Tuolumne River Mining Reach Restoration Project: Warner-Deardorff Segment No. 3 -Construction

Project Information

1. **Proposal Title:**

   Tuolumne River Mining Reach Restoration Project: Warner-Deardorff Segment No. 3 -Construction

2. **Proposal applicants:**

   Wilton Fryer, Turlock Irrigation District

3. **Corresponding Contact Person:**

   Wilton Fryer
   Turlock Irrigation District
   333 East Canal Drive Turlock, CA 95380
   209 883-8316
   wbfryer@tid.org

4. **Project Keywords:**

   Anadromous salmonids
   Fluvial Geomorphology
   Habitat Restoration, Instream

5. **Type of project:**

   Implementation_Full

6. **Does the project involve land acquisition, either in fee or through a conservation easement?**

   Yes

   If yes, is there an existing specific restoration plan for this site?

   Yes

7. **Topic Area**:

   Channel Dynamics and Sediment Transport

8. **Type of applicant:**

   Local Agency

9. **Location - GIS coordinates:**

Latitude: 37.65032028

Longitude: -120.6822592

Datum:

Describe project location using information such as water bodies, river miles, road intersections, landmarks, and size in acres.

Tuolumne River from RM 35.2 to RM 36.5, approximately 3 miles downstream of the Roberts Ferry Bridge, restoring 73 acres of riparian floodway along 1.3 miles of river channel.

10. **Location - Ecozone:**

    13.2 Tuolumne River

11. **Location - County:**

    Stanislaus

12. **Location - City:**

    Does your project fall within a city jurisdiction?

    No

13. **Location - Tribal Lands:**

    Does your project fall on or adjacent to tribal lands?

    No

14. **Location - Congressional District:**

    18

15. **Location:**

    California State Senate District Number: 12

    California Assembly District Number: 25

16. **How many years of funding are you requesting?**

    3

17. **Requested Funds:**
    a) Are your overhead rates different depending on whether funds are state or federal?

       No

       If no, list single overhead rate and total requested funds:

Single Overhead Rate: 0

Total Requested Funds: 10,839,000

b) Do you have cost share partners already identified?

Yes

If yes, list partners and amount contributed by each:

Tuolumne River Technical Advisory Committee 40,000

c) Do you have potential cost share partners?

No

d) Are you specifically seeking non-federal cost share funds through this solicitation?

No

If the total non-federal cost share funds requested above does not match the total state funds requested in 17a, please explain the difference:

The $40,000 in TRTAC funding contribution for this project is actually being spent as part of the earlier project Warner Deardorff Segment No 3 Design (1999-F02).

18. **Is this proposal for next-phase funding of an ongoing project funded by CALFED?**

Yes

If yes, identify project number(s), title(s) and CALFED program (e.g., ERP, Watershed, WUE, Drinking Water):

2001-C209 TR Mining Reach: Warner-Deardorff Segment No. 3 AFRP / CALFED

Have you previously received funding from CALFED for other projects not listed above?

Yes

If yes, identify project number(s), title(s) and CALFED program.

1997-M09	**TR Mining Reac: 7\11Segment No. 1**	**AFRP, CF-Cat III, TRTAC, CF-USBR**

1999-F02 TR Minng Reach: MJ Ruddy Segment No. 2 AFRP, CALFED, TRTAC

1997-M08 TR Special Run Pool 9 AFRP, CF-Cat III, TRTAC

1999-F01 TR Special Run Pool 10 Repair AFRP

2001-B201 TR Special Run Pool 10 Design CALFED

2001-C208 TR Fine Sediment Management CALFED

19. **Is this proposal for next-phase funding of an ongoing project funded by CVPIA?**

    No

    Have you previously received funding from CVPIA for other projects not listed above?

    Yes

    If yes, identify project number(s), title(s) and CVPIA program.

    11332-0-J017 TR Course Sediment Management AFRP

20. **Is this proposal for next-phase funding of an ongoing project funded by an entity other than CALFED or CVPIA?**

    No

    Please list suggested reviewers for your proposal. (optional)

    Kevin Faulkenberry DWR Fresno 559-230-3320

    Jeffery Mount, PhD State Reclamation Board 916-653-5440

    Kris Vyverberg DFG Sacramento 916-653-8711

21. **Comments:**

Doctors Healy, Dunne, and Kondolf were not listed as they served on the Adaptive Management Forum or are on the CALFED science panel and will be looking at the project in that capacity. The above reviewers were not contacted.

Environmental Compliance Checklist

Tuolumne River Mining Reach Restoration Project: Warner-Deardorff Segment No. 3 -Construction

1. **CEQA or NEPA Compliance**
   a) Will this project require compliance with CEQA?

      Yes

   b) Will this project require compliance with NEPA?

      Yes

   c) If neither CEQA or NEPA compliance is required, please explain why compliance is not required for the actions in this proposal.

2. **If the project will require CEQA and/or NEPA compliance, identify the lead agency(ies).** *If not applicable, put "None".*

   CEQA Lead Agency: Turlock Irrigation District
   NEPA Lead Agency (or co-lead:) none
   NEPA Co-Lead Agency (if applicable): US Fish & Wildlife Service

3. **Please check which type of CEQA/NEPA documentation is anticipated.**

   CEQA
   -Categorical Exemption
   XNegative Declaration or Mitigated Negative Declaration
   -EIR
   -none

   NEPA
   -Categorical Exclusion
   XEnvironmental Assessment/FONSI
   -EIS
   -none

   If you anticipate relying on either the Categorical Exemption or Categorical Exclusion for this project, please specifically identify the exemption and/or exclusion that you believe covers this project.

4. **CEQA/NEPA Process**
   a) Is the CEQA/NEPA process complete?

      Yes

   b) If the CEQA/NEPA document has been completed, please list document name(s):

      Tiered EA/IS Mitigated Negative Declaration: Gravel Mining Reach & Special Run Pools 9/10 Restoration and Mitigation Projects SCH# 98052070

5. **Environmental Permitting and Approvals** (*If a permit is not required, leave both Required? and Obtained? check boxes blank.*)

LOCAL PERMITS AND APPROVALS

Conditional use permit	Required
Variance	
Subdivision Map Act	
Grading Permit	
General Plan Amendment	
Specific Plan Approval	
Rezone	
Williamson Act Contract Cancellation	
Other	

STATE PERMITS AND APPROVALS

Scientific Collecting Permit	
CESA Compliance: 2081	
CESA Compliance: NCCP	
1601/03	Required
CWA 401 certification	Required
Coastal Development Permit	
Reclamation Board Approval	Required
Notification of DPC or BCDC	
Other	Required

FEDERAL PERMITS AND APPROVALS

ESA Compliance Section 7 Consultation	Required
ESA Compliance Section 10 Permit	
Rivers and Harbors Act	
CWA 404	Required
Other	

PERMISSION TO ACCESS PROPERTY

Permission to access city, county or other local agency land. Agency Name:	
Permission to access state land. Agency Name: State Lands Commission	Required
Permission to access federal land. Agency Name:	
Permission to access private land. Landowner Name: Sante Fe Agregates, Martin Ruddy,Bret, Kurt, Roger Warner, Walter Deardorff	Required

6. **Comments.**

State "Other" is possible lease with State Lands Commision Local Use Permit is modification of existing mining permit reclamation plan boundary with restorationarea boundary. Landowners have signed project concurance letters to allow project to proceed, but formal conservation and access easements will be required prior to construction.

Land Use Checklist

<u>Tuolumne River Mining Reach Restoration Project: Warner-Deardorff Segment No. 3 -Construction</u>

1. **Does the project involve land acquisition, either in fee or through a conservation easement?**

   Yes

   If you answered yes to #1, please answer the following questions:

   a) **How many acres will be acquired?**

      <u>Fee</u>: 74
      <u>Easement</u>: 0
      <u>Total</u>: 74

   b) Will existing water rights be acquired?

      No

   c) Are any changes to water rights or delivery of water proposed?

      No

2. **Will the applicant require access across public or private property that the applicant does not own to accomplish the activities in the proposal?**

   Yes

3. **Do the actions in the proposal involve physical changes in the land use?**

   Yes

   If you answered yes to #3, please answer the following questions:

   a) How many acres of land will be subject to a land use change under the proposal?

      74

   b) Describe what changes will occur on the land involved in the proposal.

      Existing mining permits will be extinguished and be replaced with riparian floodway. There is no conversion of agricultural lands involved in the restoration project.

   c) List current and proposed land use, zoning and general plan designations of the area subject to a land use change under the proposal.

Category	Current	Proposed (if no change, specify "none")
Land Use	Aggregate mining and residual mining pits. Zoned A-40	Project area will be come riparian forest in an active river floodway.
Zoning	Zoned A-40	Swamp & Overflow
General Plan Designation	Agriculture & Mineral Resources	none

d) **Is the land currently under a Williamson Act contract?**

Yes

e) **Is the land mapped as Prime Farmland, Farmland of Statewide Importance, Unique Farmland or Farmland of Local Importance under the California Department of Conservation's Farmland Mapping and Monitoring Program?**

No

f) **Describe what entity or organization will manage the property and provide operations and maintenance services.**

TID will hold the easement (or fee title) and provide operations and management of the project area.

4. **Comments.**

The landowner is given the option of a conservation easement or fee title transfer of the project area to TID. The Water Code allows TID, as an irrigation district, to aquire the land in fee without having to redue the Williamson Act contract.

Conflict of Interest Checklist

Tuolumne River Mining Reach Restoration Project: Warner-Deardorff Segment No. 3 -Construction

Please list below the full names and organizations of all individuals in the following categories:

- **Applicants listed in the proposal who wrote the proposal, will be performing the tasks listed in the proposal or who will benefit financially if the proposal is funded.**
- **Subcontractors listed in the proposal who will perform some tasks listed in the proposal and will benefit financially if the proposal is funded.**
- **Individuals not listed in the proposal who helped with proposal development, for example by reviewing drafts, or by providing critical suggestions or ideas contained within the proposal.**

The information provided on this form will be used to select appropriate and unbiased reviewers for your proposal.

Applicant(s):

Wilton Fryer, Turlock Irrigation District

Subcontractor(s):

Are specific subcontractors identified in this proposal? Yes

If yes, please list the name(s) and organization(s):

Scott McBain, etal	McBain & Trush
Jennifer Vick, etal	Stillwater Sciences
Dave Peterson, etal	HDR Engineering, Inc.
Dick Grey	Specialty Appraisals
Curtis Alling, Etal	EDAW, Inc
Steve Long	Cutler & Associates
None	None
None	None
None	None
None	None

Helped with proposal development:

Are there persons who helped with proposal development?

Yes

If yes, please list the name(s) and organization(s):

Darren Mierau McBain & Trush

Jennifer Vick Stillwater Sciences

Comments:

Construction contractor is unknown at this time and information will be provided when a successful bid is awarded.

Budget Summary

Tuolumne River Mining Reach Restoration Project: Warner-Deardorff Segment No. 3 -Construction

Please provide a detailed budget for each year of requested funds, indicating on the form whether the indirect costs are based on the Federal overhead rate, State overhead rate, or are independent of fund source.

Independent of Fund Source

Year 1												
Task No.	Task Description	Direct Labor Hours	Salary *(per year)*	Benefits *(per year)*	Travel	Supplies & Expendables	Services or Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Cost
1	Design						166,000			166000.0		166000.00
2	easements						1,819,000			1819000.0		1819000.00
3	Project Management						60,000			60000.0		60000.00
4	ROW Services						45,000			45000.0		45000.00
		0	0.00	0.00	0.00	0.00	2090000.00	0.00	0.00	2090000.00	0.00	2090000.00

Year 2												
Task No.	Task Description	Direct Labor Hours	Salary *(per year)*	Benefits *(per year)*	Travel	Supplies & Expendables	Services or Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Cost
5	Construction						6,930,000			6930000.0		6930000.00
6	Construction Management						124,000			124000.0		124000.00
7	Constuction Contingency						693,000			693000.0		693000.00
3	Project Management						65,000			65000.0		65000.00
8	Permits						38,000			38000.0		38000.00
		0	0.00	0.00	0.00	0.00	7850000.00	0.00	0.00	7850000.00	0.00	7850000.00

Year 3												
Task No.	Task Description	Direct Labor Hours	Salary *(per year)*	Benefits *(per year)*	Travel	Supplies & Expendables	Services or Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Cost
9	Revegetation						606,000			606000.0		606000.00
10	Monitoring						180,000			180000.0		180000.00
7	Constuction Contingency						61,000			61000.0		61000.00
3	Project Management						52,000			52000.0		52000.00
		0	0.00	0.00	0.00	0.00	899000.00	0.00	0.00	899000.00	0.00	899000.00

Grand Total=10839000.00

Comments.
Tasks occuring in multiple years maintain the same Task Number.

Budget Justification

Tuolumne River Mining Reach Restoration Project: Warner-Deardorff Segment No. 3 -Construction

Direct Labor Hours. Provide estimated hours proposed for each individual.

None

Salary. Provide estimated rate of compensation proposed for each individual.

None

Benefits. Provide the overall benefit rate applicable to each category of employee proposed in the project.

None

Travel. Provide purpose and estimate costs for all non-local travel.

None

Supplies & Expendables. Indicate separately the amounts proposed for office, laboratory, computing, and field supplies.

None

Services or Consultants. Identify the specific tasks for which these services would be used. Estimate amount of time required and the hourly or daily rate.

Project costs are based on engineers estimate from prilimiary (30%) design drawings, experiance from costs of restoration projects currently under construction, and consultant contract proposals for work under this PSP.

Equipment. Identify non-expendable personal property having a useful life of more than one (1) year and an acquisition cost of more than $5,000 per unit. If fabrication of equipment is proposed, list parts and materials required for each, and show costs separately from the other items.

None

Project Management. Describe the specific costs associated with insuring accomplishment of a specific project, such as inspection of work in progress, validation of costs, report preparation, giving presentatons, reponse to project specific questions and necessary costs directly associated with specific project oversight.

Project Management cost represents 20% of TID Program Manager time based on past four years of managing prior projects.

Other Direct Costs. Provide any other direct costs not already covered.

None

Indirect Costs. Explain what is encompassed in the overhead rate (indirect costs). Overhead should include costs associated with general office requirements such as rent, phones, furniture, general office staff, etc., generally distributed by a predetermined percentage (or surcharge) of specific costs.

None

Ecosystem Restoration Program - 2002 Proposal Solicitation Package (PSP): Form II - Executive Summary

Proposal Title: Tuolumne River Mining Reach Restoration Project: Warner-Deardorff Segment No. 3 – Construction

LOCATION & SCOPE of WORK:
Ecological Zone 13. The overall Mining Reach Project involves implementation of full-scale restoration on a 6.1-mile reach (River Mile 34.2 to 40.3) of the lower Tuolumne River below La Grange Dam. The Warner-Deardorff Segment represents the third element being reconstructed in the Mining Reach, restoring 73 acres of riparian floodplain habitat and 1.3 miles of inchannel riverine habitat for fall run chinook salmon from River Mile 35.2 to 36.5. The Warner-Deardorff Segment No. 3 Project was originally submitted under the 2001 PSP. However, only the design, easement appraisals, and pre project monitoring were funded at that time. This is a re-submittal of that project to allow completion of the easement acquisition, permitting for construction, the construction phase of the work including the riparian revegetation, and post project monitoring.

BIOLOGICAL & ERPP OBJECTIVES:
1. Restore and increase habitat conducive to natural production of San Joaquin fall-run salmon.
2. Reconstruct natural channel geometry scaled to current channel forming flows, which allows active fluvial processes to maintain the restored aquatic habitat within a 500-foot wide riparian floodway.
3. Restore native riparian plant communities in their predicted hydrological regime within the floodway.
4. Reduce out-migrating juvenal salmonid losses through entrapment in adjacent fish predator habitat.

CONCEPTUAL MODEL FOR RESTORATION OF THE MINING REACH:
The problems that are the focus of the Tuolumne River restoration program fall into two major categories: (1) impairment of geomorphic and ecosystem processes caused by flow regulation, gold and aggregate mining, and land uses, and (2) reduction in fall-run chinook salmon population abundance and resiliency. Potential solutions are identified in four interconnected conceptual models depicting the current understanding of the geomorphic functions in the river, the river's chinook salmon population dynamics, effects of measures to improve geomorphic and ecosystem function, and the potential to increase chinook salmon population abundance and resiliency.

APPROACH:
The design objectives of the Mining Reach Project are to restore riparian habitats and salmonid habitats along a contiguous riparian floodway. These objectives, which will form the basis of testable hypotheses, include:

1. Improve salmonid spawning and rearing habitats by restoring an alternate bar (pool riffle) morphology, restoring spawning habitat within a channel that is allowed to meander within a riparian floodway, and filling in-channel mining pits;

2. Improve juvenile salmon survival by preventing future connection between the Tuolumne River and off-channel mining pits;
3. Restore native riparian communities on appropriate geomorphic surfaces (i.e., active channel and floodplain terraces) within the restored floodway;
4. Restore habitats for special status species (e.g., egrets, ospreys, hawks, and herons);
5. Restore a fully vegetated riparian floodway width that will safely convey regulated flood flows up to 15,000 cfs (the maximum regulated flow from Don Pedro Reservoir);
6. Allow the river channel the ability to migrate within the restored floodway to improve and maintain riparian and salmonid habitat;

C. CHANGES IN DIRECTED ACTION PSP:

The entire PSP has been updated and descriptions clarified in response to the Adaptive Management Forum final report and the review panel comments. Major changes are:

1. Expanded description of Conceptual Model relationships and experimental design; pp 4-5
2. Expanded explanation of Design & Approach pp 6-8, Attachment 4
3. Expanded explanation of Section 5 Monitoring and Performance Measures, including riparian ecology experiments, pp 10-12
4. Expansion of Budget discussion, particularly land acquisition costs, pp 19, 21-22
5. Addition of Attachment 5 Project EA/IS Mitigation & Monitoring Program

**TUOLUMNE RIVER MINING REACH RESTORATION PROJECT:
WARNER-DEARDORFF SEGMENT No. 3 - CONSTRUCTION**

A PROJECT DESCRIPTION: Project Goals & Scope of Work

1. PROBLEM STATEMENT

The fall run chinook salmon in the tributaries of the San Joaquin River is currently listed as a species of concern by the USFWS. The Tuolumne River is the largest tributary of the San Joaquin River and the Don Pedro Project is the largest reservoir located above the fall-run chinook salmon spawning reach on the Tuolumne River. Don Pedro Reservoir is owned by the TID and the MID and is licensed by the Federal Energy Regulatory Commission (FERC). The Tuolumne River supports a population of fall-run chinook salmon, whose numbers have fluctuated from 40,000 fish in 1985, to a low of 100 fish in 1991, and is on another upward swing with 7,000 fish in 1997; 8,900 in 1998; 7,900 in 1999; and 18,000 in 2000. Given the large potential to make significant improvements in wild salmon production and the success of the stakeholder organization, Tuolumne River Technical Advisory Committee, in promoting river-wide restoration goals, the CALFED – ERP has designated the Tuolumne River as one of three Demonstration Streams in the Central Valley. The problems that are the focus of the Tuolumne River restoration program fall into two major categories: (1) impairment of geomorphic and ecosystem processes caused by flow regulation, gold and aggregate mining, and land uses, and (2) reduction in fall-run chinook salmon population abundance and resiliency.

Anadromous salmonid populations in the lower Tuolumne River require adequate ecosystem health to achieve and sustain their potential productivity. Restoring and maintaining dynamic geomorphic processes are crucial for insuring healthy river ecosystems with natural productive salmonid populations. Complete restoration of a river ecosystem is infeasible for alluvial rivers regulated by large dams. Conceptual models are used to identify factors, such as quality and aerial extent of available spawning riffles and associated habitat, periodic entrapment of juvenile salmon in mining pits during high river flows, sediment management, etc., which lead to prioritizing actions that would best improve the ecosystem, particularly salmonid habitat.

One of many stressors identified in recent studies on the Tuolumne River that limit salmonid populations are the habitat impacts from past extensive in-stream and current off-channel mining. Instream and off-channel mining pits have negatively impacted salmonid populations and habitat by stranding juveniles in ponds during outmigration, fostering large populations of non-native predator fish (bass), and degrading spawning and rearing habitats by either complete removal during aggregate extraction, degradation by channel encroachment from dikes along mining pits, or fine sediment infiltration. Many of the older off-channel pits have only a small berm of undisturbed native material separating them from the river. Common floods (e.g., 1983, 1986, 1995, & 1998) of less than 8,000 cfs regularly breach some of these brims resulting in entrapment of salmon fry and smolts.

1a. Geographic Location

The overall Mining Reach Project is a full-scale restoration implementation project in

Ecological Zone13, East San Joaquin Basin along a 6.1-mile length of channel located on the lower Tuolumne River, between river mile 34.2 and river mile 40.3, approximately 23 miles east of Modesto in Stanislaus County. This PSP is for the Warner-Deardorff Segment No. 3, the third portion of the Mining Reach Project, and encompasses 73 acres of riparian floodway along a 1.3-mile channel between river mile 35.2 and 36.5.

1b. Tuolumne River Restoration Program

The Tuolumne River Technical Advisory Committee (TRTAC) was formed under the auspices of the 1995 Don Pedro Project Settlement Agreement (FERC License No. 2299). The TRTAC has goals that include restoring self-sustaining instream aquatic habitat and shaded riverine aquatic habitat for the primary benefit of San Joaquin fall-run chinook salmon in the Tuolumne River below La Grange Dam. To help guide their actions and those of others planning restoration projects, the TRTAC has developed a *Habitat Restoration Plan for the Lower Tuolumne River Corridor* (McBain & Trush 2000) This Habitat Restoration Plan details the science behind an integrated, long-term fish and riparian habitat restoration and monitoring program that utilizes adaptive management for enhancing the natural production of salmon in the Tuolumne River below La Grange Dam. The development of the Habitat Restoration Plan represents a systematic description of the current state of the science for the Tuolumne River based on over $10,000,000 of District funded monitoring, system modeling, and related studies conducted since 1971 and application of relevant information from studies and projects on other gravel bedded rivers, principally in California. The results of the earlier District monitoring and studies can be found in the annual reports to FERC.

The Habitat Restoration Plan divides the Tuolumne River into seven basic reaches, each representing where specific types of restoration projects could be applied within that reach based on the fluvial, riparian, and fishery life stage characteristics applicable to that stream segment. Some of these projects focus on restoration of geomorphic processes, others on riparian forest restoration and predator reduction, and still others deal with gravel re-introduction, cleaning, and sediment management for improvement of spawning and juvenal salmon survival. A more refined design document, *Tuolumne River Floodway Restoration – Project Design Approach & Rationale* specific for the Mining Reach Project and Special Run Pools 9 & 10 is being developed by McBain & Trush that incorporates lessons learned from current projects on Clear Creek, the Merced and Tuolumne rivers, and expands on information from the *Habitat Restoration Plan for the Lower Tuolumne River Corridor*.

1c. Goals and Objectives

The overarching goal of the TRTAC restoration program is a goal commonly shared by the CALFED and AFRP programs, which is to re-establish critical geomorphic and hydrologic processes, a natural channel morphology, and healthy habitat conditions, within contemporary regulated flow and sediment conditions. This is considered the most promising strategy for recovery and maintenance of salmonid populations along with the associated native flora and fauna of the river. The Tuolumne River has a highly regulated flow regime, with reservoir storage upstream of the project area 38% greater than the average annual runoff, which produces reduced flow and sediment supply regimes in the project area. The project goal thus targets a scaled-down version of the former river, but with dynamic fluvial processes (sediment transport and scour, floodplain inundation, channel migration) that function to maintain the habitat characteristics favored by chinook salmon and other fish, avian, and wildlife populations.

1d. Hypotheses

The design objectives of the Mining Reach Project are to restore riparian habitats and salmonid habitats with a continuous riparian floodway through this 6.1-mile reach of the Tuolumne River between river mile 34.2 and 40.3. These objectives, which will form the basis of testable hypotheses, include:

1. Improve salmonid spawning and rearing habitats by restoring an alternate bar (pool riffle) morphology, restoring spawning habitat within a channel that is allowed to meander, and filling in-channel mining pits;
2. Improve juvenile salmon survival by preventing future connection between the Tuolumne River and off-channel mining pits;
3. Restore native riparian communities on appropriate geomorphic surfaces (i.e., active channel and floodplain terraces) within the restored floodway;
4. Restore habitats for special status species (e.g., egrets, ospreys, hawks, and herons);
5. Restore a fully vegetated riparian floodway width that will safely convey regulated flood flows up to 15,000 cfs (the maximum regulated flow from Don Pedro Reservoir);
6. Allow the river channel the ability to migrate within the restored floodway to improve and maintain riparian and salmonid habitat;

2. PROJECT JUSTIFICATION & CONCEPTUAL MODELS

2a. FERC Project Implementation Mandate

In 1995, through the FERC relicensing process for the Don Pedro Project, the Districts and the City and County of San Francisco (CCSF) entered into a FERC Settlement Agreement (FSA) with the USFWS, CDFG, and several environmental and stakeholder groups. This FSA establishes minimum flow requirements for the Tuolumne River downstream of the Don Pedro Project and sets forth a strategy and implementation procedures for recovery of the lower Tuolumne River chinook salmon population. Using adaptive management, the FSA goals are to: (1) increase the abundance of wild chinook salmon in the Tuolumne River, (2) protect any remaining genetic characteristics unique to the Tuolumne River chinook salmon population, and (3) improve salmon habitat in the Tuolumne River. The FSA directed the establishment of the TRTAC, to be made up of biologists of the signatories to the FSA, and for the TRTAC to develop and implement ten priority restoration projects by 2005. Through development of the Restoration Plan and other planning efforts, the TRTAC has identified a total of 14-projects, with the four segments of the Mining Reach Project being the first four projects so identified.

2b. Conceptual Models

In June 2001 UC Davis Center for the Environment and AFRP sponsored an Adaptive Management Forum specifically reviewing the science behind the large-scale restoration projects on the Tuolumne River. The TRTAC Monitoring Subcommittee, with assistance and peer review by panel members from the Adaptive Management Forum, developed six interconnected conceptual models depicting their current understanding of the science and geomorphic functions in the river, the river's chinook salmon population dynamics, effects of measures to improve geomorphic and ecosystem function, and the potential to increase chinook salmon population abundance and resiliency. These conceptual models are presented in the report *AFRP / CALFED Adaptive Management Forum: Tuolumne River Restoration Summary Report* (AMF Summary Report, Stillwater Sciences 2001). Attachment No. 1 has the summary diagrams depicting these Conceptual Models developed during that forum. The four models S-1, G-1, P-1, and P-2 are most applicable to the Mining Reach Project. The models describe the functions and processes that are desired for sustainable natural salmon production. The Mining Reach projects rescale the channel to allow these processes to occur under the regulated flow regime set forth in the FERC Settlement Agreement and associated FERC Order.

Model S-1. Overarching model of factors affecting chinook salmon population abundance in the Tuolumne River. This conceptual model depicts the factors affecting each chinook salmon life history stage, within and outside of the Tuolumne River basin. Within the basin, research and monitoring have identified three primary factors that limit chinook salmon population abundance. These factors are: (1) redd superimposition; (2) low survival-to-emergence resulting from low substrate permeability; and (3) low outmigrant survival resulting from spring flow conditions, predation by largemouth bass, and water temperature. The Mining Reach projects create a six mile continuum of additional high quality spawning areas that should help reduce the level of redd superimposition and competition for spawning area upstream of the project area. By reshaping the channel to allow fluvial processes to occur, the substrate permeability is anticipated to improve, based on current bedload and permeability monitoring. Currently the fines that reduce substrate permeability are not moved down stream because the existing low flow channel is too wide for the current flow regime. The reshaped channel form is intended to create more of the riffle pool habitat required for outmigrant survival.

Model G-1. Overarching model of the effects of dams and mining on geomorphic inputs and processes, habitat structure, and population response. This model illustrates linkages between physical inputs, physical processes, habitat structure, and biological responses and the effects of dams and mining on these linkages. In this model, dams have altered seasonal flow patterns in the lower river, reduced peak flow magnitude, reduced fine sediment supply, and eliminated coarse sediment supply. The Mining Reach Project reestablishes the physical processes scaled to the regulated flow regime of the river. The key assumption is that reestablishing these physical fluvial processes will allow riverine and riparian biological processes to be active and self- sustaining in the restored areas. While there will be continuity of process within the mining reach, it is acknowledged that it may be necessary to augment the supply of course aggregate at the upper end of the reach to maintain the projects.

Model P-1. Effects of reconstruction of Special Run-Pools (SRPs) on geomorphic process, riparian vegetation, and chinook salmon survival. In this model constructing a meandering channel and floodplain that are scaled to contemporary flow conditions in the Tuolumne River improves in-channel and floodplain geomorphic and riparian processes and chinook salmon survival. Constructing an appropriately scaled channel increases the frequency of bed mobilization and restores sediment transport continuity within the Mining Reach. The project allows a balance of sediment supply and transport capacity and allows the river to create and maintain active alluvial features, such as bars and riffles. Applying the model to the design of the project results in a narrower more sinuous low flow channel in a wider floodway designed for maximum regulated flood releases. The narrower channel produces the velocity and associated shear forces required to mobilize the size of aggregate that was originally deposited under pre watershed development conditions.

Model P-2. Effects of reconstruction of the Gravel Mining Reach on geomorphic processes, riparian vegetation, and chinook salmon survival. In this model, reconstructing a channel and floodplain that are scaled to contemporary flow conditions combined with planting native riparian vegetation on the reconstructed floodplain and maintaining coarse sediment supply improves in-channel and floodplain geomorphic and riparian processes and improves chinook salmon spawning and rearing habitat. By providing conditions that allow the channel to construct bars and riffles, the project improves salmon spawning, incubation, and rearing habitats. This model also identifies the need for fine sediment transport to maintain the riparian habitat within floodway along the river. With the regulated flow regime of the river there is a greatly reduced supply of both course and fine sediment. In the Mining Project design the upper levels on the floodway benches are built with an initial supply of fine sediment in place because little natural fine sediment recruitment is anticipated based on upstream bedload transport measurements and assessment of fine sediment sources entering the river. This project placed sediment allows both natural recruitment of riparian vegetation and higher survival of the revegetation planting within the project. These planting design elements are based on experience from the earlier 4-Pumps work in the MJ Ruddy Segment No. 2 project area where a lack of a fine substrate contributed to very low survival of planted species and virtually no natural recruitment on lower bench areas. The project revegetation plan includes experiments to test natural recruitment on high and low terraces. The aggregate imported to reconstruct the channel will provide continuity of aggregate transport within the Mining Reach, but long-term project maintenance may require augmentation of course aggregate at the upstream end of the reach. Bedload monitoring and tracer rock studies will be used to evaluate aggregate transport within the project area.

Prior to the Adaptive Management Forum, the Habitat Restoration Plan identified 10 "Attributes of Alluvial River Integrity" that when in balance will provide for a dynamic riverine ecosystem. The *Attributes* were first introduced for the Trinity River Maintenance Flow Study (McBain and Trush 1997), and later incorporated in the Trinity River Flow Evaluation Study (USFWS and HVT, 1999), and finally published in the Proceedings of the National Academy of Sciences (Trush et al. 2000). The *Attributes* are essentially a set of hypotheses that describe the critical geomorphic processes that form and maintain alluvial rivers. The *Attributes* are key elements of the physical processes within the Conceptual Models developed for the AMF and provide a basis for understanding river ecosystems to: 1) improve our understanding of how rivers function, 2) illustrate how human alterations to the environment may have affected the fundamental geomorphic and ecological processes of a particular alluvial river, and 3) develop quantitative and measurable restoration objectives. These attributes form the basis for the conceptual design objectives outlined above that will be used in the restoration and monitoring of the riparian floodway channel in the Mining Reach projects. The *Attributes* are as follows: 1) Spatially complex channel shape; 2) Variable streamflow patterns; 3) Frequently disturbed riverbed surface; 4) Periodic riverbed scour and fill; 5) Balanced fine and course sediment volumes; 6) Periodic channel migration and/or avulsion; 7) A functional floodplain; 8) Infrequent channel resetting floods; 9) Self-sustaining, diverse riparian corridor; and 10) Naturally fluctuating groundwater table.

Based on the Attributes and our current understanding of alluvial rivers, one can describe the linkages between **physical inputs** (e.g., sunlight, streamflow, sediment), **physical processes** (e.g., sediment transport, bank erosion, fine sediment deposition), **habitat structure** (e.g., shallow-gradient riffles, well-sorted and clean spawning gravels) and **biological responses** (e.g., healthy incubation, low density-dependent mortality). The effects of dams, streamflow and coarse sediment regulation, mining, and other human alterations can be related to these linkages. In the Tuolumne River, dams have eliminated coarse and fine sediment supply (Attribute 5), reduced the magnitude, duration, and frequency of peak flows (Attributes 2, 3, 7, 8), and altered seasonal flow patterns (Attribute 2). In addition, aggregate mining and gold dredging have reduced coarse sediment supply to the river by removing stored sediment from the channel and floodplain (Attribute 1) and trapping coarse sediment that is in transport on the bed. These reductions in key inputs to the system (i.e., sediment and water) have reduced sediment transport (Attribute 3, 4), channel migration and avulsion (Attribute 6), and floodplain inundation (Attribute 7) and have resulted in channel incision, bed armoring, channel narrowing (through riparian vegetation encroachment), and abandonment of pre-dam floodplains. In addition, mining has left extensive pond complexes along the channel margins that entrap emigrating juvenile salmonids. These alterations in habitat structure have cumulatively reduced the quantity and degraded the quality of salmonid habitat.

3. APPROACH, STRATEGY & DESIGN

The ecosystem-based approach to restoration stemming from the conceptual models developed for the Tuolumne River centers on re-establishing the critical geomorphic and hydrologic processes that sustain alluvial rivers. The ERP and Strategic Plan support this approach by "proposing an integrated-systems approach that attempts to protect and recover multiple species by restoring or mimicking the natural physical processes that create and maintain diverse and healthy habitats" (Strategic Plan pg 2-6). The *Attributes* provide a framework of geomorphic processes required to meet this goal, generate information useful in an adaptive management framework, and provide a basis for long term monitoring.

The general location and layout of restoration treatments and activities for the four respective Mining Reach Project segments are found in Attachment No. 2 which shows four maps, Figures 8 through 11 from the Mining Reach Project EA/IS, diagramming how the typical design and restoration treatments are integrated within the entire Mining Reach Project. The project starts at the upstream end with the 7-11 Segment No. 1 (RM. 37.6-40.3), then the M. J. Ruddy Segment No. 2 (RM. 36.5-37.6), followed by the Warner-Deardorff Segment No. 3 (RM. 35.1-36.5), and finishing with the Reed Segment No. 4 (RM. 34.2-35.1).

Portions of the 6.1-mile long reach will be widened and reformed into a 500-foot wide riparian floodplain recreating a riffle and run pattern within the restored meander channel of the river. Native vegetation will be planted on restored river terraces in a species composition determined by channel morphology and hydrologic regime, similar to that found on undisturbed segments of the river. The *Habitat Restoration Plan for the Lower Tuolumne River* riparian inventory is used as the basis of the restoration planting. The revegetation pallet includes understory forbs and shrubs that are commonly associated with the tree species to be planted. The riparian reforestation is intended to provide food and shade for juvenile salmon. Terrestrial species will also benefit from a more continuous corridor of riparian habitat in the restored areas. It is anticipated there will be changes in birds and other riparian forest dwelling species as the vegetation grows to maturity. To minimize long-term future maintenance expenditures, this restoration work is being designed with the intent to provide a self-maintaining riparian floodway channel once the revegetation is completed and established. The wider floodway will allow the river channel meander to provide a sustainable and dynamic river morphology, i.e., flood flow-related channel-bed movement with periodic scour, that partially or fully restores the processes associated with natural salmon production and survival. Starting in 1973 the mining companies were required to construct dikes to separate the extraction pits from the river channel. The early dikes on the lower terraces effectively constrict the flows that can be released from the reservoir. As a result of the Mining Reach Project, the channel capacity in the project area will increase from 7,000 cfs to 15,000 cfs, the maximum regulated flow that can be released from Don Pedro Reservoir. This higher flow capacity will enable fluvial processes to occur that are beneficial to the floodplain sustainability yet can occur without damage to adjacent aggregate mining operations. Riverwide benefits are derived from the these projects because removing the manmade restrictions within the Mining Reach will allow the benefits of increased flows to occur throughout the spawning areas in the 12 miles of river upstream of the project.

The Mining Reach Project is divided into four segments solely for the purpose of constructing manageable sized pieces and to allow adaptive management adjustments in design based on prior year construction experiences. The CEQA / NEPA mitigated EA/IS for all four segments has been completed through prior USFWS-AFRP funding with a TID-MID-CCSF contribution towards permitting costs. AFRP and CALFED have funded design, construction, revegetation, and monitoring for first two segments and preliminary design for this segment. The sequence of segments to be constructed are intended to allow finished work to remain structurally sound against a designed flood event of 15,000 cfs in case funding for a subsequent project is delayed or not forthcoming.

A key element of the Warner-Deardorff Project is the purchase of the aggregate resources under the existing mining permit that covers the 73 acres of the project. The volume of aggregate so purchased is many times greater than the aggregate that will need to be imported to the project to complete the restoration work. The project will require significant quantities of imported materials to fill a 20-acre portion of the 40-acre pit area created by past gravel mining and construct setback dikes to create the wider floodway channel. Recently the mining company has shown by excavation adjacent to the project area that there is a significantly larger volume of aggregate remaining under the 20-acre pit than was originally envisioned when the project budget was developed. This has the potential to increase the project acquisition costs by a yet to be determined amount. The high costs of the land acquisition for this project are primarily due to the purchase of the underlying mineral rights, as the current mining permits would enable mining on the river floodway. If the project does not come to fruition in the near future, the landowners have indicated they will begin to actively mine the area. The costs of restoring this portion of the river corridor after mining would be significantly greater than the projected costs to purchase the materials that are already in place.

The river channel will be reformed into a 500-foot wide riparian floodway complete with native vegetation in a mix similar to that found along undisturbed segments of the Tuolumne River. The bank full channel will be hydraulically sized for a 2-year flood flow of 5,000 cfs under currently regulated flows. The sinuosity of the low flow channel is increased by the riffle pool construction; the revegetation will increase the hydraulic roughness in the channel, yet the wider floodway allows a lower river stage to pass through the project area. The setback dikes constructed for the project floodway are designed to remain stable under the maximum regulated flow of 15,000 cfs.. It is anticipated and planned that during such high flow events there will be some movement of the channel within the flood way to expose added spawning materials and clean existing spawning gravels. In addition to the main channel, the design include "anti stranding channels" constructed along the floodway benches. These broad shallow "v" drainage channels provide a way for fry and smolts to return to main channel on receding river flows. They also provide micro topographic features that allow for more complexity in the riparian planting pallet. The specific design parameters for the channel are summarized in Attachment 4. These parameters are run in a HEC-RAS hydraulic model, used to create the project design, plans, and to satisfy the permit requirements of the regulatory agencies. Hydraulic modeling uses agency accepted roughness factors for new construction and mature riparian vegetation. Attachment No. 3 is a typical design segment from the upstream MJ Ruddy project showing the riffle pool sequence in the main channel, anti stranding channels on floodway benches, and the riparian planting pallet including several experimental treatments.

4. FEASIBILITY

Monitoring and related fishery studies on the Tuolumne, conducted by the Districts and DFG since construction of the Don Pedro Project in 1971, have formed the basis for refining information on the stressors impacting fall run salmon and the types of restoration projects that should benefit the Tuolumne. The 4-Pumps program funded a small-scale inchannel project on reforming riffle pool sequences in a portion of the upstream MJ Ruddy Segment No. 2 in 1991. Design lessons from that 4-Pumps project have been incorporated into the larger scale designs of the current projects because the intended fluvial processes did occur at the design bank full flows of 5,000 cfs that will be found in the current project. Experiments in the earlier 4-Pumps project found that sorting the aggregate placed in the spawning riffles was not effective in improving the quality, so there is no special sorting of aggregates placed in the riffles in the Mining Reach projects. Without a wider floodway to reduce the velocity, the 4-Pumps improvements were not stable under high flow conditions. Limited revegetation success occurred in the 4 Pumps project area partly due to a lack of fine sediment supply to the floodway, poor matching of plant types to the appropriate geomorphic surfaces in the channel, and early recession of the water table due to rapid reductions in spring flows under regulated flows. The revegetation plan for the Warner-Deardorff Segment No. 3 has been expanded and the design refined based on the lessons learned from the 4-Pumps work and recent restoration work for Special Run Pool 9 at RM 26 that was planted in December 2001. Vegetation module types will be planted to better match the benches and zones associated with channel morphology. Revegetation will include understory forbs and shrubs. The planting density and variety is intended to provide rapid canopy closure to reduce competition from non-native species, particularly those that are not shade tolerant. Topsoil will be incorporated in the portion of the benches subject to bankfull flow to provide an improved soil matrix for early survival. Supplemental periodic deep irrigation combined with the use of container stock is intended to insure adequate development of root structure is available in the first season after planting. This design is a key element in all the Mining Reach projects because the regulated spring runoff pattern has a rapid transition from the 30-day spring pulse flow that ends on 15 May to the summer flows that start on 1 June and do not exceed 250 cfs in most years. There is no assurance in the first growing season after winter planting that the spring pulse flow will exceed the bankfull flow of 5,000 cfs that inundates the riparian planting area. Under these conditions the water table is anticipated to drop at a rate far in excess of documented root growth in cuttings. The periodic deep irrigation is intended to facilitate root growth to the summer water table by the end of the first summer season. Piezometers with continuous stage recorders will be used to document water table changes across the floodway, particularly since mining pits with lower water levels are often on the backside of the restoration floodway. Sampling of root patterns on the Grayson River ranch project in summer 2002 confirmed that periodic deep flood irrigation fosters deep roots over those form more frequent drip irrigation. Spring and summer water table levels were below the root zone.

The reconstruction work in the flowing water of the river with heavy equipment is anticipated to be limited for fishery reasons to an annual opportunity window of 120 days from 1 June through 30 September of each season when the fall run salmon are normally not in the river. Construction out of the water will occur throughout the year with appropriate erosion control measures. The restoration plantings are also seasonally restricted to the winter months when planting materials are dormant. Construction design, revegetation design, permitting, pre project monitoring, and acquisition of conservation easements are being done for each segment of the Mining Reach as funding becomes available.

Some of the dike and reconstruction materials are anticipated to be supplied by mining from existing tailings deposits that are located at the upstream end of the mining reach and are regulated under County use permits. One benefit of using these tailings is that it may be possible to restore additional floodplain habitat during the mining of these excavation areas. The project EA/IS identified and addressed mitigation for utilization and transportation of the various sources of restoration materials locally available for this project. Additional materials for the major setback levees may need to be imported into the site.

Creation of the riparian floodway habitat zone by the setback dikes will require the long-term maintenance of project improvements. TID and MID will jointly hold conservation easements from willing sellers that protect the public investment, but at the same time protect the land owner’s property and water rights. The terms of the District’s control of the conservation easements took time to resolve with the landowners due to their concerns over potential liability and public access to their remaining land. The landowners have agreed to the same process for easement acquisition in all four segments in the Mining Reach. Perpetual maintenance of project facilities will be by the Districts. Elimination of any overlapping jurisdictional boundary between the restoration project works and the existing mining company SMARA reclamation plans will require revisions in the reclamation plan boundaries that are a part of the County Use Permits issued to the mining companies.

This is the fourth of ten restoration projects being proposed for the Tuolumne River based on the Habitat Restoration Plan for the Lower Tuolumne River Corridor developed by the TRTAC. The staff will continue to work closely with the affected landowners and mining operators in the development of site-specific adjustments during the design phase to create final plans. The firm of EDAW, Inc. was hired to assist with the CEQA, NEPA, and permitting work. The NEPA work was jointly prepared with the USFWS and coordinated with the AFRP program. A mitigated EA/IS was jointly developed between TID, as project manager & lead agency, and the USFWS as the Federal funding agency. The EA/IS was tiered off the 1995 EIS for the FERC Settlement Agreement for the Don Pedro Project. Public and agency comments were heard in July and August 1998 and the comments focused on economic issues of compensation for conservation easements and lost availability of aggregate supplies. No environmental comments were received. An addendum to the proposed mitigation measures addressing the comments received was finalized and adopted in July 1999 and is listed as State Clearing House #98052070. The mitigation is designed to avoid a take of listed species such that take permits under ESA \ CESA should not be required. A programatic Section 7 consultation process was completed with USFWS for the 7\11 Segment and SRP 9 regarding elderberry and is the format to be used on all remaining segments in the Mining Reach and Special Run Pool 10. The State Reclamation Board and the TID have developed an MOA that utilizes the findings from the Section 7 consultation for each Mining Reach Project segment, whereby the Reclamation Board will now allow restoration project planting of elderberry shrubs within the designated floodway. The riparian planting plans include modules of elderberry within the floodway.

The following is a list of the agencies and associated permits to be acquired in each of the four Mining Reach Project segments.

1) A Nationwide 27 Permit from the USACE, including a 404 wetlands delineation.
2) A1600 Series Streambed Alteration Agreement from CDFG.
3) A Mining Lease and Boundary Delineation finding from the State Lands Commission.
4) Modification of the Stanislaus County use permits for the mining operations.
5) A RWQCB 401 Water Quality Permit.
6) An Encroachment Permit from the Reclamation Board.
7) ESA consultations for Valley Elderberry Longhorn Beetle

5. MONITORING PLAN & PERFORMANCE MEASURES

A detailed project specific mitigation and monitoring program was developed as part of the EA/IS for the entire Mining Reach Project and is applicable to the Warner-Deardorff Segment No. 3 as the third element of that project. The firms Stillwater Sciences and McBain & Trush are the principle firms designing and conducting the monitoring for the restoration projects. The monitoring plan developed in 1998 is found in Attachment No.7. Table 1 summarizes the general aspects of the monitoring plan based on specific sized hydrologic events. The monitoring program outlines actions for specific flow events to evaluate fluvial and other riverine processes. The actual time period when these events occur will be random due to the variable nature of the watershed hydrology. Capturing these events will require short turn around time and flexibility by those conducting the monitoring. Therefore, the post project monitoring program needs to cover a longer time period than the initial project funding cycle. The District anticipates fluvial and riverine process monitoring will be incorporated into the long term fishery monitoring for the Don Pedro Project. The District will seek added funding in subsequent years to cover these extended monitoring costs. The monitoring plan in Tables 1 and 2 submitted with for this project was developed from the EA\IS for the Mining Reach Project and is principally focused on salmon survival and related geomorphic and instream salmon habitat conditions. The TRTAC will be asked to expand the long term monitoring program for the Mining Reach Project to include more riparian forest ecology. Additional funding will be sought for these monitoring costs and Stillwater Sciences and McBain & Trush will be asked to develop the expanded habitat monitoring plans.

Table 2 outlines the monitoring and data collection that will be used in all four segments of the Mining Reach to evaluate the restoration activities. These monitoring activities can be grouped into three basic areas. In addition, the Adaptive Management Forum Report for the Tuolumne River, Section 4.4 identifies potential areas where experiments, particularly for riparian vegetation ecology, could be incorporated into the project and associated monitoring program. Some of these recommendations have already been incorporated into the revegetation plans for the upstream 7\11 and MJ Ruddy projects and will be repeated in the Warner-Deardorff Project. The firm H.A.R.T. INC., which also supplies the plants and the revegetation design, will conduct these revegetation experiments.

1. Physical & Geomorphic Processes:
   Pre and post construction changes will be documented and compared with as-built engineering drawings. This assures that the desired channel contours and cross sections were built as designed and can be used to assess future geomorphological changes after major flood events. Permanent survey benchmarks are being established throughout the project to facilitate monitoring. Tracer rock studies will be used to monitor bedload movement and verify estimates of sediment transport developed from pre-project monitoring studies. Bed load sampling results from other restoration projects and Don Pedro Project fishery studies will be used to evaluate sediment transport within the project. For a complete description of the monitoring program please see Stillwater Sciences (1998) attached to this proposal.

2. Riparian habitat:
   Revegetation will require annual inspections during the first few years to confirm survival of planted materials, perform replanting if deemed necessary, and to assess natural changes in the vegetation mix. Monitoring vegetation would then be reduced to evaluations after significant flood events. The revegetation design uses 50-foot wide (0.04 acre) hexagonal planting modules that are designed to facilitate monitoring because the center point for any "hex" can be relocated at a later date from the as-built drawings to allow for post project monitoring. There are 18 different hexagonal planting units classed by predominant vegetation type. These planting units are grouped together to recreate the diverse mosaic patches and strings of vegetation found on undisturbed areas of the Tuolumne. Several of the Forum experimental opportunities are already part of the riparian planting plan, and are

currently set up on the upstream 7\11 and MJ Ruddy segments of the Mining Reach. See Attachment No 3.Bank planting areas on both the benches and in the anti stranding channels are planned to test natural recruitment under differing topographic and water table regimes. Within this area there will also be piezometers with continuous stage recorders to monitor the water table fluctuations. There are two planting blocks with no understory planting; one uses cuttings and the other uses container stock to test survivability between the two methods. The benches on the north side of the channel will not have topsoil and natural recruitment in course materials will be evaluated. These experimental elements are not included in the more general project wide monitoring plan in Tables 1 & 2.

3. Fishery Resources changes:
This will involve evaluation of pre and post project changes in habitat conditions and populations for both fish predators and all life stages of salmon. Monitoring criteria would include items such as flow velocity, temperature, comparisons of estimated transit time through the old vs. new stream channel, combined with sampling observations of fish populations and spawning riffle conditions and habitat utilization. Temperature and production models, previously developed for the Tuolumne River as part of the FERC riverwide monitoring program, will be used in the fishery habitat evaluations. This portion of the monitoring focuses on changes in fish habitat with the implicit assumption that improvements in habitat quantity and quality correlate with increased productivity and survivability of the fall run salmon. The Don Pedro Project monitoring program conducted by the District focuses on overall fish population dynamics and ecology, and includes continuous temperature recording, seining, invertebrate sampling, and rotary screw trapping in addition, information is gathered on fry and smolt salmon habitat use and population distribution during out migration periods.

Pre project monitoring started in 1998 to provide two seasons of baseline conditions for project evaluation. When higher river flows were available bedload transport sampling was conducted in March 2000 under separate TRTAC funding and the results will be applied to refining the physical process monitoring. Gravel permeability studies were conducted in 2001 and 2002 in conjunction with emergent fry survival studies. Post project monitoring will start after the completion of the 7\11 Segment No. 1 and will progressively increase in aerial extent as more segments are restored. The project specific monitoring was designed to compliment and not duplicate the riverwide fishery monitoring requirements required in the FERC Settlement Agreement (FSA). Annual project monitoring summaries will be provided to the TRTAC.

The first level of peer review for monitoring comes from the biologists that make up the regular representation on the TRTAC. There is a Monitoring Subcommittee of the TRTAC charged with close technical review of the FSA and project specific monitoring. The firms of Stillwater Sciences and McBain & Trush provide technical design of monitoring programs and analysis of the results. Outside peer review of the TRTAC monitoring programs took place in December 1998 when the UC Davis Centers for Water and Wildland Resources prepared a peer review evaluation of competing fry and smolt survival methods currently used on the Tuolumne River. The June 2001 Adaptive Management Forum sponsored by AFRP and UC Davis - Center for the Environment has also provided peer review comments for the monitoring associated with the conceptual models developed for the projects.

6. DATA HANDLING & STORAGE

The project elements to be monitored are shown in Table 1. Table 2 summarizes the general hypothesis, monitoring parameters, and data evaluation approach for each parameter that will be in the project specific monitoring program for the Mining Reach Project. Reports and analysis will be prepared by the firm contracted to conduct the monitoring and these will be submitted to the TRTAC for review. These monitoring reports will be part of the annual Status Report submitted to FERC along with the associated riverwide monitoring conducted by the Districts. Copies of project related monitoring reports would also be submitted to the CALFED funding administrator as part of the deliverables under the CALFED contracts.

7. EXPECTED PRODUCTS & OUTCOMES

The Warner-Deardorff Segment No. 3 is full-scale implementation of a restoration project that entails easement acquisition, permitting, construction, and post project monitoring. In addition to the project related monitoring in outlined in Section 5, the typical deliverables for the actual construction include engineering design drawings (partially funded under the prior PSP for the MJ Ruddy Segment No. 2), construction bid specifications, biological surveys and associated permits from the regulatory agencies, appraisals for land acquisition and conservation easements, and recorded easement documents.

Completion of the restoration construction, including the riparian revegetation of the project area, will be the primary physical product from this project. Evidence of project functional success will be shown if monitoring confirms desired fluvial and geomorphic processes occur in the restoration area during the intended flow event. An indication of success for fishery related processes include estimates of increased numbers of redds and other improvements in spawning & emergence related activities.

8. PROJECT SCHEDULE

The project timeline in Attachment No. 5 shows the schedule of major activities for the Warner-Deardorff Segment in relation to the four Mining Reach Projects. Preliminary design and permitting work started on this project in June 2000 as part of the design and permitting already funded for the upstream MJ Ruddy project. Directed action under this PSP will fund pre project monitoring and ROW acquisition in 2003 and construction starting in spring 2004. A delay in funding or development of a cooperator agreement with the funding administrator can have serious impacts on construction. There is a limited period between 1 June and 30 September when inchannel restoration work is allowed by the regulatory agencies. All the Rights-of-Way and permitting must be completed prior to the start of construction and the design work must proceed these two tasks.

TABLE 1 Mining Reach Monitoring Elements: schedule based on a sequence of hypothesized flows.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Hypothetical annual peak discharge in cfs		***3650***	***7280***	***2980***	***1200***	***10400***	***8010***	***6870***		
CONSTRUCTION	PHASE I	PHASE II	PHASE III	PHASE IV						
MONITORING ELEMENTS										
PHASE I										
GEOMORPHOLOGY	Pb	ab,rx	n, rx, xs, thal			rx*, xs, thal	xs, thal	xs, thal		
FISHERIES	Map	map, sss	Sss	sss	sss	Sss	sss	sss#		
RIPARIAN		ab, pp, $	bio, $	pp	pp	Bio	pp, bio			
PHASE II										
GEOMORPHOLOGY	pb		ab, n, rx, thal			rx*, xs, thal	xs, thal			
FISHERIES		map	map, sss	sss				sss#		
RIPARIAN			ab, pp, bio, $	$	pp	pp, bio	bio	pp, bio		
PHASE III										
GEOMORPHOLOGY	Pb			ab, rx, thal		rx*, n, xs, thal	xs, thal	xs, thal		
FISHERIES			Map	map, sss	sss			sss#		
RIPARIAN				ab, pp, $	$	pp, bio	pp, bio	bio	pp	
PHASE IV										
GEOMORPHOLOGY	Pb				ab, rx	rx*, xs, thal	n, xs, thal	xs, thal		
FISHERIES				map	map, sss	Sss		sss#		
RIPARIAN					ab, pp, $	$	pp	pp		pp

<u>Geomorphology symbols</u>: pb = pre-built channel topography; ab = as-built channel topography; n = Manning's "n" hydraulic calculation; rx = bed mobility with tracer rocks; thal = channel vertical adjustment with thalweg profile; xs = channel planform adjustment with cross-section profiles; * = bed mobility observed; Fisheries <u>symbols</u>: ef = bass abundance by electrofishing; sv = smolt survival estimate; map = habitat mapping; sss = annual spawning and seining surveys; # denotes that spawning surveys will occur annually by CDFG <u>Riparian symbols</u>: pb = pre-built vegetation; ab = as-built vegetation; pp = project performance plots; bio = bioengineered bank protection; $ = last year of irrigation

TABLE 2 Turlock Irrigation District AFRP – CALFED Project Monitoring Plan Summary

Project: Tuolumne River -- Warner / Deardorff Segment of Mining Reach 20 Sep 01

Summary of Ecological & biological objectives, hypotheses, and monitoring parameters and approaches:

1) Objective: Restore and increase habitat for natural salmon production			
Hypothesis	Monitoring Parameter	Data Evaluation Approach	Comments
A. Restore alternate bar (pool riffle) morphology.	Pre vs. post construction and topographic changes.	Measure channel cross sections after construction from as-built drawings.	As-Built drawing becomes starting point for fluvial process monitoring.
B. Restore spawning habitat.	Area of riffles created from channel re-construction	Evaluate use during spawning period, redd counts, etc.	

2) Objective: Reconstruct a natural channel geometry scaled to current channel forming flows			
Hypothesis	Monitoring Parameter	Data Evaluation Approach	Comments
A. Geomorphological & fluvial process occur at channel forming flows (approx. 5,000 cfs)	Channel thalweg movement	Measure cross sections after flow events of predetermined magnitude.	Frequency of occurrence subject to random timing of flow events. Target three samples.
	Bed load mobility	Monitor movement of tracer rocks, D84 & D50 size, after flow events of predetermined magnitude.	
	Bed load mobility	Take surface pebble counts and subsurface bulk samples to evaluate size distribution.	
	Bed load mobility	Calculate effective Manning's "n" during flow events	
B. Floodway will convey design flow (15,000 cfs in this reach of the river) without damage.	Post event channel changes; particularly vegetation and project facilities.	Visually inspect after flow event.	Frequency of occurrence subject to random timing of flow events. Target three samples.
	Dike Maintenance & Operation Plan	To be developed by end of construction.	Coordinate with County SMARA reclamation plans

3) Objective: Restore native riparian plant communities within their predicted hydrological regime			
Hypothesis	Monitoring Parameter	Data Evaluation Approach	Comments
A. Composition and distribution of native riparian vegetation can be re-established.	Survival: 90 % 1st year, 70 % 2nd year, & 60 % 3rd year with 10 % increase in cover in same period.	Set up permanent plots to track survival. Evaluate vigor, size, species dominance, canopy coverage, etc.	Plants will be irrigated for year 1 & 2
B. Establish different plant series on appropriate reconstructed geomorphic surfaces.	Pre & Post construction vegetation mapping.	Up to 20 separate plant series (landscape types) will be used to re-create plant community diversity within floodplain.	Protection from beavers will be necessary.
C. Bio-engineering is effective bank stabilization	Survival of vegetation plantings.	Evaluate vigor, size, species dominance, canopy coverage, etc.	
	Stability of bank	Document changes in bank stability after specified flow events.	Frequency of occurrence subject to random timing of flow events. Target three samples.

4) Objective: Reduce salmon fish predator habitat			
Hypothesis	Monitoring Parameter	Data Evaluation Approach	Comments
A. Reduce potential to breach dikes and connect off-channel mining pits to the main river channel.	Pre vs. post project construction changes.	Measure channel cross sections after construction. Using as-built drawings and topographic and photogrametry data.	Proposed setback dikes are wider and higher than current dikes.

B. ECOLOGICAL & BIOLOGICAL BENEFITS

1. ERP GOALS and CVPIA PRIORITIES

The Mining Reach projects address the ERPP objectives and visions for the Tuolumne River Ecological Unit identified on pages 409 & 410 of the ERPP Vol. II. These include restoration of stream & riparian habitat; ecological processes; gravel recruitment, transport, and cleaning processes; a diverse self-sustaining riparian corridor; and predator reduction.

2. RELATIONSHIP TO OTHER ECOSYSTEM RESTORATION PROJECTS

The types of restoration projects along the 52 miles of the lower Tuolumne River are based on the anticipated fluvial & geomorphological processes and the fall run chinook salmon life stage associated with that reach of the river. The Habitat Restoration Plan developed by the TRTAC describes this in more detail with seven reaches and associated project types. The goal of the restoration projects is to have higher numbers of returning salmon combined with more stable levels of natural fall-run salmon production. This is to be achieved through improvements in spawning conditions in the upper reach of the river combined with increased and improved spawning areas and habitat in the Mining Reach area plus reduced predation in the SRP areas.

The Warner-Deardorff Segment No. 3 is the third of four segments in the 6.1 mile long Mining Reach Project. The projects in this reach are characterized by creating wider functioning floodplains and improved riffle pool channel forms that benefit fry and smolt survival and provide improved spawning areas. The floodplains also provide improved connectivity for riparian forest species. Downstream, at river mile 25.1 to 26.0, the TRTAC is sponsoring two predator isolation projects, SRP 9 & SRP 10. The principle focus of these projects is on improving survival of out-migrating salmon fry and smolts. Construction of SRP 9 was completed in December 2001, including the revegetation. The SRP projects involve refilling inchannel-mining pits to reduce the lake-like bass habitat and returning the channel to a pre mining riffle pool sequence with riparian planting on the recreated floodplain.

Upstream of the Mining Reach near La Grange, restoration projects focus on improving spawning conditions, including improvements in the quantity and quality of the spawnable gravels. The DFG has a multiphase gravel introduction project that started in 1999. The AFRP and CALFED have funded development of long-term course and fine sediment management plans for this area. A TRTAC sponsored project for long term aggregate acquisition to supplement restoration material was funded by CALFED as item No. 182 under the 2002 PSP.

In the Tailings Reach between the Mining Reach and the Spawning Reach, the Friends of the Tuolumne (FOTT) have acquired lands known as Bob Cat Flat and two riffle improvement projects at river mile 43 and 44 have been funded under separate PSP and 4-Pumps submittals. The project at RM 43 has 4-Pumps funding and will be administered by TID for the FOTT.

Downstream of the SRP projects there are riparian habitat projects like the Grayson River Ranch sponsored by the Friends of the Tuolumne and funded by AFRP and NRCS. The Stanislaus County Parks Department in conjunction with the cities of Modesto, Ceres, and Waterford are using the concepts and criteria developed in the Habitat Restoration Plan in the preparation of a comprehensive river parkway planning effort.

3. REQUEST FOR NEXT PHASE FUNDING

The Warner-Deardorff Segment No. 3 of the Mining Reach Project was originally submitted for the PSP 2001 funding cycle. The only portions of the project funded under the 2001 PSP were design, pre project baseline monitoring, permits, and appraisals. This Directed Action request is for funding to complete the easement acquisition in 2003 followed by construction and revegetation of the project in 2004. These two activities cannot be split because the Districts will not take on acquiring easements if there is not complete assurance the construction will be funded. The costs of the project are based on the recent costs for the SRP 9 project and the 7/11 Segment No. 1 project.

The status of the Warner-Deardorff Segment No. 3 is as follows. The design has proceeded to the preliminary stage and is out for review with the owners and mining company and permitting agencies. Preliminary special status species surveys have started and this will be used for the regulatory permits required for construction. Work has started on the appraisal background valuations and ROW (easement) mapping.

4. STATUS OF PRIOR CALFED-AFRP FUNDED PROJECTS

A) Mining Reach – 7/11 Segment No.1 (CF1997-M09): Construction started in April 2002.

B) Mining Reach – MJ Ruddy Segment No.2 (CF1999-F02): The engineering design drawings have been completed to the preliminary (90%) stage and are currently out for final comments. The special species surveys required for the regulatory permits have been started. Appraisal work has begun on the conservation easements. The preliminary design engineering for the Warner-Deardorff Segment of the Mining Reach was started with the MJ Ruddy Segment so that regulatory permits for both projects could be obtained simultaneously, saving approximately $80,000 in CEQA, NEPA, and permitting costs.

C) Special Run Pool 9 (CF1997-M08): The first of two years of pre-project monitoring was completed in the summer of 1999 and the project design was completed in late 2000. Construction of the SRP 9 Project was completed in December 2001.

D) Special Run Pool 10 (CF1999-F01): This project has three parts. During the construction of SRP 9, the breach in the dike separating SRP 10 and a large off-channel mining pit was filled in to eliminate a significant source of bass predation on juvenal salmon. Also a second year of the pre-project monitoring was performed on SRP 9 and SRP 10 under funding for the SRP 10 Breach Repair Project. In the 2001 PSP (CF2001-B201), only the design work for the full scale SRP 10 Project restoration was funded. Design work has started.

E) The Course Sediment Plan, Funded separately by AFRP (CVPIA 3406(b)(1) program), involving gravel quality improvements in upper reaches of the river near La Grange, started in October 2000. This project looks to identify the best places to increase supplies of course sediment in the upper reaches of the Tuolumne River and where to reduce the sources of fine sediment entering the primary spawning areas of the river. The work is approximately 60% complete. One outcome of this study was an aggregate acquisition and wetlands restoration project funded as CF 2002 - No. 182 under the PSP 2002.

F) The Fine Sediment Management Plan (CF2001-C208) is the companion project with the Course Sediment Management Plan. The work started in October 2001 and is progressing on schedule.

5. SYSTEM-WIDE ECOSYSTEM BENEFITS

The Mining Reach Project involves widening the channel to create a 500-foot wide riparian floodway. The Warner-Deardorff Segment work removes a major manmade constriction in the flow capacity of the river by allowing the channel to convey a flow of 15,000 cfs, up from the current capacity of 7,000 cfs. The maximum regulated release from Don Pedro is 14,500 cfs. Enabling these higher flows to be released without damaging the adjacent aggregate mining operations also allows a wider extent of periodic fluvial processes to occur over the entire 52 miles of river below La Grange Dam that cannot occur under current operations.

6. LAND ACQUISITION

There are four parcels that will be affected by this project. All four landowners signed "project concurrence" forms when the original PSP 2001 was submitted and these are on file with CALFED. These landowners were involved with the rest of the landowners in the Mining Reach that we have been working with since 1997. They also participated in the Public Outreach programs conducted in 1998. The portion of their lands covered by this project are covered under a pre-SMARA county use (mining) permit #1211, only a shallow portion of the 40 acres owned by the three Warner brothers was mined. This mined area now forms a pond that is the primary source of entrapment for out migration of salmon fry because the pond dikes are usually the first to breach in the Mining Reach. There are no orchards or other farmable agricultural lands involved in the Warner-Deardorff Segment of the Mining Reach Project. Mr. Deardorff has provided the District with proprietary information on the aggregate and mineral quantities and prices for his unmined portion of the project and these were incorporated in the project budget. Very recent mining on the Warner property adjacent to the pond area has revealed significantly larger quantities of aggregate will be involved in the acquisition of this property. The increased value has yet to be determined. It is highly dependent on the complex impacts of complying with Surface Mining And Reclamation Act (SMARA) regulations will have in determining how much could be mined. Mr. Deardorff has indicated that if the restoration project is not funded he will proceed to mine his portion of the project area in conjunction with another portion of his property that is to be converted to mining with in the next few years.

C APPLICANT QUALIFICATIONS

Since 1971, TID, MID, and CCSF have, in cooperation with DFG and USFWS, monitored river conditions and developed programs that enhance the natural production of fall-run chinook salmon in the Tuolumne River. The project manager for these activities has been TID.

1. TRTAC and Other Local Support for Project

The firm of McBain & Trush was retained in 1996 by TID through the TRTAC to develop an integrated, long-term salmon and riparian habitat restoration plan for the Tuolumne River below La Grange Dam using fluvial geomorphology principles. They prepared preliminary designs for specific restoration projects, which had been approved by the TRTAC participants as high priority projects.

2. Project Management

The Program Manager is Wilton Fryer, P.E. Mr. Fryer graduated from the University of California at Davis with a BS in Soil & Water Science, an MS in Irrigation Science, and later an ME in Civil Engineering with an emphasis in water resources. He is currently registered as both a Civil Engineer and an Agricultural Engineer. Accomplishments: Completion of the SRP 9 project and conduct of the Mining Reach 7\11 Segment No 1 restoration projects. Development and implementation of the Oakdale Irrigation District Irrigation Master Plan; Directed a $22 million canal rehabilitation project for OID where 54 miles of dirt canals were replaced with pipe; Development of the OID domestic water service system; Designer and project manager for a replacement water treatment plant for the TID La Grange Domestic Water System; Restoration program manager for TID since July 1996.

Tim Ford has been the staff aquatic biologist for both TID and MID since 1981. Mr. Ford graduated from the University of California at Davis with BS in Wildlife & Fisheries Biology in 1977. He worked as a Biological Technician for the Modoc, Tahoe, and Stanislaus National Forests prior to working for the Districts. Mr. Ford is tasked with planning, coordinating, and conducting the aquatic resources program for the Districts, and his responsibilities at TID include field studies, monitoring programs, program development, consultant supervision, and coordination with Don Pedro project operations. TID staff will provide contracting support and financial service support as needed.

3. Consultants

Consultants retained during the first phase of the Mining Reach and SRP 9 projects continue to be retained for subsequent phases of the projects to insure continuity in the design and analysis. The engineering firm of HDR Engineering, Inc. has been retained to prepare detailed construction plans and specifications, conservation easement related maps and documents, and oversee construction management. The firm of EDAW Inc. has been retained to perform the CEQA and NEPA environmental work, prepare biological surveys, and to obtain necessary State and Federal permits. The firm of HART, Inc., will provide revegetation design and the supply of native plant materials. The firm of Specialty Appraisals provides certified appraisals for acquisition of conservation easements. Cutler & Associates provides assistance with easement acquisition.

The firm of McBain & Trush has performed project concept design work, and will continue to provide oversight during the detailed civil construction design work, revegetation design and implementation, and fluvial process monitoring. McBain & Trush is a professional consulting partnership specializing in applying fluvial geomorphic and ecological research to river management and restoration, particularly in regulated river ecosystems. The principals on this project are Scott McBain, Dr. William Trush, and John Bair. Scott McBain is a hydraulic engineer and fluvial geomorphologist with an MS in Civil Engineering from the University of California at Berkeley. He specializes in effects of high stream flows on channel morphology, bedload transport, watershed sediment yields, and stream restoration. Dr. William Trush is an adjunct professor in the California State University Humboldt (CSUH) Fisheries Department, specializing in anadromous fish ecology, anadromous fish interactions with fluvial geomorphology, channel maintenance flows and hydrology, riparian ecology, and stream restoration and management. He is also Director of the CSUH Institute for River Ecosystems. John Bair is a riparian botanist with an MS in Environmental Systems from CSUH. He specializes in riparian interactions with geomorphic processes and riparian restoration.

Stillwater Sciences is a firm of biological, ecological, and geological scientists. The company specializes in the integration of biological and geomorphic information to understand critical ecological processes and identify effective measures for maintaining and restoring functioning ecosystems. In addition to expertise in fisheries and terrestrial resources, its founding members have over fifty years of experience in fluvial geomorphology, sediment transport engineering, and stream habitat restoration issues associated with large dams. Stillwater Sciences has worked directly with the Tuolumne River Technical Advisory Committee (TRTAC) and the Turlock and Modesto Irrigation Districts to implement the 1995 FERC Settlement Agreement monitoring program. Principle staff working on the project is Noah Hume, PhD, with over site by Dr. Peter Baker. Dr. Hume has over 15 years experience as an aquatic ecologist and environmental engineer working on projects emphasizing water quality and supply as it relates to fish population and composition.

D. PROJECT BUDGET

The total project cost is estimated to be $10,673,000. Approximately 73 acres of riparian floodway with an improved riffle-pool sequence in the adjacent river channel will be created in this 1.2-mile long segment of the Mining Reach Project. The cost estimate is based on construction experience with two current restoration projects. There is over 500,000 cubic yards of imported fill in this project. ROW acquisition costs represent gross cost estimates to purchase the mining rights for all 73 acres subject to being mined under an old County Use Permit #1211 that predates SMARA regulations. The 35-acre Deardorff portion was never mined. In addition there now appears to be more material under the 40-acre pond than was originally anticipated and that could increase the overall budget. Application of current regulatory setbacks could reduce the amount of aggregate that would need to be paid for at full market value. . Determination of the extent that regulatory limitations might now apply is anticipated to complicate the valuation process, but has the potential to reduce the acquisition costs.

The project cost is high because large quantities of materials are required to re-establish the floodway across a portion of the 40-acre pond. There are cost vs. functionality tradeoffs that can be considered as the design is refined. Lowering the floodway bench to save materials results in more frequent inundation at lower flows. Such a change affects the effectiveness of the bank full channel design to achieve the desired fluvial processes. Changing the bankfull stage in turn affects the riparian forest species composition and creates more of a wetland habitat than was originally envisioned. With construction scheduled for 2004, it may be possible to have aggregate acquired under the CF 2002-No. 182 available for this project at a cost lower than shown in the engineers estimate.

The preliminary design of the Warner-Deardorff Segment No. 3 was integrated into the design work for the upstream MJ Ruddy Segment No. 2 to take advantage of reducing the environmental permitting costs by $88,000 and a potential to save an additional $35,000 in engineering costs, if the Warner-Deardorff funding came through in time to not have a break in the design work. To make that combination work, the TRTAC contribution of $40,000 shown in the 2001 PSP for the Warner-Deardorff project was added to the $75,000 TRTAC cost share already slated for the MJ Ruddy project under AFRP cooperator agreement #11332-9-J025. As a result there is no additional TRTAC cost share shown under this PSP.

The basic project component costs consist of $6,929,000 for setback levee construction and floodplain reconstruction, $607,000 for revegetation, a $754,000 construction contingency, $1,819,000 for mineral rights purchases, $83,000 for construction permits, $124,000 for construction management, $154,000 for project management, and $203,000 for project monitoring (geomorphic $107,000, fishery $35,000, riparian $61,000). The Districts will be contributing $40,000 to the monitoring and permitting costs under the MJ Ruddy Segment No 2 Project agreement with AFRP. The engineering estimate shown in Attachment 6 provides a better view of what goes into the project construction budget estimate than the CALFED budget table format.

E. LOCAL INVOLVEMENT

The parties most directly impacted by the proposed project are the four local landowners and the aggregate-mining operator, Santa Fe Aggregates. The TID staff and consultants started working with local stakeholders in 1997 and will continue to meet with the affected stakeholders to listen to and address their individual concerns. Recognizing those individual concerns, the landowners and the mining operators have been cooperative and supportive of the project. Periodic meeting were held with an executive committee of the landowners in the early stages of the Mining Reach Project. Typical discussions at those meeting included restoration project activities, terms and conditions in conservation easements, ROW appraisal processes, USFWS hazardous material surveys, project design issues, etc. More detailed meetings are now held with the owners within specific project segments.

Several outreach meetings have been held with City of Modesto and Stanislaus County public works and planning agency staffs starting in December 1998. The Stanislaus County planning department is also actively involved with the Project induced modifications to the mining reclamation plan boundary in the use permits for the mining operations in the project areas. The EA/IS for the four segments in the Mining Reach Project and Special Run Pools 9 and 10 went through a public hearing in June 1998. The comments received were addressed in the amended mitigation plan for the EA\IS. The final EA\IS was adoption in July 1999 and it outlines the mitigation and monitoring that are to be followed to minimize impacts associated with the restoration activities. There was also a public outreach workshop for the Habitat Restoration Plan attended by most of the landowners affected by the restoration projects. This workshop included presentations by TRTAC member groups and agencies. The following information is already on file with CALFED under the 2001 PSP for the Warner-Deardorff Project CF # 2001-C209: Copies of the notice letters for this phase of the project that were sent to the Stanislaus County Board of Supervisors and Planning Department during the 2001 PSP process and signed project concurrence statements from the owners affected by the project.

F. COMPLIANCE WITH STANDARD TERMS & CONDITIONS

Applicant is a public entity. The applicable PSP project group type is Public Works Construction. The applicant agrees to the terms and conditions of the 2002 Proposal Solicitation Package and intends to comply with those terms and conditions.

It is anticipated that private contractors will perform a majority of the public works construction effort. The applicant will be deferring the requirement for submission of bid & payment bonds until such time as each subcontract is sought and awarded and before any work under the subcontract is performed.

G. LITERATURE CITED

Habitat Restoration Plan for the Lower Tuolumne River Corridor (McBain & Trush 2000)

AFRP / CALFED Adaptive Management Forum: Tuolumne River Restoration Summary Report (AMF Summary Report, Stillwater Sciences 2001)

Trinity River Maintenance Flow Study (McBain and Trush 1997)

Tiered EA/IS Mitigated Negative Declaration – Gravel Mining Reach & Special Run Pools 9/10 Restoration and Mitigation Projects July 1999 (SCH#98052070)

Tuolumne River Floodway Restoration – Project Design Approach & Rationale (draft) (McBain & Trush)

Final 1998 Monitoring Implementation Plan for Tuolumne River SRP9 and 10, and Mining Reach Restoration Projects (McBain & Trush and Stillwater Sciences 30 July 1998)

Tuolumne River Restoration Project Monitoring – Special Run Pools 9 & 10 and Gravel Mining Reach 7\11 Phase (McBain & Trush and Stillwater Sciences June 1999)

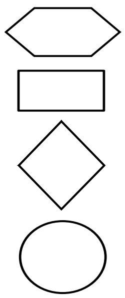
Submitted by:
TURLOCK IRRIGATION DISTRICT

By Wilton Fryer
Habitat Restoration Program Project Manager
Date: 30 September 2002

ATTACHMENT No. 1 – Conceptual Models

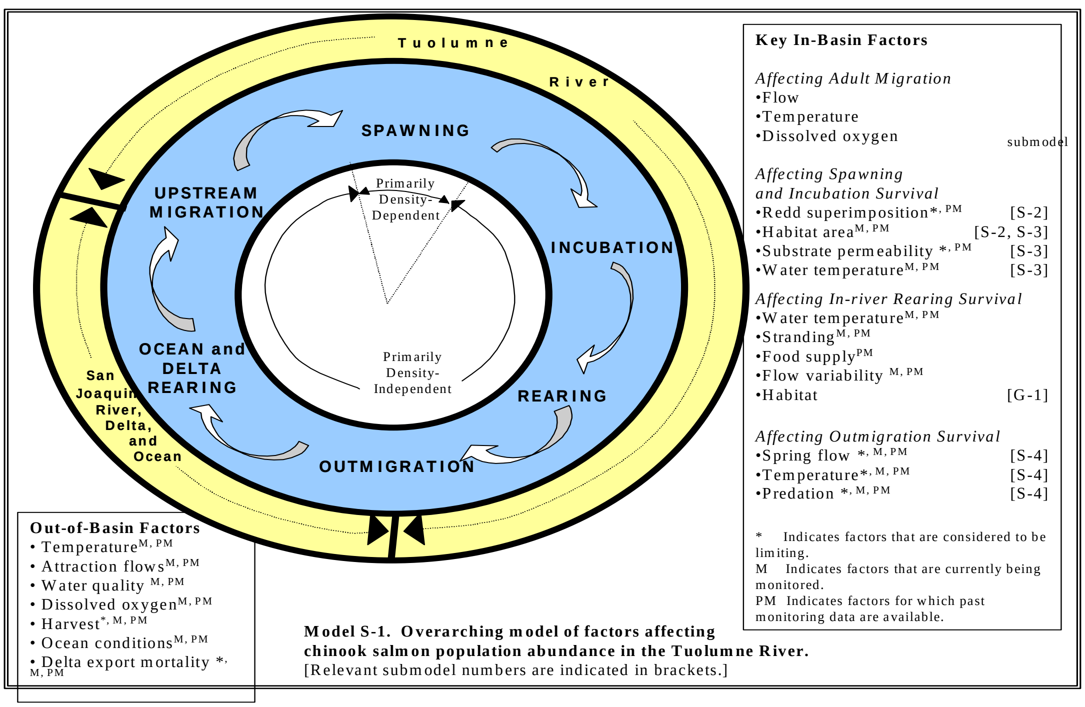
The models attached are grouped into the following categories:
S = Salmon life cycle and limiting factors models
G = Geomorphic process models
P = Project-specific models

The shapes used in the flowcharts signify the following:



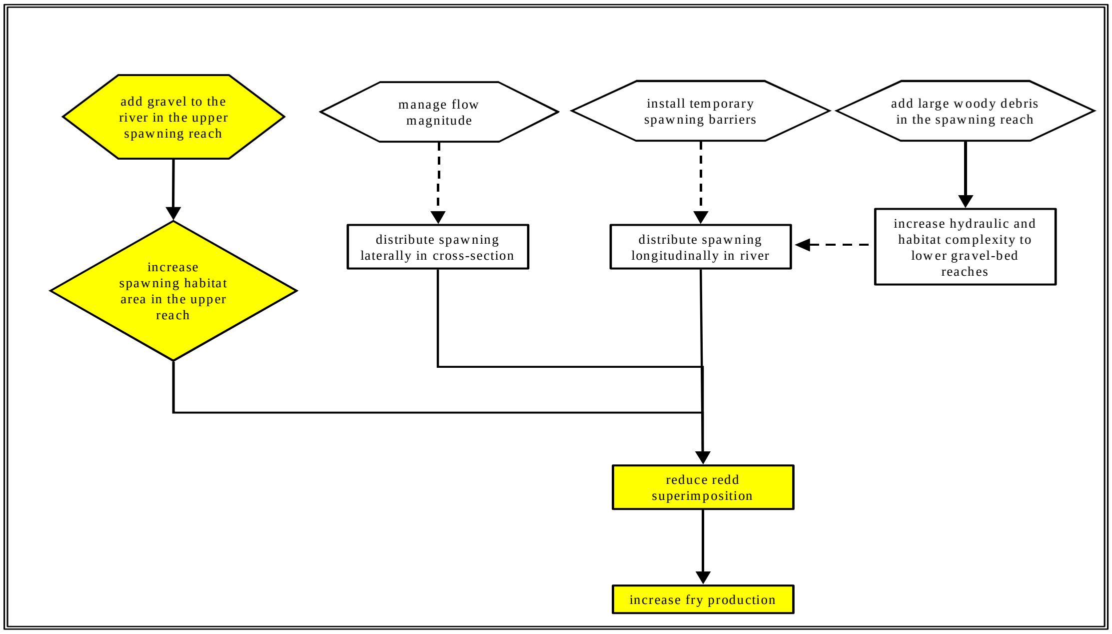
In the S and G models, shading indicates pathways that are being targeted by current restoration actions.

Dashed lines (around boxes or as pathways) indicate increasing uncertainty.

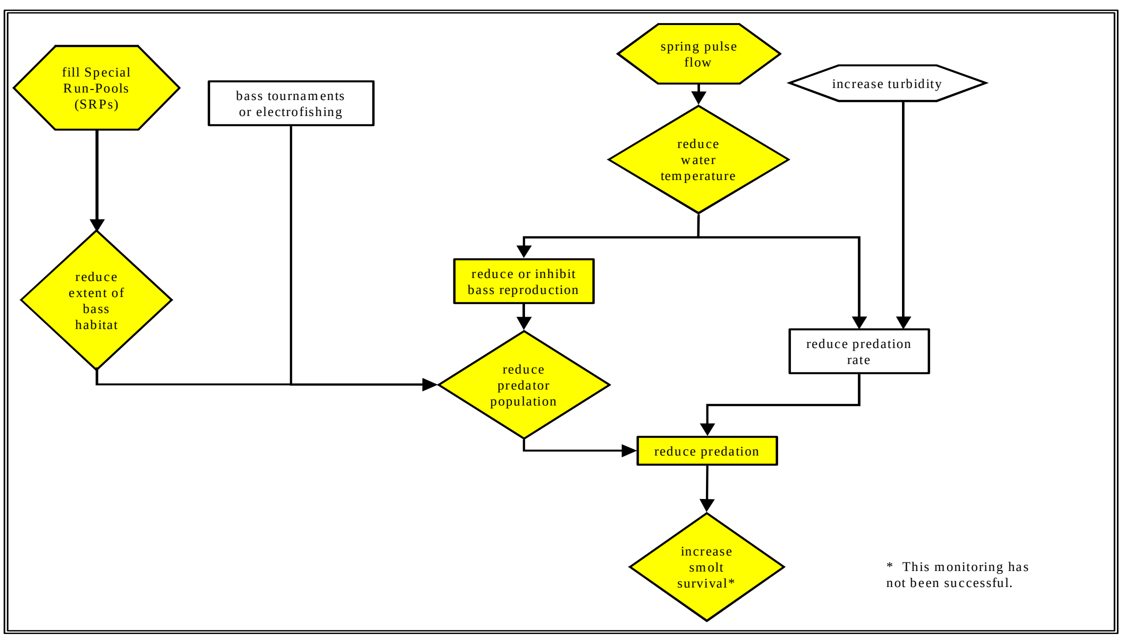


Model S-1. Overarching model of factors affecting chinook salmon population abundance in the Tuolumne River.
[Relevant submodel numbers are indicated in brackets.]

ATTACHMENT No. 1 – Conceptual Models

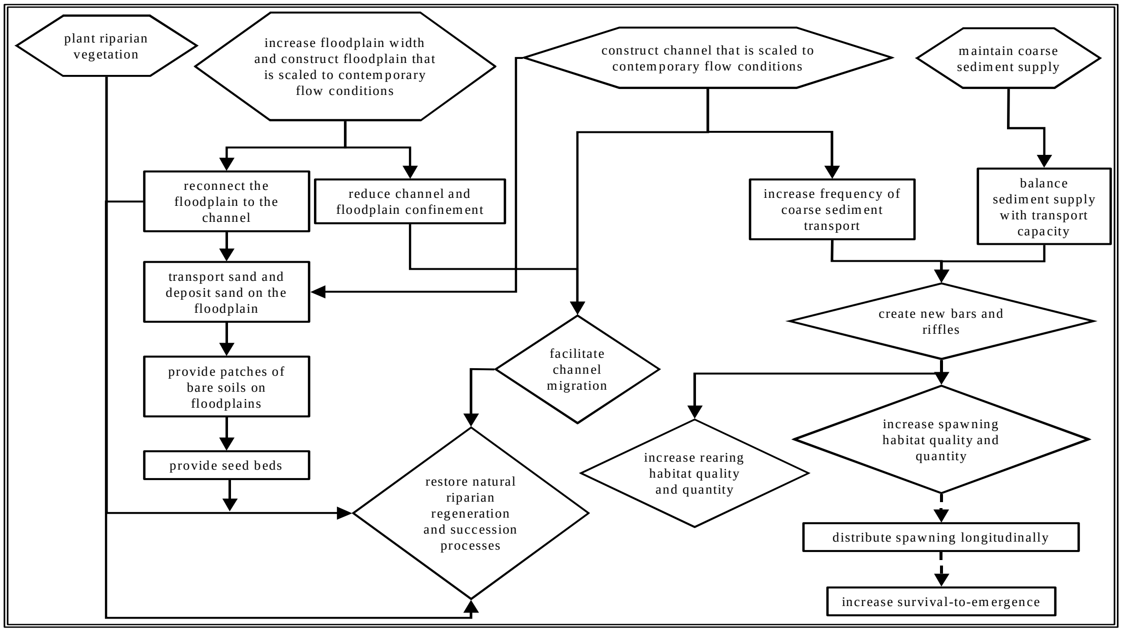


Model S-2. Potential alternative actions to reduce chinook salmon redd superimposition.

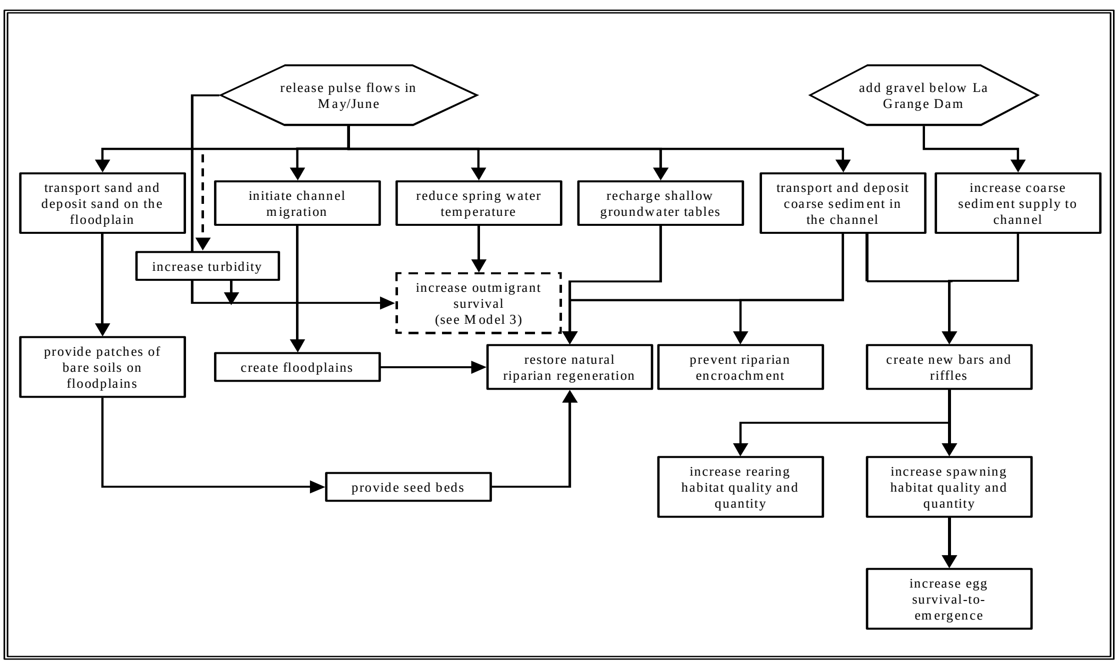


Model S-4. Potential alternative actions to increase juvenile outmigrant survival.

ATTACHMENT No. 1 – Conceptual Models

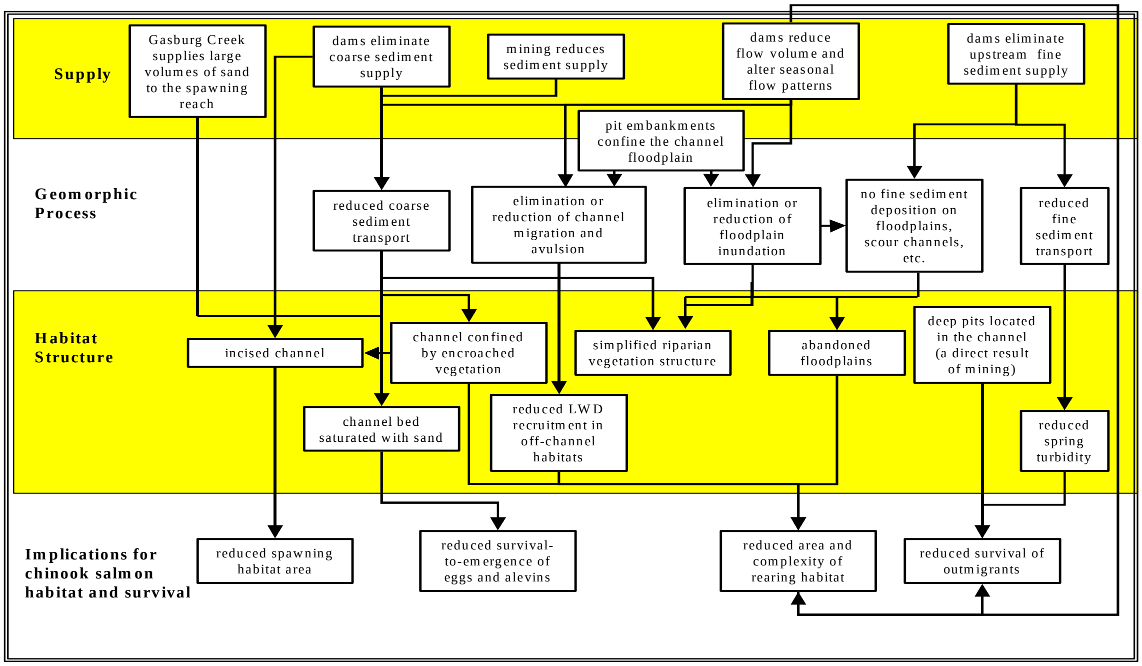


Model P-2. Effects of reconstruction of the Gravel Mining Reach on geomorphic processes, riparian vegetation, and chinook salmon survival.

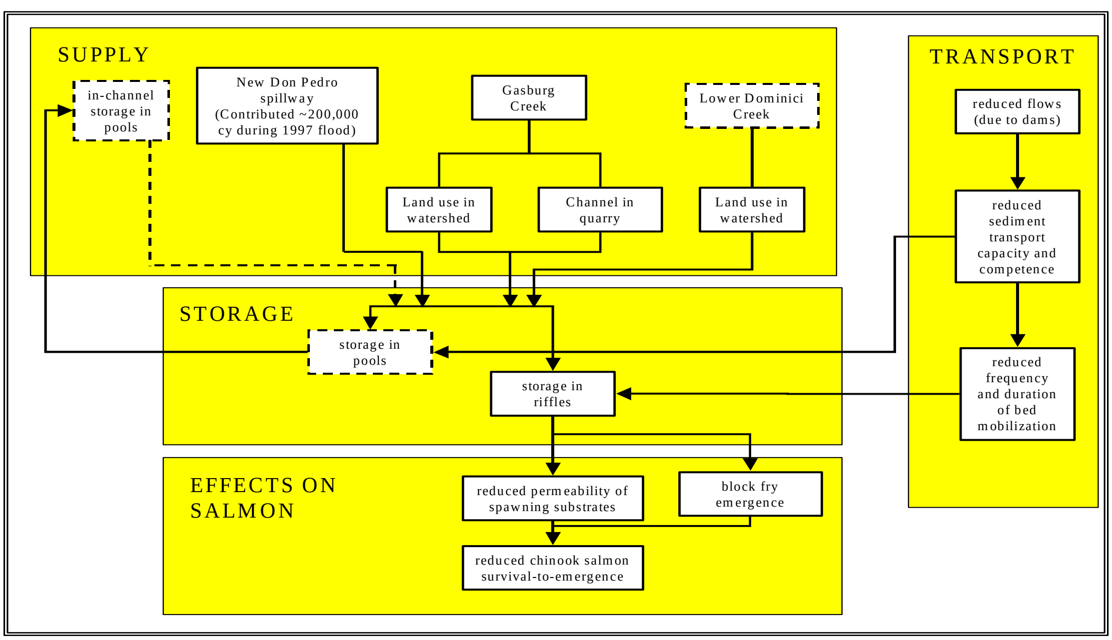


Model P-3. Effects of flow and coarse sediment management on aquatic and riparian habitat and chinook salmon survival.

ATTACHMENT No. 1 – Conceptual Models

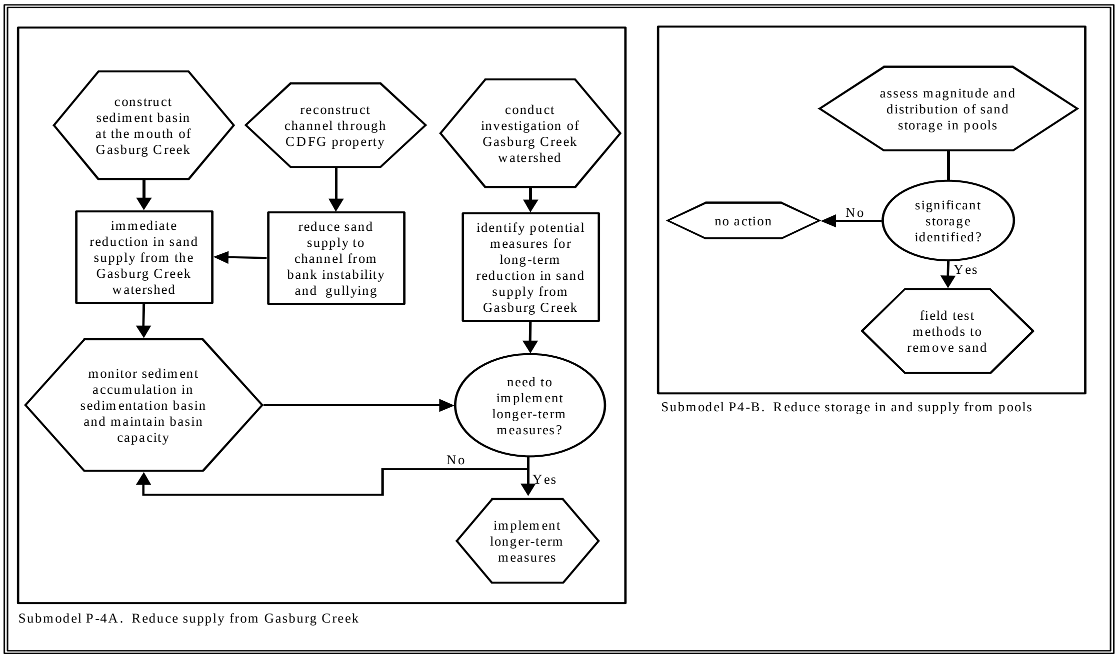


Model G-1. Overarching model linking the effects of dams and gravel mining to physical processes, habitat structure, and chinook salmon population response in the Tuolumne River.

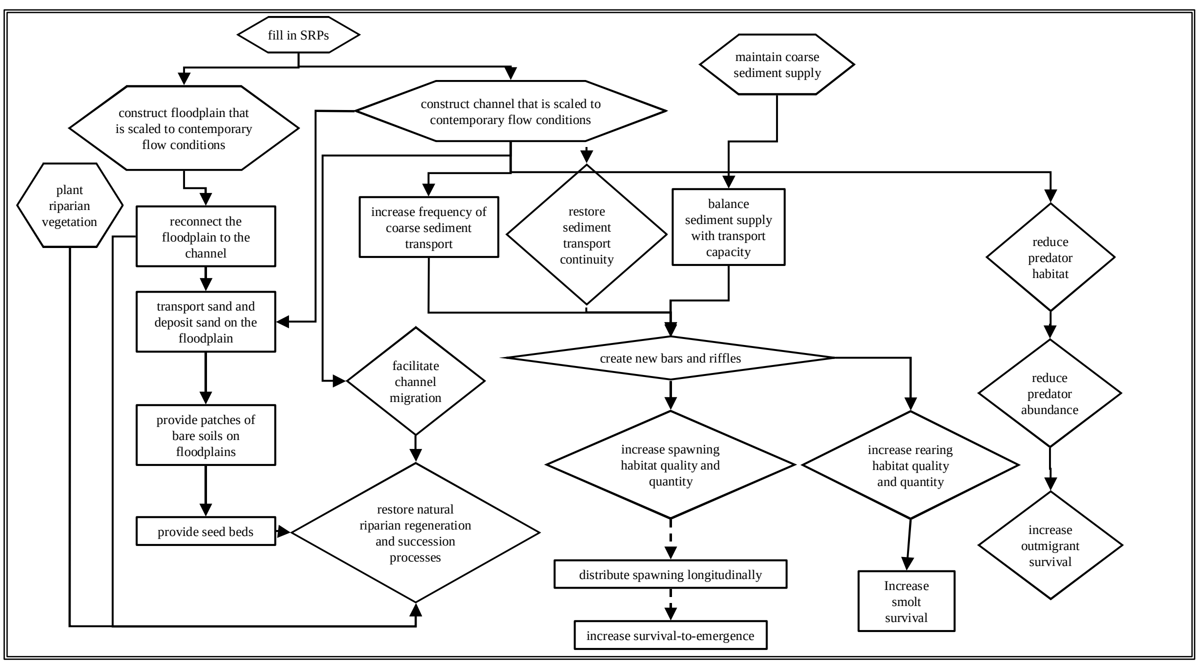


Model G-2. Fine sediment supply and storage and effects on chinook salmon survival in the Tuolumne River.

ATTACHMENT No. 1 – Conceptual Models

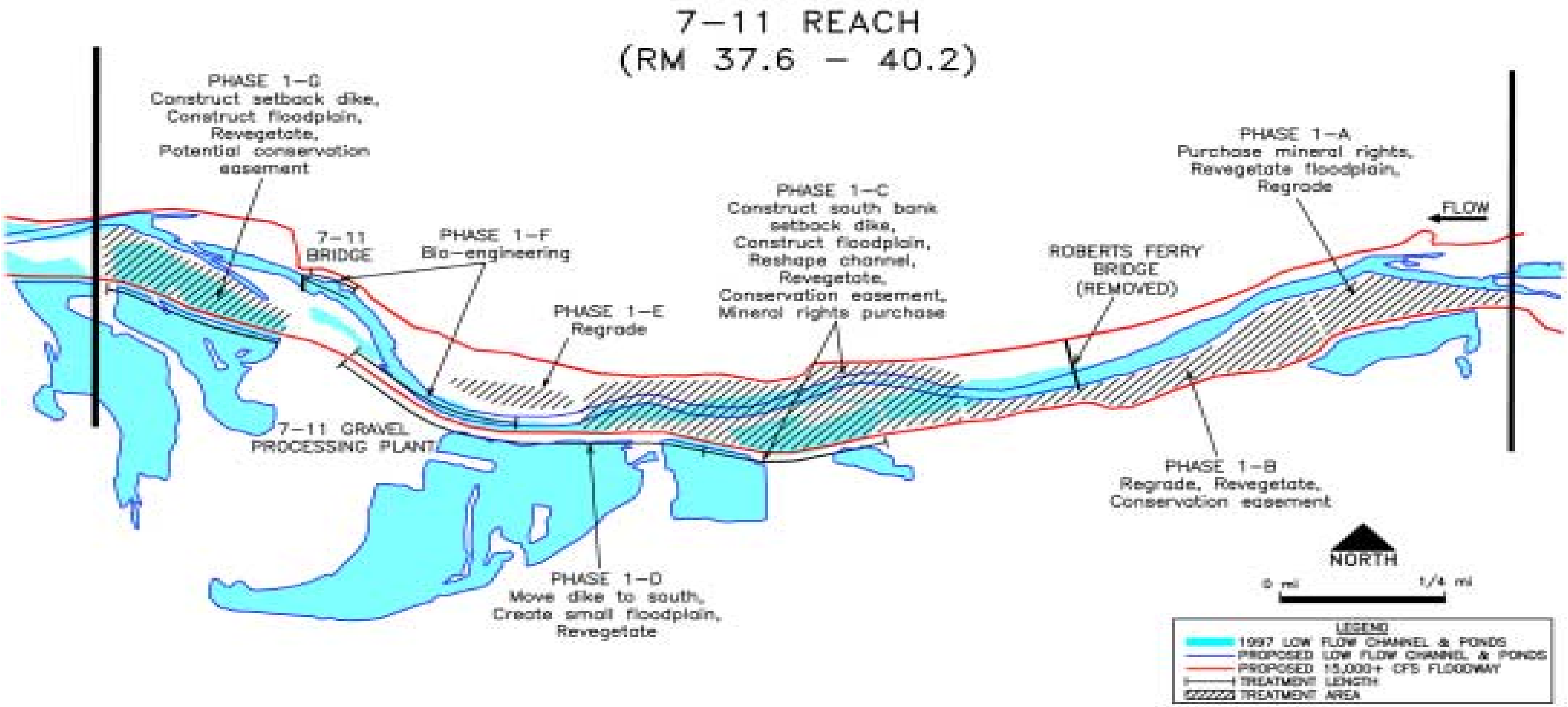


Submodels P-4A & P-4B. Measures to reduce sediment supply from Gasburg Creek reduce fine sediment storage and supply from pools.

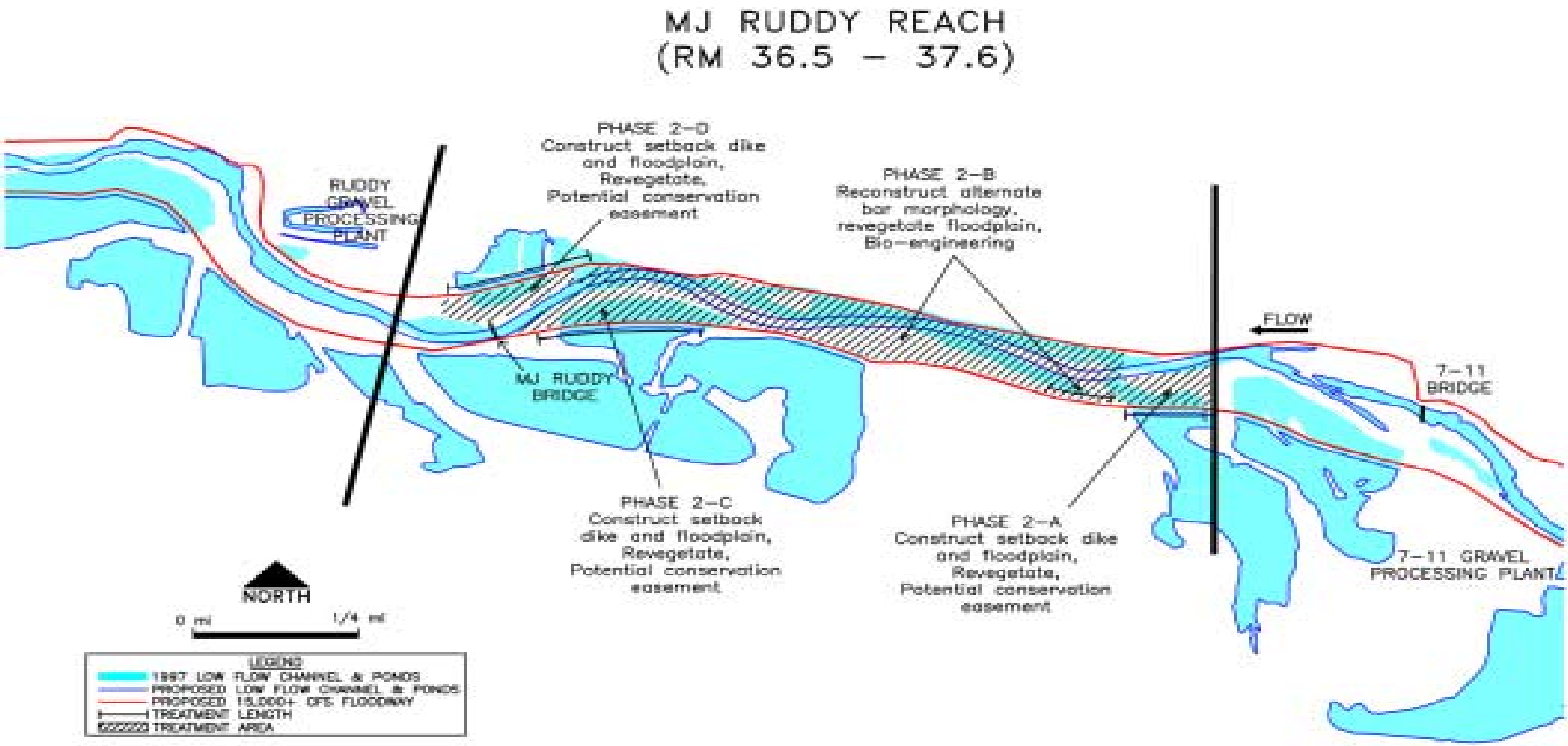


Model P-1. Effects of reconstruction of Special Run-Pools (SRPs) on geomorphic processes, riparian vegetation, and chinook salmon survival.

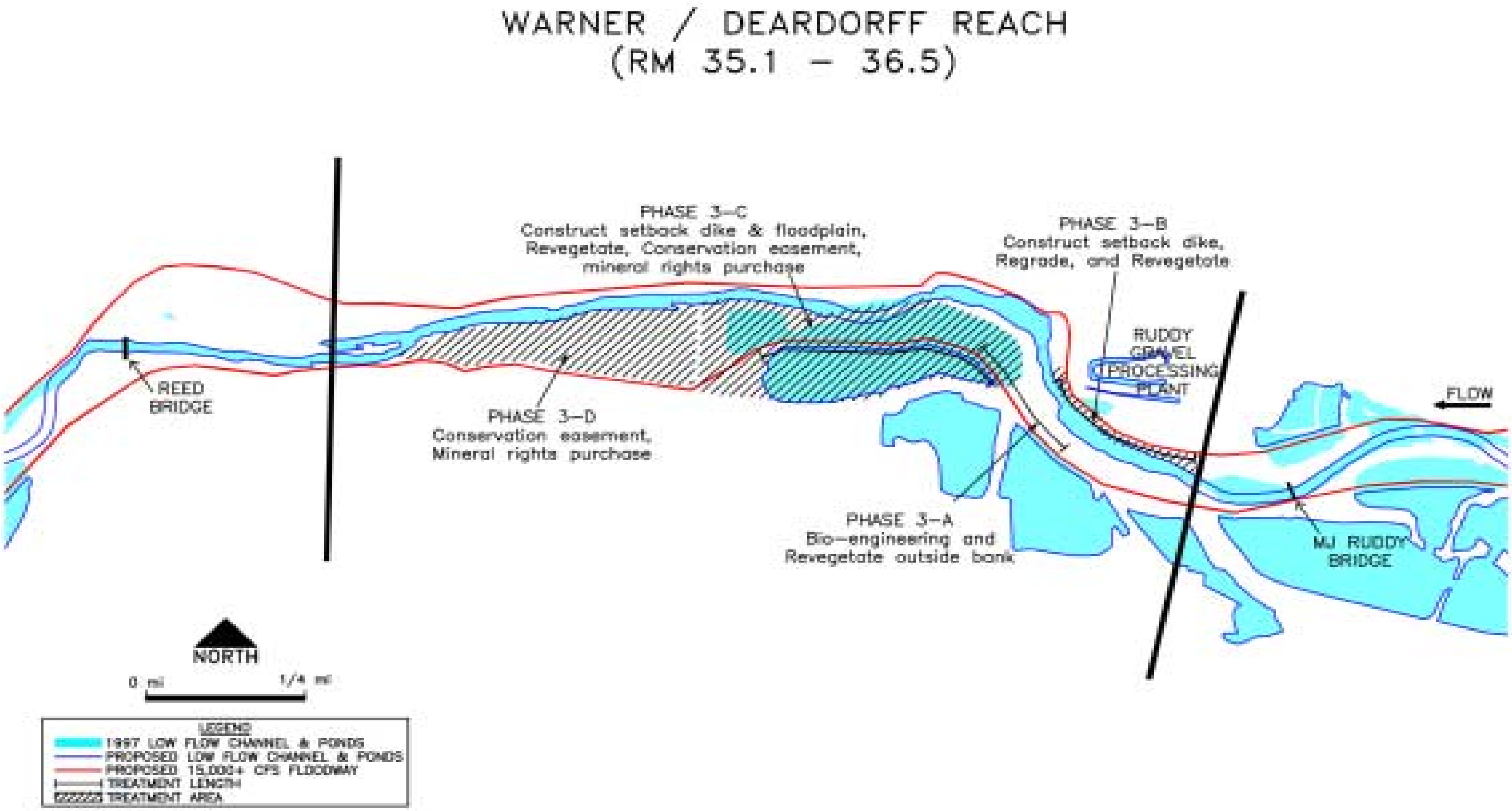
ATTACHMENT No. 2 – Mining Reach Project Maps – Segment No. 1



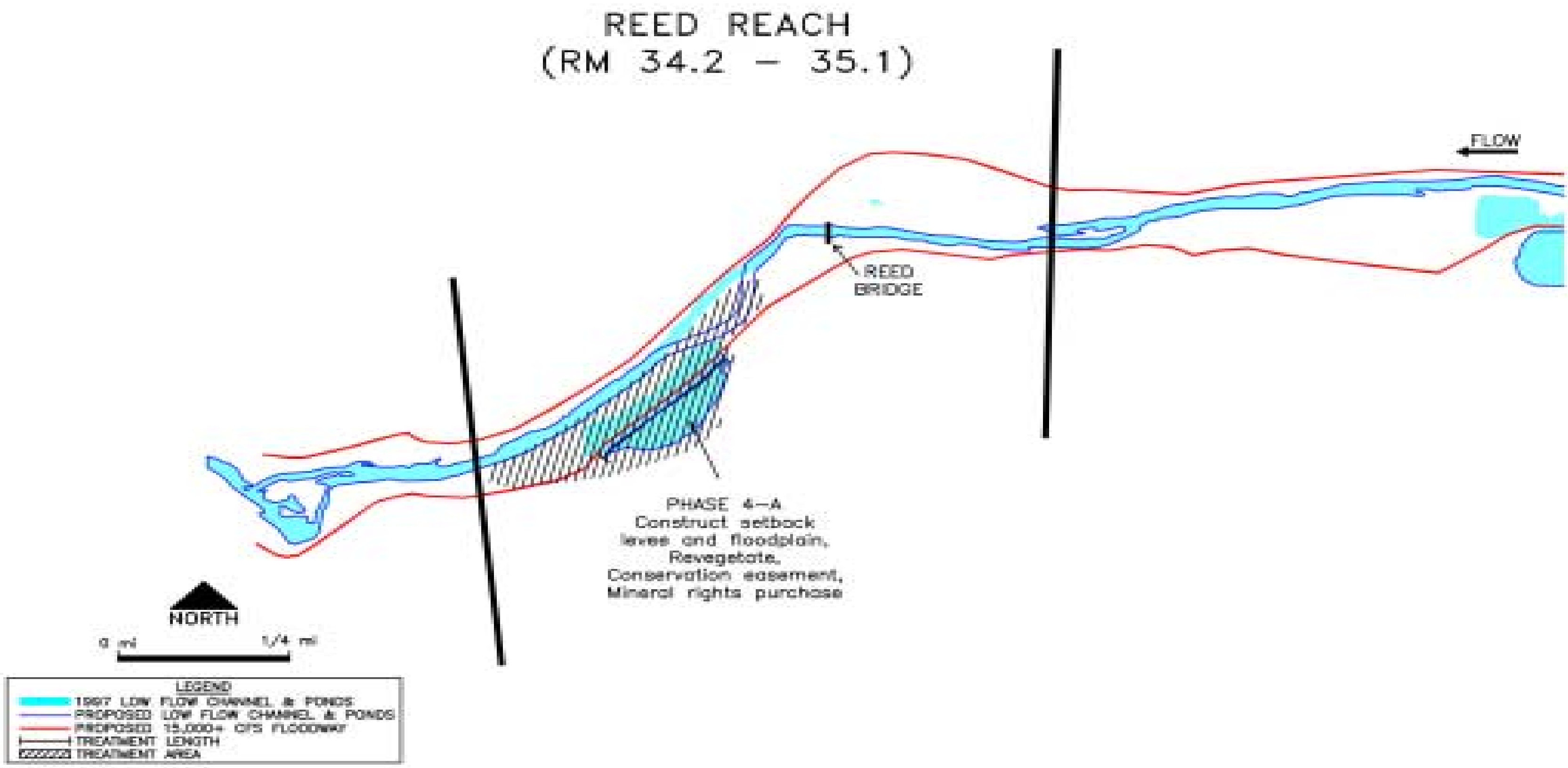
ATTACHMENT No. 2 – Mining reach Project Maps – Segment No. 2



ATTACHMENT No. 2 – Mining Reach Project Maps – Segment No. 3



ATTACHMENT No. 2 –Mining Reach Project Maps – Segment No. 4



Attachment 3. Typical Channel and Riparian Design

ATTACHMENT No. 4 – CHANNEL DESIGN PARAMETERS

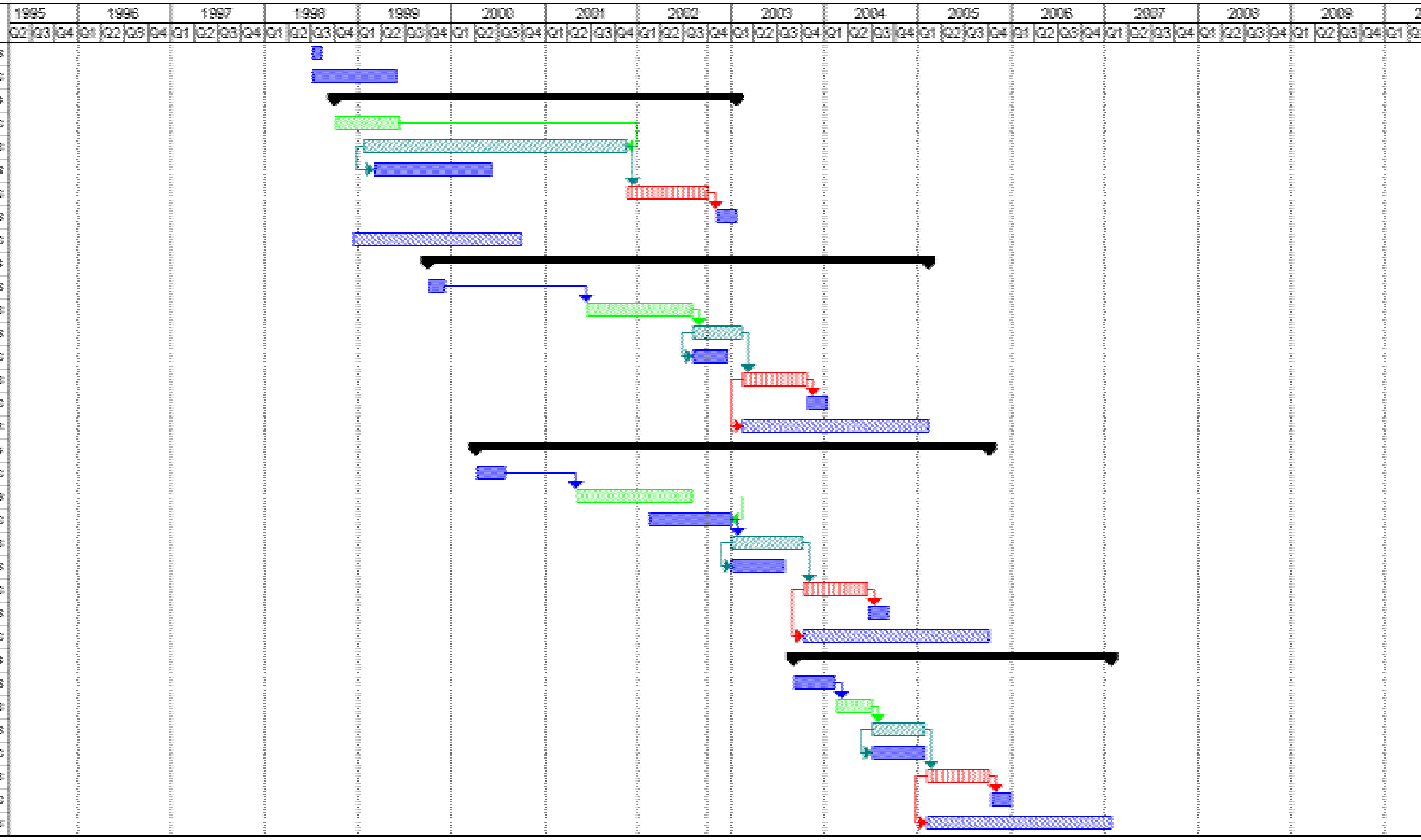
Proposed channel dimensions for Project Reach

Channel parameter	Dimension
Target channel morphology	Meandering with anti stranding channels
Existing channel alignment gradient	.0030
Design channel alignment gradient	.0023
Pre NDPP reservoir meander length	3,400 ft
Target design meander length	1,600 – 2,000 ft
Sinuosity	1.1 – 1.2
Pre NDPP Non regulated bankfull flow (2 year flood)	12,000 cfs
Design regulated bankfull flow (2 year flood)	5,000 cfs
Design maximum (D_{98}) particle size	6 in
Design maximum (D_{84}) particle size	5 in
Design bankfull channel width	175 – 200 ft
Design low flow (150 cfs) channel width	75 – 90 ft
Design bankfull channel maximum depth in riffles	6.0 ft
Design low flow (150 cfs) channel depth in riffles	0.5 – 1.5 ft
Design low flow (150 cfs) channel depth in pools	4 – 8 ft
Average spawning flow velocity	1.3 – 2.5 ft/sec
Average bankfull flow velocity	4 – 5 ft/sec

Source: (draft) Tuolumne River Floodway Restoration – Project Design Approach & Rationale – McBain & Trush

ATTACHMENT No. 5 – project Schedule

ID	Task Name	Duration
1	Hydraulic Design	6 wks
2	EA/IS	48 wks
3	**7/11 Segment**	**1127 days**
4	Design	36 wks
5	Easements	148 wks
6	Permits	66 wks
7	Construction	45 wks
8	Revegetation	12 wks
9	Monitoring	95 wks
10	**MJ Ruddy Segment**	**1399 days**
11	Funding	9 wks
12	Design	60 wks
13	Easements	28 wks
14	Permits	20 wks
15	Construction	36 wks
16	Revegetation	12 wks
17	Monitoring	104 wks
18	**Warner Segment**	**1437 days**
19	Funding Phase I	16 wks
20	Design	65.4 wks
21	Funding Phase II	45.8 wks
22	Easements	48 wks
23	Permits	30 wks
24	Construction	36 wks
25	Revegetation	12 wks
26	Monitoring	104 wks
27	**Reed Segment**	**898 days**
28	Funding	24 wks
29	Design	20 wks
30	Easements	30 wks
31	Permits	30 wks
32	Construction	36 wks
33	Revegetation	12 wks
34	Monitoring	104 wks



ATTACHMENT No. 6 – Engineers Estimate

Engineer's Opinion of Probable Cost - 30% Design
Turlock Irrigation District
Tuolumne River Restoration **Warner - Deardorff Segment No. 3**
Date - 7/17/01 – TDB HDR Engineering

Construction Costs			Imp. Length	1.2 miles	
Item	Description	Unit	Unit Price	Quantity	Item Price
1	Trench and Excavation Shoring	LS	8,400.00	0	-
2	Clearing and Grubbing	ACRE	2,500.00	38.71	96,775
3	Instream Imported Fill	CY	11.00	31,588	347,468
4	Imported Mass Fill	CY	10.00	334,819	3,348,190
5	Imported Topsoil Fill	CY	8.00	63,779	510,232
6	Onsite Cut/Fill	CY	5.50	219,633	1,207,982
7	Dike Embankment	CY	10.00	70,903	709,030
8	Construct Dike Patrol Road Surface - 4" Thickness	SF	0.40	0	-
9	Construct Waterside Access Ramp	EA	24,000.00	2	48,000
10	Construct Landside Access Ramp	EA	3,000.00	0	-
11	Slope Vegetated Rock Slope Protection	SY	80.00	1,889	151,120
12	Place 1/2 Ton Rock Slope Protection	TON	65.00	0	-
13	Place 25 lb Rock Slope Protection	TON	65.00	0	-
14	Construct New Pipe Gate	EA	4,000.00	2	8,000
15	Construct Monitoring Survey Benchmarks	EA	500.00	6	3,000
16	Remove Miscellaneous Debris from Stream	LS	15,000.00	1	15,000
17	Remove Existing Barbed Wire Fencing	LF	4.50	200	900
18	Construct Barbed Wire Fencing	LF	4.50	0	-
19	Protect Existing Trees in Place (Misc. Costs)	EA	100.00	19	1,900
20	Tree Removal	EA	600.00	25	15,000
21	Protect Existing Irrigation Piping In Place	LS	2,000.00	1	2,000
22	Remove Existing Irrigation Laterals	LS	7,500.00	1	7,500
23	Scarify Existing Grade Terraces	ACRE	600.00	50	30,000
	Subtotal of construction				6,502,000
24	Soil Moisture Station	EA	600.00	3	1,800
25	Planting Module Type 1 - Rush	EA	747.50	30	22,425
26	Planting Module Type 2 - Sedge	EA	201.00	72	14,472
27	Planting Module Type 3 - Mugwort	EA	144.00	19	2,736
28	Planting Module Type 4 - Wild Rose	EA	201.00	45	9,045
29	Planting Module Type 5 - Blackberry	EA	207.00	17	3,519
30	Planting Module Type 6 - Lupine/Blazing Star	EA	624.00	0	-
31	Planting Module Type 7 - Elderberry	EA	202.00	34	6,868
32	Planting Module Type 8 - Arroyo Willow	EA	213.00	42	8,946
33	Planting Module Type 9 - Mulefat	EA	190.00	0	-
34	Planting Module Type 10 - Button Bush	EA	236.00	9	2,124
35	Planting Module Type 11 - Alder	EA	276.00	109	30,084
36	Planting Module Type 12 - Red Willow	EA	256.00	34	8,704
37	Planting Module Type 13 - Shining Willow	EA	256.00	25	6,400

38	Planting Module Type 14 - Black Willow	EA	288.00	67	19,296
39	Planting Module Type 15 - Mixed Willow	EA	299.00	33	9,867
40	Planting Module Type 16 - Cottonwood	EA	288.00	86	24,768
41	Planting Module Type 17 - Mixed Cottonwood	EA	311.00	162	50,382
42	Planting Module Type 18 - Ash / w/o Boxelder	EA	294.00	100	29,400
43	Planting Module Type 19 - Western Sycamore	EA	299.00	29	8,671
44	Planting Module Type 20 - Mixed Valley Oak	EA	311.00	382	118,802
45	Furnish and Install Beaver Protection	EA	50.00	1,078	53,900
46	Hydroseeding (Native Grass Species)	ACRE	2,000.00	3.9	7,800
47	Irrigation (1 Years Post Construction)	LS	160,000.00	1	160,000
48	Dewatering	LS	-	0	-
49	Silt Fence	LF	0.90	7,300	6,570
	Subtotal of revegetation				607,000
	Rounded Construction Subtotal				$ 7,109,000

General Contractor Indirect Costs

Construction Management (Contractor)	Percent	1.00%	$ 7,109,000	$ 74,090
Insurance and bonds	Percent	3.40%	$ 7,109,000	$ 241,706
Job Cleanup/Closeout	Percent	0.30%	$ 7,109,000	$ 21,327
Mobilization	Percent	1.25%	$ 7,109,000	$ 88,863
	Rounded Subtotal			$ 427,000
	Total Construction Costs			$ 7,536,000
	Contingencies		**10%**	$ 754,000
TOTAL CONSTRUCTION COSTS WITH CONTINGENCIES				$ 8,290,000

Other Project Costs

Right-of-Way Acquisition	Acres	$ 1,000	73.1	$ 73,100
Right-of-Way Acquisition	Acres	$ 15,000	5	$ 75,000
Mineral Rights Acquisition	LS	$ 1,671,000	1	$ 1,671,000
		Rounded Subtotal		$ 1,819,000

Final design from 30% to 100% inc bidding	Engineering/SDC	2.00%	166,000
	Permitting & ROW Services	1.00%	83,000
	Const. Services/Insp.	1.50%	124,000
	Project Mgt TID	1.75%	154,000
	Rounded Subtotal		527,000

TOTAL ESTIMATED PROJECT COSTS	$ 10,636,000

PROJECT MONITORING (Developed from EA/IS)

Geomorphic processes	$ 107,000
Fishery resources	$ 35,000
Riparian resources	$ 61,000
Rounded Subtotal	$ 203,000

PSP 2002 PROJECT TOTAL	$ 10,839,000

ATTACHMENT No. 7 – EA/IS Mitigation & Monitoring Program

FINAL 1998 MONITORING IMPLEMENTATION PLAN FOR TUOLUMNE RIVER SRP 9 AND 10, AND GRAVEL MINING REACH RESTORATION PROJECTS

Prepared for:

Tuolumne River Technical Advisory Committee
Monitoring Subcommittee
(Don Pedro Project, FERC License No. 2299)

Prepared by:

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July 30, 1998

1. INTRODUCTION

The SRP 9 and 10 and Gravel Mining Reach Channel Restoration Projects are proceeding to the implementation phase, with the SRP 9 and the Gravel Mining Reach Phase 1 (7/11) project reach projected to begin in late summer or fall of 1998. As required by the funding and permitting agencies, the ADraft Monitoring Plan for the Gravel Mining Reach and Special Run Pools 9/10 Restoration Projects≅ (Monitoring Plan, Attachment D of USFWS/TID 1998) was prepared to accompany the CEQA/NEPA Environmental Documentation and to outline objectives and general protocols for monitoring restoration project performance and mitigation success. First year (1998) monitoring will include biological and geomorphological baseline assessments. Tasks included in the baseline biological resources component are:

Estimate survival of juvenile chinook salmon migrating through SRPs 9 and 10 (currently underway under the purview of the USFWS-AFRP and TRTAC);

Estimate predator abundance (smallmouth and largemouth bass) in SRPs 9 and 10 and in reference sites; and

Map smallmouth bass, largemouth bass and chinook salmon habitat availability at SRPs 9 and 10 and in the Gravel Mining Reach Phase I (7/11) project reach.

Tasks included in the baseline geomorphic component are:

Establish locations of cross-section and long-profile endpoints; and

Establish pre-project conditions for channel migration/planform adjustment and channel aggradation/degradation by cross-section and longitudinal profile survey (either re-surveyed or by using survey data collected by KNS Surveying.

Because the last three water years were above average in runoff (Table 1), bass populations on the Tuolumne River may be suppressed below abundance levels detectable by methods proposed in the Draft Monitoring Plan. Additionally, streamflows are projected to remain above 500 cfs through July and August, 1998 which may challenge conventional sampling methods. Objectives outlined in the Draft Monitoring Plan for monitoring bass abundance thus warrant a pilot-level-investigation to determine if additional field work is needed and to determine which field methods may best be suited for addressing project monitoring objectives.

Habitat mapping is scheduled to proceed at SRP 9 and 10 and the 7/11 Phase of the Gravel Mining Reach in July/August 1998. Habitat mapping will also benefit from a concurrent pilot-level field assessment of the distribution and abundance of bass species within the mapped habitats.

Table 1. Water yield and water year classifications for the three previous years on the Tuolumne River. Water year classifications based on Tuolumne River Corridor Restoration Plan (McBain & Trush 1998).

We propose to combine the field components for the initial year of pre-project monitoring to reduce costs, increase efficiency of data collection, and share collective scientific expertise. This memorandum presents a strategy for field implementation of first-year monitoring objectives, provides budget allocations, and describes field sampling methods to meet the first year=s objectives outlined in the Draft Monitoring Plan.

2. MONITORING OBJECTIVES

Because the restoration objectives differed for the SRPs and the Gravel Mining Reach, the proposed monitoring objectives emphasized somewhat different monitoring protocols between the two sites. The SRP 9 and 10 project proposal hypothesized that restoring this reach would greatly reduce predator habitat and abundance, reduce the potential for bass predation on salmon, and increase salmon survival through this reach of river; the Draft Monitoring Plan proposed to assess predator abundance and juvenile chinook salmon survival, as well as mapping habitat availability as a second-tier objective. The Gravel Mining Reach project objectives placed greater emphasis on geomorphic aspects (expanded floodway, bedload transport, channel meandering), as well as improvements in chinook salmon habitat availability (chinook spawning and rearing); the Draft Monitoring Plan emphasized detailed cross section surveys (and other geomorphic protocols listed in the Draft Monitoring Plan) and habitat mapping to track changes in habitat quantity and quality, particularly for chinook salmon spawning and rearing habitat. The strategy outlined for year-1 implementation reflects the different objectives emphasized for each project reach.

In general, the questions driving our objectives are:

What effect does restoration in the SRP sites (i.e., reduction in available habitat) have on smallmouth and largemouth bass population abundance both in the restored sites, and in upstream and downstream reaches?

To what extent is chinook salmon and bass predator habitat availability altered through project implementation? Can habitat availability be objectively quantified and compared for pre- and post- restoration for these fish species?

Does restoring a more natural alluvial channel morphology (i.e., removal of levee confinement, restored low-water channel scaled to the contemporary flow regime, restored alternate bar, pool-riffle morphology, isolation of off-channel aggregate extraction ponds, etc.) and revegetated floodplains in the Gravel Mining Reach provide improved rearing conditions (increased availability and higher quality habitat) for juvenile chinook salmon and improved spawning conditions for adults?

Is predation by introduced bass species (and other species) a significant factor limiting juvenile salmon survival and recruitment?

2.1. PREDATOR ABUNDANCE AT SRP SITES

Objectives for predator abundance monitoring at the SRP sites include:

- estimate abundance of adult largemouth and smallmouth bass in SRPs 9 and 10, and in reference sites;
- document the distribution of adult bass species within SRP sites on habitat maps, and measure microhabitat features such as depth, velocity, substrate and cover associated with observed bass; Snorkel surveys may also include a cursory level evaluation of bass distribution at night to see how that compares to that observed in the day, depending on field conditions (flow conditions, visibility).
- compare pre- and post-restoration habitat availability for largemouth bass, smallmouth bass and chinook salmon;
- document incidental observations of other fish species within the SRP project reaches; and
- qualitatively assess foraging habits of predator species using gastric lavage during electrofishing surveys to get a rough estimate of salmon predation during the period of sampling. (Because surveys will be implemented in summer, this objective will not be achieved in 1998. However, this effort will occur in subsequent years if flow conditions during smolt out-migration are conducive to electrofishing the SRPs and reference sites).

Predator abundance monitoring attempts to assess changes in bass abundance resulting from the restoration project. The initial strategy proposed in the Draft Monitoring Plan was to survey SRPs 9 and 10 by electrofishing techniques to establish pre-project baseline conditions, survey an undisturbed SRP reference site (possibly SRP 7 or 8), and an additional reference site that resembles anticipated post-project conditions (site unspecified). Sampling methods to be tested this year include a multiple marked-recapture experiment over a several week period at one or two of the SRP sites combined with a multiple-pass depletion test on the last marked-recapture run, to obtain two separate abundance estimates. This first-year assessment will help direct sampling for predator abundance in subsequent years.

Two important points have been raised in reference to the proposed sampling design described above. First, the multiple-pass depletion method may not be successful in sampling entire SRP units due to their large depth and surface area, and sub-sampling may violate assumptions of the model, nullifying comparisons of the two methods. Additionally, uncertainty about fish abundance and their relative distribution within SRP sites may present additional sampling challenges. Second, recent and past years= high flows may potentially contribute to suppressed bass populations in the Tuolumne River. The Summer Flow Fisheries Studies (EA 1996) provide bass abundance data gathered by direct observation during summers of 1988-1994. Data from summer 1993 studies, (the only above-normal water year of the study) showed that estimated bass abundance was greatly reduced in 1993 compared to all other years of the study (Figure 9, Attachment 96-3.4; for example, bass decreased from 382 fish observed in 1992 to 27 bass in 1993, then rebounded to 423 bass in 1994). As shown in Table 1, WY 1995-97 were all above average in water yield. WY 1998 streamflows have also been above average, and are higher than any year of the Summer Flow Fisheries Studies. It is anticipated that flows will remain high (2,000-4,000 cfs) through June and remain higher than normal during summer months. These conditions coupled with potentially low bass numbers may further reduce the effectiveness of the proposed method. If this is the case, this monitoring objective should be re-evaluated to determine if redirection of monitoring funding is warranted.

2.2. HABITAT AVAILABILITY

The habitat availability component of monitoring will address the following objectives:

quantify habitat availability for specific life stages of largemouth bass, smallmouth bass and chinook salmon prior to restoration;

compare pre- and post-restoration habitat availability for largemouth bass, smallmouth bass and chinook salmon;

document the distribution of predator species within SRP units (this information is also useful to determine electrofishing methods); and
compare habitat preference criteria (depth, velocity, substrate and cover) reported in the literature for bass species to that measured in the field using direct observations.

Changes in the availability of fish habitat will be assessed by quantifying pre-and post-restoration conditions using plan-maps to delineate habitat boundaries for specific life stages of priority fish species. Priority species include largemouth bass, smallmouth bass and chinook salmon. Field maps will be produced from aerial photographs and topographic surveys obtained for the construction design phase of the restoration project. These maps will provide the physical template for delineating habitat boundaries for chinook salmon, smallmouth bass and largemouth bass. Identification of habitat boundaries will be based on specified criteria for species habitat preferences (Table 2). Habitat mapping for bass will focus on adult bass foraging habitat since this life stage has potentially the greatest impact to juvenile chinook salmon survival. In addition, chinook salmon spawning and rearing habitat will be mapped. For bass species, preference criteria will focus primarily on depth and cover preferences, and secondarily on velocity, substrate and other physical parameters. For chinook salmon, depth, velocity and substrate preferences will determine habitat boundaries . Maps with boundary delineations will be digitized into the Tuolumne River GIS database, to determine habitat area availability for each species and life-stage. These areas can then be compared to post-restoration conditions and tracked through time to assess changes in fish habitat.

Direct observation (snorkeling) during field mapping will verify habitat use (fish distribution) by various life stages of the fish species of interest. Location, behavior, and microhabitat variables (depth, velocity, substrate and cover) for fish observed by direct observation will be documented, and then compared to the generalized criteria specified for that species/life stage.

2.3. GEOMORPHIC COMPONENTS

Two objectives were outlined for pre-project geomorphic monitoring:

establish locations of cross-section and longitudinal profile endpoints at SRPs 9 and 10 and the Phase I (7/11) reach of the Gravel Mining Reach project; and
document pre-project conditions for channel migration/planform adjustment and channel aggradation/degradation by cross-section survey (either re-surveyed or by using the survey data generated by KNS Surveying.

At this time it appears that the topographic data collected by surveyors for the project channel design phase will provide acceptable point density detail to extrapolate cross sections and long profiles to establish pre-construction conditions. During 1998 field work, survey endpoints (rebar pins) will be installed.

3. PROPOSED MONITORING STRATEGY

3.1. METHODS FOR BASS ABUNDANCE ESTIMATES

Underwater observation

We propose an initial assessment of the distribution and abundance of smallmouth and largemouth bass in SRPs 9 and 10 to provide information for both the habitat mapping and bass abundance objectives. This initial phase of field work will include 4 days of direct observation, with 3 crew snorkeling to locate and count bass.

Direct observation surveys will employ a method known as *distance sampling* to estimate the density of smallmouth bass, largemouth bass, and squawfish, which can be extrapolated to a population estimate by knowing the total area of the surveyed habitat unit (in this case the SRPs). This population estimate will be independent of, and directly comparable to, subsequent population estimates obtained by electrofishing surveys (from marked-recapture, and depletion removal), thus providing a third independent estimate of the predator populations.

Distance sampling relies on observing the location of fish (or other objects) relative to a fixed transect line; i.e., surveyors record the fish position on the transect and the distance from the transect. The model provides a way to obtain reliable estimates of the density of objects (fish) with fairly mild assumptions. Three critical assumptions must be met for reliable density estimates (Buckland et al. 1993): (1) objects on the transect line are detected with certainty; (2) objects are detected at their initial location; and (3) measurements of distances are exact.

During day-1 of direct observation, crew will practice identifying fish species and underwater observation techniques, then return at night to conduct qualitative assessments of predator population distribution and abundance. On day-2, the field crew will conduct a pilot study to test distance sampling techniques. The pilot study will involve random placement of a known Apopulation≅ of objects (we will use 50 plastic soda bottles suspended from the pool bottom with lead weights and fishing line) within a known area (approx. 40 ft wide cross section of SRP 9), then conduct direct observation distance sampling to estimate the density (and hence population) of the objects. This pilot study will allow crews to practice underwater sampling techniques, verify distance estimates (testing assumption 3), and evaluate of the accuracy of the population estimate. Field crew will also collect the microhabitat data during day-2. On days 3 and 4, distance sampling will be conducted at SRPs 9 and 10 to estimate smallmouth bass, largemouth bass and squawfish abundance. SRP 9 will include at least 5 perpendicular transects, spaced at 150 ft intervals, and repeat counts of at least 2 or 3 dives per transect. SRP 10 will accommodate up to 8 transects and employ the same replication as in SRP 9.

In addition to the distance sampling surveys, crews will also mark the location of observed bass (during other dives) using lead weights with buoys that can later be relocated. Divers will record fish species and marker number, estimate total length and relative fish depth, and record their behavior (foraging, feeding, etc.). Crew will then return to record microhabitat data (depth, velocity, substrate, cover) for comparison to literature data used in habitat mapping. Underwater observation will also be conducted at night to qualitatively assess differences between day and night abundance and distribution for smallmouth and largemouth bass.

Results of underwater observation surveys will be evaluated to determine the utility of using underwater observation in future sampling efforts to quantify bass abundance. The Summer Flow Fisheries Studies (EA 1996) provided bass abundance data gathered by direct observation during summers of 1988-1994, demonstrating that underwater observation techniques can be effective, at least at low flow conditions. Flow releases during the Summer Flow Fisheries Studies were much lower than anticipated in summer/fall 1998. Data gathered from underwater observation will be used to estimate relative abundance of bass using the statistical methods described in Hayes and Baird 1994. Sampling efficiencies for underwater census will be determined by comparing underwater census to population estimates obtained by electrofishing.

Electrofishing surveys

Following this pilot-level evaluation of bass distribution and abundance, more extensive bass electrofishing surveys will be outlined to determine which field (and statistical) methods will be used. As described in the Draft Monitoring Plan, several methods are available using electrofishing techniques, but the best method should be determined based on the pilot assessment of abundance. The following four options are suggested as potential sampling designs:

multiple-pass depletion at several SRPs and reference sites, attempting an independent abundance estimate for each unit in a single night survey;

marked-recapture at fewer sites, with repeat effort at each selected SRP (and reference sites) to estimate abundance (this technique may be more difficult if bass abundance is too low to allow sufficient recapture for statistical treatment);

a combination of methods, in which marked-recapture is conducted at fewer sites over several weeks, and then followed by multiple-pass depletion sampling on the final night of fishing to compare estimates from each method;

concentrating effort at only one SRP (e.g., SRP 9) to allow sufficient treatment at a single site for determining the best techniques for subsequent years= sampling;
no electrofishing if bass abundances are too low, potentially replaced with more extensive direct observation surveys if visibility conditions are suitable.

Electrofishing (or snorkel) surveys will have approximately 8 nights (or days) with a 3-person crew to estimate bass abundance (as allocated in the Draft Monitoring Plan budget).

3.2. METHODS FOR HABITAT MAPPING

Field mapping of habitat availability for chinook salmon and small and largemouth bass will be conducted in four phases: 1) pre-field map preparation, 2) field mapping of physical habitat criteria for selected species, 3) post-field interpretation and digitized map preparation, and 4) field verification of habitat use by selected fish species.

Pre-field map preparation
We will use the following baseline geomorphic information to develop preliminary maps of physical habitat criteria:

high resolution aerial photos from March 1998 taken at 3,000 cfs (scale: 1≅=280=);
topographic data gathered by aerial photogrammetry and bathymetric survey, converted to topographic contours and overlaid onto aerial photos; and
cross-section survey data collected for the geomorphic baseline assessment.

The aerial photos will be scanned and orthorectified using control points consistent with the existing GIS database. This will allow topographic data to be overlain onto the aerial photographs for use in the field, and will allow photo reprints of any scale and map size. The channel bathymetry will be converted to depth contours based on the anticipated discharge during field mapping (expected to be around 500 cfs), i.e., field maps will have topographic contours based on water surface stage height. Adjusting benchmarked topographic data to (relative) depth data will aid field crews in assessing field habitat conditions while avoiding extensive depth measurements in the field. The field maps will then be reproduced at approximately 1≅=200=, plotted on 11≅x17≅ or larger prints, then laminated for use in the field. The field maps will use plastic overlays attached on a large clipboard for mapping different components (physical habitat criteria, different fish species habitat boundaries, etc.).

2) Field mapping
The field mapping activity will delineate geomorphic and fish habitat boundaries on the field maps. We will use the geomorphically-based habitat classification system developed

for the Lower American River (Snider et al 1992), modified for the Tuolumne River. This system, used on the American and Mokelumne Rivers, includes four levels of habitat classification: (1) study reach, (2) major channel feature, (3) channel feature type, and (4) habitat unit. This classification system was chosen because of its broad applicability to mainstem Central Valley alluvial rivers, to maintain consistency with other agency projects, and for its utility on a river-wide basis on the Tuolumne River in addition to specific project reaches. Subsequent habitat mapping within the Tuolumne River corridor can incorporate project reaches into a consistent river-wide system. Modification of the American River classification system for the Tuolumne River will not preclude later comparison to the American River or Mokelumne River data.

Level-1 (study reach) will incorporate the seven subreaches for the Tuolumne River developed by McBain and Trush in the Tuolumne River Corridor Restoration Plan, including: (1) Lower Sand-bedded Subreach, (2) Urban Sand-bedded Subreach, (3) Upper Sand-bedded Subreach, (4) In-channel Gravel Mining Subreach, (5) Gravel Mining Subreach, (6) Dredger-tailing Subreach, (7) Critical Salmon Spawning Subreach. The project-specific mapping proposed here will occur in subreach 4 (SRPs) and subreach 5 (Gravel Mining Reach).

Level-2 (major channel feature) includes three types of major channel features, including bar complexes, flatwater areas, and off-channel areas. Bar complexes are defined as river segments in which submergent and emergent [gravel] bars are the primary channel morphological features. Flatwaters are segments in which the primary channel is uniform, simple, and without gravel bars or channel controls. Off-channel areas are distinctly separate from the main channel and lie outside the main channel cross-sectional profile.

Level-3 (channel feature types) include 10 channel types tiered hierarchically from level-2 categories. These channel feature types are defined in Table 3.

Level-4 (habitat units) include 9 habitat types typically found along the Tuolumne River corridor, including: pool head, pool body and pool tail (where distinguishable), runs, glides, riffles (slopes measured), backwater zones, SRPs, and off-channel ponds (assessed from photographs only). Habitat units are defined in Table 3.

Other geomorphic and physical habitat features will include sketches of particle facies (including estimated particle size diameter), location of low-water channel (100-500 cfs) and bankfull channel (approximately 5400 cfs), in-channel and overhead cover, aquatic rooted and emergent vegetation (macrophytic only), riparian vegetation that contributes to instream cover, location and dimensions of LWD and other large in-channel structures, and spot temperature measurements at different depths and locations.

Field crews will work systematically through the project reaches, using the habitat classification system and the predetermined habitat criteria for smallmouth bass, largemouth bass and chinook salmon, to prepare habitat maps delineating geomorphic unit boundaries and fish habitat boundaries. Fish-use sites located by direct observation will be added to the field maps as individual points, including depth, velocity, substrate and cover data. Crews will work with velocity meters to determine depth and velocity boundaries that correspond to the fish life stages of interest. Separate map overlays will be prepared for each habitat classification level and for each species to avoid confusing mapped boundaries. Velocity data will be obtained systematically by profiling velocity at regular intervals along the river channel from water=s edge to deeper zones. Velocity isoclines will be plotted on maps, and combined with depth topography, will indicate zones where physical characteristics correspond to fish habitat criteria. Substrate and cover will be mapped by visually delineating distinct zones or patches of substrate and cover. Underwater observation will also be employed to aid in delineating these boundaries.

Mapping at SRP sites will focus primarily on adult largemouth and smallmouth bass foraging habitat for several reasons. First, adult bass have the most significant impact on chinook salmon, thus addressing specific monitoring and restoration objectives. Second, adult habitat is the likely target for significant change in availability, whereas juvenile bass rearing habitat may not be appreciably changed. Additionally, attempting to map habitat availability for all life stages would require a much greater level of effort and would only secondarily address project objectives. Mapping at SRP sites will require 4 field days with a 2-person crew, in addition to the snorkel surveys.

Mapping at the 7/11 Reach will focus primarily on chinook salmon spawning and rearing habitat, and secondarily on bass habitat. Mapping will require 5 field days with a 2-person crew and will employ snorkeling to assess fish distributions.

Because habitat areas and locations change with discharge, an important component of our evaluation of fish habitat availability will be to assess habitat at different flows. Assessing all flows typically found in the Tuolumne River is prohibitive, but we will attempt to assess a range of flows, including a LOW flow of 150 cfs (the minimum instream flow allowable under the FERC license), a MODERATE flow of 500 to 1,000 cfs (the flow range expected during the 1998 summer field season, and a HIGH flow of 1,000 to 3,000 cfs (typical of winter and spring conditions in wetter years). During the initial mapping activity all channel features, habitat units, and fish habitat boundaries will be mapped. In subsequent mapping activities during different flows, mapping will selectively focus on specific fish species and life history stages (i.e., mapping will require the same degree of effort to delineate fish habitat boundaries, and will secondarily focus on habitat classification protocols. Additionally, because future flows cannot be determined, subsequent mapping is contingent upon those flows that do occur, and field mapping will adapt to those conditions.

3) Final map preparation

The physical habitat maps will be converted to species maps by refining habitat boundary delineations made in the field, and then digitizing habitat boundaries for each species and life stage into the GIS-based maps. These maps can then be reproduced as color maps showing habitat boundaries as different layers and can be used for analyses of habitat availability to show areas of overlap and for later comparisons to post restoration project conditions. Criteria for interpretation of habitat suitability for target species are shown in Table 2. More detailed information on species life histories, from which the criteria in Table 2 were derived, is provided in section 5 of this memorandum

4) Field verification of habitat use

Verification of habitat use will be addressed in two ways, first using snorkel surveys before and during map preparation, and then by seining for juvenile chinook salmon at selected sites within the restored reaches during winter and spring months. The initial two days of snorkeling will allow an assessment of fish habitat use and distribution within subsequently mapped areas. During step two of the mapping activity, field crew will snorkel periodically to determine instream habitat conditions and fish presence. These data will be incorporated into the maps.

The Draft Monitoring Plan included seining during the chinook rearing season to assess the distribution and abundance of juvenile chinook within newly restored project reaches. Because seining is not included in year-1 implementation, this component is not described in detail here. Data generated from seining in project reaches will be included in habitat maps.

Beginning in winter of 1999, a more focused salmon sampling effort (including juvenile seining, electrofishing, underwater observation, or combination) will likely be initiated. The design of future monitoring strategies will be based in part on an assessment of techniques and results obtained from 1998 field studies.

Table 3. Geomorphically-based habitat classification system developed for the American River (Snider et. al. 1992), and adapted for application to the Tuolumne River restoration projects.

Classification Level	***Definition***
BAR COMPLEXES	
Island Complex	Stable island located in main channel; supports established riparian vegetation.
Mid-Channel Bar	Temporary island located in main channel; generally lacks established riparian vegetation.

Lateral Bar	Contiguous with one main-channel bank, does not span channel; less built up than island complex; lacks established riparian vegetation.
Channel-Spanning Bar	Spans entire channel at approximate right angle.
Transverse Bar	Spans entire channel at approximate acute angle.
FLATWATER	
Channel Bend	Main channel primarily curved.
Straight Channel	Main channel primarily without curvature.
Split Channel	Main channel split into two or more channels.
OFF-CHANNEL	
Contiguous	Off-channel area contiguous with main channel.
Non-Contiguous	Off-channel area not contiguous with main channel.
HABITAT UNITS	
Pool Head	Transition area from fast water unit to a pool; water surface slope decrease and bed slope increases.
Pool Body	Very slow velocity; generally contains deepest portion of pool.
Pool Tail	Transition area into fast water unit; depth decreases and velocity increases.
Glide	Relatively low gradient and below average depths and velocities; no turbulence.
Run	Moderate gradient with above average depths and velocities; low to moderate turbulence.
Riffle	Relatively high gradient with above average velocities, below average depths; surface turbulence and channel controls.
Backwater	Low-velocity areas not contiguous with the main channel; often associated with downstream ends of lateral bars, and shaded by riparian vegetation.
Special Run Pool	SRPs are in-channel aggregate extraction pits generally located in Subreach 4.
Off-Channel Pond	Off-channel aggregate extraction pits isolated from the main channel by dikes or berms; generally located in Subreach 5.

3.3. GEOMORPHIC MONITORING

Cross section surveys using engineers levels will establish pre-project channel morphology in sufficient detail (high point densities) to assess construction implementation and track long-term channel adjustments that result from future high flow events. Cross-sections will be established at key planform locations, including the apex of meander bends (likely location of bank erosion) and riffles (to assess aggradation/ degradation). A minimum of 5 cross sections will be established at SRP sites, and 10 cross sections at the 7/11 Reach. Vertical and horizontal control (elevation and planform coordinate system will be consistent with the channel design surveys and existing GIS, respectively. This will allow locations and elevations to be compared over time.

4. BUDGET SUMMARY

The year-1 implementation budget is presented in Table 4. The total cost for field implementation, data analysis, and report preparation is $64,266. This figure is approximately in accordance with budget estimated in the Draft Monitoring Plan.

5. SPECIES LIFE HISTORIES AND HABITAT CRITERIA

5.1.1. Chinook salmon

Chinook salmon *(Oncorhynchus tshawytscha)* are the largest of the five Pacific salmon species, reaching weights up to 99 pounds (45 kg), although most adults weigh from 10 to 40 pounds. Chinook are anadromous and semelparous (die after spawning once), with two behavioral forms: one designated as Astream-type≅ and the other as Aocean-type≅ (Healey, 1991). Ocean-type chinook are typical of populations on the Pacific coast south of British Columbia, including the Tuolumne River fall-run population. In general, ocean types migrate to sea during their first year of life, usually within three months after emerging from the spawning gravels, spend most of their ocean life in coastal waters, and return to their natal river in the fall, a few days or weeks before spawning. Fall-run chinook salmon constitute the most abundant anadromous run in the Sacramento/San Joaquin River system (over 90% of the population), and support the bulk of ocean harvest.

Most chinook salmon return to spawn in freshwater streams when they are between two and five years old. The two-year-old grilse (precocious males and females) are abundant in some years, but Central Valley runs are comprised mostly of three-year-olds. Four- and five-year-old fish were once far more common than at present. The gradual decrease in average age and size of fish in the Central Valley runs is a result of heavy commercial ocean fishing (Ricker 1981).

In the Tuolumne River, adult chinook salmon typically arrive on the spawning grounds from October into December, peaking in early to mid November. Spawning takes place from mid October through late December. Duration of incubation varies depending on water temperature but generally extends for 60-90 days. Alevins remain in the gravel for two or three weeks after hatching, absorbing most of their yolk sac before emerging as fry into the water column. Fry emerge mostly from January to March. Fry (length<50mm) may emigrate from the river into the Bay/Delta estuary soon after emergence, or rear in the river for several months. The later-emigrating juveniles (length>50mm) generally leave the Tuolumne River in April or May and enter the ocean as smolts between April and July. Hatton and Clark (1942) trapped emigrating fry and juveniles in fyke nets at Mossdale in the San Joaquin delta from 1939-1941. Their data suggest bimodal peaks in emigration, with one peak in February and another in April. Several factors may determine the timing of fry and juvenile migration, and whether fry and juveniles rear in-river or continue downstream. Some research suggests that fry migration is related to flow magnitude. Kjelson et al. (1981) observed peak seine catches of chinook fry in the Sacramento/San Joaquin Delta correlated with increases in streamflow from storm runoff. Other authors speculate that social interaction or density-dependent mechanisms cause fry to be displaced downstream (Reimers 1968; Lister 1966; Major, 1969)

5.1.1.1. Adult migration and spawning habitat

Adult chinook salmon require depths greater than 9 inches (24 cm) and water velocities less than 8.0 ft/s (2.44 m/s) for successful upstream migration (Thompson 1972, as cited in Bjornn and Reiser 1991). Marcotte (1984) reports that suitability of adult holding pools declines at depths less than 7.9 ft (2.4 m) and that optimal water velocity ranges from 0.5B1.2 ft/s (15B37 cm/s). In the John Day River, Oregon, adult chinook hold in pools with depths exceeding 5 ft (1.5 m) that contain cover from undercut banks, overhanging vegetation, boulders, or woody debris (Lindsay et al. 1986).

Most chinook salmon spawn in the mainstems and lower reaches of large rivers or tributaries, although spawning has been observed over a broad range of stream sizes, from small tributaries 6B10 ft (2B3 m) wide (Vronskiy 1972) to very large mainstem reaches (Healey 1991). Chinook prefer low gradient (< 3 percent) reaches for spawning and rearing but occasionally use higher gradient areas (Kostow 1995).

The availability of well-oxygenated intragravel flow appears to be the most important requirement for successful chinook spawning, and can be a limiting factor in areas with otherwise appropriate spawning conditions (Healey 1991). Spawning sites (redds) are usually located near pool tailouts or the heads of riffles where the water changes from a smooth to a turbulent flow and where suitably-sized gravel and high levels of dissolved oxygen are available. Chinook have also been observed spawning in other areas that have high rates of intragravel flow such as below log jams and on the upstream side of gravel dunes (Russell et al. 1983, as cited in Healey 1991).

Chinook are capable of spawning within a wide range of sediment sizes, provided that intragravel flow is adequate (Healey 1991). Substrates preferred by chinook consist of sediment sizes ranging from 0.5B4 in (13B102 mm) in diameter, with less than 25 percent incidence of fines less than 2 mm in diameter (Platts et al. 1979; Bell 1986, as cited in Bjornn and Reiser 1991). Some authors suggest that spring chinook dig smaller redds and use coarser gravels than fall chinook (Burner 1951). Redd sizes are typically 110B180 ft2 (10B17 m2) in area, although they can range anywhere from 5B480 ft2 (0.5B45 m2) in area (Healey 1991). Past research on the Tuolumne River used 216 ft2 as an average redd size (EA 1992).

Because of their larger size, chinook apparently are able to spawn in deeper water with higher velocities than other salmonids (Healey 1991). Chinook spawn over a wide range of water depths, varying from 2 inches (5 cm) to 22 feet (7 m) (Burner 1951, Vronskiy 1972, Chapman et al. 1986, Healey 1991). Typical spawning depths range from 12B22 in (30B56 cm) (Healey 1991). Nine inches (24 cm) has been cited as the minimum preferred depth for spawning (Russell et al. 1983; Thompson 1972, as cited in Bjornn and Reiser 1991). Average water velocities in spawning areas range from 1 ft/s (0.3 m/s) to over 3 ft/s (1 m/s), with an observed range of 0.3B6.2 ft/s (0.1B1.9 m/s) (Healey 1991, Thompson 1972, as cited in Bjornn and Reiser 1991).

Review of the current literature suggests that 42.5B57.5EF (5.8B14.2EC) is the optimum temperature range for incubating chinook (Bell 1986, Bjornn and Rieser 1991). Sublethal stress and/or mortality of incubating eggs resulting from elevated temperatures would be expected to begin at temperatures of about 14.4EC (58EF) for constant exposures. Adult and juvenile chinook salmon require water temperatures below 70B77EF (21B25EC). Sustained water temperatures above 81EF (27EC) are lethal (Cramer and Hammock 1952, Moyle 1976).

5.1.1.2. Juvenile habitat

Extensive use of mainstem reaches and estuaries as rearing habitat distinguishes juvenile chinook salmon from coho salmon, steelhead, and sea-run cutthroat trout. Early rearing typically occurs in mainstem reaches having relatively low gradients (Nicholas and Hankin 1989).

Following emergence, fry occupy low velocity, shallow areas near stream margins, including backwater eddies and areas associated with bank cover or large woody debris, where they aggregate in schools of 20 to 40 (Lister and Genoe 1970, Everest and Chapman 1972, McCain 1992). Fry also may use pool margins and pool tails associated with bedrock obstructions, rootwads, and overhanging banks. As summer progresses and fry increase in size, use of lateral habitat declines (Reedy 1995) as juveniles shift away from backwater areas into pools, especially lateral scour, channel confluence, and mid-channel pools, where they feed on invertebrate drift near the surface (Lister and Genoe 1970, Everest and Chapman 1972, Hillman et al. 1987, McCain 1992). Reedy (1995) found maximum summer rearing densities to occur in the heads of pools, where juvenile chinook formed schools.

Juvenile chinook salmon appear to prefer pools with cover provided by banks, overhanging vegetation, larger substrates, or large woody debris. Juvenile densities in pools have been found to increase with increasing amounts of cover (Steward and Bjornn unpublished data, as cited in Bjornn and Reiser 1991). During higher flow events, juveniles have been observed to move to deeper areas in pools and may also move laterally toward channel margins in search of velocity refuge (Steward and Bjornn 1987, Shirvell 1994). Shirvell (1994) suggests that preferred habitat locations vary according to activity. For feeding, juvenile chinook and other salmonids are likely to select positions with optimal velocity conditions, whereas for predator avoidance, optimal light conditions are likely more important (Shirvell 1994).

Substantial variability in the velocity, depth, substrate, and habitat type preferences of juvenile chinook has been reported. Rubin et al. (1991) indicate that mean water column velocities within the range of 0.2B0.8 ft/s (0.05B0.25 m/s) are suitable and that water velocities from 0.2B0.5 ft/s (0.05B0.15 m/s) are optimal. Everest and Chapman (1972) found that in summer, age 0+ chinook prefer areas with water velocities less than 1.6 ft/s (0.50 m/s), while Healey (1991) suggests an upper velocity limit of 1 ft/s (0.3 m/s).

Rubin et al. (1991) found that juvenile chinook preferred water depths over 1 ft (0.3 m). In Crooked Fork Creek juveniles preferred pools and eddies with depths of 2B3 ft (0.6B1 m), while depths of only 0.5B1 ft (0.15B0.30 m) were preferred in Johnson Creek, Idaho, suggesting that depth preferences vary according to local conditions or habitat availability.

In Johnson Creek, chinook did not display strong preferences for substrate types during summer rearing, living over bed materials ranging from silt to cobble 8 inches (20 cm) in diameter, although highest densities occurred over silt and sand (Everest and Chapman 1972). Rubin et al. (1991) found juveniles to be common in areas with both organic detritus substrate and silt-sand and cobble-boulder substrates.

5.1.2. Largemouth bass (adult foraging habitat)

Largemouth bass *(Micropterus salmoides)* are centrarchids native to the eastern U.S. In their native range, largemouth bass prefer lacustrine (lake-like) habitats (Emig 1966, Scott and Crossman 1973, both as cited by Stuber et al. 1982); however, the species is often abundant in streams, especially lower elevation streams of southeastern United States (Fajen 1975). Optimal riverine habitat for largemouth bass generally consists of low gradients (# 0.04), a high percentage of pool and backwater habitat (Stuber et al. 1982), fine-grained (sand or mud) substrates, some aquatic vegetation, and relatively clear water (Trautman 1957, Larimore and Smith 1963, Scott and Crossman 1973, all as cited in Stuber et al. 1982). These streams often contain a diverse fish community (Fajen 1975). Bain et al. (1991) group largemouth bass into a guild of fish using Adepositional shoreline microhabitats≅.

In California, numerous centrarchid species have been introduced and have become established in lakes, reservoirs, and streams. CDFG (1987) reports that centrarchid abundance in the Sacramento-San Joaquin Delta and tributary streams is correlated primarily with the dead-end slough habitat, and secondarily with intermediate water conductivity and transparency typical of these habitats. They were also abundant in oxbows, channels behind berm islands, and small embayments where calm water and riparian or aquatic vegetation were common. Moyle (1976) describes largemouth bass habitat as Awarm, quiet waters with low turbidities and beds of aquatic plants.≅

Largemouth bass appear to maintain relatively small home ranges in both stream and lake habitats (Bain and Boltz 1992) with short term movements often less than 100 m (Lewis and Flickinger 1967, Warden and Lorio 1975, Winter 1977, all as cited by Bain and Boltz 1992). Home ranges were no larger than 5.1 acres in an Illinois lake (Fish and Savitz 1983, as cited by Bain and Boltz 1992) and 12.75 acres in Florida lakes (Mesing and Wicker 1986, as cited by Bain and Boltz 1992).

Most studies of largemouth bass have been conducted in lakes, and less information has been gathered on habitat preference in streams. The focus of this review is on habitat suitable for adult largemouth bass of a size associated with a piscivorous (fish-eating) diet (∃ 200 mm fork length), and pertaining to the Lower Tuolumne River. The most important habitat criteria for largemouth bass in Central Valley streams such as the Tuolumne River are likely suitable temperatures, relatively deep habitats and slow current velocities, and suitable prey and cover.

5.1.2.1. Temperature

Water temperatures optimum for largemouth bass growth range from 20 to 30^{o}C (Moyle 1976). Stuber et al. (1982) report optimal temperatures for growth as ranging from 24B30 ^{o}C (Mohler 1966, Coutant 1975, Brungs and Jones 1977, Carlander 1977, Venables et al. 1978). Very little growth of largemouth bass occurs at temperatures below 15^{o}C (Mohler 1966, as cited in Stuber et al. 1982) or above 36 ^{o}C (Markus 1932, as cited by Heidinger 1976). Male bass do not feed during spawning and while guarding fry following hatching. Bass consumption rates increase with temperature, with approximately three times as much food being consumed at 20 ^{o}C as at 10 ^{o}C (Hathaway 1927, as cited by Heidinger 1976).

5.1.2.2. Depth and velocity

Adult largemouth bass use a broad range of depths, probably because they have few predators of their own once they reach adult size. Because of their preference for areas that support aquatic vegetation (used as cover for sit-and-wait feeding and also used as cover by the smaller fish that are preferred prey), depths that support submergent vegetation (< about 6 m [20 ft]) are probably more suitable as adult bass habitat. However, throughout the year largemouth may also use habitats without submergent vegetation cover. In lakes in northern latitudes, deeper habitats (3B15 m mean depth) are used for overwintering by largemouth bass (Robbins and MacCrimmon 1974, Carlander 1977, Winter 1977; all as cited in Stuber et al. 1982). Shallow rather than deeper depths likely limit habitat suitability for adult bass.

Depths used for nesting bass may define the range of depths used during the spring and summer. Largemouth may construct nests at depths ranging from 0.15 to 7.5 m (0.5-24 ft) (Swingle and Smith 1950, Harlan and Speaker 1956, Mraz 1964, Clugston 1966, Allan and Romero 1975; all as cited in Stuber et al. 1982). Nest sites are usually placed in water averaging 0.30 to 1.33 m (1 to 4.4 ft) (Heidinger 1976, Stuber et al. 1982), although nests may be placed in water barely deep enough to cover the dorsal fin of the male bass (about 15 cm [6 inches]) (Hunsaker and Crawford 1964, Heidinger 1976). Shallow areas are more likely used if floating or overhanging vegetation, docks, or woody debris cover is present (Hunsaker and Crawford 1964). Nests have been found at depths of 5 to 8 m in lakes (Heidinger 1976; Miller and Kramer 1971, as cited in Stuber et al. 1982). Habitat suitability for largemouth bass in the Tuolumne River is less likely determined by depth as much as by velocity, temperature and prey availability.

Adult largemouth bass use habitats with low current velocity, with optimal velocities being under < 6 cm/s (0.2 ft/s) and velocities over 10 cm/s (0.34 ft/s) being avoided by the species (Hardin and Bovee 1978, as cited in Stuber et al. 1982). Current velocities of over 20 cm/s (0.66 ft/s) are believed to be unsuitable (Hardin and Bovee 1978, as cited in Stuber et al. 1982). Mortality of largemouth bass embryos may occur in water velocities of 40 cm/s (Dudley 1969, as cited in Stuber et al. 1982). Optimal velocities for largemouth bass fry are those less than 4 cm/s (0.13 ft/s) (Hardin and Bovee 1978, as cited in Stuber et al. 1982) and fry cannot tolerate current velocities over 27 cm/s (0.89 ft/s) (MacLeod 1967, Laurence 1972, both as cited in Stuber et al. 1982).

5.1.2.3. Prey and cover

Largemouth bass may be completely piscivorous by the time they reach lengths of 80B100 mm (Keast 1970, Clady 1974, Kramer and Smith 1962; all as cited in Werner et al. 1977). However, these fish typically cannot prey on chinook salmon smolts, which range in size from 50 to 120 mm fork length. Due to gape limitations and swimming speeds needed to capture larger prey, an adult bass would probably need to attain at least 200 mm fork length to feed on fish of this size, a size which corresponds to sexual maturity (Heidinger 1976). Largemouth bass do not feed at water temperatures below 5oC or above

The Tuolumne River fish community includes a wide range of suitable prey species for largemouth bass, particularly sunfishes which are prey to native bass habitat; other native and non-native fish species, crayfish and bullfrogs are suitable bass prey in the Tuolumne River. Cover in the form of floating, submerged, or riparian vegetation, woody debris, undercut banks, or possibly turbidity may be necessary for maintaining bass populations, but it is unclear whether cover is necessary for successful bass foraging. Because adult largemouth are reported to use a wide range of depths and because prey are likely to be fairly abundant in the Tuolumne, suitable temperatures and low current velocities may be the most important indicators of potential adult largemouth bass habitat in the Tuolumne River.

There is conflicting information in the literature regarding quantitative relationships between vegetation cover and largemouth bass populations. Although largemouth bass often concentrate in or near vegetation, there is evidence that they are not sensitive to changes in the vegetation density (Bain and Boltz 1992). Much variation may be due to difficulties in sampling fish in large deep habitats and differences in the scale at which vegetation cover is being measured. Additionally, in areas with less vegetation, adult largemouth bass may adapt their behavior from a sit-and-wait (ambush) mode of predation to a more active search mode (Savino and Stein 1982, as cited in Bain and Boltz 1992). Vegetation removal experiments show that adult bass concentrations may remain relatively unchanged (Bailey 1978, Klussmann et al. 1988, both as cited in Bain and Boltz 1992); however, many of these studies appear to be fairly short term and may not adequately reflect longer term impacts of removing vegetation cover.

Dense vegetation may provide excellent cover for the small prey species, but may result in reduced capture rates (Crowder and Cooper 1979, as cited in Durocher et al. 1984; Glass 1971, Savino and Stein 1982; both as cited in Savino and Stein 1989; Saiki and Tash 1979, as cited in Stuber et al. 1982). Largemouth bass may prefer heavily vegetated sites because of the relatively high prey abundance found there (Prince and Maughan 1979, as cited in Savino and Stein 1989). Prey encounter rates and vulnerability to predation will be higher in these areas, and although predation rate may be reduced as cover increases and the number of prey remains constant (Glass 1971, Savino and Stein 1982), consumption can be maintained at adequate levels if prey numbers are higher in heavily vegetated areas (Savino and Stein 1989). Vegetation coverage as low as 15% has been reported to limit foraging effectiveness by adult largemouth in a laboratory (Savino and Stein 1982, as cited in Bain and Boltz 1992). These authors reported that plant coverage less than 40% resulted in prey species easily escaping capture by adult largemouth bass.

There is little agreement in the literature on optimal vegetation coverage for adult largemouth bass. Vegetation cover that results in high largemouth bass production or the highest biomass estimates may not necessarily reflect optimal foraging conditions for larger adults. Based on the literature and inference about foraging strategies, it is likely that intermediate vegetation densities, or patchy cover by submerged vegetation is optimal as adult foraging habitat.

In the Tuolumne River, at least 2 growing seasons would likely be required for bass to attain sizes large enough to prey on chinook salmon. Overlap in habitat between salmon fry and largemouth bass is not likely substantial due to differences in temperature preferences. Therefore, predation on juvenile salmonids is likely most important during downstream migration in the spring (March through June) when juveniles or smolts travel through adult bass habitat.

5.1.3. Smallmouth bass (adult foraging habitat)

Smallmouth bass occur in large clear water lakes (Coble 1975) and in streams of moderate gradient with riffle-pool morphology, relatively low turbidity, and cobble-boulder substrates (Hubbs and Bailey 1938, Reynolds 1965, Coble 1975, Lee et al. 1980, Todd and Rabeni 1989). Optimal stream reaches for adult smallmouth contain large pools, slow runs, eddies or backwaters with abundant cover (e.g., boulders, rock ledges, undercut banks, and LWD), and prey (especially small fish and crayfish). In streams, larger adult smallmouth bass have been described as pool guild members (Schlosser 1982), run or pool inhabitants (Leonard and Orth 1988), and habitat generalists (Bain et al. 1988, Lobb and Orth 1991). Smallmouth bass are biologically quite similar to largemouth bass; however, smallmouth bass show a greater preference for cooler streams with current and adult smallmouth bass may be less piscivorous than largemouth bass where crayfish are available as prey (McGinnis 1984).

Adult smallmouth bass tend to remain in a single home pool or area of similar size throughout an entire season (Larimore 1952, Munther 1970, as cited in Coble 1975).

Restricted home ranges have been observed in both lakes and streams (Gerking 1953, Fraser 1955, Funk 1957, Latta 1963, White 1970; all as cited in Coble 1975). Munther (1970) concluded that movement between suitable habitat areas was probably a function of the distance and harshness of the environments separating them. Through the use of radio-telemetry, Todd and Rabeni (1989) concluded that adult smallmouth bass established consistent and predictable home ranges that overlapped with one another. Within each home range, individual bass were observed to spend more than half of their time at one specific wood or boulder cover object. Adults moved between pools in the spring before or during the spawning season, but 75 percent of tagged fish returned to their home pool following the spawning season. Movement between pools occurred much less frequently in summer and winter than during spring and fall when floods were more frequent. The authors hypothesized that movement away from home pools for spawning may serve to disperse the young.

Because of their ability to tolerate cooler temperatures than largemouth bass, smallmouth bass habitat may overlap with fry and juvenile chinook salmon rearing habitat. Smallmouth bass as small as 40B50 mm may become piscivorous (Tester 1932, Lachner 1950, Webster 1954, all as cited in Coble 1975). In the Tuolumne River, juvenile smallmouth bass likely feed primarily on insects and other small invertebrates during their first growing season, whereas larger salmonid fry (30 mm at emergence) do not become an important part of the diet until their second growing season, when they reach fork lengths over 100 mm. Several authors have noted that crayfish appear to be the preferred prey of smallmouth bass when they are abundant [citations] and that substrate preferences shown by adult smallmouth bass may be strongly influenced by the suitability of habitat for crayfish [citations]. When prey is abundant, smallmouth bass may show strong size preferences when feeding (Probst et al. 1984). Probst et al. (1984) found that for smallmouth bass longer than 254 mm, 90 percent of all crayfish consumed were from 24B46 mm in length, despite their availability in a large range of sizes. The study showed no relation between length of the adult smallmouth bass and the size of crayfish preyed on, indicating an optimum prey size range. In this study, adult smallmouth bass over 254 mm also fed about equally on cyprinids which were generally less than about 100 mm long (mean length of fish eaten was 80 mm). Larger adults also fed on larger fish, but did not ignore smaller prey fish.

Based on the results of Probst et al. (1984), as well Stein (1977), it seems that emergent salmonid fry are likely suitable prey to age-1 smallmouth bass (∃100 mm fork length). Larger juvenile and smolt chinook salmon would be vulnerable to older age-classes of smallmouth bass. However, if sufficient prey fish and crayfish of the smaller preferred sizes are available, it may be more energetically profitable for smallmouth to prey on these items. Conditions where salmonid fry and juveniles are locally abundant (in spawning areas, good rearing habitat, or during outmigration) may be an exception.

Results of District predation studies (EA 1992) show that smallmouth bass as small as 160 mm fork length are capable of feeding on salmon during outmigration. Smallmouth bass would be expected to reach this size sometime during their second growing season.

5.1.3.1. Temperature

Optimal growth of smallmouth bass in the laboratory occurs at temperatures of about 26-29 ^{o}C (79 to 84^{o}F) (Rowan 1962, Peek 1965, Horning and Pearson 1973; all as cited in Coble 1975). More often, smallmouth bass are reported as occupying temperatures of 20B26^{o}C (68B78.8^{o}F) (Coble 1975, Coutant 1975, as cited in Bevelhimer 1996) in summer, although they have occasionally been observed in the field at temperatures of 26.1B26.7^{o}C (79B80^{o}F) (Munther 1970, White 1970; as cited in Coble 1975). Although smallmouth bass apparently prefer slightly cooler temperatures than largemouth bass, they have been observed to engage in a behavior termed Asunning≅ in which they seek warmer areas of the stream where they remain relatively motionless near the water surface (within a meter) for a portion of the day (Munther 1970). Munther (1970) found smallmouth bass occupying temperatures up to 26.7^{o}C (80^{o}F) during periods when the only other water of this temperature was in areas only a few inches deep. Webster (1954, cited in Munther 1970) noticed a similar attraction to a warm inflow from a stream into a lake. Munther (1970) also observed that mature smallmouth bass (>229B254 mm) moved into shallow pools with rocky substrate in the spring when this habitat was often 0.8^{o} to 2.8^{o}C (1.5^{o} to 5^{o}F) warmer than the main channel. Spawning in these shallow, warm pools occurred three to four weeks before spawning in the main channel. This behavior may indicate a willingness to use shallow areas in the spring and the potential for fry and juvenile chinook salmon using shallow areas on the margins of pools to be vulnerable to smallmouth predation in the Tuolumne River.

Temperatures below about 10^{o}C (50^{o}F) resulted in pronounced cover-seeking behavior (Beerman 1924, Hubbs and Bailey 1938, Webster 1954; all as cited in Coble 1975), while temperatures below 4.4^{o}C (40^{o}F) resulted in torpor and little or no feeding activity (Coble 1975). Munther (1970) observed that when temperatures dropped below 15.5^{o}C (60^{o}F), smallmouth bass could not be found by electrofishing in depths less than 2.3 m (8 ft), but that they could be found in deep rocky pools at least 3.6 m (13 ft) deep. Deep areas may be preferred during cooler periods of the year, but intermediate depths may be preferred during summer.

5.1.3.2. Depth and velocity

Adult smallmouth bass are habitat generalists able to use a wide variety of depths. Most studies report suitable depths between 0.45 and 2.5 m (1.5 and 8.2 ft) (Probst 1983, Studley et al. 1986, Rankin 1986, Todd and Rabeni 1989), although Barrett and Maughan (1994) showed a distinct drop in adult preference at depths over 1.3 m (4.26 ft). In this study, smallmouth had access to deeper water but were rarely observed there. Larger smallmouth bass appear to use deeper habitats than smaller (Probst et al. 1984, Studley et al. 1986). Studley et al. (1986) reported that mean depths used by juvenile (100B200 mm) and adult (>200 mm) smallmouth bass in California streams were 1.55 and 1.95 m (5.1 and 6.4 ft), respectively. Probst (1983, as cited by Todd and Rabeni 1989) reported that smallmouth bass select depths of 0.4B1.6 m (1.3B5.2 ft). In Rankin=s (1986) study, intermediate depths were preferred, and the deepest depths at the study sites (maximum depths at the sites were 1.8 and 2.5 m [5.9 and 8.2 ft]) were neither strongly preferred nor avoided.

Although smallmouth bass may spawn in areas as shallow as 0.3 m (1 ft), researchers have reported that adults generally avoid areas with depths less than 0.45B0.66 m (Probst 1983, Rankin 1986, Todd and Rabeni 1989). Rankin (1986) noted that smallmouth bass generally avoided depths less than 0.45 m (1.5 ft). Todd and Rabeni (1989) reported that depths of less than 0.66 m (2.2 ft) were avoided by adult smallmouth, even though habitats at this depth supported about two-thirds the total cover at site one and half the total cover at site 2.

Use of habitats deeper than about 2.5 m (8.2 ft) appears to be more common during the late fall and winter seasons. Smallmouth bass residing in streams or lakes in the more northern portions of their range require deep areas in which to overwinter. The use of very deep areas in streams during other times of the year or in warmer streams is less well understood, probably due to the difficulty in sampling these habitats. Munther (1970) observed that late fall and winter smallmouth bass habitat in the Snake River appeared to be in quiet rocky pools at least 3.7 m (12 ft) deep. Nests have been found in water up to 6.1 m (20 ft) deep (Mraz 1964, as cited by Coble 1975).

Although smallmouth bass are often found in streams with swifter currents than largemouth bass, they appear to prefer little or no current, similar to largemouth bass (Larimore and Garrels 1982, Probst 1983, Sechnick et al. 1986; all as cited in Todd and Rabeni 1989). Pools with moderate surface current may be used if large substrate or cover objects provide areas of reduced current (Paragamian 1973, as cited in Coble 1975). They have been observed to use areas in the lee of objects near the edges of current (Hubbs and Bailey 1938, Harlan and Speaker 1956, Munther 1970, all as cited in Coble 1975). Rankin (1986) noted that smallmouth bass of all sizes typically selected areas with currents below 15 cm/s and were rarely found in areas with velocities over 20 cm/s. Sechnick et al. (1986) found that both juvenile (140B160 mm) and adult (240B260 mm) smallmouth selected velocities under 10 cm/s in a simulated stream. Todd and Rabeni (1989) reported that areas with velocities less than 20 cm/s were preferred. During floods, they observed that smallmouth bass were more often found closer to shore or in eddies than during normal flows. In a study of smallmouth bass in California streams, Studley et al. (1986) reported the 95 percent confidence interval for velocities used by adult smallmouth (> 200 mm) ranged from 6.4 to 9.7 cm/s.

5.1.3.3. Substrate and cover

Most studies show a strong smallmouth preference for rocky substrate (Hubbs and Bailey 1938, Hubert 1981, Paragamian 1981; all as cited in Rankin 1986), with larger-sized substrates such as cobble and rubble generally being preferred over finer substrate (Edwards et al. 1983, Rankin 1986, Studley et al. 1986, Todd and Rabeni 1989). This choice of substrate may be driven by their apparent preference of crayfish as prey (McGinnis 1984) as these substrates tend to provide optimum habitat for crayfish. In addition, when temperatures drop below about 4.4^{o}C (40^{o}F), smallmouth bass may require interstitial habitats in rocky areas. Barrett and Maughan (1994) found that a smallmouth bass population in a central Arizona stream was able to persist in an area despite the lack of rubble or boulder substrate and interstitial spaces.

Many researchers have noted that cover appears to be very important in habitat selection by adult smallmouth bass in the laboratory (Haines and Butler 1969, as cited by Bevelhimer 1996, Sechnick et al. 1986) and the field (Emery 1973, Peterson and Myhr 1979, Hubert and Lackey 1980; all as cited in Bevelhimer 1996). Boulders, logjams, and rootwads were most often mentioned as cover during the summer. Reasons for a preference for cover over open water habitats include light avoidance, predator avoidance, nest defense, prey abundance, and predatory effectiveness (Bevelhimer 1996). Probst et al. (1984) found that the distribution of smallmouth bass was strongly related to some aspect of cover, and only one adult bass over 250 mm was found in open water during their study. As the size of bass increased in this study, the use of rootwads and log jams as cover increased and the use of vegetation and boulders decreased. Sechnick et al. (1986) found that distribution of bass from 140B260 mm was most strongly affected by cover in a simulated stream environment. Reduction in availability of cover resulted in reductions in smallmouth bass populations and growth (Griswold et al. 1978, as cited in Sechnick et al. 1986). Lobb and Orth (1991) found the highest densities of juvenile and adult smallmouth bass in association with snags in the summer, although bass were collected in all habitat types sampled.

Walters and Wilson (1996) concluded that smallmouth bass appeared to be both macrohabitat and microhabitat generalists and thus a poor indicator species of habitat alterations. Orth and Maughan (1982) found no relation between WUA and standing crops of juvenile and adult smallmouth bass in field tests of the IFIM. Similarly, Wiley et al. (1987) found no relation between low-flow percent usable area and density of adult smallmouth bass. Todd and Rabeni (1989) concluded that a relatively small amount of quality habitat may be sufficient to support a large biomass of adult smallmouth bass. Their study took place in a stream with one of the highest standing stocks of smallmouth bass of any comparable stream (the Jacks Fork River). In this stream, they found that smallmouth spent the majority of their time in somewhat less than 10 percent of the total habitat area available and that a single well-situated boulder could accommodate up to eight adult smallmouth bass as cover.

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