Exhibit E

Ecological Goals of the Restoration Flows

Fisheries Management Plan:
A Framework for Adaptive Management in the San Joaquin River Restoration Program

SAN JOAQUIN RIVER
RESTORATION PROGRAM

November 2010

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Abbreviations and Acronyms

cfs	cubic feet per second
cm/day	centimeters per day
Fall Period	Restoration Flow releases allocated during the period from October 1 through November 30
FMWG	Fisheries Management Work Group
Settlement	Stipulation of Settlement
SJRRP	San Joaquin River Restoration Program
Spring Period	Restoration Flows depicted in each flow schedule from March 1 through May 1

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1.0 Introduction

The Stipulation of Settlement (Settlement) (NRDC vs. Rodgers 2006) provides a specified Restoration Flow schedule. This document provides an overview of the water year types and flow schedule components, and describes the ecological goals (i.e., intent) of each seasonal flow schedule component.

The information presented here is a summary of the ecological goals of the Restoration Flow schedule as developed and documented during the Settlement process. The ecological goals described herein are therefore based entirely on the testimony given by several expert witnesses during pre-Settlement hearings in 2005, before the Settlement and implementation of the San Joaquin River Restoration Program (SJRRP). As part of the SJRRP, the Fisheries Management Work Group (FMWG) recently developed conceptual models for spring-run and fall-run Chinook salmon (Exhibit A) that include hypothesized life-history traits, habitat requirements, and limiting factors of reintroduced Chinook salmon populations. The conceptual models assume the Restoration Flow schedules will be implemented, and thus incorporate assumptions related to the ecological effects of the Restoration Flows on reintroduced salmon and their habitat in the San Joaquin River from Friant Dam to the Merced River confluence. However, neither the conceptual models nor this document address potential differences between the hypothesized effects of the Restoration Flows on reintroduced Chinook salmon and the pre-Settlement ecological goals of the Restoration Flows. For an assessment of the FMWG's understanding of the application of the Restoration Flow schedules, the reader is referred to Exhibit A.

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2.0 Restoration Flow Schedule

The Restoration Flow schedule identified in Exhibit B of the Settlement consists of a set of six flow schedules (Figure E-1) that vary in magnitude and volume according to the annual unimpaired runoff of the San Joaquin River at Friant Dam for a water year (October 1 through September 30).

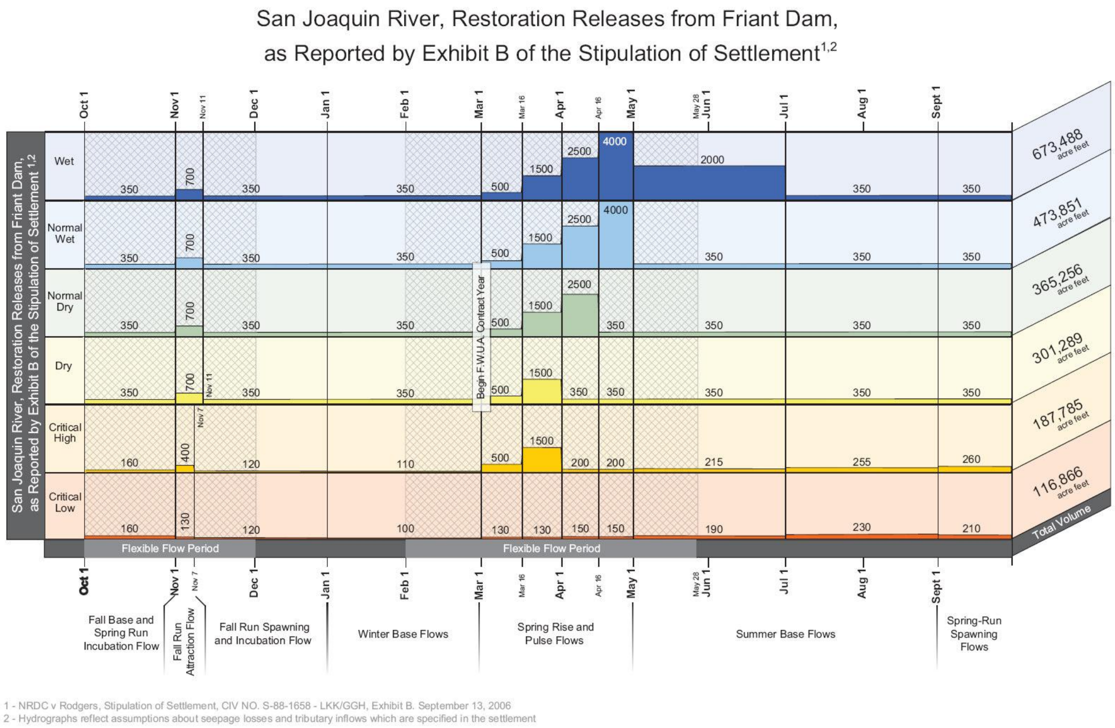

Figure E-1.
Restoration Flow Schedule

Exhibit B, Paragraph 3 of the Settlement requires that the stair-step flow schedules be transformed (i.e., “smoothed”) to continuous line flow schedules before December 31, 2008, before the initiation of Interim and Restoration flows. For additional information related to the transformation of the stair-step flow schedules, including the recommended approach, the reader is referred to the Program Environmental Impact Statement/Report.

2.1 Water Year Types

The six year types (referred to as Restoration Flow year types) are “Critical-Low,” “Critical-High,” “Dry,” “Normal-Dry,” “Normal-Wet,” and “Wet.” Based on the historical record of unimpaired flow for water years 1922 through 2004, Exhibit B of the Settlement includes a Restoration year type classification system based on percentage of occurrence in this 83-year period (Table E-1). The wettest 20 percent of these years are classified as “Wet.” In order of descending wetness, the next 30 percent of the years are classified as “Normal-Wet,” the next 30 percent of the years are classified as “Normal-Dry,” and the next 15 percent of the years are classified as “Dry.” The remaining 5 percent of the years are classified as “critical.” A subset of the critical years, those with less than 400 thousand acre-feet (TAF) of unimpaired runoff, are classified as “Critical-Low”; the remaining critical years are classified as “Critical-High.”

Table E-1.
Frequency of Occurrence of
Water Year Types

Water Year Type	Frequency (%)
Wet	20
Normal-Wet	30
Normal-Dry	30
Dry	15
Critical-High	4
Critical-Low	1

2.2 Seasonal Flow Schedule Components

Components of the flow schedule are defined for each water year type, with flows in specified amounts throughout the year corresponding to key seasonal life-history requirements of salmon and other ecosystem components (Table E-2). Some of the seasonal flow components vary in amount and duration depending upon water year type classification. The ecological goals of the seasonal flow schedule components are described in subsequent sections of this Exhibit.

Table E-2.
Seasonal Flow Schedule Components

Component	Time Period
Fall Base and Spring-Run Incubation Flow	October 1 to November 1
Fall-Run Attraction Flow	November 1 to 11 (to Nov. 7 in critical years)
Fall-Run Spawning and Incubation Flow	November 11 to January 1
Winter Base Flows	January 1 to March 1
Spring Rise and Pulse Flows	March 1 to May 1
Summer Base Flows	May 1 to September 1
Spring-Run Spawning Flows	September 1 to October 1

2.2.1 Flexible Flow Periods

The Restoration Flow schedule includes two “flexible flow periods,” one in the fall and one in the spring, intended to allow flexibility with regard to the timing, magnitude, and ramping rates of flows released from Friant Dam. The flexible flow periods coincide with the timing of critical life history stages of Chinook salmon and other native fishes, with the intent of providing sufficient flow management flexibility to meet fish habitat requirements (e.g., suitable water temperature, floodplain inundation) in response to real-time river conditions and species responses. Restoration Flow releases allocated during the period from October 1 through November 30 (the “Fall Period”) in any year may be shifted up to 4 weeks earlier or later than what is depicted in the flow schedule for that year, and managed flexibly within that range, as long as the total volume of Restoration Flows allocated for the Fall Period is not changed. Similarly, the Restoration Flows depicted in each flow schedule from March 1 through May 1 (the “Spring Period”) may be shifted up to 4 weeks earlier or later as long as the total volume of Restoration Flows allocated during the spring flexible flow period (February 1 through May 28) is not changed (Settlement, Exhibit B, paragraph 4[b]).

2.2.2 Buffer Flows

The daily flows provided under the Restoration Flow schedule, or as modified by the application of flexible flows, may also be augmented by the application of Buffer Flows consisting of up to 10 percent of the daily flows. Buffer Flows from October 1 through December 31 are defined in the Settlement (Paragraph 4[c]) as 10 percent of the total volume of base flows during that period. These buffer flows may be managed flexibly as a block of water during the Fall Period, as described above and in Paragraph 4(b) of the Settlement. Up to 50 percent of the Buffer Flows available from May 1 through September 30, not to exceed 5 TAF, may be moved to augment flows during the Spring or Fall periods.

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3.0 Ecological Goals

The Restoration Flows are intended to meet a suite of ecological goals that will be instrumental in achieving the Restoration Goal. The ecological goals include providing: (1) conditions suitable to meet the requirements of each Chinook salmon life stage, (2) conditions suitable for native fishes and warm water game fishes, (2) sufficient water to periodically perform geomorphic functions, including mobilization (i.e., flushing) of salmonid spawning gravels, and (4) sufficient water for recruitment and maintenance of native riparian vegetation. Except during critically dry years (5 percent of years), the flow schedules were designed to provide continuous flow from Friant Dam to the Merced River at all times of year to achieve these goals.

The ecological goals of the Restoration Flows were defined and described during the Settlement process, and relied in large part on the testimony of several expert witnesses. The following description of the ecological goals is based on a review and summary of these testimonies, as cited throughout this section.

3.1 Chinook Salmon Life Stage Needs

The Restoration Flow schedules are intended to provide suitable conditions for each phase of the Chinook salmon life history, including: adult migration for spring- and fall-run Chinook salmon, adult holding for spring-run, spawning and incubation, juvenile rearing, and outmigration of juveniles. The primary focus in Reach 1 is Chinook salmon but the conditions will also foster a diverse assemblage of native fishes. Reach 1A is expected to provide suitable conditions for all life stages of spring-run Chinook salmon because of cold water dam releases, the presence of deep pools for adult holding habitat, and extensive riffles and runs for spawning and rearing of juvenile fish. In Reach 1B, the water will usually be too warm in summer to support rearing spring-run Chinook salmon, but it could be managed for early season (i.e., spring) rearing by juvenile spring-run and fall-run Chinook salmon.

Adult Chinook salmon migration requires continuous flow to the Merced River confluence and suitable water temperatures. Holding for adult spring-run Chinook salmon requires suitable water temperatures in Reach 1A. Spawning and incubation requires suitable water temperatures and adequate depths and velocities over spawning gravels in Reach 1. Juvenile rearing requires suitable water temperatures and inundated floodplains. Outmigration of juvenile Chinook salmon requires continuous flow to the Merced River confluence and cool water temperatures during the spring and early summer periods (Moyle 2005 (p. 27–43), Kondolf 2005 (p. 14–15)).

The Restoration Flow schedules were designed to take into account the interactions of temperature and flow (as modeled by Dr. Deas) so that flows for salmonids and other fishes are provided only if they create suitable temperature conditions for the life-history stages present (Moyle 2005 (p. 47), Deas 2005 (p. 27)).

The FMWG developed conceptual models for spring-run and fall-run Chinook salmon (Exhibit A) to lay the foundation for the Fisheries Management Plan. The conceptual models assume all restoration actions prescribed in the Settlement, including the flow schedules will be implemented. For an assessment of the FMWG's understanding of the application of the restoration flow schedules, the reader is referred to Exhibit A.

3.2 Support a Diverse Fish Assemblage

Reach 1 is expected to provide suitable conditions for native fishes. In Reach 2, flows are intended to provide connectivity to downstream and upstream reaches (for fish movement), to maintain native fishes, and to establish complex habitats generated by riparian vegetation and other factors (Moyle 2005 (p. 46)). Presumed members of the native fish assemblage expected to be present in Reaches 1 and 2 would include Kern brook lamprey, lamprey, Sacramento hitch, Sacramento blackfish, hardhead, Sacramento pikeminnow, Sacramento sucker, rainbow trout, tule perch, threespine stickleback, prickly sculpin and riffle sculpin. Reaches 3 through 5 will be dominated by nonnative fishes, such as various basses, sunfishes, and catfishes (Moyle 2005 (p. 24, 46)).

3.3 Geomorphic Processes

In Normal-Wet and Wet years, the flow schedule include a block of water averaging 4,000 cubic feet per second (cfs) from April 16 through April 30 to perform several functions, including but not limited to geomorphic functions such as flushing spawning gravels ("The Flushing Flows"). The Settlement states that the Flushing Flows will include a peak release as close to 8,000 cfs as possible for several hours and then recede (i.e., ramp down) at an appropriate rate. The primary goal of the Flushing Flows is to mobilize spawning gravels, reduce armoring, and flush fine sediments (Settlement, Exhibit B, paragraph 5).

By mobilizing gravels and flushing fine sediment, the Flushing Flows are expected to maintain suitable gravel quality for successful spawning and incubation by Chinook salmon. Gravel should be movable by female Chinook salmon, have a loose texture, and be free of sediment so eggs receive adequate intragravel flow and dissolved oxygen (Kondolf 2005 (p. 15)). Flows to mobilize spawning gravel are commonly considered to be needed approximately every 2 years on average (Kondolf and Wilcock 1996, Kondolf 1998, cited in Kondolf 2005 (p. 16)).

3.4 Riparian Vegetation Recruitment and Maintenance

The Settlement states that in Wet years, in coordination with the peak Flushing Flow releases, Restoration Flows should be gradually ramped down over a 60- to 90-day period to promote the establishment of riparian vegetation at appropriate elevations in the channel (Settlement, Exhibit B, paragraph 6). The flow schedules were therefore designed to establish and maintain native riparian tree species along all reaches (Kondolf 2005 (p. 17)).

Riparian vegetation, particularly large woody species such as Fremont cottonwoods that grow along the river banks, provides essential functions for numerous aquatic species including native and nonnative fish. Riparian trees and other riparian vegetation shade the channel and help maintain cooler water temperatures during the spring and summer months, create and maintain channel complexity, cycle nutrients, and provide food and cover for a variety of aquatic species. As large trees fall into the channel, they create hydraulic conditions that scour the bed, cause deposition of gravel, and create sheltered backwater areas important for juvenile salmonid rearing. Wood-sheltered areas of the stream margin may retain cooler groundwater and thereby serve as cold water refugia for adult and juvenile salmon (Keller and Swanson 1979, cited in Kondolf 2005 (p. 17)).

Recruitment and maintenance of cottonwood trees requires spring flows for seedbed preparation and seedling establishment, and summer flows for vegetation maintenance. Seedbed preparation requires pulses of high discharge for scouring bed and gravel bar surfaces, and for deposition of sands and silts on bars and floodplains, to produce patches of mineral soil suitable for seedling establishment (Kondolf 2005 (p. 22)). Seedling establishment requires relatively high flows during the spring germination period so that seedlings establish on surfaces high enough relative to the channel so that seedlings are not scoured or killed by prolonged inundation. Seedlings also require gradual recession of the spring flow schedule during and after the seed germination period so the growth of the newly established roots can keep pace with the declining water table well into the summer months (Kondolf 2005 (p. 17, 18)). The recession limb associated with cottonwood establishment should also create conditions suitable for other tree species such as black willow and narrow leaf willow (Kondolf 2005 (p. 18)). A flow suitable for riparian recruitment every 5 to 10 years (Wet years only) should be sufficient to ensure regeneration of a riparian forest (Kondolf 2005 (p. 17)). Spring Pulse Flows on the order of 1,500 to 4,000 cfs are needed in Dry, Normal-Dry and Normal-Wet years to scour encroaching seedlings or impede seedling establishment in the low-flow channel to maintain channel conditions (Kondolf 2005 (p. 24)). Mature trees require sufficient Summer Base Flows to provide adequate moisture (Kondolf 2005 (p. 18)). In critically dry years, one or more pulses of water should be released to flood-irrigate the riparian plants, increasing their survival rate during the period of desiccation (Kondolf 2005 (p. 25)).

3.5 Seasonal Flow Schedule Components

The ecological goals of each distinct seasonal flow schedule component (Figure E-1, Table E-2) are described below. The descriptions begin with the Fall Base and Spring-Run Incubation Flow, starting on October 1, to correspond with the beginning of the water year and the flow schedule depicted in Figure E-1.

3.5.1 Fall Base and Spring-Run Incubation Flow

The Fall Base and Spring-Run Incubation Flow maintains 350 cfs during October, except in critical years (Table E-3). In Critical-Low and Critical-High years, flows decrease to 160 from the Spring-Run Spawning flows (described in later text).

Table E-3.
Dates and Discharge of Fall Base and Spring-Run Incubation Flows

Date	Water Year Type and Discharge (cfs)					
	Critical-Low	Critical-High	Dry	Normal-Dry	Normal-Wet	Wet
10/1–10/31	160	160	350	350	350	350

Key: cfs = cubic feet per second

Ecological goals of the Fall Base and Spring-Run Incubation Flow include the following:

- Provide conditions suitable for spring-run Chinook salmon incubation in Reach 1
- Provide flows to maintain a diverse community of native fishes in Reaches 1 and 2

Fish Goals

The Fall Base and Spring-Run Incubation Flow schedule was designed to provide suitable water temperatures for spring-run Chinook salmon incubation and rearing in Reach 1. Fall Base Flows also provide general habitat for resident native fishes in Reaches 1 and 2 (Moyle 2005 (p. 47)). In all but critical years, Fall and Winter Base Flows are set at the level prevailing during spring-run Chinook salmon spawning in September, to prevent stranding and dewatering of their redds (Kondolf 2005 (p. 20)).

3.5.2 Fall-Run Attraction Flow

The Fall-Run Attraction Flow is a short increase in flow from the Fall Base and Spring-Run Incubation Flow in all years except Critical-Low years, in which flows are decreased (Table E-4). The duration of the Fall-Run Attraction Flow is 7 days in Critical-Low and Critical-High water years and 10 days in wetter water years.

Table E-4.
Dates and Discharge of Fall-Run Attraction Flows

Date	Water Year Type and Discharge (cfs)					
	Critical-Low	Critical-High	Dry	Normal-Dry	Normal-Wet	Wet
11/1–11/6	130	400	700	700	700	700
11/7–11/10	n/a	n/a	700	700	700	700

Key: cfs = cubic feet per second

Ecological goals of the Fall-Run Attraction Flow include the following:

- Provide conditions suitable for adult fall-run Chinook salmon migration
- Provide conditions suitable to stimulate emigration of juvenile spring-run Chinook salmon

Fish Goals

The Fall-Run Attraction Flow schedule was designed to provide suitable water temperatures for adult fall-run Chinook salmon spawning. After accounting for seepage losses, this flow is expected to provide a 400 to 500 cfs pulse flow at the mouth of the Merced River for 10 days during all but critical years and for 6 days in Critical-Low and Critical-High years, including 2 days for ramping up and down at each end. The pulse is designed to bring adult fall-run Chinook salmon upstream to spawn (USFWS 1994, cited in Kondolf 2005 (p. 15, 19–20); Moyle 2005 (p. 47)). The Fall-Run Attraction Flow occurs during the fall flexible flow period and the exact time of the pulse would be based on monitoring for the presence of fall-run Chinook salmon at the Merced River confluence, timing of fall run Chinook salmon entering the tributaries to the San Joaquin River and coordination with any pulse flows being released from these tributaries. The length of the release is based in part on estimated travel times of adult Chinook salmon to the potential spawning area in Reach 1 (3 to 7 days). This pulse should also enable some spring-run Chinook salmon fry to emigrate (as in Butte Creek) (Moyle 2005 (p. 47)).

3.5.3 Fall-Run Spawning and Incubation Flow

The Fall-Run Spawning and Incubation Flow begins on November 7 in Critical-Low and Critical-High water years, and on November 11 in wetter water years. The Fall-Run Spawning and Incubation Flow ramps down from the Fall-Run Attraction Flow to achieve the Fall Base Flow of 350 cfs, except in critical years, in which flows are further decreased (Table E-5).

Table E-5.
Dates and Discharge of Fall-Run Spawning and Incubation Flows

Date	Water Year Type and Discharge (cfs)					
	Critical-Low	Critical-High	Dry	Normal-Dry	Normal-Wet	Wet
11/7–11/10	120	120	n/a	n/a	n/a	n/a
11/11–12/31	120	120	350	350	350	350

Key: cfs = cubic feet per second

Ecological goals of the Fall-Run Spawning and Incubation Flow include the following:

- Provide conditions suitable for fall-run Chinook salmon spawning and incubation in Reach 1
- Provide conditions suitable to stimulate emigration of juvenile spring-run Chinook salmon

Fish Goals

Fall-Run Spawning and Incubation Flow schedule was designed to provide suitable water temperatures for fall-run Chinook salmon egg incubation. Releases of 350 cfs from Friant Dam, which should assure a minimum flow of 150 cfs throughout the river, would allow for continued upstream migration of adult fall-run Chinook salmon (Fry and Hughes 1958, USFWS 1994, Kondolf 2000, McBain and Trush 2002, Cain et al. 2003; all as cited in Kondolf 2005 (p. 20)). A base flow of 350 cfs is also needed to maintain wetted spawning habitat in Reach 1 (i.e., flow over redds) (Moyle 2005 (p. 48)).

3.5.4 Winter Base Flow

The Winter Base Flow maintains the Fall Run Spawning and Incubation Flow of 350 cfs for the months of January and February, except in critical years in which flows are further decreased (Table E-6).

Table E-6.
Dates and Discharge of Winter Base Flows

Date	Water Year Type and Discharge (cfs)					
	Critical-Low	Critical-High	Dry	Normal-Dry	Normal-Wet	Wet
1/1–2/28	100	110	350	350	350	350

Key: cfs = cubic feet per second

Ecological goals of the Winter Base Flow include the following:

- Provide conditions suitable for egg incubation of fall-run Chinook salmon in Reach 1
- Provide conditions suitable for rearing of spring-run and fall-run Chinook salmon in Reach 1
- Provide flows to maintain a diverse community of native fishes in Reaches 1 and 2

Fish Goals

The Winter Base Flow schedule was designed to provide suitable water temperatures for fall-run Chinook salmon egg incubation and for fry/juvenile rearing of both runs of salmon in Reach 1 (McCullough 1999, Moyle 2002, Ward et al. 2002, 2003, Stillwater Sciences 2003, Marine and Cech 2004; all as cited in Moyle 2005 (p. 36–39, 58); Deas 2005 (p. 27)). A base flow of 350 cfs is also needed to maintain wetted spawning habitat for Chinook salmon in Reach 1 (i.e., flow over redds) throughout the fall-run egg incubation period (Moyle 2005 (p. 48); McBain and Trush 2002, Cain et al. 2003, cited in Kondolf 2005 (p. 20-21)), as well as to provide general habitat for resident native fishes in Reaches 1 and 2 (Moyle 2005 (p. 47)).

3.5.5 Spring Rise and Pulse Flow

The Winter Base Flow ramps up to achieve the Spring Rise and Pulse Flow from March 1 through April 30 (Table E-7). The spring rise is accompanied by short-duration, high-discharge pulses of flow to facilitate salmon migration, vegetation recruitment and maintenance, gravel mobility and other channel conditions. This time period (March 1 to April 30) is included in the Spring Flexible Flow Period.

Table E-7.
Dates and Discharge of Spring Rise and Pulse Flows

Date	Discharge (cfs)					
	Critical-Low	Critical-High	Dry	Normal-Dry	Normal-Wet	Wet
3/1–3/15	130	500	500	500	500	500
3/15–3/31	130	1,500	1,500	1,500	1,500	1,500
4/1–4/15	150	200	350	2,500	2,500	2,500
4/16–4/30	150	200	350	350	4,000	4,000

Key: cfs = cubic feet per second

Ecological goals of the Spring Rise and Pulse Flow include:

- Provide suitable conditions for juvenile Chinook salmon outmigration of both runs
- Provide suitable conditions for adult spring-run Chinook salmon upstream migration
- Provide suitable conditions for spawning of resident native fishes
- Provide floodplain inundation for Chinook salmon rearing and other species (e.g., Sacramento splittail spawning) in wetter years
- Provide flows sufficient to initiate fluvial geomorphic processes (i.e., mobilization and flushing of spawning gravels) in wetter years
- Provide flows sufficient for riparian seedbed preparation, seedling establishment, and to prevent vegetation encroachment in wetter years
- Provide base flows to maintain established vegetation

Fish Goals

The Spring Rise and Pulse Flow schedule was designed to provide suitable water temperatures for critical life stages of Chinook salmon and other native fishes. The timing of Spring Pulse Flows should be coordinated with the abundance of adult Chinook salmon below near the confluence of the Merced River to maximize the number of salmon moving upstream to spawn (Moyle 2005 (p. 48)). In Normal-Dry, Normal-Wet and Wet years, flows should provide supplemental edge and side channel habitats and floodplain inundation for 2 to 3 weeks to allow for spawning of native fishes and rearing of juvenile salmon and other native fishes under highly productive conditions (Moyle 2005 (p. 49)).

Geomorphic Goals

The flexible timing and magnitude of releases during this period should be invoked to ensure that the flow schedule periodically includes a peak flow release of 8,000 cfs for about two hours, thence receding over the course of a few days or more to 4,000 cfs. This release is recommended in Normal-Wet and Wet years (50 percent of years) to mobilize spawning gravels, to maintain their looseness and flush fine sediments, thus improving salmon spawning habitat (Kondolf 2005 (p. 21), Moyle 2005 (p. 49–50)).

Riparian Vegetation Goals

In wetter years the geomorphic pulse flow (8,000 cfs) is also intended to prepare the seedbed for cottonwoods (Kondolf 2005 (p. 22), Jones and Stokes 1998, as cited in Kondolf 2005 (p. 23)). Vegetation recruitment flows of approximately 4,000 cfs (range: 3,000 to 6,000 cfs) combined with the high spring pulse recommended for wetter years are intended to disperse seeds and facilitate seed germination in the target zone 60 to 200 centimeters (2 to 6.5 feet) above the Summer Base Flow water level and to reduce vegetation encroachment in the low-flow channel (Kondolf and Wilcock 1996, Mahoney and Rood 1998, Cain 1997, Tsujimoto 1999, Stillwater Sciences 2003, Cain et al. 2003; all as cited in Kondolf 2005 (p. 18–19, 23–24)). Successful seedling establishment requires gradual recession of spring flows averaging approximately 3 to 4 percent over 60 to 90 days, corresponding to a general 2.5 centimeters per day (cm/day) rate of water table decline in wetter years (Mahoney and Rood 1998, Jones and Stokes 1998, Stillwater Sciences 2003, Cain et al. 2003; all as cited in Kondolf 2005, (p. 24–25)). In Normal-Dry and Dry years, Spring Pulse Flows of 1,500 to 2,500 cfs are expected to scour or otherwise impede detrimental encroachment of vegetation in the low-flow channel (Kondolf 2005 (p. 24)).

3.5.6 Summer Base Flow

The Spring Rise and Pulse Flow is ramped down in Normal-Wet and Wet years during May and June to achieve the Summer Base Flow (Table E-8). The Summer Base Flow in all years except critical years is 350 cfs. The Wet year block of water of 2,000 cfs in May through June is for shaping a riparian recruitment recession flow. In critical years, flows ramp up through August to achieve reduced Summer Base Flows ranging from 190 to 255 cfs. May 1 through May 28 is included in the flexible flow period.

Table E-8.
Dates and Discharge of Summer Base Flows

Date	Water Year Type and Discharge (cfs)					
	Critical-Low	Critical-High	Dry	Normal-Dry	Normal-Wet	Wet
5/1–6/30	190	215	350	350	350	2,000
7/1–8/31	230	255	350	350	350	350

Key: cfs = cubic feet per second

Ecological goals of the Summer Base Flow include the following:

- Provide flows to maintain adult holding and juvenile rearing habitat for spring-run Chinook salmon in Reach 1
- Provide flows to maintain a diverse community of native fishes in Reaches 1 and 2
- Provide flows to promote riparian seedling establishment in wetter years
- Provide base flows to maintain established riparian vegetation

Fish Goals

The Summer Base Flow schedule was designed to provide suitable water temperatures for adult spring-run Chinook salmon holding, and for fry/juvenile rearing of spring-run Chinook salmon in Reach 1. This may include yearling spring-run Chinook salmon. Summer Base Flows of 350 cfs are also intended to provide general habitat for resident native fishes, and a wetted channel down to the confluence of the Merced River to maintain populations of native fishes, game fishes, and other fishes, based on temperature models (Moyle 2005 (p. 47)). In Critical-Low years, only flows to satisfy riparian diversion rights would be released. These releases are expected to maintain continuous flow approximately to Gravelly Ford, thus maintaining holding and rearing habitat for Chinook salmon below Friant Dam and other native fish habitat throughout most or all of Reach 1. Under these conditions, the objective of maintaining continuous flow down to the Merced River confluence would be abandoned (Moyle 2005 (p. 50), Kondolf 2005 (p. 25)).

Riparian Vegetation Goals

In wetter years, spring vegetation recruitment flows are followed with a gradual stage recession (less than 2.5 cm/day rate of water table decline) to promote seedling establishment (Mahoney and Rood 1998, Jones and Stokes 1998, Stillwater Sciences 2003, Cain et al. 2003; all as cited in Kondolf 2005, (p. 24–25)). Summer Base Flows of 350 cfs are required to maintain established riparian vegetation (Kondolf 2005 (p. 18, 22)). In Critical-High years, one or more pulses of water should be released to flood-irrigate the riparian plants, increasing their survival rate during the period of desiccation (Kondolf 2005 (p. 25)). In Critical-Low years, flow releases would only be sufficient to meet riparian diversion needs, and riparian vegetation would be affected. Some trees (especially young, recently established plants without extensive and deep roots) may die during the period of desiccation while better established trees may be able to survive (Kondolf 2005 (p. 25)).

3.5.7 Spring-Run Spawning Flow

The Spring-Run Spawning Flow maintains 350 cfs during the month of September, except in critical years (Table E-9).

Table E-9.
Dates and Discharge of Spring-Run Spawning Flows

Date	Water Year Type and Discharge (cfs)					
	Critical-Low	Critical-High	Dry	Normal-Dry	Normal-Wet	Wet
9/1-9/30	210	260	350	350	350	350

Key:
cfs = cubic feet per second

Ecological goals of the Spring-Run Spawning Flow include the following.

- Provide conditions suitable for spring-run Chinook salmon spawning in Reach 1
- Provide flows to maintain a diverse community of native fishes in Reaches 1 and 2

Fish Goals

The Spring-Run Spawning Flow schedule was designed to provide suitable water temperatures for spring-run Chinook salmon spawning in Reach 1. Flows in September are set at 350 cfs to provide for continuous flow all the way to the Merced River for adult Chinook salmon migration, and to provide general habitat conditions suitable for resident native fishes (Moyle 2005 (p. 47), Kondolf 2005 (p. 20)).

4.0 References

4.1 Primary References

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