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Chapter 7. System Reoperation

Introduction

System reoperation in the context of water resources means changing existing operation and management procedures for a water resources system consisting of supply and conveyance facilities and end user demands with the goal of increasing desired benefits from the system. System reoperation may seek to improve existing water facilities to meet existing system needs more efficiently and reliably, or it may seek to prioritize one system need over another. Although reoperation of existing facilities is generally regarded as the preferred alternative to constructing major new facilities, minor physical modifications to existing facilities may be necessary to reduce bottlenecks and to meet operational goals. Changes to the water rights or regulatory framework for allocating water — for example, modifying existing water rights or creating new supply exchange agreements — may also be required.

Some systems may be very simple and include only a single surface water reservoir or groundwater basin. Other water systems may be much more complex, consisting of many facilities that form a combination of local, interregional, and interstate water sources and destinations. The concept “system reoperation” applies to whatever the system may be. Reoperation can be implemented at different scales within a system, ranging from individual facilities to several integrated components.

Reoperation of existing facilities usually serves three basic purposes:

1. Address a specific problem(s) and/or need(s).
2. Improve efficiencies.
3. Adapt to anticipated future changes. Good examples of factors driving reoperation are changes in water demands, legal and regulatory constraints, and key physical variables such as climate.

Background

California’s statewide water system is comprised of a diverse set of local, State, and federal projects, as depicted in Figure 7-1. These projects include facilities such as dams and reservoirs, hydropower plants, canals, and water diversion structures. Many of these facilities were developed in the 20th century, and were not designed, constructed, or operated as an integrated water supply and flood management system. Over time, operations of the two largest projects, the State Water Project (SWP), operated by the State, and the Central Valley Project (CVP), operated by the federal government, have been integrated to a certain degree. The current level of integration is based on the Coordinated Operating Agreement that was initiated in the 1970s and finalized in 1986.

California’s water supply and flood control systems are inextricably linked, from Trinity County in the north to Imperial County in the south, through physical interconnections and coordinated management arrangements. This reality influences water resources planning in two ways:

1. Changes in water management at any point may have consequences throughout the rest of the system.
2. The inherent physical interconnections in the system provide opportunities for improving water resource benefits throughout the state via systemwide optimization.

1 DWR’s System Reoperation Study (SRS) was undertaken with these two points in mind. In recognition of
 2 these points, this SRS represents a systems analysis to understand how changes influence the system and
 3 in what ways the system can be optimized to meet reoperation goals. Current water resources problems
 4 necessitate better integration and optimization of the State’s flood protection and water supply
 5 management system.

6 PLACEHOLDER Figure 7-1 Location of Local, State, and Federal Water Projects

7 [Any draft tables, figures, and boxes that accompany this text for the public review draft are included at
 8 the end of the chapter.]

9 Study Authorization

10 The authorization and funding of the System Reoperation Study were granted by the Legislature through
 11 Senate Bill X2 1 (SB X2 1) (chapter 1, statutes of 2008 – Water Code Section 83002.5), which mandated
 12 and allocated resources for “*planning and feasibility studies to identify potential options for the*
 13 *reoperation of the state’s flood protection and water supply systems that will optimize the use of existing*
 14 *facilities and groundwater storage capacity.*” Specifically, SB X2 1 stipulated that “*the studies shall*
 15 *incorporate appropriate climate change strategies and be designed to determine the potential to achieve*
 16 *the following objectives:*

17 *(I) Integration of flood protection and water supply systems to increase water supply*
 18 *reliability and flood protection, improve water quality, and provide for ecosystem*
 19 *protection and restoration.*

20 *(II) Reoperation of existing reservoirs, flood facilities, and other water facilities in*
 21 *conjunction with groundwater storage to improve water supply reliability, flood hazard*
 22 *reduction, and ecosystem protection and to reduce groundwater overdraft.*

23 *(III) Promotion of more effective groundwater management and protection and greater*
 24 *integration of groundwater and surface water resource uses.*

25 *(IV) Improvement of existing water conveyance systems to increase water supply*
 26 *reliability, improve water quality, expand flood protection, and protect and restore*
 27 *ecosystems.”*

28 To meet the legislative objectives, DWR, in coordination with willing participants, is conducting studies
 29 to identify and evaluate potential operations strategies for reoperation of the State’s flood protection and
 30 water supply systems. These reoperations strategies will be assessed with respect to their ability to
 31 improve (1) water supply reliability, (2) flood hazard reduction, and (3) ecosystem protection and
 32 restoration.

33 Along with the three objectives water quality, groundwater overdraft, and climate change are also
 34 mentioned in SB X2 1. Water quality affects water supply and ecosystems, and is therefore included in
 35 those discussions. Similarly, groundwater overdraft is considered as a component of water supply.
 36 Finally, because climate change increases the variability of hydrology and because such variability is

1 expected to further stress future water supply, flood hazard management infrastructure, and aquatic
2 ecosystems, climate change is part of each of those topical areas.

3 Geographic Scope

4 The geographic scope of this study could include the entire state; however, a close read of the authorizing
5 language indicates a focus on systems and system-wide analyses. The legislative mandate focuses this
6 study on the “State’s flood protection and water supply systems.” This suggests that emphasis should be
7 given to those areas of the state where both of these systems are found. Much of the State’s flood control
8 infrastructure is located in the Central Valley and the Central Valley is also where the greatest
9 concentration of interconnected water supply infrastructure is located. Additionally, a significant
10 percentage of California’s water supply originates in the northern Central Valley. Because this
11 infrastructure has had a profound effect on aquatic ecosystems, the greatest potential for ecosystem
12 restoration through infrastructure reoperation is also found in the Central Valley. For these reasons, the
13 initial geographic scope for identifying system reoperation will be limited to the Central Valley.

14 DWR recognizes that there are several independent watersheds that contain a certain level of systemized
15 infrastructure development. Ownership of these systems varies and opportunities for reoperation and
16 optimization may exist provided cooperation from the owners and operators can be obtained. However,
17 the initial focus for system reoperation is in the Central Valley due to the integration, size, and proximity
18 of existing infrastructure, and the perceived opportunities for meeting the stated goals of the authorizing
19 legislation. Figure 7-2 shows the location of the Central Valley and study area for the System Reoperation
20 Study.

21 **PLACEHOLDER Figure 7-2 Location of Central Valley and Study Area of System Reoperation** 22 **Study**

23 [Any draft tables, figures, and boxes that accompany this text for the public review draft are included at
24 the end of the chapter.]

25 Study Phases

26 Five phases were identified in the System Reoperation Plan of Study (June 2011) for carrying out the
27 study. The primary purpose of the Plan of Study was to define the phases of the study such that it can be
28 used as a guide to implement each phase. The study phases have been modified and updated since the
29 Plan of Study was completed. The current study phases are as follows.

30 **Phase 1: Preliminary Reoperation Measures and Concepts**

31 In Phase 1, the relevant existing literature, related programs, and available tools were assessed for use in
32 subsequent phases. The planning process to formulate preliminary reoperation strategies was established
33 and followed. This phase is important in that it established the ground rules for developing the System
34 Reoperation Study and identified preliminary reoperation measures and concepts.

35 **Phase 2: Strategy Formulation and Refinement**

36 In Phase 2, the preliminary reoperation measures and concepts identified from Phase 1 was refined and
37 formulated into potential reoperation strategies. Phase 2 included input and identification of fatal flaws
38 from technical experts, affected parties, as well as outreach and coordination with other relevant

1 programs. Phase 2 yielded specific potential reoperation strategies determined to warrant continued
2 consideration.

3 **Phase 3: Preliminary Assessments of Strategies**

4 Preliminary assessments were conducted on those strategies carried forward from Phase 2. The purpose of
5 the preliminary assessments was to identify fatal flaws, assess the strategies ability to meet the objectives
6 of the study, and rank the reoperation strategies relative to one another. These preliminary assessments
7 provided a sound basis for selecting strategies that warrant reconnaissance level assessments in Phase 4.

8 **Phase 4: Reconnaissance Level Assessments of Strategies**

9 Strategies carried forward from Phase 3 were subject to a reconnaissance level assessment. The
10 reconnaissance level assessment was performed at a more detailed level than the preliminary assessments
11 and was anticipated to rely upon existing tools (e.g., water supply, flood, and ecosystem related models).
12 The purpose of the reconnaissance assessments was to evaluate and determine whether or not the selected
13 strategies warranted further evaluation for potential recommendation for implementation, developed a
14 relative ranking of the reoperation strategies, and identified needed funding and key steps necessary for
15 implementation.

16 Phase 5 was identified in the Plan of Study as the strategy implementation phase. Strategy
17 implementation is beyond the scope of this study and is therefore not a part of it.

18 **Planning Principles**

19 In development of the SRS, DWR has adopted a set of guiding principles:

- 20 • Water supply benefits resulting from reoperation will be shared with the owners of the projects as
21 negotiated with the owners.
- 22 • Reoperation studies of regional and local projects will be performed with the collaborative and
23 voluntary participation of the facilities owners and operators.
- 24 • Priority for study will be reoperation opportunities that simultaneously reduce flood hazards,
25 improve water supply reliability, and restore damaged ecosystems.

26 **Phase 1: Preliminary Reoperation Measures and Concepts**

27 During Phase 1, management and physical reoperation measures were identified that addressed one or
28 more of the objectives and capitalized on existing opportunities. Measures were formulated based on a
29 review of available reoperation literature and suggestions from knowledgeable experts. Reoperation
30 measures were combined with other measures to create reoperation scenarios resulting in greater benefits
31 to the water system. A conjunctive use scenario, for example, might include construction of conveyance
32 and recharge facilities, integration of two or more reservoir project operations, and reoperation at those
33 same reservoirs. Thus, many individual measures are not complete by themselves, but must be combined
34 with other measures.

35 The measures were formulated and organized based on the system reoperation building blocks identified
36 in the Plan of Study. During measure formulation, measures were only identified under these building
37 block categories:

- 38 • Integrate CVP, SWP, and other local projects.
- 39 • Reoperate reservoirs.

- 1 • Integrate management of groundwater and surface water.
- 2 • Facilitate water transfers.
- 3 • Change stream flow regime/patterns.
- 4 • Expand through valley conveyance/reactive floodplains.

5 The preliminary reoperation measures and concepts developed in Phase 1 are shown in Box 7-1. Phase 1
6 was completed in July 2011.

7 **PLACEHOLDER Box 7-1 System Reoperation Measures and Concepts**

8 [Any draft tables, figures, and boxes that accompany this text for the public review draft are included at
9 the end of the chapter.]

10 **Phase 2: Reoperation Strategy Formulation and Refinement**

11 In Phase 2, preliminary reoperation strategies were formulated based in part on the reoperation measures
12 and concepts identified in Phase 1 and in part from inputs from cooperators. Those strategies were further
13 developed and screened through a process of consultations with agency experts, facility owners and
14 operators, and experts from within the study team and well beyond. The reoperation strategy candidates
15 were formulated based on the following criteria:

- 16 • Has the potential to provide net benefits that satisfy the three study objectives of (1) flood hazard
17 reduction, (2) improvements in water supply reliability, and (3) restoration of natural functions in
18 developed river features.
- 19 • Can be accomplished with only minor capital improvements to the water system, which are
20 limited to those that are necessary to reoperate existing infrastructure. The exception is the
21 isolated Delta conveyance. All of the promising reoperation strategies that have a nexus to the
22 Delta will be evaluated with and without an isolated Delta conveyance in Phase 3.

23 Preliminary reoperation strategies that were formulated and vetted during Phase 2 are shown in Box 7-2.

24 **PLACEHOLDER Box 7-2 Preliminary Reoperation Strategies**

25 [Any draft tables, figures, and boxes that accompany this text for the public review draft are included at
26 the end of the chapter.]

27 During the summer of 2012, the study team consulted with various water management institutions and
28 organizations whose infrastructures or water management policies would be implicated in the reoperation
29 strategies or that have expert knowledge of system reoperation. Through this vetting process, the study
30 team obtained input and used the information to further refine some reoperation strategies and eliminate
31 some other strategies. The organizations that the study team consulted with during conducting the vetting
32 process are shown in Box 7-3.

33 **PLACEHOLDER Box 7-3 Organizations Consulted During Phase 2**

34 [Any draft tables, figures, and boxes that accompany this text for the public review draft are included at
35 the end of the chapter.]

36 As a result of the vetting process, some of the preliminary reoperation strategies shown in Table 7-2 were
37 eliminated from further consideration due to various reasons including unwillingness of the facility

1 owner(s) to participate in the study, there is little or no operational flexibility for reoperation, or there is
 2 little or no benefit from reoperation. The preliminary strategies that did not survive after the vetting
 3 process include:

- 4 • Reoperation of Friant Dam (Lake Millerton). According to the Friant Water Authority, Lake
 5 Millerton is already operated to carryover only dead storage in many, perhaps most, years. That
 6 means there is very little additional operation flexibility that would be exploited under the
 7 reservoir reoperation in conjunction with groundwater banking options.
- 8 • Reoperation of Folsom Reservoir. Folsom Reservoir, too, has limited operational flexibility under
 9 current demands and constraints. This conclusion is based on previous vetting with the CVP
 10 Folsom operations staff. It appears that the best way to incorporate Folsom Reservoir into a
 11 reoperation scenario may be in conjunction with Shasta Reservoir reoperation.
- 12 • Reoperation of New Don Pedro Reservoir. The co-operating irrigation districts, Turlock Irrigation
 13 District and Modesto Irrigation District, are going through a FERC (Federal Energy Regulatory
 14 Commission) relicensing process and do not wish to collaborate with DWR to study reoperation
 15 of New Don Pedro Reservoir.
- 16 • Reoperation of Camanche and Pardee reservoirs. According to East Bay Municipal Utility
 17 District, the Camanche and Pardee reservoirs are already operating efficiently and do not have
 18 potential operational flexibility for reoperation.
- 19 • Reactivating Floodplains for Improved Flood Management and Ecosystem Restoration. This
 20 stand-alone strategy does not appear to be able to achieve the three objectives of the study. Some
 21 type of reactivating floodplains or floodplain inundation concepts may be included in the
 22 strategies that will be carried forward into Phase 3.
- 23 • Mechanisms to Facilitate Conservation Water Transfers. This strategy does not appear to be able
 24 to achieve the three objectives of the study. Also, no entities were interested in pursuing this
 25 strategy during the vetting process.
- 26 • Systemwide Reoperation Strategies to Implement the Solution Strategies of the Bay Delta
 27 Conservation Plan (BDCP). The details of this strategy are not well defined because solution
 28 strategies of BDCP will not be known until its EIR/EIS is completed. The new Delta conveyance
 29 associated with BDCP will be analyzed for all strategies that have a nexus to the Delta.

30 The surviving reoperation strategy candidates that emerged from the vetting process and will be carried
 31 forward into Phase 3 for preliminary assessments are:

- 32 • Reoperation of Shasta Reservoir.
- 33 • Reoperation of Oroville Reservoir.
- 34 • Reoperation of New Exchequer Dam (Lake McClure).
- 35 • Integration of the SWP and CVP operations.

37 **Basic Concept of Reservoir Reoperation for Shasta and Oroville Reservoirs**

38 The basic concept for the reoperation of Shasta and Oroville reservoirs is to lower carryover storage
 39 levels relative to current operations to increase flood reservation by conveying additional water to either
 40 an existing or future groundwater bank located in the Sacramento Valley or south of Delta with available
 41 capacity. This reoperation would reduce flood control spills and would occur at times when excess
 42 conveyance capacity is available in the Delta. To the extent reservoirs recover fully, the banked water is a
 43 supplement to water supplies. In dry years where complete storage recovery does not occur, the reservoir

1 would be paid back with withdrawals from the groundwater bank and delivered to CVP/SWP customers
2 on a full cost recovery basis.

3 **Basic Concept for Reoperation of New Exchequer Dam**

4 The concept for reoperation of New Exchequer Dam (Lake McClure) is with reservoir payback by in lieu
5 groundwater banking within the Merced Irrigation District and the Merced Area Groundwater Planning
6 Initiative (MAGPI). The reoperation would enable environmental flows to be restored from the dam to the
7 Delta to help restore steelhead trout. This strategy would be developed and conducted in partnership with
8 Merced Irrigation District and MAGPI. The environmental flow release would have to be managed
9 through the downstream infrastructure. Releases from Lake McClure pass through a series of power
10 plants and smaller diversions and are regulated at McSwain Reservoir. Below McSwain Reservoir, water
11 is diverted to Merced Irrigation District at the PG&E Merced Falls Dam and is diverted further
12 downstream at Crocker-Huffman Diversion Dam. It is possible that the surplus water dedicated to
13 steelhead recovery in the Merced River could be diverted below the confluence with the San Joaquin
14 River for water supply.

15 **Operational Components**

16 Four operational components will be included in the reoperation strategies:

- 17 • Forecast-Based Operations. The goal is to reduce flood control space in reservoirs to allow higher
18 storages at certain times of the year based on improved inflow forecasts.
- 19 • Conjunctive Management. The goal is to develop more integrated management of groundwater
20 and surface water supplies. Several different operational changes are possible with increased
21 conjunctive management including increased groundwater banking through in lieu and active
22 recharge and more aggressive reservoir reoperations backstopped by groundwater pumping.
- 23 • System Integration. The goal is to integrate operations between multiple reservoirs or increase the
24 degree of integration at reservoirs that are currently integrated.
- 25 • Environmental Flows. A variety of new environmental flows may be included in each strategy.
26 Differences in the timing and magnitude of environmental flows change how those flows can be
27 used to meet multiple project objectives. Flows under consideration include floodplain inundation
28 flows, spring pulse flows, flows to improve water temperature, and flows coordinated with fish
29 hatchery operations.

30 The Shasta Reservoir reoperation strategy may consider fish passage above Shasta Dam into the colder
31 water environments of the Upper Sacramento and McCloud rivers as a component. Fish passage above
32 Shasta Dam is a core element of the Salmon Recovery Plan of National Marine Fishery Services NMFS.
33 The key issue is whether fish passage would allow more flexible operations of Shasta Dam that could
34 facilitate the reoperation concepts under consideration.

35 **Trade-off Analysis**

36 A trade-off analysis is being performed as part of Phase 2 to help define the operations of the strategies.
37 One of the purposes of the trade-off analysis is to identify combinations of measures that will meet all
38 three objectives of the study. While the ultimate objective of the System Reoperation Study is to achieve
39 simultaneous and system-wide net improvements in water supply, flood control, and ecosystem
40 protection/restoration, there may be conflicts among the competing goals in the reoperation strategies.
41 Understanding of trade-offs among the competing goals will help in strategy formulation as the various

1 measures and benefit types are pursued. For example, there may be trade-offs within ecosystem goals
 2 between environmental flow improvements above the Delta and Delta outflow, and between different
 3 species (delta smelt and salmon) or even life stages of the same species (out-migration versus over-
 4 summer holding). There are also trade-offs between goals such as water supply and flood hazard
 5 reduction.

6 A trade-off analysis will facilitate consideration of the relative priority of the system reoperation
 7 objectives. For example, an ecosystem restoration action, if implemented in the existing system, will have
 8 an effect on water supply and perhaps other restoration objectives such as temperature management. This
 9 trade-off analysis will provide a foundation for understanding the water system effects and will inform
 10 how measures can be ultimately combined into full system reoperation strategies. In addition, the trade-
 11 off analysis will give potential system reoperation participants, such as managers, operators, regulators,
 12 and other stakeholders a better understanding of each measure under consideration.

13 Some of the key trade-offs analysis being evaluated as part of the Phase 2 includes:

- 14 ● Flexibility in temperature management operations at Shasta Dam – the ability to change releases
 15 from Shasta Dam while complying with winter run temperature requirements is a key trade-off
 16 for evaluating conjunctive management and environmental flows at Shasta Dam.
- 17 ● Evaluating trade-offs in temperature and flow between higher spring releases and risks of warmer
 18 temperatures in the fall.
- 19 ● North of Delta water supply reliability versus systemwide water supply.
- 20 ● Evaluating the effects on water supply and storage in Lake Oroville from increased instream
 21 flows in the Feather River

22 Phase 2 is anticipated to be completed in the summer of 2013.

23 **Next Steps**

24 **Phase 3 Preliminary Assessments of Strategies**

25 The study team will continue to refine the reoperation strategies to change operations in ways that may
 26 result in improved system performance in terms of additional water supply, flood hazard reduction, and
 27 ecosystem protection and restoration. Those reoperation strategies that survived through the vetting
 28 process will be evaluated for potential benefits at the regional and systemwide scale during the Phase 3.

29 The purpose of Phase 3 is to evaluate, sort, and rank strategies based on their performance in meeting the
 30 goals and objectives of the study. The strategies will be examined for acceptability, completeness,
 31 effectiveness, and efficiency. Phase 3 will include:

- 32 ● Defining baseline operations.
- 33 ● Evaluating these system reoperation strategies:
 - 34 ○ Identifying existing physical and operational constraints.
 - 35 ○ Identifying new or modified physical facilities needed for potential system reoperation
 36 strategies.
 - 37 ○ Conducting hydrologic and other modeling.
 - 38 ○ Quantifying benefits.

- 1 • Ranking reoperation strategies based on their performance.
- 2 • Selecting reoperation strategies to be carried forward into Phase 4 for more detailed analysis.

3 Phase 4 Reconnaissance Level Assessments of Strategies

4 In Phase 4, the strategies evaluated in Phase 3 that met the objectives of the study will be carried forward
5 into Phase 4 for more detail evaluations. Phase 4 will include:

- 6 • Analyzing and assessing reoperation strategies.
- 7 • Evaluating benefits.
- 8 • Evaluating costs.
- 9 • Quantifying economic benefits.
- 10 • Developing conceptual designs for facilities modifications.
- 11 • Identifying institutional challenges.
- 12 • Documenting the findings.
- 13 • Recommending strategies for potential implementation.
- 14 • Identifying funding and key steps necessary for implementation.
- 15 • Making recommendations for next steps.
- 16 • Preparing a report.

17 Climate Change

18 Climate change presents a huge challenge for California water management. Recent climate change
19 studies project a broad range of potential effects, such as increases in air temperature, changes in the
20 timing, amount, and form of precipitation, changes in runoff timing and volume, sea level rise, increased
21 storm extremes, greater floods, and longer droughts.

22 While there is much uncertainty about how climate change will affect the overall amount of precipitation
23 in California, there is general agreement that climate change will affect both the timing and form of
24 precipitation. Climate change studies indicate that more precipitation will fall in the form of rain instead
25 of snow and that higher temperatures will cause earlier snowmelt. The results of these changes in
26 precipitation form and timing will be a decrease in the overall snowpack storage, as well as earlier and
27 greater runoff from both rainfall and earlier snowmelt.

28 Climate Change Adaptation

29 Most of California's major surface water reservoirs are managed for multiple benefits, but are primarily
30 managed for water supply and flood protection. During the winter, when storms are common, flood
31 protection takes priority and this drives reservoir operation decisions. For the rest of the year, when
32 storms are uncommon, water supply, water quality, and ecosystem management drive reservoir operation
33 decisions.

34 As runoff patterns shift to occurring earlier in the year, more and more runoff will arrive during the flood
35 operations period. Much of this water will need to pass through reservoirs, it will not be stored, and this
36 allows the reservoirs to maintain adequate flood protection space. By the time the flood protection season
37 ends, much of the runoff will have already passed through the reservoirs and will not be available in
38 storage for use later in the year, which is during peak water demand periods.

1 In addition to changes in precipitation timing and form as a result of climate change, studies indicate that
 2 sea levels may rise by as much as 55 inches at the Golden Gate Bridge by 2100. Sea level rise would
 3 increase salinity in the Delta, requiring larger amounts of fresh water to control salinity for SWP, CVP,
 4 and other Delta water user operations. Delta salinity requirements are one of the primary constraints
 5 guiding the operation of the SWP and CVP systems.

6 System reoperation measures that primarily use existing storage infrastructure and conveyance systems,
 7 such as conjunctive use of surface water and groundwater, could help reduce climate change impacts such
 8 as reduced snowpack, more precipitation in the form of rain, and early snow melt. For example, by
 9 moving water to groundwater banking sites in the fall, reservoir levels could be lowered further so that
 10 excess water during the winter and spring could be stored in the reservoirs. This early reservoir drawdown
 11 would increase flood storage capacity and therefore improve flood protection. In turn, the water stored in
 12 groundwater banking sites would help supplement summer water supplies and decrease the reliance on
 13 reduced snowpack runoff.

14 Large-scale system reoperation measures, such as conjunctive use of surface water and groundwater,
 15 provide opportunities to adapt operations to climate change with an efficient and consistent approach.

16 **Climate Change Mitigation**

17 Mitigation is accomplished by reducing or offsetting greenhouse gas (GHG) emissions to lessen
 18 contributions to climate change. System reoperations can lead to emission reductions or emission
 19 increases, depending on the goals of the reoperation and whether climate change is considered during
 20 planning. For example, reoperating systems in a way that maximizes hydroelectric power generation
 21 would allow water managers to produce clean, renewable energy, thus reducing the need for GHG-
 22 intensive energy produced from burning of fossil fuels. However, because climate change is expected to
 23 bring larger, more intense precipitation events, reoperating the systems to provide additional flood
 24 protection benefits through the early release of water may decrease water availability during the summer
 25 months when water and electricity demands are highest, which could result in water pumping, water
 26 imports, and therefore increase the purchase of GHG-intensive energy sources. Reoperating systems that
 27 keep GHG emissions to the minimum of what is necessary to operate would be the best way to meet the
 28 needs of all parties while mitigating for climate change.

29 **Major Implementation Issues**

30 **Physical Constraints**

31 The capacity of existing infrastructure, such as storage and conveyance, could limit system reoperation
 32 opportunities to make water transfers, conduct conjunctive water management, and refine flood
 33 operations. Future studies should focus on eliminating infrastructure constraints in order to add flexibility
 34 to systems.

35 **Institutional Constraints**

36 Although there are numerous institutional arrangements that help water resource projects function
 37 together as a system, these same institutional arrangements present some very inflexible constraints that
 38 make it difficult and time consuming to consider the reoperation potential of an entire system. Some of
 39 the relevant institutional constraints and the challenges they present are listed below.

- 1 • California’s priority system for surface water rights, including area-of-origin water rights,
2 presents complications for large-scale changes.
- 3 • Contractual obligations for water deliveries largely constrain the operations of many projects.
- 4 • Flood rule curves mandate the reservation of flood control space during the flood season.
5 Changing rule curves would require congressional approval, which is a difficult and time-
6 consuming process.
- 7 • Coordinated operating agreements already govern the operation of multiple projects (e.g., the
8 agreement that governs SWP and CVP operations).
- 9 • Changes in federal project purposes require congressional approval.

10 Integrating Water Resource Management

11 California water resources management involves many tiers and players. Facilities are operated for local,
12 regional, or nearly statewide beneficial uses. Implementing large-scale system reoperation would involve
13 a combination of regulatory actions by local, regional, State, and federal agencies.

14 Planning, Design, and Implementation Costs

15 As mentioned earlier in this chapter, significant up-front and ongoing costs can be involved with system
16 reoperation, as with the planning, design, and implementation of any large-scale infrastructure project.

17 Up-front planning and design costs might include such items as data collection, hydrologic and hydraulic
18 model development, decision support systems development, and environmental documentation necessary
19 just to evaluate the benefits and impacts of proposed reoperation strategies through the feasibility study
20 level. Tangible implementation costs would be associated with the actual removal, modification, or
21 construction of any infrastructure.

22 Water management agencies might have difficulty raising needed funds for feasibility-level studies and
23 implementation due to existing contracts or regulations that prohibit them from increasing water or energy
24 rates. As with implementing any large-scale project, selling the project costs to those directly in line to
25 receive benefits is a foregone necessity.

26 Recommendations

27 The following recommendations can help facilitate reoperation to meet water supply reliability, flood
28 management, hydropower, water quality, ecosystem, and other objectives better.

- 29 1. State, federal, regional, and local agencies should collaborate on large-scale system reoper-
30 ation studies to pool resources and share benefits.
- 31 2. The State and federal water operators should encourage and expand the use of forecast-
32 based and forecast-coordinated reservoir operations.
- 33 3. The State should take the lead to establish a baseline hydrology applicable to large-scale
34 system reoperations modeling.
- 35 4. The State should fund reoperation studies of smaller regional water purveyors through the
36 Integrated Regional Water Management Grant Program.
- 37 5. The State should take the lead and develop an integrated water resources analytical tool to
38 support regional and statewide system reoperation analysis that balances water supply,
39 flood protection, water quality, and ecosystem needs. This tool would make the State a
40 leader in large-scale integrated water management.

1 **References**

2 **References Cited**

3 No references were cited within this chapter.

4 **Additional References**

5 California Department of Water Resources. 2011. *System Reoperation Program, Phase 1 - Plan of Study*.
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20 Yuba County Water Agency. 2008. *Forecast-Coordinated Operations of Lake Oroville and New Bullards*
21 *Bar Reservoir for Managing Major Flood Events*. January 2008 update. Marysville (CA): Yuba
22 County Water Agency. Prepared and produced by GEI Consultants Inc. [Brochure.] 8 pp.

Table 7-1 System Reoperation Measures and Concepts

<p>Integrate Groundwater and Surface Water Operations</p> <ul style="list-style-type: none"> • Integrate operations of reservoirs in the American River watershed with groundwater pumping operations of groundwater authorities in the Sacramento area near the American River. • Integrate operations of reservoirs in the Sacramento River watershed with groundwater pumping operations of the San Joaquin County groundwater users. • Integrate operations of reservoirs in the Sacramento River watershed with groundwater pumping operations in the San Joaquin River or the Tulare Basin groundwater users. • Reoperation and groundwater storage options to facilitate Bay Delta Conservation Plan solutions. • Integrate operations of reservoirs in the San Joaquin River watershed and groundwater pumping operations of the Merced district groundwater users using in lieu recharge. • Integrate operations of reservoirs in the San Joaquin River watershed and groundwater pumping operations of the Madera district groundwater users using active recharge. • Integrate operations of reservoirs in the San Joaquin River watershed and groundwater pumping operations of the Merced and Turlock district groundwater users.
<p>Integrate SWP, CVP, USACE, and Local Surface Water Operations</p> <ul style="list-style-type: none"> • Integrate CVP-SWP reservoir operations. • Integrate operations of CVP, SWP, and South of Delta export pumps. • Integrate operation of CVP reservoirs and USACE reservoirs. • Integrate CVP-SWP reservoir operations and local reservoir operations.
<p>Reactivate Floodplains for Improved Flood Hazard Reduction</p> <ul style="list-style-type: none"> • Reoperate flood control reservoirs in the Central Valley in conjunction with reactivated downstream floodplains.
<p>Reduce Physical Losses of Water Supply Through Transfer Facilitation</p> <ul style="list-style-type: none"> • Reduction in physical losses of water supply through transfer facilitation.
<p>Capture Flood Control Spills and Store Them in Quarries</p> <ul style="list-style-type: none"> • Divert American River flood flows into existing sand and gravel quarries in the Mather Field/Jackson Highway/Florin Road area.
<p>Improve Reservoir Operations Using Forecasting</p> <ul style="list-style-type: none"> • Implement forecast-based operations at CVP/SWP reservoirs in the Sacramento River watershed. • Implement forecast-based operations at locally-owned reservoirs. • Implement forecast-based operations in the Sacramento River watershed reservoirs. • Implement forecast-based water quality operations at CVP/SWP reservoirs. • Implement forecast-based water supply delivery releases at CVP/SWP reservoirs. • Implement forecast-based operations at CVP reservoirs in the San Joaquin River watershed • Implement forecast-based operations at locally-owned reservoirs in the San Joaquin River watershed. • Implement forecast-based operations at CVP and locally-owned reservoirs in the San Joaquin River watershed.

Table 7-2 Preliminary Reoperation Strategies

Reoperation of

- Shasta Reservoir
- Camanche Reservoir
- Oroville Reservoir
- Pardee Reservoir
- Folsom Reservoir
- New Exchequer Dam (Lake McClure)
- New Don Pedro Dam Reservoir
- Friant Dam (Lake Millerton)

Reactivate Floodplains for Improved Flood Management
and Ecosystem Restoration

Mechanisms to Facilitate Conservation Water Transfers

Systemwide Reoperation Strategies to Implement the
Solution Strategies of the Bay Delta Conservation Plan
(BDCP)

Integrate SWP and CVP Operations

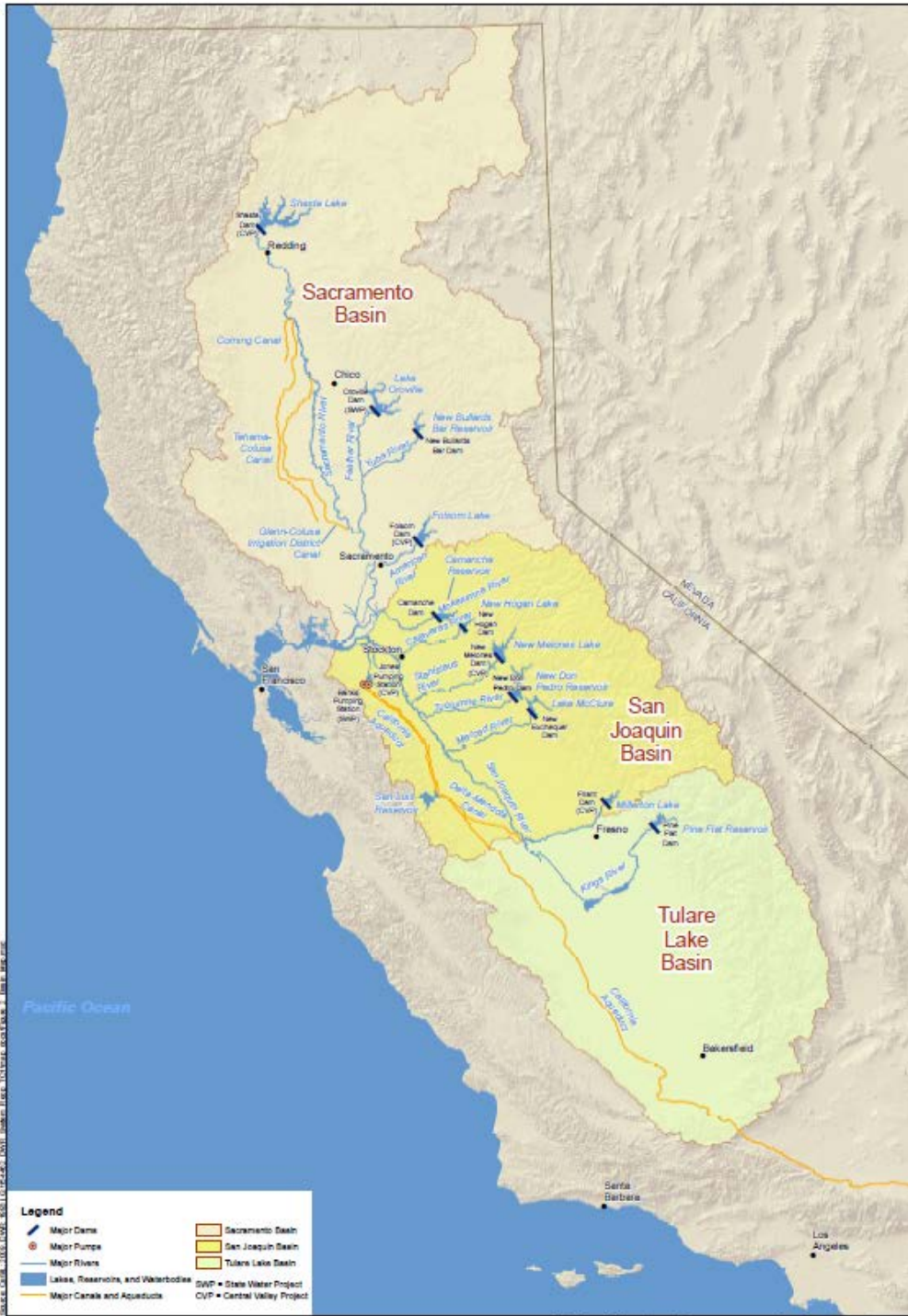
Table 7-3 Organizations Consulted During Phase 2

U.S. Bureau of Reclamation	Glenn-Colusa Irrigation District	Arvin-Edison Waters Storage District	Kern Water Bank Authority
SWP & CVP Operators	RD 108	Orange Co. Water District	San Gabriel Basin Water Quality Authority
U.S. Army Corps of Engineers	Madera Irrigation District	Water Replenishment District	The Nature Conservancy
Friant Water Authority	Turlock Irrigation District	Three Valleys Municipal Water District	California Water Plan – Stakeholder groups
East Bay Municipal Utility District	Semitropic-Rosamond Water Bank Authority	Calleguas Municipal Water District	Water Research Foundation
Merced Irrigation District	Metropolitan Water District	Raymond Basin Management Board	NOAA Fisheries
Modesto Irrigation District	North San Joaquin Water Conservation District	Inland Empire Utilities Agency	

Figure 7-1 Location of Local, State, and Federal Water Projects



Figure 7-2 Location of Central Valley and Study Area of System Reoperation Study



1 **Box 7-1 System Reoperation Measures and Concepts**

2 **Integrate Groundwater and Surface Water Operations**

- 3 • Integrate operations of reservoirs in the American River Watershed with groundwater pumping operations of
- 4 groundwater authorities in the Sacramento area near the American River.
- 5 • Integrate operations of reservoirs in the Sacramento River Watershed with groundwater pumping operations of the
- 6 San Joaquin County groundwater users.
- 7 • Integrate operations of reservoirs in the Sacramento River Watershed with groundwater pumping operations of the
- 8 San Joaquin River of the Tulare basin groundwater users.
- 9 • Integrate reoperation and groundwater storage operations to facilitate Bay Delta Conservation Plan solutions.
- 10 • Integrate operations of reservoirs in the San Joaquin River Watershed and groundwater pumping operations of the
- 11 Merced District groundwater users using in lieu recharge.
- 12 • Integrate operations of reservoirs in the San Joaquin River Watershed and groundwater pumping operations of the
- 13 Madera District groundwater users using active recharge.
- 14 • Integrate operations of reservoirs in the San Joaquin River Watershed and groundwater pumping operations of the
- 15 Merced and Turlock Districts' groundwater users.

16 **Integrate SWR, CVP, USACE, and Local Surface Water Operations**

- 17 • Integrate CVP-SWP reservoir operations.
- 18 • Integrate operations of CVP, SWP, and South of Delta export pumps.
- 19 • Integrate operation of CVP reservoirs and USACE reservoirs.
- 20 • Integrate CVP-SWP reservoir operations and local reservoir operations.

21 **Reactivate Floodplains for Improved Flood Hazard Reduction**

- 22 • Reoperate flood control reservoirs in the Central Valley in conjunction with reactivated downstream floodplains.

23 **Reduce Physical Losses of Water Supply through Transfer Facilitation**

24 **Capture Flood Control Spills and Store Them in Quarries**

- 25 • Divert American River flood flows into existing sand and gravel quarries in the Mather Field/Jackson
- 26 Highway/Florin Road area.

27 **Improve Reservoir Operations Using Forecasting**

- 28 • Implement forecast-based operations at CVP/SWP reservoirs in the Sacramento River Watershed.
- 29 • Implement forecast-based operations at locally-owned reservoirs.
- 30 • Implement forecast-based operations in the Sacramento River Watershed reservoirs.
- 31 • Implement forecast-based water quality operations at CVP/SWP reservoirs.
- 32 • Implement forecast-based water supply delivery releases at CVP/SWP reservoirs.
- 33 • Implement forecast-based operations at CVP reservoirs in the San Joaquin River Watershed
- 34 • Implement forecast-based operations at locally-owned reservoirs in the San Joaquin River Watershed.
- 35 • Implement forecast-based operations at CVP and locally-owned reservoirs in the San Joaquin River Watershed.
- 36

1 **Box 7-2 Preliminary Reoperations Strategies**

2 Reoperation of

- 3 • Shasta Dam
- 4 • Camanche Reservoir
- 5 • Oroville Reservoir
- 6 • Pardee Reservoir
- 7 • Folsom Reservoir
- 8 • New Exchequer Dam (Lake McClure)

9 Reactivate floodplains for improved flood management and ecosystem restoration

10 Develop mechanisms to facilitate conservation water transfers

11 Develop systemwide reoperation strategies to implement the solution strategies of the Bay Delta Conservation Plan (BDCP)

12 Integrate SWP and CVP operations

1 **Box 7-3 Organizations Consulted During Phase 2**

- 2 Arvin-Edison Waters Storage District
- 3 California Water Plan – Stakeholder groups
- 4 Calleguas Municipal Water District
- 5 East Bay Municipal Utility District
- 6 Friant Water Authority
- 7 Glenn-Colusa Irrigation District
- 8 Inland Empire Utilities Agency
- 9 Kern Water Bank Authority
- 10 Madera Irrigation District
- 11 Merced Irrigation District
- 12 Metropolitan Water District
- 13 Modesto Irrigation District
- 14 NOAA Fisheries
- 15 North San Joaquin Water Conservation District
- 16 Orange County Water District
- 17 Raymond Basin Management Board
- 18 RD 108
- 19 San Gabriel Basin Water Quality Authority
- 20 Semitropic-Rosamond Water Bank Authority
- 21 SWP & CVP Operators
- 22 The Nature Conservancy
- 23 Three Valleys Municipal Water District
- 24 Turlock Irrigation District
- 25 U.S. Army Corps of Engineers
- 26 U.S. Bureau of Reclamation