San Joaquin River Restoration Program
Restoration Administrator

Memorandum

Date: April 23, 2011

To: Ali Forsythe – SJRRP Program Manager

cc. Michael Jackson, Ed Salazar
Doug DeFlitch, the TAC

From: Rod Meade – Restoration Administrator

Subject: Transmittal of RA Spring 2011 Interim Flow Program Real-Time Management Recommendations to the Secretary of the Interior

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Attached for your review and action are my Spring 2011 Real-Time Management Recommendations. As provided for in the Settlement, I prepared these recommendations based on consultation with and assistance from my Technical Advisory Committee (TAC). Prior to submitting the final version of these recommendations I also consulted with federal liaisons to the TAC and with the Fish Management Work Group (FMWG). Suggestions provided by representatives of the FMWG are addressed in my recommendations. The assistance and consultation provided by the TAC and FMWG has been essential; however, as always, the recommendations to The Secretary of the Interior contained in the attached report are mine.

As I indicate in the attached report, these recommendations focus on spring 2011 and on real-time management measures and objectives, not updated Interim Flow release recommendations. Based on the continuing precipitation pattern this spring we have progressed to a point where we recently transitioned from a "normal-wet" year to a "wet" water year. Accordingly, I expect to receive an updated Allocation and Flow Bench Evaluation Report from Reclamation that will provide information needed for me to consider whether I should update my current Interim Flow release recommendation and hydrograph dated March 7, 2011.

In addition, based on the transition to a "wet" water year, I have been discussing the potential for initiating riparian recruitment flows later this spring following the conclusion of the flood releases that have necessitated by continuing rainfall. The Reclamation flood releases are expected to continue at least into May and I am currently in discussions with your staff concerning the process for determining how to move from flood releases to riparian recruitment flows in a manner that is consistent with the terms of the Settlement. After receiving the updated Allocation from Reclamation staff I will consult with the TAC and others to determine whether to prepare an updated Interim Flow release recommendation and hydrograph. I will also consider whether to provide recommendations for initiating riparian recruitment flows later this spring and how to implement such flows.

Thank you for your consideration of these recommendations. I look forward to talking with you soon.

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RA SPRING 2011 INTERIM FLOW PROGRAM
REAL-TIME MANAGEMENT RECOMMENDATIONS

1 INTRODUCTION AND PURPOSE

The San Joaquin River Restoration Program Restoration Administrator (RA), after consulting with the Technical Advisory Committee (TAC), is required under the Stipulation of Settlement in *NRDC* v. *Rodgers* (CIV-S- 88-1658-LKK/GGH) (Settlement) to develop recommendations for "implementation of a program of Interim Flows in order to collect relevant data concerning flows, temperatures, fish needs, seepage losses, recirculation, recapture and reuse". My recommendations are provided for consideration by the overall TAC prior to submittal by me to the Secretary of the Interior as the 2011 Interim Flow Program recommendations. The TAC reviewed studies, data, and other activities undertaken by the Implementing Agencies during the Interim Flows to provide consultation to me as necessary.

These Interim Flow recommendations include three objectives: 1) initiate real-time flow management, coordination, and implementation, 2) identify processes needed to refine annual Interim Flow and Restoration Flow releases, and 3) identify short-term monitoring, modeling, and studies needed to address specific areas of uncertainty in implementing required actions of the Settlement, including refinement of Interim and Restoration Flows. The TAC includes members from the California Department of Fish and Game (CDFG) and Department of Water Resources (DWR), with input from the three federal liaison agencies. My 2011 Interim Flow recommendations are based on the best available information.

Interim Flows are defined by the Settlement as those flow releases from Friant Dam that began October 1, 2009, and end when the Restoration Flows commence (no later than January 1, 2014). The goal of the Interim Flows is to provide information to inform and improve implementation of the Settlement to achieve the two primary restoration goals of the Settlement (Paragraph 2):

1) *Restoration Goal*: restore and maintain fish populations in good condition in the mainstem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally-reproducing and self-sustaining populations of Chinook salmon.
2) *Water Management Goal*: Reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in this Settlement.

Developing an effective restoration program for Chinook salmon and other fish in the San Joaquin River requires that a number of uncertainties and potentially limiting factors affecting salmon and other fish within the river be identified and addressed. The Settlement acknowledges that additional information needs would be addressed through experiments conducted during the Interim Flow period.

My recommendations are based on an interdisciplinary approach to achieving the Restoration Goal that includes fish biology, hydrology, geomorphology, terrestrial biology, water project operations, engineering, geohydrology, water quality, and recirculation, recapture and reuse. The Interim Flow period provides an opportunity to collect important information that is intended to improve implementation of actions to achieve the Restoration Goal and Water Management Goal by:

- Reducing scientific uncertainties;
- Providing information needed to enable real-time flow management;
- Identifying refinements to the existing flow and water quality monitoring program;

- Providing information to inform decisions on fish migration pathways (*e.g.*, use of Reach 4B versus, or in combination with the Eastside Bypass) and design of physical facilities (*e.g.*, headgates, channel modifications) to better achieve flow routing and fish migration objectives;
- Providing information that will shape and refine the seasonal instream flow releases (hydrographs) under inter- and intra-annual variation in hydrology, including the decision process necessary to accommodate hydrologic and forecasting uncertainties;
- Providing field-based information to calibrate, validate, and/or improve predictive models for guiding future recommendations and management;
- Providing information that will assist planning and decisions regarding potential mechanisms for recirculation, recapture, and reuse;
- Identifying additional information needed prior to reintroduction of salmon into the river;
- Providing baseline information on channel conditions upon which future changes can be documented; and
- Establishing a foundation for future management decisions and program refinements as part of long-term adaptive management for the river consistent with the terms of the Settlement.

2 DESIGNING A REAL-TIME MANAGEMENT PROCESS FOR IMPLEMENTING SPRING 2011 INTERIM FLOW RELEASES

Following the conclusion of the Interim Flow period, Restoration Flow management during the spring "flexible flow period" will require periods of "real-time" flow management to improve the ability to facilitate successful rearing, growth, and outmigration of juvenile Chinook salmon, which in turn will improve our ability to meet the Restoration Goal. In addition, real-time instream flow management may be required for attraction and suitable water depths for upstream adult Chinook salmon migration. Due to the long distance between Friant Dam and the San Francisco Bay-Delta, and the high ambient air temperatures common to the San Joaquin valley during the April-May juvenile and smolt outmigration period, a primary management objective of "real-time" flow releases will be to provide water temperatures that are suitable for successful juvenile and smolt outmigration, at least in select reaches within the mainstem of the river. Real-time flow management will create additional complexity for already complex reservoir and river release management responsibility for Reclamation. For this reason, the primary objective during the spring 2011 Interim Flow period is to begin implementing real-time flow management to identify and begin resolving the management challenges and conflicts to prepare for: (1) Chinook salmon reintroduction by the end of 2012; and (2) commencement of Restoration Flows beginning no later than January 1, 2014. Recommended objectives for spring 2011 Interim Flow releases include the following:

- Identifying preliminary biological management targets for water temperatures, water depths, ramping rates, and seasonal floodplain inundation;
- Identifying real-time data needs that would be required to implement instream flow management such as telemetered water temperature measurements, water surface elevations, groundwater elevations, predicted (*e.g.*, 7-day forecast) meteorological conditions, reservoir inflow, and reservoir water temperatures (cold water pool volume);
- Testing the ability of the existing reservoir water temperature, river water temperature, surface water-groundwater models, flow routing models, and floodplain inundation models to accurately predict the ability to manage and meet downstream fish management targets over a wide range of environmental conditions;

- Testing the ability of the existing analytical tools to provide flexibility in adjusting to variation in basin hydrologic conditions, to serve as the basis for revising instream flow release strategies in near real-time, and to provide a reliable accounting of water allocations, both in the past and near future. The analytical tools must be capable of showing that the Interim Flow recommendations conform with the constraints and requirements of the Settlement Agreement;
- Identifying the lag times that occur between making changes to the instream flow releases at Friant Dam and the resulting changes in conditions at various downstream management locations;
- Determine the flexibility in managing releases on a daily and weekly time steps for accommodating changing environmental conditions (*e.g.*, changes in tributary inflows, downstream diversion operations, variation in air temperatures, etc.);
- Determine the coordination procedures between the RA and Program Implementing Agencies needed to effectively develop, implement, and monitor real-time Interim Flows; and
- If 2011 is a Wet water year, develop a release hydrograph that likely could be capable of naturally recruiting riparian vegetation on target surfaces.

These recommendations focus on spring 2011 Interim Flow releases. Based on the recent progression to a "wet" water year and the prospect for considering implementation of riparian recruitment flows later this spring, I expect to prepare updated Interim Flow recommendations addressing spring releases from Friant Dam. My updated flow recommendations/hydrograph will be based on the updated SJRRP Allocation and Flow Bench Evaluation which is expected to be prepared by Reclamation in the near future. It also is likely that I could be recommending adjustments to fall attractant flow recommendations later this summer.

With respect to the spring real-time management recommendations set forth in this document, I recommend a coordinated process involving myself (as advised by the TAC) and the Implementing Agencies that includes:

1) Collaboration with the Fish Management Work Group (FMWG).

I recommend continuing collaboration by the RA and TAC with the FMWG to identify biological targets to guide 2011 Friant Dam flow releases. These target conditions include:(a) average daily and maximum daily water temperature targets to provide suitable habitat conditions for Chinook salmon spawning and egg incubation, smoltification, and juvenile rearing and fry/smolt outmigration; and (b) ramping rates for periods when managed flows are being reduced to avoid the risk of juvenile stranding, seasonal variation in floodplain inundation and water depths that provide suitable habitat for juvenile Chinook salmon within the river channel and floodplains, and water depths suitable for adult fish passage. These management targets would be expressed as specific numeric conditions, by seasonal period and location.

2) Using the existing analytical models to test hypothetical flow release scenarios.

Based on assumed hydrologic and meteorological conditions, use existing analytical models developed by the SJRRP to assess the instream flows that would be expected to meet the biological targets, by date and location, over the spring flow period. The models can assess the type and resolution of data necessary to develop reliable instream flow management strategies and respond to variation in environmental conditions as reflected in historic hydrology and meteorological conditions within the basin. The models can also identify the specific data required to predict the conditions within the river for each biological target parameter, the lag times required to be taken into account in terms of both predicted future conditions (*e.g.*, long and short range weather predictions), as well as the response time to achieve downstream conditions that meet the biological targets. Model results can be used to develop a template Interim Flow hydrograph for the expected Normal-Wet water year that would identify specific targets that

would be met, by date and location, reflecting the anticipated range in environmental conditions (*e.g.*, cool, average, hot weather conditions, wet, normal, dry hydrologic conditions). The targets will: (1) allow instream flows to be managed consistent with the allocations and operations specified by the Settlement Agreement; and (2) provide a framework for testing the accuracy and performance of the existing analytic models through development of specific hydrographs that could be implemented as part of the 2011 Interim Flow release. Flow benches in the template hydrograph will be designed to allow testing of the analytic models to more accurately predict actual conditions observed in the river. A variety of specific biological targets can be tested singularly and in combination. The experimental design enables identifying the specific target(s), expected conditions in the river by date and location, and the monitoring required to assess whether or not the target condition was met based on actual field measurements. This hydrograph formed the basis for my initial 2011 Interim Flow schedule recommendations to the Secretary of Interior.

3) Revising Interim Flow Recommendations

Flow releases associated with a specific biological target may be varied within a prescribed range based on results of field monitoring, in combination with revised modeling of the 2011 Interim Flow recommendations (*e.g.*, water allocation, cold water pool volume, groundwater elevations, etc.). This variation will test the ability of real-time management to refine instream flow releases, as well as test the ability of the project to respond to real-time conditions affecting habitat suitability for all in-river life stages of Chinook salmon. Much of the monitoring and modeling data during the 2011 Interim Flow period will be updated weekly to report results of: (a) predicted and actual conditions within the river; (b) real-time refinements to dam releases that were implemented; (c) updated accounting of water allocations that have been exhausted and those that remain in the 2011 Interim Flow account; and (d) targets and test conditions to be met during the subsequent test period. These results will be used by me, the TAC, Program staff, and other parties to test model predictions and evaluate whether management targets are being met. The results will also be used to refine analytic and accounting tools, field monitoring equipment and reporting, and coordination and communication channels during the spring 2011 Interim Flow period that will serve as the foundation for further developing and refining the restoration strategies.

2.1 Proposed Real-time Management Steps

I recommend that proposed real-time management steps include the following:

1) Develop Biological Management Targets

In consultation with the TAC, and based on our review of the Fisheries Management Plan and consultation with SJRRP staff and FMWG I proposed biological targets for 2011 Interim Flows real-time management (Table 1). These biological targets focus on water temperature targets, adult fish passage targets, anti-stranding down ramping rate targets, and potential inundation area targets for juvenile salmon rearing. Each target is specific to magnitude, location, season, and as needed, duration.

2) Apply Existing Model Runs of the USJRBSI Water Temperature Model (Millerton Reservoir)

Reclamation ran the USJRBSI water temperature model for Millerton Reservoir using actual flow and meteorological conditions for the 1980-2003 time series. Reclamation ran USJRBSI model for the same time series for Restoration Flow releases. Results of these modeling efforts for this time series predict that median Settlement release temperatures always are expected to be less than 55° F for the April-October period, but exceed 55° F in November (SJRRP 2008). In addition, maximum predicted Millerton release temperatures under the Settlement are predicted to be as high as 55-59° F from July-November (SJRRP 2008). Therefore, cold water pool availability at the end of the summer (October-November) may be problematic in some years for spring-run and fall-run spawning and egg incubation target temperatures.

Additional model runs are not recommended for developing the 2011 Interim Flow template hydrographs (predictions from previous model runs will be used instead). I recommend continued monitoring of Millerton release water temperatures and reservoir temperature profiles for 2011 Interim Flows to document cold-water pool conditions.

3) Apply SJR5Q Water Temperature Model Results (San Joaquin River)

Reclamation also ran the SJR5Q water temperature model for the San Joaquin River over the 1980-2003 time series using existing riparian vegetation shading, observed meteorology, observed tributary contributions, actual flow losses, actual flow releases, Settlement hydrographs, and predicted water temperature boundary conditions (Millerton releases, as described above). The model results will be used to predict water temperature at selected management target nodes from Friant Dam to the upstream end of Mendota Pool. Conveyance and seepage constraints limit the magnitude of Interim Flows downstream of Mendota Pool to the Merced River confluence, thus the focus in spring 2011 will be upstream of Mendota Pool. Reclamation would work with the RA (advised by the TAC) to provide the matrix of SJR5Q water temperature model predictions for a wide range of flow releases and Millerton Reservoir release temperatures, as well as for varying meteorological conditions at locations between Friant Dam and the Merced River. The TAC reviewed these water temperature predictions and created a gaming spreadsheet to predict water temperatures at key management target locations for any flow release and seasonal timing. A template Interim Flow hydrograph was developed based on a February Normal-Wet year Restoration Allocation, and serves as the basis for 2011 Interim Flow Recommendations. The Interim Flow releases are based on a "normal" meteorological condition (52% probability), as well as a warmer than normal meteorological condition (89% probability) and cooler than normal meteorological condition (12% probability).

4) Develop or Refine Relationships Between Flow and Stage Change

Developing the relationships between flows and stage changes will enable evaluation of ramping rates at varying locations. It also will enable evaluation of water depths to assess adult passage at critical riffles, and inundation levels to evaluate juvenile rearing on floodplains. DWR surveyed water surface elevations for Friant Dam flow releases up to 1,600 cfs, and if Interim Flow releases or flood control releases exceed 1,600 cfs, additional water surface elevation data should be collected in all reaches to improve hydraulic model predictions of water surface elevations as a function of flow. In addition, water surface elevations have been monitored by CDFG as part of the microhabitat studies, and will be available for hydraulic model calibration if needed.

5) Continue Monitoring Water Temperatures at Real-time Stations.

The SJRRP has a network of real-time monitoring stations between Friant Dam and Merced River. These stations should be continued to be monitored in real-time, as those locations coincide or bracket 2011 Interim Flow biological target locations, as well as future downstream biological target locations. I recommend that real-time water temperature monitoring capability be added to the USGS gaging station immediately below Mendota Pool. I also recommend that real time release temperatures from Friant Dam should continue to be monitored to evaluate Millerton Reservoir temperature model predictions. Results of water temperature monitoring need to be reviewed on a daily basis (real-time), and discussed during the weekly conference calls. Monitoring of non-real-time locations by CDFG will also continue to enable end-of-season comparisons with temperature model predictions and biological targets at key locations (Highway 99 Bridge, Skaggs Bridge).

6) Monitor 7-day Meteorological Forecasts.

I recommend that during the flexible flow period, 7-day maximum air temperature forecasts for Firebaugh and Fresno be conducted prior to weekly conference calls to evaluate potential changes in flow recommendations in response to forecasted changes in air temperatures. Forecasted and actual meteorological conditions should be discussed during the weekly conference calls, and based on how "normal" those forecasted maximum air temperatures are expected to be based on the historical range of values, flow recommendations may be adjusted up or down in an attempt to meet biological water temperature targets in a water-efficient manner.

7) Update Water Year Forecast and Restoration Allocation.

Restoration Allocation to the San Joaquin River is based on a smoothing of Exhibit B water year release volume blocks; as predicted unimpaired runoff forecasts change through the spring, corresponding Restoration Allocation likewise changes. Therefore, as DWR and Reclamation update runoff forecasts through the spring, I recommend that the corresponding Restoration Allocation and flow recommendations be revisited during weekly conference calls.

8) Convene Weekly Coordination Conference Calls with the RA, TAC, and SJRRP Program Staff

To facilitate technical input between SJRRP Program Staff and the RA/TAC, I recommend that the weekly coordination conference calls, such as the Flow Scheduling Subgroup calls recently initiated by Reclamation, continue through the flexible flow period in the spring. These conference calls provide valuable opportunities to summarize current flows, runoff forecasts, restoration allocations, actual water temperatures and other water quality parameters, comparisons of measured water temperatures with target values, and forecasted precipitation and meteorological conditions. The conference calls facilitate discussion and input on real-time changes to flow recommendations and ongoing monitoring activities, particularly those that may require adjustments to the flow recommendations.

I recommend that Steps 4-8 should be repeated on a weekly basis until the end of the flexible flow period, or when the water temperature model results and real-time water temperature modeling lead to the conclusion that meteorological conditions are too warm to reasonably meet water temperature target in a water-efficient way. In the event riparian recruitment flows are implemented later in the spring, it would be advisable to continue repeating Steps 4-8 through the implementation period for those recruitment flows.

2.2 Proposed follow-up to support future real-time management

To support future real-time flow management, I recommend that the following steps be implemented *after* the conclusion of spring 2011 Interim Flow releases:

1) Evaluate and Revise the Unsteady Flow Routing Model (San Joaquin River)

I recommend that DWR run the HEC-RAS unsteady flow model for actual 2010 Interim Flows (including actual tributary accretion, flood control releases, and flow losses) for the reach from Friant Dam to Mendota Pool, and perhaps to the Merced River confluence.

2) Evaluate and Revise the San Joaquin River Water Temperature Model

I will work with the TAC to compare predicted and measured water temperatures at various locations between Friant Dam and Mendota Pool. In collaboration with Reclamation and the FMWG and TAC and based on their evaluation of the performance of the water temperature model, I will recommend whether

additional calibration of the SJR5Q model is necessary, or whether a physically-based water temperature model is needed to improve water temperature predictions.

3) Evaluate and Revise Millerton Reservoir Water Temperature Model

I will work with the TAC to compare predicted and measured Millerton Release water temperatures. In collaboration with Reclamation and the FMWG, I will work with the TAC to evaluate the performance of the Millerton Reservoir water temperature model, and recommend whether additional calibration of the USJRBI Millerton Reservoir model needed is to improve temperature predictions.

2.3 Real-time Management Strategy

The proposed approach for developing the management strategy for the spring 2011 Interim Flow experimental investigations is based on establishing a set of biologically based habitat metrics (target conditions) used to predict the real-time releases from Friant Dam needed to achieve the target objectives. The target objectives were developed based on the life history of Chinook salmon and life-stage specific habitat requirements. The target objectives for real-time management were developed to reflect the seasonal time period as well as the geographic locations where habitat requirements would be relevant to each life stage of interest. A broad range of habitat objectives were initially developed for each Chinook salmon life stage from review of information available in the scientific literature and results of habitat and fish studies conducted in other Central Valley streams and rivers. The habitat criteria were then evaluated to assess which criteria would be most important for testing as part of the 2011 Interim Flow investigations. Criteria will be based on results of prior field monitoring, as well as on modeling of the response of habitat conditions to changes in seasonal flow releases from Friant Dam, consistent with the Settlement Agreement. As a result of constraints on implementation of non-flow physical habitat modifications within the river prior to the 2011 Interim Flow period, the management strategy focused on real-time management of Friant Dam releases to meet downstream habitat target objectives. The target objectives for spring 2011 Interim Flow releases reflect consideration of multiple metrics, including:

- Water temperatures, seasonally and geographically adjusted, for suitable habitat conditions for all in-river life stages of Chinook salmon;
- Instream flows to provide sufficient water depths for upstream passage by adult spring-run Chinook salmon;
- Water temperatures suitable for upstream migration of adult spring-run Chinook salmon and downstream migration of juvenile Chinook salmon;
- Seasonal floodplain inundation for support juvenile Chinook salmon rearing habitat;
- Ramping rates (rate of change in instream flows) that reduce the risk of juvenile Chinook salmon stranding; and
- River stage changes that reduce the risk of Chinook salmon redd dewatering.

For each of these management targets, numeric objectives were established at specific locations and time periods within the river based on the habitat use predicted by spring-run Chinook salmon after reintroduction. Based on these habitat targets, results of various models and data analyses were used to predict, based on a range of seasonal climate conditions (*e.g.*, cool, average, and warm seasonal air temperatures), the instream flow releases from Friant Dam that would meet the objectives. Results of these analyses were then compiled and integrated for use as a basis for establishing an initial Interim Flow hydrograph for a Normal-Wet water year and corresponding water allocation established by the Settlement Agreement for Interim Flow experimentation. The flow release magnitude is capped based on downstream conveyance constraints (*i.e.*, <1,445 cfs in Reach 2).

2.4 Real-time Management Objectives

Target habitat objectives developed for use in designing and managing the spring 2011 Interim Flows are summarized in Table 1. The target objectives are presented by month and location based on the habitat needs that were identified for each of the key life stages of spring-run Chinook salmon that will be ultimately addressed as part of instream flow management under both the interim and long-term restoration and reintroduction of salmonids into the river. The target objectives selected for use in the 2011 studies are based on TAC review of information available in the scientific literature, review of draft sections of the San Joaquin River Fish Management Plan, discussions with fishery biologists working on habitat issues and river management for salmonids in other Central Valley river systems, and comments provided by the San Joaquin River Fish Management Work Group. The targets were also selected to examine and further refine key relationships been seasonal instream flows and habitat metrics that are reflected in the predictive models that have been developed as part of the technical foundation for the restoration program. Analyses are currently underway using the available modeling tools to assess which among the various parameters selected for use in designing the 2011 Interim Flow program are the key limiting drivers for determining seasonal timing and magnitude of instream flows that would be released over a range of hydrographs and varying watershed hydrologic conditions. Based on results of these analyses, a series of initial hydrographs were developed for use as a planning base and framework for the 2011 Interim Flow program of Friant Dam instream flow releases.

Table 1. Proposed initial long-term management objectives for Interim Flow releases.

Habitat Parameter	Metric	Target Location (s)	Sept-Nov	Dec	Jan	Feb	Mar	Apr	May	June
Spawning and egg incubation	Daily maximum water temp < 13^{o}C	Reach 1	X	X	X	X	X			
Juvenile migration	Daily maximum water temp < 20^{o}C	Reaches 1-5				X	X	X	X	
Juvenile migration	3-day running average daily average water temp < 17^{o}C	Reaches 1-5				X	X	X	X	
Juvenile smoltification	Daily maximum water temp < 12^{o}C	Reaches 1-5		X	X	X	X	X	X	
Juvenile rearing	Daily average water temp 13-15^{o}C	Reach 1A	X	X	X	X	X	X	X	X
Juvenile rearing	Daily average water temp 13-15^{o}C	Reaches 1-5				X	X	X	X	
Juvenile rearing	3-day running average daily average water temp 15-18^{o}C	Reaches 1-5				X	X	X	X	
Adult passage	>25% of wetted width greater than 0.8 ft deep	Reaches 1-5	X				X	X	X	X
Adult passage	Daily maximum water temp < 20^{o}C	Reaches 1-5	X				X	X	X	X
Adult attraction	10-day daily average flow>775 cfs just above Merced River confluence	Reach 5	X				X	X	X	X
Floodplain inundation	1.0<depth<3.3 ft Velocity<1.5 ft/sec	Reaches 1-5				X	X	X	X	
Juvenile stranding	Daily stage drop<0.5 ft/day	Reaches 1-5				X	X	X	X	
Redd dewatering	Water depth over redd > 0.8 ft	Reach 1	X	X	X	X	X			

Assumptions:

- All spawning and egg incubation occurs in Reach 1A
- Juvenile outmigration and adult spring-run upstream migration may sometimes be feasible in May and perhaps June; this needs to be checked for water temperature feasibility by water year type
- Redd dewatering criteria may be modified based on channel configuration and spawning gravel distribution
- Primary adult fall-run passage is assumed to be October-November, range of passage is assumed to be September-December.

Many of these objectives are preliminary because salmon reintroduction has not yet occurred. Thus, the objectives focus on the overall goal of simulating real-time management of flow releases if fish were in the system. Due to the initial year of real-time management, and based on discussions with the FMWG, a smaller subset of the above management objectives identified in Table 1 are targeted for 2011 Interim Flow releases and indicated in Table 2. The management target locations for 2011 Interim Flows focus on Reaches 1-2 rather than Reaches 3-5 because conveyance and seepage constraints will likely limit Interim Flow volumes through and beyond Mendota Dam at magnitudes well below Friant Dam releases. In other words, SJRRP ability to conduct Friant Dam releases to meet management targets downstream of Mendota Pool will be limited, thus we are focusing management targets upstream of Mendota Pool.

Table 2. Proposed real-time biological management objectives targeted for 2011 Interim Flows.

Month	Life history stage	Temperature target	Target location
January	Egg Incubation	<13^{0}C	Downstream Boundary Reach 1A (HWY 99 Bridge)
February	Egg Incubation	<13^{0}C	Downstream Boundary Reach 1A (HWY 99 Bridge)
March	Smoltification	<12^{0}C	Middle of Reach 1B (Skaggs Bridge)
April	Juvenile and Adult Migration	<17^{0}C 3-day mean, <20^{0}C daily max	Middle of Reach 1B, upstream of Mendota Pool (San Mateo Crossing)
May	Juvenile and Adult Migration	<17^{0}C 3-day mean, <20^{0}C daily max	Middle of Reach 1B, upstream of Mendota Pool (San Mateo Crossing)
June	Juvenile and Adult Migration	<20^{0}C	Middle of Reach 1B, upstream of Mendota Pool (San Mateo Crossing)

The Table 2 thresholds were translated into graphical format in Figure 1, and for a given flow release, Friant Dam release temperature, and day of year, the predicted water temperature at the target locations was extracted from the temperature model database.

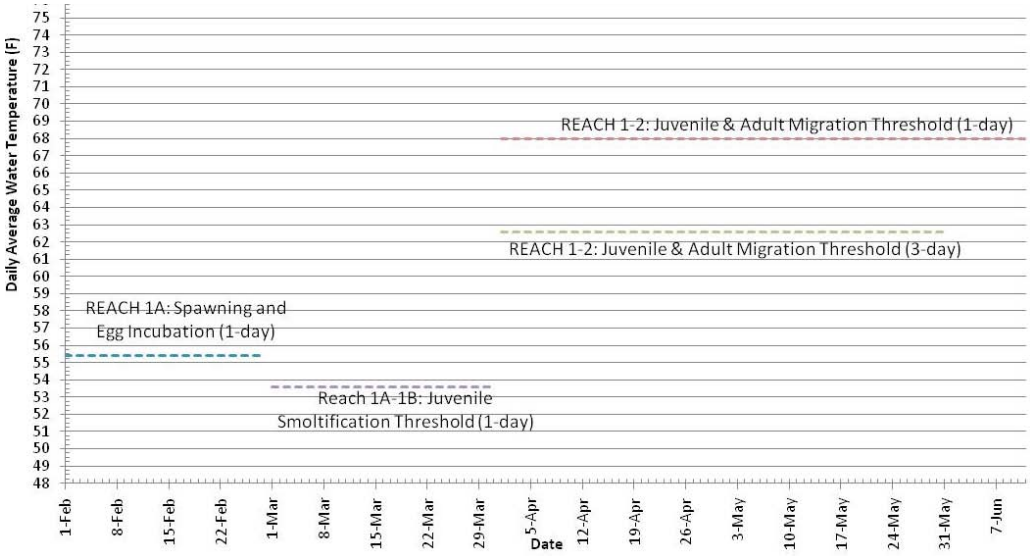

Figure 1. Proposed real-time management objectives, target locations, and time periods specifically targeted for 2011 Interim Flows.

2.5 Real-time Management Tools

A variety of analytical tools were developed based on results of monitoring within Millerton Lake and the lower San Joaquin River that are available to be used as a foundation for the 2011 real-time Interim Flow investigation. These predictive models can assess the expected Interim Flow releases from Friant Dam

that will be needed to meet specific water temperature, water depth, or floodplain inundation targets. These tools were used, in combination with assumptions about a range of possible late winter and spring climate conditions, as the basis for developing the template 2011 Interim Flow hydrograph. The modeling tools used included:

- Millerton reservoir temperature model
- SJR temperature model
- HEC-RAS model (adult fish passage, flow routing, flow inundation curves)

In addition to their use in developing the initial hydrograph, these model predictions will be used on an iterative basis to revise and refine the real-time flow releases based on results of field monitoring results. The field monitoring results collected as part of the 2011 Interim Flow releases will also be used to independently validate the predictions of the various models and will be used to revise and refine each of the models if necessary.

3 CONSTRAINTS ON SPRING 2011 INTERIM FLOWS

The February 1, 2011 Allocation and Default Flow Schedule document (SJRRP 2011) identifies the 2011 downstream conveyance limitation as 1,445 cfs at Gravelly Ford, which translates into a maximum Friant Dam release of approximately 1,630 cfs depending on assumed Reach 1 riparian demands. Therefore, my current flow release recommendations do not exceed 1,630 cfs to remain consistent with the Settlement's direction on conveyance constraints. However, as noted in SJRRP (2011), there may be additional seepage constraints that may require reductions in flow releases. Because these additional seepage constraints are still being evaluated, they are not incorporated into my current 2011 Interim Flow Real-time Management Recommendations. However, Reclamation may impose additional restrictions on Friant Dam Interim Flow releases as those seepage constraints become better quantified. In addition, based on observations of shallow groundwater tables in Reach 4 during the 2010 Interim Flow releases, I expect Reclamation to continue to limit Interim Flow releases downstream of Mendota Pool throughout the spring 2011 Interim Flow releases.

4 2011 INTERIM FLOW RECOMMENDATIONS

On January 21, 2011, I worked with the TAC to develop initial 2011 Interim Flow release recommendations based on Reclamation's unimpaired inflow forecast for February 1, 2011, using the 90% exceedence value of 2,170,000 ac-ft (Table 3). The inflow forecast translates to a Restoration Allocation of a release of 501,041 ac-ft at Friant Dam, or a flow volume of 384,300 ac-ft at Gravelly Ford. Based on Reclamation's computations of default hydrograph releases constrained by the then used downstream conveyance capacity, the February 1, 2011 Restoration Allocation for Interim Flow releases at Friant Dam was estimated in the January 24, 2011 Interim Flow recommendations to be 404,041 ac-ft, or 287,300 ac-ft at Gravelly Ford. The TAC and I conducted numerous gaming exercises of Friant Dam Interim Flow releases to achieve the real-time management targets in Table 3 and in Figures 2 and 3 for use as a basis for 2011 Interim Flow recommendations, to assure that:

1. Net flow volume did not exceed the February 1, 2011 Restoration Allocation;

2. Flow magnitude on any given day did not exceed Schedule 2 of State Board Order WR 2010-0029-DWR; and

3. Flow magnitude did not exceed downstream conveyance constraints of 1,445 cfs at Gravelly Ford.

The RA further consulted with the TAC and the Flow Scheduling Subgroup to provide a revised Interim Flow recommendation on March 7, 2011 that responded to a revised SJRRP Restoration Allocation, and to SJRRP concerns and observations regarding the relationship between river flows and groundwater seepage in lands adjacent to the river channel (Table 4, Figure 4, and Figure 5). Interim Flow update summaries also were provided to SJRRP staff by me on February 28, 2011 and March 14, 2011.

Table 3. January 24, 2011 RA Recommended Releases from Friant Dam and Target Flows at Gravelly Ford: February 1, 2011 through February 29, 2012.

Completion of the 2010 Restoration Year (2/1/2011 through 2/28/2011)		
Start/End Dates	Estimated Friant Dam Release Necessary to Achieve Gravelly Ford Target Flows (cfs)	Gravelly Ford Flow Targets (cfs)*
Feb 1 – Feb 7	200	105
Feb 8 – Feb 19	350	255
Feb 20 – Feb 28	460	365
Implementation of the 2011 Restoration Year (Allocation of 287,300 acre-feet for the Period 3/1/2011 through 2/29/2012)		
Start/End Dates	Estimated Friant Dam Release Necessary to Achieve Gravelly Ford Target Flows (cfs)	Gravelly Ford Flow Targets (cfs)*
Mar 1 – Mar 7	550	425
Mar 8 – Mar 19	1,200	1,075
Mar 20 – Mar 31	1,450	1,325
Apr 1 – Apr 10	1,000	855
Apr 11 – Apr 22	1,100	955
Apr 23 – Apr 30	1,450	1,305
May 1 – May 18	1,630	1,445
May 19 – May 31	350	165
June 1 – June 30	350	165
July 1 – Aug 31	350	125
Sept 1 – Sept 30	350	145
Oct 1 – Oct 31	350	195
Nov 1 – Nov 10	700	575
Nov 11 – Dec 31	350	235
Jan 1 – Feb 29	350	255
Total March 1-Feb 29 Allocation:	404,254 ac-ft	287,308 ac-ft
Total March 1-Feb 29 Rec'd Volume:	404,112 ac-ft	286,969 ac-ft

*Computed using Settlement Exhibit B seasonal riparian releases and flow-specific Reach 2 losses

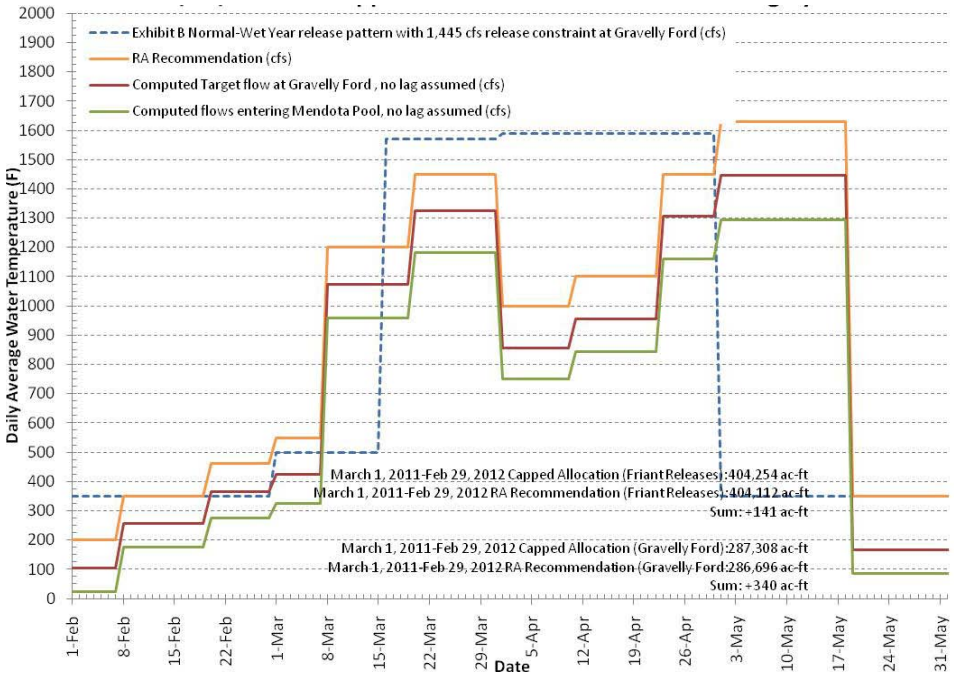

Figure 2. January 24, 2011 Illustrative Friant Dam Spring Release Hydrograph for 2011 Interim Flows to achieve real-time temperature management targets, and corresponding flows at Gravelly Ford and entering Mendota Pool assuming no travel time.

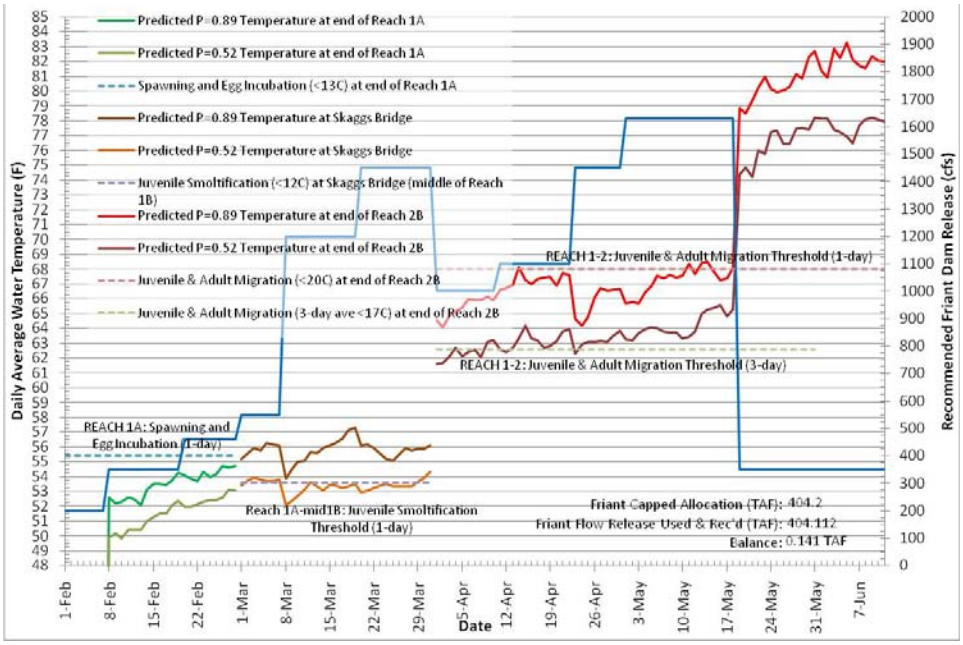

Figure 3. January 24, 2011 Illustrative Friant Dam Spring Release Hydrograph for 2011 Interim Flows, showing corresponding predicted water temperatures at management target locations for historic median (0.52 probability) and warm (0.89 probability) conditions.

Table 4. March 7, 2011 RA Recommended Releases from Friant Dam and Target Flows at Gravelly Ford: February 1, 2011 through February 29, 2012.

Completion of the 2010 Restoration Year (2/1/2011 through 2/28/2011)		
Start/End Dates	Estimated Friant Dam Release Necessary to Achieve Gravelly Ford Target Flows (cfs)	Gravelly Ford Flow Targets (cfs)*
Feb 1 – Feb 7	200	105
Feb 8 – Feb 19	350	255
Feb 20 – Feb 28	460	365
Implementation of the 2011 Restoration Year (Allocation of 287,300 acre-feet for the Period 3/1/2011 through 2/29/2012)		
Start/End Dates	Estimated Friant Dam Release Necessary to Achieve Gravelly Ford Target Flows (cfs)	Gravelly Ford Flow Targets (cfs)*
Mar 1 – Mar 7	550	425
Mar 8 – Mar 16	900	775
Mar 17 – Mar 19	1,200	1,075
Mar 20 – Mar 31	1,450	1,325
Apr 1 – Apr 10	1,000	855
Apr 11 – Apr 22	1,100	955
Apr 23 – Apr 30	1,450	1,305
May 1 – May 18	1,630	1,445
May 19 – May 31	350	165
June 1 – June 30	350	165
July 1 – Aug 31	350	125
Sept 1 – Sept 30	350	145
Oct 1 – Oct 31	350	195
Nov 1 – Nov 10	700	575
Nov 11 – Dec 31	350	235
Jan 1 – Feb 29	350	255
Total March 1-Feb 29 Allocation:	404,254 ac-ft	287,308 ac-ft
Total March 1-Feb 29 Rec'd Volume:	398,757 ac-ft	281,613 ac-ft

*Computed using Settlement Exhibit B seasonal riparian releases and flow-specific Reach 2 losses

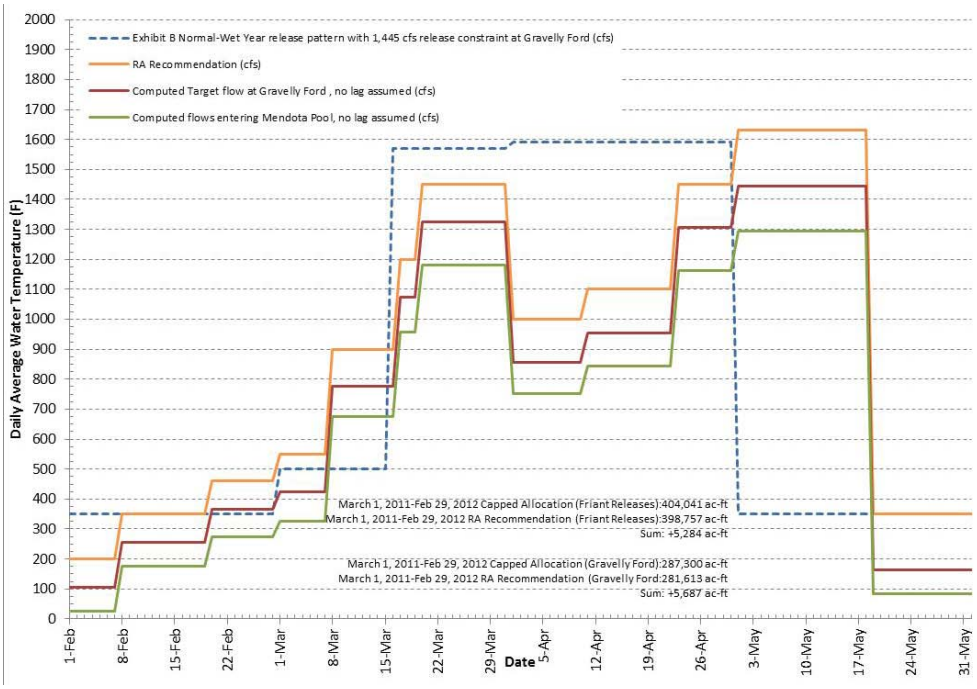

Figure 4. March 7, 2011 Illustrative Friant Dam Spring Release Hydrograph for 2011 Interim Flows to achieve real-time temperature management targets, and corresponding flows at Gravelly Ford and entering Mendota Pool assuming no travel time.

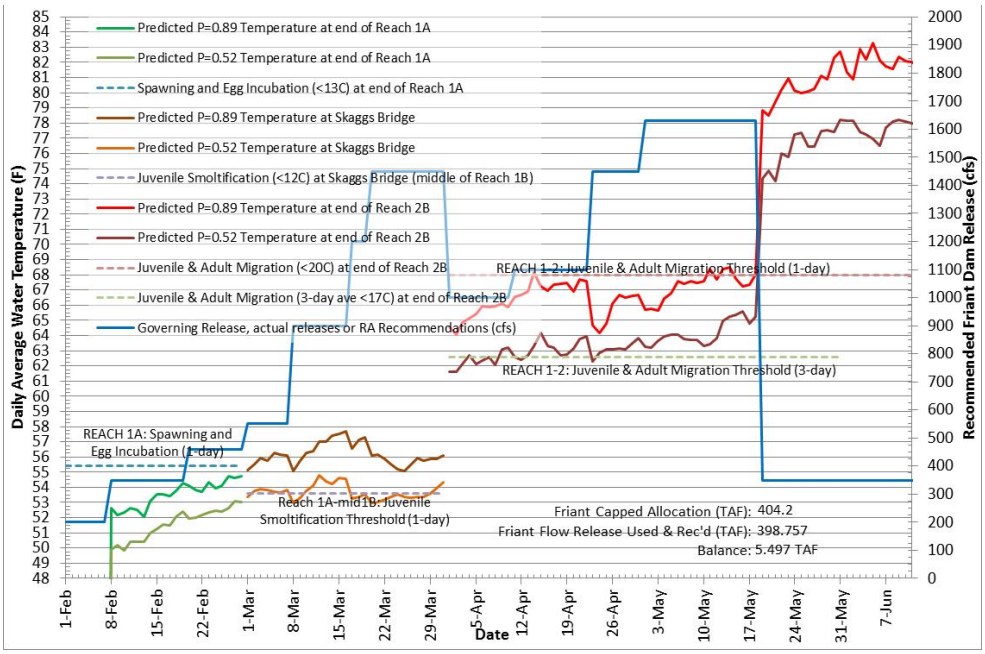

Figure 5. March 7, 2011 Illustrative Friant Dam Spring Release Hydrograph for 2011 Interim Flows, showing corresponding predicted water temperatures at management target locations for historic median (0.52 probability) and warm (0.89 probability) conditions.

4.1 Downstream Extent of Interim Flows

I recommend that, consistent with the terms of the Settlement, the 2011 Interim Flow releases continue to 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.

4.2 Recommendations Related to Downstream Interim Flow Targets

While the latest conveyance capacity estimates for at the upstream end of Reach 2 indicate a conveyance capacity of up to 1,445 cfs at the upper end of the Reach, SJRRP staff are continuing to investigate the conveyance capacity in Reaches 2, 3 and 4 and continuing to investigate potential seepage impacts on agricultural lands adjacent to these Reaches. At this time, the information needed to enable specific Interim Flow recommendations below Mendota Pool is still being compiled and evaluated. I expect that evolving information on seepage impacts will continue to constrain releases downstream of Mendota Pool and Sack Dam.

Accordingly, lacking reliable information concerning potential impacts of higher flows in Reaches 3 and 4, I do not recommend specific target flows for Reaches 3, 4, and 5 at this time. As Interim Flow monitoring information on seepage impacts in Reaches 3 and 4 continues to be compiled and analyzed, and as the Program analyzes and remedies these seepage impacts, I recommend that Interim Flow releases from Mendota Dam and Sack Dam be ramped up in stages consistent with conclusions that flow increases would not result in material, unmitigated impacts to San Joaquin River facilities or adjacent landowners consistent with the terms of the Settlement. As soon as downstream conditions permit, I recommend that

flows into Reaches 3 and 4 ultimately be increased to achieve the 1,225 cfs target flows set forth in Exhibit B of the Settlement.

5 REFERENCES

San Joaquin River Restoration Program (SJRRP) 2008. *Temperature Model Sensitivity Analysis Set 3*, Draft Technical Memorandum, June 20, 2008.