APPENDIX A

Draft Recommendations for Experimental Flow Releases to Benefit Riparian Vegetation Along The San Joaquin River

Prepared for:

U.S. Bureau or Reclamation
South-Central California Area Office
2666 N. Grove Industrial Drive, 106
Fresno, CA 93727-1551
Contact: Paula J. Landis, P.E.
209/487-5103

Prepared by:

Jones & Stokes Associates, Inc.
2600 V Street, Suite 100
Sacramento, CA 95818-1914
Contact: Steve Chainey
916/737-3000

and

Mussetter Engineers, Inc.
1730 South College Avenue, Suite 100
Fort Collins, CO 80525
Contact: Mike Harvey
970/224-4612

May 14, 1999

Table of Contents:

Table 1. Study Reaches of the San Joaquin River, Friant Dam - Mendota Pool

Reach	Reach Code	River Miles*	Description
Mendota Pool to Chowchilla Canal	2A	205-216	High sinuosity meanders, no state/federal project levees, channel dry most of the year; riparian vegetation patchy or absent except for the lower few miles in backwater of Mendota Pool
Chowchilla Canal to Gravelly Ford	2B	216-229	Low sinuosity meanders, confined by state/federal project levees, channel dry most of the year; riparian vegetation patchy or absent
Gravelly Ford to Herndon	1B	229-243	Low sinuosity meandering, confined by terraces; narrow riparian strip
Herndon to Friant Dam	1A	243-267	Terrace confined channel, extensive aggregate mining; well established riparian fringe

* River miles correspond to the U.S. Bureau of Reclamation's (1997) aerial photography atlas of the San Joaquin River.

Table 2. Modeled Cross Sections of the San Joaquin River, Friant Dam - Mendota Pool

Reach	Cross Section Code	River Mile	Description
Mendota Pool to	A38	210.3	Point bar of moderate radius of curvature bend
	A86	215.5	Point bar of very low radius of curvature bend
Chowchilla Canal	A109	217.5	Point bar with project levees
	A140	220.5	Multiple channels and bars in levee setback area
	A158	222.5	Multiple bars, no left bank levee
	10	229.5	Low sinuosity meandering channel with bars, no
Gravelly Ford to	97	234.2	Floodplain an old channel remnant with split flow
	130	236.8	Wide floodplain with split flow channel
Herndon to Friant	348	250	Multiple channels and bars
	500	260.2	Split flow reach with bars

Pilot Project Purpose and Background

The proposed pilot project entails the release of flows June through October 1999 which exceed the normally scheduled releases below Friant to meet riparian water requirements. The primary purpose of the augmented flows is to promote the dispersal and germination of seed from native riparian trees, and the survival of young seedlings, along the San Joaquin River between Friant and Mendota Pool. A parallel purpose is to test the hypothesis that managed flows in spring that coincide with the season of seed release of riparian trees can be used to successfully establish new populations of riparian habitat, and that these new populations will survive subsequent dry seasons and higher scouring flows in the winter. The pilot project therefore also entails monitoring the downstream effects of the augmented flows at ten recommended cross sections, and the response of native vegetation.

Background
Pilot Project Purpose
Environmental Enhancement Objectives
Adaptive Learning Objectives
Effects of Recent Water Year Flows (1997 to 1999)

[NOTE: text for the sections listed above will be completed well before the June 30 contractual deadline, and probably by the end of next week, May 14]

Alternative Flow Release Schedules

[NOTE: additional text for the sections that follow will be completed well before the June 30 contractual deadline, and probably by the end of next week, May 14]

Three alternative augmentation flow release schedules are presented (see attached Excel files with detailed schedule spreadsheets and monthly charts). The augmentation flows are assumed to be the flows that reach the gage at Gravelly Ford, and would be <u>additive</u> to the current flow releases below Friant Dam to meet riparian water rights between Friant and Gravelly Ford. Each schedule runs from June 1 through October 30 with gradually declining flows. Schedule A requires a total of 43,050 acre feet, beginning June 1 with 600 cubic feet per second (cfs) and ending October 30 at 25 cfs. Schedule B requires a total of 31,350 acre feet, beginning June 1 with 600 cubic feet per second (cfs) and ending October 30 at 25 cfs, with flows in June and July declining at twice the rate as Schedule A. Schedule C requires a total of 21,600 acre feet, beginning June 1 with 300 cubic feet per second (cfs) and ending October 30 at 15 cfs.

To simplify the review and interpretation of the flows release schedules, it is assumed that a discharge rate of one cfs running continuously for 24 hours is the equivalent of two acre-feet of water per day (the actual conversion is 1.98). It is also assumed that each month contains the same number of days (30) to simplify the comparison of alternatives and cumulative monthly subtotals of water use. Once a final recommended schedule is arrived at, the precise expected water requirement will be computed and adjusted to represent a flow schedule to be released at the Friant Dam outlet.

Schedule A is preferable because it appears that flows below 500 cfs would only wet a relatively small area of bars and low floodplain adjoining the low flow channel (see cross sections with stage discharge water surfaces). Also, the more gradual flow recession in Schedule A assures a better germination and survival of small seedlings. Schedule B is similar to A, but requires approximately 11,700 acre-feet less water, and the areas and seed wetted at higher stages in June will tend to dry out more quickly. Schedule C is a less desirable pilot release schedule, but requires the least amount of water because the initial stage and discharge is half as much as A or B. Under Schedule C, seedlings would tend to occur closer to the shoreline of the low flow channel where they are more vulnerable to scour of the sand bed during higher flows that may occur in winter and early spring.

Commencement of augmentation releases should begin as soon as possible, but no later than June 1, because cottonwood and willow seed is already reported to be present in the air and on the river water surface throughout Reaches 1 and 2 (Mike Harvey, personal communication). The concentrated seed release of cottonwood trees typically only lasts for a few weeks, and its seed is only viable for days to weeks depending on humidity and soil surface moisture.

Gradual Flow Recession from 600 cfs- Schedule A

Less Gradual Flow Recession from 600 cfs- Schedule B

Gradual Flow Recession from 300 cfs- Schedule C

Other Flow Management Options

1999 Monitoring Recommendations

Riparian Vegetation Monitoring

Rationale

The purpose of the riparian vegetation monitoring is to record baseline conditions and to measure vegetation responses to flow releases. The baseline condition refers to the condition of the riparian vegetation prior to the commencement of the release of the first augmented flows. The baseline condition can be recorded after the initial releases have been made, provided that the vegetation condition that existed prior to a response of the vegetation is still evident. Because different life stages of riparian vegetation respond to the magnitude of flows at different times of year (seasons) it is imperative that data for both riparian plants and hydrology will be collected for each life stage in the monitoring effort such that responses of riparian species can be correlated to the timing and magnitude of flows. A brief explanation of the dependence of the different riparian species' life cycle components on hydrologic conditions follows.

Essential components of riparian species' life cycle are: (1) seed dispersal, (2) germination and establishment, (3) growth and (4) mortality. Each of these components is to some extent dependent on the timing and magnitude of flows in the river. Although mature riparian shrubs and trees will be affected by flows, the most sensitive period in the life of a riparian plant is generally the first three years, with the first year being most critically dependent on river hydrology. Riparian vegetation monitoring effort should be greatest in the first year after seed dispersal. Cottonwood and willow seed is dispersed by water in spring, and after deposition on moist sand bars and low floodplain surfaces, and the seeds germinate in late spring and early summer, when moisture and sunlight are available on the seed bed. During summer and fall, seedlings may grow rapidly, provided that growth of the roots keeps up with any receding of the water table. If groundwater and underflow recede more rapidly than can be tracked by root growth, mortality due to dessication will be the result in coarse alluvial substrates that have low moisture retention. Other factors than dessication, such as competition with introduced weeds, or herbivory (e.g., by beavers or livestock) may contribute to mortality too. During winter, seedlings may be uprooted by flood flows, in particular if the root system did not have sufficient opportunity to expand during the previous summer.

Methods

Seedling establishment and baseline monitoring. Monitoring of baseline conditions and establishment of seedlings can be combined during a monitoring visit in early summer. A permanent transect spanning the active floodplain on one side of the river should be established at each cross section. The transect should be permanently marked with a metal stake above the active floodplain (e.g., on a levee) and should run perpendicular to the channel. The location of the permanent marker should be recorded with differentially corrected global positioning system (GPS), and be mapped on an aerial photograph. The compass bearing of the transect, taken from the marker should also be recorded.

Seedlings and young saplings generally occur in discrete bands on the sand and gravel bars and low floodplain surfaces. The two most recent major flood flows occurred in the winters of 1994/1995 and 1996/1997. Therefore, seedlings and young saplings of up to 4 years old are of most interest. Seedlings and young saplings of up to approximately 6 feet tall should be recorded. Whether this height cut-off is sufficiently large should be verified with tree ring analysis. The location of all clusters of native riparian seedlings and young saplings, e.g., Fremont cottonwood, willow species, box elder, Oregon ash and western sycamore, occurring within 500 feet of each side of the transect should be mapped, and species composition and estimated age should be recorded. Location of the clusters should be recorded as the perpendicular distance to the transect and the distance along the transect to shortest line from the transect to the cluster. If available, differentially corrected GPS readings would probably provide more accurate location information. For each cluster, dominant (most prevalent) species, average and range of height, approximate elevation above the water and approximate average age should be recorded. The water level on the transect should be marked with a colored pinflag for future reference. The 2 x 500 foot width of the sampling area may be insufficient to sample sufficient seedling clusters for statistically representative sample, or may be too large for expeditious sampling, and, therefore, may need to be reduced or enlarged for a particular transect, depending on the cluster density.

At least 30 clusters of seedlings and young saplings at each sampling transect should be permanently marked at two ends with a 30-inch metal stake ("rebar"). The rebar should be driven 25 inches into the ground to reduce the probability of loss due to scour, and marked with pinflags. The top 5 inches of the rebar should be brightly painted. If the rebar gets buried with sand after a flood event, they can be relocated with a metal detector and GPS unit. If seedlings are identified that germinated this year, then at least 15 clusters of these new seedlings should be marked. For each cluster the following data should be recorded: elevation above the water surface, length of the cluster, number of seedlings/young saplings.

For each seedling and young sapling height, species and signs of stress should be recorded. Height should be recorded in 3 inch increments for seedlings up to 2 feet tall, and in 6 inch increments for seedlings and young saplings taller than 2 feet. The following stress signs should be recorded: herbivory, leaf loss, yellowing (chlorosis), wilting, and leaf size reduction. Each should be rated on a scale of 0 (no stress) to 5 (most severe stress). If more than 50 seedlings or young saplings occur in a cluster then a random subsample of 50 plants should be recorded only.

In addition to data on native riparian seedlings and young saplings data should be collected on cover of competing weeds and colonization of invasive nonnative woody riparian species. The density and species composition of herbaceous species (e.g., cocklebur, beggar ticks, smartweed, watergrass) inside the clusters and within 2 feet of the perimeter of the clusters of riparian seedlings and saplings should be recorded. Any substantive patches of invasive nonnative woody riparian adult plants (e.g., tamarisk and giant reed) or concentrations of tamarisk seedlings within the riparian vegetation sampling area should be mapped.

Repeated field sampling. Ideally, the riparian vegetation sampling stations should be monitored once a month from June - November in 1999 and from April - November in 2000 and 2001, and all data recorded during baseline sampling should be recorded at each sampling event. However, budget constraints may necessitate a reduction in sampling effort. The lowest recommended sampling intensity would be as follows. At least in July and September of 1999 and May, July and September of 2000 all data recorded for the riparian seedlings and young saplings should be recorded again. The data collected in July will show the result of seedling germination and establishment. The September data will provide an estimate of summer mortality and the May data will show winter mortality as the result of scour. This sampling protocol can only be a generic starting point, because unusual, or less frequent flow events, such as a high snowmelt flow in June or July may require an adjustment of the timing of monitoring.

The ten riparian vegetation sampling stations cover only a small portion of the entire riparian zone of the study area. It is therefore strongly recommended that a reconnaissance survey of the riparian zone from Friant Dam to Mendota Pool be conducted in September. This survey will provide crucial observations about the distribution pattern of regeneration and mortality of native riparian species in the study area as a whole. This information will allow extrapolation of the detailed transect data to larger reaches of the river.

Data analysis and interpretation. The riparian vegetation data will be used to interpret the ecological benefits of the augmented flow releases. Therefore, the scientific validity of the results is of great importance. The data should be analyzed using straightforward accepted statistical tools and the relationship between the riparian vegetation data and hydrology should be carefully interpreted. Statistical tools could include linear or non-linear multiple regression, discrete multivariate analysis and parametric or nonparametric survival analysis. The riparian vegetation measurements should be used to interpret the nature and magnitude of the four essential life cycle processes: dispersal, germination and establishment, growth and mortality, and the effects of hydrology and geomorphology on these processes should be interpreted. These interpretations should be developed for each sampling transect, and the pattern of these relationships should also be interpreted relative to the location of the transects along the river.

Physical Processes Monitoring

Rationale

The purpose of monitoring the physical processes is to record baseline channel geometry and flow conditions, and to measure the effects of variable flow releases below Friant on physical parameters that may be important to the establishment of riparian vegetation. The baseline condition refers to the base flow, stage, and shape of the channel cross-section prior to the commencement of the first augmented flows. The baseline flow condition must be recorded before the initial releases have been made. Because different life stages of riparian vegetation respond to the magnitude of flows at different times of year (seasons), it is imperative that physical data (flow, stage, geometry) be collected throughout the monitoring effort such that responses of riparian vegetation can be correlated to the timing and magnitude of flows or the absence of flow continuity.

Essential components and rationale for monitoring physical data include:

a.) Recording detailed cross section geometry at each monitoring transect in the beginning and at the end of the augmented flow release schedule. This will establish whether the topographic and bathymetric data developed by the Corps of Engineers for this reach of the San Joaquin River accurately depicts channel conditions at low flow, or has changed since June 1998. End of season cross section surveys will establish whether augmented flows have caused sand or gravel in the bed of the channel to be mobilized or bars to be rearranged, thereby modifying the channel geometry.

b.) Developing stage/discharge relationship curves for each of the representative cross sections at monitoring transects. This will establish how much flow is required to incrementally increase the water surface elevation in order to inundate particular bar and floodplain surfaces where riparian trees are most likely to be successful at long term survival, and to understand the floodplain wetting and seed dispersal effects of higher reservoir "spillage" flows in winter and spring.

c.) Repeat observations of flow stage at each cross section will determine the amount and proportion of flow loss throughout the Friant to Mendota reach of the river throughout the dry season under the augmented flow conditions and with a gradually receding hydrograph. This information will be valuable to compute channel bed percolation and evapotranspiration losses at different river segments, and to predict the performance and seasonal water cost of future flow release schedules. And,

d.) Begin to establish an understanding of the functional relationships between flow conditions or seasonal patterns of flow in Reaches 1 and 2, and the corresponding vegetation response. This knowledge will help to inform future river management decisions, and refine realistic

E-006440

goals and objectives for riparian restoration in the affected river reaches.

Each of these components is to some extent dependent on the timing and magnitude of flows in the river.

Methods

Following are our recommendations for physical parameters that should be monitored prior to and during the flow releases:

1. Conduct a monument survey of the endpoints of the cross sections for future relocation, and perform a detailed survey of the primary channel at each cross section prior to the augmented release. During the initial location of the cross sections, determine whether or not additional cross sections near the main monitoring cross section are necessary to characterize the reach, and if so, establish and survey the additional cross sections.

2. Establish a staff gage at each cross section for use in monitoring low flow water surface elevations. Tie the staff gage to the surveyed cross section monuments.

3. Gage the stream (measure actual discharge) at each cross section (a) prior to the release, (b) at least once during the rising limb of the release hydrograph, (c) at the seasonal peak of the release hydrograph, and (d) at least once during the recession limb of the hydrograph. Develop stage-discharge curves for each cross section in order to compute flows based on simple observations of water surface stage.

4. During each discharge gaging event, establish the water-surface slope in the vicinity of the cross section by surveying a water-surface profile along at least one bank for 2 to 4 channel widths up-and downstream from the cross section.

5. Collect samples or conduct Wolman Counts of the bed and bank material (sand and gravel) at each cross section prior to the augmentation release hydrograph.

6. Resurvey each cross section after completion of the seasonal augmentation release hydrograph, or when flows cease at particular cross sections, whichever comes first.

7. Resample the bed material at each cross section after completion of the release hydrograph.

The field crews should pay particular attention to evidence of scour within the cross section during the hydrograph, because this could affect the stage-discharge relationship at the cross section and the ability to disperse seed or maintain adequate moisture levels following germination. The most critical area may only be the sand bed reach below Gravelly Ford because the upstream reaches are continuously wetted under the existing flow regime, and are more likely to be armored with coarse gravel and cobble bed material.

Data Analysis and Future Use

Analysis of Completed Monitoring Data

Applying Results to Future Flows