11.2 Reasonable and Prudent Alternative – Specific Actions

11.2.1. Decision-Making Procedures, Monitoring and Adaptive Management Protocols

11.2.1.1 Responsibilities and Procedures of Technical Teams

There are currently four Fisheries and Operations Technical Teams whose function is to make recommendations for adjusting operations to meet contractual obligations for water delivery and minimize adverse effects on listed anadromous fish species:

- Sacramento River Temperature Task Group (SRTTG)
- Clear Creek Technical Working Group (CCTWG)
- American River Group (ARG)
- San Joaquin River Technical Committee (SJRTC)

This RPA requires the creation of three additional technical teams:

- Delta Operations for Salmon and Sturgeon (DOSS) Group
- Stanislaus Operations Group (SOG)
- Interagency Fish Passage Steering Committee

Each group has responsibility to gather and analyze information, and make recommendations, regarding adjustments to water operations within the range of flexibility prescribed in the implementation procedures for a specific action in their particular geographic area. Under previous operations plans, recommendations for adjustments were made to the Water Operations Management Team (WOMT), a management-level group of representatives of Reclamation, DWR, CDFG, NMFS, and USFWS. The WOMT then made recommendations to state and regional directors for final action.

The Project Description for the proposed action (Appendix 1 to this Opinion), as revised by this RPA, establishes the responsibilities of each technical team. The RPA establishes the operations parameters that are necessary to avoid jeopardizing listed species or adversely modifying their critical habitat. Within those parameters, there is flexibility to adjust actions within a specified range based on current conditions. The allowed range of flexibility is prescribed in the "implementation procedures" portion of the RPA action. The technical teams and the WOMT will work within those implementation procedures to meet discretionary water contract obligations to the greatest extent consistent with survival and recovery of listed species. The teams also may recommend changes to the measures in this RPA, as detailed in the Research and Adaptive Management section of the RPA. Recommended changes outside the range of flexibility specified in the implementation procedures must receive written review and concurrence by NMFS and may trigger re-initiation.

This action prescribes standard operating procedures for decision-making that will apply to all teams.

1) Within 90 days of issuance of this Opinion, Reclamation shall send to the WOMT members a list of current members of each technical team. The WOMT representatives shall review the membership and make changes, if necessary. All groups shall include members with expertise in fish biology and hydrology. Each group shall designate a group leader to convene meetings and assure that necessary administrative steps are taken, such as recording and distributing meeting notes and recommendations.

2) Each group shall establish a regular meeting schedule at the beginning of each year, based on the anticipated need for adjustments to operations, and distribute the schedule to the members of the group. The group leader may reschedule a meeting, or call a special meeting, with three days notice at his or her discretion, or on request of NMFS or any two or more group members.

3) Brief notes of each meeting shall be recorded, including issues considered, recommendations made, and key information on which recommendations were based. Meeting notes shall be distributed to members within two days of the meeting.

4) Within one day after a technical team advises that an operational action should be initiated, changed, suspended, or terminated, consistent with the implementation procedures specified for actions in this RPA, the group leader shall provide to NMFS and Reclamation written advice and a biological rationale. The technical teams shall use the process described in the applicable RPA implementation procedures to provide a framework for their analysis. NMFS shall determine whether the proposed action is consistent with the implementation procedures in this RPA. If NMFS determines that the proposed action is consistent with the implementation procedures, then it avoids jeopardy to listed species or adverse modification of critical habitat. Both the technical team's advice and NMFS' recommendation shall be presented to the WOMT for discussion and concurrence. In the event that there is not consensus at the workgroup level, the workgroup leader shall convey the options and summary of the technical discussion to NMFS for consideration. NMFS will make a recommendation for action within the procedural guidelines of this RPA. NMFS will present its recommendations to the WOMT for discussion and concurrence (see #6 below).

5) If the recommended action will affect species within the jurisdiction of USFWS as well as NMFS, the technical team making the recommendation shall, to the extent that time allows, first coordinate with the Smelt Working Group (SWG). The technical team and the SWG, to the extent feasible, shall jointly make a recommendation to USFWS and NMFS (the Services), who will jointly determine whether the recommended action is consistent with the actions and implementation procedures of this RPA and is, therefore,

necessary to avoid jeopardy to listed species and adverse modification of critical habitat. The Services shall then present their findings and recommendations to the WOMT.

6) The WOMT shall either concur with NMFS' (or the Services', as appropriate) recommendation or provide a written alternative to the recommendation, with biological justification, to NMFS (or the Services) within one calendar day. NMFS (or the Services) shall then make a determination as to whether the action proposed by the WOMT is consistent with this Opinion and ESA obligations.

7) Once NMFS (or the Services) makes a final determination that a proposed operational action is consistent with ESA obligations, Reclamation and DWR shall implement the operational action within two calendar days. Reclamation and DWR shall submit to NMFS (or the Services) data demonstrating the implementation of the action on a weekly basis, or post their operations on their website.

8) The action shall remain in effect until NMFS (or the Services), with advice from the appropriate technical team(s), determines that it should be modified or terminated as inconsistent with the implementation procedures for the RPA. The action shall be modified or terminated within two calendar days of such a determination.

9) These procedures may be modified for a particular team or working group by mutual agreement of NMFS and Reclamation. Modifications to the procedures shall be in writing, dated, and promptly distributed to all members of the group.

11.2.1.2. Research and Adaptive Management

Not later than November 30 of every year, in conjunction with the Delta Science Program or other Science Peer Review process, Reclamation and NMFS shall host a workshop to review the prior water years' operations and to determine whether any measures prescribed in this RPA should be altered in light of information learned from prior years' operations or research. After completion of the annual review, NMFS may initiate a process to amend specific measures in this RPA to reflect new information, provided that the amendment is consistent with the Opinion's underlying analysis and conclusions and does not limit the effectiveness of the RPA in avoiding jeopardy to listed species or adverse modification of critical habitat. NMFS will ask the appropriate informational and technical teams to assess the need for a particular amendment and make recommendations to NMFS, according to the group processes for decision-making set forth in this RPA in action 11.2.1.1 above.

2011 Amendment: In the Fall of 2010, the Delta Stewardship Council convened an Independent Review Panel (IRP) to assist in the annual review required in this action[1]. On November 8-9,

[1] Under direction from the Secretaries of Commerce and Interior, the NMFS review was expanded to include a review of the implementation of the FWS' 2008 OCAP Opinion. The integrated review provided an opportunity to assure that the NMFS and FWS RPAs worked together in an ecosystem context.

2010, the Delta Science Program held a workshop to provide the IRP a forum for presentations and discussion of previously submitted technical reports. Following the workshop, the IRP produced a report that included recommendations for adjustments to the RPA, based on information presented in the review process. The IRP Report was finalized on December 9, 2010 (Anderson *et al*. 2010; http://www.deltacouncil.ca.gov/delta_science_program/events/workshop_OCAP_2010.html).

NMFS has amended the RPA consistent with the IRP recommendations and this Opinion's underlying analysis and conclusions[2]. This amended RPA supersedes the 2009 RPA.

2017 Amendment: This amendment is based on the following considerations:

1) Operations of Shasta and Keswick reservoirs were the subject of multiple annual reviews. Shasta operations were one of the main focuses in the 2015 annual review.
2) 2014 and 2015, the third and fourth years of drought conditions (*e.g*., dry hydrology, high air temperatures), resulted in extremely challenging operations of Shasta and Keswick reservoirs that resulted in many lessons learned on what to consider in the development and implementation of both the February forecast process and the May temperature management plan process.
3) The main conclusion that NMFS has made is that the Shasta RPA actions are not performing as we thought it would when we wrote the 2009 CVP/SWP operations Opinion. The performance metrics in RPA Action I.2.1 have not been met. Even more important, the level of incidental take in 2014 and 2015 was greater than analyzed or authorized in 2009 when the RPA was developed. Therefore, a reinitiation trigger has been met. In light of this, Reclamation recently requested reinitation of the CVP/SWP operations consultation. NMFS expects that reconsultation will provide a comprehensive analysis of integrated operations.
4) New science and models, for example, the River Assessment for Forecasting Temperature decision support tool and the temperature-dependent mortality model, are available that should be included in the forecasting and temperature management process.
5) Finally, since the 2011 amendment, there have been clarifications and adaptive management changes made that are reflected in this 2017 amendment to update the RPA.

NMFS has amended the RPA to reflect new best available scientific and commercial information and to ensure that take authorizations associated with RPA Action Suite I.2 are still valid, based on lessons learned from water years 2014-2016. The amendment is consistent with the Opinion's underlying analysis and conclusions. Rationale provided for the specific amendments explain the need for the amendments and how they meet the objectives of the specific RPA actions.

This amended RPA supercedes the 2009 RPA with 2011 amendments. Amendments to the Shasta RPA actions will be issued in a phased approach. As mentioned above, the current

[2] In addition, NMFS has taken this opportunity to correct some errors in the 2009 RPA. All changes are noted and explained in the "Rationale for 2011 amendment" sections accompanying the amendments.

amendment is needed to reflect new best available scientific and commercial information, and lessons learned from operations during the drought conditions throughout water years 2014-2016. There is also ongoing collaborative science being developed through monitoring work, and refinement of temperature forecasting models, that will inform the implementation and likely success of meeting the biological objectives identified for the RPA actions, that may warrant a subsequent amendment. Finally, these new and refined tools and monitoring will be used to inform the reconsultation of CVP/SWP operations.

NMFS and Reclamation will establish a research program in coordination with the Delta Science Program and other agencies to address key research and management questions arising from this Opinion. Prior to the beginning of a new calendar year, Reclamation shall submit to NMFS a research plan for the following year, developed in coordination with the above programs and agencies. Reclamation also shall provide NMFS access to all draft and final reports associated with this research. Specific research projects that have been identified as important to begin in the first year and complete as soon as possible are:

1) Cooperative development of a salmonid lifecycle model acceptable to NMFS, Reclamation, CDFG, and DWR

2) Temperature monitoring and modeling identified in RPA Action I.1.5

3) Green sturgeon research described in the RBDD actions

4) Rearing habitat evaluation metrics to guide rearing habitat Action 1.6

1) A 6-year acoustic-tagged study of juvenile salmonids out-migration in the San Joaquin River and through the southern Delta identified in Action IV.2.2.

11.2.1.3. Monitoring and Reporting

1) Reclamation and DWR shall participate in the design, implementation, and funding of the comprehensive CV steelhead monitoring program, under development through ERP, that includes adult and juvenile direct counts, redd surveys, and escapement estimates on CVP- and SWP-controlled streams. This program is necessary to develop better juvenile production estimates that form the basis of incidental take limits and will also provide necessary information to calculate triggers for operational actions.

2) Reclamation and DWR shall ensure that all monitoring programs regarding the effects of CVP and SWP operations and which result in the direct take of winter-run, spring-run, CV steelhead, or Southern DPS of green sturgeon, are conducted by a person or entity that has been authorized by NMFS. Reclamation and DWR shall establish a contact person to coordinate these activities with NMFS.

3) Reclamation and DWR shall submit weekly reports to the interagency Data Assessment Team (DAT) regarding the results of monitoring and incidental take of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon associated with operations of project facilities.

4) Reclamation and DWR shall provide an annual written report to NMFS no later than November 1, following the salvage season of approximately October to May. This report shall provide the data gathered and summarize the results of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon monitoring and incidental take associated with the operation of the Delta pumping plants (including the Rock Slough Pumping Plant). All juvenile mortality must be minimized and reported, including those from special studies conducted during salvage operations. This report should be sent to NMFS (West Coast Region, California Central Valley Office, 650 Capitol Mall, Suite 5-100, Sacramento, California 95814-4706).

   Rationale for 2017 amendment: Changing the deadline for annual salvage reports provides the Projects with a more reasonable timeframe to submit them after each water year ends on September 30.

5) Reclamation and DWR shall continue the real-time monitoring of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon in the lower Sacramento River, the lower San Joaquin River, and the Delta to establish presence and timing to serve as a basis for the management of DCC gate operations and CVP and SWP Delta pumping operations consistent with actions in this RPA. Reclamation and DWR shall conduct continuous real-time monitoring between October 1 and June 30 of each year, commencing in 2009.

6) Reclamation and DWR shall submit weekly DAT reports and an annual written report to NMFS describing the results of real-time monitoring of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon associated with operations of the DCC and CVP and SWP Delta pumping facilities, and other Division level operations authorized through this RPA.

7) Reclamation shall coordinate with NMFS, the USFWS, and CDFG to continue implementation and funding of fisheries monitoring of spring-run and CV steelhead (including adult snorkel surveys, population estimates for steelhead, and rotary screw trapping) in Clear Creek to aide in determining the benefits and effects of flow and temperature management.

8) Monitoring Requirements: The following (A-E) are necessary to adaptively manage project operations and are either directly related to management of releases (*e.g.*, temperature and flow), or are a necessary component of the Salmon Decision Process used to manage Delta operations (*e.g.*, DCC gates and export pumping). Reclamation

and DWR shall jointly fund these monitoring locations for the duration of the Opinion (through 2030) to ensure compliance with the RPA and assess the performance of the RPA actions. Most of these monitoring stations already exist and are currently being funded through a variety of sources (*i.e.*, CDFG, USFWS, Reclamation, DWR, CALFED, and Interagency Ecological Program), however, CALFED funding for monitoring ends in 2009 and CDFG funding has been reduced due to budget cuts.

a) Upstream: Adult escapement and juvenile monitoring for spring-run, winter-run, and steelhead on the Sacramento River, American River, Feather River, Clear Creek, Mill Creek, Deer Creek and Battle Creek. These may be performed through carcass surveys, redd surveys, weir counts, and rotary screw trapping. Unless prevented by circumstances beyond the control of Reclamation, aerial redd counts shall be conducted annually on the mainstem Sacramento River from Keswick Dam downstream to at least Tehama Bridge, from at least April through September. These surveys are necessary to determine the temporal and spatial distribution of winter-run and spring-run Chinook salmon. Exceptions to the annual aerial redd counts are allowed only when requested in writing (including the specific circumstance that may preclude the aerial redd surveys) and upon written concurrence by NMFS.

   Rationale for 2011 amendment: Aerial redd counts have been conducted annually at least since 2001. However, in water year 2010, they were conducted later in the winter-run Chinook salmon spawning season, and the SRTTG did not have the benefit of the temporal and spatial distribution data to inform its recommendation of a temperature compliance point. The IRP noted the confusion in the final establishment of the temperature compliance point: "It is not known why the compliance point was established downstream (Jelly's Ferry) when aerial redd surveys in 2010 indicated redds were upstream of Airport Road Bridge." (Anderson *et al*. 2010, page 12, note E).

b) RBDD: Adult counts using the three current fish ladders until the new pumping plant is operational. Rotary screw trapping to determine juvenile Chinook salmon passage or abundance year-round before and after pumping plant is operational. Green sturgeon monitoring, to include adult and juvenile estimates of passage, relative abundance, and run timing, in order to determine habitat use and population size with respect to management of Shasta Reservoir resources.
c) Sacramento River new juvenile monitoring station: The exact location to be determined, between RBDD and Knights Landing, in order to give early warning of fish movement and determine survival of listed fish species leaving spawning habitat in the upper Sacramento River.
d) Delta: Continuation of the following monitoring stations that are part of the IEP: Chipps Island Trawl, Sacramento Trawl, Knights Landings RST, and beach seining program. Additionally, assist in funding new studies to determine green sturgeon relative abundance and habitat use in the Delta.

e) San Joaquin River monitoring shall include: Adult escapement and juvenile monitoring for steelhead on the Stanislaus River; Mossdale Kodiak Trawling to determine steelhead smolt passage; steelhead survival studies associated with VAMP; monitoring at HORB to determine steelhead movement in and around the barrier; predation studies in front of HORB and at the three agricultural barriers in the South Delta; and new studies to include the use of non-lethal fish guidance devices (*e.g.*, sound, light, or air bubbles) instead of rock barriers to keep juveniles out of the area influenced by export pumping.

11.2.2 Actions Listed by Division

I. SACRAMENTO RIVER DIVISION

Action Suite I.2. Shasta Operations

Introduction to Shasta Operations: Maintaining suitable temperatures for egg incubation, fry emergence, and juvenile rearing in the Sacramento River is critically important for survival and recovery of the winter-run ESU. The winter-run ESU has been reduced to a single population, which has been blocked from its historical range above Shasta Dam. Consequently, suitable temperatures and habitat for this population must be maintained downstream of Shasta Dam through management of the cold water pool behind the dam in the summer. Maintaining optimum conditions for this species below Shasta is crucial until additional populations are established in other habitats or this population is restored to its historical range. Spring-run are also affected by temperature management actions from Shasta Reservoir.

The effects analysis in this Opinion highlights the very challenging nature of maintaining an adequate cold water pool in critically dry years, extended dry periods, and under future conditions, which will be affected by increased downstream water demands and climate change. This suite of actions is designed to ensure that Reclamation uses maximum discretion to reduce adverse impacts of the projects to winter-run and spring-run in the Sacramento River by maintaining sufficient carryover storage and optimizing use of the cold water pool. In most years, reservoir releases through the use of the TCD are a necessity in order to maintain the bare minimum population levels necessary for survival (Yates *et al.* 2008, Angilletta *et al.* 2008).

The effects analysis in this Opinion, and supplemental information provided by Reclamation, make it clear that despite Reclamation's best efforts, severe temperature-related effects cannot be avoided in some years. The RPA includes exception procedures to deal with this reality. Due to these unavoidable adverse effects, the RPA also specifies other actions that Reclamation must take, within its existing authority and discretion, to compensate for these periods of unavoidably high temperatures. These actions include restoration of habitat at Battle Creek that may be

support a second population of winter-run, and a fish passage program at Keswick and Shasta dams to partially restore winter-run to their historical cold water habitat.

Objectives: The following objectives must be achieved to address the avoidable and unavoidable adverse effects of Shasta operations on winter-run and spring-run:

1) Ensure a sufficient cold water pool to provide suitable temperatures for winter-run egg and fry incubation in most years, without sacrificing the potential for cold water management in a subsequent year. Additional actions to those in the 2004 CVP/SWP operations Opinion are needed, due to increased vulnerability of the population to temperature effects attributable to changes in Trinity River ROD operations, projected climate change hydrology, and increased water demands in the Sacramento River system.

2) Ensure suitable temperature regimes for spring-run egg and fry incubation, especially in September and October. Suitable spring-run temperatures will also partially minimize temperature effects to naturally-spawning, non-listed Sacramento River fall-run, an important prey base for endangered Southern Resident killer whales.

3) Establish a second population of winter-run in Battle Creek as soon as possible, to partially compensate for unavoidable project-related effects on the one remaining population.

4) Restore passage at Shasta Reservoir with experimental reintroductions of winter-run to the upper Sacramento and/or McCloud rivers, to partially compensate for unavoidable project-related effects on the remaining population.

2017 amendment: Appendix 2-A of the CVP/SWP operations Opinion is the "Decision Criteria and Processes for Sacramento River Water Temperature Management." NMFS searched the RPA for Appendix 2-A and did not find any references to it. It appears to be a stand alone document that includes information and requirements that may be inconsistent or confusing in consideration of this RPA, and especially the 2017 amendments to RPA Action Suite I.2. To that end, and through this 2017 amendment, NMFS is rescinding Appendix 2-A from the CVP/SWP operations Opinion, and any compliance requirements within Appendix 2-A are not valid.

Action I.2.1 Objective-Based Management.

Objective: NMFS and Reclamation will work together to establish temperature dependent mortality objectives by water year type, and manage to these objectives, in order to minimize temperature effects associated with operations of the CVP. This 2017 amendment contains an initial set of objectives that may be adjusted in subsequent amendments or the reconsultation of CVP/SWP operations.

To establish and operate to a set of performance measures for End-of-April (EOA) storage and End-of-September (EOS) carryover storage in order to meet the temperature requirements set forth in the subsequent actions. Performance measures will help to ensure that the beneficial variability of the system from changes in hydrology will be measured and maintained.

The following conceptual objectives were adapted from the multi-year drought sequence experienced in Australia, and applied to the following RPA Actions based on water year type.

	Critically Dry	**Dry**	**Below Normal**	**Above Normal & Wet**
Objectives	PROTECT - Avoid critical loss of population - Avoid catastrophic changes to habitat	MAINTAIN - Maintain river function with reduced reproductive capacity - Manage within dry-spell tolerance	RECOVER - Improve ecological health and resilience - Improve recruitment opportunities	ENHANCE - Maximize species recruitment opportunities - Restore key floodplain linkages - Restore key ecological flows
Priorities	- Undertake emergency flows to avoid catastrophic changes - Carry-over water for critical environments in the following year	- Provide priority flow components - Carry-over water for critical environmental components in the following year	- Provide all in-bank flow components - Provide out-of-bank flows if reach dry-spell tolerance - Carry-over water for large watering events	- Provide all ecological functioning flow components

Action: The following objectives shall be attained. Reclamation shall use these performance metrics for forecasting, temperature planning and implementation and shall report on them annually to NMFS. If there is significant deviation from these objectives, then Reclamation shall reinitiate consultation with NMFS.

1) Temperature-dependent mortality to winter-run Chinook shall not exceed the following:
   - Critically dry: <30% mortality
   - Dry: <8% mortality
   - Below Normal: <3% mortality
   - Above Normal: <3% mortality
   - Wet: <3% mortality

2) EOA storage at Shasta Reservoir, based on water year type, in order to meet the temperature-dependent mortality objectives and the requirements set forth in RPA Action I.2.4, below, shall be no less than:
   - Critically dry: 3.3 million acre-feet (MAF)
   - Dry: 3.9 MAF
   - Below Normal: 4.2 MAF
   - Above Normal: 4.2 MAF
   - Wet: 4.2 MAF

3) EOS carryover storage at Shasta Reservoir, based on water year type, shall be no less than:
   - Critically dry: 1.9 MAF
   - Dry: 2.2 MAF
   - Below Normal: 2.2 MAF
   - Above Normal: 2.8 MAF
   - Wet: 3.2 MAF

Rationale:

- This 2017 amendment deletes the previous performance measures that were based on temperature compliance locations to be met with prescribed frequency. The 2009 RPA with 2011 amendments required a temperature compliance point to be between Balls Ferry and Bend Bridge from May 15 through September 30. In 2017, NMFS concludes that the most appropriate compliance location should be at the most downstream redd [see Anderson *et al*. (2010, 2011) and EPA (2003)].
- The 2017 temperature dependent mortality objectives take advantage of new scientific models (*e.g*., Martin *et al*. 2016), and are intended to create the most flexible and effective operations by directly managing to a biologically meaningful objective. The variability in objectives by water year type is based on the variable goals that can realistically be achieved given drier years (when effects will be greater) versus wetter years (when species recovery is possible).
- The EOA and EOS storage objectives consider hydrology (*i.e*., water year type), and are provided in order to meet the temperature requirements set forth in the subsequent actions in preserving key aspects of life history and run time diversity. EOA storage of 3.9 MAF will allow operation of the upper gates for more flexibility in blending operations and extend the use of the cold water pool. The volumes are taken from those presented in the CVP/SWP operations BA, effects analysis in the Opinion, and NMFS technical memo on historic Shasta operations, and a 2017 Reclamation analysis of the relationships between storage and cold water pool volumes.

Action I.2.2. November through February Keswick Release Schedule (Fall Actions)

Objective: Minimize impacts to listed species and naturally spawning non-listed fall-run from high water temperatures by implementing standard procedures for release of cold water from Shasta Reservoir.

Action: Depending on EOS carryover storage and hydrology, Reclamation shall develop and implement a Keswick release schedule, and reduce deliveries and exports as detailed below.

Action I.2.2.A Implementation Procedures for EOS Storage at 2.4 MAF and Above

If the EOS storage is at 2.4 MAF or above, by October 15, Reclamation shall convene a group including NMFS, USFWS, and CDFG, to consider a range of fall actions. A written monthly average Keswick release schedule shall be developed and submitted to NMFS by November 1 of each year, based on the criteria below. The monthly release schedule shall be tracked through the work group. If there is any disagreement in the group, including NMFS technical staff, the issue/action shall be elevated to the Shasta Water Interagency Management (SWIM) Team (see Action I.2.4, below) for resolution.

The workgroup shall consider and the following criteria in developing a Keswick release schedule:

1) Need for flood control space: A maximum 3.25 MAF end-of-November storage is necessary to maintain space in Shasta Reservoir for flood control.

2) Need for stable Sacramento River level/stage to increase habitat for optimal spring-run and fall-run redds/egg incubation and minimization of redd dewatering and juvenile stranding.

3) Need/recommendation to implement USFWS' Delta smelt Fall X2 action as determined by the Habitat Study Group (HSG) formed in accordance with the 2008 Delta smelt Opinion. NMFS will continue to participate in the HSG chartered through the 2008 Delta smelt biological opinion. If, through the HSG, a fall flow action is recommended that draws down fall storage significantly from historical patterns, then NMFS and USFWS will confer and recommend to Reclamation an optimal storage and fall flow pattern to address multiple species' needs.

If there is a disagreement at the workgroup level, actions may be elevated to the NMFS California Central Valley Office Assistant Regional Administrator and resolved through the WOMT's standard operating procedures.

Rationale: 2.2 MAF EOS storage is linked to the potential to provide sufficient cold water to meet the minimum Balls Ferry Compliance point in the following year, and it is achievable approximately 85 percent of the time. Based on historical patterns, EOS storage will be above 2.4 MAF 70 percent of the time. The 2.4 MAF storage value provides a reasonable

margin above the 2.2 level to increase the likelihood that the Balls Ferry Compliance Point will be reached while also implementing fall releases to benefit other species and life stages. Therefore, in these circumstances, actions should target the fall life history stages of the species covered by this Opinion *(i.e.*, spring-run spawning, winter-run emigration). The development of a Keswick release schedule is a direct method for controlling storage maintained in Shasta Reservoir. It allows Reclamation to operate in a predictable way, while meeting the biological requirements of the species. The B2IT workgroup, or similar interagency work group, has been used in the past to target actions to benefit fall-run during this time of year using b(2) resources, and, because of its expertise, may also be used by Reclamation to develop this flow schedule. In the past, the B2IT group has used the CVPIA AFRP guidelines to target reservoir releases. Over time, it may be possible to develop a generic release schedule for these months, based on the experience of the work group.

Action I.2.2.B Implementation Procedures for EOS Storage Above 1.9 MAF and Below 2.4 MAF

If EOS storage is between 1.9 and 2.4 MAF, then Reclamation shall convene a group including NMFS, USFWS, and CDFG, to consider a range of fall actions. Reclamation shall provide NMFS and the work group with storage projections based on 50 percent, 70 percent, and 90 percent hydrology through February, and develop a monthly average Keswick release schedule based on the criteria below. The monthly release schedule shall be submitted to NMFS by November 1.

Criteria for the release schedule shall include:

1) Maintain Keswick releases between 7,000 cfs and 3,250 cfs to reduce adverse effects on mainstem spring-run and conserve storage for next year's cold water pool.

2) Consider fall-run needs per CVPIA AFRP guidelines, through January, including stabilizing flows to keep redds from de-watering.

3) Be more conservative in Keswick releases throughout fall and early winter if hydrology is dry, and release more water for other purposes if hydrology becomes wet. For example, release no more than 4,000 cfs if hydrology remains dry.

The Keswick release schedule shall follow this or a similar format, to be refined by the workgroup:

	October forecast based on EOS storage	50% hydrology		70% hydrology		90% hydrology	
		Projected storage MAF	Planned release CFS	Projected storage MAF	Planned release CFS	Projected storage MAF	Planned release CFS

Monthly average Keswick release	November						
	December						
	January						
	February						

Reclamation, in coordination with the work group, shall review updated hydrology and choose a monthly average release for every month (November, December, January, February), based on the release schedule. In the event that the updated hydrology indicates a very dry pattern and consequent likely reduction in storage, the work group may advise Reclamation to take additional actions, including export curtailments, if necessary to conserve storage

If there is a disagreement at the work group level, actions may be elevated to NMFS and resolved through the SWIM Team.

Rationale: It is necessary to be reasonably conservative with fall releases to increase the likelihood of adequate storage in the following year to provide cold water releases for winter-run. This action is intended to reduce adverse effects on each species without compromising the ability to reduce adverse effects on another species. A work group with biologists from multiple agencies will refine the flow schedule, providing operational certainty while allowing for real-time operational changes based on updated hydrology. Over time, it may be possible to develop a generic release schedule for these months, based on the experience of the work group.

Action I.2.2.C. Implementation and Exception Procedures for EOS Storage of 1.9 MAF or Below

If the EOS storage is at or below 1.9 MAF, then Reclamation shall:

1) In early October, reduce Keswick releases to 3,250 cfs as soon as possible, unless higher releases are necessary to meet temperature compliance points (see action I.2.3).

2) Starting in early October, if cool weather prevails and temperature control does not mandate higher flows, curtail discretionary water deliveries (including, but not limited to agricultural rice decomposition deliveries) to the extent that these do not coincide with temperature management for the species. It is important to maintain suitable temperatures targeted to each life stage. Depending on air and water temperatures, delivery of water for rice decomposition, and any other discretionary purposes at this time of year, may coincide with the temperature management regime for spring-run and fall-run. This action shall be closely coordinated with NMFS, USFWS, and CDFG.

3) By November 1, submit to NMFS storage projections based on 50 percent, 70 percent, and 90 percent hydrology through February. In coordination with NMFS, Reclamation

shall: (1) develop a monthly average Keswick release schedule similar in format to that in Action I.2.2.B, based on the criteria below and including actions specified below; and (2) review updated hydrology and choose a monthly average release for every month, based on the release schedule. November releases shall be based on a 90 percent hydrology estimate.

Criteria and actions:

1) Keswick releases shall be managed to improve storage and maintained at 3,250 cfs unless hydrology improves.

2) November monthly releases will be based on 90 percent hydrology.

3) Consider fall-run needs through January as per CVPIA AFRP guidelines, including stabilizing flows to keep redds from dewatering.

4) Continue to curtail discretionary agricultural rice decomposition deliveries to the extent that these do not coincide with temperature management for the species, or impact other ESA-listed species. It is important to maintain suitable temperatures targeted to each life stage. Depending on air and water temperatures, delivery of water for rice decomposition may coincide with the temperature management regime for spring-run and fall-run. This action shall be closely coordinated with NMFS. USFWS, and CDFG.

5) If operational changes are necessary to meet Delta outflow, X2, or other legal requirements during this time, then:

    a) CVP/SWP Delta combined exports shall be curtailed to 2,000 cfs if necessary to meet legal requirements while maintaining a 3,250 cfs Keswick release (or other planned release based on biological needs of species); and
    b) if it is necessary to curtail combined exports to values more restrictive than 2000 cfs in order to meet Delta outflow, X2, or other legal requirements, then Reclamation and DWR shall, as an overall strategy, first, increase releases from Oroville or Folsom; and
    c) in general, Reclamation shall increase releases from Keswick as a last resort.
    d) Based on updated monthly hydrology, this restriction may be relaxed, with NMFS' concurrence.

6) If the hydrology and storage have not improved by January, additional restrictions apply – see Action I.2.4.

Rationale: Per actions I.2.3 and I.2.4 below, Reclamation is required to meet 1.9 MAF EOS. The BA's CALSIM modeling shows that during a severe or extended drought, 1.9 EOS storage may not be achievable. In this circumstance, Reclamation should take additional

steps in the fall and winter months to conserve Shasta storage to the maximum extent possible, in order to increase the probability of maintaining cold water supplies necessary for egg incubation for the following summer's cohort of winter-run.

Assessment of the hydrologic record and CALSIM modeling shows that operational actions taken during the first year of a drought sequence are very important to providing adequate storage and operations in subsequent drought years. The biological effects of an extended drought are particularly severe for winter-run. Extended drought conditions are predicted to increase in the future in response to climate change. While it is not possible to predict the onset of a drought sequence, in order to ensure that project operations avoid jeopardizing listed species, Reclamation should operate in any year in which storage falls below 1.9 MAF EOS as potentially the first year of a drought sequence. The CVP storage system is likely to recover more quickly in the winter and spring months if additional storage conservation measures are taken in the fall and winter.

The curtailments to discretionary rice decomposition deliveries and combined export curtailment of 2,000 cfs are necessary to conserve storage when EOS storage is low. These actions were developed through an exchange of information and expertise with Reclamation operators.

This action is consistent with comments from the Calfed Science Peer Review panel. That panel recommended that Shasta be operated on a two-year (as opposed to single year) hydrologic planning cycle and that Reclamation take additional steps to incorporate planning for potential drought and extended drought into its operations.

Action I.2.3. February Forecast; March – May 14 Keswick Release Schedule (Spring Actions)

Objective: To conserve water in Shasta Reservoir in the spring in order to provide sufficient water to reduce adverse effects of high water temperature in the summer months for winter-run, without sacrificing carryover storage in the fall.

Actions:

1) Prior to initial water allocations, Reclamation shall make its initial forecast of deliverable water, between February 15th and March 15th, and analyze the effects of that forecast on the ability to meet the objectives in RPA Action I.2.1. Acknowledging considerable uncertainty in this long-range forecast, the goal is to plan operations that provide sufficient cold water to meet the objectives 90% of the time. Keeping this 90% objective in mind, the model shall contain conservative inputs for hydrology, including precipitation, runoff and snowpack, ambient summer air temperatures, and assumptions or projections about lake stratification. In the other 10% of the time, it may be necessary to revise allocations in the May period, associated with the final temperature plan.

2) Subsequent updates of water delivery commitments must be based on monthly forecasts at least as conservative as the 90 percent probability of exceedence.
   a) Reclamation shall provide the draft February forecast, and a projection of temperature management operations for the summer months, to NMFS no later than seven business days after receipt of the official DWR runoff forecast. The forecast shall demonstrate that the objectives in RPA Action I.2.1 can be attained, including EOA and EOS storage objectives. The draft February forecast shall also include:
      i. Relatively stable Keswick releases August through October in order to minimize the potential for winter-run redd dewatering[3];
      ii. Projected Shasta cold water pool volume based on a stratification model or hindcasting comparable Shasta volumes;
   b) NMFS shall be provided at 3 three business days to review the draft forecast.
   c) NMFS shall review the draft February forecast to determine whether the ESA requirements for temperature and flow management would be met while implementing the forecasted delivery schedule.
   d) NMFS shall provide a written evaluation to Reclamation prior to Reclamation making the first allocation announcements and for each subsequent month for discretionary contract deliveries.
   e) Reclamation shall manage releases from Keswick consistent with the February forecast and subsequent monthly hydrology updates.
   f) By mutual agreement with NMFS, Reclamation may postpone this forecast and their initial allocations announcement until March 15.

3) Reclamation shall make releases to maintain a temperature compliance point at Jellys Ferry and not in excess of 61°F 7DADM at CCR[4] from April 15 through May 14[5].

Rationale for 2017 amendment: Additional requirements/expectations are provided for the initial forecast and inputs to temperature modeling, based on lessons learned in the last few years of operations, and what may be necessary to provide for suitable winter-run egg and alevin incubation throughout the temperature management season. The February forecast was required as part of Reclamation's initial allocations planning in order to determine the impact of Shasta management. Additional requirements, which were not included previously, are included to address the potential for winter-run redd dewatering and to provide for suitable pre-spawning temperatures.

[3] The extent of allowable winter-run redd dewatering depends on many factors, including Shasta storage, water year type, strength of the run (which unfortunately is not known until after the season), and CDFW monitoring of the redds most vulnerable to dewatering. Therefore, the extent of dewatering will be based on real-time assessments of the above factors and monitoring.

[4] EPA (2003) recommends 61°F 7DADM as suitable adult Chinook salmon holding temperatures prior to spawning.

[5] This RPA Action will conclude at the onset of winter-run spawning, determined by CDFW aerial redd surveys and carcass surveys, and therefore, may be earlier or later than May 14.

Action I.2.3.A Implementation Procedures if February Forecast, Based on 90 Percent Hydrology, Shows Temperature Management is Achievable

If all of the following metrics are met, based on the February forecast, then Reclamation shall announce allocations and operate Keswick releases in March, April, and May consistent with its standard plan of operation. Preparation of a separate Keswick release schedule is not necessary in these circumstances.

1) End of April storage ≥ 4.2 MAF
2) End of September storage ≥ 3.2 MAF
3) 51.5°F Keswick release temperature from May 15 through October 31 [this would be used as a surrogate for 55°F 7-day average of the daily maximum temperatures (7DADM) at the CCR California Data Exchange Center gaging station upstream of the confluence of Clear Creek on the Sacramento River]
4) Full side gate access of the Shasta Dam temperature control device no earlier than October 15;

Rationale: The 90 percent forecast is a conservative approach for assessing the potential to manage water temperaures and meet EOS performance goals. If both of these performance goals are projected to be met at the time of the February forecast, then no restrictions on allocations due to this suite of actions are necessary.

Action I.2.3.B Implementation Procedures if February Forecast, Based on 90 Percent Hydrology, Shows that not all of the Metrics in Action I.2.3.A are Achievable

1) If, the February forecast, based on 90 percent hydrology, shows that not all of the metrics in Action I.2.3.A, above, are achievable, then Reclamation shall implement the following Keswick release schedule, based on water year type, until the Sacramento River temperature management plan pursuant to RPA Action I.2.4 is finalized:

Water Year Type	**Monthly Keswick release schedule (cfs)**						
	Apr	May	Jun	Jul	Aug	Sep	Oct
Critically Dry	4,000	7,500	7,500	7,500	7,500	7,000	5,000
Dry	6,000	8,000	10,000	10,000	10,000	7,500	6,000
Below Normal	6,000	9,000	12,000	12,000	12,000	7,500	6,500
Above Normal	6,500	11,000	12,500	14,500	12,000	9,000	7,000
Wet	8,000	12,000	13,500	14,500	12,000	10,000	7,000

2) The Keswick release schedule shall include the following criteria and actions:

   a) Maintain minimum monthly average flows necessary to meet nondiscretionary delivery obligations and legal requirements.
   b) Provide for flow-related biological needs of spring life stages of all species covered by this Opinion in the Sacramento River and Delta, to the greatest extent possible.

c) If operational changes are necessary to meet Delta outflow, X2, or other legal requirements during this time, then:

- CVP/SWP Delta combined exports shall be curtailed to 2,000 cfs if necessary to meet legal requirements while maintaining a 3,250 cfs Keswick Dam release (or other planned release based on biological needs of species); and
- if it is necessary to curtail combined exports to values more restrictive than 2,000 cfs in order to meet Delta outflow, X2, or other legal requirements, then Reclamation and DWR shall, as an overall strategy, first, increase releases from Oroville or Folsom Dam; and
- in general, Reclamation shall increase releases from Keswick Dam as a last resort.
- Based on improvements in updated monthly hydrology, this restriction may be relaxed, with NMFS' concurrence.

Rationale: It is necessary to manage storage for potential dry years, to reduce adverse effects on winter-run egg incubation in summer months, and on spring-run in fall months. According to information provided by Reclamation, the hydrology is too variable this time of year to provide for a meaningful 3-month release schedule. Instead, monthly consultations between NMFS and Reclamation are needed to ensure that operations are based on biological criteria.

Action I.2.3.C Drought Exception Procedures if February Forecast, Based on 90 Percent Hydrology, Shows that 55°F 7DADM at CCR or 1.9 MAF EOS Storage is Not Achievable

Reclamation shall follow all procedures immediately above (Action I.2.3.B) and, in addition, shall:

1) By March 1, provide a contingency plan with a written justification that all actions within Reclamation's authorities and discretion are being taken to preserve cold water at Shasta Reservoir for the protection of winter-run.

2) The contingency plan shall also, at a minimum, include the following assessments and actions:

   a) Relaxation of Wilkins Slough navigation criteria to at most 3,800 cfs.
   b) An assessment of any additional technological or operational measures that may be feasible and may increase the ability to manage the cold water pool.
   c) Notification to State Water Resources Control Board that meeting the biological needs of winter-run and the needs of resident species in the Delta, delivery of water to nondiscretionary Sacramento Settlement Contractors, and Delta outflow requirements per D-1641, may be in conflict in the coming season and requesting the Board's

assistance in determining appropriate contingency measures, and exercising their authorities to put these measures in place.

3) If, during the temperature control season, temperature control on the Sacramento River cannot be maintained, then Reclamation shall bypass power at Shasta Dam if NMFS determines a bypass is necessary for preserving the cold water pool. This power by-pass may be necessary to maintain temperature controls for winter-run, or later in the temperature season, for spring-run.

Rationale: In these circumstances, there is a one-in-ten likelihood that minimal requirements for winter-run egg survival will not be achieved due to depletion of the cold water pool, resulting in temperature-related mortality of winter-run and, in addition, most likely contributing to temperature-related mortality of spring-run spawning in the fall. This is a conservative forecast, since there is a 90 percent probability that conditions will improve. However, the effects analysis in this Opinion concludes that these poor conditions could be catastrophic to the species, potentially leading to a significant reduction in the viability of winter-run. Delta objectives (salinity, X2, E/I ratio, OMR flow restrictions for both smelt and salmon) are also controlling at this time of year. There is potential for conflict between the need to maintain storage at Shasta and other legal and ecological requirements. Consequently, it is necessary to immediately limit releases from Shasta and develop a contingency plan.

Notification to the State Water Resources Control Board (SWRCB) is essential. Sacramento Settlement Contract withdrawal volumes from the Sacramento River can be quite substantial during these months. The court has recently concluded that Reclamation does not have discretion to curtail the Sacramento Settlement contractors to meet Federal ESA requirements. Therefore, NMFS is limited in developing an RPA that minimizes take to acceptable levels in these circumstances. Consequently, other actions are necessary to avoid jeopardy to the species, including fish passage at Shasta Dam in the long term.

Separate from this consultation, NMFS will work with the SWRCB to determine whether contingency plans within the Board's authority are warranted, and to assist in developing such plans that will allow Reclamation to meet ESA requirements. The incidental take statement for this Opinion also provides limitations of ESA incidental take coverage for Settlement Contractors under the terms of this Opinion.

Action I.2.4 May 15[6] Through October Keswick Release Schedule (Summer Action)

Objective: To manage the cold water storage within Shasta Reservoir and make cold water releases from Shasta Reservoir to provide suitable habitat temperatures for winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon in the Sacramento River

[6] This action will be initiated at the onset winter-run spawning, determined by CDFW aerial redd surveys and carcass surveys, and therefore, may be earlier or later than May 15.

between Keswick Dam and Bend Bridge, while retaining sufficient carryover storage to manage for next year's cohorts. To the extent feasible, manage for suitable temperatures for naturally spawning fall-run.

Action: Reclamation shall develop and implement an annual Temperature Management Plan by May 15 to manage the cold water supply within Shasta Reservoir and make cold water releases from Shasta Reservoir and Spring Creek to provide suitable temperatures for listed species, and, when feasible, fall-run.

Reclamation shall manage operations to achieve water temperatures in the Sacramento River as follows:

1) Not exceed the temperature-dependent mortality objectives identified in RPA Action I.2.1.
2) Not in excess of 55°F 7DADM at CCR[7] from the onset of winter-run spawning, based on CDFW aerial redd or carcass surveys, through 100% winter-run emergence for protection of winter-run, and not in excess of 55°F 7DADM at CCR through October 31, if applicable, for protection of mainstem spring run, whenever possible. The temperature compliance point shall be adjusted upstream or downstream to the downstream-most winter-run redd, based on CDFW data on winter-run redd location.
    a. Upon concurrence from NMFS, Reclamation may elect to implement a pilot study for up to 3 years, and operate to meet a surrogate to the temperature criterion of 55°F 7DADM at CCR. A surrogate temperature criterion may be granted annually, for up to 3 years, with the following requirements:
        i. Temperature management at the downstream-most winter-run redd, based on water year type, as follows:
            1. Critically dry: < 56°F daily average temperature
            2. Dry: < 54°F daily average temperature
            3. Below Normal: < 53°F daily average temperature
            4. Above Normal: < 53°F daily average tempearture
            5. Wet: < 53°F daily average temperature
        ii. During each of the 3 pilot study years, Reclamation shall operate to the agreed upon temperature criterion while also striving to meet 55°F 7DADM at CCR (or different temperature compliance point if modified based on the downstream most winter-run redd location).
        iii. By December 1 of each pilot study year, Reclamation shall submit to NMFS a report that includes:
            1. water temperatures from the surrogate temperature criterion and location;

[7] Alternatively, the temperature compliance point and metric could be 56°F daily average temperature at Balls Ferry, or 53°F daily average temperature at CCR. Since 7DADM is the preferred metric, a change back to daily average temperature warrants further discussion and establishing a relationship between the 2 metrics and temperature compliance points.

2. 7DADM water temperatures at CCR (or location of the downstream most winter-run redd location; and
3. an analysis of how, operationally, a 55°F 7DADM at CCR (or different temperature compliance point if modified based on the downstream most winter-run redd location) could have been met.

iv. Data and analyses from the annual reports will form the basis for whether a surrogate will be granted in the subsequent year.

3) Reclamation shall operate to a final Temperature Management Plan starting May 15 and ending October 31.

a. Reclamation and NMFS shall convene a Shasta Water Interagency Management (SWIM) Team, comprised of representatives from Reclamation, NMFS, USFWS, CDFW, and the State Water Resources Control Board, to track the implementation of the final Temperature Management Plan (including significant changes in treal-time operations). The SWIM Team will utilize information from its member agencies, as well as technical information from the SRTTG and other relevant stakeholders, to inform decisions and changes in operations.

i. The SWIM Team will consider:
1. data on winter-run redd construction and egg/alevin incubation timing, location, and distribution,
2. Shasta isothermalbaths,
3. temperature-dependent mortality modeling results,
4. actual vs. modeled Shasta cold water pool volume <49°F to ensure that actual cold water pool volume is not less than 95% of modeled for wet and above normal water year types, and not less than 99% of modeled for critical, dry, and below normal water year types.
5. projected temperature control device gate operations and configurations,
6. date of full side gate access, and adjust operations to ensure that full side gate access is no earlier than October 15, and
7. downstream diversions, flows, and Delta requirements.

ii. The SWIM Team will determine:
1. the frequency of its meetings; and
2. if existing interagency teams, for example, WOMT, would satisfy the requirements and expectations, above.

4) As part of the adaptive management process, and in coordination with NMFS, by March 2010, Reclamation shall fund an independent modeler to review these procedures and the recommendations of the Calfed Science Panel report on temperature management and recommend specific refinements to these procedures to achieve optimal temperature management, with due consideration of the Calfed Science panel's recommendations (Deas *et al*., 2009) regarding temperature management. Upon written concurrence of

NMFS, refinements to the implementation procedures for this action suite, based on the independent contractor's report, may be adopted and implemented.

a. Reclamation, in coordination with NMFS and the Sacramento River Settlement Contractors, shall develop and implement a work plan for Shasta and Trinity divisions seasonal operational water temperature modeling. The resulting water temperature modeling shall support better February forecasting and decision making, to include uncertainty estimates, joint probabilities of risk, and estimates of Shasta Reservoir stratification. Any temperature model developed through this effort shall utilize a platform so that it can be independently run.

Implementation Procedures: Reclamation shall take the following steps to develop an annual Temperature Management plan:

1) By April 15, Reclamation shall develop and submit to NMFS a draft Temperature Management Plan, to include:
   a. both 50 percent and 90 percent forecasts, including EOS storages, consistent with its draft plan of summer operations.
   b. Outputs from the temperature-dependent model run based on inputs using the temperature model runs that demonstrate that the objectives in RPA Action I.2.1 have a high likelihood of being met.
2) NMFS will provide comments within five business days to Reclamation, recommending that Reclamation either: (1) operate to one of the options; or (2) develop an alternative operations plan necessary to meet reasonably attainable preferred TCP and EOS storage.
3) Within five business days of receiving NMFS' recommendations, and based on NMFS' comments, Reclamation will develop an operations plan with specific monthly average Keswick releases to attain both TCP from May 15 through the EOS and EOS storage, and submit the plan to NMFS for concurrence.
4) By May 15, Reclamation and NMFS shall jointly submit a final Temperature Management Plan to meet the SWRCB 90-5 requirements using the SRTTG. From May 15 through October 31, the SWIM Team shall track implementation of this plan, and shall refine it based real-time information, including run timing, location of redds, air and surface water temperature modeling, and projected versus actual extent of the cold water pool.

Rationale: Depending on hydrology and air temperature, from May through October, it is necessary to use the cold water pool in Shasta Reservoir to provide cold water releases to maintain suitable water temperatures for listed anadromous fish below Shasta. Without access to the cold water pool, suitable temperatures for egg incubation are not attainable. Preparation of an annual Temperature Management Plan allows Reclamation, in consultation with NMFS, to achieve optimal cold water management in a given year. Temperature management provides for adequate egg and alevin incubation temperatures, and conserving EOS storage. The storage level at the EOS is important to manage the risk of unsuitably warm water temperatures for winter-run in the following summer. Maintaining suitable

temperatures in September and October is also important to minimize adverse effects of project operations to main stem Sacramento River spring-run. Fall-run, a non-listed species that is important as a prey base for Southern Resident Killer Whale, also benefits from suitable temperatures in the Fall.

Development of 2 to 4 options for temperature management, prior to finalizing a plan allows for meaningful discussion of appropriate risk management strategies in a given year, based on timely hydrologic and biological considerations. Important factors differ from year to year, and need to be considered in operations planning. They include timing and location of spawning and redds based on aerial surveys; the extent of the cold water pool, given air temperatures; and operation of the Temperature Control Device to provide optimal use of the cold water pool. Preparation of a draft plan also allows for iterative planning and feedback. Operations can be tailored each year to achieve the optimal approach to temperature management to maintain viable populations of anadromous fish, based on the best available information.

The Calfed Science Program peer review report on temperature management emphasized the importance of refining temperature management practices in the long term and included recommendations for doing so. The requirement to hire an independent contractor to recommend specific refinements to the procedures in this RPA responds to these recommendations.

Rationale for 2017 Amendment:

- Best available science (*e.g.*, Martin *et al*. 2016) and monitoring (*e.g.*, rotary screw trapping at Red Bluff Diversion Dam) since issuance of the 2009 CVP/SWP operations Opinion have indicated that 56°F daily average temperature is not as protective as initially thought for incubating eggs and alevin. Martin *et al*. (2016[8]) predicted that the slower flowing water in the river would not supply the oxygen needed for egg viability in elevated temperature conditions, and that field studies found that the slower flow in the river equated to about a 3ºC difference in the temperature tolerance of eggs.
- EPA (2003) recommended 55°F 7DADM for incubating Chinook salmon eggs and alevin, and Anderson *et al*. (2010, 2011) recommended temperature management where the redds are, not farther downstream.
- Daily average temperature (maintaining 56°F further downstream or 53°F at the downstream-most redd) is provided as a surrogate to 55°F 7DADM to provide operational flexibility and allow for a pilot study to be conducted.
- The SWIM Team was created in 2016 to monitor the implementation of the Sacramento River temperature management plan. The SWIM Team member agencies found the regular check-ins helpful in both accountability to the temperature management plan, and

[8] Martin, B. T., A. Pike, S. N. John, N. Hamda, J. Roberts, S. T. Lindley, and E. M. Danner. 2016. Phenomenological vs. biophysical models of thermal stress in aquatic eggs. Ecology Letters (2016).

also would provide the member agencies enough time in case operational adjustments are necessary.

Action I.2.5 Post Temperature Compliance Season Winter-Run Egg-to-Fry Survival Evaluation

Objective: To adaptively manage operations in subsequent years in order to minimize egg and fry mortality, as estimated using the temperature-dependent mortality model.

Action: Planned operations or other non-operational actions in subsequent years shall be adjusted in order to improve egg-to-fry survival, if necessary. Based on the 1996-2015 average egg-to-fry survival of 23.6% (27% prior to the drought), Reclamation shall achieve the following egg-to-fry survival metrics:

- Critically dry years: >15%
- Dry years: >20%
- Below Normal years: >25%
- Above Normal years: >25%
- Wet years: >25%

Rationale: Each year, the egg-to-fry survival to the Red Bluff Diversion Dam is calculated after the temperature management season. It is, in effect, how well Reclamation did in operations to protect the early life stages of winter-run Chinook salmon. Annual hindcasts and associated reports are critical in understanding the effects of various operations of Shasta and Keswick dams and reservoirs.

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Action I.4. Wilkins Slough Operations

Objective: Enhance the ability to manage temperatures for anadromous fish below Shasta Dam by operating Wilkins Slough in the manner that best conserves the dam's cold water pool for summer releases.

Action: Reclamation shall convene the SRTTG to review past operational data, hydrology, and fisheries needs, and recommend Wilkins Slough minimum flows for anadromous fish in critically dry years in lieu of the current 5,000 cfs navigation criterion.

In years other than critically dry years**,** the need for a variance from the 5,000 cfs navigation criterion will be considered during the process of developing the Keswick release schedules (Action I.2.2-4).

Without SRTTG recommendations on Wilkins Slough minimum flows, Reclamation shall operate to Wilkins Slough flows less than 5,000 cfs, depending on Shasta storage, water year type, Delta requirements, and consultation with the fish agencies.

Rationale: In some circumstances, maintaining the Wilkins Slough navigation channel at 5,000 cfs may be a significant draw on Shasta reservoir levels and affect the summer cold water pool necessary to maintain suitable temperatures for winter-run egg incubation and emergence. Reclamation has stated that it is no longer necessary to maintain 5,000 cfs for navigation (CVP/SWP operations BA, page 2-39). Operating to a minimal flow level based on fish needs, rather than on outdated navigational requirements, will enhance the ability to use cold-water releases to maintain cooler summer temperatures in the Sacramento River.

Rationale for 2017 amendment: The deadline for the development of Wilkins Slough minimum flows was December 1, 2009, and NMFS is not aware of any current effort by Reclamation to develop those minimum flows. Water year 2014 was a critically dry water year type, and minimum flows at Wilkins Slough were reduced to 3,800 cfs. Although this flow level is not preferable, it was feasible, and the reduced flow was necessary to extend the limited cold water pool. Reduced flows at Wilkins Slough will be made in lieu of Reclamation meeting the original RPA action.