Master Response 2.2
Adaptive Implementation

Overview

The Porter-Cologne Water Quality Control Act states that a water quality control plan consists of a designation or establishment of beneficial uses to be protected, water quality objectives, and program of implementation needed for achieving water quality objectives (Wat. Code § 13050(j)) (Appendix K, *Revised Water Quality Control Plan*). The plan amendments revise the water quality objectives for Lower San Joaquin River (LSJR) flows to reasonably protect fish and wildlife beneficial uses.

The revised LSJR flow objectives are both narrative and numeric. The numeric portion requires that 40 percent of the unimpaired flow is maintained February through June in the Stanislaus, Tuolumne, and Merced Rivers within a range of 30 to 50 percent of the unimpaired flow. The numeric February—June LSJR flow objectives work together with the narrative objectives. The numeric objective provides flows that more closely mimic natural hydrograph conditions, but flows can also be adjusted, shaped, or shifted if information supports that shaping the flows better achieves the narrative goal of supporting San Joaquin River (SJR) Watershed fish populations migrating through the Delta.

As described in the *Adaptive Implementation* section of the *Executive Summary*:

> The unimpaired flow objective is not intended to be implemented in a way that requires rigid adherence with a fixed percent of unimpaired flow. It is intended to determine a quantity of water that can be "shaped" or shifted in time to provide more functionally useful flows. Functionally useful flows are designed to achieve a specific function, such as increased habitat, more optimal temperatures, or a migration cue. The unimpaired flow requirement is also not intended to remain at one fixed percent, but rather to be adaptively implemented within a range of unimpaired flow in response to changing information and changing conditions.

Adaptive implementation is a feature of the LSJR program of implementation that allows for adjustment of the required percentage of unimpaired flow in specified ways to improve the functions of those flows and better achieve the water quality objective. The Stanislaus, Tuolumne and Merced Working Group (STM Working Group) will advise the California State Water Resources Control Board (State Water Board) and the State Water Board's Executive Director on matters pertaining to the implementation of the LSJR flow objectives, including adaptive implementation. The composition of the STM Working Group is anticipated to include State Water Board staff, water managers on the Stanislaus, Tuolumne, and Merced Rivers, state and federal fishery agency staff, and others. The role of the STM Working Group is described in more detail in this master response.

Adaptive adjustments can be approved: 1) by the State Water Board on an annual or long-term basis; or 2) by the State Water Board Executive Director. The State Water Board can approve changes to use any of the four adaptive methods on an annual or long-term basis, but the Executive Director's authority to approve an adaptive adjustment is limited to changes on an annual basis and requires either a recommendation or concurrence from the members of the STM Working Group. Whether a recommendation or concurrence is necessary depends on the requirement detailed in the

program of implementation for that adaptive adjustment (*Implementation of February through June LSJR Flow Objectives* section of Appendix K).

Adaptive implementation can be used to optimize flows to achieve the objectives while serving other beneficial uses, such as agricultural, municipal, and recreational uses, provided that serving other uses does not reduce intended benefits to fish and wildlife, and that specified requirements are met. As described in the *Executive Summary*, the adaptive implementation element of the flow proposal is intended to accomplish the following goals.

- Respond to changing information and changing conditions, including changes in flow patterns from climate change.
- Minimize adverse water temperature effects.
- Support scientific experiments that assess the benefits of different flow regimes.

The absolute requirements of the proposed LSJR flow objectives and program of implementation are as follows.

- Maintain flows in the LSJR equal to the quantity of water (or budget) represented by 40 percent unimpaired flow in an adaptive range of 30 to 50 percent on a 7-day running average.
- Attain the narrative objective to "support and maintain the natural production of viable native San Joaquin River watershed fish populations migrating through the Delta."
- Meet any existing biological goals approved by the State Water Board.

The adaptive implementation methods of the flow proposal do not discard the concept of mimicking the hydrograph. Rather, they enhance it—the narrative and numeric LSJR flow objectives and program of implementation work together to achieve the goal of reasonably protecting fish and wildlife beneficial uses in the LSJR. Water quality objectives for fish and wildlife beneficial uses are found in Table 3 of Appendix K. The narrative LSJR flow objective states:

> Maintain inflow conditions from the San Joaquin River watershed to the Delta at Vernalis sufficient to support and maintain the natural production of viable native San Joaquin River watershed fish populations migrating through the Delta. Inflow conditions that reasonably contribute toward maintaining viable native migratory San Joaquin River fish populations include, but may not be limited to, flows that more closely mimic the natural hydrographic conditions to which native fish species are adapted, including the relative magnitude, duration, timing, and spatial extent of flows as they would naturally occur.

In this way, the LSJR flow objective adaptive implementation framework is simple and flexible. Some commenters characterized this simple framework as a flaw that should be fixed. Commenters suggested that the adaptive implementation framework needs more structure and additional rules. The flexible, yet specific, nature of the adaptive implementation framework, however, is intended to provide maximum operational and implementation flexibility while still achieving program goals of reasonable fish and wildlife protection.

The State Water Board reviewed all comments related to adaptive implementation. This master responds to many comments, questions, and criticisms that were received on adaptive implementation. While the adaptive implementation framework remains unchanged, this master response highlights revisions made in response to comments to clarify the adaptive nature of the program of implementation. This master response also provides illustrative examples of how the

unimpaired flow percentage can be treated as a volume of water that can be shaped and shifted, under the adaptive implementation methods to better achieve program goals.

This master response describes two key elements of adaptive implementation.

- How adaptive implementation can be used to maximize the habitat, temperature, and other benefits achieved through the narrative and numeric objectives.
- Constraints and rules governing how adaptive implementation can be used.

In addition, this master response addresses the following topics and questions raised by commenters.

- The four adaptive implementation methods
    - How the four methods can shape flows.
    - How each method can be used to better achieve the fish and wildlife objectives.
    - How adaptive implementation and adaptive management differ and how the adaptive implementation framework can support successful adaptive management.
- The role of the STM Working Group in adaptive implementation
    - The STM Working Group structure and governance.
    - Criteria available for the STM Working Group to shape flows.
- Adaptive implementation process
    - Examples of how adaptive implementation would work.
    - Reporting requirements and examples.
- Adaptive implementation information needs
    - Information needed for successful adaptive implementation.
    - Adaptive implementation can work with currently available information; additional information can improve adaptive implementation.
- Biological needs for adaptive implementation
    - Description of how biological metrics can be used.
    - Adaptive implementation will work even if it takes a long time to see a change in biological metrics because other things like temperature and habitat can be measured.
- Monitoring and assessment

This master response includes for ease of reference a table of contents on the following page to help guide readers to specific subject areas and find where the topics of their concern are addressed.

Please see Master Response 1.2, *Water Quality Control Planning Process*, for a discussion of the State Water Board's legal authority to implement the plan amendments. For additional information regarding governance and the role of the STM Working Group see Master Response 2.1, *Amendments to the Water Quality Control Program*. For additional information regarding the importance of June flows to adaptive implementation, please see Master Response 3.1, *Fish Protection*, and Master Response 3.2, *Surface Water Analyses and Modeling*. For information on the State Water Board

potentially requiring non-flow measures when it allocates responsibility for meeting the LSJR flow objectives, please see Master Response 5.2, *Incorporation of Non-Flow Measures*.

Table of Contents

Adaptive Implementation Description

Adaptive implementation is an integral part of achieving the LSJR flow objectives (Appendix K, *Revised Water Quality Control Plan*, Table 3). The program of implementation describes how the LSJR flow requirement can best achieve program goals using adaptive implementation. Adaptive implementation establishes the bounds and rules by which a limited quantity of water can be managed to maximize fish and wildlife protection benefits. The scientific basis for the LSJR flow objectives is detailed in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives* and Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow between February 1 and June 30*. These analyses demonstrate that the proposed flows will result in reasonable protection of fish and wildlife through cooler water temperatures and other habitat improvements.

The range of required flows established in the water quality objective provides reasonable protection of fish and wildlife beneficial uses under a range of conditions. The range of conditions includes the following elements.

- Hydrologic variability, both year to year and within years, which can include sudden shifts from wet to dry conditions (or the inverse) and is amplified by climate change.
- Habitat changes, such as improvements from complementary non-flow measures that, together with flow, achieve fish and wildlife protection goals.

In addition, the range of flows may provide flexibility, such as using proportionally more flow in dry years and less in wet years (e.g., higher percent unimpaired flow in dry years and lower percent unimpaired flow in wet years). This will help maximize the efficient use of water for both fish and wildlife improvements and water supply reliability. Adaptive implementation also provides flexibility to ensure that the block of water represented by the percent of unimpaired flow can be used to maximize year-round fish and wildlife benefits.

As stated in the *Implementation of February through June LSJR Flow Objectives* section of Appendix K, the adaptive implementation framework comprises the following four methods.

- **Variable quantity:** the total quantity of water set aside for fish and wildlife protection can vary between 30 and 50 percent.
- **Flow shaping:** the total quantity of water required February through June can be shaped during the February—June period.
- **Flow shifting:** a portion of the total quantity of water required from February through June can be shifted to other times of year.
- **Minimum flows:** the minimum flows when the quantity of water defined by the 30 to 50 percent range is extremely low.

The LSJR flow objectives and program of implementation criteria for adaptive adjustments require that the adjustment meet two criteria.

- Sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta (the narrative objective).
- Meet any existing biological goals approved by the State Water Board.

The program of implementation also allows adaptive adjustments for experiments that will improve scientific understanding of needed measures for the protection of fish and wildlife beneficial uses, such as the optimal timing of required flows.

Per the numeric LSJR flow objective and program of implementation, the starting point for the February—June adaptive range is 40 percent of unimpaired flow, based on a minimum 7-day running average, from each of the Stanislaus, Tuolumne, and Merced Rivers. In addition, a minimum flow must be maintained at Vernalis at all times. The minimum flow is not a "ceiling" on the unimpaired flow but is instead a "floor." If, under the required percent of unimpaired flow, the volume of water in the SJR as measured at Vernalis drops below 1,000 cubic feet per second (cfs), then the three tributaries must provide sufficient flows to maintain 1,000 cfs. The 1,000 cfs base flow at Vernalis can be adaptively implemented between 800 and 1,200 cfs.

Four Methods of Adaptive Implementation

Variable Quantity

The variable quantity method of adaptive implementation *Adaptive Methods for February through June Flows* section of Appendix K, *Revised Water Control Plan*) can be changed by the State Water Board on an annual or long-term basis or by the Executive Director on an annual basis as follows.

(a) The required percent of unimpaired flow may be adjusted to any value between 30 percent and 50 percent, inclusive. The Executive Director may approve changes within this range on an annual basis if all members of the Stanislaus, Tuolumne, and Merced Working Group (STM), described below, agree to the changes.

The variable quantity method of adaptive implementation can be used to adjust the total quantity of water set aside for fish and wildlife protection to a specific value between 30 and 50 percent. This allows the percent of unimpaired flow to be increased if it is determined that an increase will be necessary to meet the narrative objective and any existing biological goals approved by the State Water Board. Alternately, it allows the percent of unimpaired flow to be decreased if the parties responsible for bypassing flow can demonstrate that a combination of flow and alternate measures would meet the narrative objective and any existing biological goals approved by the State Water Board. For example, floodplain habitat provides a positive effect on growth of juvenile Central Valley salmonids. When properly timed, there is a significant relationship between juvenile survival and floodplain acre-days (Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow between February 1 and June 30*). Increasing juvenile survivability can increase population abundance, a criterion for the biological goals (*Adaptive Methods for February through June Flows* section of Appendix K). If physical improvements to the connectivity between the river and the floodplain increase the appropriate type of floodplain habitat, such improvements might support an adaptive adjustment to the required 40 percent of unimpaired flow. If the required percent of unimpaired flow is adaptively adjusted based on the inclusion of non-flow measures, the combined relative benefit of the non-flow measure(s) and the percent of unimpaired flow should support the natural production of viable native SJR Watershed fish populations migrating through the Delta at a level comparable to that achieved with 40 percent unimpaired flow. The expected benefits must be demonstrated through monitoring and review in the program of implementation or other best available scientific information.

In the previous example, the proposed level of unimpaired flow and the complementary non-flow action would need to be evaluated in the context of the annual plans for adaptive implementation

actions (annual operations plans) on the tributary to determine if the collective actions are sufficient to meet the narrative objective. Annual operations plans are discussed under *Adaptive Implementation Products, Plans, and Processes*.

There may be disagreements on the rationale for changes in the percent of unimpaired flow required within the adaptive range. The proposed adaptive implementation process requires that the State Water Board, which acts in public meetings, approve multi-year changes to the overall unimpaired flow percent (e.g., a change from 40 to 35 percent). Annual changes to the overall unimpaired flow percent must be approved by the State Water Board unless there is full agreement by the STM Working Group, in which case the State Water Board Executive Director may approve the change.

Flow Shaping

The flow-shaping method of adaptive implementation (*Adaptive Methods for February through June Flows* section of Appendix K, *Revised Water Control Plan*) can be changed by the State Water Board on an annual or long-term basis or the Executive Director on an annual basis as follows.

> (b) The required percent of unimpaired flow for February through June may be managed as a total volume of water and released on an adaptive schedule during that period where scientific information indicates a flow pattern different from that which would occur by tracking the unimpaired flow percentage would better protect fish and wildlife beneficial uses. The total volume of water must be at least equal to the volume of water that would be released by tracking the unimpaired flow percentage from February through June. The Executive Director may approve such changes on an annual basis if the change is recommended by one or more members of the STM.

The flow-shaping method of adaptive implementation allows entities responsible for complying with the flow requirement to manage the total volume of February—June unimpaired flows as a water budget that can be shaped to better maximize achievement of the LSJR flow objectives. Maintaining a specified percent of unimpaired flow, such as 40 percent, improves conditions in the Stanislaus, Tuolumne, and Merced Rivers by better reflecting the magnitude, frequency, duration, timing, and rate of change of flows that are important to protect fish and wildlife. However, shaping these flows from February through June to provide more optimal flow patterns can potentially increase benefits to fish and wildlife.

The flow-shaping method does not require a specific flow-shaping pattern. The method provides flexibility to allow flow shaping where proposed changes would meet the following criteria, in addition to the two criteria that must be met for approval of adaptive adjustments.

- The proposed shape would achieve better protection of fish and wildlife than would be achieved by strict adherence to the minimum 7-day running average of the percent of unimpaired flow.
- The volume of water that would be released from February through June with the proposed shape would be at least equal to the volume of water that would be released by tracking the unimpaired flow percentage from February through June.

The use of flow shaping would be subject to the applicable requirements of state law. The State Water Board or Executive Director may approve flow shaping consistent with the criteria in the program of implementation. Incidental increases in unimpaired flows above 40 percent would not create flow-shaping "credits." For example, a reservoir operator's flood control releases would not reduce the required percent of unimpaired flows later that month or in another month unless such

releases were approved by either the Executive Director or the State Water Board as part of an adaptive implementation action for the protection of fish and wildlife. Absent any such approval, the unimpaired flow percent must be provided on a 7-day running average.

Flow Shifting

The flow-shifting method of adaptive implementation (*Adaptive Methods for February through June Flows* section of Appendix K, *Revised Water Control Plan*) can be changed by the State Water Board on an annual or long-term basis or by the Executive Director on an annual basis as follows.

> (c) The release of a portion of the February through June unimpaired flow may be delayed until after June to prevent adverse effects to fisheries, including temperature, that would otherwise result from implementation of the February through June flow requirements. The ability to delay release of flow until after June is only allowed when the unimpaired flow requirement is greater than 30 percent. If the requirement is greater than 30 percent but less than 40 percent under (a) above, the amount of flow that may be released after June is limited to the portion of the unimpaired flow requirement over 30 percent. (For example, if the flow requirement is 35 percent, 5 percent may be released after June.) If the requirement is 40 percent or greater under (a) above, then 25 percent of the total volume of the flow requirement may be released after June. (For example, if the requirement is 50 percent, at least 37.5 percent unimpaired flow must be released in February through June and up to 12.5 percent unimpaired flow may be released after June.) The Executive Director may approve changes on an annual basis if the change is recommended by one or more members of the STM.

The flow-shifting method of adaptive implementation allows shifting some of the water represented by 40 percent of unimpaired flow to other times of year, outside of the February—June period. Flow shifting may be beneficial when assessment of real-time water availability and fish conditions shows that the benefit of achieving temperature or other goals outside of the February—June period exceeds the benefit of using the flows entirely during the February—June period.

Like all methods of the adaptive implementation framework, flow shifting may only be approved if information produced during the monitoring and review process in the program of implementation or other best available information indicates the action will help meet the narrative objective and any biological goals approved by the State Water Board as part of the program of implementation.

There are limits on how much of the block of water represented by February—June flows can be shifted because, at the lower end of the 30 to 50 percent range, the full quantity of water may be needed to reasonably protect the use. No flow shifting would be allowed at 30 percent of unimpaired flow. Only water in excess of 30 percent may be shifted to other times of year.

Rigid adherence with a specified percent of unimpaired flow, such as 40 percent, achieves the goal of better reflecting the magnitude, frequency, duration, timing, and rate of change of flows that are important to protect fish and wildlife. Shifting some of these flows to times other than from February through June, however, can provide more optimal flow patterns and increase benefits to fish and wildlife. Although no specific flow shifting is required, some shifting will be needed to avoid significant adverse temperature impacts on fish in the summer and fall, especially at unimpaired flows at the high end of the 30 to 50 percent range. The amount of shifting would depend on the quantity of water stored in reservoirs and the hydrology of each specific year (wet or dry).

The substitute environmental document (SED) models a wide range of flow conditions with some flow shifting to maintain temperature conditions observed under baseline. Any flow shifting conducted under the constraints of the allowed adaptive implementation would fall within the range

of unimpaired flows modeled in the SED and would achieve the narrative fish and wildlife protection goals.

The flow flow-shifting method of adaptive implementation recognizes that there can be no perfect foresight about specific future needs, and tightly constrained requirements could lead to undesirable outcomes. That is why flow shifting would not require that flows shifted after the February—June period be used if conditions do not warrant use of the flows. This prevents the release of water at times of the year when there may be little or no benefit.

Taken together, the flow-shaping and flow-shifting methods of adaptive implementation provide the framework for increasing flow functions. It would be impossible to anticipate every possible combination of flow patterns from February through June combined with all possible amounts and times of flow shifting that would optimize protection of fish and wildlife in all years. Rather than requiring specific flow patterns and timing, the program of implementation achieves this goal by allowing flows to be shaped and shifted, using the block of water represented by 40 percent of unimpaired flow. The SED analyzes the effects of 20 to 60 percent of unimpaired flow and baseline conditions, which in many years represents flows far lower than 20 percent of unimpaired flow. This wide range of flows reflects the wide range of flows that would occur under the 30 to 50 percent of unimpaired flow proposal (LSJR Alternative 3). In all cases, however, using all methods of adaptive implementation, flow conditions would be higher than under baseline.

Some commenters asserted that mimicking the natural hydrograph through a percent of unimpaired is inconsistent with adaptive implementation methods. The flow shaping and flow shifting allowed under the program of implementation would not eliminate the benefits obtained by mimicking the natural hydrograph. Rather, flow shaping and shifting would enhance many aspects of the natural hydrograph that are most functionally useful. The numeric February—June flow objective of 40 percent unimpaired flows in an adaptive range of 30 to 50 percent of unimpaired flows works together with the narrative objective. Because only a portion of the total unimpaired flow would be available for fish and wildlife, flow shaping allows short duration and higher-magnitude flows to achieve improved biological responses using a limited quantity of water. Under current conditions, flows in most years are relatively flat, with no high flows during the February—June period. Even if flows under the flow proposal are shifted so that flows do not fully track the pattern of unimpaired February—June flows, the general pattern of higher February—June flows would still "more closely mimic the natural hydrographic conditions to which native fish species are adapted." The program of implementation only allows shifting of flows higher than 30 percent of unimpaired flow, so flows would, in most cases, be higher than the current condition.

Minimum Base Flow

The numeric portion of the LSJR flow objectives for the reasonable protection of fish and wildlife beneficial uses requires a minimum base flow of 1,000 cfs. If implementation of the unimpaired flow percentage results in flows at Vernalis of less than 1,000 cfs, then the three tributaries must provide additional outflow to meet the base flow requirement.

The minimum base flow method of the adaptive implementation element (*Adaptive Methods for February through June Flows* section of Appendix K, *Revised Water Control Plan*), like the other three methods of adaptive implementation, can be changed by the State Water Board on an annual or long-term basis or by the Executive Director on an annual basis as follows.

(d) The required base flow for February through June may be adjusted to any value between 800 and 1,200 cfs, inclusive. The Executive Director may approve changes within this range on an annual basis if all members of the STM Working Group agree to the changes.

The base flow requirement is apportioned between the three tributaries as follows.

When the percentage of unimpaired flow requirement is insufficient to meet the minimum base flow requirement, the Stanislaus River shall provide 29 percent, the Tuolumne River 47 percent and the Merced River 24 percent of the additional total outflow needed to achieve and maintain the required base flow at Vernalis.

This base flow provides a minimum flow to protect fish and wildlife, for example in critically dry years, when the unimpaired flow percentage would otherwise result in flows too low to protect fish and wildlife.

Other Features of Adaptive Implementation

According to the program of implementation, all of the adjustments described previously may be made independently or combined.

Any of the adjustments in (a)-(d) above may be made independently of each other or combined. The adjustments in (a), (b), and (c) may also be made independently on each of the Stanislaus, Tuolumne, and Merced Rivers, so long as the flows are coordinated to achieve beneficial results in the LSJR related to the protection of fish and wildlife beneficial uses.

The program of implementation allows both annual and long-term adaptive implementation changes, which can encompass multiple years. To clarify that a multi-year plan may be submitted for consideration by the State Water Board or Executive Director at any time, the following language was added to the program of implementation, under the section *titled "Annual Adaptive Operations Plan*":

A multi-year adaptive implementation plan may also be submitted at any time.

Difference between Adaptive Implementation and Adaptive Management

Some commenters had difficulty distinguishing between the terms *adaptive implementation* and *adaptive management* or used them interchangeably. Adaptive implementation, as referenced in the SED, refers to the four adaptive implementation methods set out in the program of implementation. These four methods, as defined previously, are actions that can be taken annually or in multiple years to set, shape, and shift unimpaired flows if specified criteria are met. Adaptive management, as used in the SED, refers to the use of a framework and flexible decision-making process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvements in water management planning and implementation of a project to achieve specified objectives (Wat. Code § 85052).

Adaptive management can be explained as a phased process of *plan, do,* and *evaluate and respond.* These phases require multiple steps such as defining a problem, establishing goals and objectives, modeling the problem, designing and implementing an action, monitoring that action, analyzing and evaluating that action, and using what was learned to continuously improve the understanding of the problem and the goals, objectives, and response to that problem (DSC 2013). Adaptive management requires a clearly defined problem statement and clear goals and objectives to address

the problem, including performance measures. Adaptive management is not "trial and error" or figuring it out later but is instead a systematic process to learn while doing (NAS 2004).

The goal of the LSJR flow objectives is the reasonable protection of fish and wildlife beneficial uses. They are expressed as both a numeric unimpaired flow objective and a narrative that calls for flows sufficient to support and maintain the natural production of the viable native LSJR fish populations migrating through the Delta. The program of implementation calls for the development of biological goals to inform the adaptive methods. The adaptive implementation actions allowed under the program of implementation can be part of the *plan* and *do* phases in the adaptive management process. These actions will then be monitored and evaluated with respect to the objectives and any biological goals that are developed. That analysis will improve understanding of the system. The response will help tailor future adaptive implementation actions to meet the goals and objectives. In this way, adaptive implementation can be a tool in the development, use, and success of adaptive management. As stated in the *Adaptive Implementation* section of the *Executive Summary*:

> The unimpaired flow objective is not intended to be implemented in a way that requires rigid adherence with a fixed percent of unimpaired flow. It is intended to determine a quantity of water that can be "shaped" or shifted in time to provide more functionally useful flows. Functionally useful flows are designed to achieve a specific function, such as increased habitat, more optimal temperatures, or a migration cue.

Scientific reviews will inform the adaptive implementation framework. As stated in the program of implementation:

> Adjustments to the February through June unimpaired flow requirements allowed by the LSJR flow objectives should be implemented in a coordinated and adaptive manner, taking into account current information. Specifically, FERC licensing proceedings on the Merced and Tuolumne Rivers, other scientific review processes initiated to develop potential management strategies on a tributary basis, and the establishment of the San Joaquin River Monitoring and Evaluation Program (SJRMEP) described below are expected to yield additional scientific information that will inform future management of flows for the protection of fish and wildlife beneficial uses.

While adaptive implementation and its associated regulatory framework allow for some flexibility and experimentation, adaptive implementation is not unbounded. The percentage of unimpaired flows must remain within the adaptive flow range of 30 to 50 percent, February through June, and the other methods of adaptive implementation described previously.

Multiple commenters asserted that adaptive implementation implies that the program of implementation lacks clear goals and does not specify methods or models to be used to evaluate success. As stated in the *Executive Summary*:

> Adaptive implementation allows the frequency, timing, magnitude, and duration of flows to shift in order to enhance the biological benefits. The LSJR alternatives entail a virtually unlimited number of possible functional flow regimes, limited only by the upper and lower bounds of the analyzed range of flows.

As set forth in the program of implementation (Appendix K, *Revised Water Quality Control Plan*), the State Water Board will seek recommendations from the STM Working Group on biological goals and procedures for implementing the objectives adaptively. The STM Working Group is charged with developing adaptive processes that will work within the bounds of the adaptive implementation framework and the upper and lower bounds of the adaptive range. The STM Working Group can use available information and identify other tools and information needed to improve adaptive

implementation over time. In this way, the STM Working Group plays an important role in adaptive implementation.

STM Working Group Structure and Governance

As described in the program of implementation for LSJR flow objectives (Appendix K, *Revised Water Quality Control Plan*), the STM Working Group will consist of entities with expertise in LSJR, Stanislaus, Tuolumne, and Merced Rivers fisheries management, hydrology, operations, and monitoring and assessment needs. These entities will include the California Department of Fish and Wildlife (DFW), National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and water users on the Stanislaus, Tuolumne, and Merced Rivers. The STM Working Group will also include State Water Board staff and may include any other persons or entities the Executive Director determines to have appropriate expertise. To afford maximum flexibility to the STM Working Group, the program of implementation does not define and require adherence to a specific governance structure.

Some commenters expressed concern with achieving consensus among STM members to make adaptive changes, including recommended annual changes under adaptive implementation methods (a) variable quantity and (d) minimum base flow. Consensus, however, is not required for decision-making, although it may facilitate decisions under methods (a) variable quantity and (d) minimum base flow. The program of implementation provides two avenues for decision-making. First, it allows decisions for annual changes to be made nimbly by the Executive Director with STM Working Group recommendation, or consensus, depending upon the adaptive implementation method. Second, it allows decisions to be made through a State Water Board process when there is no consensus or when multi-year changes are proposed. This structure allows the STM Working Group to help shape important, short-duration changes when needed to achieve program goals. However, this construct also provides a balance between more nimble decision-making and adequate rigor by ensuring that longer-term changes cannot occur without State Water Board oversight. For example, according to the variable quantity method of adaptive implementation, the Executive Director may approve changes within the range on an annual basis if all members of the STM Working Group agree. If there is no agreement, the State Water Board may address the matter and make a determination. Multi-year changes do not require agreement of all STM Working Group members; however, all multi-year changes require State Water Board approval.

Several commenters expressed concern as to the level of information needed to inform changes in flows. The program of implementation is designed to allow changes based on available information produced through monitoring and review processes or other best available scientific information. Furthermore, fish and wildlife will be reasonably protected even if there is little change from rigid adherence from the 40 percent flow requirement. Benefits in temperature and habitat will occur even with little adaptive implementation of flows, as shown in Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow between February 1 and June 30*. As stated in the *Executive Summary*, these temperature "*improvements are low estimates of the temperature improvements that can be achieved with increased flow because flow patterns were not optimized to achieve temperature benefits. Adaptive implementation of the blocks of water represented by the various percents of unimpaired flow can result in even larger benefits*." While the adaptive changes are not required, available science shows that some flow shifting or shaping is expected to provide even greater benefits. The additional benefits are demonstrated in Chapter 19, where it can be seen that

achieving unimpaired flows of more than 50 percent, through flow shaping at critical periods, would result in greater temperature and habitat improvements than rigid adherence with 40 percent unimpaired flow.

Several commenters expressed concern regarding the level of effort needed to have an effective STM Working Group. Ideally, the STM Working Group would have broad participation from water agencies, fisheries agencies and other entities. However, even if participation is limited to State Water Board staff, the STM Working Group will be able to develop and implement adaptive measures. Sufficient information is already in place, and enough is known about functional flow needs to shape and shift flows on a year-to-year basis. Adaptive implementation will, however, benefit from participation by a wide range of stakeholders with relevant expertise. As stated in Appendix K:

> The State Water Board will seek participation in the STM Working Group by the following entities who have expertise in LSJR, Stanislaus, Tuolumne, and Merced Rivers fisheries management, hydrology, operations, and monitoring and assessment needs: the DFW; NMFS; USFWS; and water users on the Stanislaus, Tuolumne, and Merced Rivers. The STM Working Group will also include State Water Board staff and may include any other persons or entities the Executive Director determines to have appropriate expertise.

As discussed in the section *Adaptive Implementation Information Needs*, available information can inform adaptive implementation while additional information is developed. It is likely that establishing biological goals and other adaptive implementation information will require a dedicated effort as well as ongoing work to monitor and adaptively implement flow. Nonetheless, the State Water Board is committed to advancing this effort and will seek to do so in partnership with a robust STM Working Group.

It is likely that stakeholders will continue to debate the correct percent of unimpaired flow. In the absence of STM Working Group consensus, a single member of the STM Working Group, including the State Water Board staff representative, may recommend use of any adaptive implementation method. If approved, the recommendation can then be implemented under the adaptive implementation framework of the program of implementation.

Several commenters expressed concern regarding the overall composition of the STM Working Group. As noted, the STM Working Group is flexible enough to allow constructive participation from a wide variety of interests. In addition, the State Water Board can provide direction to the Executive Director at any time, before or after adoption of the Plan, regarding the composition of the STM Working Group. The program of implementation provides the Executive Director with broad discretion to include any persons that have appropriate expertise.

Adaptive Implementation Products, Plans, and Process

The plan amendments establish the LSJR flow objectives, 40 percent of unimpaired flow, within a range of 30 to 50 percent. Multiple commenters expressed concern with the lack of a detailed description of the adaptive implementation component of the proposal.

Although the entire adaptive implementation framework is set forth in Appendix K, *Revised Water Quality Control Plan*, this section provides a more detailed description of how the process will work by briefly describing the products and plans required under the program of implementation. This is followed by a description of adaptive implementation information needs and specific examples of

how implementation planning and implementation could proceed, both with and without use of the allowed flexibility. These are examples of how the process could work but not how it must work because of the flexibility afforded in the program of implementation.

Table 2.2-1 shows each adaptive implementation method and its purpose, identifies the responsible parties, and notes the due date for each. These products and plans are listed roughly in the order in which the information will be needed to help ensure implementation of the LSJR flow objectives and adaptively manage flows. Appendix K, states:

> The State Water Board will require annual and comprehensive monitoring, evaluation, and reporting through water rights and water quality actions. Pursuant to its authorities, including Water Code section 13165, comprehensive monitoring will be required to address both the individual and cumulative impacts of diversions and discharges to fish and wildlife beneficial uses.

The specific entities responsible for monitoring and reporting requirements will be established when the State Water Board determines the responsibility for achieving the LSJR flow objectives. STM membership will consist of persons or entities the State Water Board Executive Director determines have appropriate expertise but, at a minimum, will consist of State Water Board staff.

Table 2.2-1. Implementation Deliverables and Due Dates

Product or Plan	Purpose	Responsibility	Due Date
Biological Goals	Will inform the adaptive methods and the evaluation of the effectiveness of the program of implementation, the San Joaquin River Monitoring and Evaluation Program, and future changes to the Bay-Delta Plan.	State Water Board will seek recommendations from the STM Working Group, State Water Board staff, and other interested persons in consultation with Delta Science Program	180 days from the date of the Office of Administrative Law's approval
Unimpaired Flow Compliance Measures	Will identify needed information and specific measures to achieve the flow objectives and to monitor and evaluate compliance. Will identify calculation of unimpaired flow for adaptive implementation, and will identify where and how flows are measured to evaluate compliance. This information will be used in annual and multi-year operations plans.	The STM Working Group or State Water Board staff as necessary, in consultation with the Delta Science Program	180 days from the date of the Office of Administrative Law's approval
Procedures for Implementation of Adaptive Methods	Will allow adaptive adjustments to be made to the February—June flows.	The STM Working Group or State Water Board staff as necessary, in consultation with the Delta Science Program	One year from the date of the Office of Administrative Law's approval
Annual Adaptive Operations Plan	Will provide for a reasonable range of hydrological conditions because the actual hydrology will not be known; will identify how unimpaired flows are calculated and how any adjustments will be made	STM Working Group, subsets, or members, as appropriate	January 10 of each year

Product or Plan	Purpose	Responsibility	Due Date
	as updated information becomes available.		
Multi-Year Operations Plan	Will provide information as described for the annual plan	STM Working Group	Any time
Annual Reporting	Will inform the next year's operations and other activities; describe implementation of flows; identify any deviations from the plan; and report on monitoring, special studies, and other measures to protect fish and wildlife.	To be determined when the State Water Board determines responsibility for achieving the LSJR flow objectives	December 31 of each year
Comprehensive Reporting	Will review progress toward meeting biological goals and identify any recommended changes to the implementation of the LSJR flow objectives. This report and recommendations must be peer-reviewed by an appropriate independent science panel, which will make its own conclusions and recommendations.	To be determined when the State Water Board determines responsibility for achieving the LSJR flow objectives	Every 3 to 5 years

The timeline for developing biological goals and unimpaired flow compliance measures is 180 days because both pieces of information will help to guide adaptive implementation. The short timeline is ambitious. It is likely that these the initial goals and compliance measures will need to be refined over time. These two items set the stage for developing procedures for implementation of adaptive methods within 1 year. These methods identify issues such as managing uncertainty in unimpaired flow calculations by reconciling accounting when more information becomes available. The methods can also include examples of what annual and multi-year plans must look like to be successful. Simple examples of operations plans are provided below. These procedures for implementation of adaptive methods will be used to guide the preparation of the annual and multi-year operations plans.

The biological goals, unimpaired flow compliance measures, and procedures for implementation of adaptive methods must be prepared in consultation with the Delta Science Program. This will ensure that sound science is used to guide the preparation of annual and multi-year operations plans.

Non-Flow Measures

The program of implementation for the flow proposal recommends non-flow actions to assist in further improving habitat conditions that benefit fish and wildlife beneficial uses or to improve related science and management within the SJR Watershed. As explained in the *Executive Summary*:

> While flow remains a key factor, the State Water Board also recognizes that a number of other factors, such as nonnative species, predation, high water temperatures, barriers to fish passage and habitat loss contribute to the degradation of fish and wildlife beneficial uses in the LSJR. Direct

> actions to address these other stressors would complement LSJR flows to protect fish and wildlife. The State Water Board, therefore, recommends certain actions in the program of implementation.

Appendix K, *Revised Water Quality Control Plan,* includes a four-page list and description of 10 non-flow recommended actions specific to the SJR. Although the program of implementation does not require non-flow actions, it recognizes the potential value of such actions to complement the LSJR flow objectives for the protection of fish and wildlife and as part of a comprehensive approach to the Delta aquatic ecosystem.

In addition, the program of implementation acknowledges that voluntary agreements may include non-flow actions that support a change in the required percent of unimpaired flow, within the prescribed range, if the criteria for adaptive adjustments are met. Per the *Voluntary Agreement* section of Appendix K:

> Voluntary agreements may include commitments to meet the flow requirements and to undertake non-flow actions. If the voluntary agreements include non-flow actions recommended in this Plan or by DFW, the non-flow measures may support a change in the required percent of unimpaired flow, within the range prescribed by the flow objectives, or other adaptive adjustments otherwise allowed in this program of implementation. Any such changes must be supported by DFW and satisfy the criteria for adaptive adjustments contained within this program of implementation. At a minimum, to be considered by the State Water Board, voluntary agreements must include provisions for transparency and accountability, monitoring and reporting, and for planning, adaptive adjustments, and periodic evaluation, that are comparable to similar elements contained in the program of implementation for the LSJR flow objectives.

Non-flow measures could help inform adaptive implementation actions. As discussed under the *Variable Quantity* section, a flow action could be paired with a non-flow action to achieve biological benefits. The program of implementation provides for non-flow actions but does not specify any equivalent protection metrics such as a specified number of acres of habitat providing equivalent protection to a specified percent of unimpaired flow. Commenters asserted that this lack of equivalent protection metrics is a flaw. There is insufficient information, however, to inform the relative quantifiable benefits of non-flow actions relative to the benefits of flow analyzed in the SED and each action will be case-specific. Thus, additional information is needed before assessing the optimal mix of flow and non-flow measures that could best reasonably protect fish and wildlife.

Adaptive Implementation Information Needs

Adaptive implementation is most effective if the following information described in the program of implementation is developed and refined:

- **Calculated unimpaired flow** at the major rim dams on each of the three tributaries.
- **Flow measurements** at LSJR flow compliance gages.
- **Biological goals** and other information to inform adaptive implementation.

Although information is available to inform adaptive implementation, refinement of this information will greatly enhance the effectiveness of adaptive implementation to achieve program goals. As stated in the *Implementation of February through June LSJR Flow Objectives* section of Appendix K, *Revised Water Quality Control Plan*, under *Unimpaired Flow Compliance*, the STM Working Group, or State Water Board staff, as necessary, will work with the Delta Science Program to ensure that sound science is used to develop this information.

Calculated Unimpaired Flow

The percent of unimpaired flow requirement is based on the same flows modeled in the SED, unimpaired flows at the rim dams on each of the three LSJR tributaries:

- Stanislaus at Goodwin
- Tuolumne at Don Pedro
- Merced at McClure

Unimpaired flow forms the basis for the flow requirement because it represents the natural water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. Unimpaired flow is therefore a direct way to establish a variable quantity of water that is allocated to fish and wildlife protection, because it represents a portion of the variable total water production in a river. The California Department of Water Resources (DWR) currently posts calculated unimpaired flows daily for several major rivers on its California Data Exchange Center (CDEC) website, including for the three LSJR tributaries.[1] DWR provides the following notes on the CDEC website:

> "Full Natural Flow" or "Unimpaired Runoff" represents the natural water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. Gauged flows at the given measurement points are increased or decreased to account for these upstream operations. The flows reported here are based on calculations done by project operators on the respective rivers, the US Army Corps of Engineers and/or Snow Surveys.
>
> Daily Full Natural Flow (FNF) calculations are based on less data than is available at the completion of each month. The sum of daily FNF reported here will not exactly match the calculated monthly FNF reported on the seasonal and water year reports. Due to the lag between the effect of upstream operations and downstream flow measurements, calculated daily FNF will fluctuate from day to day.

As stated in the *Unimpaired Flow Compliance* Section of Appendix K, *Revised Water Quality Control Plan*, the State Water Board recognizes that information and specific measures are needed to achieve the LSJR flow objectives and to monitor and evaluate compliance:

> Implementation of the unimpaired flow requirement for February through June will require the development of information and specific measures to achieve the flow objectives and to monitor and evaluate compliance. The STM, or State Water Board staff as necessary, will, in consultation with the Delta Science Program, develop and recommend such proposed measures.

DWR determines unimpaired flow on both a daily and monthly basis. The daily unimpaired flow estimates frequently lag by several days, so are not always available on a real-time basis. This lag occurs because the unimpaired flow estimates rely upon sparse and variable data that do not necessarily reflect the actual unimpaired flow on any given day. For example, changes in reservoir storage are used for some of the estimates. Reservoir storage is, in some instances, determined by reservoir water elevations, which can be affected by environmental factors such as wind. Wind has the effect of pushing water higher or lower at the location of a stage gage used to calculate reservoir storage. This means that stage and reservoir storage can be overestimated or underestimated. In extreme cases, daily calculated unimpaired flows can even be determined to be negative. It would not make sense to base flows on negative or zero flow calculations; if rigorously applied, a zero flow

[1] http://cdec.water.ca.gov/cgi-progs/stages/FNF.

would be fatal to fish. Accordingly, the STM Working Group is charged with determining specific methods of measuring and reconciling unimpaired flow measurements to address issues regarding appropriate data and methodologies. Compliance with required flows will be evaluated based on the best available information. The *Unimpaired Flow Compliance* section of Appendix K, anticipates the need and value of refining the specific measures to achieve the LSJR flow objectives.

The 180 days allowed for development and Executive Director approval of this information is an ambitious timeframe. The information, however, will inform implementation of the LSJR flow objectives. The relatively short period is intended to encourage rapid development of this important information. The effort, however, need not be exhaustive, because much of the foundational information needed to calculate and use unimpaired flow is already available, and flows are monitored near the confluence of each river. A standardization of methods that the STM Working Group intends to rely on for adaptive implementation should be developed. The text in Appendix K, *Revised Water Quality Control Plan*, has been revised to clarify that the calculated methods can be updated and improved over time:

> As information and methods improve, specific measures to achieve the flow objectives and to monitor and evaluate compliance may be modified and submitted for approval.

Refined data and methods may simplify, streamline, and standardize the identification of flow targets. For example, flow shaping can determine functional flows based on the required percent of unimpaired flow. Again, rigid adherence with a percent of unimpaired flow on a 7-day average is not the only way to achieve fish and wildlife protection goals or to evaluate compliance. Accounting of flows can be completed when sufficient information becomes available, which may occur well after the 7-day averaging period. This means that focus should be placed on using the best available accurate unimpaired flow estimates. Day-to-day variations caused by current methods used to estimate unimpaired flow will average out over longer periods. Shorter or longer averaging periods have no effect on the quantity of water required and provided to protect fish and wildlife. The quantity is the same for a 3-day, 7-day, or 14-day averaging period.

According to the program of implementation, the STM Working Group will work with State Water Board and the Delta Science Program to identify other methods and data to determine unimpaired flow and compliance with the flow requirement. The STM Working Group will continue to use the modeled metrics that informed establishment of the flow requirements: the specified percent of unimpaired flow calculated at each of the three rim dams must be maintained, as a 7-day average, at the confluence of each of the rivers with the LSJR. The State Water Board Executive Director will consider approving measures to achieve the LSJR flow objectives and evaluate compliance within 180 days of the Office of Administrative Law's approval of the amendments to the *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (Bay-Delta Plan).

Water supply effects and fish and wildlife benefits are modeled in the SED using the required percent of unimpaired flow, as calculated at the rim dams and required at the confluence of each river. Unimpaired flows would be higher at locations further downstream of the rim dams than at the rim dams, and unimpaired flow upstream of the rim dams would be lower than at the rim dams. Except for large rainfall runoff events on the valley floor, which could lead to significantly higher unimpaired flows of short duration downstream of the rim dams than at the rim dams themselves, the difference in unimpaired flow between the rim dams and the confluence of each river would likely be relatively small. These differences would have only a small effect on the determination of unimpaired flows because the biggest differences would be of short duration during high flow

periods. Other locations and methods could be used so long as they do not result in large decreases of the calculated unimpaired flows relative to the locations and methods used in the SED.

Some commenters expressed concern that flows downstream of the rim dams are affected by other factors, in addition to surface water accretions. These other factors include groundwater losses and gains, agricultural return flows, and surface water diversions. Accretions from groundwater and return flows would help to increase and achieve the required flows, while depletions from diversions and groundwater losses would reduce flows. Characterization and quantification of these accretions and depletions would help the STM Working Group manage the unimpaired flows, and in all cases, the narrative fish and wildlife objective must be achieved. In other words, the river reaches from the rim dam to the confluence or each LSJR compliance gage cannot be dewatered by, for example, diverting all flows at the rim dams and returning the flows further downstream.

Flow Measurements

Compliance locations for the LSJR flow objectives are identified as the three existing gages near the confluence of each of the LSJR tributaries (Appendix K, *Revised Water Quality Control Plan*, Table 3):

- Stanislaus River at Koetitz (DWR Gage KOT)
- Tuolumne River at Modesto (U.S. Geological Survey [USGS] Gage 1129000)
- Merced River near Stevenson (DWR Gage MST)

These stations are currently the farthest downstream gage on each of the three tributaries. As indicated in the program of implementation (Appendix K, *Revised Water Quality Control Plan*), these could be replaced with new stations:

> The Executive Director may approve changes to the compliance locations and gage station numbers set forth in Table 3 if information shows that another location and gage station more accurately represent the flows of the LSJR tributary at its confluence with the LSJR.

The STM Working Group should work with Delta Science Program and others to develop information to support changing a compliance location. Any such proposal should demonstrate how the change will still achieve both the numeric and narrative fish and wildlife protection objectives.

A goal of the numeric flow objectives is to provide flows to protect fish that migrate to or from the salmon-bearing tributaries of the LSJR. As described in the LSJR program of implementation (Appendix K, *Revised Water Quality Control Plan*), this includes not just the three tributaries, but also the mainstem LSJR through Vernalis and downstream through the Delta:

> Although the lowest downstream compliance location for the LSJR flow objectives is at Vernalis, the objectives are intended to protect migratory LSJR fish in a larger area, including within the Delta, where fish that migrate to or from the LSJR watershed depend on adequate flows from the LSJR and its salmon-bearing tributaries.

The selection of measurement locations and methods should consider the information needed to manage flows adaptively and to monitor and assess flow compliance. While a flexible approach to compliance locations can support project goals, if no better alternatives are identified or agreed upon by the STM Working Group and others, the STM Working Group will maintain the original compliance locations. This provides flexibility without loss of regulatory rigor.

Biological Goals

The program of implementation requires the development of biological goals that can be used to inform adaptive implementation and to evaluate the effectiveness of the program of implementation, the monitoring and evaluation program, and future changes to the 2006 Bay-Delta Plan. Based on recommendations from the STM Working Group, State Water Board, and other interested persons, the State Water Board will consider approving the biological goals within 180 days of the Office of Administrative Law's approval of the amendments to the 2006 Bay-Delta Plan. This short timeline provides incentive for interested parties to work together to develop the biological goals to guide adaptive implementation. Once developed, those biological goals may be modified by the State Water Board based on new information developed through monitoring and evaluation activities or other pertinent sources of scientific information.

The program of implementation recognizes that new, currently unavailable information will be needed to inform adaptive implementation and that biological goals are particularly important. The following types of biological goals are specifically identified for LSJR salmonids: abundance, productivity as measured by population growth rate, genetic and life history diversity, and population spatial extent, distribution, and structure. Ideally, such goals would already be available; however, adaptive implementation can proceed as they are developed.

There may be disagreements on the rationale for adaptive implementation, including changes in the percent of unimpaired flow required within the adaptive range. Where there is disagreement over a proposed single-year change to the percent of unimpaired flow within the adaptive range, the State Water Board must approve the proposed program. The State Water Board must also approve any proposed multi-year change. This ensures that any contentious short-term changes and all long-term changes are presented to and approved by the State Water Board.

Even when biological goals are developed, it could be many years before a clear indicator shows improvements in any metrics used for biological goals. Multiple commenters asserted that the flexibility afforded by this adaptive implementation framework will make it impossible to discern any changes that occur in response to increased flows and other measures. While it may take many years for flow or other changes to have an effect, even when there is an effect, it may be obscured by normal year-to-year variability. This is one reason that biological goals are identified as one tool for adaptive implementation, supplementing other actions such as habitat improvements, improving and tracking of temperatures, and practices that the best available science shows will improve conditions for fish to meet the narrative flow objective.

As noted, other types of information can also inform adaptive implementation, such as monitoring temperature and measuring the amount of habitat available for salmon spawning and rearing. It may be possible, for example, to increase the quantity of rearing habitat by making physical improvements to floodplains and channels instead of through flow increases. The quantity of restored habitat and temperature monitoring could be used to assess potential improvements and protections of fish and wildlife. The following language in the *Biological Goals* section of Appendix K, *Revised Water Quality Control Plan*, has been revised to make it clear that other metrics, such as temperature and increases in habitat acreage, can be used in conjunction with biological goals to assess attainment of the narrative LSJR fish and wildlife objective:

> Reasonable contributions to these biological goals may include meeting temperature targets and other measures of quality and quantity of spawning, rearing, and migration habitat, fry production, and juvenile outmigrant survival to the confluence of each tributary to the LSJR.

As described in Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow between February 1 and June 30*, a large body of scientific work shows improvements in fish populations with improved temperature and habitat conditions. Although measurement of temperature and habitat are not direct measures of improved fish populations, they are good indicators of likely improvements.

Based on comments received, the *Biological Goals* section in Appendix K, *Revised Water Quality Control Plan*, has been appended to state:

> Biological goals should be specific, measurable, achievable, result-focused, and include a time frame for when they will be achieved.

Biological goals will be one of the tools used to inform adaptive implementation, including changes to the flow percent required within the adaptive range. Biological goals and other information will also be used to evaluate the overall effectiveness of the program of implementation

Some commenters suggested that the numeric biological goals or S.M.A.R.T. objectives should be included in this Bay-Delta Plan Update. As noted above, biological goals will address S.M.A.R.T. concepts. It is premature, however, to include specific numeric targets for biological goals because the relevant scientific information has not yet been developed. Waiting for the development of biological goals for inclusion in the Bay-Delta Plan would further delay implementation of the LSJR flow objective. Moreover, adaptive implementation can proceed before additional information is available, as explained previously.

Examples of Adaptive Implementation

Many examples of creative adaptive implementation are allowable under the existing adaptive implementation framework. As discussed previously, the development of annual and multi-year operations plans will be guided by the procedures for implementation of adaptive methods developed by the STM Working Group in consultation with the Delta Science Program. Following are some examples of annual and multi-year plans that show how different adaptive implementation methods may be used.

Example 1: Single Year Change to an Alternative Percent Unimpaired Flow

Using only adaptive implementation measure (a) variable quantity, the volume of water represented by the 7-day running average unimpaired flow from February through June could be reduced from 40 percent to 35 percent. One rationale for such a change is that other measures are being used to provide the same or greater level of protection as 40 percent flows and the change will meet the narrative objective and any approved biological goals.

The Executive Director may approve this type of 1-year plan if all members of the STM Working Group agree to the change. If the STM Working Group does not agree, only the State Water Board can approve such a 1-year proposal.

In practice, it is likely that a proposal to adjust the overall required flow percent would span multiple years because other measures, such as habitat improvements, likely have an effect over multiple years. It may also be desirable for the STM Working Group to agree to higher percent flows

in drier years in exchange for lower percent flows in wetter years as a means of maximizing fish benefits and reducing water supply effects (through the ability to store more water in wetter years to carry over to dry years). See Example 2.

This approach can be applied to a single tributary or multiple tributaries so long as the collective benefits are considered and the criteria for adaptive adjustments are met.

Example 2: Multi-Year Change to an Alternative Percent Unimpaired Flow Depending on Water Year Type

Using only adaptive implementation measure (a) variable quantity, the volume of water represented by the 7-day running average unimpaired flow from February through June could be changed from 40 percent in all years to 45 percent in critically dry and dry years, 35 percent in above-normal and wet years, and 40 percent in below-normal years. One rationale for such a change could be that the same or greater level of protection as 40 percent flows is achieved by flexing the flow amounts and the change meets the narrative objective and any approved biological goals. Such a proposal may have overall water supply benefits by creating more opportunities to store water in wetter years in exchange for bypassing more water in dry years.

Alternatively, and again using only adaptive implementation measure (a) variable quantity, the volume of water represented by the 7-day running average unimpaired flow from February through June could be changed from 40 percent in all years to 30 percent in a critically dry year that follows a critically dry or dry year, 43 percent in below-normal, above-normal, and wet years and 40 percent in all other dry and critically dry years if the change meets the narrative objective and any approved biological goals. This example provides dry year relief during successive dry years, thus providing some water supply benefit in exchange for providing more water at other times.

There are endless permutations of this type of adaptive implementation. Any specific proposal must be supported by information showing that the change will meet the criteria for adaptive adjustments: (1) it will be sufficient to support and maintain the natural production of viable native San Joaquin River watershed fish populations migrating through the Delta; and (2) it will meet any existing biological goals approved by the State Water Board. Any such multi-year change in unimpaired flow percent must be approved by the State Water Board.

Example 3: February Though June Adaptive Implementation of 40 Percent Unimpaired Flow (Simple Flow Shaping)

Using only adaptive implementation measure (b) flow shaping, the volume of water represented by the 7-day running average unimpaired flow from February through June could at times better achieve the narrative fish and wildlife objective through flow shaping than through rigid adherence to the 7-day running average. In this example, the STM Working Group proposes an annual operations plan by January 10, as specified in the *Annual Adaptive Operations Plan* section of Appendix K, *Revised Water Quality Control Plan*. Although some information will not be known about February—June flows before January 10, enough information is available to develop an initial plan before the start of the February—June flow objective season, so the State Water Board and stakeholders can anticipate how the system will be operated. The prior year's hydrology and reservoir condition will be known with certainty, and the quantity of snowpack already on the ground that could contribute to February—June flows may be known. The initial plan can rely on

available information. As stated in Appendix K, *Revised Water Quality Control Plan*, the plan may be modified after January 10, as more information becomes available, with the approval of the Executive Director.

As an example, an initial and revised plan could propose adaptive implementation of the February—June flow objectives, based on current storage and forecasted hydrology, as follows:

- Provide 30 percent of unimpaired in February and March on a 7-day running average; keep a running tally of the quantity of water represented by 10 percent of unimpaired flow not provided for February and March (referred to as banked water), to be used in April and May.
- Provide 40 percent of unimpaired flow in April and May, plus the additional quantity of water banked in February and March, during a 6-week period in April and May, with the specific 6-week period to be identified based on fish and temperature conditions.
- Firm up estimates of June unimpaired flows by May 1.
- Submit an updated plan by May 15 to use the 40 percent of unimpaired June flows in one of the following two ways. The choice will be determined by the real-time temperature conditions and presence of fish in June.
    - Shift all but some minimum instream flow amount early into May or into May and early June.
    - Use entirely in June.

Note that the banked water scenario would not be feasible in all years. In wet or above-normal years, for example, there may not be reservoir capacity (or biological need) to bank water, particularly in wet years following wet years.

The Executive Director may approve this type of 1-year plan if it is proposed by one or more members of the STM Working Group and the criteria for adaptive adjustments are met.

In this example, only the flow-shaping method of adaptive implementation is used. It is likely that a more complicated adaptive implementation plan may be proposed that makes the best use of June flows, as shown in Example 4.

Example 4: Flow Shaping and Shifting

The first three methods used in this example are the same as in Example 3, based on current storage and forecasted hydrology, but instead of simply shaping flows during the February—June period, some of the June flows are shifted to other months using implementation measure (c) flow shifting as follows:

- Provide 30 percent of unimpaired flow February and March on a 7-day running average; keep a running tally of the quantity of water represented by 10 percent of unimpaired flow not provided for February and March (i.e., the banked water) to be used in April and May.
- Provide 40 percent of unimpaired flow in April and May and release the additional quantity of water banked in February and March during a 6-week period to be identified based on fish and temperature conditions.
- Firm up estimates of June unimpaired flows by May 1.
- Submit an updated plan by May 15 to use a portion of the 40 percent of unimpaired June flows in one of the following four ways.

- Shift all June flows except for some minimum instream flow amount into May.
- Use June flows entirely in June (if air and water temperatures and presence of fish make this a reasonable option).
- Shift a portion of the flow to the summer and fall (by keeping amounts in excess of a specified minimum flow in storage) consistent with the limits in (c).
- Use a mix of all of the above options.

The Executive Director may approve this type of 1-year plan if it is proposed by one or more members of the STM Working Group and the criteria for adaptive adjustments are met.

As for Example 3, the banked water scenario may not be feasible in all years. In wet or above-normal years, for example, there may not be reservoir capacity (or biological need) to bank water, particularly in wet years following wet years. The same may also apply to banking June water for other months in very wet years.

Example 5: Change Percent Unimpaired Flow, Combined with Flow Shaping and Shifting

A combination of the approaches in Examples 1 through 4 may be proposed and implemented so long as it is approved by the State Water Board and meets the criteria for adaptive adjustments.

Monitoring and Assessment

The *San Joaquin River Monitoring and Evaluation Program* section of Appendix K, *Revised Water Quality Control* Plan, describes required monitoring and assessment. There are short-term annual and multi-year timelines for reporting, monitoring, and assessment. Specific responsibility for these various monitoring and assessment elements will be assigned when the State Water Board assigns responsibility for implementing the LSJR flow objectives in water right or water quality proceedings. Several commenters suggested that there should be oversight and review of this monitoring, in addition to State Water Board oversight. The following language has been added:

> At least every five years, the State Water Board will request the Delta Science Program to conduct periodic reviews of the San Joaquin River Monitoring and Evaluation Program.

Master Response 2.1, *Amendments to the Water Quality Control Program*, provides additional information about monitoring and assessment.

Modeling Conceptualization of Adaptive Implementation

The modeling scenarios for each LSJR alternative reasonably represent implementation of the LSJR flow objectives within the adaptive ranges. The program of implementation expressly requires the development of minimum reservoir carryover storage targets or other requirements to help ensure that the implementation of the flow objectives will not have significant adverse temperature or other impacts effects on fish and wildlife. The WSE model incorporates carryover storage guidelines

and other reservoir operation parameters to represent reasonable methods of re-operating reservoirs to meet LSJR flow objectives, minimize redirected impacts to temperature, and maximize water deliveries to customers. Please refer to Master Response 3.2, *Surface Water Analyses and Modelingl*, and Appendix F.1, *Hydrologic and Water Quality Modeling,* for additional detail.

References Cited

Delta Stewardship Council (DSC). 2013. Appendix C. *Adaptive Management and the Delta Plan.* Available: http://deltacouncil.ca.gov/sites/default/files/documents/files/AppC_Adaptive%20Management_2013.pdf. Accessed: April 20, 2018.

National Academy of Sciences (NAS). 2004. *Adaptive Management for Water Resources Planning*. Washington, DC: The National Academies Press.