Tuolumne River Sediment Acquisition and Spawning Gravel Transfusion Project

Project Information

1. **Proposal Title:**

   Tuolumne River Sediment Acquisition and Spawning Gravel Transfusion Project

2. **Proposal applicants:**

   Wilton Fryer, Turlock Irrigation District

3. **Corresponding Contact Person:**

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

4. **Project Keywords:**

   Channel Dynamics
   Habitat Restoration, Wetland
   Sediment quality

5. **Type of project:**

   Implementation_Full

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

   No

7. **Topic Area**:

   Channel Dynamics and Sediment Transport

8. **Type of applicant:**

   Local Agency

9. **Location - GIS coordinates:**

   Latitude: 37.636

   Longitude: -120.503

   Datum:

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

The Tuolumne River channel, from river mile 52 (below La Grange Dam) to river mile 41 (at Turlock Lake State Recreation Area) The Joe Domecq County Park and the Zanker family parcels) located in the historic floodway, now separated from the Tuolumne River by Lake Road, and extend from river mile 46.0 to RM 47.5

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:**

    Condit No 18

15. **Location:**

    California State Senate District Number: 12th District Mentieth

    California Assembly District Number: 25th District Cogdill

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: 4325100

b) Do you have cost share partners already identified?

Yes

If yes, list partners and amount contributed by each:

Tuolumne River Technical Advisory Committee 50000

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:

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

No

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-MO9	**Tuolumne River Mining Reach7/11 Segment (No 1)**	**AFRP, CALFED-Cat III, TRTAC, USBR (CF)**
1999-FO2	**Tuolumne River Mining Reach MJ Ruddy Segment (No 2)**	**AFRP, TRTAC**
1997-MO8	**Tuolumne River SRP 9**	**AFRP, TRTAC, CALFED Cat III**
1999-FO1	**Tuolumne River SRP 10 Repair**	**AFRP**
2001-E208	**Tuolumne River Fine Sediment Management**	**CALFED**
2001-B201	**Tuolumne River Special Run Pool 10 Design**	**CALFED**

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

Yes

If yes, identify project number(s), title(s) and CVPIA program (e.g. AFRP, AFSP, b(1) other).

1133201017	**Tuolumne River Coarse Sediment Management**	**AFRP USFWS**

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

No

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)

Kris Vyverburg	**California Department of Fish and Game**	**(916) 653-8711**	**kavburg@dfg.ca.gov**
G Matthias Kondolf	**University of California**	**(510) 644-8381**	**gkondolf@aol.com**

21. **Comments:**

Not sure if the "keyword" section accepted my selections

Environmental Compliance Checklist

Tuolumne River Sediment Acquisition and Spawning Gravel Transfusion Project

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".*

   <u>CEQA Lead Agency:</u> Stanislaus County
   <u>NEPA Lead Agency (or co-lead:)</u> US Fish and Wildlife Service
   <u>NEPA Co-Lead Agency (if applicable):</u>

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?

      No

      If the CEQA/NEPA process is not complete, please describe the dates for completing draft and/or final CEQA/NEPA documents.

      Final CEQA/NEPA Document completed by October 2003

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

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	Required
General Plan Amendment	
Specific Plan Approval	
Rezone	
Williamson Act Contract Cancellation	
Other	Required

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: Stanislaus County Parks and Recreation Department	Required
Permission to access state land. Agency Name:	
Permission to access federal land. Agency Name:	
Permission to access private land. Landowner Name: Alan Zanker	Required

6. **Comments.**

County Mosquito Abatement Plan may be required. State Lands Lease would be required.

Land Use Checklist

Tuolumne River Sediment Acquisition and Spawning Gravel Transfusion Project

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

   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?**

   No

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

   No

   If you answered no to #3, explain what type of actions are involved in the proposal (i.e., research only, planning only).

   One parcel is County Park, currently used for recreation, and will remain the same, just enhanced. Other parcel is private, and will remain private, but with habitat improvements

4. **Comments.**

Conflict of Interest Checklist

Tuolumne River Sediment Acquisition and Spawning Gravel Transfusion Project

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, et al	McBain and Trush
Aldaron Laird	Trinity 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 and Trush**

Scott McBain McBain and Trush

Aldaron Laird Trinity Associates

Comments:

Budget Summary

Tuolumne River Sediment Acquisition and Spawning Gravel Transfusion Project

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	Conceptual Restoration Design						25000			25000.0		25000.00
2	Appraisal						30000			30000.0		30000.00
3	Mineral Purchase								1200000	1200000.0		1200000.00
4	Environmental Compliance and Permitting						155000			155000.0		155000.00
5	Contingency						141000			141000.0		141000.00
		0	0.00	0.00	0.00	0.00	351000.00	0.00	1200000.00	1551000.00	0.00	1551000.00

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**
1	Final Design, Construction Plans						35000			35000.0		35000.00
2	Construction Implementation						2509000			2509000.0		2509000.00
3	Contingency						255000			255000.0		255000.00
		0	0.00	0.00	0.00	0.00	2799000.00	0.00	0.00	2799000.00	0.00	2799000.00

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**
		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Grand Total=4350000.00

Comments.

Budget Justification

Tuolumne River Sediment Acquisition and Spawning Gravel Transfusion Project

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

No funds are sought for these purposes

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

No funds are sought for these purposes

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

No funds are sought for these purposes

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

No funds are sought for these purposes

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

No funds are sought for these purposes

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.

Restoration Design: The design costs include licensed site survey, CAD design of wetland and gravel introduction sites, material excavation, processing, and delivery planning, external engineering review, project description for environmental document. Appraisal: based on cost estimate provided by professional mineral appraiser working in Modesto. Regulatory Compliance: costs for Environmental Document and permits estimated based on costs of permitting and regulatory compliance in Tuolumne River Mining Reach and SRP 9 projects, and in Clear Creek Floodway Rehabilitation Project. Construction Implementation: costs based on Engineers estimates from Mining Reach and SRP 9 earthwork, regional material trucking costs, riparian and wetland revegetation, and monitoring.

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.

No funds are sought for these purposes

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.

For Service Contracts, project management was included in the total costs. For example, the Conceptual Restoration Design, Regulatory Compliance, and COnstruction Implementation tasks all include budget for project management. TID project management costs represent 20% of project manager time, based on prior 4 years of project management activities.

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

Mineral Cost: The cost to purchase the aggregate is based on a preliminary appraisal of mineral value prepared by professional mineral appraiser, using projected 2003 royalty and discount values.

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.

No funds are sought for these purposes

Executive Summary

Tuolumne River Sediment Acquisition and Spawning Gravel Transfusion Project

TUOLUMNE RIVER SEDIMENT ACQUISITION AND SPAWNING GRAVEL TRANSFUSION PROJECT A Proposal Submitted by: TURLOCK IRRIGATION DISTRICT 333 E. Canal Drive, Box 949 Turlock CA, 95318 Wilton Fryer, P.E. (209) 883-8316 On Behalf of the: TUOLUMNE RIVER TECHNICAL ADVISORY COMMITTEE In the Central Valley of California, the high cost of purchasing commercial-grade aggregate for channel restoration projects, and the pressures to conserve limited aggregate reserves for regional development, has required proponents of river restoration to become resourceful in obtaining gravel and cobble supplies. On the Tuolumne River, gravel and cobble are needed to restore degraded sections of river to more productive conditions, and to increase salmon spawning gravel. During development of the Coarse Sediment Management Plan the Tuolumne River Technical Advisory Committee has identified several parcels near La Grange that were historically floodplain and terrace alluvial deposits, that were dredged for gold in the 1930s, then re-excavated in the 1960s to provide aggregate for constructing Don Pedro Dam. Some coarse sediment was left in place, and now exists as barren surfaces that provide little wildlife habitat or recreational uses. Additionally, recent spawning habitat assessments have indicated chinook salmon spawning habitat availability has decreased by up to 66%, and spawning gravel restoration is needed to sustain recent rebounds in the salmon population. We propose to accomplish several restoration goals in one comprehensive project: Ø acquire a long-term source of coarse sediment (approximately 2.7 million tons) at the Joe Domecq County Park (Stanislaus County) and Zanker properties, to be set aside for river restoration projects, to lower project costs and reduce demand on regional aggregate reserves permitted for commercial development; Ø initiate the spawning gravel transfusion phase of coarse sediment management by adding gravel into the river to increase the spawning gravel supply and improve geomorphic processes; Ø restore wildlife habitat (wetlands and upland habitats) and recreational uses (trails, campgrounds, wildlife viewing) to Stanislaus County property and the Zanker family property; This project is one of ten priority projects sponsored by the TRTAC to meet requirements of the NDPP FERC license.

Proposal

Turlock Irrigation District

Tuolumne River Sediment Acquisition and Spawning Gravel Transfusion Project

Wilton Fryer, Turlock Irrigation District

TUOLUMNE RIVER
SEDIMENT ACQUISITION AND SPAWNING GRAVEL TRANSFUSION PROJECT

A Proposal Submitted by:

TURLOCK IRRIGATION DISTRICT
333 E. Canal Drive, Box 949
Turlock CA, 95318
Wilton Fryer, P.E.
(209) 883-8316

On Behalf of the:
TUOLUMNE RIVER TECHNICAL ADVISORY COMMITTEE

Executive Summary

In the Central Valley of California, the high cost of purchasing commercial-grade aggregate for channel restoration projects, and the pressures to conserve limited aggregate reserves for regional development, has required proponents of river restoration to become resourceful in obtaining gravel and cobble supplies. On the Tuolumne River, gravel and cobble are needed to restore degraded sections of river to more productive conditions, and to increase salmon spawning gravel. During development of the 'Coarse Sediment Management Plan' the Tuolumne River Technical Advisory Committee has identified several parcels near La Grange that were historically floodplain and terrace alluvial deposits, that were dredged for gold in the 1930's, then re-excavated in the 1960's to provide aggregate for constructing Don Pedro Dam. Some coarse sediment was left in place, and now exists as barren surfaces that provide little wildlife habitat or recreational uses. Additionally, recent spawning habitat assessments have indicated chinook salmon spawning habitat availability has decreased by up to 66%, and spawning gravel restoration is needed to sustain recent rebounds in the salmon population. We propose to accomplish several restoration goals in one comprehensive project:

- acquire a long-term source of coarse sediment (approximately 2.7 million tons) at the Joe Domecq County Park (Stanislaus County) and Zanker properties, to be set aside for river restoration projects, to lower project costs and reduce demand on regional aggregate reserves permitted for commercial development;
- initiate the spawning gravel transfusion phase of coarse sediment management by adding gravel into the river to increase the spawning gravel supply and improve geomorphic processes;
- restore wildlife habitat (wetlands and upland habitats) and recreational uses (trails, campgrounds, wildlife viewing) to Stanislaus County property and the Zanker family property;

This project is one of ten 'priority projects' sponsored by the TRTAC to meet requirements of the NDPP FERC license.

A. PROJECT DESCRIPTION

1. Problem Statement

The Lower Tuolumne River is a central focus in restoration efforts underway in the Central Valley of California. From top (La Grange Dam) to bottom (San Joaquin River confluence), there are 17 different projects in various stages of planning and/or implementation, including several multi-million dollar channel reconstruction projects funded by CALFED and AFRP. The success of the stakeholder organization – The Tuolumne River Technical Advisory Committee (TRTAC) – in promoting river-wide restoration goals and implementing restoration projects, combined with the tremendous opportunity for significant improvements in the river, has prompted CALFED ERP to recommend the Tuolumne River as one of three Demonstration Streams in the Central Valley, and the only one in the San Joaquin basin (CALFED 2001). CALFED and AFRP also selected the Tuolumne River and the TRTAC as the first stakeholder group to present their restoration planning and monitoring programs during the first Adaptive Management Forum held in June 2001.

These tremendous and costly planning and restoration efforts are in response to the severity of impacts that cumulatively have degraded the Tuolumne River ecosystem during the past 150 years. Beginning with the Gold Rush, the Tuolumne River has been extensively modified by land use practices (agriculture, ranching, urbanization) and resource extraction (water for irrigation, gold mining, aggregate mining). Streamflow regulation began with construction of Wheaton Dam (1871) and La Grange Dam (1893), intensified in the 1920s with the construction of several large reservoirs in the basin, and culminated in 1971 with construction of the New Don Pedro Project (NDPP), which more than tripled the storage capacity of the basin and stores 106% of the average annual basin outflow of 1.9 million acre-feet. During the early twentieth century, the Tuolumne River channel and floodplain were dredged for gold. The gold dredges excavated channel and floodplain deposits to the depth of bedrock (approximately 25 feet) and often realigned the river channel. After recovering the gold, the dredges deposited the remaining tailings back onto the floodplain, creating large, cobble-armored windrows that replaced the deep, rich soils of the valley floor deposits (Figure 1). By the end of the gold mining era, the floodplain adjacent to 12.5 miles of the river had been converted to dredger tailing deposits. In the 1960's much of the tailings were excavated to provide construction material for New Don Pedro Dam. Much of these areas remain today as barren, unproductive surfaces, with exposed gravel/cobble and little or no soil layer.

The Tuolumne River has also been extensively mined for aggregate[1]. Large-scale aggregate mining began in the 1940s and continues today. Historically, aggregate mines extracted sand and gravel directly from the active river channel, creating large, in-channel pits. More recent mining operations have excavated sand and gravel from floodplains and terraces directly adjacent to the river channel. These floodplain and terrace pits are poorly separated from the river by narrow berms (Figure 2), which often fail even during moderate flows, resulting in direct connection of the pits to the river channel. The January 1997 flood, which peaked at nearly 60,000 cfs, caused extensive damage in the mining reach, breaching nearly every pit berm. Additional degradation has resulted from the lack of coarse sediment recruitment from the upper Tuolumne River watershed that historically maintained sediment supply in the gravel-bedded reaches below La Grange dam. More than a century of steady gravel attrition in the alluvial spawning reaches has caused channel downcutting and widening, armored the channel bed, impaired geomorphic processes, and slowly diminished the available chinook salmon spawning habitat. Recent spawning habitat surveys documented spawning habitat losses of up to 44% since 1988 spawning habitat estimates, likely resulting from lack of gravel recruitment and from catastrophic losses of entire riffles during the 1997 flood (McBain and Trush 2001a).

Ironically, this history of extensive gravel/cobble manipulation by dredging and aggregate mining, combined with the consequent need to fill mined sections of river channel and resupply spawning gravels, has created an enormous local demand for coarse sediment for use in restoration projects. The river is in critical and immediate need of large volumes of spawning gravel to restore and maintain spawning habitat

1 In this proposal "aggregate" is a technical term referring to sand, gravel, and crushed stone mined commercially for construction material such as concrete and road base. 'Sediment' refers to alluvium transported and deposited by the river, and includes sand, gravel, and cobble-sized particles. 'Gravel' refers to particles ranging in size from approximately ¼ inch to 5 inches, the range suitable as spawning habitat. We will henceforth use the term 'sediment' to refer to river alluvium and material used in restoration projects, and 'aggregate' to refer to rock purchased from commercial producers. Also, the conversion factor of 1 cubic yard (CY) = 1.6 tons is used in this proposal]

Figure 1. The Tuolumne River in 1937 after nearly the entire floodway was dredged for gold. This portion of channel was subsequently "rehabilitated" with Davis-Grundsyk Act funds, but is now in critical need of gravel to maintain chinook salmon spawning habitat.

Figure 2. The Tuolumne River (in forground of photo) in the active Mining Reach, showing inadequate berms separating floodplain mining pits from the river.

that is in turn necessary to *sustain* the salmon population rebound that has occurred during the past six years (and eventually achieve CALFED, AFRP, and TRTAC population targets) (McBain and Trush 2000). Large volumes of sediment are also needed to implement the Mining Reach restoration projects, Special-Run-Pool projects, and channel restoration in the Dredger Reach.

This increased demand for sediment for use in large-scale restoration activities is in direct conflict, however, with the regional demand for permitted aggregate "reserves", particularly in the Stanislaus County region currently experiencing rapid economic and population growth. This growing conflict was expressed in comments provided to the CEQA/NEPA environmental document for the Gravel Mining Reach Restoration Project by the Central Valley Rock, Sand & Gravel Association (CVRS&GA), which stated that "Since the Tuolumne River is a major aggregate resource area serving Stanislaus County, the proposed restoration project will have an impact on the continued availability of these resources." The CVRS&GA also noted that, based on the most current information available, the currently permitted aggregate reserves in Stanislaus County would be depleted by 2002.

The solution to these problems is twofold. First, purchase a suitable supply of sediment to be set aside and designated for restoration purposes, preferably a large enough supply that it precludes any future demand for the regions' commercial reserves, and that is in close proximity of the upper river where the 'restoration' demand is greatest. This strategy of securing a long-term source of sediment for restoration projects has been exercised on the Merced River (Merced River Ranch), Stanislaus River (Two-mile Bar), and Clear Creek (Reading Bar and Former Shooting Gallery). Second, proceed with the "gravel transfusion" phase of coarse sediment management, in which a large volume of spawning-sized gravel is placed back into the river to resupply riffles and gravel bars, to reverse the impacts from mining, streamflow regulation and sediment blockage by dams. These two tasks are the primary subject of the Coarse Sediment Management Plan being prepared for the TRTAC, with funding provided by AFRP.

The Coarse Sediment Plan has identified several large parcels (totaling ~300 acres) in the La Grange vicinity that were historically river floodplains and terraces that were dredged for gold in the 1930's, then partially re-excavated to provide aggregate for constructing New Don Pedro Dam (Figure 3). Some dredger spoils were left in place, and now exist as flat, barren, rocky surfaces that provide little or no wildlife habitat or recreational value. The two parcels with the largest remaining gravel deposits in the upper Tuolumne River area are the Joe Domecq County Park (owned by Stanislaus County) and the Zanker property (Figure 4). These two contiguous parcels are on the south side of Lake Road, and are separated from the Tuolumne River by Lake Road. In addition to meeting the two most important selection criteria (reducing the demand on regional aggregate supplies, and close proximity to the upper river) these sites offer the additional bonus of providing the opportunity to restore high quality off-channel wetland habitat to land that presently is barren and unproductive. Both the Zanker family and representatives of Stanislaus County have expressed strong support and willingness to coordinate with TRTAC in developing this project.

This proposal seeks funding from CALFED and/or AFRP to carry out these three high-priority actions: (1) purchase mineral rights and conservation easements, obtain mining permits and other regulatory requirements, and develop restoration (reclamation) plans for the Stanislaus County Joe Domecq parcels and the Zanker family parcels; (2) initiate restoration of the Domecq County Park and Zanker property, including extraction of sediment for river restoration, and wetland/upland habitat restoration; (3) implement the large gravel transfusion phase of the coarse sediment management plan by placing approximately 100,000 cubic yards of spawning gravel in the river between La Grange (RM 52.0) and Roberts Ferry Bridge (RM 39.5).

a) Geographic Location

The Tuolumne River is located within the CALFED 'East San Joaquin Basin' Ecological Management Zone. The Tuolumne River drains a 1,960-square mile watershed on the western slope of the Sierra Nevada Range and is the largest of three major tributaries to the San Joaquin River (Figure 5). The river originates in Yosemite National Park and flows southwest to its confluence with the San Joaquin River, approximately 10 miles (16 km) west of the city of Modesto. The upper watershed is characterized by deep canyons and mountainous terrain. As the Tuolumne River emerges from the Sierra Nevada foothills into the Central Valley, the river transitions to a gently sloping alluvial valley. Within the alluvial valley, the river can be divided into two geomorphic reaches that are defined by channel slope and bed composition. The gravel-bedded zone extends from La Grange Dam (RM 52) to Geer Rd Bridge (RM 24), and the sand-bedded zone extends from Geer Rd Bridge to the confluence with the San Joaquin River

Figure 3. Historical aerial photos of the Tuolumne River floodway showing the land dredged for gold (upper) then scraped of most dredger tailings for use in construction of New Don Pedro Dam.

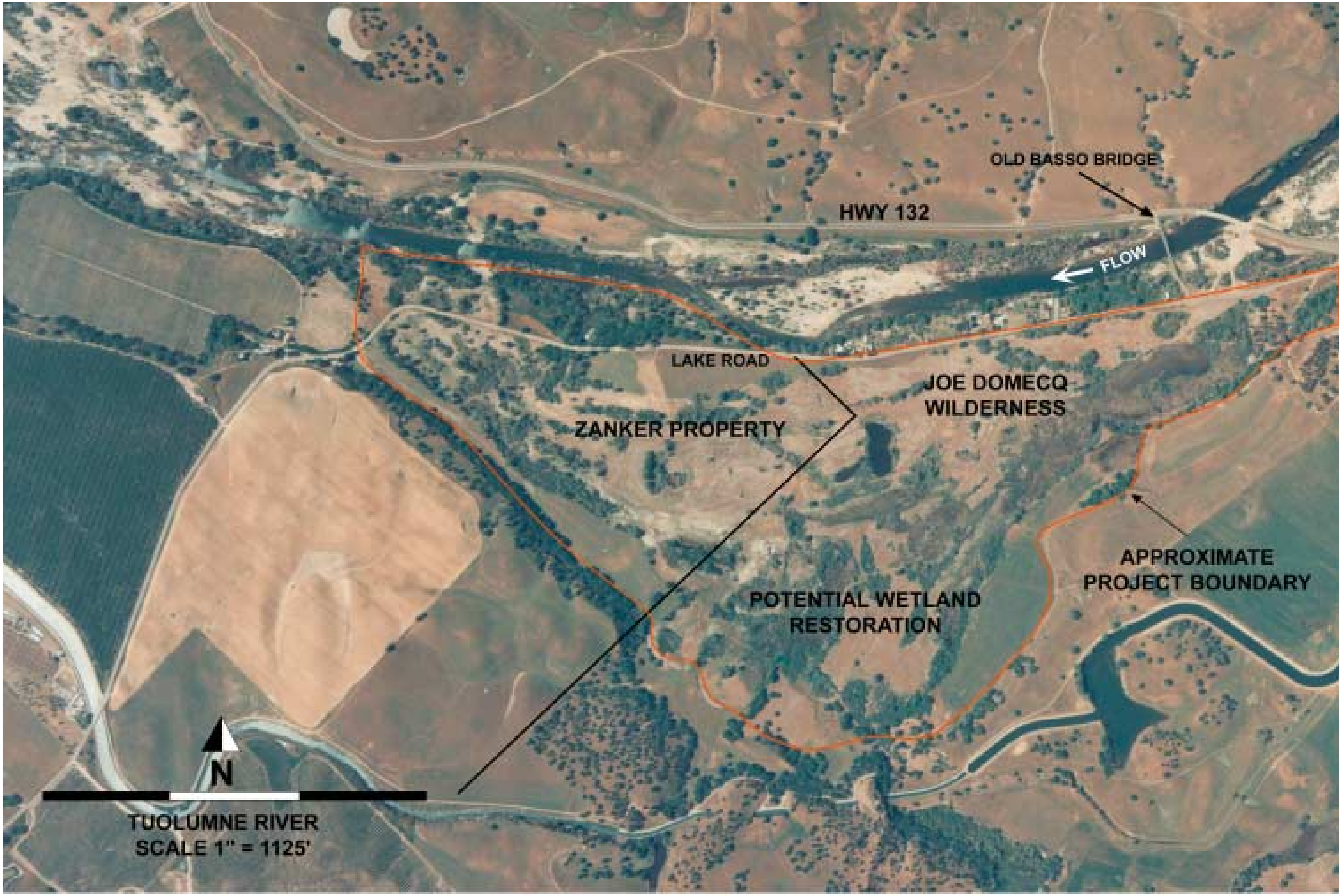


Figure 4. Parcels identified in the Tuolumne River Coarse Sediment Management Plan development that contain large volumes of sediment suitable for river restoration. These two parcels total approximately 300 acres.

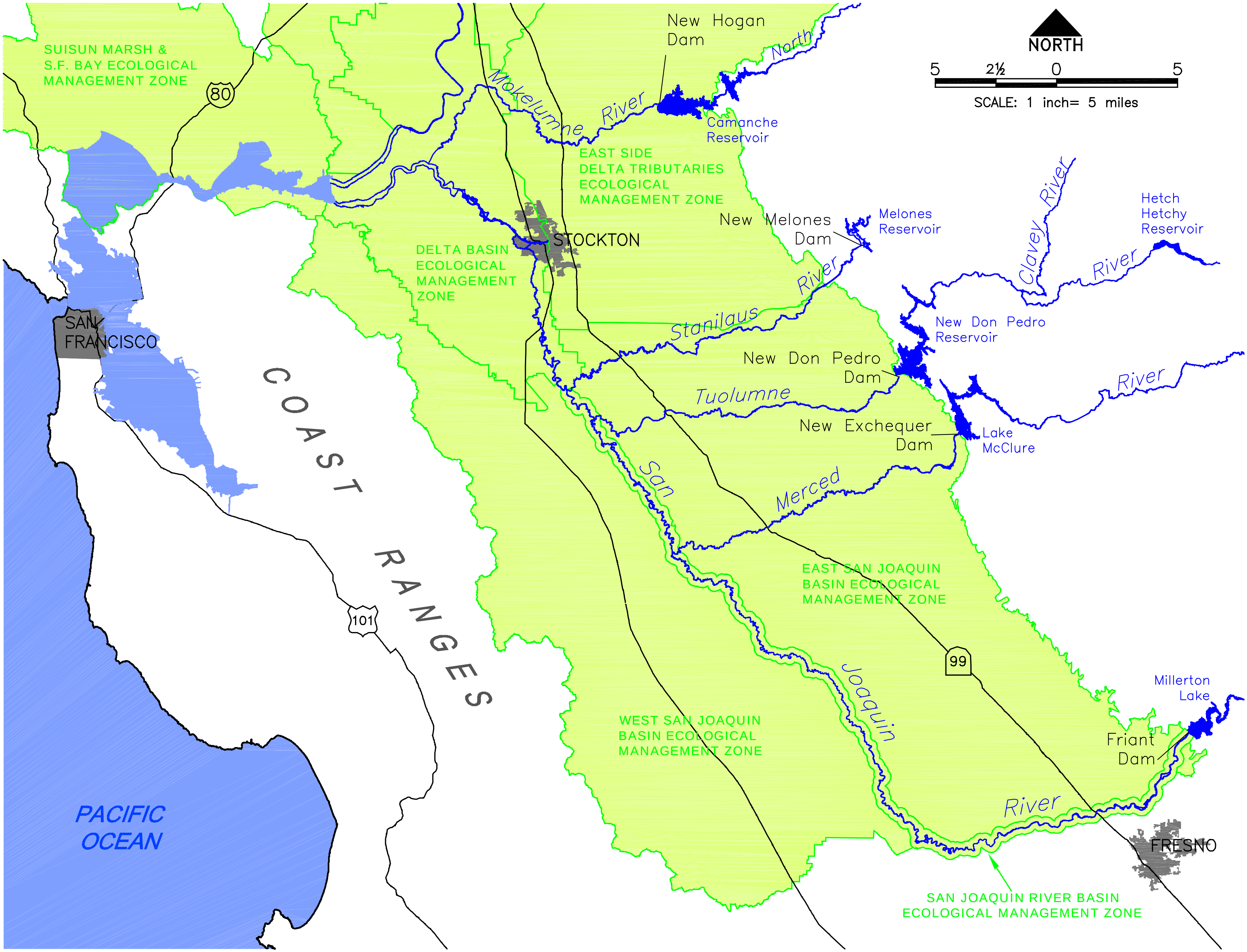


Figure 5. Location of the Tuolumne River within the CALFED "East San Joaquin Ecological Management Zone".

(RM 0). The gravel bedded zone provides spawning and rearing habitat for the fall-run chinook salmon population and is the focus of this proposal. The upper 15 miles of gravel-bedded zone (Figure 6) has been surveyed for spawning habitat availability and coarse sediment supply conditions. The proposed gravel source sites (the Joe Domecq County Park and the Zanker family parcels) are located in the historic floodway, now separated from the river by Lake Road, and extend from RM 46.0 to RM 47.5 (Figures 4 and 6). Prior to being dredged for gold in the 1930's, the Domecq/Zanker properties were formerly the DeLaney Ranch, as depicted in the historical lithograph (Figure 7).

b) Tuolumne River Restoration Program

Since 1971, the Turlock and Modesto Irrigation Districts (the Districts), in cooperation with the California Department of Fish and Game (CDFG) and the U.S. Fish and Wildlife Service (USFWS), have conducted extensive studies of chinook salmon population dynamics and habitat in the lower Tuolumne River as part of the Don Pedro Project FERC Study Program. The objective of these studies was to identify potential management actions for increasing chinook population abundance and improving chinook salmon habitat in the Tuolumne River. 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 groups. The FSA establishes minimum flow requirements for the Tuolumne River downstream of the Don Pedro Project and sets forth a strategy 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. Since the completion of the FSA, the Tuolumne River Technical Advisory Committee (TRTAC) has worked to develop and implement studies of specific aspects of salmon biology and habitat required by the FSA. The TRTAC has developed a comprehensive, process-based *Habitat Restoration Plan for the Lower Tuolumne River Corridor (McBain and Trush 2000)* (Restoration Plan), that integrates fluvial geomorphic processes as a foundation for ecosystem recovery and chinook salmon restoration . Several large-scale channel reconstruction projects are identified in the Restoration Plan, and initial phases of these projects are currently being implemented. 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.

c) Goals and Objectives

The overarching goal of the TRTAC and 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, as the most promising strategy for recovery and maintenance of salmonid populations and the river's native flora and fauna. Because this strategy will be carried out under regulated flow and sediment regimes, this goal targets a scaled-down version of the river, with dynamic fluvial processes (sediment transport and scour, floodplain inundation, channel migration) that create and maintain habitat characteristics favored by chinook salmon and other fish, avian, and wildlife populations.

This goal is thus a testable hypothesis that can be continually evaluated through an adaptive management approach. Funding for this project will help enable Tuolumne River restoration proponents (and CALFED/AFRP) to evaluate this important hypothesis by first securing a long-term source of sediment necessary to implement present and future restoration projects, and second by adding a large enough quantity of clean spawning gravel into the river to "restore" the supply that has been lost during the past century of sediment regulation.

The primary objectives of this project are:

- Obtain a long-term source of sediment (gravel and cobble) to sustain immediate and future restoration and spawning gravel augmentation projects along the river, and simultaneously reduce the demand for regionally valuable commercial aggregate;
- Restore off-channel wildlife habitat (wetlands and upland habitats) in the Stanislaus County and Zanker parcels as the dredger spoils are removed;
- improve recreational uses (trails, campgrounds, wildlife viewing), and general habitat value on the Stanislaus County parcels;
- Introduce gravel and cobbles to the Tuolumne River in appropriate locations to increase chinook salmon spawning and rearing habitat, and greatly improve geomorphic processes during high flow events;

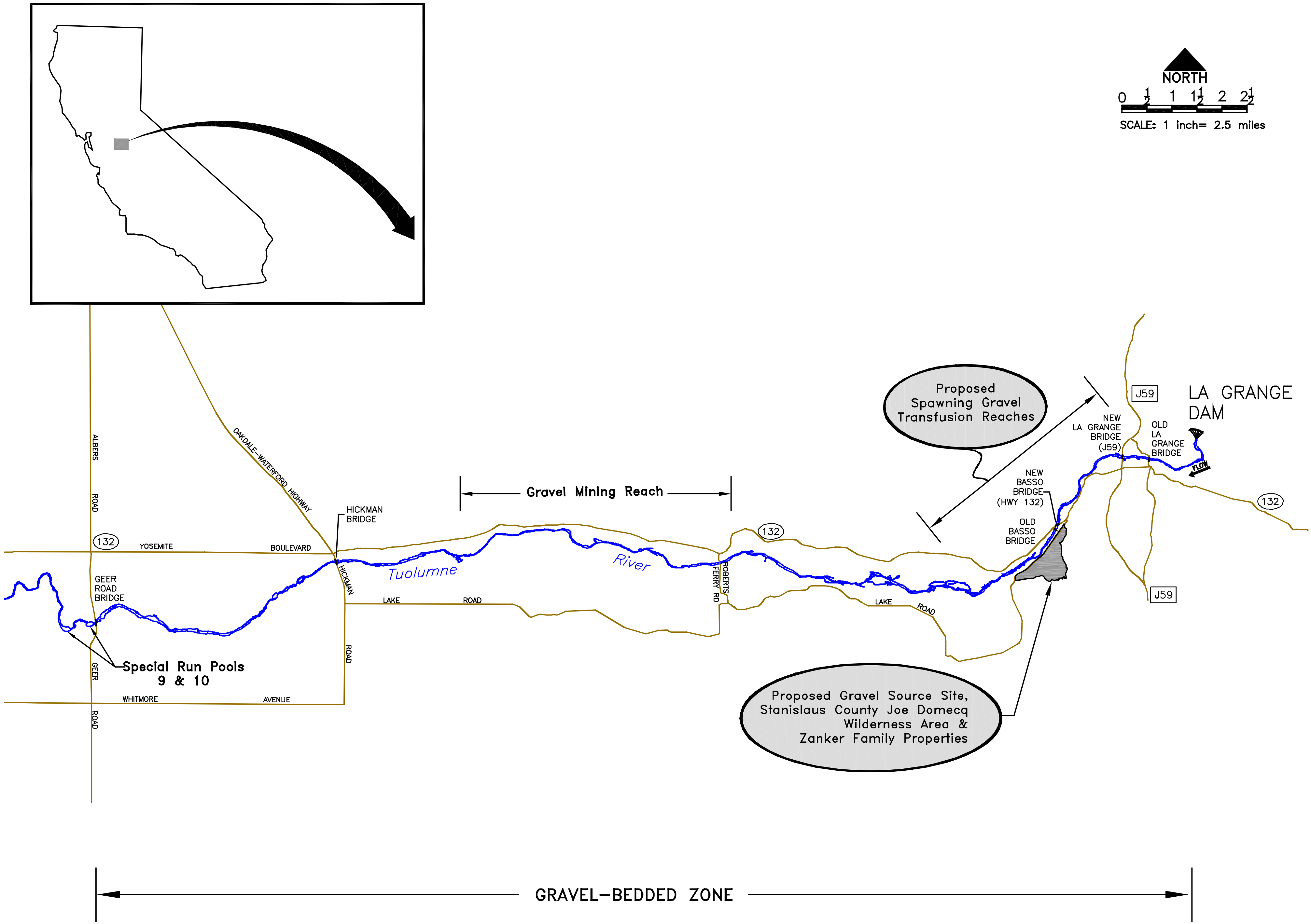
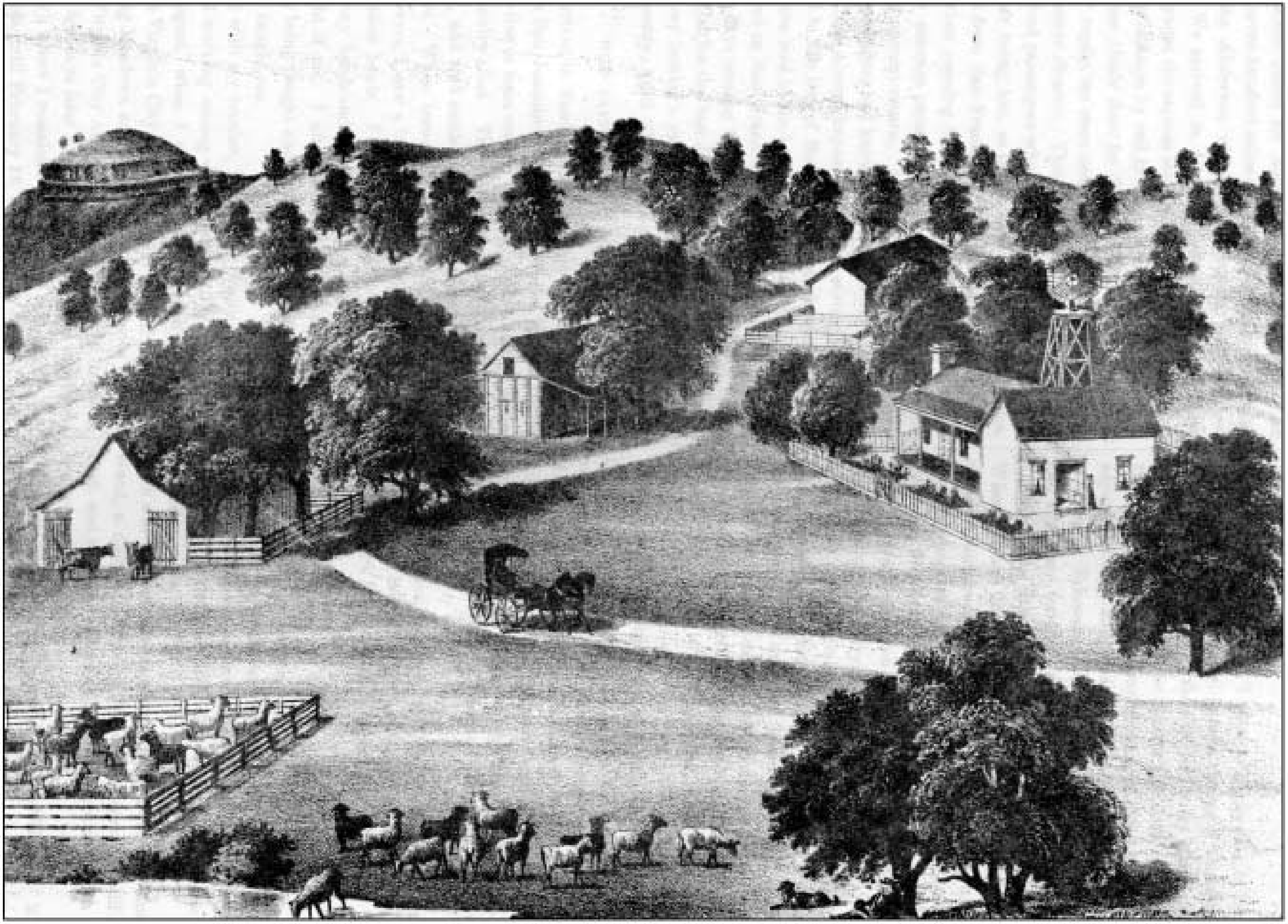


Figure 6. Location of the gravel source and gravel transfusion project sites along the Tuolumne River gravel bedded zone.



RES. & RANCH, OF P.H. DELANEY, ON THE TUOLUMNE RIVER, STANISLAUS CO. CAL.

Figure 7. Historical lithograph of the former DeLaney Ranch, which was sold then dredged, and is now the Joe Domecq, County Park and Zanker Family properties. For referance, the hillside at top left of the lithograph showing the TID canal excavation can also be seen in the arial photo of figure 4.

d) Hypotheses

H-1: The contemporary regulated flow regime and blocked coarse sediment supply impair the fluvial geomorphic processes necessary for creating and maintaining a healthy alluvial channel. Improving the coarse sediment supply in the channel will help restore the fluvial geomorphic processes and a natural channel morphology, but at a smaller scale than existed prior to streamflow/sediment regulation. This hypothesis entails an entire set of conceptual models, which will be described below;
H-2: the presently armored channel bed surface and enlarged channel dimensions increase the threshold for bed particle mobility and thus reduce the frequency of habitat-maintaining bed mobilizing events; adding gravel to resupply the channel will reduce the average particle size, increase sediment storage and therefore reduce channel dimensions, and eventually reduce the flow magnitude necessary to mobilize the channel bed;
H-3: spawning habitat quantity and quality has been identified as a factor limiting chinook salmon smolt production and subsequent recruitment; restoring the quantity and quality of spawning habitat below La Grange Dam will increase fry production and therefore contribute to achieving salmon population targets established by CALFED, AFRP, and the TRTAC;

e) External Engineering Review

As with other public works construction projects being developed and implemented on the Tuolumne River, this project will be subject to the same level of scrutiny and review. The initial task of this project is to develop a conceptual restoration design for the Domecq County Park and Zanker properties, and for the Gravel Transfusion sites. This conceptual restoration design will contain detailed information regarding: current and proposed topography, sediment volumes available for mining, sediment volumes proposed for extraction, a Mining Plan, haul routes, stockpile areas, wetland and terrestrial habitat restoration design specifications, gravel introduction designs and construction specifications, hydraulic modeling of channel hydraulics with proposed gravel additions, and monitoring plans. This Design Document will be available for review by external engineers, the Stanislaus County representatives, the Zanker family, and the public. We suggest Kevin Faulkenberry (DWR), and Kris Vyverburg (DFG) as qualified engineering reviewers.

2. Justification for the Project

a) Long-term Gravel Source

The primary justification for this project is the need to acquire a long-term source of sediment specifically designated for restoration purposes, to implement the Tuolumne River Restoration Plan. Acquiring a source of sediment will reduce the pressures on regional aggregate reserves, and would likely greatly reduce the cost of sediment for restoration projects. This strategy has already been followed on the Merced River, with acquisition of the Merced River Ranch, and the Stanislaus, with acquisition of Two-mile Bar.

An evaluation of the aggregate consumption and overall demand for gravel for restoration is informative. In just four projects, either funded or in proposal submission phase (SRP's 9 and 10, 7/11 and Ruddy Mining Reaches), approximately 777,000 CY (1.24 million tons) of sediment will be purchased and imported to restore the river channel and floodplains. This volume translates to approximately $8.5 million just for the aggregate costs (at $11/CY) for these four projects. The Tuolumne River Coarse Sediment Plan (McBain and Trush in preparation) estimates approximately 100,000 to 150,000 CY (160,000 tons) are needed in the upper spawning reach, and then approximately 2,000 to 4,000 CY annually to maintain equilibrium in supply and downstream transport. Other proposed or planned projects further downstream will also require large volumes of sediment to restore natural channel and floodplain morphology. To achieve complete restoration of the river (including filling all in-channel mining pits) will require on the order of 2,300,000 CY (3.68 million tons) of sediment (Table 1).

To put this into a regional perspective, one forecast of future aggregate consumption in Stanislaus County, based on present per capita aggregate consumption and future population growth projections, estimated a total projected consumption of 244 million tons (153 million CY) of aggregate through 2040 (E. Griffin & Associates personal communication). Special Report 173, prepared by the California Division of Mines and Geology (CDMG), reported the Tuolumne River floodway corridor is the largest aggregate resource in Stanislaus County, containing an estimated 217 million tons (135 million CY) (Higgins and Dupras 1993). As of 1993, permitted reserves in Stanislaus County totaled 27.7 million tons (17.3 million CY), and were predicted to be depleted by 2002. An additional 16 million tons of reserves were added in 1996, and near-term aggregate reserves are therefore secure. Additional permitted reserves will be required to

Table 1. Estimated sediment supplies needed for Tuolumne River restoration projects. Volumes are approximate.

	Aggregate Demand	
Restoration Project	CUBIC YARDS	TONS
SRP 5	175,000	280,000
SRP 6	160,000	256,000
SRP 7	320,000	512,000
SRP 8	825,000	1,320,000
SRP 9	144,000	230,400
SRP 10	293,000	468,800
7/11 Mining Reach	156,200	249,920
Ruddy Mining Reach	184,000	294,400
Warner/Deardorff Mining Reach	366,000	585,600
Reed Mining Reach	unknown	
TOTAL	**2,623,200**	**4,197,120**

maintain the reserve base and to meet the regional aggregate demand. This considerable current and future demand for aggregate, combined with the limited regional supply base, places an extremely high priority on the need to obtain a sediment supply set aside for river restoration.

b) Spawning Habitat Improvement

A second justification for the project is to provide an immediate and long-term source of spawning gravel to restore spawning habitat and sustain the salmon population. During the 2000/01 spawning season, spawning habitat availability was assessed from riffle A3/4 below La Grange Dam (RM 51.7) to Turlock Lake State Recreation Area (RM 41.6/Riffle 25). The 00/01 season was ideal for this assessment because the large spawning run had occupied all the usable spawning habitat. Laminated aerial photos were used in the field to map all spawning habitat in the upper 10 miles of the Tuolumne River spawning reaches, then these areas were digitized to quantify the spawning area available (Appendix A). We compared our 00/01 data with 1988 estimates of spawning habitat availability conducted under previous District monitoring efforts (EA 1992). This comparison provides some insight into trends in spawning habitat availability. A draft technical memorandum describing the results is attached in Appendix B. Our findings are summarized here:

- spawning habitat area has decreased by as much as 44% compared to the 1988 estimates, a result of gravel export during the 1997 flood and lack of gravel recruitment;
- the most evident impacts are generally in riffles upstream of New La Grange Bridge and in the reach below Basso Bridge (RM 42 to 48), whereas the best spawning habitat is between New La Grange and Basso Bridges (RM 48 to 50);
- several entire riffles have been scoured and completely eliminated, both from the 1997 flood and from the lack of sediment recruitment from above the dams. Riffles 6, 9, 10, 11, 17B and C, and 19 now provide no spawning habitat. Riffles 13A, 14, 15, 20 and 23B are more than 85% reduced, compared to 1988.
- an estimated 98,500 ft^2 of spawning habitat is available in the Dredger Reach. Using a common literature value of 216 ft^2 per chinook spawning pair (Burner 1951 as cited in Bjornn and Reiser 1991), the 6 mile Dredger Reach could support only 456 spawners without superimposition;
- the La Grange Spawning Reach (RM 48 to 52) provided 410,500 ft^2 of suitable spawning habitat, enough to support an estimated 1900 spawning pairs (at 216 ft^2/spawning pair);
- extrapolating the relatively healthy spawning habitat density in the La Grange to Basso reach (152,000 ft^2/mi) to the entire 9.65 miles of river assessed, then comparing this "maximum density estimate" (~1.5 million ft^2) to our empirical measurement (~509,000 ft^2), shows that only approximately 34% of the total spawning potential of the reaches upstream of TLSRA is actually available as suitable spawning habitat.

This current estimate of spawning habitat availability is considerably lower (~44%) than previous estimates, and will require revision in the chinook salmon population projections that are based on spawning habitat availability and other limiting factors. The Tuolumne River Chinook Salmon 'EACH' population model and the Redd Superimposition Model developed by the Districts are currently being updated under the Coarse Sediment Management Plan for use in evaluating chinook salmon habitat and population dynamics, and implications of recent habitat losses and the potential effects of restoration.

c) FERC Project Implementation Mandate

In 1995, through the FERC relicensing process for the Don Pedro Project, the Turlock and Modesto Irrigation Districts (Districts) and the City and County of San Francisco (CCSF) entered into a FERC Settlement Agreement (FSA) with the USFWS, CDFG, and several environmental 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 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 these ten projects (Table 2), which includes the spawning gravel addition recommended in the Restoration Plan. Gravel addition methods, gravel composition, and prioritized locations are being developed in the Coarse Sediment Management Plan (McBain and Trush, in progress). This planning effort has also assisted CDFG in implementing recent gravel augmentation projects in the reach near Old La Grange Bridge (RM 50.5).

Table 2. Tuolumne River Technical Advisory Committee selected “priority projects” to meet FERC License requirements.

		River Mile Location	River Mile Length	Forcasted Construction Schedule					
				2001	2002	2003	2004	2005	2006
Gravel Mining Reach		34.2-40.3	6.1						
1	7/11 Reach	37.7-40.3	2.6	x	x				
2	Ruddy Reach	36.6-37.7	1.1		x				
3	Warner/Deardorff Reach	35.2-36.6	1.4			x			
4	Reed Reach	34.2-35.2	1				x		
Other Projects									
5	SRP 9	25.8-26.0	0.2	x					
6	SRP 10	25.0-25.4	0.4			x	x		
7	River Mile 43 Channel Restoration	42.8-43.2	0.4		x				
8	Gravel Transfusion	40-52	12			x	x	x	?
9	Gasburg Creek Sediment Basin	50.3				x			
10	Gravel Cleaning	~40-52				x	?	?	?

d) Gravel Source Criteria

The Tuolumne River Restoration Plan developed a preliminary 'Gravel Source Inventory', that listed and quantified sources of sediment available for river restoration purposes. The Restoration Plan recommended targeting dredger tailings as a primary source of restoration project sediment and specified four primary criteria that should be used to prioritize and select potential restoration sediment sources:

- the material was lower in commercial quality than pit-run aggregate, to avoid removing a high quality aggregate reserve from commercial/infrastructure use;
- the material could be extracted without creating a pit adjacent to the river to avoid perpetuating the same situation the restoration project(s) were attempting to remedy;
- the material could be extracted and the extraction or "borrow" site could be restored to better conditions (e.g., creating shallow off-channel wetlands, restoring floodplain adjacent to the river, or replacing a xeric surface with native riparian vegetation);
- the source was within 20 miles one-way of most of the channel restoration projects planned for the Tuolumne River;

The Tuolumne River Coarse Sediment Management Plan has used these criteria to evaluate and target long-term restoration sediment sources for development. The proposed Domecq/Zanker parcels contain an estimated 2.4 million tons of usable sediment (1.5 million CY), and meet all the above criteria. First, as discussed, these parcels were previously dredged, then scraped of most tailing deposits during construction of New Don Pedro Dam, and are thus of lower quality than commercial floodplain-pit aggregate. Second, by purchasing mineral rights to this material, as targeted by this proposal, the TRTAC can utilize a portion of the material for restoration and leave remaining material on-site, avoiding complete material excavation to form another pit. This proposal will also allow the TRTAC to avoid purchasing commercial aggregate obtained from mining pits. The TRTAC would develop a restoration design (reclamation plan) in conjunction with Stanislaus County and the Zanker family that is supported by all parties. Third, both the Zanker family and Stanislaus County representatives support the goal of restoring the xeric, dredged and scraped surfaces to better quality habitat, including perennial wetlands, riparian habitat, and intermittent Valley Oak (*Quercus lobata*) woodland habitat. Last, the Domecq/Zanker parcels are at river mile 46.5 to 47.5, approximately 20 miles from the furthest downstream project (SRP 10), and as close as possible to the spawning reaches proposed for gravel transfusion (Figure 6).

e) Conceptual Models

In June 2001, the Anadromous Fish Restoration Program (AFRP) and CALFED, working through the Information Center for the Environment (University of California–Davis), convened the first of several Adaptive Management Forums. These Forums are broadly intended to review the planning and implementation of large-scale restoration projects in the Central Valley, and to provide input and assistance to the personnel and organizations responsible for design, implementation, and monitoring of large-scale restoration projects. Forum I focused on the Tuolumne River (June 2001), Forum II will evaluate the Merced River restoration program (November 2001), and Forum III is intended to focus on Clear Creek (April 2002).

One of many useful outcomes of the Tuolumne River Adaptive Management Forum was development of a set of peer reviewed, detailed conceptual models that illustrate our current understanding of the Tuolumne River system These conceptual models were developed by AMF Panel members, Stillwater Sciences, and McBain and Trush. See Appendix C for description of these conceptual models.

In addition to the conceptual models developed as part of the Adaptive Management Forum, the *Restoration Plan* proposed the "Attributes of Alluvial River Integrity" as a conceptual basis for evaluating fluvial geomorphic processes. 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 (PNAS) (Trush et al. 2000). The *Attributes* are essentially a set of hypotheses that describe the critical geomorphic processes that form and maintain alluvial rivers. Combining the *Attributes* with the Conceptual Models developed for the AMF, provides a basis of understanding of river ecosystems to: 1) to 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. The PNAS publication is provided as Appendix D to this proposal, and can be found at http://www.pnas.org/all.shtml by entering Vol 97:11858.

Based on the Attributes and our current understanding of alluvial rivers, we 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) as shown in Figure 8. Then 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.

The conceptual model specific to this project hypothesizes that the alluvial reaches of the Tuolumne River have become depleted of a large volume of coarse sediment that historically: (1) composed the bed and banks of the bankfull channel, (2) was stored in alternate bars, and (3) formed floodplain and terraces. The bankfull channel has consequently widened and deepened, and the bed has become armored. Additionally, the natural alternate bar sequences that provide salmonid habitat have been replaced by long pools, and the "pool-cascade" morphology described in the Restoration Plan (pp. 95-106). These changes in channel morphology have in turn reduced the quantity and quality of salmon habitat, and have impaired the fluvial geomorphic processes that create and maintain healthy habitat. Adding gravel back into the channel will provide immediate benefit of increasing the availability of spawning habitat, and will provide long-term benefits of reducing the threshold for bed mobility and therefore increasing the frequency of bed mobilization. Restoring these dynamic processes to the Tuolumne River will allow the river to reform a more natural channel morphology and provide more and better chinook salmon habitat.

f) Hypothesis Testing

The broad hypothesis being tested by this restoration approach is whether fluvial processes can be restored in a highly regulated river such as the Tuolumne River, but at a smaller scale than existed naturally, as a way to restore and maintain channel morphology, riparian vegetation, and salmon populations. Testing this hypothesis will require importing a large volume of fine and coarse gravel, then allowing winter high flows to "rework" the reintroduced gravel to a natural channel morphology and periodically maintain it.

A secondary hypothesis is based on previous monitoring conducted by the Districts (EA 1992), which proposed that spawning habitat was a major factor limiting salmon production, by encouraging redd superimposition and associated egg mortality. By greatly increasing the amount of spawning habitat available in the upper river (where salmon preferentially spawn), we can observe the long-term effect on annual escapement.

The above hypotheses will be tested in the following manner:
<u>H-1 and H-2 [Improving the coarse sediment supply in the channel will help restore the fluvial geomorphic processes and a natural channel morphology, at a smaller scale than the pre-regulated channel]</u>.
The TRTAC channel dynamics monitoring program has employed a multi-tiered approach combining installation of tracer rocks and bed scour experiments to document bed mobility thresholds and frequency, along with empirical measurement and modeling to quantify bedload transport. The Coarse Sediment Management Plan has established a permanent bedload transport measurement station at riffle 4B above Basso bridge and has begun developing a discharge-transport rating curve that will allow long-term quantification of the volume of coarse sediment transported out of the spawning reaches. In addition, the TRTAC has established and surveyed at least 19 cross sections and surveyed the longitudinal thalweg profile in the reach above Basso Bridge for long-term monitoring of changes in channel morphology.
<u>H-2 [restoring the quantity and quality of spawning habitat below La Grange Dam will increase fry production and therefore contribute to achieving salmon population targets]</u>.

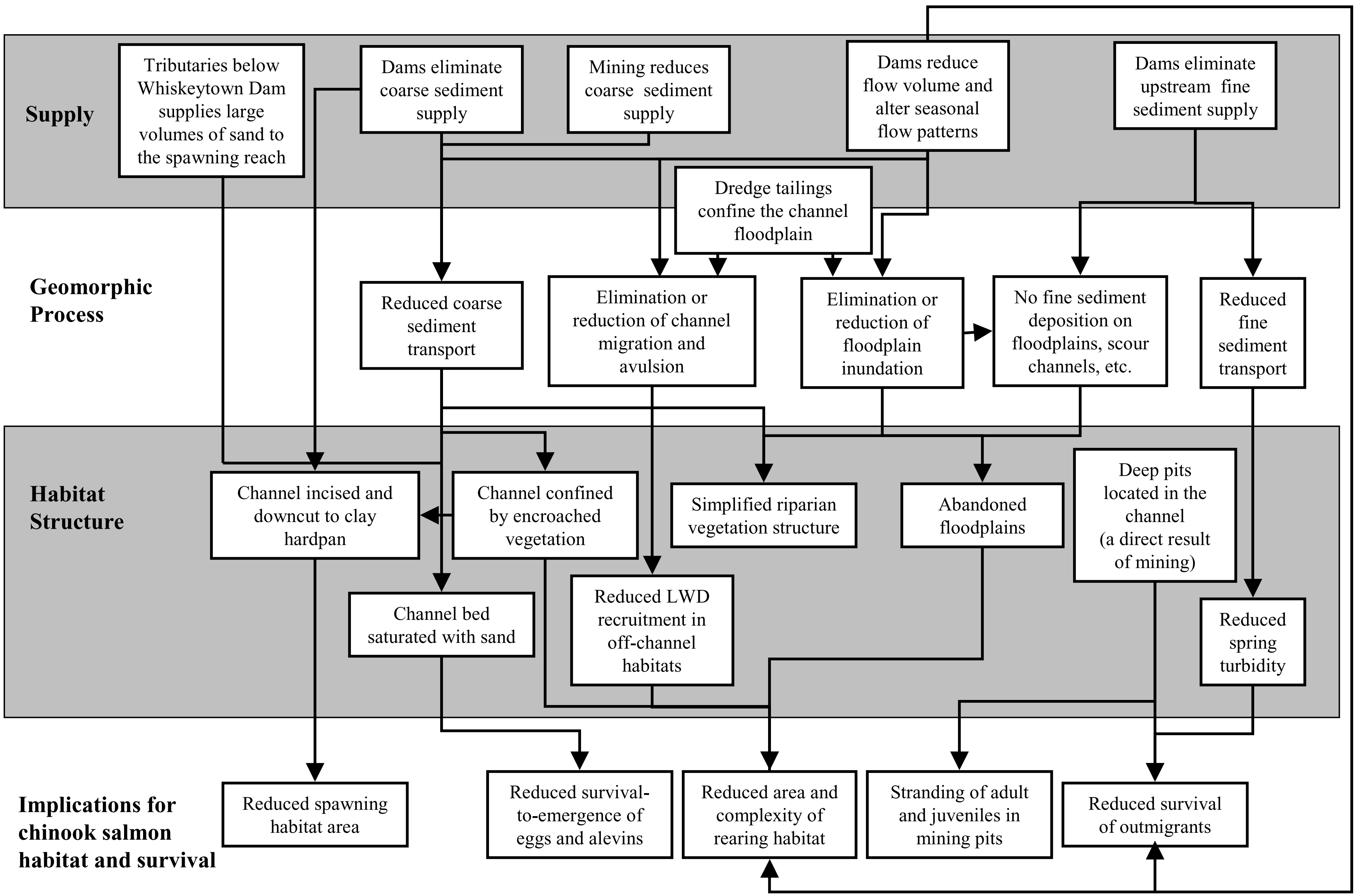


Figure 8. Overarching conceptual model linking the impacts of dams and gravel mining to physical processes, habitat structure, and chinook salmon population on the Tuolumne River, CA. Prepared by Stillwater Sciences and the Tuolumne River Technical Advisory Committee.

The TRTAC and CDFG will continue to estimate the annual salmon escapement for comparison to escapement data collected during the past 60 years, and will continue the annual salmon fry and juvenile seining program conducted by the Districts. Additionally, the TRTAC has implemented a spawning gravel quality assessment program including particle size analyses and permeability monitoring, and will soon begin evaluating the relationship between gravel composition, permeability, and salmon fry survival-to-emergence.

g) Key Uncertainties

The key uncertainties associated with this project are:

1) the total (net) volume of sediment available at the Domecq/Zanker sites for extraction and use in restoration projects. These net coarse sediment volumes for each property (Domecq and Zanker) were determined in the following manner: (1) for the Zanker property, a resource analysis report commissioned by the Zanker family reported a gross volume of 2 million tons (1.25 million CY) of coarse sediment contained on their property. This report also analyzed sediment composition from 12 test pits, and determined approximately 50% of the gross sediment volume was fine sediment smaller than 3/8 inch. This fine sediment portion of the total material volume would be screened and removed before being used as spawning gravel. We assumed a maximum of only 60% of the gross material volume would be mined, to meet restoration goals and reclamation plan requirements. This assumptions yielded a net maximum usable volume of 1.2 million tons of coarse sediment (750,000 CY). (2) for the Joe Domecq County Park, we assumed no mining would occur in areas with mature vegetation, then measured the surface areas barren of vegetation as potentially mineable areas (76 acres). We then assumed mining to an average depth of 6 ft, which we assume would allow portions of these areas to be mined below the groundwater depth to provide open-water wetlands, other areas as shallow emergent wetlands, and unmined areas integrated into designs as terrestrial areas. These assumptions provided a maximum net volume of coarse sediment available from the Joe Domecq area of 1.2 million tons (740,000 CY) (Table 3). Combined, these calculations and assumptions yield a total usable sediment volume of 2,380,000 tons (1,480,000CY). We are confident this is a relatively balanced, reasonable estimate of sediment availability.
2) an agreement of mineral rights acquisition and royalty values between landowners (willing sellers) and TID. This agreement will be negotiated in the initial appraisal phase of the project. To determine an approximate cost of the mineral for budgeting purposes, we have assumed a royalty value of $0.55 per ton of sediment, which is similar to regional values currently in use. This royalty was applied to the gross mineral volume available at the Zanker property (i.e., the entire mineral rights would be purchased), and applied to the potential net volume of mineral removed from the Joe Domecq County Park (i.e., Stanislaus County receives royalty only for mineral actually purchased).
3) value of a conservation easement at the Zanker properties. This would preserve in perpetuity areas that are restored following removal of the coarse sediment material.
4) meeting regulatory compliance requirements. The project will involve development of a CEQA/NEPA document for regulatory purposes, followed by acquisition of numerous regulatory permits from various state and federal agencies. The project would also require approval of a Conditional Use Permit from Stanislaus County for mining.
5) development of a phased Reclamation /Habitat Restoration Plan. This plan will require meeting regulatory compliance standards and Reclamation Plan requirements during the phased gravel extraction and habitat restoration process, which may be extended over a period of several years. The Plan would attempt to minimize disturbance at habitat restoration sites, minimize costs for excavation and transportation, and maximize material yield for gravel transfusion and other restoration projects.
6) near-future demand for the remaining purchased sediment at the project site. This demand will be influenced, to some extent, by future projects implemented with funding provided by CALFED/AFRP.

h) Adaptive Management Framework

This project **IS an adaptive response** to previous planning efforts and recent attempts to implement other projects. First, the Tuolumne River Restoration Plan acknowledged the scarcity of regional aggregate reserves and the near-future demand for restoration material. The Restoration Plan recommended targeting dredger tailings as the primary source of restoration sediment, in order to “minimize future conflict or competition with commercial aggregate operators on the river” (McBain and Trush 2000).

Table 3. Estimate of total sediment available from the Zanker property and the Joe Domecq County Park.

	SURFACE AREA (acres)	SEDIMENT VOLUME (tons)	SEDIMENT VOLUME (yd3)	Notes/Assumptions
Zanker property				
estimate of total sediment available	96	2,000,000 #	1,250,000	assumes mining to 20 ft depth
estimate of total sediment available		1,200,000	750,000	based on mining 60% of available material
Joe Domecq Wilderness				
estimate of total sediment available		NA	NA	no material testing performed to-date
estimate of total sediment available	208	1,178,637 #	736,648	based on mining average 6 ft deep in unvegetated
Total Sediment Purchased for Export to Restoration Projects		**2,378,637**	**1,486,648**	

Sediment volume upon which total mineral cost is based.

Also, recent projects that are being planned or implemented have incurred relatively high costs for purchasing aggregate on the open market, thus warranting locating and obtaining an alternative, lower-cost source of coarse sediment for restoration projects.

This project is also responding to the currently degraded conditions of spawning riffles that has resulted from slow gravel attrition in riffles due to lack of gravel recruitment below La Grange Dam, and more catastrophic habitat loss resulting from the 1997 flood. Recent habitat assessments have indicated that spawning habitat availability has been reduced approximately 40% compared to previous assessments in the primary spawning reaches from La Grange Dam to Roberts Ferry Bridge. Implementing the proposed gravel transfusion project will also provide an adaptive management opportunity. Several tributaries in the Central Valley are implementing gravel addition projects, including the Stanislaus, the Upper Sacramento, Clear Creek, and the Trinity River. The combined information from these projects will allow the TRTAC, CALFED, and AFRP to eventually develop standardized introduction methods useful for all Central Valley impounded rivers. The Tuolumne River (with CDFG as lead project proponent in Phases I and II of the La Grange Gravel Addition Projects), has already begun experimenting with estimating gravel introduction needs, employing different gravel introduction methods and gravel compositions, and then evaluating the project success in terms of spawning use (Appendix E).

3. Approach

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 (Appendix D) provide a framework of geomorphic processes that define this goal, but also generates information useful in an adaptive management framework.

The restoration approach proposed for the Domecq/Zanker borrow site is as follows: (1) excavate previously dredged and scraped material from relatively unproductive zones (those with armored cobble surfaces, lacking soil development, groundwater, etc.) (Figure 4), (2) process and transport this material to the Tuolumne River either as screened and washed spawning gravel for insertion at 'gravel transfusion sites', or as bulk, unprocessed material to be used at large-scale channel reconstruction sites, and (3) reclaim the 'borrow' site to wetland, riparian, and woodland habitats by replanting with native riparian and wetland vegetation. Areas that already provide 'healthy' habitat, such as intermittent patches of willow and cottonwood, or the existing wetland ponds at the Domecq County Park, will be integrated into the overall restoration design to highlight their value. The sediment extraction process will be implemented in phases according to the restoration material needs; the restoration design will thus incorporate appropriate design criteria to allow implementation of a phased reclamation plan. This approach is similar to the restoration approach successfully implemented in Clear Creek, California, with reclamation of the 'borrow site' linked to the phased use of material at the restoration project sites. In the case of the Tuolumne River, the gravel transfusion project would be implemented under this proposal. Future projects, such as SRP's 5, 6, 7 and 8, while not part of this project, will benefit from the availability of a permitted reserve of coarse sediment specifically designated for restoration projects.

The gravel management strategy proposed for the upper spawning reaches has proposed (1) introducing a large volume of gravel to resupply spawning riffles and alternate bars, and restore the in-channel sediment supply that has been lost during the last 108 years since the La Grange Dam was constructed, then (2) implementing annual gravel augmentation (or periodic, depending on the prior winter flow regime) below La Grange Dam and other locations to replace the volume transported downstream. The TRTAC has begun collecting empirical data and developing models of bedload transport rates that will eventually allow managers to predict, based on the prior winter flow regime, the volume of coarse sediment augmentation required to maintain an equilibrium in in-channel sediment supply (Figure 9). This supply maintenance (via mechanical sediment introduction) thus responds to periodic channelbed mobilization and scour that occurs periodically during wet water year types, and results in high quality habitat maintained through natural processes (McBain and Trush 2001a).

This project differs from previous gravel augmentation actions implemented on the Tuolumne River, first by the scale of the proposed gravel transfusion, and second by the method proposed for obtaining the gravel supply. Phase I of the CDFG/DWR gravel augmentation program placed approximately 12,500 cubic yards of gravel at Riffle 1A below La Grange Bridge in 1999. Phase II of the Spawning Gravel

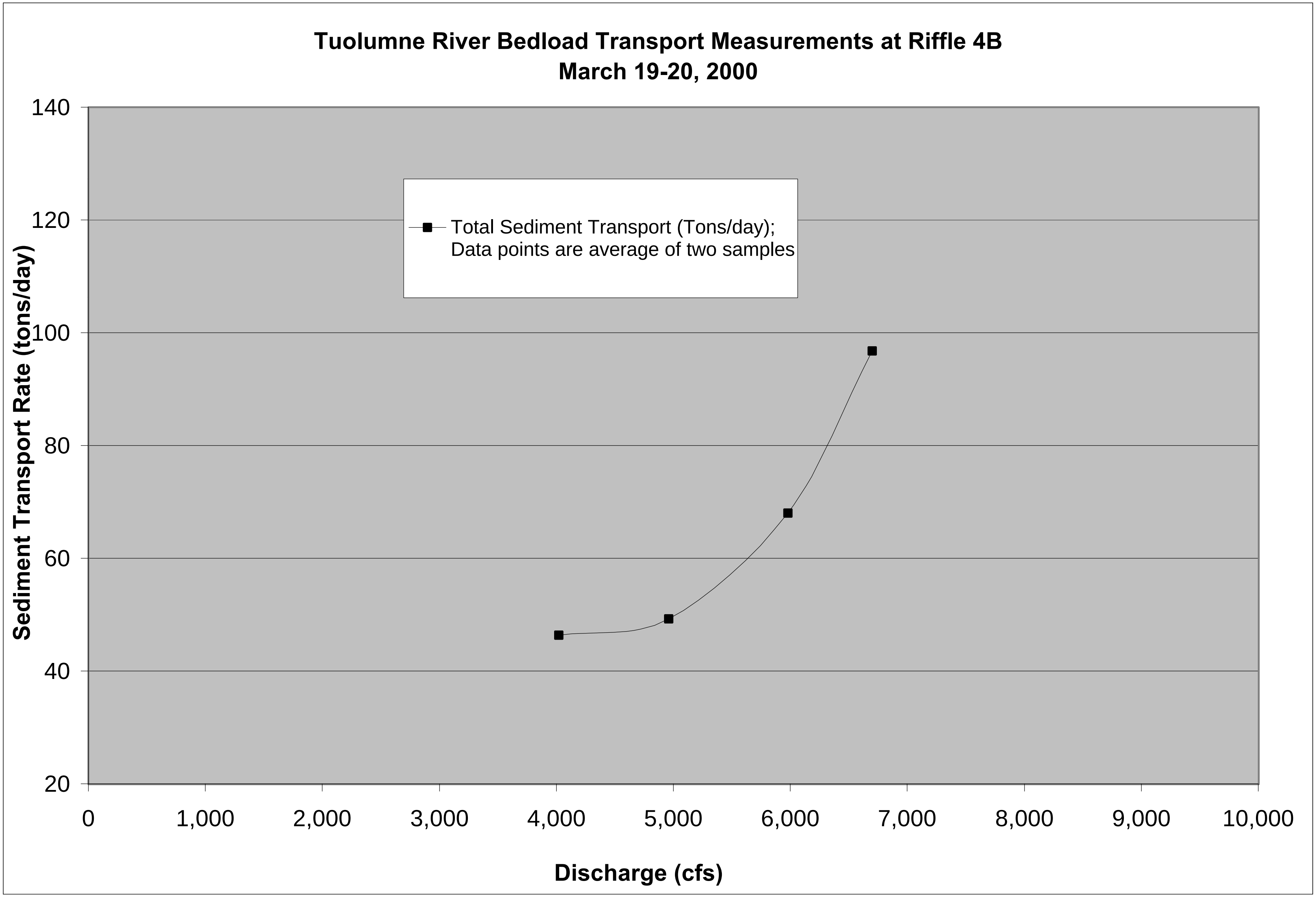


Figure 9. Preliminary sediment transport rating curve developed from empirical measurements at Tuolumne River riffle 4B, Just upstream of Basso Bridge (RM 48.2). Measurments were conducted during three days of controlled flow releases from New Don Pedro Dam provided by the Turlock and Modesto Irrigation Districts.

Introduction Project was funded by AFRP and the Tracy Mitigation Program, and imported approximately 10,000 CY of spawning gravel in 2001. This gravel has not yet been placed into the channel due to permitting delays, and should be completed in 2002. Gravel introduction designs and recommendations for different locations, gravel placement methods, and gravel composition have been developed for this reach (McBain and Trush 2001a, Appendix E). We propose to continue the TRTAC integration with the DFG/DWR program by providing an alternative and less expensive gravel source, larger gravel volumes available for introduction, comprehensive permitting for the entire transfusion project, and integrated implementation and monitoring strategies to maximize the experimental opportunities and information obtained from these projects.

a) Scope of Work

The two broad goals put forth by this proposal (material acquisition and gravel transfusion) will require a minimum of two years to complete the planning and implementation phases. In this proposal, we delineate project tasks and budget according to a two-year timeline (Figure 10).

YEAR 1:

TASK 1: Prepare Conceptual Restoration Designs.

The Tuolumne River Technical Advisory Committee has committed to provide $50,000. in cost-share funding for this task. These funds will be used to initiate four subtasks: (A) perform a Regulatory Constraint Analysis to identify the constraints imposed on the project design by agencies with jurisdiction over land use and resource protection, (B) conduct total-station topographic surveys to develop ground topography and digital terrain model of existing conditions, (C) excavate test pits on-site to estimate the depth of sediment material and groundwater, and sieve excavated material to determine material composition; and (D) develop a conceptual restoration design to estimate material volumes available for excavation, and delineate a project footprint for regulatory compliance purposes. These three subtasks provide essential information for the next several planning phases of the project.

TASK 2: Material Appraisal and Purchase.

Following regionally established conventional methods used to determine the value of aggregate reserves, a professional Mineral Appraiser will be contracted to establish a total purchase value of the aggregate reserves contained on the Stanislaus County Joe Domecq parcel, and on the Zanker parcel. The mineral valuation process is based on the following information and assumptions: (1) the quantity and quality of the reserves, (2) access to processing and the market, (3) the projected production period, (4) a royalty rate and appropriate discount rate, (5) expensed attributed to owning the land, and residual value of the land upon completion of the mining operation. Occasionally several appraisers are employed for the same purpose, and the final mineral purchase price negotiated between buyer and seller. The Zanker parcel will also include an agreement to establish a Perpetual Conservation Easement to preserve those areas mined for sediment and restored to wetland and riparian habitat. Completion of this task results in the purchase of mineral rights and payment of conservation easement from the Zanker family, and payment of mineral royalties to Stanislaus County.

TASK 3: Regulatory Compliance and Permit Acquisition.

This project will require preparation of environmental documents pursuant to CEQA/NEPA. In addition, the project will require acquisition of appropriate local, state and federal permits, leases or easements, which would involve the following agencies: Stanislaus County, Mosquito Abatement District, County Parks and Recreation, California Division of Mines and Geology, Department of Fish and Game, Department of Water Resources' Reclamation Board, State Lands Commission, Regional Water Quality Board, Regional Air Quality Board, State Office of Historical Preservation, US Army Corps of Engineers, Fish and Wildlife Service and National Marine Fisheries Service. Because these properties, which have aggregate resources, do not have Conditional Use Permits (CUP) to allow mining, the project will also require a CUP and approval by Stanislaus County of a Reclamation Plan. The Conceptual Restoration Design developed in Task 1 will serve as the Reclamation Plan, which will describe the mining operation, reclamation/ revegetation to seasonal or perennial wetlands, riparian habitat, and upland habitat.

YEAR 2:

TASK 4: Develop Final Grading Plans, Construction Specifications, and Bid Packages for the Domecq/Zanker Borrow Site and the Gravel Transfusion Sites.

Based on the preliminary designs developed in Task 1 and the approved Reclamation Plan, this task will develop the final grading plans, construction specifications, and the bid documents necessary to solicit construction bids for project implementation. This includes grading plans, specs, and bid docs for the

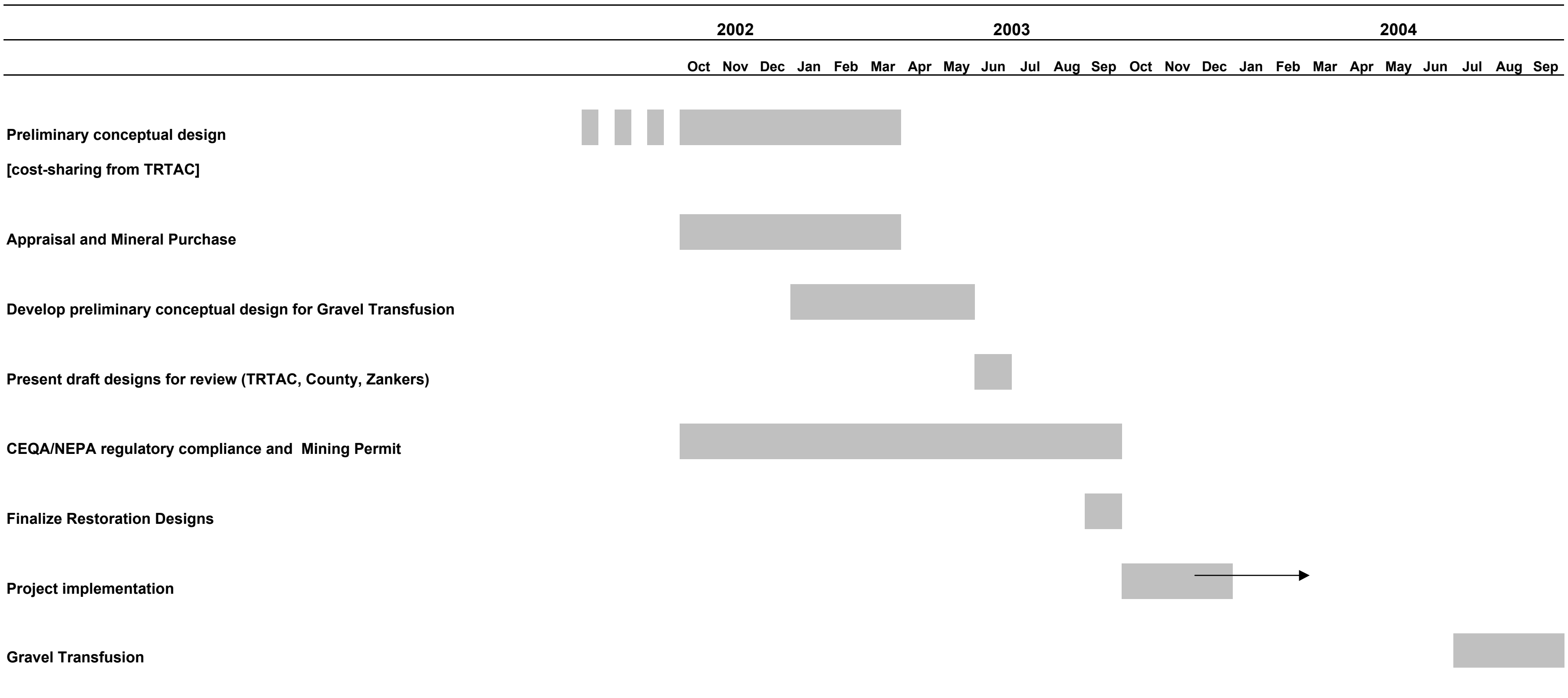


Figure 10. Proposed 2-year timeline for development of the "Tuolumne River Sediment Acquisition and Spawning Gravel Transfusion Project".

Domecq/Zanker properties (material borrow site) and the gravel transfusion sites targeted for gravel introduction (Appendix A, Plates 1-5)

TASK 5: Project Implementation.
This task will solicit bids for the project construction phase, award a contract to the successful bid, then implement the project. Project implementation will include (1) excavation and on-site processing of approximately 200,000 CY of material to produce approximately 100,000 CY of clean, high quality spawning gravel (based on screening and removal of fine sediments smaller than 3/8 inch, estimated to compose approximately 50% of the total material volume) (2) transport, stockpiling, and insertion of approximately 100,000 CY of cleaned and sorted spawning gravel into specified locations along the spawning reaches of the Tuolumne River below La Grange Dam, (3) initial implementation of borrow site reclamation, including revegetation of wetland, riparian, and woodland habitats in the areas mined during this phase of borrow material extraction (estimated at approximately 20-30 acres), and (4) monitoring at the material extraction/wetland restoration site and at the gravel transfusion sites.

b) Sediment Cost Evaluation and Remaining Sediment Supply

Based on our preliminary volume estimates, approximately 1.34 million CY of material would remain for use in other restoration projects at the completion of this project (Table 3). Costs for mining and transporting this sediment to other project locations and meeting requirements of the Reclamation Plan would be contained within future project budgets. This project, however, provides a substantial up-front investment by purchasing the sediment and completing regulatory compliance requirements, thus reducing the cost of material for future projects (perhaps substantially).

We compared the unit cost of sediment purchased in this proposal to current market costs for commercial aggregate. Our proposal includes the purchase of mineral rights, appraisal, regulatory compliance and permit acquisition, reclamation plan development costs, excavation, on-site processing (screening and washing), and transportation costs based on a 90 minute truck turn-around time. The total cost per ton of this material was $9.03/ton. Current bids on the Tuolumne River restoration projects range from $11/ton to as high as $15/ton for material delivered to approximately the same location. Increasing the potential site (transportation) distance to a 120-minute truck turn-around (round-trip distance to SRP 10, the furthest downstream project), would increase material costs to approximately $11/ton, still competitive with the current costs being incurred at SRP 9 (Table 4). In addition to providing sediment with significant cost savings, this approach will also achieve other priorities of reducing demand for commercial aggregate reserves, avoid creating additional floodplain pits next to the river, and allow wetland and riparian restoration of a valuable public resource.

4. Feasibility

This project approach is a public works construction project that will require planning, permitting, engineering design and review, and implementation phases similar to other large-scale earthworks projects, and also similar to the restoration projects currently being implemented by TID and the TRTAC (SRP 9 and the 7/11 Mining Reach). Conceptually the project is relatively straightforward: purchase the mineral rights to aggregate, meet environmental compliance and permitting requirements, develop a reclamation/restoration plan, develop engineering/earthwork plans, mine a small portion of the purchased sediment, and transport it to the river for spawning gravel injections. No land acquisition is included in this project. Additionally, the Zanker family and representatives of Stanislaus County are eager participants in the project, and want to see the sites reclaimed to high quality wetland habitat.

There are, however, two important hurdles in this project approach: the mineral rights appraisal process, and a County Conditional Use Permit for Mining. The process of mineral valuation is typically performed with assistance of Real Estate/Mineral Appraisers, whose task is to determine an appropriate current market value for the mineral proposed for purchase. This valuation process depends occasionally on the subjective opinion of the Appraiser, but is nevertheless based on the Uniform Standards of Professional Practices. Thus, while all attempts to establish fair and reasonable market values are made during the process, there is nevertheless the possibility that the outcome of the appraisal process does not meet the interests of the seller, and the purchase cannot proceed. This potential scenario would apply only to the private property in this proposal.

The second contingency, the Conditional Use Permit, is less definitive. The California Surface Mining and Reclamation Act of 1975 (SMARA) required the CA Division of Mines and Geology (CDMG) to identify all mineral resources in the state that have potential for resource development (i.e., mining).

Table 4. Comparison of unit costs for aggregate produced by this project compared to the cost of aggregate purchased from commercial producers.

	(Cost per Ton)	*(Cost per CY)*
Sediment cost + Regulatory Compliance/Permitting	$0.59	$0.95
Earthwork Onsite Cut/Fill,Stockpile		$5.50
Onsite Material Processing (wash and sort to >3/8" gravel)		$2.00
Transport cost for 14 yard truck load, based on 90 minute truck round-trip		$6.00
Total unit costs for screening, washing, transporting	**$9.03**	**$14.45**
Current minimum cost of **commercial aggregate**	**$11.00**	**$17.60**

Along the Tuolumne River, CDMG identified approximately 217 million tons of aggregate, including the mineral contained in the Joe Domecq County Park and the Zanker properties (Higgins and Dupras 1993). Aggregate available for mining is referred to as a "resource" until a CUP and Reclamation Plan are approved by the County Planning Department, after which it becomes a "reserve". As of 1993, permitted reserves in Stanislaus County totaled 27.7 million tons, and were predicted to be depleted by 2002. An additional 16 million tons of reserves were added in 1996. Additional permitted reserves will be required to maintain adequate supply to meet the regional aggregate demand. We have had several conversations with Stanislaus County to identify critical issues, impacts, or other impediments to the completion of this project. The Stanislaus County Planning Department is aware of our intentions of pursuing this project and eventually applying for a Mining Permit, and the Stanislaus County Environmental Resources Department is an active supporter of this project, willing to present the project to the County Board of Supervisors to seek their approval at the appropriate time. If these two issues (appraisal and permitting) proceed in a relatively routine manner, consistent with other similar projects, then this project can be completed in the two-year timeframe allotted.

a) Environmental Compliance and Permitting

Environmental compliance and permitting has been designated as an entire task under this project, and is described in the Approach section above. Required permits are listed in the Environmental Compliance checklist of the Online Forms.

5. Performance Measures

The success of this project will be measured in several ways. First, monitoring elements will be designed and implemented to measure project performance at the borrow site (Domecq/Zanker parcels). Wetland and riparian revegetation will be assessed by quantifying the survival rate of planted stock for a period of two years using percent-cover of planted vegetation measured in sample plots as a performance criterion, and with specified 'success criteria' predetermined. This measure will allow long-term tracking of vegetation density at restored sites. Second, in the gravel transfusion tasks, spawning gravel placed into the channel will be monitored by (1) cross section surveys to evaluate planform and topographic response to streamflow; (2) longitudinal profile surveys of the channel thalweg, to evaluate how the channel thalweg evolves in response to flows; and (3) tracer rocks and scour cores, installed to evaluate the surface particle mobility of the channel bed. And third, we will evaluate the per unit cost of sediment produced from this project and compare this cost to regional costs from commercial producers. This will allow us to determine if developing reserves specifically designated for restoration purposes reduces the costs of restoration projects, and if so, by how much. This information would be useful for planning purposes in other stream corridors where large sediment volumes are potentially needed.

6. Data Handling and Storage

The Turlock Irrigation District (TID) will function as contract manager for this project, similar to other projects funded on the Tuolumne River by CALFED. TID typically develops service contracts with consultants specializing in various components of the project planning and implementation, and then serves as the clearinghouse for project related information. Reports and analysis prepared by the firm contracted to conduct the monitoring are submitted to the TRTAC for review. These monitoring reports are also part of the annual Status Report submitted to FERC along with the associated riverwide monitoring conducted by the Districts and TRTAC. All reports, maps, GIS data, draft and final project design documents, regulatory compliance documents, bid specification packages, and monitoring data are compiled with TID as project records. Information is generally stored in MS Excel and Word, AutoCAD, and ArcInfo. All final reports prepared during this project will be provided to CALFED and AFRP, and additional reports and data will be available to CALFED/AFRP upon request.

7. Expected Products/Outcomes

This project will provide the following products:

<u>Restoration conceptual design document</u>, describing the Domecq/Zanker parcel restoration design, design parameters, project boundaries, expected future condition, and …

<u>Environmental compliance document</u> describing project impacts, and …;

<u>Permits and Leases</u> obtained from appropriate local, state, and federal agencies;

<u>Public workshop</u> organized to present the proposed restoration design to interested public agencies, such as County Supervisors, and to local citizens;

<u>Project Completion Report</u>, describing the project planning and implementation phases, submitted to CALFED and available on request;

Annual monitoring reports (for two monitoring years) describing the project performance in meeting targeted goals and objectives.

If this project is fully implemented, the Tuolumne River would be one of the first tributaries in the Central Valley to undergo a large-scale "gravel transfusion" to significantly increase the in-channel supply of sediment that has been lost during more than a century following construction of La Grange dam. A similar gravel restoration approach is being recommended for Clear Creek (McBain and Trush 2001), tributary to the Sacramento River near Redding, CA. This transfusion of gravel on the Tuolumne River would include rebuilding spawning riffles and pool tails to provide immediate benefits to chinook salmon by substantially increasing the amount of spawning habitat available. It would also include supplementing stream banks that have become artificially widened due to scour and lack of supply. The transfusion also proposes supplementing lateral gravel bars to provide a stored supply within the bankfull channel available for downstream transport during high flows.

8. Work Schedule

If approved by CALFED by March 2002, a conceptual restoration design will be developed for the Joe Domecq County Park and Zanker Ranch with cost-share funds provided by the TRTAC. Beginning in October 2002 with completion of a contract with CALFED, we have allowed an additional six months for completion of the conceptual design and the mineral appraisal/purchase process, and one entire year for the Regulatory Compliance and Permitting process. Assuming completion of all regulatory requirements, project design and construction specifications by Fall 2003, the project implementation can proceed during winter/spring 2003/04. The gravel transfusion would be required to take place during the summer low flow period of 120 days from 1 June through 30 September when the fall run chinook salmon are normally not in the river. 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. Construction out of the water will occur throughout the year with appropriate erosion control measures. With this proposed timeline, the project completion date is approximately October 2004, for a two year project timeline. Figure 10 shows the project timeline.

B. APPLICABILITY TO CALFED ERP AND SCIENCE PROGRAM GOALS AND IMPLEMENTATION PLAN AND CVPIA PRIORITIES

1. CALFED ERP and Science Program

SJ-1. Continue habitat restoration actions including channel-floodplain reconstruction projects and habitat restoration studies in collaboration with local groups.

This gravel augmentation project directly addresses the Restoration Priority #1 for the San Joaquin Region. This project will purchase mineral rights for a large volume of gravel, obtain necessary permits, extract approximately 200,000 CY, then restore the borrow area to wetland and riparian habitat. The gravel material will be screened and washed to remove coarse (>5 inches) and fine (<1/4 inch) material, transported to the Tuolumne River and placed into the channel to supplement spawning habitat at riffles and pool tails. In addition to meeting the CALFED restoration priorities, this project continues development of priority projects outlined by the TRTAC habitat restoration program. The Tuolumne River Restoration Plan (McBain and Trush 2000, p.165) recommended implementing "a large 'transfusion' of coarse sediment to provide alluvial deposits immediately available for chinook salmon spawning, and for eventual downstream transport and redeposition". The Coarse Sediment Management Plan (with funding provided by AFRP) has further developed this sediment management objective by (1) habitat mapping to quantify existing spawning conditions, (2) delineating in-channel and lateral gravel augmentation areas for immediate implementation (Appendix A), (3) quantifying the volume of coarse sediment needed to accomplish the gravel transfusion, and (4) developing a plan for obtaining and developing the highest priority and most logical source of gravel. Results from in-channel habitat assessments indicate the need for placing approximately 100,000 to 150,000 CY of spawning gravel in the reach between Riffle A3/4 below La Grange Dam downstream to the Bobcat Flat restoration projects. This project will place approximately 100,000 CY in this reach. Below this reach, the Bobcat Flat projects and the Mining Reach projects have integrated gravel augmentation and channel reconstruction into the restoration approach (Figure 11). Once completed, this combination of gravel augmentation and channel reconstruction projects will provide high quality spawning and rearing conditions to 18 miles of the gravel-bedded zone (Figure 11).

Sediment supply in the Tuolumne River has been regulated since 1893 when La Grange dam was constructed. Further impairment occurred when the entire river and floodplains were dredged for gold

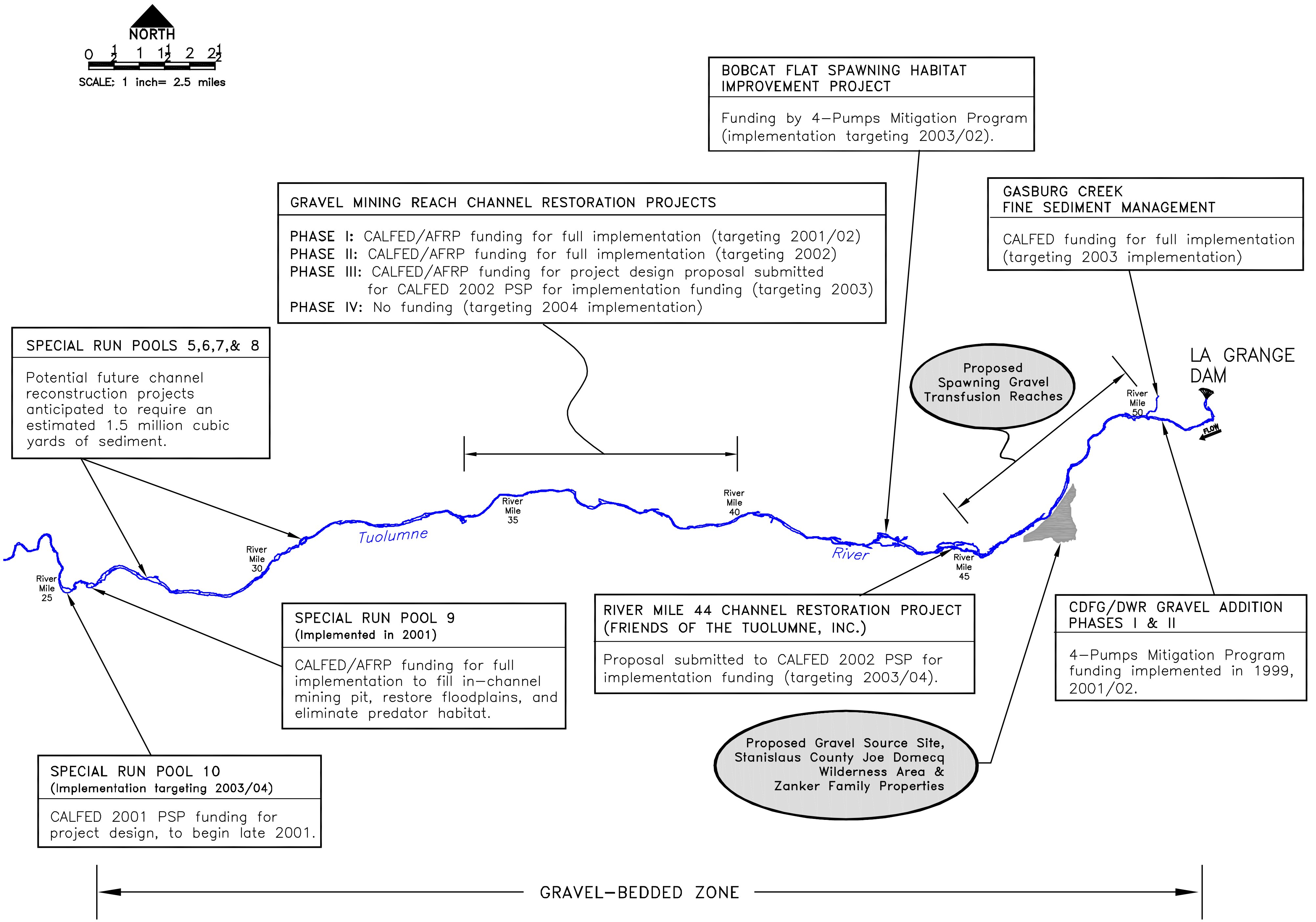


Figure 11. Relationship of the proposed project with other on going restoration projects on the Tuolumne River.

during the early 1900's. Adding approximately 100,000 to 150,000 cubic yards of gravel from river mile 44 to 52 will address the century of slow gravel starvation. As mentioned, the TRTAC has begun developing discharge-sediment transport rating curves and a comprehensive monitoring program to allow prediction of annual/periodic gravel introduction (following the transfusion phase) to maintain the restored supply (Figure 12). The Coarse Sediment Management Plan will be completed in early 2002. This two-phased strategy (gravel transfusion and periodic maintenance) will provide a comprehensive and lasting solution to the spawning gravel deficit the river currently experiences.

The 2002 PSP suggests that gravel augmentation "could deliberately vary the scale, rate, depth, method, and location of gravel injections and monitor gravel movement, habitat conditions (such as intragravel permeability)…". This is precisely the approach developed in the Phase II Gravel Introduction Technical Memorandum (McBain and Trush 2001a) (Appendix E) prepared for DFG/DWR. This technical memorandum provided five different injection techniques, scaled planform drawings with air photo background, and cross section surveys, showing different injection locations and gravel depths. These recommendations will be implemented in 2001/ 02. In addition, the TRTAC has sponsored and developed a river-wide gravel permeability monitoring program, and the TRTAC Monitoring Subcommittee is currently preparing plans for more site-specific permeability monitoring. The TRTAC will also be implementing the Fine Sediment Management Program (funded by CALFED) that among several tasks, will evaluate the relationship between gravel permeability and chinook egg survival-to-emergence. These experimental/monitoring programs will be integrated with this gravel transfusion project.

SJ-2. Restore geomorphic processes in stream and riparian corridors.
Restoring geomorphic processes in the Tuolumne River will first require restoring a channel morphology that is sized to the post-dam regulated flow regime. Recent field surveys performed for the Coarse Sediment Management Plan observed large sections of channel where scour from recent high flows and lack of sediment supply resulted in a drastic widening and deepening of the channel. Gravel augmentation will not only restore a more appropriate channel geometry to promote key geomorphic processes (gravel mobilization, spawning/rearing habitat maintenance), but will also reduce the median particle size of the channel bed sediments from the current coarsened conditions, to increase spawning habitat and reduce bed mobility thresholds..

2. CVPIA/AFRP Priorities

While the Tuolumne River is not among the CVPIA priorities because the NDPP is privately owned, the AFRP has a large investment in Tuolumne River restoration due to the many restoration opportunities and strong stakeholder support. The recent rebound in the salmon population has shown that the target population of an average annual escapement of 18,000 fall-run chinook is achievable in the near future. The Revised Draft Restoration Plan for the AFRP, Tuolumne River Action-2 (p.87) gave a HIGH priority to "…restoring and replenishing spawning gravel." This project proposes to implement this AFRP priority.

3. Relationship to Other Ecosystem Restoration Projects

The gravel transfusion portion of this project seeks to address degraded conditions in the upper gravel-bedded reaches downstream of La Grange Dam that have resulted from many decades of lost sediment supply, reduced natural flow regime, and past catastrophic dredger mining. The reach upstream of Basso Bridge would not benefit from the large-scale channel reconstruction approach being applied further downstream, but gravel transfusion is a high priority in this reach. Reaches downstream of Basso Bridge, and particularly the Gravel Mining Reach (Figure 11), are receiving a more intensive reconstruction approach, and large volumes of sediment are being imported to reconstruct bankfull channel dimensions and floodplains. These projects will eventually benefit from upstream gravel transfusion as coarse sediments are routed downstream and provide a supply to maintain the restored downstream reaches. This approach will take considerable time and effort to restore sediment transport continuity to the entire gravel-bedded zone, but this is the ultimate goal of the ecosystem-based restoration approach.

A primary benefit of this project is to provide a source of coarse sediment for future restoration projects. Following completion of this project, an estimated 1.47 million cubic yards of sediment will remain, and provide enough supply for several (and potentially all) planned or proposed restoration projects (Figure 11). Use of this material will incur only the expense of excavation, transporting the material, and revegetation at the extraction site, but will be considerably less expensive than sediment purchased from the commercial market.

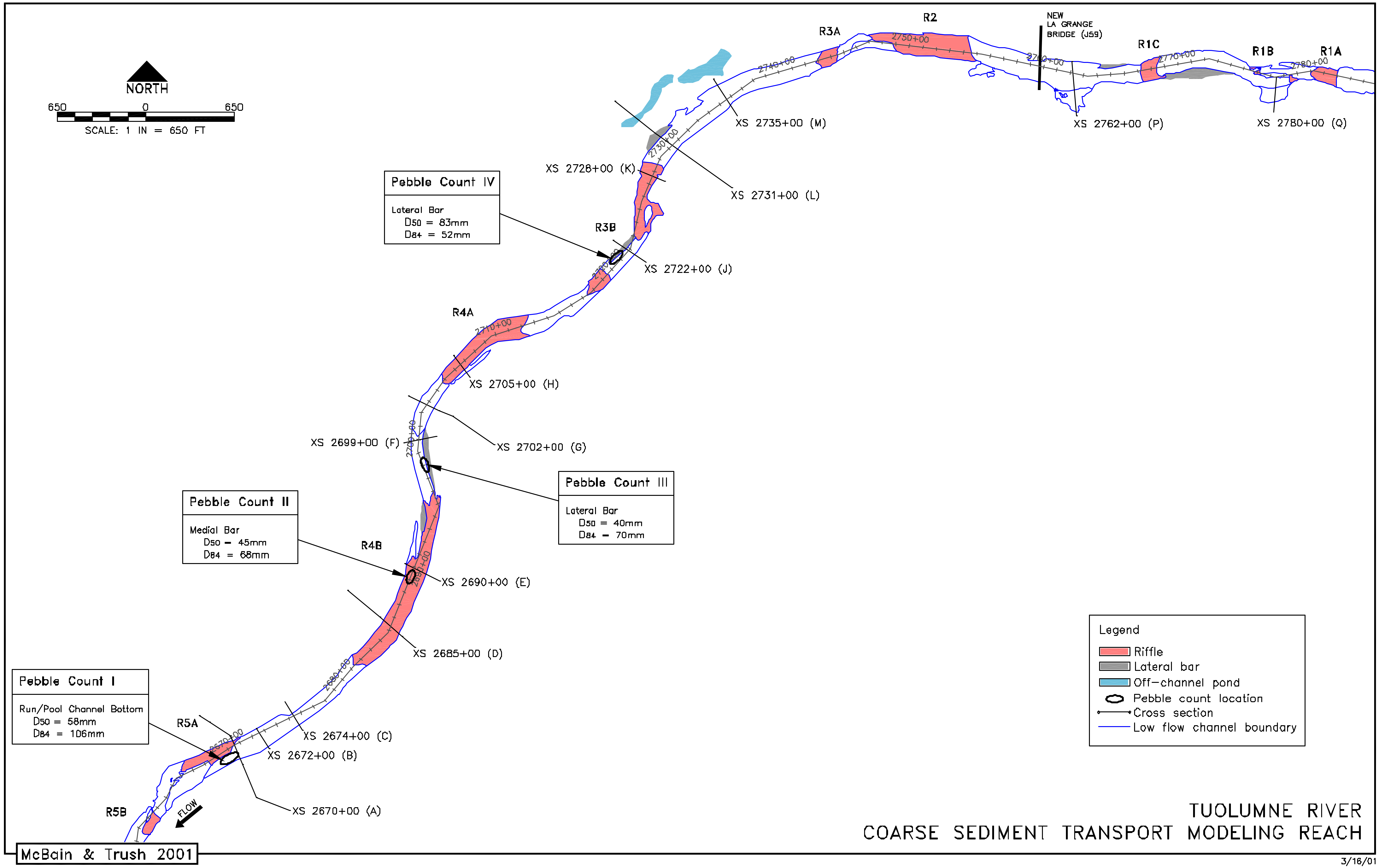


Figure 12. Cross section, longitudinal profile surveys, and pebble count data were used to develop a Sediment Transport Model for the upper Tuolumne River spawning reach. Empirical measurement were cunducted at cross section 2685+00 (D) at riffle 4B. Empirical and modeling data will be used to determine sediment transport out of this reach, and therefore the periodic "sediment replacement" volume.

4. Request for Next-Phase Funding

This is not a request for next phase funding.

5. Previous Recipients of CALFED Program or CVPIA Funding

A) Mining Reach – 7/11 Segment No.1 (CF1997-M09): The design and permitting is complete. Appraisals for conservation easements are complete and the valuation offers accepted by the landowners in February 2001. The construction contract for the work has been negotiated, but execution of the contract is pending resolution of the easement terms. Construction is anticipated to start in October 2001.
B) Mining Reach – MJ Ruddy Segment No.2 (CF1999-F02): The engineering design drawings have been completed to the preliminary (30%) stage and are currently being reviewed. 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): CALFED-AFRP funded restoration work in SRP 9. The first of two years of pre-project monitoring were completed in the summer of 1999 and the project design was completed in late 2000. Construction of the SRP 9 Project started in June 2001. The earthwork will be completed in early October and the revegetation planting is scheduled for 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. The cooperator agreement between the funds administrator, National Fish & Wildlife Foundation (NFWF), and TID to allow that work to start is anticipated to be in place by mid October 2001.
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 obtain a long-term source of sediment for use in restoration projects. The work is approximately 40% complete.
F) The Fine Sediment Management Plan (CF2001-C208) is the companion project with the Course Sediment Management Plan. The cooperator agreement between NFWF and TID has just been completed and work should start in October 2001.

6. System-Wide Ecosystem Benefits

Restoring the coarse sediment budget and increasing gravel storage in the channel provides many system-wide benefits. By introducing a large volume of coarse sediment back into the channel via the "transfusion", and then maintaining that supply by periodic augmentation, this material will slowly route downstream. As the new sediment equilibrium is achieved, sediment transport continuity will be restored, and gravels will be "re-used" as they are transported through each successive gravel bar. The analogy often used to understand this restoration approach describes the river channel as a conveyor belt slowly moving downstream. Under natural conditions the conveyor belt is layered with coarse sediment, and regularly spaced piles of "stored" gravel sit on the conveyor belt margins, analogous to the alternate bar morphology typical of alluvial rivers. Under regulated conditions, the alternate bar storage sites become depleted by scour and downstream transport (and fossilized by riparian encroachment). By re-supplying the large volume of gravel back onto the conveyor belt as channelbed and bars, and then routinely adding additional gravel at the top of the conveyor belt, coarse sediment supply and transport conditions will be extended further and further downstream, to eventually supply gravel to the channel reconstruction project reaches. Ideally, once bedload supply and transport continuity are fully restored, only the periodic gravel introduction at the top of the conveyor belt will be necessary.

Another synergistic benefit of this project, mentioned above, results from re-scaling the channel geometry and particle size distribution of the channelbed to the contemporary flow regime, which in turn allows the bed to become mobilized by lower flows. Frequent bed mobilization is a recommended strategy for maintaining high quality aquatic habitat. One consequence of reducing sediment composition and increasing the frequency of bed mobility is that the volume of periodic augmentation necessary to maintain the supply may increase, thus increasing overall sediment introduction costs. This additional cost is likely small, however, relative to the increased benefits of a healthy salmon population and a healthier Tuolumne River ecosystem.

7. Additional information for land acquisition

Willing Sellers. This project does not include land acquisition. It does, however, include the purchase of mineral rights contained on approximately 100 acres of privately owned property (the Zanker parcels), and mineral royalty and restoration designs for approximately 208 acres of publicly owned land (the Stanislaus County Joe Domecq County Park). **All landowners have expressed willingness to participate in this project.** The Zanker family has been patiently awaiting development of the Coarse Sediment Management Plan, have provided access to the river bordering their property, and have been extremely supportive of the concept of restoring wetland and riparian habitat and avoiding creating large mining pits. Combining the Count property with the Zanker property offers several important advantages: (1) the Zanker property is contiguous with the Joe Domecq County Park, making habitat restoration more comprehensive, (2) the Zanker family has shown strong support for this project and share the TRTAC and Restoration Plan vision of restoring wetland habitat in formerly dredged areas, and (3) the Zanker properties contain a significant volume of coarse sediment strategically located and critical to current and future restoration efforts. The largest portion of land affected by the project lies within the Joe Domecq County Park, currently owned and managed by Stanislaus County. We have coordinated with the Stanislaus County Planning Department (Bob Kachel), and the Department of Parks and Recreation (Kevin Williams, Steve Brodie) to develop this project. Stanislaus County is a willing and enthusiastic participants in this project, eager for the opportunity to become involved with river restoration, and to improve the condition of public parklands already set aside for recreational uses for Stanislaus County citizens and visitors. We have reviewed the Stanislaus County Parks Master Plan and found that our proposed mineral purchase and habitat restoration is compatible with the Master Plan's explicit goals of improving regional park facilities (hiking trails, picnic areas, general nature study, nature interpretation centers). Development of hike-in campsites in the Joe Domecq Wilderness is proposed in the Parks Master Plan. Kevin Williams, Director of the County Department of Parks and Recreation, has proposed that revenue received through purchase of the sediment could be set aside and used specifically to achieve goals stated in the Parks Master Plan. This procedure would require approval from the Stanislaus County Board of Supervisors, which Mr. Williams is prepared to pursue.

Consistent with County General Plan. The merits of this project are consistent with the Stanislaus County General Plan. The extraction of mine tailing deposits at these properties provides an opportunity to reclaim these lands to a condition (upland, riparian and wetland habitats) that is compatible with the surrounding natural environment of Stanislaus County's Joe Domecq County Park. These restored mined lands will also help meet the goals of Stanislaus County's Parks Master Plan by increasing use and area accessible to the public and wildlife. While reducing the competition for commercially available mineral resources/reserves the proposed project will further the protection of these mineral resources, by supplying coarse sediment for future restoration projects aiding the Tuolumne River and its salmon fishery. We have relied on two primary factors in presenting this project to the Stanislaus County Departmental representatives. First, through acquisition of mineral resources on these properties, we are attempting to reduce the impact of river restoration projects on the regional commercial aggregate demand, which is consistent with Stanislaus County General Plan, and consistent with concerns voiced by the Central Valley Rock, Sand & Gravel Association during the Mining Reach CEQA/NEPA process. Second, by mining the County properties of remaining dredged material, we are helping promote the goals stated in the Stanislaus County Parks Master Plan of improving regional park facilities.

Prioritize land not mapped as Prime, of Statewide Importance, or Unique Farmland. Neither of the proposes parcels and land areas are mapped as Prime, of Statewide Importance, or Unique Farmland.

Ecological Criteria. This project provides a unique opportunity to meet CVPIA goals stated in the Draft Stage 1 Implementation Plan (p. 171) of prioritizing wetland habitat restoration in the Central Valley, to partially mitigate for the over 90% loss of wetland habitat since the 1940's. Development of all coarse sediment material at the site will allow restoration of an estimated 100 acres of wetland.

Time-sensitive acquisition opportunity. The acquisition of mineral resources proposed by this project is a time-sensitive opportunity for several reasons. First, the Zanker family has begun the process to develop the mineral resources on their property (mineral evaluation by a geotechnical consultant, and a biological inventory), and intend to proceed with resource development. The opportunity to acquire this supply for river restoration may therefore be brief. Second, the demand for coarse sediment for restoration projects currently being implemented has already impacted the regional aggregate reserves, and to avoid further impacts to aggregate reserves will require timely acquisition and development of an sediment source designated solely for restoration purposes. Third, the condition of spawning habitat in the upper reaches needs to be addressed immediately in order to sustain the recent surge in fall-run chinook salmon escapement, particularly during this cycle of high escapement years.

C. QUALIFICATIONS

1. Principal Participants

Wilton Fryer, P.E., has been program manager for the Turlock and Modesto Irrigation District Restoration Program since 1997. Mr. Fryer graduated from the University of California at Davis with a BS in Soil & Water Science, an MS in Irrigation Science, and an ME in Civil Engineering with an emphasis in water resources. He is currently registered as both a Civil Engineer and an Agricultural Engineer. Since 1997 Mr. Fryer has supervised contract management, planning, and implementation of several large-scale restoration projects currently being funded by CALFED and AFRP, including the SRP 9 and 10 projects, the Mining Reach restoration, Coarse and Fine Sediment Management. Other accomplishments: 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.

Tim Ford has been the staff aquatic biologist for TID and MID since 1981. Mr. Ford graduated from the University of California at Davis with a 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, program development, consultant supervision, and coordination with Don Pedro project operations.

McBain and Trush, Inc. is a professional consulting firm applying fluvial geomorphic and ecological research to river preservation, management, and restoration. The principals are Scott McBain, M.S., an assistant hydraulic engineer and fluvial geomorphologist, and Dr. William Trush, a river ecologist and adjunct professor at Humboldt State University Department of Fisheries. Primary technical staff that will be working on the project include: Darren Mierau, Project Manager (M.A., aquatic biologist) has been involved with the Tuolumne River restoration program since 1997, assisted in completion of the Habitat Restoration Plan, developed and implemented monitoring plans in the Gravel Mining Reach and SRP projects, is currently project manager for the Coarse Sediment Management Plan, and will continue as project manager for the Sediment Source/Gravel Transfusion project. Scott McBain (MS Hydraulic Engineering) was principle scientist in developing the Habitat Restoration Plan, has extensive experience in channel restoration design (Clear Creek, Tuolumne River, Merced River) and will oversee design of the Domecq/Zanker restoration design. John Bair, (M.A. riparian botanist) has developed riparian and wetland restoration designs in Clear Creek and the Tuolumne River, assisted in developing riparian components of the Trinity River Flow Evaluation Study, and is lead riparian botanist on the Mono Basin Restoration and Monitoring, Fred Meyer, (B.S. Environmental Engineering) will assist in topographic surveying and design, and Geoff Hales (R.G., M.S. Geology) will assist in materials testing and evaluation. Since 1995, McBain and Trush have worked to promote sustainable river ecosystem restoration and management, with activities including:

- Development of the *Habitat Restoration Plan for the Lower Tuolumne River Corridor* (McBain and Trush 2000)
- Contributors to the *Trinity River Flow Evaluation Study* (USFWS and HVT 2000) and *Trinity River Channel Maintenance Flow Study* (McBain and Trush 1997)
- Development of the Mono Lake Tributaries *Restoration Plan* (LADWP);
- Contributing authors to CALFED Tributary Assessments and CALFED White Papers
- Clear Creek Mining Reach Restoration Project Design

Kevin Williams (representing Stanislaus County) is the Director of the Stanislaus County Parks and Recreation Department and the Department of Environmental Resources, and has a BA degree in Zoology from UC Berkeley, and a Masters in Biology from Humboldt State University.

Aldaron Laird is an Environmental Planner with twelve years experience as a specialist in regulatory compliance in riverine environments. Since 1989, Aldaron's experience with the Tuolumne River includes securing Conditional Use Permits, approvals of Surface Mine Reclamation Plans from Stanislaus County, negotiating Streambed Alteration Agreements from California Department of Fish and Game, conducting Historical Studies and acquiring Leases or waivers from the State Lands Commission for Santa Fe Aggregates (formerly M.J. Ruddy & Sons), George Reed Company, Western Stone, and Turlock

Irrigation District Additionally, Aldaron was successful in developing and securing funding in 1993 for two of the first Tuolumne River anadromous salmonid habitat restoration projects funded by the 4- Pumps Mitigation Program.

2. Planning Organizations

The Tuolumne River Technical Advisory Committee (TRTAC) was formed by the 1995 FERC Settlement Agreement to oversee the restoration and monitoring programs on the lower Tuolumne River. The TRTAC is composed of representatives from the Turlock and Modesto Irrigation Districts, the City and County of San Francisco, the US Fish and Wildlife Service, the CA Department of Fish and Game, the FERC, the National Marine Fisheries Service, the San Francisco Bay Area Water Users Association, the Tuolumne River Preservation Trust, Friends of the Tuolumne, Inc., and the CA Sport Fishing Protection Alliance. Since its precedent-setting formation in 1995, the TRTAC has provided effective planning and leadership for one of the largest restoration programs in the state. This project is one of ten PRIORITY PROJECTS selected and sponsored by the TRTAC for implementation by the target date of 2005 to meet requirements of the NDPP FERC license.

3. Other Collaborators

Stillwater Sciences. The firm of Stillwater Sciences has been retained by the Districts in past projects to assist with the design and implementation of the fishery monitoring plan components. Stillwater Sciences is actively involved with the river wide monitoring associated with the Districts' FERC Settlement Agreement.

4. Conflicts of Interest

No potential conflicts of interest are anticipated

D. COSTS

1. Budget

We are requesting $4,350,000 in funding from CALFED to complete this project. Of this funding request, approximately $1,200,000 is designated for mineral purchase royalties, and $2,544,000 is for project implementation. The remaining $606,000 is for the restoration design, appraisal, permitting costs, and contingencies (at 10%).

2. Cost-Sharing

The Tuolumne River Technical Advisory Committee will provide $50,000 in cost-share funding, designated for conceptual restoration design costs.

E. LOCAL INVOLVEMENT

One of the many benefits of this project is to increase Stanislaus County's participation with ongoing Tuolumne River restoration and planning efforts. This project is a mutually beneficial situation for all parties, whereby the TRTAC restoration program can acquire a less expensive long-term source of sediment for restoration projects deemed a high priority, the TRTAC can use this material to improve habitat conditions within the river, and can provide Stanislaus County additional means to improve public lands. Through this project, the County can also act pro-actively in an effort to reduce the loss of regionally valuable commercial aggregate, which is a revenue base for the County.

F. COMPLIANCE WITH STANDARD TERMS AND 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

Bjornn, T. C., and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 in W. R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitats. Special Publication No. 19. American Fisheries Society, Bethesda, Maryland.

E.A. (EA Engineering, Science, and Technology). 1992. Report of Turlock Irrigation District and Modesto Irrigation District pursuant to Article 39 or the License for the Son Pedro Project, Fisheries Studies Report, Volume II.

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McBain and Trush. 1997. Trinity River Channel Maintenance Flow Study Final Report. Prepared for the Hoopa Valley Tribe, Trinity River Task Force.

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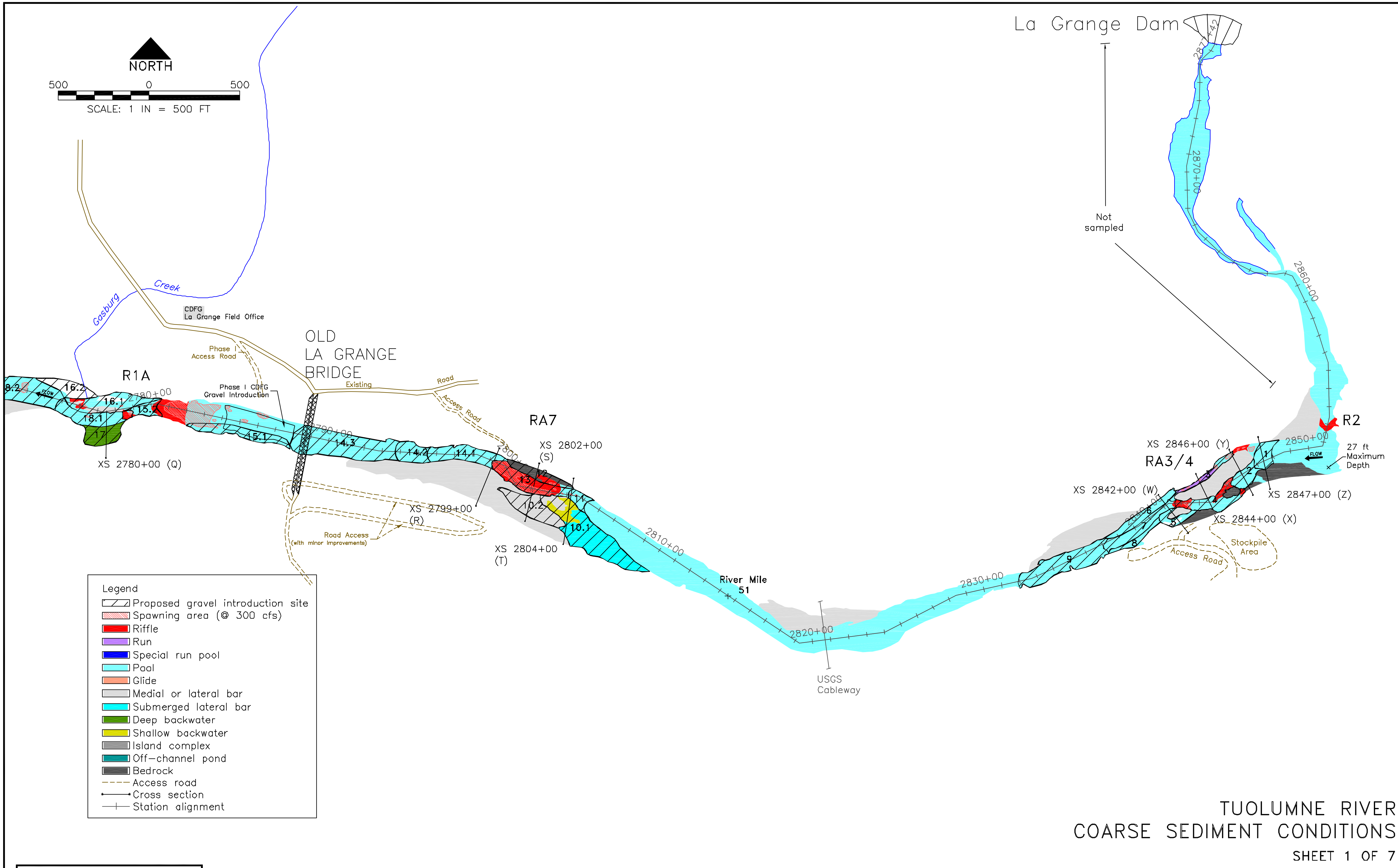
Trush, W.J., S.M. McBain, and L.B. Leopold. Attributes of an alluvial river and their relation to water policy and management. Proceedings of the National Academy of Science, 97(22): 11858-63.

USFWS and Hoopa Valley Tribe. 1999. Trinity River Flow Evaluation Final Report. Prepared for the Secretary of the Interior.

H. APPENDICES

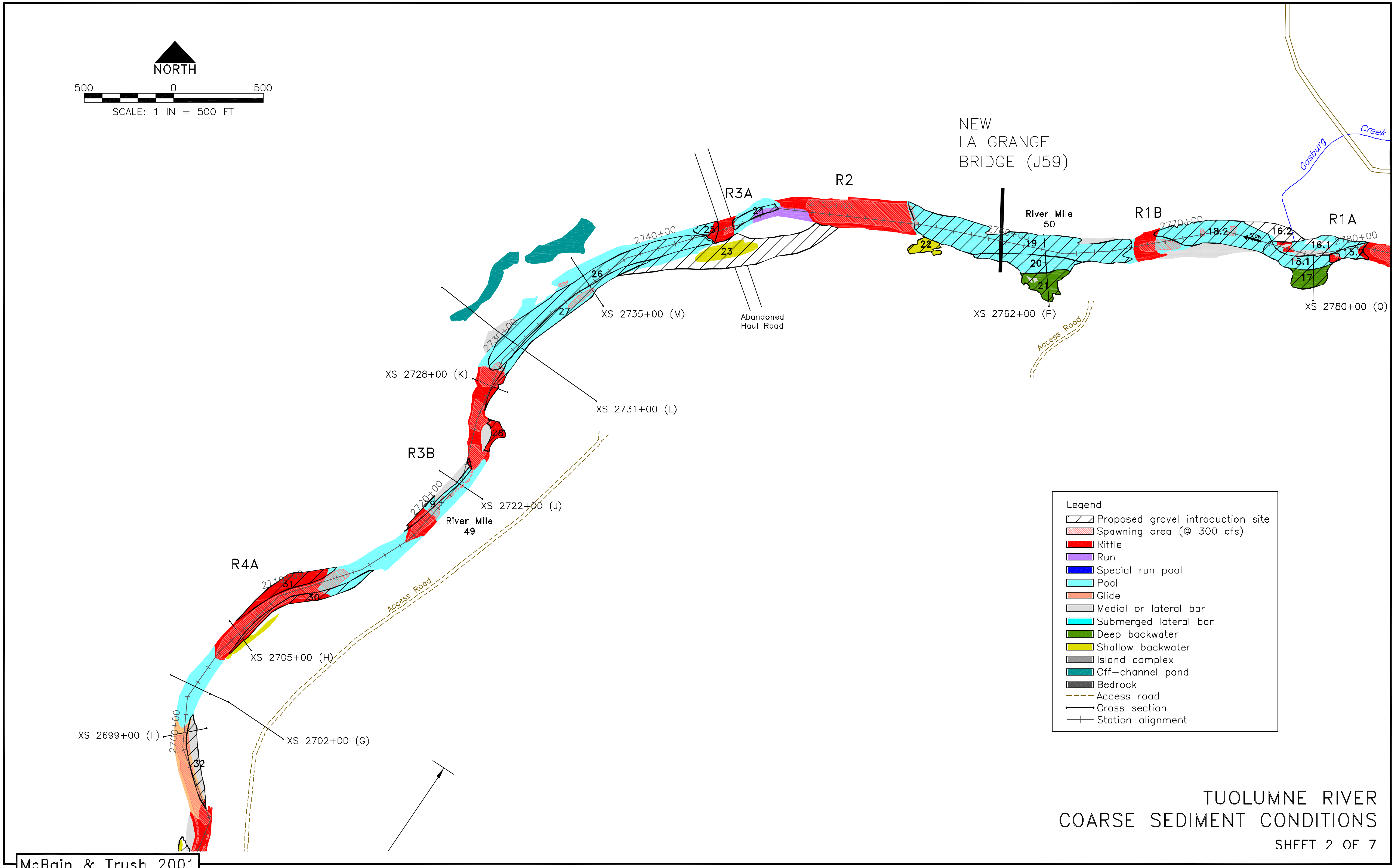
A. Habitat maps of the Tuolumne River from La Grange Dam to Turlock Lake State Recreation Area
B. Tuolumne River Chinook Salmon Spawning Habitat Availability Technical Memorandum
C. Conceptual Models for the Tuolumne River Restoration Program
D. PNAS Publication of the Attributes of Alluvial River Integrity
E. Tuolumne River Phase II Gravel Introduction Technical Memorandum
F. Letter of Support from Stanislaus County Department of Parks and Recreation

APPENDIX A



McBain & Trush 2001

8/23/01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R3A
R3B
R4A
River Mile
50
River Mile
49
Gasburg
Creek
Abandoned
Haul Road
Access Road
Access Road
Access Road
2740+00
2730+00
2720+00
2710+00
2700+00
2770+00
2780+00
XS 2780+00 (Q)
XS 2762+00 (P)
XS 2735+00 (M)
XS 2731+00 (L)
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XS 2702+00 (G)
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15.2
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20
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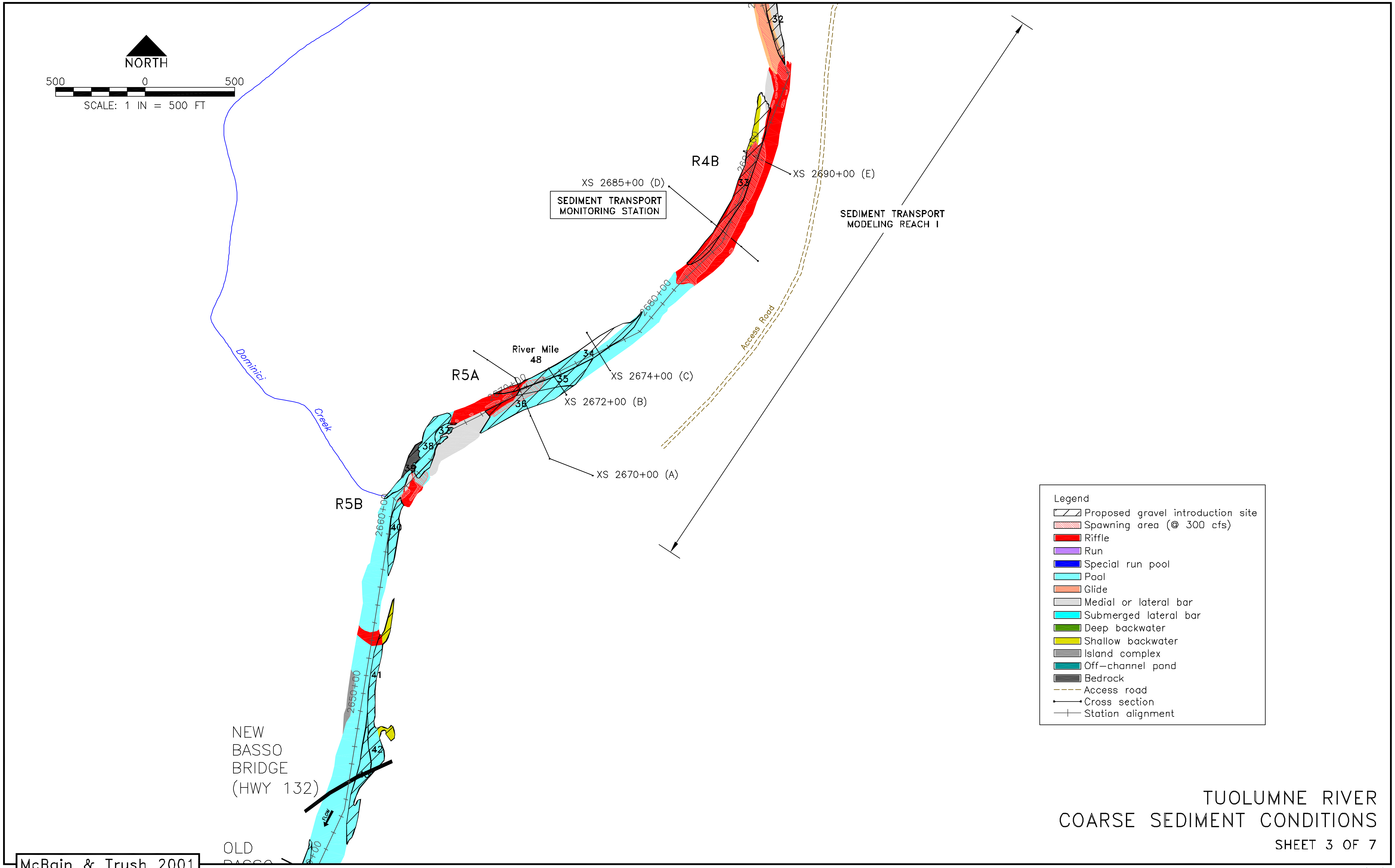
27
28
29
30
31
32
Legend
Proposed gravel introduction site
Spawning area (@ 300 cfs)
Riffle
Run
Special run pool
Pool
Glide
Medial or lateral bar
Submerged lateral bar
Deep backwater
Shallow backwater
Island complex
Off-channel pond
Bedrock
Access road
Cross section
Station alignment
TUOLUMNE RIVER
COARSE SEDIMENT CONDITIONS
SHEET 2 OF 7
McBain & Trush 2001

8/23/01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Dominici
Creek
R4B
R5A
R5B
XS 2685+00 (D)
SEDIMENT TRANSPORT MONITORING STATION
XS 2690+00 (E)
SEDIMENT TRANSPORT MODELING REACH I
Access Road
River Mile 48
XS 2674+00 (C)
XS 2672+00 (B)
XS 2670+00 (A)
2680+00
2670+00
2660+00
2650+00
32
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41
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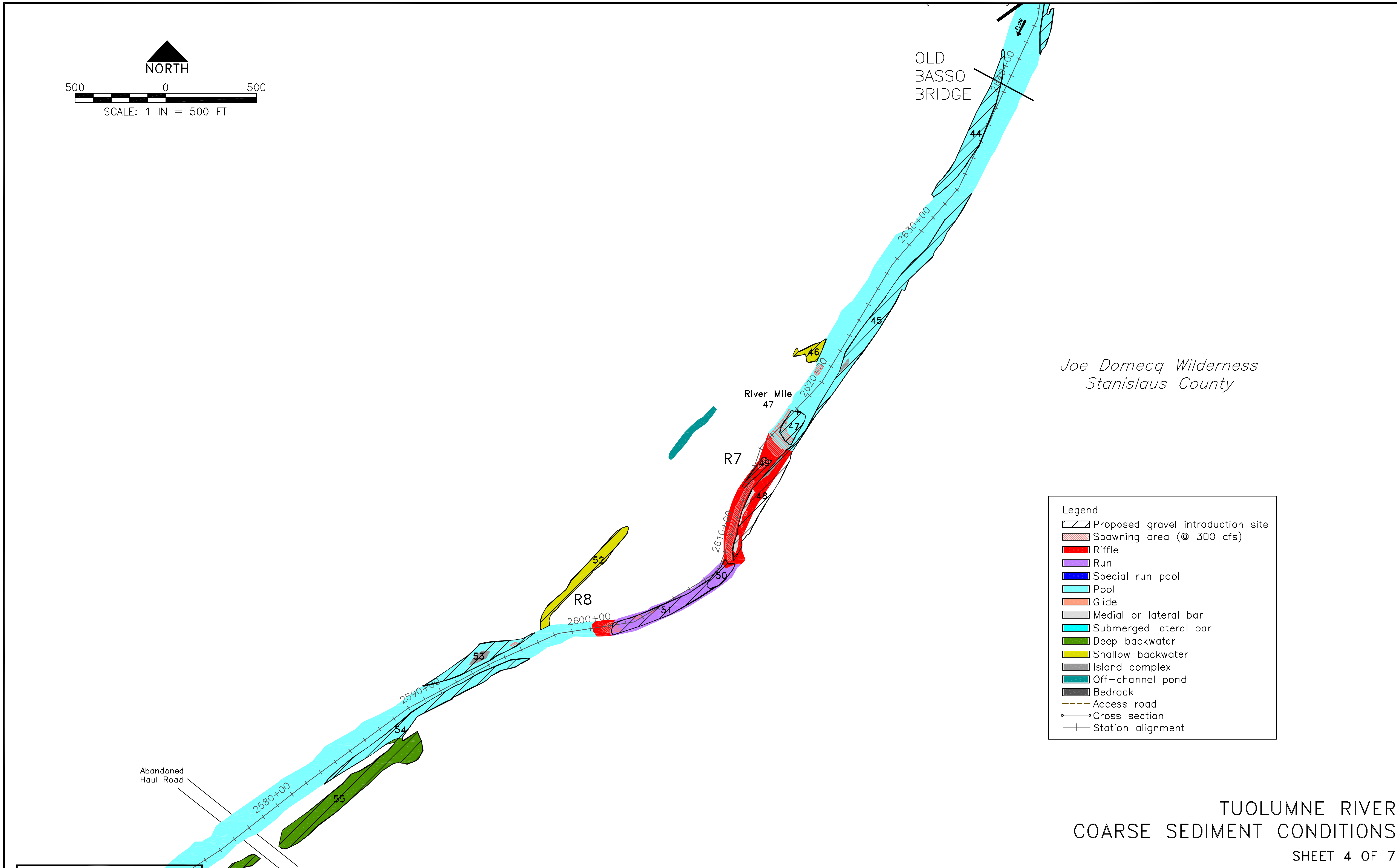
NEW BASSO BRIDGE (HWY 132)
OLD
Flow
Legend
Proposed gravel introduction site
Spawning area (@ 300 cfs)
Riffle
Run
Special run pool
Pool
Glide
Medial or lateral bar
Submerged lateral bar
Deep backwater
Shallow backwater
Island complex
Off-channel pond
Bedrock
Access road
Cross section
Station alignment
TUOLUMNE RIVER
COARSE SEDIMENT CONDITIONS
SHEET 3 OF 7
McBain & Trush 2001

8/23/01



TUOLUMNE RIVER
COARSE SEDIMENT CONDITIONS

SHEET 4 OF 7

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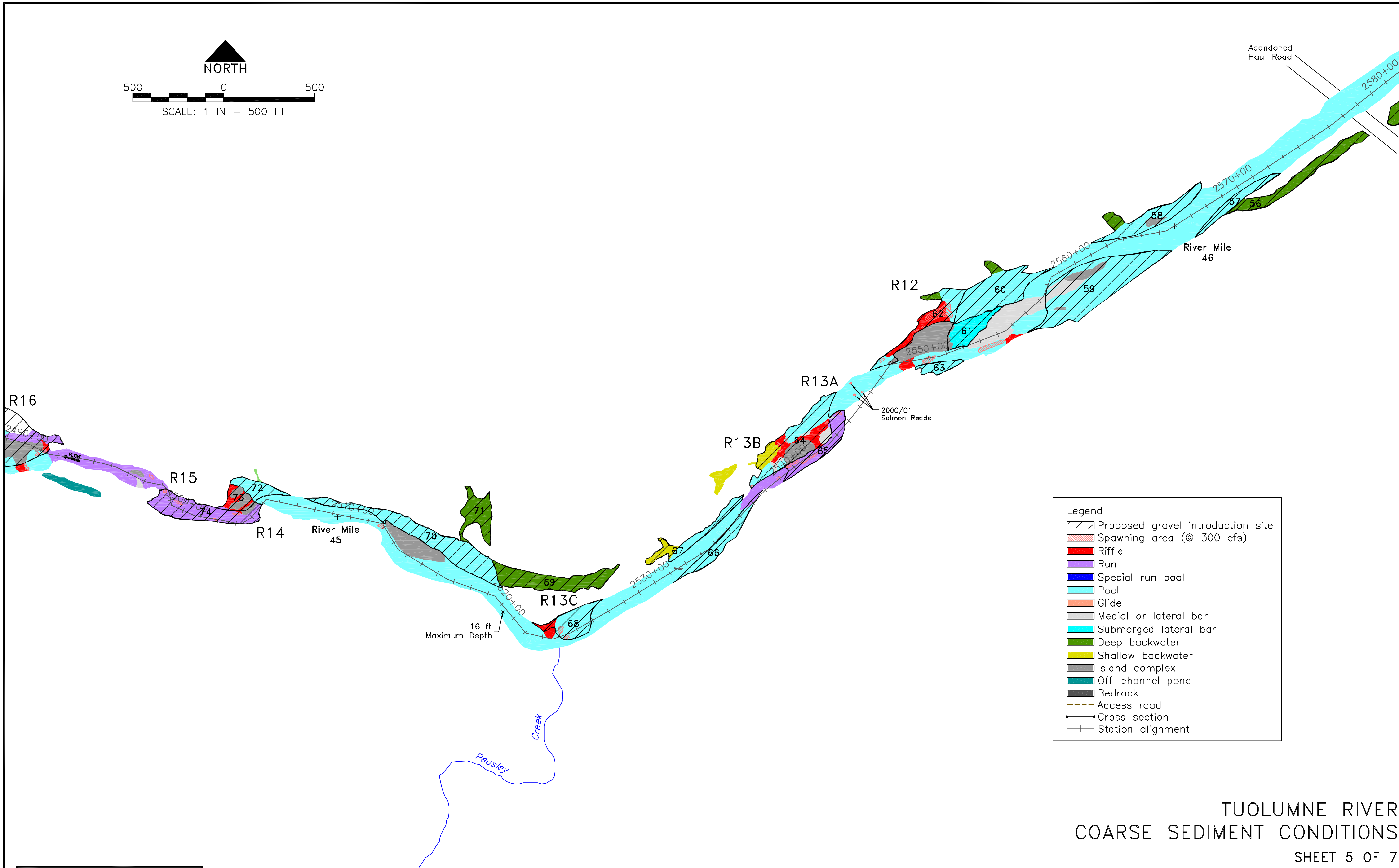

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COARSE SEDIMENT CONDITIONS
SHEET 5 OF 7

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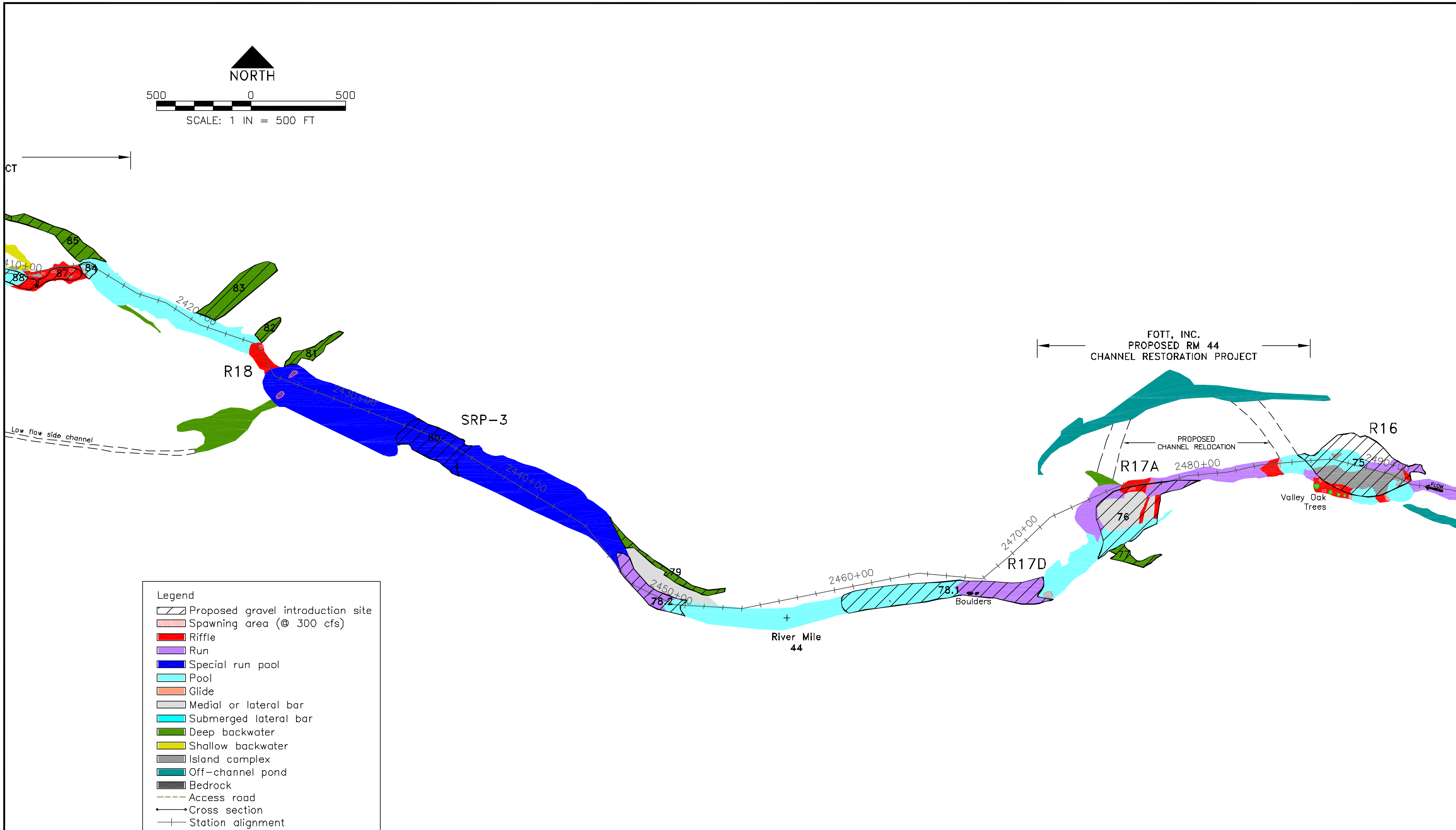

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COARSE SEDIMENT CONDITIONS

SHEET 6 OF 7

McBain & Trush 2001

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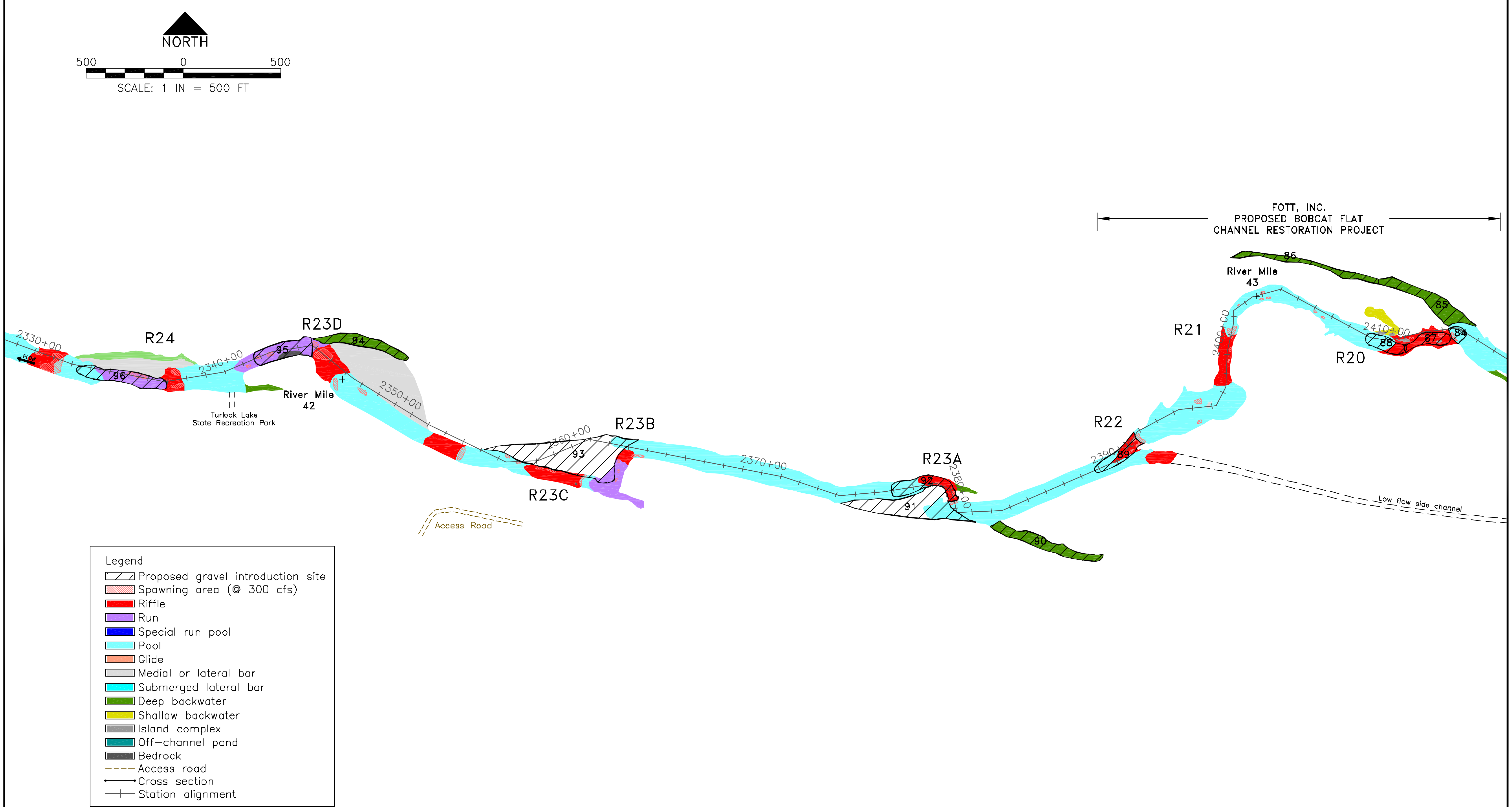

TUOLUMNE RIVER
COARSE SEDIMENT CONDITIONS

SHEET 7 OF 7

McBain & Trush 2001

8/23/01

APPENDIX B

McBain & Trush
FISHERIES
HYDROLOGY
RIPARIAN ECOLOGY
STREAM RESTORATION
FLUVIAL GEOMORPHOLOGY
P.O. Box 663, Arcata, CA 95518 • 824 L Street, Studio 5, Arcata, CA 95521
Phone: (707)826-7794 • Fax: (707)826-7795

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TUOLUMNE RIVER CHINOOK SALMON SPAWNING HABITAT AVAILABILITY

TECHNICAL MEMORANDUM

Prepared for the
Tuolumne River Technical Advisory Committee

Prepared by
McBain and Trush
P.O. Box 663
Arcata, CA 95518

August 22, 2001

Introduction

The purpose of this technical memorandum is to summarize results of our recent field mapping and assessment of the conditions of spawning habitat availability in the Tuolumne River below La Grange Dam downstream to the Turlock Lake State Recreation Area. The past spawning season provided a glimpse of the potential production capacity of the Tuolumne River. However, current degraded conditions in the upper spawning reaches likely cannot sustain this population level across all water year types, nor achieve the higher population levels targeted by the TRTAC, CALFED and AFRP.

The Tuolumne River Technical Advisory Committee developed the *Habitat Restoration Plan for the Lower Tuolumne River Corridor* (McBain and Trush 2000) to guide restoration activities on the river. A primary recommendation in the Restoration Plan was to restore coarse sediment conditions in the Gravel-bedded Zone, first by adding large volumes of gravel and cobble to rapidly improve the coarse sediment storage in the channel, then by periodically adding coarse sediment approximately at the rate it is transported downstream during high flows. This gravel introduction program began in 1999 with implementation of the DFG/DWR Phase I Gravel Addition Project at La Grange, which introduced approximately 12,500 cubic yards of gravel at riffle 1A below La Grange Bridge. Phase II of the Spawning Gravel Introduction Project was funded by AFRP and the Tracy Mitigation Program to continue spawning gravel introduction in the upper reaches of the Tuolumne River., and will be implemented in 2001. The AFRP program also funded McBain and Trush to prepare a Coarse Sediment Management Plan that would provide additional detail on high priority gravel introduction sites, refined volume estimates, methods for gravel introduction, and specific monitoring guidelines.

Methods

One task of the Sediment Management Plan was to habitat map the entire upper two reaches of the Gravel-bedded Zone (the Dominant Spawning Reach and the Dredger Reach) down to the boundary of our previous mapping conducted in the 7/11 Materials Reach. In December 2000 we mapped the available spawning habitat in the reach between La Grange Dam and Basso Bridge, to compare to previous spawning habitat assessments conducted by the Districts in 1988 (EA 1992). This recent survey was "ideal" because the presence of a large chinook spawning run had essentially delineated most or all the usable spawning habitat. We used high resolution aerial photos (scale: 1 in = 100 ft), which produced a fairly accurate representation of spawning habitat for digitizing. We followed up with habitat mapping in the Dredger Reach in February, accompanied by CDFG personnel, who were able to identify spawning habitat used during the 2000/01 spawning run. Habitat in this reach was much more difficult to identify than in the upper reach because of the degraded conditions in this reach and the patchy distribution of habitat. Our mapping effort extended to Turlock Lake State Recreation Area at RM 41.6 (Riffle 25), thus encompassing 10 miles of the spawning reach.

Note that the following comparisons of recently collected data to estimates made previously by the Districts (EA 1992) requires some qualification. Volume IV, Appendix 6 of the "Fisheries Studies Report" (EA 1992), titled "Lower Tuolumne River Spawning Gravel Availability and Superimposition Report" quantified spawning gravel availability for the entire Gravel-bedded Zone from La Grange Dam to Fox Grove. The spawning habitat estimates were made for flows of 100 cfs and 230 cfs by digitizing aerial photos. Spawning habitat was delineated by defining the entire areal extent of the riffles. Spawning use or preference was not incorporated in the interpretation guidelines. The guidelines therefore resulted in a maximum estimate of available spawning habitat. Our observations during the 2000/01 surveys partially validated this assumption: almost the entire area of riffles with relatively healthy morphology such as R3A to R4B was used for spawning. In contrast, riffles in the Dredger Reach below Basso Bridge frequently had only a small percentage of the riffle available as suitable spawning habitat. Comparison of past and present surveys are thus less than ideal. It is, however, critically important to establish a fixed point for spawning habitat availability in the Tuolumne River, to which to compare future surveys that evaluate our restoration efforts. Our mapping has nearly accomplished this.

Also note that the location of riffles changes even under natural (unregulated) conditions. Comparison of what was labeled riffle 12C-North in 1988, for example, to a riffle in the same vicinity in 2000/01 is not ideally perfect. We have attempted, however, to maintain the same riffle numbers as currently used by CDFG during spawning and redd surveys. Some correction may still be required.

Results

Our assessment in the upper reach (Dominant Spawning Reach) indicates that spawning habitat has decreased by as much as 44% compared to the 1988 data, likely a result of steady gravel attrition from annual bedload transport and lack of upstream supply, as well as from the catastrophic degradation from the January 1997 flood. Based on spawning habitat availability, channel widening and downcutting, and chinook spawning preferences (redd densities), the most evident impacts are generally in the riffles upstream of New La Grange Bridge (NLGB), compared to riffles between NLGB and Basso Bridge. For example, spawning habitat at riffle A3/4 has been reduced from 22,000 ft^2 in 1988 to approximately 3,700 ft^2 in 2000; Riffle A5 is nearly completely scoured away, with water depths of 5 to 6 ft, coarse substrate, and very little velocity; Riffle A6 supported only one or two redds in 2000/01 spawning season.

In the Dredger Reach, the condition of spawning riffles is much worse. As mentioned, the disjointed, patchy distribution of riffles and spawning habitat that result from the "pool-cascade" morphology that has evolved in this reach (see Restoration Plan pg. 106), has resulted in a drastic reduction in spawning habitat availability. First, several entire riffles have been scoured and completely eliminated as result of the 1997 flood and from the loss of coarse sediment recruitment. Riffles 6, 9, 10, 11, 17B and C, and 19 now provide no suitable spawning habitat. Riffles 13A, 14, 15, 20 and 23B are more than 85% reduced, compared to the area available in 1988.

Downstream of the Dredger Reach, spawning conditions in the six mile long Gravel Mining Reach are equally poor.

We documented 98,500 ft^2 of available spawning habitat in the Dredger Reach. Using a common literature value of 216 ft^2 per chinook spawning pair (Burner 1951 as cited in Bjornn and Reiser 1991), the 6 mile Dredger Reach could support only 456 spawners without superimposition. Using a more conservative figure of 54 ft^2 for the average area of chinook redds, the Dredger Reach could still support only 1824 chinook redds. By contrast, conditions in the Dominant Spawning Reach are much better, providing 410,500 ft^2 of suitable spawning habitat, enough to support an estimated 1900 spawning pairs (at 216 ft^2/spawning pair) or 7,600 redds (at 54 ft^2/redd). But conditions in this reach are steadily worsening, as shown by the steady attrition and loss of habitat moving progressively downstream of La Grange Dam.

Literature Cited

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. *In* W.R. Meehan (*ed*), Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19, Maryland.

EA Engineering, Science and Technology. 1992. Volume II. Report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 39 of the License for the Don Pedro Project, Fisheries Studies Report. Lafayette, CA.

Table 1. Summary of spawning habitat availability for each riffle from La Grange Dam downstream to Turlock Lake State Recreation Area, using the 1988 District estimates for comparison.

DOMINANT SPAWNING REACH (La Grange Dam to Basso Bridge)

RIFFLE	1988 ESTIMATE	2000/01 ESTIMATE	REDUCTION	% REDUCTION
RA3/4	22,475	3,702	18,773	84%
RA5A	16,277	0	16,277	100%
RA5B	8,336	0	8,336	100%
RA6	10,147	0	10,147	100%
RA7A	7,596	16,740	-9,144	-120%
R1A	92,257	78,761	60,268	65%
R1B	27,269	13,150	14,119	52%
R2	86,867	76,072	10,795	12%
R3A	38,268	7,076	31,192	82%
R3B	44,135	70,137	-26,002	-59%
R4A	125,523	57,821	67,702	54%
R4B	178,077	108,810	69,267	39%
R5A	64,395	18,140	46,255	72%
R5B	9,167	6,936	2,231	24%
TOTAL	**730,789**	**410,573**	**320,216**	**44%**

DREDGER REACH (Basso Bridge to Turlock Lake State Recreation Area)

RIFFLE	1988 ESTIMATE	2000/01 ESTIMATE	REDUCTION	% REDUCTION
R6	26,050	0	26,050	100%
R7	67,747	34,489	33,258	49%
R8	22,023	5,449	16,574	75%
R9	34,862	0	34,862	100%
R10	7,458	0	7,458	100%
R11	23,206	0	23,206	100%
R12	5,959	12,627	-6,668	-112%
R13A	10,550	779	9,771	93%
R13B	10,151	3,103	7,048	69%
R13C	12,283	1,357	10,926	89%
R14	9,478	1,064	8,414	89%
R15	24,840	1,142	23,698	95%
R16	1,758	2,529	-771	-44%
R17A	4,431	1,354	3,077	69%
R17B	11,272	0	11,272	100%
R17C	18,315	0	18,315	100%
R17D	2,072	1,148	924	45%
R18	17,421	2,181	15,240	87%
R19	9,736	0	9,736	100%
R20	19,203	1,766	17,437	91%
R21	5,974	2,469	3,505	59%
R22	4,037	2,954	1,083	27%
R23A	6,933	1,016	5,917	85%
R23B	9,091	612	8,479	93%
R23C	14,088	3,454	10,634	75%
R23D	22,698	7,627	15,071	66%
R24	18,175	11,348	6,827	38%
TOTAL	**419,811**	**98,467**	**321,344**	**77%**

APPENDIX C

The following conceptual model text and appendix B is an excerpt from -

AFRP / CALFED Adaptive Management Forum

Tuolumne River Restoration Program
Summary Report

Summary of studies, conceptual models,
restoration projects, and ongoing monitoring

Prepared by

Stillwater Sciences
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with the

Tuolumne River Technical
Advisory Committee

Conceptual Models

The TRTAC Monitoring Subcommittee has developed a series of six interconnected conceptual models depicting our current understanding of the geomorphic functions in the river and the river's chinook salmon population and the effects of measures to improve geomorphic and ecosystem function and increase chinook salmon population abundance. These conceptual models are provided in Appendix B and are described below.

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. Other factors could also affect chinook salmon population abundance, but these are not considered to be limiting. Of the limiting factors identified, redd superimposition is the only density-dependent mortality factor. The superimposition model developed from field studies supports the hypothesis that superimposition and delayed fry emergence can explain the stock-recruitment curves developed from empirical observations in the Tuolumne River (TID/MID 1997, Report 96-6).

Model S-2. Potential alternative measures to reduce chinook salmon redd superimposition. In this model, four potential measures are identified to reduce chinook salmon redd superimposition. These measures include adding gravel to the spawning reach, managing flows to distribute spawning laterally in the channel, installing temporary barriers to distribute spawning longitudinally in the channel, and adding large woody debris to improve spawning habitat suitability in the underutilized (downstream) portion of the spawning reach. The effectiveness of these measures has not been assessed. Testing of temporary spawning barriers is identified as an action to be implemented under the FSA.

Model S-3. Potential alternative measures to improve chinook salmon survival-to-emergence. This model depicts the effects of fine sediment management, coarse sediment management, and flow management on salmon spawning and incubation conditions and survival-to-emergence. In this model, components of the fine sediment management program, which has been tentatively approved for funding by CALFED, reduce fine sediment supply to the channel by reducing delivery from Gasburg Creek and reducing storage (and thus potential supply) in pools. By reducing fine sediment supply, the project reduces risk of entombment of alevins and increases substrate permeability in the spawning reach, thus increasing survival-to-emergence. Addition of coarse sediment to the channel under the Coarse Sediment Management Program, which has been funded by the AFRP, increases the area of potential spawning habitat and potentially dilutes fine sediment storage in the channel. This addition of coarse sediment increase the frequency of bed mobilization and increases coarse sediment storage, thus allowing the river to construct bars and riffles and potentially increasing substrate permeability. In combination with sediment management measures, increasing peak flows would increase the frequency of bed mobilization and flush fine sediment downstream. The timing and magnitude of peak flows, however, would need to be timed to avoid scouring redds. Increasing peak flows in spring would avoid impacts to redds and could also increase survival by increasing turbidity and reducing predation. (Note that adverse effects of excessive turbidity on salmon can also occur).

Model S-4. Potential alternative measures to reduce predation on juvenile outmigrants. This model depicts potential alternative measures to reduce predation on juvenile salmon outmigrants by largemouth bass. Alternative measures include actions to directly or indirectly reduce largemouth bass abundance or largemouth bass feeding rates. Measures identified to directly reduce bass abundance include angler harvest and electrofishing. The potential effectiveness of these measures and risks to non-target species has not been assessed. Measures to indirectly reduce predator abundance include filling in Special Run-Pools (SRPs), thus reducing the extent of bass habitat, and increasing spring flows, thus reducing bass reproduction. Measures to reduce feeding rates include increasing spring flows, thus reducing water temperature and bass foraging, and increasing turbidity, thus reducing predation efficiency. Laboratory studies conducted by the Districts indicate that bass foraging efficiency is greatly reduced by increasing turbidity (TID/MID 1992, Appendix 23). The relative uncertainty and potential benefits of these measures vary, and most would require further testing and validation before application. Currently the only measures being tested are the effects of channel reconstruction on predator abundance and the effects of spring flow on chinook salmon 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. In addition, aggregate mining and gold dredging have reduced coarse sediment supply to the river by removing stored sediment from the channel and floodplain and by 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, channel migration and avulsion, recruitment of large wood, and floodplain inundation 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 large, lake-like pits in the river channel. These alterations have reduced habitat quality for chinook salmon spawning, incubation, rearing, and outmigration. In addition, reductions in flow magnitude and alteration of seasonal flow patterns potentially affect run timing and emigration timing, as well as incubation, rearing, and outmigrant survival.

Model G-2. Fine sediment supply and storage in the Tuolumne River and effects in chinook salmon survival. This model illustrates sources and storage of fine sediment in the Tuolumne River and the effects of fine sediment on chinook salmon survival. In this model, fine sediment is supplied to the spawning reach primarily by Gasburg Creek and erosion from the New Don Pedro Dam spillway that occurred during the 1997 flood. The volume of sediment supplied from the Gasburg Creek watershed is exacerbated by grazing and possibly by historical hydraulic mining in the watershed. Gullying, channel incision, and bank failure in the watershed have been documented by field reconnaissance surveys. In the lower watershed, Gasburg Creek flows through an abandoned sand mine. Surface erosion in this reach has increased sand supplied to the channel above background or "natural" levels. The magnitude and importance of supply from Lower Dominci Creek is not certain.

Combined with the reduction in sediment transport capacity resulting from flow regulation, this increase in fine sediment supply has resulted in increased storage of fine sediment in riffles and possibly in pools. (Sand storage in pools has not been assessed.) The sand stored in pools can be mobilized during high flows, thus increasing supply. The increase in the volume of sand stored in riffles results in reduced permeability in spawning substrates and a concomitant reduction in salmon survival-to-emergence.

References

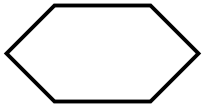
TID/MID (Turlock and Modesto Irrigation Districts). 1992. Effects of turbidity on bass predation efficiency. Appendix 23 to Don Pedro Project Fisheries Studies Report (FERC Article 39, Project No. 2299). *In* Report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 39 of the License for the Don Pedro Project, No. 2299. Vol. VII. Prepared for TID/MID by EA Engineering, Science, and Technology, Lafayette, California.

TID/MID (Turlock Irrigation District and Modesto Irrigation District). 1997. Redd Superimposition Report (Report 96-6). *In* Report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 39 of the License for the Don Pedro Project, No. 2299. Vol. VI. Prepared for TID/MID by EA Engineering, Science, and Technology, Lafayette, California.

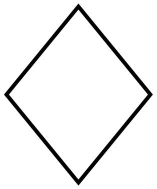
Appendix B.
Conceptual Models

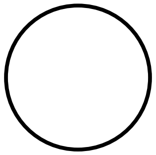
The models attached are grouped into the following categories:
S = Salmon life cycle and limiting factors models
G = Geomorphic process models
P = Project-specific models

The shapes used in the flowcharts signify the following:


action

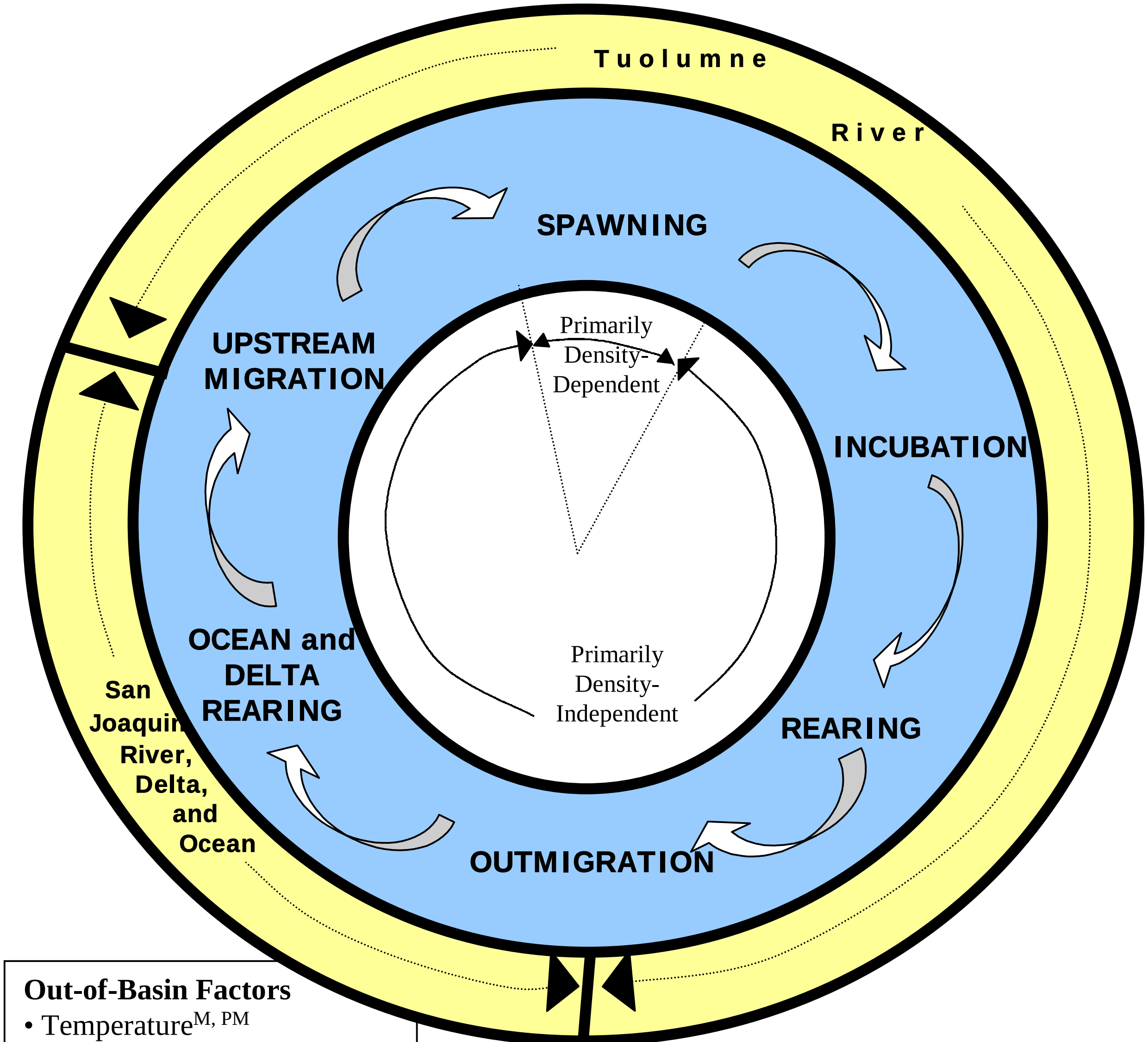

anticipated result


monitored parameter


decision point

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.



Key In-Basin Factors

Affecting Adult Migration
•Flow
•Temperature
•Dissolved oxygen

submodel

Affecting Spawning and Incubation Survival
•Redd superimposition*, PM [S-2]
•Habitat area M, PM [S-2, S-3]
•Substrate permeability *, PM [S-3]
•Water temperature M, PM [S-3]

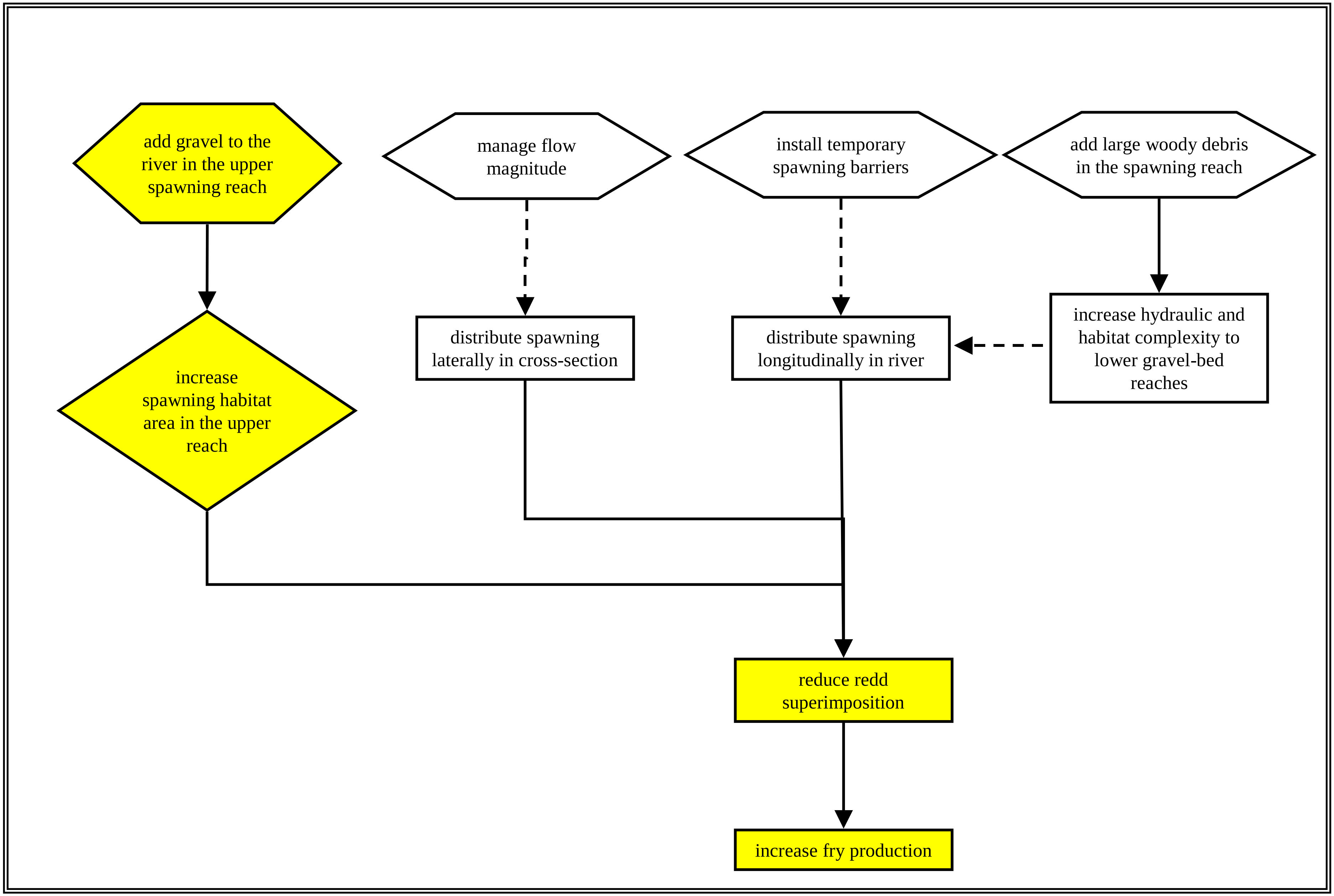
Affecting In-river Rearing Survival
•Water temperature M, PM
•Stranding M, PM
•Food supply PM
•Flow variability M, PM
•Habitat [G-1]

Affecting Outmigration Survival
•Spring flow *, M, PM [S-4]
•Temperature*, M, PM [S-4]
•Predation *, M, PM [S-4]

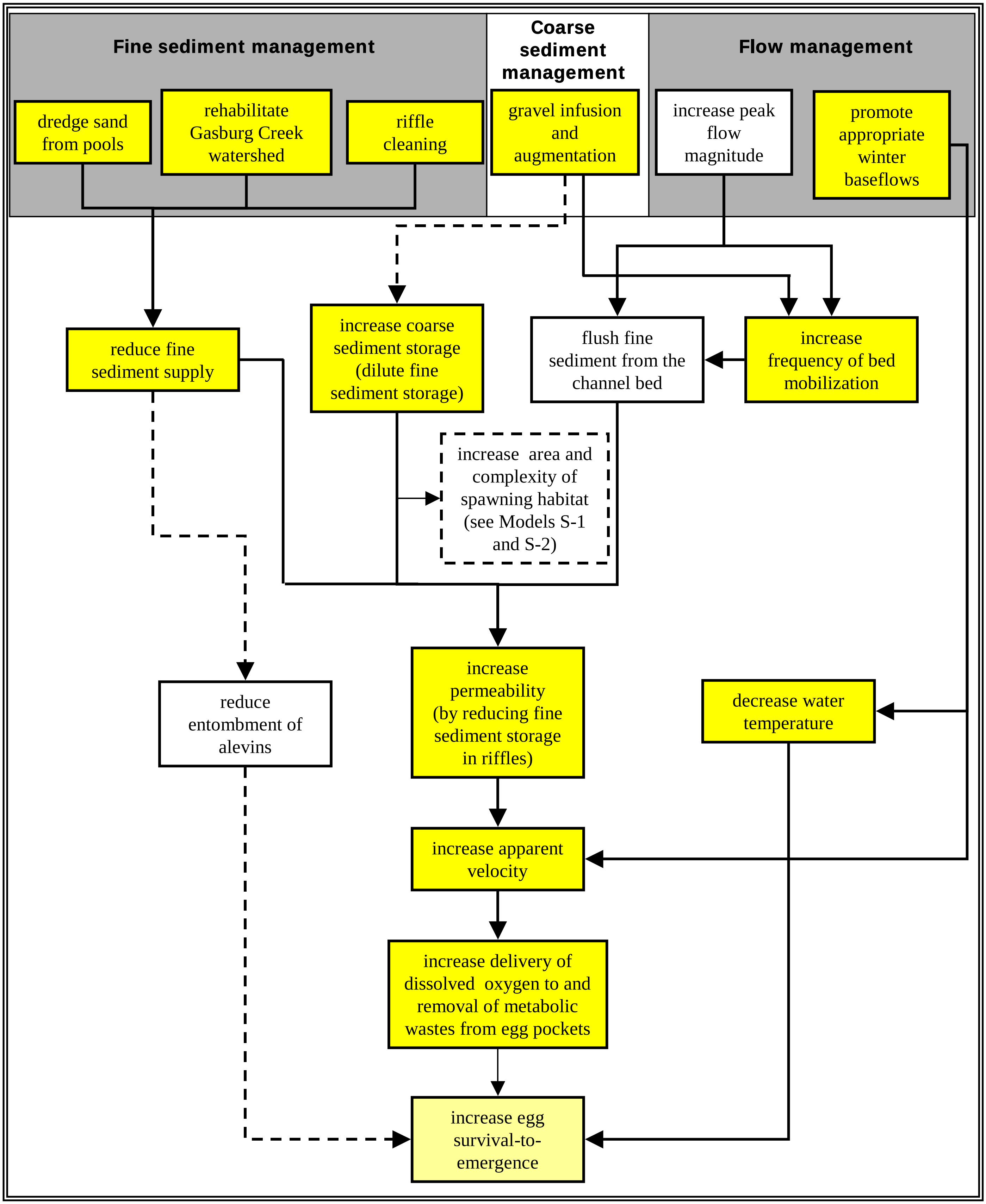
* Indicates factors that are considered to be limiting.
M Indicates factors that are currently being monitored.
PM Indicates factors for which past monitoring data are available.

Out-of-Basin Factors
• Temperature M, PM
• Attraction flows M, PM
• Water quality M, PM
• Dissolved oxygen M, PM
• Harvest*, M, PM
• Ocean conditions M, PM
• Delta export mortality *, M, PM

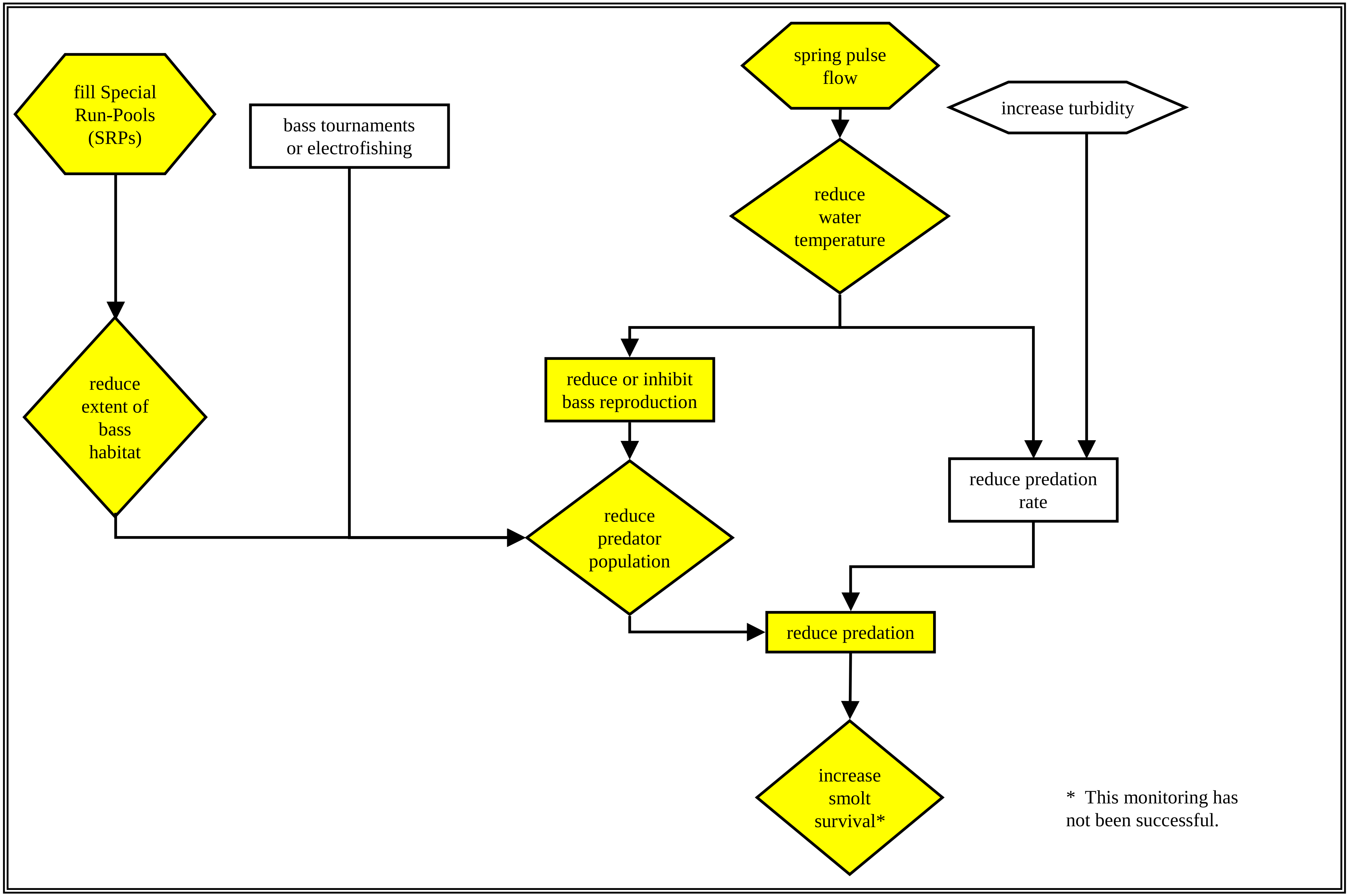
Model S-1. Overarching model of factors affecting chinook salmon population abundance in the Tuolumne River.
[Relevant submodel numbers are indicated in brackets.]



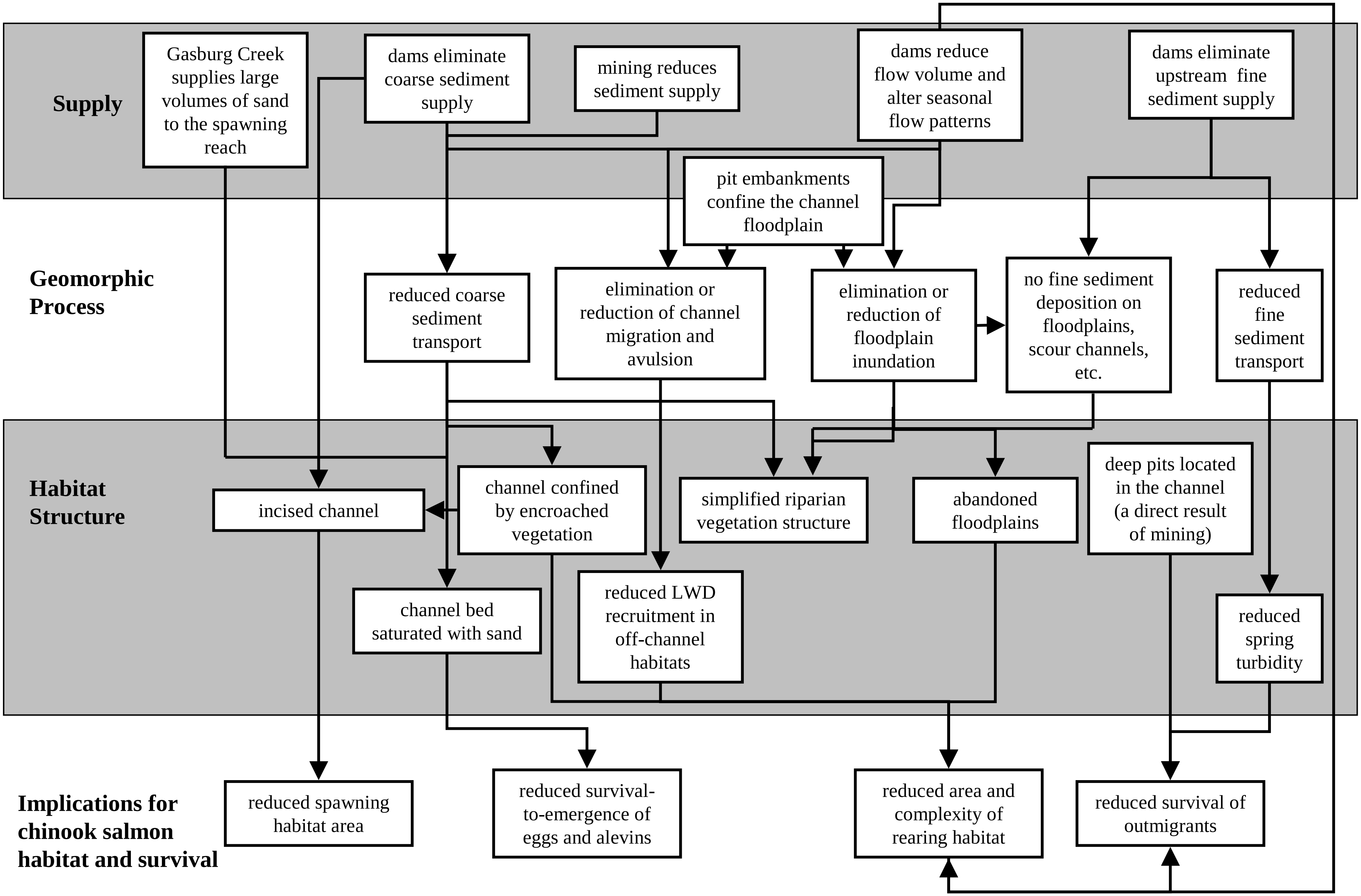
Model S-2. Potential alternative actions to reduce chinook salmon redd superimposition.



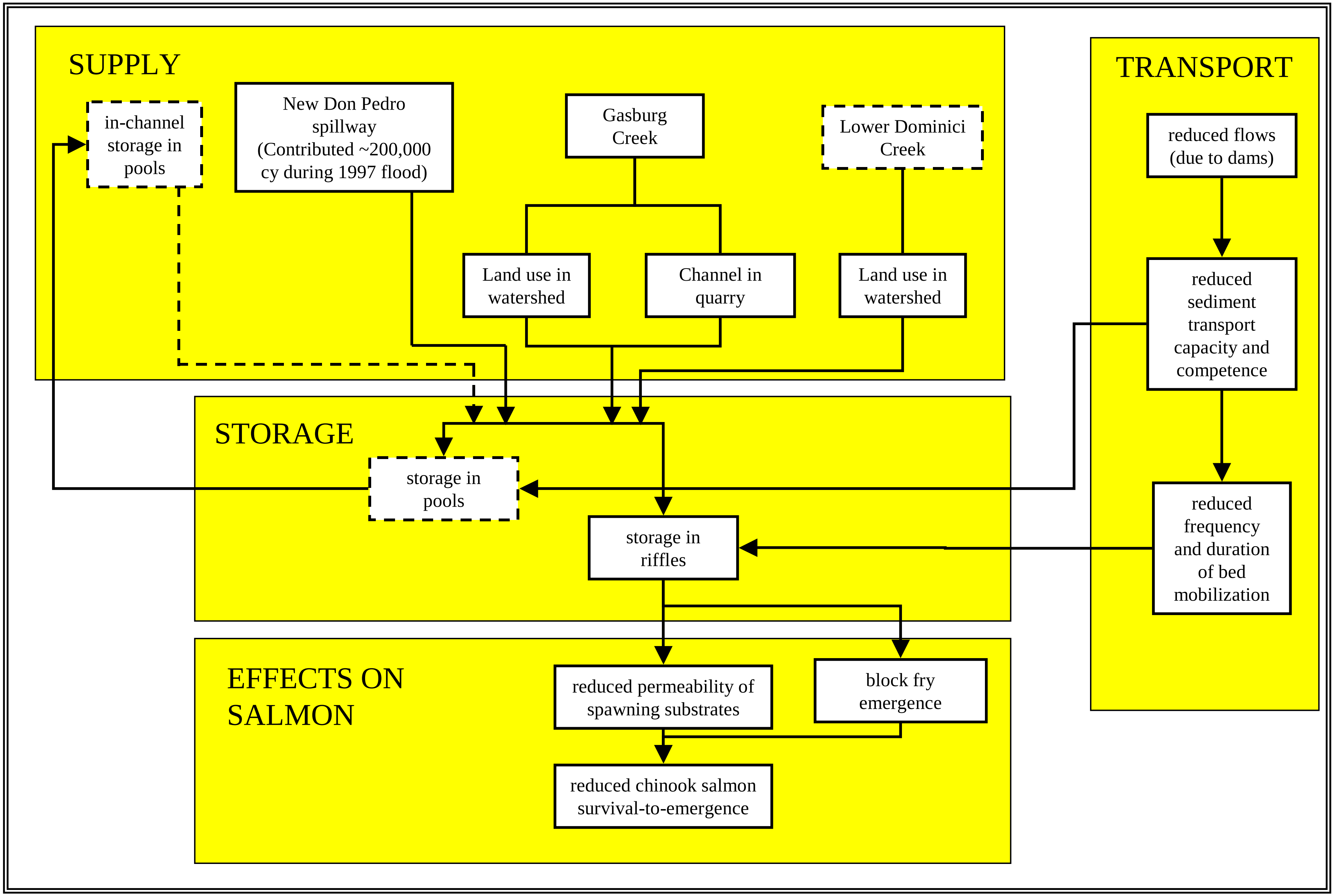
Model S-3. Potential alternative actions to improve chinook salmon survival-to-emergence.



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



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.

APPENDIX D

Attributes of an alluvial river and their relation to water policy and management

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Contributed by Luna B. Leopold, August 15, 2000

Rivers around the world are being regulated by dams to accommodate the needs of a rapidly growing global population. These regulatory efforts usually oppose the natural tendency of rivers to flood, move sediment, and migrate. Although an economic benefit, river regulation has come at unforeseen and unevaluated cumulative ecological costs. Historic and contemporary approaches to remedy environmental losses have largely ignored hydrologic, geomorphic, and biotic processes that form and maintain healthy alluvial river ecosystems. Several commonly known concepts that govern how alluvial channels work have been compiled into a set of "attributes" for alluvial river integrity. These attributes provide a minimum checklist of critical geomorphic and ecological processes derived from field observation and experimentation, a set of hypotheses to chart and evaluate strategies for restoring and preserving alluvial river ecosystems. They can guide how to (*i*) restore alluvial processes below an existing dam without necessarily resorting to extreme measures such as demolishing one, and (*ii*) preserve alluvial river integrity below proposed dams. Once altered by dam construction, a regulated alluvial river will never function as before. But a scaled-down morphology could retain much of a river's original integrity if key processes addressed in the attributes are explicitly provided. Although such a restoration strategy is an experiment, it may be the most practical solution for recovering regulated alluvial river ecosystems and the species that inhabit them. Preservation or restoration of the alluvial river attributes is a logical policy direction for river management in the future.

Since the 1990s, the physical and environmental consequences of river alteration and management have been openly questioned. Continued increases in flood losses, both financial and human, and the unanticipated and unwanted results of dams and channel straightening, invite reevaluation of river management. Reevaluation has even led to removing existing dams (e.g., Butte and Clear creeks in California, Elwha River in Washington), as well as implementing experimental releases of high flows (1, 2).

Historically, river policymakers and resource managers have been less attentive to a growing body of experience, experiment, and theory concerning geomorphic processes that form and maintain alluvial river ecosystems. There are several commonly known concepts that govern how healthy alluvial channels work that we have compiled as attributes of alluvial river integrity. These attributes can guide how to (*i*) restore alluvial processes downstream of an existing dam without necessarily resorting to extreme measures such as demolishing one, and (*ii*) preserve alluvial river integrity below proposed dams. This set of attributes is not a classification system or a substitute for individual study and observation on a river. It provides a minimum checklist of critical geomorphic and ecological processes derived from field observation and experimentation, a set of hypotheses to chart and evaluate strategies for restoring and preserving alluvial river ecosystems. At the ever-present risk of oversimplification, the attributes also can help policymakers appreciate many of the complex requirements of alluvial river ecosystems.

Alluvial river ecosystems persist through a complex, interacting array of physical and biological processes. For any impetus imposed on the river ecosystem (e.g., a recommended flow release), we should expect a response (e.g., scouring sand from a pool). The significance of an impetus will depend on an appropriate threshold beyond which a specific response is expected. A process, therefore, is comprised of an impetus and an expected response. To use the alluvial river attributes as guidelines for recovering or preserving critical processes, one must consider how the magnitude, duration, frequency, and timing of an impetus will exceed a threshold to produce a desired response. Rarely, however, is a single impetus imposed on a river ecosystem associated with a single response.

Floods are primary impetuses for all alluvial river morphology. An increase in discharge may initiate bed surface movement and bank erosion, once the force exerted by the flood event (the impetus) has passed some threshold for movement or erosion. This threshold may require a specific flow magnitude and duration before producing a significant morphological response. The timing and frequency of the flood also may have profound effects on a species or a population. Mobilizing sand from a pool in January may smother salmon eggs incubating in the downstream riffle. The impetus, therefore, cannot be prescribed as a simple measure of force, nor can the total reaction be as succinctly quantified or even fully anticipated. It is with this backdrop of uncertainty that the attributes were compiled.

The Alluvial River Attributes

The alluvial river attributes (3) can help river managers identify desired processes, then help prescribe necessary impetuses based on useful empirical relationships and thresholds developed by river geomorphologists and ecologists. All of the concepts deriving the alluvial attributes have been described among a wide range of professional journals, technical books, and agency reports (reviewed in ref. 2), but their compilation has not been previously published. They may not apply equally to all alluvial river ecosystems. Some rivers may not be capable of achieving certain attributes because of overriding constraints, e.g., a river passing through an urbanized corridor often is not free to migrate. These constraints do not eliminate the attributes' usefulness; knowing what might remain broken should influence what can be repaired.

Attribute No. 1. ***The primary geomorphic and ecological unit of an alluvial river is the alternate bar sequence.*** *Dynamic alternating bar sequences are the basic structural underpinnings for aquatic and riparian communities in healthy alluvial river ecosystems.*

The fundamental building block of an alluvial river is the alternate bar unit, composed of an aggradational lobe or point bar, and a scour hole or pool (Fig. 1). A submerged transverse bar, commonly called a riffle, connects alternating point bars. An alternate bar sequence, comprised of two alternate bar units, is a meander wavelength; each wavelength is between 9 and 11 bankfull widths (4). The idealized alternate bar sequence is

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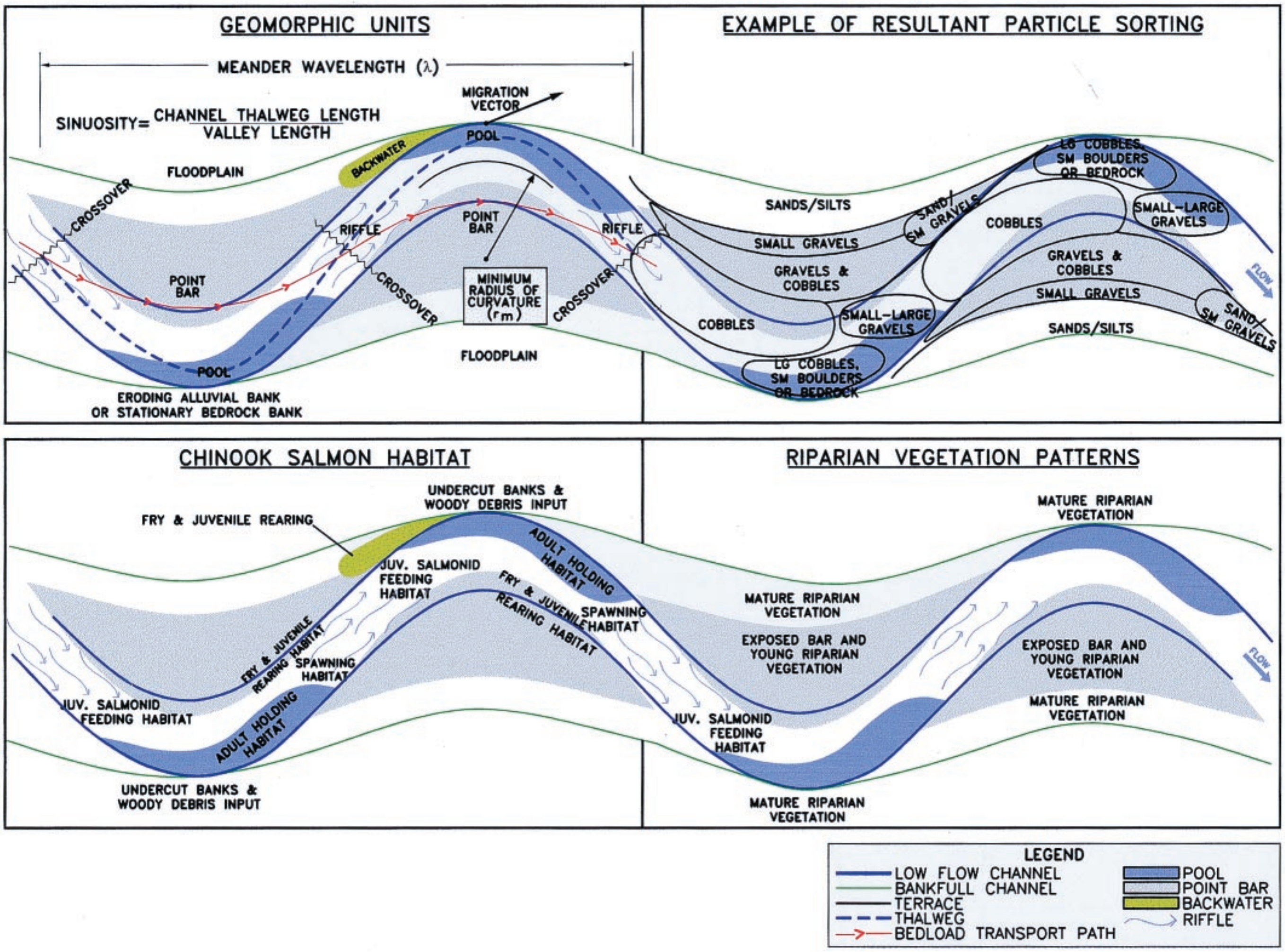

Fig. 1. An idealized alternate bar sequence showing geomorphic units, particle-sorting trends, typical salmonid habitats, and riparian vegetation succession patterns.

rarely found in nature, because natural geomorphic variability (e.g., valley width contractions, bedrock exposures, etc.) perturbs the idealized channel form shown in Fig. 1. Floods flowing through alternating bar sequences frequently rearrange the bar topography, producing diverse, high-quality aquatic and terrestrial habitat.

Attribute No. 2. ***Each annual hydrograph component accomplishes specific geomorphic and ecological functions.*** *Annual hydrograph components (including winter storm events, baseflows, snowmelt peaks, and snowmelt recession limbs) collectively provide the impetus for processes that shape and sustain alluvial river ecosystems. These components are uniquely characterized by year-to-year variation in flow magnitude, duration, frequency, and timing.*

Hydrograph components are seasonal patterns of daily average flow that recur from year to year. For many rivers in the western U.S., these hydrograph components include summer baseflows, rainfall- and rain-on-snow-generated floods, winter baseflows, snowmelt peak runoff, and snowmelt recession (Fig. 2). Each annual hydrograph component can be characterized by its interannual variability in flow magnitude, duration, frequency, and timing. A subset of all processes needed to create and sustain alluvial river ecosystems is provided by each hydrograph component. Eliminate or alter the interannual variability of the hydrograph components, and the ecosystem is invariably altered.

Attribute No. 3. ***The channelbed surface is frequently mobilized.*** *Coarse alluvial channelbed surfaces are significantly mobilized by bankfull or greater floods that generally occur every 1–2 years.*

As streamflow rises throughout a winter storm and during peak snowmelt, a geomorphic threshold for mobilizing the channelbed surface is eventually exceeded. This flow threshold typically occurs over a narrow range of streamflow and varies spatially, depending on the morphology, grain size, and location of sediment deposits (Fig. 3). In general, grains on the channelbed surface are mobilized many times a year, but sometimes not at all in other years, such that, over the long-term, the streambed is mobilized on the order of once a year. The duration of channelbed mobilization is a function of the duration of the high flow, which is typically on the order of days.

Attribute No. 4. ***Alternate bars must be periodically scoured deeper than their coarse surface layers.*** *Floods that exceed the threshold for scouring bed material are needed to mobilize and rejuvenate alternate bars. Alternate bars are periodically scoured deeper than their coarse surface layer, typically by floods exceeding 5- to 10-year annual maximum flood recurrences. Scour is generally followed by redeposition, often with minimal net change in the alternating bar topography.*

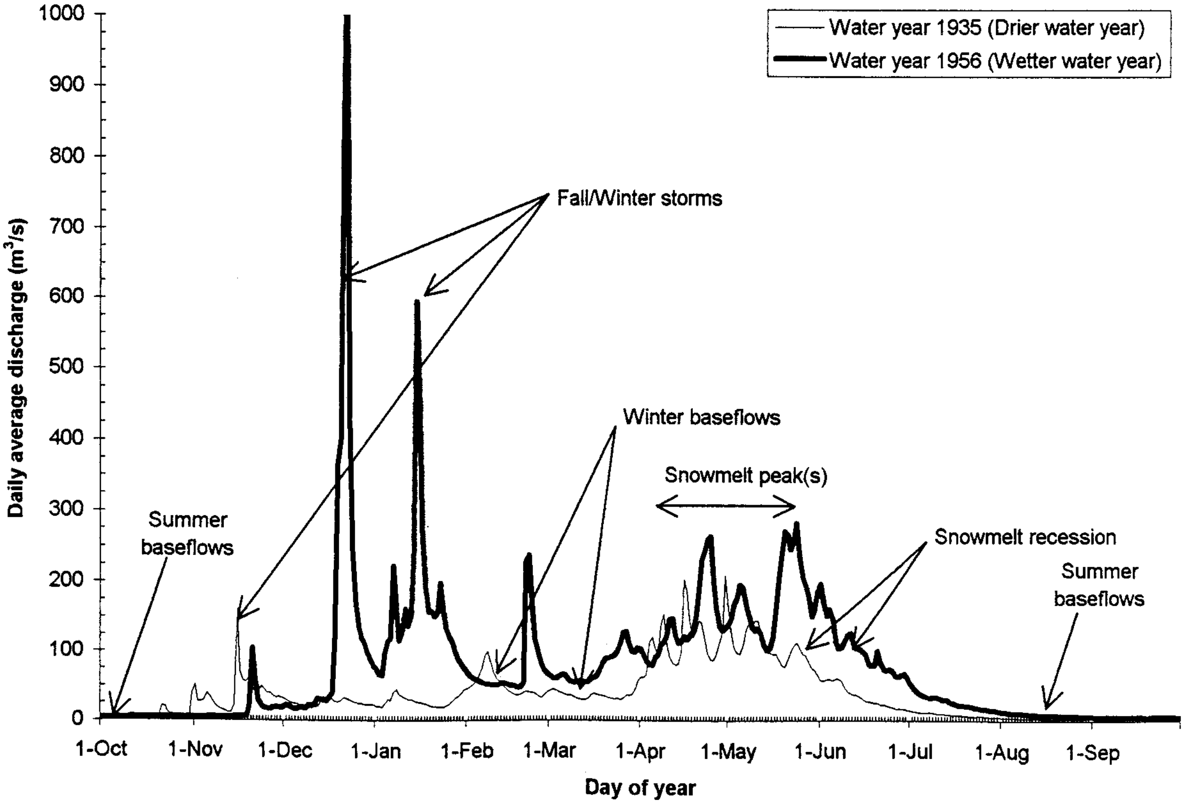

Fig. 2. Hydrograph components of an annual hydrograph by using 1956 (wetter year) and 1935 (drier year) unimpaired flows on the Trinity River in California.

Complex alternating bar sequences are partly created and maintained by providing the natural frequency and intensity of bed scour dependent on discharges that vary in magnitude and duration. During the rising limb of a hydrograph, after the bed surface begins to move, the rate of gravel transport rapidly increases and the bed surface begins to scour. The degree of scour can be significant, up to several feet deep. Infrequent, wet years typically generate storms with a high magnitude and long duration; scour depth will be substantial. On the receding limb of a flood hydrograph, gravel and cobbles redeposit, often resulting in no net change in channelbed elevation after the flood.

Attribute No. 5. ***Fine and coarse sediment budgets are balanced.*** *River reaches export fine and coarse sediment at rates approximately equal to sediment input rates.*

Although the amount and mode of sediment stored may fluctuate within a given river reach, channel-wide morphology is sustained in dynamic quasiequilibrium when averaged over many years. The magnitude and duration of high flows surpassing a flow threshold for channelbed mobility are critical for balancing the sediment budget. Chronic channelbed aggradation and/or degradation are indicators of sediment budget imbalances. A balanced coarse sediment budget implies bedload continuity; that is, the coarser particle sizes comprising the channel bed must be transported through alternate bar sequences.

Attribute No. 6. ***Alluvial channels are free to migrate.*** *During lateral migration, the channel erodes older flood plain and terrace deposits on the outside bend whereas it deposits sediment on the bar and flood plain of the inside bend. Although outer and inner bend processes may be caused by different hydrograph components, the long-term result is maintenance of channel width.*

Channel migration is one of the most important processes creating diverse aquatic and terrestrial habitats: Sediment and woody debris are delivered into the river and flood plains are rebuilt on the inside of the meander. That the stream has occupied numerous locations in its valley is evidenced by direct observations of its movement over time, and by indirect evidence obtained if one digs deeply enough into the flood plain. Gravel and cobbles laid down by the river many years before will be found. The channel does not typically migrate during periods of low flow, but migrates during flows approaching and exceeding bankfull discharge. Shear stress on the outside of bends exceeds that necessary to erode the materials on the outside of the bank. In lower gradient reaches of alluvial rivers, migration tends to be more gradual.

Attribute No. 7. ***Flood plains are frequently inundated.*** *Flood plain inundation typically occurs every 1–2 years. Flood plain inundation attenuates flood peaks, moderates alternate bar scour, and promotes nutrient cycling.*

As flows increase beyond that which can be contained by the bankfull channel, water spreads across the flatter flood plain surface. The threshold for this process is the bankfull discharge. This first threshold allows flow simply to spill out of the bankfull channel and wet the flood plain surface; a slightly larger discharge is required to transport and deposit the fine sediments that are in suspension. Flood plain inundation also moderates alternate bar scour in the mainstem channel by limiting flow depth increases within the bankfull channel during floods. As water covers the flood plain, flow velocity decreases. Sediment begins to settle, causing fresh deposits of fine sands and silts on the flood plain. This deposition promotes riparian vegetation regeneration and growth.

Attribute No. 8. ***Large floods create and sustain a complex mainstem and flood plain morphology.*** *Large floods—those exceeding 10- to*

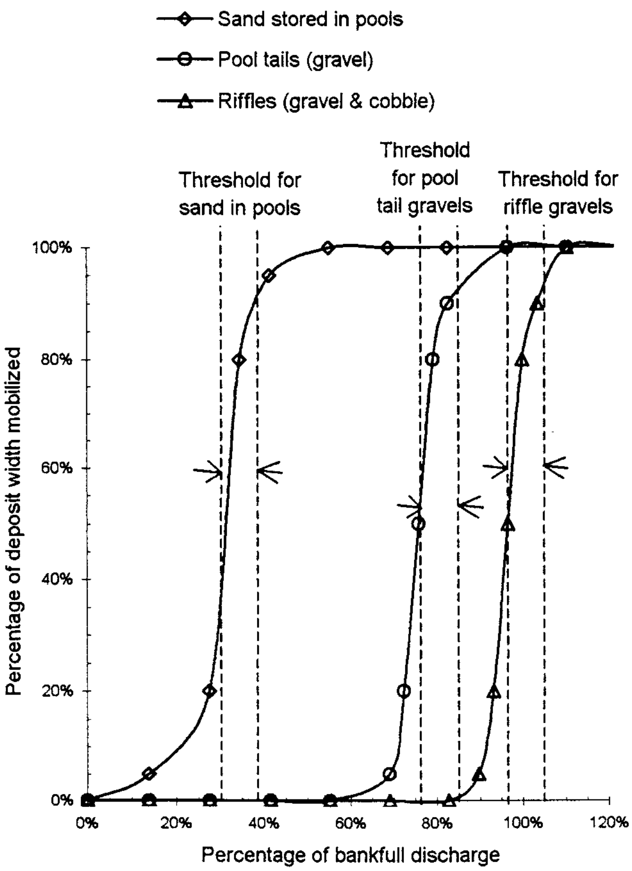

Fig. 3. Conceptual bed mobility thresholds, showing the narrow range in discharge that initially mobilizes the surfaces of selected alluvial features.

20-year recurrence events—reshape and/or redirect entire meander sequences, avulse mainstem channels, rejuvenate mature riparian stands to early successional stages, form and maintain side channels, scour flood plains, and perpetuate off-channel wetlands, including oxbows.

A still larger flow threshold than floodplain inundation is one that scours the flood plain. The streamflow necessary to surpass this threshold is typically many times the bankfull flow because shear stress on the vegetated flood plain surface must be high enough to cause scour. Infrequent large floods are critical for sustaining channel complexity because they change river location and morphology on a large scale and prevent riparian vegetation from dominating the river corridor.

Attribute No. 9. ***Diverse riparian plant communities are sustained by the natural occurrence of annual hydrograph components.*** *Natural, interannual variability of hydrograph components is necessary for woody riparian plant life history strategies to perpetuate early and late successional stand structures.*

Native riparian plant communities characteristic of alluvial river ecosystems are adapted to, and thus sustained by, a constantly changing fluvial environment. The magnitude and duration of annual hydrograph components needed for alternate bar scour, channel migration, floodplain inundation and scour, and channel avulsion provide necessary substrate conditions for successful seedling establishment and stand development. The timing and frequency of annual hydrograph components must coincide with seasonally dependent life history requirements, such as the short window of time when riparian plants are dispersing seeds. A sustainable supply of large woody debris from the riparian zone ultimately depends on variable age classes of woody riparian vegetation and a migrating channel.

Attribute No. 10. ***Groundwater in the valley bottomlands is hydraulically connected to the mainstem channel.*** *When flood plains are inundated, a portion of surface runoff from the watershed is retained as groundwater recharge in the valley bottomlands.*

The river corridor is hydraulically interconnected. Groundwater in the floodplain is closely connected to mainstem flows (5) and can be periodically recharged by mainstem flooding. Avulsed meander bends often create oxbow wetlands, which retain direct hydraulic connectivity to mainstem surface flows.

The alluvial river attributes can be used to recommend flow releases and other management activities below an existing dam. Although this strategy is being considered in other locations, we will use the Trinity River in Northern California as an example, where the recovery of Pacific salmon and steelhead trout is being linked with the overall goal of restoring an alluvial river ecosystem.

The Trinity River at Lewiston

The mainstem Trinity River in northern California was once an alluvial river capable of constantly reshaping its channelbed and banks. In 1963, the U.S. Bureau of Reclamation constructed a large storage reservoir and diversion tunnel to store and divert up to 90% of the natural streamflow from the Trinity River into the Sacramento River for power generation and agricultural/municipal water supply (6). Historically, Trinity River daily flows varied from less than 2.8 m^3/s baseflows in dry summers to near 2,800 m^3/s floods in wet winters. Snowmelt peak runoff and its recession limb were two critical annual hydrograph components generated upstream of Lewiston (Fig. 2). In wet years, snowmelt runoff typically peaked at 340 m^3/s or higher in late June or July, whereas in dry years the peak would only be 110 m^3/s or lower in mid-May through mid-June (7). Together they provided the magnitude and duration of flows needed to balance the sediment budget and accomplish a wide range of physical and biological processes. Both hydrograph components theoretically could have occurred at any time of the year and still have balanced the sediment budget. But seasonal timing of snowmelt runoff was critical to ecological processes.

Peak snowmelt runoff was an important environmental cue for juvenile salmonids to begin their migration to the Pacific Ocean (2). Amphibians needed snowmelt runoff to keep oxbow wetlands inundated. If the snowmelt recession limb did not extend into early June, the wetland might have dried out before amphibians could complete their aquatic life history stage. Interannual variability of timing, magnitude, and duration of snowmelt recession limbs determined whether a particular oxbow wetland could sustain an amphibian population. Successful cottonwood regeneration on freshly deposited floodplains also required specific snowmelt peaks and recession limbs to create favorable moisture conditions for seedling germination, as well as the absence of extreme winter storm events the following year to prevent seedling loss.

After the dam was completed, flows were kept nearly constant at 4.2 m^3/s; river managers thought that 4.2 m^3/s would provide ideal hydraulic conditions for chinook salmon spawning. What river managers did not foresee was that by eliminating hydrograph components they would set in motion a chain of predictable events. Seedlings, no longer scoured away by frequent winter and snowmelt floods, rapidly encroached onto the alternate bars. Prominent berms of freshly deposited sand and silt accumulated along the channel margins within the maturing dense riparian vegetation (Fig. 4), effectively isolating the floodplain from the mainstem river. High shear stresses of infrequent high flow events were then concentrated in the channel's center.

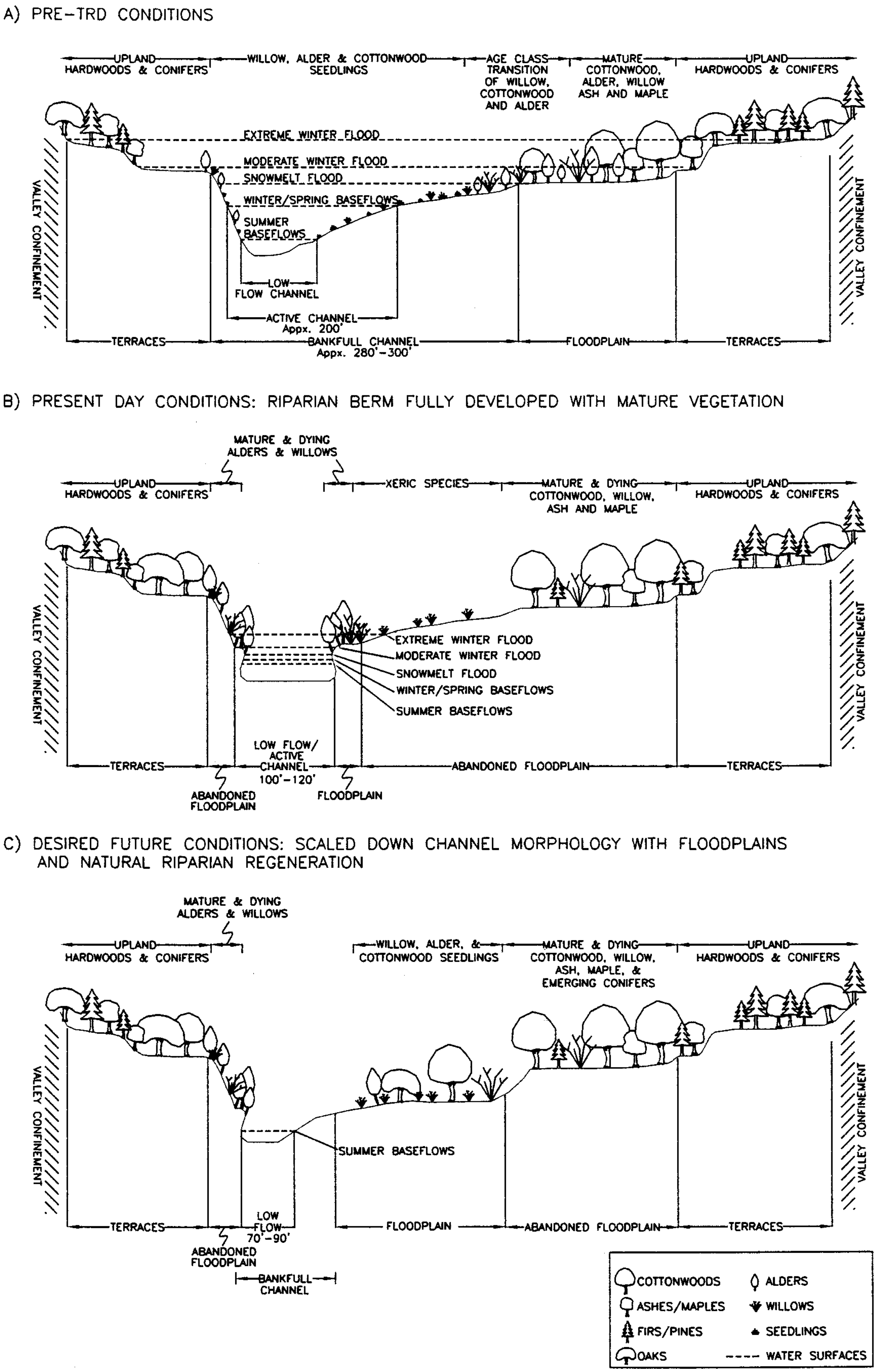

Fig. 4. Evolution of channel geometry and riparian vegetation in response to flow and sediment regulation from the Trinity River Division of the Central Valley Project in California, 1963–1999.

The river's complex alternate bar morphology was quickly transformed into a smaller, confined rectangular channel (Fig. 4) now unable to meander. Floodplains were abandoned. Cumulatively, this flume-like morphology and floodplain isolation greatly reduced habitat quantity and complexity important to numerous aquatic and riparian species.

Salmon populations were immediately and significantly affected. With most of their primary spawning and rearing habitat upstream of an impassable dam, the mainstem channel below Lewiston became the primary habitat provider. When young salmon emerge from spawning gravels as fry, their immediate habitat preference is for gently sloped, low velocity, exposed cobble areas typically found along predam alternate bar margins. In contrast, the vertical banks of the postdam channel allow excessive velocities to extend up to the banks' edges. Although the constant 4.2 m^3/s dam release temporarily accommodated spawning habitat needs, fry rearing habitat became a limiting factor to salmon production because of this rapid change in channel shape.

Was the widespread habitat loss in the Trinity River predictable? Managers who expected that spawning habitat would be preserved below the dams ignored the sediment budget (*Attribute No. 5*). Trinity and Lewiston dams prevent all bed material from passing downstream; the only sources for spawning gravels are downstream tributary inputs, minor flood plain scour, and occasional gravel introductions. The snowmelt peak and recession hydrograph components were completely eliminated (*Attribute No. 2*), even though this river ecosystem had been dominated by snowmelt runoff. Of the planned flow releases greater than 4.2 m^3/s, all were well below the threshold for mobilizing the channelbed (*Attributes Nos. 3* and *4*), routing bed load (*Attribute No. 5*), or inundating the floodplain (*Attributes Nos*. *7*, *8*, and *10*). Consequently, seedlings escaped being scoured and encroached onto the predam alternating bars (*Attribute No. 9*). Loss of the alternate bar morphology (*Attribute No. 1*) was inevitable; so was the loss of habitat created by it.

Was the widespread habitat loss on the Trinity River preventable? Anadromous salmonids cannot pass upstream of Lewiston Dam, therefore their habitat will never be completely replaced unless both dams are removed. The mainstem Trinity River below Lewiston Dam cannot be brought back to its original dimension. But a scaled-down alluvial channel morphology in equilibrium with its constrained sediment budget, reduced hydrograph components, and occasional bed material introductions could greatly restore habitat abundance and quality.

A new restoration approach for the Trinity River that is guided by the alluvial attributes is in its final planning stages. An environmental impact statement/report (6) includes this new restoration strategy, developed by the U.S. Fish and Wildlife Service and Hoopa Valley Tribe (2), as one fishery restoration alternative. The management goal would be to rebuild and maintain a self-sustaining alternate bar morphology and riparian community by using the attributes as a blueprint. Planned releases from Lewiston Dam would provide snowmelt peak and snowmelt recession hydrograph components (*Attribute No. 2*) to recreate physical processes that will recover an alluvial channel morphology (*Attributes Nos. 1*, *3*, *4*, and *6–8*) and sustain off-channel wetlands (*Attribute No. 10*). The sediment budget would be balanced by releasing appropriate hydrograph components with sediment transport capacities commensurate with sediment inputs (*Attribute No. 5*). If transport capacities exceed supply, as might occur during large flood releases in wet years, bed material would be introduced into the mainstem to compensate. Riparian berms on segments of fossilized alternating bars (in the upper 64 km) would be mechanically cleared as a precursor to reestablishing dynamic alternating bars (*Attribute No. 9*).

Conclusion

Society is embarking on a grand experiment. Recent dam removals are merely forerunners of a much larger task ahead. Many more dams will remain than are removed. In practice, we must rely on the crucial assumption that native species have evolved with the natural flow regime. Violating this assumption often results in consequences that can be highly significant and difficult to reverse. The intent to recover alluvial river ecosystems below dams, as proposed for the Trinity River in northern California, will be controversial. To obtain the societal benefits of water diversion, flood control, and hydropower generation, rivers will continue to receive less flow and sediment than under unimpaired conditions. But if important attributes are provided to the greatest extent possible, alluvial river integrity can be substantially recovered. The compromise will be a smaller alluvial river; it may not recover its predam dimensions, but it would exhibit the dynamic alternate bar and floodplain morphology of the predam channel. Although a restoration strategy guided by the alluvial attributes is an experiment, it may be the most practical direction toward recovering regulated alluvial river ecosystems and the species that inhabit them.

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3. Trush, W. J. & McBain, S. M. (2000) in *Stream Notes*, ed. Rocky Mountain Research Station (U.S. Forest Service, Fort Collins, CO).
4. Leopold, L. B., Wolman, M. G. & Miller, J. P. (1964) *Fluvial Processes in Geomorphology* (Freeman, San Francisco).
5. Hurr, R. T. (1983) *U.S. Geological Survey Professional Paper* 1277-H (U.S. Geological Survey, Reston, VA).
6. U.S. Fish and Wildlife Service, U.S. Bureau of Reclamation, Hoopa Valley Tribe & Trinity County (1999) *Trinity River Mainstem Fishery Restoration Environmental Impact Statement/Report* (U.S. Fish and Wildlife Service, Sacramento, CA).
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APPENDIX E

TUOLUMNE RIVER PHASE II GRAVEL INTRODUCTION TECHNICAL MEMORANDUM

Prepared on Behalf of
Tuolumne River Technical Advisory Committee

for

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and

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February 28, 2001

Background

The Tuolumne River Technical Advisory Committee developed the *Habitat Restoration Plan for the Lower Tuolumne River Corridor* (McBain and Trush 2000) to guide restoration activities on the river. A primary recommendation in the Restoration Plan was to restore coarse sediment conditions in the Gravel-bedded Zone, first by adding large volumes of gravel and cobble to rapidly improve the coarse sediment storage in the channel, then by periodically adding coarse sediment approximately at the rate it is transported downstream during high flows. This gravel introduction program began in 1999 with implementation of the DFG/DWR Phase I Gravel Addition Project at La Grange, which introduced approximately 12,500 cubic yards of gravel at riffle 1A below La Grange Bridge. Phase II of the Spawning Gravel Introduction Project was funded by AFRP and the Tracy Mitigation Program to continue spawning gravel introduction in the upper reaches of the Tuolumne River. The AFRP program also funded McBain and Trush to prepare a Coarse Sediment Management Plan that would provide additional detail on high priority gravel introduction sites, refined volume estimates, methods for gravel introduction, and specific monitoring guidelines. Because the Sediment Management Plan will not be complete before the DFG/DWR Phase II project is implemented, McBain and Trush have prepared this technical memorandum to help guide the implementation of the Phase II project.

Data Collection

To date, we have collected the following information for the Sediment Management Plan:

- habitat mapped, using recent aerial photos (Dec 1999) and methods developed for other Tuolumne River projects; mapping includes pool-riffle-run units, gravel bars, and chinook spawning habitat as indicated by recent redd construction;
- surveyed several potential sites that would benefit from spawning gravel or coarse sediment augmentation, and assessed logistical opportunities/constraints (road construction needs, land ownership, etc.);
- installed and surveyed 19 new cross sections between La Grange Dam and Basso, monumented with rebar pins and tied to real elevation control where possible; cross sections are numbered according to longitudinal stationing from the San Joaquin River, similar to other Tuolumne River project reaches; cross sections and other survey data were used to estimate gravel volumes at specific proposed sites;
- performed pebble counts of existing and proposed sediment conditions;
- compared pre-1990's habitat data with recent data to document spawning habitat attrition at specific riffles, in order to aid in prioritizing the selection of gravel introduction sites for 2001 and for future projects;
- assessed historical conditions at selected sites from early aerial photo sequences;

The primary focus of the Sediment Management Plan is in the reach between La Grange Dam and Basso Bridge. We mapped the available spawning habitat in this reach in December 2000, to compare to previous spawning habitat assessments conducted by the Districts in 1988 (EA 1992). Our assessment in the upper reach indicates that spawning habitat has decreased by as much as 44% compared to the 1988 data, likely a result of steady gravel attrition from annual bedload transport and lack of upstream supply, as well as from the catastrophic degradation from the January 1997 flood. Based on spawning habitat availability, channel widening and downcutting, and chinook spawning preferences (redd densities), the most evident impacts are generally in the riffles upstream of New La Grange Bridge (NLGB), compared to riffles between NLGB and Basso Bridge. For example, spawning habitat at riffle A3/4 has been reduced from 22,000 ft2 in 1988 to approximately 3,700 ft2 in 2000; Riffle A5 is nearly completely scoured away, with water depths of 5 to 6 ft, coarse substrate, and very little velocity; Riffle A6 supported only one or two redds in 2000/01 spawning season.

Site Selection, Methods, and Volumes

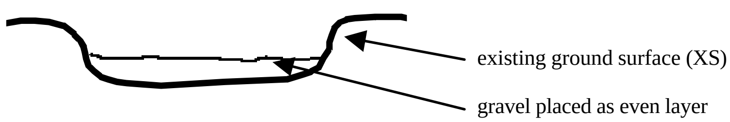
During the Feb 13 meeting, the TRTAC agreed that sites upstream of New La Grange Bridge were highest priority. This reach receives the highest concentration of spawners, and gravel placed here will not only provide immediate benefit to salmon, but will continue to benefit salmon in future years as the gravel is routed downstream. Our selection of preferred sites for 2001 implementation was therefore prioritized as follows (see Figure 1 for site locations):

- ➢ the section of channel between riffles A7 and 1B (upstream and downstream of the Phase I project site) was recommended as a preferred site for implementation in 2001. In addition, the TRTAC discussed supplementing the riffle 1A Phase I site with a gravel bar extending from the left bank, with the objective of increasing channel confinement, providing better velocities in the riffle, and introducing a somewhat finer gravel mixture.

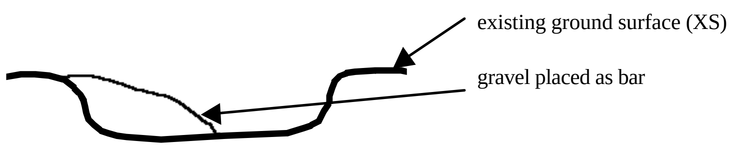
- riffles A1 and A2 were not recommended because of the limited long-term benefits to be gained at these sites, both located upstream of a deep pool that would prevent gravel from routing downstream in future events;
- riffle A3/4 would require construction of a new access road on TID property, and was recommended as a project for implementation by the Districts;
- riffles A5 and A6 are high priority, but access is limited to a single location at the USGS Cableway;

Early implementation of gravel introduction (prior to completion of the Coarse Sediment Management Plan) provides an excellent opportunity to experiment with gravel placement techniques to maximize . We propose several different techniques for gravel placement (Figure 3):

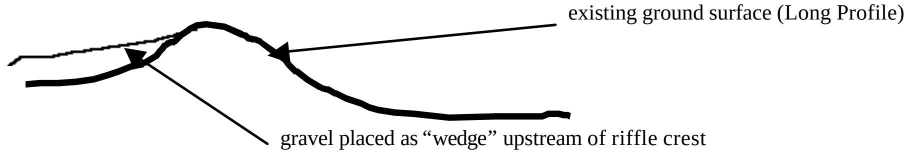
1. Riffle supplementation: this method entails placing clean, well-sorted gravel onto the existing channelbed in an even layer of specified depth;



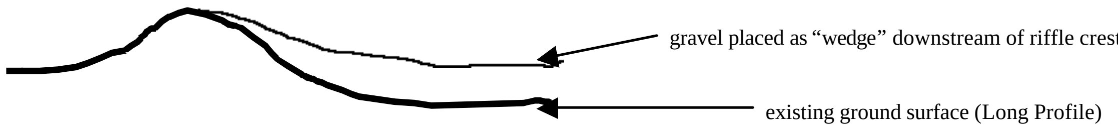
2. Point bar supplementation: this method would place gravel as a lateral bar to increase confinement and provide long-term supply;



3. Pool tail supplementation: this method would increase spawning habitat area on overly-steep pool-tails;



4. Riffle wedge: this method would layer gravel increasing in depth moving downstream to reduce the riffle slope and increase spawning habitat;



5. Recruitment pile: this method would place a quantity of gravel on or near the channel margin, available for downstream transport at high flows; long-term recruitment locations could be identified for routine (annual) supplementation;

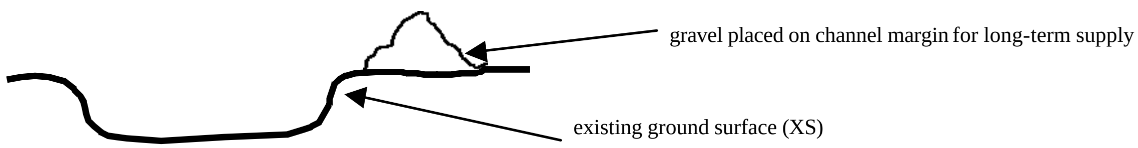


Figure 3. Suggested gravel introduction methods that can be used to address different channel conditions.

In addition to placement of large quantities of gravel directly in the channel for immediate spawning habitat supplementation, our assessment of coarse sediment storage conditions below La Grange Dam concluded that gravel could be placed in a natural gravel bar morphology in several locations to increase coarse sediment storage for eventual downstream transport, to improve channel confinement, and to increase water velocities during spawning flows. Restoring a more natural alternate bar morphology will improve bedload transport continuity, and therefore better downstream routing of introduced gravels during high flows. Importantly, this strategy will discourage future riffle loss by providing instream sediment storage to replace gravels transported from riffles during high flows. In addition, the large backwater dredging pit should be filled to reconstruct bankfull channel confinement. A coarser (unprocessed) gravel composition can potentially be used to construct bars and fill backwaters.

Figure 1 shows recommended spawning gravel and coarse sediment introduction sites from riffle A7 to riffle 1B. We delineated discrete gravel introduction polygons (numbered 10 to 18) to provide gravel volume estimates and flexibility in gravel addition methods and particle size composition. These polygons were digitized to estimate the surface area, and combined with the recommended depth of gravel placement, yielded the estimated gravel volumes. We used cross section surveys to estimate the appropriate depth of gravel placement in the riffle A7 section. We have not installed cross sections in the portion of channel below riffle 1A, and estimates of gravel depth should be refined with additional surveys.

In addition to the planview map of the gravel introduction sites (Figure 1), we provide the 1999 aerial photo of the proposed gravel introduction reach upstream and downstream of Old La Grange Bridge (Figure 2),cross sections with "proposed channel contours" sketched onto cross section plots. These contour lines were used to estimate recommended gravel depths/volumes. Placement of gravel into the channel during implementation may be simplified, with less topographic detail than is reflected in the sketched contour lines.

Below we describe each gravel introduction polygon, the main objective for gravel placement, and provide a rough volume estimate.

Polygon 10: Impacts of bank scour and lack of supply from upstream sources are clearly evident in recent air photos and field visits. Spawning habitat in adjacent portions of the channel will benefit from increased confinement in the upper portion of the riffle, by increasing velocities in the pool tail spawning areas at spawning flows (~300 cfs). Additionally, this material will be available for transport at high flows to maintain spawning gravel supply at downstream riffles. Recommended gravel introduction volume at polygon 10 is approximately 4,300 yd^3. A coarser, heterogeneous mix of unwashed gravel and cobble could be used here. Figure 4 (XS-2804+00) shows the proposed gravel introduction morphology on the left bank bar.

Polygon 11: The pool tail at the head of riffle A7 emerges from a deep pool, and has an unnaturally steep longitudinal morphology (Figure 4), and bedrock has become exposed within the channel. Introducing gravel in the pool tail downstream to the riffle crest will increase available spawning habitat. Gravel should be placed so the riffle crest elevation is not increased at this site. Recommended volume = 700 yd^3. Figure 4 (XS-2804+00) shows the proposed pool tail morphology.

Polygon 12: The direction of flow entering the riffle causes frequent scour of the bedrock outcropping on the right bank. We recommend placing a small volume of gravel on this bedrock ledge for future transport during high flows to maintain spawning gravel at downstream riffles. Recommended volume = 600 yd^3. This material should be relatively clean, fine gravel (1-4 inch) to facilitate mobilization and downstream transport. Figure 5 shows the proposed right bank bar morphology.

Polygon 13: The main portion of the riffle provides usable spawning habitat, but the spawning area could be improved and increased by reducing the riffle slope. Measured slope from the riffle crest to XS-R is 0.0070. Raising the channelbed approximately 2.0 ft at XS 2802+00 would reduce slope to 0.0020. Gravel should be placed so the riffle crest elevation is not increased at this site. This would require a gravel “wedge” of increasing depth from 0.0 ft at the upstream riffle crest to 2.0 ft at XS 2802+00. Recommended volume = 1,200 yd^3. Figure 5 shows the proposed riffle cross section contour.

Polygon 14a,b: The riffle ends abruptly into a pool with depths increasing in the downstream direction up to 11 ft. By adding gravel at the downstream end of the riffle, the entire riffle length can be extended and substantially increase the available spawning habitat. Gravel should be placed contiguous with polygon 13 and extend approximately 300-500 ft downstream (depending on the volume of material available), with constant slope of approximately 0.0020. Recommended volume = 5,200 yd^3. Figure 5 shows the proposed cross section contour extending downstream from the riffle tail.

Subtotal gravel volume for introduction at riffle A7 = 12,000 yd^3

Polygon 15a: The CDFG Phase I gravel addition at riffle 1A below the Old La Grange Bridge substantially increased the volume of coarse sediment in this portion of channel, replacing much of the material scoured downstream during the 1997 flood. The channel is over-widened in this reach, however, contributes to water velocities below the usable range for salmonid spawning. Additionally, the material appears somewhat coarser than the preference range for chinook salmon. The TRTAC Subcommittee agreed that the Phase I project would likely be improved by further supplementing riffle 1A with gravel placed as a left bank bar to slightly increase confinement and velocities during spawning flows, and with finer gravels sprinkled throughout the riffle. Recommended volume = 3,500 yd^3. Figure 1 shows the proposed location and extent of gravel placement.

Polygon 15b: The section of channel between riffles 1A and 1B was extensively altered during the 1997 flood. The large right bank bar opposite the left bank backwater was nearly entirely scoured away, and a small side-channel formed. Very little spawning was observed in this reach in 2000-01. This gravel introduction polygon would extend riffle 1A further downstream and eliminate the small scour pool. Recommended volume = 1,500 yd^3. Figure 1 shows the proposed location and extent of gravel placement.

Polygon 16: The former right bank bar that was scoured during the 1997 flood should be replaced to restore high flow (<5,000 cfs) confinement through this section of channel. Replacing the bar would eliminate the right side channel and backwater areas where velocities were too low for salmon spawning. This bar will also provide in-channel gravel storage available to maintain downstream spawning riffles and reduce/prevent future losses. Recommended volume = 4,000 yd^3. Figure 1 shows the proposed location and extent of gravel placement.

Polygon 17: The large backwater pond on the left bank is a remnant dredger mining pit. Backwater areas provide habitat for bass during summer when water temperatures are higher, trap and store fine sediments (sand), and eliminate the bankfull channel confinement that allows bedload transport continuity through the reach. Filling in this backwater pond (Figure 7) will significantly improve spawning habitat and geomorphic conditions in this reach. A coarser, heterogeneous mix of gravel and cobble could be used here. Recommended volume = 6,000 yd^3. Figure 1 shows the proposed location and extent of gravel placement.

Polygon 18a: The section of channel between the backwater pond and right bank bar was also significantly scoured during the 1997 flood. Water depths exceed 6-8 ft. By placing gravel back into this portion of the channel, riffle 1A could be extended further downstream to increase the amount of spawning habitat available. Additional surveying would be necessary here to refine the estimate of gravel depths appropriate to restore a suitable riffle slope. Recommended volume = 3,000 yd^3. Figure 1 shows the proposed location and extent of gravel placement.

Polygon 18b: If enough gravel is available (within funding constraints) during Phase II, then riffle 1A can be extended further downstream by supplementing the channel between polygon 18a and riffle 1B with approximately 2 ft of clean spawning gravel. Additional surveying would be necessary here to refine the estimate of gravel depths appropriate to restore a suitable riffle slope. Recommended volume = 5,000 yd^3. Figure 1 shows the proposed location and extent of gravel placement.

Subtotal gravel volume for introduction at riffle 1A/B (including 18b) = 23,000 yd^3

Total gravel volume recommended for Phase II introduction = 35,000 yd^3

Site Access

During the Feb 13th TRTAC meeting, we discussed access to the riffle A7 and 1A/B sites. Access to riffle A7 from the south bank would require trucks passing through downtown La Grange, then down the Old La Grange Bridge road and onto the floodplain via a steep, unimproved dirt road on the west (downstream) side of the bridge. Trucks would then pass under the bridge and upstream on the floodplain where access is relatively straightforward. Access to riffles 1A/B would be relatively easy here. An abandoned dirt road leads from the Old La Grange Bridge road to riffle A7, but this road would require substantial improvements (grading and brush/tree limb clearing) to provide access for dump trucks. This property is owned by Stanislaus County.

Access from the north bank appears preferable. Haul trucks would avoid having to pass through downtown La Grange, and very little road improvement would be necessary. The existing improved dirt road leading past the DFG La Grange Field Office, past La Grange Bridge, then up-river along the hillside would provide access to riffle A7. A small section of road grading and placement of a temporary culvert to cross the small swale would be required to descend the hill to the introduction site. Improving this access would also provide a future long-term gravel introduction site for routine maintenance (by placing small quantities of gravel on the right bank bedrock bar). Access to the sites downstream of Old La Grange Bridge already exists along the north bank from the Phase I project. All property on the north bank is owned either by Stanislaus County or the State of California.

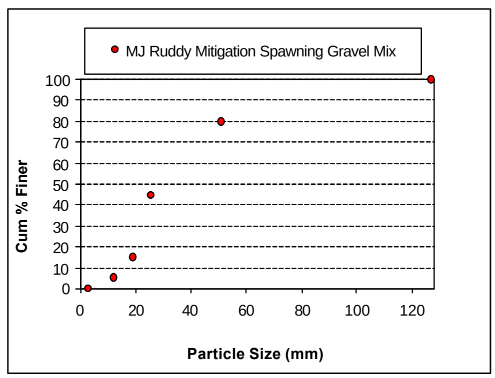
Gravel Composition

Gravel size requirements vary with a fish's life stage. For spawning adult chinook salmon, considerable research has been conducted to describe suitable spawning gravel size compositions. For example, Raleigh (et al. 1986) reported the optimal mix for chinook salmon ranging from 20 to 106 mm. Chambers (1956) reported suitable gravel mixes of: 21% for 3 to 12.5 mm; 41% for 12.5 to 60 mm; 24% for 60 to 100 mm; and 14% for 60 to 150 mm. Allen and Hassler (1986) developed profiles of habitat requirements for chinook salmon in the Pacific Southwest, and site Bell's (1973) findings that optimal gravels range from 13 to 102 mm, and that 80% of the particles should range from 13 to 51 mm, and the remaining 20% from 51 to 103 mm. This size range also agrees with Thompson (1972) as cited in Bjornn and Reiser for fall chinook salmon. Platts et al. (1979) reported spawning gravel mixes from the South Fork Salmon River, Idaho containing 84% of 10 to 76 mm, and the remaining greater than 76 mm. Finally, Kondolf and Wolman (1993) compiled published and original reports containing spawning gravel size distribution data for salmonids, and noted a large range of spawning gravel sizes used by chinook salmon. Describing the ideal or definitive spawning gravel mixture is thus not possible.

Previous spawning gravel improvement projects on the Tuolumne River (TFC 1990) used literature information to develop a gravel composition suitable for chinook salmon spawning riffles specifically for the Tuolumne River. They recommended (and used) the following gravel mixture at riffle 36A in the Santa Fe Aggregates (formerly MJ Ruddy) Mining Reach:

Table 1. Gravel composition used at MJ Ruddy (riffle 36A) for spawning gravel mitigation in 1989.

Percent of Total	*Particle Size (mm)*	*Particle Size (inches)*
5%	3 to 12.5 mm	1/8 " to 1/2"
10%	12.5 to 19.1 mm	1/2" to3/4"
30%	19.1 to 25.4 mm	3/4" to 1"
35%	25.4 to 51 mm	1" to 2"
20%	51 to 127 mm	2" to 5"



This gravel mixture equates to approximately 80% finer than 51 mm (2 inches), with D_{50} = 28 mm and D_{84} = 60 mm. We recommend using a spawning gravel mixture that conforms as closely as is practical to the above mixture, but that does not exceed the 20% recommended for the larger 2" to 5" component.

We performed surface pebble counts at several riffle sites in the reach between New La Grange Bridge and Basso Bridge, at locations with good spawning gravel-sized gravel distributions. Table 2 shows the particle sizes of the most recent pebble count data. This data conforms well with the recommended gravel mixture above, since the surface particle composition is generally coarser than the subsurface bulk sample.

Table 2. Particle sizes from recent pebble count data.

Pebble Ct Location	D_{50}	D_{84}	*Type of Facies*
Riffle 3B	52	83	Low water margin of lateral bar
Riffle 4A	40	70	Low water margin of lateral bar
Riffle 4B	45	68	Surface of shallowly inundated medial bar surrounded by numerous redds
Riffle 5A	58	106	Coarser facies representative of riffle and run thalweg

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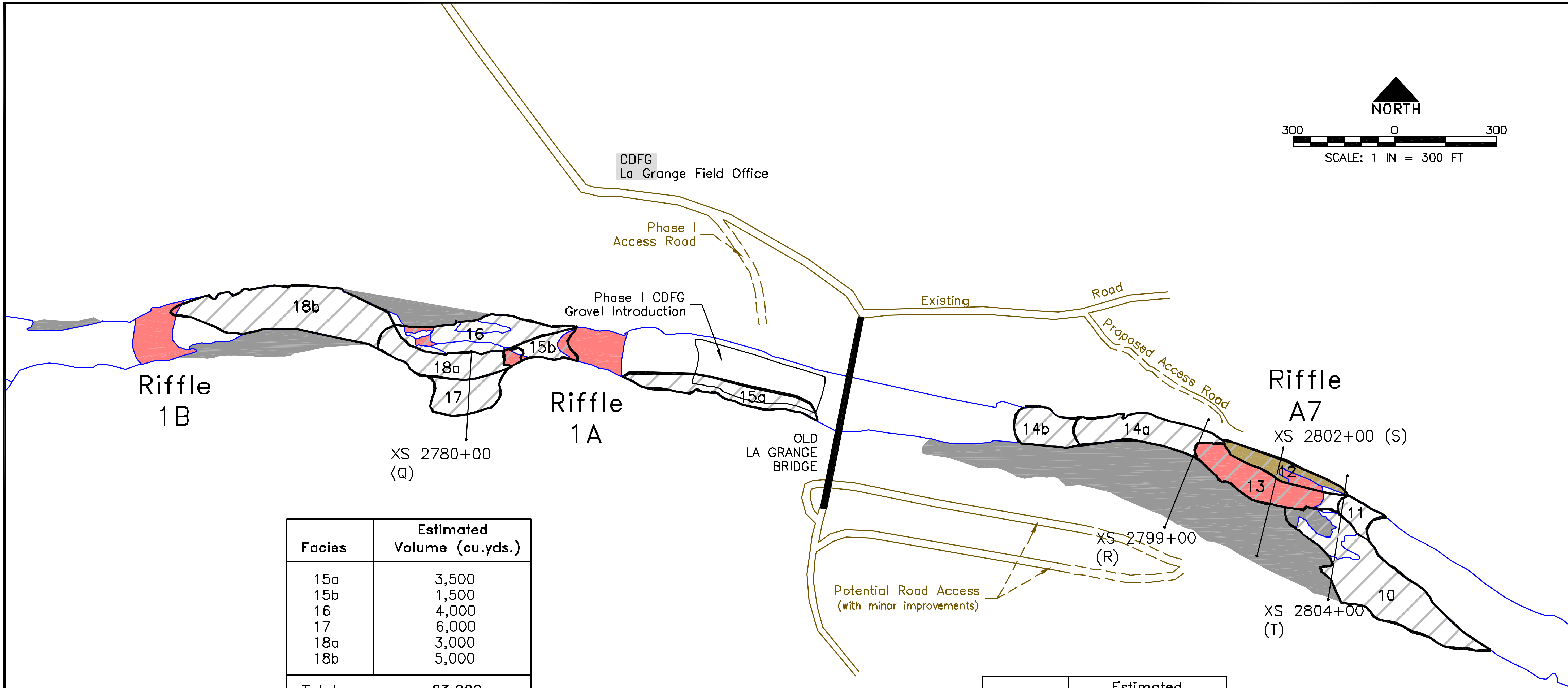

Facies	Estimated Volume (cu.yds.)
15a	3,500
15b	1,500
16	4,000
17	6,000
18a	3,000
18b	5,000
Total	23,000

Facies	Estimated Volume (cu.yds.)
10	4,300
11	700
12	600
13	1,200
14a	3,200
14b	2,000
Total	**12,000**

Legend
- Riffle (mapped in 2001)
- Lateral gravel bar
- Bedrock ledge
- Proposed gravel introduction site
- Cross section (surveyed in 2000)
- Low flow channel boundary (from 1999 air photo)

FIGURE 1. TUOLUMNE RIVER
CDFG/DWR PHASE II GRAVEL ADDITION PROJECT

McBain & Trush 2001

2/28/01

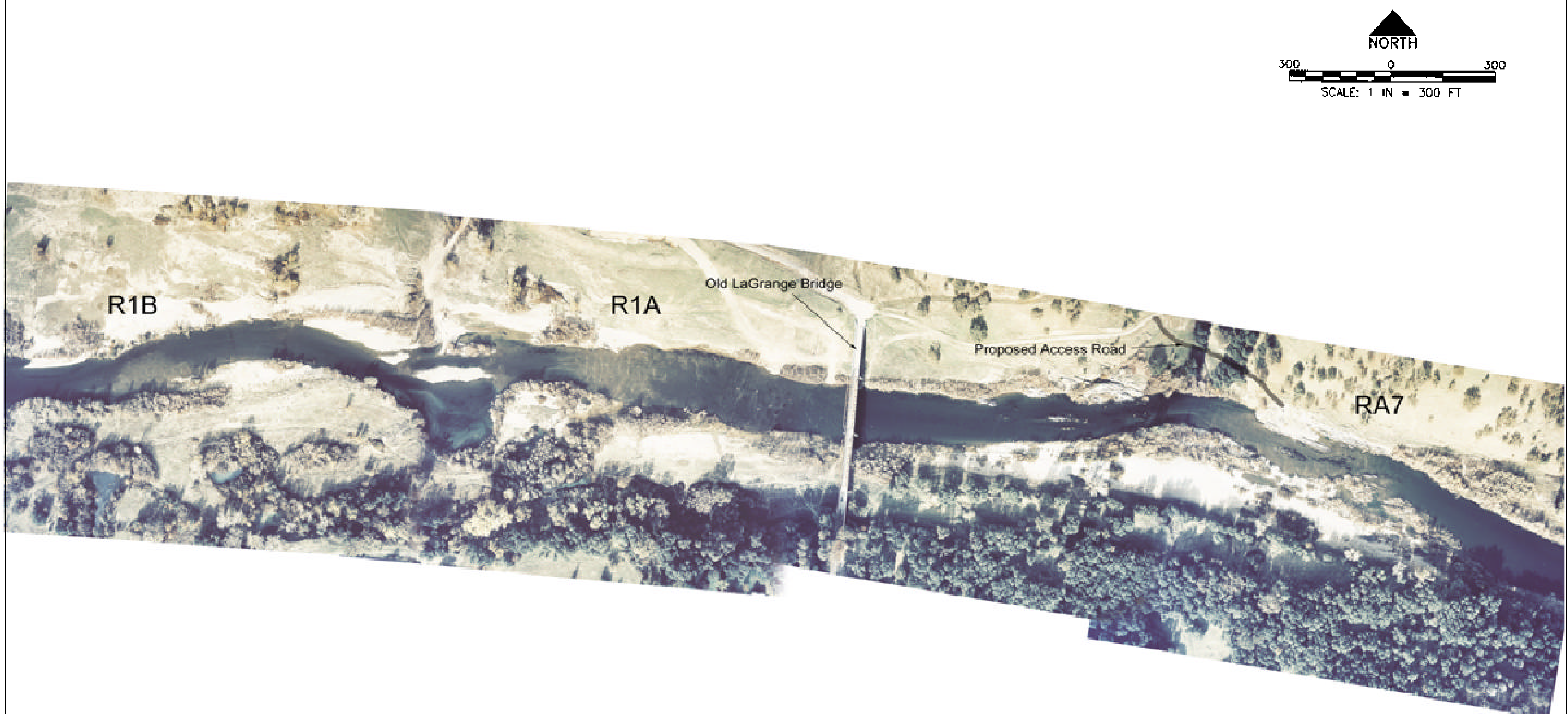

FIGURE 2. TUOLUMNE RIVER
DEC. 1999 AIR PHOTO OF CDFG/DWR PHASE II GRAVEL INTRODUCTION SITES

McBain & Trush 2001

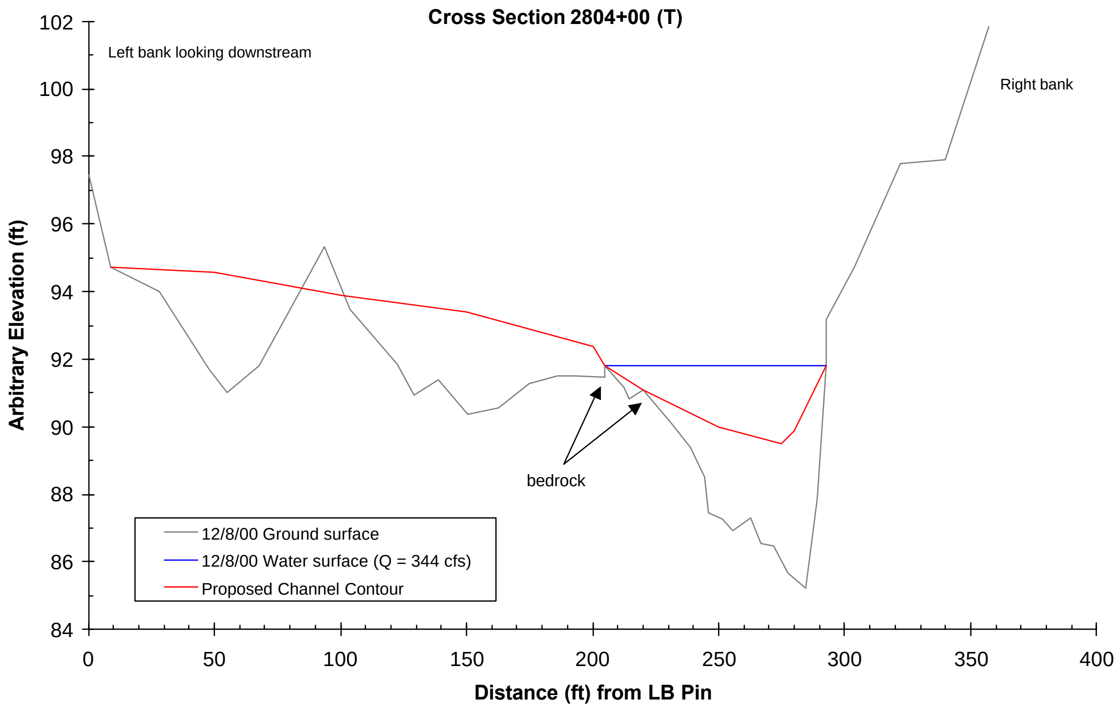

Figure 4. Cross Section 2804+00 traversing pool-tail at the head of riffle A7. The left bank lateral bar has been scoured and depleted of most coarse sediment stored on the bank. The right bank has become incised to bedrock, and the face of the pool-tail steepened.

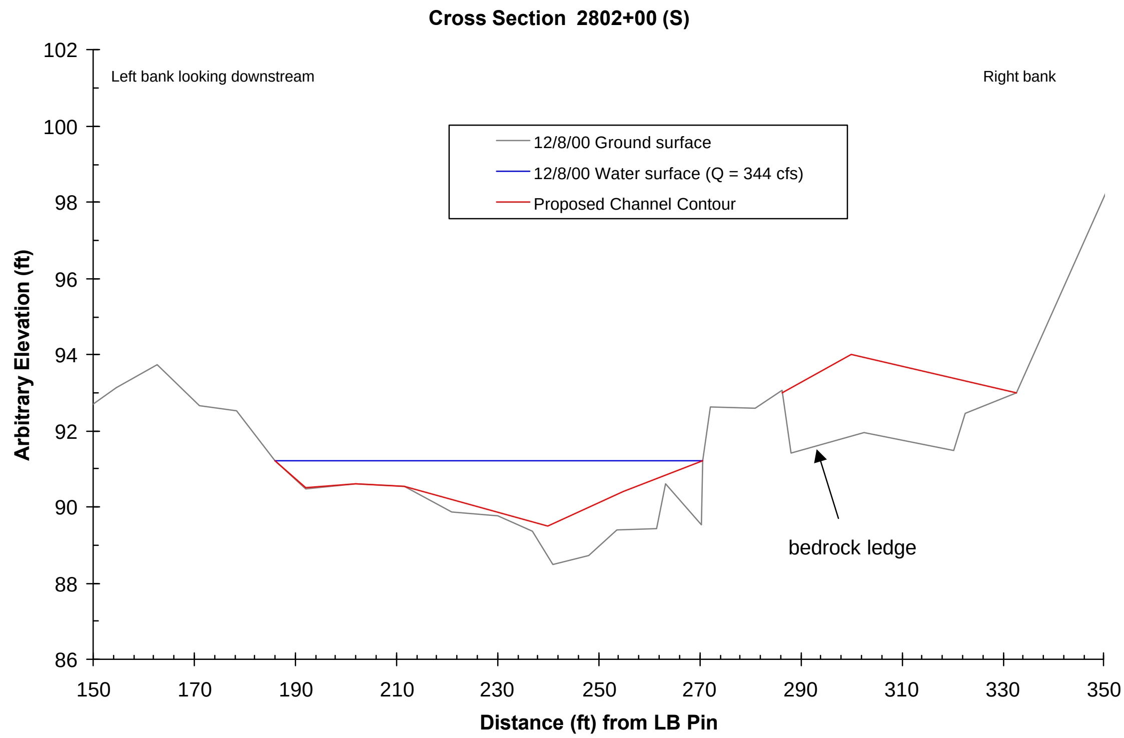

Figure 5. Cross Section 2802+00 traversing the middle portion of riffle A7. The left side of the riffle provides good spawning habitat, but the right half has higher velocities that exceed the suitable range for chinook spawning. Additionally, the right bank bedrock ledge is an ideal site to re-supply gravel storage.

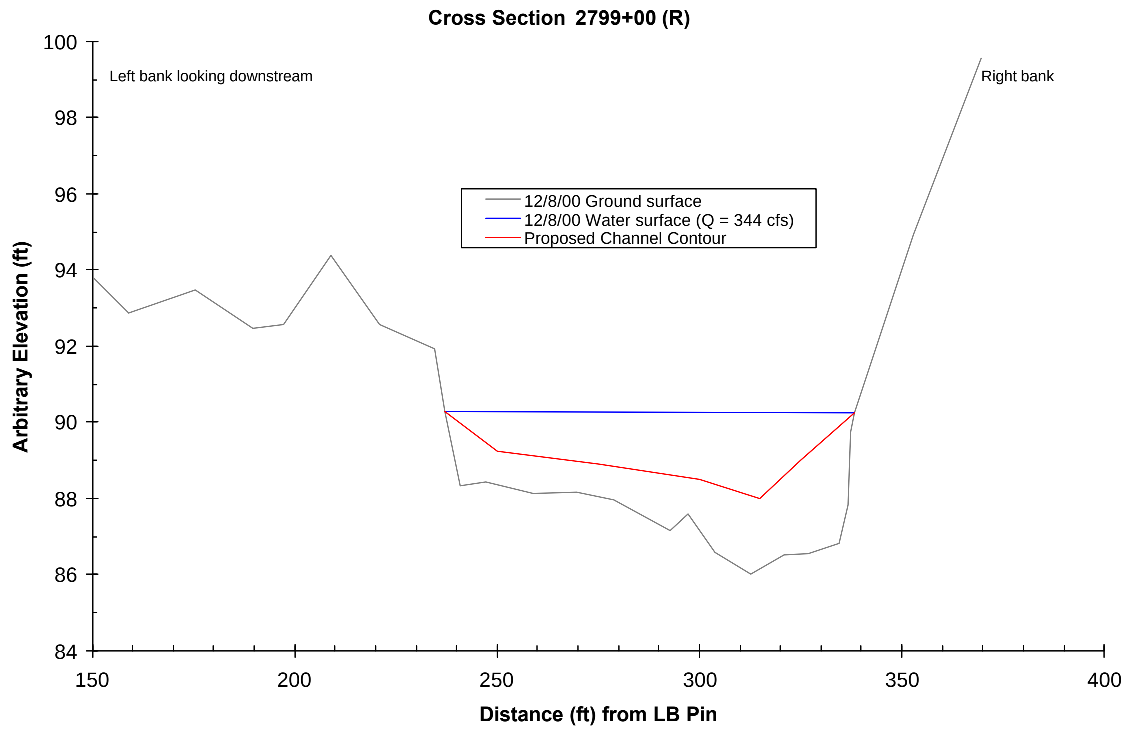

Figure 6. Cross Section 2799+00 traversing the downstream end of riffle A7. beyond this cross section the channel deepens to 6-8 ft.

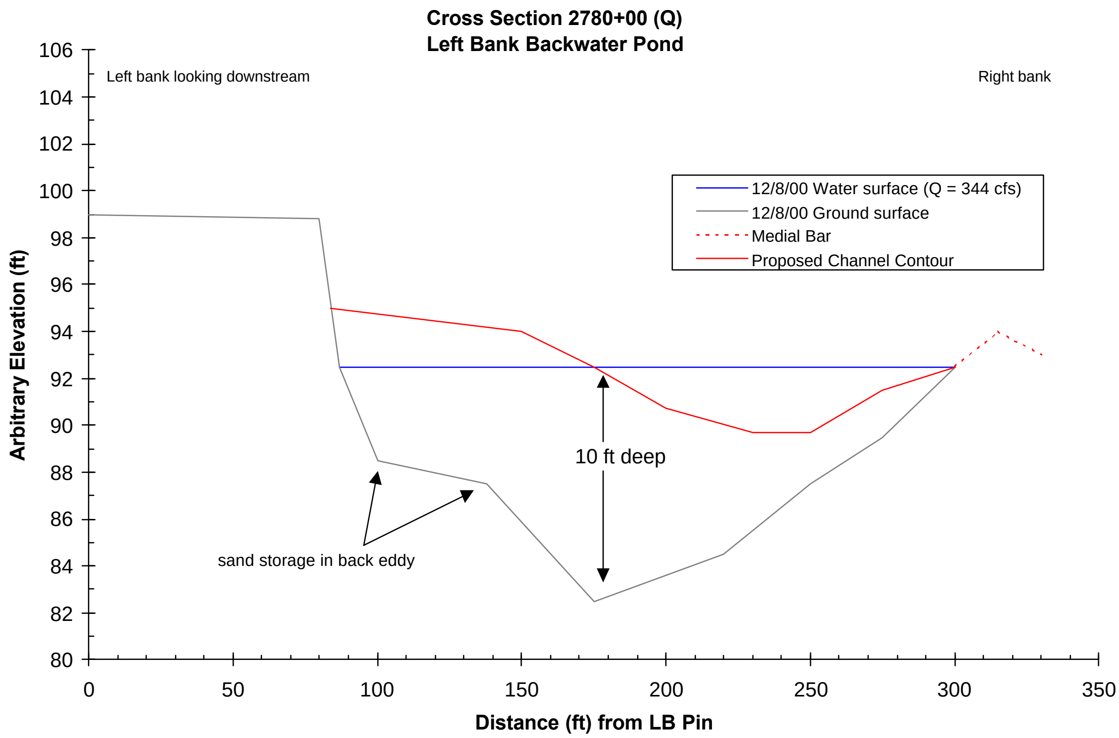

Figure 7. Cross Section 2780+00 traversing the left bank backwater pit that was left from dredger mining operations. Filling the pit would reconfine the low water channel.

APPENDIX F

Stanislaus County
Striving to be the Best

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October 3, 2001

Mr. Wilton B. Fryer
Water Planning Department Manager
Turlock Irrigation District
333 East Canal Drive
Turlock, CA 95380

Re: Tuolumne River Sediment Acquisition and Spawning Gravel Transfusion Project

Dear Mr. Fryer:

I am writing in support of the referenced proposed Turlock Irritation District project. If the project is funded by CALFED, and should the Stanislaus County Board of Supervisors approve extraction of gravel sediment from the Joe Domecq Wilderness and subsequent wetland and upland habitat restoration at that County Park, the outcome would be to enhance natural habitats and recreational opportunities in Stanislaus County. In addition to enhancing Chinook salmon populations and habitat, those portions of this County park which are unproductive, barren, dredged and scraped, would be restored to perennial wetlands, riparian habitat and Valley Oak woodland habitat.

These activities would be consistent with the County's Park Master Plan, which was adopted by the Supervisors in 1999. It states that, "protection of the natural environment is an important aspect of outdoor recreation." Moreover, the Plan determined that the outdoor activities that should have top priority for public funds included walking, trail hiking, general nature study, freshwater fishing and visiting historic sites. The Plan concluded that open space is one of the park amenities considered most important for the County. The project as proposed would include and address these objectives.

Clearly, the outcome of the proposed project would be beneficial to the environment and the residents of this County. Therefore, if the project is funded by CALFED (or if County approval is needed as a condition precedent to funding), I would be pleased to request the Board of Supervisors to consider approving our participation in this interesting and beneficial project.

Sincerely,

Kevin M. Williams

Kevin M. Williams
Director

c: Supervisor Ray Simon, District 1
Supervisor Tom Mayfield, District 2
Supervisor Nick Blom, District 3
Supervisor Pat Paul, District 4
Supervisor Paul Caruso, District 5
Reagan M. Wilson, CEO