guadalupe Creek** – From May 1 to October 31, Valley Water is to maintain water temperatures not to exceed 64.4°F throughout as much of the Cold Water Management Zone (the 3.3-mile reach from the outlets of Guadalupe Dam to approximately Camden Avenue) as available cold-water supply will allow. Valley Water is to make these releases in accordance with the reservoir operations rule curves. There are no Cold Water Management Zones designated for the other study area creeks (the Guadalupe River, Alamitos Creek, Calero Creek, and Los Gatos Creek).
Composite Habitat Suitability Index	A single index that combines habitat suitability indices for multiple environmental variables to represent an overall extent of habitat suitability for a species and life stage.
critical riffle	Critical riffle is the riffle that would limit passage within a reach (between two points of interest).
effective spawning habitat	Spawning habitat that has suitable embryo incubation conditions (water depth and temperature) throughout an incubation period such that it leads to eggs successfully hatching.
fry	The life stage of salmonids between alevin and parr. They can typically swim and catch their own food. Alevin – The larval salmonid that has hatched but has not fully absorbed its yolk sac, and generally has not yet emerged from the spawning gravel.
Habitat Suitability Index (HSI)	The extent to which the values of evaluated habitat variables are representative of optimal habitat conditions for a given species and life stage.
Habitat Availability Index (HAI)	An index intended to represent an area of suitable habitat for a given species and life stage, assuming that the area of suitable habitat is directly proportional to a composite habitat suitability index.
redd	Nest-like depression constructed by female salmonids facilitating increased hyporheic flow for developing eggs and alevins.

riffle	A short, relatively shallow and coarse-bedded length of stream over which the stream flows at slower velocity but a higher turbulence than it normally does in comparison to a pool.
smolt	The physiological process that prepares a juvenile anadromous fish to survive the transition from fresh water to salt water. Also refers to a juvenile anadromous fish that has made those physiological changes.
water year	A continuous 12-month period selected to present data relative to hydrologic conditions during which a complete annual hydrologic cycle normally occurs. The water year used by the U.S. Geological Survey in the publication of its records of streamflow extends from October 1 of one calendar year to September 30 of the next calendar year and is designated by the year in which it ends.
wetted area	The stream area estimated to have a water depth greater than zero for a given flow.

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Appendix K – Fisheries and Aquatic Habitat Technical Memorandum

1 Fisheries and Aquatic Habitat Technical Memorandum

1.1 Introduction

The Santa Clara Valley Water District (Valley Water) holds water rights licenses in the Stevens Creek and the Guadalupe River watersheds. In response to a complaint that Valley Water operations affected fish and wildlife, Valley Water convened local environmental organizations and state and federal resource agencies in settlement negotiations and developed what is known as the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE). Measures developed through FAHCE are intended to modify instream flows and improve habitat conditions, as appropriate, to meet the management objectives specified in the Settlement Agreement regarding the water rights of Valley Water on Coyote, Guadalupe, and Stevens Creeks, as agreed in the Settlement Agreement (Valley Water et al. 2003). The Fish Habitat Restoration Plan (FHRP) addresses all measures described in the Settlement Agreement and provides additional detail about how each measure has been or would be implemented, as well as additional information on monitoring and maintenance. The effects of the FHRP are being analyzed to meet California Environmental Quality Act (CEQA) requirements. The FHRP measures can be categorized as "flow measures" or "non-flow measures." The flow measures differ between the Proposed Project and a FAHCE-plus Alternative (see Section 1.4.3, *Flow Measures Analysis Methodology*). This Appendix K, *Fisheries and Aquatic Habitat Technical Memorandum*, describes and evaluates the impacts of the flow measures associated with the Proposed Project (that is, FAHCE Alternative) and FAHCE-plus Alternative on fisheries and aquatic habitat in portions of the Stevens Creek and Guadalupe River watersheds in northern Santa Clara County, California.

This Technical Memorandum is purposefully focused on the flow measures associated with the Proposed Project because available modeled results necessitated a detailed quantitative analysis of how the Proposed Project or FAHCE-plus Alternative would affect fisheries resources. Non-flow measures are assessed qualitatively in the associated Proposed Project Environmental Impact Report (EIR). The No Project Alternative and Non-flow Measures Only Alternative are also assessed in the EIR.

The Technical Memorandum describes the study area, environmental setting (current and future baselines), methodology, and an assessment of the effects of the Proposed Project and FAHCE-plus Alternative on "candidate, sensitive, or special status species" (CEQA – Appendix G). Special-status fish species with reasonable potential to occur in the Stevens Creek and Guadalupe River watersheds below impassable barriers (see Section 1.2, *Study Area*) are steelhead, Chinook salmon, Pacific lamprey, Sacramento hitch, and riffle sculpin, although Chinook salmon, Sacramento hitch, and riffle sculpin are present only in the Guadalupe River watershed (see Section 1.3, *Environmental Setting*). Non-fisheries aquatic and semi-aquatic resources (for example, amphibians, turtles) are excluded from this analysis and evaluated in a separate technical memorandum (Valley Water 2017a).

1.2 Study Area

The study area is in the Stevens Creek watershed downstream of Stevens Dam and in the Guadalupe River watershed downstream of Almaden Dam, Calero Dam, Guadalupe Dam, and James J. Lenihan Dam in northern Santa Clara County, California (Figure 1, Figure 2), here referred to as the "Stevens Creek portion of the study area" and the "Guadalupe River portion of the study area."

For the purposes of evaluating fisheries and aquatic habitat, the downstream extents of the study area creeks end at the regions of tidal influence. The tidally influenced areas of the study area creeks generally include downstream reaches of Stevens Creek (approximately midway between

Highway 101 and the Crittenden Lane pedestrian bridge) and the Guadalupe River (approximately located at the pedestrian bridge downstream of the Montague Expressway). The tidally influenced reaches represent a gradient from freshwater to brackish to saline tidal marsh vegetation and tidally exposed flats within the channels. The Proposed Project would not substantively affect aquatic habitat conditions in the tidally influenced and estuarine reaches of Stevens Creek and the Guadalupe River (Alviso Slough) because of the dominant influence that tidal conditions have on the habitat in these areas, both historically and under current baseline conditions. Valley Water recognizes that changes in reservoir flow releases to the upstream reaches of these streams could have some minor effect on flow-dependent habitat availability or salinity conditions in the tidally influenced reaches, depending on the time of year, climatic conditions, tidal influence, and accretions and depletions of flow along the creeks. The study area creeks have the greatest potential to alter aquatic habitat conditions in tidally influenced reaches during relatively high-flow events during the winter and spring because of a combination of reservoir releases and downstream accretions, including urban runoff. However, the Proposed Project is intended to influence controlled reservoir releases only at relatively low flows and would not affect flow rates during flood events, reservoir spill events, or emergency operations. Therefore, the Proposed Project would not substantially affect aquatic habitat conditions in the tidally influenced reaches of the study area. For the reasons described above, the tidally influenced areas of study area creeks are not included in the study area for aquatic resources.

1.2.1 Stevens Creek Watershed Portion of the Study Area

The areas assessed for the Stevens Creek watershed includes the portion of Stevens Creek downstream of Stevens Creek Dam, which impounds Stevens Creek Reservoir and upstream of the tidally influenced area, approximately midway between Highway 101 and the Crittenden Lane pedestrian bridge (Figure 1).

Several small ephemeral and perennial drainages feed into the creek upstream of Stevens Creek Reservoir, which is managed by Valley Water. Heney Creek and diversions from Permanente Creek flow into Stevens Creek downstream of the dam, and Stevens Creek ultimately discharges into San Francisco Bay near the city of Mountain View.

Stevens Creek Reservoir has 3,138 acre-feet of capacity, and Stevens Dam is one of six original systems approved for construction by voters in 1934 and completed in 1935. In addition to Stevens Creek Reservoir and Dam, Valley Water operates the West Pipeline, which can be used to provide imported water to the stream via the Stevens Creek turnout. Stevens Creek does not have any instream diversion facilities.

Figure 1. Stevens Creek Watershed

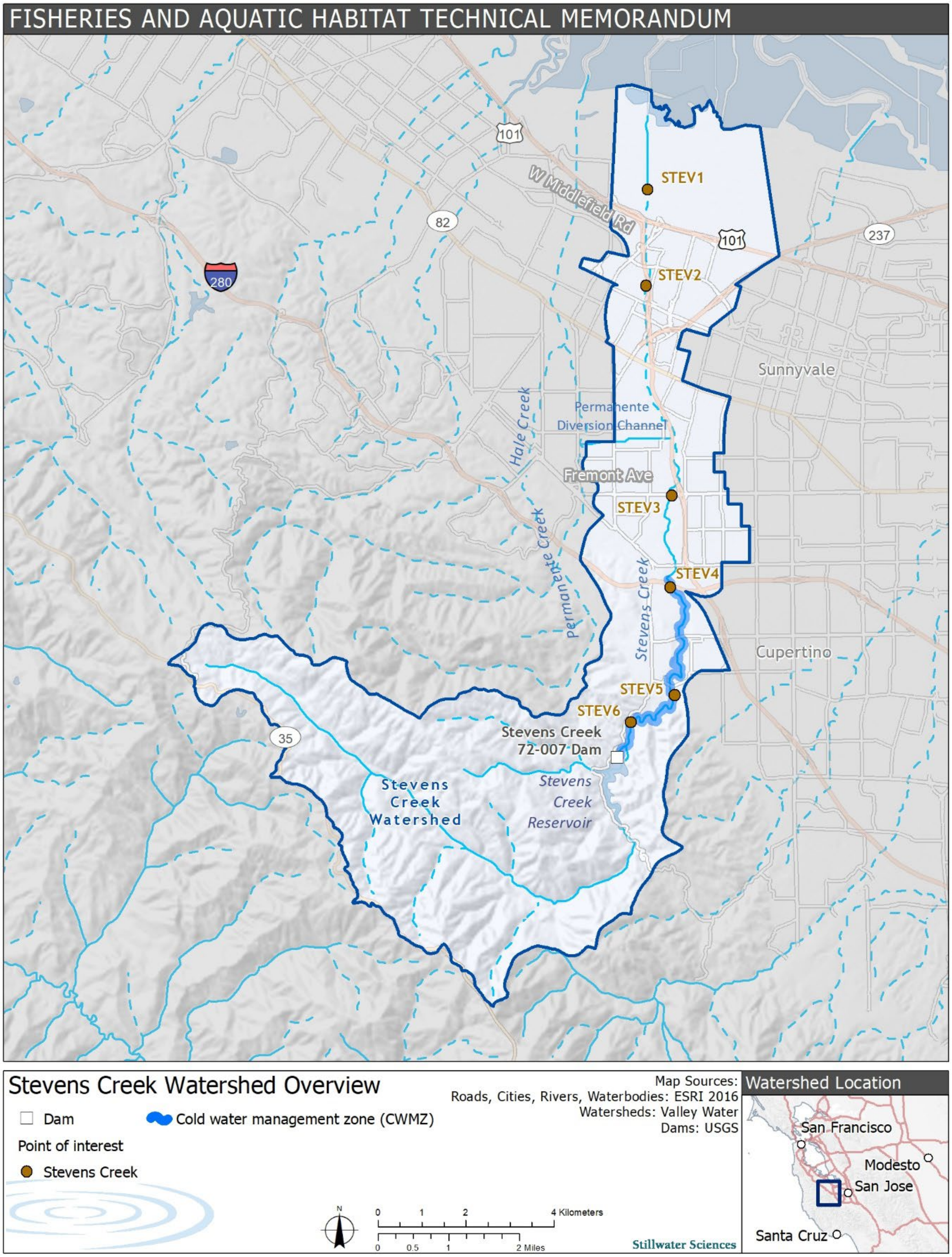
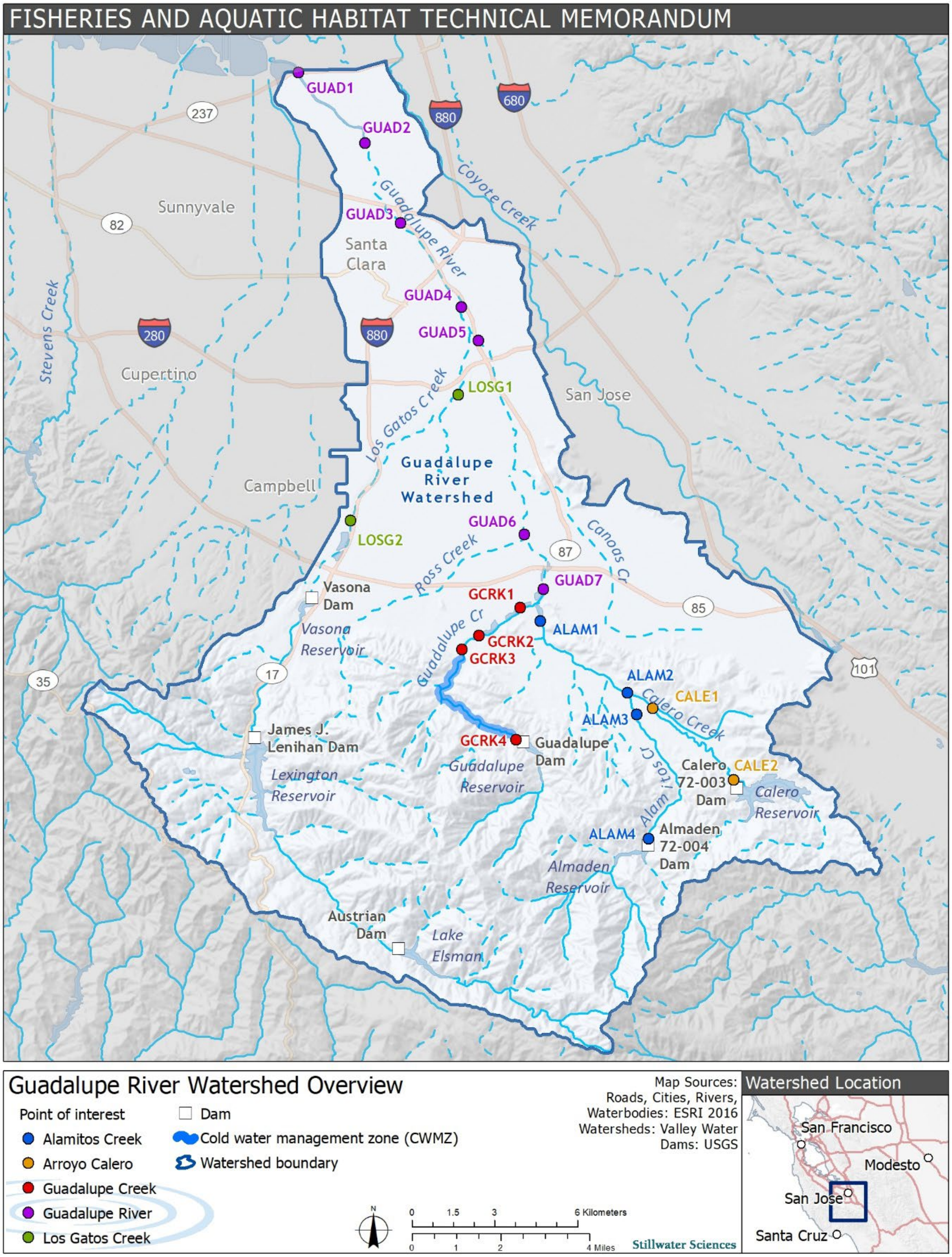


Figure 2. Guadalupe River Watershed



1.2.2 Guadalupe River Portion of the Study Area

The areas assessed for the Guadalupe River watershed include the Guadalupe River upstream of the tidally influenced area (approximately located at the pedestrian bridge downstream of the Montague Expressway) and the following major tributaries: Los Gatos Creek, Guadalupe Creek, Alamitos Creek, and Calero Creek downstream of Almaden Dam, Calero Dam, Guadalupe Dam, and James J. Lenihan Dam (Figure 2). The Guadalupe River ultimately discharges to the San Francisco Bay via Alviso Slough in the community of Alviso, which is part of the city of San José.

The present-day hydrology of the Guadalupe River portion of the study area has been substantially influenced by Valley Water's water supply operations as well as urbanization of the Santa Clara Valley floor. Upper watershed reservoirs capture rainfall runoff during the winter and store the water for use in the dry summer months.

The **Guadalupe River** mainstem begins at the confluence of Guadalupe and Alamitos Creeks approximately 400 feet downstream of Almaden Lake and flows north for 14 miles through heavily urbanized portions of San José before discharging to the San Francisco Bay. In addition to the three major tributaries (Los Gatos Creek, Guadalupe Creek, and Alamitos Creek), the mainstem also intersects Ross Creek and Canoas Creek, which are trapezoidal channels with earthen and concrete sections throughout that do not provide fish habitat.

Los Gatos Creek, which is the westernmost tributary, begins in the Santa Cruz Mountains. Its waters form Lexington Reservoir and Vasona Reservoir and supply water to Lake Elsman, a reservoir that is owned by the San José Water Company. Historically, the lower part of Los Gatos Creek was a braided stream entering a marsh area at its confluence with the Guadalupe River, but it has been modified over time and is now a defined channel. These channel modifications, which include a series of diversion ditches and off-stream percolation ponds, enhance the creek's ability to protect against floods and function as a water supply facility.

Guadalupe Creek also originates in the Santa Cruz Mountains. Guadalupe Reservoir impounds the channel of Guadalupe Creek in a narrow, northwest-trending valley. Water released from the reservoir maintains perennial stream habitat downstream in Guadalupe Creek, as storage allows, to the confluence with Alamitos Creek where they form the Guadalupe River.

Alamitos Creek, which is the easternmost tributary, begins in the Santa Cruz Mountains and crosses the lower-elevation foothills before reaching the Santa Clara Valley floor. Almaden Reservoir is located on Alamitos Creek in the upper watershed. Below the Almaden Reservoir Dam, Alamitos Creek joins Guadalupe Creek to form the Guadalupe River.

- **Calero Creek** (also known as Arroyo Calero) is a tributary of Alamitos Creek and supplies water to Calero Reservoir. Downstream of Calero Reservoir, Calero Creek flows northwest to its confluence with Alamitos Creek.

- **Points of Interest**

This technical memo used Points of Interest (POIs) within each stream to evaluate modeled data. The POIs included in the model are displayed in Figure 1 and Figure 2. STEV 2, GUAD 2, and ALAM 1 were excluded from this analysis, as explained in Section 1.4.3, *Flow Measures Analysis Methodology.*

1.3 Environmental Setting

The environmental setting describes the existing conditions of aquatic biological resources in the study area.

1.3.1 Fish Species and Related Aquatic Habitat

The analysis for aquatic biological resources in the study area consisted of a review of relevant literature listing fish species observed within the Stevens Creek and Guadalupe River watersheds. Native fish species currently known to reside in the study area are compiled in Attachment K.1, *Known Native Fish Species in Stevens Creek and Guadalupe River Watersheds*.

The assessment of potential impacts and/or benefits of the Proposed Project is an analysis of "candidate, sensitive, or special-status species," as suggested by CEQA Guidelines Appendix G, and of species that may interact with the candidate, sensitive, or special-status species, for which there are sufficient data to support the analysis. Special-status aquatic species with the potential to occur in the study area are summarized in Table 1. In this technical memorandum, the potential impacts of the Proposed Project on special-status species that are known to occur or are likely to occur within the study area, along with impacts on their habitat, are analyzed. In Chapter 4, *Alternatives*, of the EIR, the potential impacts of the alternatives on the same species are analyzed. Special-status species unlikely to occur or that are not present within the study area are not addressed further in this analysis. Assessments for the likelihood of special-status species to occur in the study area are based on known species' ranges, necessary habitat features and preferences for the species, and previous observations within the study area.

1.3.1.1 Central California Coast Steelhead

Regulatory Status

The California Central Coast steelhead Distinct Population Segment (DPS) includes naturally spawned populations of steelhead (and their progeny) residing below long-term impassable barriers, both natural and human-made, in locations including, but not limited to, the study area (Stevens Creek, Alamitos Creek, Calero Creek, Guadalupe Creek, and the Guadalupe River mainstem below long-term impassable barriers) (62 *Federal Register* [FR] 159; 71 FR 834). The DPS was federally listed as threatened on August 18, 1997 (62 FR 159).

For ease of communication, "the DPS" is used interchangeably with "steelhead" in this technical memorandum. The DPS acronym is used in specific regulatory contexts regarding the Central California Coast (CCC) steelhead DPS and steelhead is used in the impact analysis and more general discussion regarding steelhead in the study area. The species name abbreviation "*O. mykiss"* is used when referring generally to fish within the species that cannot be differentiated between the resident form (which is not listed) and anadromous form (which is listed and referred to as steelhead or the DPS) (see the *Life History* section below for further explanation).

The final critical habitat designation for the DPS was issued on September 2, 2005 (70 FR 52488), and includes stream reaches in the Santa Clara Hydrologic Unit. Stream reaches designated in the study area are Stevens Creek downstream of Stevens Creek Reservoir and the Guadalupe River downstream of West Hedding Street.

Table 1. Potential Special-status Aquatic Species Documented in the Proposed Project Study Area

Common Name Scientific Name	Status Federal/State	Distribution in California	Habitat Association	Likelihood to Occur in the Study Area
Central California Coast steelhead *Oncorhynchus mykiss*	Federally Threatened/--	Coastal California streams from the Russian River, south to Aptos Creek, San Francisco, San Pablo, and Suisun bays; the drainages of San Francisco, San Pablo, and Suisun bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin rivers; excludes the Sacramento/San Joaquin Delta	Rivers and streams with cold water, clean gravel of appropriate size for spawning, and suitable rearing habitat; typically rear in freshwater for one or more years before migrating to the ocean	*Present:* Observed in the study area in both Stevens Creek and Guadalupe River watersheds
Central Valley fall-run Chinook salmon *Oncorhynchus tshawytscha*	--/California Species of Special Concern	Sacramento River and its tributaries; Sacramento-San Joaquin Delta; San Francisco, San Pablo, and Suisun bays	Coastal streams and large mainstem rivers; spawns in gravel riffles; juveniles typically rear for a few months before migrating to the ocean	*Present:* Observed in the Guadalupe River watershed
Pacific lamprey *Entosphenus tridentatus*	--/California Species of Special Concern	Coastal California streams from the Oregon border to Baja; the drainages of San Francisco, San Pablo, and Suisun bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin rivers	Coastal rivers and streams with cold water and clean gravel of appropriate size for spawning; spawns at the upstream edges of riffles in sandy gravel; ammocetes (larvae) typically rear in backwater areas with fine substrate for five or more years before migrating to the ocean	*Present:* Observed in the study area in both the Stevens Creek and Guadalupe River watersheds
Riffle sculpin *Cottus gulosus*	--/California Species of Special Concern	Central Valley watersheds including the San Joaquin River, Mokelumne River south to the Kawaeah River, Putah Creek and from the American River north to the upper Sacramento and McCloud rivers; drainages of the San Francisco Bay including Coyote Creek, Guadalupe River, Napa River, Sonoma Creek, Corta Madera Creek, and Green Valley Creek; Salinas and Pajaro Rivers, Russian River, and Redwood creeks	Headwater rivers and streams with cold water and adequate flow with rock or gravel substrate; adults occupy fairly shallow, fast flowing water with adequate velocity refugia; spawns under rocks in swift riffles or inside cavities in submerged woody debris; all life stages are benthic and do not disperse far from their natal nest	*Present:* Observed in the Guadalupe River watershed in the Guadalupe River and Guadalupe Creek

Common Name Scientific Name	Status Federal/State	Distribution in California	Habitat Association	Likelihood to Occur in the Study Area
Sacramento hitch *Lavinia exilicauda*	--/California Species of Special Concern	Sacramento-San Joaquin, Clear Lake, Russian River, and Pajaro-Salinas drainages; drainages of the San Francisco Bay including Coyote, Alameda, and other creeks draining Santa Clara, Contra Costa, and Alameda Counties; Suisun Creek, and the Sacramento-San Joaquin Delta	Warm, low-elevation sloughs, lakes, low-velocity stretches of rivers, and low-gradient streams; juveniles are typically found in run habitat with abundant cover, while adults are found in deep pools with abundant cover; spawns primarily in riffles of tributary streams to lakes, rivers, and sloughs in clean, fine to medium sized gravel	*Likely:* The species has not been observed upstream of the Stevens Creek estuary; observed in the Guadalupe River watershed in the lower Guadalupe River downstream of Airport Parkway and in Los Gatos Creek
Eulachon *Thaleichthys pacificus*	Federally Threatened/--	Northeastern Pacific Ocean and coastal streams; northern California (Mad River basin) to southwest and south-central Alaska; extirpated in the Sacramento River system and farther south in California[1]	Coastal streams and large mainstem rivers thought to have spring freshets	*Unlikely:* The study area does not overlap with the range of the species and the species has not been observed upstream of the Guadalupe River estuary

Population Status

Steelhead are known to use most creeks in the study area (Table 1). The National Marine Fisheries Service (NMFS) final Coastal Multispecies Recovery Plan categorized the historical Stevens Creek and Guadalupe River watershed steelhead populations as independent populations (NMFS 2016). This "independent" category included both functionally and potentially independent populations. Potentially independent populations have "a high likelihood of persisting over 100-year time scales, but are too strongly influenced by immigration from other populations to exhibit independent [population] dynamics" (Bjorkstedt et al. 2005, p. 16). Functionally independent populations have "a high likelihood of persisting over 100-year time scales" without immigration from other populations (Bjorksted et al. 2005, p. 16). These designations are consistent with McElhany et al.'s (2000) definition of independent "viable salmonid populations".

Bjorkstedt et al. (2005) concluded that the DPS historically consisted of 37 independent populations and possibly 30 or more dependent populations of winter-run steelhead. These populations were aggregated into five geographically based diversity strata.[1] The Coastal San Francisco Bay diversity stratum includes the Stevens Creek and Guadalupe River watersheds. The Stevens Creek population includes steelhead in Stevens Creek only; the Guadalupe River population includes steelhead in the Guadalupe River and in Los Gatos, Guadalupe, Alamitos, and Calero Creeks (NMFS 2016).

Life History

Table 2 reflects the potential seasonal occurrence in the study area for steelhead (and other special-status species) according to life stage.

Oncorhynchus mykiss exhibits different life history strategies (NMFS 1998), including anadromy, where juveniles[2] rear in freshwater rivers and creeks, smolts[3] migrate to the ocean where they mature to adults, and adults return to freshwater rivers and creeks to spawn (usually at ages four to five). *Oncorhynchus mykiss* can also exhibit a resident life history, where rearing, maturing, and spawning all occur within freshwater. Steelhead is the term commonly used for the anadromous life histories, while rainbow trout is the term for the freshwater-resident life history. Because they are the same species, in cases where life history is uncertain, the scientific name *O. mykiss* is used.

Steelhead exhibit highly variable life history patterns throughout their range but are broadly categorized into winter and summer reproductive ecotypes. Only winter steelhead are found in the CCC steelhead DPS. Steelhead spawning in California has been reported as early as December and can extend through April, as reflected in Table 2 (FAHCE 2003; Hallock et al. 1961; Leidy 2007; McEwan and Jackson 1996; Valley Water 2000; Williams 2006), however migration and spawning peaks February through March. Adults spawn soon after reaching spawning grounds (Moyle et al. 2008).

Upon emerging from the gravel, fry rear in edgewater habitats and move gradually into pools (a smooth surface and low-velocity, deep water) and riffles (shallow, where water flows over coarse

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[1] The five strata include: North Coastal, Interior, Santa Cruz Mountains, Coastal San Francisco Bay, and Interior San Francisco Bay (Bjorkstedt et al. 2005; Spence et al. 2008).

[2] In this report juvenile steelhead refers to both young-of-the-year (YOY) and age 1+/2+, unless indicated separately. YOY are age 0+ individuals less than one year old that hatched the previous spring or in early summer and are the offspring of adults that spawned the previous winter or early spring. Age 1+/2+ refers to all pre-smolt juveniles one year old or older. YOY are likely to be between 3 and 6 months old, and age 1+/2+ are likely between 1.25 and 2.5 years old.

[3] Smolts are juvenile steelhead migrating to the ocean (that is, smolting) that exhibit silver coloration and have no parr marks.

streambed particles and create surface turbulence) as they grow larger. Juvenile steelhead rear for a minimum of one, and typically two or more years, in freshwater before migrating to the ocean during smoltification (the process of physiological change that allows ocean survival) (NMFS 2016). Juvenile steelhead emigration to the ocean in the study area is assumed to occur from February through May (Valley Water 2000, McEwan 2001).

Habitat Requirements

To migrate upstream, adult steelhead require depths greater than 0.5 ft (Thompson 1972; Bell 1991), and velocities less than or equal to 8 feet per second (Thompson 1972; Bell 1991). Thermal migration barriers for adult immigration have frequently been reported for salmonids, including steelhead, when water temperatures reach approximately 70°F (McCullough et al. 2001). Based on a review of various water temperature studies on anadromous salmonids summarized in McCullough et al. (2001), USEPA (2003) found that an overall reduction in migration fitness attributable to cumulative stresses occurred at constant water temperatures greater than 62.6°F to 64.4°F. Telemetry research on summer-run steelhead in the Columbia River basin has identified approximately 19°C (~66°F) as an important behavioral thermal threshold, where adults have been observed to seek out thermal refugia during their upstream migration (Keefer et al. 2009, as cited in Keefer et al. 2018).

Steelhead select spawning sites with gravel substrate and sufficient water velocity to maintain circulation through the gravel, providing a clean, well oxygenated environment for incubating eggs. The preferred flow velocity for spawning is generally in the range of 1 to 3 feet per second (Raleigh et al. 1984). The preferred gravel substrate for spawning steelhead is in the range of 0.5 to 4 inches in diameter (Bjornn and Reiser 1991; NMFS 2016). In addition to substrate size, the percentage of fine sediment (in terms of cobble embeddedness) is also a primary determinant of spawning and incubation habitat quality. For example, Bjornn and Reiser (1991) present data showing that survival of steelhead (and Chinook salmon) embryos generally begins to decline as the percentage of fine sediment in the redd increases above 25%. Additionally, optimal steelhead spawning and embryo incubation water temperatures have been reported to range from 39–52°F (McEwan and Nelson 1991). Based on a review of various water temperature studies on anadromous salmonid embryos summarized in McCullough et al. (2001), USEPA (2003) found that good survival of embryos occurs at constant water temperatures of about 39.2–53.6°F. Based on review of various water temperature studies, including sources identified above, Bratovich et al. (2012) identified an upper optimal WTI value of 54°F and an upper tolerable index value of 57°F for steelhead embryo incubation to be applied in an evaluation of the reintroduction of steelhead to the upper Yuba River Watershed.

After they emerge from the gravel, fry inhabit low-velocity areas along the stream margins. As they feed and grow, they gradually move to deeper and faster water. Juvenile salmonids prefer well shaded pools at least 3.28 feet deep with dense overhead cover, or abundant submerged cover, composed of undercut banks, logs, roots, and other woody debris (NMFS 2016). Cover provides juvenile steelhead with velocity refuge and a means to avoid predation (Shirvell 1990; Meehan and Bjornn 1991). Cover is particularly important in areas where water depths are shallow, such as some stream reaches during summer low flow conditions. For example, yearling and older *O. mykiss* (less than 4 inches) will reportedly abandon areas that are less than 6 inches deep unless there is abundant cover (Cramer and Ackerman 2009). However, during summer rearing, steelhead tend to use riffles and other habitats not strongly associated with cover (Shapovalov and Taft 1954) and that provide increased prey availability, which can offset increased metabolic demands associated with high water temperatures (Smith and Li 1983). Cover also provides refuge from high flows during the winter and spring, but steelhead in central California streams remain active during the winter, based on high growth rates (Sogard et al. 2009).

Water temperature and food availability are critical factors for rearing juveniles. The reported preferred and tolerable water temperatures for juvenile steelhead can be highly variable, potentially associated with variable acclimation temperatures, local adaptation, and other site-specific conditions. For example, preferred water temperatures for fry and juvenile steelhead across geographic regions have been reported to range from about 45–65°F (Adams et al. 1975; Myrick and Cech 2001; Rich 1987), or less than 55°F (USEPA 2003; McCullough et al. 2001). When additional food is available, juvenile *O. mykiss* and steelhead can also increase feeding to meet increased metabolic demands imposed by above-optimal temperatures, and growth rates can be higher under warmer conditions (Wurtsbaugh and Davis 1977; Hayes et al. 2008). The upper incipient lethal temperature (UILT) for juvenile rainbow trout is reported to be 75-79°F (Sullivan et al. 2000; McCullough 2001), but juvenile steelhead in Southern California have been observed at 31.5°C (88.7°F) (Sloat and Osterback 2013).

In addition to direct effects of temperature on steelhead metabolic rate, temperature can also influence steelhead indirectly by influencing ecological interactions (for example, competition and predation) and food availability. For example, in some watersheds, warm water temperatures support and provide a competitive advantage for aquatic invasive species such as largemouth bass (*Micropterus salmoides*) (Rahel and Olden 2008). Aquatic invasive species have been documented to prey on juvenile steelhead and compete for habitat and food resources (Carey et al. 2011; Thompson et al. 2012).

Most literature regarding water temperature effects on steelhead smolting suggest that water temperatures less than 52°F are required for successful smoltification to occur (Adams et al. 1975; Myrick and Cech 2001; Rich 1987). However, the Sonoma County Water Agency (2016) identified a value of 59°F for steelhead smoltification in the Russian River (within the CCC steelhead DPS) as resulting in impacts that tend to be less than significant, assuming a short duration of exposure, and outmigration in the study area has been observed during temperatures greater than 52°F (Valley Water unpublished data), suggesting local adaptation of higher thermal tolerance by steelhead in the study area.

It should be noted that the majority of available data used for evaluating temperature tolerance in McCollough et al. (2001) was from steelhead populations in the Pacific Northwest U.S., and since publication, additional studies have provided evidence for population specific thermal tolerances for steelhead (Myrick and Cech 2001; 2005; Sloat and Osterback 2013; Verhille et al. 2016; Zillig et al. 2021) with populations at the steelhead southern range having higher temperature tolerance compared to more northern populations.

Several habitat characteristics are known to influence *O. mykiss* populations in the study area. Reservoirs in the Guadalupe River system reportedly block sediment transport and access to habitat, and can impair habitat complexity, cover, and effective spawning habitat availability (NMFS 2016). NMFS (2016) also reports water quality as limiting steelhead survival in the Guadalupe River watershed.

Occurrence in the Study Area

Steelhead occur and spawn within the Stevens Creek watershed portion of the study area (FAHCE 2003; Smith 2013, 2020; Abel 2011; Valley Water 2021b). Juvenile *O. mykiss* were captured in surveys conducted downstream of Stevens Creek Reservoir between 2013 and 2020 (Smith 2019; Valley Water 2021b). According to Smith (2020), *O. mykiss* spawning access and population numbers in Stevens Creek were high in 2010, but low in 2014, 2015, and 2016. Steelhead densities in Stevens Creek substantially increased in 2017 and 2019. Steelhead were scarce or absent within downstream reaches of Stevens Creek in 2010, 2014, 2015, 2016, and 2017, but were recorded again after high flows in 2019 (Smith 2020). Sampling conducted by Valley Water in 2020 detected several *O. mykiss* indicated with densities increasing toward the downstream sampling stations, which correspond to STEV 4 (Valley Water 2021b). Steelhead captured during the 2020 surveys were likely YOY fish from water year 2020, with the remaining fish likely yearling fish from water year 2019 (Valley Water 2021b).

Steelhead occur and spawn within the Guadalupe River watershed portion of the study area (FAHCE 2003; Leidy 2007; Valley Water 2021a). Surveys in the Guadalupe River and Guadalupe Creek from water years (WY) 2004 through 2013 all consistently reported *O. mykiss* presence (Valley Water and Stillwater Sciences 2013). Repeat surveys between 2015 and 2020, indicate drought-related conditions may have limited the distribution, and abundance of steelhead in the Guadalupe River, with decreased population abundance occurring during periods of drought (Valley Water and Stillwater Sciences 2015, 2016, 2017; Valley Water et al. 2018b). Surveys conducted in the Guadalupe River, Guadalupe Creek, Alamitos Creek, Los Gatos Creek, and Calero Creek indicate juvenile *O. mykiss* are higher in abundance in tributary streams than in the Guadalupe River, with the exception of Los Gatos Creek where no *O. mykiss* have been detected since 2014 (Hobbs et al. 2014; Valley Water and Stillwater Sciences 2015, 2016, 2017; Valley Water 2019b; Valley Water 2021a). These surveys also indicate that Guadalupe, Alamitos, and Calero creeks show signs of successful reproduction (Valley Water and Stillwater Sciences 2015, 2016, 2017; Valley Water 2019a, 2020b).

Table 2. Potential Seasonal Occurrence in the Study Area by Life Stage for Special-status Species

Life Stage	January	February	March	April	May	June	July	August	September	October	November	December
Steelhead												
Adult Immigration	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟦🟦🟦🟦
Spawning	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟦🟦🟦🟦
Fry Rearing	🟨🟨🟨🟨	🟨🟨🟨🟨	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨
Juvenile Rearing	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦
Smolt Emigration	🟨🟨🟨🟨	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨
Chinook Salmon												
Adult Immigration	🟦🟦🟦🟦	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦
Spawning	🟦🟦🟦🟦	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦
Fry Rearing	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨
Juvenile Rearing	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨
Smolt Emigration	🟨🟨🟨🟨	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨
Pacific Lamprey												
Adult Immigration	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨
Pre-Spawning Holding	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟨🟨🟨🟨	🟨🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦
Spawning and Incubation	🟨🟨🟨🟨	🟨🟨🟨🟨	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨
Larvae Rearing	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦
Juvenile Emigration	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟦🟦🟦🟦
Riffle Sculpin												
Spawning	🟨🟨🟨🟨	🟦🟦🟦🟦	🟦🟦🟦🟦	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨
Fry Rearing	🟨🟨🟨🟨	🟨🟨🟨🟨	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦
Juvenile Rearing	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦
Sacramento Hitch												
Spawning and Incubation	🟨🟨🟨🟨	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨	🟨🟨🟨🟨
Juvenile Rearing	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦	🟦🟦🟦🟦

*Blue boxes indicate when species life stages are expected to occur in the study area. Yellow boxes show times when species is not expected to occur in the study area.

1.3.1.2 Central Valley Fall-run Chinook Salmon

Regulatory Status

Central Valley fall-run and late fall-run Chinook salmon are considered by NMFS to be the same evolutionarily significant unit (ESU) (64 FR 50394). NMFS determined that listing the Central Valley fall-run Chinook salmon ESU as threatened was not warranted (64 FR 50394), but subsequently classified Central Valley fall-run Chinook salmon as a species of concern because of specific risk factors, including population size and hatchery influence (69 FR 19975). Because the Central Valley fall-run Chinook salmon ESU is not listed as federally endangered or threatened, critical habitat has not been designated for this species. CDFW considers Central Valley fall-run Chinook salmon a Species of Special Concern and indicates that the species is found within Central Valley rivers and streams, but range maps do not include Santa Clara County (CDFW 2018).

The study area does not occur within the Central Valley fall-run Chinook salmon ESU boundary or California Species of Special Concern boundary.

Population Status

The study area is not encompassed by the range of the Central Valley fall-run Chinook salmon. Central Valley fall-run Chinook salmon have been observed in the Guadalupe River watershed within the last 20 years and are native to California and the Sacramento-San Joaquin Province, but historical data suggest they are not endemic to the Guadalupe or Stevens Creek watersheds, and only occurred on a transient basis. Specific genetic testing of more than 450 Chinook salmon captured in Santa Clara Valley indicate the fish are closely related to Central Valley fall-run Chinook salmon, and the presence of fin-clipped hatchery fish with coded wire tags indicates a strong probability of straying (Garcia-Rossi 2002). Bjorkstedt et al. (2005) suggest that off-site hatchery releases (for example, hatchery releases in San Francisco Bay) have increased straying rates such that Chinook salmon spawning in San Francisco Bay tributaries are heavily affected by, or potentially entirely derived from, Central Valley hatchery stocks. Therefore, no definitive answer can be made on the nativity of Chinook salmon to the Guadalupe River watershed, though it is unlikely that they were historically persistent there, and the current population is of hatchery origins (Valley Water 2018a). Consequently, Chinook salmon populations in the study area are not recognized as reproductively isolated populations. Williams et al. (2011) recommended that populations recently identified in the Napa and Guadalupe Rivers, along with future populations found in basins inclusive of the San Francisco Bay/San Pablo Bay complex that exhibit fall-run timing, should be included in the Central Valley fall-run Chinook salmon ESU. However, the delineation of the Central Valley fall-run Chinook salmon ESU has not been modified (NMFS 2016).

For ease of communication, herein Central Valley fall-run Chinook salmon are referred to as Chinook salmon unless they are discussed in a regulatory context specific to the ESU then they are referred to as Central Valley fall-run Chinook salmon.

Life History

Central Valley fall-run Chinook salmon adult upstream migration has generally been reported to occur between August and December (Valley Water et al. 2003, FAHCE 2003, Leidy 2007, Moyle 2002). However, based on monitoring of adult fall-run Chinook salmon migrating upstream in the Guadalupe River watershed, the adult migration period peaks in October and November but may extend as late as January in the study area (Valley Water 2018b, 2020b).

Literature suggests that Central Valley fall-run Chinook salmon adults spawn from the fall through mid-winter. The Fish and Aquatic Habitat Collaborative Effort (FAHCE) limiting factors analyses

(Valley Water 2000) used a time period for Chinook salmon adult spawning of October through February. Generally, Valley Water expects that Chinook salmon in the study area could spawn from October through December. Laboratory experiments in British Columbia (Beacham et al. 1989) found that the average incubation duration of Chinook salmon eggs to fry emergence was 77 days at 53.5°F (consistent with water temperatures during winter in the study area), indicating that Chinook salmon embryos that spawned in January would reach the fry emergence stage by the end of March. Therefore, it can be assumed that embryo incubation may extend through March.

Juvenile Chinook salmon rearing is expected to occur from about January through June (Valley Water 2000; FAHCE 2003. Based on juvenile emigration surveys conducted in the Guadalupe River and nearby Coyote Creek (Valley Water, unpublished data), fry sized juveniles (that is, less than 2 inches fork length) may emigrate from January through April. Central Valley fall-run Chinook salmon generally emigrate from Central Valley rivers as young of the year (Kimmerer and Brown 2006). Chinook salmon juvenile emigration in the study area is assumed to occur from about February through June, particularly April through June, associated with storm events (Valley Water 2000; FAHCE 2003).

Habitat Requirements

Adult Chinook salmon require flows of adequate depth and velocity to successfully migrate upstream in freshwater river systems. Thermal migration barriers have frequently been reported for adult salmonid upstream migration, including Chinook salmon (McCullough et al. 2001). Based on a review of various water temperature studies on anadromous salmonids summarized in McCullough et al. (2001), USEPA (2003) found that an overall reduction in migration fitness attributable to cumulative stresses occurred at constant water temperatures greater than 62.6°F to 64.4°F. However, recent literature suggests that salmonids in southerly locations, including Chinook salmon, may have thermal physiologies capable of tolerating higher water temperatures compared with more northerly populations that were evaluated to establish temperature tolerances (Zillig et al. 2021).

Chinook salmon depend on suitable substrate and water temperature conditions for successful spawning and embryo incubation. Specifically, spawning Chinook salmon require clean, loose gravel in swift, relatively shallow areas. Because of their larger size, Chinook salmon can spawn in higher water velocities and use coarser substrates than other salmon species (PFMC 1999). Spawning Chinook salmon in California’s Trinity River reportedly preferred gravel and cobble from 2 to 6 inches in diameter that was less than 40% embedded in fine sediment (USFWS 1997). In Clear Creek (a tributary to the Sacramento River), spawning Chinook salmon used substrate sized between about 1 and 6 inches, with a preference for substrate between 1 and 3 inches (Giovanetti and Brown 2013). Raleigh et al. (1984) assumed that particles must be at least 0.5 inches in diameter to permit adequate percolation for successful embryonic development. In general, water temperature-related Chinook salmon embryo survival has been suggested to be optimal at approximately 43–54°F (Myrick and Cech 2004). Based on a review of various water temperature studies on anadromous salmonid embryos summarized in McCullough et al. (2001), USEPA (2003) found that survival is optimized at constant water temperatures of about 39.2–53.6°F. Chinook salmon–specific studies indicate that Chinook salmon egg and alevin survival decreased rapidly when water temperatures exceed approximately 56°F (Seymour 1956; Boles 1988; USFWS 1999).

The percentage of fine sediment (in terms of cobble embeddedness) is a primary determinant of spawning and incubation habitat quality. For example, Bjornn and Reiser (1991) present data showing that the survival of Chinook salmon embryos generally begins to decline as the percentage of fine sediment in the redd increases above 25%.

Juvenile Chinook salmon are known to prefer slower water habitats than many other salmonid species (Quinn 2005) and have been reported to actively seek out slow backwaters, pools, or floodplain habitat for rearing (Sommer et al. 2001; Jeffres et al. 2008). However, juvenile Chinook salmon have been reported to show a clear preference for faster water (up to an average of about 1.8 feet per second) as they grow, consistent with trends found with salmonids in other rivers (Bjornn and Reiser 1991). Juvenile Chinook salmon use water depth (deep, low-velocity pools and bank eddies), surface turbulence, instream structures, and substrate as cover, with substrate being a primary source of escape and winter cover (Raleigh et al. 1986).

Water temperature is generally considered to be a key limiting factor for the Central Valley fall-run Chinook salmon juvenile rearing life stage, particularly during late spring. The water temperature reported to allow for maximum growth of juvenile Central Valley fall-run Chinook salmon with maximal rations is 66.2°F (Cech and Myrick 1999). Similar to results reported by Cech and Myrick (1999), Marine (1992) found that maximum growth rates of Sacramento River fall-run Chinook salmon were observed in juveniles reared at 62.6–68.0°F, with lower growth rates for juveniles reared at 69.8–75.2°F. Overall, based on water temperature effects on growth, saltwater adaptation, and predation avoidance, Marine and Cech (2004) found that juvenile Central Valley fall-run Chinook salmon reared at water temperatures of 68°F or greater experienced decreased growth, altered smolt physiology, and increased predation vulnerability compared with juveniles reared at water temperatures considered to be near optimal (55.4–60.8°F).

Occurrence in the Study Area

Chinook salmon have not been documented in Stevens Creek historically or under existing conditions. Chinook salmon have been documented in the Guadalupe River watershed within the Guadalupe River (including estuarine reaches), Guadalupe Creek, Alamitos Creek, Calero Creek, and Los Gatos Creek (Valley Water unpublished data; Valley Water and Stillwater Sciences 2017) over the past 20 years, although Chinook salmon were not documented in the Guadalupe River watershed until the mid-1980s (Leidy 2007). Valley Water reported fluctuating numbers of spawning Chinook salmon from 1995 through 2018 in the Guadalupe River watershed (Valley Water 2018b). Since 2002, Chinook salmon range has expanded as a result of barrier remediation, so that fish occurrences decreased in the Guadalupe River but increased in upstream tributaries, including Los Gatos, Guadalupe, Calero, and Alamitos Creeks (Valley Water 2018b).

1.3.1.3 Pacific Lamprey

Regulatory Status

The U.S. Fish and Wildlife Service (USFWS) was petitioned to list Pacific lamprey under the ESA in 2003 (Nawa et al. 2003). USFWS discontinued status review in December 2004 because of inadequate information (USFWS 2004). As a result of the petition, the USFWS recognized the declining status of Pacific lamprey throughout its range and established the “Pacific Lamprey Conservation Initiative” (PLCI) to facilitate conservation of the species (Luzier et al. 2011; Goodman and Reid 2012). Through the PLCI, the USFWS is working to improve the status of the species by proactively engaging in a concerted, collaborative conservation effort to address threats, restore habitat, increase knowledge, and improve distribution and abundance. The PLCI includes the San Francisco Bay Regional Management Unit (RMU), which is contained in the study area, and its component Coyote Hydrologic Unit Code watershed, which contains reaches in the study area (Goodman and Reid 2017).

The Pacific lamprey is listed by the state of California as a Species of Special Concern, with a status rating of “Moderate Concern” (Moyle et al. 2015). This rating denotes the species was “considered to be under no immediate threat of extinction" but were in "long-term decline or had naturally small, isolated populations which warrant frequent status re-assessment" (CDFW 2015).

Population Status

Pacific lamprey were historically distributed along the Pacific Rim from Mexico to Japan (Goodman and Reid 2017), including the entire California coast and major inland river systems (Moyle et al. 2009). Limited abundance data indicates that abundance of Pacific lamprey has declined sharply throughout their range, including the San Francisco Bay RMU, within the past 50–75 years relative to historical levels (Goodman and Reid 2017). Moyle (2009) reports that populations of Pacific lamprey across California are in decline, but there is no immediate threat of extinction in the state. Current distribution of the species is restricted in many river systems because of the presence of large dams or other impassable structures (Moyle et al. 2009; Goodman and Reid 2017). According to USFWS (2019), fish passage is the primary constraint to lamprey distribution in the San Francisco Bay RMU.

According to Docker (2010), Pacific lamprey across the west coast of North America do not show major genetic differences between populations. This suggests a lack of natal homing in the species, meaning Pacific lamprey do not necessarily spawn in the stream where they were born (Docker 2010). Because Pacific lamprey are not listed as endangered or threatened, critical habitat has not been designated. The species does not currently have USFWS designated distinct population segments.

Life History

Pacific lamprey are anadromous fish with three developmental stages: larvae (ammocoete), juvenile (macrophthalmia), and adult. Larvae reside entirely in freshwater before transforming into juveniles, which migrate to the ocean where they feed parasitically and grow into adults. Adults return to freshwater, where they spawn and die.

Adult Pacific lamprey migrate into freshwater at a length of approximately 20 to 30 inches (Chase 2001). Once adults enter freshwater, they stop feeding and primarily expend energy towards upstream migration and sexual maturation (Johnson et al. 2015).

Freshwater entry typically occurs during winter and spring (Kan 1975; Chase 2001). The adult freshwater residence period can be divided into three distinct stages: (1) initial migration from the ocean to holding areas, (2) pre-spawning holding, and (3) secondary migration to spawning sites (Clemens et al. 2010; Starcevich et al. 2014). The pre-spawning holding stage begins when individuals cease upstream movement, generally in early summer, and continues until fish begin their secondary migration to spawn the following spring (Robinson and Bayer 2005; Starcevich et al. 2014). Pacific lamprey do not necessarily home to natal spawning streams (Moyle et al. 2009, Spice et al. 2012). Instead, migrating adults appear to select spawning streams, at least in part, based on bile acid compounds secreted by ammocoetes that act as migratory pheromones (Robinson et al. 2009, Yun et al. 2011). This mode of selecting spawning streams induces migratory adults to select locations where ammocoete rearing has been successful as a result of suitable habitat and, therefore, has been called the "suitable river strategy" (Waldman et al. 2008).

Spawning typically takes place between March and June and redds are constructed in gravel and cobble substrates within pool and run (sections without flow obstructions, even stream beds, and water flows faster than pools) tailouts or low-gradient riffles (Brumo et al. 2009; Gunckel et al. 2009). Larvae emerge from spawning gravels about one to two months after spawning, depending on water temperature, at a size of about 0.3 inch (Meeuwig et al. 2005; Brumo 2006). After hatching, the larvae drift downstream to backwater areas and burrow into fine sediment substrate, feeding on algae and detritus (Torgerson and Close 2004). Depending on growth rate, the larval phase lasts approximately four to eight years, during which time individuals grow to about 6 inches (Dawson et al. 2015). After reaching sufficient size, larval Pacific lamprey transform into juveniles in late summer to fall (Dawson et al. 2015). During this metamorphosis, they develop eyes, a suctoral disc, sharp teeth, more-defined fins, and counter-shaded coloration (with silvery sides) in preparation for migration to the ocean (McGree et al. 2008; Manzon et al. 2015).

While little is known about Pacific lamprey juvenile outmigration timing in the study area, outmigration in other watersheds typically occurs at night in the winter and spring and is associated with high-flow events (Goodman et al. 2015). In the study area, summer and fall flows in the downstream portions of the two watersheds tend to be relatively low with intermittent, dry reaches; therefore, downstream migration likely occurs primarily in the winter and spring when sufficient stream flow is present to facilitate movement.

After juveniles migrate to the ocean, they spend one to three years in the marine environment, during which time they parasitize a wide variety of ocean fishes, including Pacific salmon, flatfish, rockfish, and pollock (Murauskas et al. 2013).

Habitat Requirements

Pacific lamprey are distributed across the northern margin of the Pacific Ocean, from central Baja California north along the west coast of North America to the Bering Sea in Alaska and off the coast of Japan (Lin et al. 2008; USFWS 2019). They spawn in a wide range of river systems, from short coastal streams to inland tributaries of large rivers (USFWS 2019).

The natural distribution of Pacific lamprey in California includes most streams with anadromous access and suitable spawning and rearing habitats, although they generally do not occupy small coastal drainages (less than approximately 10 square miles), even when suitable habitat is available (Swift and Howard 2009; Goodman and Reid 2012, 2017; Reid and Goodman 2016a). In general, over-summering habitat consists of protected areas associated with large cobble or boulder substrates, bedrock crevices, man-made structures such as bridge abutments, and large wood (Robinson and Bayer 2005; Lampman 2011; Starcevich et al. 2014). Effective spawning habitat consists of gravel and cobble substrates within pool and run tailouts and low-gradient riffles (Stone 2006, Brumo et al. 2009, Gunckel et al. 2009). Pacific lamprey can utilize a wide range of substrate sizes for redd construction, but most spawning occurs in locations with dominant particle sizes ranging from approximately 10–100 mm (0.4–3.9 inches) (Stone 2006; Gunckel et al. 2009). The principal habitat characteristics required for larvae are perennial water, fine sediments (sands and silts), and suitable water temperatures (generally below 74°F) (Claire 2004; Torgersen and Close 2004; Stone and Barndt 2005).

Unlike salmonids that can swim through or jump over high-velocity barriers, Pacific lamprey are specialized anguilliform swimmers, with high-efficiency but relatively low-speed swimming (Mesa et al. 2003; Reid and Goodman 2016b). Swimming Pacific lamprey are often challenged by structural features (for example, waterfalls, dams, fish ladders) (Goodman and Reid 2017). Often, they travel along the shallow periphery or even out of the water over wetted surfaces of a feature. This allows them to climb substantial waterfalls, beyond the leaping or swimming ability of salmonids; however, simple angular edges or porous surfaces (for example, grates) can block their passage.

Water temperature requirements for larval Pacific lamprey have not been well described. Meeuwig et al. (2005) found a sharp decline in survival and increase in development abnormalities in embryos as incubation temperature increased from 64°F to 71°F. However, lamprey larvae appear to tolerate higher temperatures than embryos (Potter and Beamish 1975). Four lamprey species from eastern North America were found to have incipient lethal water temperatures ranging from 82°F to 87°F after being acclimated at 59°F (Potter and Beamish 1975), but it is uncertain whether Pacific lamprey have a similar tolerance. Larval Pacific lamprey are commonly found in locations with water temperatures greater than 75°F, and there is some evidence that they can behaviorally thermoregulate through burrowing into streambed substrates, which are cooler than ambient water (Claire 2004).

Occurrence in the Study Area

Pacific lamprey have been found in Stevens Creek downstream of the Stevens Creek Reservoir, but records of their occurrence are rare, suggesting Pacific lamprey may be present in the Stevens Creek watershed under existing conditions but their abundance is inferred to be relatively low compared with the Guadalupe River watershed (Stillwater Sciences 2004). It is assumed that Pacific lamprey have been historically abundant in the San Francisco Bay region, and there are historical records of their presence in the Guadalupe River (Goodman and Reid 2017). Observations over the last 100 years suggest that Pacific lamprey were relatively abundant in the Guadalupe River watershed (Leidy 2007). Pacific lamprey have been documented in the Guadalupe River (including estuarine reaches) and Alamitos Creek over the past couple of decades (Leidy 2007). Pacific lamprey were detected and caught during annual surveys in freshwater reaches of the Guadalupe River from 2004 through 2017 (Valley Water, unpublished data). During a 2018 fish salvage effort, seven adults and one larva were captured in Los Gatos Creek (Stillwater Sciences 2018). Migrant trapping in the downstream reaches of the Guadalupe River also suggests that Pacific lamprey were common in downstream reaches in the past (Leidy 2007). Annual surveys for juvenile steelhead have not resulted in detections of lamprey in the Guadalupe River watershed portion of the study area from 2013 to 2020; however, monitoring methods are aimed at detecting *O. mykiss* and may be less effective for lamprey detection. Valley Water detected a presumed lamprey in 2019 at the Alamitos fishway on the Guadalupe River, but the species identification was not conclusive (Valley Water 2020b).

1.3.1.4 Riffle Sculpin

Regulatory Status

Riffle sculpin are not federally listed but are a California Species of Special Concern (CNDDB 2020).

Population Status

Riffle sculpin are endemic to California (Moyle 2002). Little is known of the species' population trends, as most fish surveys conducted in California do not identify sculpin to species level; however, Leidy (2007) and Moyle (2002) indicate that riffle sculpin were more widely distributed in California in the past and have been extirpated from San Mateo Creek (CDFW 2015; Leidy 2007). Most populations of riffle sculpin are geographically isolated from other populations, which make them vulnerable to local extinctions (CDFW 2015). Additionally, due to their physiology, the species is vulnerable to habitat changes that result in reduced flows or increased instream temperatures (CDFW 2015).

Riffle sculpin in the San Francisco Bay region are found in Coyote Creek, the Guadalupe River watershed, the Napa River, Sonoma Creek, Corte Madera Creek, and Green Valley Creek (Leidy 2007). In these systems, riffle sculpin are typically restricted to the upper or middle reaches in headwater tributaries.

Life History

The age and growth structures of riffle sculpin are not well understood and are based primarily on length-frequency distributions (Moyle 2002). Riffle sculpin can grow up to 6 inches; however, most adults are typically 2–3 inches long (CDFW 2015). Adults are thought to mature at the end of their second year, with spawning occurring from February through March (Moyle 2002). Spawning occurs under rocks in swift riffles or inside cavities in submerged logs (CFW 2015). Males choose spawning locations and remain in the nest to guard embryos until they hatch (CDFW 2015). A female can lay between 400–1,000 eggs with embryos typically hatching within 11–24 days later at water temperatures ranging from 59–75°F (Moyle 2002). Fry are benthic and do not move far after emerging from their nests. Juvenile and adults are poor dispersers and generally stay close to where their natal nests were located (CDFW 2015).

Riffle sculpin are opportunistic feeders and feed mostly at night. They prey primarily on benthic macroinvertebrates, mainly the larvae of caddisflies, stoneflies, and mayflies, but also eat amphipods and small fish (Moyle 2002).

Habitat Requirements

Riffle sculpin are found exclusively in permanent headwater streams with rocky or gravel substrates. They prefer cold, well oxygenated streams with dissolved oxygen levels near saturation, which restricts their occurrences to areas with ample flowing water (CDFW 2015). Riffle sculpin are most abundant in streams with water temperatures that do not exceed 77–79°F while temperatures above 86°F are typically lethal (Moyle 2002).

They occupy riffles and pools but prefer areas that have adequate cover in the form of rocks, gravel, woody debris, or undercut banks (CDFW 2015). Riffle sculpin also require suitable habitat for benthic macroinvertebrates, their primary prey source (CDFW 2015). Riffle sculpin are typically found in headwater streams and upper watersheds and generally utilize the same headwater and upper watershed habitats as steelhead and Pacific lamprey (Leidy 2007).

Occurrence in the Study Area

Riffle sculpin have been documented in Guadalupe Watershed within the past 20 years. Sampling conducted by Valley Water from 2004 to 2020 resulted in observations of riffle sculpin in Guadalupe Creek in all years, and one individual was captured in the Guadalupe River in 2018 (Valley Water unpublished data 2004-2017; Valley Water 2019b, 2020b, and 2021b). Riffle sculpin in Guadalupe Creek are predominately found in the upstream reaches and generally decline downstream of Camden Avenue (GCRK 3) (Smith 2013; Valley Water 2019b, 2020b, and 2021b). Sampling conducted by Valley Water from 2018 to 2020 has resulted in no detections of riffle sculpin in Alamitos, Calero, or Los Gatos creeks (Valley Water 2019b, 2020b).

1.3.1.5 Sacramento Hitch

Regulatory Status

Sacramento hitch are not federally listed but are a California Species of Special Concern (CNDDB 2020).

Population Status

Sacramento hitch are endemic to California (Leidy 2007) and historically occur in the region. Little documentation is available on the abundance and distribution of Sacramento hitch, although it is believed that population numbers are decreasing (CDFW 2015). The species is fragmented into isolated populations because of major dams and agriculture (CDFW 2015). The decline is also attributed to loss of spawning flows in the spring, loss of summer rearing and holding habitat, pollution, and predation by non-native fishes (Moyle 2002).

Sacramento hitch in the San Francisco estuary region tend to exhibit narrow geographic distribution, but high abundance in the areas they do occupy (Leidy 2007). Sacramento hitch likely reside in less than 15 watersheds in the San Francisco estuary region (Leidy 2007), including the Guadalupe River watershed. Sacramento hitch can survive in impaired habitats, as evidenced by their ability to persist in urban streams (CDFW 2015).

Life History

Sacramento hitch are cyprinids that can grow up to 14 inches with females growing faster and larger than males, though there are notable differences in body size and proportions throughout populations (Moyle 2002). Growth rates appear to be directly related to summer temperatures and the productivity of their environments, with hitch growing faster in warmer and more productive environments (Moyle 2002). Sacramento hitch can reach up to 6 inches at the end of their first year (Moyle 2002). Females generally mature in their second or third year, and males in their first, second, or third year (Moyle 2002). They are omnivores, and in streams can feed on filamentous algae as well as aquatic and terrestrial insects (Moyle 2002). They feed in open water, and juvenile Sacramento hitch (2-3 inches in length) will feed on drift at the heads of pools in the summer (Moyle 2002). Sacramento hitch primarily feed, and are most active, during the day (Moyle 2002).

Sacramento hitch can spawn as early as February and as late as July (Table 2). Spawning is known to occur in riffles of streams after increased flows resulting from spring rains (Moyle 2002). Sacramento hitch require clean, fine to medium gravel for spawning and water temperatures of 57°F to 79°F (Moyle 2002). Sacramento hitch spawn in groups, with one to five males following each female (Moyle 2002). Spawning movements typically involve chasing, rapid swimming, and splashing (Kimsey 1960). Often, pairs or groups of fish move to shallow water to spawn, exposing their backs and pressing their bodies closely together (Kimsey 1960). Sacramento hitch can also spawn in ponds and reservoirs and are known to hybridize with Sacramento blackfish and California roach (Moyle 2002).

Female Sacramento hitch have been known to contain over 26,000 eggs, but larger numbers are likely possible in the correct conditions (Moyle 2002). Males fertilize the eggs immediately after release, and the fertilized eggs then sink into the gravel below (Moyle 2002). The eggs absorb water and swell considerably, about 4 times their original size, which lodges them into the gravel (Moyle 2002). Hatching occurs three to seven days later at temperatures of 59–72°F, with larvae free-swimming in three to four days (Moyle 2002). Young Sacramento hitch spend about two months in shallow water or near aquatic plant beds before moving to open water when they are around 2 inches in length (Moyle 2002). Juvenile rearing can occur year-round (Table 2). Much is still unknown of Sacramento hitch spawning and life cycle characteristics (Moyle 2002).

Habitat Requirements

Sacramento hitch prefer warm, lowland waters, but are also known to be abundant in cool, clear streams (Moyle 2002). They can reside in clear streams, turbid sloughs, lakes, and reservoirs (CDFW 2015). In streams, smaller fish are often associated with beds of aquatic or emergent vegetation that are utilized as cover, and larger fish reside in deep pools with overhanding trees (Moyle 2002). Juvenile (2–3 inches) Sacramento hitch have also been seen schooling at pool edges, and adults have been observed in undercut banks bordering pools (Leidy 2007). Sacramento hitch are known to prefer stream habitat that includes riffles and shallow waters with smaller gravel (CDFW 2015). Sacramento hitch are also associated with unshaded pools with low water clarity and silt or sand substrates, where they can occur in high densities (Leidy 2007). They are known to use flooded marshes as cover for their young (Moyle 2002). Like non-native fishes in the San Francisco estuary region, Sacramento hitch tend to utilize middle to lower reaches of large streams (Leidy 2007).

Sacramento hitch have the highest temperature tolerance of any native fish in the Central Valley, with juvenile fish able to acclimate to temperatures around 86°F in the lab (Moyle 2002). However, adults tend to select temperatures of 80–84°F and are most abundant in water temperatures cooler than 77°F during the summer (Moyle 2002). Sacramento hitch can also survive in brackish water, with reports of Sacramento hitch being found in salinities as high as nine parts per thousand (Moyle 2002).

Occurrence in the Study Area

There are several historical records of Sacramento hitch within the Stevens Creek estuary from the late 1970s and early 1980s, but no documentation upstream of the estuary (Leidy 2007). No hitch were detected in the Stevens Creek watershed during surveys conducted by Smith (2019) from 2015 to 2019.[4] Also, Valley Water (2021c) conducted electrofishing surveys in six locations downstream of the dam from 2013 to 2020 and no hitch were detected. Therefore, the species has not been documented upstream of the estuary and is considered absent from the Stevens Creek watershed portion of the study area.

Sacramento hitch have been documented in the Guadalupe River portion of the study area within the past 20 years (Leidy 2007). Sacramento hitch were first documented in the lower reaches of the Guadalupe River (downstream of the Norman Mineta Airport) in 1986 (Smith 2013). Electrofishing surveys conducted by Valley Water from 2004 to 2020 resulted in no detections of hitch in the Guadalupe River or Guadalupe Creek upstream of Airport Parkway (Valley Water unpublished data 2004-2017; Valley Water 2019b, 2020b, and 2021b). Sampling conducted by Valley Water from 2018 to 2020 has resulted in no detections of hitch in Alamitos, Calero, or Los Gatos Creek (Valley Water 2019b, 2020b, and 2021b). However, during a 2018 fish salvage effort, seven Sacramento hitch were observed and captured in Los Gatos Creek (Stillwater Sciences 2018). Therefore, hitch are considered potentially present in Los Gatos Creek and the Guadalupe River mainstem downstream of the Norman Mineta Airport.

1.3.1.6 Physical Habitat Descriptions

Stevens Creek Watershed and Study Area

Stevens Creek Reservoir was constructed in 1935 and raised an additional 10 feet in 1985 to increase the reservoir capacity to 3,128 acre feet of water. Reservoir releases and changes in seasonal precipitation cause variations in flow within Stevens Creek. There are two reaches that contain perennial flows: one downstream of the reservoir and another downstream of Middlefield Road. There is also a dry-back zone during spring and fall between Fremont Avenue and Middlefield Road (Smith 2020). Stillwater Sciences (2004) reported that the reaches just downstream of the reservoir that are wet year-round have the highest habitat complexity. Stevens Creek watershed above the reservoir is mostly undeveloped forest and rangeland, while much of the watershed downstream of Stevens Creek Reservoir is dominated by high-density residential neighborhoods, including the cities of Cupertino, Los Altos, Sunnyvale, and Mountain View. Stevens Creek is bounded by a sinuous channel in the upstream reaches (STEV 6 to STEV 4), contains dense vegetation growing on well-established alluvial floodplains, and consists of dark algae-covered grains embedded in clay-rich substrate (Stillwater Sciences 2004). Beginning at STEV 4, the channel becomes constricted, narrow, and straight, with locations containing higher incisions, bank failure, and greater bed mobility (Stillwater Sciences 2004). Smith (2020) reported high amounts of alluvial sediment below the reservoir and before STEV 4 between 2013 to 2020. Those same years, there was high turbidity recorded at sampled locations upstream and downstream of the reservoir before STEV 4. These sediments and turbidity levels have resulted in a fairly silty streambed (Smith 2020). In the upstream reaches above the reservoir, debris jams resulting from flattened vegetation are present (Stillwater

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[4] June 2015; July 2015 and 2016; August 2013; September 2014; October 2013, 2016, 2017, 2018, and 2019; and November 2014 and 2015.

Sciences 2004). From 2013 through 2020, the mean water temperature was 70°F immediately downstream of the Stevens Creek Reservoir by September (Smith 2020). The reach from the reservoir to STEV 3 had a mean water temperature of 64.4 to 68°F by September, with temperatures typically declining after July (Smith 2020). Steelhead spawning gravel has been observed in one perennial reach, occurring in the first two miles downstream of the dam (Stillwater Sciences 2004). Stevens Creek contains several partial barriers that can impede fish migration (Smith 2020). Passage barriers include fish ladders between STEV 3 and STEV 1, at Moffett Boulevard and along Highway 85 downstream Fremont Avenue, and a potential barrier at a partial weir/logjam directly downstream of STEV 4 (Smith 2020). Stevens Creek Reservoir is considered impaired due to mercury in fish (Valley Water 2020a).

A Cold Water Management Zone (CWMZ) is identified in the Proposed Project in upstream Stevens Creek between STEV 4 and STEV 6, which is downstream from the Stevens Creek Dam to Interstate 280. The CWMZ was designated in the Settlement Agreement Regarding Water Rights of the Santa Clara Valley Water District on Coyote, Guadalupe, and Stevens Creeks (FAHCE Settlement Agreement) (Valley Water et al. 2003). The purpose of the CWMZ is to provide habitat with suitable temperatures for growth year-round, and especially during summer and fall months when water temperatures are the highest. However, the duration and magnitude of cold water releases are highly dependent on water storage in Stevens Reservoir.

See Section 1.2.1, *Stevens Creek Watershed Portion of the Study Area,* for more information on the Stevens Creek Watershed.

Guadalupe River Watershed Portion of the Study Area

As with Stevens Creek watershed, reservoir releases from several reservoirs and changes in seasonal precipitation cause variations in flow within the Guadalupe River watershed portion of the study area. In the Guadalupe River watershed, Vasona, Guadalupe, Calero, and Almaden reservoirs were built in 1935. Lexington Reservoir was constructed in the 1950s increasing storage in the Los Gatos Creek system (Smith 2013) (3.7-2). Much of the watershed lies in urbanized areas, and an estimated 6,500 tons of mercury have entered the local streams as a result of historic mining in the area that continued until the 1970's.

Guadalupe River

The Guadalupe River main stem is perennial in most water years (Smith 2013) with dry back conditions observed during droughts. Valley Water conducts steelhead rearing surveys annually that document fish species and habitat observed in sampled reaches of the Guadalupe River watershed portion of the study area. While these surveys are not comprehensive of the entire study area, they still provide valuable information regarding the types of habitats observed in the field in each of the reaches. During 2020 survey teams observed dense riparian corridors, pools, riffles, and runs were observed in the lower reaches of the Guadalupe River main stem downstream of GUAD5. Survey teams also observed gravel, cobble, and boulder substrates in the most downstream reaches of the Guadalupe River main stem downstream of GUAD5 (Valley Water 2021a). A segment directly upstream of GUAD5 contains a channel bottom of cellular concrete mattress with natural substrate deposits (Valley Water 2021a). Stretches from GUAD5 to GUAD6 consisted of runs, pools, riffles, and glides (little turbulence, and faster velocity than pools) (Valley Water 2021a). The primary substrate observed from GUAD5 to GUAD6 was silt, boulders, cobbles (Valley Water 2021a). The survey teams observed variable complexity throughout the Guadalupe River main stem reaches, such as emergent or overhanging vegetation, boulders or artificial structures, and large woody debris (Valley Water 2021a). Surveys conducted in 2019 and 2020 reported a large homeless encampment and high anthropogenic disturbances including trash and debris directly upstream of GUAD5 (Valley Water

2020b, 2021a). Mercury levels in the Guadalupe River are considered high due to a history of mercury mining in the region, and no fish caught at those locations can be consumed (OEHHA 2020).

Los Gatos Creek

Most of Los Gatos Creek is located within developed urban or residential locations. Surveys conducted in 2019 and 2020 reported human disturbances including homeless encampments and debris at sites downstream of LOSG2 (Valley Water 2020b, 2021a). The majority of the creek contains high habitat complexity, including undercut banks, large woody debris, and submerged roots (Valley Water 2020b). The downstream reach of Los Gatos Creek, near the confluence with Guadalupe River, was historically altered from a braided stream entering a marsh to a defined channel. Los Gatos Creek contains stream habitats of glides, runs, riffles, and pools (Valley Water 2020b). Substrate consists of cobble and sand in the reaches downstream of LOSG1 and cobble, gravel, and boulders between LOSG2 and LOSG1 (Valley Water 2020b). One reach upstream of LOSG2 within Los Gatos Creek was the location of the Valley Water Stream Maintenance Los Gatos Creek Instream Habitat Complexity Project, which installed large woody debris and augmented gravel. This reach also contains riffles, runs, glides, as well as a cobble and gravel substrate (Valley Water 2020b). Vasona Dam lies below the Vasona Reservoir on Los Gatos Creek, and a high-drop structure on Los Gatos Creek near Camden Avenue currently obstructs fish passage upstream of the drop to Vasona Reservoir (Smith 2013).

Guadalupe Creek

Releases from the Guadalupe Reservoir and water discharged from the Almaden Valley Pipeline typically maintain the 1.65-mile of perennial stream habitat of Guadalupe Creek down to the confluence with the Guadalupe River (FAHCE-FHRP 2021). The Guadalupe Reservoir is impounded by Guadalupe Dam, which is located near GCRK4. As part of the Downtown Guadalupe Flood Protection Project, an extensive geomorphic and riparian restoration completed in 2002, took place in the reaches downstream of GCRK2 on Guadalupe Creek. Reaches downstream of GCRK 2 sampled by Valley Water on Guadalupe Creek contain gravel and cobble substrates, pools, riffles, and runs (Valley Water 2020b). In between GCRK 2 and GCRK 3 a small impoundment known as Masson Dam diverts water from Guadalupe Creek. Upstream of Masson Dam, the substrate is primarily made up of gravel and cobble, aside from some boulders in upstream stretches (Valley Water 2020b). The reach upstream of Masson Dam (near GCRK 3) contain a variety of habitat types, including riffles, runs without obstructions, glides, pools, and cascades (Valley Water 2020b). The majority of Guadalupe Creek contains emergent vegetation or is surrounded by overhanging vegetation (Valley Water 2020b). Stream complexity varies throughout the creek and it contains few artificial structures, minimal woody debris and roots, and boulders and undercut banks in the upstream reaches (Valley Water 2020b). Masson Dam contains two fish ladders for fish passage upstream and downstream of the dam (Smith 2013, FAHCE-FHRP 2021). Surveys conducted in 2019 reported human disturbances including a homeless encampment near GCRK1 (Valley Water 2020b). Mercury levels in Guadalupe Reservoir and Guadalupe Creek are considered high due to a history of mercury mining in the region, and no fish caught at those locations can be consumed (OEHHA 2020).

A CWMZ was designated in the FAHCE Settlement Agreement (Valley Water et al. 2003) on Guadalupe Creek from the outlet of the Guadalupe Reservoir downstream to approximately the creek's intersection with Camden Avenue in the Montevideo neighborhood of South San José, California (3.7-2). The purpose of the Guadalupe Creek CWMZ is to support steelhead juvenile rearing by maintaining a suitable water temperature for growth year (that is, not to exceed 18°C) throughout as much of the CWMZ as the available cold water supply in the reservoir will allow between May 1 and Oct 31, when stream temperatures are highest.

Alamitos Creek

Alamitos Creek, within the Guadalupe River watershed, is primarily situated in urban, residential areas (Valley Water 2020b). Alamitos Creek contains Almaden Dam, which sits below Almaden Reservoir near ALAM 4. The Coyote Alamitos Canal, a stormwater canal designed to funnel runoff from the Santa Teresa Foothills to Lake Almaden, runs from Almaden Lake County Park to Coyote Creek Parkway (City of San José 2007). Alamitos Lake is downstream of ALAM1, near the confluence of Guadalupe Creek, the Guadalupe River, and Alamitos Creeks (Figure 3.7-2). Calero Creek flows into Alamitos Creek near ALAM2. The reach near ALAM3 is the location of the Valley Water Stream Maintenance Program's Alamitos Creek Instream Habitat Complexity Project (Valley Water 2021a). Mercury levels in Almaden Reservoir, Almaden Lake, and Alamitos Creek are considered high due to a history of gold mining in the region, and no fish caught from those locations can be consumed (OEHHA 2020).

Alamitos Creek includes emergent vegetation, is surrounded by overhanging vegetation, and contains boulders, root structures, woody debris, undercut banks, and artificial structures (Valley Water 2020b). Reaches of Alamitos Creek downstream of ALAM2 contain riffles, pools, and runs (Valley Water 2020b). The reaches upstream of the Calero Creek confluence contain riffles, runs, and pools, cascades, glides, and step-runs (a series of runs, separated by short riffles) (Valley Water 2020b). Substrate throughout the creek generally consists of cobble, gravel, boulders, and silt (Valley Water 2020b).

Calero Creek

From Calero Reservoir, Calero Creek flows for approximately 4 miles to the confluence with Alamitos Creek. The majority of Calero Creek contains riffles, pools, and runs (Valley Water 2020b). According to Smith (2013), substrate is generally silty in Calero Creek, but there are records of gravel, cobble, and sandy substrates (Valley Water 2020b). Calero Creek is surrounded by urban residential and agricultural land uses (Valley Water 2020b). The creek contains emergent vegetation and is surrounded by overhanging vegetation, and contains undercut banks, boulders, emergent roots, and woody debris (Valley Water 2020b). Calero Dam is a fish passage barrier, limiting movement to the upstream portion of Calero Creek, though habitat upstream of the dam does not support adequate conditions for steelhead (Smith 2013). Mercury levels in Calero Reservoir and Calero Creek are considered high due to a history of mercury mining in the region, and no fish caught at those locations can be consumed (OEHHA 2020).

See Section 1.2.2, *Guadalupe River Portion of the Study Area*, for more information about the Guadalupe River, Los Gatos Creek, Guadalupe Creek, Alamitos Creek, and Calero Creek.

1.4 Methodology

This appendix focuses on the Proposed Project reservoir re-operation rule curves (flow measures), which were quantitatively modeled. The flow measures are intended to improve aquatic habitat conditions in the watersheds. Hydrologic, hydraulic, water temperature, and fisheries modeling was performed to provide a quantitative basis from which to assess the impacts of the flow measures on fish species and aquatic habitats. Specifically, the modeling analyses represent operational conditions that would occur as a result of the Proposed Project and FAHCE-plus Alternative, which are compared with modeled data that represent operational conditions that occur under the current baseline conditions and the future baseline conditions (*Water Supply Technical Memorandum* [Valley Water 2021d]).

1.4.1 Reservoir Operations

The FAHCE process resulted in a series of reservoir reoperation rule curves developed in collaboration with stakeholders that describe planned changes to the release of impounded water from seven Valley Water reservoirs (Stevens, Guadalupe, Almaden, Calero, Anderson/Coyote, and Lexington reservoirs) to support the life cycle needs of steelhead and Chinook salmon as appropriate. These rule curves form a central element of the Settlement Agreement, identifying seasonal peak flows to facilitate passage of upmigrating adult steelhead and outmigrating juvenile Chinook salmon and steelhead smolts, and to provide instream flows and reduce water temperatures to levels more suitable for juvenile steelhead rearing in the central coastal California region. The detailed FAHCE rule curves and flow ramping parameters are included in the FHRP, *Reservoir Reoperation Rule Curves – FAHCE Settlement Agreement Appendix E*, which is provided in Appendix A of the EIR (Valley Water *in prep.*).

This technical memo evaluates these re-operation rule curves at a project level, using data from the hydrologic and hydraulic modeling completed in conjunction with the development of the FHRP specific to targeted fish species for both the existing conditions and future conditions baselines.

Existing operation of each reservoir is governed by rule curves developed to achieve specific purposes (for example, water supply, flood control and environmental flows) for that reservoir. The reservoir re-operation rule curves were developed to add operational criteria that benefit steelhead and salmon by providing winter base flows, pulse flows, and summer base flows to support each life stage, as well as providing a framework for ramping flows and reservoir operations under low-flow conditions.

These rule curves were calculated so that the minimum release rate for each type of release could be met in 90% of historic water year conditions; the calculations used to determine the rule curves assumed that the reservoir storage volume would be at least that which was documented in 90% of all water years on record for each reservoir. At least 30 years of historic data are available for each Valley Water-managed reservoir; a 21-year subset of data (herein, 21-year modeling period) was used in the hydrologic modeling (with a one-year spin-up, providing a 20-year analysis period). This does not mean that flow management is guaranteed in 90% of all years; rather, the rule curves for each reservoir were developed to meet flow-based obligations consistent with 90% of all water years in the current dataset. In high precipitation years, more flows may be available for recharge, water supply, and environmental uses. In periods of extended drought, less flow may be available for recharge, water supply, and environmental uses.

1.4.1.1 Proposed Project

The following paragraphs provide a brief description of the flows:

- **Proposed Winter Base Flow Releases**: Winter base flows are reservoir releases made between November 1 and April 30 to improve winter and springtime habitat for salmonids. These are in addition to the Valley Water's minimum bypass flow releases required by CDFW LSAAs that are required at all instream diversions below the dams to maintain a wetted channel downstream. The specific flow rate would depend on the reservoir storage and where that storage volume falls within the range of curves. Proposed winter flow releases would not be initiated until there is adequate storage above a given curve to allow for five days of consecutive releases at that release rate. Higher reservoir storage volume allows for increased reservoir releases, up to the maximum reservoir re-operation rule curve for that reservoir. As reservoir storage decreases, or if storage never reaches the maximum re-operation rule curve, a reduced winter flow would be released. In dry water years, where adequate storage above even the minimum rule curve does not allow for five days of consecutive releases, winter base flow releases may not occur. All winter base flow releases would be made between November 1 and April 30; the only exception is at Stevens Creek Reservoir, where winter base flow releases would occur between January 1 and April 30.

- Proposed Spring Pulse Flow Releases: Valley Water proposes to implement pulse flows to improve passage conditions for migrating steelhead, Chinook salmon, or both, depending on the watershed. Pulse flows are reservoir releases of 50 cubic feet per second (cfs) for a period of five consecutive days made between February 1 and April 30. These releases would be at the same locations as those described above for Winter Base Flow Releases, except no spring pulse flows would occur at Lexington Reservoir because the pulse flows would be muted prior to reaching areas where anadromous fish occur due to flow control at Vasona Reservoir. Upstream passage for adults would be enhanced by providing a greater volume of water over potential impediments and critical riffles. These short-term pulse events would also benefit outmigrating juveniles by providing them cues for migration, encouraging them to swim downstream from the upper watershed, aiding them in their downstream migration to San Francisco Bay and ultimately to the ocean. Pulse flow releases would be provided at all reservoirs except Lexington in accordance with reservoir re-operation rule curves and would be triggered when reservoir storage volume reaches about 75 to 85 percent of reservoir storage capacity. Such conditions are probable in average to wet water years, or about 50 percent of the time. Pulse flows would be operated up to two periods of five consecutive days of stream flow that meet or exceed 50 cfs, including those caused by flood releases and spill events, between February 1 and April 30 of any one water year.
- **Proposed Summer Base Flow Releases (during the Summer Cold Water Program)**: Summer base flows would be made between May 1 and October 31, based on each reservoir's re-operation rule curve to enhance summer rearing conditions for steelhead. Below Stevens and Guadalupe Dams, Valley Water would maintain CWMZs along designated lengths of stream to provide over-summer refugia for rearing steelhead based on available cold water in the reservoirs. The extent of each reservoir's CWMZ may vary by year, depending on reservoir storage volume. Proposed reservoir re-operation rule curves for these reservoirs are designed to maintain cold water storage availability for summer flow releases. Between April 15 and April 30 of each year, Valley Water would survey Guadalupe and Stevens Creek reservoirs to determine the volume of the hypolimnion that is at or below 14 degrees Celsius (°C) for Guadalupe Reservoir and 15°C at Stevens Creek Reservoir. Based on this information, Valley Water would determine the appropriate reservoir release rates to maximize the extent of the CWMZs from April 30 (when winter base flows end) through October 31. Additional reservoir temperature profiles would be made monthly from June through October to aid in determining cold water releases. Releases of warmer than ideal water may need to be made in certain years to avoid dry conditions in the CWMZ.
- **Proposed Flow Ramping**: Flow ramping is used to manage changes in reservoir release flow volumes to minimize impacts on aquatic species. Flow ramping manages changes in the rate of water flow in a slow, stepwise fashion, helping fish and other aquatic life to avoid stranding. Ramping would occur whenever Valley Water-controlled flows from reservoirs would be decreased by 50 percent or more from the existing flow condition. Flows that are under Valley Water control would be reduced in specified increments over a specified period, in accordance with the discharge rating curves that would be used to determine ramping schedules at each reservoir. Ramping would be applied to reservoir releases, pulse flow releases, and controlled releases from pipelines and diversion dams. Flow ramping applies only to flows within Valley Water control; inflow to the stream from uncontrolled events such as natural runoff or reservoir

spillway flows is not subject to the ramping provisions. When ramping is needed, Valley Water has developed protocols to ramp reservoir releases, depending on whether the original flow is more or less than 50 cfs.

1.4.1.2 FAHCE-plus Alternative

The FAHCE-plus Alternative is intended to increase the benefit of reservoir releases during key salmonid life stages. Based on hydrologic modeling outputs, an update of the FAHCE rule curves was developed that combined concepts of the Proposed Project flow measures with an additional set of rules designed to maximize fish migration (as recommended by the TWG [technical working group]). This revised scenario is known as the FAHCE-plus Alternative. This alternative was developed to determine the extent to which the fisheries' benefits of the Proposed Project's rule curves could be further enhanced. The FAHCE-plus Alternative includes the following elements:

- Pulse Flow Revisions, which include both adjustment of the FAHCE-plus flows in magnitude, duration, and frequency based on model outputs and prioritization of multipurpose pulse flows to aid in both up- and outmigration of steelhead.
- Winter Base Flow Adjustments, which include conservation of reservoir storage in the winter for pulse flows; this would also make summer rearing flows more reliable.
- Summer Base Flow Adjustments, which include a slight increase in temperature limits of summer cold water releases, still within the optimal temperature range for steelhead rearing, to enhance summer rearing habitat. This allows a greater portion of the reservoir volume to be used to provide summer flows.

FAHCE-plus flow measure changes relative to the Proposed Project are as follows:

- **Pulse Flow Revisions:** Review of the hydrologic model results showed that additional migration opportunities could be provided if adjustments were made to the Proposed Project pulse flow design. New safeguard pulse flows were developed for FAHCE-plus specific to each watershed. In addition to changes in magnitude and duration, the timing of pulse flows was expanded to include pulse checks throughout the adult salmonid upstream migration period. To produce connection flows in the maximum years possible, a safeguard pulse flow was added in March with a lower threshold than standard pulse flows. The safeguard pulse flow would be activated if upstream steelhead migration flows were not available by March 1 of any given water year. In addition, a regular outmigration pulse flow was added in mid-April of each year. Safeguard and outmigration pulse releases would occur in years when storage is available to support summer rearing and still enable a minimum reservoir carryover.

- **Winter Base Flow Adjustments:** The Proposed Project rule curves include multiple flow levels for winter base flows based on a tiered system of reservoir storage. The flow tiers were reviewed for the FAHCE-plus Alternative based on updated understandings of adequate depths for spawning and incubation. Tiers that supported incubation in the critical spawning areas (for example, CWMZs) were retained for the FAHCE-plus Alternative. Tiers that did not provide additional benefit to the spawning reaches downstream were considered for removal. The reserved water in the FAHCE-plus Alternative enables additional pulse flows.

- **Summer Base Flow Adjustments:** Summer base flows under the Proposed Project would be more reliable and cooler. To enhance summer rearing habitat with the FAHCE-plus Alternative, temperature limits were raised but were kept within the optimal temperature range for steelhead rearing. This raise in temperature allows a greater portion of the reservoir volume to be used to provide summer flows and provide additional rearing habitat downstream, according to the model.

1.4.1.3 Operational Periods

As explained in the FAHCE Settlement Agreement, the flow releases in the streams are divided into winter and summer operational periods (Valley Water et al. 2003). In general, the winter operational period runs from November 1 to April 30 and the summer operational period runs from May 1 to October 31 for all streams with a reservoir, with slight variations in the naming of these operational periods based on the purpose of the releases made during these periods. The winter operational period contains both Winter Base Flow Operations and any applicable pulse flow operations. The Stevens Creek operational periods are defined slightly differently for this analysis than defined in the FAHCE Settlement Agreement to better characterize the potential changes in habitat availability from flow variations. Stevens Creek winter operations are evaluated from January 1 to April 30 (herein, “Winter Base Flow Operations (excluding Fall Flows)”) and Stevens Creek summer operations are evaluated from May 1 to December 31 (herein, “Summer Cold Water Program and Fall Flows”) since Stevens Creek winter flow operations from November 1 to December 31 are similar to those defined for the summer operations. Table 3 summarizes the reservoir operational periods used in this analysis. Note that although operational periods are defined for tributaries within the Guadalupe River portion of the study area, there are no operational periods defined for the Guadalupe River since there is no reservoir with a release rule-curve in the Guadalupe River itself.

Table 3. Reservoir Operational Periods in Stevens and Guadalupe Watersheds

Stream	Winter Base Flow Operations (excluding Fall Flows)	Winter Base Flow Operations	Summer Cold Water Program	Summer Release Program	Summer Cold Water Program and Fall Flows
Stevens Creek	Jan 1 to Apr 30	N/A	N/A	N/A	May 1 to Dec 31
Los Gatos Creek	N/A	Nov 1 to Apr 30	N/A	May 1 to Oct 31	N/A
Guadalupe Creek	N/A	Nov 1 to Apr 30	May 1 to Oct 31	N/A	N/A
Alamitos Creek	N/A	Nov 1 to Apr 30	N/A	May 1 to Oct 31	N/A
Calero Creek	N/A	Nov 1 to Apr 30	N/A	May 1 to Oct 31	N/A
Guadalupe River	N/A	N/A	N/A	N/A	N/A

Note: Apr = April; Dec = December; N/A = not applicable; Nov = November; Oct = October

1.4.2 Baseline Conditions

Current and future baselines are summarized here and used throughout the analysis for comparison with the Proposed Project and the FAHCE-plus Alternative.

The Division of Safety of Dams (DSOD) required dam safety restrictions that reduce the storage capacities of the Guadalupe (65% of original capacity), Almaden (93%), and Calero (46%) reservoirs in the Guadalupe River watershed until safety concerns specific to each dam have been addressed. Valley Water is addressing the dam safety concerns at each of these facilities via separate projects, including the Guadalupe Reservoir Seismic Retrofit Project (seismic upgrades), Almaden Dam

Improvements Project (outlet and spillway upgrades), and Calero Reservoir Seismic Retrofit Project (seismic upgrades). These projects are not part of the analysis in this technical memorandum, but they are important for understanding the difference between current and future baseline.

The DSOD restrictions, however, do affect the Proposed Project and FAHCE-plus Alternative, because implementation of the reservoir flow releases (including the pulse flow releases) that make up the proposed re-operation rule curves would be limited to flow release levels that correspond to the interim restricted capacity of each facility, assuming water storage reaches that level in a given year, until each retrofit project is completed. Flow releases associated with optimal re-operation rule curves at these reservoirs would not occur until DSOD operational restrictions are lifted. This technical memorandum considers both scenarios—the existing baseline condition during which water demands reflect current demographics and reservoir capacities for Almaden Calero, and Guadalupe Reservoirs, such that reservoir capacities would be restricted at these facilities (short-term conditions and assessment of the Proposed Project and FAHCE-plus Alternative against the current baseline) and a future baseline condition, which reflects lifting of DSOD restrictions on the three facilities (long-term conditions and assessment of the Proposed Project and FAHCE-plus Alternative against the future baseline).

The current baseline condition is represented by a modeled projection of 2015 flow conditions using a hydrological period of record extending from 1990 through 2010. This represents existing conditions because 2015 reflects the latest published water demands and usage in Valley Water's 2015 UWMP (Valley Water 2016). In addition to 2015 supplies and demands, the current baseline incorporates seismic restrictions for dams in the Guadalupe River portion of the study area.

The future baseline condition uses 2035-level water demands based on demographic growth projections and reflects elimination of seismic restrictions on dam operations and reservoir storage, based on the assumption that seismic conditions have been corrected by various projects. The future baseline condition essentially reflects "business as usual operations" without implementation of FAHCE measures, which are compared to the Proposed Project flow measures to assess long-term operational impacts that could result from implementing the Project measures once water demand increases and dam seismic restrictions are lifted. In addition to eliminated dam seismic restrictions, the future baseline condition also includes projected 2035 water supplies and demands as defined in Valley Water's 2015 UWMP and Water Supply Master Plan 2040 (Valley Water 2016, Valley Water 2019a). The CalSim II model that was used to represent the future conditions of imported water supplies to Valley Water included a 2030 emissions scenario regarding temperature and sea level rise (15 cm), and changes to central valley inflows reflecting changes to precipitation patterns and snow melt.

1.4.3 Flow Measures Analysis Methodology

1.4.3.1 Model Overview

Hydrologic, hydraulic, water temperature, and fisheries habitat modeling provide a quantitative basis from which to assess the effects of the flow measures under the Proposed Project (and the alternatives), relative to the baseline scenarios. Models and other tools applied in the evaluation of the Proposed Project (and the alternatives) include:

- Hydrologic modeling (Water Evaluation and Planning [WEAP] model) to simulate mean daily river flows at specific nodes downstream of study area reservoirs and average daily reservoir storage volumes.

- HEC-RAS hydraulic modeling at specific POIs and within defined stream reaches and habitat types downstream of the study area reservoirs to simulate water depth, water velocity, and wetted area.
- Water temperature modeling to simulate mean daily river water temperatures at specific POIs downstream of study area reservoirs (known as the *Temperature Modeling Technical Memorandum* [Valley Water and HDR 2019]).
- Fisheries Habitat Availability Estimation (Valley Water 2021c) for steelhead and Chinook salmon life stages to estimate the suitability and extent of physical habitat availability and passage in defined reaches of each creek based on modeled flows, hydraulics, water temperatures, and habitat monitoring data. A Tableau tool was used to calculate the following metrics by species: effective spawning habitat availability indicator (HAI), fry rearing HAI, juvenile rearing HAI, adult upstream passage extent, and juvenile downstream passage, as defined in the *Fisheries Habitat Availability Estimation Methodology Technical Memorandum* (Valley Water 2021c).

1.4.3.2 Water Evaluation and Planning Hydrologic Model

Hydrologic, hydraulic, water temperature, and fisheries modeling was performed to provide a quantitative basis from which to assess project-level operations related impacts of the Proposed Project reservoir re-operation rule curves (flow measures) on fish species and aquatic habitats. Specifically, the modeling analyses were intended to simulate representative operational conditions that would occur because of the Proposed Project or the FAHCE-plus Alternative, which could be compared to modeled data intended to represent operational conditions that occur under the current baseline conditions and under the future baseline conditions (*Water Supply Technical Memorandum* [Valley Water 2021d]).

Daily hydrology (flow) and hydraulics (for example, water depth) in the Guadalupe River and the Stevens Creek watershed portions of the study area for each modeling scenario (for example, baselines, Proposed Project, and Alternatives) were simulated from 1991 to 2010 by the WEAP model at specific POIs in each stream (SEI and Valley Water 2020; SEI 2020; FAHCE TWG 2016).[5] The EIR Appendix G, *Valley Water Daily WEAP Model Technical Memorandum,* includes details of the WEAP model (SEI and Valley Water 2020). The EIR Appendix J, *White Paper on Work Flow of the HEC-RAS Cross Section Analysis,* includes details of the hydraulics model component (SEI 2020). The EIR Appendix H, *Methods for Establishing Reaches of Interest and Points of Interest,* includes details on how POIs were determined (FAHCE TWG 2016).

Daily water temperature was also simulated over the 21-year modeling period (1990 to 2010) at the POIs in each stream using a calibrated water temperature regression model (HDR and Valley Water 2020 for further details). The EIR Appendix I, *Temperature Modeling Technical Memorandum,* includes details on the water temperature model (Valley Water and HDR 2019).

Daily habitat availability for steelhead and Chinook salmon life stages, was estimated over the 21-year modeling period based on the simulated flows, hydraulics, water temperatures, and measured structural habitat data at representative locations in the streams. Habitat availability was estimated for

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[5] The *Valley Water Daily WEAP Model Technical Memorandum* prepared by SEI and Valley Water (2020) includes details of the WEAP model; the *White Paper on Work Flow of the HEC-RAS* (Hydrologic Engineering Center's River Analysis System) *Cross Section Analysis* prepared by SEI (2020) includes details of the hydraulics model component; and *Methods for Establishing Reaches of Interest and Points of Interest* technical memorandum prepared by the FAHCE TWG (2016) includes details on how POIs were determined.

three life stages: effective spawning[6] fry rearing,[7] and juvenile rearing.[8] The term "effective spawning" is defined as spawning habitat that leads to successful incubation, and it is used to collectively describe spawning and incubation life stages throughout this technical memorandum. Please refer to the *Fisheries Habitat Availability Estimation Methodology Technical Memorandum* prepared by Valley Water (2021c) and *Use of Habitat Data in Support of CEQA Analysis for FAHCE Fish Habitat Restoration Plan* prepared by Valley Water (2017b) for further details on how the habitat availability for each of the three life stages was estimated. Please refer to Valley Water (2016, 2017b) for further information on the measured structural habitat data used in the habitat modeling.

Daily fish passage suitability for adult[9] and juvenile[10] steelhead and Chinook salmon was estimated over the 21-year modeling period based on simulated daily water depths and water temperatures at each POI (see Valley Water [2021] for further details). Daily upstream adult passage suitability was calculated for each species during the period they would migrate upstream. Daily upstream adult passage at a POI was considered suitable for a species when the predicted thalweg water depth and water temperature at the POI satisfy the species-specific adult minimum water depth and maximum water temperature criteria listed in the *Fisheries Habitat Availability Estimation Methodology Technical Memorandum* (Valley Water 2021c). The WEAP model estimates the farthest upstream POI that adult steelhead and Chinook salmon would be able to potentially reach for each day during their migration life stage as the farthest upstream POI at which the species-specific water depth and water temperature criteria are met at all downstream POIs on a single day.

Daily downstream juvenile passage suitability also was calculated for each species during the period they would migrate downstream. The number of days with suitable downstream juvenile passage was calculated by the WEAP model as the number of individual days when the model predicted thalweg water depth and water temperature were suitable throughout the stream (that is, from the upstream-most POI to the downstream-most POI) based on the species-specific juvenile water depth and water temperature thresholds listed in the EIR Appendix N, *Fisheries Habitat Availability Estimation Methodology* (Valley Water 2021c).

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[6] Effective spawning habitat is defined as spawning habitat that results in successful incubation. Effective is referred to as upper optimal incubation-adjusted spawning in the *Fisheries Habitat Availability Estimation Methodology* technical memorandum prepared by Valley Water (2021c). Estimates of effective spawning (that is, upper optimal incubation-adjusted spawning) habitat take into consideration the stream conditions (that is, depth, velocity, water temperature, and stream substrate) that are required for both spawning and incubation as defined in the *Fisheries Habitat Availability Estimation Methodology* technical memorandum prepared by Valley Water (2021c).

[7] Fry rearing evaluates the composite suitability of depth, velocity, water temperature, and cover as defined in the *Fisheries Habitat Availability Estimation Methodology* technical memorandum prepared by Valley Water (2021c).

[8] Juvenile rearing evaluates the composite suitability of depth, velocity, water temperature, and cover as defined in the *Fisheries Habitat Availability Estimation Methodology* technical memorandum prepared by Valley Water (2021c).

[9] Hydraulic upstream adult passage criteria applied to each passage node include: (1) sufficient flow at each passage node that corresponds to the minimum mean daily depth for the species of interest; (2) sufficient flow for adults to pass a nearby critical riffle, if applicable; and (3) sufficient flow to allow passage of adults based on simulated hydraulics and fish swimming speed abilities at each riffle passage node based on FishXing analyses. The hydraulic-dependent upstream passage extent is the passage node (POI) at which flows are not sufficient to meet all three specified criteria.

[10] Downstream juvenile passage was determined by: (1) whether simulated mean daily flows provide sufficient water depth at each POI for the species of interest downstream of the spawning grounds; and (2) whether water temperatures were suitable for juveniles at each POI.

The "FAHCE WEAP Model" essentially refers to the combination of the hydrological and biological modeling described above, serving as a platform to integrate hydrological modeling with key habitat metrics and tools. The FAHCE WEAP Model connects a physical systems model with fish habitat suitability to assess management adaptations for the benefit of threatened species (Valley Water 2020). The FAHCE WEAP Model recognizes that the underlying system hydrology stems from both physical watershed processes and from the operation of a water management system comprising dams, diversions, and groundwater recharge basins. The FAHCE WEAP Model refers generally to the modeling conducted for the baselines (current and future) and for the Proposed Project flow measures (which comprise releases pursuant to the rule curves established pursuant to the FAHCE Settlement Agreement [2003]), and the FAHCE-plus Alternative flow measures, in the analysis for this section, with the specific model output referred to, or compared with, clarified in-text or by section heading.

The models used in the analyses, although mathematically precise, should be viewed as having inherent uncertainty because of limitations in the theoretical basis of the models, underlying data availability, and the scope of the formulation and function for which each model is designed. Please refer to the hydrological and biological model technical memorandums[11] for discussions and/or quantification of the uncertainty associated with the models.

1.4.3.3 Application of the FAHCE WEAP Model to This Analysis

The FAHCE WEAP model represents the best available information with which to evaluate changes in the Stevens Creek and the Guadalupe River portions of the study area and conduct flow-based aquatic analyses of the Proposed Project and FAHCE-plus Alternative compared to current and future baseline conditions.

In this analysis, the following parameters were analyzed over a 20-year analysis period (1991–2010) to assess the effects of the Proposed Project and FAHCE-plus Alternative on aquatic biological resources:

- Habitat (square feet) − represented by the Daily Habitat Availability Index (HAI) for steelhead and Chinook salmon effective spawning, fry rearing, and juvenile rearing, as calculated by the FAHCE WEAP Model. HAI evaluates the composite suitability of depth, velocity, water temperature, and stream substrate for effective spawning, and depth, velocity, water temperature, and cover for fry and juvenile rearing.
- Adult upstream passage and juvenile downstream passage (days) for steelhead and Chinook salmon, as calculated by the FAHCE WEAP Model.
- Wetted area (square feet or acres), as calculated by the FAHCE WEAP Model.
- Water discharge (that is, flow; cfs), as calculated by the FAHCE WEAP Model.
- Water depth (feet), as calculated by the FAHCE WEAP Model.
- Water temperature as the 7-day moving Mean Weekly Average Temperature (MWAT;°F), calculated from daily average temperatures output by the FAHCE WEAP Model.

While the FAHCE WEAP Model estimated conditions from 1990 to 2010 (that is, 21-year modeling period), model initial conditions would influence the results during the beginning of 1990 (that is, the

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[11] *Water Supply Analysis Technical Memorandum* (Valley Water 2021d); *Valley Water Daily WEAP Model Technical Memorandum* (SEI and Valley Water 2020); *White Paper on Work Flow of the HEC-RAS Cross Section Analysis* (SEI 2020); *Methods for Establishing Reaches of Interest and Points of Interest* technical memorandum (FAHCE TWG 2016); *Fisheries Habitat Availability Estimation Methodology* Technical Memorandum (Valley Water 2021c); and *Use of Habitat Data in Support of CEQA Analysis for FAHCE Fish Habitat Restoration Plan* (Valley Water 2017b).

model spin-up period) and introduce uncertainties that do not represent the impact of the reservoir operations on watershed conditions. The influence of model initial conditions would become negligible as precipitation during winter and spring 1990 became more significantly influential on model results. A consistent number of years needs to be used when calculating daily statistics to avoid biasing the statistics during part of the year, so the analysis presented here calculated the statistics using model results from 1991 to 2010 (that is, the 20-year analysis period) to characterize watershed conditions most accurately due to reservoir operations scenarios independent of model initial conditions. In addition to calculating statistics for the individual baselines and the Proposed Project model scenarios over a 20-year period, the absolute differences and relative percent change between the baselines and respective Proposed Project model scenarios were calculated.

Variations in the above-listed hydrological and biological parameters at each POI within each tributary from 1991 to 2010 were summarized by calculating the maximum, average, and minimum for each day of the calendar year.[12] Overall averages across the entire life-stage, as well as during the relevant summer and winter operational periods (described below for each watershed), were calculated for habitat during each life-stage (that is, effective spawning, fry rearing, and juvenile rearing). While the averages across entire life-stages or operational periods quantified the general trends across the time period, these averages frequently resulted in very low habitat areas when there were long periods of zero habitat (for example, effective spawning) and they should not be used to quantify the habitat area on individual days during the averaging period. Annual average upstream and downstream passage during the relevant period of occurrence were also calculated for each stream. Subsequently, the difference (annual average change) for each relevant parameter and statistic (maximum, average, minimum) resulting from the Proposed Project or FAHCE-plus Alternative, compared with the current and future baselines, were calculated for each POI. The overall average differences across all POIs across the entire life-stage, as well as during the relevant summer and winter operational periods (described below for each watershed), were also calculated. The overall average differences across life-stages and operational periods also frequently resulted in very low habitat areas when there were long periods of zero habitat (for example, effective spawning) so they should not be used to quantify the habitat area on individual days during the averaging period.

The modeled habitat and wetted area reported for each POI represent the habitat or wetted area for the stream reach between that POI and the nearest downstream POI (for example, a habitat estimate at POI 6 in a stream would represent all habitat between POI 6 and POI 5). Alternatively, modeled water depth and water temperature characterize the conditions at the specific POI point, and they do not represent conditions along a reach of the stream.

Individual POIs were generally grouped for comparisons based on similarities in known physical habitat, presence and timing of species and life stage within reaches of the watershed, as well as based on operational and management considerations. For example, POIs in Stevens Creek are grouped as upstream and downstream because the upstream area is within a CWMZ and contains more suitable habitat compared to the downstream reaches. STEV 4, 5, and 6 are within the CWMZ, although STEV 4 is at the downstream extent (Figure 1), so habitat model outputs for STEV 5 and 6 are relevant to analyses of habitat and passage conditions in the Stevens Creek CWMZ. Within the Guadalupe River portion of the study area, locations were grouped and discussed by tributaries (for example, Los Gatos, Guadalupe, and Alamitos Creeks) or the mainstem Guadalupe River. In Guadalupe Creek, GCRK 4 is at the upstream extent of the CWMZ and GCRK 3 is at the downstream

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[12] The parameter variations were also calculated over a water year basis instead of a calendar year basis, but differences in analysis results were negligible. As such, only the parameter variations over a calendar year basis are presented in this analysis.

extent (Figure 2); therefore, habitat model outputs for GCRK 4 are relevant to analyses of habitat and passage conditions in the Guadalupe Creek CWMZ.

For the purposes of this analysis, habitat model results from Guadalupe River POIs GUAD 1 and GUAD 2 were excluded since the modeled water temperature necessary to correctly estimate the habitat availability was not available.

Fish Habitat and Passage

Where FAHCE WEAP modeled HAI and passage were available (that is, for steelhead and Chinook salmon), the differences in the modeled daily life-stage habitat availability and daily upstream and downstream passage between the Proposed Project or the FAHCE-plus Alternative and the current and future baselines were calculated to quantitatively evaluate how conditions for steelhead and Chinook salmon would change. Differences were calculated as the Proposed Project or FAHCE-plus Alternative minus the applicable baseline, such that a positive difference indicates an increase in habitat or passage and a negative difference indicates a decrease under the Proposed Project or FAHCE-plus Alternative. The statistics used to analyze variations in habitat and passage are summarized above in Section 1.4.3.3, *Application of the FAHCE WEAP Model to This Analysis*.

To evaluate impacts of the Proposed Project or FAHCE-plus Alternative on steelhead and Chinook salmon habitat and passage, the absolute and proportional changes were both assessed to ensure a biologically meaningful analysis. For example, a large proportional change in habitat may not be biologically meaningful if the absolute amount of habitat is very small. Generally, relatively small differences in either the absolute or proportional changes in habitat or passage were considered negligible since they would be within the range of the model uncertainty.

Habitat and passage methods are detailed further in the subsections below.

Habitat Availability Index

Differences were only calculated during the applicable life stage during the operational periods. For example, the difference in the fry-rearing steelhead habitat during the Winter Base Flow Operations only considered the March 1 to April 30 portion of the fry-rearing life stage. Daily habitat differences were calculated for each life stage at each POI, and these were summed across all POI for a stream group (for example, the Guadalupe River) to determine the total daily habitat differences across this stream group. In figures, the daily habitat difference is presented as the absolute daily maximum, daily average, and absolute daily minimum across the entire 20-year analysis period (1991 to 2010) to characterize the potential range of variation between the Proposed Project or the FAHCE-plus Alternative and the current and future baselines. Additionally, the total number of days adult steelhead and Chinook salmon passage occurred throughout the 20-year analysis period was calculated by summing the days with suitable conditions from 1991 to 2010.

Daily habitat availability was not modeled for Pacific lamprey, Sacramento hitch, or riffle sculpin in the Stevens Creek or the Guadalupe River portions of the study area because these three species were not the focal species of the Settlement Agreement (Valley Water et al. 2003) and therefore not included during model development. Please see the *Wetted Area and Water Temperature Model Outputs* section immediately below for details of the analyses for these species.

Wetted Area and Water Temperature Model Outputs

When the FAHCE WEAP Model was not able to estimate the daily habitat availability at a POI for effective spawning, fry rearing, and/or juvenile rearing, the effects of the Proposed Project on these habitat types were evaluated using a combination of the FAHCE WEAP Model wetted area and water temperature results. This was the case for all the Pacific lamprey, Sacramento hitch, and riffle sculpin results, as well as for Calero Creek, and results for specific POIs in other streams. Daily maximum, average, and minimum values for wetted area and water temperature were calculated for each day of the year (that is, Jan 1 to Dec 31) from the 1991 to 2010 FAHCE WEAP Model results under the current and future baselines and the corresponding Proposed Project scenarios. Additionally, the difference between the wetted area and water temperature for the respective baseline and Proposed Project model scenarios were calculated for each day in the 20-year analysis period, then the daily maximum, average, and minimum values for the difference between the flow, wetted area, and water temperature were estimated for each day of the year.

In addition to wetted area and temperature, modeled HAI for steelhead was considered when life cycles and habitat preference overlap between species. For example, Pacific lamprey, riffle sculpin, Sacramento hitch, and steelhead overlap in timing of spawning and rearing and share some habitat preference during spawning (for example, they prefer gravel substrate with flowing, cool water) and temperature tolerances. Additionally, Pacific lamprey and steelhead overlap in timing of migration. Habitat preferences can vary during rearing (see Section 1.3, *Environmental Setting*, for additional details on habitat preferences), and temperature tolerances can also vary between species and life stage. Sacramento hitch can occupy more diverse habitat and can tolerate warmer temperatures (up to 86°F) compared with steelhead.

Passage

The average number of days per year when stream conditions were suitable at individual POIs for adult steelhead and Chinook salmon passage during the modeling period was estimated from the FAHCE WEAP Model predicted daily upstream adult passage suitability. Additionally, the total number of days when adult steelhead and Chinook salmon passage could occur throughout the 20-year analysis period was calculated by summing the days with suitable passage conditions from 1991 to 2010.

The average number of days per year when stream conditions were suitable for juvenile downstream steelhead and Chinook salmon passage from the upstream-most POI in the stream to the downstream-most POI to reach the San Francisco Bay was estimated from the FAHCE WEAP Model predicted daily downstream juvenile passage suitability. Additionally, the total number of days when juvenile steelhead and Chinook salmon passage could occur throughout the 20-year analysis period was calculated by summing the days with suitable passage conditions from 1991 to 2010. The number of passage events per year was estimated from the number of days with suitable juvenile downstream passage conditions estimated by the FAHCE WEAP Model. A passage event occurred when there were suitable juvenile downstream passage conditions from the upstream-most POI in the stream to the downstream-most POI to reach the San Francisco Bay for a consecutive number of days listed in the *Fisheries Habitat Estimation Methodology Technical Memorandum* (Valley Water 2021c). When the consecutive number of days for juvenile downstream passage to occur was a fraction of a day based on the juvenile downstream migration rates, the number of days required for a passage event was always rounded up (for example, 3.1 days would become 4 days).

The number of days when the thalweg water depth was suitable for downstream juvenile steelhead passage was calculated for each stream during the 20-year analysis period to evaluate the influence of juvenile steelhead water temperature criteria on the FAHCE WEAP Model predicted daily downstream juvenile passage suitability. The number of days with suitable downstream juvenile steelhead passage without water temperature criteria was calculated for a stream by comparing the FAHCE WEAP Model predicted thalweg depth with the minimum juvenile steelhead water depth criteria listed in the *Fisheries Habitat Estimation Methodology Technical Memorandum* (Valley Water 2021c). A day was classified as having suitable downstream juvenile steelhead passage when the

FAHCE WEAP Model predicted thalweg depth was greater than 0.4 feet from the upstream-most POI to the downstream-most POI for that stream. For example, a day was classified as having suitable downstream steelhead passage in Guadalupe Creek when the thalweg water depth was greater than 0.4 feet in all the POI in Guadalupe Creek (that is, GCRK 1 to GCRK 4) and the Guadalupe River (that is, GUAD 1 to GUAD 7), since juvenile steelhead in the upstream reaches of Guadalupe Creek (that is, GCRK 4) would have to migrate past all these POIs to reach the San Francisco Bay. The daily downstream juvenile steelhead passage suitability was calculated in each stream for each day during the downstream juvenile steelhead migration period in the 20-year analysis period.

Additionally, the number of downstream juvenile steelhead passage events per year without water temperature criteria was estimated from the calculated using the number of days with suitable downstream juvenile steelhead passage without water temperature criteria. A juvenile downstream steelhead passage event occurred when there were suitable juvenile downstream passage conditions without water temperature criteria from the upstream-most POI in the stream to the downstream-most POI to reach the San Francisco Bay for the consecutive number of days listed in the *Fisheries Habitat Estimation Methodology Technical Memorandum* (Valley Water 2021c). When the consecutive number of days for juvenile downstream steelhead passage to occur was a fraction of a day based on the juvenile downstream steelhead migration rates, the number of days required for a juvenile downstream steelhead passage event was always rounded up (for example, 3.1 days would become 4 days).

Downstream-migrating juvenile Chinook salmon can tolerate higher water temperatures than downstream-migrating juvenile steelhead, so the juvenile Chinook salmon water temperature criteria in the FAHCE WEAP Model (that is, 65°F) would not have frequently limited downstream juvenile Chinook salmon passage in the Stevens Creek or the Guadalupe River portions of the study area (Williams 2010). The number of days when the thalweg water depth was suitable for downstream juvenile Chinook salmon passage was calculated and compared to the analysis of both thalweg water depth and temperature together. There was very little difference between the two analyses. The effect of the Proposed Project on downstream juvenile Chinook salmon passage suitability was evaluated primarily using the FAHCE WEAP Model predicted daily downstream juvenile passage suitability results that considered both thalweg depth and water temperature.

Given that there was no FAHCE WEAP Model passage output available for Pacific lamprey, but that thalweg depth was available, the number of days when the thalweg water depth was suitable for downstream juvenile Pacific lamprey passage and adult upstream Pacific lamprey passage was calculated for each stream during the 20-year analysis period to evaluate FAHCE WEAP Model predicted daily downstream juvenile passage suitability. The number of days with suitable downstream juvenile Pacific lamprey passage and adult upstream Pacific lamprey passage was calculated for a stream by comparing the FAHCE WEAP Model predicted thalweg depth with the minimum relevant Pacific lamprey water depth criteria (Lamprey TWG 2020) across the relevant period (Table 4). A day was classified as having suitable passage when the FAHCE WEAP Model predicted thalweg depth was greater than 1 inch from the upstream-most POI to the downstream-most POI for that stream. The daily downstream juvenile Pacific lamprey passage and daily adult upstream Pacific lamprey passage suitability was calculated in each stream for each day during the relevant migration time periods (Table 4) in the 20-year analysis period. Additionally, because the minimum depth requirement for adult Pacific lamprey upstream passage (1 inch [in]; Lamprey TWG 2020) is less than for adult steelhead (0.7 feet), the FAHCE WEAP Model passage suitability results were also used to support the analyses of Pacific lamprey passage.

To evaluate impacts of the Proposed Project or FAHCE-plus Alternative on steelhead and Chinook salmon habitat and passage, the absolute and proportional changes were both assessed to ensure a biologically meaningful analysis. For example, a large proportional change in habitat may not be biologically meaningful if the absolute amount of habitat is very small. Generally, relatively small differences in either the absolute or proportional changes in habitat or passage were considered negligible since they would be within the range of the model uncertainty.

1.4.3.4 Hydrology and Hydraulics

As described above, for each of the Proposed Project and FAHCE-plus Alternative, the modeled differences in wetted area and water depth from the current and future baselines were calculated to quantitatively evaluate how conditions for steelhead, Chinook salmon, Pacific lamprey, and Sacramento hitch would change.

1.4.3.5 Water Temperature

Water temperature was calculated as the 7-day moving Mean Weekly Average Temperature (MWAT;°F) from daily average temperatures output by the FAHCE WEAP Model. As described above, for each of the Proposed Project and FAHCE-plus Alternative, the difference in MWAT from the current and future baselines was calculated to quantitatively evaluate how conditions for steelhead, Chinook salmon, Pacific lamprey, and Sacramento hitch would change. The daily MWAT statistics are the maximum, average, or minimum MWAT value for an individual day in the 20-year analysis period (1991–2010). The MWAT exceedance probability also was calculated from the daily 1991 to 2010 MWAT to estimate the frequency at which water temperature thresholds would be exceeded.

1.5 Proposed Project Assessment

This section evaluates the effects of the Proposed Project measures on fisheries resources, as compared with current and future baseline conditions. The FAHCE WEAP Model (SEI and Valley Water 2020) was used to model hydrologic, hydraulic, water temperature, and fisheries current baseline conditions. In the Stevens Creek portion of the study area, Stevens Creek was assessed. In the Guadalupe River portion of the study area, Los Gatos Creek, Guadalupe Creek, Alamitos Creek, Calero Creek as well as the Guadalupe River, were assessed.

As described in K.4.2, *Flow Measures Analysis Methodology,* there were no HAI model outputs for Pacific lamprey, Sacramento hitch, and riffle sculpin habitat and passage. Thus, the effects of the Proposed Project on Pacific lamprey, Sacramento hitch, and riffle sculpin habitat and passage were evaluated based on a combination of modeled data for flow, water depth, wetted area, and water temperature, as well as based on modeled HAI for steelhead when life cycles and habitat preference overlap between the species. For example, Pacific lamprey and steelhead overlap in timing of migration, spawning, and rearing and share some habitat preference such as during spawning (for example, they both prefer gravel substrate) and temperature tolerances. Sacramento hitch and steelhead overlap in timing for spawning and rearing; however, Sacramento hitch can occupy more diverse habitat and can tolerate warmer temperatures (up to 86°F) compared to steelhead.

1.5.1 Assessment of the Project in the Stevens Creek Watershed Portion of the Study Area

1.5.1.1 Assessment of Steelhead, Steelhead Habitat, and Migration Conditions in the Stevens Creek Watershed

Assessments of the effects of the Proposed Project on steelhead, steelhead habitat, and migration conditions within the Stevens Creek portion of the study area are provided in the following subsections.

Flow Measures Current Baseline Assessment

Effective Steelhead Spawning Habitat

The FAHCE WEAP Model predicts “effective spawning habitat” by evaluating whether the in-stream conditions meet both spawning habitat and incubation (depth and water temperature) habitat criteria for successful incubation as further described in Section 1.4.3, *Flow Measures Analysis Methodology*. Based on the results of the FAHCE WEAP Model, the Proposed Project would result in 55% (3,800 square feet) average increased in effective spawning habitat compared with the current baseline (Figure 3; Table 4) because of flow increases resulting in more wetted area within the creek being available for effective spawning habitat. The largest increase in effective spawning habitat would occur in the downstream reaches of Stevens Creek (between STEV 2 and STEV 3; 125% increase), and effective spawning habitat would increase 26% on average in the upstream reaches (STEV 4 to STEV 6), which currently supports the highest quality spawning and rearing habitat in Stevens Creek (Leidy 1984; Leidy et al. 2003) (Table 4).

In the early 2000s, the amount of available spawning habitat in Stevens Creek was described as abundant relative to rearing habitat (Stillwater Sciences 2004) likely attributable to the high fecundity of female steelhead. Female steelhead can deposit more than 3,000 eggs (Moyle 2002). Assuming a fry rearing density of 5.6 fish per square feet of stream (the highest observed in nearby Upper Penitencia Creek; Stillwater Sciences 2007), and a low survival to emergence estimate of 25%, 30 females would be needed to produce enough fry to fully seed the estimated maximum available rearing habitat (507,712 square feet) within Stevens Creek. Surveys suggest fewer than 30 adult females spawn in Stevens Creek in a season (Smith 2019). The NMFS (2016) Recovery Plan provided spawner abundance targets for Stevens Creek at 900 spawners.

Figure 3. Change in Steelhead Effective Spawning Habitat Compared with the Current Baseline in Stevens Creek

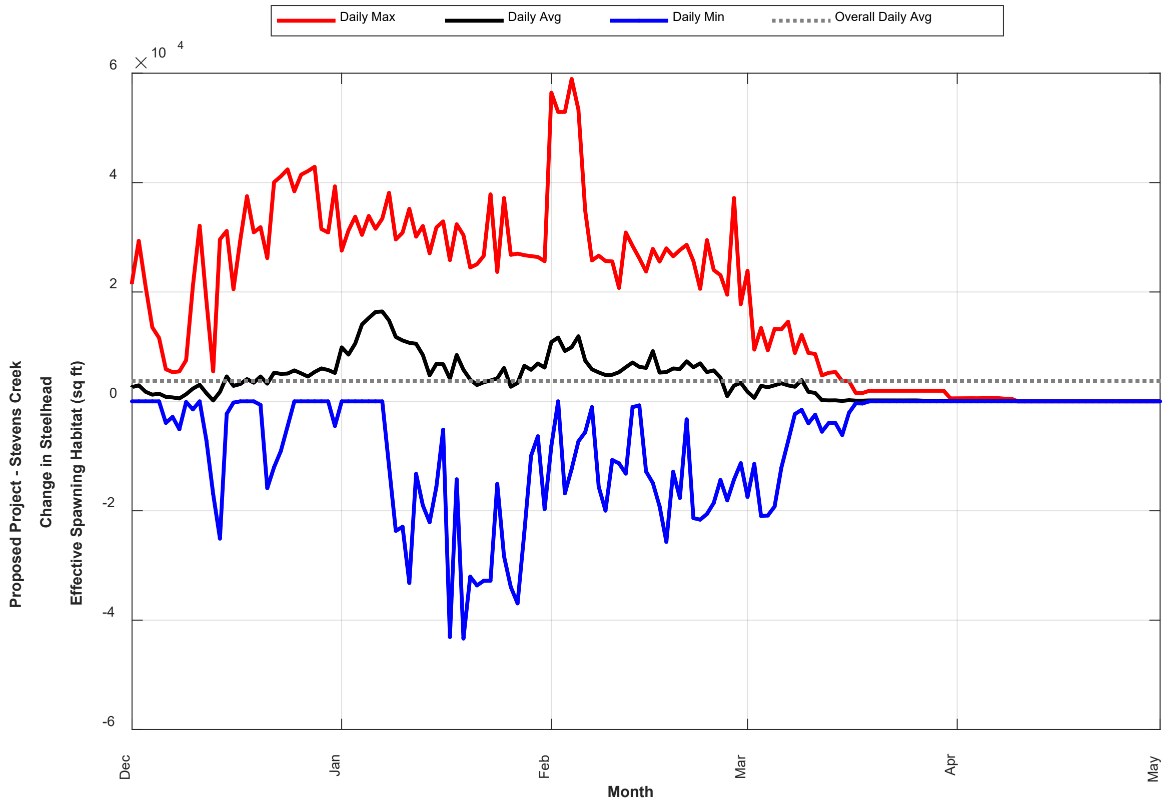


Table 4. Proposed Project Steelhead Habitat Compared with the Current Baseline in Stevens Creek

Stevens Creek[a,b]	STEV3 River Mile 7.1	STEV4 River Mile 8.8	STEV5 River Mile 11.1	STEV6 River Mile 12.3	Total
Steelhead Habitat Current Baseline (sq ft)					
Effective Spawning	1,960	1,690	1,430	1,820	6,900
Fry Rearing Total (March 1–May 31)	75,400	45,000	70,200	36,700	227,000
Fry Rearing Winter Base Flow Operations (excluding Fall Flows) (March 1–April 30)	80,900	44,100	69,500	36,500	231,000
Fry Rearing Summer Cold Water Program and Fall Flows (May 1–May 31)	64,400	46,700	71,700	37,000	220,000
Juvenile Rearing Total (year-round)	41,800	36,500	61,000	28,200	167,000
Juvenile Rearing Winter Base Flow Operations (excluding Fall Flows) (Jan 1–Apr 30)	87,400	47,600	75,600	38,200	249,000
Juvenile Rearing Summer Cold Water Program and Fall Flows (May 1–Dec 31)	19,400	31,000	53,800	23,300	127,000

Stevens Creek[a,b]	STEV3 River Mile 7.1	STEV4 River Mile 8.8	STEV5 River Mile 11.1	STEV6 River Mile 12.3	Total
Steelhead Habitat Proposed Project (sq ft)					
Effective Spawning	4,410	2,320	1,590	2,350	10,700
Fry Rearing Total (March 1–May 31)	90,800	45,600	70,200	37,800	244,000
Fry Rearing Winter Base Flow Operations (excluding Fall Flows) (March 1–April 30)	105,000	46,800	70,600	39,200	262,000
Fry Rearing Summer Cold Water Program and Fall Flows (May 1–May 31)	62,900	43,200	69,300	35,000	210,000
Juvenile Rearing Total (year-round)	53,100	36,200	63,100	30,200	183,000
Juvenile Rearing Winter Base Flow Operations (excluding Fall Flows) (Jan 1–Apr 30)	120,000	55,600	87,900	46,400	310,000
Juvenile Rearing Summer Cold Water Program and Fall Flows (May 1–Dec 31)	20,100	26,700	51,000	22,300	120,000
Change in Habitat (sq ft)					
Effective Spawning	2,450 (125%)	630 (37.28%)	160 (11.19%)	530 (29.12%)	3,800 (55.07%)
Fry Rearing Total (March 1–May 31)	15,400 (20.42%)	600 (1.33%)	0 (0%)	1,100 (3%)	17,000 (7.49%)
Fry Rearing Winter Base Flow Operations (excluding Fall Flows) (March 1–April 30)	24,100 (29.79%)	2,700 (6.12%)	1,100 (1.58%)	2,700 (7.4%)	31,000 (13.42%)
Fry Rearing Summer Cold Water Program and Fall Flows (May 1–May 31)	-1,500 (-2.33%)	-3,500 (-7.49%)	-2,400 (-3.35%)	-2,000 (-5.41%)	-10,000 (-4.55%)
Juvenile Rearing Total (year-round)	11,300 (27.03%)	-300 (-0.82%)	2,100 (3.44%)	2,000 (7.09%)	16,000 (9.58%)
Juvenile Rearing Winter Base Flow Operations (excluding Fall Flows) (Jan 1–Apr 30)	32,600 (37.3%)	8,000 (16.81%)	12,300 (16.27%)	8,200 (21.47%)	61,000 (24.5%)
Juvenile Rearing Summer Cold Water Program and Fall Flows (May 1–Dec 31)	700 (3.61%)	-4,300 (-13.87%)	-2,800 (-5.2%)	-1,000 (-4.29%)	-7,000 (-5.51%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

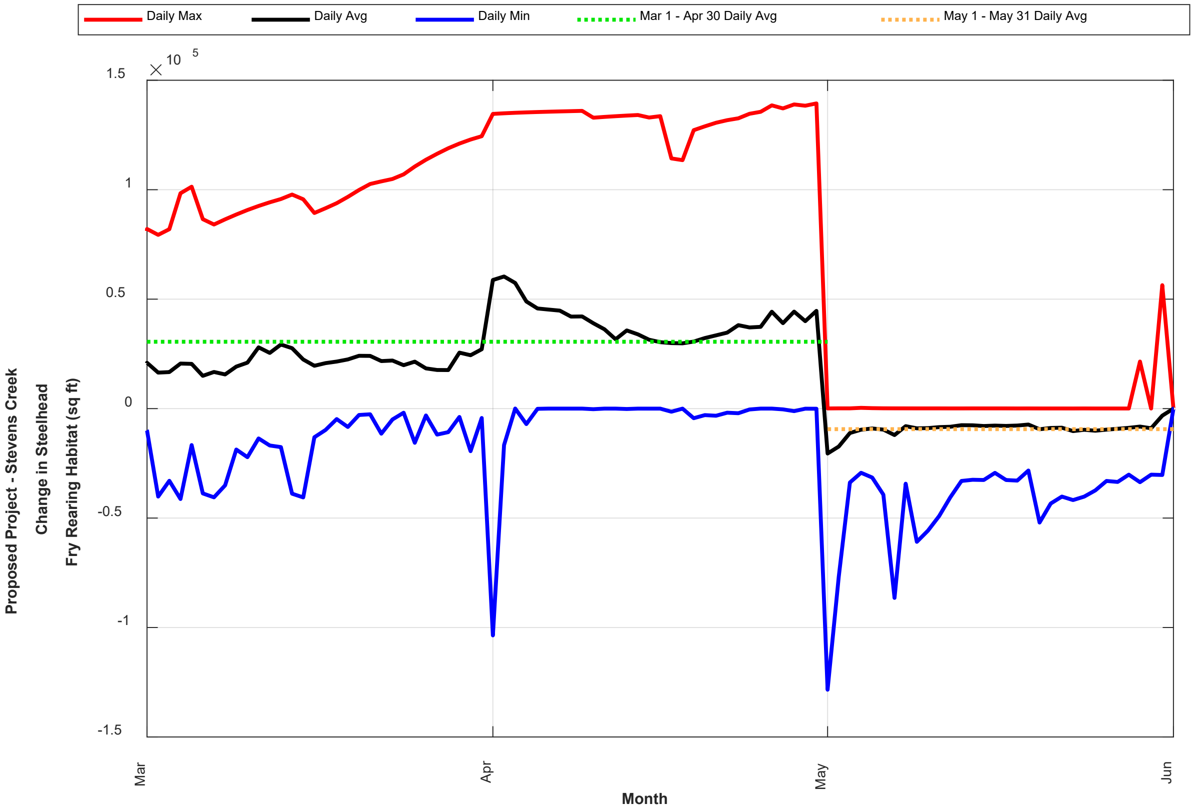
[b] Modeled average daily habitat availability not available for the points of interest not shown.

Fry Rearing Habitat

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in an 8% (17,000 square feet) increase in suitable fry rearing habitat in Stevens Creek compared with the current baseline (Figure 4; Table 4). The largest increase in fry rearing habitat at 20% would occur in downstream Stevens Creek (between STEV 2 and STEV 3) (Table 4). The Proposed Project would result in minimal changes to fry rearing habitat within upstream reaches (between STEV 4 to STEV 6) (Table 4) where the best available rearing habitat is currently located (Leidy 1984; Leidy et al. 2003).

Table 4 shows that fry rearing average HAI for the Proposed Project compared with the current baseline during the fry rearing life stage (March 1 to May 31) and averaged across POIs 3 through 6 in Stevens Creek. The amount of suitable fry rearing habitat would not be consistently increased under the Proposed Project throughout the fry rearing period (March 1 through May 31) (Figure 4). A 13% (31,000 square feet) increase in fry rearing habitat would be observed from March 1 through April 30) and there would be a 5% (10,000 square feet) decrease in fry rearing habitat from May 1 through May 31 under the Proposed Project compared with the current baseline. The modeled decrease late in the fry rearing season is attributable to the operational regimen, which is required to change to the Summer Cold Water Program and Fall Flows in May, as outlined in the Settlement Agreement (Valley Water et al. 2003). The Summer Cold Water Program and Fall Flows would result in decreased flows, primarily to retain cold water in the reservoirs for release (see Section 1.4.3, *Flow Measures Analysis Methodology*, for additional details on the Summer Cold Water Program and Fall Flows). Therefore, the operational regimen results in a slight reduction in fry rearing habitat and a higher quality habitat in the form of maintaining temperatures within the optimal range for juvenile growth within the CWMZ during the late summer/early fall.

Figure 4. Change in Steelhead Fry Rearing Habitat Compared with the Current Baseline in Stevens Creek



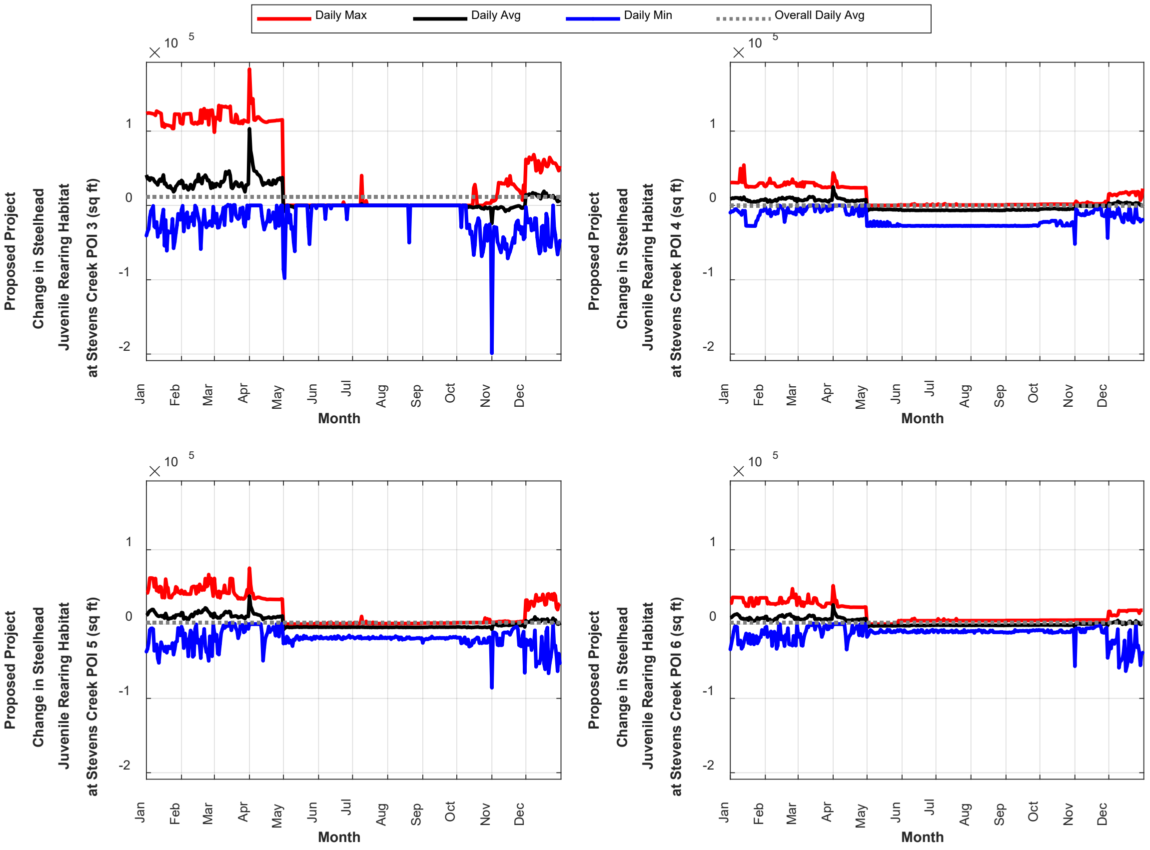
Juvenile Rearing Habitat

Figure 5 reveals Stevens Creek HAI under the current baseline conditions for the Proposed Project compared with the current baseline for steelhead during the juvenile rearing life stage. The HAI is calculated during the juvenile rearing life stage, which includes the entire year from January 1 to December 31. The data presented are the daily averages, absolute daily minimums, and absolute daily maximums, calculated for the entire 20-year modeling period (1990 to 2010) and averaged across all POIs that were modeled in Stevens Creek (STEV 3 through 6).

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 10% (16,000 square feet) increase to juvenile rearing habitat compared with the current baseline. (Figure 5; Table 4). The largest increase in juvenile rearing habitat of 27% would occur in downstream Stevens Creek (between STEV 2 and STEV 3) (Table 4). The increase in juvenile rearing habitat predicted in downstream Stevens Creek under the Proposed Project would occur during the winter and there would be no juvenile rearing habitat between STEV 2 and STEV 3 between May and October under either the current baseline or the Proposed Project, which is attributed to low flows within this downstream reach. Under either the current baseline or Proposed Project, juveniles rearing within the downstream reach could attempt to migrate to avoid unsuitable conditions during the summer, but as evidenced by simulated wetted areas, reduced flows would create upstream and downstream passage barriers approximately one month before juvenile rearing habitat reaches zero in mid-July, which would likely reduce the ability to migrate from this reach in many years.

The farthest upstream reaches (STEV 4 to STEV 6), where the best rearing habitat is located and the most juveniles are observed during surveys (Abel 2011; NMFS 2016), would experience a 3% (3,800 square feet) increase in modeled juvenile rearing habitat on average under the Proposed Project (Table 4). There would be overall annual increases and a 25% increase during Winter Base Flow Operations (excluding Fall Flows) (January 1 to April 30) in upstream Stevens Creek, however juvenile rearing habitat in the upstream reaches would experience a 8% (8,100 square feet) decrease during the Stevens Creek Summer Cold Water Program and Fall Flows (May 1 to December 31) under the Proposed Project (Figure 5; Table 4). This decrease in juvenile rearing habitat during the Summer Cold Water Program and Fall Flows is attributable to reduced stream flows, an operational measure in favor of maintaining cooler water temperatures within the CWMZ (see Section 1.4.3, *Flow Measures Analysis Methodology,* for additional details on the Summer Cold Water Program and Fall Flows). Temperatures greater than 64°F are considered near the upper range of tolerance for juveniles (McCullough et al. 2001) and the upper temperature threshold for optimal growth typically ranges from 64°F to 66°F (Myrick and Cech 2004, 2005), although steelhead in Central California may be capable of tolerating and even benefiting from higher temperatures (Myrick and Cech 2001). Under the current baseline, modeled MWATs in the CWMZ would exceed 64.4°F only 0.1% of the time and there is little difference in the exceedance probabilities for this upper temperature threshold under the Proposed Project (Attachment K.2 – Figures K.2.5 and K.2.6). Therefore, although there are differences in temperatures within the CWMZ sites under the Proposed Project compared with the current baseline (Attachment K.2 – Figure K.2.5), any differences in juvenile growth because of temperature differences would be minimal; hence the models predict an overall reduction in juvenile rearing habitat during the summer.

Figure 5. Change in Juvenile Rearing Habitat Compared with the Current Baseline in Stevens Creek[a]



[a] No average daily habitat availability model results are available for the points of interest not shown.

Migration Conditions

Adult Upstream Passage

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in an average increase in adult upstream passage of 25% (23 days per year) in downstream Stevens Creek (STEV 1 and STEV 2) and a decrease (reduced by an average of 4% or one day per year) on adult passage in upstream Stevens Creek (STEV 3 through STEV 6) (Figure 6; Table 5). The upstream reaches of Stevens Creek (upstream of STEV 3) have the highest quality spawning and rearing habitat in Stevens Creek and highest juvenile *O. mykiss* abundance (Leidy 1984; Leidy et al. 2003).

Figure 6. Change in Average Adult Steelhead Upstream Passage Days Compared with the Current Baseline in Stevens Creek

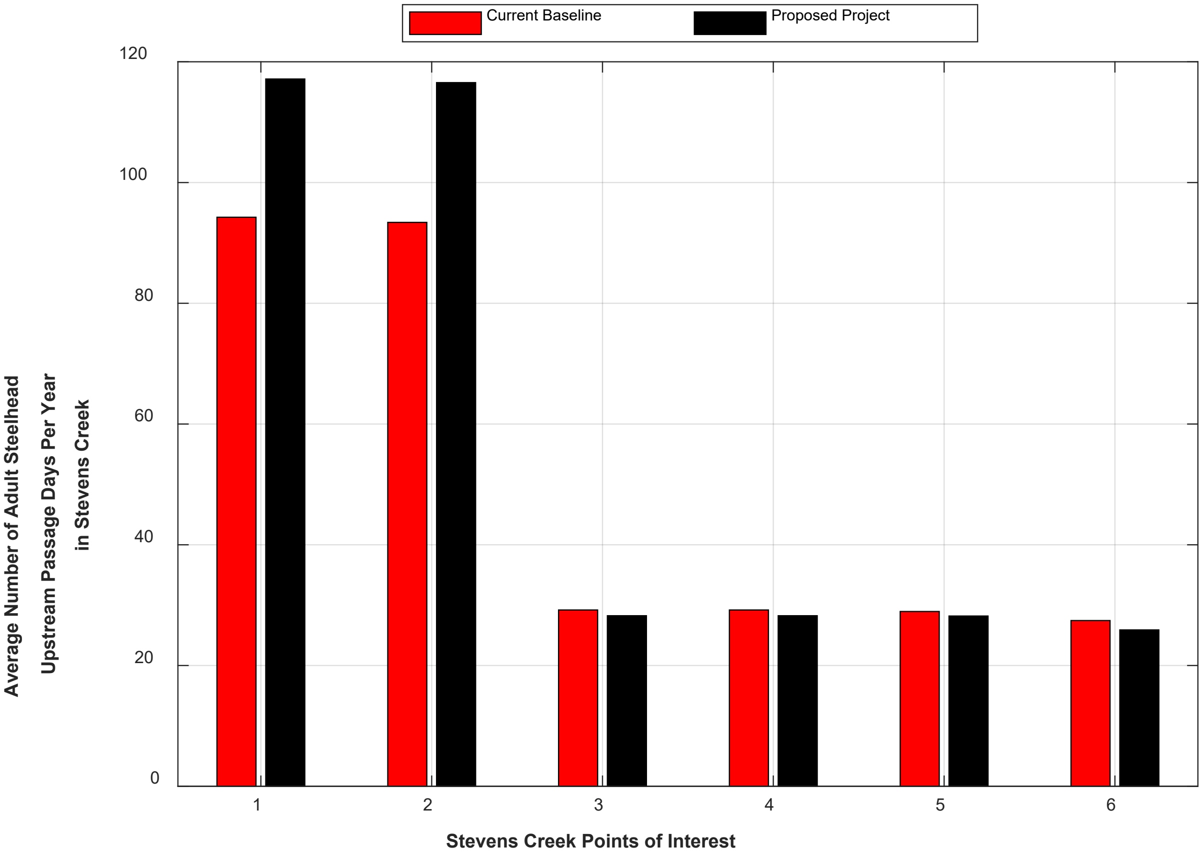


Table 5. Proposed Project Adult Steelhead Upstream Passage Compared with the Current Baseline in Stevens Creek

Parameter	STEV 1	STEV 2	STEV 3	STEV 4	STEV 5	STEV 6
Current Baseline (days)[a]						
Total Adult Upstream Passage (1991–2010)	1,885	1,868	584	584	579	549
Average Adult Upstream Passage Per Year	94	93	29	29	29	27
Proposed Project (days)[a]						
Total Adult Upstream Passage (1991–2010)	2,343	2,331	565	565	564	518
Average Adult Upstream Passage Per Year	117	117	28	28	28	26
Difference (days)						
Total Adult Upstream Passage (1991–2010)	458.00	463.00	-19.00	-19.00	-15.00	-31.00

Parameter	STEV 1	STEV 2	STEV 3	STEV 4	STEV 5	STEV 6
Average Adult Upstream Passage Per Year	22.90	23.15	-0.95	-0.95	-0.75	-1.55
Difference (%)						
Total Adult Upstream Passage (1991–2010)	24.30	24.79	-3.25	-3.25	-2.59	-5.65
Average Adult Upstream Passage Per Year	24.30	24.79	-3.25	-3.25	-2.59	-5.65

[a] Rounded to whole days

Juvenile Downstream Passage

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in an average increase in juvenile downstream passage of 20% (8 days per year) in upstream Stevens Creek (STEV 3 through STEV 6) compared with the current baseline (Figure 7; Table 6). The increase in downstream passage days under the Proposed Project would provide additional opportunities for steelhead smolts to emigrate to the ocean from rearing habitat within Stevens Creek.

Figure 7. Juvenile Steelhead Downstream Passage Days Compared with the Current Baseline in Stevens Creek

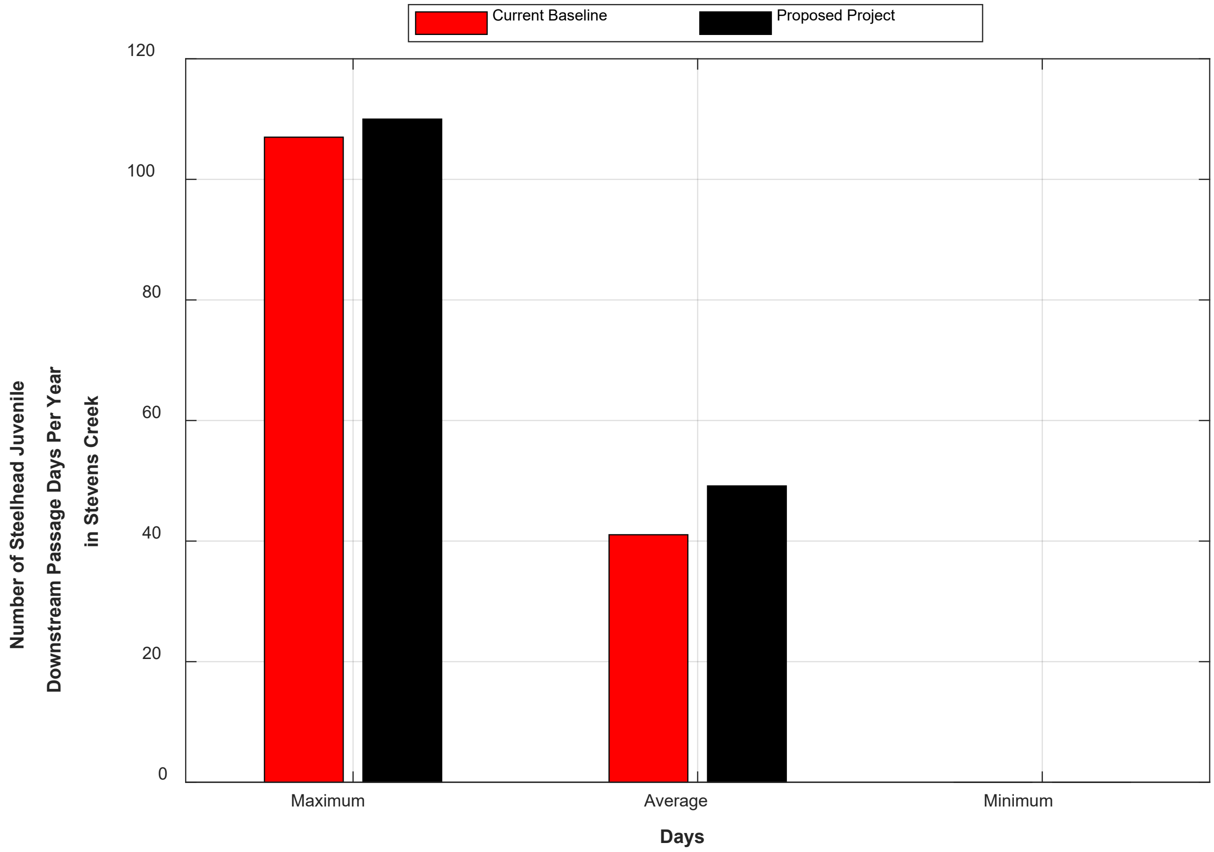


Table 6. Proposed Project Juvenile Steelhead Downstream Passage Days Compared with the Current Baseline in Stevens Creek

Parameter	STEV 6 with Water Temperature Criteria[b]
Current Baseline (days)[a]	
Total Juvenile Downstream Passage (1991–2010)	821
Average Juvenile Downstream Passage Per Year	41
Proposed Project (days)[a]	
Total Juvenile Downstream Passage (1991–2010)	983
Average Juvenile Downstream Passage Per Year	49
Difference (days)	
Total Juvenile Downstream Passage (1991–2010)	162.00
Average Juvenile Downstream Passage Per Year	8.00
Difference (%)	
Total Juvenile Downstream Passage (1991–2010)	19.73
Average Juvenile Downstream Passage Per Year	19.51

[a] Rounded to whole days.

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Flow Measures Future Baseline Assessment

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in nearly identical increases to effective spawning habitat in both downstream and upstream reaches of Stevens Creek compared with the future baseline as that of the comparison of the Proposed Project with the current baseline. For the reasons outlined in the comparison of the Proposed Project with the current baseline, the Proposed Project would increase steelhead effective spawning habitat compared with the future baseline in the Stevens Creek watershed portion of the study area.

Fry Rearing Habitat

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in nearly identical increases and decreases to fry rearing habitat in both downstream and upstream reaches of Stevens Creek compared with the future baseline as that of the comparison of the Proposed Project with the current baseline. For the reasons outlined in the comparison of the Proposed Project with the current baseline, the Proposed Project would result in an increase in flow and the corresponding expansion in the total wetted area available for fry rearing compared with the future baseline in the Stevens Creek watershed portion of the study area.

Juvenile Rearing Habitat

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in nearly identical increases to juvenile rearing habitat in the winter and decreases in the summer in both downstream and upstream reaches of Stevens Creek compared with the future baseline as that of the comparison of the Proposed Project with the current baseline (Table 7). For the reasons outlined in the current baseline, suitable juvenile rearing habitat would increase across all sites during the winter with a decrease in modeled juvenile rearing habitat in the summer.

Table 7. Proposed Project Steelhead Habitat Compared with the Future Baseline in Stevens Creek

Stevens Creek[a,b]	STEV3 River Mile 7.1	STEV4 River Mile 8.8	STEV5 River Mile 11.1	STEV6 River Mile 12.3	Total
Steelhead Habitat Future Baseline (sq ft)					
Effective Spawning	1,960	1,690	1,430	1,820	6,900
Fry Rearing Total (March 1–May 31)	75,400	45,000	70,200	36,700	227,000
Fry Rearing Winter Base Flow Operations (excluding Fall Flows) (March 1–April 30)	80,900	44,100	69,500	36,500	231,000
Fry Rearing Summer Cold Water Program and Fall Flows (May 1–May 31)	64,400	46,700	71,700	37,000	220,000
Juvenile Rearing Total (year-round)	41,800	36,500	61,000	28,200	167,000
Juvenile Rearing Winter Base Flow Operations (excluding Fall Flows) (Jan 1–Apr 30)	87,400	47,600	75,600	38,200	249,000
Juvenile Rearing Summer Cold Water Program and Fall Flows (May 1–Dec 31)	19,400	31,000	53,800	23,300	127,000
Steelhead Habitat Proposed Project (sq ft)					
Effective Spawning	4,410	2,320	1,590	2,350	10,700
Fry Rearing Total (March 1–May 31)	90,800	45,600	70,200	37,800	244,000
Fry Rearing Winter Base Flow Operations (excluding Fall Flows) (March 1–April 30)	105,000	46,800	70,600	39,200	262,000
Fry Rearing Summer Cold Water Program and Fall Flows (May 1–May 31)	62,900	43,200	69,300	35,000	210,000
Juvenile Rearing Total (year-round)	53,100	36,200	63,100	30,200	183,000
Juvenile Rearing Winter Base Flow Operations (excluding Fall Flows) (Jan 1–Apr 30)	120,000	55,600	87,900	46,400	310,000
Juvenile Rearing Summer Cold Water Program and Fall Flows (May 1–Dec 31)	20,100	26,700	51,000	22,300	120,000

Stevens Creek[a,b]	STEV3 River Mile 7.1	STEV4 River Mile 8.8	STEV5 River Mile 11.1	STEV6 River Mile 12.3	Total
Change in Habitat (sq ft)					
Effective Spawning	2,450 (125%)	630 (37.28%)	160 (11.19%)	530 (29.12%)	3,800 (55.07%)
Fry Rearing Total (March 1–May 31)	15,400 (20.42%)	600 (1.33%)	0 (0%)	1,100 (3%)	17,000 (7.49%)
Fry Rearing Winter Base Flow Operations (excluding Fall Flows) (March 1–April 30)	24,100 (29.79%)	2,700 (6.12%)	1,100 (1.58%)	2,700 (7.4%)	31,000 (13.42%)
Fry Rearing Summer Cold Water Program and Fall Flows (May 1–May 31)	-1,500 (-2.33%)	-3,500 (-7.49%)	-2,400 (-3.35%)	-2,000 (-5.41%)	-10,000 (-4.55%)
Juvenile Rearing Total (year-round)	11,300 (27.03%)	-300 (-0.82%)	2,100 (3.44%)	2,000 (7.09%)	16,000 (9.58%)
Juvenile Rearing Winter Base Flow Operations (excluding Fall Flows) (Jan 1–Apr 30)	32,600 (37.3%)	8,000 (16.81%)	12,300 (16.27%)	8,200 (21.47%)	61,000 (24.5%)
Juvenile Rearing Summer Cold Water Program and Fall Flows (May 1–Dec 31)	700 (3.61%)	-4,300 (-13.87%)	-2,800 (-5.2%)	-1,000 (-4.29%)	-7,000 (-5.51%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

[b] Modeled average daily habitat availability not available for the points of interest not shown.

Migration Conditions

Adult Upstream Passage

Based on the results of the FAHCE WEAP Model, there are negligible differences in adult upstream passage between the current and future baseline under the Proposed Project (Table 8; see *Flow Measures Compared with Current Baseline Impact Analysis* above). Therefore, the Proposed Project would result in increased fish passage opportunities within the downstream reaches of the Stevens Creek watershed portion of the study area and little to no change in passage within the upstream reaches compared with the future baseline.

Table 8. Proposed Project Adult Steelhead Upstream Passage Compared with the Future Baseline in Stevens Creek

Parameter	STEV 1	STEV 2	STEV 3	STEV 4	STEV 5	STEV 6
Future Baseline (days)[a]						
Total Adult Upstream Passage (1991–2010)	1,885	1,868	584	584	579	549
Average Adult Upstream Passage Per Year	94	93	29	29	29	27
Proposed Project (days)[a]						
Total Adult Upstream Passage (1991–2010)	2,343	2,331	565	565	564	518
Average Adult Upstream Passage Per Year	117	117	28	28	28	26
Difference (days)						
Total Adult Upstream Passage (1991–2010)	458.00	463.00	-19.00	-19.00	-15.00	-31.00
Average Adult Upstream Passage Per Year	22.90	23.15	-0.95	-0.95	-0.75	-1.55
Difference (%)						
Total Adult Upstream Passage (1991–2010)	24.30	24.79	-3.25	-3.25	-2.59	-5.65
Average Adult Upstream Passage Per Year	24.30	24.79	-3.25	-3.25	-2.59	-5.65

[a] Rounded to whole days

Juvenile Downstream Passage

Based on the results of the FAHCE WEAP Model, there are negligible differences in juvenile downstream passage between the current and future baseline under the Proposed Project (Table 9; see *Flow Measures Compared with Current Baseline Impact Analysis* above). Therefore, the Proposed Project would increase juvenile downstream passage in upstream reaches of Stevens Creek compared to the future baseline conditions.

Table 9. Proposed Project Juvenile Steelhead Downstream Passage Compared with the Future Baseline in Stevens Creek

Parameter	STEV 6 with Water Temperature Criteria[b]
Future Baseline (days)[a]	
Total Juvenile Downstream Passage (1991–2010)	821
Average Juvenile Downstream Passage Per Year	41
Proposed Project (days)[a]	
Total Juvenile Downstream Passage (1991–2010)	983
Average Juvenile Downstream Passage Per Year	49

Parameter	STEV 6 with Water Temperature Criteria[b]
Difference (days)	
Total Juvenile Downstream Passage (1991–2010)	162.00
Average Juvenile Downstream Passage Per Year	8.00
Difference (%)	
Total Juvenile Downstream Passage (1991–2010)	19.73
Average Juvenile Downstream Passage Per Year	19.51

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

1.5.1.2 Assessment of Pacific Lamprey, Pacific Lamprey Habitat, and Migration Conditions in the Stevens Creek Watershed Portion of the Study Area

Assessments of the effects of the Proposed Project on Pacific lamprey, Pacific lamprey habitat, and Pacific lamprey migration conditions within the Stevens Creek portion of the study area are provided in the following subsections. There were no HAI or passage model outputs for Pacific lamprey. Thus, the effects of the Proposed Project on Pacific lamprey habitat and passage were evaluated using other modeled data, including wetted area and thalweg depth, review of water temperature for suitability, as well as based on modeled HAI for steelhead when life cycles and habitat preference overlap between the species.

Flow Measures Current Baseline Assessment

Pre-Spawning Holding Habitat

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in increased pre-spawning holding habitat during the winter as a result of increased flows and wetted area under Winter Base Flow Operations (excluding Fall Flows), and the Summer Cold Water Program and Fall Flows have variable effects on pre-spawning holding habitat during the summer between downstream and upstream Stevens Creek. Decreases in rearing habitat would occur in upstream Stevens Creek (STEV 4 through STEV 6) during the Summer Cold Water Program and Fall Flows because of reduced flows and wetted area without any benefits from reduced temperatures to offset decreased wetted area (there were minimal differences in water temperature under the Proposed Project and current baseline). In addition, there is effectively no change in pre-spawning holding habitat in downstream Stevens Creek during the summer due to reduced flows combined with high water temperatures. Therefore, any increases in holding habitat during the winter in downstream Stevens Creek would be negated during the summer unless holding Pacific lamprey migrated to different areas of the watershed prior to summer low flows. As evidenced by simulated wetted areas, reduced flows would create upstream and downstream passage barriers approximately one month before pre-spawning holding habitat would disappear in mid-July, which would likely reduce the ability to migrate from this reach in many years.

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, under the Proposed Project, habitat for Pacific lamprey spawning and incubation would increase for two months (March 1 through April 31) of the spawning and incubation period and depending on the location in Stevens Creek, remain unchanged or decrease during four months of the spawning and incubation period for this species (March 1 through August 31). Increases in effective spawning and incubation habitat would occur from March 1 through April 31 under the Proposed Project as a result of increased flows that increase wetted area under Winter Base Flow Operations (excluding Fall Flows) but spawning and incubation habitat would be generally decreased from May 1 through August 31 as a result of the Summer Cold Water Program and Fall Flows that reduce flows and wetted area in Stevens Creek (Attachment K.2 – Figures K.2.1, K.2.2, K.2.3, and K.2.4). Of note, although wetted area would increase in downstream Stevens Creek (STEV 2 through STEV 3) under the Proposed Project (Attachment K.2 – Figure K.2.4), there is effectively no flow during this time in downstream Stevens Creek in either the current baseline or the Proposed Project. Adequate flows are needed to supply oxygen and maintain suitable water temperatures for egg incubation (ranging from 50–71°F). As a result, egg incubation would not be supported after approximately mid-July in downstream Stevens Creek, but this is consistent between both the Proposed Project and the current baseline. It is expected spawning would cease by June 1 in Stevens Creek, and because the length of Pacific lamprey embryo incubation is highly dependent on water temperature, high water temperatures in the region would result in incubation being completed by the end of July at the latest (Meeuwig et al. 2005; Brumo 2006).

Larvae Rearing Habitat

Based on the results of the FAHCE WEAP Model, and considering that Pacific lamprey larvae rearing can occur year-round, the Proposed Project would increase rearing habitat during the winter (between December and April, inclusive) because of increased wetted area (Table 7; Attachment K.2 – Figures K.2.3 and K.2.4), but the Proposed Project would have variable effects on rearing habitat during the summer between downstream and upstream Stevens Creek. There is effectively no flow in downstream Stevens Creeks during the summer (Figure K.2.1) in both the current baseline and the Proposed Project, but wetted area would generally increase at POIs STEV 2 and STEV 3 between July and October under the Proposed Project (Attachment K.2 – Figure K.2.4). Pacific lamprey utilize slower moving waters with fine silt substrates compared to juvenile steelhead and Pacific lamprey larvae have been shown to withstand prolonged periods of dewatering if they can burrow deep enough in the hyporheic zone to remain wetted (Rodriguez-Lozano 2019). Increased wetted area in downstream Stevens Creek could provide additional rearing habitat if temperatures remain suitable (less than 71°F; Meeuwig et al. 2005) and/or if larvae can burrow to find suitable conditions in the hyporheic zone. Modeled temperature was not available for STEV 1 and STEV 2 in downstream Stevens Creek, but modeled MWAT at STEV 3 would remain suitable (average less than 66°F; maximum less than 70°F) during the summer. Small decreases in rearing habitat would occur in upstream Stevens Creek (STEV 4 to STEV 6) during the Summer Cold Water Program and Fall Flows as a result of reduced flows and wetted area (Attachment K.2 – Figures K.2.1, K.2.2, K.2.3, and K.2.4).

Migration Conditions

Adult Upstream Passage

During the adult Pacific lamprey upstream migration period (January 1 through June 30), the FAHCE WEAP Model results for thalweg depth indicate a 28% average increase (29 days per year) in modeled adult upstream passage opportunities in the Stevens Creek watershed under the Proposed Project when compared with the current baseline. In addition to the thalweg depth analysis, modeled results for adult steelhead upstream passage, which overlaps with the timing of upstream passage of adult Pacific lamprey (January through April), also indicate increases to adult Pacific lamprey upstream passage opportunities in downstream Stevens Creek and little to no change in passage to the upstream reaches of Stevens Creek (STEV 4 through STEV 6).

Juvenile Downstream Passage

During the juvenile Pacific lamprey downstream migration period (December 1 through May 31), the FAHCE WEAP Model results for thalweg water depth indicate a 30% (34 day per year) average increase to downstream migration compared with the current baseline. Additionally, modeled downstream passage for steelhead (with the water temperature criteria included), which overlap with the timing of downstream passage of juvenile Pacific lamprey between December and May, was increased from February to May under the Proposed Project.

Flow Measures Future Baseline Assessment

Pre-Spawning Holding Habitat

Based on the results of the FAHCE WEAP Model, there are negligible differences in the Proposed Project in analysis between the current and future baseline for pre-spawning holding habitat. For the reasons outlined in the comparison to current baseline, decreases in flows and wetted area during the summer under the Proposed Project would reduce pre-spawning holding habitat, but increases in pre-spawning holding habitat would occur during the winter because of increases in flows and wetted area.

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, there are negligible differences in the Proposed Project in analysis between the current and future baseline for effective spawning habitat. For the reasons outlined in the comparison to current baseline, decreases in flow during the summer would not affect Pacific lamprey incubation in Stevens Creek and there would be overall increases in effective spawning habitat attributable to flow increases in winter under the Proposed Project compared with the future baseline.

Larvae Rearing Habitat

Based on the results of the FAHCE WEAP Model, and considering that Pacific lamprey larvae rearing can occur year-round, there would be beneficial changes of larvae rearing habitat with the Proposed Project compared with the future baseline. Increased wetted area in Stevens Creek between January and April and at POIs STEV 2 and STEV 3 in downstream Stevens Creek between July and October (Attachment K.2 − Figures K.2.9 and K.2.10) could provide additional rearing habitat given that temperatures remain suitable (Attachment K.2 − Figures K.2.11 and K.2.12). However, between May and October, during the Summer Cold Water Program and Fall Flows, very small decreases in rearing habitat would occur in upstream Stevens Creek. However, Pacific lamprey larvae have been shown to withstand prolonged periods of dewatering if they can burrow deep enough in the hyporheic zone to remain wetted (Rodriguez-Lozano 2019).

Migration Conditions

Adult Upstream Passage

Based on the results of the FAHCE WEAP Model and results for thalweg water depths, the Proposed Project would result in nearly identical changes to adult upstream passage in Stevens Creek compared with the future baseline as that of the comparison with the current baseline. For the reasons outlined in the comparison to current baseline, the Proposed Project would, on average, increase Pacific lamprey adult upstream passage.

Juvenile Downstream Passage

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in nearly identical changes to modeled juvenile downstream passage in Stevens Creek compared with the future baseline as that of the comparison with the current baseline. For the reasons outlined in the comparison to current baseline, the Proposed Project would, on average, increase Pacific lamprey juvenile downstream passage.

1.5.1.3 Stevens Creek Watershed Portion of the Study Area Conclusion

When compared with the current and future baselines, the Proposed Project flow measures provide a net benefit to steelhead and Pacific lamprey within the Stevens Creek portion of the study area.

Steelhead

For steelhead, implementing the Proposed Project flow measures would result in increased effective spawning and rearing habitat from late fall to spring, and overall increases in upstream and downstream passage opportunities, as well as less juvenile rearing habitat due to decreased flows from May through November. Fish passage would increase in downstream reaches, with minimal change in upstream reaches of Stevens Creek. Increases in water for flow during late fall and spring support habitat for more steelhead life stages (that is, effective spawning, fry rearing, and winter/spring juvenile rearing) than the decrease in water for flow during summer through early fall (that is, summer/fall juvenile rearing).

The decreases in summer/fall juvenile rearing habitat do not occur during the life stage period identified as limiting for steelhead in Stevens Creek, and the decreases in summer/fall juvenile rearing habitat are relatively small compared with the total available summer/fall juvenile rearing habitat. The best available juvenile rearing habitat is in the CWMZ, and this CWMZ habitat would decrease during the summer but would remain suitable for steelhead rearing under the Proposed Project with regard to both predicted habitat and water temperature. Although habitat is modeled to increase downstream of STEV 3 during the winter under the Proposed Project, there is currently no habitat to support rearing in this reach during the summer. There would be variable effects both spatially and temporally on juvenile rearing habitat under the Proposed Project. Overall, the Proposed Project would result in a net increase of juvenile rearing habitat compared with the current baseline.

On balance, the Proposed Project flow measures would benefit steelhead in the Stevens Creek portion of the study area.

Pacific Lamprey

Although the operations associated with the Proposed Project are management actions that benefit federally listed steelhead and salmon, the actions are anticipated to provide an overall benefit to Pacific lamprey as well. Increased flow during the fall and winter because of the flow measures designed for steelhead also benefit the anadromous life history phases of Pacific lamprey.

For Pacific lamprey, implementing the Proposed Project flow measures would result in benefits to winter pre-spawning holding habitat, larvae rearing habitat in the downstream reaches, and upstream and downstream passage opportunities, along with decreases to pre-spawning holding habitat in the summer and negligible changes of larvae rearing habitat in the upstream reaches.

The Proposed Project would result in a truncated spawning and incubation window for Pacific lamprey. However, spawning typically ends by mid-June, and thus decreased flows during the period of the Summer Cold Water Program and Fall Flows (Table 5) would be offset by increased effective spawning habitat during Winter Base Flow Operations (excluding Fall Flows).

There would be a net increase in larvae rearing habitat during the winter and variable changes to larvae rearing habitat during the summer under the Proposed Project. Increases in larvae rearing habitat during the winter would offset reduced habitat in the upstream reaches of Stevens Creek during the summer.

On balance, the Proposed Project flow measures would benefit Pacific lamprey in the Stevens Creek portion of the study area.

1.5.2 Assessment of the Project in the Guadalupe River Portion of the Study Area

1.5.2.1 Assessment of Steelhead, Steelhead Habitat, and Migration Conditions in the Guadalupe River Portion of the Study Area

Assessments of the effects of the Proposed Project on steelhead, steelhead habitat, and steelhead migration within the Guadalupe River portion of the study area are provided in the following subsections.

Flow Measures Current Baseline Assessment

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 35% (1,793 square feet) increase in effective spawning habitat across POIs in the Guadalupe River compared with the current baseline (Table 10). Effective spawning habitat was increased at all POIs. Modeled increases were observed in the early spawning period (December) with little to no change during the rest of the spawning period (January through May) when most upstream migration occurs (Moyle et al. 2008) (Figure 8).

Figure 8. Change in Steelhead Effective Spawning Habitat in the Guadalupe River Compared with the Current Baseline

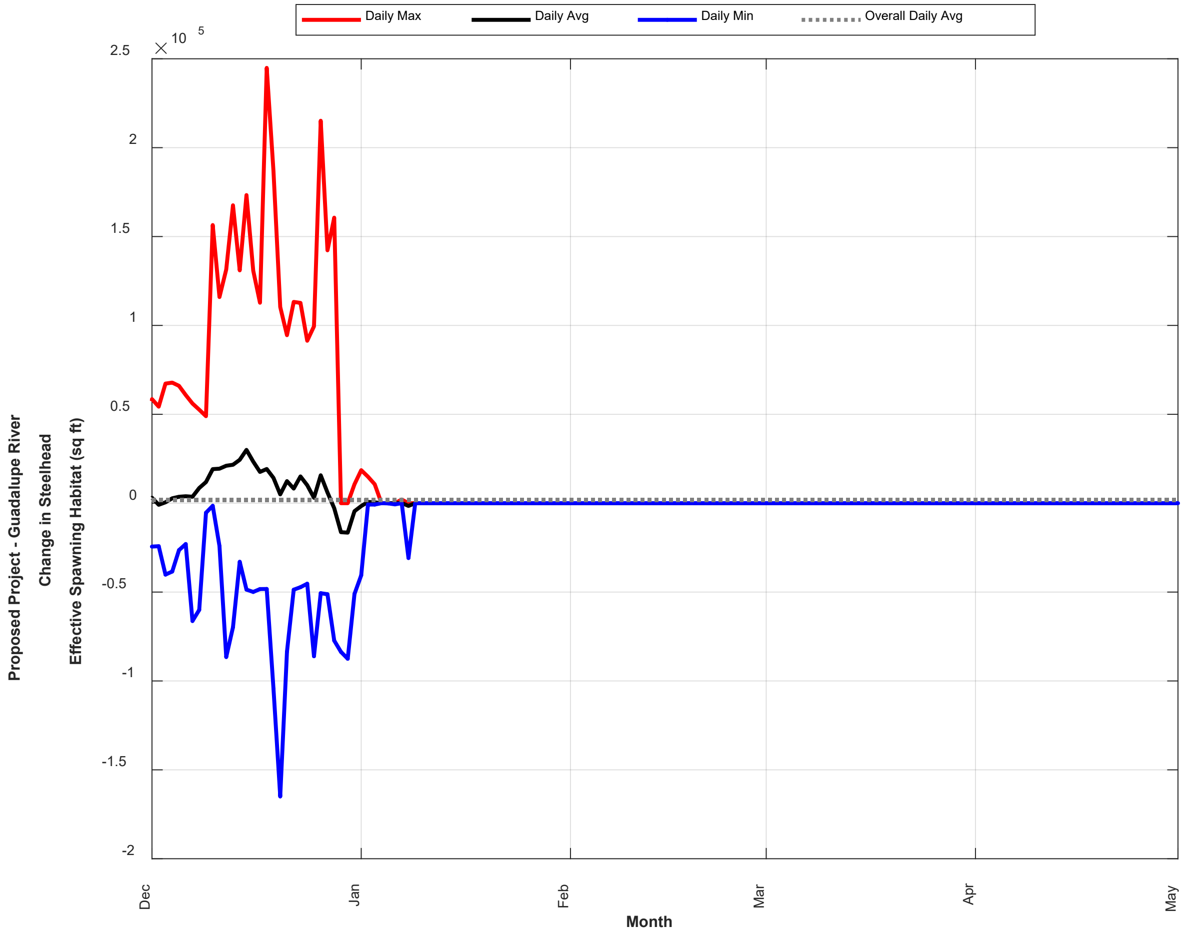


Table 10. Proposed Project Steelhead Habitat Compared with the Current Baseline in the Guadalupe River

Guadalupe River[a,b]	GUAD 3 River Mile 10.07	GUAD 4 River Mile 12.52	GUAD 5 River Mile 13.42	GUAD 6 River Mile 18.45	GUAD 7 River Mile 19.93	Total
Steelhead Habitat Current Baseline (sq ft)						
Effective Spawning	2,490	294	290	941	1,040	5,055
Fry Rearing Total (March 1–May 31)	147,000	168,000	66,800	405,000	400,000	1,186,800
Fry Rearing Winter Base Flow Operations (March 1–April 30)	155,000	167,000	71,500	435,000	406,000	1,234,500
Fry Rearing Summer Cold Water Program and Fall Flows (May 1–May 31)	131,000	170,000	57,500	347,000	387,000	1,092,500

Guadalupe River[a,b]	GUAD 3 River Mile 10.07	GUAD 4 River Mile 12.52	GUAD 5 River Mile 13.42	GUAD 6 River Mile 18.45	GUAD 7 River Mile 19.93	Total
Juvenile Rearing Total (year-round)	240,000	259,000	75,200	309,000	330,000	1,213,200
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	290,000	297,000	105,000	483,000	401,000	1,576,000
Juvenile Rearing Summer Cold Water Program and Fall Flows (May 1–Oct 31)	190,000	222,000	45,800	138,000	261,000	856,800
Steelhead Habitat Proposed Project (sq ft)						
Effective Spawning	2,760	412	546	1,550	1,580	6,848
Fry Rearing Total (March 1–May 31)	147,000	167,000	66,900	410,000	399,000	1,189,900
Fry Rearing Winter Base Flow Operations (March 1–April 30)	155,000	166,000	71,700	438,000	403,000	1,233,700
Fry Rearing Summer Cold Water Program and Fall Flows (May 1–May 31)	130,000	169,000	57,300	356,000	391,000	1,103,300
Juvenile Rearing Total (year-round)	239,000	257,000	75,700	315,000	326,000	1,212,700
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	291,000	296,000	106,000	493,000	390,000	1576,000
Juvenile Rearing Summer Cold Water Program and Fall Flows (May 1–Oct 31)	188,000	219,000	45,700	139,000	263,000	854,700
Change in Habitat (sq ft)						
Effective Spawning	270 (10.84%)	118 (40.14%)	256 (88.28%)	609 (64.72%)	540 (51.92%)	1,793 (35.47%)
Fry Rearing Total (March 1–May 31)	0 (0%)	-1,000 (-0.6%)	100 (0.15%)	5,000 (1.23%)	-1,000 (-0.25%)	3,100 (0.26%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	0 (0%)	-1,000 (-0.6%)	200 (0.28%)	3,000 (0.69%)	-3,000 (-0.74%)	-800 (-0.06%)
Fry Rearing Summer Cold Water Program and Fall Flows (May 1–May 31)	-1,000 (-0.76%)	-1,000 (-0.59%)	-200 (-0.35%)	9,000 (2.59%)	4,000 (1.03%)	10,800 (0.99%)
Juvenile Rearing Total (year-round)	-1,000 (-0.42%)	-2,000 (-0.77%)	500 (0.66%)	6,000 (1.94%)	-4,000 (-1.21%)	-500 (-0.04%)
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	1,000 (0.34%)	-1,000 (-0.34%)	1,000 (0.95%)	10,000 (2.07%)	-11,000 (-2.74%)	0 (0%)
Juvenile Rearing Summer Cold Water Program and Fall Flows (May 1–Oct 31)	-2,000 (-1.05%)	-3,000 (-1.35%)	-100 (-0.22%)	1,000 (0.72%)	2,000 (0.77%)	-2,100 (-0.25%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

[b] No average daily habitat availability model results are available for the points of interest not shown.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 19% (199 square feet) decrease in effective spawning habitat across POIs in Los Gatos Creek compared with the current baseline (Table 11). Modeled decreases were observed in the early spawning period (late December through early January) with little to no change during the rest of the spawning period (early January through May) when most upstream migration occurs (Moyle et al. 2008) (Figure 9).

Figure 9. Change in Steelhead Effective Spawning Habitat in Los Gatos Creek Compared with the Current Baseline

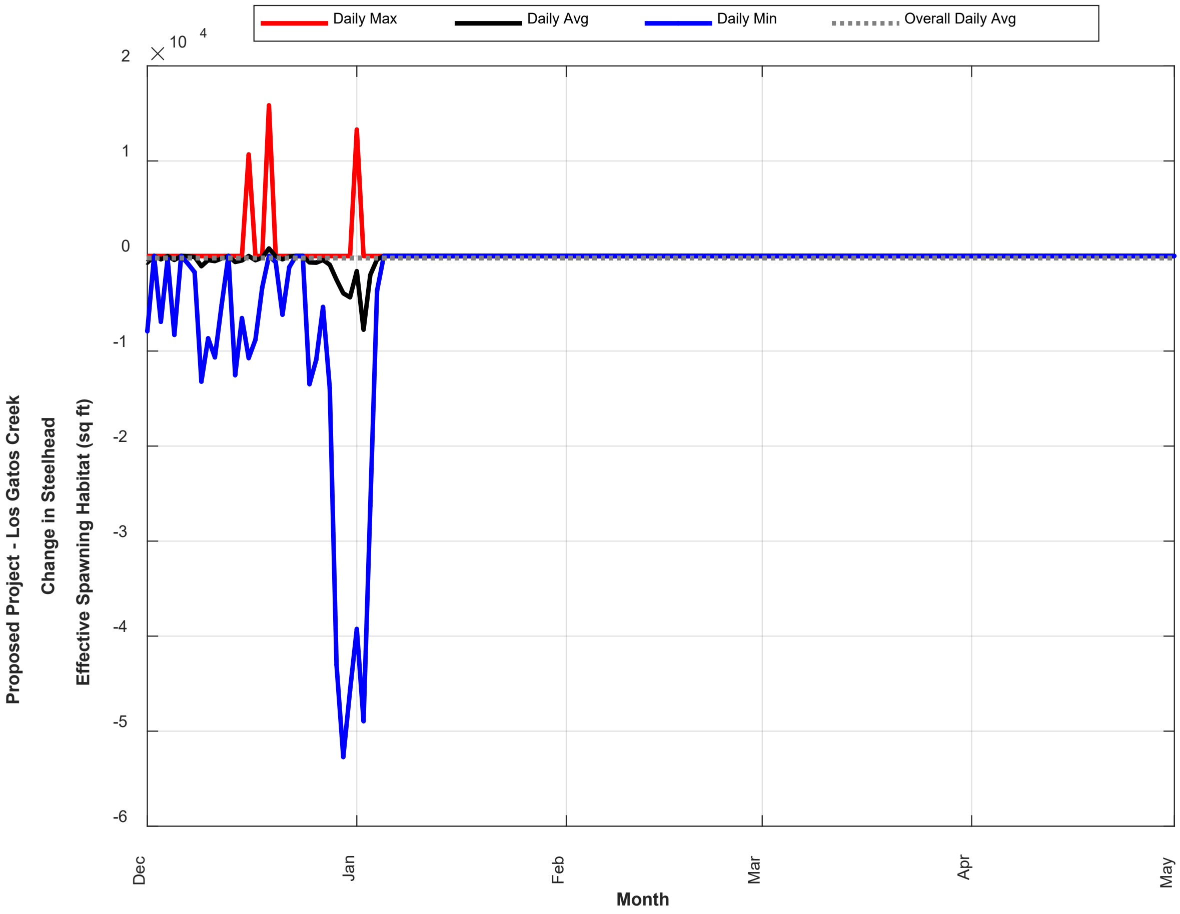


Table 11. Proposed Project Steelhead Habitat Compared with the Current Baseline in Los Gatos Creek

Los Gatos Creek[a]	LOSG 1 River Mile 14.70	LOSG 2 River Mile 18.91	Total
Steelhead Habitat Current Baseline (sq ft)			
Effective Spawning	527	547	1,074
Fry Rearing Total (March 1–May 31)	136,000	246,000	382,000
Fry Rearing Winter Base Flow Operations (March 1–April 30)	133,000	240,000	373,000
Fry Rearing Summer Release Program (May 1–May 31)	142,000	258,000	400,000

Los Gatos Creek[a]	LOSG 1 River Mile 14.70	LOSG 2 River Mile 18.91	Total
Juvenile Rearing Total (year-round)	114,000	217,000	331,000
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	121,000	211,000	332,000
Juvenile Rearing Summer Release Program (May 1–Oct 31)	107,000	222,000	329,000
Steelhead Habitat Proposed Project (sq ft)			
Effective Spawning	408	467	875
Fry Rearing Total (March 1–May 31)	137,000	251,000	388,000
Fry Rearing Winter Base Flow Operations (March 1–April 30)	138,000	253,000	391,000
Fry Rearing Summer Release Program (May 1–May 31)	135,000	248,000	383,000
Juvenile Rearing Total (year-round)	109,000	208,000	317,000
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	116,000	198,000	314,000
Juvenile Rearing Summer Release Program (May 1–Oct 31)	102,000	217,000	319,000
Change in Habitat (sq ft)			
Effective Spawning	-119 (-22.58%)	-80 (-14.63%)	-199 (-18.53%)
Fry Rearing Total (March 1–May 31)	1,000 (0.74%)	5,000 (2.03%)	6,000 (1.57%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	5,000 (3.76%)	13,000 (5.42%)	18,000 (4.83%)
Fry Rearing Summer Release Program (May 1–May 31)	-7,000 (-4.93%)	-10,000 (-3.88%)	-17,000 (-4.25%)
Juvenile Rearing Total (year-round)	-5,000 (-4.39%)	-9,000 (-4.15%)	-14,000 (-4.23%)
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	-5,000 (-4.13%)	-13,000 (-6.16%)	-18,000 (-5.42%)
Juvenile Rearing Summer Release Program (May 1–Oct 31)	-5,000 (-4.67%)	-5,000 (-2.25%)	-10,000 (-3.04%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 29% (223 square feet) average increase in the daily effective spawning habitat during the spawning and incubation life-stage period (that is, Dec to May) across POIs in Guadalupe Creek compared with the current baseline (Figure 10; Table 12). Changes in effective spawning habitat under the Proposed Project varied among POIs (Table 12), but the average effective spawning habitat increases at all POIs, except at the downstream-most POI near the confluence with the Guadalupe River (GCRK 1) where there is an average decrease of 28 square feet due to flow decreases in December. There are negligible differences in the average effective spawning habitat at GCRK 1 between the current baseline and the Proposed Project from January to May. In the Guadalupe Creek CWMZ, there would be a 29% (117 square foot) average increase of modeled steelhead effective spawning habitat, with much of the increase in effective spawning habitat occurring during January through mid-March. Increases in effective spawning are likely related to increased wetted area in Guadalupe Creek under the Proposed Project. During the periods when an increase of effective spawning habitat is observed (Figure 10) and assuming increases in effective spawning habitat are discrete continuous areas, an average increase of 223 square feet could potentially accommodate up to 3 additional redds (or 6 spawning pairs) based on an average redd size of 73 square feet (Orcutt et al. 1968). Larger increases in daily average effective spawning habitat at GCRK 4 (that is, the CWMZ) on individual days during late January to late February would potentially accommodate more redds when spawning pairs are likely to arrive in the system in Guadalupe Creek (Valley Water 2019a). While the increase in daily average effective spawning habitat could potentially accommodate additional redds, the increase may create fewer redds due to uneven distribution of the habitat increase amongst the POI reaches and increases potentially not creating discrete areas of 73 square feet of effective spawning habitat.

Figure 10. Change in Steelhead Effective Spawning Habitat in Guadalupe Creek Compared with the Current Baseline

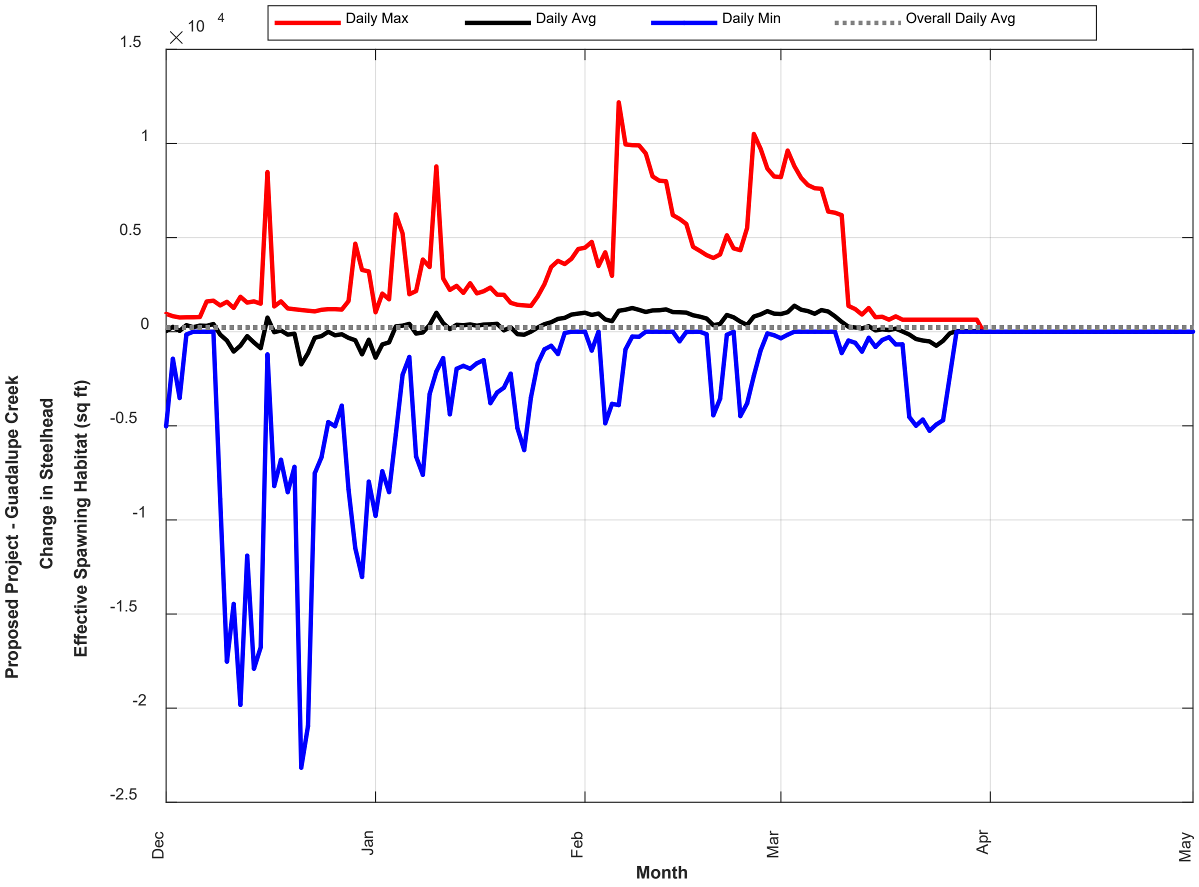


Table 12. Proposed Project Steelhead Habitat Compared with the Current Baseline in Guadalupe Creek

Guadalupe Creek[a]	GCRK 1 River Mile 20.71	GCRK 2 River Mile 21.91	GCRK 3 River Mile 22.54	GCRK 4 River Mile 26.17	Total
Steelhead Habitat Current Baseline (sq ft)					
Effective Spawning	63	254	39	403	759
Fry Rearing Total (March 1–May 31)	17,300	43,600	3,550	2,5700	90,150
Fry Rearing Winter Base Flow Operations (March 1–April 30)	21,100	43,600	3,390	24,800	92,890
Fry Rearing Summer Cold Water Program (May 1–May 31)	9,890	43,700	3,850	27,500	84,940
Juvenile Rearing Total (year-round)	7,700	32,000	2,630	13,700	56,030
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	14,800	36,700	3,000	13,600	68,100
Juvenile Rearing Summer Cold Water Program (May 1–Oct 31)	748	27,400	2,270	13,900	44,318
Steelhead Habitat Proposed Project (sq ft)					
Effective Spawning	36	369	58	520	982
Fry Rearing Total (March 1–May 31)	18,900	43,500	3,330	25,200	90,930
Fry Rearing Winter Base Flow Operations (March 1–April 30)	24,600	50,700	3,490	24,600	103,390
Fry Rearing Summer Cold Water Program (May 1–May 31)	7,880	29,300	3,020	26,300	66,500
Juvenile Rearing Total (year-round)	9,150	27,100	2,330	14,900	53,480
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	17,900	43,900	3,650	20,700	86,150
Juvenile Rearing Summer Cold Water Program (May 1–Oct 31)	526	10,500	1,030	9,120	21,176
Change in Habitat (sq ft)					
Effective Spawning	-28 (-43.83%)	115 (45.28%)	19 (49.22%)	117 (29.03%)	223 (29.43%)
Fry Rearing Total (March 1–May 31)	1,600 (9.25%)	-100 (-0.23%)	-220 (-6.2%)	-500 (-1.95%)	780 (0.87%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	3,500 (16.59%)	7,100 (16.28%)	100 (2.95%)	-200 (-0.81%)	10,500 (11.3%)
Fry Rearing Summer Cold Water Program (May 1–May 31)	-2,010 (-20.32%)	-14,400 (-32.95%)	-830 (-21.56%)	-1,200 (-4.36%)	-18,440 (-21.71%)
Juvenile Rearing Total (year-round)	1,450 (18.83%)	-4,900 (-15.31%)	-300 (-11.41%)	1,200 (8.76%)	-2,550 (-4.55%)

Guadalupe Creek[a]	GCRK 1 River Mile 20.71	GCRK 2 River Mile 21.91	GCRK 3 River Mile 22.54	GCRK 4 River Mile 26.17	Total
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	3,100 (20.95%)	7,200 (19.62%)	650 (21.67%)	7,100 (52.21%)	18,050 (26.51%)
Juvenile Rearing Summer Cold Water Program (May 1–Oct 31)	-222 (-29.68%)	-16,900 (-61.68%)	-1,240 (-54.63%)	-4,780 (-34.39%)	-23,142 (-52.22%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 19% (12 square feet) average decrease in the daily effective spawning habitat during the spawning and incubation life-stage period (that is, Dec to May) across POIs in Alamitos Creek (Figure 11; Table 13). The decrease would primarily occur during December in the reach from ALAM 1 to ALAM 2 (represented by the model results at ALAM 2), with no change in the average effective spawning habitat at ALAM 2 from late December to May under the Proposed Project compared to the current baseline. The modeled daily effective spawning habitat increase between ALAM 2 and ALAM 3 (represented by the model results at ALAM 3) under the Proposed Project compared to the current baseline is relatively small compared an average redd size of 73 square feet (Orcutt et al. 1968). While the increase in daily effective spawning habitat in the reach between ALAM 3 and ALAM 4 (represented by the model results at ALAM 4) averaged across the entire spawning and incubation life-stage period (that is, Dec to May) under the Proposed Project is 21.31% (7 square feet), the frequency modeled daily effective spawning habitat in this reach exceeds 73 square feet for individual days changes under the Proposed Project compared to the current baseline. The average daily effective spawning habitat between ALAM 3 and ALAM 4 exceeds 73 square feet more frequently under the Proposed Project than under the current baseline from December through late January and maintains a similar frequency of exceeding 73 square feet from late January to early February. The average daily effective spawning habitat in this reach exceeds 73 square feet less frequently under the Proposed Project than under the current baseline in early February to late February, but average daily effective spawning habitat maintains a similar frequency of exceeding 73 square feet after late February.

Figure 11. Change in Steelhead Effective Spawning Habitat in Alamitos Creek Compared with the Current Baseline

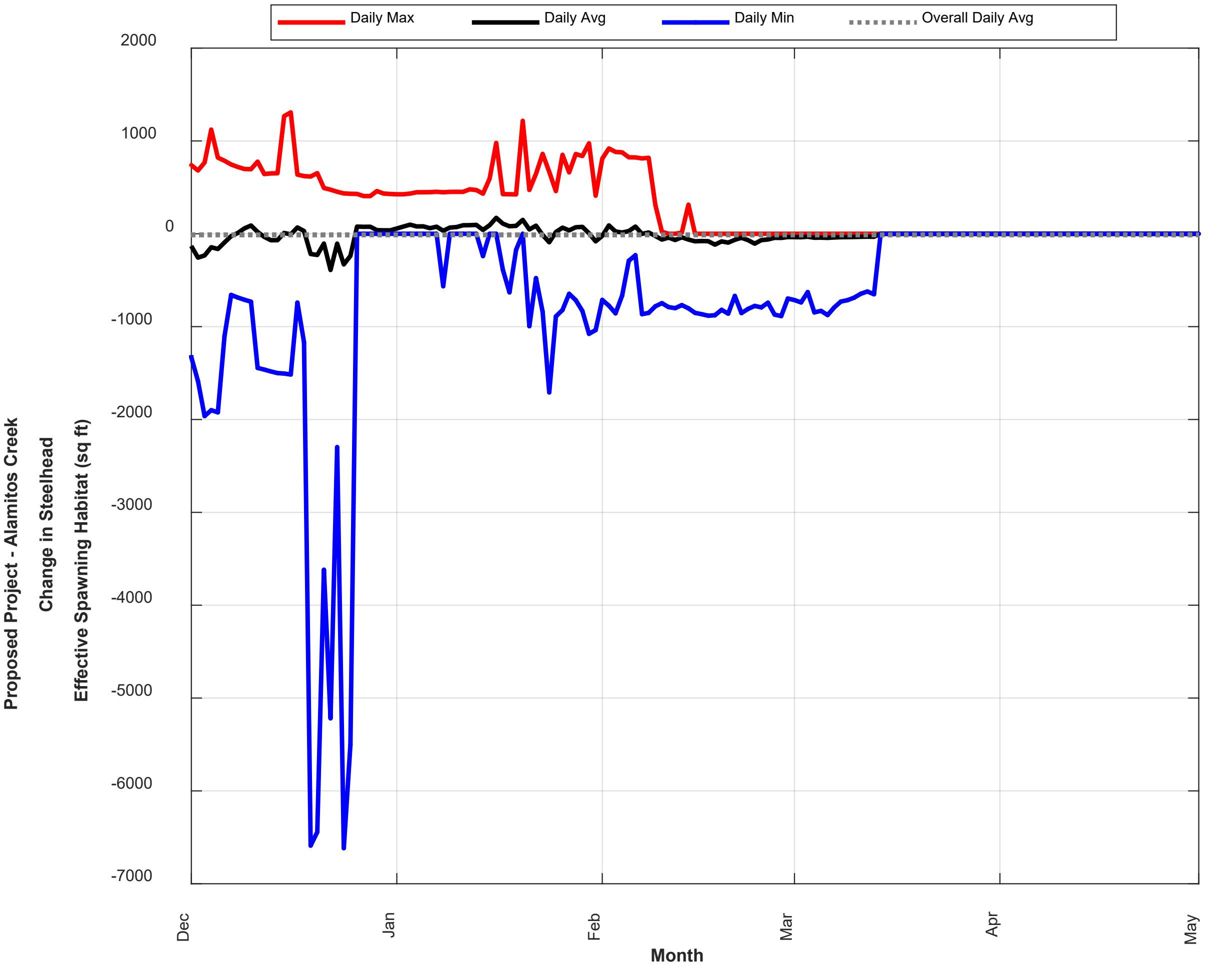


Table 13. Proposed Project Steelhead Habitat Compared with the Current Baseline in Alamitos Creek

Alamitos Creek[a,b]	ALAM 2 River Mile 23.61	ALAM 3 River Mile 24.26	ALAM 4 River Mile 27.89	Total
Steelhead Habitat Current Baseline (sq ft)				
Effective Spawning	31	2	31	64
Fry Rearing Total (March 1–May 31)	56,500	6,940	3,610	67,050
Fry Rearing Winter Base Flow Operations (March 1–April 30)	57,900	7,100	3,350	68,350
Fry Rearing Summer Release Program (May 1–May 31)	53,700	6,620	4,150	64,470

Alamitos Creek[a,b]	ALAM 2 River Mile 23.61	ALAM 3 River Mile 24.26	ALAM 4 River Mile 27.89	Total
Juvenile Rearing Total (year-round)	60,900	5,480	3,070	69,450
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	70,000	6,350	3,000	79,350
Juvenile Rearing Summer Release Program (May 1–Oct 31)	51,900	4,620	3,140	59,660
Steelhead Habitat Proposed Project (sq ft)				
Effective Spawning	7	8	37	52
Fry Rearing Total (March 1–May 31)	57,000	7,370	3,810	68,180
Fry Rearing Winter Base Flow Operations (March 1–April 30)	58,200	7,760	3,650	69,610
Fry Rearing Summer Release Program (May 1–May 31)	54,600	6,610	4,130	65,340
Juvenile Rearing Total (year-round)	60,600	6,040	3,580	70,220
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	67,000	7,550	4,030	78,580
Juvenile Rearing Summer Release Program (May 1–Oct 31)	54,300	4,560	3,130	61,990
Change in Habitat (sq ft)				
Effective Spawning	-24 (-78.39%)	6 (304.06%)	7 (21.31%)	-12 (-18.7%)
Fry Rearing Total (March 1–May 31)	500 (0.88%)	430 (6.2%)	200 (5.54%)	1,130 (1.69%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	300 (0.52%)	660 (9.3%)	300 (8.96%)	1,260 (1.84%)
Fry Rearing Summer Release Program (May 1–May 31)	900 (1.68%)	-10 (-0.15%)	-20 (-0.48%)	870 (1.35%)
Juvenile Rearing Total (year-round)	-300 (-0.49%)	560 (10.22%)	510 (16.61%)	770 (1.11%)
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	-3,000 (-4.29%)	1,200 (18.9%)	1,030 (34.33%)	-770 (-0.97%)
Juvenile Rearing Summer Release Program (May 1–Oct 31)	2,400 (4.62%)	-60 (-1.3%)	-10 (-0.32%)	2,330 (3.91%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

[b] No average daily habitat availability model results are available for the points of interest not shown.

There were no model results for effective spawning habitat for Calero Creek despite known occurrence of spawning and rearing in this tributary (Valley Water unpublished data). Based on the results of the FAHCE WEAP Model for wetted area, the Proposed Project would result in a decrease in effective spawning habitat across POIs in Calero Creek compared with the current baseline (Table 14) due to decreased wetted area (Attachment K.2 – Figure K.2.63 and Figure K.2.64). Decreases would be mostly attributed to changes in wetted area at POI 2 (Attachment K.2 – Figure K.2.64).

Table 14. Proposed Project Steelhead Habitat Compared with the Current Baseline in Calero Creek

Calero Creek[a]	CALE 1 River Mile 24.33	CALE 2 River Mile 27.59	Total
Steelhead Habitat Current Baseline (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (March 1–May 31)	2,650	60,100[c]	62,750[c]
Fry Rearing Winter Base Flow Operations (March 1–April 30)	2,740	46,600[c]	49,340[c]
Fry Rearing Summer Release Program (May 1–May 31)	2,470	86,800	89,270
Juvenile Rearing Total (year-round)	2,550	56,800[c]	59,350[c]
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	2,850	31,400[c]	34,250[c]
Juvenile Rearing Summer Release Program (May 1–Oct 31)	2,250	81,800	84,050
Steelhead Habitat Proposed Project (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (March 1–May 31)	2,530	54,000[c]	56,530[c]
Fry Rearing Winter Base Flow Operations (March 1–April 30)	2,510	35,300[c]	37,810[c]
Fry Rearing Summer Release Program (May 1–May 31)	2,570	90,700	93,270
Juvenile Rearing Total (year-round)	2,360	54,600[c]	56,960[c]
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	2,320	21,900[c]	24,220[c]
Juvenile Rearing Summer Release Program (May 1–Oct 31)	2,400	86,800	89,200
Change in Habitat (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (March 1–May 31)	-120 (-4.53%)	-6,100 (-10.15%)[c]	-6,220 (-9.91%)[c]
Fry Rearing Winter Base Flow Operations (March 1–April 30)	-230 (-8.39%)	-11,300 (-24.25%)[c]	-11,530 (-23.37%)[c]
Fry Rearing Summer Release Program (May 1–May 31)	100 (4.05%)	3,900 (4.49%)	4,000 (4.48%)

Calero Creek[a]	CALE 1 River Mile 24.33	CALE 2 River Mile 27.59	Total
Juvenile Rearing Total (year-round)	-190 (-7.45%)	-2,200 (-3.87%)[c]	-2,390 (-4.03%) [c]
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	-530 (-18.6%)	-9,500 (-30.25%)[c]	-10,030 (-29.28%)[c]
Juvenile Rearing Summer Release Program (May 1–Oct 31)	150 (6.67%)	5,000 (6.11%)	5,150 (6.13%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

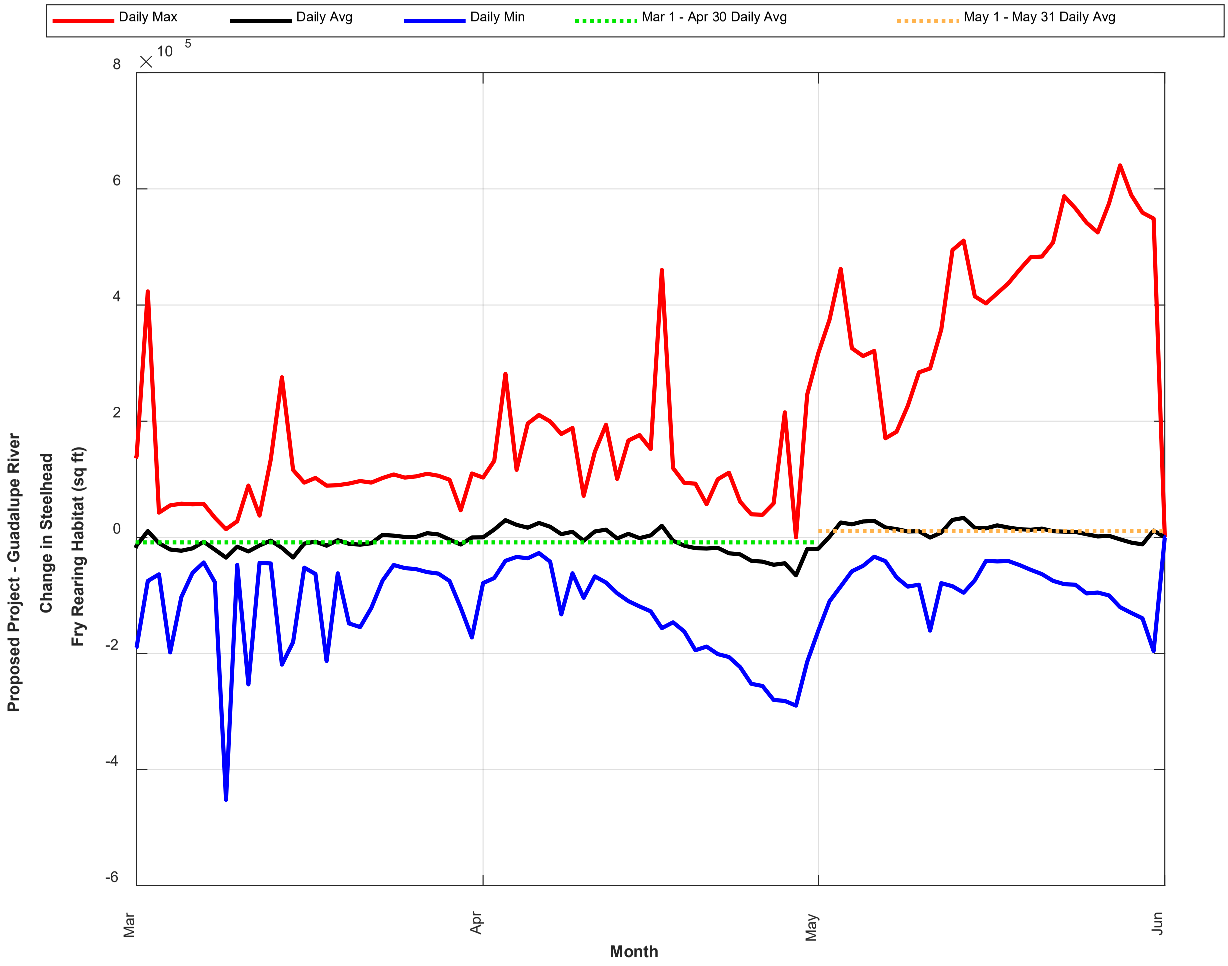
[b] Effective spawning model results were not available in Calero Creek because no substrate suitable for spawning was recorded by the subsample habitat survey of Calero Creek input into the FAHCE WEAP Model. Subsequent surveys indicate there is substrate suitable for spawning in Calero Creek (Valley Water 2019a, 2020).

[c] Average daily fry rearing and juvenile rearing habitat availability model results do not quantify conditions when winter cover was considered in the habitat estimate (December 1 through March 31 for steelhead) since no winter cover was recorded by the subsample habitat survey of the CALE 2 reach of Calero Creek (that is, the reach between CALE 1 and CALE 2) input into the FAHCE WEAP Model. Subsequent surveys indicate there is winter cover available in this reach of Calero Creek (Valley Water 2019a, 2020).

Fry Rearing Habitat

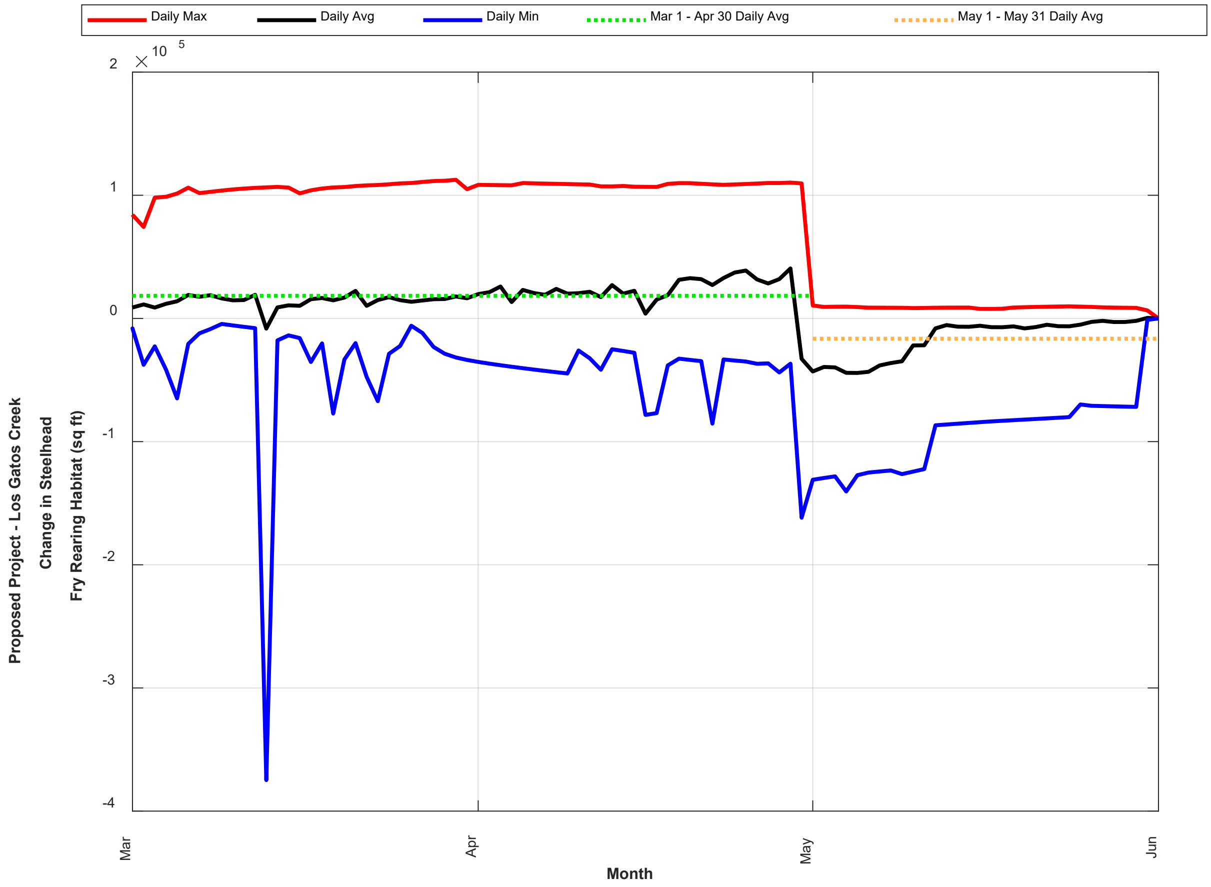
Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 0.3% (3,100 square feet) increase in suitable fry rearing habitat across POIs in the Guadalupe River compared with the current baseline (Figure 12; Table 10). Less than 1.5% increases or decreases in modeled fry rearing habitat is consistently observed across POIs in the Guadalupe River (Table 10). Overall, fry rearing habitat is abundant in the Guadalupe River under the current baseline (1,186,800 square feet).

Figure 12. Change in Steelhead Fry Rearing Habitat in the Guadalupe River Compared with the Current Baseline



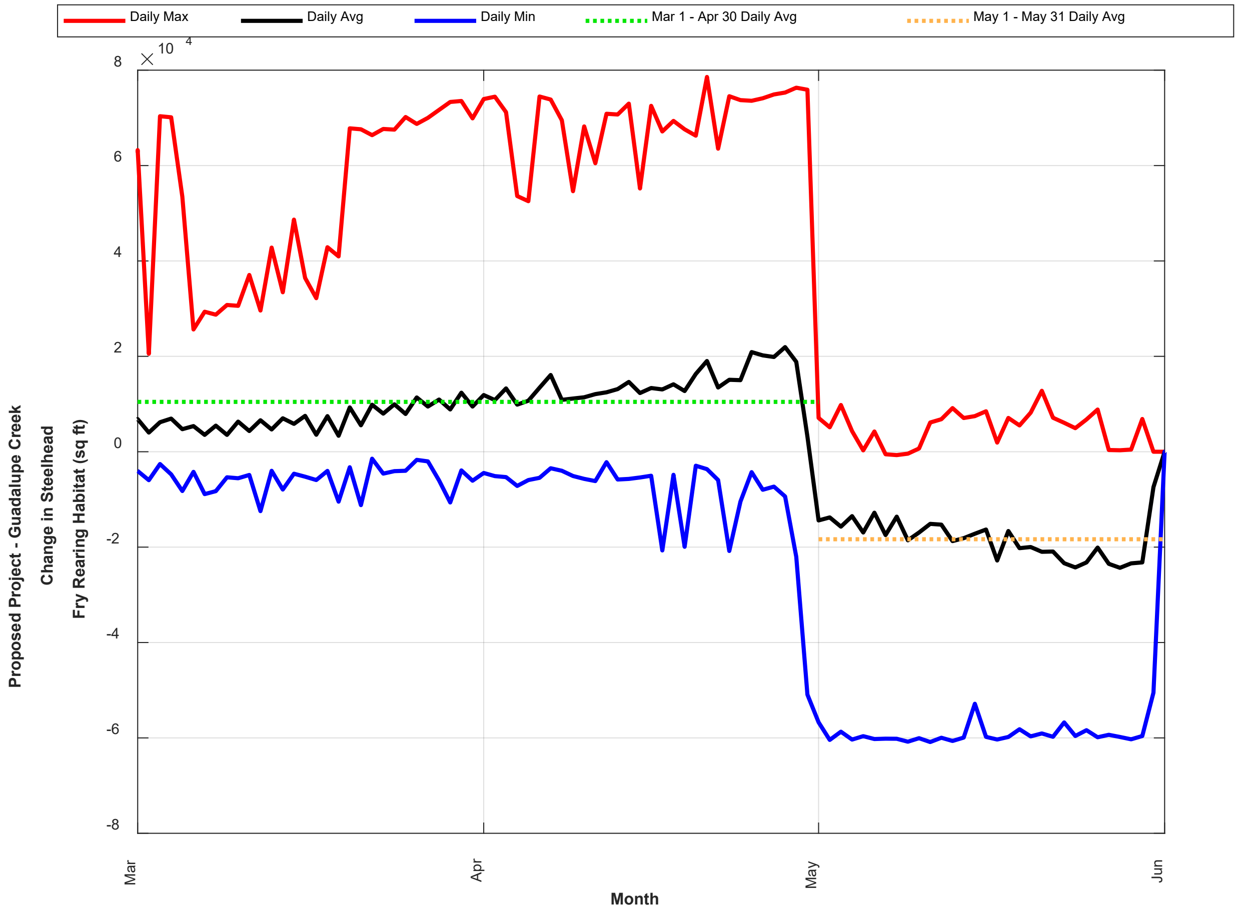
Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 2% (6,000 square feet) average increase across POIs in Los Gatos Creek compared with the current baseline (Figure 13; Table 11), although there would be variability over time (Figure 13). During Winter Base Flow Operations from March to April, fry rearing habitat increased by 5%, while fry rearing habitat decreased by 4% during the Summer Release Program in May likely because of decreased wetted area and elevated water temperatures (greater than 65°F). Los Gatos Creek contains a large amount (382,000 square feet) of fry rearing habitat under the current baseline.

Figure 13. Change in Steelhead Fry Rearing Habitat in Los Gatos Creek Compared with the Current Baseline



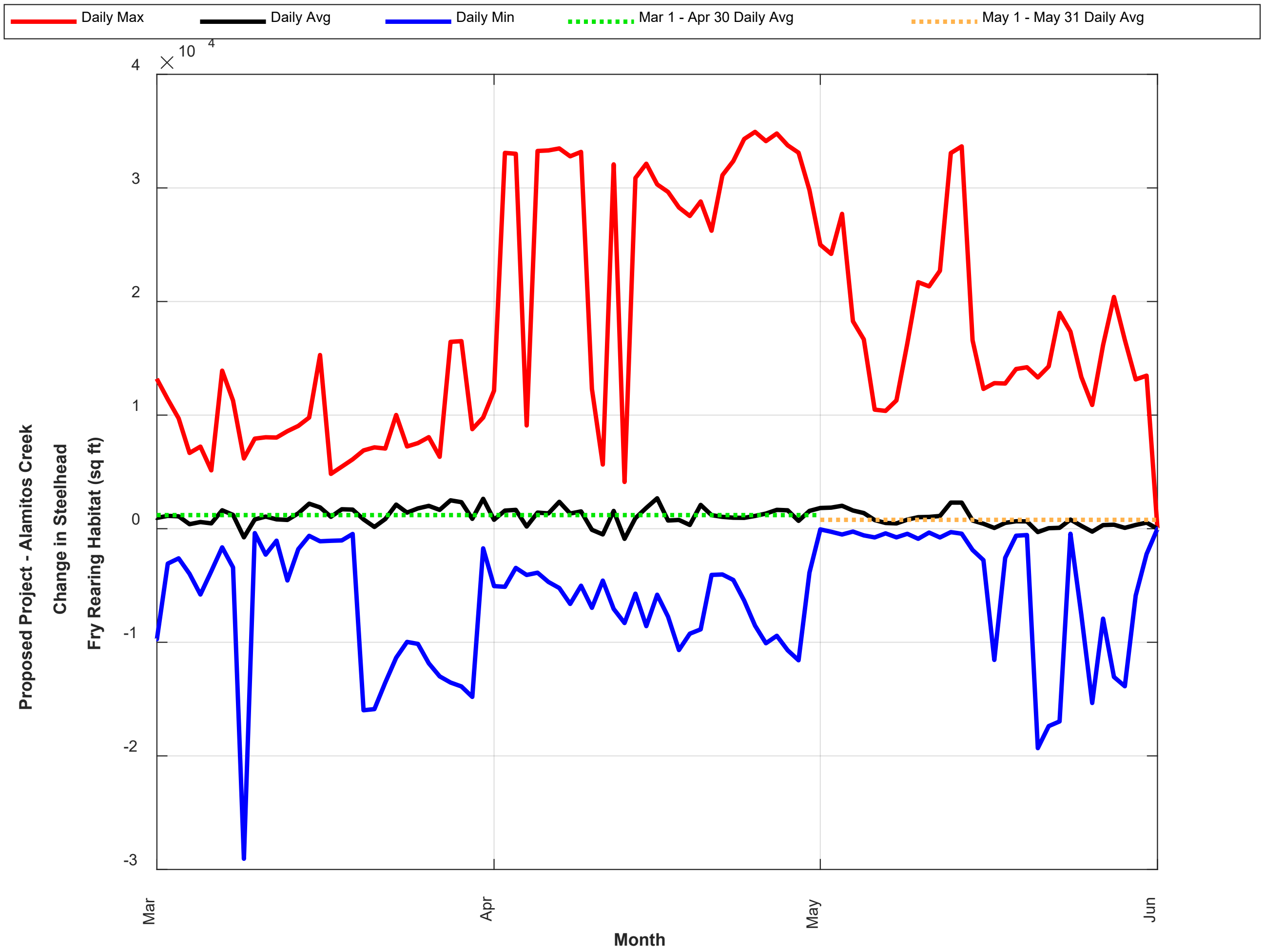
Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 0.9% (780 square feet) increase in suitable fry rearing habitat across POIs in Guadalupe Creek compared with the current baseline (Table 12), although there was variability over time. During Winter Base Flow Operations from March to April, modeled fry rearing habitat increased by 11% (10,500 square feet). Modeled fry rearing habitat decreased by 22% (18,440 square feet) during the Summer Cold Water Program in May (Figure 14; Table 12). Given the complexity of the model and HAIs, it is sometimes difficult to tease out the specific reason, but it is likely because of reduced wetted area. In the Guadalupe Creek CWMZ, fry rearing habitat decreased by a total of 2% (500 square feet), with a less than 1% (200 square feet) decrease observed during the Winter Base Flow Operations and a larger decrease of 4% (1,200 square feet) observed during the Summer Cold Water Program.

Figure 14. Change in Steelhead Fry Rearing Habitat in Guadalupe Creek



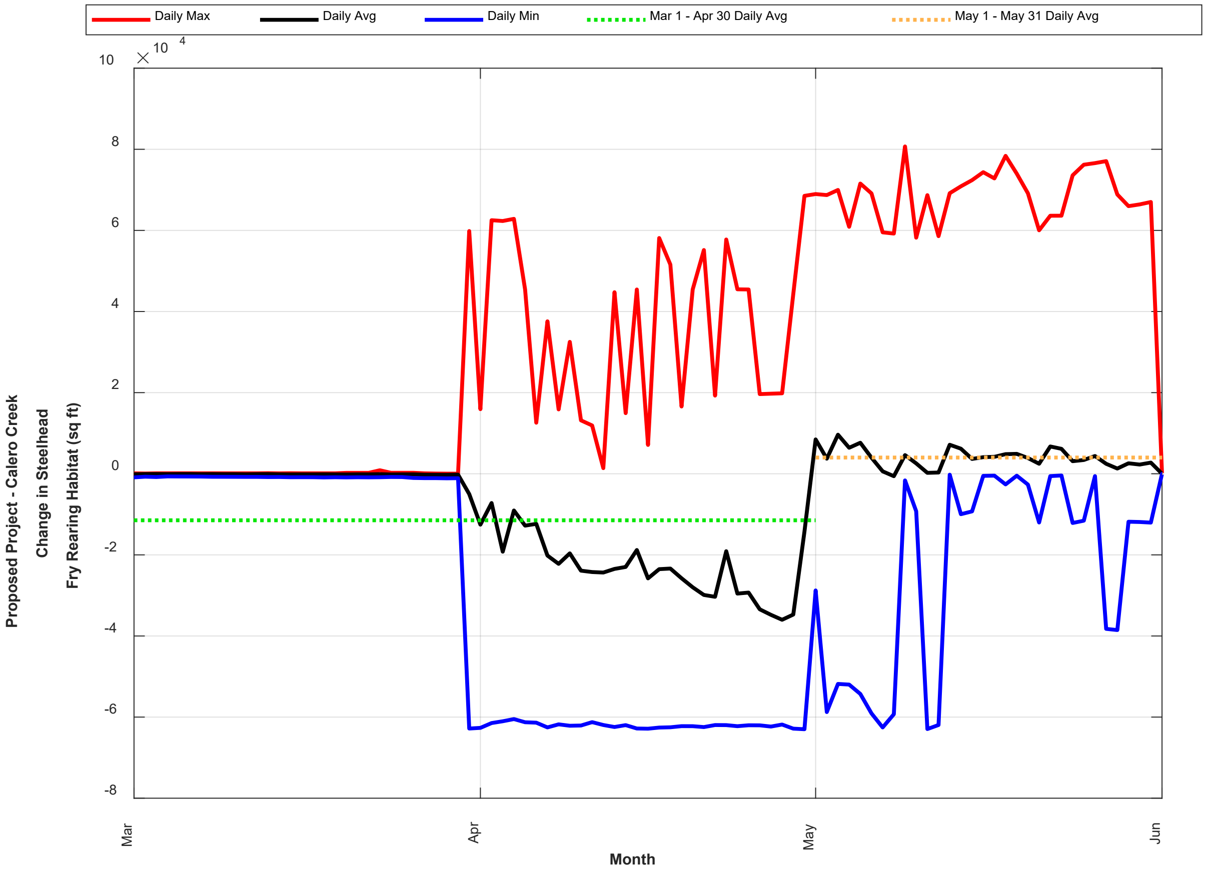
Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 2% (1,130 square feet) increase in suitable fry rearing habitat across POIs in Alamitos Creek compared with the current baseline, and there was little effect of the Summer Release Program on fry rearing habitat (Figure 15; Table 13). Alamitos Creek has a large amount (67,050 square feet) of fry rearing habitat under the current baseline.

Figure 15. Change in Steelhead Fry Rearing Habitat in Alamitos Creek Compared with the Current Baseline



Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 10% (6,220 square feet) decrease in fry rearing habitat across POIs in Calero Creek compared with the current baseline (Table 12), although there was variability over time. During the period when fry rearing habitat overlaps with Winter Base Flow Operations from March 1 to April 30, fry rearing habitat decreased on average by 23% (11,530 square feet) according to the FAHCE WEAP Model results. However, this average decrease during Winter Base Flow Operations does not fully characterize the change in fry rearing habitat during March. Habitat survey data input into the model indicated there was zero winter cover in the reach associated with the CALE 2 POI (that is, CALE 1 to CALE 2) and caused fry rearing habitat to be zero in March under all scenarios, but subsequent habitat surveys indicated there was winter cover (Valley Water 2019a, 2020). Variations in wetted area at CALE 2 in March under the Proposed Project compared to the current baseline (Attachment K.2 – Figures K.2.64) suggest that there would be a decrease in fry rearing habitat during the time when the model output predicted zero habitat (March to April). The fry rearing habitat decrease in March would likely be a smaller relative magnitude than in April since the decrease in wetted area in March is less than in April at CALE 2. While fry rearing habitat decreased in March through April, fry rearing habitat increased by 5% (4,000 square feet) during the Summer Cold Water Program in May (Figure 16; Table 12), likely because of increased wetted area.

Figure 16. Change in Steelhead Fry Rearing Habitat in Calero Creek[a]



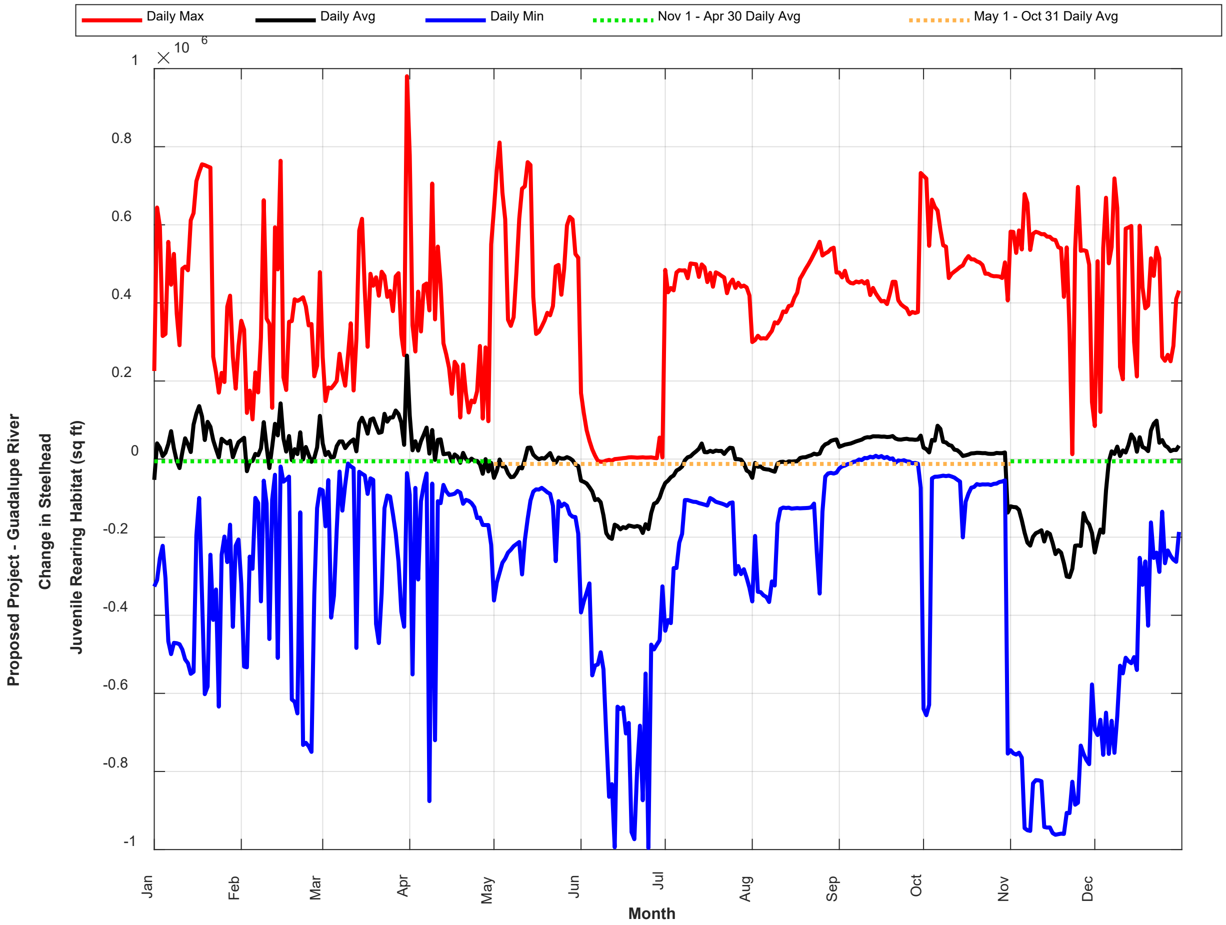
[a] Calero Creek habitat survey results in the reach between CALE 1 and CALE 2 input into the FAHCE WEAP Model did not record any winter cover, so fry and juvenile rearing habitat model results in this reach were zero during the period when winter cover is considered in the habitat estimate (that is, December 1 through March 31 for steelhead; January 1 through March 31 for Chinook salmon). Subsequent habitat surveys identified winter cover between CALE 1 and CALE 2 (Valley Water 2019a, 2020).

There would be little change to fry rearing habitat in the Guadalupe River portion of the study area at most locations with the Proposed Project compared with the current baseline, with the exception being a 6,000 square feet increase in Los Gatos Creek and a 6,220 square feet decrease in Calero Creek.

Juvenile Rearing Habitat

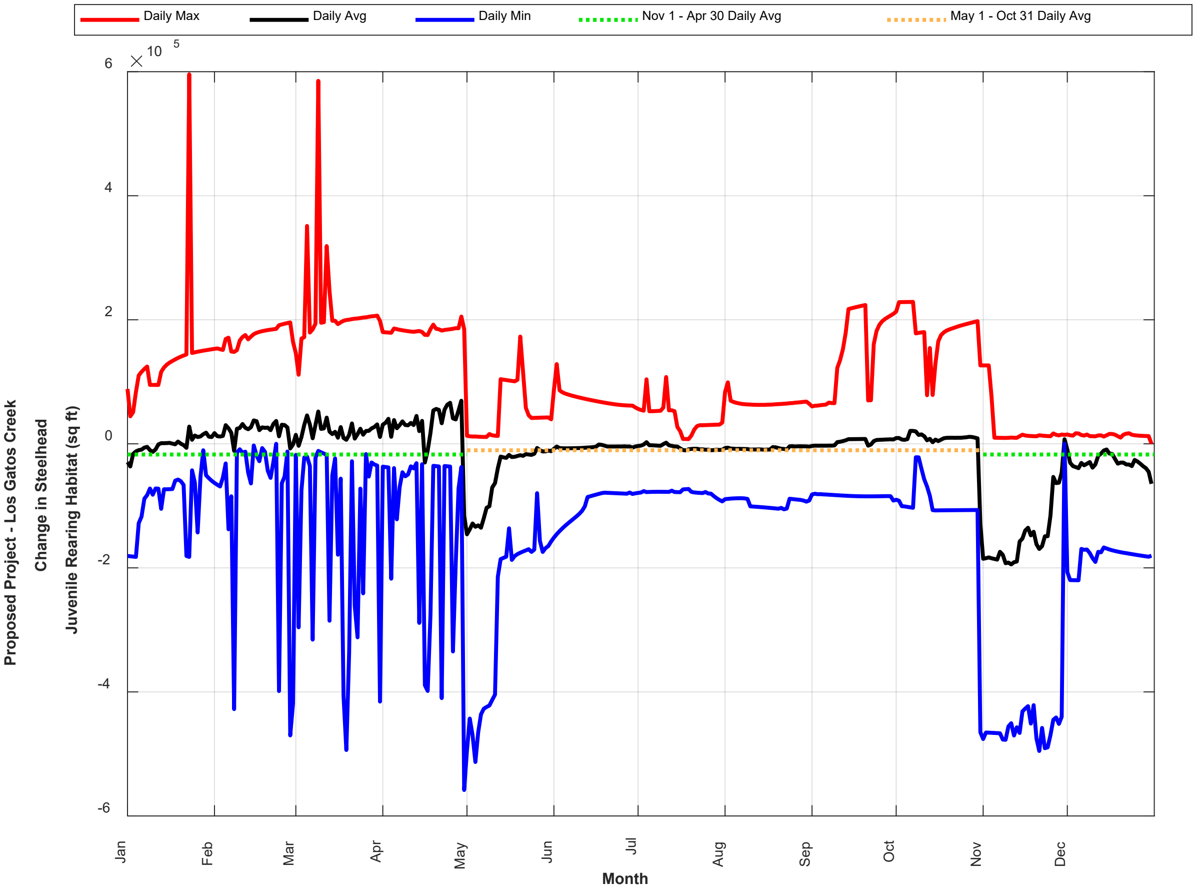
Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 0.04% (500 square feet) decrease in suitable juvenile rearing habitat across POIs in the Guadalupe River compared with the current baseline (Table 10). Decreases in juvenile rearing habitat were apparent in June and November (Figure 17), likely a result of reduced wetted area in both months, as well as elevated water temperatures in June (Attachment K.2 – Figures K.2.15, K.2.16, K.2.17, and K.2.18) in the Guadalupe River.

Figure 17. Change in Steelhead Juvenile Rearing Habitat in the Guadalupe River



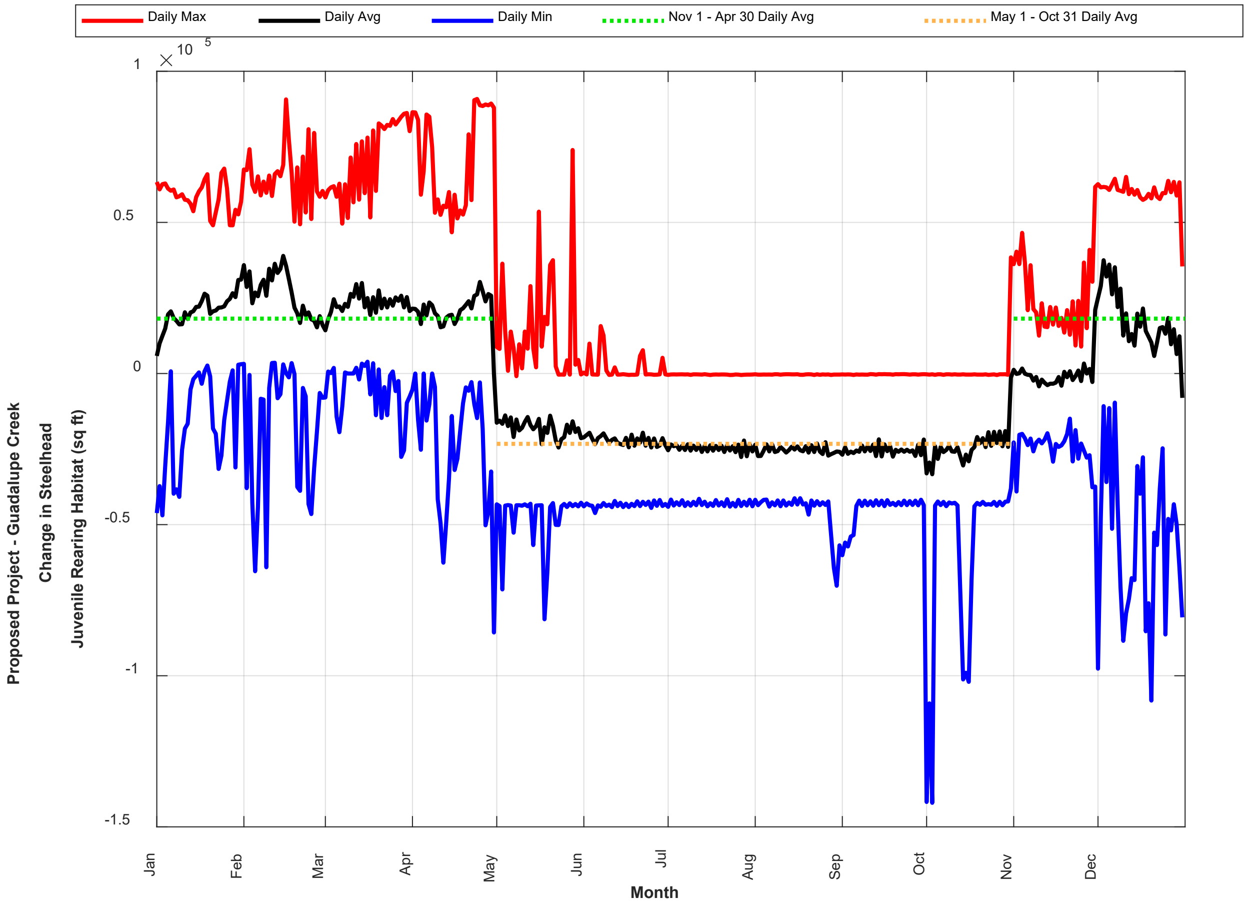
Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 4% (14,000 square feet) decrease in juvenile rearing habitat across POIs in Los Gatos Creek compared with the current baseline (Table 11) with little to no change under the Proposed Project throughout the juvenile rearing period except May and November (Figure 18) where larger decreases would occur (Attachment K.2 – Figures K.2.27, K.2.28, K.2.29, and K.2.30). Los Gatos Creek contains a large amount (331,000 square feet) of juvenile rearing habitat under the current baseline.

Figure 18. Change in Steelhead Juvenile Rearing Habitat in Los Gatos Creek



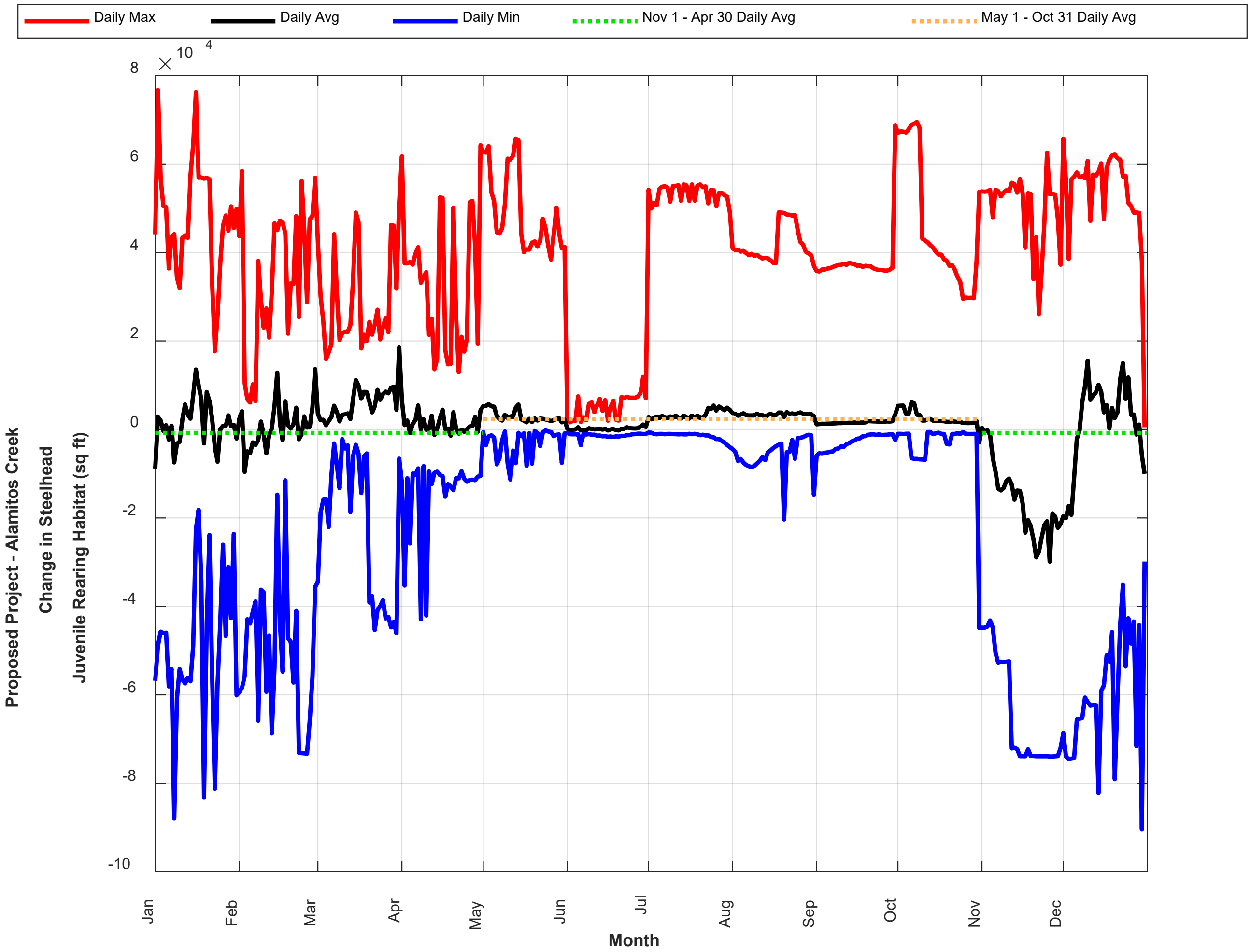
Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 5% (2,550 square feet) decrease in juvenile rearing habitat across POIs in Guadalupe Creek compared with the current baseline (Table 12). The trends in juvenile rearing habitat over time revealed 27% (18,050 square feet) increase under the Proposed Project during Winter Base Flow Operations and a 52% (23,142 square feet) decrease during Summer Cold Water Program releases (Figure 19; Table 12). In the Guadalupe Creek CWMZ, juvenile rearing habitat increased by a 9% (1,200 square feet), with a 52% (7,100 square feet) increase observed during the Winter Base Flow Operations and a decrease of 34% (4,780 square feet) observed during the Summer Cold Water Program. The decreases during the Summer Cold Water Program in the CWMZ are a result of a decrease in wetted area, while the decreases downstream of the CWMZ are the result of reduced wetted area and above metabolically optimal water temperatures for steelhead (that is, 65°F) (Attachment K.2 – Figures K.2.39, K.2.40, K.2.41, and K.2.42). Despite the large proportional changes across operational periods, the overall change is only 5% (2,550 square feet) across the entire juvenile rearing period, and the season differences balance out in Guadalupe Creek.

Figure 19. Change in Steelhead Juvenile Rearing Habitat in Guadalupe Creek Compared with the Current Baseline



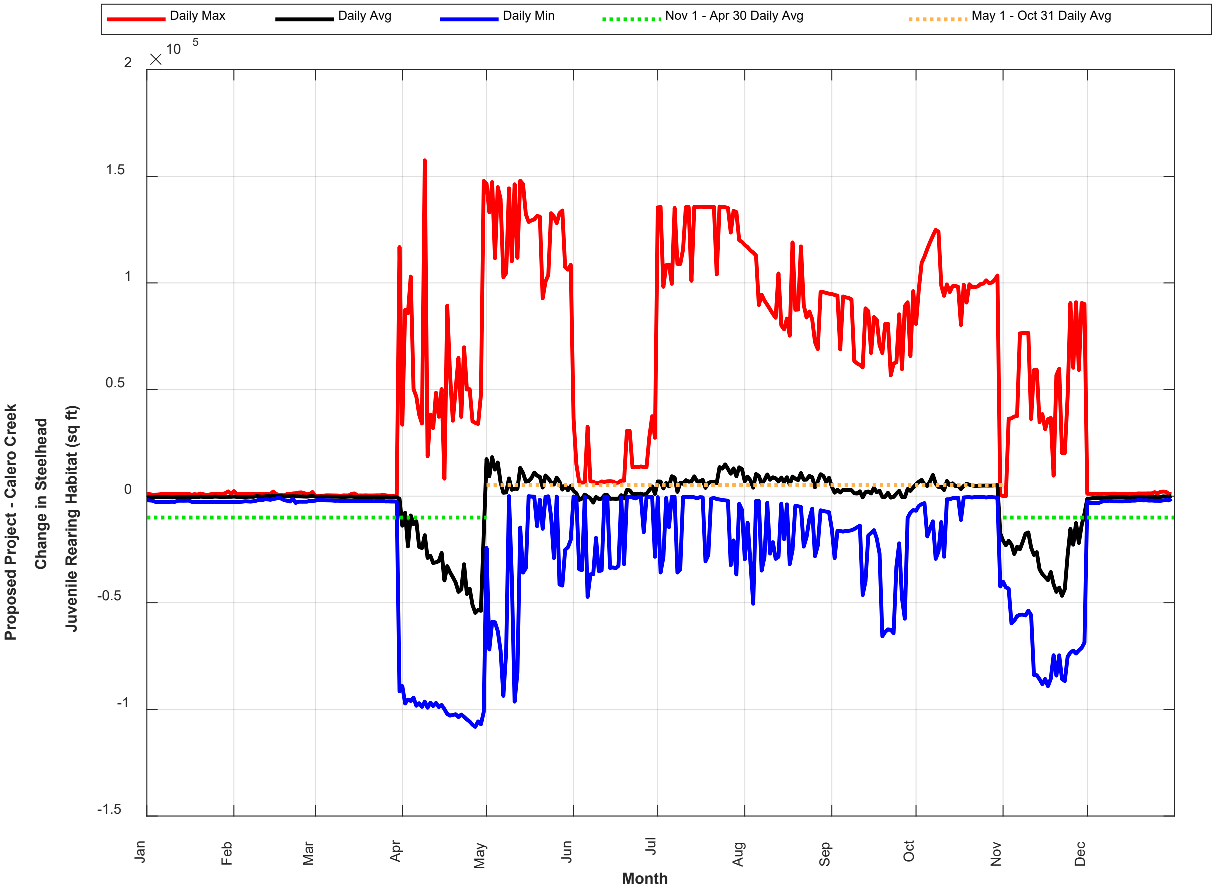
Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 1% (770 square feet) increase across POIs compared with the current baseline in Alamitos Creek (Table 13). An abrupt decrease would occur in November under the Proposed Project (Figure 20) because of decreased wetted area (Attachment K.2 – Figures K.2.51 and K.2.52).

Figure 20. Change in Steelhead Juvenile Rearing Habitat in Alamitos Creek



Based on the results of the FAHCE WEAP Model, there would be a 4% (2,390 square feet) decrease in juvenile rearing habitat in Calero Creek compared with the current baseline. A 29% (10,030 square feet) average decrease would occur during Winter Base Flow Operations releases attributable to decreased wetted area, and a 6% (5,150 square feet) average increase during the Summer Cold Water Program releases attributable to increased wetted area under the Proposed Project. As described for fry rearing, the average decrease during Winter Base Flow Operations does not completely characterize the change in juvenile rearing habitat during this period because habitat surveys indicated there was zero winter cover in the reach associated with the CALE 2 POI (that is, CALE 1 to CALE 2) and caused juvenile rearing habitat to be zero in this reach during December 1 to March 31 under all scenarios. Subsequent habitat surveys indicated there was winter cover (Valley Water 2019a, 2020), so juvenile rearing habitat would not actually be zero in this reach during the winter. Variations in wetted area at CALE 2 under the Proposed Project compared to the current baseline (Attachment K.2 – Figures K.2.63 and K.2.64) suggest there would be a slight increase or decrease in the average change in juvenile rearing habitat during Winter Base Flow Operations estimated by the model results since wetted area decreases in December to mid/late-January, increases in late-January through February, and decreases in March.

Figure 21. Change in Steelhead Juvenile Rearing Habitat in Calero Creek[a]



[a] Calero Creek habitat survey results in the reach between CALE 1 and CALE 2 input into the FAHCE WEAP Model did not record any winter cover, so fry and juvenile rearing habitat model results in this reach were zero during the period when winter cover is considered in the habitat estimate (that is, December 1 through March 31 for steelhead; January 1 through March 31 for Chinook salmon). Subsequent habitat surveys identified winter cover between CALE 1 and CALE 2 (Valley Water 2019a, 2020).

Increases in juvenile rearing habitat were observed in most locations during Winter Base Flow Operations from March to April, but there were decreases in juvenile rearing habitat observed at locations during the Summer Cold Water Program or Summer Release Program because of reduced wetted area and/or elevated water temperatures. Calero Creek was the exception and juvenile rearing habitat would decrease in the winter and increase in the summer.

Migration Conditions

Adult Upstream Passage

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 3% (2 days per year) average increase to adult upstream passage at sites in the Guadalupe River portion of the study area. In the upstream reach (GUAD 6 and GUAD 7) upstream passage increased by 12% (9 days per year) on average (Figure 22; Table 15).

Figure 22. Change in Average Adult Steelhead Upstream Passage Days in the Guadalupe River Compared with the Current Baseline

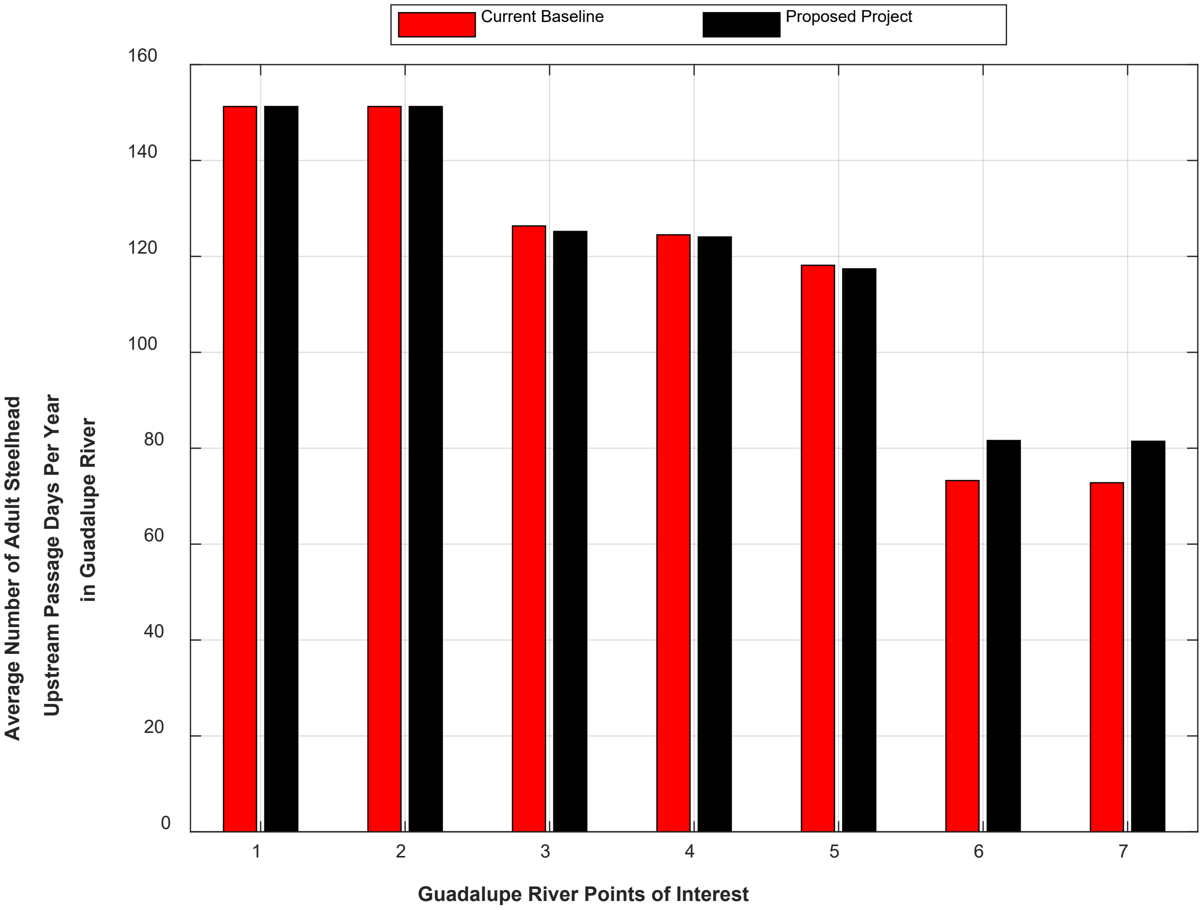


Table 15. Proposed Project Adult Steelhead Upstream Passage Compared with the Current Baseline in the Guadalupe River

Parameter	GUAD 1	GUAD 2	GUAD 3	GUAD 4	GUAD 5	GUAD 6	GUAD 7
Current Baseline (days)[a]							
Total Adult Upstream Passage (1991–2010)	3,025	3,025	2,527	2,490	2,363	1,465	1,456
Average Adult Upstream Passage Per Year	151	151	126	125	118	73	73
Proposed Project (days)[a]							
Total Adult Upstream Passage (1991–2010)	3,025	3,025	2,504	2,481	2,348	1,632	1,629
Average Adult Upstream Passage Per Year	151	151	125	124	117	82	81

Parameter	GUAD 1	GUAD 2	GUAD 3	GUAD 4	GUAD 5	GUAD 6	GUAD 7
Difference (days)							
Total Adult Upstream Passage (1991–2010)	0.00	0.00	-23.00	-9.00	-15.00	167.00	173.00
Average Adult Upstream Passage Per Year	0.00	0.00	-1.15	-0.45	-0.75	8.35	8.65
Difference (%)							
Total Adult Upstream Passage (1991–2010)	0.00	0.00	-0.91	-0.36	-0.63	11.40	11.88
Average Adult Upstream Passage Per Year	0.00	0.00	-0.91	-0.36	-0.63	11.40	11.88

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 4% (2 days per year) average decrease to adult upstream passage in Los Gatos Creek compared with the current baseline (Figure 23; Table 16). Despite a 2 day per year decrease in Los Gatos Creek, Los Gatos Creek would maintain a total of 44 days per year of passage opportunities.

Figure 23. Change in Average Adult Steelhead Upstream Passage Days in Los Gatos Creek Compared with the Current Baseline

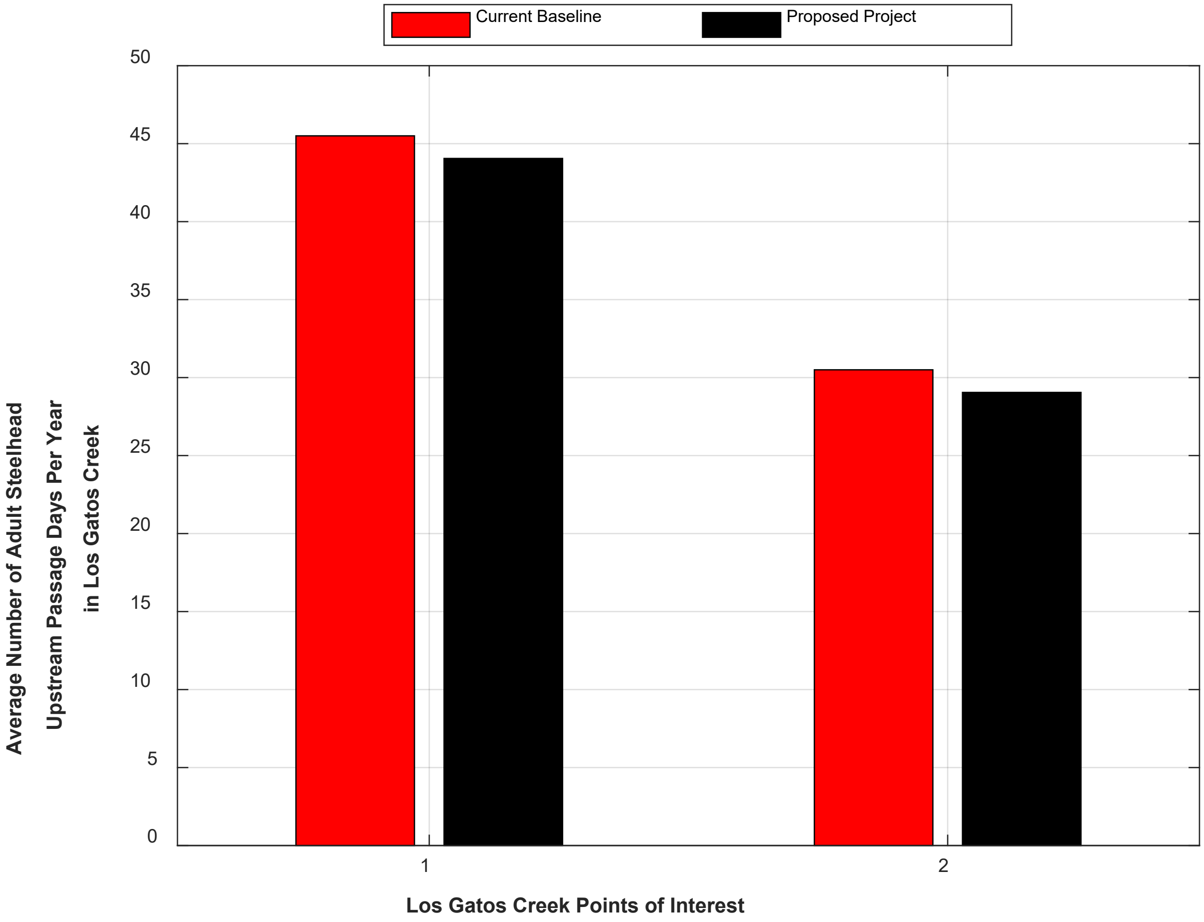


Table 16. Proposed Project Adult Steelhead Upstream Passage Compared with the Current Baseline in Los Gatos Creek

Parameter	LOSG 1	LOSG 2
Current Baseline (days)[a]		
Total Adult Upstream Passage (1991–2010)	910	610
Average Adult Upstream Passage Per Year	46	31
Proposed Project (days)[a]		
Total Adult Upstream Passage (1991–2010)	881	581
Average Adult Upstream Passage Per Year	44	29
Difference (days)		
Total Adult Upstream Passage (1991–2010)	-29.00	-29.00
Average Adult Upstream Passage Per Year	-1.45	-1.45

Parameter	LOSG 1	LOSG 2
Difference (%)		
Total Adult Upstream Passage (1991–2010)	-3.19	-4.75
Average Adult Upstream Passage Per Year	-3.19	-4.75

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 3% (1 day per year) average increase to adult upstream passage in Guadalupe Creek compared with the current baseline (Figure 24; Table 17).

Figure 24. Change in Average Adult Steelhead Upstream Passage Days in Guadalupe Creek

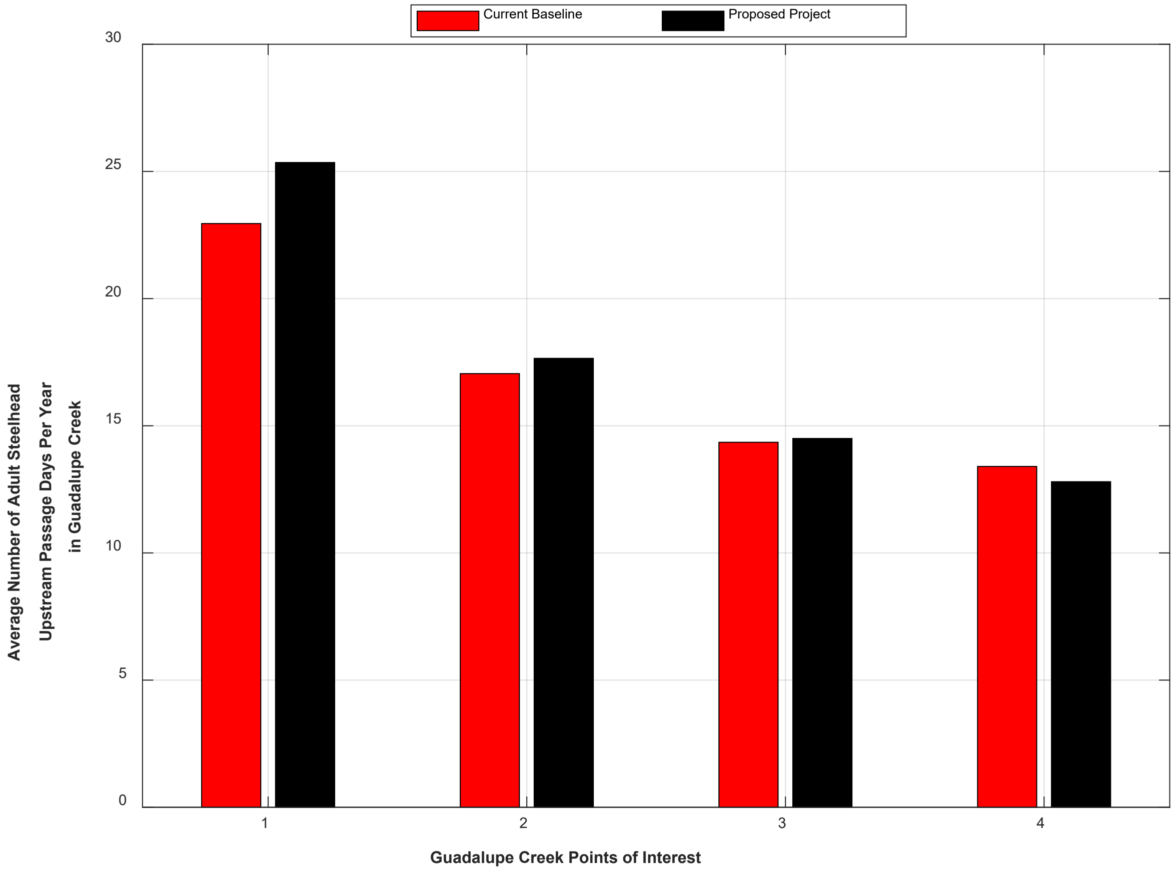


Table 17. Proposed Project Adult Steelhead Upstream Passage Compared with the Current Baseline in Guadalupe Creek

Parameter	GCRK 1	GCRK 2	GCRK 3	GCRK 4
Current Baseline (days)[a]				
Total Adult Upstream Passage (1991–2010)	459	341	287	268
Average Adult Upstream Passage Per Year	23	17	14	13
Proposed Project (days)[a]				
Total Adult Upstream Passage (1991–2010)	507	353	290	256
Average Adult Upstream Passage Per Year	25	18	15	13
Difference (days)				
Total Adult Upstream Passage (1991–2010)	48.00	12.00	3.00	-12.00
Average Adult Upstream Passage Per Year	2.40	0.60	0.15	-0.60
Difference (%)				
Total Adult Upstream Passage (1991–2010)	10.46	3.52	1.05	-4.48
Average Adult Upstream Passage Per Year	10.46	3.52	1.05	-4.48

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in increases to adult upstream passage in Alamitos Creek by an average of 5% (3 days per year) compared with the current baseline (Figure 25; Table 18). Upstream migration would improve by 12% (9 days per year) on average at the downstream site (ALM 1) (Figure 25; Table 18). Therefore, the Proposed Project would increase adult upstream passage opportunities compared with the current baseline conditions in Alamitos Creek.

Figure 25. Change in Average Adult Steelhead Upstream Passage Days in Alamitos Creek Compared with the Current Baseline

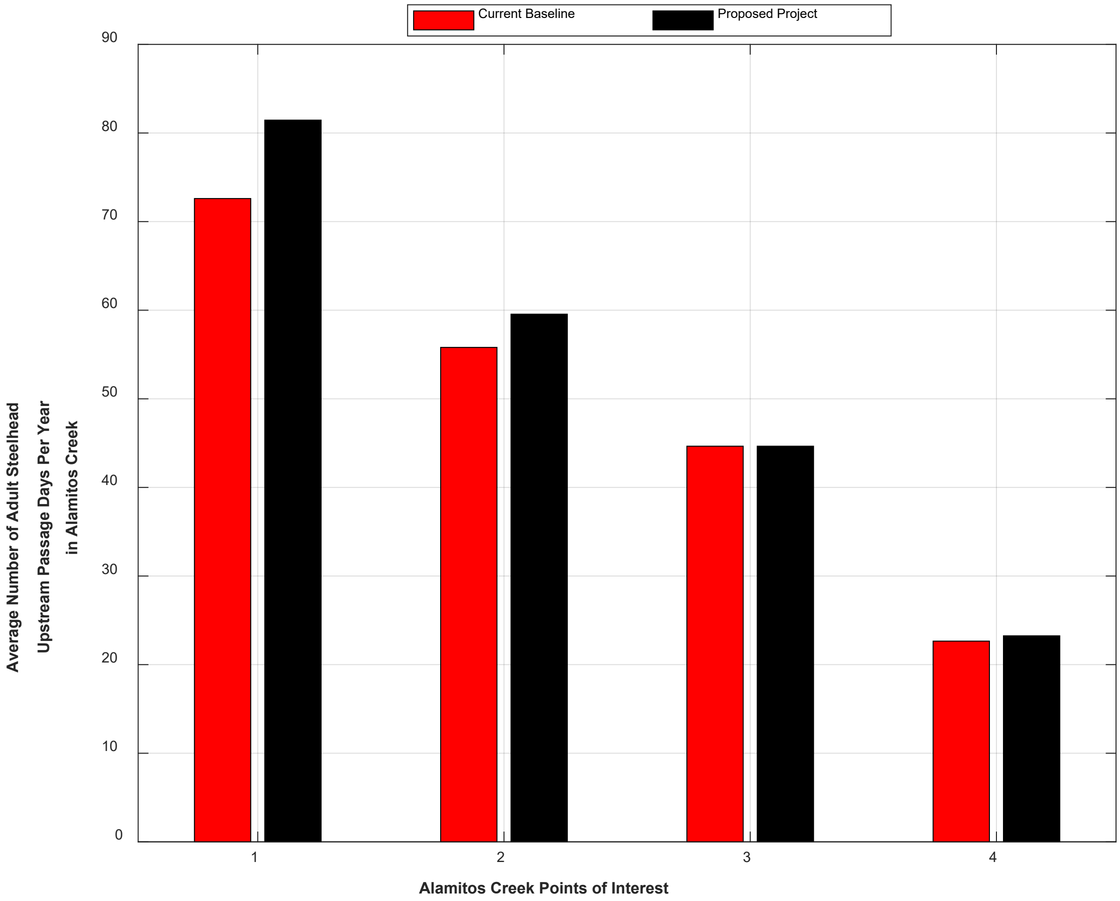


Table 18. Proposed Project Adult Steelhead Upstream Passage Compared with the Current Baseline in Alamitos Creek

Parameter	ALAM 1	ALAM 2	ALAM 3	ALAM 4
Current Baseline (days)[a]				
Total Adult Upstream Passage (1991–2010)	1,452	1,116	893	453
Average Adult Upstream Passage Per Year	73	56	45	23
Proposed Project (days)[a]				
Total Adult Upstream Passage (1991–2010)	1,629	1,191	893	465
Average Adult Upstream Passage Per Year	81	60	45	23
Difference (days)				
Total Adult Upstream Passage (1991–2010)	177.00	75.00	0.00	12.00
Average Adult Upstream Passage Per Year	8.85	3.75	0.00	0.60

Parameter	ALAM 1	ALAM 2	ALAM 3	ALAM 4
Difference (%)				
Total Adult Upstream Passage (1991–2010)	12.19	6.72	0.00	2.65
Average Adult Upstream Passage Per Year	12.19	6.72	0.00	2.65

[a] Rounded to whole days

The Proposed Project would result in 7% (2 days per year) average increase of adult upstream passage in Calero Creek compared with the current baseline (Figure 26; Table 19).

Figure 26. Change in Average Adult Steelhead Upstream Passage Days in Calero Creek

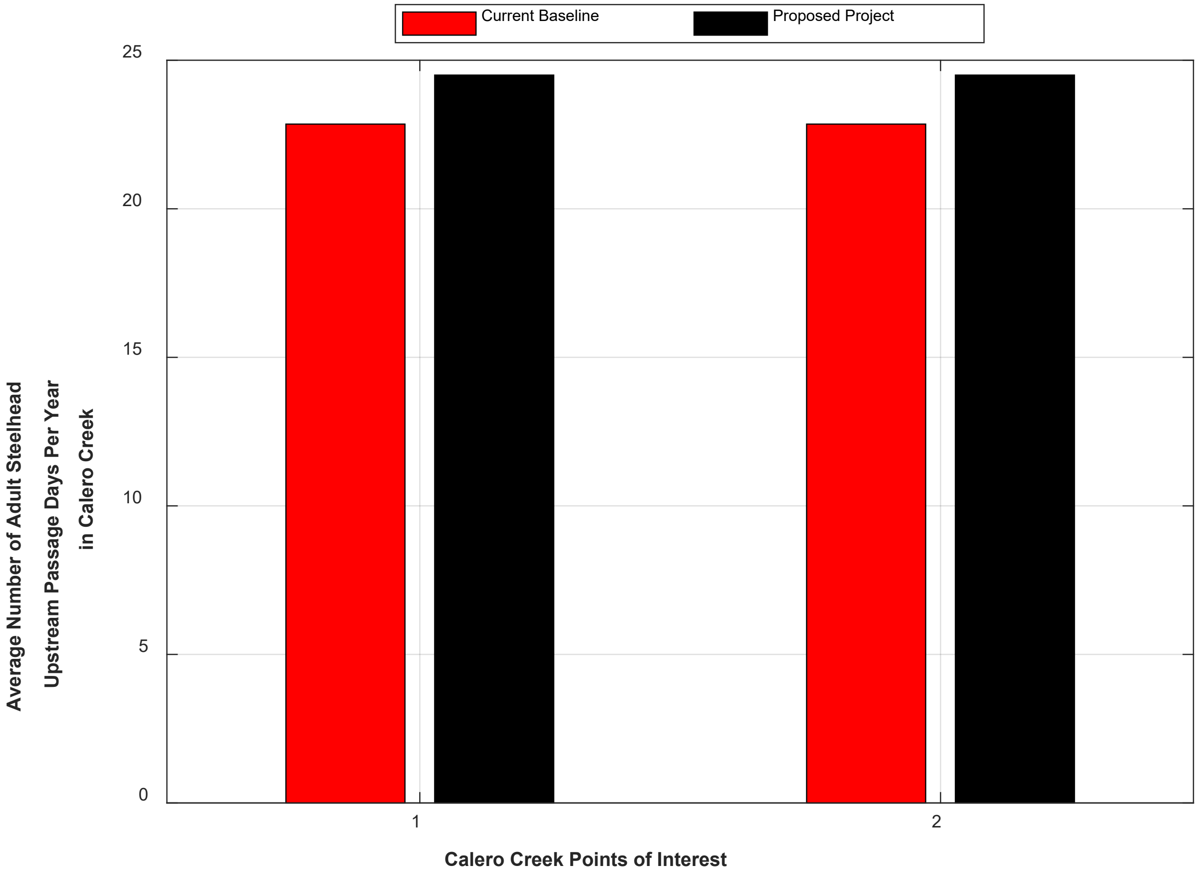


Table 19. Proposed Project Adult Steelhead Upstream Passage Compared with the Current Baseline in Calero Creek

Parameter	CALE 1	CALE 2
Current Baseline (days)[a]		
Total Adult Upstream Passage (1991–2010)	457	457
Average Adult Upstream Passage Per Year	23	23
Proposed Project (days)[a]		
Total Adult Upstream Passage (1991–2010)	490	490
Average Adult Upstream Passage Per Year	25	25
Difference (days)		
Total Adult Upstream Passage (1991–2010)	33.00	33.00
Average Adult Upstream Passage Per Year	1.65	1.65
Difference (%)		
Total Adult Upstream Passage (1991–2010)	7.22	7.22
Average Adult Upstream Passage Per Year	7.22	7.22

[a] Rounded to whole days

Overall, the Proposed Project would result in increased adult upstream passage opportunities compared with the current baseline conditions in the Guadalupe River portion of the study area.

Juvenile Downstream Passage

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 2% (1 day per year) average increase to juvenile downstream passage in the Guadalupe River compared with the current baseline (Figure 27; Table 20). Evaluating the juvenile downstream passage excluding the water temperature criteria used to calculate the FAHCE WEAP Model results, the Proposed Project would result in an 11% (7 days per year) average increase to juvenile downstream passage in the Guadalupe River compared with the current baseline (Table 20). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in the Guadalupe River under the Proposed Project compared to the current baseline. Additionally, there was no change in number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in the Guadalupe River under the Proposed Project compared to the current baseline.

Figure 27. Juvenile Steelhead Downstream Passage Days in the Guadalupe River Compared with the Current Baseline

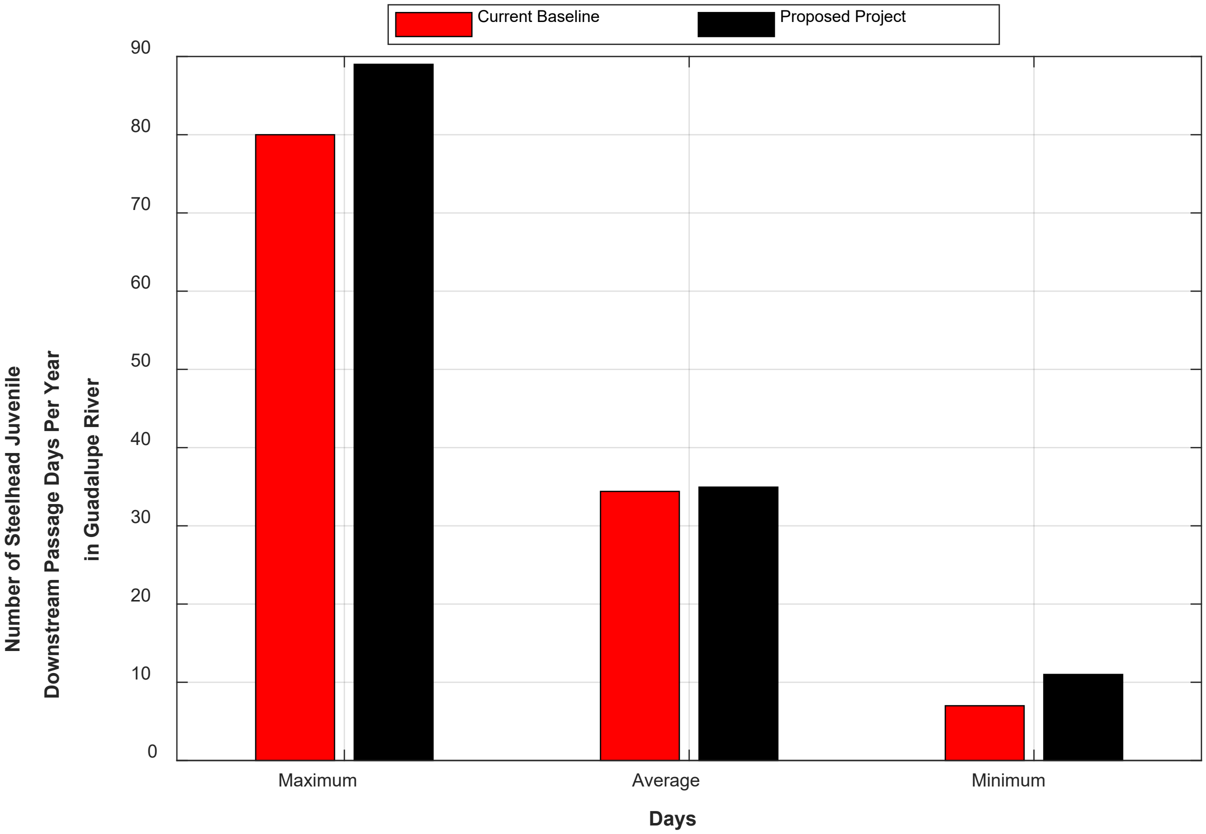


Table 20. Proposed Project Juvenile Steelhead Downstream Passage Compared with the Current Baseline in the Guadalupe River

Parameter	GUAD 7 with Water Temperature Criteria[b]	GUAD 7 without Water Temperature Criteria[c]
***Current Baseline (days)*[a]**		
Total Juvenile Downstream Passage (1991–2010)	688	1,322
Average Juvenile Downstream Passage Per Year	34	66
***Proposed Project (days)*[a]**		
Total Juvenile Downstream Passage (1991–2010)	699	1,456
Average Juvenile Downstream Passage Per Year	35	73
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	11.00	134.00
Average Juvenile Downstream Passage Per Year	1.00	7.00

Parameter	GUAD 7 with Water Temperature Criteria[b]	GUAD 7 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	1.60	10.14
Average Juvenile Downstream Passage Per Year	2.94	10.61

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 5% (2 days per year) average decrease to juvenile downstream passage in Los Gatos Creek compared with the current baseline (Figure 28; Table 21). Evaluating the juvenile downstream passage excluding the water temperature criteria used to calculate the FAHCE WEAP Model results, the Proposed Project would result in a 30% (24 days per year) average increase to juvenile downstream passage in Los Gatos Creek compared with the current baseline (Table 21). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in Los Gatos Creek under the Proposed Project compared to the current baseline. Additionally, there was no change in number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in Los Gatos Creek under the Proposed Project compared to the current baseline.

Figure 28. Juvenile Steelhead Downstream Passage Days in Los Gatos Creek Compared with the Current Baseline

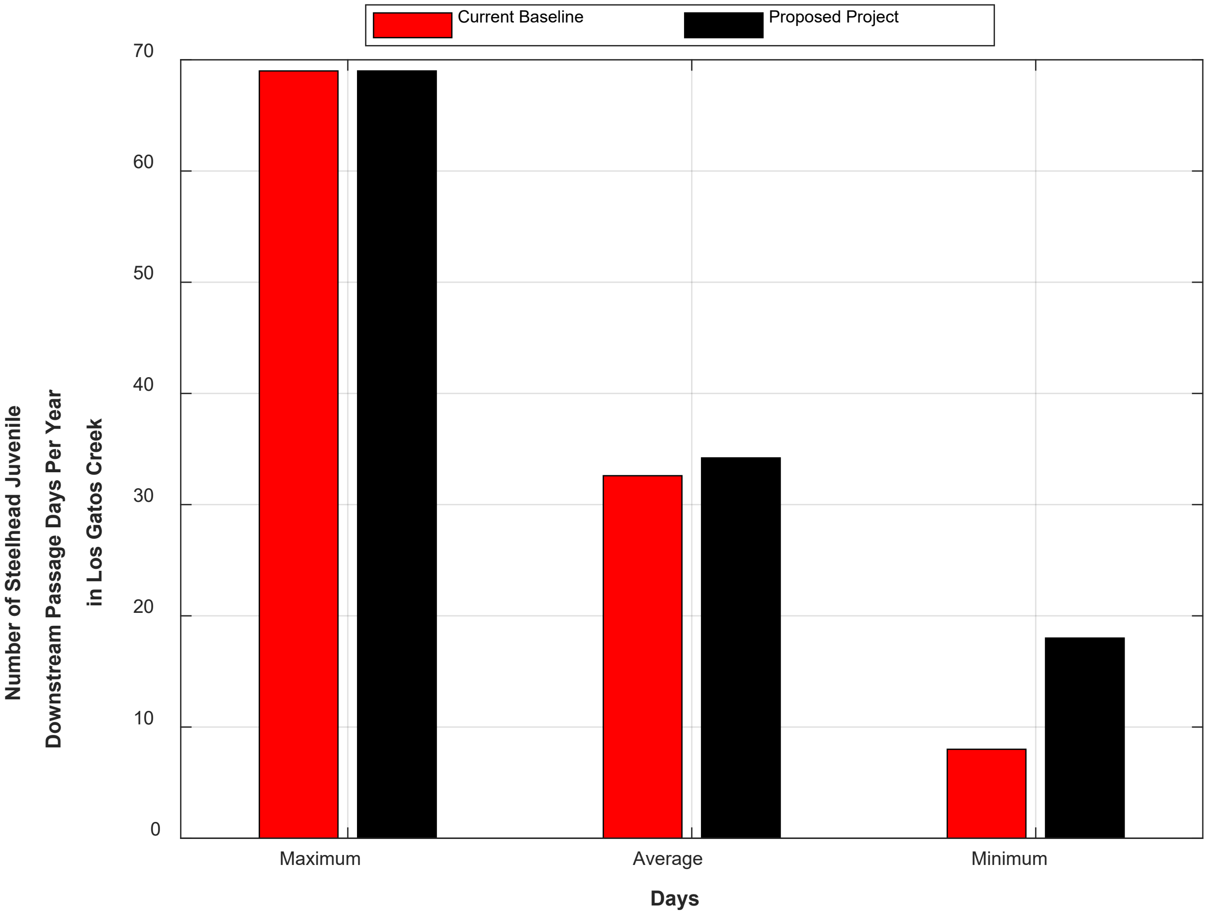


Table 21. Proposed Project Juvenile Steelhead Downstream Passage Compared with the Current Baseline in Los Gatos Creek

Parameter	LOSG 2 with Water Temperature Criteria[b]	LOSG 2 without Water Temperature Criteria[c]
Current Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	652	1,613
Average Juvenile Downstream Passage Per Year	33	81
Proposed Project (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	684	2,109
Average Juvenile Downstream Passage Per Year	34	105
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	32.00	496.00
Average Juvenile Downstream Passage Per Year	1.00	24.00

Parameter	LOSG 2 with Water Temperature Criteria[b]	LOSG 2 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	4.91	30.75
Average Juvenile Downstream Passage Per Year	3.03	29.63

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in an increase of juvenile downstream passage in Guadalupe Creek by an average of 44% (7 days per year) compared with the current baseline (Figure 29; Table 22). Evaluating the juvenile downstream passage excluding the water temperature criteria used to calculate the FAHCE WEAP Model results, the Proposed Project would result in a 33% (8 days per year) average increase to juvenile downstream passage in Guadalupe Creek compared with the current baseline (Table 22). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in Guadalupe Creek increased by one under the Proposed Project compared to the current baseline. Additionally, the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in Guadalupe Creek increased by one under the Proposed Project compared to the current baseline.

Figure 29. Juvenile Steelhead Downstream Passage Days in Guadalupe Creek Compared to the Current Baseline

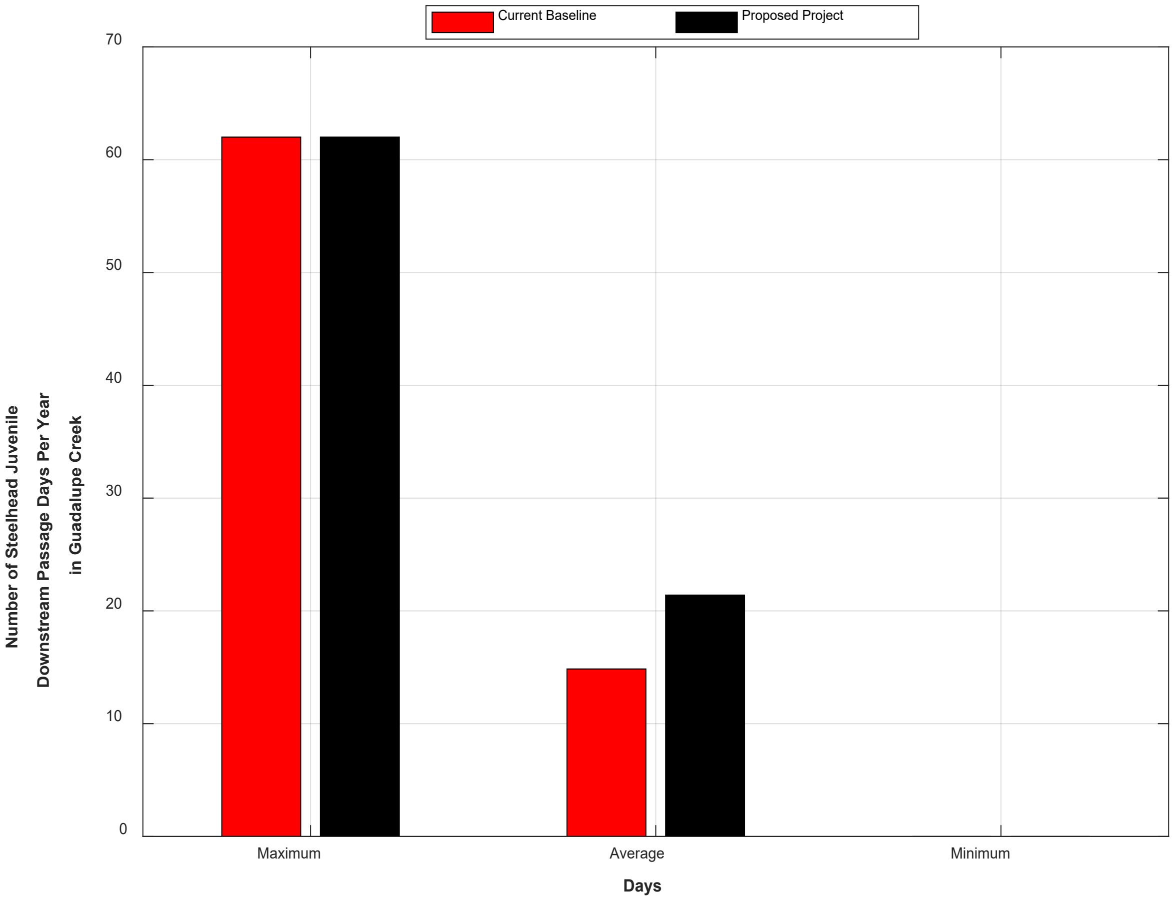


Table 22. Proposed Project Juvenile Steelhead Downstream Passage Compared with the Current Baseline in Guadalupe Creek

Parameter	GCRK 4 with Water Temperature Criteria[b]	GCRK 4 without Water Temperature Criteria[c]
Current Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	297	472
Average Juvenile Downstream Passage Per Year	15	24
Proposed Project (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	428	639
Average Juvenile Downstream Passage Per Year	21	32

Parameter	GCRK 4 with Water Temperature Criteria[b]	GCRK 4 without Water Temperature Criteria[c]
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	131.00	167.00
Average Juvenile Downstream Passage Per Year	6.00	8.00
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	44.11	35.38
Average Juvenile Downstream Passage Per Year	40.00	33.33

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 4% (1 day per year) average decrease to juvenile downstream passage in Alamitos Creek compared with the current baseline (Figure 30; Table 23). Evaluating the juvenile downstream passage excluding the water temperature criteria used to calculate the FAHCE WEAP Model results, the Proposed Project would result in an 5% (2 days per year) average increase to juvenile downstream passage in Alamitos Creek compared with the current baseline (Table 23). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in Alamitos Creek under the Proposed Project compared to the current baseline. Additionally, there was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in Alamitos Creek under the Proposed Project compared to the current baseline.

Figure 30. Juvenile Steelhead Downstream Passage Days in Alamitos Creek Compared with the Current Baseline

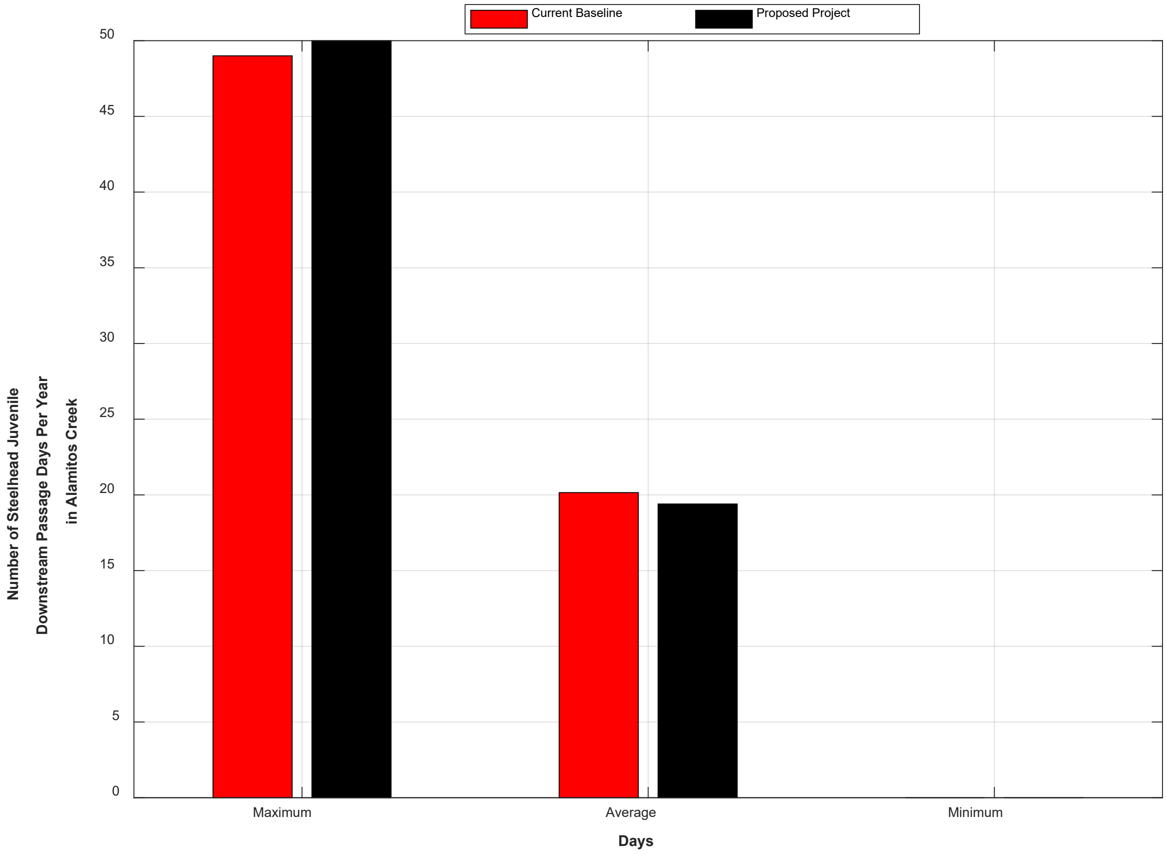


Table 23. Proposed Project Juvenile Steelhead Downstream Passage Compared with the Current Baseline in Alamitos Creek

Parameter	ALAM 4 with Water Temperature Criteria[b]	ALAM 4 without Water Temperature Criteria[c]
Current Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	403	856
Average Juvenile Downstream Passage Per Year	20	43.0
Proposed Project (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	388	909
Average Juvenile Downstream Passage Per Year	19	45.0
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	-15.00	53.00
Average Juvenile Downstream Passage Per Year	-1.00	2.00

Parameter	ALAM 4 with Water Temperature Criteria[b]	ALAM 4 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	-3.72	6.19
Average Juvenile Downstream Passage Per Year	-5.00	4.65

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

The Proposed Project would result in a 3% (1 day per year) average decrease to juvenile downstream passage in in Calero Creek compared with the current baseline (Figure 31; Table 24). Evaluating the juvenile downstream passage excluding the water temperature criteria used to calculate the FAHCE WEAP Model results, the Proposed Project would result in no change to juvenile downstream passage in Calero Creek compared with the current baseline (Table 24). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in Calero Creek decreased by two under the Proposed Project compared to the current baseline. There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in Calero Creek under the Proposed Project compared to the current baseline.

Figure 31. Juvenile Steelhead Downstream Passage Days in Calero Creek Compared with the Current Baseline

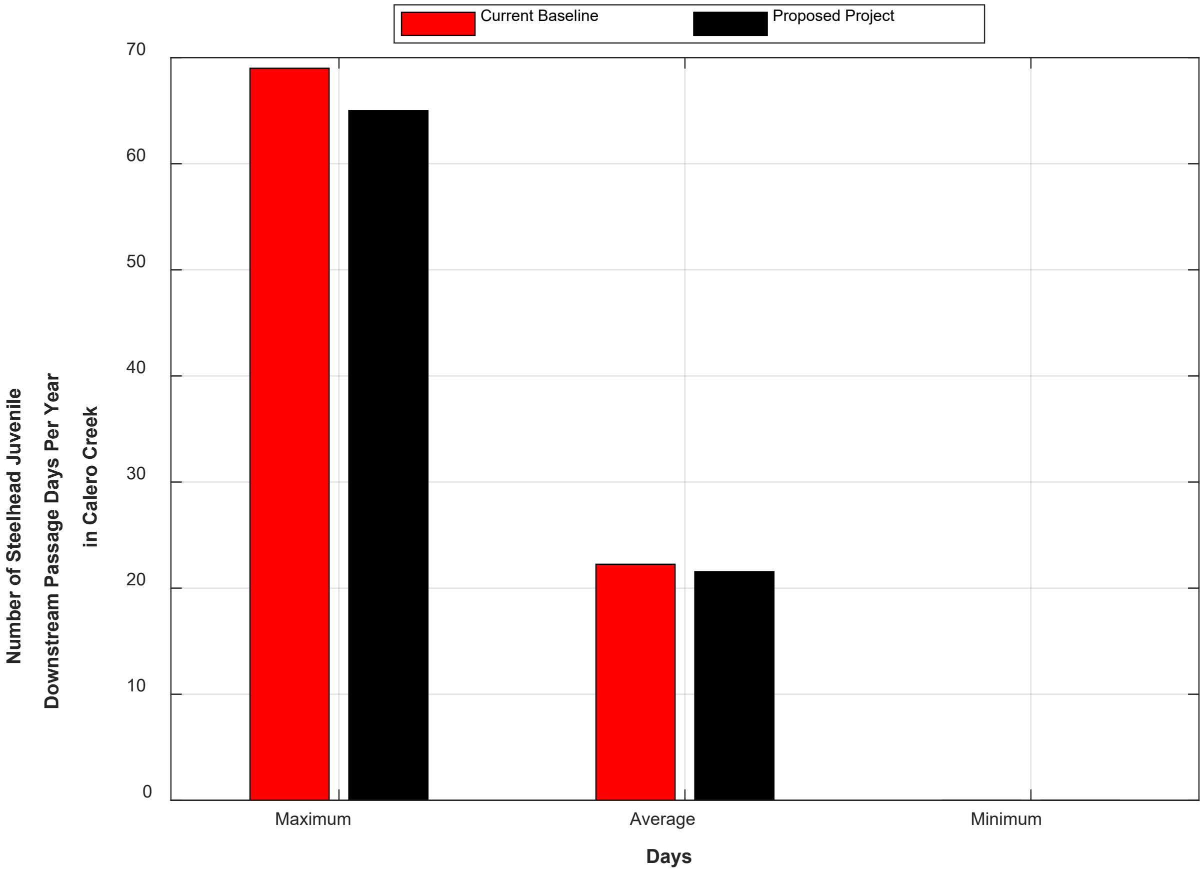


Table 24. Proposed Project Juvenile Steelhead Downstream Passage Compared with the Current Baseline in Calero Creek

Parameter	CALE 2 with Water Temperature Criteria[b]	CALE 2 without Water Temperature Criteria[c]
Current Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	445	693
Average Juvenile Downstream Passage Per Year	22	35
Proposed Project (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	431	695
Average Juvenile Downstream Passage Per Year	22	35
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	-14.00	2.00
Average Juvenile Downstream Passage Per Year	0.00	0.00

Parameter	CALE 2 with Water Temperature Criteria[b]	CALE 2 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	-3.15	0.29
Average Juvenile Downstream Passage Per Year	0.00	0.00

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Overall, the Proposed Project would increase downstream passage compared with the current baseline in the Guadalupe River portion of the study area.

Flow Measures Future Baseline Assessment

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 38% (2,457 square feet) increase in effective spawning habitat across POIs in the Guadalupe River compared with the future baseline (Table 25). Modeled increases were observed in the early spawning period (December) with little to no change during the rest of the spawning period (January through May) when most upstream migration occurs (Moyle et al. 2008) (Figure 32).

Figure 32. Change in Steelhead Effective Spawning Habitat in the Guadalupe River Compared to the Future Baseline

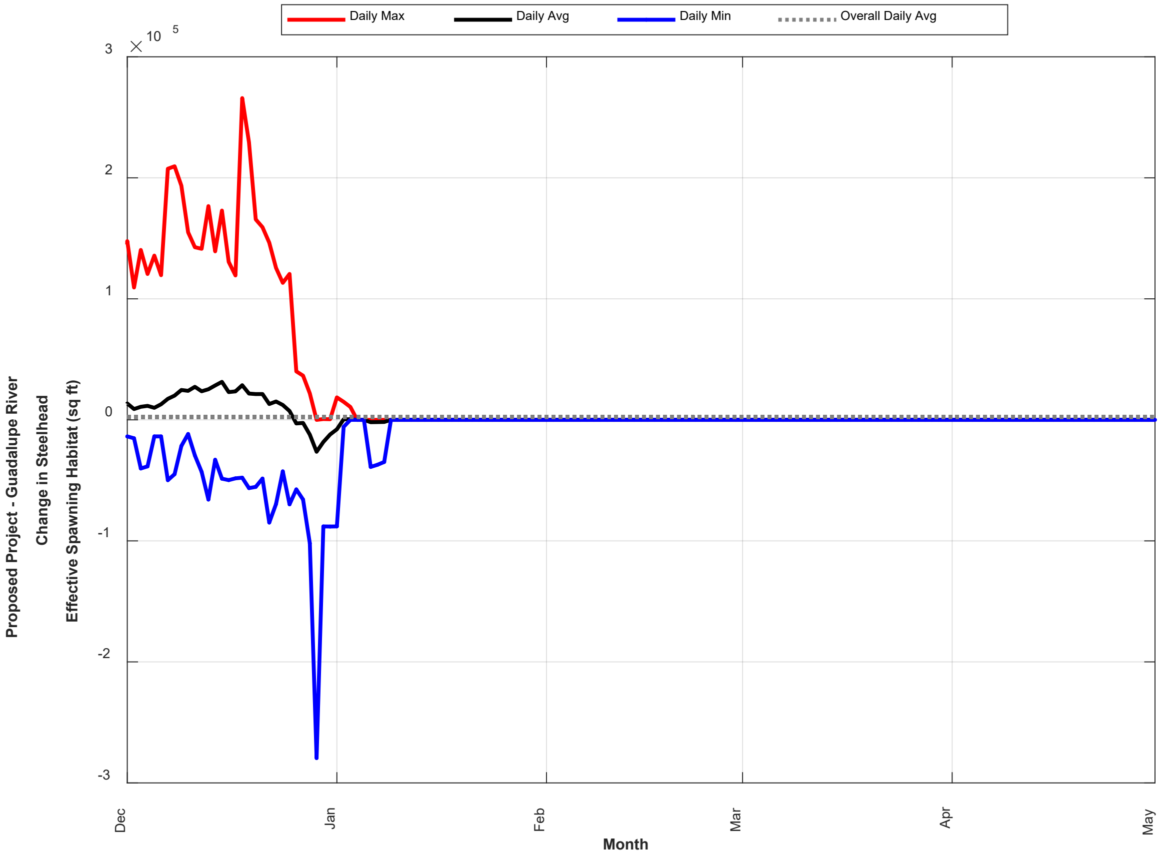


Table 25. Proposed Project Steelhead Habitat Compared with the Future Baseline in the Guadalupe River

Guadalupe River[a,b]	GUAD 3 River Mile 10.07	GUAD 4 River Mile 12.52	GUAD 5 River Mile 13.42	GUAD 6 River Mile 18.45	GUAD 7 River Mile 19.93	Total
Steelhead Habitat Future Baseline (sq ft)						
Effective Spawning	2,840	282	380	1,500	1,550	6,552
Fry Rearing Total (March 1–May 31)	146,000	170,000	67,500	415,000	416,000	1,214,500
Fry Rearing Winter Base Flow Operations (March 1–April 30)	153,000	169,000	71,700	430,000	418,000	1,241,700
Fry Rearing Summer Release Program (May 1–May 31)	131,000	171,000	59,400	383,000	413,000	1,157,400
Juvenile Rearing Total (year-round)	241,000	262,000	76,700	313,000	342,000	1,234,700
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	288,000	297,000	105,000	475,000	398,000	1,563,000

Guadalupe River[a,b]	GUAD 3 River Mile 10.07	GUAD 4 River Mile 12.52	GUAD 5 River Mile 13.42	GUAD 6 River Mile 18.45	GUAD 7 River Mile 19.93	Total
Juvenile Rearing Summer Release Program (May 1–Oct 31)	194,000	228,000	48,800	154,000	288,000	912,800
Steelhead Habitat Proposed Project (sq ft)						
Effective Spawning	3,440	642	577	2,230	2,120	9,009
Fry Rearing Total (March 1–May 31)	148,000	168,000	69,200	433,000	414,000	1,232,200
Fry Rearing Winter Base Flow Operations (March 1–April 30)	157,000	166,000	73,700	457,000	410,000	1,263,700
Fry Rearing Summer Release Program (May 1–May 31)	131,000	171,000	60,300	386,000	422,000	1,170,300
Juvenile Rearing Total (year-round)	243,000	262,000	78,400	336,000	344,000	1,263,400
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	295,000	299,000	109,000	526,000	412,000	1,641,000
Juvenile Rearing Summer Release Program (May 1–Oct 31)	192,000	225,000	47,900	149,000	278,000	891,900
Change in Habitat (sq ft)						
Effective Spawning	600 (21.13%)	360 (127.66%)	197 (51.84%)	730 (48.67%)	570 (36.77%)	2,457 (37.5%)
Fry Rearing Total (March 1–May 31)	2,000 (1.37%)	-2,000 (-1.18%)	1,700 (2.52%)	18,000 (4.34%)	-2,000 (-0.48%)	17,700 (1.46%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	4,000 (2.61%)	-3,000 (-1.78%)	2,000 (2.79%)	27,000 (6.28%)	-8,000 (-1.91%)	22,000 (1.77%)
Fry Rearing Summer Release Program (May 1–May 31)	0 (0%)	0 (0%)	900 (1.52%)	3,000 (0.78%)	9,000 (2.18%)	12,900 (1.11%)
Juvenile Rearing Total (year-round)	2,000 (0.83%)	0 (0%)	1,700 (2.22%)	23,000 (7.35%)	2,000 (0.58%)	28,700 (2.32%)
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	7,000 (2.43%)	2,000 (0.67%)	4,000 (3.81%)	51,000 (10.74%)	14,000 (3.52%)	78,000 (4.99%)
Juvenile Rearing Summer Release Program (May 1–Oct 31)	-2,000 (-1.03%)	-3,000 (-1.32%)	-900 (-1.84%)	-5,000 (-3.25%)	-10,000 (-3.47%)	-20,900 (-2.29%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

[b] No average daily habitat availability model results are available for the points of interest not shown.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 16% (195 square feet) average decrease across POIs in Los Gatos Creek compared with the future baseline (Table 25). Modeled decreases were observed in the early spawning period (late December through early January) with little to no change during the rest of the spawning period (early January through May) when most upstream migration occurs (Moyle et al. 2008) (Figure 33).

Figure 33. Change in Steelhead Effective Spawning Habitat in Los Gatos Creek

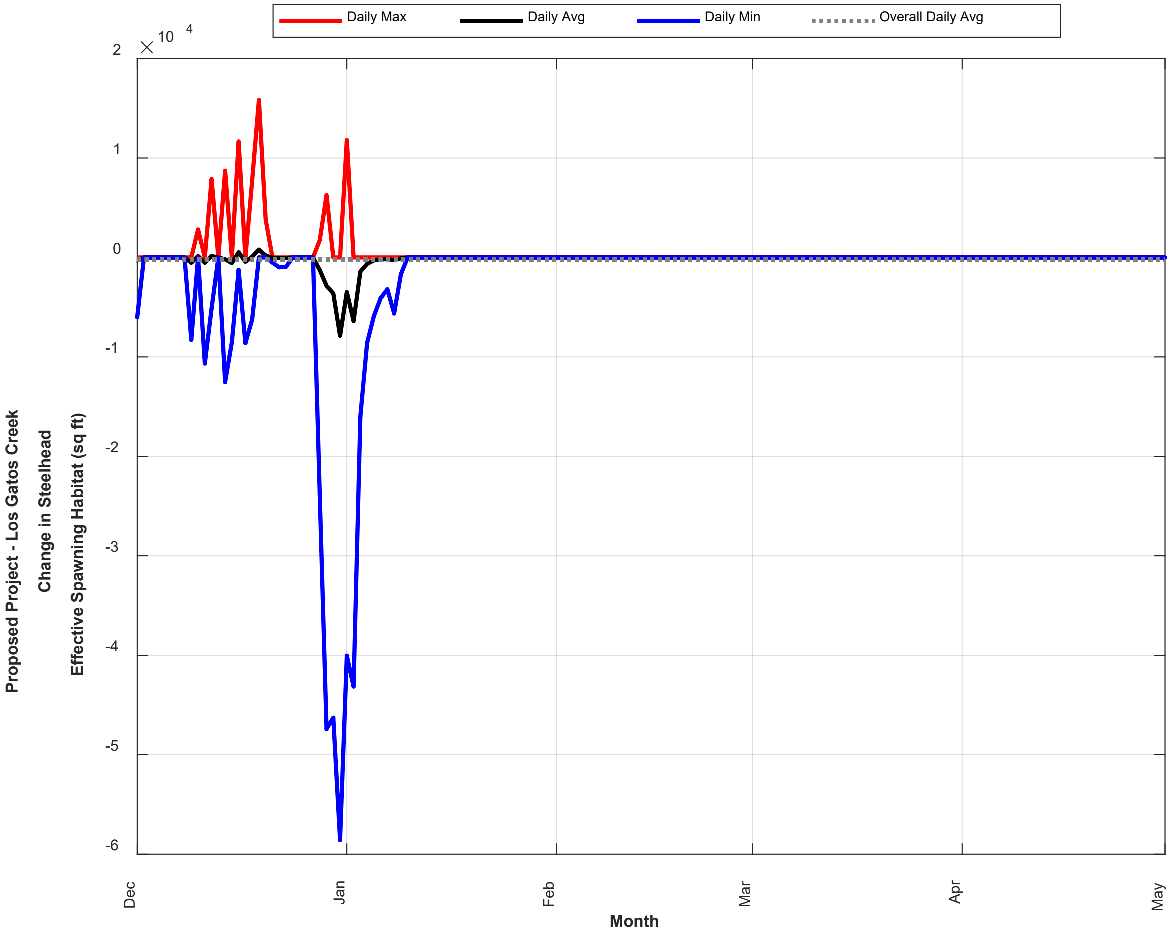


Table 26. Proposed Project Steelhead Habitat Compared with the Future Baseline in Los Gatos Creek

Los Gatos Creek[a]	LOSG 1 River Mile 14.70	LOSG 2 River Mile 18.91	Total
Steelhead Habitat Future Baseline (sq ft)			
Effective Spawning	594	593	1,187
Fry Rearing Total (March 1–May 31)	139,000	248,000	387,000
Fry Rearing Winter Base Flow Operations (March 1–April 30)	137,000	241,000	378,000
Fry Rearing Summer Release Program (May 1–May 31)	144,000	260,000	404,000
Juvenile Rearing Total (year-round)	123,000	225,000	348,000
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	130,000	216,000	346,000

Los Gatos Creek[a]	LOSG 1 River Mile 14.70	LOSG 2 River Mile 18.91	Total
Juvenile Rearing Summer Release Program (May 1–Oct 31)	116,000	234,000	350,000
Steelhead Habitat Proposed Project (sq ft)			
Effective Spawning	495	497	992
Fry Rearing Total (March 1–May 31)	139,000	250,000	389,000
Fry Rearing Winter Base Flow Operations (March 1–April 30)	140,000	250,000	390,000
Fry Rearing Summer Release Program (May 1–May 31)	138,000	250,000	388,000
Juvenile Rearing Total (year-round)	117,000	214,000	331,000
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	122,000	199,000	321,000
Juvenile Rearing Summer Release Program (May 1–Oct 31)	113,000	230,000	343,000
Change in Habitat (sq ft)			
Effective Spawning	-99 (-16.67%)	-96 (-16.19%)	-195 (-16.43%)
Fry Rearing Total (March 1–May 31)	0 (0%)	2,000 (0.81%)	2,000 (0.52%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	3,000 (2.19%)	9,000 (3.73%)	12,000 (3.17%)
Fry Rearing Summer Release Program (May 1–May 31)	-6,000 (-4.17%)	-10,000 (-3.85%)	-16,000 (-3.96%)
Juvenile Rearing Total (year-round)	-6,000 (-4.88%)	-11,000 (-4.89%)	-17,000 (-4.89%)
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	-8,000 (-6.15%)	-17,000 (-7.87%)	-25,000 (-7.23%)
Juvenile Rearing Summer Release Program (May 1–Oct 31)	-3,000 (-2.59%)	-4,000 (-1.71%)	-7,000 (-2%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 115% (634 square feet) average increase across POIs in Guadalupe Creek compared with the future baseline (Figure 34). Changes in effective spawning habitat under the Proposed Project varied among POIs, but all POIs would have increases in effective spawning habitat except at the downstream-most POI near the confluence with the Guadalupe River (GCRK 1). In the Guadalupe Creek CWMZ, there would be an 82% (229 square foot) increase in steelhead effective spawning habitat. During the periods when an increase of effective spawning habitat is observed (Figure 34) and assuming increases in effective spawning habitat are discrete continuous areas and an average redd size of 73 square feet (Orcutt et al. 1968), the modeled increase in the average effective spawning habitat could potentially accommodate multiple additional redds in the Guadalupe Creek reaches between GCRK 1 and GCRK2 and GCRK 3 and GCRK 4 under the Proposed Project than under the future baseline.

Figure 34. Change in Steelhead Effective Spawning Habitat in Guadalupe Creek

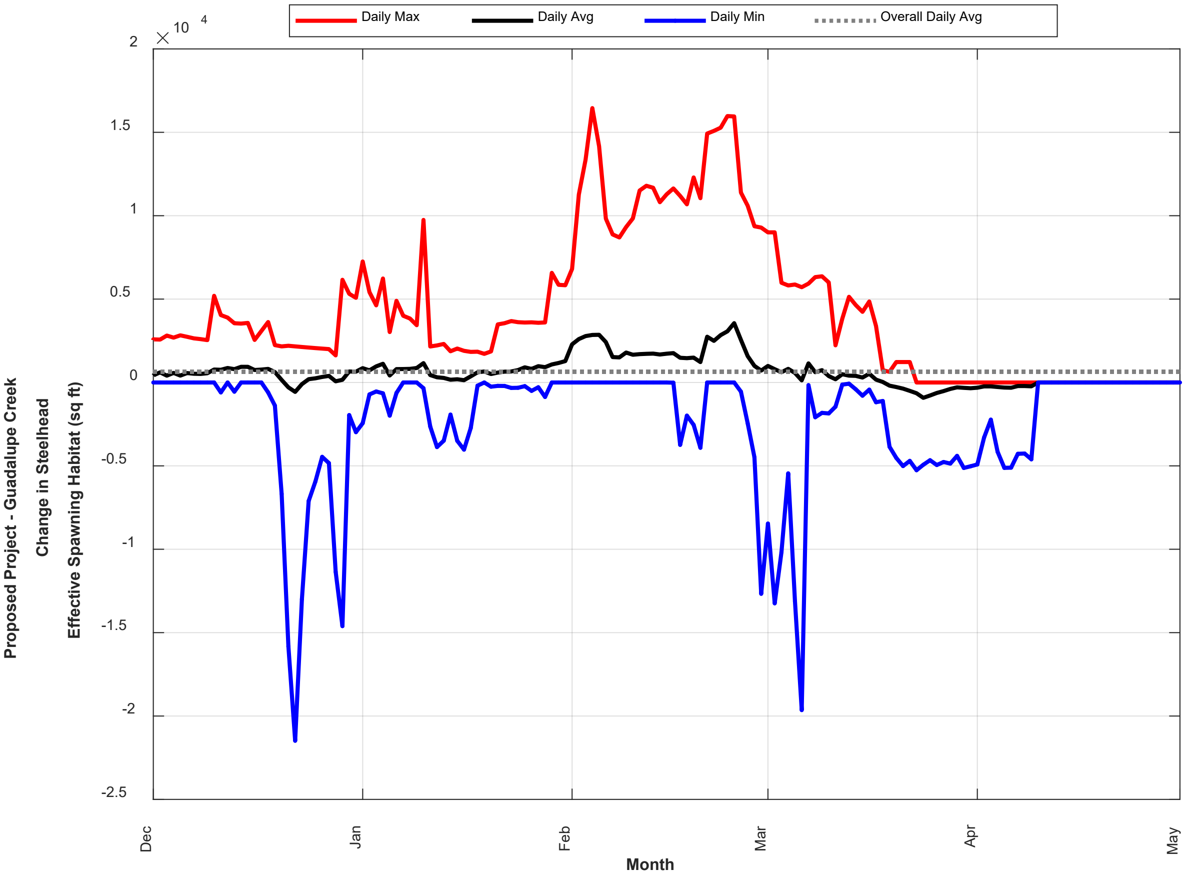


Table 27. Proposed Project Steelhead Habitat Compared with the Future Baseline in Guadalupe Creek

Guadalupe Creek[a]	GCRK 1 River Mile 20.71	GCRK 2 River Mile 21.91	GCRK 3 River Mile 22.54	GCRK 4 River Mile 26.17	Total
Steelhead Habitat Future Baseline (sq ft)					
Effective Spawning	36	202	35	280	553
Fry Rearing Total (March 1–May 31)	19,600	44,100	3,600	24,500	91,800
Fry Rearing Winter Base Flow Operations (March 1–April 30)	21,100	43,200	3,410	24,600	92,310
Fry Rearing Summer Cold Water Program (May 1–May 31)	16,500	45,800	3,970	24,400	90,670
Juvenile Rearing Total (year-round)	89,50	33,800	2,790	18,200	63,740

Guadalupe Creek[a]	GCRK 1 River Mile 20.71	GCRK 2 River Mile 21.91	GCRK 3 River Mile 22.54	GCRK 4 River Mile 26.17	Total
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	15,000	36,800	2,960	13,100	67,860
Juvenile Rearing Summer Cold Water Program (May 1–Oct 31)	2,960	31,000	2,610	23,100	59,670
Steelhead Habitat Proposed Project (sq ft)					
Effective Spawning	32	576	69	509	1,187
Fry Rearing Total (March 1–May 31)	20,300	45,000	3,400	25,500	94,200
Fry Rearing Winter Base Flow Operations (March 1–April 30)	26,000	51,200	3,450	24,800	105,450
Fry Rearing Summer Cold Water Program (May 1–May 31)	9,020	32,700	3,300	26,800	71,820
Juvenile Rearing Total (year-round)	10,100	30,800	2,550	16,200	59,650
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	19,700	46,500	3,750	21,600	91,550
Juvenile Rearing Summer Cold Water Program (May 1–Oct 31)	646	15,300	1,360	10,800	28,106
Change in Habitat (sq ft)					
Effective Spawning	-3 (-9.5%)	374 (185.15%)	35 (100%)	229 (81.79%)	634 (114.81%)
Fry Rearing Total (March 1–May 31)	700 (3.57%)	900 (2.04%)	-200 (-5.56%)	1,000 (4.08%)	2,400 (2.61%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	4,900 (23.22%)	8,000 (18.52%)	40 (1.17%)	200 (0.81%)	13,140 (14.23%)
Fry Rearing Summer Cold Water Program (May 1–May 31)	-7,480 (-45.33%)	-13,100 (-28.6%)	-670 (-16.88%)	2,400 (9.84%)	-18,850 (-20.79%)
Juvenile Rearing Total (year-round)	1,150 (12.85%)	-3,000 (-8.88%)	-240 (-8.6%)	-2,000 (-10.99%)	-4,090 (-6.42%)
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	4,700 (31.33%)	9,700 (26.36%)	790 (26.69%)	8,500 (64.89%)	23,690 (34.91%)
Juvenile Rearing Summer Cold Water Program (May 1–Oct 31)	-2,314 (-78.18%)	-15,700 (-50.65%)	-1,250 (-47.89%)	-12,300 (-53.25%)	-31,564 (-52.9%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 35% (28 square feet) average increase across POIs in Alamitos Creek compared with the future baseline (Figure 35; Table 28).

Figure 35. Change in Steelhead Effective Spawning Habitat in Alamitos Creek

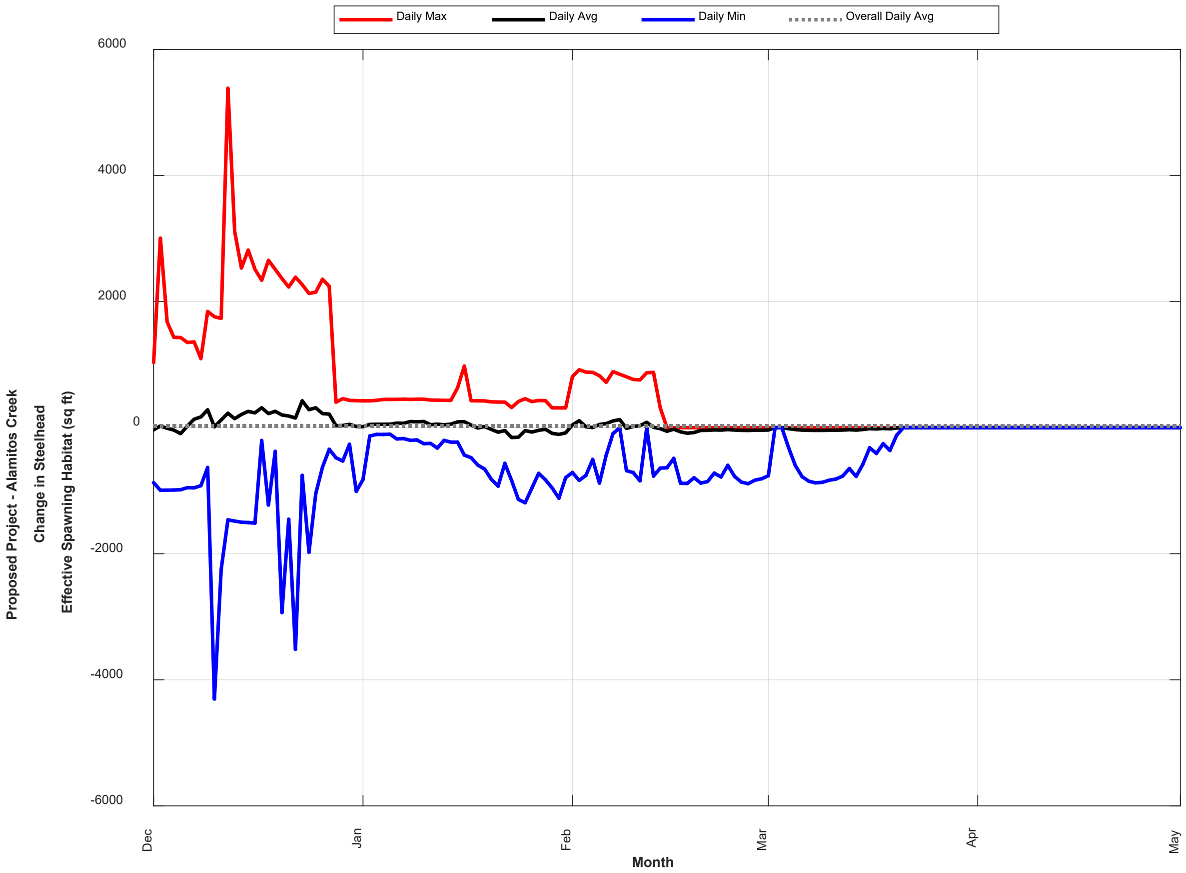


Table 28. Proposed Project Steelhead Habitat Compared with the Future Baseline in Alamitos Creek

Alamitos Creek[a,b]	ALAM 2 River Mile 23.61	ALAM 3 River Mile 24.26	ALAM 4 River Mile 27.89	Total
Steelhead Habitat Future Baseline (sq ft)				
Effective Spawning	38	5	36	79
Fry Rearing Total (March 1–May 31)	56,500	6,490	3,580	66,570
Fry Rearing Winter Base Flow Operations (March 1–April 30)	56,200	6,410	3,280	65,890
Fry Rearing Summer Release Program (May 1–May 31)	56,900	6,640	4,150	67,690
Juvenile Rearing Total (year-round)	60,500	5,340	3,060	68,900
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	64,800	5,870	2,870	73,540

Alamitos Creek[a,b]	ALAM 2 River Mile 23.61	ALAM 3 River Mile 24.26	ALAM 4 River Mile 27.89	Total
Juvenile Rearing Summer Release Program (May 1–Oct 31)	56,300	4,820	3,250	64,370
Steelhead Habitat Proposed Project (sq ft)				
Effective Spawning	59	6	42	107
Fry Rearing Total (March 1–May 31)	58,500	7,380	3,810	69,690
Fry Rearing Winter Base Flow Operations (March 1–April 30)	59,100	7,760	3,650	70,510
Fry Rearing Summer Release Program (May 1–May 31)	57,100	6,620	41,40	67,860
Juvenile Rearing Total (year-round)	63,300	6,030	3,620	72,950
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	68,800	7,420	4,040	80,260
Juvenile Rearing Summer Release Program (May 1–Oct 31)	58,000	4,670	3,200	65,870
Change in Habitat (sq ft)				
Effective Spawning	21 (55.29%)	1 (11.88%)	6 (16.48%)	28 (34.7%)
Fry Rearing Total (March 1–May 31)	2,000 (3.54%)	890 (13.71%)	230 (6.42%)	3,120 (4.69%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	2,900 (5.16%)	1,350 (21.06%)	370 (11.28%)	4,620 (7.01%)
Fry Rearing Summer Release Program (May 1–May 31)	200 (0.35%)	-20 (-0.3%)	-10 (-0.24%)	170 (0.25%)
Juvenile Rearing Total (year-round)	2,800 (4.63%)	690 (12.92%)	560 (18.3%)	4,050 (5.88%)
Juvenile Rearing Winter Base Flow Operations (Nov 1–Apr 30)	4,000 (6.17%)	1,550 (26.41%)	1,170 (40.77%)	6,720 (9.14%)
Juvenile Rearing Summer Release Program (May 1–Oct 31)	1,700 (3.02%)	-150 (-3.11%)	-50 (-1.54%)	1,500 (2.33%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

[b] No average daily habitat availability model results are available for the points of interest not shown.

There were no FAHCE WEAP Model predictions for effective spawning habitat in Calero Creek despite known occurrence of spawners (Valley Water unpublished data). Based on the results of the FAHCE WEAP Model for wetted area, effective spawning habitat would increase across POIs in Calero Creek compared with the future baseline (Table 29) due to increased wetted area during Winter Base Flow Operations (Attachment K.2 – K.2.69 and K.2.70).

Table 29. Proposed Project Steelhead Habitat Compared with the Future Baseline in Calero Creek

Calero Creek[a]	CALE 1 River Mile 24.33	CALE 2 River Mile 27.59	Total
Steelhead Habitat Future Baseline (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (March 1–May 31)	2,730	62,300[c]	65,030[c]
Fry Rearing Winter Base Flow Operations (March 1–April 30)	2,790	47,500[c]	50,290[c]
Fry Rearing Summer Release Program (May 1–May 31)	2,620	91,300	93,920
Juvenile Rearing Total (year-round)	2,500	59,000[c]	61,500[c]
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	2,620	31,400[c]	34,020[c]
Juvenile Rearing Summer Release Program (May 1–Oct 31)	2,380	86,200	88,580
Steelhead Habitat Proposed Project (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (March 1–May 31)	2,810	66,700[c]	69,510[c]
Fry Rearing Winter Base Flow Operations (March 1–April 30)	2,880	52,700[c]	55,580[c]
Fry Rearing Summer Release Program (May 1–May 31)	2,680	94,300	96,980
Juvenile Rearing Total (year-round)	2,560	60,600[c]	63,160[c]
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	2,600	29,300[c]	31,900[c]
Juvenile Rearing Summer Release Program (May 1–Oct 31)	2,520	91,500	94,020
Change in Habitat (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (March 1–May 31)	80 (2.93%)	4,400 (7.06%)[c]	4,480 (6.89%)[c]
Fry Rearing Winter Base Flow Operations (March 1–April 30)	90 (3.23%)	5,200 (10.95%)[c]	5,290 (10.52%)[c]
Fry Rearing Summer Release Program (May 1–May 31)	60 (2.29%)	3,000 (3.29%)	3,060 (3.26%)
Juvenile Rearing Total (year-round)	60 (2.4%)	1,600 (2.71%)[c]	1,660 (2.7%)[c]
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	-20 (-0.76%)	-2,100 (-6.69%)[c]	-2,120 (-6.23%)[c]
Juvenile Rearing Summer Release Program (May 1–Oct 31)	140 (5.88%)	5,300 (6.15%)	5,440 (6.14%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

[b] Effective spawning model results were not available in Calero Creek because no substrate suitable for spawning was recorded by the subsample habitat survey of Calero Creek input into the FAHCE WEAP Model. Subsequent surveys indicate there is substrate suitable for spawning in Calero Creek (Valley Water 2019a, 2020).

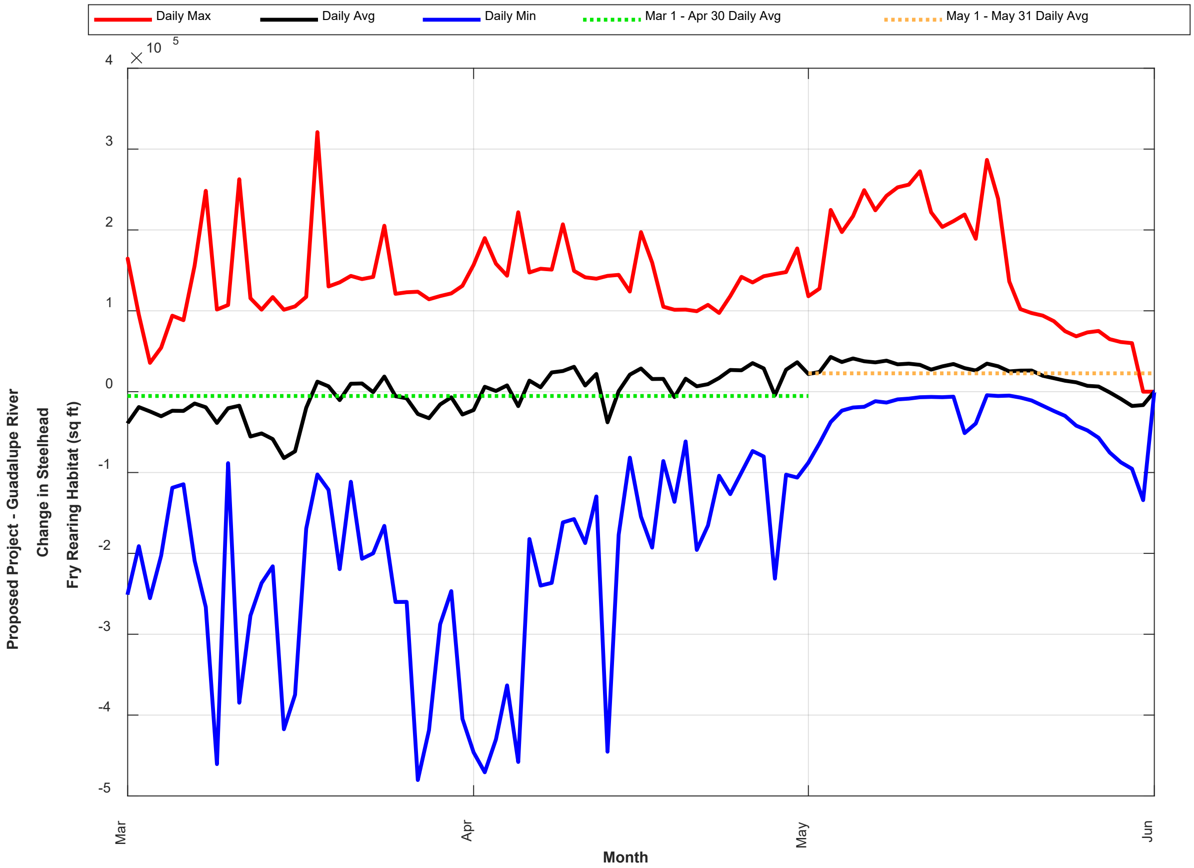
[c] Average daily fry rearing and juvenile rearing habitat availability model results do not quantify conditions when winter cover was considered in the habitat estimate (December 1 through March 31 for steelhead) since no winter cover was recorded by the subsample habitat survey of the CALE 2 reach of Calero Creek (that is, the reach between CALE 1 and CALE 2) input into the FAHCE WEAP Model. Subsequent surveys indicate there is winter cover available in this reach of Calero Creek (Valley Water 2019a, 2020).

Similar trends were observed for the effects of the Proposed Project on effective spawning habitat compared with the current and future baselines with the exception of Calero Creek where there would be a decrease compared with the current baseline and an increase compared with the future baseline.

Fry Rearing Habitat

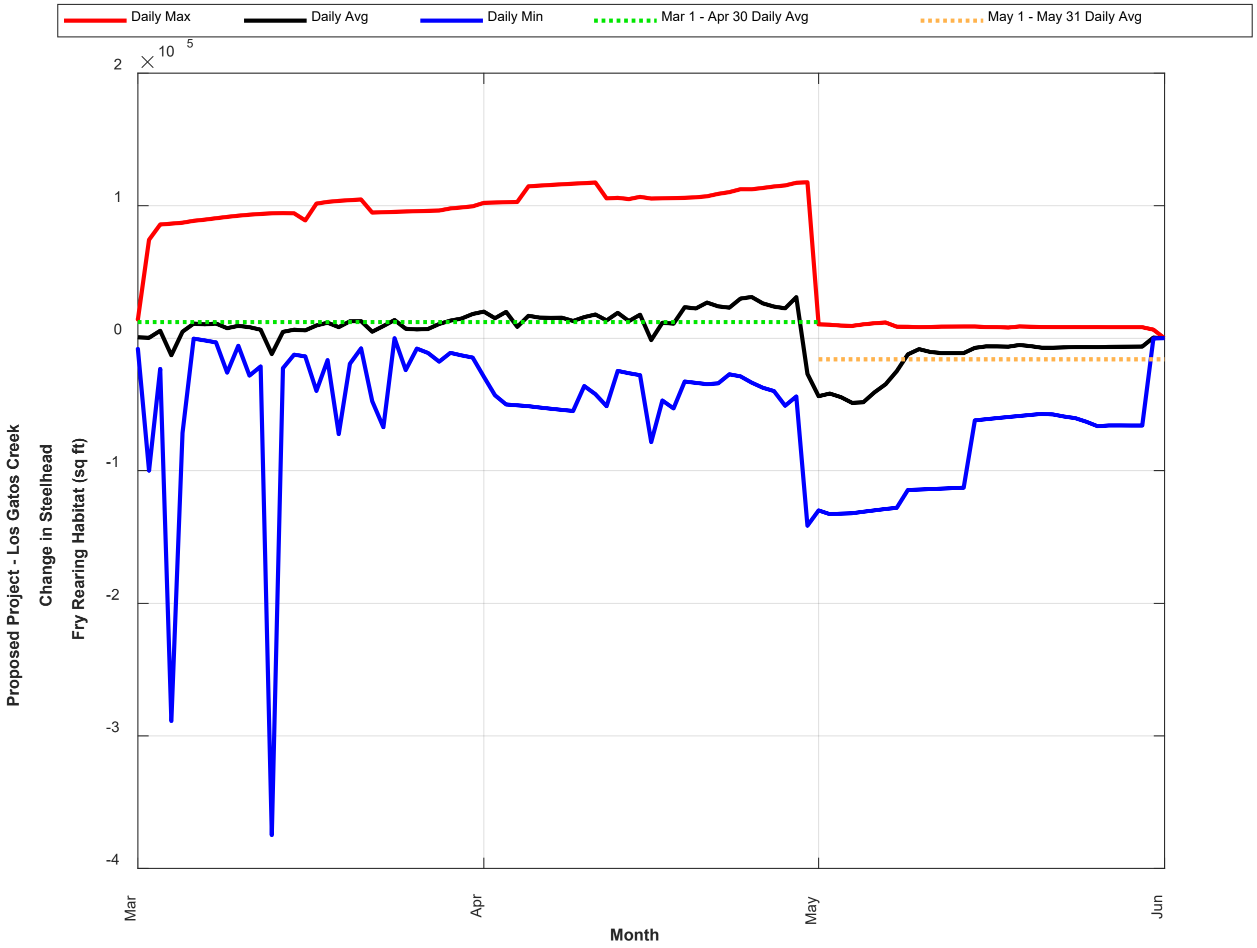
Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 1% (17,700 square feet) increase in suitable fry rearing habitat across POIs in the Guadalupe River compared with the future baseline (Figure 36; Table 25). There is 1,214,500 square feet of fry rearing habitat in the Guadalupe River under the future baseline.

Figure 36. Change in Steelhead Fry Rearing Habitat in the Guadalupe River



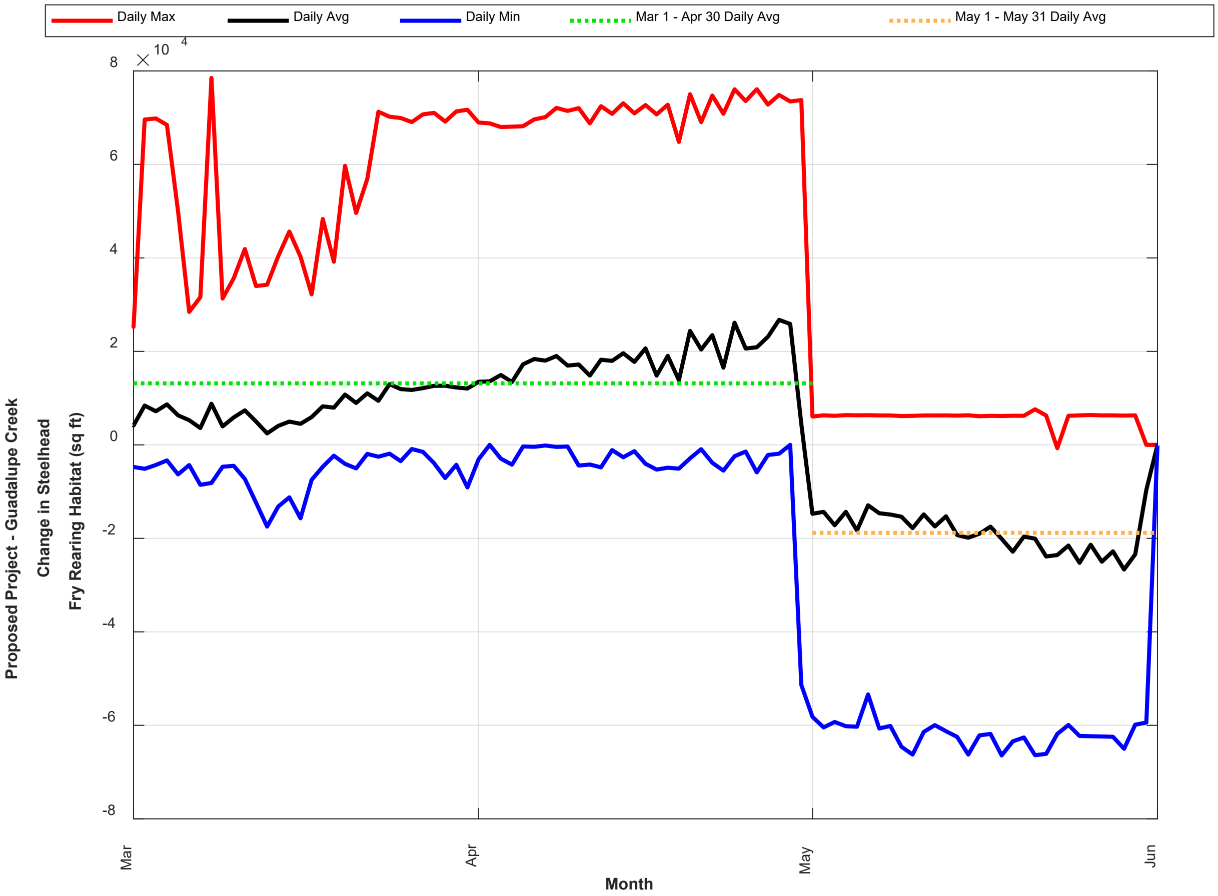
Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a less than 1% (2,000 square feet) average increase in fry rearing habitat across POIs in Los Gatos Creek compared with the future baseline (Figure 37; Table 26). During Winter Base Flow Operations from March to April, fry rearing habitat would increase by 3%. However, fry rearing habitat would decrease by 4% during the Summer Release Program in May (Figure 37; Table 26), likely attributable to decreased wetted area in Los Gatos Creek.

Figure 37. Change in Steelhead Fry Rearing Habitat in Los Gatos Creek



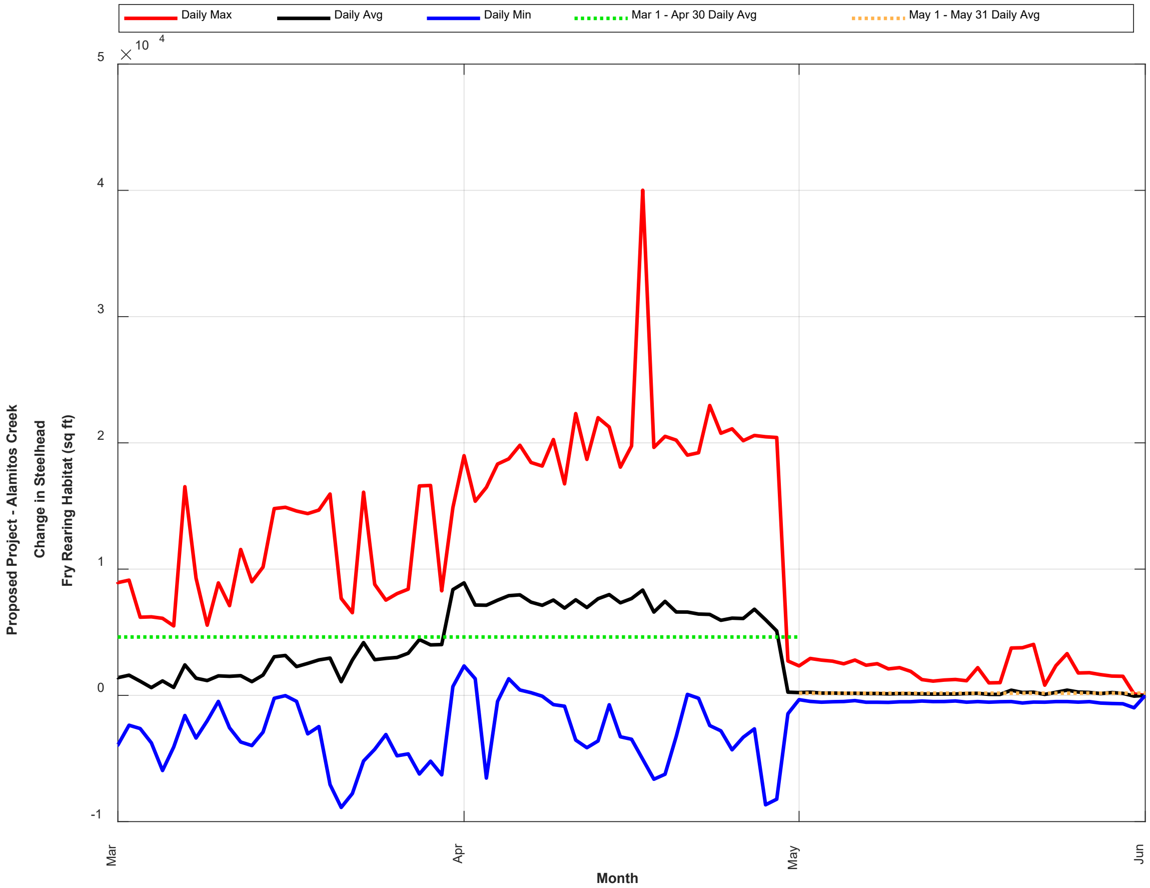
Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 3% (2,400 square feet) average increase across POIs in Guadalupe Creek compared with the future baseline (Figure 38; Table 27), although there was variability across POIs and over time. During Winter Base Flow Operations from March to April, fry rearing habitat would increase by 14%, but fry rearing habitat would decrease by 21% during the Summer Cold Water Program in May (Figure 38; Table 27) likely because of reduced wetted area and increased temperatures . In Guadalupe Creek and under the Summer Cold Water Program, fry rearing habitat would decrease at all POIs except the farthest upstream site in the CWMZ (GCRK 4). In the Guadalupe Creek CWMZ, fry rearing habitat would increase by 4% (1,000 square feet), with a less than 1% (200 square feet) increase during the Winter Base Flow Operations and an increase of 10% (2,400 square feet) during the Summer Cold Water Program with the Proposed Project (Table 27).

Figure 38. Change in Steelhead Fry Rearing Habitat in Guadalupe Creek



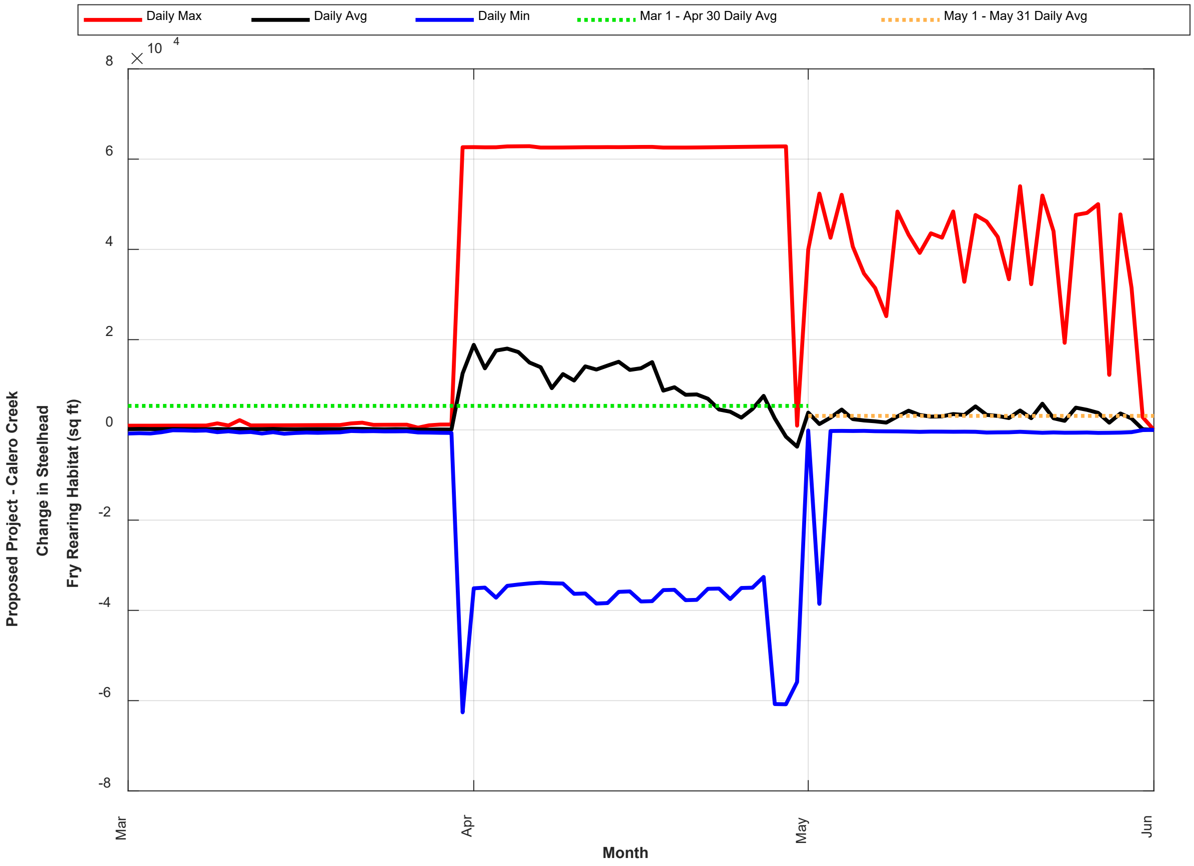
Based on the results of the FAHCE WEAP Model, compared with the future baseline, the Proposed Project would result in an 7% (4,620 square feet) average increase across POIs from March to April and remain relatively unchanged (0.3% difference) during the Summer Release Program (Figure 39; Table 28) in Alamitos Creek. Alamitos Creek has a large amount (66,570 square feet) of fry rearing habitat under future baseline.

Figure 39. Change in Steelhead Fry Rearing Habitat in Alamitos Creek



Based on the results of the FAHCE WEAP Model, there would be a 7% (4,480 square feet) increase in fry rearing habitat in Calero Creek compared with the future baseline with increases observed during both Winter Base Flow Operations and the Summer Release Program (Figure 40; Table 29) likely due to increased wetted area. The average increase during Winter Base Flow Operations does not completely characterize the change in fry rearing habitat during March. Habitat survey data input into the model indicated there was zero winter cover in the reach associated with the CALE 2 POI (that is, CALE 1 to CALE 2) and caused fry rearing habitat to be zero in March under all scenarios, but subsequent habitat surveys indicated there was winter cover (Valley Water 2019a, 2020). Variations in wetted area at CALE 2 in March under the Proposed Project compared to the future baseline (Attachment K.2 – Figures K.2.69 and K.2.70) suggest that there would be an increase in fry rearing habitat during the time when the model output predicts zero habitat in March. The largest increase in wetted area during the fry rearing habitat life stage would occur during March, so there would likely be a larger increase in fry rearing habitat in Calero Creek during Winter Base Flow Operations than estimated by the FAHCE WEAP Model results.

Figure 40. Change in Steelhead Fry Rearing Habitat in Calero Creek[a]



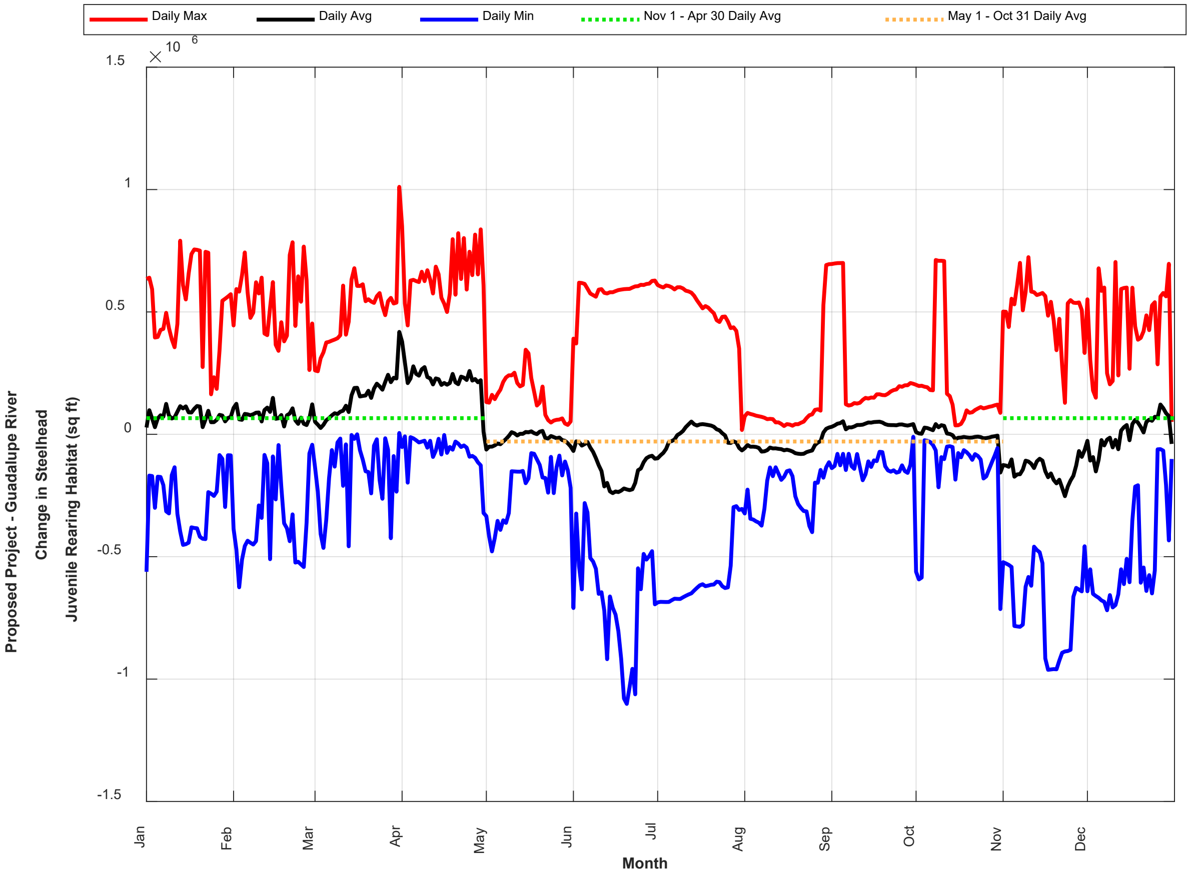
[a] Calero Creek habitat survey results in the reach between CALE 1 and CALE 2 input into the FAHCE WEAP Model did not record any winter cover, so fry and juvenile rearing habitat model results in this reach were zero during the period when winter cover is considered in the habitat estimate (that is, December 1 through March 31 for steelhead; January 1 through March 31 for Chinook salmon). Subsequent habitat surveys identified winter cover between CALE 1 and CALE 2 (Valley Water 2019a, 2020).

Overall, the Proposed Project would result in increases in fry rearing habitat within the Guadalupe River portion of the study area compared with the future baseline.

Juvenile Rearing Habitat

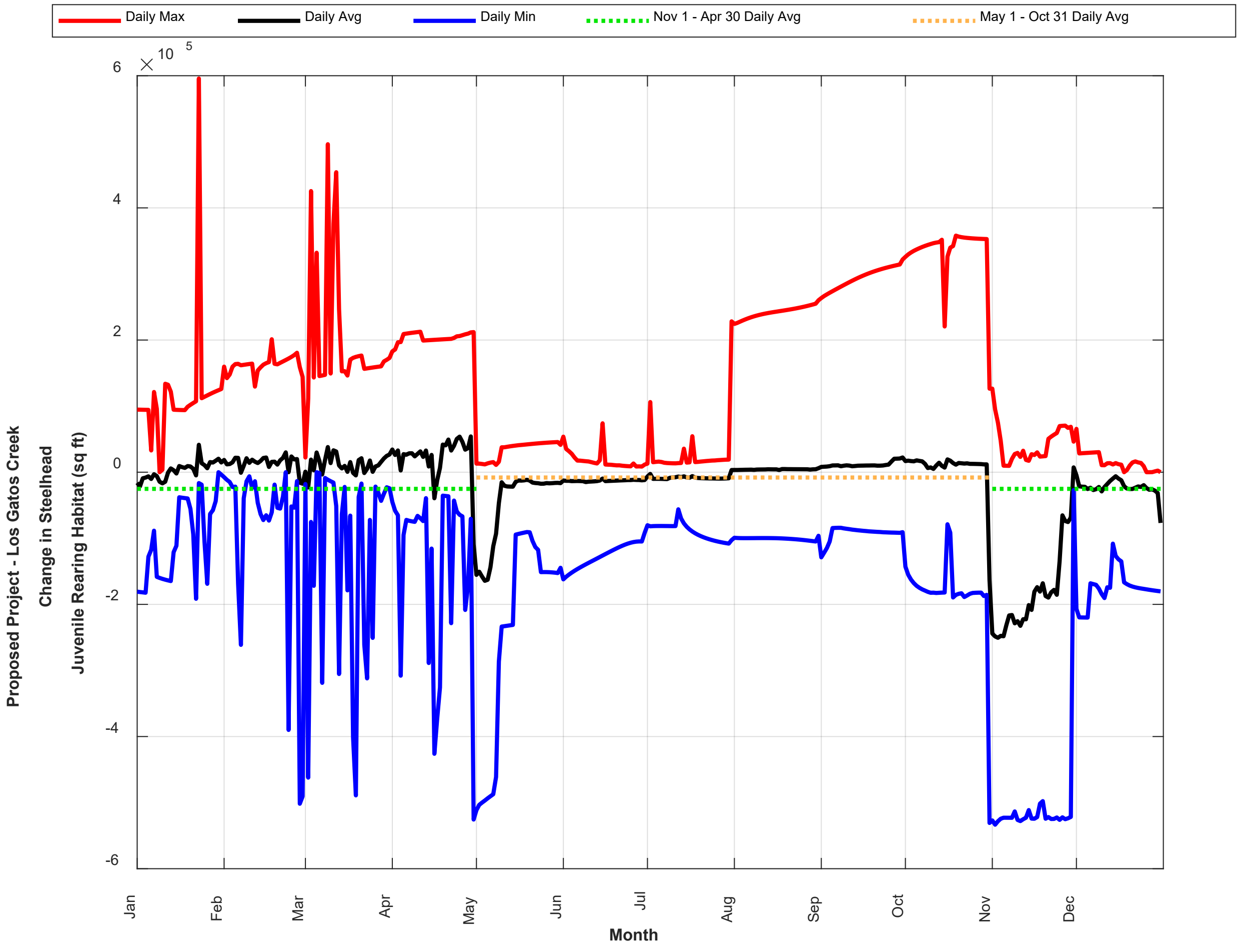
Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 2% (28,700 square feet) average increase across POIs in the Guadalupe River, with 5% increases during the Winter Base Flow Operations and 2% decreases during the Summer Release Program (Figure 41; Table 25). The largest decreases occurred in June and November (Figure 41), likely the result of reduced wetted area in both months and elevated water temperatures in June (Attachment K.2 – Figures K.2.21, K.2.22, K.2.23, and K.2.24). Juvenile rearing habitat is not limited in the Guadalupe River. There is 1,234,700 square feet of juvenile rearing habitat under future baseline conditions.

Figure 41. Change in Steelhead Juvenile Rearing Habitat in the Guadalupe River



Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 5% (17,000 square feet) average decrease across POIs in Los Gatos Creek, compared with the future baseline (Figure 42; Table 26). Decreases are modeled during both the Winter Base Flow Operations and Summer Release Program period, with the largest decreases occurring in May and November (Figure 42), likely the result of reduced wetted area in both months and elevated water temperatures in May (Attachment K.2 – Figures K.2.33, K.2.34, K.2.35, and K.2.36). Los Gatos Creek contains a large amount (348,000 square feet) of modeled juvenile rearing habitat under the future baseline.

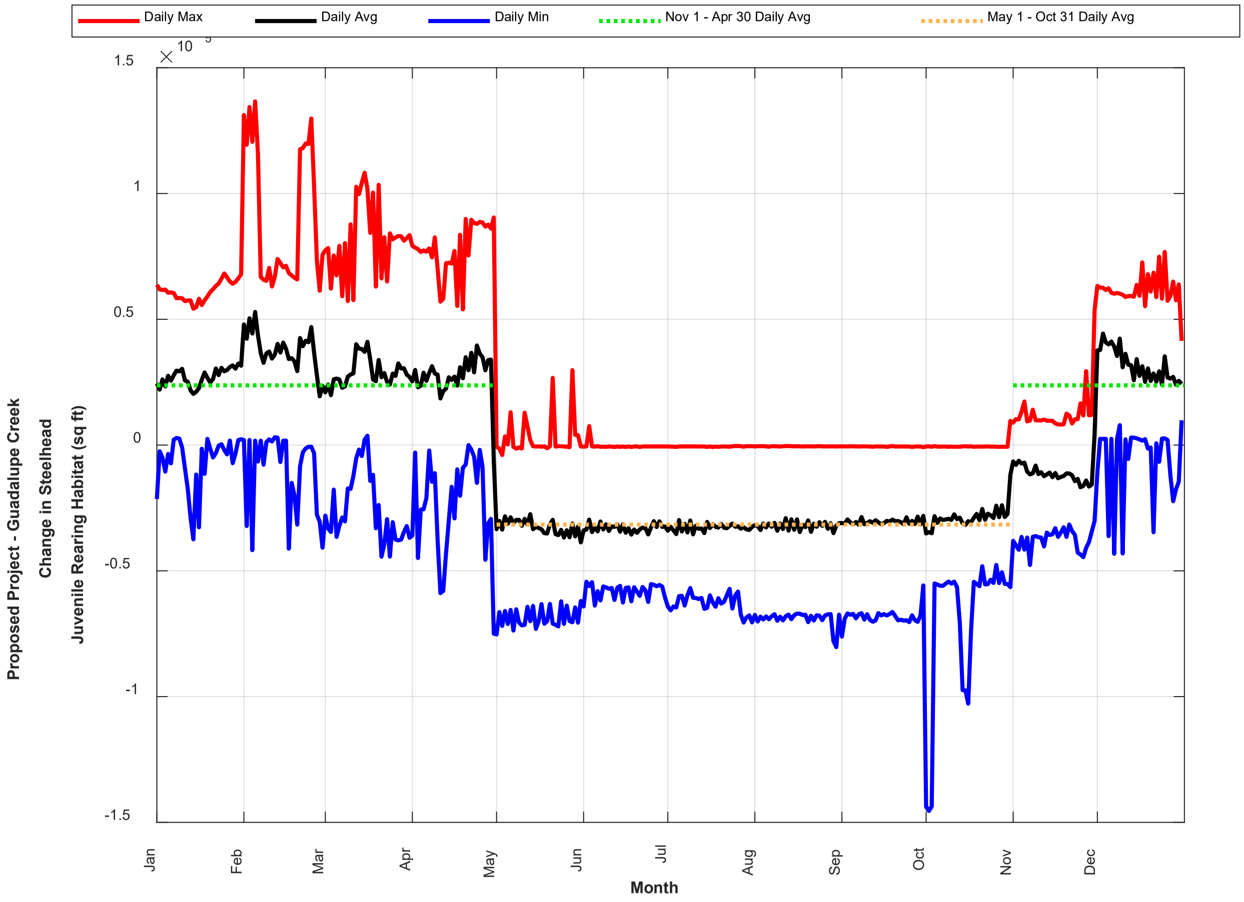
Figure 42. Change in Steelhead Juvenile Rearing Habitat in Los Gatos Creek



Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 6% (4,090 square feet) average decrease across POIs in Guadalupe Creek compared with the future baseline (Table 27) with a 35% (23,690 square feet) increase under the Proposed Project during Winter Base Flow Operations and a 53% (31,564 square feet) decrease during Summer Cold Water Program releases (Figure 43; Table 27). The decreases that are modeled during the Summer Cold Water Program that are downstream of the CWMZ are the result of reduced wetted area and increased water temperatures (Attachment K.2 – Figures K.2.35 and K.2.36).

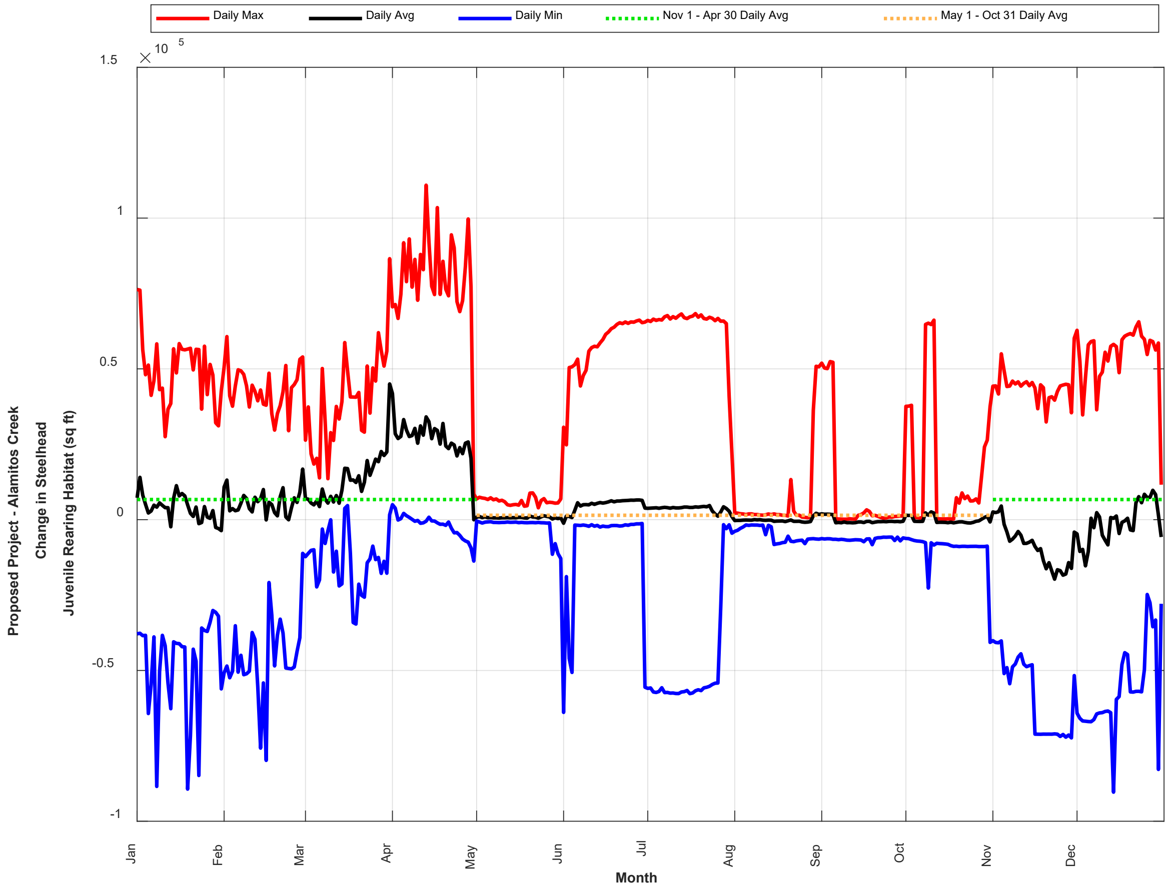
In the Guadalupe Creek CWMZ, modeled juvenile rearing habitat decreased by 11% (2,000 square feet), with a 65% (8,500 square feet) increase observed during the Winter Base Flow Operations and a decrease of 53% (12,300 square feet) observed during the Summer Cold Water Program. Decreases in juvenile rearing habitat in the Guadalupe Creek CWMZ during the Summer Cold Water Program are likely due to a decrease in wetted area, as MWATs remain below 65°F throughout the juvenile rearing period under the Proposed Project (Attachment K.2 – Figures K.2.35 and K.2.36). There would be a large amount (63,740 square feet) of juvenile rearing habitat available in Guadalupe Creek under the future baseline.

Figure 43. Change in Steelhead Juvenile Rearing Habitat in Guadalupe Creek



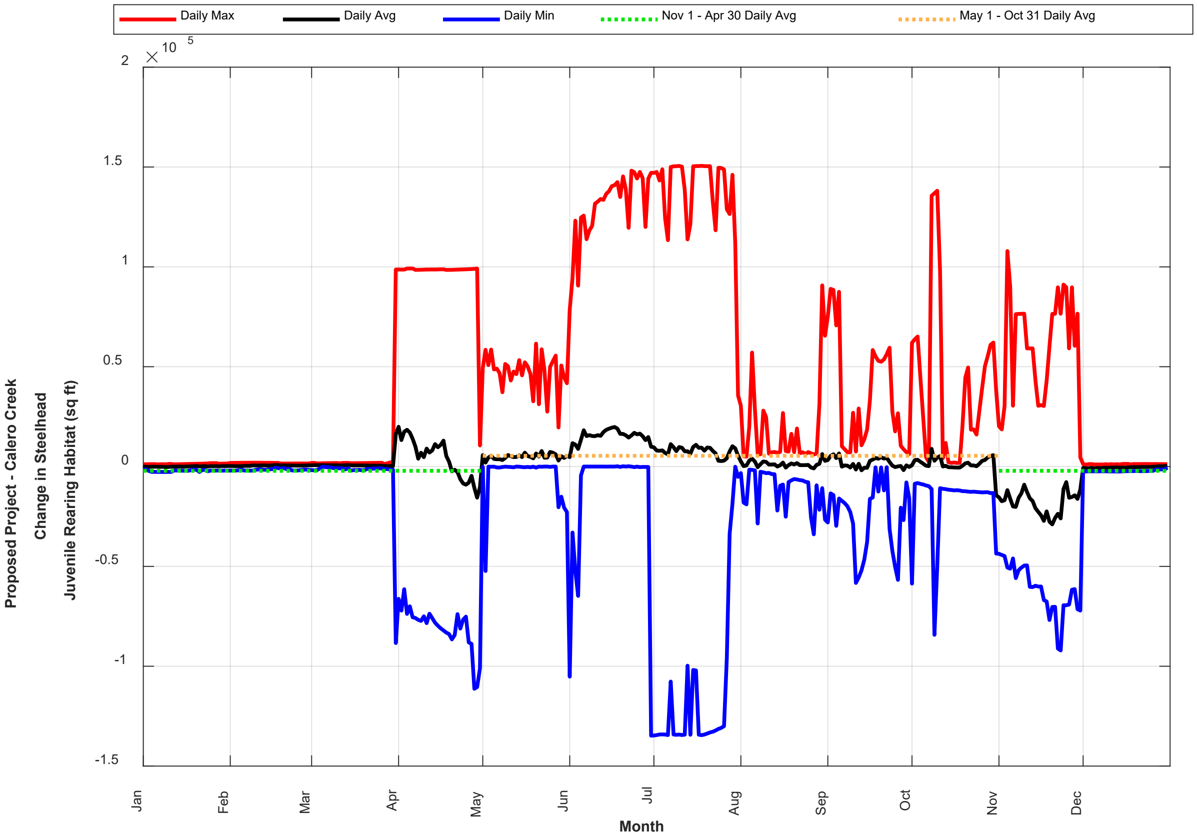
Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 6% (4,050 square feet) increase in suitable juvenile rearing habitat across POIs in Alamitos Creek compared with the future baseline (Table 28) with a 9% (6,720 square feet) increase under the Proposed Project during Winter Base Flow Operations and a 2% (1,500 square feet) increase during the Summer Release Program (Figure 44; Table 28).

Figure 44. Change in Steelhead Juvenile Rearing Habitat in Alamitos Creek



Based on the results of the FAHCE WEAP Model, there would be a 3% (1,660 square feet) increase in juvenile rearing habitat in Calero Creek compared with the future baseline (Figure 45; Table 29). The model estimated increase in juvenile rearing habitat is likely an underestimate because the model predicted zero juvenile rearing habitat in the reach associated with the CALE 2 POI during the December 1 to March 31 portion of Winter Base Flow Operations. As described for fry rearing habitat above, the model estimated zero rearing habitat because no winter cover was input into the CALE 2 reach of the model based on the available habitat survey data for the reach when modeling was conducted. Subsequent habitat surveys indicated there was winter cover (Valley Water 2019a, 2020). Variations in wetted area at CALE 2 from December 1 to March 31 under the Proposed Project compared to the future baseline indicate there would be increased juvenile rearing habitat during this time due to increases in wetted area (Attachment K.2 – Figures K.2.69 and K.2.70). The largest increase in wetted area in the CALE 2 reach of Calero Creek would occur from late December through March, so there would likely an increase in juvenile rearing habitat in Calero Creek during Winter Base Flow Operations rather than the than the 6% (2,120 square feet) average decrease estimated by the FAHCE WEAP Model results. A 6% (5,440 square feet) average increase during the Summer Cold Water Program releases.

Figure 45. Change in Steelhead Juvenile Rearing Habitat in Calero Creek[a]



[a] Calero Creek habitat survey results in the reach between CALE 1 and CALE 2 input into the FAHCE WEAP Model did not record any winter cover, so fry and juvenile rearing habitat model results in this reach were zero during the period when winter cover is considered in the habitat estimate (that is, December 1 through March 31 for steelhead; January 1 through March 31 for Chinook salmon). Subsequent habitat surveys identified winter cover between CALE 1 and CALE 2 (Valley Water 2019a, 2020).

The Proposed Project would result in overall increases to juvenile rearing habitat in the Guadalupe River, Alamitos Creek, and Calero Creek and overall decreases in Los Gatos Creek and Guadalupe Creek.

Migration Conditions

Adult Upstream Passage

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 2% (3 days per year) average increase to adult upstream passage at downstream sites in the Guadalupe River and increases in upstream passage at the upstream POIs compared with the future baseline (Figure 46; Table 30). On average, upstream passage was increased by 35% (23 days per year) at GUAD 6 and GUAD 7 (Figure 46; Table 30).

Figure 46. Change in Average Adult Steelhead Upstream Passage Days in the Guadalupe River

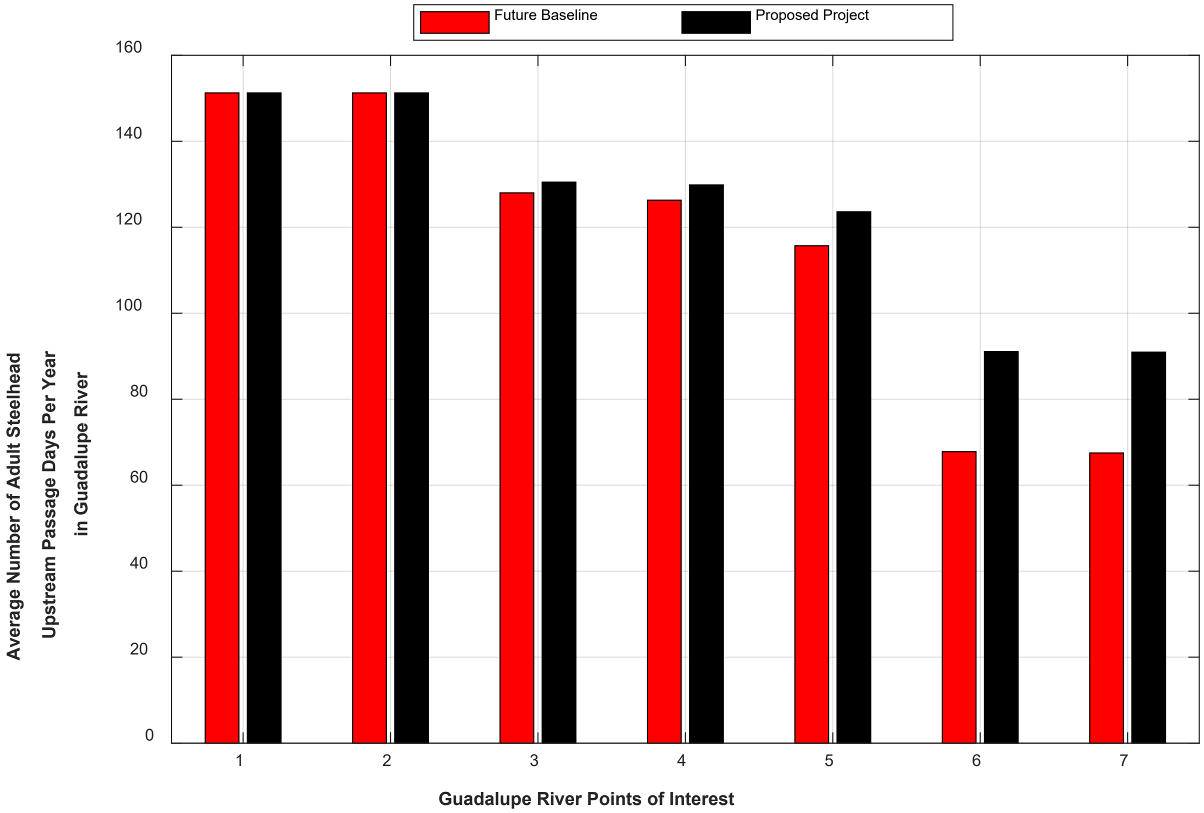


Table 30. Proposed Project Adult Steelhead Upstream Passage Compared with the Future Baseline in the Guadalupe River

Parameter	GUAD 1	GUAD 2	GUAD 3	GUAD 4	GUAD 5	GUAD 6	GUAD 7
Future Baseline (days)[a]							
Total Adult Upstream Passage (1991–2010)	3,025	3,025	2,560	2,526	2,314	1,356	1,350
Average Adult Upstream Passage Per Year	151	151	128	126	116	68	68
Proposed Project (days)[a]							
Total Adult Upstream Passage (1991–2010)	3,025	3,025	2,610	2,597	2,472	1,822	1,819
Average Adult Upstream Passage Per Year	151	151	131	130	124	91	91
Difference (days)							
Total Adult Upstream Passage (1991–2010)	0.00	0.00	50.00	71.00	158.00	466.00	469.00
Average Adult Upstream Passage Per Year	0.00	0.00	2.50	3.55	7.90	23.30	23.45

Parameter	GUAD 1	GUAD 2	GUAD 3	GUAD 4	GUAD 5	GUAD 6	GUAD 7
Difference (%)							
Total Adult Upstream Passage (1991–2010)	0.00	0.00	1.95	2.81	6.83	34.37	34.74
Average Adult Upstream Passage Per Year	0.00	0.00	1.95	2.81	6.83	34.37	34.74

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 3% (1 day per year) average decrease to adult upstream passage in Los Gatos Creek compared with the future baseline (Figure 47; Table 31). There are 38 days of upstream passage provided under the future baseline (Table 31).

Figure 47. Change in Average Adult Steelhead Upstream Passage Days in Los Gatos Creek

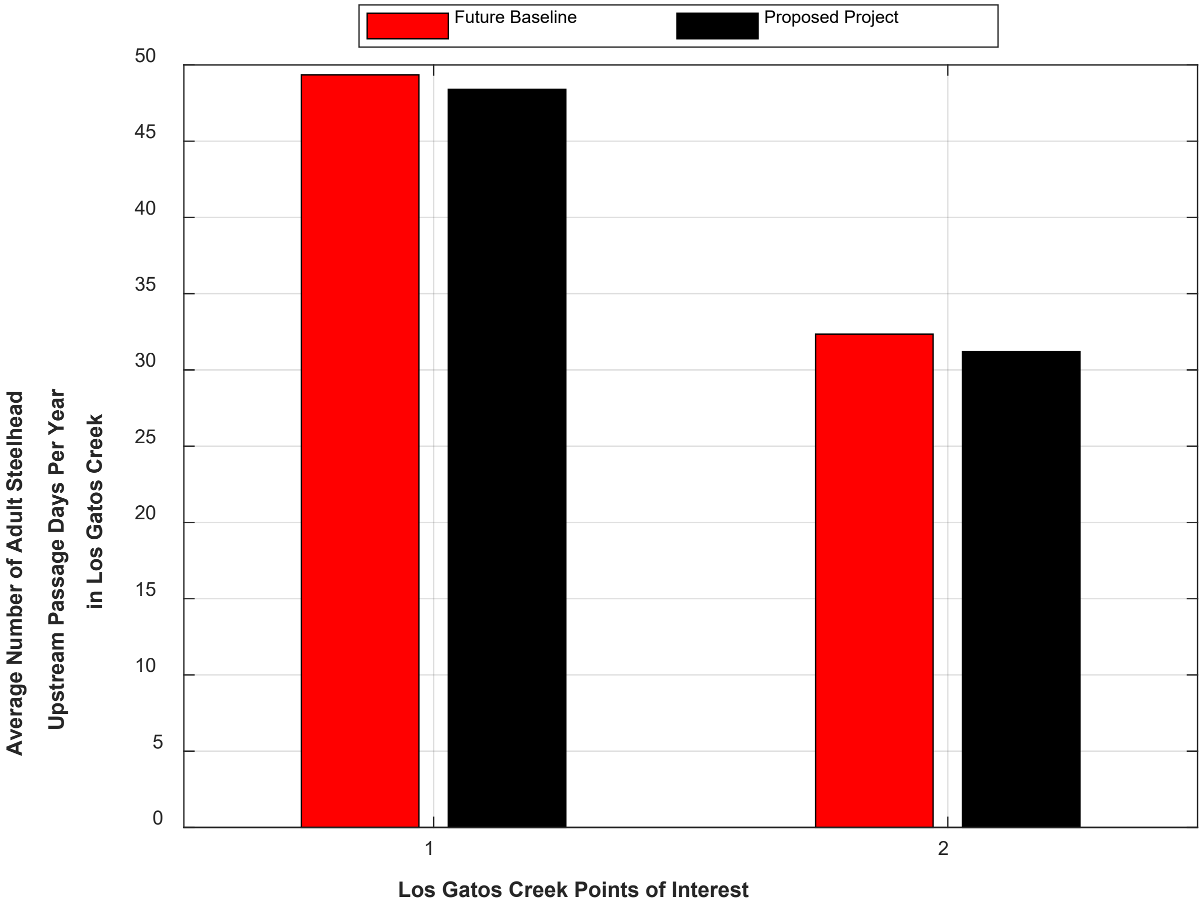


Table 31. Proposed Project 2035 Adult Steelhead Upstream Passage Compared with the Future Baseline in Los Gatos Creek

Parameter	LOSG 1	LOSG 2
Future Baseline (days)[a]		
Total Adult Upstream Passage (1991–2010)	987	647
Average Adult Upstream Passage Per Year	49	32
Proposed Project (days)[a]		
Total Adult Upstream Passage (1991–2010)	968	624
Average Adult Upstream Passage Per Year	48	31
Difference (days)		
Total Adult Upstream Passage (1991–2010)	-19.00	-23.00
Average Adult Upstream Passage Per Year	-0.95	-1.15
Difference (%)		
Total Adult Upstream Passage (1991–2010)	-1.93	-3.55
Average Adult Upstream Passage Per Year	-1.93	-3.55

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in increases to adult upstream passage in Guadalupe Creek compared with the future baseline. On average, upstream passage would increase by 26% (4 days per year) (Figure 48; Table 32). There are limited passage opportunities under the future baseline (13 days per year on average) (Table 32).

Figure 48. Change in Average Adult Steelhead Upstream Passage Days in Guadalupe Creek

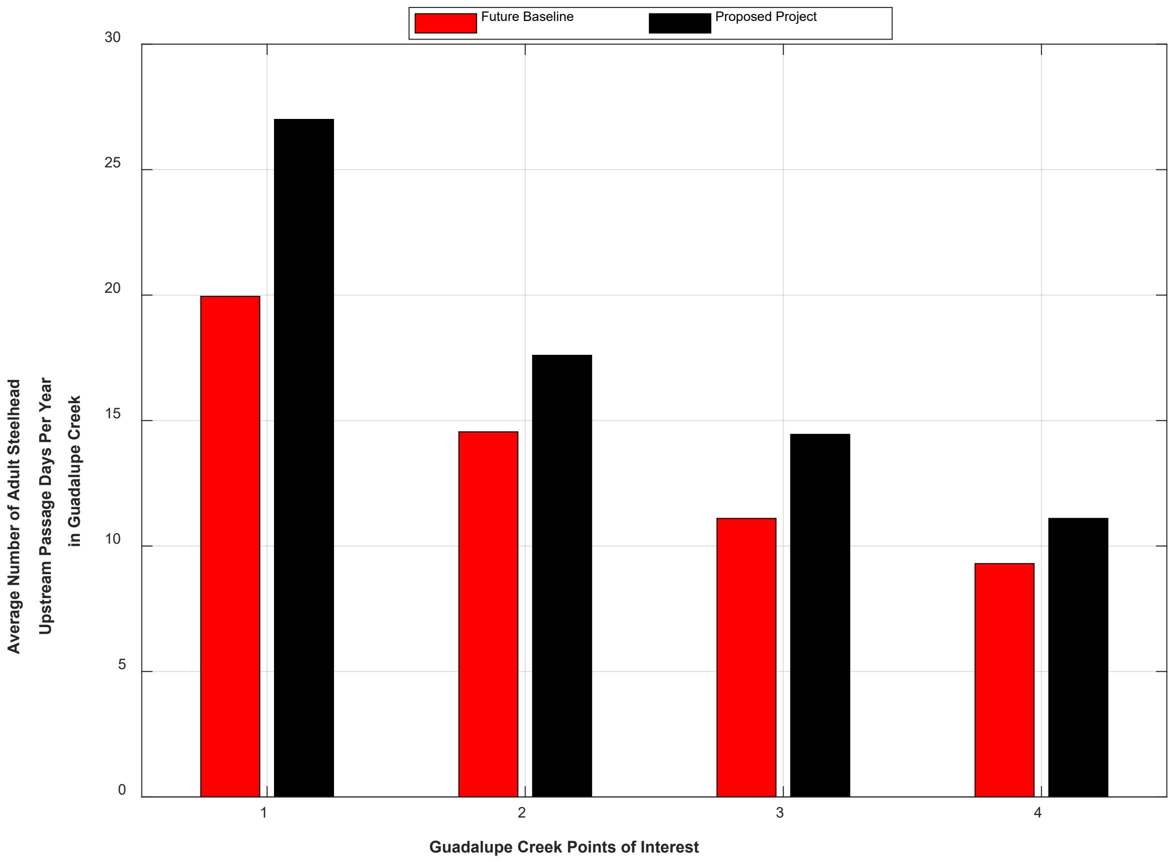


Table 32. Proposed Project Adult Steelhead Upstream Passage Compared with the Future Baseline in Guadalupe Creek

Parameter	GCRK 1	GCRK 2	GCRK 3	GCRK 4
Future Baseline (days)[a]				
Total Adult Upstream Passage (1991–2010)	399	291	222	186
Average Adult Upstream Passage Per Year	20	15	11	9
Proposed Project (days)[a]				
Total Adult Upstream Passage (1991–2010)	540	352	289	222
Average Adult Upstream Passage Per Year	27	18	14	11
Difference (days)				
Total Adult Upstream Passage (1991–2010)	141.00	61.00	67.00	36.00
Average Adult Upstream Passage Per Year	7.05	3.05	3.35	1.80

Parameter	GCRK 1	GCRK 2	GCRK 3	GCRK 4
Difference (%)				
Total Adult Upstream Passage (1991–2010)	35.34	20.96	30.18	19.35
Average Adult Upstream Passage Per Year	35.34	20.96	30.18	19.35

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in increases to adult upstream passage in Alamitos Creek at all POIs by an average of 30% (13 days per year) compared with the future baseline (Figure 49; Table 33).

Figure 49. Change in Average Adult Steelhead Upstream Passage Days in Alamitos Creek

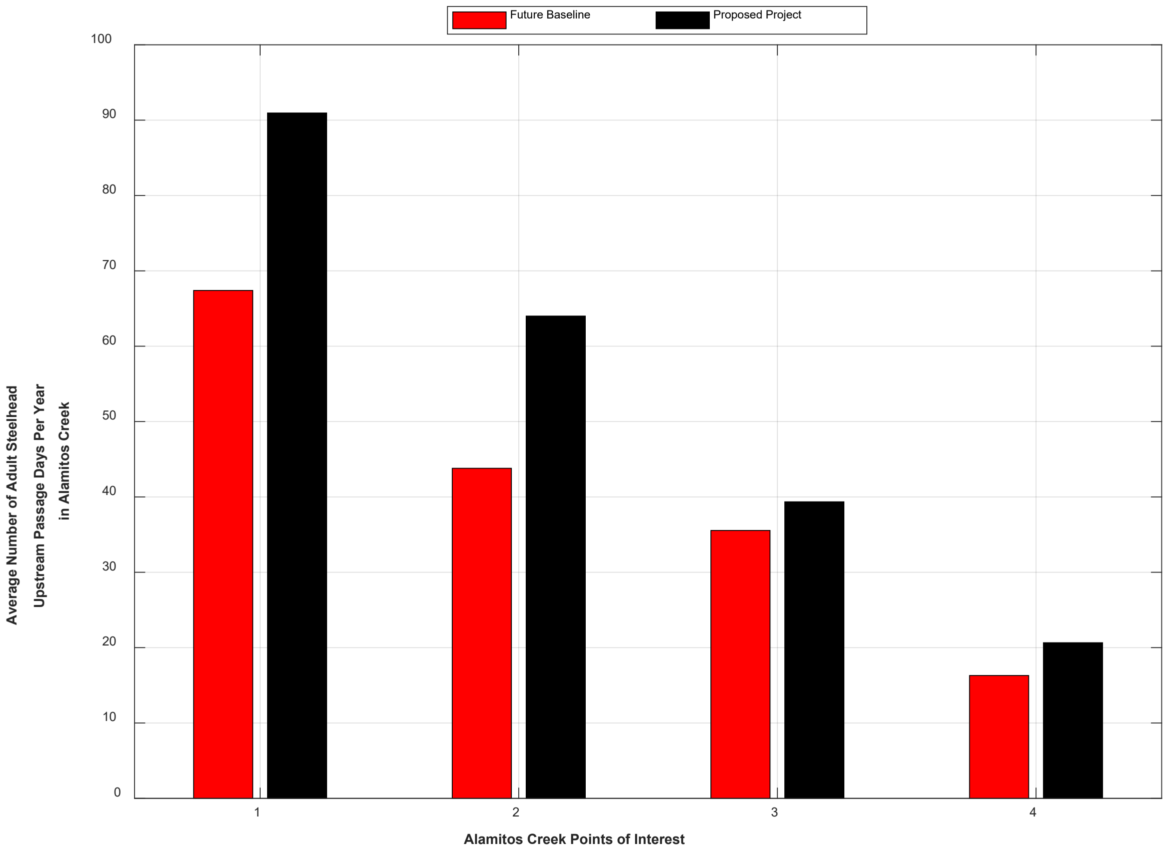


Table 33. Proposed Project Adult Steelhead Upstream Passage Compared with the Future Baseline in Alamitos Creek

Parameter	ALAM 1	ALAM 2	ALAM 3	ALAM 4
Future Baseline (days)[a]				
Total Adult Upstream Passage (1991–2010)	1,348	876	711	326
Average Adult Upstream Passage Per Year	67	44	36	16
Proposed Project (days)[a]				
Total Adult Upstream Passage (1991–2010)	1,819	1,280	787	413
Average Adult Upstream Passage Per Year	91	64	39	21
Difference (days)				
Total Adult Upstream Passage (1991–2010)	471.00	404.00	76.00	87.00
Average Adult Upstream Passage Per Year	23.55	20.20	3.80	4.35
Difference (%)				
Total Adult Upstream Passage (1991–2010)	34.94	46.12	10.69	26.69
Average Adult Upstream Passage Per Year	34.94	46.12	10.69	26.69

[a] Rounded to whole days

The Proposed Project would result in a 414% (9 days per year) average increase to adult upstream passage in Calero Creek compared with the future baseline (Figure 50; Table 34).

Figure 50. Change in Average Adult Steelhead Upstream Passage Days in Calero Creek

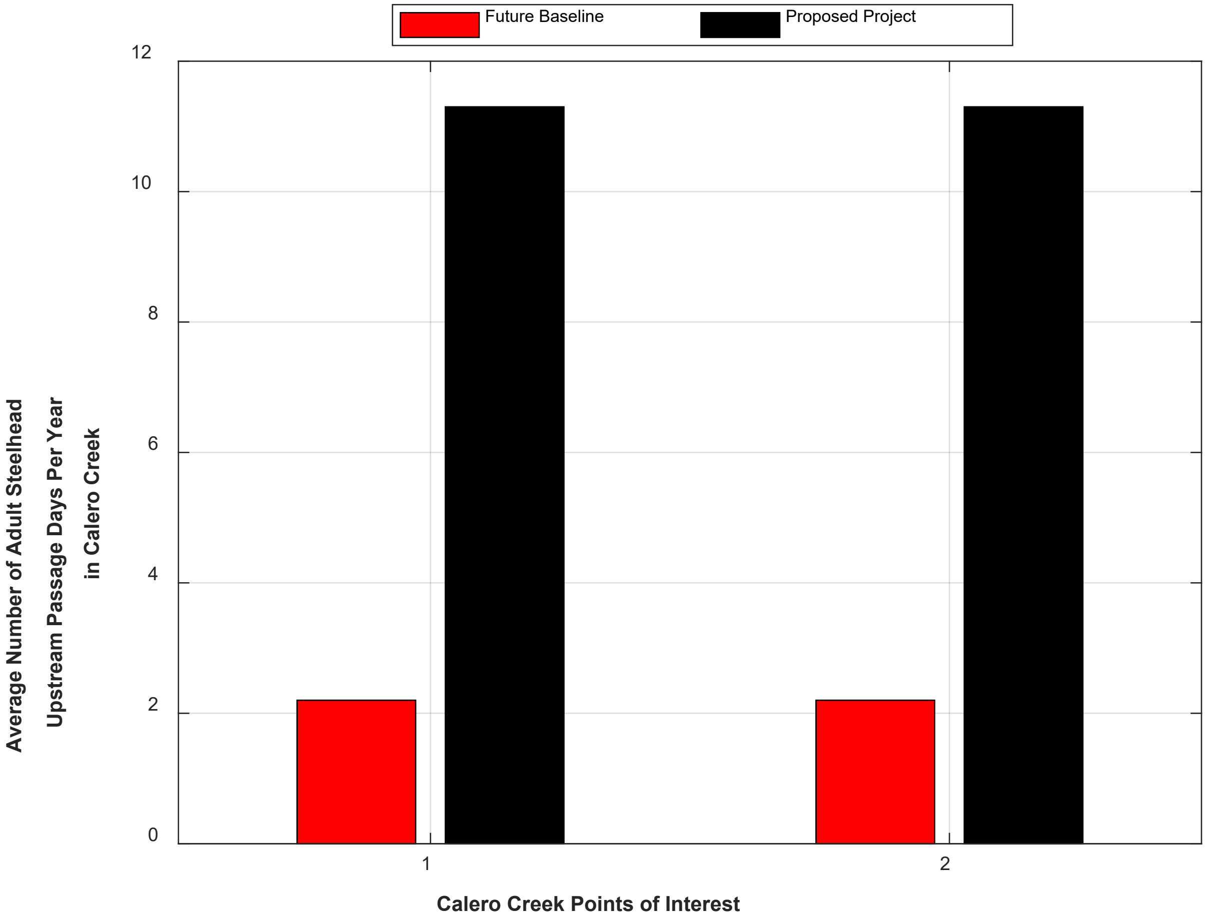


Table 34. Proposed Project Adult Steelhead Upstream Passage Compared with the Future Baseline in Calero Creek

Parameter	CALE 1	CALE 2
Future Baseline (days)[a]		
Total Adult Upstream Passage (1991–2010)	44	44
Average Adult Upstream Passage Per Year	2	2
Proposed Project (days)[a]		
Total Adult Upstream Passage (1991–2010)	226	226
Average Adult Upstream Passage Per Year	11	11
Difference (days)		
Total Adult Upstream Passage (1991–2010)	182.00	182.00
Average Adult Upstream Passage Per Year	9.10	9.10

Parameter	CALE 1	CALE 2
Difference (%)		
Total Adult Upstream Passage (1991–2010)	413.64	413.64
Average Adult Upstream Passage Per Year	413.64	413.64

[a] Rounded to whole days

The Proposed Project would result in additional upstream passage opportunities (an increase from the Proposed Project compared with the future baseline) for steelhead in the Guadalupe River portion of the study area compared with the future baseline.

Juvenile Downstream Passage

Based on the results of the FAHCE WEAP Model, the Proposed Project would increase juvenile downstream passage in the Guadalupe River by an average of 21% (7 days per year) compared with the future baseline (Figure 51; Table 35). Evaluating the juvenile downstream passage excluding the water temperature criteria used to calculate the FAHCE WEAP Model results, the Proposed Project would result in a 25% (16 days per year) average increase to juvenile downstream passage in the Guadalupe River compared with the future baseline (Table 35). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in the Guadalupe River under the Proposed Project compared to the future baseline. Additionally, there was no change in number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in the Guadalupe River under the Proposed Project compared to the future baseline.

Figure 51. Juvenile Steelhead Downstream Passage Days in the Guadalupe River

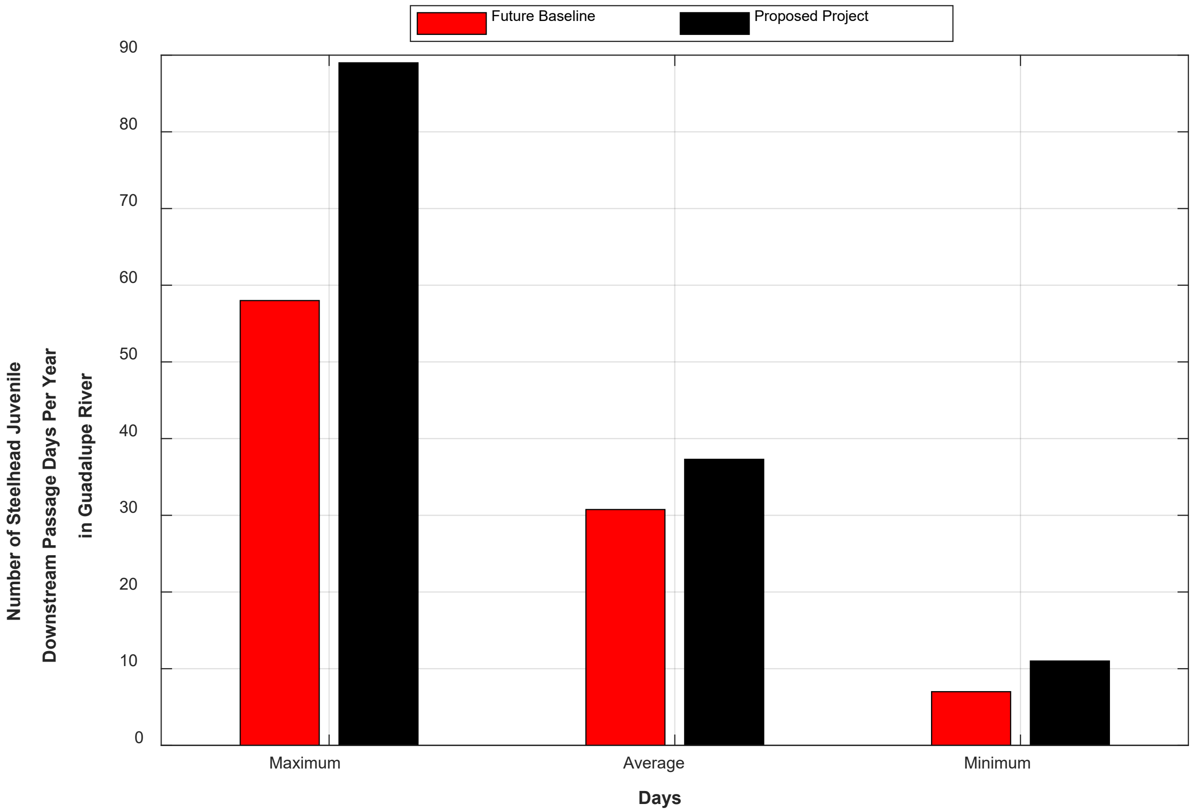


Table 35. Proposed Project Juvenile Steelhead Downstream Passage Compared with the Future Baseline in the Guadalupe River

Parameter	GUAD 7 with Water Temperature Criteria[b]	GUAD 7 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	615	1,255
Average Juvenile Downstream Passage Per Year	31	63
Proposed Project (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	746	1,576
Average Juvenile Downstream Passage Per Year	37	79
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	131.00	321.00
Average Juvenile Downstream Passage Per Year	6.00	16.00

Parameter	GUAD 7 with Water Temperature Criteria[b]	GUAD 7 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	21.30	25.58
Average Juvenile Downstream Passage Per Year	19.35	25.40

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in an 8% (3 days per year) average increase to juvenile downstream passage in Los Gatos Creek compared with the future baseline (Figure 52; Table 36). Evaluating the juvenile downstream passage excluding the water temperature criteria used to calculate the FAHCE WEAP Model results, the Proposed Project would result in a 13% (12 days per year) average increase to juvenile downstream passage in Los Gatos Creek compared with the future baseline (Table 36). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in Los Gatos Creek under the Proposed Project compared to the future baseline. Additionally, there was no change in number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in Los Gatos Creek under the Proposed Project compared to the future baseline.

Figure 52. Juvenile Steelhead Downstream Passage Days in Los Gatos Creek

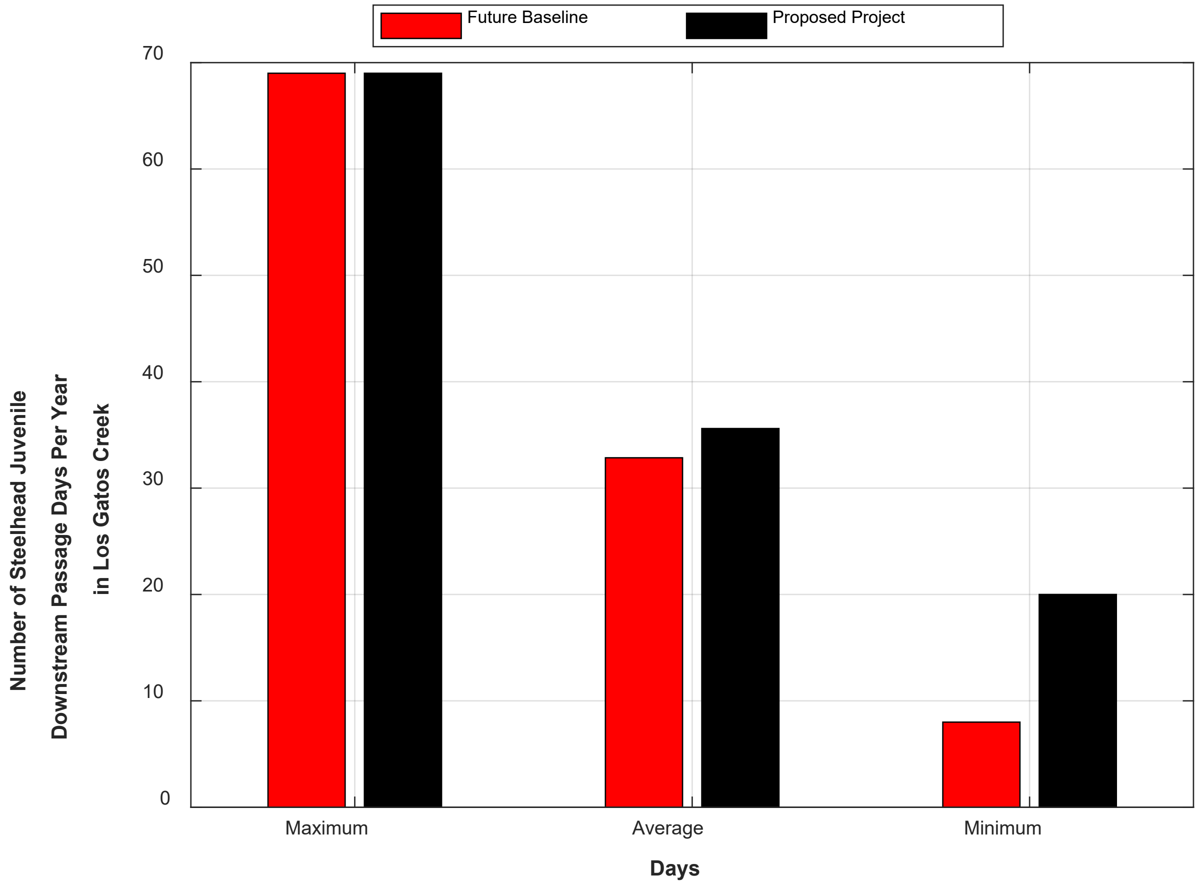


Table 36. Proposed Project Juvenile Steelhead Downstream Passage Compared with the Future Baseline in Los Gatos Creek

Parameter	LOSG 2 with Water Temperature Criteria[b]	LOSG 2 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	657	1,857
Average Juvenile Downstream Passage Per Year	33	93
Proposed Project (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	712	2,099
Average Juvenile Downstream Passage Per Year	36	105
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	55.00	242.00
Average Juvenile Downstream Passage Per Year	3.00	12.00

Parameter	LOSG 2 with Water Temperature Criteria[b]	LOSG 2 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	8.37	13.03
Average Juvenile Downstream Passage Per Year	9.09	12.90

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in an increase of juvenile downstream passage in Guadalupe Creek by an average of 212% (17 days per year) compared with the future baseline (Figure 53; Table 37). Evaluating the juvenile downstream passage excluding the water temperature criteria used to calculate the FAHCE WEAP Model results, the Proposed Project would result in an 87% (17 days per year) average increase to juvenile downstream passage in Guadalupe Creek compared with the future baseline (Table 37). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in Guadalupe Creek increased by seven under the Proposed Project compared to the future baseline. Additionally, the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in Guadalupe Creek increased by five under the Proposed Project compared to the future baseline.

Figure 53. Juvenile Steelhead Downstream Passage Days in Guadalupe Creek

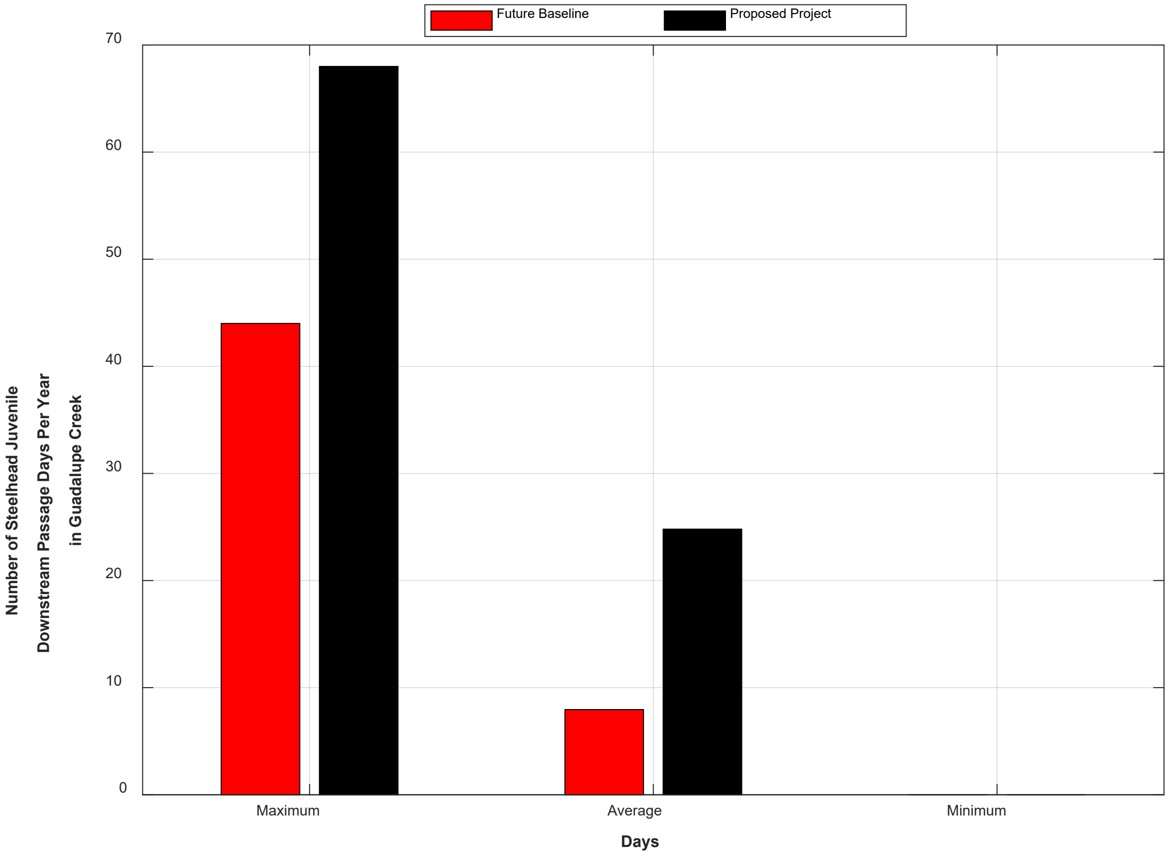


Table 37. Proposed Project Juvenile Steelhead Downstream Passage Compared with the Future Baseline in Guadalupe Creek

Parameter	GCRK 4 with Water Temperature Criteria[b]	GCRK 4 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	159	386
Average Juvenile Downstream Passage Per Year	8	19
Proposed Project (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	496	721
Average Juvenile Downstream Passage Per Year	25	36
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	337.00	335.00
Average Juvenile Downstream Passage Per Year	17.00	17.00

Parameter	GCRK 4 with Water Temperature Criteria[b]	GCRK 4 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	211.95	86.79
Average Juvenile Downstream Passage Per Year	212.50	89.47

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 16% (3 days on average per year) average increase to juvenile downstream passage in Alamitos Creek compared with the future baseline (Figure 54; Table 38). Evaluating the juvenile downstream passage excluding the water temperature criteria used to calculate the FAHCE WEAP Model results, the Proposed Project would result in a 29% (10 days per year) average increase to juvenile downstream passage in Alamitos Creek compared with the future baseline (Table 38). There was no change in the number years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in Alamitos Creek under the Proposed Project compared to the future baseline. The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in Alamitos Creek decreased by one under the Proposed Project compared to the future baseline.

Figure 54. Juvenile Steelhead Downstream Passage Days in Alamitos Creek

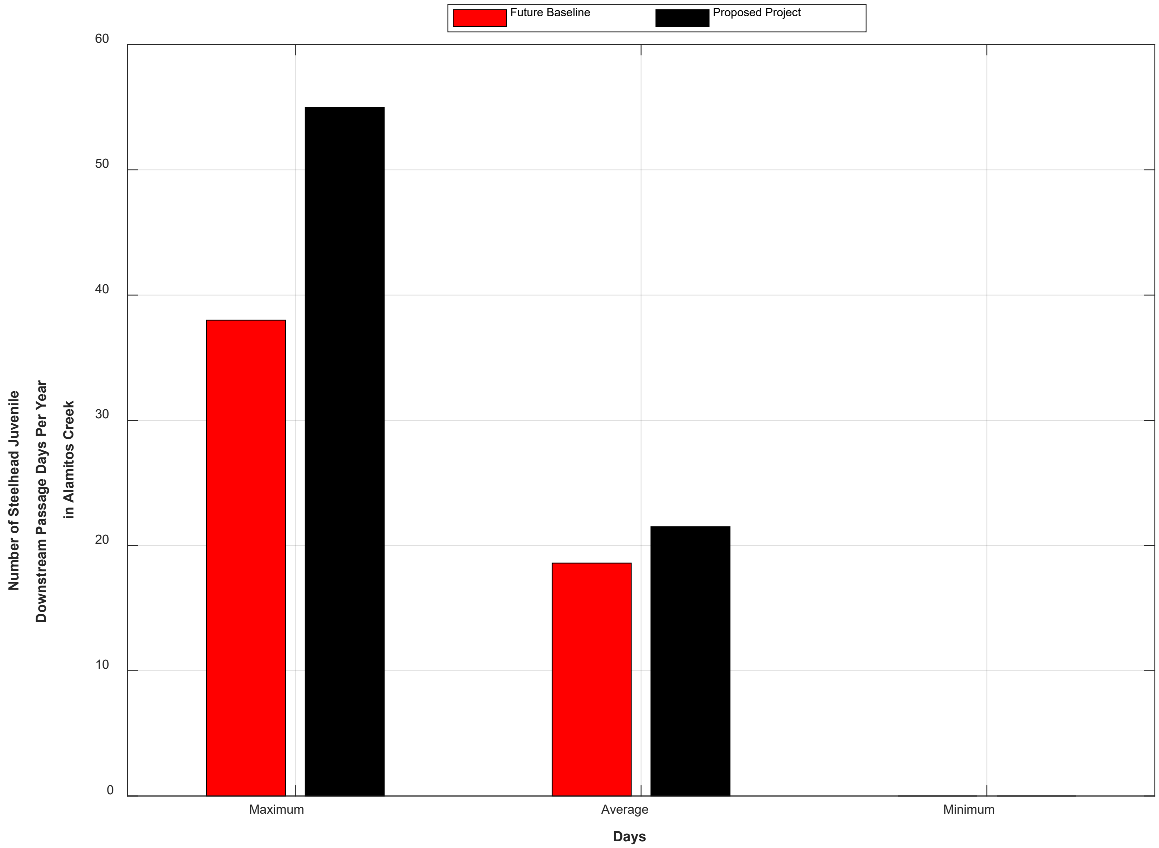


Table 38. Proposed Project Juvenile Steelhead Downstream Passage Compared with the Future Baseline in Alamitos Creek

Parameter	ALAM 4 with Water Temperature Criteria[b]	ALAM 4 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	372	700
Average Juvenile Downstream Passage Per Year	19	35
Proposed Project (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	430	902
Average Juvenile Downstream Passage Per Year	22	45
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	58.00	202.00
Average Juvenile Downstream Passage Per Year	3.00	10.00

Parameter	ALAM 4 with Water Temperature Criteria[b]	ALAM 4 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	15.59	28.86
Average Juvenile Downstream Passage Per Year	15.79	28.57

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

The Proposed Project would result in a 252% (21 days per year) average increase to juvenile downstream passage in in Calero Creek compared with the future baseline (Figure 55; Table 39). Evaluating the juvenile downstream passage excluding the water temperature criteria used to calculate the FAHCE WEAP Model results, the Proposed Project would result in a 282% (38 days per year) average increase to juvenile downstream passage in Calero Creek compared with the future baseline (Table 39). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in Calero Creek increased by seven under the Proposed Project compared to the future baseline. The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in Calero Creek increased by six under the Proposed Project compared to the future baseline.

Figure 55. Juvenile Steelhead Downstream Passage Days in Calero Creek

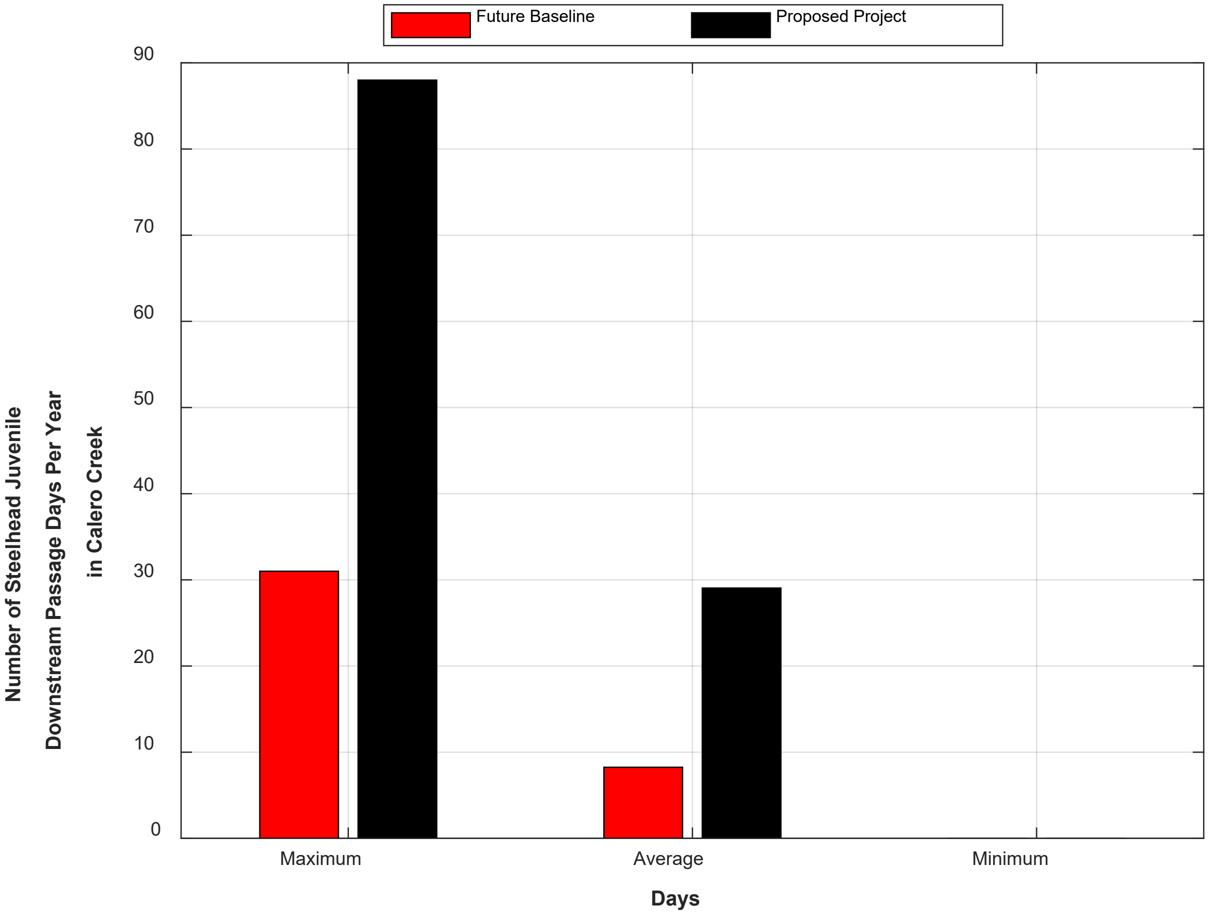


Table 39. Proposed Project Juvenile Steelhead Downstream Passage Compared with the Future Baseline in Calero Creek

Parameter	CALE 2 with Water Temperature Criteria[b]	CALE 2 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	165	267
Average Juvenile Downstream Passage Per Year	8	13
Proposed Project (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	581	1019
Average Juvenile Downstream Passage Per Year	29	51
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	416.00	752.00
Average Juvenile Downstream Passage Per Year	21.00	38.00

Parameter	CALE 2 with Water Temperature Criteria[b]	CALE 2 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	252.12	281.65
Average Juvenile Downstream Passage Per Year	262.50	292.31

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

The Proposed Project would improve juvenile downstream passage throughout the Guadalupe River portion of the study area compared with the future baseline.

1.5.2.2 Assessment of Chinook Salmon, Chinook Salmon Habitat, and Migration Conditions in the Guadalupe River Portion of the Study Area

Assessments of the effects of the Proposed Project on Chinook salmon, Chinook salmon habitat, and Chinook salmon migration within the Guadalupe River portion of the study area are provided in the following subsections.

Flow Measures Current Baseline Assessment

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, there would be an average decrease in effective spawning habitat in the Guadalupe River for Chinook salmon resulting from the Proposed Project. The Proposed Project would result in a 37% (4,478 square feet) average decrease in effective spawning habitat across POIs in the Guadalupe River compared with the current baseline (Figure 56; Table 40). The FAHCE WEAP Model results indicate that decreases in the effective spawning habitat would be due to MWAT exceeding the upper optimal thermal threshold for Chinook salmon (56°F) during the incubation period and decreased water depth (Attachment K.2 – Figures K.2.15, K.2.16, K.2.17, and K.2.18). Effective spawning habitat decreased at all POIs, with the largest decrease occurring at GUAD 3 in December (Figure 56). Overall, the Proposed Project would result in an average decrease of 4,478square feet of effective spawning habitat in the Guadalupe River.

Figure 56. Change in Chinook Salmon Effective Spawning Habitat in the Guadalupe River

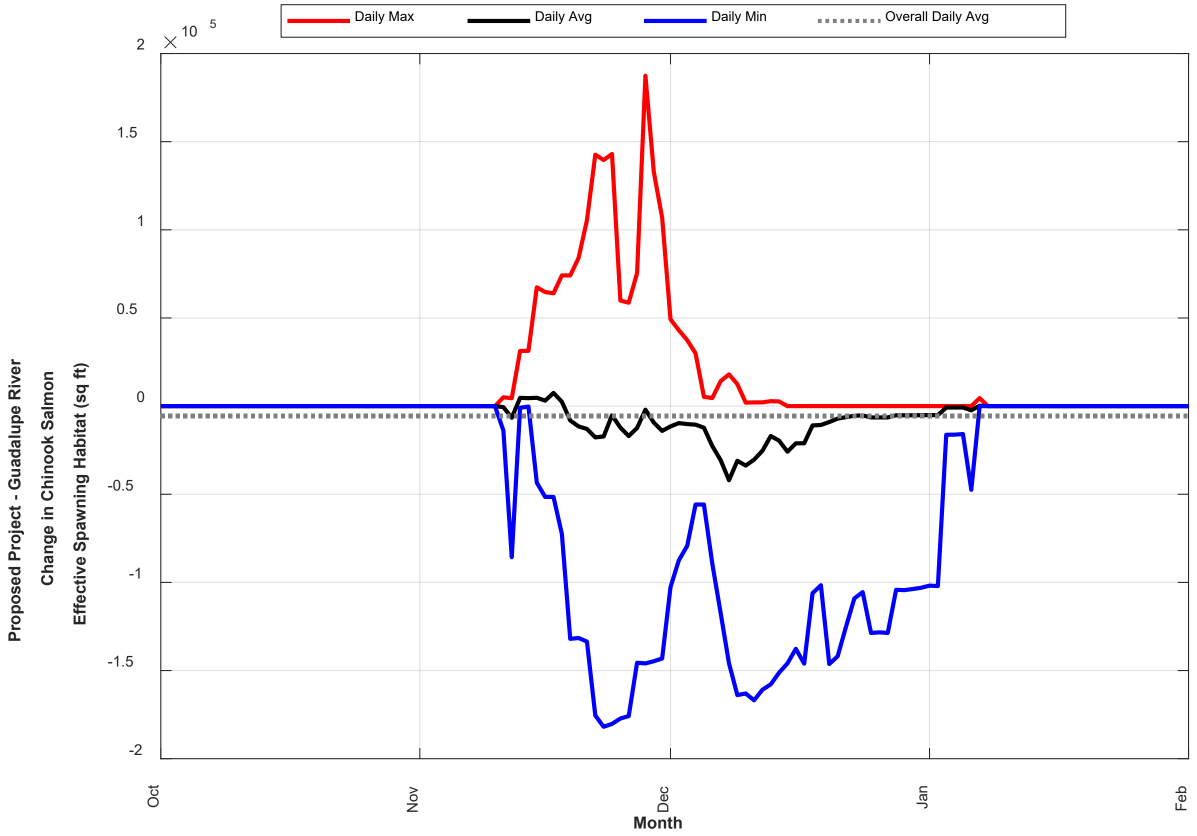


Table 40. Proposed Project Chinook Salmon Habitat Compared with the Current Baseline in the Guadalupe River

Guadalupe River[a,b]	**GUAD 3 River Mile 10.07**	**GUAD 4 River Mile 12.52**	**GUAD 5 River Mile 13.42**	**GUAD 6 River Mile 18.45**	**GUAD 7 River Mile 19.93**	**Total**
Chinook Salmon Habitat Current Baseline (sq ft)						
Effective Spawning	4,830	2,850	359	552	3,650	12,241
Fry Rearing Total (Jan 1–Apr 30)	211,000	199,000	93,400	561,000	395,000	1,459,400
Juvenile Rearing Total (Jan 1–Jun 30)	204,000	210,000	75,500	469,000	377,000	1,335,500
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	223,000	215,000	83,600	546,000	419,000	1486,600
Juvenile Rearing Summer Release Program (May 1–Jun 30)	166,000	199,000	59,200	317,000	293,000	1,034,200

Guadalupe River[a,b]	GUAD 3 River Mile 10.07	GUAD 4 River Mile 12.52	GUAD 5 River Mile 13.42	GUAD 6 River Mile 18.45	GUAD 7 River Mile 19.93	Total
Chinook Salmon Proposed Project (sq ft)						
Effective Spawning	2,610	1,790	312	441	2,610	7,763
Fry Rearing Total (Jan 1–Apr 30)	212,000	196,000	94,100	564,000	393,000	1,459,100
Juvenile Rearing Total (Jan 1–Jun 30)	203,000	208,000	74,100	470,000	370,000	1,325,100
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	224,000	216,000	83,700	556,000	417,000	1,496,700
Juvenile Rearing Summer Release Program (May 1–Jun 30)	161,000	192,000	55,000	300,000	276,000	984,000
Change in Habitat (sq ft)						
Effective Spawning	-2,220 (-45.96%)	-1,060 (-37.19%)	-47 (-13.09%)	-111 (-20.11%)	-1,040 (-28.49%)	-4,478 (-36.58%)
Fry Rearing Total (Jan 1–Apr 30)	1,000 (0.47%)	-3,000 (-1.51%)	700 (0.75%)	3,000 (0.53%)	-2,000 (-0.51%)	-300 (-0.02%)
Juvenile Rearing Total (Jan 1–Jun 30)	-1,000 (-0.49%)	-2,000 (-0.95%)	-1,400 (-1.85%)	1,000 (0.21%)	-7,000 (-1.86%)	-10,400 (-0.78%)
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	1,000 (0.45%)	1,000 (0.47%)	100 (0.12%)	10,000 (1.83%)	-2,000 (-0.48%)	10,100 (0.68%)
Juvenile Rearing Summer Release Program (May 1–Jun 30)	-5,000 (-3.01%)	-7,000 (-3.52%)	-4,200 (-7.09%)	-17,000 (-5.36%)	-17,000 (-5.8%)	-50,200 (-4.85%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

[b] No average daily habitat availability model results are available for the points of interest not shown.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in an 80% (5,088 square feet) average decrease in effective spawning habitat in Los Gatos Creek compared with the current baseline. Effective spawning habitat under the current baseline has a total area of 6,390 square feet, while the Proposed Project would reduce available effective spawning habitat to 1,302 square feet (Figure 57; Table 41). Average effective spawning habitat was decreased at both POIs, with the largest decrease occurring in November because of a decrease in flow that results in a significant decrease in wetted area in Los Gatos Creek (Attachment K.2 – Figures K.2.25, K.2.26, K.2.27, and K.2.28; Table 41).

Figure 57. Change in Chinook Salmon Effective Spawning Habitat in Los Gatos Creek

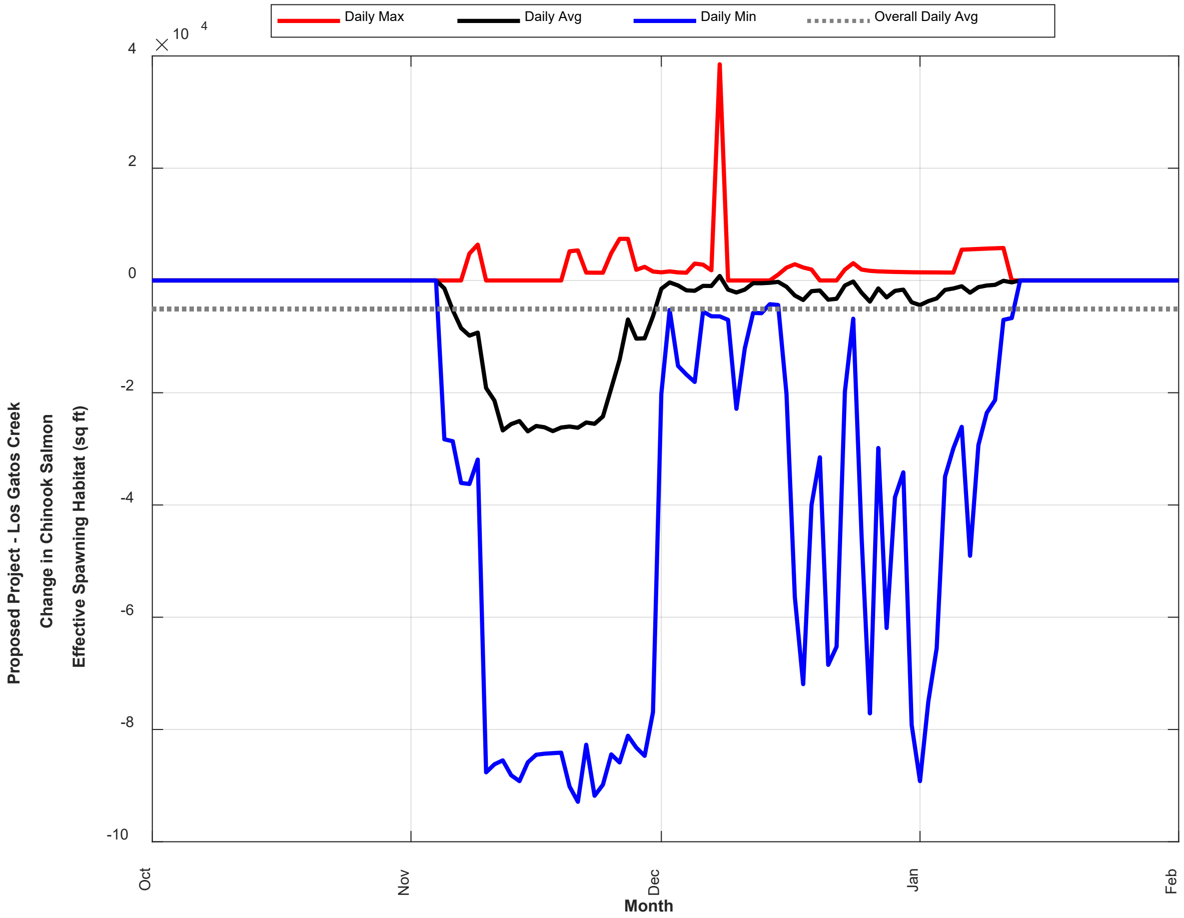


Table 41. Proposed Project Chinook Salmon Habitat Compared with the Current Baseline in Los Gatos Creek

Los Gatos Creek[a]	LOSG 1 River Mile 14.70	LOSG 2 River Mile 18.91	Total
Chinook Salmon Habitat Current Baseline (sq ft)			
Effective Spawning	2,810	3,580	6,390
Fry Rearing Total (Jan 1–Apr 30)	175,000	313,000	488,000
Juvenile Rearing Total (Jan 1–Jun 30)	139,000	253,000	392,000
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	142,000	251,000	393,000
Juvenile Rearing Summer Release Program (May 1–Jun 30)	133,000	256,000	389,000

Los Gatos Creek[a]	LOSG 1 River Mile 14.70	LOSG 2 River Mile 18.91	Total
Chinook Salmon Proposed Project (sq ft)			
Effective Spawning	513	789	1,302
Fry Rearing Total (Jan 1–Apr 30)	180,000	323,000	503,000
Juvenile Rearing Total (Jan 1–Jun 30)	141,000	259,000	400,000
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	149,000	266,000	415,000
Juvenile Rearing Summer Release Program (May 1–Jun 30)	125,000	245,000	370,000
Change in Habitat (sq ft)			
Effective Spawning	-2,297 (-81.74%)	-2,791 (-77.96%)	-5,088 (-79.62%)
Fry Rearing Total (Jan 1–Apr 30)	5,000 (2.86%)	10,000 (3.19%)	15,000 (3.07%)
Juvenile Rearing Total (Jan 1–Jun 30)	2,000 (1.44%)	6,000 (2.37%)	8,000 (2.04%)
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	7,000 (4.93%)	15,000 (5.98%)	22,000 (5.6%)
Juvenile Rearing Summer Release Program (May 1–Jun 30)	-8,000 (-6.02%)	-11,000 (-4.3%)	-19,000 (-4.88%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 100% (901 square feet) average increase in daily effective spawning habitat in Guadalupe Creek during the spawning and incubation life-stage period for Chinook salmon (that is, October 15 to January 31) compared with the current baseline (Figure 58; Table 42). In the Guadalupe Creek CWMZ, there would be a 60% (136 square foot) average increase in modeled Chinook salmon effective spawning habitat over the entire life stage. Modeled average effective spawning habitat in Guadalupe Creek increases to 1,799 square feet under the Proposed Project compared with 898 square feet under the current baseline. Changes in average effective spawning habitat under the Proposed Project would vary among POIs, but all POIs would have an average increase in the daily effective spawning habitat compared with the current baseline in Guadalupe Creek (Table 42).

Figure 58. Change in Chinook Salmon Effective Spawning Habitat in Guadalupe Creek

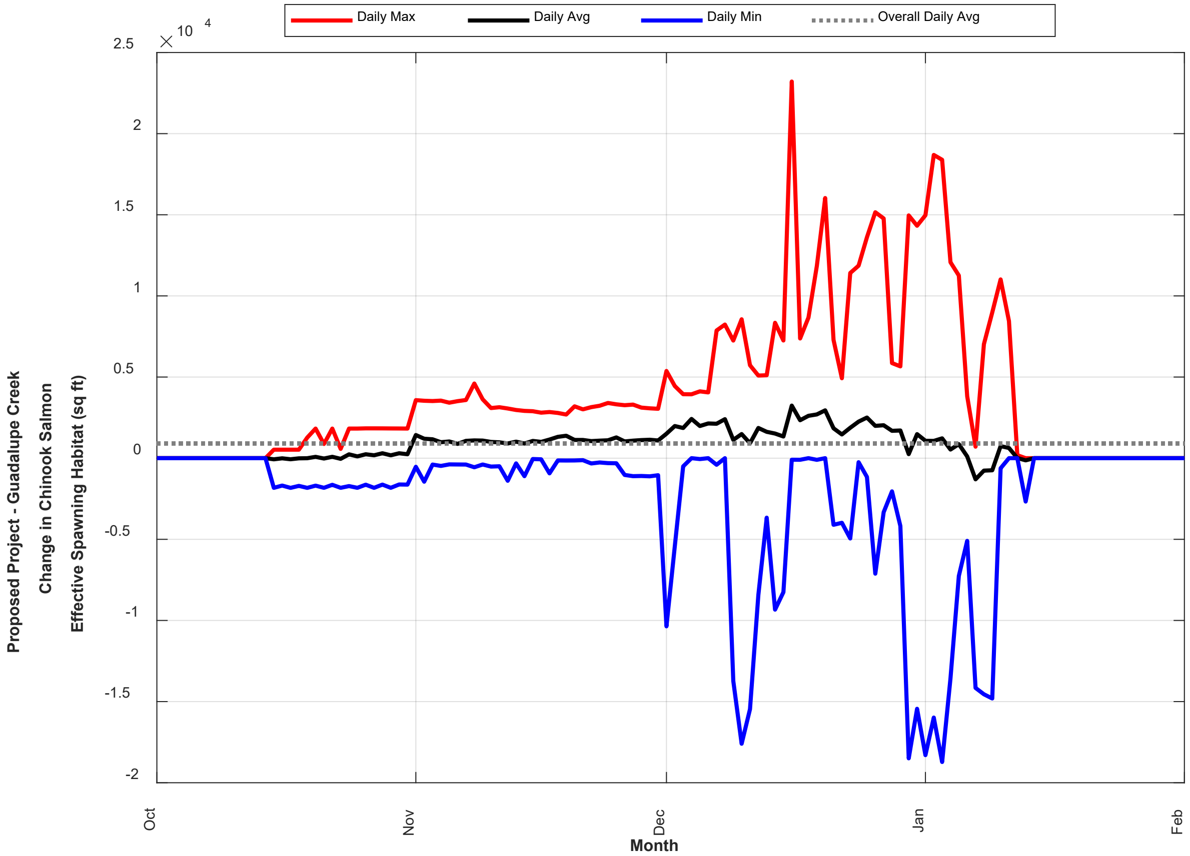


Table 42. Proposed Project Chinook Salmon Habitat Compared with the Current Baseline in Guadalupe Creek

Guadalupe Creek[a]	GCRK 1 River Mile 20.71	GCRK 2 River Mile 21.91	GCRK 3 River Mile 22.54	GCRK 4 River Mile 26.17	Total
Chinook Salmon Habitat Current Baseline (sq ft)					
Effective Spawning	92	522	58	227	898
Fry Rearing Total (Jan 1–Apr 30)	20,900	40,700	3,350	23,800	88,750
Juvenile Rearing Total (Jan 1–Jun 30)	15,100	40,400	3,580	22,400	81,480
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	20,300	42,600	3,580	20,400	86,880
Juvenile Rearing Summer Cold Water Program (May 1–Jun 30)	4,730	36,000	3,600	26,400	70,730

Guadalupe Creek[a]	GCRK 1 River Mile 20.71	GCRK 2 River Mile 21.91	GCRK 3 River Mile 22.54	GCRK 4 River Mile 26.17	Total
Chinook Salmon Proposed Project (sq ft)					
Effective Spawning	238	1,120	78	363	1,799
Fry Rearing Total (Jan 1–Apr 30)	23,400	47,300	3,350	24,000	98,050
Juvenile Rearing Total (Jan 1–Jun 30)	17,500	40,300	3,400	25,100	86,300
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	24,600	50,100	3,980	26,200	104,880
Juvenile Rearing Summer Cold Water Program (May 1–Jun 30)	3,470	20,800	2,270	22,800	49,340
Change in Habitat (sq ft)					
Effective Spawning	146.5 (160.11%)	598 (114.56%)	20.1 (34.78%)	136 (59.91%)	901 (100.26%)
Fry Rearing Total (Jan 1–Apr 30)	2,500 (11.96%)	6,600 (16.22%)	0 (0%)	200 (0.84%)	9,300 (10.48%)
Juvenile Rearing Total (Jan 1–Jun 30)	2,400 (15.89%)	-100 (-0.25%)	-180 (-5.03%)	2,700 (12.05%)	4,820 (5.92%)
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	4,300 (21.18%)	7,500 (17.61%)	400 (11.17%)	5,800 (28.43%)	18,000 (20.72%)
Juvenile Rearing Summer Cold Water Program (May 1–Jun 30)	-1,260 (-26.64%)	-15,200 (-42.22%)	-1,330 (-36.94%)	-3,600 (-13.64%)	-21,390 (-30.24%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 16% (76 square feet) average decrease in daily effective spawning habitat in Alamitos Creek during the spawning and incubation life-stage period for Chinook salmon (that is, October 15 to January 31) compared with the current baseline (Figure 59; Table 43). The decrease in effective spawning habitat would primarily occur during November through early December in the reach from ALAM 1 to ALAM 2 (represented by the model results at ALAM 2). While the average decrease over the entire effective spawning period at ALAM 2 was 210 square feet, the model estimates the average daily effective spawning habitat on individual days for Chinook salmon in this reach under the Proposed Project still would be between approximately 100 square feet to slightly over 500 square feet during November through early December. Modeled increases in the average daily effective spawning habitat between ALAM 2 and ALAM 3 (represented by the model results at ALAM 3) are relatively small under the Proposed Project compared to the current baseline, but the average daily effective spawning habitat between ALAM 3 and ALAM 4 (represented by the model results at ALAM 4) would more than double from approximately 150 square feet or less under the current baseline to approximately 350 square feet to 500 square feet under the Proposed Project. Additionally, average daily effective spawning habitat at ALAM 4 would consistently exceed 100 square feet from December through mid-January under the Proposed Project compared to only limited periods (for example, approximately a week) at the end of November and beginning of January under the current baseline.

Figure 59. Change in Chinook Salmon Effective Spawning Habitat in Alamitos Creek

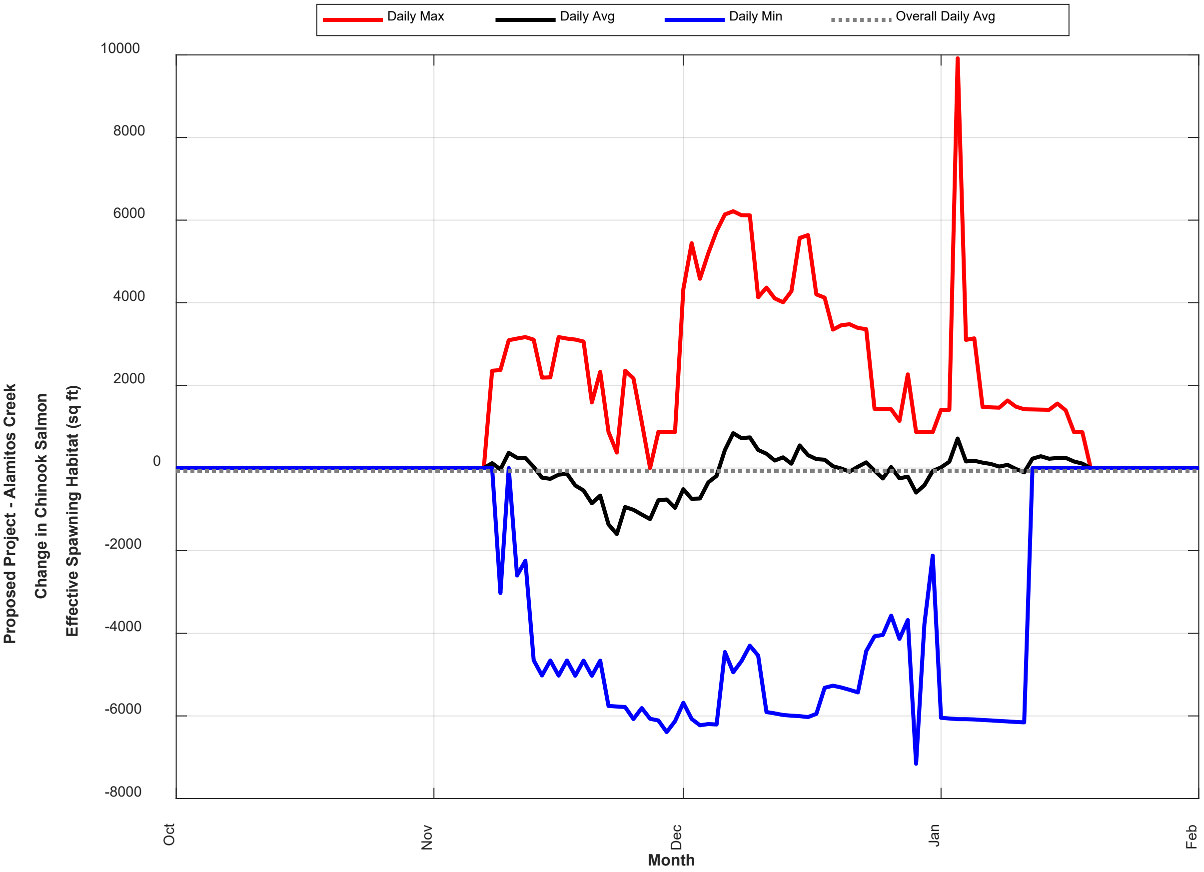


Table 43. Proposed Project Chinook Salmon Habitat Compared with the Current Baseline in Alamitos Creek

Alamitos Creek[a,b]	ALAM 2 River Mile 23.61	ALAM 3 River Mile 24.26	ALAM 4 River Mile 27.89	Total
Chinook Salmon Habitat Current Baseline (sq ft)				
Effective Spawning	421	9	34	464
Fry Rearing Total (Jan 1–Apr 30)	69,900	7,270	3,050	80,220
Juvenile Rearing Total (Jan 1–Jun 30)	66,000	6,970	3,250	76,220
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	70,800	7,430	2,950	81,180
Juvenile Rearing Summer Release Program (May 1–Jun 30)	56,500	6,050	3,850	66,400

Alamitos Creek[a,b]	ALAM 2 River Mile 23.61	ALAM 3 River Mile 24.26	ALAM 4 River Mile 27.89	Total
Chinook Salmon Proposed Project (sq ft)				
Effective Spawning	211	32	145	388
Fry Rearing Total (Jan 1–Apr 30)	69,700	7,930	3,460	81,090
Juvenile Rearing Total (Jan 1–Jun 30)	66,100	7,480	3,660	77,240
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	70,400	8,230	3,580	82,210
Juvenile Rearing Summer Release Program (May 1–Jun 30)	57,500	6,010	3,830	67,340
Change in Habitat (sq ft)				
Effective Spawning	-210 (-49.88%)	23 (255.56%)	111 (326.47%)	-76 (-16.38%)
Fry Rearing Total (Jan 1–Apr 30)	-200 (-0.29%)	660 (9.08%)	410 (13.44%)	870 (1.08%)
Juvenile Rearing Total (Jan 1–Jun 30)	100 (0.15%)	510 (7.32%)	410 (12.62%)	1,020 (1.34%)
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	-400 (-0.56%)	800 (10.77%)	630 (21.36%)	1,030 (1.27%)
Juvenile Rearing Summer Release Program (May 1–Jun 30)	1,000 (1.77%)	-40 (-0.66%)	-20 (-0.52%)	940 (1.42%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

[b] No average daily habitat availability model results are available for the points of interest not shown.

Based on the results of the FAHCE WEAP Model for average wetted area, effective spawning habitat would decrease across POIs in Calero Creek compared with the current baseline, which may decrease effective spawning habitat on average.

Table 44. Proposed Project Chinook Salmon Habitat Compared with the Current Baseline in Calero Creek

Calero Creek[a]	CALE 1 River Mile 24.33	CALE 2 River Mile 27.59	Total
Chinook Salmon Habitat Current Baseline (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (Jan 1–Apr 30)	2,840	26,000[c]	28,840[c]
Juvenile Rearing Total (Jan 1–Jun 30)	2,970	52,000[c]	54,970[c]
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	3,050	25,200[c]	28,250[c]
Juvenile Rearing Summer Release Program (May 1–Jun 30)	2,810	105,000	107,810

Calero Creek[a]	CALE 1 River Mile 24.33	CALE 2 River Mile 27.59	Total
Chinook Salmon Proposed Project (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (Jan 1–Apr 30)	2,640	21,800[c]	24,440[c]
Juvenile Rearing Total (Jan 1–Jun 30)	2,800	49,100[c]	51,900[c]
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	2,750	19,400[c]	22,150[c]
Juvenile Rearing Summer Release Program (May 1–Jun 30)	2,880	108,000	110,880
Change in Habitat (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (Jan 1–Apr 30)	-200 (-7.04%)	-4,200 (-16.15%)[c]	-4,400 (-15.26%)[c]
Juvenile Rearing Total (Jan 1–Jun 30)	-170 (-5.72%)	-2,900 (-5.58%)[c]	-3,070 (-5.58%)[c]
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	-300 (-9.84%)	-5,800 (-23.02%)[c]	-6,100 (-21.59%)[c]
Juvenile Rearing Summer Release Program (May 1–Jun 30)	70 (2.49%)	3,000 (2.86%)	3,070 (2.85%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

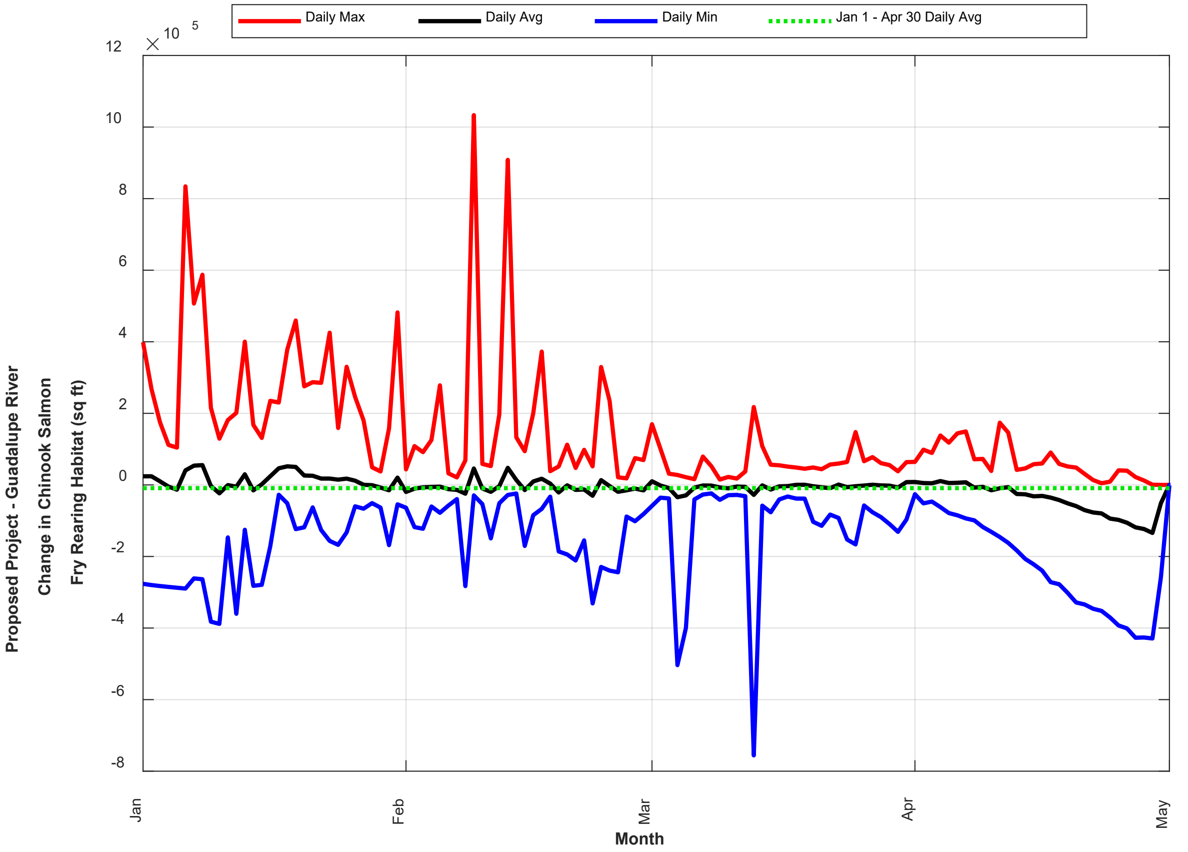
[b] Effective spawning model results were not available in Calero Creek because no substrate suitable for spawning was recorded by the subsample habitat survey of Calero Creek input into the FAHCE WEAP Model. Subsequent surveys indicate there is substrate suitable for spawning in Calero Creek (Valley Water 2019a, 2020).

[c] Average daily fry rearing and juvenile rearing habitat availability model results do not quantify conditions when winter cover was considered in the habitat estimate (January 1 through March 31 for Chinook salmon) since no winter cover was recorded by the subsample habitat survey of the CALE 2 reach of Calero Creek (that is, the reach between CALE 1 and CALE 2) input into the FAHCE WEAP Model. Subsequent surveys indicate there is winter cover available in this reach of Calero Creek (Valley Water 2019a, 2020).

Fry Rearing Habitat

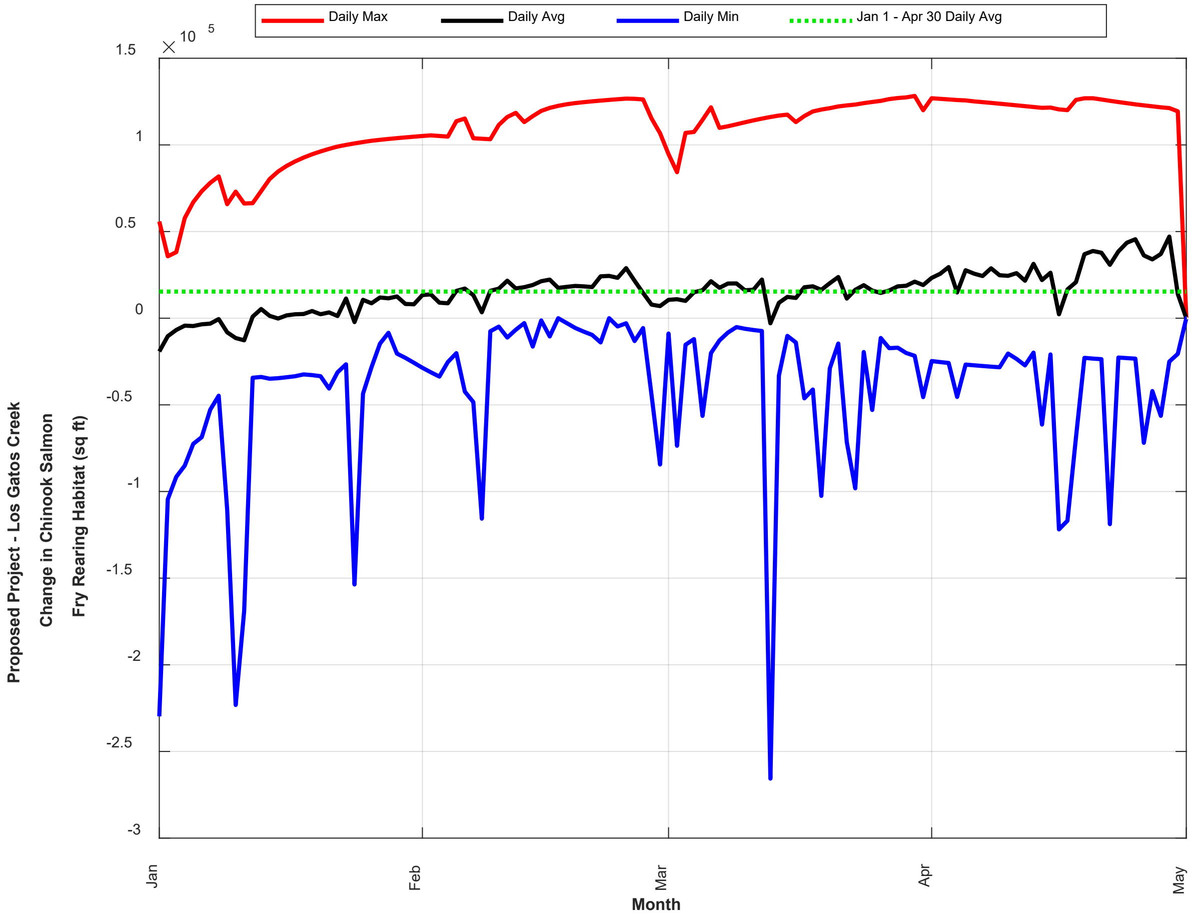
Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 0.02% (300 square feet) decrease in fry rearing habitat in the Guadalupe River for Chinook salmon resulting from the Proposed Project compared with the current baseline (Figure 60; Table 40).

Figure 60. Change in Chinook Salmon Fry Rearing Habitat in the Guadalupe River



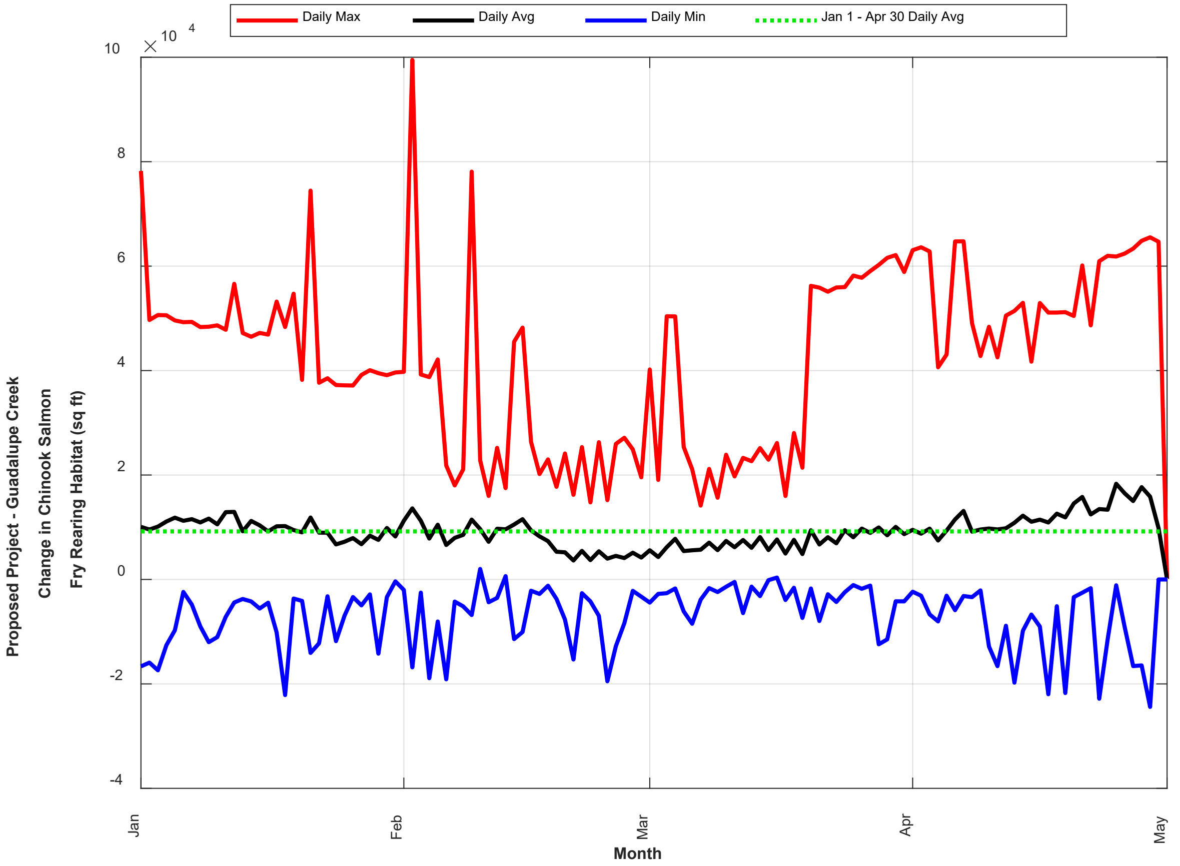
Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 3% (15,000 square feet) increase in suitable fry rearing habitat across POIs in Los Gatos Creek compared with the current baseline (Figure 61; Table 41). Fry rearing habitat in Los Gatos Creek would steadily increase throughout the fry rearing period (January 1 through April 30) under the Proposed Project.

Figure 61. Change in Chinook Salmon Fry Rearing Habitat in Los Gatos Creek



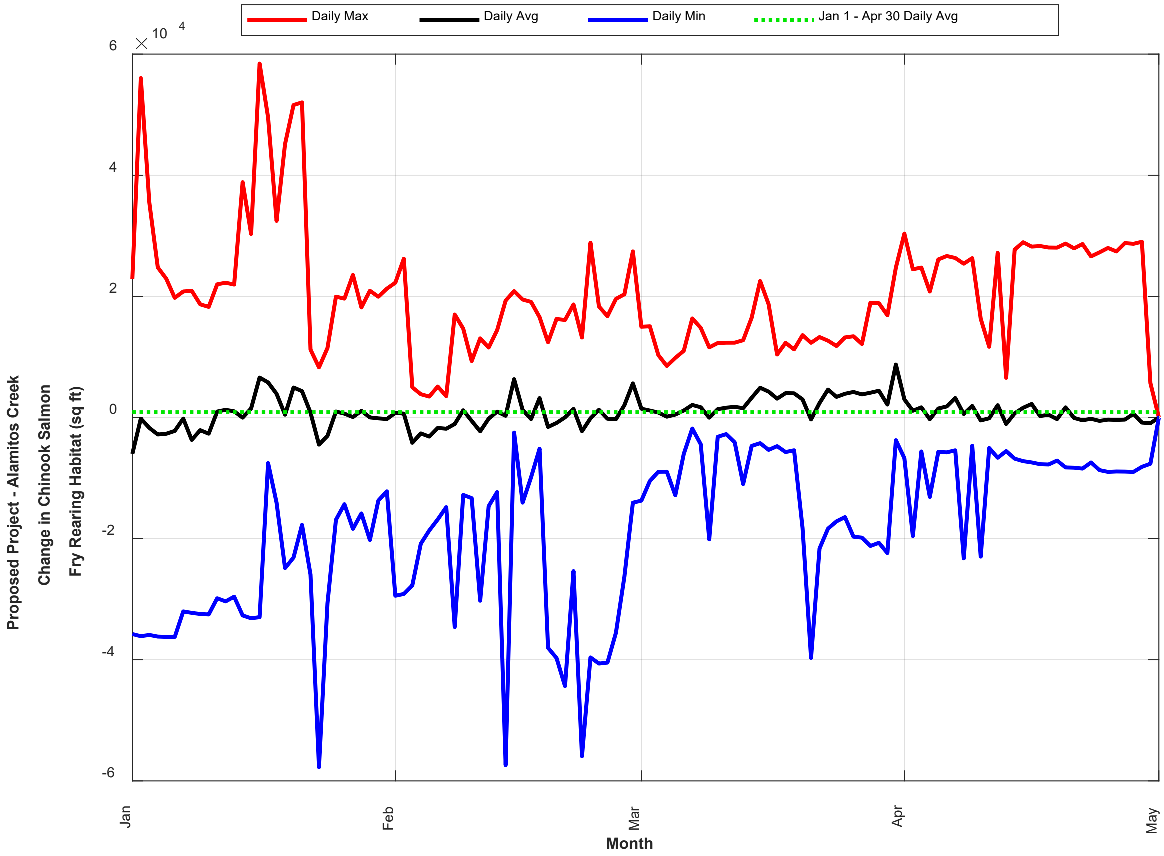
Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 10% (9,300 square feet) increase in suitable fry rearing habitat in Guadalupe Creek compared with the current baseline (Figure 62; Table 42). In the Guadalupe Creek CWMZ, Chinook salmon fry rearing habitat increased by less than 1% (200 square feet) when compared with the current baseline. Fry rearing habitat in Guadalupe Creek steadily increases from March until the end of the fry rearing period (April 30) under the current baseline.

Figure 62. Change in Chinook Salmon Fry Rearing Habitat in Guadalupe Creek



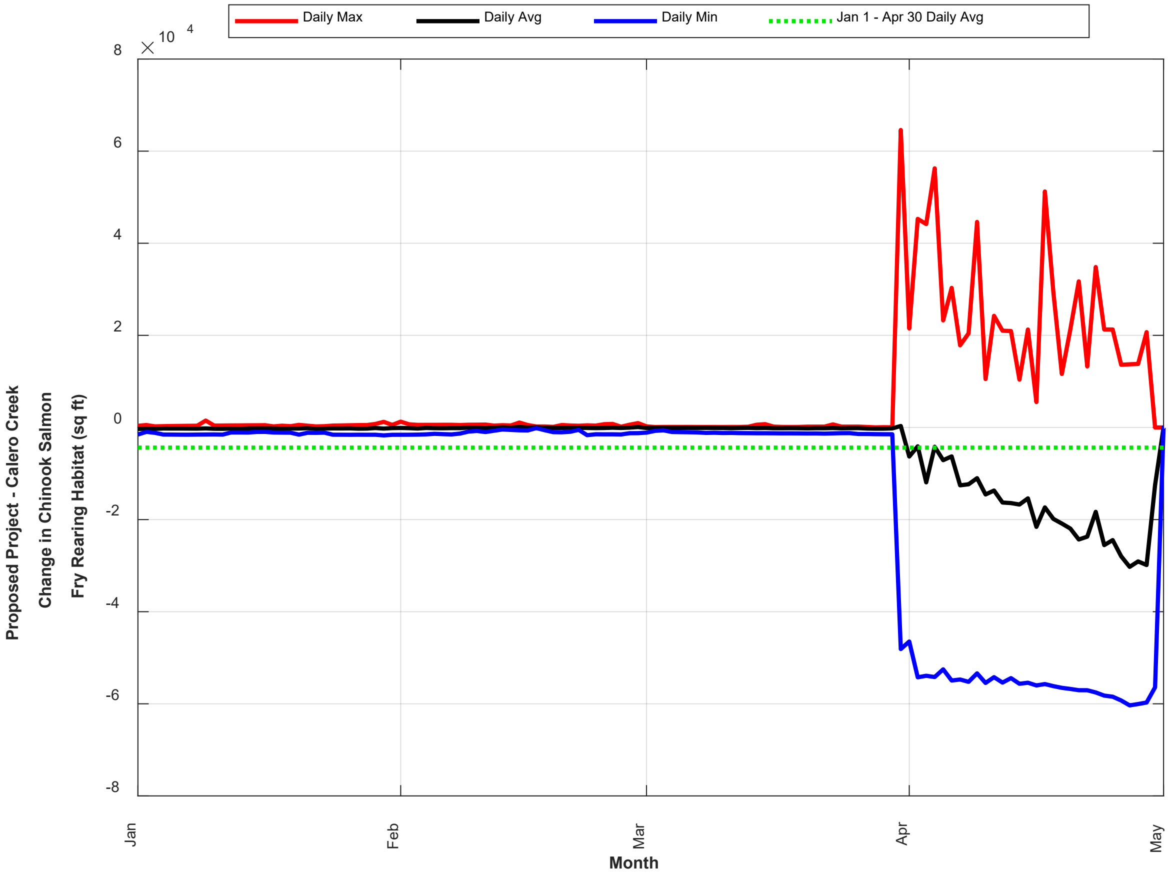
Based on the model, the Proposed Project would result in a 1% (870 square feet) increase in suitable fry rearing habitat across POIs in Alamitos Creek compared with the current baseline (Figure 63; Table 43). Fry rearing habitat in Alamitos Creek reaches a maximum in late April; however, there is a relatively consistent amount of habitat available throughout the fry rearing period.

Figure 63. Change in Chinook Salmon Fry Rearing Habitat in Alamitos Creek



There would be a 15% (4,400 square feet) decrease in fry rearing habitat in Calero Creek compared with the current baseline. The average decrease during Winter Base Flow Operations does not completely characterize the change in fry rearing habitat during January 1 through March 31. Habitat survey data input into the model indicated there was zero winter cover in the reach associated with the CALE 2 POI (that is, CALE 1 to CALE 2) and caused fry rearing habitat to be zero in January through March under all scenarios, but subsequent habitat surveys indicated there was winter cover (Valley Water 2019a, 2020). Variations in wetted area at CALE 2 under the Proposed Project compared to the current baseline (Attachment K.2 – Figures K.2.63 and K.2.64) suggest there would be a slight increase or decrease in the average change in fry rearing habitat during Winter Base Flow Operations estimated by the model results since wetted area decreases in early January, increases in late-January and February, and decreases in March.

Figure 64. Change in Chinook Salmon Fry Rearing Habitat in Calero Creek[a]

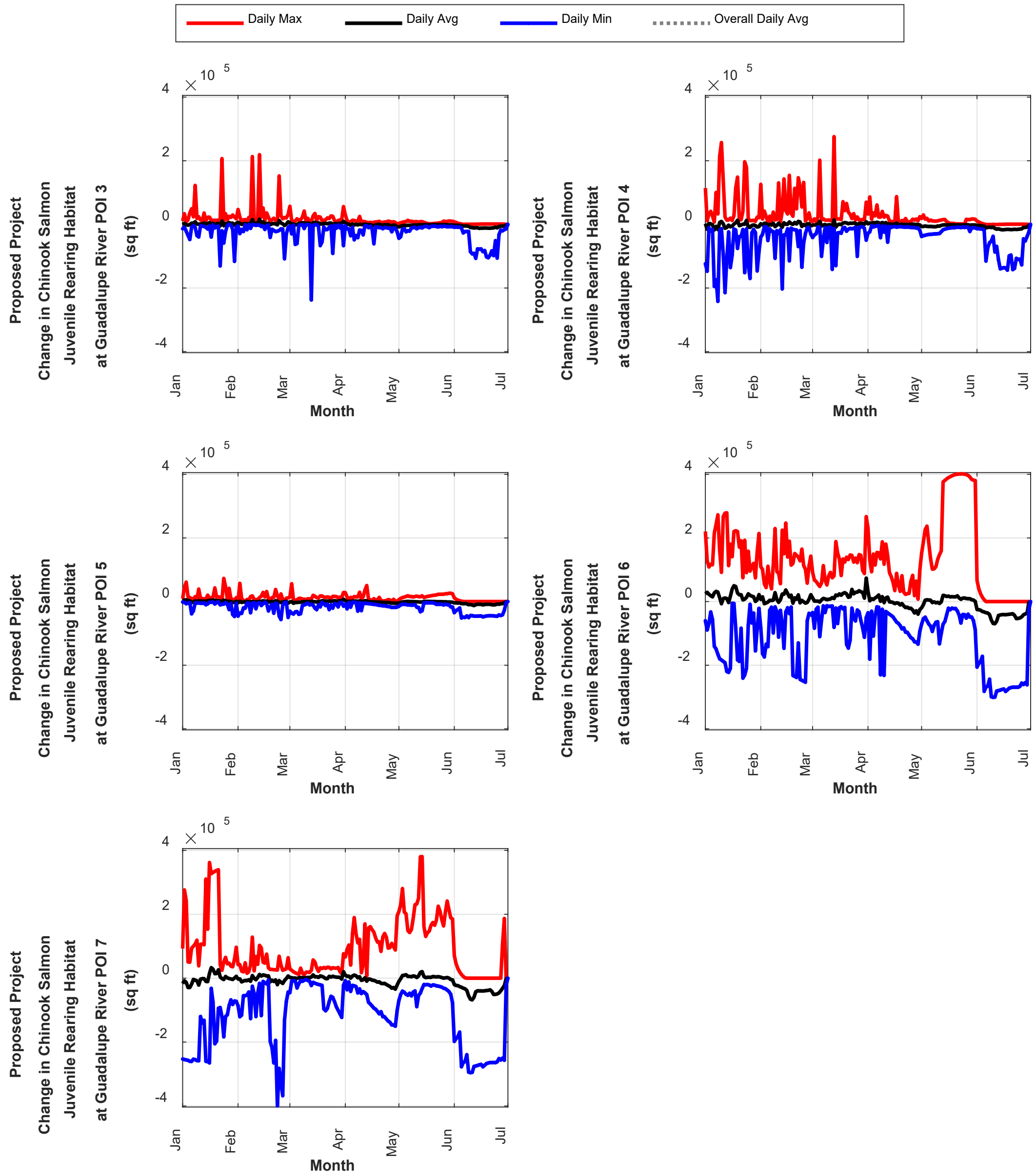


[a] Calero Creek habitat survey results in the reach between CALE 1 and CALE 2 input into the FAHCE WEAP Model did not record any winter cover, so fry and juvenile rearing habitat model results in this reach were zero during the period when winter cover is considered in the habitat estimate (that is, December 1 through March 31 for steelhead; January 1 through March 31 for Chinook salmon). Subsequent habitat surveys identified winter cover between CALE 1 and CALE 2 (Valley Water 2019a, 2020).

Juvenile Rearing Habitat

Based on the results of the FAHCE WEAP Model, the absolute amount of juvenile rearing habitat would decrease by 10,400 square feet in the Guadalupe River under the Proposed Project, a decrease of 0.8% compared with the current baseline (Table 40). The trends in juvenile rearing habitat over time revealed a slight increase under the Proposed Project during the Winter Base Flow Operations (1%) and a decrease during the Summer Release Program (5%) (Figure 65; Table 40). The largest decrease in available juvenile rearing habitat occurred in June (Figure 65), likely the result of reduced wetted area and elevated water temperatures.

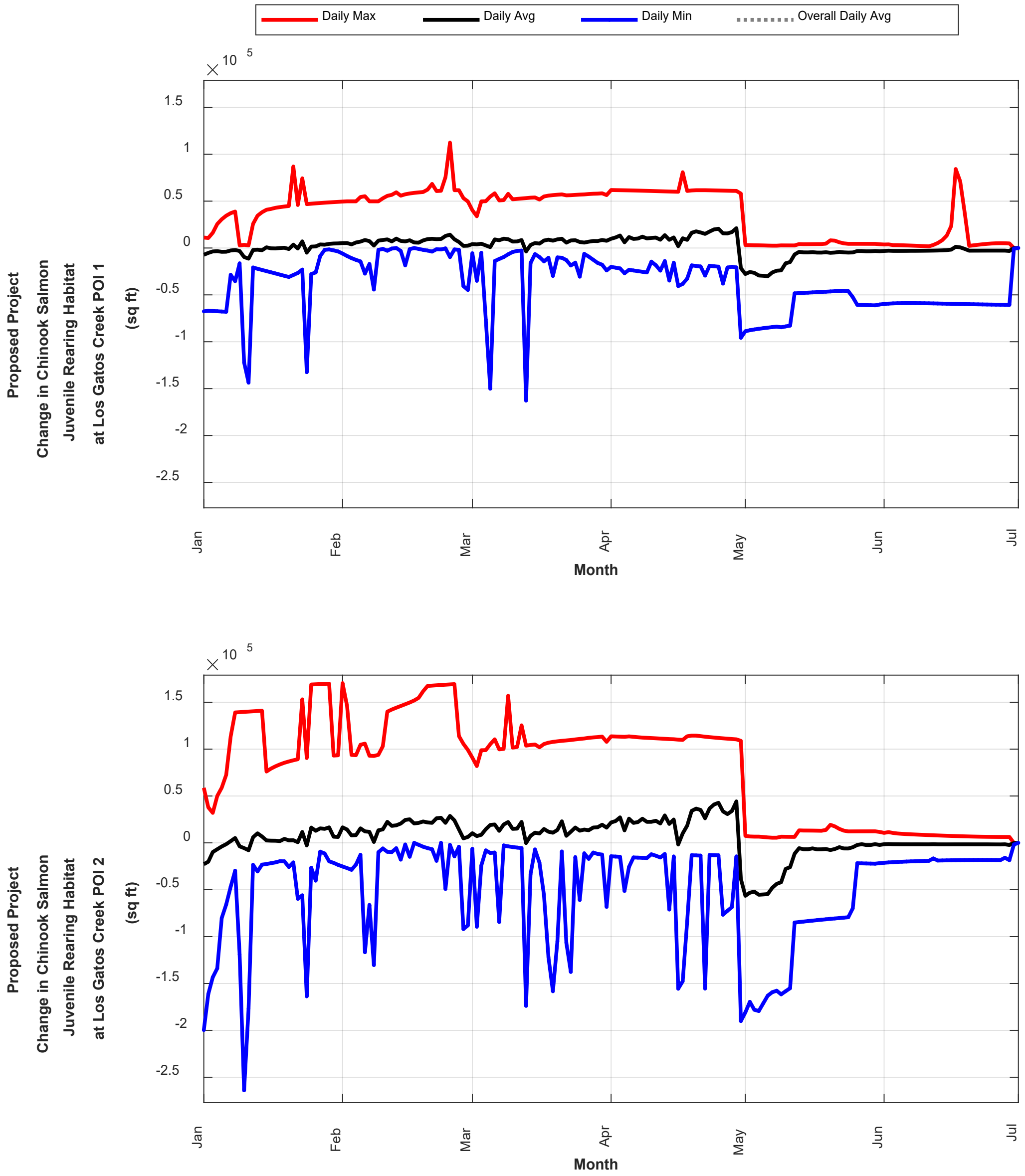
Figure 65. Change in Chinook Salmon Juvenile Rearing Habitat at GUAD 3 through 7 in the Guadalupe River[a]



[a] No average daily habitat availability model results are available for the points of interest not shown.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 2% (8,000 square feet) increase in juvenile rearing habitat in Los Gatos Creek compared with the current baseline (Table 41). The trends in juvenile rearing habitat over time would increase under the Proposed Project during the Winter Base Flow Operations (6%; 22,000 square feet) and decrease during the Summer Release Program (5%; 19,000 square feet) (Figure 66; Table 41). Los Gatos Creek contains a large amount 392,040 square feet of juvenile rearing habitat under the current baseline and the Proposed Project would increase the available habitat to 400,000 square feet.

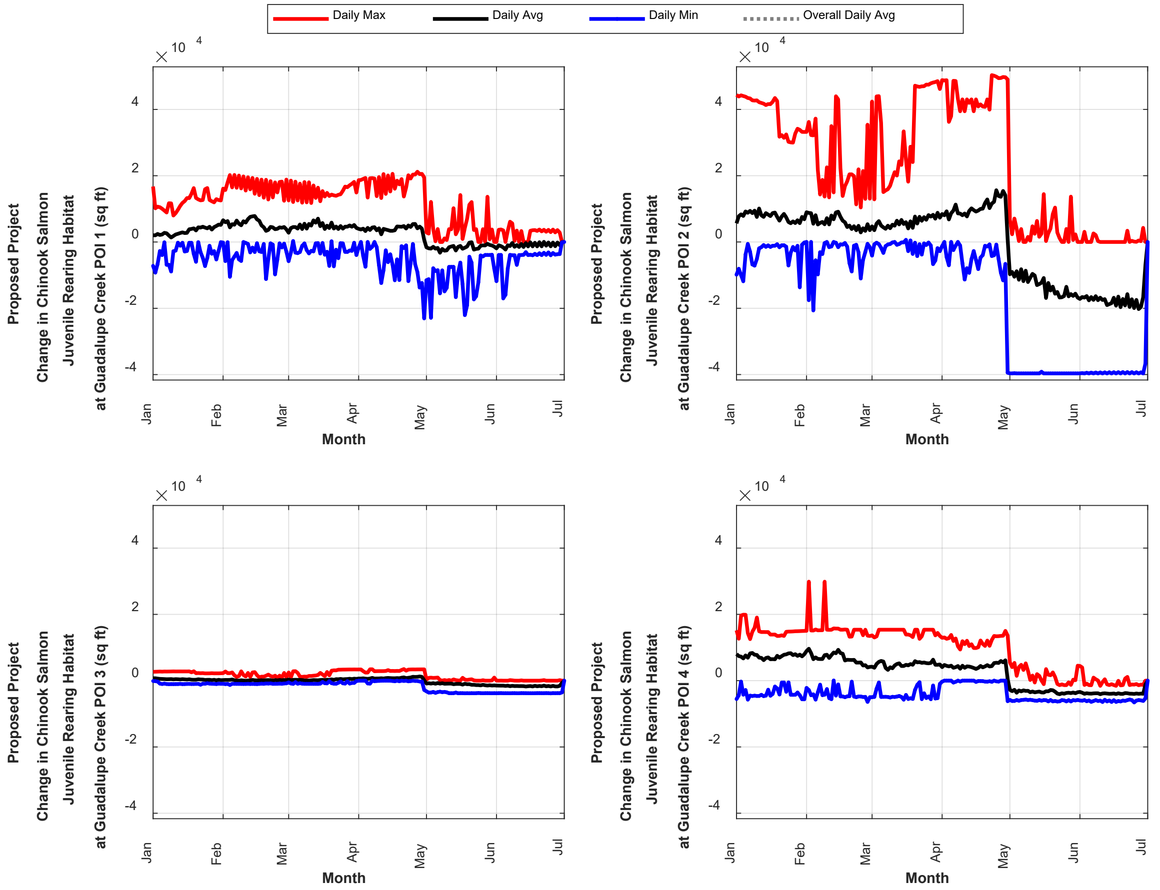
Figure 66. Change in Chinook Salmon Juvenile Rearing Habitat at LOSG 1 and 2 in Los Gatos Creek



Based on the results of the FAHCE WEAP Model, there would be a 6% increase (4,820 square feet) increase in juvenile rearing habitat across POIs in Guadalupe Creek compared with the current baseline (Table 42). The trends in juvenile rearing habitat over time showed increases (21%; 18,000 square feet) under the Proposed Project during Winter Base Flow Operations and decreases (30%; 21,390 square feet) during the Summer Cold Water Program (Figure 67; Table 42). In the Guadalupe Creek CWMZ, juvenile rearing habitat increased by 12% (2,700 square feet), with a 28% (5,800 square feet) increase occurring during the Winter Base Flow Operations followed by a 14% (3,600 square feet) decrease during the Summer Cold Water Program. Average MWAT under the Proposed Project remained below 65°F throughout the Summer Cold Water Program in the

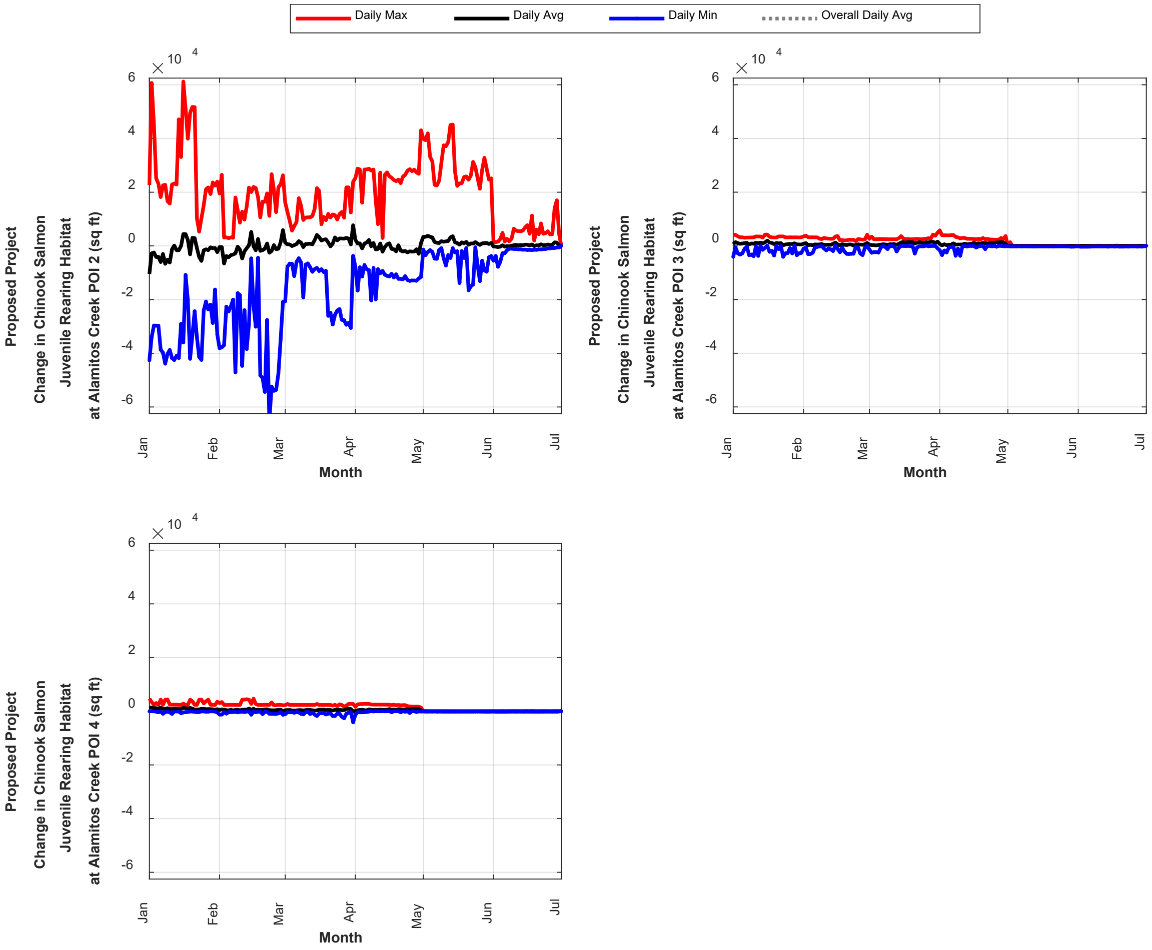
Guadalupe Creek CWMZ, so decreases in habitat within the CWMZ are strictly a function of a decrease in wetted area. The decreases in habitat during the Summer Cold Water Program downstream of the CWMZ are the result of reduced wetted area and elevated water temperatures (that is, above 65°F) in Guadalupe Creek (Attachment K.2 – Figures K.2.39, K.2.40, K.2.41 and K.2.42).

Figure 67. Change in Chinook Salmon Juvenile Rearing Habitat in Guadalupe Creek



Based on the results of the FAHCE WEAP Model, there would be an increase in juvenile rearing habitat in Alamitos Creek for Chinook salmon resulting from the Proposed Project. The Proposed Project would result in a 1% (870 square feet) increase compared with the current baseline (Table 43). An abrupt decrease in juvenile rearing habitat would occur in June (Figure 68) as a result of decreased wetted area (Attachment K.2 – Figures K.2.51 and K.2.52); however, the decrease comes at the end of the juvenile Chinook salmon outmigration period, when most juveniles would have already outmigrated from the watershed.

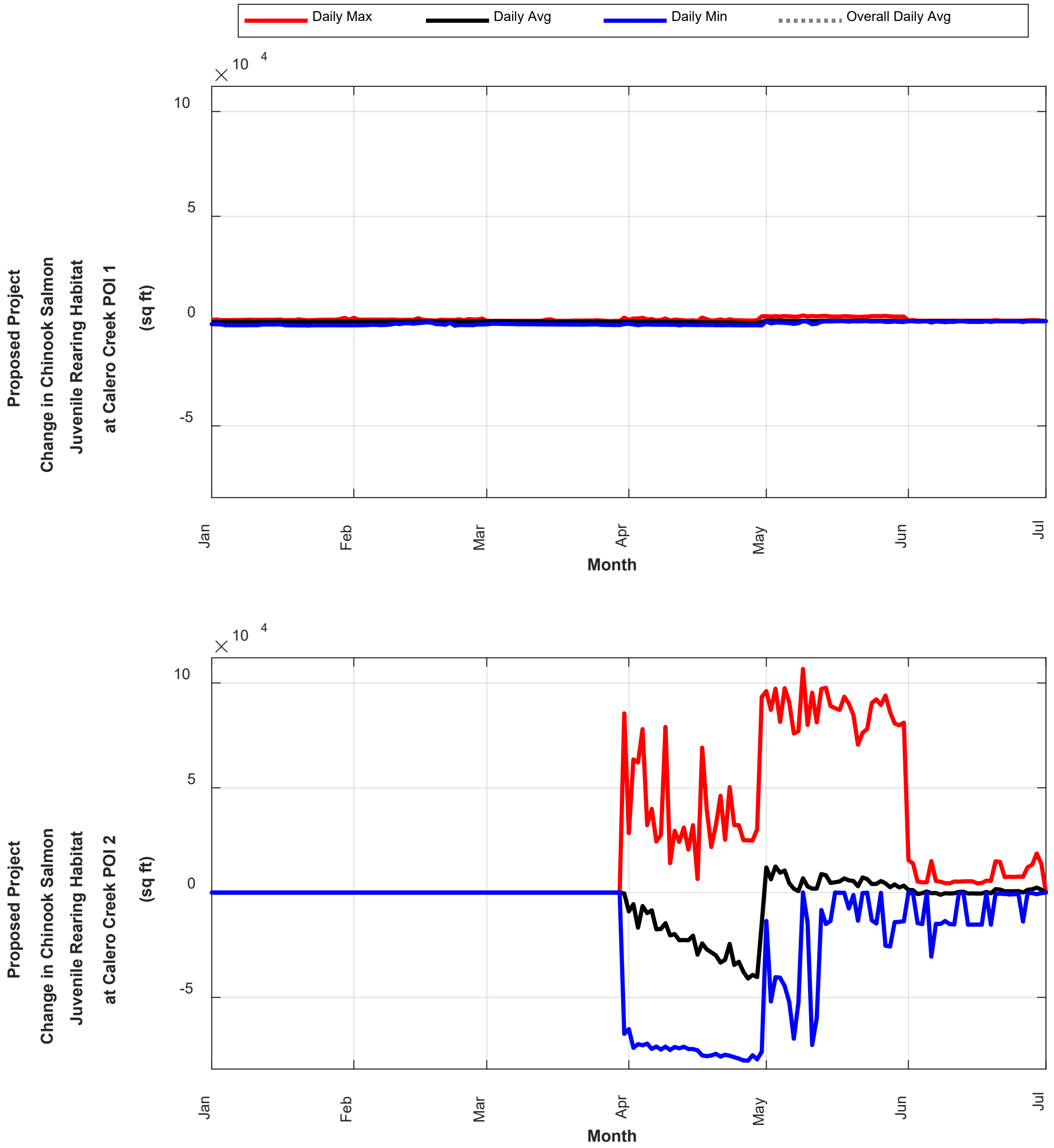
Figure 68. Change in Chinook Salmon Juvenile Rearing Habitat in Alamitos Creek[a]



[a] No average daily habitat availability model results are available for the points of interest not shown.

Based on the results of the FAHCE WEAP Model, there would be a 6% (3,070 square feet) average decrease in juvenile rearing habitat in Calero Creek compared with the current baseline. A 22% (6,100 square feet) average decrease would occur during Winter Base Flow Operations releases attributable to decreased wetted area, and a 3% (3,070 square feet) average increase during the Summer Cold Water Program releases attributable to increased wetted area under the Proposed Project. As described for fry rearing habitat, the average decrease during Winter Base Flow Operations does not completely characterize the change in rearing habitat during January 1 through March 31. Habitat survey data input into the model indicated there was zero winter cover in the reach associated with the CALE 2 POI (that is, CALE 1 to CALE 2) and caused juvenile rearing habitat to be zero in January through March under all scenarios, but subsequent habitat surveys indicated there was winter cover (Valley Water 2019a, 2020).Variations in wetted area at CALE 2 under the Proposed Project compared to the current baseline (Attachment K.2 – Figures K.2.63 and K.2.64) suggest there would be a slight increase or decrease in the average change in juvenile rearing habitat during Winter Base Flow Operations estimated by the model results since wetted area decreases in early January, increases in late-January and February, and decreases in March.

Figure 69. Change in Chinook Salmon Juvenile Rearing Habitat in Calero Creek[a]



[a] Calero Creek habitat survey results in the reach between CALE 1 and CALE 2 input into the FAHCE WEAP Model did not record any winter cover, so fry and juvenile rearing habitat model results in this reach shown in the Calero Creek POI 2 (that is, CALE 2) plot were zero during the period when winter cover is considered in the habitat estimate (that is, December 1 through March 31 for steelhead; January 1 through March 31 for Chinook salmon). Subsequent habitat surveys identified winter cover between CALE 1 and CALE 2 (Valley Water 2019a, 2020).

Migration Conditions

Adult Upstream Passage

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in variable changes to adult upstream Chinook salmon passage in the Guadalupe River compared with the current baseline. Adult upstream passage at the farthest upstream sites (GUAD 6 and GUAD 7) increased by an average of 4 days per year (17%) while the downstream sites (GUAD 3 and GUAD 4) saw a decrease in 4 passage days per year (8%) (Figure 70; Table 45). Under the current baseline, the Guadalupe River would result in an average of 59 adult upstream passage days per year, while the Proposed Project would result in an average of 58 adult upstream passage days per year.

Figure 70. Change in Average Adult Chinook Salmon Upstream Passage Days in the Guadalupe River

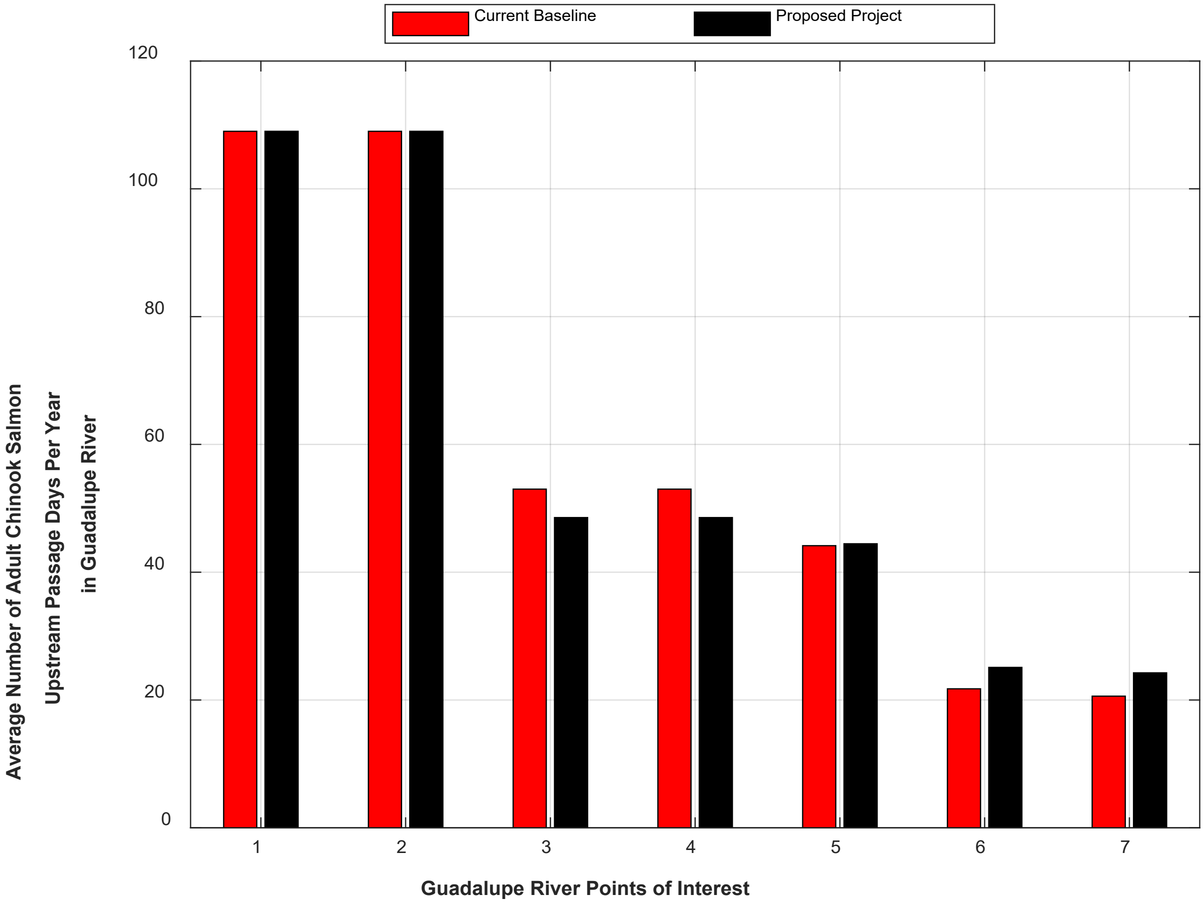


Table 45. Proposed Project Adult Chinook Upstream Passage Compared with the Current Baseline in the Guadalupe River

Parameter	GUAD 1	GUAD 2	GUAD 3	GUAD 4	GUAD 5	GUAD 6	GUAD 7
Current Baseline (days)[a]							
Total Adult Upstream Passage (1991–2010)	2,180	2,180	1,060	1,060	883	435	412
Average Adult Upstream Passage Per Year	109	109	53	53	44	22	21
Proposed Project (days)[a]							
Total Adult Upstream Passage (1991–2010)	2,180	2,180	971	971	889	502	485
Average Adult Upstream Passage Per Year	109	109	49	49	44	25	24
Difference (days)							
Total Adult Upstream Passage (1991–2010)	0.00	0.00	-89.00	-89.00	6.00	67.00	73.00
Average Adult Upstream Passage Per Year	0.00	0.00	-4.45	-4.45	0.30	3.35	3.65
Difference (%)							
Total Adult Upstream Passage (1991–2010)	0.00	0.00	-8.40	-8.40	0.68	15.40	17.72
Average Adult Upstream Passage Per Year	0.00	0.00	-8.40	-8.40	0.68	15.40	17.72

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a decrease (16% or less than 2 days per year on average) to adult upstream Chinook salmon passage in Los Gatos Creek compared with the current baseline (Figure 71; Table 46).

Figure 71. Change in Average Adult Chinook Salmon Upstream Passage Days in Los Gatos Creek

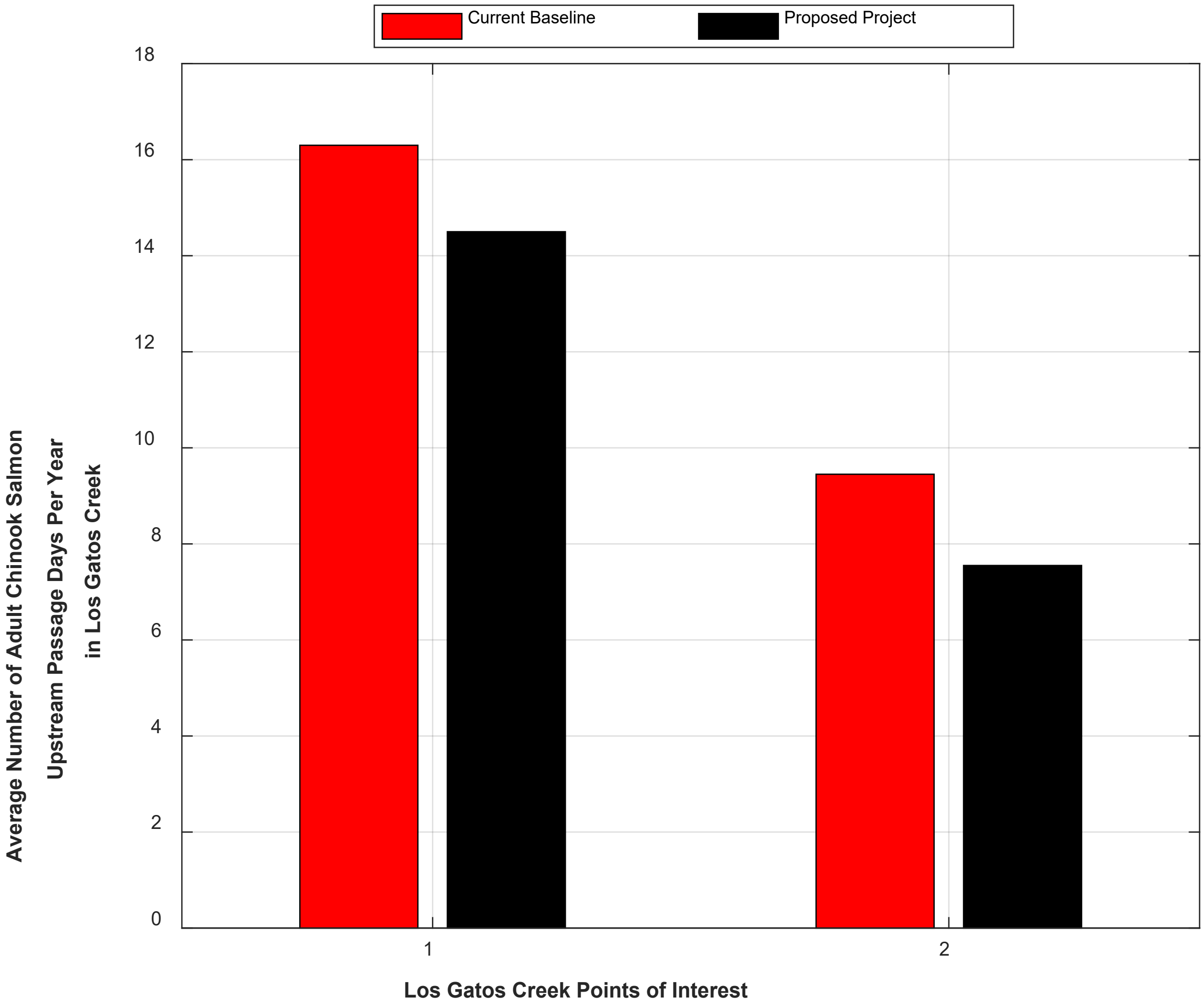


Table 46. Proposed Project Adult Chinook Upstream Passage Compared with the Current Baseline in Los Gatos Creek

Parameter	LOSG 1	LOSG 2
Current Baseline (days)[a]		
Total Adult Upstream Passage (1991–2010)	326	189
Average Adult Upstream Passage Per Year	16	9
Proposed Project (days)[a]		
Total Adult Upstream Passage (1991–2010)	290	151
Average Adult Upstream Passage Per Year	15	8

Parameter	LOSG 1	LOSG 2
Difference (days)		
Total Adult Upstream Passage (1991–2010)	-36.00	-38.00
Average Adult Upstream Passage Per Year	-1.80	-1.90
Difference (%)		
Total Adult Upstream Passage (1991–2010)	-11.04	-20.11
Average Adult Upstream Passage Per Year	-11.04	-20.11

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a decrease (21% or less than 1 day per year on average) to adult upstream Chinook salmon passage at Guadalupe Creek compared with the current baseline (Figure 72; Table 47). On average, there are 4 passage days per year across sites in Guadalupe Creek under the current baseline, and the Proposed Project would reduce the average passage days by one day.

Figure 72. Change in Average Adult Chinook Salmon Upstream Passage Days in Guadalupe Creek

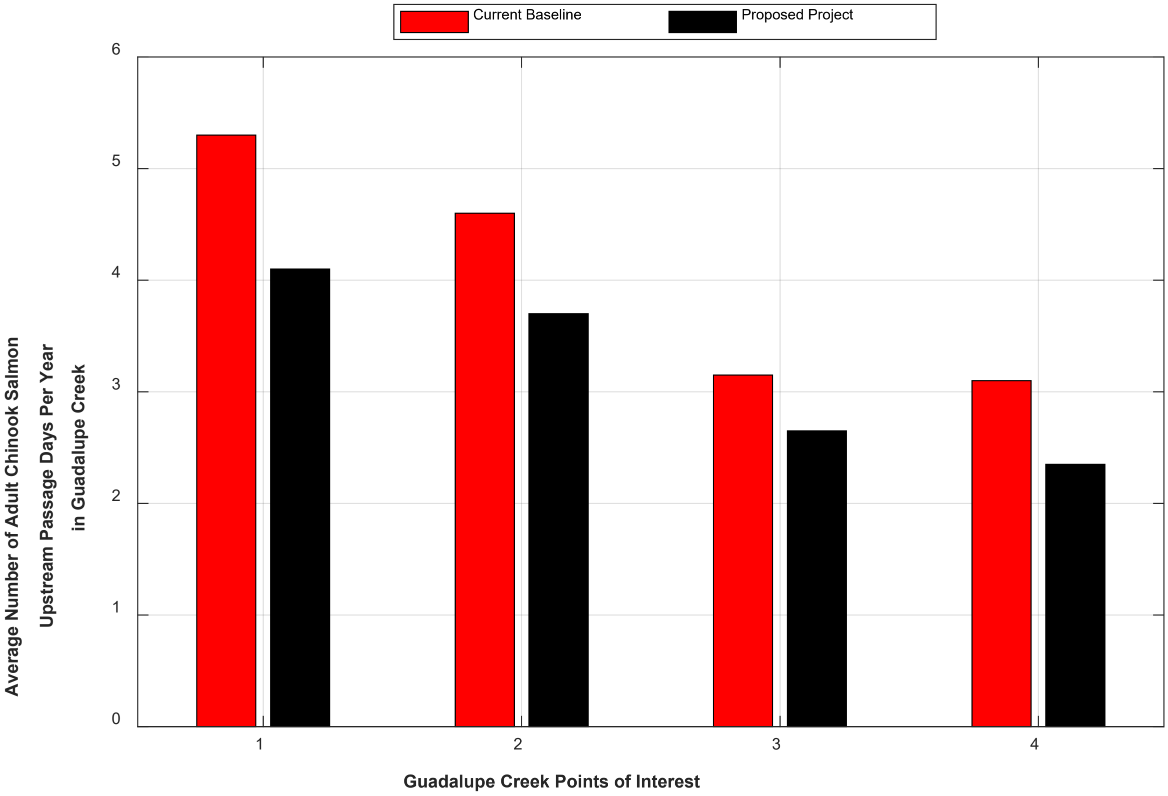


Table 47. Proposed Project 2015 Adult Chinook Upstream Passage Compared with the Current Baseline in Guadalupe Creek

Parameter	GCRK 1	GCRK 2	GCRK 3	GCRK 4
Current Baseline (days)[a]				
Total Adult Upstream Passage (1991–2010)	106	92	63	62
Average Adult Upstream Passage Per Year	5	5	3	3
Proposed Project (days)[a]				
Total Adult Upstream Passage (1991–2010)	82	74	53	47
Average Adult Upstream Passage Per Year	4	4	3	2
Difference (days)				
Total Adult Upstream Passage (1991–2010)	-24.00	-18.00	-10.00	-15.00
Average Adult Upstream Passage Per Year	-1.20	-0.90	-0.50	-0.75
Difference (%)				
Total Adult Upstream Passage (1991–2010)	-22.64	-19.57	-15.87	-24.19
Average Adult Upstream Passage Per Year	-22.64	-19.57	-15.87	-24.19

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in an 19% increase (4 days per year on average) to adult upstream Chinook salmon passage at ALAM 1 in downstream Alamitos Creek, while causing a decrease (17% or 1 day per year on average) at upstream sites compared with the current baseline conditions (Figure 73; Table 48).

Figure 73. Change in Average Adult Chinook Salmon Upstream Passage Days in Alamitos Creek

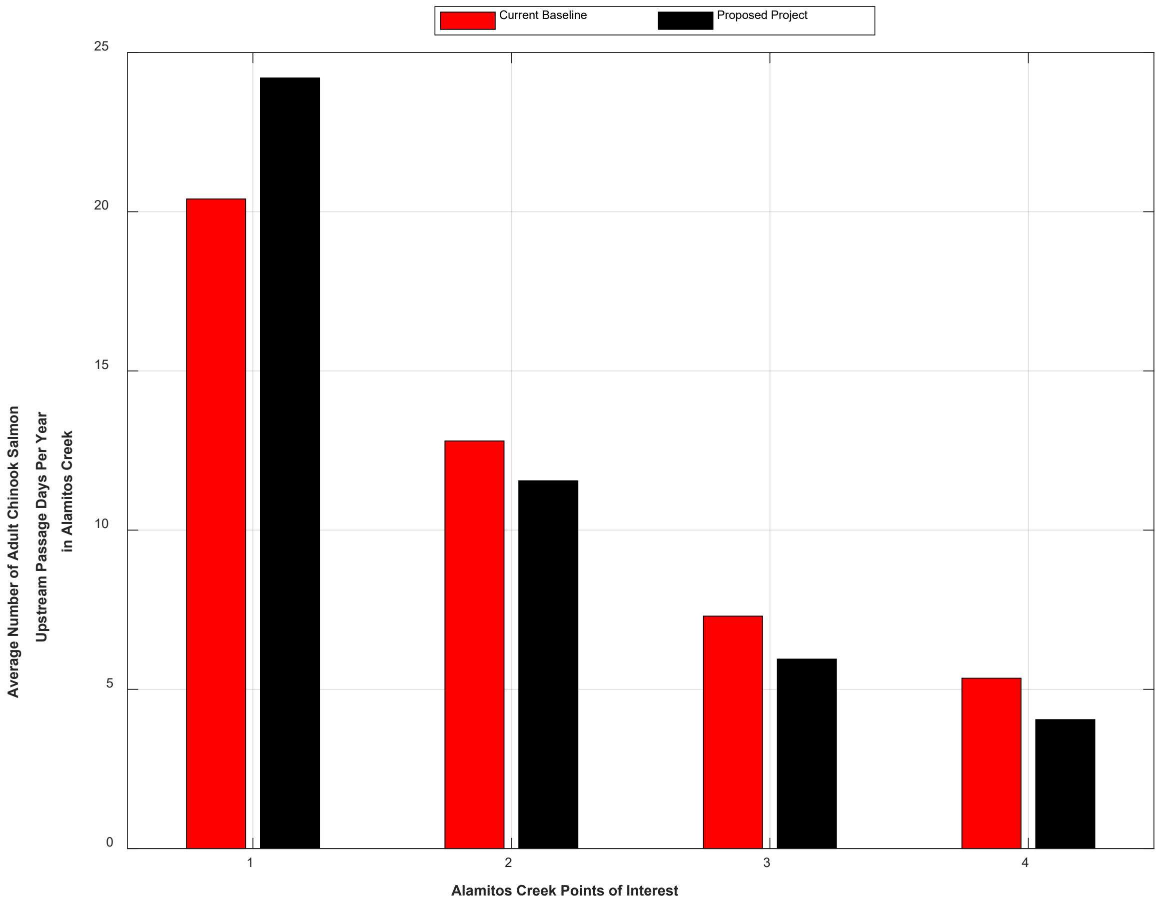


Table 48. Proposed Project Adult Chinook Upstream Passage Compared with the Current Baseline in Alamitos Creek

Parameter	ALAM 1	ALAM 2	ALAM 3	ALAM 4
Current Baseline (days)[a]				
Total Adult Upstream Passage (1991–2010)	408	256	146	107
Average Adult Upstream Passage Per Year	20	13	7	5
Proposed Project (days)[a]				
Total Adult Upstream Passage (1991–2010)	484	231	119	81
Average Adult Upstream Passage Per Year	24	12	6	4
Difference (days)				
Total Adult Upstream Passage (1991–2010)	76.00	-25.00	-27.00	-26.00
Average Adult Upstream Passage Per Year	3.80	-1.25	-1.35	-1.30

Parameter	ALAM 1	ALAM 2	ALAM 3	ALAM 4
Difference (%)				
Total Adult Upstream Passage (1991–2010)	18.63	-9.77	-18.49	-24.30
Average Adult Upstream Passage Per Year	18.63	-9.77	-18.49	-24.30

[a] Rounded to whole days

The Proposed Project would result in a 3% (less than 1 day per year) average increase to adult upstream passage in in Calero Creek compared with the current baseline.

Figure 74. Change in Average Adult Chinook Salmon Upstream Passage Days in Calero Creek

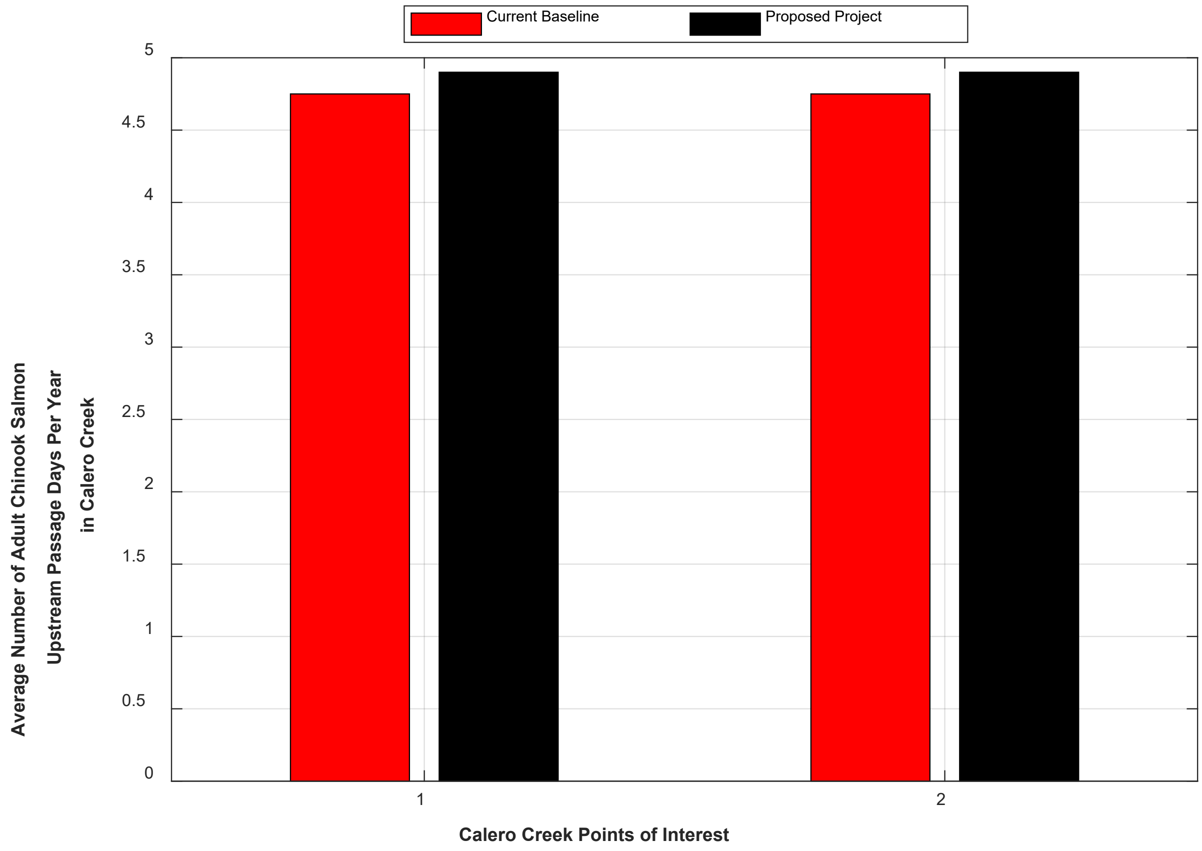


Table 49. Proposed Project Adult Chinook Salmon Upstream Passage Compared with the Current Baseline in Calero Creek

Parameter	CALE 1	CALE 2
***Current Baseline (days)*[a]**		
Total Adult Upstream Passage (1991–2010)	95	95
Average Adult Upstream Passage Per Year	5	5
***Proposed Project (days)*[a]**		
Total Adult Upstream Passage (1991–2010)	98	98
Average Adult Upstream Passage Per Year	5	5
Difference (days)		
Total Adult Upstream Passage (1991–2010)	3.00	3.00
Average Adult Upstream Passage Per Year	0.15	0.15
Difference (%)		
Total Adult Upstream Passage (1991–2010)	3.16	3.16
Average Adult Upstream Passage Per Year	3.16	3.16

[a] Rounded to whole days

Juvenile Downstream Passage

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a negligible increase (3% or 2 days per year on average) to juvenile downstream Chinook salmon passage opportunities in the Guadalupe River compared with the current baseline (Figure 75; Table 50). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the Proposed Project would result in a 4% (3 days per year) average increase to juvenile downstream passage in the Guadalupe River compared with the current baseline (Table 50). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in the Guadalupe River under the Proposed Project compared to the current baseline.

Figure 75. Juvenile Chinook Salmon Downstream Passage Days in the Guadalupe River

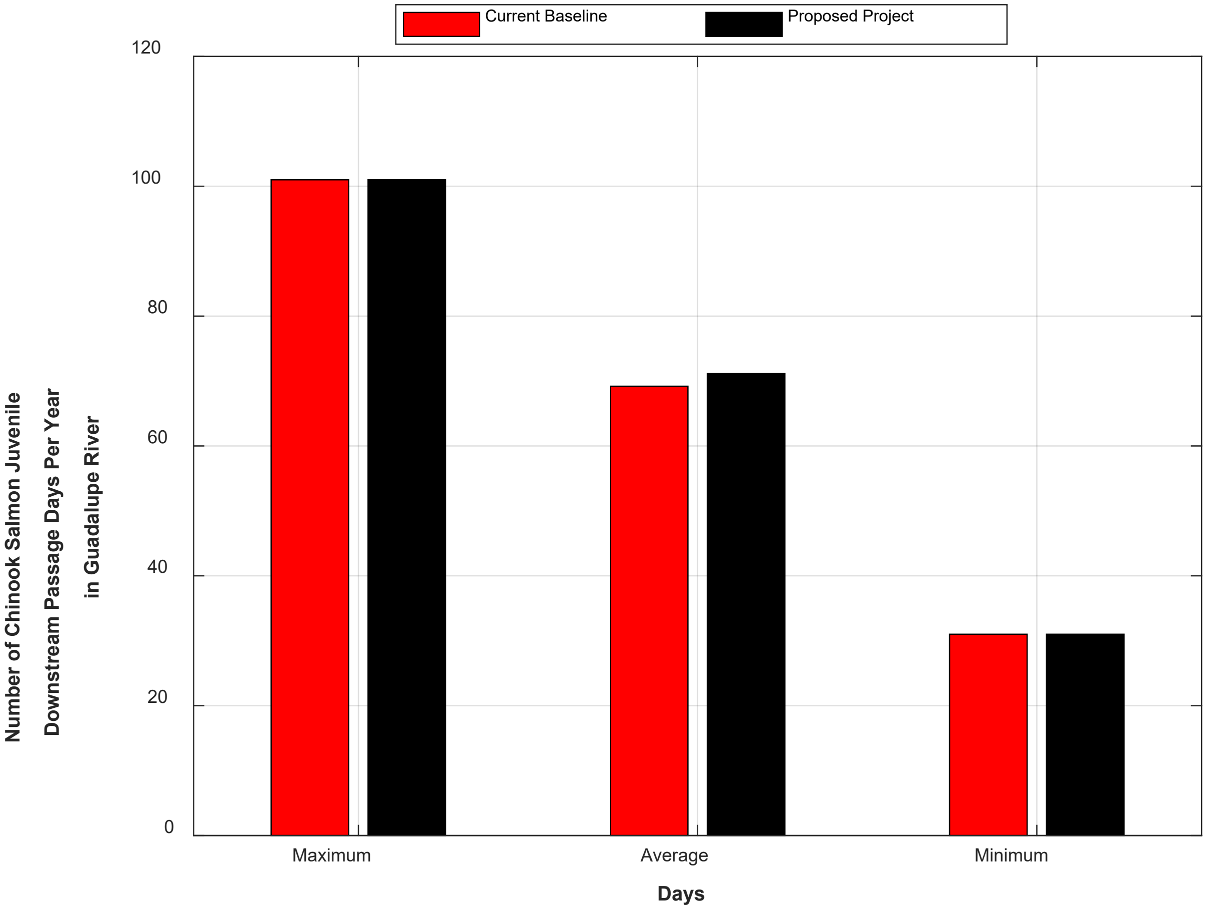


Table 50. Proposed Project Juvenile Chinook Downstream Passage Compared with the Current Baseline in the Guadalupe River

Parameter	GUAD 7 with Water Temperature Criteria[b]
Current Baseline (days)[a]	
Total Juvenile Downstream Passage (1991–2010)	1,384
Average Juvenile Downstream Passage Per Year	69
Proposed Project (days)[a]	
Total Juvenile Downstream Passage (1991–2010)	1,423
Average Juvenile Downstream Passage Per Year	71
Difference (days)	
Total Juvenile Downstream Passage (1991–2010)	39.00
Average Juvenile Downstream Passage Per Year	2.00

Parameter	GUAD 7 with Water Temperature Criteria[b]
Difference (%)	
Total Juvenile Downstream Passage (1991–2010)	2.82
Average Juvenile Downstream Passage Per Year	2.90

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a 1% (1 day per year on average) decrease to juvenile downstream passage in Los Gatos Creek compared with the current baseline (Figure 76; Table 51). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the Proposed Project would result in a 2% (3 days per year) average increase to juvenile downstream passage in Los Gatos Creek compared with the current baseline (Table 51). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in Los Gatos Creek under the Proposed Project compared to the current baseline.

Figure 76. Juvenile Chinook Salmon Downstream Passage Days in Los Gatos Creek

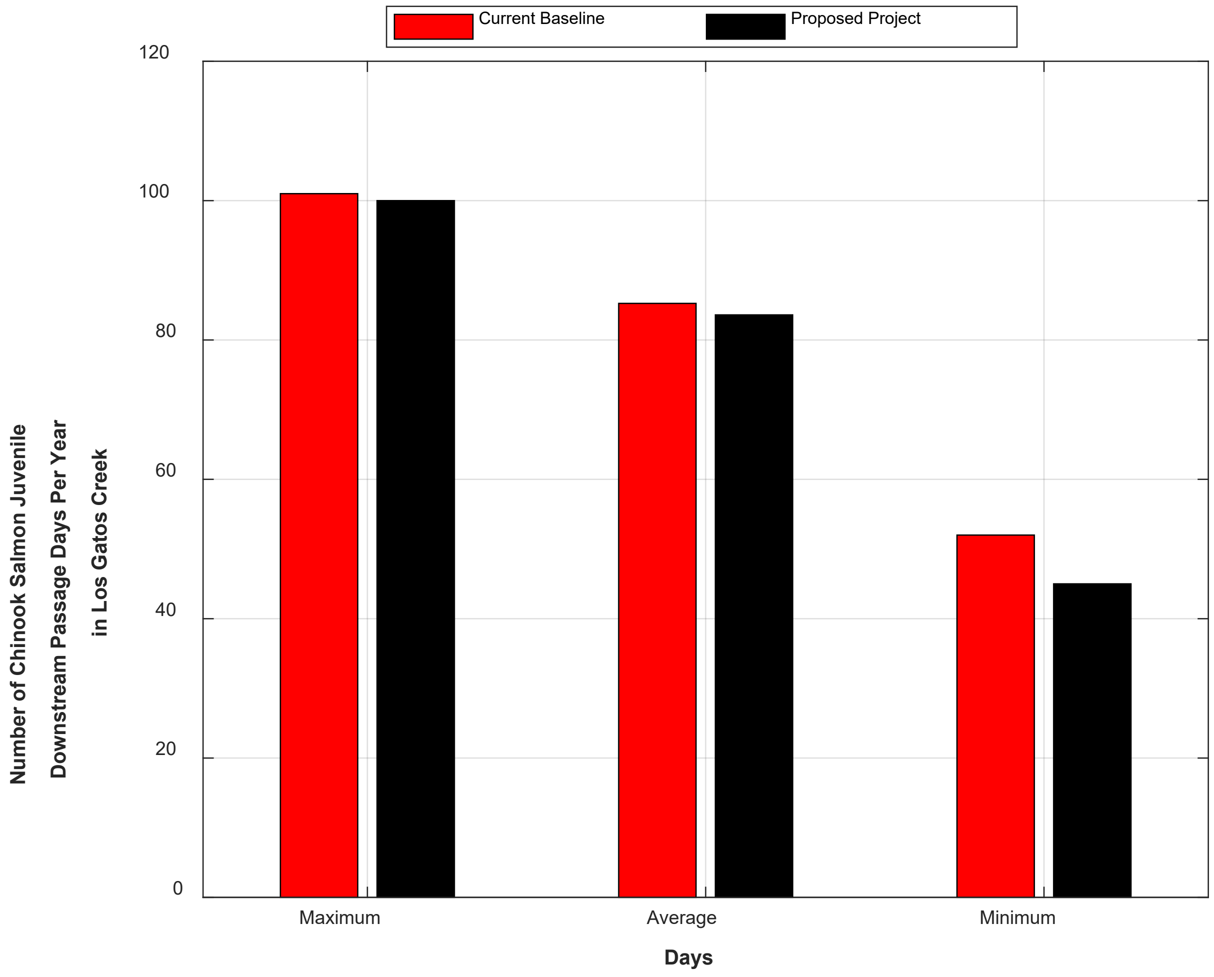


Table 51. Proposed Project 2015 Juvenile Chinook Downstream Passage Compared with the Current Baseline in Los Gatos Creek

Parameter	LOSG 2 with Water Temperature Criteria[b]	LOSG 2 without Water Temperature Criteria[c]
Current Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	1,705	2,997
Average Juvenile Downstream Passage Per Year	85	150
Proposed Project (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	1,672	2,936
Average Juvenile Downstream Passage Per Year	84	147
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	-33.00	-61.00
Average Juvenile Downstream Passage Per Year	-1.00	-3.00

Parameter	LOSG 2 with Water Temperature Criteria[b]	LOSG 2 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	-1.94	-2.04
Average Juvenile Downstream Passage Per Year	-1.18	-2.00

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the Proposed Project would increase juvenile downstream passage in Guadalupe Creek by an average of 15 days per year or a 47% increase compared with the current baseline (Figure 77; Table 52). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the Proposed Project would result in a 45% (15 days per year) average increase to juvenile downstream passage in Guadalupe Creek compared with the current baseline (Table 52). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in Guadalupe Creek increased by two under the Proposed Project compared with the current baseline.

Figure 77. Juvenile Chinook Salmon Downstream Passage Days in Guadalupe Creek

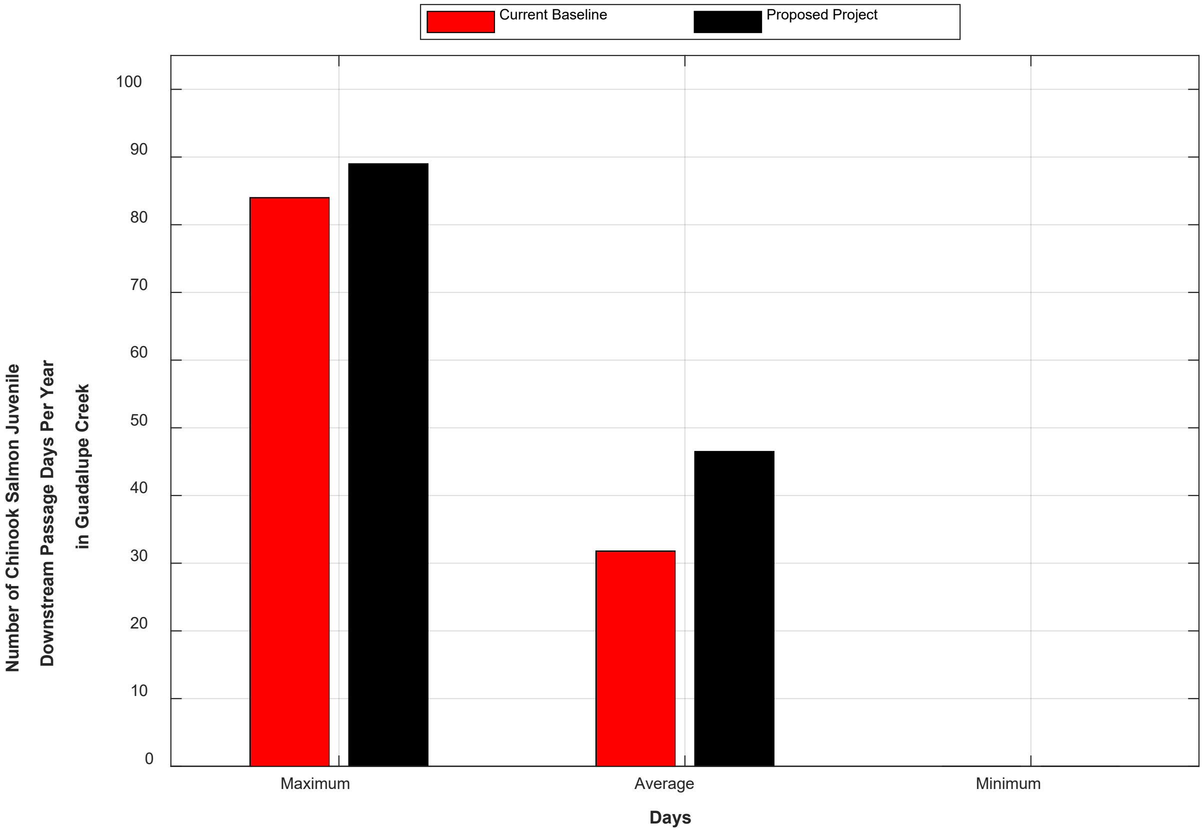


Table 52. Proposed Project 2015 Juvenile Chinook Downstream Passage Compared with the Current Baseline in Guadalupe Creek

Parameter	GCRK 4 with Water Temperature Criteria[b]	GCRK 4 without Water Temperature Criteria[c]
Current Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	636	666
Average Juvenile Downstream Passage Per Year	32	33
Proposed Project (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	930	965
Average Juvenile Downstream Passage Per Year	47	48
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	294.00	299.00
Average Juvenile Downstream Passage Per Year	15.00	15.00
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	46.23	44.89
Average Juvenile Downstream Passage Per Year	46.88	45.45

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the Proposed Project would increase juvenile downstream passage in Alamitos Creek by 7% or an average of 4 days per year compared with the current baseline (Figure 78; Table 53). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the Proposed Project would result in the same increase of 7% (4 days per year) to juvenile downstream passage in Alamitos Creek compared with the current baseline (Table 53). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in Alamitos Creek under the Proposed Project compared to the current baseline.

Figure 78. Juvenile Chinook Salmon Downstream Passage Days in Alamitos Creek

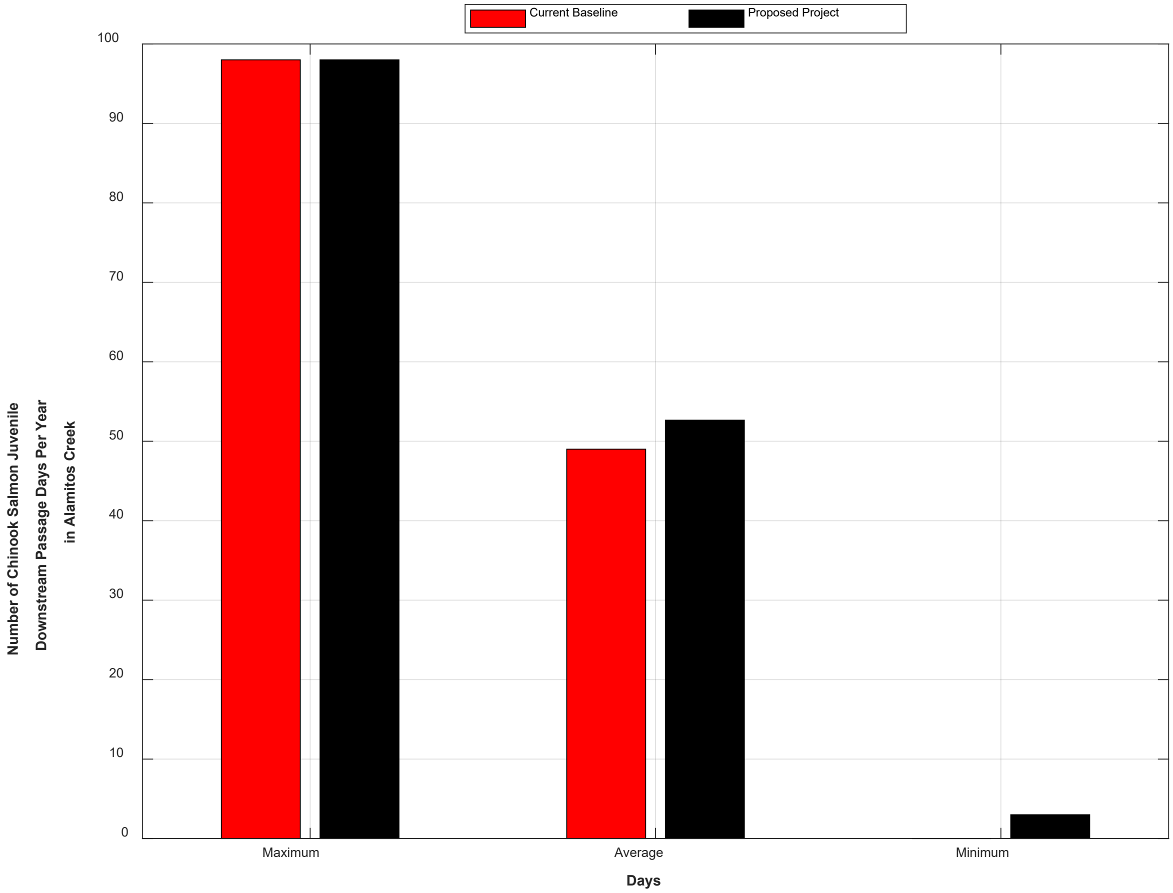


Table 53. Proposed Project 2015 Juvenile Chinook Downstream Passage Compared with the Current Baseline in Alamitos Creek

Parameter	ALAM 4 with Water Temperature Criteria[b]	ALAM 4 without Water Temperature Criteria[c]
Current Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	980	1,143
Average Juvenile Downstream Passage Per Year	49	57
Proposed Project (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	1,053	1,229
Average Juvenile Downstream Passage Per Year	53	61

Parameter	ALAM 4 with Water Temperature Criteria[b]	ALAM 4 without Water Temperature Criteria[c]
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	73.00	86.00
Average Juvenile Downstream Passage Per Year	4.00	4.00
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	7.45	7.52
Average Juvenile Downstream Passage Per Year	8.16	7.02

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

The Proposed Project would result in a 6% (3 days per year) average decrease to juvenile downstream passage in in Calero Creek compared with the current baseline. Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the Proposed Project would also result in a decrease to juvenile downstream passage in Calero Creek compared with the current baseline (Table 54). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in Calero Creek decreased by one under the Proposed Project compared to the current baseline.

Figure 79. Juvenile Chinook Salmon Downstream Passage Days in Calero Creek

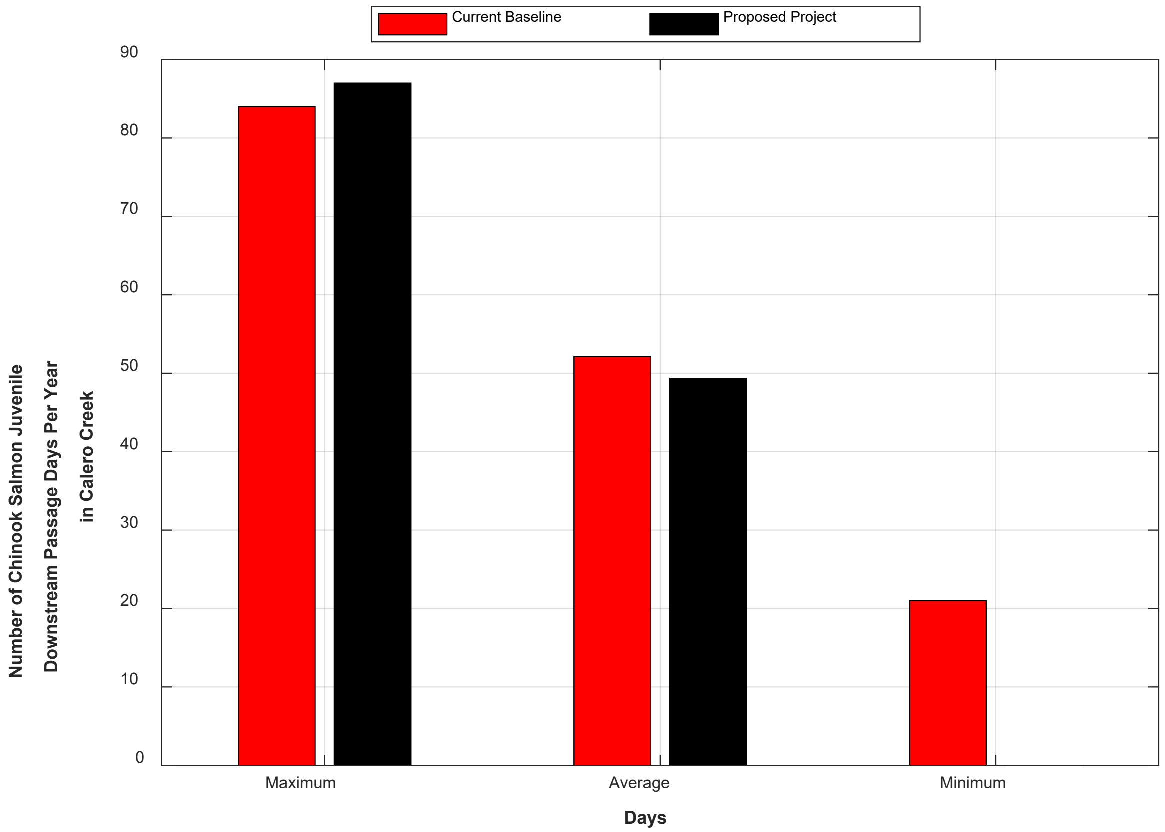


Table 54. Proposed Project 2015 Juvenile Chinook Downstream Passage Compared with the Current Baseline in Calero Creek

Parameter	CALE 2 with Water Temperature Criteria[b]	CALE 2 without Water Temperature Criteria[c]
Current Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	1,043	1,074
Average Juvenile Downstream Passage Per Year	52	54
Proposed Project (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	987	1,009
Average Juvenile Downstream Passage Per Year	49	50
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	-56.00	-65.00
Average Juvenile Downstream Passage Per Year	-3.00	-4.00

Parameter	CALE 2 with Water Temperature Criteria[b]	CALE 2 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	-5.37	-6.05
Average Juvenile Downstream Passage Per Year	-5.77	-7.41

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Flow Measures Future Baseline Assessment

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, there would be a decrease in effective spawning habitat in the Guadalupe River for Chinook salmon resulting from the Proposed Project. The Proposed Project would result in a 10% (1,212 square feet) decrease in effective spawning habitat in the Guadalupe River compared with the future baseline (Figure 80; Table 55). Effective spawning habitat was increased at the upstream sites (GUAD 5 through GUAD 7); however, decreases were observed at the downstream sites (GUAD 3 through GUAD 4) under the Proposed Project compared with the future baseline. Apart from a sharp decline in effective spawning habitat in December, which can be attributed to the 10% decrease in available habitat, there is little difference for the remainder of the spawning season between the Proposed Project and the future baseline (Figure 80).

Figure 80. Change in Chinook Salmon Effective Spawning Habitat in the Guadalupe River

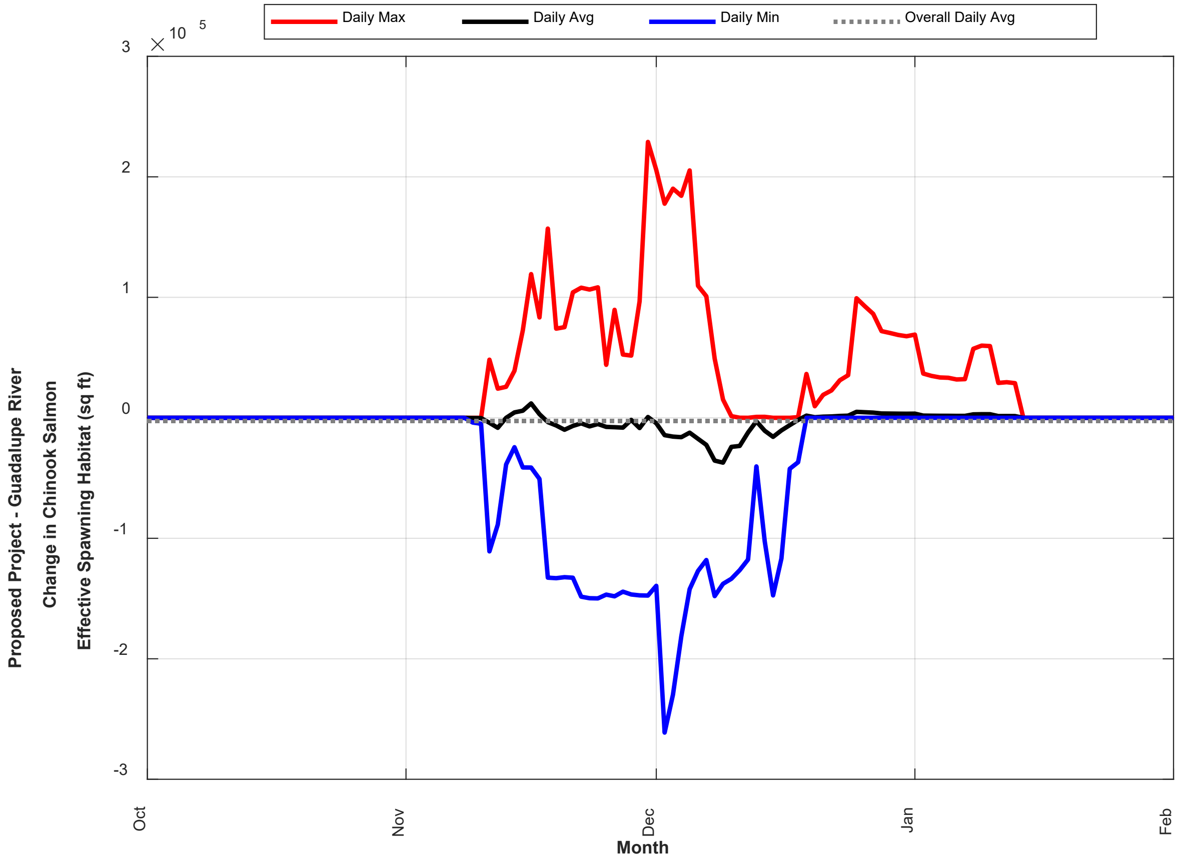


Table 55. Proposed Project Chinook Salmon Habitat Compared with the Future Baseline in the Guadalupe River

Guadalupe River[a,b]	GUAD 3 River Mile 10.07	GUAD 4 River Mile 12.52	GUAD 5 River Mile 13.42	GUAD 6 River Mile 18.45	GUAD 7 River Mile 19.93	Total
Chinook Salmon Habitat Future Baseline (sq ft)						
Effective Spawning	4,900	3,230	262	612	2,650	11,654
Fry Rearing Total (Jan 1–Apr 30)	209,000	202,000	93,800	568,000	400,000	1,472,800
Juvenile Rearing Total (Jan 1–Jun 30)	204,000	213,000	77,800	483,000	392,000	1,369,800
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	222,000	218,000	85,100	546,000	421,000	1,492,100
Juvenile Rearing Summer Release Program (May 1–Jun 30)	169,000	203,000	63,400	359,000	332,000	1,126,400
Chinook Salmon Proposed Project (sq ft)						
Effective Spawning	2,530	1,610	352	1,280	4,670	10,442

Guadalupe River[a,b]	GUAD 3 River Mile 10.07	GUAD 4 River Mile 12.52	GUAD 5 River Mile 13.42	GUAD 6 River Mile 18.45	GUAD 7 River Mile 19.93	Total
Fry Rearing Total (Jan 1–Apr 30)	214,000	197,000	96,600	584,000	407,000	1,498,600
Juvenile Rearing Total (Jan 1–Jun 30)	207,000	210,000	77,500	504,000	394,000	1,392,500
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	228,000	217,000	86,500	585,000	432,000	1,548,500
Juvenile Rearing Summer Release Program (May 1–Jun 30)	165,000	196,000	59,700	343,000	318,000	1,081,700
Change in Habitat (sq ft)						
Effective Spawning	-2,370 (-48.37%)	-1,620 (-50.15%)	90 (34.35%)	668 (109.15%)	2,020 (76.23%)	-1,212 (-10.4%)
Fry Rearing Total (Jan 1–Apr 30)	5,000 (2.39%)	-5,000 (-2.48%)	2,800 (2.99%)	16,000 (2.82%)	7,000 (1.75%)	25,800 (1.75%)
Juvenile Rearing Total (Jan 1–Jun 30)	3,000 (1.47%)	-3,000 (-1.41%)	-300 (-0.39%)	21,000 (4.35%)	2,000 (0.51%)	22,700 (1.66%)
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	6,000 (2.7%)	-1,000 (-0.46%)	1,400 (1.65%)	39,000 (7.14%)	11,000 (2.61%)	56,400 (3.78%)
Juvenile Rearing Summer Release Program (May 1–Jun 30)	-4,000 (-2.37%)	-7,000 (-3.45%)	-3,700 (-5.84%)	-16,000 (-4.46%)	-14,000 (-4.22%)	-44,700 (-3.97%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

[b] No average daily habitat availability model results are available for the points of interest not shown.

Based on the results of the FAHCE WEAP Model, there would be in an average decrease in effective spawning habitat in Los Gatos Creek for Chinook salmon resulting from the Proposed Project. The Proposed Project would result in an 81% (5,667 square feet) decrease compared with the future baseline, with a sharp decline in effective spawning habitat observed in November (Figure 81). The decrease in effective spawning habitat can be attributed to decreases in flow a subsequent decrease in wetted area under the Proposed Project that reduce the suitability of the water depth for spawning in Los Gatos Creek (Table 56; Attachment K.2 – Figures K.2.33 and K.2.34).

Figure 81. Change in Chinook Salmon Effective Spawning Habitat in Los Gatos Creek

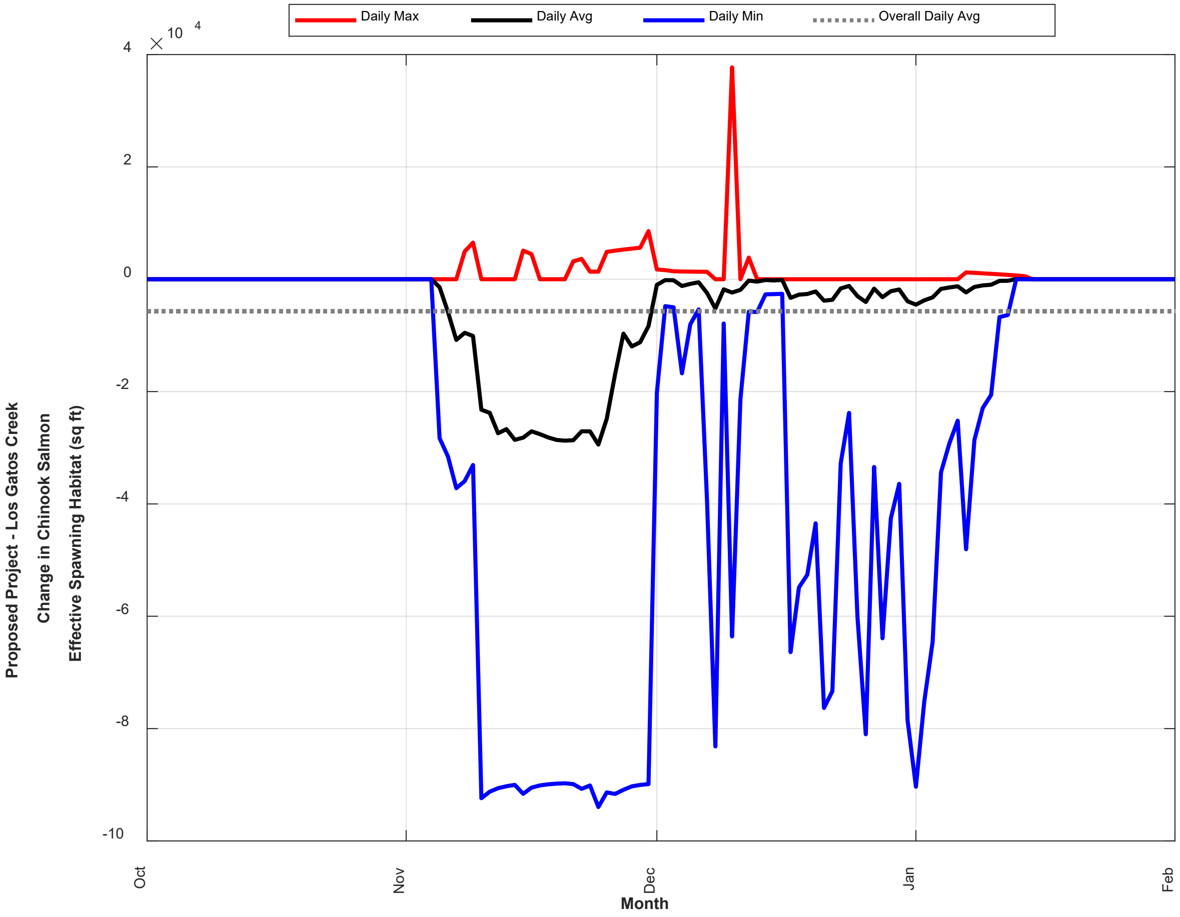


Table 56. Proposed Project Chinook Salmon Habitat Compared with the Future Baseline in Los Gatos Creek

Los Gatos Creek[a]	**LOSG 1 River Mile 14.70**	**LOSG 2 River Mile 18.91**	**Total**
Chinook Salmon Habitat Future Baseline (sq ft)			
Effective Spawning	3,200	3,820	7,020
Fry Rearing Total (Jan 1–Apr 30)	179,000	315,000	494,000
Juvenile Rearing Total (Jan 1–Jun 30)	144,000	256,000	400,000
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	149,000	255,000	404,000
Juvenile Rearing Summer Release Program (May 1–Jun 30)	134,000	260,000	394,000

Los Gatos Creek[a]	LOSG 1 River Mile 14.70	LOSG 2 River Mile 18.91	Total
Chinook Salmon Proposed Project (sq ft)			
Effective Spawning	722	631	1,353
Fry Rearing Total (Jan 1–Apr 30)	183,000	323,000	506,000
Juvenile Rearing Total (Jan 1–Jun 30)	144,000	260,000	404,000
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	152,000	266,000	418,000
Juvenile Rearing Summer Release Program (May 1–Jun 30)	128,000	249,000	377,000
Change in Habitat (sq ft)			
Effective Spawning	-2,478 (-77.44%)	-3,189 (-83.48%)	-5,667 (-80.73%)
Fry Rearing Total (Jan 1–Apr 30)	4,000 (2.23%)	8,000 (2.54%)	12,000 (2.43%)
Juvenile Rearing Total (Jan 1–Jun 30)	0 (0%)	4,000 (1.56%)	4,000 (1%)
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	3,000 (2.01%)	11,000 (4.31%)	14,000 (3.47%)
Juvenile Rearing Summer Release Program (May 1–Jun 30)	-6,000 (-4.48%)	-11,000 (-4.23%)	-17,000 (-4.31%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

Based on the results of the FAHCE WEAP Model, there would be in an average increase in the daily effective spawning habitat in Guadalupe Creek during the spawning and incubation life-stage period for Chinook salmon (that is, October 15 to January 31) resulting from the Proposed Project (Figure 82). The Proposed Project would result in a 196% (1,608 square feet) average increase in the daily effective habitat across the entire spawning/incubation life stage compared with the future baseline (Table 57). In the Guadalupe Creek CWMZ, the modeled Chinook salmon effective spawning habitat had an average increase of 155% (264 square feet) across the entire spawning/incubation life stage when compared with the future baseline.

Figure 82. Change in Chinook Salmon Effective Spawning Habitat in Guadalupe Creek

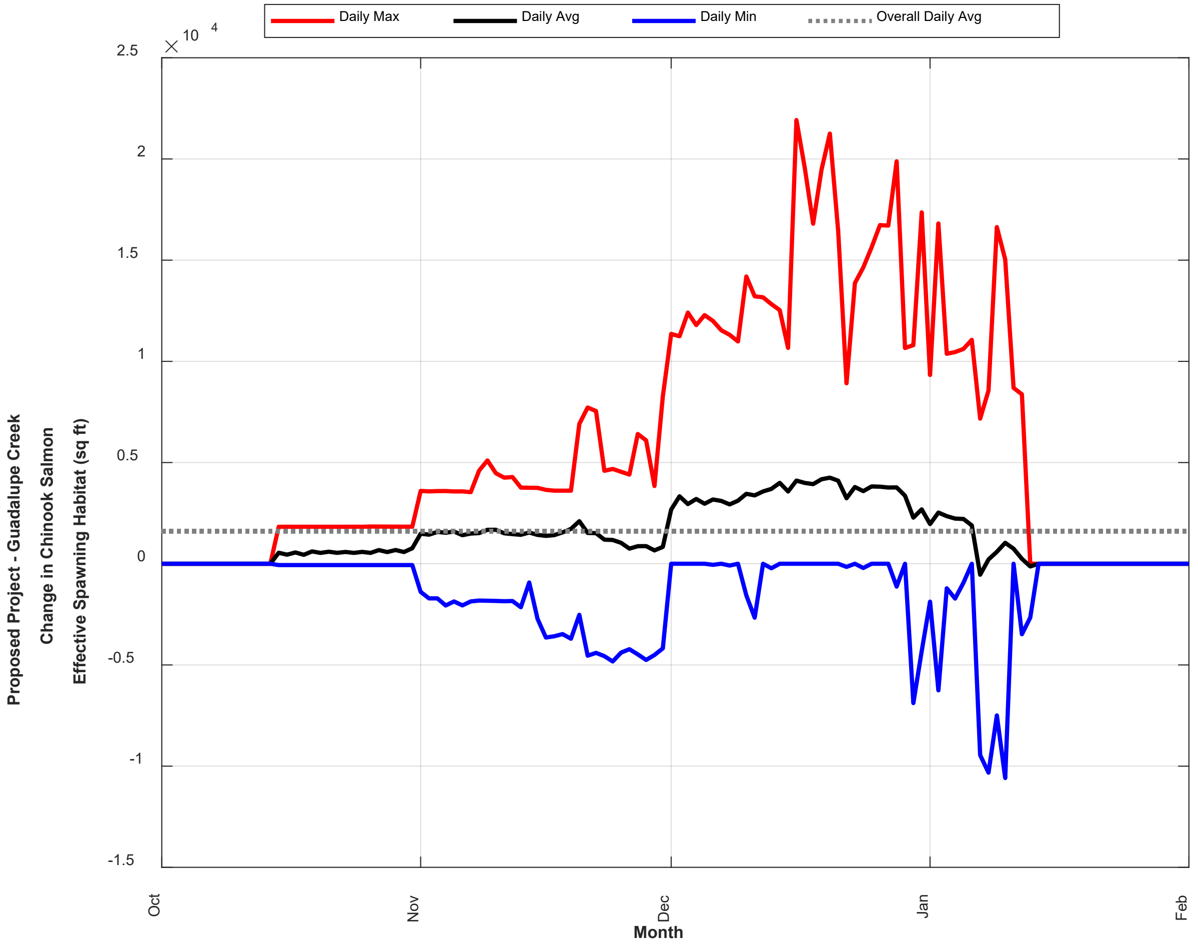


Table 57. Proposed Project Chinook Salmon Habitat Compared with the Future Baseline in Guadalupe Creek

Guadalupe Creek[a]	GCRK 1 River Mile 20.71	GCRK 2 River Mile 21.91	GCRK 3 River Mile 22.54	GCRK 4 River Mile 26.17	Total
Chinook Salmon Habitat Future Baseline (sq ft)					
Effective Spawning	86	510	53	170	820
Fry Rearing Total (Jan 1–Apr 30)	21,100	41,000	3,390	23,800	89,290
Juvenile Rearing Total (Jan 1–Jun 30)	17,000	41,600	3,710	22,400	84,710
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	20,600	42,700	3,610	19,500	86,410
Juvenile Rearing Summer Cold Water Program (May 1–Jun 30)	9,780	39,300	3,930	28,200	81,210

Guadalupe Creek[a]	**GCRK 1 River Mile 20.71**	**GCRK 2 River Mile 21.91**	**GCRK 3 River Mile 22.54**	**GCRK 4 River Mile 26.17**	**Total**
Chinook Salmon Proposed Project (sq ft)					
Effective Spawning	364	1,540	90	434	2,428
Fry Rearing Total (Jan 1–Apr 30)	24,400	49,000	3,370	24,200	100,970
Juvenile Rearing Total (Jan 1–Jun 30)	19,000	42,500	3,540	25,700	90,740
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	26,500	52,000	4,030	26,800	109,330
Juvenile Rearing Summer Cold Water Program (May 1–Jun 30)	4,080	23,900	2,570	23,600	54,150
Change in Habitat (sq ft)					
Effective Spawning	278 (323.26%)	1,030 (201.96%)	37 (69.8%)	264 (155.29%)	1,608 (196.10%)
Fry Rearing Total (Jan 1–Apr 30)	3,300 (15.64%)	8,000 (19.51%)	-20 (-0.59%)	400 (1.68%)	11,680 (13.08%)
Juvenile Rearing Total (Jan 1–Jun 30)	2,000 (11.76%)	900 (2.16%)	-170 (-4.58%)	3,300 (14.73%)	6,030 (7.12%)
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	5,900 (28.64%)	9,300 (21.78%)	420 (11.63%)	7,300 (37.44%)	22,920 (26.52%)
Juvenile Rearing Summer Cold Water Program (May 1–Jun 30)	-5,700 (-58.28%)	-15,400 (-39.19%)	-1,360 (-34.61%)	-4,600 (-16.31%)	-27,060 (-33.32%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

Based on the results of the FAHCE WEAP Model, there would be in an average increase in daily effective spawning habitat in Alamitos Creek during the spawning and incubation life-stage period for Chinook salmon (that is, October 15 to January 31) resulting from the Proposed Project (Figure 83). The Proposed Project would result in a 120% (669 square feet) average increase in effective spawning habitat across the entire spawning/incubation life stage compared with the future baseline (Table 58).

Figure 83. Change in Chinook Salmon Effective Spawning Habitat in Alamitos Creek

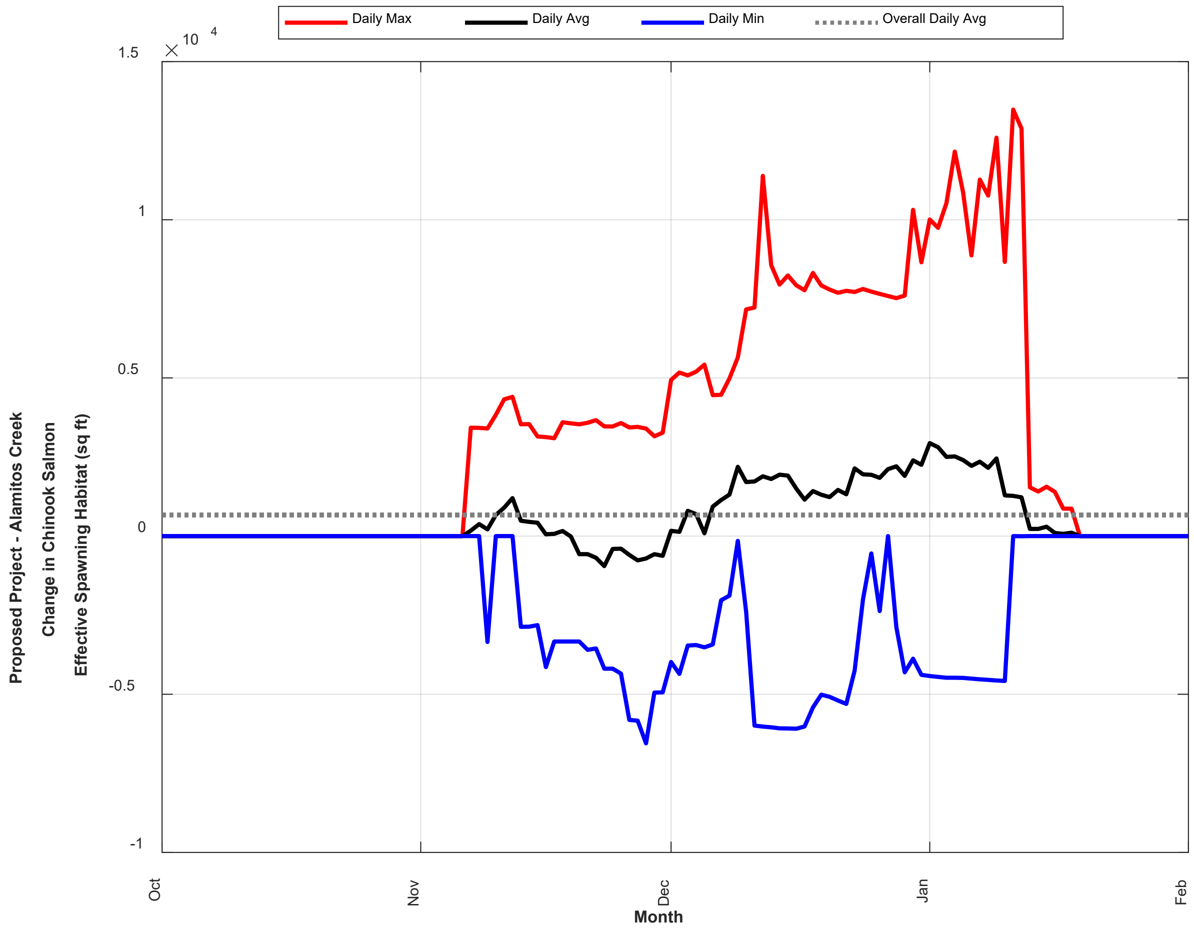


Table 58. Proposed Project Chinook Salmon Habitat Compared with the Future Baseline in Alamitos Creek

Alamitos Creek[a,b]	**ALAM 2 River Mile 23.61**	**ALAM 3 River Mile 24.26**	**ALAM 4 River Mile 27.89**	**Total**
Chinook Salmon Habitat Future Baseline (sq ft)				
Effective Spawning	496	13	45	554
Fry Rearing Total (Jan 1–Apr 30)	66,200	6,910	3,130	76,240
Juvenile Rearing Total (Jan 1–Jun 30)	64,300	6,670	3,270	74,240
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	66,000	6,950	2,960	75,910
Juvenile Rearing Summer Release Program (May 1–Jun 30)	60,800	6,120	3,900	70,820

Alamitos Creek[a,b]	ALAM 2 River Mile 23.61	ALAM 3 River Mile 24.26	ALAM 4 River Mile 27.89	Total
Chinook Salmon Proposed Project (sq ft)				
Effective Spawning	1,020	43	160	1,223
Fry Rearing Total (Jan 1–Apr 30)	70,700	7,830	3,520	82,050
Juvenile Rearing Total (Jan 1–Jun 30)	68,300	7,400	3,710	79,410
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	71,000	8,090	3,640	82,730
Juvenile Rearing Summer Release Program (May 1–Jun 30)	62,900	6,040	3,850	72,790
Change in Habitat (sq ft)				
Effective Spawning	524 (105.65%)	30 (230.77%)	115 (255.56%)	669 (120.76%)
Fry Rearing Total (Jan 1–Apr 30)	4,500 (6.8%)	920 (13.31%)	390 (12.46%)	5,810 (7.62%)
Juvenile Rearing Total (Jan 1–Jun 30)	4,000 (6.22%)	730 (10.94%)	440 (13.46%)	5,170 (6.96%)
Juvenile Rearing Winter Base Flow Operations (Jan 1–April 30)	5,000 (7.58%)	1,140 (16.4%)	680 (22.97%)	6,820 (8.98%)
Juvenile Rearing Summer Release Program (May 1–Jun 30)	2,100 (3.45%)	-80 (-1.31%)	-50 (-1.28%)	1,970 (2.78%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

[b] No average daily habitat availability model results are available for the points of interest not shown.

Based on the results of the FAHCE WEAP Model for wetted area, effective spawning habitat would decrease across POIs in Calero Creek compared with the future baseline.

Table 59. Proposed Project Chinook Salmon Habitat Compared with the Future Baseline in Calero Creek

Calero Creek[a]	CALE 1 River Mile 24.33	CALE 2 River Mile 27.59	Total
Chinook Salmon Habitat Future Baseline (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (Jan 1–Apr 30)	2,800	26,600[c]	29,400[c]
Juvenile Rearing Total (Jan 1–Jun 30)	2,920	53,600[c]	56,520[c]
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	2,920	25,900[c]	28,820[c]
Juvenile Rearing Summer Release Program (May 1–Jun 30)	2,910	109,000	111,910

Calero Creek[a]	CALE 1 River Mile 24.33	CALE 2 River Mile 27.59	Total
Chinook Salmon Proposed Project (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (Jan 1–Apr 30)	2,920	27,000[c]	29,920[c]
Juvenile Rearing Total (Jan 1–Jun 30)	3,080	56,400[c]	59,480[c]
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	3,070	26,600[c]	29,670[c]
Juvenile Rearing Summer Release Program (May 1–Jun 30)	3100	116000	119,100
Change in Habitat (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (Jan 1–Apr 30)	120 (4.29%)	400 (1.5%)[c]	520 (1.77%)[c]
Juvenile Rearing Total (Jan 1–Jun 30)	160 (5.48%)	2,800 (5.22%)[c]	2,960 (5.24%)[c]
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	150 (5.14%)	700 (2.7%)[c]	850 (2.95%)[c]
Juvenile Rearing Summer Release Program (May 1–Jun 30)	190 (6.53%)	7,000 (6.42%)	7,190 (6.42%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

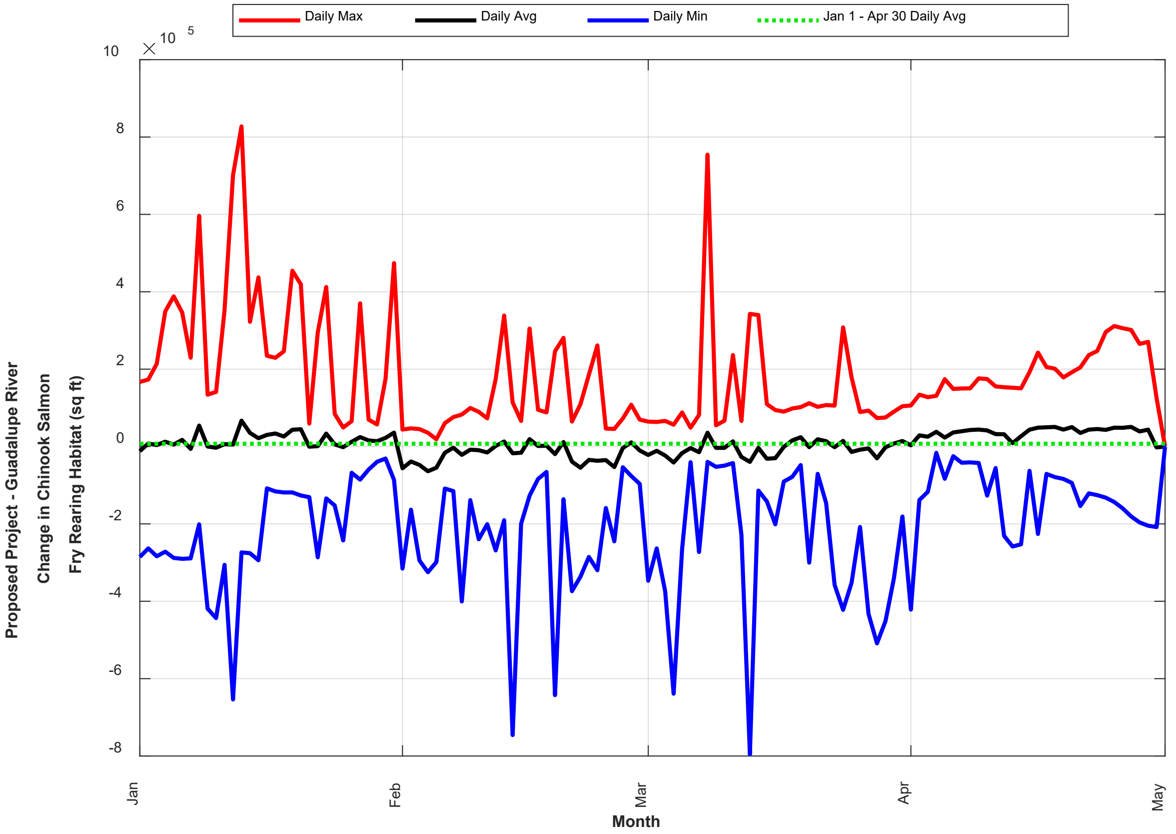
[b] Effective spawning model results were not available in Calero Creek because no substrate suitable for spawning was recorded by the subsample habitat survey of Calero Creek input into the FAHCE WEAP Model. Subsequent surveys indicate there is substrate suitable for spawning in Calero Creek (Valley Water 2019a, 2020).

[c] Average daily fry rearing and juvenile rearing habitat availability model results do not quantify conditions when winter cover was considered in the habitat estimate (January 1 through March 31 for Chinook salmon) since no winter cover was recorded by the subsample habitat survey of the CALE 2 reach of Calero Creek (that is, the reach between CALE 1 and CALE 2) input into the FAHCE WEAP Model. Subsequent surveys indicate there is winter cover available in this reach of Calero Creek (Valley Water 2019a, 2020).

Fry Rearing Habitat

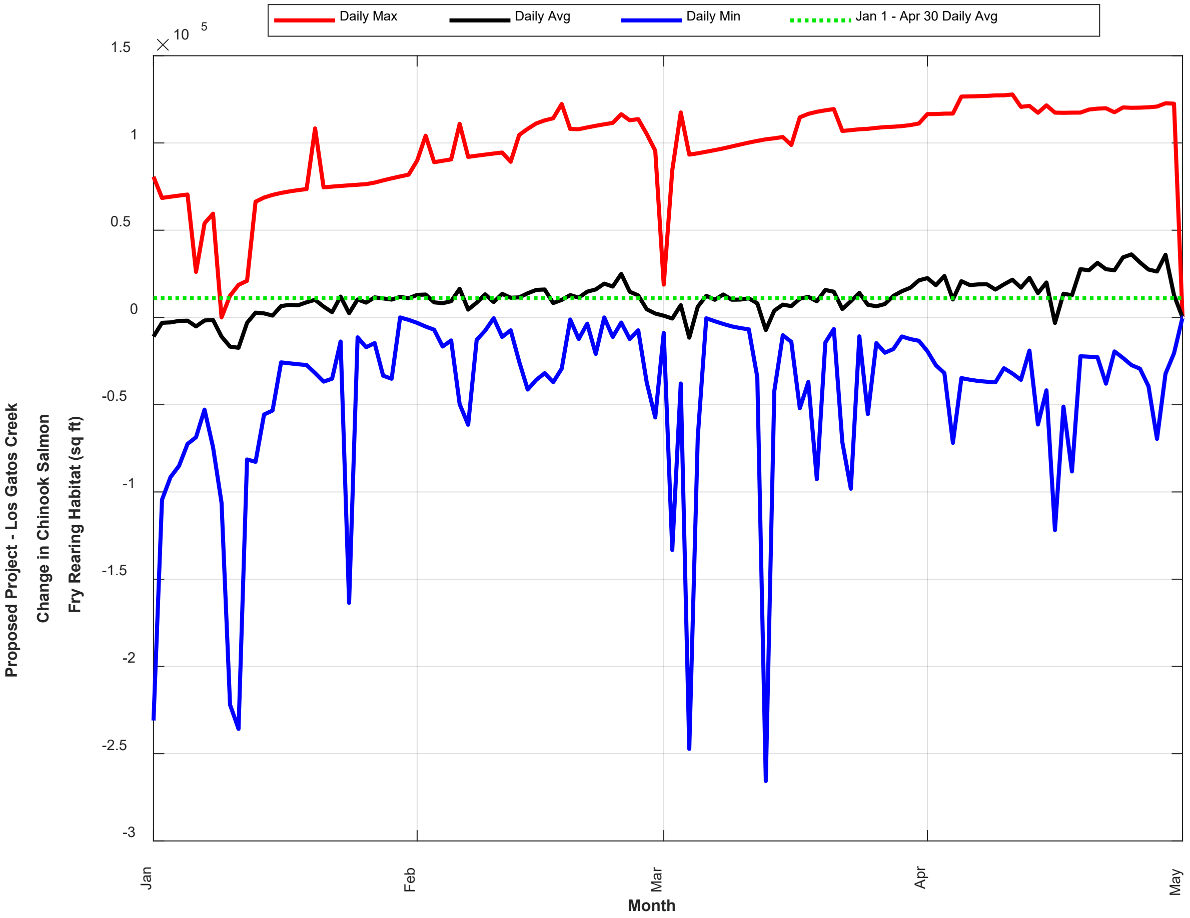
Based on the results of the FAHCE WEAP Model, there would be in an average increase in fry rearing habitat in the Guadalupe River for Chinook salmon resulting from the Proposed Project (Figure 84). The Proposed Project would result in a 2% (25,800 square feet) increase compared with the future baseline (Table 55).

Figure 84. Change in Chinook Salmon Fry Rearing Habitat in the Guadalupe River



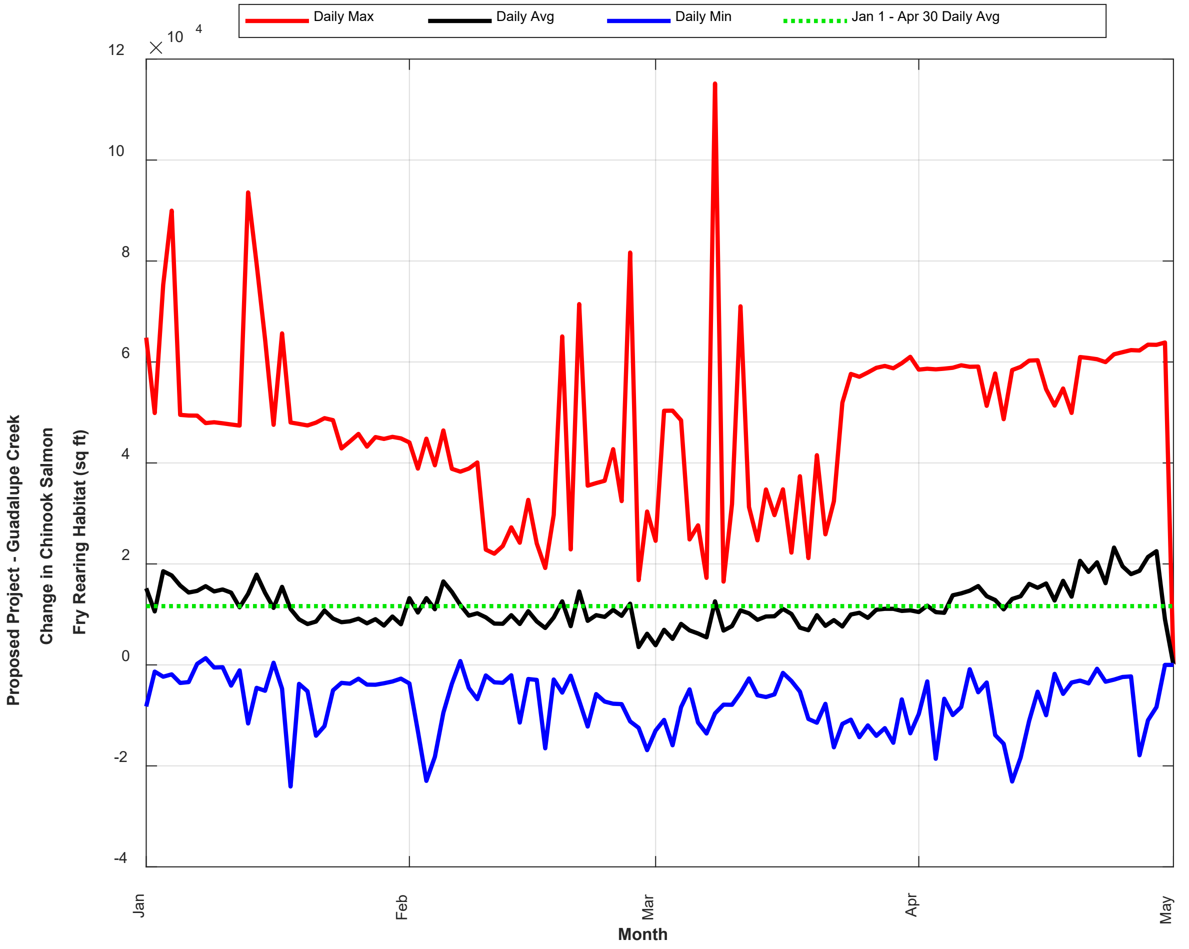
Based on the results of the FAHCE WEAP Model, there would be an average increase in fry rearing habitat in Los Gatos Creek for Chinook salmon resulting from the Proposed Project (Figure 85; Table 56). The Proposed Project would result in a 2% (12,000 square feet) increase compared with the future baseline.

Figure 85. Change in Chinook Salmon Fry Rearing Habitat in Los Gatos Creek



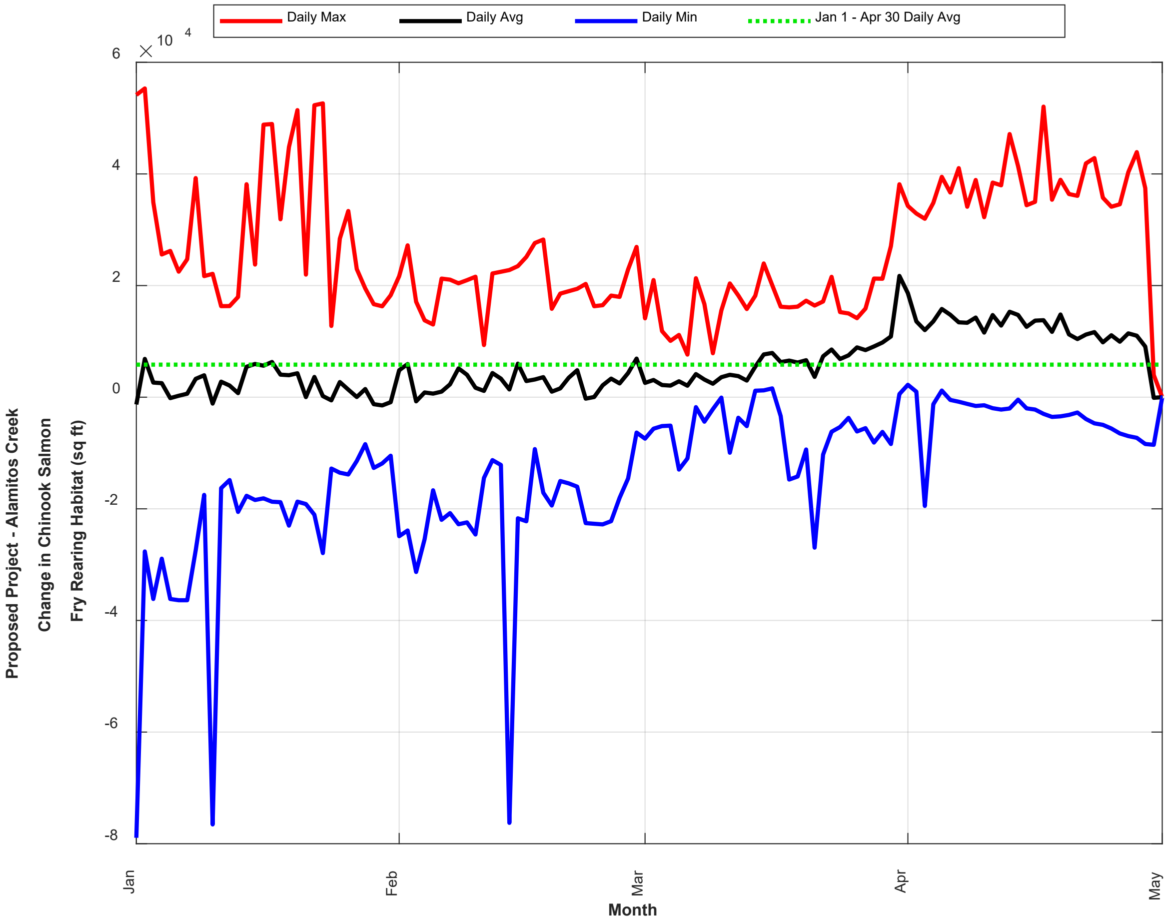
Based on the results of the FAHCE WEAP Model, there would be an average increase in fry rearing habitat in Guadalupe Creek for Chinook salmon resulting from the Proposed Project. The Proposed Project would result in a 13% (11,680 square feet) increase in suitable fry rearing habitat in Guadalupe Creek compared with the future baseline (Figure 86; Table 57). In the Guadalupe Creek CWMZ, modeled Chinook salmon fry rearing habitat increased by 2% (400 square feet) when compared with the future baseline. Suitable fry rearing habitat in Guadalupe Creek remains fairly constant throughout the fry rearing period, with the largest amount of suitable fry rearing habitat available in late April (Figure 86).

Figure 86. Change in Chinook Salmon Fry Rearing Habitat in Guadalupe Creek



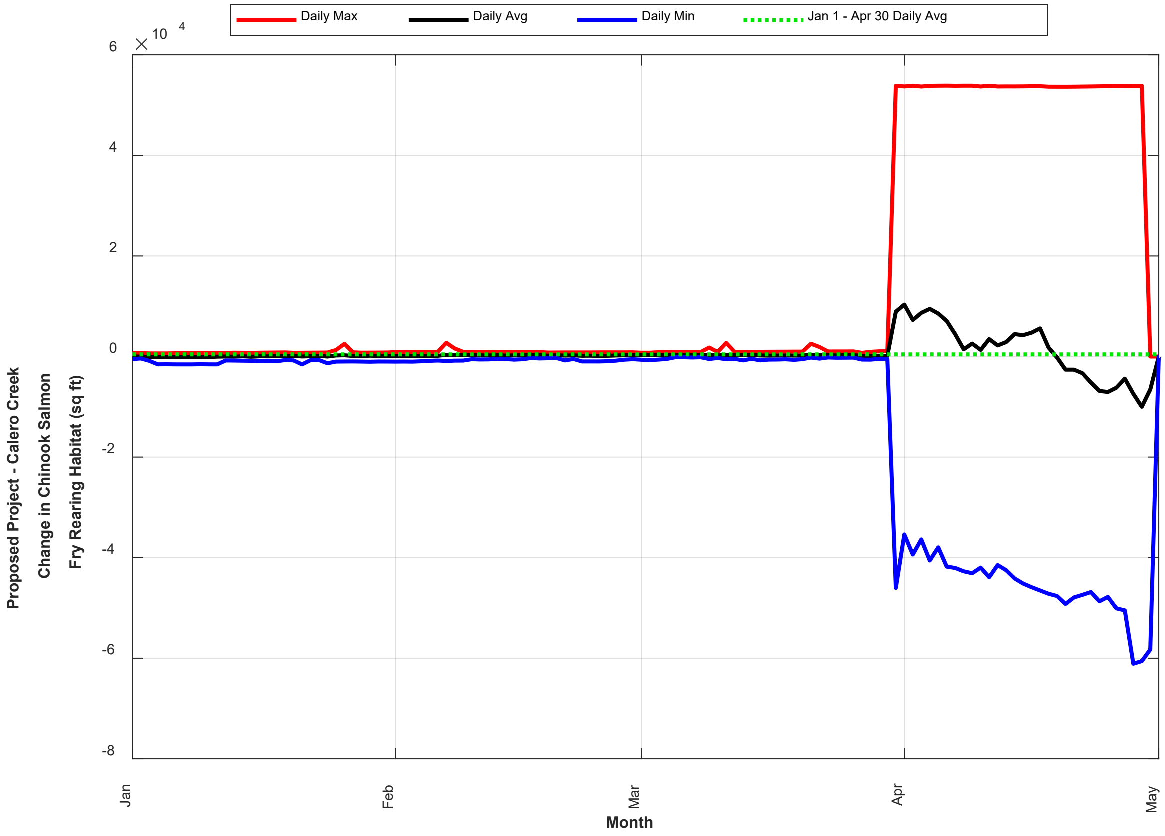
Based on the results of the FAHCE WEAP Model, there would be in an average increase in fry rearing habitat in Alamitos Creek for Chinook salmon resulting from the Proposed Project. The Proposed Project would result in an 8% (5,810 square feet) increase compared with the future baseline (Figure 87; Table 58). The largest increase in suitable fry rearing habitat would occur in Alamitos Creek in late March and continue through late April, the end of the fry rearing period.

Figure 87. Change in Chinook Salmon Fry Rearing Habitat in Alamitos Creek



Based on the results of the FAHCE WEAP Model, there would be 2% (520 square feet) increase in fry rearing habitat in Calero Creek compared with the current baseline. The average increase between January 1 and May 31 does not completely characterize the change in fry rearing habitat during this period because habitat surveys indicated there was zero winter cover in the reach associated with the CALE 2 POI (that is, CALE 1 to CALE 2) and caused fry rearing habitat to be zero in this reach during January 1 to March 31 under all scenarios. Subsequent habitat surveys indicated there was winter cover (Valley Water 2019a, 2020), so fry rearing habitat would not actually be zero in this reach between January 1 and March 31. Increases in wetted area at CALE 2 from January 1 to March 31 under the Proposed Project compared to the future baseline further indicate fry rearing habitat during this time would be greater than estimated by the model habitat results (Attachment K.2 – Figures K.2.69 and K.2.70).

Figure 88. Change in Chinook Salmon Fry Rearing Habitat in Calero Creek[a]

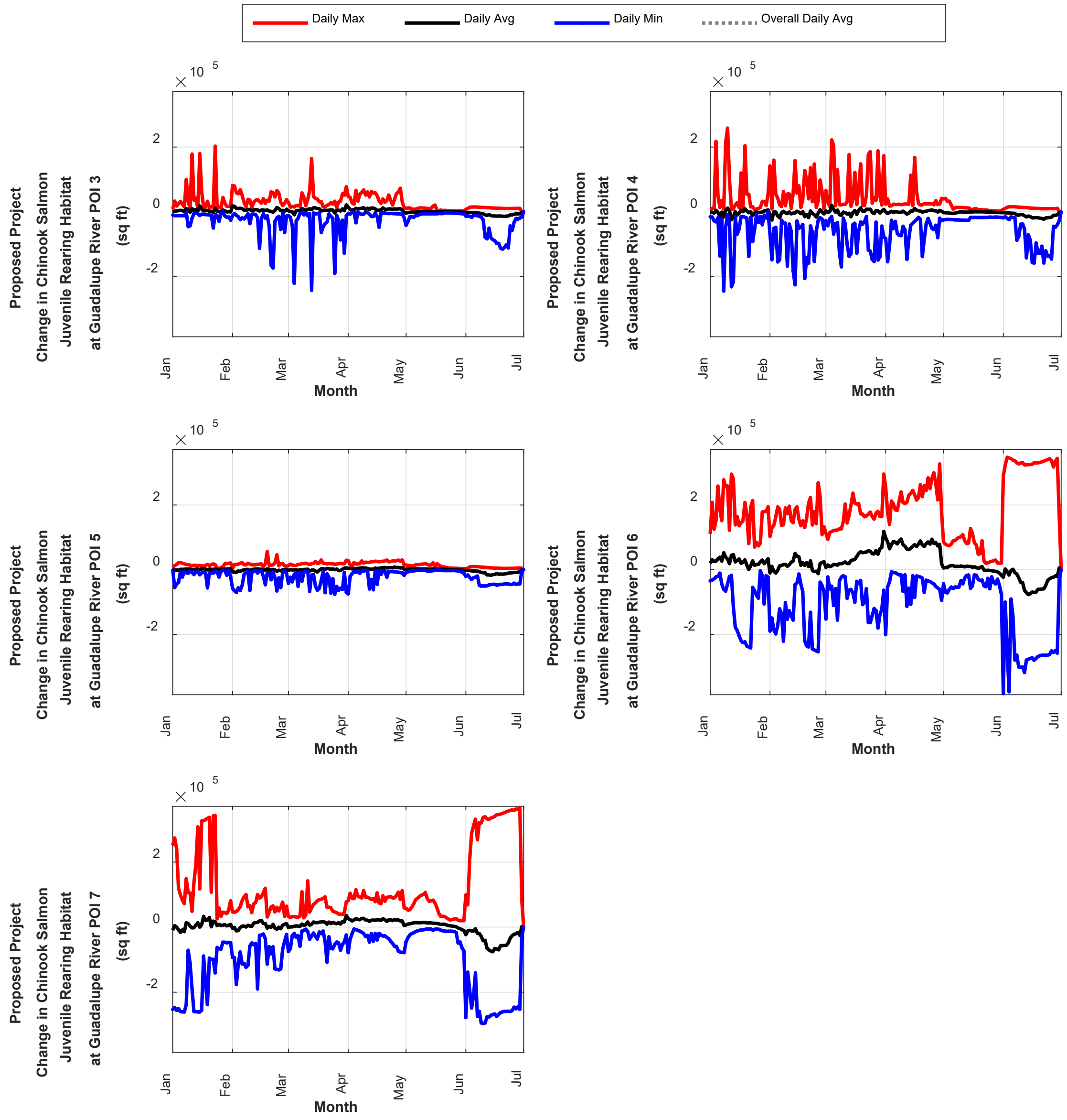


[a] Calero Creek habitat survey results in the reach between CALE 1 and CALE 2 input into the FAHCE WEAP Model did not record any winter cover, so fry and juvenile rearing habitat model results in this reach were zero during the period when winter cover is considered in the habitat estimate (that is, December 1 through March 31 for steelhead; January 1 through March 31 for Chinook salmon). Subsequent habitat surveys identified winter cover between CALE 1 and CALE 2 (Valley Water 2019a, 2020).

Juvenile Rearing Habitat

Based on the results of the FAHCE WEAP Model, the absolute amount of juvenile rearing habitat would increase by 2% (22,700 square feet) in the Guadalupe River under the Proposed Project compared with the future baseline (Table 55). The trends in juvenile rearing habitat over time revealed a 4% (14,000 square feet) increase under the Proposed Project during the Winter Base Flow Operations and a 4% (17,000 square feet) decrease during Summer Release Program (Figure 89; Table 55). The largest decrease in available juvenile rearing habitat would occur in June (Figure 89), likely the result of reduced wetted area and elevated water temperatures.

Figure 89. Change in Chinook Salmon Juvenile Rearing Habitat at GUAD 3 through 7 in the Guadalupe River[a]



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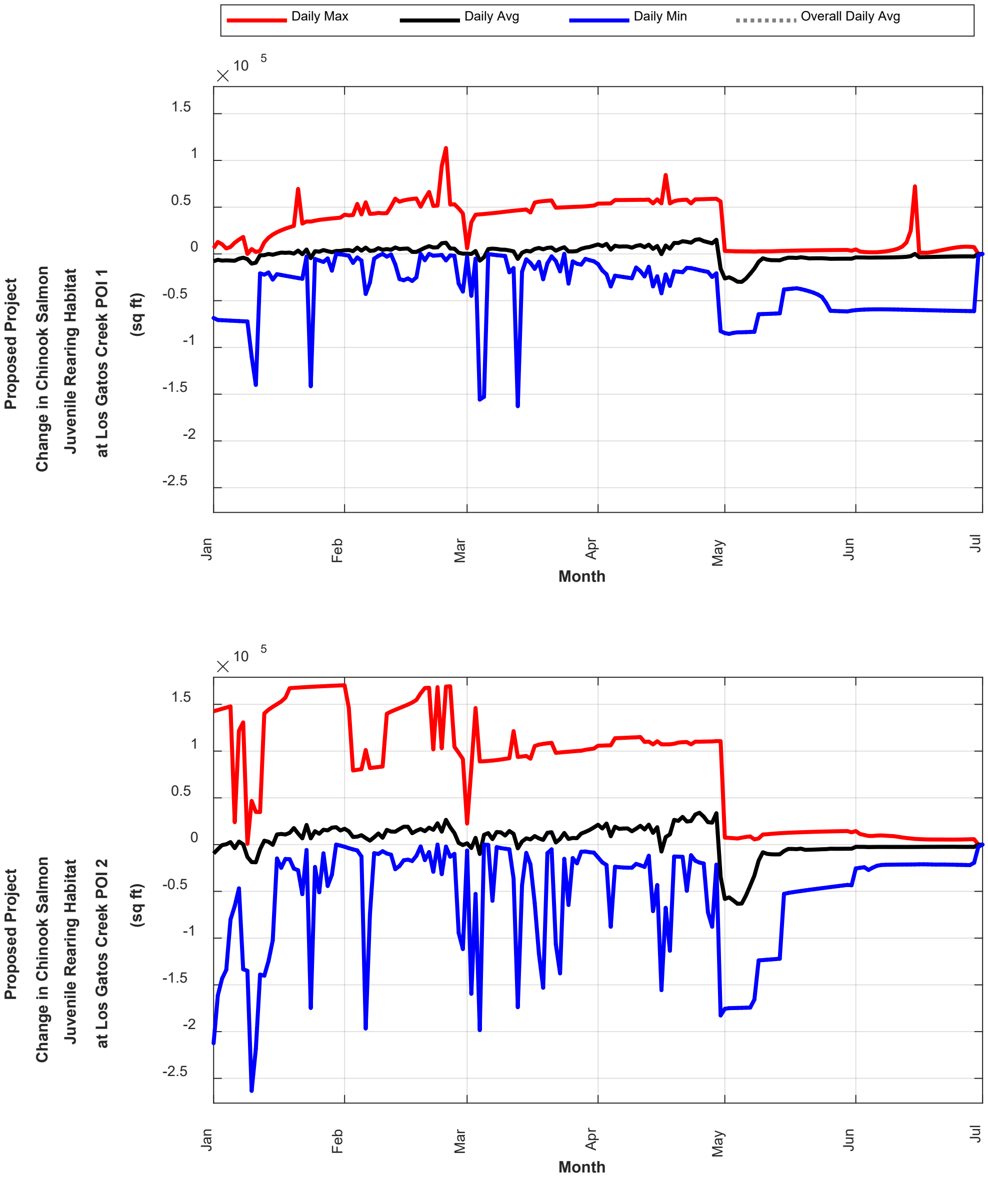
[a] No average daily habitat availability model results are available for the points of interest not shown.

Based on the results of the FAHCE WEAP Model, there would be in an average increase in juvenile rearing habitat in Los Gatos Creek for Chinook salmon resulting from the Proposed Project (Figure 90). The Proposed Project would result in a 1% (4,000 square feet) increase compared with the future baseline (Table 56). The trends in juvenile rearing habitat over time would be a 4% (14,000 square feet) increase under the Proposed Project during Winter Base Flow Operations and a 4% (17,000 square feet) decrease during the Summer Release Program (Figure 90). A sharp decline in juvenile rearing habitat would occur in Los Gatos Creek when the Summer Release Program begins on May 1

(Figure 90), likely because of reduced wetted area and elevated water temperatures (Attachment K.2 – Figure K.2.33, K.2.34, K.2.35, and K.2.36).

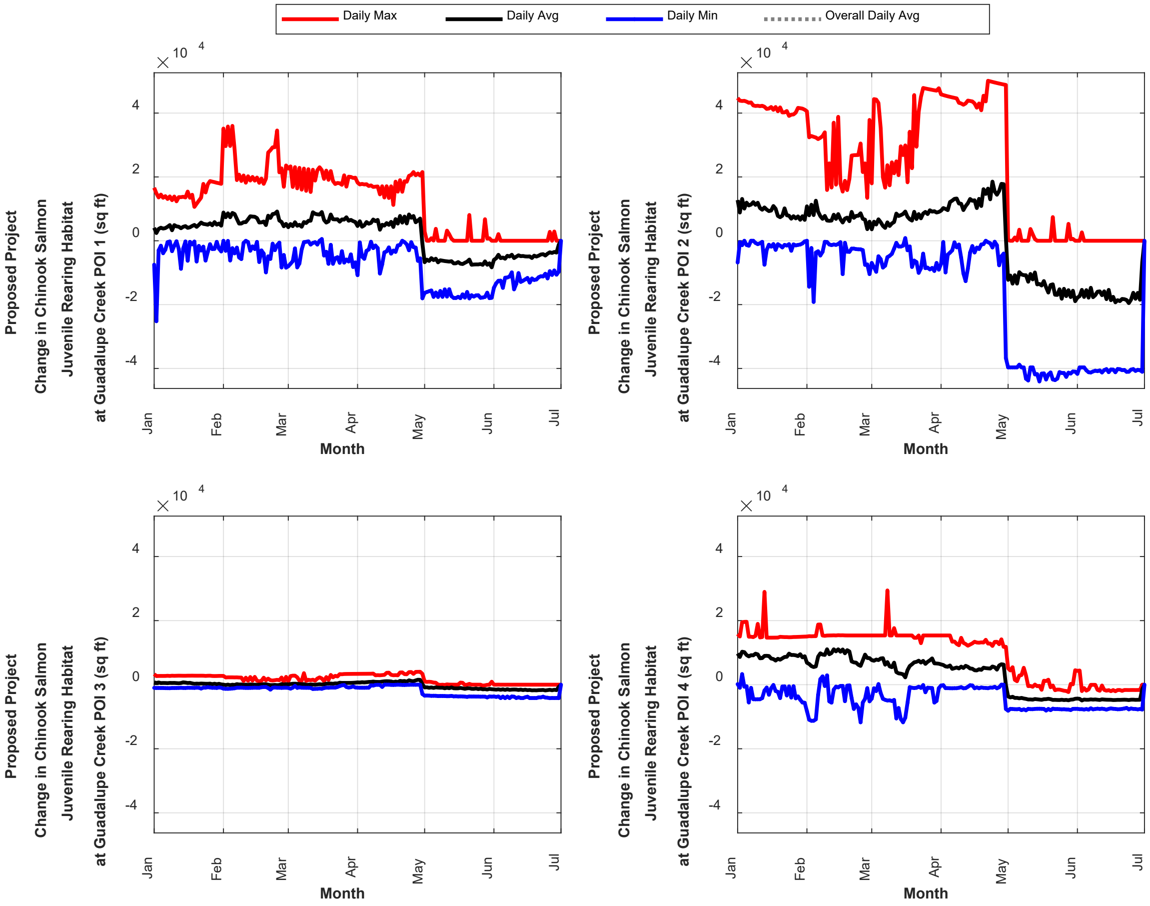
Figure 90. Change in Chinook Salmon Juvenile Rearing Habitat at LOSG 1 and 2 in Los Gatos Creek



Based on the results of the FAHCE WEAP Model, there would be in an average increase in juvenile rearing habitat in Guadalupe Creek for Chinook salmon resulting from the Proposed Project. The Proposed Project would result in a 7% (6,030 square feet) increase compared with the future baseline. The trends in juvenile rearing habitat over time would be a 27% (22,920 square feet) increase under the Proposed Project during Winter Base Flow Operations and a 33% (27,060 square feet) decrease during the Summer Cold Water Program (Figure 91; Table 57). In the Guadalupe

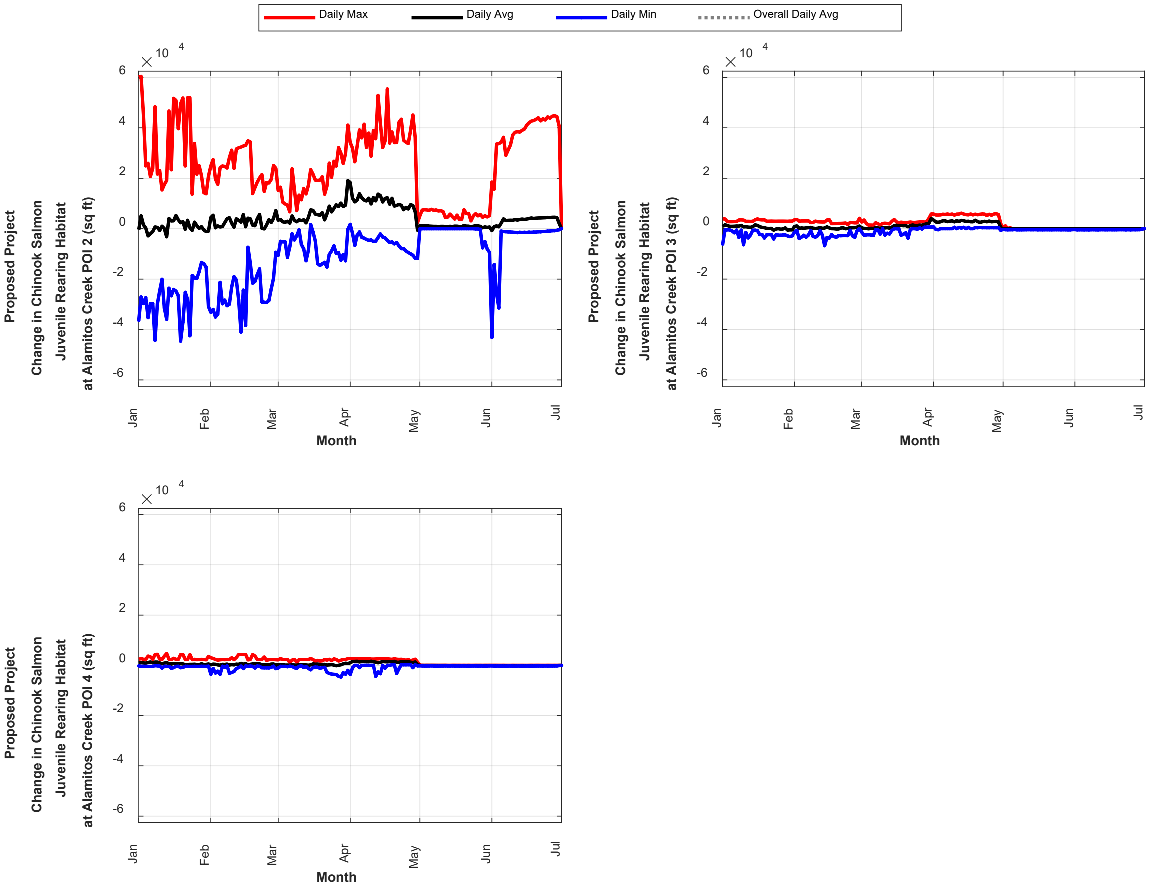
Creek CWMZ, modeled juvenile rearing habitat increased by 15% (3,300 square feet), with a 37% (7,300 square feet) increase occurring during the Winter Base Flow Operations followed by a 16% (4,600 square feet) decrease during the Summer Cold Water Program, Average water temperatures under the Proposed Project remained below 65°F throughout the Summer Cold Water Program in the Guadalupe Creek CWMZ, so decreases in habitat within the CWMZ are strictly a function of a decrease in wetted area. The decreases in habitat during the Summer Cold Water Program downstream of the CWMZ are the result of reduced wetted area and elevated water temperatures (that is, above 65°F) in Guadalupe Creek (Attachment K.2 – Figures K.2.45, K.2.46, K.2.47, and K.2.48).

Figure 91. Change in Chinook Salmon Juvenile Rearing Habitat at GCRK 1 through 4 in Guadalupe Creek



Based on the results of the FAHCE WEAP Model, there would be in an average increase in juvenile rearing habitat in Alamitos Creek for Chinook salmon resulting from the Proposed Project. The Proposed Project would result in a 7% (5,170 square feet) increase compared with the future baseline. The trends in juvenile rearing habitat over time would be a 9% (6,820 square feet) increase under the Proposed Project during the Winter Base Flow Operations and a 3% (1,970 square feet) increase during the Summer Release Program in Alamitos Creek (Figure 92; Table 58).

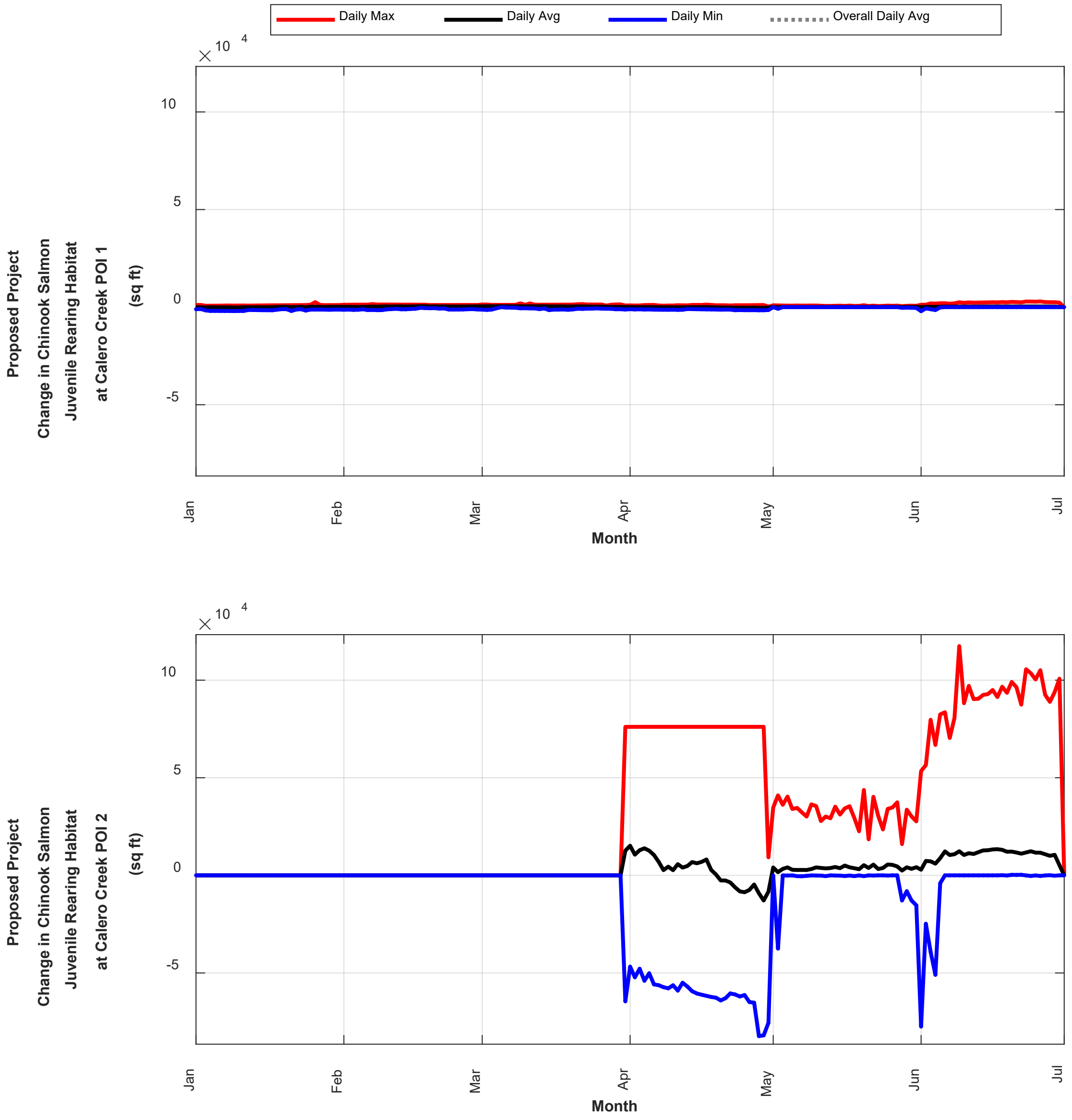
Figure 92. Change in Chinook Salmon Juvenile Rearing Habitat at ALAM 1 through 4 in Alamitos Creek[a]



[a] No average daily habitat availability model results are available for the points of interest not shown.

Based on the results of the FAHCE WEAP Model, there would be a 5% (2,960 square feet) increase in juvenile rearing habitat in Calero Creek compared with the future baseline with a 3% (850 square feet) increase during the Winter Base Flow Operations and a 6% (7,190 square feet) increase during the Summer Release Program. The average increases estimated from the model results do not completely characterize the change in juvenile rearing habitat during January 1 to March 31 because habitat surveys indicated there was zero winter cover in the reach associated with the CALE 2 POI (that is, CALE 1 to CALE 2) and caused juvenile rearing habitat to be zero in this reach during January 1 to March 31 under all scenarios. Subsequent habitat surveys indicated there was winter cover (Valley Water 2019a, 2020), so juvenile rearing habitat would not actually be zero in this reach between January 1 and March 31. Increases in wetted area at CALE 2 from January 1 to March 31 under the Proposed Project compared to the future baseline further indicate juvenile rearing habitat during this time would be greater than estimated by the model habitat results (Attachment K.2 – Figures K.2.69 and K.2.70).

Figure 93. Change in Chinook Salmon Juvenile Rearing Habitat at GCRK 1 through 4 in Calero Creek[a]



[a] Calero Creek habitat survey results in the reach between CALE 1 and CALE 2 input into the FAHCE WEAP Model did not record any winter cover, so fry and juvenile rearing habitat model results in this reach shown in the Calero Creek POI 2 (that is, CALE 2) plot were zero during the period when winter cover is considered in the habitat estimate (that is, December 1 through March 31 for steelhead; January 1 through March 31 for Chinook salmon). Subsequent habitat surveys identified winter cover between CALE 1 and CALE 2 (Valley Water 2019a, 2020).

Migration Conditions

Adult Upstream Passage

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in increases by an average of 3% to adult upstream Chinook salmon passage in the Guadalupe River compared with future baseline (Figure 94; Table 60). GUAD 3 and GUAD 4 would see an average decrease (8 days per year), while the upstream POIs would see an increase (5 days per year), with the exception of GUAD 5 which saw an increase (1 day per year). Although passage varied across sites, the average number of passage days (61 days per year) remained the same under both the future baseline and the Proposed Project.

Figure 94. Change in Average Adult Chinook Salmon Upstream Passage Days in the Guadalupe River

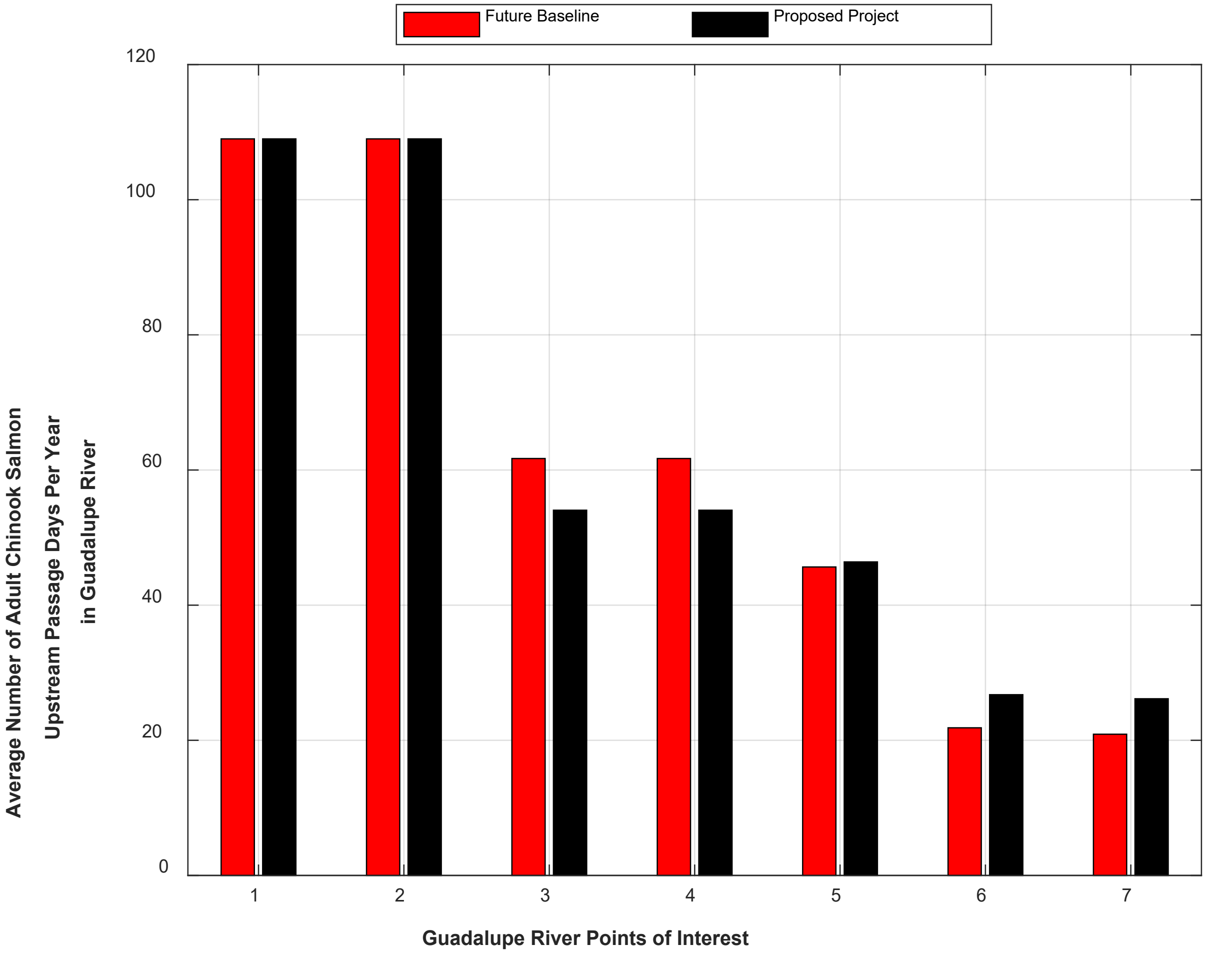


Table 60. Proposed Project Adult Chinook Upstream Passage Compared with the Future Baseline in the Guadalupe River

Parameter	GUAD 1	GUAD 2	GUAD 3	GUAD 4	GUAD 5	GUAD 6	GUAD 7
Future Baseline (days) [a]							
Total Adult Upstream Passage (1991–2010)	2,180	2,180	1,234	1,234	913	437	418
Average Adult Upstream Passage Per Year	109	109	62	62	46	22	21
Proposed Project (days) [a]							
Total Adult Upstream Passage (1991–2010)	2,180	2,180	1,081	1,081	928	535	523
Average Adult Upstream Passage Per Year	109	109	54	54	46	27	26
Difference (days)							
Total Adult Upstream Passage (1991–2010)	0.00	0.00	-153.00	-153.00	15.00	98.00	105.00
Average Adult Upstream Passage Per Year	0.00	0.00	-7.65	-7.65	0.75	4.90	5.25
Difference (%)							
Total Adult Upstream Passage (1991–2010)	0.00	0.00	-12.40	-12.40	1.64	22.43	25.12
Average Adult Upstream Passage Per Year	0.00	0.00	-12.40	-12.40	1.64	22.43	25.12

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the Proposed Project would decrease adult upstream passage by an average of 39% (7 days per year) in Los Gatos Creek compared with the future baseline (Figure 95; Table 61). The loss of passage opportunities equates to a 30% and 47% reduction in average annual passage days at LOSG 1 and LOSG 2, respectively.

Figure 95. Change in Average Adult Chinook Salmon Upstream Passage Days in Los Gatos Creek

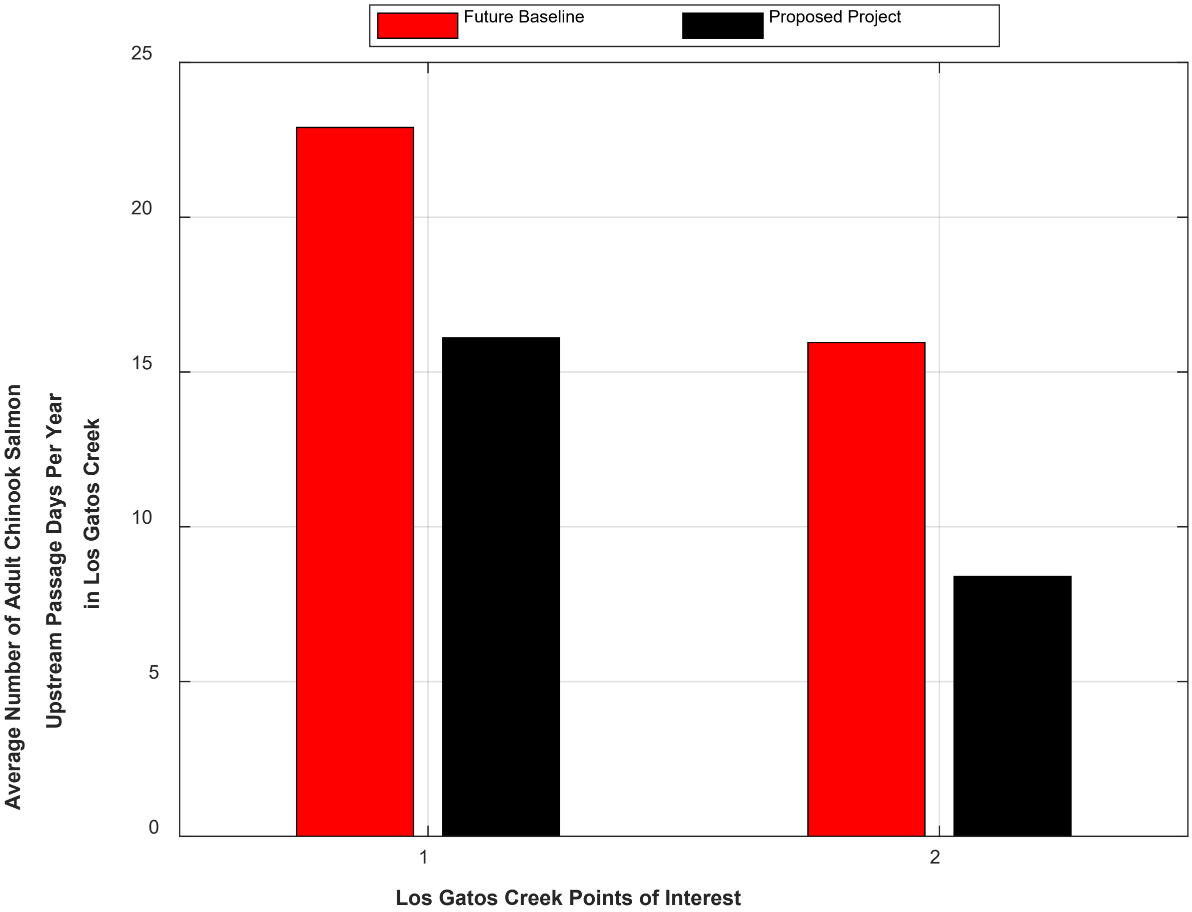


Table 61. Proposed Project 2035 Adult Chinook Upstream Passage Compared with the Future Baseline in Los Gatos Creek

Parameter	LOSG 1	LOSG 2
Future Baseline (days) [a]		
Total Adult Upstream Passage (1991–2010)	458	319
Average Adult Upstream Passage Per Year	23	16
Proposed Project (days) [a]		
Total Adult Upstream Passage (1991–2010)	322	168
Average Adult Upstream Passage Per Year	16	8
Difference (days)		
Total Adult Upstream Passage (1991–2010)	-136.00	-151.00
Average Adult Upstream Passage Per Year	-6.80	-7.55

Parameter	LOSG 1	LOSG 2
Difference (%)		
Total Adult Upstream Passage (1991–2010)	-29.69	-47.34
Average Adult Upstream Passage Per Year	-29.69	-47.34

[a] Rounded to whole days

The Proposed Project would result in decreases (5% or less than 1 day per year on average) to adult upstream Chinook salmon passage at Guadalupe Creek compared with the future baseline (Figure 96; Table 62).

Figure 96. Change in Average Adult Chinook Salmon Upstream Passage Days in Guadalupe Creek

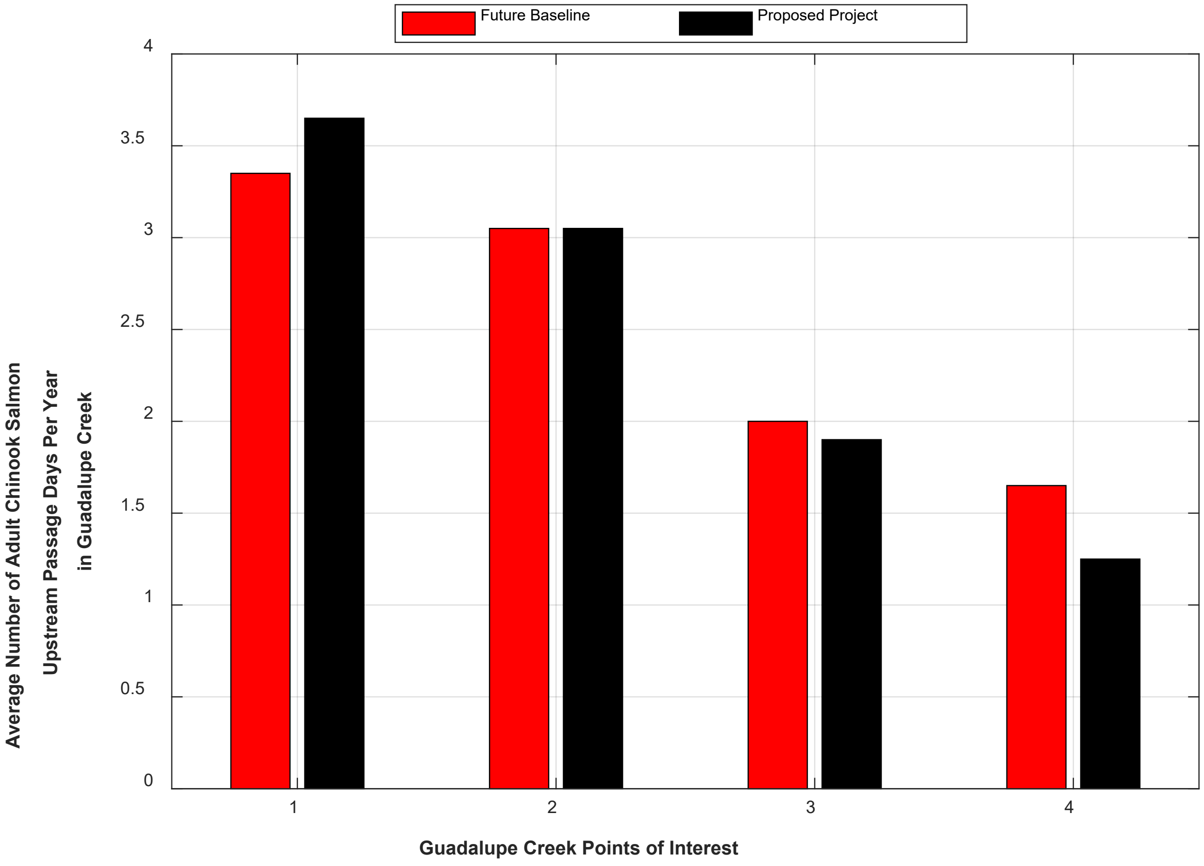


Table 62. Proposed Project Adult Chinook Upstream Passage Compared with the Future Baseline in Guadalupe Creek

Parameter	GCRK 1	GCRK 2	GCRK 3	GCRK 4
Future Baseline (days)[a]				
Total Adult Upstream Passage (1991–2010)	67	61	40	33
Average Adult Upstream Passage Per Year	3	3	2	2
Proposed Project (days)[a]				
Total Adult Upstream Passage (1991–2010)	73	61	38	25
Average Adult Upstream Passage Per Year	4	3	2	1
Difference (days)				
Total Adult Upstream Passage (1991–2010)	6.00	0.00	-2.00	-8.00
Average Adult Upstream Passage Per Year	0.30	0.00	-0.10	-0.40
Difference (%)				
Total Adult Upstream Passage (1991–2010)	8.96	0.00	-5.00	-24.24
Average Adult Upstream Passage Per Year	8.96	0.00	-5.00	-24.24

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in increases (25% or 5 days per year on average) to adult upstream Chinook salmon passage at ALAM 1, the downstream site in Alamitos Creek compared with future baseline. The upstream sites would see an average decrease of 17% (less than 1 day per year on average) to adult upstream Chinook salmon passage because of the Proposed Project compared with the future baseline. Despite the variability amongst sites, the average number of upstream passage days (9 days per year) would remain the same under both the future baseline and the Proposed Project (Figure 97; Table 63).

Figure 97. Change in Average Adult Chinook Salmon Upstream Passage Days in Alamitos Creek

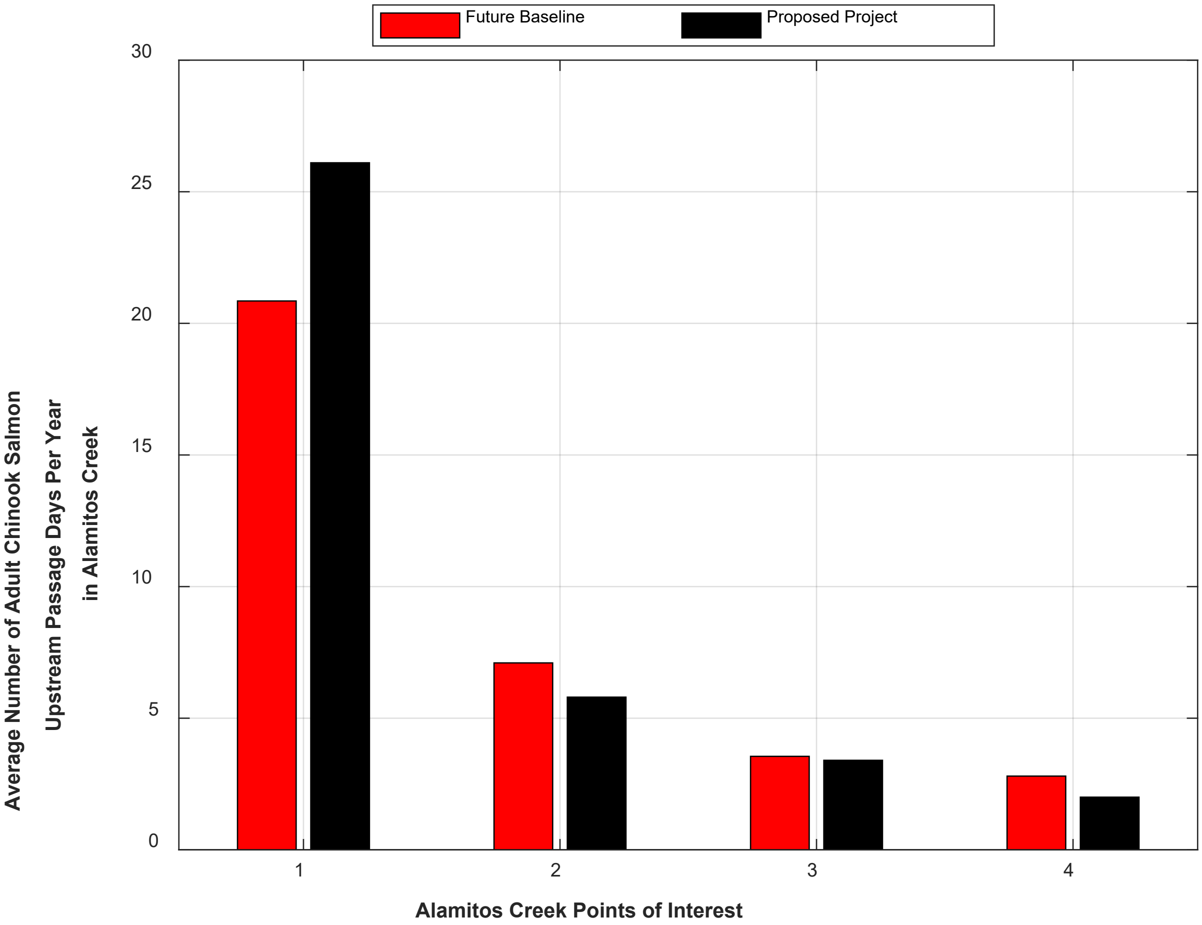


Table 63. Proposed Project Adult Chinook Upstream Passage Compared with the Future Baseline in Alamitos Creek

Parameter	ALAM 1	ALAM 2	ALAM 3	ALAM 4
Future Baseline (days) [a]				
Total Adult Upstream Passage (1991–2010)	417	142	71	56
Average Adult Upstream Passage Per Year	21	7	4	3
Proposed Project (days) [a]				
Total Adult Upstream Passage (1991–2010)	522	116	68	40
Average Adult Upstream Passage Per Year	26	6	3	2
Difference (days)				
Total Adult Upstream Passage (1991–2010)	105.00	-26.00	-3.00	-16.00
Average Adult Upstream Passage Per Year	5.25	-1.30	-0.15	-0.80

Parameter	ALAM 1	ALAM 2	ALAM 3	ALAM 4
Difference (%)				
Total Adult Upstream Passage (1991–2010)	25.18	-18.31	-4.23	-28.57
Average Adult Upstream Passage Per Year	25.18	-18.31	-4.23	-28.57

[a] Rounded to whole days

The Proposed Project would result in a 267% increase (8 days per year on average) to adult upstream passage in Calero Creek compared with the future baseline.

Figure 98. Change in Average Adult Chinook Salmon Upstream Passage Days in Calero Creek

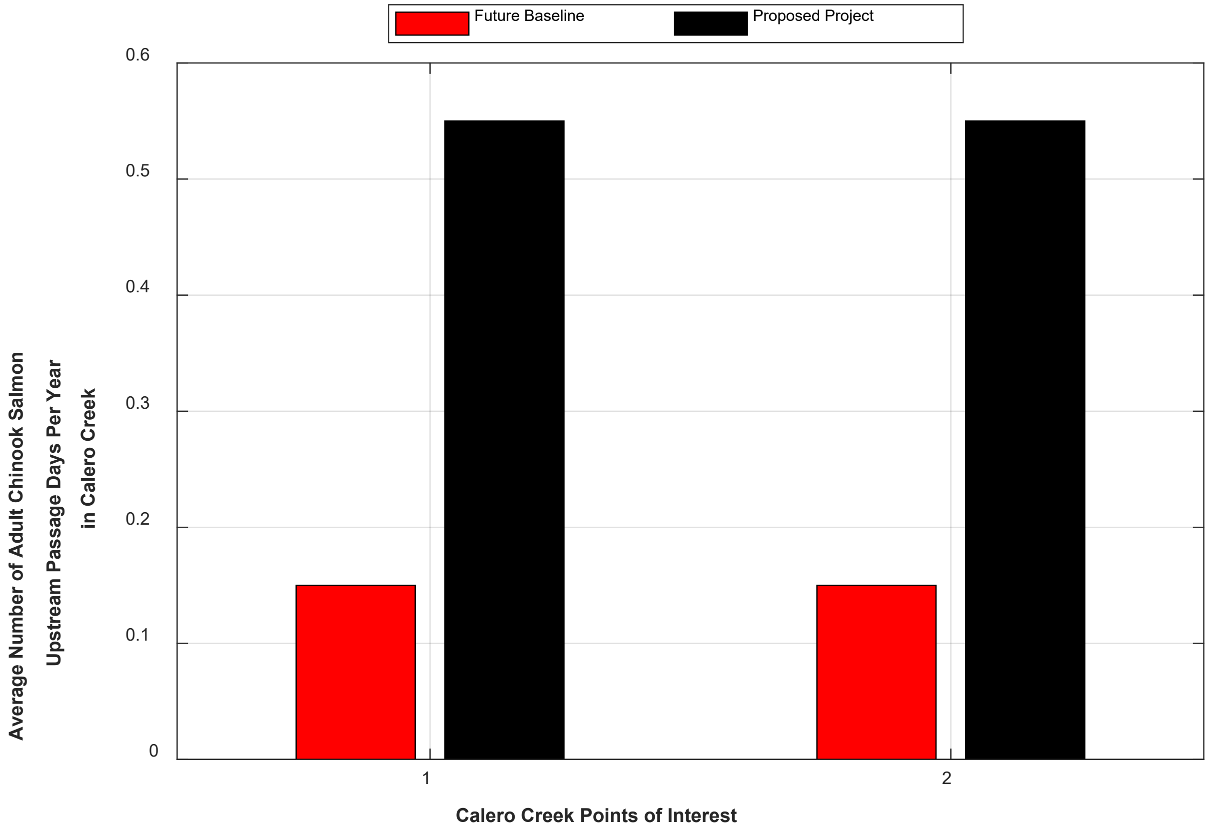


Table 64. Proposed Project Adult Chinook Salmon Upstream Passage Compared to the Future Baseline in Calero Creek

Parameter	CALE 1	CALE 2
***Future Baseline (days)*[a]**		
Total Adult Upstream Passage (1991–2010)	3	3
Average Adult Upstream Passage Per Year	0	0
***Proposed Project (days)*[a]**		
Total Adult Upstream Passage (1991–2010)	11	11
Average Adult Upstream Passage Per Year	1	1
Difference (days)		
Total Adult Upstream Passage (1991–2010)	8.00	8.00
Average Adult Upstream Passage Per Year	0.40	0.40
Difference (%)		
Total Adult Upstream Passage (1991–2010)	266.67	266.67
Average Adult Upstream Passage Per Year	266.67	266.67

[a] Rounded to whole days

The Proposed Project would reduce upstream passage opportunities in Los Gatos Creek and Guadalupe Creek, while there would be increases in passage opportunities in the Guadalupe River, Alamitos Creek, and Calero Creek. Adult upstream passage opportunities would remain high in the Guadalupe River under both the Proposed Project and the future baseline conditions at 61 days per year.

Juvenile Downstream Passage

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in an increase to juvenile downstream passage by an average of 18 days per year (29%) in the Guadalupe River (Figure 99; Table 65). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the Proposed Project would result in an 16% (12 days per year) average increase to juvenile downstream passage in the Guadalupe River compared with the future baseline (Table 65). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in the Guadalupe River under the Proposed Project compared with the future baseline.

Figure 99. Juvenile Chinook Salmon Downstream Passage Days in the Guadalupe River

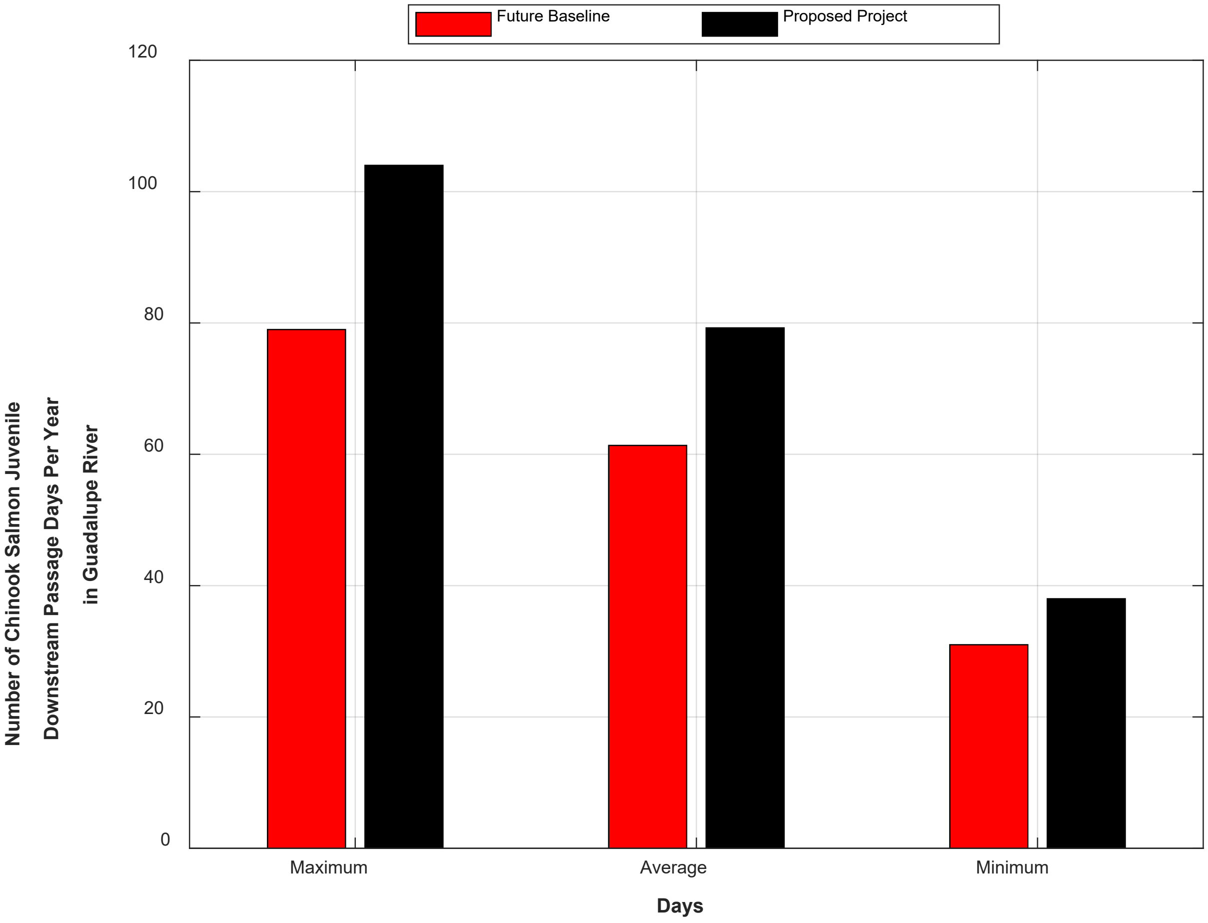


Table 65. Proposed Project Juvenile Chinook Downstream Passage Compared with the Future Baseline in the Guadalupe River

Parameter	GUAD 7 with Water Temperature Criteria[b]
Future Baseline (days)[a]	
Total Juvenile Downstream Passage (1991–2010)	1,227
Average Juvenile Downstream Passage Per Year	61
Proposed Project (days)[a]	
Total Juvenile Downstream Passage (1991–2010)	1,585
Average Juvenile Downstream Passage Per Year	79

Parameter	GUAD 7 with Water Temperature Criteria[b]
Difference (days)	
Total Juvenile Downstream Passage (1991–2010)	358.00
Average Juvenile Downstream Passage Per Year	18.00
Difference (%)	
Total Juvenile Downstream Passage (1991–2010)	29.18
Average Juvenile Downstream Passage Per Year	29.51

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in a negligible increase (4 days per year; 5%) to downstream passage at sites in Los Gatos Creek (Figure 100; Table 66). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the Proposed Project would result in an 2% (3 days per year) average decrease to juvenile downstream passage in Los Gatos Creek compared with the future baseline (Table 66). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in Los Gatos Creek under the Proposed Project compared with the future baseline.

Figure 100. Juvenile Chinook Salmon Downstream Passage Days in Los Gatos Creek

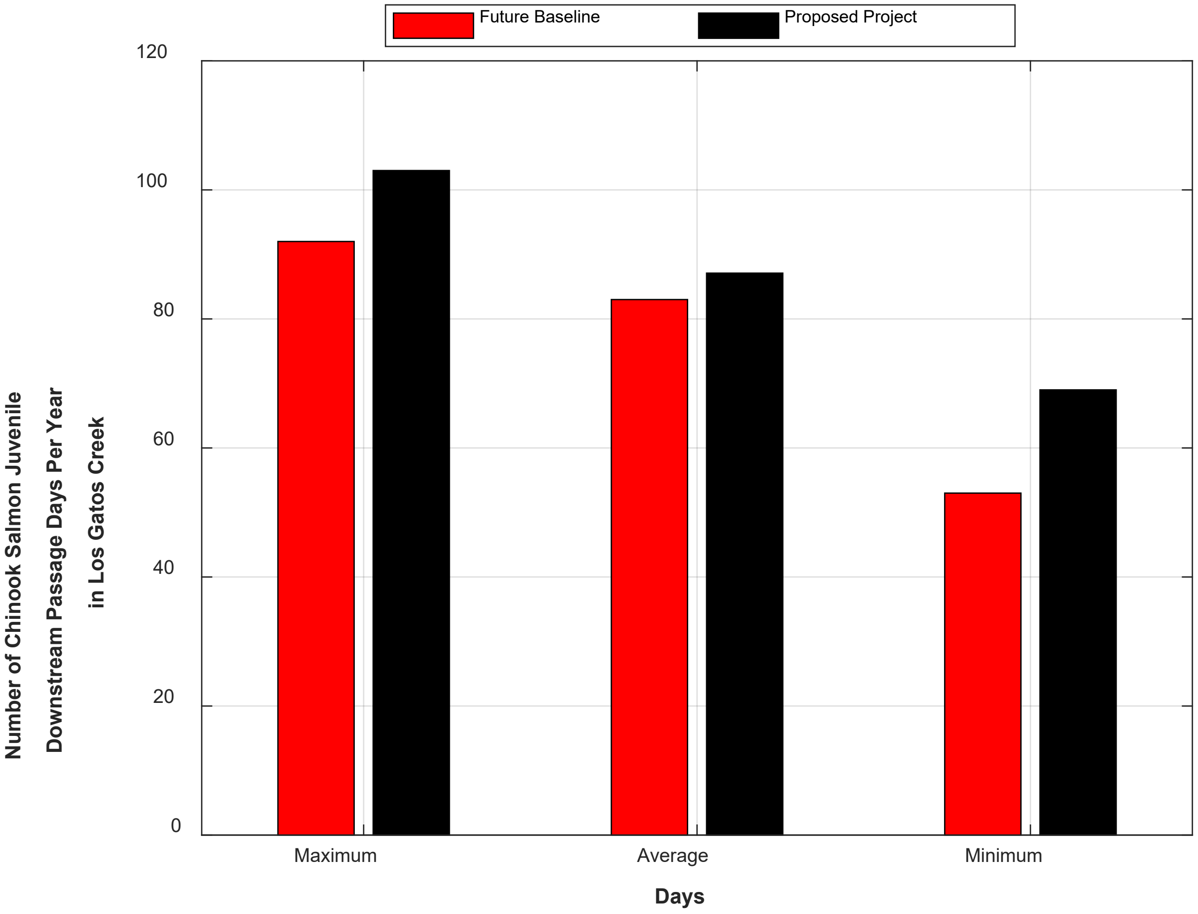


Table 66. Proposed Project Juvenile Chinook Downstream Passage Compared with the Future Baseline in Los Gatos Creek

Parameter	LOSG 2 with Water Temperature Criteria[b]	LOSG 2 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	1,660	2,993
Average Juvenile Downstream Passage Per Year	83	150
Proposed Project (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	1,742	2,935
Average Juvenile Downstream Passage Per Year	87	147
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	82.00	-58.00
Average Juvenile Downstream Passage Per Year	4.00	-3.00

Parameter	LOSG 2 with Water Temperature Criteria[b]	LOSG 2 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	4.94	-1.94
Average Juvenile Downstream Passage Per Year	4.82	-2.00

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in an increase of 36 days per year (157%) in juvenile downstream passage at sites in Guadalupe Creek compared with the future baseline (Figure 101; Table 67). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the Proposed Project would result in an 114% (32 days per year) average increase to juvenile downstream passage in Guadalupe Creek compared with the future baseline (Table 67). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in Guadalupe Creek increased by five under the Proposed Project compared with the future baseline.

Figure 101. Juvenile Chinook Salmon Downstream Passage Days in Guadalupe Creek

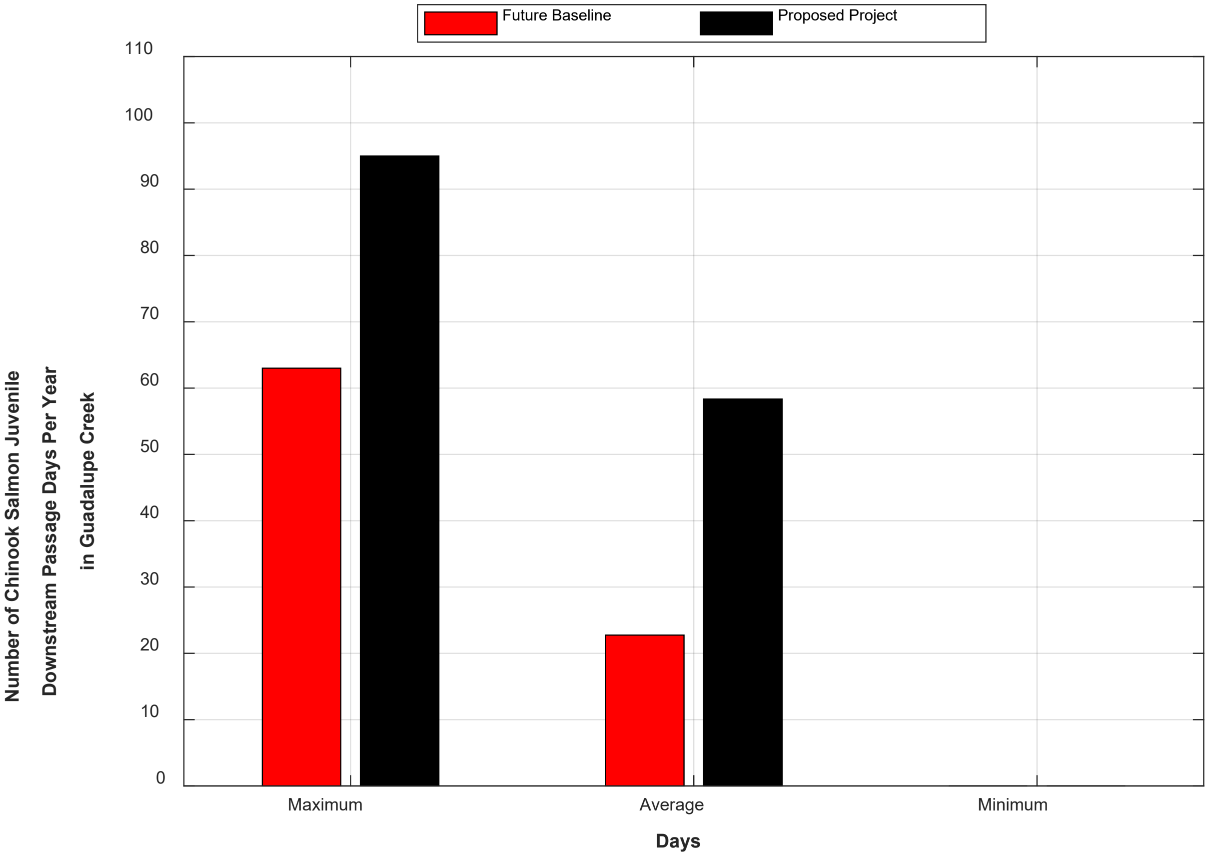


Table 67. Proposed Project Juvenile Chinook Downstream Passage Compared with the Future Baseline in Guadalupe Creek

Parameter	GCRK 4 with Water Temperature Criteria[b]	GCRK 4 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	455	563
Average Juvenile Downstream Passage Per Year	23	28
Proposed Project (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	1,167	1,192
Average Juvenile Downstream Passage Per Year	58	60
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	712.00	629.00
Average Juvenile Downstream Passage Per Year	35.00	32.00
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	156.48	111.72
Average Juvenile Downstream Passage Per Year	152.17	114.29

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in an increase of 17 days (45%) in juvenile downstream passage at sites in Alamitos Creek compared with the future baseline (Figure 102; Table 68). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the Proposed Project would result in an 27% (13 days per year) average increase to juvenile downstream passage in Alamitos Creek compared with the future baseline (Table 68). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in Alamitos Creek decreased by two under the Proposed Project compared to the future baseline.

Figure 102. Juvenile Chinook Salmon Downstream Passage Days in Alamitos Creek

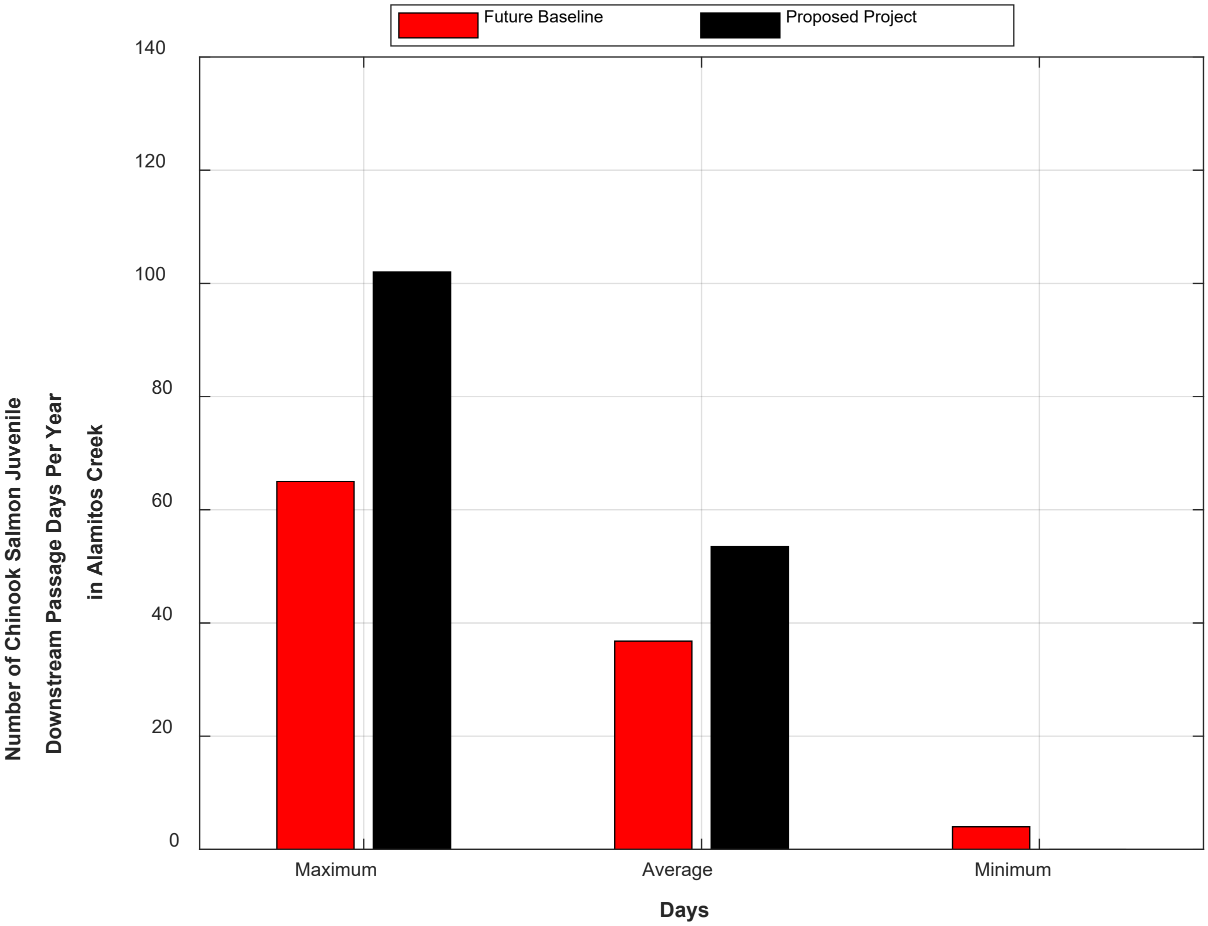


Table 68. Proposed Project Juvenile Chinook Downstream Passage Compared with the Future Baseline in Alamitos Creek

Parameter	ALAM 4 with Water Temperature Criteria[b]	ALAM 4 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	736	962
Average Juvenile Downstream Passage Per Year	37	48
Proposed Project (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	1,070	1,224
Average Juvenile Downstream Passage Per Year	54	61
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	334.00	262.00
Average Juvenile Downstream Passage Per Year	17.00	13.00

Parameter	ALAM 4 with Water Temperature Criteria[b]	ALAM 4 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	45.38	27.23
Average Juvenile Downstream Passage Per Year	45.95	27.08

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

The Proposed Project would result in a 75% increase (30 days per year on average) to juvenile downstream passage in in Calero Creek compared with the current baseline. Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the Proposed Project would result in an 73% (30 days per year) average increase to juvenile downstream passage in Calero Creek compared with the future baseline (Table 69). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in Calero Creek decreased by one under the Proposed Project compared to the future baseline.

Figure 103. Juvenile Chinook Salmon Downstream Passage Days in Calero Creek

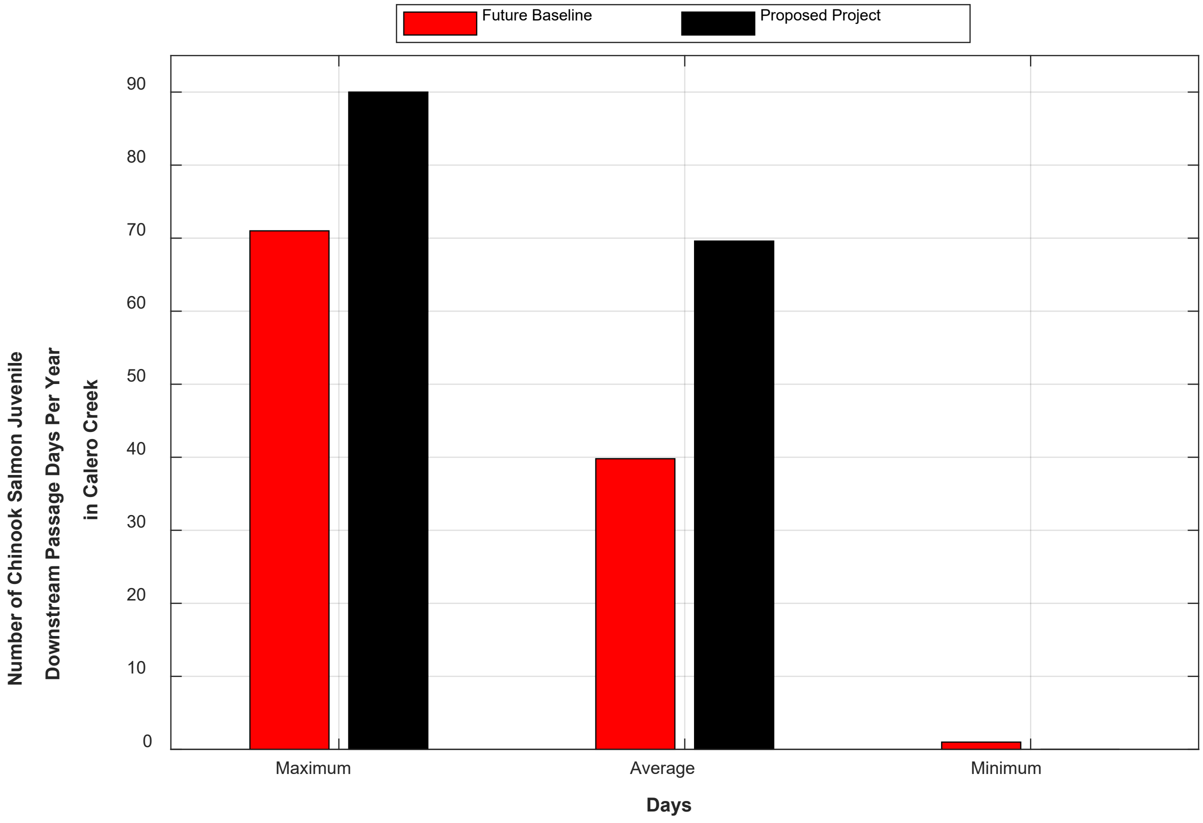


Table 69. Proposed Project Juvenile Chinook Downstream Passage Compared with the Future Baseline in Calero Creek

Parameter	CALE 2 with Water Temperature Criteria[b]	CALE 2 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	796	812
Average Juvenile Downstream Passage Per Year	40	41
Proposed Project (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	1,392	1,414
Average Juvenile Downstream Passage Per Year	70	71
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	596.00	602.00
Average Juvenile Downstream Passage Per Year	30.00	30.00
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	74.87	74.14
Average Juvenile Downstream Passage Per Year	75.00	73.17

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

The Proposed Project would result in a substantial increase in juvenile downstream passage opportunities (an increase over the Proposed Project compared with the current baseline) for Chinook salmon in the Guadalupe River portion of the study area compared with the future baseline.

1.5.2.3 Assessment of Pacific Lamprey, Pacific Lamprey Habitat, and Migration Conditions in the Guadalupe River Portion of the Study Area

Assessments of the effects of the Proposed Project on Pacific lamprey, Pacific lamprey habitat, and Pacific lamprey migration within the Guadalupe River portion of the study are provided in the following subsections. There were no HAI or passage model outputs for Pacific lamprey. Thus, the effects of the Proposed Project on Pacific lamprey were evaluated using other modeled data, including wetted area, thalweg depth, review of temperature suitability, as well as based on modeled HAI for steelhead when life cycles and habitat preference overlap between the species.

Flow Measures Current Baseline Assessment

Pre-Spawning Holding Habitat

Based on the results of the FAHCE WEAP Model, there would be a decrease in pre-spawning holding habitat in the Guadalupe River and Los Gatos Creek for Pacific lamprey resulting from the Proposed Project. The Proposed Project would result in increased habitat during Winter Base Flow Operations and decreased habitat during the Summer Release Program because of changes in wetted area in the Guadalupe River and Los Gatos Creek. Abrupt decreases in wetted area relative with the current baseline would occur during May and November which could dry out habitat occupied by pre-spawning holding Pacific lamprey in these reaches and force holding adults to relocate or strand.

Increases in winter habitat and decreases during the summer could offset and the Proposed Project compared with the current baseline in the Guadalupe River and Los Gatos Creek.

Based on the results of the FAHCE WEAP Model, there would be a change in pre-spawning holding habitat in Guadalupe Creek and Alamitos Creek for Pacific lamprey resulting from the Proposed Project. The Proposed Project would result in increased habitat during Winter Base Flow Operations and minor decreases or no change in habitat during the Summer Cold Water Program and Summer Release Program. Therefore, the Proposed Project would result in minimal changes to pre-spawning holding habitat compared with the current baseline in Guadalupe Creek and Alamitos Creek.

Based on the results of the FAHCE WEAP Model, there would be a decrease in pre-spawning holding habitat in Calero Creek during November through April but an increase from May to October compared with the current baseline due to changes in wetted area (Attachment K.2 – Figures K.2.63 and K.2.64).

Spawning Habitat

Based on the results of the FAHCE WEAP Model, under the Proposed Project, wetted area in the Guadalupe River, Los Gatos Creek and Alamitos Creek would increase during Winter Base Flow Operations but generally decrease during Summer Release Program compared with the current baseline (Attachment K.3, *Guadalupe River Watershed* section). There were changes predicted for steelhead effective spawning habitat during months when spawning and incubation overlap with Pacific lamprey (March through April), and because Pacific lamprey and steelhead share similar habitat preferences during spawning and incubation, there would be changes to spawning habitat for Pacific lamprey during these months. Pacific lamprey spawning and incubation habitat from May through August would decrease under the Proposed Project in the Guadalupe River, Los Gatos Creek, and Alamitos Creek because of decreased wetted area (Attachment K.2, *Guadalupe River Watershed* section). Temperatures between May through August would also be unsuitable (greater than 64°F) for spawning and egg incubation (Meeuwig et al. 2005), but unsuitable temperatures would occur under both the current baseline and Proposed Project (Attachment K.2, *Guadalupe River Watershed* section). As a result of high temperatures, spawning and egg incubation success would be reduced during this time under both the Proposed Project and the current baseline. Overall, the Proposed Project would have changes to Pacific lamprey spawning and incubation habitat compared with the current baseline in the Guadalupe River, Los Gatos Creek, and Alamitos Creek.

Based on the results of the FAHCE WEAP Model, during Winter Base Flow Operations in Guadalupe Creek, the Proposed Project would have similar effects on Pacific lamprey spawning and rearing habitat compared with the current baseline as was described above for the Guadalupe River and Los Gatos Creek (increased wetted area but negligible changes for spawning and incubation habitat in March through April). Also similar to the Guadalupe River and Los Gatos Creek, there would be decreases in wetted area in Guadalupe Creek starting in May resulting from the Summer Cold Water Program, which could decrease spawning and incubation habitat (Attachment K.2 – Figures K.2.39 and K.2.40). Unlike conditions in the Guadalupe River and Los Gatos Creek, under the current baseline, daily average temperatures in Guadalupe Creek would generally remain suitable for spawning and incubation during the summer months (May through August), but under the Proposed Project, daily average temperatures would be increased to above optimal temperatures for spawning and rearing starting in June except at the upstream POI in Guadalupe Creek (GCRK 4) (Attachment K.2 – Figures K.2.41 and K.2.42).

Based on the results of the FAHCE WEAP Model, there would be a decrease in effective spawning habitat in Calero Creek from March to April and an increase from May to August compared with the current baseline because of changes in wetted area (Attachment K.2 – Figures K.2.63 and K.2.64).

Larvae Rearing Habitat

Pacific lamprey larvae prefer different habitat (slower moving water and sandy/silt substrate) and can tolerate higher water temperatures compared to rearing steelhead and Chinook salmon, which prevents use of HAI models for steelhead and Chinook salmon to help evaluate the effects of the Proposed Project on Pacific lamprey larvae rearing. Instead, predicted changes to wetted area within the watershed were assessed to evaluate potential effects of the Proposed Project.

Based on the results of the FAHCE WEAP Model, under the Proposed Project, similar patterns in wetted area were observed across sites within the Guadalupe River portion of the study area compared with the current baseline. Wetted area generally increased during Winter Base Flow Operations and remained the same or decreased during the Summer Cold Water Program or Summer Release Program, except for Calero Creek, where larvae rearing habitat decreased during Winter Base Flow Operations and increased during the Summer Release Program compared with current baseline (Attachment K.2 – Figures K.2.63 and K.2.64). It is worth noting abrupt decreases in wetted area would occur during May and November in the Guadalupe River and Los Gatos Creeks (Attachment K.2 – Figures K.2.15, K.2.16, K.2.27 and K.2.28), which could dry out habitat occupied by Pacific lamprey larvae in these reaches and force larvae to relocate or perish.

Migration Conditions

Adult Upstream Passage

During the adult Pacific lamprey upstream migration period (January 1 through June 30), the FAHCE WEAP Model results for thalweg water depth indicate no change to adult upstream passage opportunities across the Guadalupe River watershed when compared with the current baseline. Model results for upstream passage for adult steelhead, which overlaps with the timing of upstream passage of adult Pacific lamprey between January and April, indicate adult upstream passage for Pacific lamprey would increase in the Guadalupe River, Alamitos Creek, Guadalupe Creek, and Calero Creek and there would be a decrease to upstream passage in Los Gatos Creek under the Proposed Project when compared with the current baseline. The decreases in adult Pacific lamprey upstream passage opportunities modeled with the thalweg depth analysis are due to decreases in flow associated with the Summer Release Program, which begins on May 1, and are not reflected in the adult steelhead upstream passage model results due to the end of the steelhead migration period occurring before the Summer Release Program begins.

Juvenile Downstream Passage

During the juvenile Pacific lamprey downstream migration period (December 1 through May 31), the FAHCE WEAP Model results for thalweg water depth indicate an 8% (11 day per year) average increase in Guadalupe Creek, no change in depth to the Guadalupe River and Los Gatos Creek, and a less than 2% (3 day per year) average decrease in Alamitos and Calero creeks to downstream migration compared to the current baseline. Additionally, modeled downstream passage for juvenile steelhead (with the water temperature criteria included), which overlap with the timing of downstream passage of juvenile Pacific lamprey between December and May, was increased from under the Proposed Project in all reaches except for Los Gatos Creek which resulted in a 4% (2 day per year) average decrease.

Flow Measures Future Baseline Assessment

Pre-Spawning Holding Habitat

Based on the results of the FAHCE WEAP Model, there are negligible differences in the Proposed Project comparisons with the current and future baseline for pre-spawning holding habitat except for Calero Creek where pre-spawning holding habitat would increase compared with the future baseline throughout the year, whereas in contrast, it decreased during the winter under the current baseline. For the reasons outlined in the current baseline, the Proposed Project would result in increases in pre-spawning holding habitat during the winter and decreases in the summer except for Calero Creek where there would be increases throughout the year.

Spawning Habitat

Based on the results of the FAHCE WEAP Model, there are negligible differences in the Proposed Project in analysis between the current and future baseline for effective spawning habitat except for Calero Creek where effective spawning habitat would increase compared with the future baseline throughout the year, whereas in contrast, it decreased during the winter under the current baseline. For the reasons outlined in the current baseline, the Proposed Project result in reduced habitat for Pacific lamprey except for Calero Creek where there would be increases throughout the year.

Larvae Rearing Habitat

Based on the results of the FAHCE WEAP Model, there are negligible differences in the Proposed Project comparisons with the current and future baseline for larvae rearing habitat with the exception of Calero Creek where larvae rearing habitat would increase compared with the future baseline throughout the year, whereas in contrast, it decreased during the winter under the current baseline. For the reasons outlined in the current baseline, the Proposed Project would result in offsetting increases in larvae rearing habitat during the winter and decreases in the summer except for Calero Creek where there would be increases throughout the year.

Migration Conditions

Adult Upstream Passage

During the adult Pacific lamprey upstream migration period (January 1 through June 30), the FAHCE WEAP Model results for thalweg depth indicate variable effects to upstream passage opportunities across the Guadalupe River watershed when compared with the future baseline. Minor increases (1–2%, 3 days per year on average) were observed in the Guadalupe River, Alamitos, and Calero Creeks, while a 2% decrease (3 days per year on average) was observed in Guadalupe Creek. The FAHCE-plus Alternative resulted in no change in adult upstream passage opportunities for adult Pacific lamprey in Los Gatos Creek when compared with the future baseline. Modeled results for adult steelhead upstream passage, which overlaps with the timing of upstream passage of adult Pacific lamprey (January through April), indicate increased passage opportunities at all locations within the Guadalupe River portion of the study area, except for Los Gatos Creek, where there would be a decrease to upstream passage under the Proposed Project compared with the future baseline.

.Juvenile Downstream Passage

During the juvenile Pacific lamprey downstream migration period (December 1 through May 31), the FAHCE WEAP Model results for thalweg water depth indicate an 8% (12 day per year) average increase in Guadalupe Creek, no change in depth to the Guadalupe River, and a less than 2% (3 day per year) average decrease in Los Gatos, Alamitos, and Calero creeks to downstream migration compared to the future baseline. Additionally, downstream passage for steelhead, which overlap with the timing of downstream passage of juvenile Pacific lamprey between December and May, was increased from under the Proposed Project in all reaches.

1.5.2.4 Assessment of Sacramento Hitch and Sacramento Hitch Habitat in the Guadalupe River Portion of the Study Area

Assessments of the effects of the Proposed Project on Sacramento hitch and Sacramento hitch habitat within the Guadalupe River portion of the study area are provided in the following subsections. Based on Smith 2013 and Leidy 2007 and sampling conducted by Valley Water and Stillwater Sciences (Valley Water unpublished data 2004-2017; Valley Water 2019b, 2020, 2021a; Stillwater Sciences 2018). Sacramento hitch have only been detected in the Guadalupe River (downstream of the Norman Mineta Airport) and Los Gatos Creek over the last 17 years; therefore, Sacramento hitch are only assessed in these two sub-watersheds.

There were no HAI model outputs for Sacramento hitch. Thus, the effects of the Proposed Project on Sacramento hitch spawning and incubation habitat were evaluated using other modeled data including wetted area and water temperature, as well as based on modeled HAI for steelhead when life cycles and habitat preference overlap between the species.

Flow Measures Current Baseline Assessment

Spawning Habitat

Based on the results of the FAHCE WEAP Model, the Proposed Project would result in increases to effective spawning habitat in the Guadalupe River and Los Gatos Creek while the steelhead spawning and hitch spawning season overlap (February-April) compared with the current baseline. The Proposed Project would result in increased spawning habitat during Winter Base Flow Operations and decreased habitat during the Summer Release Program staring in May. Predicted water temperatures in the Guadalupe River and Los Gatos Creek remain similar under the Proposed Project compared with the current baseline.

Rearing Habitat

Based on the results of the FAHCE WEAP Model under the Proposed Project, similar patterns in wetted area were observed across sites within the Guadalupe River portion of the study area compared with the current baseline. Wetted area generally increased during Winter Base Flow Operations and remained the same or decreased during Summer Cold Water Program or Summer Release Program (Attachment K.2, *Guadalupe River Watershed* section). It is worth noting abrupt decreases in wetted area would occur during May and November in the Guadalupe River and Los Gatos Creek (Attachment K.2 – Figures K.2.15, K.2.16, K.2.27, and K.2.28), which could dry out habitat occupied by Sacramento hitch in these reaches and increase density and competition in other locations.

Flow Measures Future Baseline Assessment

Spawning Habitat

Based on the results of the FAHCE WEAP Model, there are little differences in the Proposed Project in analysis between the current and future baseline for effective spawning habitat. For the reasons outlined in the current baseline, the Proposed Project would result in similar changes to Sacramento hitch habitat.

Rearing Habitat

Based on the results of the FAHCE WEAP Model, there are negligible differences in the Proposed Project in analysis between the current and future baseline for fry rearing habitat. For the reasons outlined in the current baseline, the Proposed Project would result in variable changes to Sacramento hitch habitat; however, there is a decrease in habitat in May and November which could dry out habitat occupied by Sacramento hitch fry and force fry to relocate or strand. .

1.5.2.5 Assessment of Riffle Sculpin and Riffle Sculpin Habitat in the Guadalupe River Portion of the Study Area

Flow Measures Current Baseline Assessment

Assessments of the effects of the Proposed Project on riffle sculpin and riffle sculpin habitat within the Guadalupe River portion of the study area are provided in the following subsections. Riffle sculpin have been documented in the Guadalupe River portion of the study area within the past 20 years. Sampling conducted by Valley Water from 2004 to 2020 resulted in detections of riffle sculpin in Guadalupe Creek in all years and one individual detection in the Guadalupe River in 2018 (Valley Water unpublished data 2004-2017; Valley Water 2019b, 2020b, and 2021b). Therefore, the effects of the Proposed Project flow measures on riffle sculpin are only assessed in these two sub-watersheds.

There were no HAI model outputs for riffle sculpin. Thus, the effects of the Proposed Project on riffle sculpin and riffle sculpin habitat were evaluated using other modeled data including wetted area and water temperature, as well as based on modeled HAI for steelhead when life cycles and habitat preference overlap between the species.

Spawning Habitat

Riffle sculpin prefer riffle habitat for spawning, and riffle habitat would be more susceptible to drying from reduced flows compared to other habitat types. Based on the results of the FAHCE WEAP Model, there would be increases to effective spawning habitat in the Guadalupe River and Guadalupe Creek during the spawning season (that is, February through March) resulting from the Proposed Project. The Proposed Project would result in increased habitat across POIs in the Guadalupe River and Guadalupe Creek during Winter Base Flow Operations, with the exception of a modeled decrease (44%; 28 square feet) in habitat at the downstream-most POI near the confluence with the Guadalupe River (that is, GCRK 1); however, riffle sculpin are predominantly found in the upstream reaches of Guadalupe Creek, and generally decline downstream of GCRK 3 (Smith 2013, Valley Water 2019b, 2020b, 2021b). Additionally, the modeled decrease at GCRK 1 represent a small amount of habitat, and although there is a large percentage decrease, it is unlikely to have adverse effects on riffle sculpin. Because riffle sculpin and steelhead share similar habitat preferences for spawning and due to the overlap in their spawning timing, riffle sculpin spawning habitat would benefit from the Proposed Project.

Fry Rearing Habitat

Based on the results of the FAHCE WEAP Model under the Proposed Project, there would be an overall increase in fry rearing habitat in the Guadalupe River and Guadalupe Creek with similar patterns in wetted area observed across sites in the Guadalupe River and Guadalupe Creek compared with the current baseline. Wetted area generally increased during Winter Base Flow Operations (March through April) and remained the same or decreased during the Summer Release Program (May–November). It is worth noting abrupt decreases in wetted area would occur during May and November in the Guadalupe River and Guadalupe Creek (Attachment K.2 – Figures K.2.15, K.2.16, K.2.39, and K.2.40), which decreases available habitat for riffle sculpin in these reaches. Riffle sculpin prefer temperatures that do not exceed 77–79°F while temperatures above 86°F (30°C) are typically lethal (Moyle 2002). Some locations might experience temperature increases under the Proposed Project during the summer, however, temperature increases are unlikely to reach temperatures above their preferred temperature range. Decreases in wetted rearing habitat would be minimal in the Guadalupe River, where fry rearing habitat is abundant, and more pronounced in Guadalupe Creek. However, decreases in Guadalupe Creek are more substantial at the downstream POIs (GCRK 1, GCRK 2, and GCRK 3) and riffle sculpin are predominantly found in the upstream reaches of Guadalupe Creek, and generally decline downstream of GCRK 3 (Smith 2013, Valley Water 2019b, 2020b, 2021b).

Flow Measures Compared with Future Baseline Impact Analysis

Spawning Habitat

Based on the results of the FAHCE WEAP Model, there are minimal differences in the Proposed Project in analysis between the current and future baseline for effective spawning habitat. For the reasons outlined in the current baseline, the Proposed Project would result in minimal changes in effective spawning habitat in the Guadalupe River and an overall increase in Guadalupe Creek within the spawning season (that is, February through March) compared with the future baseline.

Fry Rearing Habitat

Based on the results of the FAHCE WEAP Model, there are minimal differences in the Proposed Project in analysis between the current and future baseline for fry rearing habitat. For the reasons outlined in the current baseline, the Proposed Project would result in minimal changes in fry rearing habitat in the Guadalupe River and an overall increase in Guadalupe Creek within the compared with the future baseline.

1.5.2.6 Guadalupe River Portion of the Study Area Conclusions

When compared with the current and future baselines, the Proposed Project flow measures provide a net benefit to steelhead, Chinook salmon, Pacific lamprey, Sacramento hitch, and riffle sculpin within the Guadalupe River portion of the study area.

Steelhead

For steelhead, implementing the Proposed Project flow measures would result in overall increases in steelhead effective spawning and rearing habitat and would support steelhead passage opportunities, and would decrease of summer juvenile rearing habitat and a loss of one day of upstream passage. These benefits would improve conditions for the anadromous steelhead population.

On balance, the Proposed Project flow measures would benefit steelhead.

Chinook Salmon

Although the operations associated with the Proposed Project are management actions that benefit federally listed steelhead and salmon, the actions are anticipated to provide an overall benefit to Chinook salmon. For Chinook salmon, implementing the Proposed Project flow measures would result in overall increases to Chinook salmon fry and juvenile rearing habitat and downstream migration opportunities, variable changes to upstream migration opportunities, and decreases to effective spawning habitat for the species. The decreases of effective spawning habitat may result in increased competition among spawners and decrease the success of redds because of reduced availability of effective spawning habitat. The largest decreases of effective spawning habitat occur in the Guadalupe River and Los Gatos Creek, and the Guadalupe River is where the majority of Chinook salmon spawning is reported within the watershed (Valley Water 2018b). Even though there are overall decreases throughout the watershed, effective spawning habitat would increase in Guadalupe Creek. Up-migrant trapping conducted by Valley Water from 1998-2006 captured a range of 13-104 adult Chinook salmon per year and additional redd surveys conducted from 1995-2016 found a range of 3-35 redds across the watershed per year (Valley Water 2018b, Valley Water et al. 2017).Although spawning survey data are not population estimates, the annual average number of redds and adult upstream migrants indicate small run sizes of Chinook salmon and, therefore, available effective spawning habitat under the Proposed Project is likely sufficient to support an increase in Chinook salmon spawner abundance within the watershed.

Upstream adult passage days at POIs in the Guadalupe River portion of the study area would be slightly decreased in the Guadalupe River portion of the study area under the Proposed Project when compared with the current baseline. Upstream migration opportunities would also be reduced in certain reaches (for example, Los Gatos Creek and Guadalupe Creek), and there would be minimal changes to upstream migration in Alamitos Creek and the Guadalupe River compared with the future baseline. Chinook salmon in the Guadalupe River portion of the study area are primarily mainstem spawners (Valley Water 2018b) and Chinook salmon are able to spawn in the Guadalupe River or hold until passage opportunities occur in the upstream tributaries of the Guadalupe River watershed. Under the Proposed Project, the Guadalupe River would maintain relatively high passage opportunities for Chinook salmon, which would allow the species plenty of opportunities to enter the watershed, migrate upstream, and spawn when conditions are suitable, noting that the largest area of effective spawning habitat is in the Guadalupe River. Overall, there would be slight decreases to Chinook salmon adult upstream migration opportunities in the Guadalupe River portion of the study, but there would still be opportunities for upstream migration.

On balance, the net benefits of the Proposed Project flow measures to fry and juvenile rearing habitat and downstream migration opportunities outweigh the potential reduction of effective spawning habitat.

Pacific Lamprey

Although the operations associated with the Proposed Project are management actions that benefit federally listed steelhead and salmon, the actions are anticipated to provide an overall benefit to Pacific lamprey as well.

> For Pacific lamprey, implementing the Proposed Project flow measures would result in increases of pre-spawning holding, spawning, and larvae rearing habitat in the winter and early spring, and overall increases in upstream and downstream passage opportunities, as well as decreases to pre-spawning holding, effective spawning, and larvae rearing habitat in the summer. The only exception is in Calero Creek, where opposite seasonal patterns are expected, with decreased habitat during the winter and ~~decreased~~ increased habitat during ~~winter~~ summer. Reduced flows and elevated temperatures in the summer would only affect the late stages of Pacific lamprey spawning and incubation in this watershed. The Guadalupe River and Alamitos Creek are believed to be the most important locations for Pacific lamprey in the watershed (Leidy 2007) and spawning and incubation habitat would not be reduced by the Proposed Project in these locations. It is expected that spawning would cease by June 1 in the Guadalupe River portion of the study area, and because the length of Pacific lamprey embryo incubation is highly dependent on water temperature, high water temperatures in the region would result in incubation being completed by the end of July at the latest (Meeuwig et al. 2005; Brumo 2006). Thus, decreases in flow and high temperatures during the summer would only affect the late stages of Pacific lamprey spawning and incubation in the Guadalupe River portion of the study area. The exception would be Calero Creek where there would be decreased winter habitat.

Adult upstream passage would be improved under the Proposed Project, especially once seismic restrictions are lifted (i.e., compared with the future baseline).

Downstream passage would be improved in Guadalupe Creek compared with the current baseline, and once seismic restrictions were lifted, downstream passage would be improved in both the Guadalupe River and Guadalupe Creek. The Guadalupe River is where the most Pacific lamprey have been observed (Leidy 2007) and improved downstream and upstream passage in this location would increase opportunities for adult access to spawning areas and juvenile migration to the ocean. Therefore, increases of downstream passage in Guadalupe River and Guadalupe Creek outweigh decreases in Los Gatos, Alamitos, and Calero Creeks, providing an overall benefit to Pacific lamprey.

On balance, the net benefits of implementing the flow measures are expected to outweigh the decreases in pre-spawning holding, spawning, and larvae rearing habitat in the summer for Pacific lamprey.

Sacramento Hitch

Although the flow measures associated with the Proposed Project are management actions that benefit federally listed steelhead and salmon, they would also benefit Sacramento hitch.

For Sacramento hitch, implementing the Proposed Project flow measures would result in overall increases to Sacramento hitch spawning and fry rearing habitat in the winter and early spring and decreases of spawning and fry rearing habitat in the summer and fall. Flow decreases in the summer and fall are similar when compared with the current and future baseline in the Guadalupe River and Los Gatos Creek, where Sacramento hitch are known to occur (Smith 2013; Jarrett 2018, Appendix K.2 – Figures K.2.13, K.2.14, K.2.19, K.2.20, K.2.25, K.2.26, K.2.31, and K.2.32). Based on modeled wetted area, decreases in rearing habitat would be most substantial during May and November, resulting from decreases in flow.

On balance, the net benefits of implementing the Proposed Project flow measures outweigh the decreases of spawning and rearing habitat in the summer.

Riffle Sculpin

Although the flow measures associated with the Proposed Project are management actions that benefit federally listed steelhead, the actions would also provide some benefits and be neutral overall to riffle sculpin.

For riffle sculpin, implementing the Proposed Project flow measures would result in overall increases to riffle sculpin spawning and fry rearing habitat in the winter and early spring and decreases of spawning and fry rearing habitat in the summer and fall. Flow decreases in the summer are similar when compared with the current and future baseline in the Guadalupe River and Guadalupe Creek, where riffle sculpin are known to occur (Valley Water unpublished data 2004-2017; Valley Water 2019b, 2020b, 2021b, Attachment K.2 – Figures K.2.13, K.2.14, K.2.19, K.2.20, K.2.37, K.2.38, K.2.43, K.2.44). Fry rearing habitat would not decrease substantially in the Guadalupe River, where fry rearing habitat is abundant. Decreases in Guadalupe Creek would occur in May and are more substantial at the downstream POIs (GCRK 1, GCRK 2, and GCRK 3); however, the effect would be reduced because riffle sculpin are predominantly found in the upstream reaches of Guadalupe Creek, and generally decline downstream of GCRK 3 (Smith 2013, Valley Water 2019b, 2020, 2021b).

On balance, the net benefits of implementing the Proposed Project flow measures outweigh the decreases of spawning and fry rearing habitat in the summer.

1.6 FAHCE-plus Alternative Assessment

This section evaluates the impacts associated with changes in Valley Water operations on fisheries resources under the FAHCE-plus Alternative and refers to the FAHCE WEAP Model scenarios described in the *Valley Water WEAP Model Technical Memorandum* (SEI and Valley Water 2020), including a current baseline model scenario, which assumes existing reservoir safety constraints, and a future baseline model scenario, which assumes reservoir safety constraints have been resolved. The FAHCE WEAP Model (SEI 2020) was used to model hydrologic, hydraulic, water temperature, and fisheries current baseline conditions. In the Stevens Creek watershed portion of the study area, Stevens Creek was assessed. In the Guadalupe River portion of the study area, Los Gatos Creek, Guadalupe Creek, Alamitos Creek, Calero Creek, and the Guadalupe River were assessed.

As described in Section 1.4.3, *Flow Measures Analysis Methodology,* there were no HAI model outputs for Pacific lamprey and Sacramento hitch habitat and passage. Thus, the effects of the FAHCE-plus Alternative on Pacific lamprey and Sacramento hitch habitat and passage were evaluated based on a combination of modeled data for flow, water depth, wetted area, and water temperature, and on modeled HAI for steelhead when life cycles and habitat preference overlap between the species. For example, Pacific lamprey and steelhead overlap in timing of migration, spawning, and rearing, and they share some habitat preferences such as spawning location attributes (for example, they both prefer gravel substrate) and temperature tolerances. Sacramento hitch and steelhead overlap in timing for spawning and rearing; however, Sacramento hitch can occupy more diverse habitat and can tolerate warmer temperatures (up to 86°F) compared with steelhead.

1.6.1 Assessment of the Project in the Stevens Creek Watershed Portion of the Study Area

1.6.1.1 Assessment of Steelhead and Steelhead Habitat in the Stevens Creek Watershed Portion of the Study Area

Assessments of the effects of the FAHCE-plus Alternative on steelhead, steelhead habitat, and migration conditions within the Stevens Creek portion of the study area are provided in the following subsections.

Flow Measures Current Baseline Assessment

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 31% (2,140 square feet) increase in effective spawning habitat compared with the current baseline (Figure 104; Table 70). The largest increase in effective spawning habitat of 83% would occur in downstream Stevens Creek (between STEV 2 and STEV 3), and effective spawning habitat would increase by 10% on average in the upstream reaches (STEV 4 to STEV 6), which have the best available spawning and rearing habitat (Leidy 1984, 2007; Leidy et al. 2003, 2005) (Table 70).

Figure 104. Change in Effective Steelhead Spawning Habitat Compared with the Current Baseline in Stevens Creek

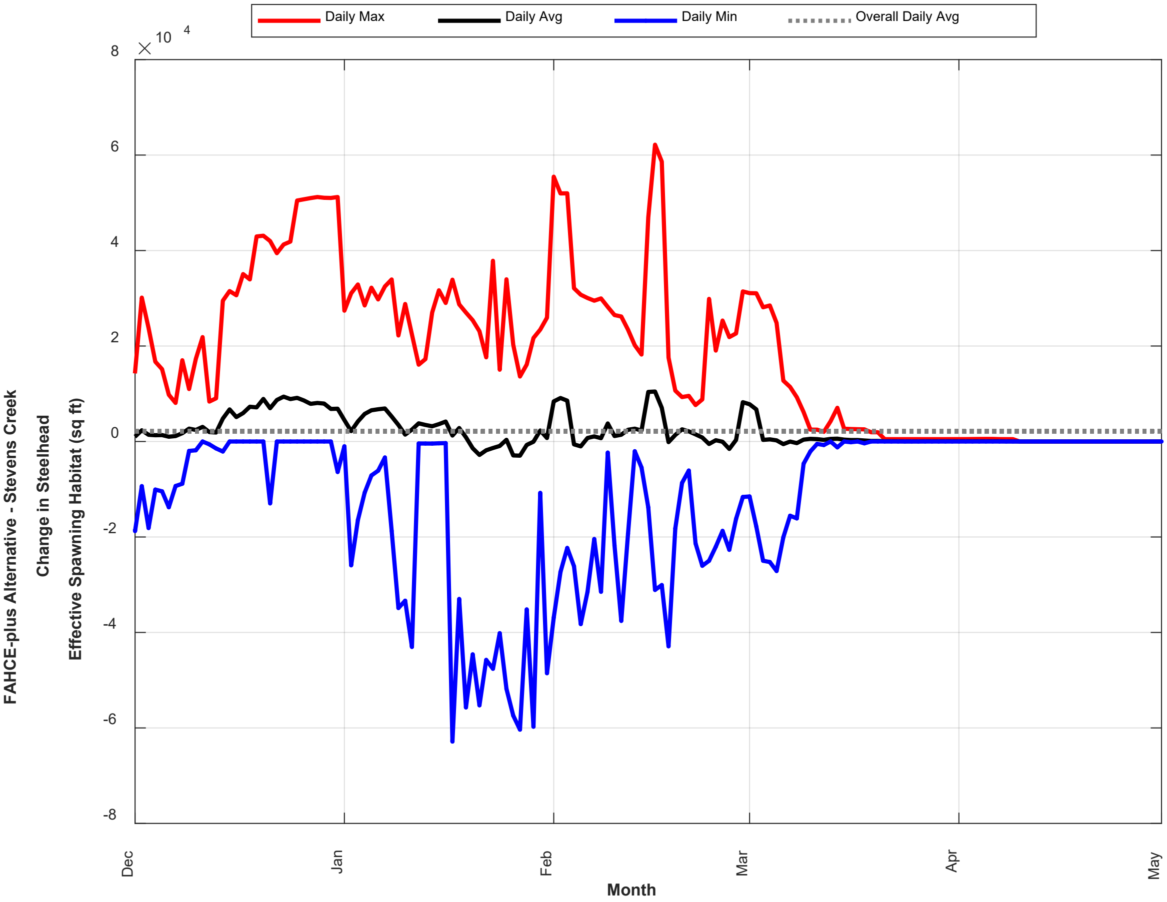


Table 70. FAHCE-plus Alternative Steelhead Habitat Compared with the Current Baseline in Stevens Creek

Stevens Creek[a,b]	STEV3 River Mile 7.1	STEV4 River Mile 8.8	STEV5 River Mile 11.1	STEV6 River Mile 12.3	Total
Steelhead Habitat Current Baseline (sq ft)					
Effective Spawning	1,960	1,690	1,430	1,820	6,900
Fry Rearing Total (March 1–May 31)	75,400	45,000	70,200	36,700	227,000
Fry Rearing Winter Base Flow Operations (March 1–April 30)	80,900	44,100	69,500	36,500	231,000
Fry Rearing Summer Cold Water Program (May 1–May 31)	64,400	46,700	71,700	37,000	220,000
Juvenile Rearing Total (year-round)	41,800	36,500	61,000	28,200	167,000
Juvenile Rearing Winter Base Flow (Jan 1–Apr 30)	87,400	47,600	75,600	38,200	249,000

Stevens Creek[a,b]	STEV3 River Mile 7.1	STEV4 River Mile 8.8	STEV5 River Mile 11.1	STEV6 River Mile 12.3	Total
Juvenile Rearing Summer Cold Water Program and Fall Flows (May 1–Dec 31)	19,400	31,000	53,800	23,300	127,000
Steelhead Habitat FAHCE-plus Alternative (sq ft)					
Effective Spawning	3,580	1,770	1,480	2,210	9,040
Fry Rearing Total (March 1–May 31)	86,600	45,200	69,700	36,700	238,000
Fry Rearing Winter Base Flow Operations (March 1–April 30)	97,800	45,400	69,400	37,200	250,000
Fry Rearing Summer Cold Water Program (May 1–May 31)	64,300	44,700	70,100	35,700	215,000
Juvenile Rearing Total (year-round)	52,500	36,600	63,000	30,400	183,000
Juvenile Rearing Winter Base Flow (Jan 1–Apr 30)	105,000	50,500	80,800	41,800	278,000
Juvenile Rearing Summer Cold Water Program and Fall Flows (May 1–Dec 31)	26,900	29,800	54,300	24,800	136,000
Change in Habitat (sq ft)					
Effective Spawning	1,620 (82.65%)	80 (4.73%)	50 (3.5%)	390 (21.43%)	2,140 (31.01%)
Fry Rearing Total (March 1–May 31)	11,200 (14.85%)	200 (0.44%)	-500 (-0.71%)	0 (0%)	11,000 (4.85%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	16,900 (20.89%)	1,300 (2.95%)	-100 (-0.14%)	700 (1.92%)	19,000 (8.23%)
Fry Rearing Summer Cold Water Program (May 1–May 31)	-100 (-0.16%)	-2,000 (-4.28%)	-1,600 (-2.23%)	-1,300 (-3.51%)	-5,000 (-2.27%)
Juvenile Rearing Total (year-round)	10,700 (25.6%)	100 (0.27%)	2,000 (3.28%)	2,200 (7.8%)	16,000 (9.58%)
Juvenile Rearing Winter Base Flow (Jan 1–Apr 30)	17,600 (20.14%)	2,900 (6.09%)	5,200 (6.88%)	3,600 (9.42%)	29,000 (11.65%)
Juvenile Rearing Summer Cold Water Program and Fall Flows (May 1–Dec 31)	7,500 (38.66%)	-1,200 (-3.87%)	500 (0.93%)	1,500 (6.44%)	9,000 (7.09%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

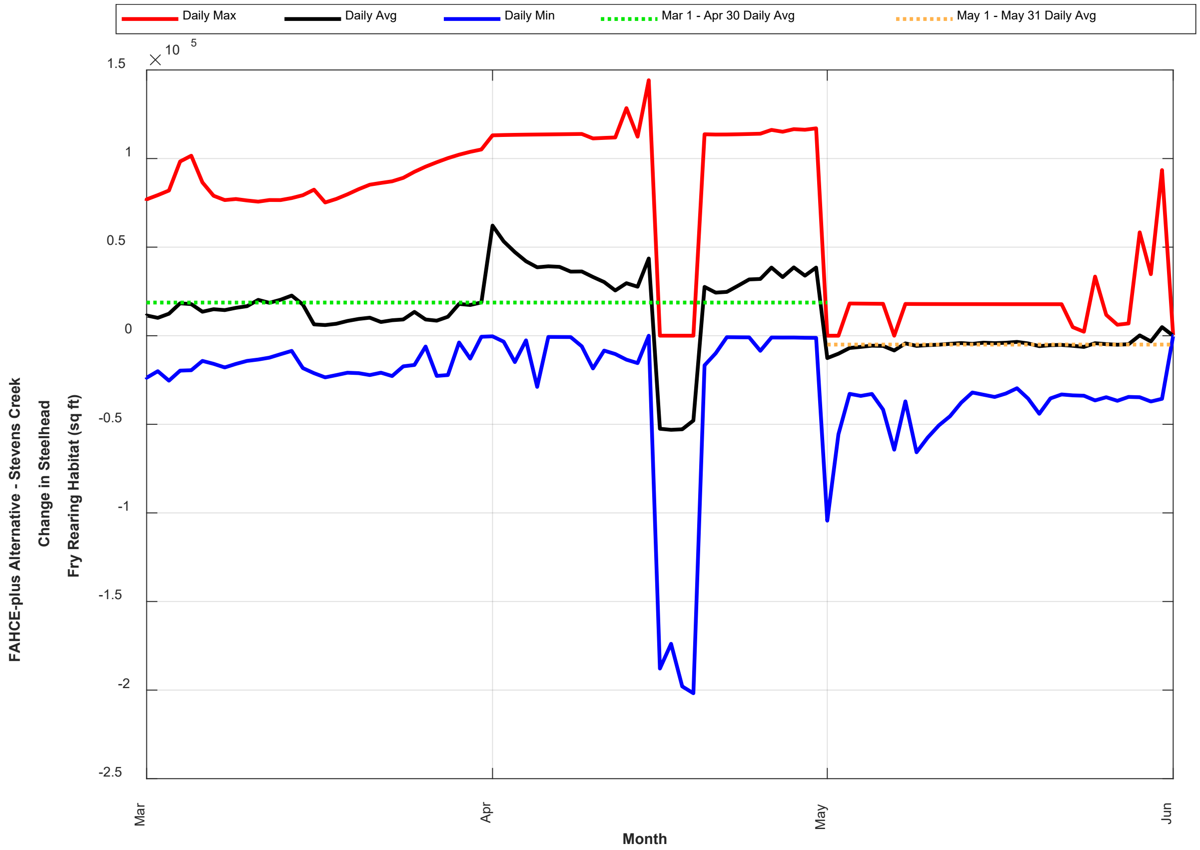
[b] No average daily habitat availability model results are available for the points of interest not shown.

Fry Rearing Habitat

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in an 5% (11,000 square feet) increase in suitable fry rearing habitat in Stevens Creek compared with the current baseline (Figure 105; Table 70). The largest increase in modeled suitable fry rearing habitat under the FAHCE-plus Alternative would occur within downstream reaches of Stevens Creek between STEV 2 and STEV 3, with a 15% increase compared with the current baseline mostly because of increased flows during Winter Base Flow Operations (excluding Fall Flows) (Table 70). There is little to no change in suitable habitat between STEV 2 and STEV 3 after May 1 between the current baseline or FAHCE-plus Alternative.

In the upstream reaches where the best available rearing habitat is located (Leidy 1984, 2007; Leidy et al. 2003, 2005), fry rearing habitat would increase by approximately 1% during the winter (March 1 through April 30) but decrease by approximately 3% during the Summer Cold Water Program and Fall Flows under the FAHCE-plus Alternative (Table 70). The FAHCE-plus Alternative would result in a negligible change (that is, -0.2%) in the average modeled fry rearing habitat in the upstream reach compared with the current baseline (Table 70).

Figure 105. Change in Steelhead Fry Rearing Habitat Compared with the Current Baseline in Stevens Creek



Juvenile Rearing Habitat

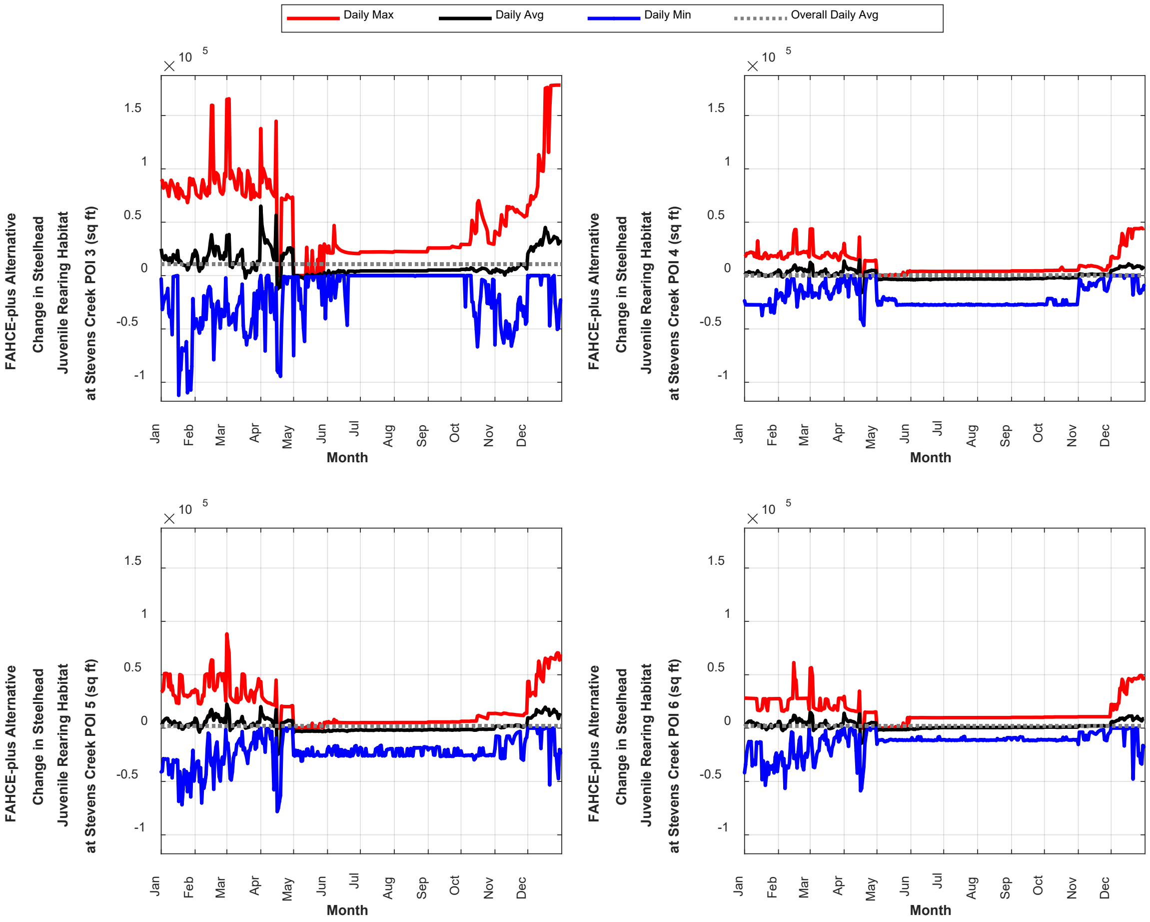
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 10% (16,000 square feet) increase in juvenile rearing habitat on average compared with the current baseline in Stevens Creek (Figure 106; Table 70). The largest increase in suitable juvenile rearing habitat would occur in downstream reaches (for example, 26% increase compared with the current baseline between STEV 2 and STEV 3, Table 70).

The farthest upstream reaches (STEV 4 to STEV 6) where the best rearing habitat is located, and the greatest abundance of juveniles are observed during surveys (Valley Water 2011, NMFS 2016), experienced a 4% (2,000 square feet) increase in juvenile rearing habitat on average under the FAHCE-plus Alternative (Table 70). There would be a 1% increase of average modeled juvenile rearing habitat under the FAHCE-plus Alternative during the Summer Cold Water Program and Fall

Flows (May 1 through December 31), but juvenile rearing habitat in the upstream reaches would decrease by 4% (2,000 square feet) on average during the warmest months (June 1 through October 31). The decrease during the warmest months under the FAHCE-plus Alternative is attributable to decreased wetted area (Attachment K.3 – Figures K.3.3, K.3.4, K.3.5, and K.3.6).

There would be minimal MWAT differences between the FAHCE-plus Alternative and the current baseline at most sites. Daily maximum MWAT at STEV 3 (downstream of the CWMZ) and STEV 4 (within the CWMZ, at the downstream end) would not exceed 70°F during the warmest months (that is, August) under the FAHCE-plus Alternative (Attachment K.3 – Figure K.3.5). Daily maximum MWAT at STEV 4 (within the CWMZ, at the downstream end), would not exceed 66°F during the warmest month (that is, August) under the FAHCE-plus Alternative (Attachment K.3 – Figure K.3.5). MWAT would rarely exceed 64°F at STEV 3 (less than 8% exceedance probability) or STEV 4 (less than 2% exceedance probability) under either scenario (Attachment K.3 – Figure K.3.6). At STEV 5 and STEV 6 (within the CWMZ), average and maximum daily MWAT do not exceed 65°F (Attachment K.3 – Figures K.3.5 and K.3.6).

Figure 106. Change in Steelhead Juvenile Rearing Habitat Compared with the Current Baseline in Stevens Creek



Migration Conditions

Adult Upstream Passage

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in an average 12% (12 days per year) increase in adult upstream passage in downstream Stevens Creek (STEV 1 and STEV 2) and a 10% (3 day per year) average increase in upstream Stevens Creek (STEV 3 through STEV 6) (Figure 107; Table 71). The increase in adult upstream passage under the FAHCE-plus Alternative would allow for additional passage for adult upstream steelhead within the Stevens Creek watershed portion of the study area.

Figure 107. Change in Average Adult Steelhead Upstream Passage Days Compared with the Current Baseline in Stevens Creek

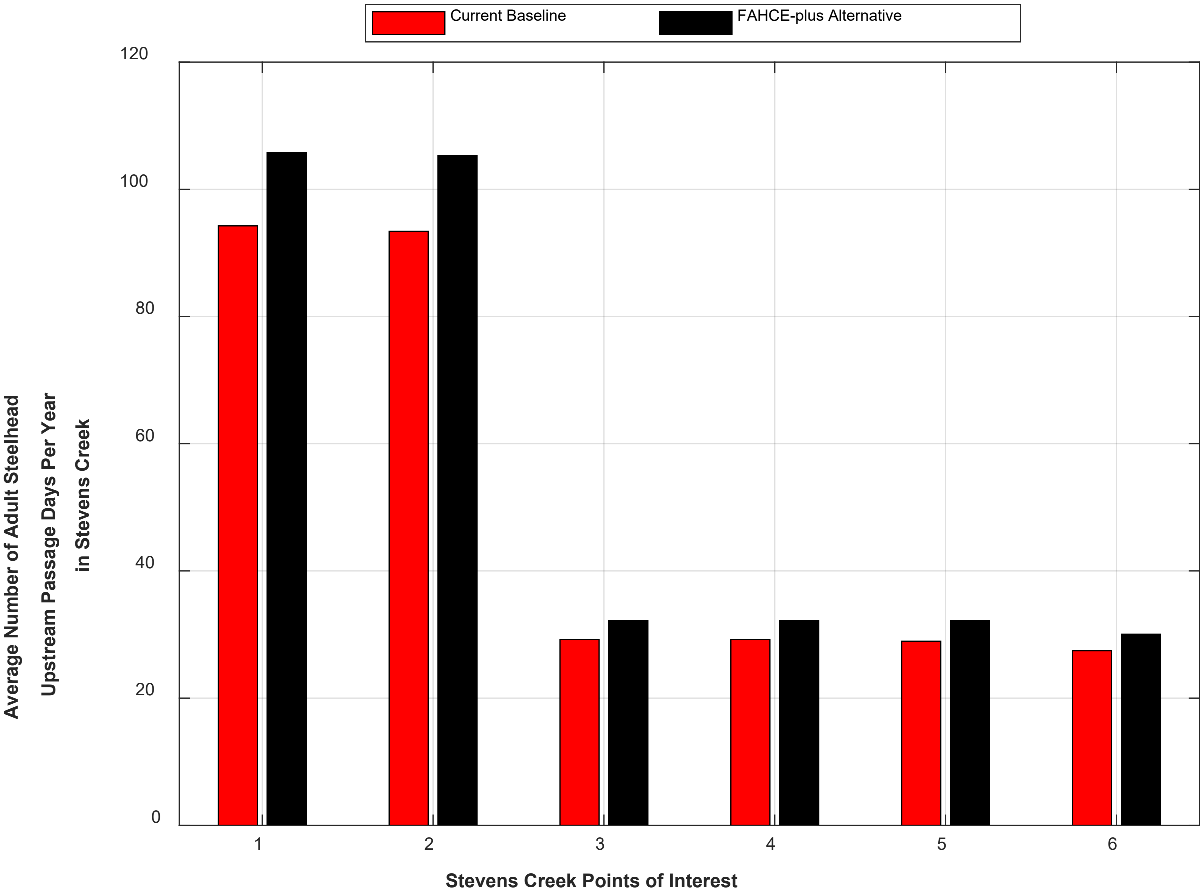


Table 71. FAHCE-plus Alternative Adult Steelhead Upstream Passage Compared with the Current Baseline in Stevens Creek

Parameter	STEV 1	STEV 2	STEV 3	STEV 4	STEV 5	STEV 6
Current Baseline (days)[a]						
Total Adult Upstream Passage (1991–2010)	1,885	1,868	584	584	579	549
Average Adult Upstream Passage Per Year	94	93	29	29	29	27
FAHCE-plus (days)[a]						
Total Adult Upstream Passage (1991–2010)	2,116	2,106	644	644	643	601
Average Adult Upstream Passage Per Year	106	105	32	32	32	30
Difference (days)						
Total Adult Upstream Passage (1991–2010)	231.00	238.00	60.00	60.00	64.00	52.00
Average Adult Upstream Passage Per Year	11.55	11.90	3.00	3.00	3.20	2.60
Difference (%)						
Total Adult Upstream Passage (1991–2010)	12.25	12.74	10.27	10.27	11.05	9.47
Average Adult Upstream Passage Per Year	12.25	12.74	10.27	10.27	11.05	9.47

[a] Rounded to whole days

Juvenile Downstream Passage

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in increases in juvenile downstream passage of 2% (1 day per year) on average in Stevens Creek (Figure 108; Table 72). There are 41 days of downstream passage per year under the current baseline (Table 72).

Figure 108. Change in Average Juvenile Steelhead Downstream Passage Days Compared with the Current Baseline in Stevens Creek

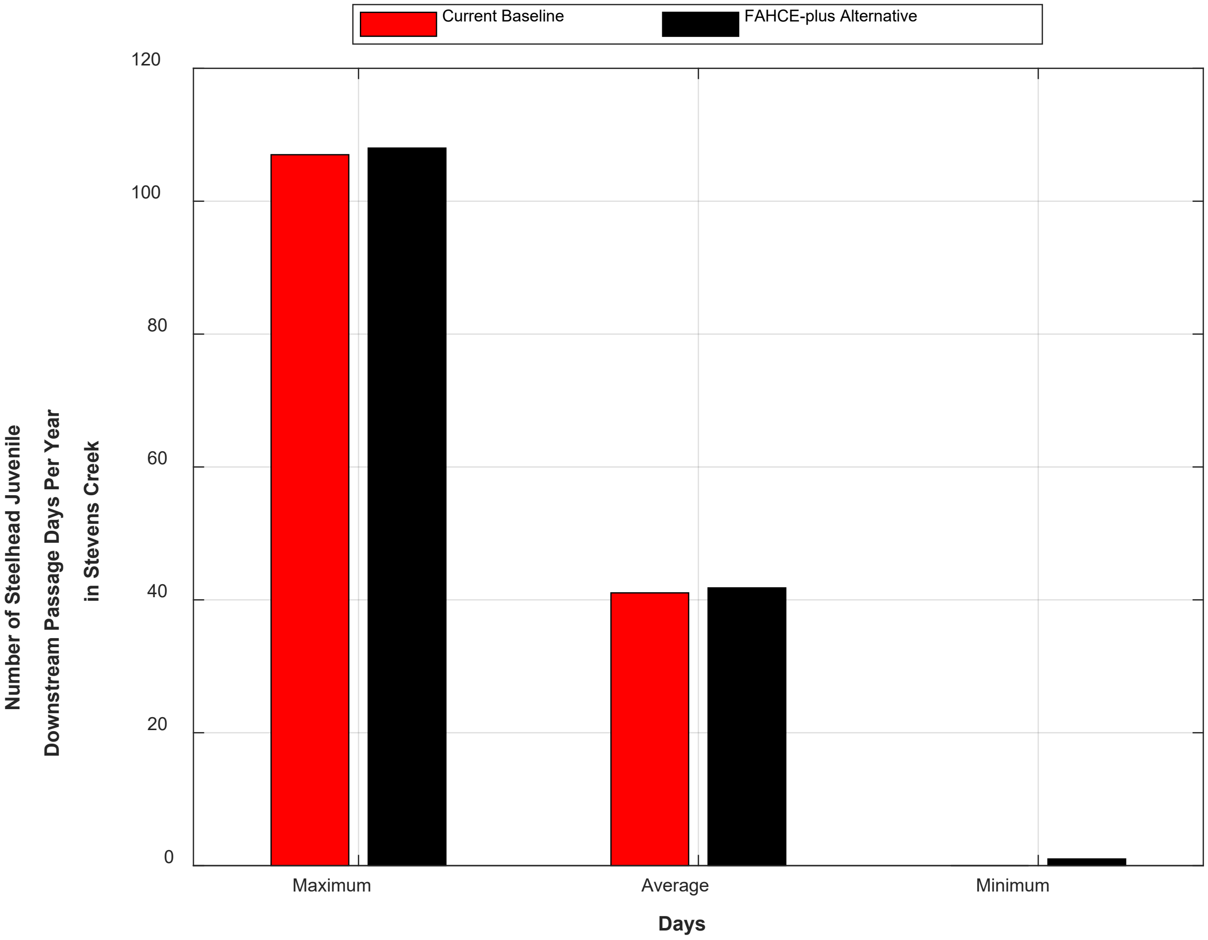


Table 72. FAHCE-plus Alternative Juvenile Steelhead Downstream Passage Days Compared with the Current Baseline in Stevens Creek

Parameter	STEV 6 with Water Temperature Criteria[b]
Current Baseline (days)[a]	
Total Juvenile Downstream Passage (1991–2010)	821
Average Juvenile Downstream Passage Per Year	41
FAHCE-plus Alternative (days)[a]	
Total Juvenile Downstream Passage (1991–2010)	836
Average Juvenile Downstream Passage Per Year	42

Parameter	STEV 6 with Water Temperature Criteria[b]
Difference (days)	
Total Juvenile Downstream Passage (1991–2010)	15.00
Average Juvenile Downstream Passage Per Year	1.00
Difference (%)	
Total Juvenile Downstream Passage (1991–2010)	1.83
Average Juvenile Downstream Passage Per Year	2.44

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Flow Measures Future Baseline Assessment

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, there would be negligible differences between current and future baselines and effective spawning habitat would be increased as described for the current baseline above (Table 73).

Fry Rearing Habitat

Based on the results of the FAHCE WEAP Model, there would be negligible differences between current and future baselines and fry rearing habitat would be increased as described for the current baseline above (Table 73).

Juvenile Rearing Habitat

Based on the results of the FAHCE WEAP Model, there would be negligible differences between current and future baselines and juvenile rearing habitat would be increased as described for the current baseline above (Table 73).

Table 73. FAHCE-plus Alternative Steelhead Habitat Compared with the Future Baseline in Stevens Creek

Stevens Creek[a,b]	STEV3 River Mile 7.1	STEV4 River mile 8.8	STEV5 River Mile 11.1	STEV6 River Mile 12.3	Total
Steelhead Habitat Future Baseline (sq ft)					
Effective Spawning	1,960	1,690	1,430	1,820	6,900
Fry Rearing Total (March 1–May 31)	75,400	45,000	70,200	36,700	227,000
Fry Rearing Winter Base Flow Operations (March 1–April 30)	80,900	44,100	69,500	36,500	231,000
Fry Rearing Summer Cold Water Program (May 1–May 31)	64,400	46,700	71,700	37,000	220,000
Juvenile Rearing Total (year-round)	41,800	36,500	61,000	28,200	167,000

Stevens Creek[a,b]	STEV3 River Mile 7.1	STEV4 River mile 8.8	STEV5 River Mile 11.1	STEV6 River Mile 12.3	Total
Juvenile Rearing Winter Base Flow (Jan 1–Apr 30)	87,400	47,600	75,600	38,200	249,000
Juvenile Rearing Summer Cold Water Program and Fall Flows (May 1–Dec 31)	19,400	31,000	53,800	23,300	127,000
Steelhead Habitat FAHCE-plus Alternative (sq ft)					
Effective Spawning	3,580	1,790	1,480	2,210	9,060
Fry Rearing Total (March 1–May 31)	86,600	45,200	69,700	36,700	238,000
Fry Rearing Winter Base Flow Operations (March 1–April 30)	97,800	45,400	69,400	37,200	250,000
Fry Rearing Summer Cold Water Program (May 1–May 31)	64,300	44,700	70,100	35,700	215,000
Juvenile Rearing Total (year-round)	52,500	36,600	63,000	30,400	183,000
Juvenile Rearing Winter Base Flow (Jan 1–Apr 30)	105,000	50,500	80,800	41,800	278,000
Juvenile Rearing Summer Cold Water Program and Fall Flows (May 1–Dec 31)	26,900	29,800	54,300	24,800	136,000
Change in Habitat (sq ft)					
Effective Spawning	1,620 (82.65%)	100 (5.92%)	50 (3.5%)	390 (21.43%)	2,160 (31.3%)
Fry Rearing Total (March 1–May 31)	11,200 (14.85%)	200 (0.44%)	-500 (-0.71%)	0 (0%)	11,000 (4.85%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	16,900 (20.89%)	1,300 (2.95%)	-100 (-0.14%)	700 (1.92%)	19,000 (8.23%)
Fry Rearing Summer Cold Water Program (May 1–May 31)	-100 (-0.16%)	-2,000 (-4.28%)	-1,600 (-2.23%)	-1,300 (-3.51%)	-5,000 (-2.27%)
Juvenile Rearing Total (year-round)	10,700 (25.6%)	100 (0.27%)	2,000 (3.28%)	2,200 (7.8%)	16,000 (9.58%)
Juvenile Rearing Winter Base Flow (Jan 1–Apr 30)	17,600 (20.14%)	2,900 (6.09%)	5,200 (6.88%)	3,600 (9.42%)	29,000 (11.65%)
Juvenile Rearing Summer Cold Water Program and Fall Flows (May 1–Dec 31)	7,500 (38.66%)	-1,200 (-3.87%)	500 (0.93%)	1,500 (6.44%)	9,000 (7.09%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

[b] No average daily habitat availability model results are available for the points of interest not shown.

Migration Conditions

Adult Upstream Passage

Based on the results of the FAHCE WEAP Model, there would be similar changes to adult upstream passage conditions from the FAHCE-plus Alternative compared with the current and future baseline. The FAHCE-plus Alternative would result in modeled increased adult upstream passage (Table 74).

Table 74. FAHCE-plus Alternative Adult Steelhead Upstream Passage Compared with the Future Baseline in Stevens Creek

Parameter	STEV 1	STEV 2	STEV 3	STEV 4	STEV 5	STEV 6
Future Baseline (days)[a]						
Total Adult Upstream Passage (1991–2010)	1,885	1,868	584	584	579	549
Average Adult Upstream Passage Per Year	94	93	29	29	29	27
FAHCE-plus (days)[a]						
Total Adult Upstream Passage (1991–2010)	2,116	2,106	644	644	643	601
Average Adult Upstream Passage Per Year	106	105	32	32	32	30
Difference (days)						
Total Adult Upstream Passage (1991–2010)	231.00	238.00	60.00	60.00	64.00	52.00
Average Adult Upstream Passage Per Year	11.55	11.90	3.00	3.00	3.20	2.60
Difference (%)						
Total Adult Upstream Passage (1991–2010)	12.25	12.74	10.27	10.27	11.05	9.47
Average Adult Upstream Passage Per Year	12.25	12.74	10.27	10.27	11.05	9.47

[a] Rounded to whole days

Juvenile Downstream Passage

Based on the results of the FAHCE WEAP Model, there would be similar changes to juvenile downstream passage from the FAHCE-plus Alternative compared with the current and future baseline and upstream migration conditions would be improved (Table 75).

Table 75. FAHCE-plus Alternative Juvenile Steelhead Downstream Passage Compared with the Future Baseline in Stevens Creek

Parameter	STEV 6 with Water Temperature Criteria[b]
Future Baseline (days)[a]	
Total Juvenile Downstream Passage (1991–2010)	821
Average Juvenile Downstream Passage Per Year	41
FAHCE-plus Alternative (days)[a]	
Total Juvenile Downstream Passage (1991–2010)	836
Average Juvenile Downstream Passage Per Year	42

Parameter	STEV 6 with Water Temperature Criteria[b]
Difference (days)	
Total Juvenile Downstream Passage (1991–2010)	15.00
Average Juvenile Downstream Passage Per Year	1.00
Difference (%)	
Total Juvenile Downstream Passage (1991–2010)	1.83
Average Juvenile Downstream Passage Per Year	2.44

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

1.6.1.2 Assessment of Pacific Lamprey and Pacific Lamprey Habitat in the Stevens Creek Watershed Portion of the Study Area

Assessments of the effects of the FAHCE-plus Alternative on Pacific lamprey, Pacific lamprey habitat and Pacific lamprey migration within the Stevens Creek portion of the study area are provided in the following subsections. There were no HAI or passage model outputs for Pacific lamprey. Thus, the effects of the FAHCE-plus Alternative on Pacific lamprey habitat and passage were evaluated using other modeled data, including wetted area and thalweg depth, as well as review of water temperature for suitability.

Flow Measures Current Baseline Assessment

Pre-Spawning Holding Habitat

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in increased pre-spawning holding habitat during the winter because of increased flows and wetted area and have variable effects on pre-spawning holding habitat during the summer between downstream and upstream Stevens Creek. Decreases in rearing habitat would occur in upstream Stevens Creek (STEV 4 through STEV 6) during the Summer Cold Water Program and Fall Flows release because of reduced flows and wetted area, but there would be increased pre-spawning holding habitat in downstream Stevens Creek during the summer because of increased wetted area (Attachment K.3 – Figures K.3.3 and K.3.4). This increase in pre-spawning holding habitat in downstream Stevens Creek occurs despite increases in daily maximum water temperatures under the FAHCE-plus Alternative during the summer (Attachment K.3 – Figure K.3.5). Overall, under the FAHCE-plus Alternative, pre-spawning holding habitat would increase during Winter Base Flow Operations (excluding Fall Flows) in both upstream and downstream Stevens Creek, increase in downstream Stevens Creek during Summer Cold Water Operations and Fall Flows, and decrease in upstream Stevens Creek during Summer Cold Water Operation and Fall Flows compared with the current baseline.

Effective Spawning Habitat

Based on modeled flows and wetted area, the FAHCE-plus Alternative would result in increased effective spawning habitat during two months of the spawning and incubation period for this species (March 1 through April 31) and depending on the location in Stevens Creek, remain unchanged or decrease during four months of the spawning and incubation period for this species (March 1 through August 31). Increases in spawning and incubation habitat would occur from March 1 through April 31 under the FAHCE-plus Alternative because of increased flows under Winter Base Flow Operations (excluding Fall Flows), but effective spawning habitat would generally decrease between May 1 and August 31 because of Summer Cold Water Program and Fall Flows releases that reduce flows and wetted area in Stevens Creek (Attachment K.3 – Figures K.3.1, K.3.3 and K.3.4). As discussed under the Proposed Project AQUA-2, given high water temperatures in the region, embryo incubation is not expected to occur after mid-July and any effects would be offset by increased spawning and incubation habitat during the winter.

Larvae Rearing Habitat

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in increased rearing habitat during the winter because of increased flows and wetted area and have variable effects on rearing habitat during the summer between downstream and upstream Stevens Creek. Decreases in rearing habitat would occur in upstream Stevens Creek (STEV 4 through STEV 6) during the Summer Cold Water Program and Fall Flows because of reduced flows and wetted area (Attachment K.3 – Figures K.3.3 and K.3.4). There is effectively no flow in downstream Stevens Creek during the summer, but wetted area would increase under the Proposed Project. Given temperatures remain suitable, increased wetted area in downstream Stevens Creek could provide additional rearing habitat for Pacific lamprey because the species prefers slower moving water with sand and/or silt substrate during larvae rearing. Modeled temperature was not available for STEV 1 and STEV 2 in downstream Stevens Creek, but modeled MWAT at STEV 3 would remain suitable (the average temperature was less than 66°F and the maximum temperature was less than 70°F) during the summer (Attachment K.3 – Figure K.3.5).

Migration Conditions

Adult Upstream Passage

During the adult Pacific lamprey upstream migration period (January 1 through June 30), the FAHCE WEAP Model results for thalweg depth indicate a 28% increase (29 days per year on average) in adult upstream passage opportunities in the Stevens Creek watershed under the FACHE-plus Alternative when compared with the current baseline. In addition to the thalweg depth analysis, modeled results for adult steelhead upstream passage, which overlaps with the timing of upstream passage of adult Pacific lamprey (January through April), also indicate increases to adult Pacific lamprey upstream passage opportunities in the Stevens Creek watershed.

Juvenile Downstream Passage

During the adult Pacific lamprey downstream migration period (December 1 through May 31), the FAHCE WEAP Model results for thalweg depth indicate a 28% (32 days per year) average increase in juvenile downstream passage opportunities in the Stevens Creek watershed under the FACHE-plus Alternative when compared with the current baseline. In addition to the thalweg depth analysis, modeled results for juvenile steelhead downstream passage (with the water temperature criteria included), which overlaps with the timing of downstream passage of juvenile Pacific lamprey (December through May), also indicate increases to adult Pacific lamprey upstream passage opportunities in the Stevens Creek watershed.

Flow Measures Future Baseline Assessment

Pre-Spawning Holding Habitat

Based on the results of the FAHCE WEAP Model, there are negligible differences in the FAHCE-plus Alternative in analysis between the current and future baseline for pre-spawning holding habitat. For the reasons outlined in the comparison to current baseline, decreases in flows and wetted area during the summer under the FAHCE-plus Alternative would reduce pre-spawning holding habitat in upstream Stevens Creek, but there would be increased pre-spawning holding habitat in downstream Stevens Creek during the summer. Increases in pre-spawning holding habitat would occur during the winter throughout Stevens Creek because of increases in flows and wetted area (Attachment K.3 – Figures K.3.9 and K.3.10).

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, there are negligible differences in the FAHCE-plus Alternative analysis between the current and future baseline for effective spawning habitat. Therefore, the FAHCE-plus Alternative would result in increases to effective spawning habitat compared with the future baseline conditions in the Stevens Creek portion of the study area.

Larvae Rearing Habitat

Based on the results of the FAHCE WEAP Model, there are negligible differences in the FAHCE-plus Alternative in analysis between the current and future baseline for larvae rearing habitat. Therefore, the FAHCE-plus Alternative would result in variable changes to larvae rearing habitat compared with the future baseline conditions in the Stevens Creek watershed portion of the study area.

Migration Conditions

Adult Upstream Passage

Based on the results of the FAHCE WEAP Model for thalweg depth and steelhead adult upstream passage, there are similar differences in the effects of the FAHCE-plus Alternative on adult upstream passage compared with the current and future baseline. Therefore, the FAHCE-plus Alternative would result in increases to upstream passage opportunities in the Stevens Creek watershed which would provide additional spawning opportunities for Pacific lamprey.

Juvenile Downstream Passage

Based on the results of the FAHCE WEAP Model, there are similar differences in the effects of the FAHCE-plus Alternative on juvenile downstream passage compared with the current and future baseline. Therefore, there would be increased opportunities for downstream passage for juvenile Pacific lamprey migration under the FAHCE-plus Alternative.

1.6.1.3 Stevens Creek Watershed Portion of the Study Area Conclusions

Steelhead

The increased habitat and migration conditions under the FAHCE-plus Alternative flow measures would result in a net benefit to anadromous steelhead. The FAHCE-plus Alternative flow measures would result in increases of all habitat types for steelhead, including effective spawning, fry rearing, and juvenile rearing habitat, on average, across both the Summer Cold Water Program and Fall Flows and Winter Base Flow Operations (excluding Fall Flows). The FAHCE-plus Alternative would also increase upstream and downstream migration conditions for both adult and juvenile steelhead throughout the Stevens Creek study area. In particular, the FAHCE-plus Alternative increases adult passage opportunities to the upstream reaches where the Stevens Creek CWMZ is located unlike the Proposed Project where there was an average 1 day per year modeled decrease in passage to the CWMZ of Stevens Creek.

Pacific Lamprey

Although the operations associated with the Proposed Project are management actions that benefit federally listed steelhead and salmon, the actions are anticipated to provide an overall benefit to Pacific lamprey as well. Net benefits of implementing the FAHCE-plus Alternative flow measures would support increased abundance of Pacific lamprey in the Stevens Creek watershed.

Under the FAHCE-plus Alternative, there would be overall increases of modeled pre-spawning holding and larvae rearing habitat in the winter, and increased upstream and downstream migration opportunities, while there would be decreased modeled spawning habitat during the Summer Cold Water Program and Fall Flows.

1.6.2 Assessment of the Project in the Guadalupe River Portion of the Study Area

1.6.2.1 Assessment of Steelhead and Steelhead Habitat in the Guadalupe River

Assessments of the effects of the FAHCE-plus Alternative on steelhead, steelhead habitat, and migration conditions within the Guadalupe River portion of the study area are provided in the following subsections.

Flow Measures Current Baseline Assessment

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 68% (3,435 square feet) average increase in daily effective spawning habitat during the spawning and incubation life-stage time period (that is, December 1 to April 30) across POIs in the Guadalupe River compared with the current baseline (Table 76). Modeled increases were observed early in the spawning period (December) with little to no change during the rest of the spawning period (January through May) when most upstream migration occurs (Moyle et al. 2008) (Figure 109).

Figure 109. Change in Effective Steelhead Spawning Habitat Compared with the Current Baseline in the Guadalupe River

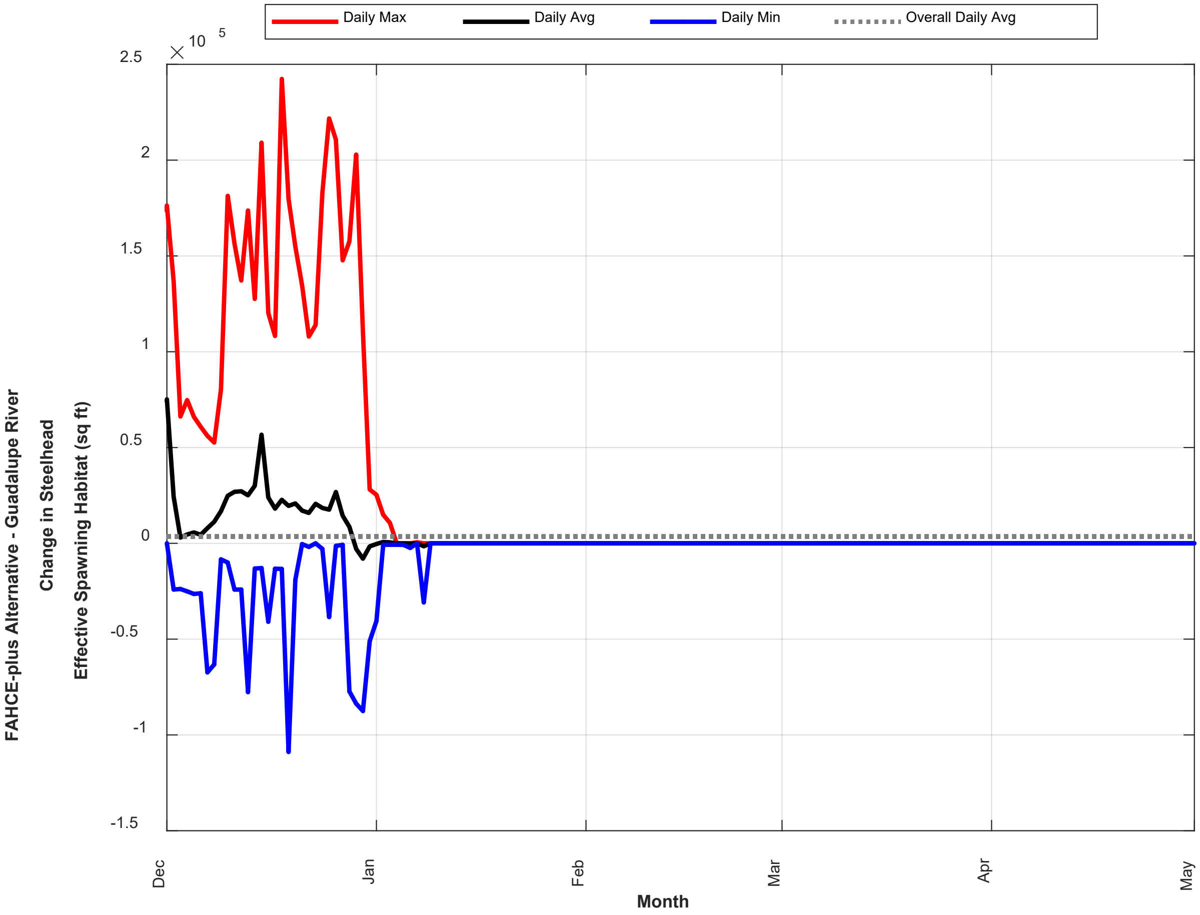


Table 76. FAHCE-plus Alternative Steelhead Habitat Compared with the Current Baseline in the Guadalupe River

Guadalupe River[a,b]	GUAD 3 River Mile 10.07	GUAD 4 River Mile 12.52	GUAD 5 River Mile 13.42	GUAD 6 River Mile 18.45	GUAD 7 River Mile 19.93	Total
Steelhead Habitat Current Baseline (sq ft)						
Effective Spawning	2,490	294	290	941	1,040	5,055
Fry Rearing Total (March 1–May 31)	147,000	168,000	66,800	405,000	400,000	1,186,800
Fry Rearing Winter Base Flow Operations (March 1–April 30)	155,000	167,000	71,500	435,000	406,000	1,234,500
Fry Rearing Summer Release Program (May 1–May 31)	131,000	170,000	57,500	347,000	387,000	1,092,500

Guadalupe River[a,b]	GUAD 3 River Mile 10.07	GUAD 4 River Mile 12.52	GUAD 5 River Mile 13.42	GUAD 6 River Mile 18.45	GUAD 7 River Mile 19.93	Total
Juvenile Rearing Total (year-round)	240,000	259,000	75,200	309,000	330,000	1,213,200
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	290,000	297,000	105,000	483,000	401,000	1,576,000
Juvenile Rearing Summer Release Program (May 1–Oct 31)	190,000	222,000	45,800	138,000	261,000	856,800
Steelhead Habitat FAHCE-plus Alternative (sq ft)						
Effective Spawning	3,530	437	543	2,010	1,970	8,490
Fry Rearing Total (March 1–May 31)	146,000	168,000	66,500	403,000	395,000	1,178,500
Fry Rearing Winter Base Flow Operations (March 1–April 30)	154,000	167,000	71,300	427,000	397,000	1,216,300
Fry Rearing Summer Release Program (May 1–May 31)	130,000	169,000	57,200	355,000	391,000	1,102,200
Juvenile Rearing Total (year-round)	239,000	257,000	75,600	311,000	323,000	1,205,600
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	291,000	296,000	106,000	484,000	381,000	1,558,000
Juvenile Rearing Summer Release Program (May 1–Oct 31)	188,000	219,000	45,900	140,000	266,000	858,900
Change in Habitat (sq ft)						
Effective Spawning	1,040 (41.77%)	143 (48.64%)	253 (87.24%)	1,069 (113.6%)	930 (89.42%)	3,435 (67.95%)
Fry Rearing Total (March 1–May 31)	-1,000 (-0.68%)	0 (0%)	-300 (-0.45%)	-2,000 (-0.49%)	-5,000 (-1.25%)	-8,300 (-0.7%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	-1,000 (-0.65%)	0 (0%)	-200 (-0.28%)	-8,000 (-1.84%)	-9,000 (-2.22%)	-18,200 (-1.47%)
Fry Rearing Summer Release Program (May 1–May 31)	-1,000 (-0.76%)	-1,000 (-0.59%)	-300 (-0.52%)	8,000 (2.31%)	4,000 (1.03%)	9,700 (0.89%)
Juvenile Rearing Total (year-round)	-1,000 (-0.42%)	-2,000 (-0.77%)	400 (0.53%)	2,000 (0.65%)	-7,000 (-2.12%)	-7,600 (-0.63%)
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	1,000 (0.34%)	-1,000 (-0.34%)	1,000 (0.95%)	1,000 (0.21%)	-20,000 (-4.99%)	-18,000 (-1.14%)
Juvenile Rearing Summer Release Program (May 1–Oct 31)	-2,000 (-1.05%)	-3,000 (-1.35%)	100 (0.22%)	2,000 (1.45%)	5,000 (1.92%)	2,100 (0.25%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

[b] No average daily habitat availability model results are available for the points of interest not shown.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 18% (198 square feet) average decrease in daily effective spawning habitat during the spawning and incubation life-stage time period (that is, December 1 to April 30) across POIs in Los Gatos Creek compared with the current baseline (Figure 110; Table 77). Modeled decreases were observed early in the spawning period (late-December through early-January) with minimal differences observed during the rest of the spawning period (early-January through May) when most upstream migration occurs (Moyle et al. 2008) (Figure 110).

Figure 110. Change in Effective Steelhead Spawning Habitat Compared with the Current Baseline in Los Gatos Creek

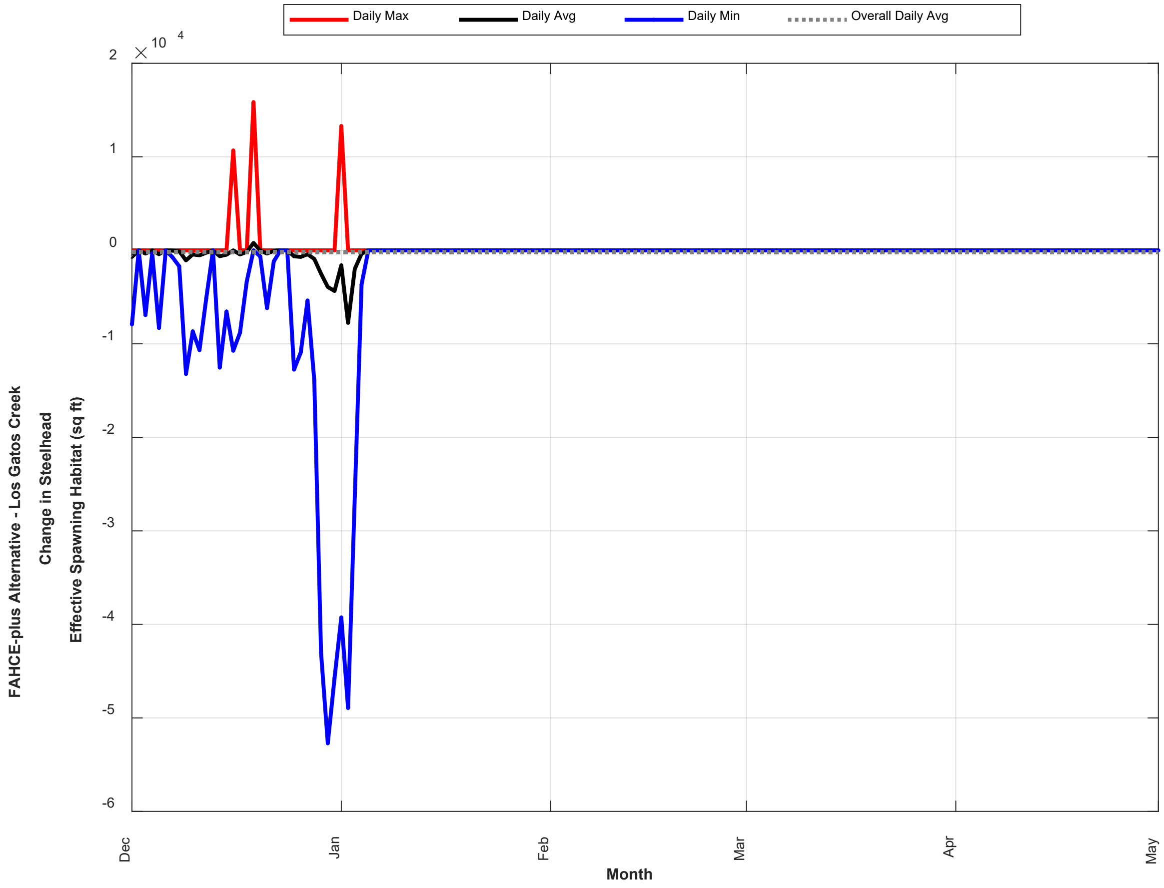


Table 77. FAHCE-plus Alternative Steelhead Habitat Compared with the Current Baseline in Los Gatos Creek

Los Gatos Creek[a]	LOSG 1 River Mile 14.70	LOSG 2 River Mile 18.91	Total
Steelhead Habitat Current Baseline (sq ft)			
Effective Spawning	527	547	1,074
Fry Rearing Total (March 1–May 31)	136,000	246,000	382,000
Fry Rearing Winter Base Flow Operations (March 1–April 30)	133,000	240,000	373,000

Los Gatos Creek[a]	LOSG 1 River Mile 14.70	LOSG 2 River Mile 18.91	Total
Fry Rearing Summer Release Program (May 1–May 31)	142,000	258,000	400,000
Juvenile Rearing Total (year-round)	114,000	217,000	331,000
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	121,000	211,000	332,000
Juvenile Rearing Summer Release Program (May 1–Oct 31)	107,000	222,000	329,000
Steelhead Habitat FAHCE-plus Alternative (sq ft)			
Effective Spawning	409	467	876
Fry Rearing Total (March 1–May 31)	137,000	251,000	388,000
Fry Rearing Winter Base Flow Operations (March 1–April 30)	138,000	253,000	391,000
Fry Rearing Summer Release Program (May 1–May 31)	135,000	248,000	383,000
Juvenile Rearing Total (year-round)	109,000	208,000	317,000
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	116,000	198,000	314,000
Juvenile Rearing Summer Release Program (May 1–Oct 31)	102,000	217,000	319,000
Change in Habitat (sq ft)			
Effective Spawning	-118 (-22.39%)	-80 (-14.63%)	-198 (-18.44%)
Fry Rearing Total (March 1–May 31)	1,000 (0.74%)	5,000 (2.03%)	6,000 (1.57%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	5,000 (3.76%)	13,000 (5.42%)	18,000 (4.83%)
Fry Rearing Summer Release Program (May 1–May 31)	-7,000 (-4.93%)	-10,000 (-3.88%)	-17,000 (-4.25%)
Juvenile Rearing Total (year-round)	-5,000 (-4.39%)	-9,000 (-4.15%)	-14,000 (-4.23%)
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	-5,000 (-4.13%)	-13,000 (-6.16%)	-18,000 (-5.42%)
Juvenile Rearing Summer Release Program (May 1–Oct 31)	-5,000 (-4.67%)	-5,000 (-2.25%)	-10,000 (-3.04%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 13% (97 square feet) average increase of daily effective spawning habitat during the spawning and incubation life-stage time period (that is, December 1 to April 30) across POIs in Guadalupe Creek compared with the current baseline (Figure 111; Table 78). The largest modeled increases would occur in downstream Guadalupe Creek (Table 78). In the Guadalupe Creek CWMZ, there would be a 1% (4 square foot) average increase in modeled steelhead effective spawning habitat across the entire spawning and incubation period. Although the average increase in daily effective spawning habitat area across the spawning and incubation period is relatively small, the modeled increases in the daily effective spawning habitat are 100 square feet or more for some periods between December and May under the FAHCE-plus Alternative, potentially accommodating additional spawners and reducing competition among spawners.

Figure 111. Change in Effective Steelhead Spawning Habitat Compared with the Current Baseline in Guadalupe Creek

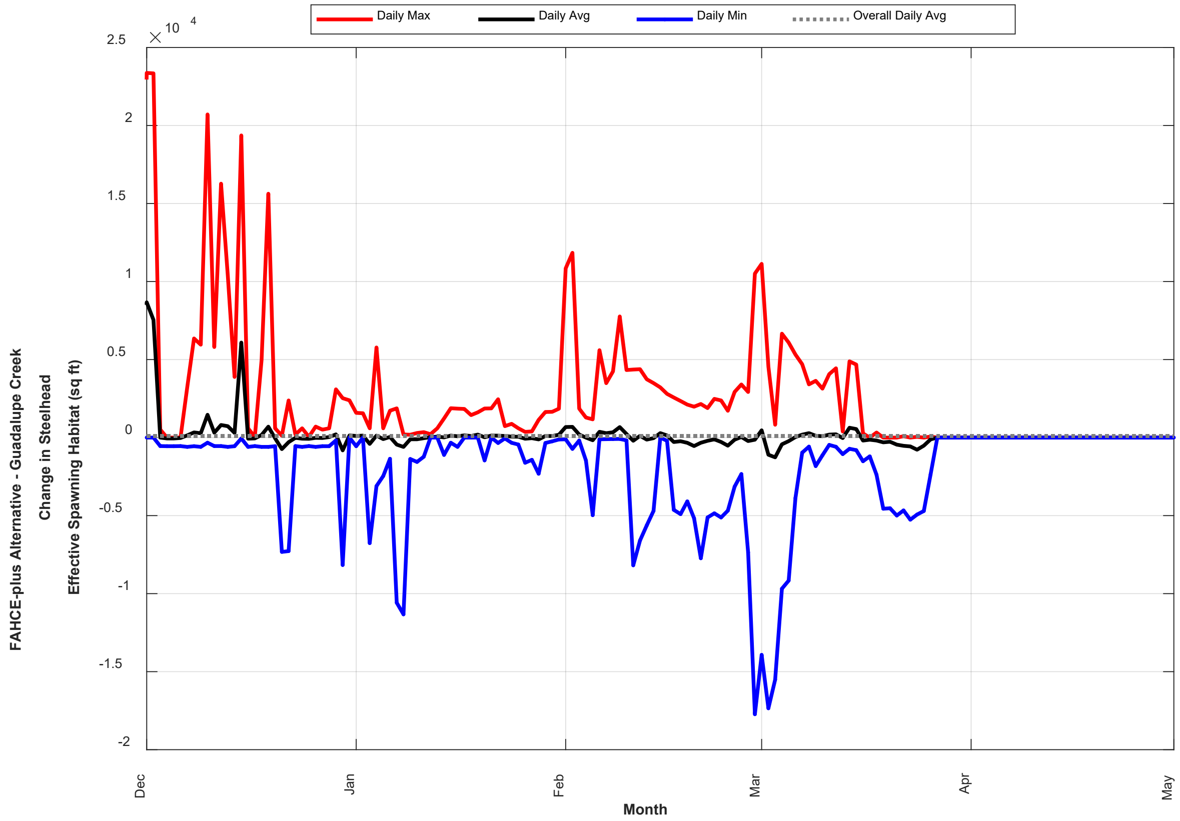


Table 78. FAHCE-plus Alternative Steelhead Habitat Compared with the Current Baseline in Guadalupe Creek

Guadalupe Creek[a]	GCRK 1 River Mile 20.71	GCRK 2 River Mile 21.91	GCRK 3 River Mile 22.54	GCRK 4 River Mile 26.17	Total
Steelhead Habitat Current Baseline (sq ft)					
Effective Spawning	63	254	39	403	759
Fry Rearing Total (March 1–May 31)	17,300	43,600	3,550	25,700	90,150
Fry Rearing Winter Base Flow Operations (March 1–April 30)	21,100	43,600	3,390	24,800	92,890
Fry Rearing Summer Cold Water Program (May 1–May 31)	9,890	43,700	3,850	27,500	84,940
Juvenile Rearing Total (year-round)	7,700	32,000	2,630	13,700	56,030
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	14,800	36,700	3,000	13,600	68,100

Guadalupe Creek[a]	GCRK 1 River Mile 20.71	GCRK 2 River Mile 21.91	GCRK 3 River Mile 22.54	GCRK 4 River Mile 26.17	Total
Juvenile Rearing Summer Cold Water Program (May 1–Oct 31)	748	27,400	2,270	13,900	44,318
Steelhead Habitat FAHCE-plus Alternative (sq ft)					
Effective Spawning	90	308	51	407	856
Fry Rearing Total (March 1–May 31)	16,900	43,400	3,510	27,300	91,110
Fry Rearing Winter Base Flow Operations (March 1–April 30)	22,000	49,500	3,630	27,500	102,630
Fry Rearing Summer Cold Water Program (May 1–May 31)	6,730	31,600	3,280	26,900	68,510
Juvenile Rearing Total (year-round)	7,940	24,000	2,210	12,400	46,550
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	15,600	38,500	3,210	15,400	72,710
Juvenile Rearing Summer Cold Water Program (May 1–Oct 31)	427	9,700	1,220	9,470	20,817
Change in Habitat (sq ft)					
Effective Spawning	27 (42.86%)	54 (21.26%)	12 (30.77%)	4 (0.99%)	97 (12.80%)
Fry Rearing Total (March 1–May 31)	-400 (-2.31%)	-200 (-0.46%)	-40 (-1.13%)	1,600 (6.23%)	960 (1.06%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	900 (4.27%)	5,900 (13.53%)	240 (7.08%)	2,700 (10.89%)	9,740 (10.49%)
Fry Rearing Summer Cold Water Program (May 1–May 31)	-3,160 (-31.95%)	-12,100 (-27.69%)	-570 (-14.81%)	-600 (-2.18%)	-16,430 (-19.34%)
Juvenile Rearing Total (year-round)	240 (3.12%)	-8,000 (-25%)	-420 (-15.97%)	-1,300 (-9.49%)	-9,480 (-16.92%)
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	800 (5.41%)	1,800 (4.9%)	210 (7%)	1,800 (13.24%)	4,610 (6.77%)
Juvenile Rearing Summer Cold Water Program (May 1–Oct 31)	-321 (-42.91%)	-17,700 (-64.6%)	-1,050 (-46.26%)	-4,430 (-31.87%)	-23,501 (-53.03%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 37% (23 square feet) average decrease in daily effective spawning habitat for steelhead during the spawning and incubation period (that is, December 1 to April 30) across POIs in Alamitos Creek compared with the current baseline (Figure 112; Table 79). The decrease would primarily occur during December in the reach from ALAM 1 to ALAM 2 (represented by the model results at ALAM 2), with no change in the average effective spawning habitat at ALAM 2 from late December to May under the FAHCE-plus Alternative compared to the current baseline. The modeled daily effective spawning habitat increase on individual days between ALAM 2 and ALAM 3 (represented by the model results at ALAM 3) under the FAHCE-plus Alternative compared to the current baseline is relatively small (typically less 20 square feet) compared to an average redd size of 73 square feet (Orcutt et al. 1968). While the modeled daily effective spawning habitat between ALAM 3 and ALAM 4 (represented by the model results at ALAM 4) increases from December through mid-January under the FAHCE-plus Alternative and periodically exceeds 73 square feet from December to early February, the daily effective spawning habitat decreases from late January to mid-March and results in the daily effective spawning at ALAM 4 having an average decrease of 13% (4 square feet) over the entire effective spawning period under the FAHCE-plus Alternative compared to the current baseline.

Figure 112. Change in Effective Steelhead Spawning Habitat Compared with the Current Baseline in Alamitos Creek

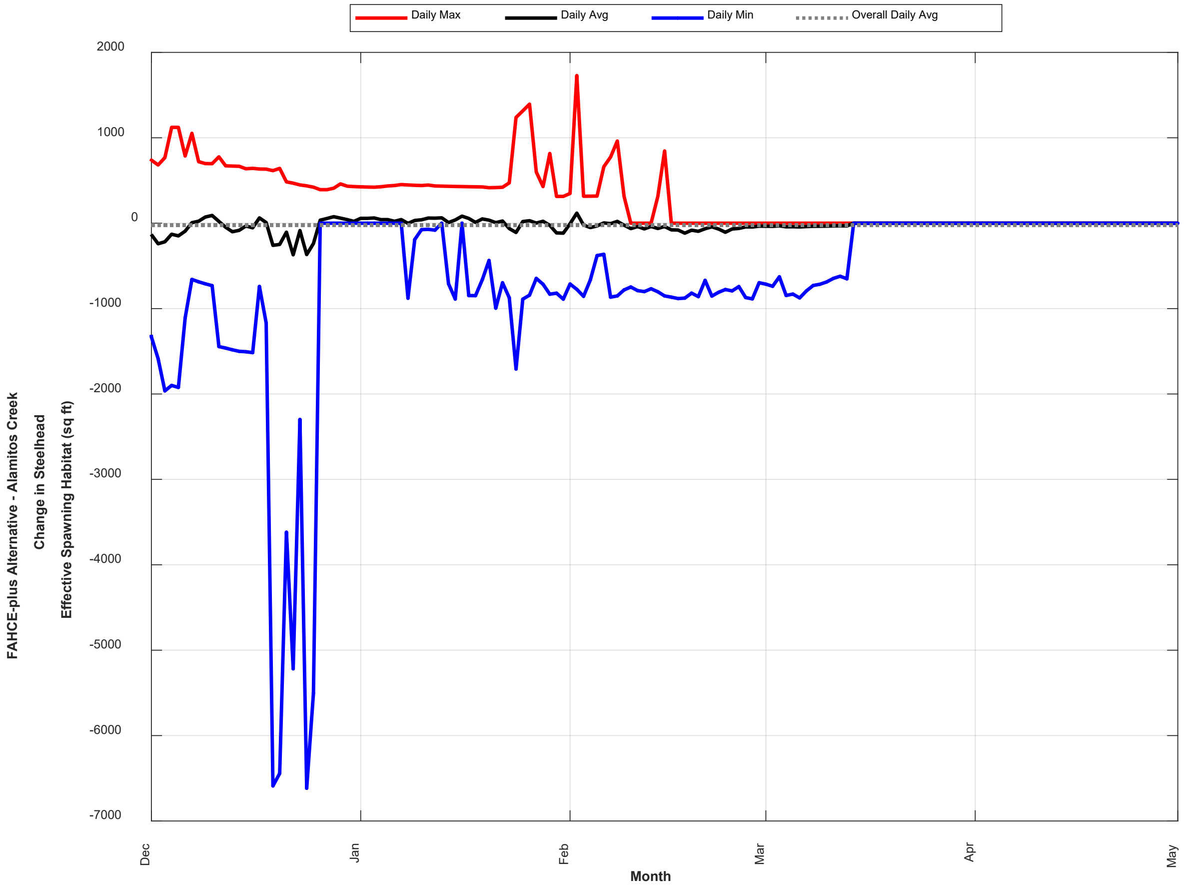


Table 79. FAHCE-plus Alternative Steelhead Habitat Compared with the Current Baseline in Alamitos Creek

Alamitos Creek[a,b]	ALAM 2 River Mile 23.61	ALAM 3 River Mile 24.26	ALAM 4 River Mile 27.89	Total
Steelhead Habitat Current Baseline (sq ft)				
Effective Spawning	31	2	31	64
Fry Rearing Total (March 1–May 31)	56,500	6,940	3,610	67,050

Alamitos Creek[a,b]	ALAM 2 River Mile 23.61	ALAM 3 River Mile 24.26	ALAM 4 River Mile 27.89	Total
Fry Rearing Winter Base Flow Operations (March 1–April 30)	57,900	7,100	3,350	68,350
Fry Rearing Summer Release Program (May 1–May 31)	53,700	6,620	4,150	64,470
Juvenile Rearing Total (year-round)	60,900	5,480	3,070	69,450
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	70,000	6,350	3,000	79,350
Juvenile Rearing Summer Release Program (May 1–Oct 31)	51,900	4,620	3,140	59,660
Steelhead Habitat FAHCE-plus Alternative (sq ft)				
Effective Spawning	7	7	26	40
Fry Rearing Total (March 1–May 31)	55,900	7,250	3,820	66,970
Fry Rearing Winter Base Flow Operations (March 1–April 30)	56,600	7,570	3,660	67,830
Fry Rearing Summer Release Program (May 1–May 31)	54,600	6,610	4,130	65,340
Juvenile Rearing Total (year-round)	60,100	5,950	3,490	69,540
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	66,000	7,440	3,910	77,350
Juvenile Rearing Summer Release Program (May 1–Oct 31)	54,200	4,470	3,080	61,750
Change in Habitat (sq ft)				
Effective Spawning	-25 (-79%)	5 (272.59%)	-4 (-13.44%)	-23 (-36.65%)
Fry Rearing Total (March 1–May 31)	-600 (-1.06%)	310 (4.47%)	210 (5.82%)	-80 (-0.12%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	-1,300 (-2.25%)	470 (6.62%)	310 (9.25%)	-520 (-0.76%)
Fry Rearing Summer Release Program (May 1–May 31)	900 (1.68%)	-10 (-0.15%)	-20 (-0.48%)	870 (1.35%)
Juvenile Rearing Total (year-round)	-800 (-1.31%)	470 (8.58%)	420 (13.68%)	90 (0.13%)
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	-4,000 (-5.71%)	1,090 (17.17%)	910 (30.33%)	-2,000 (-2.52%)
Juvenile Rearing Summer Release Program (May 1–Oct 31)	2,300 (4.43%)	-150 (-3.25%)	-60 (-1.91%)	2,090 (3.5%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

[b] No average daily habitat availability model results are available for the points of interest not shown.

There were no FAHCE WEAP Model predictions for effective spawning habitat in Calero Creek despite known occurrence of spawners (Valley Water unpublished data). Based on the results of the FAHCE WEAP Model for wetted area, effective spawning habitat would decrease in Calero Creek compared with the current baseline due to decreased wetted area during Winter Base Flow Operations (Attachment K.3 – Figures K.3.63 and K.3.64).

Table 80. FAHCE-plus Alternative Steelhead Habitat Compared with the Current Baseline in Calero Creek

Calero Creek[a]	CALE 1 River Mile 24.33	CALE 2 River Mile 27.59	Total
Steelhead Habitat Current Baseline (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (March 1-May 31)	2,650	60,100[c]	62,750[c]
Fry Rearing Winter Base Flow Operations (March 1-April 30)	2,740	46,600[c]	49,340[c]
Fry Rearing Summer Release Program (May 1-May 31)	2,470	86,800	89,270
Juvenile Rearing Total (year-round)	2,550	56,800[c]	59,350[c]
Juvenile Rearing Winter Base Flow (Nov 1-Apr 30)	2,850	31,400[c]	34,250[c]
Juvenile Rearing Summer Release Program (May 1-Oct 31)	2,250	81,800	84,050
Steelhead Habitat FAHCE-plus Alternative (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (March 1-May 31)	2,540	54,100[c]	56,640[c]
Fry Rearing Winter Base Flow Operations (March 1-April 30)	2,520	35,500[c]	38,020[c]
Fry Rearing Summer Release Program (May 1-May 31)	2,570	90,700	93,270
Juvenile Rearing Total (year-round)	2,360	54,600[c]	56,960[c]
Juvenile Rearing Winter Base Flow (Nov 1-Apr 30)	2,320	21,900[c]	24,220[c]
Juvenile Rearing Summer Release Program (May 1-Oct 31)	2,400	86,900	89,300
Change in Habitat (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (March 1-May 31)	-110 (-4.15%)	-6,000 (-9.98%)[c]	-6,110 (-9.74%)[c]
Fry Rearing Winter Base Flow Operations (March 1-April 30)	-220 (-8.03%)	-11,100 (-23.82%)[c]	-11,320 (-22.94%)[c]
Fry Rearing Summer Release Program (May 1-May 31)	100 (4.05%)	3,900 (4.49%)	4,000 (4.48%)
Juvenile Rearing Total (year-round)	-190 (-7.45%)	-2,200 (-3.87%)[c]	-2,390 (-4.03%)[c]
Juvenile Rearing Winter Base Flow (Nov 1-Apr 30)	-530 (-18.60%)	-9,500 (-30.25%)[c]	-10,030 (-29.28%)[c]

Calero Creek[a]	CALE 1 River Mile 24.33	CALE 2 River Mile 27.59	Total
Juvenile Rearing Summer Release Program (May 1-Oct 31)	150 (6.67%)	5,100 (6.23%)	5,250 (6.25%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

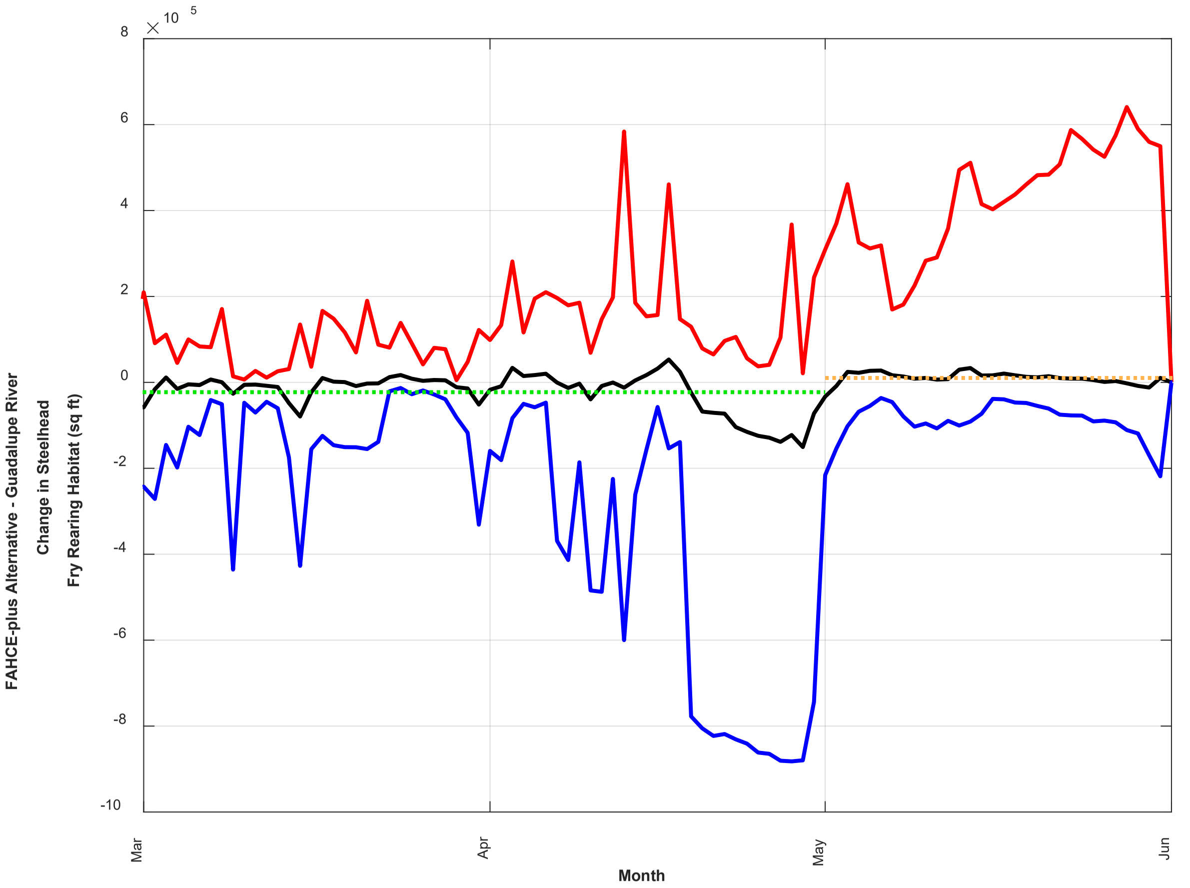
[b] Effective spawning model results were not available in Calero Creek because no substrate suitable for spawning was recorded by the subsample habitat survey of Calero Creek input into the FAHCE WEAP Model. Subsequent surveys indicate there is substrate suitable for spawning in Calero Creek (Valley Water 2019, 2020).

[c] Average daily fry rearing and juvenile rearing habitat availability model results do not quantify conditions when winter cover was considered in the habitat estimate (December 1 through March 31 for steelhead) since no winter cover was recorded by the subsample habitat survey of the CALE 2 reach of Calero Creek (that is, the reach between CALE 1 and CALE 2) input into the FAHCE WEAP Model. Subsequent surveys indicate there is winter cover available in this reach of Calero Creek (Valley Water 2019, 2020).

Fry Rearing Habitat

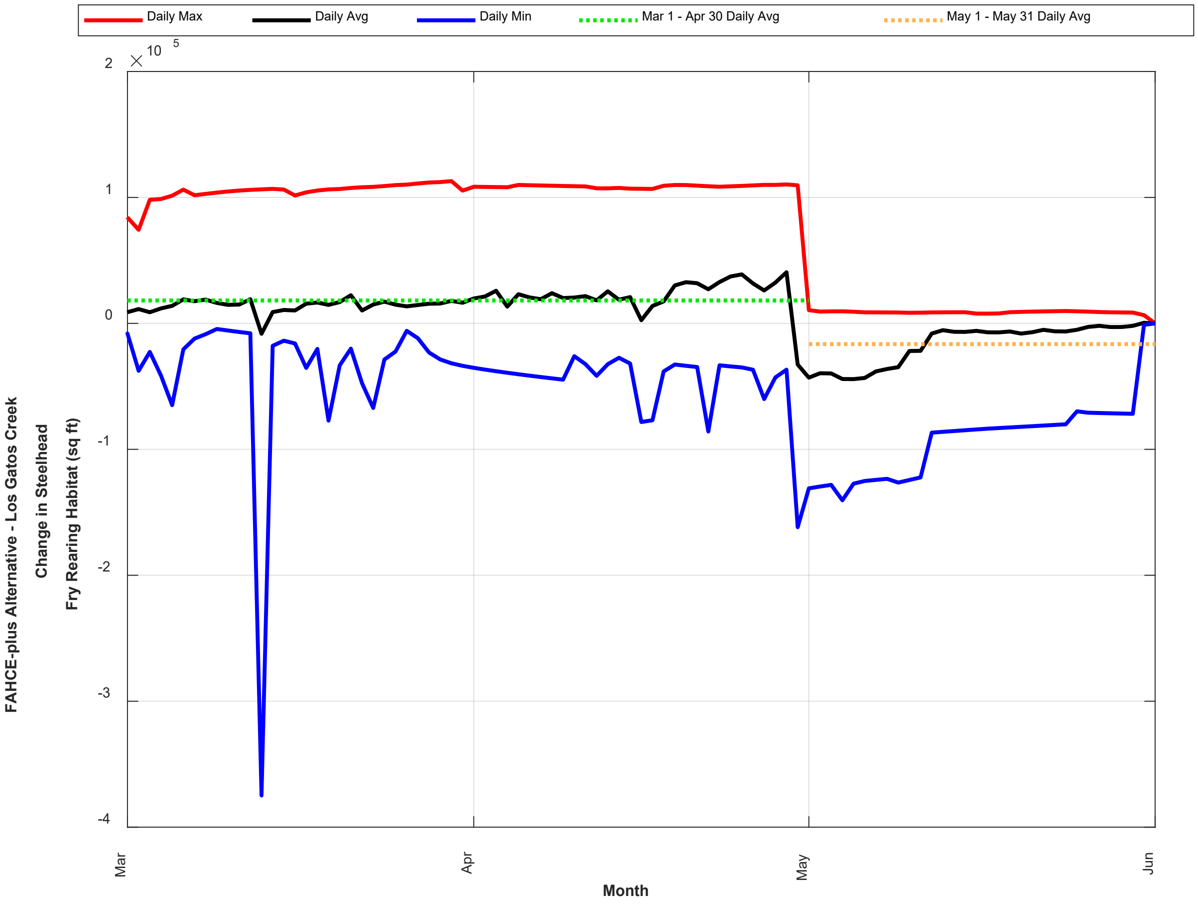
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 0.7% (8,300 square feet) average decrease in fry rearing habitat in the Guadalupe River for steelhead compared with the current baseline (Figure 113; Table 76). There is a large amount (XXXX square feet) of fry rearing habitat in the Guadalupe River under the current baseline.

Figure 113. Change in Steelhead Fry Rearing Habitat Compared with the Current Baseline in the Guadalupe River



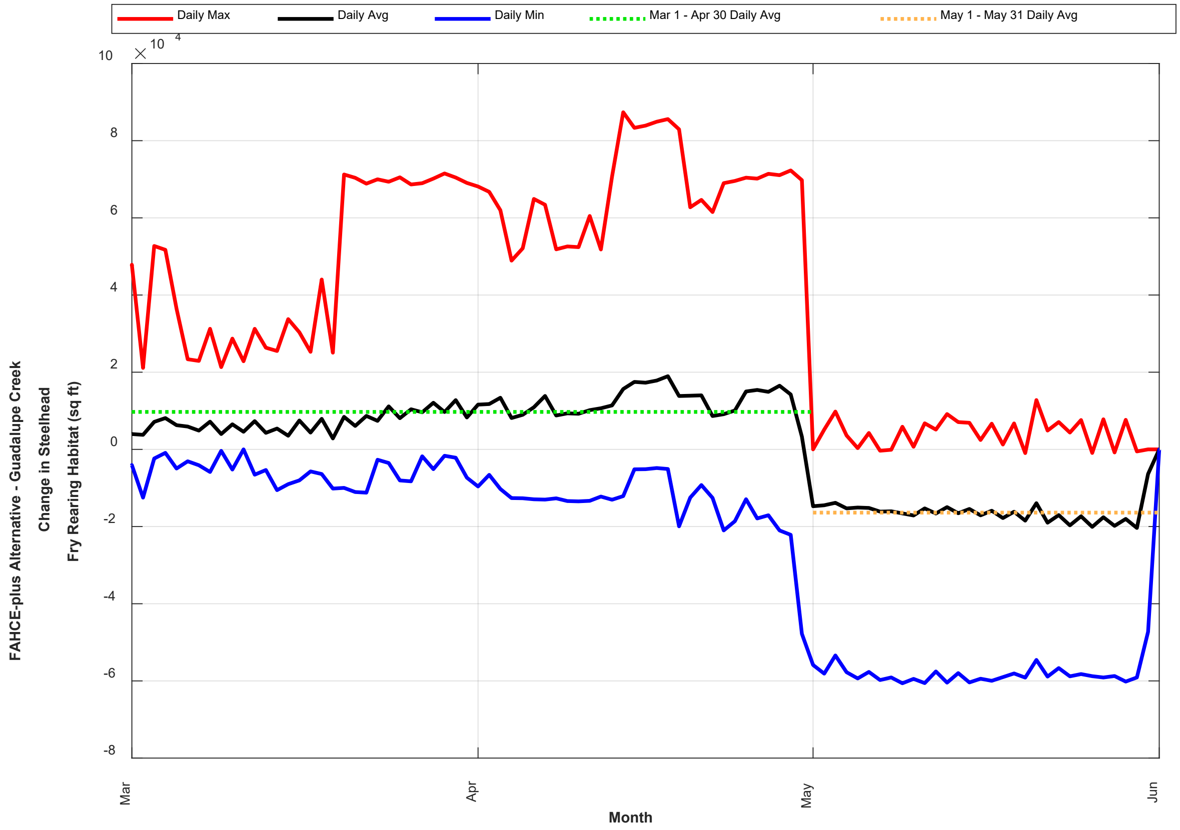
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in an average 2% (6,000 square feet) increase in fry rearing habitat in Los Gatos Creek for steelhead compared with the current baseline (Figure 114; Table 77). During Winter Base Flow Operations from March to April, fry rearing habitat would increase by 5%, but fry rearing habitat would decrease by 4% during the Summer Release Program in May (Figure 114; Table 77), likely attributable to decreased wetted area in May (Attachment K.3 – Figures K.3.27 and K.3.28). Suboptimal water temperatures for rearing (greater than 64°F) also occur in May, but the occurrence of high temperatures in May is consistent under both the FAHCE-plus Alternative and current baseline (Attachment K.3 – Figure K.3.29). Los Gatos Creek contains a large amount (382,000 square feet) of fry rearing habitat under the current baseline.

Figure 114. Change in Steelhead Fry Rearing Habitat Compared with the Current Baseline in Los Gatos Creek



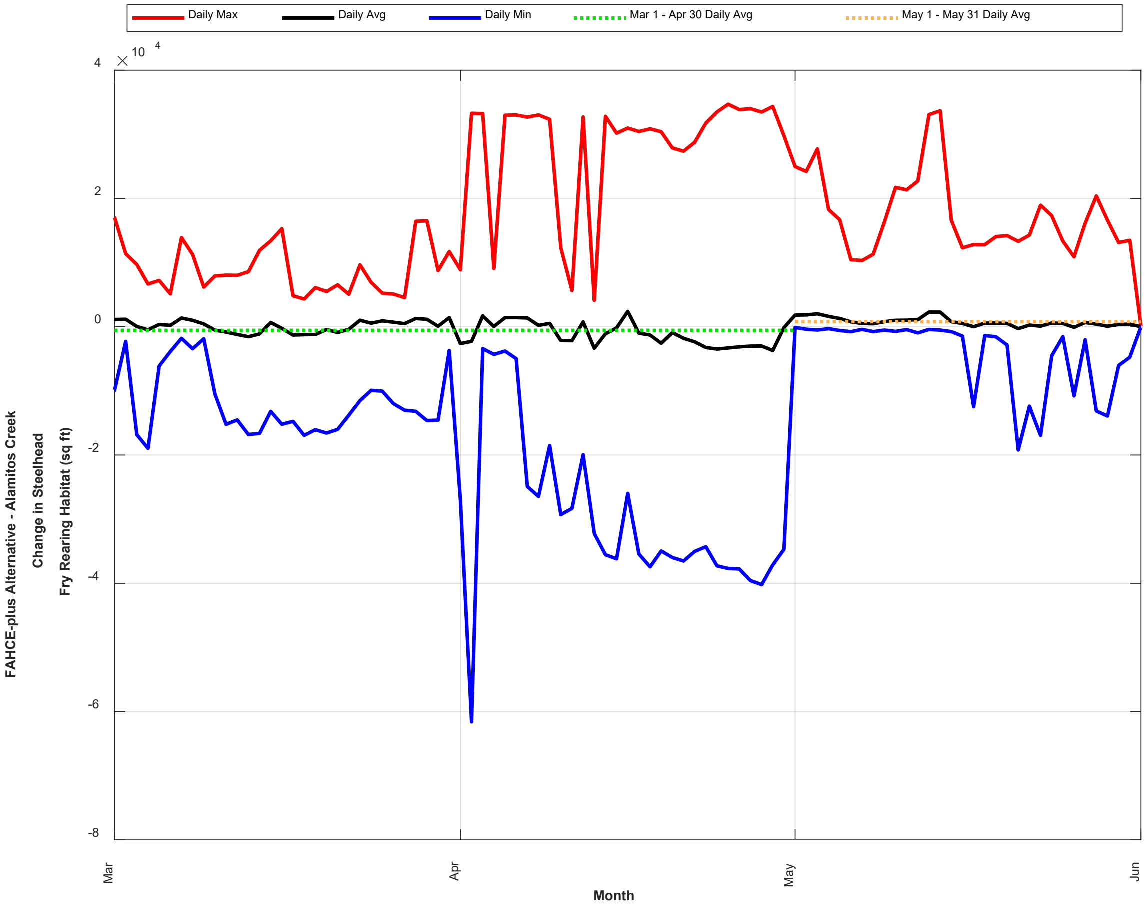
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 1% (960 square feet) average increase in fry rearing habitat in Guadalupe Creek for steelhead compared with the current baseline (Figure 115; Table 78). Changes in fry rearing habitat varied seasonally. A 10% average increase was observed from March to April and a 19% (16,340 square feet) average decrease was observed during May compared with the current baseline (Figure 115; Table 78) likely attributable to changes in wetted area under the FAHCE-plus Alternative (Attachment K.3 – Figures K.3.39 and K.3.40). In the Guadalupe Creek CWMZ, fry rearing habitat decreased by a total of 6% (1,600 square feet), with an 11% (2,700 square feet) increase observed during the Winter Base Flow Operations followed by a 2% (600 square feet) decrease during the Summer Cold Water Program. Decrease in fry rearing habitat within the Guadalupe Creek CWMZ are a result of a decrease in wetted area while decreases downstream of the CWMZ are a result of a decrease in wetted area and increased water temperatures (Attachment K.3. – Figures K.3.25, K.3.26, and K.3.27).

Figure 115. Change in Steelhead Fry Rearing Habitat Compared with the Current Baseline in Guadalupe Creek



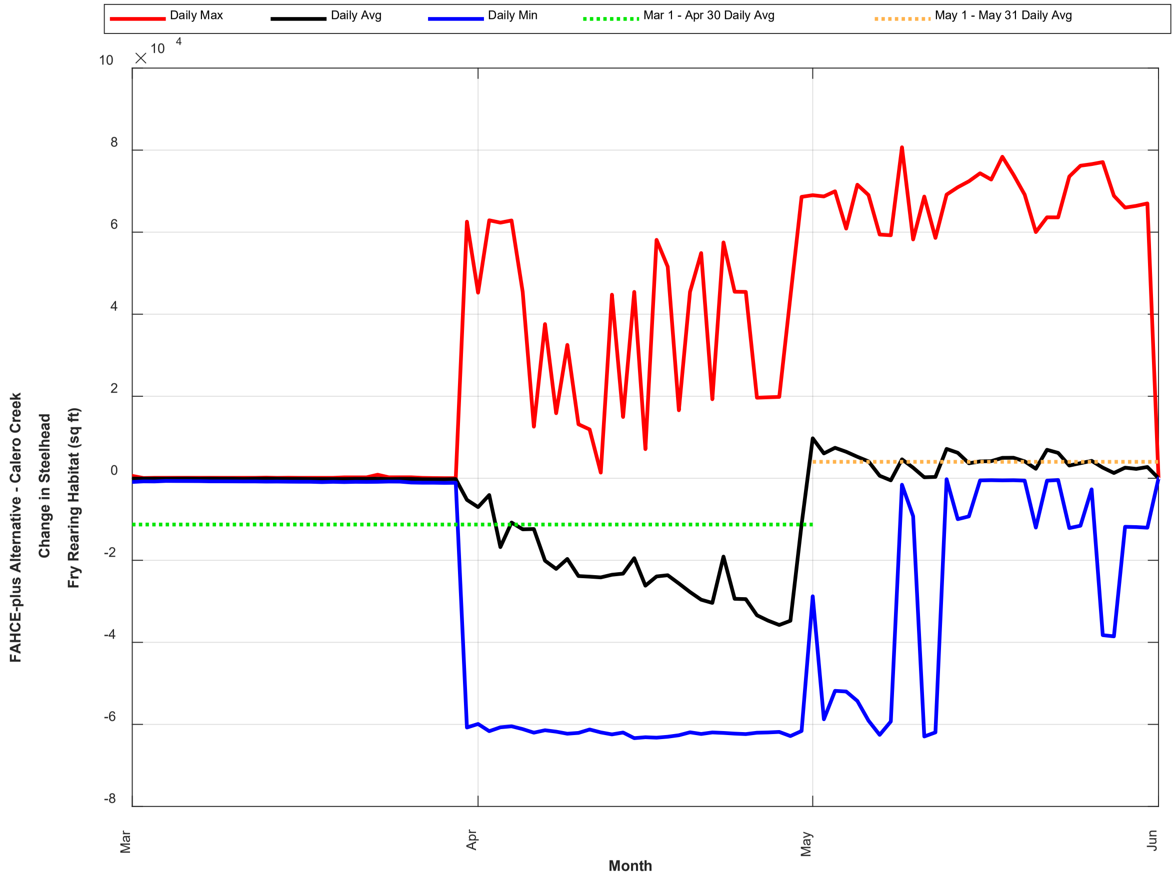
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 0.1% (80 square feet) average decrease in fry rearing habitat in Alamitos Creek for steelhead compared with the current baseline (Figure 116; Table 79).

Figure 116. Change in Steelhead Fry Rearing Habitat Compared with the Current Baseline in Alamitos Creek



There would be a 10% (6,110 square feet) average decrease in fry rearing habitat in Calero Creek compared with the current baseline with a 23% (11,320 square feet) average decrease from March to April and a 4% (4,000 square feet) average increase in May compared with the current baseline (Figure 117; Table 80). The average decrease during Winter Base Flow Operations does not completely characterize the change in fry rearing habitat during January 1 through March 31. Habitat survey data input into the model indicated there was zero winter cover in the reach associated with the CALE 2 POI (that is, CALE 1 to CALE 2) and caused fry rearing habitat to be zero in January through March under all scenarios, but subsequent habitat surveys indicated there was winter cover (Valley Water 2019, 2020). Variations in wetted area at CALE 2 in March under the FAHCE-plus Alternative compared to the current baseline (Attachment K.3 – Figures K.3.63 and K.3.64) suggest that there would be a decrease in fry rearing habitat during the time when the model output predicted zero habitat (March to April). The fry rearing habitat decrease in March would likely be a smaller relative magnitude than in April since the decrease in wetted area in March is less than in April at CALE 2.

Figure 117. Change in Steelhead Fry Rearing Habitat Compared with the Current Baseline in Calero Creek[a]



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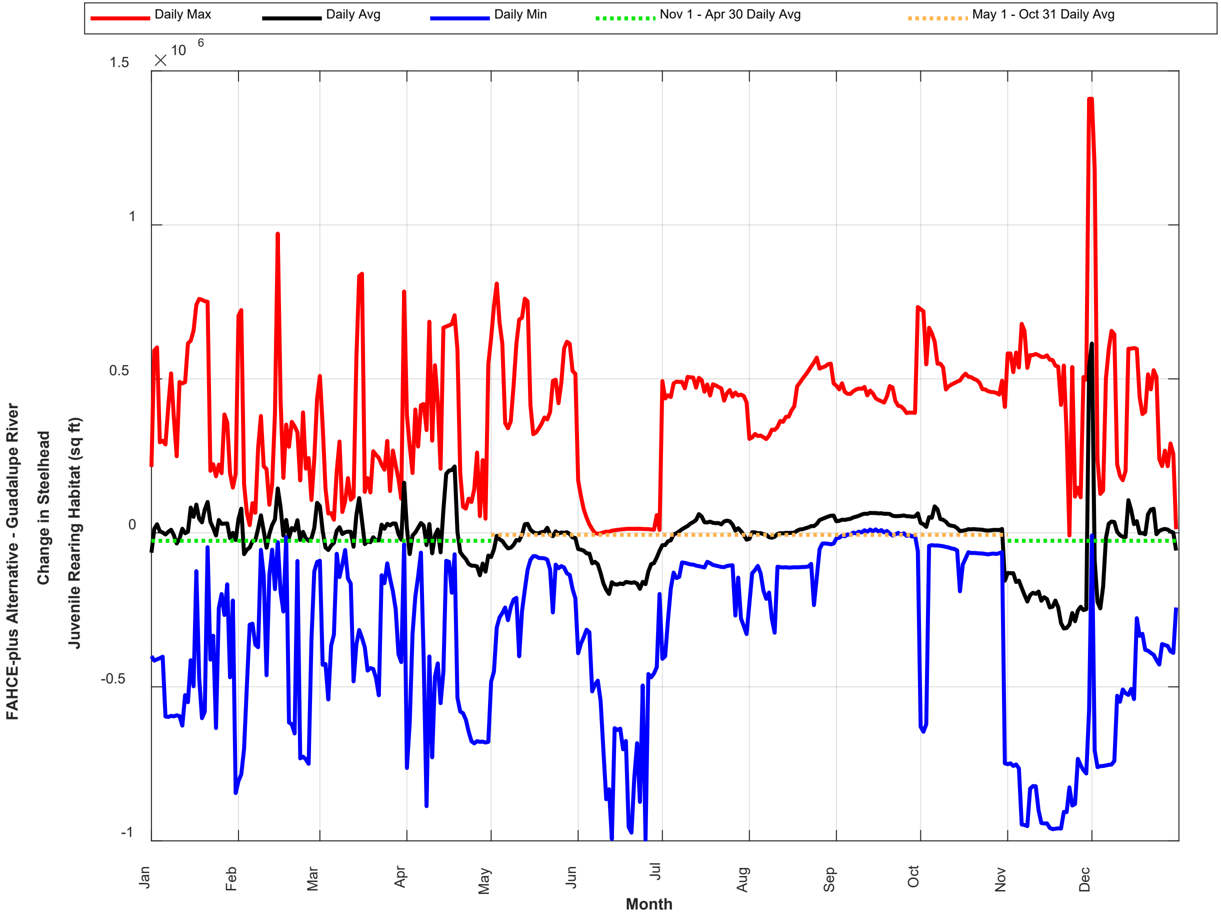
[a] Calero Creek habitat survey results in the reach between CALE 1 and CALE 2 input into the FAHCE WEAP Model did not record any winter cover, so fry and juvenile rearing habitat model results in this reach were zero during the period when winter cover is considered in the habitat estimate (that is, December 1 through March 31 for steelhead; January 1 through March 31 for Chinook salmon). Subsequent habitat surveys identified winter cover between CALE 1 and CALE 2 (Valley Water 2019, 2020).

There were changes to fry rearing habitat in the Guadalupe River portion of the study area at most locations under the FAHCE-plus Alternative. Increases were mostly observed during the winter and decreases were mostly observed during the summer, except for Calero Creek, where fry rearing habitat would decrease during Winter Baseflow Operations and increase during the Summer Release Program compared the current baseline.

Juvenile Rearing Habitat

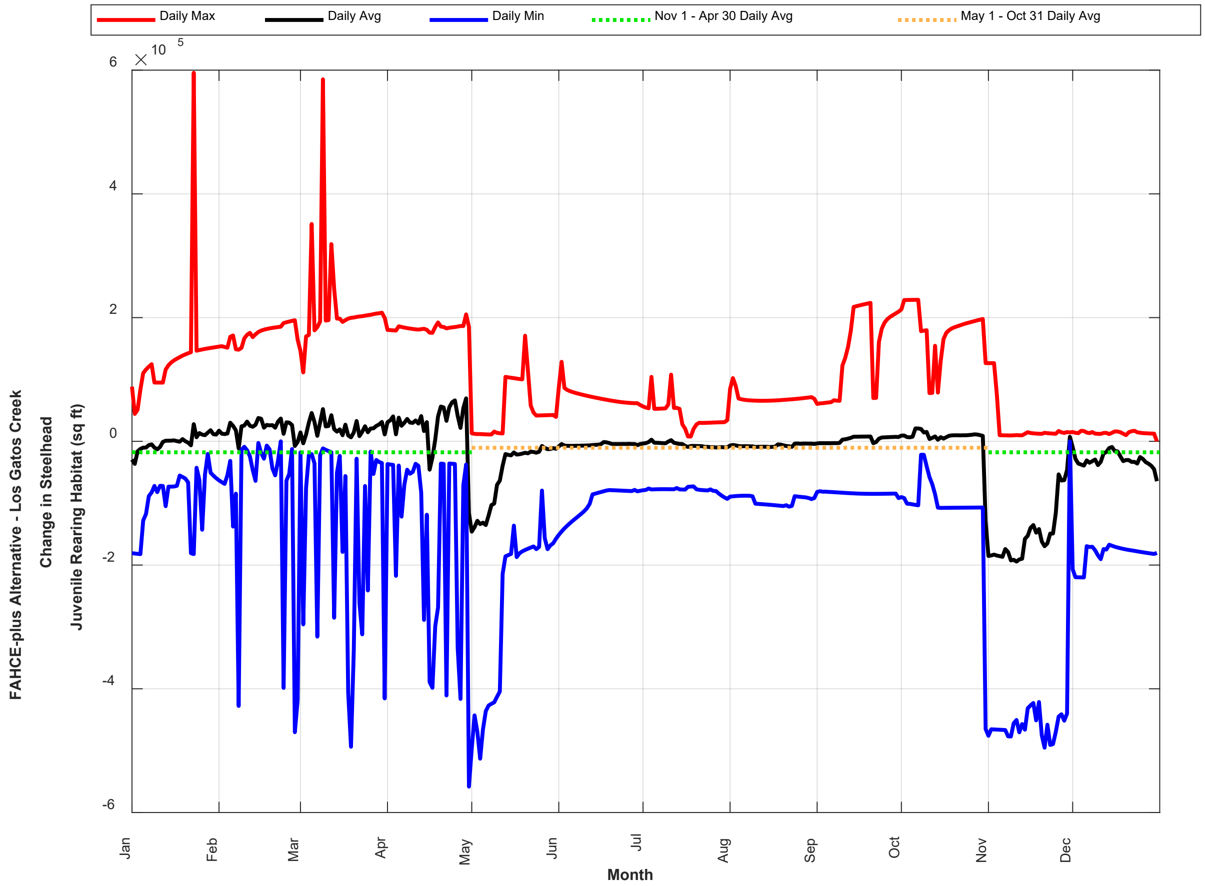
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 0.6% (7,600 square feet) average decrease in steelhead juvenile rearing habitat in the Guadalupe River portion of the study area compared with the current baseline (Figure 118; Table 76). Decreases in juvenile rearing habitat were apparent in two months, June and November (Figure 118), likely a result of reduced wetted area in both months, as well as increased water temperatures in June (Attachment K.3 – Figures K.3.15, K.3.16, and K.3.17).

Figure 118. Change in Steelhead Juvenile Rearing Habitat Compared with the Current Baseline in the Guadalupe River



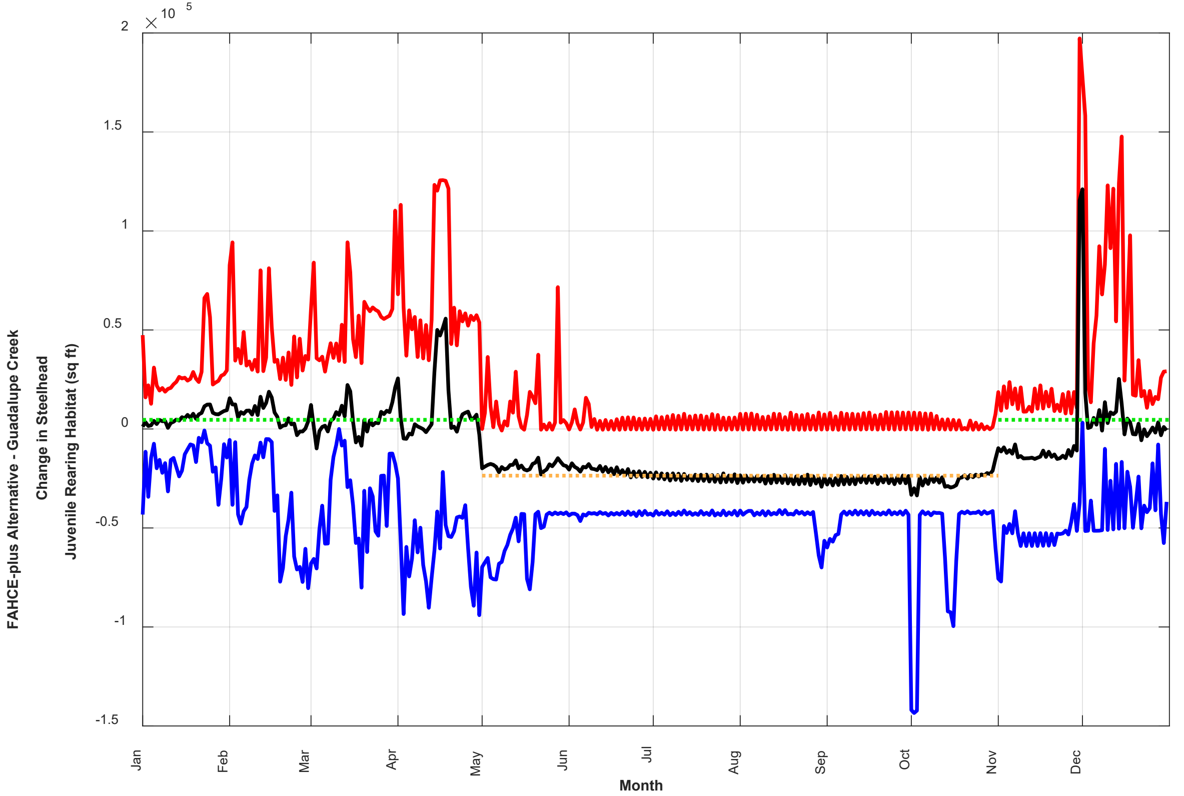
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 4% (14,000 square feet) average decrease across POIs in Los Gatos Creek compared with the current baseline (Figure 119; Table 77). Decreases in juvenile rearing habitat were apparent in May and November (Figure 119), likely a result of reduced wetted area in both months (Attachment K.3 – Figures K.3.27, K.3.28, and K.3.29). Despite decreases, Los Gatos Creek contains a large amount (331,000 square feet) of juvenile rearing habitat under the current baseline.

Figure 119. Change in Steelhead Juvenile Rearing Habitat Compared with the Current Baseline in Los Gatos Creek



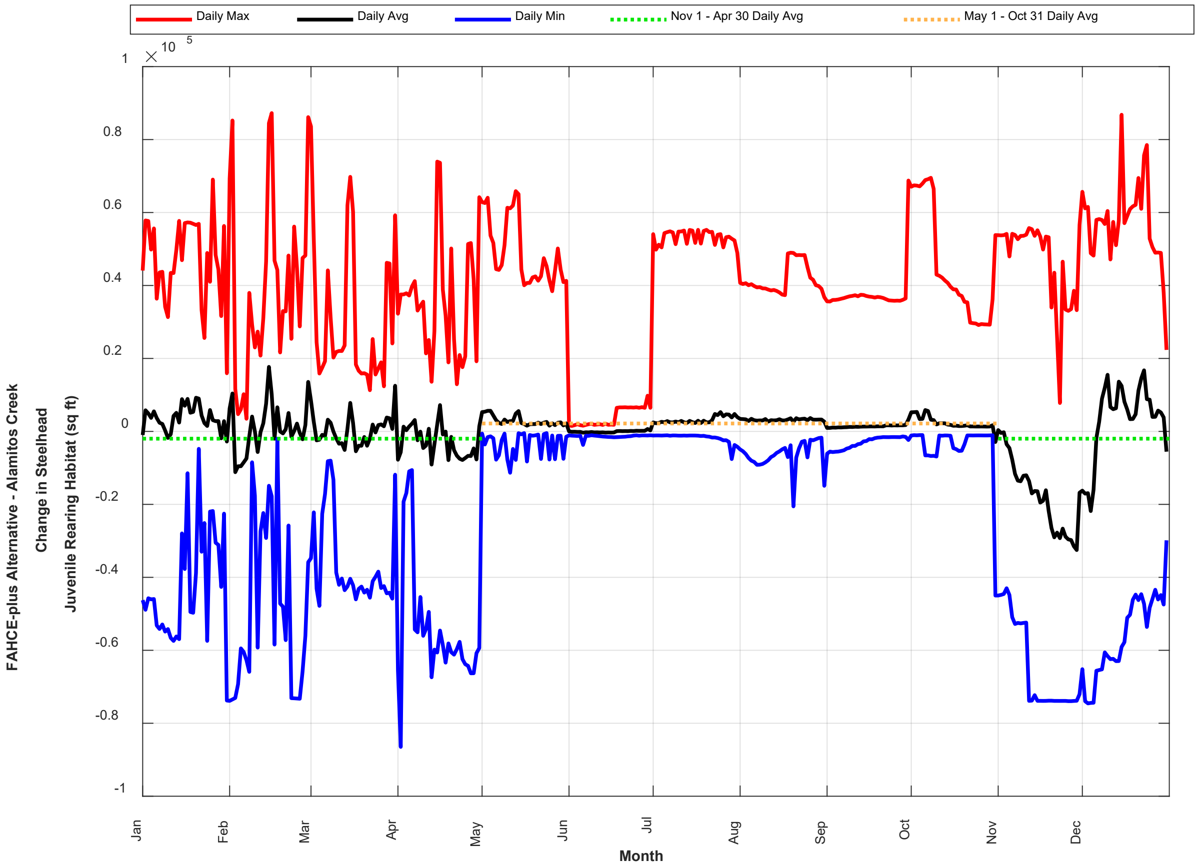
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 17% (9,480 square feet) decrease in steelhead juvenile rearing habitat within Guadalupe Creek compared with the current baseline (Figure 120; Table 78). A 7% (4,610 square feet) average increase would occur during Winter Base Flow Operations and a 53% (23,501 square feet) decrease during Summer Cold Water Program releases across POIs in Guadalupe Creek, compared with the current baseline (Figure 120; Table 78). In the Guadalupe Creek CWMZ, juvenile rearing habitat decreased by 9% (1,300 square feet), with a 13% (1,800 square feet) increase observed during the Winter Base Flow Operations followed by a decrease of 32% (4,430 square feet) during the Summer Cold Water Program. Decreases in fry rearing habitat in the Guadalupe Creek CWMZ during the Summer Cold Water Program are a result of decreased wetted area. In the CWMZ, MWAT remains below 65°F throughout the juvenile rearing period under the FAHCE-plus Alternative (Attachment K.3 – Figures K.3.25, K.3.26, and K.3.27). Downstream of the Guadalupe Creek CWMZ, decreases of juvenile rearing habitat during the Summer Cold Water Program are attributable to a combination of reduced wetted area and increased temperatures Attachment K.3 – Figures K.3.25, K.3.26, and K.3.27).

Figure 120. Change in Steelhead Juvenile Rearing Habitat Compared with the Current Baseline in Guadalupe Creek



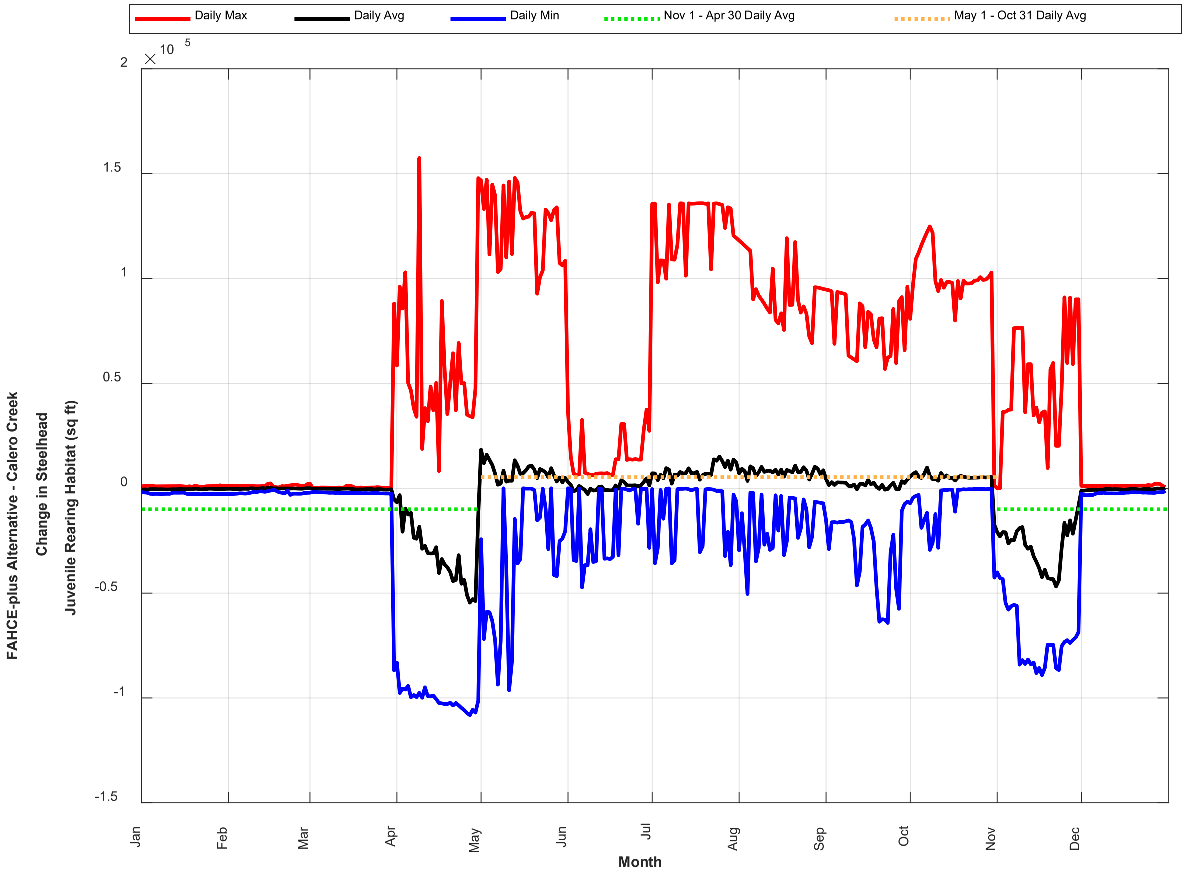
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 0.1% (90 square feet) average increase in steelhead juvenile rearing habitat within Alamitos Creek compared with the current baseline (Figure 121; Table 79). The FAHCE-plus Alternative would result in an abrupt average decrease in November compared with the current baseline, likely because of decreased wetted area (Attachment K.3 – Figures K.3.51, and K.3.52), but increases in average juvenile rearing habitat would occur during Winter Base Flow Operations (Figure 121).

Figure 121. Change in Steelhead Juvenile Rearing Habitat Compared with the Current Baseline in Alamitos Creek



There would be a 4% (2,390 square feet) average decrease in juvenile rearing habitat in Calero Creek with a 29% (10,030 square feet) average decrease during Winter Base Flow Operations attributable to decreased wetted area, and a 6% (5,250 square feet) average increase during the Summer Cold Water Program attributable to increased wetted area under the FAHCE-plus Alternative (Figure 122; Attachment K.3 – Figures K.3.63 and K.3.64; Table 80). As described for fry rearing, the average decrease during Winter Base Flow Operations does not completely characterize the change in juvenile rearing habitat during this period because habitat surveys indicated there was zero winter cover in the reach associated with the CALE 2 POI (that is, CALE 1 to CALE 2) and caused juvenile rearing habitat to be zero in this reach during December 1 to March 31 under all scenarios. Subsequent habitat surveys indicated there was winter cover (Valley Water 2019, 2020), so juvenile rearing habitat would not actually be zero in this reach during the winter. Variations in wetted area at CALE 2 under the FAHCE-plus Alternative compared to the current baseline (Attachment K.3 – Figures K.3.63 and K.3.64) suggest there would be a slight increase or decrease in the average change in juvenile rearing habitat during Winter Base Flow Operations estimated by the model results since wetted area decreases in December to mid/late-January, increases in late-January through February, and decreases in March.

Figure 122. Change in Steelhead Juvenile Rearing Habitat Compared with the Current Baseline in Calero Creek[a]



[a] Calero Creek habitat survey results in the reach between CALE 1 and CALE 2 input into the FAHCE WEAP Model did not record any winter cover, so fry and juvenile rearing habitat model results in this reach were zero during the period when winter cover is considered in the habitat estimate (that is, December 1 through March 31 for steelhead; January 1 through March 31 for Chinook salmon). Subsequent habitat surveys identified winter cover between CALE 1 and CALE 2 (Valley Water 2019, 2020).

Most locations within the Guadalupe River portion of the study area experienced decreases in juvenile rearing habitat under the FAHCE-plus Alternative and the observed decreases would be larger than those observed under the Proposed Project. Decreases in juvenile rearing habitat were typically observed during the Summer Cold Water Program and Summer Release Program and are related to reduced wetted area. However, Calero Creek shows an opposite trend with increased juvenile rearing habitat modeled during the Summer Cold Water Program and decreases during the Winter Baseflow Period.

Migration Conditions

Adult Upstream Passage

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 2% (1 day per year) average decrease to adult upstream passage across all POIs in the Guadalupe River, except for the upstream POIs (GUAD 6 and GUAD 7) where upstream passage increased by 8% (6 days per year) on average (Figure 123; Table 81). There are 73 days of upstream passage provided at the upstream sites under the current baseline (Table 81).

Figure 123. Change in Average Adult Steelhead Upstream Passage Days Compared with the Current Baseline in the Guadalupe River

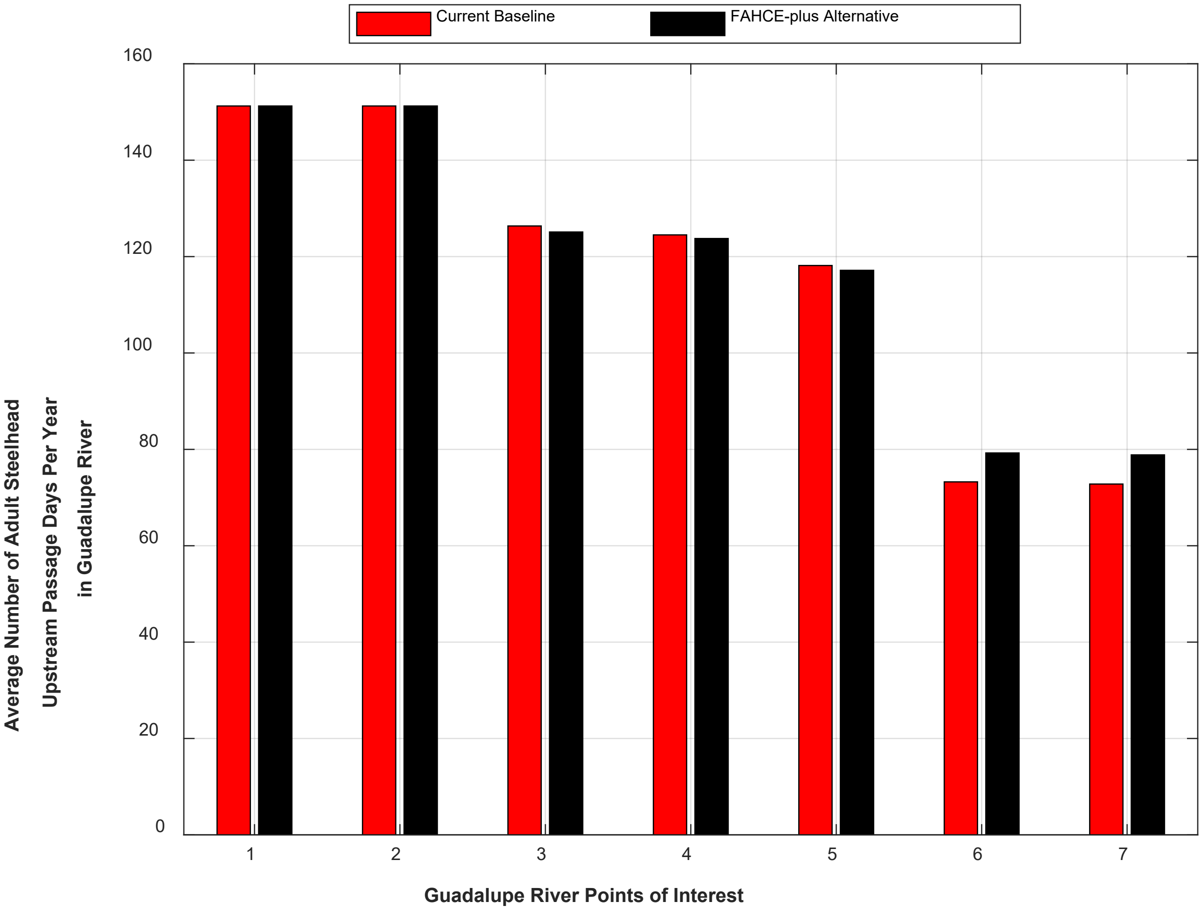


Table 81. FAHCE-plus Alternative Adult Steelhead Upstream Passage Compared with the Current Baseline in the Guadalupe River

Parameter	GUAD 1	GUAD 2	GUAD 3	GUAD 4	GUAD 5	GUAD 6	GUAD 7
Current Baseline (days)[a]							
Total Adult Upstream Passage (1991–2010)	3,025	3,025	2,527	2,490	2,363	1,465	1,456
Average Adult Upstream Passage Per Year	151	151	126	125	118	73	73
FAHCE-plus Alternative (days)[a]							
Total Adult Upstream Passage (1991–2010)	3,025	3,025	2,502	2,475	2,343	1,585	1,577
Average Adult Upstream Passage Per Year	151	151	125	124	117	79	79
Difference (days)							
Total Adult Upstream Passage (1991–2010)	0.00	0.00	-25.00	-15.00	-20.00	120.00	121.00
Average Adult Upstream Passage Per Year	0.00	0.00	-1.25	-0.75	-1.00	6.00	6.05
Difference (%)							
Total Adult Upstream Passage (1991–2010)	0.00	0.00	-0.99	-0.60	-0.85	8.19	8.31
Average Adult Upstream Passage Per Year	0.00	0.00	-0.99	-0.60	-0.85	8.19	8.31

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 5% (less than 2 days per year on average) average decrease to adult upstream passage in Los Gatos Creek compared with the current baseline (Figure 124; Table 82).

Figure 124. Change in Average Adult Steelhead Upstream Passage Days Compared with the Current Baseline in Los Gatos Creek

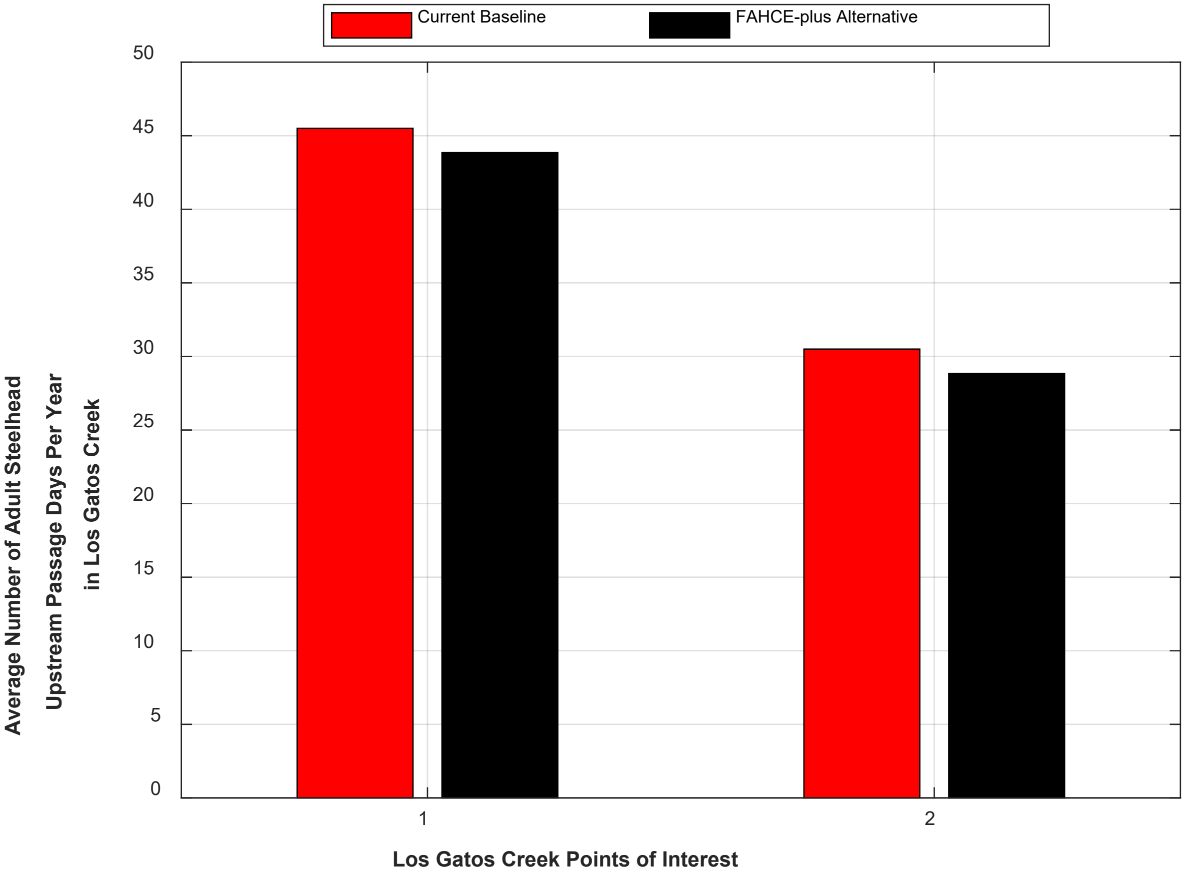


Table 82. FAHCE-plus Alternative Adult Steelhead Upstream Passage Compared with the Current Baseline in Los Gatos Creek

Parameter	LOSG 1	LOSG 2
Current Baseline (days)^a		
Total Adult Upstream Passage (1991–2010)	910	610
Average Adult Upstream Passage Per Year	46	31
FAHCE-plus Alternative (days)^a		
Total Adult Upstream Passage (1991–2010)	877	577
Average Adult Upstream Passage Per Year	44	29
Difference (days)		
Total Adult Upstream Passage (1991–2010)	-33.00	-33.00
Average Adult Upstream Passage Per Year	-1.65	-1.65

Parameter	LOSG 1	LOSG 2
Difference (%)		
Total Adult Upstream Passage (1991–2010)	-3.63	-5.41
Average Adult Upstream Passage Per Year	-3.63	-5.41

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 14% (approximately 2 days per year) average increase to adult upstream passage in Guadalupe Creek compared with the current baseline (Figure 125; Table 83). There would be a modeled 17 days per year on average under the current baseline (Table 83).

Figure 125. Change in Average Adult Steelhead Upstream Passage Days Compared with the Current Baseline in Guadalupe Creek

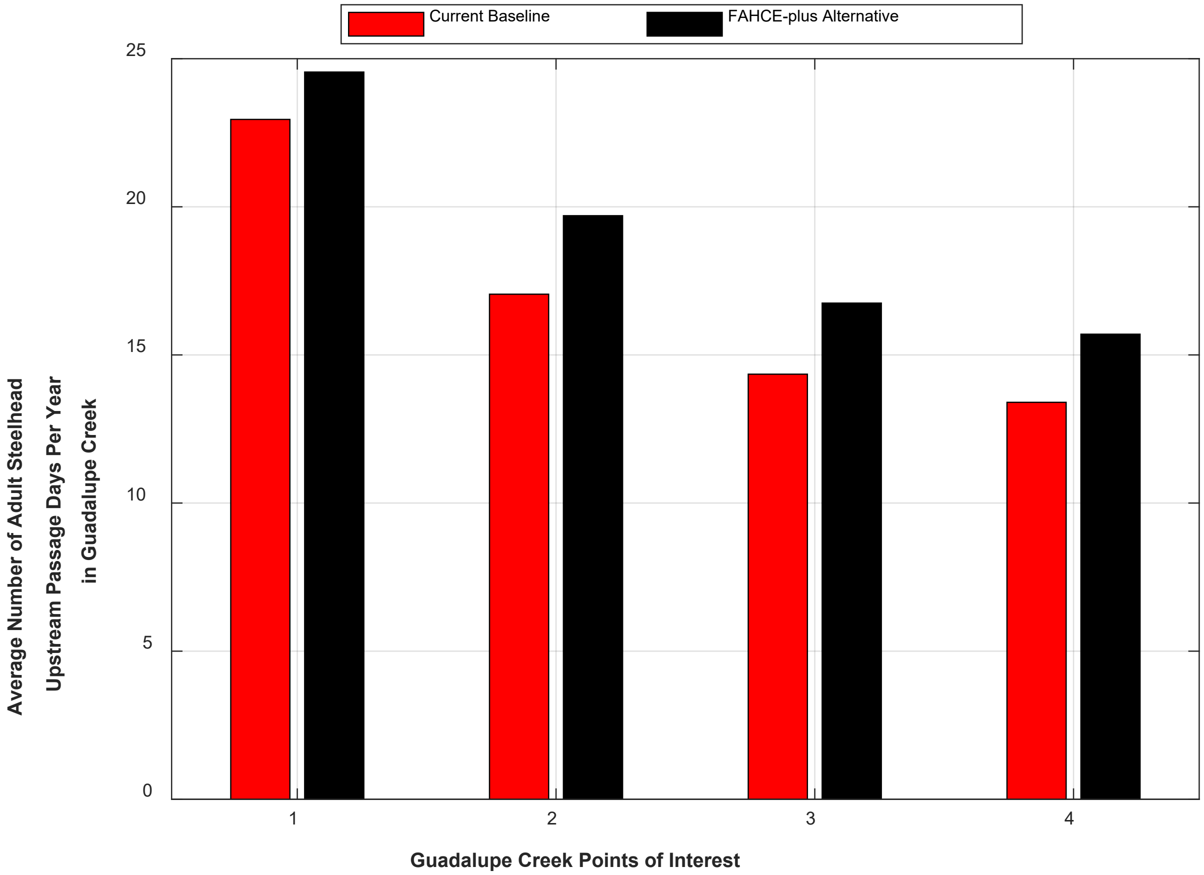


Table 83. FAHCE-plus Alternative Adult Steelhead Upstream Passage Compared with the Current Baseline in Guadalupe Creek

Parameter	GCRK 1	GCRK 2	GCRK 3	GCRK 4
Current Baseline (days)[a]				
Total Adult Upstream Passage (1991–2010)	459	341	287	268
Average Adult Upstream Passage Per Year	23	17	14	13
FAHCE-plus Alternative (days)[a]				
Total Adult Upstream Passage (1991–2010)	491	394	335	314
Average Adult Upstream Passage Per Year	25	20	17	16
Difference (days)				
Total Adult Upstream Passage (1991–2010)	32.00	53.00	48.00	46.00
Average Adult Upstream Passage Per Year	1.60	2.65	2.40	2.30
Difference (%)				
Total Adult Upstream Passage (1991–2010)	6.97	15.54	16.72	17.16
Average Adult Upstream Passage Per Year	6.97	15.54	16.72	17.16

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in an average 6% (3 days per year) increase to adult upstream passage in Alamitos Creek compared with the current baseline (Figure 126; Table 84). There would be a modeled 49 days per year on average under the current baseline.

Figure 126. Change in Average Adult Steelhead Upstream Passage Days Compared with the Current Baseline in Alamitos Creek

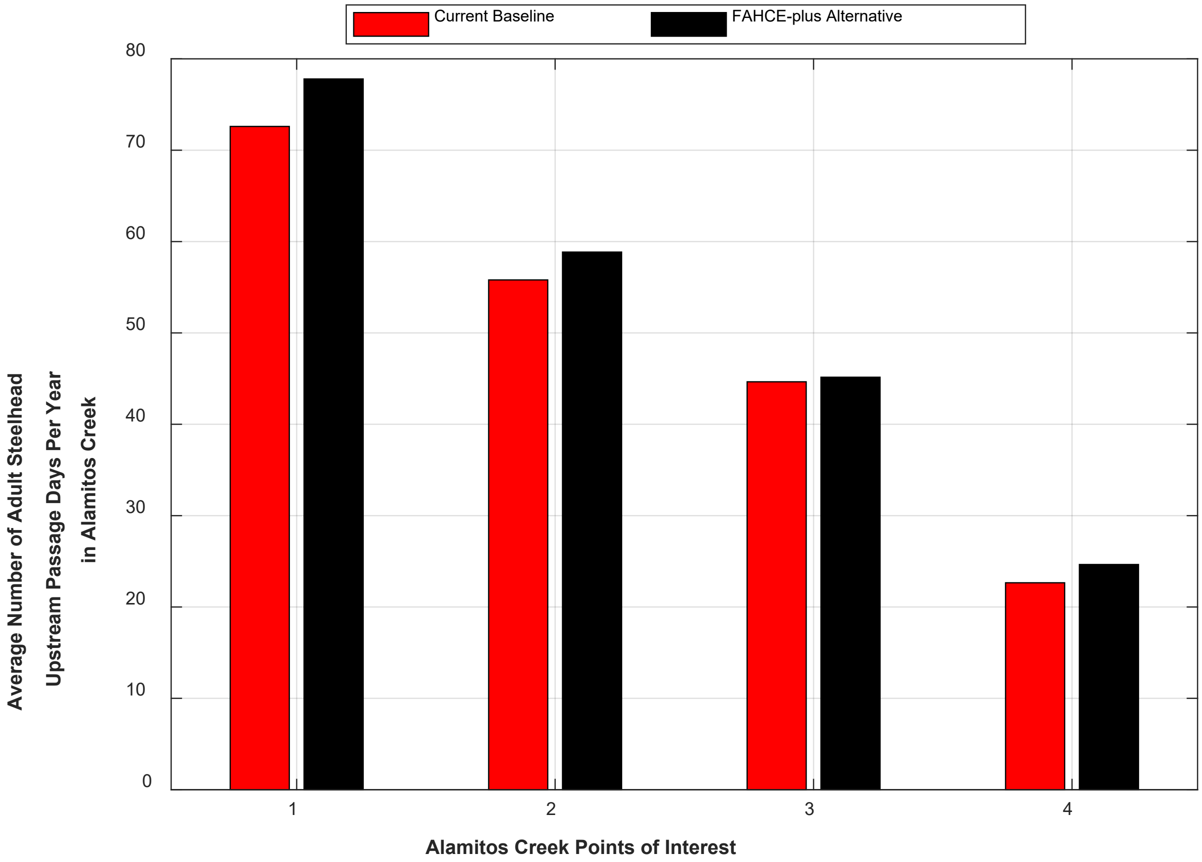


Table 84. FAHCE-plus Alternative Adult Steelhead Upstream Passage Compared with the Current Baseline in Alamitos Creek

Parameter	ALAM 1	ALAM 2	ALAM 3	ALAM 4
Current Baseline (days)[a]				
Total Adult Upstream Passage (1991–2010)	1,452	1,116	893	453
Average Adult Upstream Passage Per Year	73	56	45	23
FAHCE-plus Alternative (days)[a]				
Total Adult Upstream Passage (1991–2010)	1,556	1,177	903	493
Average Adult Upstream Passage Per Year	78	59	45	25
Difference (days)				
Total Adult Upstream Passage (1991–2010)	104.00	61.00	10.00	40.00
Average Adult Upstream Passage Per Year	5.20	3.05	0.50	2.00

Parameter	ALAM 1	ALAM 2	ALAM 3	ALAM 4
Difference (%)				
Total Adult Upstream Passage (1991–2010)	7.16	5.47	1.12	8.83
Average Adult Upstream Passage Per Year	7.16	5.47	1.12	8.83

[a] Rounded to whole days

The Proposed Project would result in a 7% (2 days per year) average increase to adult upstream passage in Calero Creek compared with the current baseline (Figure 127; Table 85).

Figure 127. Change in Average Adult Steelhead Upstream Passage Days Compared with the Current Baseline in Calero Creek

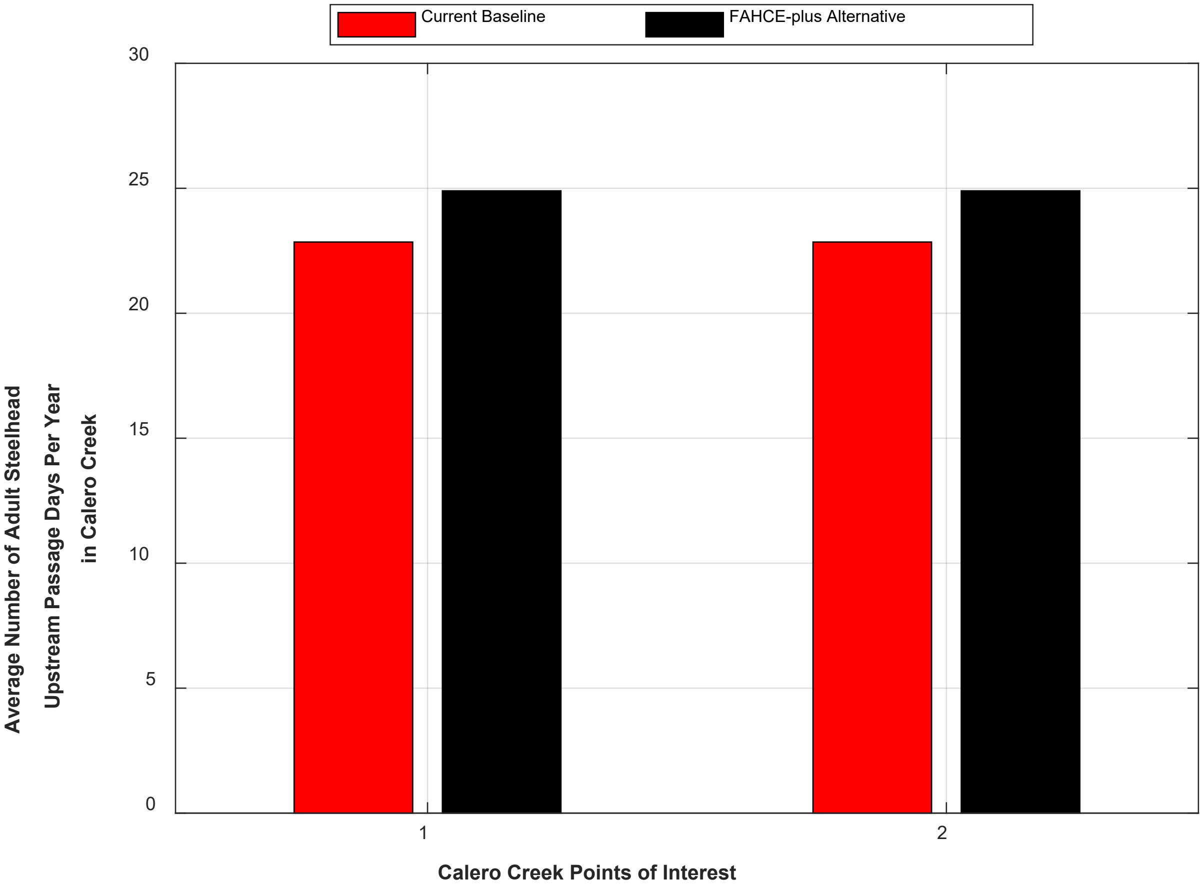


Table 85. FAHCE-plus Alternative Adult Steelhead Upstream Passage Compared with the Current Baseline in Calero Creek

Parameter	CALE 1	CALE 2
Current Baseline (days)[a]		
Total Adult Upstream Passage (1991–2010)	457	457
Average Adult Upstream Passage Per Year	23	23
FAHCE-plus Alternative (days)[a]		
Total Adult Upstream Passage (1991–2010)	490	490
Average Adult Upstream Passage Per Year	25	25
Difference (days)		
Total Adult Upstream Passage (1991–2010)	33.00	33.00
Average Adult Upstream Passage Per Year	1.65	1.65
Difference (%)		
Total Adult Upstream Passage (1991–2010)	7.22	7.22
Average Adult Upstream Passage Per Year	7.22	7.22

[a] Rounded to whole days

Juvenile Downstream Passage

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 3% (1 day per year on average) decrease to juvenile downstream passage in the Guadalupe River compared with the current baseline (Figure 128; Table 86). Evaluating the juvenile downstream passage excluding the water temperature criteria, the FAHCE-plus Alternative would result in a5% (3 days per year) average increase to juvenile downstream passage in the Guadalupe River compared with the current baseline (Table 86). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in the Guadalupe River under the FAHCE-plus Alternative compared to the current baseline. Additionally, there was no change in number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in the Guadalupe River under the FAHCE-plus Alternative compared to the current baseline.

Figure 128. Change in Average Juvenile Steelhead Downstream Passage Days Compared with the Current Baseline in the Guadalupe River

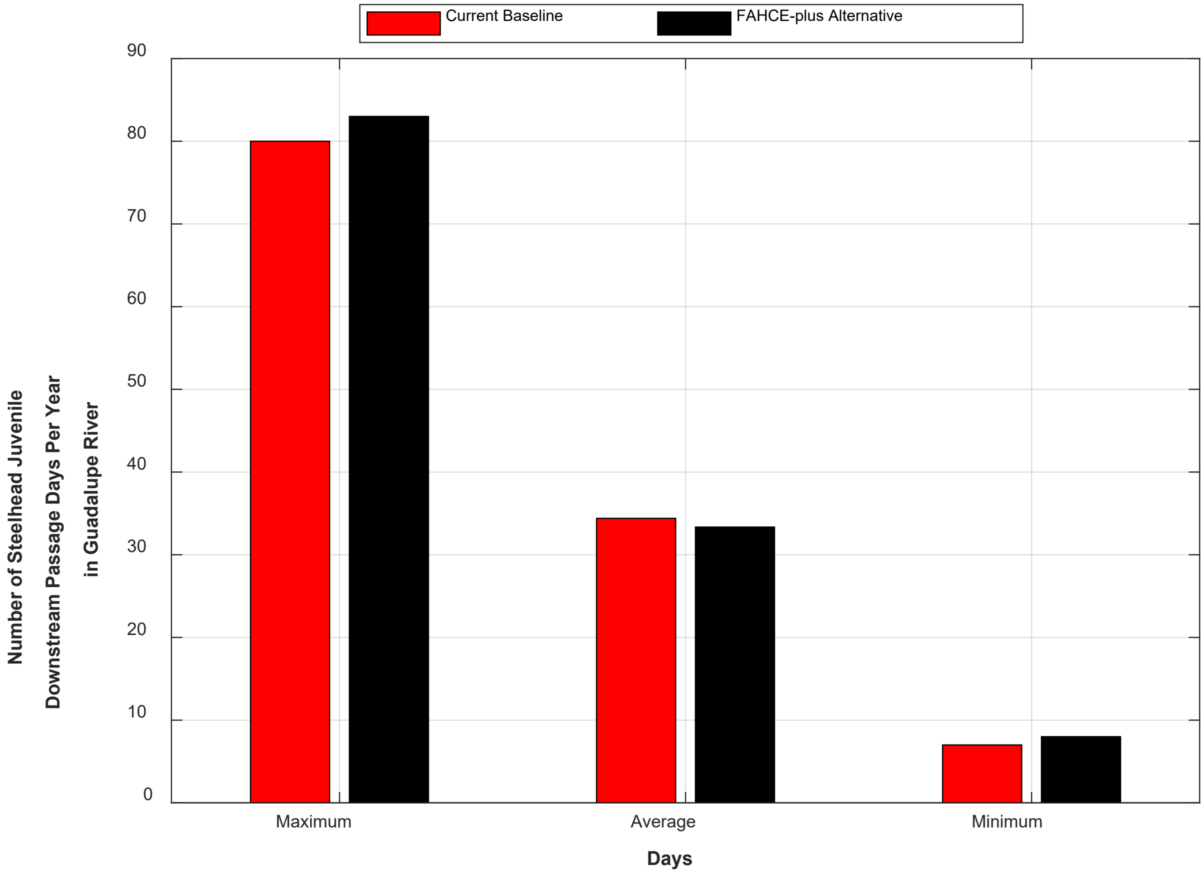


Table 86. FAHCE-plus Alternative Juvenile Steelhead Downstream Passage Compared with the Current Baseline in the Guadalupe River

Parameter	GUAD 7 with Water Temperature Criteria[b]	GUAD 7 without Water Temperature Criteria[c]
Current Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	688	1,322
Average Juvenile Downstream Passage Per Year	34	66
FAHCE-plus Alternative (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	667	1,376
Average Juvenile Downstream Passage Per Year	33	69
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	-21.00	54.00
Average Juvenile Downstream Passage Per Year	-1.00	3.00

Parameter	GUAD 7 with Water Temperature Criteria[b]	GUAD 7 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	-3.05	4.08
Average Juvenile Downstream Passage Per Year	-2.94	4.55

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 3% (1 day per year on average) increase to juvenile downstream passage in Los Gatos Creek compared with the current baseline (Figure 129; Table 87). However, during dry years (when the minimum passage is observed), FAHCE-plus Alternative would nearly double the number of downstream passage days per year (Figure 129). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in a 31% (24 days per year) average increase to juvenile downstream passage in Los Gatos Creek compared with the current baseline (Table 87). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in Los Gatos Creek under the FAHCE-plus Alternative compared to the current baseline. Additionally, there was no change in number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in Los Gatos Creek under the FAHCE-plus Alternative compared to the current baseline.

Figure 129. Change in Average Juvenile Steelhead Downstream Passage Days Compared with the Current Baseline in Los Gatos Creek

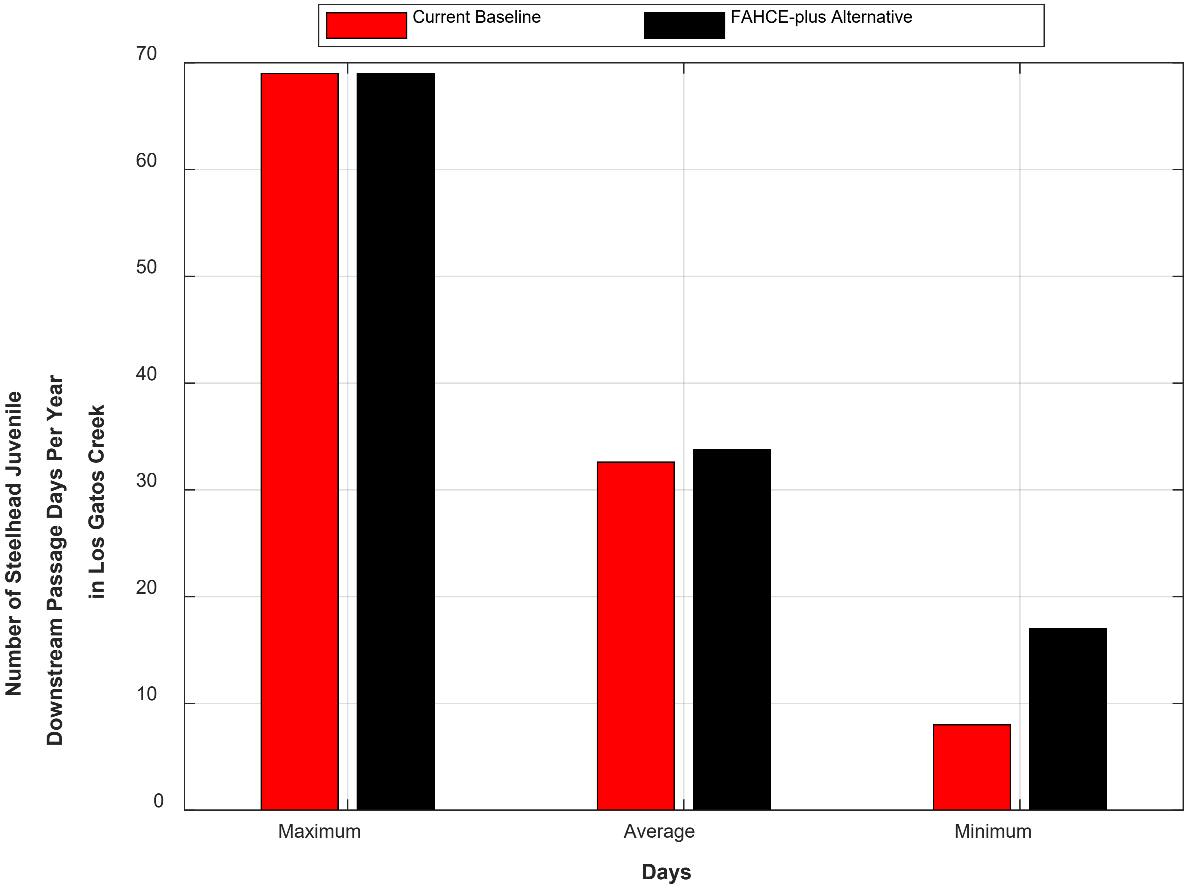


Table 87. FAHCE-plus Alternative Juvenile Steelhead Downstream Passage Compared with the Current Baseline in Los Gatos Creek

Parameter	LOSG 2 with Water Temperature Criteria[b]	LOSG 2 without Water Temperature Criteria[c]
Current Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	652	1,613
Average Juvenile Downstream Passage Per Year	33	81
FAHCE-plus Alternative (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	675	2,109
Average Juvenile Downstream Passage Per Year	34	105
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	23.00	496.00
Average Juvenile Downstream Passage Per Year	1.00	24.00

Parameter	LOSG 2 with Water Temperature Criteria[b]	LOSG 2 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	3.53	30.75
Average Juvenile Downstream Passage Per Year	3.03	29.63

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 7% (1 day per year) average increase of juvenile downstream passage in Guadalupe Creek compared with the current baseline (Figure 130; Table 88). There are 15 days per year of downstream passage provided under the current baseline (Table 88). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in a 13% (3 days per year) average increase to juvenile downstream passage in Guadalupe Creek compared with the current baseline (Table 88). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in Guadalupe Creek increased by one under the FAHCE-plus Alternative compared to the current baseline. There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in Guadalupe Creek under the FAHCE-plus Alternative compared to the current baseline.

Figure 130. Change in Average Juvenile Steelhead Downstream Passage Days Compared with the Current Baseline in Guadalupe Creek

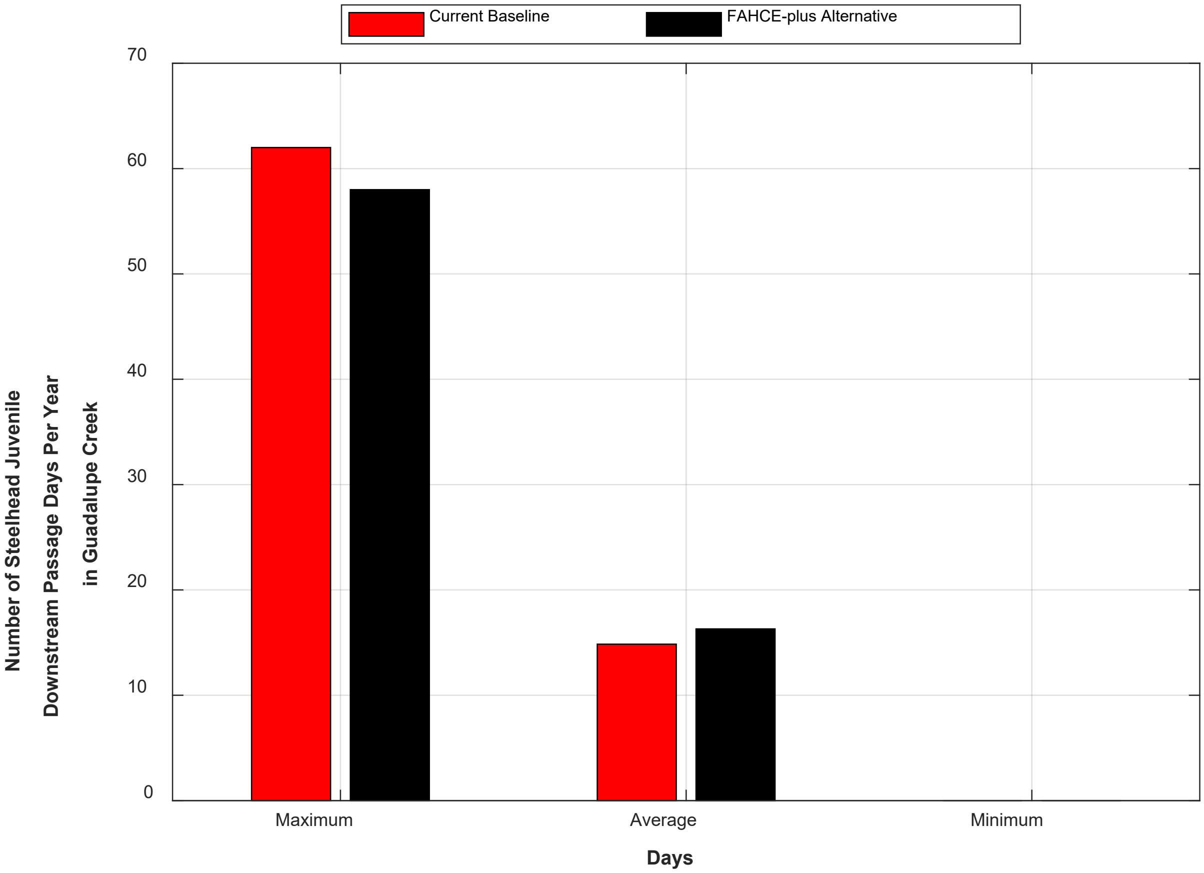


Table 88. FAHCE-plus Alternative Juvenile Steelhead Downstream Passage Compared with the Current Baseline in Guadalupe Creek

Parameter	GCRK 4 with Water Temperature Criteria[b]	GCRK 4 without Water Temperature Criteria[c]
***Current Baseline (days)*[a]**		
Total Juvenile Downstream Passage (1991–2010)	297	472
Average Juvenile Downstream Passage Per Year	15	24
***FAHCE-plus Alternative (days)*[a]**		
Total Juvenile Downstream Passage (1991–2010)	326	540
Average Juvenile Downstream Passage Per Year	16	27
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	29.00	68.00
Average Juvenile Downstream Passage Per Year	1.00	3.00

Parameter	GCRK 4 with Water Temperature Criteria[b]	GCRK 4 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	9.76	14.41
Average Juvenile Downstream Passage Per Year	6.67	12.50

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 10% (less than 2 days per year on average) average decrease to juvenile downstream passage in Alamitos Creek compared with the current baseline (Figure 131; Table 89). A decrease of less than 2 days per year on average under the FAHCE-plus Alternative would result in negligible changes to juvenile downstream passage opportunities compared with the current baseline conditions in Alamitos Creek. Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in a 2% (1 day per year) average increase to juvenile downstream passage in Alamitos Creek compared with the current baseline (Table 89). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in Alamitos Creek under the FAHCE-plus Alternative compared to the current baseline. Additionally, there was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in Alamitos Creek under the FAHCE-plus Alternative compared to the current baseline.

Figure 131. Change in Average Juvenile Steelhead Downstream Passage Days Compared with the Current Baseline in Alamitos Creek

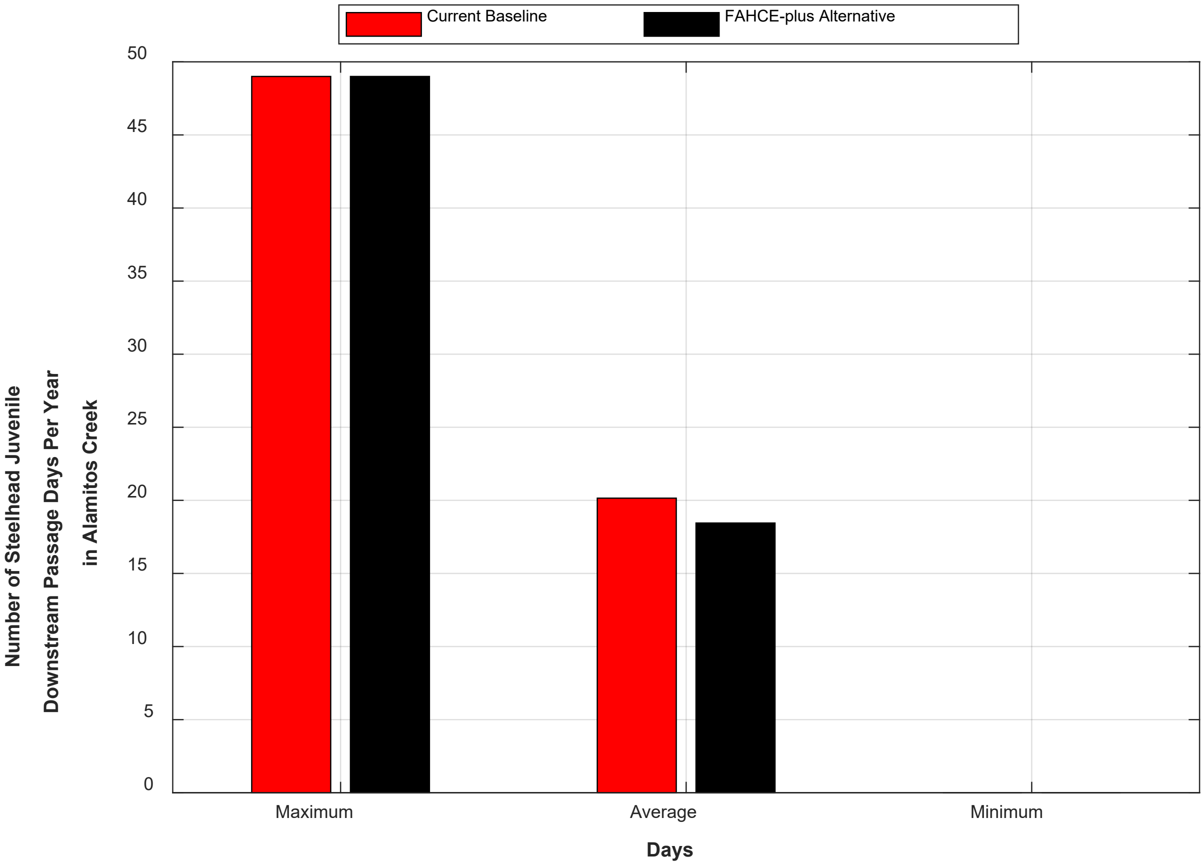


Table 89. FAHCE-plus Alternative Juvenile Steelhead Downstream Passage Compared with the Current Baseline in Alamitos Creek

Parameter	ALAM 4 with Water Temperature Criteria[b]	ALAM 4 without Water Temperature Criteria[c]
Current Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	403	856
Average Juvenile Downstream Passage Per Year	20	43
FAHCE-plus Alternative (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	369	879
Average Juvenile Downstream Passage Per Year	18	44
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	-34.00	23.00
Average Juvenile Downstream Passage Per Year	-2.00	1.00

Parameter	ALAM 4 with Water Temperature Criteria[b]	ALAM 4 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	-8.44	2.69
Average Juvenile Downstream Passage Per Year	-10.00	2.33

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

The Proposed Project would result in a 5% (1 day per year) average decrease to juvenile downstream passage in in Calero Creek compared with the current baseline (Figure 132; Table 90). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in no change to juvenile downstream passage in Calero Creek compared with the current baseline (Table 90). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in Calero Creek decreased by two under the FAHCE-plus Alternative compared to the current baseline. There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in Calero Creek under the FAHCE-plus Alternative compared to the current baseline.

Figure 132. Change in Average Juvenile Steelhead Downstream Passage Days Compared with the Current Baseline in Calero Creek

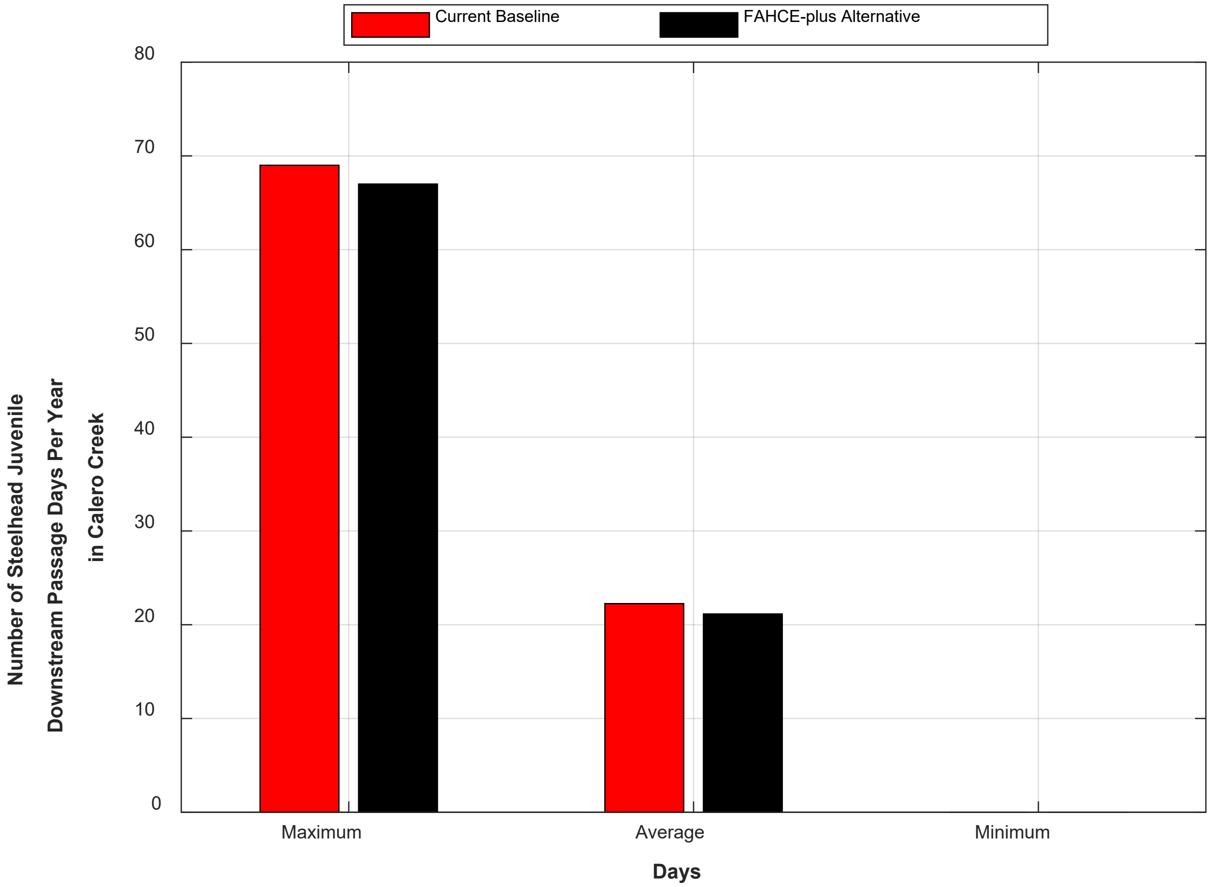


Table 90. FAHCE-plus Alternative Juvenile Steelhead Downstream Passage Compared with the Current Baseline in Calero Creek

Parameter	CALE 2 with Water Temperature Criteria[b]	CALE 2 without Water Temperature Criteria[c]
Current Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	445	693
Average Juvenile Downstream Passage Per Year	22	35
FAHCE-plus Alternative (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	423	697
Average Juvenile Downstream Passage Per Year	21	35
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	-22.00	4.00
Average Juvenile Downstream Passage Per Year	-1.00	0.00

Parameter	CALE 2 with Water Temperature Criteria[b]	CALE 2 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	-4.94	0.58
Average Juvenile Downstream Passage Per Year	-4.55	0.00

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Flow Measures Future Baseline Assessment

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 56% (3,681 square feet) average increase in daily effective spawning habitat during the spawning and incubation life-stage time period (that is, December 1 to April 30) in the Guadalupe River compared with the future baseline (Table 91). The increases would be observed in the early spawning period (December) with minimal differences observed during the remainder of the spawning period (January through May) when most upstream migration occurs (Moyle et al. 2008) (Figure 133).

Figure 133. Change in Effective Steelhead Spawning Habitat Compared with the Future Baseline in the Guadalupe River

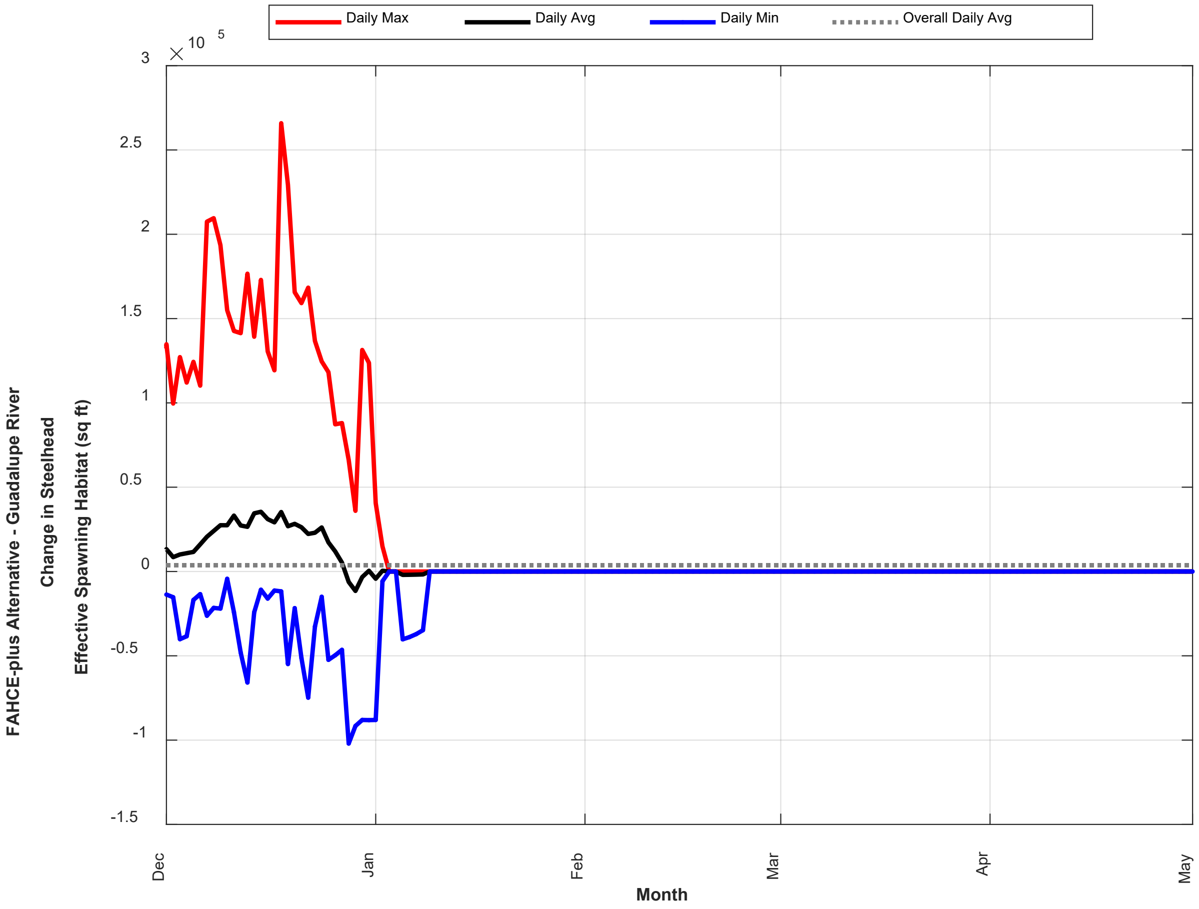


Table 91. FAHCE-plus Alternative Steelhead Habitat Compared with the Future Baseline in the Guadalupe River

Guadalupe River[a,b]	GUAD 3 River Mile 10.07	GUAD 4 River Mile 12.52	GUAD 5 River Mile 13.42	GUAD 6 River Mile 18.45	GUAD 7 River Mile 19.93	Total
Steelhead Habitat Future Baseline (sq ft)						
Effective Spawning	2,840	282	380	1,500	1,550	6,552
Fry Rearing Total (March 1–May 31)	146,000	170,000	67,500	415,000	416,000	1,214,500
Fry Rearing Winter Base Flow Operations (March 1–April 30)	153,000	169,000	71,700	430,000	418,000	1,241,700
Fry Rearing Summer Release Program (May 1–May 31)	131,000	171,000	59,400	383,000	413,000	1,157,400
Juvenile Rearing Total (year-round)	241,000	262,000	76,700	313,000	342,000	1,234,700

Guadalupe River[a,b]	GUAD 3 River Mile 10.07	GUAD 4 River Mile 12.52	GUAD 5 River Mile 13.42	GUAD 6 River Mile 18.45	GUAD 7 River Mile 19.93	Total
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	288,000	297,000	105,000	475,000	398,000	1,563,000
Juvenile Rearing Summer Release Program (May 1–Oct 31)	194,000	228,000	48,800	154,000	288,000	912,800
Steelhead Habitat FAHCE-plus Alternative (sq ft)						
Effective Spawning	4,070	625	598	2,540	2,400	1,0233
Fry Rearing Total (March 1–May 31)	148,000	168,000	69,500	437,000	417,000	1,239,500
Fry Rearing Winter Base Flow Operations (March 1–April 30)	157,000	166,000	74,100	461,000	414,000	1,272,100
Fry Rearing Summer Release Program (May 1–May 31)	131,000	172,000	60,500	388,000	423,000	1,174,500
Juvenile Rearing Total (year-round)	243,000	262,000	78,200	337,000	341,000	1,261,200
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	294,000	299,000	109,000	527,000	411,000	164,0000
Juvenile Rearing Summer Release Program (May 1–Oct 31)	193,000	225,000	47,500	150,000	27,3000	888,500
Change in Habitat (sq ft)						
Effective Spawning	1,230 (43.31%)	343 (121.63%)	218 (57.37%)	1,040 (69.33%)	850 (54.84%)	3,681 (56.18%)
Fry Rearing Total (March 1–May 31)	2,000 (1.37%)	-2,000 (-1.18%)	2,000 (2.96%)	22,000 (5.3%)	1,000 (0.24%)	25,000 (2.06%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	4,000 (2.61%)	-3,000 (-1.78%)	2,400 (3.35%)	31,000 (7.21%)	-4,000 (-0.96%)	30,400 (2.45%)
Fry Rearing Summer Release Program (May 1–May 31)	0 (0%)	1,000 (0.58%)	1,100 (1.85%)	5,000 (1.31%)	10,000 (2.42%)	17,100 (1.48%)
Juvenile Rearing Total (year-round)	2,000 (0.83%)	0 (0%)	1,500 (1.96%)	24,000 (7.67%)	-1,000 (-0.29%)	26,500 (2.15%)
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	6,000 (2.08%)	2,000 (0.67%)	4,000 (3.81%)	52,000 (10.95%)	13,000 (3.27%)	77,000 (4.93%)
Juvenile Rearing Summer Release Program (May 1–Oct 31)	-1,000 (-0.52%)	-3,000 (-1.32%)	-1,300 (-2.66%)	-4,000 (-2.6%)	-15,000 (-5.21%)	-24,300 (-2.66%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

[b] No average daily habitat availability model results are available for the points of interest not shown.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 16% (195 square feet) average decrease in daily effective spawning habitat during the spawning and incubation life-stage time period (that is, December 1 to April 30) across POIs in Los Gatos Creek compared with the future baseline (Table 92). Decreases were observed in the early spawning period (late-December through early-January) with minimal differences observed during the remainder of the spawning period (early-January through May) when most upstream migration occurs (Moyle et al. 2008) (Figure 134).

Figure 134. Change in Effective Steelhead Spawning Habitat Compared with the Future Baseline in Los Gatos Creek

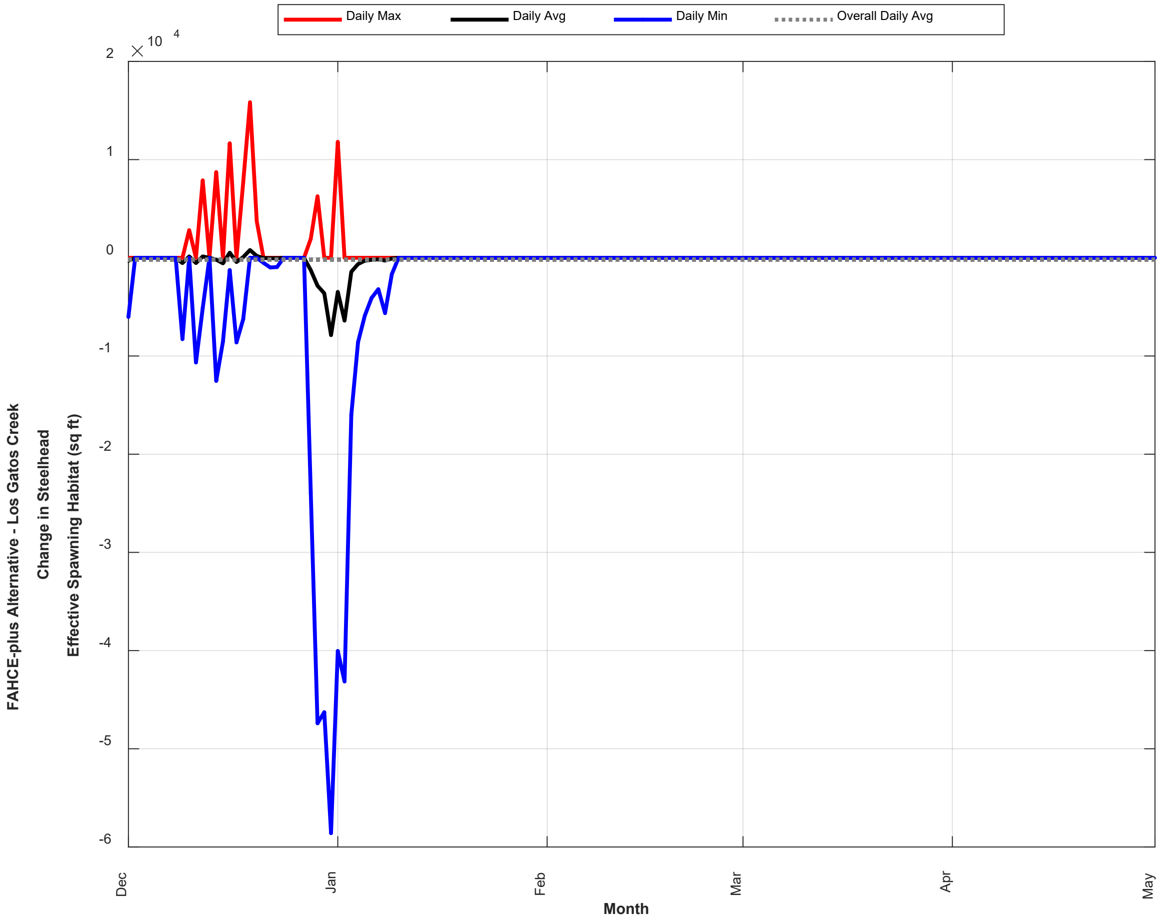


Table 92. FAHCE-plus Alternative Steelhead Habitat Compared with the Future Baseline in Los Gatos Creek

Los Gatos Creek[a]	LOSG 1 River Mile 14.70	LOSG 2 River Mile 18.91	Total
Steelhead Habitat Future Baseline (sq ft)			
Effective Spawning	594	593	1,187
Fry Rearing Total (March 1–May 31)	139,000	248,000	387,000
Fry Rearing Winter Base Flow Operations (March 1–April 30)	137,000	241,000	378,000
Fry Rearing Summer Release Program (May 1–May 31)	144,000	260,000	404,000
Juvenile Rearing Total (year-round)	123,000	225,000	348,000
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	130,000	216,000	346,000
Juvenile Rearing Summer Release Program (May 1–Oct 31)	116,000	234,000	350,000
Steelhead Habitat FAHCE-plus Alternative (sq ft)			
Effective Spawning	495	497	992
Fry Rearing Total (March 1–May 31)	139,000	250,000	389,000
Fry Rearing Winter Base Flow Operations (March 1–April 30)	140,000	250,000	390,000
Fry Rearing Summer Release Program (May 1–May 31)	138,000	250,000	388,000
Juvenile Rearing Total (year-round)	118,000	214,000	332,000
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	122,000	199,000	321,000
Juvenile Rearing Summer Release Program (May 1–Oct 31)	113,000	230,000	343,000
Change in Habitat (sq ft)			
Effective Spawning	-99 (-16.67%)	-96 (-16.19%)	-195 (-16.43%)
Fry Rearing Total (March 1–May 31)	0 (0%)	2,000 (0.81%)	2,000 (0.52%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	3,000 (2.19%)	9,000 (3.73%)	12,000 (3.17%)
Fry Rearing Summer Release Program (May 1–May 31)	-6,000 (-4.17%)	-10,000 (-3.85%)	-16,000 (-3.96%)
Juvenile Rearing Total (year-round)	-5,000 (-4.07%)	-11,000 (-4.89%)	-16,000 (-4.6%)
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	-8,000 (-6.15%)	-17,000 (-7.87%)	-25,000 (-7.23%)
Juvenile Rearing Summer Release Program (May 1–Oct 31)	-3,000 (-2.59%)	-4,000 (-1.71%)	-7,000 (-2%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 50% (279 square feet) average increase in daily effective spawning habitat for steelhead during the spawning and incubation life-stage time period (that is, December 1 to April 30) across POIs in Guadalupe Creek compared with the future baseline (Figure 135; Table 93). In the Guadalupe Creek CWMZ, there would be a 39% (108 square foot) average increase in steelhead effective spawning habitat across the entire spawning/incubation life-stage. Increases were likely a result of increased wetted area under the FAHCE-plus Alternative (Attachment K.3 – Figures K.3.45, and K.3.46). Although the modeled average increase in daily effective spawning habitat across the entire spawning/incubation life-stage is relatively small, the modeled increases in the daily effective spawning habitat are 100 square feet or more for multiple weeks between December and mid-March under the FAHCE-plus Alternative. In the Guadalupe Creek CWMZ, there is a 300 square foot or more increase in the average daily effective spawning habitat between February 1 and February 15 under the FAHCE-plus Alternative compared to the future baseline. Furthermore, the modeled average daily effective spawning habitat in the Guadalupe Creek CWMZ increases above 1,000 square feet several times between January and mid-March under the FAHCE-plus Alternative when the modeled average daily effective spawning habitat in this reach did not exceed 1,000 square feet from December to May under the future baseline. These increases in the daily effective spawning habitat under the FAHCE-plus Alternative would accommodate additional spawners and reduce competition among spawners.

Figure 135. Change in Effective Steelhead Spawning Habitat Compared with the Future Baseline in Guadalupe Creek

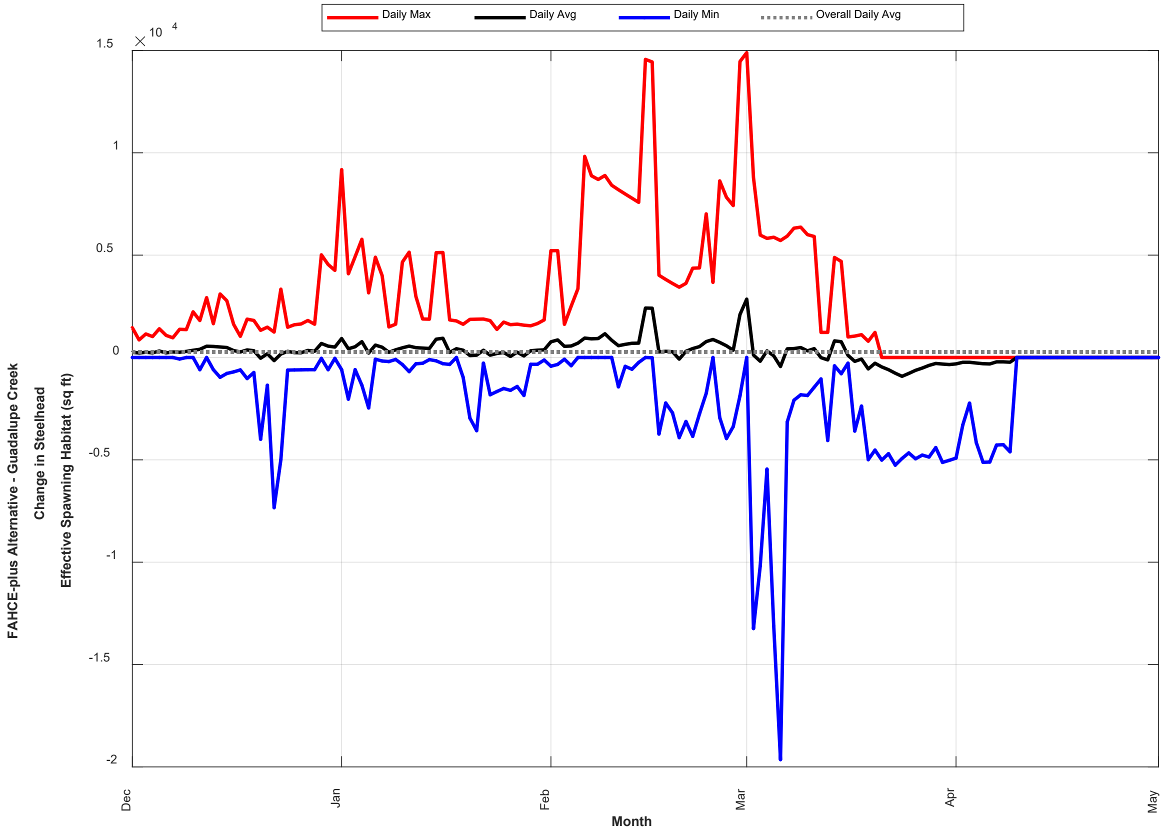


Table 93. FAHCE-plus Alternative Steelhead Habitat Compared with the Future Baseline in Guadalupe Creek

Guadalupe Creek[a]	GCRK 1 River Mile 20.71	GCRK 2 River Mile 21.91	GCRK 3 River Mile 22.54	GCRK 4 River Mile 26.17	Total
Steelhead Habitat Future Baseline (sq ft)					
Effective Spawning	36	202	35	280	553
Fry Rearing Total (March 1–May 31)	19,600	44,100	3,600	24,500	91,800
Fry Rearing Winter Base Flow Operations (March 1–April 30)	21,100	43,200	3,410	24,600	92,310
Fry Rearing Summer Cold Water Program (May 1–May 31)	16,500	45,800	3,970	24,400	90,670
Juvenile Rearing Total (year-round)	8,950	33,800	2,790	18,200	63,740
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	15,000	36,800	2,960	13,100	67,860
Juvenile Rearing Summer Cold Water Program (May 1–Oct 31)	2,960	31,000	2,610	23,100	59,670
Steelhead Habitat FAHCE-plus Alternative (sq ft)					
Effective Spawning	30	359	55	388	832
Fry Rearing Total (March 1–May 31)	18,600	45,700	3,460	26,800	94,560
Fry Rearing Winter Base Flow Operations (March 1–April 30)	23,800	50,700	3,460	26,600	104,560
Fry Rearing Summer Cold Water Program (May 1–May 31)	8,420	35,800	3,460	27,400	75,080
Juvenile Rearing Total (year-round)	9,060	30,200	2,610	15,100	56,970
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	17,500	43,000	3,540	18,000	82,040
Juvenile Rearing Summer Cold Water Program (May 1–Oct 31)	699	17,600	17,00	12,200	32,199
Change in Habitat (sq ft)					
Effective Spawning	-6 (-16.67%)	157 (77.72%)	20 (57.64%)	108 (38.57%)	279 (50.45%)
Fry Rearing Total (March 1–May 31)	-1,000 (-5.1%)	1,600 (3.63%)	-140 (-3.89%)	2,300 (9.39%)	2,760 (3.01%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	2,700 (12.8%)	7,500 (17.36%)	50 (1.47%)	2,000 (8.13%)	12,250 (13.27%)
Fry Rearing Summer Cold Water Program (May 1–May 31)	-8,080 (-48.97%)	-10,000 (-21.83%)	-510 (-12.85%)	3,000 (12.3%)	-15,590 (-17.19%)
Juvenile Rearing Total (year-round)	110 (1.23%)	-3,600 (-10.65%)	-180 (-6.45%)	-3,100 (-17.03%)	-6,770 (-10.62%)
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	2,500 (16.67%)	6,200 (16.85%)	580 (19.59%)	4,900 (37.4%)	14,180 (20.9%)

Guadalupe Creek[a]	GCRK 1 River Mile 20.71	GCRK 2 River Mile 21.91	GCRK 3 River Mile 22.54	GCRK 4 River Mile 26.17	Total
Juvenile Rearing Summer Cold Water Program (May 1–Oct 31)	-2,261 (-76.39%)	-13,400 (-43.23%)	-910 (-34.87%)	-10,900 (-47.19%)	-27,471 (-46.04%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

[b] No average daily habitat availability model results are available for the points of interest not shown.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 36% (29 square feet) average increase in daily effective spawning habitat for steelhead during the spawning and incubation life-stage time period (that is, December 1 to April 30) across POIs in Alamitos Creek compared with the future baseline (Figure 136; Table 94). The largest square footage increase in the daily effective spawning habitat under the FAHCE-plus Alternative occurs between ALAM 1 and ALAM 2 (represented by the model results at ALAM 2) since the average daily effective spawning habitat in this reach during December increases from around 250 to 350 square feet under the future baseline to 375 to 500 square feet under the FAHCE-plus Alternative. The modeled daily effective spawning habitat increase on individual days between ALAM 2 and ALAM 3 (represented by the model results at ALAM 3) under the FAHCE-plus Alternative compared to the future baseline is relatively small (typically less 20 square feet) compared to an average redd size of 73 square feet (Orcutt et al. 1968). Modeled daily effective spawning habitat between ALAM 3 and ALAM 4 (represented by the model results at ALAM 4) increases from December through mid-January and the frequency daily effective spawning habitat exceeds 73 square feet increases from December to early February under the FAHCE-plus Alternative compared to the future baseline. While there is a decrease in the average daily effective spawning habitat at ALAM 4 from mid-February to mid-March under the FAHCE-plus Alternative compared to the future baseline, this decrease would have a negligible change (two days) in the frequency the average daily effective spawning exceeds 73 square feet. Decreases in the modeled daily effective spawning habitat result from decreases in the flow and the associated decrease in wetted area in Alamitos Creek under the FAHCE-plus Alternative compared to the current baseline (Attachment K.3 – Figures K.3.50 and K.3.52).

Figure 136. Change in Effective Steelhead Spawning Habitat Compared with the Future Baseline in Alamitos Creek

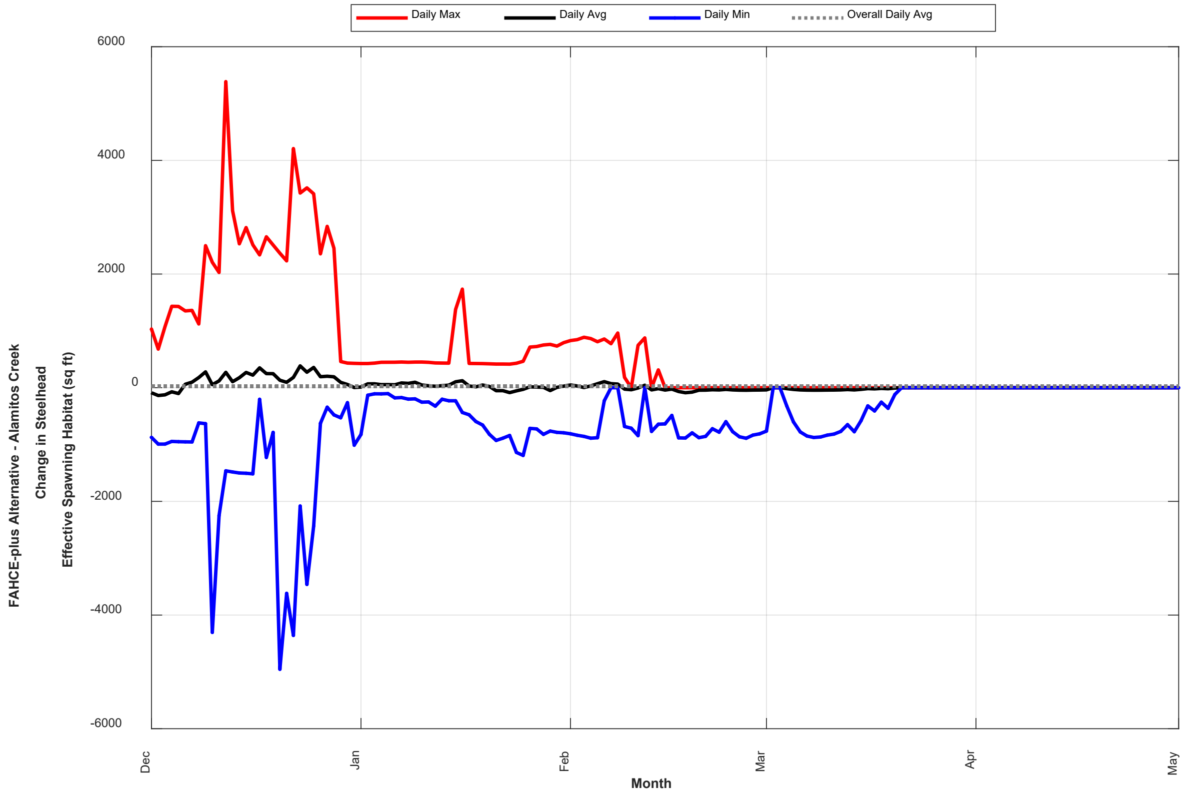


Table 94. FAHCE-plus Alternative Steelhead Habitat Compared with the Future Baseline in Alamitos Creek

Alamitos Creek[a,b]	ALAM 2 River Mile 23.61	ALAM 3 River Mile 24.26	ALAM 4 River Mile 27.89	Total
Steelhead Habitat Future Baseline (sq ft)				
Effective Spawning	38	5	36	79
Fry Rearing Total (March 1–May 31)	56,500	6,490	3,580	66,570
Fry Rearing Winter Base Flow Operations (March 1–April 30)	56,200	6,410	3,280	65,890
Fry Rearing Summer Release Program (May 1–May 31)	56,900	6,640	4,150	67,690
Juvenile Rearing Total (year-round)	60,500	5,340	3,060	68,900
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	64,800	5,870	2,870	73,540
Juvenile Rearing Summer Release Program (May 1–Oct 31)	56,300	4,820	3,250	64,370

Alamitos Creek[a,b]	ALAM 2 River Mile 23.61	ALAM 3 River Mile 24.26	ALAM 4 River Mile 27.89	Total
Steelhead Habitat FAHCE-plus Alternative (sq ft)				
Effective Spawning	58	10	40	108
Fry Rearing Total (March 1–May 31)	58,800	7,260	3,870	69,930
Fry Rearing Winter Base Flow Operations (March 1–April 30)	59,600	7,590	3,740	70,930
Fry Rearing Summer Release Program (May 1–May 31)	57,200	6,610	4,130	67,940
Juvenile Rearing Total (year-round)	63,000	5,960	3,570	72,530
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	70,500	7,370	3,990	81,860
Juvenile Rearing Summer Release Program (May 1–Oct 31)	55,600	4,570	3,160	63,330
Change in Habitat (sq ft)				
Effective Spawning	21 (54.5%)	5 (93.66%)	3 (8.79%)	29 (36%)
Fry Rearing Total (March 1–May 31)	2,300 (4.07%)	770 (11.86%)	290 (8.1%)	3,360 (5.05%)
Fry Rearing Winter Base Flow Operations (March 1–April 30)	3,400 (6.05%)	1,180 (18.41%)	460 (14.02%)	5,040 (7.65%)
Fry Rearing Summer Release Program (May 1–May 31)	300 (0.53%)	-30 (-0.45%)	-20 (-0.48%)	250 (0.37%)
Juvenile Rearing Total (year-round)	2,500 (4.13%)	620 (11.61%)	510 (16.67%)	3,630 (5.27%)
Juvenile Rearing Winter Base Flow (Nov 1–Apr 30)	5,700 (8.8%)	1,500 (25.55%)	1,120 (39.02%)	8,320 (11.31%)
Juvenile Rearing Summer Release Program (May 1–Oct 31)	-700 (-1.24%)	-250 (-5.19%)	-90 (-2.77%)	-1,040 (-1.62%)

There were no FAHCE WEAP Model predictions for effective spawning habitat in Calero Creek despite known occurrence of spawners. Based on the results of the FAHCE WEAP Model for wetted area, effective spawning habitat would be expected to increase in Calero Creek compared with the future baseline due to increased wetted area during Winter Base Flow Operations when spawning is expected to occur (Attachment K.3 – Figures K.3.69 and K.3.70).

Table 95. FAHCE-plus Alternative Steelhead Habitat Compared with the Future Baseline in Calero Creek

Calero Creek[a]	CALE 1 River Mile 24.33	CALE 2 River Mile 27.59	Total
Steelhead Habitat Current Baseline (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (March 1-May 31)	2,730	62,300[c]	65,030[c]
Fry Rearing Winter Base Flow Operations (March 1-April 30)	2,790	47,500[c]	50,290[c]
Fry Rearing Summer Release Program (May 1-May 31)	2,620	91,300	93,920
Juvenile Rearing Total (year-round)	2,500	59,000[c]	61,500[c]
Juvenile Rearing Winter Base Flow (Nov 1-Apr 30)	2,620	31,400[c]	34,020[c]
Juvenile Rearing Summer Release Program (May 1-Oct 31)	2,380	86,200	88,580
Steelhead Habitat FAHCE-plus Alternative (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (March 1-May 31)	2,860	68,200[c]	71,060[c]
Fry Rearing Winter Base Flow Operations (March 1-April 30)	2,950	55,000[c]	57,950[c]
Fry Rearing Summer Release Program (May 1-May 31)	2,680	94,300	96,980
Juvenile Rearing Total (year-round)	2,600	59,500[c]	62,100[c]
Juvenile Rearing Winter Base Flow (Nov 1-Apr 30)	2,750	28,900[c]	31,650[c]
Juvenile Rearing Summer Release Program (May 1-Oct 31)	2,460	89,600	92,060
Change in Habitat (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (March 1-May 31)	130 (4.76%)	5,900 (9.47%)[c]	6,030 (9.27%)[c]
Fry Rearing Winter Base Flow Operations (March 1-April 30)	160 (5.73%)	7,500 (15.79%)[c]	7,660 (15.23%)[c]
Fry Rearing Summer Release Program (May 1-May 31)	60 (2.29%)	3,000 (3.29%)	3,060 (3.26%)
Juvenile Rearing Total (year-round)	100 (4%)	500 (0.85%)[c]	600 (0.98%)[c]

Calero Creek[a]	CALE 1 River Mile 24.33	CALE 2 River Mile 27.59	Total
Juvenile Rearing Winter Base Flow (Nov 1-Apr 30)	130 (4.96%)	-2,500 (-7.96%)[c]	-2,370 (-6.97%)[c]
Juvenile Rearing Summer Release Program (May 1-Oct 31)	80 (3.36%)	3,400 (3.94%)	3,480 (3.93%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

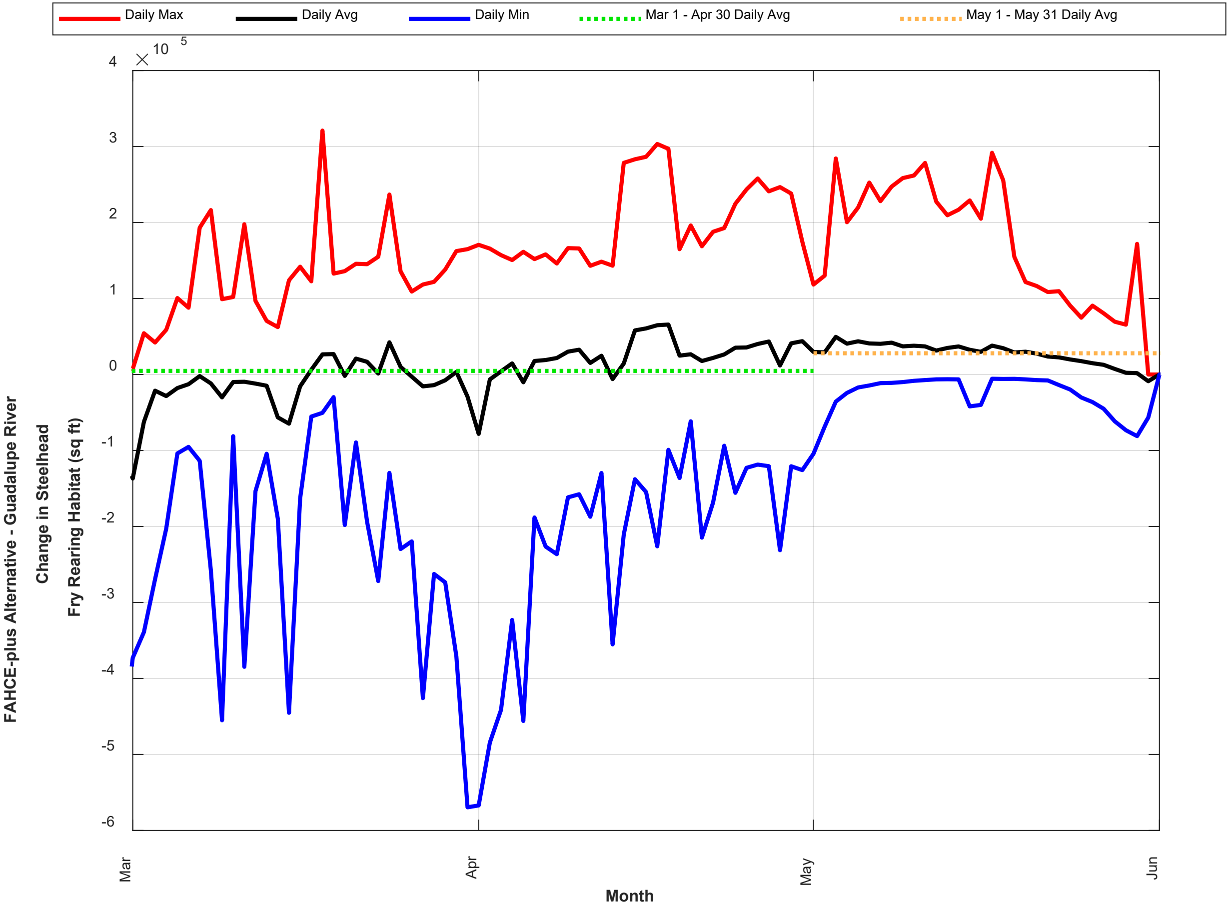
[b] Effective spawning model results were not available in Calero Creek because no substrate suitable for spawning was recorded by the subsample habitat survey of Calero Creek input into the FAHCE WEAP Model. Subsequent surveys indicate there is substrate suitable for spawning in Calero Creek (Valley Water 2019, 2020).

[c] Average daily fry rearing and juvenile rearing habitat availability model results do not quantify conditions when winter cover was considered in the habitat estimate (December 1 through March 31 for steelhead) since no winter cover was recorded by the subsample habitat survey of the CALE 2 reach of Calero Creek (that is, the reach between CALE 1 and CALE 2) input into the FAHCE WEAP Model. Subsequent surveys indicate there is winter cover available in this reach of Calero Creek (Valley Water 2019, 2020).

Fry Rearing Habitat

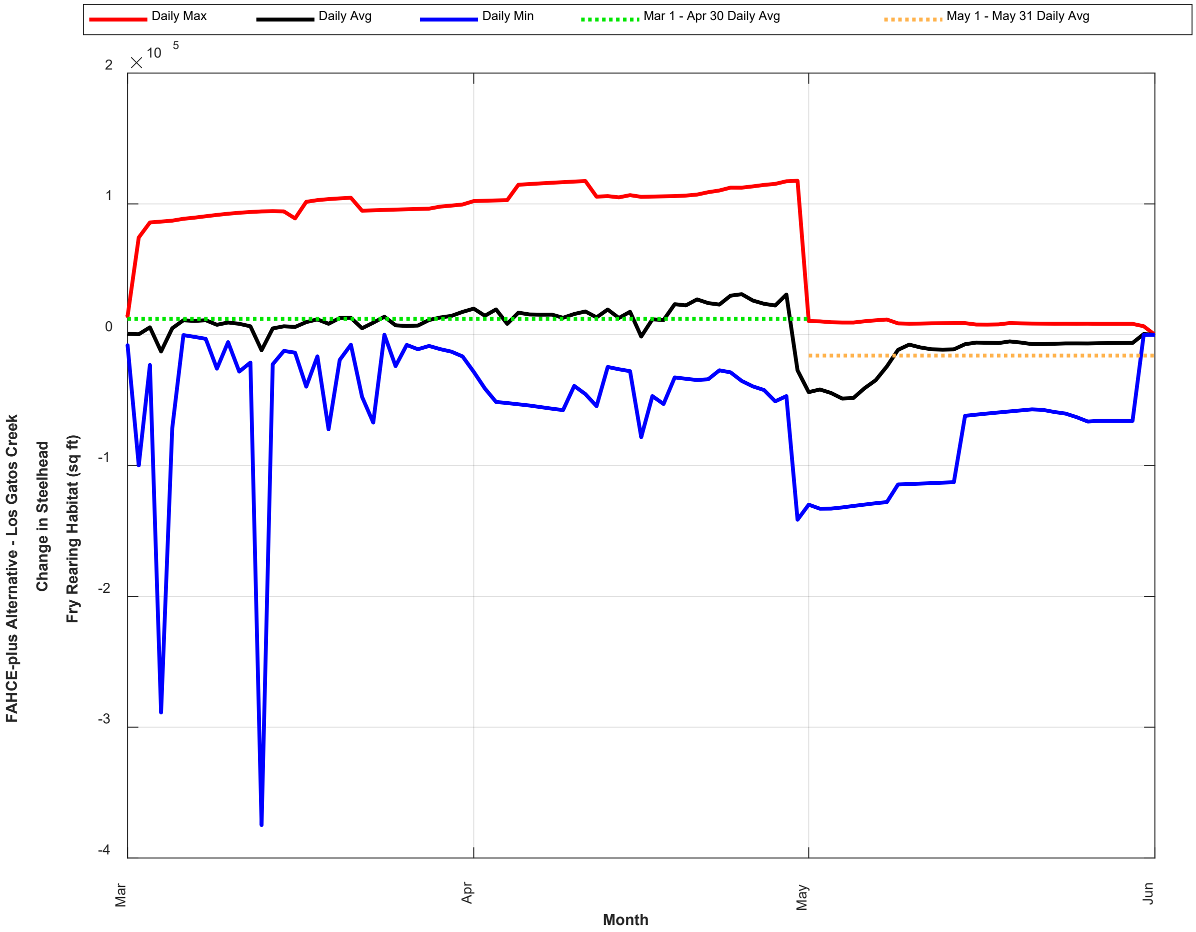
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 2% (25,000 square feet) average increase in fry rearing habitat in the Guadalupe River for steelhead compared with the future baseline (Figure 137; Table 91). There is a large amount of fry rearing habitat in the Guadalupe River under future baseline conditions (1,214,500 square feet).

Figure 137. Change in Steelhead Fry Rearing Habitat Compared with the Future Baseline in the Guadalupe River



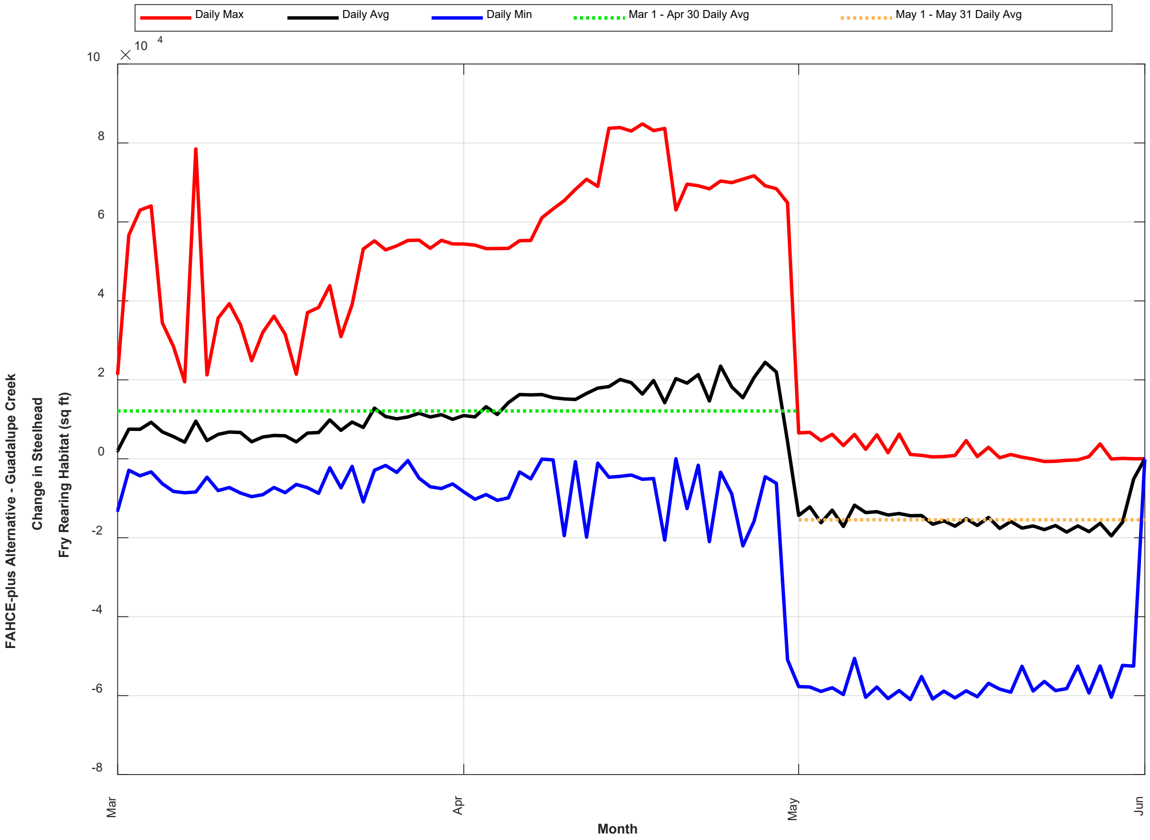
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 0.5% (2,000 square feet) average increase in fry rearing habitat in Los Gatos Creek for steelhead compared with the future baseline (Figure 138; Table 92). During Winter Base Flow Operations from March to April, fry rearing habitat increased by 3%, but fry rearing habitat decreased by 4% during the Summer Release Program in May (Figure 138; Table 92) likely because of decreased wetted area in May (Attachment K.3 – Figures K.3.33, and K.3.34). Suboptimal water temperatures for rearing (greater than 65°F) also occur in May under both scenarios (Attachment K.3 – Figure K.3.35). Los Gatos Creek contains a large amount (387,000 square feet) of fry rearing habitat under the future baseline.

Figure 138. Change in Steelhead Fry Rearing Habitat Compared with the Future Baseline in Los Gatos Creek



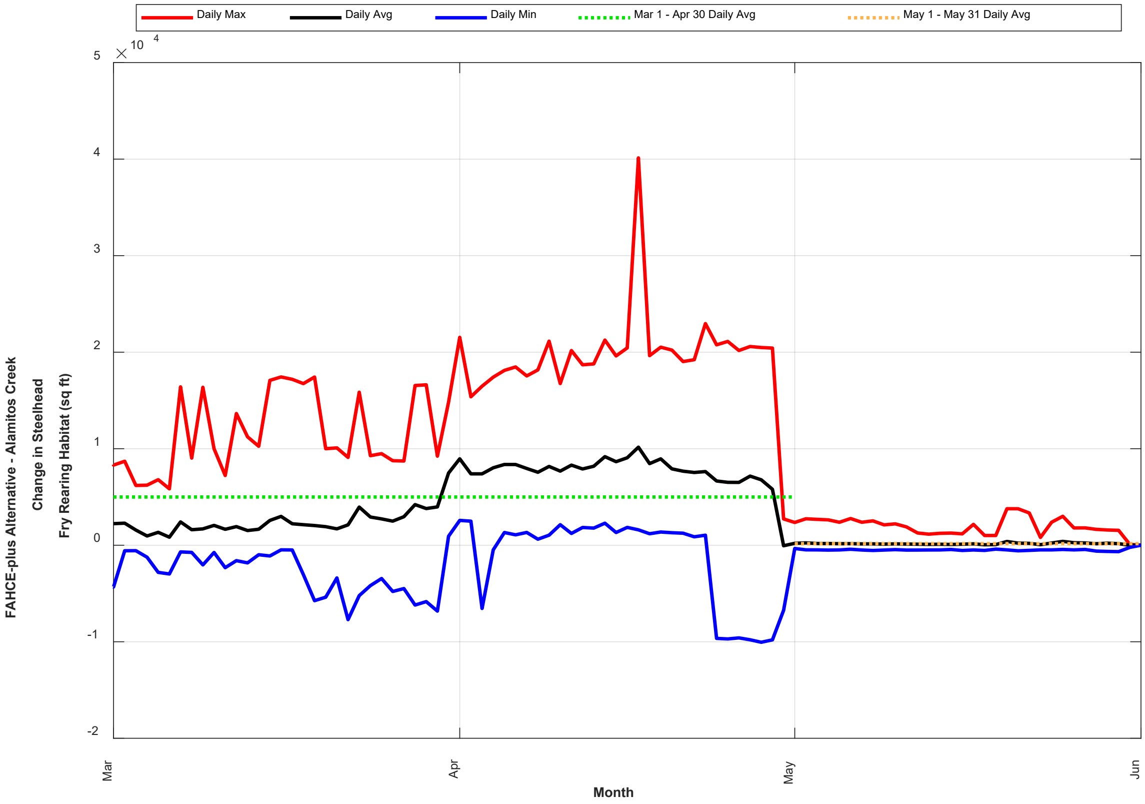
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 3% (2,760 square feet) average increase in fry rearing habitat in Guadalupe Creek for steelhead compared with the future baseline (Figure 139; Table 93). Changes in fry rearing habitat varied seasonally. A 13% (12,250 square feet) average increase was observed from March to April and a 17% (15,590 square feet) average decrease was observed during May compared with the future baseline (Figure 139; Table 93). In the Guadalupe Creek CWMZ, fry rearing habitat increased by a total of 9% (2,300 square feet), with an 8% (2,000 square feet) increase observed during the Winter Base Flow Operations followed by a 12% (3,000 square feet) increase during the Summer Cold Water Program. The decreases in fry rearing habitat downstream of the CWMZ are a result of a decrease in wetted area and increased water temperatures (Attachment K.3 – Figures K.3.45 and K.3.46).

Figure 139. Change in Steelhead Fry Rearing Habitat Compared with the Future Baseline in Guadalupe Creek



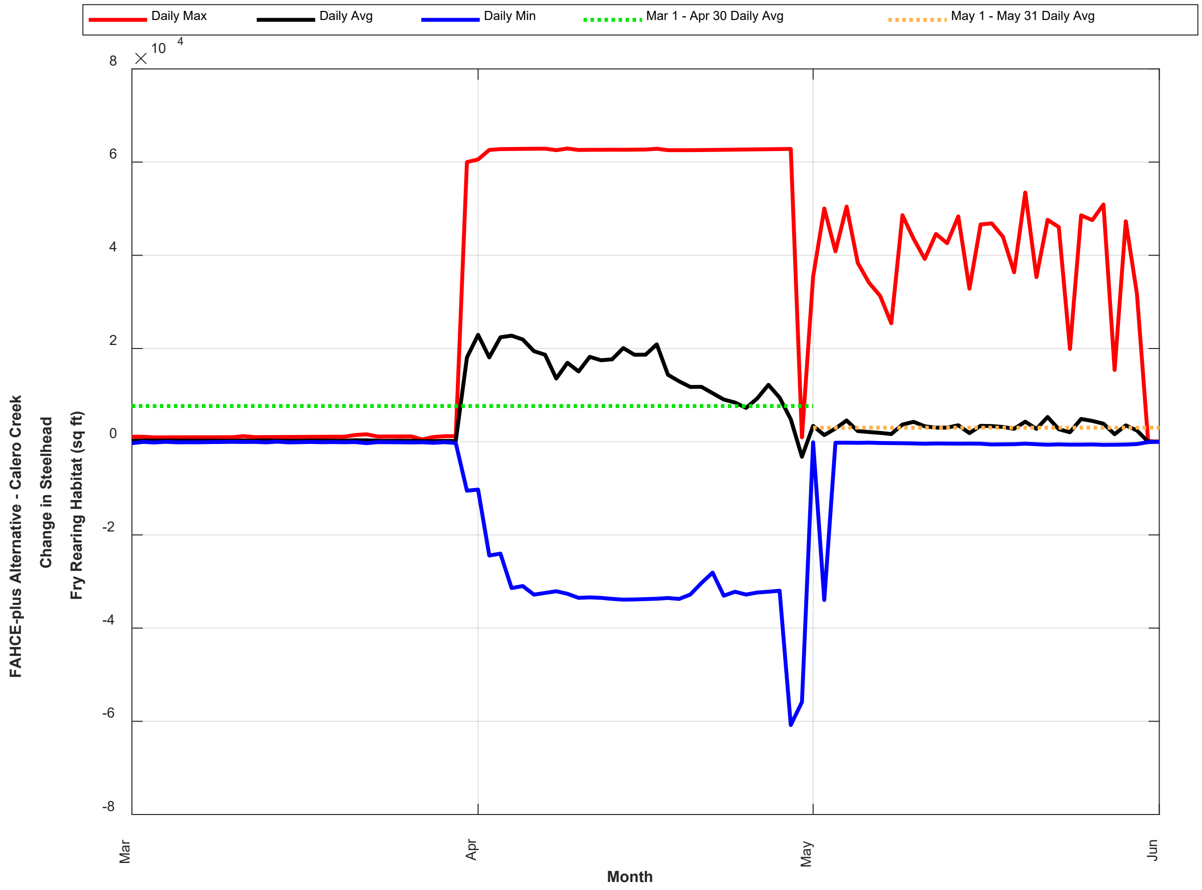
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 5% (3,360 square feet) average increase in fry rearing habitat in Alamitos Creek for steelhead compared with the future baseline. During Winter Base Flow Operations from March to April, fry rearing habitat increased by 8%, but would result in a 0.4% increase during the Summer Release Program in May (Figure 140; Table 94).

Figure 140. Change in Steelhead Fry Rearing Habitat Compared with the Future Baseline in Alamitos Creek



There would be an 9% (6,030 square feet) average increase in fry rearing habitat in Calero Creek compared with the future baseline with a 15% (7,660 square feet) average increase from March to April and a 3% (3,060 square feet) average increase in May (Figure 141; Table 95). These changes are likely attributable to increases in wetted area during both Winter Base Flow Operations and the Summer Release Program. The average increase during Winter Base Flow Operations does not completely characterize the change in fry rearing habitat during March. Habitat survey data input into the model indicated there was zero winter cover in the reach associated with the CALE 2 POI (that is, CALE 1 to CALE 2) and caused fry rearing habitat to be zero in March under all scenarios, but subsequent habitat surveys indicated there was winter cover (Valley Water 2019, 2020). Variations in wetted area at CALE 2 in March under the FAHCE-plus Alternative compared to the future baseline (Attachment K.3 – Figures K.3.69 and K.3.70) suggest that there would be an increase in fry rearing habitat during the time when the model output predicts zero habitat in March. The largest increase in wetted area during the fry rearing habitat life-stage would occur during March, so there would likely be a larger increase in fry rearing habitat in Calero Creek during Winter Base Flow Operations than estimated by the FAHCE WEAP Model results.

Figure 141. Change in Steelhead Fry Rearing Habitat Compared with the Future Baseline in Calero Creek[a]

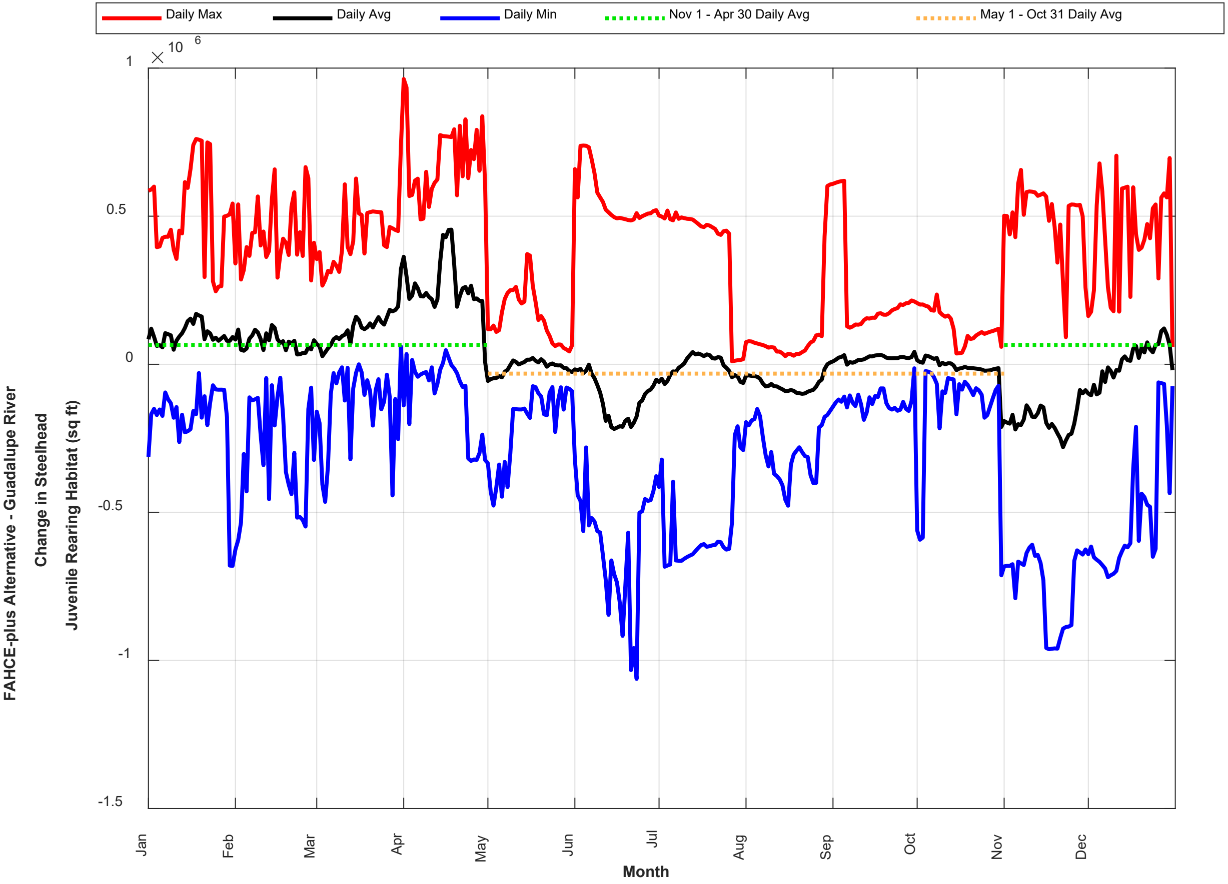


[a] Calero Creek habitat survey results in the reach between CALE 1 and CALE 2 input into the FAHCE WEAP Model did not record any winter cover, so fry and juvenile rearing habitat model results in this reach were zero during the period when winter cover is considered in the habitat estimate (that is, December 1 through March 31 for steelhead; January 1 through March 31 for Chinook salmon). Subsequent habitat surveys identified winter cover between CALE 1 and CALE 2 (Valley Water 2019, 2020).

Juvenile Rearing Habitat

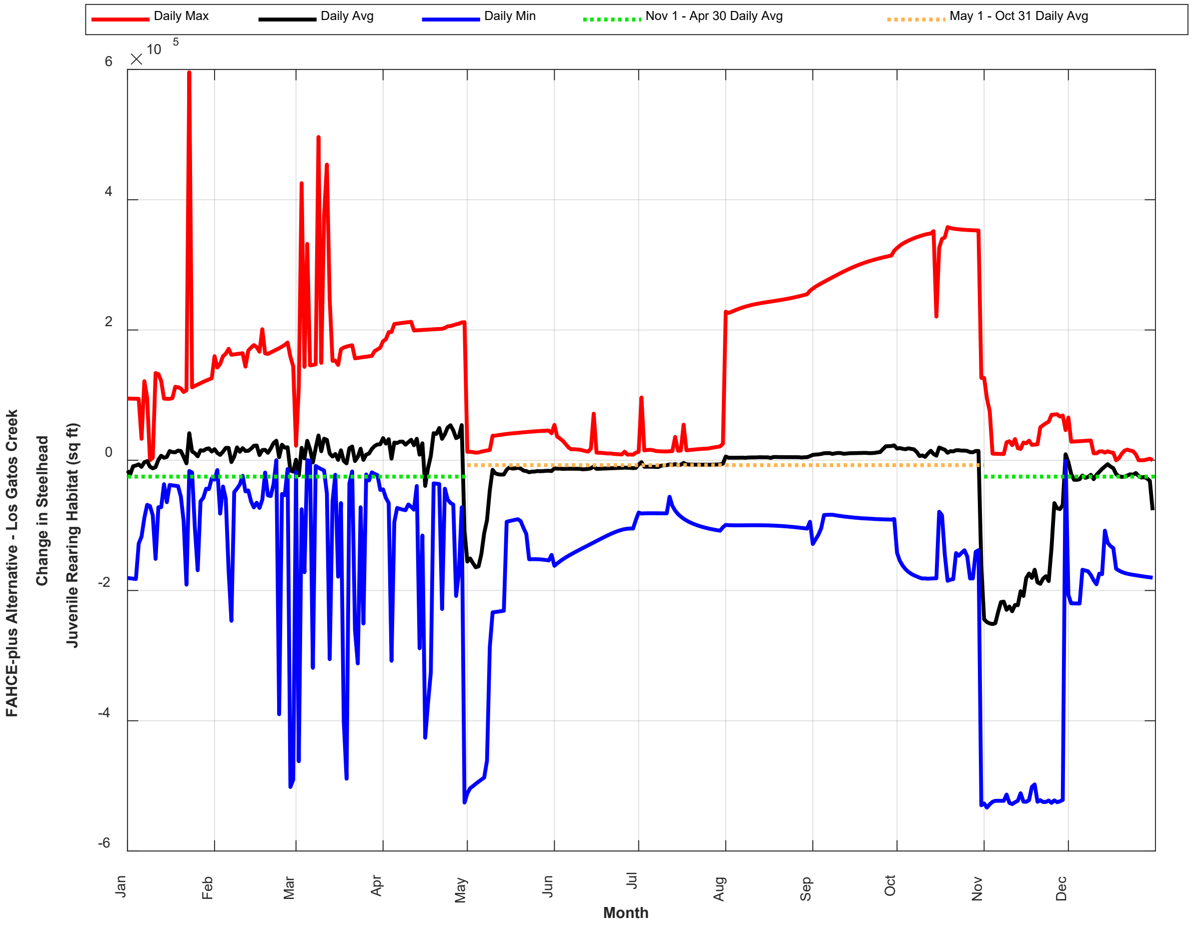
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 2% (26,500 square feet) increase in steelhead juvenile rearing habitat in the Guadalupe River compared with the future baseline. Increases were apparent in April while decreases were apparent during June and November (Figure 142). Juvenile rearing habitat increased by 5% during Winter Base Flow Operations and decreased by 3% during the Summer Release Program. Despite a large, absolute increase in juvenile rearing habitat under the FAHCE-plus Alternative, the Guadalupe River contains a large amount of juvenile rearing habitat (1,234,700 square feet) under the future baseline.

Figure 142. Change in Steelhead Juvenile Rearing Habitat Compared with the Future Baseline in the Guadalupe River



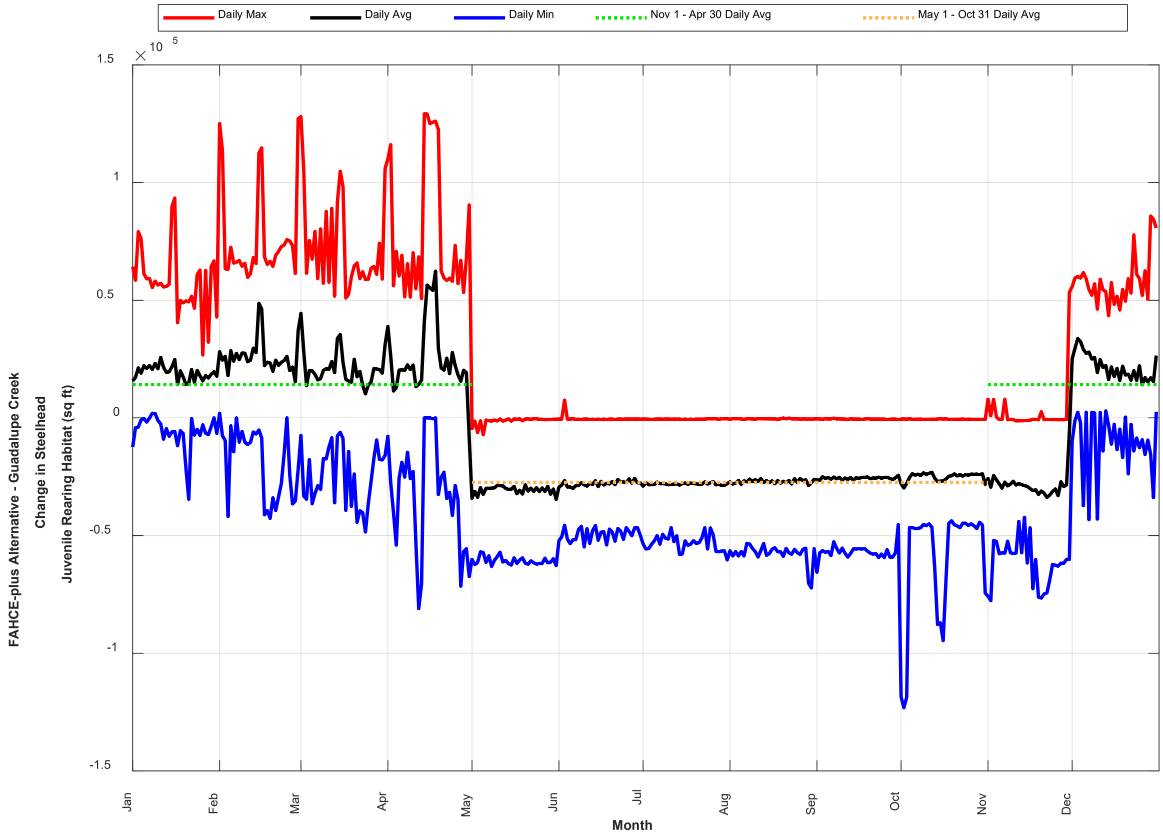
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 5% (16,000 square feet) average decrease in steelhead juvenile rearing habitat in Los Gatos Creek compared with the future baseline (Figure 143; Table 92). Decreases would occur in May and November (Figure 143), likely the result of reduced wetted area in both months (Attachment K.3 – Figures K.3.33, and K.3.34). Los Gatos Creek contains a large amount (348,000 square feet) of juvenile rearing habitat under the future baseline.

Figure 143. Change in Steelhead Juvenile Rearing Habitat Compared with the Future Baseline in Los Gatos Creek



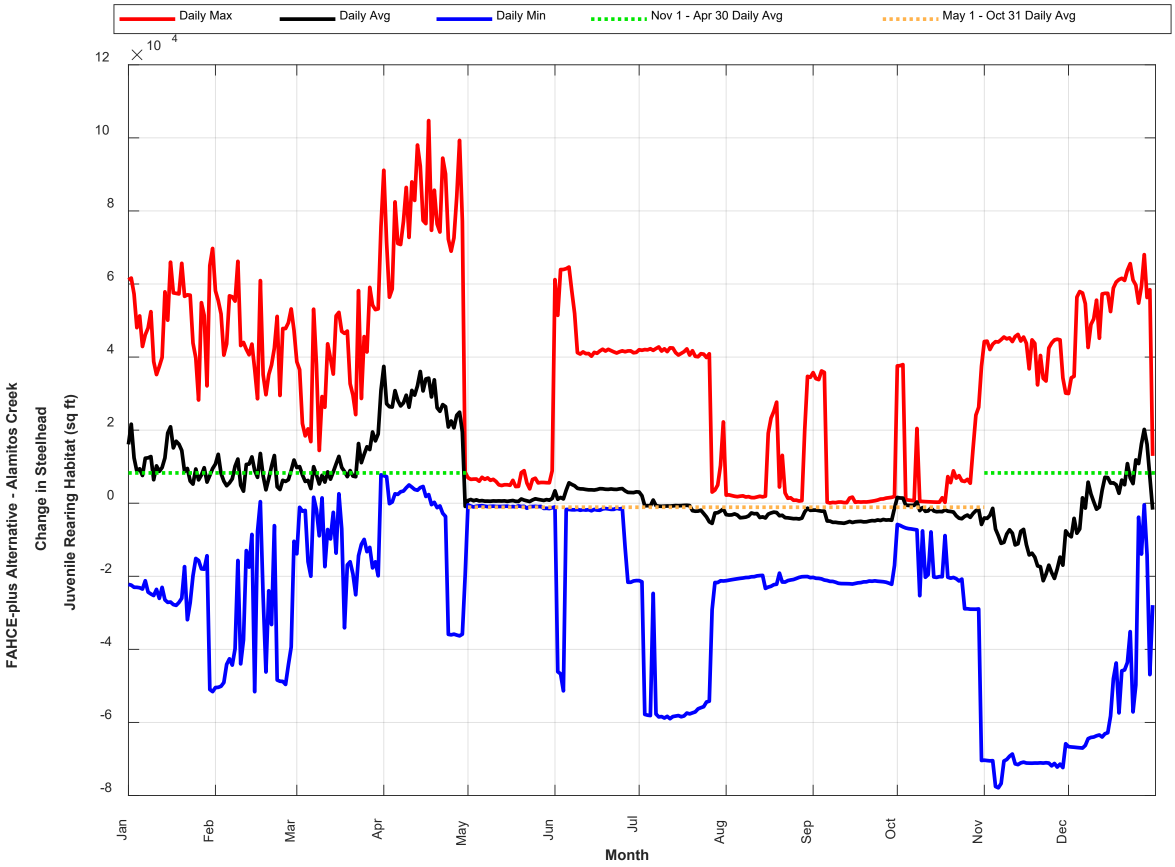
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 11% (6,770 square feet) decrease in steelhead juvenile rearing habitat within Guadalupe Creek compared with the future baseline (Figure 144; Table 93). The trends revealed a 21% (14,180 square feet) increase during Winter Base Flow Operations and 46% (27,471 square feet) decrease during the Summer Cold Water Program across POIs in Guadalupe Creek, compared with the future baseline (Figure 144; Table 93). In the Guadalupe Creek CWMZ, juvenile rearing habitat decreased by a 17% (3,100 square feet), with a 37% (4,900 square feet) increase observed during the Winter Base Flow Operations followed by a decrease of 47% (10,900 square feet) during the Summer Cold Water Program. Decreases in fry rearing habitat in the Guadalupe Creek CWMZ during the Summer Cold Water Program are a result of decreased wetted area as MWAT remains below 65°F throughout the juvenile rearing period under the FAHCE-plus Alternative (Attachment K.3 – Figures K.3.45, K.3.46, and K.3.47). Downstream of the Guadalupe Creek CWMZ, decreases during the Summer Cold Water Program are attributable to a combination of reduced wetted area and increased temperatures (Attachment K.3 – Figures K.3.45, K.3.46, and K.3.47).

Figure 144. Change in Steelhead Juvenile Rearing Habitat Compared with the Future Baseline in Guadalupe Creek



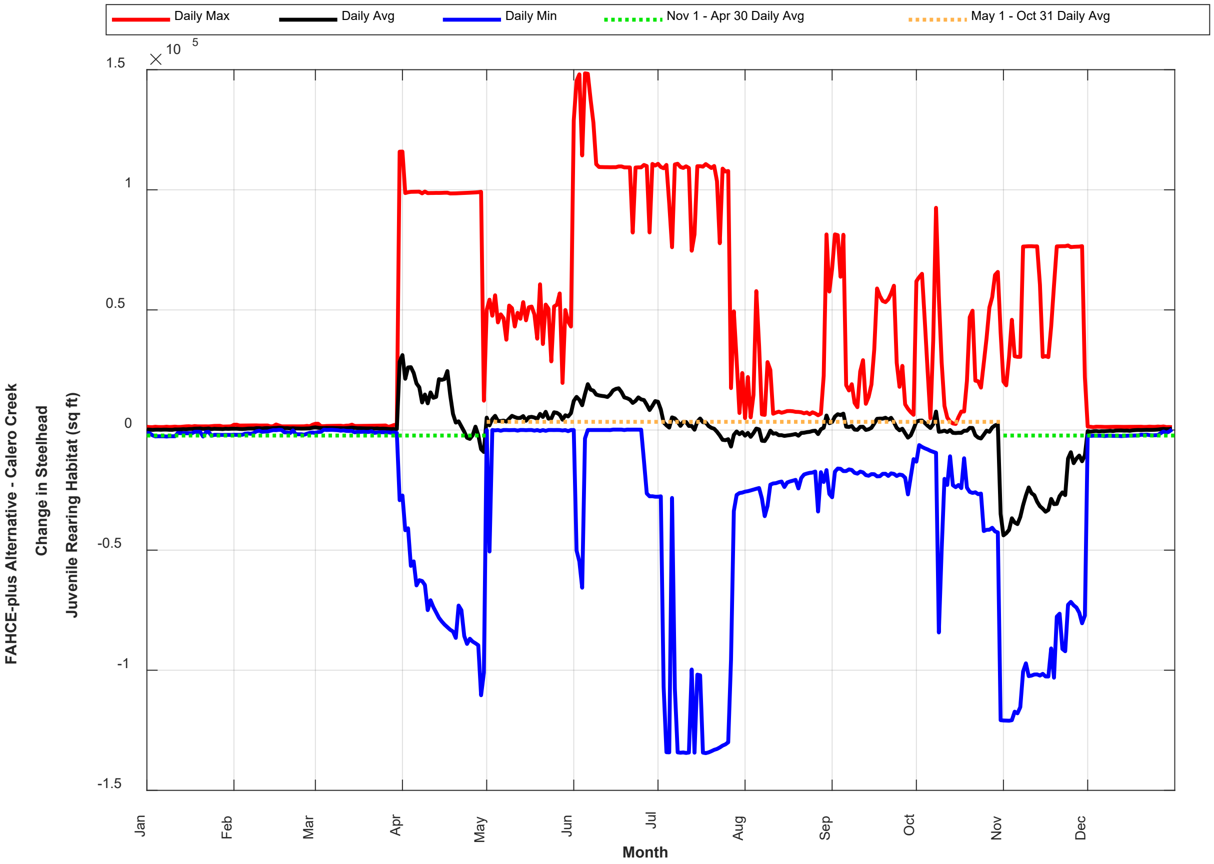
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 5% (3,630 square feet) increase in steelhead juvenile rearing habitat within Alamitos Creek compared with the future baseline. The FAHCE-plus Alternative would result in an 11% increase during Winter Base Flow Operations and a 2% decrease during the Summer Release Program compared with the future baseline (Figure 145; Table 94). An abrupt decrease was also apparent in November related to reduced wetted area (Attachment K.3 – Figures K.3.57 and K.3.58).

Figure 145. Change in Steelhead Juvenile Rearing Habitat Compared with the Future Baseline in Alamitos Creek



There would be a 1% (600 square feet) average increase in juvenile rearing habitat in Calero Creek compared with the future baseline (Figure 146; Table 95). As described for fry rearing habitat above, the model estimated zero rearing habitat because no winter cover was input into the CALE 2 reach of the model based on the available habitat survey data for the reach when modeling was conducted. Subsequent habitat surveys indicated there was winter cover (Valley Water 2019, 2020). Variations in wetted area at CALE 2 from December 1 to March 31 under the FAHCE-plus Alternative compared to the future baseline suggest there would be increased juvenile rearing habitat during this time due to increases in wetted area (Attachment K.3 – Figures K.3.69 and K.3.70). The largest increase in wetted area in the CALE 2 reach of Calero Creek would occur from late December through March, so the increase in juvenile rearing habitat in Calero Creek during Winter Base Flow Operations would likely be greater than estimated by the FAHCE WEAP model results.

Figure 146. Change in Steelhead Juvenile Rearing Habitat Compared with the Future Baseline in Calero Creek[a]



[a] Calero Creek habitat survey results in the reach between CALE 1 and CALE 2 input into the FAHCE WEAP Model did not record any winter cover, so fry and juvenile rearing habitat model results in this reach were zero during the period when winter cover is considered in the habitat estimate (that is, December 1 through March 31 for steelhead; January 1 through March 31 for Chinook salmon). Subsequent habitat surveys identified winter cover between CALE 1 and CALE 2 (Valley Water 2019, 2020).

Migration Conditions

Adult Upstream Passage

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 12% (9 days per year on average) increase to adult upstream passage at sites in the Guadalupe River, most notably at the upstream-most POIs (GUAD 6 and GUAD 7) where upstream passage increased by 35% (24 days per year) on average (Figure 147; Table 96).

Figure 147. Change in Average Adult Steelhead Upstream Passage Days Compared with the Future Baseline in the Guadalupe River

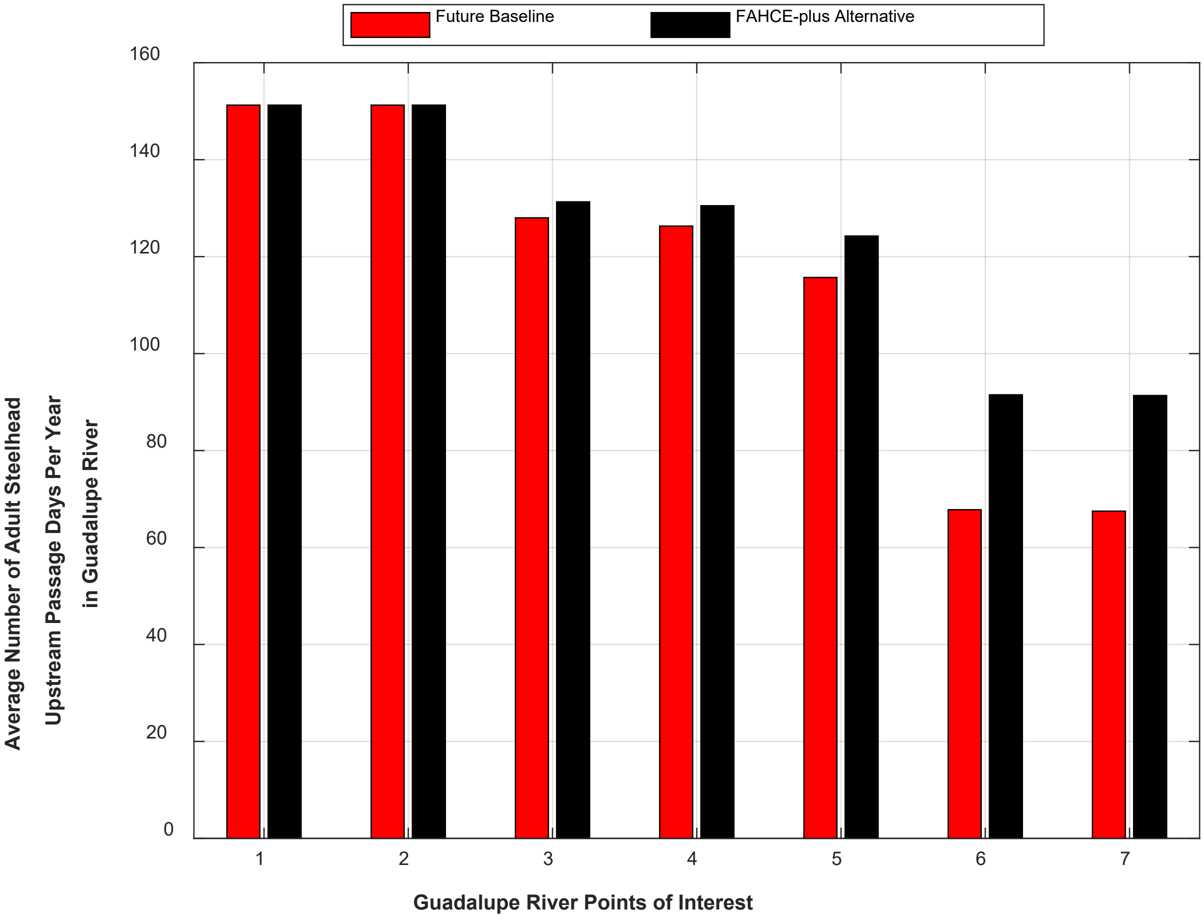


Table 96. FAHCE-plus Alternative Adult Steelhead Upstream Passage Compared with the Future Baseline in the Guadalupe River

Parameter	GUAD 1	GUAD 2	GUAD 3	GUAD 4	GUAD 5	GUAD 6	GUAD 7
***Future Baseline (days)*[a]**							
Total Adult Upstream Passage (1991–2010)	3,025	3,025	2,560	2,526	2,314	1,356	1,350
Average Adult Upstream Passage Per Year	151	151	128	126	116	68	68
***FAHCE-plus Alternative (days)*[a]**							
Total Adult Upstream Passage (1991–2010)	3,025	3,025	2,626	2,610	2,485	1,830	1,827
Average Adult Upstream Passage Per Year	151	151	131	131	124	92	91

Parameter	GUAD 1	GUAD 2	GUAD 3	GUAD 4	GUAD 5	GUAD 6	GUAD 7
Difference (days)							
Total Adult Upstream Passage (1991–2010)	0.00	0.00	66.00	84.00	171.00	474.00	477.00
Average Adult Upstream Passage Per Year	0.00	0.00	3.30	4.20	8.55	23.70	23.85
Difference (%)							
Total Adult Upstream Passage (1991–2010)	0.00	0.00	2.58	3.33	7.39	34.96	35.33
Average Adult Upstream Passage Per Year	0.00	0.00	2.58	3.33	7.39	34.96	35.33

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 3% (approximately 1 day per) average decrease to adult upstream passage in Los Gatos Creek compared with the future baseline (Figure 148; Table 97).

Figure 148. Change in Average Adult Steelhead Upstream Passage Days Compared with the Future Baseline in Los Gatos Creek

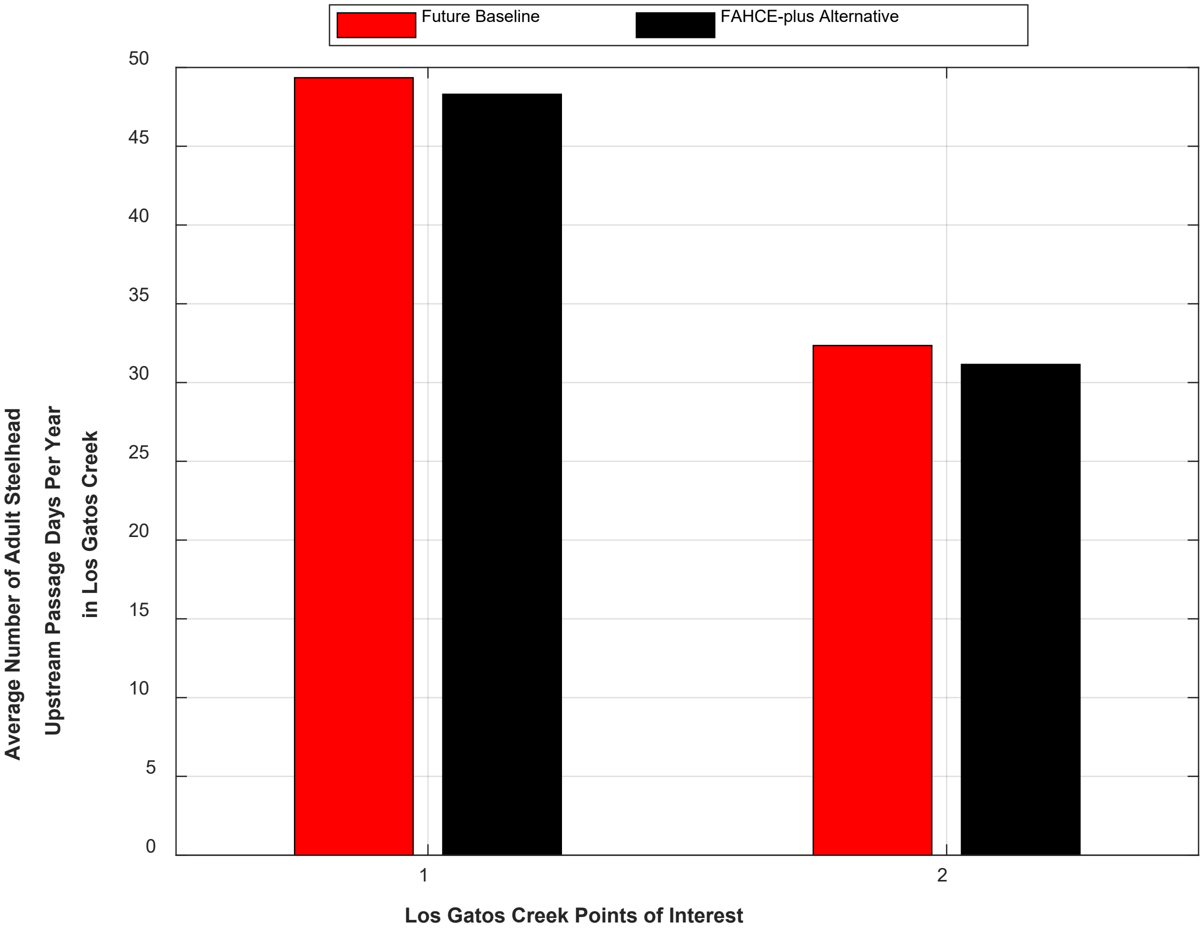


Table 97. FAHCE-plus Alternative Adult Steelhead Upstream Passage Compared with the Future Baseline in Los Gatos Creek

Parameter	LOSG 1	LOSG 2
Future Baseline (days)[a]		
Total Adult Upstream Passage (1991–2010)	987	647
Average Adult Upstream Passage Per Year	49	32
FAHCE-plus Alternative (days)[a]		
Total Adult Upstream Passage (1991–2010)	966	623
Average Adult Upstream Passage Per Year	48	31
Difference (days)		
Total Adult Upstream Passage (1991–2010)	-21.00	-24.00
Average Adult Upstream Passage Per Year	-1.05	-1.20

Parameter	LOSG 1	LOSG 2
Difference (%)		
Total Adult Upstream Passage (1991–2010)	-2.13	-3.71
Average Adult Upstream Passage Per Year	-2.13	-3.71

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in 25% (approximately 3 days per year) average increases to adult upstream passage in Guadalupe Creek compared with the future baseline (Figure 149; Table 98). There are limited passage opportunities under the future baseline (14 days per year on average) (Table 98).

Figure 149. Change in Average Adult Steelhead Upstream Passage Days Compared with the Future Baseline in Guadalupe Creek

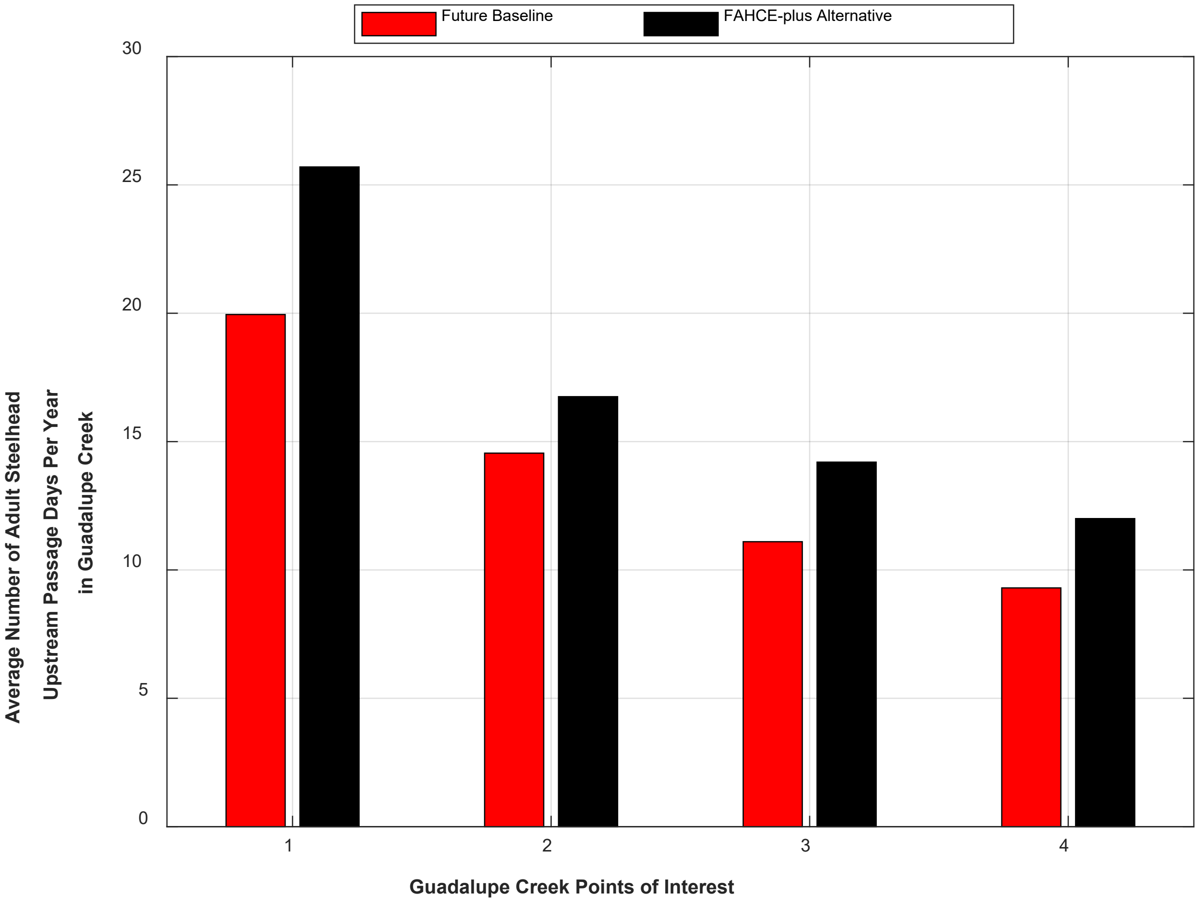


Table 98. FAHCE-plus Alternative Adult Steelhead Upstream Passage Compared with the Future Baseline in Guadalupe Creek

Parameter	GCRK 1	GCRK 2	GCRK 3	GCRK 4
Future Baseline (days) [a]				
Total Adult Upstream Passage (1991–2010)	399	291	222	186
Average Adult Upstream Passage Per Year	20	15	11	9
FAHCE-plus Alternative (days) [a]				
Total Adult Upstream Passage (1991–2010)	514	335	284	240
Average Adult Upstream Passage Per Year	26	17	14	12
Difference (days)				
Total Adult Upstream Passage (1991–2010)	115.00	44.00	62.00	54.00
Average Adult Upstream Passage Per Year	5.75	2.20	3.10	2.70
Difference (%)				
Total Adult Upstream Passage (1991–2010)	28.82	15.12	27.93	29.03
Average Adult Upstream Passage Per Year	28.82	15.12	27.93	29.03

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in substantial increases to adult upstream passage in Alamitos Creek by an average of 29% (13 days per year) compared with the future baseline (Figure 150; Table 99).

Figure 150. Change in Average Adult Steelhead Upstream Passage Days Compared with the Future Baseline in Alamitos Creek

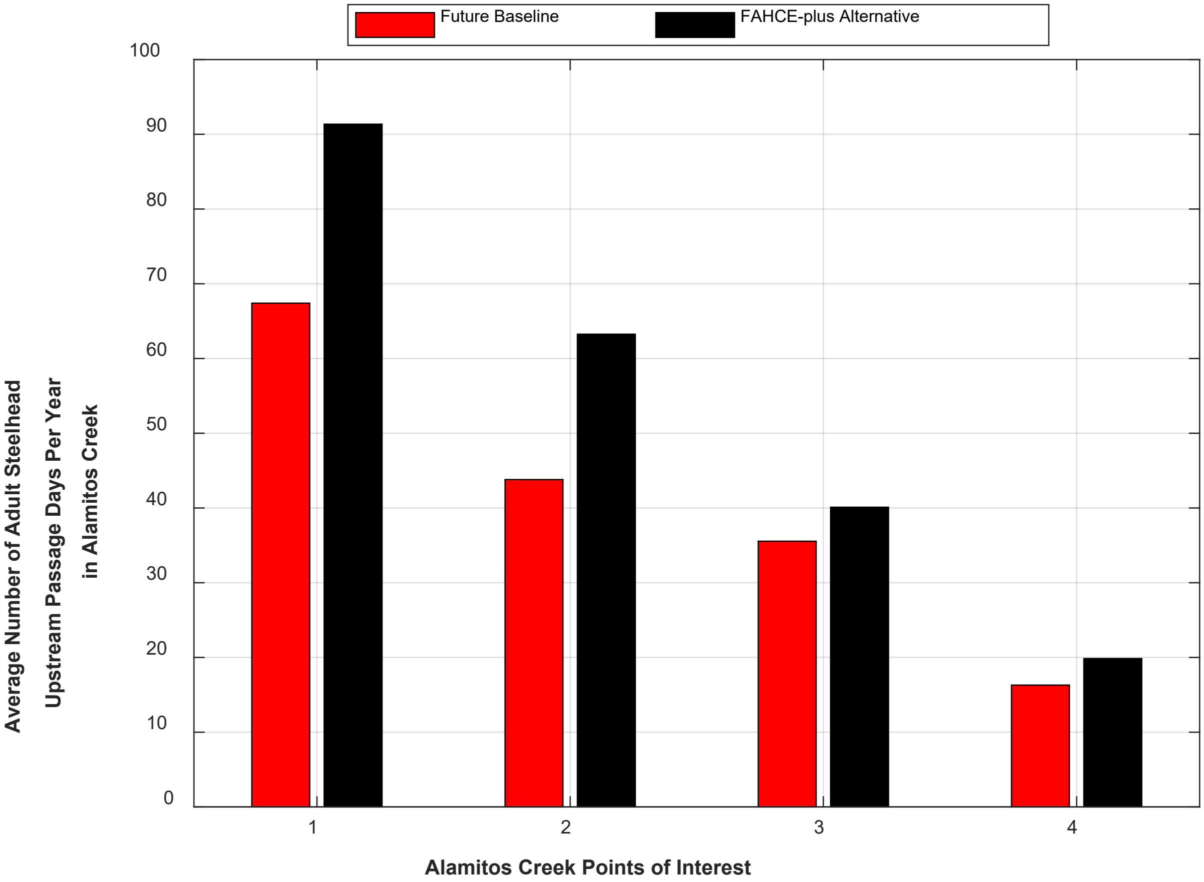


Table 99. FAHCE-plus Alternative Adult Steelhead Upstream Passage Compared with the Future Baseline in Alamitos Creek

Parameter	ALAM 1	ALAM 2	ALAM 3	ALAM 4
Future Baseline (days)[a]				
Total Adult Upstream Passage (1991–2010)	1,348	876	711	326
Average Adult Upstream Passage Per Year	67	44	36	16
FAHCE-plus Alternative (days)[a]				
Total Adult Upstream Passage (1991–2010)	1,827	1,265	802	397
Average Adult Upstream Passage Per Year	91	63	40	20
Difference (days)				
Total Adult Upstream Passage (1991–2010)	479.00	389.00	91.00	71.00
Average Adult Upstream Passage Per Year	23.95	19.45	4.55	3.55

Parameter	ALAM 1	ALAM 2	ALAM 3	ALAM 4
Difference (%)				
Total Adult Upstream Passage (1991–2010)	35.53	44.41	12.80	21.78
Average Adult Upstream Passage Per Year	35.53	44.41	12.80	21.78

[a] Rounded to whole days

There would be a 414% (9 days per year) average increase to adult upstream passage in Calero Creek compared with the future baseline (Figure 151; Table 100).

Figure 151. Change in Average Adult Steelhead Upstream Passage Days Compared with the Future Baseline in Calero Creek

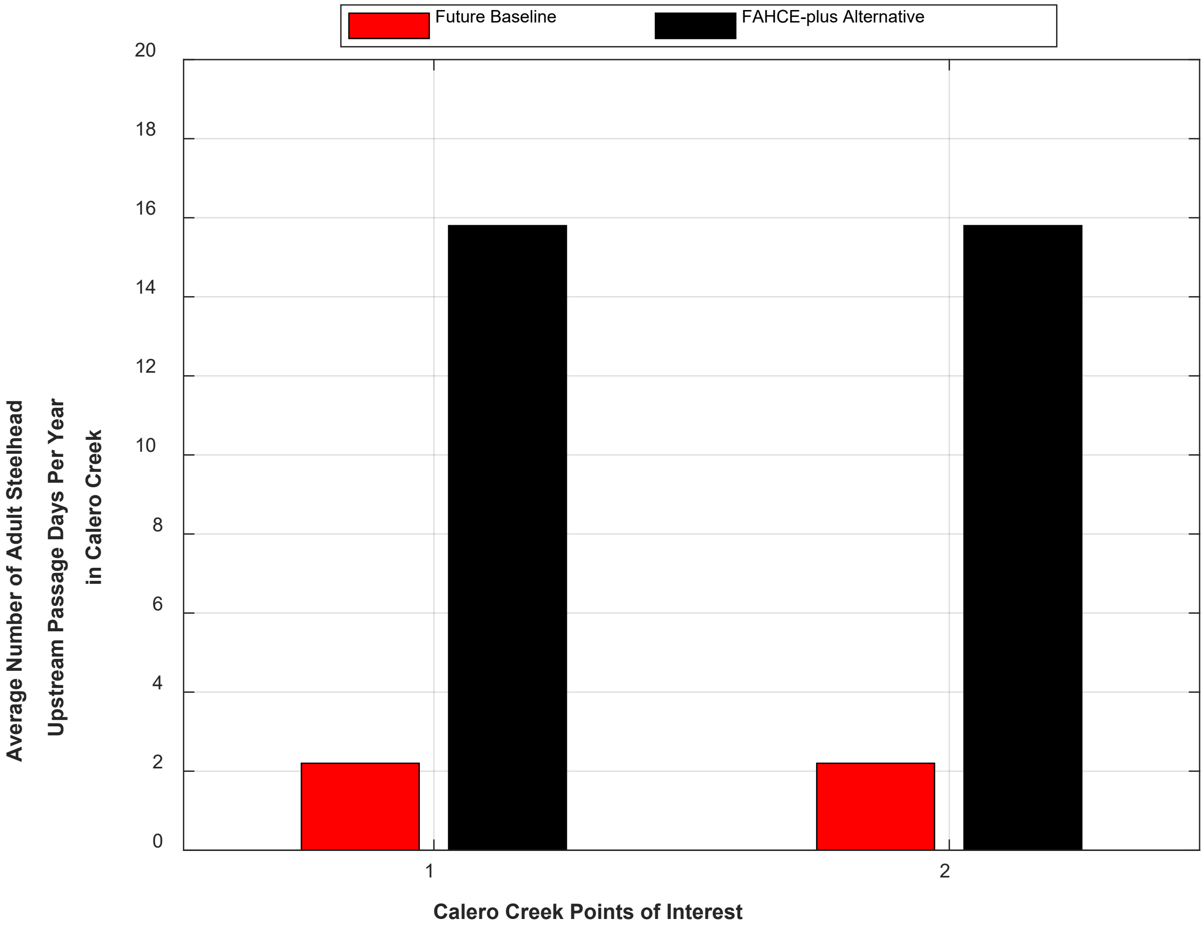


Table 100. FAHCE-plus Alternative Adult Steelhead Upstream Passage Compared with the Future Baseline in Calero Creek

Parameter	CALE 1	CALE 2
Future Baseline (days)[a]		
Total Adult Upstream Passage (1991–2010)	44	44
Average Adult Upstream Passage Per Year	2	2
FAHCE-plus Alternative (days)[a]		
Total Adult Upstream Passage (1991–2010)	226	226
Average Adult Upstream Passage Per Year	11	11
Difference (days)		
Total Adult Upstream Passage (1991–2010)	182.00	182.00
Average Adult Upstream Passage Per Year	9.10	9.10
Difference (%)		
Total Adult Upstream Passage (1991–2010)	413.64	413.64
Average Adult Upstream Passage Per Year	413.64	413.64

[a] Rounded to whole days

The FAHCE-plus Alternative compared with the future baseline would result in increases to adult upstream passage in many locations within the Guadalupe River portion of the study area, except for Los Gatos Creek which would result in a decrease. Increases in passage is a primary goal of the FAHCE-plus Alternative.

Juvenile Downstream Passage

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result a 19% (6 days per year) average increase to juvenile downstream passage in the Guadalupe River compared with the future baseline (Figure 152; Table 101). There would also be a substantial increase in downstream passage in both wet and dry years (Figure 152). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in a 27% (17 days per year) average increase to juvenile downstream passage in the Guadalupe River compared with the future baseline (Table 101). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in the Guadalupe River under the FAHCE-plus Alternative compared to the future baseline. Additionally, there was no change in number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in the Guadalupe River under the FAHCE-plus Alternative compared to the future baseline.

Figure 152. Change in Average Juvenile Steelhead Downstream Passage Days Compared with the Future Baseline in the Guadalupe River

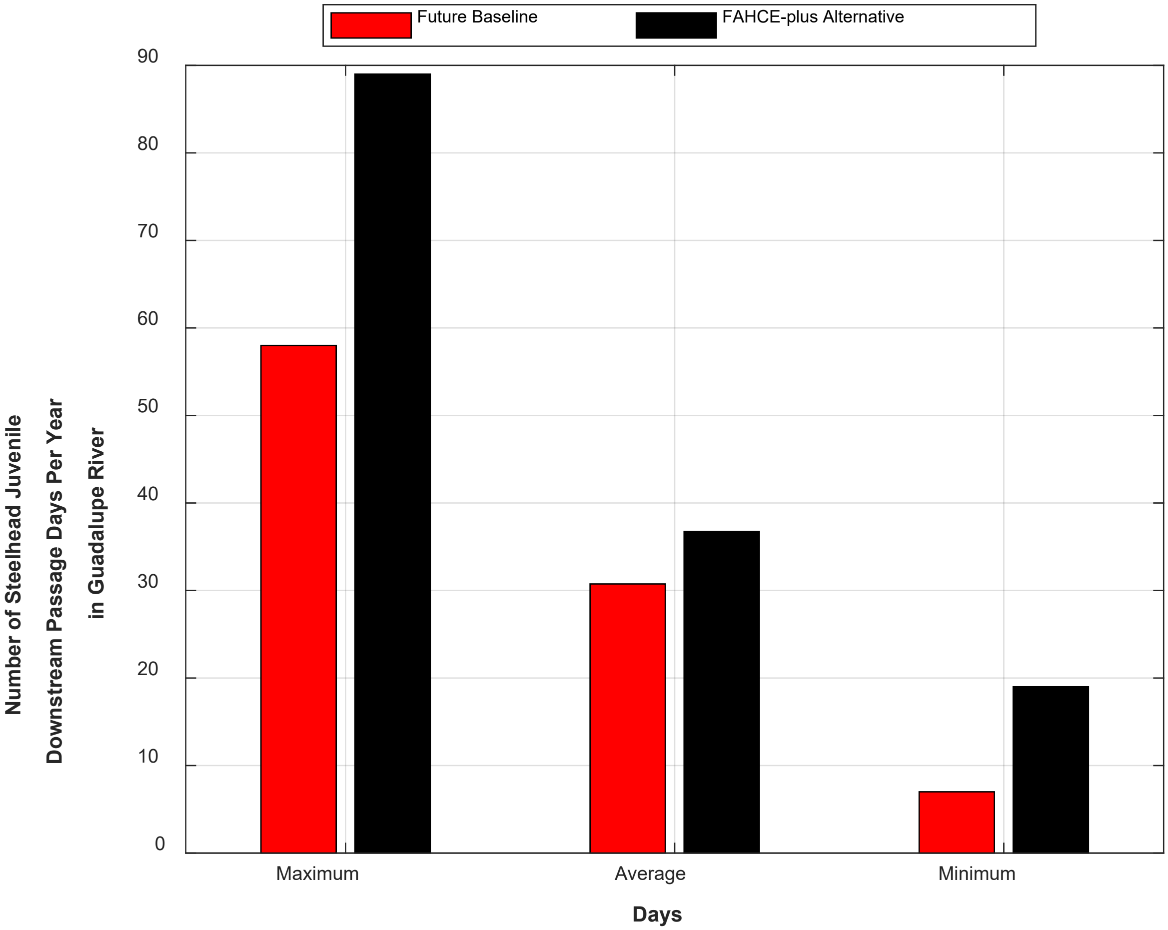


Table 101. FAHCE-plus Alternative Juvenile Steelhead Downstream Passage Compared with the Future Baseline in the Guadalupe River

Parameter	GUAD 7 with Water Temperature Criteria[b]	GUAD 7 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	615	1,255
Average Juvenile Downstream Passage Per Year	31	63
FAHCE-plus Alternative (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	735	1,594
Average Juvenile Downstream Passage Per Year	37	80

Parameter	GUAD 7 with Water Temperature Criteria[b]	GUAD 7 without Water Temperature Criteria[c]
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	120.00	339.00
Average Juvenile Downstream Passage Per Year	6.00	17.00
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	19.51	27.01
Average Juvenile Downstream Passage Per Year	19.35	26.98

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 6% (2 days per year) average increase to juvenile downstream passage in Los Gatos Creek compared with the future baseline (Figure 153; Table 102). However, during dry years (when the minimum passage is observed), the FAHCE-plus Alternative would nearly double the number of downstream passage days per year (Figure 153). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in a 13% (12 days per year) average increase to juvenile downstream passage in Los Gatos Creek compared with the future baseline (Table 102). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in Los Gatos Creek under the FAHCE-plus Alternative compared to the future baseline. Additionally, there was no change in number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in Los Gatos Creek under the FAHCE-plus Alternative compared to the future baseline.

Figure 153. Change in Average Juvenile Steelhead Downstream Passage Days Compared with the Future Baseline in Los Gatos Creek

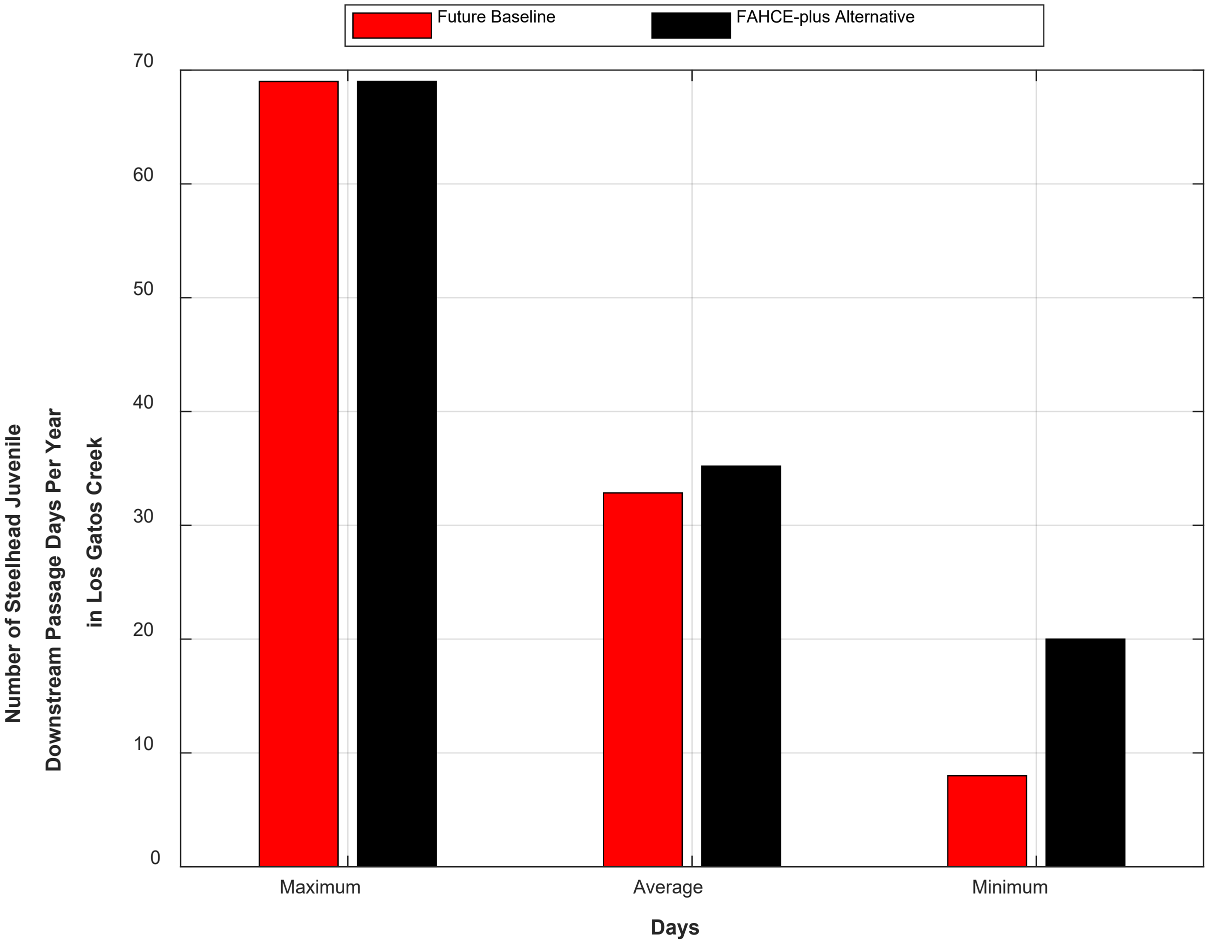


Table 102. FAHCE-plus Alternative Juvenile Steelhead Downstream Passage Compared with the Future Baseline in Los Gatos Creek

Parameter	LOSG 2 with Water Temperature Criteria[b]	LOSG 2 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	657	1,857
Average Juvenile Downstream Passage Per Year	33	93
FAHCE-plus Alternative (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	704	2,097
Average Juvenile Downstream Passage Per Year	35	105

Parameter	LOSG 2 with Water Temperature Criteria[b]	LOSG 2 without Water Temperature Criteria[c]
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	47.00	240.00
Average Juvenile Downstream Passage Per Year	2.00	12.00
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	7.15	12.92
Average Juvenile Downstream Passage Per Year	6.06	12.90

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 200% (16 days per year, or nearly triple compared with the future baseline) average increase to juvenile downstream passage in Guadalupe Creek (Figure 154; Table 103). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in a 100% (19 days per year) average increase to juvenile downstream passage in Guadalupe Creek compared with the future baseline (Table 103). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in Guadalupe Creek increased by six under the FAHCE-plus Alternative compared to the future baseline. Additionally, the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in Guadalupe Creek increased by five under the FAHCE-plus Alternative compared to the future baseline.

Figure 154. Change in Average Juvenile Steelhead Downstream Passage Days Compared with the Future Baseline in Guadalupe Creek

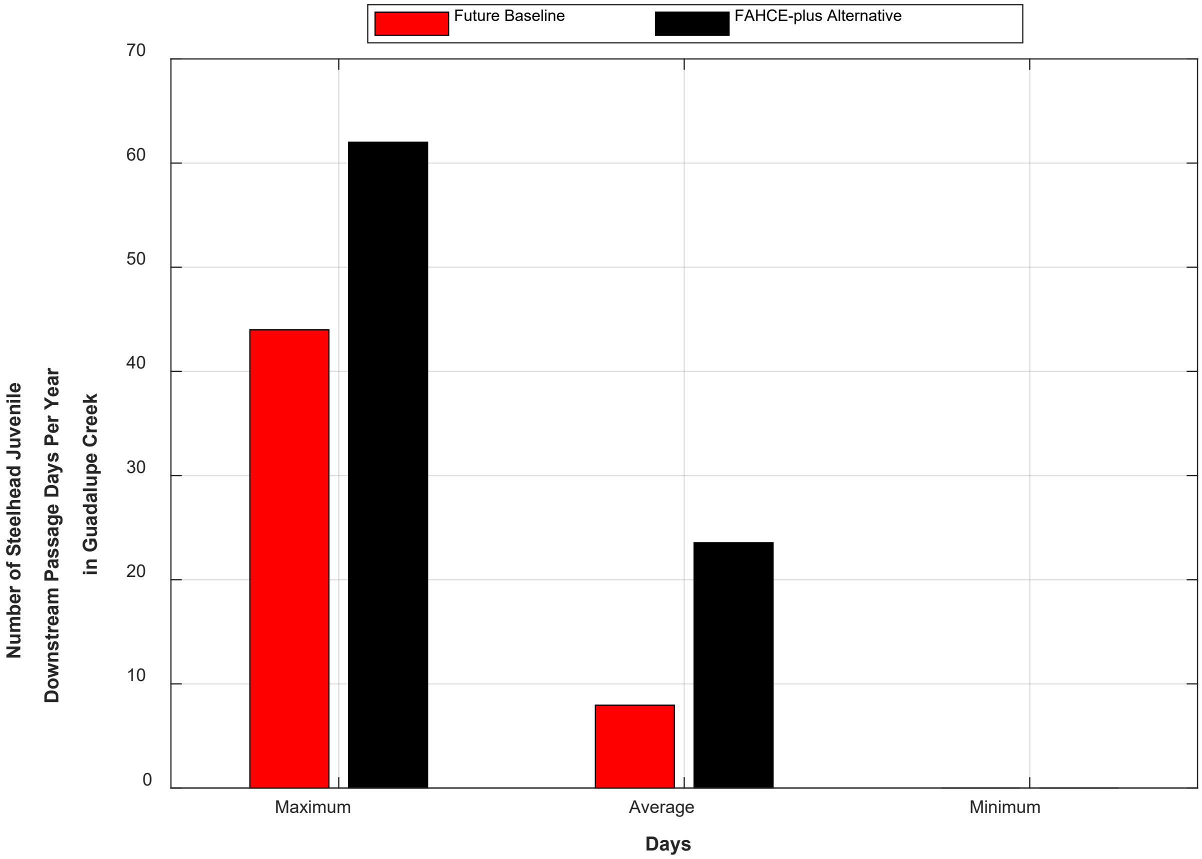


Table 103. FAHCE-plus Alternative Juvenile Steelhead Downstream Passage Compared with the Future Baseline in Guadalupe Creek

Parameter	GCRK 4 with Water Temperature Criteria[b]	GCRK 4 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	159	386
Average Juvenile Downstream Passage Per Year	8	19
FAHCE-plus Alternative (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	471	760
Average Juvenile Downstream Passage Per Year	24	38
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	312.00	374.00
Average Juvenile Downstream Passage Per Year	16.00	19.00

Parameter	GCRK 4 with Water Temperature Criteria[b]	GCRK 4 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	196.23	96.89
Average Juvenile Downstream Passage Per Year	200.00	100.00

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 5% (1 day per year on average) increase to juvenile downstream passage in Alamitos Creek compared with the future baseline (Figure 155; Table 104). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in a 20% (7 days per year) average increase to juvenile downstream passage in Alamitos Creek compared with the future baseline (Table 104). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in Alamitos Creek decreased by one under the FAHCE-plus Alternative compared to the future baseline. Additionally, the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in Alamitos Creek decreased by one under the FAHCE-plus Alternative compared to the future baseline.

Figure 155. Change in Average Juvenile Steelhead Downstream Passage Days Compared with the Future Baseline in Alamitos Creek

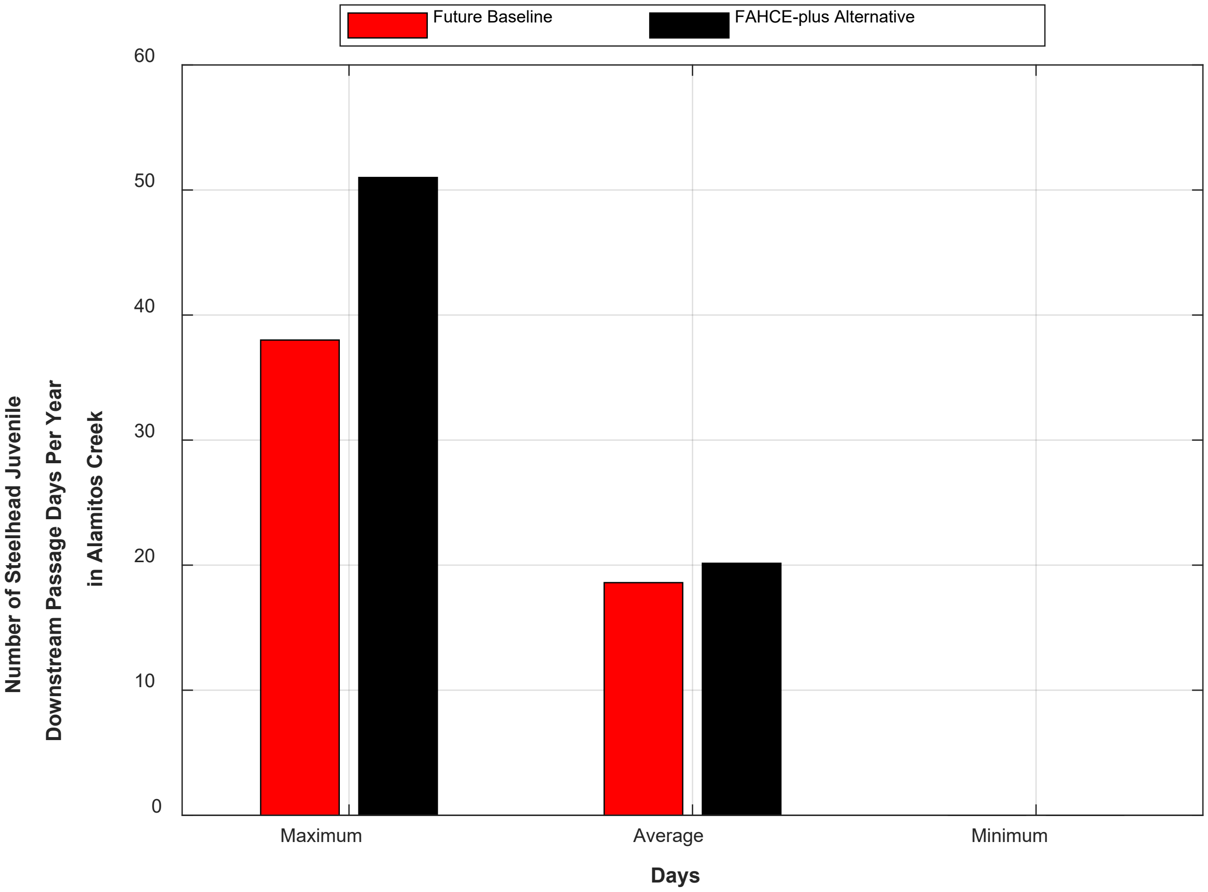


Table 104. FAHCE-plus Alternative Juvenile Steelhead Downstream Passage Compared with the Future Baseline in Alamitos Creek

Parameter	ALAM 4 with Water Temperature Criteria[b]	ALAM 4 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	372	700
Average Juvenile Downstream Passage Per Year	19	35
FAHCE-plus Alternative (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	403	830
Average Juvenile Downstream Passage Per Year	20	42
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	31.00	130.00
Average Juvenile Downstream Passage Per Year	1.00	7.00

Parameter	ALAM 4 with Water Temperature Criteria[b]	ALAM 4 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	8.33	18.57
Average Juvenile Downstream Passage Per Year	5.26	20.00

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

The Proposed Project would result in a 281% (23 days per year) average increase to juvenile downstream passage in Calero Creek, which is nearly quadruple the passage opportunities provided by the future baseline (Figure 156; Table 105). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in a 338% (44 days per year) average increase to juvenile downstream passage in Calero Creek compared with the future baseline (Table 105). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for steelhead in Calero Creek increased by nine under the FAHCE-plus Alternative compared to the future baseline. Additionally, the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event when excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results for steelhead in Calero Creek increased by six under the FAHCE-plus Alternative compared to the future baseline.

Figure 156. Change in Average Juvenile Steelhead Downstream Passage Days Compared with the Future Baseline in Calero Creek

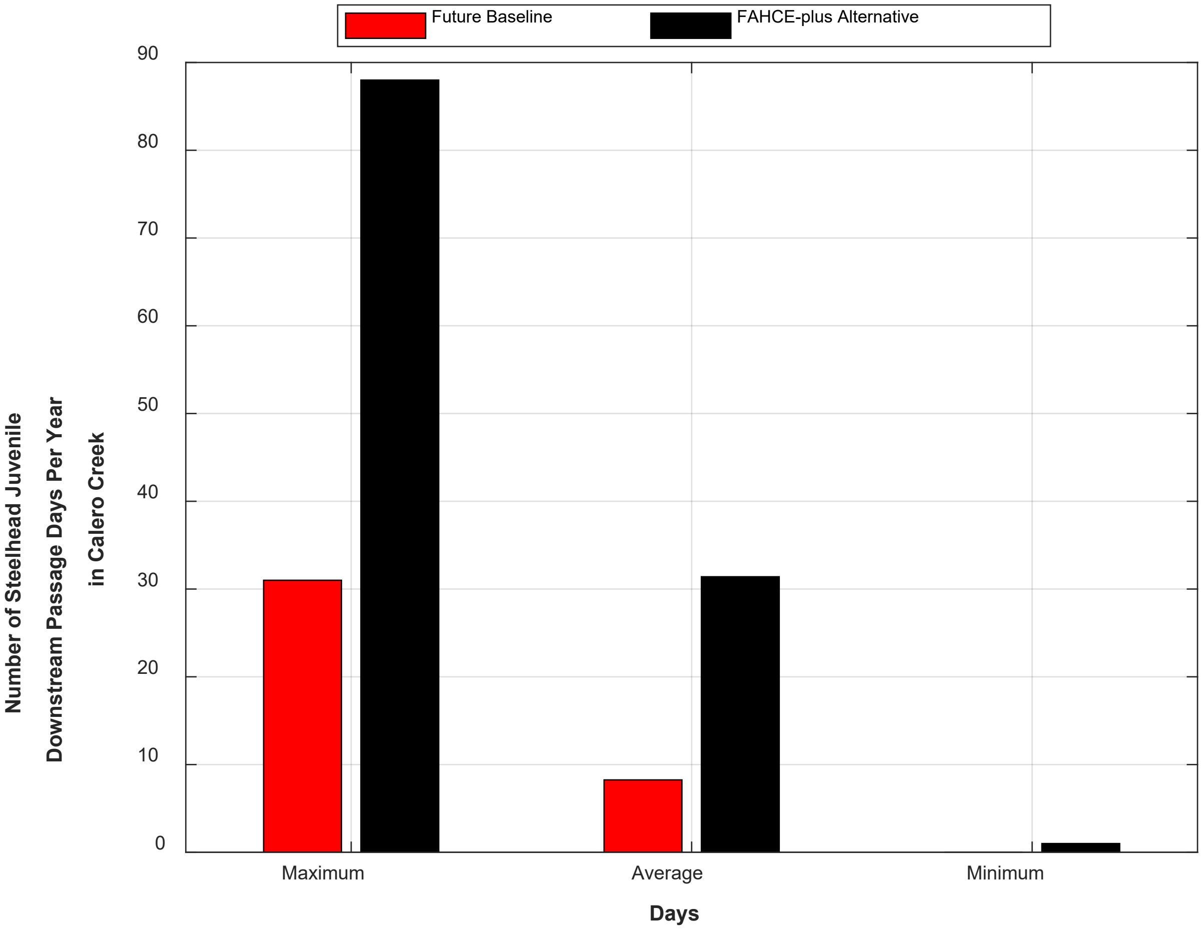


Table 105. FAHCE-plus Alternative Juvenile Steelhead Downstream Passage Compared with the Future Baseline in Calero Creek

Parameter	CALE 2 with Water Temperature Criteria[b]	CALE 2 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	165	267
Average Juvenile Downstream Passage Per Year	8	13
FAHCE-plus Alternative (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	628	1130
Average Juvenile Downstream Passage Per Year	31	57
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	463.00	863.00
Average Juvenile Downstream Passage Per Year	23.00	44.00

Parameter	CALE 2 with Water Temperature Criteria[b]	CALE 2 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	280.61	323.22
Average Juvenile Downstream Passage Per Year	287.50	338.46

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

1.6.2.2 Assessment of Chinook Salmon and Chinook Salmon Habitat in the Guadalupe River Portion of the Study Area

Assessments of the effects of the FAHCE-plus Alternative on Chinook salmon, Chinook salmon habitat, and migration conditions within the Guadalupe River portion of the study area are provided in the following subsections.

Flow Measures Current Baseline Assessment

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, there would be a 26% (3,230 square feet) average decrease in effective spawning habitat in the Guadalupe River during the spawning and incubation life-stage time period for Chinook salmon (that is, October 15 to January 31) resulting from the FAHCE-plus Alternative (Figure 157; Table 106).

Figure 157. Change in Effective Chinook Salmon Spawning Habitat Compared with the Current Baseline in the Guadalupe River

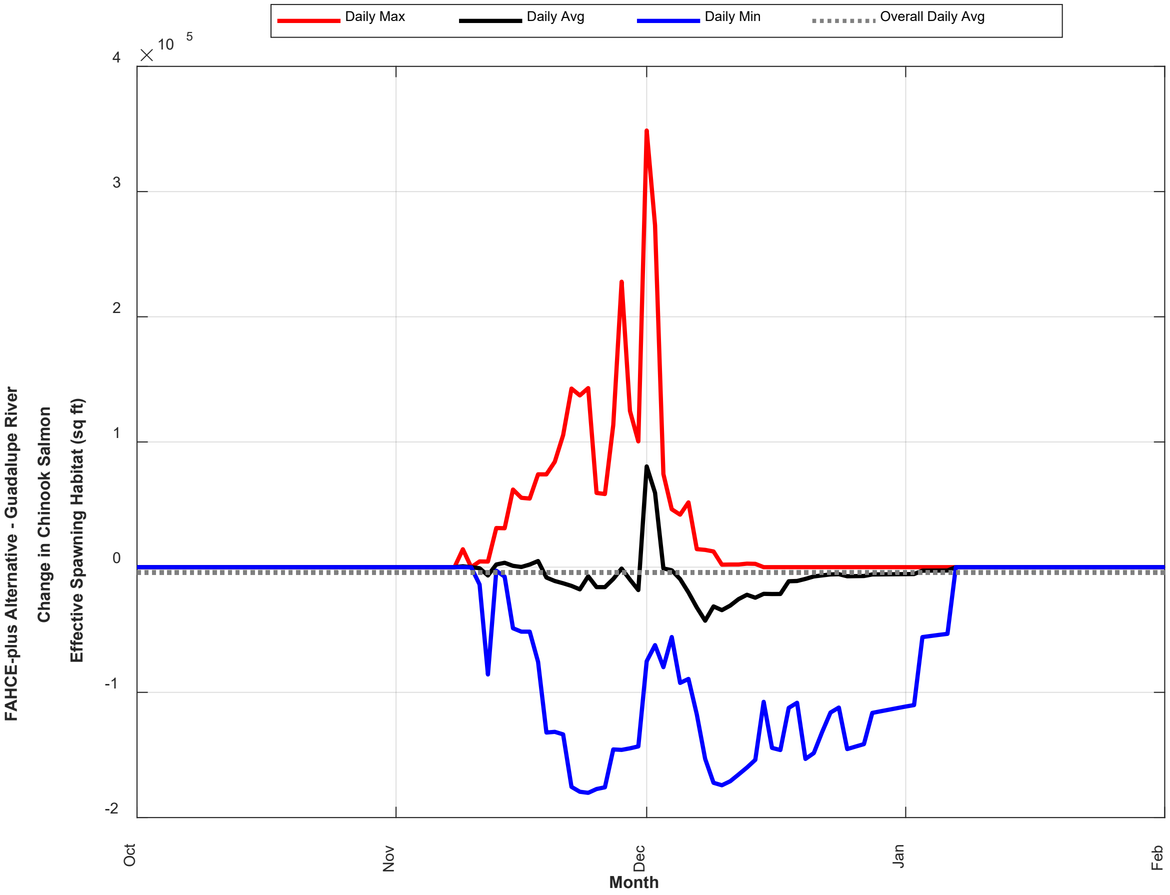


Table 106. FAHCE-plus Alternative Chinook Salmon Habitat Compared with the Current Baseline in the Guadalupe River

Guadalupe River[a,b]	GUAD 3 River Mile 10.07	GUAD 4 River Mile 12.52	GUAD 5 River Mile 13.42	GUAD 6 River Mile 18.45	GUAD 7 River Mile 19.93	Total
Chinook Salmon Habitat Current Baseline (sq ft)						
Effective Spawning	4,830	2,850	359	552	3,650	12,241
Fry Rearing Total (Jan 1–Apr 30)	211,000	199,000	93,400	561,000	395,000	1,459,400
Juvenile Rearing Total (Jan 1–Jun 30)	204,000	210,000	75,500	469,000	377,000	1,335,500
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	223,000	215,000	83,600	546,000	419,000	1,486,600
Juvenile Rearing Summer Release Program (May 1–Jun 30)	166,000	199,000	59,200	317,000	293,000	1,034,200

Guadalupe River[a,b]	GUAD 3 River Mile 10.07	GUAD 4 River Mile 12.52	GUAD 5 River Mile 13.42	GUAD 6 River Mile 18.45	GUAD 7 River Mile 19.93	Total
Chinook Salmon FAHCE-plus Alternative (sq ft)						
Effective Spawning	3,060	1,870	388	823	2,870	9,011
Fry Rearing Total (Jan 1–Apr 30)	211,000	197,000	93,500	558,000	387,000	1,446,500
Juvenile Rearing Total (Jan 1–Jun 30)	202,000	208,000	74,100	462,000	364,000	1,310,100
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	223,000	216,000	83,500	544,000	408,000	1,474,500
Juvenile Rearing Summer Release Program (May 1–Jun 30)	162,000	192,000	55,300	301,000	277,000	987,300
Change in Habitat (sq ft)						
Effective Spawning	-1,770 (-36.65%)	-980 (-34.39%)	29 (8.08%)	271 (49.09%)	-780 (-21.37%)	-3,230 (-26.39%)
Fry Rearing Total (Jan 1–Apr 30)	0 (0%)	-2,000 (-1.01%)	100 (0.11%)	-3,000 (-0.53%)	-8,000 (-2.03%)	-12,900 (-0.88%)
Juvenile Rearing Total (Jan 1–Jun 30)	-2,000 (-0.98%)	-2,000 (-0.95%)	-1,400 (-1.85%)	-7,000 (-1.49%)	-13,000 (-3.45%)	-25,400 (-1.9%)
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	0 (0%)	1,000 (0.47%)	-100 (-0.12%)	-2,000 (-0.37%)	-11,000 (-2.63%)	-12,100 (-0.81%)
Juvenile Rearing Summer Release Program (May 1–Jun 30)	-4,000 (-2.41%)	-7,000 (-3.52%)	-3,900 (-6.59%)	-16,000 (-5.05%)	-16,000 (-5.46%)	-46,900 (-4.53%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.
[b] No average daily habitat availability model results are available for the points of interest not shown.

Based on the results of the FAHCE WEAP Model, there would be an average 80% (5,088 square feet) decrease in effective spawning habitat in Los Gatos Creek during the spawning and incubation life-stage time period for Chinook salmon (that is, October 15 to January 31) resulting from the FAHCE-plus Alternative (Table 107). The decrease in effective spawning habitat is observed in November and there is little change in effective spawning habitat under the FAHCE-plus Alternative outside of this period in Los Gatos Creek (Figure 158).

Figure 158. Change in Effective Chinook Salmon Spawning Habitat Compared with the Current Baseline in Los Gatos Creek

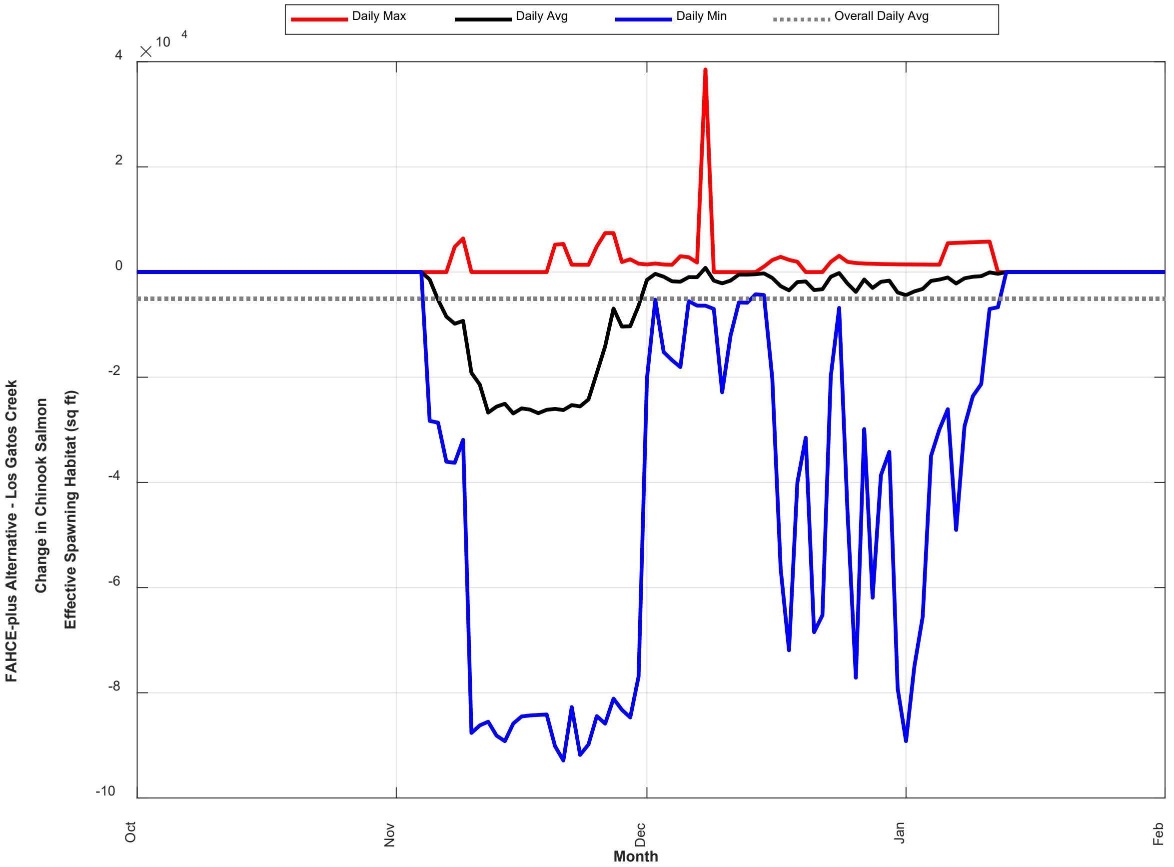


Table 107. FAHCE-plus Alternative Chinook Salmon Habitat Compared with the Current Baseline in Los Gatos Creek

Los Gatos Creek[a]	LOSG 1 River Mile 14.70	LOSG 2 River Mile 18.91	Total
Chinook Salmon Habitat Current Baseline (sq ft)			
Effective Spawning	2,810	3,580	6,390
Fry Rearing Total (Jan 1–Apr 30)	175,000	313,000	488,000
Juvenile Rearing Total (Jan 1–Jun 30)	139,000	253,000	392,000
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	142,000	251,000	393,000
Juvenile Rearing Summer Release Program (May 1–Jun 30)	133,000	256,000	389,000

Los Gatos Creek[a]	**LOSG 1 River Mile 14.70**	**LOSG 2 River Mile 18.91**	**Total**
Chinook Salmon FAHCE-plus Alternative (sq ft)			
Effective Spawning	513	789	1,302
Fry Rearing Total (Jan 1–Apr 30)	180,000	323,000	503,000
Juvenile Rearing Total (Jan 1–Jun 30)	141,000	259,000	400,000
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	148,000	265,000	413,000
Juvenile Rearing Summer Release Program (May 1–Jun 30)	125,000	245,000	370,000
Change in Habitat (sq ft)			
Effective Spawning	-2,297 (-81.74%)	-2,791 (-77.96%)	-5,088 (-79.62%)
Fry Rearing Total (Jan 1–Apr 30)	5,000 (2.86%)	10,000 (3.19%)	15,000 (3.07%)
Juvenile Rearing Total (Jan 1–Jun 30)	2,000 (1.44%)	6,000 (2.37%)	8,000 (2.04%)
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	6,000 (4.23%)	14,000 (5.58%)	20,000 (5.09%)
Juvenile Rearing Summer Release Program (May 1–Jun 30)	-8,000 (-6.02%)	-11,000 (-4.3%)	-19,000 (-4.88%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

Based on the results of the FAHCE WEAP Model, there would be a 79% (705 square feet) average increase in daily effective spawning habitat in Guadalupe Creek during the spawning and incubation life-stage time period for Chinook salmon (that is, October 15 to January 31) resulting from the FAHCE-plus Alternative when compared with the current base (Table 108). In the Guadalupe Creek CWMZ (represented by the model results at GUAD 4), there would be a 130% (294 square foot) average increase in Chinook salmon effective spawning habitat over the entire life-stage. Daily effective spawning habitat primarily increases in December when multiple large peaks occur under the FAHCE-plus Alternative with very little change during the remainder of the spawning and incubation period in Guadalupe Creek (Figure 159).

Figure 159. Change in Effective Chinook Salmon Spawning Habitat Compared with the Current Baseline in Guadalupe Creek

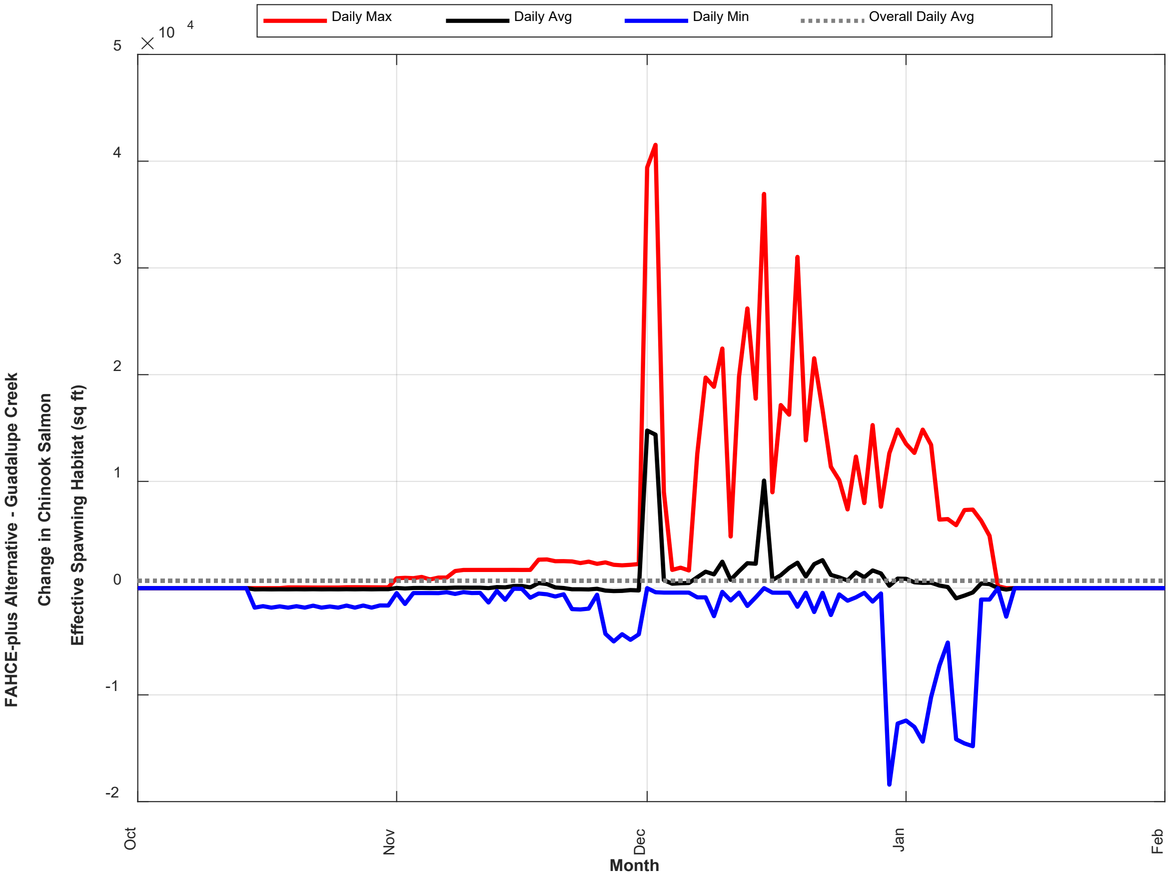


Table 108. FAHCE-plus Alternative Chinook Salmon Habitat Compared with the Current Baseline in Guadalupe Creek

Guadalupe Creek[a]	GCRK 1 River Mile 20.71	GCRK 2 River Mile 21.91	GCRK 3 River Mile 22.54	GCRK 4 River Mile 26.17	Total
Chinook Salmon Habitat Current Baseline (sq ft)					
Effective Spawning	92	522	58	227	898
Fry Rearing Total (Jan 1–Apr 30)	20,900	40,700	3,350	23,800	88,750
Juvenile Rearing Total (Jan 1–Jun 30)	15,100	40,400	3,580	22,400	81,480
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	20,300	42,600	3,580	20,400	86,880
Juvenile Rearing Summer Cold Water Program (May 1–Jun 30)	4,730	36,000	3,600	26,400	70,730

Guadalupe Creek[a]	GCRK 1 River Mile 20.71	GCRK 2 River Mile 21.91	GCRK 3 River Mile 22.54	GCRK 4 River Mile 26.17	Total
Chinook Salmon FAHCE-plus Alternative (sq ft)					
Effective Spawning	364	653	65	521	1,603
Fry Rearing Total (Jan 1–Apr 30)	21,600	44,300	3,360	23,200	92,460
Juvenile Rearing Total (Jan 1–Jun 30)	15,300	38,500	3,430	24,100	81,330
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	21,700	46,500	3,850	24,500	96,550
Juvenile Rearing Summer Cold Water Program (May 1–Jun 30)	2,700	22,800	2,580	23,500	51,580
Change in Habitat (sq ft)					
Effective Spawning	273 (297.81%)	131 (25.1%)	7 (12.28%)	294 (129.52%)	705 (78.51%)
Fry Rearing Total (Jan 1–Apr 30)	700 (3.35%)	3,600 (8.85%)	10 (0.3%)	-600 (-2.52%)	3,710 (4.18%)
Juvenile Rearing Total (Jan 1–Jun 30)	200 (1.32%)	-1,900 (-4.7%)	-150 (-4.19%)	1,700 (7.59%)	-150 (-0.18%)
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	1,400 (6.9%)	3,900 (9.15%)	270 (7.54%)	4,100 (20.1%)	9,670 (11.13%)
Juvenile Rearing Summer Cold Water Program (May 1–Jun 30)	-2,030 (-42.92%)	-13,200 (-36.67%)	-1,020 (-28.33%)	-2,900 (-10.98%)	-19,150 (-27.07%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

Based on the results of the FAHCE WEAP Model, there would be a 23% (108 square feet) average decrease in daily effective spawning habitat in Alamitos Creek for Chinook salmon resulting from the FAHCE-plus Alternative (Figure 160; Table 109). The average decrease in daily effective spawning habitat over the entire life-stage primarily results from decreases in daily effective spawning habitat during November in the reach between ALAM 1 and ALAM 2 (represented by model results at ALAM 2) under the FAHCE-plus Alternative. While there would be a decrease in the daily effective spawning habitat for Chinook salmon during November at ALAM 2 under the FAHCE-plus Alternative compared to the current baseline, the daily effective spawning habitat at ALAM 2 would still range from 139 square feet to approximately 500 square feet under the FAHCE-plus Alternative during this time. Decreases in the daily effective spawning habitat in November are associated with a decrease in flow and the associated decrease in wetted area in Alamitos Creek under the FAHCE-plus Alternative compared to the current baseline (Attachment K.3 – Figures K.3.50 and K.3.52). Modeled increases in the average daily effective spawning habitat between ALAM 2 and ALAM 3 (represented by the model results at ALAM 3) are relatively small under the FAHCE-plus Alternative compared to the current baseline. Average daily effective spawning habitat for Chinook salmon between ALAM 3 and ALAM 4 (represented by the model results at ALAM 4) would increase from approximately 150 square feet or less under the current baseline to approximately 250 square feet to 500 square feet under the FAHCE-plus Alternative. Additionally, average daily effective spawning habitat at ALAM 4 would consistently exceed 100 square feet from December through mid-January under the FAHCE-plus

Alternative compared to only limited periods (for example, approximately 1 week) at the end of November and beginning of January under the current baseline.

Figure 160. Change in Effective Chinook Salmon Spawning Habitat Compared with the Current Baseline in Alamitos Creek

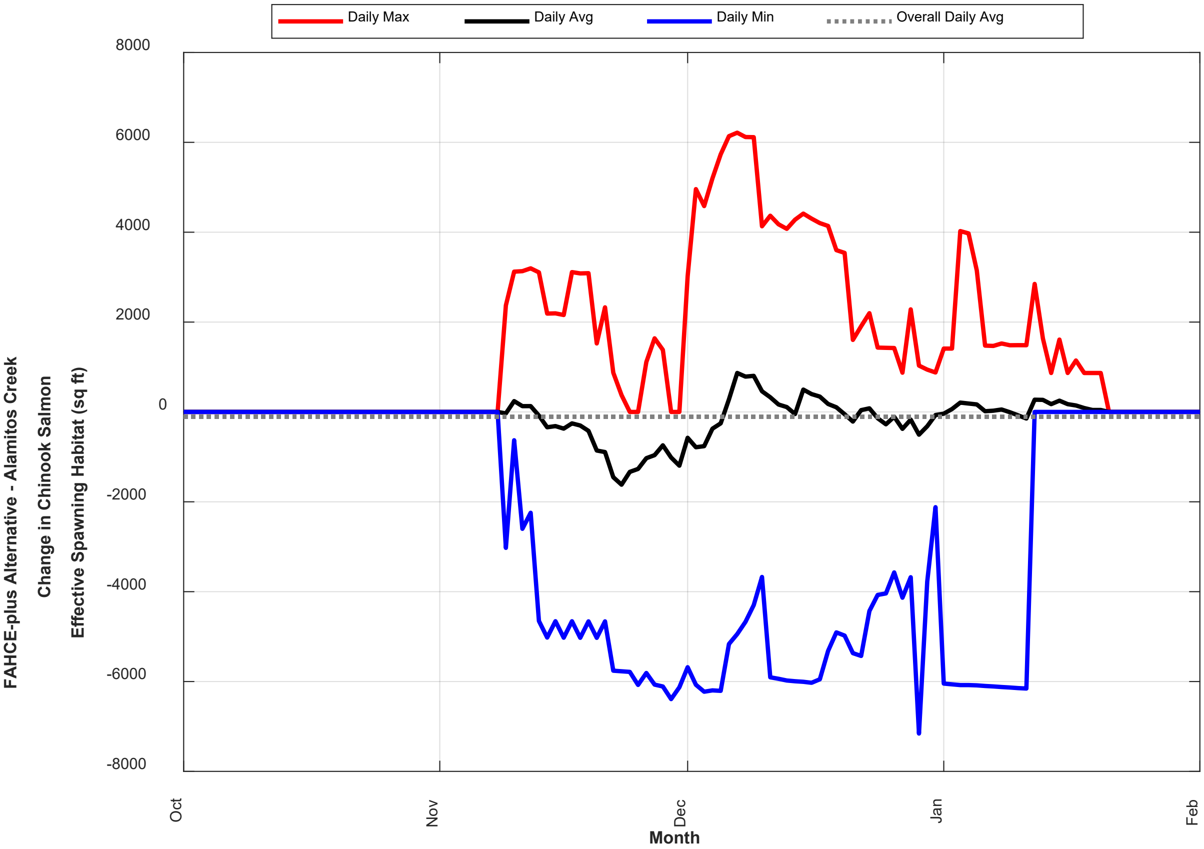


Table 109. FAHCE-plus Alternative Chinook Salmon Habitat Compared with the Current Baseline in Alamitos Creek

Alamitos Creek[a,b]	ALAM 2 River Mile 23.61	ALAM 3 River Mile 24.26	ALAM 4 River Mile 27.89	Total
Chinook Salmon Habitat Current Baseline (sq ft)				
Effective Spawning	421	9	33	462
Fry Rearing Total (Jan 1–Apr 30)	69,900	7,270	3,050	80,220
Juvenile Rearing Total (Jan 1–Jun 30)	66,000	6,970	3,250	76,220
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	70,800	7,430	2,950	81,180
Juvenile Rearing Summer Release Program (May 1–Jun 30)	56,500	6,050	3,850	66,400

Alamitos Creek[a,b]	**ALAM 2 River Mile 23.61**	**ALAM 3 River Mile 24.26**	**ALAM 4 River Mile 27.89**	**Total**
Chinook Salmon FAHCE-plus Alternative (sq ft)				
Effective Spawning	191	21	142	354
Fry Rearing Total (Jan 1–Apr 30)	68,900	7,810	3,410	80,120
Juvenile Rearing Total (Jan 1–Jun 30)	65,300	7,400	3,610	76,310
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	69,400	8,110	3,500	81,010
Juvenile Rearing Summer Release Program (May 1–Jun 30)	57,200	5,980	3,820	67,000
Change in Habitat (sq ft)				
Effective Spawning	-230 (-54.63%)	12 (138.69%)	109 (335.58%)	-108 (-23.43%)
Fry Rearing Total (Jan 1–Apr 30)	-1,000 (-1.43%)	540 (7.43%)	360 (11.8%)	-100 (-0.12%)
Juvenile Rearing Total (Jan 1–Jun 30)	-700 (-1.06%)	430 (6.17%)	360 (11.08%)	90 (0.12%)
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	-1,400 (-1.98%)	680 (9.15%)	550 (18.64%)	-170 (-0.21%)
Juvenile Rearing Summer Release Program (May 1–Jun 30)	700 (1.24%)	-70 (-1.16%)	-30 (-0.78%)	600 (0.9%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

[b] No average daily habitat availability model results are available for the points of interest not shown.

Based on the results of the FAHCE WEAP Model for wetted area, effective spawning habitat would decrease in Calero Creek compared with the current baseline due to decreased wetted area during Winter Base Flow Operations. The largest decrease in effective spawning habitat would occur during the beginning of the spawning period (October–December).

Table 110. FAHCE-plus Alternative Chinook Salmon Habitat Compared with the Current Baseline in Calero Creek

Calero Creek[a]	CALE 1 River Mile 24.33	CALE 2 River Mile 27.59	Total
Chinook Salmon Habitat Current Baseline (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (Jan 1–Apr 30)	2,840	26,000[c]	28,840 [c]
Juvenile Rearing Total (Jan 1–Jun 30)	2,970	52,000[c]	54,970[c]
Juvenile Rearing Winter Base Flow (Jan 1-April 30)	3,050	25,200[c]	28,250[c]
Juvenile Rearing Summer Release Program (May 1-Jun 30)	2,810	105,000	107,810
Chinook Salmon FAHCE-plus Alternative (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (Jan 1-Apr 30)	2,650	21,800[c]	24,450[c]
Juvenile Rearing Total (Jan 1-Jun 30)	2,800	49,200[c]	52,000[c]
Juvenile Rearing Winter Base Flow (Jan 1-April 30)	2,760	19,500[c]	22,260[c]
Juvenile Rearing Summer Release Program (May 1-Jun 30)	2,890	108,000	110,890
Change in Habitat (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (Jan 1-Apr 30)	-190 (-6.69%)	-4,200 (-16.15%)[c]	-4,390 (-15.22%)[c]
Juvenile Rearing Total (Jan 1-Jun 30)	-170 (-5.72%)	-2,800 (-5.38%)[c]	-2,970 (-5.40%)[c]
Juvenile Rearing Winter Base Flow (Jan 1-April 30)	-290 (-9.51%)	-5,700 (-22.62%)[c]	-5,990 (-21.20%)[c]
Juvenile Rearing Summer Release Program (May 1-Jun 30)	80 (2.85%)	3,000 (2.86%)	3,080 (2.86%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

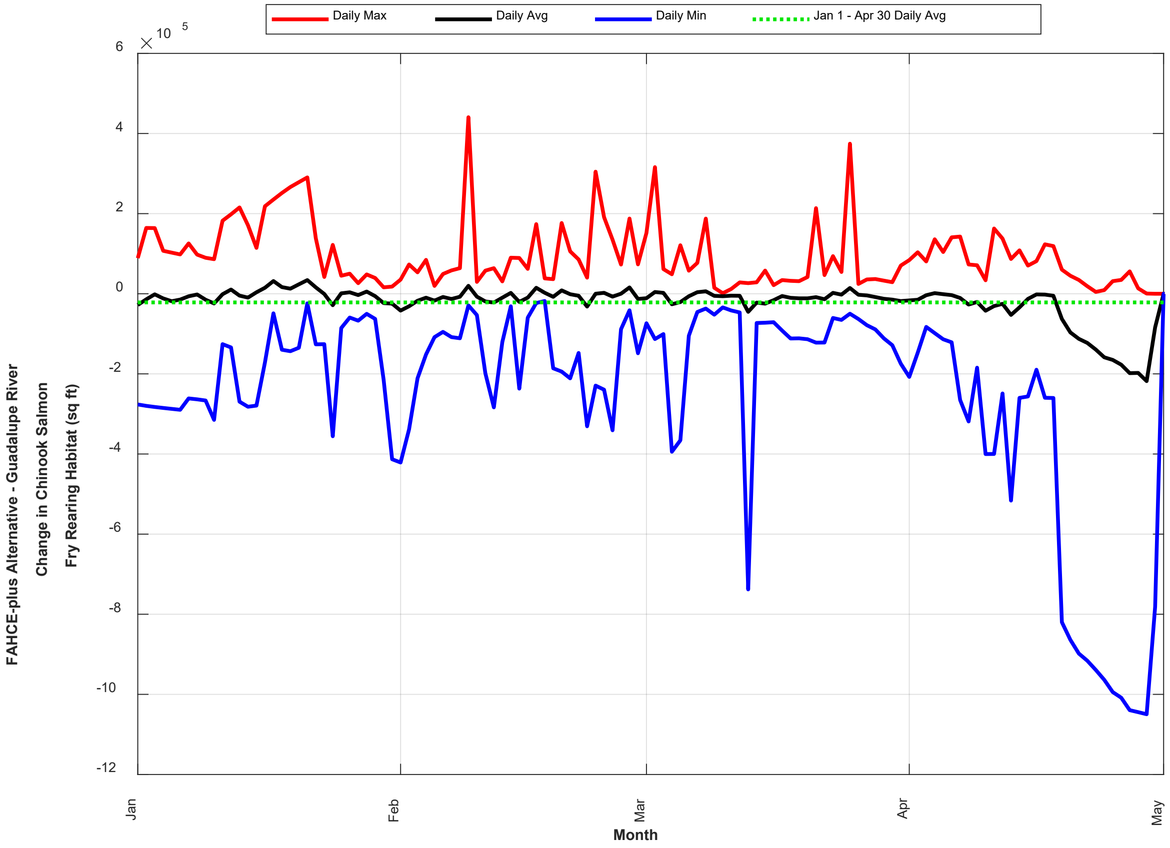
[b] Effective spawning model results were not available in Calero Creek because no substrate suitable for spawning was recorded by the subsample habitat survey of Calero Creek input into the FAHCE WEAP Model. Subsequent surveys indicate there is substrate suitable for spawning in Calero Creek (Valley Water 2019, 2020).

[c] Average daily fry rearing and juvenile rearing habitat availability model results do not quantify conditions when winter cover was considered in the habitat estimate (January 1 through March 31 for Chinook salmon) since no winter cover was recorded by the subsample habitat survey of the CALE 2 reach of Calero Creek (that is, the reach between CALE 1 and CALE 2) input into the FAHCE WEAP Model. Subsequent surveys indicate there is winter cover available in this reach of Calero Creek (Valley Water 2019, 2020).

Fry Rearing Habitat

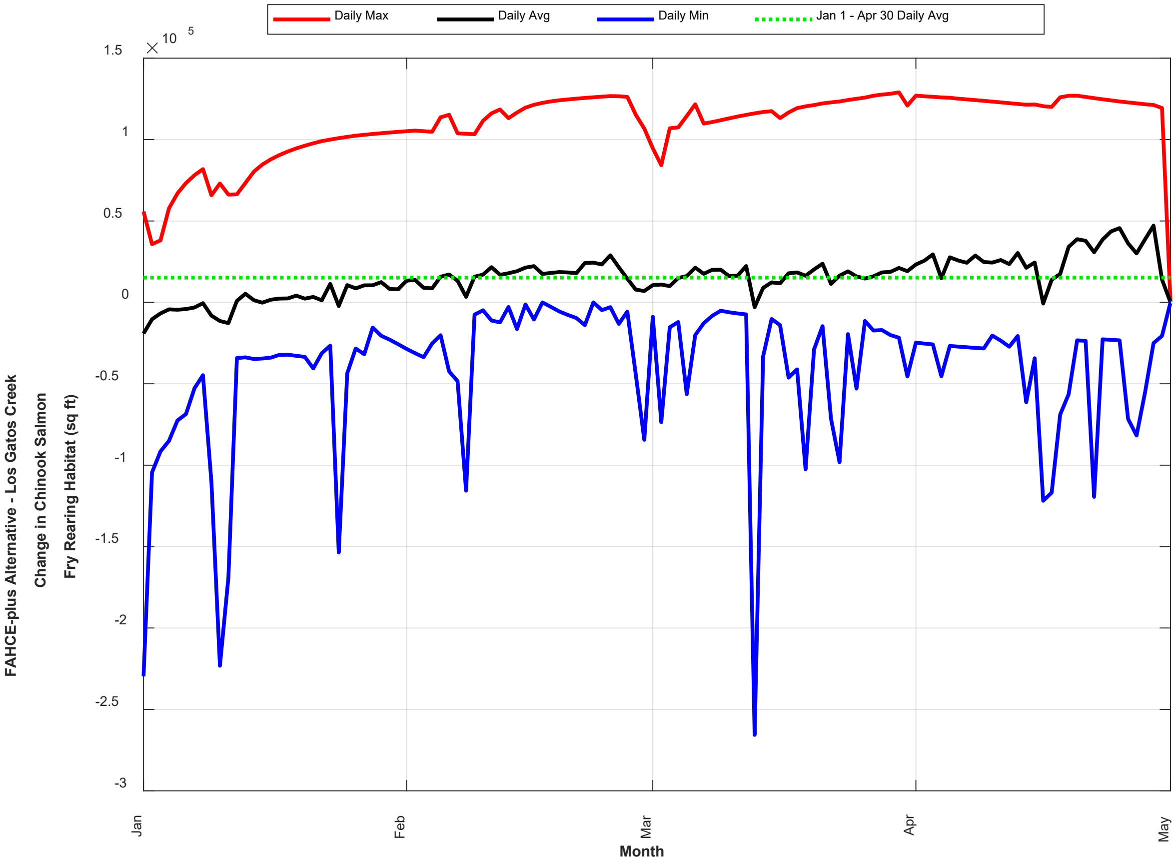
Based on the results of the FAHCE WEAP Model, there would be a 1% (12,900 square feet) decrease in fry rearing habitat in the Guadalupe River for Chinook salmon resulting from the FAHCE-plus Alternative when compared with the current baseline (Table 106). The largest decrease in suitable fry rearing habitat occurs in mid-April, with little change from the current baseline observed outside of this period (Figure 161).

Figure 161. Change in Chinook Salmon Fry Rearing Habitat Compared with the Current Baseline in the Guadalupe River



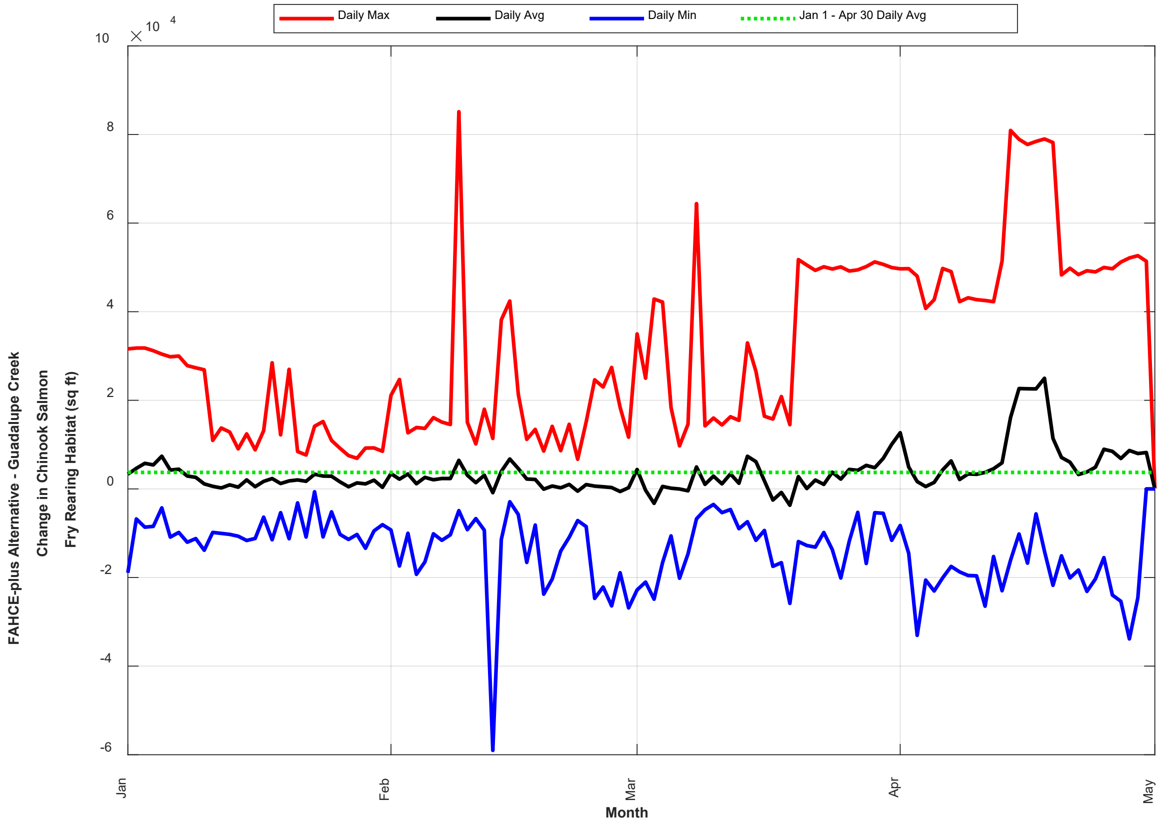
Based on the results of the FAHCE WEAP Model, there would be an average 3% (15,000 square feet) average increase in fry rearing habitat in Los Gatos Creek for Chinook salmon resulting from the FAHCE-plus Alternative when compared with the current baseline (Figure 162; Table 107). Fry rearing habitat steadily increases over the course of the fry rearing period in Los Gatos Creek, reaching a maximum in late April.

Figure 162. Change in Chinook Salmon Fry Rearing Habitat Compared with the Current Baseline in Los Gatos Creek



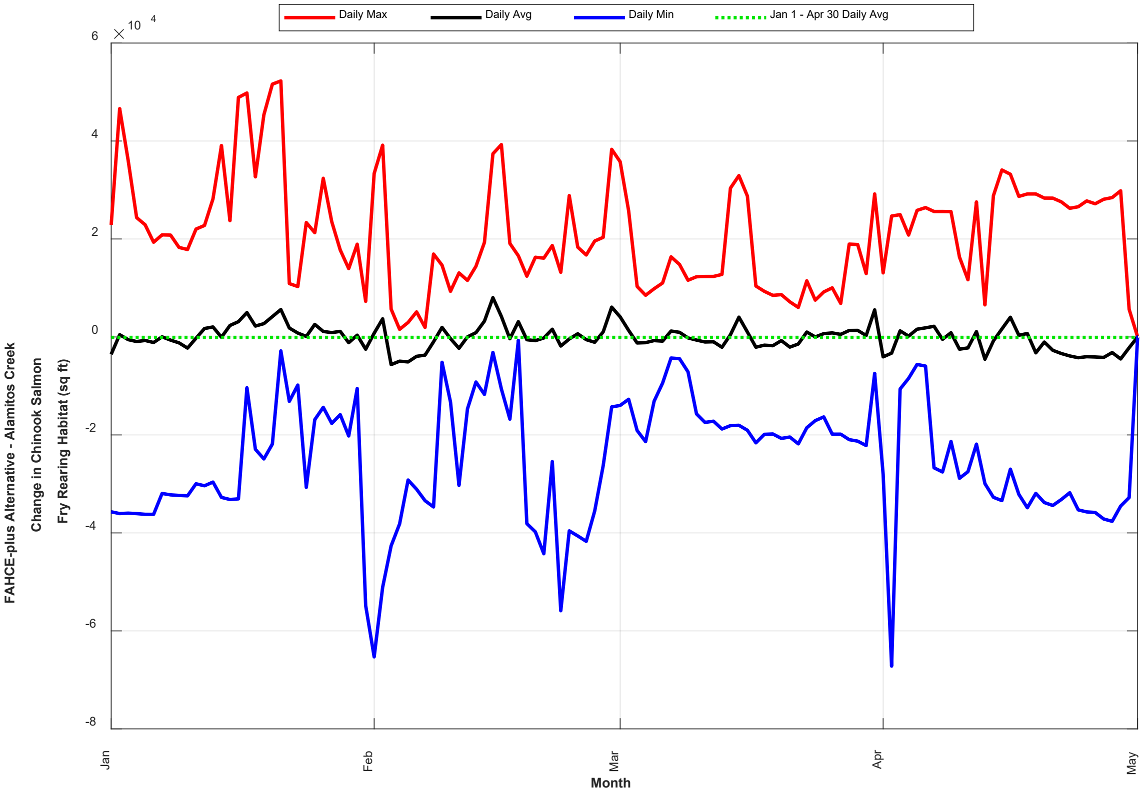
Based on the results of the FAHCE WEAP Model, there would be an average 4% (3,710 square feet) increase in fry rearing habitat in Guadalupe Creek for Chinook salmon resulting from the FAHCE-plus Alternative when compared with the current baseline. In the Guadalupe Creek CWMZ, Chinook salmon fry rearing habitat decreased by 3% (600 square feet) when compared with the current baseline. Suitable fry rearing habitat in Guadalupe Creek reaches a maximum in mid-April (Figure 163; Table 108).

Figure 163. Change in Chinook Salmon Fry Rearing Habitat Compared with the Current Baseline in Guadalupe Creek



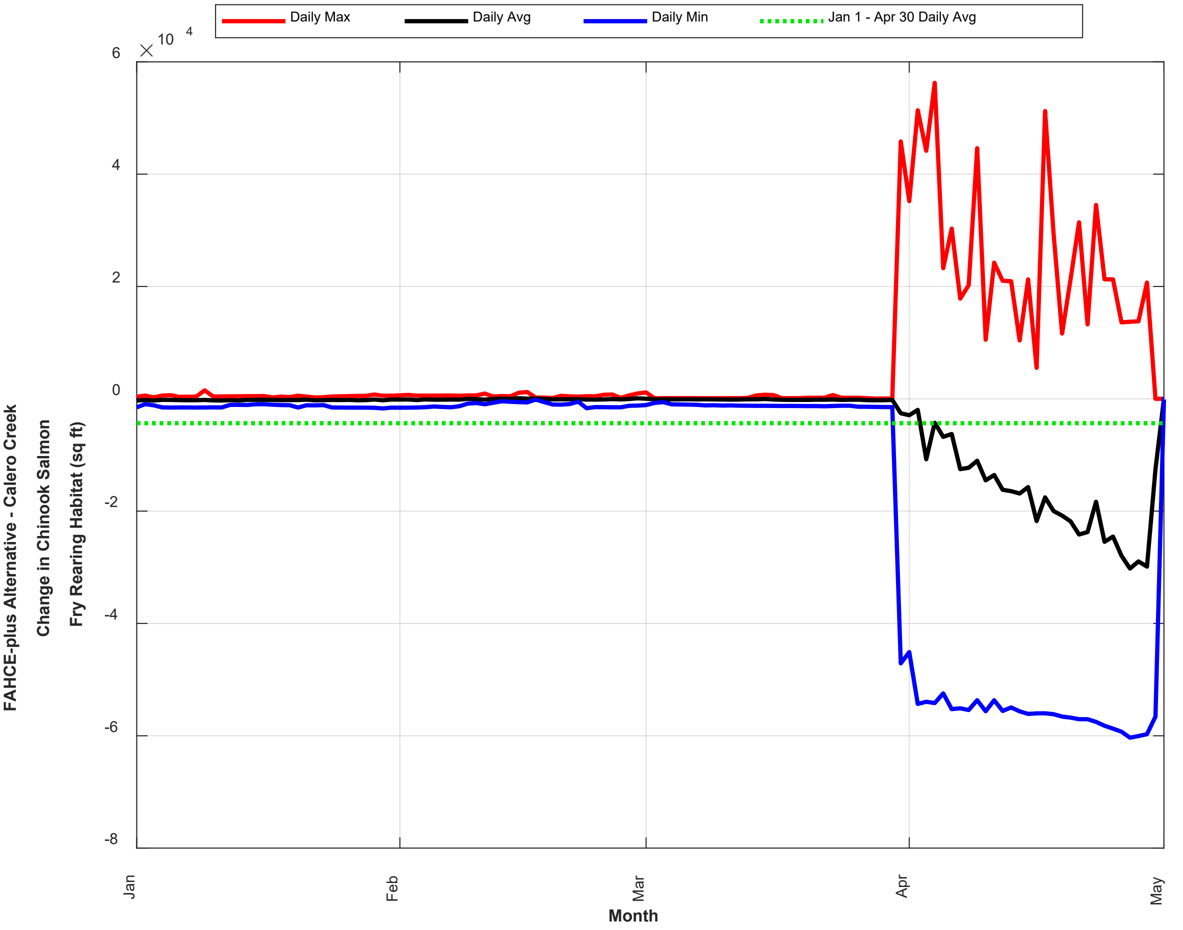
Based on the results of the FAHCE WEAP Model, there would be a negligible <1% (100 square feet) decrease in fry rearing habitat in Alamitos Creek for Chinook salmon resulting from the FAHCE-plus Alternative (Figure 164; Table 109).

Figure 164. Change in Chinook Salmon Fry Rearing Habitat Compared with the Current Baseline in Alamitos Creek



There would be a 15% (4,390 square feet) average decrease in fry rearing habitat in Calero Creek compared with the current baseline (Figure 165). These changes are likely attributable to decreases in wetted area during Winter Base Flow Operations. The average decrease during Winter Base Flow Operations does not completely characterize the change in fry rearing habitat during January 1 through March 31. Habitat survey data input into the model indicated there was zero winter cover in the reach associated with the CALE 2 POI (that is, CALE 1 to CALE 2) and caused fry rearing habitat to be zero in January through March under all scenarios, but subsequent habitat surveys indicated there was winter cover (Valley Water 2019, 2020). Variations in wetted area at CALE 2 under the FAHCE-plus Alternative compared to the current baseline (Attachment K.3 – Figures K.3.63 and K.3.64) suggest there would be a slight increase or decrease in the average change in fry rearing habitat during Winter Base Flow Operations estimated by the model results since wetted area decreases in early January, increases in late-January and February, and decreases in March.

Figure 165. Change in Chinook Salmon Fry Rearing Habitat Compared with the Current Baseline in Calero Creek[a]

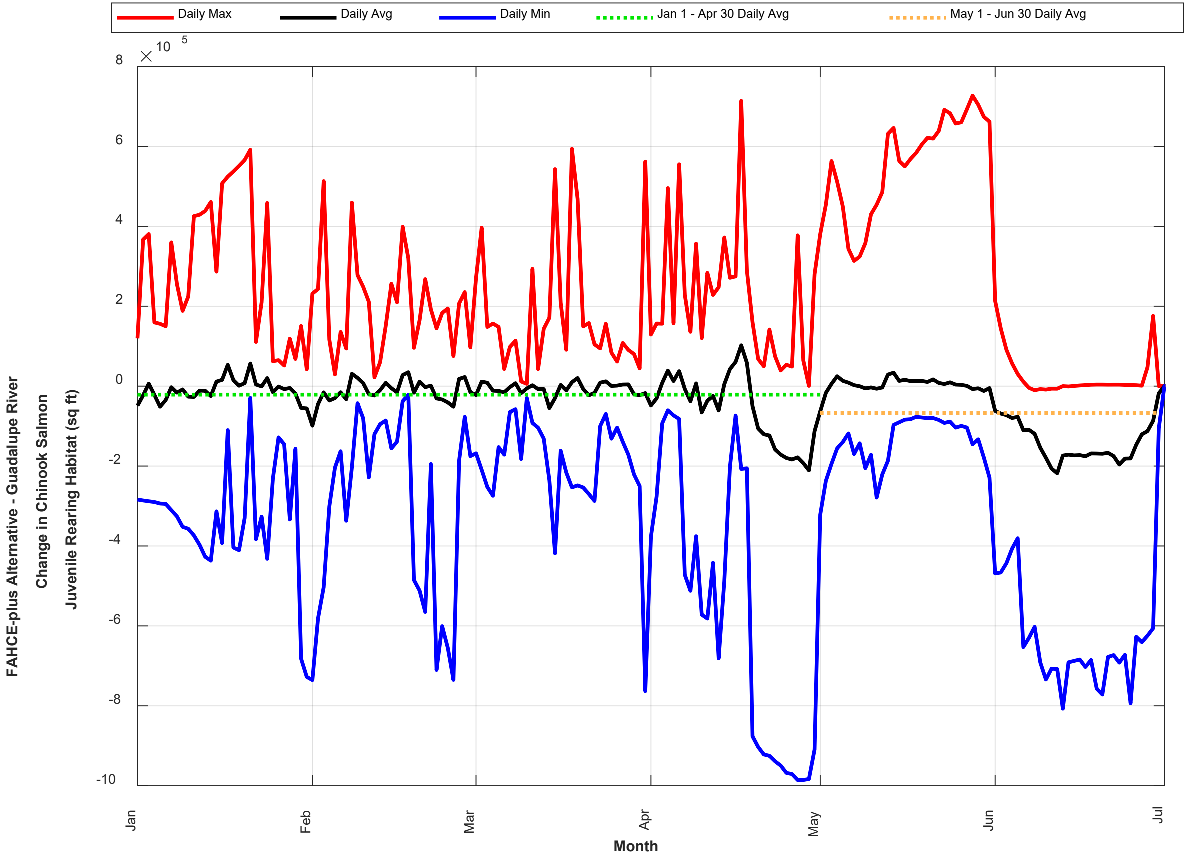


[a] Calero Creek habitat survey results in the reach between CALE 1 and CALE 2 input into the FAHCE WEAP Model did not record any winter cover, so fry and juvenile rearing habitat model results in this reach were zero during the period when winter cover is considered in the habitat estimate (that is, December 1 through March 31 for steelhead; January 1 through March 31 for Chinook salmon). Subsequent habitat surveys identified winter cover between CALE 1 and CALE 2 (Valley Water 2019, 2020).

Juvenile Rearing Habitat

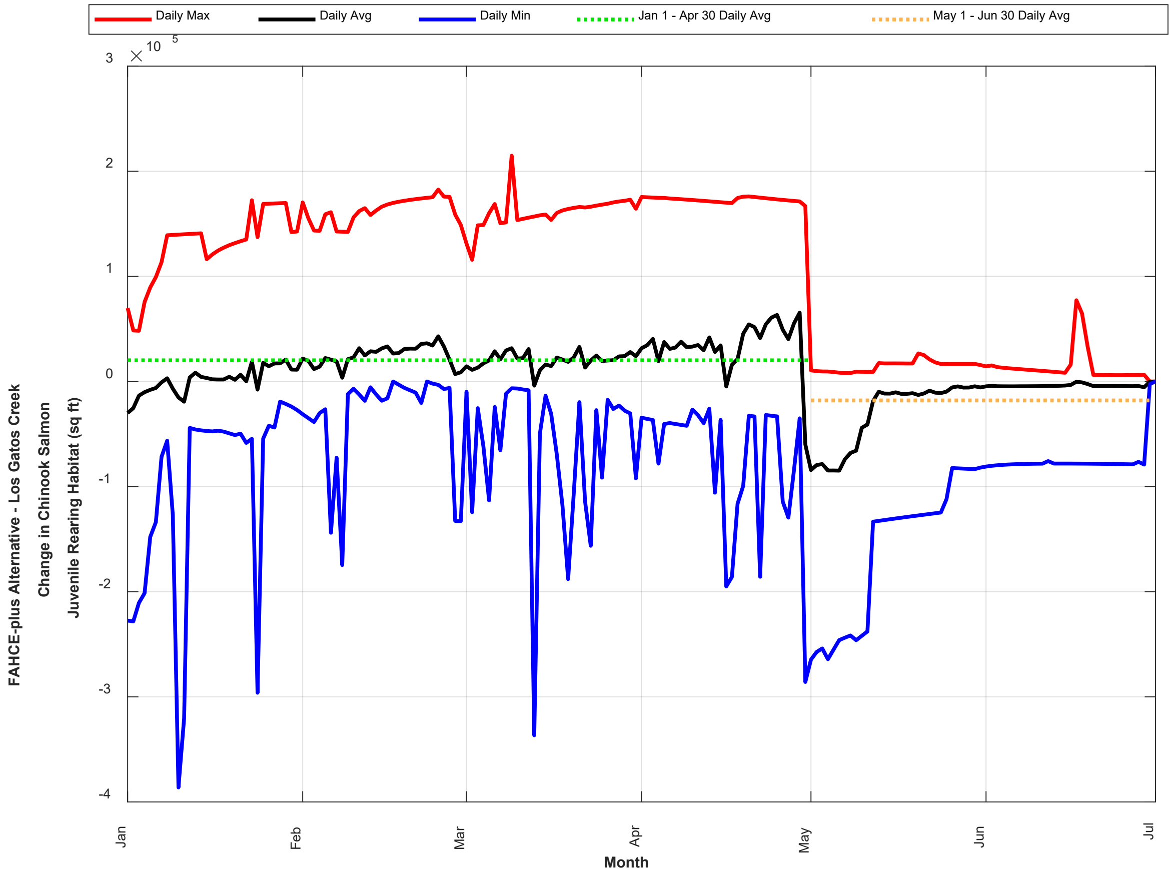
Based on the results of the FAHCE WEAP Model, there would be a 2% (25,400 square feet) decrease in juvenile rearing habitat in the Guadalupe River for Chinook salmon resulting from the FAHCE-plus Alternative (Figure 166; Table 106). The trends in juvenile rearing habitat over time revealed a slight (less than 1%) decrease under the FAHCE-plus Alternative during the Winter Base Flow Operations and a larger (5%) decrease during the Summer Release Program. The decreases during the Winter Base Flow Operations are associated with decreases in wetted area, while the decrease during the Summer Release Program are associated with warmer water temperatures because of decreased flows and a loss of wetted area (Attachment K.3 – Figures K.3.15, K.3.16, and K.3.17)

Figure 166. Change in Chinook Salmon Juvenile Rearing Habitat Compared with the Current Baseline in the Guadalupe River



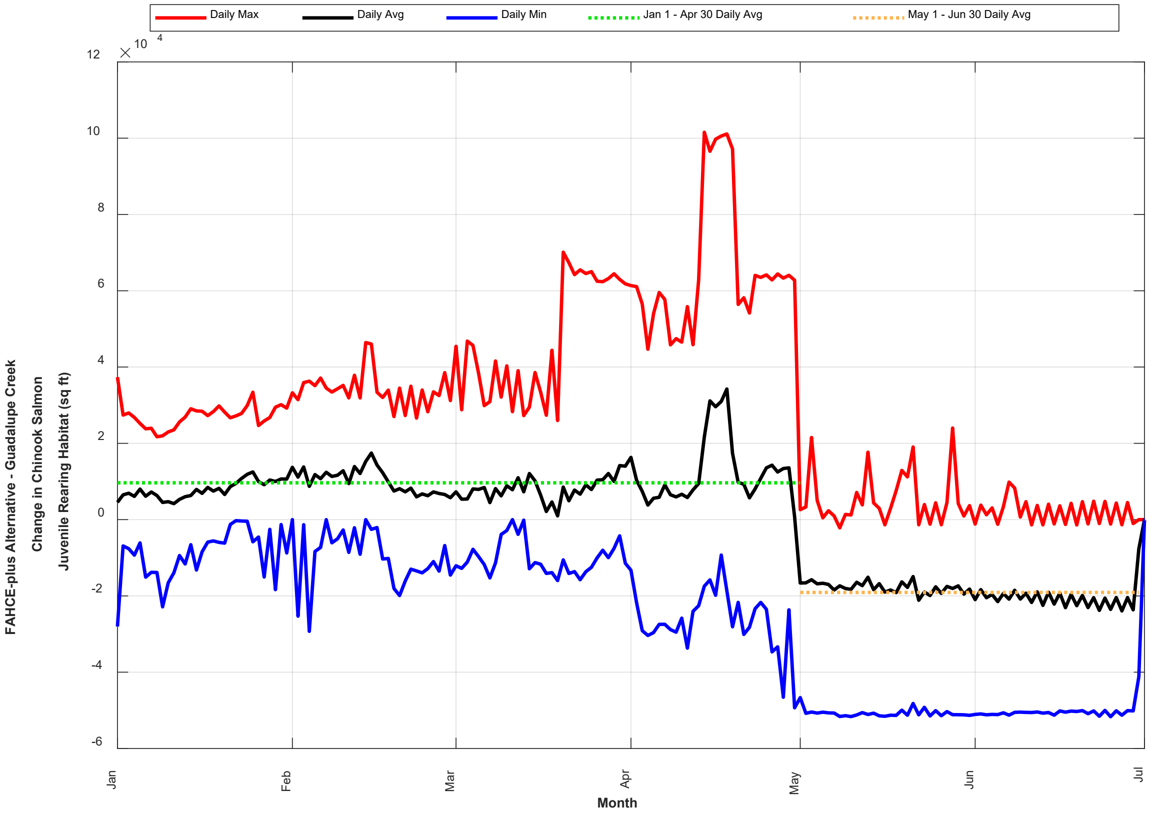
Based on the results of the FAHCE WEAP Model, there would be an average 2% (8,000 square feet) increase in juvenile rearing habitat in Los Gatos Creek for Chinook salmon resulting from the FAHCE-plus Alternative when compared with the current baseline (Figure 167; Table 107). The trends in juvenile rearing habitat over time revealed a 5% (20,000 square feet) increase under the FAHCE-plus Alternative during the Winter Base Flow Operations and a 5% (19,000 square feet) decrease during the Summer Release Program. Decreases during the Summer Release Program are associated with decreased flow and a subsequent loss of wetted area (Figures K.3.27 and K.3.28).

Figure 167. Change in Chinook Salmon Juvenile Rearing Habitat Compared with the Current Baseline in Los Gatos Creek



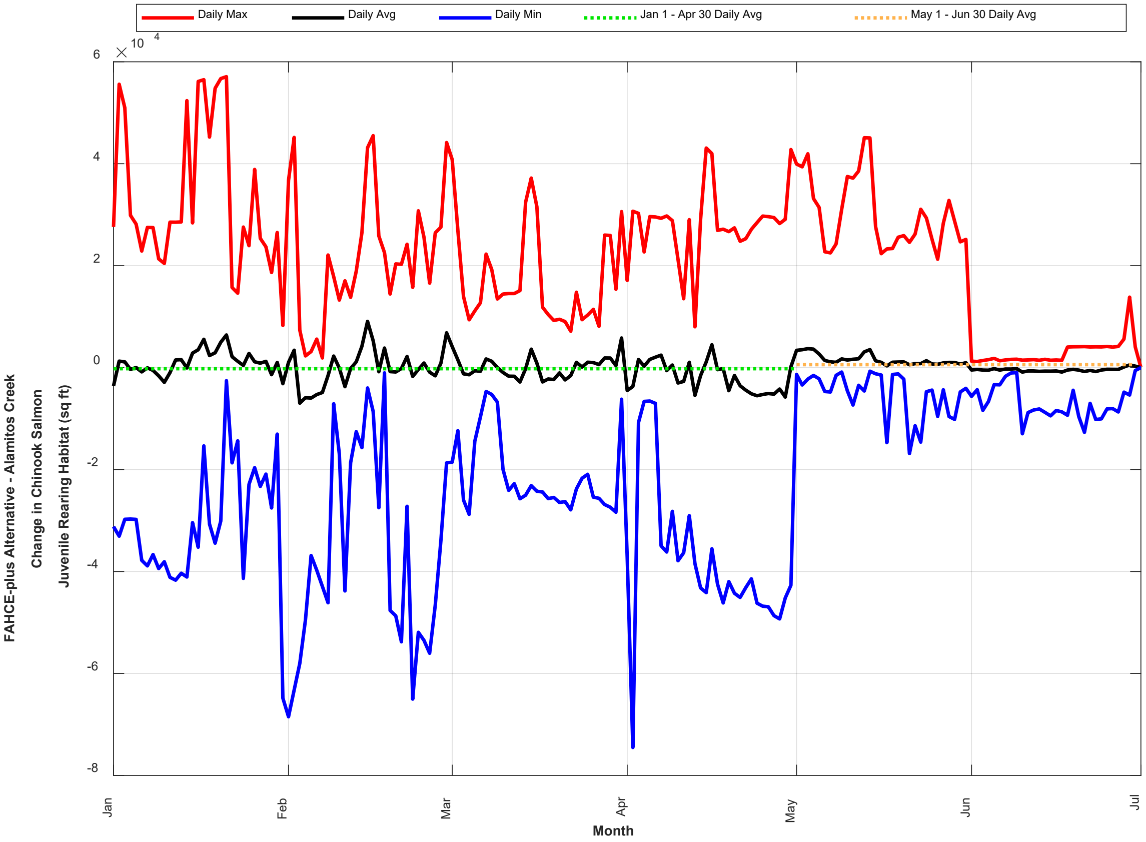
Based on the results of the FAHCE WEAP Model, there would be a less than 1%% (150 square feet) decrease in juvenile rearing habitat in Guadalupe Creek for Chinook salmon resulting from the FAHCE-plus Alternative (Figure 168; Table 108). The trends in juvenile rearing habitat over time showed increases (11%; 9,670 square feet) under the FAHCE-plus Alternative during Winter Base Flow Operations and decreases (27%; 19,150 square feet) during the Summer Release Program in Guadalupe Creek. In the Guadalupe Creek CWMZ, juvenile rearing habitat increased by 8% (1,700 square feet), with a 20% (4,100 square feet) increase occurring during the Winter Base Flow Operations followed by an 11% (2,900 square feet) decrease during the Summer Cold Water Program, MWAT under the Proposed Project remained below 65°F throughout the Summer Cold Water Program in the Guadalupe Creek CWMZ, so decreases in habitat within the CWMZ are strictly a function of a decrease in wetted area. The decreases in habitat during the Summer Cold Water Program downstream of the CWMZ are also a result of reduced wetted areas in Guadalupe Creek (Attachment K.3 – Figures K.3.39, K.3.40).

Figure 168. Change in Chinook Salmon Juvenile Rearing Habitat Compared with the Current Baseline in Guadalupe Creek



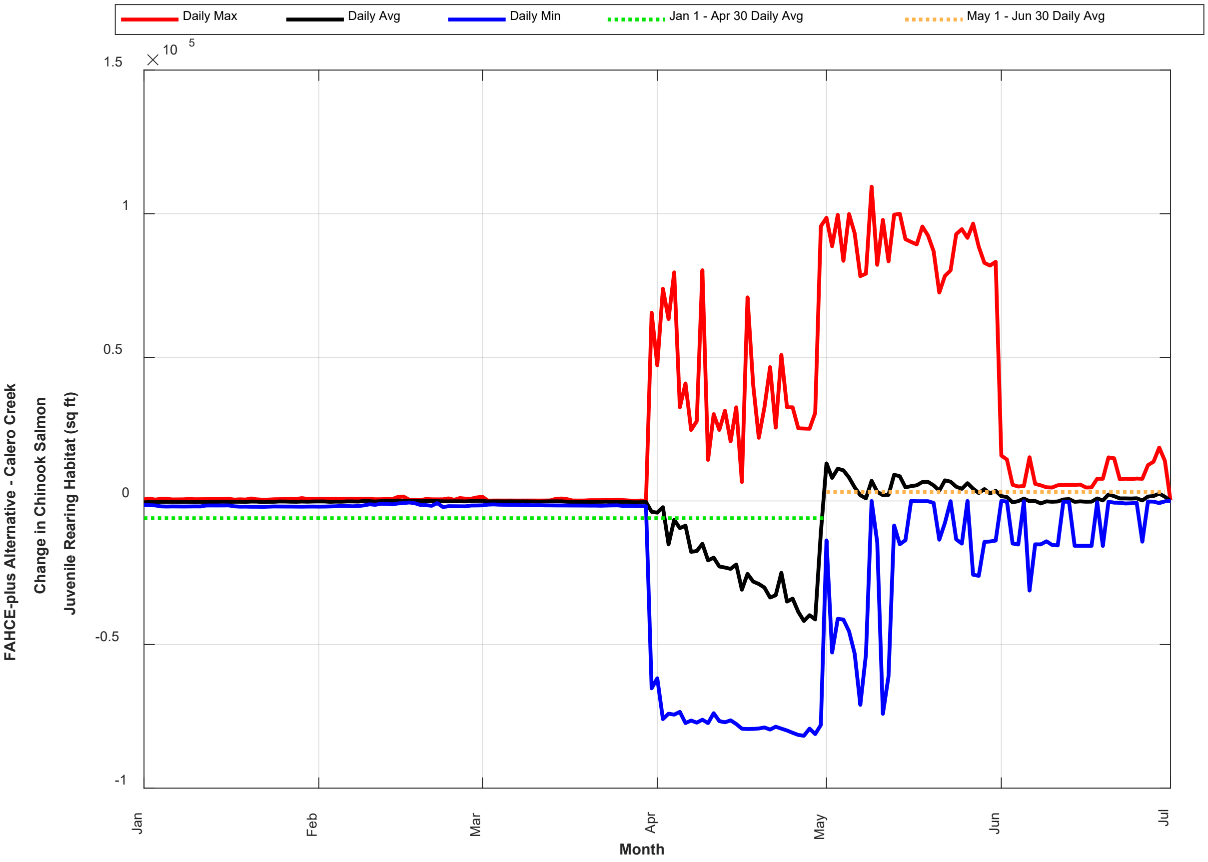
Based on the results of the FAHCE WEAP Model, there would be a less than 1% (90 square feet) increase in juvenile rearing habitat in Alamitos Creek for Chinook salmon resulting from the FAHCE-plus Alternative when compared with the current baseline (Figure 169; Table 109). The trends in juvenile rearing habitat over time showed decreases (0.2%; 170 square feet) under the FAHCE-plus Alternative during Winter Base Flow Operations and increases (1%; 600 square feet) during the Summer Release Program in Alamitos Creek.

Figure 169. Change in Chinook Salmon Juvenile Rearing Habitat Compared with the Current Baseline in Alamitos Creek



There would be a 5% (2,970 square feet) average decrease in juvenile rearing habitat in Calero Creek compared with the current baseline with a 21% (5,990) average decrease during the Winter Base Flow Operations and a 3% (3,080 square feet) average increase during the Summer Release Program (Figure 170). As described for fry rearing habitat, average decreases do not completely characterize the change in rearing habitat during January 1 through March 31. Habitat survey data input into the model indicated there was zero winter cover in the reach associated with the CALE 2 POI (that is, CALE 1 to CALE 2) and caused juvenile rearing habitat to be zero in January through March under all scenarios, but subsequent habitat surveys indicated there was winter cover (Valley Water 2019, 2020). Variations in wetted area at CALE 2 under the FAHCE-plus Alternative compared to the current baseline (Attachment K.3 – Figures K.3.63 and K.3.64) suggest there would be a slight increase or decrease in the average change in juvenile rearing habitat during Winter Base Flow Operations estimated by the model results since wetted area decreases in early January, increases in late-January and February, and decreases in March.

Figure 170. Change in Chinook Salmon Juvenile Rearing Habitat Compared with the Current Baseline in Calero Creek[a]



[a] Calero Creek habitat survey results in the reach between CALE 1 and CALE 2 input into the FAHCE WEAP Model did not record any winter cover, so fry and juvenile rearing habitat model results in this reach were zero during the period when winter cover is considered in the habitat estimate (that is, December 1 through March 31 for steelhead; January 1 through March 31 for Chinook salmon). Subsequent habitat surveys identified winter cover between CALE 1 and CALE 2 (Valley Water 2019, 2020).

Migration Conditions

Adult Upstream Passage

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 6% (less than 1 day per year on average) average increase to adult upstream Chinook salmon passage in the Guadalupe River compared with the current baseline (Figure 171; Table 111).

Figure 171. Change in Average Adult Chinook Salmon Upstream Passage Days Compared with the Current Baseline in the Guadalupe River

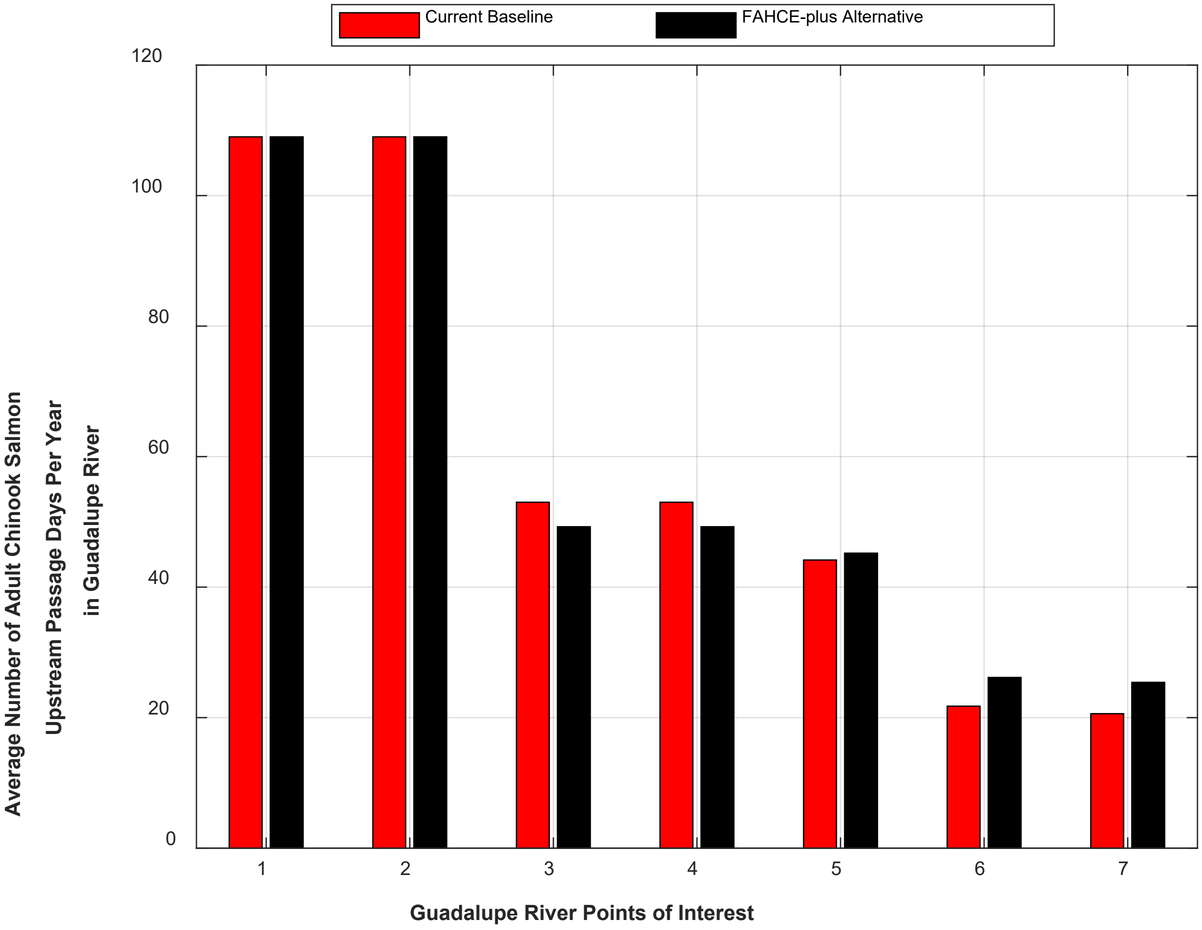


Table 111. FAHCE-plus Alternative Adult Chinook Salmon Upstream Passage Compared with the Current Baseline in the Guadalupe River

Parameter	GUAD 1	GUAD 2	GUAD 3	GUAD 4	GUAD 5	GUAD 6	GUAD 7
Current Baseline (days)[a]							
Total Adult Upstream Passage (1991–2010)	2,180	2,180	1,060	1,060	883	435	412
Average Adult Upstream Passage Per Year	109	109	53	53	44	22	21
FAHCE-plus Alternative (days)[a]							
Total Adult Upstream Passage (1991–2010)	2,180	2,180	985	985	904	523	508
Average Adult Upstream Passage Per Year	109	109	49	49	45	26	25

Parameter	GUAD 1	GUAD 2	GUAD 3	GUAD 4	GUAD 5	GUAD 6	GUAD 7
Difference (days)							
Total Adult Upstream Passage (1991–2010)	0.00	0.00	-75.00	-75.00	21.00	88.00	96.00
Average Adult Upstream Passage Per Year	0.00	0.00	-3.75	-3.75	1.05	4.40	4.80
Difference (%)							
Total Adult Upstream Passage (1991–2010)	0.00	0.00	-7.08	-7.08	2.38	20.23	23.30
Average Adult Upstream Passage Per Year	0.00	0.00	-7.08	-7.08	2.38	20.23	23.30

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 16% (less than 2 days per year on average) average decrease to adult upstream Chinook salmon passage at Los Gatos Creek compared with the current baseline (Figure 172; Table 112).

Figure 172. Change in Average Adult Chinook Salmon Upstream Passage Days Compared with the Current Baseline in Los Gatos Creek

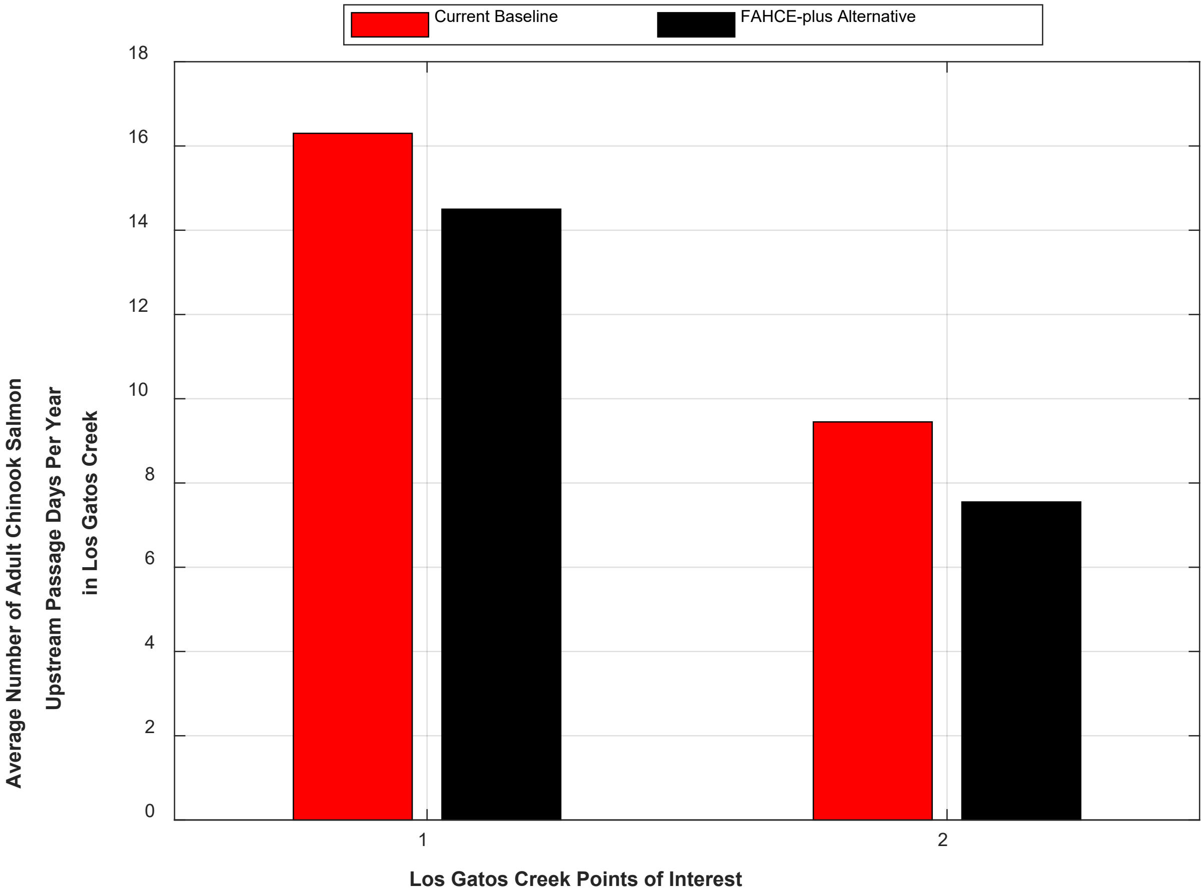


Table 112. FAHCE-plus Alternative Adult Chinook Salmon Upstream Passage Compared with the Current Baseline in Los Gatos Creek

Parameter	LOSG 1	LOSG 2
Current Baseline (days)[a]		
Total Adult Upstream Passage (1991–2010)	326	189
Average Adult Upstream Passage Per Year	16	9
FAHCE-plus Alternative (days)[a]		
Total Adult Upstream Passage (1991–2010)	290	151
Average Adult Upstream Passage Per Year	15	8
Difference (days)		
Total Adult Upstream Passage (1991–2010)	-36.00	-38.00
Average Adult Upstream Passage Per Year	-1.80	-1.90
Difference (%)		
Total Adult Upstream Passage (1991–2010)	-11.04	-20.11
Average Adult Upstream Passage Per Year	-11.04	-20.11

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 28% (1 day per year on average) increase to adult upstream Chinook salmon passage at Guadalupe Creek compared with the current baseline (Figure 173; Table 113).

Figure 173. Change in Average Adult Chinook Salmon Upstream Passage Days Compared with the Current Baseline in Guadalupe Creek

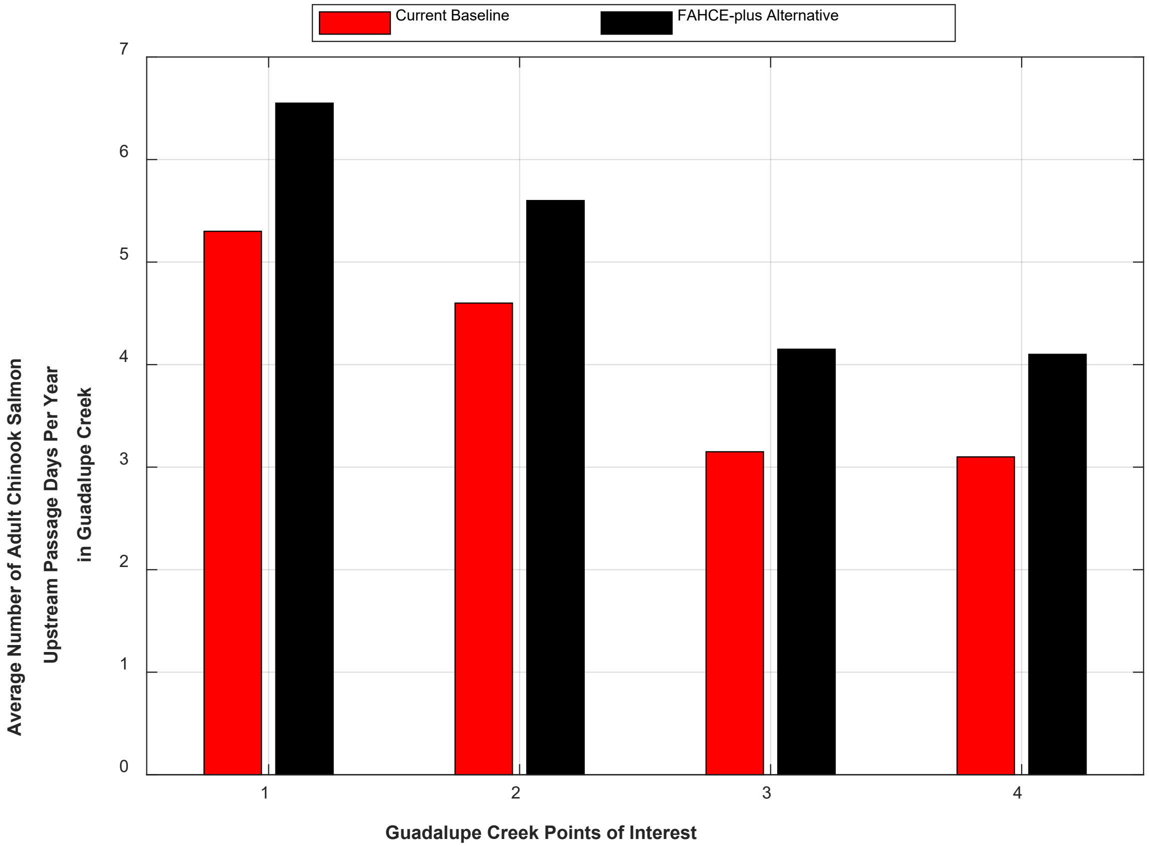


Table 113. FAHCE-plus Alternative Adult Chinook Salmon Upstream Passage Compared with the Current Baseline in Guadalupe Creek

Parameter	GCRK 1	GCRK 2	GCRK 3	GCRK 4
***Current Baseline (days)*[a]**				
Total Adult Upstream Passage (1991–2010)	106	92	63	62
Average Adult Upstream Passage Per Year	5	5	3	3
***FAHCE-plus Alternative (days)*[a]**				
Total Adult Upstream Passage (1991–2010)	131	112	83	82
Average Adult Upstream Passage Per Year	7	6	4	4
Difference (days)				
Total Adult Upstream Passage (1991–2010)	25.00	20.00	20.00	20.00
Average Adult Upstream Passage Per Year	1.25	1.00	1.00	1.00
Difference (%)				
Total Adult Upstream Passage (1991–2010)	23.58	21.74	31.75	32.26
Average Adult Upstream Passage Per Year	23.58	21.74	31.75	32.26

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 18% average increase (4 days per year on average) to adult upstream Chinook salmon passage at ALAM 1 in downstream Alamitos Creek, and an increase of 3% (less than 1 passage day per year on average) at upstream sites compared with current baseline (Figure 174; Table 114).

Figure 174. Change in Average Adult Chinook Salmon Upstream Passage Days Compared with the Current Baseline in Alamitos Creek

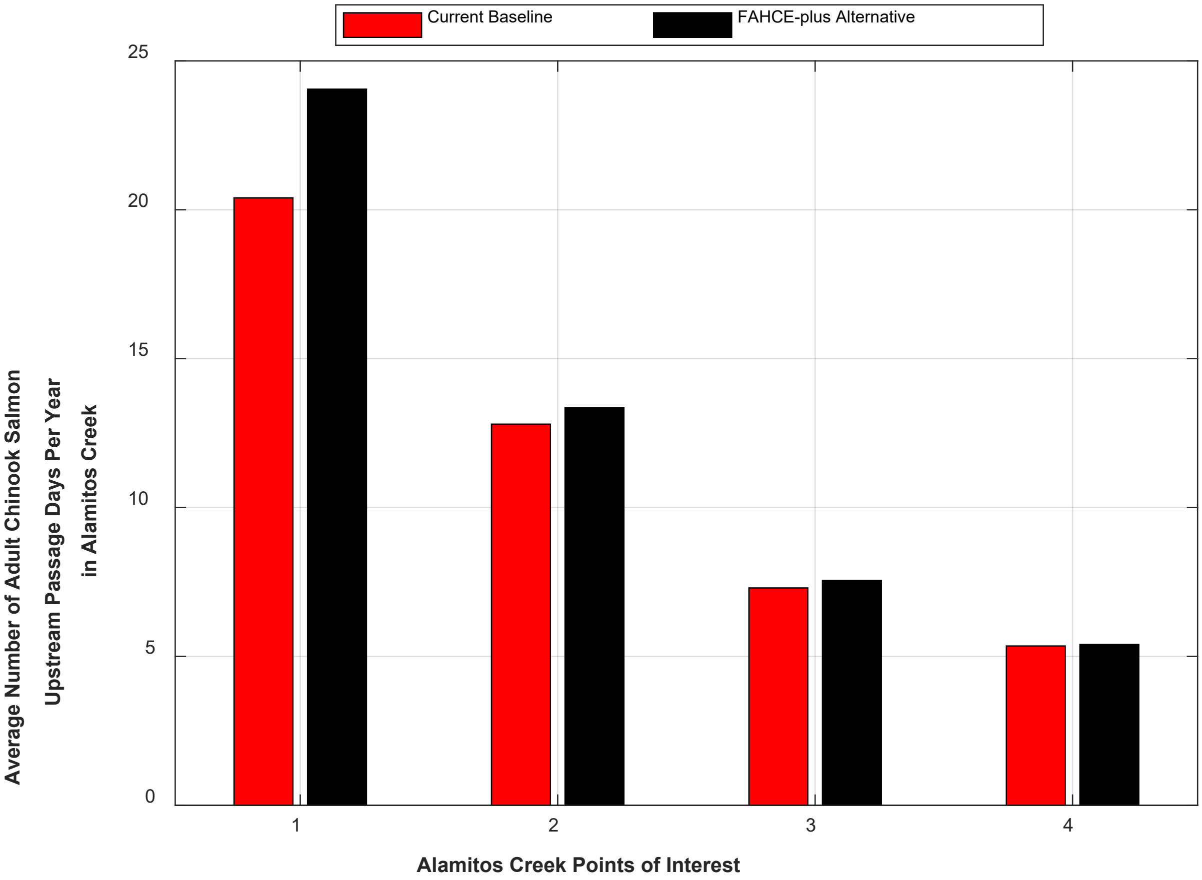


Table 114. FAHCE-plus Alternative Adult Chinook Salmon Upstream Passage Compared with the Current Baseline in Alamitos Creek

Parameter	ALAM 1	ALAM 2	ALAM 3	ALAM 4
Current Baseline (days)[a]				
Total Adult Upstream Passage (1991–2010)	408	256	146	107
Average Adult Upstream Passage Per Year	20	13	7	5
FAHCE-plus Alternative (days)[a]				
Total Adult Upstream Passage (1991–2010)	481	267	151	108
Average Adult Upstream Passage Per Year	24	13	8	5

Parameter	ALAM 1	ALAM 2	ALAM 3	ALAM 4
Difference (days)				
Total Adult Upstream Passage (1991–2010)	73.00	11.00	5.00	1.00
Average Adult Upstream Passage Per Year	3.65	0.55	0.25	0.05
Difference (%)				
Total Adult Upstream Passage (1991–2010)	17.89	4.30	3.42	0.93
Average Adult Upstream Passage Per Year	17.89	4.30	3.42	0.93

[a] Rounded to whole days

The FAHCE-plus Alternative would result in a 5% (4 days per year) average increase in Calero Creek compared with the current baseline (Figure 175).

Figure 175. Change in Average Adult Chinook Salmon Upstream Passage Days Compared with the Current Baseline in Calero Creek

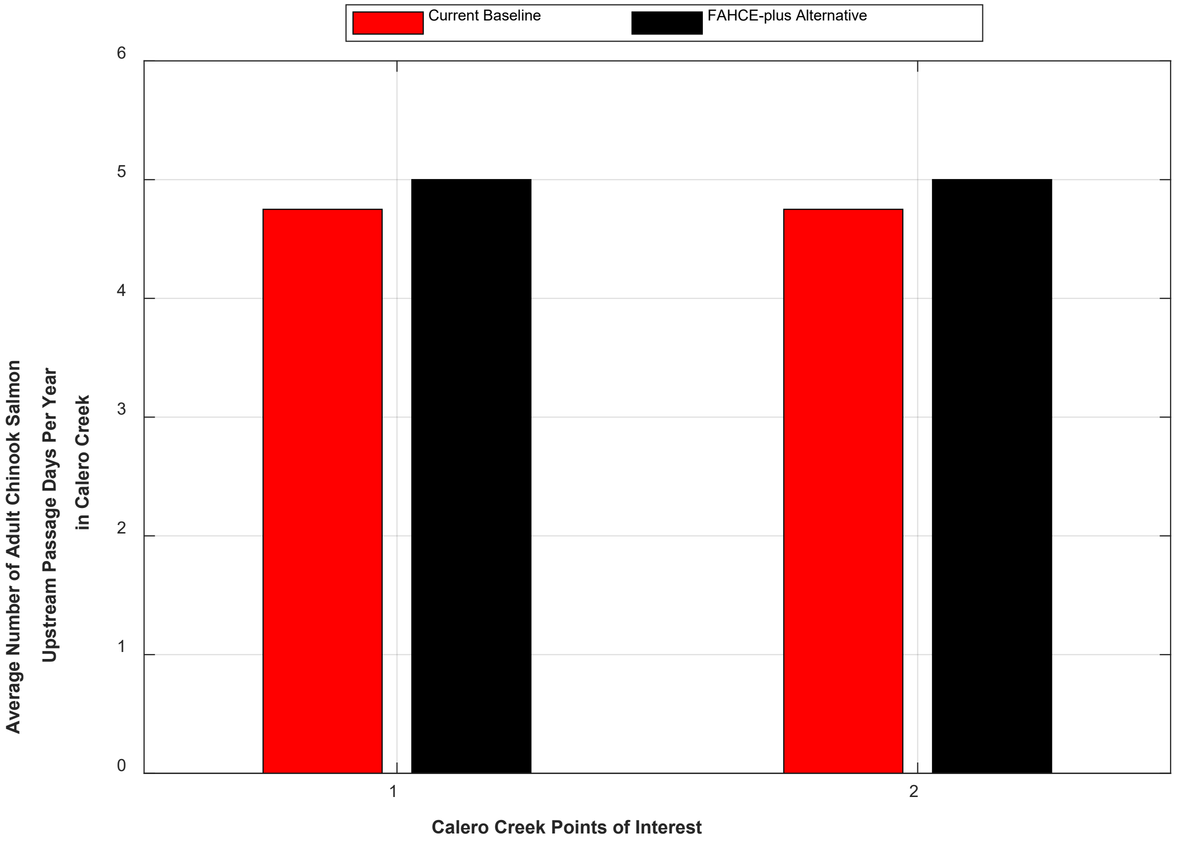


Table 115. FAHCE-plus Alternative Adult Chinook Salmon Upstream Passage Compared with the Current Baseline in Calero Creek

Parameter	CALE 1	CALE 2
Current Baseline (days)[a]		
Total Adult Upstream Passage (1991–2010)	95	95
Average Adult Upstream Passage Per Year	5	5
FAHCE-plus Alternative (days)[a]		
Total Adult Upstream Passage (1991–2010)	98	98
Average Adult Upstream Passage Per Year	5	5
Difference (days)		
Total Adult Upstream Passage (1991–2010)	3.00	3.00
Average Adult Upstream Passage Per Year	0.15	0.15
Difference (%)		
Total Adult Upstream Passage (1991–2010)	3.16	3.16
Average Adult Upstream Passage Per Year	3.16	3.16

[a] Rounded to whole days

All reaches in the Guadalupe River portion of the study area were modeled to have increases in adult upstream passage opportunities under the FAHCE-plus Alternative except for Los Gatos Creek.

Juvenile Downstream Passage

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in no changes to juvenile downstream Chinook salmon passage in the Guadalupe River compared with current baseline (Figure 176; Table 116). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in a 1% (1 day per year) average increase to juvenile downstream passage in the Guadalupe River compared with the current baseline (Table 116). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in the Guadalupe River under the FAHCE-plus Alternative compared to the current baseline.

Figure 176. Change in Juvenile Chinook Salmon Downstream Passage Days Compared with the Current Baseline in the Guadalupe River

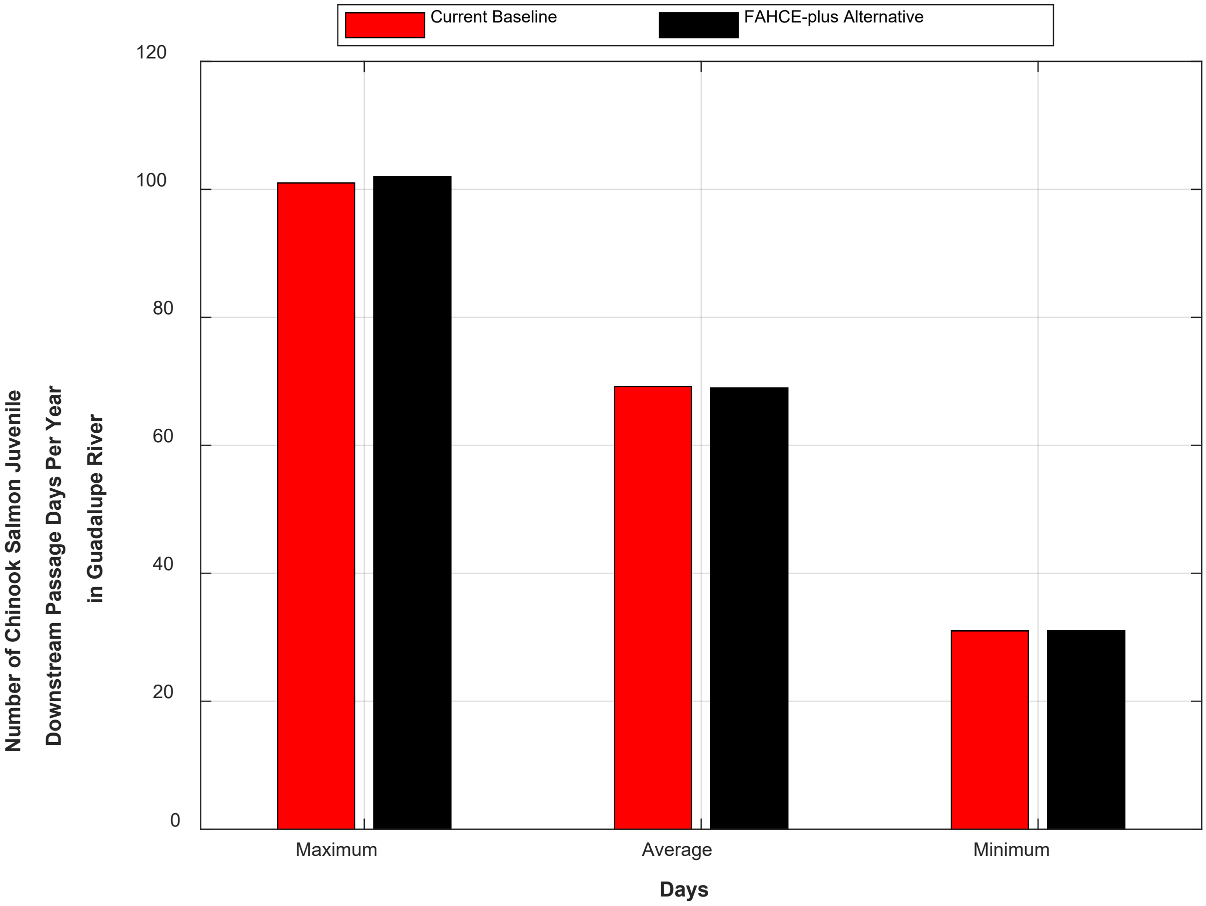


Table 116. FAHCE-plus Alternative Juvenile Chinook Salmon Downstream Passage Compared with the Current Baseline in the Guadalupe River

Parameter	GUAD 7 with Water Temperature Criteria[b]
Current Baseline (days)[a]	
Total Juvenile Downstream Passage (1991–2010)	1,384
Average Juvenile Downstream Passage Per Year	69
FAHCE-plus Alternative (days)[a]	
Total Juvenile Downstream Passage (1991–2010)	1,379
Average Juvenile Downstream Passage Per Year	69
Difference (days)	
Total Juvenile Downstream Passage (1991–2010)	-5.00
Average Juvenile Downstream Passage Per Year	0.00

Parameter	GUAD 7 with Water Temperature Criteria[b]
Difference (%)	
Total Juvenile Downstream Passage (1991–2010)	-0.36
Average Juvenile Downstream Passage Per Year	0.00

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 2% (2 days per year on average) decrease to juvenile downstream Chinook salmon passage at Los Gatos Creek compared with the current baseline (Figure 177; Table 117). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in a 2% (3 days per year) average decrease to juvenile downstream passage in Los Gatos Creek compared with the current baseline (Table 117). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in Los Gatos Creek under the FAHCE-plus Alternative compared to the current baseline.

Figure 177. Change in Juvenile Chinook Salmon Downstream Passage Days Compared with the Current Baseline Los Gatos Creek

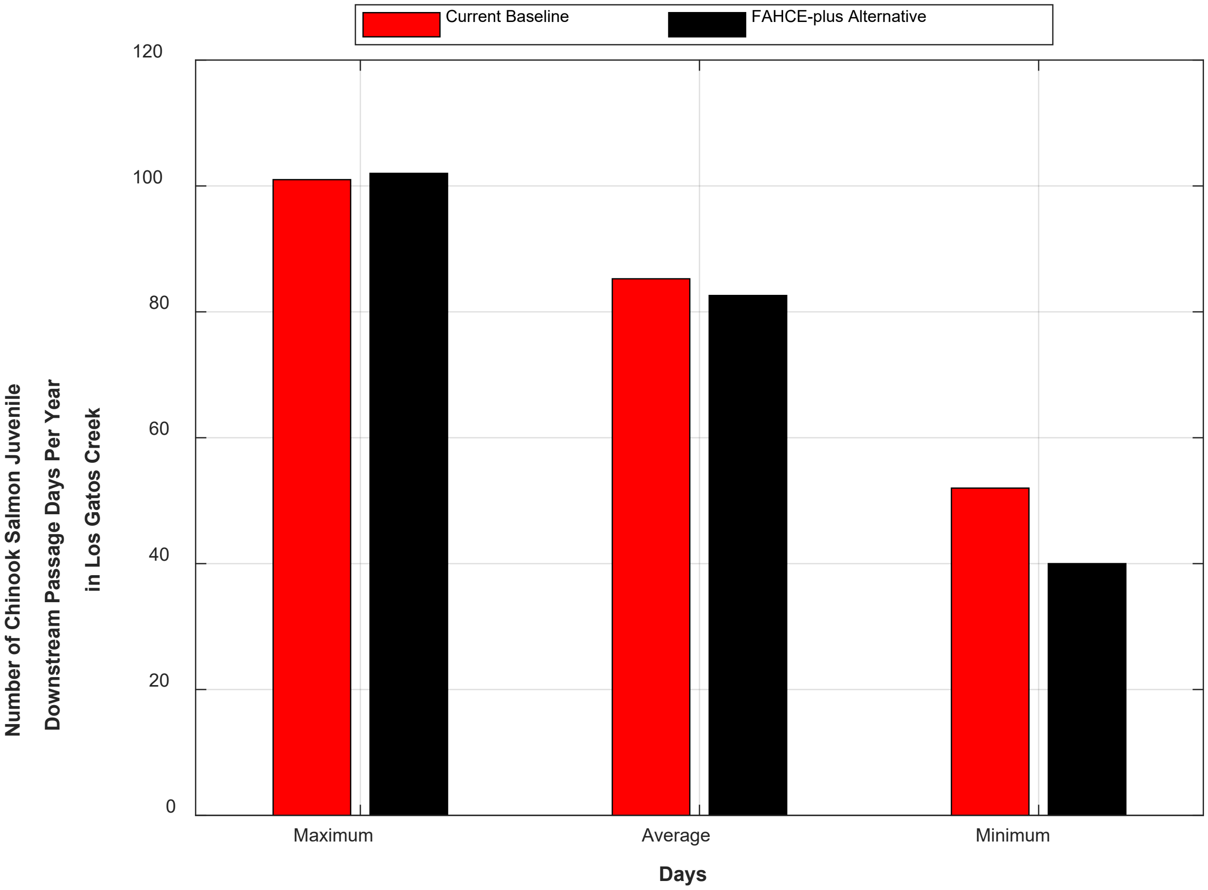


Table 117. FAHCE-plus Alternative Juvenile Chinook Salmon Downstream Passage Compared with the Current Baseline in Los Gatos Creek

Parameter	LOSG 2 with Water Temperature Criteria[b]	LOSG 2 without Water Temperature Criteria[c]
Current Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	1,705	2,997
Average Juvenile Downstream Passage Per Year	85	150
FAHCE-plus Alternative (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	1,652	2,936
Average Juvenile Downstream Passage Per Year	83	147

Parameter	LOSG 2 with Water Temperature Criteria[b]	LOSG 2 without Water Temperature Criteria[c]
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	-53.00	-61.00
Average Juvenile Downstream Passage Per Year	-2.00	-3.00
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	-3.11	-2.04
Average Juvenile Downstream Passage Per Year	-2.35	-2.00

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 19% (6 days per year on average) increase to juvenile downstream Chinook salmon passage at Guadalupe Creek compared with current baseline (Figure 178; Table 118). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in a 21% (7 day per year) average increase to juvenile downstream passage in Guadalupe Creek compared with the current baseline (Table 118). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in Guadalupe Creek increased by one under the FAHCE-plus Alternative compared to the current baseline.

Figure 178. Change in Juvenile Chinook Salmon Downstream Passage Days Compared with the Current Baseline in Guadalupe Creek

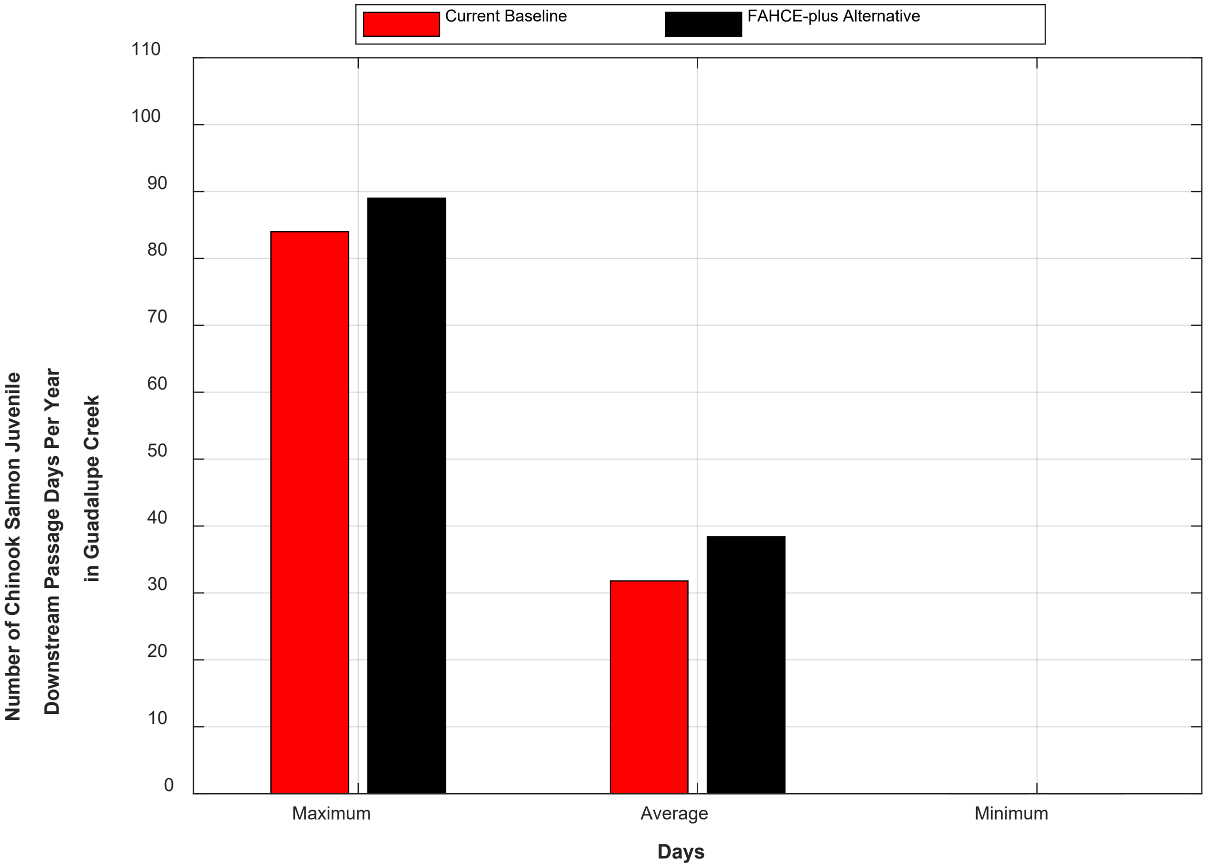


Table 118. FAHCE-plus Alternative Juvenile Chinook Salmon Downstream Passage Compared with the Current Baseline in Guadalupe Creek

Parameter	GCRK 4 with Water Temperature Criteria[b]	GCRK 4 without Water Temperature Criteria[c]
***Current Baseline (days)**[a]*		
Total Juvenile Downstream Passage (1991–2010)	636	666
Average Juvenile Downstream Passage Per Year	32	33
***FAHCE-plus Alternative (days)**[a]*		
Total Juvenile Downstream Passage (1991–2010)	768	798
Average Juvenile Downstream Passage Per Year	38	40
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	132.00	132.00
Average Juvenile Downstream Passage Per Year	6.00	7.00

Parameter	GCRK 4 with Water Temperature Criteria[b]	GCRK 4 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	20.75	19.82
Average Juvenile Downstream Passage Per Year	18.75	21.21

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in 8% (4 days per year on average) decreases to juvenile downstream Chinook salmon passage at Alamitos Creek compared with the current baseline (Figure 179; Table 119). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in a 5% (3 day per year) average decrease to juvenile downstream passage in Alamitos Creek compared with the current baseline (Table 119). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in Alamitos Creek decreased by two under the FAHCE-plus Alternative compared to the current baseline.

Figure 179. Change in Juvenile Chinook Salmon Downstream Passage Days Compared with the Current Baseline in Alamitos Creek

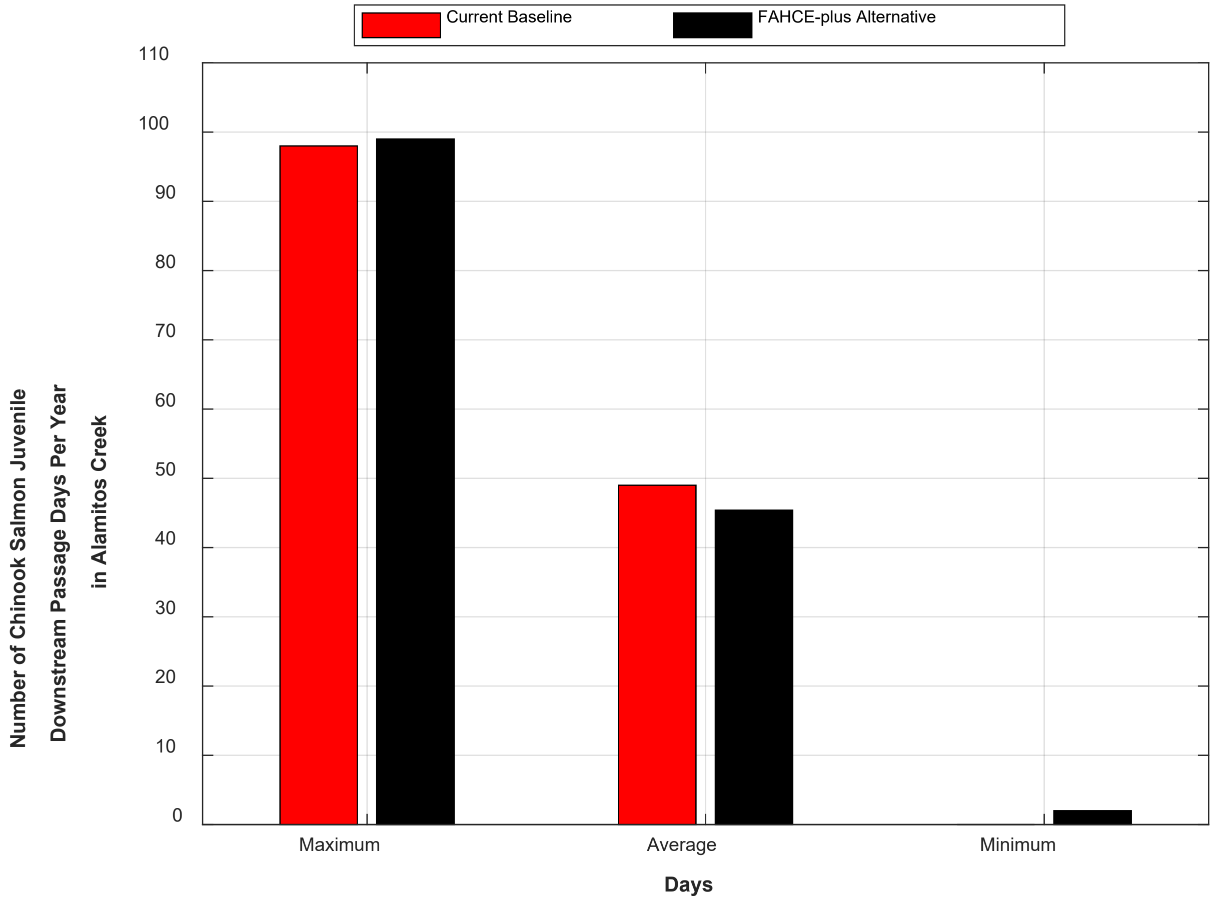


Table 119. FAHCE-plus Alternative Juvenile Chinook Salmon Downstream Passage Compared with the Current Baseline in Alamitos Creek

Parameter	ALAM 4 with Water Temperature Criteria[b]	ALAM 4 without Water Temperature Criteria[c]
Current Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	980	1,143
Average Juvenile Downstream Passage Per Year	49	57
FAHCE-plus Alternative (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	908	1,081
Average Juvenile Downstream Passage Per Year	45	54
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	-72.00	-62.00
Average Juvenile Downstream Passage Per Year	-4.00	-3.00
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	-7.35	-5.42
Average Juvenile Downstream Passage Per Year	-8.16	-5.26

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

There would be a 6% (3 days per year) average decrease to juvenile downstream passage in Calero Creek compared with the current baseline (Figure 180). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in a 7% (4 day per year) average decrease to juvenile downstream passage in Calero Creek compared with the current baseline (Table 120). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in Calero Creek decreased by one under the FAHCE-plus Alternative compared to the current baseline.

Figure 180. Change in Juvenile Chinook Salmon Downstream Passage Days Compared with the Current Baseline in Alamitos Creek

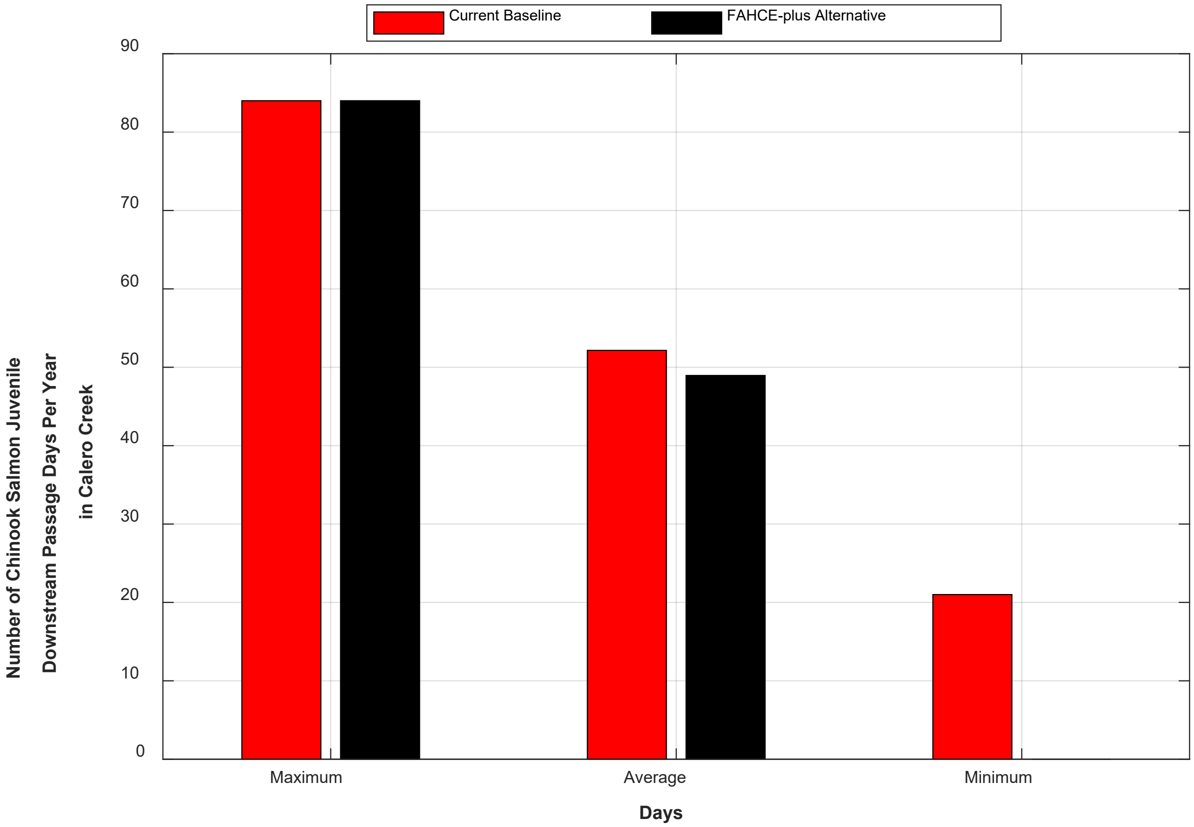


Table 120. FAHCE-plus Alternative Juvenile Chinook Salmon Downstream Passage Compared with the Current Baseline in Calero Creek

Parameter	CALE 2 with Water Temperature Criteria[b]	CALE 2 without Water Temperature Criteria[c]
Current Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	1,043	1,074
Average Juvenile Downstream Passage Per Year	52	54
FAHCE-plus Alternative (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	979	1,003
Average Juvenile Downstream Passage Per Year	49	50
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	-64.00	-71.00
Average Juvenile Downstream Passage Per Year	-3.00	-4.00
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	-6.14	-6.61
Average Juvenile Downstream Passage Per Year	-5.77	-7.41

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Flow Measures Future Baseline Assessment

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, there would be an average 31% (3,610 square feet) decrease in effective spawning habitat in the Guadalupe River during the spawning and incubation life-stage time period for Chinook salmon (that is, October 15 to January 31) resulting from the FAHCE-plus Alternative compared with the future baseline (Figure 181). Decreases are associated with increased water temperatures at the end of the incubation period and decreased water depths (Attachment K.3 – Figures K.3.21, K.3.22, and K.3.23).

Figure 181. Change in Effective Chinook Salmon Spawning Habitat Compared with the Future Baseline in the Guadalupe River

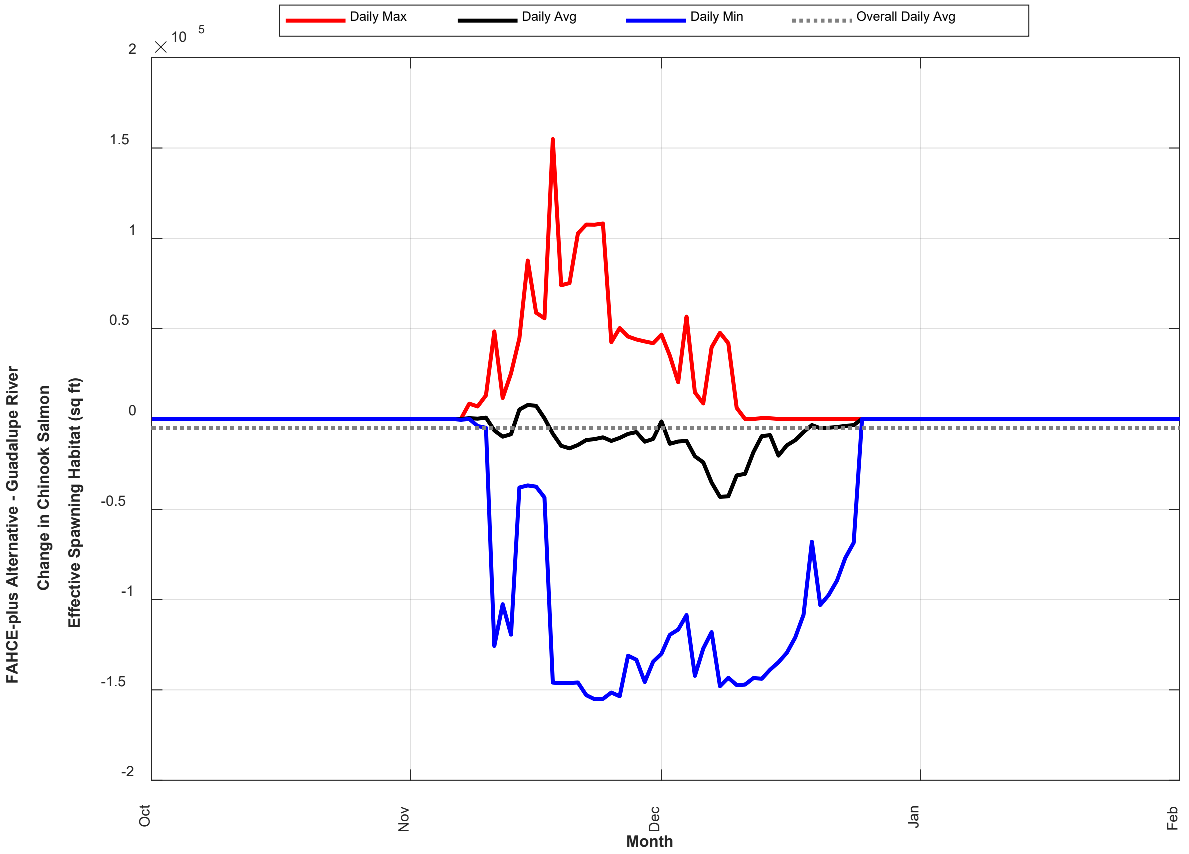


Table 121. FAHCE-plus Alternative Chinook Salmon Habitat Compared with the Future Baseline in the Guadalupe River

Guadalupe River[a,b]	GUAD 3 River Mile 10.07	GUAD 4 River Mile 12.52	GUAD 5 River Mile 13.42	GUAD 6 River Mile 18.45	GUAD 7 River Mile 19.93	Total
Chinook Salmon Habitat Future Baseline (sq ft)						
Effective Spawning	4,900	3,230	262	612	2,650	11,654
Fry Rearing Total (Jan 1–Apr 30)	209,000	202,000	93,800	568,000	400,000	1,472,800
Juvenile Rearing Total (Jan 1–Jun 30)	204,000	213,000	77,800	483,000	392,000	1,369,800
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	222,000	218,000	85,100	546,000	421,000	1,492,100
Juvenile Rearing Summer Release Program (May 1–Jun 30)	169,000	203,000	63,400	359,000	332,000	1,126,400

Guadalupe River[a,b]	GUAD 3 River Mile 10.07	GUAD 4 River Mile 12.52	GUAD 5 River Mile 13.42	GUAD 6 River Mile 18.45	GUAD 7 River Mile 19.93	Total
Chinook Salmon FAHCE-plus Alternative (sq ft)						
Effective Spawning	2,640	1,640	407	697	2,660	8,044
Fry Rearing Total (Jan 1–Apr 30)	214,000	197,000	96,700	586,000	408,000	1,501,700
Juvenile Rearing Total (Jan 1–Jun 30)	207,000	211,000	78,000	507,000	398,000	1,401,000
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	227,000	217,000	86,800	587,000	436,000	1,553,800
Juvenile Rearing Summer Release Program (May 1–Jun 30)	166,000	198,000	60,500	349,000	322,000	1,095,500
Change in Habitat (sq ft)						
Effective Spawning	-2,260 (-46.12%)	-1,590 (-49.23%)	145 (55.34%)	85 (13.89%)	10 (0.38%)	-3,610 (-30.98%)
Fry Rearing Total (Jan 1–Apr 30)	5,000 (2.39%)	-5,000 (-2.48%)	2,900 (3.09%)	18,000 (3.17%)	8,000 (2%)	28,900 (1.96%)
Juvenile Rearing Total (Jan 1–Jun 30)	3,000 (1.47%)	-2,000 (-0.94%)	200 (0.26%)	24,000 (4.97%)	6,000 (1.53%)	31,200 (2.28%)
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	5,000 (2.25%)	-1,000 (-0.46%)	1,700 (2%)	41,000 (7.51%)	15,000 (3.56%)	61,700 (4.14%)
Juvenile Rearing Summer Release Program (May 1–Jun 30)	-3,000 (-1.78%)	-5,000 (-2.46%)	-2,900 (-4.57%)	-10,000 (-2.79%)	-10,000 (-3.01%)	-30,900 (-2.74%)

a Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

b No average daily habitat availability model results are available for the points of interest not shown.

Based on the results of the FAHCE WEAP Model, there would be an 81% (5,664 square feet) average decrease in effective spawning habitat in Los Gatos Creek during the spawning and incubation life-stage time period for Chinook salmon (that is, October 15 to January 31) resulting from the FAHCE-plus Alternative compared with the future baseline (Figure 182; Table 122). The decrease in effective spawning habitat is observed in November and there is little change in effective spawning habitat under the FAHCE-plus Alternative outside of this period. Decreases in effective spawning habitat in November are associated with a decrease in flow and a subsequent decrease in average wetted area at each POI in Los Gatos Creek (Attachment K.3 – Figures K.3.33 and K.3.34).

Figure 182. Change in Effective Chinook Salmon Spawning Habitat Compared with the Future Baseline in Los Gatos Creek

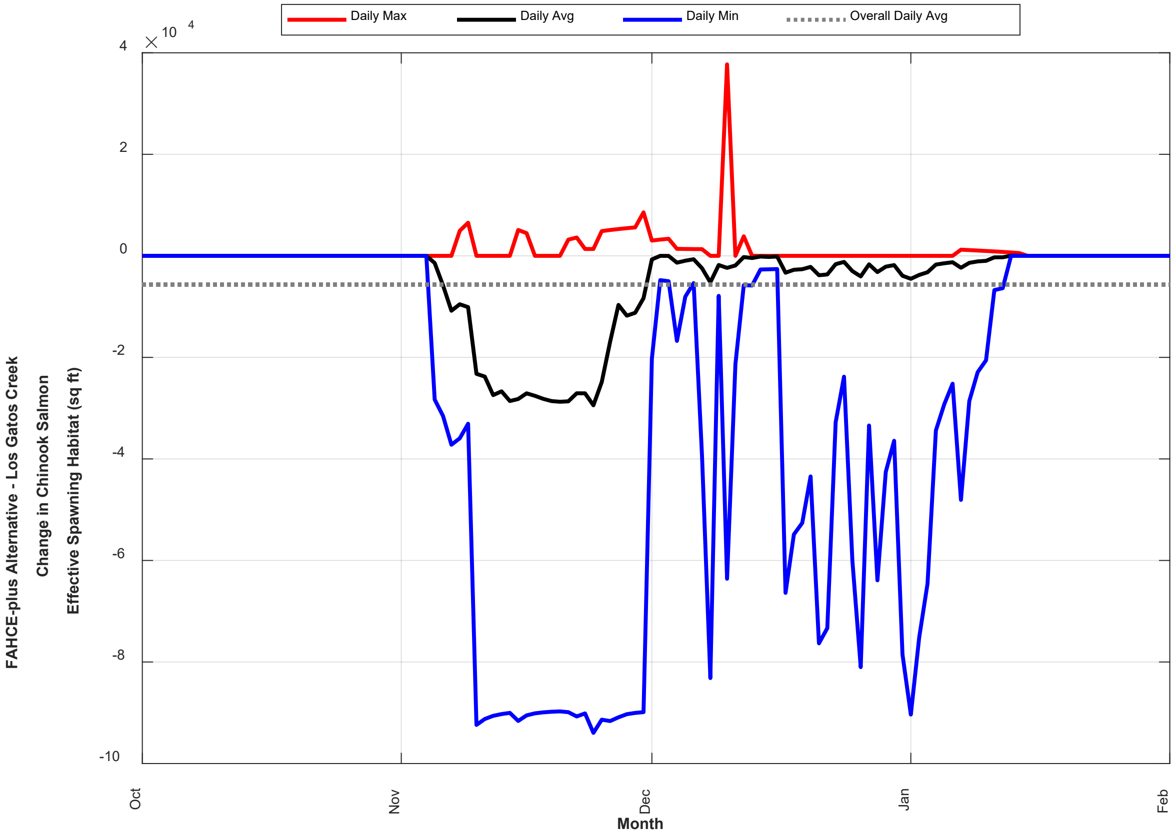


Table 122. FAHCE-plus Alternative Chinook Salmon Habitat Compared with the Future Baseline in Los Gatos Creek

Los Gatos Creek[a]	LOSG 1 River Mile 14.70	LOSG 2 River Mile 18.91	Total
Chinook Salmon Habitat Future Baseline (sq ft)			
Effective Spawning	3,200	3,820	7,020
Fry Rearing Total (Jan 1–Apr 30)	179,000	315,000	494,000
Juvenile Rearing Total (Jan 1–Jun 30)	144,000	256,000	400,000
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	149,000	255,000	404,000
Juvenile Rearing Summer Release Program (May 1–Jun 30)	134,000	260,000	394,000

Los Gatos Creek[a]	LOSG 1 River Mile 14.70	LOSG 2 River Mile 18.91	Total
Chinook Salmon FAHCE-plus Alternative (sq ft)			
Effective Spawning	723	633	1,356
Fry Rearing Total (Jan 1–Apr 30)	182,000	323,000	505,000
Juvenile Rearing Total (Jan 1–Jun 30)	144,000	261,000	405,000
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	152,000	266,000	418,000
Juvenile Rearing Summer Release Program (May 1–Jun 30)	128,000	249,000	377,000
Change in Habitat (sq ft)			
Effective Spawning	-2,477 (-77.41%)	-3,187 (-83.43%)	-5,664 (-80.68%)
Fry Rearing Total (Jan 1–Apr 30)	3,000 (1.68%)	8,000 (2.54%)	11,000 (2.23%)
Juvenile Rearing Total (Jan 1–Jun 30)	0 (0%)	5,000 (1.95%)	5,000 (1.25%)
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	3,000 (2.01%)	11,000 (4.31%)	14,000 (3.47%)
Juvenile Rearing Summer Release Program (May 1–Jun 30)	-6,000 (-4.48%)	-11,000 (-4.23%)	-17,000 (-4.31%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

Based on the results of the FAHCE WEAP Model, there would be a 114% (935 square feet) average increase in daily effective spawning habitat in Guadalupe Creek during the spawning and incubation life-stage time period for Chinook salmon (that is, October 15 to January 31) resulting from the FAHCE-plus Alternative compared with the future baseline (Figure 183; Table 123). In the Guadalupe Creek CWMZ (represented by GUAD 4 in the model results), Chinook salmon daily effective spawning habitat had an average increase of 96% (164 square feet) over the entire life-stage when compared with the future baseline.

Figure 183. Change in Effective Chinook Salmon Spawning Habitat Compared with the Future Baseline in Guadalupe Creek

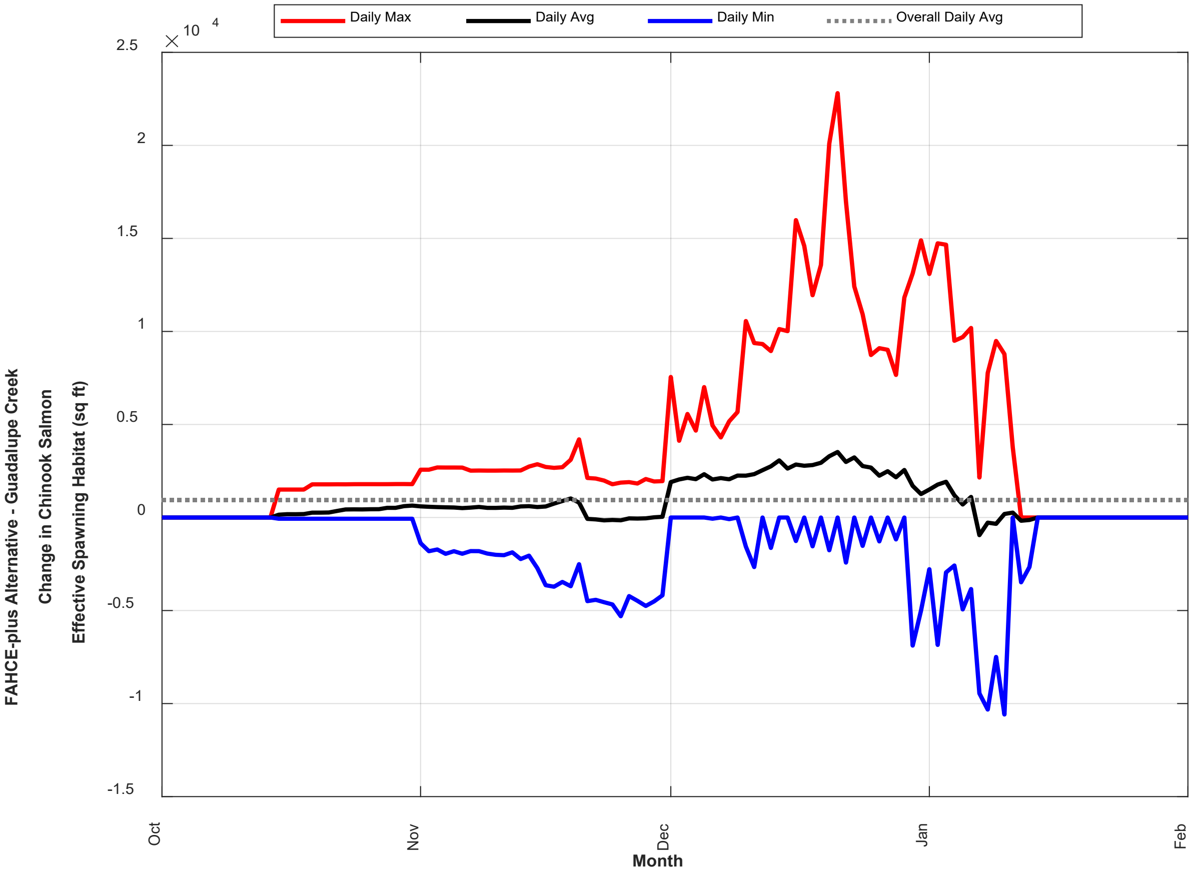


Table 123. FAHCE-plus Alternative Chinook Salmon Habitat Compared with the Future Baseline in Guadalupe Creek

Guadalupe Creek[a]	GCRK 1 River Mile 20.71	GCRK 2 River Mile 21.91	GCRK 3 River Mile 22.54	GCRK 4 River Mile 26.17	Total
Chinook Salmon Habitat Future Baseline (sq ft)					
Effective Spawning	86	510	53	170	820
Fry Rearing Total (Jan 1–Apr 30)	21,100	41,000	3,390	23,800	89,290
Juvenile Rearing Total (Jan 1–Jun 30)	17,000	41,600	3,710	22,400	84,710
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	20,600	42,700	3,610	19,500	86,410
Juvenile Rearing Summer Cold Water Program (May 1–Jun 30)	9,780	39,300	3,930	28,200	81,210

Guadalupe Creek[a]	GCRK 1 River Mile 20.71	GCRK 2 River Mile 21.91	GCRK 3 River Mile 22.54	GCRK 4 River Mile 26.17	Total
Chinook Salmon FAHCE-plus Alternative (sq ft)					
Effective Spawning	250	1,100	71	334	1,755
Fry Rearing Total (Jan 1–Apr 30)	23,200	47,900	3,420	23,900	98,420
Juvenile Rearing Total (Jan 1–Jun 30)	17,700	43,000	3,630	25,400	89,730
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	24,800	50,600	3,960	25,700	105,060
Juvenile Rearing Summer Cold Water Program (May 1–Jun 30)	3,570	28,000	2,960	24,800	59,330
Change in Habitat (sq ft)					
Effective Spawning	164 (189.69%)	590 (115.69%)	18 (33.27%)	164 (96.47%)	935 (114.14%)
Fry Rearing Total (Jan 1–Apr 30)	2,100 (9.95%)	6,900 (16.83%)	30 (0.88%)	100 (0.42%)	9,130 (10.23%)
Juvenile Rearing Total (Jan 1–Jun 30)	700 (4.12%)	1,400 (3.37%)	-80 (-2.16%)	3,000 (13.39%)	5,020 (5.93%)
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	4,200 (20.39%)	7,900 (18.5%)	350 (9.7%)	6,200 (31.79%)	18,650 (21.58%)
Juvenile Rearing Summer Cold Water Program (May 1–Jun 30)	-6,210 (-63.5%)	-11,300 (-28.75%)	-970 (-24.68%)	-3,400 (-12.06%)	-21,880 (-26.94%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

Based on the results of the FAHCE WEAP Model, there would be an 116% (645 square feet) average increase in daily effective spawning habitat in Alamitos Creek during the spawning and incubation life-stage time period for Chinook salmon (that is, October 15 to January 31) resulting from the FAHCE-plus Alternative compared with the future baseline (Figure 184; Table 124). Decreases in the daily average change in effective spawning habitat for Chinook salmon during November are primarily the result of decreases in the daily effective spawning habitat in the reach between ALAM 1 and ALAM 2 (represented by model results at ALAM 2) during this time under the FAHCE-plus Alternative compared to the future baseline, but the average daily effective spawning habitat at ALAM 2 would remain above 1,000 square feet under the FAHCE-plus Alternative during this time. Decreases in the daily effective spawning habitat in November are associated with a decrease in flow in Alamitos Creek under the FAHCE-plus Alternative compared to the future baseline (Attachment K.3 – Figures K.3.55 and K.3.56).

Figure 184. Change in Effective Chinook Salmon Spawning Habitat Compared with the Future Baseline in Alamitos Creek

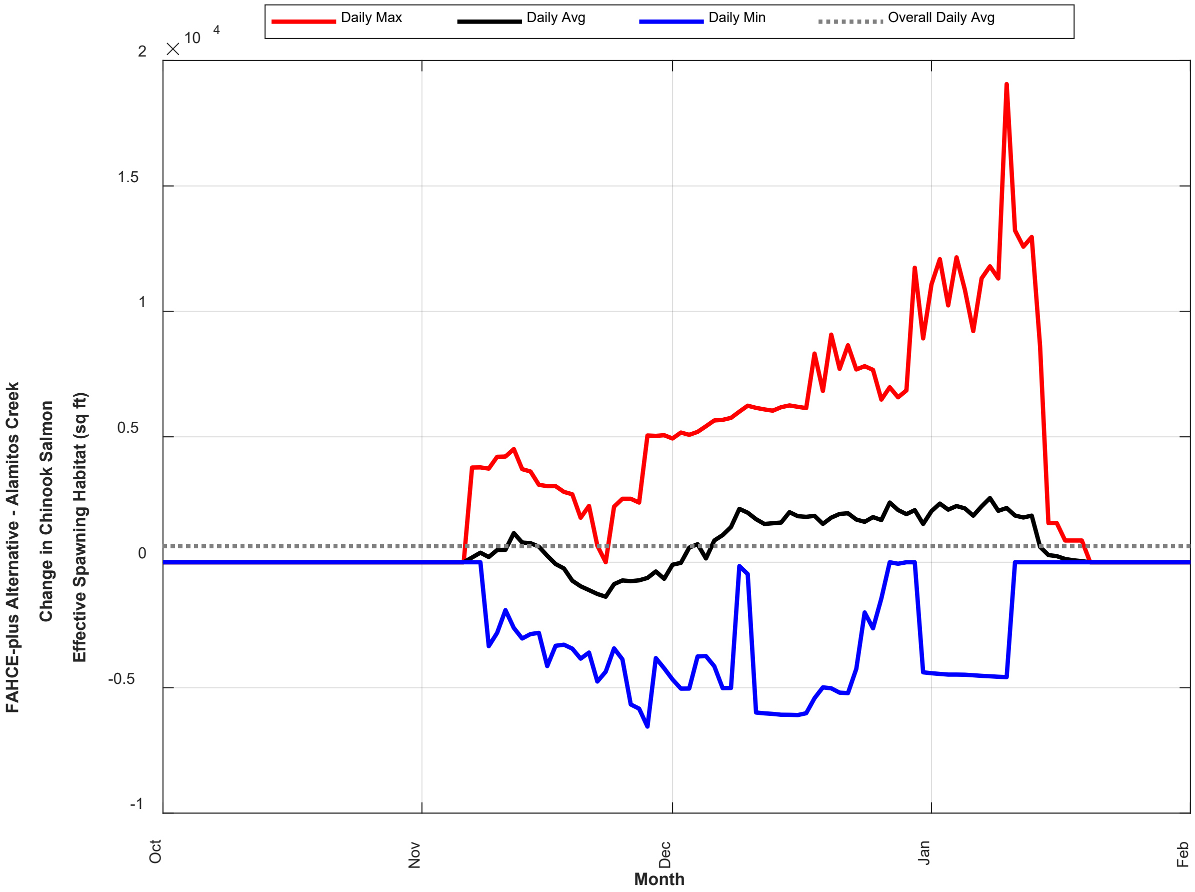


Table 124. FAHCE-plus Alternative Chinook Salmon Habitat Compared with the Future Baseline in Alamitos Creek

Alamitos Creek[a,b]	ALAM 2 River Mile 23.61	ALAM 3 River Mile 24.26	ALAM 4 River Mile 27.89	Total
Chinook Salmon Habitat Future Baseline (sq ft)				
Effective Spawning	496	13	45	554
Fry Rearing Total (Jan 1–Apr 30)	66,200	6,910	3,130	76,240
Juvenile Rearing Total (Jan 1–Jun 30)	64,300	6,670	3,270	74,240
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	66,000	6,950	2,960	75,910
Juvenile Rearing Summer Release Program (May 1–Jun 30)	60,800	6,120	3,900	70,820

Alamitos Creek[a,b]	ALAM 2 River Mile 23.61	ALAM 3 River Mile 24.26	ALAM 4 River Mile 27.89	Total
Chinook Salmon FAHCE-plus Alternative (sq ft)				
Effective Spawning	1,020	22	157	1,199
Fry Rearing Total (Jan 1–Apr 30)	72,000	7,740	3,540	83,280
Juvenile Rearing Total (Jan 1–Jun 30)	69,300	7,350	3,700	80,350
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	72,600	8,020	3,630	84,250
Juvenile Rearing Summer Release Program (May 1–Jun 30)	62,600	6,010	3,840	72,450
Change in Habitat (sq ft)				
Effective Spawning	524 (105.65%)	9 (73.02%)	112 (245.81%)	645 (116.39%)
Fry Rearing Total (Jan 1–Apr 30)	5,800 (8.76%)	830 (12.01%)	410 (13.1%)	7,040 (9.23%)
Juvenile Rearing Total (Jan 1–Jun 30)	5,000 (7.78%)	680 (10.19%)	430 (13.15%)	6,110 (8.23%)
Juvenile Rearing Winter Base Flow (Jan 1–April 30)	6,600 (10%)	1,070 (15.4%)	670 (22.64%)	8,340 (10.99%)
Juvenile Rearing Summer Release Program (May 1–Jun 30)	1,800 (2.96%)	-110 (-1.8%)	-60 (-1.54%)	1,630 (2.3%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

[b] No average daily habitat availability model results are available for the points of interest not shown.

Based on the results of the FAHCE WEAP Model for wetted area, effective spawning habitat would decrease in Calero Creek compared with the future baseline due to decreased wetted area during Winter Base Flow Operations. The largest decrease in effective spawning habitat would occur during the beginning of the spawning period (October–November), with the rest of the spawning period (December–January) providing more effective spawning habitat compared with the future baseline.

Table 125. FAHCE-plus Alternative Chinook Salmon Habitat Compared with the Future Baseline in Calero Creek

Calero Creek[a]	CALE 1 River Mile 24.33	CALE 2 River Mile 27.59	Total
Chinook Salmon Habitat Future Baseline (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (Jan 1-Apr 30)	2,800	26,600[c]	29,400[c]
Juvenile Rearing Total (Jan 1-Jun 30)	2,920	53,600[c]	56,520[c]
Juvenile Rearing Winter Base Flow (Jan 1-April 30)	2,920	25,900[c]	28,820[c]
Juvenile Rearing Summer Release Program (May 1-Jun 30)	2,910	109,000	111,910

Calero Creek[a]	CALE 1 River Mile 24.33	CALE 2 River Mile 27.59	Total
Chinook Salmon FAHCE-plus Alternative (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (Jan 1-Apr 30)	3,020	28,000[c]	31,020[c]
Juvenile Rearing Total (Jan 1-Jun 30)	3,170	57,200[c]	60,370[c]
Juvenile Rearing Winter Base Flow (Jan 1-April 30)	3,220	28,000[c]	31,220[c]
Juvenile Rearing Summer Release Program (May 1-Jun 30)	3,080	115,000	118,080
Change in Habitat (sq ft)			
Effective Spawning[b]	NA	NA	NA
Fry Rearing Total (Jan 1-Apr 30)	220 (7.86%)	1,400 (5.26%)[c]	1,620 (5.51%)[c]
Juvenile Rearing Total (Jan 1-Jun 30)	250 (8.56%)	3,600 (6.72%)[c]	3,850 (6.81%)[c]
Juvenile Rearing Winter Base Flow (Jan 1-April 30)	300 (10.27%)	2,100 (8.11%)[c]	2,400 (8.33%)[c]
Juvenile Rearing Summer Release Program (May 1-Jun 30)	170 (5.84%)	6,000 (5.5%)	6,170 (5.51%)

[a] Habitat is the FAHCE WEAP modeled average daily habitat availability averaged across the applicable life-stage period. Where specified, this definition of habitat applies to the life-stage period within a reservoir operation period.

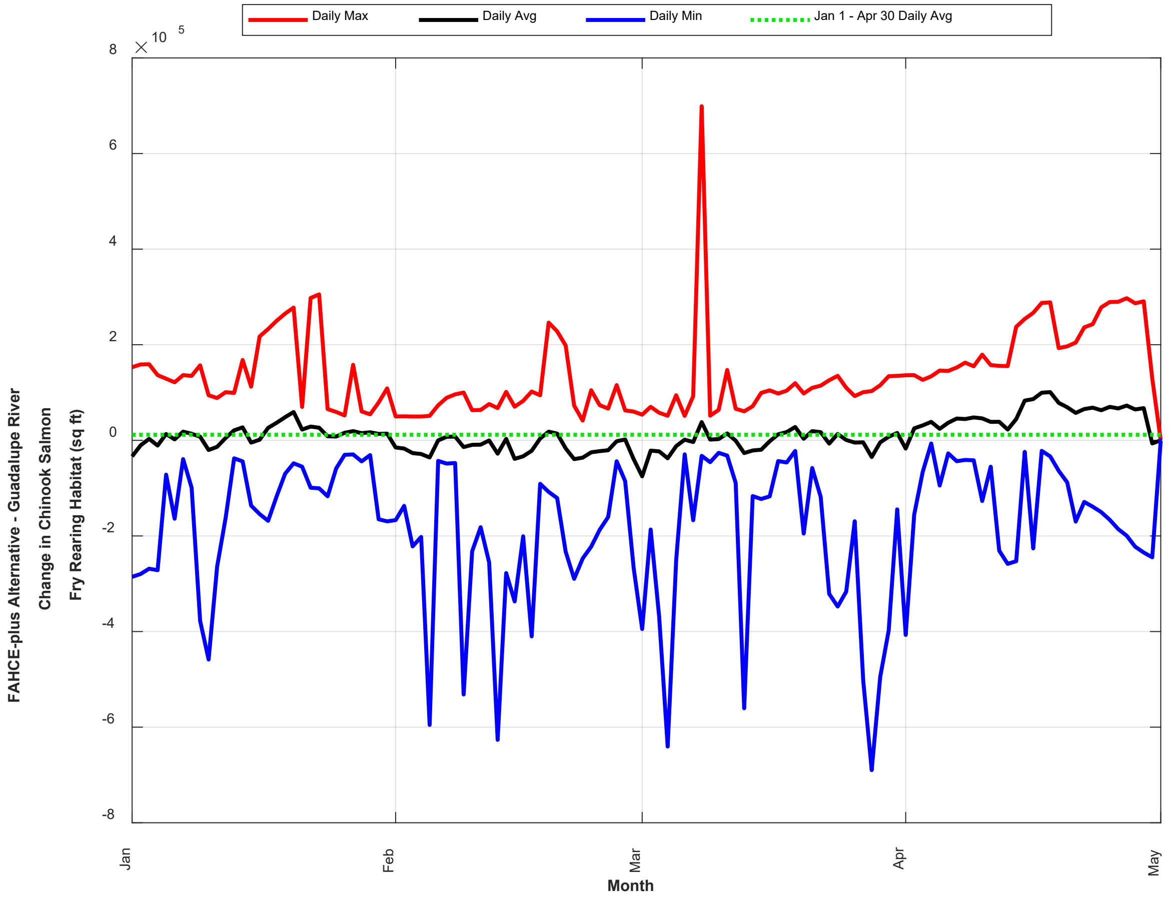
[b] Effective spawning model results were not available in Calero Creek because no substrate suitable for spawning was recorded by the subsample habitat survey of Calero Creek input into the FAHCE WEAP Model. Subsequent surveys indicate there is substrate suitable for spawning in Calero Creek (Valley Water 2019, 2020).

[c] Average daily fry rearing and juvenile rearing habitat availability model results do not quantify conditions when winter cover was considered in the habitat estimate (January 1 through March 31 for Chinook salmon) since no winter cover was recorded by the subsample habitat survey of the CALE 2 reach of Calero Creek (that is, the reach between CALE 1 and CALE 2) input into the FAHCE WEAP Model. Subsequent surveys indicate there is winter cover available in this reach of Calero Creek (Valley Water 2019, 2020).

Fry Rearing Habitat

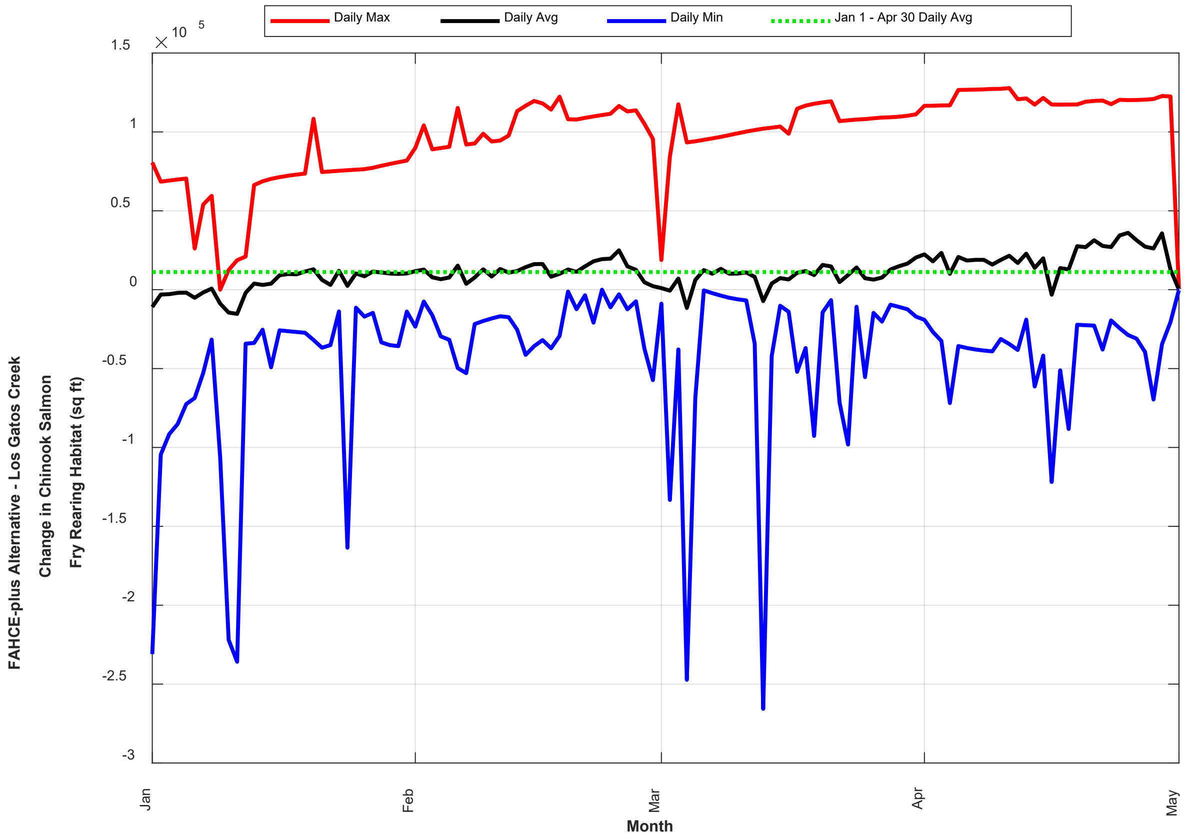
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 2% (28,900 square feet) average increase in fry rearing habitat in the Guadalupe River for Chinook salmon compared with the future baseline (Figure 185; Table 121).

Figure 185. Change in Chinook Salmon Fry Rearing Habitat Compared with the Future Baseline in the Guadalupe River



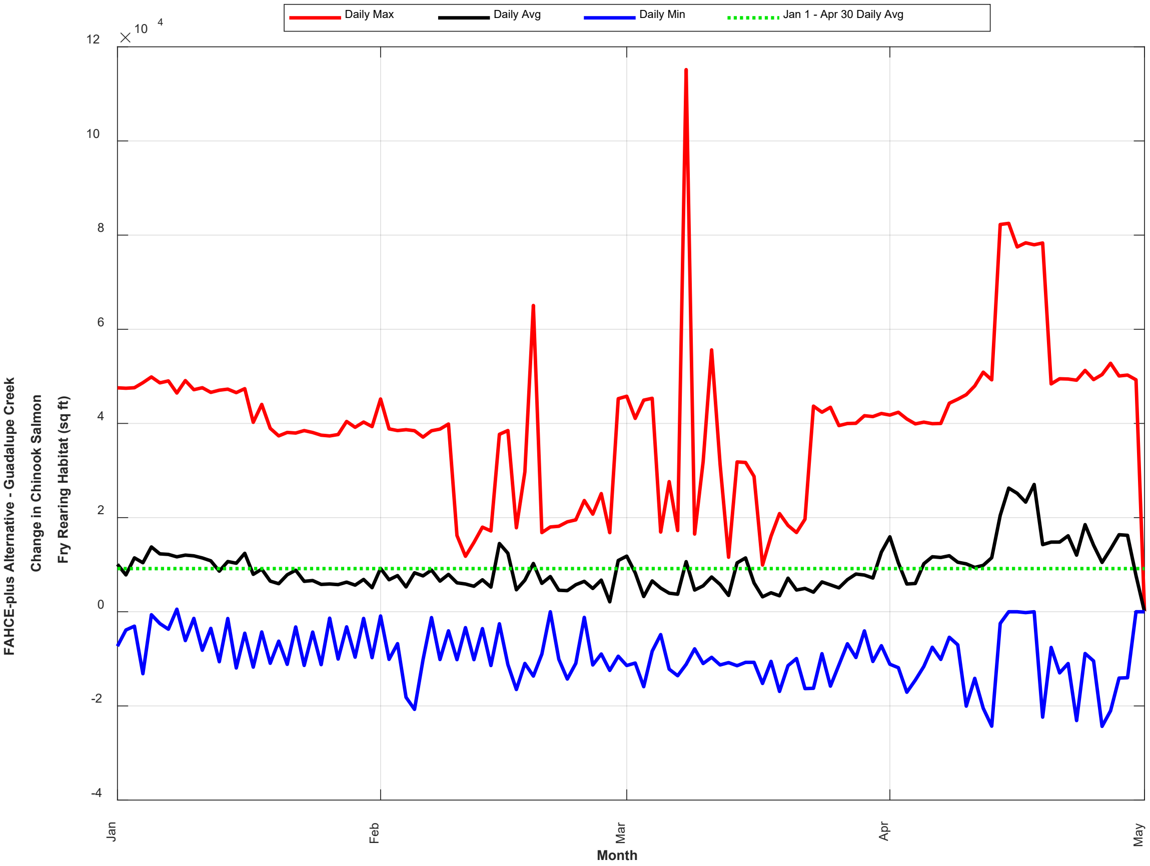
Based on the results of the FAHCE WEAP Model, there would be an average 2% (11,000 square feet) increase in fry rearing habitat in Los Gatos Creek for Chinook salmon resulting from the FAHCE-plus Alternative compared with the future baseline (Figure 186; Table 122).

Figure 186. Change in Chinook Salmon Fry Rearing Habitat Compared with the Future Baseline in Los Gatos Creek



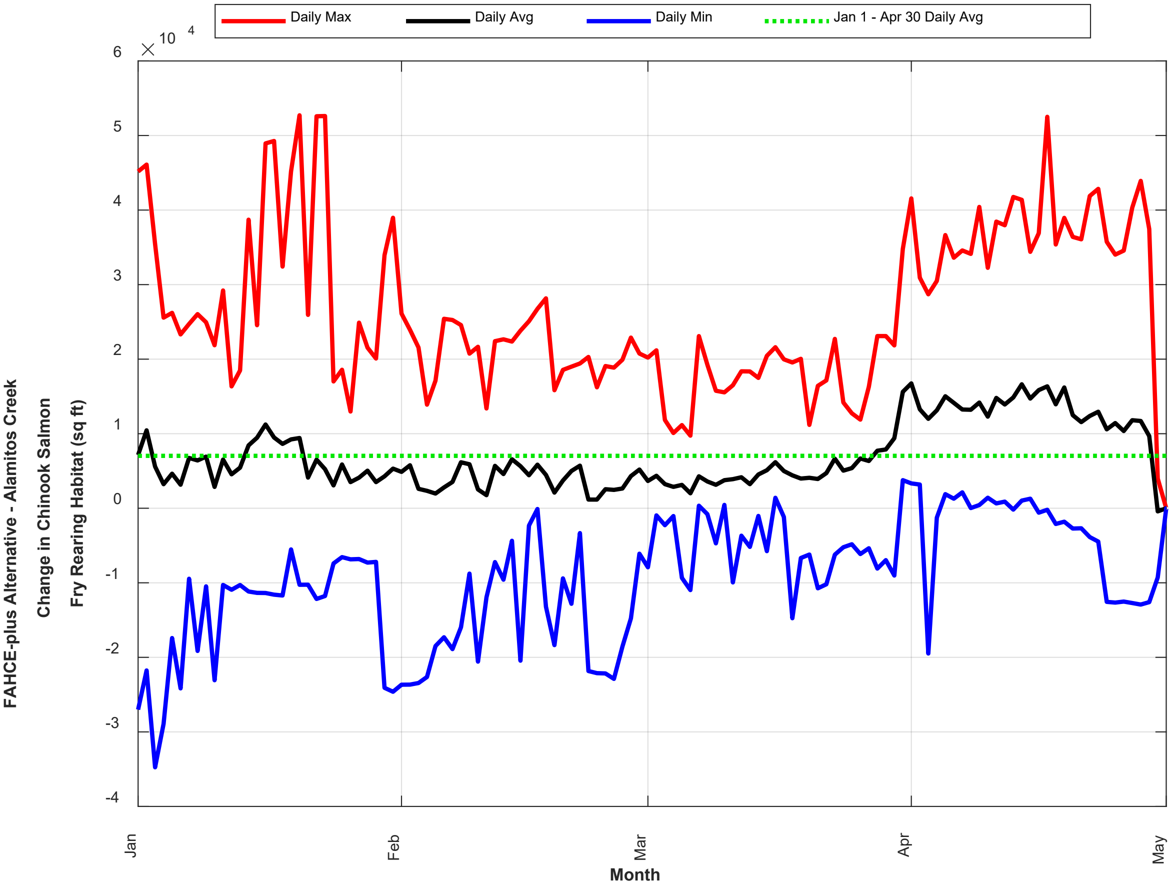
Based on the results of the FAHCE WEAP Model, there would be a 10% average (9,130 square feet) increase in fry rearing habitat in Guadalupe Creek for Chinook salmon resulting from the FAHCE-plus Alternative compared with the future baseline (Figure 187; Table 123). In the Guadalupe Creek CWMZ, Chinook salmon fry rearing habitat increased by less than 1% (100 square feet) when compared with the future baseline.

Figure 187. Change in Chinook Salmon Fry Rearing Habitat Compared with the Future Baseline in Guadalupe Creek



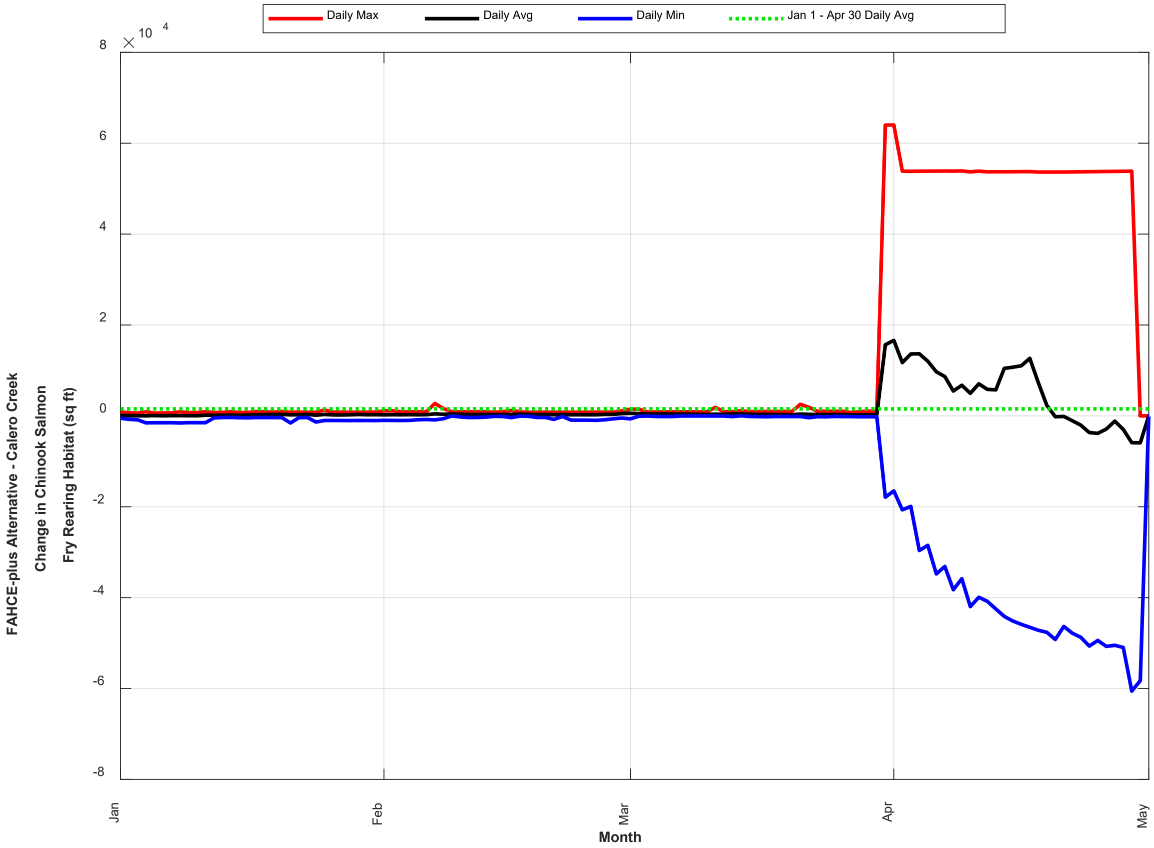
Based on the results of the FAHCE WEAP Model, there would be a 9% (7,040 square feet) average increase in fry rearing habitat in Alamitos Creek for Chinook salmon resulting from the FAHCE-plus Alternative compared with the future baseline (Figure 188; Table 124).

Figure 188. Change in Chinook Salmon Fry Rearing Habitat Compared with the Future Baseline in Alamitos Creek



There would be a 6% (1,620 square feet) average increase in fry rearing habitat in Calero Creek compared with the future baseline (Figure 189, Table 125). The average increase between January 1 and May 31 does not completely characterize the change in fry rearing habitat during this period because habitat surveys indicated there was zero winter cover in the reach associated with the CALE 2 POI (that is, CALE 1 to CALE 2) and caused fry rearing habitat to be zero in this reach during January 1 to March 31 under all scenarios. Subsequent habitat surveys indicated there was winter cover (Valley Water 2019, 2020), so fry rearing habitat would not actually be zero in this reach between January 1 and March 31. Increases in wetted area at CALE 2 from January 1 to March 31 under the FAHCE-plus Alternative compared to the future baseline further indicate fry rearing habitat during this time would be greater than estimated by the model habitat results (Attachment K.3 – Figures K.3.69 and K.3.70).

Figure 189. Change in Chinook Salmon Fry Rearing Habitat Compared with the Future Baseline in Calero Creek[a]

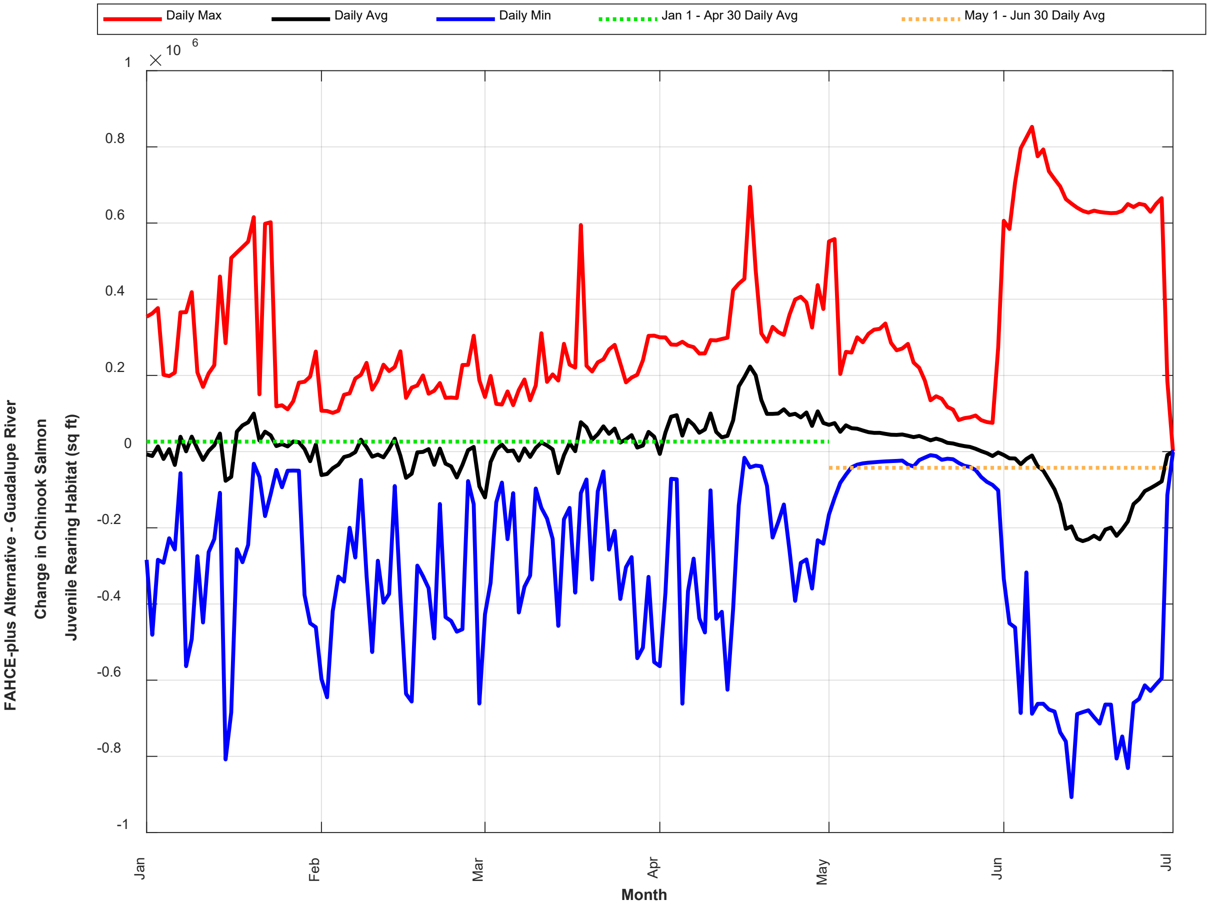


[a] Calero Creek habitat survey results in the reach between CALE 1 and CALE 2 input into the FAHCE WEAP Model did not record any winter cover, so fry and juvenile rearing habitat model results in this reach were zero during the period when winter cover is considered in the habitat estimate (that is, December 1 through March 31 for steelhead; January 1 through March 31 for Chinook salmon). Subsequent habitat surveys identified winter cover between CALE 1 and CALE 2 (Valley Water 2019, 2020).

Juvenile Rearing Habitat

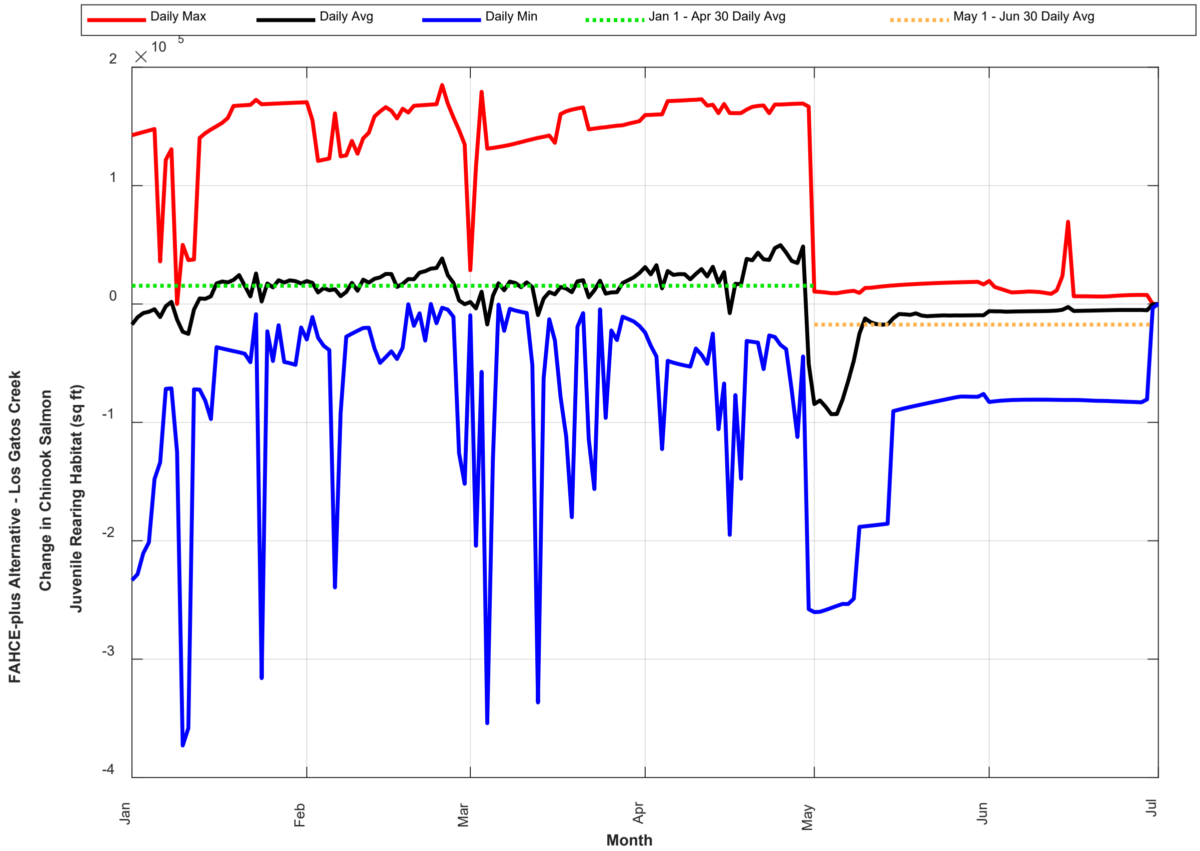
Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 2% increase (31,200 square feet) in juvenile rearing habitat in the Guadalupe River for Chinook salmon compared with the future baseline (Figure 190; Table 121). The trends in juvenile rearing habitat over time revealed an increase of 4% (61,700 square feet) under the FAHCE-plus Alternative during Winter Base Flow Operations and a decrease of 3% (30,900 square feet) during the Summer Release Program (Figure 190). Juvenile rearing habitat declined steadily throughout the month of May and reached a minimum in the middle of June. Decreases in juvenile rearing habitat are associated with increased water temperatures resulting from a reduction in flow and average wetted areas during the Summer Release Program in the Guadalupe River (Attachment K.3 – Figures K.3.21, K.3.22, and K.3.23).

Figure 190. Change in Chinook Salmon Juvenile Rearing Habitat Compared with the Future Baseline in the Guadalupe River



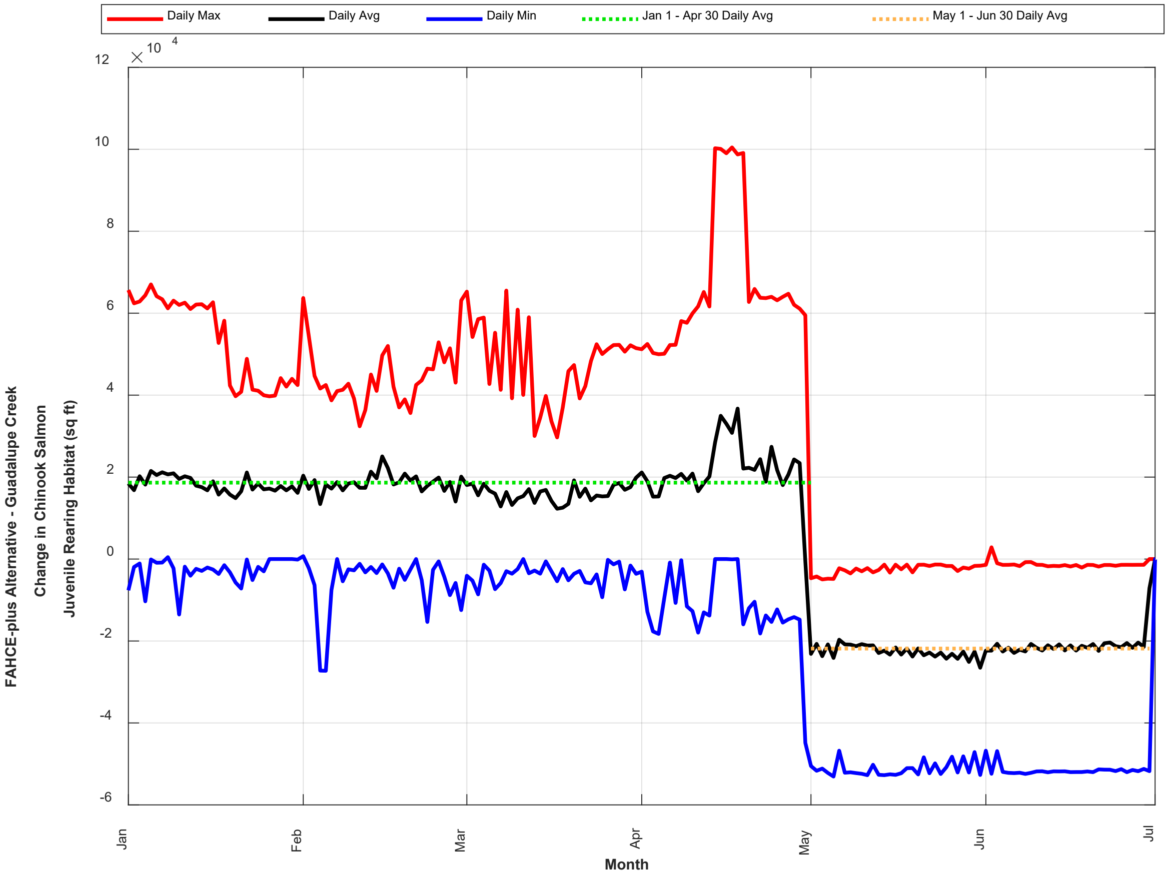
Based on the results of the FAHCE WEAP Model, there would be an average 1% (5,000 square feet) average increase in juvenile rearing habitat in Los Gatos Creek for Chinook salmon resulting from the FAHCE-plus Alternative compared with the future baseline (Figure 191; Table 122). The trends in juvenile rearing habitat over time revealed a 4% (14,000 square feet) increase under the FAHCE-plus Alternative during Winter Base Flow Operations and a 4% (17,000 square feet) decrease during the Summer Release Program in Los Gatos Creek.

Figure 191. Change in Chinook Salmon Juvenile Rearing Habitat Compared with the Future Baseline in Los Gatos Creek



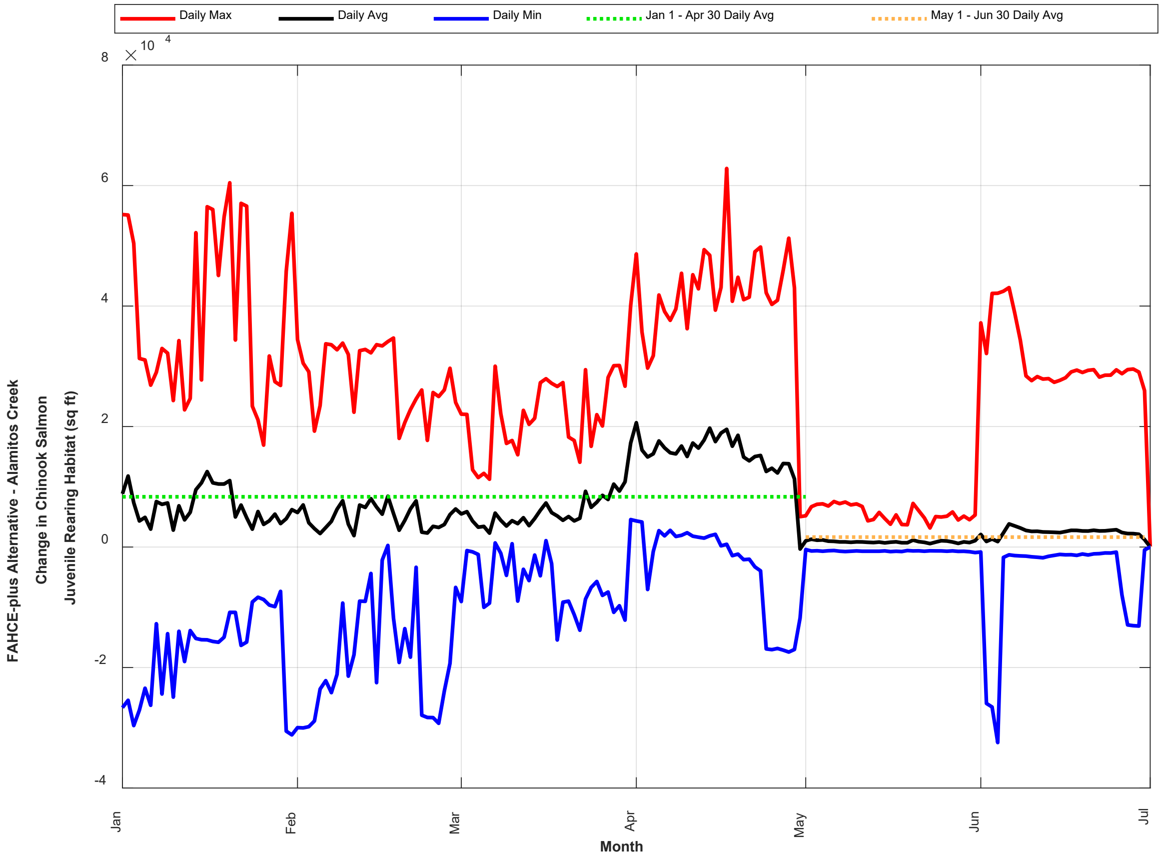
Based on the results of the FAHCE WEAP Model, there would be a 6% increase (5,020 square feet) in juvenile rearing habitat in Guadalupe Creek for Chinook salmon resulting from the FAHCE-plus Alternative compared with the future baseline (Figure 192; Table 123). The trends in juvenile rearing habitat over time would be a 22% (18,650 square feet) increase under the FAHCE-plus Alternative during Winter Base Flow Operations followed by a 27% (21,880 square feet) decrease during the Summer Cold Water Program. In the Guadalupe Creek CWMZ, juvenile rearing habitat increased by 13% (3,000 square feet), with a 32% (6,200 square feet) increase occurring during the Winter Base Flow Operations followed by a 12% (3,400 square feet) decrease during the Summer Cold Water Program. MWAT resulting from the FAHCE-plus Alternative remained below 65°F throughout the Summer Cold Water Program in the Guadalupe Creek CWMZ, so decreases in habitat within the CWMZ are strictly a function of a decrease in wetted area. The decreases in habitat during the Summer Cold Water Program downstream of the CWMZ are the result of reduced wetted area and elevated water temperatures (that is, above 65°F) in Guadalupe Creek.

Figure 192. Change in Chinook Juvenile Rearing Habitat Compared with the Future Baseline in Guadalupe Creek



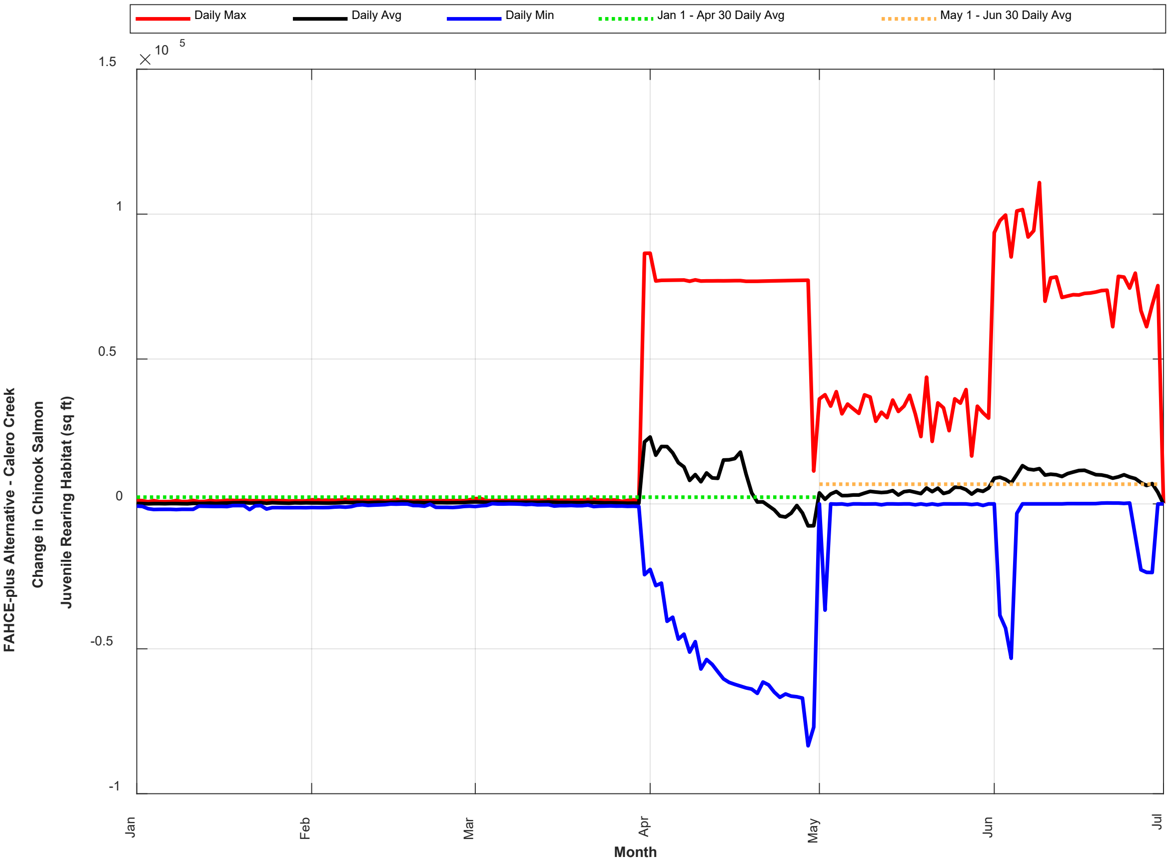
Based on the results of the FAHCE WEAP Model, there would be an 8% increase (6,110 square feet) in juvenile rearing habitat in Alamitos Creek for Chinook salmon resulting from the FAHCE-plus Alternative compared with the future baseline (Figure 193; Table 124).

Figure 193. Change in Chinook Juvenile Rearing Habitat Compared with the Future Baseline in Alamitos Creek



There would be a 7% (3,850 square feet) average increase in juvenile rearing habitat in Calero Creek compared with the future baseline with a 8% (2,400 square feet) increase during the Winter Base Flow Operations and a 6% (6,170 square feet) increase during the Summer Release Program (Figure 194; Table 125). The average increases estimated from the model results do not completely characterize the change in juvenile rearing habitat during January 1 to March 31 because habitat surveys indicated there was zero winter cover in the reach associated with the CALE 2 POI (that is, CALE 1 to CALE 2) and caused juvenile rearing habitat to be zero in this reach during January 1 to March 31 under all scenarios. Subsequent habitat surveys indicated there was winter cover (Valley Water 2019, 2020), so juvenile rearing habitat would not actually be zero in this reach between January 1 and March 31. Increases in wetted area at CALE 2 from January 1 to March 31 under the FAHCE-plus Alternative compared to the future baseline further indicate juvenile rearing habitat during this time would be greater than estimated by the model habitat results (Attachment K.3 – Figures K.3.69 and K.3.70).

Figure 194. Change in Chinook Juvenile Rearing Habitat Compared with the Future Baseline in Calero Creek[a]



[a] Calero Creek habitat survey results in the reach between CALE 1 and CALE 2 input into the FAHCE WEAP Model did not record any winter cover, so fry and juvenile rearing habitat model results in this reach were zero during the period when winter cover is considered in the habitat estimate (that is, December 1 through March 31 for steelhead; January 1 through March 31 for Chinook salmon). Subsequent habitat surveys identified winter cover between CALE 1 and CALE 2 (Valley Water 2019, 2020).

Migration Conditions

Adult Upstream Passage

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 1% (less than 1 day per year) average decrease to adult upstream Chinook salmon passage in the Guadalupe River compared with the future baseline (Figure 195; Table 126).

Figure 195. Change in Average Adult Chinook Salmon Upstream Passage Days Compared with the Future Baseline in the Guadalupe River

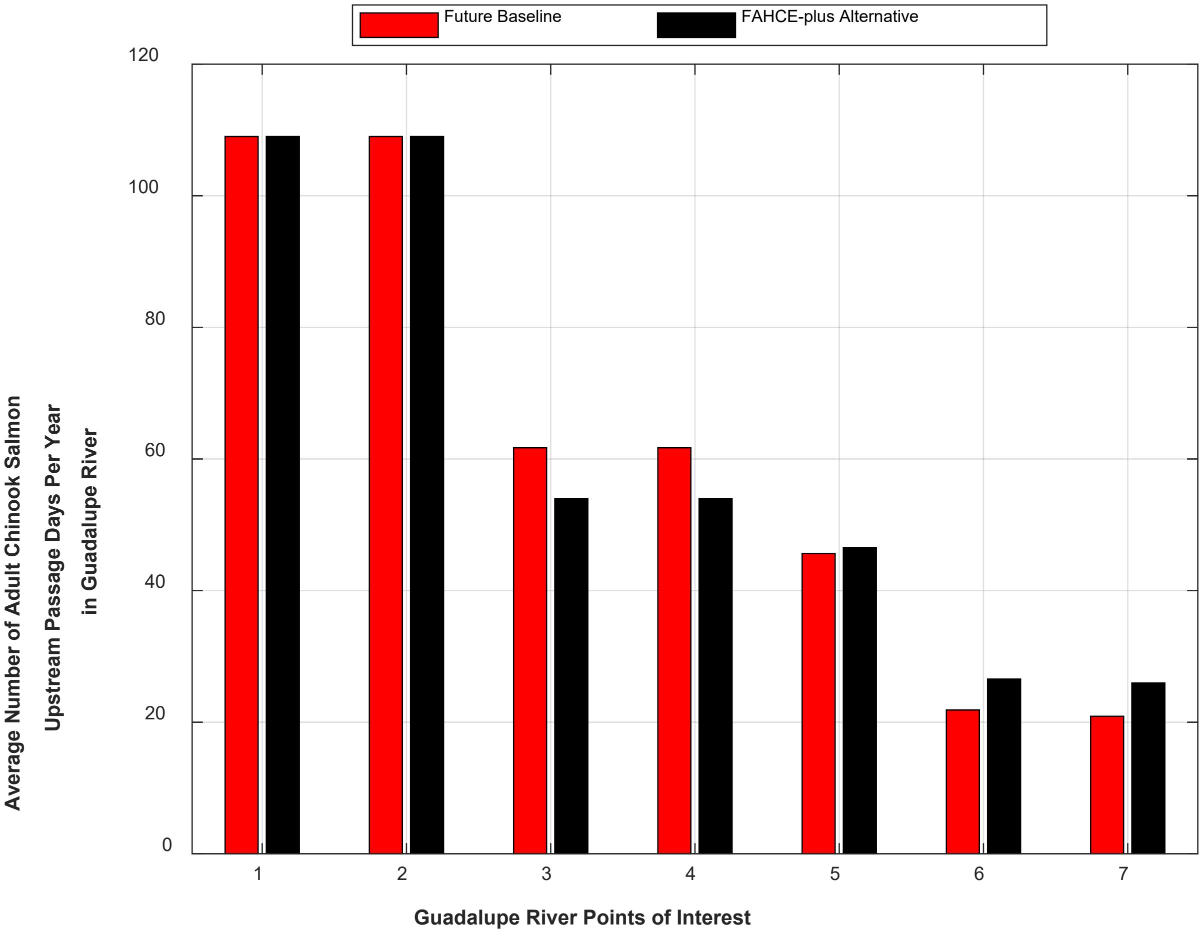


Table 126. FAHCE-plus Alternative Adult Chinook Salmon Upstream Passage Compared with the Future Baseline in the Guadalupe River

Parameter	GUAD 1	GUAD 2	GUAD 3	GUAD 4	GUAD 5	GUAD 6	GUAD 7
Future Baseline (days)[a]							
Total Adult Upstream Passage (1991–2010)	2,180	2,180	1,234	1,234	913	437	418
Average Adult Upstream Passage Per Year	109	109	62	62	46	22	21
FAHCE-plus Alternative (days)[a]							
Total Adult Upstream Passage (1991–2010)	2,180	2,180	1,080	1,080	931	531	519
Average Adult Upstream Passage Per Year	109	109	54	54	47	27	26

Parameter	GUAD 1	GUAD 2	GUAD 3	GUAD 4	GUAD 5	GUAD 6	GUAD 7
Difference (days)							
Total Adult Upstream Passage (1991–2010)	0.00	0.00	-154.00	-154.00	18.00	94.00	101.00
Average Adult Upstream Passage Per Year	0.00	0.00	-7.70	-7.70	0.90	4.70	5.05
Difference (%)							
Total Adult Upstream Passage (1991–2010)	0.00	0.00	-12.48	-12.48	1.97	21.51	24.16
Average Adult Upstream Passage Per Year	0.00	0.00	-12.48	-12.48	1.97	21.51	24.16

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 39% (7 days per year on average) decrease to adult upstream Chinook salmon passage at Los Gatos Creek compared with the future baseline (Figure 196; Table 127).

Figure 196. Change in Average Adult Chinook Salmon Upstream Passage Days Compared with the Future Baseline in Los Gatos Creek

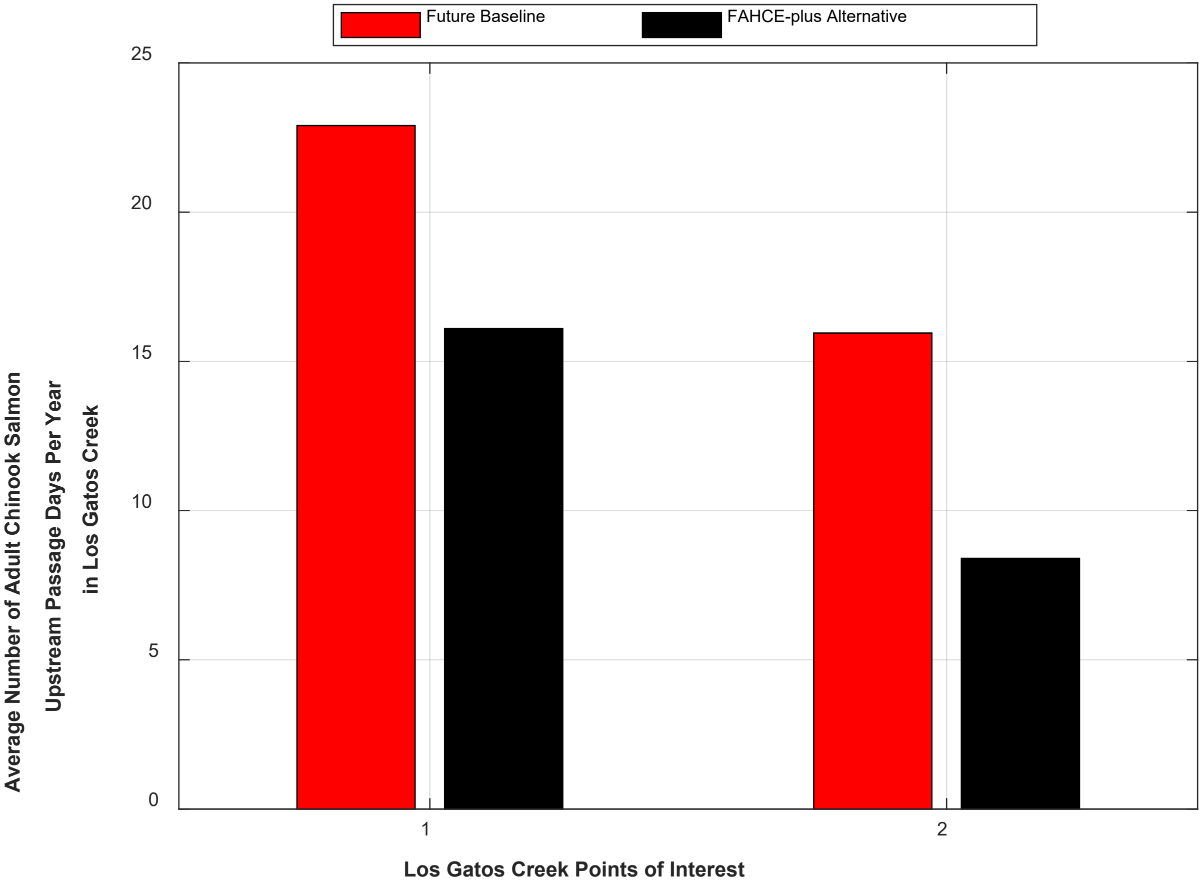


Table 127. FAHCE-plus Alternative Adult Chinook Salmon Upstream Passage Compared with the Future Baseline in Los Gatos Creek

Parameter	LOSG 1	LOSG 2
Future Baseline (days)[a]		
Total Adult Upstream Passage (1991–2010)	458	319
Average Adult Upstream Passage Per Year	23	16
FAHCE-plus Alternative (days)[a]		
Total Adult Upstream Passage (1991–2010)	322	168
Average Adult Upstream Passage Per Year	16	8
Difference (days)		
Total Adult Upstream Passage (1991–2010)	-136.00	-151.00
Average Adult Upstream Passage Per Year	-6.80	-7.55
Difference (%)		
Total Adult Upstream Passage (1991–2010)	-29.69	-47.34
Average Adult Upstream Passage Per Year	-29.69	-47.34

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 21% (less than 1 day per year on average) average increase to adult upstream passage at Guadalupe Creek compared with the future baseline (Figure 197; Table 128).

Figure 197. Change in Average Adult Chinook Salmon Upstream Passage Days Compared with the Future Baseline in Guadalupe Creek

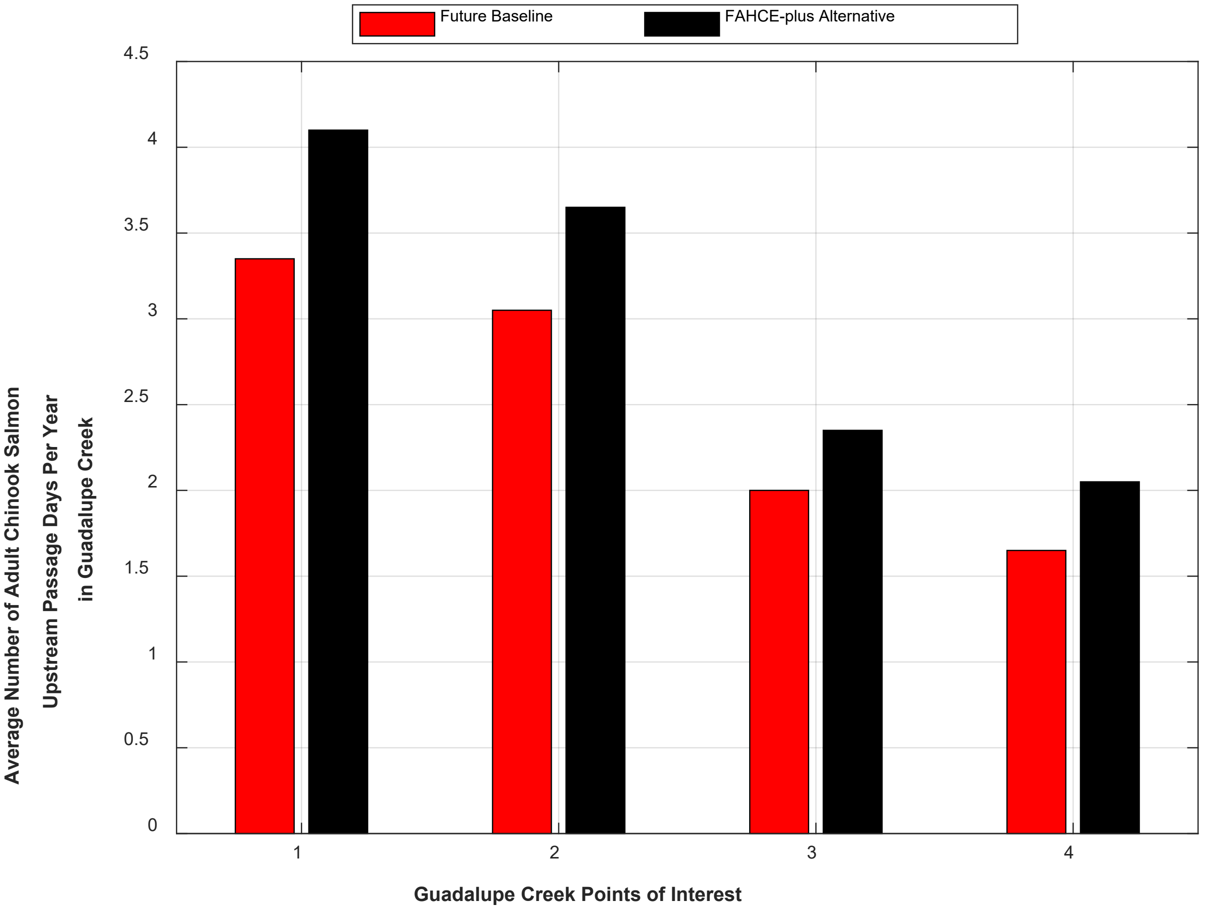


Table 128. FAHCE-plus Alternative Adult Chinook Salmon Upstream Passage Compared with the Future Baseline in Guadalupe Creek

Parameter	GCRK 1	GCRK 2	GCRK 3	GCRK 4
Future Baseline (days)[a]				
Total Adult Upstream Passage (1991–2010)	67	61	40	33
Average Adult Upstream Passage Per Year	3	3	2	2
FAHCE-plus Alternative (days)[a]				
Total Adult Upstream Passage (1991–2010)	82	73	47	41
Average Adult Upstream Passage Per Year	4	4	2	2
Difference (days)				
Total Adult Upstream Passage (1991–2010)	15.00	12.00	7.00	8.00
Average Adult Upstream Passage Per Year	0.75	0.60	0.35	0.40

Parameter	GCRK 1	GCRK 2	GCRK 3	GCRK 4
Difference (%)				
Total Adult Upstream Passage (1991–2010)	22.39	19.67	17.50	24.24
Average Adult Upstream Passage Per Year	22.39	19.67	17.50	24.24

[a] Rounded to whole days

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 22% (2 days per year on average) average increase to adult upstream passage in Alamitos Creek compared with the future baseline (Figure 198; Table 129).

Figure 198. Change in Average Adult Chinook Salmon Upstream Passage Days Compared with the Future Baseline in Alamitos Creek

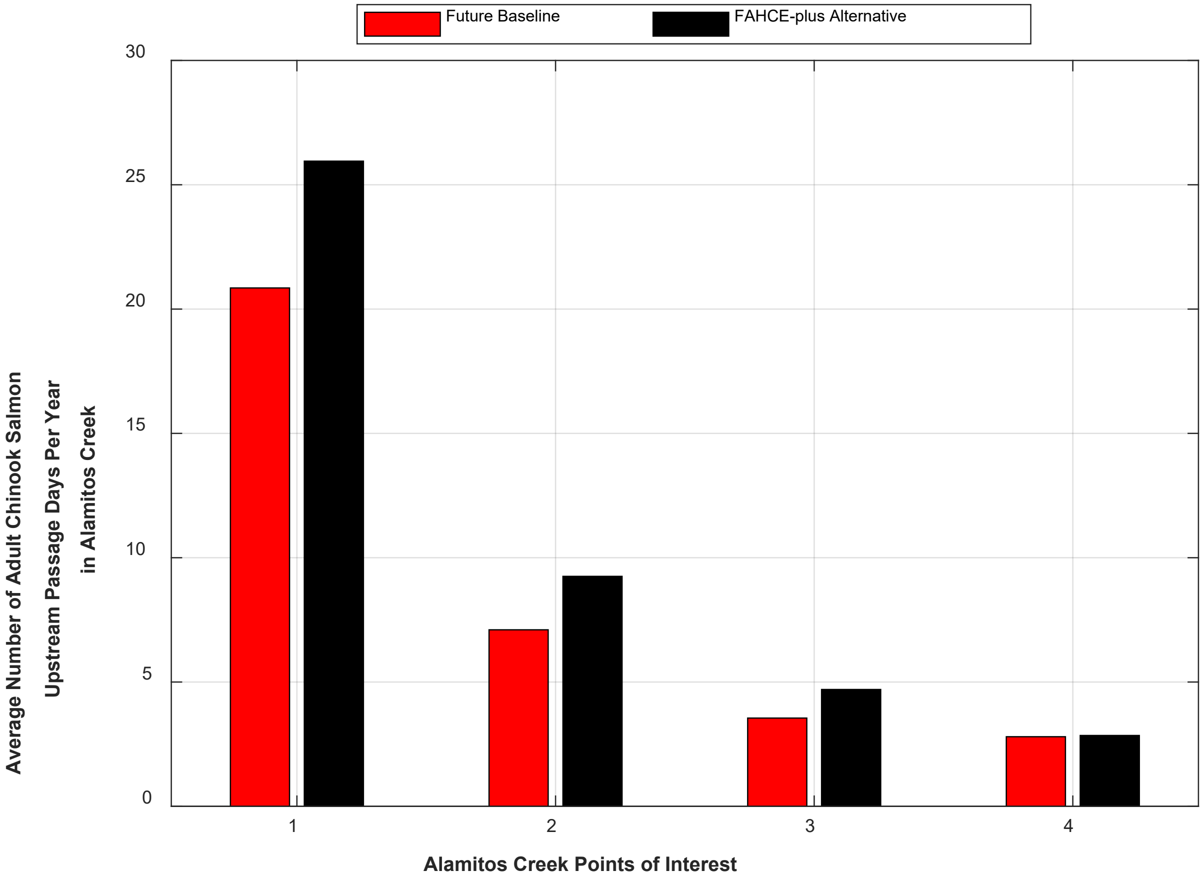


Table 129. FAHCE-plus Alternative Adult Chinook Salmon Upstream Passage Compared with the Future Baseline in Alamitos Creek

Parameter	ALAM 1	ALAM 2	ALAM 3	ALAM 4
Future Baseline (days)[a]				
Total Adult Upstream Passage (1991–2010)	417	142	71	56
Average Adult Upstream Passage Per Year	21	7	4	3

Parameter	ALAM 1	ALAM 2	ALAM 3	ALAM 4
FAHCE-plus Alternative (days)[a]				
Total Adult Upstream Passage (1991–2010)	519	185	94	57
Average Adult Upstream Passage Per Year	26	9	5	3
Difference (days)				
Total Adult Upstream Passage (1991–2010)	102.00	43.00	23.00	1.00
Average Adult Upstream Passage Per Year	5.10	2.15	1.15	0.05
Difference (%)				
Total Adult Upstream Passage (1991–2010)	24.46	30.28	32.39	1.79
Average Adult Upstream Passage Per Year	24.46	30.28	32.39	1.79

[a] Rounded to whole days

The FAHCE-plus Alternative would result in a 267% (less than 1 day per year) on average increase to adult upstream passage in Calero Creek compared with the future baseline given the extremely low amount of passage provided in Calero Creek under the future baseline (Figure 199).

Figure 199. Change in Average Adult Chinook Salmon Upstream Passage Days Compared with the Future Baseline in Calero Creek

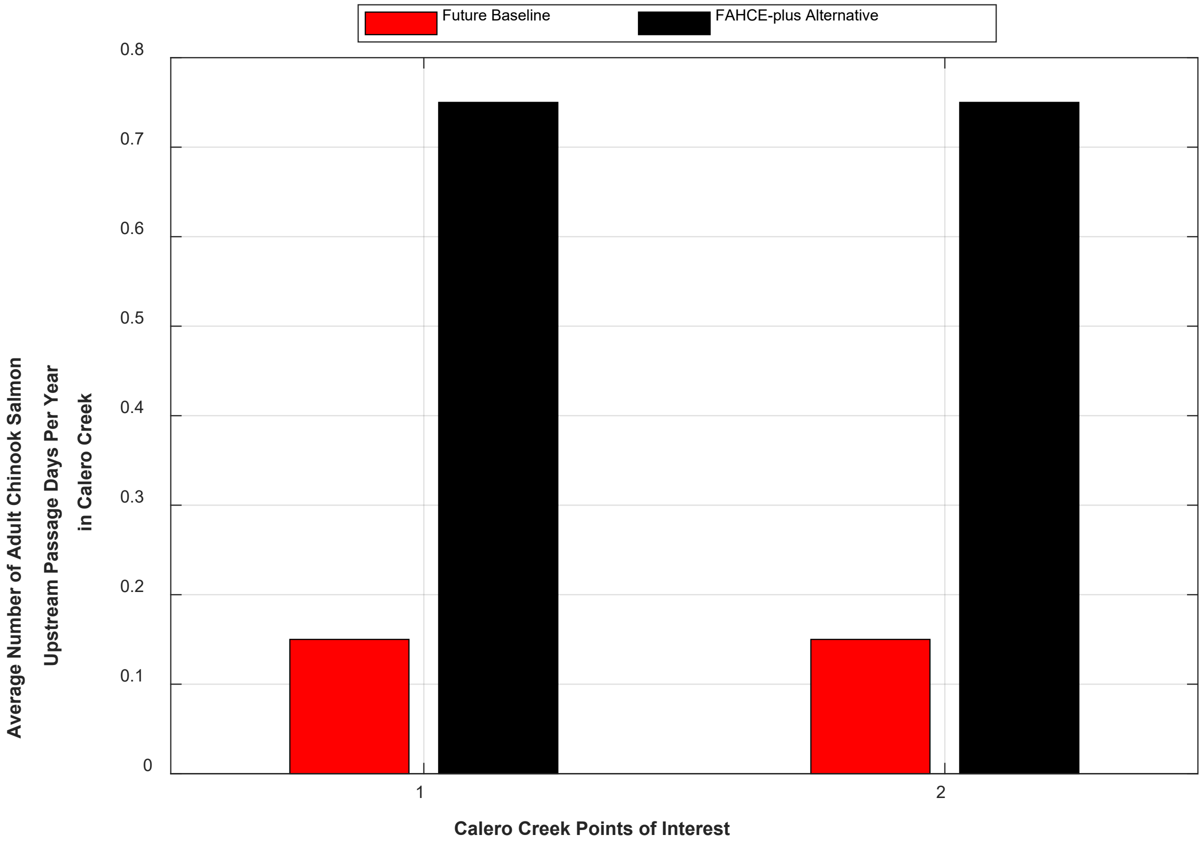


Table 130. FAHCE-plus Alternative Adult Chinook Salmon Upstream Passage Compared with the Future Baseline in Calero Creek

Parameter	CALE 1	CALE 2
Future Baseline (days)[a]		
Total Adult Upstream Passage (1991–2010)	3	3
Average Adult Upstream Passage Per Year	0	0
FAHCE-plus Alternative (days)[a]		
Total Adult Upstream Passage (1991–2010)	11	11
Average Adult Upstream Passage Per Year	1	1
Difference (days)		
Total Adult Upstream Passage (1991–2010)	8.00	8.00
Average Adult Upstream Passage Per Year	0.40	0.40
Difference (%)		
Total Adult Upstream Passage (1991–2010)	266.67	266.67
Average Adult Upstream Passage Per Year	266.67	266.67

[a] Rounded to whole days

Juvenile Downstream Passage

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 30% (18 days per year) average increase to juvenile Chinook salmon downstream passage in the Guadalupe River compared with the future baseline (Figure 200; Table 131). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in a 16% (12 days per year) average increase to juvenile downstream passage in the Guadalupe River compared with the future baseline (Table 131). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in the Guadalupe River under the FAHCE-plus Alternative compared to the future baseline.

Figure 200. Change in Juvenile Chinook Salmon Downstream Passage Days Compared with the Future Baseline in the Guadalupe River

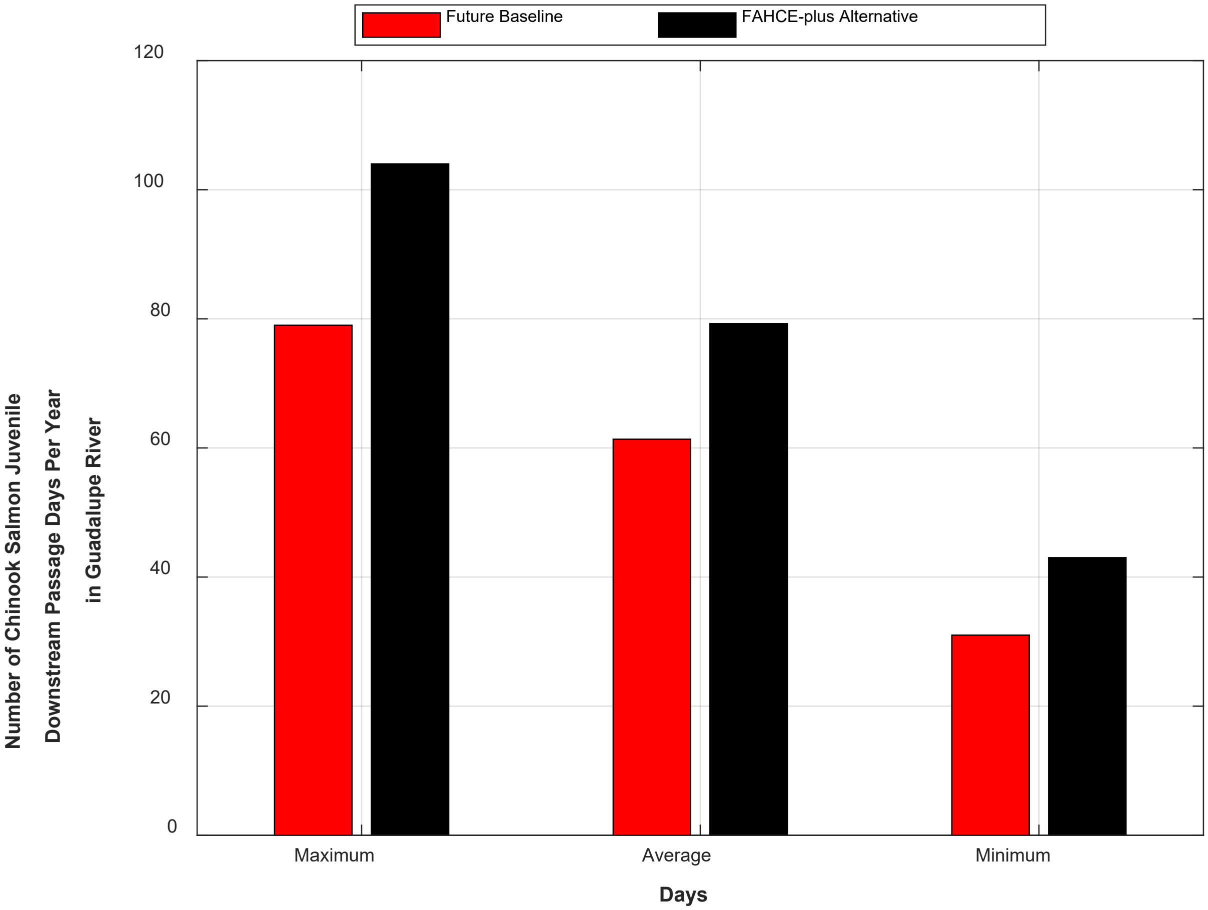


Table 131. FAHCE-plus Alternative Juvenile Chinook Salmon Downstream Passage Compared with the Future Baseline in the Guadalupe River

Parameter	GUAD 7 with Water Temperature Criteria[b]
Future Baseline (days)[a]	
Total Juvenile Downstream Passage (1991–2010)	1,227
Average Juvenile Downstream Passage Per Year	61
FAHCE-plus Alternative (days)[a]	
Total Juvenile Downstream Passage (1991–2010)	1,585
Average Juvenile Downstream Passage Per Year	79
Difference (days)	
Total Juvenile Downstream Passage (1991–2010)	358.00
Average Juvenile Downstream Passage Per Year	18.00
Difference (%)	
Total Juvenile Downstream Passage (1991–2010)	29.18
Average Juvenile Downstream Passage Per Year	29.51

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 6% (5 days per year) average increase to juvenile Chinook salmon downstream passage at Los Gatos Creek compared with future baseline (Figure 201; Table 132). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in a 2% (3 days per year) average decrease to juvenile downstream passage in Los Gatos Creek compared with the future baseline (Table 132). There was no change in the number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in Los Gatos Creek under the FAHCE-plus Alternative compared to the future baseline.

Figure 201. Change in Juvenile Chinook Salmon Downstream Passage Days Compared with the Future Baseline in Los Gatos Creek

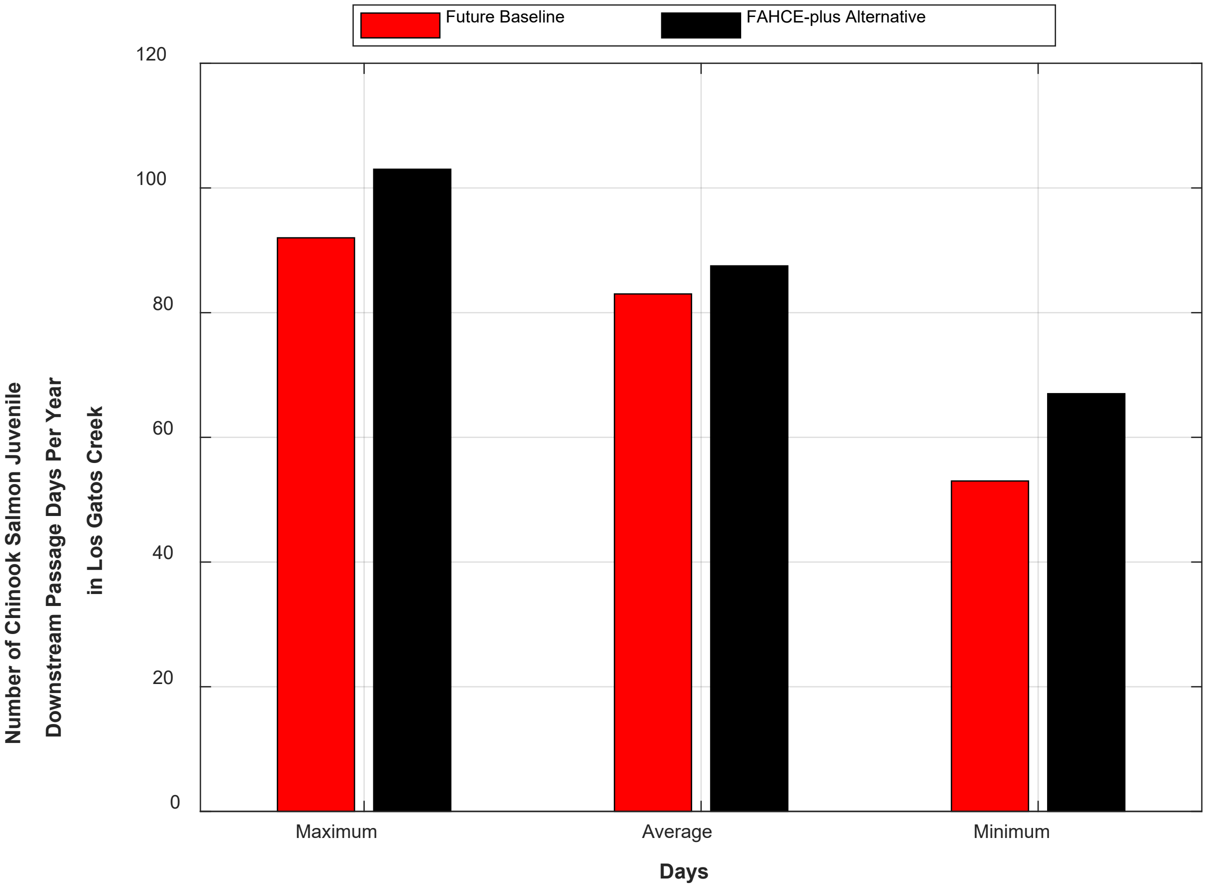


Table 132. FAHCE-plus Alternative Juvenile Chinook Salmon Downstream Passage Compared with the Future Baseline in Los Gatos Creek

Parameter	LOSG 2 with Water Temperature Criteria[b]	LOSG 2 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	1,660	2,993
Average Juvenile Downstream Passage Per Year	83	150
FAHCE-plus Alternative (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	1,750	2,936
Average Juvenile Downstream Passage Per Year	88	147
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	90.00	-57.00
Average Juvenile Downstream Passage Per Year	5.00	-3.00
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	5.42	-1.90
Average Juvenile Downstream Passage Per Year	6.02	-2.00

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 135% (32 days per year on average) increase to juvenile downstream Chinook salmon passage at Guadalupe Creek compared with the future baseline (Figure 202; Table 133). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in a 96% (27 days per year) average increase to juvenile downstream passage in Guadalupe Creek compared with the future baseline (Table 133). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in Guadalupe Creek increased by five under the FAHCE-plus Alternative compared to the future baseline.

Figure 202. Change in Juvenile Chinook Salmon Downstream Passage Days Compared with the Future Baseline in Guadalupe Creek

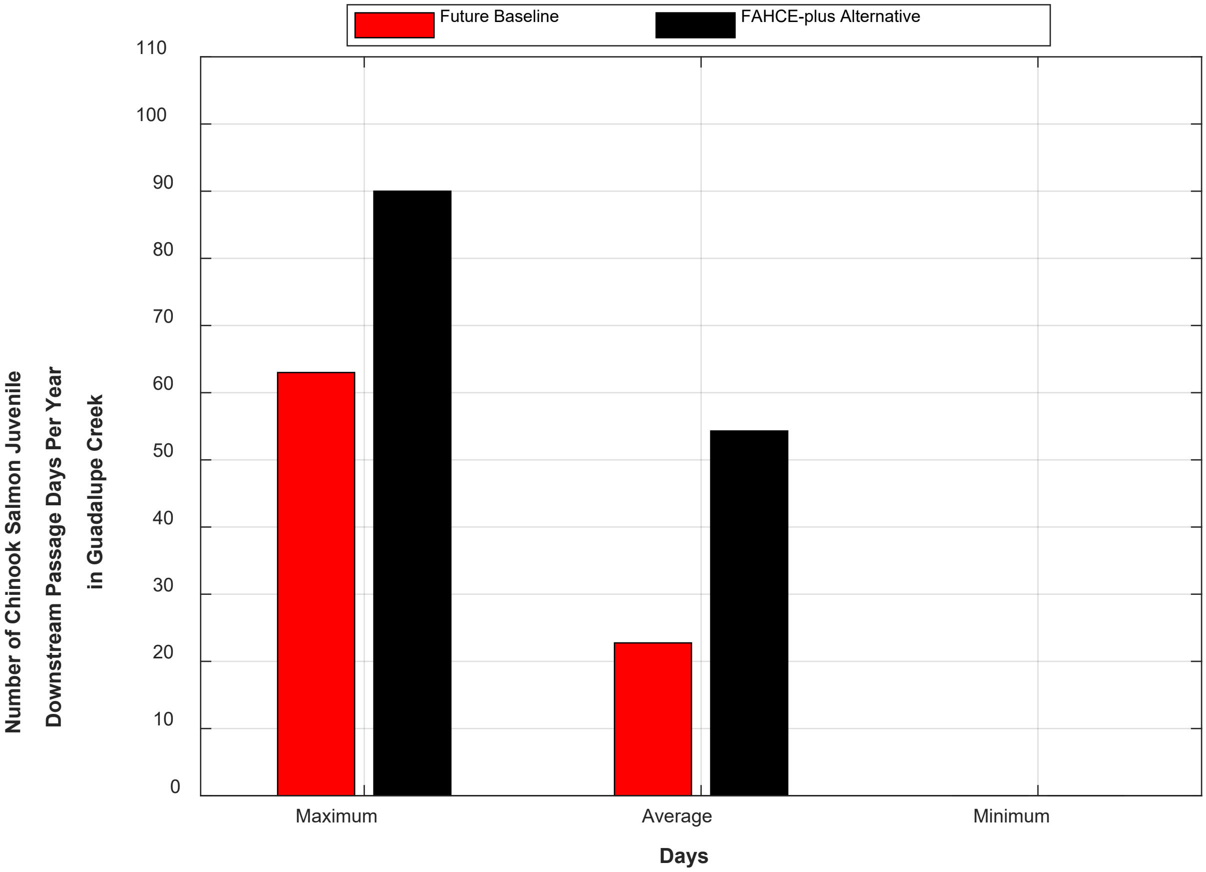


Table 133. FAHCE-plus Alternative Juvenile Chinook Salmon Downstream Passage Compared with the Future Baseline in Guadalupe Creek

Parameter	GCRK 4 with Water Temperature Criteria[b]	GCRK 4 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	455	563
Average Juvenile Downstream Passage Per Year	23	28
FAHCE-plus Alternative (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	1,086	1,103
Average Juvenile Downstream Passage Per Year	54	55
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	631.00	540.00
Average Juvenile Downstream Passage Per Year	31.00	27.00
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	138.68	95.91
Average Juvenile Downstream Passage Per Year	134.78	96.43

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in a 27% (11 days per year on average) increase to juvenile downstream Chinook salmon passage at Alamitos Creek compared with the future baseline (Figure 203; Table 134). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in a 15% (7 days per year) average increase to juvenile downstream passage in Alamitos Creek compared with the future baseline (Table 134). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in Alamitos Creek decreased by three under the FAHCE-plus Alternative compared to the future baseline.

Figure 203. Change in Juvenile Chinook Salmon Downstream Passage Days Compared with the Future Baseline in Alamitos Creek

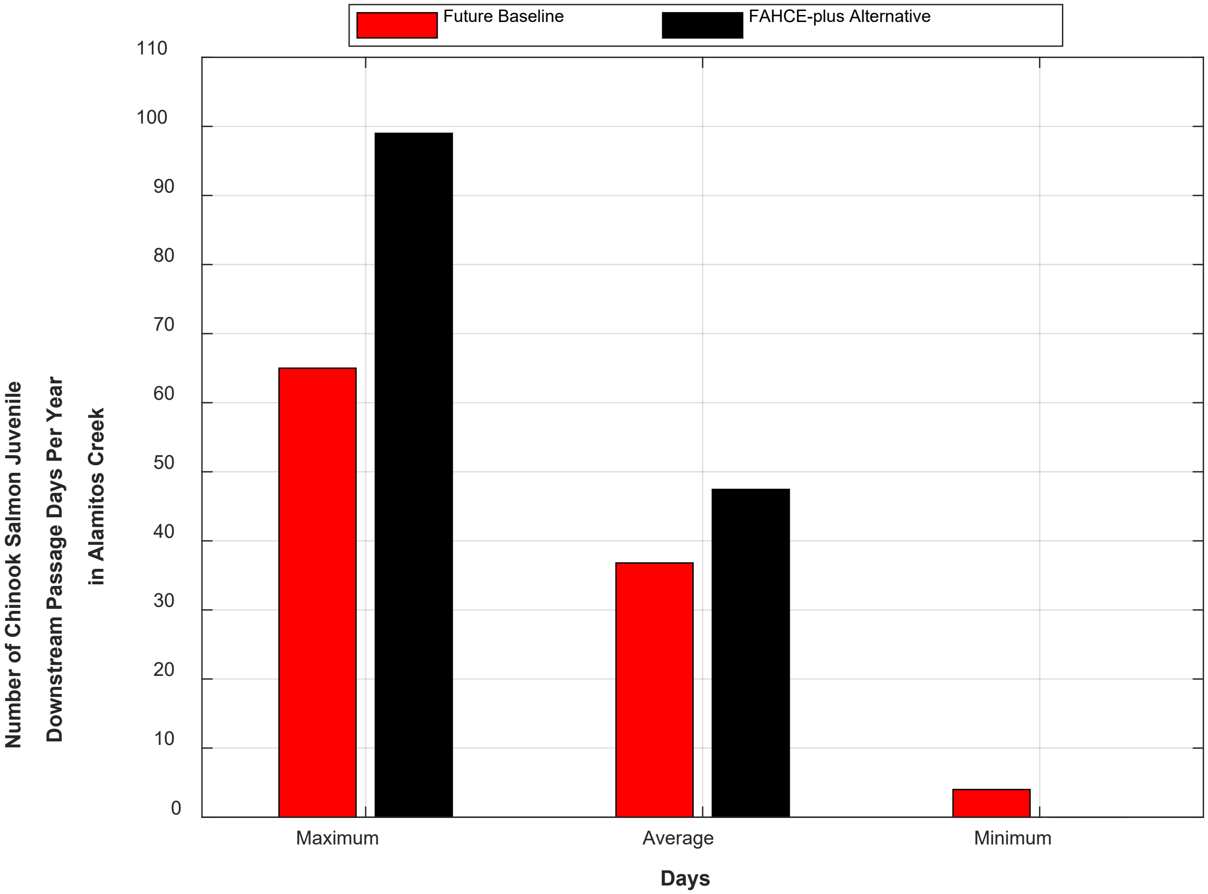


Table 134. FAHCE-plus Alternative Juvenile Chinook Salmon Downstream Passage Compared with the Future Baseline in Alamitos Creek

Parameter	ALAM 4 with Water Temperature Criteria[b]	ALAM 4 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	736	962
Average Juvenile Downstream Passage Per Year	37	48
FAHCE-plus Alternative (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	949	1,102
Average Juvenile Downstream Passage Per Year	47	55
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	213.00	140.00
Average Juvenile Downstream Passage Per Year	10.00	7.00

Parameter	ALAM 4 with Water Temperature Criteria[b]	ALAM 4 without Water Temperature Criteria[c]
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	28.94	14.55
Average Juvenile Downstream Passage Per Year	27.03	14.58

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

There would be an 88% (35 days per year) average increase to juvenile downstream passage in Calero Creek compared with the future baseline (Figure 204). Evaluating the juvenile downstream passage excluding the water temperature criteria utilized to calculate the FAHCE WEAP Model results, the FAHCE-plus Alternative would result in the same average increase to juvenile downstream passage in Alamitos Creek with the water temperature criteria compared with the future baseline (Table 135). The number of years in the 20-year FAHCE WEAP Model analysis period with at least one juvenile downstream passage event for chinook in Calero Creek increased by one under the FAHCE-plus Alternative compared to the future baseline.

Figure 204. Change in Juvenile Chinook Salmon Downstream Passage Days Compared with the Future Baseline in Calero Creek

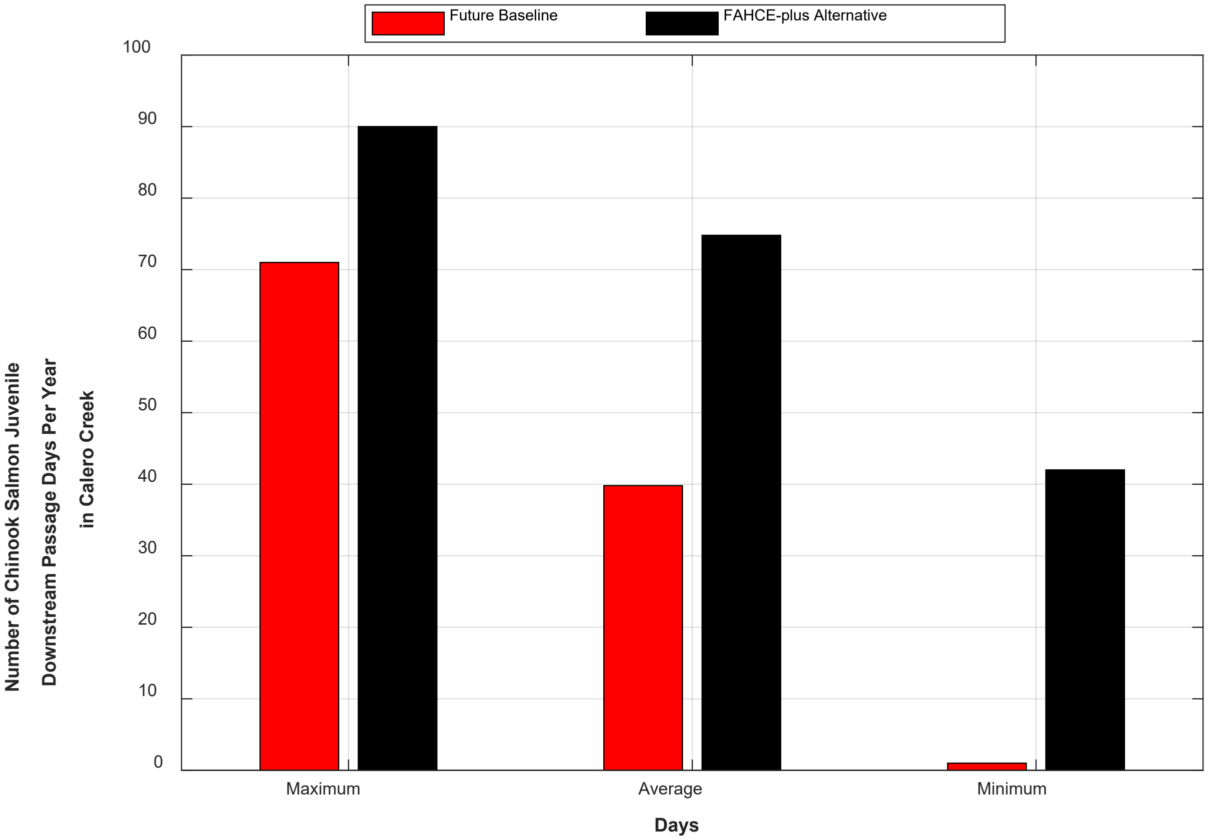


Table 135. FAHCE-plus Alternative Juvenile Chinook Salmon Downstream Passage Compared with the Future Baseline in Calero Creek.

Parameter	CALE 2 with Water Temperature Criteria[b]	CALE 2 without Water Temperature Criteria[c]
Future Baseline (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	796	812
Average Juvenile Downstream Passage Per Year	40	41
FAHCE-plus Alternative (days)[a]		
Total Juvenile Downstream Passage (1991–2010)	1,496	1,525
Average Juvenile Downstream Passage Per Year	75	76
Difference (days)		
Total Juvenile Downstream Passage (1991–2010)	700.00	713.00
Average Juvenile Downstream Passage Per Year	35.00	35.00
Difference (%)		
Total Juvenile Downstream Passage (1991–2010)	87.94	87.81
Average Juvenile Downstream Passage Per Year	87.50	85.37

[a] Rounded to whole days

[b] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c).

[c] Calculated in accordance with the Fisheries Habitat Availability Estimation Methodology (Valley Water 2021c) but excluding the species-specific water temperature criteria.

The FAHCE-plus Alternative would increase juvenile downstream passage opportunities at all locations within the Guadalupe River portion of the study area compared with the future baseline.

1.6.2.3 Assessment of Pacific Lamprey and Pacific Lamprey Habitat in the Guadalupe River Portion of the Study Area

Assessments of the effects of the FAHCE-plus Alternative on Pacific lamprey, Pacific lamprey habitat, and Pacific lamprey migration conditions within the Guadalupe River portion of the study area are provided in the following subsections. There were no HAI or passage model outputs for Pacific lamprey. Thus, the effects of the FAHCE-plus Alternative on Pacific lamprey habitat and passage were evaluated using other modeled data, including wetted area and thalweg depth, as well as review of water temperature for suitability.

Flow Measures Current Baseline Assessment

Pre-Spawning Holding Habitat

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative had similar effects on wetted area and temperatures as the Proposed Project across locations in the Guadalupe River portion of the study area, and thus would have similar impacts. Refer to Section 1.5.2.3, *Assessment of Pacific Lamprey, Pacific Lamprey Habitat, and Migration Conditions in the Guadalupe River Portion of the Study Area,* for more details.

Based on the results of the FAHCE WEAP Model, under the FAHCE-plus Alternative there would be decreases to pre-spawning holding habitat during the summer and increases during the winter based on changes in wetted area and temperature within the Guadalupe River portion of the study area

(Attachment K.3 – Figures K.3.15, K.3.16, K.3.17, K.3.27, K.3.28, K.3.29, K.3.39, K.3.40, K.3.41, K.3.51, K.3.52, and K.3.53).

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative had similar effects on wetted area and temperatures as the Proposed Project across locations in the Guadalupe River portion of the study area, and thus would have similar impacts. Refer to Section 1.5.2.3, *Assessment of Pacific Lamprey, Pacific Lamprey Habitat, and Migration Conditions in the Guadalupe River Portion of the Study Area,* for more details.

The FAHCE-plus Alternative would result in increased habitat during Winter Base Flow Operations and decreased habitat during the summer releases. However, in Guadalupe Creek downstream of the CWMZ, spawning and incubation habitat would decrease from May through August because of increased MWAT and reduced wetted area resulting from the FAHCE-plus Alternative (Attachment K.3 – Figures K.3.15, K.3.16, K.3.17, K.3.27, K.3.28, K.3.29, K.3.39, K.3.40, K.3.41, K.3.51, K.3.52, and K.3.53). As discussed previously, spawning would be expected to cease by June in the watershed and elevated water temperatures in the region would result in embryo incubation being complete by mid-July. Therefore, the decreased flows and increased temperatures starting in May would only impact the late spawners in the watershed and increases in effective spawning habitat in the winter would likely offset the late season decreases.

Larvae Rearing Habitat

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative had similar effects on wetted area and temperatures as the Proposed Project across locations in the Guadalupe River portion of the study area, and thus would have similar impacts. Refer to Section 1.5.2.3, *Assessment of Pacific Lamprey, Pacific Lamprey Habitat, and Migration Conditions in the Guadalupe River Portion of the Study Area,* for more details.

Based on the results of the FAHCE WEAP Model, under the FAHCE-plus Alternative there would be decreases to larvae rearing habitat during the summer and increases during the winter based on changes in wetted area within the Guadalupe River portion of the study area except for Calero Creek, where larvae rearing habitat would decrease in the winter and increase in the summer compared with the current baseline (Attachment K.3 – Figures K.3.15, K.3.16, K.3.27, K.3.28, K.3.39, K.3.40, K.3.51, and K.3.52).

Migration Conditions

Adult Upstream Passage

During the adult Pacific lamprey upstream migration period (January 1 through June 30), the FAHCE WEAP Model results for thalweg depth indicate variable effects to upstream passage opportunities across the Guadalupe River watershed when compared with the current baseline. Minor decreases (1-2%, 2-3 days per year on average) were observed in the Guadalupe River and Alamitos and Calero Creeks, while a larger 10% decrease (14 days per year on average) was observed in Guadalupe Creek. The FAHCE-plus Alternative resulted in no change in adult upstream passage opportunities for adult Pacific lamprey in Los Gatos Creek when compared with the current baseline. Modeled results for adult steelhead upstream passage, which overlaps with the timing of upstream passage of adult Pacific lamprey (January through April), indicate increases in passage opportunities in Calero, Guadalupe and Alamitos Creeks and minor fluctuations in passage opportunities in the Guadalupe River and Los Gatos Creek. The decreases associated with the thalweg depth analysis are due to decreases in flow associated with the Summer Release Program, which begins in May, which are not reflected in the adult steelhead upstream passage model results due to the end of the steelhead migration period occurring before the Summer Release Program begins on May 1.

Juvenile Downstream Passage

Based on the results of the FAHCE WEAP model, the FAHCE-plus Alternative would result in an average increase in opportunity for downstream passage in the Guadalupe River portion of the study area compared to the current baseline. The number of days the thalweg water depths in the Guadalupe River watershed increased resulted in a less than 2% (less than 2 days) average increase across the entire watershed, with the exception of Alamitos and Calero Creeks, which would have a 4% (6 days) average increase compared to the current baseline during Pacific lamprey downstream migration periods (December 1 through May 31). Modeled results for juvenile steelhead downstream passage (with the water temperature criteria included), which overlaps with the timing of downstream passage of juvenile Pacific lamprey (December through May), indicate increases in passage opportunities in Los Gatos and Guadalupe creeks and minor fluctuations in passage opportunities in the Guadalupe River, Alamitos Creek, and Calero Creek.

Flow Measures Future Baseline Assessment

Pre-Spawning Holding Habitat

Based on the results of the FAHCE WEAP Model, there are negligible differences in the FAHCE-plus Alternative in analysis between the current and future baseline for pre-spawning holding habitat except for Calero Creek. In Calero Creek, the FAHCE-plus Alternative would increase pre-spawning holding habitat when compared with the future baseline, whereas a decrease would be observed when compared with the current baseline. For the reasons outlined in the current baseline, the FAHCE-plus Alternative would result in decreases to pre-spawning holding habitat during the summer and increases during the winter based on changes in wetted area and temperature within the Guadalupe River portion of the study area .

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, there are negligible differences in the FAHCE-plus Alternative in analysis between the current and future baseline for effective spawning habitat except for Calero Creek. In Calero Creek, the FAHCE-plus Alternative would increase effective spawning habitat during the winter and decrease it during the summer when compared with the future baseline, whereas a decrease would be observed in the winter and an increase in the summer when compared with current baseline. Despite differences in Calero Creek between the current and future baseline. For the reasons outlined in the current baseline, the FAHCE-plus Alternative would result in increased habitat during Winter Base Flow Operations and decreased habitat during the summer releases.

Larvae Rearing Habitat

Based on the results of the FAHCE WEAP Model, there are negligible differences in the FAHCE-plus Alternative in analysis between the current and future baseline for larvae rearing habitat except for Calero Creek. In Calero Creek, the FAHCE-plus Alternative would increase larvae rearing habitat during the winter and decrease it during the summer when compared with the future baseline, whereas a decrease would be observed in the winter and an increase in the summer when compared with current baseline. For the reasons outlined in the current baseline, the FAHCE-plus Alternative would result in decreases to larvae rearing habitat during the summer and increases during the winter based on changes in wetted area within the Guadalupe River portion of the study area .

Migration Conditions

Adult Upstream Passage

During the adult Pacific lamprey upstream migration period (January 1 through June 30), the FAHCE WEAP Model results for thalweg depth indicate variable effects to upstream passage opportunities across the Guadalupe River watershed when compared with the future baseline. Minor increases (1-2%, 2-4 days per year on average) were observed in the Guadalupe River and Alamitos and Calero Creeks, while a 12% decrease (17 days per year on average) was observed in Guadalupe Creek. The FAHCE-plus Alternative resulted in no change in adult upstream passage opportunities for adult Pacific lamprey in Los Gatos Creek when compared with the future baseline. Modeled results for adult steelhead upstream passage, which overlaps with the timing of upstream passage of adult Pacific lamprey (January through April), indicate increases in passage opportunities in Calero, Guadalupe and Alamitos Creeks and minor fluctuations in passage opportunities in the Guadalupe River and Los Gatos Creek. The decreases associated with the thalweg depth analysis are due to decreases in flow associated with the Summer Release Program, which begins in May, and are not reflected in the adult steelhead upstream passage model results due to the end of the steelhead migration period occurring before the Summer Release Program begins on May 1.

Juvenile Downstream Passage

Based on the results of the FAHCE WEAP model, the FAHCE-plus Alternative would result in variable changes to downstream passage across the Guadalupe River watershed compared to the future baseline. The thalweg water depth analysis resulted in a 1% (1 day per year) average increase in the Guadalupe River, remained unchanged in Los Gatos, Alamitos, and Calero Creeks, and resulted in a 3% (2 days per year) average decrease in Guadalupe Creek. Modeled results for juvenile steelhead downstream passage (with the water temperature criteria included), which overlaps with the timing of downstream passage of adult Pacific lamprey (December through May), indicate increases in all reaches within the Guadalupe River watershed.

1.6.2.4 Assessment of Sacramento Hitch and Sacramento Hitch Habitat in the Guadalupe River Portion of the Study Area

Assessments of the effects of the FAHCE-plus Alternative on Sacramento hitch and Sacramento hitch habitat within the Guadalupe River portion of the study area are provided in the following subsections. Based on Smith 2013 and Leidy 2007 and sampling conducted by Valley Water and Stillwater Sciences (Valley Water unpublished data 2004-2017; Valley Water 2019, 2020, 2021a; Stillwater Sciences 2018). Sacramento hitch have only been detected in the Guadalupe River (downstream of the Norman Mineta Airport) and Los Gatos Creek over the last 17 years; therefore, Sacramento hitch are only assessed in these two sub-watersheds.

There were no HAI model outputs for Sacramento hitch. Thus, the effects of the FAHCE-plus Alternative on Sacramento hitch and Sacramento hitch habitat were evaluated based on other modeled data including wetted area and water temperature, as well as based on modeled HAI for steelhead when life cycles and habitat preference overlap between the species.

Flow Measures Current Baseline Assessment

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, and an analysis of modeled water temperature and wetted area, the FAHCE-plus Alternative would result in increases to effective spawning habitat in the Guadalupe River and a slight decrease in Los Gatos Creek while the steelhead spawning and hitch spawning season overlap (February–April) compared with the current baseline. Effective spawning habitat in both the Guadalupe River and Los Gatos Creek would decrease for the remainder of the spawning season (May–July) beginning at the start of the Summer Release Program due to decreased wetted areas.

Fry Rearing Habitat

There would be variable changes in fry rearing habitat in the Guadalupe River portion of the study area compared with the current baseline. The FAHCE-plus Alternative would result in increased habitat during Winter Base Flow Operations and decreased habitat during the Summer Release Program. The increases to Sacramento hitch rearing habitat in winter and decreases in summer likely offset.

Flow Measures Future Baseline Assessment

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, there are minor differences in the FAHCE-plus Alternative in analysis between the current and future baseline for effective spawning habitat. Refer to Section 1.5.2.4, *Assessment of Sacramento Hitch and Sacramento Hitch Habitat in the Guadalupe River Watershed,* for more details.

Fry Rearing Habitat

Based on the results of the FAHCE WEAP Model, there are minor differences in the FAHCE-plus Alternative in analysis between the current and future baseline for fry rearing habitat. Refer to Section 1.5.2.4, *Assessment of Sacramento Hitch and Sacramento Hitch Habitat in the Guadalupe River Watershed,* for more details.

1.6.2.5 Riffle Sculpin

Assessments of the effects of the Proposed Project on riffle sculpin and riffle sculpin habitat within the Guadalupe River portion of the study area are provided in the following subsections. Riffle sculpin have been documented in the Guadalupe River portion of the study area within the past 20 years. Sampling conducted by Valley Water from 2004 to 2020 resulted in detections of riffle sculpin in Guadalupe Creek in all years and one individual detection in the Guadalupe River in 2018 (Valley Water unpublished data 2004-2017; Valley Water 2019, 2020, and 2021a). Therefore, the effects of the FAHCE-plus Alternative flow measures on riffle sculpin are only assessed in these two sub-watersheds.

There were no HAI model outputs for riffle sculpin. Thus, the effects of the Proposed Project on riffle sculpin and riffle sculpin habitat were evaluated using other modeled data including wetted area and water temperature, as well as based on modeled HAI for steelhead when life cycles and habitat preference overlap between the species.

Flow Measures Current Baseline Assessment

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model, the FAHCE-plus Alternative would result in increases to effective spawning habitat in the Guadalupe River and Guadalupe Creek compared with the current baseline. The FAHCE-plus Alternative results in increased habitat during Winter Base Flow Operations (when spawning occurs for riffle sculpin; March–April) in both the Guadalupe River and Guadalupe Creek. Increased habitat is a result of increased flow in both systems which results in an increased wetted area. Riffle sculpin prefer riffle habitat for spawning, and riffle habitat would increase as flows are increased, resulting in an increase in effective spawning habitat.

Fry Rearing Habitat

The FAHCE-plus Alternative would result in an overall decrease in fry rearing habitat in the Guadalupe River during Winter Base Flow Operations which corresponds to the beginning of the fry rearing period for riffle sculpin (March-April); however, the decrease is small relative to the total amount of fry rearing habitat available in the Guadalupe River (over 1.1 million square feet). There would be a larger decrease in fry rearing habitat during the Summer Release Program (May-November) across POIs in the Guadalupe River due to decreased flow and increased water temperatures. Despite the overall decrease, the Guadalupe River provides a significant amount of suitable fry rearing habitat under the FAHCE-plus Alternative. In Guadalupe Creek, the FAHCE-plus Alternative would result in similar increases in fry rearing habitat during Winter Base Flow Operations and a larger overall decrease during the Summer Release Program when compared with the current baseline. Modeled results showed that GCRK 4, where riffle sculpin are abundant in Guadalupe Creek, had the largest increase during the Winter Base Flow Operations and the smallest decrease during the Summer Release Program. The mechanism behind the decreases during the Summer Release Program is an overall decrease in wetted area associated with decreased flow.

Flow Measures Future Baseline Assessment

Effective Spawning Habitat

Based on the results of the FAHCE WEAP Model there would be an overall net increase in effective spawning habitat in both the Guadalupe River and Guadalupe Creek resulting from the FAHCE-plus Alternative when compared with the future baseline. The FAHCE-plus Alternative resulted in greater increases to effective spawning habitat in Guadalupe Creek and a similar increase to effective spawning habitat in the Guadalupe River compared with the current and future baselines. The FAHCE-plus Alternative results in a spike in effective spawning habitat in the Guadalupe River towards the end of the spawning period (March) resulting from migration flow releases.

Fry Rearing Habitat

The FAHCE-plus Alternative results in an overall net increase in fry rearing habitat in both the Guadalupe River and Guadalupe Creek during Winter Base Flow Operations and a decrease in fry rearing habitat in during the Summer Release Program when compared with the future baseline. Although habitat decreased in the Guadalupe River during the Summer Release Program, the overall decrease was small relative to the amount of fry rearing habitat available in the watershed. In Guadalupe Creek, there was large (over 50%) decrease in fry rearing habitat during the Summer Release Program due to decreases in wetted area; however, riffle sculpin are found primarily in the upper watershed (upstream of GCRK 3) and GCRK 4 experienced the least amount of fry rearing habitat loss during this time.

1.6.2.6 Guadalupe River Portion of the Study Area Conclusions

Steelhead

The FAHCE-plus Alternative flow measures would result in overall average increases of effective spawning and fry rearing habitat, and upstream and downstream passage opportunities, with the tradeoff of decreased average juvenile rearing habitat in Los Gatos Creek and Guadalupe Creek.

The amount of available effective spawning habitat under the current baseline conditions is not considered to be limiting to steelhead (Moyle 2002). Substantial increases of effective spawning habitat in the Guadalupe River and Guadalupe Creek, as well as an increase in Calero Creek compared with the future baseline, outweigh the small average area of decreased effective spawning habitat in Alamitos Creek, decrease in Los Gatos Creek at a time of year when few migrants are expected, and decrease in Calero Creek compared with the current baseline. Fry rearing habitat would increase on average in Los Gatos Creek and Guadalupe Creek compared with the current baseline and increase on average in all streams compared with the future baseline. These beneficial increases outweigh any near-term average decrease of fry rearing habitat in the Guadalupe River and Calero Creek.

Juvenile rearing habitat would increase slightly in Alamitos Creek, but would decrease in Los Gatos Creek and Guadalupe Creek under the current and future baselines. The decrease would be substantial in Guadalupe Creek, which is known to continually support rearing steelhead (Valley Water et al. 2015, 2016, 2017, 2018), during the summer and fall and would be lesser in Los Gatos Creek due to the existing large areas of rearing habitat available. The Guadalupe River and Calero Creek would experience average decreases of juvenile rearing habitat compared with the current baseline and increases compared with the future baseline.

The FAHCE-plus Alternative flow measures would increase upstream and downstream passage opportunities overall. There would be a substantial average increase of upstream passage to Guadalupe Creek and Alamitos Creek, which are tributaries that support high abundances of *O. mykiss* (Valley Water et al. 2015, 2016, 2017, 2018). Increased upstream passage opportunities to these tributaries would provide additional spawning opportunities for steelhead in the Guadalupe River portion of the study area.

Downstream passage would be largely unaffected until seismic restrictions are lifted, after which some streams would experience an increase in downstream passage under the FAHCE-plus Alternative. When downstream passage was analyzed with and without water temperature criteria, results varied slightly, with some increase of passage when assessed without water temperature. Improved passage conditions would support the anadromous life history within the Guadalupe River portion of the study area.

Chinook Salmon

Although the operations associated with the Proposed Project are management actions that benefit federally listed steelhead and salmon, the actions are anticipated to provide an overall benefit to Chinook salmon as well. Net changes of habitat and passage due to implementation of the FAHCE-plus Alternative flow measures would not substantially change overall conditions for Chinook salmon in the Guadalupe River watershed.

Implementing the FAHCE-plus Alternative flow measures would result in overall increase in upstream and downstream passage opportunities, minor changes in fry and juvenile rearing habitat, and an overall decrease of effective spawning habitat. Increased passage opportunities would be beneficial, and the Guadalupe River would maintain relatively high passage opportunities for Chinook salmon, which would allow the species more opportunities to enter the watershed, migrate upstream, and spawn when conditions are present. Increased fry and juvenile rearing habitat would support a greater abundance of fry and juveniles benefitting the Chinook salmon population and reducing the dependency on hatchery stocks.

The FAHCE-plus Alternative would decrease the amount of effective spawning habitat across POIs in the Guadalupe River portion of the study area, with the exception of Guadalupe Creek, where effective spawning habitat would substantially increase when compared with current and future baselines, and Alamitos Creek compared with the future baseline. The loss of habitat mainly occurs earlier in the spawning season and has little to no change later in the spawning season when more spawners would be expected to arrive at the effective spawning habitat. Additionally, spawning surveys conducted by Valley Water from 1995-2014 found an average of 11 redds per year during the survey period throughout the Guadalupe River portion of the study area (Valley Water 2018). Although spawning survey data are not population estimates, the annual average number of redds indicate small run sizes of Chinook salmon and therefore, available effective spawning habitat under the Proposed Project is likely sufficient to support the current run size of Chinook salmon within the watershed.

The FAHCE-plus Alternative compared with the current baseline would result in minimal changes on average to Chinook salmon fry rearing habitat in the Guadalupe River portion of the watershed. The FAHCE-plus Alternative compared with the future baseline would on average increase fry rearing habitat at all POIs by 2% to 10%, which would benefit Chinook salmon. Increases would occur because of increased wetted area during winter operations from March to April but fry rearing habitat in these locations would generally decrease during summer operations in May.

The FAHCE-plus Alternative is modeled to increase juvenile rearing habitat in the Guadalupe River main stem and all tributaries. Most locations within the Guadalupe River portion of the study area would have increased juvenile rearing habitat under the FAHCE-plus Alternative, except for the Guadalupe River and Guadalupe Creek where available habitat decreased slightly. Increases were mostly observed during Winter Base Flow Operations from March to April and decreases in juvenile rearing habitat would occur at some locations during Summer Release Program.

The FAHCE-plus Alternative would increase juvenile downstream passage in Los Gatos Creek, Guadalupe Creek, Alamitos Creek, and Calero Creek, and there would be no change in the Guadalupe River, compared with the future baseline. The FAHCE-plus Alternative would also increase adult upstream passage in Guadalupe Creek, Alamitos Creek, and Calero Creek, but would decrease passage in Los Gatos Creek. Upstream passage at POIs in the Guadalupe River would have negligible changes and continue to provide an average of 60 days of passage per year under the FAHCE-plus Alternative. Chinook salmon are able to spawn in the Guadalupe River or hold until passage opportunities present themselves at the upstream tributaries in the Guadalupe River portion of the study area (Valley Water 2018; Moyle 2002).

On balance, the FAHCE-plus Alternative is expected to maintain the abundance of naturally spawned Chinook salmon in the watershed.

Pacific Lamprey

The FAHCE-plus Alternative flow measures would have variable effects on pre-spawning holding, spawning and larvae rearing habitat compared with the current and future baselines. Generally, increased flows and wetted area during the winter would provide additional habitat for Pacific lamprey but decreases in flow and/or increased summer temperatures would reduce habitat during the summer compared with baseline conditions.

Upstream passage would be slightly decreased under the FAHCE-plus Alternative compared with the current baseline and would slightly increase when compared with the future baseline. Downstream passage would be improved under the future baseline. The Guadalupe River is the location where the most Pacific lamprey are observed (Leidy 2007), and improved downstream and upstream passage in this location would increase opportunities for juvenile migration to the ocean and adult access to spawning areas.

Sacramento Hitch

The FAHCE-plus Alternative flow measures would result in neutral changes of conditions for Sacramento hitch. When compared with the current and future baselines, implementing the FAHCE-plus Alternative flow measures would result in increases to Sacramento hitch spawning and rearing habitat in winter and early spring and decreases during the summer. Although some locations might experience water temperature increases under the FAHCE-plus Alternative, temperature increases would not be elevated enough to limit the availability of spawning and incubation habitat. Additionally, Sacramento hitch are likely to move to suitable summer holding habitat such as deep pools and are unlikely to become stranded as a result of reduced flows. The reduction in wetted area and increased temperatures during the summer are unlikely to have an impact on Sacramento hitch spawning and incubation. Therefore, given the benefits to habitat during the winter and spring, the impacts in the summer are unlikely to substantially change conditions for the species.

Riffle Sculpin

The FAHCE-plus Alternative flow measures would result in neutral changes of conditions for riffle sculpin. When compared with the current and future baselines, implementing the FAHCE-plus Alternative flow measures would result in increases to spawning and rearing habitat in winter and early spring and decreases during the summer. In both the Guadalupe River and Guadalupe Creek there would be net increases to effective spawning habitat. Water temperature increases would not limit the availability of spawning and incubation habitat as increases would occur outside of the spawning season for riffle sculpin (that is, February through March). If water temperature increases to 86°F, this could cause rearing riffle sculpin to relocate or result in stress or mortality, though it is unlikely temperatures would exceed 86°F in the upper portion of the watershed, where riffle sculpin are present. Given the benefits to habitat during the winter and spring, and potential habitat reduction in the summer, the overall change would be neutral.

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Attachment K.1 – Known Native Fish Species in Stevens Creek and Guadalupe River Watersheds

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Known Native Fish Species in Stevens Creek and Guadalupe River Watersheds

Common Name Scientific Name	Federal/ California Status	Observations[a]
Central California Coast Steelhead *Oncorhynchus mykiss*	Federally Threatened/--	Recent records of species in Stevens Creek watershed and Guadalupe River watershed (Smith 2019; Valley Water 2020).
Central Valley Fall-run Chinook Salmon[b] *Oncorhynchus tshawytscha*	--/California Species of Special Concern	Recent records of species in Guadalupe River watershed (Valley Water et al. 2017).
Pacific lamprey *Entosphenus tridentatus*	--/California Species of Special Concern	Recent records of species in Guadalupe River watershed (Valley Water, unpubl. data; Stillwater Sciences 2018). Historic records in Stevens Creek watershed (Stillwater Sciences 2004).
Sacramento Hitch *Lavinia exilicauda*	--/California Species of Special Concern	Historic records of species in the lower portions of the Guadalupe River watershed (Smith 2013). No observations in Guadalupe Creek, Alamitos Creek, or Calero Creek (Valley Water unpublished data 2004-2017; Valley Water 2019, 2020, 2021). The species has not been observed upstream of the Stevens Creek estuary (Leidy 2007; Snyder 1905).
Eulachon *Thaleichthys pacificus*	Federally Threatened/--	Historic record of species in Guadalupe River estuary (Leidy 2007). No observations upstream of the Guadalupe River estuary (including during surveys conducted in Guadalupe River, Guadalupe Creek, Alamitos Creek, Calero Creek, and Los Gatos Creek from 2018 through 2020 [Valley Water 2019, 2020, 2021]), and the species range does not include the study area (NMFS 2017).
Sacramento blackfish *Orthodon microlepidotus*	Not listed	Historic records for Guadalupe River watershed do not show species pre-1905 (Snyder 1905), but species was historically observed by surveyors (Leidy 2007). Recently, no detections in Guadalupe River or Guadalupe Creek between 2004 and 2020; and no detections in Alamitos Creek, Calero Creek, and Los Gatos Creek between 2018 and 2020 (Valley Water unpublished data 2004-2017; Valley Water 2019, 2020, 2021).
Sacramento splittail *Pogonichthys macrolepidotus*	Not listed	Historic records for Guadalupe River watershed do not show species pre-1905 (Snyder 1905), but species was observed in Guadalupe River watershed by surveyors in 1987 (Leidy 2007). No detections in Guadalupe River or Guadalupe Creek between 2004 and 2020; and no detections in Alamitos Creek, Calero Creek, and Los Gatos Creek between 2018 and 2020 (Valley Water unpublished data 2004-2017; Valley Water 2019, 2020, 2021).
Sacramento sucker *Catostomus occidentalis*	Not listed	Recent records of species in Stevens Creek watershed and Guadalupe River watershed (Smith 2019; Valley Water 2020).

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Common Name Scientific Name	Federal/ California Status	Observations[a]
Prickly sculpin *Cottus asper*	Not listed	Recent record of species in Stevens Creek watershed and Guadalupe River watershed and (Smith 2019; Valley Water 2020).
Riffle sculpin *Cottus gulosus*	Not listed	Recent records of species in Guadalupe River watershed in Guadalupe River and Guadalupe Creek (Valley Water unpublished data 2004-2017; Valley Water 2020).
California roach *Lavinia symmetricus*	Not listed	Recent records of species in Guadalupe River watershed and Stevens Creek watershed (Smith 2019).
White sturgeon *Acipenser transmontanus*	Not listed	Historic record of species in tidal riverine and estuarine habitats of Guadalupe River watershed (Leidy 2007)
Sacramento Pikeminnow *Ptychocheilus grandis*	Not listed	Recent records of species in the Guadalupe River watershed and Stevens Creek watershed (Leidy 2007).
Longfin smelt *Spirinchus thaleichthys*	Federal Candidate/ State threatened	Historic records of species in tidal reaches within Guadalupe River watershed (Leidy 2007).
Tule perch[c] *Hysterocarpus traskii*	Not listed	Recent records of species in Guadalupe River watershed (Valley Water 2020).
Shiner perch *Cymatogaster aggregata*	Not listed	Historic records in tidal riverine and estuarine habitat of Guadalupe River watershed (Leidy 2007).
Starry flounder *Platichthys stellatus*	Not listed	Historic records in tidal riverine and estuarine habitat of Guadalupe River watershed (Leidy 2007).
Threespine stickleback *Gasterosteus aculeatus*	Not listed	Recent records of species occurrence in Stevens Creek watershed and historic records in lower Guadalupe River watershed (that is, below Guadalupe River POI GUAD 3) (Leidy 2007; Smith 2019; Valley Water 2019, 2020, 2021c; Valley Water unpublished data 2004-2017).
Longjaw mudsucker *Gillichthys mirabilis*	Not listed	Historic records of species occurrence in tidal riverine and estuarine habitat of Guadalupe River watershed (Leidy 2007).
Staghorn sculpin *Leptocottus armatus*	Not listed	Recent records of species occurrence in Guadalupe River watershed (Leidy 2007).

[a] "Recent records" refers to an observation that occurred within approximately the last 15 years (January 1, 2005 through present day); "historic records" refers to an observation that is older than approximately 15 years (older than December 31, 2004).

[b] While Chinook salmon are native to California, there is no historical data suggesting they were historically present in Santa Clara County (Leidy 2007; Snyder 1905). Genetic analysis and presence of adipose fin clipped fish indicates that Chinook salmon in the Guadalupe River watershed are hatchery strays (Garcia-Rossi and Hedgecock 2002). Based on historic hydrology, genetic analysis, and lack of occurrence of these fish in scientific literature pertaining to Guadalupe River watershed, Chinook salmon are not native to the Guadalupe River watershed.

[c] Tule perch are native to California and were observed in the Coyote Creek watershed, which is adjacent to the Guadalupe River watershed, in 1922 (Hubbs 1925). Though the species is regionally native, Snyder (1905) and Leidy (2007) suggest that Tule perch were likely not historically present in Guadalupe River watershed (Leidy 2007; Snyder 1905).

Attachment K.1 – Known Native Fish Species in Stevens Creek and Guadalupe River Watersheds

References

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Valley Water unpublished data 2004-2017.

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Attachment K.2 – Proposed Project Supplementary Figures

Attachment K.2 – Proposed Project Supplementary Figures

Attachment K.2 – Proposed Project Supplementary Figures

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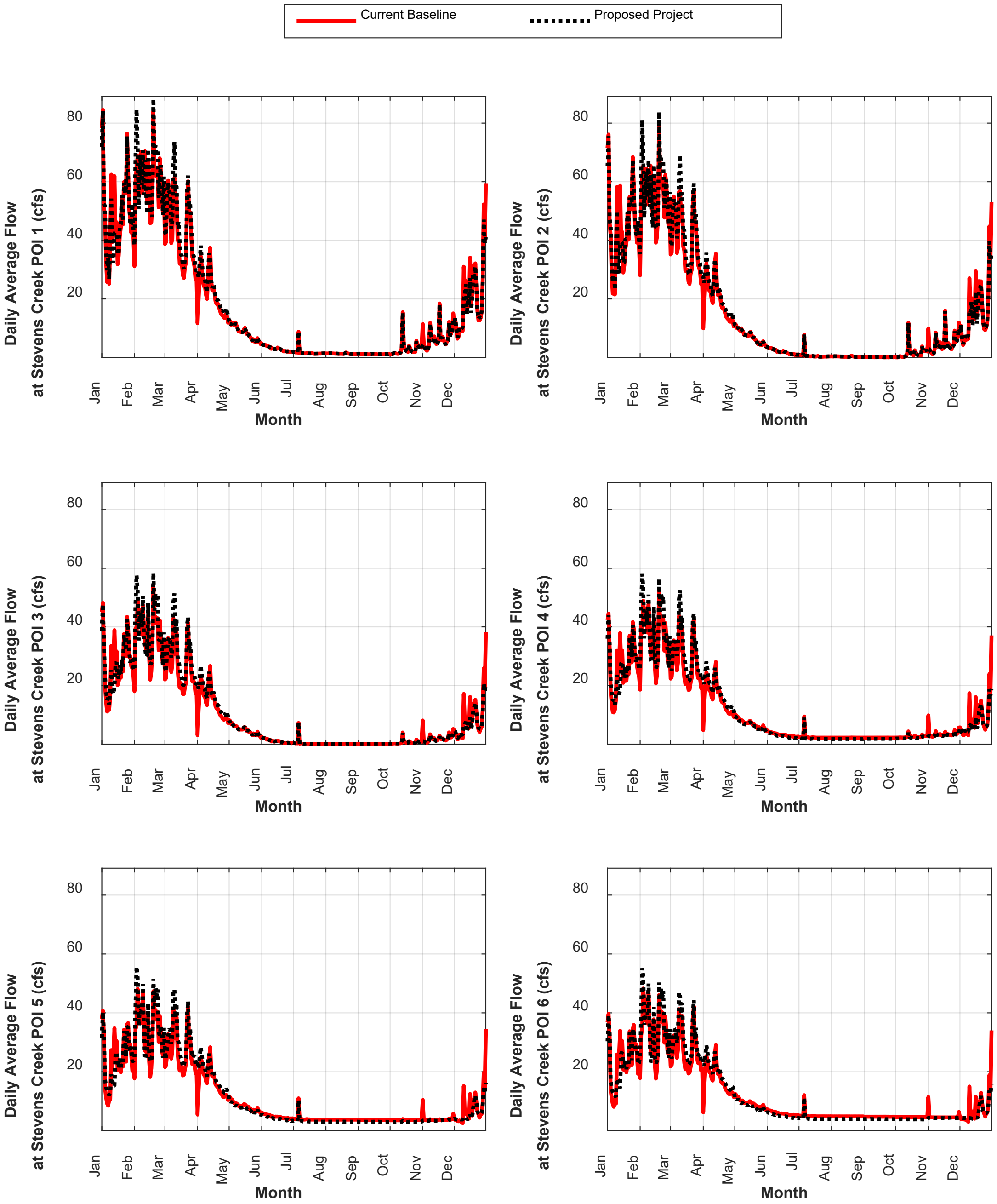
Attachment K.2 – Proposed Project Supplementary Figures

Stevens Creek Watershed

Current Baseline Comparisons

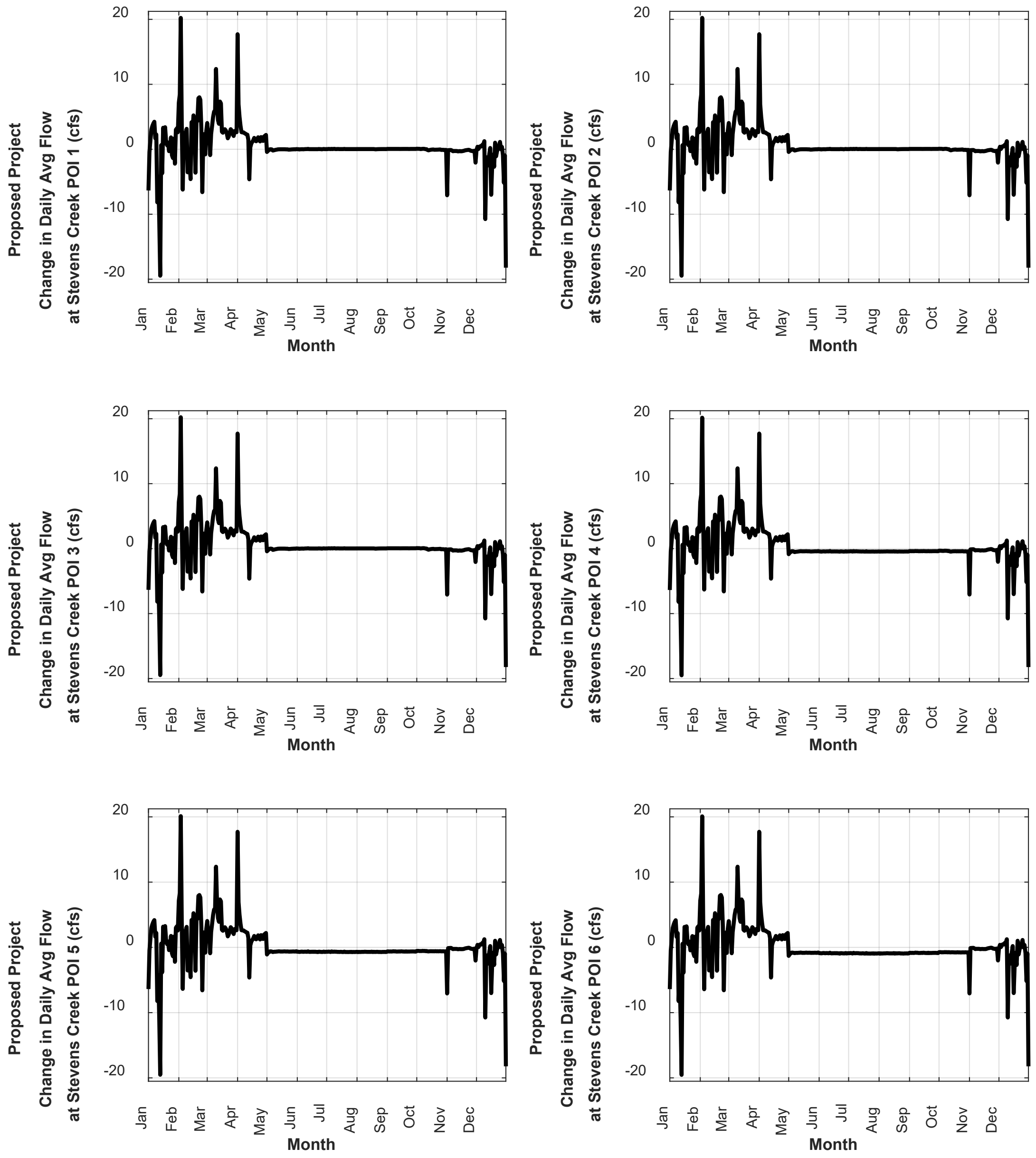
Flow Figures

Figure K.2.1



Attachment K.2 – Proposed Project Supplementary Figures

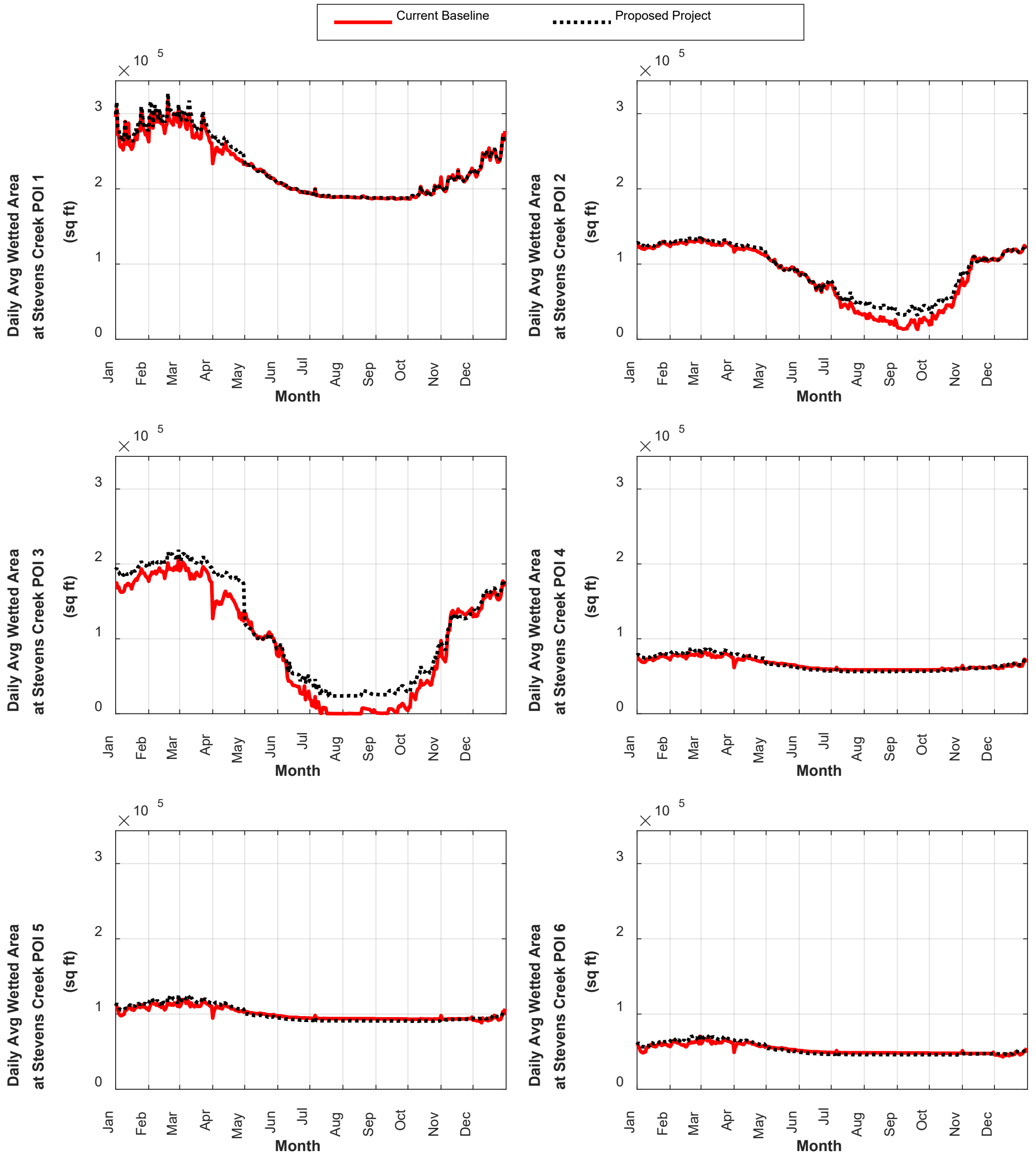
Figure K.2.2



Attachment K.2 – Proposed Project Supplementary Figures

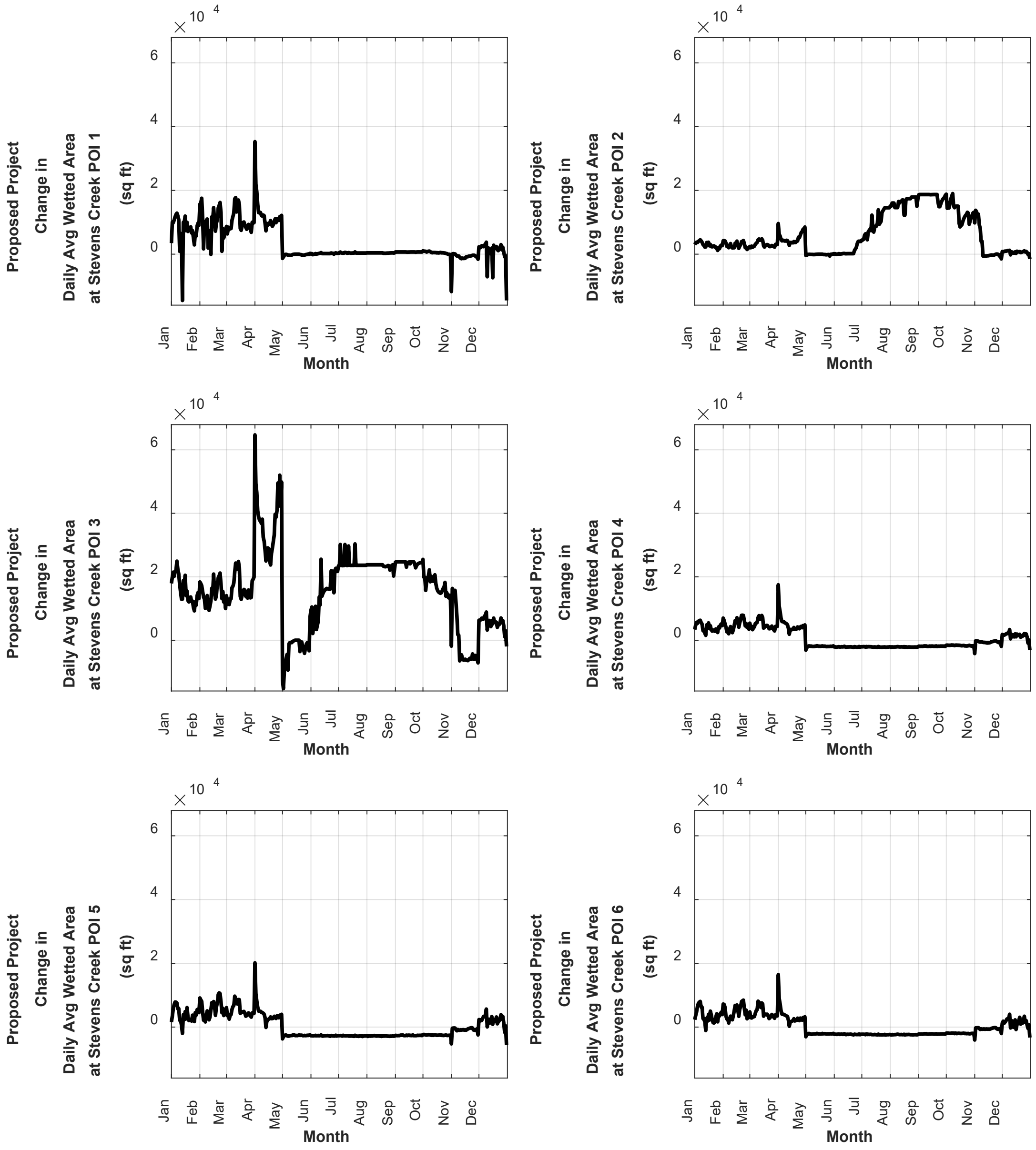
Wetted Area Figures

Figure K.2.3



Attachment K.2 – Proposed Project Supplementary Figures

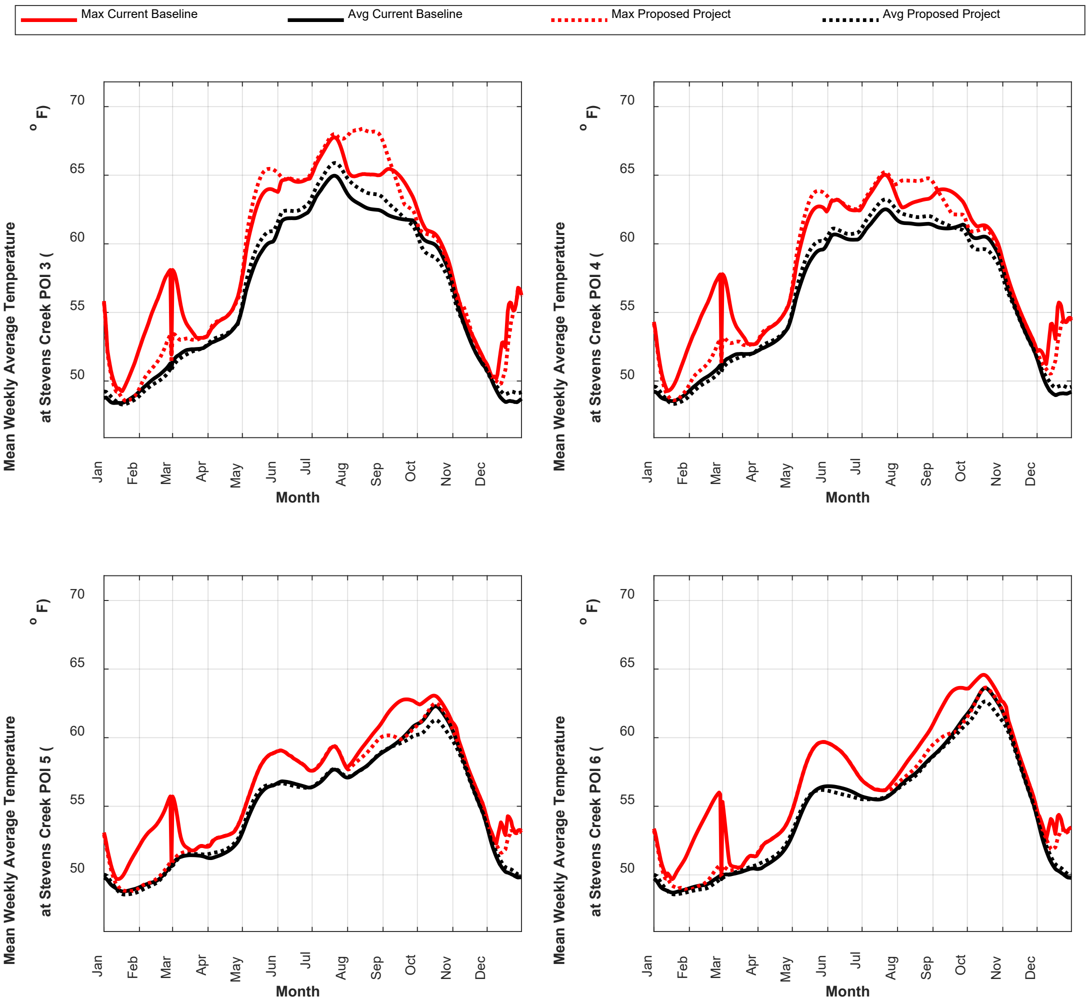
Figure K.2.4



Attachment K.2 – Proposed Project Supplementary Figures

Water Temperature Figures

Figure K.2.5[a]



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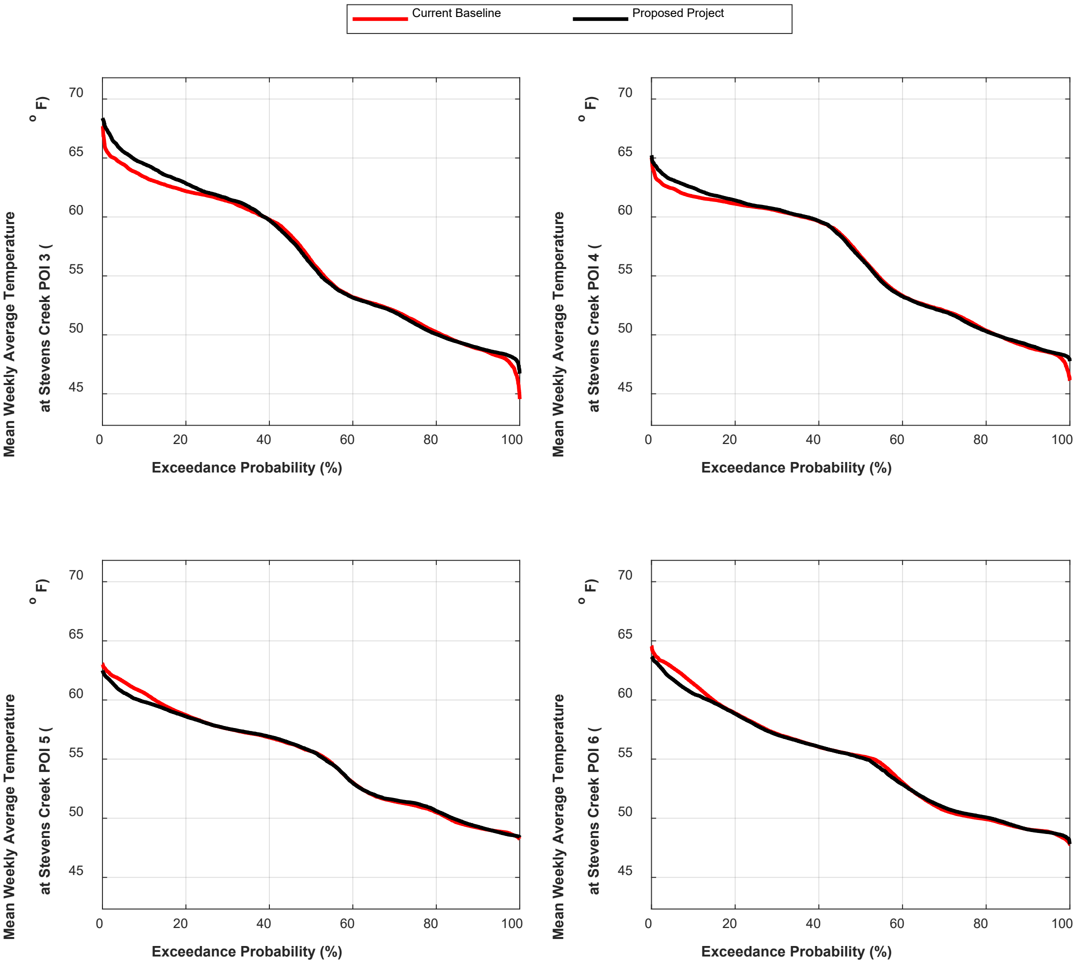
[a] No water temperature model results are available for the points of interest not shown.

Figure K.2.6[a]



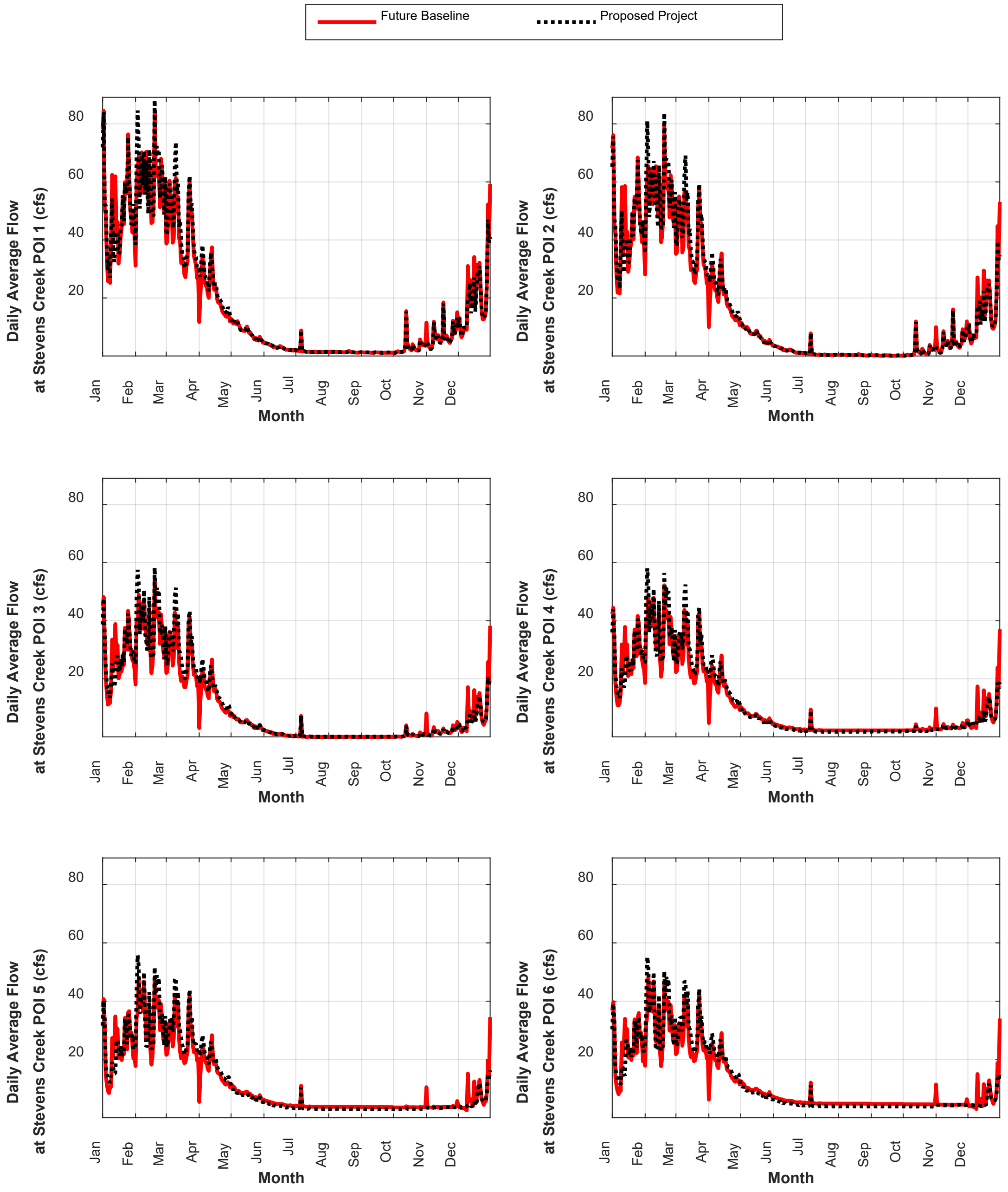
[a] No water temperature model results are available for the points of interest not shown.

Attachment K.2 – Proposed Project Supplementary Figures

Future Baseline Comparisons

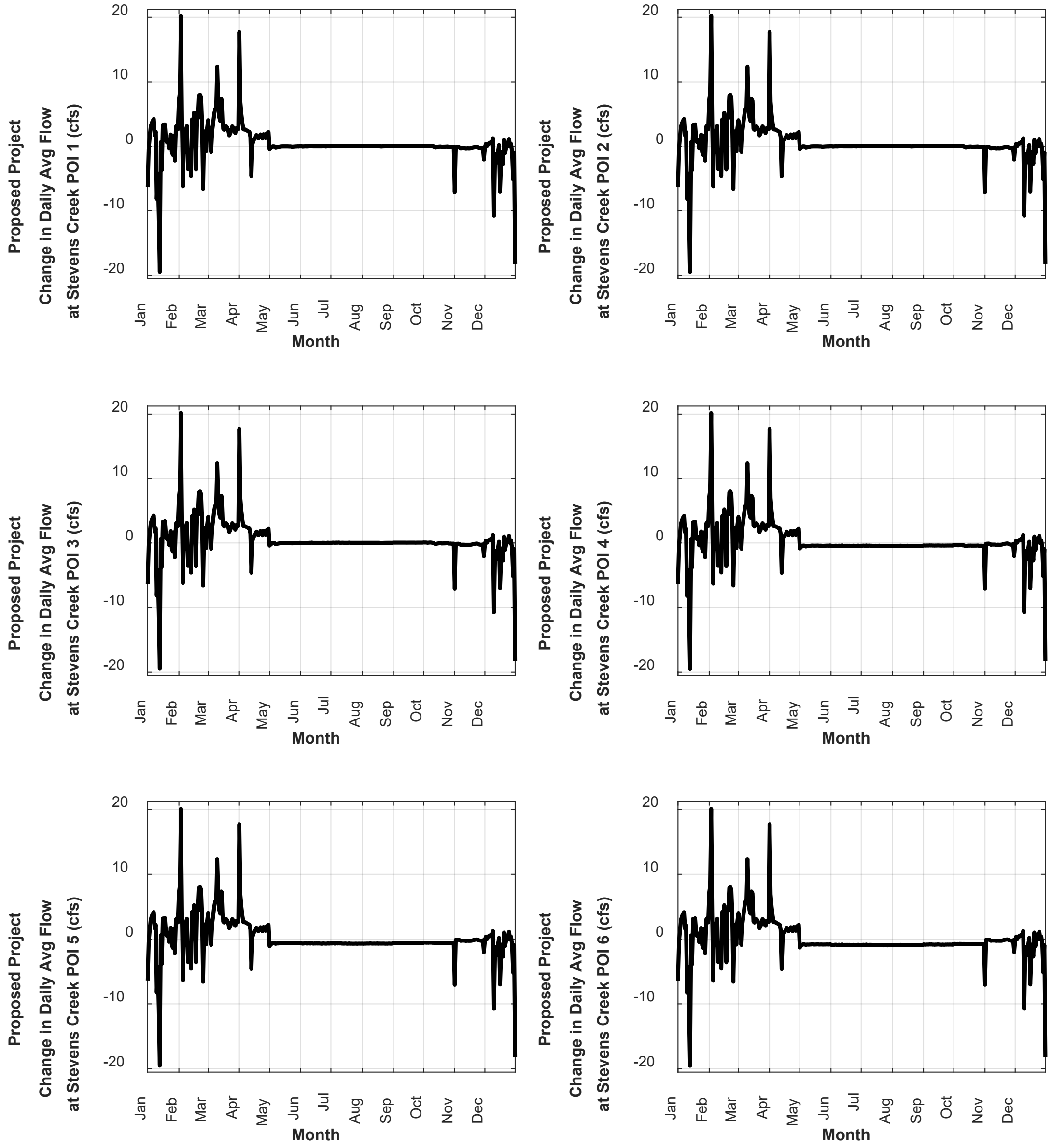
Flow Figures

Figure K.2.7



Attachment K.2 – Proposed Project Supplementary Figures

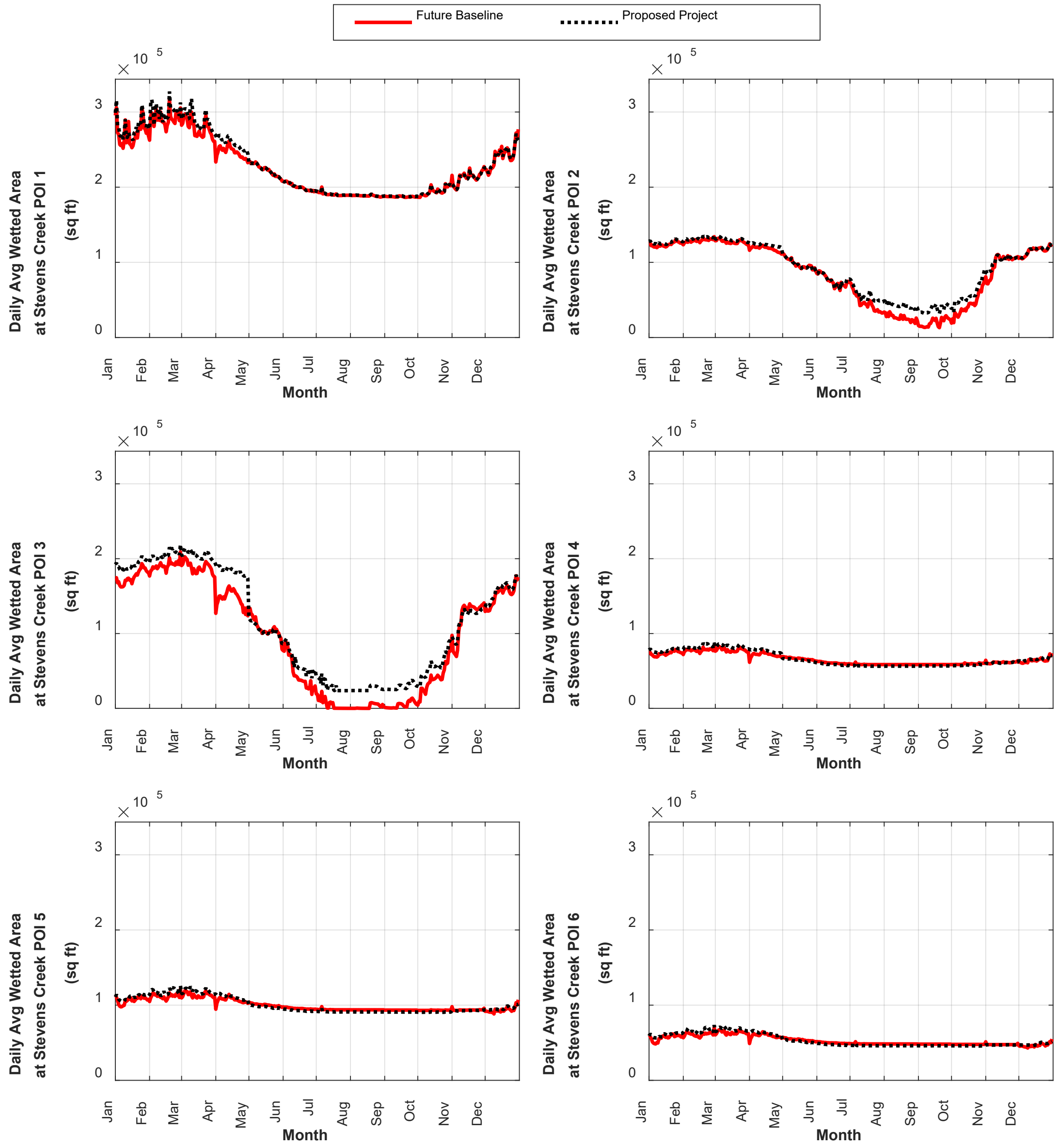
Figure K.2.8



Attachment K.2 – Proposed Project Supplementary Figures

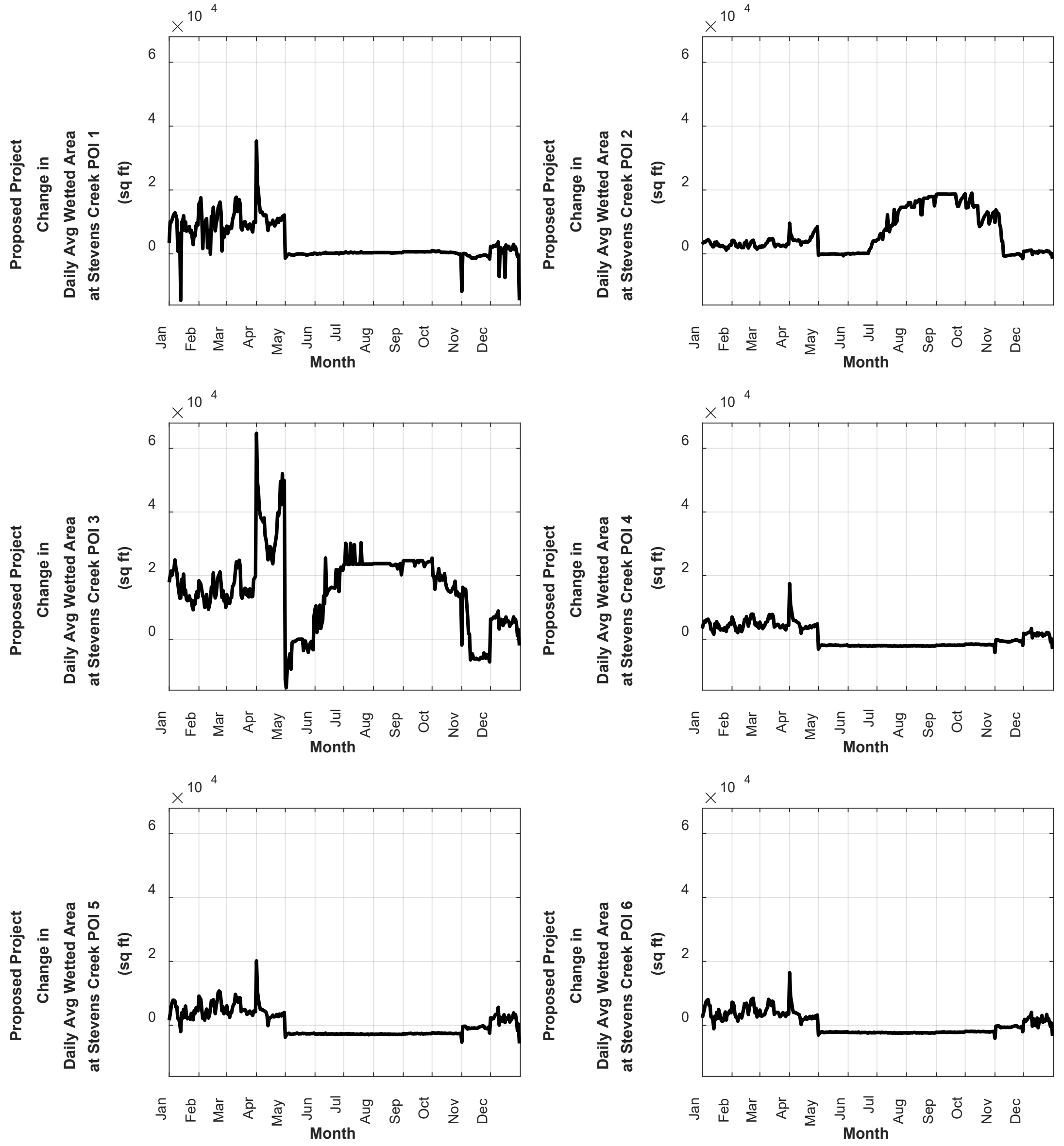
Wetted Area Figures

Figure K.2.9



Attachment K.2 – Proposed Project Supplementary Figures

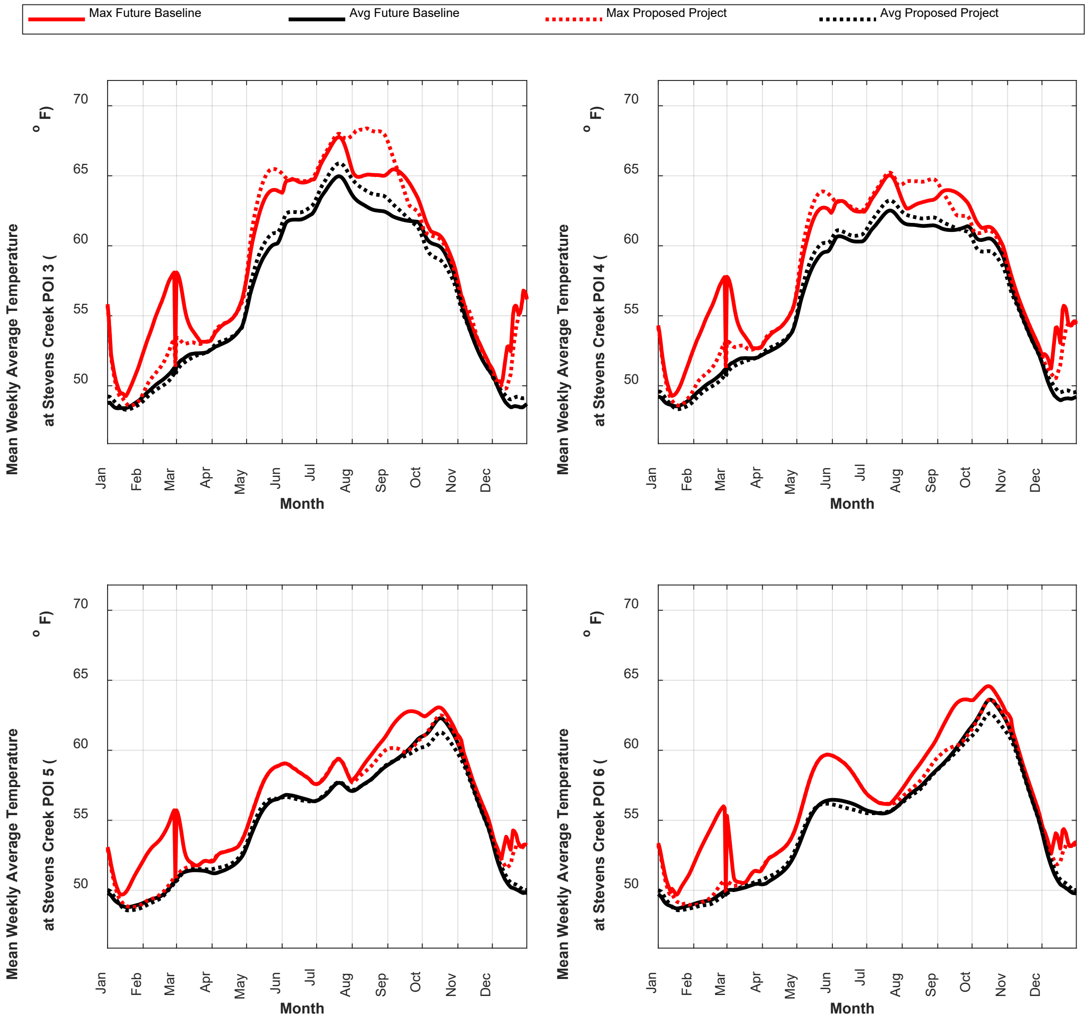
Figure K.2.10



Attachment K.2 – Proposed Project Supplementary Figures

Water Temperature Figures

Figure K.2.11[a]



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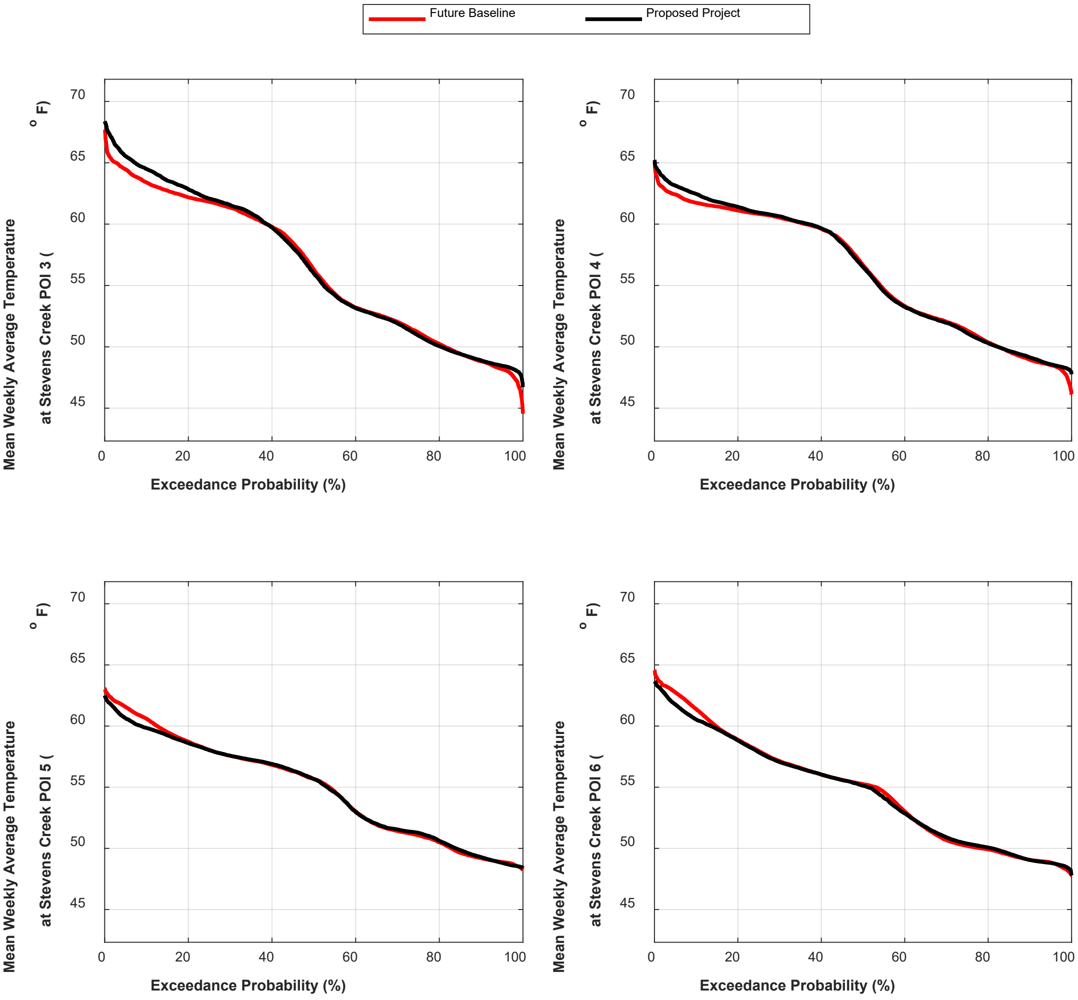
[a] No water temperature model results are available for the points of interest not shown.

Figure K.2.12[a]



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[a] No water temperature model results are available for the points of interest not shown.

Guadalupe River Watershed

Current Baseline Comparisons

Flow Figures

Figure K.2.13

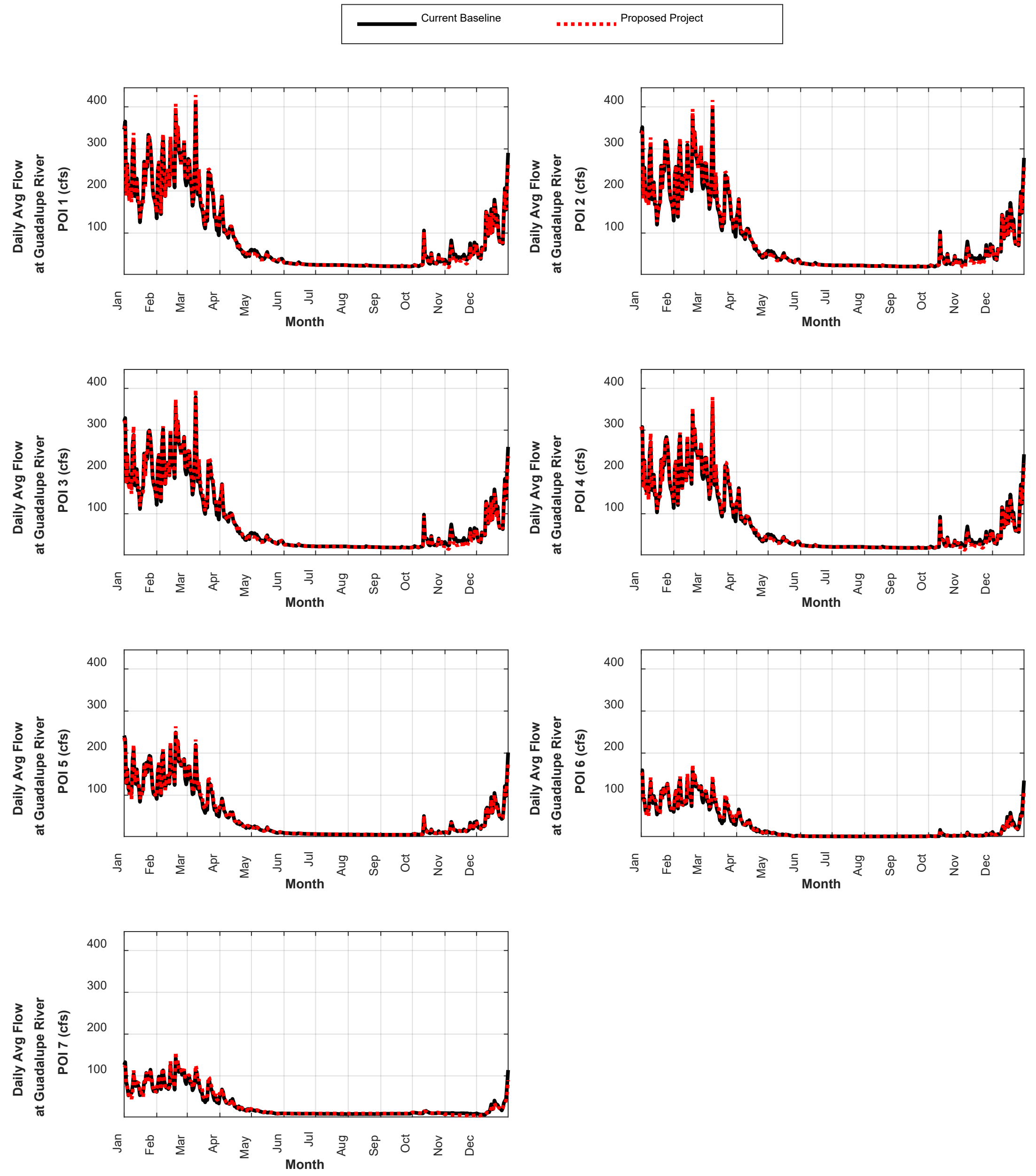
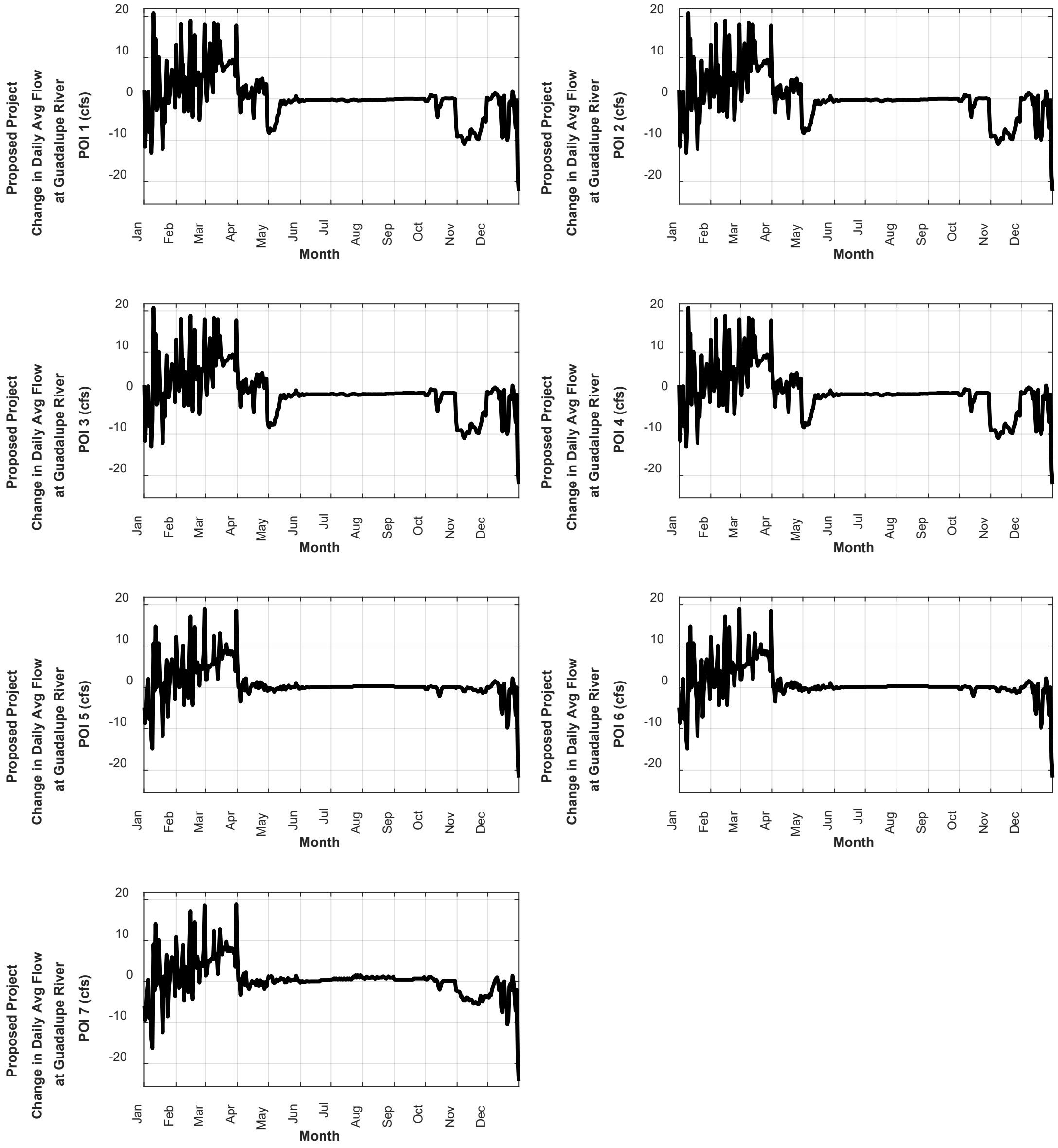


Figure K.2.14


Proposed Project Change in Daily Avg Flow at Guadalupe River POI 1 (cfs)
Proposed Project Change in Daily Avg Flow at Guadalupe River POI 2 (cfs)
Proposed Project Change in Daily Avg Flow at Guadalupe River POI 3 (cfs)
Proposed Project Change in Daily Avg Flow at Guadalupe River POI 4 (cfs)
Proposed Project Change in Daily Avg Flow at Guadalupe River POI 5 (cfs)
Proposed Project Change in Daily Avg Flow at Guadalupe River POI 6 (cfs)
Proposed Project Change in Daily Avg Flow at Guadalupe River POI 7 (cfs)
20
10
0
-10
-20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.2 – Proposed Project Supplementary Figures

Wetted Area Figures

Figure K.2.15

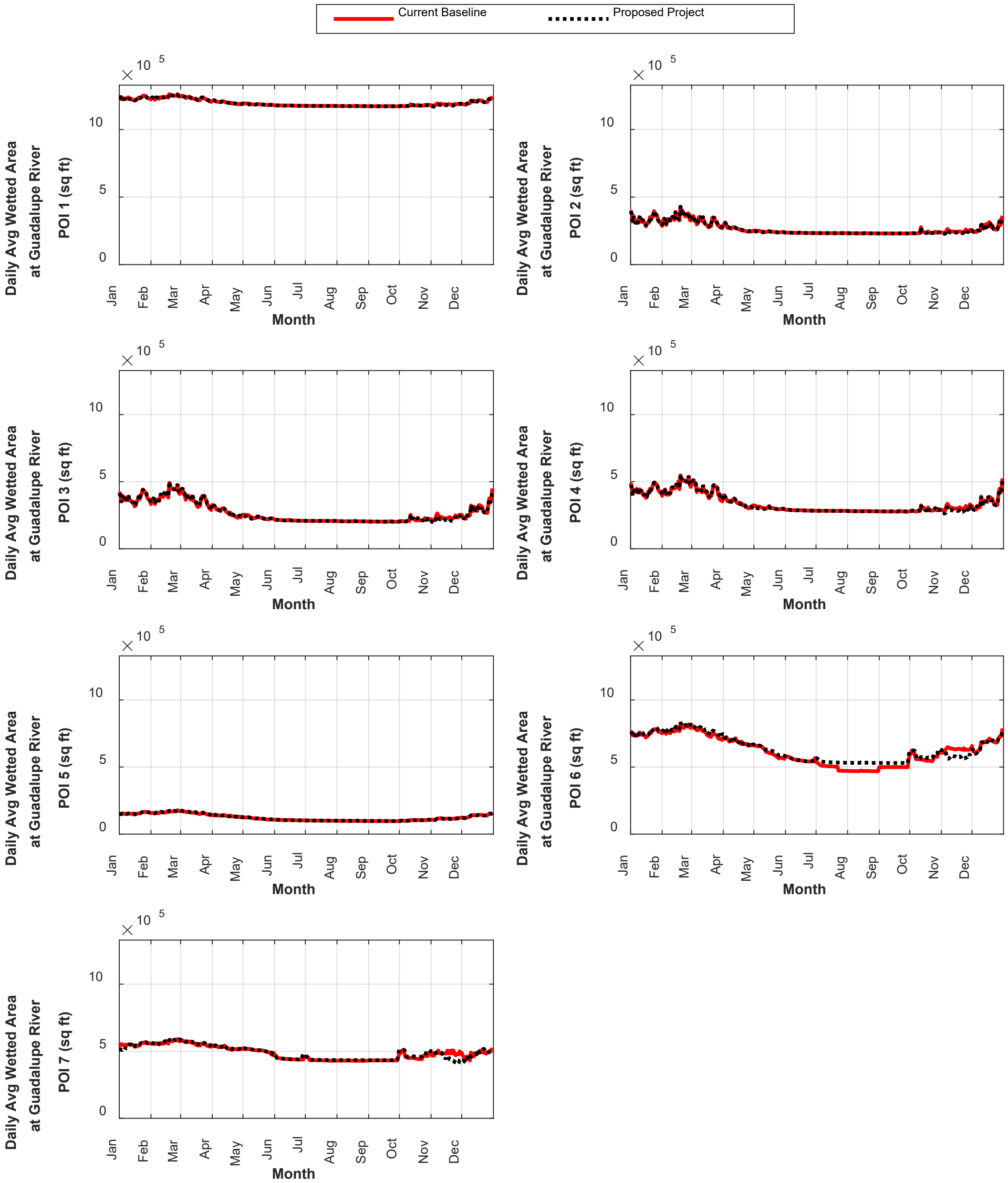
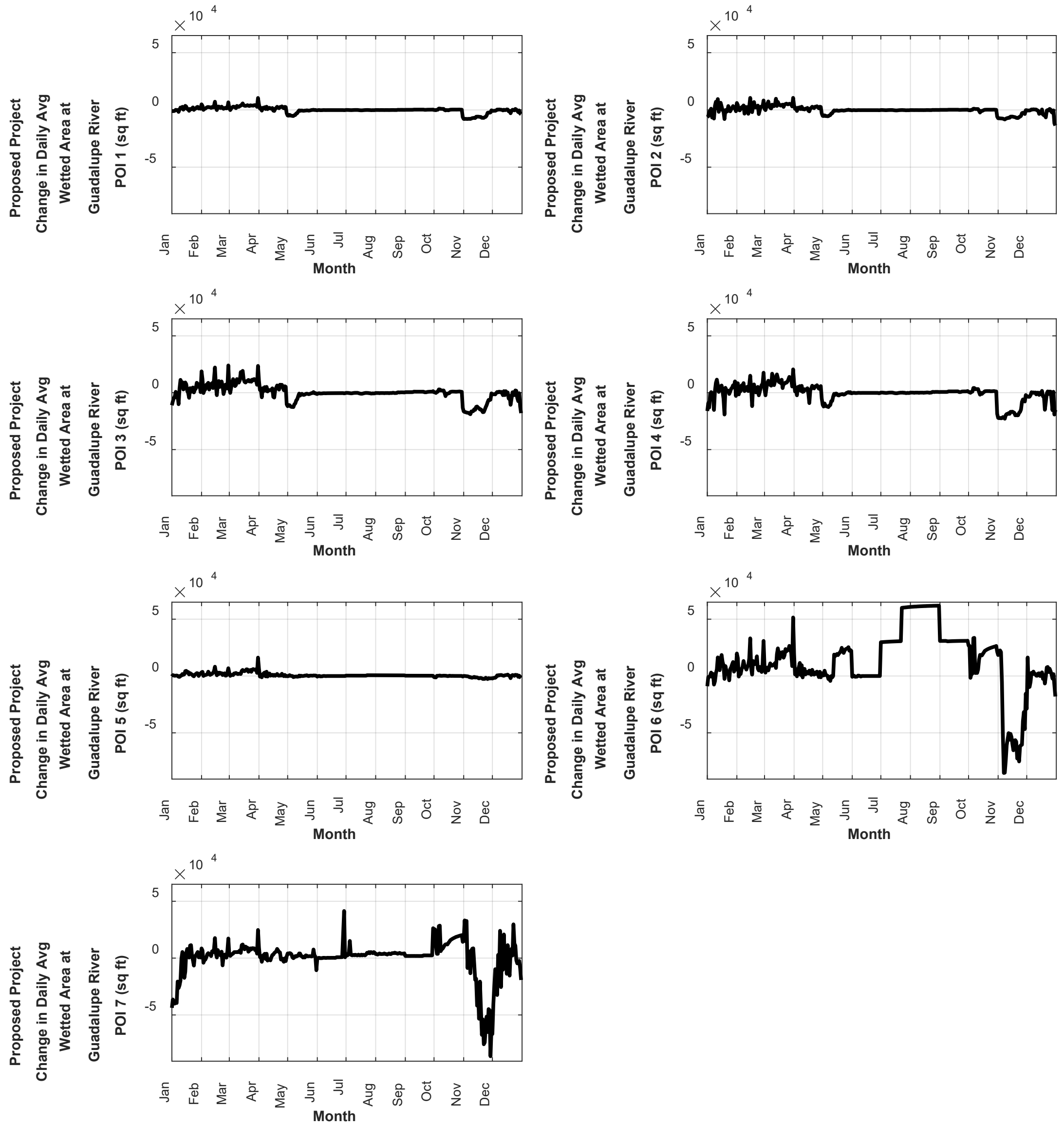


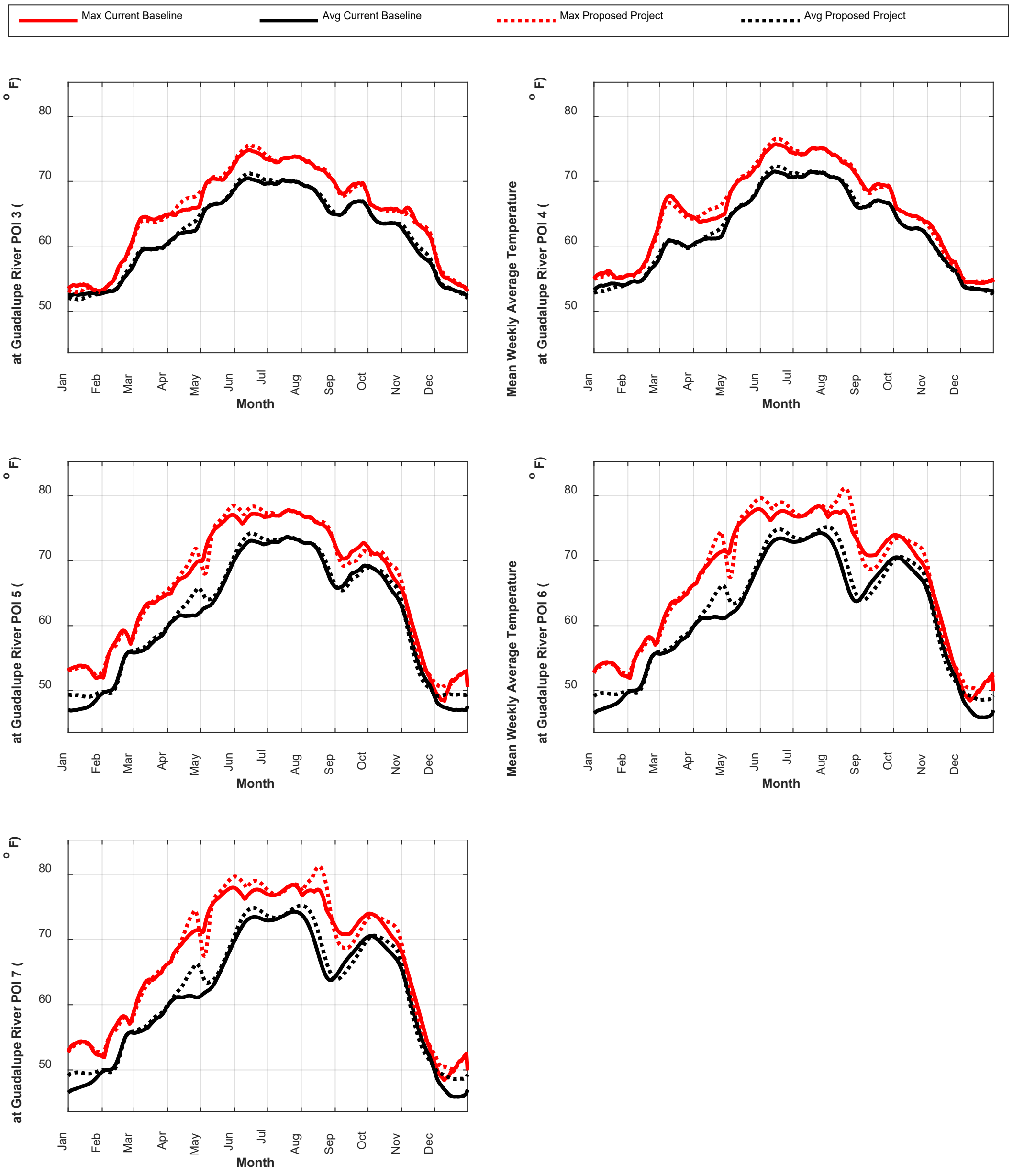
Figure K.2.16


×10 4
5
0
-5
Proposed Project Change in Daily Avg Wetted Area at Guadalupe River POI 1 (sq ft)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month
Proposed Project Change in Daily Avg Wetted Area at Guadalupe River POI 2 (sq ft)
Proposed Project Change in Daily Avg Wetted Area at Guadalupe River POI 3 (sq ft)
Proposed Project Change in Daily Avg Wetted Area at Guadalupe River POI 4 (sq ft)
Proposed Project Change in Daily Avg Wetted Area at Guadalupe River POI 5 (sq ft)
Proposed Project Change in Daily Avg Wetted Area at Guadalupe River POI 6 (sq ft)
Proposed Project Change in Daily Avg Wetted Area at Guadalupe River POI 7 (sq ft)

Attachment K.2 – Proposed Project Supplementary Figures

Water Temperature Figures

Figure K.2.17^{a}



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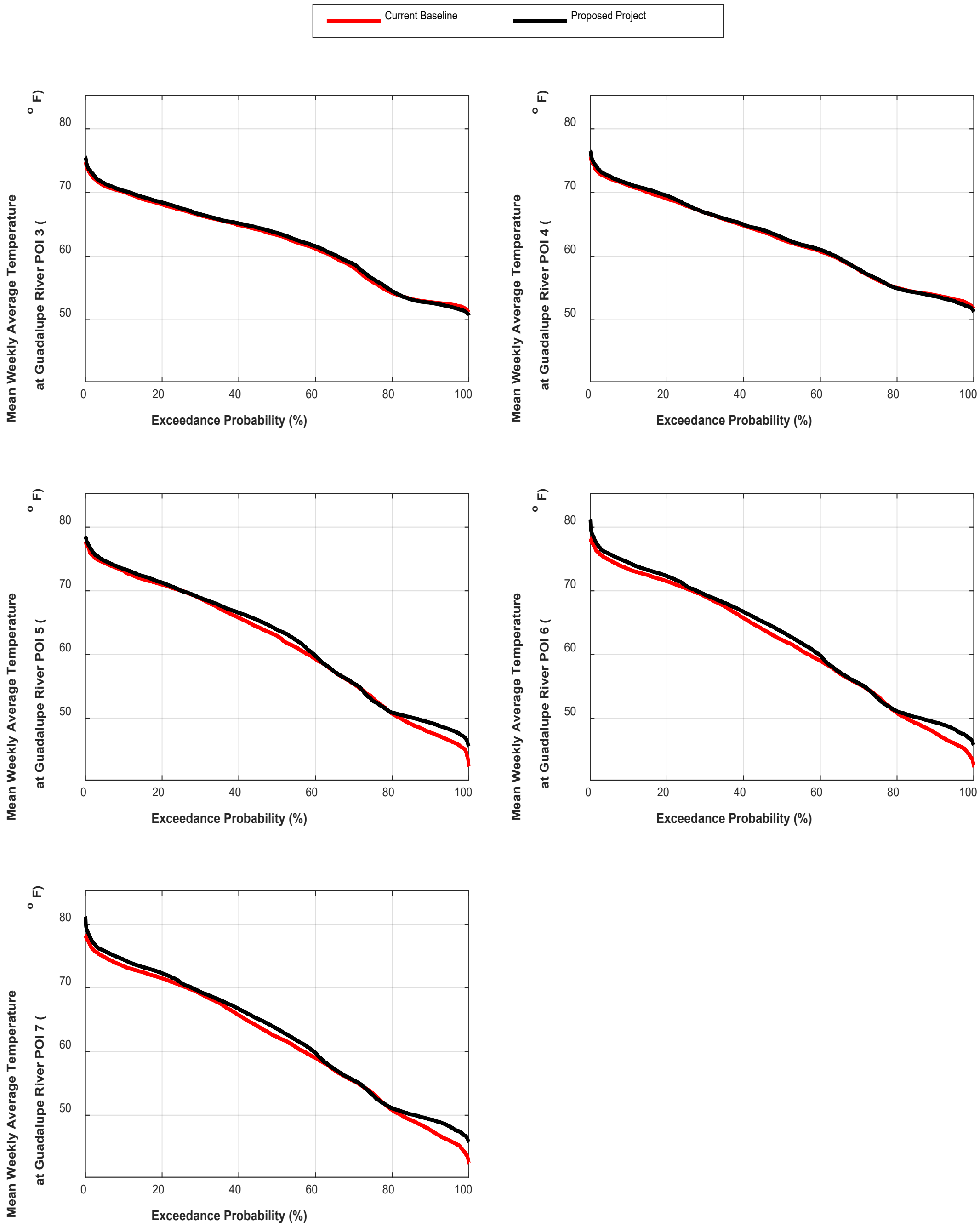
[a] No water temperature model results are available for the points of interest not shown.

Attachment K.2 – Proposed Project Supplementary Figures

Figure K.2.18^{a}



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[a] No water temperature model results are available for the points of interest not shown.

Attachment K.2 – Proposed Project Supplementary Figures

Future Baseline Comparisons

Flow Figures

Figure K.2.19

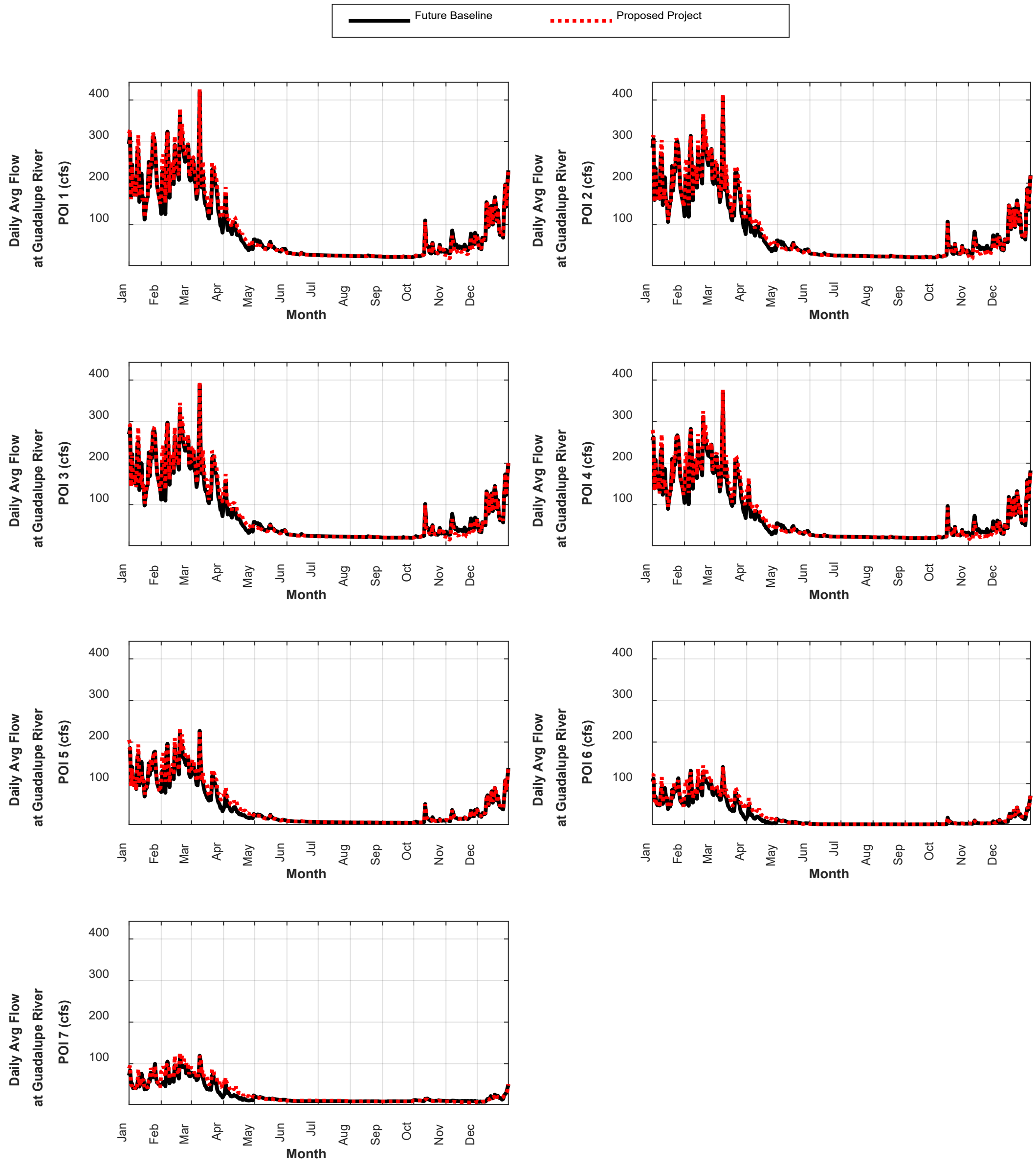
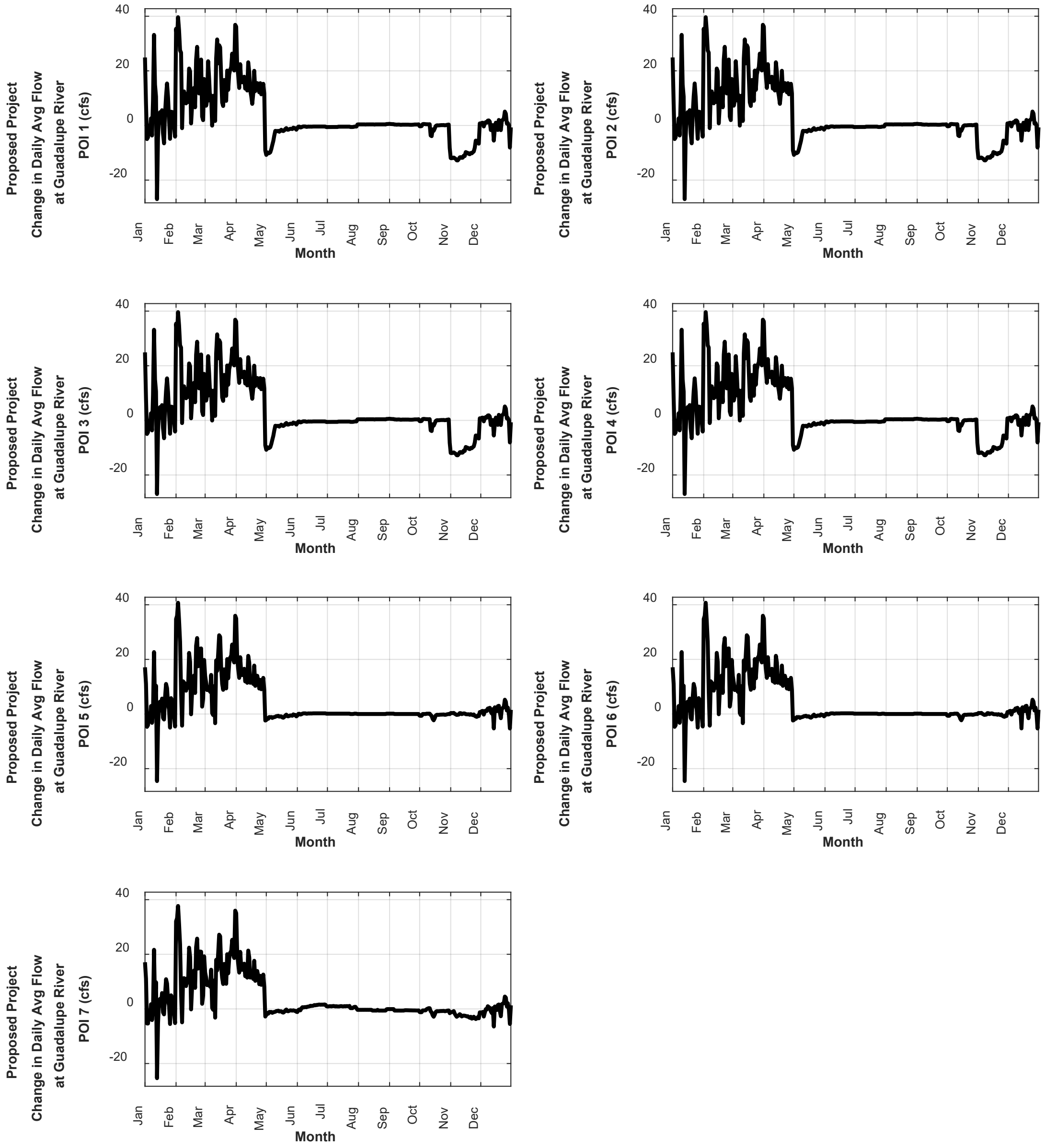


Figure K.2.20


Proposed Project
Change in Daily Avg Flow
at Guadalupe River
POI 1 (cfs)
POI 2 (cfs)
POI 3 (cfs)
POI 4 (cfs)
POI 5 (cfs)
POI 6 (cfs)
POI 7 (cfs)
40
20
0
-20
Jan
Feb
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Sep
Oct
Nov
Dec
Month

Attachment K.2 – Proposed Project Supplementary Figures

Wetted Area Figures

Figure K.2.21

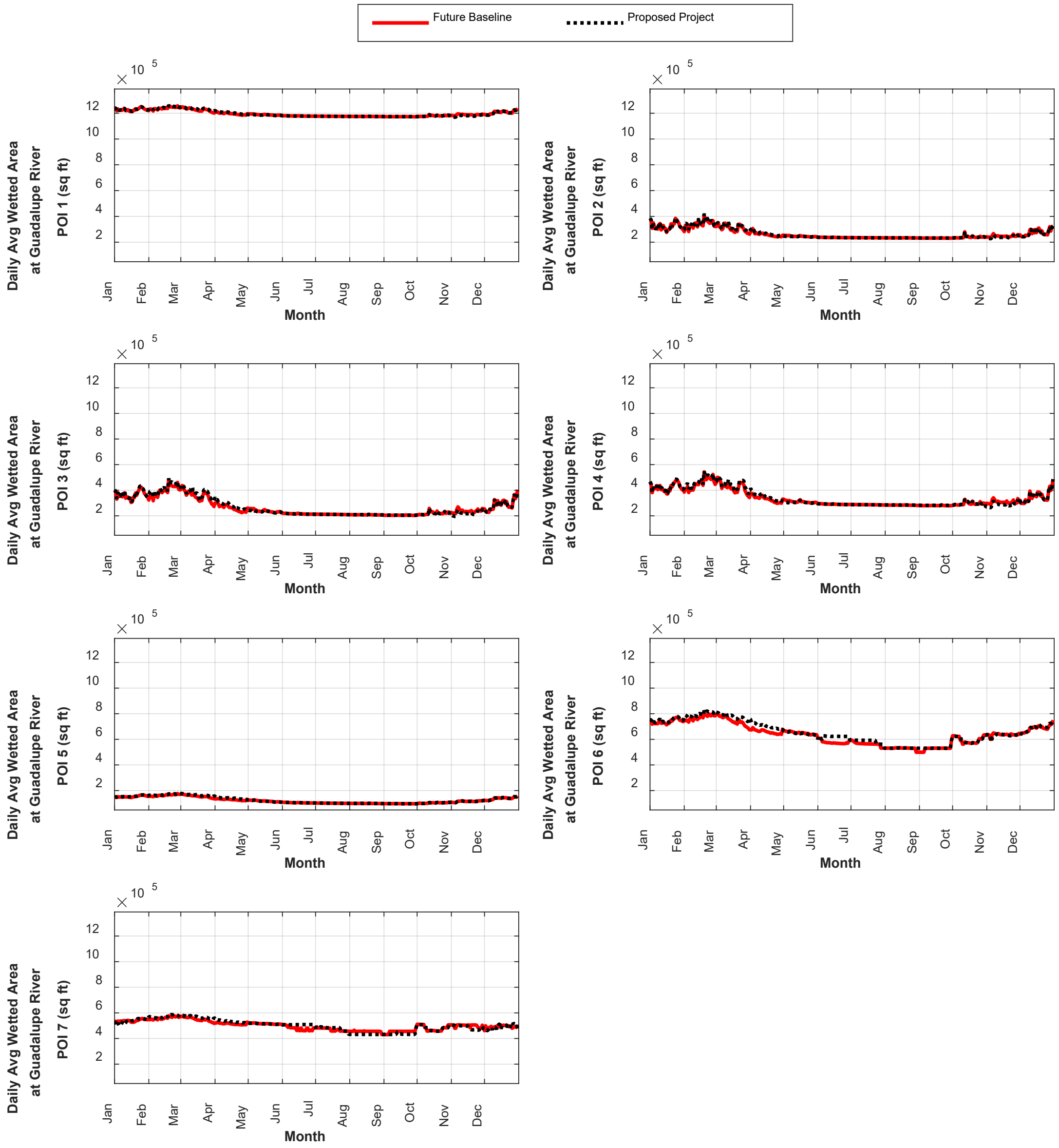
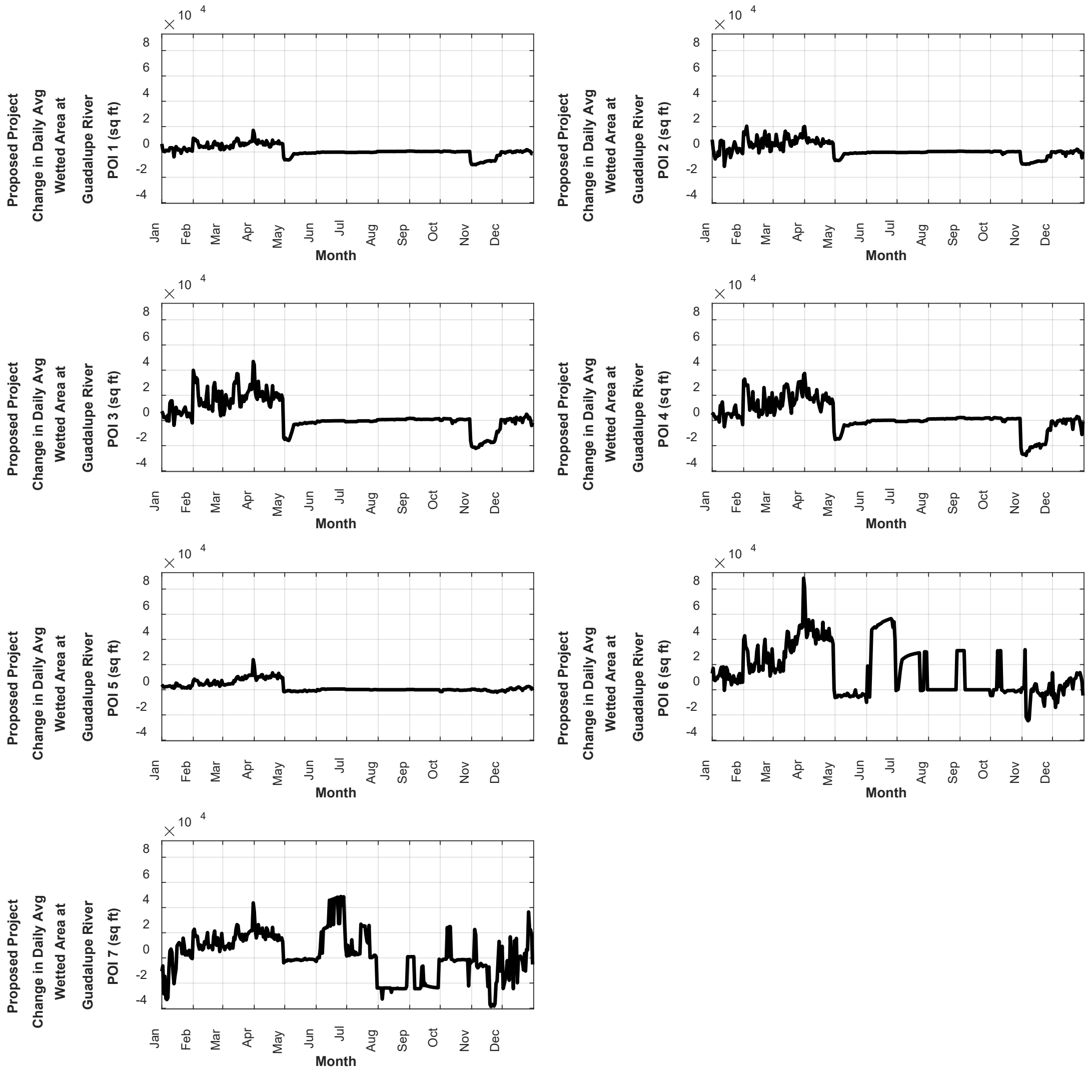


Figure K.2.22


×10^4
8
6
4
2
0
-2
-4
Proposed Project Change in Daily Avg Wetted Area at Guadalupe River POI 1 (sq ft)
Proposed Project Change in Daily Avg Wetted Area at Guadalupe River POI 2 (sq ft)
Proposed Project Change in Daily Avg Wetted Area at Guadalupe River POI 3 (sq ft)
Proposed Project Change in Daily Avg Wetted Area at Guadalupe River POI 4 (sq ft)
Proposed Project Change in Daily Avg Wetted Area at Guadalupe River POI 5 (sq ft)
Proposed Project Change in Daily Avg Wetted Area at Guadalupe River POI 6 (sq ft)
Proposed Project Change in Daily Avg Wetted Area at Guadalupe River POI 7 (sq ft)
Jan
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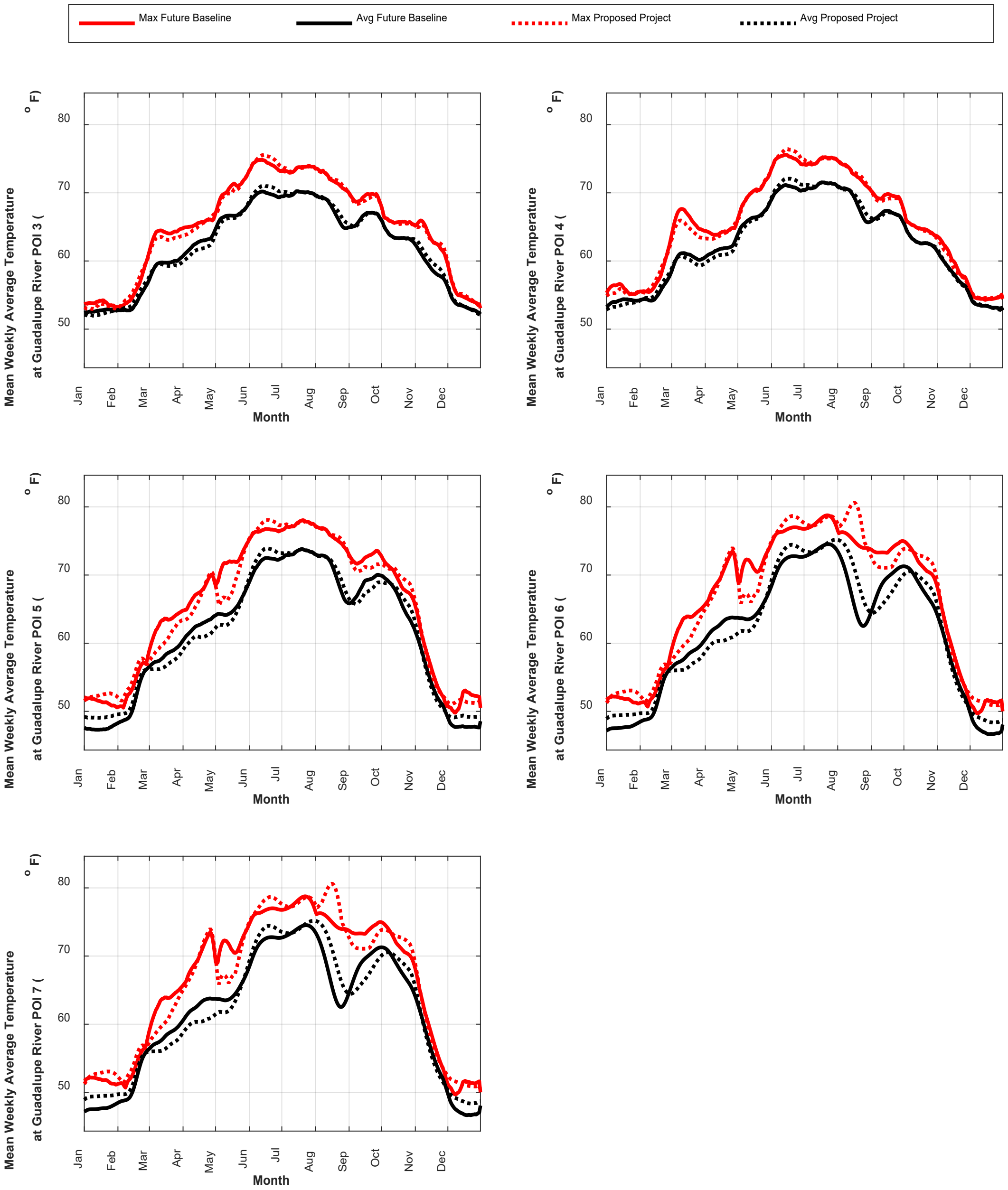
Nov
Dec
Month

Attachment K.2 – Proposed Project Supplementary Figures

Water Temperature Figures

Figure K.2.23[a]



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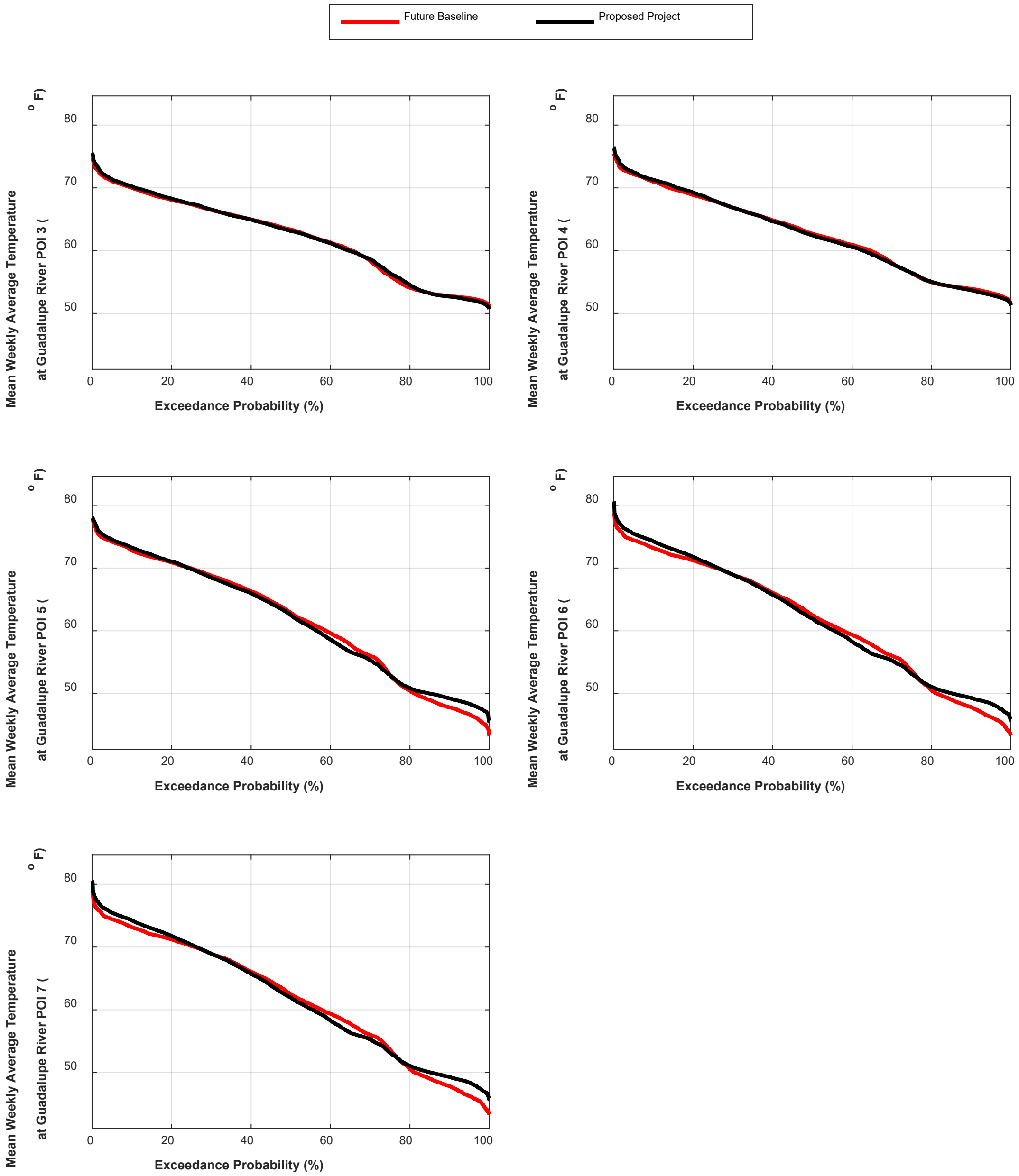
[a] No water temperature model results are available for the points of interest not shown.

Figure K.2.24[a]



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[a] No water temperature model results are available for the points of interest not shown.

Los Gatos Creek

Current Baseline Comparisons

Flow Figures

Figure K.2.25

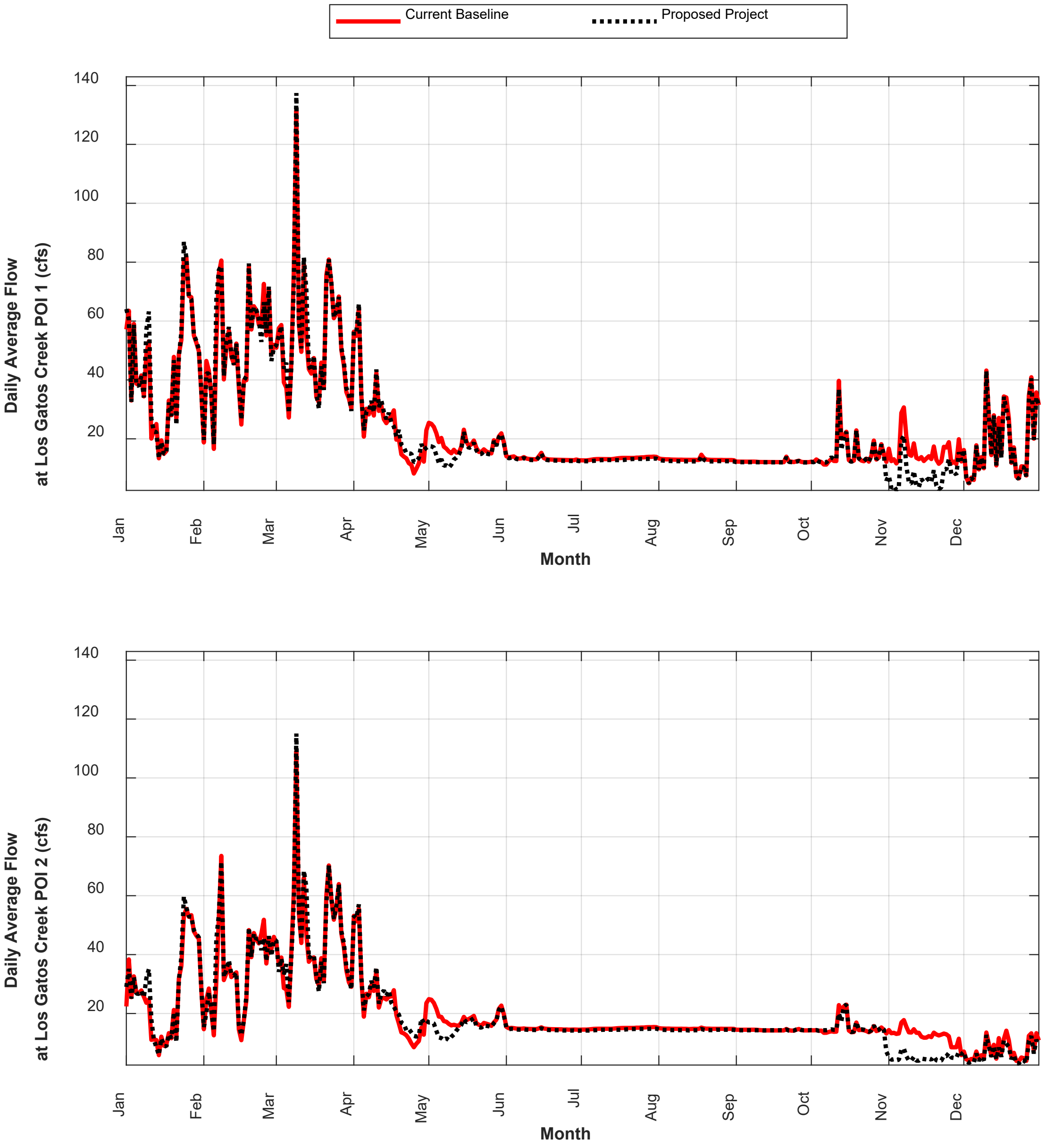
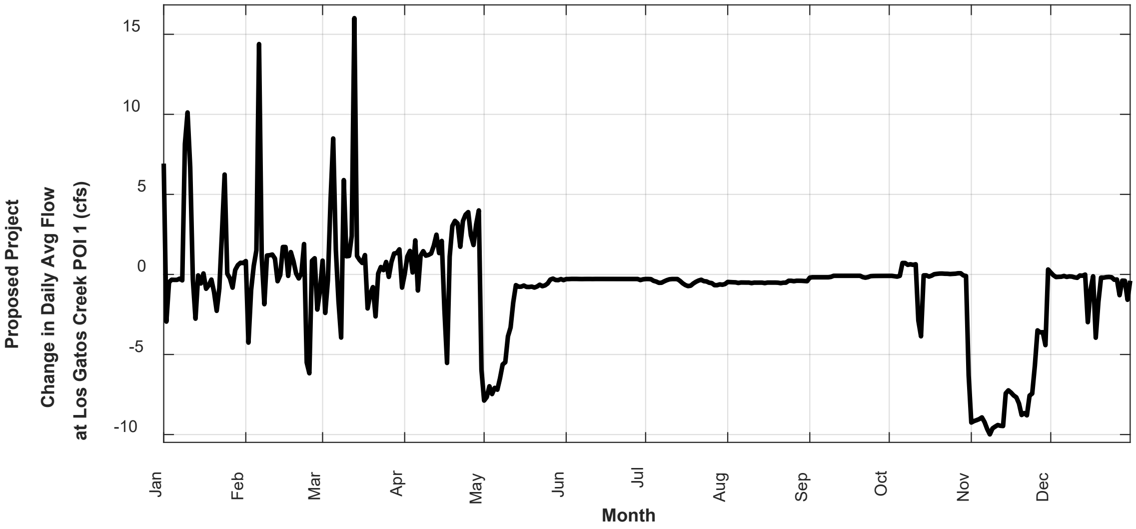


Figure K.2.26


Proposed Project
Change in Daily Avg Flow
at Los Gatos Creek POI 1 (cfs)
15
10
5
0
-5
-10
Jan
Feb
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Apr
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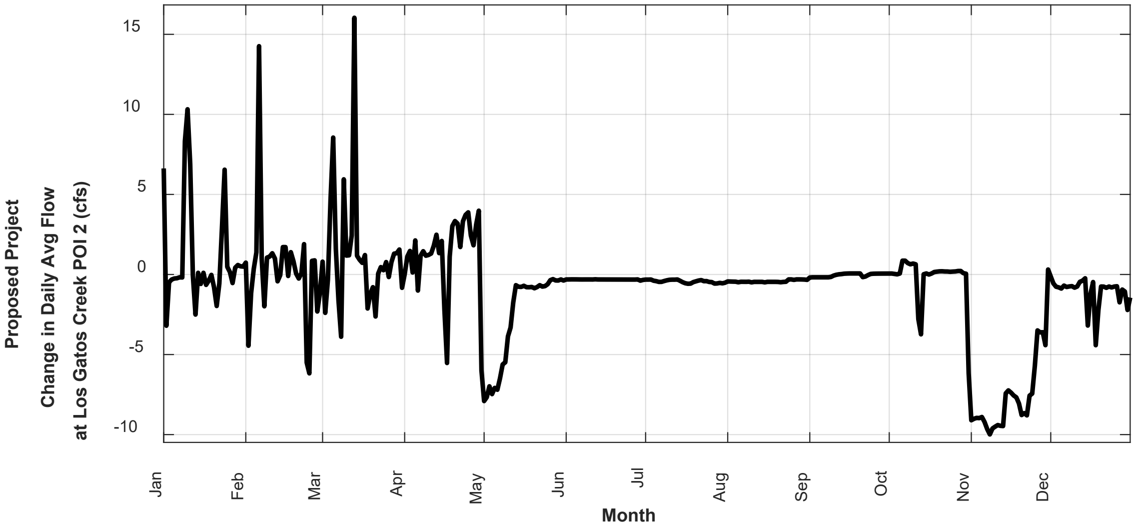
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


Proposed Project
Change in Daily Avg Flow
at Los Gatos Creek POI 2 (cfs)
15
10
5
0
-5
-10
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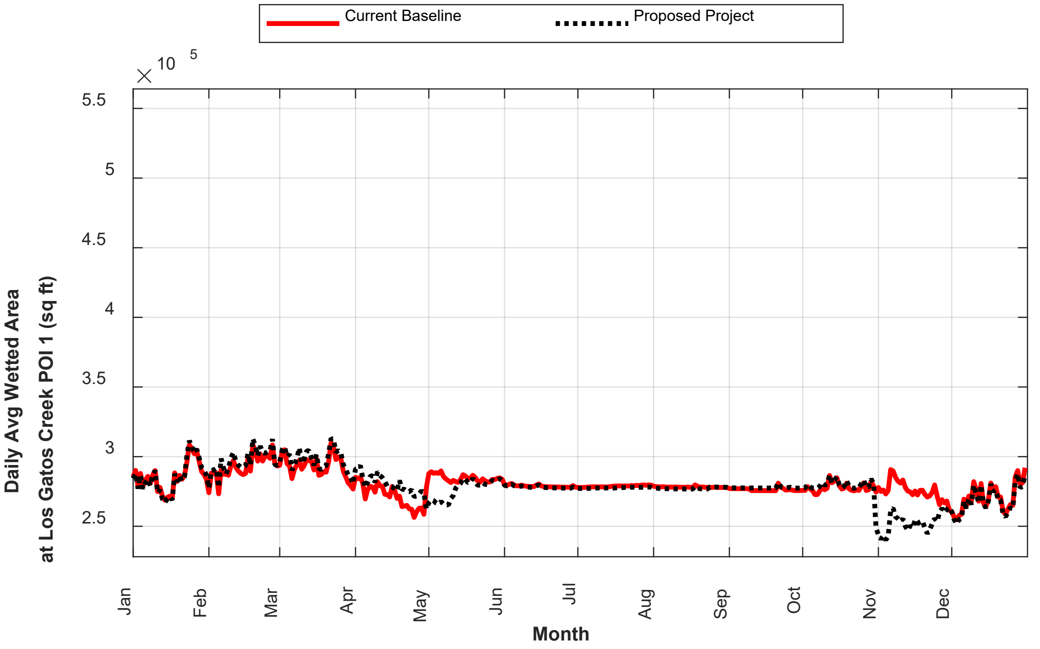
Aug
Sep
Oct
Nov
Dec
Month

Wetted Area Figures

Figure K.2.27



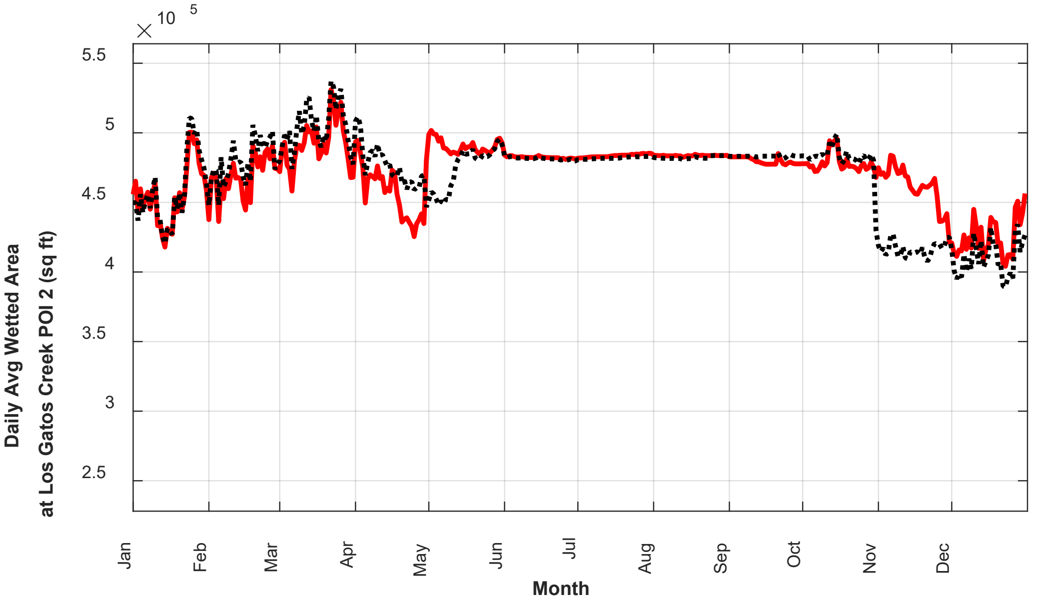
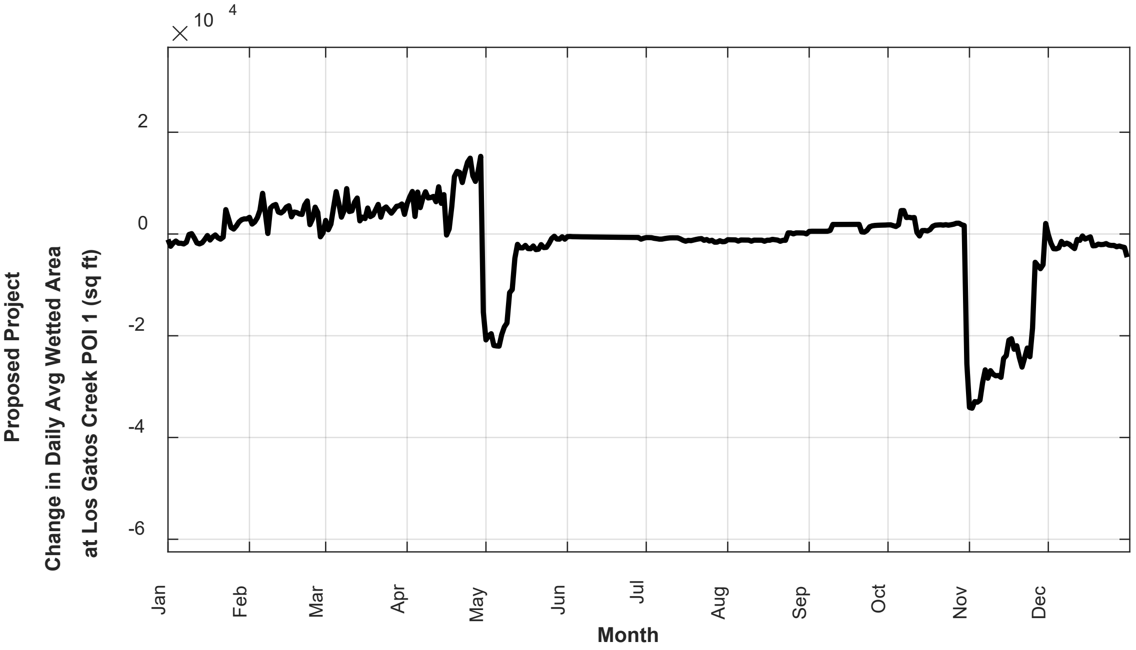
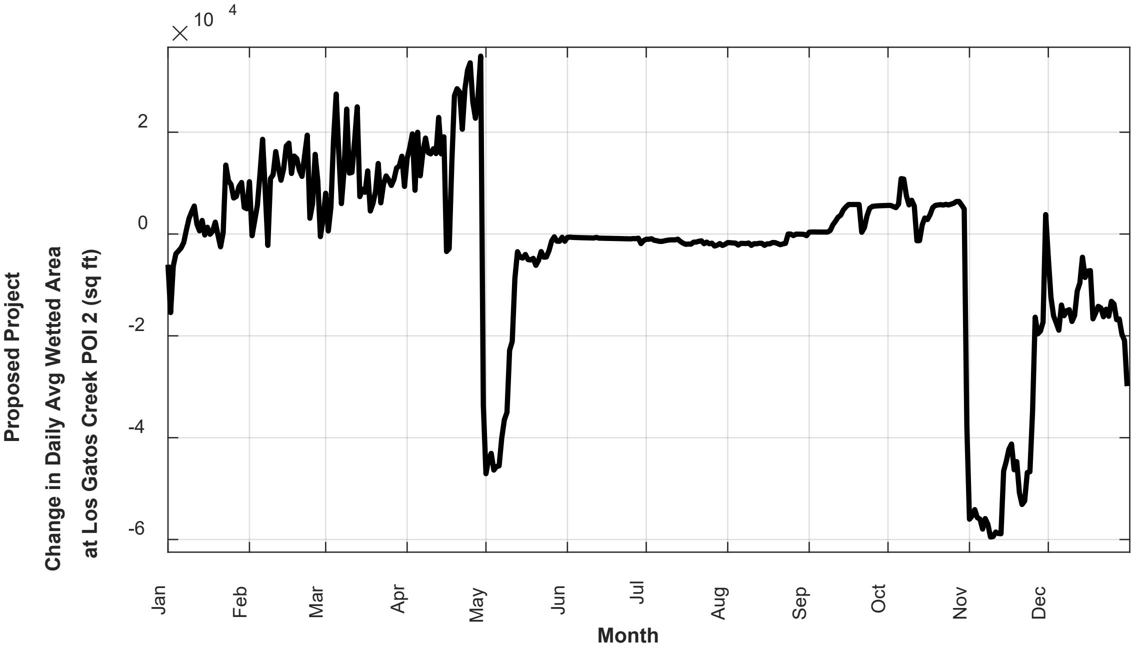


Figure K.2.28



×10 4
2
0
-2
-4
-6
Proposed Project
Change in Daily Avg Wetted Area
at Los Gatos Creek POI 1 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month



×10 4
2
0
-2
-4
-6
Proposed Project
Change in Daily Avg Wetted Area
at Los Gatos Creek POI 2 (sq ft)
Jan
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Jul
Aug
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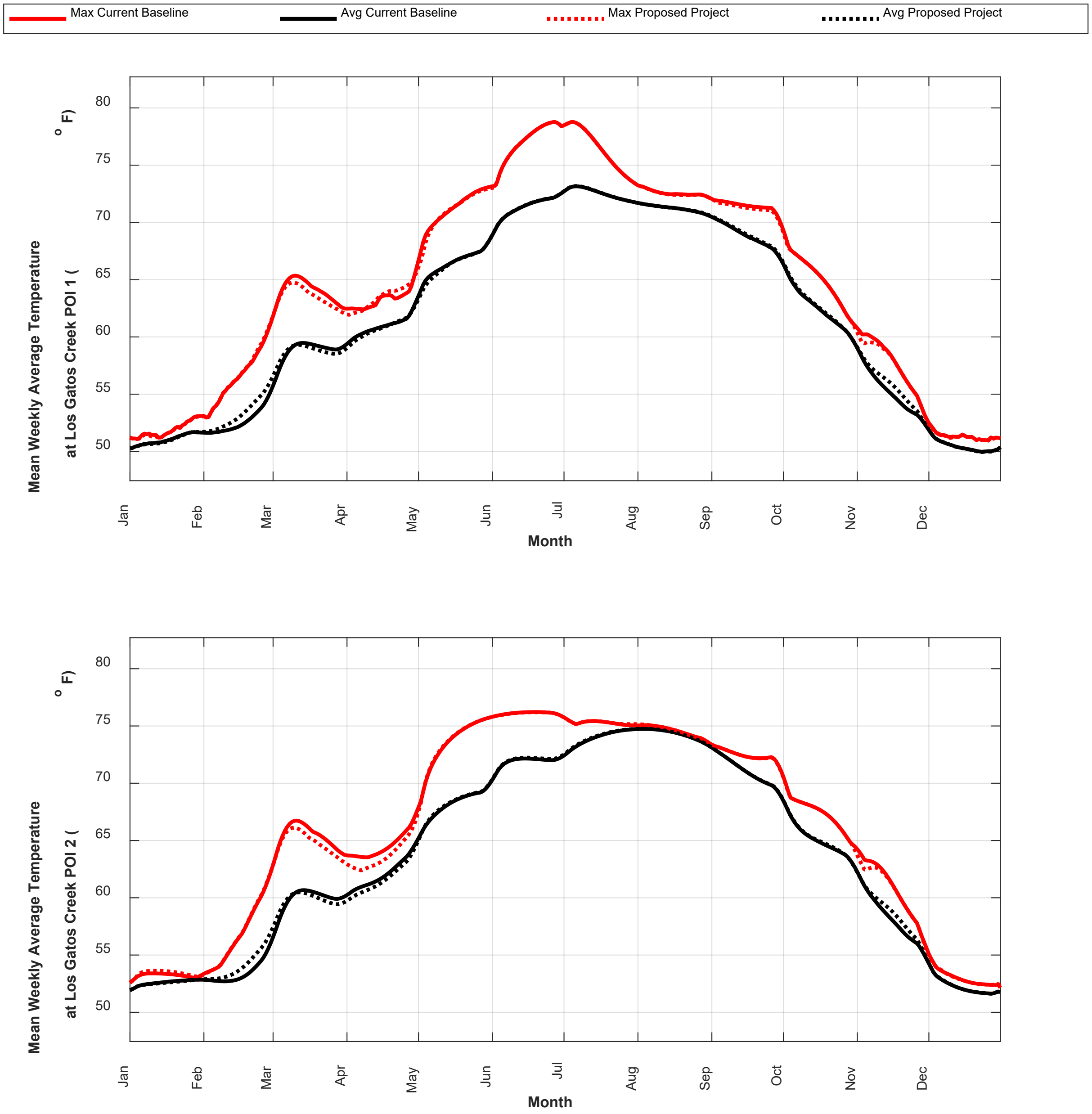
Oct
Nov
Dec
Month

Attachment K.2 – Proposed Project Supplementary Figures

Water Temperature Figures

Figure K.2.29



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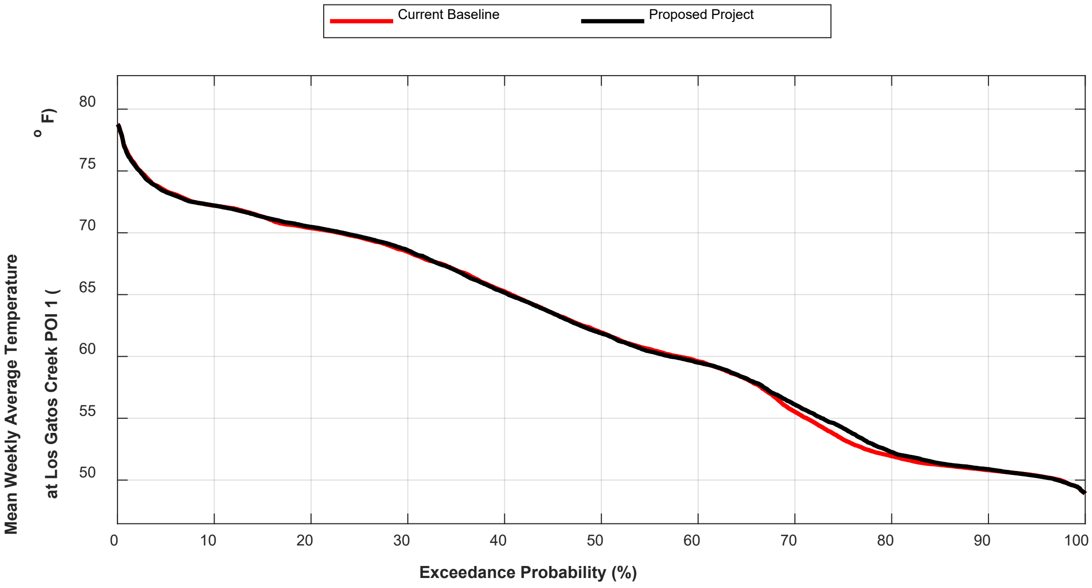
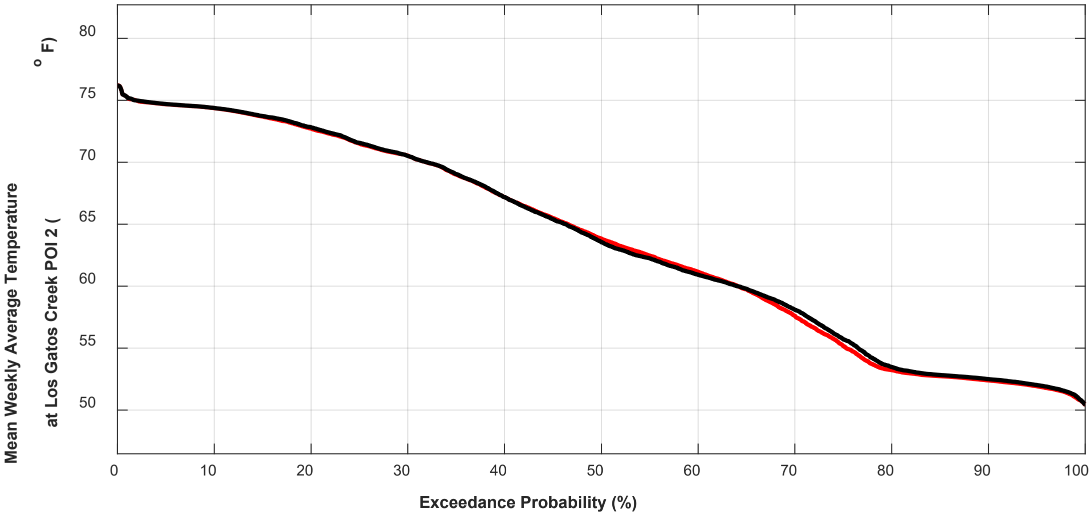

Current Baseline
Proposed Project
Mean Weekly Average Temperature at Los Gatos Creek POI 1 (°F)
80
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
100
Exceedance Probability (%)


Mean Weekly Average Temperature at Los Gatos Creek POI 2 (°F)
80
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
100
Exceedance Probability (%)

Future Baseline Comparisons

Flow Figures

Figure K.2.31

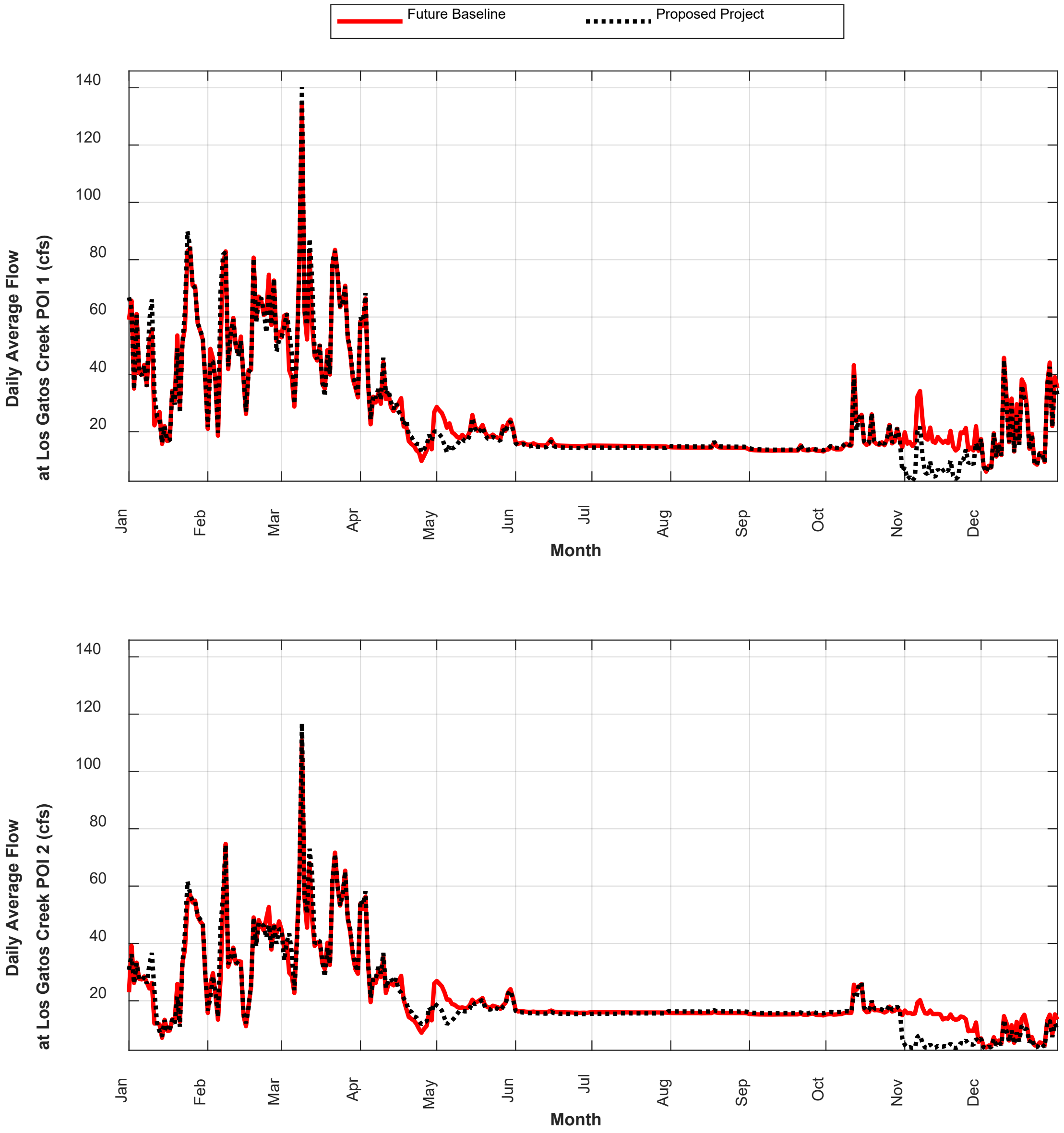
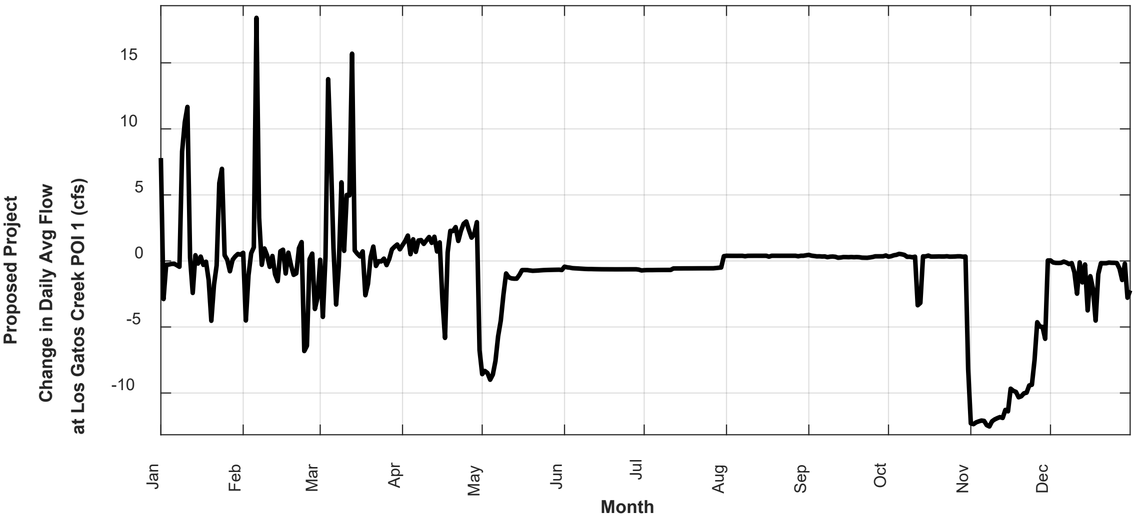
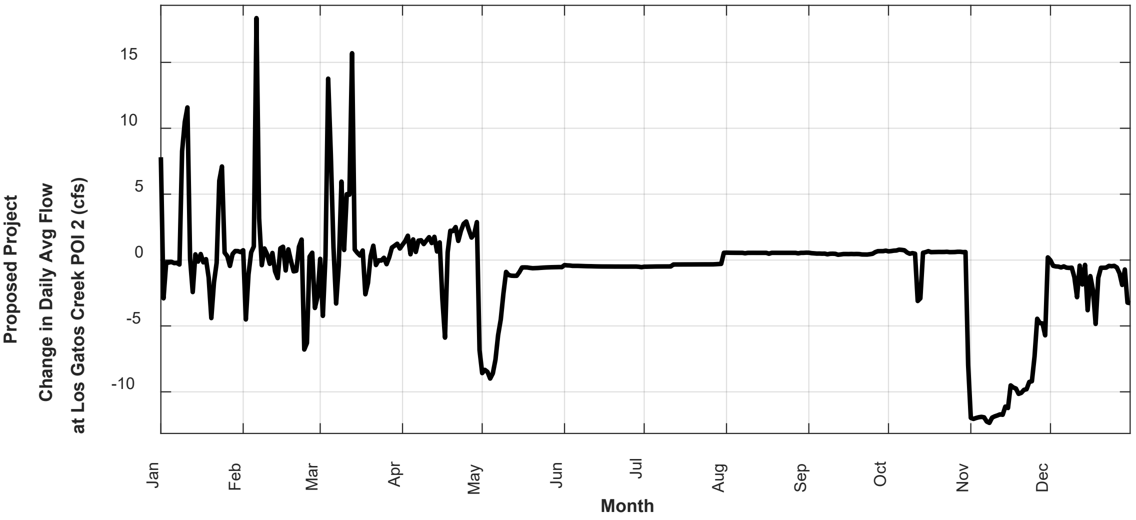


Figure K.2.32


15
10
5
0
-5
-10
Proposed Project
Change in Daily Avg Flow
at Los Gatos Creek POI 1 (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


15
10
5
0
-5
-10
Proposed Project
Change in Daily Avg Flow
at Los Gatos Creek POI 2 (cfs)
Jan
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Oct
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Dec
Month

Attachment K.2 – Proposed Project Supplementary Figures

Wetted Area Figures

Figure K.2.33

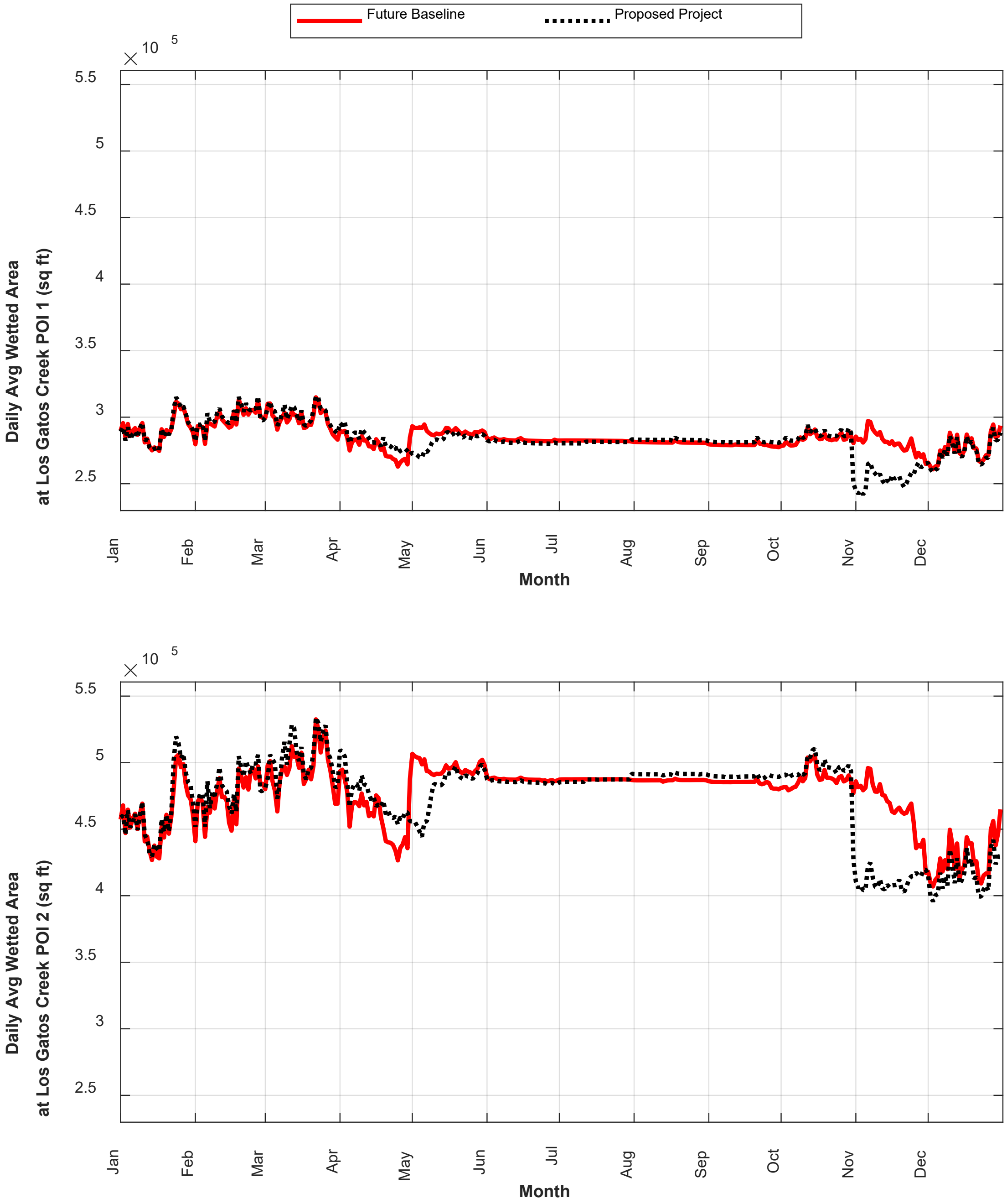
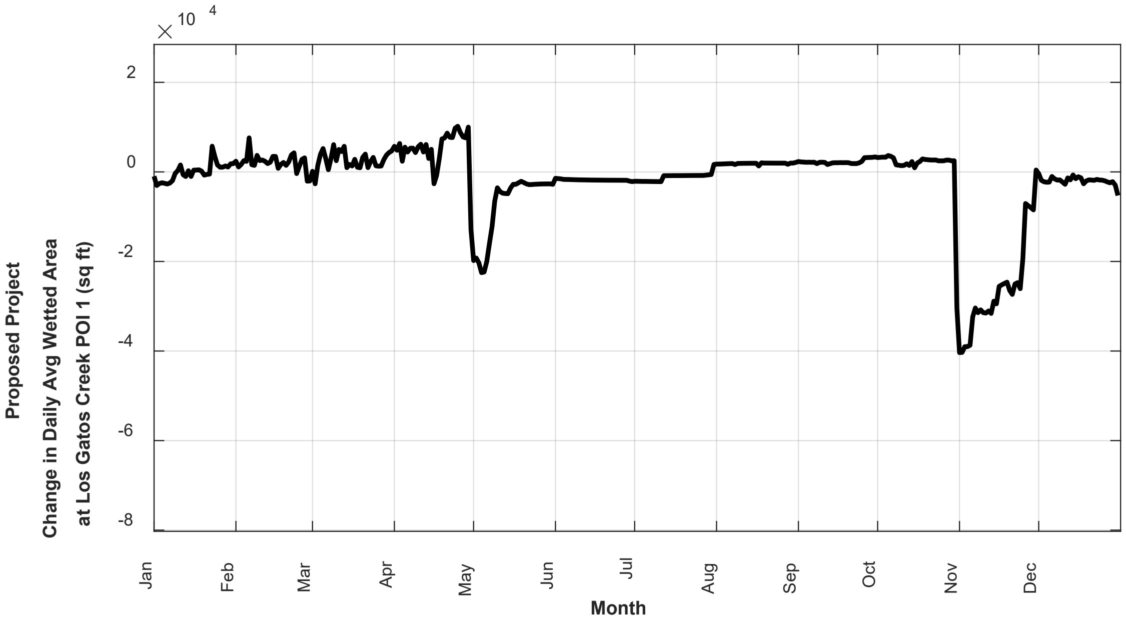
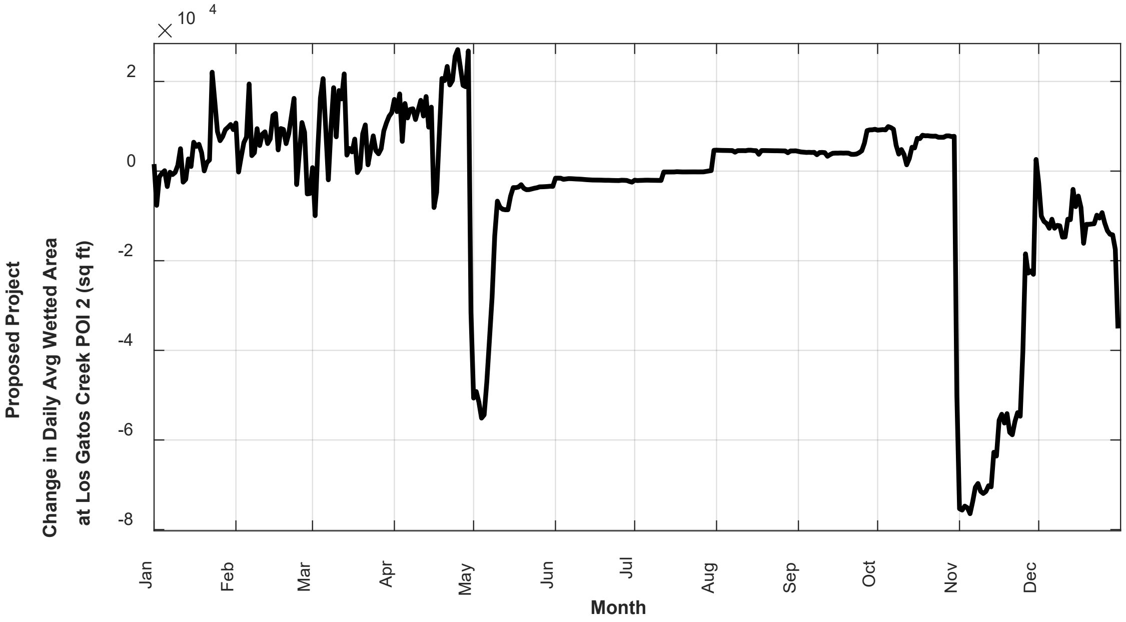


Figure K.2.34


×10 4
2
0
-2
-4
-6
-8
Proposed Project
Change in Daily Avg Wetted Area
at Los Gatos Creek POI 1 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


×10 4
2
0
-2
-4
-6
-8
Proposed Project
Change in Daily Avg Wetted Area
at Los Gatos Creek POI 2 (sq ft)
Jan
Feb
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Dec
Month

Attachment K.2 – Proposed Project Supplementary Figures

Water Temperature Figures

Figure K.2.35

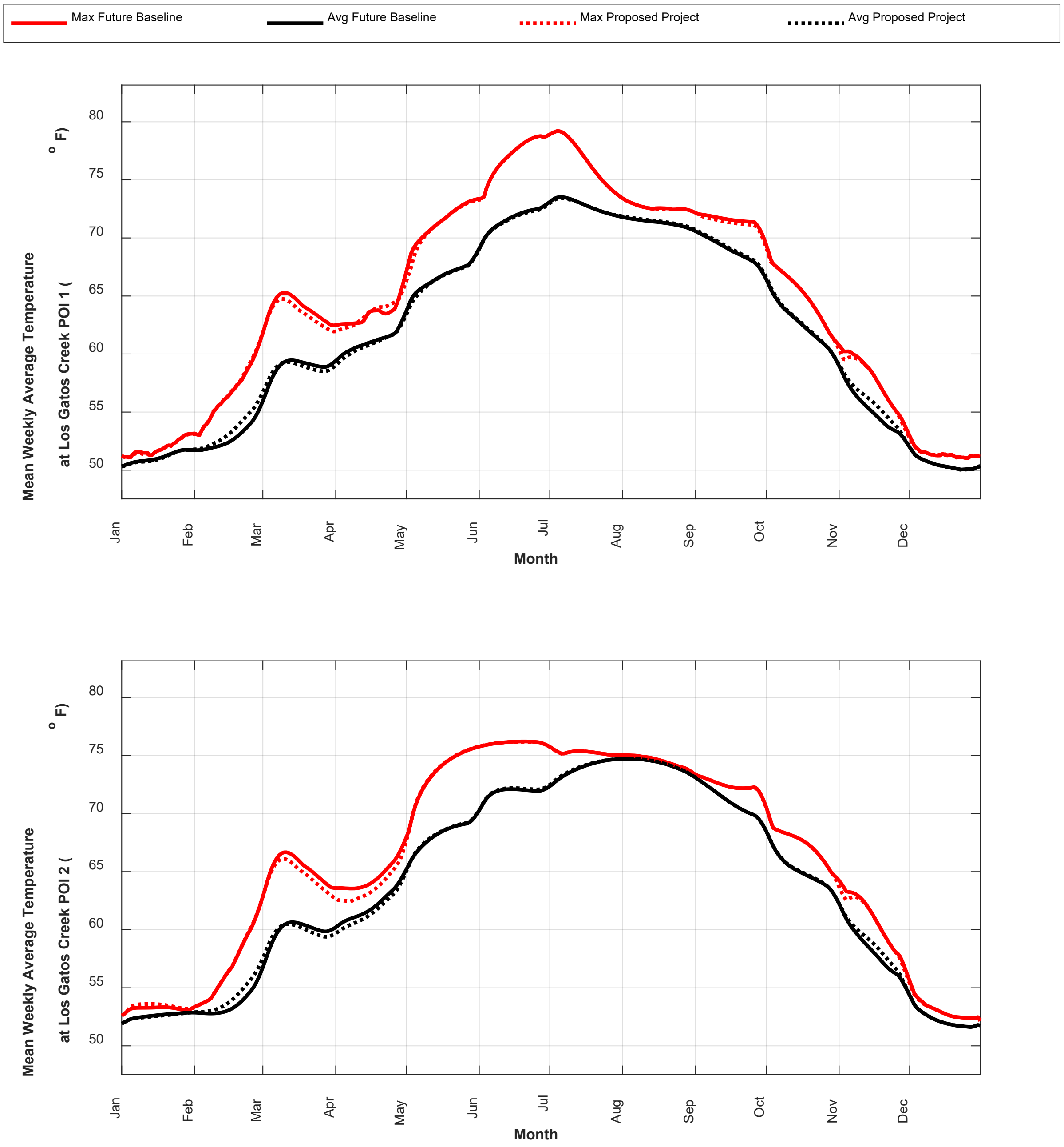
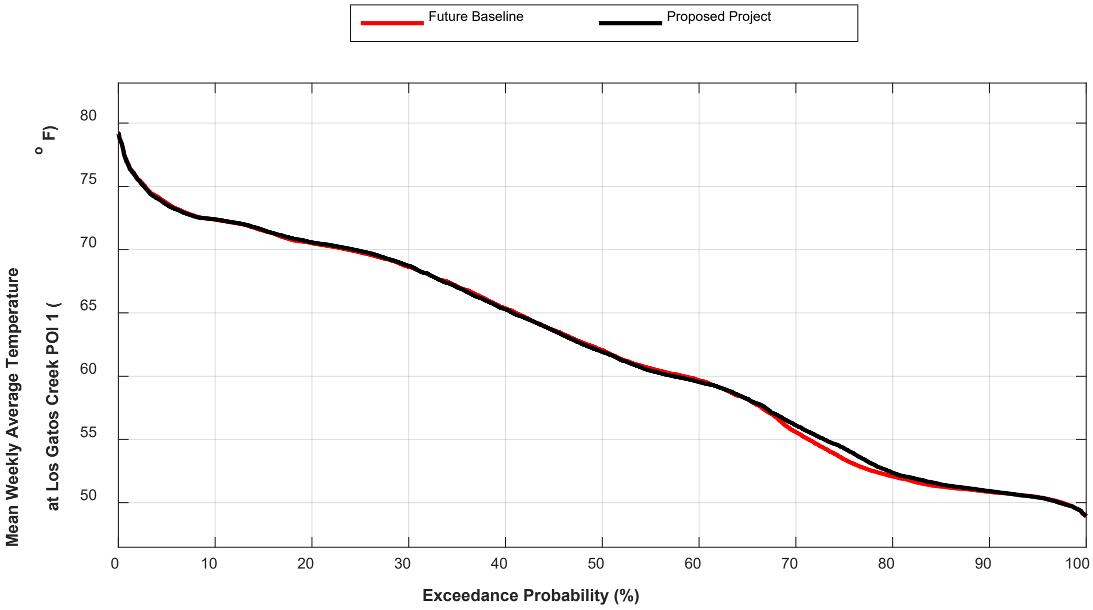
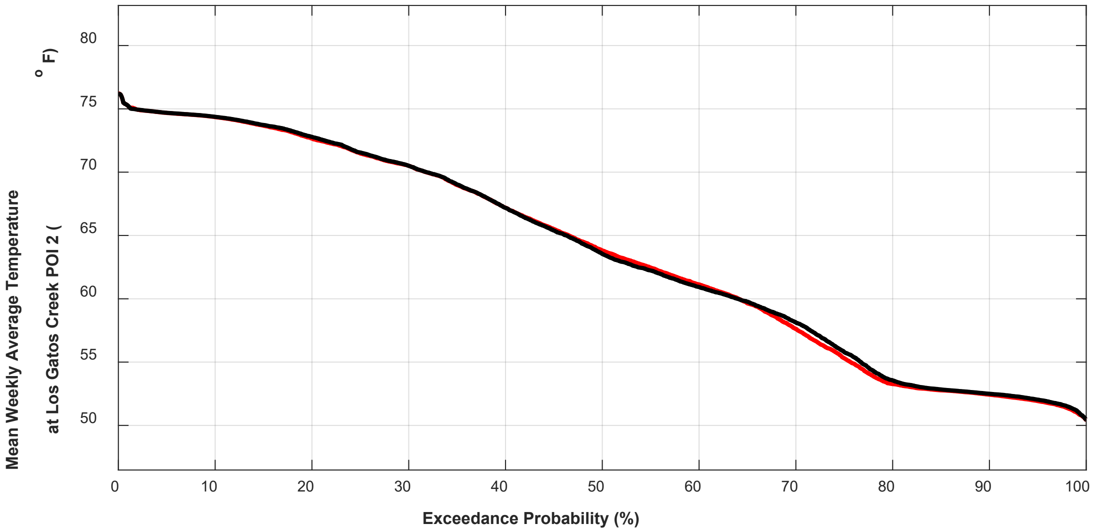


Figure K.2.36


Future Baseline
Proposed Project
Mean Weekly Average Temperature
at Los Gatos Creek POI 1 (o F)
80
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
100
Exceedance Probability (%)


Mean Weekly Average Temperature
at Los Gatos Creek POI 2 (o F)
80
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
100
Exceedance Probability (%)

Attachment K.2 – Proposed Project Supplementary Figures

Guadalupe Creek

Current Baseline Comparisons

Flow Figures

Figure K.2.37

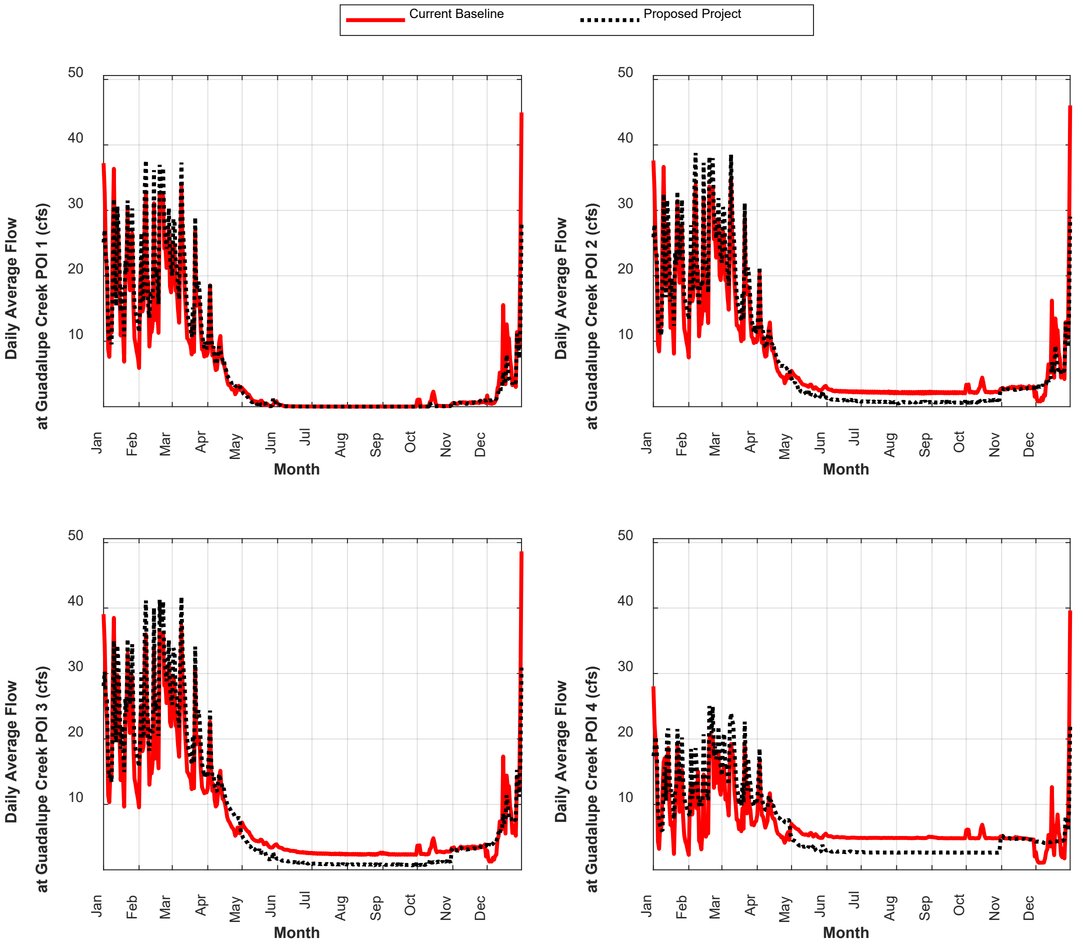
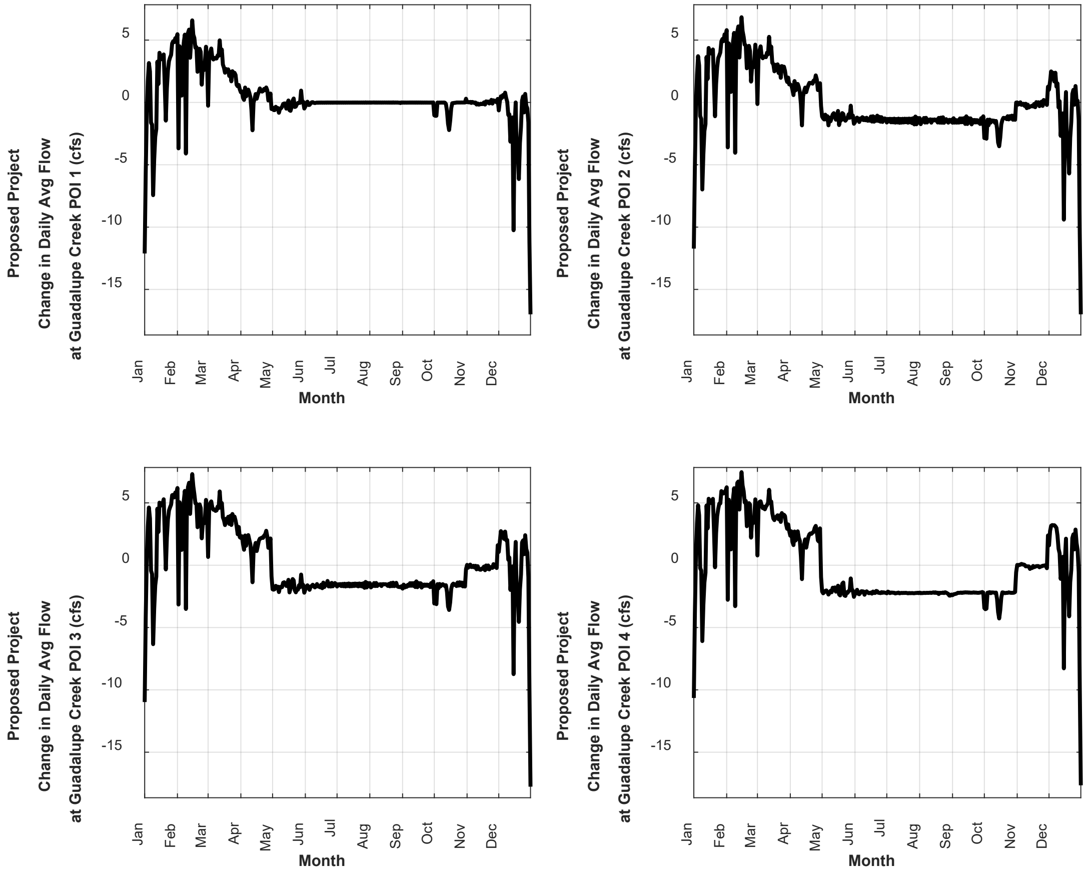


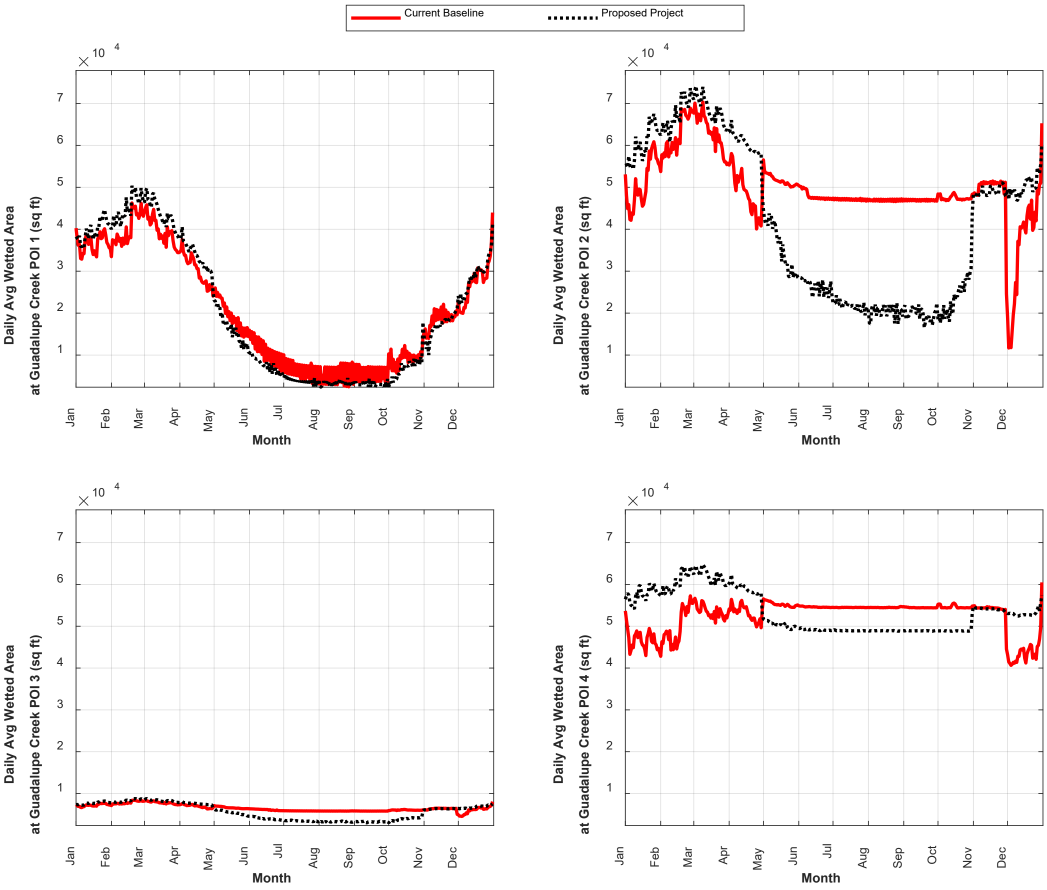
Figure K.2.38


Proposed Project
Change in Daily Avg Flow
at Guadalupe Creek POI 1 (cfs)
Proposed Project
Change in Daily Avg Flow
at Guadalupe Creek POI 2 (cfs)
Proposed Project
Change in Daily Avg Flow
at Guadalupe Creek POI 3 (cfs)
Proposed Project
Change in Daily Avg Flow
at Guadalupe Creek POI 4 (cfs)
5
0
-5
-10
-15
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.2 – Proposed Project Supplementary Figures

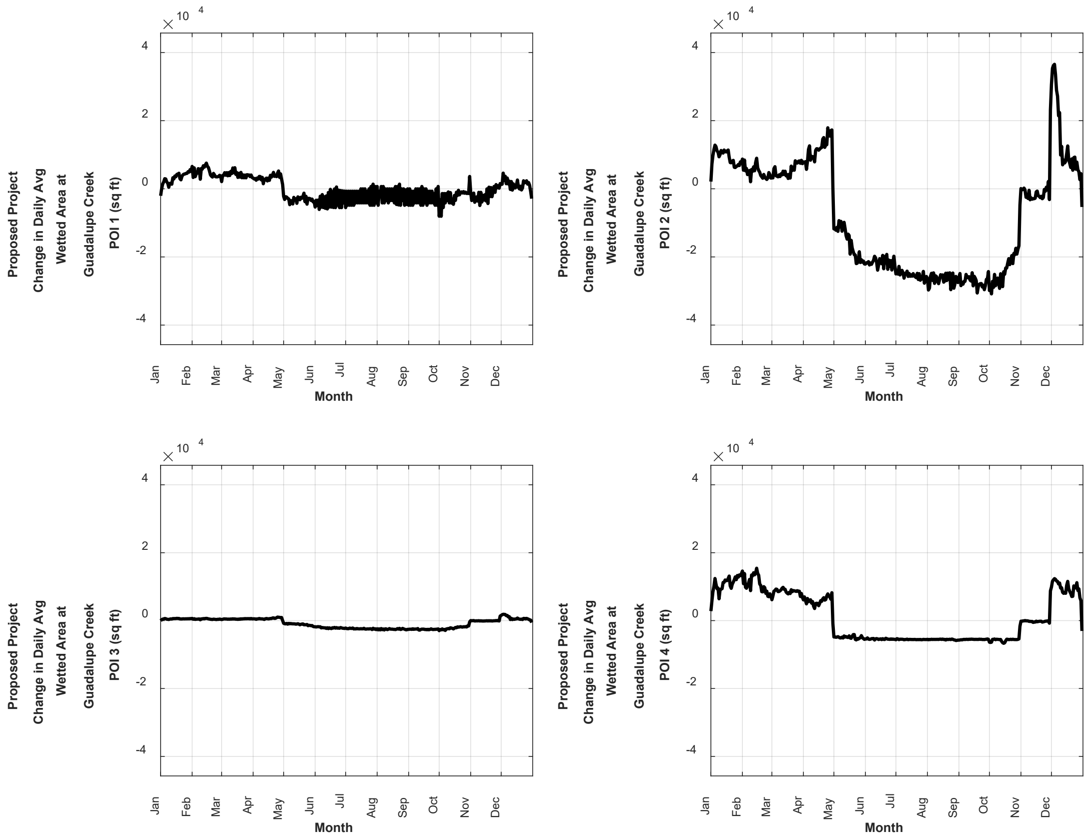
Wetted Area Figures

Figure K.2.39



Attachment K.2 – Proposed Project Supplementary Figures

Figure K.2.40



Attachment K.2 – Proposed Project Supplementary Figures

Water Temperature Figures

Figure K.2.41

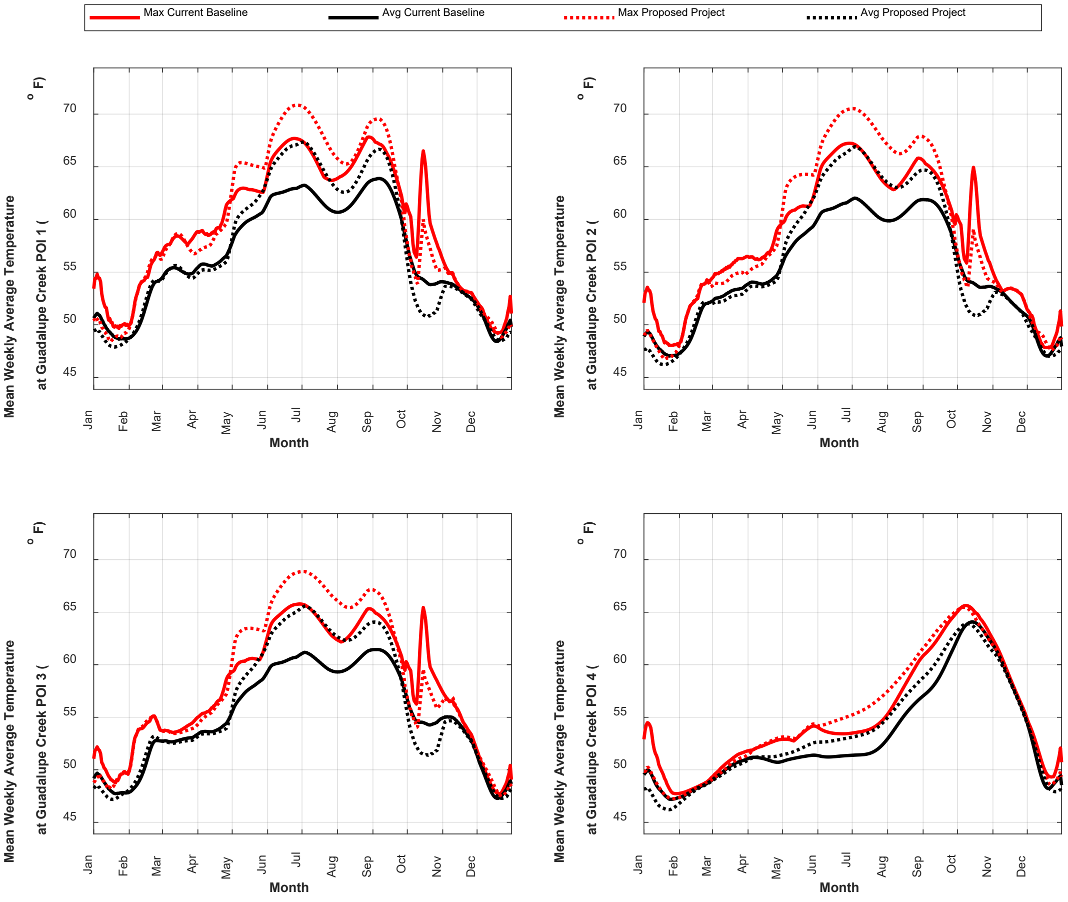
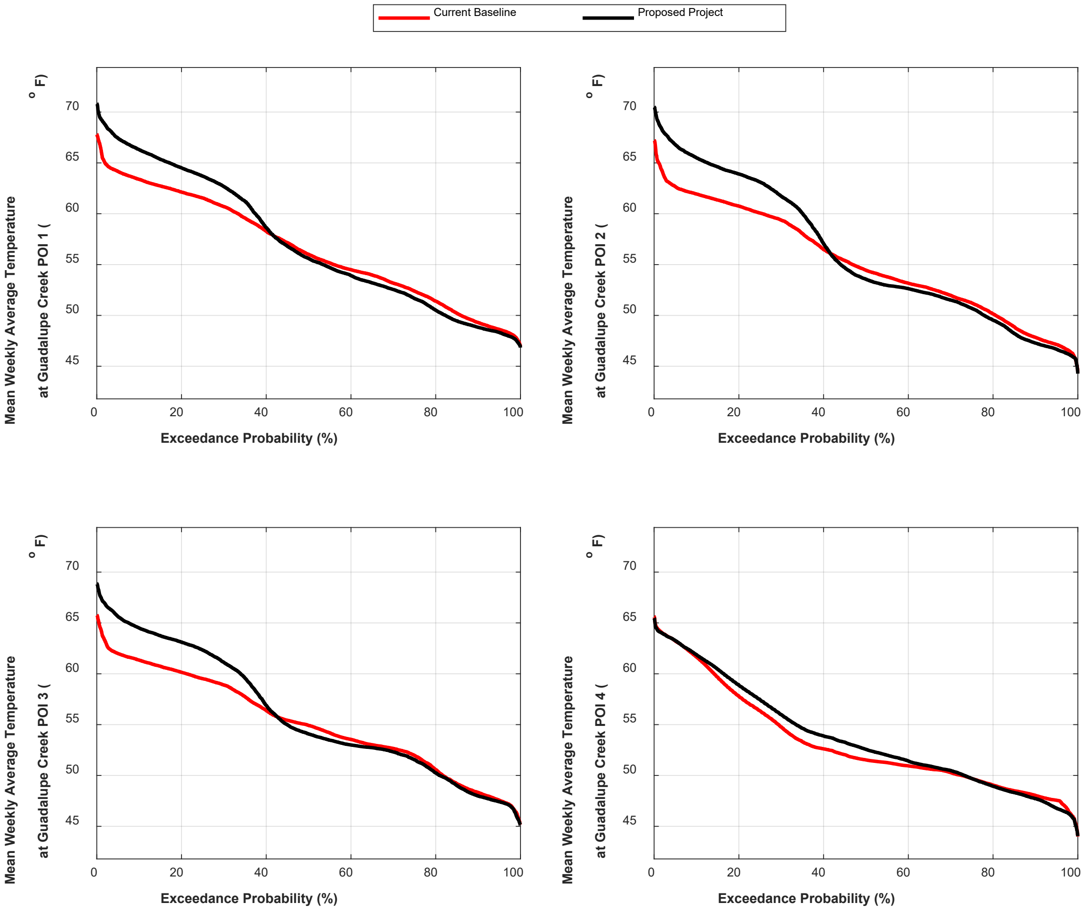


Figure K.2.42


Current Baseline
Proposed Project
Mean Weekly Average Temperature
at Guadalupe Creek POI 1 (° F)
at Guadalupe Creek POI 2 (° F)
at Guadalupe Creek POI 3 (° F)
at Guadalupe Creek POI 4 (° F)
70
65
60
55
50
45
0
20
40
60
80
100
Exceedance Probability (%)

Attachment K.2 – Proposed Project Supplementary Figures

Future Baseline Comparisons

Flow Figures

Figure K.2.43

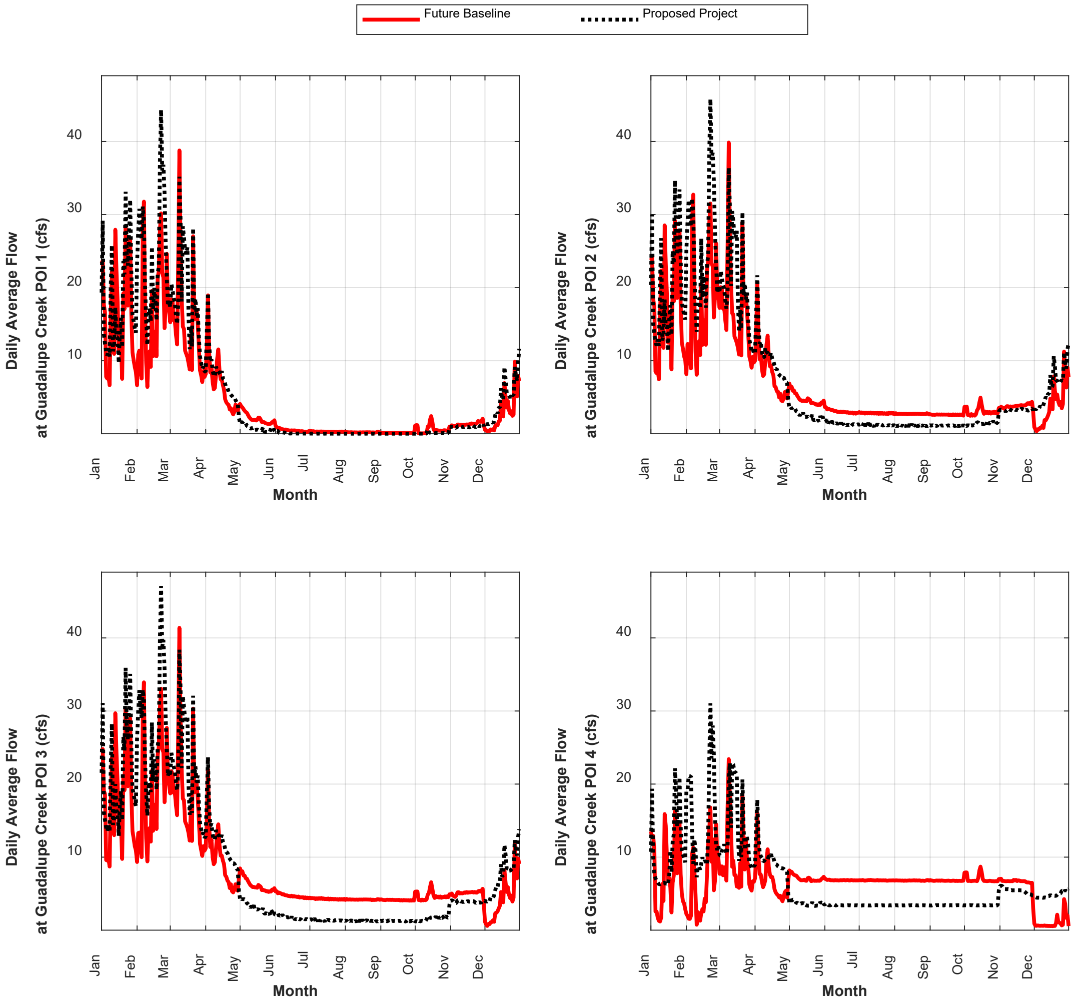
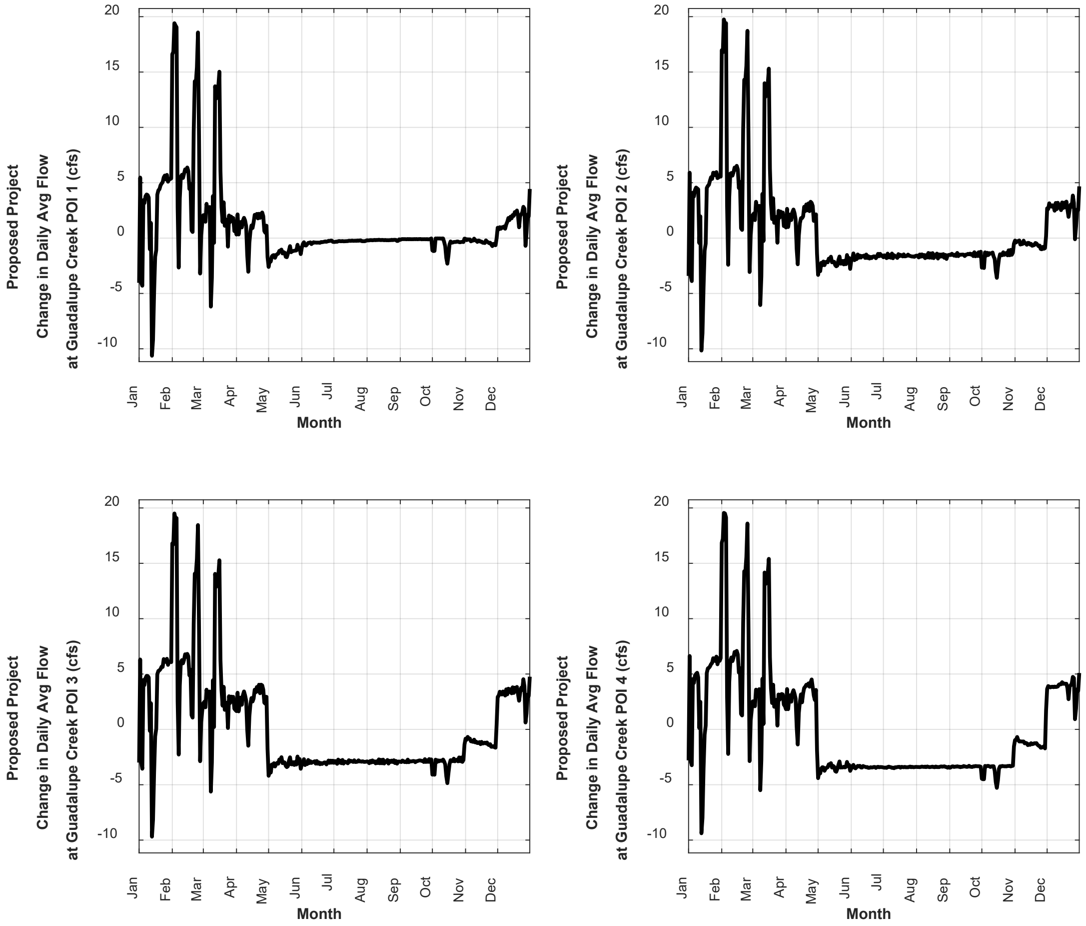


Figure K.2.44


Proposed Project
Change in Daily Avg Flow
at Guadalupe Creek POI 1 (cfs)
Proposed Project
Change in Daily Avg Flow
at Guadalupe Creek POI 2 (cfs)
Proposed Project
Change in Daily Avg Flow
at Guadalupe Creek POI 3 (cfs)
Proposed Project
Change in Daily Avg Flow
at Guadalupe Creek POI 4 (cfs)
20
15
10
5
0
-5
-10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Wetted Area Figures

Figure K.2.45

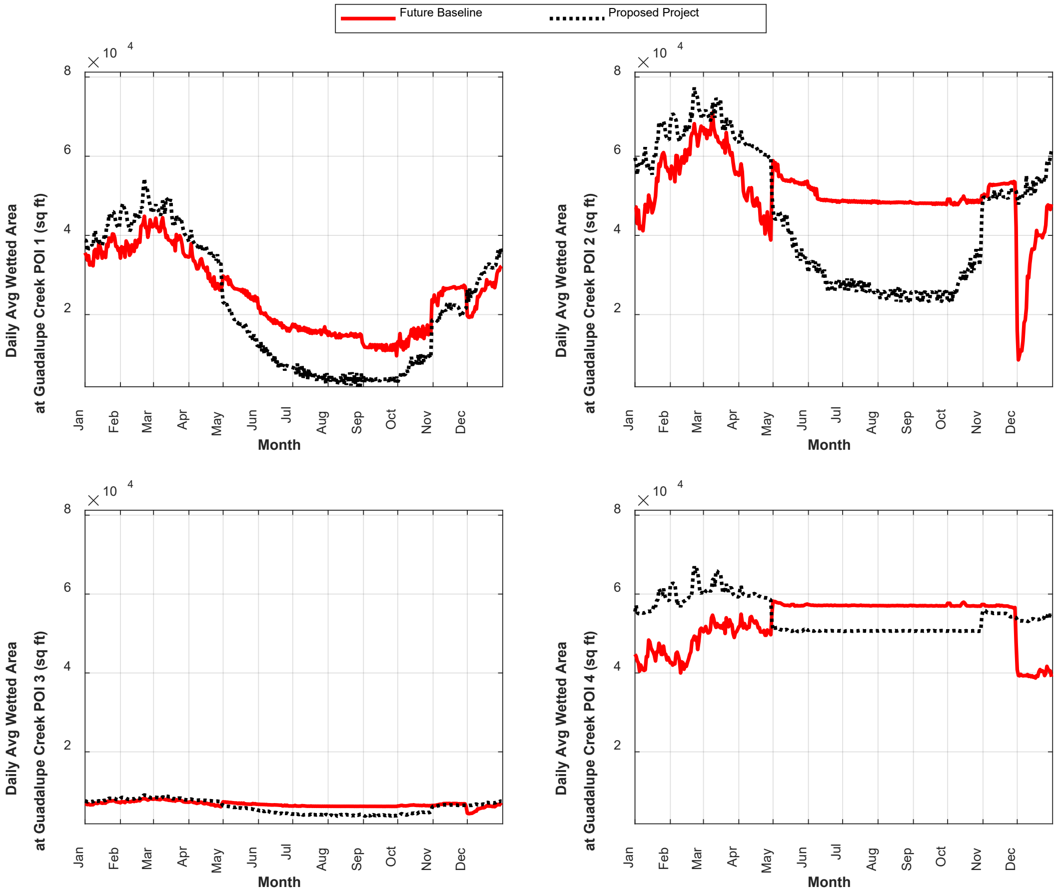
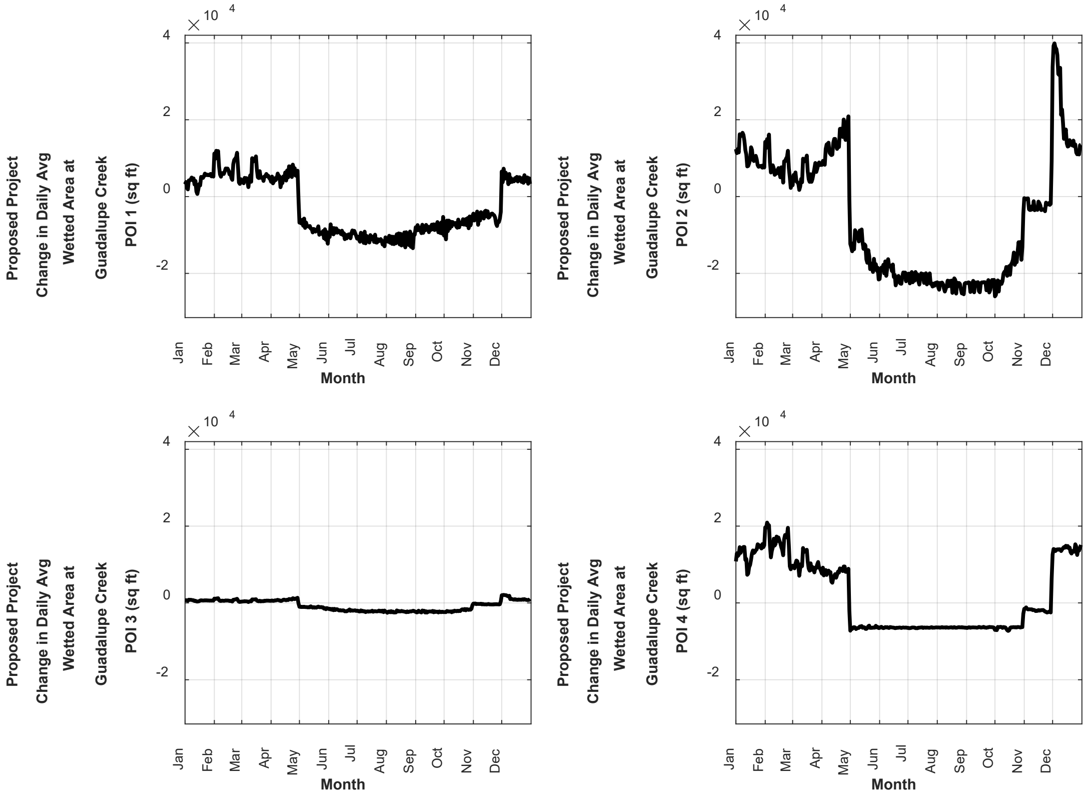


Figure K.2.46


×10^4
4
2
0
-2
Proposed Project Change in Daily Avg Wetted Area at Guadalupe Creek POI 1 (sq ft)
Proposed Project Change in Daily Avg Wetted Area at Guadalupe Creek POI 2 (sq ft)
Proposed Project Change in Daily Avg Wetted Area at Guadalupe Creek POI 3 (sq ft)
Proposed Project Change in Daily Avg Wetted Area at Guadalupe Creek POI 4 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.2 – Proposed Project Supplementary Figures

Water Temperature Figures

Figure K.2.47

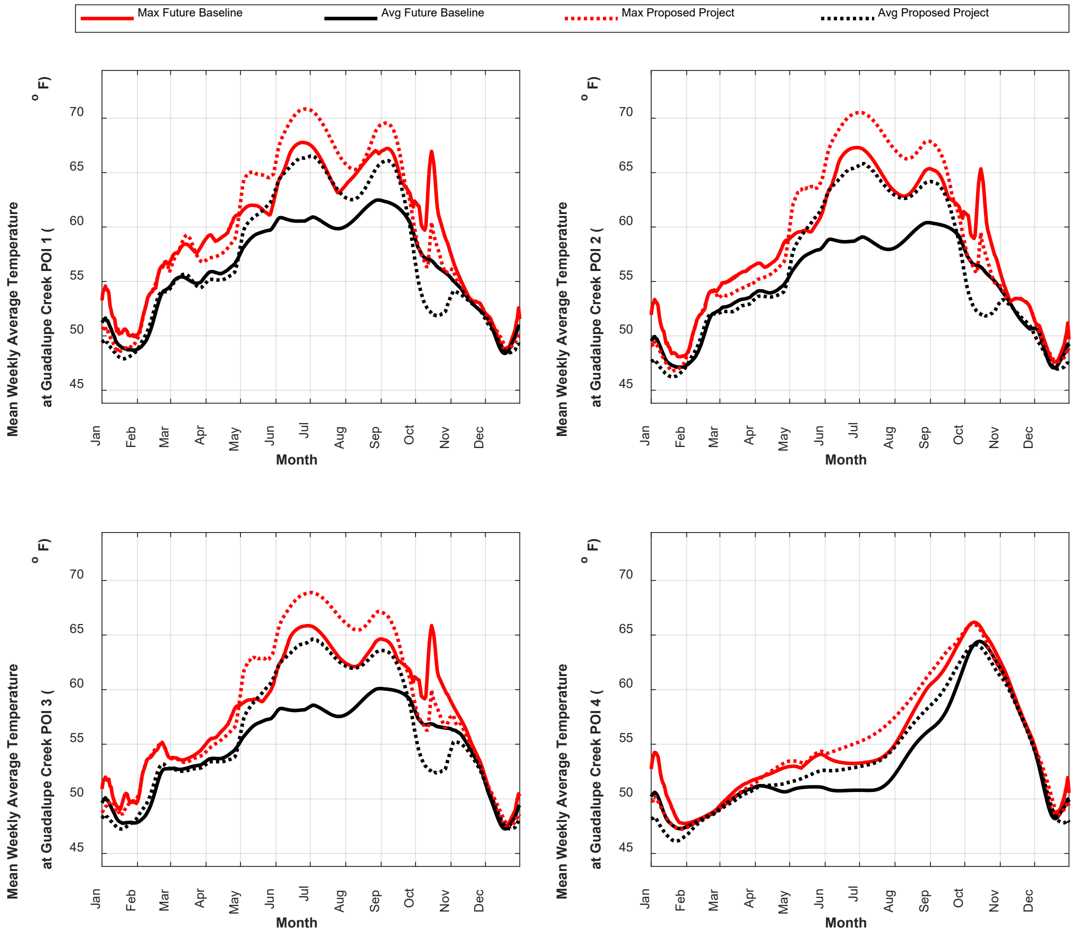
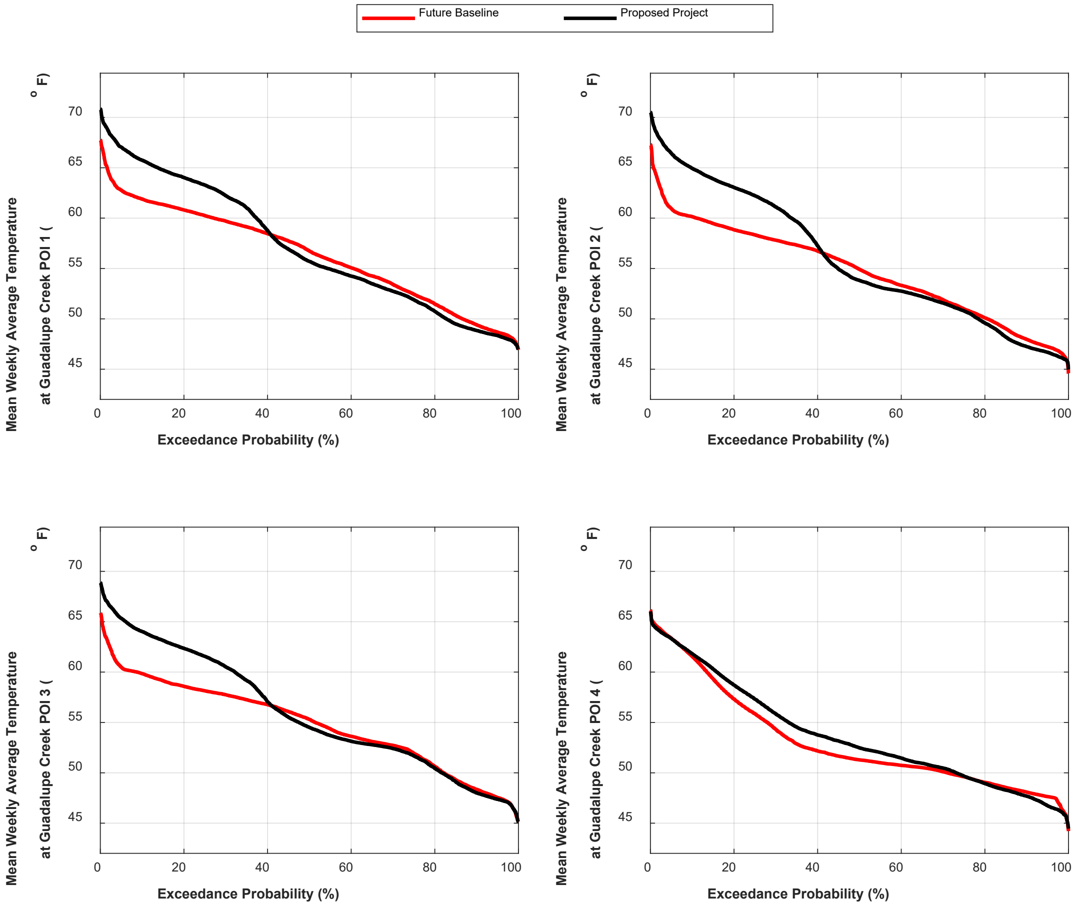


Figure K.2.48


Future Baseline
Proposed Project
Mean Weekly Average Temperature at Guadalupe Creek POI 1 (° F)
Mean Weekly Average Temperature at Guadalupe Creek POI 2 (° F)
Mean Weekly Average Temperature at Guadalupe Creek POI 3 (° F)
Mean Weekly Average Temperature at Guadalupe Creek POI 4 (° F)
70
65
60
55
50
45
0
20
40
60
80
100
Exceedance Probability (%)

Attachment K.2 – Proposed Project Supplementary Figures

Alamitos Creek

Current Baseline Comparisons

Flow Figures

Figure K.2.49

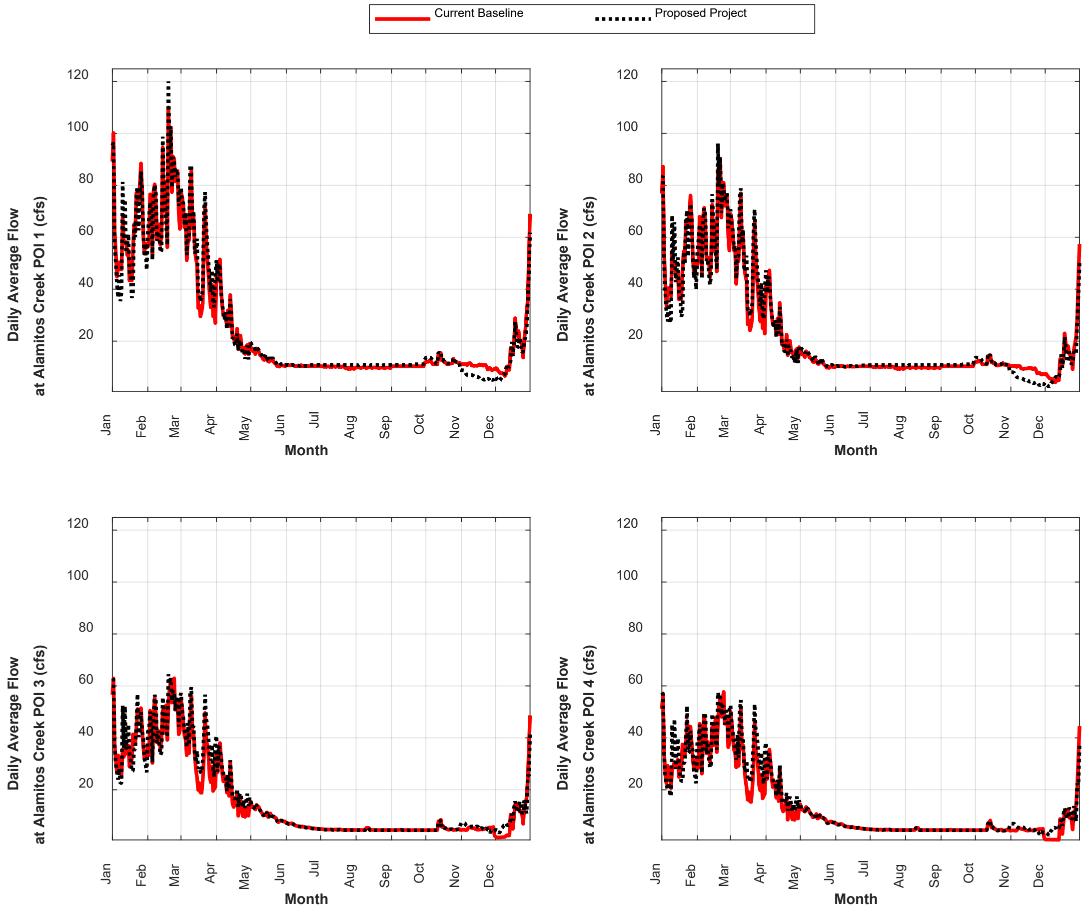
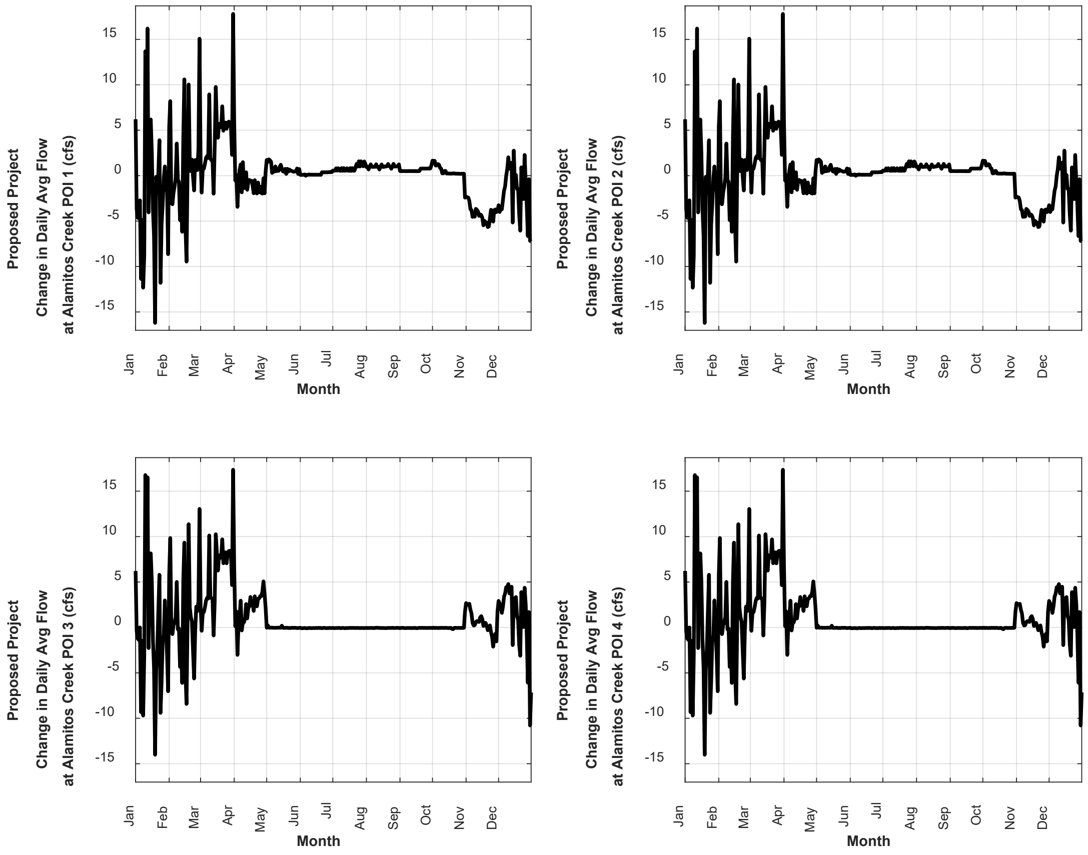


Figure K.2.50


Proposed Project
Change in Daily Avg Flow
at Alamitos Creek POI 1 (cfs)
Proposed Project
Change in Daily Avg Flow
at Alamitos Creek POI 2 (cfs)
Proposed Project
Change in Daily Avg Flow
at Alamitos Creek POI 3 (cfs)
Proposed Project
Change in Daily Avg Flow
at Alamitos Creek POI 4 (cfs)
15
10
5
0
-5
-10
-15
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Wetted Area Figures

Figure K.2.51

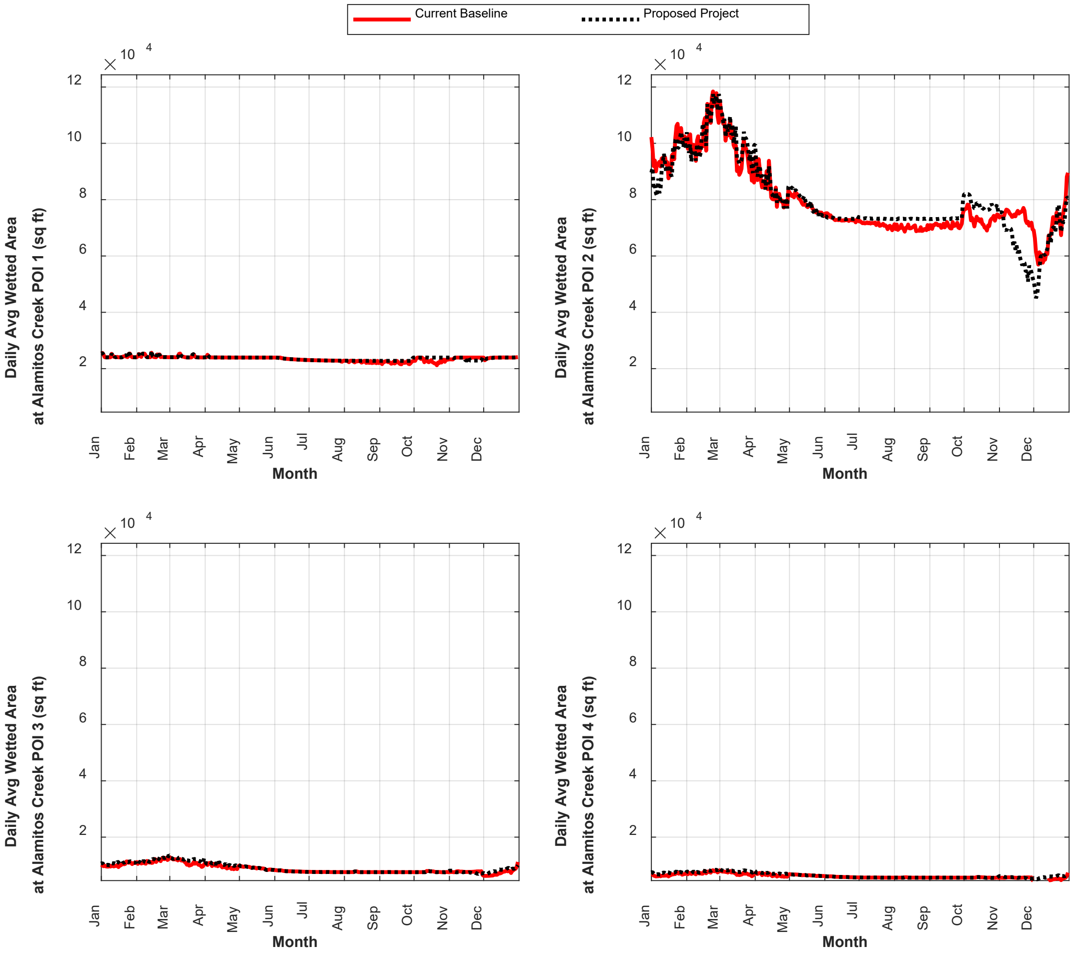
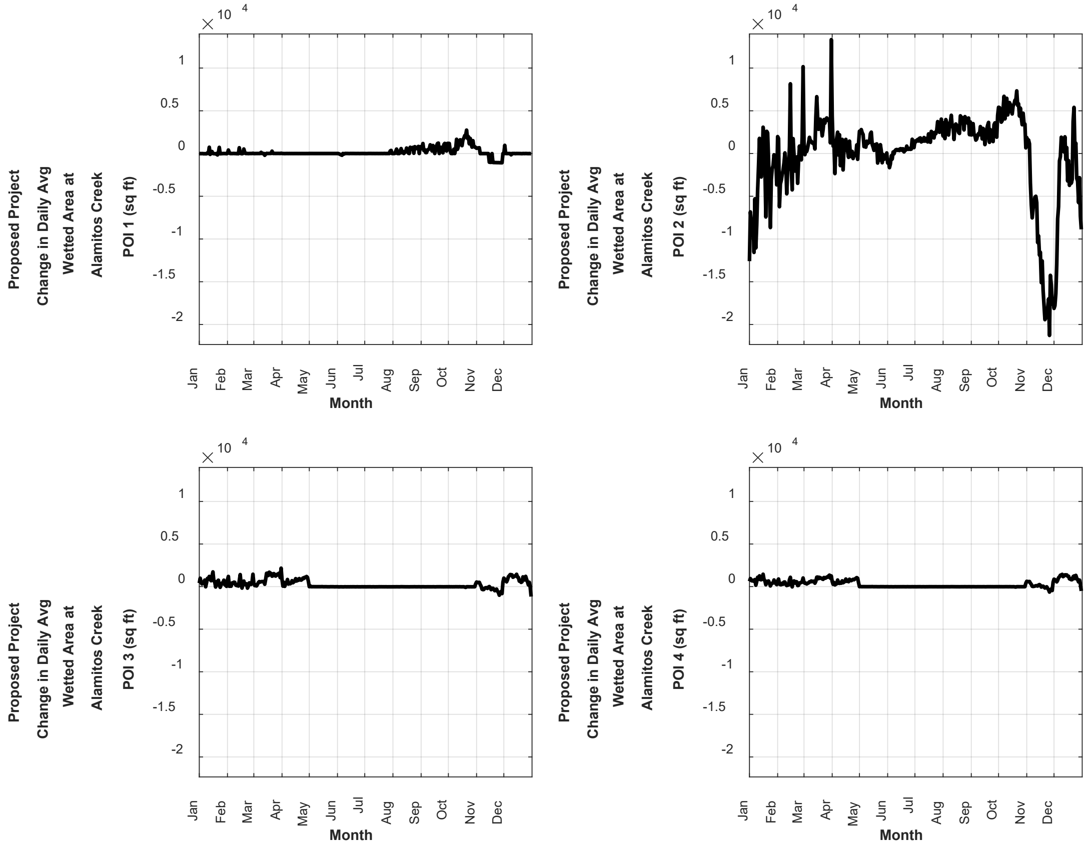


Figure K.2.52


×10^4
Proposed Project Change in Daily Avg Wetted Area at Alamitos Creek POI 1 (sq ft)
Proposed Project Change in Daily Avg Wetted Area at Alamitos Creek POI 2 (sq ft)
Proposed Project Change in Daily Avg Wetted Area at Alamitos Creek POI 3 (sq ft)
Proposed Project Change in Daily Avg Wetted Area at Alamitos Creek POI 4 (sq ft)
1
0.5
0
-0.5
-1
-1.5
-2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.2 – Proposed Project Supplementary Figures

Water Temperature Figures

Figure K.2.53

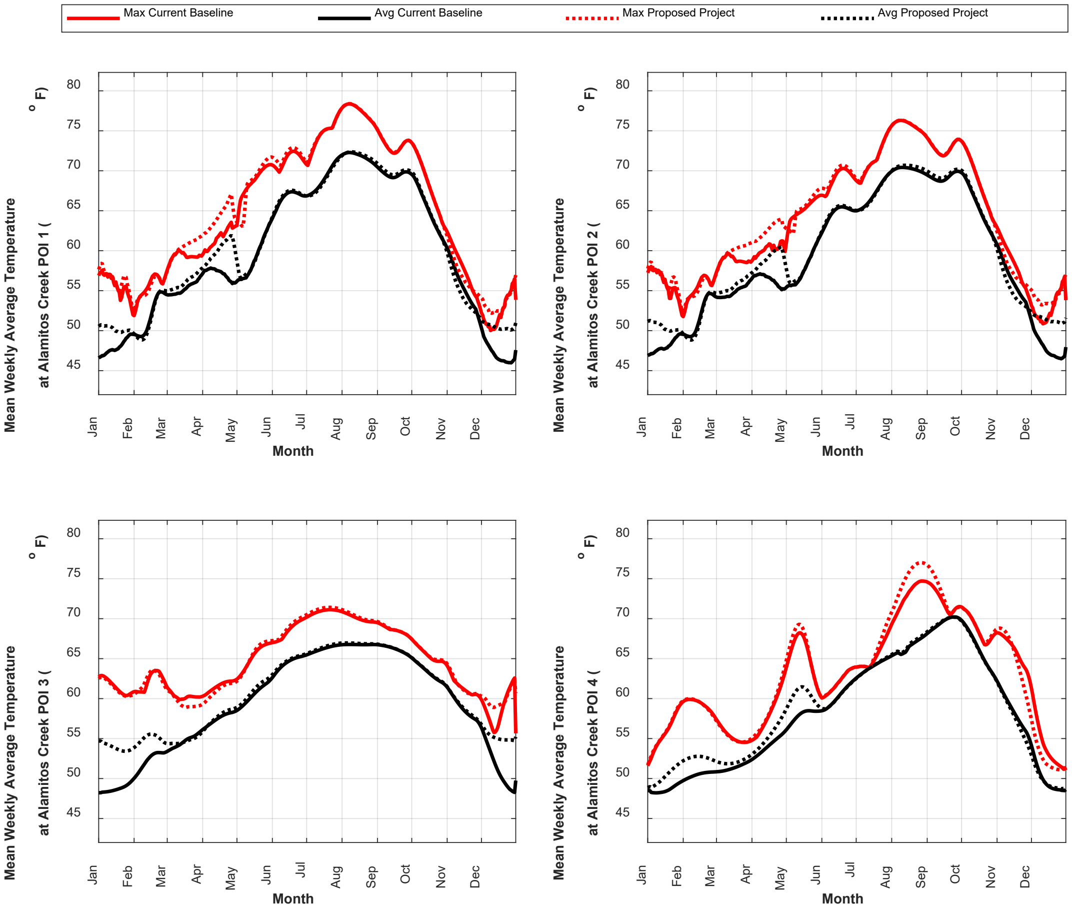
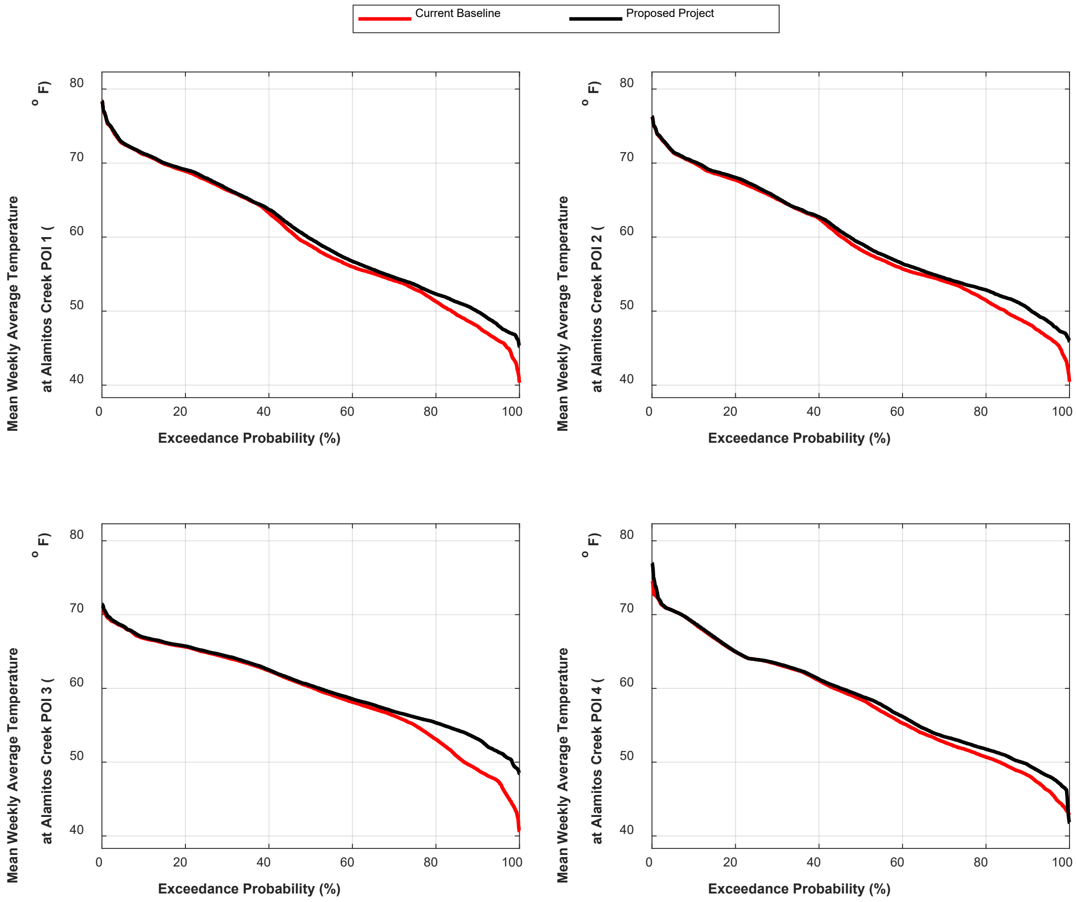


Figure K.2.54


Current Baseline
Proposed Project
Mean Weekly Average Temperature at Alamitos Creek POI 1 (°F)
Mean Weekly Average Temperature at Alamitos Creek POI 2 (°F)
Mean Weekly Average Temperature at Alamitos Creek POI 3 (°F)
Mean Weekly Average Temperature at Alamitos Creek POI 4 (°F)
40
50
60
70
80
0
20
40
60
80
100
Exceedance Probability (%)

Attachment K.2 – Proposed Project Supplementary Figures

Future Baseline Comparisons

Flow Figures

Figure K.2.55

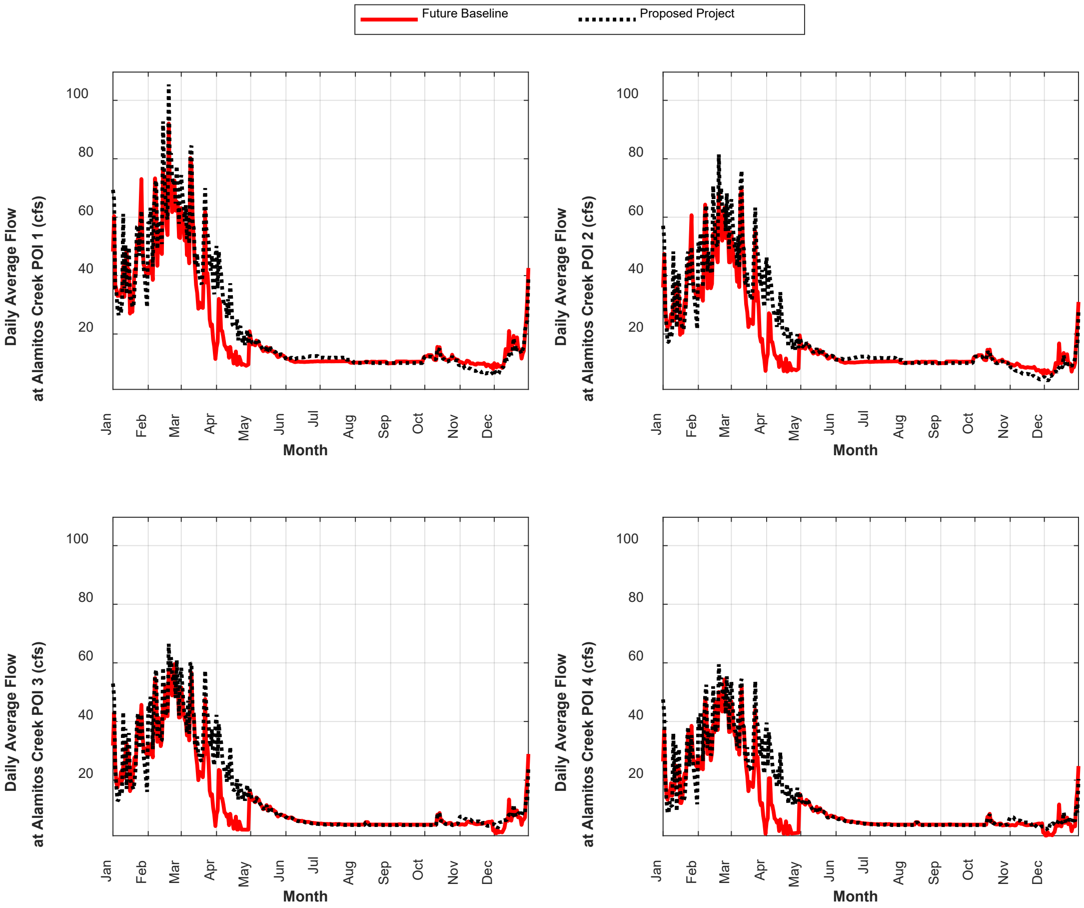
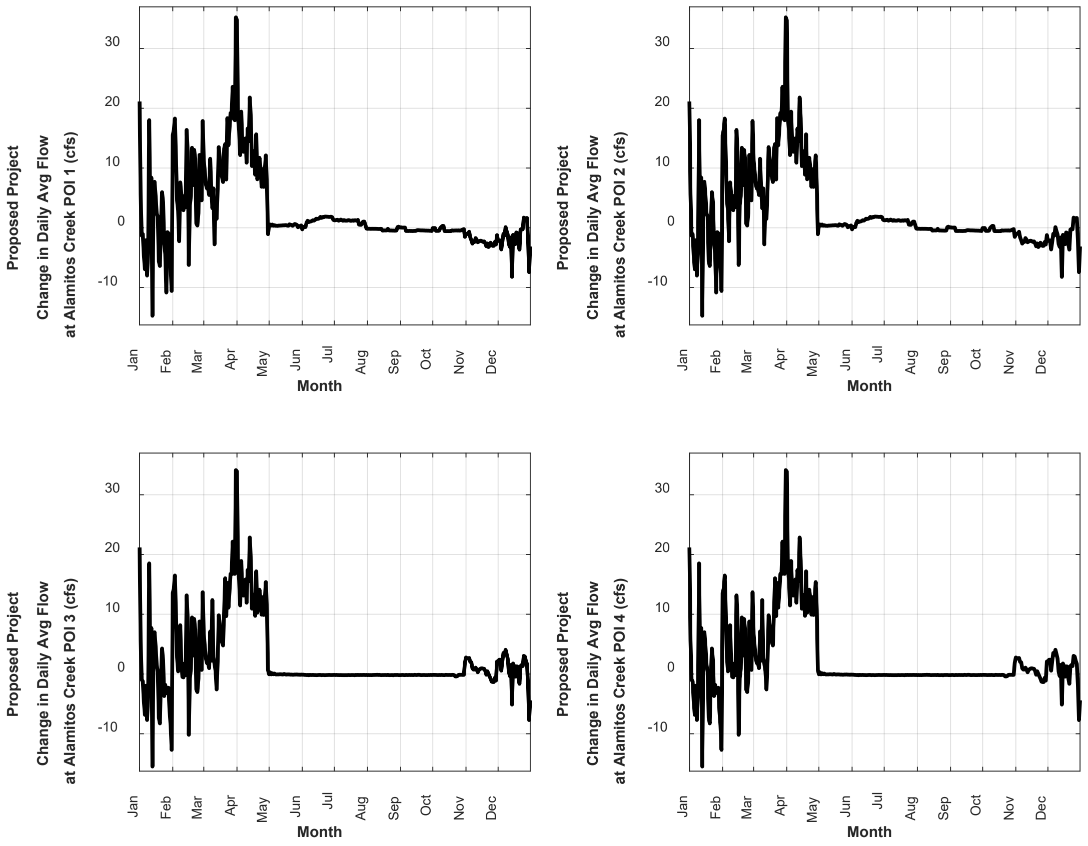


Figure K.2.56


Proposed Project
Change in Daily Avg Flow
at Alamitos Creek POI 1 (cfs)
Proposed Project
Change in Daily Avg Flow
at Alamitos Creek POI 2 (cfs)
Proposed Project
Change in Daily Avg Flow
at Alamitos Creek POI 3 (cfs)
Proposed Project
Change in Daily Avg Flow
at Alamitos Creek POI 4 (cfs)
30
20
10
0
-10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.2 – Proposed Project Supplementary Figures

Wetted Area Figures

Figure K.2.57

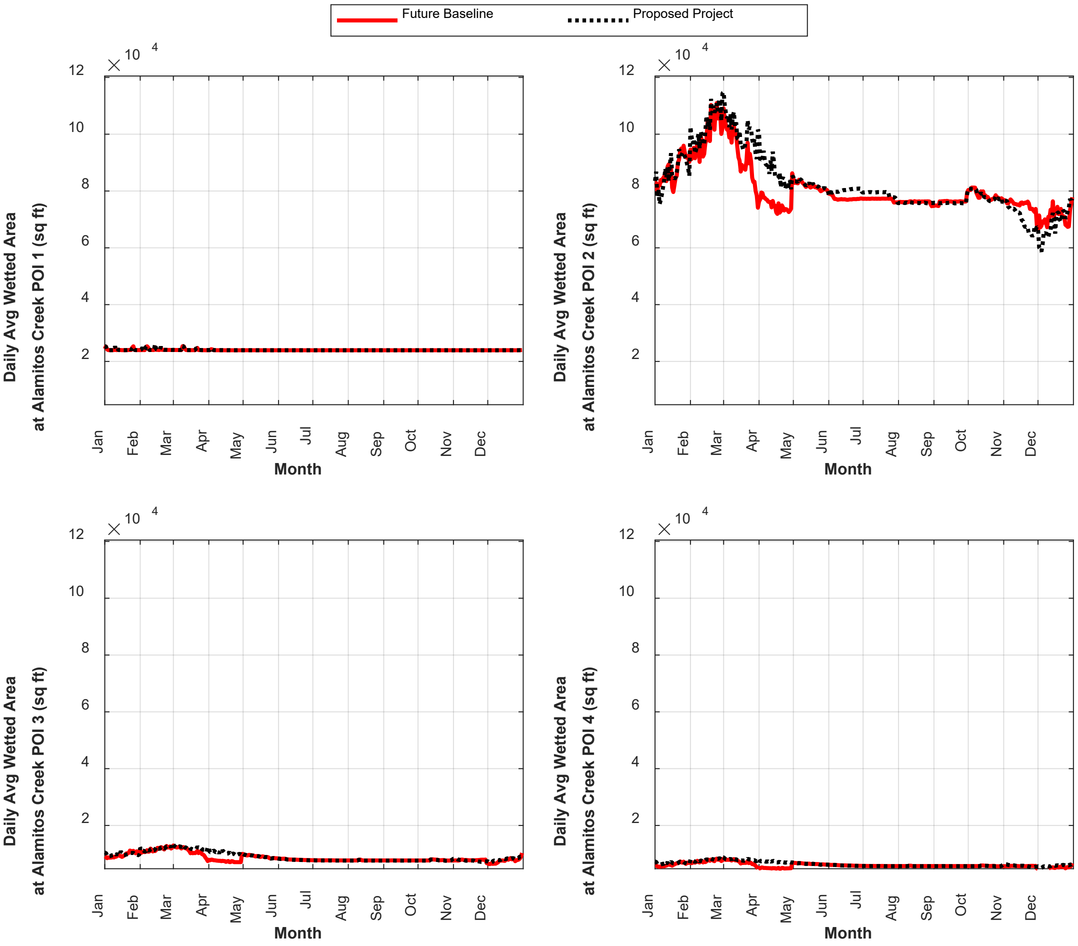
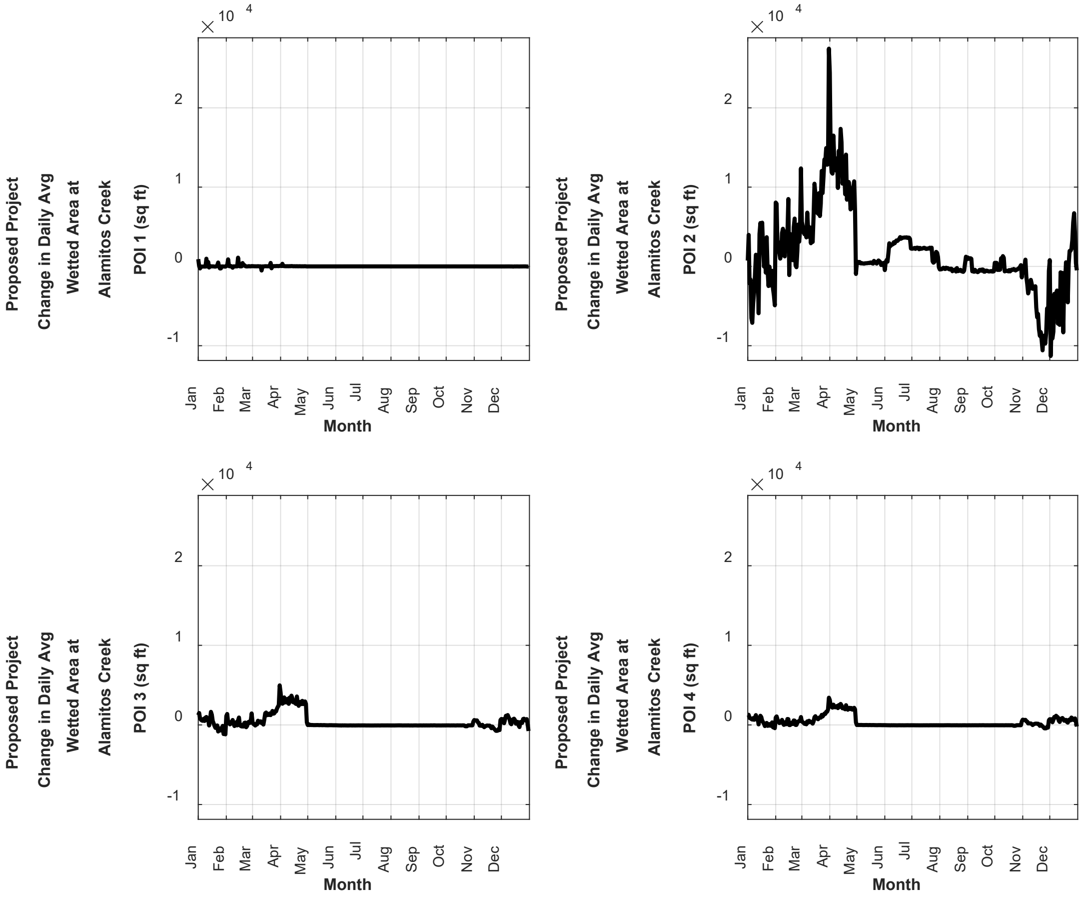


Figure K.2.58


×10 4
2
1
0
-1
Proposed Project Change in Daily Avg Wetted Area at Alamitos Creek POI 1 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
×10 4
2
1
0
-1
Proposed Project Change in Daily Avg Wetted Area at Alamitos Creek POI 2 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
×10 4
2
1
0
-1
Proposed Project Change in Daily Avg Wetted Area at Alamitos Creek POI 3 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
×10 4
2
1
0
-1
Proposed Project Change in Daily Avg Wetted Area at Alamitos Creek POI 4 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Water Temperature Figures

Figure K.2.59

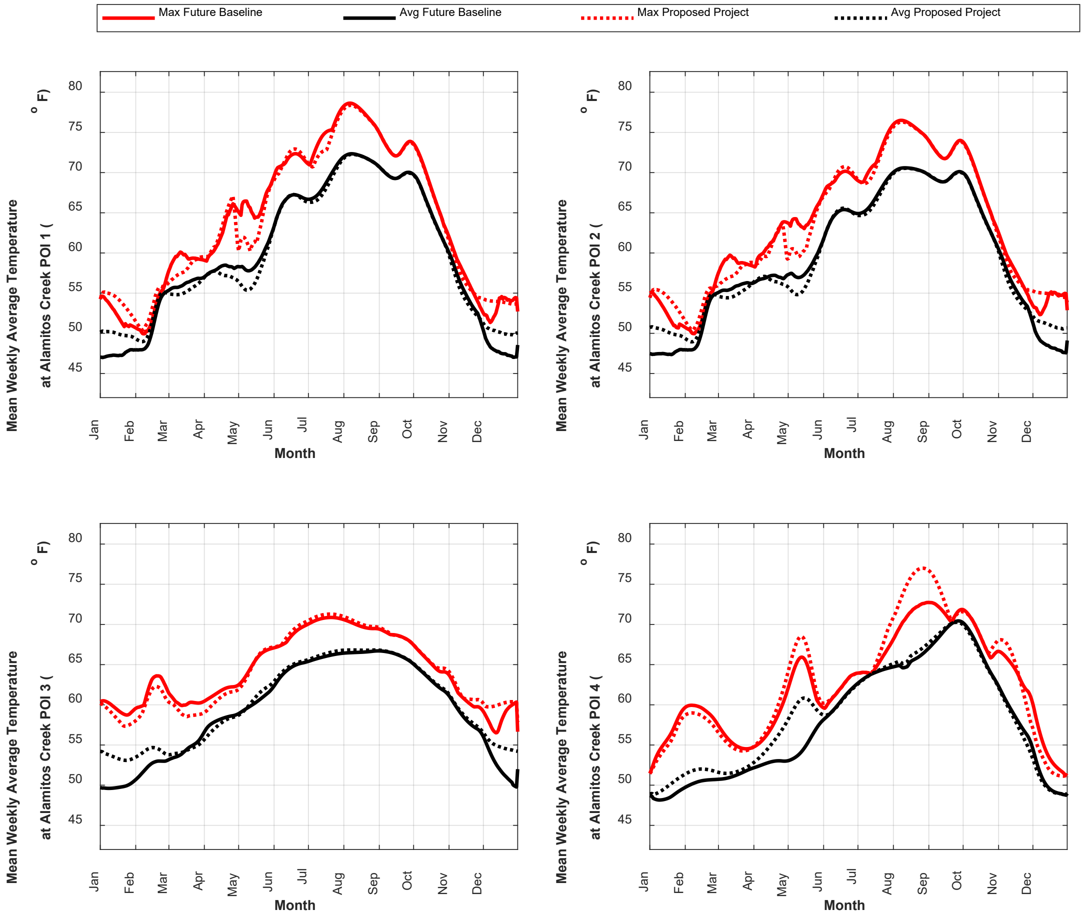
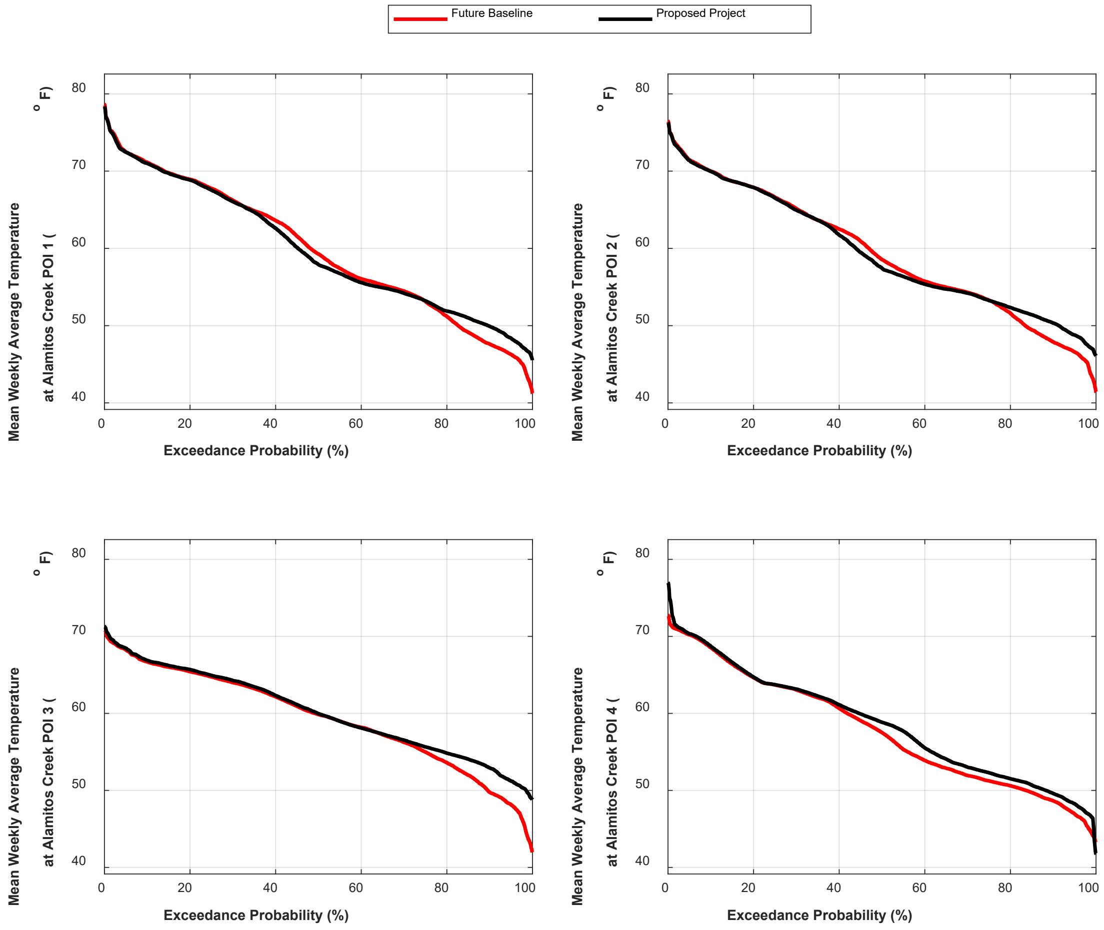


Figure K.2.60


Future Baseline
Proposed Project
Mean Weekly Average Temperature at Alamitos Creek POI 1 (° F)
Mean Weekly Average Temperature at Alamitos Creek POI 2 (° F)
Mean Weekly Average Temperature at Alamitos Creek POI 3 (° F)
Mean Weekly Average Temperature at Alamitos Creek POI 4 (° F)
80
70
60
50
40
0
20
40
60
80
100
Exceedance Probability (%)

Calero Creek

Current Baseline Comparisons

Flow Figures

Figure K.2.61

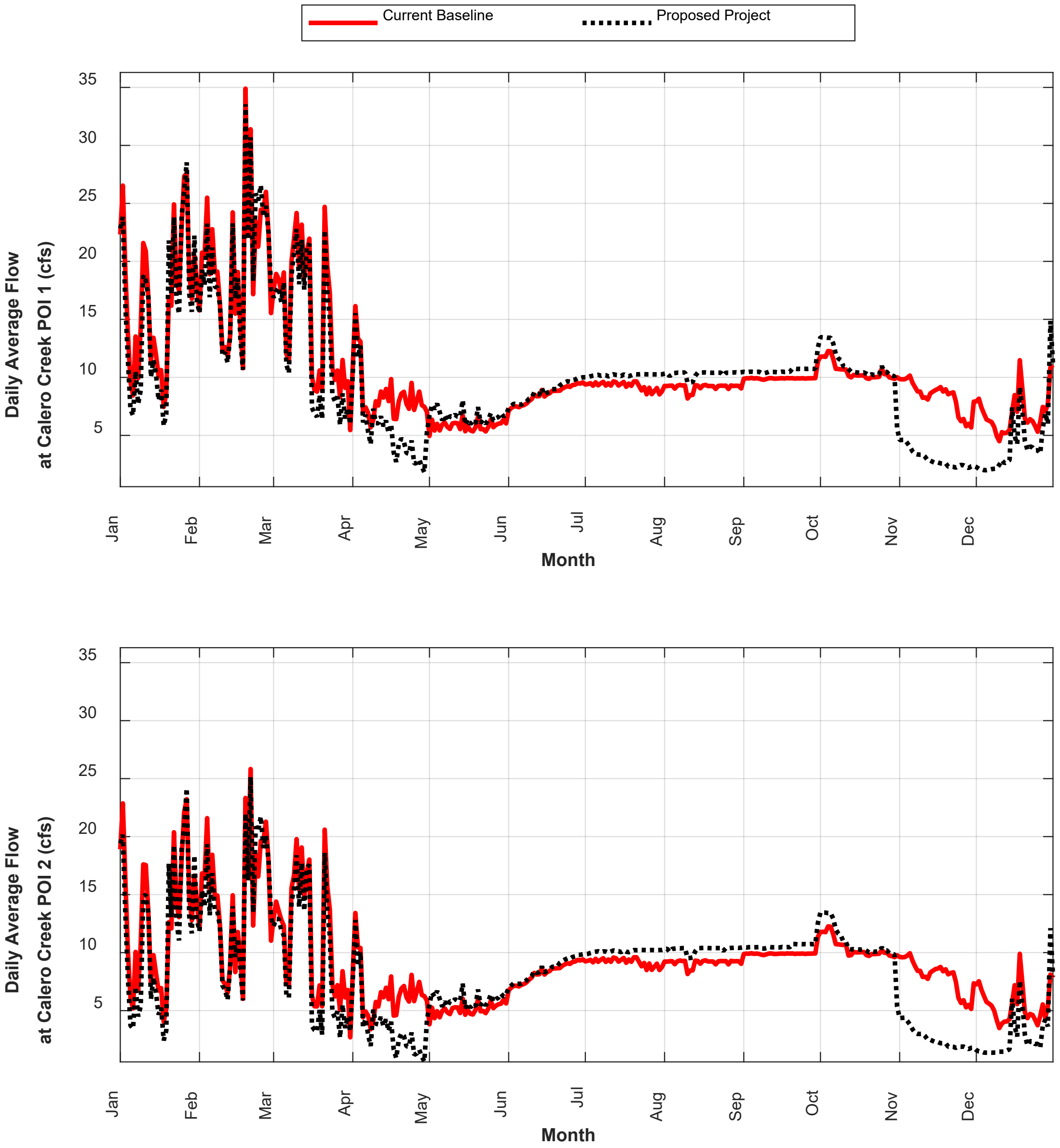
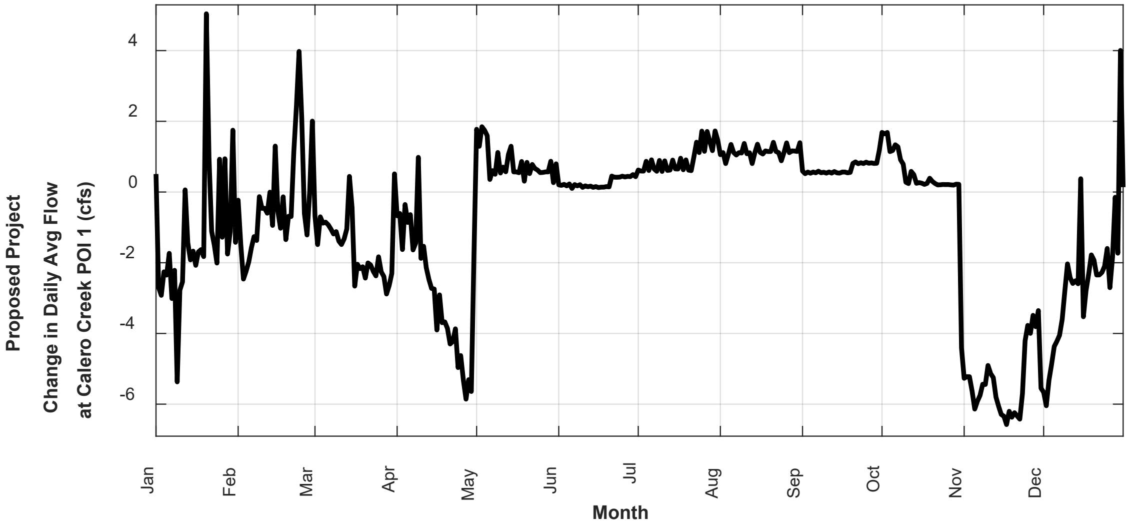
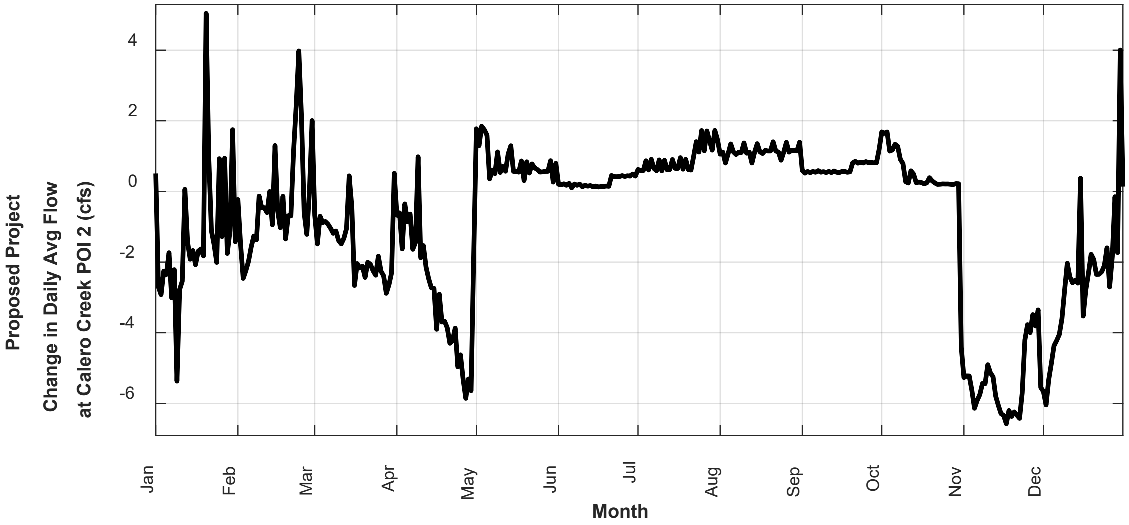


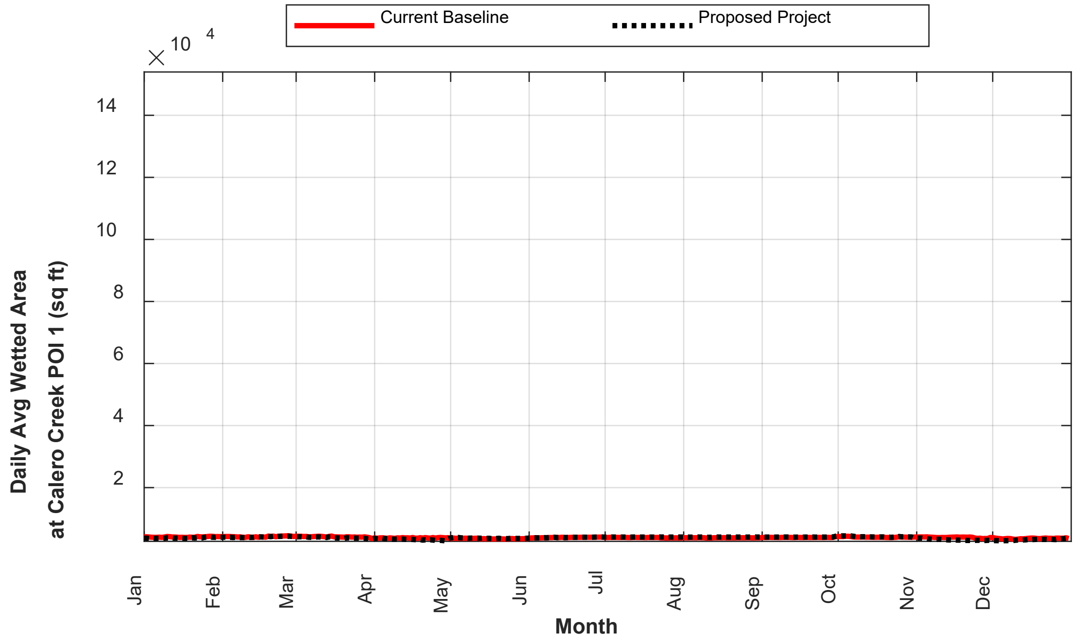
Figure K.2.62


Proposed Project
Change in Daily Avg Flow
at Calero Creek POI 1 (cfs)
4
2
0
-2
-4
-6
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


Proposed Project
Change in Daily Avg Flow
at Calero Creek POI 2 (cfs)
4
2
0
-2
-4
-6
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Wetted Area Figures

Figure K.2.63



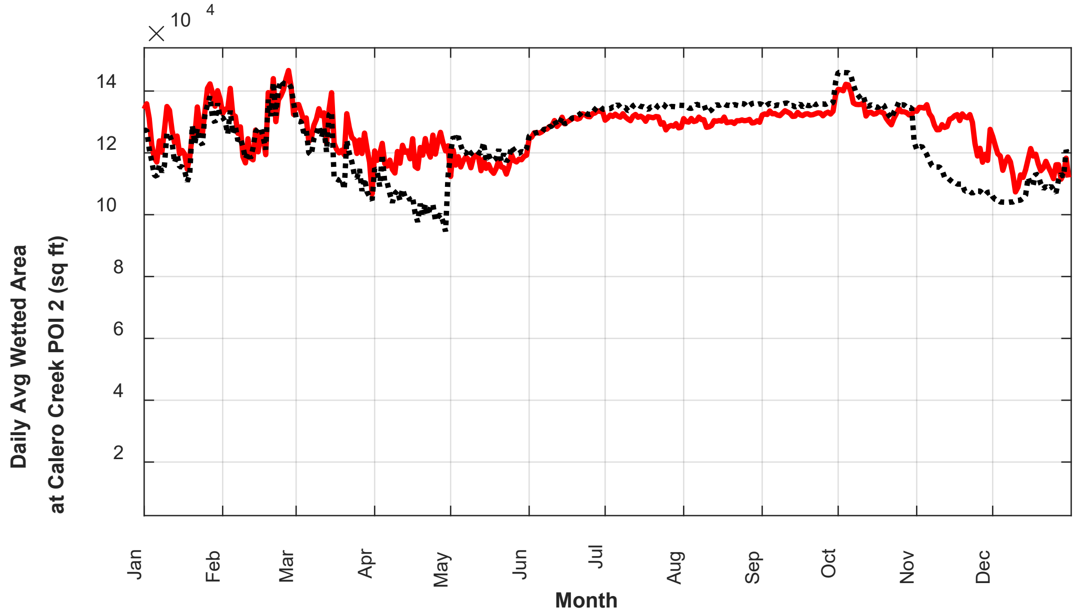
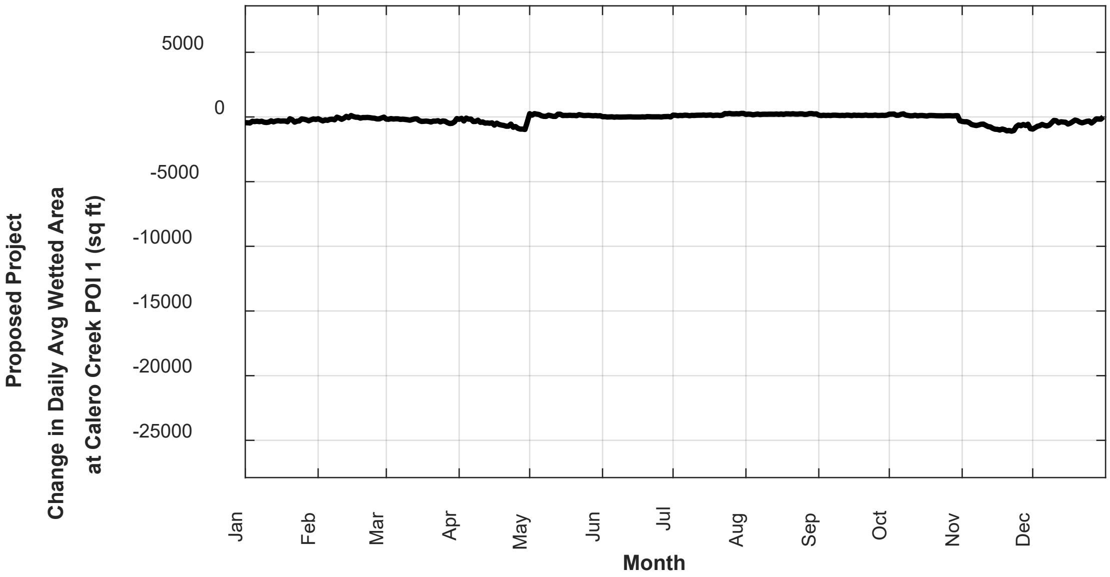


Figure K.2.64


5000
0
-5000
-10000
-15000
-20000
-25000
Proposed Project
Change in Daily Avg Wetted Area
at Calero Creek POI 1 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


5000
0
-5000
-10000
-15000
-20000
-25000
Proposed Project
Change in Daily Avg Wetted Area
at Calero Creek POI 2 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.2 – Proposed Project Supplementary Figures

Water Temperature Figures

Figure K.2.65

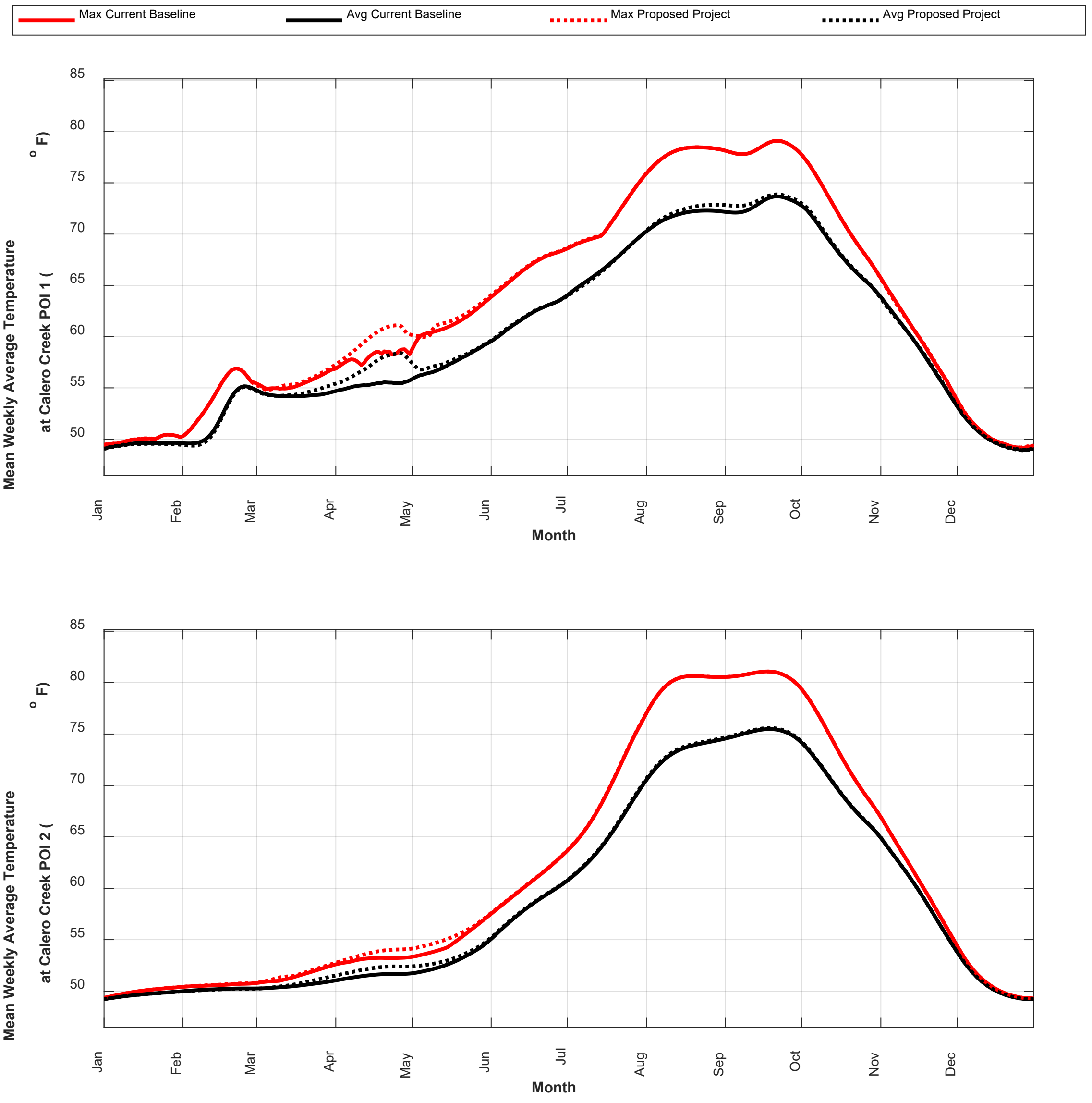
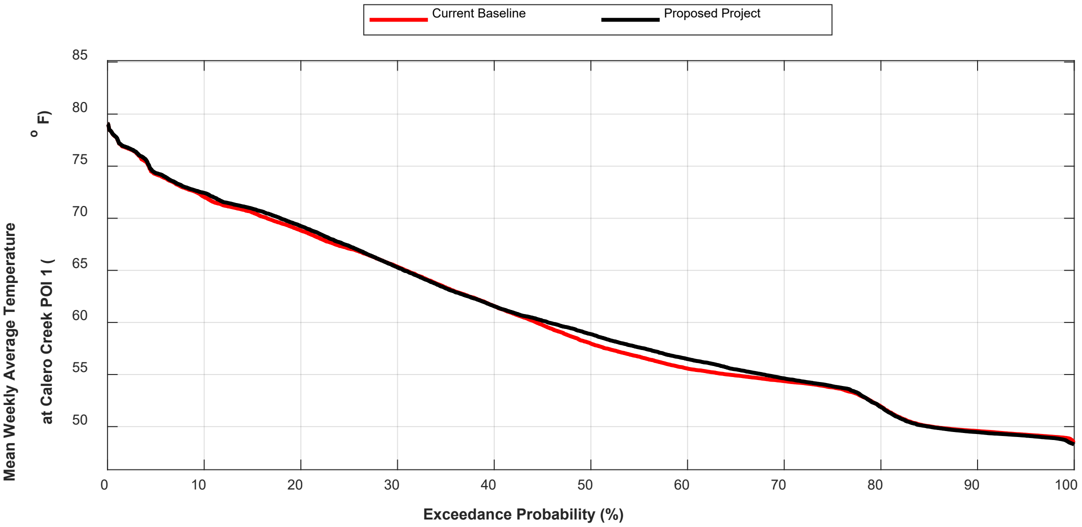
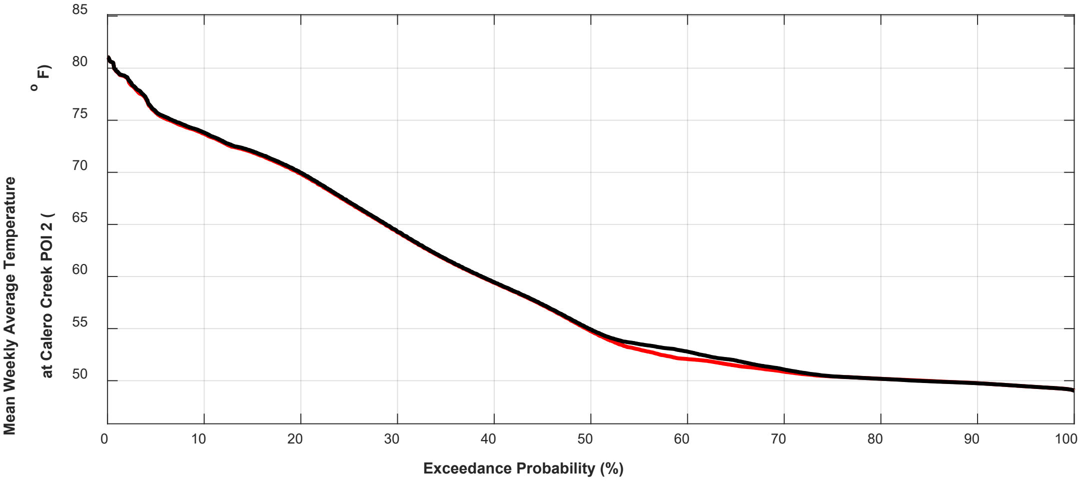


Figure K.2.66


Current Baseline
Proposed Project
85
80
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
100
Mean Weekly Average Temperature at Calero Creek POI 1 (° F)
Exceedance Probability (%)


85
80
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
100
Mean Weekly Average Temperature at Calero Creek POI 2 (° F)
Exceedance Probability (%)

Attachment K.2 – Proposed Project Supplementary Figures

Future Baseline Comparisons

Flow Figures

Figure K.2.67

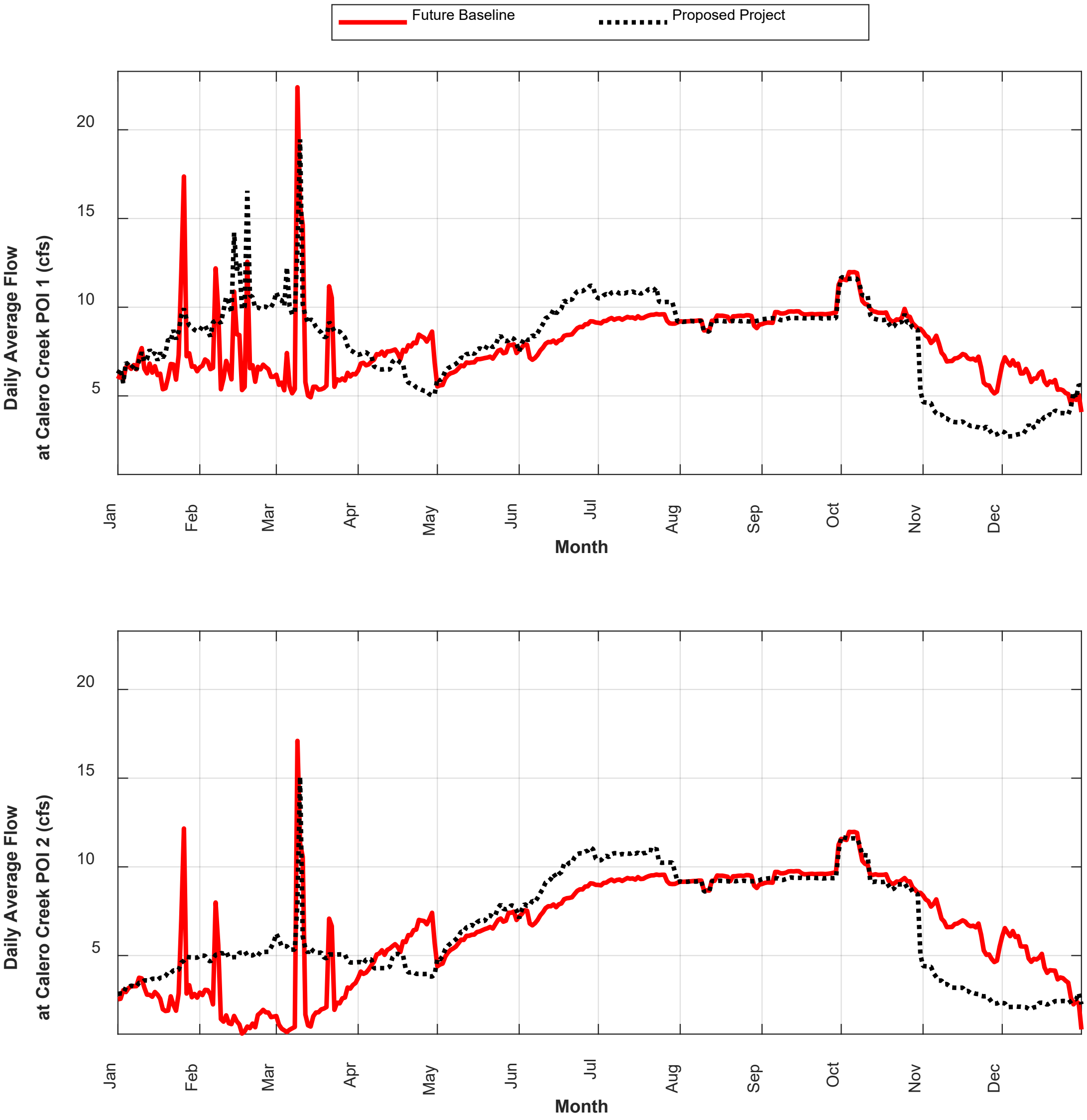
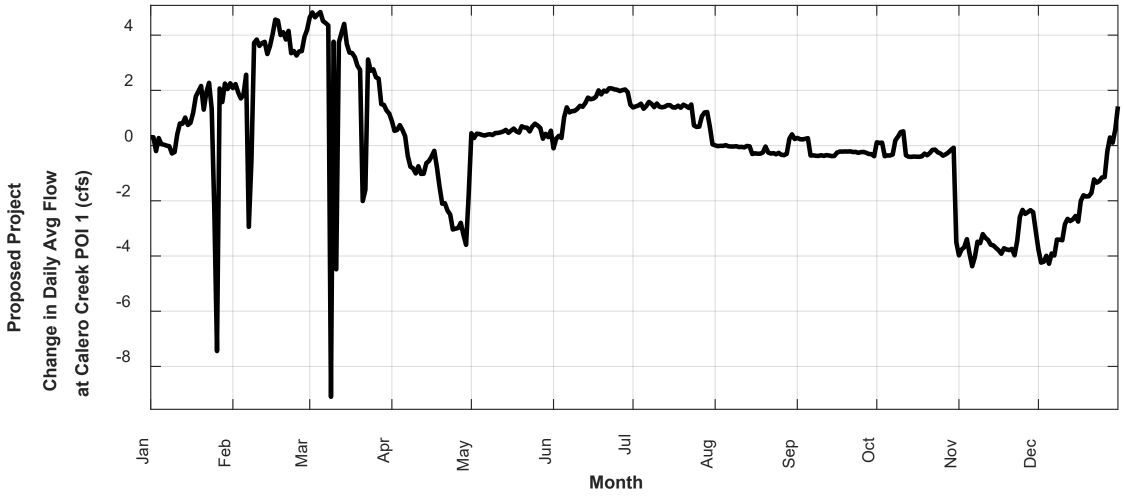
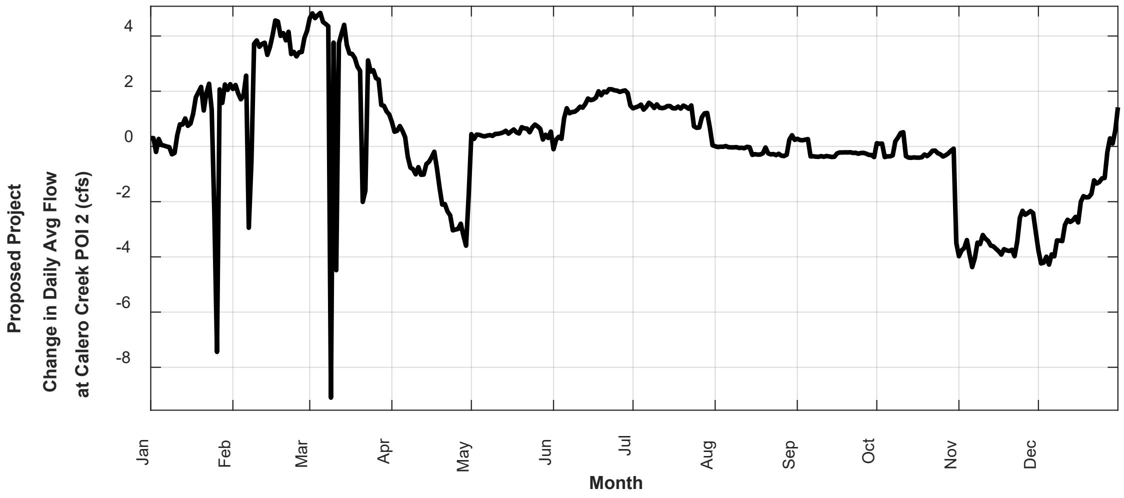


Figure K.2.68


Proposed Project
Change in Daily Avg Flow
at Calero Creek POI 1 (cfs)
4
2
0
-2
-4
-6
-8
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


Proposed Project
Change in Daily Avg Flow
at Calero Creek POI 2 (cfs)
4
2
0
-2
-4
-6
-8
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.2 – Proposed Project Supplementary Figures

Wetted Area Figures

Figure K.2.69

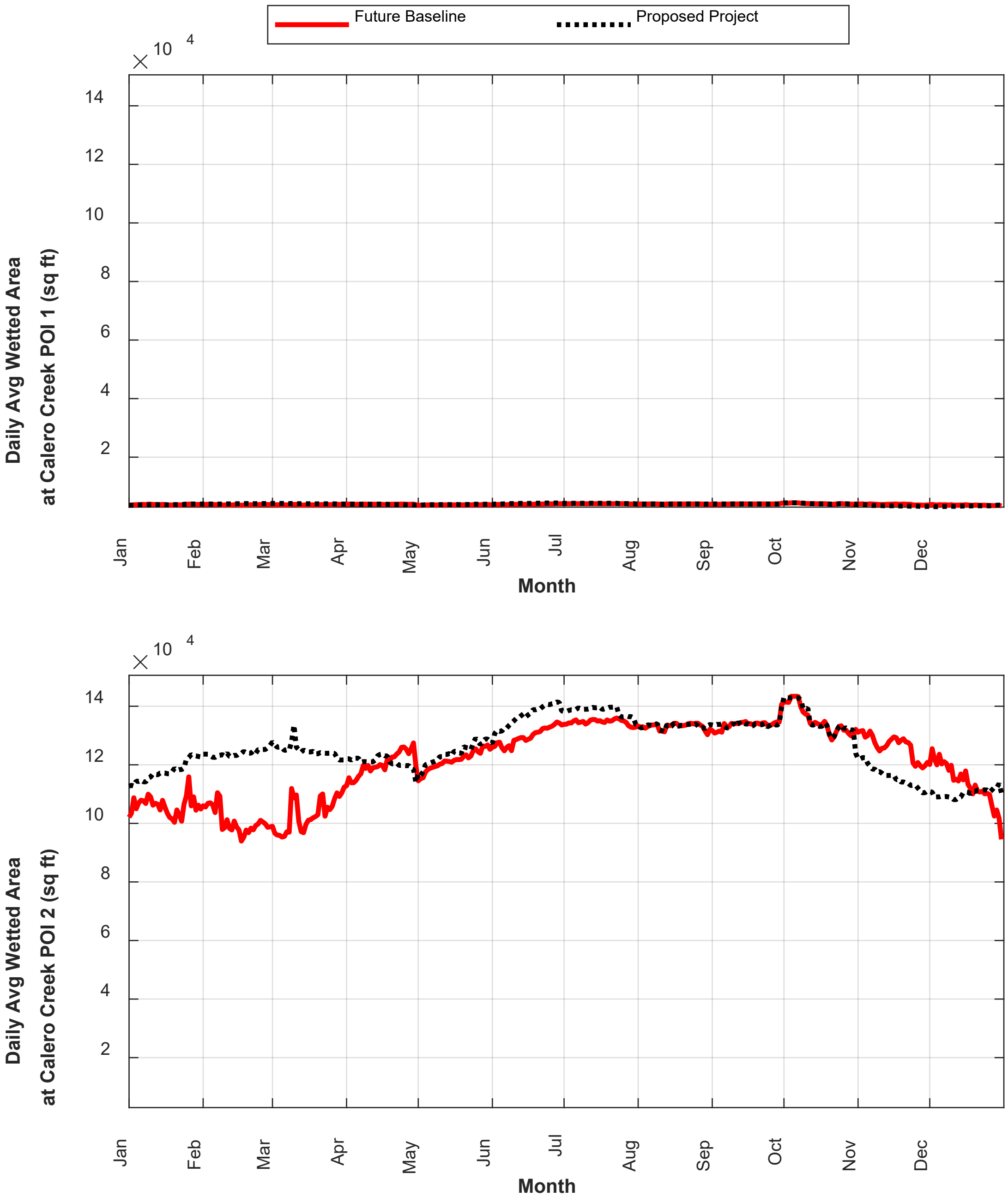
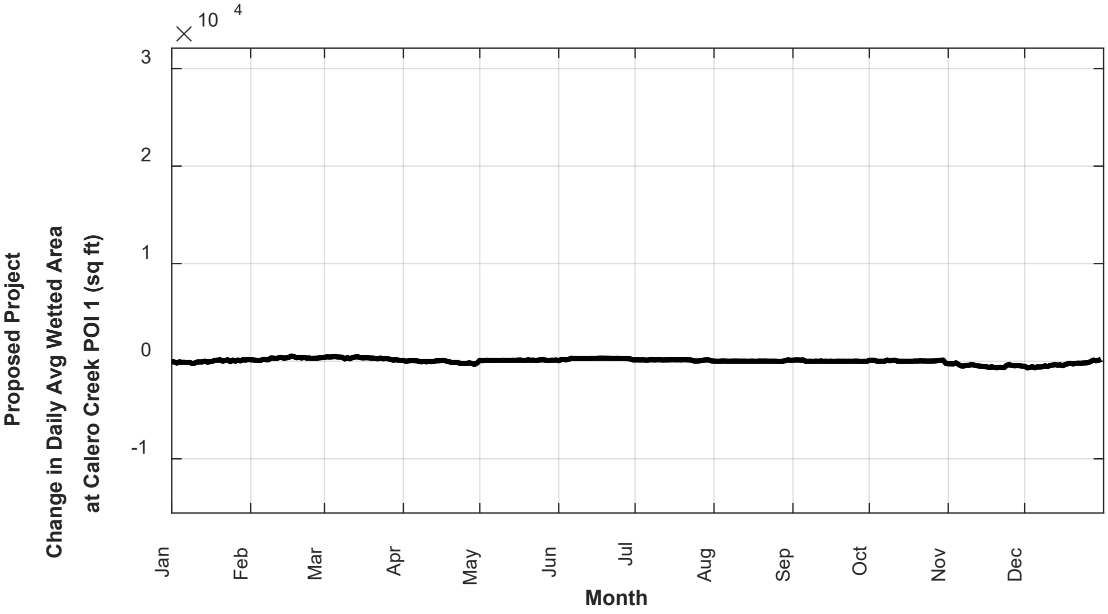
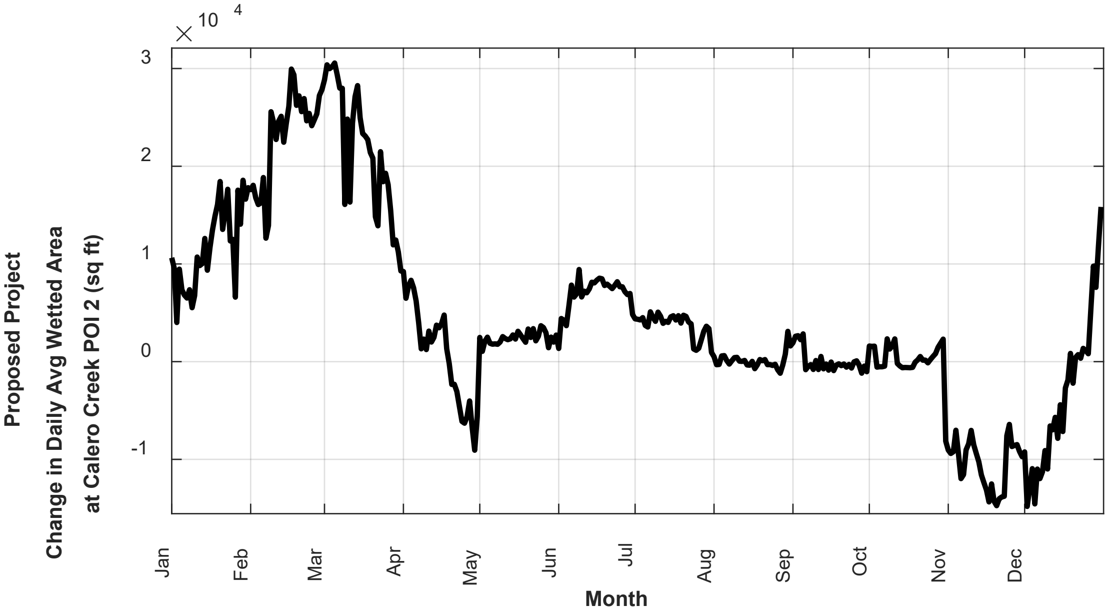


Figure K.2.70


×10^4
3
2
1
0
-1
Proposed Project
Change in Daily Avg Wetted Area
at Calero Creek POI 1 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


×10^4
3
2
1
0
-1
Proposed Project
Change in Daily Avg Wetted Area
at Calero Creek POI 2 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.2 – Proposed Project Supplementary Figures

Water Temperature Figures

Figure K.2.71

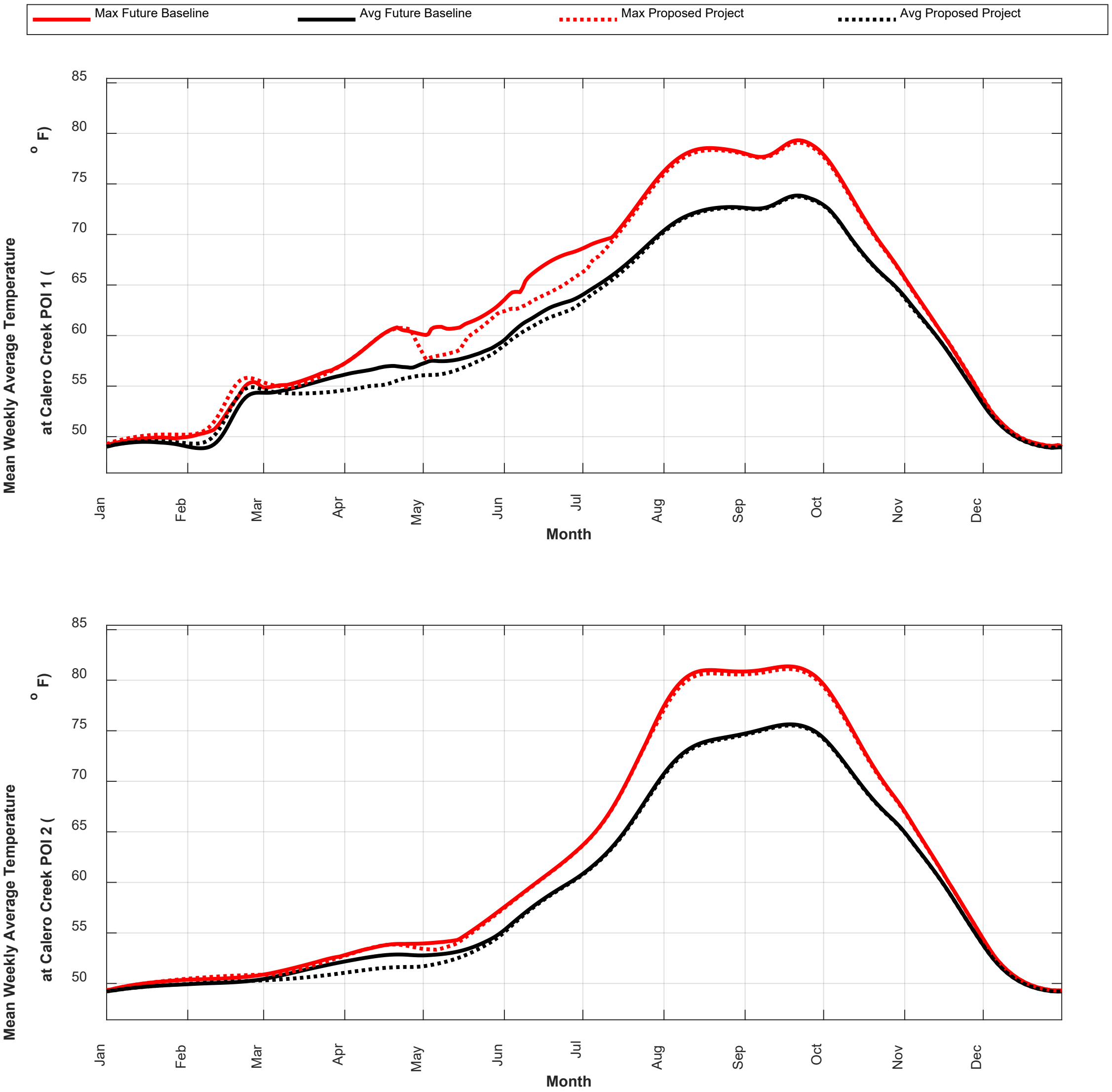
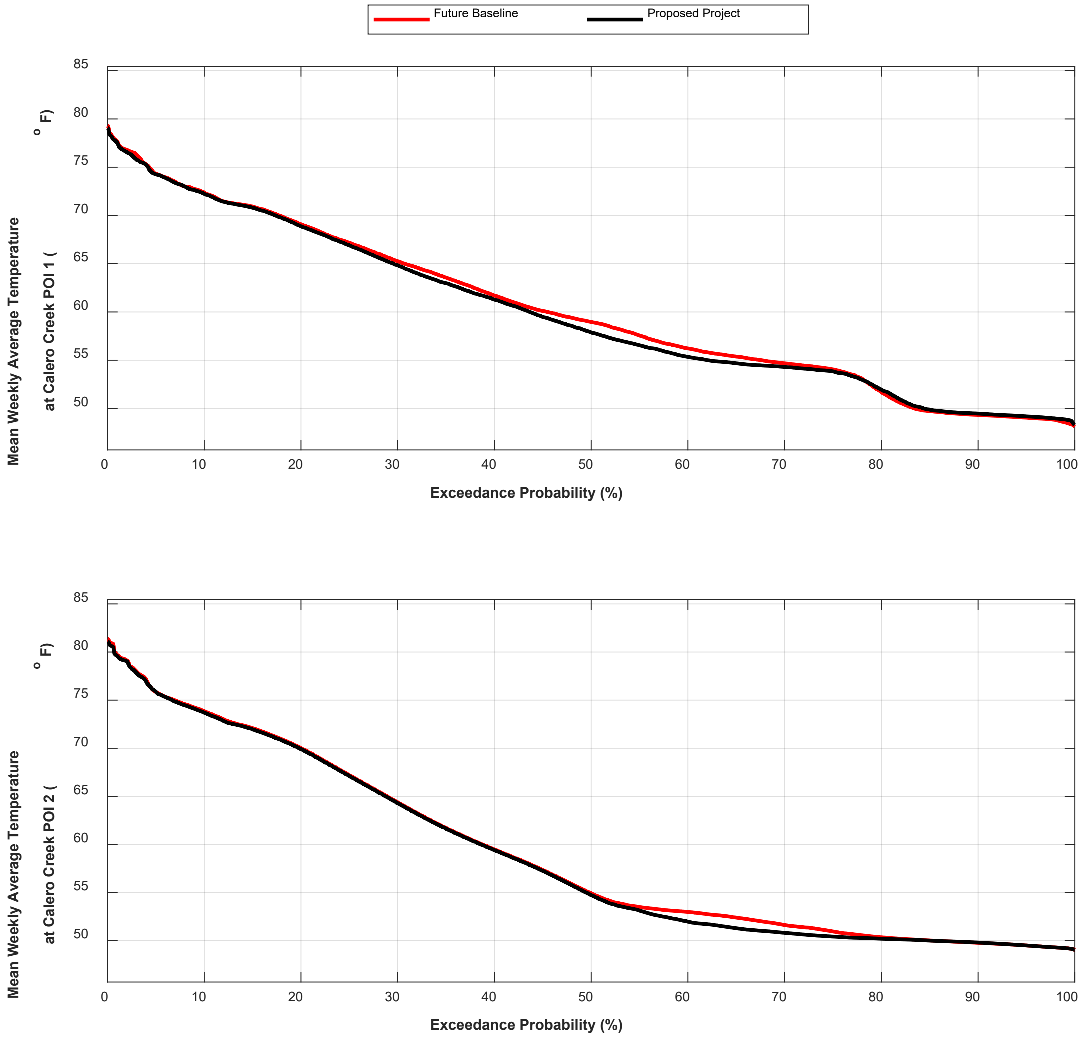


Figure K.2.72


Future Baseline
Proposed Project
Mean Weekly Average Temperature
at Calero Creek POI 1 (° F)
85
80
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
100
Exceedance Probability (%)
Mean Weekly Average Temperature
at Calero Creek POI 2 (° F)
85
80
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
100
Exceedance Probability (%)

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

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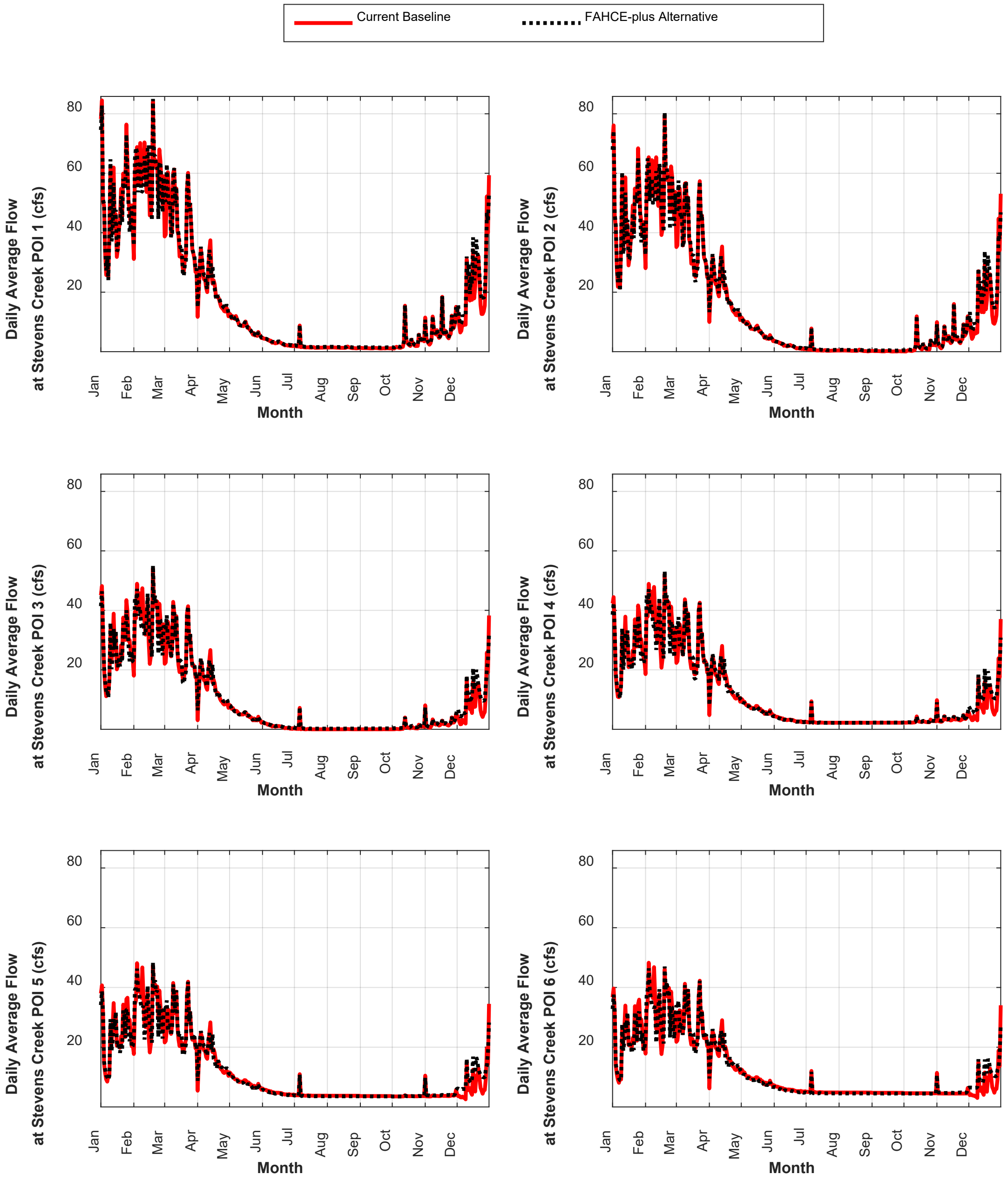
Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Stevens Creek

Current Baseline Comparisons

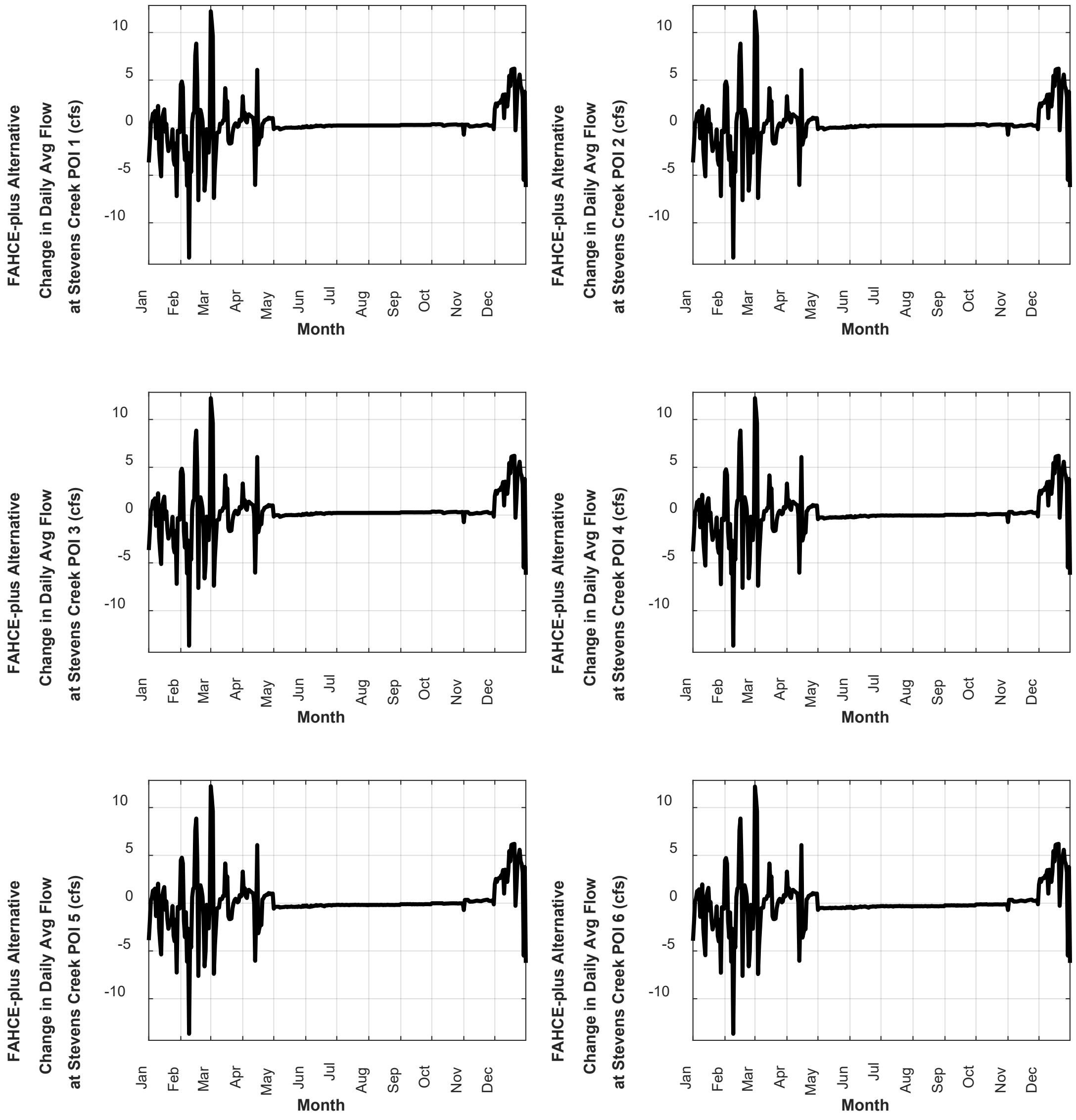
Flow Figures

Figure K.3.1



Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

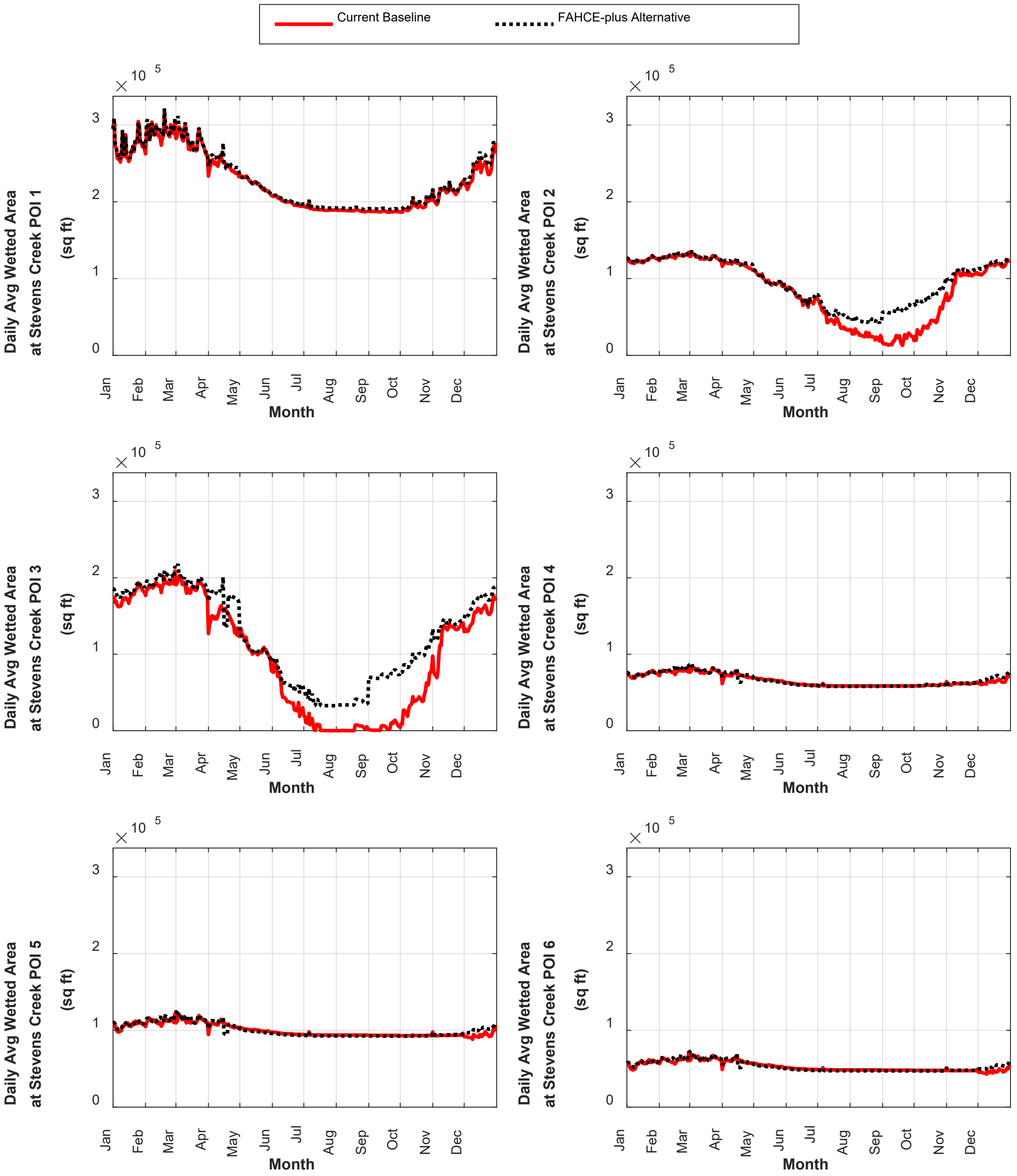
Figure K.3.2



Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

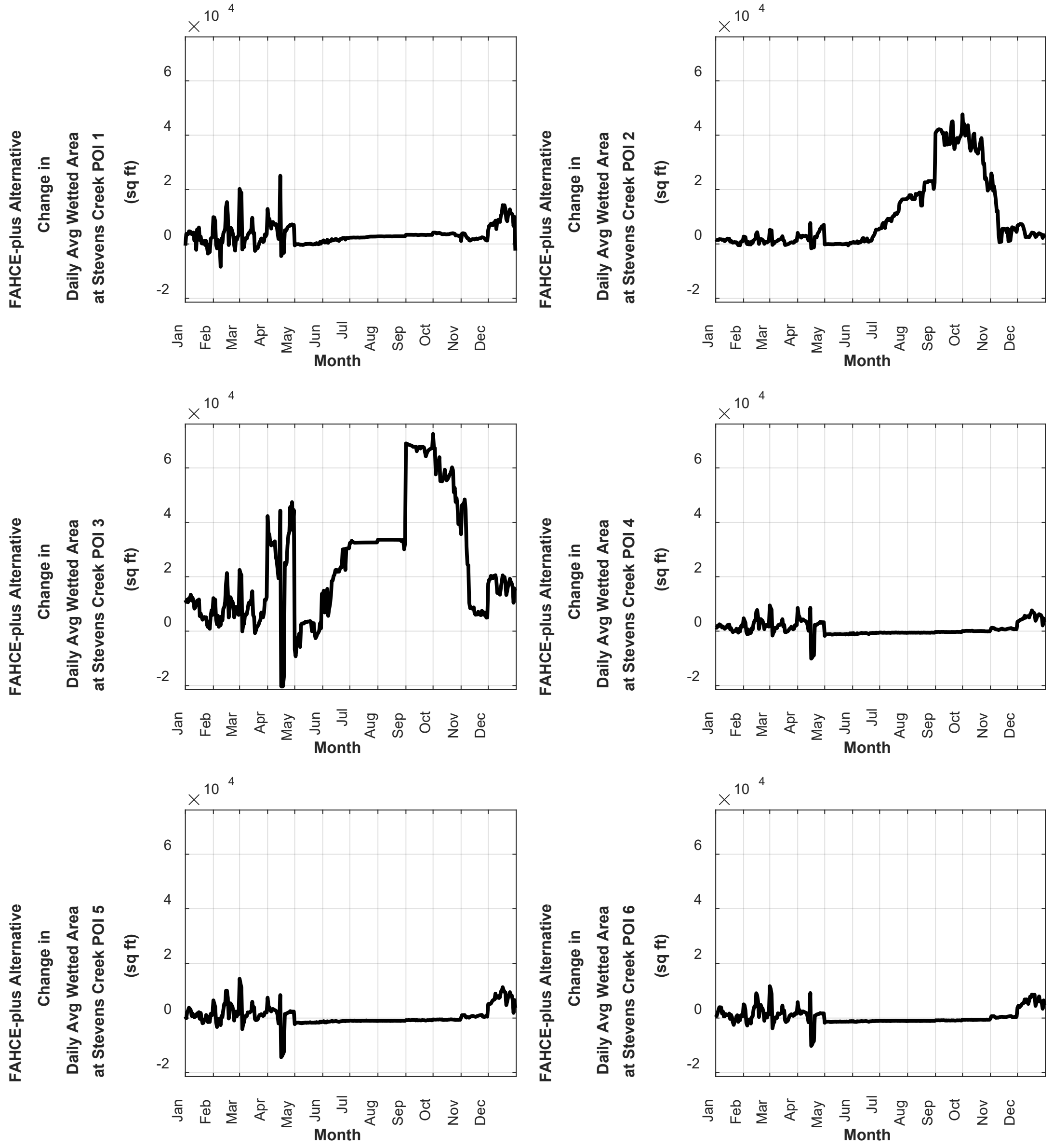
Wetted Area Figures

Figure K.3.3



Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

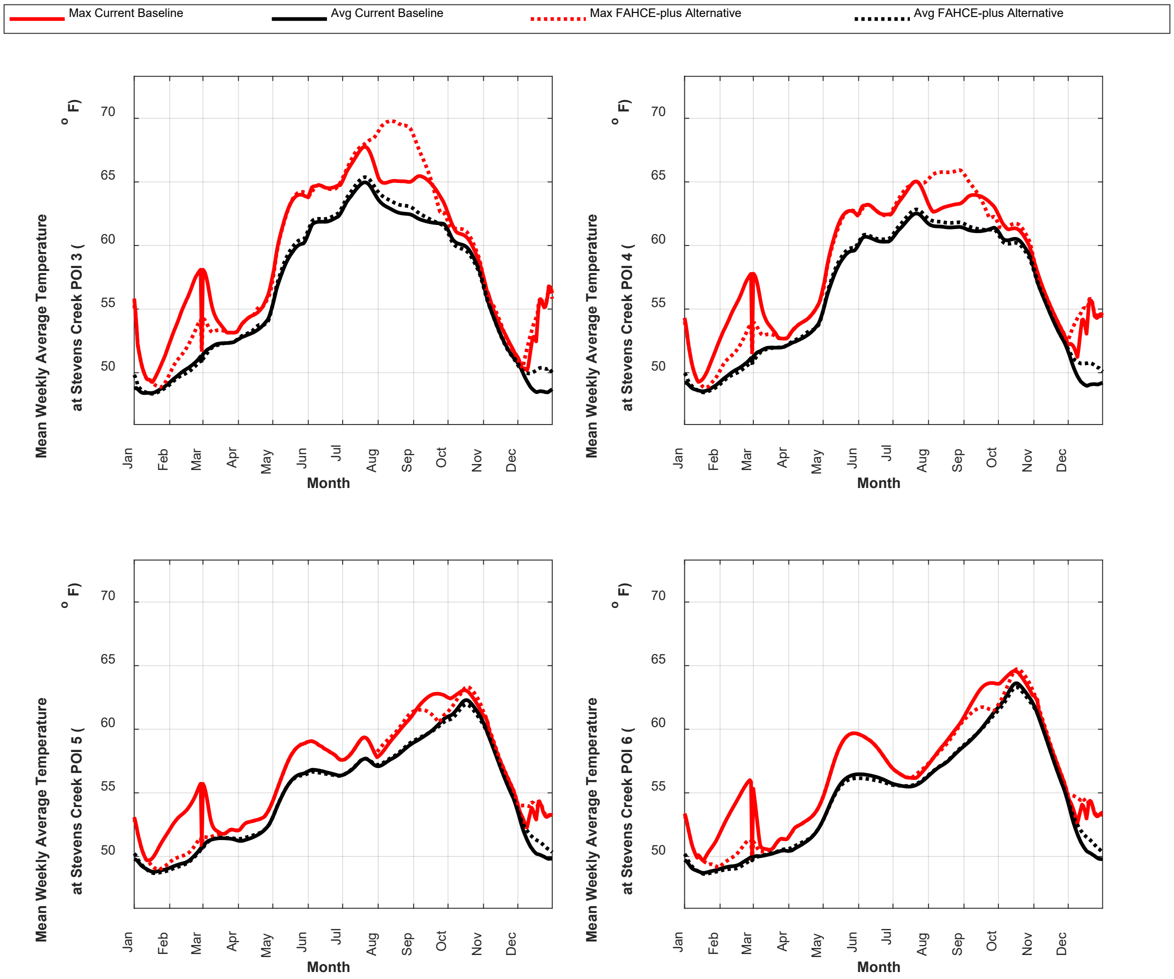
Figure K.3.4



Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Water Temperature Figures

Figure K.3.5[a]



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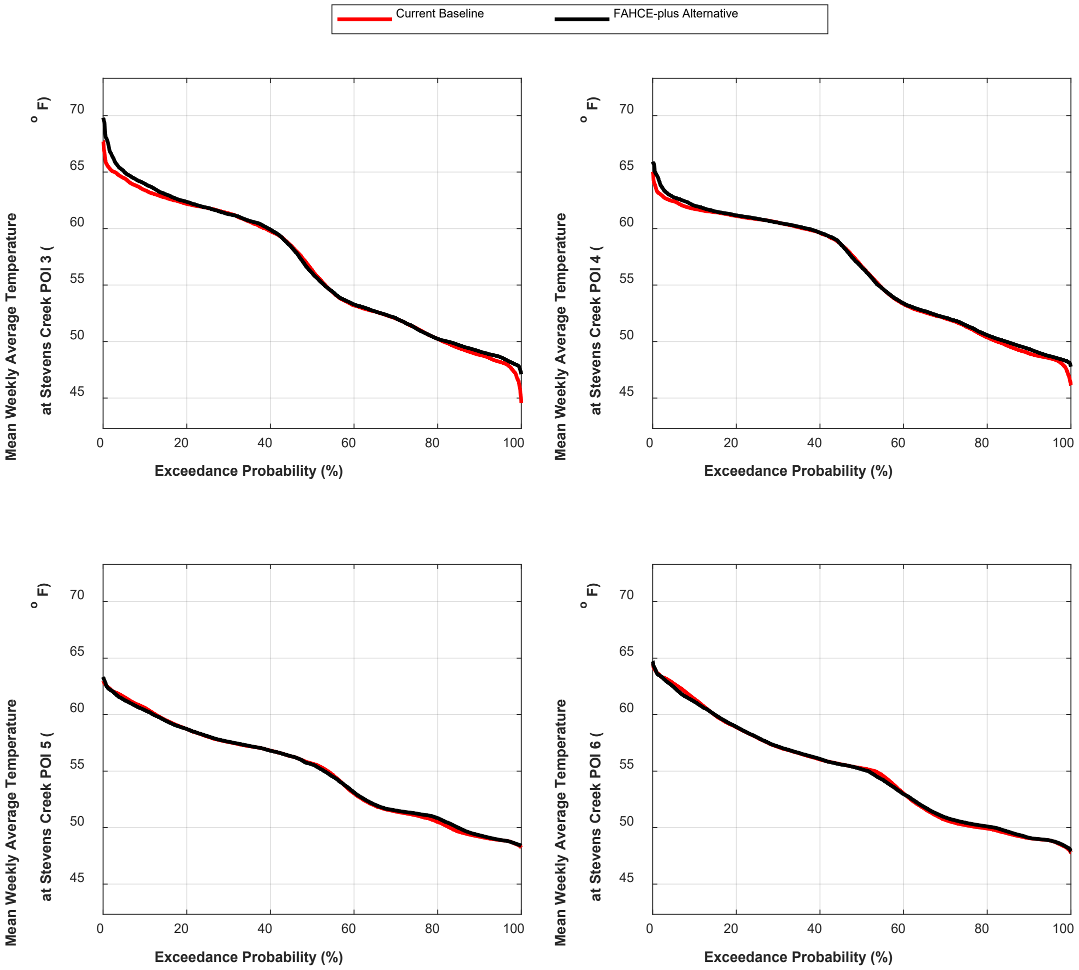
[a] No water temperature model results are available for the points of interest not shown.

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Figure K.3.6[a]



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[a] No water temperature model results are available for the points of interest not shown.

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Future Baseline Comparisons

Flow Figures

Figure K.3.7

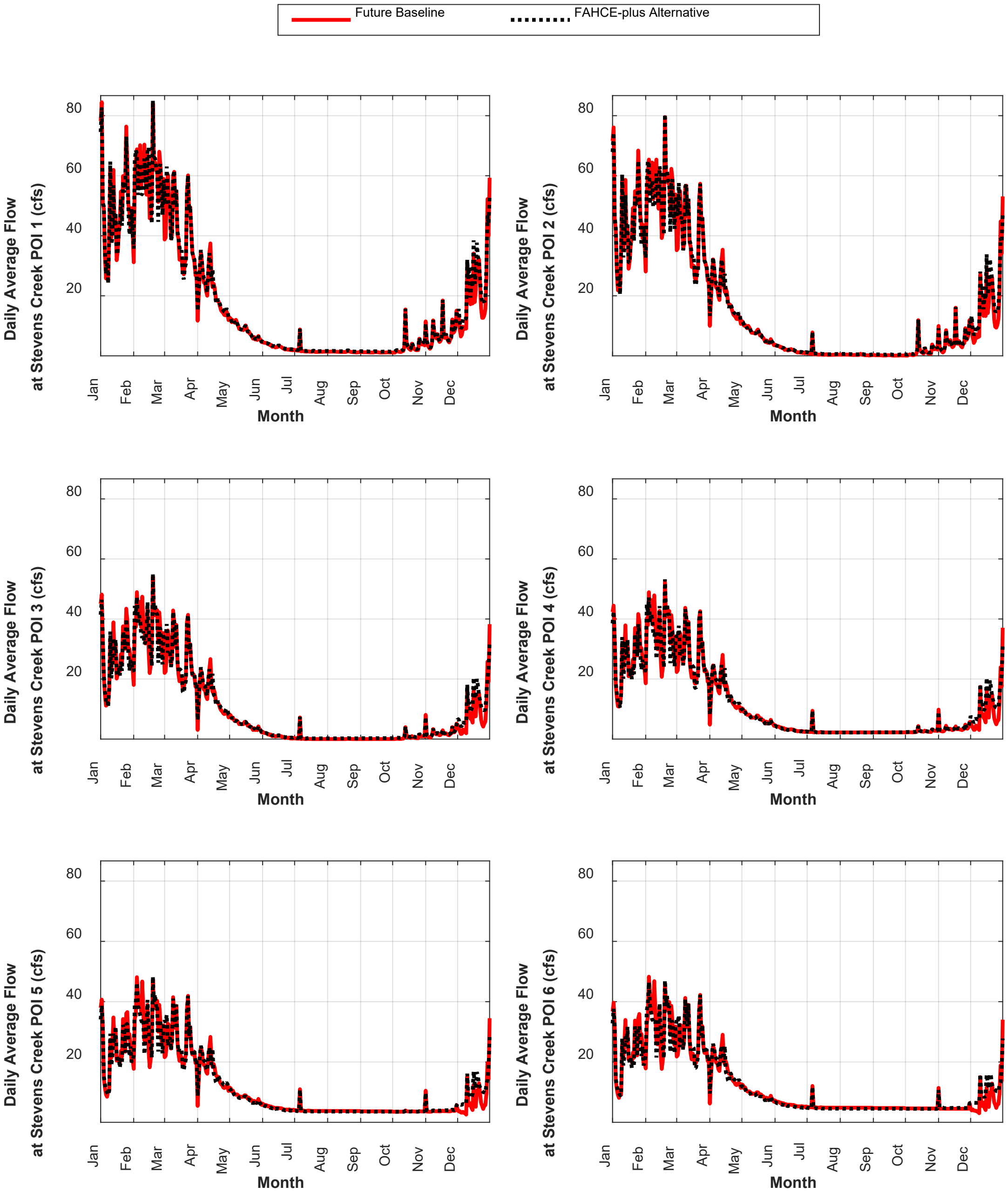
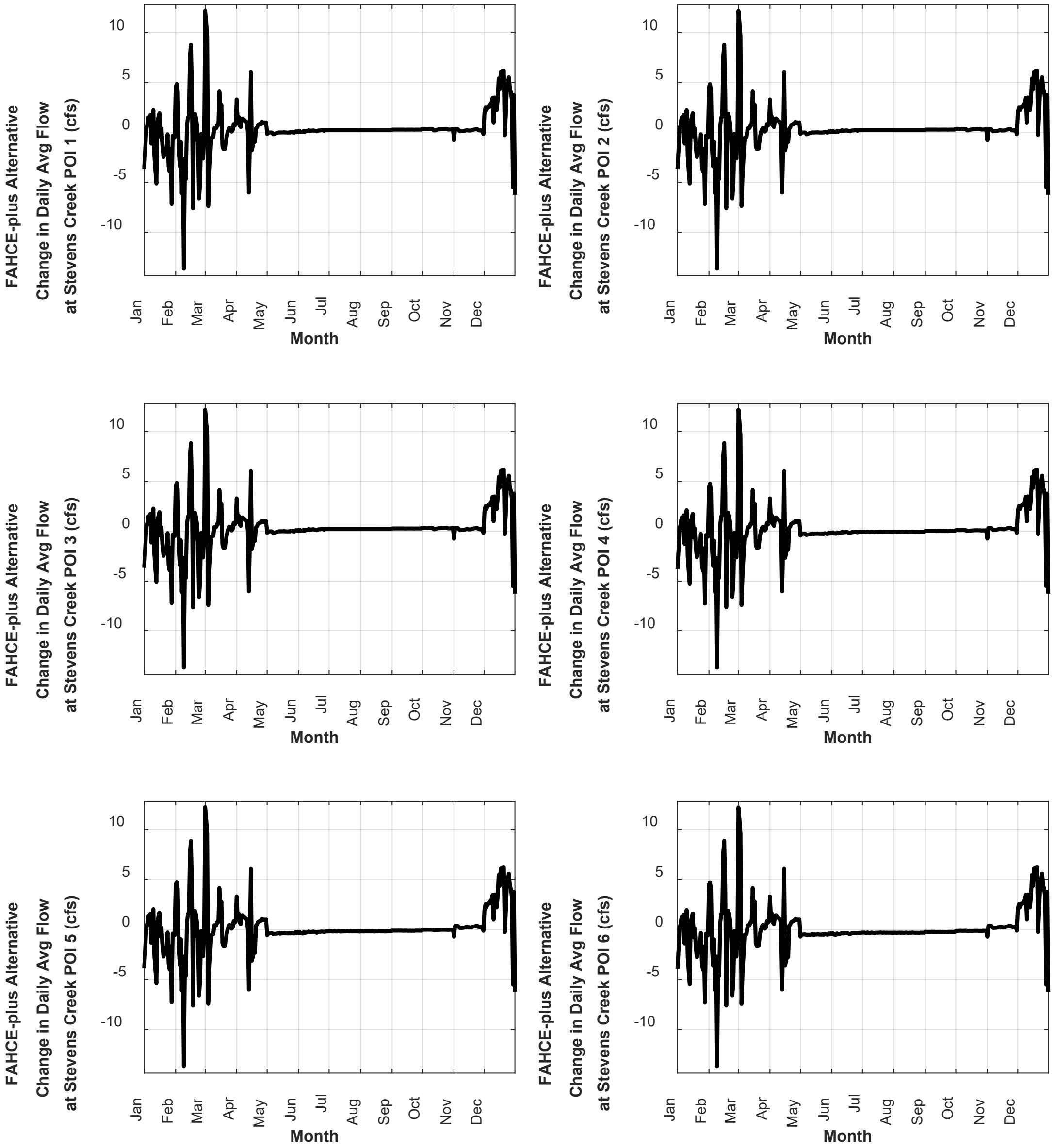


Figure K.3.8


FAHCE-plus Alternative
Change in Daily Avg Flow
at Stevens Creek POI 1 (cfs)
10
5
0
-5
-10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
FAHCE-plus Alternative
Change in Daily Avg Flow
at Stevens Creek POI 2 (cfs)
10
5
0
-5
-10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
FAHCE-plus Alternative
Change in Daily Avg Flow
at Stevens Creek POI 3 (cfs)
10
5
0
-5
-10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
FAHCE-plus Alternative
Change in Daily Avg Flow
at Stevens Creek POI 4 (cfs)
10
5
0
-5
-10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
FAHCE-plus Alternative
Change in Daily Avg Flow
at Stevens Creek POI 5 (cfs)
10
5
0
-5
-10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
FAHCE-plus Alternative
Change in Daily Avg Flow
at Stevens Creek POI 6 (cfs)
10
5
0
-5
-10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Wetted Area Figures

Figure K.3.9

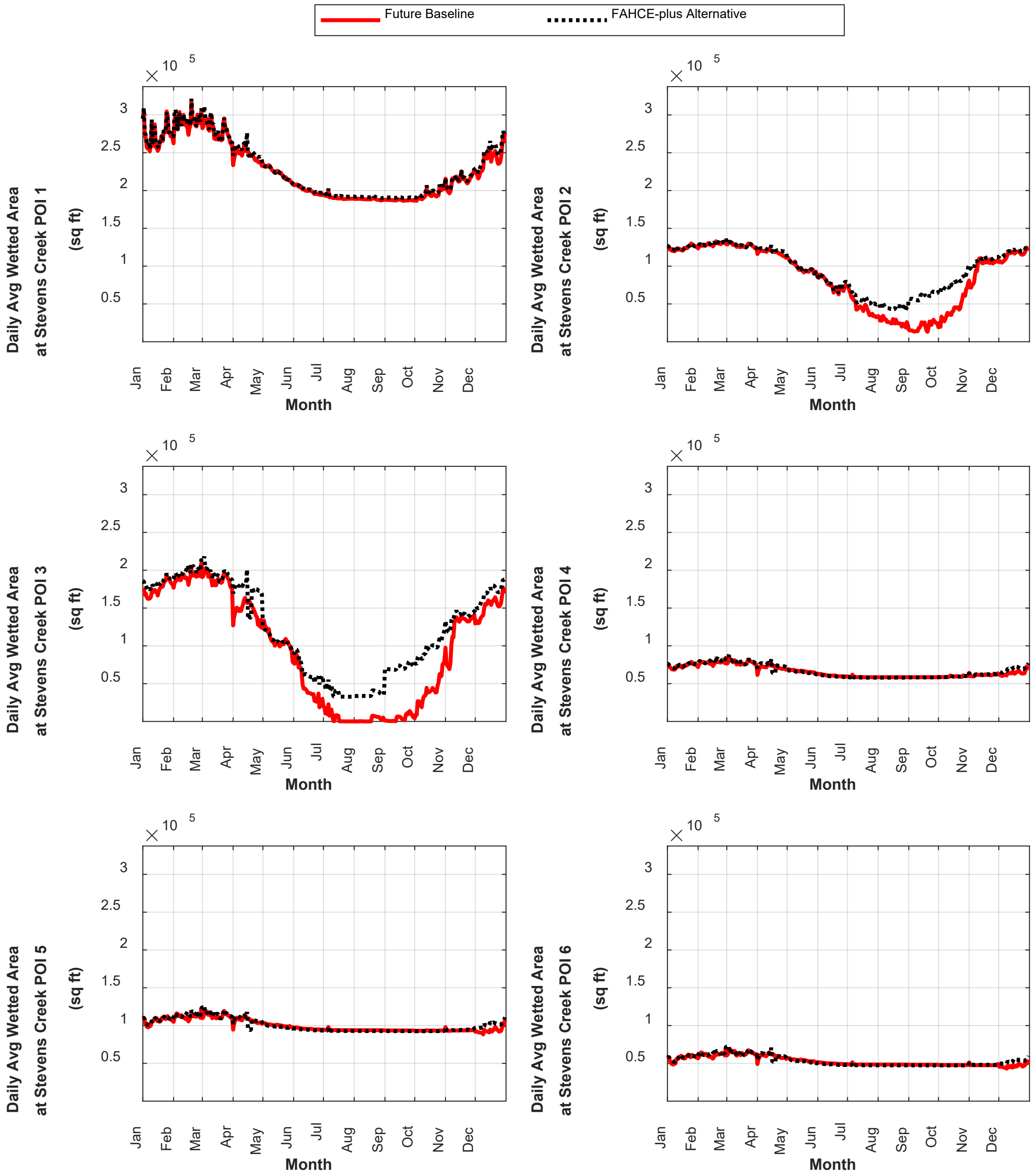
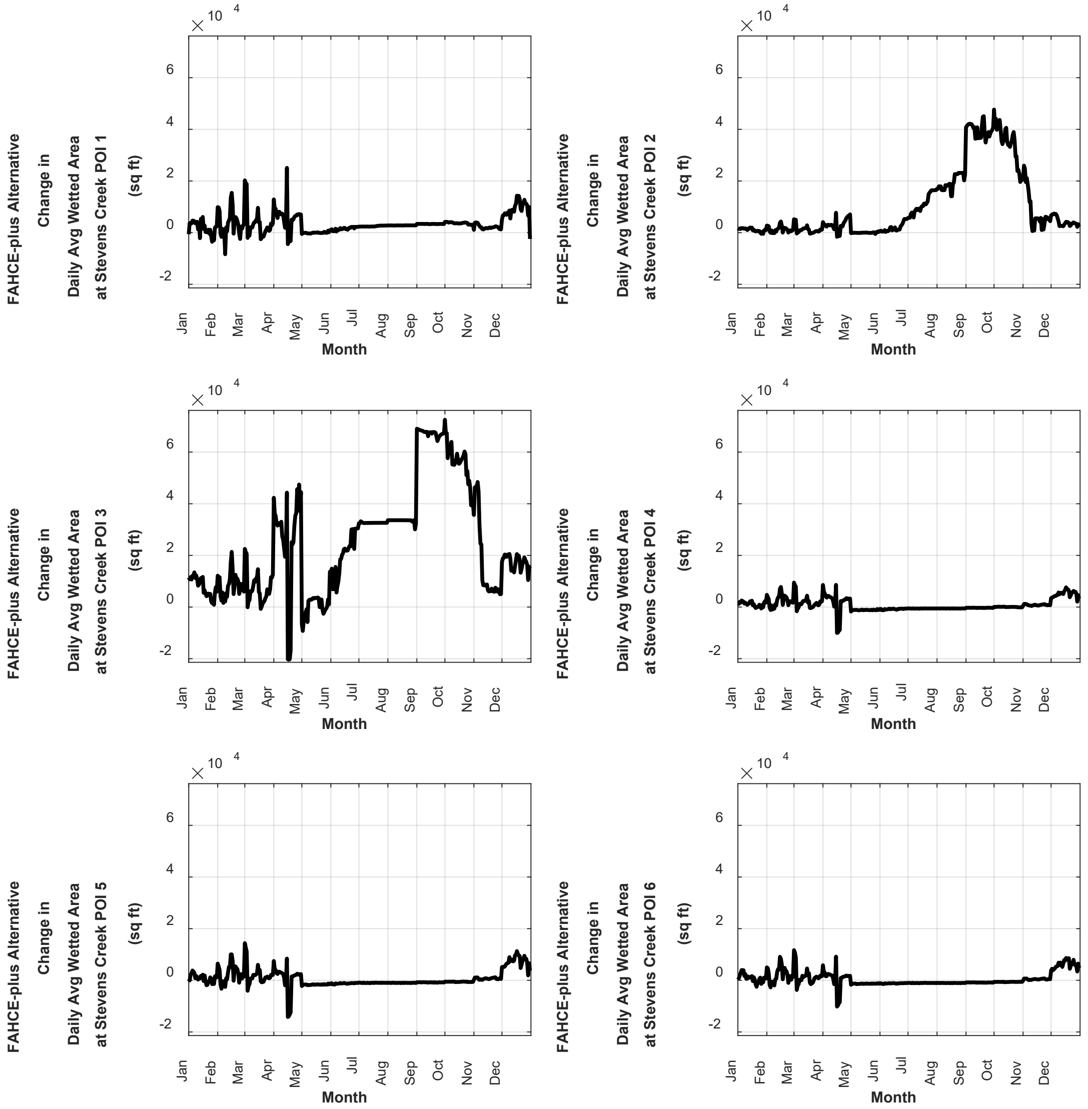


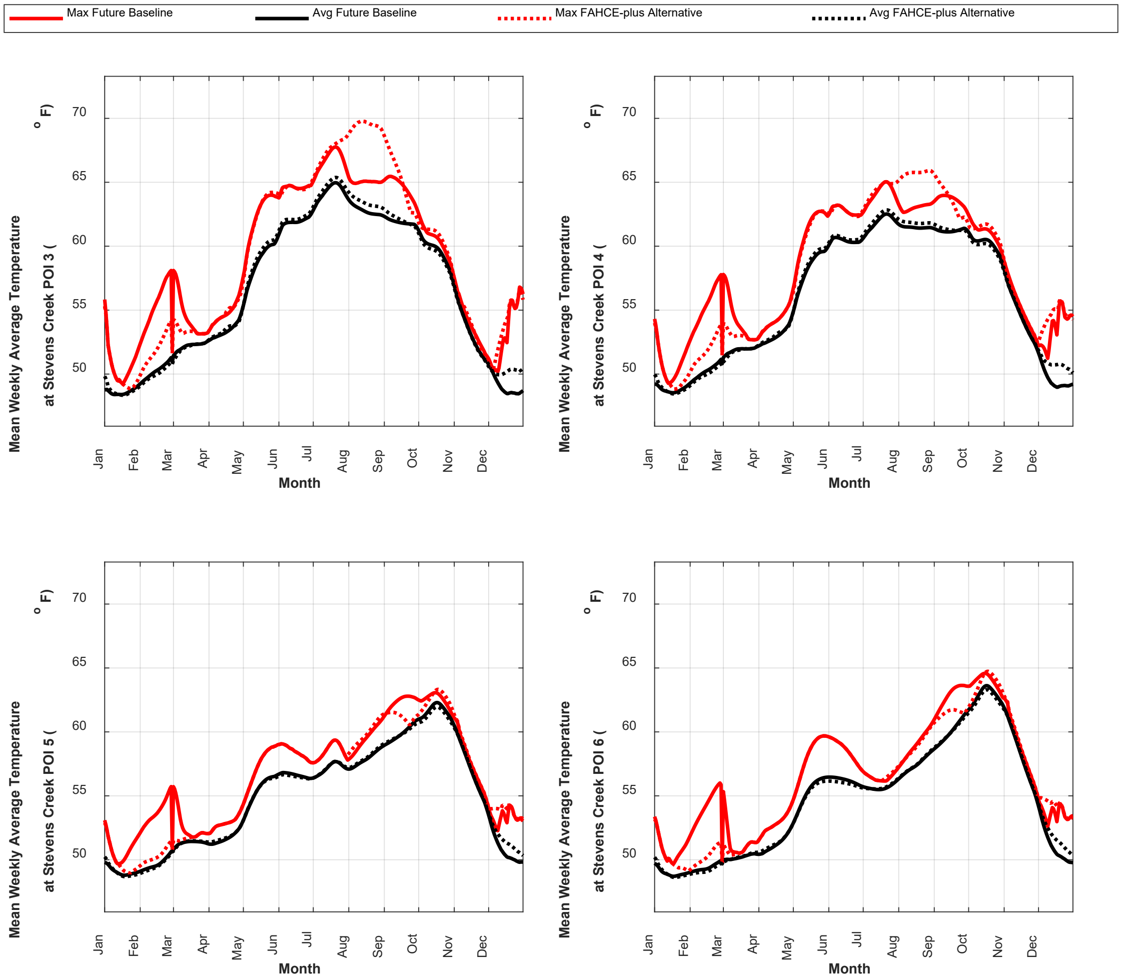
Figure K.3.10


×10 4
6
4
2
0
-2
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Stevens Creek POI 1 (sq ft)
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Stevens Creek POI 2 (sq ft)
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Stevens Creek POI 3 (sq ft)
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Stevens Creek POI 4 (sq ft)
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Stevens Creek POI 5 (sq ft)
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Stevens Creek POI 6 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

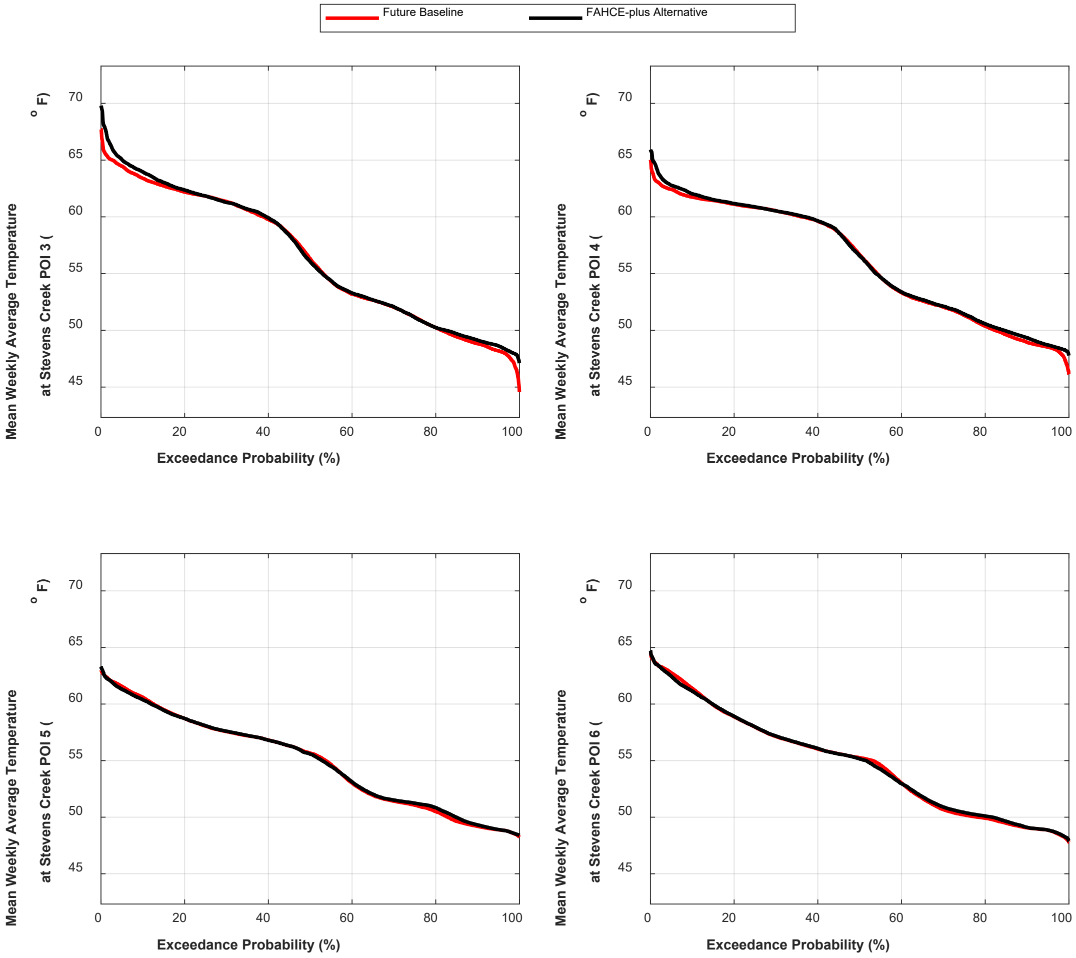
Water Temperature Figures

Figure K.3.11[a]



[a] No water temperature model results are available for the points of interest not shown.

Figure K.3.12[a]



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[a] No water temperature model results are available for the points of interest not shown.

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Guadalupe River

Current Baseline Comparisons

Flow Figures

Figure K.3.13

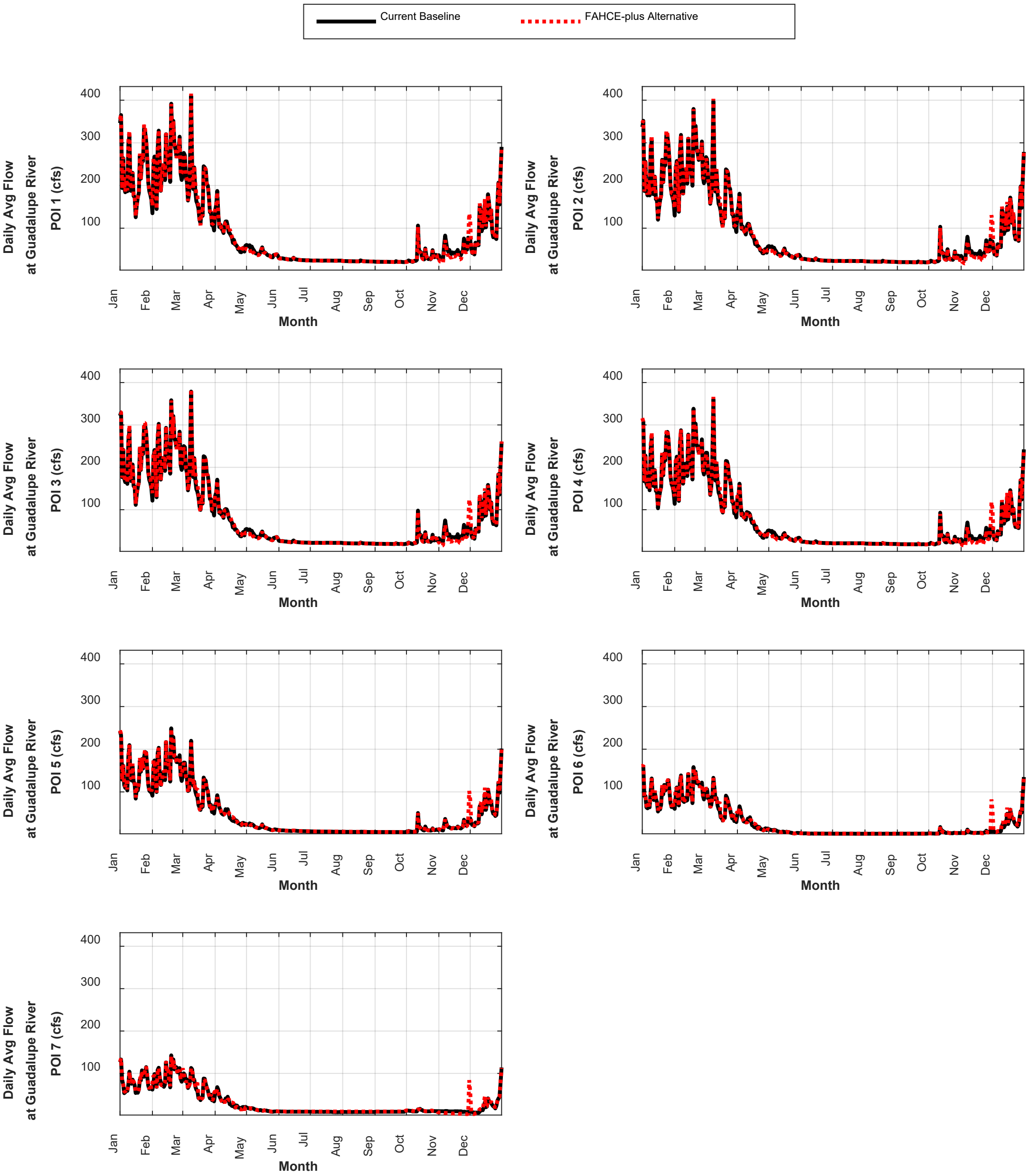
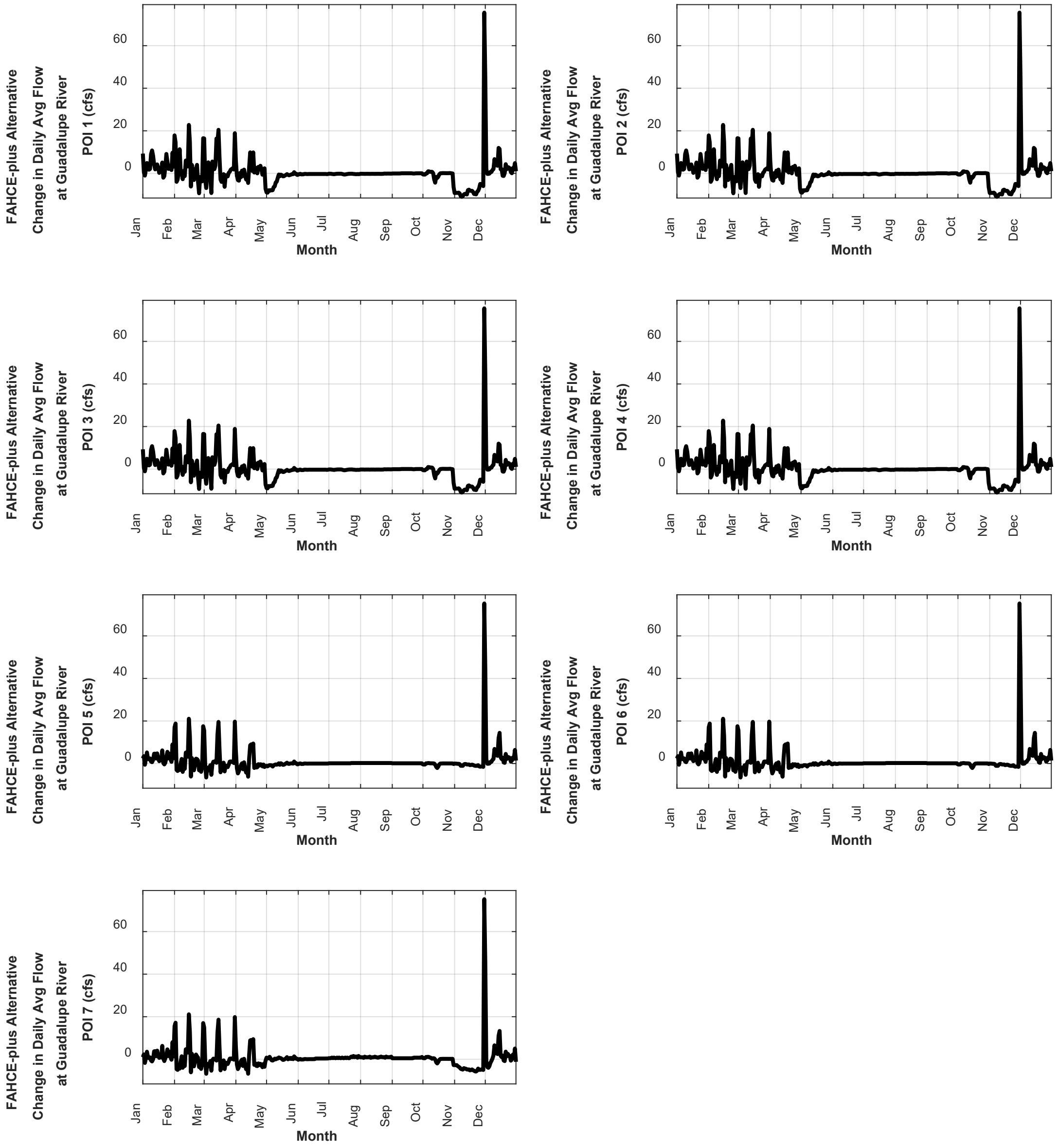


Figure K.3.14


FAHCE-plus Alternative Change in Daily Avg Flow at Guadalupe River POI 1 (cfs)
FAHCE-plus Alternative Change in Daily Avg Flow at Guadalupe River POI 2 (cfs)
FAHCE-plus Alternative Change in Daily Avg Flow at Guadalupe River POI 3 (cfs)
FAHCE-plus Alternative Change in Daily Avg Flow at Guadalupe River POI 4 (cfs)
FAHCE-plus Alternative Change in Daily Avg Flow at Guadalupe River POI 5 (cfs)
FAHCE-plus Alternative Change in Daily Avg Flow at Guadalupe River POI 6 (cfs)
FAHCE-plus Alternative Change in Daily Avg Flow at Guadalupe River POI 7 (cfs)
0
20
40
60
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Wetted Area Figures

Figure K.3.15

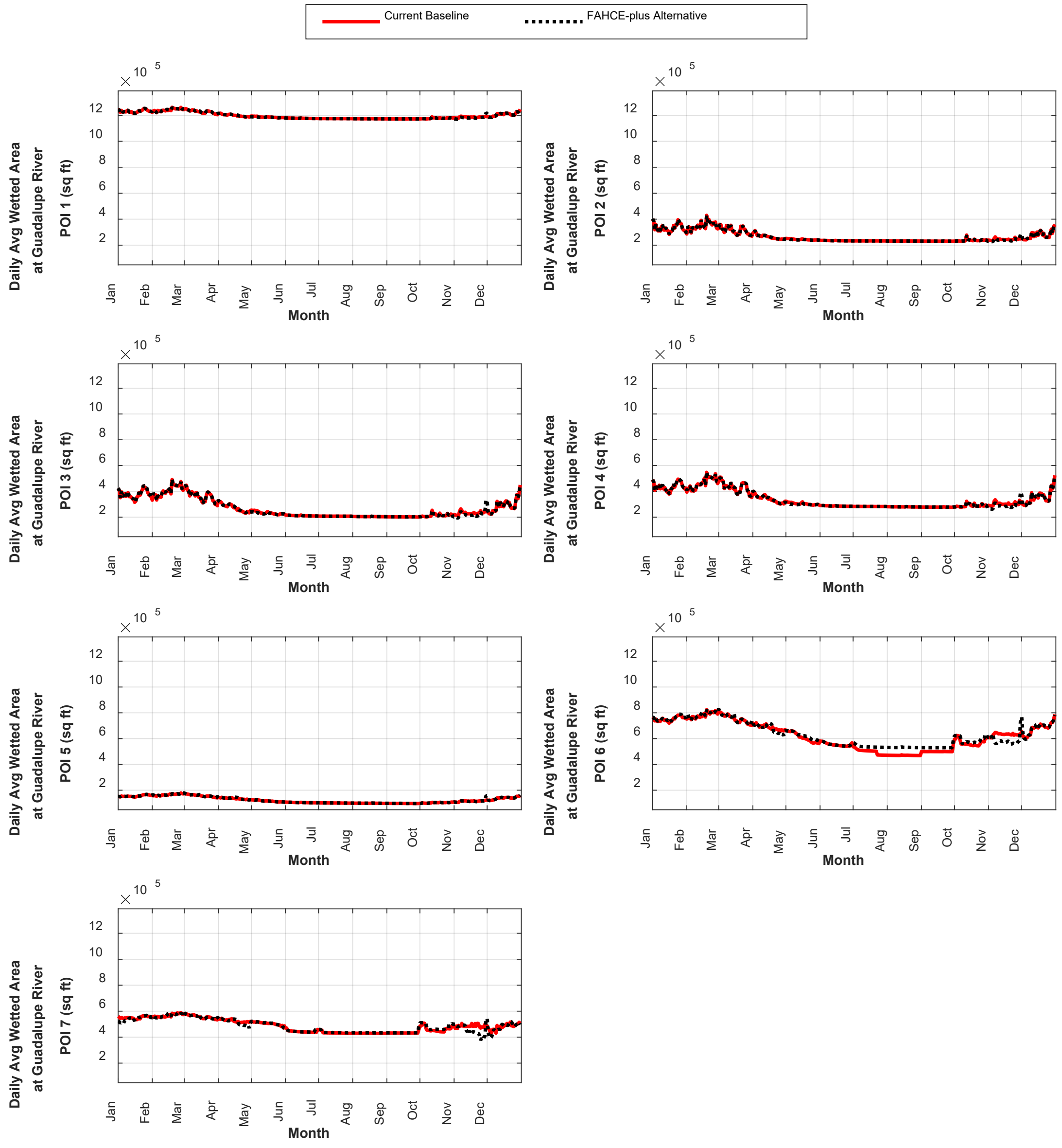
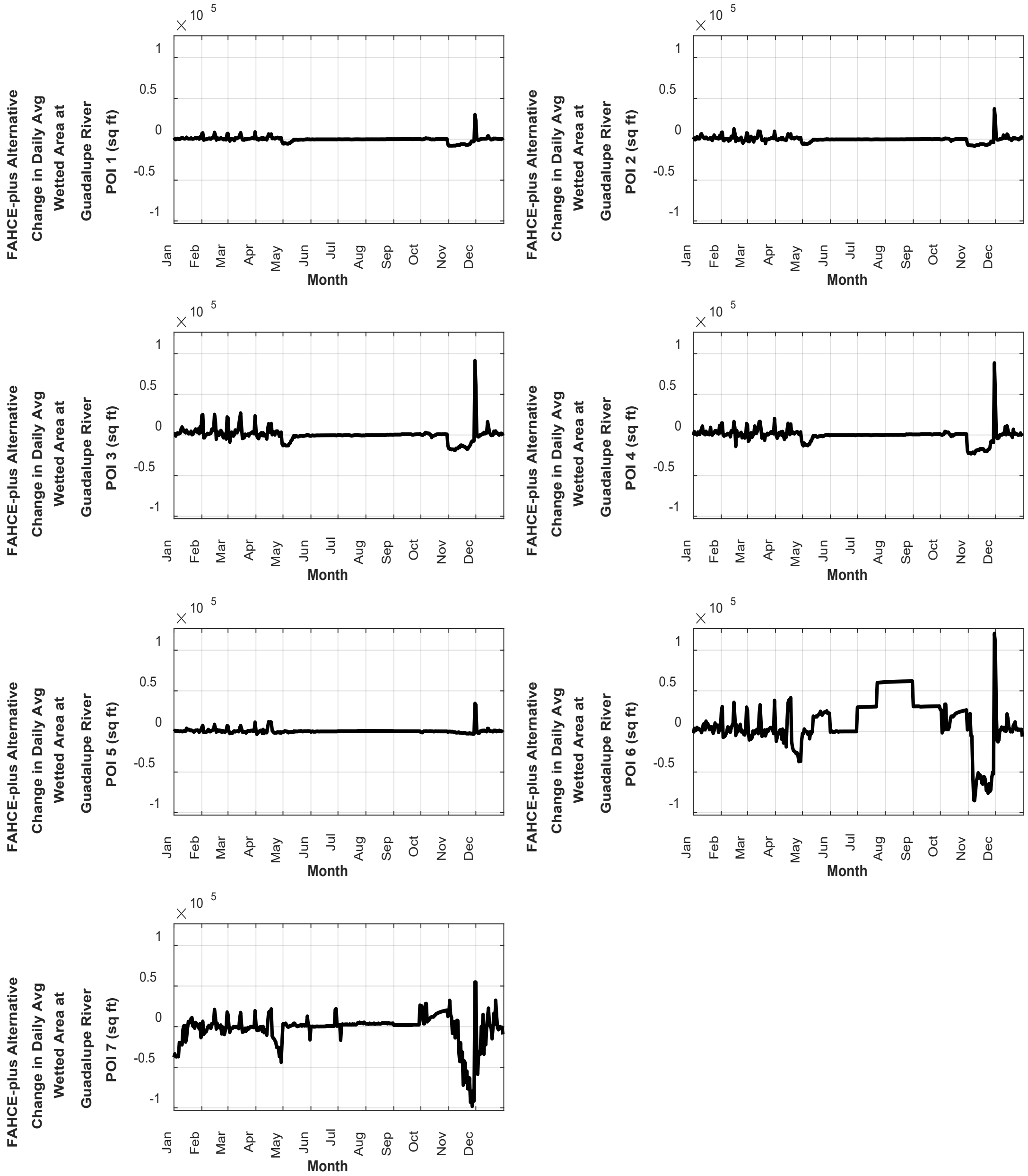


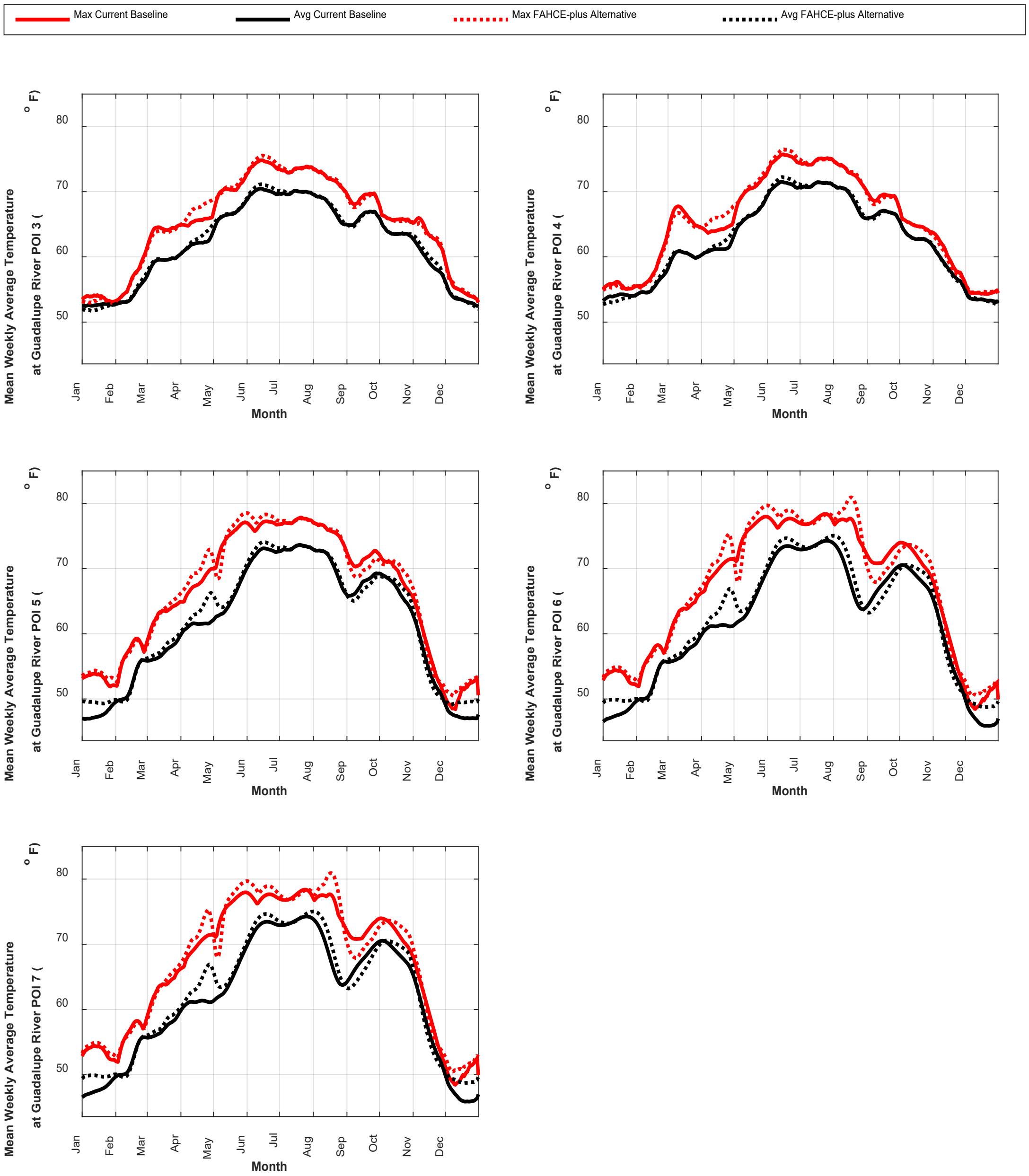
Figure K.3.16


×10 5
1
0.5
0
-0.5
-1
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe River POI 1 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe River POI 2 (sq ft)
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe River POI 3 (sq ft)
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe River POI 4 (sq ft)
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe River POI 5 (sq ft)
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe River POI 6 (sq ft)
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe River POI 7 (sq ft)

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Water Temperature Figures

Figure K.3.17[a]



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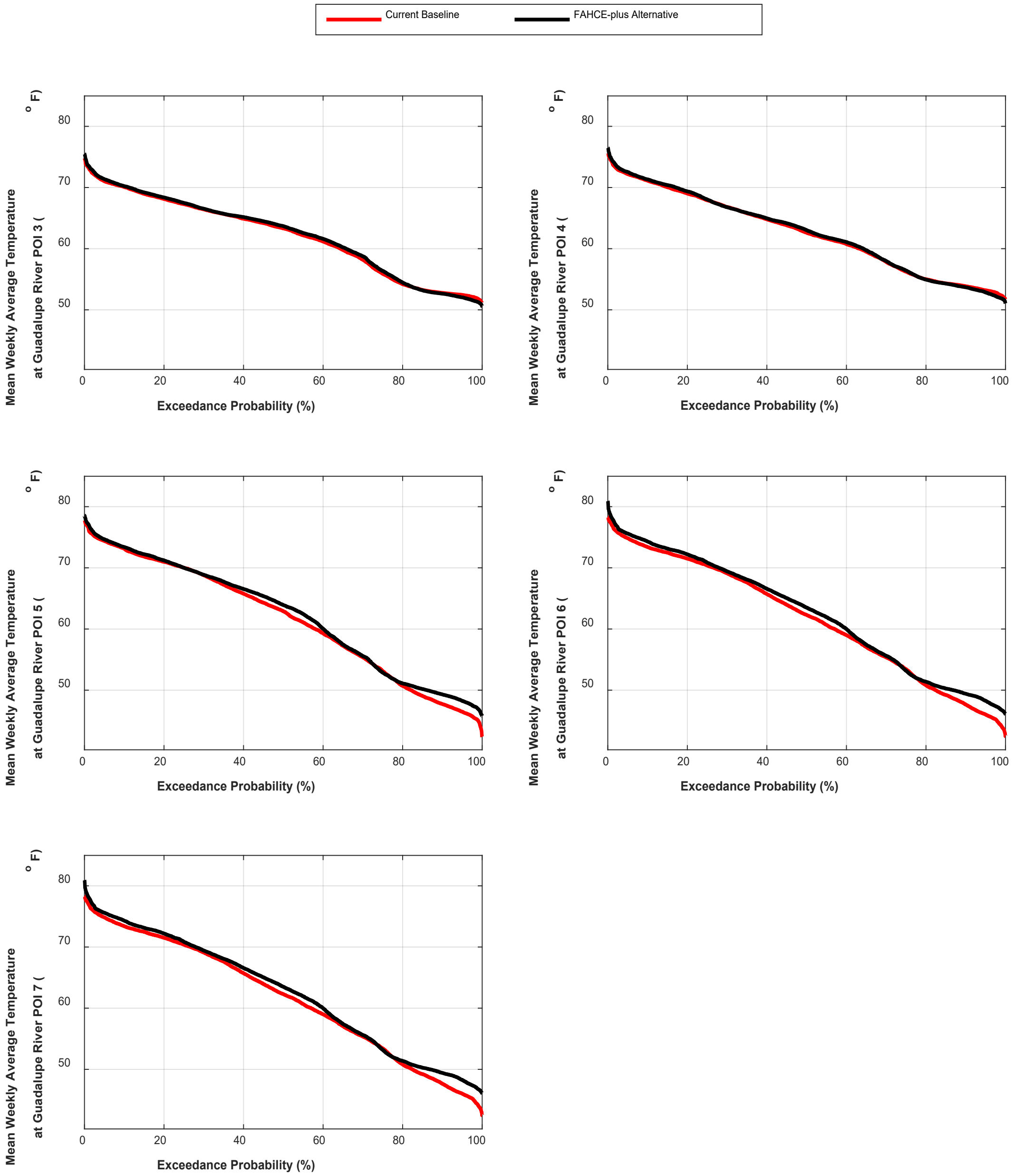
[a] No water temperature model results are available for the points of interest not shown.

Figure K.3.18[a]



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[a] No water temperature model results are available for the points of interest not shown.

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Future Baseline Comparisons

Flow Figures

Figure K.3.19

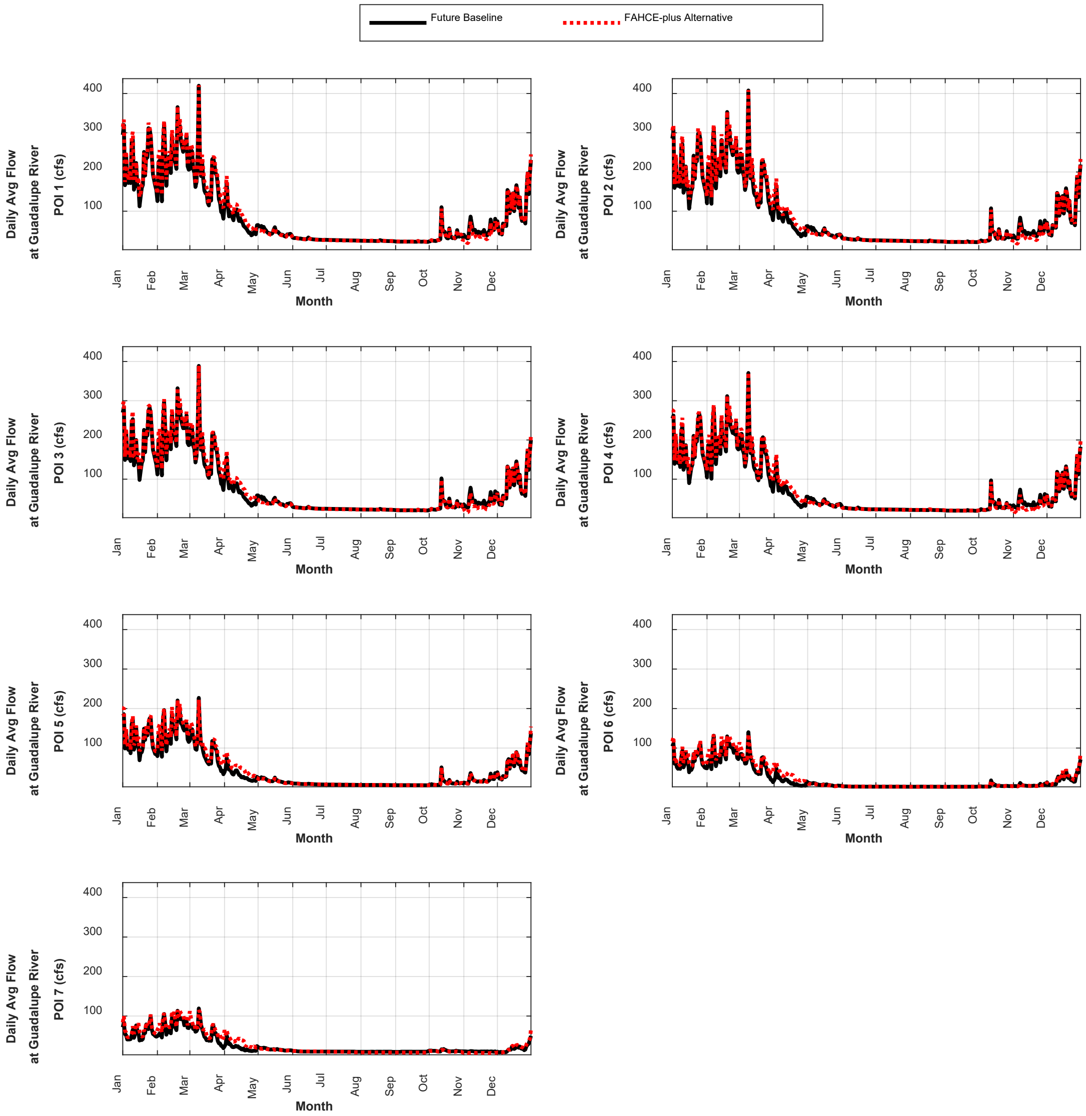
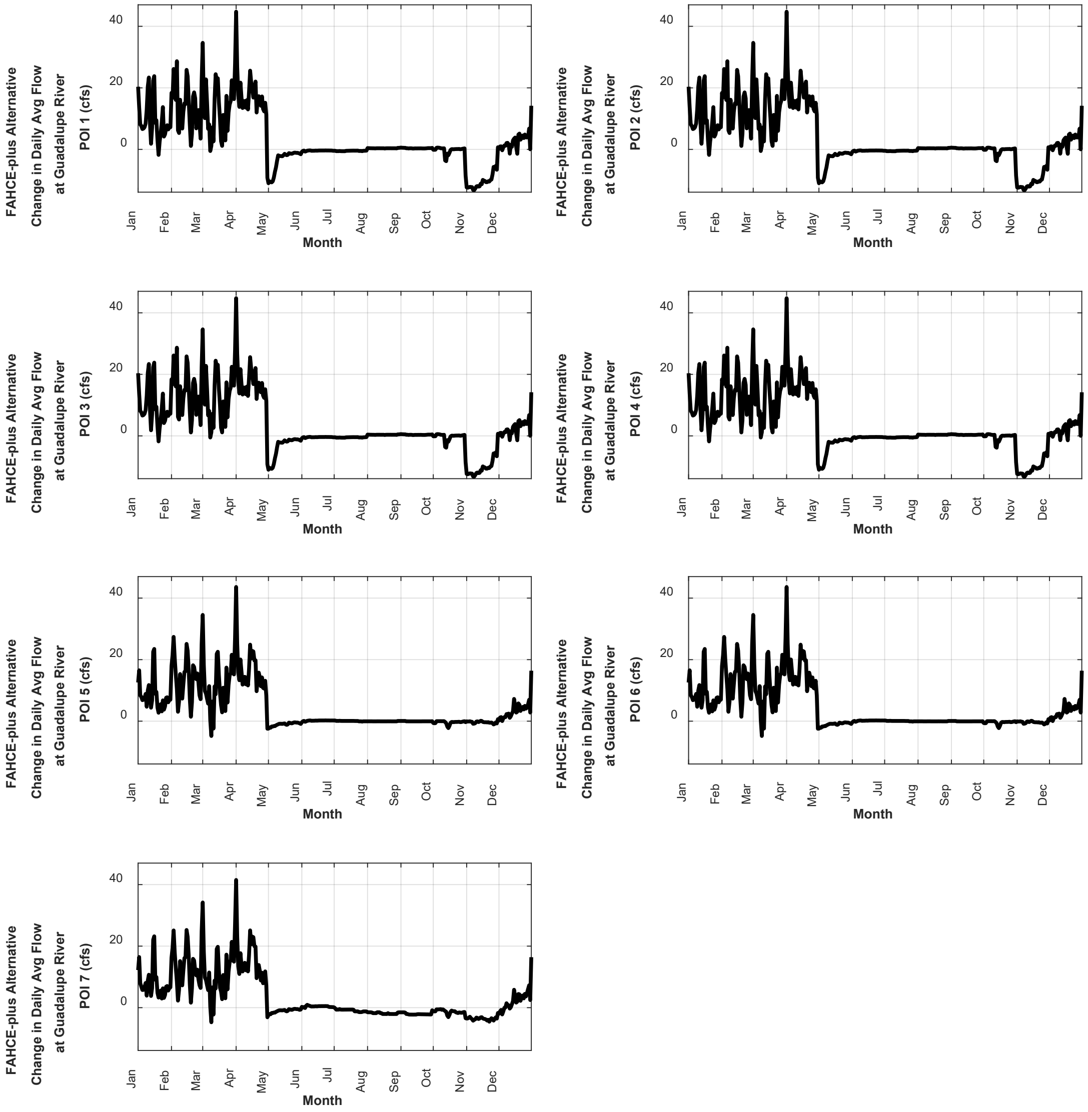


Figure K.3.20


FAHCE-plus Alternative
Change in Daily Avg Flow
at Guadalupe River
POI 1 (cfs)
POI 2 (cfs)
POI 3 (cfs)
POI 4 (cfs)
POI 5 (cfs)
POI 6 (cfs)
POI 7 (cfs)
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Wetted Area Figures

Figure K.3.21

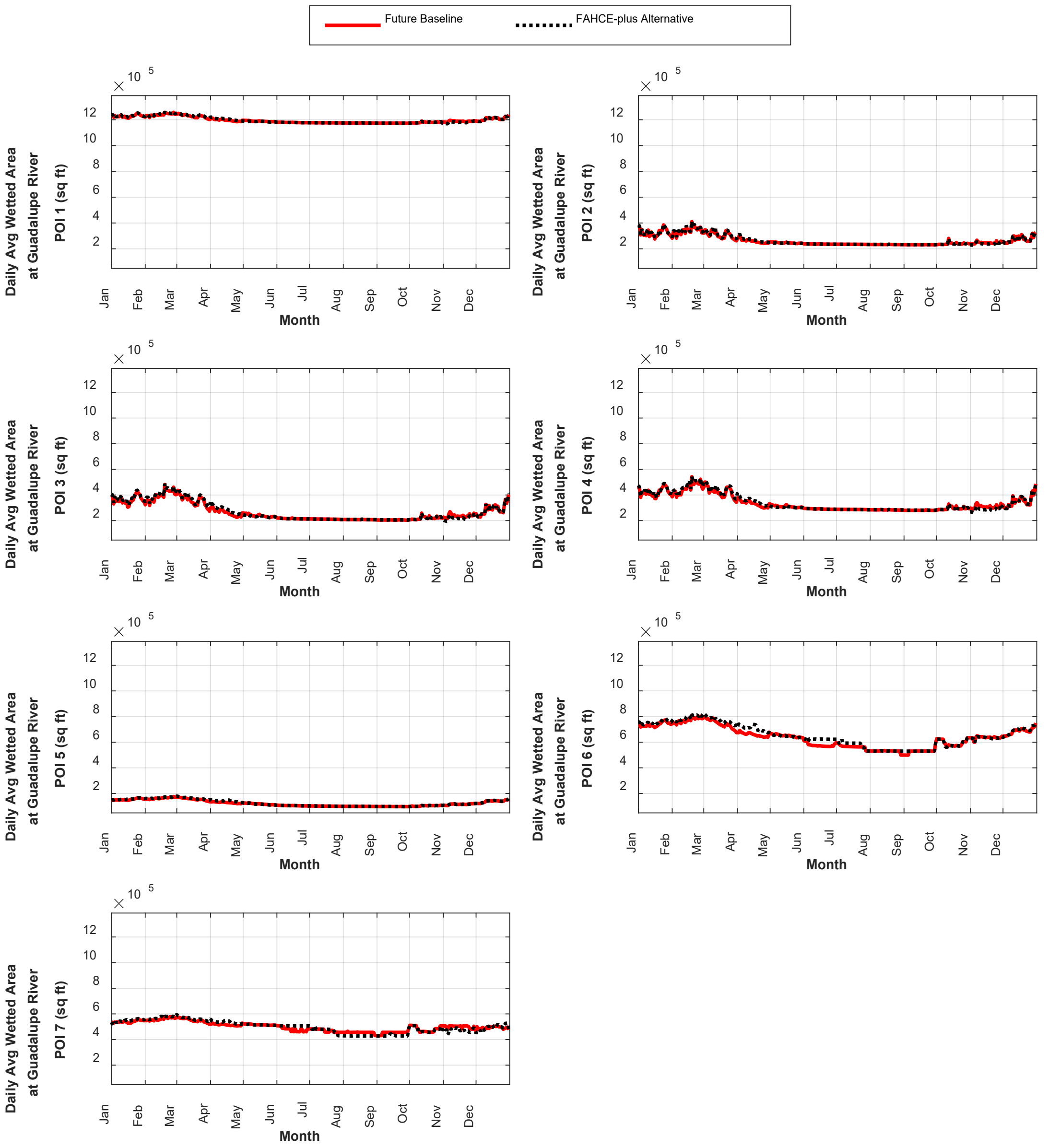
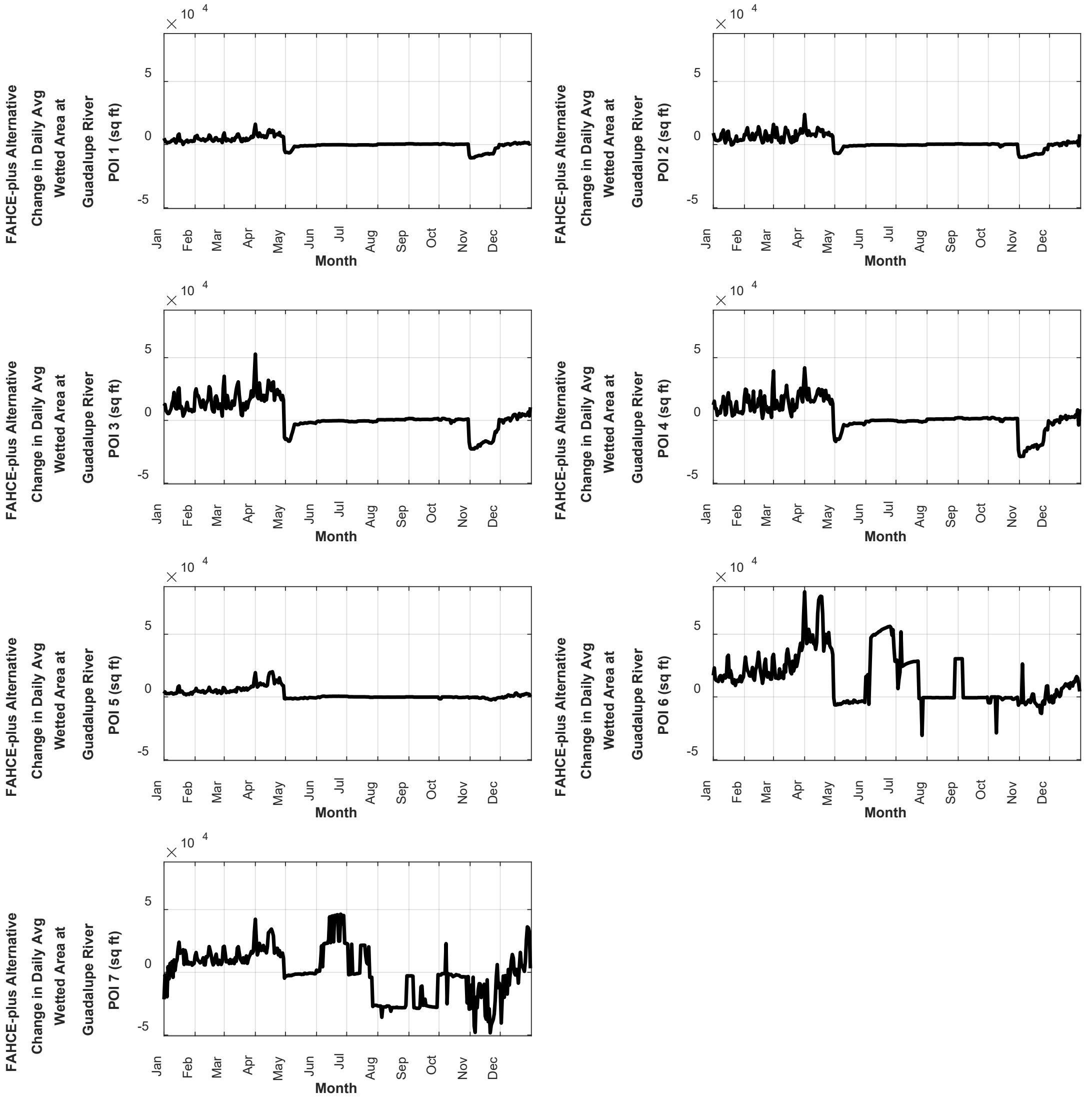


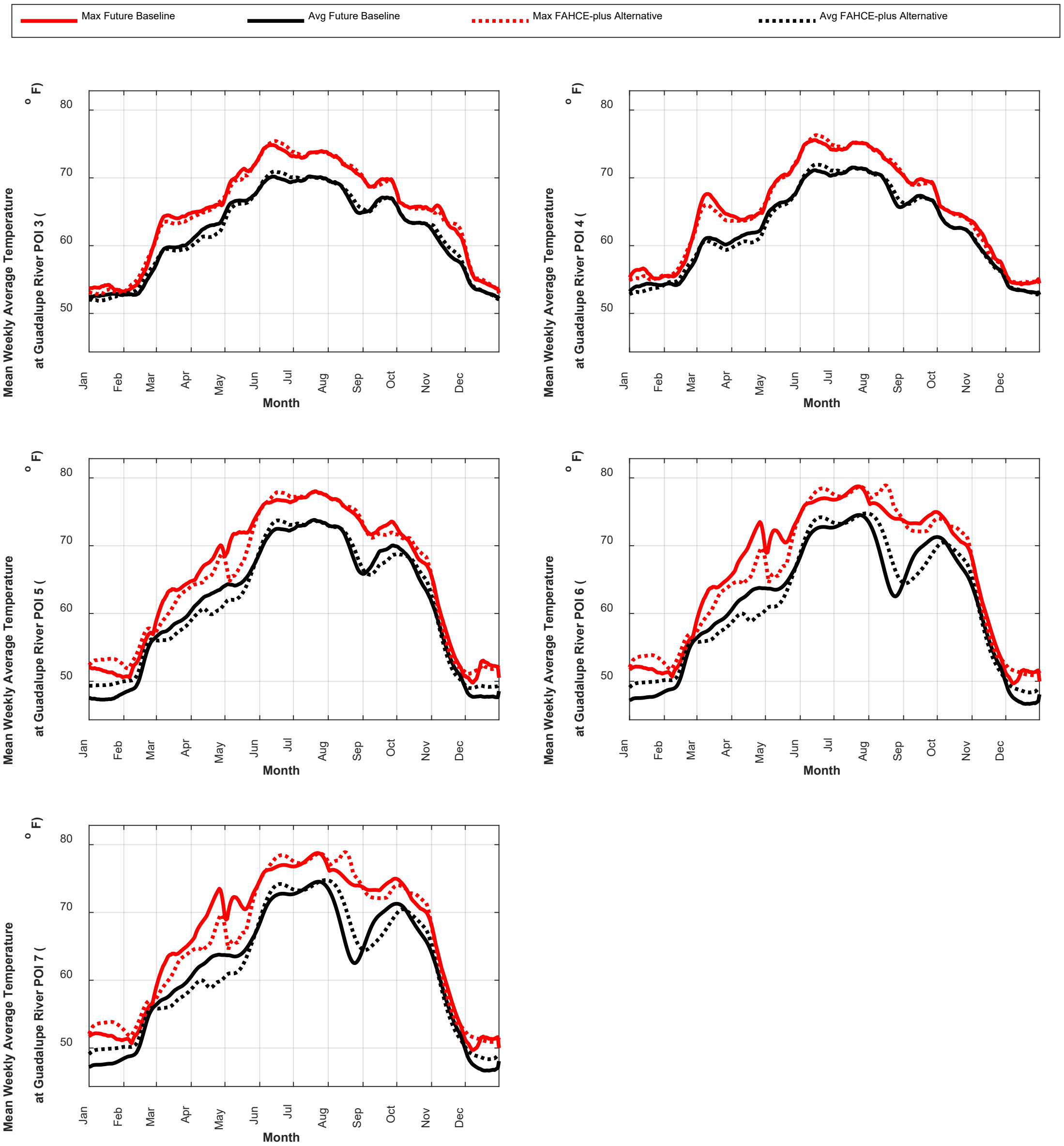
Figure K.3.22


× 10 4
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe River POI 1 (sq ft)
5
0
-5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
× 10 4
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe River POI 2 (sq ft)
× 10 4
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe River POI 3 (sq ft)
× 10 4
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe River POI 4 (sq ft)
× 10 4
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe River POI 5 (sq ft)
× 10 4
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe River POI 6 (sq ft)
× 10 4
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe River POI 7 (sq ft)

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Water Temperature Figures

Figure K.3.23[a]



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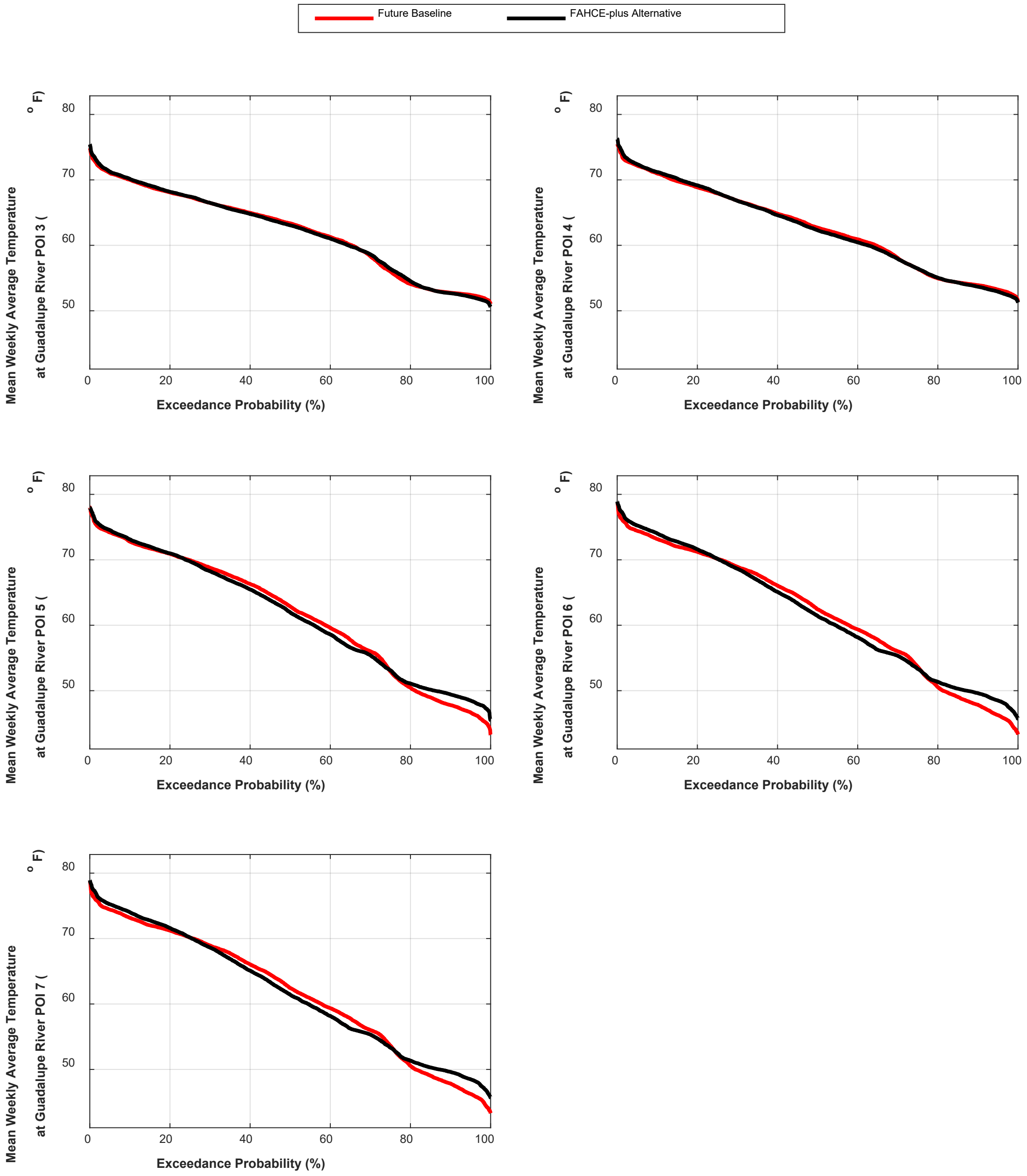
[a] No water temperature model results are available for the points of interest not shown.

Figure K.3.24[a]



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[a] No water temperature model results are available for the points of interest not shown.

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Los Gatos Creek

Current Baseline Comparisons

Flow Figures

Figure K.3.25

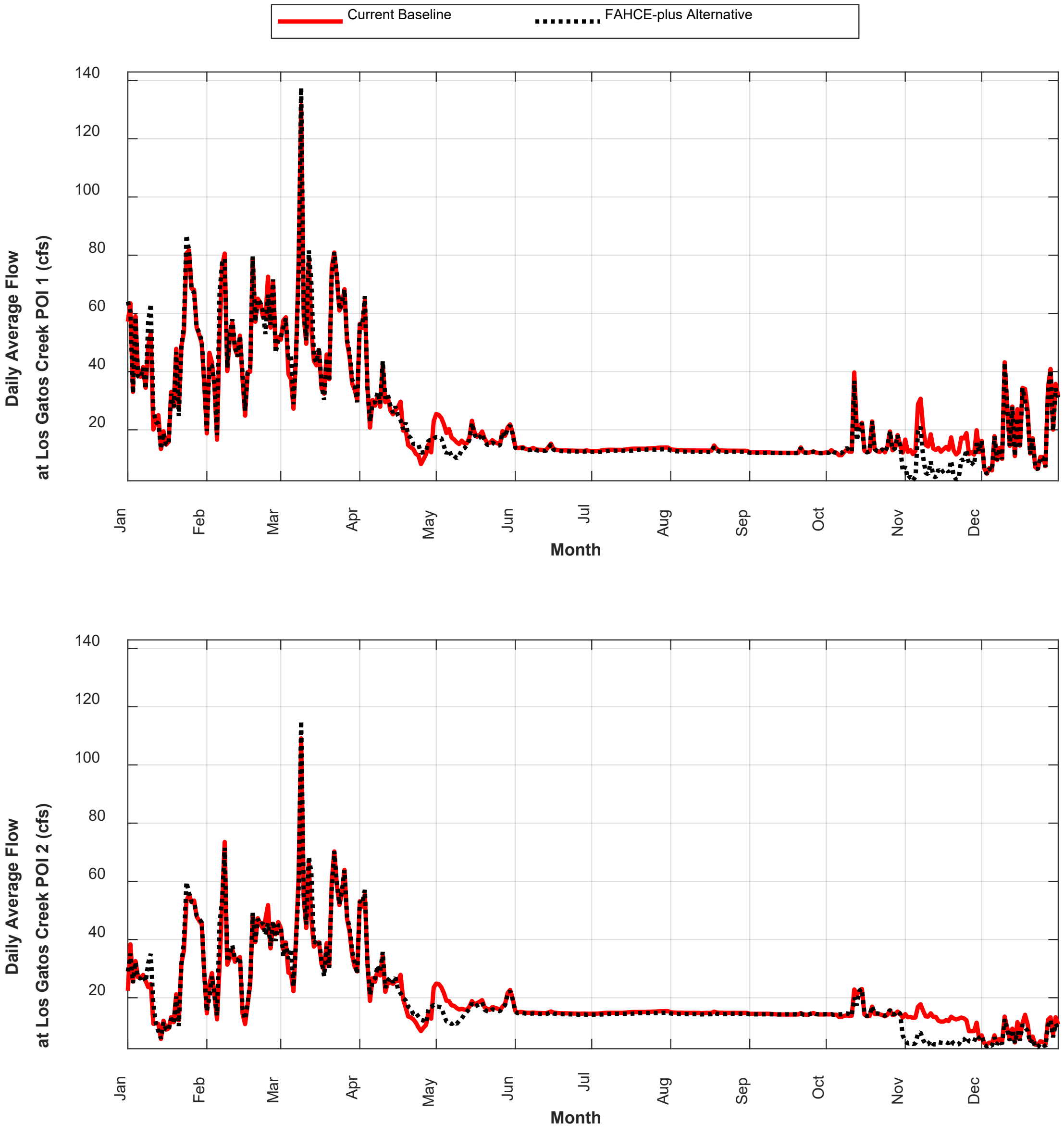
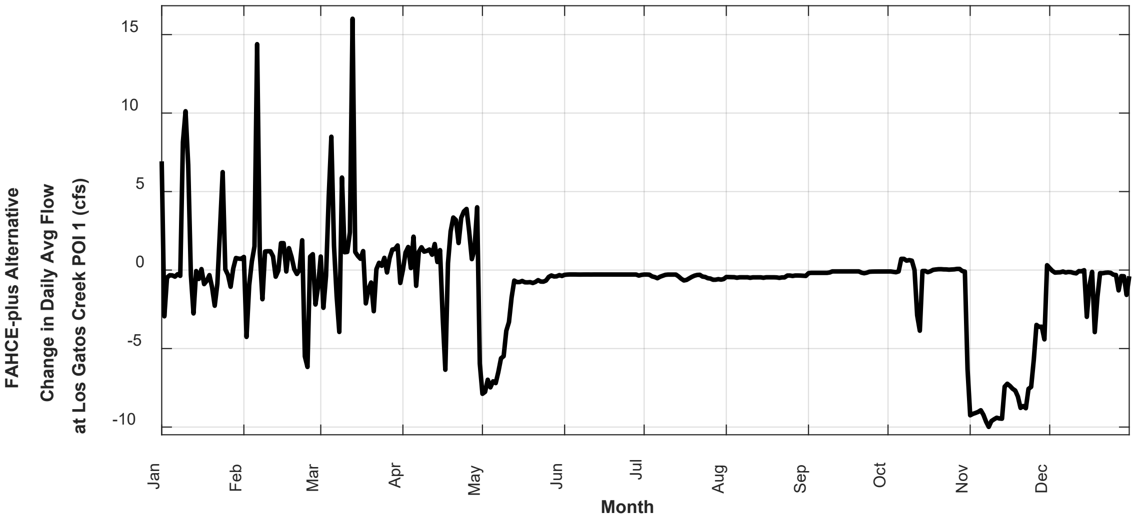
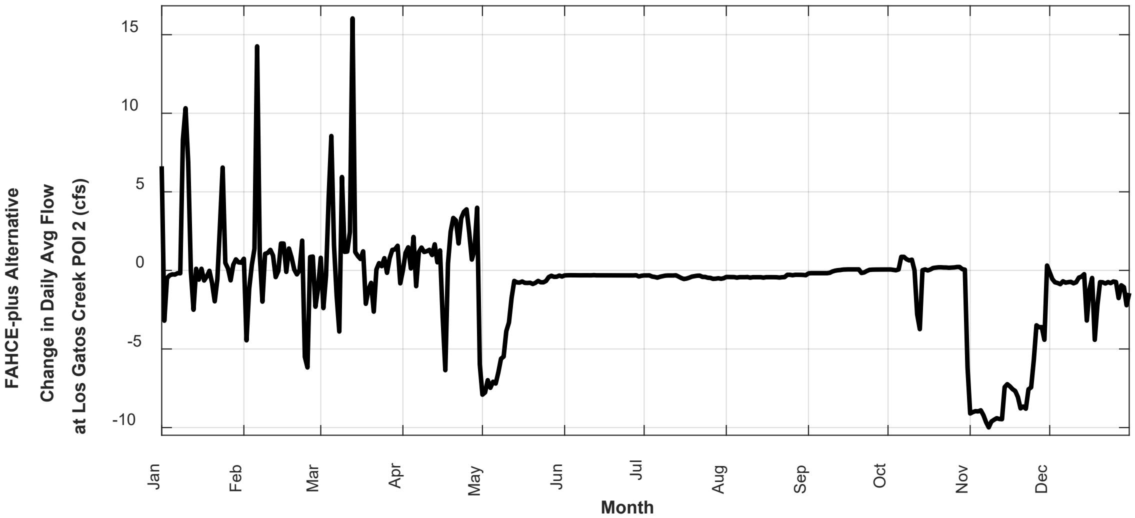


Figure K.3.26


FAHCE-plus Alternative
Change in Daily Avg Flow
at Los Gatos Creek POI 1 (cfs)
15
10
5
0
-5
-10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


FAHCE-plus Alternative
Change in Daily Avg Flow
at Los Gatos Creek POI 2 (cfs)
15
10
5
0
-5
-10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Wetted Area Figures

Figure K.3.27

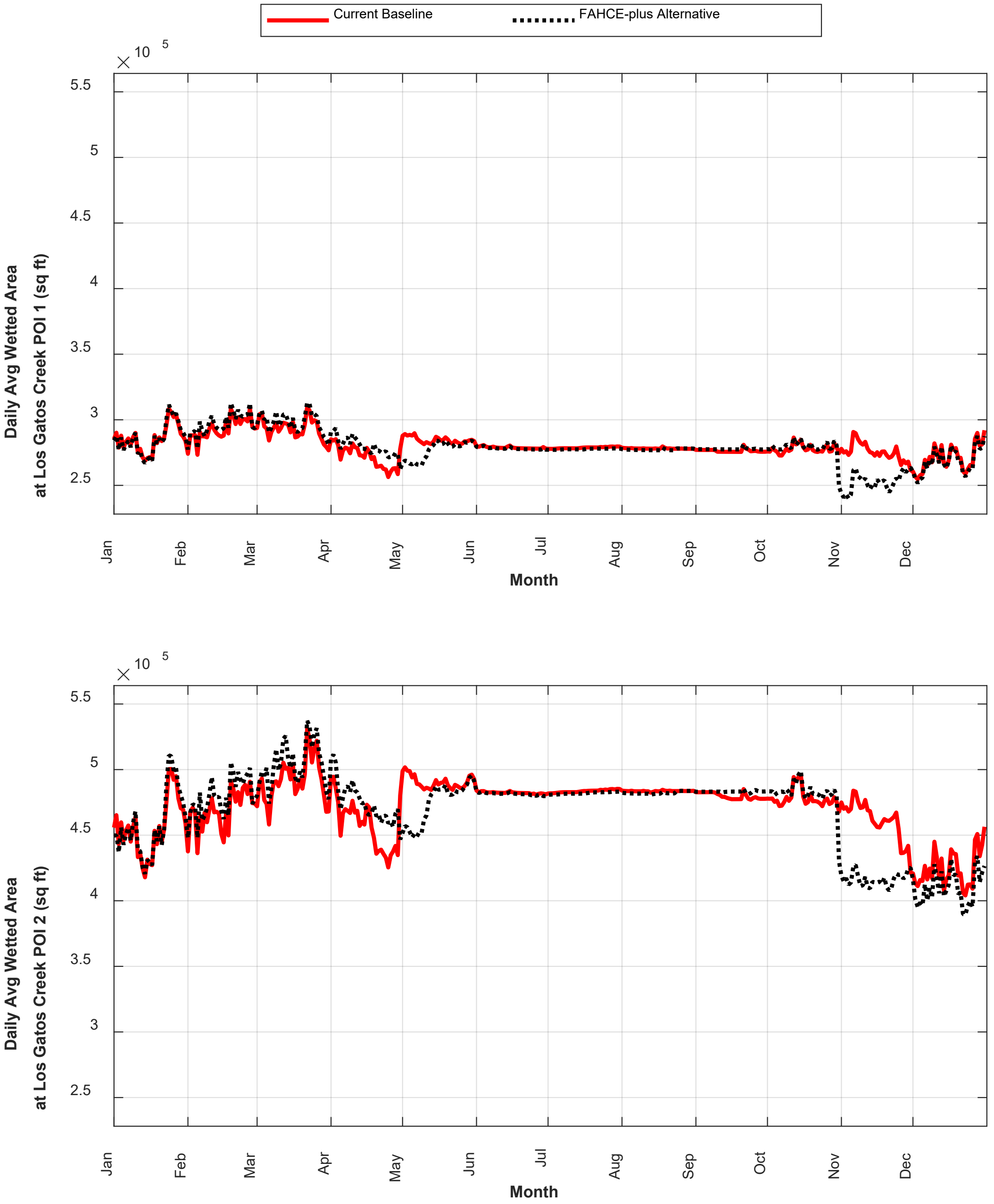
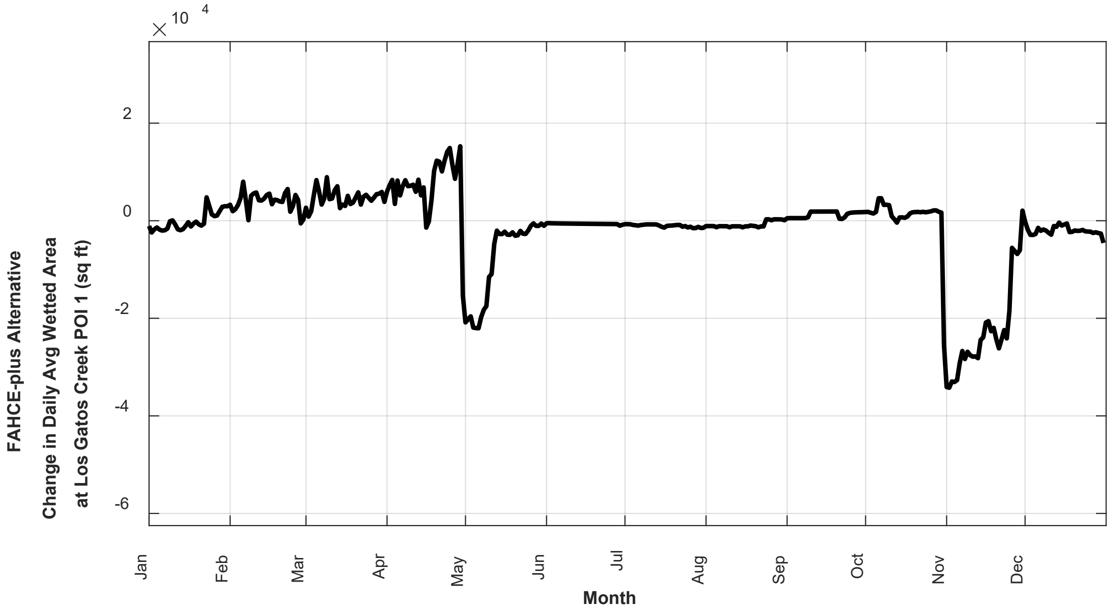
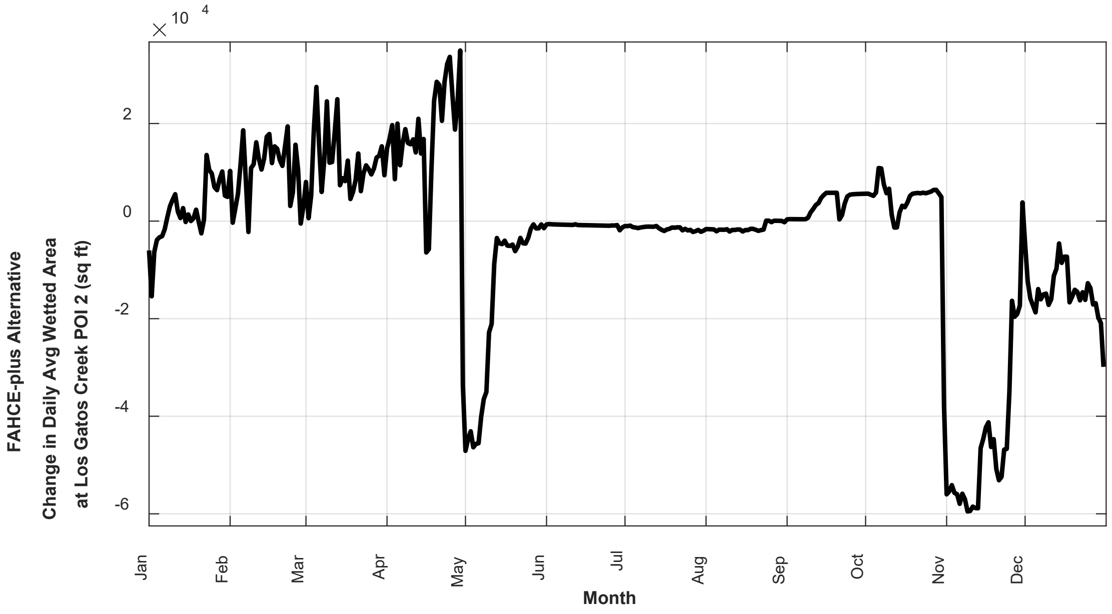


Figure K.3.28


×10 4
2
0
-2
-4
-6
FAHCE-plus Alternative
Change in Daily Avg Wetted Area
at Los Gatos Creek POI 1 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


×10 4
2
0
-2
-4
-6
FAHCE-plus Alternative
Change in Daily Avg Wetted Area
at Los Gatos Creek POI 2 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Water Temperature Figures

Figure K.3.29

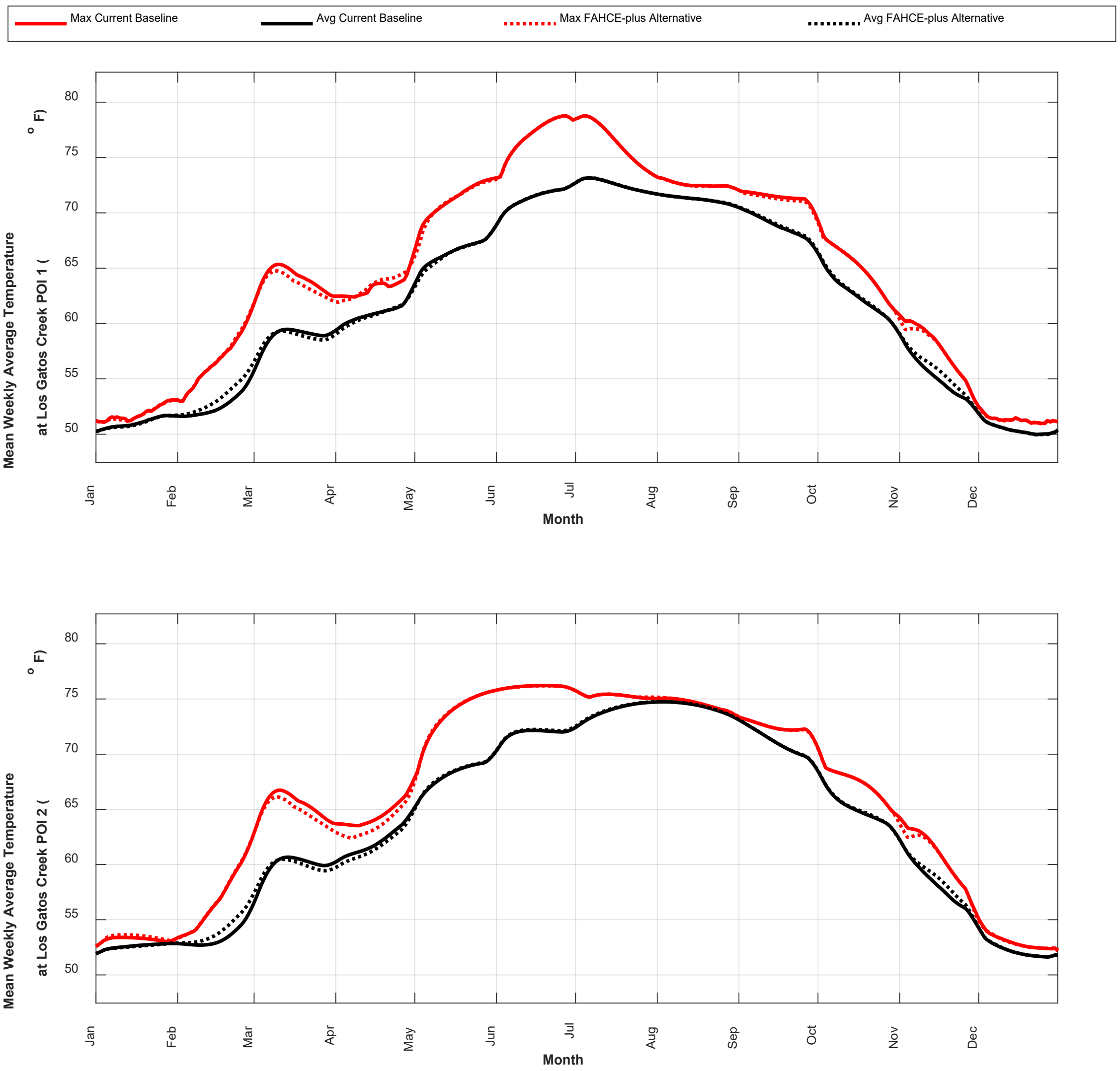
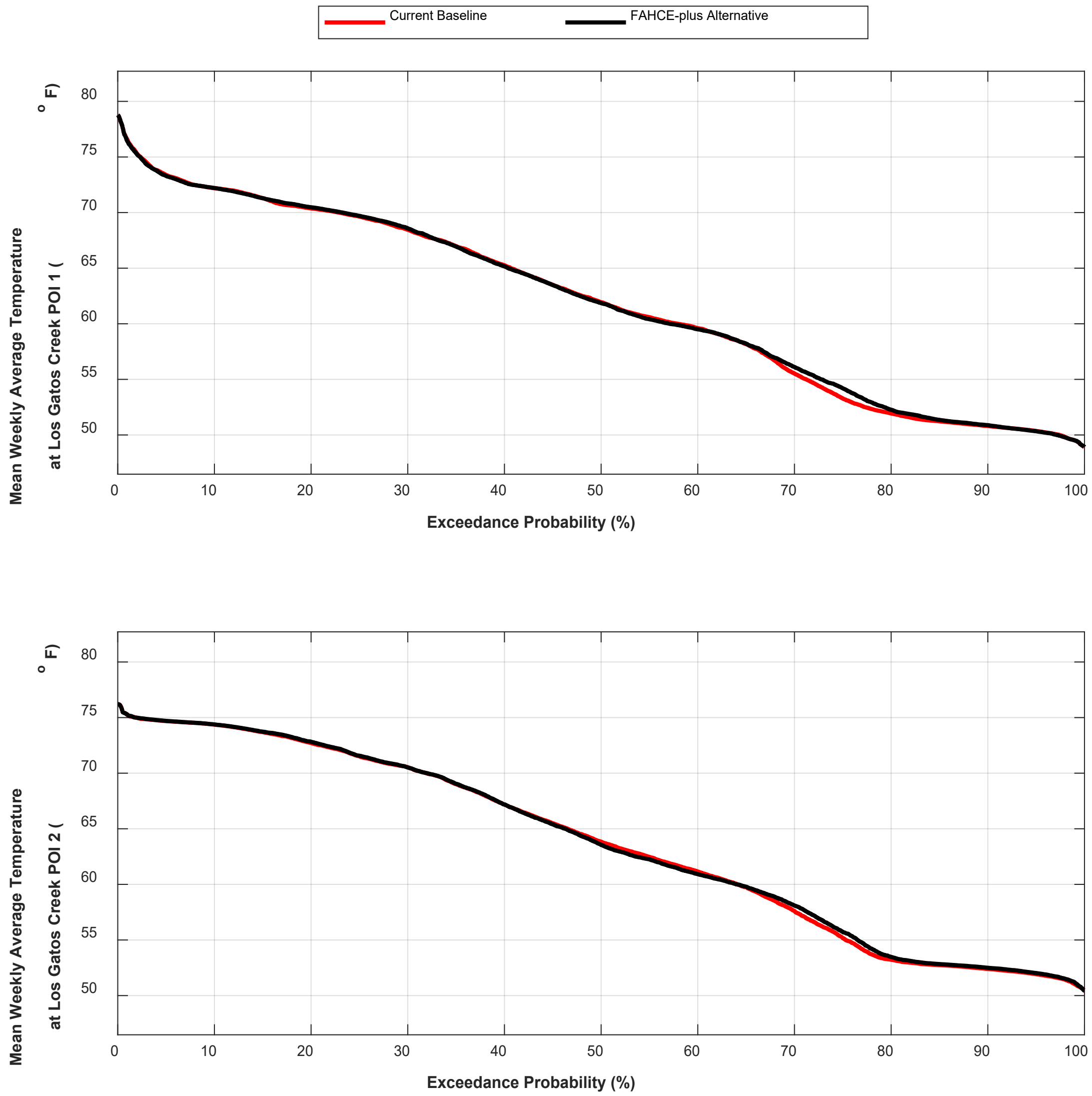


Figure K.3.30

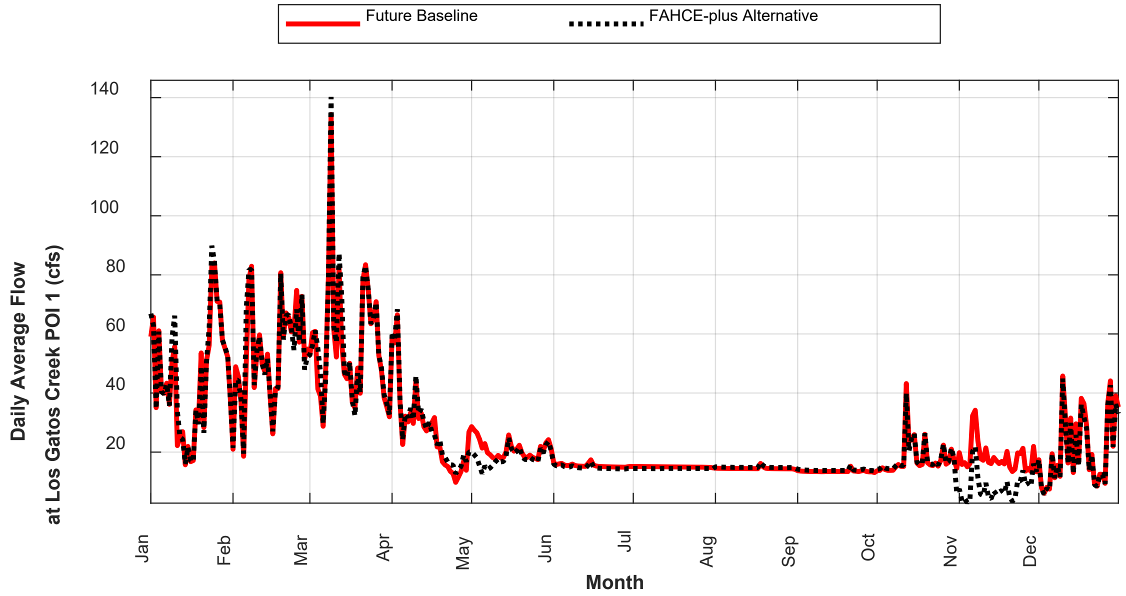

Current Baseline
FAHCE-plus Alternative
Mean Weekly Average Temperature at Los Gatos Creek POI 1 (° F)
80
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
100
Exceedance Probability (%)
Mean Weekly Average Temperature at Los Gatos Creek POI 2 (° F)
80
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
100
Exceedance Probability (%)

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Future Baseline Comparisons

Flow Figures

Figure K.3.31



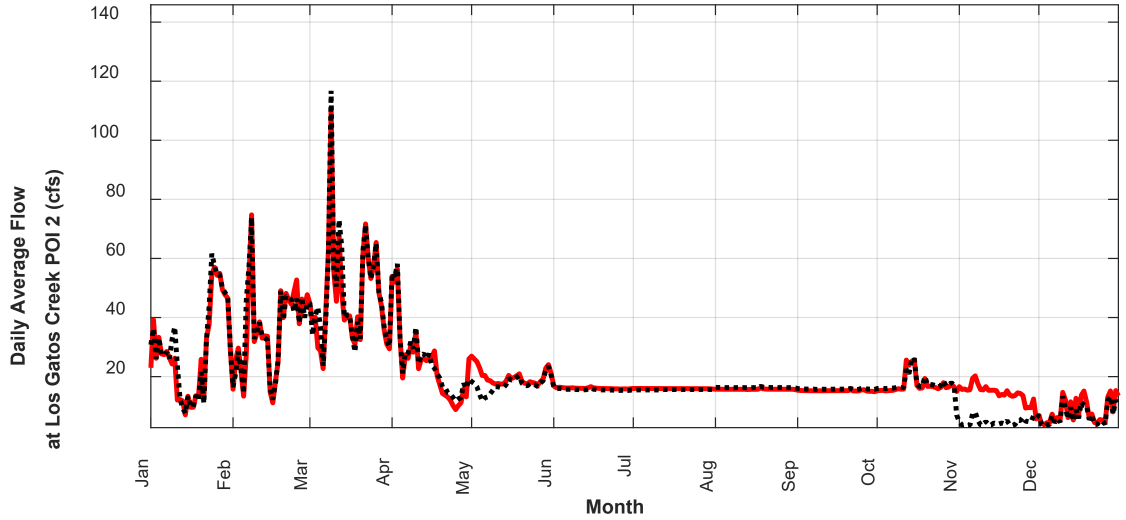
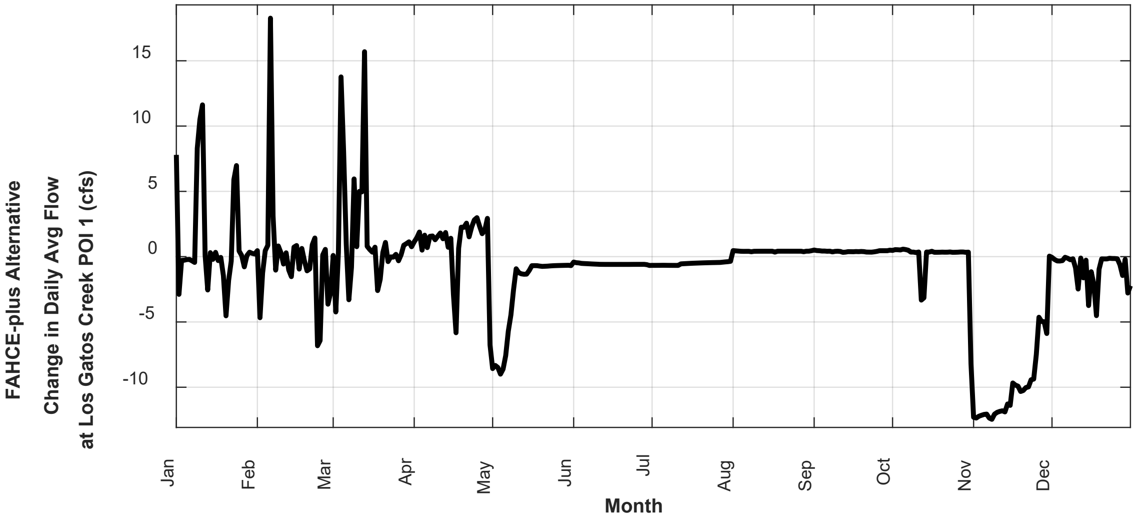
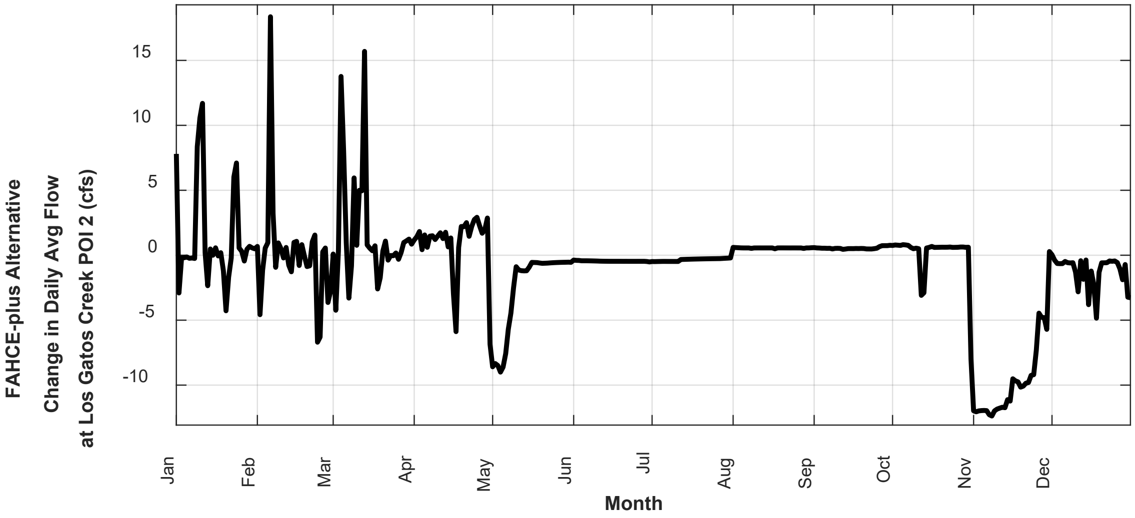


Figure K.3.32


15
10
5
0
-5
-10
FAHCE-plus Alternative
Change in Daily Avg Flow
at Los Gatos Creek POI 1 (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


15
10
5
0
-5
-10
FAHCE-plus Alternative
Change in Daily Avg Flow
at Los Gatos Creek POI 2 (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Wetted Area Figures

Figure K.3.33

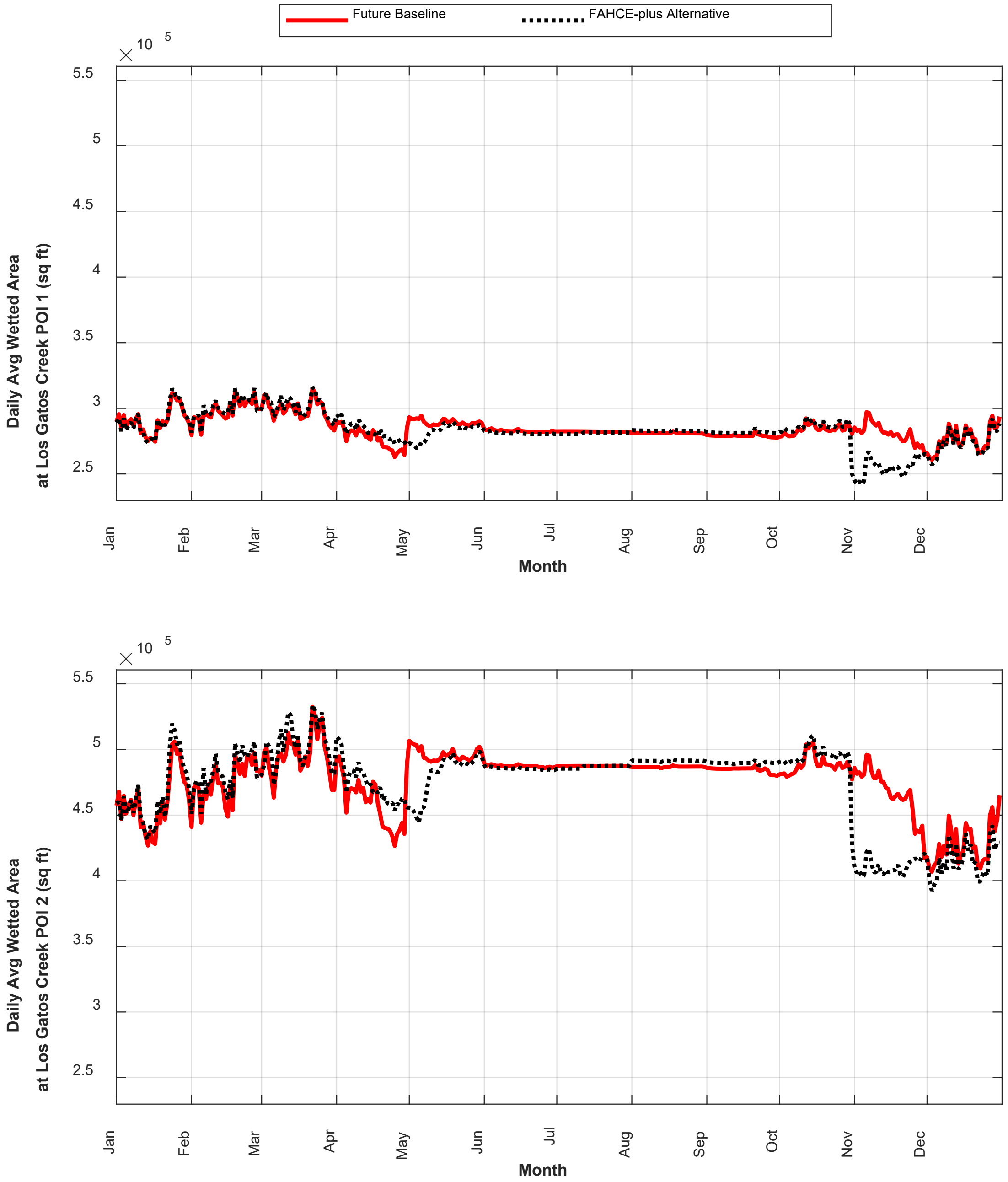
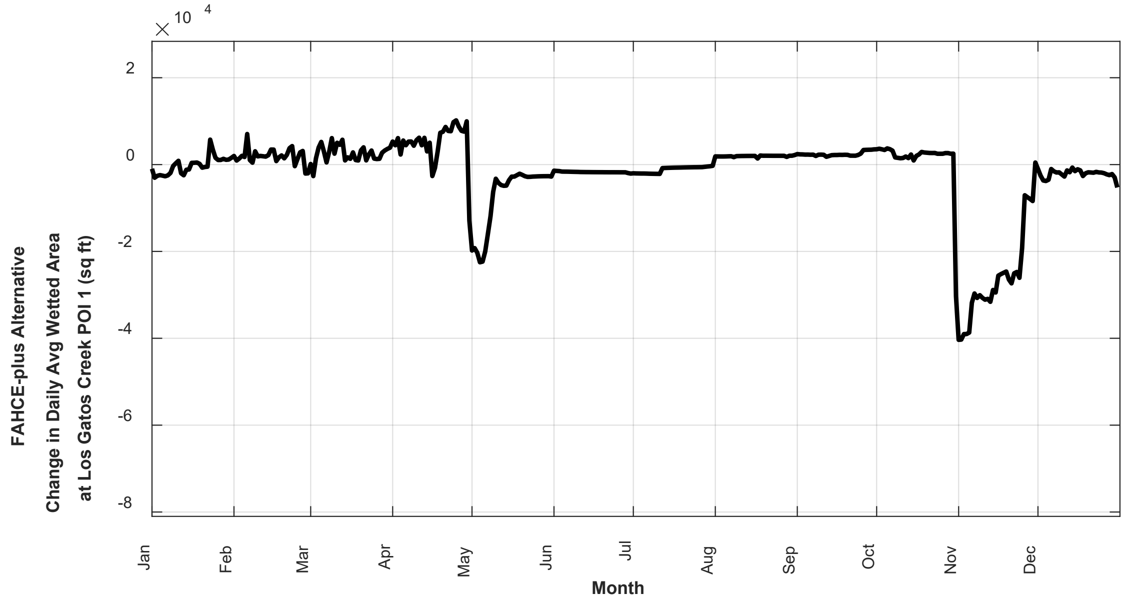
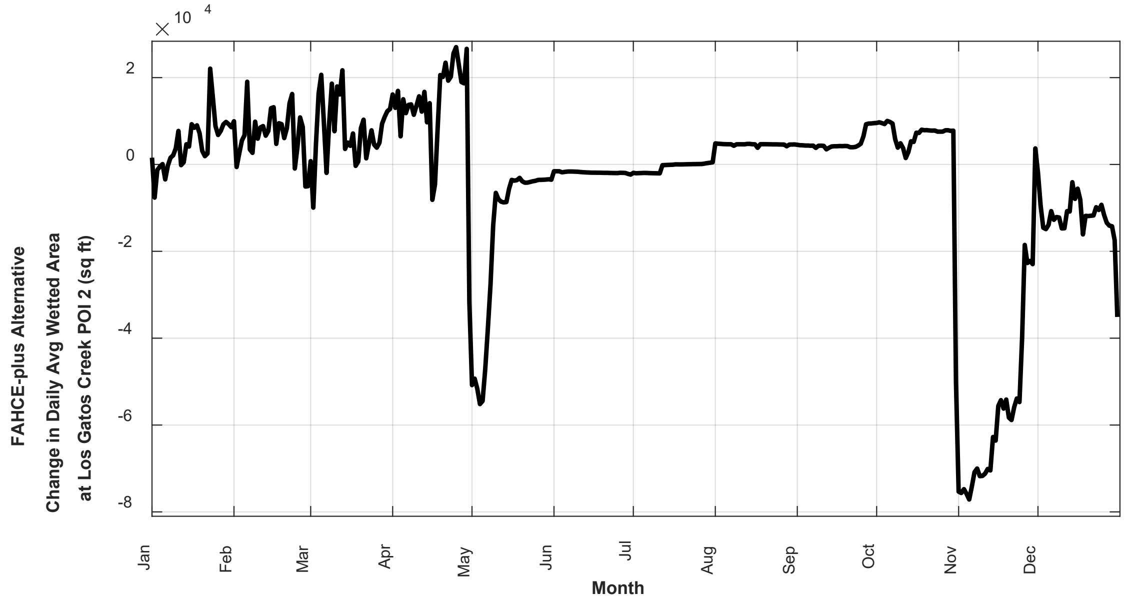


Figure K.3.34


× 10 4
2
0
-2
-4
-6
-8
FAHCE-plus Alternative
Change in Daily Avg Wetted Area
at Los Gatos Creek POI 1 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


× 10 4
2
0
-2
-4
-6
-8
FAHCE-plus Alternative
Change in Daily Avg Wetted Area
at Los Gatos Creek POI 2 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Water Temperature Figures

Figure K.3.35

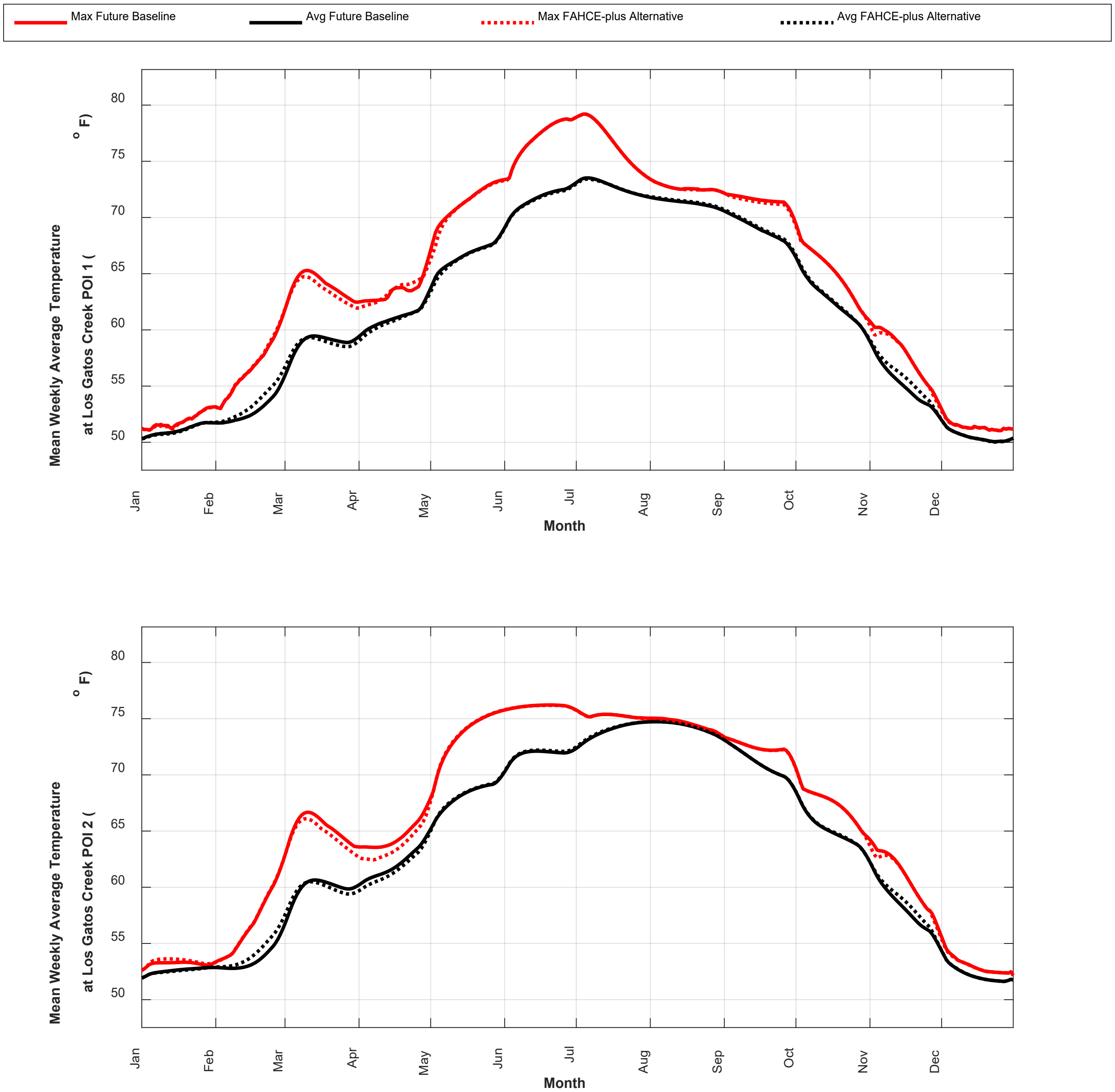
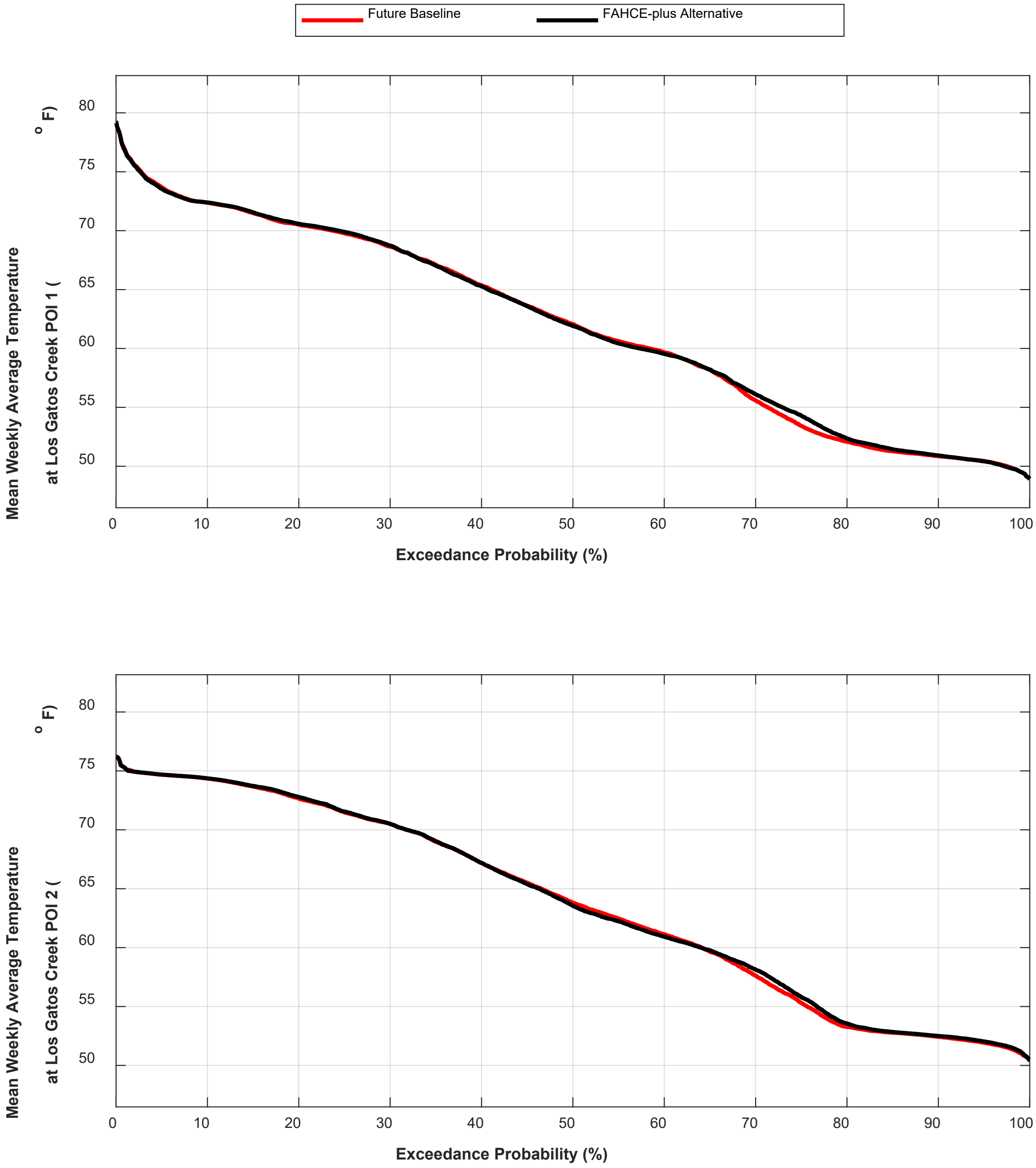


Figure K.3.36


Future Baseline
FAHCE-plus Alternative
Mean Weekly Average Temperature at Los Gatos Creek POI 1 (° F)
80
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
100
Exceedance Probability (%)
Mean Weekly Average Temperature at Los Gatos Creek POI 2 (° F)
80
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
100
Exceedance Probability (%)

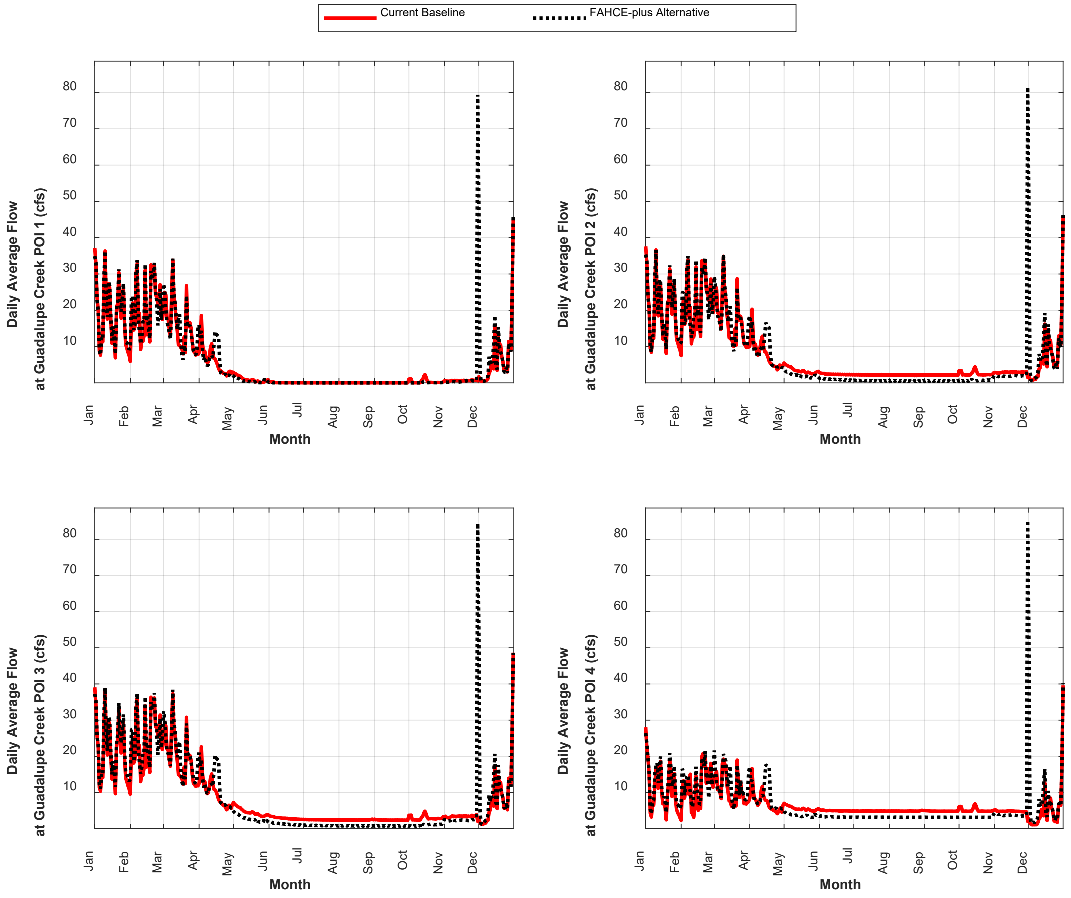
Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Guadalupe Creek

Current Baseline Comparisons

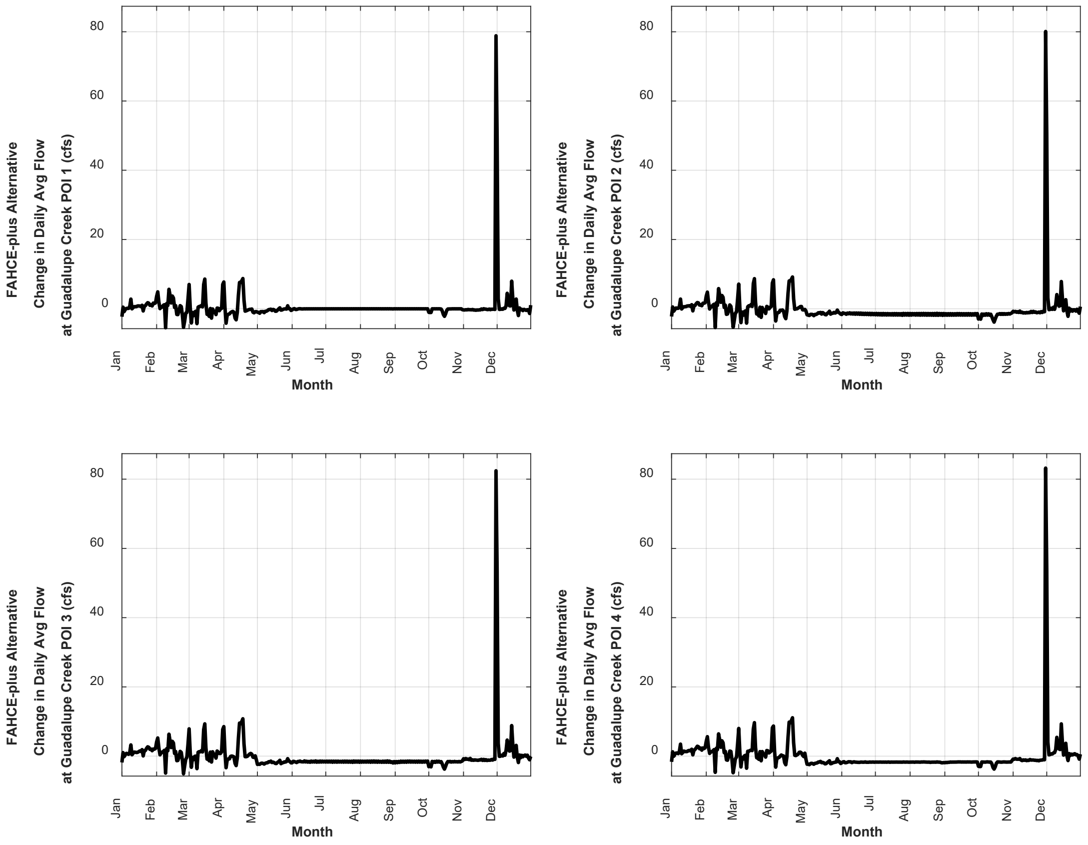
Flow Figures

Figure K.3.37



Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Figure K.3.38



Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Wetted Area Figures

Figure K.3.39

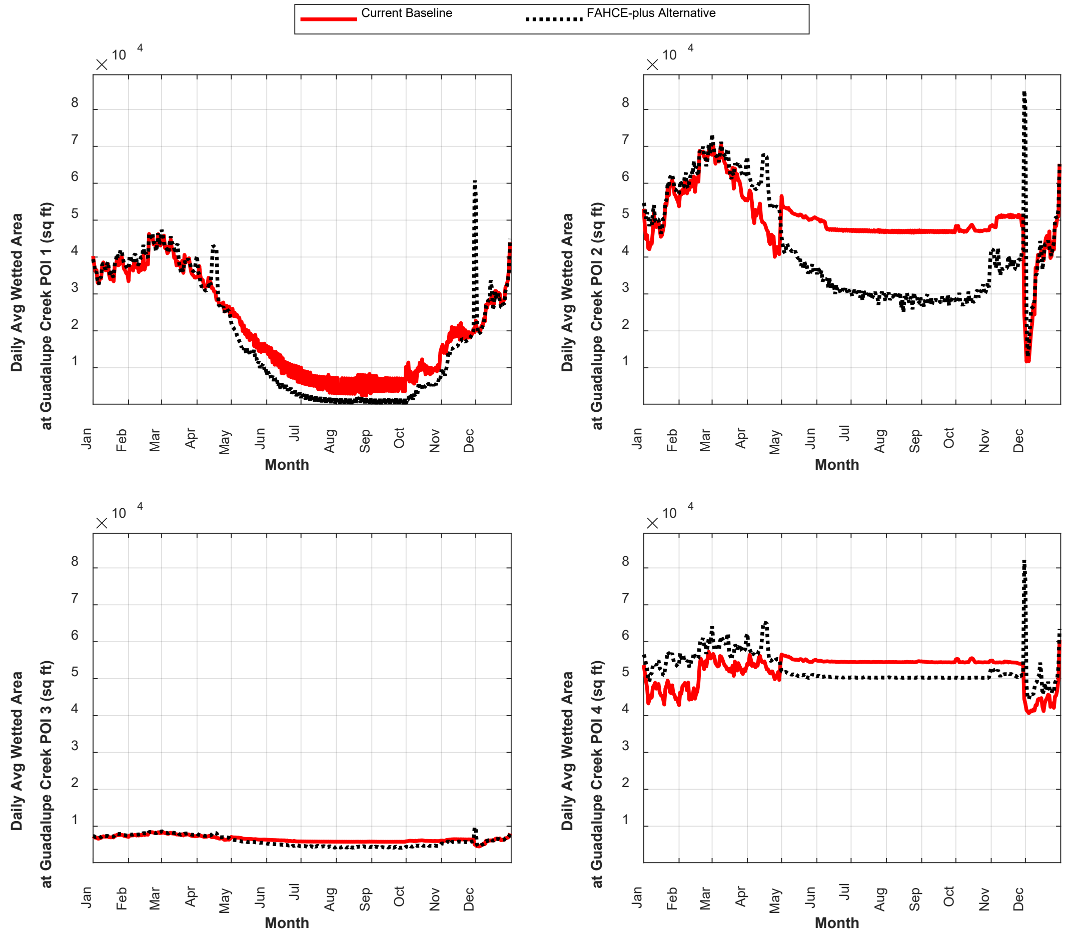
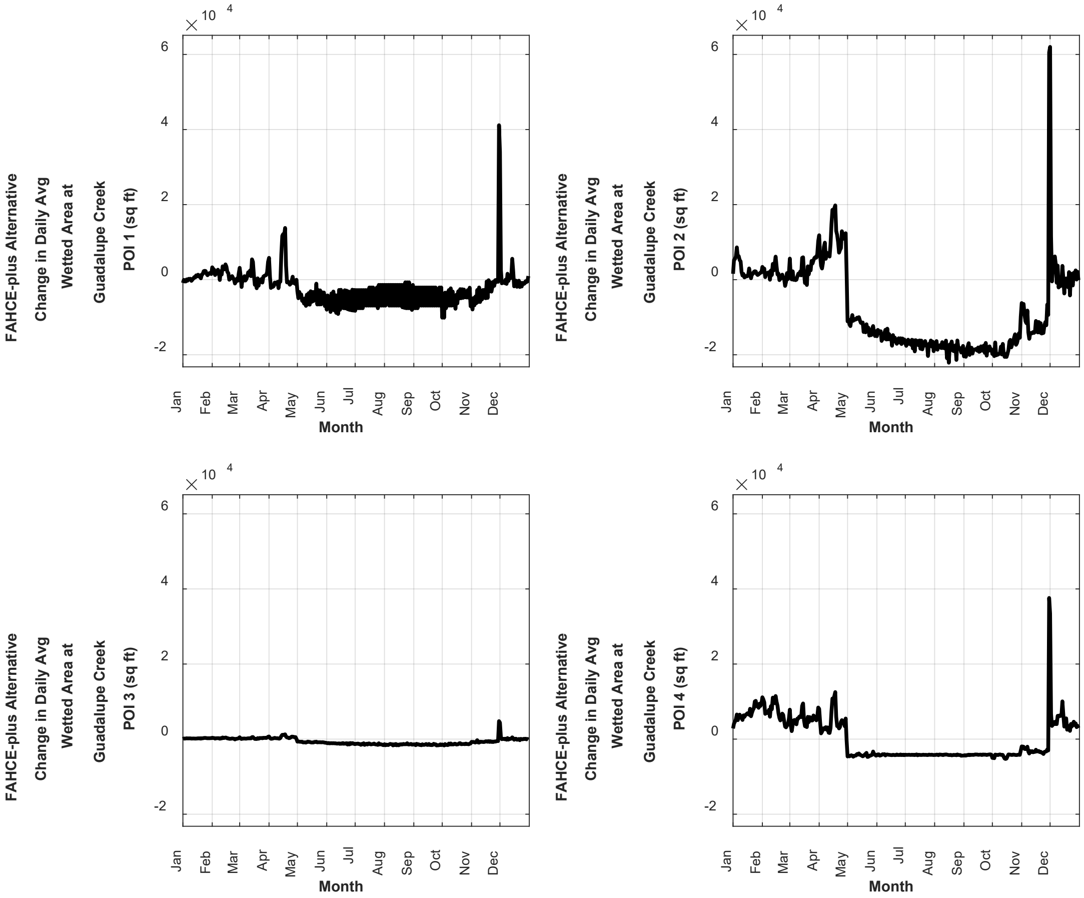


Figure K.3.40


×10^4
6
4
2
0
-2
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe Creek POI 1 (sq ft)
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe Creek POI 2 (sq ft)
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe Creek POI 3 (sq ft)
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe Creek POI 4 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Water Temperature Figures

Figure K.3.41

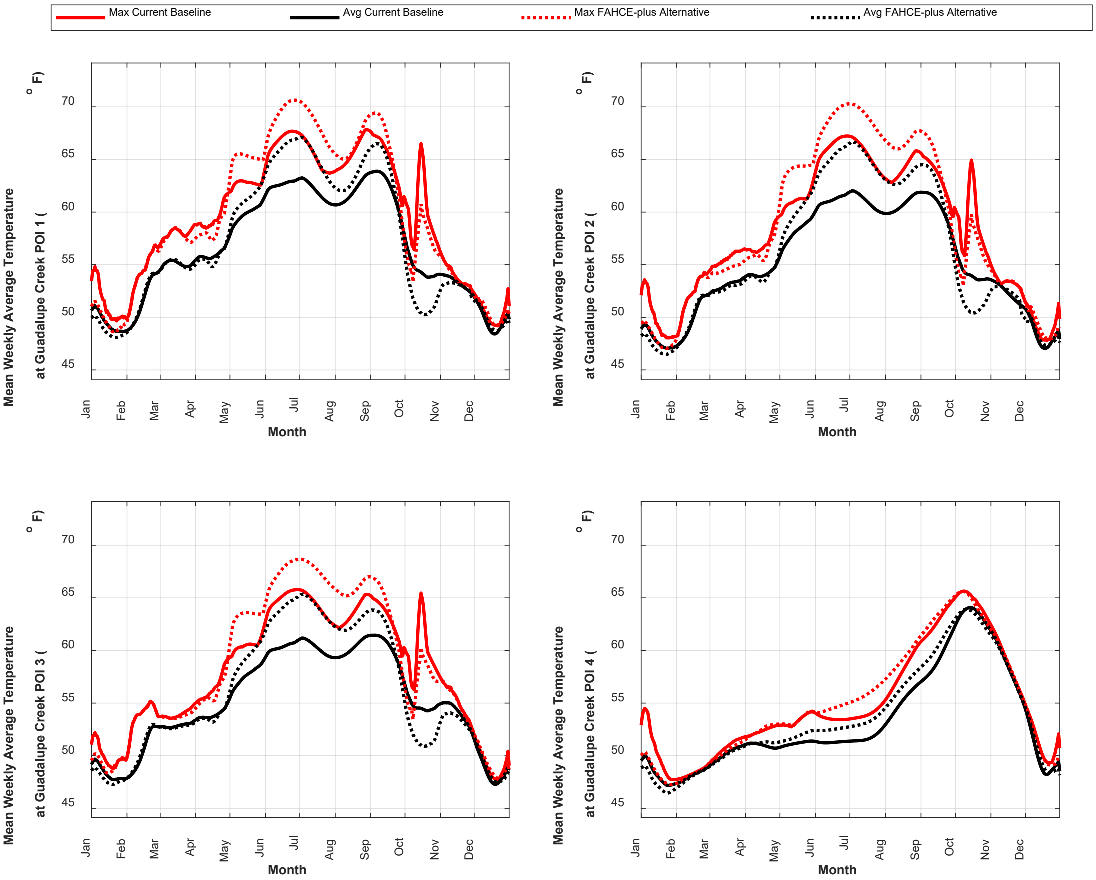
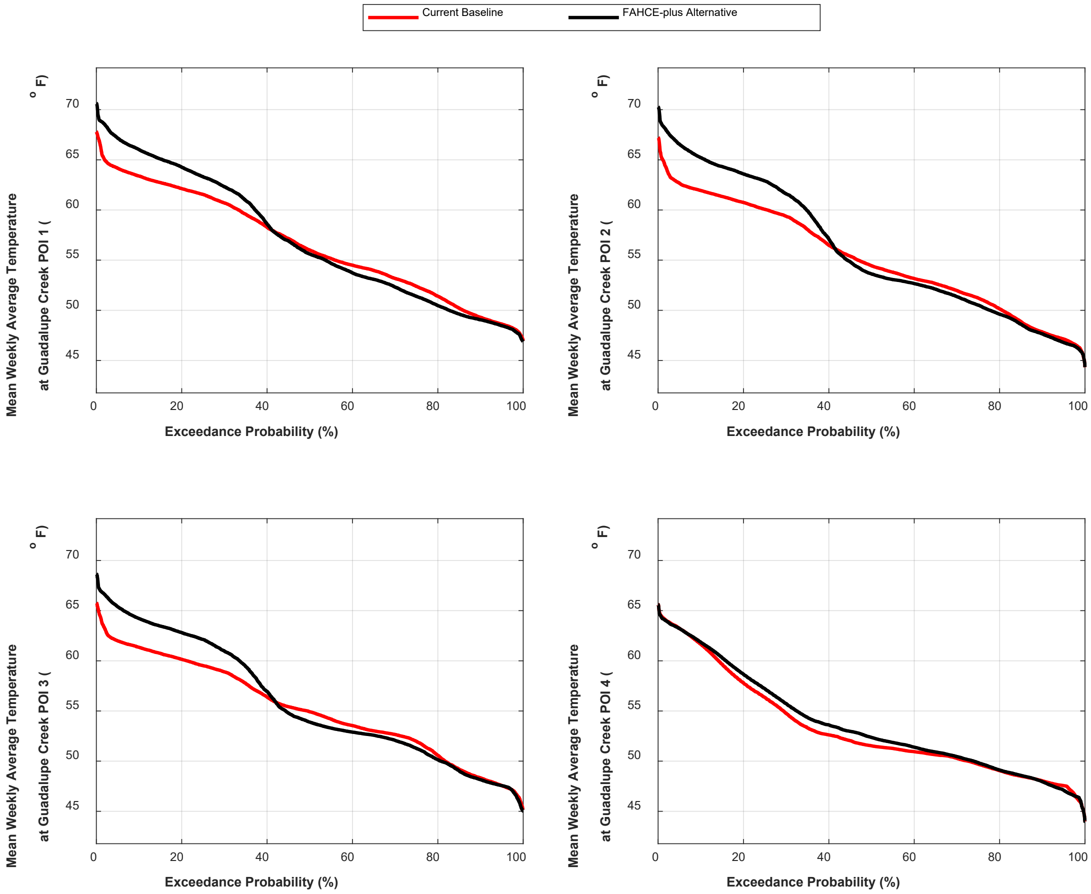


Figure K.3.42


Current Baseline
FAHCE-plus Alternative
Mean Weekly Average Temperature at Guadalupe Creek POI 1 (° F)
Mean Weekly Average Temperature at Guadalupe Creek POI 2 (° F)
Mean Weekly Average Temperature at Guadalupe Creek POI 3 (° F)
Mean Weekly Average Temperature at Guadalupe Creek POI 4 (° F)
70
65
60
55
50
45
0
20
40
60
80
100
Exceedance Probability (%)

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Future Baseline Comparisons

Flow Figures

Figure K.3.43

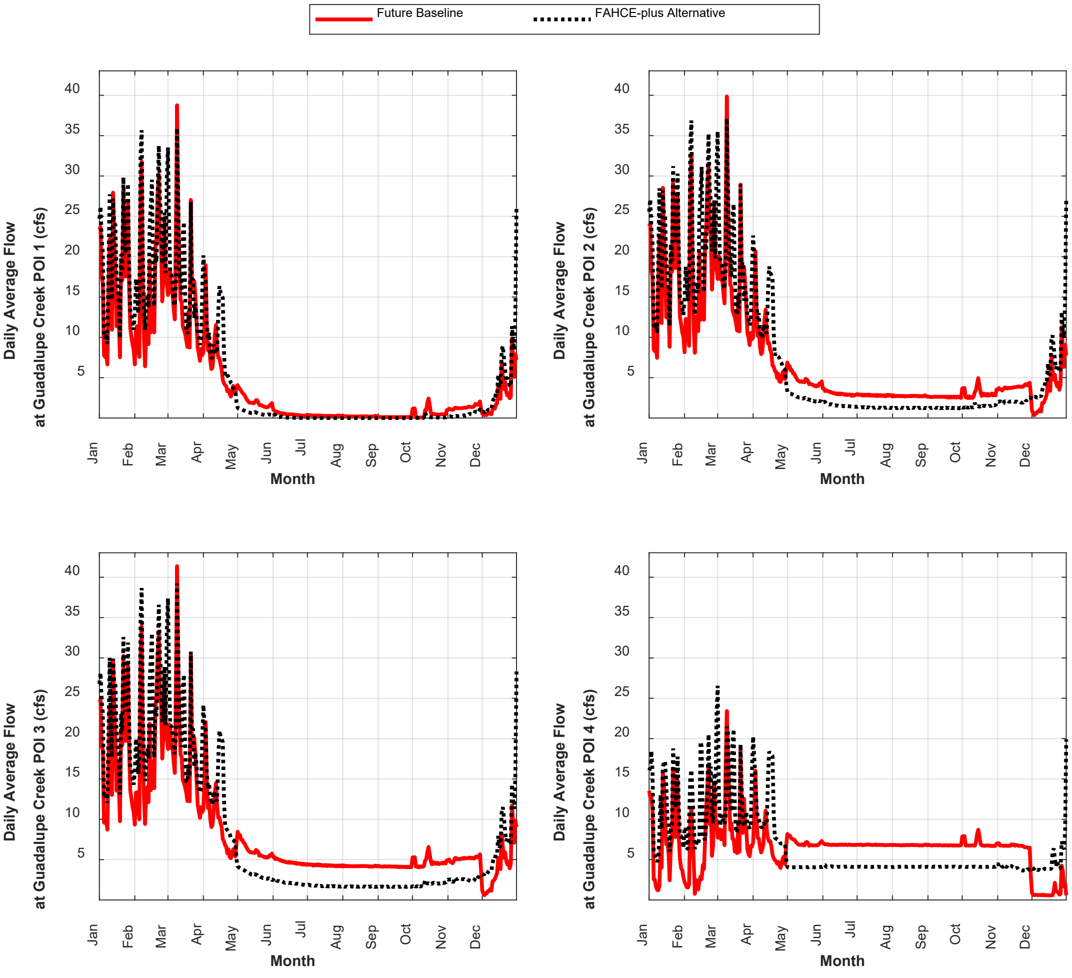
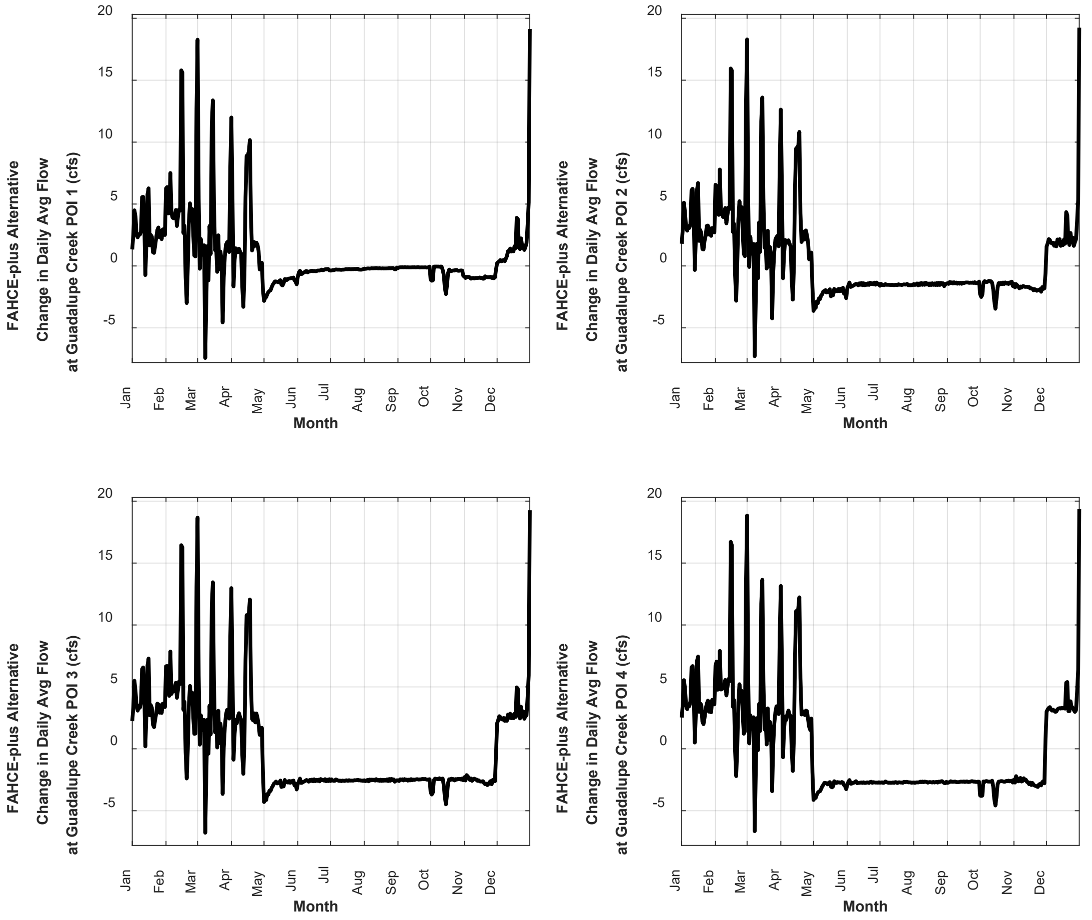


Figure K.3.44


FAHCE-plus Alternative
Change in Daily Avg Flow
at Guadalupe Creek POI 1 (cfs)
FAHCE-plus Alternative
Change in Daily Avg Flow
at Guadalupe Creek POI 2 (cfs)
FAHCE-plus Alternative
Change in Daily Avg Flow
at Guadalupe Creek POI 3 (cfs)
FAHCE-plus Alternative
Change in Daily Avg Flow
at Guadalupe Creek POI 4 (cfs)
20
15
10
5
0
-5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Wetted Area Figures

Figure K.3.45

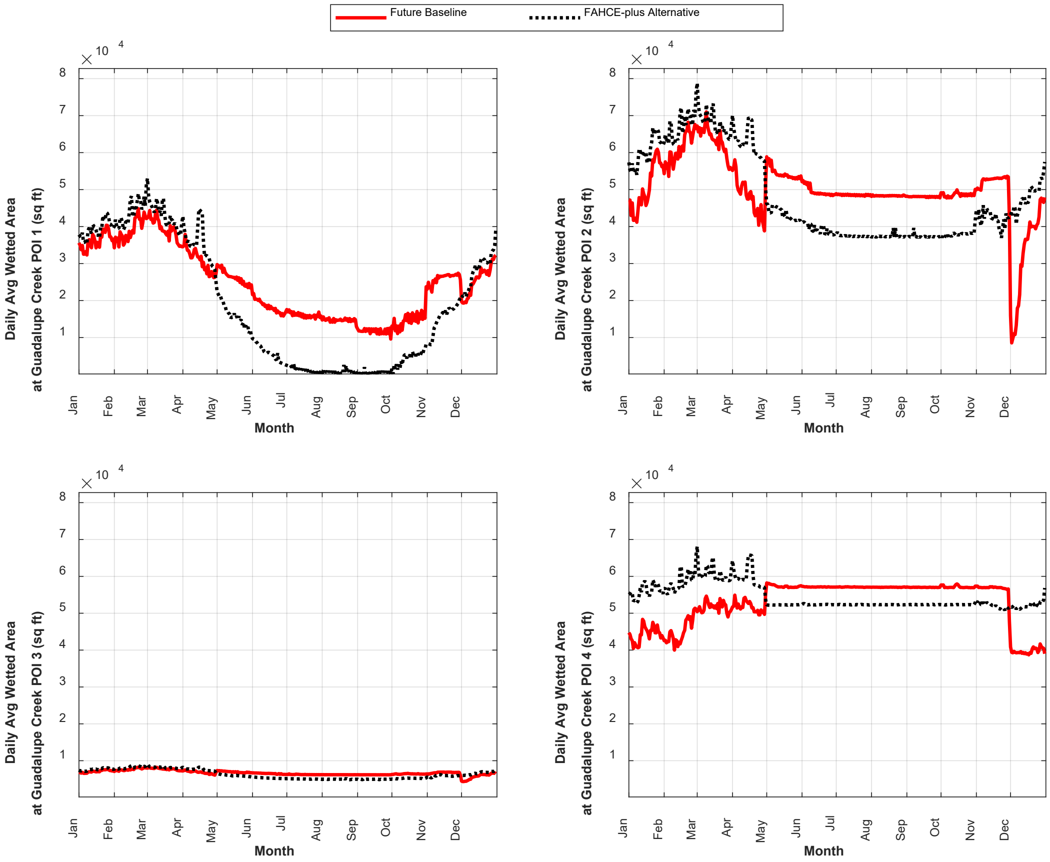
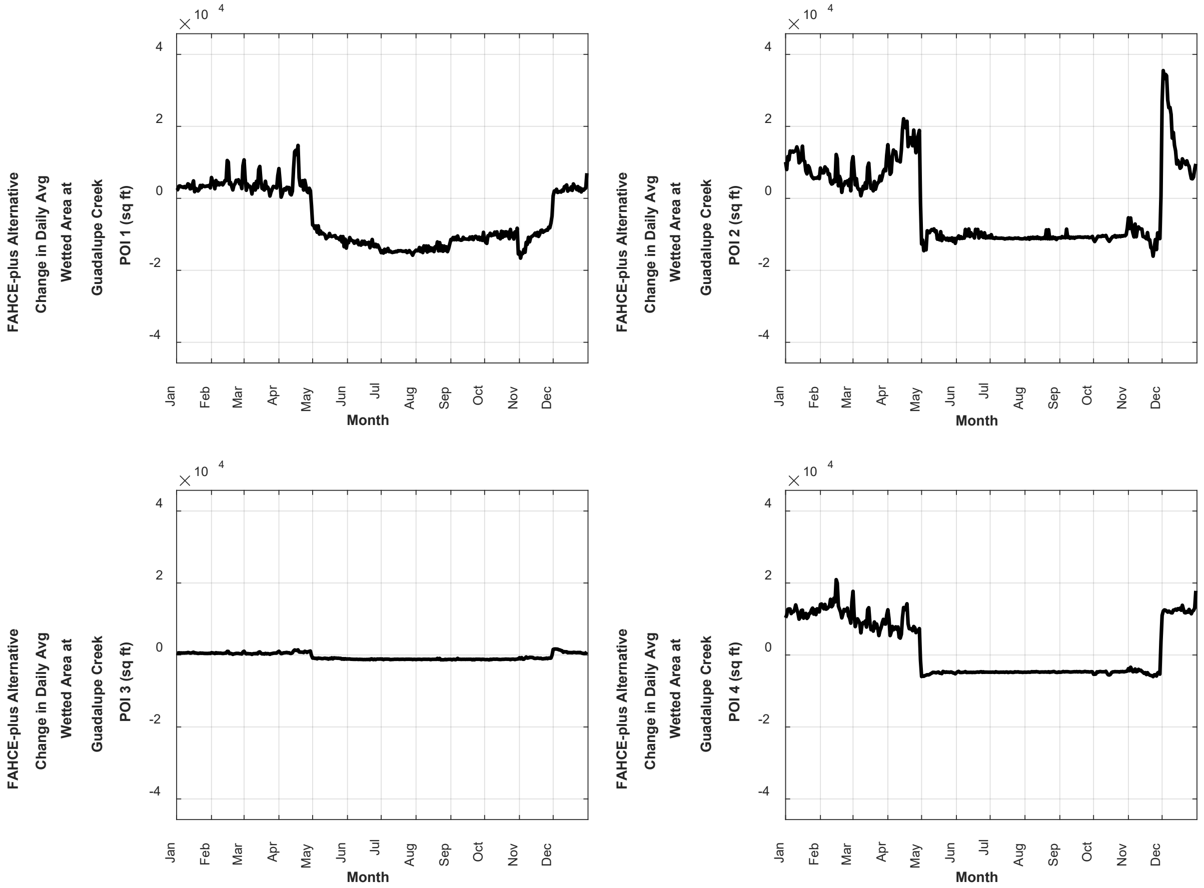


Figure K.3.46


×10^4
4
2
0
-2
-4
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe Creek POI 1 (sq ft)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month
×10^4
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe Creek POI 2 (sq ft)
Month
×10^4
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe Creek POI 3 (sq ft)
Month
×10^4
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Guadalupe Creek POI 4 (sq ft)
Month

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Water Temperature Figures

Figure K.3.47

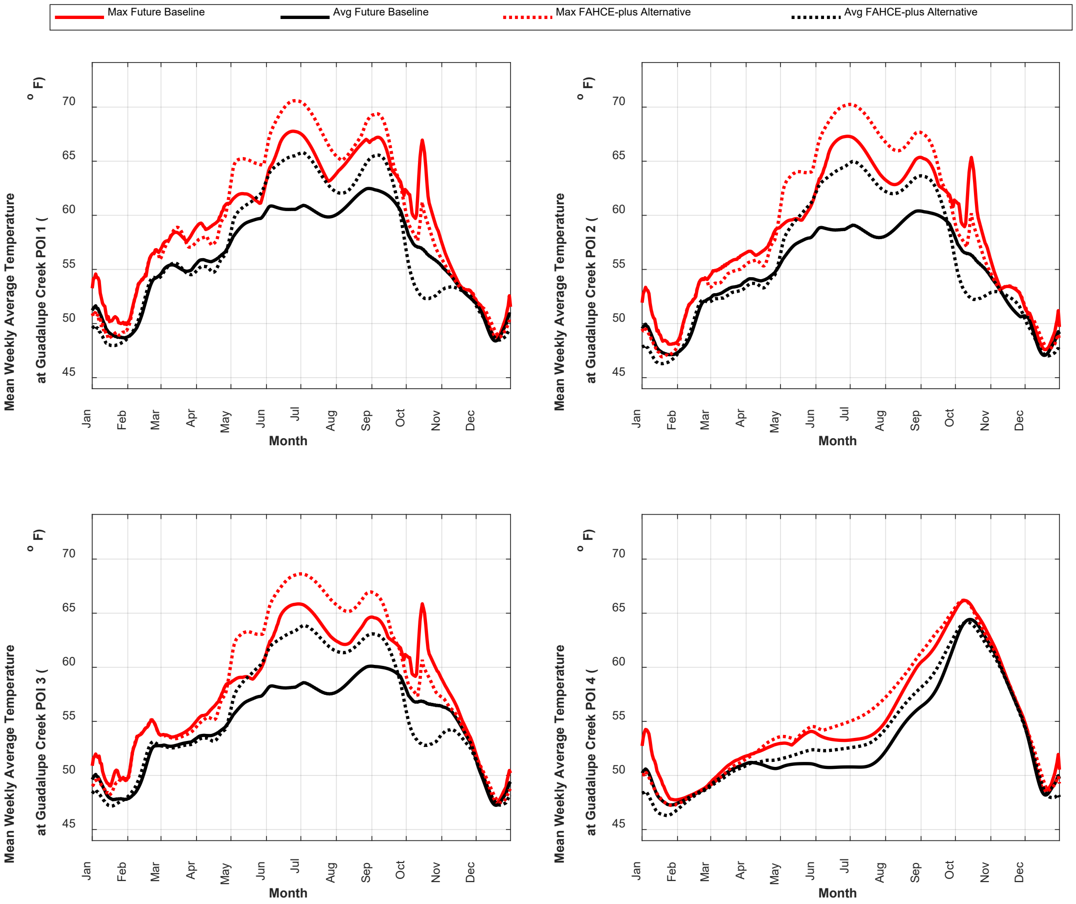
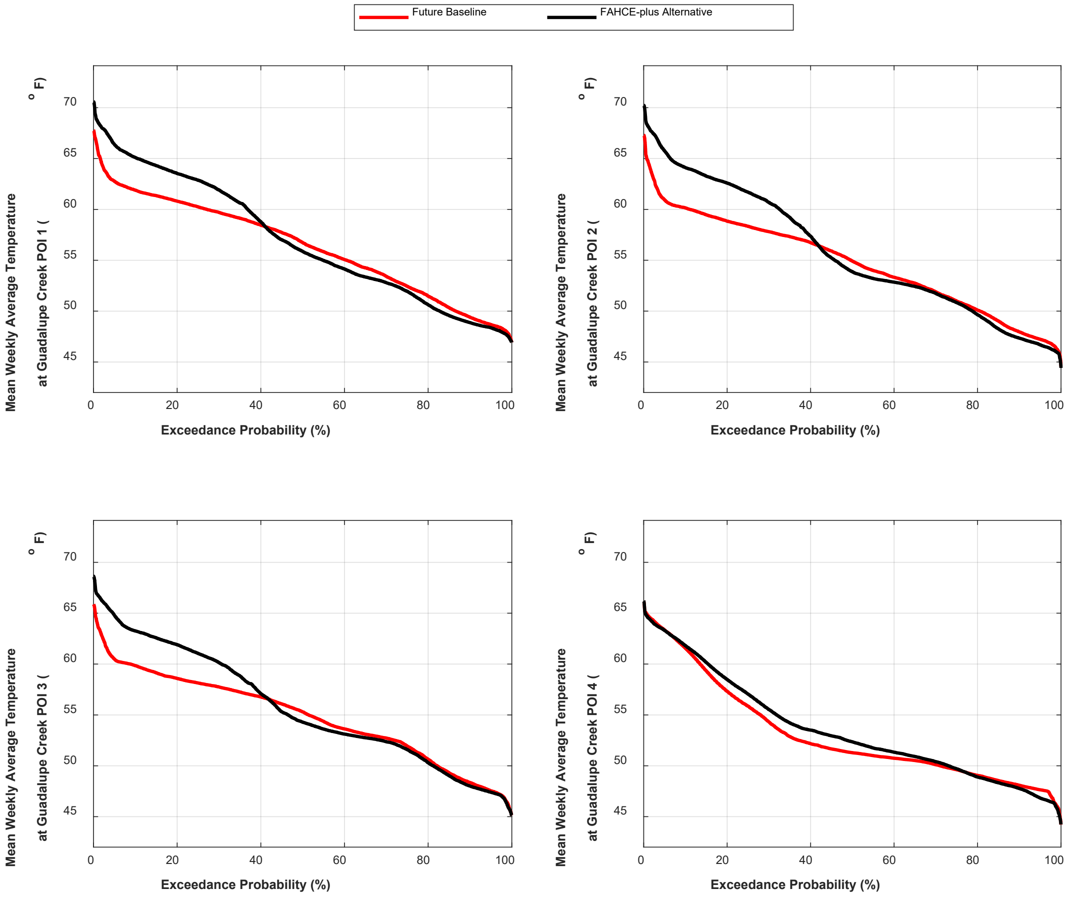


Figure K.3.48


Future Baseline
FAHCE-plus Alternative
Mean Weekly Average Temperature at Guadalupe Creek POI 1 (°F)
Mean Weekly Average Temperature at Guadalupe Creek POI 2 (°F)
Mean Weekly Average Temperature at Guadalupe Creek POI 3 (°F)
Mean Weekly Average Temperature at Guadalupe Creek POI 4 (°F)
70
65
60
55
50
45
0
20
40
60
80
100
Exceedance Probability (%)

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Alamitos Creek

Current Baseline Comparisons

Flow Figures

Figure K.3.49

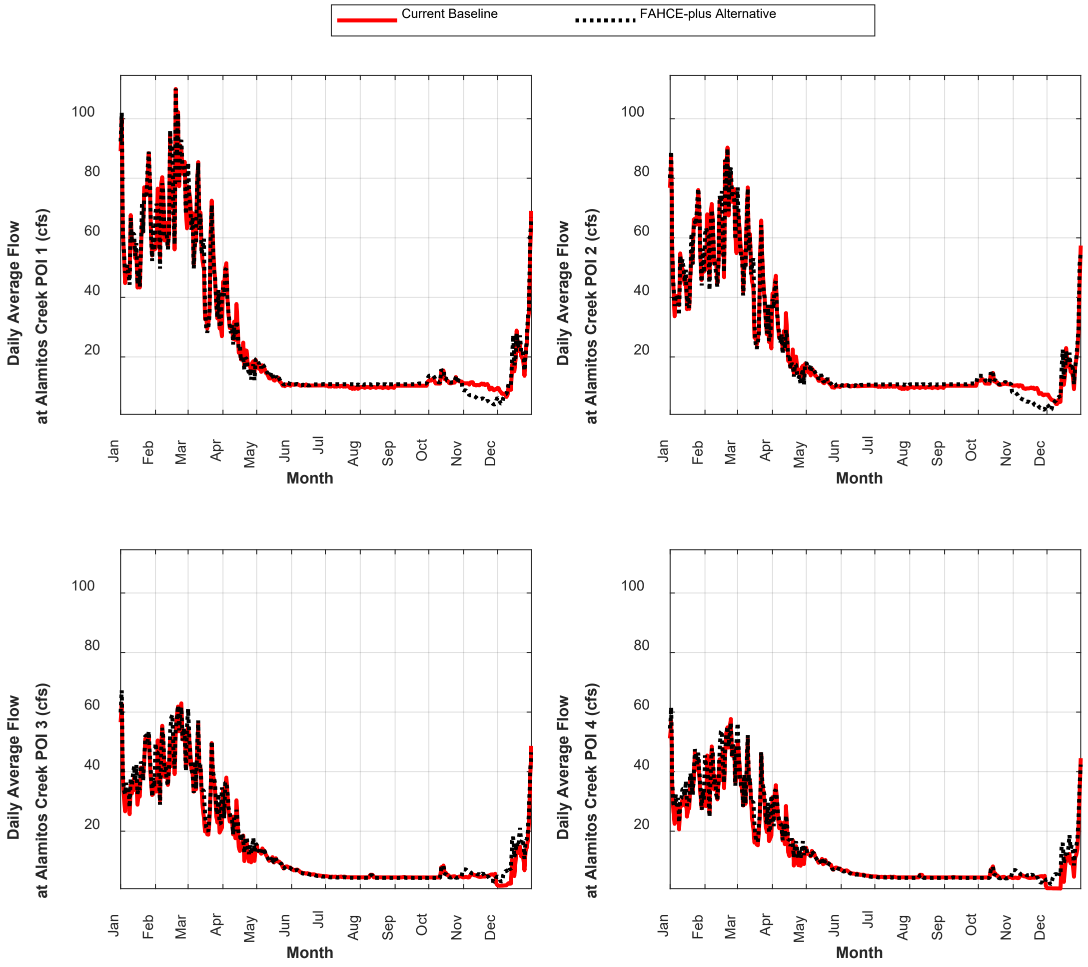
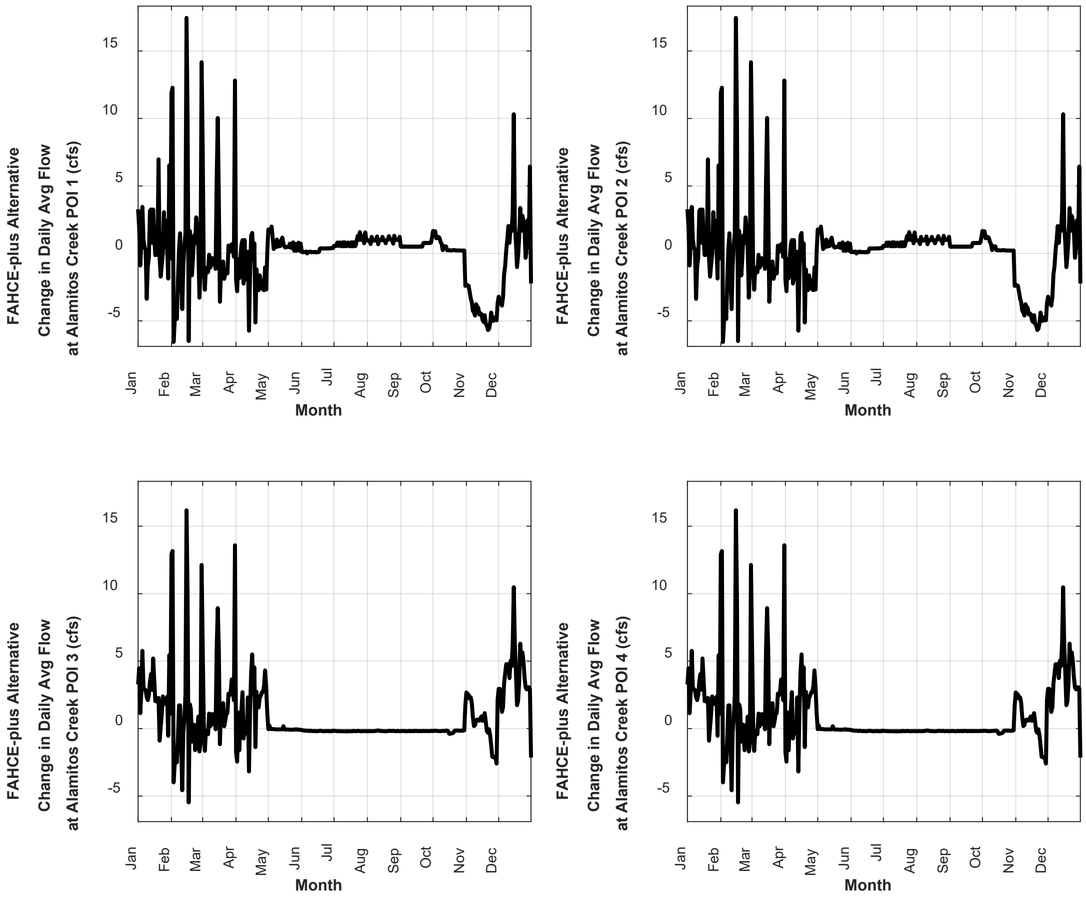


Figure K.3.50


FAHCE-plus Alternative
Change in Daily Avg Flow
at Alamitos Creek POI 1 (cfs)
FAHCE-plus Alternative
Change in Daily Avg Flow
at Alamitos Creek POI 2 (cfs)
FAHCE-plus Alternative
Change in Daily Avg Flow
at Alamitos Creek POI 3 (cfs)
FAHCE-plus Alternative
Change in Daily Avg Flow
at Alamitos Creek POI 4 (cfs)
15
10
5
0
-5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Wetted Area Figures

Figure K.3.51

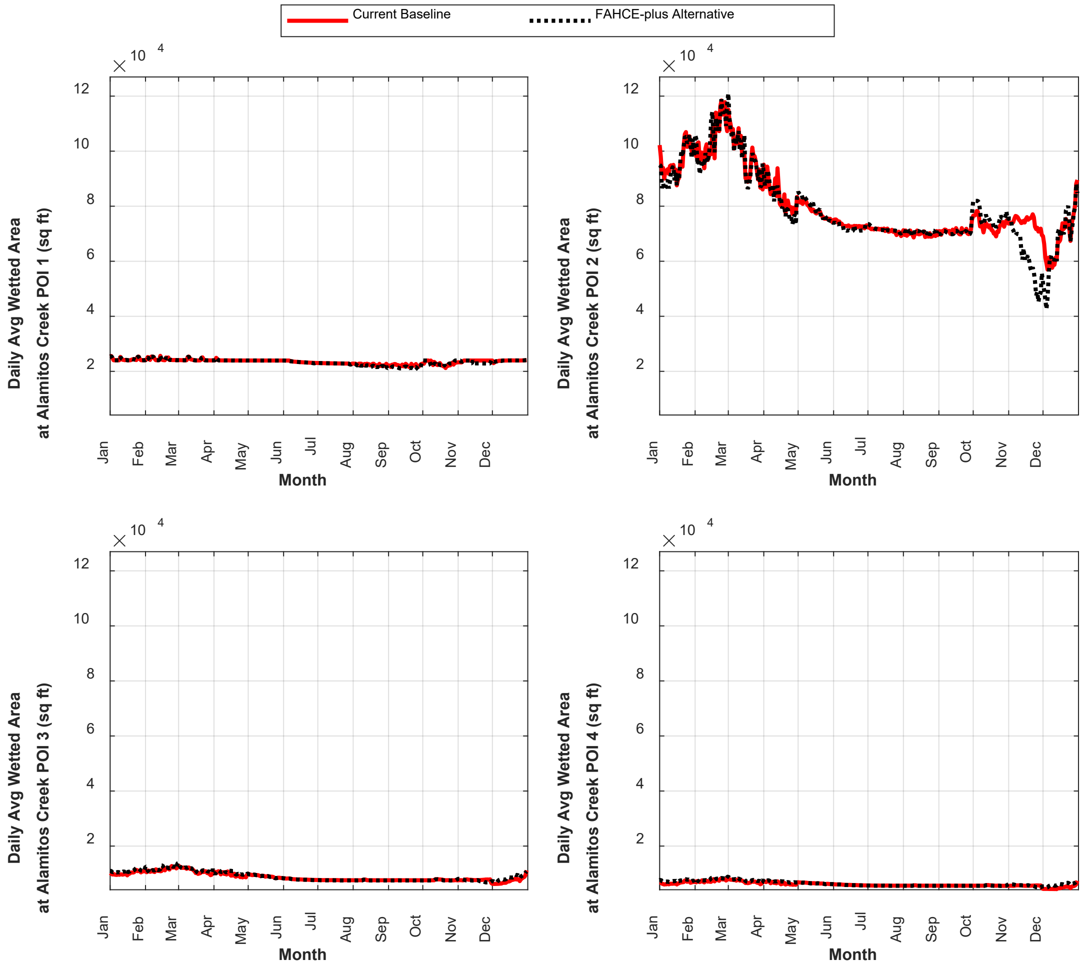
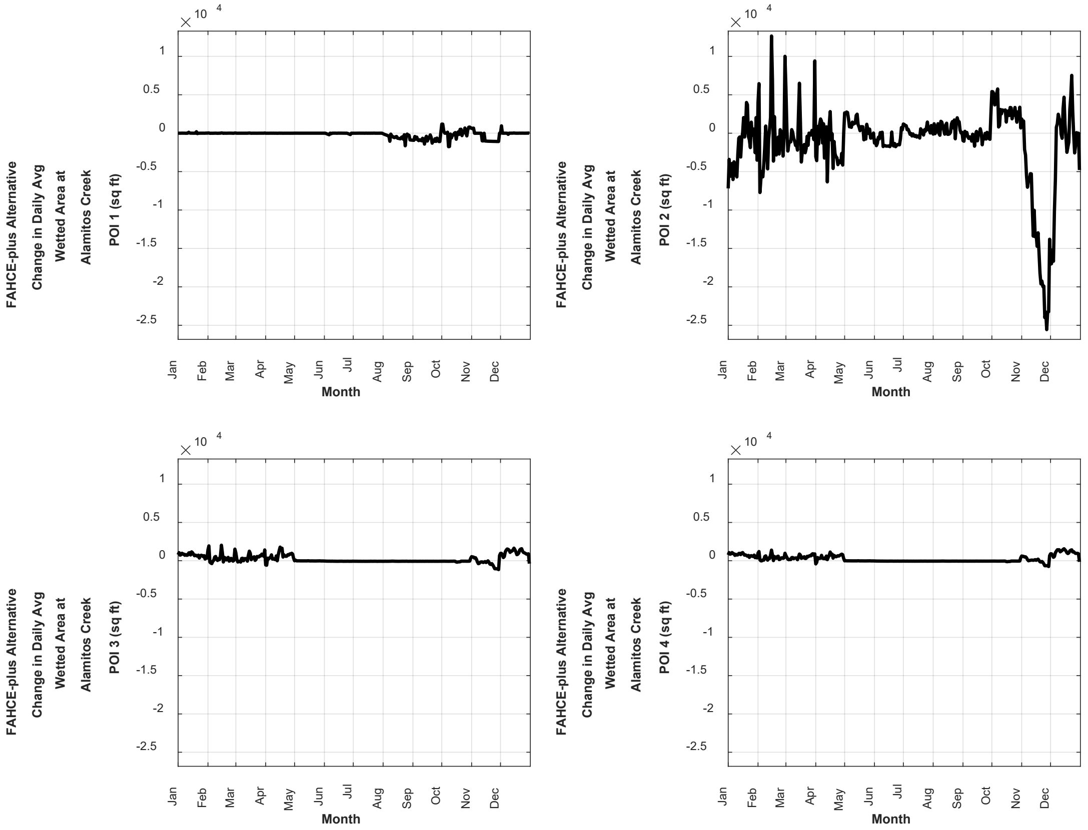


Figure K.3.52


×10 4
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Alamitos Creek POI 1 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
×10 4
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Alamitos Creek POI 2 (sq ft)
Month
×10 4
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Alamitos Creek POI 3 (sq ft)
Month
×10 4
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Alamitos Creek POI 4 (sq ft)
Month

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Water Temperature Figures

Figure K.3.53

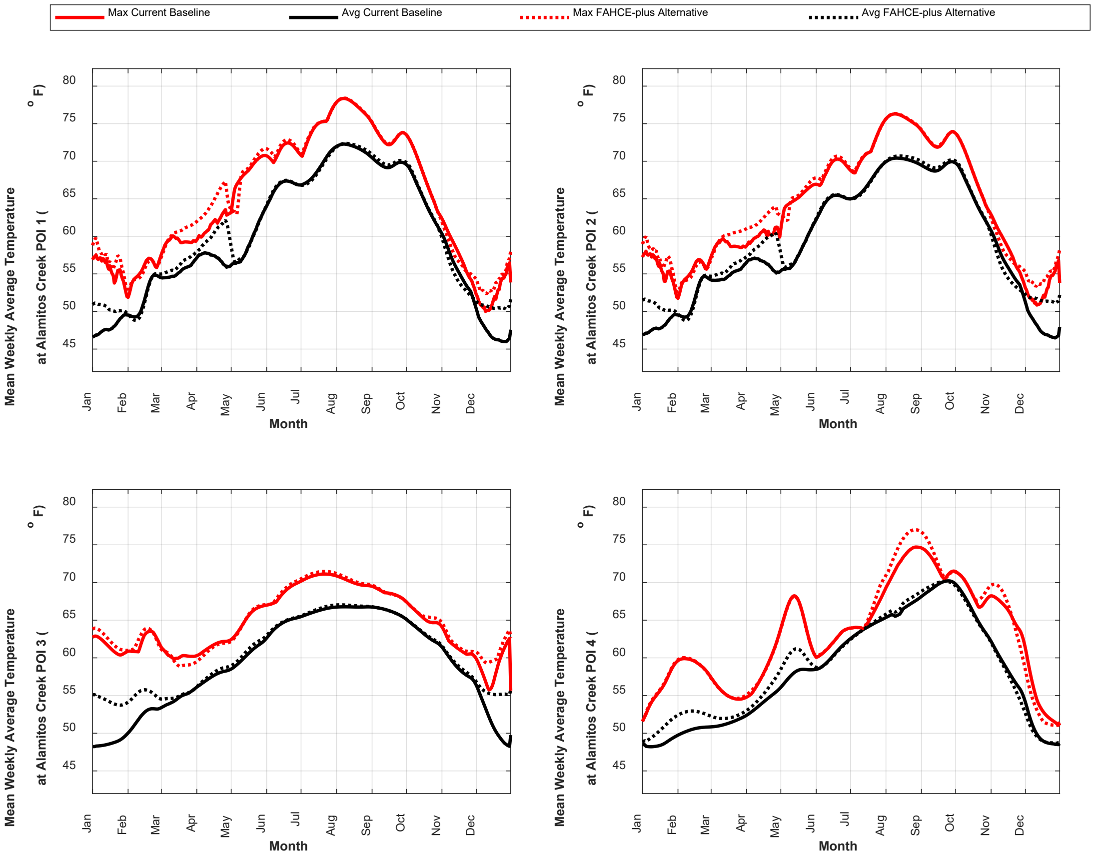
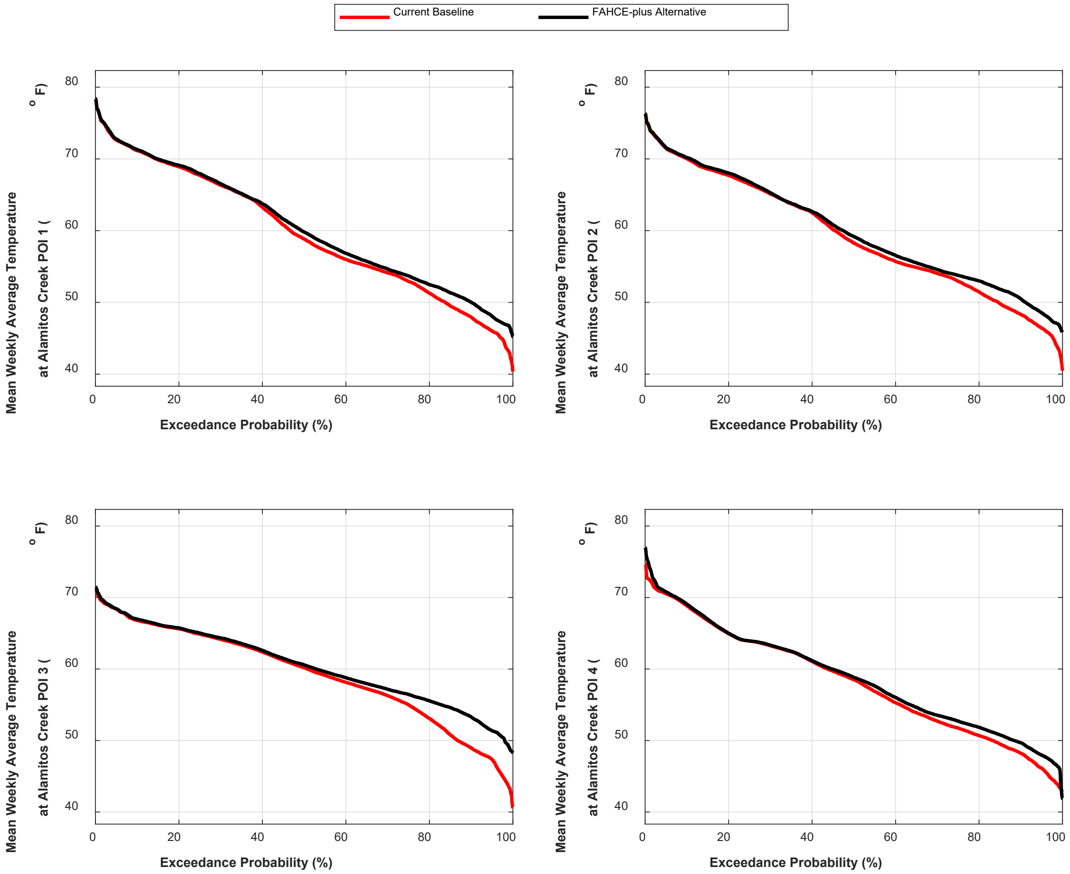


Figure K.3.54


Current Baseline
FAHCE-plus Alternative
Mean Weekly Average Temperature at Alamitos Creek POI 1 (° F)
Mean Weekly Average Temperature at Alamitos Creek POI 2 (° F)
Mean Weekly Average Temperature at Alamitos Creek POI 3 (° F)
Mean Weekly Average Temperature at Alamitos Creek POI 4 (° F)
80
70
60
50
40
0
20
40
60
80
100
Exceedance Probability (%)

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Future Baseline Comparisons

Flow Figures

Figure K.3.55

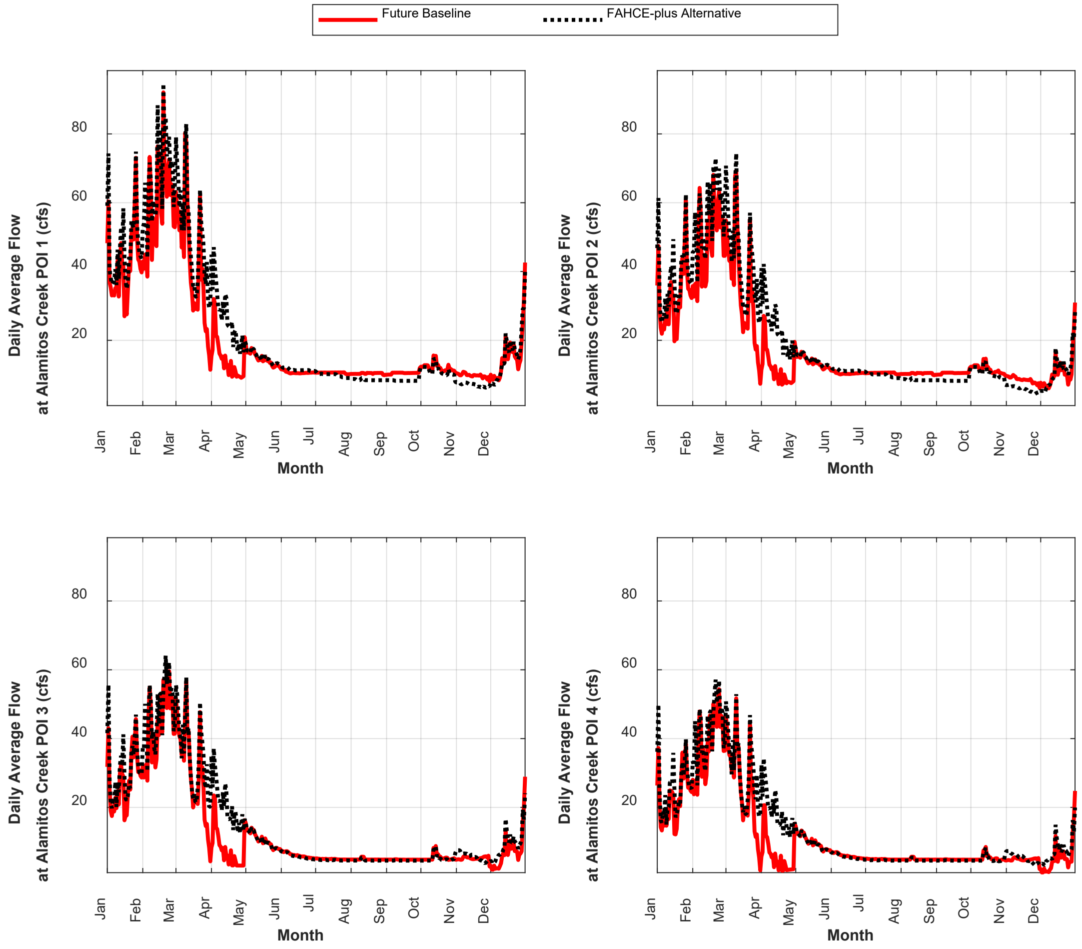
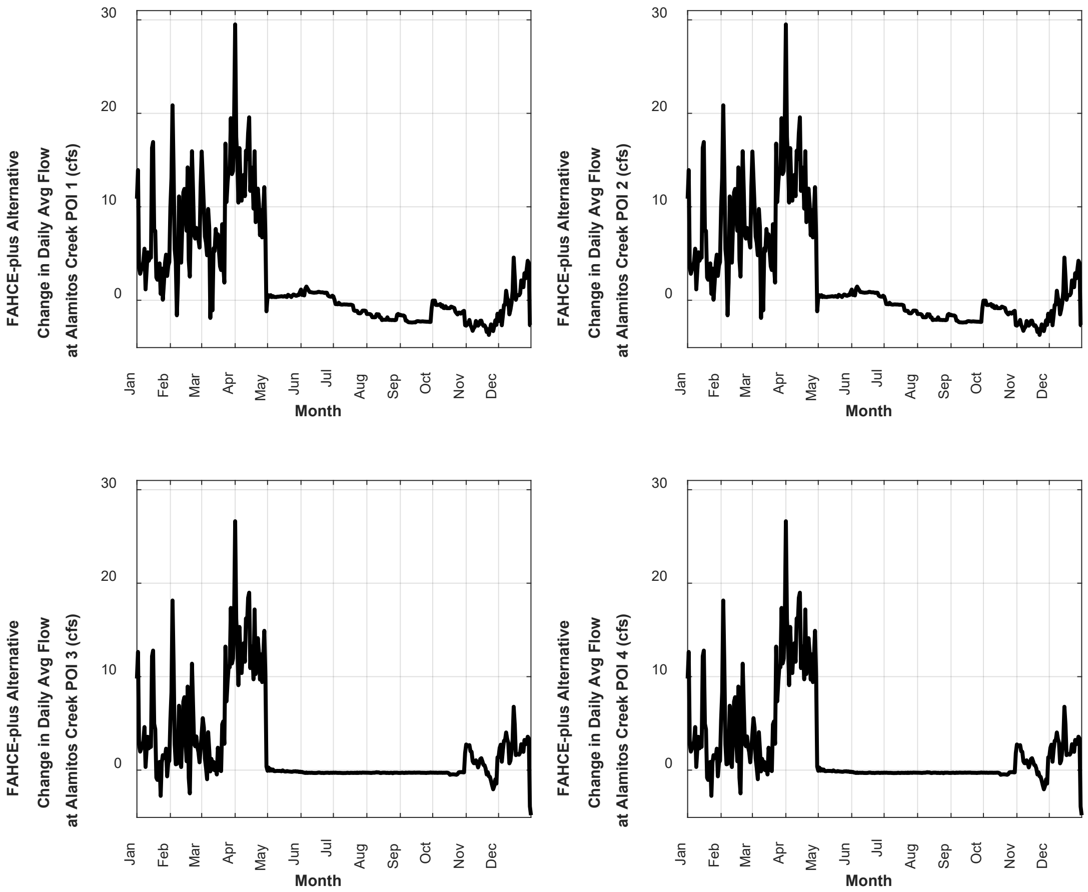


Figure K.3.56


30
20
10
0
FAHCE-plus Alternative Change in Daily Avg Flow at Alamitos Creek POI 1 (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
30
20
10
0
FAHCE-plus Alternative Change in Daily Avg Flow at Alamitos Creek POI 2 (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
30
20
10
0
FAHCE-plus Alternative Change in Daily Avg Flow at Alamitos Creek POI 3 (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
30
20
10
0
FAHCE-plus Alternative Change in Daily Avg Flow at Alamitos Creek POI 4 (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Wetted Area Figures

Figure K.3.57

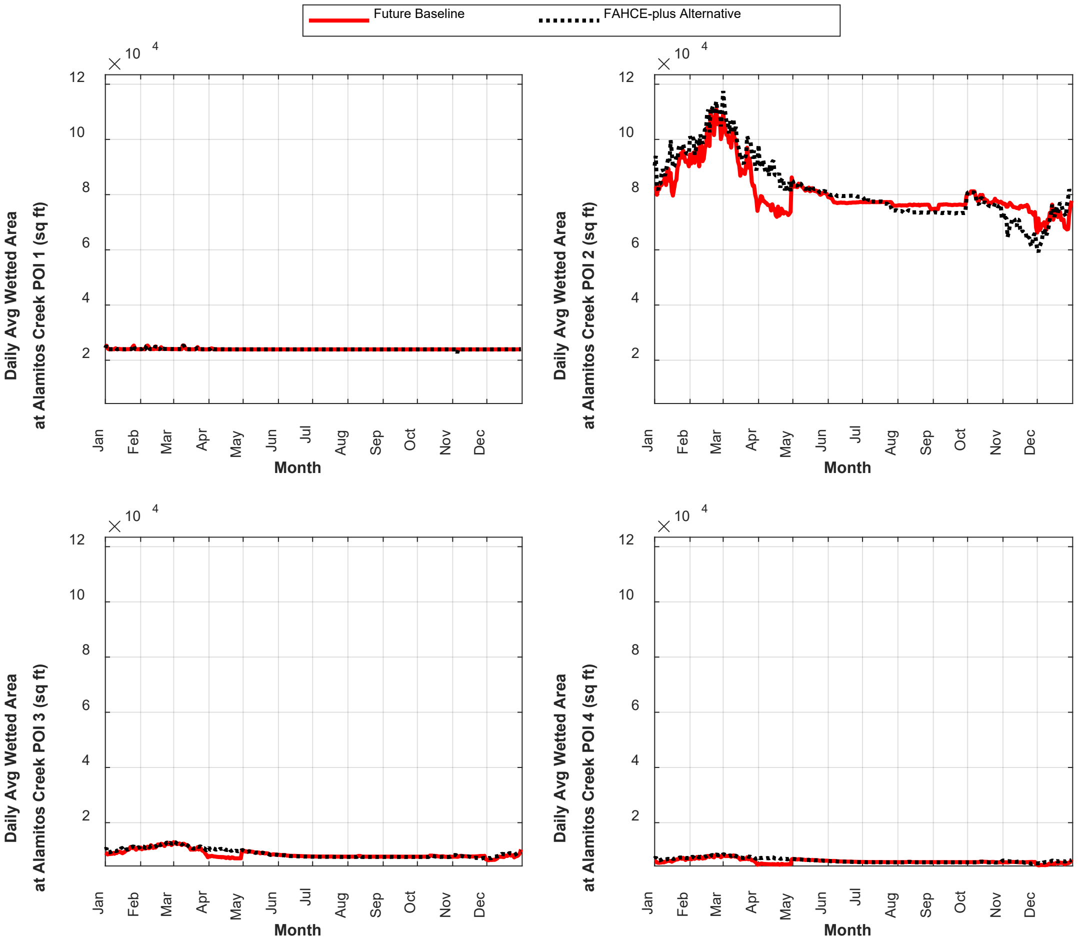
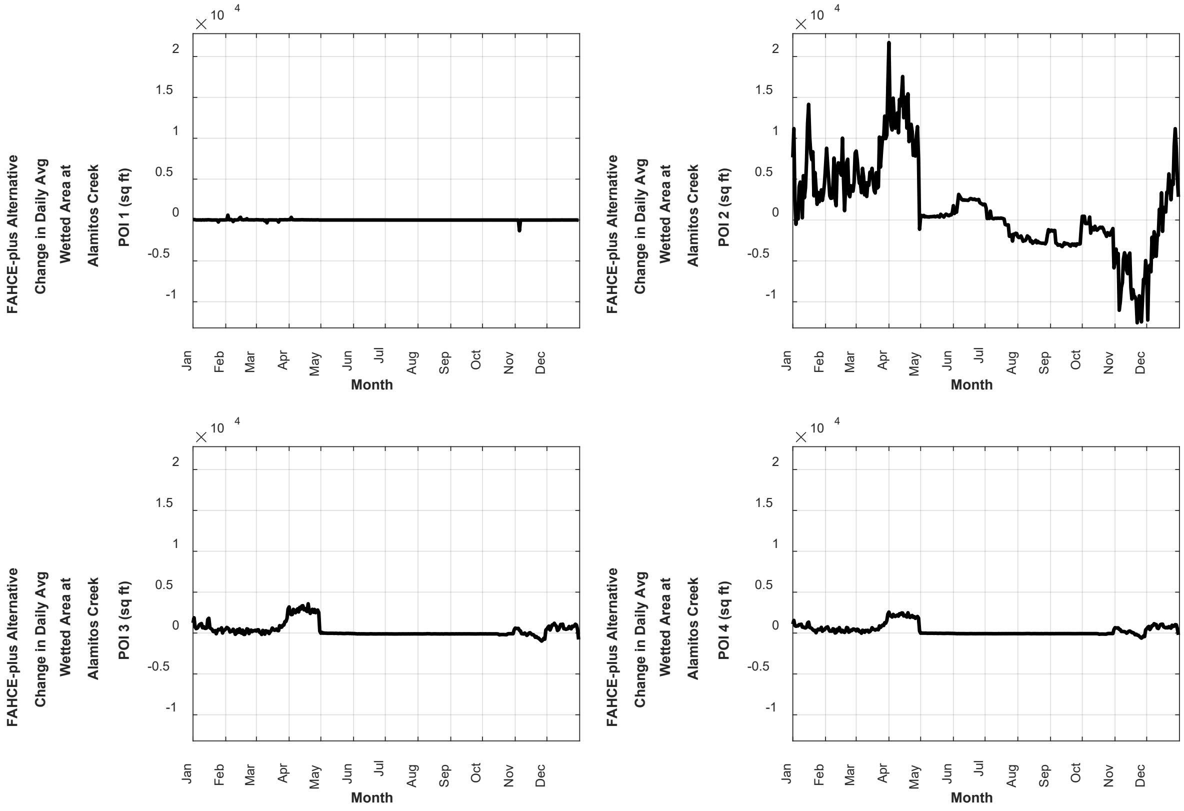


Figure K.3.58


×10^4
2
1.5
1
0.5
0
-0.5
-1
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Alamitos Creek POI 1 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Alamitos Creek POI 2 (sq ft)
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Alamitos Creek POI 3 (sq ft)
FAHCE-plus Alternative Change in Daily Avg Wetted Area at Alamitos Creek POI 4 (sq ft)

Water Temperature Figures

Figure K.3.59

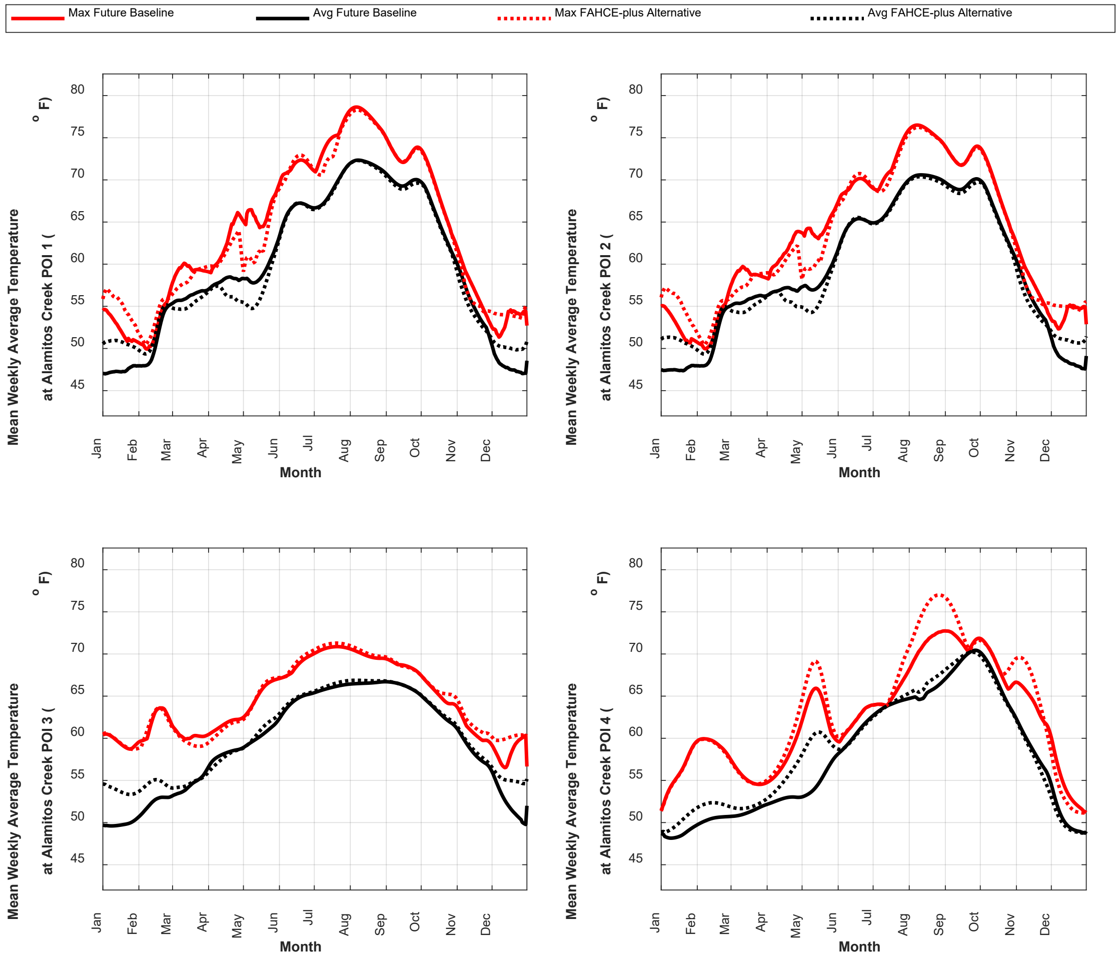
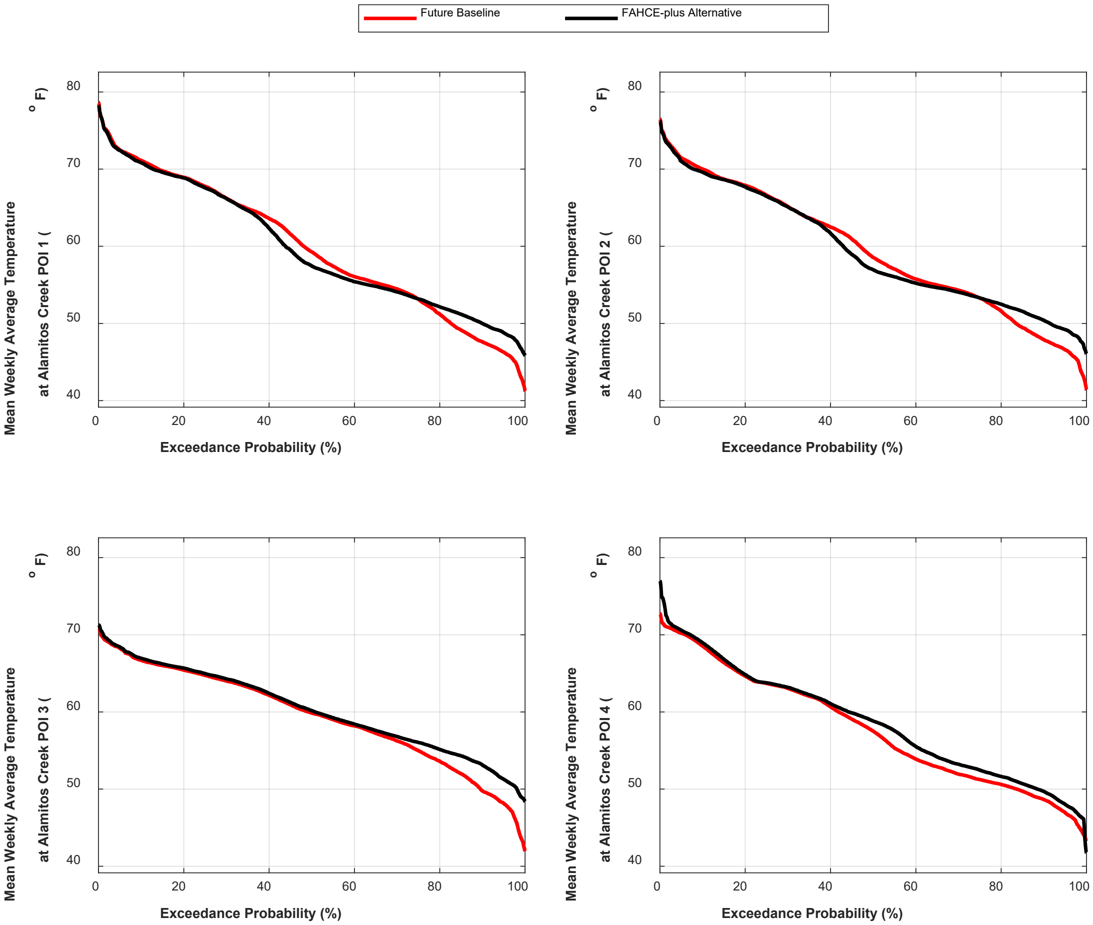


Figure K.3.60


Future Baseline
FAHCE-plus Alternative
Mean Weekly Average Temperature at Alamitos Creek POI 1 (° F)
Mean Weekly Average Temperature at Alamitos Creek POI 2 (° F)
Mean Weekly Average Temperature at Alamitos Creek POI 3 (° F)
Mean Weekly Average Temperature at Alamitos Creek POI 4 (° F)
Exceedance Probability (%)
0
20
40
60
80
100
40
50
60
70
80

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Calero Creek

Current Baseline Comparisons

Flow Figures

Figure K.3.61

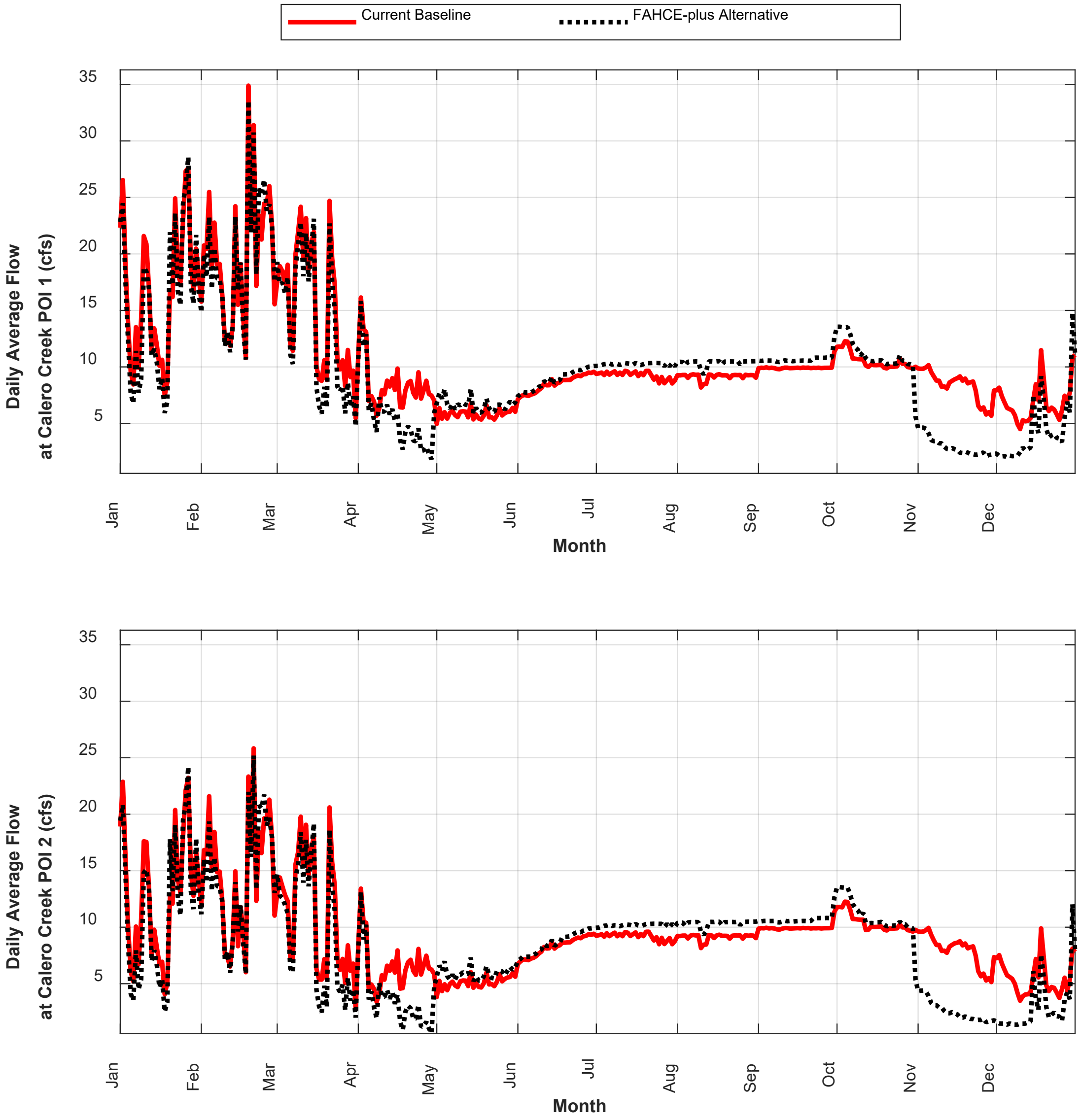
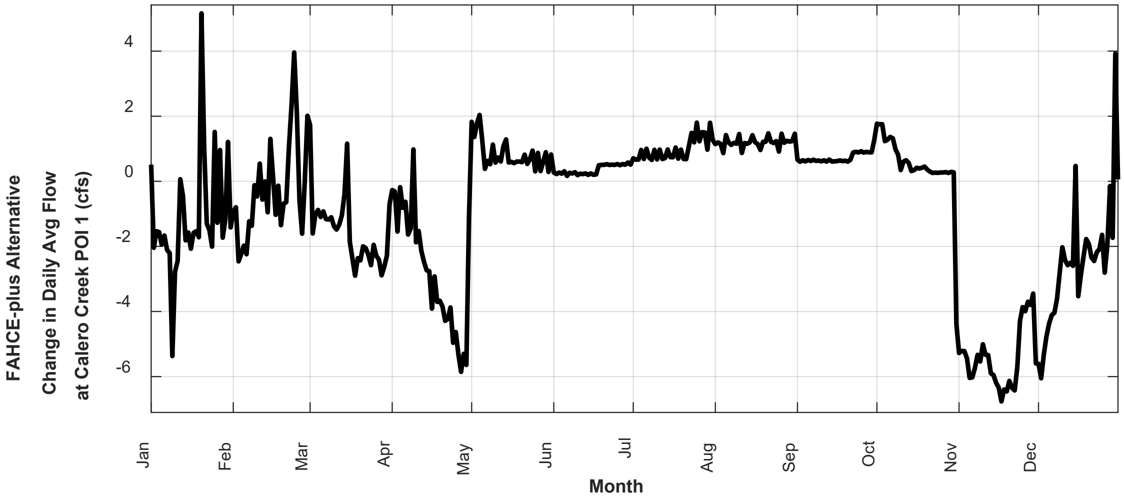
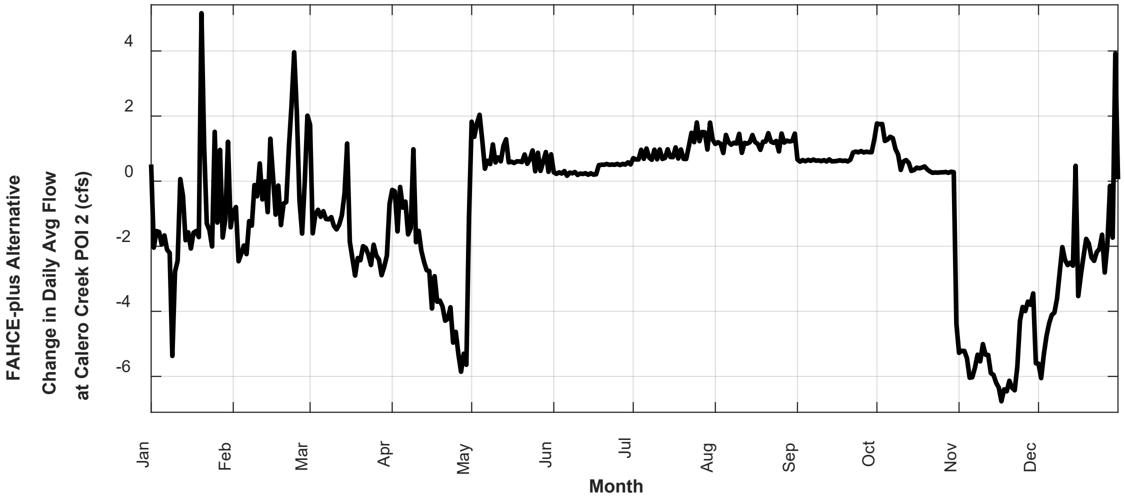


Figure K.3.62


FAHCE-plus Alternative
Change in Daily Avg Flow
at Calero Creek POI 1 (cfs)
4
2
0
-2
-4
-6
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


FAHCE-plus Alternative
Change in Daily Avg Flow
at Calero Creek POI 2 (cfs)
4
2
0
-2
-4
-6
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Wetted Area Figures

Figure K.3.63

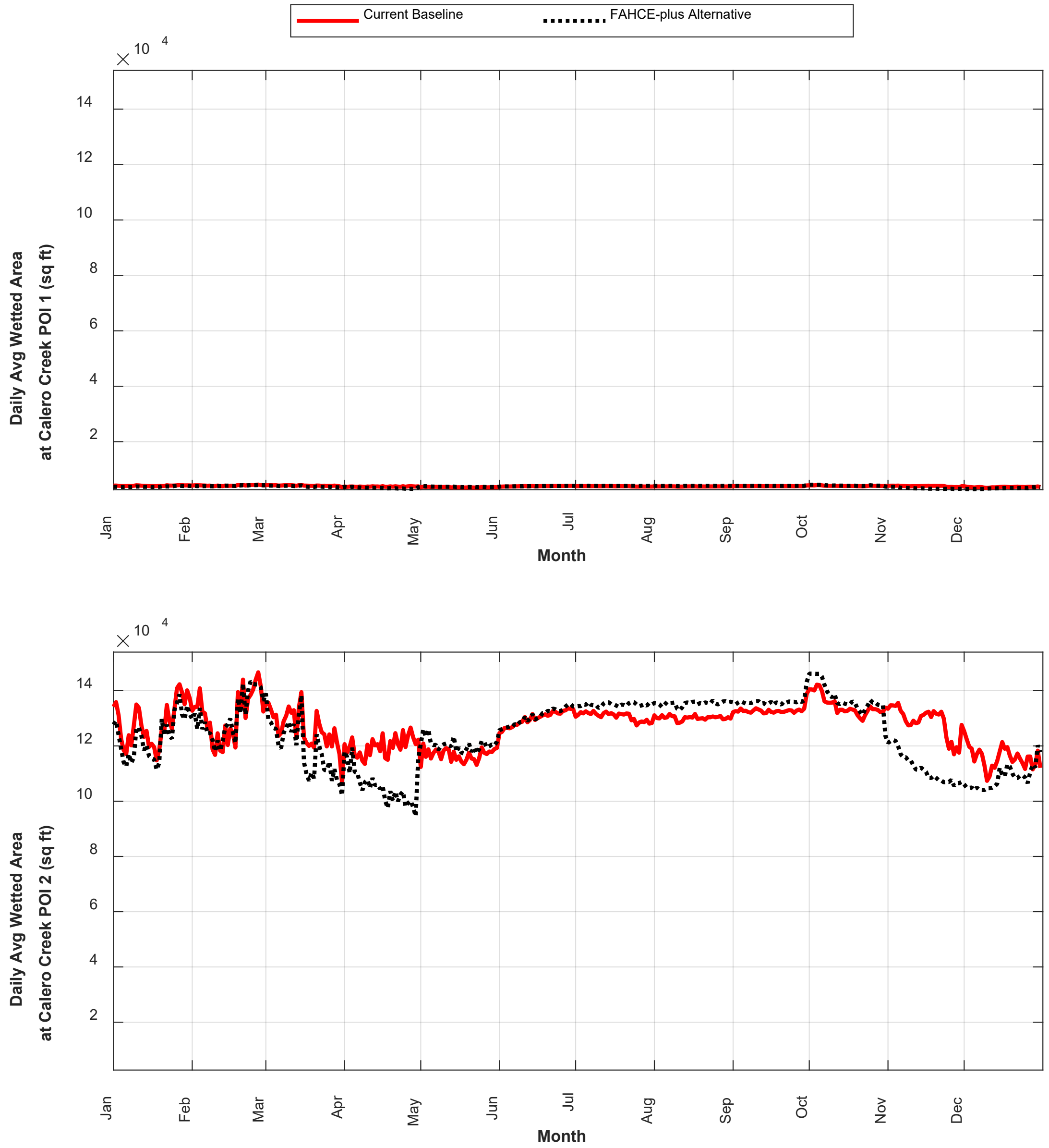
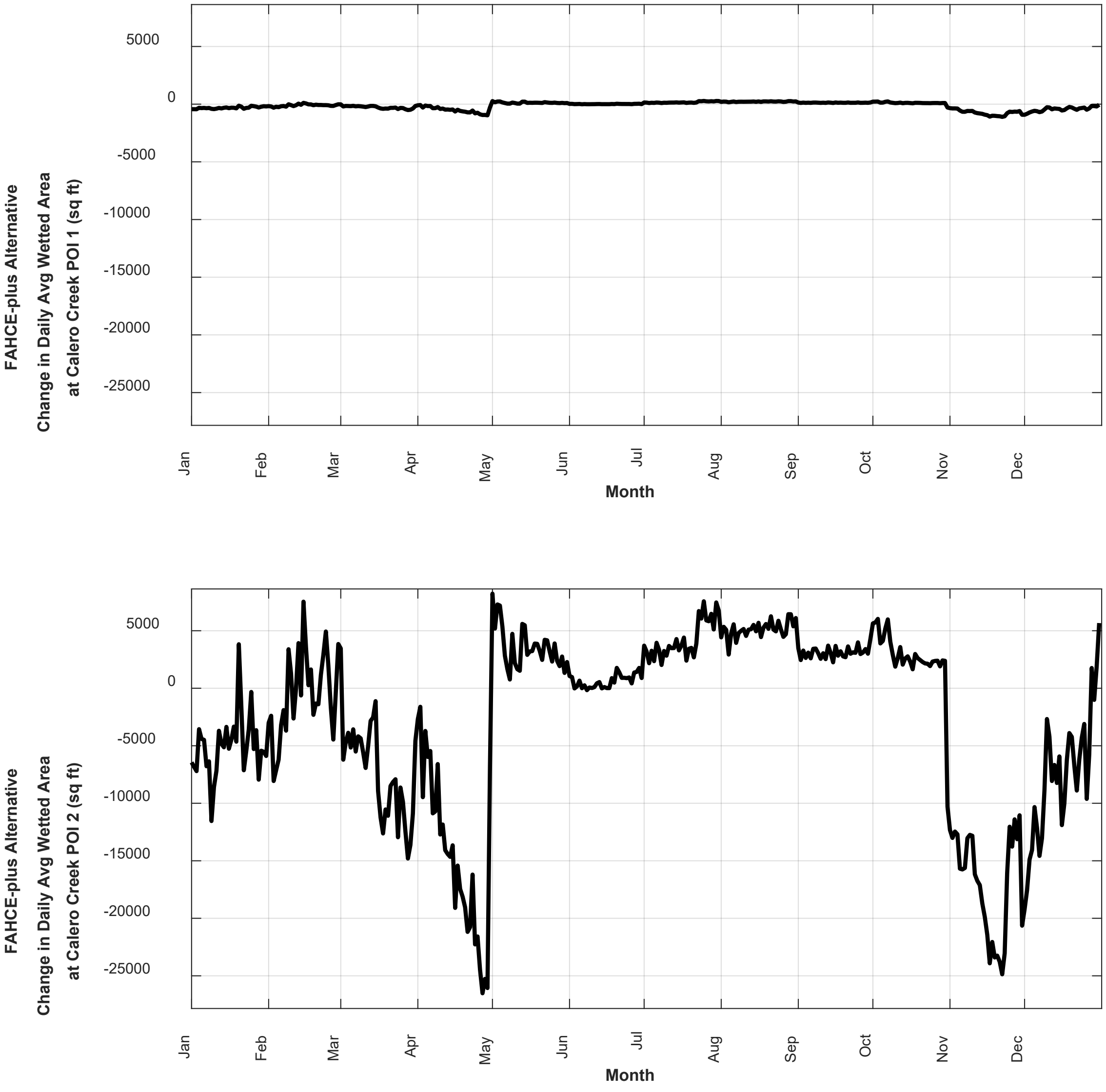


Figure K.3.64


5000
0
-5000
-10000
-15000
-20000
-25000
FAHCE-plus Alternative
Change in Daily Avg Wetted Area
at Calero Creek POI 1 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
5000
0
-5000
-10000
-15000
-20000
-25000
FAHCE-plus Alternative
Change in Daily Avg Wetted Area
at Calero Creek POI 2 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Water Temperature Figures

Figure K.3.65

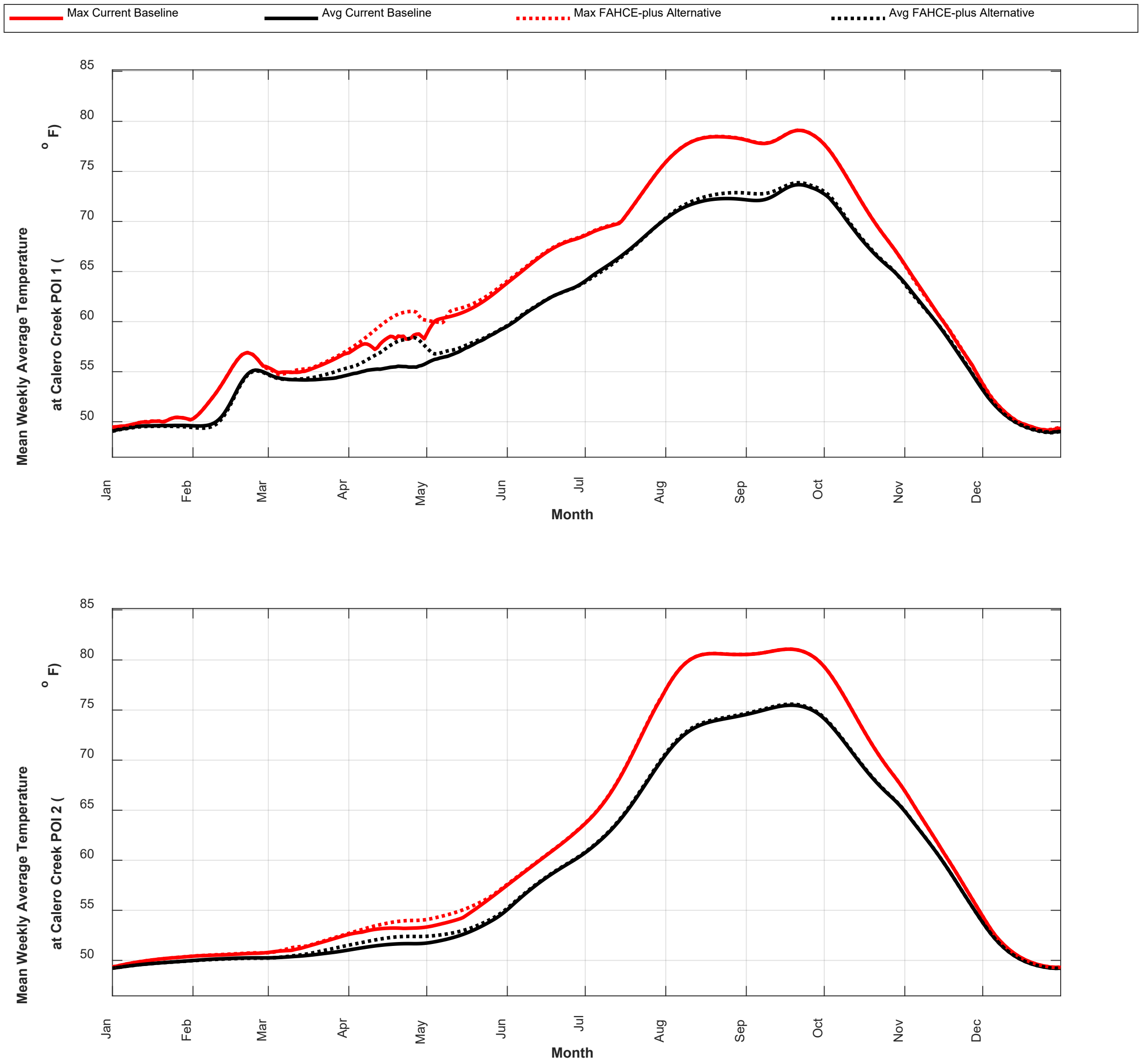
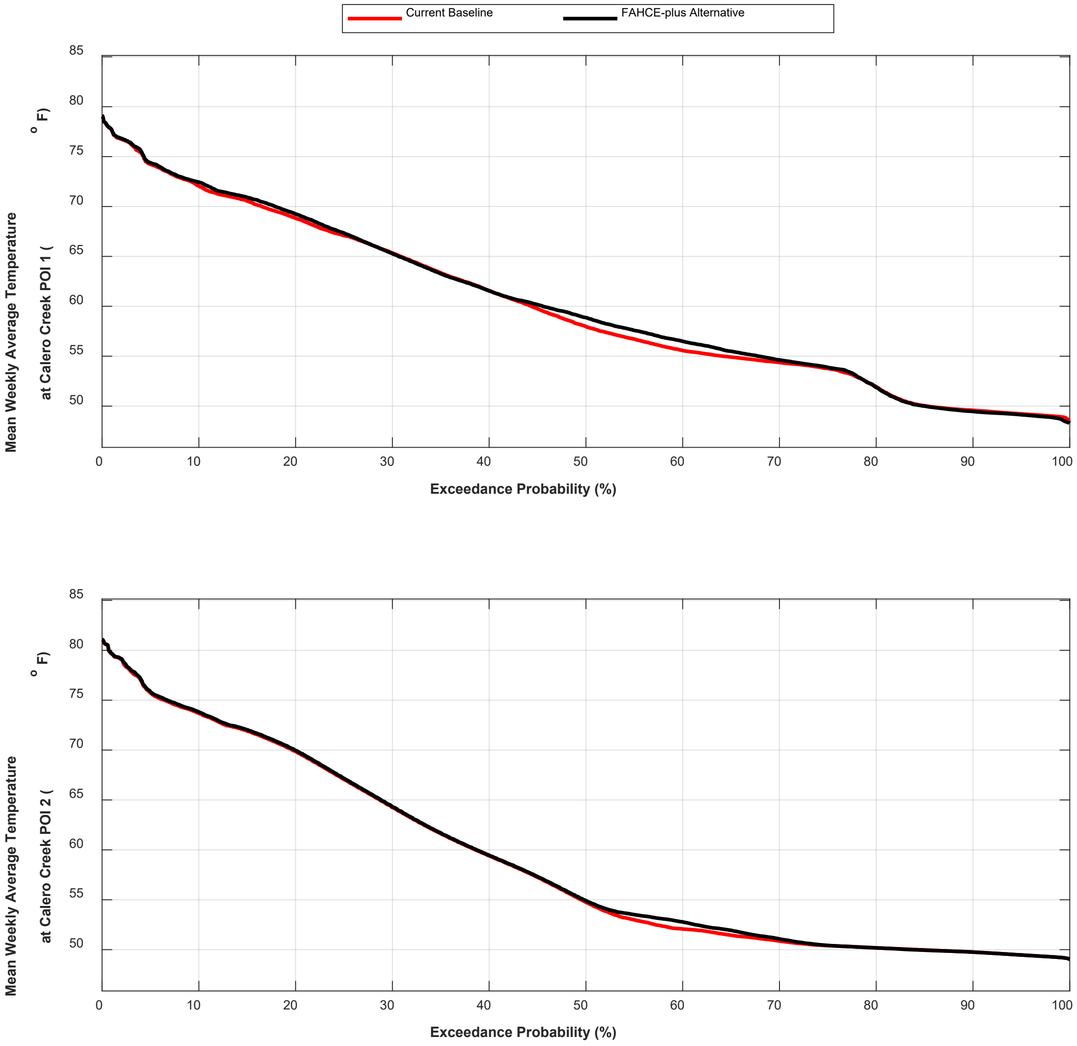


Figure K.3.66


Current Baseline
FAHCE-plus Alternative
Mean Weekly Average Temperature at Calero Creek POI 1 (° F)
85
80
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
100
Exceedance Probability (%)
Mean Weekly Average Temperature at Calero Creek POI 2 (° F)
85
80
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
100
Exceedance Probability (%)

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Future Baseline Comparisons

Flow Figures

Figure K.3.67

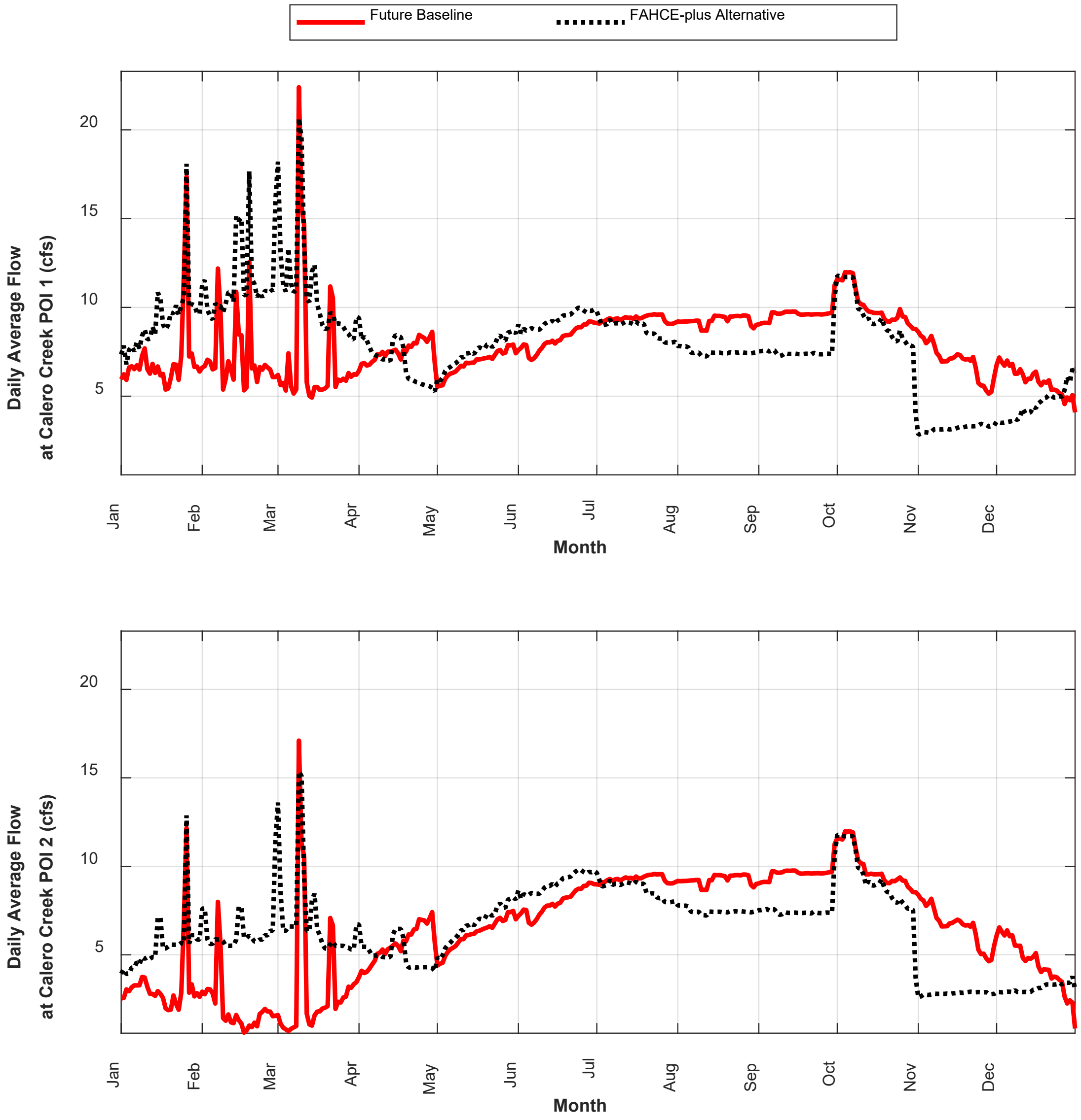
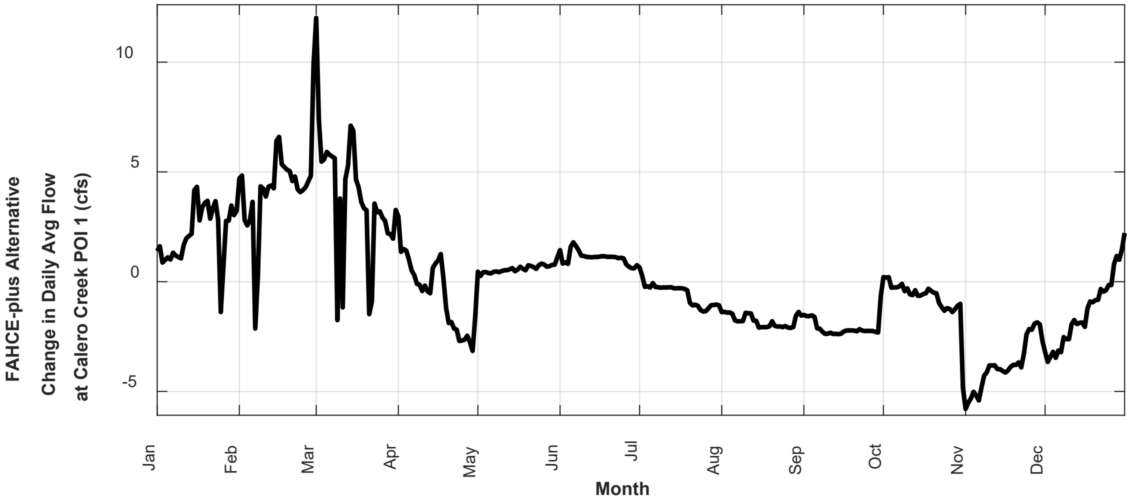
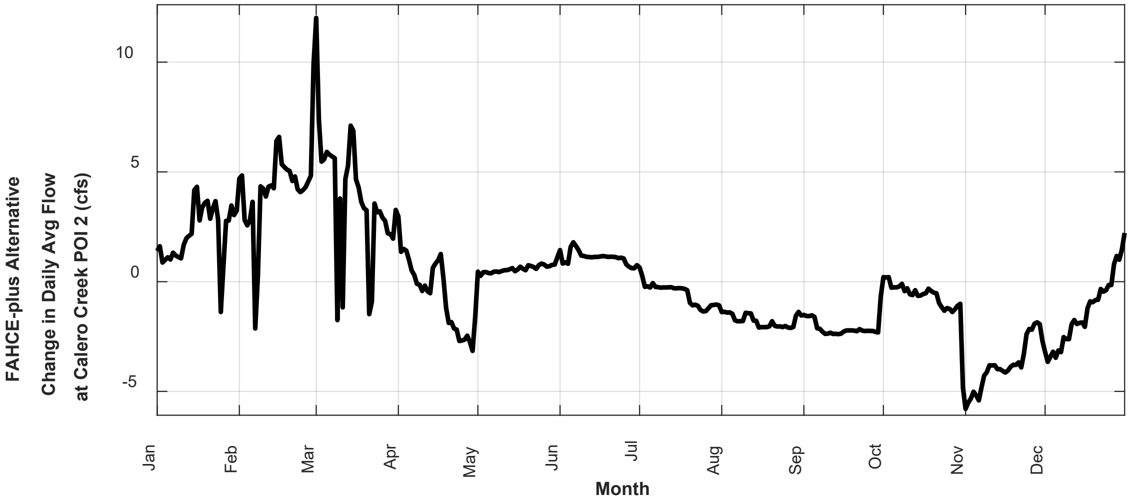


Figure K.3.68


FAHCE-plus Alternative
Change in Daily Avg Flow
at Calero Creek POI 1 (cfs)
10
5
0
-5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


FAHCE-plus Alternative
Change in Daily Avg Flow
at Calero Creek POI 2 (cfs)
10
5
0
-5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Wetted Area Figures

Figure K.3.69

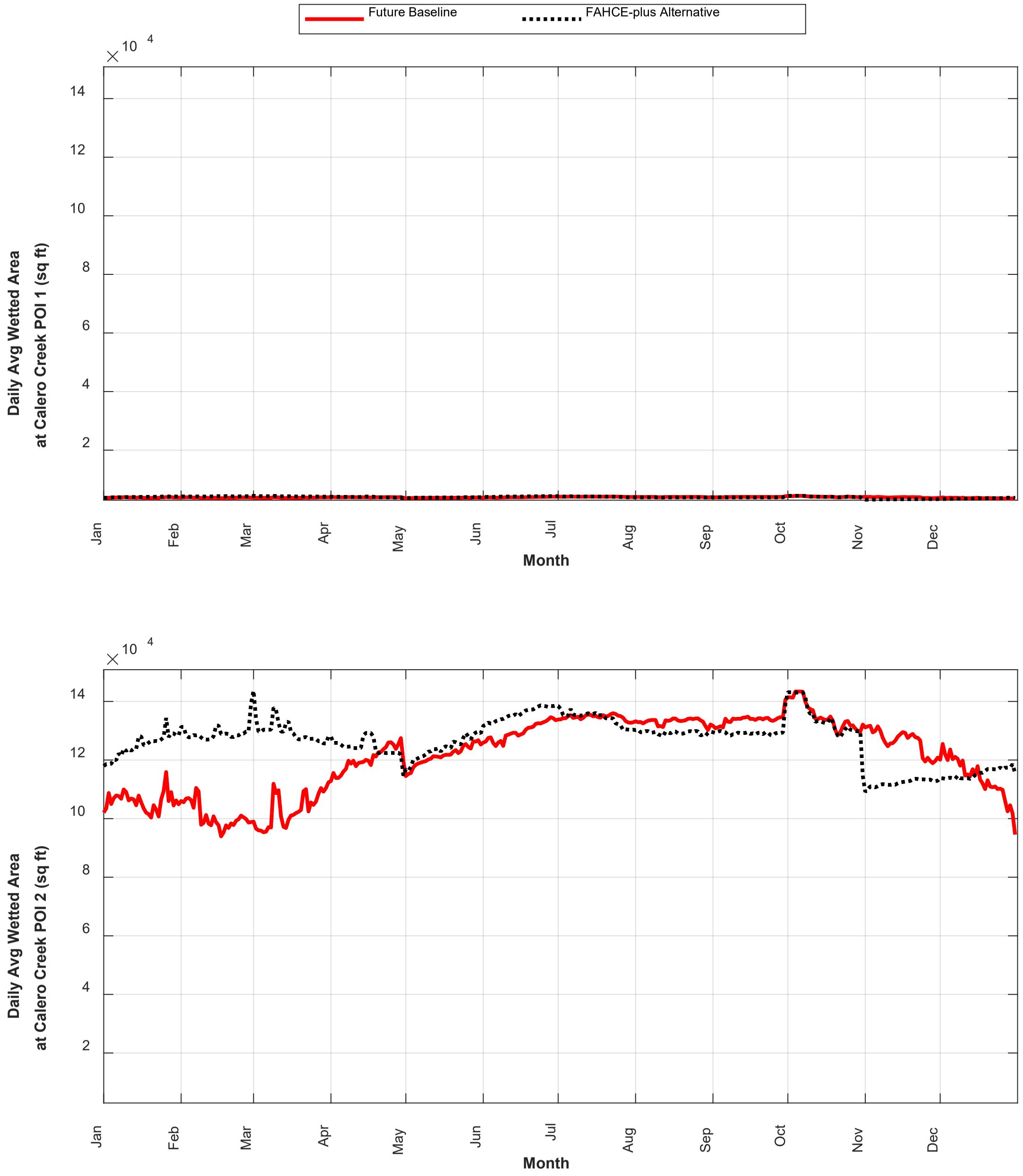
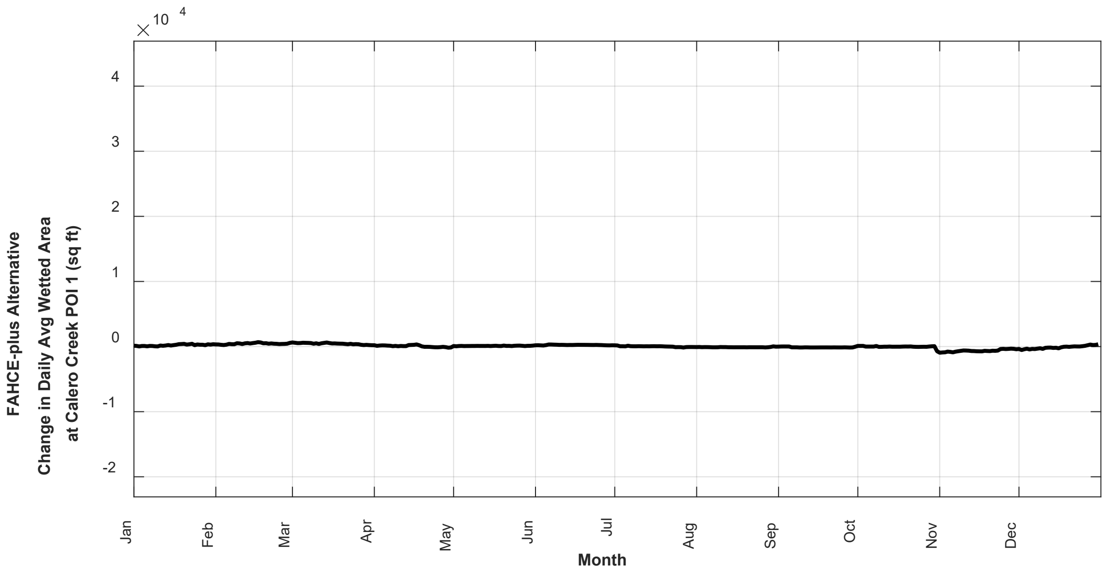
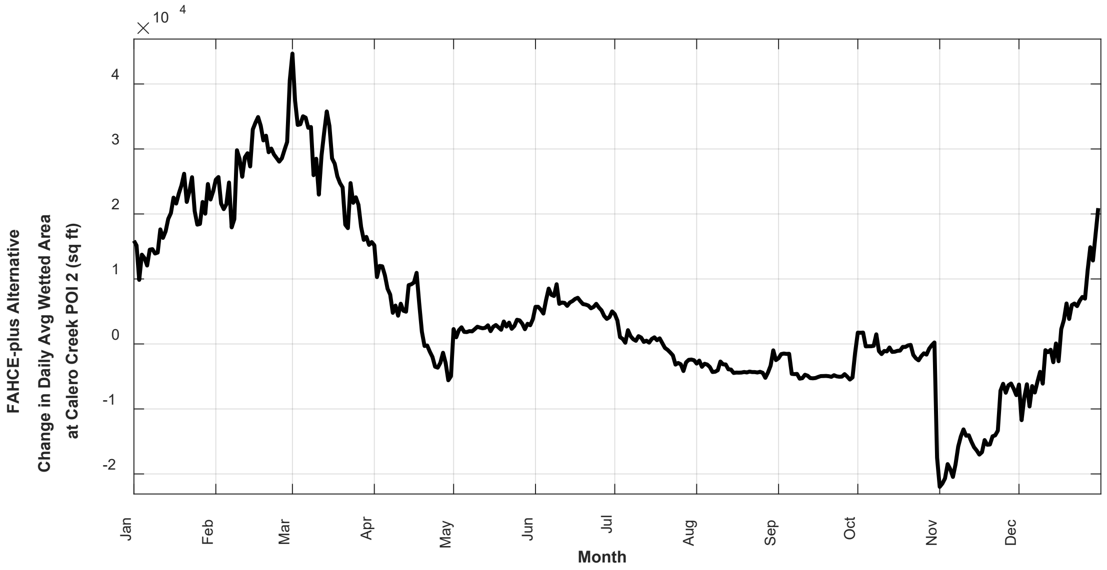


Figure K.3.70


×10 4
4
3
2
1
0
-1
-2
FAHCE-plus Alternative
Change in Daily Avg Wetted Area
at Calero Creek POI 1 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


×10 4
4
3
2
1
0
-1
-2
FAHCE-plus Alternative
Change in Daily Avg Wetted Area
at Calero Creek POI 2 (sq ft)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Attachment K.3 – FAHCE-plus Alternative Supplementary Figures

Water Temperature Figures

Figure K.3.71

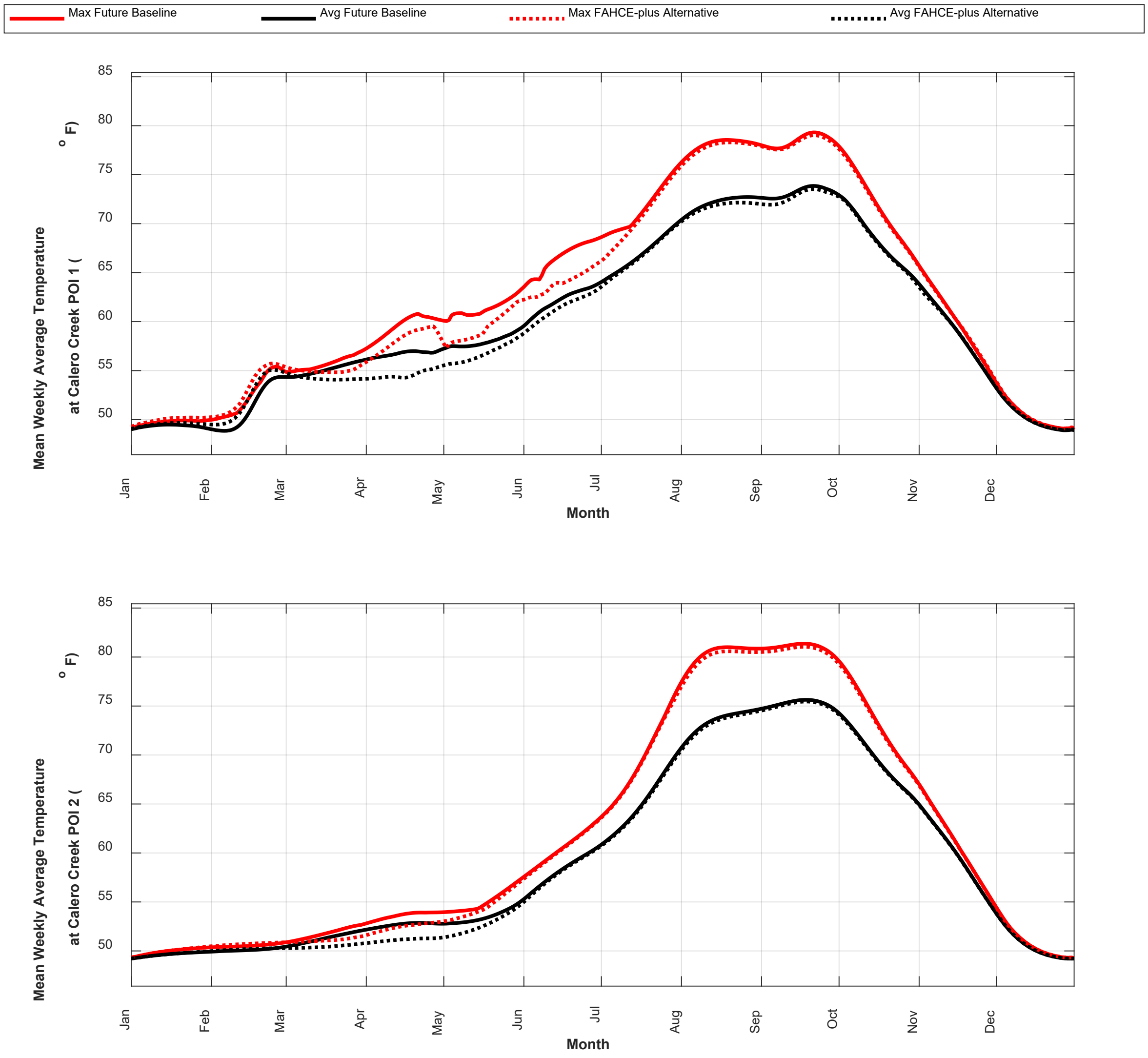
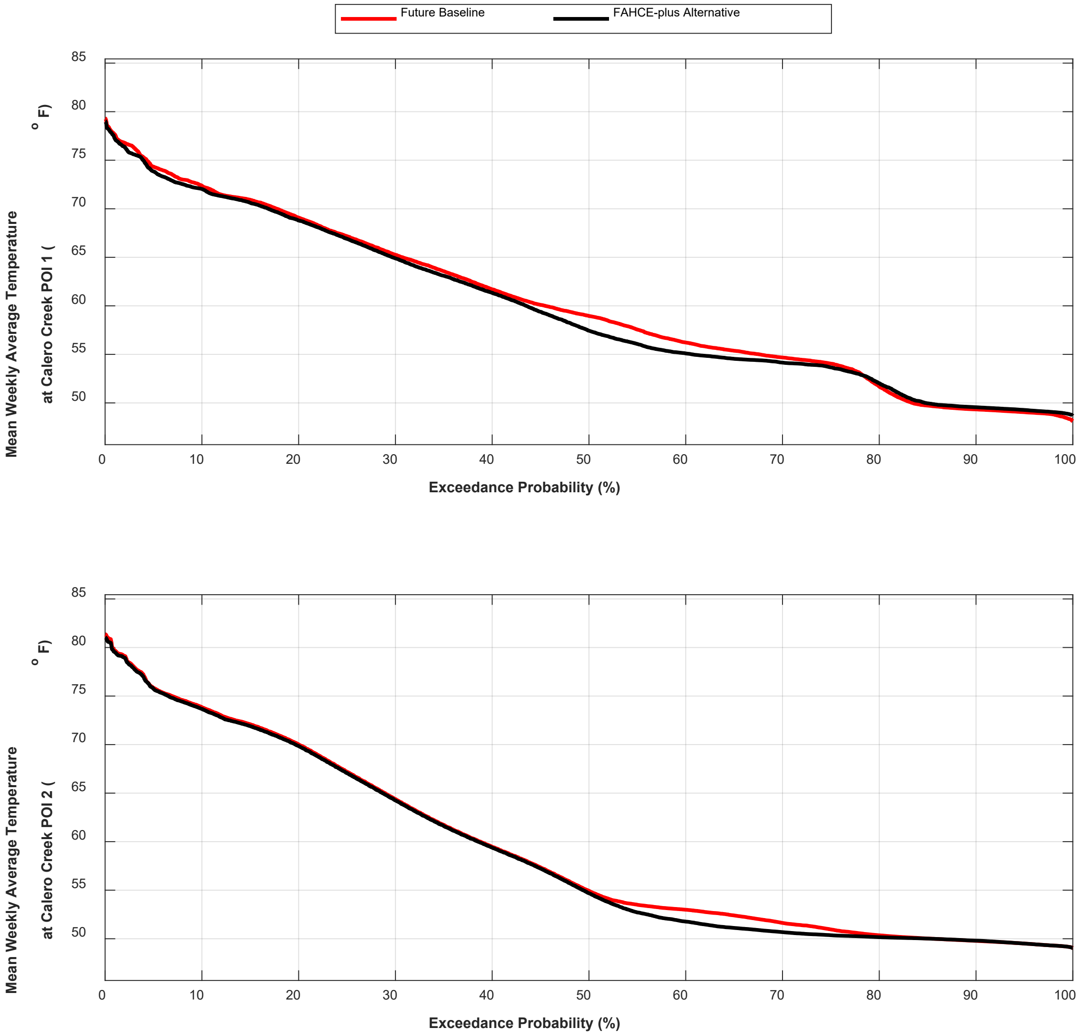


Figure K.3.72


Future Baseline
FAHCE-plus Alternative
Mean Weekly Average Temperature at Calero Creek POI 1 (° F)
85
80
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
100
Exceedance Probability (%)
Mean Weekly Average Temperature at Calero Creek POI 2 (° F)
85
80
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
100
Exceedance Probability (%)

Appendix L

Proposed Petitions to Change Water Rights

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Appendix L – Proposed Petitions to Change Water Rights

Proposed Petitions to Change Water Rights

Valley Water is preparing Petitions for Change for submittal to the California State Water Resources Control Board (SWRCB) to update ten north county water rights licenses. Updates and changes proposed are intended to reflect present conditions. Specifically, Points of Diversion and Re-diversions are updated to modern survey standards, Places of Storage are defined, maps for all features are provided in accordance with current standards, Diversion to Underground Storage is added to reflect current operations, and updated reservoir capacity curves are provided as necessary.

The Petitions for Change also seek to add Fish and Wildlife Enhancement as a Purpose of Use to resolve the 1996 Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) complaint. Inclusion of Fish and Wildlife Enhancement as a purpose of use allows the licensee to account for any water used for these purposes in the annual reporting.

The following table provides a list of the water rights included in this effort. The table includes the appropriation under each license, the specified Diversion Period, the existing Purpose of Use, and the proposed changes and additions to the Purpose of Use. The existing licenses for these ten facilities are also included in the order they appear in the table.

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Appendix L – Proposed Petitions to Change Water Rights

Proposed Petitions to Change Water Rights

Valley Water Facility Water Source	Application No.	Permit No.	License No.	Last Notice of Change Date	Appropriation (AFY)	Maximum Withdrawal Amount	Diversion Period	Existing Purpose Use	Proposed Changes to Purpose of Use	Changes to Facilities	Proposed Change to Place of Use
	Priority Date	Permit Date	License Date								
Stevens Creek Watershed											
Stevens Creek Reservoir Stevens Creek	7143	4918	2207	1/7/1974	4,000	Not specified	12/01 to 04/30	Domestic and Irrigation	Municipal, Fish and Wildlife Preservation and Enhancement	None	Santa Clara County
	12/9/1931	3/25/1937	5/7/1941								
Guadalupe Watershed											
Alamitos Percolation Ponds Guadalupe Creek	5653	3009	6943	1/7/1974	3,302	Not specified	11/15 to 05/01	Domestic and Irrigation	Municipal, Fish and Wildlife Preservation and Enhancement	Diversion facility fish ladder added in 1999.	Santa Clara County
	8/1/1927	4/13/1928	7/18/1963								
Guadalupe Reservoir Guadalupe Creek	7142	4917	2206	1/7/1974	3,500	Not specified	12/01 to 04/30	Domestic and Irrigation	Municipal, Fish and Wildlife Preservation and Enhancement	None	Santa Clara County
	12/9/1931	3/25/1937	5/7/1941								
Masson Dam Guadalupe Creek	9455	5428	2837	8/11/1978	0.77 cfs (323 AFY)	Not specified	10/01 to 05/01	Irrigation, Domestic, and Industrial	Municipal, Fish and Wildlife Preservation and Enhancement	Diversion facility completed in 1978. Diversion facility fish ladder and screen added in 1999.	Santa Clara County
	11/16/1938	5/18/1944	8/21/1946								
Almaden Reservoir Alamitos Creek	7141	4916	2205	1/7/1974	2,500	Not specified	12/01 to 04/30	Domestic and Irrigation	Municipal, Fish and Wildlife Preservation and Enhancement	None	Santa Clara County
	12/9/1931	3/25/1937	5/7/1941								
Almaden-Calero Canal Alamitos Creek	8099	4920	2209	1/7/1974	6,000 (not to exceed 100 cfs)	Not specified	12/01 to 04/30	Domestic and Irrigation	Municipal, Fish and Wildlife Preservation and Enhancement, Distribution to Storage	None	Santa Clara County
	9/11/1934	3/25/1937	5/7/1941								
Calero Reservoir Calero Creek	8098	4919	2208	1/7/1974	3,500	Not specified	12/01 to 04/30	Domestic and Irrigation	Municipal, Fish and Wildlife Preservation and Enhancement	None	Santa Clara County
	9/11/1934	3/25/1937	5/7/1941								
Kirk Dam Los Gatos Creek	5654	3010	11791	None	9,090 (Not to exceed 80 cfs)	Not to exceed 9,090 AFY	11/15 to 05/01	Domestic and Irrigation	Municipal, Fish and Wildlife Preservation and Enhancement	Diversion facility fish screen and operable dam added in 2013.	Santa Clara County
	8/1/1927	4/13/1928	6/6/1985								
Vasona Reservoir Los Gatos Creek	8387	4921	6944	1/7/1974	1,684	Not specified	12/01 to 06/01	Domestic and Irrigation	Municipal, Fish and Wildlife Preservation and Enhancement	None	Santa Clara County
	7/10/1935	3/25/1937	7/18/1963								
Lexington Reservoir Los Gatos Creek	11751	7689	5729	1/7/1974	30,000	Not specified	11/01 to 05/15	Domestic and Irrigation	Municipal, Fish and Wildlife Preservation and Enhancement	None	Santa Clara County
	3/3/1947	1/31/1950	6/5/1959								

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Appendix M

Water Supply Technical Memorandum

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Appendix M: Water Supply Technical Memorandum

Fisheries and Aquatic Habitat Collaborative Effort (FAHCE)
Santa Clara Valley Water District

January 2021

WATER SUPPLY IMPACTS FROM IMPLEMENTATION OF THE FISH HABITAT RESTORATION PLAN

Implementation of the Fish Habitat Restoration Plan (FHRP) has the potential to adversely impact available water supply in Santa Clara County due to altered releases from reservoirs. Valley Water's reservoirs were constructed to capture winter runoff from the upper watersheds for release through the remainder of the year to provide recharge of the groundwater basins through infiltration in natural channels and in off-stream percolation facilities where this water is diverted. Changing the timing and volume of releases to better support fish habitat has the potential to impact the amount of water Valley Water can recharge into the groundwater basins, which is a key strategy to maintain sufficient water supply in the county.

Water Supply Planning

Valley Water uses the Water Evaluation and Planning (WEAP) model developed by the Stockholm Environment Institute in evaluating water supply alternatives. WEAP is a software tool designed for water resources planning, which uses water demand and supply information that considers multiple and competing uses and priorities. Valley Water simulates its facilities and operations including groundwater basins,[1] reservoirs, creeks, imported supplies, treatment plants, water banking, distribution facilities, and conservation efforts in the model. The model also accounts for non-Valley Water sources and distribution of water in the county such as water from San Francisco Public Utilities Commission (SFPUC) Regional Water System, recycled water, and local water developed by retailers.

For water supply planning, Valley Water operates WEAP on a monthly time-step that simulates the hydrology of 94 years from 1922 through 2015. Water delivery is modeled to meet demands according to availability and priority. Demands in the system include urban retailers, agricultural, independent groundwater pumping, raw water deliveries, environmental flow requirements, and groundwater recharge. Retailer demands are based on retailer projections and, depending on the scenario being analyzed, regional growth projections. Agricultural demands, independent groundwater pumping, and raw water deliveries are estimated based on historical use and growth projections. Environmental flow requirements are based on permit requirements. Groundwater recharge demands are based on recharge facility capacity.

To meet county-wide demands in the model, non-Valley Water supplies are used first including SFPUC supplies, recycled water, and local surface water supplies from San Jose Water Company and Stanford University. These supplies are followed by Valley Water managed local surface water and imported water. If there are remaining unmet demands for municipal/industrial, domestic, or agricultural use, they are met with groundwater pumping. This preserves groundwater supplies for droughts and other shortages as much as possible.

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[1] WEAP tracks water in and out of groundwater basins as a large 'bucket'. It does account for movement within a groundwater basin or if specific areas within a basin are full or not. Specific groundwater modeling is necessary to satisfy those needs.

Supplies in excess of municipal, industrial, domestic, agricultural, and environmental needs are sent to percolation ponds to recharge the groundwater basins and/or held over in reservoirs and other storage facilities, including Semitropic Groundwater Bank. The model tracks water resources throughout the county including imported water, rainfall, reservoir levels, river flow, treatment plant production, groundwater recharge, groundwater pumping, recycled water, and delivery of water to meet all demands.

The effectiveness of a given water supply scenario is determined by the evaluation of key outputs as measured against a baseline; these include groundwater storage, the ability of a project alternative to avoid the need for the Board to request water use reductions, and total water yield.

Groundwater Storage

Groundwater is essential because one of Valley Water's key missions is to maintain groundwater storage as a reserve for dry years and to ensure that undesirable results, such as inelastic land subsidence, do not reoccur. Average and minimum groundwater storage for the three groundwater management areas are analyzed to see how groundwater conditions are maintained in a scenario. Groundwater storage is also used to determine if water use reduction recommendations are triggered under Valley Water's Water Shortage Contingency Plan (WSCP).

Avoidance of Water Use Reduction Recommendations

The Valley Water approved WSCP identifies various Valley Water actions, including calling on the community to reduce water use, in response to drought or other shortages. The WSCP is based on the end of year groundwater storage as this reflects the general health of the water system. The WSCP has five levels; ranging from Level 1 (Normal) when short-term water use reductions are not needed to Level 5 (Emergency), which can be triggered by an immediate crisis. Each level has a short-term water use reduction range that the Board can call upon the public to achieve. For example, in 2015 when the groundwater level was projected to be in the 'critical' stage by the end of the year, the Board called for a 30% reduction in water use. In evaluating water supply scenarios, Valley Water seeks alternatives that can reduce the number of years (over the 94-year simulation in the model) that trigger calls for reductions, as well as the severity of those reductions. Valley Water's current level of service goal is to develop supplies to meet 100% of demands in normal years identified in Valley Water's Water Supply Master Plan and at least 80% of demands in drought years.

Water Supply Used

A third measure of the robustness of a water supply scenario is the total water supply used. This is a summation of average water recharged from natural groundwater, local surface water delivered to treatment plants and recharge facilities, and imported water delivered to treatment plants and treatment facilities. Dry years can be specifically appraised for each water supply scenario to see how it performs in extended dry conditions.

Baseline Year

Consistent with the release of the Notice of Preparation, and modeling work for fisheries, the baseline year is 2015. Water supply demands for 2015 are based on the projections from the 2010 Urban Water Management Plan. Actual demands for 2015 were substantially lower than the projections from 2010 and from previous years due to on-going dry conditions and the associated water use reductions called for during the drought. Since the actual demands for 2015 were so low, the use of the projections from 2010 present a more conservative depiction of potential impacts from implementation of the FHRP.

FAHCE Modeling

Early modeling for FAHCE utilized the same model that is used for water supply analysis in a monthly time step as is performed for water supply analysis, but it was determined that greater detail was necessary to evaluate potential impacts and benefits from revised reservoir releases in the FHRP on fisheries. For this purpose, a Daily Model was created based on the Monthly Model. The details of how the Daily Model was created can be found in SCVWD Daily WEAP Model Technical Memorandum[2]. The Daily Model was disaggregated from the monthly time step to a daily time step, and the model was modified and updated to best mimic Valley Water's facilities, creeks, and rivers to evaluate key fisheries habitat. Additional urban accretions were added to the model to account for all the water in the creek including flows not used for water supply.

The following results and attached table and charts are based on WEAP Daily Model output completed on September 16, 2019.

Methodology

Simulations developed using the FAHCE WEAP Daily Model, and post-processing tools were used to quantitatively assess potential changes in available water supply and groundwater storage that could occur under the FHRP and alternatives relative to the Baseline condition.

WEAP model results are more reliable for comparative purposes than for absolute predictions of conditions. Model assumptions are the same for the FAHCE, FAHCE Plus, and Baseline model runs, except operations specific to the FAHCE scenarios. The focus of the evaluation is on the differences in results between the Baseline model runs and the two FAHCE and FAHCE Plus scenarios. Results from a single simulation might not correspond to actual operations for a specific month or year but are representative of general conditions. Model results are best interpreted using various statistical measures such as changes in long-term and water year-type averages and differences in probabilities of exceedance. Model output includes storage at each of the Project Area reservoirs, groundwater storage in each subbasin, stream flows along the primary tributaries between the reservoirs and San Francisco Bay, water delivered to water treatment plants and groundwater recharge facilities, the need for demand reductions consistent with the WSCP, and total water supply used.

The WEAP model scenarios that consider 2015 levels of water supply demands are based on demand projections from the 2010 Urban Water Management Plan; current seismic restrictions on storage are in place; imported supplies based on the Existing Conditions scenario from the California Department of Water Resources 2015 Delivery Capability Report; and no additional water supply sources are added.

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[2] Valley Water. 2020. Valley Water Daily WEAP Model Technical Memorandum. October 2020.

Model scenarios for 2035 consider projected 2035 demands consistent with Valley Water's Water Supply Master Plan Update, which uses 2015 Urban Water Management Plan estimates adjusted for retailer compliance with per capita water use levels required under state law and regional growth projections. Additional water supplies are available through the development of 24,000 acre-feet per year of indirect potable reuse water; District water conservation and demand management efforts consistent with the Water Supply Master Plan No Regrets Package; improvements made to Anderson, Calero, Guadalupe, and Almaden Reservoirs to remove seismic restrictions on storage; and imported water based on the construction of the Delta Conveyance Project.

Threshold of Significance

Based on Valley Water's process in evaluating water supply alternatives as discussed above, the following threshold is used to determine the significance of the FHRP:

- Would the Project result in increased water use restrictions, the number years of water use restrictions, and/or a reduction in total water supply used due to a substantial reduction in available water supplies?

Analysis

Avoidance of Water Use Restrictions

The WSCP is based on the end of year groundwater storage as this reflects the general health of the water system. In the 2015 Base Case, three of the 21 years require demand reductions with a maximum 20% reduction; this holds true for FAHCE and FAHCE Plus scenarios as well (Demand Reductions in Table 1). In the 2035 Base Case, there are two years of 10% demand reductions. The FAHCE and FAHCE Plus scenarios both add a third year of 10% demand reduction. In all cases the years of demand reduction occur in 1991 through 1993, which were part of an extended drought that lasted from 1987 through 1992. The rest of the modeled period is generally average to wet years so additional restrictions would not be expected.

Groundwater Storage

Overall average groundwater levels are all within half of percent between the base, FAHCE and FAHCE Plus scenarios in both 2015 and 2035 (Groundwater Averages in Table 1). The FAHCE and FAHCE Plus scenarios show slower rebound in the Coyote Valley versus the base case in the drought years of the early 1990s (Figure 3 and Figure 4). This is largely the result of limitations in the use of imported water to Coyote Creek during the summer months. Coyote Creek is the sole facility available for managed recharge in the Coyote Valley. When flows are limited in the creek it directly influences groundwater levels in Coyote Valley. In the WEAP model, it is assumed that imported water is too warm for discharge to Coyote Creek during the summer. During dry years, there is little supply available in Anderson Reservoir, so this limits water available in Coyote Creek for recharge and results in lower groundwater storage in the FAHCE and FAHCE Plus scenarios than the base case. However, groundwater conditions improve after the drought years and the FAHCE and FAHCE Plus results closely follow the base case results over the simulation period. Additionally, all three simulations indicate that the groundwater storage in the Coyote Valley remains above targets set (5,000 AF) in the Valley Water's 2016 Groundwater Management Plan, even during the drought years of the early 1990s.

Groundwater levels in the Santa Clara Plain (Figures 1 and 2) and Llagas subbasins (Figures 5 and 6) do not show significant differences under the FAHCE and FAHCE Plus scenarios compared to base case conditions.

Conclusion

The inclusion of the FAHCE and FAHCE Plus rules curves in the operation of Valley Water reservoirs has a less than significant impact on water supply resources.

Limitations on the use of imported water in Coyote Creek may result in significant impacts to groundwater levels in Coyote Valley, particularly during drought years. It should be noted that the hydrologic conditions simulated between 1990 and 2010 only include the back half of an extended drought that lasted from 1987 through 1992. Given the response to the simulated groundwater levels and storage during the drought years of the early 1990s, it is possible that the FAHCE or FAHCE Plus scenarios under a more severe and (or) extended drought may result in more severe or prolonged lowering of groundwater levels and storage in Coyote Valley.

TABLE 1

WEAP Daily Model Water Supply Output Summary	2015 Base Case	2015 FAHCE	2015 FAHCE +	2035 Base	2035 FAHCE	2035 FAHCE +
Groundwater Storage (Annual Avg. AF)						
Coyote Subbasin	23,697	22,574	22,574	24,044	23,096	23,096
Llagas Subbasin	98,980	99,243	99,187	112,827	113,023	113,007
North County Santa Clara Subbasin	317,922	317,021	316,797	336,976	338,174	337,997
Sum	440,598	438,837	438,558	473,847	474,294	474,100
Local Reservoir Storage (Annual Avg. AF)						
Almaden Reservoir	966	1,011	920	1,044	1,076	966
Anderson Reservoir	39,220	40,414	39,890	53,526	52,883	51,096
Calero Reservoir	4,080	4,203	4,202	5,567	5,299	5,439
Chesbro Reservoir	3,623	3,623	3,623	3,623	3,623	3,623
Coyote Reservoir	10,429	10,670	10,668	10,552	10,807	10,785
Guadalupe Reservoir	1,330	1,547	1,376	1,772	1,811	1,712
Lexington Reservoir	8,120	8,341	8,341	8,140	8,400	8,400
Stevens Creek Reservoir	2,210	2,251	2,090	2,210	2,251	2,090
Uvas Reservoir	5,848	5,848	5,848	5,857	5,857	5,857
Sum of Local Storage	75,826	77,909	76,958	92,290	92,009	89,969
Non-Local Storage (Annual Avg. AF)						
Semitropic	141,519	141,279	140,297	151,534	163,445	163,531
CVP Carryover	23,711	22,508	22,157	17,227	19,119	18,750
SWP Carryover	19,247	18,635	18,356	13,120	14,541	14,292
Sum of Non-Local Storage	184,476	182,421	180,810	181,881	197,105	196,573
Demand Reductions						
Years with Reductions (Maximum)	3 (20%)	3 (20%)	3 (20%)	2 (10%)	3 (10%)	3 (10%)
Number of Years in Stage 2 (10%)	1	1	1	2	3	3
Number of Years in Stage 3 (20%)	2	2	2	-	-	-
Minimum North County GW Storage	199,678	200,944	201,305	271,296	272,933	274,139

Figure 1

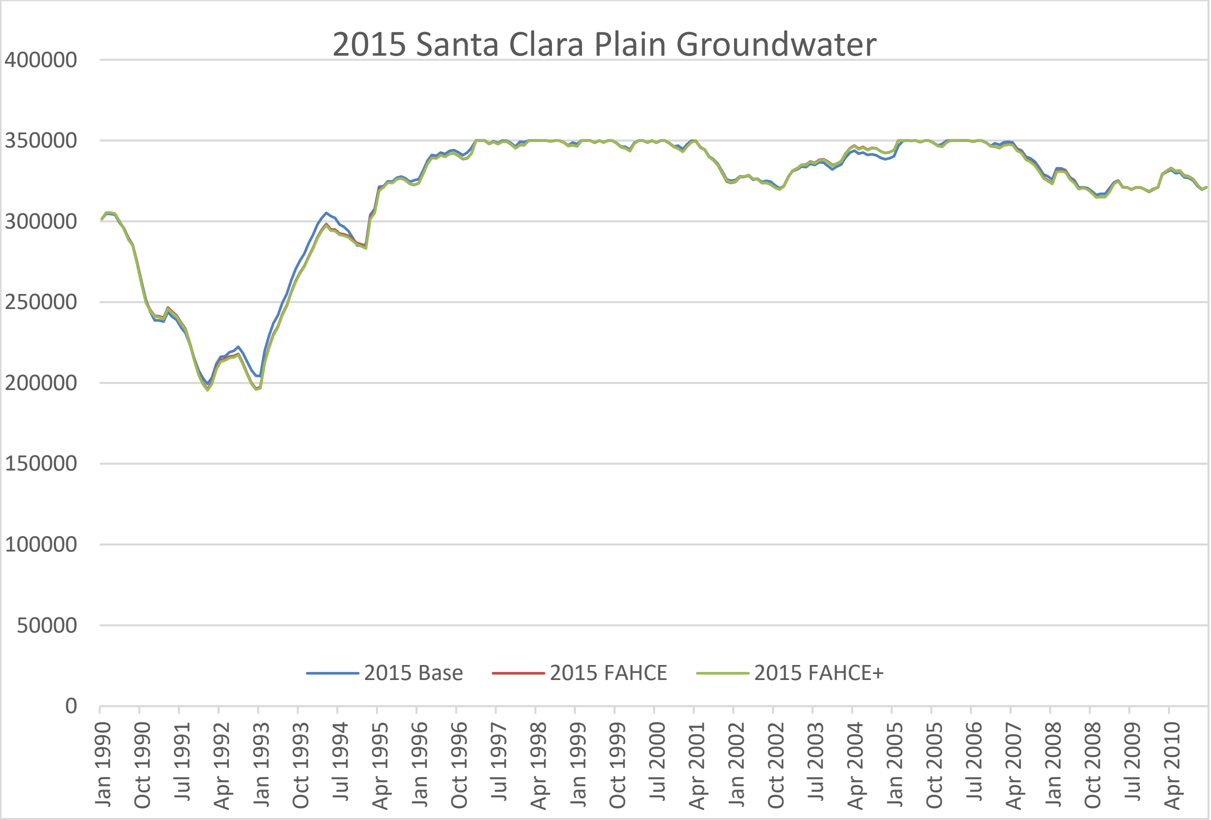


Figure 2

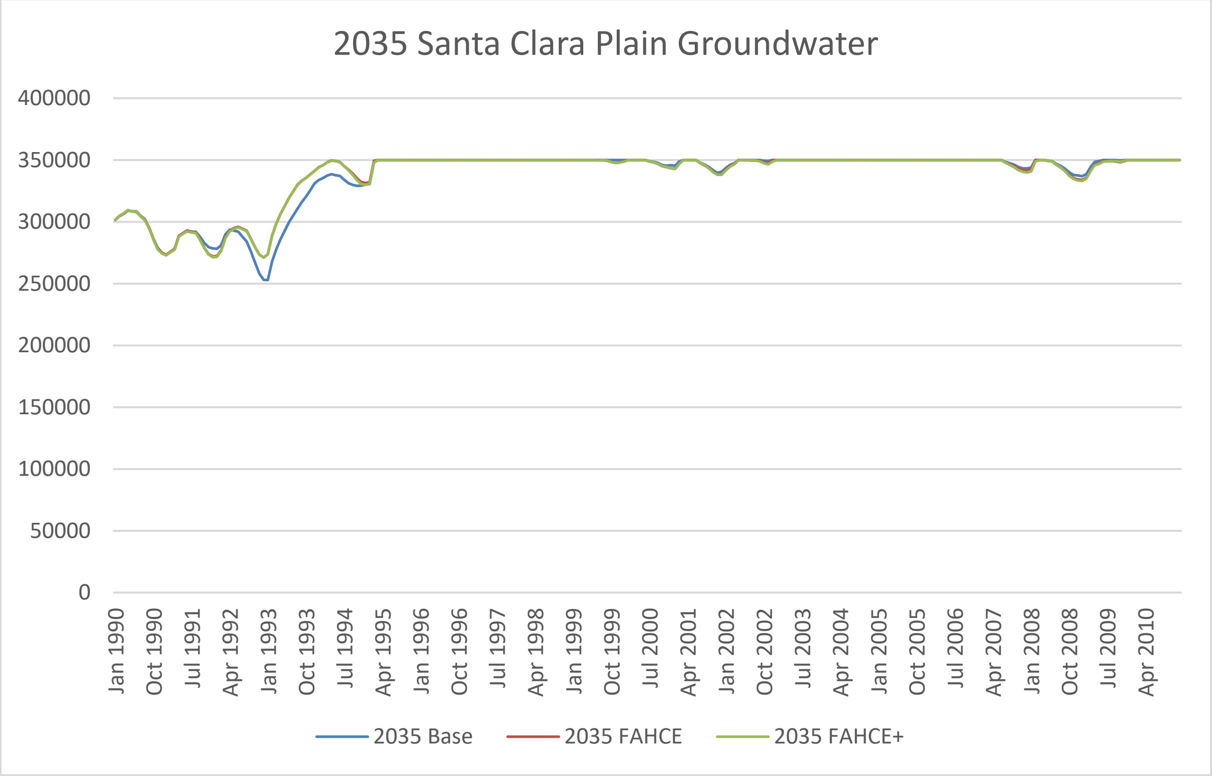


Figure 3

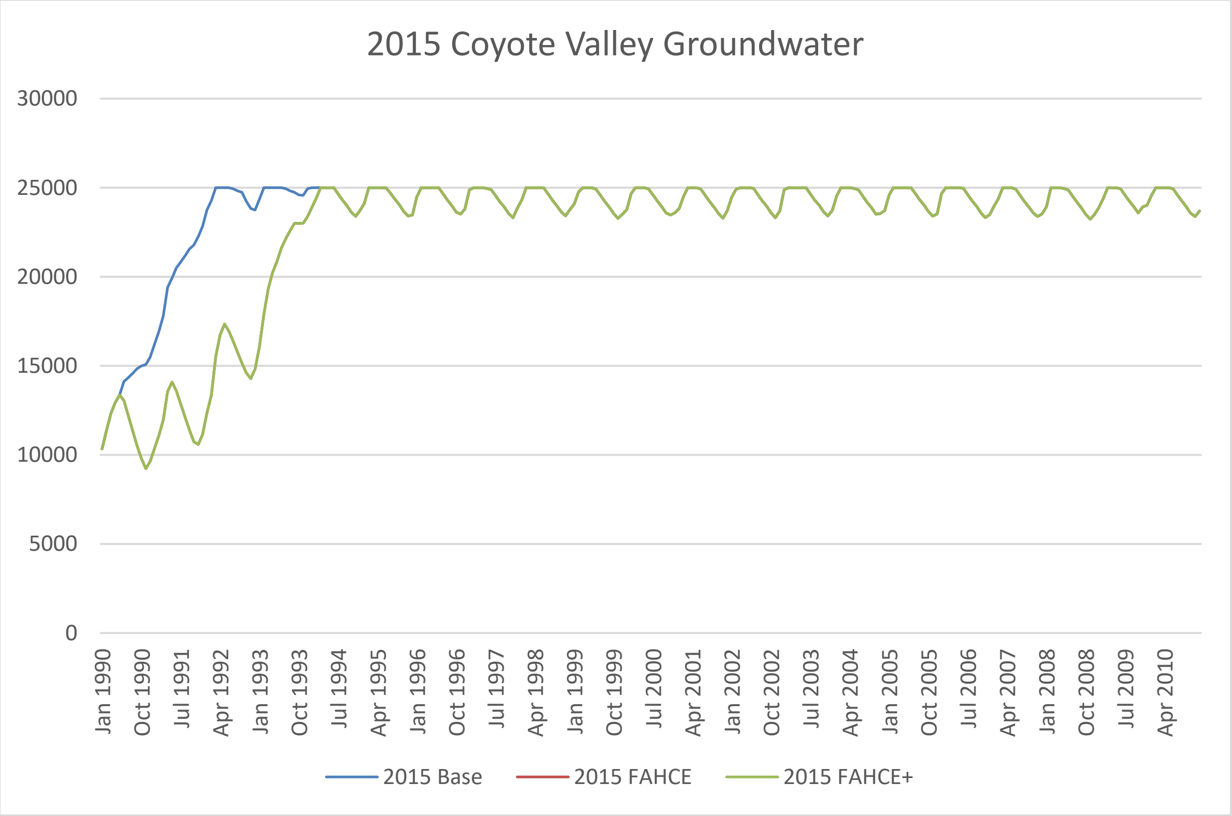


Figure 4

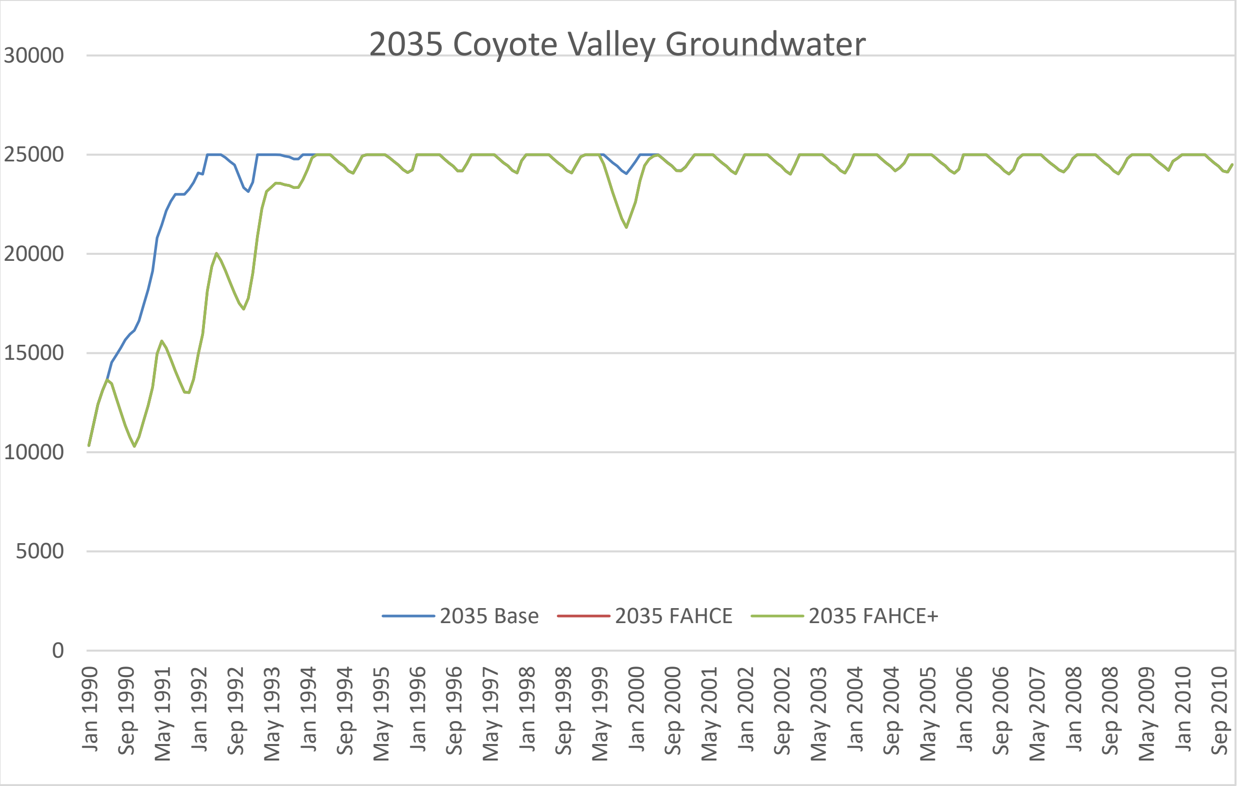


Figure 5

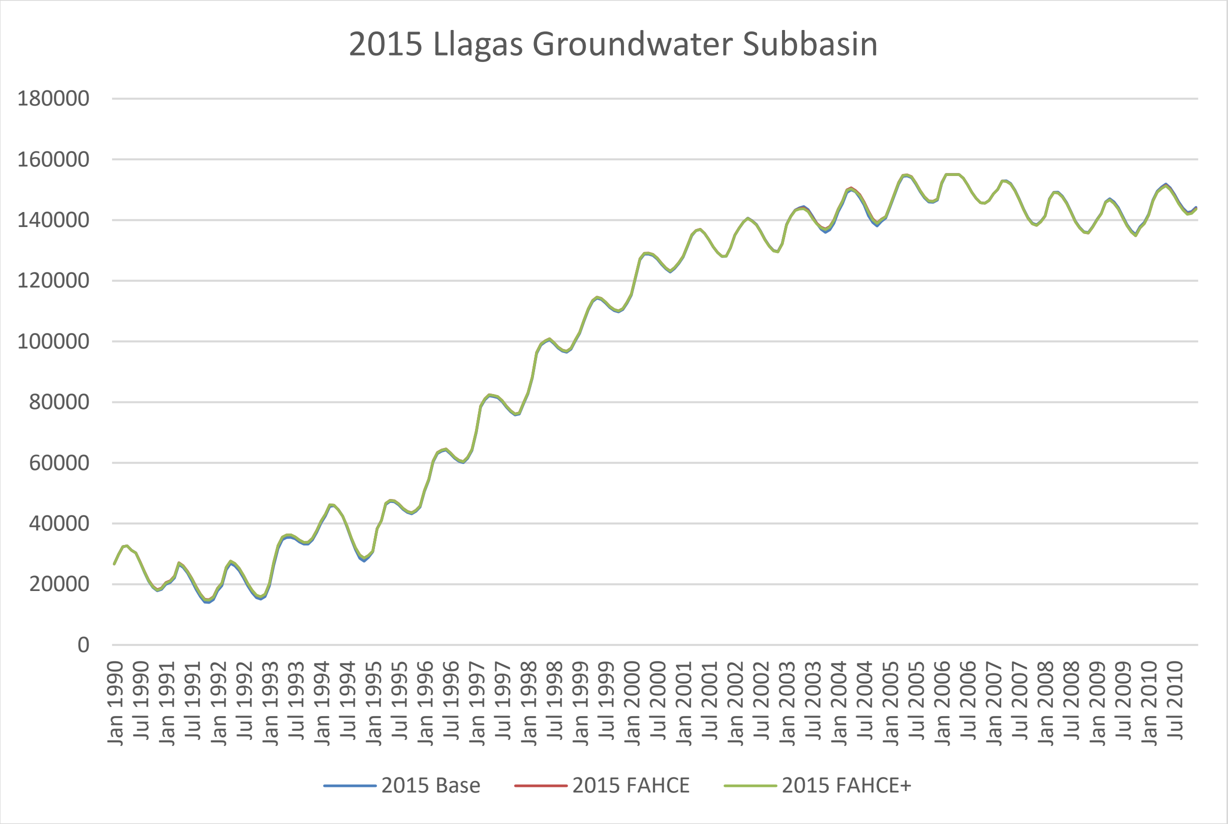
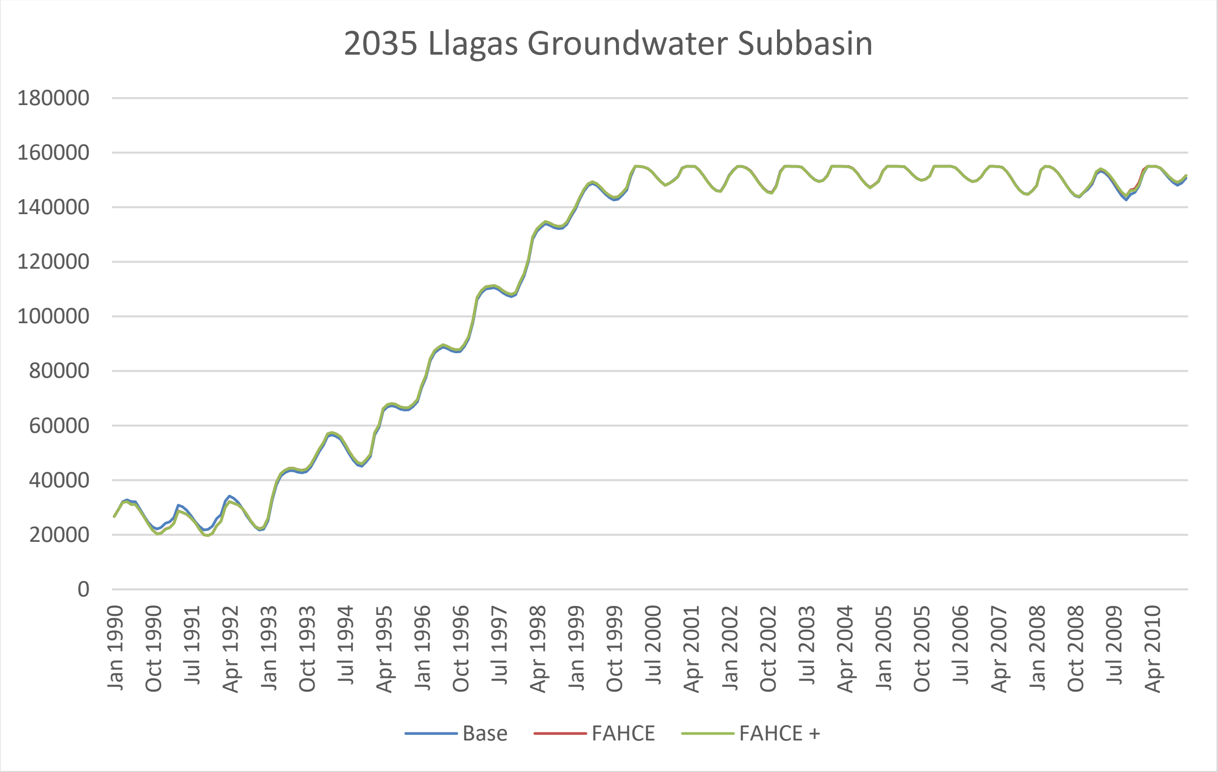


Figure 6



Appendix N

Fisheries Habitat Availability Estimation Methodology

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Appendix N – Fisheries Habitat Availability Estimation Methodology

Fish and Aquatic Habitat Collaborative Effort
Draft Program Environmental Impact Report

Santa Clara Valley Water District

Santa Clara County, California

May 2021

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Appendix N – Fisheries Habitat Availability Estimation Methodology

Contents

Tables

Figures

Attachments

Attachment A – FAHCE Entrix Inc. Report: Habitat Data Verification Project, Workplan
Attachment B – Summary of Lifestage Timing Information Reviewed

Appendix N – Fisheries Habitat Availability Estimation Methodology

1 Fisheries Habitat Availability Estimation Methodology

1.1 Introduction and Purpose

The Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) Settlement Agreement was initialed in 2003. A key Settlement Agreement provision is to implement reservoir flow releases and restoration measures (Proposed Project) to support salmon and steelhead, as appropriate, in Stevens Creek, the Guadalupe River, Los Gatos Creek, Guadalupe Creek, Alamitos Creek, and Calero Creek (that is, the study area).

The FAHCE Project is intended to support the Santa Clara Valley Water District's (Valley Water's) proposal to change its water rights to provide water for fisheries and wildlife enhancement. The FAHCE Project was developed by the FAHCE Technical Advisory Committee (TAC) based on studies and analyses conducted between 1998 and 2001. The goal of the TAC was to develop modified reservoir releases and diversion operations to improve anadromous fish habitat and passage conditions in the study area. A number of fish habitat improvement measures, including reservoir re-operations rule curves (flow measures) and other habitat improvements (non-flow measures), were incorporated into the FAHCE Settlement Agreement.

Relative to evaluating changes in only flows and water temperatures, the FAHCE Project developed methodologies to evaluate more biologically meaningful representations of habitat and passage conditions for the target species of the FAHCE Settlement Agreement (that is, steelhead and fall-run Chinook salmon) including water depth, water velocity, water temperature suitability, and other biological variables.

The purpose of this memorandum is to present the methodology used to estimate lifestage-specific habitat suitability[1] and availability[2] and fish migration conditions, including development and application of habitat suitability criteria, development of composite indices of habitat suitability, development of indices of habitat availability, and individual-based simulation of adult and juvenile passage. An overview of the generalized steps to estimate habitat availability and passage conditions is summarized in Figure 1.1-1. This memorandum references other FAHCE technical memoranda that describe the hydraulic, hydrologic, and water temperature models developed to support this evaluation. The results of implementing this methodology are provided in the FAHCE Environmental Impact Report (EIR).

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[1] For the purposes of this memorandum, *habitat suitability* refers to the extent to which the values of evaluated habitat variables are representative of optimal habitat conditions for a given species and lifestage.

[2] For the purposes of this memorandum, *habitat availability* refers to an index intended to represent an area of suitable habitat for a given species and lifestage, assuming that the area of suitable habitat is directly proportional to an index of habitat suitability.

Figure 1.1-1. Overview of Generalized Steps to Estimate Habitat Availability in Study Area

Simulate Flow and Water Temperature	• Simulate daily flow at representative locations, including Points of Interest (POI) • Estimate daily water temperature at representative locations
Collect Structural and Habitat Typing Data	• Collect structural habitat data and habitat type proportions in each reach • Identify proportions of Pool/Riffle/Run in each reach based on habitat typing data
Develop Representative Hydraulic Modeling	• Classify HEC-RAS cross-sections into Pool/Riffle/Run habitat types • Identify representative cross-sections for each habitat type in each reach
Model Habitat Variables	• Simulate water depth and velocity for each habitat type by reach, and water temperature for each reach on a daily basis under each operational scenario • Incorporate structural habitat variables (substrate size, embeddedness, and instream cover)
Develop and Apply Habitat Suitability Criteria	• Develop Habitat Suitability Criteria (HSC) for adult and juvenile passage, spawning, incubation, fry rearing, and juvenile rearing • Develop Composite Habitat Suitability Indices (CHSIs)
Estimate Habitat Availability Indices and Simulate Passage Conditions	• Calculate daily habitat availability indices by reach and creek for spawning, incubation, fry rearing, and juvenile rearing • Simulate individual-based adult upstream passage and juvenile downstream passage based on modeled habitat conditions in each creek

2 Habitat Availability and Passage Modeling and Characterization

2.1 Overview

Figure 2.1-1 presents an overview of the steps used to estimate habitat availability indices and simulate passage conditions by species and lifestage in the study area, including: (1) simulation of flows, hydraulics, water temperatures, and collection of structural habitat data; (2) development and application of habitat suitability criteria[3] (HSC); (3) calculation of habitat suitability indices (HSIs); (4) calculation of composite habitat suitability indices (CHSIs) and passage indices on a daily basis; (5) calculation of habitat availability indices by species and lifestage on a daily basis; and (6) individual-based simulation of upstream adult migration and downstream juvenile emigration. Figure 2.1-1 also includes reference to the other diagrams presented later in this memorandum to describe specific procedures of the methodology in more detail.

The hydraulic, water quality, and structural habitat variables selected to evaluate habitat availability for each lifestage of steelhead and fall-run Chinook salmon are summarized below. Habitat variables and their specific application for estimating habitat availability are described in more detail in subsequent sections of this memorandum.

2.1.1 Adult Upstream Migration

The suitability of adult upstream migration conditions is evaluated in terms of the distance that adults are able to migrate upstream from the Bay in each creek on a daily basis, as well as the number of daily adult cohorts that could migrate to spawning reaches in each creek during each spawning season (that is, adult passage events). Evaluation of adult upstream migration and passage events is based on simulated water depths and water temperatures. The daily upstream migration distance is determined at discrete points throughout each creek.

2.1.2 Spawning and Embryo Incubation

Spawning habitat suitability is defined in this evaluation by ranges of water depths, velocities, substrate size composition, and substrate quality. Substrate quality is defined by the amount of embeddedness, or average proportion that spawning substrate is buried or embedded in fine substrate. Although additional variables may be components of spawning and incubation habitat quality, such as gravel permeability and hyporheic water quality (reviewed by Williams 2006) and nearby availability of cover (Merz 2001; Senter and Pasternack 2010; Wheaton et al. 2004), associated modeling and data are not available for the study area. Additionally, spawning HSC generally are expected to emphasize substrate characteristics over cover elements (Normandeau Associates, Inc. 2014).

Although water temperature is also an important component of spawning habitat suitability, water temperature during spawning is addressed through the embryo incubation habitat suitability evaluation.

Successful embryo incubation may be affected by many physical variables (Merz et al. 2004). For the purposes of this evaluation, embryo incubation habitat suitability is defined by variables that can be simulated with the models available - water depth and water temperature.

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[3] Habitat Suitability Criteria are also often referred to as Habitat Suitability Curves, Habitat Preference Criteria, etc.

2.1.3 Fry and Juvenile Rearing

Fry and juvenile rearing habitat suitability is defined in this evaluation by simulated depth, velocity, and water temperature, and amount and types of cover/shelter. Given lifestage-specific preferences, the suitability of depth and velocity are defined separately for fry and juveniles. In addition, because of differing habitat preferences of juvenile salmonids during the winter relative to the remainder of the year, cover is defined differently during the winter months.

2.1.4 Juvenile Emigration

The suitability of juvenile emigration conditions is defined by the frequency with which juveniles can successfully emigrate from the upstream modeled reach of each creek downstream to the Bay. Successful daily emigration is evaluated based on simulated water depth and water temperature.

2.2 Flow and Hydraulic Modeling and Application

Simulating hydraulic and water temperature conditions requires a method to simulate flows throughout the area of interest. For this analysis, modeled flows were provided from a Water Evaluation and Planning (WEAP) model at designated flow nodes (also referred to as Points of Interest, or POI) within designated Reaches of Interest (ROI). The ROI were developed by representatives of the California Department of Fish and Wildlife (CDFW) and National Marine Fisheries Service (NMFS) to obtain flows at biologically-relevant areas (see *Methods for Establishing Reaches of Interest and Points of Interest Technical Memorandum* [FAHCE Technical Workgroup 2016; Appendix H] and Figure 2.2-1 and Figure 2.2-2**,** and). As shown in Figure 2.2-1 and Figure 2.2-2, each ROI was designated by expected use, including migration, spawning, and/or rearing. All POIs were designated as locations to be evaluated for passage. Mean daily flows are simulated over a period of record extending from calendar year 1990 through 2010. A detailed description of the hydrologic model is provided in the *SCVWD Daily WEAP Model Technical Memorandum* (SEI 2016; Appendix G).

Modeled flows were used in conjunction with HEC-RAS[4] modeling to develop relationships between flow, and water depth and velocity (that is, depth-discharge and velocity-discharge relationships), and to simulate the wetted width of the channel, as further described, below.

A suite of pre-existing HEC-RAS models for the study area were developed by Valley Water primarily between 1999 and 2016, depending on the creek and reach, for the primary purpose of flood risk analysis (see SEI 2017). Because the pre-existing HEC-RAS models for the study area had been developed for the purpose of simulating flood stage, they generally lacked low-flow streambed topographic resolution (SEI 2017). Therefore, new transects were surveyed by Valley Water during 2016 in the vicinity of POI in specific areas where fish passage may be limiting (that is, at shallow riffles). A new transect was surveyed at most POIs, except for several POIs where only deep pools were encountered, and two POIs where man-made features represented the most limiting fish passage conditions (for example, on the concrete apron downstream of the Fremont Avenue fish ladder in Stevens Creek) (SEI 2017). Hydraulic modeling at these transects were used to simulate thalweg water depths for adult and juvenile fish passage (see SEI 2017 for additional detail). In addition to modeling thalweg depths by POI for evaluating fish passage conditions, flows at which critical riffles would be passable also were identified based on critical riffle surveys conducted by Valley Water in 2016 (see Section 3.3.1.1).

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[4] HEC-RAS is a River Analysis System (RAS) program developed and updated by the Hydrologic Engineering Center (HEC) of the USACE that models the hydraulics of water flow through rivers and man-made waterways.

Figure 2.1-1. Habitat Availability Estimation Overview Diagram

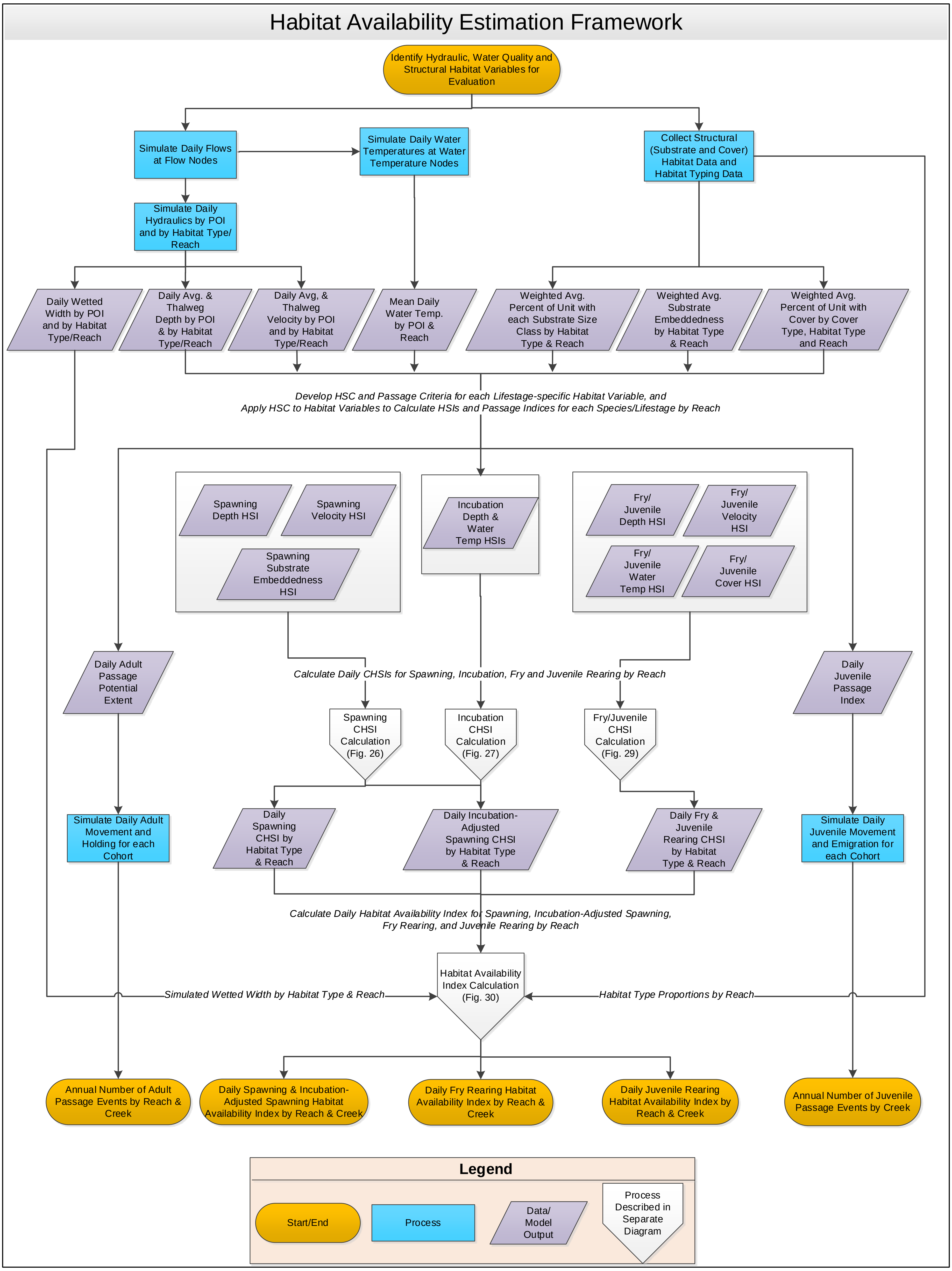

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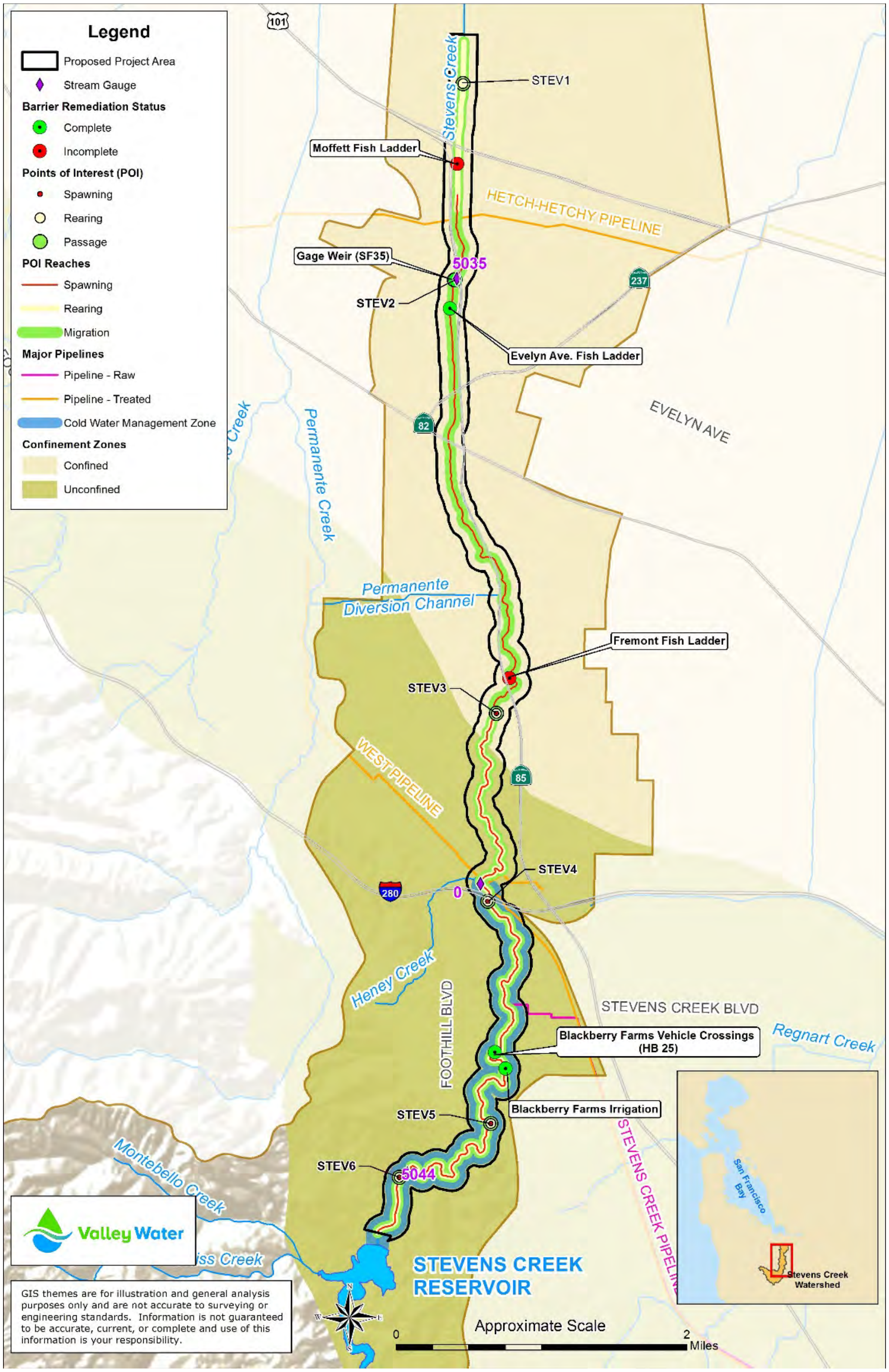
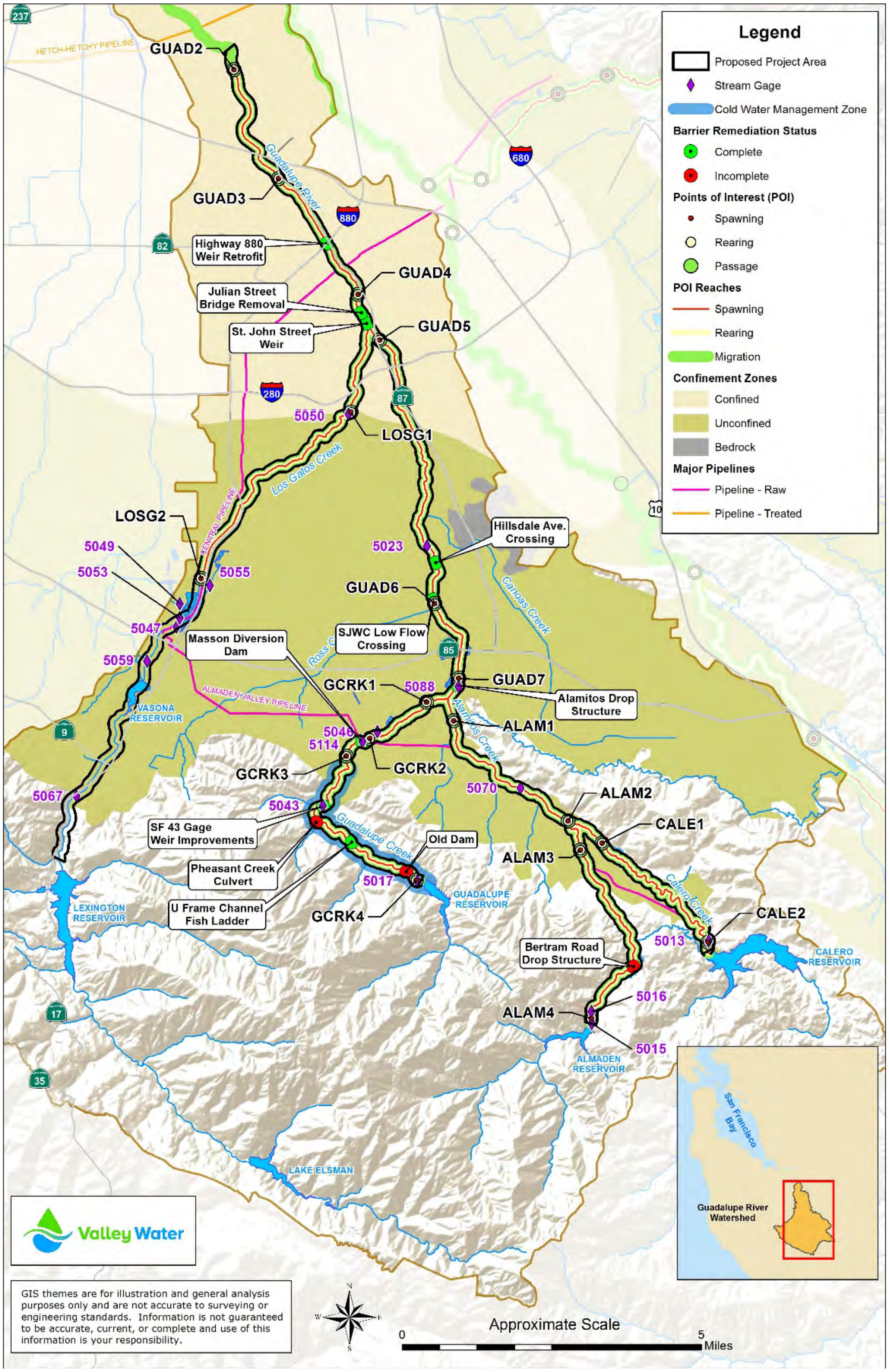
Figure 2.2-2. Points of Interest and Reaches of Interest in Stevens Creek Watershed



GIS themes are for illustration and general analysis purposes only and are not accurate to surveying or engineering standards. Information is not guaranteed to be accurate, current, or complete and use of this information is your responsibility.

Figure 2.2-3. Points of Interest and Reaches of Interest in Guadalupe River Watershed



For the purpose of simulating water depth and velocity by habitat type (that is, riffle, run, pool) to quantify spawning and rearing habitat suitability and availability, a hydraulic geomorphic methodology was developed to classify the pre-existing HEC-RAS transects by habitat type in each reach (SEI 2017). After all transects were classified by habitat type and reach, the transect closest to the centroid (that is, based on a ternary plot of water surface width, mean depth and mean velocity) among those transects was selected as the representative transect to model hydraulics for that habitat type for a reach (see SEI 2017 for additional detail).

2.3 Water Temperature Estimation and Application

Mean daily water temperature is estimated at various locations in the study area creeks over the 1990-2010 period of hydrologic simulation. Least-squares regression analysis was conducted using historical daily flow, reservoir storage, water temperature, and daily maximum historical air temperature data measured during the 2000 to 2014 calibration period. The resulting regression coefficients are applied to WEAP modeled mean daily flow and end-of-day storage output, to estimate mean daily water temperatures at each water temperature model node (that is, model output location). For the two creeks with coldwater management zones (that is, Guadalupe and Stevens) described in the 2003 FAHCE Settlement Agreement, historical water temperature profiles for the associated reservoirs (that is, Guadalupe and Stevens Creek) are used to simulate release water temperatures into the uppermost reaches of these creeks below the dams. Simulated mean daily water temperatures are reported at selected locations generally corresponding to POIs. Refer to the *Temperature Modeling Technical Memorandum* (Appendix I) for a detailed description of the water temperature estimation methodology.

2.3.1 Application of Estimated Water Temperatures

Application of estimated water temperatures to the habitat availability and passage analyses differs between the passage evaluations and the indices of habitat suitability and habitat availability. For the adult and juvenile passage evaluations, passage is evaluated primarily at discrete locations (that is, passage POIs; Figure 2.2-1 and Figure 2.2-2) and, therefore, representative mean daily water temperatures are needed at each passage POI. By contrast, habitat suitability and availability indices for the spawning/embryo incubation and fry/juvenile rearing lifestages are estimated by reach and, therefore, require an estimated water temperature to represent each reach on a daily basis. The methodologies for applying simulated water temperatures to the adult and juvenile passage evaluations and the habitat suitability/availability evaluations are described below.

2.3.1.1 Passage Evaluations

For the adult and juvenile passage evaluations, simulated water temperatures are applied at single locations (POIs), which are generally in the vicinity of water temperature estimation model nodes. However, as identified in the Water Temperature Modeling Technical Memorandum, water temperatures are not estimated at or near some POIs, as follows.

- GUAD6 - located in the upper portion of the Guadalupe River
- GUAD1 and GUAD2 - the two most downstream POIs in the Guadalupe River
- STEV1 and STEV2 - the most downstream POIs in Stevens Creek

Given tidal influences, water temperatures are not estimated in the reach below San José Airport in the Guadalupe River (that is, GUAD2, GUAD1). For GUAD6, mean daily water temperatures at GUAD7 are applied also because it is the closest node available. For STEV1, insufficient or anomalous water temperature monitoring data prevented reliable estimation of water temperatures at this location.

2.3.1.2 Habitat Suitability and Availability Evaluations

Because indices of fisheries habitat suitability and availability are estimated throughout the lengths of the study area creeks below primary passage barriers, estimated water temperatures are required throughout the lengths of the creeks being assessed. In addition, because flows and hydraulics are simulated by reach, simulated water temperatures are required for each reach.

Because water temperatures change (generally warming during the spring through summer, with some exceptions) with distance downstream of a water temperature node, utilizing a water temperature node near the upstream extent of a POI reach may underestimate water temperature (and overestimate habitat suitability) downstream of the node. Conversely, utilization of a downstream node may overestimate water temperature (and underestimate habitat suitability) within the reach upstream of that node. Therefore, simulated daily water temperatures at both the upstream and downstream extent of a POI reach were used to calculate an average daily water temperature for the reach when feasible. For the lowermost reaches of tributaries to the Guadalupe River, the most downstream water temperature node in the tributary is applied.

Estimated mean daily water temperatures by reach, in combination with species and lifestage-specific water temperature index values or suitability criteria, are used to define thermal habitat suitability for each species and lifestage, as further described in subsequent sections of this document.

2.4 Structural Habitat Characteristics

The physical structure of a channel is defined by specific characteristics, such as channel width, substrate size composition, substrate embeddedness, and overhead or instream object cover (Bovee 1982). For the purposes of modeling habitat suitability and availability, these habitat characteristics define the structure of a channel and are assumed to be constant over a specific range of flows.

Structural habitat and habitat typing data were collected throughout most of the study area during the summer and fall of 1999 (Entrix 2000) based on the habitat inventory methodology in the CDFW Stream Restoration Manual (Flosi et al. 1998). Given potential changes in habitat type proportions and in other structural habitat characteristics that may have occurred since 1999, Valley Water conducted habitat typing and collected additional structural habitat characteristic data (for example, substrate size and embeddedness, and instream cover metrics) in each creek being evaluated in the study area. Data collection efforts were conducted during August through October of 2016, and included surveying, on average, approximately 10 percent of the total lengths of the creeks using a random sampling methodology stratified by geomorphic reach (sampling methodology described in Attachment A). These data were collected to validate and/or update the structural habitat data collected during 1999, and to further characterize structural habitat conditions in the study area for the purposes of estimating habitat suitability and availability as part of this evaluation. Results of the 2016 surveys are summarized in Appendix O.

Substrate size and embeddedness are used to evaluate structural habitat conditions for spawning, and the percentages of each habitat unit with specific instream cover components were used to evaluate structural habitat conditions for fry and juvenile rearing. To facilitate the expansion of these variables from sampled sites by habitat type within a reach, a weighted average of each habitat variable (that is, percent of unit with each substrate size class, substrate embeddedness, total percent of unit with cover, and percent of unit with specific cover categories) is calculated for each habitat type for each reach. The weighting applied to the structural data for a sampled habitat unit is calculated based on the linear proportion (length-wise along the creek) of the sampled unit of a given habitat type relative to all sampled units of that habitat type in a reach. Structural habitat variables are applied to the spawning and rearing habitat suitability evaluations.

3 Habitat Availability Estimation

3.1 Overview

Hydraulic, water temperature, and structural habitat characteristic data are required to simulate the area of suitable habitat for anadromous salmonid spawning, embryo incubation, and juvenile rearing. Specifically, the suitability of anadromous salmonid spawning habitat is typically defined by values or ranges of depth and velocity, water temperature, and substrate size and quality, while the suitability of juvenile salmonid rearing habitat is typically defined by values or ranges of depth and velocity, water temperature, and amount and type of instream cover/shelter, including substrate characteristics.

The suitability for a given lifestage of each habitat attribute is evaluated through application of HSC. HSC provide relationships between a habitat variable and assumed suitability for a given species and lifestage. HSC are typically used for habitat attributes including water depth, water velocity, substrate composition, and types of instream cover/shelter. Therefore, simulation of each habitat variable, in conjunction with the application of HSC, allow for an estimation of a habitat suitability index at a given flow in a given reach for a given habitat variable. Suitability index values for each species and lifestage are then composited by reach for each creek to develop an overall index of habitat suitability for each species/lifestage by reach and creek on a daily basis. The daily composite suitability index for a species/lifestage by reach and creek is then converted to a daily index of habitat availability by multiplying the composite suitability index by the associated area of the reach to obtain an estimate of available habitat in each reach and creek.

3.2 Life History

Estimating habitat availability for a species and lifestage over the appropriate time period is dependent on the lifestage-specific temporal distribution (that is, the time period when a specific lifestage may be present). Therefore, species and lifestage-specific life histories are described in the following sections for Central California Coast (CCC) steelhead and Central Valley fall-run Chinook salmon. It is generally understood that regional and river-specific environmental conditions influence inter-and intra-annual freshwater lifestage periodicities of an anadromous salmonid population. However, for evaluation purposes, a generalized life history periodicity is required for each lifestage of steelhead and fall-run Chinook salmon. Table 3.2-1 presents the lifestage-specific temporal periods used to evaluate the effects of the Proposed Project and alternatives on habitat conditions. Evaluations conducted for each species and lifestage are then further explained in the following subsections. Literature reviewed and relevant lifestage timing information is summarized in Attachment B.

Table 3.2-1. Lifestage Periodicities Used in FAHCE Evaluation

Lifestage	FAHCE Lifestage-Specific Temporal Distributions																																															
	January				February				March				April				May				June				July				August				September				October				November				December			
Steelhead																																																
Adult Immigration	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																													■	■	■	■
Adult Spawning	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																													■	■	■	■
Fry Rearing									■	■	■	■	■	■	■	■	■	■	■	■																												
Juvenile Rearing	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Smolt Emigration					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																												
Fall-run Chinook Salmon																																																
Adult Immigration	■	■	■	■																																			■	■	■	■	■	■	■	■	■	■
Adult Spawning	■	■	■	■																																			■	■	■	■	■	■	■	■	■	■
Fry Rearing	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																																
Juvenile Rearing	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																								
Juvenile Emigration					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																								

3.2.1 Central California Coast Steelhead

The following sections describe literature and data used to develop lifestage-specific periodicities for evaluation of CCC steelhead, including adult immigration, adult spawning, embryo incubation, fry rearing, juvenile rearing, and juvenile outmigration.

3.2.1.1 Adult Immigration

The majority of CCC steelhead typically migrate into freshwater between late-December and April, entering rivers in reproductive condition and spawning soon after reaching spawning grounds (Moyle et al. 2008). Various literature sources from California were examined to identify the appropriate evaluation time period for steelhead adult immigration (Entrix 2003; FAHCE 2003a; 2003b; Fukushima and Lesh 1998; Holmes and Cowan 2014; Leidy 2007; McEwan and Jackson 1996; Merz et al. 2015; Moyle 2002; Nishijima et al. 2009; Valley Water 2000; Shapovalov and Taft 1954; Williams 2006). Examples from the Central Valley (for Central Valley steelhead) suggested that adult steelhead begin to enter freshwater as early as August (Leidy 2007; Williams 2006), but most literature reported November or December as the start of the adult immigration period. Although most of the Central Valley literature reported that upstream migration extends through March or April, an example for CCC steelhead indicated that adult immigration may extend through May (Holmes and Cowan 2014).

Although adult steelhead immigration timing data are limited in the study area, Nishijima et al. (2009) investigated steelhead adult passage in the Guadalupe River and Guadalupe Creek at the Alamitos and Masson Fishways, respectively using VAKI Riverwatchers. Investigation of adult steelhead passage from 2004 through 2008 indicates that the majority of adult steelhead immigration occurred from February through April (Figure 3.2-1 through Figure 3.2-4). The VAKI Riverwatchers were generally operational from about mid-October through about mid-May of each year.

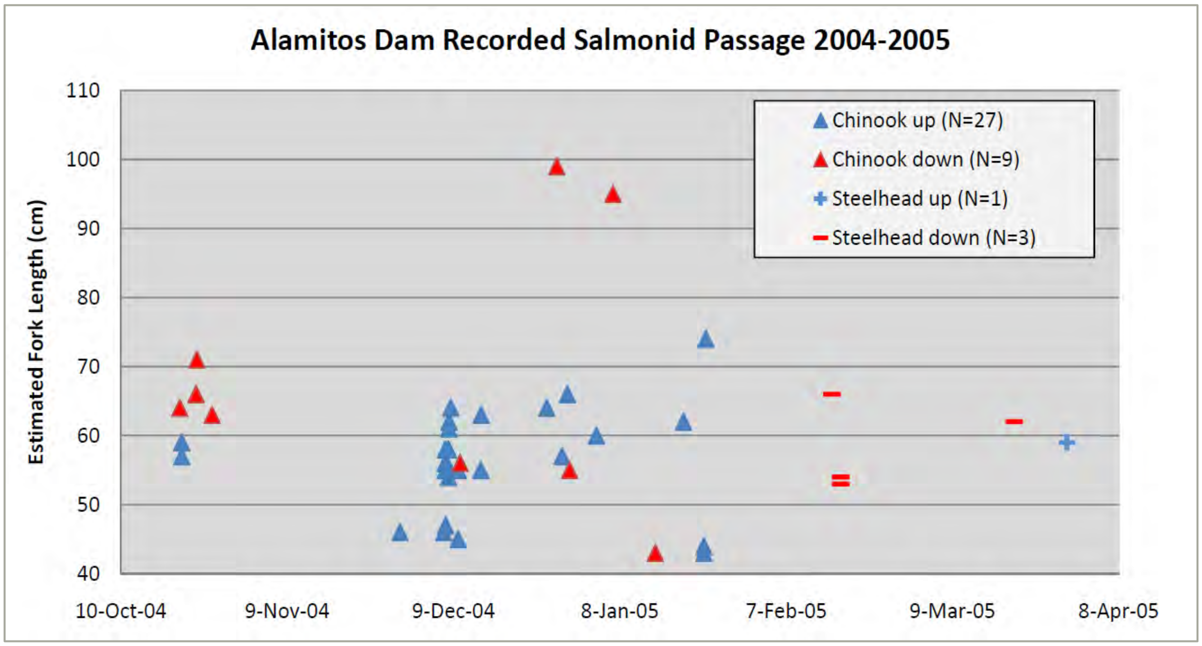
Although insufficient numbers of adult steelhead were observed during 2004-2005 and 2005-2006 at Alamitos Fishway to inform adult immigration timing, adult steelhead were observed passing upstream at Masson Dam during both 2007 and 2008. However, steelhead observations were concentrated during separate and discrete time periods during 2007 and 2008. Specifically, adult steelhead passing upstream during 2007 were observed between about the beginning of March through the third week of March, while adults passing upstream during 2008 were observed from about mid-April through the end of April.

In addition to evaluating available literature, lifestage-specific timing input was provided by CDFW and Valley Water staff familiar with the study area watersheds. CDFW staff recommended the period of

December through April for steelhead adult immigration (M. Leicester and T. Schane, pers. comm., 2016), while Valley Water staff suggested mid-December through early-April (J. Abel, pers. comm., 2016).

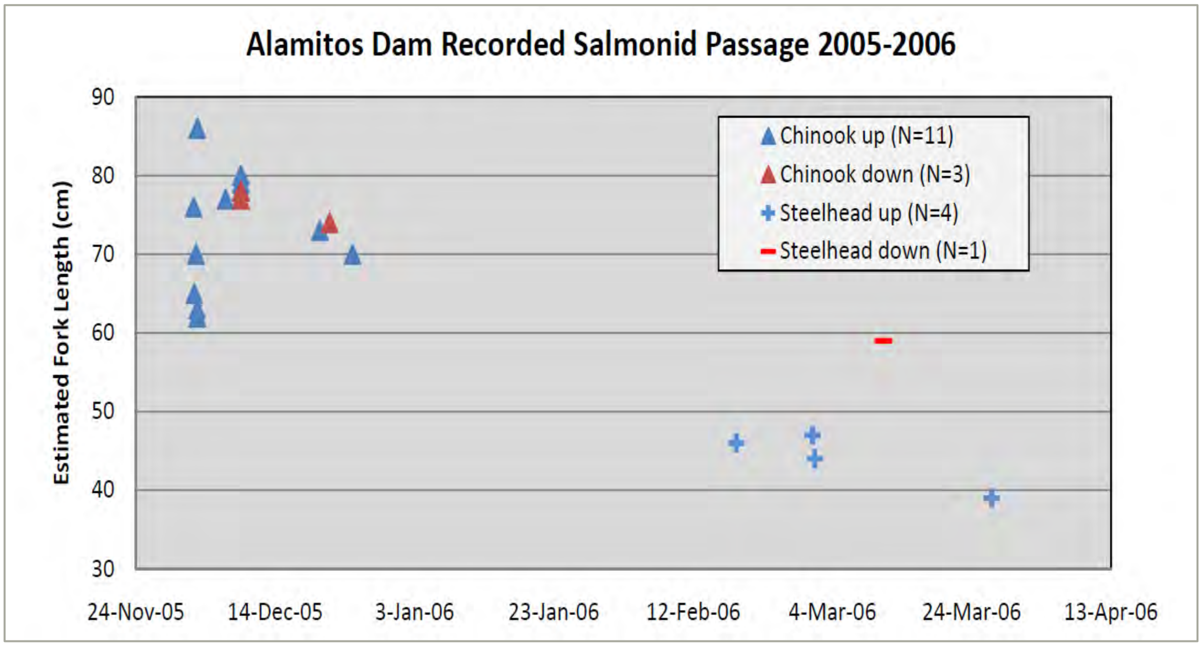
Based on review of available literature and input provided by CDFW and Valley Water staff, December through April was selected as the evaluation period for steelhead adult immigration.

Figure 3.2-1. 2004–2005 Chinook Salmon and Steelhead Adult Passage in Guadalupe River at Alamitos Fishway



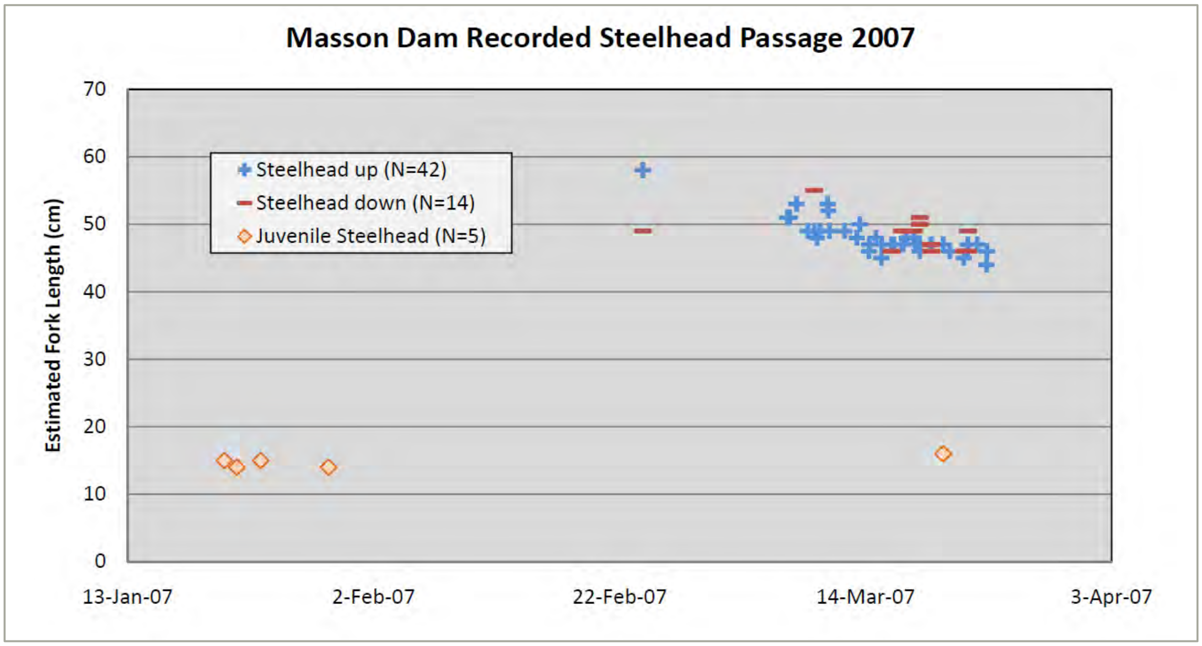
Source: Nishijima et al. 2009

Figure 3.2-2. 2005–2006 Chinook Salmon and Steelhead Adult Passage in Guadalupe River at Alamitos Fishway



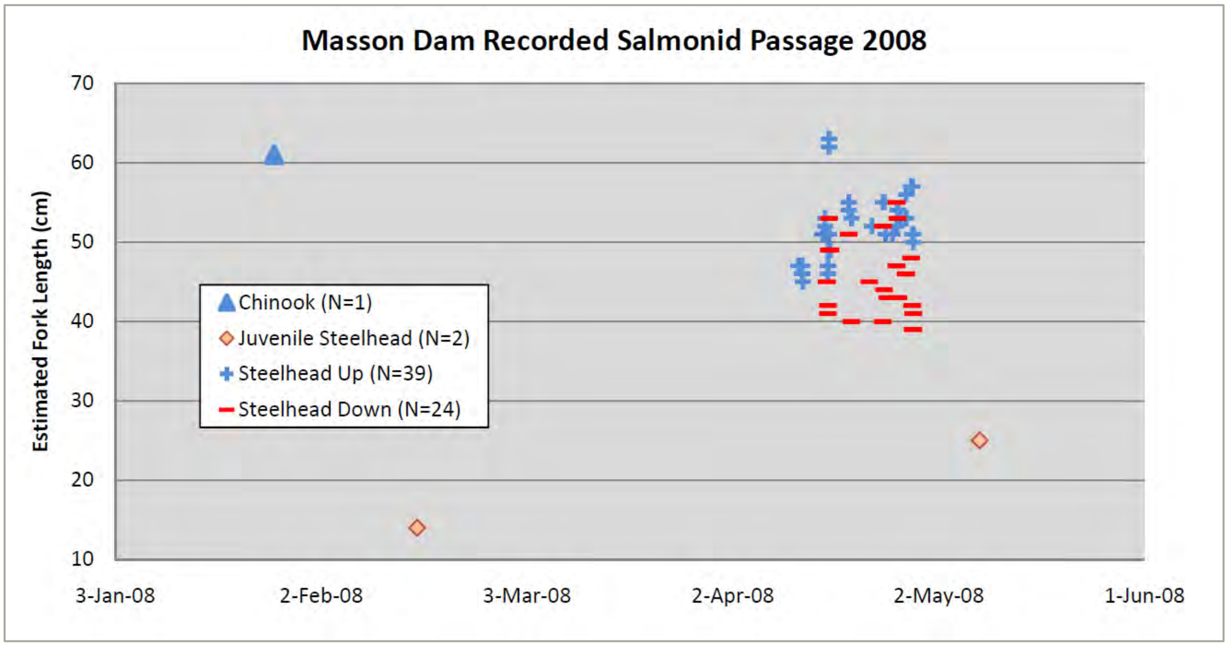
Source: Nishijima et al. 2009

Figure 3.2-3. 2007 Steelhead Adult Passage in Guadalupe Creek at Masson Fishway



Source: Nishijima et al. 2009

Figure 3.2-4. 2008 Chinook Salmon and Steelhead Adult Passage in Guadalupe Creek at Masson Fishway



Source: Nishijima et al. 2009

3.2.1.2 Adult Spawning

Steelhead spawning in California has primarily been reported to begin as early as December or January and extend through April (FAHCE 2003a; 2003b; Hallock et al. 1961; Leidy 2007; McEwan and Jackson 1996; Valley Water 2000; Williams 2006). A summary of stream-specific adult steelhead spawning timing in the central California coast region is provided below.

- Steelhead spawn in the Russian River during December through March, and peak steelhead spawning occurs from December through February (SCWA 2016).
- In Lagunitas Creek, upstream migration occurred during January through mid-March, and spawning occurred from mid-January through March (SWRCB 1995).
- In the Gualala River, DeHaven (2002) reported that steelhead likely spawned from December through at least the end of April.
- Based on redd surveys conducted in Upper Penitencia Creek during 2011, eight steelhead redds were observed between mid-January and mid-March, seven of which were observed between mid-February and mid-March (Will and Stern 2012).

One example from the central California coast indicated that spawning extends through May (Holmes and Cowan 2014). Input from CDFW and District staff (M. Leicester and T. Schane, pers. comm., 2016; J. Abel, pers. comm., 2016) suggested that the steelhead spawning period in the Santa Clara Valley was similar to that reported in the majority of the reviewed literature. Specifically, on June 23, 2016, CDFW staff recommended the use of December or January through April to evaluate steelhead adult spawning (M. Leicester and T. Schane, pers. comm., 2016).

Based on review of available literature and input provided by CDFW and Valley Water staff regarding adult immigration and spawning, December through April was selected as the evaluation period for steelhead adult spawning.

3.2.1.3 Embryo Incubation

Most embryo incubation timing literature reviewed focuses on the duration of incubation as a function of water temperature rather than describing generalized embryo incubation timing (McEwan and Jackson 1996; Merz et al. 2015; Moyle 2002; and Shapovalov and Taft 1954; Williams 2006). Therefore, a pre-defined time period is not used to evaluate embryo incubation habitat conditions. As described in Section 3.3.3, incubation duration is calculated separately for each daily spawning cohort based on reaching sufficient ATUs (°F) from each day of spawning to the estimated time of fry emergence.

3.2.1.4 Fry Rearing

Many authors have reported juvenile salmonids measuring <50 mm in fork length to be classified as fry (Roper and Scarnecchia 2000; Martin et. al 2001; Kindopp and Bilski 2009; Thedinga et al. 1994). Therefore, for the purposes of this evaluation, steelhead fry are considered to be less than approximately 50 mm.

During lower American River juvenile emigration surveys conducted during 1993-1994, 1994-1995, 1995-1996, 1996-1997, and 1998-1999, although few in number, young-of-year (YOY) *O. mykiss* of fry-size (less than approximately 50 mm) were generally captured during March through May. Similarly, the 2013 lower American River emigration survey found that fry (ranging from 22 to 41 mm) were captured primarily during March, with a few observed in April (PSMFC 2014).

Based on 7 years of juvenile steelhead sampling in the lower Mokelumne River (1997-2004), most YOY steelhead observed from February through June were less than about 50 mm, while 75 percent of YOY juveniles observed during July were greater than 50 mm (Merz et al. 2015), indicating that most of the observed YOY steelhead were fry-sized through June.

Based on multi-year fisheries datasets including rotary screw trap (RST) surveys in the lower Yuba River, the RMT (2013) identified the steelhead fry rearing period as extending from April through July.

Although few in number, several *O. mykiss* captured during the 1998 Guadalupe River emigration survey were less than 50 mm, and were caught during May (Valley Water, unpublished data). All *O. mykiss* observed during the Stevens Creek 1999 emigration survey starting in April were larger than 50 mm (Valley Water, unpublished data).

Based on the information above, and in consideration of the differences in water temperature regimes in the rivers described, it is assumed for the purposes of this evaluation that steelhead fry may be expected to potentially be present in the study area during March through May. Therefore, March through May was selected as the steelhead fry rearing evaluation period.

3.2.1.5 Juvenile Rearing

It is generally accepted that steelhead juvenile rearing takes place year-round (FAHCE 2003a; Holmes and Cowan 2014; Merz et al. 2015; Shapovalov and Taft 1954; Williams 2006). According to Valley Water staff, steelhead juvenile rearing in study area streams is typically 1.5 to 2 or more years depending on stream productivity and downstream passage, which can exhibit substantial interannual variability (J. Abel, pers. comm., 2016). For evaluation purposes, steelhead juveniles are assumed to potentially be present year-round.

3.2.1.6 Juvenile Outmigration

Available literature from California was examined to identify steelhead juvenile outmigration timing (Beakes et al. 2010; FAHCE 2003a and 2003b; Holmes and Cowan 2014; Merz et al. 2015; Valley Water 2000; Shapovalov and Taft 1954; Williams 2006). Although these sources exhibit little agreement on precise outmigration periods, the reviewed literature is generally in agreement that juvenile steelhead outmigrate from mid- to late winter through late spring or early summer. However, one example from the California Central Coast indicates that the steelhead outmigration period begins as early as November (Holmes and Cowan 2014). Additional sources from the California Central Coast and the Central Valley suggested that steelhead outmigration extends as late as the end of July (Beakes et al 2010; Merz et al. 2015). The FAHCE limiting factors analyses utilized a time period for steelhead juvenile outmigration of February through May (Valley Water 2000), while the FAHCE (2003a) Summary Report identified a time period of January through May. The 2003 FAHCE Settlement Agreement identified target flow conditions for facilitating juvenile steelhead (and Chinook salmon) outmigration during February through April (FAHCE 2003b).

On June 23, 2016, CDFW staff recommended the use of February through May to evaluate juvenile steelhead outmigration (M. Leicester and T. Schane, pers. comm., 2016). Consistent with CDFW staff, on June 24, 2016, Valley Water also suggested the use of February through May, with the possibility of extending into June during wetter years (J. Abel, pers. comm., 2016).

Based on available literature and input provided by CDFW and the Valley Water staff, February through May was selected as the evaluation period for juvenile steelhead outmigration.

3.2.2 Central Valley Fall-run Chinook Salmon

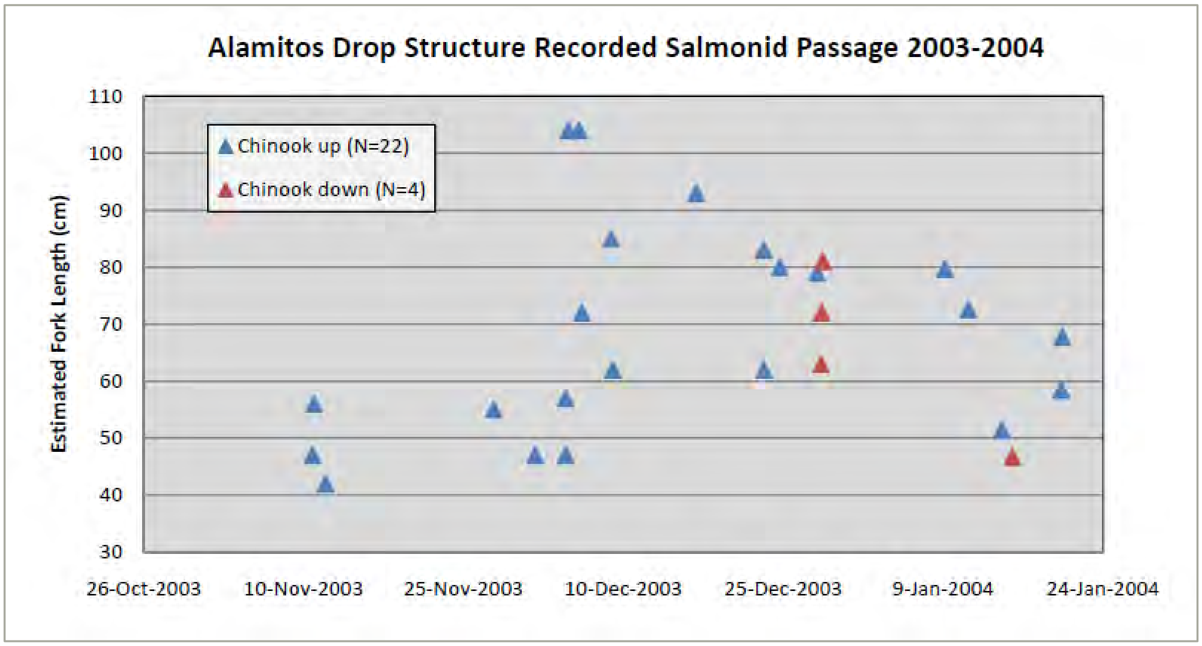
The following sections describe literature and data used to develop lifestage-specific periodicities for evaluation of Central Valley fall-run Chinook salmon in the study area, including adult immigration, adult spawning, embryo incubation, fry rearing, juvenile rearing, and juvenile outmigration.

3.2.2.1 Adult Immigration

Literature and reports from the study area, San Francisco Bay region, and Central Valley were examined to develop the Central Valley fall-run Chinook salmon adult immigration timing for evaluation purposes (FAHCE 2003a; 2003b; Fukushima and Lesh 1998; Leidy 2007; Merz et al. 2015 and 2013; Moyle 2002; Nishijima et al. 2009; Valley Water 2000; Williams 2006; Zeug et al. 2014). August through December is the most common period indicated in the sources reviewed as the generalized Central Valley fall-run Chinook salmon adult immigration period. However, as described below, the immigration period may extend as late as January in the study area (Nishijima et al. 2009).

As previously described for steelhead, Nishijima et al. (2009) investigated adult Chinook salmon passage in the Guadalupe River and Guadalupe Creek at the Alamitos and Masson Fishways, respectively. Investigation of adult Chinook salmon passage from 2003 through 2008 suggests that adult fall-run Chinook salmon immigration occurs from mid-October into late January, with a peak around early December (Figure 3.2-1 and Figure 3.2-2, above; Figure 3.2-5).

Figure 3.2-5. 2003–2004 Chinook Salmon Adult Passage in Guadalupe River at Alamitos Fishway



Source: Nishijima et al. 2009

In addition to the VAKI Riverwatcher data, upstream migrant trapping was conducted in the Guadalupe River from late summer into the fall or winter during 1998, 1999, 2000, and 2001 (Valley Water 2002). Because of high flow events, the trap was not operational for the entire potential upstream migration period for fall-run Chinook salmon in any year (see Valley Water 2002). Nonetheless, Chinook salmon were captured in the Guadalupe River during 1998 primarily from late September into mid-November (when the trap became non-operational for several weeks), throughout the entire operational period of mid-August through early October during 1999, during late September into early October of the late August to early October operational period in 2000, and throughout most of the operational periods between mid-September and mid-November in 2001.

On June 23, 2016, CDFW staff recommended a fall-run Chinook salmon adult immigration evaluation period of mid-October through December (M. Leicester and T. Schane, pers. comm., 2016). On June 24, 2015, Valley Water staff also suggested October through December (J. Abel, pers. comm., 2016).

Based on review of available data and literature, and input provided by CDFW and the Valley Water staff, mid-October through January was selected as the evaluation period for fall-run Chinook salmon adult immigration.

3.2.2.2 Adult Spawning

The literature examined for Central Valley fall-run Chinook salmon spawning timing showed little agreement on precise spawning periods (FAHCE 2003a and 2003b; Leidy 2007; Merz et al. 2013; Moyle 2002; Valley Water 2000; Williams 2006; Zeug et al. 2014). Overall, the reviewed literature suggests that Central Valley fall-run Chinook salmon adults spawn from the fall through mid-winter. The FAHCE limiting factors analyses utilized a time period for Chinook salmon adult spawning of October through February (Valley Water 2000), while the FAHCE (2003a) Summary Report identified a time period of October through December. The 2003 FAHCE Settlement Agreement did not specify a Chinook salmon spawning period, but did identify winter base flows to benefit Chinook salmon and steelhead spawning and embryo incubation during November through April (FAHCE 2003b).

On June 23, 2016, CDFW staff recommended the use of October through December to evaluate Chinook salmon spawning (M. Leicester and T. Schane, pers. comm., 2016). On June 24, 2016, Valley Water staff also suggested the use of October through December (J. Abel, pers. comm., 2016).

Based on review of available data and literature, and input provided by CDFW and the Valley Water staff, mid-October was selected as the onset of spawning. Because adult Chinook salmon have been observed migrating upstream into January in the study area, a spawning time period of mid-October through January was selected for evaluation purposes.

3.2.2.3 Embryo Incubation

Much of the embryo incubation timing literature focuses on the duration of incubation as a function of water temperature rather than describing generalized embryo incubation timing (Merz et al. 2015; Moyle 2002; Williams 2006). Therefore, a pre-defined time period is not used to evaluate embryo incubation habitat conditions. As described in Section 3.3.3, incubation duration is calculated separately for each daily spawning cohort based on reaching sufficient ATUs (°F) from each day of spawning to the estimated time of fry emergence.

3.2.2.4 Fry Rearing

Although there is substantial variability in size, Chinook salmon fry are typically 33 to 36 mm in length when they emerge from the substrate (PFMC 1999). As previously mentioned, juvenile salmonids measuring <50 mm in fork length have often been classified as fry (Roper and Scarnecchia 2000; Martin et. al 2001; Kindopp and Bilski 2009; Thedinga et al. 1994). For example, juvenile fall-run Chinook salmon RST surveys conducted in the lower American River generally classified most Chinook salmon less than approximately 45 to 50 mm as yolk-sac fry or fry based on ontogenetic (that is, developmental) characteristics (Snider and Titus 1995; Snider et al. 1997; Snider et al. 1998; Snider and Titus 2000; Snider and Titus 2002).

Juvenile fish snorkeling surveys conducted in the lower Yuba River found that juvenile Chinook salmon in the 30 to 50 mm size class tended to occupy shallower habitats than larger (and presumably older) individuals (RMT 2013), which is consistent with other observations of salmonids (for example, Bjornn and Reiser 1991). In other words, individuals in the 30 to 50 mm size range were observed to exhibit characteristic habitat preferences of “fry.”

During lower American River juvenile fall-run Chinook salmon emigration surveys conducted during 1993-1994, 1994-1995, 1995-1996, 1996-1997, and 1998-1999, the weekly mean length (FL) of individuals captured generally exceeded the 45 to 50 mm size range between late March and early May, but primarily during April. The 2013 lower American River emigration survey (PSMFC 2014) found that fry (ranging from 30 to 56 mm) were generally captured until late March.

Based on 7 years of juvenile fall-run Chinook salmon sampling in the lower Mokelumne River (1997-2004), 75 percent of juveniles observed during May were larger than 50 mm, while 75 percent of juveniles observed during June were larger than about 75 mm (Merz et al. 2015), indicating that most of the fry-sized individuals had left the river by sometime during May.

Based on multi-year fisheries datasets including RST surveys in the lower Yuba River, the RMT (2013) identified the fall-run Chinook salmon fry rearing period as extending from late-December through April.

RST surveys conducted in the Russian River starting on March 1 of 2002 and 2003 indicate that juvenile fall-run Chinook salmon were less than about 50 mm in length until about mid-March (SCWA 2005).

Emigration surveys in the Guadalupe River during 1999 observed juvenile fall-run Chinook salmon during a few days in mid-April and during early May, all of which were larger than 50 mm (Valley Water, unpublished data).

Based on the information above, it is assumed that fall-run Chinook salmon fry may be expected to potentially be present in the study area during January through April. Therefore, January through April was selected as the fall-run Chinook salmon fry rearing period for evaluation.

3.2.2.5 Juvenile Rearing

Available data and literature from the study area and Central Valley were examined to identify a representative Central Valley fall-run Chinook salmon juvenile rearing periodicity (FAHCE 2003a; 2003b; Leidy 2007; Merz et al. 2013; 2015; Valley Water 2000; Williams 2006). Based on the sources reviewed, there was general agreement that juvenile fall-run Chinook salmon rear from the winter through the spring. Of the literature reviewed, Merz et al. (2013) reported the broadest period of mid-December through early July. The FAHCE limiting factors analyses utilized a time period for Chinook salmon juvenile rearing of February through June (Valley Water 2000), while the FAHCE (2003a) Summary Report identified a time period of January through June.

On June 23, 2016, CDFW recommended the use of January through June to evaluate Chinook salmon juvenile rearing in accordance with the FAHCE Summary Report (M. Leicester and T. Schane, pers. comm., 2016). On June 24, 2016, Valley Water staff suggested that Chinook salmon rearing would generally be complete by the end of May (J. Abel, pers. comm., 2016).

In consideration of the above information, January through June was selected as the fall-run Chinook salmon juvenile rearing evaluation period.

3.2.2.6 Juvenile Outmigration

Fall-run Chinook salmon generally emigrate from Central Valley rivers as YOY (Kimmerer and Brown 2006). Observations from the lower American River, lower Feather River, lower Yuba River, and other Central Valley streams suggest that the majority of juvenile Chinook salmon emigrate from natal streams as fry (for example, DWR 1999; DWR 2003; DWR 2007; Gaines and Martin 2002; Kindopp and Bilski 2009; Snider et al. 1998; RMT 2013). For example, an annual average of 83 percent of juvenile Chinook salmon captured over nine years of RST surveys (1999-2008) in the lower Yuba River ranged from 30 to 49 mm FL (RMT 2013). Moreover, juvenile Chinook salmon ranging from 30 to 69 mm represented on average 95 percent of all juvenile Chinook salmon captured in the lower Yuba River surveys. Similarly, an average of about 88 percent of fall-run Chinook salmon juveniles emigrated as yolk-sac fry or fry during five years of RST surveys conducted in the lower American River (1994, 1995, 1996, 1998, 1999), with the remaining emigrants primarily recorded as parr (Snider and Titus 2002). Although only about 48 percent emigrated as fry during 1997, flood events may have killed many of the embryos that would have otherwise emerged and emigrated as fry in the lower American River (Snider and Titus 2002).

Available literature examined for fall-run Chinook salmon juvenile outmigration timing indicated variable outmigration periods (FAHCE 2003a; 2003b; Merz et al. 2013; 2015; Valley Water 2000; Williams 2006; Zeug 2014). Studies from the Central Valley report the broadest time period for juvenile outmigration, such as December through early July (Merz et al. 2013; 2015; Williams 2006; Zeug 2014).

Although not part of the Central Valley fall-run Chinook salmon ESU, Russian River juvenile Chinook salmon reportedly rear for a short period of time before emigrating to the ocean, and generally emigrate by their fourth month of life (SCWA 2016). Based on four years of RST survey data collected in the Russian River[5] (2000–2004), peak outmigration generally occurred between about mid-April and mid-May (SCWA 2005). Based on the most comprehensive RST survey year (2002; 74 sampling days), the vast majority of juveniles passing the traps occurred during April and May, with about 98 percent of juveniles observed passing the traps by the end of May.

Both the FAHCE limiting factors analyses (Valley Water 2000) and FAHCE (2003a) Summary Report identified a Chinook salmon juvenile outmigration period of April through June. The 2003 FAHCE Settlement Agreement identified target flow conditions for facilitating Chinook salmon (and steelhead) juvenile outmigration during February through April (FAHCE 2003b).

On June 23, 2016, CDFW staff recommended the use of April through June to evaluate juvenile Chinook salmon juvenile in accordance with the FAHCE Summary Report (M. Leicester and T. Schane, pers. comm., 2016). On June 24, 2016, Valley Water staff suggested that the juvenile Chinook salmon outmigration would generally be over by early June (J. Abel, pers. comm., 2016).

Based on the above information, February through June was selected as the evaluation period for fall-run Chinook salmon juvenile emigration.

3.3 Development and Application of HSC

As previously described, HSC are indices that describe the relative suitability of specific habitat attributes for a specific species and lifestage. An HSC scale ranges between 0.0 (representing totally unsuitable conditions) and 1.0 (representing optimal conditions). HSC can vary in form depending on the attribute, and can include continuous curve distributions for depth or velocity, stepped functions for categorical attributes such as substrate or cover, or binary criteria (for example, an attribute is either fully suitable or fully unsuitable) (Normandeau Associates, Inc. 2014). Depending on the data available for the study area, HSC can be developed from the literature (that is, Category 1 curves), or from physical and hydraulic measurements made in the field over species microhabitats (that is, Category 2 curves) (Bovee 1986). Category 1 HSC were developed for this evaluation for steelhead and fall-run Chinook salmon spawning and embryo incubation, fry rearing, and juvenile rearing because of insufficient site-specific physical and hydraulic data associated with steelhead and fall-run Chinook salmon microhabitats in the study area.

There are various ways in which Category 1 HSC can be developed for an area without local HSC. Some investigators have suggested that “enveloped HSC” (that is, ‘drawing’ a composite HSC that envelops all the observation data of HSC derived from several relevant sources) are a viable alternative when site-specific HSC are not available or concerns of bias may invalidate their application (Hardy and Addley 2001; Hardy et al. 2006). For example, Hardy and Addley (2001) reviewed studies that suggested that suitability criteria corrected for biases still differed among years and between rivers, and that combining data from multiple rivers and years provided a more practical solution for representing the niche dimensions of depth and velocity. Jowett (1992) advocated the use of generalized envelope criteria based on the finding that using enveloped suitability criteria from four rivers performed almost as well as stream-specific criteria, and substantially better than criteria developed at one river and applied to a different river.

For the study area streams, species and lifestage-specific depth and velocity HSC were developed as continuous curves based on compilation of HSC from watersheds of similar size to the study area watersheds. Because the largest study area watershed (Coyote Creek Watershed) is about 320 mi^2,

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[5] RSTs were installed just downstream of the Mirabel Inflatable Dam, located at river kilometer 36.4.

watersheds less than 500 mi^2 were assessed, in addition to the Trinity River Watershed because of the fact that a relatively large amount of water is diverted out of the Trinity River Watershed to the Central Valley (Table 3.3-1). However, given limited HSC available for some lifestages (for example, Chinook salmon fry and juveniles) in watersheds less than 500 mi^2, some additional HSC were compiled and used from larger watersheds (Aceituno 1990; Beakes et al. 2014). Generic HSC provided by Bovee (1978) also were assessed because they are based on a compilation of HSC from several streams of varying size.

Table 3.3-1. Studies Reviewed For Developing Steelhead and Fall-run Chinook Salmon Depth and Velocity Habitat Suitability Criteria

Reference	Available Information
Aceituno, M.E. 1990. Habitat Preference Criteria for Chinook Salmon of the Stanislaus River, California. US Department of the Interior Fish & Wildlife Service, Sacramento, California.	Depth and velocity suitability curves for Chinook salmon fry in the Stanislaus River, CA
Beakes, M.P., Moore, J.W., Retford, N., Brown, R., Merz, J.E. and Sogard, S.M., 2014. Evaluating Statistical Approaches to Quantifying Juvenile Chinook Salmon Habitat in a Regulated California River. River Research and Applications, 30(2), pp.180-191.	Depth and velocity suitability curves for Chinook salmon fry and juvenile rearing in the American River, CA
Bovee, K.D. 1978. Probability of Use Criteria for the Family Salmonidae. Instream Flow Information Paper 4. United States Fish and Wildlife Service FWS/OBS-78/07. 80 pp.	Depth and velocity suitability curves for steelhead adult spawning, juvenile rearing, and fry rearing, as well as Chinook salmon adult spawning and juvenile rearing in streams throughout the Pacific Northwest
Hampton, M. 1988. Development of Habitat Preference Criteria for Anadromous Salmonids of the Trinity River. United States Department of the Interior, Fish and Wildlife Service, Division of Ecological Services, Sacramento, California. 93 pp.	Depth and velocity suitability curves for steelhead adult spawning and juvenile rearing, as well as Chinook salmon adult spawning, juvenile rearing, and fry rearing in the Trinity River, CA
Hampton, M. 1997. Microhabitat Suitability Criteria for Anadromous Salmonids of the Trinity River. United States Fish and Wildlife Service, Arcata, CA. 252 pp.	Depth and velocity suitability curves for steelhead adult spawning, juvenile rearing, and fry rearing, as well as Chinook salmon adult spawning, juvenile rearing, and fry rearing in the Trinity River, CA
Holmes, R.W., M.A. Allen, and S. Bros-Seeman. 2014. Habitat Suitability Criteria Juvenile Steelhead in the Big Sur River, Monterey County. California Department of Fish and Wildlife, Water Branch Instream Flow Program Technical Report 14-1. 181 pp.	Depth and velocity suitability curves for steelhead fry and juvenile rearing in the Big Sur River, CA
Snider, B., K.A.F. Urquhart, and D. Marston. 1995, The Relationship between Instream Flow and Coho Salmon and Steelhead Habitat Availability in Scott Creek Santa Cruz County California. California Department of Fish and Game, Environmental Services Division, Stream Flow and Habitat Evaluation Program, Sacramento, CA, 48 pp., + appendix.	Depth and velocity suitability curves for steelhead adult spawning and juvenile rearing, as well as velocity suitability curves for steelhead fry rearing in Scott Creek, CA
United States Fish and Wildlife Service (USFWS). 2007. Flow-habitat relationships for spring Chinook Salmon and Steelhead/Rainbow Trout Spawning in Clear Creek between	Depth and velocity suitability curves for steelhead adult spawning in Clear Creek, CA

Reference	Available Information
Whiskeytown Dam and Clear Creek Road. USFWS, Sacramento, CA.	
USFWS. 2011. Flow-habitat Relationships for Fall-run Chinook Salmon and Steelhead/Rainbow Trout Spawning in Clear Creek between Clear Creek Road and the Sacramento River. USFWS, Sacramento, CA.	Depth and velocity suitability curves for Chinook salmon adult spawning in Clear Creek, CA

For this evaluation, a comprehensive approach to developing Category 1 depth and velocity HSC was undertaken by developing enveloping and mean HSC from the selected published HSC. Enveloping HSC were developed by identifying depth and velocity values at each HSI value of 0.0, 0.2, 0.4, 0.5, 0.6, 0.8, and 1.0 in the published HSC. The enveloping HSC were developed by utilizing the left-most ascending limbs and right-most descending limbs of the compiled HSC. A similar approach was undertaken to develop the mean HSC, but instead of using the outside limbs, the mean depth and velocity values were calculated for each HSI value of 0.0, 0.2, 0.4, 0.5, 0.6, 0.8, and 1.0.

Based on input from the TWG, including various CDFW staff, Valley Water staff, and respected experts, the mean HSC were selected for use in this evaluation.

The development and application of HSC by habitat attribute for each species and lifestage is described in the following sections, including discussion of relevant lifestage-specific habitat requirements and preferences.

3.3.1 Steelhead Adult Upstream Migration

The suitability of steelhead upstream migration conditions is first evaluated in terms of the distance upstream from the Bay that provides sufficient water depth and thermal conditions during a single day (that is, upstream passage potential extent). The daily upstream passage potential extent is identified based on both simulated hydraulic variables and simulated water temperatures.

Because the upstream passage potential extent simply represents the length of a stream from the Bay that provides suitable migration conditions at each POI on a single day, it does not necessarily represent the location at which an adult could have actually migrated to on that day. Therefore, a methodology was also developed to provide a more biologically-meaningful assessment of adult upstream passage (that is, adult passage events), which incorporates the maximum extent an adult could have migrated upstream based upon migration rate (miles/day).

3.3.1.1 Upstream Passage Potential Extent

Passage criteria applied to each POI include: (1) sufficient flow that corresponds to a thalweg depth of at least 0.7 feet; (2) sufficient flow for adults to pass a nearby critical riffle, if applicable; and (3) suitable water temperature for adult immigration and holding. The upstream passage potential extent is the most downstream passage node (POI) at which flows and water temperatures are not sufficient to meet all specified criteria on a single day. Each adult passage variable evaluated is described below.

Water Depth

Based on review of literature on suitable water depths for adult steelhead passage (for example, Thompson 1972; SWRCB 2007; CDFW 2013; SWRCB 2014; Holmes et al. 2016), a thalweg water depth criterion of 0.7 ft or greater was selected for evaluation purposes. A criterion of 0.7 feet or greater was developed in coordination with the TWG, and has recently been applied as a depth criterion for adult steelhead on the California coast (for example, CDFW 2013; SWRCB 2014). Thalweg depth at each passage POI is simulated using modeled flow and HEC-RAS modeling which incorporated riffle transects that were surveyed in 2016 (see SEI 2017).

Critical Riffle Flow

Critical riffle flow analyses were conducted in the vicinity of selected POI during 2016 in accordance with the CDFW (2013) Standard Operating Procedure for Critical Riffle Analysis for Fish Passage in California. Eleven critical riffle analysis (CRA) surveys were carried out by the District, in which a riffle near a POI was identified and surveyed at 1 - 3 different flows, detailing the water depth along the survey transect (see SEI 2017). Flows at which adult passage would be successful based on the CDFW (2013) criteria were identified and applied to simulated daily flows at the nearby POI. Criteria identified by CDFW (2013) include: (1) At least 10 percent of the entire length of the transect must be contiguous for the minimum depth established for the target fish; and (2) a total of at least 25 percent of the entire transect must meet the minimum depth established for passage of the target fish.

Water Temperature

Limited studies have been conducted on water temperature-related effects on upstream migrating adult steelhead. Thermal migration barriers have frequently been reported for salmonids, including steelhead, when water temperatures reach approximately 70°F (McCullough et al. 2001). Based on a review of various water temperature studies on anadromous salmonids summarized in McCullough et al. (2001), EPA (2003) indicated that an overall reduction in migration fitness attributable to cumulative stresses occurred at constant water temperatures greater than 17 to 18°C (62.6 to 64.4°F). Telemetry research on summer-run steelhead in the Columbia River basin has identified approximately 19°C (~66°F) as an important behavioral thermal threshold, where adults have been observed to seek out thermal refugia during their upstream migration (Keefer et al. 2009, as cited in Keefer et al. 2018).

Based on some of the above-referenced studies, Bratovich et al. (2012) identified an upper optimal water temperature index (WTI) value of 64°F, and an upper tolerable value of 68°F for steelhead adult migration to be applied in an evaluation of the reintroduction of steelhead to the upper Yuba River Watershed. For steelhead adult holding, Bratovich et al. (2012) identified upper optimal and upper tolerable WTI values of 61 and 65°F, respectively. Tolerable water temperature values represent thermal conditions in which physiological processes and behaviors (for example, growth, reproduction, migration) still occur, but are reduced from their optimal states because of water temperature-related effects; optimal water temperature values represent thermal conditions in which physiological processes and behaviors are not affected appreciably by water temperature (Bratovich et al. 2012).

Because daily modeled water temperatures are applied during each day of the steelhead upstream migration period as a binary criterion (that is, migration is classified as either suitable or completely unsuitable during a given day), an upper tolerable WTI value is considered to be appropriate for modeling evaluation purposes.

As described above, suitable water temperatures for adult migration are typically higher than adult holding water temperatures, primarily because of increased duration of exposure to water temperature during adult holding relative to migration. Because adult holding is incorporated into the upstream migration (passage events) analysis, and because tolerable water temperatures are lower for adult holding relative to adult migration, the upper tolerable WTI value for adult steelhead holding (65°F) was selected for the adult steelhead passage evaluations.

3.3.1.2 Adult Passage Events

Migration Rate and Holding Assumptions

The distance and rate that salmonids can travel is affected by several factors, including flow, time of day, turbidity, and water temperature (NMFS 2000), but the most influential factor is likely flow (Shapovalov and Taft 1954). Migration rates for adult steelhead (and fall-run Chinook salmon) are not available for the study area. Therefore, a literature review was conducted for adult salmonid migration rates in other areas.

In the Columbia River, adult steelhead migration rates were observed to range from 7 to 21 km/day (~4.3 to 13 mi/day), depending on the reach and year (Keefer et al. 2004). Unlike the study area creeks, there are no water depth-related passage impedances in the Columbia River. Therefore, migration rates in the study area creeks may be closer to the lower end of the migration rate ranges observed in the Columbia River.

Dettman and Kelly (1986, as cited in NMFS 2000) reported that steelhead upstream migration rates ranged from 1 to 10 days, and averaged 4 days, following increases in flow, to travel the 18.5 miles of the lower Carmel River. This suggests an average migration rate of about 4.6 miles per day for the first steelhead arriving in the upper reach. The longest duration required for adults to migrate upstream (that is, 9 and 10 days) appeared to be associated with the two largest flow events over a 13-year period (NMFS 2000).

In evaluating adult steelhead passage in the Santa Ynez River (part of the Southern California Steelhead DPS), the SWRCB (2011) indicated that, although the amount of time it takes adults to migrate upstream to spawn in the Santa Ynez River is not known, the available information indicates a migration range for salmonids of 8 to 31 miles per day, depending on flows (Groot and Margolis 1991, as cited in SWRCB 2011).

Because adult salmonids are observed to hold during their upstream migrations (as observed for fall-run Chinook salmon in the study area, described in Section 3.3.6.2, below), passage events are assumed to not require continuous days of passage. Therefore, it was assumed that adults are able to hold while waiting for passage to be provided at the next upstream POI, assuming that water depth is sufficient (that is, 0.7 ft for steelhead) and the adult holding upper tolerable WTI value is not exceeded at the POI or reach where they are assumed to be holding. Because both adult steelhead (and fall-run Chinook salmon) are believed to spawn relatively shortly after freshwater entry, and based on the radio telemetry results described for Chinook salmon in the Guadalupe River (Section 3.3.6.2), adult steelhead are assumed to be able to hold for a total of up to 30 days downstream of designated spawning reaches. In addition, in the event that adult passage conditions are not suitable at the most downstream POI, adults also are assumed to be able to hold in the Bay for up to 30 days prior to entering the creek.

Because the estimated upstream migration rate for steelhead in the Carmel River (4.6 mi/day; ~7.4 km/day), which is more representative of the study area creeks than the Columbia River, is similar to the lower end of the range of steelhead migration rates reported in the Columbia River (7 km/day; ~4.3 mi/day), the lower end of the ranges of upstream migration rates for steelhead (4.3 mi/day) from Keefer et al. (2004) are used to quantify passage events over the simulation period.

Definition of Adult Passage Events

Passage events are defined with respect to adults that enter the system (that is, the river or creek) from the Bay on each day of their respective immigration periods (that is, Dec. 1 – Apr. 30 for steelhead).

Adults (that is, daily adult cohorts) entering a creek on each day of their immigration period are assumed to move upstream (given suitable passage conditions) on a daily basis based on the species-specific assumed migration rate. Daily adult cohorts are assumed to migrate past each POI as long as adult passage conditions (as defined by modeled adult passage potential extent) are suitable. If a daily cohort reaches a POI which does not have suitable passage conditions, the daily cohort is allowed to hold in the reach below the unpassable POI and wait for upstream passage conditions to become suitable. However, if holding conditions are not suitable where a daily cohort is assumed to hold (as defined by modeled average pool depth and average water temperature in a reach below a POI) the daily cohort is assumed to be able to move downstream of the adult position to the upstream-most reach that provides suitable holding conditions.

Passage events are evaluated for each daily adult cohort[6] for each annual adult immigration season, and are classified as successful or unsuccessful. If an adult daily cohort reaches any of the designated spawning reaches of the subject stream within 30 days of the initiation of upstream passage, the adult daily cohort is considered to have a successful passage event. However, if an adult daily cohort spends a cumulative duration of 30 or more consecutive days migrating and/or holding downstream of the lowermost designated spawning reach of the stream, the adult daily cohort is considered to have an unsuccessful passage event for that year. In addition, if a daily cohort spends 30 days or more holding in the Bay awaiting for passage conditions to become suitable at the most-downstream POI, that cohort is considered to have an unsuccessful passage event for that year. Detailed rules employed to evaluate passage events for each adult daily cohort are summarized below.

Detailed Adult Passage Event Rules

1. A daily cohort is allowed to move upstream from one day to the next if modeled passage conditions are suitable at the POI (s) immediately upstream of the location of the cohort on the previous day. The daily extent of upstream migration is limited by the species migration rate (that is, 4.3 mi/day for steelhead).
2. When upstream passage conditions are not suitable at the POI immediately upstream of the daily cohort's location from one day to the next, the cohort holds at its previous day's location, assuming that holding conditions are suitable in the reach within which the holding location occurred.
3. Suitable holding conditions are defined by average pool water depth for a reach, and reach-averaged water temperature.
   a. Average pool depths greater than or equal to 0.7 ft. are considered suitable for adult steelhead holding.
   b. Reach-averaged daily average water temperatures cooler than or equal to 65°F are considered suitable for adult steelhead holding.
4. If holding conditions (water depth and temperature) are not suitable in the reach of a daily cohort's given location, the daily cohort is allowed to move downstream from one day to the next. The daily cohort is placed downstream of their current location until the first downstream reach with both

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[6] A daily adult cohort represents adults entering the creek being evaluated on each day of the specified adult immigration period.

suitable average pool depth and reach-averaged daily average water temperature is found. The daily cohort is placed at the upstream POI representing that reach. There is no assumed limit on the extent of downstream movement.

5. Each daily cohort is tracked (that is, allowed to migrate upstream or downstream, or hold at a particular location) during each of the remaining days in the species immigration period, unless the cohort spends 30 or more days downstream of the spawning reaches, or spends 30 or more days in the Bay, which resulted in unsuccessful passage for that adult daily cohort.[7]
6. Once a daily cohort reaches a spawning reach, that cohort is considered to have a successful passage event to that reach. Daily cohorts reaching a spawning reach are allowed to continue to migrate upstream or hold, to allow them to potentially migrate to spawning reaches located farther upstream. Therefore, a daily cohort is allowed to have up to one successful passage event to each of the specified spawning reaches of a creek.
7. Each step above is repeated for each adult daily cohort of the specified species immigration period in each water year of the simulation period, for each model scenario.

3.3.2 Steelhead Spawning

Steelhead spawning habitat suitability is evaluated through the application of HSC to simulated depths and velocities during the steelhead spawning period, in conjunction with the application of HSC to substrate size composition and percent embeddedness.

3.3.2.1 Depth and Velocity

Based on discussions with the TWG during 2016, literature from watersheds less than 500 mi^2 (Snider et al. 1995; USFWS 2007) as well as from the Trinity River (Hampton 1997) and Bovee (1978) were compiled for the development of steelhead spawning depth and velocity HSC. The extended tails presented in the USFWS (2007) HSC curve were excluded to avoid the potential for overestimation of spawning habitat in deep areas, as discussed at TWG meetings during 2016. As described above, for the purposes of this evaluation, HSC were developed using calculated mean depth and velocity values for each HSI value of 0.0, 0.2, 0.4, 0.5, 0.6, 0.8, and 1.0. Resultant steelhead spawning depth HSC are presented in Table 3.3-2 and Figure 3.3-1, and resultant steelhead spawning velocity HSC are presented in Table 3.3-3 and Figure 3.3-2.

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[7] Because the modeled upstream passage extent is only available for the dates of the species immigration period, the steelhead cohorts imitating upstream passage from April 1 through April 30 are tracked for up to and less than 30 days.

Table 3.3-2. Depth and Suitability Index Values for Steelhead Adult Spawning Depth HSC

Suitability Index	Depth (feet)
0.00	0.33
0.20	0.50
0.40	0.68
0.50	0.78
0.60	0.86
0.80	0.94
1.00	1.24
0.80	1.40
0.60	1.58
0.50	1.68
0.40	1.80
0.20	2.13
0.00	3.40

Figure 3.3-1. Steelhead Adult Spawning Depth HSC

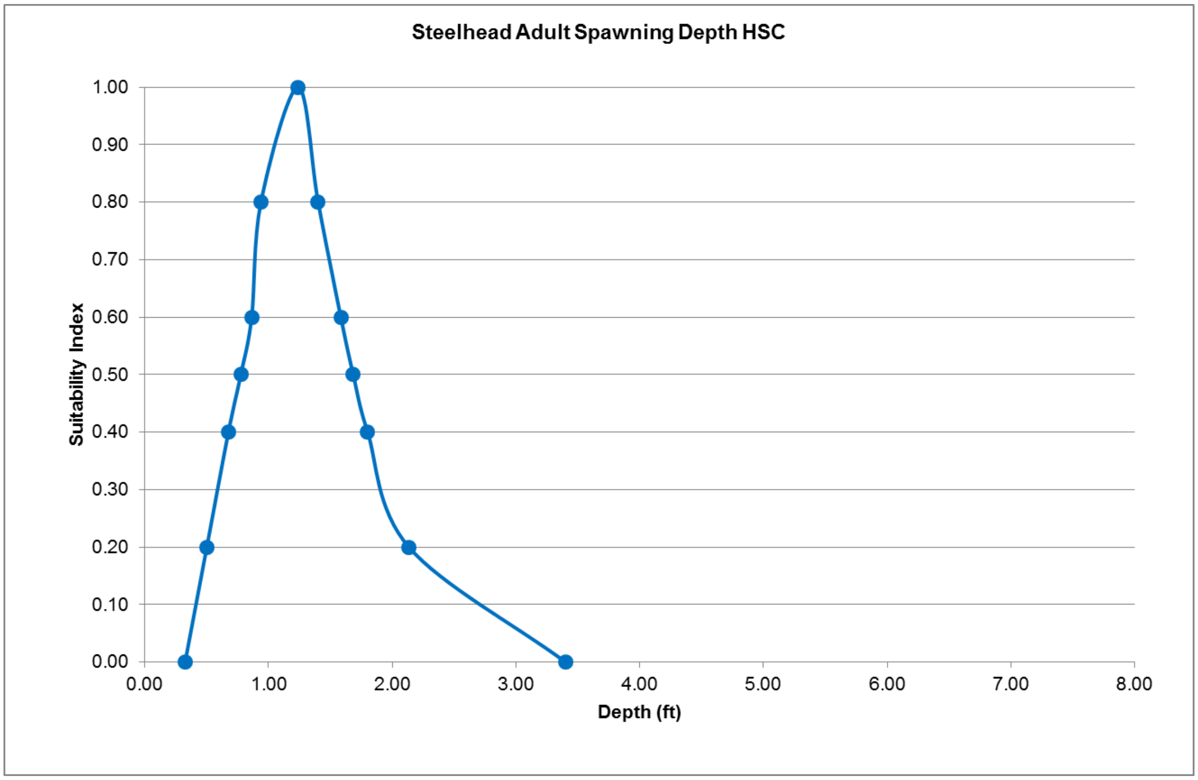
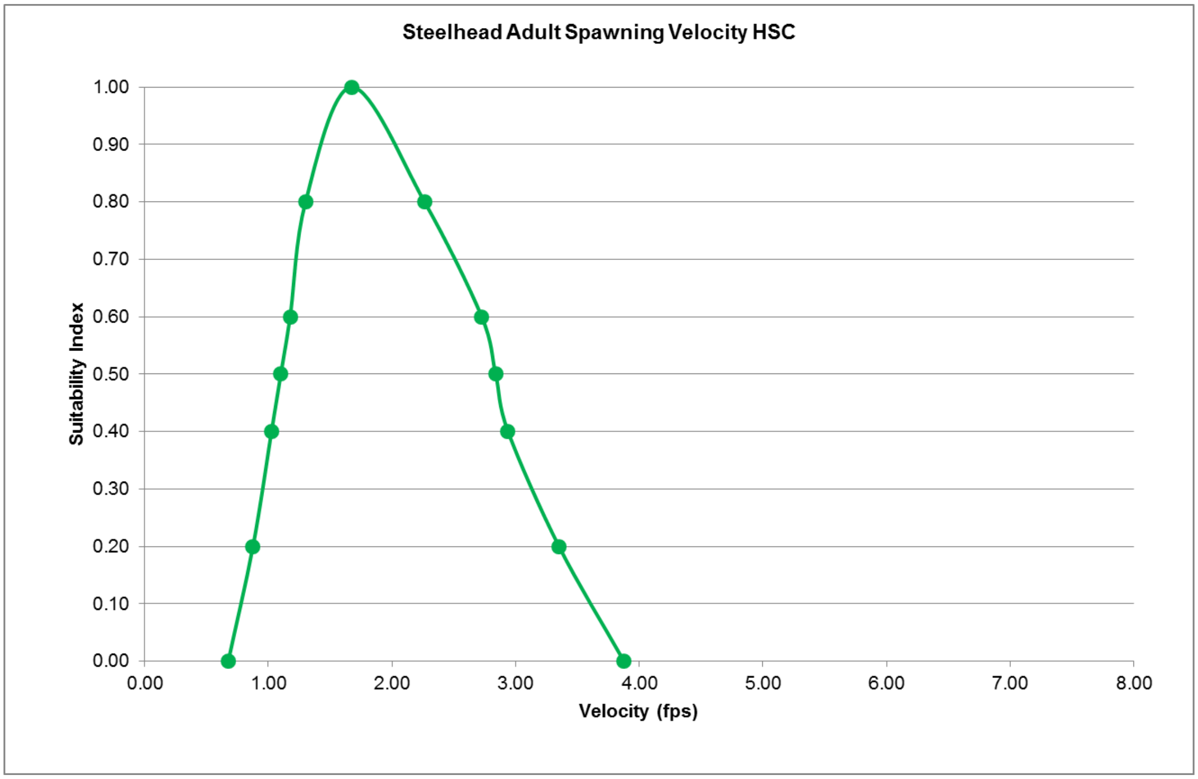


Table 3.3-3. Velocity and Suitability Index Values for Steelhead Adult Spawning Velocity HSC

Suitability Index	Velocity (fps)
0.00	0.68
0.20	0.88
0.40	1.03
0.50	1.10
0.60	1.18
0.80	1.30
1.00	1.68
0.80	2.26
0.60	2.73
0.50	2.84
0.40	2.94
0.20	3.35
0.00	3.88

Figure 3.3-2. Steelhead Adult Spawning Velocity HSC



3.3.2.2 Water Temperature

Because suitable spawning habitat availability is restricted by the suitability of embryo incubation conditions, water temperature HSC for steelhead spawning and embryo incubation are incorporated into the steelhead embryo incubation evaluation, as described under *Steelhead Embryo Incubation*, below.

3.3.2.3 Substrate

Substrate HSC for spawning steelhead are not available for the study area. Therefore, suitable substrate size and substrate embeddedness criteria for steelhead spawning were identified based on review of available literature. Substrate size criteria are applied in a binary fashion, while substrate quality criteria are applied as a continuous function in consideration of the aerial proportion of a habitat unit containing suitably-sized substrate.

Spawning steelhead in the Trinity River reportedly prefer gravel from 1 to 3 inches in diameter that is less than 20 percent embedded in fine sediment (USFWS 1997). In Clear Creek, spawning steelhead prefer substrate sized between about 0.1 and 3 inches, particularly substrate between 1 and 2 inches (USFWS 2011). An instream flow study conducted by CDFW (2015) in a small Central Valley stream supporting steelhead and fall-run Chinook salmon (Auburn Ravine) classified steelhead spawning substrate suitability as 1.0 for substrate ranging from 0.2 to 3 inches, and as 0.5 for substrate between 3 and 4 inches. However, Raleigh et al. (1984) assumed that particles must be at least 0.5 inches in diameter to permit adequate percolation for successful embryonic development. Further, according to the NMFS (2016) Coastal Multispecies Recovery Plan, steelhead prefer clean and loose gravel mostly sized between 1.3 cm (0.5 in) and 10.2 cm (4 in). Based on consideration of the above information, for the purposes of this evaluation, steelhead spawning substrate size is assumed to be completely suitable between 0.5 and 4 inches (that is, HSI = 1.0), and completely unsuitable if less than 0.5 inches or larger than 4 inches (that is, HSI = 0).

By contrast to the hydraulic and substrate embeddedness HSC, the weighted average percent of a habitat unit with suitably-sized substrate (that is, 0.5 – 4 in) is in the format of percent suitable area (that is, data collected from the FAHCE streams were reported as the percent of a habitat unit with suitably-sized substrate). Therefore, the weighted average percent area of a habitat type with suitably-sized substrate is simply multiplied by the weighted average substrate embeddedness HSI (described below) to obtain an index of spawning substrate suitability, which is then composited with the other spawning habitat variables (that is, depth and velocity), as discussed below under *Spawning CHSI*.

In addition to substrate size, the percent of fine sediment (in terms of cobble embeddedness) also is a primary determinant of spawning and incubation habitat quality. For example, Bjornn and Reiser (1991) present data showing that survival of steelhead (and Chinook salmon) embryos generally begins to decline as the percentage of fine sediment in the redd increases above 25 percent. Using data from Bjornn and Resier (1991), Cramer et al. (2012) scaled egg carrying capacity to decline directly proportional to embeddedness when embeddedness exceeded 25 percent, up to 55 percent embeddedness when egg survival was assumed to be near zero. Further, Flosi et al. (2010) associate substrate that is less than 25 percent embedded with optimal salmonid spawning habitat, while 25 to 50 percent embeddedness is moderately impaired, 50 to 75 percent is highly impaired, and greater than 75 percent is severely impaired.

Based on the above information, the HSI for steelhead spawning substrate embeddedness was developed by assigning 25 percent or less embeddedness a value of 1.0, 25 to 50 percent embeddedness a value of 0.5, and greater than 50 percent embeddedness a value of 0. Because available embeddedness data for the study area were collected in quartile percentages, no interpolation is carried out between the specified HSI values. HSC are applied to the weighted average percent embeddedness by habitat type for each reach. If the substrate embeddedness HSI is equal to 0, then spawning habitat is unsuitable for that habitat type and reach, regardless of the HSI values for the other spawning habitat variables.

3.3.3 Steelhead Embryo Incubation

Successful embryo incubation may be affected by many physical variables (see Merz et al. 2004). For the purposes of this evaluation, steelhead embryo incubation habitat suitability is defined by variables that can be modeled with the tools available - water depth and water temperature. The embryo incubation habitat suitability analysis is not used to evaluate embryo incubation independent of other lifestages, but is instead used to calculate “incubation-adjusted” spawning habitat suitability. In other words, a suitable spawning area is not effective spawning habitat unless the flow regime during the incubation period maintains the habitat in a suitable condition for the eggs to hatch (Waddle 2001). As applied in this evaluation, a given habitat type in a reach may only provide for suitable incubation-adjusted spawning habitat if embryo incubation conditions are suitable throughout a simulated incubation period at that habitat type and reach.

To allow for water temperature-dependent durations of embryo incubation, the steelhead embryo incubation period is estimated separately for each daily spawning cohort (that is, for each day of the specified spawning period). Incubation duration is calculated based on reaching sufficient ATUs (°F) from the day of spawning to fry emergence. An ATU is defined as degrees Fahrenheit above 32°F, accumulated during a 24-hour period. The number of ATUs (°F) to reach fry emergence for steelhead is assumed to be 1,080°F (Hannon et al. 2003). ATUs are estimated based on simulated mean daily water temperatures at the upstream-most reach where spawning occurs in each creek. It is recognized that utilizing simulated water temperatures in the uppermost reach of each creek may result in an overall extended duration of incubation throughout the spawning reaches of each creek. However, it reduces the potential for overestimation of successful incubation and fry emergence associated with water temperature tolerance. In other words, incubation duration will generally be longer based on using water temperatures in the uppermost reach relative to downstream reaches, which provides a more protective evaluation of embryo incubation throughout a creek.

Although studies have found that intragravel water temperatures may differ from surface water temperatures (Merz et al. 2004), for the purposes of this evaluation, simulated water temperatures are assumed to represent incubation temperatures. Depth and water temperature HSC applied to steelhead embryo incubation are discussed in more detail below.

3.3.3.1 Depth

Water depth may not be a critical variable for egg incubation success as long as eggs are kept moist during incubation and redds are submerged when fry begin to hatch and emerge (Raleigh et al. 1984). However, in the absence of detailed information on incubation conditions in the study area, simulated water depth by habitat type and reach is used to determine whether eggs are submerged in water. The SWRCB (2007) assumed that the minimum depth for embryo incubation is approximately 0.1 ft above the bed surface. Therefore, for the purposes of this evaluation, an average water depth by habitat type and reach of 0.1 feet is applied as a binary criterion for an entire estimated incubation period. In other words, the incubation depth HSI for a spawning day is equal to 1.0 if water depth is greater than or equal to 0.1 ft at that habitat type and reach for each day of a forecasted incubation period. If the 0.1 ft criterion is not met for at least one day of the forecasted incubation period, the incubation depth HSI for that spawning day is equal to 0.

3.3.3.2 Water Temperature

Optimal steelhead spawning temperatures have been reported to range from 39°F to 52°F (CDFG 1991). Most of the studies of *O. mykiss* embryo incubation conducted at or near 54.0°F report high survival and normal development (Kamler and Kato 1983; Redding and Schreck 1979; Rombough 1988). Embryonic mortality increases sharply and development becomes retarded at incubation temperatures greater than or equal to 57.0°F (~13.9°C) (Velsen 1987; Rombough 1988). Thus, from the available literature, water temperatures in the low 50°F range appear to support high embryo survival, with substantial mortality to steelhead eggs reportedly occurring at water temperatures in the high 50°F range and above.

Limited studies have been conducted on water temperature-related effects on steelhead embryo incubation. In general, water temperature-related embryo survival is generally believed to be maximized at approximately 7 to 10°C (~45 to 50°F), with some increase in mortality below and above this range (Myrick and Cech 2004). Based on a review of various water temperature studies on anadromous salmonid embryos summarized in McCullough et al. (2001), EPA (2003) indicated that good survival occurs at constant water temperatures of about 4 to 12°C (39.2 to 53.6°F).

Based on review of various water temperature studies, including sources identified above, Bratovich et al. (2012) identified an upper optimal WTI value of 54°F and an upper tolerable index value of 57°F for steelhead embryo incubation to be applied in an evaluation of the reintroduction of steelhead to the upper Yuba River Watershed.

Based on the above information, for the purposes of this assessment, two separate indices of steelhead embryo incubation suitability are calculated – one index using an upper optimal water temperature criterion of 54°F and another index using an upper tolerable criterion of 57°F. Therefore, two separate incubation-adjusted spawning HSI are calculated for each habitat type by reach on each day of the steelhead spawning period for each model year. The upper optimal incubation-adjusted spawning HSI for a habitat type and reach is equal to 1.0 if water temperature is less than or equal to 54°F for every day of the forecasted incubation period associated with a given spawning day. Similarly, the upper tolerable incubation-adjusted spawning HSI for a habitat type and reach is equal to 1.0 if water temperature is less than or equal to 57°F for every day of the forecasted incubation period associated with that spawning day. If the applicable WTI value is exceeded on at least one day of a daily spawning cohort's forecasted incubation period for a habitat type and reach, then the incubation-adjusted spawning HSI for that spawning day is calculated as 0.

3.3.4 Steelhead Fry and Juvenile Rearing

Steelhead fry and juvenile rearing habitat suitability is defined in this evaluation by depth, velocity, characterization of cover/shelter, and water temperature.

3.3.4.1 Depth and Velocity

Given lifestage-specific preferences, separate depth and velocity HSC are identified and applied for fry and juveniles. Depth and velocity HSC were developed for steelhead fry according to the same method applied for steelhead spawning, but included compiling HSC from Holmes et al. (2014), Snider et al. (1995), Hampton (1997) and Bovee (1978) for fry velocity, and the same references except for Snider et al. (1995) for fry depth. Resultant steelhead fry depth HSC are presented in Table 3.3-4 and Figure 3.3-3, and resultant steelhead fry velocity HSC are presented in Table 3.3-5 and Figure 3.3-4.

Depth and velocity HSC were developed for steelhead juveniles according to the same method and sources used for developing steelhead fry HSC, except that Snider et al. (1995) was able to be incorporated into the juvenile depth HSC. In addition, because there is substantial variability in reported juvenile steelhead/rainbow trout depth preferences among streams, additional literature was considered as well. For example, although juvenile rainbow trout have been reported to be located at depths of approximately 1 to 4 feet, preferred water depths of greater than 10 feet also have been observed (Raleigh et al. 1984). Bustard and Narver (1975) reported that Age 1+ juvenile steelhead in Carnation Creek, British Columbia, preferred depths of greater than 3 feet. A pool depth of 3 feet has commonly been used as a reference for “fully functional” salmonid habitat (see NMFS and Kier Associates 2008). Greater pool depth typically provides more cover and rearing space for older (age 1+ and 2+) juvenile steelhead (NMFS and Kier Associates 2008). In the absence of local depth HSC, Raleigh et al. (1984) recommended that rainbow trout juvenile depth HSI be equal to 1.0 for all depths greater than or equal to 2 feet.

Based on the above information, the depth HSC was slightly modified from the mean literature HSC values to include a depth of up to 3.0 ft as completely suitable (that is, HSC=1). Because the depths associated with the HSI values from 0.8 to 0.2 were less than 3 ft, the depths associated with HSI values of 0.8, 0.6, 0.5, and 0.4 were linearly interpolated between the depth at an HSI of 1.0 and the depth at an HSI of 0.2. Resultant steelhead juvenile depth HSC are presented in Table 3.3-6 and Figure 3.3-5, and resultant steelhead juvenile velocity HSC are presented in Table 3.3-7 and Figure 3.3-6.

3.3.4.2 Water Temperature

Reported preferred and tolerable water temperatures for juvenile steelhead or rainbow trout can be highly variable, potentially associated with variable acclimation temperatures as well as the study setting. For example, preferred water temperatures for fry and juvenile steelhead across geographic regions have been reported to range from about 45°F to 65°F (~7.2–18.3°C) (Adams *et al.* 1975; Myrick and Cech 2001; Rich 1987), or less than 55°F (~12.8°C) (EPA 2003; McCullough *et al.* 2001). However, juvenile steelhead have been observed to persist at summer water temperatures of up to 28°C (~82°F) or even 30°C (86°F) in eastern Oregon streams (Li et al. 1994), while Myrick and Cech (2000; 2005) reported critical thermal maxima ranging from 30 to 32°C (~86 to 90°F) for some strains of rainbow trout acclimated to water temperatures of 20 to 25°C (68 to 77°F). Similarly, Sloat and Osterback (2013) found that juvenile steelhead over-summering in pools in a stream in the Santa Clara River Basin were able to persist through the summer at occupied water temperatures ranging from 20.3 to 28.2°C (~69 to 83°F), in pools with water temperatures that reached nearly 31.5°C (88.7°F). Sloat and Osterback (2013) hypothesize that a lack of interspecific competition between the observed juvenile steelhead and other fish species in their study area may have resulted in persistence at water temperatures nearing the maxima identified in laboratory settings. Based on various studies, juvenile steelhead are reported to be less sensitive to warm water temperatures relative to other salmonid species (NMFS 2016).

Table 3.3-4. Depth and Suitability Index Values for Steelhead Fry Depth HSC

Suitability Index	Depth (ft)
0.00	0.00
0.20	0.13
0.40	0.20
0.50	0.25
0.60	0.27
0.80	0.30
1.00	0.63
0.80	0.98
0.60	1.17
0.50	1.30
0.40	1.42
0.20	1.80
0.00	4.25

Figure 3.3-3. Steelhead Fry Depth HSC

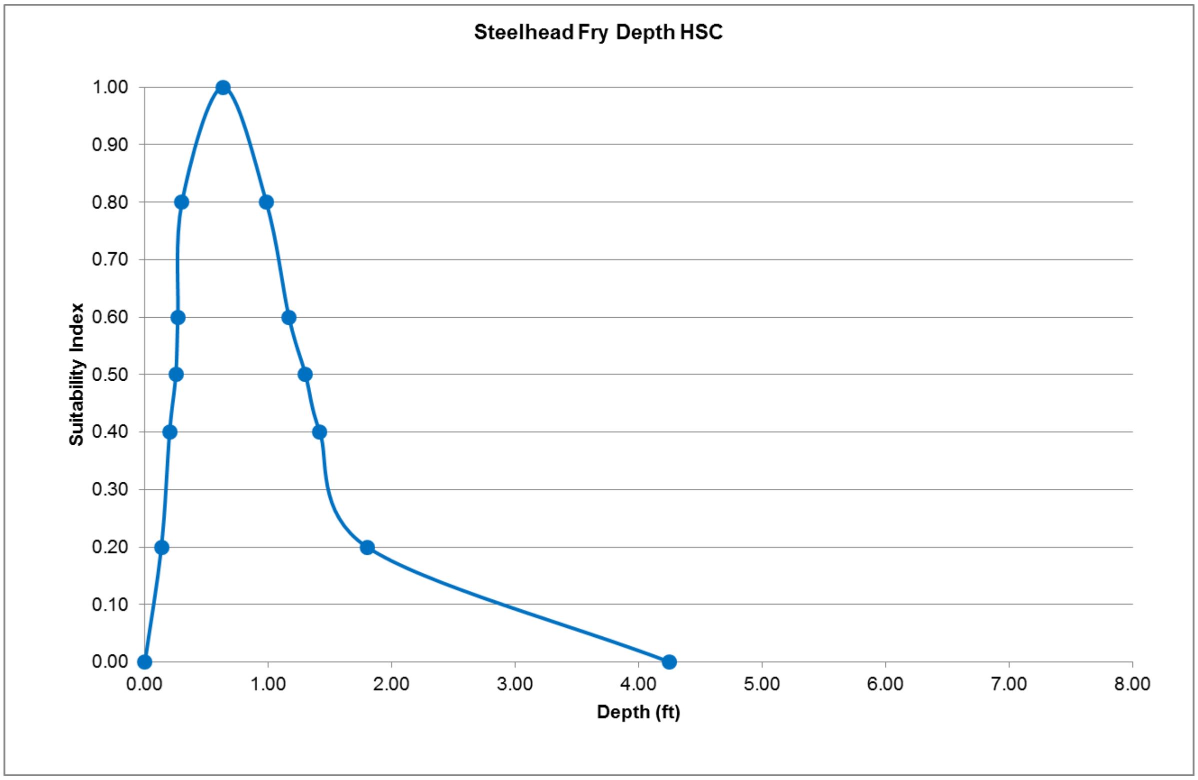


Table 3.3-5. Velocity and Suitability Index Values for Steelhead Fry Velocity HSC

Suitability Index	Velocity (fps)
0.00	0.00
0.20	0.08
0.40	0.11
0.50	0.11
0.60	0.11
0.80	0.14
1.00	0.41
0.80	0.69
0.60	1.00
0.50	1.20
0.40	1.35
0.20	1.69
0.00	2.81

Figure 3.3-4. Steelhead Fry Velocity HSC

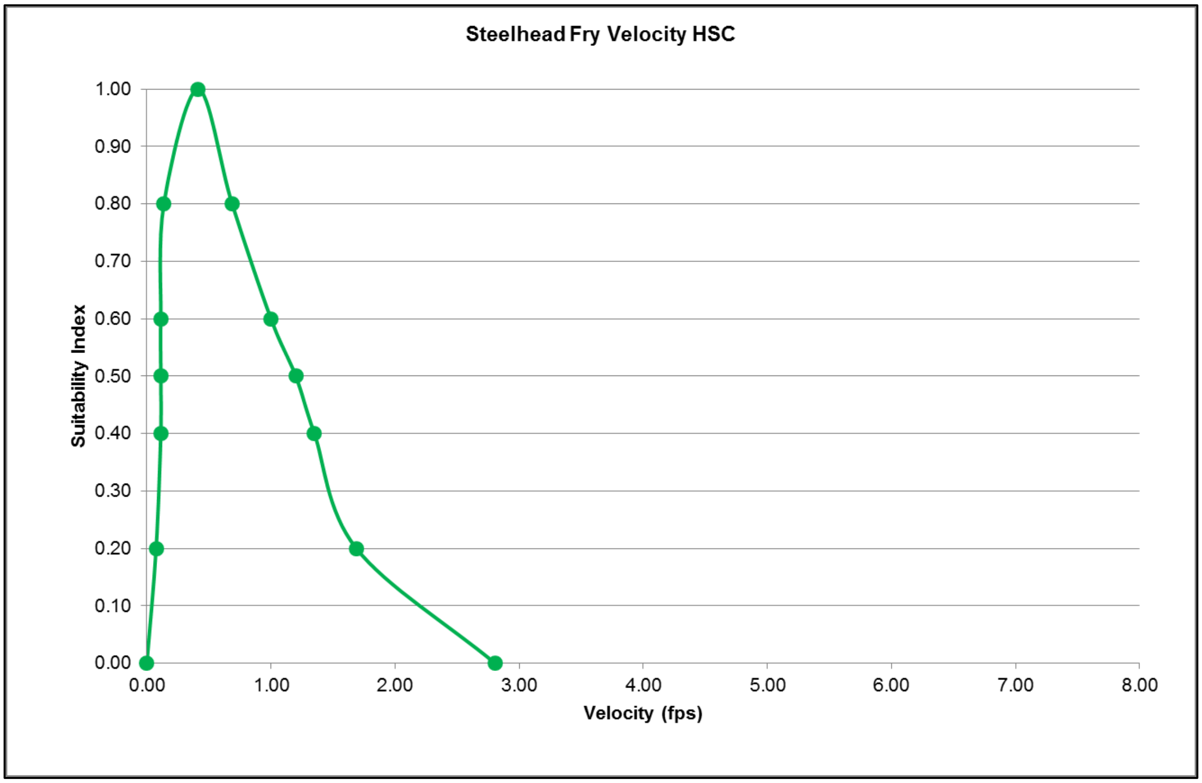


Table 3.3-6. Depth and Suitability Index Values for Steelhead Juvenile Rearing Depth HSC

Suitability Index	Depth (ft)
0.00	0.22
0.20	0.47
0.40	0.60
0.50	0.69
0.60	0.83
0.80	1.01
1.00	1.49
1.00	3.00
0.80	3.23
0.60	3.46
0.50	3.57
0.40	3.68
0.20	3.91
0.00	5.70

Figure 3.3-5. Steelhead Juvenile Rearing Depth HSC

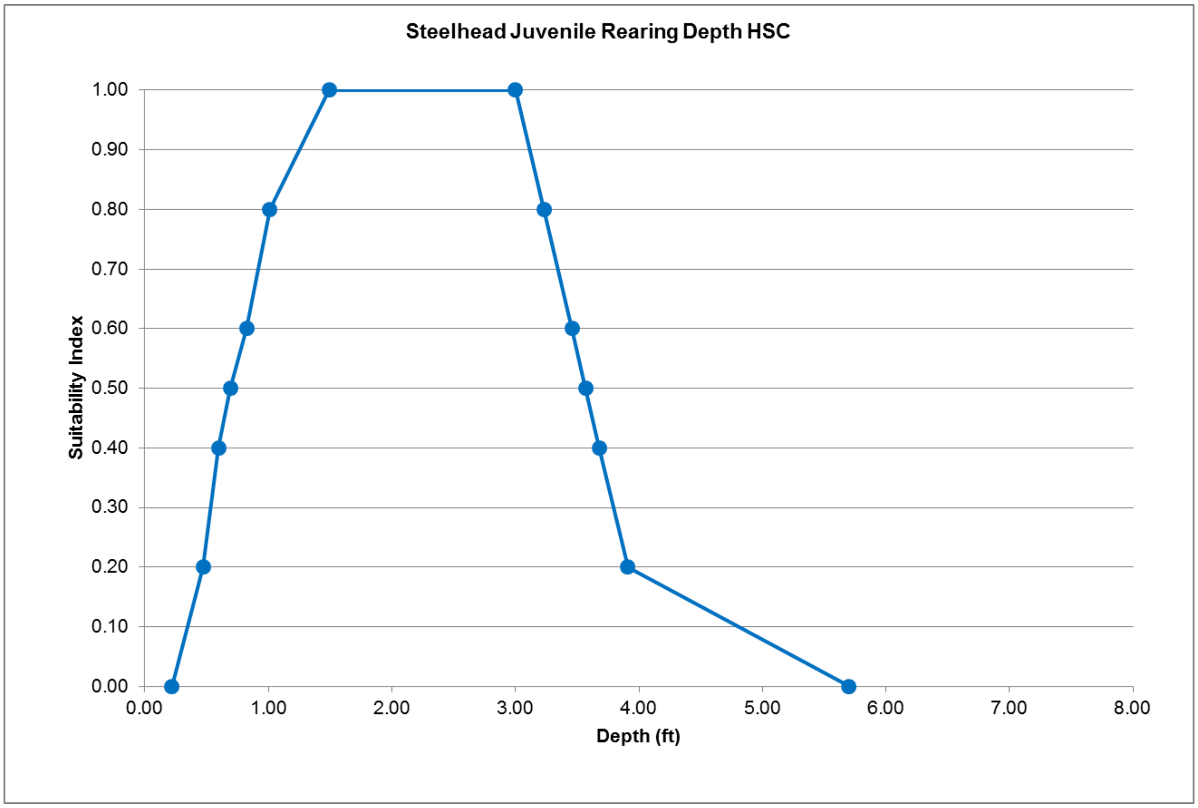
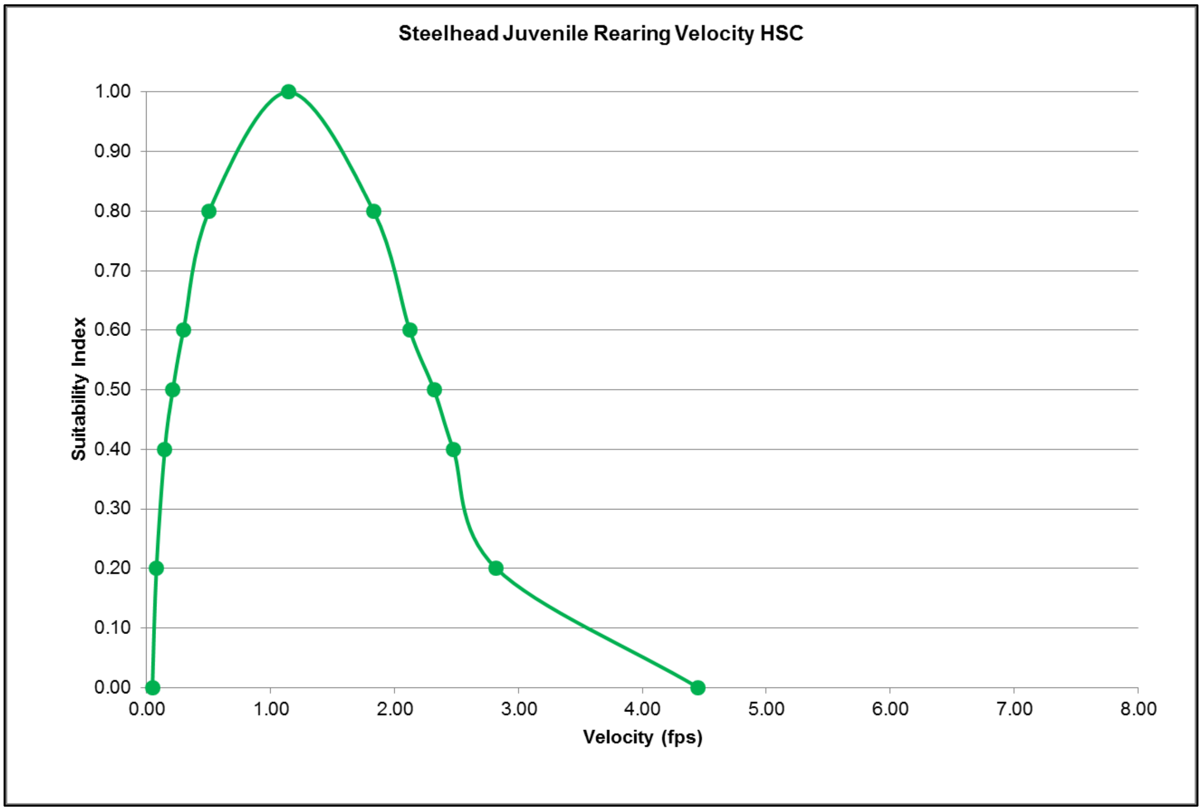


Table 3.3-7. Velocity and Suitability Index Values for Steelhead Juvenile Rearing Velocity HSC

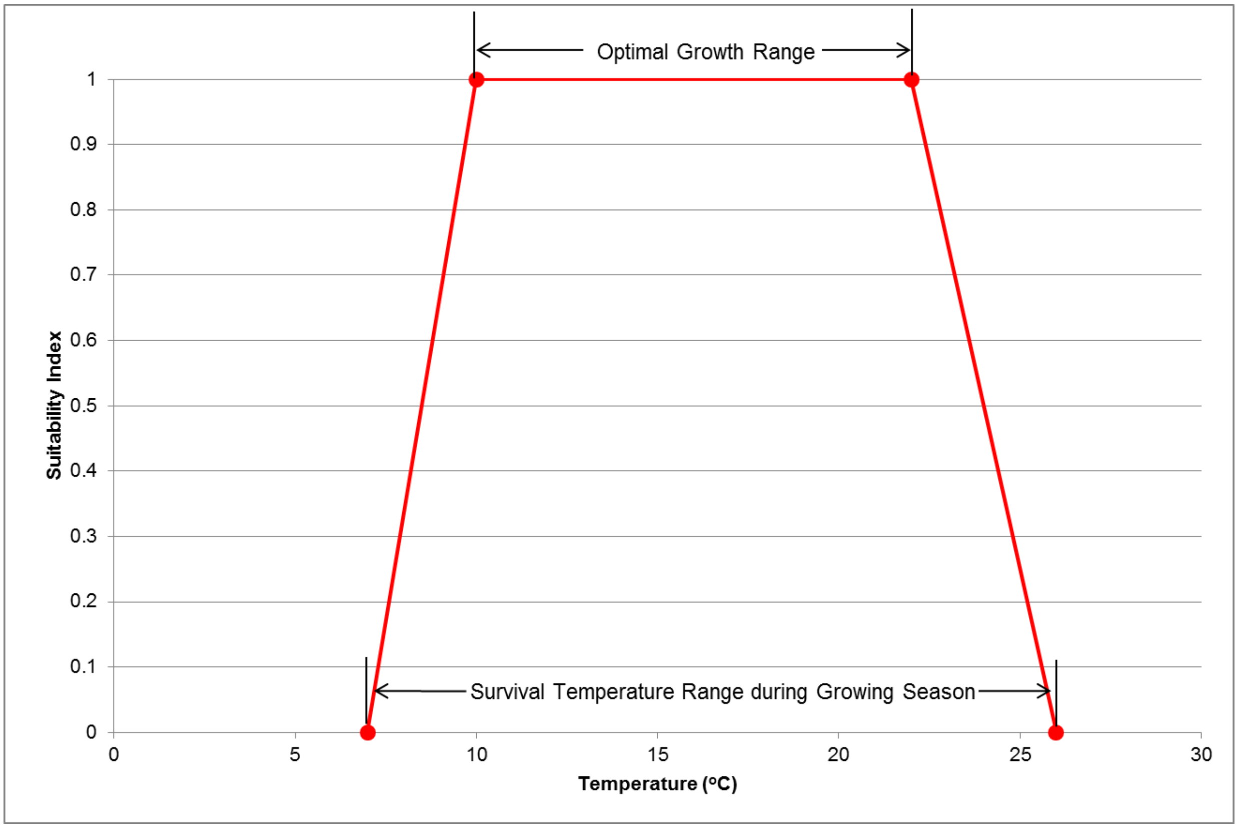
Suitability Index	Velocity (fps)
0.00	0.05
0.20	0.08
0.40	0.15
0.50	0.21
0.60	0.30
0.80	0.50
1.00	1.14
0.80	1.83
0.60	2.12
0.50	2.32
0.40	2.47
0.20	2.82
0.00	4.45

Figure 3.3-6. Steelhead Juvenile Rearing Velocity HSC



For the purposes of this assessment, a continuous function was developed for fry and juvenile rearing water temperature suitability, based on the principles of a generic water temperature suitability curve presented in Bovee et al. (1998). The curve was constructed based on overlaying two sets of binary water temperature criteria pertaining to “optimal growth” and survival. The suitability index is a sliding scale where an index of 1.0 represents the optimum water temperature range for a species/lifestage, and an index of 0.0 represents water temperatures that are unsuitable, or outside of the survivable range of water temperatures during the growing season (Figure 3.3-7). The water temperature values selected to develop the steelhead fry and juvenile water temperature HSC are described below.

Figure 3.3-7. Generic Water Temperature HSC Example



Source: Adapted from Bovee et al. (1998)

EPA (2003) identified water temperature ranges for juvenile salmonid strains in the Pacific Northwest corresponding to optimal growth rate for two conditions – “unlimited food” and “limited food,” based on data presented in McCullough et al. (2001). As discussed by McCullough et al. (2001), food availability in the field is typically believed to be substantially less than that needed to provide satiation feeding. For example, field studies have suggested that wild fish fed at about 60 percent of maximum ration (Myrick and Cech 2001), indicating that lower water temperatures are required to allow for optimum growth rates compared to optimal growth water temperatures identified based on feeding at near 100 percent satiation (McCullough et al. 2001; Myrick and Cech 2001). However, analysis of cutthroat trout growth and consumption data in Bear Creek, WA by Sullivan et al. (2000) found that the individual fish represented by the average population weight was feeding at near satiation throughout the growing season. EPA (2003) identified constant water temperatures ranging from 13 to 20°C (55.4 to 68°F) for unlimited food conditions, and constant water temperatures ranging from 10-

16°C (50 to 60.8°F) for limited food conditions to provide for optimal growth rates of juvenile salmonids in general.

Myrick and Cech (2005) found that Nimbus Hatchery strain age-0 steelhead fed satiation rations had the highest growth rate when acclimated to 19°C (66.2°F), and lower growth rates when acclimated to 11°C (51.8°F) and 15°C (59°F). Because food consumption rate did not show the expected water temperature-related increase among the treatments, food conversion efficiency apparently increased at the warmer water temperature (Myrick and Cech 2005). Myrick and Cech (2005) report that a higher steelhead growth rate at 19°C than at colder temperatures is consistent with results from previous studies on steelhead, resident rainbow trout, and other salmonids.

As reported by Myrick and Cech (2004), one of the most comprehensive studies published on water temperature and steelhead growth was conducted in the North Santiam River, OR, which found that maximal growth occurred at 16.4°C (61.5°F), while some steelhead were able to grow at temperatures as high as 22°C (71.6°F) (Wurtsbaugh and Davis 1997a, b, as cited in Myrick and Cech 2004). Specifically, as water temperature increased, growth rate increased from a minimum of 1 percent weight/day at 6.9°C (44.4°F) to a maximum of 3.5 percent weight/day at 16.4°C (61.5°F). As ration levels decreased from 100 percent to 60 to 70 percent satiation, the optimum growth temperature decreased. Using data from Wurtsbaugh and Davis (1977), Myrick and Cech (2001) plotted a fitted distribution to the growth rates observed under ration levels of 100 percent and under 60 to 70 percent, which suggested that the water temperature associated with the maximum growth rate was approximately 2°F lower under 60 to 70 percent rations relative to 100 percent rations. However, water temperatures associated with the plateau at the top of each of the fitted curves partially overlap with each other, suggesting that similar water temperatures provide the maximum growth rate for different ration levels. In addition, based on a study of American River steelhead growth rates and water temperature in the lower American River (at 100 percent satiation and 82 to 92 percent satiation), growth rates at ration levels 8 to 18 percent lower than satiation were generally the same as those at 100 percent satiation. This similarity was attributed to a higher conversion efficiency at the lower ration levels, which is consistent with the conclusions of Wurtsbaugh and Davis (1997b, as cited in Myrick and Cech 2001). Therefore, it is generally expected that juvenile steelhead growth rates in the study area may be optimal at water temperatures ranging from approximately 64 to 66°F, depending on ration levels. This is further supported by findings from NMFS (2016). Based on several studies (including some of the studies cited above), NMFS (2016) stated that optimal water temperatures for juvenile steelhead growth range from 12 to 19°C (~54 to 66°F).

Very limited data are available on thermal minima for juvenile steelhead or rainbow trout. Although water temperatures in the study area are not expected to approach thermal minima, juvenile rainbow trout have been found to tolerate water temperatures as low as 0 to 2°C (32 to 35.6°F) depending on acclimation temperature (Myrick and Cech 2001). The maximum weekly average water temperature for survival of juvenile (and adult) rainbow trout is reportedly 75.2°F (EPA 2002). Based on numerous studies, the upper incipient lethal temperature (UILT) for juvenile rainbow trout is reported to be 75-79°F (Sullivan et al. 2000; McCullough 2001).

Based on a review of various water temperature studies, Bratovich et al. (2012) selected 65°F as the steelhead juvenile rearing and downstream movement upper optimal WTI value to be applied in an evaluation of the reintroduction of steelhead to the upper Yuba River Watershed.

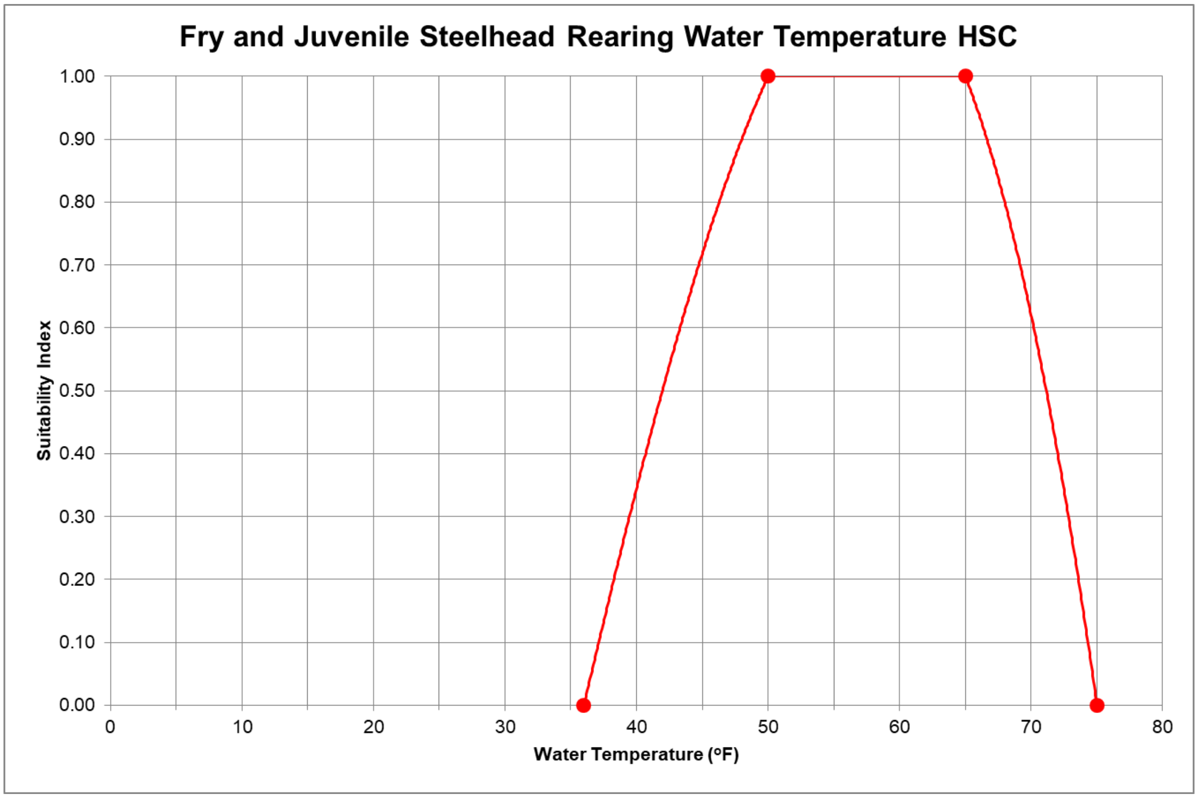
Based on the above information, an optimal growth range for fry and juvenile steelhead was identified for this evaluation as 50 to 65°F, and survivable water temperatures were identified as 36 to 75°F. The resulting water temperature HSC are presented in Figure 3.3-8.

The lower limit of optimal growth value of 50°F was selected based on EPA (2003). The upper limit of optimal growth value of 65°F was selected based on: (1) the water temperatures associated with optimal growth at various rations in the North Santiam River and in the lower American River (see Myrick and Cech 2001); (2) the upper optimal WTI value identified by Bratovich et al. (2012) for juvenile steelhead rearing in the Central Valley; and (3) NMFS (2016).

The lower survival value of 36°F was based on the higher thermal minima identified for juvenile rainbow trout across studies presented by Myrick and Cech (2001), and the upper survival value of 75°F was based on the lower end of the range of UILTs reported by Sullivan et al. (2000) and McCullough et al. (2001) for rainbow trout.

Modified from Bovee et al. (1998), the suitability index was developed by fitting a third order polynomial function to the lower survivable temperature value (36°F), lower optimal growth temperature value (50°F), upper optimal growth temperature value (65°F), and the upper survivable temperature value (75°F). The polynomial function was applied to daily water temperatures when water temperature was between 36 and 50°F (exclusive) and when water temperatures were between 65 and 75°F (exclusive). When water temperatures were between 50 and 65°F (inclusive), an HSI of 1.0 was applied; when water temperatures were less than or equal to 36°F, or greater than or equal to 75°F, an HSI of 0.0 was applied. The resulting HSC exhibits a more biologically-realistic shape relative to the example shown in Bovee et al. (1998). As shown in Figure 3.3-8, as water temperature increases or decreases farther from the optimal range, suitability values decrease at a greater rate. This relationship is consistent with previously-developed relationships between water temperature and growth rate for various coldwater fish species, including anadromous salmonids (for example, see Figure 5 in Bratovich et al. 2012; Figure 2.3 in Sullivan et al. 2000; Figure 1 in Brett et al. 1982; Figure G.4 in Myrick and Cech 2001; Figure 2 in McCullough et al. 2001).

Figure 3.3-8. Fry and Juvenile Steelhead Rearing Water Temperature HSC



3.3.4.3 Cover

Juvenile salmonids prefer well shaded pools with dense overhead cover or abundant submerged cover composed of undercut banks, logs, roots, and other woody debris (NMFS 2016). In Caspar and Pudding creeks in Mendocino County, Gallagher et al. (2014) found that YOY steelhead were positively associated with dry large-wood (defined as either single pieces of wood in the bankfull channel or dry log jams within and above the channel), and older age steelhead were positively associated with cover habitat formed by wet and dry wood, and undercut banks. Cover may be particularly important in areas where water depth is shallow, such as during summer low-flow conditions. For example, yearling and older trout (> 100 mm) will reportedly abandon areas that are less than 6 inches deep unless there is abundant cover (Cramer and Ackerman 2009).

Based on the available data in the study area, the areal percent of a habitat unit with cover was used to define cover suitability for fry and juvenile steelhead. Cover was defined to include all categories of shelter per the CDFW Stream Restoration Manual (Flosi et al. 2010). Raleigh et al. (1984) assigned a cover area of equal to or greater than 15 percent as measured during the late growing season (that is, low-flow period) to an HSI of 1.0 for juvenile *O. mykiss*.

Based on the above information, the percent of area with cover HSC developed by Raleigh et al. (1984) are applied to steelhead fry and juvenile rearing during the spring, summer and fall months (the percent area of a habitat type with greater than 15 percent cover has an HSI of 1 with a linear relationship between 0 percent cover [HSI = 0] and 15 percent cover). Rearing cover HSC are applied to the weighted average percent of unit with cover by habitat type and reach.

Given the somewhat differing habitat preferences of juvenile steelhead during the winter relative to the remainder of the year, separate cover HSC are applied during the winter months (that is, December through March). Substrate selected by Trinity River steelhead juveniles during the winter were characterized by clean cobble substrates, with observed overwintering juveniles almost always located underneath cobbles or boulders (USFWS 1997). Results of research elsewhere also indicate that juvenile steelhead use interstitial spaces between rocks and cobble as overwintering habitat (Morgan and Hinojosa 1996; Stillwater Sciences 2006). Based on review of available studies of juvenile salmonid habitat preferences during the winter, Cramer and Ackerman (2009) concluded that steelhead and Chinook salmon fry have a strong tendency to enter interstitial space among cobble and boulder substrates. Although a hiding response observed by juvenile steelhead has been reported to be influenced by relatively cold water temperatures (for example, less than 8°C; 46.4°F) (see Bustard and Narver 1975 and references therein), Stillwater Sciences (2004; 2006) hypothesized that lack of cover for juveniles during the winter may be a key limiting factor for steelhead in Stevens Creek and in upper Penitencia Creek.

Raleigh et al. (1984) developed winter cover HSC for fry and small juvenile *O. mykiss* based on the areal percent of cobbles and boulders, defined by a size class of 10 to 40 cm (~4 to 15 inches). Raleigh et al. (1984) assigned an area comprised of cobbles and boulders equal to or greater than 10 percent of the stream to an HSI of 1.0 for juvenile *O. mykiss*. However, during periods of high flow, juvenile steelhead (and Chinook salmon) in the central coast region select habitats with reduced water velocity associated with additional types of features besides large substrates, including undercut banks, side channels, and deep pools formed by root wads and other large structures (NMFS 2016). Therefore, additional cover components identified by Flosi et al. (2010) are considered to be potential winter cover for juvenile steelhead in this evaluation, including undercut bank, large woody debris (d>12 inches), root mass, and bedrock ledge.

Based on the above information, the percent of area with cobble (4 to 10-inch diameter) substrate, boulder (>10-inch diameter) substrate, undercut bank, large woody debris (d>12 inches), root mass, and bedrock ledge are applied to steelhead fry and juveniles during the winter months. In other words, if a 10 percent or greater areal proportion of a habitat type in a reach contains the above-defined substrate and/or cover elements, an HSI of 1 is applied. If less than 10 percent of the area of a habitat type in a reach contains the above-specified substrate and cover elements, then an HSI of 0 is applied. Specifically, rearing cover HSC are applied to the weighted average percent of unit with the above-specified winter cover types by habitat type and reach.

3.3.5 Steelhead Juvenile Emigration

Juvenile salmonid downstream migration timing may be affected by various environmental factors, including flow, water temperature, chemical factors (for example, oxygen), turbidity, light, and food availability (Shapovalov and Taft 1954; Friesen et al. 2007; Giorgi et al. 1997; Kock et al. 2015; Gregory and Levings 1998). Migration timing also may be influenced by size of fish, while the size of the emigrating fish can depend upon the time of migration (Shapovalov and Taft 1954). Because most environmental factors potentially influencing migration are related to each other, any given factor may either be influencing migration or may be an incidental factor (Shapovalov and Taft 1954).

For the purposes of this evaluation, it is assumed that juvenile steelhead emigrate from the study area creeks as yearlings (typically as age 1+ or age 2+), consistent with steelhead life history in the North-Central California Coast Domain (NMFS 2016).

The suitability of steelhead juvenile emigration conditions is first evaluated in terms of the daily frequency when juvenile passage conditions are suitable throughout the subject creek (that is, from the upstream-most POI in each creek downstream to the Bay) during a single day (that is, juvenile passage suitability frequency). The daily juvenile passage suitability frequency is calculated for each model year based on both simulated hydraulic variables and simulated water temperatures.

Because the juvenile passage suitability frequency simply represents the number of days that provide suitable migration conditions at all POIs in a creek on a single day, it does not necessary represent the ability of juveniles to successfully emigrate to the Bay. Therefore, a methodology was also developed to provide a more biologically-meaningful assessment of juvenile emigration (that is, juvenile passage events).

3.3.5.1 Juvenile Passage Suitability Frequency

Juvenile passage suitability is determined based on: (1) whether simulated mean daily flows provide sufficient thalweg depth (that is, 0.4 ft) at each POI to allow juvenile passage; (2) whether simulated mean daily flows correspond to passable flows based on critical riffle analyses conducted at each applicable POI; and (3) whether water temperatures are less than or equal to the selected WTI value for juvenile (smolt) emigration at each POI.

Based on review of available literature (for example, CDFW 2013), a depth of 0.4 ft is applied as a binary criterion to daily modeled thalweg water depth at each POI during the steelhead juvenile emigration period.

Most literature on water temperature effects on steelhead smolting suggest that water temperatures less than 52°F(~11°C) are required for successful smoltification to occur (Adams et al. 1975; Myrick and Cech 2001; Rich 1987). Myrick and Cech (2001) suggest that water temperatures between 43-50°F are the “physiologically optimal” temperatures required during the parr-smolt transformation and necessary to maximize saltwater survival. Bratovich et al. (2012) selected 52°F and 55°F as the steelhead smolt emigration upper optimal and upper tolerable WTI values, respectively, to be applied in an evaluation of the reintroduction of steelhead to the upper Yuba River Watershed.

NMFS (2016) stated that suitable water temperatures during the parr to smolt transformation and outmigration periods for steelhead (and Chinook salmon) range between 10 to 17°C (~50 to 63°F), with water temperatures less than 15°C (59°F) considered to be most optimal (Zedonis and Newcomb 1997). Zedonis and Newcomb (1997) state that any increase in water temperature above 15°C (59°F) during the smolt outmigration period would result in decreased smolting tendencies.

Based on the conclusions of Zedonis and Newcomb (1997), SCWA (2016) identified an upper tolerance WTI value for steelhead smolt emigration of 59°F. SCWA (2016) assumed that for the Russian River, water temperatures up to 59°F would tend to result in less than significant impacts under CEQA to steelhead smolt emigration under a low duration of exposure. As discussed by SCWA (2016), although the literature indicates that optimal smolting conditions occur at low water temperatures (for example, less than about 55°F), water temperatures in the Russian River are naturally warm compared to many steelhead streams. To cope with the elevated water temperatures in the Russian River, SCWA (2016) hypothesized that steelhead likely migrate earlier in the year compared to other salmonids. In addition, SCWA (2016) indicated that the Russian River is a relatively short river compared to many steelhead streams, and emigrating smolts would be able to pass through the river in a short amount of time, potentially reaching the ocean before experiencing thermal stress. It should be noted that the study area streams are even shorter than the Russian River. The rain-dominated watersheds of the study area generally experience greater than optimal steelhead smolting water temperatures along at least a portion of their lengths during most of the specified steelhead smolt emigration period (that is, February through May).

Based on the above information, an upper tolerable water temperature value of 59°F is applied as a binary criterion to simulated daily water temperatures by POI during the steelhead smolt emigration period.

3.3.5.2 Juvenile Passage Events

The number of days of successful juvenile emigration required for juveniles to emigrate from the uppermost reach of each creek to the San Francisco Bay is estimated based on juvenile downstream migration rates. Because juvenile downstream migration rates are not available for the study area creeks, a literature review of migration rates was conducted for other areas.

Radio telemetry studies in the Willamette River (Oregon) found that mean downstream migration rates for juvenile (yearling) steelhead was 2.7 km/day (1.7 mi/day) in 2001 (n=10) and 14.9 km/day (9.3 mi/day) in 2002 (n=43) (ODFW 2003; Friesen et al. 2007).

A study on juvenile steelhead (smolt) emigration in the Russian River found that median downstream travel rates for juveniles ranged from 0.6 to 0.8 km/hr (Manning et al. 2005). This would equate to about 14.4 km/day (8.7 mi/day) to 19.2 km/day (11.9 mi/day). Specifically, the median downstream travel time for 44 juveniles was 0.8 km/hr during 2001, 0.7 km/hr for 19 juveniles during 2002, and 0.6 km/hr for 22 juveniles during 2004 (Manning et al. 2005).

Because the Russian River is located within the CCC steelhead DPS, it was assumed that juvenile steelhead downstream migration rates in the Russian River would be the most appropriate data to apply to the study area creeks. To minimize the potential for overestimating migration rates, the lowest median annual migration rate of 0.6 km/hr was applied (that is, 14.4 km/day; 8.7 mi/day).

The number of days estimated to be required for juvenile steelhead to emigrate from the uppermost POI of each creek to the San Francisco Bay was calculated based on the estimated downstream migration rates and distances from the upstream POI in each creek to the Bay (Table 3.3-8).

Juvenile passage events are defined with respect to juveniles emigrating from the system (that is, the river or creek) on each day of the emigration period (that is, Feb 1 through May 31 for steelhead). If successful juvenile passage conditions occur at each POI in the creek for the requisite number of consecutive days for juveniles to reach the Bay, then a passage event is identified for that daily emigration cohort. Therefore, each daily emigration cohort could have up to one successful passage event. The number of successful downstream passage events is then calculated for each year of the simulation period for each creek.

Table 3.3-8. Estimated Migration Durations for Juvenile Steelhead to Migrate from Uppermost POI of Each Creek to San Francisco Bay

Creek	POIs	Migration Duration for Juvenile Steelhead (days)
Guadalupe River	7	2.2
Los Gatos Creek	2	2.1
Guadalupe Creek	4	2.9
Alamitos Creek	4	3.1
Calero Creek	2	3.1
Stevens Creek	6	1.4

3.3.6 Fall-run Chinook Salmon Adult Upstream Migration

The suitability of fall-run Chinook salmon upstream migration conditions is evaluated using the same types of methodologies previously described for steelhead, but with the application of migration and holding criteria specific to Chinook salmon.

3.3.6.1 Upstream Passage Potential Extent

Water Depth

Based on review of literature on suitable water depths for adult Chinook salmon passage (for example, Thompson 1972; SWRCB 2007; CDFW 2013; SWRCB 2014), a thalweg water depth criterion of 0.9 ft or greater was selected for evaluation purposes. A criterion of 0.9 feet or greater was developed in collaboration with the TWG, and has frequently been applied as a depth criterion for adult Chinook salmon on the California coast (for example, CDFW 2013; SWRCB 2014). Thalweg depth at each passage POI is simulated using modeled flow and HEC-RAS modeling which incorporated riffle transects that were surveyed in 2016 (see SEI 2017).

Critical Riffle Flow

As previously described for steelhead, critical riffle flow analyses were conducted in the vicinity of selected POI in 2016 in accordance with CDFW (2013) (see SEI 2017). Flows at which adult passage would be successful based on the CDFW (2013) criteria were identified and applied to simulated daily flows at the nearby POI.

Water Temperature

Thermal migration barriers have frequently been reported for salmonids, including Chinook salmon, when water temperatures reach approximately 70°F (McCullough et al. 2001). Based on telemetry studies of adult fall-run Chinook salmon in the Columbia River, Goniea et al. (2006) found that mean and median migration rates through the lower Columbia River slowed significantly when water temperatures were above about 20°C (68°F) because of temporary use of tributaries as thermal refugia.

Based on a review of various water temperature studies on anadromous salmonids summarized in McCullough et al. (2001), EPA (2003) indicated that an overall reduction in migration fitness attributable to cumulative stresses occurred at constant water temperatures greater than 17 to 18°C (62.6 to 64.4°F). During each of the years when water temperature-related mortality of Chinook salmon was not observed in Butte Creek (2001, 2004-2007), on average, daily water temperatures did not exceed 65.8°F for more than 7 days (Bratovich et al. 2012).

Based on some of the above-referenced studies, Bratovich et al. (2012) identified an upper optimal WTI value of 64°F, and an upper tolerable value of 68°F for Chinook salmon adult migration. For Chinook salmon adult holding, Bratovich et al. (2012) identified upper optimal and upper tolerable WTI values of 61 and 65°F, respectively.

Because daily modeled water temperatures are applied during each day of the Chinook salmon upstream migration period as a binary criterion (that is, migration is classified as either suitable or completely unsuitable during a given day), an upper tolerable WTI value is considered to be appropriate for modeling evaluation purposes.

As described above, suitable water temperatures for adult migration are typically higher than adult holding water temperatures, primarily because of increased duration of exposure to water temperature during adult holding relative to migration. Because adult holding is incorporated into the upstream migration (passage events) analysis, and because tolerable water temperatures are lower for adult holding relative to adult migration, the upper tolerable WTI value for adult Chinook salmon holding (65°F) was selected for the adult Chinook salmon passage evaluations.

3.3.6.2 Adult Passage Events

Migration Rate and Holding Assumptions

Migration rates for adult fall-run Chinook salmon are not available for the study area. Therefore, a literature review was conducted for adult salmonid migration rates in other areas.

In the Columbia River, adult fall-run Chinook salmon migration rates ranged from 19 to 31 km/day (~11.8 to 19.3 mi/day), depending on the reach and year (Keefer et al. 2004). Unlike the study area creeks, there are no water depth-related passage impedances in the Columbia River. Therefore, migration rates in the study area creeks may be closer to the lower end of the migration rate ranges observed in the Columbia River.

Adult Chinook salmon were tagged and tracked during their upstream migration in the Guadalupe River during a radio telemetry study in the 2003/2004 season. Average survival time of the 39 tagged adults was about 20 days, ranging from 2 days to 64 days (Valley Water 2004). The mean distance traveled upstream from the trapping and tagging location (located about 8 miles upstream of the San Francisco Bay) was 3.4 miles, ranging from 100 ft during poor water quality and elevated water temperature conditions, to 11.2 miles during suitable water quality and thermal conditions (Valley Water 2004). It should be noted that poor migration and water quality conditions were present during a portion of the study period, including the presence of three separate temporary culverts and illegal construction discharge upstream of the adult trapping site. Although some tagged adults passed through the two downstream culverts, the upstream-most culvert was unpassable until it was removed at the end of October. Two tagged adults held in a pool below the upstream-most culvert for 21 and 22 days, respectively, and continued their upstream migration after the culvert was removed (Valley Water 2004). Illegal construction discharge into the Guadalupe River during mid-August through mid-September, in combination with elevated water temperatures, resulted in the mortality of tagged adult Chinook salmon, as well as other fish species which were not handled or captured (Valley Water 2004). Based on the artificial impediments and poor water quality conditions observed during portions of the study period, it could be expected that adult migration would have been more successful (that is, more adults may have migrated further upstream) under less stressful conditions.

Because adult salmonids are observed to hold during their upstream migrations, including in the study area, passage events are assumed to not require continuous days of passage. Therefore, it is assumed that adults are able to hold while waiting for passage to be provided at the next upstream POI, assuming that water depth is sufficient (that is, 0.9 ft for Chinook salmon) and the adult holding upper tolerable WTI value is not exceeded at the POI or reach where they are assumed to be holding. Because fall-run Chinook salmon are believed to spawn relatively soon after freshwater entry, and based on the radio telemetry results described above, adult fall-run Chinook salmon are assumed to be able to hold for a total of up to 30 days downstream of designated spawning reaches. In addition, in the event that adult passage conditions are not suitable at the most downstream POI, adults also are assumed to be able to hold in the Bay for up to 30 days.

Consistent with the adult steelhead migration evaluation, the lower end of the ranges of upstream migration rates for fall-run Chinook salmon (19 km/day; 11.8 mi/day) from Keefer et al. (2004) are used to quantify passage events over the simulation period.

Definition of Adult Passage Events

Passage events are defined with respect to adults that enter the system (that is, the river or creek) from the Bay on each day of the immigration period (that is, Oct. 15 – Jan. 31 for Chinook salmon).

Adults (that is, daily adult cohorts) entering a creek on each day of their immigration period are assumed to move upstream (given suitable passage conditions) on a daily basis based on the species-specific assumed migration rate. Daily adult cohorts are assumed to migrate past each POI as long as adult passage conditions (as defined by modeled adult passage potential extent) are suitable. If a daily cohort reaches a POI which does not have suitable passage conditions, the daily cohort is allowed to hold in the reach below the unpassable POI and wait for upstream passage conditions to become suitable. However, if holding conditions are not suitable where a daily cohort is assumed to hold (as defined by modeled average pool depth and average water temperature in a reach below a POI) the daily cohort is assumed to be able to move downstream of the adult position to the upstream-most reach that provided suitable holding conditions.

Passage events are evaluated for each daily adult cohort[8] for each annual adult immigration season, and are classified as successful or unsuccessful. If an adult daily cohort reaches any of the designated spawning reaches of the subject stream within 30 days of the initiation of upstream passage, the adult daily cohort is considered to have a successful passage event.[9] However, if an adult daily cohort spends a cumulative duration of 30 or more consecutive days migrating and/or holding downstream of the lowermost spawning reach of the stream, the adult daily cohort is considered to have an unsuccessful passage event for that year. In addition, if a daily cohort spends 30 days or more holding in the Bay awaiting for passage conditions to become suitable at the most-downstream POI, that cohort is considered to have an unsuccessful passage event for that year. Detailed rules employed to evaluate passage events for each adult daily cohort are the same as those described for adult steelhead, but with the application of the specified hydraulic criteria and upstream migration rates for Chinook salmon.

3.3.7 Fall-run Chinook Salmon Spawning

As previously discussed for steelhead, fall-run Chinook salmon spawning habitat suitability is evaluated through the application of HSC to simulated depths and velocities during the fall-run Chinook salmon spawning period, in conjunction with the application of HSC to substrate size composition and percent embeddedness. Spawning female Chinook salmon select areas of the stream with high subgravel flow, which is consistent with the incubation requirements of the larger eggs produced by Chinook salmon (Healey 1991). Although Chapman (1943) and Vronskiy (1972) observed most Chinook salmon redds at the heads of riffles, other documented spawning areas included pools below log jams or even deep areas below waterfalls, where subgravel flow rates would be expected to be relatively high. Chinook salmon appear to be able to spawn in areas that may be relatively shallow or deep, or slow or fast, if there are suitable subgravel flow conditions (Healey 1991).

3.3.7.1 Depth and Velocity

Based on discussions with the TWG during 2016, literature from watersheds less than 500 mi2 (USFWS 2011), as well as from the Trinity River (Hampton 1997) and Bovee (1978), were compiled for the development of fall-run Chinook salmon spawning depth and velocity HSC. The USFWS (2011) HSCs were modified to exclude the extended tails at relatively deep depths to avoid the potential for overestimation of spawning habitat in deep areas, as discussed at TWG meetings during 2016. Resultant Chinook salmon spawning depth HSC are presented in Table 3.3-9 and Figure 3.3-9,

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[8] A daily adult cohort represents adults entering the creek being evaluated on each day of the specified adult immigration period.

[9] Because the modeled upstream passage extent is only available for the dates of the species immigration period, the Chinook salmon cohorts initiating upstream passage from Jan. 2 through Jan. 31 are tracked for up to and less than 30 days.

and resultant Chinook salmon spawning velocity HSC are presented in Table 3.3-10 and Figure 3.3-10.

Table 3.3-9. Depth and Suitability Index Values for Chinook Salmon Adult Spawning Depth HSC

Suitability Index	Depth (feet)
0.00	0.23
0.20	0.43
0.40	0.52
0.50	0.58
0.60	0.63
0.80	0.75
1.00	1.13
0.80	1.48
0.60	1.67
0.50	1.75
0.40	1.88
0.20	2.15
0.00	3.30

Figure 3.3-9. Chinook Salmon Adult Spawning Depth HSC

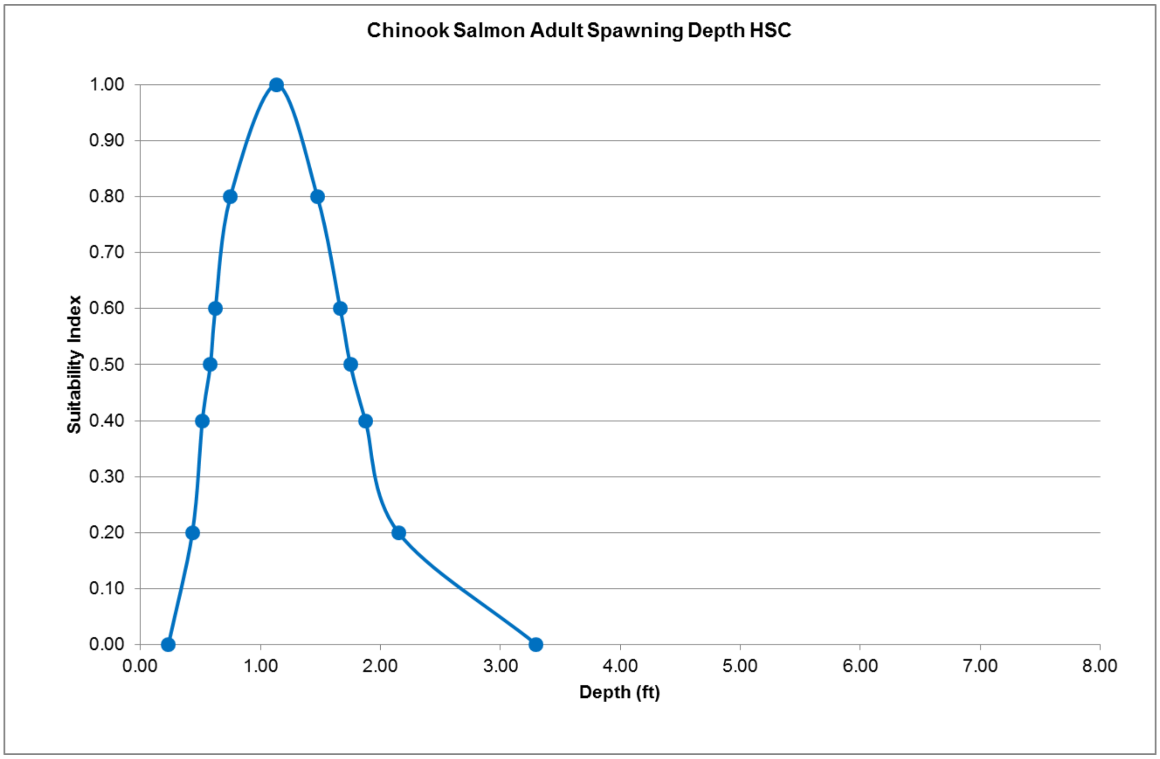
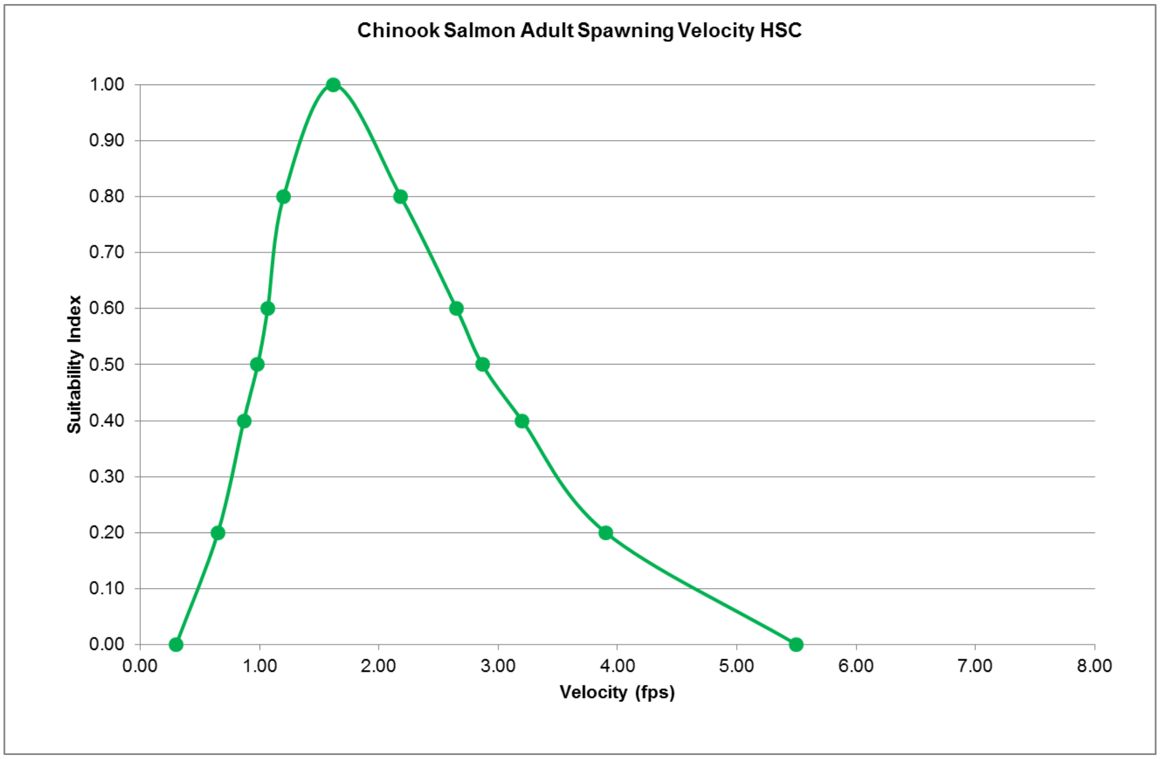


Table 3.3-10. Velocity and Suitability Index Values for Chinook Salmon Adult Spawning Velocity HSC

Suitability Index	Velocity (fps)
0.00	0.30
0.20	0.65
0.40	0.87
0.50	0.98
0.60	1.07
0.80	1.20
1.00	1.62
0.80	2.18
0.60	2.65
0.50	2.87
0.40	3.20
0.20	3.90
0.00	5.50

Figure 3.3-10. Chinook Salmon Adult Spawning Velocity HSC



3.3.7.2 Water Temperature

Because suitable spawning habitat availability is restricted by the suitability of embryo incubation conditions, water temperature HSC for fall-run Chinook salmon spawning and embryo incubation are incorporated into the steelhead embryo incubation evaluation, below.

3.3.7.3 Substrate

Substrate HSC for spawning fall-run Chinook salmon are not available for the study area. Therefore, suitable substrate size and substrate quality for fall-run Chinook salmon spawning based on the literature were identified and applied. Substrate size criteria are applied in a binary fashion in consideration of the aerial proportion of a habitat unit containing suitably-sized substrate, while substrate quality criteria are applied as a continuous function.

Because of their larger size, Chinook salmon are able to spawn in higher water velocities and utilize coarser substrates than other salmon species (PFMC 1999). Spawning Chinook salmon in the Trinity River reportedly preferred gravel and cobble from 2 to 6 inches in diameter that was less than 40 percent embedded in fine sediment (USFWS 1997). In Clear Creek, spawning Chinook salmon utilized substrate sized between about 1 and 6 inches, with a preference for substrate between 1 and 3 inches (USFWS 2011). An instream flow study conducted by CDFW (2015) in Auburn Ravine classified fall-run Chinook salmon spawning substrate suitability as 1.0 for substrate ranging from 0.1 to 6 inches. Raleigh et al. (1984) assumed that particles must be at least 0.5 inches in diameter to permit adequate percolation for successful embryonic development. Based on consideration of the above information, fall-run Chinook salmon spawning substrate size within a habitat unit is assumed to be completely suitable between 0.5 and 6 inches (that is, HSI = 1.0), and completely unsuitable if less than 0.5 inches or larger than 6 inches (that is, HSI = 0). HSC are applied to the weighted average percent of each habitat type with suitably-sized spawning substrate for each reach.

As previously described for steelhead, the percent of fine sediment (in terms of cobble embeddedness) also is a primary determinant of spawning and incubation habitat quality. For example, Bjornn and Reiser (1991) present data showing that survival of Chinook salmon embryos generally begins to decline as the percentage of fine sediment in the redd increases above 25 percent. Flosi et al. (2010) associate substrate that is less than 25 percent embedded with optimal salmonid spawning habitat, while 25 to 50 percent embeddedness is moderately impaired, 50 to 75 percent is highly impaired, and greater than 75 percent is severely impaired. Based on the above information, HSC for fall-run Chinook salmon spawning substrate quality was developed by assigning 25 percent or less embeddedness a value of 1.0, 25 to 50 percent embeddedness a value of 0.5, and greater than 50 percent embeddedness a value of 0. Because available embeddedness data for the study area were collected in quartile percentages, no interpolation was required between the specified HSC values. HSC are applied to the weighted average embeddedness by habitat type for each reach.

3.3.8 Fall-run Chinook Salmon Embryo Incubation

As previously described for steelhead, the embryo incubation habitat suitability analysis is not used to evaluate embryo incubation independent of other lifestages. Instead, the embryo incubation suitability analysis is used to constrain potential spawning habitat to calculate “incubation-adjusted” spawning habitat availability.

As described for steelhead, the incubation period is estimated for each daily spawning cohort based on the expected duration of incubation, which is calculated based on reaching sufficient ATUs (°F) to fry emergence. The number of ATUs (°F) to reach fry emergence for fall-run Chinook salmon is assumed to be 1,649°F, based on averaging reported ATUs in the literature required to reach 50 percent hatch and to reach 50 percent emergence (Bedore et al. 2015). ATUs are estimated based on simulated average daily water temperatures at the most upstream reach where spawning is known to occur in each creek.

Depth and water temperature HSC applied to fall-run Chinook salmon embryo incubation are discussed in more detail below.

3.3.8.1 Depth

As discussed for steelhead, a depth of 0.1 feet also was applied as a binary criterion for the forecasted fall-run Chinook salmon incubation period for each daily spawning cohort (SWRCB 2007).

3.3.8.2 Water Temperature

In general, water temperature-related Chinook salmon embryo survival has been suggested to be optimal at approximately 6 to 12°C (~43 to 54°F) based on available water temperature-related studies (Myrick and Cech 2004). Based on a review of various water temperature studies on anadromous salmonid embryos summarized in McCullough et al. (2001), EPA (2003) indicated that good survival occurs at constant water temperatures of about 4 to 12°C (39.2 to 53.6°F). Chinook salmon-specific studies indicate that Chinook salmon egg and alevin survival decreased rapidly when water temperatures exceed approximately 56°F (~13.3°C) (Seymour 1956; Boles et al. 1988; USFWS 1999). Boles et al. (1988) found that mortalities in Chinook salmon fry were reduced to low levels when eggs were incubation at constant temperatures from 50 to 55°F (10 to 12.8°C). Constant egg incubation temperatures between 42.5°F and 57.5°F reportedly resulted in normal development (Combs and Burrows 1957).

Based on a review of water temperature studies, including some of the studies identified above, Bratovich et al. (2012) identified Chinook salmon embryo incubation upper optimal and upper tolerable WTI values of 56°F and 58°F, respectively.

Based on the above information, for the purposes of this assessment, two separate indices of Chinook salmon embryo incubation suitability are calculated – one index using an upper optimal water temperature criterion of 56°F and another index using an upper tolerable criterion of 58°F. Therefore, two separate incubation-adjusted spawning HSI are calculated for each habitat type by reach on each day of the Chinook salmon spawning period for each model year. The upper optimal incubation-adjusted spawning HSI for a habitat type and reach is equal to 1.0 if water temperature is less than or equal to 56°F for every day of the forecasted incubation period associated with a daily spawning cohort. Similarly, the upper tolerable incubation-adjusted spawning HSI for a habitat type and reach is equal to 1.0 if water temperature is less than or equal to 58°F for every day of the forecasted incubation period associated with a daily spawning cohort. If the applicable WTI value is exceeded for at least one day of a daily spawning cohort’s forecasted incubation period for a habitat type and reach, then the incubation-adjusted spawning HSI for that spawning day is calculated as 0.

3.3.9 Fall-run Chinook Salmon Fry and Juvenile Rearing

Fall-run Chinook salmon fry and juvenile rearing habitat suitability is defined in this evaluation by depth, velocity, characterization of cover/shelter, and water temperature.

3.3.9.1 Depth and Velocity

Juvenile Chinook salmon are known to prefer slower water habitats than many other salmonid species (Quinn 2005), and have been reported to actively seek out slow backwaters, pools, or floodplain habitat for rearing (Sommer et al. 2001; Jeffres et al. 2008). Similarly, juvenile Chinook salmon have been reported to show a clear preference for faster water (up to an average of about 1.8 ft/s) as they grow, consistent with trends found with salmonids in other rivers (Bjornn and Reiser 1991). Snorkel surveys conducted in the lower Yuba River during 2012 indicate that the vast majority of juvenile Chinook salmon observations in the lower Yuba River occurred in water velocities and depths indicative of slackwater and slow glide mesohabitats (RMT 2013).

Given lifestage-specific preferences, separate depth and velocity HSC were identified and applied for fry and juveniles. Depth and velocity HSC were developed for fall-run Chinook salmon fry according to the same method applied for fall-run Chinook salmon spawning, but included compiling HSC from Hampton (1997), Beakes et al. (2014), and Aceituno (1990). Because limited fall-run Chinook salmon fry depth and velocity HSC were readily available from watersheds less than 500 mi^2, the American River (Beakes et al. 2014) and Stanislaus River (Aceituno 1990) HSC were included. HSC were developed for this evaluation using the same procedures described above for steelhead. Resultant fall-run Chinook salmon fry depth HSC are presented in Table 3.3-11 and Figure 3.3-11, and resultant Chinook salmon fry velocity HSC are presented in Table 3.3-12 and Figure 3.3-12.

Table 3.3-11. Depth and Suitability Index Values for Chinook Salmon Fry Depth HSC

Suitability Index	Depth (ft)
0.00	0.00
0.20	0.25
0.40	0.48
0.50	0.62
0.60	0.77
0.80	1.00
1.00	1.30
0.80	1.78
0.60	2.07
0.50	2.20
0.40	2.43
0.20	3.08
0.00	5.72

Figure 3.3-11. Chinook Salmon Fry Depth HSC

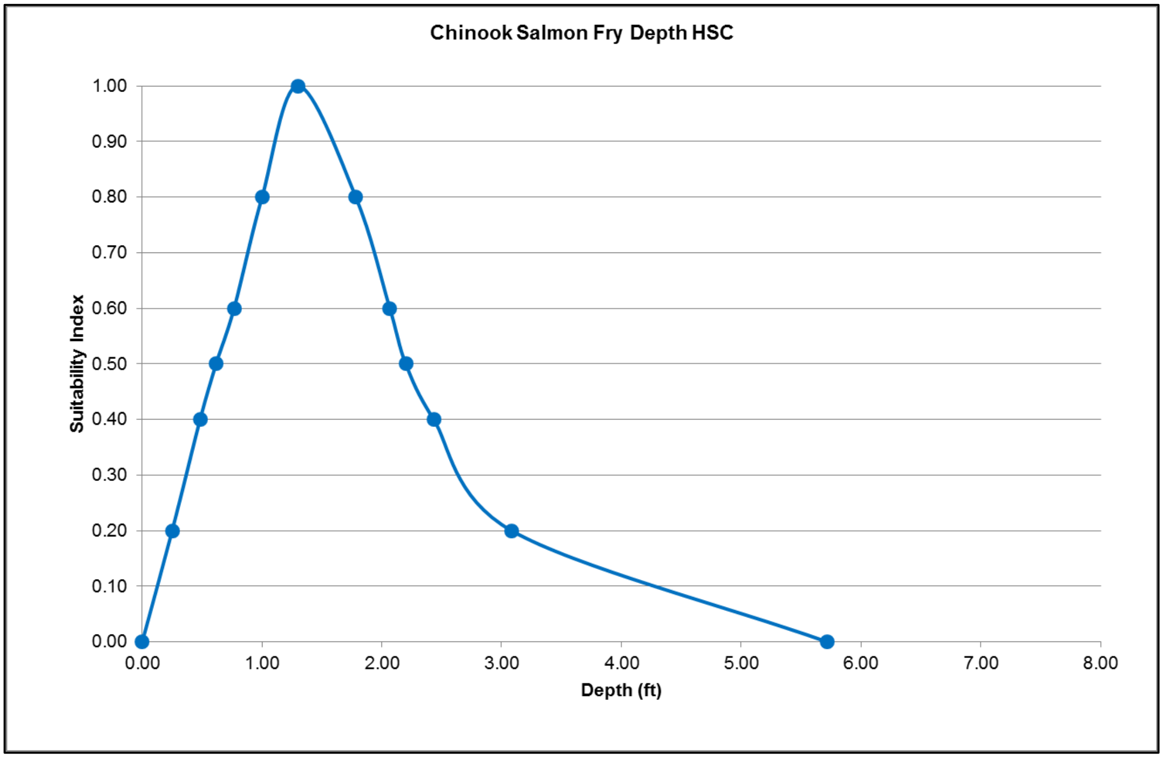
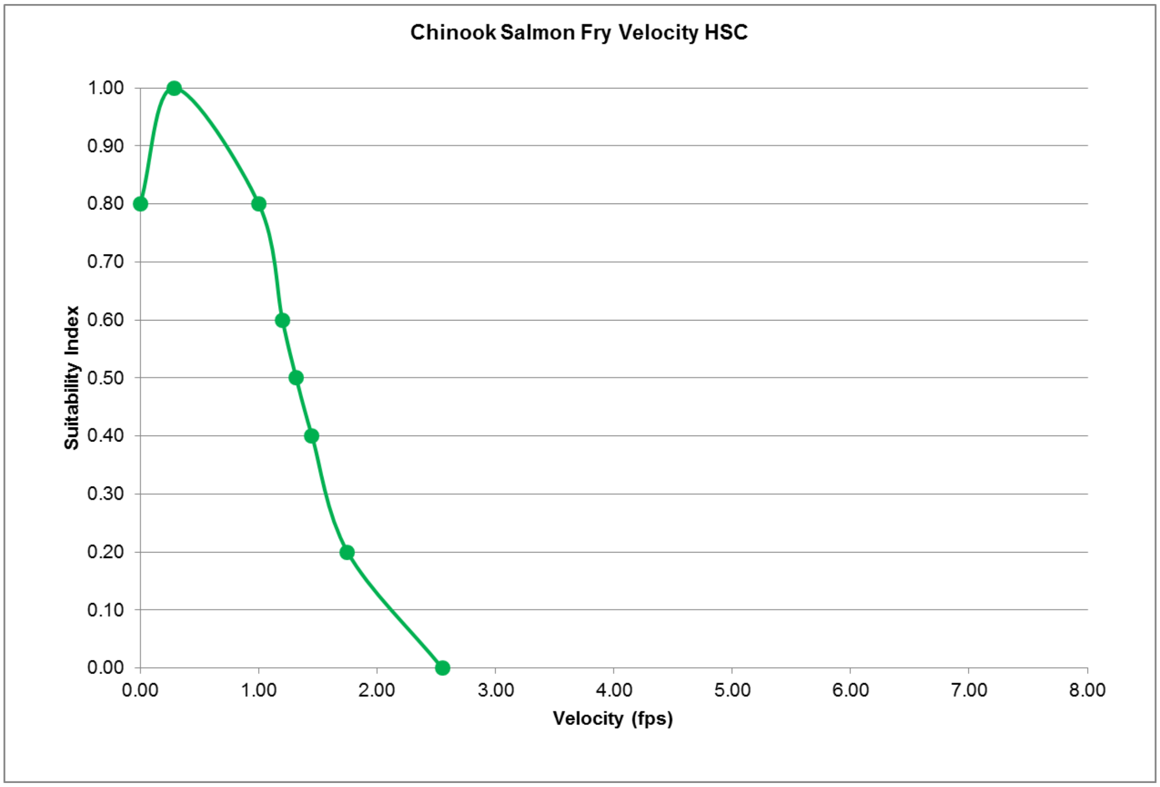


Table 3.3-12. Velocity and Suitability Index Values for Chinook Salmon Fry Velocity HSC

Suitability Index	Velocity (fps)
0.80	0.00
1.00	0.28
0.80	1.00
0.60	1.20
0.50	1.32
0.40	1.45
0.20	1.75
0.00	2.55

Figure 3.3-12. Chinook Salmon Fry Velocity HSC



Depth and velocity HSC were developed for fall-run Chinook salmon juveniles according to the same method used for developing fall-run Chinook salmon fry HSC, except that HSC from Hampton (1997), Bovee (1978) and Beakes et al. (2014) were incorporated into the juvenile depth HSC. In addition, the juvenile Chinook salmon depth HSC from Bovee (1978) and Hampton (1997) were modified to remove the extended "tails" that show HSC values of 1 (that is, 100 percent suitable depths) at continually increasing depths, as discussed at TWG meetings during 2016.

Resultant fall-run Chinook salmon juvenile depth HSC are presented in Table 3.3-13 and Figure 3.3-13, and resultant steelhead juvenile velocity HSC are presented in Table 3.3-14 and Figure 3.3-14.

Table 3.3-13. Depth and Suitability Index Values for Chinook Salmon Juvenile Rearing Depth HSC

Suitability Index	Depth (ft)
0.00	0.08
0.20	0.30
0.40	0.47
0.50	0.55
0.60	0.62
0.80	0.83
1.00	1.27
0.80	2.00
0.60	2.50
0.50	2.60
0.40	2.80
0.20	3.20
0.00	3.90

Figure 3.3-13. Chinook Salmon Juvenile Rearing Depth HSC

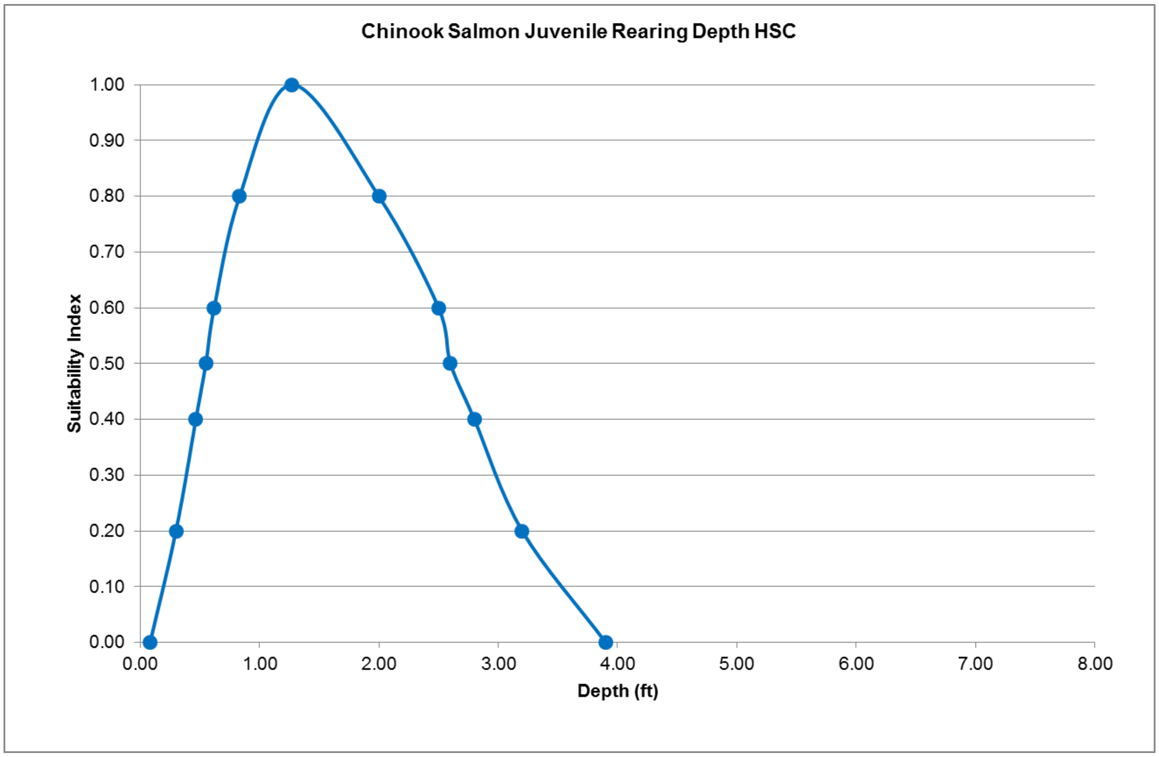
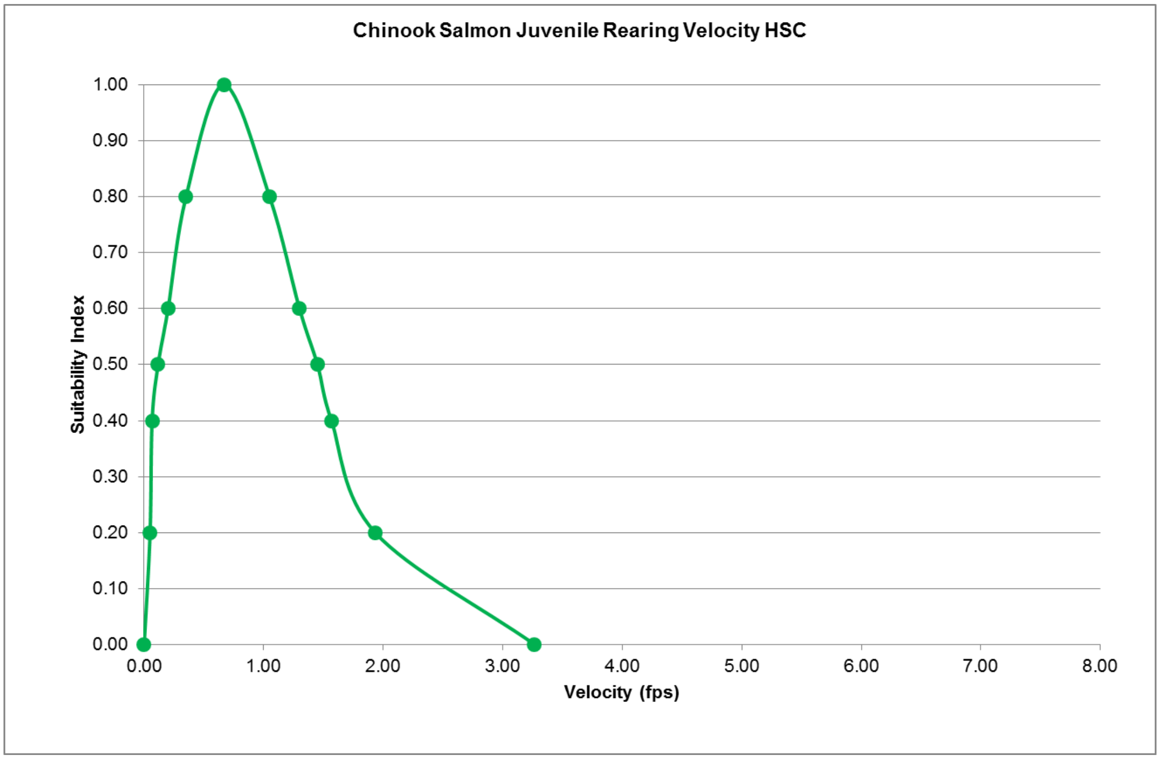


Table 3.3-14. Velocity and Suitability Index Values for Chinook Salmon Juvenile Rearing Velocity HSC

Suitability Index	Velocity (fps)
0.00	0.00
0.20	0.05
0.40	0.07
0.50	0.12
0.60	0.20
0.80	0.35
1.00	0.67
0.80	1.05
0.60	1.30
0.50	1.45
0.40	1.57
0.20	1.93
0.00	3.27

Figure 3.3-14. Chinook Salmon Juvenile Rearing Velocity HSC



3.3.9.2 Water Temperature

Water temperature HSC were developed for fry and juvenile fall-run Chinook salmon rearing using the same methodology previously discussed for fry and juvenile steelhead. The water temperature values selected to develop the fall-run Chinook salmon fry and juvenile water temperature HSC are described below.

In the Central Valley, water temperature is generally considered to be the most limiting factor for the fall-run Chinook salmon juvenile rearing lifestage, particularly during late-spring. The water temperature reported to allow for maximum growth of juvenile Central Valley Chinook salmon with maximal rations is 66.2°F (19°C) (Cech and Myrick 1999). Similar to results reported by Cech and Myrick (1999), Marine (1992) found that maximum growth rates of Sacramento River fall-run Chinook salmon were observed in juveniles reared at 17 to 20°C (62.6 to 68.0°F), with lower growth rates for juveniles reared at 21 to 24°C (69.8 to 75.2°F).

EPA (2003) identified constant water temperatures ranging from 13 to 20°C (55.4 to 68°F) for unlimited food conditions, and constant water temperatures ranging from 10 to 16°C (50 to 60.8°F) for limited food conditions to provide for optimal growth rates of juvenile salmonids in general.

Myrick and Cech (2001) report that a study on fall-run Chinook salmon from the Nimbus Hatchery (Rich 1987) addressed the widest water temperature range out of similar studies in the Central Valley. Rich (1987) reported a maximum growth rate of 2.8 percent weight/day at 13.2°C (55.8°F), 14.1°C (57.4°F) and 15.3°C (59.5°F), with reduced growth rates at temperatures above 15.3°C (that is, 2.4 percent weight/day at 19°C (66.2°F) and 2.0 percent weight/day at 21°C (69.8°F)). However, Myrick and Cech (2001) report that fish were exposed to fluctuations in water quality, particularly dissolved oxygen levels, as well as pathogens, which may have resulted in reduced growth rates compared to under more suitable conditions.

Brett et al. (1982) determined that water temperatures of 18.9–20.5 °C (66 to 68.9°F) were optimal for juvenile Chinook salmon from the Big Qualicum and Nechako Rivers fed to satiation, which is consistent with the 19°C (66.2°F) identified as optimal by Cech and Myrick (1999). However, when juvenile Chinook salmon were fed at 60 percent of satiation, Brett et al. (1982) identified an optimal growth temperature of 15°C (59°F), and suggested that a temperature of 20°C (68°F) would allow for about 50 percent of maximum growth capacity, and no growth at 21.4°C (70.5°F).

A separate laboratory study conducted on juvenile Chinook salmon from the Nechako River (Shelbourn et al. 1995, as cited in Myrick and Cech 2001) evaluated growth rates associated with rations of 60 percent, 80 percent, and 100 percent at water temperatures varying between 10.2°C and 18.9°C. The maximum growth rate at both the 80 percent and 100 percent consumption rates occurred at 18.8°C (65.8°F), while the maximum growth rate at the 60 percent consumption rate occurred at 12.6°C (54.7°F).

Marine and Cech (2004) conducted a laboratory study with hatchery Sacramento River fall-run Chinook salmon fry on water temperature effects on growth, saltwater adaptation and predation avoidance, while providing rations estimated to approximate natural conditions (that is, 60 to 80 percent). Growth of the juveniles reared at 21 to 24°C (69.8 to 75.2°F) was statistically significantly lower than growth of the juveniles reared at water temperatures of 13 to 16°C (55.4 to 60.8°F) and 17 to 20°C (62.6 to 68°F). The average weights of juveniles per water temperature treatment were very similar among all three treatments from the start of the study on February 13 through early May. Juveniles in the 13 to 16°C and 17 to 20°C treatments continued to have a very similar average weight through early June, but the fish in the 17 to 20°C treatment exhibited an increased average weight during the last sample when the study completed in late June. Marine and Cech (2004) note that the similar growth performance of juvenile Chinook salmon reared in water temperatures up to

20°C may suggest that juvenile Sacramento River Chinook salmon are able to maintain growth rates at slightly higher temperatures than more northerly stocks, which is consistent with results reported for at least one other Central Valley fall-run Chinook salmon population (Myrick and Cech 2002, as cited in Marine and Cech 2004).

Overall, based on water temperature effects on growth, saltwater adaptation, and predation avoidance, Marine and Cech (2004) found that juveniles reared at water temperatures of 20°C (68°F) or greater experienced decrease growth, altered smolt physiology, and increased predation vulnerability compared with juveniles reared at water temperatures considered to be near optimal (13 to 16°C; ~55.4 to 60.8°F). Based on Marine and Cech (2004) and Boles et al. (1988), NMFS (2016) stated that optimal water temperatures for both Chinook salmon fry and juveniles range from 12 to 16°C (~54 to 61°F).

Based on a review of various water temperature studies, Bratovich et al. (2012) selected 61°F as the Chinook salmon juvenile rearing and downstream movement upper optimal WTI value to be applied in an evaluation of the reintroduction of spring-run Chinook salmon to the upper Yuba River Watershed.

Although water temperatures in the study area are not expected to approach thermal minima, juvenile Chinook salmon have been found to tolerate water temperatures as low as 0.8°C (33.4°F) depending on acclimation temperature (Myrick and Cech 2001). Based on several studies across geographic regions, the UILT for juvenile Chinook salmon is reported to be 75-77°F (Myrick and Cech 2001).

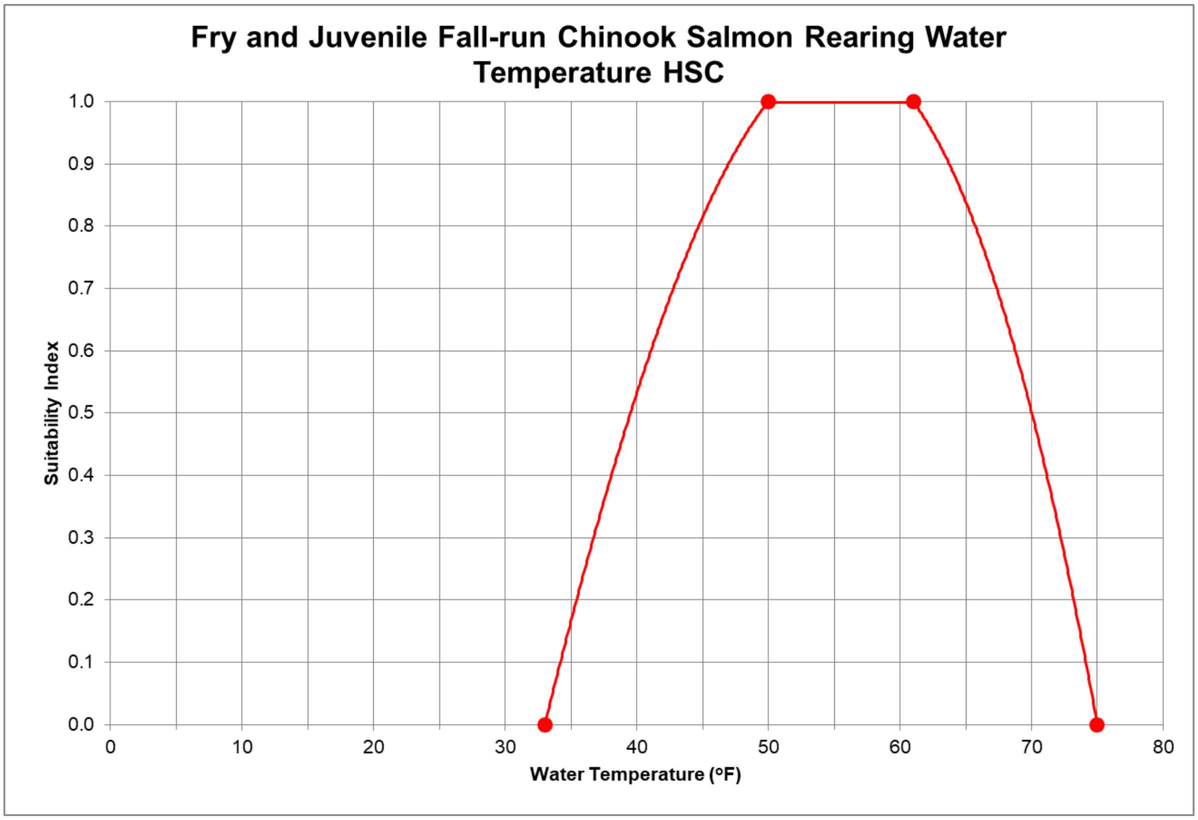
Based on the above information, an optimal growth water temperature range for fry and juvenile Chinook salmon was identified for this evaluation as 50 to 61°F, and survivable water temperatures were identified as 33 to 75°F. The resulting water temperature HSC is presented in Figure 3.3-15.

The lower limit of optimal growth value of 50°F was selected based on EPA (2003). The upper limit of optimal growth value of 61°F was selected based primarily on the results of the laboratory study conducted by Marine and Cech (2004), because it was conducted on Central Valley fall-run Chinook salmon, and addressed growth, as well as saltwater adaptation and predator avoidance during the Central Valley fall-run Chinook salmon fry rearing and emigration period.

The lower survival value of 33°F was based on the thermal minima identified for juvenile Chinook salmon across studies presented by Myrick and Cech (2001), and the upper survival value of 75°F was based on the lower end of the range of UILTs reviewed by Myrick and Cech (2001) for Chinook salmon.

Modified from Bovee et al. (1998), the suitability index was developed by fitting a third order polynomial function to the lower survivable temperature value (33°F), lower optimal growth temperature value (50°F), upper optimal growth temperature value (61°F), and the upper survivable temperature value (75°F). The polynomial function is applied to daily water temperatures when water temperature is between 33 and 50°F (exclusive) and when water temperatures are between 61 and 75°F (exclusive). When water temperatures are between 50 and 61°F (inclusive), an HSI of 1.0 is applied; when water temperatures are less than or equal to 33°F, or greater than or equal to 75°F, an HSI of 0.0 is applied. As shown in Figure 3.3-15, as water temperature increases or decreases farther from the optimal range, suitability values decrease at a greater rate. This relationship is consistent with previously-developed relationships between water temperature and growth rate for various coldwater fish species, including anadromous salmonids (for example, see Figure 5 in Bratovich et al. 2012; Figure 2.3 in Sullivan et al. 2000; Figure 1 in Brett et al. 1982; Figure G.4 in Myrick and Cech 2001; Figure 2 in McCullough et al. 2001).

Figure 3.3-15. Fry and Juvenile Fall-run Chinook Salmon Rearing Water Temperature HSC



3.3.9.3 Cover

Juvenile Chinook salmon use water depth (deep, low-velocity pools and bank eddies), surface turbulence, instream structures, and substrate as cover, with substrate being a primary source of escape and winter cover (see Raleigh et al. 1986 and references therein). Juvenile Chinook salmon reportedly inhabit primarily pools and stream margins, particularly near undercut banks, woody debris, and other areas with cover and reduced water velocity (Lister and Genoe 1970; Bjornn and Reiser 1991). Based on the available data in the study area, the areal percent of a habitat unit with cover was used to define cover suitability for fry and juvenile Chinook salmon.

For the purposes of this assessment, cover is defined to include all categories of cover per the CDFW Stream Restoration Manual (Flosi et al. 2010). Raleigh et al. (1986) assigned a cover area of equal to or greater than 20 percent as measured during the late growing season (that is, low-flow period) to an HSI of 1.0 for juvenile Chinook salmon.

Based on the above information, the percent of area with cover HSC developed by Raleigh et al. (1986) are applied to fall-run Chinook salmon fry and juvenile rearing during the spring and early summer months (within a habitat unit, an area with greater than 20 percent cover has an HSI of 1 with a linear relationship between 0 percent cover [HSI = 0] and 20 percent cover),

Given the somewhat differing habitat preferences of juvenile Chinook salmon during the winter relative to the remainder of the year, separate cover HSC are applied during the winter months (that is, January through March). Based on review of available studies of juvenile salmonid habitat preferences during the winter, Cramer and Ackerman (2009) concluded that steelhead and Chinook salmon fry have a strong tendency to enter interstitial space among cobble and boulder substrates. However, studies in some streams suggest that Chinook salmon fry may use a greater diversity of cover types than steelhead during high flow conditions. For example, results of four years of snorkel surveys in the Stanislaus River indicate that Chinook salmon fry were consistently most abundant along margins with vegetative cover (FISHBIO and Normandeau Associates 2012). During relatively high flows, margins of the Stanislaus River are dominated by deep, vegetated habitats with slow current, which were found to provide suitable fry habitat (based on high relative index densities of Chinook fry) (FISHBIO and Normandeau Associates 2012). Similar results were found for Chinook salmon fry habitat preference during high flows in the Klamath River (Hardy and Addley 2001).

Raleigh et al. (1986) developed winter cover HSC for YOY Chinook salmon based on the areal percent of cobbles and boulders, defined by a size class of 10 to 40 cm (~4-15 inches). An area comprised of cobbles and boulders equal to or greater than 15 percent of the stream was assumed to be adequate. In a comprehensive review of HSC for salmonids, Cramer (2001) found that the cobble/boulder HSC for winter habitat specified in Raleigh et al. (1986) for Chinook salmon appeared to be reasonable. However, during periods of high flow, juvenile Chinook salmon in the central coast region select habitats with reduced water velocity associated with additional types of features besides large substrates, including undercut banks, side channels, and deep pools formed by rootwads and other large structures (NMFS 2016). Moreover, as described above, Chinook salmon fry have been observed in the Central Valley to also utilize vegetated habitats as cover during high flows. Therefore, additional cover components identified by Flosi et al. (2010) were considered to be potential winter cover for fry and juvenile Chinook salmon in this evaluation, including undercut bank, large woody debris (d>12 inches), root mass, and bedrock ledge.

Based on the above information, the percent of area with cobble (4 to 10-inch diameter) substrate, boulder (>10-inch diameter) substrate, undercut bank, large woody debris (d>12 inches), root mass, and bedrock ledge are applied to Chinook salmon fry and juveniles during the winter months. In other words, if a 10 percent or greater areal proportion of a habitat type in a reach contains the above-defined substrate and/or cover elements, an HSI of 1 is applied. If less than 10 percent of the area of a habitat type in a reach contains the above-specified substrate and cover elements, then an HSI of 0 is applied. Specifically, rearing cover HSC are applied to the weighted average percent of unit with the above-specified winter cover types by habitat type and reach.

3.3.10 Fall-run Chinook Salmon Juvenile Emigration

The suitability of fall-run Chinook salmon juvenile emigration conditions are evaluated using the same types of methodologies previously described for steelhead, but with the application of passage and migration criteria specific to Chinook salmon. For the purposes of this evaluation, it is assumed that juvenile fall-run Chinook salmon emigrate as YOY, consistent with generalizations for fall-run Chinook salmon in the Central Valley and the California coast (for example, Kimmerer and Brown 2006; Myers et al. 1998).

The suitability of Chinook salmon juvenile emigration conditions is first evaluated in terms of the daily frequency when juvenile passage conditions are suitable throughout the subject creek (that is, from the upstream-most POI in each creek downstream to the Bay) during a single day (that is, juvenile passage suitability frequency). The daily juvenile passage suitability frequency is calculated for each model year based on both simulated hydraulic variables and simulated water temperatures.

3.3.10.1 Juvenile Passage Suitability Frequency

Juvenile passage suitability is determined based on: (1) whether simulated mean daily flows provide sufficient thalweg depth (that is, 0.3 ft) at each POI to allow juvenile passage; (2) whether simulated mean daily flows correspond to passable flows based on critical riffle analyses conducted at each applicable POI; and (3) whether water temperatures are less than or equal to the selected WTI value for juvenile emigration at each POI.

Based on review of available literature (for example, CDFW 2013), a depth of 0.3 ft is applied as a binary criterion to daily modeled thalweg water depth at each POI during the Chinook salmon juvenile emigration period.

As previously described, the majority of Central Valley fall-run Chinook salmon generally emigrate from rivers in the Central Valley as fry. Based on water temperature effects on growth, saltwater adaptation, and predation avoidance, Marine and Cech (2004) found that juveniles reared at water temperatures of 20°C (68°F) or greater experienced decrease growth, altered smolt physiology, and increased predation vulnerability compared with juveniles reared at water temperatures considered to be near optimal (13 to 16°C; ~55.4 to 60.8°F). Bratovich et al. (2012) selected 61°F and 65°F as the Chinook salmon juvenile rearing and downstream movement upper optimal and upper tolerable WTI values, respectively.

The relative proportion of Chinook salmon that emigrate from the study area as fry and smolts is not known. Therefore, water temperature suitability for Chinook salmon smolts also was considered in this evaluation. Relative to steelhead, most literature indicates that Chinook salmon smolts encounter and smolt in higher water temperatures (Zedonis and Newcomb 1997; Bratovich et al. 2012). Based on evidence from hatchery, laboratory and natural experiment settings, water temperatures that support smoltification for fall-run Chinook salmon range from 10 to 20°C (50 to 68°F), with 10 to 17°C (~50 to 63°F) being more optimal (Zedonis and Newcomb 1997). Zedonis and Newcomb (1997) state that smoltification may become compromised at water temperatures above 17°C (~63°F). Bratovich et al. (2012) selected 63°F and 68°F as the Chinook salmon yearling+ smolt emigration upper optimal and upper tolerable WTI values, respectively.

Based on the above information, an upper tolerable water temperature value of 65°F is applied as a binary criterion to simulated daily water temperatures by POI during the Chinook salmon juvenile emigration period. This criterion was selected because it represents an upper tolerable value for Chinook salmon fry and juvenile downstream movement, while also being lower than the upper tolerable water temperature value for smolt emigration indicated by Bratovich et al. (2012) and similarly suggested by Zedonis and Newcomb (1997) (that is, 68°F). In addition, application of a single water temperature value to encompass both YOY and smolt emigration allows for a more simplified analysis of juvenile Chinook salmon emigration.

3.3.10.2 Juvenile Passage Events

The number of days of successful juvenile emigration required for juveniles to emigrate from the uppermost reach of each creek to the San Francisco Bay is estimated based on juvenile downstream migration rates. Because juvenile downstream migration rates are not available for the study area creeks, a literature review of migration rates was conducted for other areas.

Radio telemetry studies in the Willamette River (Oregon) found that the mean downstream migration rates for sub-yearling juvenile (primarily spring-run) Chinook salmon was about 8.6 km/day (5.3 mi/day) in 2001 (n=9), 7.3 km/day (4.5 mi/day) in 2002 (n=24), and 15.7 km/day (9.8 mi/day) in 2003 (ODFW 2003; Friesen et al. 2007).

Based on 10 years (2004-2013) of studies involving tagging about 125,000 juvenile Chinook salmon in the Willamette River, Schroeder et al. (2015) found that sub-yearling spring-run Chinook salmon migrated from Willamette Falls to the Columbia River Estuary at an average rate of 25.2 km/day (15.7 mi/day), and migrated at a rate of 11.7 km/day (7.3 mi/day) further upstream in the Willamette River.

Giorgi et al. (1997) calculated a mean downstream migration rate for age-0 Chinook salmon (n=1,332) in the Columbia River of 15.6 km/day (9.7 mi/day), ranging from 0.8 to 50.9 km/day (0.5 to 31.6 mi/day).

For juvenile fall-run Chinook salmon, the studies conducted by Schroeder et al. (2015) appeared to be the most comprehensive downstream migration data that included YOY juveniles. To minimize the potential for overestimating migration rates, the lower average downstream migration rate for the upstream reach in the Willamette River was applied (that is, 11.7 km/day; 7.3 mi/day).

The number of days estimated to be required for juvenile fall-run Chinook salmon to emigrate from the uppermost POI of each creek to the San Francisco Bay is calculated based on the estimated downstream migration rates and distances from the upstream POI in each creek to the Bay (Table 3.3-15).

Juvenile passage events are defined with respect to juveniles emigrating from the system (that is, the river or creek) on each day of the emigration period (that is, Feb 1 through June 30 for Chinook salmon). If successful juvenile passage conditions occur at each POI in the creek for the requisite number of consecutive days for juveniles to reach the Bay, then a passage event is identified for that daily emigration cohort. Therefore, each daily emigration cohort could have up to one successful passage event. The number of successful downstream passage events are then calculated for each year of the simulation period for each creek.

Table 3.3-15. Estimated Migration Durations for Juvenile Fall-run Chinook Salmon to Migrate from Uppermost POI of Each Creek to San Francisco Bay

Creek	POI	Migration Duration for Juvenile Chinook Salmon (days)
Guadalupe River	7	2.7
Los Gatos Creek	2	2.6
Guadalupe Creek	4	3.6
Alamitos Creek	4	3.8
Calero Creek	2	3.8

3.4 Composite Indices of Habitat Suitability

Composite daily indices of habitat suitability are simulated for spawning, embryo incubation-adjusted spawning, fry rearing, and juvenile rearing for the respective specified time periods of evaluation.

Several types of calculations have been used by investigators to develop composite habitat suitability indices for multiple habitat variables to develop a single habitat index, such as a product equation (or joint-suitability-factor method) (Bovee 1986), arithmetic mean (Bovee 1986), geometric mean (Waddle 2001), and the lowest suitability factor method (Waddle 2001), among others. Generally, use of the product equation assumes that fish select particular habitat variables independently of others and that each variable is equally important (Bovee 1986; Bovee et al. 1998). The use of an arithmetic mean assumes that suitable habitat conditions for one habitat attribute can compensate for poor conditions of another habitat attribute (Bovee 1986). The geometric mean method allows for more compensatory relations among habitat variables compared to using an arithmetic mean. By contrast to the arithmetic mean and geometric mean methods, the lowest suitability factor method (or limiting factor model) uses the HSI with the lowest value as the composite index, which assumes that all variables have a substantial effect on the evaluated lifestage, such that high HSI values for one or more attributes cannot compensate for a low suitability rating of another attribute (Waddle 2001).

Based on discussions with the TWG during 2016, the geometric mean method is applied to develop CHSI for spawning, fry and juvenile rearing, as identified for juvenile rearing, below.

> Juvenile Rearing CHSI = $(HSI_{depth} * HSI_{velocity} * HSI_{temperature} * HSI_{cover})^{1/n}$
> *where* HSI_n is the suitability index value for variable *n*, and n is the number of input variables (for example, 4).

Because hydraulic variables are modeled for a given habitat type in a given reach, lifestage-specific composite indices of habitat suitability are calculated for each modeled habitat type within each modeled reach.

Additional discussion of the methodologies used to develop each lifestage-specific composite index is described below.

3.4.1 Spawning

The CHSI for spawning is calculated on a daily basis during the specified steelhead spawning period for each habitat type (for example, pool, riffle, and run) in each reach of a given creek. The composite index is calculated first by calculating the geometric mean of the HSI for depth and velocity. As previously mentioned, depth and velocity HSI are each based on the application of a single set of HSC in the form of continuous functions. Next, a substrate suitability HSI is calculated based on the product of the embeddedness HSI and the weighted average percent of unit with suitably-sized substrate. The product method is applied to composite the embeddedness HSI and the weighted average percent of unit with suitably-sized substrate because the resulting composite incorporates a proportional area. Finally, the product of the substrate suitability HSI and the geometric mean of the depth and velocity HSI is calculated to identify the spawning CHSI for a habitat type and reach on a given day. An overview of the spawning CHSI calculation procedures is provided in Figure 3.4-1.

3.4.2 Incubation

The CHSI for incubation is calculated on a daily basis during the forecasted incubation period for a daily spawning cohort for each habitat type (for example, pool, riffle, and run) in each reach of a given creek. The composite index is calculated based on the binary application of both depth and water temperature to each day of a forecasted incubation period. An overview of the incubation CHSI calculation procedures is provided in Figure 3.4-2.

Figure 3.4-1. Spawning CHSI Calculation Procedures

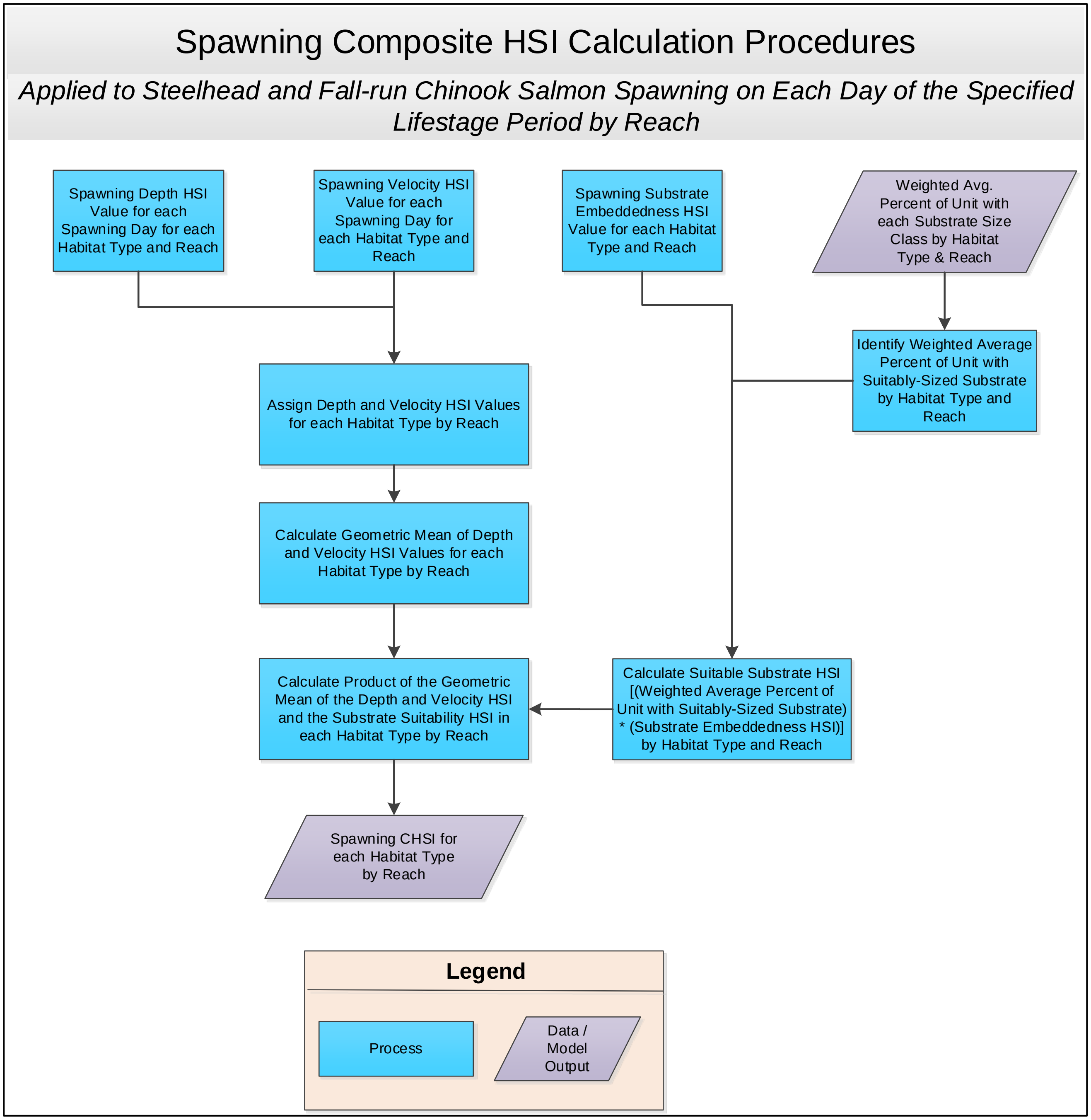
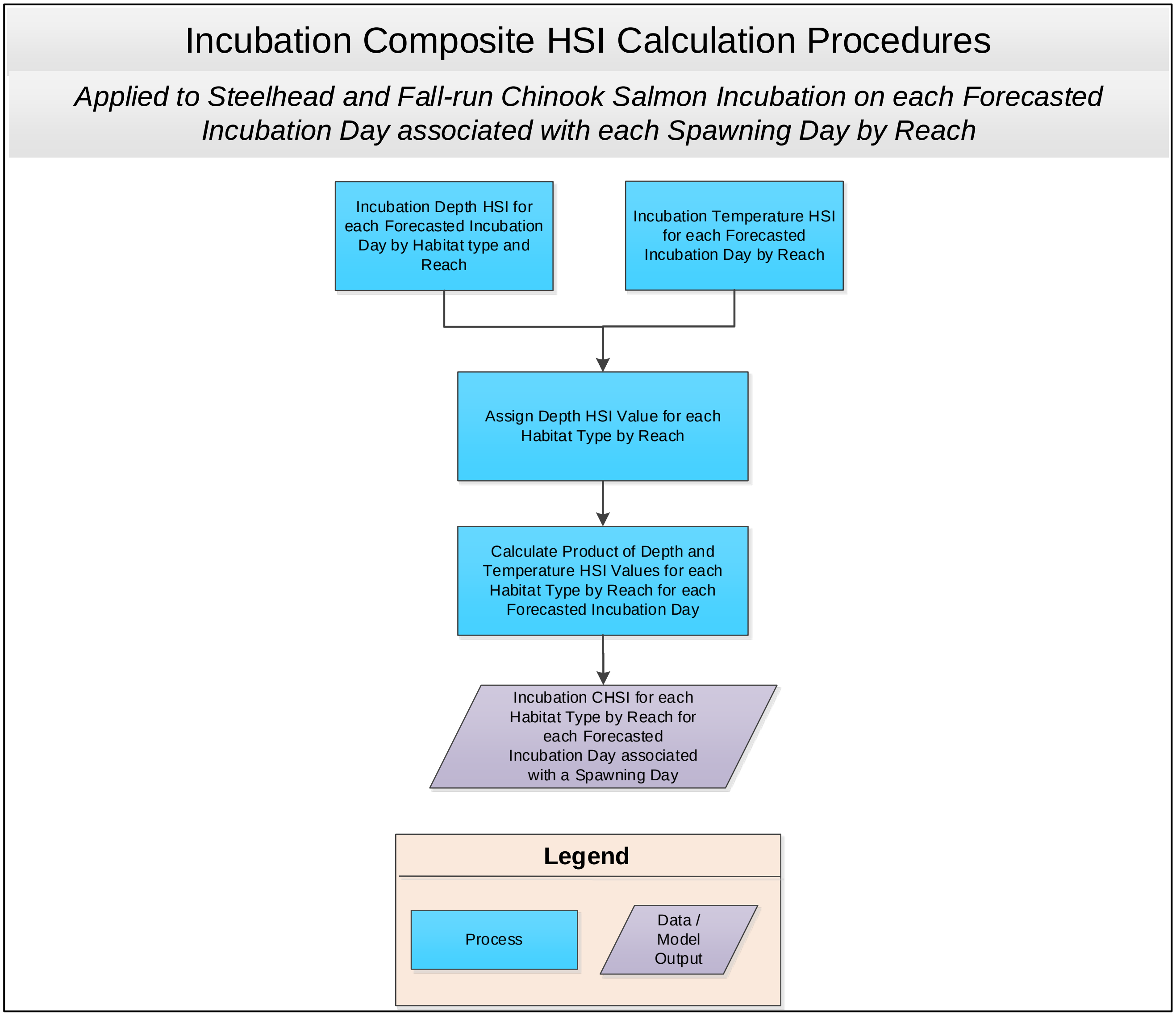


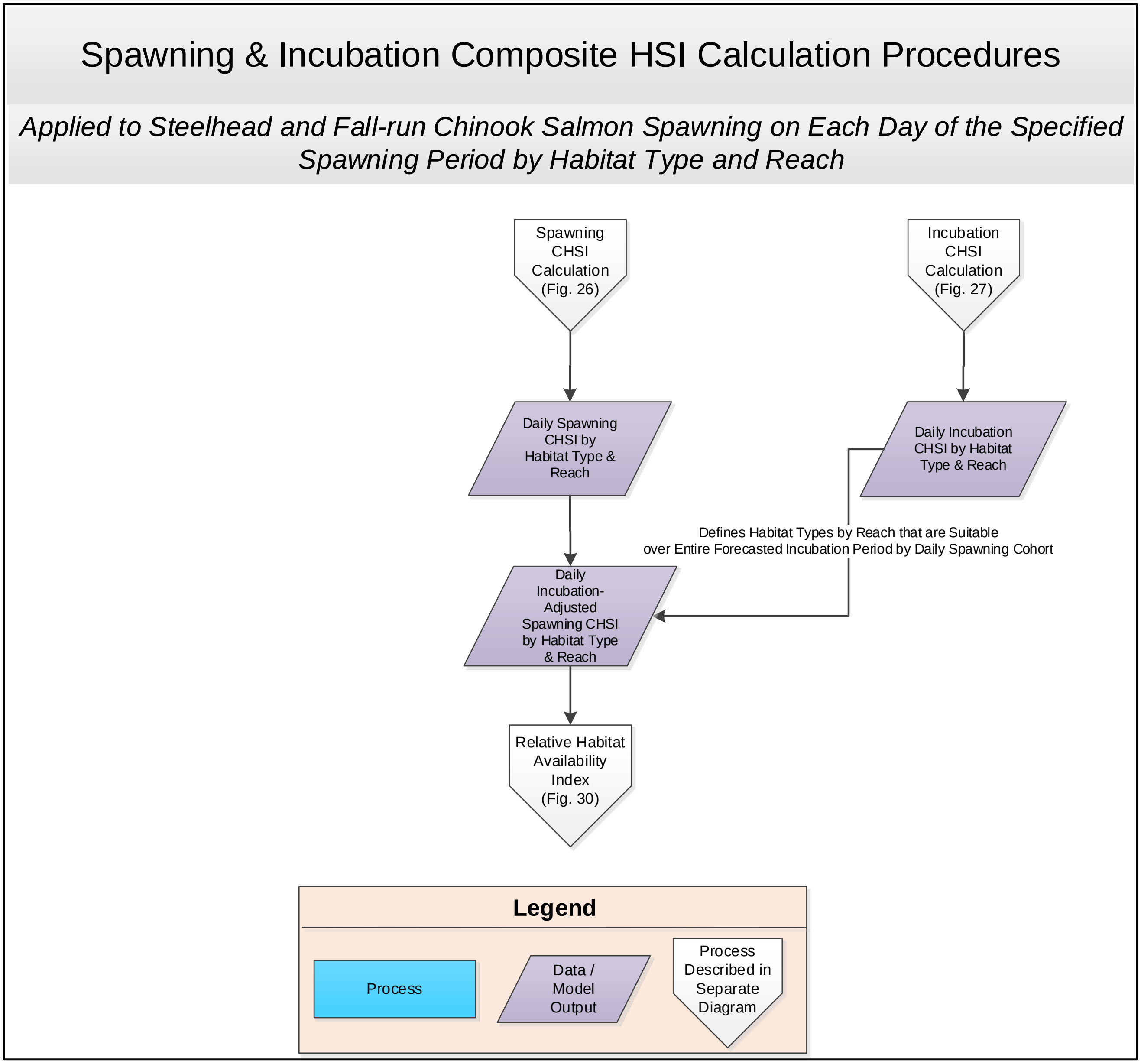
Figure 3.4-2. Incubation CHSI Calculation Procedures



3.4.2.1 Spawning and Incubation Habitat

After the spawning and incubation CHSIs are calculated for a given day, additional steps are performed to refine the spawning CHSI in consideration of the incubation HSI (Figure 3.4-3). In other words, the suitability of embryo incubation conditions, as determined by sufficient water depth and suitable water temperatures throughout the estimated embryo incubation period for each daily spawning cohort, is used to scale the daily spawning CHSI to calculate the daily incubation-adjusted spawning CHSI.

Figure 3.4-3. Incubation-adjusted Spawning CHSI Calculation Procedures

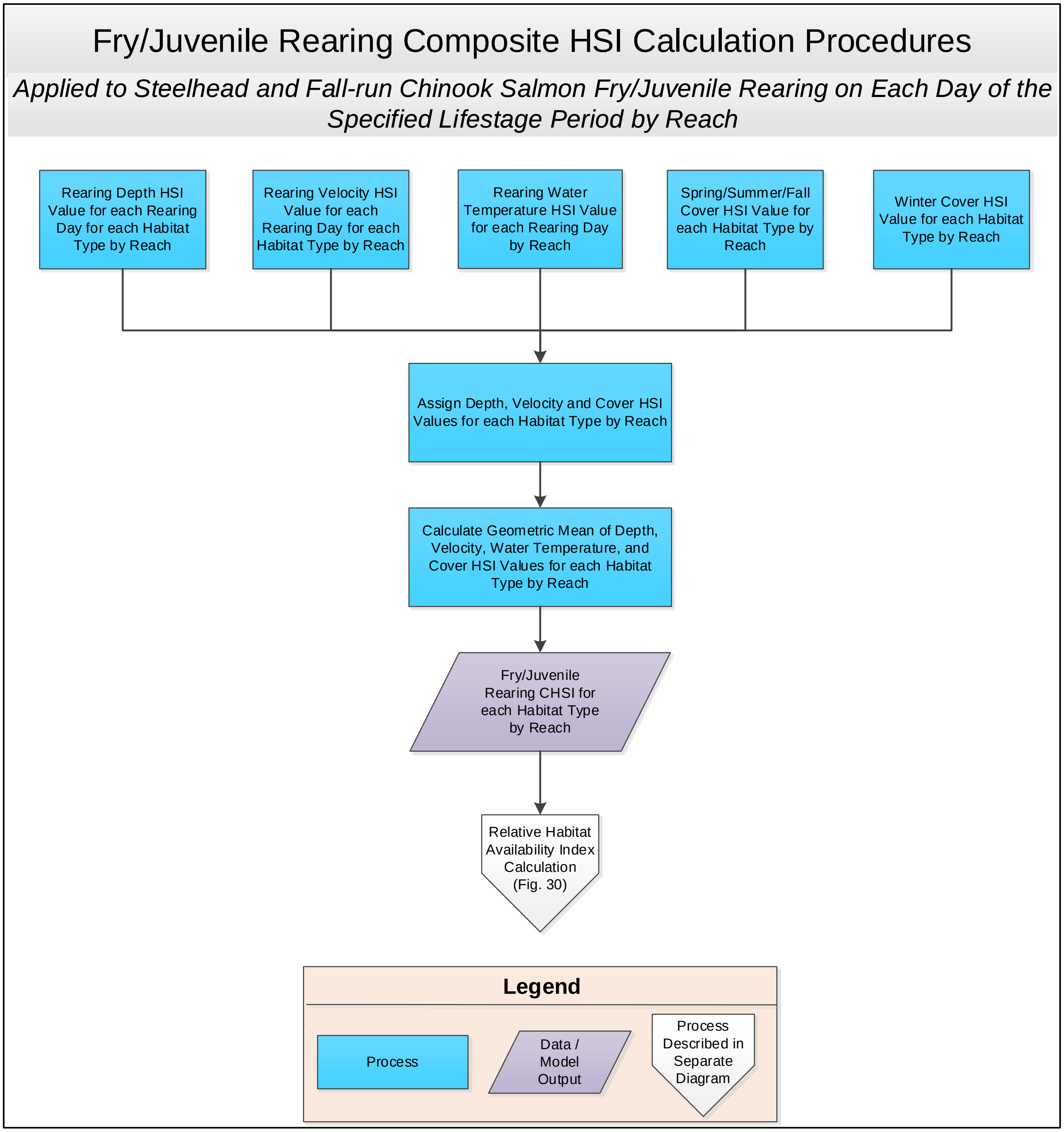


3.4.3 Fry and Juvenile Rearing

The CHSI for fry rearing is calculated on a daily basis during the specified fry rearing period for each habitat type in each reach of a given creek. The CHSI is calculated based on the geometric mean of the HSIs for depth, velocity, water temperature, and cover. The depth, velocity, water temperature, and cover HSIs are each based on the application of HSC in the form of continuous functions.

The juvenile rearing CHSI uses the same methodology as described for fry rearing, but includes the application of different sets of HSC specific to juveniles for depth and velocity during the juvenile rearing different time period. An overview of the fry and juvenile rearing CHSI calculation procedures is provided in Figure 3.4-4.

Figure 3.4-4. Fry/Juvenile Rearing CHSI Calculation Procedures



3.5 Habitat Availability Indices

For evaluation of model scenarios, indices of habitat availability (for example, often referred to as weighted usable area) for spawning, incubation-adjusted spawning, fry rearing and juvenile rearing are estimated based on the CHSI and estimated stream area. Figure 3.5-1 provides the overview of the calculation of the relative habitat availability index.

Specifically, daily indices of habitat availability (in terms of area) for spawning, incubation-adjusted spawning, fry rearing, and juvenile rearing are calculated based on the product of the CHSI and associated estimated area for each reach, as described below.

First, habitat type proportions calculated for the 2016 habitat sampling reaches were used to determine the habitat type proportions in each geomorphic reach identified by Entrix (2000). Because the flow, hydraulic, water temperature, and habitat availability estimation modeling is carried out by POI reach, the habitat type proportions by geomorphic reach were converted to habitat type proportions by POI reach based on the proportion of each geomorphic reach within each POI reach (see SEI 2017). The area of each habitat type in a (POI) reach is assumed to be the product of the modeled wetted area of a reach and the habitat type proportion for that reach. However, because the width of the channel used to estimate spawning habitat availability should not extend past the typical area of spawning substrate, the wetted width is constrained to the average measured active channel width (see Figure 3.5-2) for that habitat type. The estimated length of a habitat type in a reach is multiplied by the modeled wetted width of that habitat type on a daily basis to calculate the area of that habitat type in a reach. The CHSI calculated for a habitat type in a reach is then multiplied by the area of that habitat type in the reach to calculate the habitat availability index for a habitat type in a (POI) reach. The habitat availability indices for each habitat type in a reach are summed for each reach, and are subsequently summed for the TWG-specified spawning or rearing reaches within the entire creek, resulting in a creek-wide habitat availability index for a given day.

Figure 3.5-1. Habitat Availability Index Calculation Procedures

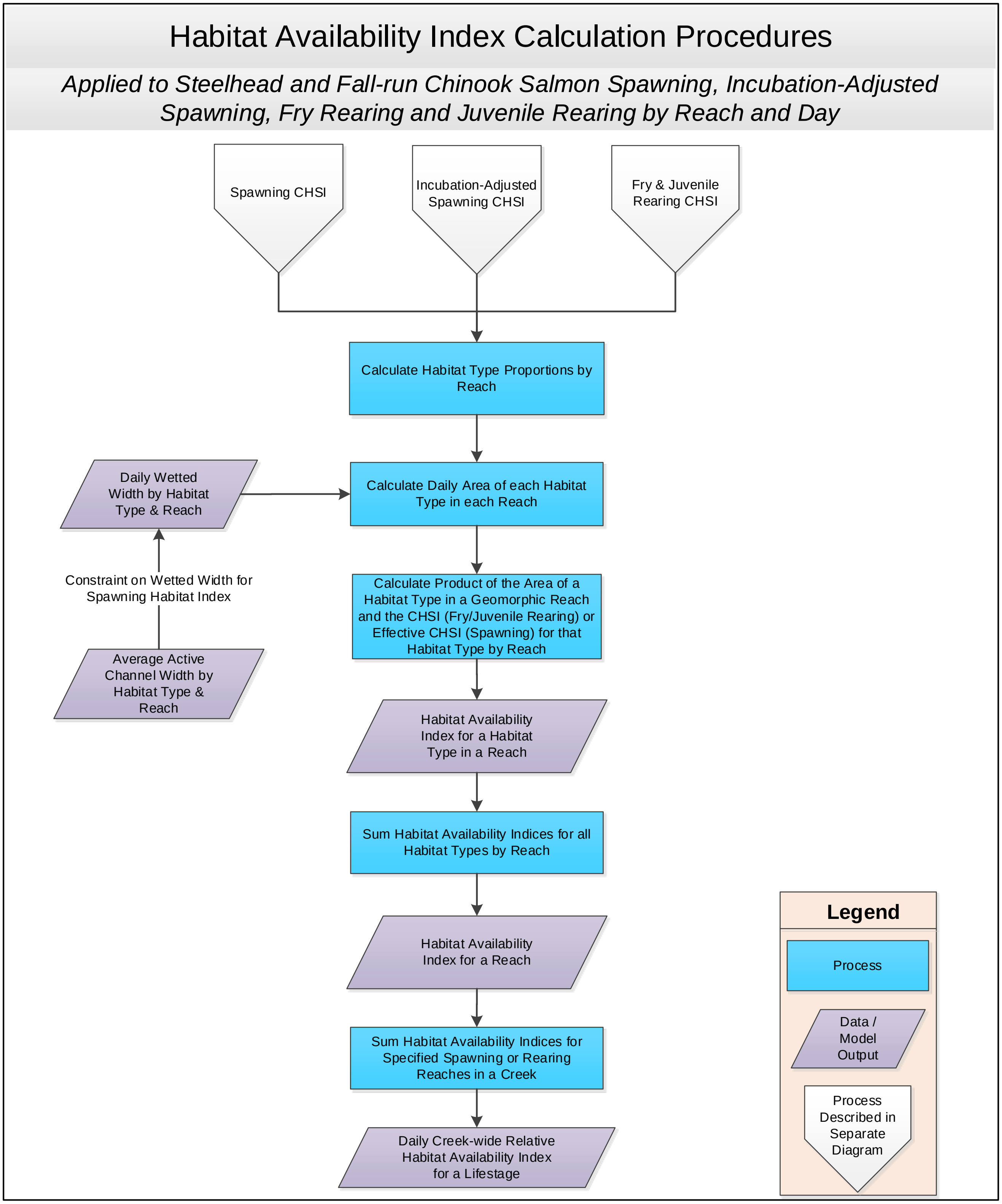


Figure 3.5-2. Example of An Active Channel

Source: Taylor and Love 2004, in Flosi et al. 2010.

The habitat availability index is effectively assuming that the suitable area of habitat for a lifestage is directly proportional to the CHSI for that lifestage. Specifically, it assumes that the area of the stream that is suitable increases or decreases in proportion to an increase or decrease in the CHSI between 0 and 1. For example, if a stream area is 100 ft^2 and the associated CHSI is 0.5, the habitat availability index would be 50 $ft^{2.}$ In other words, the area of potential habitat (that is, the area of stream) is reduced according to the CHSI, or the proportion of assumed optimal habitat suitability (that is, 100 ft^2 * 0.5).

Although habitat availability indices are estimated in terms of area, they should only be considered indices of habitat availability and should only be used as approximations, given various assumptions and considerations, including, among others: (1) simulated depth, velocity, and wetted width at one transect within a habitat unit are assumed to be representative of hydraulic conditions in the entire habitat unit; (2) simulated depth, velocity, and wetted width at one transect within a habitat type are assumed to be representative of hydraulic conditions in all habitat units of that habitat type within a specified reach; (3) structural habitat data and habitat type proportions are applied based on conditions observed at a subset of habitat units; (4) composite suitability indices are calculated using HSC from watersheds outside of the study area; and (5) calculating a habitat index based on the product of a composite suitability index and area results in a unit-less metric (Payne 2003).

4 Synthesis and Comparison of Results

The resulting daily spawning, incubation-adjusted spawning, fry rearing, and juvenile rearing habitat availability indices, adult passage extent and passage events, and the juvenile passage index and juvenile passage events described in the preceding sections are compiled over the respective periods of evaluation. The results are then compared for each alternative, including the Proposed Project, relative to the baseline conditions, using annual-time series figures, probability of exceedance figures, and average monthly values. The detailed results of the analyses based on these methodologies are presented in Appendix O of the FAHCE EIR.

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Personal Communications

Abel, J. June 24, 2016. Email from Jae Abel, Valley Water to Adrian Pitts, HDR. RE: FAHCE Technical Working Group Action Item Request.

M. Leicester and T. Schane. June 23, 2016. Email from Tami Schane, CDFW to Holly Kennedy, HDR. Comments on Draft Lifestage timing table.

Appendix N – Fisheries Habitat Availability Estimation Methodology

Attachment A – FAHCE Entrix Inc. Report: Habitat Data Verification Project, Workplan

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WORKPLAN

Purpose of this work

The Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) Technical Workgroup (TWG) is developing a model with habitat simulation necessary to analyze the biological impacts of the reservoir reoperation rule curves for Stevens Creek, the Guadalupe River, Guadalupe Creek, Alamitos Creek, Calero Creek, and Coyote Creek specified by the FAHCE Settlement Agreement. The analysis supports preparation of a Program Environmental Impact Report evaluating the FAHCE Fish Habitat Restoration Plan.

In 1999, Entrix, Inc., conducted a habitat typing study (Entrix 2000) for the FAHCE program that served as a key data set used to develop the fish restoration measures specified in Article 6 of draft Settlement Agreement. While the data provide useful information regarding the stream conditions in 1999; the issue is whether the TWG can rely on these data as the basis for modeling existing habitat.

Repeating the Entrix survey for all the streams would greatly extend the schedule and costs for completing the FAHCE Modeling Study Plan (Appendix G). The District proposed verifying the Entrix data through random sampling of 5% of the study area. The Technical Workgroup agreed that if the Entrix data could be verified then its use in the habitat simulation and impact analysis would be acceptable.

Structure of the work plan.

SECTION 1	OBJECTIVES
SECTION 2	SELECTION OF SAMPLING SITES
SECTION 3	SAMPLING METHODOLOGY
SECTION 4	STAFF PROJECT ROLES
SECTION 5	REFERENCES
APPENDIX A	SAFETY PLAN
APPENDIX B	SITE MAPS
APPENDIX C	STAFF SCHEDULE
APPENDIX D	DATA COLLECTION FORMS
APPENDIX E	FIGURES DEPICTING BANKFULL AND ACTIVE CHANNELS
APPENDIX F	AQUATIC INVASIVE SPECIES DECONTAMINATION PROTOCOL
APPENDIX G	BASIS FOR THE HABITAT VALIDATION METHODOLOGY
APPENDIX H	ROSGEN CLASSIFICATION
APPENDIX I	HABITAT INVENTORY TRAINING

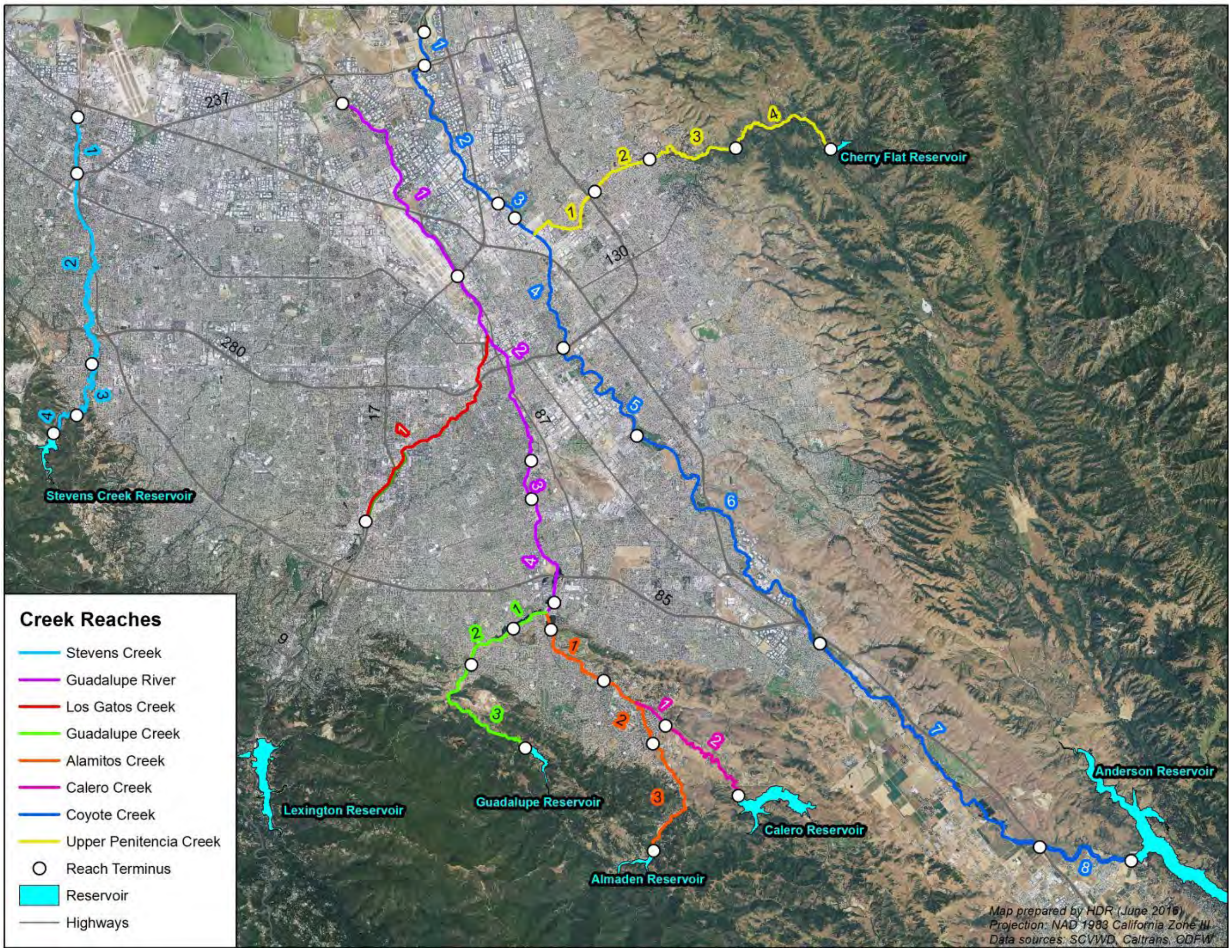
1. Objectives

The goal of this work is to test the validity and application of the 1999 Entrix data to establish the amount of available habitat under current conditions. The methodology is intended to statistically demonstrate that the larger data set can be used with a measurable degree of certainty in the biological impact analysis. Specific objectives of this workplan are to:

- Replicate the methodology to sample a subset of the habitat units surveyed in 1999 to evaluate changes in the streams.

- Validate the 1999 data so it may be used as a baseline for future monitoring of the physical habitat.

If the 1999 data eludes validation under current conditions, this new data would replace it.



Map prepared by HDR (June 2016)
Projection: NAD 1983 California Zone III
Data sources: SCVWD, Caltrans, CDFW

Figure 1 Creek reach delineations based on geomorphic reaches identified by Entrix (2000).

2. Selection of Sampling Sites.

The length of each sampling site will be derived based on California Rapid Assessment Method (CRAM) procedures described in the user manual for monitoring wetlands and riparian areas (CWMW 2013). Sampling site length will be 10x the average bankfull channel width for each stream; maximum reach length is 200 m (656 ft); minimum reach length is 100 m (328 ft). Sample locations will be identified for each geomorphic reach delineated by Entrix (1999) based on a random sampling of sample sites such that the total length of habitat units surveyed (based on 1999 habitat inventory data) cover at least 5% of the reach (with the exception of the reaches described in APPENDIX G). Random sampling sites were generated with the random number generating function in MS Excel based on the total length of each creek. Details on sampling spatial extent, site selection, and reach sampling rates are located in APPENDIX G.

3. Sampling Methodology

Fish habitat data methodology is described below based on the methods of Flosi (2010) except where modified by Entrix (1999) (described in section 3.1). Habitat data collected at each surveyed habitat unit include the following.

a) Habitat unit type
b) Habitat unit location
c) Habitat unit photograph
d) Length of habitat unit
e) Mean width of habitat unit (Bankfull, active channel, wetted channel)
f) Length of pool tail-out
g) Depth of pool tail crest
h) Mean depth of habitat unit
i) Maximum depth of pool units
j) Area of habitat unit with instream shelter/cover & shelter value
k) Areal proportion of cover by cover type
l) Percent canopy cover
m) Substrate size composition of cobble substrate (entire unit and pool tail-out)
n) Embeddeness of small cobble (entire unit and pool tail-out)
o) Pool tail substrate size
p) LWD count
q) Bank composition
r) Bank Vegetation (% covered and dominant vegetation)

Each sampling site will be classified by channel type according to Rosgen (1996). The Rosgen (1996) classification is provided in Appendix H. Per the sample form, the time of first and last sample, water temperature, air temperature, turbidity, conductivity, and dissolved oxygen will be recorded.

3.1. Training

Crew leads will be trained in the Flosi methodology by NMFS while habitat typing Porter Creek, NMFS is attempting verify the validity of an older data set on this creek. Supporting field crew personnel will be trained by crew leads. A copy of Part III Habitat Inventory Methods, Flosi (2010) and Rosgen (1996) channel type classification will be provided and adhered to by all sampling participants as part of the training. This material will be carried by each team for reference.

3.2 Permitting

The work being conducted under this plan will have no physical impact on the environment and no handling of aquatic organisms will occur. Therefore, this work does not fall under the jurisdiction of any regulatory agency and is not subject to regulatory permits.

3.3 Field Data Collection Protocols

Staff will be divided into teams of two with at least one field lead per crew. Daily sampling efforts will be conducted by one to three crews. Prior to deployment crews will coordinate reaches to be sampled, and all necessary sampling gear will be provided. Four-wheel drive vehicles will be secured through the motor pool to access staging site. All distance and depths will be measured in feet to the nearest tenth of a foot. Data will be collected following the protocols described below, modified from Flosi (2010), Entrix (1996), and Rosgen (1996).

a) Habitat unit type

CDFG Level IV habitat unit types will be identified, as described in Flosi (2010). The minimum length of a habitat unit is equal to the width of the wetted stream channel.

RIFFLE		
Low Gradient Riffle	(LGR)	[1.1]
High Gradient Riffle	(HGR)	[1.2]
CASCADE		
Cascade	(CAS)	[2.1]
Bedrock Sheet	(BRS)	[2.2]
FLATWATER		
Pocket Water	(POW)	[3.1]
Glide	(GLD)	[3.2]
Run	(RUN)	[3.3]
Step Run	(SRN)	[3.4]
Edgewater	(EDW)	[3.5]
MAIN CHANNEL POOL		
Trench Pool	(TRP)	[4.1]
Mid-Channel Pool	(MCP)	[4.2]
Channel Confluence Pool	(CCP)	[4.3]
Step Pool	(STP)	[4.4]
SCOUR POOL		
Corner Pool	(CRP)	[5.1]
L. Scour Pool - Log Enhanced	(LSL)	[5.2]
L. Scour Pool - Root Wad Enhanced	(LSR)	[5.3]
L. Scour Pool - Bedrock Formed	(LSBk)	[5.4]
L. Scour Pool - Boulder Formed	(LSBo)	[5.5]
Plunge Pool (PLP) [5.6] {9}		
BACKWATER POOLS		
Secondary Channel Pool	(SCP)	[6.1]
Backwater Pool - Boulder Formed	(BPB)	[6.2]
Backwater Pool - Root Wad Formed	(BPR)	[6.3]

Backwater Pool - Log Formed	(BPL)	[6.4]
Dammed Pool	(DPL)	[6.5]
ADDITIONAL UNIT DESIGNATIONS		
Dry	(DRY)	[7.0]
Culvert	(CUL)	[8.0]
Not Surveyed	(NS)	[9.0]
Not Surveyed due to a marsh	(MAR)	[9.1]

b) Habitat unit type location

For each sampling site GPS coordinates will be recorded at the downstream end of each habitat unit. Coordinates will be recorded for the upstream end of the last habitat unit in the sampled reach.

c) Habitat unit photographs

Four photographs will be taken of each habitat unit within the sampling site; upstream end of a unit looking downstream, downstream looking upstream, left bank, and right bank. Additional photos of the substrate will be taken; these include a stadia rod placed horizontally for scale.

d) Length of habitat unit

Length of habitat unit will be measured along the thalweg. The thalweg is defined as line that connects the lowest points in a stream channel.

e) Mean width of habitat unit (wetted channel, bankfull, and active channel)

This is modified from Flosi (2010) to include active channel and bankfull for the purpose of potential carrying capacity estimation. Mean width of habitat unit will be determined for the wetted channel, bankfull, and for the active channel, based on the average of two transects. Wetted channel is defined as the width of the wetted stream at the time of the survey..

Bankfull is defined as the elevation point of incipient flooding, indicated by deposits of sand or silt at the active scour mark, break in Stream bank slope, and perennial vegetation limit..

The **active channel**, as described in Flosi (2010) Volume 2, part IX Figures IX-3 and IX-4 (APPENDIX E), is the elevation delineating the highest water level that has been maintained for a sufficient period of time to leave evidence on the landscape (relatively free of vegetation; conveys most of the water and sediment during high flow).

f) Length of pool tail-out

The pool tail out is defined as a distinct break in streambed slope occurring downstream from a pool. Length of pool tail-out will be measured at each pool from the distinct break in slope to the tail-out crest. In addition to Flosi (2010), for the purposes of potential carrying capacity estimation

g) Depth of pool tail crest

Maximum depth of thalweg at pool tail crest, taken only in pool habitat units to determine a pool's residual volume.

h) Mean depth of each habitat unit

Mean depth of habitat unit in feet will be determined by taking four equally spaced depth measurements along the thalweg of the habitat unit. This will be used to determine pool volume of the habitat unit.

i) Maximum depth of pool units

Maximum depth in feet will be recorded in pool habitat units. Modified from Flosi (2010) to follow Entrix (2000), measuring max depth of pool units only.

j) Area of stream with canopy cover

The percent of stream area shaded by tree canopy will be estimated using a spherical densiometer at the upstream end of the habitat unit in the center of the wetted channel.

k) Shelter Value

Enter the number code (0 to 3) that corresponds to the dominant structural shelter type that exists in the unit, see below.

Value	**Instream Shelter Complexity Value Examples:**
0	● No shelter.
1	● One to five boulders.
	● Bare undercut bank or bedrock ledge.
	● Single piece of large wood (>12" diameter and 6' long) defined as large woody debris (LWD).
2	● One or two pieces of LWD associated with any amount of small wood (<12" diameter) defined as small woody debris (SWD).
	● Six or more boulders per 50 feet.
	● Stable undercut bank with root mass, and less than 12" undercut.
	● A single root wad lacking complexity.
	● Branches in or near the water.
	● Limited submersed vegetative fish cover.
	● Bubble curtain.
3	**Combinations of (must have at least two cover types):**
	● LWD/boulders/root wads.
	● Three or more pieces of LWD combined with SWD.
	● Three or more boulders combined with LWD/SWD.
	● Bubble curtain combined with LWD or boulders.
	● Stable undercut bank with greater than 12" undercut, associated with root mass or LWD.

- Extensive submersed vegetative fish cover.

l) Area of habitat unit with instream shelter/cover

The total areal percentage of the unit occupied by structural shelter/cover within the wetted channel and the active channel will be visually estimated in quartiles (0%, 1-25%, 26-50%, 51-75%, and 76-100%).

m) Areal proportion of cover by cover type

The areal percentage of the unit occupied by instream structure in the active channel. Visually estimated in quartiles (0%, 1-25%, 26-50%, 51-75%, and 76-100%).

i. Undercut bank
ii. Small woody debris (d<12”)
iii. Large woody debris (d>12”)
iv. Root mass
v. Terrestrial vegetation
vi. Aquatic vegetation
vii. Bubble curtain (Includes whitewater)
viii. Boulders
ix. Bedrock ledges

n) Substrate Size Composition

Substrate will be categorized based on the areal percent of each substrate size comprising the habitat unit (within the wetted channel and the active channel), to the nearest 10% of the area of the habitat unit based on visual estimation. Photos will be taken to confirm visual estimation. Only substrates with >10% areal composition will be recorded. Substrate sizes will be based on the table below. Modified from Flosi (2010) to (1) follow Entrix (2000) by visually estimating areal percentage of each substrate size class in habitat unit (not just the two most dominant); (2) include separate assessment of substrate size composition in pool tailout for potential carrying capacity estimation purposes; and (3) modified particle size tables to better match spawning substrate for steelhead and Chinook.

Particle Size	**Inches**
Boulder	>10"
Large Cobble	6-10”
Medium Cobble	4-6”
Small Cobble	0.5-4"
Gravel	.08-0.5"
Sand	<0.08"
Silt/Clay	n/a
Bedrock	n/a

o) Percent embeddedness of cobble substrate (entire unit and pool tail-out)

Average percent embeddedness of suitable spawning-sized substrate will be determined for each habitat unit (within the wetted channel and the active channel) based on selecting and sampling at least five small cobbles (0.5”-4.0”) and estimating the amount of stone buried in the sediment. Cobble selection will be done through the step-toe method. Starting on the shoreline, take a step into the stream. Averting your gaze, pick up the first particle touched by the tip of your index finger at the toe of your wader. Continue across the channel in an upstream direction towards the opposite bank and repeat the process, continuing to pick up particles until you have the requisite number of measurements. Estimation of embeddedness is done by removing the cobble from the streambed and observing the line between the "shiny" buried portion and the duller exposed portion. Embeddedness will be recorded based on a visual estimate on a quartile scale, in addition to 0-5% (i.e., 0-5, 6-25, 26-50, 51-75, 76-100%). For pool units, percent embeddedness will also be determined for five additional small cobbles randomly selected in the pool tail-out. This methodology was modified from Flosi (2010) to follow Entrix (2000) by adding visual estimates of small cobble-embeddedness in the entire unit.

p) Pool tail substrate

The dominant substrate type will be visually estimated and recorded for each pool tail-out based on the classifications in the table above. Photos will be taken to confirm visual estimation.

q) Large woody debris count diameter >1' and length from 6' to 20'

Record the number of pieces of large woody debris that have a diameter greater than one foot and a length between six and twenty feet, and are wholly or partially within the bankfull discharge elevation of that habitat unit.

r) Large woody debris count diameter >1' and length > 20'

Record the number of pieces of large woody debris that have a diameter greater than one foot and a length greater than twenty feet, and are wholly or partially within the bankfull discharge elevation of that habitat unit.

s) Bank Composition

Observed from the base of the stream bank to the bankfull discharge level. Enter the number (1 through 7) for the composition type corresponding to the list below based on visual estimation. Do this independently for the right and left banks, right is the right side of the stream when facing downstream.

1) Silt/Clay
2) Sand (>0.08)
3) Gravel (0.08-0.5)
4) Cobble (0.5-10")
5) Boulder (>10")
6) Bedrock
7) Concrete

t) Bank Vegetation

Visually estimate total percentage of the bank covered with vegetation (0%, 1-25%, 26-50%, 51-75%, and 76-100%) from the bankfull discharge level to 20 feet upslope. Enter the dominant vegetation type (8 through 11) corresponding the list below.

8) Grass
9) Brush

10) Hardwood Trees
11) Coniferous Trees

3.2 Equipment

The following equipment is required:

Crew Sampling Gear

☐ Habitat Inventory Data Forms/Flosi Protocols
☐ Pencils and waterproof marker
☐ GPS
☐ Camera
☐ 1” = 100’ scale map of area to be surveyed
☐ Stadia rod (fiberglass, calibrated in tenths)
☐ Fiberglass open reel tape, 200 ft.
☐ Aluminum clipboard and waterproof notebook
☐ First aid kit
☐ Float tube
☐ Watch
☐ Flow meter and top setting rod
☐ Calculator
☐ List of emergency contact information
☐ Turbidimeter
☐ Spherical densiometer
☐ YSI water quality sampling equipment

Personal Gear

☐ Waders/boots
☐ Hat
☐ Sunscreen
☐ Cellular phone
☐ Wading staff
☐ Drinking water
☐ Polarized glasses
☐ Gloves
☐ Tecnu
☐ Cell Phone
☐ Hand sanitizer

4. Staff Project Roles

PROJECT STAFF CONTACTS

Name	Title (*Project Role*)	Extension	Cellular Phone
Debra Caldon	Project Owner	3057	
Ryan Heacock	Project Manager	3202	408 832 0274
Jason Nishijima	Principle Investigator	2863	408 309 8768
Les Layng	Lead field personnel	2739	541 337 7939
Jae Abel	Lead field personnel	2655	408 202 5209
Joe Chavez	Lead field personnel	2276	717 515 7286
Clayton Leal	Lead field personnel	2753	408 728 1027
Jen Watson	Lead field personnel	2578	408 599 8034
Jen Jelincic	Supporting field personnel	2648	
Emily Moffitt	Supporting field personnel	2793	
Dan Corral	Supporting field personnel	2793	
Cristal Romero	Supporting field personnel	2789	
Michelle Jordan	Supporting field personnel	3125	
Logan Thompson	Supporting field personnel	2789	

5. References

California Wetlands Monitoring Workgroup (CWMW). 2013. California Rapid Assessment Method (CRAM) for Wetlands and Riparian Areas, Version 6.1 pp. 95

ENTRIX, Inc. 1999. Standard Operation Procedures for the Santa Clara Valley Water District Habitat Inventory. Sacramento, CA

ENTRIX. 2000. Stream Habitat Inventory Summary Report. Fisheries and Aquatic Habitat Collaborative Effort (FAHCE). draft report. Project Number 552301. Sacramento, CA

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins. 2010. California salmonid stream habitat restoration manual. 4th Edition. California Department of Fish and Game, Inland Fisheries Division, Sacramento, California. 525 p. http://www.dfg.ca.gov/fish/resources/habitatmanual.asp

Rosgen, D.L. and H.L Silvey. 1996. Applied River Morphology. Wildland Hydrology, Fort Collins, CO.

APPENDIX A

SAFETY PLAN

The purpose of this safety plan is ensure crews perform in a safe manner. It provides descriptions of procedures and equipment needed, as well as emergency contact information for SCVWD personnel conducting habitat assessment surveys.

Field Safety Procedures

Prior to the initiating the habitat surveys, a crew of 2 field crew will conduct an office and/or field reconnaissance of the Study Area to identify and assess potential hazards to field staff within the Reach. These include but are not limited to:

- Deep pools with steep banks
- Difficult terrain
- Presence and disposition of homeless encampments
- Potential for dangerous and/or nuisance fauna (mountain lion, hornet nest, etc.)
- Prevalence of nuisance flora (poison oak, blackberry, stinging nettle, etc.)

Gather the following additional logistical information:

- Estimate effort involved with conducting surveys. Allow additional time if terrain has numerous obstacles. If survey of Study Area cannot be completed in one day, divide study area into sections and locate intermediate access points.
- Locate suitable areas for access/vehicle parking
- Assess hazardous areas and identify areas, which require avoidance.
- Identify route, including alternate routes around hazards as well as ingress and egress points. Mark route on 1" = 100' scale map as guide for conducting surveys.

Prior to conducting field work email project owner and project manager with description of locations to be surveyed, participating staff, when work will commence and end. Provide notification of staff locations in the field.

Safety Related Equipment/Supplies

- 1" = 100' scale map of area to be surveyed
- Cellular phone
- List of emergency contact information
- Wading staff
- Chest waders
- First Aid Kit

Emergency Contacts

Emergency Dispatcher (911) Numbers
San Jose (Police): (408) 277-8911

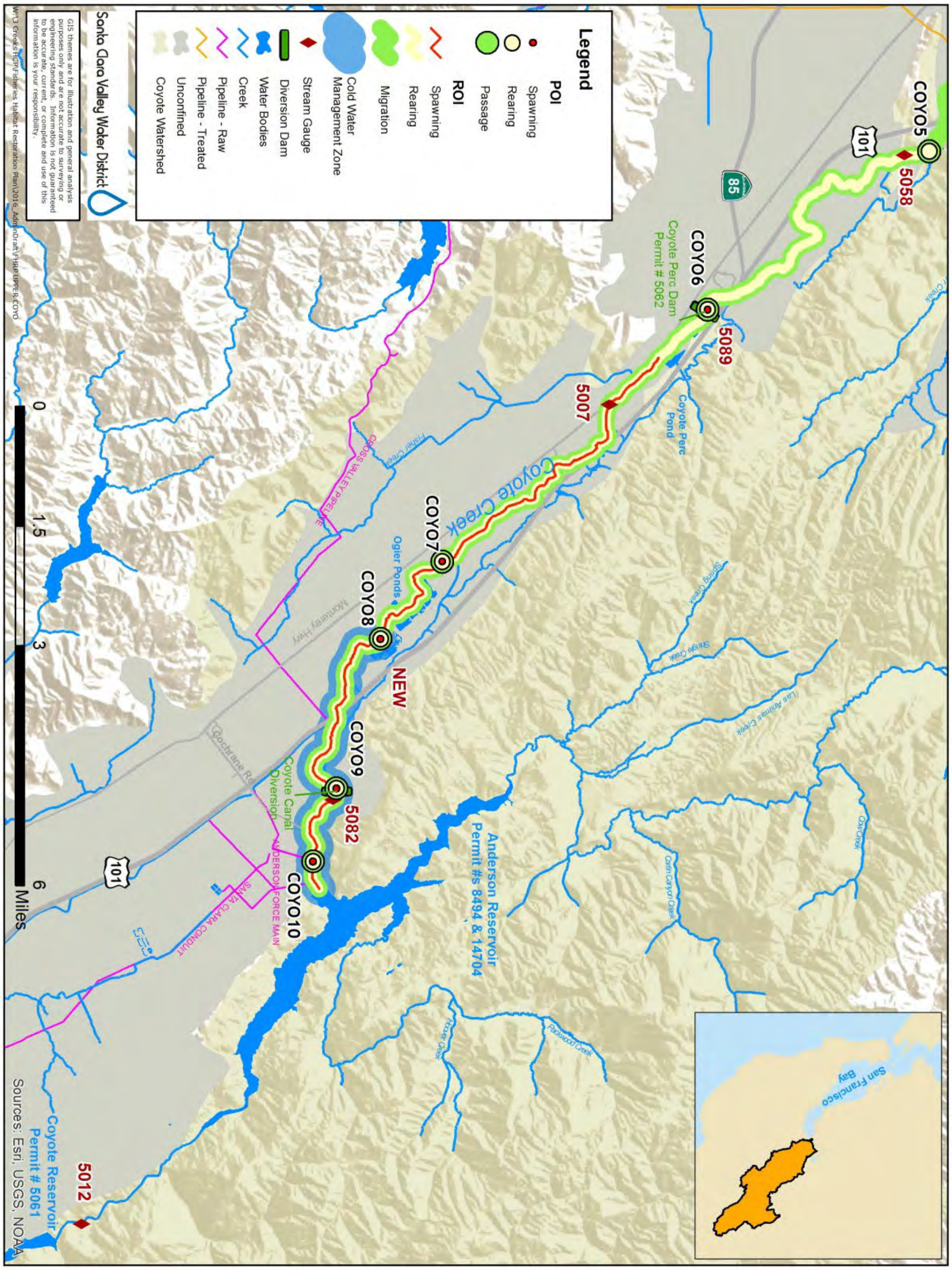
San Jose (Fire): (408) 277-8991
Cupertino: (408) 299-3233

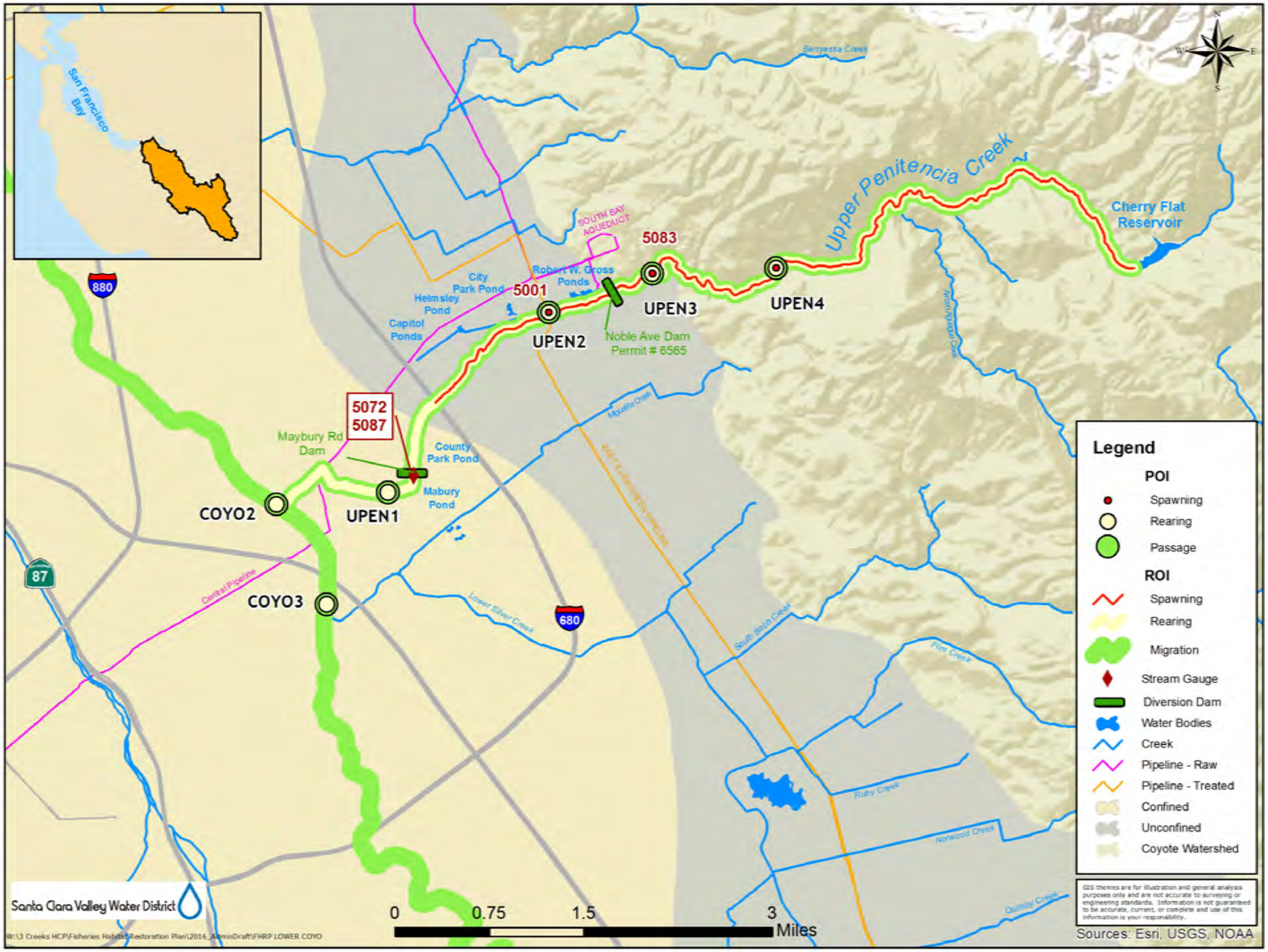
Santa Clara Valley Water District
Larry Lopez: (408) 728-2230
Paul Burnett: (408) 960-5634
Steven Camp: (408) 728-1024
Geoffrey Weigand: (408) 728-0481
Debra Caldon: (408) 630-3057 (Project Owner)
Ryan Heacock: (408) 630-3202 (Project Manager)

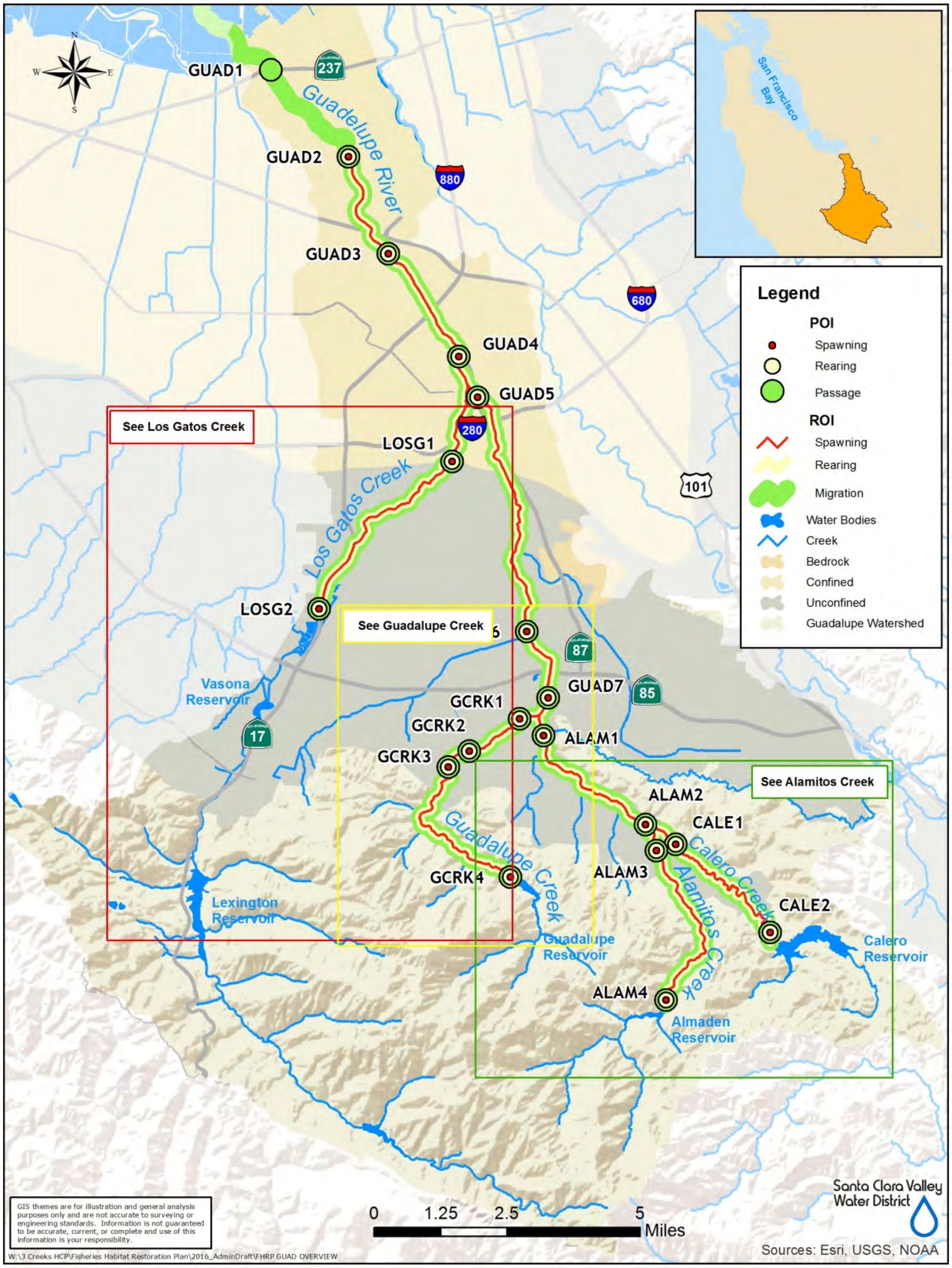
Santa Clara County Parks Department
Bill Burr: (408) 268-3883
Flint Glines: (408)867-3654

Hospitals In and Near Santa Clara County
San Jose: Kaiser Permanente Santa Clara Medical Center, 250 Hospital Parkway, San Jose, CA 95119 - 408-972-7000
San Jose: Good Samaritan Hospital, 2425 Samaritan Drive, www.goodsamsj.org – 408-559-2011

APPENDIX B

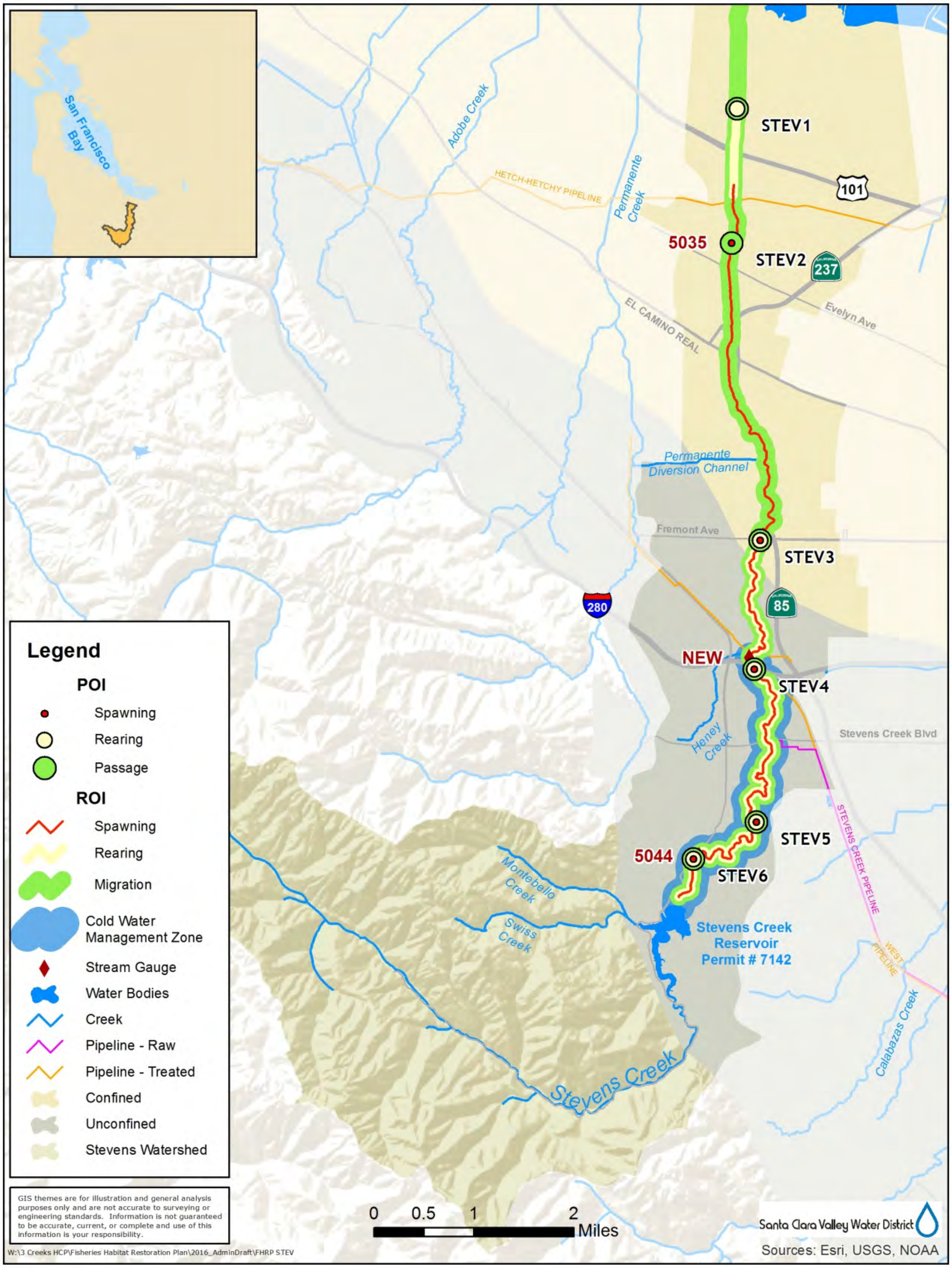

COYO5
5058
101
85
COYO6
5089
Coyote Perc Dam
Permit # 5062
Coyote Perc Pond
5007
Coyote Creek
COYO7
Ogier Ponds
NEW
COYO8
COYO9
5082
Coyote Canal Diversion
COYO10
ANDERSON FORCE MAIN
SANTA CLARA CONDUIT
CROSS VALLEY PIPELINE
Monterey Hwy
Cochrane Rd
Anderson Reservoir
Permit #s 8494 & 14704
Cow Creek
Las Animas Creek
Spring Creek
Carlin Canyon Creek
Packwood Creek
Hoover Creek
Fisher Creek
5012
Coyote Reservoir
Permit # 5061
San Francisco Bay
Legend
POI
Spawning
Rearing
Passage
ROI
Spawning
Rearing
Migration
Cold Water Management Zone
Stream Gauge
Diversion Dam
Water Bodies
Creek
Pipeline - Raw
Pipeline - Treated
Unconfined
Coyote Watershed
Santa Clara Valley Water District
GIS themes are for illustration and general analysis purposes only and are not accurate to surveying or engineering standards. Information is not guaranteed to be accurate, current, or complete and use of this information is your responsibility.
W:\3 Creeks HCP\Fisheries Habitat Restoration Plan\2016_AdminDraft\FHRP UPPER COYO
0
1.5
3
6
Miles
Sources: Esri, USGS, NOAA

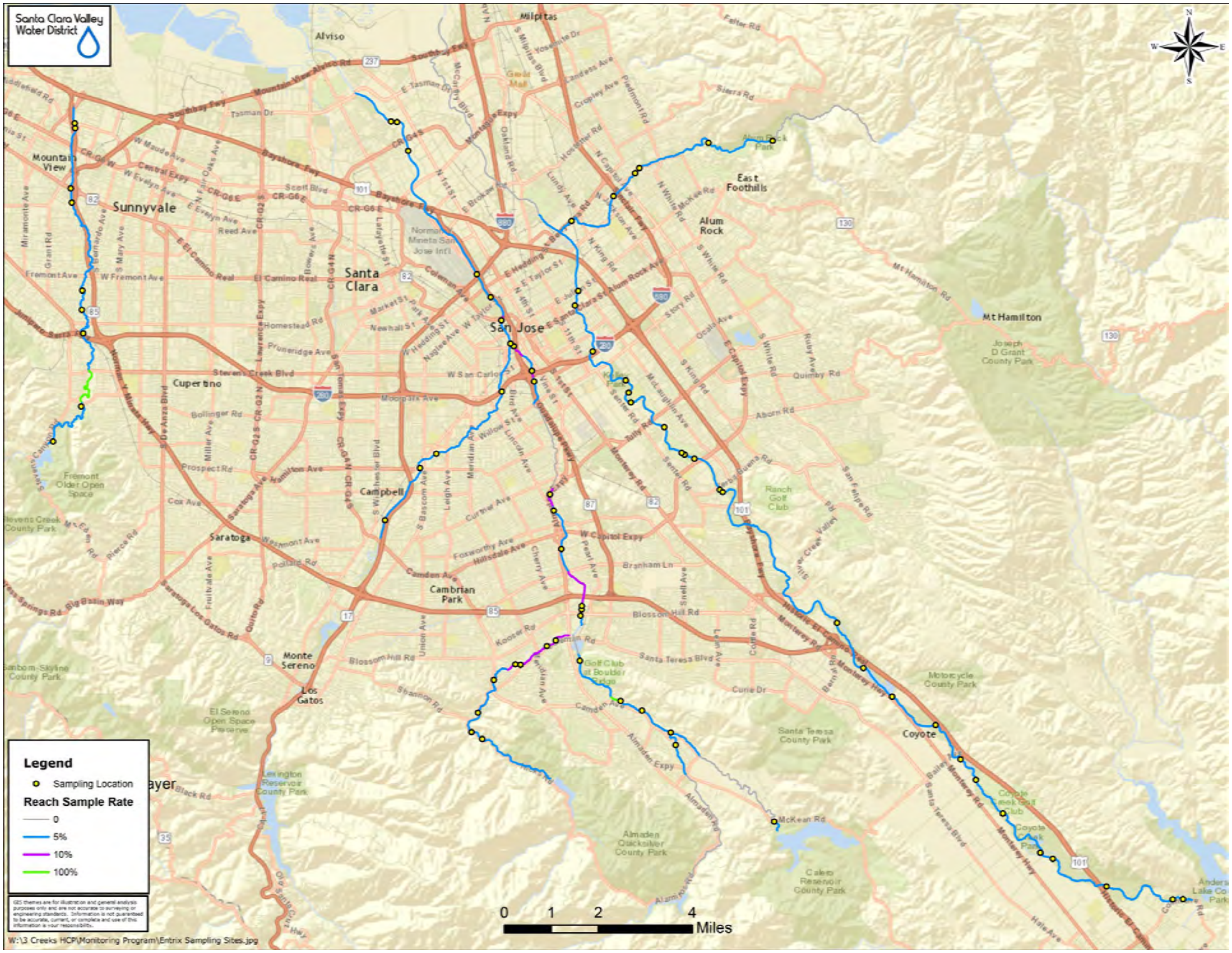

San Francisco Bay
880
87
680
Berryessa Creek
Upper Penitencia Creek
Cherry Flat Reservoir
SOUTH BAY AQUEDUCT
5083
5001
Robert W. Gross Ponds
City Park Pond
Helmsley Pond
Capitol Ponds
UPEN2
UPEN3
UPEN4
Noble Ave Dam Permit # 6565
5072
5087
Maybury Rd Dam
County Park Pond
Mabury Pond
COYO2
UPEN1
COYO3
Central Pipeline
Lower Silver Creek
Miguelita Creek
South Babb Creek
Flint Creek
Ruby Creek
Norwood Creek
Quimby Creek
Arroyo Aguague Creek
N
S
E
W
Legend
POI
● Spawning
○ Rearing
● Passage
ROI
Spawning
Rearing
Migration
♦ Stream Gauge
Diversion Dam
Water Bodies
Creek
Pipeline - Raw
Pipeline - Treated
Confined
Unconfined
Coyote Watershed
GIS themes are for illustration and general analysis purposes only and are not accurate to surveying or engineering standards. Information is not guaranteed to be accurate, current, or complete and use of this information is your responsibility.
Santa Clara Valley Water District
0
0.75
1.5
3
Miles
Sources: Esri, USGS, NOAA
W:\3 Creeks HCP\Fisheries Habitat Restoration Plan\2016_AdminDraft\FHRP LOWER COYO



GIS themes are for illustration and general analysis purposes only and are not accurate to surveying or engineering standards. Information is not guaranteed to be accurate, current, or complete and use of this information is your responsibility.

W:\3 Creeks HCP\Fisheries Habitat Restoration Plan\2016_AdminDraft\FHRP GUAD OVERVIEW


San Francisco Bay
Adobe Creek
HETCH-HETCHY PIPELINE
Permanente Creek
STEV1
101
5035
STEV2
237
EL CAMINO REAL
Evelyn Ave
Permanente Diversion Channel
Fremont Ave
STEV3
280
85
NEW
STEV4
Stevens Creek Blvd
Heney Creek
STEVENS CREEK PIPELINE
STEV5
5044
STEV6
Montebello Creek
Swiss Creek
Stevens Creek Reservoir Permit # 7142
WEST PIPELINE
Calabazas Creek
Stevens Creek
Legend
POI
Spawning
Rearing
Passage
ROI
Spawning
Rearing
Migration
Cold Water Management Zone
Stream Gauge
Water Bodies
Creek
Pipeline - Raw
Pipeline - Treated
Confined
Unconfined
Stevens Watershed
GIS themes are for illustration and general analysis purposes only and are not accurate to surveying or engineering standards. Information is not guaranteed to be accurate, current, or complete and use of this information is your responsibility.
0
0.5
1
2
Miles
Santa Clara Valley Water District
Sources: Esri, USGS, NOAA
W:\3 Creeks HCP\Fisheries Habitat Restoration Plan\2016_AdminDraft\FHRP STEV


Santa Clara Valley Water District
N
E
S
W
Legend
Sampling Location
Reach Sample Rate
0
5%
10%
100%
GIS themes are for illustration and general analysis purposes only and are not accurate to surveying or engineering standards. Information is not guaranteed to be accurate, current, or complete and use of this information is your responsibility.
W:\3 Creeks HCP\Monitoring Program\Entrix Sampling Sites.jpg
0
1
2
4
Miles
Alviso
Milpitas
Mountain View
Sunnyvale
Santa Clara
San Jose
Cupertino
Campbell
Saratoga
Cambrian Park
Monte Sereno
Los Gatos
East Foothills
Alum Rock
Mt Hamilton
Joseph D Grant County Park
Coyote
Motorcycle County Park
Santa Teresa County Park
Almaden Quicksilver County Park
Calero Reservoir County Park
Fremont Older Open Space
El Sereno Open Space Preserve
Lexington Reservoir County Park
Ranch Golf Club
Norman Y Mineta San Jose Intl

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APPENDIX C

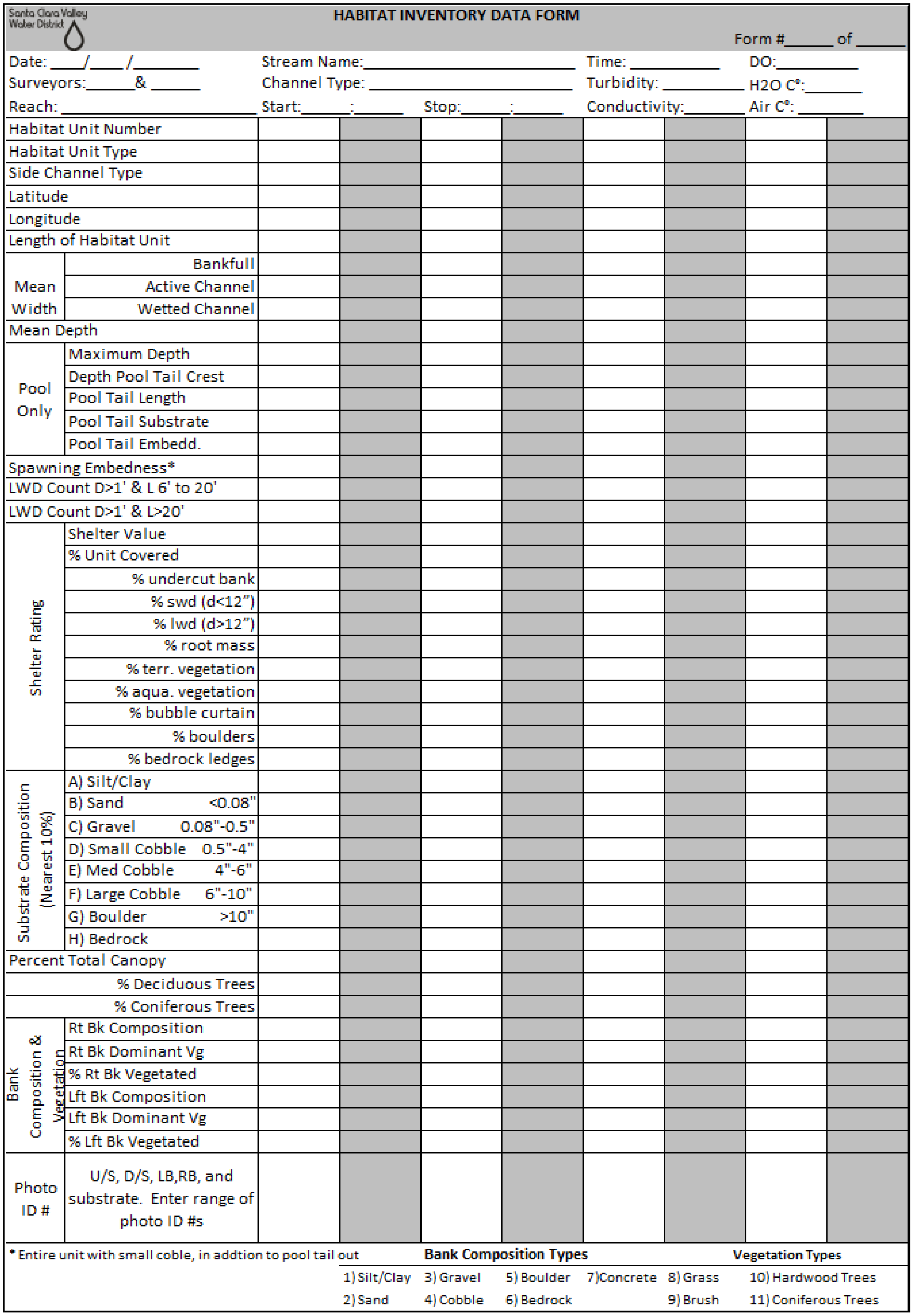
STAFF SCHEDULE

Date	Day	Activity	Field Lead						Interns						
			Jason N.	Les L.	Clayton L.	Jen W.	Joe C.	Jae A.	Jen J.	Emily M.	Dan C.	Cristal R.	Michelle J.	Logan T.	Reg. Agency
8/23/16	Tue	Training/NMFS	✓	✓											
8/25/16	Thu	Habitat Typing	✓	✓											
8/26/16	Fri	Habitat Typing	✓	✓											
8/29/16	Mon	Habitat Typing	✓	✓											
8/30/16	Tue	Habitat Typing	✓	✓											
8/31/16	Wed	Habitat Typing	✓	✓											
9/1/16	Thu	Habitat Typing	✓	✓											
9/5/16	Mon	Habitat Typing	✓	✓											
9/6/16	Tue	Habitat Typing	✓	✓											
9/7/16	Wed	Habitat Typing	✓	✓											
9/8/16	Thu	Habitat Typing	✓	✓											
9/9/16	Fri	Habitat Typing	✓	✓											
9/12/16	Mon	Habitat Typing	✓	✓											
9/13/16	Tue	Habitat Typing	✓	✓											
9/14/16	Wed	Habitat Typing	✓	✓											
9/15/16	Thu	Habitat Typing	✓	✓											

*Staff will be divided into teams of two with at least one field lead per crew with up to three crews.

APPENDIX D

DATA COLLECTION FORMS



Santa Clara Valley Water District

HABITAT INVENTORY DATA FORM

Form #______ of ______

Date: ____/____/________ Stream Name:________________________ Time: ___________ DO:__________

Surveyors:______& ______ Channel Type: ________________________ Turbidity: __________ H2O C°:_______

Reach: ________________________ Start:______:______ Stop:______:______ Conductivity:_______ Air C°: ________

Habitat Unit Number									
Habitat Unit Type									
Side Channel Type									
Latitude									
Longitude									
Length of Habitat Unit									
Mean Width	Bankfull								
	Active Channel								
	Wetted Channel								
Mean Depth									
Pool Only	Maximum Depth								
	Depth Pool Tail Crest								
	Pool Tail Length								
	Pool Tail Substrate								
	Pool Tail Embedd.								
Spawning Embedness*									
LWD Count D>1' & L 6' to 20'									
LWD Count D>1' & L>20'									
Shelter Rating	Shelter Value								
	% Unit Covered								
	% undercut bank								
	% swd (d<12")								
	% lwd (d>12")								
	% root mass								
	% terr. vegetation								
	% aqua. vegetation								
	% bubble curtain								
	% boulders								
	% bedrock ledges								
Substrate Composition (Nearest 10%)	A) Silt/Clay								
	B) Sand <0.08"								
	C) Gravel 0.08"-0.5"								
	D) Small Cobble 0.5"-4"								
	E) Med Cobble 4"-6"								
	F) Large Cobble 6"-10"								
	G) Boulder >10"								
	H) Bedrock								
Percent Total Canopy									
	% Deciduous Trees								
	% Coniferous Trees								
Bank Composition & Vegetation	Rt Bk Composition								
	Rt Bk Dominant Vg								
	% Rt Bk Vegetated								
	Lft Bk Composition								
	Lft Bk Dominant Vg								
	% Lft Bk Vegetated								
Photo ID #	U/S, D/S, LB,RB, and substrate. Enter range of photo ID #s								

* Entire unit with small coble, in addtion to pool tail out

Bank Composition Types

1) Silt/Clay
2) Sand
3) Gravel
4) Cobble
5) Boulder
6) Bedrock
7)Concrete

Vegetation Types

8) Grass
9) Brush
10) Hardwood Trees
11) Coniferous Trees

Unit #_______	LB	RB	Width	LB	RB	Width	Mean
Bankfull							
Active Channel							
Wetted Channel							

Comments:

Mean Depth Along Thalweg	
1	
2	
3	
4	
Mean	

Unit #_______	LB	RB	Width	LB	RB	Width	Mean
Bankfull							
Active Channel							
Wetted Channel							

Comments:

Mean Depth Along Thalweg	
1	
2	
3	
4	
Mean	

Unit #_______	LB	RB	Width	LB	RB	Width	Mean
Bankfull							
Active Channel							
Wetted Channel							

Comments:

Mean Depth Along Thalweg	
1	
2	
3	
4	
Mean	

Unit #_______	LB	RB	Width	LB	RB	Width	Mean
Bankfull							
Active Channel							
Wetted Channel							

Comments:

Mean Depth Along Thalweg	
1	
2	
3	
4	
Mean	

Unit #_______	LB	RB	Width	LB	RB	Width	Mean
Bankfull							
Active Channel							
Wetted Channel							

Comments:

Mean Depth Along Thalweg	
1	
2	
3	
4	
Mean	

Unit #_______	LB	RB	Width	LB	RB	Width	Mean
Bankfull							
Active Channel							
Wetted Channel							

Comments:

Mean Depth Along Thalweg	
1	
2	
3	
4	
Mean	

Unit #_______	LB	RB	Width	LB	RB	Width	Mean
Bankfull							
Active Channel							
Wetted Channel							

Comments:

Mean Depth Along Thalweg	
1	
2	
3	
4	
Mean	

Unit #_______	LB	RB	Width	LB	RB	Width	Mean
Bankfull							
Active Channel							
Wetted Channel							

Comments:

Mean Depth Along Thalweg	
1	
2	
3	
4	
Mean	

APPENDIX E

CALIFORNIA SALMONID STREAM
HABITAT RESTORATION MANUAL

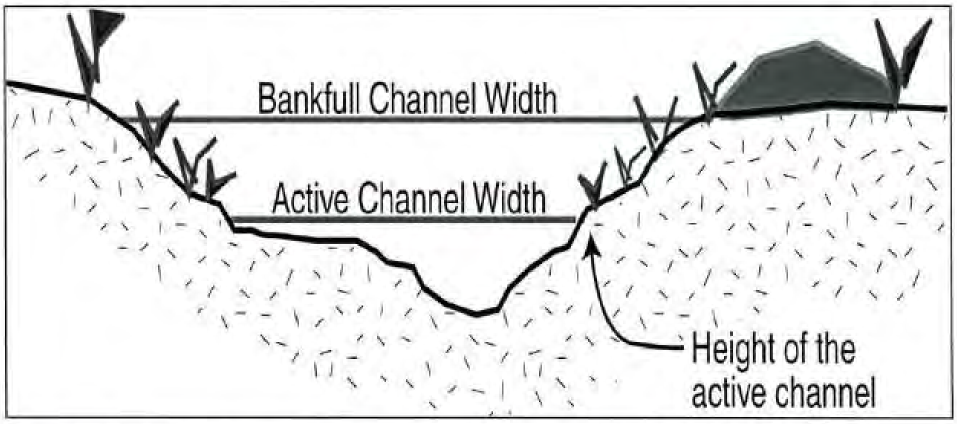
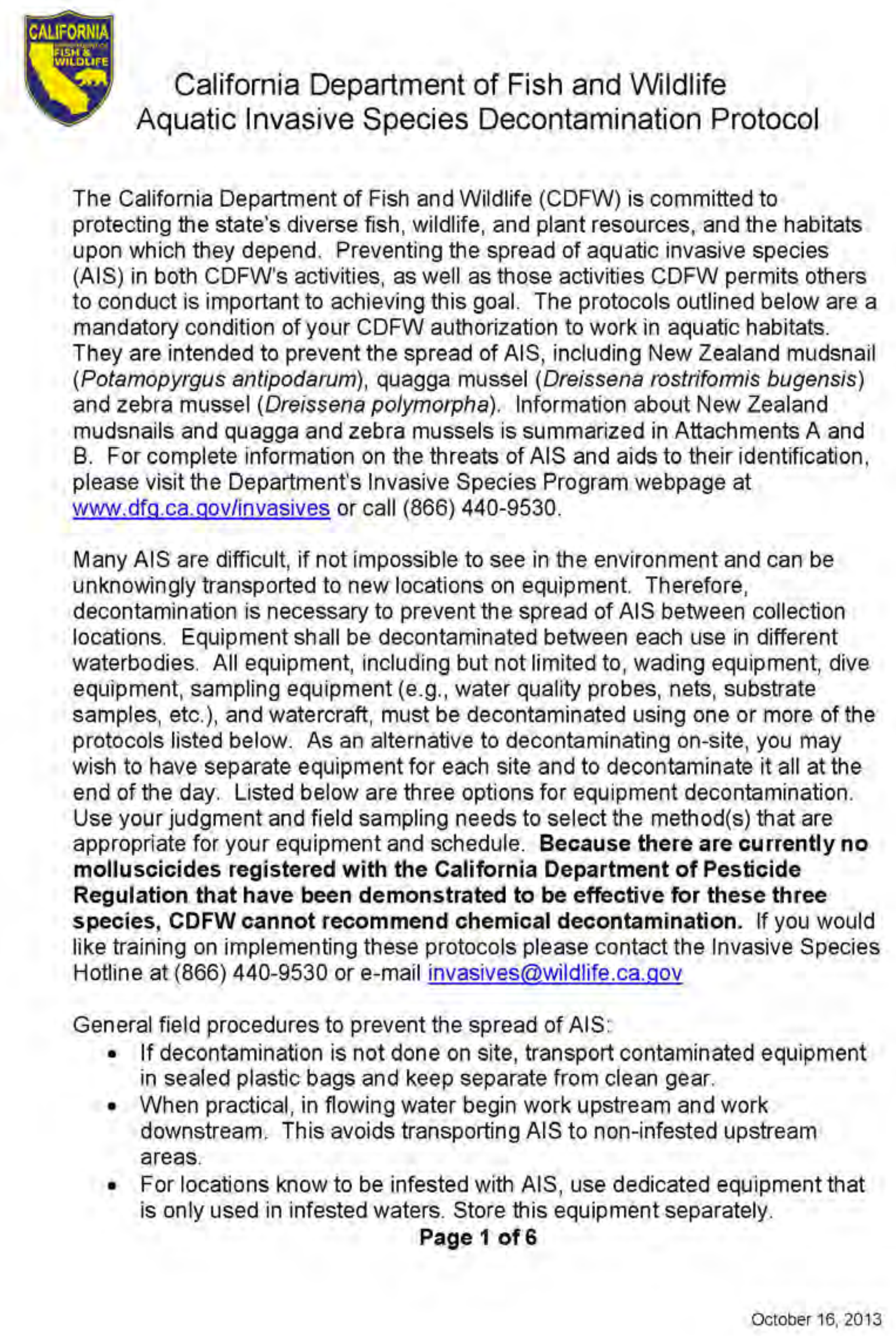


Figure IX-3. Active channel width versus bankfull channel width.

Figure IX-4. Example of active and bankfull channel margin.

FISH PASSAGE EVALUATION IX-10 March 2004

APPENDIX F



California Department of Fish and Wildlife
Aquatic Invasive Species Decontamination Protocol

The California Department of Fish and Wildlife (CDFW) is committed to protecting the state's diverse fish, wildlife, and plant resources, and the habitats upon which they depend. Preventing the spread of aquatic invasive species (AIS) in both CDFW's activities, as well as those activities CDFW permits others to conduct is important to achieving this goal. The protocols outlined below are a mandatory condition of your CDFW authorization to work in aquatic habitats. They are intended to prevent the spread of AIS, including New Zealand mudsnail (*Potamopyrgus antipodarum*), quagga mussel (*Dreissena rostriformis bugensis*) and zebra mussel (*Dreissena polymorpha*). Information about New Zealand mudsnails and quagga and zebra mussels is summarized in Attachments A and B. For complete information on the threats of AIS and aids to their identification, please visit the Department's Invasive Species Program webpage at www.dfg.ca.gov/invasives or call (866) 440-9530.

Many AIS are difficult, if not impossible to see in the environment and can be unknowingly transported to new locations on equipment. Therefore, decontamination is necessary to prevent the spread of AIS between collection locations. Equipment shall be decontaminated between each use in different waterbodies. All equipment, including but not limited to, wading equipment, dive equipment, sampling equipment (e.g., water quality probes, nets, substrate samples, etc.), and watercraft, must be decontaminated using one or more of the protocols listed below. As an alternative to decontaminating on-site, you may wish to have separate equipment for each site and to decontaminate it all at the end of the day. Listed below are three options for equipment decontamination. Use your judgment and field sampling needs to select the method(s) that are appropriate for your equipment and schedule. **Because there are currently no molluscicides registered with the California Department of Pesticide Regulation that have been demonstrated to be effective for these three species, CDFW cannot recommend chemical decontamination.** If you would like training on implementing these protocols please contact the Invasive Species Hotline at (866) 440-9530 or e-mail invasives@wildlife.ca.gov

General field procedures to prevent the spread of AIS:

- If decontamination is not done on site, transport contaminated equipment in sealed plastic bags and keep separate from clean gear.
- When practical, in flowing water begin work upstream and work downstream. This avoids transporting AIS to non-infested upstream areas.
- For locations know to be infested with AIS, use dedicated equipment that is only used in infested waters. Store this equipment separately.

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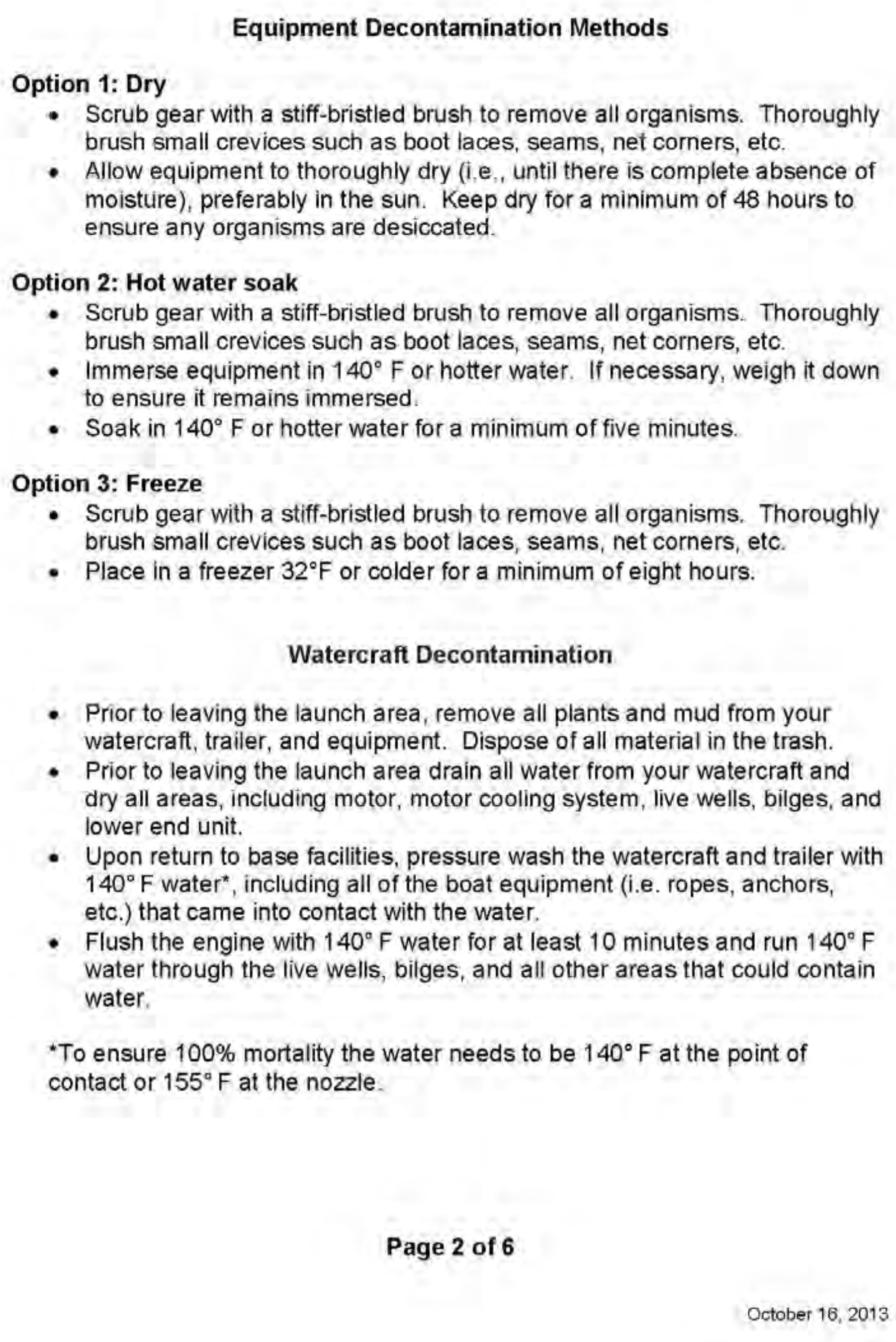


Equipment Decontamination Methods

Option 1: Dry

- Scrub gear with a stiff-bristled brush to remove all organisms. Thoroughly brush small crevices such as boot laces, seams, net corners, etc.
- Allow equipment to thoroughly dry (i.e., until there is complete absence of moisture), preferably in the sun. Keep dry for a minimum of 48 hours to ensure any organisms are desiccated.

Option 2: Hot water soak

- Scrub gear with a stiff-bristled brush to remove all organisms. Thoroughly brush small crevices such as boot laces, seams, net corners, etc.
- Immerse equipment in 140° F or hotter water. If necessary, weigh it down to ensure it remains immersed.
- Soak in 140° F or hotter water for a minimum of five minutes.

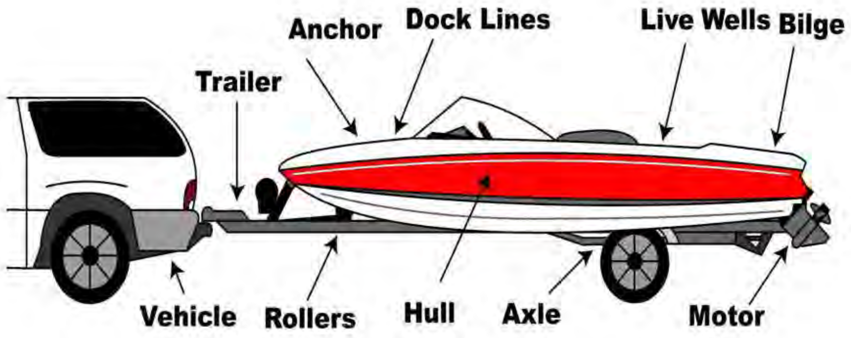
Option 3: Freeze

- Scrub gear with a stiff-bristled brush to remove all organisms. Thoroughly brush small crevices such as boot laces, seams, net corners, etc.
- Place in a freezer 32°F or colder for a minimum of eight hours.

Watercraft Decontamination

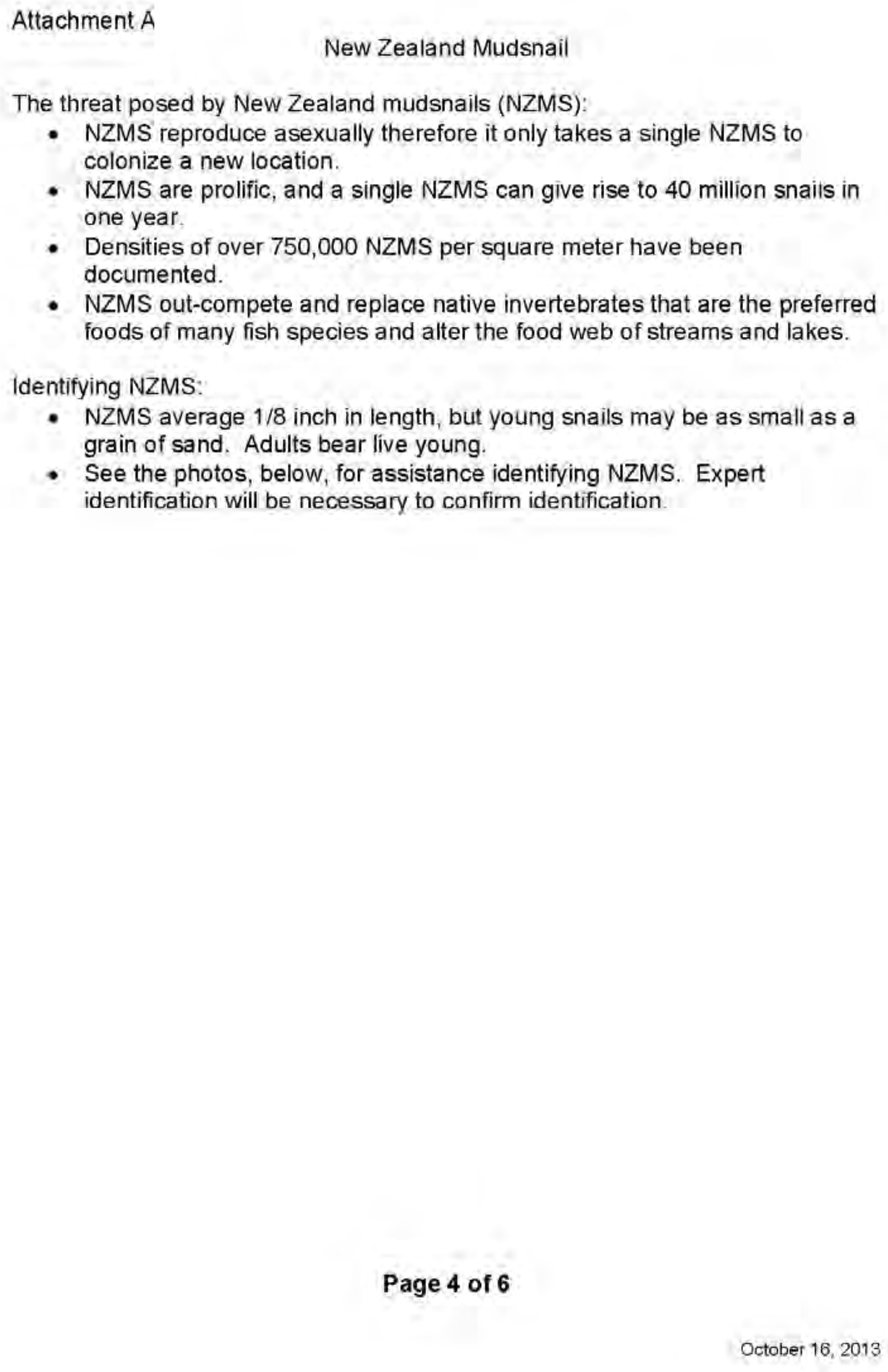
- Prior to leaving the launch area, remove all plants and mud from your watercraft, trailer, and equipment. Dispose of all material in the trash.
- Prior to leaving the launch area drain all water from your watercraft and dry all areas, including motor, motor cooling system, live wells, bilges, and lower end unit.
- Upon return to base facilities, pressure wash the watercraft and trailer with 140° F water*, including all of the boat equipment (i.e. ropes, anchors, etc.) that came into contact with the water.
- Flush the engine with 140° F water for at least 10 minutes and run 140° F water through the live wells, bilges, and all other areas that could contain water.

*To ensure 100% mortality the water needs to be 140° F at the point of contact or 155° F at the nozzle.



Reporting Aquatic Invasive Species

If you suspect you have found New Zealand mudsnail, quagga and zebra mussels, or other AIS, please immediately notify the CDFW Invasive Species Program at (866) 440-9530 or e-mail invasives@wildlife.ca.gov. Please provide your contact information, specific location of discovery, and digital photographs of the organisms (if possible).



Attachment A

New Zealand Mudsnail

The threat posed by New Zealand mudsnails (NZMS):

- NZMS reproduce asexually therefore it only takes a single NZMS to colonize a new location.
- NZMS are prolific, and a single NZMS can give rise to 40 million snails in one year.
- Densities of over 750,000 NZMS per square meter have been documented.
- NZMS out-compete and replace native invertebrates that are the preferred foods of many fish species and alter the food web of streams and lakes.

Identifying NZMS:

- NZMS average 1/8 inch in length, but young snails may be as small as a grain of sand. Adults bear live young.
- See the photos, below, for assistance identifying NZMS. Expert identification will be necessary to confirm identification.

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IDENTIFYING THE NEW ZEALAND MUDSNAIL

Size: A mature snail is usually less than 5 mm (.2 in) long. (Photo by Jane and Michael Liu.)

Shape: Shell is elongated and dextral (its whorls or spirals lean toward the right). Snail typically has between 5 to 6 whorls on its shell. (Photo by D. L. Gustafson, http://www.esg.montana.edu/aim/mollusca/nzms.)

Color: Most snails have a light- to dark-brown shell that may appear to be black when wet. (Photo by Jane and Michael Liu.)

Embryos: Upon dissection, mature snails will have brooded embryos. (Photo by D. L. Gustafson, http://www.esg.montana.edu/aim/mollusca/nzms.)

Operculum: The mudsnail operculum (a rounded plate that seals the mouth of the shell when the animal's body is inside) can be seen on live snails but is not easily visible on dead or preserved snails. (Photo by D. L. Gustafson, http://www.esg.montana.edu/aim/mollusca/nzms.)

NZMS Habitat:

- NZMS can live in most aquatic habitats, including silted river bottoms, clear mountain streams, reservoirs, lakes and estuaries.
- NZMS have a temperature tolerance of 32-77° F.
- NZMS can survive out of water for more than 25 days in cool, moist environments, and have been found over 40 feet from water.

Current known locations of NZMS in California can be found at http://nas.er.usgs.gov/taxgroup/mollusks/newzealandmudsnaildistribution.aspx

Attachment B

Quagga and Zebra Mussels

The threat posed by quagga and zebra mussels (Dreissenid mussels):

- Dreissenid mussels multiply quickly and out-compete other species for food and space.
- Their presence can alter food webs and alter environments, negatively affecting native and game fish species.
- Dreissenid mussels attach to hard and soft surfaces, and negatively impact water delivery systems, hydroelectric facilities, agriculture, recreational boating and fishing.
- Adults can survive up to 30 days out of water in cool, humid conditions.
- Produce microscopic larvae that can be unknowingly transported in water, including live-wells, bilges, and motors.

Identifying Dreissenid mussels:

- Typically the same size as a fingernail but can grow up to about 2 inches long.
- Variable, usually dark and light alternating stripes. May also be solid cream, brown, or black.

Dreissenid mussel habitat:

- Variable, including both hard and soft surfaces in freshwater.
- From surface depth to more than 400 feet in depth.

Current known locations of Dreissenid mussels in California can be found http://nas.er.usgs.gov/taxgroup/mollusks/zebramussel/maps/CaliforniaDreissenaMap.jpg

APPENDIX G
BASIS FOR THE HABITAT VALIDATION METHODOLOGY

Fisheries Habitat Data Requirements to Support FAHCE Fisheries Evaluation

Introduction and Purpose

The Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) Technical Workgroup (TWG) is currently developing a biological evaluation framework to compare simulated fisheries habitat conditions under several model scenarios to support the CEQA alternatives analyses of reservoir reoperations and associated instream flow and water temperature conditions. The effects of simulated changes in hydraulic and water temperature conditions on fishery habitat are evaluated in consideration of existing substrate and instream cover/shelter conditions in FAHCE streams (i.e., Stevens Creek, the Guadalupe River, Guadalupe Creek, Alamitos Creek, Calero Creek, Coyote Creek and upper Penitencia Creek). Instream hydraulic, water temperature, substrate and cover conditions must be integrated to understand the relative ability of an alternative scenario to provide suitable habitat area and to determine the degree to which the alternative can meet habitat restoration goals of the project.

For the purposes of the FAHCE fisheries habitat evaluation, key habitat data are required for simulating habitat conditions throughout the creeks in the study area: (1) habitat-type and dimensions; and (2) habitat quantity and quality conditions.

Existing Habitat Data Validation

Habitat inventory data (near-census habitat typing and suitability data) were collected on FACHE streams during 1999 to inform the FAHCE Technical Advisory Committee (TAC) (Entrix 2000). Surveys were conducted during July through October of 1999 using methods modified from Flosi (1998). These data provide information on habitat types and conditions that may provide usable information for modeling and quantifying suitable habitat if it can be shown that the observations made in 1999 are substantially similar to today's conditions. Therefore, this memorandum proposes habitat sampling be conducted during the summer of 2016 to validate and/or update the Entrix (2000) Rosgen reach classification, habitat typing and habitat suitability data. The reason for classifying streams on the basis of channel morphology is to better understand the stream's condition and potential behavior under the influence of different types of changes (Rosgen 1994). Objectives of the Rosgen stream classification include being able to predict a stream's behavior, develop hydraulic and sediment relationships, and provide a mechanism for extrapolation of site-specific data to stream reaches with similar characteristics (Rosgen 1994). The ability to extrapolate site-specific data to other areas within the same stream reach is particularly useful because habitat data collected in a proportion of each reach can be applied to an entire reach for the purposes of developing comparative estimates of fisheries habitat availability and carrying capacity.

An additional reason to classify streams based on channel morphology is to inform the development of future stream rehabilitation measures and to assist in monitoring the effects on fish habitat (Rosgen 1994). In order to reduce the potential for unanticipated geomorphological consequences of implementing stream rehabilitation measures due to incompatibilities between the in-channel structure and the geomorphology of the stream, in-channel structure guidelines by Rosgen stream type were developed by Rosgen and Fittante (1986). In addition, Flosi (2010) identify specific in-channel structures that may generally be considered for each type of Rosgen stream classification.

This memorandum references creek reaches in the study area based on the Rosgen (1994) reach classifications developed in Entrix (2000) (**Table 1**; **Figure 1**). For additional detail on the reach delineations, refer to Entrix (2000).

Table 1. Geomorphic Reach Classifications and Locations.

Stream	Reach	Channel Type	Start (Downstream)	End (Upstream)
Guadalupe River	1	Altered C	Tasman Drive	I-880
	2	G	I-880	Franquette Drive
	3	Altered C	Franquette Drive	Gauging station near Old Almaden Rd
	4	G	Gauging station near Old Almaden Rd	Blossom Hill Drop Structure
Los Gatos Creek	1	F	Confluence with Guadalupe R.	Camden Drop Structure
Guadalupe Creek	1	Altered C	Confluence with Guadalupe R.	Meridian Avenue
	2	Altered E	Meridian Avenue	Camden Avenue
	3	B	Camden Avenue	Guadalupe Reservoir Outlet
Alamitos Creek	1	Altered F	Almaden Lake	Near intersection of Winterset Way & Camden Ave
	2	Altered C	Near intersection of Winterset Way & Camden Ave	US of McKean Rd
	3	B	Near intersection of McKean & Harry roads	Almaden Reservoir
Calero Creek	1	Altered G	Confluence with Alamito Creek	Harry Road
	2	E	Harry Road	Calero Reservoir Outlet
Coyote Creek	1	Altered E	Near Zanker Road	Highway 237
	2	Altered G	Highway 237	Oakland Road
	3	E	Oakland Road	Adjacent to Hazlett Way
	4	G	Adjacent to Hazlett Way	Adjacent to San Jose Christian College (Orvis Ave)

	5	E	Adjacent to San Jose Christian College (Orvis Ave)	Adjacent to Balfour Drive
	6	C	Adjacent to Balfour Drive	Downstream end of the Lake @ Metcalf Park
	7	C	Downstream end of the Lake at Metcalf Park	Highway 101 in Morgan Hill
	8	E	Highway 101 in Morgan Hill	Anderson Dam
Upper Penitencia Creek	1	Altered G	Confluence with Coyote Creek	Capitol Avenue
	2	C	Capitol Avenue	Adjacent to Noble Ave
	3	G	Adjacent to Noble Ave	Bridge upstream of the Vistor's Center
	4	A	Bridge upstream of the Visitor's Center	Cherry Flat Reservoir
Stevens Creek	1	Altered G	Moffett Blvd	Landels Elementary School
	2	G	Landels Elementary School	Stevens Creek Blvd
	3	E	Stevens Creek Blvd	Near Linda Vista Park
	4	B	Near Linda Vista Park	Stevens Creek Reservoir

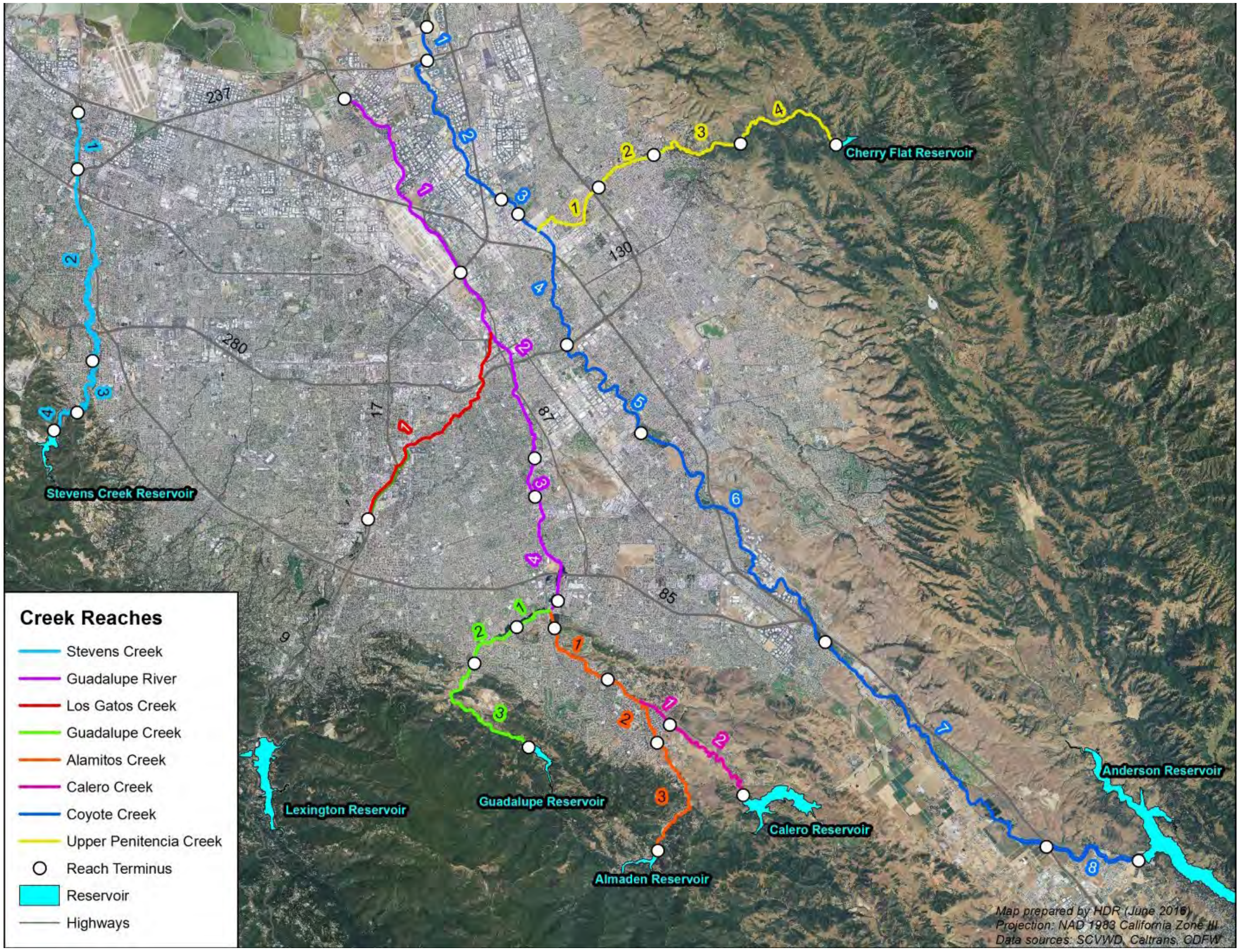

Figure 1. Creek reach delineations based on geomorphic reaches identified by Entrix (2000).

Additional Habitat Data Collection Efforts

Since the 1999 habitat surveys, additional habitat typing and suitability data have been collected in some reaches of the study area, including Coyote Creek as part of the Coyote Creek Flood Protection Project, and Guadalupe Creek and the Guadalupe River as part of the Guadalupe River Flood Protection Project. In addition, habitat typing and habitat quality data were collected in relatively short reaches (~250-650 ft) of Stevens Creek during 2010. To the extent feasible, these data were compared to the 1999 Entrix data to identify changes in the habitat data between 1999 and 2001-2007, as described below.

Coyote Creek

Habitat typing and suitability data similar to the data collected during the 1999 surveys were collected during the summer of 2006 between Montague Expressway to Interstate 280 (Entrix 2006), which corresponds to the majority of Reach 2 and the entirety of Reach 3 and Reach 4 in Coyote Creek. The 2006 habitat survey results indicate that habitat types were primarily composed of pools (about 84% of the length of the entire 2006 study reach), with lesser amounts of runs (about 15% of the study reach length) and riffles (about 1% of the study reach length). Based on an approximation of the locations of the habitat units surveyed in 1999, the habitat units located within the extent of the reach surveyed in 2006 (i.e., Montague Expressway upstream to I-280) were extracted in ArcGIS to compute the proportion of each habitat type for comparison to the 2006 habitat typing results (**Table 2**). Similar habitat type proportions were identified in the 1999 and 2006 surveys, with the exception of a reported reduction in the length of riffle habitat, and an increase in the reported length of flatwater habitat. The reported difference in proportion of riffle and flatwater habitat units could be due to various factors, including differences in flow conditions observed during the two surveys, differences in survey methodologies, geomorphic changes to the channel, and/or spatial inconsistencies between the 1999 and 2006 habitat data. Measured flows during the 1999 habitat surveys in Reaches 2-4 during October ranged from 2 to 21 cfs, while measured flows during the 2006 habitat survey in July and August ranged from 4 to 18 cfs.

Table 2. Proportion of riffle, flatwater and pool habitat units by length identified during the 2006 habitat inventory and as estimated during the 1999 habitat inventory in Coyote Creek between Montague Expressway and I-280.

Year	Creek	Reach	Riffle	Flatwater	Pool
1999	Coyote Creek	Montague Expressway to I-280	0.03	0.12	0.85
2006	Coyote Creek	Montague Expressway to I-280	0.01	0.15	0.84

Habitat suitability data collected during the 2006 lower Coyote Creek survey included the following.

- Cover complexity (scale of 1-3; Flosi, 1998)
- Areal percent of each habitat unit with cover by cover type (quartile scale; Flosi, 1998)
- Canopy cover (scale of 1-100%)
- Vegetation type (quartile scale) and quality (scale of 1-4; Flosi, 1998)
- Area of spawning gravel based on a size class of 1-13 cm (0.4 – 5.1 in) located in pool tailout or riffles that maintained a contiguous spawning gravel area of at least one square meter.

As described above for the habitat unit proportions, the habitat units surveyed in 2000 located approximately within the extent of the reach surveyed in 2006 were extracted in ArcGIS in order to compare the 2006 habitat data with the 2000 habitat data.

For cover complexity (scale of 1-3), the average complexity reported in 2000 was 1.4, compared to an average complexity of 1.5 during 2006.

Percent of unit with cover was collected in quartiles by both Entrix (2000) and Entrix (2006), limiting the usefulness of comparing datasets. Nonetheless, the average percent of unit with cover value (scale of 1-4, where 1 = 1-25%) was 1.4 as reported by Entrix (2000) and 1.3 as reported by Entrix (2006).

Although Entrix (2006) rated canopy cover on a continuous scale of 1-100%, Entrix (2000) rated canopy cover on a quartile scale. The average percent canopy cover reported by Entrix (2006) was 68%, while the average percent canopy cover reported by Entrix (2000) was 1.6 (on a scale of 1-4).

Vegetation type was reported in quartiles by Entrix (2006), but was reported on a continuous scale of 1-100% by Entrix (2000). Entrix (2006) reported that the average percent of deciduous vegetation was 1.6 (on a scale of 1-4), while Entrix (2000) reported that nearly every unit in this reach was surrounded by 100% deciduous vegetation. Vegetation quality was not reported by Entrix (2000), and therefore cannot be compared to the Entrix (2006) data.

Although Entrix (2006) reportedly collected area of suitable spawning gravel, there is only documentation of whether a habitat unit contained suitable spawning substrate – no reporting of area of spawning substrate is included in the report. Approximately 940 square feet of suitable spawning gravel was documented by Entrix (2000) in this reach.

Guadalupe River and Guadalupe Creek

Since the 1999 habitat surveys, habitat typing has been conducted during multiple years in the Guadalupe River within two study reaches that encompass a portion of Reach 1 and Reach 2. The study reach from Airport Parkway to I-880 (stream distance of approximately 1.2 miles) was habitat typed each year from 2001 through 2007, and the study reach from I-880 to upstream of I-280 (stream distance of approximately 2.5 miles) was habitat typed during 2001, 2005, 2006 and 2007. Habitat typing in Guadalupe Creek was conducted from Almaden Expressway to Masson Dam (encompassing Reach 1 and part of Reach 2 in Guadalupe Creek, with a stream distance of approximately 1.6 miles) each year from 2001 through 2007. Habitat types in the Guadalupe River and in Guadalupe Creek were classified according to pools, riffles and runs. Based on an approximation of the locations of the habitat units surveyed in 1999, the habitat units located within the extent of the reaches surveyed in the Guadalupe River and Guadalupe Creek during 2001-2007 were extracted in ArcGIS to compute the proportion of each habitat type for comparison to the multi-year habitat type datasets.

For the Guadalupe River reach from Airport Parkway to I-880, notable differences are apparent between the habitat type proportions identified in 1999 relative to 2001-2007 (**Table 3**). Therefore, the average habitat type proportions shown in Table 3 are for the data collected during 2001-2007.

Table 3. Proportion of riffle, flatwater and pool habitat units by length identified during habitat typing conducted during 2002 through 2007, and as estimated during the 1999 habitat inventory in the Guadalupe River from Airport Parkway upstream to I-880.

Year	Creek	Reach	Riffle	Flatwater	Pool
1999	Guadalupe River	Airport Parkway to I-880	0.02	0.32	0.65
2001	Guadalupe River	Airport Parkway to I-880	0.15	0.64	0.21
2002	Guadalupe River	Airport Parkway to I-880	0.07	0.69	0.23
2003	Guadalupe River	Airport Parkway to I-880	0.11	0.50	0.39
2004	Guadalupe River	Airport Parkway to I-880	0.08	0.55	0.37

2005	Guadalupe River	Airport Parkway to I-880	0.13	0.33	0.54
2006	Guadalupe River	Airport Parkway to I-880	0.17	0.38	0.45
2007	Guadalupe River	Airport Parkway to I-880	0.15	0.36	0.49
Average (ex 1999)	Guadalupe River	Airport Parkway to I-880	*0.12*	*0.49*	*0.38*

The proportional lengths of the three habitat types in the Guadalupe River from Airport Parkway to I-880 during the 2001-2007 surveys varied annually, but show a reduction in the proportion of flatwater units over time and an increase in the proportion of pool units over time. No consistent trend is evident in the proportion of riffle units during 2001-2007. Regression analysis of the 2001-2007 habitat type proportions indicates that the slope of the regression of riffle proportions is not statistically significantly different from 0 (p>.05), while the regression slopes of flatwater and pool proportions are statistically significantly different from 0 (p<.05) (**Figure 2**).

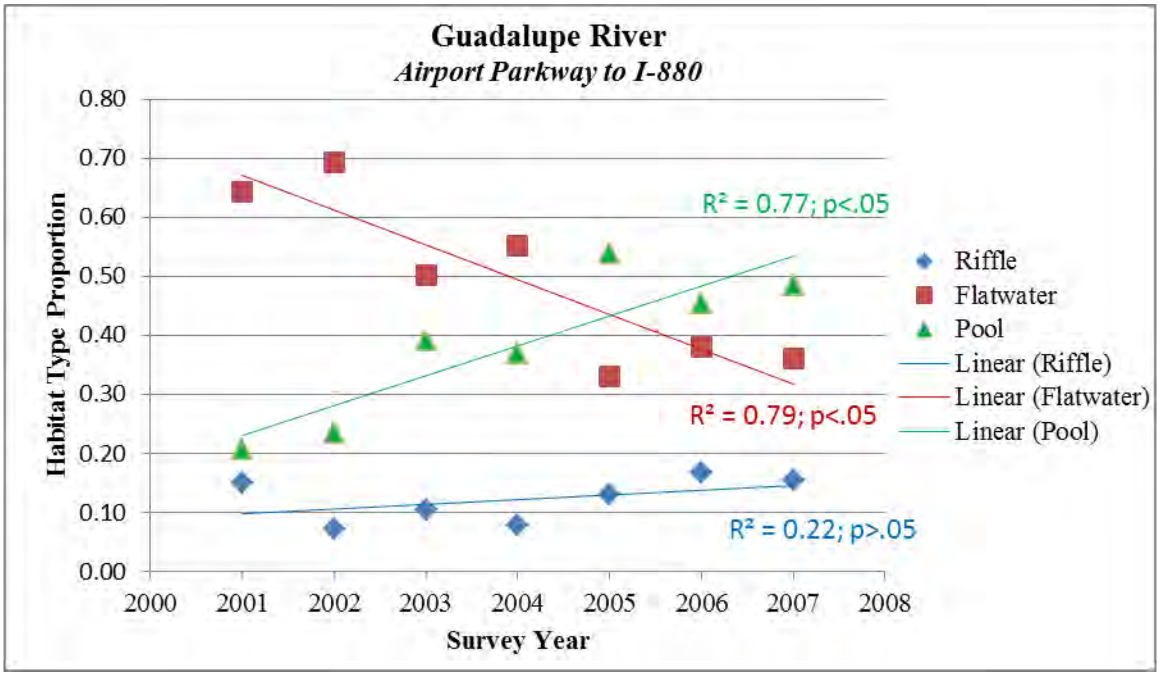

Figure 2. Linear regression of proportion of riffle, flatwater and pool habitats in the Guadalupe River from Airport Parkway to I-880 during 2001-2007.

The average proportional length or riffle, flatwater and pool units over the 2001-2007 dataset was 0.12, 0.49, and 0.38, respectively. By contrast to the 2001-2007 data, the 1999 habitat typing data indicate proportional lengths of 0.02, 0.32, and 0.65 for riffle, flatwater and pool units, suggesting that pools represent a much longer length of the reach and that riffles represent a much smaller length of the reach relative to the more recent surveys.

For the Guadalupe River reach from I-880 to upstream of I-280, habitat type proportions are notably different between 1999 survey and the 2001 and 2005-2007 surveys (**Table 4**). The proportional lengths of the three habitat types during the 2001 and 2005-2007 surveys were very similar year to year, with no consistent trend in changes in habitat type proportions. Regression analysis of the 2001 and 2005-2007 habitat type proportions indicates that the slope of the regression of each habitat type proportion is not statistically significantly different from 0 (p>.05) (**Figure 3**).

Table 4. Proportion of riffle, flatwater and pool habitat units by length identified during habitat typing conducted during 2001, 2005, 2006 and 2007, and as estimated during the 1999 habitat inventory in the Guadalupe River from I-880 to upstream of I-280.

Year	Creek	Reach	Riffle	Flatwater	Pool
1999	Guadalupe River	I-880 to Upstream of I-280	0.07	0.17	0.76
2001	Guadalupe River	I-880 to Upstream of I-280	0.15	0.41	0.44
2005	Guadalupe River	I-880 to Upstream of I-280	0.14	0.44	0.42
2006	Guadalupe River	I-880 to Upstream of I-280	0.16	0.47	0.38
2007	Guadalupe River	I-880 to Upstream of I-280	0.15	0.44	0.40
Average (ex 1999)	Guadalupe River	I-880 to Upstream of I-280	0.15	0.44	0.41

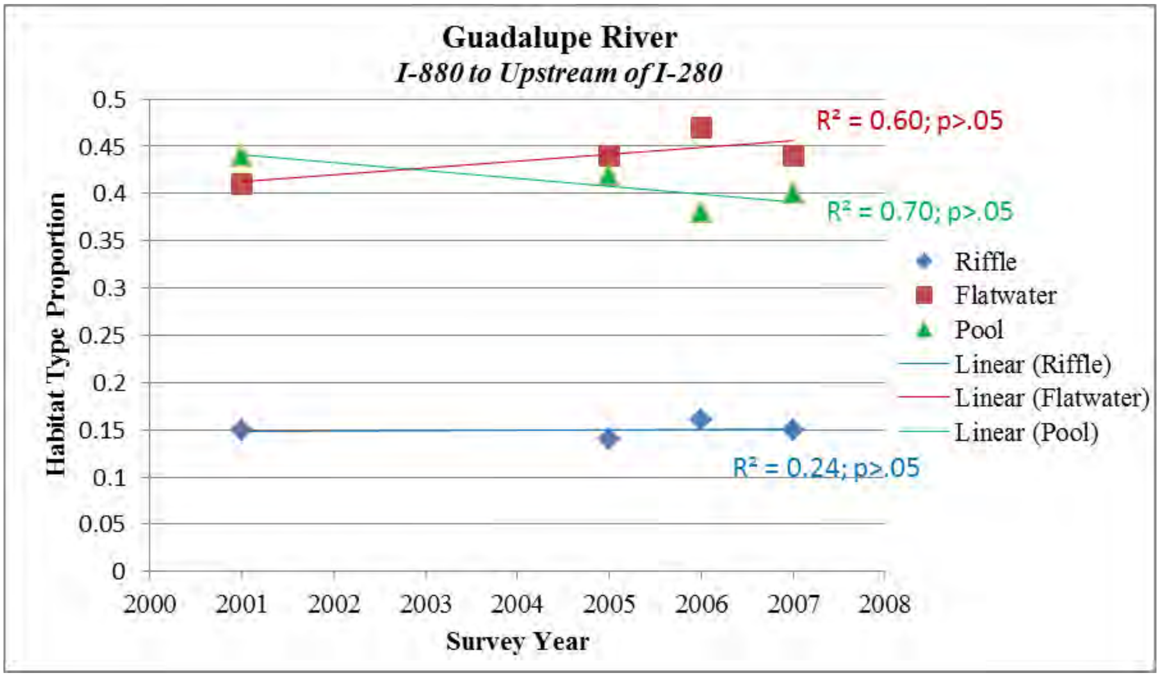

Figure 3. Linear regression of proportion of riffle, flatwater and pool habitats in the Guadalupe River from I-880 to upstream of I-280 during 2001 and 2005-2007.

The average proportional length or riffle, flatwater and pool units over the 2001 and 2005-2007 dataset was 0.15, 0.44 and 0.41, respectively. By contrast, the 1999 habitat typing data indicate proportional lengths of 0.07, 0.17 and 0.76 for riffle, flatwater and pool units, respectively. The notable differences in proportions of all three habitat units between the 1999 and the more recent surveys could be due to various factors, including differences in flow conditions observed during the two surveys, differences in survey methodologies, geomorphic changes to the channel, and/or spatial inconsistencies between the 1999 and 2001/2005-2007 habitat data.

The proportional lengths of the three habitat types in Guadalupe Creek from Almaden Expressway to Masson Dam during the 2002-2007 surveys exhibited some variability year to year, with flatwater units generally comprising about half of the length of reach, riffles comprising 22 to 40 percent of the reach, and pools comprising 17 to 34 percent of the reach (**Table 5**). Regression analysis of the 2002-2007 habitat type proportions indicates that the slope of the regression of each habitat type proportion is not statistically significantly different from 0 (p>.05) (**Figure 4**).

Table 5. Proportion of riffle, flatwater and pool habitat units by length identified during habitat typing conducted during 2002 through 2007, and as estimated during the 1999 habitat inventory in Guadalupe Creek from Almaden Expressway to Masson Dam.

Year	Creek	Reach	Riffle	Flatwater	Pool
1999	Guadalupe Creek	Almaden Expressway to Masson Dam	0.20	0.33	0.47
2002	Guadalupe Creek	Almaden Expressway to Masson Dam	0.26	0.56	0.17
2003	Guadalupe Creek	Almaden Expressway to Masson Dam	0.22	0.52	0.26
2004	Guadalupe Creek	Almaden Expressway to Masson Dam	0.23	0.43	0.34
2005	Guadalupe Creek	Almaden Expressway to Masson Dam	0.40	0.46	0.14
2006	Guadalupe Creek	Almaden Expressway to Masson Dam	0.29	0.51	0.20
2007	Guadalupe Creek	Almaden Expressway to Masson Dam	0.28	0.54	0.18
Average (ex 1999)	Guadalupe Creek	Almaden Expressway to Masson Dam	0.28	0.50	0.21

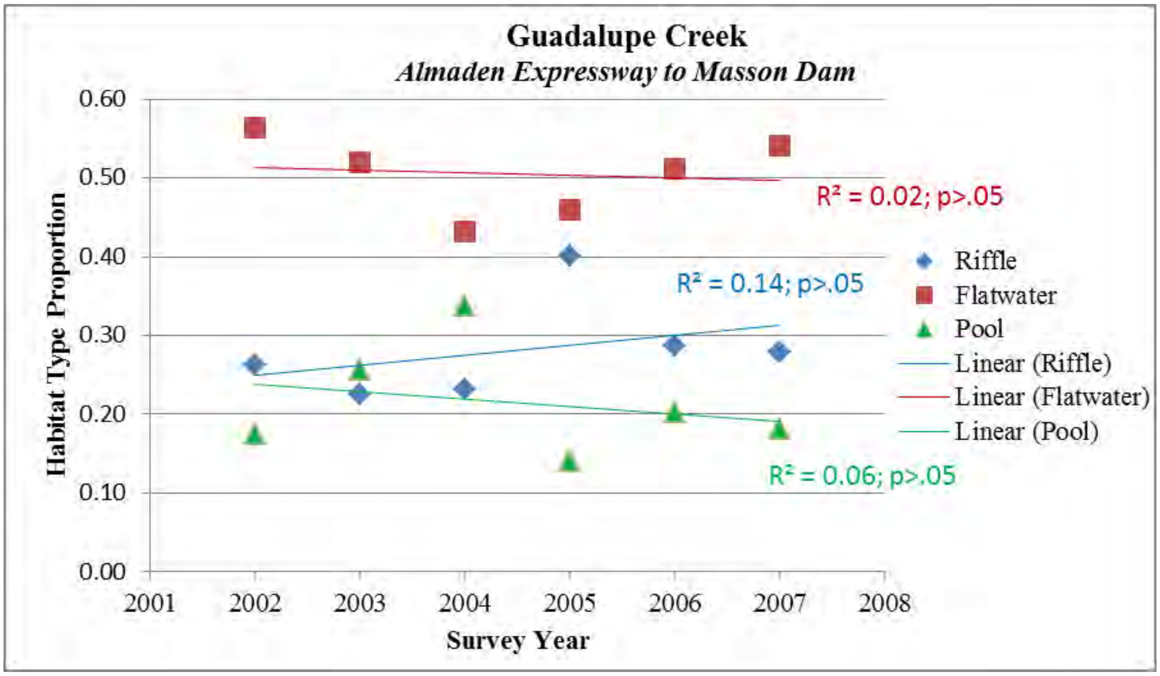

Figure 4. Linear regression of proportion of riffle, flatwater and pool habitats in Guadalupe Creek from Almaden Expressway to Masson Dam during 2002-2007.

The average proportional length or riffle, flatwater and pool units over the 2002-2007 Guadalupe Creek dataset were 0.28, 0.50 and 0.21, respectively. By contrast, the 1999 habitat typing data indicate proportional lengths of 0.20, 0.33 and 0.47 for riffle, flatwater and pool units, respectively, suggesting that pools comprised a longer length of the reach than flatwater units during 1999.

Examination of the habitat type proportions estimated from the 1999 surveys and observed in the more recent surveys in both reaches of the Guadalupe River and in the Guadalupe Creek reach indicate that the proportional lengths of riffle and flatwater units were much lower and the length of pool units was much higher in 1999 relative to the more recent surveys. The relative increase in the length of riffle and flatwater units and the relative decrease in the length of pool units observed in the more recent surveys could be due to various factors, including differences in flow conditions observed during the two surveys, differences in survey methodologies, geomorphic changes to the channel, and/or spatial inconsistencies between the 1999 and more recent habitat data.

In addition to the habitat typing surveys, fish habitat suitability data also were collected in areas within the same reaches as the habitat typing in Guadalupe Creek and the Guadalupe River during 2012-2015. Juvenile summer rearing habitat suitability surveys included delineation of polygons based on the following criteria.

- Water depth >0.5 ft
- Water velocity 0.5–2.5 ft/sec
- Cover within 5 ft
- Minimum polygon area 5 ft^2

The habitat suitability data collected during 2012-2015 could not be readily compared to the habitat suitability data collected during 1999 due to the difference in the spatial scale at which the data were collected. For the purposes of this memorandum, an attempt to synthesize and summarize the habitat data was not undertaken. For detailed mapping and summaries of the habitat and fisheries data collected, refer to the Water Year 2012, 2013, 2014 and 2015 Mitigation Monitoring Reports for the Lower, Downtown, and Upper Guadalupe River Projects (Santa Clara Valley Water District and Stillwater Sciences 2013; 2014; 2015; Santa Clara Valley Water District, U.S. Army Corps of Engineers – San Francisco District, and Stillwater Sciences 2016)

Stevens Creek

Due to the relatively short reaches where habitat data were collected, the Stevens Creek habitat data collected during 2010 (Abel 2011) were not readily comparable to the 1999 Entrix data. Identification of the habitat data collected during 1999 within the specific habitat units surveyed during 2010 would require very accurate spatial representation of the 1999 habitat data, which is not currently available. Therefore, the habitat data collected during 2010 in Stevens Creek is simply summarized below.

The purpose of the 2010 field effort was to produce a limited fall index of the distribution and density of juvenile *O. mykiss* and to collect some qualitative data on the habitats sampled. Data were collected during September and October. Habitat typing was similar to the Level II/Level III CDFW classification (Flosi, 1998) and a modified subset of the Entrix (2000) habitat assessment. Data collected included: (1) habitat unit type and dimensions; (2) characterization of the relative canopy cover; (3) substrate conditions; (4) in-stream fish habitat structure and cover; (5) bank-side vegetation; (6) habitat quality/constraints for juvenile SHRT; and (7) whether spawning habitat appeared to be present (Abel 2011). Water quality data also were collected.

Data were collected at 12 sites ranging from 213 ft to 646 ft long, each of which generally included at least one pool, flatwater and riffle. Measured flows during the habitat survey ranged from 4 cfs near Stevens Creek Reservoir to 0.5 cfs towards the lower region of Stevens Creek. Turbidity ranged from less than 1 NTU in the lower reach to about 25 NTUs in the upper reach. Dissolved oxygen generally ranged from about 8 to 9 mg/l, but was as low as 6 mg/l at one site towards the lower end of the creek, and was as high as 9.8 at one site in the middle region of the creek.

Habitat type proportions varied across sites. Pools represented 78-89% of the habitat units at the 2 most downstream sites and over 50% of the units at the two most upstream sites. Flatwater units represented at least 50% of the units at 5 of the sites. Riffle proportions ranged from 5% at the most downstream site, to approximately 50% at 2 of the mid to upper sites. Average habitat type proportions based on length were 45% pool, 23% riffle and 32% flatwater.

Substrate was dominated by gravel, cobble and silt at most sites, but was dominated by silt, gravel and sand at the two most downstream sites. Spawning areas were identified at 7 of the 12 sites, primarily including the more upstream sites. Embedded substrate was identified at all spawning sites.

On average, instream cover characterization was dominated by depth and boulders, followed by surface turbulence, vegetation, rootmass and woody debris. Canopy coverage ranged from 22% to 95%, with an average of 74% across all sites. A qualitative classification of juvenile (age 1+/2+) habitat quality indicated generally fair or good conditions at the upstream sites and fair to poor conditions at the downstream sites. Habitat constraints for juvenile rearing were identified as turbidity, and to a lesser extent, substrate and cover at the upstream sites, substrate, flow and/or cover at the downstream sites, and substrate and depth at the sites in the middle region of the creek. For additional detail, see Abel (2011).

Existing Data Considerations

As previously discussed, the proportion of each habitat unit type must be determined for each reach in the study area in order to simulate water depths and velocities throughout each creek according to habitat type. Additional habitat-related information is necessary in order to quantify area of suitable habitat for juvenile and adult anadromous salmonids associated with physical structure (e.g., instream cover characteristics) and sediment (e.g., substrate size and quality) conditions.

Continued channel maintenance activities for the purposes of flood control in some reaches of the study area are not expected to have altered the relatively homogenous habitat conditions in those reaches (e.g., lower reaches of Coyote Creek) since the habitat assessment in 1999. However, some notable flood control and restoration projects may have altered habitat types and habitat suitability in some reaches in the study area since the 1999 surveys, as follows.

- Guadalupe River (Downtown Guadalupe Flood Control Project (FCP))
  - Segment 3A - Downstream (North) end of Coleman Avenue upstream approximately 600 feet
    - Widened channel; lined with cellular concrete mattress (CCM)
  - Segment 3B - Downstream of Santa Clara Street to Upstream end of Park Avenue (approximately 1800 feet)
    - Widened channel; lined with concrete and CCM
  - Segment 3C - Woz Way to Grant Street (approximately 1000 feet)
    - Widened channel; lined with CCM

- Guadalupe River (Upper Guadalupe FCP)
  - Reach 12- Branham to Blossom Hill Road
    - Gravel augmentation (intermittent) - installed cobble/gravel riffles to improve geomorphic stability and improve fish habitat
  - Reach 10B
    - ACoE added channel meanders, coarse gravel, and willow plantings (approximately 1700 feet)

- Guadalupe Creek (Mitigation project for Downtown Guadalupe FCP)
  - Almaden Expressway to Masson Dam (approximately 1.5 miles)

        - Reformed channel; added riparian plantings, instream woody material, root wads, boulder and gravel

- Alamitos Creek (Stream Maintenance Program (SMP))
    - Greystone Creek Confluence to approximately 900 feet upstream
        - Erosion control and geomorphic fix; added channel meanders and boulder wings

- Stevens Creek (Blackberry Farms Restoration)
    - Stevens Creek Boulevard upstream to McClellan Road
        - Channel restoration and riparian plantings

As indicated by the types of channel modifications and restoration actions referenced above, it is expected that habitat type proportions may have changed since 1999, particularly in the restoration areas in the Guadalupe River, Guadalupe Creek, Alamitos Creek, and in Stevens Creek. As described above for a lower reach of Coyote Creek, habitat type proportions were very similar as observed during the 1999 and 2006 surveys, except for a slight reduction in the length of riffle units and a slight increase in the length of flatwater units during the 2006 survey relative to the 1999 survey. By contrast, the more recent habitat typing surveys in the Guadalupe River and Guadalupe Creek indicate relatively large increases in the proportion of riffle and flatwater units and relatively large decreases in the proportion of pool units, relative to the 1999 survey data. Based on the apparent changes in habitat type proportions relative to the 1999 survey data, particularly in the Guadalupe River and in Guadalupe Creek, and due to some substantial changes to some reaches of the study area, additional habitat typing will be conducted to update the habitat type proportions identified in 1999, particularly in the reaches where major channel modifications and restoration actions have been undertaken.

Relative to the geomorphic reach classifications and the overall habitat type proportions by reach, there is relatively higher uncertainty in the existing accuracy of the data relating to habitat suitability, such as the substrate size composition and the area of a habitat unit that contained cover elements. The physical habitat-related suitability of the creeks is driven by ongoing ecological processes that are relatively more sensitive to anthropogenic disturbances. Ongoing land use and urbanization-related activities, as well as effects of the upstream dams, may have resulted in altered habitat suitability conditions relative to the 1999 habitat assessment.

In consideration of the substantial channel modifications and restoration actions undertaken since 1999, as well as the uncertainty associated with the habitat suitability-related data collected during 1999, a habitat sampling methodology was developed to efficiently validate or update the previously-collected habitat typing and habitat suitability data collected in 1999 and in subsequent years.

Sampling Plan Development

Data Collection Considerations

Sampling Spatial Extent

Based on the habitat suitability and habitat typing data collected in 1999 and subsequent habitat data collection efforts, the proposed sampling plan includes nearly all accessible reaches that were surveyed in 1999, with the exception of Coyote Creek reaches 2 and 3. In Coyote Creek, very little suitable juvenile rearing habitat and spawning habitat was observed by Entrix (2000) in the most downstream surveyed reaches (i.e., Reaches 2 and 3). The total area of suitable juvenile rearing habitat reported for reaches 2 and 3 amounted to approximately 0.04% of the total amount of suitable juvenile rearing habitat in Coyote Creek, while the total amount of spawning area in reaches 2 and 3 amounted to approximately 3.8% of all spawning habitat in Coyote Creek.

Based on the relatively minor amounts of suitable juvenile rearing and spawning habitat reported in reaches 2 and 3 in Coyote Creek, the extent of the proposed sampling plan will exclude these reaches due to the assumption that they will not provide substantive amounts of suitable habitat for steelhead or fall-run Chinook salmon. Additional Reaches to be excluded from the random sampling plan only include reaches that were not surveyed by Entrix (2000) or are not accessible to anadromous fish, as indicated below.

- A degraded section of the Guadalupe River between Willow Street and Almaden Expressway (approximately 2 miles) in Reaches 2 and 3.
- Reach 3 of Alamitos Creek due to lack of access permissions on private property private property.
- Reach 1 of Coyote Creek because it is tidally-influenced.
- Most of Reach 2 (i.e., Harry Road to McKean Road) in Calero creek due to lack of access permissions on private property.
- Reach 4 in Upper Penitencia Creek due to a natural fish barrier.

Sample Size and Sample Selection Procedures

CDFW Random Sampling Procedures

The CDFW (Flosi, 2010) habitat typing procedure is a standardized methodology that physically describes 100 percent of the wetted channel. A basin-level habitat inventory is designed to produce a thorough description of the physical fish habitat using a classification that is on the scale of a stream's naturally occurring pool-riffle-run units. During basin-level habitat typing, full sampling of each habitat unit requires recording all characteristics of each habitat unit as per the "Instructions for completing the Habitat Inventory Data Form" (Part III in Flosi, 2010). However, CDFW determined that similar stream descriptive detail could be accomplished with a detailed habitat sampling level of approximately 10 percent (while still habitat typing 100% of the wetted channel), based on CDFW's analysis of over 200 stream habitat inventory data sets (Flosi, 2010). They recommended that an entire stream be habitat typed and that approximately 10%

of the stream's habitat units be randomly sampled completely according to the Flosi (2010) habitat inventory protocol in order to provide a basin level view of the stream for restoration planning purposes.

Sample Size Refinement

Because the subsampling procedures described by Flosi (2010) assume that a near-census habitat typing and suitability survey has not been completed on the target creeks, the 10% detailed habitat sampling guideline may not necessarily be required for this evaluation given the previously conducted habitat inventory during 1999 (Entrix 2000). Conducting habitat typing in 100% of the wetted channel of all streams was not considered due to the associated time and staff requirements. To answer the question of how much subsampling should be conducted, a series of Monte Carlo simulations were used to obtain a random sample (without replacement) of the habitat units of each particular reach that were inventoried in 1999 by Entrix (2000).

Monte Carlo simulation is a computerized mathematical technique that allows accounting for risk in quantitative analysis and decision-making. Monte Carlo simulation furnishes the decision-maker with a range of possible outcomes and the probabilities they will occur for any choice of action.

Monte Carlo simulation performs risk analysis by building models of possible results by substituting a range of values—a probability distribution—for any factor that has inherent uncertainty.

During a Monte Carlo simulation, values are sampled at random from the input probability distributions. Each set of samples is called an iteration, and the resulting outcome from that sample is recorded, numerous iterations are conducted, and the result is a probability distribution of possible outcomes.

The Monte Carlo estimate of a statistic's sampling distribution can be used in a variety of ways, including testing null hypotheses under a variety of plausible conditions.

The data collected during the near-census 1999 surveys of the creeks and streams in the study area (Entrix 2000) was used to evaluate whether 5% or 10% of the length of the streams would be subsampled.

For a given stream and reach, a Monte Carlo trial involved a random selection (without replacement) from the habitat units of the particular stream reach that were surveyed in 1999 until the sum of the lengths of the selected habitat units exceeded 5% or 10% of the reach length. A random selection without replacement implies that the resulting samples of habitat units will not contain repeated habitat units.

There are no general theoretical guidelines for the number of trials required for experimental results to be valid (Mooney 1997). Most simulations published include 1,000 or more trials, and simulations of 10,000 to 25,000 trials are not uncommon (Mooney 1997). For example, in an evaluation of Chinook salmon early lifestage freshwater survival associated with habitat improvements in tributaries to the Snake River, Oregon and Idaho, 1,000 Monte Carlo simulations were conducted (McHugh and Budy 2002). As another example, in conducting sensitivity analyses of model output estimating population metrics of fall-run Chinook salmon and steelhead associated with habitat conditions in Washington, 1,000 Monte Carlo simulations were attempted but 106 resulted in unusable parameter combinations (Steel et al. 2009).

For FAHCE evaluation purposes, the assessment consisted in performing a series of 5,100 Monte Carlo trials for specific stream reaches surveyed during 1999. Because the approach was intended to utilize at least 5,000 trial outcomes, 5,100 trials were conducted recognizing that some unknown number of trials would result in cases when the test statistic used in the evaluation (the t-statistic) could not be calculated (because the variance of the sampled data was equal to zero). Thus, a total of 5,100 random sampling simulations were performed for two sample sizes – 5% and 10% of the reach length for Reach 7 and Reach 8 of Coyote Creek, Reach 2 of Stevens Creek, and Reach 4 of the Guadalupe River.

For each habitat unit in the sample generated in a Monte Carlo iteration (or “trial”), the following five values were recorded:

- Habitat unit number,
- Habitat unit type,
- Habitat unit length (feet),
- Percentage of the habitat unit area suitable for 4" juveniles (%), and
- Amount of spawning gravel in the selected habitat unit (square feet).

Sample size (defined as a proportion of the length of a reach, 5% or 10%) simulations were performed with the 1999 habitat data to allow for an evaluation of the probability of whether the average value for two of the suitability metrics (area of suitable juvenile rearing habitat, and area of spawning gravel) were statistically significantly different from the average value of the two suitability metrics for the entire reach. Statistical significance was determined by performing two-tailed t-tests. Thus, for each sample generated in a Monte Carlo trial (*i*, with *i* ranging from 1 to 5,100) the following statistics were calculated:

- n_i, the sample size or number of habitat units in the sample generated in a Monte Carlo trial *i*.
- $\overline{X}_i$, the average percentage of the habitat unit area suitable for 4" juveniles (or the average area of the spawning gravels) in sample *i*.
- $S_{\overline{X}_i} = \sqrt{Var(X)_i / n_i}$, the sample standards error of the average percentage of the habitat unit area suitable for 4" juveniles (or the average area of the spawning gravels) in sample *i*.
- $t_i = \left(\overline{X}_i - \mu\right) / S_{\overline{X}_i}$, the t-statistic for the average percentage of the habitat unit area suitable for 4" juveniles (or the average area of the spawning gravels) in sample *i*.
- $t_{0.05(2),\, n_i - 1}$, the critical value for the two-tailed t-tests with a 5% significance level.

Whenever the absolute value of t_i was greater than $t_{0.05(2),\, n_i - 1}$ the null hypotheses were rejected. The two null hypotheses were: (1) the average percentage of the habitat unit area suitable for 4" juveniles in sample i is equal to the average of the habitat unit area suitable for 4" juveniles for all the habitat units surveyed in the particular stream reach during 1999; and (2) the average area of the spawning gravels in sample i is equal to the average area of the spawning gravels for all the habitat units surveyed in the particular stream reach during 1999.

The number of cases in which the null hypotheses are not rejected were counted over the 5,100 Monte Carlo simulations performed under the two sampling schemes (5% and 10% of the length of the stream reach), and divided by the number of cases over the 5,100 Monte Carlo simulations for which the t-tests were possible to assess the probability of obtaining results similar to those of 1999 under each of the two sampling schemes.

As with the number of trials required, there are no general theoretical guidelines for decision-making when comparing the resultant probabilities of not rejecting the null hypotheses under the two subsampling schemes of 5% or 10% of individual reach length. Examination of **Table 6** below indicates little difference (< 3%) between the two subsampling schemes of 5% and 10% associated with the first suitability metric (i.e., percent of suitable juvenile rearing habitat area). Based upon these results, application of a 5% subsampling scheme may be appropriate in consideration of increased efficiency and potential cost savings. Regarding the second suitability metric (i.e., area of spawning gravel) considered in Table 1, its is doubtful that a 5.2% or 6.6% difference between the two subsampling schemes warrants the additional expenditure of doubling the effort and cost (100% increase) of subsampling.

Table 6. Comparison of the resultant probabilities of not rejecting the null hypotheses under the two subsampling schemes of 5% or 10% of individual reach length.

Stream Reach	Prob. of not rejecting Ho Juvenile Suitable Area (%)			Prob. of not rejecting Ho Spawning Gravel Area (ft2)		
	5%	10%	Difference	5%	10%	Difference
Stevens Creek Reach 2	91.0%	93.6%	2.6%	75.8%	82.4%	6.6%
Coyote Creek Reach 7	91.8%	94.7%	2.9%	78.3%	83.5%	5.2%
Coyote Creek Reach 8	90.8%	90.1%	-0.7%	73.7%	75.0%	1.3%
Guadalupe River Reach 4	89.4%	90.4%	1.0%	85.5%	86.4%	0.9%

Based on the proposed 5% random sampling throughout most study area reaches, as well as 10% or 100% sampling in some of the recently modified reaches, it is currently estimated that at least 6% of the study area may be sampled during the 2016 field effort.

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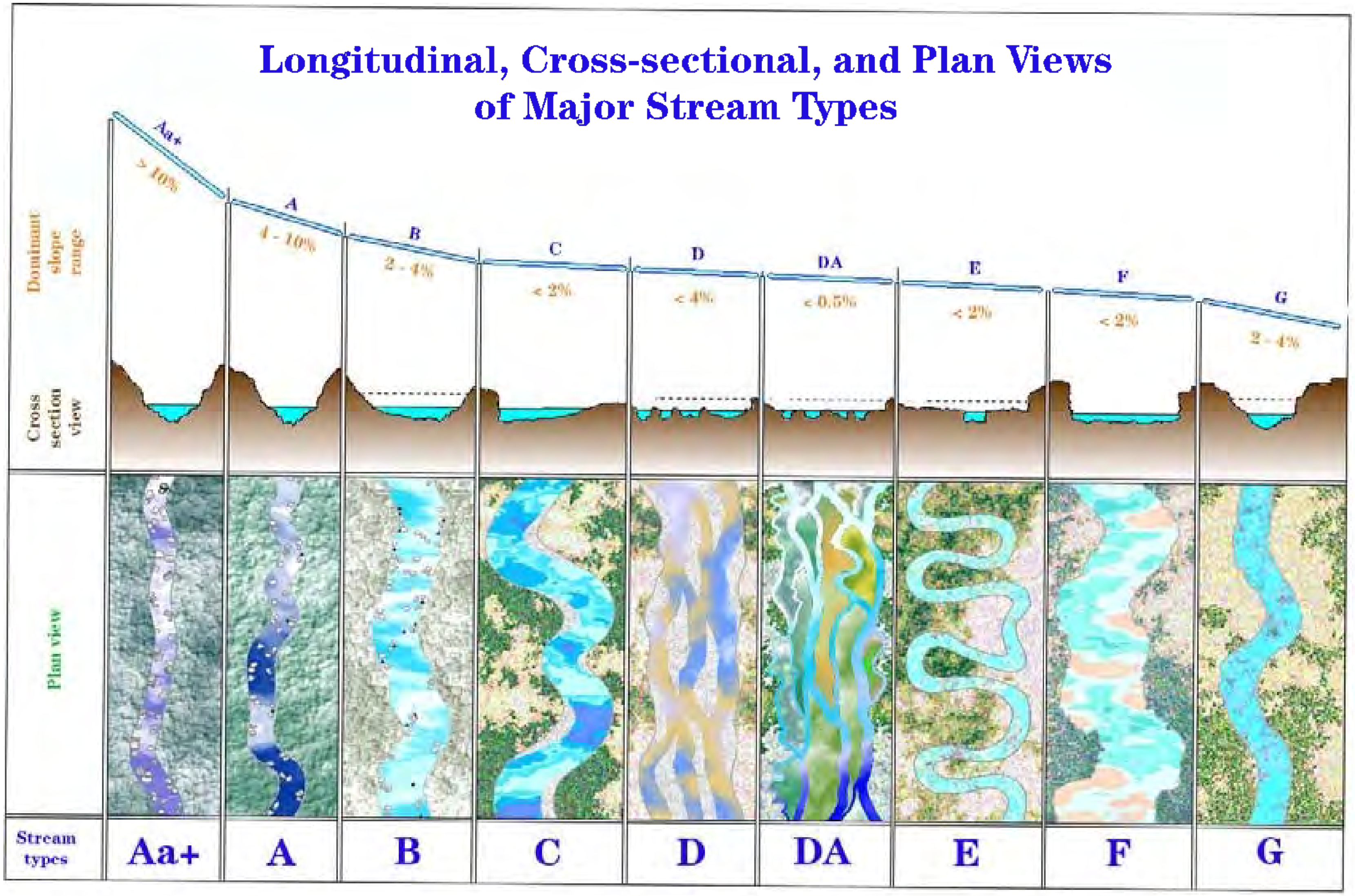
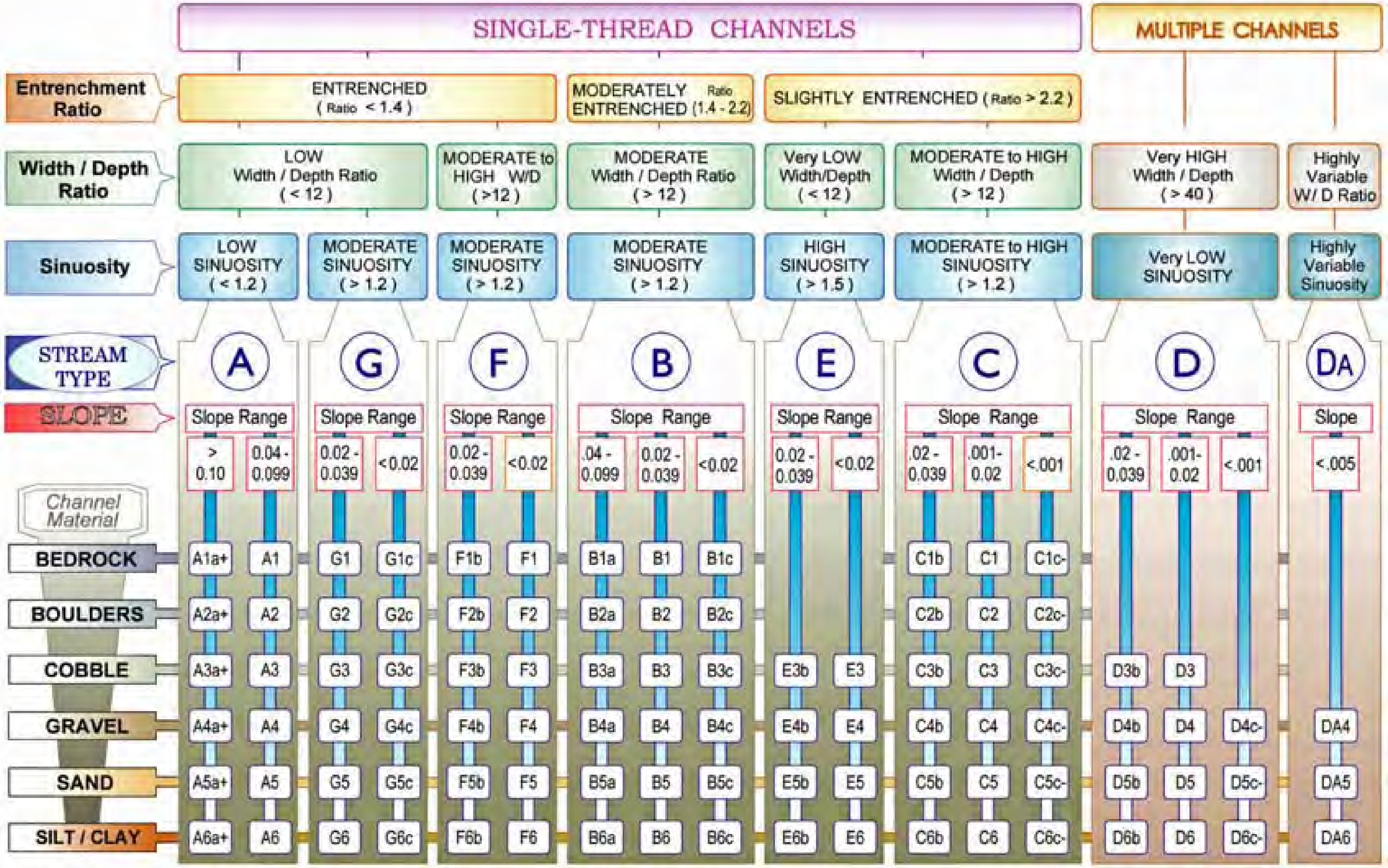
Santa Clara Valley Water District, U.S. Army Corps of Engineers – San Francisco District, and Stillwater Sciences. 2016. Water Year 2015 Mitigation Monitoring Reports for the Lower, Downtown, and Upper Guadalupe River Projects.

APPENDIX H
ROSGEN CLASSIFICATION





	SINGLE-THREAD CHANNELS														MULTIPLE CHANNELS			
Entrenchment Ratio	ENTRENCHED (Ratio < 1.4)						MODERATELY ENTRENCHED Ratio (1.4 - 2.2)			SLIGHTLY ENTRENCHED (Ratio > 2.2)								
Width / Depth Ratio	LOW Width / Depth Ratio (< 12)				MODERATE to HIGH W/D (>12)		MODERATE Width / Depth Ratio (> 12)			Very LOW Width/Depth (< 12)		MODERATE to HIGH Width / Depth (> 12)			Very HIGH Width / Depth (> 40)			Highly Variable W/ D Ratio
Sinuosity	LOW SINUOSITY (< 1.2)		MODERATE SINUOSITY (> 1.2)		MODERATE SINUOSITY (> 1.2)		MODERATE SINUOSITY (> 1.2)			HIGH SINUOSITY (> 1.5)		MODERATE to HIGH SINUOSITY (> 1.2)			Very LOW SINUOSITY			Highly Variable Sinuosity
STREAM TYPE	A		G		F		B			E		C			D			DA
SLOPE	Slope Range		Slope Range		Slope Range		Slope Range			Slope Range		Slope Range			Slope Range			Slope
Channel Material	> 0.10	0.04 - 0.099	0.02 - 0.039	<0.02	0.02 - 0.039	<0.02	.04 - 0.099	0.02 - 0.039	<0.02	0.02 - 0.039	<0.02	.02 - 0.039	.001- 0.02	<.001	.02 - 0.039	.001- 0.02	<.001	<.005
BEDROCK	A1a+	A1	G1	G1c	F1b	F1	B1a	B1	B1c			C1b	C1	C1c-				
BOULDERS	A2a+	A2	G2	G2c	F2b	F2	B2a	B2	B2c			C2b	C2	C2c-				
COBBLE	A3a+	A3	G3	G3c	F3b	F3	B3a	B3	B3c	E3b	E3	C3b	C3	C3c-	D3b	D3		
GRAVEL	A4a+	A4	G4	G4c	F4b	F4	B4a	B4	B4c	E4b	E4	C4b	C4	C4c-	D4b	D4	D4c-	DA4
SAND	A5a+	A5	G5	G5c	F5b	F5	B5a	B5	B5c	E5b	E5	C5b	C5	C5c-	D5b	D5	D5c-	DA5
SILT / CLAY	A6a+	A6	G6	G6c	F6b	F6	B6a	B6	B6c	E6b	E6	C6b	C6	C6c-	D6b	D6	D6c-	DA6

KEY to the *ROSGEN* CLASSIFICATION of NATURAL RIVERS. As a function of the *"continuum of physical variables"* within stream reaches, values of ***Entrenchment*** and ***Sinuosity*** ratios can vary by +/- 0.2 units; while values for ***Width / Depth*** ratios can vary by +/- 2.0 units.

Stream type	General description	Entrench-ment ratio	W/d ratio	Sinuosity	Slope	Landform/
Aa+	Very steep, deeply entrenched, debris transport, torrent streams	<1.4	<12	1.0 to 1.1	>.10	Very high relief. Erosional, bedrock, or depositional features; debris flow potential. Deeply entrenched streams. Vertical steps with deep scour pools; waterfalls
A	Steep, entrenched, cascading, step-pool streams. High energy/ debris transport associated with depositional soils. Very stable if bedrock or boulder-dominated channel	<1.4	<12	1.0 to 1.2	.04 to .10	High relief. Erosional or depositional and bedrock forms. Entrenched and confined streams with cascading reaches. Frequently spaced, deep pools in associated step-pool bed morphology
B	Moderately entrenched, moderate gradient, riffle dominated channel with infrequently spaced pools. Very stable plan and profile. Stable banks	1.4 to 2.2	>12	>1.2	.02 to .039	Moderate relief, colluvial deposition and/or structural. Moderate entrenchment and width-to-depth ratio. Narrow, gently sloping valleys. Rapids predominate with scour pools
C	Low gradient, meandering, point bar, riffle/pool, alluvial channels with broad, well-defined flood plains	>2.2	>12	>1.2	<.02	Broad valleys with terraces, in association with flood plains, alluvial soils. Slightly entrenched with well-defined meandering channels. Riffle/ pool bed morphology
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks	n/a	>40	n/a	<.04	Broad valleys with alluvium, steeper fans. Glacial debris and depositional features. Active lateral adjustment with abundance of sediment supply. Convergence/divergence bed features aggradational processes, high bed load and bank erosion
DA	Anastomizing (multiple channels) narrow and deep with extensive, well-vegetated flood plains and associated wetlands. Very gentle relief with highly variable sinuosities and width-to-depth ratios. Very stable streambanks	>2.2	Highly variable	Highly variable	<.005	Broad, low-gradient valleys with fine alluvium and/or lacustrine soils. Anastomized (multiple channel) geologic control creating fine deposition with well-vegetated bars that are laterally stable with broad wetland flood plains. Very low bed-load, high wash load sediment
E	Low gradient, meandering riffle/pool stream with low width-to-depth ratio and little deposition. Very efficient and stable. High meander width ratio	>2.2	<12	>1.5	<.02	Broad valley/meadows. Alluvial materials with flood plains. Highly sinuous with stable, well-vegetated banks. Riffle/pool morphology with very low width-to-depth ratios
F	Entrenched meandering riffle/pool channel on low gradients with high width-to-depth ratio	<1.4	>12	>1.2	<.02	Entrenched in highly weathered material. Gentle gradients with a high width-to-depth ratio. Meandering, laterally unstable with high bank erosion rates. Riffle/pool morphology
G	Entrenched gully step-pool and low width-to-depth ratio on moderate gradients	<1.4	<12	>1.2	.02 to .039	Gullies, step-pool morphology with moderate slopes and low width-to-depth ratio. Narrow valleys, or deeply incised in alluvial or colluvial materials (fans or deltas). Unstable, with grade control problems and high bank erosion rates

Habitat Inventory Training Photos – August 23, 2016

A habitat typing field training was conducted by Bob Coey (NMFS) according to the CDFW Stream Restoration Manual protocol (Flosi et al. 2010) on August 23, 2016 at Porter Creek in the Russian River Watershed. Participants included NMFS, CDFW and SCVWD staff.

Participant	Affiliation
Bob Coey	NMFS
Dan Wilson	NMFS
Andy Trent	NMFS
Tami Schane	CDFW
Jason Nishijima	SCVWD
Les Layng	SCVWD
Jae Abel	SCVWD
Joe Chavez	SCVWD
Chris Van Amburg	SCVWD
Jennifer Watson	SCVWD
Clayton Leal	SCVWD
Morgan Neal	HDR

Figure 2. Habitat typing training at Porter Creek on August 23, 2016 with NMFS, CDFW and SCVWD staff.

Figure 3. Habitat typing training at Porter Creek on August 23, 2016 – assessing bank composition metrics.

Figure 4. Habitat typing training at Porter Creek on August 23, 2016 – assessing habitat types.

Figure 5. Habitat typing training at Porter Creek on August 23, 2016 – looking upstream from downstream end of Unit 1 in Reach 2.

Figure 6. Habitat typing training at Porter Creek on August 23, 2016 – NMFS and SCVWD staff measuring habitat unit dimensions and depths.

Figure 7. Habitat typing training at Porter Creek on August 23, 2016 – assessing habitat unit characteristics in Reach 2.

Figure 8. Habitat typing training at Porter Creek on August 23, 2016 – example of a habitat unit with low amount of instream cover (<10%) and instream cover of low complexity.

Figure 9. Habitat typing training at Porter Creek on August 23, 2016 – example of a habitat unit with relatively high amount of instream cover (~40%) and instream cover of medium to high complexity.

Figure 10. Habitat typing training at Porter Creek on August 23, 2016 – NMFS and SCVWD staff assessing habitat unit dimensions and characteristics.

Appendix N – Fisheries Habitat Availability Estimation Methodology

Attachment B – Summary of Lifestage Timing Information Reviewed

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Table B-1. Literature Review on Steelhead Adult Immigration Periodicity

Steelhead Adult Immigration Timing	
Resource Citation	**Relevant Findings**
Entrix, Inc. 2003. 2002 Fish Trapping Study Data Summary for San Antonio and Arroyo Hondo final Report.Sacramento, CA. Prepared for Bureau of Strategic and Systems Planning Public Utilities Commission City and County of San Francisco. April 3, 2003. 19 pp.	Immigrating adults in San Antonio Creek were captured between February 8 and March 23 with a peak on March 8, immigrating adults in Arroyo Hondo were captured between February 15 and March 7 (pages 3 and 4).
Fisheries and Aquatic Habitat Collaborative Effort (FAHCE). 2003a. Fisheries and Aquatic Habitat Collaborative Effort Summary Report. February 26, 2003.	An adult steelhead immigration period of November through April is identified (figure 3, page 13).
FAHCE. 2003b. Settlement Agreement Regarding Water Rights of the Santa Clara Valley Water District on Coyote, Guadalupe, and Stevens Creeks. January 6, 2003.	This reports mentions winter base flows from November 1 to April 30 (all throughout document) to benefit steelhead spawning and incubation, but does not mention benefits to adult immigration. However, pulse flows between February 1 to April 30 are mentioned to facilitate immigration of adult steelhead (all throughout document).
Fukushima, L. and E. W. Lesh. 1998. Adult and Juvenile Anadromous Salmonid Migration Timing in California Streams. *California Fish and Game.* 84(3):133-145.	For all tributaries of the San Francisco Bay included in this report, except for the Sacramento River (November to April), they reported that adult steelhead migrate between December and April (appendix 1, pages 141-142).
Holmes, R. W. and W. Cowan. Instream Flow Evaluation Steelhead Spawning and Rearing, Big Sur River, Monterey County. Technical Report 14-2. Water Branch Instream Flow Program, California Department of Fish and Wildlife, Sacramento, CA.	An adult steelhead immigration period of November through May is identified (figure 2, page 4).
Liedy, R. A. 2007. Ecology, Assemblage Structure, Distribution, and Status of Fishes in Streams Tributary to the San Francisco Estuary, California. United States Environmental Protection Agency: San Francisco Estuary Institute. April 2007. Contribution No. 530.	Steelhead within the San Francisco Estuary may be classified as *ocean-maturing* or *winter* steelhead that typically begin their spawning migration during the fall and winter, and spawn within a few weeks to a few months from when they enter freshwater (McEwan and Jackson 1996, page 105); Because of releases of cold water from large Central Valley reservoirs and the large number of hatchery derived fish, steelhead may begin to move into upstream tributaries as early as August and September. Upstream migrating steelhead may be observed within San Francisco Bay and Suisun Marsh/Bay between August and March (page 105).
McEwan, D., and T.A. Jackson. 1996. Steelhead restoration and management plan for California. California Department of Fish and Game, Sacramento, CA.	Ocean-maturing steelhead (winter steelhead) typically begin their spawning migration in fall and winter and spawn within a few weeks to a few months from the time they enter fresh water. Ocean-maturing steelhead generally spawn January through March, but spawning can extend into spring and possibly early summer months (Overview of Steelhead Biology, page 22).
Merz, J. E., D. G. Delaney, J. D. Setka, and M. L. Workman. Seasonal Rearing Habitat in a Large Mediterranean-climate River: Management Implications at the Southern Extent of Pacific Salmon (*Oncorhynchus Spp.*). *River Research and Applications* . September 2015.	Adults immigrants are observed from October through March (page 2).
Moyle, P. B. 2002. Inland fishes of California. Revised and expanded. Berkeley, University of California Press. 502 pp.	California winter steelhead enter coastal streams after rains increase flow, which in turn breach sandbars on mouth lagoons and permit passage through lower reaches. Fish may move upstream any time during the period December-March, although peaks for such activity are typically in January and February (page 279).
Nishijima, J., L. Porcella, and D. Salsbery. 2009. Masson Fishway 2007-2008 Monitring Report and Alamitos and Masson Fishway 2003-2008 Summary Report. Guadalupe Watershed Program Support Unit, Santa Clara Valley Water District. San Jose, California. April 2009. 14 pp.	The timing of the steelhead run in Guadalupe Creek in 2007-08 was later than observed in 2006-07. The bulk of the steelhead recorded in 2007 were in March, while the majority of steelhead showed up in 2008 in April (Figure 23). The timing of steelhead occurrence does not seem tied to flow events, since the early spring flows were similar across the years. However, temperature data (Figure 24 and 25) show that water temperature at the Masson Fishway increased earlier in the 2007 season than in 2008, implying the temperature may have had an effect on the timing of steelhead migration each season (page 5).
Santa Clara Valley Water District (SCVWD). 2000. Summary and Conclusions FAHCE TAC Evaluation of the Effects of Santa Clara Valley Water District Facilities and Operations on Factors Limiting Habitat Availability and Quality for Steelhead and Chinook Salmon. February 25, 2000.	An adult steelhead immigration period of January through April is identified (exhibit 5, page 5 and table, page 36).
Shapovalov, L., and A. C. Taft. 1954. The life histories of the steelhead rainbow trout (Salmo gairdneri gairdneri) and silver salmon (Oncorhynchus kisutch). California Department of Fish and Game, Fish Bulletin 98: 1-275.	In general, the bulk of the fish enter the streams and spawn in the winter and spring, but it is probable that in the larger rivers, such as the Sacramento, Eel, Klamath, and Columbia, some steelhead enter from the sea in all or nearly all months (page 108); Steelhead, like silver salmon, ascend both on rising and falling stream levels, but cease movement during peak floods (page 142).
Williams, J. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. *San Francisco Estuary and Watershed Science* . 4(3): 1-398.	Anadromous steelhead enter freshwater mainly from August through November, but RBDD ladder records show that a few enter at all times of year (page 33).

Table B-2. Literature Review on Steelhead Adult Spawning Periodicity

Steelhead Adult Spawning Timing	
Resource Citation	**Relevant Findings**
Fisheries and Aquatic Habitat Collaborative Effort (FAHCE). 2003a. Fisheries and Aquatic Habitat Collaborative Effort Summary Report. February 26, 2003.	A steelhead spawning period of January through April is identified (figure 3, page 13).
FAHCE. 2003b. Settlement Agreement Regarding Water Rights of the Santa Clara Valley Water District on Coyote, Guadalupe, and Stevens Creeks. January 6, 2003.	This report mentions winter base flows from November 1 to April 30 (all throughout document) to benefit steelhead spawning and incubation.
Hallock, R. J., W. F. Van Woert, and L. Shapovalov. 1961. An Evaluation of Stocking Hatchery-reared Steelhead Rainbow Trout (Salmo Gairdnerii Gairdnerii) in the Sacramento River System. California Department of Fish and Game, Fish Bulletin 114: 1-74.	A steelhead spawning period from the latter part of December through April is identified as well as a peak in February (page 16).
Holmes, R. W. and W. Cowan. Instream Flow Evaluation Steelhead Spawning and Rearing, Big Sur River, Monterey County. Technical Report 14-2. Water Branch Instream Flow Program, California Department of Fish and Wildlife, Sacramento, CA.	An adult steelhead spawning period of December through May is identified (figure 2, page 4).
Liedy, R. A. 2007. Ecology, Assemblage Structure, Distribution, and Status of Fishes in Streams Tributary to the San Francisco Estuary, California. United States Environmental Protection Agency: San Francisco Estuary Institute. April 2007. Contribution No. 530.	Ocean-maturing (winter) steelhead typically spawn between December and April, with most spawning occurring between January through March (Moyle 2002, page 105).
McEwan, D., and T.A. Jackson. 1996. Steelhead restoration and management plan for California. California Department of Fish and Game, Sacramento, CA.	In California, most steelhead spawn from December through April (Overview of Steelhead Biology, page 19); Ocean-maturing steelhead (winter steelhead) generally spawn January through March, but spawning can extend into spring and possibly early summer months (Overview of Steelhead Biology, page 22).
Santa Clara Valley Water District (SCVWD). 2000. Summary and Conclusions FAHCE TAC Evaluation of the Effects of Santa Clara Valley Water District Facilities and Operations on Factors Limiting Habitat Availability and Quality for Steelhead and Chinook Salmon. February 25, 2000.	A steelhead spawning period of January through April is identified (Exhibit 5, page 5 and table, page 36).
Williams, J. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. *San Francisco Estuary and Watershed Science*. 4(3): 1-398.	Spawning occurs mainly from December through April (Hallock et al. 1961), so adults typically spend a few months in freshwater before spawning (page 33-34).

Table B-3. Literature Review on Steelhead Embryo Incubation Periodicity

Steelhead Embryo Incubation Timing	
Resource Citation	**Relevant Findings**
Fisheries and Aquatic Habitat Collaborative Effort (FAHCE). 2003a. Fisheries and Aquatic Habitat Collaborative Effort Summary Report. February 26, 2003.	A steelhead embryo incubation period of January through May is identified (figure 3, page 13).
FAHCE. 2003b. Settlement Agreement Regarding Water Rights of the Santa Clara Valley Water District on Coyote, Guadalupe, and Stevens Creeks. January 6, 2003.	This report mentions winter base flows from November 1 to April 30 (all throughout document) to benefit steelhead spawning and incubation.
Holmes, R. W. and W. Cowan. Instream Flow Evaluation Steelhead Spawning and Rearing, Big Sur River, Monterey County. Technical Report 14-2. Water Branch Instream Flow Program, California Department of Fish and Wildlife, Sacramento, CA.	An egg incubation period of December through June is identified (figure 2, page 4).
McEwan, D., and T.A. Jackson. 1996. Steelhead restoration and management plan for California. California Department of Fish and Game, Sacramento, CA.	The legnth of time it takes for eggs to hatch depends mostly on water temperature. Hatchling of steelhead eggs in hatcheries takes about 30 days at 51^{o} F (Leitritz and Lewis 1980). Fry emerge from the gravel usually about four to six weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft 1954, Overview of Steelhead Biology, page 19).
Merz, J. E., D. G. Delaney, J. D. Setka, and M. L. Workman. 2015. Seasonal Rearing Habitat in a Large Mediterranean-climate River: Management Implications at the Southern Extent of Pacific Salmon (*Oncorhynchus Spp.*). *River Research and Applications*. September 2015.	Age 0 steelhead typically appear in February (page 2).
Moyle, P. B. 2002. Inland fishes of California. Revised and expanded. Berkeley, University of California Press. 502 pp.	Eggs hatch in 3-4 weeks (at 10-15^{o}C), and fry emerge from the gravel 2-3 weeks later (page 279).
Santa Clara Valley Water District (SCVWD). 2000. Summary and Conclusions FAHCE TAC Evaluation of the Effects of Santa Clara Valley Water District Facilities and Operations on Factors Limiting Habitat Availability and Quality for Steelhead and Chinook Salmon. February 25, 2000.	A steelhead embryo incubation period of January through April is identified (exhibit 5, page 5 and table, page 36).
Shapovalov, L., and A. C. Taft. 1954. The life histories of the steelhead rainbow trout (Salmo gairdneri gairdneri) and silver salmon (Oncorhynchus kisutch). California Department of Fish and Game, Fish Bulletin 98: 1-275.	The number of days required for steelhead eggs to hatch varies from about 19 at an average temperature of 60° F. to about 80 at an average temperature of 40° F. At the temperatures prevailing in Waddell Creek, the usual hatching time is from 25 to 35 days (page 154-155).
Williams, J. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. *San Francisco Estuary and Watershed Science*. 4(3): 1-398.	Juvenile steelhead emerge from late winter to summer (page 34).

Table B-4. Literature Review on Steelhead Juvenile Rearing Periodicity

Steelhead Juvenile Rearing Timing	
Resource Citation	**Relevant Findings**
Fisheries and Aquatic Habitat Collaborative Effort (FAHCE). 2003a. Fisheries and Aquatic Habitat Collaborative Effort Summary Report. February 26, 2003.	Reaing is identified as year-round (figure 3, page 13).
FAHCE. 2003b. Settlement Agreement Regarding Water Rights of the Santa Clara Valley Water District on Coyote, Guadalupe, and Stevens Creeks. January 6, 2003.	This report mentions maintaining cool water temperatures (18-19^{o} C) from May 1 - October 31 to support stealhead juvenile rearing (all throughout document).
Holmes, R. W. and W. Cowan. Instream Flow Evaluation Steelhead Spawning and Rearing, Big Sur River, Monterey County. Technical Report 14-2. Water Branch Instream Flow Program, California Department of Fish and Wildlife, Sacramento, CA.	A year-round juvenile rearing period is identified (figure 2, page 4).
Merz, J. E., D. G. Delaney, J. D. Setka, and M. L. Workman. 2015. Seasonal Rearing Habitat in a Large Mediterranean-climate River: Management Implications at the Southern Extent of Pacific Salmon (*Oncorhynchus Spp.*). *River Research and Applications*. September 2015.	They rear in freshwater for one or more years (page 2).
Santa Clara Valley Water District (SCVWD). 2000. Summary and Conclusions FAHCE TAC Evaluation of the Effects of Santa Clara Valley Water District Facilities and Operations on Factors Limiting Habitat Availability and Quality for Steelhead and Chinook Salmon. February 25, 2000.	A period of May through October is identified for rearing (exhibit 5, page 5 and table, page 36).
Satterthwaite, W. H., M. P. Beakes, E. M. Collins, D. R. Swank, J. E. Merz, R. G. Titus, S. M. Sogard, and M. Mangel. 2009. Steelhead Life History on California's Central Coast: Insights from a State-dependent Model. *Transactions of the American Fisheries Society*. 138: 532-548.	A variety of gentic cues and environmental factors influence the "decision" to continue rearing, smolt, or mature and become residents thus resulting in a wide array of steelhead life histories. These cues and factors were modeled using a state-dependent model to predict the observed patterns in variation on California's Central Coast. At this time it is not clear how this information can be integrated into the FAHCE model.
Satterthwaite, W. H., M. P. Beakes, E. M. Collins, D. R. Swank, J. E. Merz, R. G. Titus, S. M. Sogard, and M. Mangel. 2010. State-dependent life history models in a changing (and regulated) environment: steelhead in the California Central Valley. *Evolutionary Applications*. 3: 221-243.	A variety of gentic cues and environmental factors influence the "decision" to continue rearing, smolt, or mature and become residents thus resulting in a wide array of steelhead life histories. These cues and factors were modeled using a state-dependent model to predict the observed patterns in variation on California's Central Valley. At this time it is not clear how this information can be integrated into the FAHCE model.
Shapovalov, L., and A. C. Taft. 1954. The life histories of the steelhead rainbow trout (Salmo gairdneri gairdneri) and silver salmon (Oncorhynchus kisutch). California Department of Fish and Game, Fish Bulletin 98: 1-275.	This is most markedly brought out by the fact that the young steelhead migrate down at various ages from + to 4, while practically all of the silver salmon migrate downstream as yearlings. While the salmon go to sea almost immediately, some of the steelhead remain for a whole season in the lagoon or the lower portion of the stream, after which some move out to sea, while others make an upstream migration and then a second downstream migration. While most of the steelhead go to sea before maturing, some fish of both sexes spawn before going to sea, while still others complete their life cycles without going to sea at all (page 158).
Sogard, S. M., J. E. Merz, W. H. Satterthwaite, M. P. Beakes, D. R. Swank, E. M Collins, R. G. Titus, and M. Mangel. 2012. Contrasts in Habitat Characteristics and Life History Patterns of Oncorhynchus mykiss in California's Central Coast and Central Valley. *Transactions of the American Fisheries Society*. 141: 747-760.	A variety of gentic cues and environmental factors influence the "decision" to continue rearing, smolt, or mature and become residents thus resulting in a wide array of steelhead life histories. These cues and factors were modeled using a state-dependent model to predict the observed patterns in variation on California's Central Coast and in California's Central Valley. At this time it is not clear how this information can be integrated into the FAHCE model.
Williams, J. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. *San Francisco Estuary and Watershed Science*. 4(3): 1-398.	Naturally produced steelhead from the upper Sacramento River and tributaries spend one to three, but usually two, years in fresh water before emigrating, usually in the spring (page 34).

Table B-5. Literature Review on Steelhead Juvenile Outmigration Periodicity

Steelhead Juvenile Outmigration Timing	
Resource Citation	**Relevant Findings**
Beakes, M. P., W. H. Satterthwaite, E. M. Collins, D. R. Swank, J. E. Merz, R. G. Titus, S. M. Sogard, and M. Mangel. 2010. Smolt Transformation in Two California Steelhead Populations: Effects of Temporal Variability in Growth. *Transactions of the American Fisheries Society*. 139: 000-000.	Reports a Northern California Central Valley (NCCV) outmigration timing of mid-December through early May and a central California coast (CCC) outmigration timing of March through July (figure 1, page 4).
Fisheries and Aquatic Habitat Collaborative Effort (FAHCE). 2003a. Fisheries and Aquatic Habitat Collaborative Effort Summary Report. February 26, 2003.	A smolt outmigration period of January through May is identified (figure 3, page 13).
FAHCE. 2003b. Settlement Agreement Regarding Water Rights of the Santa Clara Valley Water District on Coyote, Guadalupe, and Stevens Creeks. January 6, 2003.	This report identifies target flow conditions/pulse flows for facilitating juvenile steelhead outmigration from February 1 through April 30 (all throughout document).
Holmes, R. W. and W. Cowan. Instream Flow Evaluation Steelhead Spawning and Rearing, Big Sur River, Monterey County. Technical Report 14-2. Water Branch Instream Flow Program, California Department of Fish and Wildlife, Sacramento, CA.	A juvenile outmigration period of November through June is identified (figure 2, page 4).
Merz, J. E., D. G. Delaney, J. D. Setka, and M. L. Workman. 2015. Seasonal Rearing Habitat in a Large Mediterranean-climate River: Management Implications at the Southern Extent of Pacific Salmon (*Oncorhynchus Spp.*). *River Research and Applications*. September 2015.	Most emigration occurs from Febraury to July (page 2).
Santa Clara Valley Water District (SCVWD). 2000. Summary and Conclusions FAHCE TAC Evaluation of the Effects of Santa Clara Valley Water District Facilities and Operations on Factors Limiting Habitat Availability and Quality for Steelhead and Chinook Salmon. February 25, 2000.	A period of February through May is identified (exhibit 5, page 5 and table, page 36).
Shapovalov, L., and A. C. Taft. 1954. The life histories of the steelhead rainbow trout (Salmo gairdneri gairdneri) and silver salmon (Oncorhynchus kisutch). California Department of Fish and Game, Fish Bulletin 98: 1-275.	Smolt outmigration is shown to occur all year with a peak through the spring and summer (Figures 11-19, pages 76-84).
Williams, J. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. *San Francisco Estuary and Watershed Science*. 4(3): 1-398.	Naturally produced steelhead from the upper Sacramento River and tributaries spend one to three, but usually two, years in fresh water before emigrating, usually in the spring (page 34).

Table B-6. Literature Review on Chinook Salmon Adult Immigration Periodicity

Chinook Salmon Adult Immigration Timing	
Resource Citation	**Relevant Findings**
Fisheries and Aquatic Habitat Collaborative Effort (FAHCE). 2003a. Fisheries and Aquatic Habitat Collaborative Effort Summary Report. February 26, 2003.	An adult Chinook salmon immigration period of August through December is identified (figure 3, page 13).
FAHCE. 2003b. Settlement Agreement Regarding Water Rights of the Santa Clara Valley Water District on Coyote, Guadalupe, and Stevens Creeks. January 6, 2003.	This report mentions winter base flows from November 1 to April 30 (all throughout document) to benefit Chinook salmon spawning and incubation, but never specifically mentions adult migration.
Fukushima, L. and E. W. Lesh. 1998. Adult and Juvenile Anadromous Salmonid Migration Timing in California Streams. *California Fish and Game.* 84(3):133-145.	For all tributaries of the San Francisco Bay, except for the Sacramento River, a Chinook salmon immigration period is not reported. For the Sacramento River, a fall-run Chinook salmon immigration period of August through December is reported (appendix 1, pages 141-142).
Liedy, R. A. 2007. Ecology, Assemblage Structure, Distribution, and Status of Fishes in Streams Tributary to the San Francisco Estuary, California. United States Environmental Protection Agency: San Francisco Estuary Institute. April 2007. Contribution No. 530.	Within Estuary tributaries, adult fall-run Chinook salmon migrations have been observed from August through January (Yoshiyama et. al. 1998 and 2001, page 102).
Merz, J. E., D. G. Delaney, J. D. Setka, and M. L. Workman. 2015. Seasonal Rearing Habitat in a Large Mediterranean-climate River: Management Implications at the Southern Extent of Pacific Salmon (*Oncorhynchus Spp.*). *River Research and Applications*. September 2015.	Adults enter freshwater from August through December, peaking in late October (page 2).
Merz, J., M. Workman, D. Threloff, and B. Cavallo. 2013. Salmon Life Cycle Considerations to Guide Stream Management: Examples from California's Central Valley. *San Francisco Estuary and Watershed Science*. 11(2): 1-26.	Reported a generalized Central Valley fall-run Chinook salmon immigration timing of June through December with the highest concentrations during October and November (table 1, page 5).
Moyle, P. B. 2002. Inland fishes of California. Revised and expanded. Berkeley, University of California Press. 502 pp.	An adult Chinook salmon immigration period of June through December with a peak of September through October for Sacramento River basin fall-run Chinook salmon is identified (table 11, Yoshiyama et al. 1998, page 255).
Nishijima, J., L. Porcella, and D. Salsbery. 2009. Masson Fishway 2007-2008 Monitring Report and Alamitos and Masson Fishway 2003-2008 Summary Report. Guadalupe Watershed Program Support Unit, Santa Clara Valley Water District. San Jose, California. April 2009. 14 pp.	Observations of adult Chinook salmon immigration demonstrate a period of mid-October through January (Figures 18-22, pages 11-13)
Santa Clara Valley Water District (SCVWD). 2000. Summary and Conclusions FAHCE TAC Evaluation of the Effects of Santa Clara Valley Water District Facilities and Operations on Factors Limiting Habitat Availability and Quality for Steelhead and Chinook Salmon. February 25, 2000.	An adult Chinook salmon immigration period of October through December is identified (exhibit 5, page 5 and table, page 36).
Williams, J. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. *San Francisco Estuary and Watershed Science*. 4(3): 1-398.	Fall-run enter the rivers from late summer to fall, and spawn shortly after arriving on their spawning grounds (page 26).
Zeug, S. C., K. Sellheim, C. Watry, J. D. Wikert, and J. Merz. 2014. Response of Juvenile Chinook Salmon to Managed Flow: Lessons Learned from a Population at the Southern Extent of their Range in North America. *Fisheries Management and Ecology*. 1-14.	In general, adults migrate from the Pacific Ocean to natal streams between August and December and spawning is initiated shortly after (page 2).

Table B-7. Literature Review on Chinook Salmon Adult Spawning Periodicity

Chinook Salmon Adult Spawning Timing	
Resource Citation	**Relevant Findings**
Fisheries and Aquatic Habitat Collaborative Effort (FAHCE). 2003a. Fisheries and Aquatic Habitat Collaborative Effort Summary Report. February 26, 2003.	A Chinook salmon spawning period of October through December is identified (figure 3, page 13).
FAHCE. 2003b. Settlement Agreement Regarding Water Rights of the Santa Clara Valley Water District on Coyote, Guadalupe, and Stevens Creeks. January 6, 2003.	This report mentions winter base flows from November 1 to April 30 (all throughout document) to benefit Chinook salmon spawning and incubation.
Liedy, R. A. 2007. Ecology, Assemblage Structure, Distribution, and Status of Fishes in Streams Tributary to the San Francisco Estuary, California. United States Environmental Protection Agency: San Francisco Estuary Institute. April 2007. Contribution No. 530.	Within Estuary tributaries, Chinook salmon spawning has been observed from September through January (Yoshiyama et. al. 1998 and 2001, page 102).
Merz, J., M. Workman, D. Threloff, and B. Cavallo. 2013. Salmon Life Cycle Considerations to Guide Stream Management: Examples from California's Central Valley. *San Francisco Estuary and Watershed Science*. 11(2): 1-26.	Reported a generalized Central Valley fall-run Chinook salmon spawn timing of late-September through January with the highest concentration from late October to December (table 1, page 5).
Moyle, P. B. 2002. Inland fishes of California. Revised and expanded. Berkeley, University of California Press. 502 pp.	A Chinook salmon spawning period of late September through December for Sacramento River basin fall-run Chinook salmon is identified (table 11, Yoshiyama et al. 1998, page 255).
Santa Clara Valley Water District (SCVWD). 2000. Summary and Conclusions FAHCE TAC Evaluation of the Effects of Santa Clara Valley Water District Facilities and Operations on Factors Limiting Habitat Availability and Quality for Steelhead and Chinook Salmon. February 25, 2000.	A Chinook salmon spawning period of October through February is identified (exhibit 5, page 5 and table, page 36).
Williams, J. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. *San Francisco Estuary and Watershed Science*. 4(3): 1-398.	Fall-run enter the rivers from late summer to fall, and spawn shortly after arriving on their spawning grounds (page 26).
Zeug, S. C., K. Sellheim, C. Watry, J. D. Wikert, and J. Merz. 2014. Response of Juvenile Chinook Salmon to Managed Flow: Lessons Learned from a Population at the Southern Extent of their Range in North America. *Fisheries Management and Ecology*. 1-14.	Spawning peaks from early October to late November (page 2).

Table B-8. Literature Review on Chinook Salmon Embryo Incubation Periodicity

Chinook Salmon Embryo Incubation Timing	
Resource Citation	**Relevant Findings**
Fisheries and Aquatic Habitat Collaborative Effort (FAHCE). 2003a. Fisheries and Aquatic Habitat Collaborative Effort Summary Report. February 26, 2003.	A Chinook salmon embryo incubation period of October through February is identified (figure 3, page 13).
FAHCE. 2003b. Settlement Agreement Regarding Water Rights of the Santa Clara Valley Water District on Coyote, Guadalupe, and Stevens Creeks. January 6, 2003.	This report mentions winter base flows from November 1 to April 30 (all throughout document) to benefit Chinook salmon spawning and incubation.
Merz, J. E., D. G. Delaney, J. D. Setka, and M. L. Workman. 2015. Seasonal Rearing Habitat in a Large Mediterranean-climate River: Management Implications at the Southern Extent of Pacific Salmon (*Oncorhynchus Spp.*). *River Research and Applications*. September 2015.	Age 0 Chinook first appear in seine samples during late December (page 2).
Merz, J., M. Workman, D. Threloff, and B. Cavallo. 2013. Salmon Life Cycle Considerations to Guide Stream Management: Examples from California's Central Valley. *San Francisco Estuary and Watershed Science*. 11(2): 1-26.	Reported a generalized Central Valley fall-run Chinook salmon embryo incubation period of October to mid-April with the highest concentration from November through March (table 1, page 5).
Moyle, P. B. 2002. Inland fishes of California. Revised and expanded. Berkeley, University of California Press. 502 pp.	For maximum embryo survival, water temperatures must be between 5 and 13° C and oxygen level must be close to saturation. Under such conditions embryos hatch in 40-60 days and remain in the gravel as sac-fry for another 4-6 weeks, usually until the yolk sac is fully absorbed. (page 257).
Santa Clara Valley Water District (SCVWD). 2000. Summary and Conclusions FAHCE TAC Evaluation of the Effects of Santa Clara Valley Water District Facilities and Operations on Factors Limiting Habitat Availability and Quality for Steelhead and Chinook Salmon. February 25, 2000.	A Chinook salmon embryo incubation period of October through February is identified (exhibit 5, page 5 and table, page 36).
Williams, J. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. *San Francisco Estuary and Watershed Science*. 4(3): 1-398.	Fall-run fry emerge from December into April, depending on the date of spawning and water temperature during incubation, and exhibit two main life-history patterns. Most begin migrating as fry, shortly after emergence (Rutter 1904, Hatton 1940), and most of these apparently rear for one to three months in the Delta before moving into the bays (Ch. 5). However, some continue directly through Carquinez Strait into San Pablo Bay (Hatton 1940). Analogous groups in Puget Sound have recently been described as "delta users" and "fry migrants" (Greene and Beechie 2004). Of the Chinook that do not leave the gravel-bed reaches as fry, most do so as parr or silvery parr by May or early June, before the lower rivers become intolerably warm, and pass fairly quickly through the Delta. These larger migrants are sometimes called "fingerlings" or "90-day Chinook"or "smolts," although few of them develop the full suite of developmental characteristics of smolts while they are still in the rivers (Ch. 5). The relative contributions of fry and pre-smolt migrants to returns are not known, although there is good evidence that the survival of the larger migrants is much higher (Ch. 10).
Zeug, S. C., K. Sellheim, C. Watry, J. D. Wikert, and J. Merz. 2014. Response of Juvenile Chinook Salmon to Managed Flow: Lessons Learned from a Population at the Southern Extent of their Range in North America. *Fisheries Management and Ecology*. 1-14.	Incubation typically occurs from October through March (page 3).

Table B-9. Literature Review on Chinook Salmon Juvenile Rearing Periodicity

Chinook Salmon Juvenile Rearing Timing	
Resource Citation	**Relevant Findings**
Fisheries and Aquatic Habitat Collaborative Effort (FAHCE). 2003a. Fisheries and Aquatic Habitat Collaborative Effort Summary Report. February 26, 2003.	This report identifies a period of January to June (figure 3, page 13).
FAHCE. 2003b. Settlement Agreement Regarding Water Rights of the Santa Clara Valley Water District on Coyote, Guadalupe, and Stevens Creeks. January 6, 2003.	This report does not mention juvenile Chinook salmon rearing.
Liedy, R. A. 2007. Ecology, Assemblage Structure, Distribution, and Status of Fishes in Streams Tributary to the San Francisco Estuary, California. United States Environmental Protection Agency: San Francisco Estuary Institute. April 2007. Contribution No. 530.	The freshwater residency time for juvenile Chinook salmon may range from 1-7 months (Yoshiyama et al. 1998 and 2001, page 102).
Merz, J. E., D. G. Delaney, J. D. Setka, and M. L. Workman. 2015. Seasonal Rearing Habitat in a Large Mediterranean-climate River: Management Implications at the Southern Extent of Pacific Salmon (*Oncorhynchus Spp.*). *River Research and Applications*. September 2015.	Typically over 95% of juveniles leave the non-tidal Lower Mokelumne River by July (page 2).
Merz, J., M. Workman, D. Threloff, and B. Cavallo. 2013. Salmon Life Cycle Considerations to Guide Stream Management: Examples from California's Central Valley. *San Francisco Estuary and Watershed Science*. 11(2): 1-26.	Reported a generalized Central Valley fall-run Chinook salmon rearing period of mid-December to early July with the highest concentration from February through May (table 1, page 5).
Santa Clara Valley Water District (SCVWD). 2000. Summary and Conclusions FAHCE TAC Evaluation of the Effects of Santa Clara Valley Water District Facilities and Operations on Factors Limiting Habitat Availability and Quality for Steelhead and Chinook Salmon. February 25, 2000.	A period of February through June is identified (exhibit 5, page 5 and table, page 36).
Williams, J. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. *San Francisco Estuary and Watershed Science*. 4(3): 1-398.	Fall-run fry emerge from December into April, depending on the date of spawning and water temperature during incubation, and exhibit two main life-history patterns. Most begin migrating as fry, shortly after emergence (Rutter 1904, Hatton 1940), and most of these apparently rear for one to three months in the Delta before moving into the bays (Ch. 5). However, some continue directly through Carquinez Strait into San Pablo Bay (Hatton 1940). Analogous groups in Puget Sound have recently been described as "delta users" and "fry migrants" (Greene and Beechie 2004). Of the Chinook that do not leave the gravel-bed reaches as fry, most do so as parr or silvery parr by May or early June, before the lower rivers become intolerably warm, and pass fairly quickly through the Delta. These larger migrants are sometimes called "fingerlings" or "90-day Chinook"or "smolts," although few of them develop the full suite of developmental characteristics of smolts while they are still in the rivers (Ch. 5). The relative contributions of fry and pre-smolt migrants to returns are not known, although there is good evidence that the survival of the larger migrants is much higher (Ch. 10).

Table B-10. Literature Review on Chinook Salmon Juvenile Outmigration Periodicity

Chinook Salmon Juvenile Outmigration Timing	
Resource Citation	**Relevant Findings**
Fisheries and Aquatic Habitat Collaborative Effort (FAHCE). 2003a. Fisheries and Aquatic Habitat Collaborative Effort Summary Report. February 26, 2003.	A Chinook salmon smolt outmigration period of April through June is identified (figure 3, page 13).
FAHCE. 2003b. Settlement Agreement Regarding Water Rights of the Santa Clara Valley Water District on Coyote, Guadalupe, and Stevens Creeks. January 6, 2003.	This report identifies target flow conditions/pulse flows for facilitating juvenile Chinook salmon outmigration from February 1 through April 30 (all throughout document).
Merz, J. E., D. G. Delaney, J. D. Setka, and M. L. Workman. 2015. Seasonal Rearing Habitat in a Large Mediterranean-climate River: Management Implications at the Southern Extent of Pacific Salmon (*Oncorhynchus Spp.*). *River Research and Applications*. September 2015.	Juveniles primarily emigrate in their first year, and typically over 95% of juveniles leave the non-tidal Lower Mokelumne River by July (page 2).
Merz, J., M. Workman, D. Threloff, and B. Cavallo. 2013. Salmon Life Cycle Considerations to Guide Stream Management: Examples from California's Central Valley. *San Francisco Estuary and Watershed Science*. 11(2): 1-26.	Reported a generalized Central Valley fall-run Chinook salmon fry emigration period of late-December through May with the highest concentration from February through March (table 1, page 5) Also reported a generalized Central Valley fall-run Chinook salmon smolt emigration period of March thru mid-July with the highest concentration from April through mid-June (table 1, page 5).
Santa Clara Valley Water District (SCVWD). 2000. Summary and Conclusions FAHCE TAC Evaluation of the Effects of Santa Clara Valley Water District Facilities and Operations on Factors Limiting Habitat Availability and Quality for Steelhead and Chinook Salmon. February 25, 2000.	A Chinook salmon smolt outmigration period of April through June is identified (exhibit 5, page 5 and table, page 36).
Williams, J. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. *San Francisco Estuary and Watershed Science*. 4(3): 1-398.	Fall-run fry emerge from December into April, depending on the date of spawning and water temperature during incubation, and exhibit two main life-history patterns. Most begin migrating as fry, shortly after emergence (Rutter 1904, Hatton 1940), and most of these apparently rear for one to three months in the Delta before moving into the bays (Ch. 5). However, some continue directly through Carquinez Strait into San Pablo Bay (Hatton 1940). Analogous groups in Puget Sound have recently been described as “delta users” and “fry migrants” (Greene and Beechie 2004). Of the Chinook that do not leave the gravel-bed reaches as fry, most do so as parr or silvery parr by May or early June, before the lower rivers become intolerably warm, and pass fairly quickly through the Delta. These larger migrants are sometimes called “fingerlings” or “90-day Chinook”or “smolts,” although few of them develop the full suite of developmental characteristics of smolts while they are still in the rivers (Ch. 5). The relative contributions of fry and pre-smolt migrants to returns are not known, although there is good evidence that the survival of the larger migrants is much higher (Ch. 10).
Zeug, S. C., K. Sellheim, C. Watry, J. D. Wikert, and J. Merz. 2014. Response of Juvenile Chinook Salmon to Managed Flow: Lessons Learned from a Population at the Southern Extent of their Range in North America. *Fisheries Management and Ecology*. 1-14.	Emigration occurs from late December to early July (page 3).

Appendix O

Use of Habitat Data in Support of CEQA Analysis for FAHCE Draft Fish Habitat Restoration Plan

Appendix O – Use of Habitat Data in Support of CEQA Analysis for FAHCE Draft Fish Habitat Restoration Plan

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Santa Clara Valley
Water District

MEMORANDUM

FC 14 (01-02-07)

TO:	SCVWD FAHCE Team	**FROM**:	Jason Nishijima, Associate Water Resources Specialist through Sarah Young, Senior Project Manager
SUBJECT:	Use of Habitat Data in Support of CEQA Analysis for FAHCE Fish Habitat Restoration Plan	**DATE**:	February 23, 2017

Purpose and Background

This memo provides the administrative record to document the use of habitat data collected in 2016 and 1999 to support CEQA analysis for FAHCE including the Fish Habitat Restoration Plan actions. The selected data on habitat types and conditions are applied in the Habitat Availability Estimation Methodology[1] to evaluate the effects of FAHCE proposed reservoir reoperation rule curves to fulfill CEQA requirements.

Habitat Data Selection Process

In 2016, the Entrix Data Verification Workplan (SCVWD 2016) was developed to test the validity and application of the 1999 Entrix data (Entrix 2000) for establishing baseline habitat availability. Field surveys were conducted consistent with the Workplan. FAHCE Technical Work Group (TWG) reviewed and refined the procedures in the Workplan and provided training opportunities to SCVWD team for conducting field surveys.

Measurements were taken in 380 habitat units within 69 sampling sites covering 7.4 miles of stream habitat; the areas covered in the sampling represents 10.5% of the stream length sampled by Entrix in 1999 in those reaches. Also, included in the District data are water quality measurements collected at the request of the California Department of Fish and Wildlife. SCVWD provided fisheries habitat and water quality data collected between August 25 and October 27, 2016.

This data collection effort is to verify the utility of the Entrix dataset in representing the baseline habitat conditions. If verified, the Entrix data will be utilized in the FAHCE TWG modeling efforts, if not, the 2016 data may be used to represent baseline habitat conditions. To examine whether or not the habitat proportions in 1999 are consistent with current habitat proportions, the amount of riffle, flatwater, and pool habitat per geomorphic reach[2] was compared to the corresponding subset collected in 2016 through a Chi-Square Goodness of Fit Test. The Chi-Square Goodness of Fit Test is used to determine whether sample data are consistent with a hypothesized distribution

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[1] For this effort data was viewed in relation to Reaches of Interest (ROI) and Points of Interest (POI). ROI are discrete reaches of stream in the Three Creeks that most likely to support specific life-stages of salmonids. POI are discrete points within ROI where temperature and flow model results will be generated and evaluated. (Attachment 1.)

[2] As part of the 1999 effort the Three Creeks were delineated by geomorphic reach. (Entrix 2000)

Table 1. Chi-Square Goodness of Fit Test for FAHCE Habitat Data

	% Length habitat unit according to 2016 Field Survey			% Length habitat unit according to Entrix Survey			Test Statistic	Critical Value	
Entrix Reach	Riffle	Flatwater/ Run	Pool	Riffle	Flatwater/ Run	Pool	X^2	$X^2_{0.05,3}$	
ALC1	26.8	49.5	23.7	16.6	48.3	35.2	**10.02**	**5.991**	Reject
ALC2	33.0	67.0	0.0	30.3	41.6	28.1	**43.95**	**5.991**	Reject
ALC3		Unsurveyed			Unsurveyed		Unsurveyed in 2016		
CAC1	0.0	92.6	7.4	27.1	46.6	26.3	**86.10**	**5.991**	Reject*
CAC2	0.0	81.5	18.5	3.8	72.5	23.1	**5.80**	**5.991**	Accept*
COC1		Unsurveyed			Unsurveyed		Unsurveyed in 2016		
COC2		Unsurveyed		0.0	0.2	0.8	Unsurveyed in 2016		
COC3		Unsurveyed		0.1	0.2	0.8	Unsurveyed in 2016		
COC4	0.3	6.8	92.9	2.8	6.5	90.7	**2.33**	**5.991**	Accept
COC5	7.7	34.3	57.9	1.9	15.8	82.3	**46.77**	**5.991**	Reject
COC6	6.9	19.4	73.7	2.9	19.4	77.7	**5.80**	**5.991**	Accept
COC7	7.1	58.2	34.7	10.2	25.2	64.7	**58.06**	**5.991**	Reject
COC8	17.1	19.9	63.0	12.4	22.8	64.8	**2.23**	**5.991**	Accept
GUC1	34.1	58.5	7.4	16.2	39.9	43.9	**58.93**	**5.991**	Reject
GUC2	46.3	30.6	23.1	21.9	29.0	49.2	**41.09**	**5.991**	Reject
GUC3	42.7	35.0	22.3	18.2	30.1	47.2	**47.05**	**5.991**	Reject
GUR1	0.0	21.6	78.4	2.2	22.8	75.0	**2.44**	**5.991**	Accept
GUR2	5.3	45.6	49.2	7.4	14.7	77.9	**75.66**	**5.991**	Reject
GUR3	0.0	100.0	0.0	1.4	48.4	50.3	**106.83**	**5.991**	Reject*
GUR4	23.2	45.2	31.6	4.3	28.5	67.2	**111.52**	**5.991**	Reject
LGC1	24.1	32.8	43.1	15.2	37.2	47.5	**6.17**	**5.991**	Reject
STC1	27.0	64.1	8.9	9.4	55.4	35.2	**53.85**	**5.991**	Reject
STC2	49.5	34.1	16.4	18.3	39.4	42.3	**69.67**	**5.991**	Reject
STC3	32.7	36.8	28.7	13.7	37.6	48.7	**34.68**	**5.991**	Reject
STC4	24.4	29.1	46.6	13.5	25.8	60.7	**12.42**	**5.991**	Reject
UPC1	58.8	41.2	0.0	42.1	40.0	17.9	**24.56**	**5.991**	Reject*
UPC2	44.5	46.8	8.7	22.8	55.6	21.6	**29.64**	**5.991**	Reject
UPC3	23.7	46.2	30.1	23.6	49.5	26.6	**0.69**	**5.991**	Accept
UPC4		Unsurveyed		23.5	44.0	32.4	Unsurveyed in 2016		

* 2016 sample size was less than 5 habitat units

Conclusion and Rationale for Data Source Selection

Not surprisingly, habitat characteristics in the Three Creeks changed due to geomorphic processes, habitat restoration efforts, and other channel or hydrological alterations. The results (Table 1) demonstrate that while only six out of the 24 sampled reaches were found consistent, the remaining showed statistically significant differences between the datasets.

The 2016 habitat data was prioritized to represent habitat type proportion for most geomorphic reaches with a few exceptions supplemented by the 1999 Entrix data. This provides a reasonably robust characterization of the habitat conditions for key reaches. The reaches where 1999 Entrix data will be used were identified and rationale are provided as follows:

A. The downstream portion of Coyote Creek including two geomorphic reaches identified by Entrix in 1999 (COC2 and COC3) were not sampled in 2016 as they were identified as ROI relevant for passage only. Additionally, at the time, access to these reaches presented a threat to staff health and safety.

B. Sections of Upper Penitencia Creek (UPC1 and UPC4) had limited wetted area to sample in 2016, the end of a five-year extreme drought cycle.

C. The subsampling in a section of Alamitos Creek (ALC2) was represented by 3 habitat units and lacked riffle habitat. The data collected by Entrix in 1999 was considered a better representation as it mapped 85 habitat units and included riffles, flatwater, and pools, which were confirmed as present in 2016, although missed by the sampling.

D. One section of Alamitos Creek (ALC3) was not sampled by Entrix or SCVWD due to a lack of access. A surrogate in Guadalupe Creek (GUC3) was selected as the most similar reach with available data. ALC3 and GUC3 were most similar in channel slope, Entrix 1999 channel designation, and level of development when compared to other potential surrogate reaches.

E. A small tidal portion of Coyote Creek (COC1) was not sampled in either effort and was excluded from the modeling as it was considered inconsequential for the analysis.

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Jason Nishijima, Associate Water Resources Specialist

Reference Materials

ENTRIX Data Verification Workplan.docx. Santa Clara Valley Water District. August 16, 2016.

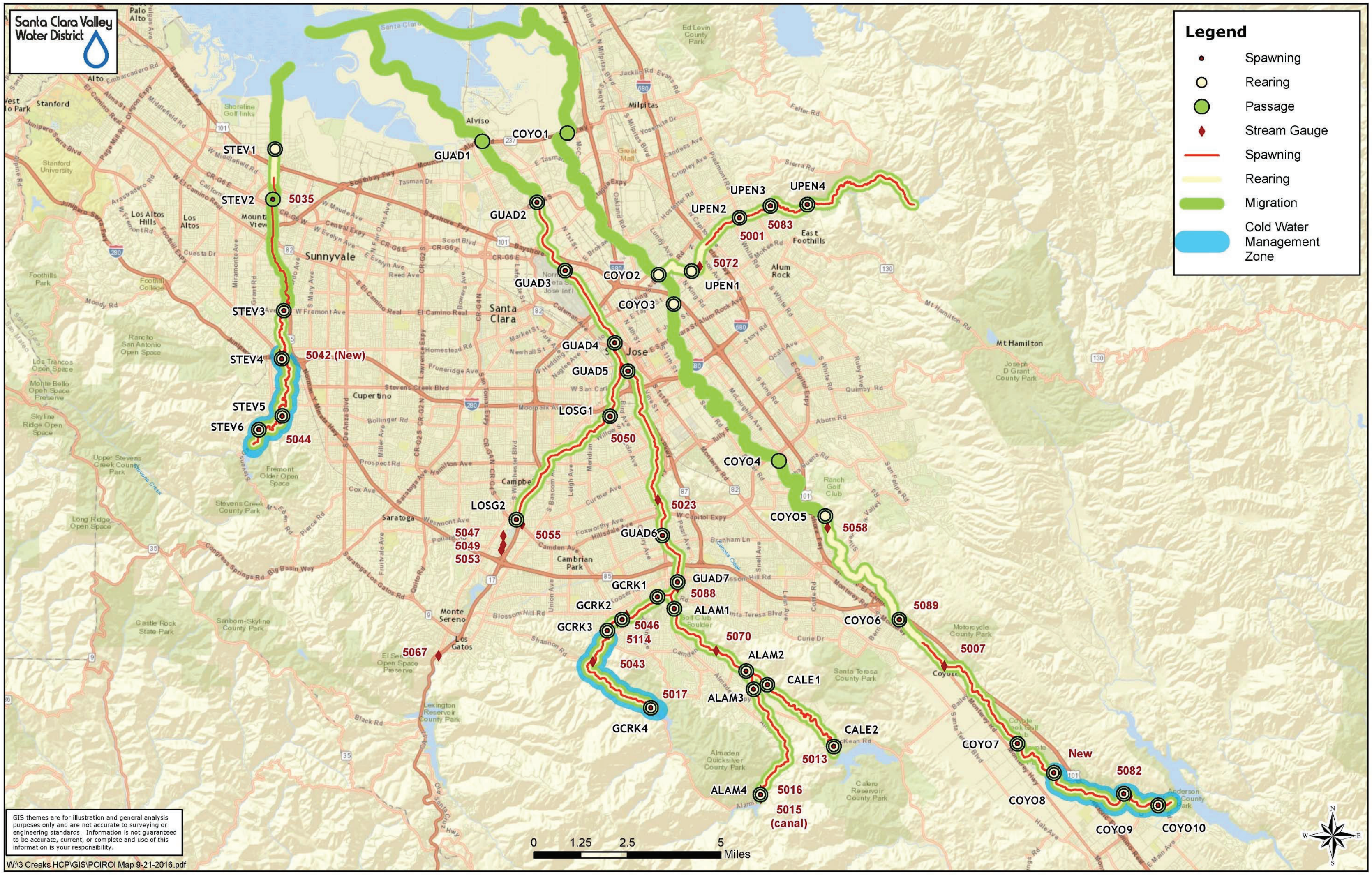
Stream Habitat Inventory Summary Report for the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE), Entrix. May 5, 2000.

Attachments:

Attachment 1. Map of Three Creeks Reaches of Interest/Points of Interest

cc: A. Fulcher (SCVWD), Jim Fiedler, Vincent Gin, Debra Caldon, Garth Hall

Attachment 1. Map of Three Creeks Reaches of Interest/Points of Interest



DRAFT MEMORANDUM

FC 14 (01-02-07)

TO: Sarah Young, Senior Project Manager

FROM: Jason Nishijima, Associate Water Resources Specialist,

SUBJECT: Selection of Data for Model Integration

DATE: February 6, 2017

PURPOSE

The Santa Clara Valley Water District (District) is leading a modeling effort to evaluate the effects of proposed reservoir reoperation rule curves in the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) Three Creeks[1] to fulfill CEQA requirements. The purpose of this memo is to document, for the administrative record, the rationale for selecting data sets to be used in model development.

The District has been providing its consultants, HDR and Stockholm Environment Institute (SEI), habitat data to feed into a model based on a Fisheries Habitat Availability Estimation Methodology[2]. One source provided by the District included relatively comprehensive habitat data collected by Entrix in 1999[3]. In 2016 approximately 10% of the stream habitat in the Three Creeks were revisited by the District[4] in an effort to test the validity and applicability of the Entrix 1999 data set and to document current conditions. This memo provides the rationale used in selecting from the data collected by Entrix in 1999 and the data collected in 2016 to represent habitat reaches in the Habitat Availability Estimation Model.

For this effort data was viewed in relation to Reaches of Interest (ROI) and Points of Interest (POI)[5]. ROI are discrete reaches of stream in the Three Creeks that most likely to support specific life-stages of salmonids. POI are discrete points within ROI where temperature and flow model results will be generated and evaluated.

Rationale for data source selection

Habitat data associated with a POI were scrutinized and selected for inclusion in the Fisheries Habitat Availability Estimation Model. The 2016 field survey data was prioritized to represent habitat type proportion for most geomorphic reaches with a few exceptions where Entrix 1999 data was used. These exceptions are:

- The downstream portion of Coyote Creek including two geomorphic reaches identified by Entrix in 1999 (COC2 and COC3) were not sampled in 2016 as they were identified as ROI relevant for passage only. Additionally, the reaches presented a threat to staff health and safety.
- Sections of Upper Penitencia Creek (UPC1 and UPC4) had limited wetted area to sample in 2016, the end of a five-year extreme drought cycle.

- The subsampling in a section of Alamitos Creek (ALC2) was represented by 3 habitat units and lacked riffle habitat. The data collected by Entrix in 1999 was considered a better representation as it mapped 85 habitat units and included riffles, flatwater, and pools, which were confirmed as present in 2016, although missed by the sampling.
- One section of Alamitos Creek (ALC3) was not sampled by Entrix or the District due to a lack of access. A surrogate in Guadalupe Creek (GUC3) was selected as the most similar reach with available data. ALC3 and GUC3 were most similar in channel slope, Entrix 1999 channel designation[3], and level of development when compared to other potential surrogate reaches.
- A small tidal portion of Coyote Creek (COC1) was not sampled in either effort and was excluded from the modeling as it was considered inconsequential for the analysis.

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Jason Nishijima, Associate Water Resources Specialist

Reference Materials

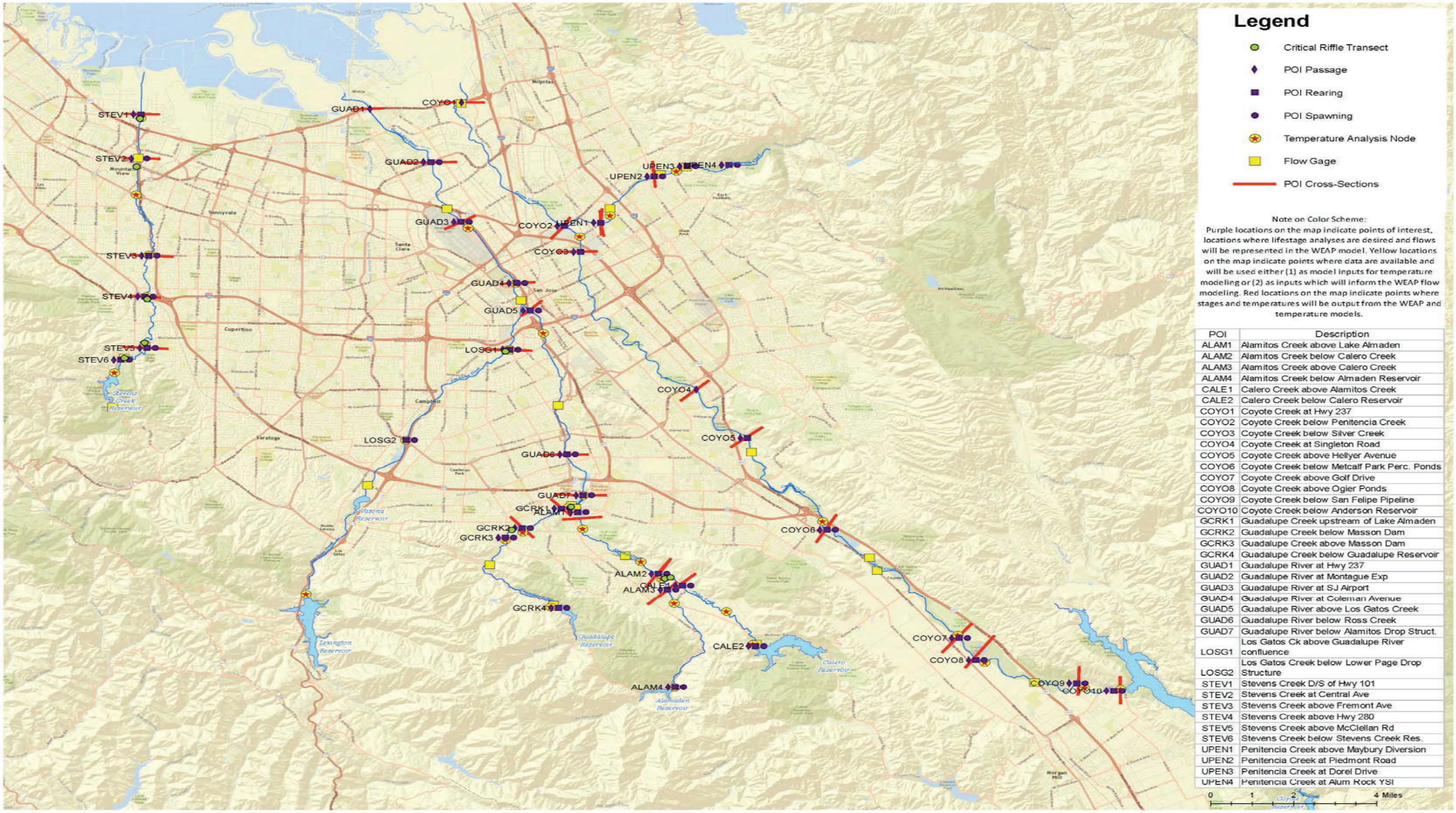
[1] Draft Settlement Agreement Regarding Water Rights of the Santa Clara Valley Water District on Coyote, Guadalupe, and Stevens Creeks. SWRCB Division of Water Rights. January 6, 2003.
[2]Fisheries Habitat Availability Estimation Methodology. HDR. February 6, 2017
[3]Stream Habitat Inventory Summary Report for the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE), Entrix. May 5, 2000.
[4] ENTRIX Data Verification Workplan.docx. Santa Clara Valley Water District. August 16, 2016.
[5] TWG Map: Points_of_interest_finalized_042016. Distributed to TWG April 24, 2016.

Attachments:

Attachment 1. Points_of_interest_finalized_042016

cc: A. Fulcher (SCVWD), H. Kennedy (HDR)

Attachment 1.



Note on Color Scheme:

Purple locations on the map indicate points of interest, locations where lifestage analyses are desired and flows will be represented in the WEAP model. Yellow locations on the map indicate points where data are available and will be used either (1) as model inputs for temperature modeling or (2) as inputs which will inform the WEAP flow modeling. Red locations on the map indicate points where stages and temperatures will be output from the WEAP and temperature models.

POI	Description
ALAM1	Alamitos Creek above Lake Almaden
ALAM2	Alamitos Creek below Calero Creek
ALAM3	Alamitos Creek above Calero Creek
ALAM4	Alamitos Creek below Almaden Reservoir
CALE1	Calero Creek above Alamitos Creek
CALE2	Calero Creek below Calero Reservoir
COYO1	Coyote Creek at Hwy 237
COYO2	Coyote Creek below Penitencia Creek
COYO3	Coyote Creek below Silver Creek
COYO4	Coyote Creek at Singleton Road
COYO5	Coyote Creek above Hellyer Avenue
COYO6	Coyote Creek below Metcalf Park Perc. Ponds
COYO7	Coyote Creek above Golf Drive
COYO8	Coyote Creek above Ogier Ponds
COYO9	Coyote Creek below San Felipe Pipeline
COYO10	Coyote Creek below Anderson Reservoir
GCRK1	Guadalupe Creek upstream of Lake Almaden
GCRK2	Guadalupe Creek below Masson Dam
GCRK3	Guadalupe Creek above Masson Dam
GCRK4	Guadalupe Creek below Guadalupe Reservoir
GUAD1	Guadalupe River at Hwy 237
GUAD2	Guadalupe River at Montague Exp
GUAD3	Guadalupe River at SJ Airport
GUAD4	Guadalupe River at Coleman Avenue
GUAD5	Guadalupe River above Los Gatos Creek
GUAD6	Guadalupe River below Ross Creek
GUAD7	Guadalupe River below Alamitos Drop Struct.
LOSG1	Los Gatos Ck above Guadalupe River confluence
LOSG2	Los Gatos Creek below Lower Page Drop Structure
STEV1	Stevens Creek D/S of Hwy 101
STEV2	Stevens Creek at Central Ave
STEV3	Stevens Creek above Fremont Ave
STEV4	Stevens Creek above Hwy 280
STEV5	Stevens Creek above McClellan Rd
STEV6	Stevens Creek below Stevens Creek Res.
UPEN1	Penitencia Creek above Maybury Diversion
UPEN2	Penitencia Creek at Piedmont Road
UPEN3	Penitencia Creek at Dorel Drive
UPEN4	Penitencia Creek at Alum Rock YSI

SANTA CLARA VALLEY WATER DISTRICT – FISH AND AQUATIC HABITAT COLLABORATIVE EFFORT (FAHCE)

REFINED POINTS OF INTEREST AND FLOW/TEMPERATURE ANALYSIS LOCATIONS

Appendix O – Use of Habitat Data in Support of CEQA Analysis for FAHCE Draft Fish Habitat Restoration Plan

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Appendix P

Terrestrial Biological Resources Technical Memorandum

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Appendix P – Terrestrial Biological Resources Technical Memorandum

Fish and Aquatic Habitat Collaborative Effort
Final Program Environmental Impact Report

Santa Clara Valley Water District

Santa Clara County, California

May 2023

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Appendix P – Terrestrial Biological Resources Technical Memorandum

Contents

Tables

Attachments

Glossary of Terms and Abbreviations

AIS	Aerial Information Systems, Inc.
CDFW	California Department of Fish and Wildlife (CDFW
CEQA	California Environmental Quality Act
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CRPR	California Rare Plant Rank
CWHR	California Wildlife Habitat Relationship
CWMZ	Cold-water management zone
EIR	Environmental Impact Report
ESA	Endangered Species Act
IPaC	Information Planning and Conservation
SMP	Stream Maintenance Program
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
Valley Water	Santa Clara Valley Water District
VHP	Valley Habitat Plan
§	Section

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Appendix P – Terrestrial Biological Resources Technical Memorandum

1 Terrestrial Biological Resources Technical Memorandum

The information below was used in the analysis for the terrestrial biological resources section of the Environmental Impact Report (EIR).

1.1 Study Area

The project area described in Chapter 2 *Project Description* of the EIR includes the basins of two watersheds in northern Santa Clara County, California, where Santa Clara Valley Water District (Valley Water) holds water rights licenses: Stevens Creek and Guadalupe River. The study area, as it pertains to the terrestrial biological analysis, is limited to specific streams and adjacent habitat that occur within these two watersheds that could be affected by implementation of the proposed project.

The total length of all creeks and rivers in the study area is approximately 90,136 miles, which comprises the following aquatic features (collectively referred to as “streams” or “creeks”) that could be directly or indirectly affected by project-related activities:

- Stevens Creek (22.28 miles)
- Guadalupe Creek (9.83 miles)
- Guadalupe River (21.68 miles)
- Calero Creek (3.97 miles)
- Alamitos Creek (7.68 miles)
- Los Gatos Creek (24.83 miles)

To assess impacts from implementation of the non-flow measures where the location of the proposed work is known, a buffer of 500 feet on either side of stream/creek centerline was applied to the cold-water management zone (CWMZ) reaches, while a buffer of 1,000 feet was added to the outer perimeter of the barrier remediation locations. It is assumed that the applied buffer areas overestimate the areas that could accommodate any potential staging areas or access needs for project activities and provide sufficient area to consider indirect impacts on terrestrial biological resources. It should be noted that efforts to avoid or minimize impacts on sensitive habitats and special-status species would be considered during project planning and implementation.

1.1.1 Reference Materials

Baseline information on wildlife resources in the study area, including special-status species and their habitats, was compiled from existing published and unpublished literature describing biological resources in the region, environmental database searches, consultation with local wildlife professionals, and information provided by staff from the California Department of Fish and Wildlife (CDFW), U.S. Fish and Wildlife Service’s (USFWS) Pacific Southwest Region, Valley Water, and U.S. Army Corps of Engineers (USACE). Project-related documentation was reviewed for site-specific data regarding habitat suitability for special-status species. Primary data sources drawn on to characterize the environmental setting in the study area included the following:

- CDFW California Natural Diversity Database (CNDDB; CDFW 2021a)
- CDFW California Wildlife Habitat Relationship (CWHR) Database (CDFW 2021b)
- California Native Plant Society (CNPS) Inventory of Rare, Threatened, and Endangered Plants (CNPS 2021)
- Google Earth mapping service aerial images of the proposed study area (Google Earth 2021)
- *Santa Clara County General Plan* (Santa Clara County 1994)

- *Santa Clara Valley Habitat Plan* (VHP; ICF 2012)
- USFWS Information Planning and Conservation (IPaC) System (USFWS 2021a)
- USFWS Critical Habitat Portal (USFWS 2021b)
- USFWS National Wetlands Inventory (USFWS 2021c)
- U.S. Department of Agriculture (USDA) Web Soil Survey (USDA 2021)

The USFWS IPaC System was queried to identify special-status species under USFWS jurisdiction that have the potential to occur in the study area, and the USFWS Critical Habitat Portal was queried to identify designated critical habitat in or adjacent to the study area. The USFWS National Wetlands Inventory was queried for information on wetlands and water/land cover types throughout the study area.

A query of the CNDDB provided a list of known occurrences for special-status species in all quadrangles that overlap the study area, including the Mountain View, Mindego Hills, Cupertino, Milpitas, San Jose East, San Jose West, Castle Rock Ridge, Los Gatos, Santa Teresa Hills, Laurel, and Loma Prieta California, U.S. Geological Survey (USGS) 7.5-minute quadrangles. Further, the CWHR database was referenced when categorizing land cover types and the USDA Web Soil Survey was queried to categorize soil types within the study area. It should be noted that these quadrangles include areas outside of the study area.

The CNPS Inventory of Rare, Threatened, and Endangered Plants was queried for special-status plant species with state or federal designations, in addition to those listed with a California Rare Plant Rank (CRPR) with a listing status of ~~1A or 1B~~ 1A, 1B, 2A, and 2B with the potential to occur within the study area.

The Santa Clara VHP, particularly Chapter 2 *Land Use and Covered Activities*, Chapter 3 *Physical and Biological Resources*, and the species accounts in Appendix C, was used to cross reference query data and further inform decisions regarding biological resources. Lastly, Google Earth aerial imagery and USGS topographical maps were reference when evaluating a species potential to occur within the study area.

Supplementing the above sources, the following were also used:

- Documents prepared for Valley Water's evaluation of its Dam Maintenance Program (for example, the *Dam Maintenance Program Programmatic Environmental Impact Report* [SCVWD 2012a])
- Documents prepared for Valley Water's Stream Maintenance Program (SMP) Update
- Almaden Calero Canal Rare Plant Surveys, 2016–2017 (SCVWD 2016–2017)

The following data were used to provide additional information for the study area:

- Land cover data for the study area was taken from the Classification and Assessment with LANDSAT of Visible Ecological Groupings dataset (CALVEG 2021)
- Data on special-status species occurrences compiled by Valley Water since 2001 were collected and reviewed, including the CWHR database (CDFW 2021b) and *California Bird Species of Special Concern* (Shuford and Gardali 2008)
- *The Jepson Manual: Vascular Plants of California* (Baldwin et al. 2012), which supplied information regarding the distribution and habitats of vascular plants in Santa Clara County

1.1.2 Vegetation Mapping

Aerial Information Systems, Inc. (AIS) conducted vegetation mapping of streams and canals in the study area for Valley Water's SMP in 2012. This information was supplemented by landcover mapping by CALVEG (2021), which was then mapped against the CWHR according to the methodology used in the SMP to determine land cover within portions of the study area that were not within the AIS-surveyed areas. Vegetation units were mapped by AIS by using aerial photographic interpretation and interactive computer digitization methods. The vegetation classification system was based on *A Manual of California Vegetation* (Sawyer et al. 2009). Each vegetation unit was coded to the group level (or alliance level where possible) and assigned a cover class density for the vegetation type mapped. The AIS mapping involved a reconnaissance-level field visit to match preliminary aerial photograph signatures with vegetation types on the ground before photographic interpretation, as well as spot-checking of selected areas in the field after preliminary photographic interpretation to verify the accuracy of mapping of certain vegetation types. Inclusion of maps depicting vegetation mapping units throughout the entire study area at a scale that allows detailed interpretation in text is infeasible because of the extent of the study area and the fine scale of the mapping units.

Table 1 shows a breakdown of the CWHR land cover types queried in the study area of each of the two watersheds (Guadalupe River and Stevens Creek) with estimated acreages of each.

Table 1. CWHR Land Cover Types Within the Study Area

Stevens Creek Watershed		Guadalupe Watershed	
CWHR Type	**Sum of Acres**	**CWHR Type**	**Sum of Acres**
Annual Grass	47.9	Annual Grass	665.3
Barren	1.2	Barren	6.9
--	--	Blue Oak Woodland	30.7
Chamise-Redshank Chaparral	23.7	Chamise-Redshank Chaparral	45.7
Coastal Oak Woodland	58.6	Coastal Oak Woodland	378.2
Coastal Scrub	6.4	Coastal Scrub	6.2
Cropland	7.1	Cropland	154.8
Fresh Emergent Wetland	19.5	Fresh Emergent Wetland	77.2
Lacustrine	138.5	Lacustrine	1,022.2
Montane Hardwood-Conifer	0.0	Mixed Chaparral	5.1
Saline Emergent Wetland	71.3	Saline Emergent Wetland	189.9
Urban	1,025.9	Urban	3,249.7
Valley Foothill Riparian	109.8	Valley Foothill Riparian	531.8
Valley Oak Woodland	33.9	Valley Oak Woodland	91.3
Total	**1,543.8**	**Total**	**6,455.0**

Vegetation types for the portions of the study area that are outside the AIS mapping boundary have been incorporated into the appropriate vegetation types below to provide a more consistent and easily understandable description of the complex land cover.

Conclusively, the cumulative study area (Guadalupe River and Stevens Creek watersheds) includes the following land cover types and wildlife habitats: freshwater emergent wetlands, freshwater marsh, seasonal wetland, riparian forest and woodland, willow riparian forest, mixed riparian forest, central California sycamore alluvial woodland, ruderal grasslands, serpentine grassland, serpentine seeps, serpentine rock outcrops, serpentine bunchgrass, mixed serpentine chaparral, chaparral and coastal sage scrub oak woodland, croplands, montane hardwood conifer, creek and stream channels, canals, barren/disturbed areas, and open water.

Additionally, results of the land cover type evaluation within the study area included a handful of CDFW sensitive natural communities. While most riparian habitats are considered sensitive communities, central California sycamore alluvial woodland communities are specifically considered a sensitive natural community by CDFW (CDFW 2021c). Further, serpentine grasslands, rock outcrops/barrens, seeps, and chaparral are considered sensitive communities by virtue of their importance to special-status plants and animals and their relatively limited extent (CDFW 2021ac; ICF 2012).

1.1.3 Sensitive Natural Communities

A brief description of the CDFW sensitive natural communities that are known to occur or have the potential to occur in the study area are described below.

1.1.3.1 Central California Sycamore Alluvial Woodland

Central California sycamore alluvial woodland, a CDFW sensitive natural community, occurs primarily in the upper watersheds above the study area in Alamitos, Guadalupe, and Stevens Creeks. It occurs on broad valley floors along low, braided riparian channels. This land cover type usually forms only where floodplains are broad and hydrology remains unmodified, specifically along low-gradient streams flowing over deep alluvial deposits and where there are sufficient winter pulse flows and natural summer dry backs of the creek channel, with persistent high subsurface flow. Sycamore alluvial woodland stands have an open canopy dominated by California sycamore, often interspersed with white alder and willows. Other associated species can include valley oak (*Quercus lobata*), coast live oak (*Quercus agrifolia*), and California bay (*Umbellularia californica*). Winter flows typically scour the understory vegetation each season, so herbaceous vegetation is spare and patchy. Riparian species such as willows (*Salix* spp.), coyote brush (*Baccharis pilularis)*, mulefat (*Baccharis salicifolia*), California buckeye (*Aesculus californica*), blackberry (*Rubus armeniacus*), Italian thistle (*Carduus pycnocephalus*), poison oak (*Toxicodendron diversilobum*), common chickweed (*Stellaria media*), and bedstraw (*Galium aparine*) can occur along the outer stream banks.

1.1.3.2 Serpentine Bunchgrass Grasslands

Serpentine bunchgrass grasslands occur on soils derived from serpentine rock substrates. Most serpentine soils support a diverse grassland assemblage dominated by purple needlegrass (*Nassella pulchra*); California dwarf plantain (*Plantago erecta*); and spring and summer wildflowers, including goldfields (*Lasthenia* spp.), buttercup (*Ranunculus californicus*), purple owl's clover (*Castilleja exserta*), and tidy-tips (*Layia platyglossa* and L. *chrysanthemoides*), among many others. Native grasses, such as onion grass (*Melica* spp.), junegrass (*Koeleria macrantha*), big squirreltail (*Elymus multisetus*), creeping wildrye (*Leymus triticoides*), and other perennial bunchgrasses, are common throughout this community.

Serpentine grasslands are highly infertile because of their extremely high levels of magnesium, chromium, and nickel; low concentrations of nutrients such as calcium and nitrogen; and low water-holding capacity. A unique group of vascular plant species, which can tolerate the relatively high magnesium-to-calcium ratio, has evolved in response to these conditions. As a result, serpentine grasslands generally support native plant communities, including rare plants such as the federally endangered Santa Clara Valley dudleya (*Dudleya setchellii*) and Metcalf Canyon jewel-flower (*Streptanthus albidus* ssp. *albidus*), as well as CRPR1B most beautiful jewel-flower (*Streptanthus albidus* ssp. *peramoenus*) and smooth lessingia (*Lessingia micradenia* var. *glabrata*). In turn, several invertebrate species, including the federally threatened Bay checkerspot butterfly (*Euphydryas editha bayensis*), depend on serpentine grasslands because their host food plants are found primarily in these habitats.

1.1.3.3 Serpentine Rock Outcrops/Barrens

Visible serpentine rock outcrops/barrens rock outcrops are usually covered in crustose (forming a crusty, fixed mass that covers the surface on which it grows) lichen species. Serpentine rock outcrops/barrens are typically found scattered within a serpentine grassland matrix such as in the San Vicente area west of Calero Reservoir, interspersed with intact, undisturbed patches of sagebrush chaparral communities. The federally endangered Santa Clara Valley dudleya is known to occur in this habitat type, and frequently dwarf plantain as well. Crevices in these outcrops provide refugia for western fence lizards (*Sceloporus occidentalis*), California kingsnakes (*Lampropeltis getula californiae*), and northern Pacific rattlesnakes (*Crotalus oreganus*). Rock wrens (*Salpinctes obsoletus*) hide their nests in these outcrops.

1.1.3.4 Serpentine Seeps

Several serpentine seeps—small wetlands that typically lack woody vegetation and are fed by small springs or creeks supported by groundwater—occur adjacent to Calero Reservoir. These seeps are distinguished from other wetlands because they occur on serpentine soils in serpentine grassland habitat. The majority of the serpentine seeps in the study area support the special-status and CRPR 1B Mt. Hamilton thistle (*Cirsium fontinale* var. *campylon*); this is the only habitat type in which this species occurs. Serpentine seeps are wetland habitats that may provide moist refugia for Sierran treefrogs, western toads, and other amphibians, but typically do not pond water deep enough to provide suitable breeding habitat for these species. They also are so limited in extent that they are infrequently used by other aquatic/wetland-associated wildlife species such as shorebirds or waterfowl.

1.1.3.5 Mixed Serpentine Chaparral

Mixed serpentine chaparral is an uncommon chaparral type that is generally composed of chaparral species tolerant of a broad range of soil conditions as well as species that are limited to serpentine soils such as leather oak (*Quercus durata*), chaparral silktassel (*Garrya congdonii*), and big berry manzanita (*Arctostaphylos glauca*). The dominant shrubs in mixed serpentine chaparral are often dwarfed and spaced more widely than is typically seen in non-serpentine stands (Holland and Keil 1995). Grasses and herbaceous vegetation may or may not be present in the spaces between the shrubs. This unique community is known to support many special-status plants such as Santa Clara thornmint (*Acanthomintha lanceolata*) and Sharsmith's harebell (*Campanula sharsmithiae*). Wildlife species typical of this community are similar to those described for chaparral and coastal scrub above.

1.1.4 Historic Survey Efforts

Valley Water has conducted a variety of surveys and monitoring efforts for previous projects that provide information on the presence and distribution of sensitive communities and plant and animal species, including special-status species and their associated habitats in Valley Water's service area.

The following discussion summarizes information collected by Valley Water that was used to describe the environmental setting for the proposed project. A number of the studies used to compile the baseline biological conditions were performed prior to the publication of the notice of preparation for this EIR (January 2015); such studies were used to inform the description of the environmental setting if they contributed relevant information representative of biological existing conditions.

1.1.4.1 Special-status Plant Surveys

In 2004 and 2008, as part of the Biodiversity Monitoring Program, Valley Water conducted comprehensive botanical surveys for special-status plants and sensitive serpentine natural communities within mapped serpentine soil and geology areas that intersected its creeks and canals. The survey methodology involved overlaying U.S. Soil Conservation Service (now the Natural Resources Conservation Service) and USGS maps of serpentine soils and associated geology on the creek and canal layers within ArcGIS for the study area. That overlay indicated that 15.3 miles of canals traversed serpentine soils and associated bedrock, as evidenced by associated plant species, vegetation types, and soil analysis (SCVWD unpublished data). During the 2004 and 2008 botanical surveys, 44 populations, or partial populations, of 6 special-status plant species were mapped by Valley Water botanist J. Hillman along the Almaden-Calero Canal. In contrast, no special-status plants were documented along any natural creeks in serpentine-dominated areas.

In 2016 and 2017, Valley Water completed rare plant surveys as part of the proposed Almaden Calero Rehabilitation Project. The entire project area was surveyed on foot, multiple times, over a 2-year period. The survey area included the entirety of the proposed project area, which includes Valley Water fee title property along the canal from Almaden Reservoir to Calero Reservoir, as well as an additional project buffer area above and below the canal. During these surveys, four CRPR 1B species, one of which is categorized as a federally endangered species, were documented:

- Woodland monolopia (*Monolopia gracilens*) – CRPR 1B.2
- Most beautiful jewelflower (*Streptanthus albidus* var. *peramoenus*) – CRPR 1B.2
- Smooth lessingia (*Lessingia micradenia* var. *glabrata*) – CRPS 1B.2
- Santa Clara Valley dudleya (*Dudleya abramsii* ssp. *Setchellii*) – FE, CRPR 1B.1

Of the four special-status plant species documented during these surveys, only two species fall within the study area: Woodland monolopia and Santa Clara Valley dudleya.

1.1.4.2 California Red-legged Frog Surveys

Between 1996 and 2001, Valley Water surveyed portions of the SMP study area for California red-legged frogs (*Rana draytonii*), following the revised 1997 USFWS protocol (USFWS 2005). Approximately 80% of the streams in the SMP with suitable habitat and that were accessible to Valley Water were surveyed. Areas in the foothills and mountain ranges were less thoroughly surveyed because of the difficulty accessing private land. Valley Water concluded that most of the county's ephemeral creeks do not support red-legged frog breeding habitat because of the absence of surface water during the tadpole-rearing season. Since 2001, Valley Water has conducted surveys for red-legged frogs in the context of pre-activity surveys for SMP activities. Furthermore, since 2004, annual surveys for the presence or absence of special-status amphibians have been conducted along portions of the following streams: Alamitos Creek, Calera Creek, Guadalupe Creek, Guadalupe River, Los Gatos Creek, Penitencia Creek, and Stevens Creek; no special-status amphibians were found at any of the survey locations.

1.1.4.3 Bird Surveys

In 2007 and 2008, EDAW, Inc. (now AECOM), conducted a habitat assessment, burrow mapping study, and standardized protocol surveys for burrowing owls along sections of multiple Valley Water-managed waterways in Palo Alto, Mountain View, Sunnyvale, Santa Clara, San Jose, Alviso, Milpitas, and Gilroy. In these areas, 236,214 linear feet of potential burrowing owl habitat along Valley Water waterways were assessed. The study was performed under Valley Water's Biodiversity Monitoring Program and was designed to monitor burrowing owl distribution, abundance, and trends in the SMP study area.

Numerous surveys for nesting birds have also been conducted for Valley Water compliance with the Migratory Bird Treaty Act. Surveys have occurred throughout Santa Clara County but generally below the 1,000-foot elevation where Valley Water activities routinely occur. These surveys have investigated potential habitat for all special-status bird species.

1.1.5 Special-status Plant and Animal Species

For the purposes of this EIR, special-status plant and animal species are those species that meet one or more of the following criteria:

- Species that are listed as threatened or endangered under the federal Endangered Species Act (ESA; 50 CFR § 17.12 for listed plants, 50 CFR § 17.11 for listed animals)
- Species that are candidates for possible future listing as threatened or endangered under the ESA (76 Federal Register 66370)
- Species that are listed or proposed for listing by the State of California as threatened or endangered under CESA (14 California Code of Regulations § 670.5)
- Plants listed as rare under the Native Plant Protection Act (Fish and Game Code § 1900 et seq.)
- Plants that CNPS considers to be "rare, threatened, or endangered in California;" CRPR List ~~1A and 1B~~ 1A, 1B, 2A, and 2B
- Species that meet the definitions of rare or endangered under the California Environmental Quality Act (CEQA; State CEQA Guidelines § 15380)
- Wildlife fully protected in California (Fish and Game Code §§ 3511 [birds], 4700 [mammals], and 5050 [reptiles and amphibians])
- Covered species under the Santa Clara VHP (§ 1.2.4 *Covered Species*)

1.1.6 Special-status Plants

All special-status plants with the potential to occur in the study area were carried forward for detailed analysis in this EIR, except CRPR List 3 and 4 species (see § 3.8.2 *Regulatory Setting* for a description).

Based on the literature review discussed in Section 3.8.1.1 of the EIR, a list of 65 special-status plants was compiled and are listed in Table 2. Table 2 also lists the species' regulatory status, its known habitat associations, its analysis status for this EIR, and the rationale for its inclusion or exclusion from further analysis in this EIR. Of the ~~66~~ 65 special-status plant species identified from the literature review, ~~26~~ 24 were determined to not have the potential for occurrences, leaving ~~40~~ 41 special-status plant species for consideration. Those species listed in Table P-2, but not carried forward in the analysis were removed from the analysis for one or more of the following reasons:

- The lack of suitable habitat for the species in the study area;
- The elevation range of the species is outside of the range in the study area;
- The study area is outside of the known species range; and/or
- The species is thought to have been extirpated from the site vicinity.

Table 2. Special-status Plant Species with Potential to Occur in the Study Area

Scientific Name	Common Name	Regulatory Status	Habitat Characteristics	Potential to Occur	Impacts Analyzed	Rationale
Amsinckia lunaris	Bent-flowered fiddleneck	1B.2	Annual herb; coastal bluff scrub, cismontane woodland, and grasslands; 5–1,640 feet; blooming period: March–June	Y	Y	Suitable habitat may be present in study area; one known occurrence in Santa Clara County; occurrence is more than 20 years old and located at Lick Observatory, 13.75 miles east of the (; CDFW 2021a)
Arctostaphylos andersonii	Anderson's manzanita	1B.2	Evergreen shrub; openings and edges of chaparral and broadleafed upland and north coast coniferous forests; 195–2,495 feet; blooming period: November–May	Y	Y	Suitable habitat may be present in study area; most likely to occur in Santa Cruz Mountains
Arctostaphylos regismontana	Kings Mountain manzanita	1B.2	Evergreen shrub; granitic or sandstone soils in chaparral and broadleafed upland and north coast coniferous forests; 1,000–2,395 feet; blooming period: December–April	N	N	No known to occur in Santa Clara County; known occurrences are associated with the upper peninsula near and north of San Mateo County (CDFW 2021a)
Arctostaphylos silvicola	Bonny Doon manzanita	1B.2	Perennial evergreen shrub; 393–1,968 feet; blooming period: January–March	N	N	Not known to occur in Santa Clara County; known occurrences are associated with the upper peninsula near Ben Lomond in the Santa Cruz Mountains (CDFW 2021a)
Astragalus tener var. *tener*	Alkali milk-vetch	1B.2	Annual herb; alkaline soils in playas, adobe clay grasslands, and vernal pools; 0–195 feet; blooming period: March–June	N	N	Historical occurrences near the San Francisco Bay; however, thought to be extirpated from Santa Clara County (CDFW 2021a)
Atriplex depressa	Brittlescale	1B.2	Annual herb; alkaline or clay soils in chenopod scrub, meadows, seeps, playas, vernal pools, and grassland; 3–1,049 feet; blooming period: April–October.	N	N	Not known to occur in Santa Clara County; one occurrence associated with Don Edwards National Wildlife Refuge just north of the study area; however, this is thought to be misidentified as A. miniscula (CDFW 2021a).
Atriplex minuscula	Lesser saltscale	1B.1	Annual herb; alkaline and sandy soils in chenopod scrub, playas, and grassland; 49–656 feet; blooming period: May–October	Y	Y	Not known to occur in Santa Clara County; however, suitable habitat may be present in the study area; one occurrence associated with Don Edwards National Wildlife Refuge just north of the study area (CDFW 2021a)

Scientific Name	Common Name	Regulatory Status	Habitat Characteristics	Potential to Occur	Impacts Analyzed	Rationale
Balsamorhiza macrolepis	Big-scale balsamroot	1B.2	Perennial herb; occasionally in serpentine soils in chaparral, cismontane woodland, and grasslands; 295–5,100 feet; blooming period: March–June	Y	Y	Suitable habitat may be present in the study area
Calyptridium parryi var. hesseae	Santa Cruz Mountains pussypaws	1B.1	Annual herb; sandy and gravelly soils in openings of chaparral and cismontane woodland; 1,000–5,020 feet; blooming period: May–August	N	N	Study area is outside of known species elevation range
Carex comosa	Bristly sedge	2B.1	Perennial rhizomatous herb; coastal prairie, marshes and swamps (lake margins), valley and foothill grassland; 0–2,050 feet; blooming period: May–September	Y	Y	Suitable habitat may be present in the study area
Carex saliniformis	Deceiving sedge	1B.2	Perennial rhizomatous herb; coastal prairie, coastal scrub, meadows and seeps, marshes and swamps (coastal salt); 0–754 feet; blooming period: May–June/July	Y	Y	Suitable habitat may be present in the study area
Castilleja affinis var. *neglecta*	Tiburon paintbrush	FE, ST, 1B.2, VHP	Hemiparasitic perennial herb; serpentinite valley and foothill grassland; 196–1,312 feet; blooming period: April–June (synonym of C. affinis, and C. a. ssp. neglecta)	Y	Y	Suitable habitat may be present within the study area; one population is known to occur southeast of study area near Anderson Lake (CDFW 2021a)
Castilleja rubicundula var. *rubicundula*	Pink creamsacs	1B.2	Hemiparasitic annual herb; serpentine soils in meadows seeps, grasslands, cismontane woodland, and openings of chaparral; 65–2,985 feet; blooming period: April–June	Y	Y	Known to occur in the Santa Cruz Mountains along the western edge of the study area (CDFW 2021a)
Ceanothus ferrisae	Coyote ceanothus	FE, 1B.1, VHP	Evergreen shrub; serpentinite in chaparral, coastal scrub, valley and foothill grassland; 393–1,510 feet; blooming period: January–May	Y	Y	Suitable habitat may be present in the study area; one population is known to occur southeast of the study area near Anderson Lake (CDFW 2021a)
Centromadia parryi ssp. *congdonii*	Congdon’s tarplant	1B.1	Annual herb; alkaline soils in grassland; 0–755 feet; blooming period: May–November	Y	Y	Suitable habitat present in study area; known to occur in the alkaline areas around San Francisco Bay (CDFW 2021a)

Scientific Name	Common Name	Regulatory Status	Habitat Characteristics	Potential to Occur	Impacts Analyzed	Rationale
Chlorogalum pomeridianum var. minus	Dwarf soaproot	1B.2	Perennial bulbiferous herb; serpentine soils in chaparral; 1,000–3,280 feet; blooming period: May–August	N	N	Only known occurrence in Santa Clara County is from more than 100 years ago near Coyote Creek, east of the study area (CDFW 2021a; CCH 2018)
Chloropyron maritimum ssp. *palustre*	Point Reyes bird's-beak	1B.2	Hemiparasitic annual herb; coastal salt marshes and swamps; 0–35 feet; blooming period: June–October	N	N	Likely extirpated from the south Bay; all records in the region are more than 100 years old (CDFW 2021a)
Chorizanthe pungens var. *hartwegiana*	Ben Lomond spineflower	FE, 1B.1	Annual herb; lower montane coniferous forest (maritime ponderosa pine sandhills); 295–2,000 feet; blooming period: April–July	N	N	Known to occur in the sandhill parklands within the Santa Cruz Mountains; occurrences associated with inland sand deposits of chaparral and ponderosa pine along Santa Cruz County (CDFW 2021a) do not occur in the study area
Chorizanthe pungens var. *pungens*	Monterey spineflower	FT, 1B.2	Annual herb; maritime chaparral, cismontane woodland, coastal dunes, coastal scrub, and valley foothill grassland; 10–1,476 feet; blooming period: April–June (July–August)	N	N	Not known to occur in Santa Clara County; known occurrences are associated with the peninsula of northern Monterey County (CDFW 2021a)
Chorizanthe robusta var. *hartwegii*	Scotts Valley spineflower	FE, 1B.1	Annual herb; meadows and seeps with sandy soil, and valley and foothill grassland with mudstone and purisima outcrops; 750–800 feet; blooming period: April–July	N	N	Known only from Scotts Valley in Santa Cruz County (CDFW 2021a)
Chorizanthe robusta var. *robusta*	Robust spineflower	FE, 1B.1	Annual herb; sandy or gravelly soils in maritime chaparral, coastal dunes and scrub, and openings of cismontane woodland; 5–985 feet; blooming period: April–September	N	N	Likely extirpated from the region; all records are more than 100 years old; nearest extant occurrences are on the west side of the Santa Cruz Mountains, near Santa Cruz (CDFW 2021a)
Cirsium fontinale var. *campylon*	Mt. Hamilton fountain thistle	1B.2, VHP	Perennial herb; serpentine seeps in chaparral, cismontane woodland, and grasslands; 325–2,920 feet; blooming period: February, April–October	Y	Y	Suitable habitat may be present in the study area; known to occur throughout Santa Clara Valley (CDFW 2021a)
Collinsia multicolor	San Francisco collinsia	1B.2	Annual herb; sometimes in serpentine soils in coastal scrub and closed-cone coniferous forest; 95–820 feet; blooming period: February–May	Y	Y	Suitable habitat may be present in the study area; known to occur in Santa Clara County in one extant occurrence at Anderson Reservoir (CDFW 2021a)

Scientific Name	Common Name	Regulatory Status	Habitat Characteristics	Potential to Occur	Impacts Analyzed	Rationale
Dacryophyllum falcifolium	Tear drop moss	1B.3	Moss; carbonate, north coast coniferous forest; 164–902 feet	N	N	Known in California from Monterey and Santa Cruz counties; no known documented occurrences in the study area (CDFW 2021a)
Dirca occidentalis	Western leatherwood	1B.2	Deciduous shrub; mesic soils in broadleaf upland and riparian forests, closed-cone and north coast coniferous forests, chaparral, and cismontane and riparian woodlands; 80–1,395 feet; blooming period: January–April	Y	Y	Suitable habitat may be present in the study area; known to occur in Santa Cruz Mountains; may occur in study area near Stevens Creek Reservoir (CDFW 2021a)
Dudleya abramsii ssp. *setchellii*	Santa Clara Valley dudleya	FE, 1B.1, VHP	Perennial herb; serpentine, rocky substrates, in cismontane woodland, valley and foothill grasslands; 196–1,493 feet; blooming period: April-October (synonym of Dudleya setchellii).	Y	Y	Suitable habitat may be present in the study area; known to occur in Santa Clara County (CDFW 2021a); documented along the Almaden Calero Canal by Valley Water biologists
Eriogonum nudum var. *decurrens*	Ben Lomond buckwheat	1B.1	Perennial herb; sandy, chaparral, cismontane woodland, and lower montane coniferous forest; 164–2,624 feet; blooming period: June–October	Y	Y	Suitable habitat may be present in the study area
Eriophyllum latilobum	San Mateo woolly sunflower	FE, CE, 1B.1	Perennial herb; cismontane woodland often within serpentine on roadcuts, coastal scrub, and lower montane coniferous forest; 147–1,082 feet; blooming period: May–June	Y	Y	Not known to occur within Santa Clara County; however, suitable habitat is present in the study area (CDFW 2021a)
Eryngium aristulatum var. *hooveri*	Hoover's button-celery	1B.1	Annual/ perennial herb; vernal pools; 9–147 feet; blooming period: July–August	Y	Y	Suitable habitat may be present in the study area
Erysimum teretifolium	Ben Lomond (Santa Cruz) wallflower	FE, CE, 1B.1	Perennial herb; inland marine sands of chaparral or lower montane coniferous forest; 393–2,000 feet; blooming period: March–July	N	N	Known to occur in the sandhill parklands within the Santa Cruz Mountains (CDFW 2021a); occurrences associated with inland sand deposits of chaparral and ponderosa pine along Santa Cruz County (CDFW 2021a), which do not occur in the study area

Scientific Name	Common Name	Regulatory Status	Habitat Characteristics	Potential to Occur	Impacts Analyzed	Rationale
Extriplex joaquinana	San Joaquin spearscale	1B.2	Annual herb; alkaline soils in chenopod scrub, meadows, seeps, playas, and grasslands; 0–2,740 feet; blooming period: April–October (synonym of *Atriplex joaquiniana*)	Y	Y	Not known to occur in Santa Clara County; however, suitable habitat may be present in the study area; one occurrence associated with Don Edwards National Wildlife Refuge just north of the study area (CDFW 2021a); known to occur at San Felipe Lake, county line
Fissidens pauperculus	Minute pocket moss	1B.2	Moss; North Coast coniferous forest (damp coastal soil); 33–3,360 feet; no bloom period	Y	Y	Suitable habitat may be present in the study area
Fritillaria liliacea	Fragrant fritillary	1B.2	Perennial bulbiferous herb; often in serpentine soils in cismontane woodland, grassland, coastal prairie and scrub; 5–1,345 feet; blooming period: February–April	Y	Y	Suitable habitat may be present in the study area; known to occur in Santa Clara County (CDFW 2021a)
Hoita strobilina	Loma Prieta hoita	1B.1, VHP	Perennial herb; usually serpentinite, mesic areas in chaparral, cismontane woodland, and riparian woodland; 98–2,851 feet; blooming period: May–October	Y	Y	Suitable habitat may be present in the study area; species known to occur in Santa Clara County (CDFW 2021a)
Holocarpha macradenia	Santa Cruz tarplant	FT, CE, 1B.1	Annual herb; coastal prairie, coastal scrub, valley and foothill grassland often with clay, sandy soil; 30–720 feet; blooming period: June–October	N	N	Suitable habitat may occur in the study area; however, all known extant populations have been reintroduced along the California central coast, mainly in southwestern Santa Clara County
Horkelia cuneate var. *sericea*	Kellog's horkelia	1B.1	Perennial herb; sandy or gravelly, openings, closed-cone coniferous forest, chaparral (maritime), coastal dunes, coastal scrub; 32–656 feet; blooming period: April–September	N	N	Occurrence from the Crocker Hills probably last remaining location in San Francisco Bay; remaining plants less distinct from ssp. *cuneata* than those formerly occurring near San Francisco (CNPS 2021)
Lasthenia conjugens	Contra Costa goldfields	FE, 1B.1	Annual herb; mesic soils in vernal pools, grasslands, alkaline playas, and cismontane woodland; 0–1,540 feet; blooming period: March–June	Y	Y	One occurrence associated with Don Edwards National Wildlife Refuge just north of the study area; not known to occur in Santa Clara County; however, alkali areas near San Francisco Bay may support the species (CDFW 2021a)

Scientific Name	Common Name	Regulatory Status	Habitat Characteristics	Potential to Occur	Impacts Analyzed	Rationale
Legenere limosa	Legenere	1B.1	Annual herb; vernal pools; 0–2,885 feet; blooming period: April–June	N	N	No CNDDB occurrences in Santa Clara County; nearest occurrence is near Sunnyvale and is more than 100 years old (CDFW 2021a); has recently been seen in the Mount Hamilton Range area (CCH 2018)
Lessingia micradenia var. glabrata	Smooth lessingia	1B.2, VHP	Annual herb; serpentinite, often roadsides, chaparral, cismontane woodland, grassland; 393–1,378 feet; blooming period: April–November	Y	Y	Known to occur in Santa Clara County (CDFW 2021a); suitable habitat may be present in the study area; documented along the Almaden Calero Canal by Valley Water biologists
Malacothamnus arcuatus	Arcuate bush-mallow	1B.2	Evergreen shrub; chaparral and cismontane woodland; 45–1,165 feet; blooming period: April–September	Y	Y	Suitable habitat may be present in the study area; known to occur in Santa Clara County, near Calero and Almaden Reservoirs (CDFW 2021a)
Malacothamnus davidsonii	Davidon's bush-mallow	1B.2	Perennial deciduous herb; chaparral, cismontane woodland, coastal scrub, riparian woodland; 606–3,740 feet; blooming period: June–January	Y	Y	Suitable habitat may be present in the study area
Malacothamnus hallii	Hall's bush-mallow	1B.2	Evergreen shrub; chaparral and coastal scrub; 30–2,495 feet; blooming period: April–October	Y	Y	Suitable habitat may be present in the study area; known to occur in Santa Clara County (CDFW 2021a)
Monardella sinuata spp. nigrescens	Northern curly-leaved monardella	1B.2	Annual herb; chaparral, coastal dunes, coastal scrub, lower montane coniferous forest, ponderosa pine sandhills; 0–984 feet; blooming period: (April) May–July (August–September)	Y	Y	Suitable habitat may occur in the study area
Monolopia gracilens	Woodland woolythreads	1B.2	Annual herb; serpentine soils in the openings of chaparral and broadleafed upland and north coast coniferous forests, grassland, and cismontane woodland; 325–3,935 feet; blooming period: February–July	Y	Y	Suitable habitat may be present in the study area; known to occur in Santa Clara County (CDFW 2021a); documented along the Almaden Calero Canal by Valley Water biologists (Valley Water 2016, 2017)

Scientific Name	Common Name	Regulatory Status	Habitat Characteristics	Potential to Occur	Impacts Analyzed	Rationale
Navarretia prostrata	Prostrate vernal pool navarretia	1B.1	Annual herb; mesic coastal scrub, meadows and seeps, alkaline grassland, and vernal pools; 49–3,968 feet; blooming period: April–July	Y	Y	Not known to occur in Santa Clara County; however, suitable habitat may be present in the study area; one occurrence associated with Don Edwards National Wildlife Refuge just north of the study area (CDFW 2021a)
Pedicularis dudleyi	Dudley's lousewort	CR, 1B.2	Perennial herb; chaparral (maritime), cismontane woodland, North Coast coniferous forest, valley and foothill grassland; 197–2,953 feet; blooming period: April–June	N	N	Not known to occur in Santa Clara County; multiple occurrences noted to the west of the study area in the Santa Cruz Mountains and Portola Redwoods State Park (CDFW 2021a)
Penstemon rattanii var. *kleei*	Santa Cruz Mountains beardtongue	1B.2	Perennial herb; chaparral, lower montane coniferous forest, and North Coast coniferous forest; 1,310–3,610 feet; blooming period: May–June	N	N	Know to occur in Santa Cruz Mountains; however, the portions of the study area that overlap with that range are well below the elevation requirements of this species (CDFW 2021a)
Pentachaeta bellidiflora	White-rayed Pentachaeta	FE, CE, 1B.1	Annual herb; cismontane woodland, valley and foothill grassland often with serpentine soil; 114–2,034 feet; blooming period: March–May	Y	Y	Not known to occur within Santa Clara County; however, suitable habitat may be present in the study area
Piperia candida	White-flowered rein orchid	1B.2	Perennial herb; serpentine soils in broadleafed upland and lower montane and north coast coniferous forests; 95–4,300 feet; blooming period: (March) May–September	Y	Y	Suitable habitat may be present in the study area; known to occur along streams in the Santa Cruz Mountains (CDFW 2021a)
Plagiobothrys chorisianus var. *chorisianus*	Choris' popcornflower	1B.2	Annual herb; mesic, chaparral, coastal prairie, coastal scrub; 10–525 feet; blooming period: March–June	Y	Y	Suitable habitat may be present in the study area
~~*Plagiobothrys chorisianus* var. *hickmanii*~~	~~Hickman's popcornflower~~	~~4.2~~	~~Annual herb; vernal pools, marshes, swamps, chaparral, coastal scrub, and closed-cone coniferous forest; 45–605 feet; blooming period: April–June~~	~~N~~	~~N~~	~~This is a widely distributed species and impacts would not be considered significant; occurrences near the study area are more than 100 years old~~
Plagiobothrys diffusus	San Francisco popcornflower	CE, 1B.1	Annual herb; coastal prairie, valley and foothill grassland; 197–1,181 feet; blooming period: March–June	N	N	Suitable habitat may be present in the study area; however, species is not known in Santa Clara County; known occurrences are tightly linked to San Francisco Bay and are presumed extirpated (CDFW 2021a)

Scientific Name	Common Name	Regulatory Status	Habitat Characteristics	Potential to Occur	Impacts Analyzed	Rationale
Plagiobothrys glaber	Hairless popcornflower	1A	Annual herb; alkaline soils in meadows and seeps and coastal salt marshes and swamps; 45–590 feet; blooming period: March–May	N	N	Extirpated from California (CNPS 2021).
Polygonum hickmanii	Scotts Valley polygonum	FE, CE, 1B.1	Annual herb; valley and foothill grassland with mudstone and sandstone; 700–820 feet; blooming period: May–August	N	N	Known only from Scotts Valley in Santa Cruz County (CDFW 2021a)
Puccinellia simplex	California alkali grass	1B.2	Annual herb; alkaline and vernally mesic soils in sinks, flats, and lake margins of chenopod scrub, meadows, seeps, grassland, and vernal pools; 5–3,050 feet; blooming period: March–May	Y	Y	Not known to occur in Santa Clara County; however, suitable habitat may be present in the study area; one occurrence associated with Don Edwards National Wildlife Refuge just north of the study area (CDFW 2021a)
Sagittaria sanfordii	Sanford's arrowhead	1B.2	Perennial herb; freshwater wetlands, and wetland-riparian; 0–2,135 feet; blooming period May–October	Y	Y	It is presumed to occur in Santa Clara County; as suitable habitat may be present in the study area (CNPS 2023).
Sanicula saxatilis	Rock sanicle	SR, 1B.2	Perennial herb; rocky, scree, and talus soils in chaparral, grassland, and broadleafed upland forest; 2,030–3,855 feet; blooming period: April–May	N	N	Study area is outside of known elevation range for the species; species known to occur in Mount Hamilton Range, east of the study area (CCH 2018)
Senecio aphanactis	Chaparral ragwort	2B.2	Annual herb; chaparral, cismontane woodland, coastal scrub, and alkaline flats; 49–2,624 feet; blooming period: January–April	Y	Y	Suitable habitat may be present in the study area; known to occur in Santa Clara County (CDFW 2021a)
Streptanthus albidus ssp. albidus	Metcalf Canyon jewelflower	FE, 1B.1, VHP	Annual herb; serpentinite valley and foothill grassland; 147–2,625 feet; blooming period: April–July	Y	Y	Suitable habitat may be present in the study area; known to occur in Santa Clara County (CDFW 2021a); documented along Alamden Calero Canal by Valley Water biologists (Valley Water 2016, 2017)

Scientific Name	Common Name	Regulatory Status	Habitat Characteristics	Potential to Occur	Impacts Analyzed	Rationale
Suaeda californica	California seablite	FE, 1B.1	Perennial evergreen shrub; marshes and swamps (coastal swamps); 0–59 feet; blooming period: July–October	N	N	Known to occur in Santa Clara County; known occurrences documented just north of the study area near Mayfield and Mud Slough along the Bay (CDFW 2021a); no work is planned in the coastal plain. Believed to be extirpated from southern Bay (CDFW 2021a).
Streptanthus albidus ssp. *peramoenus*	Most beautiful jewelflower	1B.2, VHP	Annual herb; serpentinite in chaparral, cismontane woodland, valley and foothill grassland; 311–3,281 feet; blooming period: March–October	Y	Y	Suitable habitat may be present in the study area; known to occur in Santa Clara County (CDFW 2021a)
Stuckeniafiliformis ssp. alpina	Slender-leaved pondweed	2B.2	Perennial rhizomatous aquatic herb; 984–7,053 feet; blooming period: May–July	Y	Y	Suitable habitat may be present in the study area
~~*Suaeda californica*~~	~~California seablite~~	~~FE, 1B.1~~	~~Evergreen shrub; coastal salt marshes and swamps; 0–50 feet; blooming period: July–October~~	~~N~~	~~N~~	~~Believed to be extirpated from southern Bay (CDFW 2021a)~~
Trifolium buckwestiorum	Santa Cruz clover	1B.1	Annual herb; gravelly soils and margins in broadleafed upland forest, cismontane woodland, and coastal prairie; 345–2,000 feet; blooming period: April–October	Y	Y	Suitable habitat may be present in the study area; known to occur in the Santa Cruz Mountains and Mount Hamilton Range (CDFW 2021a)
Trifolium hydrophilum	Saline clover	1B.2	Annual herb; marshes, swamps, vernal pools, and grasslands with mesic or alkaline soils; 0–985 feet; blooming period: April–June	Y	Y	Historical occurrences in the study area, as well as recent occurrences to the north (CDFW 2021a); suitable habitat along San Francisco Bay, as well as other alkaline areas in the study area
Trifolium polyodon	Pacific Grove clover	1B.1	Annual herb; mesic, sometimes granitic, closed-cone coniferous forest, coastal prairie, meadows and seeps, valley and foothill grassland; 16–1,394 feet; blooming period: April–June (July)	Y	Y	Suitable habitat may occur in the study area

Scientific Name	Common Name	Regulatory Status	Habitat Characteristics	Potential to Occur	Impacts Analyzed	Rationale
Tropidocarpum capparideum	Caper-fruited tropidocarpum	1B.1	Annual herb; alkaline hills in valley and foothill grassland; 3–1,493 feet; blooming period: March–April	N	N	Not known to occur in Santa Clara County; occurrences associated with the East Bay (Livermore area) and Monterey (CDFW 2021a; CCH 2018)

Notes: CRPR 1B = Plants rare, threatened, or endangered in California and elsewhere; CRPR 2 = Plants rare, threatened, or endangered in California but more common elsewhere; CRPR 3 = Plants about which information is needed-a review list; CRPR 4 = Plants of limited distribution-a watch list; .1 = seriously endangered in California; .2 = fairly endangered in California; .3 = not very endangered in California; FE = Federally Endangered; ST = State Threatened; VHP = VHP covered species

1.1.7 Special-status Animals

The legal status and potential for occurrence of special-status animal species known to occur or having the potential to occur in the study area are provided in Table 3. Based on the literature review discussed in Section 3.8.4 of the EIR, a list of ~~53~~ 79 special-status animal species potentially occurring in the study area was compiled and is listed in Table 3. This table also lists the species' regulatory status, its preferred habitat, its analysis status for this EIR, and the rationale for its inclusion or exclusion from further analysis in this EIR. Of the ~~53~~ 79 special-status animal species identified in the literature review, ~~25~~ 44 were determined to not have the potential for occurrence, leaving ~~28~~ 35 special-status animal species for consideration.

Those species are listed in Table 3, but not carried forward in the analysis, were determined to be absent from the study area for one or more of the following reasons:

- Do not have extant populations or occurrences, and are known to breed or could potentially breed in the study area;
- Do not occur fairly commonly as nonbreeders in the study area (and therefore could be substantially affected by activities that occur under the proposed project);
- Are not described in the VHP as potentially occurring in the study area; and/or
- Are not species about which the resource agencies and/or the VHP have expressed particular concern such that an expanded discussion is required.

Table 3. Special-status Animal Species with Potential to Occur in the Study Area

Name	Regulatory Status	Habitat	Potential to Occur	Analyzed in Document	Rationale
Invertebrates					
Bay checkerspot butterfly (*Euphydryas editha bayensis*)	FT, VHP	~~Native~~ Occurs in native grasslands on serpentine soils; larval host plants are *Plantago erecta* and/or *Castilleja* sp.	Y	Y	Suitable habitat may be present in the study area; VHP (ICF 2012) maps areas just southeast of the study area as occupied and maps the grassland southeast of Anderson Dam on County Parks property; designated critical habitat occurs within the southern portion of the study area near Calero Reservoir and continues farther east into the Coyote Hills (USFWS 2021b)
Callippe silverspot butterfly (*Speyeria callippe callippe*)	FE	Occurs in native grasslands and associated habitats with topography in the San Francisco Bay area; larval host plants are *Viola pedunculata*.	Y	Y	Historically found in Santa Clara County; suitable habitat may be present near the Project boundary associated with the proximity to the bay near the fog belt (USFWS 2020).
Conservancy Fairy Shrimp (*Branchinecta conservation*)	FE	Occurs in seasonal wetland habitats, including vernal pools, clay flats, alkaline pools, ephemeral stock tanks, roadside ditches, and road ruts	N	N	This species has not been documented within the study area; the study area is outside of the species' known range (CDFW 2021a).
Crotch bumble bee (*Bombus crotchii*)	SC	Occurs in a variety of habitats including open grasslands, shrublands, and semi-urban settings.	Y	N	This species' historic range included the study area, but it has not been documented in the study area since 2002. The current distribution is outside the study area (Hatfield et al. 2018).
Monarch butterfly, (*Danaus plexippus*)	FC	Occurs in native grasslands with nectar and milkweed resources;; larval obligate milkweed host plant (primarily *Asclepias* spp.); roost in in wind-protected groves of gum (*Eucalyptus* spp.), Monterey pine (*Pinus radiata*), or Monterey cypress (*Hesperocyparis macrocarpa*) with nectar and water sources nearby.	Y	Y	Monarch butterflies have been documented in Santa Clara County. Suitable overwintering trees such as eucalyptus are present. Additionally, there are likely milkweed and nectar plants located within the study area based on its location along riparian corridors and presence of milkweed observations within a mile (Western Monarch and Milkweed Database 2018).

Name	Regulatory Status	Habitat	Potential to Occur	Analyzed in Document	Rationale
Mount Hermon June beetle (*Polyphylla barbata*)	FE	Occurs in sparsely vegetated ponderosa pine and chaparral habitat with sandy sedimentary derived soils in the Zayante Sandhills formation in Santa Cruz County	N	N	Suitable habitat for this species does not occur within the study area, and the study area is outside of this species' known range; the nearest documented occurrence is located in Santa Cruz County along the San Lorenzo River (CDFW 2021a); Zayante Sandhills formation does not occur within the study area
Ohlone tiger beetle (*Cicindela Ohlone*)	FE	Occurs on coastal terraces with remnant stands of open native grassland containing purple needlegrass (*Stipa pulchra*), California oat grass (*Danthonia californica*), Gairdners yampa (*Perideridia gairdneri*), and/or Kellogg's yampa (*Perideridia kelloggii*) and poorly drained clay or sandy clay soils	N	N	No coastal stands of native grassland occur within the study area
Smith's blue butterfly (*Euphilotes enoptes smithi*)	FE	Occurs in dune habitat with coast or seacliff buckwheat around Monterey Bay	N	N	No dune habitat occurs within the study area
Vernal pool tadpole shrimp (*Lepidurus packardi*)	FE	Occurs in seasonal wetland habitats, including vernal pools, clay flats, alkaline pools, ephemeral stock tanks, roadside ditches, and road ruts	N	N	Occupied critical habitat for this species has been designated in Alameda County approximately 1.3 miles north of Coyote Creek, within Warm Spring's seasonal wetland unit of Don Edwards National Wildlife Refuge (CDFW 2021a), east of the study area; the species has not been documented in the study area, which lacks suitable vernal pool habitat
Vernal pool fairy shrimp (*Branchinecta lynchi*)	FT	Occurs in seasonal wetland habitats, including vernal pools, clay flats, alkaline pools, ephemeral stock tanks, roadside ditches, and road ruts	N	N	This species has not been documented within the study area, and the study area is outside of this species known range (CDFW 2021a)

Name	Regulatory Status	Habitat	Potential to Occur	Analyzed in Document	Rationale
Western bumble bee (*Bombus occidentalis*)	SC	Occurs in meadows and grasslands with floral resources. Largely restricted to high-elevation sites in the Sierra Nevada.	Y	N	This species was historically found in Santa Clara County but has gone through a major decline in distribution. Although the study area includes habitat the species historically used, its current range is outside the study area (Hatfield et al. 2018).
Zayante band-winged grasshopper (*Trimerotropis infantilis*)	FE	Occurs in open sandy areas with sparse, low annual and perennial herbs on high ridges and hills with sparse ponderosa pine within the Zayante Sandhills formation in Santa Cruz County.	N	N	Only occurrence in the study area is a historical record that is listed as extirpated (CDFW 2021a); Zayante Sandhills formation does not occur within the study area
Mammal					
American badger (*Taxidea taxus*)	SSC	Burrows in grasslands and occasionally in infrequently disked agricultural areas	Y	Y	Known to occur in the study area primarily in grasslands and less frequently disturbed agricultural habitats, mostly in the foothills, but sometimes on the Santa Clara Valley floor (CDFW 2021a)
Pallid bat (*Antrozous pallidus*)	SSC	Forages over many habitats; roosts in caves, rock outcrops, buildings, and hollow trees	Y	Y	Historically, likely present in a number of locations throughout the study area, but this species has declined in recent decades; known maternity colonies occur at several locations east of the study area: Cochrane Road near Anderson Dam, south of Berryessa Creek; close to Old Piedmont Road, on Chaboya Court at the end of Quimby Road in eastern San José; and on the Highway 152 bridge over Uvas Creek; suitable roosting sites are present in a number of other areas, particularly in or near open space or less developed areas around the periphery of the study area, and the species might be more widespread than is known; individuals could potentially forage in the study area in open areas located within several miles of colonies
Townsend's big-eared bat (*Corynorhinus townsendii*)	SSC	Roosts in caves and mine tunnels, and occasionally in deep crevices in trees such as redwoods or in abandoned buildings, in a variety of habitats	N	N	There are no known extant populations on the Santa Clara Valley floor; individuals have been recorded recently in Santa Clara County on the property east of the study area; no breeding populations are known near the study area

Name	Regulatory Status	Habitat	Potential to Occur	Analyzed in Document	Rationale
San Francisco dusky-footed woodrat (*Neotoma fuscipes annectens*)	SSC	Nests in a variety of habitats, including riparian areas, oak woodlands, and scrub	Y	Y	Species is known to occur within Santa Clara County (CDFW 2021a); where low open valleys are less developed in the study area, woodrat populations appear to remain intact
Salt-marsh wandering shrew *(Sorex vagrans halicoetes)*	SSC	Medium to high marsh with abundant driftwood and common pickleweed	N	N	Now confined to salt marshes of the south Bay, salt marsh wandering shrews occur most often in medium to high wet tidal marsh (6–8 feet above sea level) with abundant driftwood and other debris for cover; this area is outside of the study area
Salt-marsh harvest mouse (*Reithrodontomys raviventris*)	FE, SE, FP	Salt marsh habitat dominated by common pickleweed; may occur in other marsh vegetation types and adjacent upland areas	N	N	Multiple CNDDB records indicate this species occurs along the tidal portions of the study area such as Palo Alto Marsh and the mouth of Steven's Creek; this area is outside of areas where potential restoration/enhancement activities would occur (CDFW 2021a)
San Joaquin kit fox (*Vulpes macrotis mutica*)	FE, ST, VHP	Flat or gently sloping grasslands, mostly on the margins of the San Joaquin Valley and adjacent valleys	N	N	Expected to occur only outside of the study area near Pacheco Creek and the uppermost reaches of the Pajaro River; if it occurs here at all, likely to occur in low numbers and infrequently during dispersal between areas of known breeding activity outside the study area; no proposed project activities are projected in areas where the species could occur
Southern sea otter (*Enhydra lutris nereis*)	FT, FP	Marine habitat along the coast from Big Sur south to Lompoc.	N	N	There are no marine resources in the study area.
Western mastiff bat (*Eumops perotis californicus*)	SSC	Occurs in open areas with abundant roost locations in rock outcrop crevices ad buildings; conifer and deciduous woodlands, coastal scrub, grasslands, and urban areas.	Y	Y	This species could occur in the study area because its current range includes Santa Clara County.
Western red bat (*Lasiurus blossevillii*)	SSC	Roosting habitat includes forests and woodlands, while foraging includes grasslands, shrublands, open woodlands and forests, and croplands.	Y	Y	This species could occur in the study area because its current range includes Santa Clara County.

Name	Regulatory Status	Habitat	Potential to Occur	Analyzed in Document	Rationale
Reptile and Amphibians					
Alameda whipsnake (*Masticophis lateralis euryxanthus*)	FT, ST	Coastal ranges, in chaparral and riparian habitat and adjacent grasslands	N	N	Southern edge of subspecies range is at the northern edge of Santa Clara County within Alameda Watershed (ICF 2012) and is not known to occur within the study area
Blunt-nosed leopard lizard (*Gambelia silus*)	FE, SE, FP	Found only in the San Joaquin Valley and adjacent foothills, as well as the Carrizo Plain and Cuyama Valley; inhabits open, sparsely vegetated areas of low relief on the valley floor and the surrounding foothills; also inhabits alkali playa and valley saltbush scrub; is generally absent from areas of steep slope, dense vegetation, or areas subject to seasonal flooding	N	N	Species' northern range is outside of the study area, and no occurrences have been documented within the study area (CDFW 2021a)
Foothill yellow-legged frog (*Rana boylii*)	FP, SE, VHP	Partially shaded shallow streams and riffles with a rocky substrate; occurs in a variety of habitats in coast ranges	Y	Y	Suitable habitat may be present; occurrences are documented along Guadalupe Creek, Rincon Creek, and below Calero Reservoir along Llagas Creek; VHP maps of primary and secondary habitat show no known occurrences in the study area (ICF 2012)
Western pond turtle (*Actinemys marmorata*)	SSC, VHP	Permanent or nearly permanent water in a variety of habitats	Y	Y	Known to occur in a number of aquatic habitats in the study area, including creeks, rivers, lakes, and ponds CDFW 2021a); away from these waterbodies, might occasionally disperse across upland portions of the study area; VHP maps of primary and secondary habitat show known occurrences within the study area (ICF 2012)
California giant salamander (*Dicamptodon ensatus*)	SSC	Occurs in wet coastal forests in or near clear, cold, permanent and semi-permanent streams and seepages; one population has been found inhabiting flowing water in a network of caves	Y	Y	Suitable habitat is present in the study area in the higher elevations of the Santa Cruz Mountains, and wintering or migrating individuals may forage in the study area; CNDDB (2021) shows occurrences, including areas along Permanente Creek, Guadalupe Creek above 700-foot elevation, and above and below Lexington Reservoir (CDFW 2021a)

Name	Regulatory Status	Habitat	Potential to Occur	Analyzed in Document	Rationale
California tiger salamander (*Ambystoma californiense*)	FT, ST, VHP	Vernal or temporary pools in annual grasslands or open woodlands	Y	Y	Species known to occur in the study area, and the VHP maps show many known and general locations within the study area; species could move through the study area or use mammal burrows and crevices as refugia throughout the study area (ICF 2012)
California red-legged frog (*Rana draytonii*)	FT, SSC, VHP	Streams, freshwater pools, and ponds with emergent or overhanging vegetation	Y	Y	Known to occur in the study area, and the VHP maps show many known and general locations and breeding, refugia, and dispersal habitats within the study area; species could move through the study area or use mammal burrows and crevices as refugia throughout the study area, though most likely to occur in aquatic habitat such as pools; the VHP maps show upland portions of the area as dispersal habitat (ICF 2012)
Coast horned lizard (*Phrynosoma blainvillii*)	SSC	Open habitats with sandy, loosely textured soils, such as chaparral, coastal scrub, annual grassland, and clearings in riparian woodlands with the presence of native harvester ants (*Pogonomyrmex barbatus*)	Y	Y	Recorded in the study area only near Calero Reservoir (ICF 2012); probably restricted to a few locations at the margins of the study area
Green sea turtle (*Chelonia mydas*)	FT	Occurs in marine habitat and sandy beaches.	N	N	The study area does not include marine areas.
Northern California legless lizard (*Anniella pulchra*)	SSC	Occurs in sandy soils in coastal dune, valley-foothill, chaparral, and coastal scrub habitat.	N	N	No coastal or dune habitat occur within the study area.
Red-bellied newt (*Taricha rivularis*)	SSC	Occurs in stream and rivers.	Y	Y	A disjunct population was identified in Stevens Creek in 2014. It is approximately 80 miles south of the nearest records in Sonoma County. There is speculation that the population may be introduced (Reilly et al. 2014).
Coast Range newt (*Taricha torosa*)	SSC	Occurs in wet forests, oak forests, chaparral, and grasslands.	Y	Y	This species is known to occur in Santa Clara County and could be present in the study area.

Name	Regulatory Status	Habitat	Potential to Occur	Analyzed in Document	Rationale
Santa Cruz black salamander (*Aneides niger*)	SSC	Occurs in mixed deciduous woodland, coniferous forests, coastal grasslands; found under rocks near streams, in talus, under damp logs, and other objects	Y	Y	Suitable habitat may be present in the study area in the higher elevations of the Santa Cruz Mountains; a 2017 occurrence was noted along Guadalupe Creek from approximately 700–2,400 feet elevation, from Rincon Creek to east side of Mt. Umunhum (CDFW 2021a)
San Francisco gartersnake (*Thamnophis sirtalis tetrataenia*)	FE, SE, FP	Endemic to California, found only on the San Francisco Peninsula from near the southern San Francisco County line south to Rancho del Oso State Park in Santa Cruz County; utilizes a wide variety of habitats, preferring grasslands or wetlands near ponds, marshes and sloughs; may overwinter in upland areas away from water	N	N	Suitable habitat and presumed extant occurrence are present in the study area in the higher elevations of the northern portion of the Santa Cruz Mountains within Stevens Creek watershed (CDFW 2021a, CDFW 2021b); this area is outside of areas where potential restoration/enhancement activities would occur
Santa Cruz longtoed salamander (*Ambystoma macrodactylum croceum)*	FE, SE, FP	Upland mesic coastal scrub, live oak or Monterey pine woodland and riparian vegetation with small mammal burrows, leaf litter or rotten logs for burrowing; breeds in shallow, usually ephemeral freshwater ponds; restricted to southern Santa Cruz County (south of Aptos Creek) and northern Monterey County	N	N	The study area is outside of the species' known range, and no occurrences have been documented within the study area (CDFW 2021a)
Avian					
Alameda song sparrow (*Melospiza melodia pusilula*)	SSC	Occurs in tidal salt marshes of south San Francisco Bay.	N	N	The study area does not include tidal salt marshes.
American peregrine falcon (*Falco peregrinus anatum*)	FP	Forages in many habitats; nests on cliffs and tall bridges and buildings	Y	Y	Uncommon breeders in the study area, but non-breeders are present in small numbers in fall and winter; might occur anywhere throughout the study area as a forager or migrant, though always at low densities; known to nest at San Jose City Hall and on electrical towers in Mountain View and managed ponds

Name	Regulatory Status	Habitat	Potential to Occur	Analyzed in Document	Rationale
American white pelican (*Pelecanus erythrorhynchos*)	SSC	Forages in shallow inland waters; current breeding range is in northeastern California.	N	N	Uncommon in Santa Clara County and unlikely in the study area.
Bank swallow (*Riparia riparia*)	ST	Colonial nesters, excavating nesting burrows in vertical banks of streams, rivers, and ocean coasts	N	N	No suitable nesting habitat is present in the study area; occur in the study area only as rare transients; only record of breeding in Santa Clara County is from the Pajaro River, and this colony has not been active in decades
Bald eagle (*Haliaeetus leucocephalus*)	SE, FP	Mainly along seacoasts, rivers, and lakes; nests in tall trees or in cliffs, occasionally on electrical towers; feeds mostly on fish	Y	Y	Species has been recorded nesting in Santa Clara County; has nested only at Calaveras Reservoir, which is outside the study area; small numbers forage in the study area at all large reservoirs, primarily during the nonbreeding season
Barrows goldeneye (*Bucephala islandica*)	SSC	Occurs in estuarine and brackish waters. Very uncommon in central California; can be found in San Francisco Bay	N	N	The study area does not include San Francisco Bay or estuarine or brackish waters.
Black skimmer *(Rynchops niger)*	SSC	Requires calm, shallow water for foraging, and sand bars, beaches, or dikes for roosting and nesting; species is a ground nester	N	N	Known to breed in southern San Francisco Bay (CDFW 2021a) and forage nearshore; this area is outside of areas where potential restoration/enhancement activities would occur
Black swift (*Cypseloides*)	SSC	Nests behind waterfalls, cliffs, and in sea caves.	N	N	The study area does not include suitable nesting habitat.
Black tern (*Childonias nuiger*)	SSC	Nest in protected marshes on floating substrate or on small mounds and rice fields.	N	N	The study area does not include suitable nesting habitat.
Brant (*Branta bernicla*)	SSC	Occurs in shallow marine waters with eel-grass beds, primarily within bays and estuaries.	N	N	The study area does not contain suitable foraging habitat.
Bryants savannah sparrow (*Passerculus sandwichensis alaudinus*)	SSC	Occurs in tidal marshes and grasslands in the coastal fog belt.	N	N	The study area does not include suitable habitat.

Name	Regulatory Status	Habitat	Potential to Occur	Analyzed in Document	Rationale
Burrowing owl (*Athene cunicularia*)	SSC, VHP	Open grasslands and ruderal habitats with suitable burrows, usually those made by California ground squirrels	Y	Y	Present year-round in the study area in open, agricultural, and grassland areas where active ground squirrel burrows are present; the species has undergone a recent decline in Santa Clara County; core populations of breeding and overwintering burrowing owls occur at the Norman Y, Mineta San Jose International Airport, in the North San Jose/Alviso area, and in the northern Mountain View area (ICF 2012)
California Ridgway's rail (*Rallus obsoletus*); (formerly the clapper rail)	FE, SE, FP	Salt marsh habitat dominated by pickleweed and cordgrass (*Spartina* spp.).	N	N	Although site-specific surveys have not been conducted in all suitable habitats for this species in the south Bay, this species is likely to occur in tidal salt marsh habitats in a number of additional areas as documented within the SMP; CNDDB records from the tidal areas near Stevens and Guadalupe Creeks note this species within suitable habitat (CDFW 2021a);this area is outside of areas where potential restoration/enhancement activities would occur
California least tern (*Sternula antillarum browni)*	FE, SE, FP	Nests along the coast on bare or sparsely vegetated, flat substrates; in the south Bay, nests in salt pans and on an old airport runway; forages for fish in open waters	~~Y~~ N	~~Y~~ N	Not known to breed in or adjacent to the study area; however, the south Bay is an important post-breeding staging area, and the species forages in late summer and early fall in saline-managed ponds within and adjacent to the Alviso area (SCVWD 2012). However, the tern does not use the study area.
California condor (*Gymnogyps californianus*)	FE, SE, FP	Nests in caves in steep, isolated cliffs, or cavities in mature redwood trees; forages over grasslands, open woodlands, and along coastal beaches	N	N	Historically present in much of Santa Clara County as a non-breeder; not currently known to occur regularly in the study area; no breeding habitat for this species is present in the study area
California black rail (*Laterallus jamaicensis Coturniculus)*	ST, FP	Breeds in fresh, brackish, and tidal salt marsh	N	N	Occurs in the south Bay primarily as a scarce winter visitor, although some birds have recently begun over-summering and breeding in the Alviso area

Name	Regulatory Status	Habitat	Potential to Occur	Analyzed in Document	Rationale
California brown pelican (*Pelecanus occidentalis californicus*)	FP	Occurs in estuarine, marine subtidal, and marine pelagic waters along the coast.	N	N	The study area does not include suitable habitat.
Grasshopper sparrow (*Ammodramus savannarum*)	SSC	Breeds and forages in grasslands, meadows, fallow fields, and pastures	Y	Y	Nests in extensive grasslands with some heterogeneity, including serpentine grasslands; in the study area, breeding birds occur in the foothills of the Santa Cruz Mountains and from Calaveras Reservoir southeast to the hills above Pacheco Creek might occur somewhat more widely during migration, but is expected to be seldom detected outside the breeding season in the study area
Golden eagle (*Aquila chrysaetos*)	FP	Breeds on cliffs or in large trees (rarely on electrical towers); forages in open areas	Y	Y	Breeds widely in the Diablo Range and less commonly in the Santa Cruz Mountains, mostly above the elevation of the study area, but a few pairs breed at the edges of the Santa Clara Valley at elevations within the study area (SCVWD 2012); forages somewhat more widely in agricultural/open space areas on the Santa Clara Valley floor
Least Bell's vireo (*Vireo bellii pusillus*)	FE, SE, VHP	Nests in heterogeneous riparian habitat, often dominated by cottonwoods and willows	Y	Y	The VHP does not map suitable habitat for this species as occurring in the study area (ICF 2012); although the abundance and distribution of this species might increase as core populations increase, it is unlikely to be more than a rare and very locally occurring breeder along southern Santa Clara County streams (south of the project site); the only breeding records in Santa Clara County are outside of the study area from Llagas Creek southeast of Gilroy in 1997 and the Pajaro River south of Gilroy in 1932 (ICF 2012); records in the county include 1–2 singing males along lower Llagas Creek in May 2001 (CDFW 2021a)
Least bittern (*Ixobrychus exilis*)	SSC	Occurs in freshwater and brackish marshes with emergent vegetation and woody plants over deep water.	N	N	The current range map does not include the study area.

Name	Regulatory Status	Habitat	Potential to Occur	Analyzed in Document	Rationale
Loggerhead shrike (*Lanius ludovicianus*)	SSC	Nests in tall shrubs and dense trees; forages in grasslands, marshes, and ruderal habitats	Y	Y	Breeds in a number of locations in the study area where open grassland, ruderal, or agricultural habitat with scattered brush, chaparral, or trees provides perches and nesting sites (SCVWD 2012); occurs slightly more widely (that is, in smaller patches of open areas providing foraging habitat) during the nonbreeding season
Long-eared owl (*Asio otus*)	SSC	Riparian bottomlands with tall, dense vegetation; dense live oak and California Bay along upland streams; and upland conifer forests; forages primarily in adjacent open areas	Y	Y	Rare resident and occasional winter visitor in Santa Clara County (SCVWD 2012); however suitable breeding and foraging habitat may be present in the study area
Marbled murrelet (*Brachyramphus marmoratus)*	~~FE,~~ FT, SE	Marine/pelagic bird; nests and roosts in large trees in coastal mature redwood and Douglas-fir forests up to 5 miles inland (CDFW 2018)	N	N	Designated critical habitat, including suitable nesting habitat is present west of Highway 35 within the higher elevations of the Santa Cruz Mountains; this area is outside of areas where potential restoration/enhancement activities would occur
Northern harrier (*Circus cyaneus)*	SSC	Nests in marshes and moist fields; forages over open areas	Y	Y	Suitable nesting, foraging, and wintering habitat may be present in the study area; CNDDB records identify occurrences within or near the study area (CDFW 2021a).
Olive-sided flycatcher (*Contopus cooperi*)	SCC	Occurs in late-successional conifer forests with open canopies; usually found above 3,018 feet.	N	N	This species is likely to occur outside of the study area in higher-elevation areas.
Purple martin (*Progne subis*)	SSC	Inhabits open forests, woodlands, and riparian areas in breeding season; found in a variety of open habitats during migration, including grassland, wet meadow, and fresh emergent wetland, usually near water (CDFW 2017d)	Y	Y	Suitable habitat may be present in the study area; rare resident and breeder in Santa Clara County
Redhead (*Aythya americana*)	SSC	Nests in freshwater, emergent wetlands with dense cattails and tules and open water.	N	N	The study area is outside of the current and historic breeding ranges.

Name	Regulatory Status	Habitat	Potential to Occur	Analyzed in Document	Rationale
Saltmarsh common yellowthroat (*Geothlypis trichas sinuosa)*	SSC	Nests in herbaceous vegetation, usually in wetlands or moist floodplains	N	N	Multiple occurrences of this subspecies have been documented along tidal sloughs and marshes (CDFW 2021a); this area is outside of areas where potential restoration/enhancement activities would occur
Short-eared owl (*Asio flammeus*)	SSC	Occurs in salt and freshwater marshes, irrigated fields, and ungrazed grasslands.	Y	Y	Suitable habitat may be present in the study area.
Southwestern willow flycatcher (*Empidonax traillii extimus*)	FE, SE	Found in bushes, willow thickets, brushy fields, and upland groves; breeds in thickets of deciduous trees and shrubs, especially willows, or along woodland edges; often near streams or marshes (especially in southern part of range)	Y	Y	This sub-species is not known or expected to breed in the study area but could occur as a migrant
Swainson's hawk (*Buteo swainsoni*)	ST	Nests in trees surrounded by extensive marshland or agricultural foraging habitat	Y	Y	Currently known to occur in Santa Clara County primarily as a very infrequent transient during migration; although nesting hawks might be returning to the region, the species is not expected to nest within or adjacent to the study area due to high levels of human disturbance (for example, roads, trails, residences, and Valley Water activities); it might forage in the study area along suitable valley-floor grassland/ agricultural land in which the species forages when in transit through the county
Tricolored blackbird (*Agelaius tricolor*)	ST, SSC, VHP	Nests near fresh water in dense emergent vegetation	Y	Y	Typically nests in extensive stands of tall emergent herbaceous vegetation in freshwater marshes and ponds; in the study area, the species is patchily distributed in the Santa Clara Valley, its distribution reflecting the patchy nature of its breeding habitat (ICF 2012); occurs as an uncommon nonbreeding forager throughout most of the study area
Vaux's swift (*Chaetura vauxi*)	SSC	Nests in large cavities of large-diameter trees; typically found in coastal redwood stands.	N	N	This species is likely to occur outside of the study area in higher-elevation areas with large-diameter trees.

Name	Regulatory Status	Habitat	Potential to Occur	Analyzed in Document	Rationale
Western snowy plover (*Charadrius lexandrines nivosus*)	FT, SSC	Coastal populations nest on dune-backed beaches, sand spits, beaches at creeks and river mouths, and salt pans at lagoons and estuaries	N	N	Although unlikely to occur within specific project sites where enhancements and restoration would occur, suitable habitat for snowy plovers may be present in the study area; critical habitat for this species does not occur within Santa Clara County; CNDDB records indicate the species is found near the mouth of the Guadalupe River and Stevens Creek (CDFW 2021a); this area is outside of areas where potential restoration/enhancement activities would occur
Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*)	FT, SE	Riparian forest nester, along the broad, lower flood bottoms of larger river systems	N	N	This species is believed to be extirpated from the Santa Clara Valley (CDFW 2021a)
White-tailed kite (*Elanus leucurus*)	FP	Nests in tall shrubs and trees, forages in grasslands, marshes, and ruderal habitats	Y	Y	Occurs at scattered locations southward along the Santa Clara Valley floor and the foothills on either side of the valley (CDFW 2021a); also, fairly common along Llagas and Uvas/Carnadero Creeks and the Pajaro River
Willow flycatcher (*Empidonax traillii*)	SE	Occurs in wet meadow and mountain riparian habitats ranging from 2,000 feet to 8,000 feet in elevation; dense willow thickets.	N	N	This species is likely to occur outside of the study area in higher-elevation areas.
Yellow rail (*Coturnicops noveboracensis*)	SSC	Densely vegetated marshes; requires sedge marshes/ meadows with moist soil or shallow standing water for breeding (Shuford and Gardali 2008)	Y	Y	Although this species is rare within the Santa Clara Valley, suitable foraging habitat is present in the marshy portion of the study area
Yellow warbler (*Setophaga petechia*)	SCC	Occurs in willows and cottonwoods along stream or in wet meadows.	Y	Y	This species is known to occur in Santa Clara County and could be present in the study area.

Name	Regulatory Status	Habitat	Potential to Occur	Analyzed in Document	Rationale
Yellow-breasted chat (*Icteria virens*)	SSC	Nests in dense stands of willow and other riparian habitat	Y	Y	Rare breeder, and only slightly more regular transient, in willow-dominated riparian habitats in the study area; historically, it likely bred more widely in Santa Clara County, but it is now rare because of the loss of suitable breeding habitat and brood parasitism by brown-headed cowbirds
Yellow-headed blackbird (*Xanthocephalus xanthocephalus*)	SSC	Nests in marshes in tall vegetation like cattails and tules over relatively deep water.	N	N	The species is believed to be extirpated from Santa Clara County due to habitat loss and, therefore, is unlikely to occur in the study area (Shuford and Gardali 2008).

Notes: SSC = California species of special concern; FE = federally endangered; FT = federally threatened; SC = state candidate for listing; SE = state endangered; FP = state fully protected; ST = state threatened; VHP = VHP covered species

1.2 USFWS Information Planning and Conservation Search Results

The following letters were obtained using the IPaC database search for the region surrounding the study area. See Attachment A.

- San Francisco Bay-Delta Office Letter
- Sacramento Office Letter
- Ventura Office Letter

1.2.1 Santa Clara Valley Habitat Plan Chapter 6: Conditions of Approval

See Appendix E of the EIR.

2 References

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Attachment A. USFWS Information Planning and Conservation Search Results

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay-Delta Fish And Wildlife
650 Capitol Mall
Suite 8-300
Sacramento, CA 95814
Phone: (916) 930-5603 Fax: (916) 930-5654
http://kim_squires@fws.gov

March 17, 2021

In Reply Refer To:
Consultation Code: 08FBDT00-2021-SLI-0111
Event Code: 08FBDT00-2021-E-00267
Project Name: FAHCE

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

San Francisco Bay-Delta Fish And Wildlife
650 Capitol Mall
Suite 8-300
Sacramento, CA 95814
(916) 930-5603

This project's location is within the jurisdiction of multiple offices. Expect additional species list documents from the following office, and expect that the species and critical habitats in each document reflect only those that fall in the office's jurisdiction:

Sacramento Fish And Wildlife Office
Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846
(916) 414-6600

Project Summary

Consultation Code: 08FBDT00-2021-SLI-0111
Event Code: 08FBDT00-2021-E-00267
Project Name: FAHCE
Project Type: WATER SUPPLY / DELIVERY
Project Description: EIR
Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@37.1800095,-121.78692965587199,14z

Counties: Alameda and Santa Clara counties, California

Endangered Species Act Species

There is a total of 18 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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[1] NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Mammals

NAME	STATUS
Salt Marsh Harvest Mouse *Reithrodontomys raviventris* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/613	Endangered
San Joaquin Kit Fox *Vulpes macrotis mutica* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/2873	Endangered

Birds

NAME	STATUS
California Clapper Rail *Rallus longirostris obsoletus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/4240	Endangered
California Least Tern *Sterna antillarum browni* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/8104	Endangered
Western Snowy Plover *Charadrius nivosus nivosus* Population: Pacific Coast population DPS-U.S.A. (CA, OR, WA), Mexico (within 50 miles of Pacific coast) There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/8035	Threatened
Yellow-billed Cuckoo *Coccyzus americanus* Population: Western U.S. DPS There is **proposed** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/3911	Threatened

Reptiles

NAME	STATUS
Alameda Whipsnake (=striped Racer) *Masticophis lateralis euryxanthus* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/5524	Threatened
Green Sea Turtle *Chelonia mydas* Population: East Pacific DPS No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/6199	Threatened

Amphibians

NAME	STATUS
California Red-legged Frog *Rana draytonii* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/2891	Threatened
California Tiger Salamander *Ambystoma californiense* Population: U.S.A. (Central CA DPS) There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/2076	Threatened

Fishes

NAME	STATUS
Delta Smelt *Hypomesus transpacificus* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/321	Threatened

Insects

NAME	STATUS
Bay Checkerspot Butterfly *Euphydryas editha bayensis* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/2320	Threatened
San Bruno Elfin Butterfly *Callophrys mossii bayensis* There is **proposed** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/3394	Endangered

Crustaceans

NAME	STATUS
Conservancy Fairy Shrimp *Branchinecta conservatio* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/8246	Endangered
Vernal Pool Tadpole Shrimp *Lepidurus packardi* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/2246	Endangered

Flowering Plants

NAME	STATUS
California Seablite *Suaeda californica* Population: No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/6310	Endangered
Contra Costa Goldfields *Lasthenia conjugens* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/7058	Endangered
Robust Spineflower *Chorizanthe robusta var. robusta* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/9287	Endangered

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish And Wildlife Office
Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846
Phone: (916) 414-6600 Fax: (916) 414-6713

In Reply Refer To:
Consultation Code: 08ESMF00-2021-SLI-1315
Event Code: 08ESMF00-2021-E-03777
Project Name: FAHCE

March 17, 2021

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, under the jurisdiction of the U.S. Fish and Wildlife Service (Service) that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the Service under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Please follow the link below to see if your proposed project has the potential to affect other species or their habitats under the jurisdiction of the National Marine Fisheries Service:

http://www.nwr.noaa.gov/protected_species/species_list/species_lists.html

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Sacramento Fish And Wildlife Office
Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846
(916) 414-6600

This project's location is within the jurisdiction of multiple offices. Expect additional species list documents from the following office, and expect that the species and critical habitats in each document reflect only those that fall in the office's jurisdiction:

San Francisco Bay-Delta Fish And Wildlife
650 Capitol Mall
Suite 8-300
Sacramento, CA 95814
(916) 930-5603

Project Summary

Consultation Code:	08ESMF00-2021-SLI-1315
Event Code:	08ESMF00-2021-E-03777
Project Name:	FAHCE
Project Type:	WATER SUPPLY / DELIVERY
Project Description:	EIR

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@37.1800095,-121.78692965587199,14z

Counties: Alameda and Santa Clara counties, California

Endangered Species Act Species

There is a total of 22 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Mammals

NAME	STATUS
Salt Marsh Harvest Mouse *Reithrodontomys raviventris* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/613	Endangered
San Joaquin Kit Fox *Vulpes macrotis mutica* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/2873	Endangered

Birds

NAME	STATUS
California Clapper Rail *Rallus longirostris obsoletus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/4240	Endangered
California Least Tern *Sterna antillarum browni* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/8104	Endangered
Marbled Murrelet *Brachyramphus marmoratus* Population: U.S.A. (CA, OR, WA) There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/4467	Threatened
Western Snowy Plover *Charadrius nivosus nivosus* Population: Pacific Coast population DPS-U.S.A. (CA, OR, WA), Mexico (within 50 miles of Pacific coast) There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/8035	Threatened
Yellow-billed Cuckoo *Coccyzus americanus* Population: Western U.S. DPS There is **proposed** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/3911	Threatened

Reptiles

NAME	STATUS
Alameda Whipsnake (=striped Racer) *Masticophis lateralis euryxanthus* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/5524	Threatened
Green Sea Turtle *Chelonia mydas* Population: East Pacific DPS No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/6199	Threatened

Amphibians

NAME	STATUS
California Red-legged Frog *Rana draytonii* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/2891	Threatened
California Tiger Salamander *Ambystoma californiense* Population: U.S.A. (Central CA DPS) There is **final** critical habitat for this species. Your location overlaps the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/2076	Threatened

Fishes

NAME	STATUS
Delta Smelt *Hypomesus transpacificus* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/321	Threatened
Tidewater Goby *Eucyclogobius newberryi* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/57	Endangered

Insects

NAME	STATUS
Bay Checkerspot Butterfly *Euphydryas editha bayensis* There is **final** critical habitat for this species. Your location overlaps the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/2320	Threatened
San Bruno Elfin Butterfly *Callophrys mossii bayensis* There is **proposed** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/3394	Endangered

Crustaceans

NAME	STATUS
Conservancy Fairy Shrimp *Branchinecta conservatio* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/8246	Endangered
Vernal Pool Tadpole Shrimp *Lepidurus packardi* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/2246	Endangered

Flowering Plants

NAME	STATUS
California Seablite *Suaeda californica* Population: No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/6310	Endangered
Contra Costa Goldfields *Lasthenia conjugens* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/7058	Endangered
Metcalf Canyon Jewelflower *Streptanthus albidus ssp. albidus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/4186	Endangered
Robust Spineflower *Chorizanthe robusta var. robusta* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/9287	Endangered
Santa Clara Valley Dudleya *Dudleya setchellii* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/3207	Endangered

Critical habitats

There are 2 critical habitats wholly or partially within your project area under this office's jurisdiction.

NAME	STATUS
Bay Checkerspot Butterfly *Euphydryas editha bayensis* https://ecos.fws.gov/ecp/species/2320#crithab	Final
California Tiger Salamander *Ambystoma californiense* https://ecos.fws.gov/ecp/species/2076#crithab	Final

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ventura Fish And Wildlife Office
2493 Portola Road, Suite B
Ventura, CA 93003-7726
Phone: (805) 644-1766 Fax: (805) 644-3958

In Reply Refer To:
Consultation Code: 08EVEN00-2018-SLI-0815
Event Code: 08EVEN00-2018-E-02103
Project Name: FAHCE

August 23, 2018

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed list identifies species listed as threatened and endangered, species proposed for listing as threatened or endangered, designated and proposed critical habitat, and species that are candidates for listing that may occur within the boundary of the area you have indicated using the U.S. Fish and Wildlife Service's (Service) Information Planning and Conservation System (IPaC). The species list fulfills the requirements under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the species list should be verified after 90 days. We recommend that verification be completed by visiting the IPaC website at regular intervals during project planning and implementation for updates to species lists following the same process you used to receive the enclosed list. Please include the Consultation Tracking Number in the header of this letter with any correspondence about the species list.

Due to staff shortages and excessive workload, we are unable to provide an official list more specific to your area. Numerous other sources of information are available for you to narrow the list to the habitats and conditions of the site in which you are interested. For example, we recommend conducting a biological site assessment or surveys for plants and animals that could help refine the list.

If a Federal agency is involved in the project, that agency has the responsibility to review its proposed activities and determine whether any listed species may be affected. If the project is a major construction project*, the Federal agency has the responsibility to prepare a biological assessment to make a determination of the effects of the action on the listed species or critical habitat. If the Federal agency determines that a listed species or critical habitat is likely to be adversely affected, it should request, in writing through our office, formal consultation pursuant to section 7 of the Act. Informal consultation may be used to exchange information and resolve conflicts with respect to threatened or endangered species or their critical habitat prior to a written request for formal consultation. During this review process, the Federal agency may engage in planning efforts but may not make any irreversible commitment of resources. Such a commitment could constitute a violation of section 7(d) of the Act.

Federal agencies are required to confer with the Service, pursuant to section 7(a)(4) of the Act, when an agency action is likely to jeopardize the continued existence of any proposed species or result in the destruction or adverse modification of proposed critical habitat (50 CFR 402.10(a)). A request for formal conference must be in writing and should include the same information that would be provided for a request for formal consultation. Conferences can also include discussions between the Service and the Federal agency to identify and resolve potential conflicts between an action and proposed species or proposed critical habitat early in the decision-making process. The Service recommends ways to minimize or avoid adverse effects of the action. These recommendations are advisory because the jeopardy prohibition of section 7(a)(2) of the Act does not apply until the species is listed or the proposed critical habitat is designated. The conference process fulfills the need to inform Federal agencies of possible steps that an agency might take at an early stage to adjust its actions to avoid jeopardizing a proposed species.

When a proposed species or proposed critical habitat may be affected by an action, the lead Federal agency may elect to enter into formal conference with the Service even if the action is not likely to jeopardize or result in the destruction or adverse modification of proposed critical habitat. If the proposed species is listed or the proposed critical habitat is designated after completion of the conference, the Federal agency may ask the Service, in writing, to confirm the conference as a formal consultation. If the Service reviews the proposed action and finds that no significant changes in the action as planned or in the information used during the conference have occurred, the Service will confirm the conference as a formal consultation on the project and no further section 7 consultation will be necessary. Use of the formal conference process in this manner can prevent delays in the event the proposed species is listed or the proposed critical habitat is designated during project development or implementation.

Candidate species are those species presently under review by the Service for consideration for Federal listing. Candidate species should be considered in the planning process because they may become listed or proposed for listing prior to project completion. Preparation of a biological assessment, as described in section 7(c) of the Act, is not required for candidate species. If early evaluation of your project indicates that it is likely to affect a candidate species, you may wish to request technical assistance from this office.

Only listed species receive protection under the Act. However, sensitive species should be considered in the planning process in the event they become listed or proposed for listing prior to project completion. We recommend that you review information in the California Department of Fish and Wildlife's Natural Diversity Data Base. You can contact the California Department of Fish and Wildlife at (916) 324-3812 for information on other sensitive species that may occur in this area.

[*A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.]

Attachment(s):

- Official Species List

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Ventura Fish And Wildlife Office
2493 Portola Road, Suite B
Ventura, CA 93003-7726
(805) 644-1766

This project's location is within the jurisdiction of multiple offices. Expect additional species list documents from the following offices, and expect that the species and critical habitats in each document reflect only those that fall in the office's jurisdiction:

Sacramento Fish And Wildlife Office
Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846
(916) 414-6600

San Francisco Bay-Delta Fish And Wildlife
650 Capitol Mall
Suite 8-300
Sacramento, CA 95814
(916) 930-5603

Project Summary

Consultation Code:	08EVEN00-2018-SLI-0815
Event Code:	08EVEN00-2018-E-02103
Project Name:	FAHCE
Project Type:	** OTHER **
Project Description:	FAHCE HCP

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/37.23773483248291N121.8080320436648W

Counties: Alameda, CA | San Benito, CA | San Mateo, CA | Santa Clara, CA | Santa Cruz, CA

Endangered Species Act Species

There is a total of 28 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Mammals

NAME	STATUS
San Joaquin Kit Fox *Vulpes macrotis mutica* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/2873	Endangered

Birds

NAME	STATUS
California Clapper Rail *Rallus longirostris obsoletus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/4240	Endangered
California Condor *Gymnogyps californianus* Population: U.S.A. only, except where listed as an experimental population There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/8193	Endangered
California Least Tern *Sterna antillarum browni* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/8104	Endangered
Least Bell's Vireo *Vireo bellii pusillus* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/5945	Endangered
Marbled Murrelet *Brachyramphus marmoratus* Population: U.S.A. (CA, OR, WA) There is **final** critical habitat for this species. Your location overlaps the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/4467	Threatened
Southwestern Willow Flycatcher *Empidonax traillii extimus* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/6749	Endangered

Reptiles

NAME	STATUS
Blunt-nosed Leopard Lizard *Gambelia silus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/625	Endangered
San Francisco Garter Snake *Thamnophis sirtalis tetrataenia* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/5956	Endangered

Amphibians

NAME	STATUS
California Red-legged Frog *Rana draytonii* There is **final** critical habitat for this species. Your location overlaps the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/2891	Threatened
California Tiger Salamander *Ambystoma californiense* Population: U.S.A. (Central CA DPS) There is **final** critical habitat for this species. Your location overlaps the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/2076	Threatened
Santa Cruz Long-toed Salamander *Ambystoma macrodactylum croceum* There is **proposed** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/7405	Endangered

Fishes

NAME	STATUS
Tidewater Goby *Eucyclogobius newberryi* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/57	Endangered

Insects

NAME	STATUS
Bay Checkerspot Butterfly *Euphydryas editha bayensis* There is **final** critical habitat for this species. Your location overlaps the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/2320	Threatened
Mount Hermon June Beetle *Polyphylla barbata* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/3982	Endangered
Ohlone Tiger Beetle *Cicindela ohlone* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/8271	Endangered
Smith's Blue Butterfly *Euphilotes enoptes smithi* There is **proposed** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/4418	Endangered
Zayante Band-winged Grasshopper *Trimerotropis infantilis* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/1036	Endangered

Crustaceans

NAME	STATUS
Vernal Pool Fairy Shrimp *Branchinecta lynchi* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/498	Threatened

Flowering Plants

NAME	STATUS
Ben Lomond Spineflower *Chorizanthe pungens var. hartwegiana* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/7498	Endangered
Ben Lomond Wallflower *Erysimum teretifolium* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/7429	Endangered
Marsh Sandwort *Arenaria paludicola* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/2229	Endangered
Menzies' Wallflower *Erysimum menziesii* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/2935	Endangered
Monterey Spineflower *Chorizanthe pungens var. pungens* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/396	Threatened
Santa Cruz Tarplant *Holocarpha macradenia* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/6832	Threatened
Scotts Valley Polygonum *Polygonum hickmanii* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/3222	Endangered
Scotts Valley Spineflower *Chorizanthe robusta var. hartwegii* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/7108	Endangered

Conifers and Cycads

NAME	STATUS
Santa Cruz Cypress *Cupressus abramsiana* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/1678	Threatened

Critical habitats

There are 2 critical habitats wholly or partially within your project area under this office's jurisdiction.

NAME	STATUS
California Tiger Salamander *Ambystoma californiense* https://ecos.fws.gov/ecp/species/2076#crithab	Final
Marbled Murrelet *Brachyramphus marmoratus* https://ecos.fws.gov/ecp/species/4467#crithab	Final

Appendix P – Terrestrial Biological Resources Technical Memorandum

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Appendix Q
CalEEMod Air Quality Modeling

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FAHCE Construction Activities

Bay Area AQMD Air District, Annual

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric	Lot Acreage	Floor Surface Area	Population
Other Non-Asphalt Surfaces	1.00	Acre	1.00	43,560.00	0

1.2 Other Project Characteristics

Urbanization	Urban	**Wind Speed (m/s)**	2.2	**Precipitation Freq (Days)**	64
Climate Zone	4			**Operational Year**	2023
Utility Company	Pacific Gas & Electric Company				
CO2 Intensity (lb/MWhr)	641.35	**CH4 Intensity (lb/MWhr)**	0.029	**N2O Intensity (lb/MWhr)**	0.006

1.3 User Entered Comments & Non-Default Data

Project Characteristics -

Land Use -

Construction Phase - Short term construction activities a various locations within the project area.

Demolition -

Trips and VMT - Haul trips during construction are to import materials for construction of cofferdams, installation of culverts, stockpiling of materials, and installing riprap.

Construction Off-road Equipment Mitigation -

Table Name	Column Name	Default Value	New Value
tblConstructionPhase	NumDays	100.00	20.00
tblConstructionPhase	PhaseEndDate	6/8/2022	2/16/2022
tblTripsAndVMT	HaulingTripNumber	0.00	5.00

2.0 Emissions Summary

2.1 Overall Construction

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2022	0.0259	0.2186	0.2045	3.9000e-004	4.7500e-003	0.0101	0.0149	1.0300e-003	9.6400e-003	0.0107	0.0000	33.0035	33.0035	6.0100e-003	0.0000	33.1539
Maximum	**0.0259**	**0.2186**	**0.2045**	**3.9000e-004**	**4.7500e-003**	**0.0101**	**0.0149**	**1.0300e-003**	**9.6400e-003**	**0.0107**	**0.0000**	**33.0035**	**33.0035**	**6.0100e-003**	**0.0000**	**33.1539**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2022	0.0259	0.2186	0.2045	3.9000e-004	3.5700e-003	0.0101	0.0137	8.5000e-004	9.6400e-003	0.0105	0.0000	33.0035	33.0035	6.0100e-003	0.0000	33.1538
Maximum	**0.0259**	**0.2186**	**0.2045**	**3.9000e-004**	**3.5700e-003**	**0.0101**	**0.0137**	**8.5000e-004**	**9.6400e-003**	**0.0105**	**0.0000**	**33.0035**	**33.0035**	**6.0100e-003**	**0.0000**	**33.1538**

	ROG	**NOx**	**CO**	**SO2**	**Fugitive PM10**	**Exhaust PM10**	**PM10 Total**	**Fugitive PM2.5**	**Exhaust PM2.5**	**PM2.5 Total**	**Bio- CO2**	**NBio-CO2**	**Total CO2**	**CH4**	**N20**	**CO2e**
Percent Reduction	**0.00**	**0.00**	**0.00**	**0.00**	**24.84**	**0.00**	**7.94**	**17.48**	**0.00**	**1.69**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Quarter	Start Date	End Date	Maximum Unmitigated ROG + NOX (tons/quarter)	Maximum Mitigated ROG + NOX (tons/quarter)
1	**1-3-2022**	**4-2-2022**	0.2312	0.2312
		Highest	0.2312	0.2312

2.2 Overall Operational

Unmitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	3.7300e-003	0.0000	1.0000e-005	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	2.0000e-005	2.0000e-005	0.0000	0.0000	2.0000e-005
Energy	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Mobile	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Waste						0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Water						0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	**3.7300e-003**	**0.0000**	**1.0000e-005**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**2.0000e-005**	**2.0000e-005**	**0.0000**	**0.0000**	**2.0000e-005**

2.2 Overall Operational

Mitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	3.7300e-003	0.0000	1.0000e-005	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	2.0000e-005	2.0000e-005	0.0000	0.0000	2.0000e-005
Energy	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Mobile	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Waste						0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Water						0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	**3.7300e-003**	**0.0000**	**1.0000e-005**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**2.0000e-005**	**2.0000e-005**	**0.0000**	**0.0000**	**2.0000e-005**

	ROG	**NOx**	**CO**	**SO2**	**Fugitive PM10**	**Exhaust PM10**	**PM10 Total**	**Fugitive PM2.5**	**Exhaust PM2.5**	**PM2.5 Total**	**Bio- CO2**	**NBio-CO2**	**Total CO2**	**CH4**	**N20**	**CO2e**
Percent Reduction	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

3.0 Construction Detail

Construction Phase

Phase Number	Phase Name	Phase Type	Start Date	End Date	Num Days Week	Num Days	Phase Description
1	Demolition	Demolition	1/3/2022	1/14/2022	5	10	
2	Building Construction	Building Construction	1/20/2022	2/16/2022	5	20	

Acres of Grading (Site Preparation Phase): 0

Acres of Grading (Grading Phase): 0

Acres of Paving: 1

Residential Indoor: 0; Residential Outdoor: 0; Non-Residential Indoor: 0; Non-Residential Outdoor: 0; Striped Parking Area: 0 (Architectural Coating – sqft)

OffRoad Equipment

Phase Name	Offroad Equipment Type	Amount	Usage Hours	Horse Power	Load Factor
Demolition	Concrete/Industrial Saws	1	8.00	81	0.73
Building Construction	Generator Sets	1	8.00	84	0.74
Building Construction	Cranes	1	6.00	231	0.29
Building Construction	Forklifts	1	6.00	89	0.20
Demolition	Rubber Tired Dozers	1	8.00	247	0.40
Building Construction	Tractors/Loaders/Backhoes	1	6.00	97	0.37
Demolition	Tractors/Loaders/Backhoes	3	8.00	97	0.37
Building Construction	Welders	3	8.00	46	0.45

Trips and VMT

Phase Name	Offroad Equipment Count	Worker Trip Number	Vendor Trip Number	Hauling Trip Number	Worker Trip Length	Vendor Trip Length	Hauling Trip Length	Worker Vehicle Class	Vendor Vehicle Class	Hauling Vehicle Class
Demolition	5	13.00	0.00	20.00	10.80	7.30	20.00	LD_Mix	HDT_Mix	HHDT
Building Construction	7	18.00	7.00	5.00	10.80	7.30	20.00	LD_Mix	HDT_Mix	HHDT

3.1 Mitigation Measures Construction

Water Exposed Area

3.2 Demolition - 2022

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					2.1400e-003	0.0000	2.1400e-003	3.2000e-004	0.0000	3.2000e-004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	8.4400e-003	0.0831	0.0698	1.2000e-004		4.1900e-003	4.1900e-003		3.9100e-003	3.9100e-003	0.0000	10.5388	10.5388	2.6900e-003	0.0000	10.6060
Total	**8.4400e-003**	**0.0831**	**0.0698**	**1.2000e-004**	**2.1400e-003**	**4.1900e-003**	**6.3300e-003**	**3.2000e-004**	**3.9100e-003**	**4.2300e-003**	**0.0000**	**10.5388**	**10.5388**	**2.6900e-003**	**0.0000**	**10.6060**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	7.0000e-005	2.4800e-003	5.6000e-004	1.0000e-005	1.7000e-004	1.0000e-005	1.8000e-004	5.0000e-005	1.0000e-005	5.0000e-005	0.0000	0.7462	0.7462	4.0000e-005	0.0000	0.7472
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	1.9000e-004	1.2000e-004	1.3400e-003	0.0000	5.1000e-004	0.0000	5.2000e-004	1.4000e-004	0.0000	1.4000e-004	0.0000	0.4183	0.4183	1.0000e-005	0.0000	0.4185
Total	**2.6000e-004**	**2.6000e-003**	**1.9000e-003**	**1.0000e-005**	**6.8000e-004**	**1.0000e-005**	**7.0000e-004**	**1.9000e-004**	**1.0000e-005**	**1.9000e-004**	**0.0000**	**1.1645**	**1.1645**	**5.0000e-005**	**0.0000**	**1.1657**

3.2 Demolition - 2022

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					9.6000e-004	0.0000	9.6000e-004	1.5000e-004	0.0000	1.5000e-004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	8.4400e-003	0.0831	0.0698	1.2000e-004		4.1900e-003	4.1900e-003		3.9100e-003	3.9100e-003	0.0000	10.5388	10.5388	2.6900e-003	0.0000	10.6060
Total	**8.4400e-003**	**0.0831**	**0.0698**	**1.2000e-004**	**9.6000e-004**	**4.1900e-003**	**5.1500e-003**	**1.5000e-004**	**3.9100e-003**	**4.0600e-003**	**0.0000**	**10.5388**	**10.5388**	**2.6900e-003**	**0.0000**	**10.6060**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	7.0000e-005	2.4800e-003	5.6000e-004	1.0000e-005	1.7000e-004	1.0000e-005	1.8000e-004	5.0000e-005	1.0000e-005	5.0000e-005	0.0000	0.7462	0.7462	4.0000e-005	0.0000	0.7472
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	1.9000e-004	1.2000e-004	1.3400e-003	0.0000	5.1000e-004	0.0000	5.2000e-004	1.4000e-004	0.0000	1.4000e-004	0.0000	0.4183	0.4183	1.0000e-005	0.0000	0.4185
Total	**2.6000e-004**	**2.6000e-003**	**1.9000e-003**	**1.0000e-005**	**6.8000e-004**	**1.0000e-005**	**7.0000e-004**	**1.9000e-004**	**1.0000e-005**	**1.9000e-004**	**0.0000**	**1.1645**	**1.1645**	**5.0000e-005**	**0.0000**	**1.1657**

3.3 Building Construction - 2022

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.0165	0.1250	0.1273	2.2000e-004		5.8900e-003	5.8900e-003		5.6900e-003	5.6900e-003	0.0000	18.1577	18.1577	3.1600e-003	0.0000	18.2368
Total	**0.0165**	**0.1250**	**0.1273**	**2.2000e-004**		**5.8900e-003**	**5.8900e-003**		**5.6900e-003**	**5.6900e-003**	**0.0000**	**18.1577**	**18.1577**	**3.1600e-003**	**0.0000**	**18.2368**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	2.0000e-005	6.2000e-004	1.4000e-004	0.0000	4.0000e-005	0.0000	4.0000e-005	1.0000e-005	0.0000	1.0000e-005	0.0000	0.1866	0.1866	1.0000e-005	0.0000	0.1868
Vendor	2.1000e-004	6.9200e-003	1.7200e-003	2.0000e-005	4.6000e-004	1.0000e-005	4.7000e-004	1.3000e-004	1.0000e-005	1.5000e-004	0.0000	1.7976	1.7976	9.0000e-005	0.0000	1.7997
Worker	5.1000e-004	3.4000e-004	3.7100e-003	1.0000e-005	1.4200e-003	1.0000e-005	1.4300e-003	3.8000e-004	1.0000e-005	3.9000e-004	0.0000	1.1583	1.1583	2.0000e-005	0.0000	1.1589
Total	**7.4000e-004**	**7.8800e-003**	**5.5700e-003**	**3.0000e-005**	**1.9200e-003**	**2.0000e-005**	**1.9400e-003**	**5.2000e-004**	**2.0000e-005**	**5.5000e-004**	**0.0000**	**3.1425**	**3.1425**	**1.2000e-004**	**0.0000**	**3.1455**

3.3 Building Construction - 2022

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.0165	0.1250	0.1273	2.2000e-004		5.8900e-003	5.8900e-003		5.6900e-003	5.6900e-003	0.0000	18.1577	18.1577	3.1600e-003	0.0000	18.2367
Total	**0.0165**	**0.1250**	**0.1273**	**2.2000e-004**		**5.8900e-003**	**5.8900e-003**		**5.6900e-003**	**5.6900e-003**	**0.0000**	**18.1577**	**18.1577**	**3.1600e-003**	**0.0000**	**18.2367**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	2.0000e-005	6.2000e-004	1.4000e-004	0.0000	4.0000e-005	0.0000	4.0000e-005	1.0000e-005	0.0000	1.0000e-005	0.0000	0.1866	0.1866	1.0000e-005	0.0000	0.1868
Vendor	2.1000e-004	6.9200e-003	1.7200e-003	2.0000e-005	4.6000e-004	1.0000e-005	4.7000e-004	1.3000e-004	1.0000e-005	1.5000e-004	0.0000	1.7976	1.7976	9.0000e-005	0.0000	1.7997
Worker	5.1000e-004	3.4000e-004	3.7100e-003	1.0000e-005	1.4200e-003	1.0000e-005	1.4300e-003	3.8000e-004	1.0000e-005	3.9000e-004	0.0000	1.1583	1.1583	2.0000e-005	0.0000	1.1589
Total	**7.4000e-004**	**7.8800e-003**	**5.5700e-003**	**3.0000e-005**	**1.9200e-003**	**2.0000e-005**	**1.9400e-003**	**5.2000e-004**	**2.0000e-005**	**5.5000e-004**	**0.0000**	**3.1425**	**3.1425**	**1.2000e-004**	**0.0000**	**3.1455**

4.0 Operational Detail - Mobile

4.1 Mitigation Measures Mobile

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Unmitigated	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

4.2 Trip Summary Information

	Average Daily Trip Rate			Unmitigated	Mitigated
Land Use	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
Other Non-Asphalt Surfaces	0.00	0.00	0.00		
Total	0.00	0.00	0.00		

4.3 Trip Type Information

	Miles			Trip %			Trip Purpose %		
Land Use	H-W or C-W	H-S or C-C	H-O or C-NW	H-W or C-W	H-S or C-C	H-O or C-NW	Primary	Diverted	Pass-by
Other Non-Asphalt Surfaces	9.50	7.30	7.30	0.00	0.00	0.00	0	0	0

4.4 Fleet Mix

Land Use	LDA	LDT1	LDT2	MDV	LHD1	LHD2	MHD	HHD	OBUS	UBUS	MCY	SBUS	MH
Other Non-Asphalt Surfaces	0.578638	0.038775	0.193686	0.110919	0.015677	0.005341	0.018293	0.026358	0.002641	0.002200	0.005832	0.000891	0.000749

5.0 Energy Detail

Historical Energy Use: N

5.1 Mitigation Measures Energy

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Electricity Mitigated						0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Electricity Unmitigated						0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NaturalGas Mitigated	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NaturalGas Unmitigated	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

5.2 Energy by Land Use - NaturalGas

Unmitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU/yr	tons/yr										MT/yr					
Other Non-Asphalt Surfaces	0	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

Mitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU/yr	tons/yr										MT/yr					
Other Non-Asphalt Surfaces	0	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

5.3 Energy by Land Use - Electricity

Unmitigated

	Electricity Use	Total CO2	CH4	N2O	CO2e
Land Use	kWh/yr	MT/yr			
Other Non-Asphalt Surfaces	0	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**

Mitigated

	Electricity Use	Total CO2	CH4	N2O	CO2e
Land Use	kWh/yr	MT/yr			
Other Non-Asphalt Surfaces	0	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**

6.0 Area Detail

6.1 Mitigation Measures Area

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	3.7300e-003	0.0000	1.0000e-005	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	2.0000e-005	2.0000e-005	0.0000	0.0000	2.0000e-005
Unmitigated	3.7300e-003	0.0000	1.0000e-005	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	2.0000e-005	2.0000e-005	0.0000	0.0000	2.0000e-005

6.2 Area by SubCategory

<u>Unmitigated</u>

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	9.1000e-004					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Consumer Products	2.8200e-003					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Landscaping	0.0000	0.0000	1.0000e-005	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	2.0000e-005	2.0000e-005	0.0000	0.0000	2.0000e-005
Total	**3.7300e-003**	**0.0000**	**1.0000e-005**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**	**0.0000**	**2.0000e-005**	**2.0000e-005**	**0.0000**	**0.0000**	**2.0000e-005**

6.2 Area by SubCategory

Mitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	9.1000e-004					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Consumer Products	2.8200e-003					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Landscaping	0.0000	0.0000	1.0000e-005	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	2.0000e-005	2.0000e-005	0.0000	0.0000	2.0000e-005
Total	**3.7300e-003**	**0.0000**	**1.0000e-005**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**	**0.0000**	**2.0000e-005**	**2.0000e-005**	**0.0000**	**0.0000**	**2.0000e-005**

7.0 Water Detail

7.1 Mitigation Measures Water

	Total CO2	CH4	N2O	CO2e
Category	MT/yr			
Mitigated	0.0000	0.0000	0.0000	0.0000
Unmitigated	0.0000	0.0000	0.0000	0.0000

7.2 Water by Land Use

Unmitigated

	Indoor/Outdoor Use	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	MT/yr			
Other Non-Asphalt Surfaces	0 / 0	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**

7.2 Water by Land Use

Mitigated

	Indoor/Outdoor Use	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	MT/yr			
Other Non-Asphalt Surfaces	0 / 0	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**

8.0 Waste Detail

8.1 Mitigation Measures Waste

Category/Year

	Total CO2	CH4	N2O	CO2e
	MT/yr			
Mitigated	0.0000	0.0000	0.0000	0.0000
Unmitigated	0.0000	0.0000	0.0000	0.0000

8.2 Waste by Land Use

Unmitigated

	Waste Disposed	Total CO2	CH4	N2O	CO2e
Land Use	tons	MT/yr			
Other Non-Asphalt Surfaces	0	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**

Mitigated

	Waste Disposed	Total CO2	CH4	N2O	CO2e
Land Use	tons	MT/yr			
Other Non-Asphalt Surfaces	0	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**

9.0 Operational Offroad

Equipment Type	Number	Hours/Day	Days/Year	Horse Power	Load Factor	Fuel Type

10.0 Stationary Equipment

Fire Pumps and Emergency Generators

Equipment Type	Number	Hours/Day	Hours/Year	Horse Power	Load Factor	Fuel Type

Boilers

Equipment Type	Number	Heat Input/Day	Heat Input/Year	Boiler Rating	Fuel Type

User Defined Equipment

Equipment Type	Number

11.0 Vegetation

FAHCE Construction Activities

Bay Area AQMD Air District, Winter

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric	Lot Acreage	Floor Surface Area	Population
Other Non-Asphalt Surfaces	1.00	Acre	1.00	43,560.00	0

1.2 Other Project Characteristics

Urbanization	Urban	**Wind Speed (m/s)**	2.2	**Precipitation Freq (Days)**	64
Climate Zone	4			**Operational Year**	2023
Utility Company	Pacific Gas & Electric Company				
CO2 Intensity (lb/MWhr)	641.35	**CH4 Intensity (lb/MWhr)**	0.029	**N2O Intensity (lb/MWhr)**	0.006

1.3 User Entered Comments & Non-Default Data

Project Characteristics -

Land Use -

Construction Phase - Short term construction activities a various locations within the project area.

Demolition -

Trips and VMT - Haul trips during construction are to import materials for construction of cofferdams, installation of culverts, stockpiling of materials, and installing riprap.

Construction Off-road Equipment Mitigation -

Table Name	Column Name	Default Value	New Value
tblConstructionPhase	NumDays	100.00	20.00
tblConstructionPhase	PhaseEndDate	6/8/2022	2/16/2022
tblTripsAndVMT	HaulingTripNumber	0.00	5.00

2.0 Emissions Summary

2.1 Overall Construction (Maximum Daily Emission)

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2022	1.7454	17.1463	14.3521	0.0266	0.5697	0.8400	1.4097	0.1027	0.7849	0.8876	0.0000	2,577.6569	2,577.6569	0.6025	0.0000	2,592.7204
Maximum	**1.7454**	**17.1463**	**14.3521**	**0.0266**	**0.5697**	**0.8400**	**1.4097**	**0.1027**	**0.7849**	**0.8876**	**0.0000**	**2,577.6569**	**2,577.6569**	**0.6025**	**0.0000**	**2,592.7204**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2022	1.7454	17.1463	14.3521	0.0266	0.3343	0.8400	1.1743	0.0671	0.7849	0.8519	0.0000	2,577.6569	2,577.6569	0.6025	0.0000	2,592.7204
Maximum	**1.7454**	**17.1463**	**14.3521**	**0.0266**	**0.3343**	**0.8400**	**1.1743**	**0.0671**	**0.7849**	**0.8519**	**0.0000**	**2,577.6569**	**2,577.6569**	**0.6025**	**0.0000**	**2,592.7204**

	ROG	**NOx**	**CO**	**SO2**	**Fugitive PM10**	**Exhaust PM10**	**PM10 Total**	**Fugitive PM2.5**	**Exhaust PM2.5**	**PM2.5 Total**	**Bio- CO2**	**NBio-CO2**	**Total CO2**	**CH4**	**N20**	**CO2e**
Percent Reduction	**0.00**	**0.00**	**0.00**	**0.00**	**41.32**	**0.00**	**16.70**	**34.70**	**0.00**	**4.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

2.2 Overall Operational

Unmitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Area	0.0204	0.0000	1.0000e-004	0.0000		0.0000	0.0000		0.0000	0.0000		2.2000e-004	2.2000e-004	0.0000		2.3000e-004
Energy	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000
Mobile	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000		0.0000
Total	**0.0204**	**0.0000**	**1.0000e-004**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**		**2.2000e-004**	**2.2000e-004**	**0.0000**	**0.0000**	**2.3000e-004**

Mitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Area	0.0204	0.0000	1.0000e-004	0.0000		0.0000	0.0000		0.0000	0.0000		2.2000e-004	2.2000e-004	0.0000		2.3000e-004
Energy	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000
Mobile	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000		0.0000
Total	**0.0204**	**0.0000**	**1.0000e-004**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**		**2.2000e-004**	**2.2000e-004**	**0.0000**	**0.0000**	**2.3000e-004**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N20	CO2e
Percent Reduction	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

3.0 Construction Detail

Construction Phase

Phase Number	Phase Name	Phase Type	Start Date	End Date	Num Days Week	Num Days	Phase Description
1	Demolition	Demolition	1/3/2022	1/14/2022	5	10	
2	Building Construction	Building Construction	1/20/2022	2/16/2022	5	20	

Acres of Grading (Site Preparation Phase): 0

Acres of Grading (Grading Phase): 0

Acres of Paving: 1

Residential Indoor: 0; Residential Outdoor: 0; Non-Residential Indoor: 0; Non-Residential Outdoor: 0; Striped Parking Area: 0 (Architectural Coating – sqft)

OffRoad Equipment

Phase Name	Offroad Equipment Type	Amount	Usage Hours	Horse Power	Load Factor
Demolition	Concrete/Industrial Saws	1	8.00	81	0.73
Building Construction	Generator Sets	1	8.00	84	0.74
Building Construction	Cranes	1	6.00	231	0.29
Building Construction	Forklifts	1	6.00	89	0.20
Demolition	Rubber Tired Dozers	1	8.00	247	0.40
Building Construction	Tractors/Loaders/Backhoes	1	6.00	97	0.37
Demolition	Tractors/Loaders/Backhoes	3	8.00	97	0.37
Building Construction	Welders	3	8.00	46	0.45

Trips and VMT

Phase Name	Offroad Equipment Count	Worker Trip Number	Vendor Trip Number	Hauling Trip Number	Worker Trip Length	Vendor Trip Length	Hauling Trip Length	Worker Vehicle Class	Vendor Vehicle Class	Hauling Vehicle Class
Demolition	5	13.00	0.00	20.00	10.80	7.30	20.00	LD_Mix	HDT_Mix	HHDT
Building Construction	7	18.00	7.00	5.00	10.80	7.30	20.00	LD_Mix	HDT_Mix	HHDT

3.1 Mitigation Measures Construction

Water Exposed Area

3.2 Demolition - 2022

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					0.4280	0.0000	0.4280	0.0648	0.0000	0.0648			0.0000			0.0000
Off-Road	1.6889	16.6217	13.9605	0.0241		0.8379	0.8379		0.7829	0.7829		2,323.4168	2,323.4168	0.5921		2,338.2191
Total	**1.6889**	**16.6217**	**13.9605**	**0.0241**	**0.4280**	**0.8379**	**1.2659**	**0.0648**	**0.7829**	**0.8477**		**2,323.4168**	**2,323.4168**	**0.5921**		**2,338.2191**

3.2 Demolition - 2022

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.0151	0.4975	0.1174	1.5200e-003	0.0349	1.4500e-003	0.0364	9.5800e-003	1.3800e-003	0.0110		162.8771	162.8771	8.5300e-003		163.0904
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000		0.0000
Worker	0.0413	0.0271	0.2742	9.2000e-004	0.1068	6.6000e-004	0.1075	0.0283	6.0000e-004	0.0289		91.3630	91.3630	1.9200e-003		91.4110
Total	**0.0564**	**0.5246**	**0.3916**	**2.4400e-003**	**0.1417**	**2.1100e-003**	**0.1438**	**0.0379**	**1.9800e-003**	**0.0399**		**254.2401**	**254.2401**	**0.0105**		**254.5014**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					0.1926	0.0000	0.1926	0.0292	0.0000	0.0292			0.0000			0.0000
Off-Road	1.6889	16.6217	13.9605	0.0241		0.8379	0.8379		0.7829	0.7829	0.0000	2,323.4168	2,323.4168	0.5921		2,338.2191
Total	**1.6889**	**16.6217**	**13.9605**	**0.0241**	**0.1926**	**0.8379**	**1.0305**	**0.0292**	**0.7829**	**0.8120**	**0.0000**	**2,323.4168**	**2,323.4168**	**0.5921**		**2,338.2191**

3.2 Demolition - 2022

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.0151	0.4975	0.1174	1.5200e-003	0.0349	1.4500e-003	0.0364	9.5800e-003	1.3800e-003	0.0110		162.8771	162.8771	8.5300e-003		163.0904
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000		0.0000
Worker	0.0413	0.0271	0.2742	9.2000e-004	0.1068	6.6000e-004	0.1075	0.0283	6.0000e-004	0.0289		91.3630	91.3630	1.9200e-003		91.4110
Total	**0.0564**	**0.5246**	**0.3916**	**2.4400e-003**	**0.1417**	**2.1100e-003**	**0.1438**	**0.0379**	**1.9800e-003**	**0.0399**		**254.2401**	**254.2401**	**0.0105**		**254.5014**

3.3 Building Construction - 2022

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	1.6487	12.5031	12.7264	0.0221		0.5889	0.5889		0.5689	0.5689		2,001.5429	2,001.5429	0.3486		2,010.2581
Total	**1.6487**	**12.5031**	**12.7264**	**0.0221**		**0.5889**	**0.5889**		**0.5689**	**0.5689**		**2,001.5429**	**2,001.5429**	**0.3486**		**2,010.2581**

3.3 Building Construction - 2022

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	1.8900e-003	0.0622	0.0147	1.9000e-004	4.3700e-003	1.8000e-004	4.5500e-003	1.2000e-003	1.7000e-004	1.3700e-003		20.3596	20.3596	1.0700e-003		20.3863
Vendor	0.0214	0.6908	0.1843	1.8400e-003	0.0474	1.4100e-003	0.0488	0.0136	1.3500e-003	0.0150		195.1872	195.1872	9.8100e-003		195.4325
Worker	0.0572	0.0375	0.3796	1.2700e-003	0.1479	9.1000e-004	0.1488	0.0392	8.4000e-004	0.0401		126.5026	126.5026	2.6600e-003		126.5691
Total	**0.0806**	**0.7904**	**0.5786**	**3.3000e-003**	**0.1996**	**2.5000e-003**	**0.2021**	**0.0541**	**2.3600e-003**	**0.0564**		**342.0494**	**342.0494**	**0.0135**		**342.3879**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	1.6487	12.5031	12.7264	0.0221		0.5889	0.5889		0.5689	0.5689	0.0000	2,001.5429	2,001.5429	0.3486		2,010.2581
Total	**1.6487**	**12.5031**	**12.7264**	**0.0221**		**0.5889**	**0.5889**		**0.5689**	**0.5689**	**0.0000**	**2,001.5429**	**2,001.5429**	**0.3486**		**2,010.2581**

3.3 Building Construction - 2022

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	1.8900e-003	0.0622	0.0147	1.9000e-004	4.3700e-003	1.8000e-004	4.5500e-003	1.2000e-003	1.7000e-004	1.3700e-003		20.3596	20.3596	1.0700e-003		20.3863
Vendor	0.0214	0.6908	0.1843	1.8400e-003	0.0474	1.4100e-003	0.0488	0.0136	1.3500e-003	0.0150		195.1872	195.1872	9.8100e-003		195.4325
Worker	0.0572	0.0375	0.3796	1.2700e-003	0.1479	9.1000e-004	0.1488	0.0392	8.4000e-004	0.0401		126.5026	126.5026	2.6600e-003		126.5691
Total	**0.0806**	**0.7904**	**0.5786**	**3.3000e-003**	**0.1996**	**2.5000e-003**	**0.2021**	**0.0541**	**2.3600e-003**	**0.0564**		**342.0494**	**342.0494**	**0.0135**		**342.3879**

4.0 Operational Detail - Mobile

4.1 Mitigation Measures Mobile

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Mitigated	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000		0.0000
Unmitigated	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000		0.0000

4.2 Trip Summary Information

	Average Daily Trip Rate			Unmitigated	Mitigated
Land Use	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
Other Non-Asphalt Surfaces	0.00	0.00	0.00		
Total	0.00	0.00	0.00		

4.3 Trip Type Information

	Miles			Trip %			Trip Purpose %		
Land Use	H-W or C-W	H-S or C-C	H-O or C-NW	H-W or C-W	H-S or C-C	H-O or C-NW	Primary	Diverted	Pass-by
Other Non-Asphalt Surfaces	9.50	7.30	7.30	0.00	0.00	0.00	0	0	0

4.4 Fleet Mix

Land Use	LDA	LDT1	LDT2	MDV	LHD1	LHD2	MHD	HHD	OBUS	UBUS	MCY	SBUS	MH
Other Non-Asphalt Surfaces	0.578638	0.038775	0.193686	0.110919	0.015677	0.005341	0.018293	0.026358	0.002641	0.002200	0.005832	0.000891	0.000749

5.0 Energy Detail

Historical Energy Use: N

5.1 Mitigation Measures Energy

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
NaturalGas Mitigated	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000
NaturalGas Unmitigated	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000

5.2 Energy by Land Use - NaturalGas

Unmitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU/yr	lb/day										lb/day					
Other Non-Asphalt Surfaces	0	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

5.2 Energy by Land Use - NaturalGas

Mitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU/yr	lb/day										lb/day					
Other Non-Asphalt Surfaces	0	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

6.0 Area Detail

6.1 Mitigation Measures Area

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Mitigated	0.0204	0.0000	1.0000e-004	0.0000		0.0000	0.0000		0.0000	0.0000		2.2000e-004	2.2000e-004	0.0000		2.3000e-004
Unmitigated	0.0204	0.0000	1.0000e-004	0.0000		0.0000	0.0000		0.0000	0.0000		2.2000e-004	2.2000e-004	0.0000		2.3000e-004

6.2 Area by SubCategory

Unmitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
SubCategory	lb/day										lb/day					
Architectural Coating	4.9800e-003					0.0000	0.0000		0.0000	0.0000			0.0000			0.0000
Consumer Products	0.0154					0.0000	0.0000		0.0000	0.0000			0.0000			0.0000
Landscaping	1.0000e-005	0.0000	1.0000e-004	0.0000		0.0000	0.0000		0.0000	0.0000		2.2000e-004	2.2000e-004	0.0000		2.3000e-004
Total	**0.0204**	**0.0000**	**1.0000e-004**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**		**2.2000e-004**	**2.2000e-004**	**0.0000**		**2.3000e-004**

Mitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
SubCategory	lb/day										lb/day					
Architectural Coating	4.9800e-003					0.0000	0.0000		0.0000	0.0000			0.0000			0.0000
Consumer Products	0.0154					0.0000	0.0000		0.0000	0.0000			0.0000			0.0000
Landscaping	1.0000e-005	0.0000	1.0000e-004	0.0000		0.0000	0.0000		0.0000	0.0000		2.2000e-004	2.2000e-004	0.0000		2.3000e-004
Total	**0.0204**	**0.0000**	**1.0000e-004**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**		**2.2000e-004**	**2.2000e-004**	**0.0000**		**2.3000e-004**

7.0 Water Detail

7.1 Mitigation Measures Water

8.0 Waste Detail

8.1 Mitigation Measures Waste

9.0 Operational Offroad

Equipment Type	Number	Hours/Day	Days/Year	Horse Power	Load Factor	Fuel Type

10.0 Stationary Equipment

Fire Pumps and Emergency Generators

Equipment Type	Number	Hours/Day	Hours/Year	Horse Power	Load Factor	Fuel Type

Boilers

Equipment Type	Number	Heat Input/Day	Heat Input/Year	Boiler Rating	Fuel Type

User Defined Equipment

Equipment Type	Number

11.0 Vegetation

FAHCE Construction Activities

Bay Area AQMD Air District, Summer

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric	Lot Acreage	Floor Surface Area	Population
Other Non-Asphalt Surfaces	1.00	Acre	1.00	43,560.00	0

1.2 Other Project Characteristics

Urbanization	Urban	**Wind Speed (m/s)**	2.2	**Precipitation Freq (Days)**	64
Climate Zone	4			**Operational Year**	2023
Utility Company	Pacific Gas & Electric Company				
CO2 Intensity (lb/MWhr)	641.35	**CH4 Intensity (lb/MWhr)**	0.029	**N2O Intensity (lb/MWhr)**	0.006

1.3 User Entered Comments & Non-Default Data

Project Characteristics -

Land Use -

Construction Phase - Short term construction activities a various locations within the project area.

Demolition -

Trips and VMT - Haul trips during construction are to import materials for construction of cofferdams, installation of culverts, stockpiling of materials, and installing riprap.

Construction Off-road Equipment Mitigation -

Table Name	Column Name	Default Value	New Value
tblConstructionPhase	NumDays	100.00	20.00
tblConstructionPhase	PhaseEndDate	6/8/2022	2/16/2022
tblTripsAndVMT	HaulingTripNumber	0.00	5.00

2.0 Emissions Summary

2.1 Overall Construction (Maximum Daily Emission)

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2022	1.7425	17.1304	14.3644	0.0267	0.5697	0.8400	1.4097	0.1027	0.7848	0.8875	0.0000	2,588.2989	2,588.2989	0.6023	0.0000	2,603.3565
Maximum	**1.7425**	**17.1304**	**14.3644**	**0.0267**	**0.5697**	**0.8400**	**1.4097**	**0.1027**	**0.7848**	**0.8875**	**0.0000**	**2,588.2989**	**2,588.2989**	**0.6023**	**0.0000**	**2,603.3565**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2022	1.7425	17.1304	14.3644	0.0267	0.3343	0.8400	1.1743	0.0671	0.7848	0.8519	0.0000	2,588.2989	2,588.2989	0.6023	0.0000	2,603.3565
Maximum	**1.7425**	**17.1304**	**14.3644**	**0.0267**	**0.3343**	**0.8400**	**1.1743**	**0.0671**	**0.7848**	**0.8519**	**0.0000**	**2,588.2989**	**2,588.2989**	**0.6023**	**0.0000**	**2,603.3565**

	ROG	**NOx**	**CO**	**SO2**	**Fugitive PM10**	**Exhaust PM10**	**PM10 Total**	**Fugitive PM2.5**	**Exhaust PM2.5**	**PM2.5 Total**	**Bio- CO2**	**NBio-CO2**	**Total CO2**	**CH4**	**N20**	**CO2e**
Percent Reduction	**0.00**	**0.00**	**0.00**	**0.00**	**41.32**	**0.00**	**16.70**	**34.70**	**0.00**	**4.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

2.2 Overall Operational

Unmitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Area	0.0204	0.0000	1.0000e-004	0.0000		0.0000	0.0000		0.0000	0.0000		2.2000e-004	2.2000e-004	0.0000		2.3000e-004
Energy	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000
Mobile	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000		0.0000
Total	**0.0204**	**0.0000**	**1.0000e-004**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**		**2.2000e-004**	**2.2000e-004**	**0.0000**	**0.0000**	**2.3000e-004**

Mitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Area	0.0204	0.0000	1.0000e-004	0.0000		0.0000	0.0000		0.0000	0.0000		2.2000e-004	2.2000e-004	0.0000		2.3000e-004
Energy	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000
Mobile	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000		0.0000
Total	**0.0204**	**0.0000**	**1.0000e-004**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**		**2.2000e-004**	**2.2000e-004**	**0.0000**	**0.0000**	**2.3000e-004**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N20	CO2e
Percent Reduction	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

3.0 Construction Detail

Construction Phase

Phase Number	Phase Name	Phase Type	Start Date	End Date	Num Days Week	Num Days	Phase Description
1	Demolition	Demolition	1/3/2022	1/14/2022	5	10	
2	Building Construction	Building Construction	1/20/2022	2/16/2022	5	20	

Acres of Grading (Site Preparation Phase): 0

Acres of Grading (Grading Phase): 0

Acres of Paving: 1

Residential Indoor: 0; Residential Outdoor: 0; Non-Residential Indoor: 0; Non-Residential Outdoor: 0; Striped Parking Area: 0 (Architectural Coating – sqft)

OffRoad Equipment

Phase Name	Offroad Equipment Type	Amount	Usage Hours	Horse Power	Load Factor
Demolition	Concrete/Industrial Saws	1	8.00	81	0.73
Building Construction	Generator Sets	1	8.00	84	0.74
Building Construction	Cranes	1	6.00	231	0.29
Building Construction	Forklifts	1	6.00	89	0.20
Demolition	Rubber Tired Dozers	1	8.00	247	0.40
Building Construction	Tractors/Loaders/Backhoes	1	6.00	97	0.37
Demolition	Tractors/Loaders/Backhoes	3	8.00	97	0.37
Building Construction	Welders	3	8.00	46	0.45

Trips and VMT

Phase Name	Offroad Equipment Count	Worker Trip Number	Vendor Trip Number	Hauling Trip Number	Worker Trip Length	Vendor Trip Length	Hauling Trip Length	Worker Vehicle Class	Vendor Vehicle Class	Hauling Vehicle Class
Demolition	5	13.00	0.00	20.00	10.80	7.30	20.00	LD_Mix	HDT_Mix	HHDT
Building Construction	7	18.00	7.00	5.00	10.80	7.30	20.00	LD_Mix	HDT_Mix	HHDT

3.1 Mitigation Measures Construction

Water Exposed Area

3.2 Demolition - 2022

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					0.4280	0.0000	0.4280	0.0648	0.0000	0.0648			0.0000			0.0000
Off-Road	1.6889	16.6217	13.9605	0.0241		0.8379	0.8379		0.7829	0.7829		2,323.4168	2,323.4168	0.5921		2,338.2191
Total	**1.6889**	**16.6217**	**13.9605**	**0.0241**	**0.4280**	**0.8379**	**1.2659**	**0.0648**	**0.7829**	**0.8477**		**2,323.4168**	**2,323.4168**	**0.5921**		**2,338.2191**

3.2 Demolition - 2022

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.0147	0.4868	0.1096	1.5500e-003	0.0349	1.4200e-003	0.0364	9.5800e-003	1.3600e-003	0.0109		165.7057	165.7057	8.1500e-003		165.9094
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000		0.0000
Worker	0.0389	0.0219	0.2942	9.9000e-004	0.1068	6.6000e-004	0.1075	0.0283	6.0000e-004	0.0289		99.1764	99.1764	2.0700e-003		99.2281
Total	**0.0536**	**0.5087**	**0.4039**	**2.5400e-003**	**0.1417**	**2.0800e-003**	**0.1438**	**0.0379**	**1.9600e-003**	**0.0399**		**264.8821**	**264.8821**	**0.0102**		**265.1374**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					0.1926	0.0000	0.1926	0.0292	0.0000	0.0292			0.0000			0.0000
Off-Road	1.6889	16.6217	13.9605	0.0241		0.8379	0.8379		0.7829	0.7829	0.0000	2,323.4168	2,323.4168	0.5921		2,338.2191
Total	**1.6889**	**16.6217**	**13.9605**	**0.0241**	**0.1926**	**0.8379**	**1.0305**	**0.0292**	**0.7829**	**0.8120**	**0.0000**	**2,323.4168**	**2,323.4168**	**0.5921**		**2,338.2191**

3.2 Demolition - 2022

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.0147	0.4868	0.1096	1.5500e-003	0.0349	1.4200e-003	0.0364	9.5800e-003	1.3600e-003	0.0109		165.7057	165.7057	8.1500e-003		165.9094
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000		0.0000
Worker	0.0389	0.0219	0.2942	9.9000e-004	0.1068	6.6000e-004	0.1075	0.0283	6.0000e-004	0.0289		99.1764	99.1764	2.0700e-003		99.2281
Total	**0.0536**	**0.5087**	**0.4039**	**2.5400e-003**	**0.1417**	**2.0800e-003**	**0.1438**	**0.0379**	**1.9600e-003**	**0.0399**		**264.8821**	**264.8821**	**0.0102**		**265.1374**

3.3 Building Construction - 2022

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	1.6487	12.5031	12.7264	0.0221		0.5889	0.5889		0.5689	0.5689		2,001.5429	2,001.5429	0.3486		2,010.2581
Total	**1.6487**	**12.5031**	**12.7264**	**0.0221**		**0.5889**	**0.5889**		**0.5689**	**0.5689**		**2,001.5429**	**2,001.5429**	**0.3486**		**2,010.2581**

3.3 Building Construction - 2022

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	1.8400e-003	0.0608	0.0137	1.9000e-004	4.3700e-003	1.8000e-004	4.5500e-003	1.2000e-003	1.7000e-004	1.3700e-003		20.7132	20.7132	1.0200e-003		20.7387
Vendor	0.0203	0.6856	0.1604	1.8900e-003	0.0474	1.3600e-003	0.0487	0.0136	1.3000e-003	0.0149		200.3012	200.3012	9.0800e-003		200.5281
Worker	0.0539	0.0303	0.4074	1.3800e-003	0.1479	9.1000e-004	0.1488	0.0392	8.4000e-004	0.0401		137.3212	137.3212	2.8600e-003		137.3927
Total	**0.0760**	**0.7768**	**0.5815**	**3.4600e-003**	**0.1996**	**2.4500e-003**	**0.2021**	**0.0541**	**2.3100e-003**	**0.0564**		**358.3355**	**358.3355**	**0.0130**		**358.6595**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	1.6487	12.5031	12.7264	0.0221		0.5889	0.5889		0.5689	0.5689	0.0000	2,001.5429	2,001.5429	0.3486		2,010.2581
Total	**1.6487**	**12.5031**	**12.7264**	**0.0221**		**0.5889**	**0.5889**		**0.5689**	**0.5689**	**0.0000**	**2,001.5429**	**2,001.5429**	**0.3486**		**2,010.2581**

3.3 Building Construction - 2022

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	1.8400e-003	0.0608	0.0137	1.9000e-004	4.3700e-003	1.8000e-004	4.5500e-003	1.2000e-003	1.7000e-004	1.3700e-003		20.7132	20.7132	1.0200e-003		20.7387
Vendor	0.0203	0.6856	0.1604	1.8900e-003	0.0474	1.3600e-003	0.0487	0.0136	1.3000e-003	0.0149		200.3012	200.3012	9.0800e-003		200.5281
Worker	0.0539	0.0303	0.4074	1.3800e-003	0.1479	9.1000e-004	0.1488	0.0392	8.4000e-004	0.0401		137.3212	137.3212	2.8600e-003		137.3927
Total	**0.0760**	**0.7768**	**0.5815**	**3.4600e-003**	**0.1996**	**2.4500e-003**	**0.2021**	**0.0541**	**2.3100e-003**	**0.0564**		**358.3355**	**358.3355**	**0.0130**		**358.6595**

4.0 Operational Detail - Mobile

4.1 Mitigation Measures Mobile

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Mitigated	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000		0.0000
Unmitigated	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000		0.0000

4.2 Trip Summary Information

	Average Daily Trip Rate			Unmitigated	Mitigated
Land Use	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
Other Non-Asphalt Surfaces	0.00	0.00	0.00		
Total	0.00	0.00	0.00		

4.3 Trip Type Information

	Miles			Trip %			Trip Purpose %		
Land Use	H-W or C-W	H-S or C-C	H-O or C-NW	H-W or C-W	H-S or C-C	H-O or C-NW	Primary	Diverted	Pass-by
Other Non-Asphalt Surfaces	9.50	7.30	7.30	0.00	0.00	0.00	0	0	0

4.4 Fleet Mix

Land Use	LDA	LDT1	LDT2	MDV	LHD1	LHD2	MHD	HHD	OBUS	UBUS	MCY	SBUS	MH
Other Non-Asphalt Surfaces	0.578638	0.038775	0.193686	0.110919	0.015677	0.005341	0.018293	0.026358	0.002641	0.002200	0.005832	0.000891	0.000749

5.0 Energy Detail

Historical Energy Use: N

5.1 Mitigation Measures Energy

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
NaturalGas Mitigated	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000
NaturalGas Unmitigated	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000

5.2 Energy by Land Use - NaturalGas

Unmitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU/yr	lb/day										lb/day					
Other Non-Asphalt Surfaces	0	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

5.2 Energy by Land Use - NaturalGas

Mitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU/yr	lb/day										lb/day					
Other Non-Asphalt Surfaces	0	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

6.0 Area Detail

6.1 Mitigation Measures Area

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Mitigated	0.0204	0.0000	1.0000e-004	0.0000		0.0000	0.0000		0.0000	0.0000		2.2000e-004	2.2000e-004	0.0000		2.3000e-004
Unmitigated	0.0204	0.0000	1.0000e-004	0.0000		0.0000	0.0000		0.0000	0.0000		2.2000e-004	2.2000e-004	0.0000		2.3000e-004

6.2 Area by SubCategory

Unmitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
SubCategory	lb/day										lb/day					
Architectural Coating	4.9800e-003					0.0000	0.0000		0.0000	0.0000			0.0000			0.0000
Consumer Products	0.0154					0.0000	0.0000		0.0000	0.0000			0.0000			0.0000
Landscaping	1.0000e-005	0.0000	1.0000e-004	0.0000		0.0000	0.0000		0.0000	0.0000		2.2000e-004	2.2000e-004	0.0000		2.3000e-004
Total	**0.0204**	**0.0000**	**1.0000e-004**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**		**2.2000e-004**	**2.2000e-004**	**0.0000**		**2.3000e-004**

Mitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
SubCategory	lb/day										lb/day					
Architectural Coating	4.9800e-003					0.0000	0.0000		0.0000	0.0000			0.0000			0.0000
Consumer Products	0.0154					0.0000	0.0000		0.0000	0.0000			0.0000			0.0000
Landscaping	1.0000e-005	0.0000	1.0000e-004	0.0000		0.0000	0.0000		0.0000	0.0000		2.2000e-004	2.2000e-004	0.0000		2.3000e-004
Total	**0.0204**	**0.0000**	**1.0000e-004**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**		**2.2000e-004**	**2.2000e-004**	**0.0000**		**2.3000e-004**

7.0 Water Detail

7.1 Mitigation Measures Water

8.0 Waste Detail

8.1 Mitigation Measures Waste

9.0 Operational Offroad

Equipment Type	Number	Hours/Day	Days/Year	Horse Power	Load Factor	Fuel Type

10.0 Stationary Equipment

Fire Pumps and Emergency Generators

Equipment Type	Number	Hours/Day	Hours/Year	Horse Power	Load Factor	Fuel Type

Boilers

Equipment Type	Number	Heat Input/Day	Heat Input/Year	Boiler Rating	Fuel Type

User Defined Equipment

Equipment Type	Number

11.0 Vegetation

Appendix R

Volumetric Analysis of Proposed FAHCE Freshwater Impact to Salinity in the South San Francisco Bay Estuary

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TECHNICAL MEMORANDUM

PROJECT: FAHCE EIR

DATE: January 12, 2022

SUBJECT: Volumetric Analysis of Proposed FAHCE Freshwater Impact to Salinity in the South San Francisco Bay Estuary

PREPARED: Jack Xu, PE, CFM

1. PURPOSE

This study aims to provide a qualitative volumetric analysis on the impacts of changes to freshwater releases to the South San Francisco Bay due to the proposed Fish and Aquatic Habitat Collaborative Effort (FAHCE) project. The primary focus of this report is on the impacts to salinity levels on the South San Francisco Bay Estuary.

2. DATASETS

Several datasets were used in this analysis:

I. Water Evaluation and Planning System (WEAP) model outputs, which included two scenarios: a base case[1] scenario and a scenario with the FAHCE project[2] implemented. This dataset contains daily outflows, as well as documenting the water year type[3].

II. Bay Area Aquatic Resources Inventory (BAARI)[4]. This dataset contains a detailed base map of the Bay Area's aquatic features that includes wetlands, open water, streams, ditches, tidal marshes and flats. The tidal flat areas were extracted from this dataset.

III. USGS Report[5] on Salinity in the South San Francisco Bay. This report gave an estimate of estuary area in the South Bay compared to the volume. It also gave some commentary on the characteristics of the South Bay with respect to salinity.

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[1] Two base cases, 2015 and 2035 condition were analyzed. The 2035 condition assumes that all dam seismic restrictions are removed – which is the base case used in this analysis. Scenario ran historical years 1990 through 2010 as input.

[2] Two proposed cases are available – FAHCE and FAHCE+. Only FAHCE+ was analyzed in this analysis.

[3] Based on the Sacramento River Index

[4] https://www.sfei.org/data/baari-version-21-gis-data#sthash.xOa9ZvLv.dpbs. Accessed 12/17/21.

[5] Schemel, Laurence E. Salinity and Temperature in South San Francisco Bay, California, at Dumbarton Bridge: Measurements from the 1995-1998 Water Years and Comparisons with Results from the 1990-1993 Water Years. 1998. USGS Report 98-650 in cooperation with CA DWR.

3. METHODOLOGY

To determine changes in freshwater flows to the bay for the FAHCE project, the WEAP dataset was analyzed to determine the percent difference. The additional volume was also compared to the volume of the South Bay estuary to determine possible salinity impacts. All these results are then qualitatively analyzed with findings from the 1998 USGS report in mind.

Overall daily flow exceedances between existing and projected FAHCE project flows are also documented to help determine natural viability since pulse flows are a large driver in the FAHCE project.

4. RESULTS

FAHCE CHANGES TO FRESHWATER FLOWS TO BAY

Monthly average changes in flow for the three river systems affected by FAHCE are detailed below. The largest appreciable increases are for the late Spring months for Guadalupe River and Coyote Creek systems. The Stevens Creek percentage increases are large during the summer, but the overall amount of freshwater is too small to make an impact on salinity. For all watersheds, there are some months that decrease the freshwater contribution to the bay. Overall, freshwater contribution increases over all water years, with Stevens Creek seeing larger increases in the dry years.

TABLE 1: *Monthly Average Change in Flow (cfs and %)*

	Guadalupe River	Stevens Creek	Coyote Creek	Guadalupe River	Stevens Creek	Coyote Creek
Jan	9.0	-0.8	1.7	4.4%	-1.8%	0.9%
Feb	12.8	-0.5	1.2	5.5%	-0.9%	0.5%
Mar	12.3	0.8	14.2	6.9%	2.0%	10.5%
Apr	17.2	0.6	14.3	23.3%	2.8%	21.7%
May	-3.7	0.0	-0.9	-7.9%	-0.3%	-2.2%
Jun	-0.4	0.2	-0.9	-1.4%	5.2%	-2.9%
Jul	-0.5	0.2	-0.8	-2.0%	13.0%	-3.4%
Aug	0.3	0.2	-0.7	1.2%	16.9%	-3.3%
Sep	0.3	0.3	-0.6	1.5%	23.6%	-3.1%
Oct	-0.2	0.3	-0.5	-0.5%	10.7%	-2.1%
Nov	-10.0	0.2	-3.4	-21.4%	2.6%	-8.2%
Dec	2.2	2.8	1.9	2.2%	13.7%	2.2%
Overall Average	**3.2**	**0.4**	**2.1**	**3.8%**	**2.0%**	**2.9%**

TABLE 2: *Average Change in Flow by Water Year Type (%)*

	Guadalupe River	**Stevens Creek**	**Coyote Creek**
Above Normal	5.0%	1.5%	5.9%
Below Normal	2.6%	-0.4%	3.7%
Critical Dry	4.2%	10.5%	0.6%
Dry	0.8%	10.8%	2.9%
Wet	4.0%	0.0%	2.2%
Overall Average	**3.8%**	**2.0%**	**2.9%**

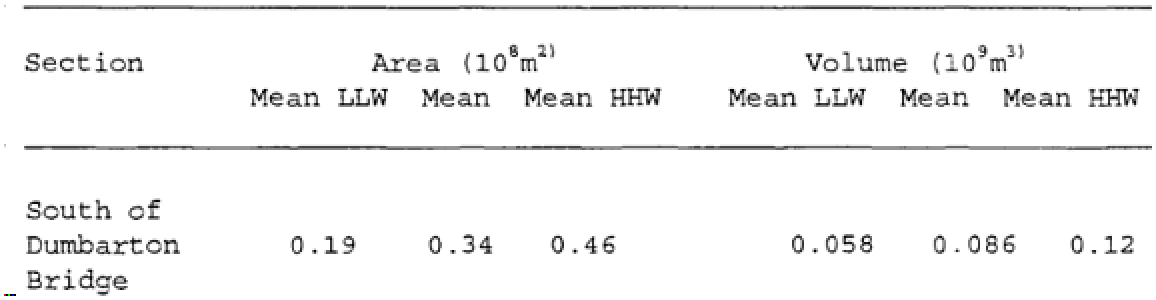
ADDITIONAL FAHCE VOLUME IN ESTUARY

Using the analysis presented in Tables 1 and 2, a daily volume was calculated. 1 cubic foot per second of flow per day is equal to approximately 2 acre-ft of volume, or 1,233 cubic meters. To be conservative, the largest monthly average value was used for each stream system:

- Guadalupe River: 17.2 cfs = 21,207 cubic meters / day
- Stevens creek: 2.8 cfs = 3,452 cubic meters / day
- Coyote Creek: 14.3 cfs = 17,632 cubic meters / day

To determine the total volume in the South Bay estuaries, data from the 1998 USGS report was used (Table 3). This area was validated using the BAARI data (Figure 1) at Mean Sea Level.

TABLE 3: *South Bay Estuary Area and Volume from 1998 USGS Report at various sea levels.*



Section	Area ($10^8 m^2$)			Volume ($10^9 m^3$)		
	Mean LLW	Mean	Mean HHW	Mean LLW	Mean	Mean HHW
South of Dumbarton Bridge	0.19	0.34	0.46	0.058	0.086	0.12

FIGURE 1: *Approximate South Bay Estuary Boundary at Mean Sea Level.*
Tidal Flat (blue) and Riverine Tidal Prism (Yellow)

Summing up all the volumes from the three river systems listed before, there is a conservative impact of about 37,291 cubic meters per day. This estimate takes the largest monthly average value for each system and is intended as a high-end envelope value. Comparing that to the total volume of the South Bay Estuary of 86 million cubic meters (Table 3), the net increases is small – about 0.043%.

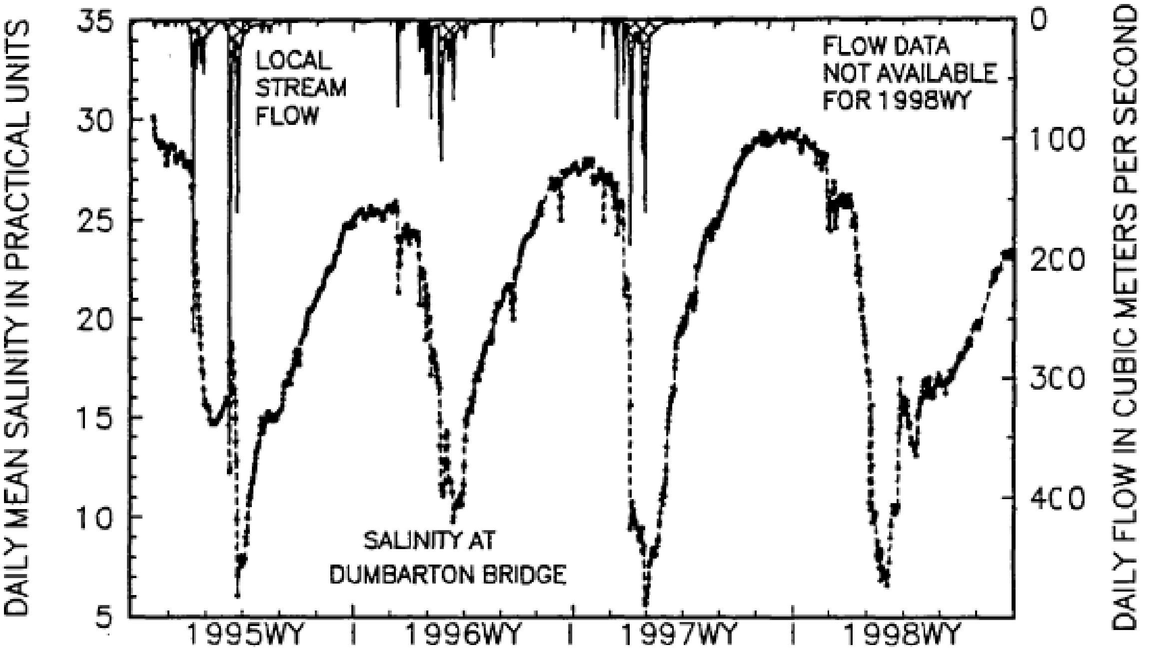
5. DISCUSSION

USGS ANALYSIS ON BAY SALINITY

During the very wet water years of 1995 through 1998, where several floods of record were observed in Palo Alto and San Jose, salinity was measured and presented in the USGS report (Figure 2). The results show local stream outflow during large storm events have a massive effect on salinity in the Bay. The USGS report states that "*details show a rapid response to local freshwater inflows and the influence of the general freshening of the bay by Delta outflow during the wet winters. Records from both vet and dry years show that salinity and temperature respond to weather events and climate variations over time scales of days to months.*"

The conclusions of the USGS study suggest that salinity changes are driven by large storm events, and less so by reservoir releases. The FAHCE impacts are mostly due to increased controlled releases through reservoir outlets of 10 – 20 cfs, which is a miniscule amount of fresh water compared to the total South Bay volume or to the typical runoff from a winter storm event (<1%). The magnitude of freshwater inflow needed to impact salinity far exceeds that of the FAHCE project. Therefore, it can be reasonably concluded this project is unlikely to cause any impacts to the salinity of the South Bay.

FIGURE 2: *Daily Mean Salinity at Dumbarton Bridge and Daily Mean Flow from local streams for water years 1995-1998.*



DAILY FLOW EXCEEDANCES

Figure 3 summarizes daily flow exceedances between existing and proposed FAHCE project conditions for all three river systems near their respective Bay outlets. These plots show that under FAHCE the natural range and frequency of freshwater flows experienced by the river systems do not change, and by inference the ecological habitats in these tidal prism areas should not be affected, as they are well suited to salinity changes based on existing conditions.

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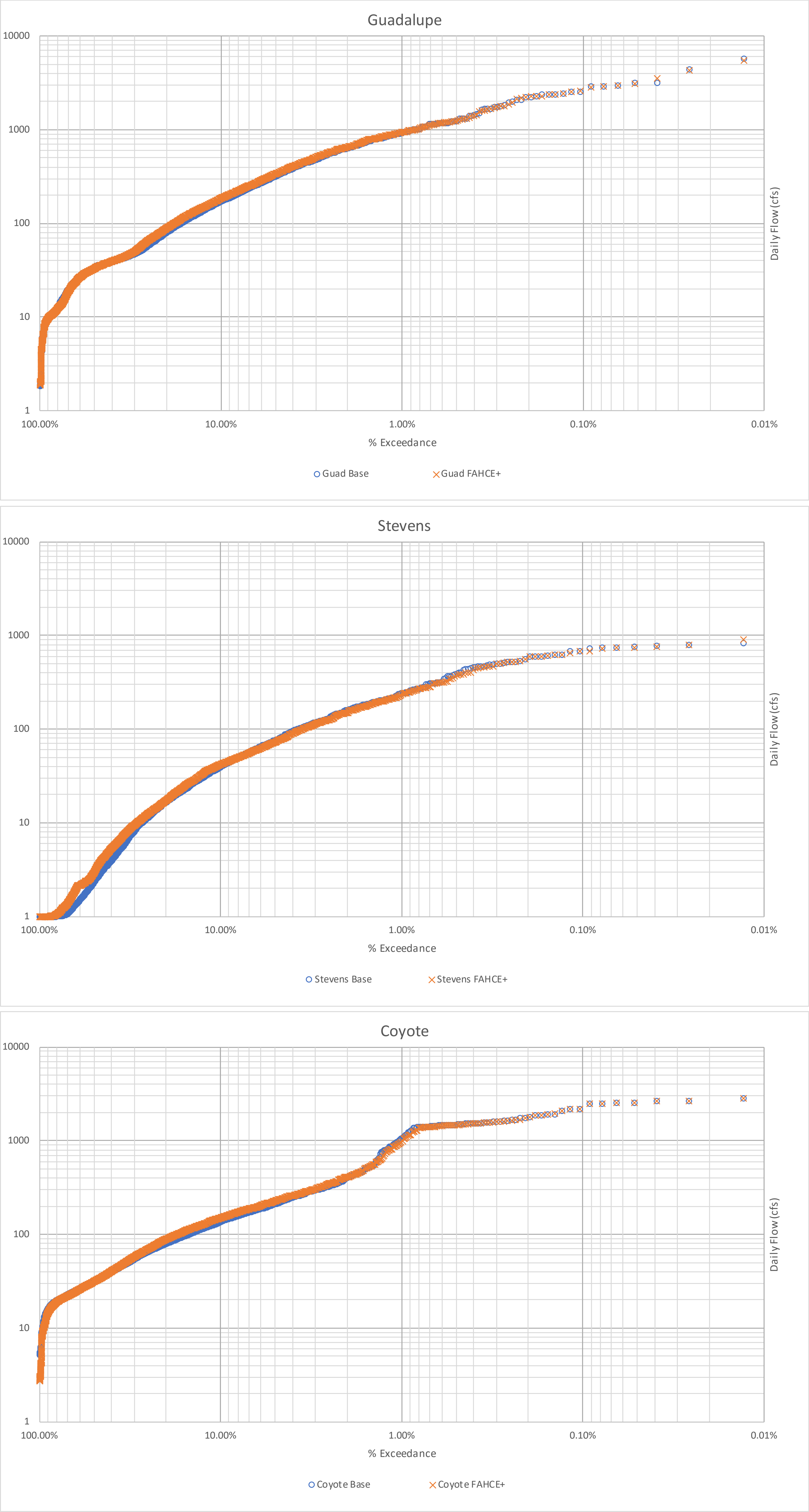
FIGURE 3: *Daily Flow Exceedances (Existing vs. Proposed)*



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