Merced River Corridor Restoration Plan Phase IV: Dredger Tailings Reach

Project Information

1. **Proposal Title:**

Merced River Corridor Restoration Plan Phase IV: Dredger Tailings Reach

2. **Proposal applicants:**

Dr. Peter Downs, Stillwater Sciences
Tim Heyne, California Department of Fish and Game

3. **Corresponding Contact Person:**

Dr. Peter Downs
Stillwater Sciences
2532 Durant Avenue, Suite 201 Berkeley, CA 94704
510 848-8098
downs@stillwatersci.com

4. **Project Keywords:**

Anadromous salmonids
Channel Dynamics
Habitat Restoration, Instream

5. **Type of project:**

Planning (Restoration or Engineering)

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

No

7. **Topic Are**a:

Channel Dynamics and Sediment Transport

8. **Type of applicant:**

Private for profit

9. **Location - GIS coordinates:**

Latitude: 37.521
Longitude: -120.429

Datum: NAD27

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

The project is located in the vicinity of Snelling on the Merced River, a tributary to the San Joaquin River. The project planning reach encompasses the Dredger Tailings Reach of the Merced River (RM 52.0-RM 45.2). The restoration pilot experiments (Merced River Ranch) extend from RM 50.3-RM 51.1.

10. **Location - Ecozone:**

13.3 Merced River

11. **Location - County:**

Merced

12. **Location - City:**

Does your project fall within a city jurisdiction?

No

13. **Location - Tribal Lands:**

Does your project fall on or adjacent to tribal lands?

No

14. **Location - Congressional District:**

18

15. **Location:**

California State Senate District Number: 12
California Assembly District Number: 26

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: 142%
Total Requested Funds: $2,192,515.

b) Do you have cost share partners already identified?

No

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?**

Yes

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

2000 E-05 Merced River Corridor Restoration Plan Phase III ERP
98 E-09 Merced River Corridor Restoration Plan Phase II ERP

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.

99-B152	**A Mechanistic Approach to Riparian Restoration in the San Joaquin Basin**	**ERP**
Service Agreement #010801	**Tuolumne River Coarse Sediment Management Plan**	**CALFED Service Agreement**
2001-C200	**Merced River Salmon Habitat Enhancement: Robinson Ranch Site-Revised Phase II**	**ERP**
1998-C16	**Developing a Method to Accurately Simulate Entrainment of Fish**	**ERP**
2001-E201	**Hill Slough West Habitat Restoration Demonstration Project, Phase II**	**ERP**
2001-K218	**Butte Creek, Big Chico Creek, and Sutter Bypass Chinook Salmon and Steelhead Evaluation**	**ERP**

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).

99173 Merced River Corridor Restoration Plan Phase I AFRP

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

Yes

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

CVPIA 11332-9-MO79	**Merced River: Ratzlaff Project**	**AFRP**
CVPIA 11332-9-MO80	**Stanislaus River: 2 Mile Bar**	**AFRP**
CVPIA 11332-0-MO09	**Stanislaus River: Smolt Survival**	**AFRP**

99-L Ratzlaff Reach: Merced River Corridor Restoration Project Phase II
A-7 (joint w/ DWR) AFRP

CVPIA 11332-1-GO06 Calaveras Salmonid Limiting Factors Study AFRP

00-L Feasibility of Long Term Aggregate Source for San Joaquin
D-10 Tributary Channel Restoration Projects AFRP

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

No

Please list suggested reviewers for your proposal. (optional)

David Montgomery, University of Washington
(206) 543-4270, dave@bigdirt.geology.washington.edu

John Buffington, University of Idaho
(208) 364-4082, jbuff@uidaho.edu

Patrick Redmond, Piedmont Engineering (406) 388-9828

21. **Comments:**

Environmental Compliance Checklist
Merced River Corridor Restoration Plan Phase IV: Dredger Tailings Reach

1. **CEQA or NEPA Compliance**

a) Will this project require compliance with CEQA?

Yes

b) Will this project require compliance with NEPA?

Yes

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

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

CEQA Lead Agency: CA Department of Fish and Game
NEPA Lead Agency (or co-lead:) US Fish and Wildlife Service
NEPA Co-Lead Agency (if applicable):

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

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

NEPA
-Categorical Exclusion
X Environmental 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.

CEQA/NEPA process will be completed by the end of 2004.

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

STATE PERMITS AND APPROVALS

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

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: Merced County, Merced Irrigation District	Required, Obtained
Permission to access state land. Agency Name: CA Department of Fish and Game	Required, Obtained
Permission to access federal land. Agency Name:	
Permission to access private land.	N/A

6. **Comments.**

Land Use Checklist
Merced River Corridor Restoration Plan Phase IV: Dredger Tailings Reach

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 yes to #3, please answer the following questions:

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

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

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

Category	Current	Proposed (if no change, specify "none")

d) Is the land currently under a Williamson Act contract?
No

e) Is the land mapped as Prime Farmland, Farmland of Statewide Importance, Unique Farmland or Farmland of Local Importance under the California Department of Conservation's Farmland Mapping and Monitoring Program?
No

f) Describe what entity or organization will manage the property and provide operations and maintenance services.
CA Department of Fish and Game and Stillwater Sciences

4. Comments.

Conflict of Interest Checklist
Merced River Corridor Restoration Plan Phase IV: Dredger Tailings Reach

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):

Dr. Pete Downs, Stillwater Sciences
Tim Heyne, California Department of Fish and Game

Subcontractor(s):

Are specific subcontractors identified in this proposal? Yes

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

Steve Kellogg	URS Greiner
Darrel Ramus	KSN, Inc.
Darrel Slotten	UC Davis

Helped with proposal development:

Are there persons who helped with proposal development?
Yes

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

Kevin Faulkenberry	CA Department of Water Resources
Ted Selb	Merced Irrigation District
Darrell Slotten	UC Davis
John Bair	McBain and Trush
Michael Fainter	Stillwater Sciences

September 2002 revisions:

Jennifer Vick	National Park Service
Jeff McLain	Habitat Restoration Coordinator, USFWS/AFRP; in a role consistent with Directed Action Coordinator

Comments:

Budget Summary
Merced River Corridor Restoration Plan Phase IV: Dredger Tailings Reach

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.

See attached Budget Summary Form.

Comments.

Budget Summary

Year 1	Direct Labor Hours	Salary	Benefits	Travel	Supplies & Expendables	Services / Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Costs
Task 1A. Conduct topographic and geomorphic field surveys	1126	$ 29,827	$ 9,246	$ 12,714	$ 988	$ 170,005	$ 780	$ 2,049	$ 225,610	69,061	$ 294,671
Task 1B. Develop sediment transport model	394	$ 18,239	$ 5,654	$ -	$ 728	$ 1,000	$ -	$ 717	$ 26,338	31,068	$ 57,406
Task 1C. Develop hydraulic model	67	$ 3,171	$ 983	$ -	$ 208	$ 38,326	$ -	$ 122	$ 42,810	9,224	$ 52,034
Task 1D. DTR tredger tailing volume and texture	56	$ 1,577	$ 489	$ -	$ 182	$ 37,603	$ -	$ 102	$ 39,953	6,454	$ 46,406
Task 1E. Implement baseline monitoring	581	$ 15,102	$ 4,682	$ 3,402	$ 1,732	$ 13,500	$ 4,137	$ 1,058	$ 43,613	27,905	$ 71,518
Task 1F. Project management	568	$ 19,753	$ 6,123	$ -	$ 707	$ -	$ -	$ 1,034	$ 27,617	33,556	$ 61,173
Total cost Task 1 Year 1	**2792.4**	**$ 87,668**	**$ 27,177**	**$ 16,116**	**$ 4,545**	**$ 260,434**	**4917.12**	**5082.168**	**$ 405,940**	**$ 177,268**	**$ 583,208**
Task 2A. MRR dredger tailing volume and texture	16	$ 540	$ 167	$ -	$ 52	$ 13,733	$ -	$ 29	$ 14,522	2,294	$ 16,816
Task 2.B. Assess MRR mercury occurrence	786	$ 24,955	$ 7,736	$ 2,252	$ 1,404	$ 75,500	$ 1,040	$ 1,535	$ 114,421	50,347	$ 164,767
Task 2C. MRR conceptual restoration design	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 2D. Project management	252	$ 8,328	$ 2,582	$ -	$ 234	$ -	$ -	$ 459	$ 11,603	14,144	$ 25,747
Total cost Task 2 Year 1	**1054**	**$ 33,823**	**$ 10,485**	**$ 2,252**	**$ 1,690**	**$ 89,233**	**1040**	**2022.28**	**$ 140,545**	**$ 66,785**	**$ 207,330**
Task 3A. Vegetation experimentation	1125	$ 22,545	$ 6,989	$ 7,080	$ 2,184	$ 43,657	$ 6,406	$ 2,047	$ 90,910	44,239	$ 135,149
Task 3B. MRR design plans	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 3C. Plan in-channel gravel infusion	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 3D. Plan post-implementation monitoring	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 3E. Project management	108	$ 3,682	$ 1,142	$ -	$ 47	$ -	$ -	$ 197	$ 5,067	6,248	$ 11,315
Total cost Task 3 Year 1	**1232.8**	**$ 26,228**	**$ 8,131**	**$ 7,080**	**$ 2,231**	**$ 43,657**	**6406.4**	**2243.696**	**$ 95,977**	**$ 50,487**	**$ 146,464**
Task 4A. Develop implementation plan	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 4B. Implementation cost research	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 4C. Draft environmental documentation	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 4D. Stakeholder coordination	265	$ 8,369	$ 2,594	$ 541	$ 458	$ 2,955	$ 83	$ 482	$ 15,482	14,595	$ 30,077
Task 4E. Project management	44	$ 1,216	$ 377	$ -	$ 34	$ -	$ -	$ 80	$ 1,707	2,066	$ 3,773
Total cost Task 4 Year 1	**308.8**	**$ 9,585**	**$ 2,971**	**$ 541**	**$ 491**	**$ 2,955**	**83.2**	**562.016**	**$ 17,189**	**$ 16,661**	**$ 33,850**

Year 2	Direct Labor Hours	Salary	Benefits	Travel	Supplies & Expendables	Services / Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Costs
Task 1A. Conduct topographic and	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 1B. Develop sediment transport	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 1C. Develop hydraulic model	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 1D. DTR tredger tailing volume	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 1E. Implement baseline monitoring	969	$ 26,177	$ 8,115	$ 5,897	$ 3,001	$ 22,500	$ 7,171	$ 1,834	$ 74,696	48,279	$ 122,975
Task 1F. Project management	71	$ 2,568	$ 796	$ -	$ 92	$ -	$ -	$ 134	$ 3,590	4,362	$ 7,952

Total cost Task 1 Year 2	**1040**	**$ 28,745**	**$ 8,911**	**$ 5,897**	**$ 3,093**	**$ 22,500**	**7171.008**	**1968.512**	**$ 78,286**	**$ 52,642**	**$ 130,927**
Task 2A. MRR dredger tailing volume	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 2.B. Assess MRR mercury	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 2C. MRR conceptual restoration	276	$ 10,319	$ 3,199	$ -	$ 649	$ 114,622	$ -	$ 522	$ 129,312	29,019	$ 158,331
Task 2D. Project management	84	$ 2,887	$ 895	$ -	$ 81	$ -	$ -	$ 159	$ 4,022	4,903	$ 8,926
Total cost Task 2 Year 2	**360**	**$ 13,206**	**$ 4,094**	**$ -**	**$ 730**	**$ 114,622**	**0**	**681.408**	**$ 133,334**	**$ 33,922**	**$ 167,256**
Task 3A. Vegetation experimentation	1125	$ 23,447	$ 7,269	$ 7,364	$ 2,271	$ 43,657	$ 6,663	$ 2,129	$ 92,800	45,834	$ 138,634
Task 3B. MRR design plans	176	$ 6,739	$ 2,089	$ -	$ 238	$ 86,324	$ -	$ 333	$ 95,723	20,079	$ 115,802
Task 3C. Plan in-channel gravel infusion	211	$ 7,995	$ 2,478	$ -	$ 178	$ 2,200	$ -	$ 400	$ 13,251	13,789	$ 27,040
Task 3D. Plan post-implementation	172	$ 5,967	$ 1,850	$ -	$ 406	$ 4,000	$ -	$ 326	$ 12,547	10,557	$ 23,104
Task 3E. Project management	216	$ 7,659	$ 2,374	$ -	$ 97	$ -	$ -	$ 409	$ 10,540	12,995	$ 23,535
Total cost Task 3 Year 2	**1900**	**$ 51,807**	**$ 16,060**	**$ 7,364**	**$ 3,191**	**$ 136,181**	**6662.656**	**3596.32**	**$ 224,861**	**$ 103,254**	**$ 328,115**
Task 4A. Develop implementation plan	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 4B. Implementation cost research	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 4C. Draft environmental	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 4D. Stakeholder coordination	199	$ 6,528	$ 2,024	$ 422	$ 357	$ 2,216	$ 65	$ 376	$ 11,987	11,375	$ 23,362
Task 4E. Project management	44	$ 1,265	$ 392	$ -	$ 35	$ -	$ -	$ 83	$ 1,775	2,149	$ 3,924
Total cost Task 4 Year 2	**242.6**	**$ 7,792**	**$ 2,416**	**$ 422**	**$ 392**	**$ 2,216**	**64.896**	**459.19328**	**$ 13,762**	**$ 13,524**	**$ 27,286**

Year 3

	Direct Labor Hours	Salary	Benefits	Travel	Supplies & Expendables	Services / Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Costs
Task 1A. Conduct topographic and	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 1B. Develop sediment transport	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 1C. Develop hydraulic model	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 1D. DTR tredger tailing volume	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 1E. Implement baseline monitoring	388	$ 10,890	$ 3,376	$ 2,453	$ 1,249	$ 9,000	$ 2,983	$ 763	$ 30,713	20,048	$ 50,762
Task 1F. Project management	71	$ 2,671	$ 828	$ -	$ 96	$ -	$ -	$ 140	$ 3,734	4,537	$ 8,271
Total cost Task 1 Year 3	**458.6**	**$ 13,560**	**$ 4,204**	**$ 2,453**	**$ 1,344**	**$ 9,000**	**2983.1393**	**902.759603**	**$ 34,447**	**$ 24,585**	**$ 59,032**
Task 2A. MRR dredger tailing volume	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 2.B. Assess MRR mercury	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 2C. MRR conceptual restoration	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 2D. Project management	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Total cost Task 2 Year 3	**0**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**0**	**0**	**$ -**	**$ -**	**$ -**
Task 3A. Vegetation experimentation	562	$ 12,193	$ 3,780	$ 3,829	$ 1,181	$ 21,829	$ 3,465	$ 1,107	$ 47,383	23,746	$ 71,129
Task 3B. MRR design plans	144	$ 5,734	$ 1,778	$ -	$ 202	$ 70,628	$ -	$ 283	$ 78,626	16,803	$ 95,429
Task 3C. Plan in-channel gravel infusion	173	$ 6,803	$ 2,109	$ -	$ 152	$ 1,800	$ -	$ 340	$ 11,204	11,726	$ 22,930
Task 3D. Plan post-implementation	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -
Task 3E. Project management	216	$ 7,966	$ 2,469	$ -	$ 101	$ -	$ -	$ 425	$ 10,962	13,515	$ 24,477
Total cost Task 3 Year 3	**1095.2**	**$ 32,696**	**$ 10,136**	**$ 3,829**	**$ 1,637**	**$ 94,257**	**3464.5811**	**2155.91434**	**$ 148,175**	**$ 65,790**	**$ 213,965**
Task 4A. Develop implementation plan	130	$ 4,133	$ 1,281	$ -	$ 281	$ 36,054	$ -	$ 256	$ 42,005	10,644	$ 52,649
Task 4B. Implementation cost research	48	$ 1,263	$ 392	$ -	$ 169	$ 7,656	$ -	$ 94	$ 9,574	2,927	$ 12,500
Task 4C. Draft environmental	60	$ 2,759	$ 855	$ -	$ 141	$ 149,566	$ -	$ 118	$ 153,439	19,645	$ 173,084
Task 4D. Stakeholder coordination	199	$ 6,789	$ 2,104	$ 439	$ 371	$ 2,216	$ 67	$ 391	$ 12,378	11,821	$ 24,199
Task 4E. Project management	352	$ 10,522	$ 3,262	$ -	$ 292	$ -	$ -	$ 693	$ 14,769	17,880	$ 32,649
Total cost Task 4 Year 3	**788.6**	**$ 25,465**	**$ 7,894**	**$ 439**	**$ 1,254**	**$ 195,492**	**67.49184**	**1552.36856**	**$ 232,165**	**$ 62,917**	**$ 295,082**

All Years

All Years	Direct Labor Hours	Salary	Benefits	Travel	Supplies & Expendables	Services / Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Costs
Task 1A. Conduct topographic and	1126	$ 29,827	$ 9,246	$ 12,714	$ 988	$ 170,005	$ 780	$ 2,049	$ 225,610	$ 69,061	$ 294,671
Task 1B. Develop sediment transport	394	$ 18,239	$ 5,654	$ -	$ 728	$ 1,000	$ -	$ 717	$ 26,338	$ 31,068	$ 57,406
Task 1C. Develop hydraulic model	67	$ 3,171	$ 983	$ -	$ 208	$ 38,326	$ -	$ 122	$ 42,810	$ 9,224	$ 52,034
Task 1D. DTR tredger tailing volume	56	$ 1,577	$ 489	$ -	$ 182	$ 37,603	$ -	$ 102	$ 39,953	$ 6,454	$ 46,406
Task 1E. Implement baseline monitoring	1938	$ 52,168	$ 16,172	$ 11,753	$ 5,982	$ 45,000	$ 14,291	$ 3,655	$ 149,022	$ 96,233	$ 245,255
Task 1F. Project management	710	$ 24,991	$ 7,747	$ -	$ 895	$ -	$ -	$ 1,308	$ 34,941	$ 42,455	$ 77,396
Total cost Task 1 All Years	**4291**	**$ 129,973**	**$ 40,292**	**$ 24,467**	**$ 8,982**	**$ 291,934**	**$ 15,071**	**$ 7,953**	**$ 518,673**	**$ 254,495**	**$ 773,167**
Task 2A. MRR dredger tailing volume	16	$ 540	$ 167	$ -	$ 52	$ 13,733	$ -	$ 29	$ 14,522	$ 2,294	$ 16,816
Task 2.B. Assess MRR mercury	786	$ 24,955	$ 7,736	$ 2,252	$ 1,404	$ 75,500	$ 1,040	$ 1,535	$ 114,421	$ 50,347	$ 164,767
Task 2C. MRR conceptual restoration	276	$ 10,319	$ 3,199	$ -	$ 649	$ 114,622	$ -	$ 522	$ 129,312	$ 29,019	$ 158,331
Task 2D. Project management	336	$ 11,215	$ 3,477	$ -	$ 315	$ -	$ -	$ 618	$ 15,625	$ 19,047	$ 34,672
Total cost Task 2 All Years	**1414**	**$ 47,030**	**$ 14,579**	**$ 2,252**	**$ 2,420**	**$ 203,855**	**$ 1,040**	**$ 2,704**	**$ 273,879**	**$ 100,707**	**$ 374,586**
Task 3A. Vegetation experimentation	2812	$ 58,185	$ 18,037	$ 18,273	$ 5,636	$ 109,143	$ 16,534	$ 5,283	$ 231,092	$ 113,820	$ 344,912
Task 3B. MRR design plans	320	$ 12,474	$ 3,867	$ -	$ 440	$ 156,952	$ -	$ 617	$ 174,349	$ 36,881	$ 211,231
Task 3C. Plan in-channel gravel infusion	384	$ 14,798	$ 4,587	$ -	$ 330	$ 4,000	$ -	$ 740	$ 24,455	$ 25,515	$ 49,970
Task 3D. Plan post-implementation	172	$ 5,967	$ 1,850	$ -	$ 406	$ 4,000	$ -	$ 326	$ 12,547	$ 10,557	$ 23,104
Task 3E. Project management	540	$ 19,308	$ 5,985	$ -	$ 245	$ -	$ -	$ 1,031	$ 26,569	$ 32,758	$ 59,327
Total cost Task 3 All Years	**4228**	**$ 110,731**	**$ 34,327**	**$ 18,273**	**$ 7,058**	**$ 274,095**	**$ 16,534**	**$ 7,996**	**$ 469,013**	**$ 219,530**	**$ 688,543**
Task 4A. Develop implementation plan	130	$ 4,133	$ 1,281	$ -	$ 281	$ 36,054	$ -	$ 256	$ 42,005	$ 10,644	$ 52,649
Task 4B. Implementation cost research	48	$ 1,263	$ 392	$ -	$ 169	$ 7,656	$ -	$ 94	$ 9,574	$ 2,927	$ 12,500
Task 4C. Draft environmental	60	$ 2,759	$ 855	$ -	$ 141	$ 149,566	$ -	$ 118	$ 153,439	$ 19,645	$ 173,084
Task 4D. Stakeholder coordination	662	$ 21,685	$ 6,722	$ 1,401	$ 1,186	$ 7,388	$ 216	$ 1,249	$ 39,847	$ 37,792	$ 77,638
Task 4E. Project management	440	$ 13,002	$ 4,031	$ -	$ 361	$ -	$ -	$ 856	$ 18,250	$ 22,095	$ 40,346
Total cost Task 4 All Years	**1340**	**$ 42,842**	**$ 13,281**	**$ 1,401**	**$ 2,138**	**$ 200,664**	**$ 216**	**$ 2,574**	**$ 263,116**	**$ 93,103**	**$ 356,218**
Total Year 1	5388	$ 157,304	$ 48,764	$ 25,989	$ 8,957	$ 396,279	$ 12,447	$ 9,910	$ 659,650	$ 311,201	$ 970,852
Total Year 2	3542.6	$ 101,550	$ 31,481	$ 13,683	$ 7,406	$ 275,519	$ 13,899	$ 6,705	$ 450,243	$ 203,342	$ 653,585
Total Year 3	2342.4	$ 71,721	$ 22,234	$ 6,721	$ 4,235	$ 298,749	$ 6,515	$ 4,611	$ 414,787	$ 153,292	$ 568,079
Total all years	11273	$ 330,575	$ 102,478	$ 46,393	$ 20,598	$ 970,548	$ 32,860	$ 21,227	$ 1,524,680	$ 667,835	$ 2,192,515
Total Task 1	4291	$ 129,973	$ 40,292	$ 24,467	$ 8,982	$ 291,934	$ 15,071	$ 7,953	$ 518,673	$ 254,495	$ 773,167
Total Task 2	1414	$ 47,030	$ 14,579	$ 2,252	$ 2,420	$ 203,855	$ 1,040	$ 2,704	$ 273,879	$ 100,707	$ 374,586
Total Task 3	4228	$ 110,731	$ 34,327	$ 18,273	$ 7,058	$ 274,095	$ 16,534	$ 7,996	$ 469,013	$ 219,530	$ 688,543
Total Task 4	1340	$ 42,842	$ 13,281	$ 1,401	$ 2,138	$ 200,664	$ 216	$ 2,574	$ 263,116	$ 93,103	$ 356,218
Total all tasks	11273	$ 330,575	$ 102,478	$ 46,393	$ 20,598	$ 970,548	$ 32,860	$ 21,227	$ 1,524,680	$ 667,835	$ 2,192,515
check	-	-	-	-	-	-	-	-	-	-	-

Budget Justification
Merced River Corridor Restoration Plan Phase IV: Dredger Tailings Reach

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

Employee Hours: Peter Baker 118 Christian Braudrick 1,214 Christine Champe 124 Yantao Cui 582 Zooey Diggory 1,375 Pete Downs 1,941Lauren Dusek 90 Michael Fainter 42 Anthony Falzone 327 Greg Fanslow 218 Craig Fixler 152 Noah Hume 216 AJ Keith 32 Sapna Khandwala 430 Frank Ligon 132 Maureen Mason 1,929 Bruce Orr 183 Angela Percival 164 Juliana Raefield 40 Rafael Real de Asua 80 Leonard Sklar 24 Jay Stallman 348 John Stella 1,412 Wayne Swaney 80

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

Employee Rates: Baker, Peter $92.88 Braudrick, Christian $69.01 Champe, Christine $106.20 Cui, Yantao $116.53 Diggory, Zooey $52.70 Downs, Peter $110.38 Dusek, Lauren $41.80 Fainter, Michael $92.99 Falzone, Anthony $58.00 Fanslow, Greg $70.96 Fixler, Craig $120.00 Hume, Noah $99.36 Keith, AJ $70.85 Khandwala, Sapna $61.56 Ligon, Frank $120.00 Mason, Maureen $40.50 Orr, Bruce $115.45 Percival, Angela $75.17 Raefield, Juliana $39.00 Real de Asua, Raf $85.76 Sklar, Leonard $112.54 Stallman, Jay $50.54 Stella, John $69.12 Swaney, Wayne $76.03

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

Stillwater pays 31% in benefits to employees in all categories.

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

All travel is from the Bay Area or Sacramento to the Merced River, and includes the cost of mileage, lodging and meals. Travel costs to conduct field surveys, monitoring, vegetation experiments, and project implementation are estimated to total $46,393.

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

Estimated break-down of supply costs: Office supplies: $2,000 Computing supplies: $750 Field supplies: $5,000 Phone: $4,550 Copies and binding: $9,625 Shipping: $2,050 Photo processing: $700

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.

In Task 1, Kjeldsen, Sinnock & Neudeck (KSN) provides long profile surveying ($74,370) and mapping services ($92,635). No time estimate was provided, as this was a bid based on the number of river miles being surveyed and mapped. An estimate was also received from URS Corp, who estimated a higher price. Also, the bid price was substantially consistent with prices paid to Del Terra for similar work recently conducted on Clear Creek. The primary subcontractor is URS Corp who provides engineering, permitting, and construction planning for the project. In Task 1, URS documents the volume and texture of dredger tailings in the reach ($35,603), conducts reach-scale hydrologic modeling ($38,326), and assists in planning, coordination, and completing the draft and final implementation plan for gravel augmentation for a Task 1 total cost of $73,929. In Task 2, URS documents the volume and texture of dredger tailings at Merced River Ranch ($12,733), supports development of grading and vegetation preliminary/ conceptual designs ($109,622) and other support for a Task 2 total cost of $122,355. In Task 3, URS conducts site grading for the revegetation experiment ($97,143) and produces designs for pilot floodplain and channel restoration projects ($154,952) for a total Task 3 cost of $252,095. In Task 4, URS takes the lead role in producing an implementation plan for the floodplain and channel restoration project ($36,054), researches costs for project implementation ($7,656), produces environmental documents and permits ($146,566), and coordinates with the Merced Stakeholders and TAC ($7,388) for a total Task 4 cost of $197,664. California Department of Fish and Game will provide project oversight and coordination throughout the duration of the project for a total of $34,000.

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.

New equipment will not be purchased for the project.

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.

Field activity organization, coordination with subconsultants, agencies, stakeholders, and the Technical Advisory Committee, data management, and project administration are the principal project management activities in Tasks 1, 2, and 3. Task 1 project management costs total $61,173. Task 2 project management costs total $25,747. Task 3 project management costs total $11,315. The project management costs of Task 4, the implementation planning phase, are $3,773. Most of the project management costs associated with Task 3 are included in the subcontractor (URS) budget.

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

Costs associated with computer systems and networks are included in Other Direct Costs.

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.

Stillwater's indirect costs include office expenses (rent, utilities, telephones, computer supplies, data connectivity, etc.), office staff, insurance, legal and accounting costs, proposal expenses and depreciation for capital items such as furniture and office equipment. As no specific place was provided, contractor fee was also included in the Indirect Costs column.

Executive Summary
Merced River Corridor Restoration Plan Phase IV: Dredger Tailings Reach

The proposed comprehensive planning actions are based around scientific assessment and experimentation to design in-channel and floodplain restoration measures for the Dredger Tailings Reach of the Merced River, a tributary to the San Joaquin River. This reach extends seven miles downstream from Crocker-Huffman Dam, the upstream limit for salmonids migrating up the river. Gold dredging in this reach removed coarse sediment from the channel and placed the tailings upon the floodplain, destroying floodplain habitat. As a result of gold dredging and coarse sediment interception by upstream dams the channel is now depleted of the coarse sediment suitable for spawning habitat. The project objectives include planning for: (1) establishment of a floodplain at an elevation that functions under the current regulated flow conditions and supports riparian recruitment processes; (2) an immediate increase in coarse in-channel sediment storage through gravel infusion; (3) a balance of coarse sediment supply with sediment transport competence and capacity through gravel augmentation; and (4) to design a monitoring and evaluation scheme intended to contribute transferable scientific understanding following project implementation. To achieve these objectives, we propose to:

- conduct reach-scale restoration planning assessments intended to evaluate the 7-mile Dredger Tailings Reach within the context of the lower Merced River as a whole;
- provide conceptual design for the remediation of the 318 acre Merced River Ranch;
- undertake site assessments for the floodplain segment of Merced River Ranch;
- complete planning tasks as the basis for future project implementation.

This project represents Phase IV of the Merced River Corridor Restoration Plan, developed by the Merced County Planning and Community Development Department and Stillwater Sciences, working with CDFG, CDWR, Merced Irrigation District, and local stakeholders. Future implementation of this project will contribute to achieving many of the geomorphic, biological, and social goals of the ERP Implementation Plan.

Addendum: Summary of changes to the originally submitted proposal

This project addresses the primary concern of the previous reviewers (i.e. implementation cost) by deferring implementation until a future round of funding. The rationale for this decision is:

1) to enable assessment, experimentation and design work to proceed to a sufficiently advanced stage that accurate, comparative, cost-effective approaches to implementation can be researched;
2) to enable resolution of policy matters regarding the re-use of dredger tailings in restoration projects and thus accurately understand the cost implications of dredger tailings processing requirements.

The authors have also taken the opportunity to incorporate into the proposal's structure findings and recommendations from the *Merced River Adaptive Management Forum Report*, published since the original submission of the proposal. In particular, opportunities for experimentation and adaptive learning have been improved. It is the intention that the proposed project completes sufficient scientific assessment, experimentation, site designs, planning and implementation support tasks to facilitate rapid implementation of pilot projects under a future round of funding.


photo courtesy of CDFG

Merced River Corridor Restoration Plan Phase IV: Dredger Tailings Reach

Prepared for
CALFED Ecosystem Restoration Program

Prepared by
Stillwater Sciences
2532 Durant Avenue
Berkeley, CA 94704

October, 2002

Stillwater Sciences

A. PROJECT DESCRIPTION: PROJECT GOALS AND SCOPE OF WORK

A.1 Problem

The Merced River is located in the southern portion of California's Central Valley and is a tributary to the San Joaquin River (Figure 1). This proposal is targeted at the Dredger Tailings Reach of the Merced River, which extends from Crocker-Huffman Dam (river mile [RM] 52) to RM 45.2, approximately 1.2 miles downstream of the Snelling Road bridge (Figure 2). Crocker-Huffman Dam represents the upstream migration limit for salmonids on the Merced River, so species that historically migrated upriver to spawn now concentrate spawning in the Dredger Tailings Reach. The Dredger Tailings Reach was mined for gold nearly a century ago. Channel and floodplain sediment deposits were excavated to bedrock, then re-deposited in rows that cover approximately 7.6 square miles of floodplain. The dredger tailings significantly reduce the value of in-stream and floodplain habitats in the reach. The extensive tailings area supports little woody vegetation, with riparian trees confined to narrow channels between the piles of tailings (Figure 3). The tailings also disconnect the river from its floodplain, confining the river to a relatively narrow channel. By confining the channel, the tailings increase the shear stress applied to channel beds during high flows, leading to channel incision and exacerbating bed coarsening, thereby reducing the quantity and quality of spawning habitats. The local effects of dredger mining are compounded by other activities in the basin, as dam construction and gravel mining have further reduced the supply of gravel available to the channel, and reservoir operations have reduced the peak flows that drive fluvial geomorphic processes.

Removal of the tailings from the floodplain has the potential to yield multiple restoration opportunities and ecosystem benefits, but the detailed impact of such activities is largely unknown. The experiments designed in this proposal will increase scientific understanding of the potential for dredger tailings removal and re-use, and is intended to improve restoration effectiveness and reduce future project uncertainty for similar projects both within and beyond the Merced River. This project includes: assessments designed to increase baseline knowledge of the Dredger Tailings Reach in the context of the Merced watershed, and the Merced River Ranch site in the context of the reach; a pilot experiment to investigate floodplain vegetation growth rates; designs to facilitate floodplain re-grading strategies that will encourage more frequent floodplain inundation; strategies for gravel infusion and gravel augmentation to promote suitable channel morphology and channel bed mobility within the context of a greatly altered flow regime; and environmental documentation to support future permitting. The assessments will be designed to ensure explicit nested linkages between experimental sites and the Merced River watershed, and should benefit other channel-floodplain modifications and gravel augmentation efforts locally, on other reaches of the Merced River, and on other San Joaquin tributaries.

The goal of the proposed project is to design pilot floodplain and channel restoration experiments, in their watershed context, intended to initiate the restoration of natural ecosystem function to the Dredger Tailings Reach of the Merced River and to set in place monitoring and evaluation schemes designed to contribute transferable scientific understanding that assists in reducing uncertainty in restoration design.

The proposed project is Phase IV of the Merced River Corridor Restoration Plan. Phase I, funded by AFRP in 1997, established the Merced River Stakeholder Group and Technical Advisory Committee (TAC). Phase II, funded by CALFED in 1998, included baseline investigations of the geomorphic and riparian vegetation characteristics of the corridor (Stillwater Sciences 2001a) and an identification of social, institutional, and infrastructural opportunities for, and constraints to, restoration (Stillwater Sciences and EDAW 2001). Phase III, funded by CALFED in 2000, involved developing the final Merced River Corridor Restoration Plan (Stillwater Sciences 2002), covering the lower 52 miles of the river. Building from the basin-scale restoration planning conducted as part of Phase III, Phase IV involves: (1) conducting reach-scale restoration planning assessments intended to evaluate the 7-mile Dredger Tailings Reach within the context of the lower Merced River as a whole; (2) conceptual design for the remediation of the 318 acre Merced River Ranch, (3) an experimental pilot project for re-vegetation, designs for floodplain restoration and strategies for channel restoration through gravel infusion and augmentation; and (4) planning tasks as the basis for project implementation in a future phase.

Task 1: reach-scale assessments in the context of the Merced River Corridor Restoration Plan will help to facilitate future implementation of the restoration experiments in the Dredger Tailings Reach (RM 52.0-45.2) and ensure that successive phases of restoration in the Reach are guided by a common vision that integrates with other activities in the lower Merced River. Reach-level activities include: (A) field surveys to gather topographic and geomorphic information needed as the precursor to experimental designs; (B) development of a sediment transport model as the basis for assessing gravel infusion requirements and channel design; (C) development of a hydraulic model as the basis for channel design; (D) photogrammetric and field surveys to determine the volume and texture of dredger tailings in the floodplain area of the Dredger Tailings Reach; and (E) two years of baseline monitoring as the core of a comprehensive monitoring and evaluation scheme for future applications, guided by the results of assessment in Tasks 1B through 1D.

Task 2: using the reach-scale assessments as context, the project will focus on plans for restoration of the 318 acre Merced River Ranch (MRR). The Ranch (RM 51.2-RM 50.3) was purchased by CDFG using CALFED funds received through a 1997 proposal grant and was identified in the Merced River Corridor Restoration Plan (Phase III; Stillwater Sciences, 2002) as the first of four restoration stages for the Dredger Tailings Reach (Figure 4). Activities will include: (A) extension of the photogrammetric and field surveys to determine the volume and texture of dredger tailings throughout the Ranch; (B) assessment of the occurrence and risk of mobilizing mercury into the environment from unprocessed dredger tailings on the site; and (C) derived conceptual design plans (30%) for grading and vegetating the entire 318-acre parcel.

Task 3: the Ranch-scale design plans will form the basis for pilot restoration experiments within a 60 acre floodplain component of the ranch. These include: (A) experimental vegetation planting and growth rates undertaken on a test area of the floodplain area during the project; (B) development of 75% design drawings for experimental floodplain re-grading and channel modification intended to provide the basis for sustained environmental improvement in a highly-disturbed flow regime; (C) experimental strategies for gravel infusion and augmentation, designed to inject excavated and sorted dredger tailings from the MRR floodplain into the channel to compensate for gravel removed from the channel and sediment trapped by upstream dams, in a manner that is compatible with the river's sediment transport capabilities; and (D) development of a comprehensive post-implementation monitoring plan that links the experimental results into the reach and watershed context.

Task 4: to address the practicalities of implementing the pilot projects, task 4 will include: (A) completion of a detailed implementation plan addressing engineering feasibility and approaches, cost-effective re-vegetation and irrigation methods, property access, access routes, and transport, and potential end-uses of the excavated tailings; (B) detailed research into comparative restoration costs for projects in the San Joaquin valley (and beyond, if appropriate); (C) completion of draft environmental documentation intended to satisfy NEPA and CEQA requirements for the Ranch site, including permitting for the pilot vegetation experiment, and (D) continued liaison with the Merced River Stakeholder Group and Technical Advisory Committee designed to ensure continued support from a well-informed public. Task 4 is intended to provide the basis for rapid permitting and implementation of the pilot studies during a later project phase.

Specific project objectives are listed in Table 1. Hypotheses to be tested by project monitoring and experimentation are described in Section A.3 (Tables 2 and 3).

Table 1. Project Objectives

TASK 1: Reach-scale Investigations for the Merced River Dredger Tailings Reach
Obtain reach-level information through baseline surveys for development of restoration strategies for the Dredger Tailings Reach.
Develop and field test a numerical model for designing gravel augmentation in the lowland rivers of the Central Valley
Develop an approach to channel restoration design that balances upstream sediment supply with reach-level sediment transport capacity
Assess the volume and texture of dredger tailings occurring in the vicinity of the Dredger Tailings Reach
Collect baseline information needed for long-term monitoring and adaptive management of restoration in the reach.
Develop cause-effect statements relating reach level assessments to downstream conditions
TASK 2: Restoration design planning for the Merced River Ranch
Assess and understand the occurrence of mercury in gravel tailings throughout the MRR site
Develop conceptual restoration plans (30%) for regrading and re-vegetation of the Ranch
TASK 3: Restoration pilot experiments for the floodplain segment of the Merced River Ranch
Understand floodplain vegetation growth characteristics experimentally for a test site on the riparian frontage of the MRR site
Design floodplain regrading and channel morphology designs that will be functional under the current, regulated flow regime
Design floodplain regrading suitable to support processes and surfaces for recruitment of native riparian plants, increase the size and connectivity of riparian vegetation patches thus improving wildlife habitat
Design a channel morphology that reduces shear stresses in the main channel during large flood events
Design a channel morphology that enhances potential for channel migration.
Design a gravel infusion plan that provides an immediate increase in coarse sediment storage in the reach and that balances sediment texture with sediment transport competence as the basis for providing chinook salmon spawning areas.
Design a gravel augmentation plan that balances sediment supply with sediment transport capacity.
Develop a detailed monitoring and evaluation plan for the restoration activities named above, and that links back to the cause-effect understanding of reach level assessments
TASK 4: Implementation Planning
Develop detailed implementation plans, cost estimates, environmental documentation and stakeholder support to permit the rapid implementation of the pilot experiments in a later project phase

A.2 Justification

For Phases II and III of the restoration planning process, Stillwater Sciences, working with the Merced River Stakeholder Group and Technical Advisory Committee, completed several studies of current conditions in the Merced River. Completed studies include: assessment of land use, zoning, property ownership, and water rights, which define many of the constraints to restoration; field investigations and pilot-level modeling of sediment transport in the gravel-bedded reaches; geomorphic mapping and floodplain assessment; mapping of the current extent and composition of riparian vegetation and invasive vegetation species; and field investigations of riparian vegetation recruitment. The results of the studies are reported in Stillwater Sciences and EDAW (2001) and Stillwater Sciences (2001a, 2002). The recently completed Merced River Adaptive Management Forum report (AMF Report; July 2002) contains valuable information for use in targeting actions and ensuring the scientific credibility of restoration projects in the Merced River. It identifies the Merced river as possibly the world's best opportunity for obtaining transferable, high quality restoration data. Overall, these studies support a good understanding of conditions in the river and in the Dredger Tailings Reach, while highlighting information still to be collected, and they facilitate the development of conceptual models based on an understanding of the historical geomorphology and hydrology of the watershed. We present three conceptual models as the basis for design and future evaluation: the first describes our understanding of the river functioning prior to European arrival as the basis for deriving restoration objectives; the second describes the current state of geomorphic and ecological processes and linkages in this reach of the Merced River as a gauge to the contemporary impairments to function and challenges for restoration; the third describes the anticipated effects of the proposed projects on ecological and geomorphic conditions in the reach as the basis against which project effectiveness and learning will be evaluated.

The reference state conceptual model for the anastomosing reach, which extends from Crocker-Huffman Dam to the Dry Creek confluence and which includes the Dredger Tailings Reach, is shown in Figure 5. The anastomosing reach is located in the transition zone from the confined valleys of the Sierra Nevada foothills to the broad alluvial floor of the Central Valley. Historically, the river in this reach was a complex, multiple-channel system consisting of a mainstem and numerous secondary channels (or sloughs). The $Q_{1.5}$ was approximately 10,000 cfs, and the coarse sediment supply from the upper watershed was approximately 11,000–21,000 tons/year (Stillwater Sciences 2001a). Driven by unregulated flow conditions, coarse sediment supply from the upper watershed and local geology, this portion of the river was highly dynamic, with the location of the mainstem channel periodically switching between various secondary channels. Channel avulsion, in combination with channel migration, constructed floodplain surfaces and ensured large woody debris input and maintained diverse in-channel habitats which supported native fauna. The unregulated flow regime provided water temperatures that supported native species, including cool water temperatures in spring and early summer that are important to rearing and outmigrating salmon and steelhead. Abundant salmon carcasses in the river following spawning periods likely increased nutrient inputs to the river, which supported the aquatic food web.

Under unregulated flow conditions, the floodplain was inundated frequently. During the winter, the floodplain was inundated for brief periods during rain and rain-on-snow events. During spring, the floodplain was inundated for weeks or months by snowmelt flows from the upper watershed. The recession limb of this snowmelt hydrograph was gradual. In addition, the supply of fine sediment from the upper watershed allowed deposition of fine sediment on the floodplain during flood events, which provided bare soil patches suitable for germination and establishment of native riparian vegetation. The construction of new floodplain surfaces, availability of bare soil patches, and patterns of inundation and drawdown provided conditions suitable to support a diverse riparian forest, which in turn supported terrestrial species.

The conceptual model of current conditions in the Dredger Tailings Reach is shown in Figure 6. Key anthropogenic alterations to the river that define current conditions include flow regulation, interception of sediment by New Exchequer Dam, direct removal of sediment from the channel and floodplain by dredging for gold, removal of riparian forests, placement of mined sediment on the floodplain in irregular tailings piles, and potential input of nutrients and contaminants.

New Exchequer Dam and McSwain Dam regulate flow in the lower Merced River (Figure 2). Together, these dams control runoff from 81% of the watershed and have a storage capacity of 105% of the watershed's average unimpaired runoff. Operation of the dams has severely reduced the magnitude of peak flows; the $Q_{1.5}$ has been reduced from 10,000 cfs to 1,300 cfs. Corps of Engineers flood control rules limit flows in the river to 6,000 cfs, which is less than the pre-dam $Q_{1.5}$. These dams also trap sediment from the upper watershed, virtually eliminating sediment supply to the lower river. Downstream of these dams, two diversion dams divert flows into two large canals that are part of the Merced Irrigation District infrastructure.

The reduction in peak flow magnitude resulting from flow regulation and flood control has resulted in reduced frequency of bed transport and elimination of channel avulsion in the reach. Under current conditions, the channel bed in this reach is immobile at flows up to 4,800 cfs ($Q_{5.3}$) (Stillwater Science 2001a, b). The predicted average annual transport capacity is 550 tons/year (Stillwater Sciences 2001b). Due to the reduced sediment supply caused by upstream dams and reduced storage caused by dredger mining, the bed in this reach is depleted of coarse sediment and is characterized by long, deep pools, with few bars or riffles. With the reduction in bed scour, riparian vegetation has encroached into the active channel, reducing the area of aquatic habitat, and sand has infiltrated into the channel bed, degrading conditions for salmon egg incubation and alevin survival. The channel in this reach is now homogenous, with little spawning and rearing habitat for chinook salmon and steelhead.

The regulated flow regime also affects water quality. The transformation of the flow regime from a snowmelt-dominated to a fall/winter-dominated hydrograph has likely increased spring and summer water temperatures, which may affect salmon and steelhead rearing and outmigration. The input of nutrients and contaminants to the reach and the effects of nutrients and contaminants on aquatic biota are not known.

The floodplain has been extensively modified by gold dredging. Gold dredges excavated the river channel, floodplain, and terraces to the depth of bedrock, usually 20–36 feet (Clark, no date). After recovering the gold, the dredgers redeposited the remaining tailings in long rows. An estimated 24 million yd^3 of dredger tailings currently cover approximately 7.6 square miles of the floodplain in this reach and in the dredged area upstream of Crocker-Huffman Dam. The dredger tailings eliminated riparian forests, replaced floodplain soils with barren rock surfaces, increased floodplain elevation, and confined the channel. Combined with the reduction in flow magnitude, the dredger tailings reduce floodplain inundation and channel migration in the reach. The direct modification of the floodplain and removal of riparian forests caused by the gold dredging, combined with modification of fluvial processes, has resulted in a limited, simplified riparian forest, which has in turn reduced terrestrial species abundance and diversity and reduced nutrient inputs to the river. The potential occurrence of mercury in the tailings and the effects of mercury on aquatic and terrestrial biota are unknown.

The proposed project is the precursor for experimental pilot projects in floodplain and channel restoration, gravel infusion and augmentation and floodplain re-vegetation. The implemented projects would increase coarse sediment storage in the channel; balance bed texture with sediment transport competence; remove dredger tailings from approximately 60 acres of floodplain along 3,600 feet of channel to create diverse floodplain surfaces at functional elevations; and reconstruct 3,600 feet of channel in the MRR site. The conceptual model illustrating the anticipated effects of the project is shown in Figure 7 and is based on the existing regulated flow regime. Sediment augmentation and channel and floodplain designs will be developed to meet the following objectives: (1) floodplain inundation duration and frequency that support the recruitment and establishment of native riparian hardwood vegetation without channel encroachment; (2) a channel bed that is more frequently mobilized to maintain ecological function (e.g. by floods of a magnitude of the $Q_{1.5}$–Q_2); (3) a channel that conveys flows up to the magnitude of the 1.5- to 2-year recurrence interval flood; (4) bed surface texture that is suitable for chinook salmon spawning; and (5) a channel that has the potential to migrate, increasing large woody debris input and supporting the creation of riparian vegetation recruitment sites (although migration will continue to be reduced due to flow regulation). Physical implications of the proposed experiments to upstream reaches are eliminated by the presence of Crocker-Huffman dam. Some of the coarse sediment introduced at the upstream end of the reach should be transported downstream of the Merced River Ranch but the low sediment transport rate will virtually eliminate significant physical connection to the downstream reach (Gravel Mining reach 1). Table 2 lists specific project physical hypotheses.

By constructing an appropriately scaled compound channel and floodplain based on physical first principles, and adding coarse sediment of a texture that can be mobilized under current flow conditions, the pilot projects would increase the frequency of bed mobilization and balance coarse sediment supply with sediment transport capacity. Combined with ongoing gravel augmentation to provide a coarse sediment supply and some channel migration, the projects would initiate conditions that allow the river to create and maintain active alluvial features, such as bars and riffles, and thus will increase in-channel habitat complexity. Resulting from the habitat changes (Figure 7) a series of expected biotic responses arise including: improvements to chinook salmon spawning and incubation success by reducing redd superimposition and increasing survival-to-emergence, changes to macroinvertebrate species composition to more available species, improvements to the extent and complexity of riparian forests and consequent increases in nesting native bird species. Table 2 lists specific project biological hypotheses: quantitative expressions of these objectives will be developed following the assessments undertaken in this project.

A.3 Approach

Task 1: Reach-scale Investigations for the Merced River Dredger Tailings Reach

Task 1A. Conduct field surveys needed for design of floodplain restoration and gravel augmentation. Field surveys documenting existing channel conditions are needed to determine the volume and placement for the initial gravel infusion. The surveys will be used to determine input to the sediment transport model (Task 1B), to determine input to the HEC-RAS model (Task 1C), to determine topography for estimating tailing volume and texture (task 1D, 2A) and to document baseline conditions for project monitoring and evaluation (Task 1E). Field surveys within the Dredger Tailings Reach will include the following:

- *Floodplain photogrammtery and mapping*. Photogrammetric analysis on black-and-white photographs (scale 1:7,200) will cover the corridor extending from the center line of the river out 750 feet on each side of the river for the entire Dredger Tailings Reach. The photographs will be orthorectified using surveyed ground points for mapping control and will serve as project base maps. Survey products will include: a topographic map with 2-foot contour intervals, orthorectified photos (hard copy and electronic files), electronic files of elevation points, and electronic elevation topographic files.
- *Channel profile survey.* The thalweg and water surface elevations will be surveyed using differential GPS. A Stillwater Sciences geomorphologist will accompany the surveyors in the field to assure that key geomorphic data are collected during the survey.
- *Channel cross sections.* A total of 40 new cross sections will be surveyed, in addition to cross sections that have recently been surveyed in the reach by Stillwater Sciences and URS (Stillwater Sciences 2001a, URS 2000). Cross sections will be surveyed using an autolevel and stadia rod. Cross section endpoints will be monumented, and endpoint locations will be recorded using differential GPS.
- *Bed texture assessment and facies mapping.* Bed surface texture will be documented by mapping facies units and conducting pebble counts in each facies unit type. Five pebble counts for each facies unit type will be conducted.

Task 1B. Develop and apply a detailed sediment transport model for designing gravel infusion and long-term gravel augmentation. As part of Phase III planning, Stillwater Sciences has applied a pilot-level, reach-scale sediment transport model to predict sediment transport capacity and competence in the Dredger Tailings Reach for existing conditions and for a range of gravel augmentation scenarios (Stillwater Sciences 2001a, b). This model represents the reach by a single cross section and can be used to predict sediment transport thresholds, transport rates, and bed texture for given channel geometries, flow conditions, and sediment supply. This model, however, cannot route sediment through the reach and cannot predict spatial patterns of deposition and scour, so we will adapt a 1-dimensional sediment transport model for application to the Dredger Tailings Reach. Stillwater Sciences has developed a peer-reviewed model, based on Parker's surface-bedload equation (Parker et al. 1982; Parker 1990; Parker 1991a, b), to predict 1-dimensional patterns of sediment deposition and scour following a sediment pulse (Cui et al., in prep). The adapted model will be used to predict: (1) sediment transport rates, (2) spatial and temporal coarse sediment deposition patterns, and (3) bed surface and bedload grain-size. The model will be applied to the Dredger Tailings Reach and the CDFG/CDWR Robinson Reach immediately downstream (RM 44 to RM 42) to refine the estimate of the volume and texture of sediment needed for the initial infusion and long-term augmentation, and to predict sediment routing through the reach. This model will provide an important tool to help ensure that the sediment placed in the reach can route downstream.

Task 1C. Develop and apply a hydraulic model to predict current and post-restoration flood levels in the Dredger Tailings Reach. The U.S. Army Corps of Engineers HEC-RAS River Analysis System Software package (Version 3.0.1) will be used to develop a reach-scale model for the Dredger Tailings Reach as a tool to design channel size, floodplain elevation, and planting patterns. HEC-RAS models have already been developed for the MRR site (URS 2000) and the Snelling reference site (Stillwater Sciences 2001a) for input into the model. The model will also be used to compute pre- and post-project flood conveyance and water surface elevations, as required for project design considerations and to obtain a Reclamation Board permit. The HEC-RAS model will predict water surface elevations, flow depths, flow velocity, and shear stresses under existing and proposed conditions. The pre-project model will be developed from field and photogrammetric surveys conducted in Task 1A. The post-restoration model will be constructed from design cross sections. Development of the model will be overseen by a URS registered PE with experience in hydraulic modeling.

Task 1D. Determine the volume and texture of dredger tailings in the Dredger Tailings Reach. The volume and texture of dredger tailings in the entire Dredger Tailings Reach must be determined in order to estimate: (1) the total volume of tailings that must be removed to achieve floodplain restoration along the entire reach, and (2) the volume of specific size classes of sediment that can be expected to become available for restoration uses. The volume of the dredger tailings throughout the reach will be estimated using photogrammetry-derived mapping in combination with field mapping for an average corridor width of 1500 feet through the Dredger Tailings Reach. Twenty dredger tailings samples will be collected through the reach, their stratigraphy noted prior to particle size analysis. Bulk density of the tailings will determined before and after excavation. These analyses will be the basis for determining the potential use for the tailing in restoration projects and elsewhere.

Task 1E. Implement baseline monitoring. The proposed project includes monitoring to document baseline physical and biological and conditions, to improve system understanding as the basis for better conceptual models, to validate numerical models and to provide the basis for generating quantitative success criteria to use in assessing future project effectiveness. The Project Team, working with Merced ID, will implement two years of baseline monitoring to document channel morphology; bed texture; sediment transport; chinook salmon field spawning habitat extent, quality and utilization; and species composition and density of benthic macroinvertebrate species and riparian bird species. Hypotheses to be tested by the monitoring programs, monitoring methods, and monitoring timing are shown in Table 2. Monitoring locations and densities will be refined prior to implementation, in coordination with the Merced River TAC. All monitoring will also be coordinated with ongoing studies being conducted by CDFG and Merced ID, and will be developed to address, to the extent possible, concerns raised by the AMF Report regarding monitoring requirements for the Merced River (section 4.1). In addition, the Project Team will compile, apply QA/QC, and synthesize available baseline data in the reach, including past salmon carcass and redd surveys conducted by CDFG and other data, as identified. The baseline monitoring scheme will be based on a comprehensive plan for effective post-project appraisal (monitoring and evaluation) for the site, and the resultant baseline data will form the basis for evaluating project success. The plan for post-project appraisal will be based on two key attributes of "success" in restoration guided by adaptive management, that is, evaluation of project effectiveness and evaluation of the learning experience (i.e. viewing the project as an experiment) (Downs and Kondolf, 2002).

Task 2: Restoration design planning for the Merced River Ranch

Task 2A. Assess the volume and texture of dredger tailings on the Merced River Ranch property
Complementing the reach-level survey, dredger tailings across the entire MRR property will also be sampled and analyzed. The volume and texture of the dredger tailings at the MRR site will be determined from the texture analysis of particle sizes in order to (1) estimate the cost of excavation and transport of the tailings, and (2) determine the grade of the tailings and the suitability of the excavated tailings for use in gravel infusion, long-term gravel maintenance, and other restoration construction. The Project Team will use a backhoe to collect samples from various locations on the floodplain and terrace from both banks of the MRR property, and analyze them for particle size distribution (10 size classes greater than 2mm in diameter) and stratigraphy.

Task 2B. Assess the occurrence of mercury at the Merced River Ranch. Mercury has been widely used to separate gold from excavated alluvial deposits throughout the western United States (Alpers and Hunerlach 2000), leaving a legacy of potential mercury contamination in the remaining tailings piles in the watersheds of the Sierra Nevada (Hunerlach et. al. 1999). The occurrence and distribution of mercury in the Dredger Tailings Reach is unknown, although some analytical testing has been conducted at two properties upstream of Crocker-Huffman Dam. There is an inherent risk of introducing mercury into the river by injecting unprocessed tailings for gravel augmentation and by exposing mercury during excavation of the floodplain. The potential occurrence of mercury in the Merced River dredger tailings may necessitate extensive processing before they are available as a restoration resource, which can affect the cost and feasibility of using the tailings for restoration.

Task 2B will: (1) characterize the spatial distribution of mercury in the dredger tailings and in the excavated floodplain; (2) compare mercury in the tailings with background levels in undredged floodplain reference sites; (3) develop grain-size associations in which mercury is encountered; and (4) assess the potential for mercury bioaccumulation in the aquatic foodchain. The specific tasks to meet these objectives are listed below:

- ***Sample dredger tailings in-place***. Excavation of the tailings that will be processed for eventual use in the pilot restoration project will expose the underlying floodplain. We will develop a peer-reviewed sampling plan to assess the occurrence of mercury in the tailings piles and the exposed floodplain, at depths that represent the projected floodplain elevations for the pilot restoration project.
- ***Sample the residue of processed tailings***. We will process a quantity of dredger tailings by washing or dry sorting, then analyzing for mercury occurrence within each size fraction. We will develop recommendations for processing and, if necessary, disposal requirements that are sufficiently protective of mercury re-release.
- ***Monitor mercury in control sites***. To compare any detected level of mercury contamination of dredger tailings and excavated floodplain with background occurrence of mercury, we will sample undredged floodplain reference sites.
- ***Monitor biota***. Dredger tailings have been previously used at restoration sites in the San Joaquin basin and this presents an opportunity to assess the risks of mercury contamination from gravel re-use. Fish and benthic invertebrates will be collected at comparable instream sites with and without dredger tailings by seining (for fish) and by Surber sampler (for invertebrates) until a sufficient number of individuals of each taxon from each site are collected (> 2 g wet weight) to assess mercury uptake within the local food web.

Sampling plans will be peer reviewed by Dr. James Rytuba of the U.S. Geological Survey and Dr. Johnnie Moore of the University of Montana. Dr. Darrell Slotton of UC Davis will assist in conducting all mercury analyses and developing a Quality Assurance Plan. The development of reliable sampling methods for detection of heterogeneous mercury deposits within dredger tailings and floodplain gravels has been the subject of much debate in the past several years. The sampling protocols used in this proposal will be developed in concert with other programs (e.g., Clear Creek) and at a minimum will build from EPA Method 1669 for aqueous samples to collect sediment, water, fish and benthic invertebrates. Bulk sediment samples will be collected, frozen, and sub-sampled and sorted, sieved, and crushed as necessary prior to homogenization and total mercury analysis. Groundwater and surface water samples at sediment sample locations and at the instream sites will be filtered and preserved in the field prior to analysis for mercury speciation (*e.g.*, total and methyl mercury). All quality control samples for sediment, water and biota will be sent to Frontier Geosciences Laboratory, Seattle, WA. A one-day public symposium will be held to present the findings of the mercury assessment to the Merced River Stakeholder Group and to CALFED.

<u>Task 2C. Merced River Ranch conceptual restoration design</u>.
Based on baseline surveys at the ranch already completed by URS (e.g. four channel and dredger tailings cross-sections, vegetation transects, habitat mapping of the 318-acre parcel, Figure 8, URS 2000), the project team will refine the restoration concepts developed initially by an interdisciplinary team of professors and students at California State University, Fresno (Brady et al. 2001). Earthwork, erosion control, planting, irrigation, and soil augmentation will be considered during the design phase. Plants will require irrigation for approximately 3 years in order to ensure the success of revegetation. A conceptual (30%) design and plans will be completed for the 318-acre parcel and used to assist in developing later design drawings for the 60-acre Merced River Ranch

pilot floodplain restoration (see Task 3). This conceptual design will be available for potential completion and implementation of future projects. Drawings will be prepared using CAD and will be presented on the orthorectified aerial photographs developed in Task 1D at 1:1,200 scale. An accompanying 30% design report will focus on all restoration design elements and considerations that require more detailed analyses.

Task 3: Restoration pilot experiments for the floodplain segment of the Merced River Ranch

Task 3A. Floodplain vegetation experimentation. Dredger tailings have been removed from floodplains at several locations along the Merced and Tuolumne rivers. Establishment success of riparian vegetation at these sites has been varied. At two sites on the Merced River, extensive cottonwood recruitment has followed removal of the tailings. On the Tuolumne River, however, recruitment of riparian vegetation at cleared sites has been limited. Soils at the MRR property are thought to consist of sand overlain by cobbles and gravels. Potentially, removal of the coarser surface fractions of the tailings to achieve the desired floodplain elevation may result in conditions that do not support establishment of planted or recruited riparian vegetation.

To assess the most effective and efficient revegetation techniques of reconstructed floodplains for application on both the MRR site and the remainder of the Dredger Tailings Reach, the Project Team will conduct a pilot study on a small area of the intended MRR pilot floodplain restoration site. The study will consist of a multiple-factorial experiment that tests the effects of site design factors and planting treatments on the survival and growth of native riparian tree seedlings. To date, research on propagation and survival of native Central Valley species has focused on Fremont cottonwood, various willows (McBride and Strahan 1984; Stromberg 1997), and valley oaks (Callaway 1992, Holmes 1995). Using this research as a starting point, the Project Team will evaluate establishment success on dredge spoils, overwinter survival, and ecophysiological requirements of several native tree species. Native riparian tree species to be tested include those found as dominant components of Central Valley mixed riparian forests and that have demonstrated different life history traits and a range of geomorphic establishment positions on river banks and floodplains (Stillwater Sciences 2001b). Survival and growth of planted seeds and seedlings of several native riparian pioneer species will be evaluated for a minimum of 18 months. Experimental hypotheses, factors, and treatments for the vegetation experimentation are described in Table 3. Final experimental design will be developed with a peer review committee.

Task 3B. Merced River Ranch floodplain restoration design plans. The Project Team will develop 50% and 75% design plans to restore approximately 60 acres of floodplain along 3,600 linear feet of river channel at the MRR site, based on review comments from the MRSG, MRTAC and others on the conceptual (30%) designs developed as part of Task 2A. The designs may include plans to use tailings from areas of the MRR not included directly as part of the pilot project. The essence of the floodplain restoration will be to create a morphologically diverse floodplain topography as the basis for maximizing the learning experience, using existing information and the results of baseline monitoring and vegetation experimentation within this project to target biological objectives. Conditions on the existing floodplain are illustrated in Figure 9.

Staging areas, access routes, haul routes, and best management practices for construction activities will be described. Irrigation designs will be prepared for maintaining plantings until establishment. The 50% design submittal will include draft specifications for planting, irrigation, grading and construction, and draft plans for grading, planting and irrigation, presented at 1:480 scale. Following review, revised 75% designs will be produced. All plans will conform to appropriate standards and guidelines.

Task 3C. Plan in-channel gravel infusion. The gravel infusion component of the pilot restoration project is designed to inject excavated and sorted dredger tailings into the channel to compensate for gravel removed from the channel and trapped by upstream dams. Gravel infusion planning will be focused from Crocker-Huffman Dam (RM 52) to the downstream end of the MRR parcel (RM 50.3), with the potential to extend farther downstream based on detailed topographic assessment of the volume of material available from the MRR site.

Gravel infusion will be planned to occur in conjunction with floodplain restoration at the MRR property to result in a channel morphology that is appropriate to the hydrological and sediment transport regime experienced by the reach. In so doing, rates of sediment transport should increase in the river and assist in developing a more diversified and changeable morphology that benefits native flora and fauna. The tailings will have been processed on site according to acceptable standards for mercury testing. The final volume and texture of sediment required to complete the infusion will be determined based on the results of Task 1 to ensure compatibility with reach dynamics. The volume of dredger tailings available from the 60-acre pilot project area is estimated to be 450,000 yd^3 (120,000 tons), of which 300,000 tons of suitable coarse sediment may be available following re-grading of the MRR floodplain. Plans for infusion will assume that coarser material such as cobble and coarse gravel will be placed in the bottom of pools during gravel infusion in the Merced River. The top 1-2 feet of infusion will consist of spawning-grade gravel and will be arranged across the channel in size fractions that are characteristic of facies mapped in the Tailings Reach and on neighboring rivers (i.e. to mimic natural hydraulic sorting processes). Excess materials at the pilot project site would be stockpiled on the MRR for use in future augmentation phases or other restoration projects being constructed on the Merced River. This task will develop plans for infusion that vary throughout the reach, including the strategies for the placement of tracer particles that would reinforce the experimental basis of the infusion and benefit future practice. The task will also focus on strategies for periodic gravel augmentation to the reach in quantities appropriate to the sediment transporting properties of the infused reach, and to offset deficiencies in practice recognized by Lutrick (2001).

<u>Task 3D. Plan post-implementation monitoring.</u> Developing from the hypotheses shown in Table 2 and the baseline monitoring plan developed in Task 1F, a targeted post-project monitoring plan will be developed to suit the specific objectives of the planned pilot floodplain restoration and gravel infusion and augmentation. Specific success and learning criteria for the pilot scheme will be quantified following the baseline monitoring and analytical work undertaken throughout this project, and include an integrated combination of physical and biological monitoring objectives based on a revised version of the conceptual model for restoration presented as Figure 7. The appraisal plan will be based on appraisal best practice identified by Downs and Kondolf (2002) and will include the provision of record drawings immediately following construction, and periodic and/or event-driven monitoring thereafter for a minimum period of 10 years. Periodic evaluation reports regarding project performance will be recommended (e.g. 1, 2, 5 and 10 years following construction), and designed to integrate the monitoring findings with those in neighboring rivers. Long-term post-project monitoring funds will be sought as an integrated component of future project implementation funding.

Task 4: Implementation Planning

<u>Task 4A. Complete a draft and final implementation plan for floodplain restoration and gravel infusion in the reach.</u> The Project Team will develop a draft and final detailed implementation plan that will include phasing, scheduling, and property access routes for the entire Dredger Tailings Reach. Phasing will generally move from upstream to downstream, beginning at Crocker-Huffman Dam, and will be developed based on property access, the volume of tailings to be moved, the feasibility of moving those volumes with regard to excavation technologies, environmental work windows, noise, and air quality. Other design elements will be analyzed for feasibility in reach-scale implementation, including irrigation methods, planting techniques, and soils augmentation.

<u>Task 4B Costs research for pilot projects implementation.</u> The project team will investigate restoration costs and alternatives for implementation of the pilot projects. Costs will be compared to related projects throughout California. The cost estimates will be organized and documented to ensure that the full cost implication of restoration measures is understood and that a carefully constructed estimate is available as the basis for implementing the pilot projects.

Task 4C: Draft environmental documentation for the Merced River Ranch pilot projects. The Project Team will prepare NEPA and CEQA environmental documents for the proposed pilot floodplain and channel restoration project (60-acre) at the Merced River Ranch and gravel augmentation within the Dredger Tailings Reach. The CEQA and NEPA documents will address the pilot floodplain restoration and gravel augmentation as a single project. These documents will tier to the CALFED or CVPIA Programmatic EIR/EIS, depending on the source of funding. For CEQA and NEPA compliance, it is anticipated that an Initial Study Negative Declaration and Environmental Assessment FONSI will be sufficient. CDFG will act as the lead agency for the CEQA process.

In addition to the CEQA/NEPA process, documentation for the following permits will be developed:

- 1603 Streambed Alteration Agreement (CDFG),
- 401 Clean Water Act Water Quality certification or waiver (Regional Water Quality Control Board),
- 404 Clean Water Act Permit (U.S. Army Corps of Engineers),
- Reclamation Board permit, and
- County Land Use/Surface Mining and Reclamation Act (SMARA) permit, if required (Merced County Planning and Community Development Department).

The projects will comply with the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA). All ESA documentation and required incidental take permits will tier to the CALFED Multi-species Conservation Strategy. Section 404 and 401 permits will tier to the programmatic MOUs and Consistency Determination.

Permit applications will be made as the basis for enabling the pilot vegetation experiments. Permit applications for the other pilot restoration tasks will not be made during this project, pending restoration design developments and policy resolution of processing requirements for dredger tailings. It is the intention that the Task will form the basis for rapid implementation during a future round of funding.

Task 4D. Coordinate with the Merced River Technical Advisory Committee and Stakeholder Group. Restoring the 7 miles of the Dredger Tailings Reach will require the participation of three public landowners (Merced County, Merced Irrigation District, and CDFG) and 10 private landowners working cooperatively over several years. Fortunately, members of the Project Team, in conjunction with Merced County Planning and Community Development Department, have worked with public and private landowners in previous years to: form the Merced River Stakeholder Group (MRSG) and the Merced River Technical Advisory Committee (MRTAC) (Phase 1); conduct baseline assessments (Phase II); and develop a restoration plan for the lower Merced River (Phase III). Stakeholder involvement will continue to be fundamental to the successful implementation of Phase IV—the Dredger Tailings Reach project following design. Survey plans, project designs, and monitoring results will be presented to both the MRSG and MRTAC for their review and input. In addition, the Project Team will continue to develop support with property owners in the Dredger Tailings Reach. In addition to MRSG and MRTAC review of plans, designs, and results, this task includes funding to continue facilitation and coordination of the MRTAC, and for liaison and meeting attendance with the MRSG.

A.4 Feasibility

This project represents the fourth phase in an ongoing restoration process on the Merced River. In Phase I of the restoration process, completed in 1999, Stillwater Sciences established the Merced River Stakeholder Group and the Merced River Technical Advisory Committee. The Stakeholder Group was formed to provide input and local leadership for the restoration process, and represents various interests throughout the Merced River corridor including landowners, riparian water users, aggregate miners, dairy operators, ranchers, farmers, environmental groups, angling groups, and local, state, and federal agencies. The TAC was formed to provide technical review and oversight for the restoration plan development and includes agency and industry representatives, as well as landowners and riparian water user representatives. Both groups have met several times in the past three years to provide input to the first three phases of the project and intend to continue meeting to provide support and leadership to fulfill long-term restoration goals along the Merced River. The proposed project is a result of coordination with both groups, and both groups support its implementation.

The proposed project will occur on property owned by the co-applicant (CDFG). Access to the channel for gravel augmentation will require crossing lands owned by CDFG and Merced ID. In addition, Stillwater Sciences has met with many landowners in the rest of the Dredger Tailings Reach. These landowners have expressed support for the project in concept, although many property rights issues will need to be addressed before further commitments can be made. Potentially, the MRR project will provide an excellent opportunity to demonstrate project implementation and benefits to landowners throughout the reach. Letters of support from several landowners in the Dredger Tailings Reach have been obtained (available upon request). Drafting of documentation to support compliance with NEPA, CEQA and the ESA, is included as Task 4C of this proposal.

A.5 Performance Measures

The development of restoration performance measures based upon *a priori* hypotheses is integral to this project (see Tables 2 and 3). Baseline monitoring efforts developed in Task 1E will be designed around expected system adjustments following restoration, as illustrated conceptually in Figure 7. Results from baseline monitoring along with restoration performance understanding documented from other projects in the Merced and in neighboring rivers will be used to develop specific, quantified physical and biological "success criteria" as the basis for a long-term monitoring and evaluation in Task 3D. The measures will include quantitative success criteria for bed texture, channel stability, floodplain inundation, and riparian vegetation establishment, and will be derived in coordination with the Merced River TAC. Performance measures will also be based in part on addressing data deficiencies identified in the Merced River AMF Report including improved baseline data, integrated physical and biological monitoring, linking of site-specific results into regional ecosystem understanding and maximizing the experimental potential of the planned actions in order to capitalize on the learning experience from restoration of the MRR reach.

A.6 Data Handling and Storage

Collection and development of data and information will cover a 3-year period and will build on previously obtained data. All data collected for baseline monitoring, as-built surveys, and post-project monitoring will undergo standard Stillwater Sciences QA/QC procedures before the originals are archived. This process includes review of field notes and data by field crew personnel, a check for accuracy of data entry, and creation of working and back-up copies of original data sheets to eliminate possible loss of or tampering with original data. All data will be archived at Stillwater Sciences including off-site back-up copies of electronic data.

A.7 Expected Products/Outcomes

The products deriving from the tasks outlined above are listed in Table 4.

A.8 Work Schedule

Tasks 1, 2, 3 and 4A through 4C will be completed generally in chronological order during the three-year contract period. Project management and Task 4D, coordination with the Merced River Stakeholder Group and Technical Advisory Committee, will continue throughout the terms of the contract. Specific details of the work schedule are shown in Figure 10.

Table 4: Expected Products/Outcomes for Each Task

Task	Expected Product/Outcomes
Task 1: Reach-scale Investigations for the Merced River Dredger Tailings Reach	
1A	• Draft and final technical memoranda reporting the findings on the channel profile, cross sections, and bed surface texture mapping and notes.
1B	• Draft and final technical memoranda reporting the findings of sediment transport modeling
1C	• Draft and final technical memoranda reporting the findings of the model development, and flood conveyance, migration potential
1D	• Draft and final technical memoranda reporting the findings of the dredger tailings volume determination and texture survey
1E	• Draft and final baseline monitoring report, reach-level monitoring and evaluation plan
Task 2: Restoration design planning for the Merced River Ranch	
2A	• Draft and final technical memoranda reporting the findings of the dredger tailings volume determination and texture survey
2B	• Draft and final technical memoranda reporting the findings of mercury assessment of current dredger tailings piles
2C	• Draft and final 30% conceptual designs for restoring and revegetating the 318-acre MRR parcel
Task 3: Restoration pilot experiments for the floodplain segment of the Merced River Ranch	
3A	• Draft and final technical memoranda reporting the findings of vegetation experiments with recommendations for final vegetation design for implementation plan
3B	• Draft and final 50% and 75% plans for floodplain and channel restoration experiments
3C	• Design strategy document for gravel infusion
3D	• Detailed plan for pilot project monitoring and evaluation, designed to maximize learning experience.
Task 4: Implementation Planning	
4A	• Draft and final implementation plan
4B	• Researched cost estimate for pilot project implementation
4C	• "Ready for application" NEPA/CEQA documents, • "Ready for application" Biological Assessment documents • "Ready for application" permit applications (USACE 404 permit, CDFG Streambed Alteration Agreement, RWQCB Section 401 Water Quality Certification, Reclamation Board permit, SMARA)
4D	• Meeting notices, agendas, sign-in sheets, minutes and presentation materials

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

B.1 ERP, Science Program and CVPIA Priorities

The large-scale restoration planning and restoration experiments included in the proposed project support several of the restoration priorities outlined in CALFED's Draft Stage 1 Implementation Plan. Specific support of individual priorities (including those of the ERPP, Science Program, and CVPIA) are indicated below with parentheses.

Task 1 of the proposed project will lay the groundwork for site- and reach-scale restoration efforts in the Dredger Tailings Reach. The intensive geomorphic and baseline monitoring efforts will extend existing CDFG/Merced ID fish monitoring efforts on the Merced River, take advantage of existing CDFG data (both Science Program priorities), and improve our understanding of at-risk species, such as chinook salmon, in the Merced River (SJ-4). The information gained from these studies will be valuable in assessing and designing future restoration efforts, both on the Merced River and throughout the San Joaquin River basin where in-channel mining has left many rivers with large mining pits and off-channel dredger tailings piles, and poor habitat for both in-channel and riparian corridor at-risk species (MR-6).

The proposed project includes revegetation, floodplain, and channel restoration experiments intended to: 1) initiate the restoration of natural ecosystem function to the Dredger Tailings Reach of the Merced River (SJ-2);

2) develop performance measures for future floodplain restoration actions (Science Program priority); 3) establish a science-based adaptive management approach to restoration on the Merced River (Science Program priority and SJ-6); and 4) contribute transferable scientific understanding that assists in reducing uncertainty in restoration design (Science Program priority).

The proposed project uses aerial photogrammetry, intensive field studies, and hydraulic and sediment transport models to determine channel and floodplain dimensions that will best re-establish natural geomorphic processes, including floodplain inundation and channel bed mobility (SJ-2). Through the restoration experiments, development of a detailed restoration implementation plan, and continued collaboration with the Merced River Stakeholder Group and Technical Advisory Committee, the project furthers the study and implementation of habitat restoration and channel-floodplain reconstruction while incorporating the comments and needs of local landowners and stakeholders (SJ-1).

Ultimately, the monitoring, experiments, and planning included in this project will lead to floodplain and channel restoration that rehabilitates geomorphic processes, improves sediment quality conditions and salmon spawning substrates, and maintains aquatic and terrestrial biotic communities and habitats (Strategic Goals 1, 2, 4, and 6 and SJ-3).

B.2 Relationship to Other Ecosystem Restoration Projects

Several restoration projects, plans, and studies are currently being implemented or planned on the Merced River that share this project's overarching goal of restoring ecosystem processes in the Merced River. These projects relate directly to the efforts of this restoration project and are key components in developing a comprehensive vision for restoring the functions of the river. Since the original submission of this proposal, the Merced River Adaptive Management Forum Report now provides a reference document for integrating restoration efforts.

- The Merced River Corridor Restoration Plan has been developed by the Merced County Planning and Community Development Department and Stillwater Sciences to provide a technically sound, publicly supported, and implementable restoration plan to improve, to the extent feasible, ecological conditions in the Merced River to benefit fish and wildlife and to recognize, protect, and address the concerns and rights of property owners and stakeholders.
- The Merced River Salmon Habitat Enhancement Project, implemented by CDFG working with CDWR, reconstructed the river channel and floodplain through Robinson Ranch, 4.3 miles of the Merced River that had been excavated for aggregate mining. The objectives of the project were to: (1) reduce predation on young salmon by non-native fish by isolating river-captured mining pits that serve as predator habitat, (2) restore or enhance salmon spawning habitat, (3) enhance passage of adult and juvenile salmon, (4) resize the channel and floodplain to restore some natural river processes, and (5) reestablish riparian vegetation. Two additional phases of this project remain.
- CDFG conducted several gravel augmentation projects in the Dredger Tailings Reach in the 1980s and 1990s and is currently working with riparian water diverters to introduce spawning gravel at several small diversion dams in the river.
- The James J. Stevinson Corporation has been placing conservation easements on nearly 9,000 acres of its landholdings at the confluence of the Merced and San Joaquin rivers. This easement will protect 2,931 acres of riparian habitat and floodplain, which comprise the largest remaining patches of riparian forest along the Merced River. In addition, the easement lands are adjacent to and will serve to expand several wildlife refuges.
- The Merced ID and CDFG jointly developed and agreed upon a formal 10-year study program to determine the potential factors that may limit salmon production in the Merced River. This program is designed to evaluate the habitats necessary of each freshwater salmon life stage for increased salmon production, and to

identify the long-term instream flow and other needs of salmon in the Merced River. The studies and instream flow scheduling will be coordinated with other studies throughout the San Joaquin Basin and the Delta. Components of this program are currently underway.

B.3 Requests for Next-phase Funding

The proposed project is Phase IV of the Merced River Corridor Restoration Plan. Phase I of the Restoration Plan was funded by the AFRP; Phases II and III were funded by the CALFED ERP. The required Requests for Next-Phase Funding (Attachment A) to this document provides additional detail regarding the previous phases and their current status.

B.4 Previous Recipients of CALFED Program or CVPIA Funding

Previous funding awarded to the applicants from the CALFED or CVPIA programs are detailed in Table 5.

B.5 System-wide Ecosystem Benefits

The project follows the development by Stillwater Sciences of the Merced River Corridor Restoration Plan and thus the project team is acutely aware of issues facing the lower Merced. The environmental assessments and experiments undertaken within this project are designed to provide the technical information and methods necessary to implement this project under a future funding phase, and to benefit the planning of similar projects in neighboring watersheds. Central this project is the theme of floodplain and in-channel habitat restoration in areas currently covered by dredger tailings. On the floodplain, mercury assessment and vegetation experiments will help assess the potential difficulties of recruiting and establishing riparian vegetation on floodplain land reclaimed from dredger tailings. Soils beneath dredger tailings often lack essential nutrients and may have minimal moisture retention, and thus experiments have the potential to yield novel data for use elsewhere in the dredger tailings reach. In-channel, mercury volume and texture assessments along with sediment transport simulations and knowledge of habitat preferences will be used to pursue the utility of gravel infusion and augmentation to maintain a valued habitat in a highly disturbed area and promote downstream sediment transport. Overall, the proposed project will improve transferable understanding of process-habitat-biota linkages for previously dredged rivers, a condition commonly found in the Bay-Delta.

B.6 Additional Information for Proposals Containing Land Acquisition

N/A

C. QUALIFICATIONS

The Project Team consists of Stillwater Sciences, California Department of Fish and Game, URS Corporation, and Kjeldsen, Sinnock & Neudeck, Inc. Stillwater Sciences will be the project contractee and project manager. URS Corp. will provide CEQA/NEPA permitting and engineering design services. Aerial Photomapping Services will provide surveying and photogrammetry services. CDFG, as the property owner of the MRR, will provide project oversight and design review and will contribute to monitoring design and implementation. Dr. Daryl Slotten will provide assistance in developing the mercury sampling design and assessment with peer review provided by Dr. Johnnie Moore (University of Montana) and Dr. James Rytuba (U.S. Geological Society). Scott McBain and John Bair of McBain & Trush will provide peer review for the vegetation experimentation design.

The lead management team will consist of Peter Downs (Stillwater Sciences), Tim Heyne (CDFG), and Steve Kellogg (URS Corporation). The team leaders will be supported by experienced staff members with extensive experience in the San Joaquin Basin (Figure 11)

Stillwater Sciences: Stillwater Sciences is a firm of biological, ecological, and geological scientists. The company specializes in developing new scientific approaches and technologies for problem-solving in aquatic and terrestrial systems. Its founding members have extensive experience in freshwater and fluvial geomorphology. Recent projects include impact assessment and restoration of rivers affected by hydroelectric dams, timber harvest, and irrigation in California and the Pacific Northwest.

Mr. Frank Ligon is an aquatic ecologist and geomorphologist with over 20 years of experience examining the role of fluvial processes and morphology on the ecology of stream fish, invertebrates, and plant communities. He has successfully managed several complex, long-term projects involving watershed analysis, salmon ecology and restoration, geomorphology and riverine ecosystem restoration. His Central Valley experience includes managing a ten-year chinook salmon ecology and restoration project on the Tuolumne River.

Dr. Peter Downs is a fluvial geomorphologist with 14 years of experience in the application of geomorphology to river management issues, with particular expertise in the field of watershed scale processes and their effects on channel processes and restoration efforts. Dr. Downs has directed research and consultancy projects for 8 years and has expertise in geomorphic assessments, river restoration design planning, post-project monitoring and evaluation, conceptualization of adaptive management and integrated river basin management planning.

Dr. Yantao Cui has over fifteen years of experience in hydraulic engineering, with the last seven years of his research focused on modeling sediment dynamics in regulated rivers in areas of California, the Pacific Northwest, Florida, China, and Papua New Guinea. His applied research projects have involved investigation of river bank erosion, effects of gravel extraction on fluvial geomorphic processes, and the downstream impacts of reservoir management and mines. Dr. Cui is a recognized expert in the development of models assessing the response of rivers to landslides and debris flows, reservoir removal, and gravel extraction and addition.

Dr. Bruce Orr has over 20 years of experience in population and community ecology of aquatic, terrestrial, and fresh and saltmarsh wetland environments in California and the western United States. Dr. Orr has managed a variety of complex, multi-year projects that have focused on the use of watershed analysis and ecosystem management TMDLs, state and federal Endangered Species Acts, and California Forest Practice Rules.

Dr. William Dietrich is a fluvial geomorphologist and former chair of the Earth and Planetary Science Department, UC Berkeley. Dr. Dietrich's research has been instrumental in the development of the watershed analysis methodologies being used to guide much of the planning effort for the restoration of Pacific salmon. His recent work has focused on the downstream effects of dams and land use on fluvial systems, the linkages between physical processes and aquatic biota, and the development of methods for restoring degraded rivers.

California Department of Fish and Game (CDFG): CDFG manages various monitoring and research projects throughout the Central Valley. The Merced River Ranch, owned by CDFG, will be the location of the proposed pilot project. In addition to being a part of the Project Team, CDFG will provide support and services at the project location.

Mr. Tim Heyne, an Associate Biologist with CDFG, has a Master's degree in Biology from Fresno State University. He has been involved with several restoration projects along the Merced River, including the Ratzlaff Restoration Project. He has managed several projects in the Central Valley, and has participated in contracting, field supervision, data collection and analysis, report writing, and database creation and management.

URS Corporation: URS Corporation (URS) is a full-service environmental consulting company comprised of professional engineers, hydrologists, planners, biologists, ecologists, geologists, geomorphologists, land surveyors, and construction managers. Its Oakland, California office provides a full range of planning, design, and management services used in wetland, riparian, and ecosystem restoration projects; water quality improvement projects; bioengineering and bank stabilization projects; watershed management programs; and sediment remediation projects. Recently, URS completed the Route 59 Merced River Mitigation and

Restoration Planning project for Caltrans and is currently completing the Milburn Unit/Hansen Farm Riparian Habitat Restoration Plan on the San Joaquin River.

Mr. Steve Kellogg has over 25 years of experience in restoration and mitigation planning in a variety of habitats including riparian, seasonal wetland, estuarine wetlands, and vernal pool habitats. He has successfully managed several projects involving restoration, watershed analysis and river ecosystem issues. His Central Valley experience includes the Grassland Bypass EIS/EIR, CALFED analyses for Vegetation and Wildlife Technical Report and EIS/EIR, and the Route 59 Merced River Mitigation and Restoration Planning Project.

Mr. George Strnad is a registered Landscape Architect, Ecological Restoration and Revegetation Specialist with over 18 years experience in environmental design and project management. His projects have included ecosystem restoration plans, mitigation plans, construction document preparation, and environmental compliance documentation. He was responsible for construction documentation preparation for the Oakdale Bridge riparian and upland vegetation and restoration project in Merced County.

Dr. Clark Fenton is a project geologist with ten years professional experience in seismic geology and geologic hazards. He has prepared rock and soil stability analyses under both static and dynamic conditions, and performed extensive geotechnical boring, trenching investigations, detailed mapping and topographic profiling.

Mr. Stephen Leach is a senior vegetation ecologist with over nine years experience conducting biological assessments and preparing permit documentation for regional, state and Federal agencies, including projects in Merced, Madera and Fresno counties.

Dr. Darrell Slotten (UC Davis): Dr. Slotton has directed applied research projects addressing heavy metal contamination and bioaccumulation issues in California aquatic ecosystems, with a primary focus on mercury for over 15 years. Dr. Slotton has led a research program throughout the foothill gold mining region of the Sierra Nevada, primarily focusing on benthic invertebrates and fish as proxies for relative bioavailable mercury concentrations and loading. Since 1999, Dr. Slotton has also been the lead PI in a TMDL-driven CALFED mercury bioaccumulation project in the Cache Creek watershed.

Kjeldsen, Sinnock & Neudeck, Inc.: Kjeldsen, Sinnock & Neudeck, Inc. (KSN), is a full service civil engineering and land surveying firm specializing in the surveying, mapping, planning, and will be providing mapping services for this project.

Project Oversight

Ms. Jennifer Vick is an aquatic ecologist and geomorphologist with extensive experience in geomorphic and ecological analysis and restoration planning throughout the Central Valley. Her hydrologic, geomorphic and ecological analyses on the Merced, Tuolumne, and Stanislaus rivers are being used to design and assess restoration programs. Ms. Vick was project manager and technical lead for the Merced River Corridor Restoration Plan, Phases I, II and III.

Peer Reviewers

Mr. Scott McBain is an assistant hydraulic engineer/fluvial geomorphologist and founding partner of McBain & Trush in Arcata, California.

Mr. John Bair is a riparian botanist with McBain & Trush specializing in riparian interactions with geomorphic processes, riparian restoration, and riparian physiology.

Dr. Johnnie N. Moore is a Professor of Geology at the University of Montana since 1977. His research examines the transport and fate of metals in aquatic systems.

Dr. James J. Rytuba is the Project Chief of geoenvironmental impacts of mercury and arsenic with the U.S. Geological Survey, Mineral Resources Survey Program in Menlo Park, CA. His primary research interests include environmental geochemical studies of heavy metal contaminants, primarily mercury and arsenic, associated with mining and mineral deposits.

D. COST

D.1 Budget

Please see Budget Summary and Budget Justification Forms for detailed budget information.

D.2 Cost-sharing

N/A

E. LOCAL INVOLVEMENT

As Phase IV of the Merced River Corridor Restoration Plan (see Section B.3), the proposed project will continue to include an active public outreach and stakeholder coordination component. Phase I of the Merced River Corridor Restoration Plan included the development of the Merced River Stakeholder Group (MRSG) and Technical Advisory Committee (MRTAC) and began a series of workshops conducted to include the public in the restoration planning process. The MRSG currently includes over 40 participants and represents a broad spectrum of interests in the watershed, including landowners, riparian water users, aggregate miners, dairy operators, ranchers, farmers, environmental groups, angling groups, and local, state, and federal management and regulatory agencies. The MRTAC participants are primarily agency and industry representatives with management or regulatory interests in the river. Phases II and III continued to involve the MRSG, which provided public input to and local leadership of the restoration plan, and the MRTAC, which provided technical review and oversight of the plan, and additional public workshops were conducted. Phase IV will further provide public outreach by continuing to coordinate with the MRSG and MRTAC (see Task 1G).

Many groups and agencies have expressed support for Phase IV of the project, including the Merced Irrigation District, Merced County Planning and Community Development Department, Merced County Board of Supervisors, San Joaquin Valley Conservancy, East Merced Resource Conservation District, Merced River Landowners Group, Merced County Parks and Recreation, and the Upper Merced Property Owners Group. In addition, many landowners along the Merced River and in the Dredger Tailings Reach are actively involved in and supportive of the proposed project. Letters of support from groups, agencies, and landowners are available upon request.

F. COMPLIANCE WITH STANDARD TERMS AND CONDITIONS

The applicants have reviewed and are able to comply with the terms and conditions set forth in Attachments D and E of the Proposal Solicitation Package.

G. LITERATURE CITED

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Tables, Figures and Attachments

Table 2. Summary of Hypotheses to be Tested and Monitoring Parameters for Floodplain Restoration & Gravel Infusion & Augmentation, Based on Current Project Understanding

Related task	Hypothesis	Post-project Monitoring Method
Hydraulics		
3B. Floodplain restoration	H1. The channel will convey the design flow (~1,700 cfs). H2. Flows exceeding the design flow will spill out of the channel and inundate the floodplain.	Record water surface elevation at one cross section at the site. Deploy Global Water WL-14 WaterLogger at the site following project construction and record hourly water surface elevation. Develop a stage-discharge curve using the stage data from the site and flow data from the Merced ID Crocker-Huffman gauge.
Geomorphic Processes and Attributes		
3C. Gravel Infusion & augmentation	G1. Adding sediment to the channel will fine the bed surface (from its current cobble-armored condition).	Document as-built bed surface texture by mapping facies units in the entire Dredger Tailings Reach and conducting pebble counts to quantify the bed surface texture in each facies unit category. Compare to pre-project conditions. Re-survey periodically.
3C. Gravel Infusion & augmentation	G2. Fining the bed surface will reduce the magnitude of the flow at which bed material transport is initiated. Under current conditions, incipient motion of the channel bed occurs at a flow of approximately 4,800 cfs (Q_5). At the sediment augmentation site(s), flow required to initiate bed motion will be approximately 2,100 cfs (Q_2).	Conduct marked rock experiments at 5 cross sections throughout the reach. Marked rocks will be the size of the d_{84} and d_{50} of the facies units in which they are deployed. Rocks will be placed and reassessed after each flow exceeding 2,000 cfs. Rocks will be deployed as soon as possible following issuance of a contract to increase the likelihood that bed-mobilizing flows occur before project construction.
3C. Gravel Infusion & augmentation	G3. Fining the bed surface will increase the depth of scour that occurs for a flow of a given magnitude.	Construct and monitor scour cores at the 5 cross sections at which marked rocks are deployed.
3C. Gravel Infusion & augmentation	G4. Adding sediment to the channel that can be mobilized by current flow conditions will increase the volume and extent of alluvial storage (as indicated by active gravel bars) in the channel at the augmentation sites and downstream.	Map the area of active bars from orthorectified aerial photographs (taken in Task 1C) during the summer low flow period. Field verify maps during Task 1A field surveys. Conduct total station surveys at five reference riffles to provide detailed topographic assessment as-built conditions. Compare to pre-project conditions. Re-survey periodically.

Related task	Hypothesis	Post-project Monitoring Method
3C. Gravel Infusion & augmentation	G5. Adding sediment to the channel and increasing bed mobility will result in increased substrate permeability at the augmentation sites and at downstream deposition sites.	Assess substrate permeability using a modified Mark VI standpipe (Terhune 1958). A sufficient number of samples will be collected to detect a 20% change in predicted chinook salmon survival to emergence. Based on a similar study in the Tuolumne River (Stillwater Sciences 2001c), it is anticipated that 12 samples/riffle will be required. Five reference riffles in the reach will be sampled.
3C. Gravel Infusion & augmentation	G6. The gravel infusion will not affect the stability of the channel cross-section.	Following placement of gravel for the infusion, re-survey pre-project cross sections surveyed in Task 1A to document as-built conditions. Resurvey cross sections periodically thereafter to document any alterations to channel geometry.
3C. Gravel Infusion & augmentation	G7. Fining the bed texture will increase the sediment transport rate. Under current conditions, the average annual transport rate is estimated to be 550 tons/year. Under post-infusion conditions, the average transport rate is predicted to be 4,500 tons/year.	Measure bedload transport rates using a 6-inch Helley-Smith sampler deployed from a cataraft at the Merced River Ranch site during at least 5 pre-project peak flows and 5 post-project peak flows.
3B. Floodplain restoration	G8. Floodplain habitats constructed during project implementation will evolve following peak flows and will retain diversity.	Document as-built floodplain conditions by surveying topographic surface. Resurvey surfaces annually or following high flows and create DTMs-of-difference to document evolving habitat surfaces.
Biotic Response		
3B. Floodplain restoration	B1. Increasing the area of suitable chinook salmon spawning habitat will reduce the frequency of redd superimposition. B2. Chinook salmon will use newly formed alluvial deposits (that result from the gravel augmentation) for spawning.	Map area of suitable spawning habitat. Apply a redd superimposition model developed for the Tuolumne River (TID/MID 1991) to estimate the number of spawners that the available habitat can accommodate without superimposition. Compare to pre-project conditions. Document the number of chinook salmon redds at each riffle in the reach and determine the number of redds/unit area (ongoing by CDFG). Conduct weekly monitoring and marking of redds at five riffles to document the occurrence and magnitude of redd superimposition.

Related task	Hypothesis	Post-project Monitoring Method
3C. Gravel Infusion & augmentation	B3. By increasing the bed mobility, macroinvertebrate species composition will shift from heavily-cased, armored, and relatively unavailable body forms (such as caddisflies) to non-cased, non-sessile, and more available body forms (such as mayflies and chironomids) for fish predators (e.g. Power et al. 1994).	Collect quantitative macroinvertebrate samples at the 5 reference sites where permeability and topography are being intensively monitored. Samples will be collected using a Hess sampler.
3B. Floodplain restoration	B4. After one year following revegetation, 80% of planted stems will survive and cover will increase by 100% compared with as-built conditions. B5. The created floodplain will support recruitment of cottonwood and other native woody riparian species.	Establish permanent vegetation plots in the 60-acre revegetation area. At each plot, conduct annual surveys to document the following: • percent survival of planted stems, • cover by planted stems, • stem density and species of recruited woody species, • cover by recruited woody species, • total species composition, and • total cover by species.
3B. Floodplain restoration	B6. Increasing the area and connectivity of riparian vegetation will increase the abundance and diversity of native nesting bird species at the restoration site.	Conduct avian census surveys at 2 locations on the MRR and 3 additional locations in the reach. Methods will be consistent with ongoing surveys being conducted in the Central Valley and will include a combination of point-count avian census surveys (as modified by Pt. Reyes Bird Observatory from Ralph et al. 1993) and vegetation relevé plots (Sawyer and Keeler-Wolf 1995). Avian census surveys will include five-minute point counts conducted a minimum of three times during the breeding season (May 1 through June 30). At each census point, a vegetation relevé survey will be conducted once annually.

Table 3. Summary of Hypotheses to be Tested and Monitoring Parameters for Vegetation Experimentation

Experimental factor	Hypothesis	Description of treatments	Potential performance parameters*
Restoration type (active planting vs. natural regeneration)	Following floodplain reconstruction, actively planting seeds and seedlings of native riparian species increases the density and diversity of woody riparian vegetation after one year through regeneration by natural seedfall. Active planting also reduces the percent cover of herbaceous vegetation and non-native plant species.	(1) fallow floodplain (2) planting of seeds (3) planting of seedlings	• % cover of woody riparian species • % cover woody vs. herbaceous species • % cover native vs. non-native species • stem density of woody vegetation
Life stage at planting	Planting native riparian tree species as seedlings ensures greater survival after the first year than planting seeds.	(1) seeds (2) seedlings	• stem density after first year • % survival • growth rate • % germination by species
Depth to groundwater	Depth to groundwater affects seedling survival and growth in the first year. Riparian tree seedlings and cuttings planted in areas with a shallow water table survive the first growing season better because of reduced drought stress. Seedling survival and growth varies for riparian species with different life history traits.	(1) shallow groundwater (approx. 1 m) (2) deeper groundwater (>2 m) Assuming that the groundwater level is the same throughout the site (verified with piezometers), treatments will occur on low and high floodplain benches.	• stem density after first year • % survival • growth rate
Irrigation	Irrigating seedlings and cuttings after planting increases seedling survival and growth over the first year because of reduced moisture stress. Irrigating throughout the entire growing season (which includes the Mediterranean climate dry season) increases survival over irrigation for the first several months after planting. Seedling survival and growth varies for riparian species with different life history traits.	(1) no irrigation (2) drip irrigation	• stem density after first year • % survival • growth rate
Substrate amendment application**	Adding mulch to plantings increases plant survival and growth through the first year because of reduced water stress and reduced competition from herbaceous plants. Seedling survival and growth varies for riparian species with different life history traits.	(1) no addition of substrate amendment (2) substrate amendment addition to each planted stem	• stem density after first year • % survival • growth rate • % cover of herbaceous species

*Actual parameters to be determined during study plan development with peer reviewer input.
**Potential treatment to be determined by site conditions once grading has been completed.

Table 5. Projects receiving previous CALFED or CVPIA funding.

Project title	Program/project number	Current status	Project milestones
Stillwater Sciences previous CALFED Program funding			
Merced River Corridor Restoration Plan-Phase II	ERP/ Project #98E-09	complete	(1) social, institutional, and infra-structural opportunities and constraints to restoration analysis; (2) baseline evaluations of geo-morphic and riparian vegetation conditions
Merced River Corridor Restoration Project-Phase III	ERP/Project #2000 E-05	Complete (Oct.2002)	development of (1) geomorphic-ally functional channel and flood-plain design guidelines; (2) the Merced River Corridor Restoration Plan; (3) conceptual designs for 5 top-priority restoration projects
A Mechanistic Approach to Riparian Restoration in the San Joaquin Basin	ERP/#99-B152	in progress	(1) literature and existing data review; (2) development of conceptual model and study plan
Tuolumne River Coarse Sediment Management Plan	Service Agreement #010801	in progress	(1) fine sediment report; EACH and stock recruitment modeling underway
M&T Ranch Pump Intake Assessment	Contract 01A120210D	complete	developed mitigating techniques for sediment burial of pump intake
Saeltzer Dam Removal Analysis	Contract B-81491	complete	(1) application of sediment transport model to a dam removal project; (2) pre- and post-dam removal channel monitoring
CDFG previous CALFED funding			
Merced River Salmon Habitat Enhancement: Robinson Ranch Site-Revised Phase II	ERP/2001-C200	complete	Two more phases will be implemented.
San Joaquin River Chinook Salmon Age Determinations: Phase II	2001-K206	in progress	50% complete with Phase I and agreements have been signed for Phase II
Chinook Salmon Movement in the lower San Joaquin River and South Delta	1998-C11	in progress	fish tagging complete. Entering in Year 2 of field work.
Basso Bridge Land Acquisition	1998-C05	complete	two smaller parcels purchased, third was not
Developing a Genetic Baseline for San Joaquin Salmon	1997-C09	in progress	second year annual report almost completed; third year to be completed by June 2002
Stillwater Sciences previous CVPIA funding			
Merced River Corridor Restoration Plan-Phase I	AFRP/	complete	formation of the Merced River Stakeholder Group and Technical Advisory Committee
Merced River: Ratzlaff Project	AFRP/CVPIA 11332-9-MO79	complete	provide comments on existing and proposed restoration efforts; coordinate with Merced River Restoration Project
Stanislaus River: 2 Mile Bar	AFRP/CVPIA 11332-9-MO80	complete	prepare summary of restoration potential and strategies, focusing on geomorphic opportunities and constraints
Stanislaus River: Smolt Survival	AFRP/CVPIA 11332-0-MO09	complete	prepare assessment of coded wire tag and multiple mark-recovery smolt survival assessment programs
Calaveras River Spawning Habitat Evaluation	AFRP/	complete	conduct reconnaissance-level evaluation of steelhead and salmon habitat conditions and population dynamics
CDFG previous CVPIA funding			
Feasibility of Long Term	00-L D-10	complete	

Project title	Program/project number	Current status	Project milestones
Aggregate Source for San Joaquin Tributary Channel Restoration Projects			
Ratzlaff Reach: Merced River Corridor Restoration Project Phase II (joint w/DWR)	99-L A-7	complete	monitoring is continuing
Riffle Atlas Update for San Joaquin Tributaries	99-L D-10	in progress	internal draft completed; being evaluated by CDFG personnel

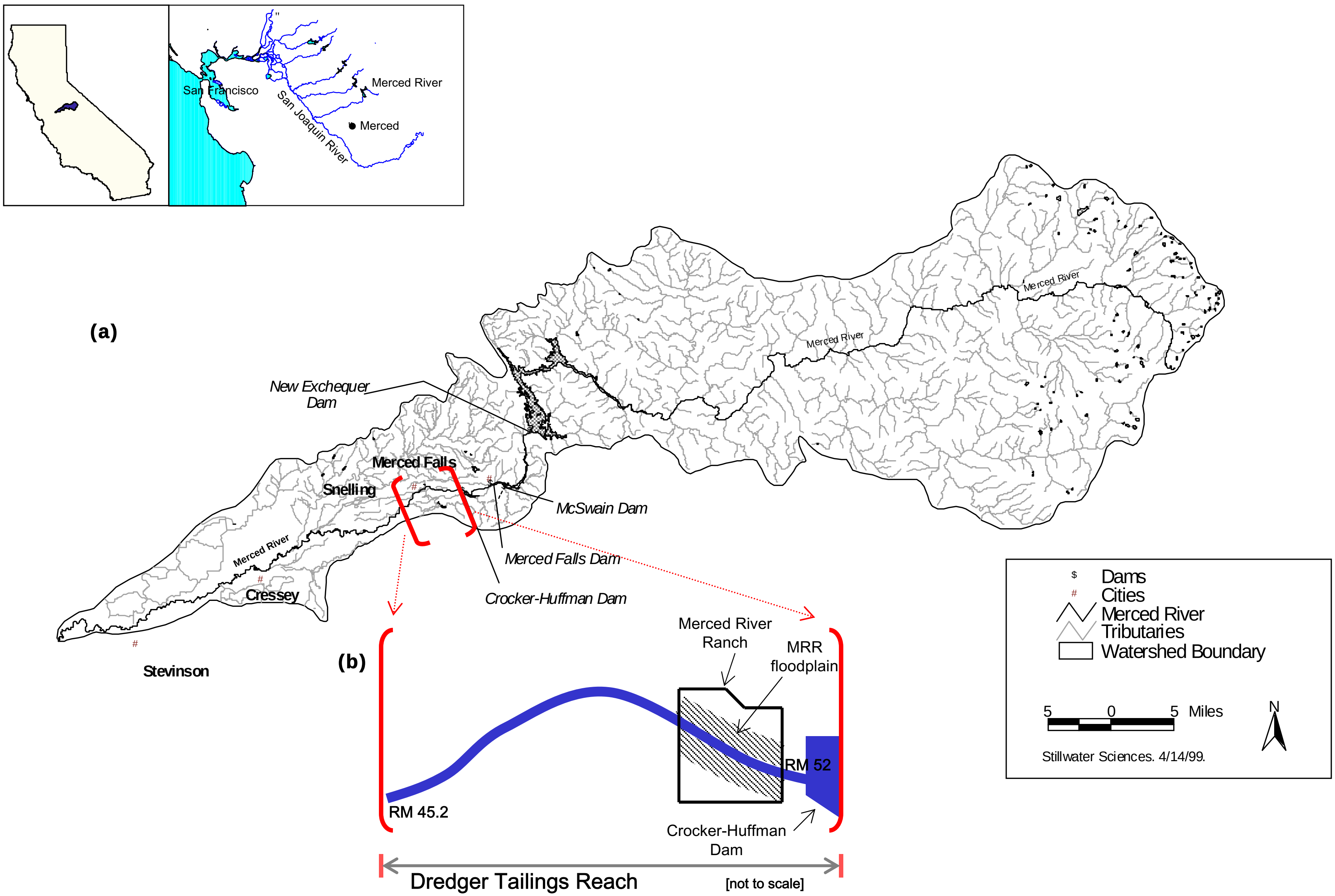


Figure 1. (a) The Merced River location and watershed, with the Dredger Tailings Reach bracketed in red, and (b) a schematic diagram showing components of the proposed project .

Stillwater Sciences

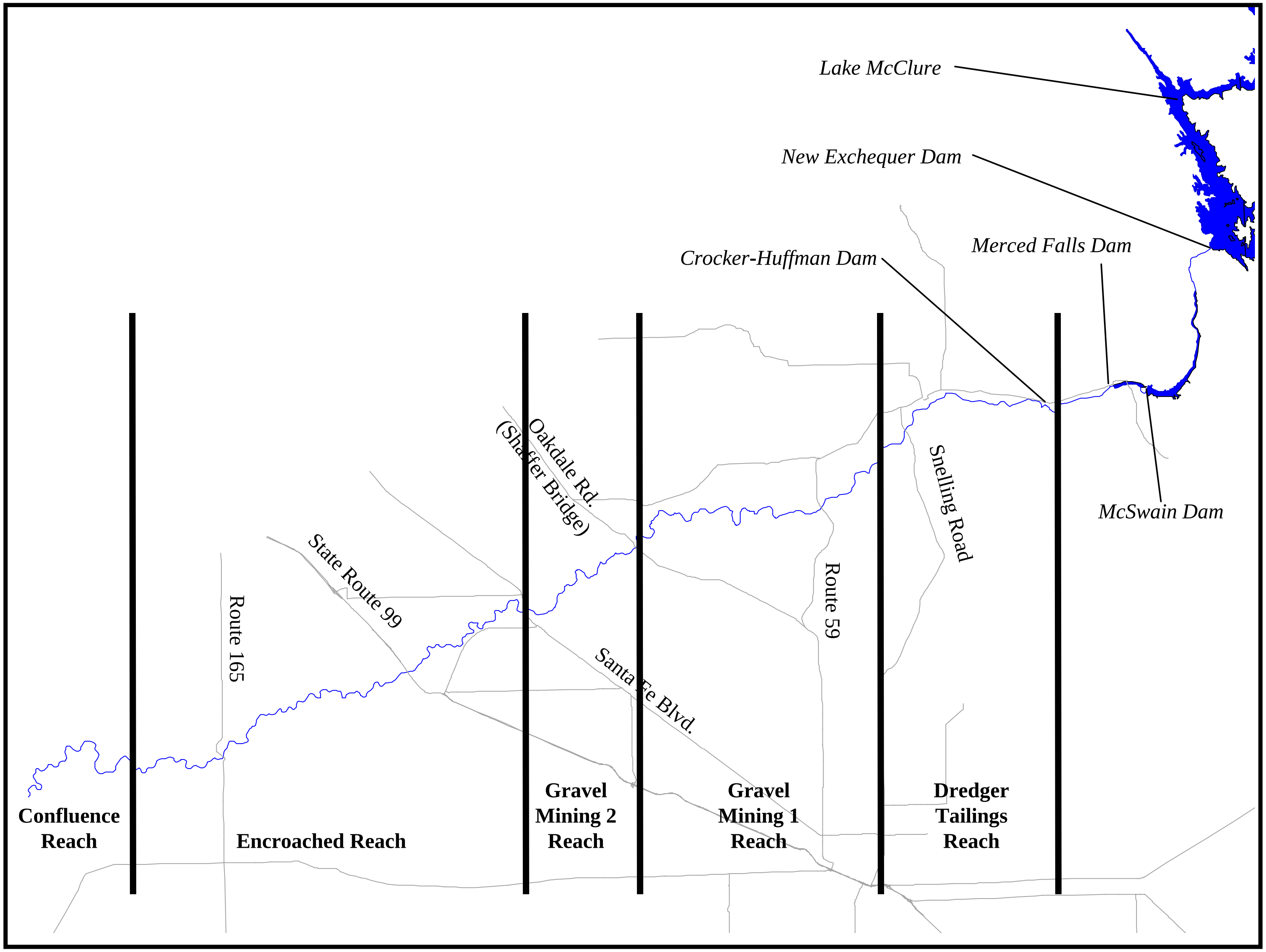


Figure 2. Merced River reach delineation.

Stillwater Sciences

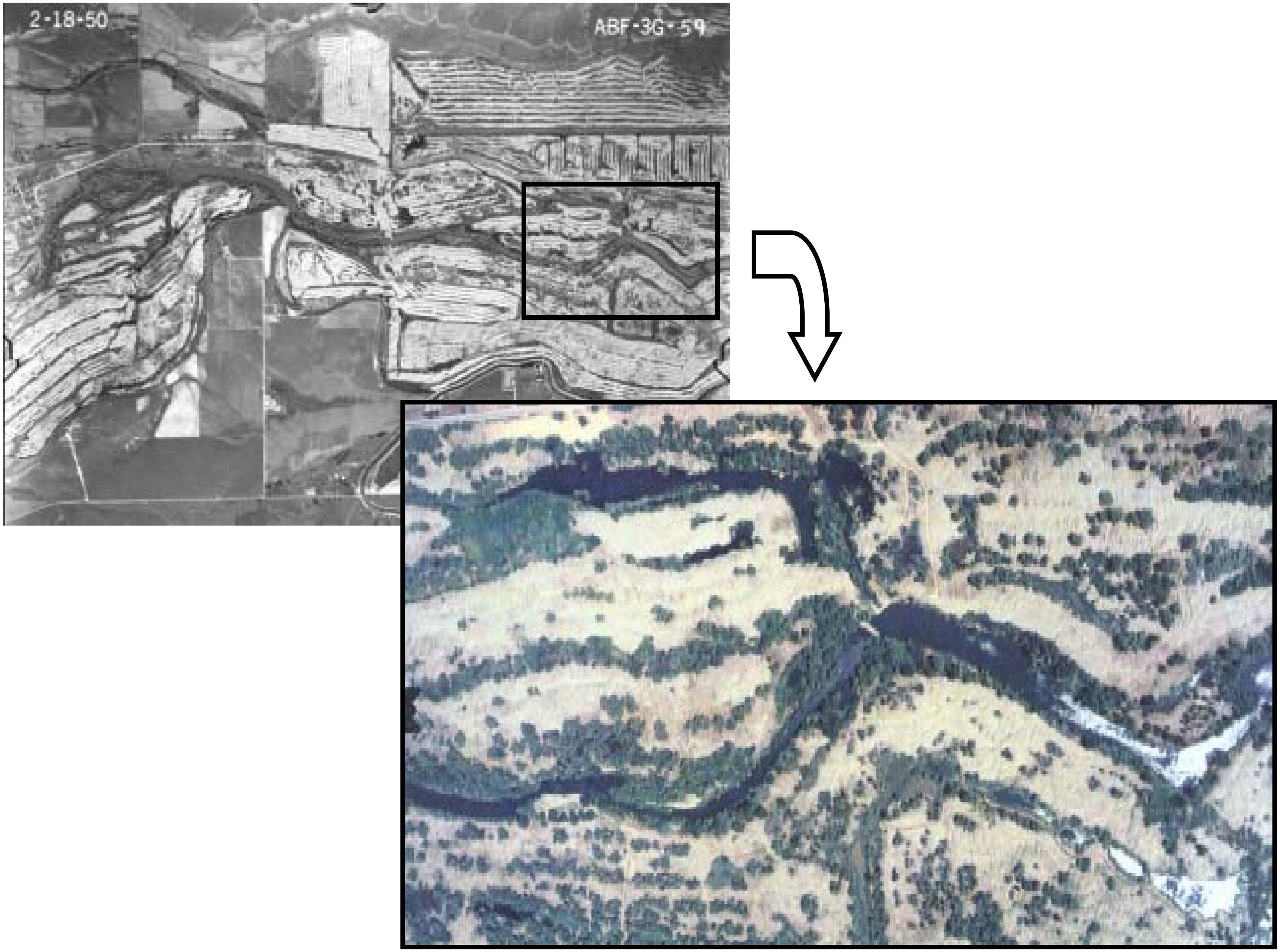
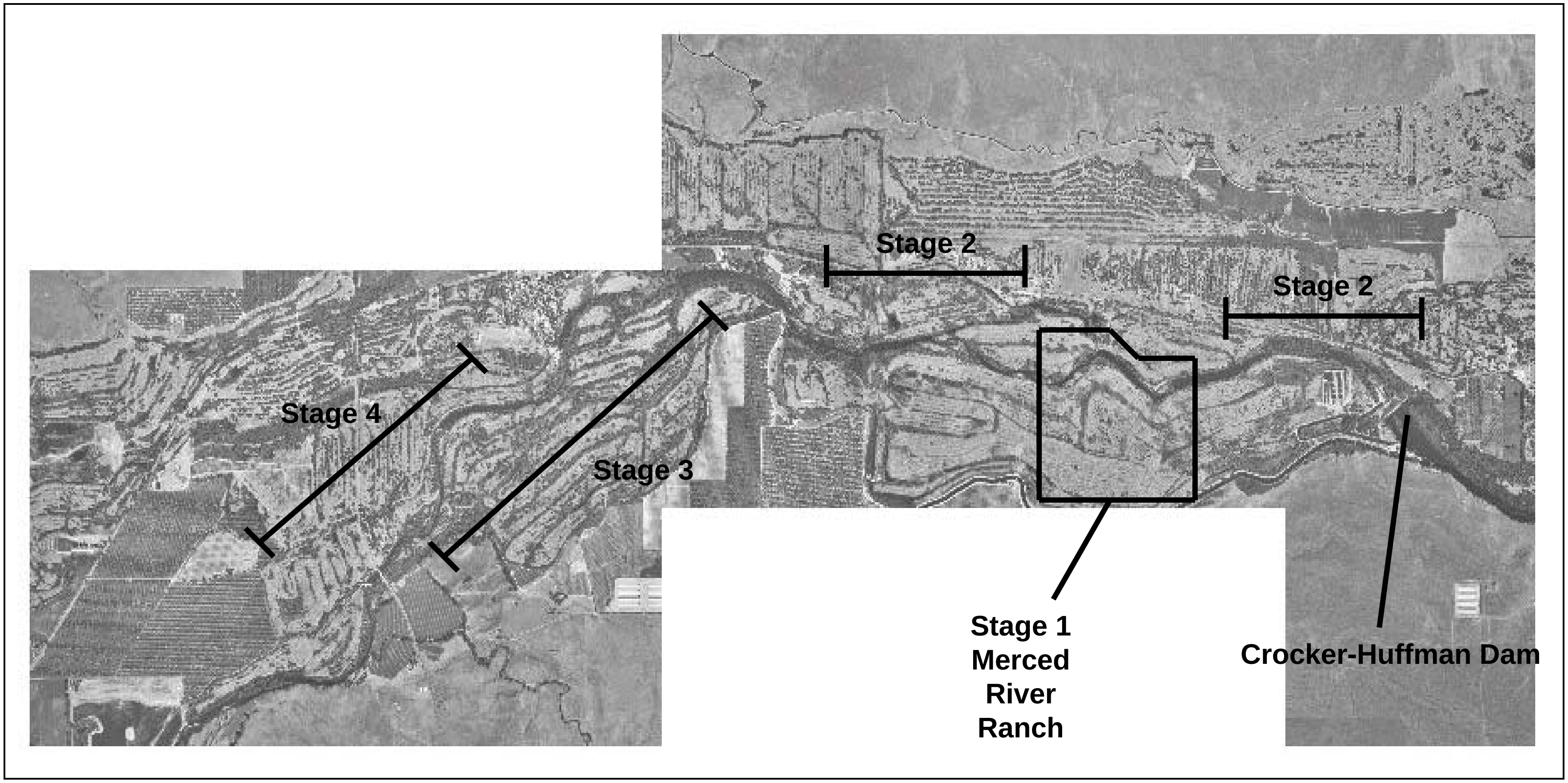


Figure 3. Dredger tailings in the Snelling Vicinity and a detail of riparian vegetation condition within tailings.
Photograph: Agricultural Stabilization and Conservation Service 1950 (top) and U.S. Bureau of Reclamation 1993 (bottom).



Stillwater Sciences

Figure 4. Preliminary stages of restoration in the Merced River Dredger Tailings Reach. Stage 1 is presented in this proposal. Stages 2, 3, and 4 (identified in the Merced River Corridor Restoration Plan) will be completed in future efforts.

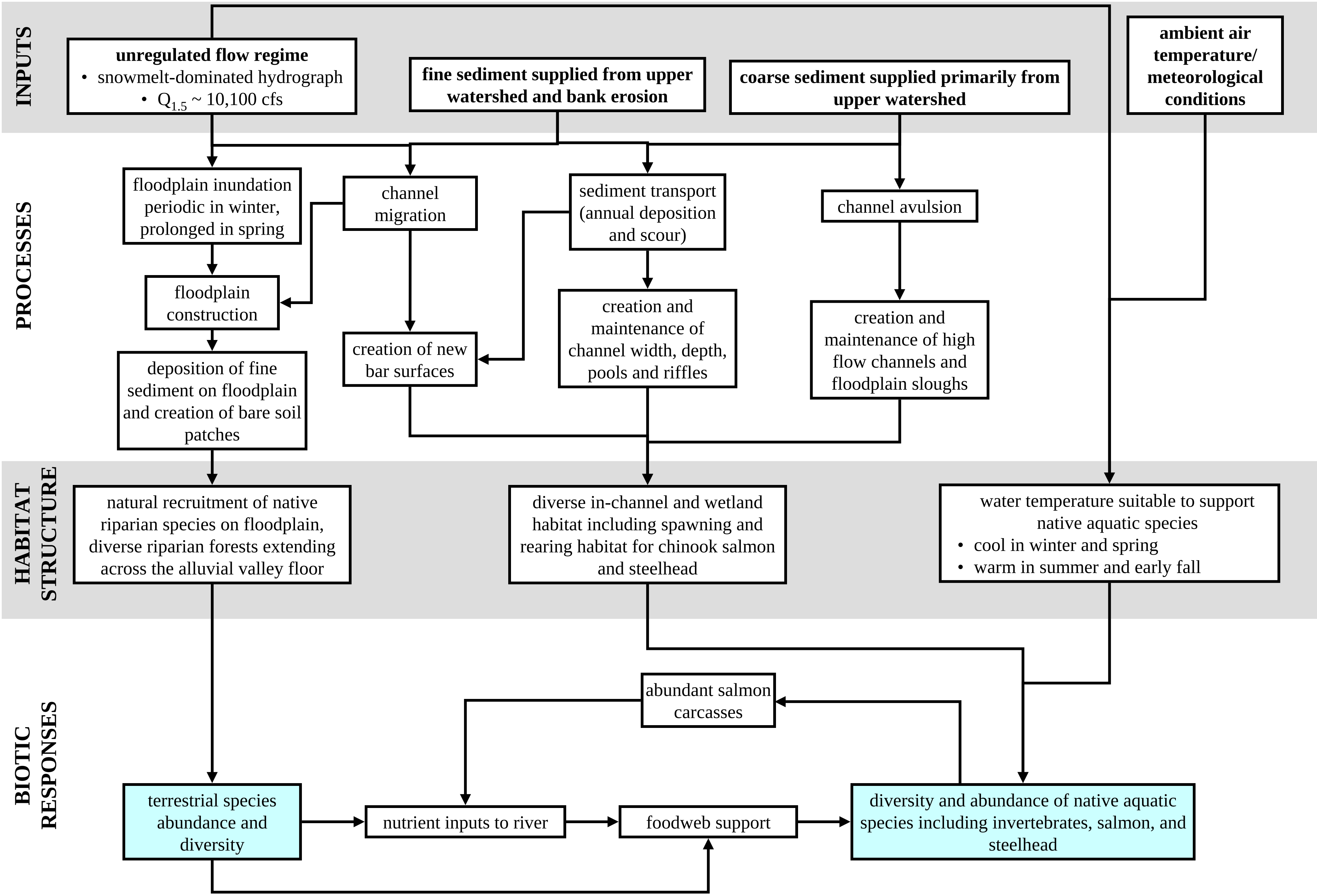


Figure 5. Conceptual model of reference state processes and linkages in the anastomosing, gravel-bedded reach of the Merced River, including the Dredger Tailings Reach.

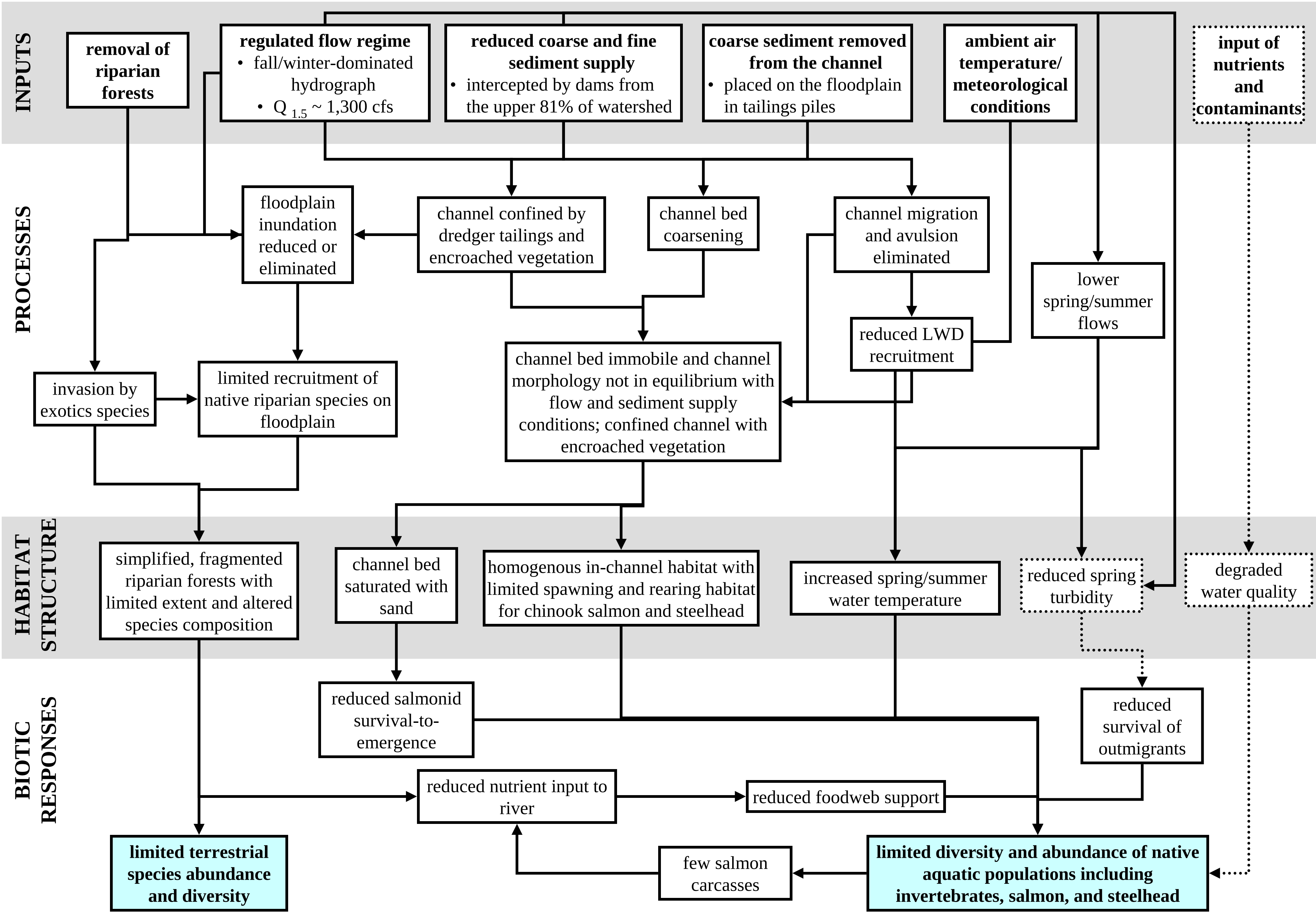


Figure 6. Conceptual model of current state processes and linkages in the Dredger Tailings Reach of the Merced River. Dashed lines indicate areas of high uncertainty based on available data.

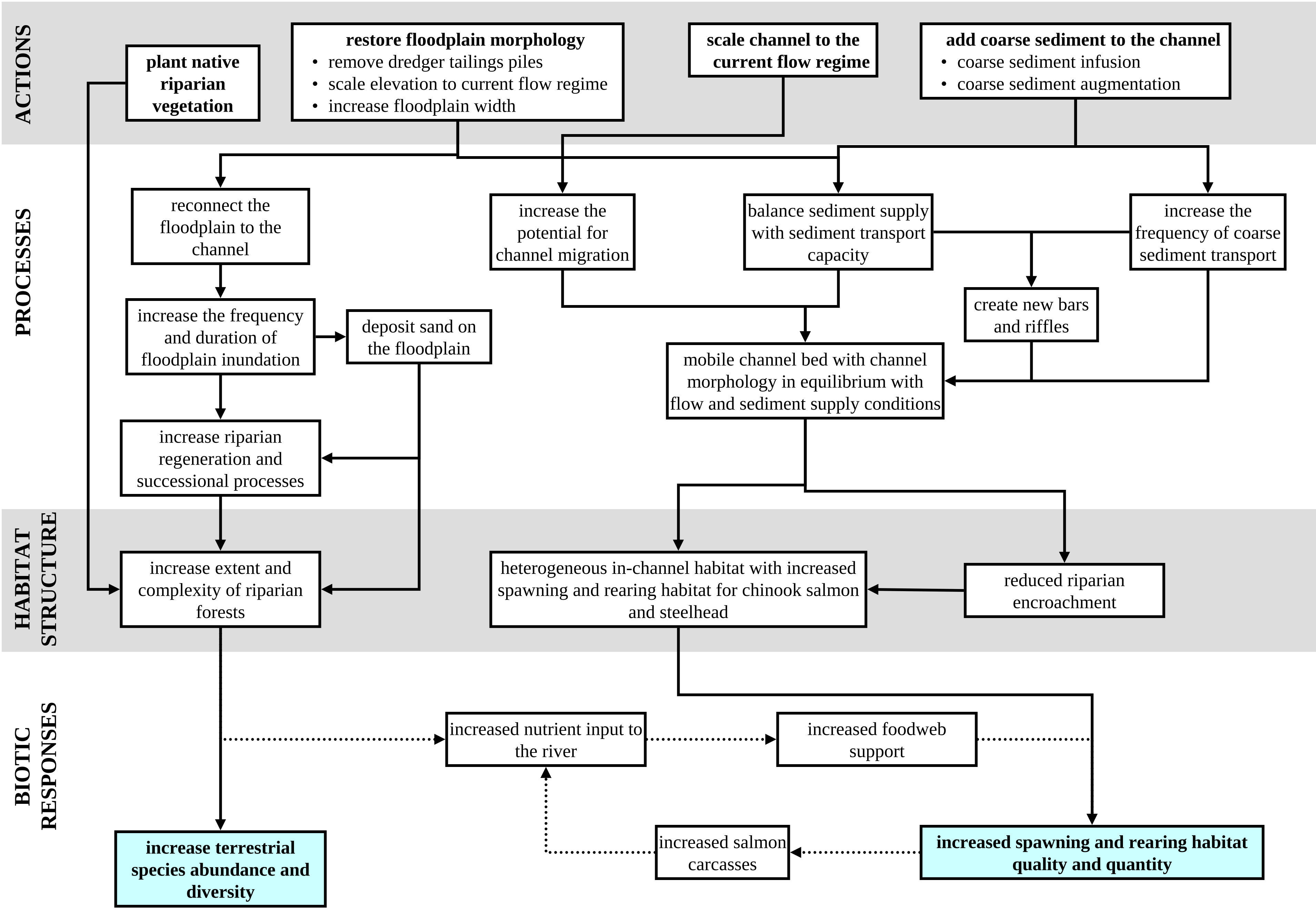


Figure 7. Conceptual model of the proposed restoration actions on the Dredger Tailings Reach of the Merced River. Dashed lines indicate areas of high uncertainty based on available data.

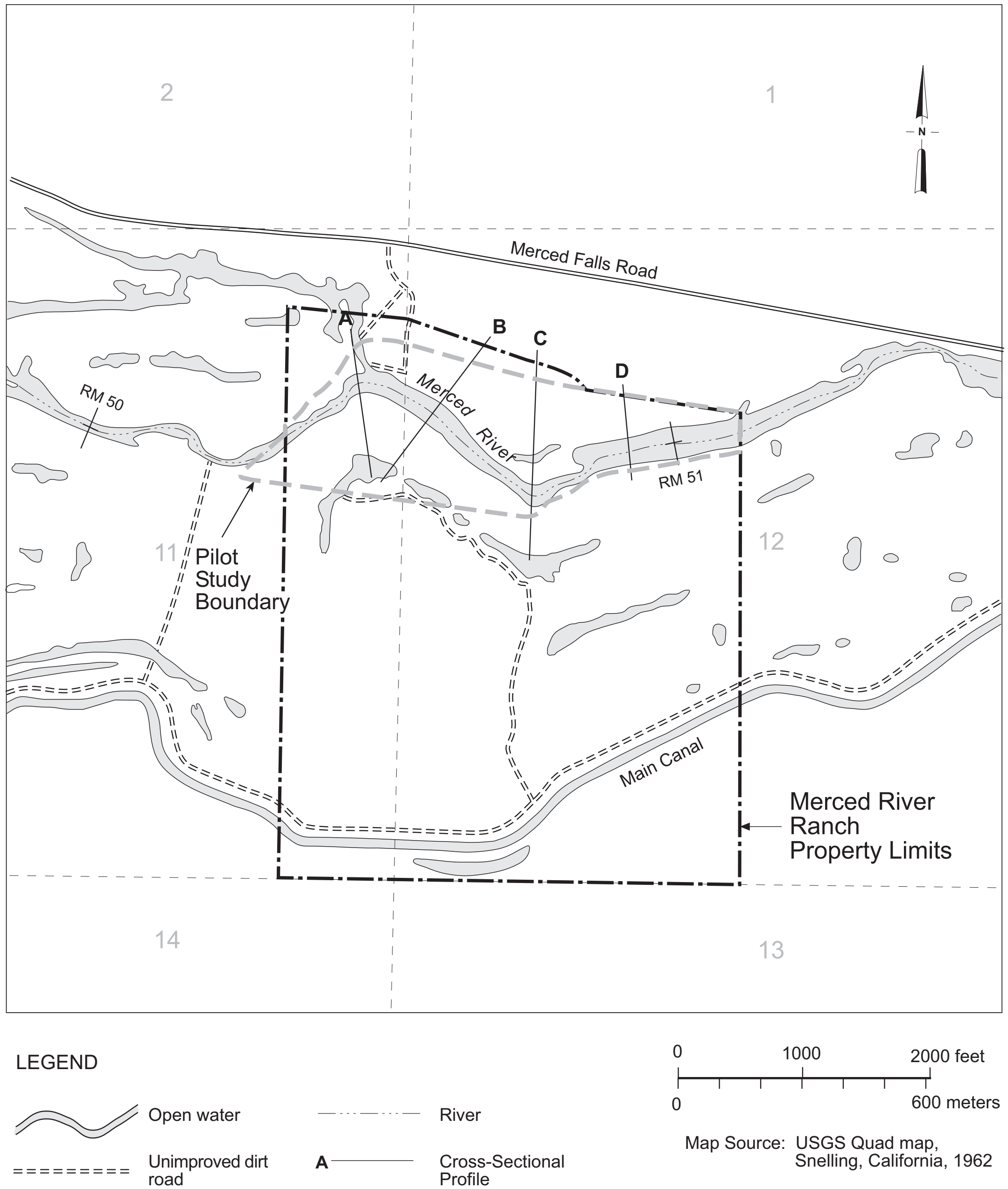


Figure 8. Summary of baseline survey cross sections completed at Merced River Ranch.

Figure 9. Dredger tailings at Merced River Ranch.

	2003								2004												2005												2006			
	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April
1: Reach-scale Investigations for the Merced River Dredger Tailings Reach.																																				
1A. Topographic and geomorphic field surveys																																				
1B. Develop sediment transport model											X																									
1C. Develop hydraulic model											X																									
1D. DTR dredger tailing volume and texture					X																															
1E. Implement baseline monitoring																				X												X				
Task 2: Restoration design planning for the Merced River Ranch.																																				
2A. MRR dredger tailing volume and texture					X																															
2B. Assess MRR mercury occurrence							X																													
2C. MRR conceptual restoration design																						X														
Task 3: Restoration pilot experiments for the floodplain segment of the Merced River Ranch.																																				
3A. Vegetation experimentation																																X				
3B. MRR design plans																														X						
3C. Plan in-channel gravel infusion																														X						
3D. Plan post-implementation monitoring																								X												
Task 4: Implementation Planning.																																				
4A. Develop implementation plan																																		X		
4B. Implementation costs research																																			X	
4C. Draft environmental documentation																																X				
4D. Stakeholder coordination																																				

X = Deliverable

Figure 10. Work schedule.

LEAD MANAGEMENT TEAM

Dr. Peter Downs, Stillwater Sciences (Project Manager)
Tim Heyne (CDFG-lead) **Steve Kellogg** (URS Corporation-lead)

Senior Project Scientists:
Frank Ligon (Stillwater Sciences), Dr. Bruce Orr (Stillwater Sciences), Dr. William Dietrich (UC Berkeley)

Task 1: Reach-scale investigations for the Merced River Dredger Tailings Reach

1A. Topographic and geomorphic field surveys
Christian Braudrick (Stillwater Sciences)
Chris Neudeck (KSN, Inc.)
1B. Sediment transport model
Dr. Yantao Cui (Stillwater Sciences)
1C. Hydraulic model
Senarath Ekanayake (URS Corp.)
1D. Volume and texture Assessment
Dr. Clark Fenton (URS Corp.)
1E. Implement baseline monitoring
Scott Wilcox (Stillwater Sciences)

Task 2: Restoration design planning for the Merced River Ranch

2A. MRR dredger tailing volume and texture assessment
Dr. Clark Fenton (URS Corp.)
2B. Assess MRR mercury occurrence
Dr. Noah Hume (Stillwater Sciences) and
Dr. Darrell Slotten (UC Davis)
Peer reviewed by Dr. James Rytuba (USGS),
and Dr. Johnnie Moore (University of Montana)
2C. MRR conceptual restoration design
George Strnad (URS Corp.)

Task 3: Restoration pilot experiments for the floodplain segment of the Merced River Ranch

3A. Vegetation experimentation
John Stella (Stillwater Sciences)
Peer reviewed by Scott McBain and John Bair (McBain & Trush)
3B. MRR design plans
Seth Gentzler (URS Corp.)
3C. Plan in-channel gravel infusion
Dr. Peter Downs (Stillwater Sciences)
3D. Plan post-implementation monitoring
Dr. Peter Downs (Stillwater Sciences)

Task 4: Implementation planning

4A. Develop implementation plan
Seth Gentzler (URS Corp.)
4B. Cost research for pilot project implementation
Seth Gentzler (URS Corp.)
4C. Draft environmental documentation
Stephen Leach (URS Corp.)
4D. Stakeholder coordination
Zooey Diggory (Stillwater Sciences)

Stillwater Sciences

Peter Downs, Ph.D., Senor Geomorphologist. River restoration design planning; channel processes.
Frank Ligon, M.S., Senior Geomorphologist/Ecologist.
Bruce Orr, Ph.D., Senior Ecologist.
Yantao Cui, Ph.D., Civil Engineer. Sediment transport model development and application for landslides, debris flows, and reservoir removal.
Noah Hume, Ph.D., Senior Environmental Engineer. Aquatic ecology and engineering; water quality, supply, and treatment.
Scott Wilcox, M.S., Senior Fisheries Biologist. Project management, impact analysis for fish, wildlife, water quality.
John Stella, M.S., Riparian Ecologist. Vegetation community classification and mapping, plant taxonomy and physiology..
Christian Braudrick, M.S., Geomorphologist. Geomorphic assessment, large woody debris dynamics.
Zooey Diggory, B.S., Watershed Specialist/Geologist. Upslope watershed assessment and fluvial restoration and erosion control.

URS Corporation

Steve Kellogg, M.S., Ecologist. Project management, restoration and mitigation planning in riparian, seasonal /estuarine wetland, and vernal pools.
George Strnad, ASLA, AIA, Senior Landscape Architect. Ecological restoration and revegetation specialist, compliance.
Seth Gentzler, P.E., Environmental Engineer. Wetland restoration design and construction plan development, hydrodynamic modeling.
Stephen Leach, M.A. Senior Biologist. Vegetation ecologist; conducts biological impact assessments, permit documentation.
Clark Fenton, Ph.D., Geologist. Seismic geology and geologic hazards. Rock and soil stability analysis under static and dynamic conditions.

California Department of Fish and Game

Tim Heyne, M.S., Biologist. Manages central valley restoration projects; involved in Merced River restoration projects.

Kjeldsen, Sinnock & Neudeck, Inc.

Chris Neudeck, R.C.E., Principal Engineer. Planning, design, and engineering design and construction

Project Oversight
Jennifer Vick, M.L.A., Ecologist/Geomorphologist. Geomorphic and ecological analysis and restoration planning throughout the Central Valley.

Peer Reviewers
Scott McBain, Ph.D., Senior Environmental Engineer, McBain & Trush.
John Bair, M.S., Riparian Botanist, McBain & Trush.
James Rytuba, Ph.D., U.S. Geological Society.
Johnnie Moore, Ph.D., University of Montana .

Senior Project Scientists
Darrell Slotten, Ph.D., University of California, Davis.
William Dietrich, Ph.D., University of California, Berkeley.

Figure 11. Organization chart

Attachment A: Requests for Next-Phase Funding

Project Description

The proposed project constitutes the fourth phase of the Merced River Corridor Restoration Plan. This Restoration Plan represents a multi-year collaboration between a broad spectrum of participants. The plan was developed through a joint project led by the Merced County Planning and Community Development Department and Stillwater Sciences, working closely with the CDFG, CDWR, Merced ID, and local stakeholders. The project was implemented in three phases. In Phase I, the Merced River Stakeholder Group (MRSG) and Merced River Technical Advisory Committee (MRTAC) were established. In Phase II the Project Team conducted baseline geomorphic and ecological studies and evaluated social, infrastructural, and institutional issues and concerns that defined opportunities and constraints for restoration in the Merced River corridor. In Phase III the Project Team completed field and modeling efforts, and developed a Corridor Restoration Plan to guide future channel and floodplain restoration in collaboration with the MRSG and MRTAC, including the identification of priority action items.

Phase IV is based on two high priority, near-term actions recommended under Phase III, and involves:

- conducting reach-scale restoration planning assessments to evaluate the 7-mile Dredger Tailings Reach within its watershed context, including: hydraulic and sediment transport calculations; assessments of dredger tailings volume and texture; baseline physical and biological monitoring;
- conceptual design for remediating the 318 acre Merced River Ranch, including: assessment of dredger tailings volume and texture; mercury occurrence and biological impact; remediation designs;
- site assessments for the floodplain segment of Merced River Ranch, including: an experimental pilot project for re-vegetation; design drawings for topographically-diverse floodplain restoration; strategies for channel restoration through gravel infusion and augmentation; a comprehensive plan for post-project monitoring and evaluation; and
- planning tasks as the basis for future project implementation, including: an implementation plan; implementation costs estimate; draft environmental documentation and stakeholder coordination.

Summary of hypotheses, conceptual model, and adaptive management framework

For Phases II and III of the restoration planning process, Stillwater Sciences, working with the MRSG and MRTAC, completed several studies of current conditions in the Merced River. Completed studies include: assessment of land use, zoning, property ownership, and water rights, which define many of the constraints to restoration; field investigations and pilot-level modeling of sediment transport in the gravel-bedded reaches; geomorphic mapping and floodplain assessment; mapping of the current extent and composition of riparian vegetation and invasive vegetation species; and field investigations of riparian vegetation recruitment. These studies provide the framework for the restoration planning of the Merced River, beginning with the Dredger Tailings Reach project proposed here.

Historically, the river in this reach was a complex, multiple-channel system, with the location of the mainstem channel switching between the various secondary channels. Under current conditions, dams control runoff and capture sediment supply from 81% of the watershed, reducing the magnitude of peak flows and bed transport and eliminating channel avulsion in the reach. Riparian vegetation has encroached into the active channel, reducing the area of aquatic habitat, and sand has infiltrated into the channel bed, degrading conditions for salmon egg incubation and alevin survival. The channel in this reach is now homogenous with little spawning and rearing habitat for chinook salmon and steelhead and is expected to support a limited diversity in aquatic species. The channel and floodplain have also been extensively modified by gold dredging, which excavated the channel and floodplain to bedrock, realigning the river and converting more than seven square miles of the floodplain to dredger tailings piles. These tailings piles have eliminated all floodplain functions, confine the river channel, and support little woody riparian vegetation.

The proposed project involves assessments and experiments designed to reduce the uncertainty in large-scale gravel infusion and floodplain restoration projects and to create transferable understanding of process-form-habitat-biota linkages in previously dredged channels. It is intended that the project, when implemented under a future funding round, will increase coarse sediment storage in the channel, balance bed texture with sediment transport competence, and remove dredger tailings from approximately 60 acres of floodplain along 3,600 feet of channel to create floodplain surfaces at functional elevations.

The project develops from a conceptual model of expected biotic responses to physical habitat changes and specific physical and biological hypotheses (Table 2). Example biotic objectives for project implementation include improvements to chinook salmon spawning and incubation success by reducing redd superimposition and increasing survival-to-emergence, changes to macroinvertebrate species composition to more available species, improvements to the extent and complexity of riparian forests and consequent increases in nesting native bird species. These objectives provide the framework for undertaking a comprehensive baseline monitoring scheme to obtain data as the basis for deriving quantified performance objectives for project implementation (section A.3, task 1E). Using this information, the project will develop a thorough plan for post-project appraisal based on two key attributes of "success" in restoration guided by adaptive management, that is, evaluation of project effectiveness and evaluation of the learning experience (Downs and Kondolf, 2002) (section A.3, task 3D). The monitoring and evaluation scheme will include the provision of record drawings immediately following construction, and periodic and/or event-driven monitoring thereafter for a minimum period of 10 years. Periodic evaluation reports regarding project performance will be designed to integrate the monitoring findings with those in neighboring rivers. While developing the monitoring and evaluation scheme, sources of long-term funding will be investigated and pursued as an integral component of future funding for project implementation.

Current status and accomplishments to date

Continuing support from the MRSG and MRTAC has provided input for all phases of the Merced River Corridor Restoration Plan. During the first three phases, the MRSG has met more than twenty times to provide stakeholder input to development of the restoration plan, review study plans and results, and contribute to the design and implementation of public workshops. The Technical Advisory Committee has met seven times to review and comment on all technical documents completed for the project.

Phase II, which was funded by CALFED ERP, was completed in May 2001. Phase II accomplishments include: (1) continued development of and coordination with the MRSG and MRTAC; (2) analysis of social, institutional, and infrastructural opportunities and constraints to restoration in the Merced River corridor (Stillwater Sciences and EDAW 2001); (3) completion of baseline assessments of geomorphic and riparian vegetation conditions from Crocker-Huffman Dam to the San Joaquin River confluence (Stillwater Sciences 2001a); and (4) a public workshop to present findings of baseline studies to a broader public than is represented in the Stakeholder Group.

In Phase III, funded by CALFED ERP, Stillwater Sciences completed field and modeling efforts, conducted public workshops, and in collaboration with the MSRG and MRTAC, developed the Merced River Corridor Restoration Plan. The plan identifies and guides restoration of critical geomorphic and ecological processes in the lower Merced River. The plan assist in ensuring the long-term effectiveness of site-specific restoration projects and provides long-term benefits to ecosystem processes, riverine habitats, and native species.

Summary of the existing data collection and monitoring program

All data collected for baseline studies underwent standard Stillwater Sciences QA/QC procedures. This process includes review of field notes and data by field crew personnel, a review and check of data entry to ensure accuracy, and creation of working and backup copies of original data sheets to eliminate possible loss or tampering of original data. In addition, all GIS coverages and metadata have been delivered to NFWF (the contract manager) in CD format.