

Appendix B

Restoration Administrator 2010 Interim Flow Program Recommendations San Joaquin River: February 1 through December 1, 2010

**Water Year 2011 Interim Flows Project
Administrative Draft Supplemental Environmental
Assessment/Initial Study**



June 2010

January 20, 2010

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Subject: Restoration Administrator Recommendations for the 2010 Interim Flow Program (February 1 through December 1, 2010)

Dear Mr. Phillips:

I am pleased to submit the attached Restoration Administrator's recommendations concerning the above. My recommendations have been prepared with careful attention to being consistent with the relevant provisions of the Settlement Agreement, the San Joaquin River Restoration Settlement Act of 2009 and the State Water Resources Control Board's September 2009 conditional approval of the 2010 Interim Flow water releases.

As in the past, I have benefitted from the excellent technical support and recommendations that were provided by the Technical Advisory Committee. The attached RA recommendations confirm the TAC's recommendations concerning the priority information gathering objectives and the modeling and monitoring objectives. In addition, I have worked with the TAC and others to refine recommendations relating to a strategy for implementing Interim Flow water release volumes, magnitudes and a process for refining the future flow schedule/hydrograph for the 2010 water year as the rainfall season progresses.

I look forward to discussing these recommendations with you in the near future after you and your staff have an opportunity to review these recommendations. Please contact me with any questions that may arise.

Best regards,

A handwritten signature in blue ink, appearing to read "R Meade, Jr.", with a stylized flourish at the end.

Roderick J. Meade, Jr.
Restoration Administrator

Attachment: Restoration Administrator 2010 Interim Flow Program Recommendations for the San Joaquin River: February 1 through December 1, 2010

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Restoration Administrator 2010 Interim Flow Program Recommendations

**San Joaquin River:
February 1 through December 1, 2010**



Prepared for:

**The Secretary of the Interior
and
San Joaquin River Restoration Program Manager**

Prepared By:

**Roderick J. Meade, Jr.
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January 2010

TABLE OF CONTENTS

EXECUTIVE SUMMARY.....	iii
1. INTRODUCTION AND PURPOSE	1
1.1. Scope and Content of the RA Recommendations	2
1.2. Consistency of the RA Recommendations with the Requirements of the Settlement and Applicable Statutory and Regulatory Requirements	2
1.2.1. <i>Settlement Agreement Requirements.....</i>	<i>2</i>
1.2.2. <i>San Joaquin River Restoration Settlement Act (Act).....</i>	<i>3</i>
1.2.3. <i>State Water Resources Control Board (SWRCB) Permit Approvals.....</i>	<i>3</i>
1.2.4. <i>Other Potential Regulatory Requirements</i>	<i>4</i>
2. PRIORITY INFORMATION NEEDS AND OBJECTIVES	5
3. MODELING AND MONITORING RECOMMENDATIONS	8
3.1. Modeling Recommendations.....	8
3.2. Monitoring Recommendations	8
3.2.1. <i>Streamflow monitoring (Reach 1-5).....</i>	<i>9</i>
3.2.2. <i>Water Temperature Monitoring (Reach 1-5).....</i>	<i>10</i>
3.2.3. <i>Flow Versus Fish Habitat Assessment (Reach 1-5).....</i>	<i>12</i>
3.2.4. <i>Hydraulic Monitoring for Adult Chinook Salmon Passage (Reach 1-5).....</i>	<i>12</i>
3.2.5. <i>Flow Accretions/Losses Monitoring (Reach 1B, 2, 4A, and bypasses)</i>	<i>13</i>
3.2.6. <i>Seepage Monitoring (Reach 2, 3, and 4A).....</i>	<i>14</i>
3.2.7. <i>Shallow Groundwater Monitoring (Reach 2, 3, and 4A).....</i>	<i>15</i>
3.2.8. <i>Fine and Coarse Sediment Transport Monitoring (Reach 1A).....</i>	<i>15</i>
3.2.9. <i>Water Surface Elevation Monitoring (Reach 1-5).....</i>	<i>16</i>
4. RECOMMENDED INTERIM FLOW RELEASES FROM FRIANT DAM... 18	18
4.1. Recommended Interim Flow Release Volumes	18
4.1.1. <i>Settlement Interim Flow Period: February 1 to December 1, 2010.....</i>	<i>18</i>
4.1.2. <i>2010 Interim Flow Releases Covered by the Final EA/IS and the SWRCB approvals for Petetions 11885, 11886, and 11887.....</i>	<i>19</i>
4.2. Maximum Sustained Interim Flow Release Magnitudes	20
4.3. Illustrative Interim Flow Release Hydrographs.....	20
4.3.1. <i>Normal-Wet Year Flow Schedule (Figure 1)</i>	<i>22</i>
4.3.2. <i>Normal-Dry Year Flow Schedule (Figure 2).....</i>	<i>23</i>
4.3.3. <i>Dry and Critical-High Year Flow Schedules (Figures 3 and 4).....</i>	<i>24</i>
4.4. Downstream Extent of Interim Flows.....	24
4.5. Recommendations Related to Downstream Interim Flow Targets.....	26
5. ADDITIONAL RECOMMENDATIONS	27
6. REFERENCES.....	28

APPENDICES

Appendix A. 2010 Interim Flow information needs and experimental studies.	29
Appendix B. Illustrative Hydrograph Daily Flows for a Normal-Wet Water Year	33
Appendix C. Illustrative Hydrograph Daily Flows for a Normal-Dry Water Year	38
Appendix D. Illustrative Hydrograph Daily Flows for a Dry Water Year	43
Appendix E. Illustrative Hydrograph Daily Flows for a Critical-High Water Year	48

LIST OF FIGURES

<i>Figure 1. RA Illustrative Interim Flow Release Volumes for February 1 – December 1, 2010 in an assumed Normal-Wet water year.</i>	<i>23</i>
<i>Figure 2. RA Illustrative Interim Flow Release Volumes for February 1 – December 1, 2010 in an assumed Normal-Dry water year.....</i>	<i>24</i>
<i>Figure 3. RA Illustrative Interim Flow Release Volumes for February 1 – December 1, 2010 in an assumed Dry water year.</i>	<i>25</i>
<i>Figure 4. RA Illustrative Interim Flow Release Volumes for February 1 – December 1, 2010 in an assumed Critical-High water year.....</i>	<i>25</i>

LIST OF TABLES

<i>Table 1. Summary of Recommended Thermistor Locations for Interim Flows.....</i>	<i>11</i>
<i>Table 2. Comparison of Riparian, Interim Flow and Total Friant Dam Releases for the Period February 1 – December 1, 2010 by Water-Year Type.....</i>	<i>19</i>
<i>Table 3. Comparison of Exhibit B Flow Volumes and Recommended “Capped” Restoration Flow Volumes by Water-Year Type.....</i>	<i>19</i>
<i>Table 4. Comparison of Recommended Interim Flow Volumes and Riparian Flow Release Volumes with EA/IS evaluation volumes for the February 1 – September 30, 2010 period.....</i>	<i>20</i>

EXECUTIVE SUMMARY

The Settlement Agreement declares that the Restoration Administrator (RA):

... in consultation with the Technical Advisory Committee, the Secretary and other appropriate federal, state and local agencies ... shall develop and recommend to the Secretary implementation of a program of Interim Flows in order to collect relevant data concerning flows, temperatures, fish needs, seepage losses, recirculation, recapture and reuse. (Settlement Agreement, Paragraph 15)

The transmitted RA recommendations address the 2010 Interim Flow releases and cover the period from February 1 through December 1, 2010. The Settlement requires that Interim Flows commence no later than February 1, 2010. The Settlement also sets forth terms and requirements that these Interim Flow recommendations must comply with. These consistency requirements are addressed in the RA Recommendations.

Not all recommendations considered by the TAC in October 2009 for submission to the RA received unanimous support. The TAC as a whole supported the recommendations on priority information needs and biological monitoring and modeling. There also was strong support for the proposed flow schedules contained in the October 2009 TAC draft Technical Memorandum, but not consensus. The RA is not required to obtain TAC agreement for recommendations submitted to the Secretary. However, the RA decided to delay preparation of these recommendations to allow time for: (a) additional consultation among the TAC and Settling Parties on alternative flow schedules; and (b) consultation among the Settling Parties on Settlement language relating to implementation of Interim Flow volumes and flow schedule. The additional consultation among the Settling Parties progressed to a point in late-December where the RA had as much guidance from the Settling Parties as possible within the limited time available. Accordingly, the RA proceeded to finalize these Interim Flow recommendations for 2010 for submittal to the Secretary of the Interior (Secretary).

Scope and Content of the RA Recommendations

The RA recommendations to the Secretary address the following topics:

- Recommended 2010 Interim Flow program objectives;
- Priority information needs and objectives;
- Modeling and Monitoring Objectives;
- Recommended Interim Flow volumes, release magnitudes and water release schedules for different water year types; and
- Other recommendations to assist the Secretary in implementing Interim Flows.

2010 Interim Flow Program Objectives

The purpose of the Interim Flow program that is being implemented through the year 2013, is to conduct research and gather information through systematic modeling and monitoring to enable Restoration Flows to be implemented in a manner that will enhance the prospect for achieving the Settlement's Restoration Goal. Within this context, the RA is recommending that the Secretary consider several specific high priority information

gathering objectives for proposed Interim Flow releases conducted from February 1 to December 1, 2010 (see Section 2 of the Recommendations). The RA also recommends that the staff install, test, calibrate and operate the instrumentation needed to gather the above information needs prior to commencement of the February 2010 Interim Flow releases.

Modeling and Monitoring Recommendations

Modeling

The RA recommends that the recently developed SJR5Q temperature model (SJRRP 2008) be run for the recommended Friant Dam Interim Flow water releases. The RA also recommends that the unsteady hydraulic model be run for the ascending portions of the recommended release benches illustrated in Figures 1-4 to predict flow routing and illustrate the expected resultant hydrograph at priority nodes in Reaches 1-5 (Gravelly Ford, Chowchilla Bifurcation Structure, below Mendota Dam, below Sack Dam, Sand Sough Control Structure, and Mariposa Bypass Structure).

Monitoring

The RA recommends that monitoring be conducted before, during, and after the 2010 Interim Flow releases to evaluate the priority study objectives, and to evaluate/validate the flow routing and water temperature model predictions. Specific monitoring recommendations address:

- Streamflow monitoring (Reaches 1-5);
- Water Temperature Monitoring (Reaches 1-5);
- Flow Versus Fish Habitat Assessment (Reaches 1-5);
- Hydraulic Monitoring for Adult Chinook Salmon Passage Assessment (Reaches 1-5);
- Flow Accretions/Losses Monitoring (Reach 1B, 2, 4A, and bypasses);
- Seepage Monitoring (Reaches 2, 3, and 4A);
- Shallow Groundwater Monitoring (Reaches 2, 3, and 4A);
- Fine and Coarse Sediment Transport Monitoring (Reach 1A); and
- Water Surface Elevation Monitoring (Reaches 1-5)

Recommended Interim Flow Releases from Friant Dam

The RA recommendations address several aspects of Interim Flow releases during 2010.

Recommended Interim Flow Release Volumes

Interim Flow release volumes for 2010 are affected by several factors, including:

- The water year type;
- The need to “cap” release volumes specified in Exhibit B of the Settlement due to downstream channel conveyance capacities; and
- The need to obtain additional environmental clearances and regulatory approval for Interim Flow water releases that would occur between October 1 and December 1 since these flows are not covered by either the Final EA/IS for the 2010 Interim Flows or the SWRCB approval received September 2009 for the 2010 Interim Flows.

The RA recommends maximum Interim Flow release volumes for four different water year types through December 1, and for the time period through September 30 that already has received regulatory approvals and is covered by the Final EA/IS. The RA also recommends that the Secretary expedite preparation of a supplemental environmental document and implementation of a strategy to obtain the necessary regulatory approval covering Interim Flows during October and November 2010.

Maximum Sustained Interim Flow Releases

Based on information from the SJRRP regarding downstream channel conveyance capacities, the RA recommends limiting the maximum sustained Interim Flow release from Friant Dam to 1,600 cfs in order to minimize the risk of material adverse impacts to downstream channel facilities and adjacent land ownerships. This recommendation is consistent with the latest staff estimates of downstream channel conveyance capacities that indicate the need to limit Friant Dam Interim Flow releases to a maximum sustained release of 1,660 cfs.

Illustrative Interim Flow Release Hydrographs

We do not know what water year type will be experienced in 2010. The RA recommends consideration of illustrative hydrographs addressing four (4) different water-year types that could be experienced during 2010: Normal-Wet, Normal-Dry, Dry and Critical-High water years (see Figures 1-4). Based on the volume and maximum sustained water release recommendations cited above and in the body of the recommendations, and the priority information needs and monitoring recommendations, the RA recommendations include flow schedule charts and detailed tabular summaries that identify daily flow rates and volumes for Interim Flows under each of the four illustrative water year types.

The four illustrative Interim Flow Schedules assume “stepped” increases in the amount of water that would be allocated for Interim Flow releases. These flow schedules also assume that the Reclamation Operator (RO) would know in advance the total rainfall/runoff for the year. Clearly, this will not be the case. Under the “stepped hydrograph” approach it is possible for relatively minor changes in the amount of precipitation/runoff to result in a water year type with significantly larger (*i.e.*, disproportionate) increase in the allocation of Interim Flow releases from Friant Dam and similarly disproportionate impacts to Friant water users. To address this potential for disproportionate allocations of water releases, the RA recommends implementing the “smoothed hydrograph” methodology that was agreed upon by the Settling Parties in December 2008. The “smoothed hydrograph” approach minimizes the potential for disproportionate commitments of Friant Dam water release volumes to the Interim Flows. As the water year progresses from February 1 to June 1, 2010, the RA recommends that the RO and RA cooperate to refine and implement the Interim Flow release schedule, with the understanding that the RO has the authority to make all decisions relating to operation of the Dam.

Downstream Extent of Interim Flows

Consistent with the Settlement, the RA recommends that the 2010 Interim Flow releases be routed downstream past Mendota Dam, past Sack Dam, through the Eastside and Mariposa

bypasses, into the downstream half of Reach 4B and past the confluence with the Merced River.

Downstream Flow Targets

While the latest conveyance capacity estimates for Reach 3 indicate a capacity of up to 1,300 cfs, staff are continuing to investigate the conveyance capacity in Reaches 3 and 4 of the River and landowner concerns about potential seepage impacts on adjacent agricultural lands. At this time, the information needed to justify a specific flow regime for Interim Flows below Mendota Pool is still being compiled and a specific flow staging schedule below Mendota Pool has not been determined.

Accordingly, lacking reliable information concerning potential impacts of higher flows in Reaches 3 and 4, the RA is not recommending specific target flows for Reaches 3 and 4 at this time. As Interim Flow monitoring information become available for Reaches 3 and 4, the RA recommends that Interim Flows be ramped up in stages and monitored to assure that flow increases would not result in material, unmitigated impacts to River facilities or adjacent landowners. If conditions permit, the RA recommends that flows into Reaches 3 and 4 ultimately be increased to the 1,225 cfs flows identified in Exhibit B of the Settlement.

Additional Recommendations

The RA recommends early completion of a functioning edition of the Restoration Flow Guidelines by the Secretary so that these guidelines can begin to be implemented during the 2010 Interim Flow process.

Finally, channel conveyance constraints below the Mendota Pool (Reaches 3 and 4) and the related need to carefully ramp up flows leaving the Mendota Pool create the likelihood that some of the Interim Flow releases from Friant Dam will be available for possible recapture and reuse. The RA recommends that the Secretary work with the Friant Water Users Authority to formulate an approach to implementing and documenting the recapture of any Interim Flow releases that do not flow beyond the Mendota Pool.

1. INTRODUCTION AND PURPOSE

The Settlement Agreement declares that the Restoration Administrator (RA) shall:

“ . . . in consultation with the Technical Advisory Committee, the Secretary and other appropriate federal, state and local agencies . . . shall develop and recommend to the Secretary implementation of a program of Interim Flows in order to collect relevant data concerning flows, temperatures, fish needs, seepage losses, recirculation, recapture and reuse.” (Settlement, Paragraph 15)

The RA recommendations contained in this submittal address the 2010 Interim Flow releases and, consistent with the Settlement Agreement (Settlement), address Interim Flow water releases from Friant Dam to the San Joaquin River during the period from February 1 through December 1, 2010. The Settlement sets forth terms and requirements for implementing the Interim Flow releases. Other statutory and regulatory requirements relating to Interim Flows also are identified and discussed in these RA Recommendations.

The RA has reviewed the October 2009 TAC recommendations to the RA covering 2010 Interim Flows and discussed these recommendations with the Technical Advisory Committee (TAC) and federal liaisons. The RA and conducted additional consultation with the TAC and agencies between October and the date of this submittal. The RA also discussed the draft RA recommendations with other interests prior to transmitting these Recommendations to the Secretary of the Interior (Secretary).

Not all recommendations considered by the TAC in October 2009 for submission to the RA received unanimous support. The TAC as a whole supported the recommendations on priority information needs and biological monitoring and modeling. There also was strong support for the proposed flow schedules contained in the October 2009 TAC draft Technical Memorandum, but not consensus. The RA is not required to obtain TAC agreement for recommendations submitted to the Secretary. However, the RA decided to delay preparation of these recommendations to allow time for: (a) additional consultation among the TAC and Settling Parties on alternative flow schedules; and (b) consultation among the Settling Parties on Settlement language relating to implementation of Interim Flow volumes and flow schedule. The additional consultation among the Settling Parties progressed to a point in late-December where the RA had as much guidance from the Settling Parties as possible within the limited time available. Accordingly, the RA proceeded to finalize these Interim Flow recommendations for 2010 for submittal to the Secretary of the Interior (Secretary).

These RA Recommendations are intended to assist the Secretary in implementing the Settlement. Under the terms of the Settlement, responsibility for implementing the Interim Flow program and all elements of the SJRRP is the responsibility of the Secretary and the Secretary of Commerce. Employees from other appropriate agencies have been designated to provide assistance in implementing the Settlement. These individuals make up the Program Management Team (PMT). The PMT consists of five state and federal agencies (Implementing Agencies): the U. S. Bureau of Reclamation (Reclamation); U. S.

Fish and Wildlife Service (USFWS); National Marine Fisheries Service (NMFS); California Department of Water Resources (DWR); and California Department of Fish and Game (DFG). Accordingly, implementing RA recommendations that are accepted by the Secretary become the responsibility of the Secretary and the PMT.

1.1. Scope and Content of the RA Recommendations

This report transmits RA Recommendations to the Secretary that address the following topics:

- Recommended 2010 Interim Flow Program Objectives;
- Recommended Interim Flow Release Schedule;
- Priority Information Needs;
- Modeling and Monitoring Objectives; and
- Other recommendations intended to assist in implementing Interim Flows in an effective manner.

While the RA is tasked with preparing and submitting Interim Flow program recommendations to the Secretary, the Secretary ultimately will determine how Friant Dam will be operated and how the Interim Flows will be monitored and managed as they flow to the confluence of the San Joaquin River with the Merced River. The Secretary will evaluate the RA's recommendations and determine whether these recommendations are consistent with the Settlement, the San Joaquin River Restoration Settlement Act of 2009 and other requirements discussed herein.

If the Secretary determines that the RA recommendations are consistent with applicable requirements, it is anticipated that these RA recommendations will be implemented as submitted depending on actual conditions along the San Joaquin River and downstream land ownerships adjacent to the River. Thus, implementation of Interim Flow releases will continue to be a coordinated and collaborative process involving the RA, the PMT and, as appropriate, other affected parties to assure that material adverse impacts to downstream users and adjacent landowners do not occur.

Future RA recommendations will be transmitted to the Secretary relating to implementing the Interim Flow program for Water years 2011 through 2013. No later than January 1, 2014, the Settlement requires that the Restoration Flow program commence. The RA, in consultation with the TAC and local, state and federal agencies, will continue to submit recommendations to the Secretary throughout the process of implementing the Restoration Flow component of the Settlement.

1.2. Consistency of the RA Recommendations with the Requirements of the Settlement and Applicable Statutory and Regulatory Requirements

1.2.1. Settlement Agreement Requirements

Paragraph 15 of the San Joaquin River Restoration Program (SJRRP) Settlement Agreement (Settlement) requires that the Restoration Administrator (RA) prepare recommendations to the Secretary for a program of Interim Flows to address areas of scientific uncertainty

(i.e., flows, temperatures, fish needs, seepage losses, recirculation, recapture, and reuse). Information acquired by the study program for Interim Flows will provide the technical foundation for preparing and refining future Restoration Flow recommendations prepared by the TAC and RA.

Paragraph 15 of the Settlement also requires that the Interim Flow program shall include releasing flows identified in Exhibit B of the Settlement to the extent that such flows would not:

- Impede or delay completion of measures specified in Paragraph 11(a) of the Settlement; or
- Exceed downstream channel capacities.
- The RA Recommendations contained are formulated to be consistent with all Settlement requirements.

1.2.2. San Joaquin River Restoration Settlement Act (Act)

In addition to Settlement requirements, the Interim Flows also must be consistent with the provisions of the Act. The San Joaquin River Restoration Settlement Act includes a number of requirements applicable to the Interim Flow program, including those which require the Secretary to:

- identify impacts and measures which shall be implemented to mitigate impacts on adjacent and downstream water users and landowners (Sec. 10004(d));
- avoid involuntary reductions in contract water allocations to Central Valley Project long-term contractors, other than Friant Division long-term contractors (Sec. 10004(f);
- prepare a study in compliance with NEPA including at a minimum (Sec. 10004(h)(1) and (3)):
 - an analysis of channel conveyance capacities and potential for levee or groundwater seepage
 - a description of the associated seepage monitoring program
 - an evaluation of possible impacts associated with release of Interim Flows and mitigation measures for those impacts
 - a description of the associated flow monitoring program
 - an analysis of the likely federal costs, if any, of any fish screens, fish bypass facilities, fish salvage facilities and related operations on the San Joaquin River south of the confluence with the Merced River
- reduce Interim Flows to the extent necessary to address any material adverse impacts to third parties from groundwater seepage caused by such flows

The RA recommendations contained are formulated to be consistent with all provisions of the Act.

1.2.3. State Water Resources Control Board (SWRCB) Permit Approvals

To enable implementation of the 2009 and 2010 Interim Flow releases from Friant Dam, the SJRRP PMT submitted three Petitions for SWRCB approval (Petitions 11885, 11886

and 11887). The SWRCB reviewed and conditionally approved these three Petitions prior to commencement of the Interim Flows on October 1, 2009, and the approvals covered both the fall 2009 Interim Flows and those that would occur commencing February 1 and continuing through September 30, 2010. Conditions adopted by the SWRCB addressed the permitted volume, timing and magnitude of Interim Flows. Other conditions addressed monitoring and reporting requirements during implementation of the Interim Flows.

The RA recommendations contained are formulated to be consistent with the conditions of approval and other requirements set forth in the SWRCB approval.

1.2.4. Other Potential Regulatory Requirements

The Interim Flow releases addressed by these RA recommendations include water releases from Friant Dam through December 1, 2010. Both the existing SWRCB approvals and the EA/IS for the 2010 Interim Flow Program cover Interim Flows only through September 30 of this year.

During implementation of the 2010 Interim Flows through September 30 additional regulatory review and monitoring of “on the ground” conditions could result in conditions or actions requiring additional regulatory actions or mitigation measures. However, it is certain that Interim Flows recommended during the months of October and November of this year will require additional environmental review and additional approvals from the SWRCB in order to be implemented. The RA recommends that the Secretary expedite efforts to initiate a strategy to obtain the required environmental clearances and approval from SWRCB.

2. PRIORITY INFORMATION NEEDS AND OBJECTIVES

In addition to recommending Interim Flow releases in a manner that is consistent with the above requirements, the RA recommendations also are designed to optimize opportunities to systematically gather new understanding of the effects of Friant Dam water releases in downstream reaches of the San Joaquin River all the way to its confluence with the Merced River. The principle goal of the Interim Flow program is to gather as wide a range of information as possible prior to commencement of Restoration Flows so that the prospect of achieving the Settlement's Restoration Goal will be enhanced.

The RA recommendations for addressing information needs and identifying field monitoring objectives drew from the following key sources of information:

- The hydrographs defined in Exhibit B of the Settlement;
- Management objectives for hydrograph components in Exhibit B of the Settlement;
- The Priority Information Needs matrix (7-23-08 version) developed by the TAC;
- The TAC recommendations contained in the October 2009 TAC Technical Memorandum to the RA;
- Continuing RA consultation with the TAC after the October TAC recommendations; and
- Discussions with technical staff from Reclamation, DFG, DWR, Program consultants, and TAC federal liaisons.

The information needs to be addressed during the Interim Flow phase of the SJRRP focus on several significant gaps in our understanding of downstream flow-related relationships. These relationships include:

- stage-discharge relationships;
- flow-water temperature relationships;
- flow attenuation;
- flow accretions and depletions;
- flow-habitat relationships;
- seepage impacts; and
- sediment transport thresholds and rates.

The RA's overarching goal is for Interim Flow releases to be implemented in a manner that addresses the most important information needs within the limits imposed by existing constraints, including the water allocation for Interim Flows, downstream conveyance limits and potential for adverse impacts to downstream adjacent land ownerships. The flow releases should also be simple enough so as not to compromise the monitoring and research being conducted in the field.

The high priority information gathering objectives recommended by the RA for the 2010 Interim Flow releases (February 1 to December 1) from Friant Dam include:

- Identifying relationships between Friant Dam release flows and physical habitat characteristics (water depth, wetted cross section, water velocity, etc.) within Reach 1A related to adult salmonid holding, spawning, and juvenile rearing habitat;

- Identifying relationships between Friant Dam flow release magnitude, local flow magnitude, and inundated floodplain area to serve as an index of fry and juvenile salmon rearing habitat;
- Evaluating Exhibit B flow accretion and loss assumptions in Reach 1-4 by releasing various flow benches of sufficient duration to establish a hydraulic equilibrium between surface water and shallow groundwater at levels that do not impact adjacent agricultural operations;
- Documenting seepage locations and shallow groundwater elevations during sustained river flows, primarily in Reaches 2, 3, and 4;
- Documenting flow magnitude and timing in Reaches 1-5 as higher Interim Flows (and flood control releases, if they occur) route downstream, as well as provide field observations to validate the HEC-RAS unsteady flow model;
- Developing information on the relationship between river flow and water depths within the main river channel related to adult and juvenile salmon passage, and identification of flow thresholds that would be expected to avoid migration impediments and delays in passage;
- Monitoring sand transport rates in Reach 1 to begin evaluating flow release thresholds for sand movement, and relate flow release magnitude with sand transport rates; and
- Evaluating coarse sediment (gravel/cobble) transport thresholds and rates in Reach 1 if flood control releases occur by using a combination of tracer rocks and bedload transport measurements.
- Documenting water temperatures in Reaches 1-5 to relate to flow release magnitude and meteorological conditions, as well as to provide field observations to validate model-predicted relationships between river flow and water temperature.

Other important information gathering objectives include the following:

- Documenting water temperatures within the Friant-Kern Canal and at multiple levels within Millerton Lake (throughout the year) to calibrate and validate model predictions of the water temperature simulation that links the thermal dynamics of the reservoir with the dynamics of the downstream river reaches;
- Evaluating the response of native and non-native fishes and changes in their habitat and distribution in response to changes in river flows;
- Improving understanding of high flow recession ramping rates and potential juvenile salmon stranding risk by evaluating stage and changes in wetted channel width as a function of flow in Reach 1;
- Evaluating thermal dynamics and potential affects on habitat suitability for salmonids and predator dynamics by monitoring water temperature diversity and hydraulic mixing within captured or instream gravel pits;

The PMT staff should install, test, calibrate and be ready to operate the instrumentation needed to gather the above information needs at least two weeks prior to commencement of the February 2010 Interim Flow releases.

In addition to these scientific field-based objectives, the RA also recommends implementing the following procedural and process objectives:

- Evaluating and refining methods/protocols for 2010 monitoring and assessments;
- Identifying and resolving operational coordination issues and processes for implementing 2010 Interim Flows (February 1-December 1); and
- Providing a framework for interagency collaboration in planning, conducting, monitoring, assessing, and reporting test results.

3. MODELING AND MONITORING RECOMMENDATIONS

A combination of predictions prior to an experiment and monitoring during and after an experiment are integral components of adaptive management. PMT staff are developing a variety of models for use in the SJRRP, and the Interim Flow releases provides an opportunity to apply, calibrate, and/or validate these models. Therefore, the RA recommends that modeling efforts be conducted prior to the releases to refine expectations in flow routing and water temperature response downstream. The RA also recommends monitoring and assessment be conducted to address the 2010 Interim Flow objectives discussed in Section 3. Of this list, the RA recommends that the priority information needs for the 2010 release schedule are as follows:

1. Monitoring water temperatures in Reaches 1-5
2. Initiating development of flow-habitat relationships in Reach 1A
3. Evaluating assumptions on flow accretions and losses in Reach 1B, 2A, 3, 4A, and the Eastside and Mariposa Bypasses
4. Evaluating hypothetical adult salmon passage in Reaches 1-5
5. Evaluating flow routing through Reaches 1-5
6. Quantifying gravel-bed mobility thresholds and bedload transport rates in Reach 1A

The TAC (2009a) provided details on the scope of the monitoring program and the linkages between the objectives of the Interim Flow tests, the hypotheses to be tested, and how the resulting information could be used to inform future management decisions. Appendix A provides additional information on the linkages between the 2010 Interim Flow program objectives and the associated monitoring program experimental design. Information gained through the monitoring and testing program included in the fall 2009 Interim Flow tests (SJRRPRA 2009, SJRRPTAC 2009b) will provide valuable additional information that will be used by the RA and others to further refine the experimental program, objectives of the 2010 tests, monitoring protocols, and priorities for data analysis and application of results to inform future management decisions.

3.1. Modeling Recommendations

The RA recommends that the recently developed SJR5Q temperature model (SJRRP 2008) be run for the recommended Friant Dam release illustrated in Figures 1 through 4 under a several possible meteorological conditions that could be expected during the February 1-December 1 period (e.g., hot-dry to cool-moist). The RA also recommends that the unsteady hydraulic model be run for the ascending portions of the recommended release benches illustrated in Figures 1-4 to predict flow routing and illustrate the expected resultant hydrograph at priority nodes in Reaches 1-5 (Gravelly Ford, Chowchilla Bifurcation Structure, below Mendota Dam, below Sack Dam, Sand Sough Control Structure, and Mariposa Bypass Structure).

3.2. Monitoring Recommendations

Monitoring should be conducted before, during, and after the 2010 Interim Flow releases to evaluate the priority study objectives discussed above, and to evaluate/validate the flow routing and water temperature model predictions, and as needed, provide calibration

information that will improve future model predictions. The TAC and RA have provided recommendations (SJRRPRA 2009, SJRRPTAC 2009a, SJRRPTAC 2009b) regarding the locations and parameters of the monitoring program. Experience gained in the fall 2009 Interim Flow program will be used to further refine the monitoring objectives, locations, frequency, and protocols prior to initiating the 2010 Interim Flow program. A more extensive summary of 2010 Interim Flow information needs and related experimental studies is provided in Appendix A.

3.2.1. Streamflow monitoring (Reach 1-5)

Streamflows should be monitored on a 15-minute interval at the gaging stations listed in SJRRPTAC (2009a) using USGS or equivalent protocols (Carter and Davidian 1968, Buchanan and Somers 1968, Buchanan and Somers 1968). Flow data from these gaging stations will document flow magnitude and attenuation, travel times, duration, timing, and ramping rates at key locations, as well as enable evaluation of the flow routing model, provide input data to the water temperature model, and relate measured fish habitat to local flow. If any of these recommended gaging stations have not yet been installed, then the RA recommends that periodic field measurements of flow be conducted (e.g., every two weeks), and that the water surface elevation be surveyed at each flow measurement effort to begin developing a stage-flow rating curve at the site.

The strategy intended to achieve this 15-minute interval monitoring objective is: a) provide distinct 9-day benches to track travel times and attenuation downstream; b) use the continuous gaging station network to document travel times and attenuation; and c) calibrate/validate the HEC-RAS model to improve future flow routing predictions. There is no temporal specificity to address this objective, but it is recommended that it be done during the Spring Period release, as well as the fall pulse release.

The RA continues to recommend synoptic flow measurements in Reach 2A and 2B to address flow depletions, and expand these synoptic measurements to Reach 3 (at least 2 locations), 4A (at least 2 locations), Eastside Bypass (at least 2 locations), Mariposa Bypass (at least 1 location), and Reach 4B2 (at least 1 location). The RA recommends that the four 1999 Pilot Project monitoring sites (RM 224.1, RM 222.1, RM 219.5, and RM 217.7) be reoccupied and used for the synoptic flow measurement locations. The actual measurement sites in the various reaches will depend on landowner access and local site measurement conditions.

Because the flow loss rates in the various reaches are hypothesized to be greater in the first days/weeks when the pulse arrives (as the shallow groundwater table is recharged), the RA recommends that synoptic flow measurements be conducted more frequently at the beginning of each bench in the Interim Flow release. Synoptic flow measurements should be done more frequently once the pulse arrives at the upstream end of a monitoring reach, and with measurement frequency extended towards the end of the bench. The frequency of synoptic measurements should be defined based on results from the fall 2009 pulse flow release.

3.2.2. Water Temperature Monitoring (Reach 1-5)

Continuation of water temperature monitoring in the San Joaquin River will improve understanding of how water temperatures change in response to flow releases and meteorological conditions, and this improved understanding will be important to inform and refine flow releases to better achieve fishery restoration goals. Water temperature should continue to be measured in all reaches of the San Joaquin River as recommended in SJRRPTAC (2009 a, b) (Table 1). Water temperature monitoring probes should be installed at least two weeks prior to commencement of the February 2010 Interim Flow releases.

Because water temperature is anticipated to be a significant factor in restoring a self-sustaining population of salmon to the San Joaquin River (Stillwater Sciences 2003), collection of additional water temperature information in Reaches 1-5 during the juvenile/smolt outmigration period (March-May) is a high priority. Reclamation has developed a SJR5Q water temperature model for the San Joaquin River (SJRRP 2008), but additional flow-water temperature information is needed during a range of flow releases and meteorological conditions to calibrate that model and improve its predictive capability. The strategy to achieve this objective is: a) maintain release for 9-day periods in late March through mid May when juvenile rates salmon would be outmigrating to provide steady flows (if possible) in the different reaches; and b) sequentially maintain releases for 9-day periods at different flow rates (e.g., 500, 800 and 1,100 cfs) up to 1,600 cfs. This approach would provide water temperature data in multiple reaches for multiple flows over varying/warming meteorological conditions, thereby providing a large range of data to inform our understanding of temperature responses to future flow releases. There is temporal specificity to this recommendation, designed to observe how relationships between flow release magnitude and water temperature change under different meteorological conditions expected during the juvenile/smolt outmigration period (March-May). This flow-water temperature information will help guide future restoration planning and refinements to the water temperature model.

The RA also recommends that the water temperature monitoring currently being conducted in Millerton Lake to document seasonal changes in the cold water pool be continued. Water temperature profiles of Millerton Lake should assess the volume of the cold-water pool and changes in cold-water pool volume in response to atmospheric conditions (including monitoring weather conditions such as air temperature and wind speed), reservoir inflow, releases, diversions, and reservoir storage.

The RA recommends that thermal dynamics of gravel pits continue to be evaluated. While some information will be gained from the fall 2009 Interim Flows, substantially more valuable data will be collected in spring 2010 because the recommended flow releases in Figures 1 and 2 will be more variable than fall 2009, and will occur when more variable and warmer meteorological conditions will occur. Improving understanding of thermal dynamics of gravel pits will improve understanding of thermal warming caused by the pits, provide insight to potential juvenile salmon predation dynamics by piscivores, and contribute toward an overall evaluation of gravel pit remediation approaches.

Table 1. Summary of Recommended Thermistor Locations for Interim Flows

Location	Description	Operator	River Mile
SJR blw Friant Dam	Trench pool just under dam	DFG	267.2
SJR at Friant Bridge	Below bridge just below dam	DFG	266.6
SJR at Lost Lake	Downstream of Lost Lake Park	DFG	264.7
SJR at Willow Unit	Access from Vulcan Gravel site	DFG	260.9
SJR at Sportsman's Club	Upstream of boat launch	DFG	256.4
SJR at Hwy 41	At Hwy 41 Bridge	Reclamation	255
SJR Gravel pits below Hwy 41	Vertical and lateral array in gravel pits	Recommended	255-233
SJR at Milburn Unit	Underneath culvert	DFG	247.5
SJR at Camp Pashayan	Just upstream of Hwy 99 Bridge	DFG	243.2
SJR at Donny Bridge	At Donny Bridge	Reclamation	240.6
SJR at Skaggs Bridge	Upstream of bridge at Skaggs Park	DFG	234.5
SJR at Gravelly Ford	At Gravelly Ford gaging station	Reclamation	227.5
SJR blw Chowchilla Bifurcation	Downstream of Bifurcation Structure	Recommended	216
SJR near Mendota	Downstream of Mendota Pool	DFG	204.5
Delta Mendota Canal	In Delta Mendota Canal	DWR	N/A
SJR at Avenue 7.5	Under Avenue 7.5 Bridge	DFG	195.2
SJR blw Sack Dam	Immediately downstream of Sack Dam	DFG	182
SJR at Hwy 152	Below bridge at Hwy 152	DFG	173.9
SJR upstr of Washington Avenue	Upstream of Washington Avenue Bridge	DFG	169.1
Sand Slough Control Structure	In Sand Slough Control Structure	DFG	N/A
SJR at Washington Bridge	Under Washington Road Bridge	DFG	168.1
Eastside Bypass	In Eastside Bypass near town of El Nido	DFG	N/A
SJR in upper Reach 4B	Upper half of Reach 4B	Recommended	158 +/-
SJR abv Mariposa Bypass	At head gate of Mariposa Bypass	DFG	147.2
SJR blw Mariposa Bypass	Below Mariposa Bypass	Recommended	147.0
Salt Slough	Salt Slough at Hwy 165 Bridge	USGS	N/A
SJR blw Eastside Bypass	Downstream of Eastside Bypass confluence	Recommended	135.6
SJR abv Bear Creek	Upstream of Eastside Bypass confluence	DFG	135.8
SJR near Stevenson	At Hwy 165 Bridge	DWR	133
Mud Slough at Hwy 140	At Hwy 140 Bridge	DWR	N/A
SJR abv Merced R confluence	Upstream of Merced River confluence	DFG	118.5
SJR blw Merced R confluence	Downstream of Merced River confluence	Recommended	118.3

In addition to harboring fish species that prey on juvenile salmon, the large gravel pits in Reach 1 may also impair water temperatures in the mainstem San Joaquin River channel via accentuated thermal loading. It is also possible that an increase in flow releases will change the thermal regime in the gravel pits, which may affect the lateral and downstream distribution of piscivorous fishes that would tend to prey on juvenile salmon as they migrate downstream through the gravel pits. Increased flow release magnitude should reduce water temperature in the pits, which may redistribute warm-water piscivores and better isolate them from cold-water juvenile salmon. Understanding the thermal dynamics and potential changes in the distribution or abundance of predatory fish such as largemouth bass that inhabit the gravel pits as a function of increased flows will support a better assessment of the risk predation mortality may pose to restoring salmon populations.

3.2.3. Flow Versus Fish Habitat Assessment (Reach 1-5)

The RA recommends that the flow versus habitat relationship assessment be initiated during the WY2010 Interim Flows. As recommended by SJRRPTAC (2009a), effort should focus on flow versus habitat in Reach 1A over a range of flows using an appropriate methodology (e.g., 2-D hydraulic modeling coupled with habitat suitability criteria). The RA recommends that a technical feedback meeting be held to discuss different methodologies, data needs, spatial extent, range of flows, habitat suitability criteria, species and life stages, and other technical and logistical issues, then a draft study plan should be prepared for review and revision prior to initiating the assessment. The strategy to achieve this objective is: a) maintain release rates for 9-day periods that provide enough time for biologists to collect field data; and b) sequentially maintain releases for 9-day periods at different flow rates (e.g., 500, 800 and 1,100 cfs) up to 1,600 cfs to develop flow-habitat relationships for flows ranging from 90 cfs (minimum riparian release prior to or after Feb-Nov Interim Flow releases) up to 1,600 cfs. This approach would provide flow-habitat data in Reach 1A for multiple flows, thereby providing a large range of data to inform our understanding of habitat responses to future flow releases. There is no temporal specificity to address this objective, but it is recommended that it be done during the Spring Period release, as well as lower flows during the summer and fall. The RA also recommends that discussion include an assessment of flow versus habitat in Reaches 2-5 that focuses on inundated area as an index for juvenile salmon rearing habitat as recommended by SJRRPTAC (2009a).

3.2.4. Hydraulic Monitoring for Adult Chinook Salmon Passage Assessment (Reach 1-5)

In Reach 2A, Reach 4A, Reach 5 and certain structures within those reaches, the RA recommends evaluating flow magnitudes needed to avoid passage barriers or delays during future adult salmon migration. Therefore, the RA recommends that potential impediments to adult salmon passage in Reaches 1-5 and the Chowchilla, Eastside, and Mariposa bypasses be evaluated by first making a visual reconnaissance of potential adult Chinook salmon passage impediments or barriers identified in the Background Report (McBain & Trush 2002), Fish Management Plan (SJRRP 2009a), and the Fisheries Implementation Plan (SJRRP in prep). Based on this visual reconnaissance, if potential locations are deemed to be partial or full barriers to adult Chinook salmon passage, then hydraulic measurements

should be conducted to compare with hydraulic constraints for adult Chinook salmon migration. Both the visual reconnaissance and field-based hydraulic measurements should be conducted during flows expected for fall-run and spring-run Chinook salmon migration (350 cfs release to approximately 1,000 cfs). Hydraulic criteria for defining passage delay or barrier will be included in the Fisheries Implementation Plan. The strategy to achieve this objective is: a) maintain release rates for 9-day periods via Friant Dam releases (for Reach 2A) and coordination with Sack Dam diversions (for Reach 4A and 5) to provide steady flows (as is possible) that allow biologists to collect field data; b) identify 10 to 15 priority locations that may impede or delay fish passage; and c) collect flow depth and possibly velocity at those locations at a variety of flows. This approach would evaluate whether flow releases during the fall and spring adult Chinook salmon migration periods are adequate to prevent passage delay or barriers. There is no temporal specificity to address this objective, but it is recommended that it be done during the Spring Period release, as well as during the fall pulse release.

Interim Flows are not being released into the Chowchilla Bypass; however, in anticipation of future routing of flood control releases through all three bypasses, adult salmon may sometimes migrate through the Chowchilla Bypass. Therefore, the RA recommends that if flood control releases occur and a portion of the flood control release is routed into the Chowchilla Bypass, that structures within the bypass be evaluated along with those in the Eastside and Mariposa bypasses.

3.2.5. Flow Accretions/Losses Monitoring (Reach 1B, 2, 4A, and bypasses)

The RA recommends that the monitoring protocol recommended for the fall 2009 Interim Flows be continued and expanded as appropriate for 2010 Interim Flows (see SJRRPRA 2009 and SJRRPTAC 2009b). The RA recommends that monitoring flow accretions and losses in Reach 2A continue to be highest priority due to the large scale of flow depletions in that reach, and monitoring should be expanded to Reaches 1B, 4A, and the Eastside Bypass, and Mariposa Bypass. Accordingly, the RA recommends a higher level of effort in Reach 2A (at least four synoptic flow measurement locations in addition to the established gaging stations), and a slightly lower level of effort in the downstream reaches. As mentioned in SJRRPRA (2009) and SJRRPTAC (2009b), the releases monitored by the 1999 Pilot Project (FWUA and NRCD, 2002) were short-duration (three day benches), and there is remaining uncertainty on: (1) the actual volume of water required to achieve steady-state flow conditions in Reach 2 and 4A, (2) once steady-state flow conditions are achieved, the steady-state flow losses in Reach 2 to the local groundwater aquifer, and (3) whether the zero flow losses in Reach 4A and the Eastside and Mariposa bypasses assumed by the Settlement are accurate. Information collected during the fall 2009 Interim Flow program will help address some of these uncertainties in Reaches 1B and 2A, and will be used to refine the releases and associated monitoring included in the 2010 Interim Flow tests.

The strategy to achieve this objective for Reach 1B and 2 is: a) release 350 cfs through February to replenish the shallow groundwater table and route flow through Reach 2; b) maintain release rates for 9-day periods to provide enough time for steady state flows to occur in Reaches 1B and 2A and allow hydrologists to collect synoptic flow data; and c)

sequentially maintain releases for 9-day periods at different flow rates (e.g., 500, 800 and 1,100 cfs) up to 1,600 cfs to develop relationships between flow magnitude and flow losses. This approach would continue providing information on flow losses in Reaches 1A and 2A over a wider range of flows, and would allow comparison with a different antecedent condition (fully wetted) compared to the fall 2009 Interim Flow release. There is no temporal specificity to address this objective, but it is recommended that it be done during the spring release.

Given the continuing uncertainty of access to private properties in downstream reaches, there is uncertainty in where synoptic measurements can occur in Reach 4A and the Eastside and Mariposa bypasses. Therefore, the RA initially recommends the following locations (where there is existing public access) pending resolution of landowner access agreements:

1. Reach 4A at the Hwy 152 Bridge
2. Reach 4A at or immediately upstream of the Sand Slough Control Structure
3. Eastside Bypass at the DWR gage "ELN", downstream of Sand Slough Control Structure
4. Eastside Bypass immediately upstream of the Mariposa Bifurcation Structure (confirm that zero flow contribution through bifurcation structure into the downstream portion of the Eastside Bypass)
5. Mariposa Bypass above Sand Slough (confirm zero flow contribution from Sand Slough).

The strategy to achieve this objective in Reach 4A and the Eastside and Mariposa bypasses is: a) route as much of the Friant Dam release (up to 600 cfs) into Reach 4A in February and March to ensure replenishment of the shallow groundwater table and fully wetted channel conditions; b) provide 9-day benches via coordination with Sack Dam diversions that provide enough time for steady state flows to occur in Reach 4A and allow hydrologists to collect synoptic flow data; and c) release benches of multiple flows up to 1,300 cfs to develop relationships between flow magnitude and flow losses in Reach 4A, the Eastside Bypass, and the Mariposa Bypass. This approach would test assumptions in Exhibit B by providing information on flow accretions and losses in Reach 4A and Eastside and Mariposa bypasses over a range of flows. There is no temporal specificity to address this objective, but it is recommended that it be done during the Spring Period release.

3.2.6. Seepage Monitoring (Reach 2, 3, and 4A)

The RA recommendations of peak flow releases less than 1,600 cfs are to prevent flows from exceeding 1,300 cfs in downstream reaches (Figure 1 through 4). In addition, the RA recommends a gradual ascension of the flow release benches at 500 cfs, 800 cfs, 1,100 cfs, and 1,600 cfs is intended to allow seepage monitoring to occur prior to the next increase in flow release from Friant Dam. Assessment of the fall 2009 Interim Flow release should refine estimates of pulse travel time through Reach 2. Results of the 1999 Pilot Project (FWUA and NRDC 2002) suggested a 7-8 day travel time, but the dry conditions over the last three years may increase the travel time and duration of flow needed to route through Reach 2A beyond 7-8 days. The RA assumes that all flows reaching the Chowchilla

Bifurcation Structure (boundary between Reach 2A and 2B) will be routed into Reach 2B where seepage impacts could be greatest. The RA recommends that potential seepage impacts in Reach 2A, 2B, 3, and 4A be closely monitored during the spring rise and pulse flow period. The seepage monitoring objectives should be: 1) determine if seepage is occurring in areas where it has historically occurred during higher flows, 2) determine the location and scale of seepage (if it is occurring), 3) compare the elevation of the shallow groundwater table to the root depths of cultivated plants in agricultural lands adjacent to the river, 4) determine if the seepage impacts can be repaired or mitigated to allow continuation of the Interim Flows, 5) determine if Interim Flow releases from Friant Dam can continue to increase in magnitude up to 1,600 cfs, and 6) determine if Interim Flow release need to be stabilized or reduced in real time to prevent material and unmitigated impacts from occurring to adjacent agricultural lands.

Field inspections of seepage should, at minimum, include monitoring of newly installed shallow groundwater wells, daily patrols on both banks and coordination with landowners to inspect for seepage impacts, document the latitude and longitude coordinates of seepage locations, estimate the flow rate of seepage occurring at each location, describe the potential damage to adjacent lands caused by continued seepage, describe the prognosis of the seepage rates and damages with continued or increasing flow releases, describe whether the seepage impacts can be remedied or mitigated easily without requiring adjustments to the Interim Flow releases. Field inspections of historical high-risk seepage areas in Reaches 2A, 2B, 3 and 4A should be concentrated during the spring rise and pulse flow period (March-May) when seepage impact risk will be greatest. Daily reports from the field inspections should be promptly provided to the Reclamation Operator (RO), Program Manager, and RA.

3.2.7. Shallow Groundwater Monitoring (Reach 2, 3, and 4A)

The shallow groundwater and deeper groundwater monitoring of piezometers and wells described in SJRRPTAC (2009b) should be expanded to Reach 3 and 4A, with locations determined by landowner access, landowner input of higher risk seepage areas, and input from SJRRP staff. Shallow groundwater wells should extend down to approximately 20 ft below the river thalweg, should not have pumps co-located in the wells, and should be monitored year-round with a pressure transducer and datalogger on a 1-hour time step. Results of the shallow groundwater monitoring will contribute towards the seepage monitoring described above, and will inform riparian restoration potential on restored floodplain areas.

3.2.8. Fine and Coarse Sediment Transport Monitoring (Reach 1A)

The RA recommends that bedload transport sampling be conducted at a location in Reach 1A between Lost Lake Park and the confluence of Little Dry Creek to document coarse and fine sediment transport and evaluate assumptions in the Settlement and earlier analyses. The RA recommended flows for 2010 should transport sand as bedload, but will almost certainly not be large enough magnitude to mobilize and transport gravels or cobbles. Evaluating fine sediment transport thresholds in Reach 1A will identify what flow magnitude begins to transport sand out of the pools and across the riffles (potentially

impacting restored salmon spawning and rearing habitat), and evaluating fine sediment transport rates will help evaluate how the Restoration Flows may affect fine sediment storage in the primary adult spawning and juvenile rearing reach immediately downstream of Friant Dam. Addressing this latter question will require a quantitative estimate of existing fine sediment storage, as well as an estimate of fine sediment sources from the adjacent watershed downstream of Friant Dam. Reconnaissance assessments in Reach 1 indicate significant in-channel storage of sand and fine sediments (Stillwater Sciences 2003). Sand that is currently stored in pools and runs may be flushed downstream when the more sustained and higher Restoration Flows are released to the San Joaquin River. Understanding the potential for flows to mobilize and re-deposit sand in Reach 1A will inform potential improvements to pool and run habitat (potential oversummering habitat for yearling juvenile salmon), as well as riffles and pool tails (spawning habitat for adult salmon).

In anticipation of future flood control releases, the RA recommends that a more rigorous bedload transport monitoring study plan be prepared and contracted so that monitoring can occur if and when flood control releases occur. Bedload transport measurements should document both coarse and fine sediment transport rates in Reach 1A (e.g., cataraft-based sampling platform with a 6" Helley-Smith or TR-2 crane-deployed bedload sampler). This approach would further evaluate assumptions on geomorphic thresholds for various Friant Dam release magnitudes, and would begin providing field data to inform future coarse sediment management (e.g., spawning gravel augmentation) and fine sediment management (e.g., how will future restoration flows and flood control releases change fine sediment storage in Reach 1).

The strategy to achieve this objective is: a) install bed mobility experiments in Reach 1A riffles, bars, and pool tails prior to the potential flood control release season (February); b) if flood control releases occur, be prepared to collect bedload transport measurements in Reach 1A during flood control release(s); c) conduct fine sediment transport rate (bedload) monitoring in Reach 1A during the benches and flood control releases above 1,000 cfs, and d) use the continuous gaging station network to document peak flow magnitudes and durations to relate to field observations of geomorphic thresholds and rates. There is no temporal specificity to address this objective; however, fine sediment transport monitoring should be conducted during the Spring Period releases above 1,000 cfs, and during flood control releases if they occur (between February and June). It is recommended that planning, contracting, and experiment installation be conducted prior to February to ensure that data dependent on flows above 1,600 cfs (maximum recommended Interim Flow release) can be collected in the event that a flood control release occurs.

3.2.9. Water Surface Elevation Monitoring (Reach 1-5)

The RA recommends that water surface elevations should be surveyed in all reaches during the peak Interim Flow releases (less than 1,600 cfs bench) and any flood control releases exceeding the peak Interim Flow release as needed to help calibrate hydraulic models and evaluate stage-discharge relationships needed for the flow-habitat assessment. When combined with the local flow magnitude measurement representative of that water surface

elevation, it should be used to calibrate hydraulic models being developed by Reclamation and DWR. To help corroborate water surface elevations and inundation area predicted by the hydraulic model, the RA recommends that an aerial photograph be flown for Reaches 1-5 as the peak Interim Flow release routes through the system. Because the travel time of the peak flow release will be longer than the duration of the release itself, the aerial photograph flight will likely have to occur over several days.

4. RECOMMENDED INTERIM FLOW RELEASES FROM FRIANT DAM

The Settlement identifies required channel and other improvements that will be necessary to implement Restoration Flows downstream of Friant Dam. Absent these required Settlement improvements (see Paragraph 11 of the Settlement), it will be necessary to manage Interim Flows to be consistent with downstream channel capacities. This section discusses the RA recommendations concerning:

- Total Interim Flow volumes for different water years;
- Maximum sustainable release rates from Friant Dam;
- Illustrative Interim Flow schedules for different water year types;
- Extent of downstream Interim Flows; and
- Downstream Interim flow targets.

4.1. Recommended Interim Flow Release Volumes

Section 4.3 of the RA recommendations identifies “illustrative” Interim Flow schedules for four different water-year types: Critical-High, Dry, Normal-Dry and Normal-Wet water years (see Figures 1 through 4 in Section 4.3). The “illustrative” character is discussed in Section 4.3 because the actual daily flow releases and total release volumes during the 2010 Interim Flow period would be further refined through application of the “smoothed hydrograph” approach to determining daily Interim Flow volumes and magnitudes based on the actual runoff forecasts prepared by the RO between February and June.

A discussion of RA recommendations concerning Interim Flow release volumes requires acknowledgement of a discrepancy between the time periods for Interim Flow release analysis required by the Settlement (see Paragraph 15) and the existing environmental documentation and public agency approvals for Interim Flow releases that cover a period that extends only to September 30, 2010.

4.1.1. Settlement Interim Flow Period: February 1 to December 1, 2010

The total release volumes identified in the “illustrative” hydrographs (Figures 1 through 4) are the sum of the Riparian Release specified in Exhibit B of the Settlement and the RA’s recommended Interim Flow release (see Table 2). Based on downstream channel conveyance capacities and recent discussions among the Settling Parties relating to interpretation of specific Settlement provisions relating to Interim Flows, the RA is recommending total Interim Flow volumes that are different than the total Interim Flow volumes set forth in Exhibit B of the Settlement for the Normal-Dry and Normal-Wet water-year types (see Table 3). For these water-year types, the maximum sustained flows in Exhibit B would significantly exceed the PMT’s calculated maximum sustained flows of 1,660 cfs. In a Normal-Wet year the Exhibit B maximum sustained flows during the Spring Period (March-April) reach 4,000 cfs and for the Normal-Dry water year the Exhibit B Spring Period maximum sustained flows would be 2,500 cfs. For the Critical-High and Dry water-year types, the RA-recommended Interim Flow volumes are the same as provided for in Exhibit B of the Settlement because the maximum sustained Interim Flows in the Spring Period would not exceed the PMT’s 1,660 cfs maximum sustained flows and thus would be consistent with downstream conveyance capacities.

Table 2 – Recommended Interim Flow Volumes and Riparian Flow Release Volumes for February 1 – December 1, 2010.

Water Year	Riparian Release Volume	RA Interim Flow Release Volume	Total Release Volume from Friant Dam
Normal-Wet water year	103,656 ac-ft	229,359 ac-ft	333,025 ac-ft
Normal-Dry water year	103,656 ac-ft	192,327 ac-ft	295,983 ac-ft
Dry water year	103,656 ac-ft	155,286 ac-ft	258,942 ac-ft
Critical-High water year	103,577 ac-ft	70,304 ac-ft	173,881 ac-ft

Table 3 – Comparison of Recommended Interim Flow Volumes with Settlement Exhibit B Flow Volumes for February 1 through December 1, 2010.

Water Year	Recommended Interim Flow Volumes	Exhibit B Interim Flow Volumes	Difference Between RA Recommended and Exhibit B Flow Volumes
Normal-Wet water year	333,025 ac-ft	431,504 ac-ft	(98,479 ac-ft)
Normal-Dry water year	295,983 ac-ft	322,909 ac-ft	(26,926 ac-ft)
Dry water year	258,942 ac-ft	258,942 ac-ft	No difference
Critical-High water year	173,881 ac-ft	173,881 ac-ft	No difference

4.1.2. 2010 Interim Flow Releases Covered by the Final EA/IS and the SWRCB Approvals of Petitions 11885, 11886 and 11887: February 1 to September 30, 2010

The Final Environmental Assessment/Initial Study (EA/IS) for the 2010 Interim Flow releases evaluates Interim Flow releases for the period through September 30, 2010, not through December 1 of this year. The SWRCB conditional approvals of Petitions 11885, 11886 and 11887 also covers the Interim Flow releases for the period which ends on September 30, 2010. Thus, the Interim Flow releases pursuant to the Settlement and these RA recommendations that would occur during October and November will require additional environmental documentation and approval by the SWRCB. Table 3 identifies the total Interim Flows volumes for the period covered by the existing EA/IS and SWRCB conditional approvals and compares the RA recommendation with Exhibit B Interim Flows for the same time period.

Using the shorter February 1, 2010 through September 30, 2010 time period, the EA/IS evaluates Interim Flow releases up to 356,787 ac-ft. However, Table 4 illustrates that the effects that “capped” RA-recommended release volumes could have are less than the Proposed Action releases in the EA/IS for the Normal-Wet and Normal-Dry years. Thus, the recommended RA releases are consistent with the EA/IS environmental assessment (Table 4).

Table 4 – Comparison of Recommended Interim Flow Volumes and Riparian Flow Release Volumes with EA/IS evaluation volumes for the February 1 – September 30, 2010 period.

Water Year	Recommended Interim Flow Volumes to September 30	Exhibit B Interim Flow Volumes to September 30	Difference Between RA Recommended and Exhibit B Flow Volumes
Normal-Wet water year	283,041 ac-ft	381,521 ac-ft	(98,480 ac-ft)
Normal-Dry water year	246,000 ac-ft	272,926 ac-ft	(26,926 ac-ft)
Dry water year	208,959 ac-ft	208,959 ac-ft	No difference
Critical-High water year	153,332 ac-ft	153,332 ac-ft	No difference

4.2. Maximum Sustained Interim Flow Release Magnitudes

Based on the most recent information, the 2010 Interim Flows cannot exceed 1,300 cfs downstream of Reach 2A in order to be consistent with downstream channel conveyance capacity. By applying this conveyance capacity constraint and factoring in the expected riparian diversions in Reach 1 and the estimated Reach 2A flow losses (see Exhibit B of the Settlement), the PMT has calculated that the maximum sustained Friant Dam Interim Flow releases should not exceed a maximum flow rate of 1,660 cfs in order to limit flows to less than the 1,300 cfs channel capacity constraint encountered downstream of Reach 2A.

Based on consultation with the TAC, the RA recommends that maximum sustained Interim Flow releases from Friant Dam not exceed 1,600 cfs. Limiting sustained flow releases to less than 1,600 cfs provides flows sufficient to address priority information needs while also providing a modest safety margin in terms of the potential downstream Interim Flows impacts on channels and adjacent land ownerships by reducing the potential for seepage impacts on downstream land ownerships adjacent to Reaches 2 and 3. Maximum sustained Interim Flow recommendations for different water year types are addressed in the illustrative flow schedules included in the following section of these recommendations.

4.3. Illustrative Interim Flow Release Hydrographs

Because the 2010 water year type is unknown at this time, the TAC prepared four sets of Interim Flow recommendations for a Normal-Wet, Normal-Dry, Dry, and Critical-High water year (Figures 1 through 4). The hydrographs presented in Figures 1 through 4 are intended to provide guidance in the shape and magnitude of the hydrograph elements that meet the 2010 objectives listed in Section 3 above based on the 2010 water-year classification. The hydrographs are also responsive to the uncertainties and constraints that remain regarding channel conveyance and seepage constraints that may limit the maximum rate of releases. The daily Friant Dam release rates and predicted flows within each downstream reach are summarized for each of the recommended hydrographs in Appendices B through D.

Because one of the primary objectives of the Interim Flows is to collect data that fills information gaps and reduces scientific uncertainty needed to achieve restoration and

water management goals, the timing of the recommended release benches provide test conditions over a range of environmental and meteorological conditions that may be observed in future years. For example, there is uncertainty in how water temperatures will respond to flow releases during different times of the year. A temperature model has been developed, but calibration data is limited. By providing variable but comparable benches during different meteorological conditions, we can gather a considerable amount of water temperature data during the Interim Flow period (and prior to salmon reintroduction) to rapidly improve the predictive capability and accuracy of the temperature model. In contrast, if we released flows that are constant or without contrasting benches, we would gather much less data and it may take many years of data collection to provide a comparable level of temperature model calibration to a variable flow release approach.

Therefore, the RA recommends that daily average flow releases that follow the general timing of the releases shown in Exhibit B of the Settlement, but with some minor variation in timing if: (a) there is good scientific justification to do so, (b) the flow magnitude is less than approximately 1,600 cfs, (c) the timing of variable flows start after the March 16 as defined by the State Water Board Permit and end prior to the end of the May 28 flexible flow period defined by the Settlement, and (c) total release volume during the 2010 period does not exceed the allocations presented in Exhibit B of the Settlement or the capped volumes and maximum sustained flows described above in Sections 4.1 and 4.2. The illustrative examples provided in Figures 1-4 cannot reflect actual releases because the Interim Flow release volumes will evolve with each monthly updated water year forecast; therefore, the primary purpose of Figures 1-4 is to illustrate the strategy of flow releases recommended to address priority information needs listed in Section 3, and provide simplicity in the release schedules. The recommended release strategy is as follows:

- Release benches targeting flow magnitudes of 350 cfs, 500 cfs, 800 cfs, 1,100 cfs, and 1,600 cfs to evaluate water temperature changes, flow-habitat relationships, flow accretions and losses, hypothetical adult salmon passage, flow routing, and fine bedload transport rates;
- Benches should be paired on the ascending and descending limbs of the peak release in order to compare and contrast different (warming) meteorological conditions through the spring;
- Releases should only deviate from those illustrated in Exhibit B between March 16 and May 28;
- Limit ascending or descending limbs to less than or equal to 500 cfs/day;
- Benches should be at least 9 days in an attempt to reach steady-state conditions in Reach 2A, provide enough time during each pulse for field data collection by Program staff, and enable evaluation of seepage impacts in Reach 2B prior to commencing the next increase in Friant Dam release;
- Manage initial flow releases into Reach 3 and 4A to be approximately 600 cfs, and pending evaluation of potential seepage impacts to adjacent agricultural lands, incrementally increase flow releases in those reaches up to 1,225 cfs while avoiding potential seepage impacts to adjacent agricultural lands.

The four (4) “illustrative” Interim Flow Schedules identify “stepped” increases in the amount of water that would be released for Interim Flows as the total amount of rainfall/runoff information becomes available for 2010 Water-Year. These “stepped” allocations of water releases from Friant Dam would create conditions where it is possible for relatively minor changes in the amount of rainfall/runoff to result in a declaration of a water year type that would trigger a significantly larger (*i.e.*, disproportionate) increase in the allocation of Interim Flow water that would be released from Friant Dam and a similarly disproportionate reduction in the allocation to Friant water users. To address this potential for disproportionate commitments of water releases to the San Joaquin River, in December of 2008, the Settling Parties agreed upon a “smoothed hydrograph” allocation methodology that would serve to minimize the potential for disproportionate commitments of Friant Dam water release volumes to the Interim Flows and Restoration Flows. The RA recommends that the Secretary implement a water release schedule based on the “smoothed hydrograph” methodology that the Settling Parties have endorsed. As the water year progresses from February 1 to June 1, 2010, and the precipitation period progresses, the RO, other Reclamation staff and the RA will collaboratively work to update the Interim Flow schedule using the “smoothed hydrograph” approach to re-calculate the appropriate flow hydrograph using the most recent rainfall data and updated water-year type estimate. This collaboration will continue until approximately June 1, 2010, to assure that there is full understanding of the Water-Year type for 2010.

The RA/TAC will refine the 2010 Interim Flow recommendations to the Secretary based on the evolving water year forecasts in February-May, using a combination of simulation model results and monitoring results of the 2009 fall Interim Flow tests. Real-time flow management will be integral to future Interim Flow and Restoration Flow releases; therefore, the RA also recommends that Reclamation, in consultation with the RA, continue the real-time flow management initiated during the fall 2009 Interim Flow release.

The magnitude and timing of flow resulting from the 2010 Interim Flow releases will vary downstream due to riparian diversions, infiltration losses, return flows, and other variables. The RA recommends that as much of the Friant Dam releases as possible (given seepage and conveyance constraints) be routed to downstream reaches to improve information gathering and understanding in Reach 3, 4, and the Eastside and Mariposa bypasses.

4.3.1. Normal-Wet Year Flow Schedule (Figure 1)

Recommended flows under the Normal-Wet year hydrograph provide for a maximum sustained Interim Flow releases of up to 1,600 cfs and 333,025 ac-ft of water (see Figure 1). To support a robust analysis of flow-habitat relationships, flow-temperature relationships, seepage, and fine sediment transport relationships. The Normal-Wet hydrograph provides for an ascending limb with releases from Friant Dam of increasing flow benches starting at 350 cfs (February 1-28) followed by a 15-day 500 cfs bench, a 9-day 800 cfs bench, a 9-day 1,100 cfs bench and 25 days of sustained 1,595 cfs water releases. The descending limb of this hydrograph replicates the 1,100 cfs, 800 cfs and 500 cfs benches prior to returning to 350 cfs flow releases and the paired water release rates on the ascending and descending limbs of the hydrograph enable monitoring of conditions at the same flow rates

under different meteorological conditions. Although limited by the 1,595 cfs maximum flow release constraint, the flow ranges in the Normal-Wet hydrograph will provide useful information on habitat, water temperatures, and sand transport, and establish the basis for testing the response of system parameters when channel conveyance capacity is higher.

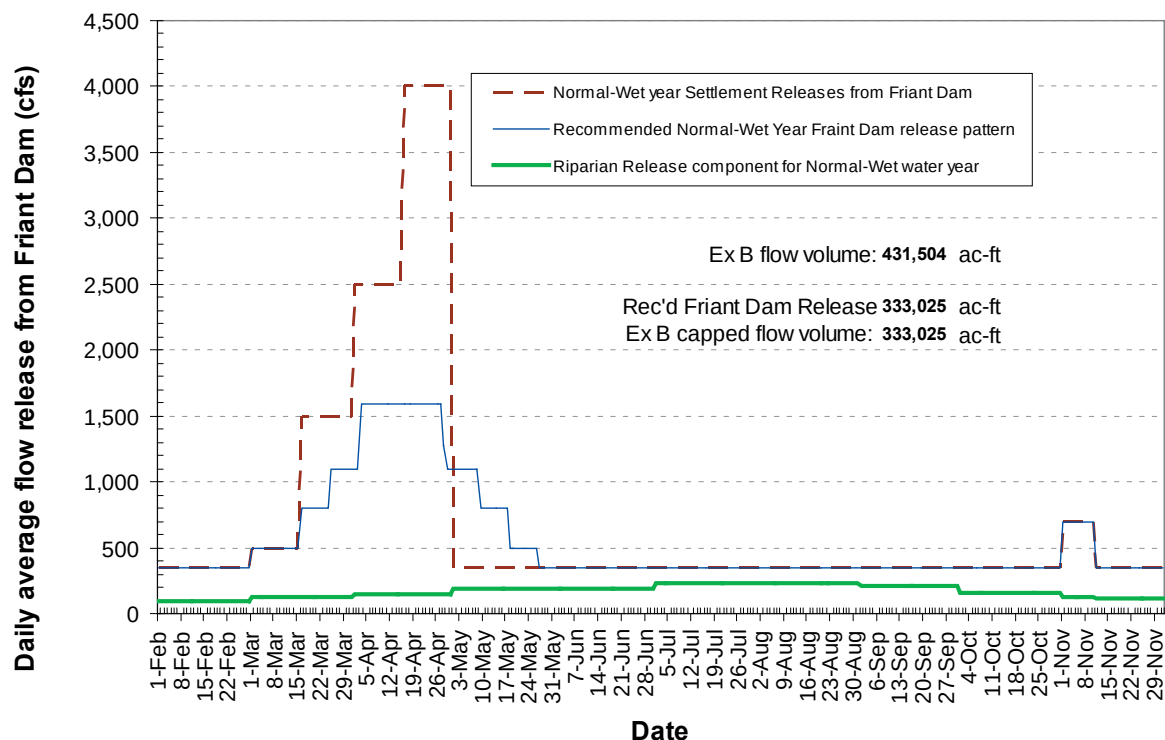


Figure 1 – RA Illustrative Interim Flow Release Volumes for February 1 – December 1, 2010 in an assumed Normal-Wet water year.

4.3.2. Normal-Dry Year Flow Schedule (Figure 2)

Recommended flows under the Normal-Dry year hydrograph provide for a maximum sustained Interim Flow releases of up to 1,595 cfs and 295,983 ac-ft of water (see Figure 2). To support a robust analysis of flow-habitat relationships, flow-temperature relationships, seepage, and fine sediment transport relationships. The Normal-Wet hydrograph provides for an ascending limb with releases from Friant Dam of increasing flow benches starting at 350 cfs (February 1-28) followed by a 15-day 500 cfs bench, a 9-day 800 cfs bench, a 9-day 1,100 cfs bench and 25 days of sustained 1,595 cfs water releases. The descending limb of this hydrograph replicates the 1,100 cfs, 800 cfs and 500 cfs benches prior to returning to 350 cfs flow releases. Although limited by the 1,595 cfs maximum flow release constraint reduced water allocation, the flow ranges in the Normal-Dry hydrograph will also provide useful information on habitat, water temperatures, and sand transport, and establish the basis for testing the response of system parameters when channel conveyance capacity is higher.

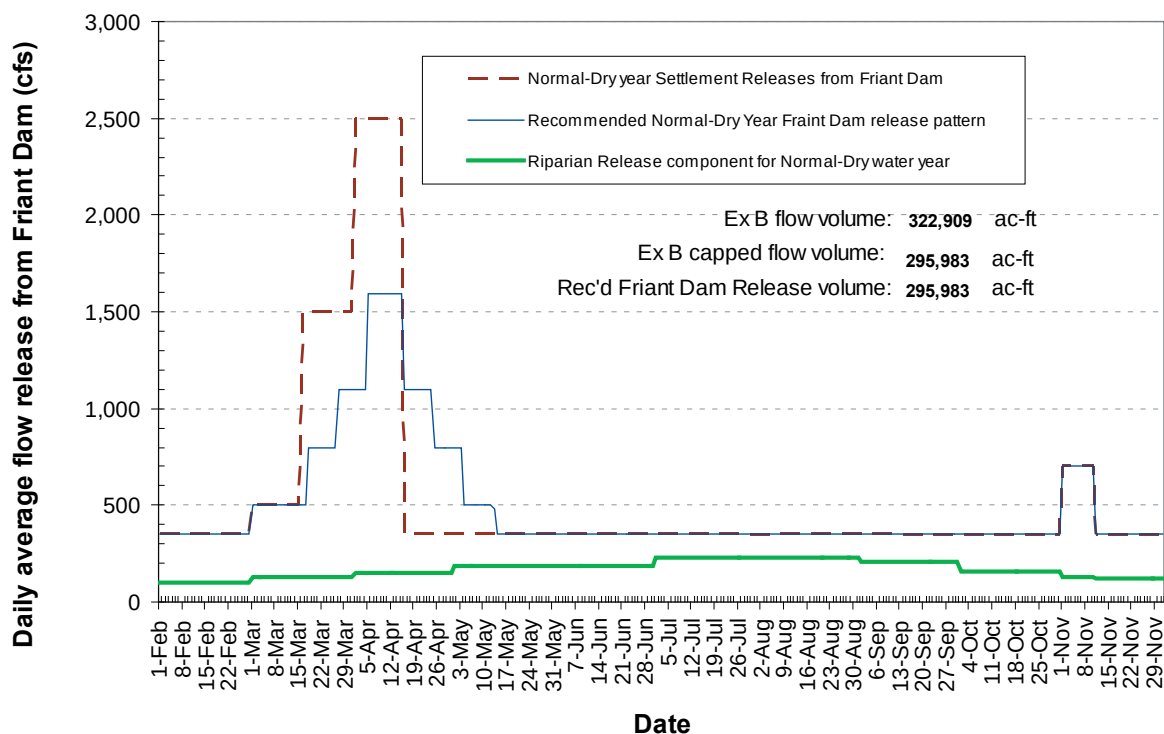


Figure 2 – RA Illustrative Interim Flow Release Volumes for February 1 – December 1, 2010 in an assumed Normal-Dry water year.

4.3.3. Dry and Critical-High Year Flow Schedules (Figures 3 and 4)

Because flow releases do not exceed 1,600 cfs in Dry and Critical-High water years, there is no need to reduce total Interim Flow volumes during these water year types. Further, the maximum sustained flow release is reduced to 1,100 cfs from the 1,595 cfs flow maximums in the Normal-Wet and Normal-Dry water years. As in the case of the first two hydrographs, these two hydrographs included paired flow benches at the 500 cfs and 800 cfs release rates to enable equal flow rates to be monitored under different meteorological conditions a few weeks apart. The Interim Flow waters made available by reducing the maximum sustained water release from Friant Dam from 1,500 cfs to 1,100 cfs enabled provision for paired benches on the ascending and descending limbs of the hydrograph.

4.4. Downstream Extent of Interim Flows

Consistent with the Settlement, the RA recommends that the 2010 Interim Flow releases be routed downstream past Mendota Dam, past Sack Dam, through the Eastside and Mariposa bypasses, into the downstream half of Reach 4B and past the confluence with the Merced River. Flow losses are expected to be greatest in Reach 2A. Flow accretions and losses are also expected in downstream reaches, and there is even less data available to estimate the location and magnitude of those possible accretions and losses. While these accretions and losses in downstream reaches are expected to be on a much smaller scale than Reach 2A, there is substantial need to gain a better quantitative understanding of the location and scale of those accretions and losses.

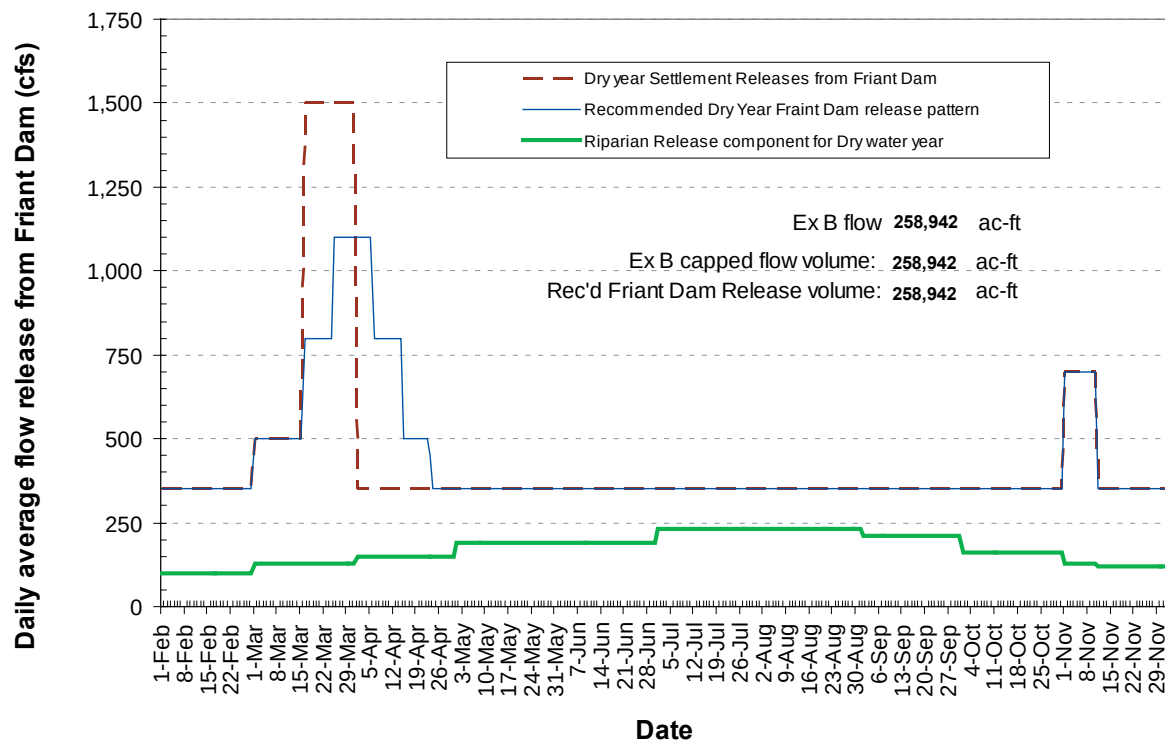


Figure 3 – RA Illustrative Interim Flow Release Volumes for February 1 – December 1, 2010 in an assumed Dry water year.

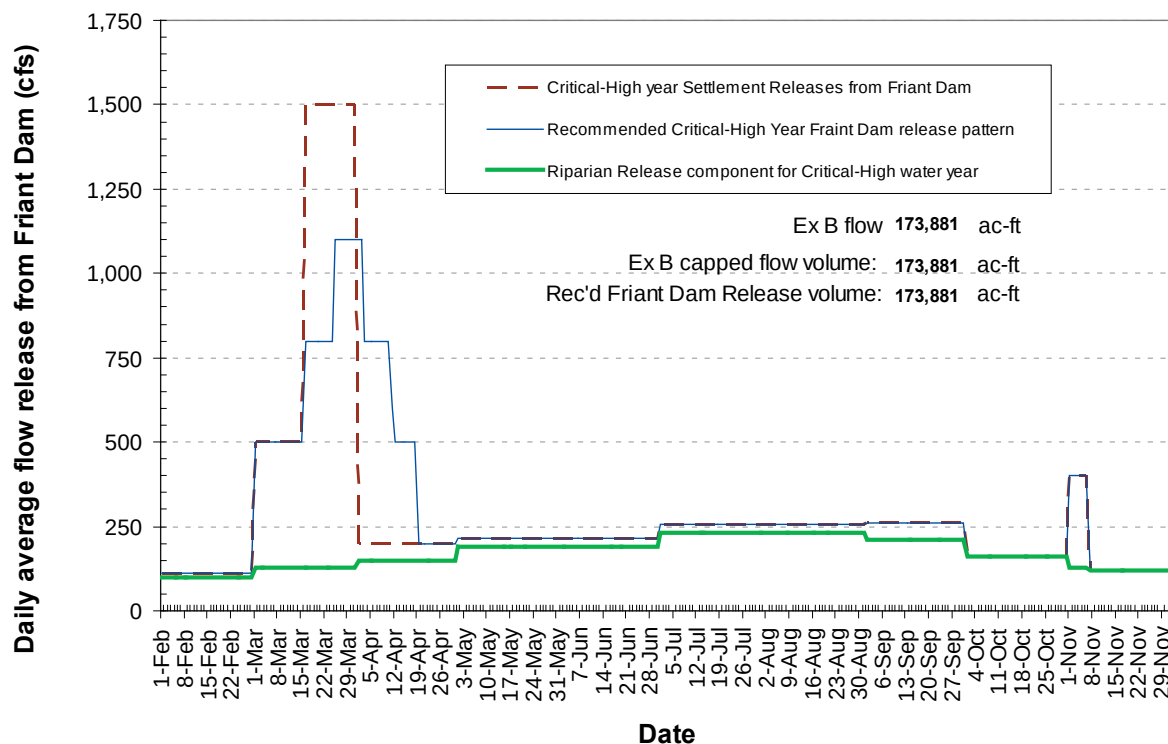


Figure 4 – RA Illustrative Interim Flow Release Volumes for February 1 – December 1, 2010 in an assumed Critical-High water year.

4.5. Recommendations Related to Downstream Interim Flow Targets

While the latest PMT conveyance capacity estimates for Reach 3 indicate a capacity of up to 1,300 cfs, PMT staff are continuing to investigate the conveyance capacity in Reaches 3 and 4 of the River and landowner concerns about potential seepage impacts on adjacent agricultural lands. At this time, the information needed to justify a specific flow regime for Interim Flows below Mendota Pool is still being compiled and the PMT has not decided on a specific flow staging schedule below Mendota Pool.

Accordingly, lacking reliable information concerning potential impacts of higher flows in Reaches 3 and 4, the RA does not recommend specific target flows for Reaches 3 and 4 at this time. As Interim Flow monitoring information become available for Reaches 3 and 4, the RA recommends that Interim Flows be ramped up in stages subject to monitoring results that support conclusions that flow increases that would not result in material, unmitigated impacts to River facilities or adjacent landowners. If conditions permit, the RA recommends that flows into Reaches 3 and 4 ultimately be increased to the 1,225 cfs flows set forth in Exhibit B of the Settlement.

5. ADDITIONAL RECOMMENDATIONS

The 2010 Interim Flow period will provide opportunities to learn how well the implementation process is working. Of particular concern to the RA are issues relating to:

- maintaining consistent communication between the RA, RO and PMT staff during this period, including timely and effective steps for refining the flow schedule; and
- implementing effective accounting procedures for tracking Interim Flows as they progress to and through the Mendota Pool to the confluence with the Merced River.

Reclamation is currently formulating Restoration Flow Guidelines (RFG) designed to define the process for implementing Restoration Flow releases from Friant Dam. The RA recommends that the Reclamation finalize the RFG as soon as possible to provide guidance to implementation of the Interim Flow releases during 2010. As part of the RFG it will be particularly important to clarify the roles of the RA, RO, PMT and other appropriate interests. In addition to clarifying the roles of involved entities, the RFG will need to establish the sequence of actions required by each party and the timelines for submittals by the RA, determinations by the RO and involvement of the PMT in decision-making. The RFG also should include provisions for updating, modifying and implementing both Interim Flows and Restoration Flows.

Finally, the channel conveyance constraints below the Mendota Pool (Reaches 3 and 4) and the need to carefully ramp flows leaving the Mendota Pool create the likelihood that some of the Interim Flow water released from Friant Dam will be available for possible recapture and reuse. The RA recommends that the Secretary work with the Friant Water Users Authority to formulate an approach to implementing and documenting the recapture of such waters if that opportunity arises.

6. REFERENCES

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APPENDIX A

Summary of 2010 Interim Flow Information Needs and Experimental Studies

APPENDIX A: Summary of 2010 Interim Flow information needs and experimental studies.

Metric	Method	Location and Time	Application of Results	Required for 2010 Interim Flows?
Surface water flow	Stream gages installed and operated to USGS standards, stage-discharge rating curves calibrated for full range of flows.	At Reaches 1-5, water stage and stream discharge measured every 15 minutes (i.e., continuous) year-round.	Accurate flow estimates at various locations along the river would be related to fish habitat assessments (e.g., flow-water depth for passage, flow-inundation area for rearing, flow-temperature for spawning/egg incubation, rearing and migration, etc.), geomorphic assessments (e.g., relating sediment transport thresholds and rates to flow), riparian assessments (e.g., relating flow magnitudes and recession rates to riparian germination and initiation), flow losses/gains, flood conveyance, and other parameters. Accurate flow estimates would also document whether reach-specific flow targets are being met by Friant Dam releases and other water management actions	Yes
Habitat suitability criteria	Compilation and analysis of data collected from other rivers and streams regarding habitat suitability (e.g., water depth, velocity, substrate, cover, water temperatures, adult holding pools, etc.) as a function of fish use preference.	Initially obtain from other regional studies (e.g., Butte Creek, Tuolumne River). Compilation required for analysis of interim flow measurements.	Habitat suitability criteria are used as the basis for estimating suitable habitat amount required for each run and lifestage of Chinook salmon reintroduced to the river.	Yes – data compilation.

Metric	Method	Location and Time	Application of Results	Required for 2010 Interim Flows?
Water depth, velocity, cover, and substrate	Measurements of field study sites (planform grid or cross-sections) over a range of flows to confirm habitat suitability criteria met.	Reach 1. Extend measurement in downstream reaches as interim flows increase above 350 cfs.	Relationships between water depth, velocity, cover, substrate, water temperature, and river flow would be used to assess physical habitat conditions for juvenile rearing habitat, adult Chinook salmon holding, and adult Chinook salmon spawning as a function of flow.	Yes
Flow-habitat rating curves	Reach 1 water depth, velocity, and substrate are measured and/or computed over a range of flows. Integrate river measurements with habitat suitability criteria through analysis and modeling to relate changes in suitable habitat quantity for each life stage.	Reach 1 for adult holding, spawning, egg incubation, juvenile rearing.	Habitat suitability criteria and professional judgment are used as the basis for evaluating the quality and availability of habitat in the river at various flows. Results of flow-habitat curves would also be used to assess how changes in flow would be expected to affect habitat and how non-flow measures such as gravel augmentation could be used in restoration to increase habitat quality or availability. Flow-habitat curves could refine baseflow releases needed from Friant Dam to increase habitat availability for adult spawning, adult holding, and/or juvenile rearing.	Yes
Water depth and velocity	Measurements at channel cross-sections over a range of flow, compare to fish passage criteria, evaluate flow or structure modification to improve passage.	At critical adult and juvenile fish passage locations in Reaches 1-5, at riffle crests and artificial structures.	Relationships between water depth and river flow at various locations would be used to assess physical conditions for juvenile and adult salmon migration. Assessment of fish passage as a function of local flows may be used to revise flow releases from Friant Dam, adjust other water management actions, and/or modify structures.	Yes

Metric	Method	Location and Time	Application of Results	Required for 2010 Interim Flows?
Water quality (dissolved oxygen, turbidity, conductivity, other parameters)	Grab sample collection at locations in each reach of the lower river for certain parameters, continuous instrumentation for other parameters. Laboratory or field instrument chemical analysis using standard protocols.	At recommended water quality sampling locations from Reaches 1-5, sampling should occur year-round using standard protocols.	Habitat suitability for various lifestages of Chinook salmon depends on water quality (e.g., dissolved oxygen concentrations). Information would be used to assess habitat suitability, identify potential stressors or toxic conditions for various species, and determine the response of various water quality parameters to changes in river flow.	Yes

APPENDIX B

Illustrative Hydrograph Daily Flows for a Normal-Wet Water Year

	Volumes at top of Reach 1 (ac-ft)	Volumes at top of Reach 2 (ac-ft)	Volumes at top of Reach 3 (ac-ft)	Volumes at top of Reach 4 (ac-ft)	Volumes at top of Reach 5 (ac-ft)	Volumes at bottom of Reach 5 (ac-ft)
Feb 1-Sept 30:	283,041	199,200	152,301	152,301	152,301	332,400
Feb 1-Dec 1:	333,025	232,383	175,091	175,091	175,091	396,248
February:	19,438	14,162	9,402	9,402	9,402	37,170
Mar 1-Dec 1:	313,587	218,221	165,689	165,689	165,689	359,078
March:	44,430	36,744	28,483	28,483	28,483	58,433
April:	90,347	81,719	73,309	73,309	73,309	97,111
May:	44,132	32,757	26,648	26,648	26,648	51,243
June:	20,826	9,818	5,058	5,058	5,058	28,860
July:	21,521	7,686	2,767	2,767	2,767	19,676
August:	21,521	7,686	2,767	2,767	2,767	19,676
September:	20,826	8,628	3,868	3,868	3,868	20,231
October:	21,521	11,990	6,793	6,793	6,793	25,240
November:	27,769	20,727	15,689	15,689	15,689	37,507
December:	694	466	307	307	307	1,101

Date	Normal-Wet year: Friant Dam Release (Top of Reach 1) (cfs)	Normal-Wet year: Anticipated flow at Gravelly Ford (Top of Reach 2) (cfs)	Normal-Wet year: Anticipated flow at Mendota Dam (Top of Reach 3) (cfs)	Normal-Wet year: Anticipated flow at Sack Dam (Top of Reach 4) (cfs)	Normal-Wet year: Anticipated flow at confluence of Eastside Bypass (Top of Reach 5) (cfs)	Normal-Wet year: Anticipated flow at confluence of Merced River (Bottom of Reach 5) (cfs)
1-Feb-10	350	255	175	175	175	675
2-Feb-10	350	255	175	175	175	675
3-Feb-10	350	255	175	175	175	675
4-Feb-10	350	255	175	175	175	675
5-Feb-10	350	255	175	175	175	675
6-Feb-10	350	255	175	175	175	675
7-Feb-10	350	255	175	175	175	675
8-Feb-10	350	255	175	175	175	675
9-Feb-10	350	255	175	175	175	675
10-Feb-10	350	255	175	175	175	675
11-Feb-10	350	255	175	175	175	675
12-Feb-10	350	255	175	175	175	675
13-Feb-10	350	255	175	175	175	675
14-Feb-10	350	255	175	175	175	675
15-Feb-10	350	255	175	175	175	675
16-Feb-10	350	255	175	175	175	675
17-Feb-10	350	255	175	175	175	675
18-Feb-10	350	255	175	175	175	675
19-Feb-10	350	255	175	175	175	675
20-Feb-10	350	255	175	175	175	675
21-Feb-10	350	255	155	155	155	655
22-Feb-10	350	255	155	155	155	655
23-Feb-10	350	255	155	155	155	655
24-Feb-10	350	255	155	155	155	655
25-Feb-10	350	255	155	155	155	655
26-Feb-10	350	255	155	155	155	655
27-Feb-10	350	255	155	155	155	655
28-Feb-10	350	255	155	155	155	655
1-Mar-10	500	375	255	255	255	755
2-Mar-10	500	375	255	255	255	755
3-Mar-10	500	375	255	255	255	755
4-Mar-10	500	375	255	255	255	755
5-Mar-10	500	375	255	255	255	755
6-Mar-10	500	375	255	255	255	755
7-Mar-10	500	375	255	255	255	755
8-Mar-10	500	375	255	255	255	755
9-Mar-10	500	375	235	235	235	735
10-Mar-10	500	375	235	235	235	735
11-Mar-10	500	375	235	235	235	735
12-Mar-10	500	375	235	235	235	735
13-Mar-10	500	375	235	235	235	735
14-Mar-10	500	375	235	235	235	735
15-Mar-10	500	375	235	235	235	735
16-Mar-10	800	675	535	535	535	1,010
17-Mar-10	800	675	520	520	520	995
18-Mar-10	800	675	520	520	520	995
19-Mar-10	800	675	520	520	520	995
20-Mar-10	800	675	520	520	520	995
21-Mar-10	800	675	520	520	520	995
22-Mar-10	800	675	520	520	520	995
23-Mar-10	800	675	520	520	520	995
24-Mar-10	800	675	520	520	520	995
25-Mar-10	1,100	975	860	860	860	1,335
26-Mar-10	1,100	975	860	860	860	1,335
27-Mar-10	1,100	975	860	860	860	1,335
28-Mar-10	1,100	975	860	860	860	1,335
29-Mar-10	1,100	975	860	860	860	1,335
30-Mar-10	1,100	975	860	860	860	1,335
31-Mar-10	1,100	975	820	820	820	1,295
1-Apr-10	1,100	955	800	800	800	1,200
2-Apr-10	1,100	955	800	800	800	1,200
3-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695
4-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695
5-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695
6-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695
7-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695
8-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695

Flows in Reaches 2-5 assume instantaneous travel times; Fall 2009 Interim Flow releases suggest approximate 7-day travel time to the top of Reach 2B

Date	Normal-Wet year: Friant Dam Release (Top of Reach 1) (cfs)	Normal-Wet year: Anticipated flow at Gravelly Ford (Top of Reach 2) (cfs)	Normal-Wet year: Anticipated flow at Mendota Dam (Top of Reach 3) (cfs)	Normal-Wet year: Anticipated flow at Sack Dam (Top of Reach 4) (cfs)	Normal-Wet year: Anticipated flow at confluence of Eastside Bypass (Top of Reach 5) (cfs)	Normal-Wet year: Anticipated flow at confluence of Merced River (Bottom of Reach 5) (cfs)
9-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695
10-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695
11-Apr-10	1,595	1,450	1,335	1,335	1,335	1,735
12-Apr-10	1,595	1,450	1,335	1,335	1,335	1,735
13-Apr-10	1,595	1,450	1,335	1,335	1,335	1,735
14-Apr-10	1,595	1,450	1,335	1,335	1,335	1,735
15-Apr-10	1,595	1,450	1,335	1,335	1,335	1,735
16-Apr-10	1,595	1,450	1,335	1,335	1,335	1,735
17-Apr-10	1,595	1,450	1,335	1,335	1,335	1,735
18-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695
19-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695
20-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695
21-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695
22-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695
23-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695
24-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695
25-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695
26-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695
27-Apr-10	1,595	1,450	1,295	1,295	1,295	1,695
28-Apr-10	1,275	1,130	975	975	975	1,375
29-Apr-10	1,100	955	865	865	865	1,265
30-Apr-10	1,100	955	865	865	865	1,265
1-May-10	1,100	915	825	825	825	1,225
2-May-10	1,100	915	825	825	825	1,225
3-May-10	1,100	915	825	825	825	1,225
4-May-10	1,100	915	825	825	825	1,225
5-May-10	1,100	915	825	825	825	1,225
6-May-10	1,100	915	805	805	805	1,205
7-May-10	1,100	915	805	805	805	1,205
8-May-10	1,100	915	805	805	805	1,205
9-May-10	800	615	505	505	505	905
10-May-10	800	615	505	505	505	905
11-May-10	800	615	505	505	505	905
12-May-10	800	615	505	505	505	905
13-May-10	800	615	505	505	505	905
14-May-10	800	615	525	525	525	925
15-May-10	800	615	525	525	525	925
16-May-10	800	615	525	525	525	925
17-May-10	800	615	525	525	525	925
18-May-10	500	315	225	225	225	625
19-May-10	500	315	225	225	225	625
20-May-10	500	315	225	225	225	625
21-May-10	500	315	205	205	205	605
22-May-10	500	315	205	205	205	605
23-May-10	500	315	205	205	205	605
24-May-10	500	315	205	205	205	605
25-May-10	500	315	205	205	205	605
26-May-10	500	315	205	205	205	605
27-May-10	350	165	55	55	55	455
28-May-10	350	165	55	55	55	455
29-May-10	350	165	85	85	85	485
30-May-10	350	165	85	85	85	485
31-May-10	350	165	85	85	85	485
1-Jun-10	350	165	85	85	85	485
2-Jun-10	350	165	85	85	85	485
3-Jun-10	350	165	85	85	85	485
4-Jun-10	350	165	85	85	85	485
5-Jun-10	350	165	85	85	85	485
6-Jun-10	350	165	85	85	85	485
7-Jun-10	350	165	85	85	85	485
8-Jun-10	350	165	85	85	85	485
9-Jun-10	350	165	85	85	85	485
10-Jun-10	350	165	85	85	85	485
11-Jun-10	350	165	85	85	85	485
12-Jun-10	350	165	85	85	85	485
13-Jun-10	350	165	85	85	85	485
14-Jun-10	350	165	85	85	85	485
15-Jun-10	350	165	85	85	85	485
16-Jun-10	350	165	85	85	85	485
17-Jun-10	350	165	85	85	85	485
18-Jun-10	350	165	85	85	85	485
19-Jun-10	350	165	85	85	85	485
20-Jun-10	350	165	85	85	85	485
21-Jun-10	350	165	85	85	85	485
22-Jun-10	350	165	85	85	85	485
23-Jun-10	350	165	85	85	85	485
24-Jun-10	350	165	85	85	85	485
25-Jun-10	350	165	85	85	85	485
26-Jun-10	350	165	85	85	85	485
27-Jun-10	350	165	85	85	85	485
28-Jun-10	350	165	85	85	85	485
29-Jun-10	350	165	85	85	85	485
30-Jun-10	350	165	85	85	85	485
1-Jul-10	350	125	45	45	45	320

Flows in Reaches 2-5 assume instantaneous travel times; Fall 2009 Interim Flow releases suggest approximate 7-day travel time to the top of Reach 2B

Date	Normal-Wet year: Friant Dam Release (Top of Reach 1) (cfs)	Normal-Wet year: Anticipated flow at Gravelly Ford (Top of Reach 2) (cfs)	Normal-Wet year: Anticipated flow at Mendota Dam (Top of Reach 3) (cfs)	Normal-Wet year: Anticipated flow at Sack Dam (Top of Reach 4) (cfs)	Normal-Wet year: Anticipated flow at confluence of Eastside Bypass (Top of Reach 5) (cfs)	Normal-Wet year: Anticipated flow at confluence of Merced River (Bottom of Reach 5) (cfs)
2-Jul-10	350	125	45	45	45	320
3-Jul-10	350	125	45	45	45	320
4-Jul-10	350	125	45	45	45	320
5-Jul-10	350	125	45	45	45	320
6-Jul-10	350	125	45	45	45	320
7-Jul-10	350	125	45	45	45	320
8-Jul-10	350	125	45	45	45	320
9-Jul-10	350	125	45	45	45	320
10-Jul-10	350	125	45	45	45	320
11-Jul-10	350	125	45	45	45	320
12-Jul-10	350	125	45	45	45	320
13-Jul-10	350	125	45	45	45	320
14-Jul-10	350	125	45	45	45	320
15-Jul-10	350	125	45	45	45	320
16-Jul-10	350	125	45	45	45	320
17-Jul-10	350	125	45	45	45	320
18-Jul-10	350	125	45	45	45	320
19-Jul-10	350	125	45	45	45	320
20-Jul-10	350	125	45	45	45	320
21-Jul-10	350	125	45	45	45	320
22-Jul-10	350	125	45	45	45	320
23-Jul-10	350	125	45	45	45	320
24-Jul-10	350	125	45	45	45	320
25-Jul-10	350	125	45	45	45	320
26-Jul-10	350	125	45	45	45	320
27-Jul-10	350	125	45	45	45	320
28-Jul-10	350	125	45	45	45	320
29-Jul-10	350	125	45	45	45	320
30-Jul-10	350	125	45	45	45	320
31-Jul-10	350	125	45	45	45	320
1-Aug-10	350	125	45	45	45	320
2-Aug-10	350	125	45	45	45	320
3-Aug-10	350	125	45	45	45	320
4-Aug-10	350	125	45	45	45	320
5-Aug-10	350	125	45	45	45	320
6-Aug-10	350	125	45	45	45	320
7-Aug-10	350	125	45	45	45	320
8-Aug-10	350	125	45	45	45	320
9-Aug-10	350	125	45	45	45	320
10-Aug-10	350	125	45	45	45	320
11-Aug-10	350	125	45	45	45	320
12-Aug-10	350	125	45	45	45	320
13-Aug-10	350	125	45	45	45	320
14-Aug-10	350	125	45	45	45	320
15-Aug-10	350	125	45	45	45	320
16-Aug-10	350	125	45	45	45	320
17-Aug-10	350	125	45	45	45	320
18-Aug-10	350	125	45	45	45	320
19-Aug-10	350	125	45	45	45	320
20-Aug-10	350	125	45	45	45	320
21-Aug-10	350	125	45	45	45	320
22-Aug-10	350	125	45	45	45	320
23-Aug-10	350	125	45	45	45	320
24-Aug-10	350	125	45	45	45	320
25-Aug-10	350	125	45	45	45	320
26-Aug-10	350	125	45	45	45	320
27-Aug-10	350	125	45	45	45	320
28-Aug-10	350	125	45	45	45	320
29-Aug-10	350	125	45	45	45	320
30-Aug-10	350	125	45	45	45	320
31-Aug-10	350	125	45	45	45	320
1-Sep-10	350	145	65	65	65	340
2-Sep-10	350	145	65	65	65	340
3-Sep-10	350	145	65	65	65	340
4-Sep-10	350	145	65	65	65	340
5-Sep-10	350	145	65	65	65	340
6-Sep-10	350	145	65	65	65	340
7-Sep-10	350	145	65	65	65	340
8-Sep-10	350	145	65	65	65	340
9-Sep-10	350	145	65	65	65	340
10-Sep-10	350	145	65	65	65	340
11-Sep-10	350	145	65	65	65	340
12-Sep-10	350	145	65	65	65	340
13-Sep-10	350	145	65	65	65	340
14-Sep-10	350	145	65	65	65	340
15-Sep-10	350	145	65	65	65	340
16-Sep-10	350	145	65	65	65	340
17-Sep-10	350	145	65	65	65	340
18-Sep-10	350	145	65	65	65	340
19-Sep-10	350	145	65	65	65	340
20-Sep-10	350	145	65	65	65	340
21-Sep-10	350	145	65	65	65	340
22-Sep-10	350	145	65	65	65	340
23-Sep-10	350	145	65	65	65	340

Flows in Reaches 2-5 assume instantaneous travel times; Fall 2009 Interim Flow releases suggest approximate 7-day travel time to the top of Reach 2B

Date	Normal-Wet year: Friant Dam Release (Top of Reach 1) (cfs)	Normal-Wet year: Anticipated flow at Gravelly Ford (Top of Reach 2) (cfs)	Normal-Wet year: Anticipated flow at Mendota Dam (Top of Reach 3) (cfs)	Normal-Wet year: Anticipated flow at Sack Dam (Top of Reach 4) (cfs)	Normal-Wet year: Anticipated flow at confluence of Eastside Bypass (Top of Reach 5) (cfs)	Normal-Wet year: Anticipated flow at confluence of Merced River (Bottom of Reach 5) (cfs)
24-Sep-10	350	145	65	65	65	340
25-Sep-10	350	145	65	65	65	340
26-Sep-10	350	145	65	65	65	340
27-Sep-10	350	145	65	65	65	340
28-Sep-10	350	145	65	65	65	340
29-Sep-10	350	145	65	65	65	340
30-Sep-10	350	145	65	65	65	340
1-Oct-10	350	195	115	115	115	415
2-Oct-10	350	195	115	115	115	415
3-Oct-10	350	195	115	115	115	415
4-Oct-10	350	195	115	115	115	415
5-Oct-10	350	195	115	115	115	415
6-Oct-10	350	195	115	115	115	415
7-Oct-10	350	195	115	115	115	415
8-Oct-10	350	195	115	115	115	415
9-Oct-10	350	195	115	115	115	415
10-Oct-10	350	195	115	115	115	415
11-Oct-10	350	195	115	115	115	415
12-Oct-10	350	195	115	115	115	415
13-Oct-10	350	195	115	115	115	415
14-Oct-10	350	195	115	115	115	415
15-Oct-10	350	195	115	115	115	415
16-Oct-10	350	195	115	115	115	415
17-Oct-10	350	195	115	115	115	415
18-Oct-10	350	195	115	115	115	415
19-Oct-10	350	195	115	115	115	415
20-Oct-10	350	195	115	115	115	415
21-Oct-10	350	195	115	115	115	415
22-Oct-10	350	195	95	95	95	395
23-Oct-10	350	195	95	95	95	395
24-Oct-10	350	195	95	95	95	395
25-Oct-10	350	195	95	95	95	395
26-Oct-10	350	195	95	95	95	395
27-Oct-10	350	195	95	95	95	395
28-Oct-10	350	195	95	95	95	395
29-Oct-10	350	195	115	115	115	415
30-Oct-10	350	195	115	115	115	415
31-Oct-10	350	195	115	115	115	415
1-Nov-10	700	575	495	495	495	795
2-Nov-10	700	575	495	495	495	795
3-Nov-10	700	575	495	495	495	795
4-Nov-10	700	575	495	495	495	795
5-Nov-10	700	575	475	475	475	775
6-Nov-10	700	575	475	475	475	775
7-Nov-10	700	575	475	475	475	775
8-Nov-10	700	575	475	475	475	775
9-Nov-10	700	575	475	475	475	775
10-Nov-10	700	575	475	475	475	775
11-Nov-10	350	235	135	135	135	535
12-Nov-10	350	235	155	155	155	555
13-Nov-10	350	235	155	155	155	555
14-Nov-10	350	235	155	155	155	555
15-Nov-10	350	235	155	155	155	555
16-Nov-10	350	235	155	155	155	555
17-Nov-10	350	235	155	155	155	555
18-Nov-10	350	235	155	155	155	555
19-Nov-10	350	235	155	155	155	555
20-Nov-10	350	235	155	155	155	555
21-Nov-10	350	235	155	155	155	555
22-Nov-10	350	235	155	155	155	555
23-Nov-10	350	235	155	155	155	555
24-Nov-10	350	235	155	155	155	555
25-Nov-10	350	235	155	155	155	555
26-Nov-10	350	235	155	155	155	555
27-Nov-10	350	235	155	155	155	555
28-Nov-10	350	235	155	155	155	555
29-Nov-10	350	235	155	155	155	555
30-Nov-10	350	235	155	155	155	555
1-Dec-10	350	235	155	155	155	555

Flows in Reaches 2-5 assume instantaneous travel times; Fall 2009 Interim Flow releases suggest approximate 7-day travel time to the top of Reach 2B

APPENDIX C

Illustrative Hydrograph Daily Flows for a Normal-Dry Water Year

	Volumes at top of Reach 1 (ac-ft)	Volumes at top of Reach 2 (ac-ft)	Volumes at top of Reach 3 (ac-ft)	Volumes at top of Reach 4 (ac-ft)	Volumes at top of Reach 5 (ac-ft)	Volumes at bottom of Reach 5 (ac-ft)
Feb 1-Sept 30:	246,000	162,159	117,600	117,600	117,600	297,699
Feb 1-Dec 1:	295,983	195,342	140,469	140,469	140,469	361,626
February:	19,438	14,162	9,719	9,719	9,719	37,488
Mar 1-Dec 1:	276,545	181,180	130,750	130,750	130,750	324,139
March:	42,050	34,364	27,025	27,025	27,025	56,975
April:	72,684	64,056	56,182	56,182	56,182	79,983
May:	27,134	15,759	10,215	10,215	10,215	34,810
June:	20,826	9,818	5,058	5,058	5,058	28,860
July:	21,521	7,686	2,767	2,767	2,767	19,676
August:	21,521	7,686	2,767	2,767	2,767	19,676
September:	20,826	8,628	3,868	3,868	3,868	20,231
October:	21,521	11,990	7,071	7,071	7,071	25,517
November:	27,769	20,727	15,491	15,491	15,491	37,309
December:	694	466	307	307	307	1,101

Date	Normal-Dry year: Friant Dam Release (Top of Reach 1)	Normal-Dry year: Anticipated flow at Gravelly Ford (Top of Reach 2) (cfs)	Normal-Dry year: Anticipated flow at Mendota Dam (Top of Reach 3) (cfs)	Normal-Dry year: Anticipated flow at Sack Dam (Top of Reach 4) (cfs)	Normal-Dry year: Anticipated flow at confluence of Eastside Bypass (Top of Reach 5) (cfs)	Normal-Dry year: Anticipated flow at confluence of Merced River (Bottom of Reach 5) (cfs)
1-Feb-10	350	255	175	175	175	675
2-Feb-10	350	255	175	175	175	675
3-Feb-10	350	255	175	175	175	675
4-Feb-10	350	255	175	175	175	675
5-Feb-10	350	255	175	175	175	675
6-Feb-10	350	255	175	175	175	675
7-Feb-10	350	255	175	175	175	675
8-Feb-10	350	255	175	175	175	675
9-Feb-10	350	255	175	175	175	675
10-Feb-10	350	255	175	175	175	675
11-Feb-10	350	255	175	175	175	675
12-Feb-10	350	255	175	175	175	675
13-Feb-10	350	255	175	175	175	675
14-Feb-10	350	255	175	175	175	675
15-Feb-10	350	255	175	175	175	675
16-Feb-10	350	255	175	175	175	675
17-Feb-10	350	255	175	175	175	675
18-Feb-10	350	255	175	175	175	675
19-Feb-10	350	255	175	175	175	675
20-Feb-10	350	255	175	175	175	675
21-Feb-10	350	255	175	175	175	675
22-Feb-10	350	255	175	175	175	675
23-Feb-10	350	255	175	175	175	675
24-Feb-10	350	255	175	175	175	675
25-Feb-10	350	255	175	175	175	675
26-Feb-10	350	255	175	175	175	675
27-Feb-10	350	255	175	175	175	675
28-Feb-10	350	255	175	175	175	675
1-Mar-10	500	375	285	285	285	785
2-Mar-10	500	375	285	285	285	785
3-Mar-10	500	375	285	285	285	785
4-Mar-10	500	375	285	285	285	785
5-Mar-10	500	375	285	285	285	785
6-Mar-10	500	375	285	285	285	785
7-Mar-10	500	375	285	285	285	785
8-Mar-10	500	375	270	270	270	770
9-Mar-10	500	375	270	270	270	770
10-Mar-10	500	375	270	270	270	770
11-Mar-10	500	375	270	270	270	770
12-Mar-10	500	375	270	270	270	770
13-Mar-10	500	375	270	270	270	770
14-Mar-10	500	375	270	270	270	770
15-Mar-10	500	375	255	255	255	755
16-Mar-10	500	375	255	255	255	730
17-Mar-10	500	375	255	255	255	730
18-Mar-10	800	675	555	555	555	1,030
19-Mar-10	800	675	555	555	555	1,030
20-Mar-10	800	675	555	555	555	1,030
21-Mar-10	800	675	535	535	535	1,010
22-Mar-10	800	675	535	535	535	1,010
23-Mar-10	800	675	535	535	535	1,010
24-Mar-10	800	675	535	535	535	1,010
25-Mar-10	800	675	535	535	535	1,010
26-Mar-10	800	675	535	535	535	1,010
27-Mar-10	1,100	975	820	820	820	1,295
28-Mar-10	1,100	975	820	820	820	1,295
29-Mar-10	1,100	975	820	820	820	1,295
30-Mar-10	1,100	975	820	820	820	1,295
31-Mar-10	1,100	975	820	820	820	1,295
1-Apr-10	1,100	955	800	800	800	1,200
2-Apr-10	1,100	955	800	800	800	1,200
3-Apr-10	1,100	955	855	855	855	1,255
4-Apr-10	1,100	955	855	855	855	1,255
5-Apr-10	1,595	1,450	1,350	1,350	1,350	1,750
6-Apr-10	1,595	1,450	1,350	1,350	1,350	1,750
7-Apr-10	1,595	1,450	1,350	1,350	1,350	1,750
8-Apr-10	1,595	1,450	1,350	1,350	1,350	1,750
9-Apr-10	1,595	1,450	1,350	1,350	1,350	1,750
10-Apr-10	1,595	1,450	1,350	1,350	1,350	1,750

Flows in Reaches 2-5 assume instantaneous travel times; Fall 2009 Interim Flow releases suggest approximate 7-day travel time to the top of Reach 2B

Date	Normal-Dry year: Friant Dam Release (Top of Reach 1)	Normal-Dry year: Anticipated flow at Gravelly Ford (Top of Reach 2) (cfs)	Normal-Dry year: Anticipated flow at Mendota Dam (Top of Reach 3) (cfs)	Normal-Dry year: Anticipated flow at Sack Dam (Top of Reach 4) (cfs)	Normal-Dry year: Anticipated flow at confluence of Eastside Bypass (Top of Reach 5) (cfs)	Normal-Dry year: Anticipated flow at confluence of Merced River (Bottom of Reach 5) (cfs)
11-Apr-10	1,595	1,450	1,330	1,330	1,330	1,730
12-Apr-10	1,595	1,450	1,330	1,330	1,330	1,730
13-Apr-10	1,595	1,450	1,330	1,330	1,330	1,730
14-Apr-10	1,595	1,450	1,330	1,330	1,330	1,730
15-Apr-10	1,595	1,450	1,330	1,330	1,330	1,730
16-Apr-10	1,100	955	835	835	835	1,235
17-Apr-10	1,100	955	805	805	805	1,205
18-Apr-10	1,100	955	805	805	805	1,205
19-Apr-10	1,100	955	805	805	805	1,205
20-Apr-10	1,100	955	805	805	805	1,205
21-Apr-10	1,100	955	805	805	805	1,205
22-Apr-10	1,100	955	805	805	805	1,205
23-Apr-10	1,100	955	800	800	800	1,200
24-Apr-10	1,100	955	800	800	800	1,200
25-Apr-10	800	655	500	500	500	900
26-Apr-10	800	655	500	500	500	900
27-Apr-10	800	655	500	500	500	900
28-Apr-10	800	655	500	500	500	900
29-Apr-10	800	655	500	500	500	900
30-Apr-10	800	655	500	500	500	900
1-May-10	800	615	500	500	500	900
2-May-10	800	615	515	515	515	915
3-May-10	800	615	515	515	515	915
4-May-10	500	315	215	215	215	615
5-May-10	500	315	215	215	215	615
6-May-10	500	315	215	215	215	615
7-May-10	500	315	215	215	215	615
8-May-10	500	315	215	215	215	615
9-May-10	500	315	235	235	235	635
10-May-10	500	315	235	235	235	635
11-May-10	500	315	235	235	235	635
12-May-10	500	315	235	235	235	635
13-May-10	480	295	215	215	215	615
14-May-10	350	165	85	85	85	485
15-May-10	350	165	85	85	85	485
16-May-10	350	165	65	65	65	465
17-May-10	350	165	65	65	65	465
18-May-10	350	165	65	65	65	465
19-May-10	350	165	65	65	65	465
20-May-10	350	165	65	65	65	465
21-May-10	350	165	65	65	65	465
22-May-10	350	165	65	65	65	465
23-May-10	350	165	85	85	85	485
24-May-10	350	165	85	85	85	485
25-May-10	350	165	85	85	85	485
26-May-10	350	165	85	85	85	485
27-May-10	350	165	85	85	85	485
28-May-10	350	165	85	85	85	485
29-May-10	350	165	85	85	85	485
30-May-10	350	165	85	85	85	485
31-May-10	350	165	85	85	85	485
1-Jun-10	350	165	85	85	85	485
2-Jun-10	350	165	85	85	85	485
3-Jun-10	350	165	85	85	85	485
4-Jun-10	350	165	85	85	85	485
5-Jun-10	350	165	85	85	85	485
6-Jun-10	350	165	85	85	85	485
7-Jun-10	350	165	85	85	85	485
8-Jun-10	350	165	85	85	85	485
9-Jun-10	350	165	85	85	85	485
10-Jun-10	350	165	85	85	85	485
11-Jun-10	350	165	85	85	85	485
12-Jun-10	350	165	85	85	85	485
13-Jun-10	350	165	85	85	85	485
14-Jun-10	350	165	85	85	85	485
15-Jun-10	350	165	85	85	85	485
16-Jun-10	350	165	85	85	85	485
17-Jun-10	350	165	85	85	85	485
18-Jun-10	350	165	85	85	85	485
19-Jun-10	350	165	85	85	85	485
20-Jun-10	350	165	85	85	85	485
21-Jun-10	350	165	85	85	85	485
22-Jun-10	350	165	85	85	85	485
23-Jun-10	350	165	85	85	85	485
24-Jun-10	350	165	85	85	85	485
25-Jun-10	350	165	85	85	85	485
26-Jun-10	350	165	85	85	85	485
27-Jun-10	350	165	85	85	85	485
28-Jun-10	350	165	85	85	85	485
29-Jun-10	350	165	85	85	85	485
30-Jun-10	350	165	85	85	85	485
1-Jul-10	350	125	45	45	45	320
2-Jul-10	350	125	45	45	45	320
3-Jul-10	350	125	45	45	45	320
4-Jul-10	350	125	45	45	45	320
5-Jul-10	350	125	45	45	45	320

Flows in Reaches 2-5 assume instantaneous travel times; Fall 2009 Interim Flow releases suggest approximate 7-day travel time to the top of Reach 2B

Date	Normal-Dry year: Friant Dam Release (Top of Reach 1)	Normal-Dry year: Anticipated flow at Gravelly Ford (Top of Reach 2) (cfs)	Normal-Dry year: Anticipated flow at Mendota Dam (Top of Reach 3) (cfs)	Normal-Dry year: Anticipated flow at Sack Dam (Top of Reach 4) (cfs)	Normal-Dry year: Anticipated flow at confluence of Eastside Bypass (Top of Reach 5) (cfs)	Normal-Dry year: Anticipated flow at confluence of Merced River (Bottom of Reach 5) (cfs)
6-Jul-10	350	125	45	45	45	320
7-Jul-10	350	125	45	45	45	320
8-Jul-10	350	125	45	45	45	320
9-Jul-10	350	125	45	45	45	320
10-Jul-10	350	125	45	45	45	320
11-Jul-10	350	125	45	45	45	320
12-Jul-10	350	125	45	45	45	320
13-Jul-10	350	125	45	45	45	320
14-Jul-10	350	125	45	45	45	320
15-Jul-10	350	125	45	45	45	320
16-Jul-10	350	125	45	45	45	320
17-Jul-10	350	125	45	45	45	320
18-Jul-10	350	125	45	45	45	320
19-Jul-10	350	125	45	45	45	320
20-Jul-10	350	125	45	45	45	320
21-Jul-10	350	125	45	45	45	320
22-Jul-10	350	125	45	45	45	320
23-Jul-10	350	125	45	45	45	320
24-Jul-10	350	125	45	45	45	320
25-Jul-10	350	125	45	45	45	320
26-Jul-10	350	125	45	45	45	320
27-Jul-10	350	125	45	45	45	320
28-Jul-10	350	125	45	45	45	320
29-Jul-10	350	125	45	45	45	320
30-Jul-10	350	125	45	45	45	320
31-Jul-10	350	125	45	45	45	320
1-Aug-10	350	125	45	45	45	320
2-Aug-10	350	125	45	45	45	320
3-Aug-10	350	125	45	45	45	320
4-Aug-10	350	125	45	45	45	320
5-Aug-10	350	125	45	45	45	320
6-Aug-10	350	125	45	45	45	320
7-Aug-10	350	125	45	45	45	320
8-Aug-10	350	125	45	45	45	320
9-Aug-10	350	125	45	45	45	320
10-Aug-10	350	125	45	45	45	320
11-Aug-10	350	125	45	45	45	320
12-Aug-10	350	125	45	45	45	320
13-Aug-10	350	125	45	45	45	320
14-Aug-10	350	125	45	45	45	320
15-Aug-10	350	125	45	45	45	320
16-Aug-10	350	125	45	45	45	320
17-Aug-10	350	125	45	45	45	320
18-Aug-10	350	125	45	45	45	320
19-Aug-10	350	125	45	45	45	320
20-Aug-10	350	125	45	45	45	320
21-Aug-10	350	125	45	45	45	320
22-Aug-10	350	125	45	45	45	320
23-Aug-10	350	125	45	45	45	320
24-Aug-10	350	125	45	45	45	320
25-Aug-10	350	125	45	45	45	320
26-Aug-10	350	125	45	45	45	320
27-Aug-10	350	125	45	45	45	320
28-Aug-10	350	125	45	45	45	320
29-Aug-10	350	125	45	45	45	320
30-Aug-10	350	125	45	45	45	320
31-Aug-10	350	125	45	45	45	320
1-Sep-10	350	145	65	65	65	340
2-Sep-10	350	145	65	65	65	340
3-Sep-10	350	145	65	65	65	340
4-Sep-10	350	145	65	65	65	340
5-Sep-10	350	145	65	65	65	340
6-Sep-10	350	145	65	65	65	340
7-Sep-10	350	145	65	65	65	340
8-Sep-10	350	145	65	65	65	340
9-Sep-10	350	145	65	65	65	340
10-Sep-10	350	145	65	65	65	340
11-Sep-10	350	145	65	65	65	340
12-Sep-10	350	145	65	65	65	340
13-Sep-10	350	145	65	65	65	340
14-Sep-10	350	145	65	65	65	340
15-Sep-10	350	145	65	65	65	340
16-Sep-10	350	145	65	65	65	340
17-Sep-10	350	145	65	65	65	340
18-Sep-10	350	145	65	65	65	340
19-Sep-10	350	145	65	65	65	340
20-Sep-10	350	145	65	65	65	340
21-Sep-10	350	145	65	65	65	340
22-Sep-10	350	145	65	65	65	340
23-Sep-10	350	145	65	65	65	340
24-Sep-10	350	145	65	65	65	340
25-Sep-10	350	145	65	65	65	340
26-Sep-10	350	145	65	65	65	340
27-Sep-10	350	145	65	65	65	340
28-Sep-10	350	145	65	65	65	340
29-Sep-10	350	145	65	65	65	340

Flows in Reaches 2-5 assume instantaneous travel times; Fall 2009 Interim Flow releases suggest approximate 7-day travel time to the top of Reach 2B

Date	Normal-Dry year: Friant Dam Release (Top of Reach 1)	Normal-Dry year: Anticipated flow at Gravelly Ford (Top of Reach 2) (cfs)	Normal-Dry year: Anticipated flow at Mendota Dam (Top of Reach 3) (cfs)	Normal-Dry year: Anticipated flow at Sack Dam (Top of Reach 4) (cfs)	Normal-Dry year: Anticipated flow at confluence of Eastside Bypass (Top of Reach 5) (cfs)	Normal-Dry year: Anticipated flow at confluence of Merced River (Bottom of Reach 5) (cfs)
30-Sep-10	350	145	65	65	65	340
1-Oct-10	350	195	115	115	115	415
2-Oct-10	350	195	115	115	115	415
3-Oct-10	350	195	115	115	115	415
4-Oct-10	350	195	115	115	115	415
5-Oct-10	350	195	115	115	115	415
6-Oct-10	350	195	115	115	115	415
7-Oct-10	350	195	115	115	115	415
8-Oct-10	350	195	115	115	115	415
9-Oct-10	350	195	115	115	115	415
10-Oct-10	350	195	115	115	115	415
11-Oct-10	350	195	115	115	115	415
12-Oct-10	350	195	115	115	115	415
13-Oct-10	350	195	115	115	115	415
14-Oct-10	350	195	115	115	115	415
15-Oct-10	350	195	115	115	115	415
16-Oct-10	350	195	115	115	115	415
17-Oct-10	350	195	115	115	115	415
18-Oct-10	350	195	115	115	115	415
19-Oct-10	350	195	115	115	115	415
20-Oct-10	350	195	115	115	115	415
21-Oct-10	350	195	115	115	115	415
22-Oct-10	350	195	115	115	115	415
23-Oct-10	350	195	115	115	115	415
24-Oct-10	350	195	115	115	115	415
25-Oct-10	350	195	115	115	115	415
26-Oct-10	350	195	115	115	115	415
27-Oct-10	350	195	115	115	115	415
28-Oct-10	350	195	115	115	115	415
29-Oct-10	350	195	115	115	115	415
30-Oct-10	350	195	115	115	115	415
31-Oct-10	350	195	115	115	115	415
1-Nov-10	700	575	475	475	475	775
2-Nov-10	700	575	475	475	475	775
3-Nov-10	700	575	475	475	475	775
4-Nov-10	700	575	475	475	475	775
5-Nov-10	700	575	475	475	475	775
6-Nov-10	700	575	475	475	475	775
7-Nov-10	700	575	475	475	475	775
8-Nov-10	700	575	475	475	475	775
9-Nov-10	700	575	475	475	475	775
10-Nov-10	700	575	475	475	475	775
11-Nov-10	350	235	135	135	135	535
12-Nov-10	350	235	135	135	135	535
13-Nov-10	350	235	155	155	155	555
14-Nov-10	350	235	155	155	155	555
15-Nov-10	350	235	155	155	155	555
16-Nov-10	350	235	155	155	155	555
17-Nov-10	350	235	155	155	155	555
18-Nov-10	350	235	155	155	155	555
19-Nov-10	350	235	155	155	155	555
20-Nov-10	350	235	155	155	155	555
21-Nov-10	350	235	155	155	155	555
22-Nov-10	350	235	155	155	155	555
23-Nov-10	350	235	155	155	155	555
24-Nov-10	350	235	155	155	155	555
25-Nov-10	350	235	155	155	155	555
26-Nov-10	350	235	155	155	155	555
27-Nov-10	350	235	155	155	155	555
28-Nov-10	350	235	155	155	155	555
29-Nov-10	350	235	155	155	155	555
30-Nov-10	350	235	155	155	155	555
1-Dec-10	350	235	155	155	155	555

Flows in Reaches 2-5 assume instantaneous travel times; Fall 2009 Interim Flow releases suggest approximate 7-day travel time to the top of Reach 2B

APPENDIX D

Illustrative Hydrograph Daily Flows for a Dry Water Year

	Volumes at top of Reach 1 (ac-ft)	Volumes at top of Reach 2 (ac-ft)	Volumes at top of Reach 3 (ac-ft)	Volumes at top of Reach 4 (ac-ft)	Volumes at top of Reach 5 (ac-ft)	Volumes at bottom of Reach 5 (ac-ft)
Feb 1-Sept 30:	208,959	125,117	84,198	84,198	84,198	264,298
Feb 1-Dec 1:	258,942	158,301	107,147	107,147	107,147	328,304
February:	19,438	14,162	9,719	9,719	9,719	37,488
Mar 1-Dec 1:	239,504	144,139	97,428	97,428	97,428	290,817
March:	44,430	36,744	29,306	29,306	29,306	59,256
April:	38,876	30,248	25,488	25,488	25,488	49,289
May:	21,521	10,145	5,226	5,226	5,226	29,821
June:	20,826	9,818	5,058	5,058	5,058	28,860
July:	21,521	7,686	2,767	2,767	2,767	19,676
August:	21,521	7,686	2,767	2,767	2,767	19,676
September:	20,826	8,628	3,868	3,868	3,868	20,231
October:	21,521	11,990	7,071	7,071	7,071	25,517
November:	27,769	20,727	15,570	15,570	15,570	37,388
December:	694	466	307	307	307	1,101

Date	Dry year: Friant Dam Release (Top of Reach 1)	Dry year: Anticipated flow at Gravelly Ford (Top of Reach 2) (cfs)	Dry year: Anticipated flow at Mendota Dam (Top of Reach 3) (cfs)	Dry year: Anticipated flow at Sack Dam (Top of Reach 4) (cfs)	Dry year: Anticipated flow at confluence of Eastside Bypass (Top of Reach 5) (cfs)	Dry year: Anticipated flow at confluence of Merced River (Bottom of Reach 5) (cfs)
1-Feb-10	350	255	175	175	175	675
2-Feb-10	350	255	175	175	175	675
3-Feb-10	350	255	175	175	175	675
4-Feb-10	350	255	175	175	175	675
5-Feb-10	350	255	175	175	175	675
6-Feb-10	350	255	175	175	175	675
7-Feb-10	350	255	175	175	175	675
8-Feb-10	350	255	175	175	175	675
9-Feb-10	350	255	175	175	175	675
10-Feb-10	350	255	175	175	175	675
11-Feb-10	350	255	175	175	175	675
12-Feb-10	350	255	175	175	175	675
13-Feb-10	350	255	175	175	175	675
14-Feb-10	350	255	175	175	175	675
15-Feb-10	350	255	175	175	175	675
16-Feb-10	350	255	175	175	175	675
17-Feb-10	350	255	175	175	175	675
18-Feb-10	350	255	175	175	175	675
19-Feb-10	350	255	175	175	175	675
20-Feb-10	350	255	175	175	175	675
21-Feb-10	350	255	175	175	175	675
22-Feb-10	350	255	175	175	175	675
23-Feb-10	350	255	175	175	175	675
24-Feb-10	350	255	175	175	175	675
25-Feb-10	350	255	175	175	175	675
26-Feb-10	350	255	175	175	175	675
27-Feb-10	350	255	175	175	175	675
28-Feb-10	350	255	175	175	175	675
1-Mar-10	500	375	285	285	285	785
2-Mar-10	500	375	285	285	285	785
3-Mar-10	500	375	285	285	285	785
4-Mar-10	500	375	285	285	285	785
5-Mar-10	500	375	285	285	285	785
6-Mar-10	500	375	285	285	285	785
7-Mar-10	500	375	285	285	285	785
8-Mar-10	500	375	285	285	285	785
9-Mar-10	500	375	285	285	285	785
10-Mar-10	500	375	285	285	285	785
11-Mar-10	500	375	285	285	285	785
12-Mar-10	500	375	285	285	285	785
13-Mar-10	500	375	285	285	285	785
14-Mar-10	500	375	285	285	285	785
15-Mar-10	500	375	285	285	285	785
16-Mar-10	800	675	525	525	525	1,000
17-Mar-10	800	675	525	525	525	1,000
18-Mar-10	800	675	525	525	525	1,000
19-Mar-10	800	675	525	525	525	1,000
20-Mar-10	800	675	525	525	525	1,000
21-Mar-10	800	675	525	525	525	1,000
22-Mar-10	800	675	525	525	525	1,000
23-Mar-10	800	675	525	525	525	1,000
24-Mar-10	800	675	525	525	525	1,000
25-Mar-10	1,100	975	825	825	825	1,300
26-Mar-10	1,100	975	825	825	825	1,300
27-Mar-10	1,100	975	825	825	825	1,300
28-Mar-10	1,100	975	825	825	825	1,300
29-Mar-10	1,100	975	825	825	825	1,300
30-Mar-10	1,100	975	825	825	825	1,300
31-Mar-10	1,100	975	825	825	825	1,300
1-Apr-10	1,100	955	875	875	875	1,275
2-Apr-10	1,100	955	875	875	875	1,275
3-Apr-10	1,100	955	875	875	875	1,275
4-Apr-10	1,100	955	875	875	875	1,275
5-Apr-10	1,100	955	875	875	875	1,275
6-Apr-10	800	655	575	575	575	975
7-Apr-10	800	655	575	575	575	975
8-Apr-10	800	655	575	575	575	975
9-Apr-10	800	655	575	575	575	975
10-Apr-10	800	655	575	575	575	975
11-Apr-10	800	655	575	575	575	975

Flows in Reaches 2-5 assume instantaneous travel times; Fall 2009 Interim Flow releases suggest approximate 7-day travel time to the top of Reach 2B

Date	Dry year: Friant Dam Release (Top of Reach 1)	Dry year: Anticipated flow at Gravelly Ford (Top of Reach 2) (cfs)	Dry year: Anticipated flow at Mendota Dam (Top of Reach 3) (cfs)	Dry year: Anticipated flow at Sack Dam (Top of Reach 4) (cfs)	Dry year: Anticipated flow at confluence of Eastside Bypass (Top of Reach 5) (cfs)	Dry year: Anticipated flow at confluence of Merced River (Bottom of Reach 5) (cfs)
12-Apr-10	800	655	575	575	575	975
13-Apr-10	800	655	575	575	575	975
14-Apr-10	800	655	575	575	575	975
15-Apr-10	500	355	275	275	275	675
16-Apr-10	500	355	275	275	275	675
17-Apr-10	500	355	275	275	275	675
18-Apr-10	500	355	275	275	275	675
19-Apr-10	500	355	275	275	275	675
20-Apr-10	500	355	275	275	275	675
21-Apr-10	500	355	275	275	275	675
22-Apr-10	500	355	275	275	275	675
23-Apr-10	450	305	225	225	225	625
24-Apr-10	350	205	125	125	125	525
25-Apr-10	350	205	125	125	125	525
26-Apr-10	350	205	125	125	125	525
27-Apr-10	350	205	125	125	125	525
28-Apr-10	350	205	125	125	125	525
29-Apr-10	350	205	125	125	125	525
30-Apr-10	350	205	125	125	125	525
1-May-10	350	165	85	85	85	485
2-May-10	350	165	85	85	85	485
3-May-10	350	165	85	85	85	485
4-May-10	350	165	85	85	85	485
5-May-10	350	165	85	85	85	485
6-May-10	350	165	85	85	85	485
7-May-10	350	165	85	85	85	485
8-May-10	350	165	85	85	85	485
9-May-10	350	165	85	85	85	485
10-May-10	350	165	85	85	85	485
11-May-10	350	165	85	85	85	485
12-May-10	350	165	85	85	85	485
13-May-10	350	165	85	85	85	485
14-May-10	350	165	85	85	85	485
15-May-10	350	165	85	85	85	485
16-May-10	350	165	85	85	85	485
17-May-10	350	165	85	85	85	485
18-May-10	350	165	85	85	85	485
19-May-10	350	165	85	85	85	485
20-May-10	350	165	85	85	85	485
21-May-10	350	165	85	85	85	485
22-May-10	350	165	85	85	85	485
23-May-10	350	165	85	85	85	485
24-May-10	350	165	85	85	85	485
25-May-10	350	165	85	85	85	485
26-May-10	350	165	85	85	85	485
27-May-10	350	165	85	85	85	485
28-May-10	350	165	85	85	85	485
29-May-10	350	165	85	85	85	485
30-May-10	350	165	85	85	85	485
31-May-10	350	165	85	85	85	485
1-Jun-10	350	165	85	85	85	485
2-Jun-10	350	165	85	85	85	485
3-Jun-10	350	165	85	85	85	485
4-Jun-10	350	165	85	85	85	485
5-Jun-10	350	165	85	85	85	485
6-Jun-10	350	165	85	85	85	485
7-Jun-10	350	165	85	85	85	485
8-Jun-10	350	165	85	85	85	485
9-Jun-10	350	165	85	85	85	485
10-Jun-10	350	165	85	85	85	485
11-Jun-10	350	165	85	85	85	485
12-Jun-10	350	165	85	85	85	485
13-Jun-10	350	165	85	85	85	485
14-Jun-10	350	165	85	85	85	485
15-Jun-10	350	165	85	85	85	485
16-Jun-10	350	165	85	85	85	485
17-Jun-10	350	165	85	85	85	485
18-Jun-10	350	165	85	85	85	485
19-Jun-10	350	165	85	85	85	485
20-Jun-10	350	165	85	85	85	485
21-Jun-10	350	165	85	85	85	485
22-Jun-10	350	165	85	85	85	485
23-Jun-10	350	165	85	85	85	485
24-Jun-10	350	165	85	85	85	485
25-Jun-10	350	165	85	85	85	485
26-Jun-10	350	165	85	85	85	485
27-Jun-10	350	165	85	85	85	485
28-Jun-10	350	165	85	85	85	485
29-Jun-10	350	165	85	85	85	485
30-Jun-10	350	165	85	85	85	485
1-Jul-10	350	125	45	45	45	320
2-Jul-10	350	125	45	45	45	320
3-Jul-10	350	125	45	45	45	320
4-Jul-10	350	125	45	45	45	320
5-Jul-10	350	125	45	45	45	320
6-Jul-10	350	125	45	45	45	320
7-Jul-10	350	125	45	45	45	320

Flows in Reaches 2-5 assume instantaneous travel times; Fall 2009 Interim Flow releases suggest approximate 7-day travel time to the top of Reach 2B

Date	Dry year: Friant Dam Release (Top of Reach 1)	Dry year: Anticipated flow at Gravelly Ford (Top of Reach 2) (cfs)	Dry year: Anticipated flow at Mendota Dam (Top of Reach 3) (cfs)	Dry year: Anticipated flow at Sack Dam (Top of Reach 4) (cfs)	Dry year: Anticipated flow at confluence of Eastside Bypass (Top of Reach 5) (cfs)	Dry year: Anticipated flow at confluence of Merced River (Bottom of Reach 5) (cfs)
8-Jul-10	350	125	45	45	45	320
9-Jul-10	350	125	45	45	45	320
10-Jul-10	350	125	45	45	45	320
11-Jul-10	350	125	45	45	45	320
12-Jul-10	350	125	45	45	45	320
13-Jul-10	350	125	45	45	45	320
14-Jul-10	350	125	45	45	45	320
15-Jul-10	350	125	45	45	45	320
16-Jul-10	350	125	45	45	45	320
17-Jul-10	350	125	45	45	45	320
18-Jul-10	350	125	45	45	45	320
19-Jul-10	350	125	45	45	45	320
20-Jul-10	350	125	45	45	45	320
21-Jul-10	350	125	45	45	45	320
22-Jul-10	350	125	45	45	45	320
23-Jul-10	350	125	45	45	45	320
24-Jul-10	350	125	45	45	45	320
25-Jul-10	350	125	45	45	45	320
26-Jul-10	350	125	45	45	45	320
27-Jul-10	350	125	45	45	45	320
28-Jul-10	350	125	45	45	45	320
29-Jul-10	350	125	45	45	45	320
30-Jul-10	350	125	45	45	45	320
31-Jul-10	350	125	45	45	45	320
1-Aug-10	350	125	45	45	45	320
2-Aug-10	350	125	45	45	45	320
3-Aug-10	350	125	45	45	45	320
4-Aug-10	350	125	45	45	45	320
5-Aug-10	350	125	45	45	45	320
6-Aug-10	350	125	45	45	45	320
7-Aug-10	350	125	45	45	45	320
8-Aug-10	350	125	45	45	45	320
9-Aug-10	350	125	45	45	45	320
10-Aug-10	350	125	45	45	45	320
11-Aug-10	350	125	45	45	45	320
12-Aug-10	350	125	45	45	45	320
13-Aug-10	350	125	45	45	45	320
14-Aug-10	350	125	45	45	45	320
15-Aug-10	350	125	45	45	45	320
16-Aug-10	350	125	45	45	45	320
17-Aug-10	350	125	45	45	45	320
18-Aug-10	350	125	45	45	45	320
19-Aug-10	350	125	45	45	45	320
20-Aug-10	350	125	45	45	45	320
21-Aug-10	350	125	45	45	45	320
22-Aug-10	350	125	45	45	45	320
23-Aug-10	350	125	45	45	45	320
24-Aug-10	350	125	45	45	45	320
25-Aug-10	350	125	45	45	45	320
26-Aug-10	350	125	45	45	45	320
27-Aug-10	350	125	45	45	45	320
28-Aug-10	350	125	45	45	45	320
29-Aug-10	350	125	45	45	45	320
30-Aug-10	350	125	45	45	45	320
31-Aug-10	350	125	45	45	45	320
1-Sep-10	350	145	65	65	65	340
2-Sep-10	350	145	65	65	65	340
3-Sep-10	350	145	65	65	65	340
4-Sep-10	350	145	65	65	65	340
5-Sep-10	350	145	65	65	65	340
6-Sep-10	350	145	65	65	65	340
7-Sep-10	350	145	65	65	65	340
8-Sep-10	350	145	65	65	65	340
9-Sep-10	350	145	65	65	65	340
10-Sep-10	350	145	65	65	65	340
11-Sep-10	350	145	65	65	65	340
12-Sep-10	350	145	65	65	65	340
13-Sep-10	350	145	65	65	65	340
14-Sep-10	350	145	65	65	65	340
15-Sep-10	350	145	65	65	65	340
16-Sep-10	350	145	65	65	65	340
17-Sep-10	350	145	65	65	65	340
18-Sep-10	350	145	65	65	65	340
19-Sep-10	350	145	65	65	65	340
20-Sep-10	350	145	65	65	65	340
21-Sep-10	350	145	65	65	65	340
22-Sep-10	350	145	65	65	65	340
23-Sep-10	350	145	65	65	65	340
24-Sep-10	350	145	65	65	65	340
25-Sep-10	350	145	65	65	65	340
26-Sep-10	350	145	65	65	65	340
27-Sep-10	350	145	65	65	65	340
28-Sep-10	350	145	65	65	65	340
29-Sep-10	350	145	65	65	65	340
30-Sep-10	350	145	65	65	65	340
1-Oct-10	350	195	115	115	115	415
2-Oct-10	350	195	115	115	115	415

Flows in Reaches 2-5 assume instantaneous travel times; Fall 2009 Interim Flow releases suggest approximate 7-day travel time to the top of Reach 2B

Date	Dry year: Friant Dam Release (Top of Reach 1)	Dry year: Anticipated flow at Gravelly Ford (Top of Reach 2) (cfs)	Dry year: Anticipated flow at Mendota Dam (Top of Reach 3) (cfs)	Dry year: Anticipated flow at Sack Dam (Top of Reach 4) (cfs)	Dry year: Anticipated flow at confluence of Eastside Bypass (Top of Reach 5) (cfs)	Dry year: Anticipated flow at confluence of Merced River (Bottom of Reach 5) (cfs)
3-Oct-10	350	195	115	115	115	415
4-Oct-10	350	195	115	115	115	415
5-Oct-10	350	195	115	115	115	415
6-Oct-10	350	195	115	115	115	415
7-Oct-10	350	195	115	115	115	415
8-Oct-10	350	195	115	115	115	415
9-Oct-10	350	195	115	115	115	415
10-Oct-10	350	195	115	115	115	415
11-Oct-10	350	195	115	115	115	415
12-Oct-10	350	195	115	115	115	415
13-Oct-10	350	195	115	115	115	415
14-Oct-10	350	195	115	115	115	415
15-Oct-10	350	195	115	115	115	415
16-Oct-10	350	195	115	115	115	415
17-Oct-10	350	195	115	115	115	415
18-Oct-10	350	195	115	115	115	415
19-Oct-10	350	195	115	115	115	415
20-Oct-10	350	195	115	115	115	415
21-Oct-10	350	195	115	115	115	415
22-Oct-10	350	195	115	115	115	415
23-Oct-10	350	195	115	115	115	415
24-Oct-10	350	195	115	115	115	415
25-Oct-10	350	195	115	115	115	415
26-Oct-10	350	195	115	115	115	415
27-Oct-10	350	195	115	115	115	415
28-Oct-10	350	195	115	115	115	415
29-Oct-10	350	195	115	115	115	415
30-Oct-10	350	195	115	115	115	415
31-Oct-10	350	195	115	115	115	415
1-Nov-10	700	575	475	475	475	775
2-Nov-10	700	575	475	475	475	775
3-Nov-10	700	575	475	475	475	775
4-Nov-10	700	575	475	475	475	775
5-Nov-10	700	575	475	475	475	775
6-Nov-10	700	575	475	475	475	775
7-Nov-10	700	575	475	475	475	775
8-Nov-10	700	575	475	475	475	775
9-Nov-10	700	575	475	475	475	775
10-Nov-10	700	575	475	475	475	775
11-Nov-10	350	235	155	155	155	555
12-Nov-10	350	235	155	155	155	555
13-Nov-10	350	235	155	155	155	555
14-Nov-10	350	235	155	155	155	555
15-Nov-10	350	235	155	155	155	555
16-Nov-10	350	235	155	155	155	555
17-Nov-10	350	235	155	155	155	555
18-Nov-10	350	235	155	155	155	555
19-Nov-10	350	235	155	155	155	555
20-Nov-10	350	235	155	155	155	555
21-Nov-10	350	235	155	155	155	555
22-Nov-10	350	235	155	155	155	555
23-Nov-10	350	235	155	155	155	555
24-Nov-10	350	235	155	155	155	555
25-Nov-10	350	235	155	155	155	555
26-Nov-10	350	235	155	155	155	555
27-Nov-10	350	235	155	155	155	555
28-Nov-10	350	235	155	155	155	555
29-Nov-10	350	235	155	155	155	555
30-Nov-10	350	235	155	155	155	555
1-Dec-10	350	235	155	155	155	555

Flows in Reaches 2-5 assume instantaneous travel times; Fall 2009 Interim Flow releases suggest approximate 7-day travel time to the top of Reach 2B

APPENDIX E

Illustrative Hydrograph Daily Flows for a Critical-High Water Year

	Volumes at top of Reach 1 (ac-ft)	Volumes at top of Reach 2 (ac-ft)	Volumes at top of Reach 3 (ac-ft)	Volumes at top of Reach 4 (ac-ft)	Volumes at top of Reach 5 (ac-ft)	Volumes at bottom of Reach 5 (ac-ft)
Feb 1-Sept 30:	153,332	69,491	46,463	46,463	46,463	226,562
Feb 1-Dec 1:	173,881	73,319	48,545	48,545	48,545	269,702
February:	6,109	833	0	0	0	27,769
Mar 1-Dec 1:	167,772	72,486	48,545	48,545	48,545	241,934
March:	44,430	36,744	29,306	29,306	29,306	59,256
April:	29,950	21,322	17,157	17,157	17,157	40,959
May:	13,220	1,845	0	0	0	24,595
June:	12,793	1,785	0	0	0	23,802
July:	15,679	1,845	0	0	0	16,909
August:	15,679	1,845	0	0	0	16,909
September:	15,471	3,273	0	0	0	16,364
October:	9,838	307	0	0	0	18,446
November:	10,473	3,511	2,083	2,083	2,083	23,901
December:	238	10	0	0	0	793

Date	Critical-High year: Friant Dam Release (Top of Reach 1)	Critical-High year: Anticipated flow at Gravelly Ford (Top of Reach 2) (cfs)	Critical-High year: Anticipated flow at Mendota Dam (Top of Reach 3) (cfs)	Critical-High year: Anticipated flow at Sack Dam (Top of Reach 4) (cfs)	Critical-High year: Anticipated flow at confluence of Eastside Bypass (Top of Reach 5) (cfs)	Critical-High year: Anticipated flow at confluence of Merced River (Bottom of Reach 5) (cfs)
1-Feb-10	110	15	0	0	0	500
2-Feb-10	110	15	0	0	0	500
3-Feb-10	110	15	0	0	0	500
4-Feb-10	110	15	0	0	0	500
5-Feb-10	110	15	0	0	0	500
6-Feb-10	110	15	0	0	0	500
7-Feb-10	110	15	0	0	0	500
8-Feb-10	110	15	0	0	0	500
9-Feb-10	110	15	0	0	0	500
10-Feb-10	110	15	0	0	0	500
11-Feb-10	110	15	0	0	0	500
12-Feb-10	110	15	0	0	0	500
13-Feb-10	110	15	0	0	0	500
14-Feb-10	110	15	0	0	0	500
15-Feb-10	110	15	0	0	0	500
16-Feb-10	110	15	0	0	0	500
17-Feb-10	110	15	0	0	0	500
18-Feb-10	110	15	0	0	0	500
19-Feb-10	110	15	0	0	0	500
20-Feb-10	110	15	0	0	0	500
21-Feb-10	110	15	0	0	0	500
22-Feb-10	110	15	0	0	0	500
23-Feb-10	110	15	0	0	0	500
24-Feb-10	110	15	0	0	0	500
25-Feb-10	110	15	0	0	0	500
26-Feb-10	110	15	0	0	0	500
27-Feb-10	110	15	0	0	0	500
28-Feb-10	110	15	0	0	0	500
1-Mar-10	500	375	285	285	285	785
2-Mar-10	500	375	285	285	285	785
3-Mar-10	500	375	285	285	285	785
4-Mar-10	500	375	285	285	285	785
5-Mar-10	500	375	285	285	285	785
6-Mar-10	500	375	285	285	285	785
7-Mar-10	500	375	285	285	285	785
8-Mar-10	500	375	285	285	285	785
9-Mar-10	500	375	285	285	285	785
10-Mar-10	500	375	285	285	285	785
11-Mar-10	500	375	285	285	285	785
12-Mar-10	500	375	285	285	285	785
13-Mar-10	500	375	285	285	285	785
14-Mar-10	500	375	285	285	285	785
15-Mar-10	500	375	285	285	285	785
16-Mar-10	800	675	525	525	525	1,000
17-Mar-10	800	675	525	525	525	1,000
18-Mar-10	800	675	525	525	525	1,000
19-Mar-10	800	675	525	525	525	1,000
20-Mar-10	800	675	525	525	525	1,000
21-Mar-10	800	675	525	525	525	1,000
22-Mar-10	800	675	525	525	525	1,000
23-Mar-10	800	675	525	525	525	1,000
24-Mar-10	800	675	525	525	525	1,000
25-Mar-10	1,100	975	825	825	825	1,300
26-Mar-10	1,100	975	825	825	825	1,300
27-Mar-10	1,100	975	825	825	825	1,300
28-Mar-10	1,100	975	825	825	825	1,300
29-Mar-10	1,100	975	825	825	825	1,300
30-Mar-10	1,100	975	825	825	825	1,300
31-Mar-10	1,100	975	825	825	825	1,300
1-Apr-10	1,100	955	875	875	875	1,275
2-Apr-10	1,100	955	875	875	875	1,275
3-Apr-10	800	655	575	575	575	975
4-Apr-10	800	655	575	575	575	975
5-Apr-10	800	655	575	575	575	975
6-Apr-10	800	655	575	575	575	975
7-Apr-10	800	655	575	575	575	975
8-Apr-10	800	655	575	575	575	975
9-Apr-10	800	655	575	575	575	975
10-Apr-10	800	655	575	575	575	975
11-Apr-10	600	455	375	375	375	775
12-Apr-10	500	355	275	275	275	675
13-Apr-10	500	355	275	275	275	675

Flows in Reaches 2-5 assume instantaneous travel times; Fall 2009 Interim Flow releases suggest approximate 7-day travel time to the top of Reach 2B

Date	Critical-High year: Friant Dam Release (Top of Reach 1)	Critical-High year: Anticipated flow at Gravelly Ford (Top of Reach 2) (cfs)	Critical-High year: Anticipated flow at Mendota Dam (Top of Reach 3) (cfs)	Critical-High year: Anticipated flow at Sack Dam (Top of Reach 4) (cfs)	Critical-High year: Anticipated flow at confluence of Eastside Bypass (Top of Reach 5) (cfs)	Critical-High year: Anticipated flow at confluence of Merced River (Bottom of Reach 5) (cfs)
14-Apr-10	500	355	275	275	275	675
15-Apr-10	500	355	275	275	275	675
16-Apr-10	500	355	275	275	275	675
17-Apr-10	500	355	275	275	275	675
18-Apr-10	500	355	275	275	275	675
19-Apr-10	200	55	0	0	0	400
20-Apr-10	200	55	0	0	0	400
21-Apr-10	200	55	0	0	0	400
22-Apr-10	200	55	0	0	0	400
23-Apr-10	200	55	0	0	0	400
24-Apr-10	200	55	0	0	0	400
25-Apr-10	200	55	0	0	0	400
26-Apr-10	200	55	0	0	0	400
27-Apr-10	200	55	0	0	0	400
28-Apr-10	200	55	0	0	0	400
29-Apr-10	200	55	0	0	0	400
30-Apr-10	200	55	0	0	0	400
1-May-10	215	30	0	0	0	400
2-May-10	215	30	0	0	0	400
3-May-10	215	30	0	0	0	400
4-May-10	215	30	0	0	0	400
5-May-10	215	30	0	0	0	400
6-May-10	215	30	0	0	0	400
7-May-10	215	30	0	0	0	400
8-May-10	215	30	0	0	0	400
9-May-10	215	30	0	0	0	400
10-May-10	215	30	0	0	0	400
11-May-10	215	30	0	0	0	400
12-May-10	215	30	0	0	0	400
13-May-10	215	30	0	0	0	400
14-May-10	215	30	0	0	0	400
15-May-10	215	30	0	0	0	400
16-May-10	215	30	0	0	0	400
17-May-10	215	30	0	0	0	400
18-May-10	215	30	0	0	0	400
19-May-10	215	30	0	0	0	400
20-May-10	215	30	0	0	0	400
21-May-10	215	30	0	0	0	400
22-May-10	215	30	0	0	0	400
23-May-10	215	30	0	0	0	400
24-May-10	215	30	0	0	0	400
25-May-10	215	30	0	0	0	400
26-May-10	215	30	0	0	0	400
27-May-10	215	30	0	0	0	400
28-May-10	215	30	0	0	0	400
29-May-10	215	30	0	0	0	400
30-May-10	215	30	0	0	0	400
31-May-10	215	30	0	0	0	400
1-Jun-10	215	30	0	0	0	400
2-Jun-10	215	30	0	0	0	400
3-Jun-10	215	30	0	0	0	400
4-Jun-10	215	30	0	0	0	400
5-Jun-10	215	30	0	0	0	400
6-Jun-10	215	30	0	0	0	400
7-Jun-10	215	30	0	0	0	400
8-Jun-10	215	30	0	0	0	400
9-Jun-10	215	30	0	0	0	400
10-Jun-10	215	30	0	0	0	400
11-Jun-10	215	30	0	0	0	400
12-Jun-10	215	30	0	0	0	400
13-Jun-10	215	30	0	0	0	400
14-Jun-10	215	30	0	0	0	400
15-Jun-10	215	30	0	0	0	400
16-Jun-10	215	30	0	0	0	400
17-Jun-10	215	30	0	0	0	400
18-Jun-10	215	30	0	0	0	400
19-Jun-10	215	30	0	0	0	400
20-Jun-10	215	30	0	0	0	400
21-Jun-10	215	30	0	0	0	400
22-Jun-10	215	30	0	0	0	400
23-Jun-10	215	30	0	0	0	400
24-Jun-10	215	30	0	0	0	400
25-Jun-10	215	30	0	0	0	400
26-Jun-10	215	30	0	0	0	400
27-Jun-10	215	30	0	0	0	400
28-Jun-10	215	30	0	0	0	400
29-Jun-10	215	30	0	0	0	400
30-Jun-10	215	30	0	0	0	400
1-Jul-10	255	30	0	0	0	275
2-Jul-10	255	30	0	0	0	275
3-Jul-10	255	30	0	0	0	275
4-Jul-10	255	30	0	0	0	275
5-Jul-10	255	30	0	0	0	275
6-Jul-10	255	30	0	0	0	275
7-Jul-10	255	30	0	0	0	275
8-Jul-10	255	30	0	0	0	275
9-Jul-10	255	30	0	0	0	275
10-Jul-10	255	30	0	0	0	275
11-Jul-10	255	30	0	0	0	275

Flows in Reaches 2-5 assume instantaneous travel times; Fall 2009 Interim Flow releases suggest approximate 7-day travel time to the top of Reach 2B

Date	Critical-High year: Friant Dam Release (Top of Reach 1)	Critical-High year: Anticipated flow at Gravelly Ford (Top of Reach 2) (cfs)	Critical-High year: Anticipated flow at Mendota Dam (Top of Reach 3) (cfs)	Critical-High year: Anticipated flow at Sack Dam (Top of Reach 4) (cfs)	Critical-High year: Anticipated flow at confluence of Eastside Bypass (Top of Reach 5) (cfs)	Critical-High year: Anticipated flow at confluence of Merced River (Bottom of Reach 5) (cfs)
12-Jul-10	255	30	0	0	0	275
13-Jul-10	255	30	0	0	0	275
14-Jul-10	255	30	0	0	0	275
15-Jul-10	255	30	0	0	0	275
16-Jul-10	255	30	0	0	0	275
17-Jul-10	255	30	0	0	0	275
18-Jul-10	255	30	0	0	0	275
19-Jul-10	255	30	0	0	0	275
20-Jul-10	255	30	0	0	0	275
21-Jul-10	255	30	0	0	0	275
22-Jul-10	255	30	0	0	0	275
23-Jul-10	255	30	0	0	0	275
24-Jul-10	255	30	0	0	0	275
25-Jul-10	255	30	0	0	0	275
26-Jul-10	255	30	0	0	0	275
27-Jul-10	255	30	0	0	0	275
28-Jul-10	255	30	0	0	0	275
29-Jul-10	255	30	0	0	0	275
30-Jul-10	255	30	0	0	0	275
31-Jul-10	255	30	0	0	0	275
1-Aug-10	255	30	0	0	0	275
2-Aug-10	255	30	0	0	0	275
3-Aug-10	255	30	0	0	0	275
4-Aug-10	255	30	0	0	0	275
5-Aug-10	255	30	0	0	0	275
6-Aug-10	255	30	0	0	0	275
7-Aug-10	255	30	0	0	0	275
8-Aug-10	255	30	0	0	0	275
9-Aug-10	255	30	0	0	0	275
10-Aug-10	255	30	0	0	0	275
11-Aug-10	255	30	0	0	0	275
12-Aug-10	255	30	0	0	0	275
13-Aug-10	255	30	0	0	0	275
14-Aug-10	255	30	0	0	0	275
15-Aug-10	255	30	0	0	0	275
16-Aug-10	255	30	0	0	0	275
17-Aug-10	255	30	0	0	0	275
18-Aug-10	255	30	0	0	0	275
19-Aug-10	255	30	0	0	0	275
20-Aug-10	255	30	0	0	0	275
21-Aug-10	255	30	0	0	0	275
22-Aug-10	255	30	0	0	0	275
23-Aug-10	255	30	0	0	0	275
24-Aug-10	255	30	0	0	0	275
25-Aug-10	255	30	0	0	0	275
26-Aug-10	255	30	0	0	0	275
27-Aug-10	255	30	0	0	0	275
28-Aug-10	255	30	0	0	0	275
29-Aug-10	255	30	0	0	0	275
30-Aug-10	255	30	0	0	0	275
31-Aug-10	255	30	0	0	0	275
1-Sep-10	260	55	0	0	0	275
2-Sep-10	260	55	0	0	0	275
3-Sep-10	260	55	0	0	0	275
4-Sep-10	260	55	0	0	0	275
5-Sep-10	260	55	0	0	0	275
6-Sep-10	260	55	0	0	0	275
7-Sep-10	260	55	0	0	0	275
8-Sep-10	260	55	0	0	0	275
9-Sep-10	260	55	0	0	0	275
10-Sep-10	260	55	0	0	0	275
11-Sep-10	260	55	0	0	0	275
12-Sep-10	260	55	0	0	0	275
13-Sep-10	260	55	0	0	0	275
14-Sep-10	260	55	0	0	0	275
15-Sep-10	260	55	0	0	0	275
16-Sep-10	260	55	0	0	0	275
17-Sep-10	260	55	0	0	0	275
18-Sep-10	260	55	0	0	0	275
19-Sep-10	260	55	0	0	0	275
20-Sep-10	260	55	0	0	0	275
21-Sep-10	260	55	0	0	0	275
22-Sep-10	260	55	0	0	0	275
23-Sep-10	260	55	0	0	0	275
24-Sep-10	260	55	0	0	0	275
25-Sep-10	260	55	0	0	0	275
26-Sep-10	260	55	0	0	0	275
27-Sep-10	260	55	0	0	0	275
28-Sep-10	260	55	0	0	0	275
29-Sep-10	260	55	0	0	0	275
30-Sep-10	260	55	0	0	0	275
1-Oct-10	160	5	0	0	0	300
2-Oct-10	160	5	0	0	0	300
3-Oct-10	160	5	0	0	0	300
4-Oct-10	160	5	0	0	0	300
5-Oct-10	160	5	0	0	0	300
6-Oct-10	160	5	0	0	0	300
7-Oct-10	160	5	0	0	0	300
8-Oct-10	160	5	0	0	0	300

Flows in Reaches 2-5 assume instantaneous travel times; Fall 2009 Interim Flow releases suggest approximate 7-day travel time to the top of Reach 2B

Date	Critical-High year: Friant Dam Release (Top of Reach 1)	Critical-High year: Anticipated flow at Gravelly Ford (Top of Reach 2) (cfs)	Critical-High year: Anticipated flow at Mendota Dam (Top of Reach 3) (cfs)	Critical-High year: Anticipated flow at Sack Dam (Top of Reach 4) (cfs)	Critical-High year: Anticipated flow at confluence of Eastside Bypass (Top of Reach 5) (cfs)	Critical-High year: Anticipated flow at confluence of Merced River (Bottom of Reach 5) (cfs)
9-Oct-10	160	5	0	0	0	300
10-Oct-10	160	5	0	0	0	300
11-Oct-10	160	5	0	0	0	300
12-Oct-10	160	5	0	0	0	300
13-Oct-10	160	5	0	0	0	300
14-Oct-10	160	5	0	0	0	300
15-Oct-10	160	5	0	0	0	300
16-Oct-10	160	5	0	0	0	300
17-Oct-10	160	5	0	0	0	300
18-Oct-10	160	5	0	0	0	300
19-Oct-10	160	5	0	0	0	300
20-Oct-10	160	5	0	0	0	300
21-Oct-10	160	5	0	0	0	300
22-Oct-10	160	5	0	0	0	300
23-Oct-10	160	5	0	0	0	300
24-Oct-10	160	5	0	0	0	300
25-Oct-10	160	5	0	0	0	300
26-Oct-10	160	5	0	0	0	300
27-Oct-10	160	5	0	0	0	300
28-Oct-10	160	5	0	0	0	300
29-Oct-10	160	5	0	0	0	300
30-Oct-10	160	5	0	0	0	300
31-Oct-10	160	5	0	0	0	300
1-Nov-10	400	275	175	175	175	475
2-Nov-10	400	275	175	175	175	475
3-Nov-10	400	275	175	175	175	475
4-Nov-10	400	275	175	175	175	475
5-Nov-10	400	275	175	175	175	475
6-Nov-10	400	275	175	175	175	475
7-Nov-10	120	5	0	0	0	300
8-Nov-10	120	5	0	0	0	300
9-Nov-10	120	5	0	0	0	300
10-Nov-10	120	5	0	0	0	300
11-Nov-10	120	5	0	0	0	400
12-Nov-10	120	5	0	0	0	400
13-Nov-10	120	5	0	0	0	400
14-Nov-10	120	5	0	0	0	400
15-Nov-10	120	5	0	0	0	400
16-Nov-10	120	5	0	0	0	400
17-Nov-10	120	5	0	0	0	400
18-Nov-10	120	5	0	0	0	400
19-Nov-10	120	5	0	0	0	400
20-Nov-10	120	5	0	0	0	400
21-Nov-10	120	5	0	0	0	400
22-Nov-10	120	5	0	0	0	400
23-Nov-10	120	5	0	0	0	400
24-Nov-10	120	5	0	0	0	400
25-Nov-10	120	5	0	0	0	400
26-Nov-10	120	5	0	0	0	400
27-Nov-10	120	5	0	0	0	400
28-Nov-10	120	5	0	0	0	400
29-Nov-10	120	5	0	0	0	400
30-Nov-10	120	5	0	0	0	400
1-Dec-10	120	5	0	0	0	400

Flows in Reaches 2-5 assume instantaneous travel times; Fall 2009 Interim Flow releases suggest approximate 7-day travel time to the top of Reach 2B