

## **Appendix 7F**

# **Sites Reservoir Discharge Temperature Modeling**

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Line items and numbers identified or noted as “No Action Alternative” represent the “Existing Conditions/No Project/No Action Condition” (described in Chapter 2 Alternatives Analysis).  
Table numbering may not be consecutive for all appendixes.

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# APPENDIX 7F

## Sites Reservoir Discharge Temperature Modeling

### 7F.1 Overview and Description

#### 7F.1.1 Introduction

This appendix describes the modeling analysis performed for estimating the temperature effects of discharges from the Sites Reservoir. This analysis was prepared to support the detailed evaluation of Sites Reservoir Project (Project) alternatives for the Sites Reservoir Draft Environmental Impact Report/ Environmental Impact Statement (DEIR/EIS).

The potential impact on Sacramento River temperature conditions, downstream of the Delevan Pipeline, due to the Sites Reservoir releases, was evaluated. The analysis was prepared only for Alternative C and Alternative D. The potential impacts were determined by comparing the results of the analysis of Alternatives C and D with the temperature modeling results for the No Action Alternative presented in Appendix 7E River Temperature Modeling.

#### 7F.1.2 Assumptions

The assumptions describing the modeling of alternatives are presented in Appendix 6A Modeling of Alternatives. The analytical framework for the detailed evaluation of the alternatives is presented in Appendix 6B Water Resources System Modeling.

Alternatives C and D were used as surrogates to identify the potential impact on Sacramento River temperature conditions, downstream of the Delevan Pipeline, due to the Sites Reservoir releases:

- Alternatives C and D include a 1.8-MAF storage capacity with existing Tehama-Colusa Canal (2,100 cubic feet per second [cfs]) and Glenn-Colusa Irrigation District Canal (1,800 cfs) and a new Delevan Pipeline with a fish screen intake and pumping plant with a diversion capacity of 2,100 cfs and a release capacity of 1,500 cfs.

The scope of this analysis was limited to the modeling of temperature conditions inside the Sites Reservoir and the temperature conditions of the releases from the Delevan Pipeline into the Sacramento River. Alternatives C and D were analyzed assuming that the results from these alternatives would represent the worst-case impacts to the Sacramento River temperature conditions downstream of the Delevan Pipeline.

The daily operations of the Sites Reservoir and Delevan Pipeline were derived from the simulation of the USRDOM model. The inflow temperatures into the Sites Reservoir and the temperature targets used for operating the selected withdrawal control structure at the Sites Reservoir outlet structure are based on Sacramento River downstream temperature conditions derived from the simulation of the USRWQM model. The upper Sacramento River daily operations modeling using the USRDOM model is presented in Appendix 6C Upper Sacramento River Daily River Flow and Operations Modeling. The upper Sacramento River temperature modeling using the USRWQM model is presented in Appendix 7E River Temperature Modeling. This analysis tiered off of the modeling described in these other documents.

### 7F.1.3 Analysis

A simple single reservoir model was developed to investigate potential temperature and water quality issues with operations of the Sites Reservoir. The model was derived from the Colusa Basin Water Quality Model (CBWQM) previously developed for Reclamation by RMA. The model has also been referred to as the RMA Sites Water Quality Model (RMA, 2005). The CBWQM was based on the HEC-5 and HEC5Q model framework developed by the Army Corps of Engineers (ACOE) Hydrologic Engineering Center (HEC).

HEC-5 inputs for the Sites Reservoir, such as the reservoir levels, storage-capacity-elevation curves, and the initial storage conditions were derived from the USRDOM model simulations for Alternatives C and D (Appendix 6C Upper Sacramento River Daily River Flow and Operations Modeling). Other time-series inputs, such as evaporation rates, inflows, and outflows, were also derived from the USRDOM model. The inflows to the Sites Reservoir were assumed to be the daily flow from Funks Forebay to the Sites Reservoir simulated in the USRDOM model. The outflow from the Sites Reservoir was specified using daily flow from the Sites Reservoir to the Funks Forebay, as simulated in the USRDOM model. Using the information from the USRDOM ensures that the daily operations in the model were consistent with the resulting operations from USRDOM and CALSIM II models (Appendix 6B Water Resources System Modeling).

HEC5Q inputs for the Sites Reservoir were derived from the CBWQM (RMA, 2005). The Sites Reservoir was simulated as a vertically segmented reservoir (with respect to temperature) in the HEC5Q model. The inputs, such as the vertical segmentation, kinetic rates, coefficients, and information needed for the thermal calculations in the reservoir, were all based on the CBWQM. The centerline elevations of the outlets in the wet well of the proposed outlet structure were based on the latest available engineering information of Sites Reservoir (Reclamation, 2011). Nine outlets were assumed at elevations 340 feet, 350 feet, 370 feet, 390 feet, 410 feet, 430 feet, 450 feet, 470 feet, and 490 feet. Figure 7F-1 shows the relationship of water surface elevations, and specific outlet elevations, corresponding to storage volumes for the Sites Reservoir.

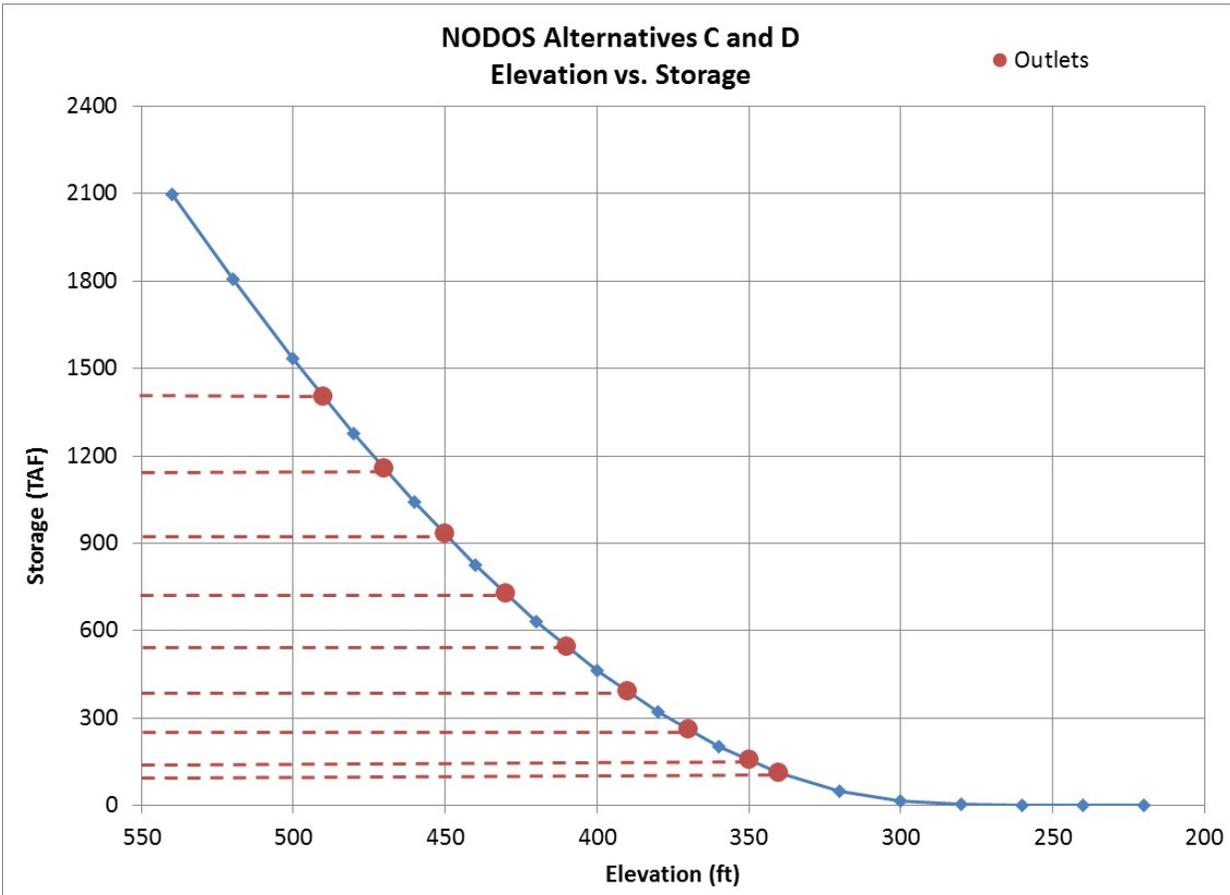
The Sites Reservoir inflow temperature time-series input was derived from the Sacramento River temperatures at the Tehama-Colusa Canal Intake, Glenn-Colusa Irrigation District Intake, and Delevan Pipeline Intake simulated in USRWQM. Sites Reservoir inflow temperature was estimated by weighting the above three temperatures by amount of flow diverted at each of the three intakes for filling Sites Reservoir simulated in USRDOM.

HEC5Q is capable of simulating reservoir temperature by operating withdrawals to meet the specified tailwater temperature objectives. For the Sites Reservoir Temperature Model, these tailwater target temperatures were specified using the monthly average temperatures in the Sacramento River upstream of the Delevan Pipeline simulated in the USRWQM model (this temperature does not vary as a function of the potential temperature of the Delevan Pipeline releases from Sites Reservoir). As is common to all larger reservoirs throughout the Central Valley, Sites Reservoir is expected to become stratified because of warming within the upper layer of the reservoir in the summer months. As described below, given the variety of outlets included as part of the Project at varying depths, operations would allow for withdrawing water at suitable depths to manage the release temperatures and generally match Sacramento River temperatures to the extent possible.

The HEC5Q model was used to simulate the temperature conditions in the reservoir and the releases for Alternatives C and D. The Sites Reservoir releases to the Sacramento River were blended with the

Sacramento River flow to estimate the water temperatures downstream of the Delevan Pipeline. The blended Sacramento River temperatures were compared to tailwater target temperatures used in the model to determine if there was any warming or cooling impact on the Sacramento River temperatures due to the blending of the water from the Sites Reservoir.

**Figure 7F-1 Alternatives C and D Sites Reservoir Storage as a Function of the Reservoir Elevation, with Reservoir Outlets Marked**



#### 7F.1.4 Limitations

The parameters for the temperature model for the Sites Reservoir were developed using data from literature and from other reservoirs in the region. Because Sites Reservoir is proposed, and therefore, cannot be observed, the model cannot be validated through in-field temperature observations. The model assumes that the temperature of releases from the reservoir could be changed to meet the target temperature in real-time (at a daily time-step). The target temperatures used for modeling were assumed based on monthly average model simulated temperatures of the river before receiving the water. The output port optimizing logic in the HEC5Q model has limitations. Potential temperature changes within conveyance features that would convey water to and from the Sites Reservoir were not taken into account when computing the inflow temperatures and the resulting blended Sacramento River temperatures.

Alternatives C and D were used as surrogates for this analysis. Alternatives A and Alternative B differ in the storage or conveyance capacities assumed, however, each alternative is modeled assuming the same objectives for water operations and the same operational policies. The specific assumptions for the other alternatives are as follows:

- Alternative A has a 1.2-MAF storage capacity with existing Tehama-Colusa Canal (2,100 cfs) and Glenn-Colusa Irrigation District Canal (1,800 cfs) and a new Delevan pipeline with a diversion capacity of 2,100 cfs and release capacity of 1,500 cfs.
- Alternative B has a 1.8-MAF storage capacity with existing Tehama-Colusa Canal (2,100 cfs) and Glenn-Colusa Irrigation District Canal (1,800 cfs) and a new release only Delevan pipeline (release capacity of 1,500 cfs). There are no fish screen intake and pumping plant associated with the new Delevan pipeline.

In this analysis, only Alternatives C and D were evaluated, based on the assumption that these alternatives would result in the worst-case impact to the Sacramento River temperature conditions downstream of the Delevan Pipeline Intake/ Discharge facilities. Of the four alternatives, C and D include the largest configuration of the Sites Reservoir, and the largest intake and discharge facilities. The potential for stratification and coldwater availability is the largest under Alternatives C and D, and similarly, the amount of water discharged to the river is the largest under Alternatives C and D. Other alternatives with either, a smaller Sites reservoir or a smaller discharge facility, potential impacts to the temperature in Sacramento River downstream of the intake will be less than those estimated under Alternatives C and D.

#### **7F.1.5 References**

- Bureau of Reclamation. 2011. Sites Reservoir Golden Gate Dam 1.81 MAF Storage Reservoir Multi-level Inlet/Outlet Tower Structure Sections.
- RMA. 2005. Upper Sacramento River Models and North of Delta Offstream Storage Model (NODOS), Presentation by Don Smith/RMA to DWR.

## 7F.2 Results

This section presents the results of the discharge temperature modeling of the Sites Reservoir, as described above.

The analysis was prepared for only Alternatives C and D. Alternatives C and D were used as surrogates to identify the potential impact on Sacramento River temperature conditions. The resulting changes in Sacramento River flows were in addition to whatever other impacts there were on Sacramento River temperatures due to systemwide operations of Alternative C and Alternative D, when compared to the No Action Alternative.

### 7F.2.1 Introduction

The Sites Reservoir discharge temperature modeling results are used in Chapter 7 Surface Water Quality in conjunction with Sacramento River temperature model results discussed in Appendix 7E River Temperature Modeling.

For each parameter and location shown in Table 7F-1, Summary Tables reports are provided. In the Summary Tables reports, for each parameter and location shown below, summary tables of temperature modeling results by month were included. The tables include long-term average, and averages by water year type (SWRCB 40-30-30 Index). The tables also include the absolute and relative differences between alternatives.

Other analyses were used to estimate river temperature conditions. The temperature modeling using the USRWQM and RECTEMP models, referred to in Chapter 7 Surface Water Quality for evaluating temperature conditions for locations in the Trinity River, Sacramento River, Feather River, and American River is included in Appendix 7E River Temperature Modeling.

**Table 7F-1  
Sites Reservoir Discharge Temperature Modeling Results Locations and Parameters**

	Report Title	Time-Step	Parameter
1	Sacramento River at Tehama-Colusa Canal Intake	Monthly	Temperature
2	Sacramento River at Glenn-Colusa Irrigation District Canal Intake	Monthly	Temperature
3	Sacramento River at Delevan Pipeline Intake	Monthly	Temperature
4	Sacramento River downstream of Delevan Pipeline	Monthly	Temperature

### 7F.2.2 Comparisons

Summary Tables reports are provided for two comparisons:

- Alternative C compared to the No Action Alternative
- Alternative D compared to the No Action Alternative

The impact shown by the comparison above does not include any impact that may occur due to changes in systemwide or Sacramento River operations due to the alternative being evaluated. To derive the total impact of changes in the river operations and changes in the discharge blending, the impact shown must be added to the results of Sacramento River temperature results presented in Appendix 7E River Temperature Modeling.

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**Alternative C Compared to No Action Alternative**

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**Table ST-1a**  
**Sacramento River at Tehama Colusa Canal Intake, Monthly Average Temperature**  
**Long-term Average and Average by Water Year Type**

Analysis Period	Monthly Average Temperature (deg-F)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Long-term</b>												
<b>Full Simulation Period<sup>1</sup></b>												
No Action Alternative	55.4	51.0	46.1	44.5	46.2	49.7	53.4	56.5	57.1	57.9	58.8	59.0
NODOS Alternative C	55.1	50.8	46.3	44.7	46.3	49.7	53.9	56.6	57.1	57.9	58.5	58.6
Difference	-0.4	-0.2	0.2	0.2	0.0	0.0	0.5	0.1	0.0	0.0	-0.3	-0.3
Percent Difference <sup>3</sup>	-0.7%	-0.3%	0.5%	0.5%	0.1%	0.1%	0.9%	0.2%	0.1%	-0.1%	-0.5%	-0.6%
<b>Water Year Types<sup>2</sup></b>												
<b>Wet (32%)</b>												
No Action Alternative	55.0	51.5	46.5	44.4	45.8	48.9	52.7	56.5	56.9	58.0	58.1	57.2
NODOS Alternative C	54.9	51.5	46.8	44.5	45.8	48.9	52.8	56.3	56.7	58.0	58.2	57.1
Difference	-0.1	0.0	0.3	0.1	0.0	0.0	0.1	-0.3	-0.2	0.0	0.1	-0.1
Percent Difference	-0.2%	-0.1%	0.6%	0.3%	0.0%	0.0%	0.1%	-0.5%	-0.3%	0.0%	0.2%	-0.2%
<b>Above Normal (15%)</b>												
No Action Alternative	54.9	50.7	46.3	44.9	46.2	49.8	53.7	57.1	57.0	57.3	58.3	58.3
NODOS Alternative C	54.6	50.6	46.6	45.0	46.3	49.9	54.1	57.1	57.1	57.5	58.3	58.2
Difference	-0.3	-0.1	0.3	0.2	0.0	0.0	0.4	0.0	0.1	0.1	0.0	-0.1
Percent Difference	-0.6%	-0.2%	0.6%	0.4%	0.1%	0.1%	0.8%	0.0%	0.1%	0.2%	-0.1%	-0.2%
<b>Below Normal (17%)</b>												
No Action Alternative	54.2	50.7	46.0	44.5	46.1	49.3	53.6	56.1	56.7	57.3	58.2	58.0
NODOS Alternative C	53.7	50.5	46.4	44.8	46.2	49.3	54.0	56.2	56.7	57.3	58.4	57.8
Difference	-0.5	-0.3	0.4	0.3	0.0	0.1	0.4	0.1	0.0	0.1	0.2	-0.2
Percent Difference	-0.9%	-0.5%	0.9%	0.6%	0.0%	0.1%	0.7%	0.1%	0.0%	0.1%	0.3%	-0.3%
<b>Dry (22%)</b>												
No Action Alternative	55.6	50.7	46.1	44.4	46.3	50.6	53.6	56.1	57.0	57.7	59.1	60.3
NODOS Alternative C	55.2	50.5	46.0	44.7	46.3	50.7	54.5	56.5	57.4	57.8	58.6	59.5
Difference	-0.4	-0.2	-0.1	0.3	0.0	0.1	0.9	0.5	0.4	0.1	-0.4	-0.8
Percent Difference	-0.7%	-0.4%	-0.2%	0.6%	0.0%	0.2%	1.6%	0.8%	0.7%	0.1%	-0.7%	-1.3%
<b>Critical (15%)</b>												
No Action Alternative	57.5	50.7	45.1	44.3	46.9	50.4	53.8	56.3	57.7	59.3	60.8	61.9
NODOS Alternative C	56.8	50.4	45.3	44.6	47.0	50.4	54.7	56.8	57.9	58.8	59.3	61.2
Difference	-0.7	-0.3	0.2	0.3	0.1	0.1	0.9	0.5	0.1	-0.5	-1.5	-0.7
Percent Difference	-1.3%	-0.6%	0.4%	0.6%	0.1%	0.1%	1.6%	0.9%	0.2%	-0.8%	-2.4%	-1.2%

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the monthly average

**Table ST-2a**  
**Sacramento River at Glenn Colusa Canal Intake, Monthly Average Temperature**  
**Long-term Average and Average by Water Year Type**

Analysis Period	Monthly Average Temperature (deg-F)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Long-term</b>												
<b>Full Simulation Period<sup>1</sup></b>												
No Action Alternative	55.9	50.8	45.6	44.4	46.6	50.5	54.7	58.5	59.2	60.1	60.8	60.3
NODOS Alternative C	55.7	50.7	45.8	44.6	46.6	50.5	55.1	58.6	59.2	60.0	60.6	60.0
Difference	-0.3	-0.2	0.2	0.2	0.0	0.0	0.5	0.2	0.1	0.0	-0.2	-0.3
Percent Difference <sup>3</sup>	-0.5%	-0.3%	0.0%	0.3%	0.0%	0.1%	0.9%	0.3%	0.1%	-0.1%	-0.4%	-0.4%
<b>Water Year Types<sup>2</sup></b>												
<b>Wet (32%)</b>												
No Action Alternative	55.5	51.4	46.0	44.4	46.1	49.6	53.8	58.6	59.2	60.3	60.1	58.5
NODOS Alternative C	55.4	51.3	46.3	44.5	46.1	49.6	53.9	58.4	59.0	60.3	60.3	58.5
Difference	-0.1	0.0	0.2	0.1	0.0	0.0	0.1	-0.2	-0.2	0.0	0.2	-0.1
Percent Difference	-0.2%	-0.1%	0.5%	0.2%	0.0%	0.0%	0.1%	-0.3%	-0.4%	0.0%	0.3%	-0.1%
<b>Above Normal (15%)</b>												
No Action Alternative	55.5	50.6	45.8	44.9	46.6	50.6	55.0	59.2	59.3	59.4	60.4	59.8
NODOS Alternative C	55.2	50.5	46.0	44.9	46.6	50.7	55.4	59.2	59.3	59.5	60.4	59.7
Difference	-0.3	-0.1	0.2	0.1	0.0	0.1	0.4	0.0	0.0	0.1	0.0	-0.1
Percent Difference	-0.5%	-0.2%	0.4%	0.2%	0.0%	0.1%	0.8%	0.1%	0.1%	0.2%	0.0%	-0.1%
<b>Below Normal (17%)</b>												
No Action Alternative	54.8	50.7	45.5	44.4	46.5	50.0	54.9	58.2	58.8	59.4	60.2	59.4
NODOS Alternative C	54.4	50.5	45.8	44.7	46.5	50.0	55.3	58.3	58.8	59.5	60.4	59.3
Difference	-0.4	-0.2	0.3	0.2	0.0	0.1	0.4	0.1	0.0	0.1	0.2	-0.1
Percent Difference	-0.7%	-0.5%	0.7%	0.5%	0.0%	0.1%	0.7%	0.2%	0.0%	0.1%	0.4%	-0.2%
<b>Dry (22%)</b>												
No Action Alternative	56.1	50.6	45.8	44.2	46.6	51.4	55.0	58.0	59.0	59.8	61.0	61.8
NODOS Alternative C	55.8	50.5	45.7	44.4	46.6	51.5	55.9	58.5	59.4	59.9	60.6	61.1
Difference	-0.3	-0.2	-0.1	0.2	0.0	0.1	0.9	0.5	0.5	0.1	-0.3	-0.7
Percent Difference	-0.5%	-0.3%	-0.2%	0.5%	0.0%	0.2%	1.6%	0.9%	0.8%	0.2%	-0.6%	-1.1%
<b>Critical (15%)</b>												
No Action Alternative	57.8	50.6	44.8	44.2	47.3	51.2	55.2	58.1	59.5	61.1	62.6	63.0
NODOS Alternative C	57.2	50.3	44.9	44.4	47.4	51.3	56.1	58.7	59.7	60.7	61.2	62.5
Difference	-0.5	-0.3	0.1	0.2	0.0	0.1	0.9	0.6	0.2	-0.4	-1.4	-0.5
Percent Difference	-0.9%	-0.6%	0.3%	0.5%	0.1%	0.1%	1.6%	1.0%	0.3%	-0.7%	-2.2%	-0.9%

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the monthly average

**Table ST-3a**  
**Sacramento River at Delevan Pipeline Intake, Monthly Average Temperature**  
**Long-term Average and Average by Water Year Type**

Analysis Period	Monthly Average Temperature (deg-F)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Long-term</b>												
<b>Full Simulation Period<sup>1</sup></b>												
No Action Alternative	57.3	51.0	45.3	44.4	47.0	51.4	56.7	61.9	64.0	65.5	65.7	63.4
NODOS Alternative C	57.1	50.8	45.4	44.5	47.0	51.5	57.1	62.1	63.6	65.0	65.5	63.2
Difference	-0.1	-0.1	0.1	0.1	0.0	0.1	0.4	0.2	-0.3	-0.5	-0.2	-0.2
Percent Difference <sup>3</sup>	-0.2%	-0.2%	0.1%	0.1%	0.0%	0.2%	0.8%	0.3%	-0.5%	-0.7%	-0.4%	-0.2%
<b>Water Year Types<sup>2</sup></b>												
<b>Wet (32%)</b>												
No Action Alternative	56.9	51.3	45.7	44.3	46.3	50.3	55.0	61.4	63.7	65.9	65.3	61.6
NODOS Alternative C	56.8	51.3	45.8	44.4	46.3	50.4	55.2	61.4	63.0	65.4	65.5	61.5
Difference	-0.1	0.0	0.1	0.0	0.0	0.0	0.1	-0.1	-0.6	-0.5	0.2	-0.1
Percent Difference	-0.2%	-0.1%	0.2%	0.0%	0.0%	0.1%	0.2%	-0.1%	-1.0%	-0.7%	0.3%	-0.1%
<b>Above Normal (15%)</b>												
No Action Alternative	57.0	50.8	45.4	45.0	47.0	51.6	56.9	62.6	64.4	64.8	65.6	63.0
NODOS Alternative C	56.9	50.7	45.5	45.0	47.0	51.8	57.4	62.6	63.9	64.4	65.6	63.0
Difference	-0.2	-0.1	0.1	0.0	0.0	0.1	0.4	0.1	-0.5	-0.5	0.0	0.0
Percent Difference	-0.3%	-0.2%	0.2%	0.0%	0.0%	0.3%	0.8%	0.1%	-0.8%	-0.7%	0.1%	0.1%
<b>Below Normal (17%)</b>												
No Action Alternative	56.2	50.9	45.1	44.4	46.9	50.8	56.8	61.7	63.8	65.2	65.4	62.8
NODOS Alternative C	56.0	50.8	45.3	44.6	46.9	50.9	57.3	61.8	63.5	64.7	65.4	62.8
Difference	-0.2	-0.2	0.2	0.1	0.0	0.1	0.4	0.2	-0.4	-0.5	0.1	0.0
Percent Difference	-0.3%	-0.3%	0.4%	0.3%	0.0%	0.2%	0.8%	0.3%	-0.5%	-0.8%	0.1%	0.0%
<b>Dry (22%)</b>												
No Action Alternative	57.5	50.8	45.6	44.1	47.2	52.7	57.8	62.0	64.0	65.2	65.8	64.9
NODOS Alternative C	57.4	50.6	45.4	44.2	47.2	52.8	58.8	62.5	64.1	64.9	65.4	64.4
Difference	-0.1	-0.2	-0.1	0.1	0.0	0.1	0.9	0.5	0.1	-0.3	-0.4	-0.5
Percent Difference	-0.2%	-0.4%	-0.3%	0.2%	-0.1%	0.3%	1.6%	0.9%	0.1%	-0.5%	-0.5%	-0.8%
<b>Critical (15%)</b>												
No Action Alternative	58.7	50.7	44.6	44.2	48.0	52.4	58.0	61.9	64.1	66.0	66.9	65.6
NODOS Alternative C	58.6	50.5	44.7	44.3	48.0	52.5	58.5	62.4	64.0	65.4	65.5	65.3
Difference	-0.2	-0.2	0.0	0.1	0.0	0.1	0.5	0.5	-0.1	-0.5	-1.3	-0.3
Percent Difference	-0.3%	-0.4%	0.1%	0.3%	0.0%	0.1%	0.8%	0.8%	-0.2%	-0.8%	-2.0%	-0.4%

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the monthly average

**Table ST-4a**  
**Sacramento River below Delevan Pipeline, Monthly Average Temperature**  
**Long-term Average and Average by Water Year Type**

Analysis Period	Monthly Average Temperature (deg-F)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Long-term</b>												
<b>Full Simulation Period<sup>1</sup></b>												
No Action Alternative	57.3	51.0	45.3	44.4	47.0	51.4	56.7	61.9	64.0	65.5	65.7	63.4
NODOS Alternative C	57.2	50.9	45.5	44.5	47.0	51.5	57.1	62.0	63.6	64.9	65.4	63.2
Difference	-0.1	0.0	0.1	0.1	0.0	0.1	0.3	0.1	-0.4	-0.5	-0.3	-0.2
Percent Difference <sup>3</sup>	-0.2%	-0.1%	0.3%	0.1%	0.0%	0.2%	0.6%	0.2%	-0.6%	-0.8%	-0.5%	-0.3%
<b>Water Year Types<sup>2</sup></b>												
<b>Wet (32%)</b>												
No Action Alternative	56.9	51.3	45.7	44.3	46.3	50.3	55.0	61.4	63.7	65.9	65.3	61.6
NODOS Alternative C	56.9	51.3	45.8	44.4	46.3	50.4	55.2	61.4	63.0	65.3	65.3	61.5
Difference	-0.1	0.0	0.1	0.0	0.0	0.0	0.1	-0.1	-0.6	-0.6	0.0	-0.1
Percent Difference	-0.1%	-0.1%	0.3%	0.0%	0.0%	0.1%	0.2%	-0.1%	-1.0%	-0.9%	0.0%	-0.2%
<b>Above Normal (15%)</b>												
No Action Alternative	57.0	50.8	45.4	45.0	47.0	51.6	56.9	62.6	64.4	64.8	65.6	63.0
NODOS Alternative C	56.8	50.8	45.6	45.0	47.0	51.8	57.4	62.6	63.9	64.2	65.4	63.0
Difference	-0.2	0.0	0.2	0.0	0.0	0.1	0.4	0.1	-0.5	-0.6	-0.2	0.0
Percent Difference	-0.4%	0.1%	0.4%	0.0%	0.0%	0.3%	0.7%	0.1%	-0.8%	-0.9%	-0.3%	0.0%
<b>Below Normal (17%)</b>												
No Action Alternative	56.2	50.9	45.1	44.4	46.9	50.8	56.8	61.7	63.8	65.2	65.4	62.8
NODOS Alternative C	56.1	50.9	45.3	44.6	46.9	50.9	57.3	61.8	63.4	64.6	65.3	62.8
Difference	-0.1	-0.1	0.2	0.1	0.0	0.1	0.4	0.2	-0.4	-0.6	-0.1	0.0
Percent Difference	-0.2%	-0.1%	0.5%	0.3%	-0.1%	0.2%	0.7%	0.2%	-0.7%	-0.9%	-0.1%	-0.1%
<b>Dry (22%)</b>												
No Action Alternative	57.5	50.8	45.6	44.1	47.2	52.7	57.8	62.0	64.0	65.2	65.8	64.9
NODOS Alternative C	57.3	50.6	45.4	44.2	47.2	52.8	58.5	62.3	63.9	64.9	65.5	64.4
Difference	-0.2	-0.2	-0.1	0.1	0.0	0.1	0.6	0.3	0.0	-0.3	-0.3	-0.5
Percent Difference	-0.4%	-0.4%	-0.3%	0.2%	-0.1%	0.2%	1.1%	0.5%	0.0%	-0.5%	-0.5%	-0.8%
<b>Critical (15%)</b>												
No Action Alternative	58.7	50.7	44.6	44.2	48.0	52.4	58.0	61.9	64.1	66.0	66.9	65.6
NODOS Alternative C	58.8	50.7	44.8	44.3	48.0	52.4	58.3	62.3	64.0	65.4	65.6	65.4
Difference	0.0	0.0	0.2	0.2	0.0	0.0	0.3	0.3	-0.2	-0.5	-1.3	-0.3
Percent Difference	0.0%	0.0%	0.4%	0.3%	-0.1%	0.0%	0.4%	0.5%	-0.3%	-0.8%	-1.9%	-0.4%

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the monthly average

## **Alternative D Compared to No Action Alternative**

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**Table ST-1b**  
**Sacramento River at Tehama Colusa Canal Intake, Monthly Average Temperature**  
**Long-term Average and Average by Water Year Type**

Analysis Period	Monthly Average Temperature (deg-F)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Long-term</b>												
<b>Full Simulation Period<sup>1</sup></b>												
No Action Alternative	55.4	51.0	46.1	44.5	46.2	49.7	53.4	56.5	57.1	57.9	58.8	59.0
NODOS Alternative D	55.1	50.8	46.3	44.7	46.3	49.7	53.7	56.4	57.2	58.0	58.6	58.6
Difference	-0.4	-0.2	0.2	0.2	0.0	0.0	0.3	-0.1	0.1	0.1	-0.2	-0.4
Percent Difference <sup>3</sup>	-0.7%	-0.3%	0.5%	0.5%	0.0%	0.1%	0.6%	-0.1%	0.3%	0.1%	-0.4%	-0.6%
<b>Water Year Types<sup>2</sup></b>												
<b>Wet (32%)</b>												
No Action Alternative	55.0	51.5	46.5	44.4	45.8	48.9	52.7	56.5	56.9	58.0	58.1	57.2
NODOS Alternative D	54.9	51.4	46.8	44.5	45.8	48.9	52.7	56.2	56.8	58.0	58.2	57.2
Difference	-0.1	-0.2	0.3	0.1	0.0	0.0	0.0	-0.4	-0.1	0.1	0.1	0.0
Percent Difference	-0.1%	-0.3%	0.7%	0.3%	0.0%	0.0%	0.0%	-0.6%	-0.2%	0.1%	0.3%	0.0%
<b>Above Normal (15%)</b>												
No Action Alternative	54.9	50.7	46.3	44.9	46.2	49.8	53.7	57.1	57.0	57.3	58.3	58.3
NODOS Alternative D	54.6	50.6	46.6	45.0	46.3	49.9	54.1	57.0	57.1	57.5	58.3	58.0
Difference	-0.3	-0.1	0.3	0.2	0.0	0.0	0.4	-0.1	0.1	0.2	-0.1	-0.3
Percent Difference	-0.6%	-0.2%	0.6%	0.4%	0.0%	0.1%	0.7%	-0.2%	0.1%	0.3%	-0.1%	-0.6%
<b>Below Normal (17%)</b>												
No Action Alternative	54.2	50.7	46.0	44.5	46.1	49.3	53.6	56.1	56.7	57.3	58.2	58.0
NODOS Alternative D	53.9	50.6	46.4	44.8	46.2	49.3	53.9	56.1	56.8	57.4	58.3	57.7
Difference	-0.3	-0.1	0.4	0.3	0.0	0.0	0.3	-0.1	0.1	0.1	0.2	-0.2
Percent Difference	-0.6%	-0.3%	1.0%	0.6%	0.1%	0.1%	0.5%	-0.1%	0.1%	0.2%	0.3%	-0.4%
<b>Dry (22%)</b>												
No Action Alternative	55.6	50.7	46.1	44.4	46.3	50.6	53.6	56.1	57.0	57.7	59.1	60.3
NODOS Alternative D	55.1	50.6	46.1	44.7	46.3	50.7	54.2	56.4	57.7	58.0	58.8	59.7
Difference	-0.5	-0.1	0.0	0.3	0.0	0.1	0.6	0.3	0.6	0.3	-0.3	-0.6
Percent Difference	-0.9%	-0.3%	0.1%	0.7%	0.0%	0.2%	1.2%	0.5%	1.1%	0.6%	-0.5%	-1.0%
<b>Critical (15%)</b>												
No Action Alternative	57.5	50.7	45.1	44.3	46.9	50.4	53.8	56.3	57.7	59.3	60.8	61.9
NODOS Alternative D	56.8	50.4	45.2	44.6	47.0	50.5	54.4	56.5	58.0	58.9	59.5	61.1
Difference	-0.7	-0.3	0.1	0.3	0.1	0.1	0.6	0.2	0.3	-0.4	-1.3	-0.8
Percent Difference	-1.3%	-0.6%	0.3%	0.7%	0.1%	0.2%	1.1%	0.3%	0.4%	-0.6%	-2.1%	-1.3%

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the monthly average

**Table ST-2b**  
**Sacramento River at Glenn Colusa Canal Intake, Monthly Average Temperature**  
**Long-term Average and Average by Water Year Type**

Analysis Period	Monthly Average Temperature (deg-F)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Long-term</b>												
<b>Full Simulation Period<sup>1</sup></b>												
No Action Alternative	55.9	50.8	45.6	44.4	46.6	50.5	54.7	58.5	59.2	60.1	60.8	60.3
NODOS Alternative D	55.7	50.7	45.8	44.6	46.6	50.5	55.0	58.5	59.4	60.2	60.6	60.0
Difference	-0.3	-0.2	0.2	0.2	0.0	0.1	0.3	0.0	0.2	0.1	-0.2	-0.3
Percent Difference <sup>3</sup>	-0.5%	-0.3%	0.0%	0.4%	0.0%	0.1%	0.6%	0.0%	0.3%	0.2%	-0.3%	-0.4%
<b>Water Year Types<sup>2</sup></b>												
<b>Wet (32%)</b>												
No Action Alternative	55.5	51.4	46.0	44.4	46.1	49.6	53.8	58.6	59.2	60.3	60.1	58.5
NODOS Alternative D	55.4	51.2	46.3	44.5	46.1	49.7	53.8	58.3	59.1	60.4	60.3	58.5
Difference	-0.1	-0.2	0.2	0.1	0.0	0.0	0.0	-0.3	-0.1	0.1	0.2	0.0
Percent Difference	-0.1%	-0.3%	0.5%	0.2%	0.0%	0.1%	0.0%	-0.5%	-0.2%	0.1%	0.3%	0.0%
<b>Above Normal (15%)</b>												
No Action Alternative	55.5	50.6	45.8	44.9	46.6	50.6	55.0	59.2	59.3	59.4	60.4	59.8
NODOS Alternative D	55.2	50.5	46.0	45.0	46.6	50.7	55.4	59.1	59.3	59.6	60.4	59.5
Difference	-0.3	-0.1	0.2	0.1	0.0	0.1	0.4	-0.1	0.1	0.2	0.0	-0.3
Percent Difference	-0.5%	-0.2%	0.4%	0.2%	0.0%	0.1%	0.7%	-0.2%	0.1%	0.3%	0.0%	-0.4%
<b>Below Normal (17%)</b>												
No Action Alternative	54.8	50.7	45.5	44.4	46.5	50.0	54.9	58.2	58.8	59.4	60.2	59.4
NODOS Alternative D	54.5	50.6	45.8	44.7	46.5	50.0	55.1	58.2	58.9	59.5	60.4	59.3
Difference	-0.3	-0.1	0.4	0.2	0.0	0.0	0.3	0.0	0.1	0.1	0.2	-0.1
Percent Difference	-0.5%	-0.2%	0.8%	0.5%	0.0%	0.1%	0.5%	-0.1%	0.1%	0.2%	0.4%	-0.2%
<b>Dry (22%)</b>												
No Action Alternative	56.1	50.6	45.8	44.2	46.6	51.4	55.0	58.0	59.0	59.8	61.0	61.8
NODOS Alternative D	55.7	50.5	45.8	44.4	46.6	51.5	55.6	58.3	59.7	60.2	60.8	61.3
Difference	-0.4	-0.1	0.0	0.2	0.0	0.1	0.6	0.3	0.7	0.4	-0.2	-0.5
Percent Difference	-0.7%	-0.2%	0.0%	0.5%	-0.1%	0.2%	1.1%	0.6%	1.2%	0.7%	-0.3%	-0.8%
<b>Critical (15%)</b>												
No Action Alternative	57.8	50.6	44.8	44.2	47.3	51.2	55.2	58.1	59.5	61.1	62.6	63.0
NODOS Alternative D	57.2	50.3	44.8	44.4	47.4	51.3	55.8	58.4	59.9	60.9	61.4	62.4
Difference	-0.5	-0.3	0.1	0.2	0.0	0.1	0.6	0.3	0.3	-0.3	-1.2	-0.6
Percent Difference	-0.9%	-0.5%	0.2%	0.6%	0.1%	0.2%	1.1%	0.4%	0.5%	-0.4%	-1.9%	-1.0%

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the monthly average

**Table ST-3b**  
**Sacramento River at Delevan Pipeline Intake, Monthly Average Temperature**  
**Long-term Average and Average by Water Year Type**

Analysis Period	Monthly Average Temperature (deg-F)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Long-term</b>												
<b>Full Simulation Period<sup>1</sup></b>												
No Action Alternative	57.3	51.0	45.3	44.4	47.0	51.4	56.7	61.9	64.0	65.5	65.7	63.4
NODOS Alternative D	57.1	50.8	45.4	44.5	47.0	51.5	57.1	62.0	64.0	65.4	65.7	63.2
Difference	-0.1	-0.1	0.1	0.1	0.0	0.1	0.4	0.1	0.0	0.0	-0.1	-0.1
Percent Difference <sup>3</sup>	-0.2%	-0.3%	0.1%	0.2%	0.0%	0.2%	0.7%	0.1%	0.1%	-0.1%	-0.1%	-0.2%
<b>Water Year Types<sup>2</sup></b>												
<b>Wet (32%)</b>												
No Action Alternative	56.9	51.3	45.7	44.3	46.3	50.3	55.0	61.4	63.7	65.9	65.3	61.6
NODOS Alternative D	56.8	51.2	45.8	44.4	46.3	50.4	55.1	61.3	63.5	65.9	65.6	61.6
Difference	-0.1	-0.1	0.1	0.0	0.0	0.1	0.1	-0.1	-0.2	-0.1	0.3	0.0
Percent Difference	-0.2%	-0.2%	0.2%	0.0%	0.0%	0.1%	0.1%	-0.2%	-0.3%	-0.1%	0.5%	0.0%
<b>Above Normal (15%)</b>												
No Action Alternative	57.0	50.8	45.4	45.0	47.0	51.6	56.9	62.6	64.4	64.8	65.6	63.0
NODOS Alternative D	56.9	50.7	45.5	45.0	46.9	51.8	57.4	62.5	64.3	64.8	65.6	62.8
Difference	-0.2	-0.1	0.1	0.0	0.0	0.2	0.4	0.0	-0.1	-0.1	0.1	-0.1
Percent Difference	-0.3%	-0.2%	0.2%	0.0%	0.0%	0.3%	0.7%	-0.1%	-0.2%	-0.1%	0.1%	-0.2%
<b>Below Normal (17%)</b>												
No Action Alternative	56.2	50.9	45.1	44.4	46.9	50.8	56.8	61.7	63.8	65.2	65.4	62.8
NODOS Alternative D	56.1	50.8	45.3	44.6	46.9	50.9	57.2	61.7	63.8	65.1	65.6	62.8
Difference	-0.1	-0.1	0.2	0.1	0.0	0.1	0.3	0.1	-0.1	-0.2	0.2	0.0
Percent Difference	-0.2%	-0.2%	0.4%	0.3%	0.0%	0.2%	0.6%	0.1%	-0.1%	-0.3%	0.3%	-0.1%
<b>Dry (22%)</b>												
No Action Alternative	57.5	50.8	45.6	44.1	47.2	52.7	57.8	62.0	64.0	65.2	65.8	64.9
NODOS Alternative D	57.3	50.7	45.5	44.2	47.2	52.8	58.5	62.3	64.5	65.4	65.7	64.6
Difference	-0.2	-0.2	-0.1	0.1	-0.1	0.2	0.6	0.3	0.5	0.2	-0.1	-0.3
Percent Difference	-0.3%	-0.3%	-0.2%	0.2%	-0.1%	0.3%	1.1%	0.5%	0.8%	0.4%	-0.1%	-0.4%
<b>Critical (15%)</b>												
No Action Alternative	58.7	50.7	44.6	44.2	48.0	52.4	58.0	61.9	64.1	66.0	66.9	65.6
NODOS Alternative D	58.6	50.5	44.6	44.4	48.0	52.5	58.6	62.2	64.4	65.8	65.9	65.3
Difference	-0.2	-0.2	0.0	0.2	0.0	0.1	0.6	0.3	0.3	-0.2	-0.9	-0.4
Percent Difference	-0.3%	-0.4%	0.0%	0.4%	0.0%	0.1%	1.1%	0.5%	0.4%	-0.2%	-1.4%	-0.6%

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the monthly average

**Table ST-4b**  
Sacramento River below Delevan Pipeline, Monthly Average Temperature  
Long-term Average and Average by Water Year Type

Analysis Period	Monthly Average Temperature (deg-F)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Long-term</b>												
<b>Full Simulation Period<sup>1</sup></b>												
No Action Alternative	57.3	51.0	45.3	44.4	47.0	51.4	56.7	61.9	64.0	65.5	65.7	63.4
NODOS Alternative D	57.1	50.8	45.4	44.5	47.0	51.5	57.1	61.9	63.8	65.2	65.5	63.2
Difference	-0.2	-0.1	0.1	0.1	0.0	0.1	0.3	0.0	-0.1	-0.2	-0.2	-0.2
Percent Difference <sup>3</sup>	-0.3%	-0.2%	0.2%	0.2%	0.0%	0.2%	0.6%	0.0%	-0.2%	-0.4%	-0.4%	-0.3%
<b>Water Year Types<sup>2</sup></b>												
<b>Wet (32%)</b>												
No Action Alternative	56.9	51.3	45.7	44.3	46.3	50.3	55.0	61.4	63.7	65.9	65.3	61.6
NODOS Alternative D	56.8	51.2	45.8	44.4	46.3	50.4	55.1	61.3	63.4	65.6	65.4	61.6
Difference	-0.1	-0.1	0.1	0.0	0.0	0.1	0.1	-0.1	-0.3	-0.3	0.1	0.0
Percent Difference	-0.2%	-0.3%	0.3%	0.0%	0.0%	0.1%	0.1%	-0.2%	-0.5%	-0.4%	0.1%	0.0%
<b>Above Normal (15%)</b>												
No Action Alternative	57.0	50.8	45.4	45.0	47.0	51.6	56.9	62.6	64.4	64.8	65.6	63.0
NODOS Alternative D	56.7	50.7	45.6	45.0	46.9	51.8	57.4	62.5	64.1	64.6	65.4	62.8
Difference	-0.3	-0.1	0.1	0.0	0.0	0.2	0.4	-0.1	-0.3	-0.3	-0.1	-0.2
Percent Difference	-0.5%	-0.2%	0.3%	0.0%	0.0%	0.3%	0.7%	-0.1%	-0.5%	-0.4%	-0.2%	-0.3%
<b>Below Normal (17%)</b>												
No Action Alternative	56.2	50.9	45.1	44.4	46.9	50.8	56.8	61.7	63.8	65.2	65.4	62.8
NODOS Alternative D	56.0	50.8	45.3	44.6	46.9	50.9	57.2	61.7	63.6	64.8	65.4	62.7
Difference	-0.2	-0.1	0.2	0.1	0.0	0.1	0.3	0.0	-0.2	-0.4	0.0	-0.1
Percent Difference	-0.4%	-0.2%	0.4%	0.3%	0.0%	0.2%	0.6%	0.1%	-0.4%	-0.6%	0.0%	-0.1%
<b>Dry (22%)</b>												
No Action Alternative	57.5	50.8	45.6	44.1	47.2	52.7	57.8	62.0	64.0	65.2	65.8	64.9
NODOS Alternative D	57.2	50.7	45.5	44.2	47.2	52.8	58.5	62.3	64.3	65.2	65.5	64.6
Difference	-0.3	-0.2	-0.1	0.1	-0.1	0.1	0.6	0.3	0.3	0.0	-0.3	-0.3
Percent Difference	-0.5%	-0.3%	-0.2%	0.2%	-0.1%	0.2%	1.1%	0.4%	0.5%	0.0%	-0.4%	-0.5%
<b>Critical (15%)</b>												
No Action Alternative	58.7	50.7	44.6	44.2	48.0	52.4	58.0	61.9	64.1	66.0	66.9	65.6
NODOS Alternative D	58.6	50.6	44.7	44.4	48.0	52.4	58.5	62.1	64.2	65.7	65.8	65.2
Difference	-0.2	-0.1	0.1	0.2	0.0	0.0	0.5	0.1	0.1	-0.3	-1.1	-0.4
Percent Difference	-0.3%	-0.3%	0.2%	0.4%	0.0%	0.1%	0.8%	0.2%	0.1%	-0.4%	-1.6%	-0.6%

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the monthly average