# Summary Information

Western Shasta Resource Conservation District

*Lower Clear Creek Monitoring Program*

Amount sought: $1,308,449

Duration: 36 months

Lead investigator: Mr. Michael Harris, Western Shasta Resource Conservation District

## Short Description

The Lower Clear Creek Floodway Restoration Project is a CALFED funded, three phase project. This project will include the following: (1) Avian Monitoring, which will use five metrics to monitor essential avian populations, including the collection of data on an established set of riparian focal species; (2) Geomorphic Monitoring, which will include the measurement of geomorphic changes at both the project scale and on the entire watershed; (3) Riparian Habitat Monitoring, which will measure eight elements of vegetation survival and productivity, wetland creation, and the success of exotic species control efforts.

## Executive Summary

The Lower Clear Creek Floodway Restoration Project (LCCFRP) is a highly successful model of watershed−based ecosystem restoration. Since 1995, a unique partnership between local, state, and federal agencies, and local stakeholders has resulted in the reversal of the large−scale ecosystem disruption that had occurred in the Clear Creek drainage system as a result of gold mining, gravel mining, dams and water diversion. Through this cooperative multi−agency partnership, the future of the stream and its salmonid population is now being restored. The project has expanded suitable spawning habitat and created new, functional channel segments, introduced coarse sediments to the new channel segments, and restored large sections of the channel and floodways to their natural state. The Ecosystem Restoration Program will provide the funds for project monitoring and evaluating that are essential to the future of this project and to similar programs located on highly regulated streambeds. Requested project funding is $1,308,449.

The LCCFRP is a CALFED funded, three−phase project. Currently, two phases and a portion of the third have been completed. Phase 1 consisted of the removal of dredger tailing material from the Reading Bar borrow site. Phase 2A filled off−channel north bank gravel pits to re−create floodplains. Phase 2B continued the restoration of the floodplain by filling in additional gravel pits to eliminate the worst salmonid stranding sites. Phase 3A relocated and reconstructed the channel in the vital upper portion of the project area. To date, over 97 acres of floodplain have been recreated, and 47 acres of riparian habitat have been planted.

The Clear Creek project will provide a model for the implementation of the Adaptive Management Process (AMP) as it is described in the proposal package by providing an opportunity to test the hypothesis that streamflow and sediment can be successfully managed to restore ecosystem function and meet resource management needs on a highly regulated river. The careful evaluation of project data and the revisions that occur as a result of this evaluation will assist CALFED in its work with similar highly regulated Central Valley streams.

The Western Shasta Resource Conservation District (WSRCD) has an extensive and successful history of conservation project implementation and monitoring. The WSRCD will be responsible for the performance of the work by all participating agencies, and for the preparation of contracts for project monitoring. The WSRCD will continue its collaboration with a technical advisory committee consisting of representatives from each partner agency in the project. The committee will also recruit community members and technical advisors from within the local community to assist in project implementation. The WSRCD has enlisted project partners with demonstrated and varied expertise in the technical aspects and administrative management of floodway restoration projects.

The main tasks of the monitoring project include the following: (1) Avian Monitoring, which will use five metrics to monitor essential avian populations, including the collection of data on an established set of riparian focal species; (2) Geomorphic Monitoring, which will include the measurement of geomorphic changes at both the project scale and on the entire watershed; (3) Riparian Habitat Monitoring, which will measure eight elements of vegetation survival and productivity, wetland creation, and the success of exotic species control efforts.

The monitoring results will be made available to project partners, community members, students, and other agencies and organizations engaged in similar efforts through regular meetings, publications, conference presentations and the WSRCD’s Watershed Information Model website. A final grant report will be completed and filed with all involved partner agencies and with funding agencies.

## A. Project Description

### 1. Project Problem, Goals and Objectives

**Problem:** Lower Clear Creek is a highly successful model of watershed-based ecosystem restoration**.** Since 1995, a unique partnership between local, state, and federal agencies, and local stakeholders has resulted in the reversal of the large-scale ecosystem disruption that occurred in the Clear Creek drainage system as a result of gold mining, gravel mining, dams and water diversion. These historical alterations in natural stream flow have resulted in impaired fluvial geomorphic processes, a damaged channel and floodplain and reduced salmonid populations. Through this unique multi-agency partnership, the watershed and its salmonid population is now being restored. The project has expanded suitable spawning habitat and created new, functional channel segments, introduced coarse sediments to the new channel segments, and restored large sections of the channel and floodways to their natural state.

The Clear Creek drainage system covers a large portion of two counties in north central California. Clear Creek originates near the 6,000 foot elevation in the Trinity Mountains, and flows south between the Trinity River basin to the west and the Sacramento River basin to the east. The lower section of Clear Creek flows south from Whiskeytown Dam for approximately 8 miles, and then flows east for 8 miles before joining the Sacramento River five miles south of Redding (Appendix A).

The decline of the watershed began over 150 years ago. The discovery of gold at Reading Bar in 1848 led to a 100-year legacy of alteration and degradation, beginning with placer mining and dredger mining up through the 1940's. Floodplains and terraces were destroyed, removing riparian and upland vegetation, and converting finer grained substrates to piles of cobbles unsuitable for natural revegetation. Commercial in-stream aggregate mining began in the 1950's and continued through the mid-1980's**,** further destroying the natural channel and floodplain morphology. The aggregate mining removed most of the gravel within a 1.8-mile reach, leaving the channel bed surface exposed to the underlying clay hardpan, and creating large in-stream and off-channel pits.

More recent events have created additional ecological degradation for the Clear Creek Watershed. Whiskeytown Dam was completed in 1963 at river mile 18 as part of the Trinity River Division of the Central Valley Project. Water releases into Clear Creek below Whiskeytown Dam have reduced stream flow by 60% of unimpaired conditions. The magnitude of common floods (2-5 year recurrence) has been reduced by approximately 60%, and all coarse and fine sediment from the upper watershed is now trapped by the reservoir. Large floods (10-20 year recurrence) continue to occur occasionally, but are less frequent than under the natural flow regime. As a result of the changes brought about by Whiskeytown Dam, the channel morphology below the dam changed in the following ways: gravel bars are less pronounced, the bed surface has become infiltrated with fine sediment, salmonid spawning habitat has become degraded, and riparian vegetation has encroached along the channel margins. Essential geomorphic processes such as sediment transport, channel bed scour and deposition, and channel migration have been severely impaired by Whiskeytown Dam. These processes are important components in creating and maintaining dynamic channel morphology, high quality salmonid and riparian habitat.

Studies of the drainage system support both the historical origins of the problem and the solutions identified by the proposal. The historical disturbance to the Lower Clear Creek is well documented in the Lower Clear Creek Watershed Analysis (WSRCD, 1996). Additionally the changes in instream habitat are documented by a CDFG memorandum (Coots, 1971), the Clear Creek Fishery Study (DWR, 1986), The Lower Clear Creek Floodway Rehabilitation Project, Channel Reconstruction, Riparian Vegetation and Wetland Creation Design (McBain and Trush**,** 2000) and the Final Report:Geomorphic

Evaluation of Lower Clear Creek Downstream of Whiskeytown Dam, California (McBain and Trush, 2001).

In 1996, gravel augmentation began on Lower Clear Creek to reverse the loss of critical spawning habitat for federal candidate Fall, Late Fall, and federal and state threatened Spring run chinook salmon (*Oncorhynchus tshawytscha*) and federally threatened steelhead (*Oncorhynchus mykiss*). Augmentation to date has taken place at five locations and has added over 86,000 tons of gravel. This successful effort has turned reaches of the creek from areas barren of alluvial material to some of the highest productivity reaches as measured by redd density. The successful gravel augmentation program is currently being expanded to include more locations in areas of high priority for Spring run chinook and steelhead (both of which are Federally and/or state listed).

In 1998, the Clear Creek Restoration Team began developing a plan for channel rehabilitation activities in the low gradient alluvial reach to reverse the impacts of instream gravel mining, dredge mining, and the installation of Whiskeytown Dam. This project, named the Lower Clear Creek Floodway Rehabilitation Project (LCCFRP), was designed in 1999. The LCCFRP is a CALFED funded, three-phase project (Appendix A). Currently, two phases and a portion of the third have been completed. **Phase 1** was completed in October 1998. This phase consisted of the removal of dredger tailing material from the Reading Bar borrow site. This material was then used to isolate a large salmonid stranding pit at the Mining Reach south pond complex. **Phase 2A**, completed in 2000, continued the extraction of borrow material at the Reading Bar site. This material was used to fill off-channel north bank gravel pits and to re-create floodplains. Extensive revegetation occurred at both the Reading Bar site and the Mining Reach site. **Phase 2B** continued the restoration of the floodplain by filling in additional gravel pits to eliminate the worst salmonid stranding sites. **Phase 3A** relocated and reconstructed the channel in the vital upper portion of the project area. To date, over 97 acres of floodplain have been recreated, and 47 aces of riparian habitat have been planted. **Phases 3B and 3C** have yet to be completed and involve continuing to relocate and reconstruct the channel in the remaining lower portion of the project reach and constructing and revegetating functional floodplains.

Project efforts including channel restoration, gravel augmentation and modified flows for salmonids provided by the CVPIA b2 program have had a significant effect on salmonid populations. To date there has been a high level of success for both the gravel augmentation program and the LCCFRP. Population numbers in Lower Clear Creek have risen dramatically from a 30 year average of less than 4000 fall run chinook salmon to 16,107 in 2002 and over 11,000 in 2003. The floodplain project has increased riparian habitat and restored functional surfaces in the most degraded area of Lower Clear Creek. Stranding has been reduced through the removal of the gravel mining pits. Project work in the new channel has resulted in a 384% increase in salmon spawning within the **Phase 3A** project footprint.

**Goals and Objectives:** The goal for the Clear Creek project is to re-establish the critical ecological processes within the current regulated flow and sediment conditions. The major purpose of the project is to promote the recovery and maintenance of the resilient, naturally reproducing salmonid populations and to restore the river's natural animal and plant communities. This main project goal was developed through the collaboration of the Lower Clear Creek Restoration Team. This project goal is consistent with the goals of the CALFED Bay-Delta Ecosystem Restoration Program, Central Valley Project Improvement Act (CVPIA), and the Anadromous Fish Restoration Program (AFRP).

The **objectives** of the LCCFRP and Gravel Augmentation are as follows:

- Rehabilitate the channel degraded by historic aggregate extraction in the Mining Reach by reconstructing the bankfull channel and floodplains;
- Restore sediment transport processes, including bedload transport continuity and fine sediment deposition on floodplain surfaces;
- Restore native riparian vegetation on floodplain and terrace surfaces by focusing on species that provide a diverse canopy structure and removing competing exotic species;
- Reduce salmonid stranding and mortality in floodplain gravel extraction pits;
- Improve habitat conditions for native fish and wildlife species including priority salmonid species of central concern to CALFED, CVPIA, and AFRP programs.

## 2. Project Justification, Models, and Hypotheses

**Justification:** This project is designed to monitor the restoration of the site of extensive damage to the channel and floodplains of Lower Clear Creek. This restoration is based on the degradation from both mining and hydrologic alterations caused by the construction of Whiskeytown Dam. The Clear Creek project will provide model implementation of the Adaptive Management Process (AMP) as it is described in the proposal package. This project will provide an opportunity to test the hypothesis that streamflow and sediment can be managed on a highly regulated river. The careful evaluation of project data and the revisions made as a result of this evaluation will assist CALFED in its work with similar highly regulated Central Valley streams. Using the AMP, the project will provide essential information for balancing continued resource use with the restoration of river ecosystem health.

**Conceptual Models:**The Lower Clear Creek Restoration Team is currently in the process of updating the Ecological Monitoring Plan for the LCCFRP and has developed new conceptual models (Appendix B) based on prior models, recent CALFED Environmental Water Program (EWP) models and the evaluation of monitoring data collected to date. The models illustrate current understanding of the Clear Creek system. These models illustrate how changes in resource inputs to the current system through restoration actions enable natural processes to restore structure and induce positive habitat responses that lead to increases in the diversity of biotic communities..

The proposed monitoring plan assesses the effectiveness of the LCCFRP by evaluating: (1) changes in the structure of the physical channel and floodplains through geomorphic monitoring, (2) changes in terrestrial habitat through riparian revegetation monitoring including an evaluation of the functional ability of constructed features to naturally recruit vegetation and key physical factors that drive vegetation response and wetland habitat creation, and (3) the response of avian species to changes in terrestrial habitat.

Additional structure for the restoration project has been provided by the conceptual model entitled "Attributes of Alluvial River Integrity", first introduced for the Trinity River Maintenance Flow Study (McBain and Trush 1997), and later incorporated in the Trinity River Flow Evaluation Study (USFWS and HVT, 1999) and the *Habitat Restoration Plan for the Lower Tuolumne River Corridor* (McBain and Trush 2000). This model was finally published in the Proceedings of the National Academy of Sciences (PNAS) (Trush et al. 2000). This conceptual model is based on the critical geomorphic and ecological processes that form and maintain alluvial rivers, and can be used to: 1) propose a set of hypotheses (the Attributes) that may be used to improve our understanding of how rivers function; 2) illustrate how human alterations to the environment may have affected the fundamental geomorphic processes of a particular alluvial river; and 3) develop quantitative and measurable restoration objectives.

Based on the Attributes and our current understanding of alluvial rivers, we can describe the linkages between **physical inputs** (e.g. woody debris, streamflow, sediment), **physical processes** (e.g., sediment transport, bank erosion, fine sediment deposition), **habitat structure** (e.g., shallow-gradient riffles, well-sorted and clean spawning gravels, riparian vegetation recruitment), **habitat responses** (habitat connectivity, increased rearing habitat) and **biotic responses** (e.g., avian nest success, salmonid density-dependent mortality) as shown in the Conceptual Models. Then the effects of dams, streamflow and coarse sediment regulation, mining, and other human alterations can be related to these linkages. In Clear Creek, Whiskeytown Dam has eliminated woody debris and coarse and fine sediment supply, reduced the magnitude, duration, and frequency of peak flows , and altered seasonal flow patterns. In addition, aggregate mining and gold dredging have reduced coarse sediment supply to the river by removing stored sediment from the channel and floodplain and trapping coarse sediment that is in transport on the streambed. These reductions in key inputs to the system (i.e., sediment and water) have reduced sediment transport, channel migration and avulsion, and floodplain inundation and have resulted in channel incision, bed armoring, channel narrowing (through riparian vegetation encroachment), and the abandonment of pre-dam floodplains. The result of these structural changes is a decrease in the quantity and quality of aquatic and terrestrial habitats, which causes a direct negative response the populations and species richness of flora and fauna that are adapted to a functional alluvial system.

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

<u>Uncertainties of the Model</u>: The conceptual models for Lower Clear Creek have several key uncertainties including:

1. Will a reduced channel and floodplain geometry with smaller particle size and reduced flow regime re-create a dynamic alluvial channel with functional, inundating floodplains?
2. Will Riparian vegetation encroachment within the active channel be scoured by periodic, moderately high events or will periodic mechanical manipulation or a combination of flows and mechanical manipulation be required?
3. Can high-value streamside wildlife habitat associated with riparian vegetation recruitment be recreated off-channel?
4. Are high value wetlands being maintained throughout the restoration project?

The Lower Clear Creek Restoration Team, with funding from the CVPIA, is also continuing to develop and refine the Clear Creek Decision Analysis and Adaptive Management Model (CCDAM). This model, developed by ESSA Technologies, is a predictive model that evaluates the effects of restoration activities system-wide. The CCDAM, which includes the development of specific testable hypotheses, will aid in adaptive management experimentation for future phases of restoration and guide management decisions. Monitoring data collected by the proposal will increase the model's accuracy and strengthen the validity of its predictions

### C. Hypotheses

The Lower Clear Creek Restoration Team developed the following broad hypotheses on which project design, monitoring, and evaluation efforts are based. General project-related hypotheses include:

(H1) Reconstructing the channel morphology and restoring geomorphic processes will increase the quality and quantity of salmonid (chinook salmon and steelhead) habitat within the project study area;
(H2) Filling mining pits and restoring bankfull channel geometry will decrease stranding-induced mortality of adult and juvenile salmonids within the project reach, and reduce predation mortality;
(H3) Filling mining pits and restoring bankfull channel geometry will improve upstream migratory passage and survival through the project reach for adult salmon and steelhead;
(H4) Revegetation of reconstructed floodplains will increase the quantity and diversity of native riparian vegetation, as well as terrestrial and avian fauna;
(H5) Reconstructing the bankfull channel and floodplain surfaces at a scale consistent with the post-dam flow regime will increase natural regeneration of riparian species on reconstructed floodplain surfaces.
(H6) Filling mining pits, creating floodplains, and restoring bankfull channel geometry will improve the geomorphic processes responsible for creating and maintaining high quality aquatic and terrestrial life and will discourage the invasion and spread of noxious invasive species.
(H7) Filling mining pits, creating floodplains, and restoring bankfull channel geometry can be implemented in a way that minimized effects to existing wetlands and does not preclude the creation of new wetlands.

There are many sub-hypotheses to these fundamental ones which are listed in Appendix C. The project hypotheses form an important component of a broader hypothesis that we can restore a scaled down dynamic alluvial river under a highly regulated setting. This hypothesis has tremendous implications for all highly regulated alluvial rivers in the CALFED study area and other watershed areas, and Clear Creek provides the best location to test this hypothesis.

**3. Previously Funded Monitoring**

Fisheries Monitoring: Fisheries resource monitoring of Lower Clear Creek and the LCCFRP has been conducted by the U.S. Fish and Wildlife Service (FWS) Red Bluff Fish and Wildlife Office (RBFWO). The monitoring procedures are directly related to the project plan. This monitoring has included the following:

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| • Rotary Screw Trapping | CVPIA , December 1998 to June 2001,<br>CALFED July 2001 to present |
| • SCS Snorkel survey | CVPIA 1999 to present |
| • LFC carcass survey | CVPIA 1998 to present |
| • STT redd survey | CVPIA 2002 to present |
| • FCS spawning area mapping | CVPIA 1998 to present |
| • Juvenile habitat use | CVPIA 1999, 2000 and 2003 |
| • Juvenile fish stranding | CVPIA 1996 to 2003 |
| • Spawning gravel evaluation | CVPIA 1997 and 1998 |
| • Water temperature and flow monitoring | CVPIA 1999 to present |

The results of fisheries monitoring programs have been shared with all project participants and analyzed for their significance. A separate ERP proposal is being developed by the USFWS to address fisheries and fisheries-related issues.

Riparian Habitation Monitoring: Riparian revegetation monitoring was initiated in the fall of 2000 following the initiation of the first phase of plantings and will begin a fifth season this fall in 2004. Monitoring currently includes a total of 7 planting sites. The annual riparian monitoring goals have been tied to two objectives: the restoration of native riparian vegetation on newly created floodplain surfaces, and the creation of favorable physical conditions for the regeneration of native riparian species on restored floodplains.

Current methods include fixed-belt row transects that monitor planting survival, height and canopy cover as well as natural recruitment density, height and canopy cover. Belt transects replaced initially-utilized circular plots in 2003 due to increased difficulties in sampling as the vegetation developed. Canopy cover was added in 2003 as an additional measure of plant productivity along each transect. The belt transect sampling design involves the sampling (approximately 10%) or complete census of patches of plants (patch) growing within the sample population (planting) using planted rows as the belt transect. Rows were initially selected using a stratified random sampling method. Weighted means are used to control for potential site variability in plantings that include larger samples associated with complete census.

Fixed scour channel transects were also added in 2003 to measure natural recruitment of woody species using a line intercept technique within three different scour channel designs.

Four annual monitoring reports have been produced to date. Several of the significant findings include:
- Differing site conditions are causing significant differences in survival and productivity by species.
- Overall, planting survival and productivity are very successful**,** given the site conditions.
- Exotic woody species recruitment on the constructed floodplains is currently low.
- Natural recruitment of riparian woody species in the lower reaches of the scour channels is excellent but is generally lacking in the upper reaches.

Recommendations for project refinement have been provided regularly, and have included suggested changes to the planting and maintenance methods and potential adaptive management experiments. Since 2002, an annual presentation of the monitoring results and recommendations has been delivered to the Restoration Team. Data collection under CALFED project funding ends in Spring 2004. The complete project report will include the results of a final assessment of the relationship between soil texture, soil moisture and summer groundwater depths, and vegetation survival and productivity. The soils-hydrology assessment was funded by the Bureau of Land Management through the Jobs in the Woods program.

Avian Monitoring: In 1999, the Point Reyes Bird Observatory began a multifaceted riparian songbird monitoring project on Lower Clear Creek. This research was expanded in restoration specific locations in 2001. The final adaptive management report for Lower Clear Creek identified the monitoring program as the most developed of the three rivers to participate in the Adaptive Management Forum..

Riparian areas throughout California have been identified as the single most important habitat for conservation of resident and neotropical migrant birds (Miller 1951, Gaines 1977, Manley and Davidson 1993, RHJV 2000). Data gathered by PRBO Conservation Science (PRBO) on the distribution and abundance of songbirds in the lower Clear Creek corridor from 1999-2004 indicate that it is an important area for the conservation of birds in the Sacramento Valley (Burnett and Harley 2004). Clear Creek is of special conservation interest to breeding birds for multiple reasons. First, the riparian bird community includes three species currently designated uncommon to rare on the Sacramento River and its tributaries. Yellow Warblers (*Dendroica petechia*), fairly common breeders at Clear Creek, have become extremely rare in the Sacramento Valley since the mid-1970s (Gaines 1977). Clear Creek and its confluence with the Sacramento River is the only known place Song Sparrows (*Melospiza melodia*) occur as breeders on the Sacramento River between Colusa County and Shasta Dam. Additionally, Yellow-breasted Chat (*Icteria virens)*, a California Bird Species of Special Concern, is more abundant along Clear Creek than at any other riparian site in the Central Valley (Burnett and Harley 2004, PRBO unpublished data).

Program data collection and observation will provide scientific documentation of the requirements for survival for these avian species. Understanding why these species continue to breed at Clear Creek will have broad conservation implications regarding effective land management and restoration extending out to the broader Sacramento River watershed. Birds serve a unique and essential purpose in the process of ecological planning. Because birds exist in an extremely diverse range of niches within an ecosystem and occupy a relatively high position in the food chain**,** they are ideal indicators of environmental conditions (DeSante and Geupel 1987, Rich 2002, Temple and Wiens 1989). Thus, birds are a model organism to measure success of restoration and changes in land management (Martin 1995). Finally, birds are both cost effective and perhaps the easiest community of organisms to monitor (RHJV 2004). To date, work has provided over 15 scientifically-based, site-specific recommendations for improving the restoration**.**

PRBO uses five metrics as quantified targets for evaluating avian restoration efforts: nest success, adult survival, focal species breeding densities, focal species abundance, and riparian bird species richness. These specific metrics were chosen to provide necessary information to evaluate response progress on multiple scales. These metrics are used to evaluate site level response and individual project performance as well as the system level response to the suite of restoration actions occurring. Additionally, results from all of these measures will elucidate the appropriate actions to take if targets are not being met. Because of project restrictions, many of these measures will only be obtained for a suite of focal species, following the research of Chase and Geupel (in press). A list of projected focal species and the habitat conditions that will be monitored is included in the PRBO avian monitoring plan.

The monitoring approach employs four standardized methodologies: nest monitoring, territory mapping, point counting, constant-effort mist-netting The individual target values are based upon five years of data collection and analysis of Clear Creek songbird populations from 1999-2003 as well as PRBO data from other riparian sites in the Sacramento Valley (PRBO unpublished data). Riparian songbird monitoring completed its last funded (CALFED) data collection season during the summer of 2004, and the final report will be complete by December 2004.

Geomorphic Monitoring: The overall geomorphic objective is to create a single thread channel morphology that is sized to the future sediment transport and flow release regimes. To achieve this objective the restoration team developed two basic research objectives. The first objective is to recreate natural geomorphic structures as they existed before the historic alteration to the environment. The second objective is to establish new morphology and waterflow, and monitor how it will be affected by high flow events.

The first objective addresses project performance as it relates to ecological and geomorphic restoration objectives, while the second addresses how well the channel was built by targeting critical channel locations most susceptible to undesired channel adjustment. These two basic geomorphic objectives were further refined into more specific process-related goals that could be readily quantified and evaluated. Specific geomorphic restoration goals at the project scale have included the following:

- Riffle matrix particles (D84) are mobilized by design bankfull discharge (3,000 cfs).
- Bankfull channel migrates across floodway.

- Bankfull channel capacity is 3,000 cfs; as flow exceeds 3,000 cfs, flow begins to spread across constructed floodplains.
- Flows inundating floodplain to a depth > 1 ft causes fine sediments to deposit on floodplain.
- Introducing gravel via the restoration project will reduce bedrock exposure in the channel and upstream gravel augmentation will help maintain this condition.
- As bankfull channel migrates across floodway, point bars and new floodplains are formed as it migrates.

These six objectives, as described in Phases 1 through 3A have been monitored since 2002. It is anticipated that Phase 3B will be completed prior to the initiation of monitoring activities included under this PSP proposal.

Note on Current Monitoring: Because of the limited length of the proposal, it is impossible to fully document all monitoring results in this document. Further descriptions of objectives and monitoring methods can be found in The Ecological Monitoring Plan for Lower Clear Creek and the PRBO Avian Monitoring Plan in Appendix D.

## 4. Approach and Scope of Work

**Task 1: Project Management** -The Western Shasta Resource Conservation District (WSRCD) has an extensive and successful history of conservation project implementation and monitoring. The WSRCD will be responsible for the performance of the work by all participating agencies, and for the preparation of contracts for project monitoring. The WSRCD will provide all technical and administrative services as needed for completion of the work, review all work performed, and coordinate budgeting and scheduling to assure that the work is completed within budget, on schedule, and in accordance with approved procedures, applicable laws, and regulations.

The WSRCD will ensure that all agreement requirements are met through completion of quarterly status reports submitted to the CALFED Project Representative. The WSRCD will be responsible for the dissemination of all monitoring reports and the scheduling of presentations resulting from monitoring reports. The WSRCD will complete all data handling requirements to ensure the long term availability of all documents pertaining to the monitoring.

**Task 2: Technical Advisory Committee -** The WSRCD will continue to convene a technical advisory committee (Restoration Team) to consist of representatives from each partner agency in the project. The committee will also recruit community members and technical advisors from within the local community to assist in project implementation. The committee will meet monthly to review progress of each of the four monitoring groups, to discuss opportunities for collaboration within the groups and within the community. The committee will work with the WSRCD to monitor progress on project goals and to facilitate communication with the community. The results of annual monitoring reports will be presented at TAC meetings to provide adaptive management feedback for future design and management decisions.

**Task 3: Avian Monitoring -** PRBO will use five metrics as quantified targets for evaluating restoration efforts: nest success, adult survival, focal species breeding densities, focal species abundance, and riparian bird species richness.

Sites of Collection: Study sites extend from the base of Whiskeytown Dam to the confluence with the Sacramento River. However, intensive study plots where densities, reproductive success, and survival data are being recorded encompass all sites from Reading Bar (2A Borrow) to the end of the project area. Additionally, intensive collection is planned at a reference site above the former Saeltzer Dam. In addition to monitoring the nests and map territory densities at the six established nest plots (Phase 4 PRAR, Saeltzer Dam, Reading Bar, Phase 2A Plug, Phase 2B South, and Phase 3A North), monitoring the proposed Phase 3B area will be included in order to gather baseline data before proposed restoration efforts begin there. Sites will be monitored in accordance with the nationally standardized, Breeding Biology Research and Monitoring Database (BBIRD; http://pica.wru.umt.edu/bbird/) procedures.

Methods of Data Collection:
*Nest Monitoring*: Nest monitoring is the collection of data by species, location and nest success rates. Nest monitoring requires biologists on sight throughout the breeding season, approximately mid-April through July.

*Territory Mapping*: Territory mapping involves tracking the movements of territorial birds in a pre-defined area multiple times throughout the breeding season in order to determine the extent and number of territories at a site following methodologies outlined in Ralph et al. (1993).

*Use of the Point Count Method*: Monitoring will continue all of the point count transects previously established along Clear Creek. The point count method is a standardized and widely applied census technique (Ralph et al., 1993) that includes a vegetation assessment component. The point count method is used to monitor population changes of over time and is the standard technique for obtaining information on the diversity and richness of birds in a given area. The vegetation component relates changes in bird composition and abundance to differences in vegetation. Point counts at Clear Creek cover riparian habitat within the project area as well as several reference sites outside the project area.

*Use of Constant-Effort-Mist Netting*: Finally, monitoring will continue the constant-effort-mist netting stations established at the Project Area and Saeltzer Dam nest monitoring plots. At these plots an array of 10 mist nets will be opened and operated in a consistent manner, according to the methodology outlined in Ralph et al. (1993) and coordinated by the Monitoring Avian Productivity and Survival (MAPS) program.

**Avian Monitoring Tasks:**
**Abundance and species richness -** Results from point counts census data provide relative measures of abundance for various species, as well as estimates of species richness. On site comparisons of treated and untreated areas will be compiled as well as comparisons to reference sites. (Burnett and DeStaebler, 2002). Quantitative targets have been chosen for both the abundance of focal species and overall species richness (In PRBO Monitoring Plan) Measurements of species richness will be calculated using four point subsets from each point count route in order that sample sizes, which can significantly influence species richness, are equalized between reference and restored sites.

**Focal Species Density -** Breeding densities will be used to evaluate the response of focal species to restoration actions, which will complement abundance and species richness data described above. Comparison of densities across years and with densities at reference sites, where no restoration has occurred, will allow for the measurement of the success of restoration. These measurements will allow for the evaluation of target levels (Table 5). Additionally, density measures will provide real numbers of birds present, enabling the determination of just how many new territories restoration efforts have created for a suite of the most important species at Clear Creek (e.g. Yellow Warbler and Yellow-breasted Chat).

**Nest Success and Adult Survival -** Reproductive success is a critical demographic component that can determine whether a species can maintain itself at a given site, rebound from past losses, and/or produce enough young to repopulate newly restored sites. Two measures of productivity will be analyzed. The first measure is based on results from nest monitoring, and the second is based on results from constant-effort mist-netting. Nest monitoring will allow the comparison of nest success, the probability that a nest successfully fledges at least one young, in both treated and untreated areas, and on site as well as at reference sites located elsewhere. In addition, there will be an investigation of the relationship between habitat, landscape and/or vegetation features. Success on restoration sites will be compared with that on reference sites (Burnett and Harley 2004).

Our quantitative targets for nest survival will be limited to those species for which we are able to achieve statistically significant sample sizes (Table 3). Surveyors will continue to monitor nests for most of the species breeding at Clear Creek. This approach will allow project staff to make specific management and restoration recommendations that will optimize the health of all avian populations on a species-by-species basis as well as at the community level.

Constant-effort mist-netting will provide an index of reproductive output by sampling fledged young that have reached independence. Productivity, as indicated by results from mist-netting, will be compared with results for nest success (sampled by nest monitoring). Whereas the two measures of productivity are usually concordant (Nur & Geupel 1993), there can be differences if, for example, survival during the nestling period is high, but survival is low in the post-fledging period. The latter period represents a critical transition from parental dependence to independence for passerine young, and may be influenced by habitat quality. Furthermore, mist net data collected over the five project years can also give indices of annual adult survivorship of bird species breeding in the area (Nur et al. 1999). Survivorship indices will be determined for key species and these results will be combined with productivity indices to model the source/sink status of species at Clear Creek.

**Task 4: Geomorphic Monitoring -** A detailed *Channel Monitoring Methods for the Clear Creek Floodway Rehabilitation Project*(Appendix D) has been prepared which (1) increases the monitoring specificity and details presented in the Ecological Monitoring Plan, (2) provides a detailed description of the methods required to complete the geomorphic, hydrologic, and streambed monitoring tasks for Phases 2 and 3, and (3) provides a detailed description of the materials and techniques to be used as a guide for implementing field monitoring programs described in the Ecological Monitoring Plan. The monitoring activities outlined in these documents have been used to evaluate design performance and project performance. The details on how these performance measures will be measured are in the monitoring plans and will be evaluated by a combination of monitoring during high flow events (targeting design performance), and long-term monitoring of channel morphology (targeting project performance).

Since the preparation of the 1999 Monitoring Plan, the following significant changes to the geomorphic setting under which the plan was developed have occurred: (1) Saeltzer Dam was removed in 2000 and the resulting geomorphic adjustments have led to the delivery of considerable volumes of sediment downstream and (2) substantial additional gravel injection has occurred, and continues to occur. In addition, a working prototype of the Clear Creek Decision Analysis Model (CCDAM) has recently been completed (Alexander, et al 2003), and the Clear Creek portion of the Adaptive Management Forum was completed. All of these changes have resulted in the need to expand the scope of the geomorphic monitoring contemplated under the original monitoring plan.

The original plan focused almost exclusively on monitoring change only within the footprints of the restoration project. While monitoring of the project areas will provide a direct measure of project performance, developing a quantitative understanding of sediment transport dynamics throughout the entire lower Clear Creek system is crucial to the overall success of the entire restoration project. Development of the tools and structure to effectively track the sediment balance on a larger scale is one of the highest priorities for this program. Efforts to begin this process have been initiated by the Restoration Team in 2004 by undertaking an update to the 2001 Gravel Management Plan. This management plan describes a variety of tasks including sediment transport data collection at other locations in the watershed, geomorphic monitoring over a much larger scale, and the evaluation of geomorphic changes and sediment delivery from the former Saeltzer Dam site. Continuation of these efforts is a necessary component of project geomorphic monitoring.

**Geomorphic Monitoring Tasks** - The geomorphic monitoring proposed in the project includes tasks at two different scales: (1) at the restoration project scale, similar to that proposed in the 1999 monitoring plan, and what was has been occurring since 2002 with the completion of Phase 3A, and (2) at the watershed scale, similar to what has been undertaken for the development of the Gravel Management Plan in its 2001 and 2005 versions.

**Restoration Project Scale:** The overall geomorphic objective at both the project site and borrow site is to create a single thread channel morphology that is properly sized to the anticipated future of sediment transport and flow release regimes. To achieve this desired condition, the Restoration Team developed two basic questions to be addressed by geomorphic monitoring: (1) Are natural geomorphic processes being restored by the project (Restoration of Processes), and (2) how is the channel location and morphology adjusting during high flow events (Project Performance)? The first question addresses project performance as it relates to ecological and geomorphic restoration objectives, while the second addresses how well the channel was built by targeting critical channel locations most susceptible to undesired channel adjustment. These two basic geomorphic questions were further broken down into more specific process-related objectives that could be readily quantified and evaluated.

**Watershed Scale:** The overall objective of project monitoring at the watershed scale is to develop a detailed sediment budget for the lower Clear Creek watershed in order to properly route coarse sediment through the system. Proper routing will ensure that the ecological function at the restoration sites and streamwide is restored effectively.

Specific geomorphic restoration objectives at the watershed scale include:

- Develop gravel injection amounts and locations to both recharge the system deficit resulting from Whiskeytown Dam operations since 1963 and instream gravel mining and to maintain the full routing of coarse sediment once the system is recharged.
- Establish tributary sediment yields through flow monitoring and sediment transport sampling to understand this component of the sediment budget and how it will affect decisions for amounts and locations of mainstem gravel injection.
- Introducing gravel at various locations in the watershed, will, over time, allow creation and maintenance of dynamic alluvial features in appropriate geomorphic settings and significantly reduce bedrock exposure in the channel.

- Maintenance of full coarse sediment routing will prevent channel incision and headcut migration that could threaten project performance.

Specific methods and results are essentially those contained in the monitoring plan and channel monitoring methods volume, with the exception that elements are limited to physical measurements of channel geometry at index reaches, longitudinal profiles linking many of the index reaches (but excluding the high gradient and poorly accessible canyon reaches), and measurements and modeling of sediment transport. All of the techniques needed for geomorphic monitoring at the watershed scale are well established and have been proven at the project scale (channel geometry and sediment transport monitoring at 3A) and to a limited extent at the watershed scale (index reaches for development and updating of the gravel management plan, geomorphic monitoring at the former Saeltzer Dam site, etc.). CC-DAM has already performed limited sediment transport modeling using WY2003 3A data to calibrate a two-fraction sediment transport model for Reach 5 as developed by Wilcock (2001), and limited 1998 transport data from the Gravel Management Plan to calibrate the model in Reach 3.

**Task 5: Riparian Habitation Monitoring**
**Approach:** Vegetation monitoring will be composed of eight elements. The first two elements (V.1. and V.2.) are a continuation of the current monitoring program funded through the California Bay Delta Authority (CBDA) Ecosystem Restoration Program. The remaining elements have been added to strengthen the ability of the vegetation monitoring program to provide more precise feedback information to the Clear Creek Restoration Team's adaptive management's decision-making process. The expanded monitoring program will also provide additional valuable information that can be better-integrated with the avian and geomorphic monitoring elements. Monitoring elements V.3, V.4., V.5., V.6. and V.7. were recommended as additions to the vegetation monitoring program in the *Lower Clear Creek Adaptive Management Forum Report* (Adaptive Management Forum Scientific and Technical Panel, 2003).

**Methods:**
V.1. Woody Vegetation on Constructed Floodplains - This element measures the survival and productivity of the "active" restoration plantings and "passive" recruitment of volunteer seedlings of woody plant species on the constructed floodplains. Performance measures for the plantings include survival, canopy cover, and height, by species. Performance measures for volunteer seedling recruitment include density, height class, and canopy cover. Monitoring methods will follow those outlined in Souza Environmental Solutions et al., 2004. Ten foot wide fixed location belt transects are used and consist of an individual planting row. Data collection occurs annually in the fall. Rows are initially selected within each planted patch using a stratified random procedure with a goal of sampling 10% of the plantings. A patch is a discrete planted area (i.e. FC-1) within a site (i.e. 2B North). A census is used for several patches that are too small or narrow to effectively sample with row transects. The patch data is then combined and analyzed by planting site. Weighted means are used to control for potential site variability in plantings that included larger samples associated with complete census. Survival, height and canopy cover data are analyzed by species and by combined total. Canopy cover data is analyzed by height class and by combined total for both plantings and natural recruitment.

V.2. Woody Vegetation in Constructed Scour Channels -Scour channels were constructed in several areas of the constructed floodplain. These scour channels were not actively planted but were designed to intercept spring groundwater to encourage natural recruitment of riparian vegetation. This project element measures the success of "passive" recruitment of volunteer seedlings of woody plant species in the constructed scour channels. The performance measure is the amount of canopy cover using a line intercept technique along fixed transects. Monitoring methods will follow those outlined in the *2003 Riparian Revegetation Monitoring Report* (Souza Environmental Solutions et al., 2004). Transects are established perpendicular to water flow in the scour channels at 30 meter intervals. Data collection occurs annually in the fall. GPS coordinates are collected for all transect endpoints, which are permanently marked with rebar stakes. Canopy cover data is analyzed by height class and by combined total, as well as by species and by combined total.

V.3. Woody Vegetation in the Constructed Stream Channel - This element will measure the recruitment and scour of volunteer seedlings of woody plant species within the active channel and banks of the constructed stream channel. The performance measure is canopy cover by species using a line intercept technique along fixed transects. Data collection occurs annually in the fall. Previously-established geomorphic monitoring channel cross-section transects are used in order to integrate the vegetation data with annual flow and erosion/deposition data. Canopy cover data is analyzed by height class and by combined total.

V.4. Herbaceous Vegetation on Constructed Floodplains - This element will measure the establishment of herbaceous plant species on the constructed floodplains. The performance measure is canopy cover using fixed-location quadrats. Data collection will occur annually in the spring. Floodplain deposition data will be collected at each quadrat in order to relate floodplain development to herbaceous species development. Canopy cover data is analyzed by native and non-native species, by perennial and annual species, and by combined total.

V.5. Herbaceous Vegetation in Constructed Scour Channels - This element will measure the establishment of herbaceous plant species in the constructed scour channels. The performance measure is canopy cover using fixed-location quadrats placed along scour channel transects established for monitoring element V.2. Quadrat locations along each transect will be established initially using a systematically random selection process which will both eliminate bias and ensure adequate distribution of quadrats across the scour channel area. Data collection will occur annually in the spring. Canopy cover data is analyzed by native and non-native species and by combined total.

V.6. Exotic Woody Vegetation - This element will measure the establishment of non-native woody plants within the restored area. In addition, the element will measure the abundance of non-native woody plants within the larger 100-year floodplain in the lower eight river miles of Clear Creek because this larger area serves as a seed source for recruitment to the restored areas and the Sacramento River. Non-native plant species are a significant threat to the future development of the riparian restoration projects. While current monitoring, which involves a 10% sampling of the restoration areas, has not indicated that a major infestation of non-native plants has yet occurred, several established plants are beginning to reach maturity and produce seed, and the adjoining lands have significant weed infestations. The performance measure is a complete mapping inventory of the restored areas and the 100-year floodplain. Additional monitoring will measure the success of current exotic woody vegetation control projects within the restored area and planned future exotic woody vegetation control projects within the larger floodplain system. The initial mapping will build on preliminary mapping that the WSRCD conducted of the restoration area several years ago with Bureau of Land Management funding. Monitoring will occur every five years by using aerial photographs to map identifiable species (ie. *Arundo donax*) coupled with a ground survey to map species that can not be identified through aerial photography interpretation or are not visible due to heavy canopy cover. Mapped exotic plant locations/populations will be classified as either mature or immature so that the data can provide a feedback mechanism to trigger management decisions prioritizing restoration actions that target seed-producing plants and populations.

V.7. Groundwater - This element is designed to measure groundwater fluctuations on the constructed floodplains and in the scour channels in order to study the relationship between vegetative response and annual hydrologic fluctuations. Approximately 18 wells will be installed and monitored along with approximately 27 previously-installed wells. Wells will be installed along vegetation monitoring transects in order to relate active and passive revegetation responses to hydrologic variables. Data will be collected in excavated pits during well installation, including depth to surface water, depth to moist soil, general textural stratification and plant root development. Wells will be installed in the fall to take advantage of the low water table, which will maximize the amount of data that can be collected regarding subsurface conditions. Photos will be taken of all excavated pits prior to well installation. Water elevations data will be collected for one year in order to capture one entire hydrologic cycle. Data will be collected monthly during the months of July through February and twice monthly during the months of March through June to gain more detailed information about the spring recession rate.

V.8. Wetlands - This element is designed to monitor the project goal of achieving a net gain in wetland habitat as a result of the restoration project and the no-net-loss of wetlands policy of several state and federal agencies involved in the project. Initial calculations of wetlands-lost vs. wetlands-gained indicated that a net gain in wetland habitat would occur. However, the information is now outdated due to designs modifications that have been implemented in the initial phases of construction. These modifications eliminated several planned wetlands in dredge tailing sites due to concerns about potential mercury methylization. Modifications were also implemented that preserved wetlands that were originally scheduled to be filled to build floodplains, due in part to concerns about the stranding of anadromous fish. The performance measure is the ratio of wetlands-gained to wetlands-lost. A delineation of waters of the U.S., including wetlands, was conducted of the project site prior to project implementation in accordance with the 1987 *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory, 1987) using a Routine Determination Method and will serve as baseline information. A subsequent delineation of waters of the U.S., including wetlands will also be conducted in accordance with the 1987 *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory, 1987), but will use an Atypical Situations Method. This method involves the use of hydrologic and vegetative indicators rather than the use of a three parameter approach (hydrologic, vegetative and hydric soil indicators) as is used in the Routine Determination Method. The two parameter method is designed for, among other situations, “man-induced wetlands” where hydric soil indicators are not likely to be present due to the recent soil disturbance and resulting insufficient time for indicator development. Monitoring will occur in 2007 to measure the total net gain/loss in waters of the U.S., as well as by wetland type, as a result of project implementation to date (through Phase 3A). Subsequent monitoring will occur two years after significant future phase implementation in order to give vegetation on the disturbed sites time to respond. It is anticipated that two additional monitoring events will be needed (after Phase 3B and Phase 3C).

**Applicability:** The current state of knowledge regarding vegetative response to riparian restoration projects in California is primarily derived from projects implemented on intact floodplains with productive soils. This project design of using highly permeable materials to completely reconstruct previously-removed floodplains presents a unique challenge for vegetation establishment. Monitoring results are beginning to provide useful information to help guide future phase designs of this project as well as other restoration projects in dredged and gravel-mined watersheds. Monitoring results will be integrated with avian monitoring data in future years to relate vegetation response to avian use. Many of the monitoring elements will also complement the objectives of the CBDA Environmental Water Program's Pilot Clear Creek Flow Augmentation Project by providing baseline information for several of the proposed performance measures.

**Task 6**: Comprehensive Monitoring Report
A comprehensive monitoring report will be completed summarizing the results of monitoring to date and management recommendations for future projects on Clear Creek and within the bay delta region.

**Task 7:** Draft and Final Grant Report
A draft and final grant report will be completed and filed with all involved partner agencies and with funding agencies. Access to this final report will be provided through the Internet and on request from the WSRCD.

## 5. Feasibility

The Clear Creek monitoring project is the next, critical step in the restoration process. The monitoring approach presented in the previous sections is feasible and appropriate for the evaluation of restoration actions taken on Lower Clear Creek. All partner agencies have a long history of successful project implementation and monitoring. The approved CALFED monitoring plan for Lower Clear Creek has been successfully followed since 2001. The proposed monitoring adds and strengthens the current information that is drawn from restoration activities on Lower Clear Creek. The WSRCD, the Clear Creek Restoration Team, the Project Design Team (McBain and Trush, Graham Matthews and Associates), and the USBR have demonstrated the ability to successfully plan and implement large-scale restoration projects, both in a timely manner and within budget. Previous funding support from CALFED (Grant 98-F15) was used to successfully implement multiple phases of the Floodway Rehabilitation Project and to complete multiple years of monitoring.

The Lower Clear Creek Floodway Rehabilitation Project is subject to all local, state, and federal environmental regulatory requirements. No permits are required for the implementation of the geomorphic and riparian revegetation monitoring. Avian monitoring requires a USFWS banding permit and sub-permits for field workers, which are issued through the monitoring entity and are currently in place. No private land is accessed for the monitoring. No zoning laws, or land use restrictions will affect monitoring projects.

## 6. Expected Outcomes and Products

Because of the significance of the monitoring taking place on Clear Creek and its unique situation, Clear Creek has been, and will likely continue to be, the focus of extensive scientific monitoring and experimentation, seminars, and informational brochures. Each year reports from each of the three monitoring entities avian, geomorphic and riparian revegetation will be reviewed and released to guide future restoration actions on Clear Creek and within the Bay Delta system. A total of nine individual annual reports and one comprehensive report will be generated.

A comprehensive workshop will be held each year to inform restoration teams working on other systems of the project's monitoring strategies and outcomes, and will include the solicitation of their recommendations and as well as a detailed discussion of the issues faced by project staff. Each monitoring team will also provide presentations at CalFed conferences and through other scientific venues, such as professional conferences and journals.

## 7. Data Handling and Storage

Because of the size and complexity of the various phases of restoration, a large volume of data and project-related information has been generated. It is essential that the project data be handled and stored to guarantee both its scientific validity and its accessibility to staff and to other professional entities. Quality Control/Quality Assurance, and information availability are both essential components of the data handling and storage process.

Data handling and storage will continue to be coordinated by WSRCD with data components located at the appropriate agency offices. Project data has been stored successfully in Microsoft Word, Microsoft Excel, AutoCad Land Development Desktop 2 and 3. All design documents produced to date have also been saved in PDF format for ease of viewing and sharing. The USFWS collects and stores monitoring data on project components such as fish counts, spawning habitat and fish passage. WSRCD also compiles monitoring data on project design, riparian revegetation and monitoring, and geomorphic components, including coarse sediment mobilization, channel morphology, fine sediment deposition, channel profiles, channel dimension evolution, mapping vegetation success, and restored floodplain cross sections. WSRCD will be the central clearing-house for all reports and data, which can be made accessible through e-mail, the WSRCD web site and online at The Watershed Information Model, an online data catalog that currently has over 747 archived documents and resources on watersheds in Shasta County including Lower Clear Creek. The WSRCD will additionally incorporate procedures to archive data files on CD’s, duplicated and stored off-site as a precaution.

## 8. Public Involvement and Outreach

The education and outreach program for this project has multiple facets. Individual members of the Technical Advisory Committee have given, and will continue to give tours of the project to other agencies and educational institutions on a regular basis and to keep them updated on the results of the programs. All project reports are posted on the Western Shasta Resource Conservation District’s WIM (Watershed Information Model) website (http://wim.shastacollege.edu), which gets thousands of hits each month. The site provides access into the database that has over 600 reports and other data on 18 watersheds in the district.

The Lower Clear Creek CRMP group is briefed about the project at their meetings and in an annual tour of the project each spring. Additional funding is being sought to update a 12-page color brochure of the entire rehabilitation project in total, for distribution throughout the District. Periodic press releases keep the public informed about the successes and work being completed in Lower Clear Creek.

The annual bird monitoring projects provide an excellent outlet for public education. Pt. Reyes plans to continue their public outreach effort, which includes field trips to study sites for local schools and community groups, and working with local educators on incorporating birds and riparian curriculum into their study presentation to local groups (e.g. Audubon Society, Horsetown Clear Creek Preserve, etc.). These efforts provide environmental education to the youth of the District, as well as inform local citizens and groups about the importance of the Clear Creek restoration. Pt. Reyes will be hiring an education intern to coordinate these efforts under the supervision of the project supervisor.

The Shasta County Department of Education’s Whiskeytown Environmental School located on Lower Clear Creek, uses the restoration work on the creek as an integral part of their week-long in-house educational programs for over 5000 fifth and sixth grade students annually. WSRCD contracts with the Bureau of Land Management to hold one-day field trips for school children to Horsetown-Clear Creek Preserve, a large preserve on Lower Clear Creek adjacent to a large segment of the restoration work, to integrate the issues and solutions to local environmental problems and opportunities into the school curriculum

**9. Work Schedule**

Project implementation will begin as soon as funding is awarded and continue for three years, until December 2008. A timeline that represents the beginning and ending of work for each task per year is included in appendix E. Each component is separable by task, as indicated in the attached graphics. The duration of project monitoring is dependent upon both the completion of future phases of the LCCRFP and the continuation of the gravel augmentation program. The avian monitoring component is expected to require three years of monitoring after the end of this proposed monitoring. Riparian monitoring would continue three additional years after the end of this grant if additional restoration is completed within the next two years. Geomorphic monitoring will only be needed following large storm events after the completion of the grant. All three components will be monitored every five to ten years to record any changes as needed.

**B. Applicability to CALFED Bay-Delta Program ERP Goals, the ERP Draft Stage 1 Implementation Plan, and CVPIA Priorities.**

**1. ERP and CVPIA Priorities**

This proposal directly addresses ERP goals, ERP Draft Stage 1 implementation Plan, CVPIA priorities and the site is one of the identified ecosystems in Chapter 2 of the PSP. Draft Stage 1 priorities addressed by the Lower Clear Creek Floodway Rehabilitation Project fall within the 'Restoration Priorities for the Sacramento Region', of the Draft Stage 1 Implementation Plan, and include several of the Stage 1 priorities:

**Restoration Priority 1:** *Develop and implement habitat management and restoration actions in collaboration with local groups such as the Sacramento River Conservation Area Non-Profit Organization.* This project has been conducted in collaboration with the Lower Clear Creek Coordinated Resource Management Planning (CRMP) Group, the Shasta-Tehama Bioregional Council, Shasta Fly Fishers, NorCal Fishing Guides & Sportsman's Assn., Shasta Sportsman, Shasta College, Horsetown Clear Creek Preserve, Shasta Historical Society, Whiskeytown Environmental Education Camp, Shasta Paddlers, Native Plant Society, Shasta County Farm Bureau, Shasta Wildlife Rescue, Redding Mountain Bikers, Black Powder, and the Redding Rancheria.

**Restoration Priority 2**: *Restore fish habitat and fish passage particularly for spring-run chinook salmon and steelhead trout and conduct passage studies*. CALFED, CVPIA and other government agencies have invested heavily in the return of spring-run salmon and winter-run steelhead access in Clear Creek, including funding for removal of Saeltzer Dam in 2000. With this migration barrier removed, spring-run salmon can over-summer in deep, cold-water pools in the Clear Creek canyon reaches below Whiskeytown Dam. Gravel augmentation is providing needed spawning habitat for these species. The potential increase in spring-run chinook salmon and winter-run steelhead fry production in reaches upstream of Saeltzer Dam could be limited by rearing habitat in those reaches. The Floodway Rehabilitation Project may provide additional rearing habitat for all species, and potential spawning habitat for steelhead, by restoring the pool-riffle morphology in the 1.8-mile project reach. In addition, floodplain restoration and scour channel construction should greatly reduce juvenile mortality caused by stranding in off-channel pits during high flows. Collectively, these project objectives could benefit spring-run chinook salmon and winter-run steelhead production from the Clear Creek watershed.

**Restoration Priority 3:** *Conduct adaptive management experiments in regard to natural and modified flow regimes to promote ecosystem functions or otherwise support restoration actions*. While the Lower Clear Creek restoration projects do not target experiments with different flow regimes, they are conducive to monitoring the effects of high flows that result from natural floods as well as dam releases.

The project is testing whether fluvial processes can be restored in a highly regulated river such as Clear Creek at a smaller scale than existed naturally, as a strategy to restore and maintain channel morphology, riparian vegetation, and salmonid populations.

**Restoration Priority 4**. *Restore geomorphic processes in stream and riparian corridors.*" The Clear Creek Floodway Rehabilitation Project is founded fundamentally on the goal of re-establishing ecological processes as the most effective way to maintain the river ecosystem. Additionally gravel augmentation may help restore sediment transport in Lower Clear Creek.

**Restoration Priority 5**. *Implement actions to prevent, control and reduce impacts of non-native invasive species in the region*. This proposed project will monitor non-native invasive plant species in order to provide information necessary to implement measures to control existing populations and prevent colonization in the restored areas. The Floodway Rehabilitation Project has restored native riparian vegetation to approximately 47 acres of floodplain that was highly degraded by aggregate and dredger mining. Portions of the restored floodway contain Tree of Heaven (*Ailanthus altissima*), Star Thistle (*Centaurea solstitialis*), and Himalayan Blackberry (*Rubus discolor*) that are monitored with funding from the BLM. Replanting immediately following construction with native riparian canopy and understory species increases the opportunity for native vegetation to become established and reduces the opportunity for non-native invasive species to spread within the Clear Creek floodway.

**CVPIA Priorities:** The general purposes of the CVPIA are identified by Congress in Section 3402(a) to "protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins of California." Section 3406 (b) 12 describes specific actions to be implemented in Clear Creek, including the development of a comprehensive program to provide flows to restore salmon and steelhead habitat below Whiskeytown Dam. The Clear Creek Floodway Rehabilitation Project, in part, will allow the development and implementation of this program by completing channel restoration.

**MSCS Big R Species:** This project will monitor actions taken to promote the ecosystem recovery of four Multi Species Conservation Strategy species, Central Valley spring run chinook salmon (*Oncorhynchus tshawytscha*), Central Valley fall/late-fall-run chinook salmon (*Oncorhynchus tshawytscha*), Central Valley steelhead (*Oncorhynchus mykiss*) and valley elderberry longhorn beetle (*Desmocerus californicus dimorphus).*

**ERP Restoration Program Milestones for the Sacramento River Basin:** This proposal measures progress toward ERP milestones in ecological processes, habitats and stressor reductions, including coarse sediment supply through the implementation of gravel augmentations and the assessment of natural sediment transport processes linked to stream channel maintenance, erosion and deposition, maintenance of fish spawning areas and regeneration of riparian revegetation. Two separate milestones for riparian habitat are measured with this project: first, the development of a program to establish, restore and maintain riparian habitat, improve floodplain habitat, salmonid shaded riverine habitat, and, second, the restoration of a portion of the two miles target of riparian restoration along the lower reaches of clear creek. Both of these expected habitat milestones can be directly measured by monitoring of the Lower Clear Creek Project. ERP stressor milestones of unimpeded upstream passage and stranding are directly addressed by monitoring of this project being completed by the USFWS.

**2. Relationship to Other Ecosystem Restoration Actions, Monitoring Programs, or System-wide Ecosystem Benefits:** Clear Creek is the upstream-most tributary to the Sacramento River. With stream flow available from the CVP, the opportunity to experiment and learn from the Clear Creek restoration program is unprecedented. With Saeltzer Dam now removed, an experienced stakeholder group in place, spawning gravel augmentation and other rehabilitation efforts established, and with relatively low risks due to public ownership and the general lack of development within the floodway, Clear Creek has the potential to be a model restoration river for CALFED and CVPIA programs. Clear Creek is also one of the top 5 priority streams for the CALFED EWP.

The highest project priority is to maximize the opportunity to gain valuable information, and to achieve this goal expediently. As emphasized throughout this proposal, information gathered from this project, and the Clear Creek restoration program in general, can be extrapolated to restoration efforts throughout the entire Central Valley. Clear Creek also was a major supplier of coarse sediment to important spawning reaches in the upper Sacramento River mainstem, estimated to be 5,000 tons/yr (CALFED ERP Vol. II). Finally, Clear Creek supports the only known breeding populations of Yellow Warblers and Song Sparrows close enough to the Sacramento River to function as a source population. Increasing habitat for these species along Clear Creek is a high riparian restoration priority for the revegetation design and for the California Partners in Flight and The Riparian Habitat Joint Venture (RHJV 2000).

**3. Additional Information for Proposals Containing Land Acquisition**

The Bureau of Land Management owns nearly all of the property contained within the project area, and no properties are proposed for purchase.

**C. Qualifications –** Summaries of the professional biographies of project participants are as follows:

**WSRCD**

**Mary Schroeder,** District Manager, received a B.S. degree in Forest Industries Management from Ohio State University, Columbus, Ohio. She has over 25-years business management experience in natural resource and wood products industries. As chief administrative officer of the District, Mary is responsible for directing the District's business and field operations consistent with the strategic plan. Mary will oversee general administration of the grant, and ensure adherence to budget and timeline.

**Michael Harris,** Projects Manager for watershed restoration, fisheries, and wildlife. He has a B.S. in Biology from California State University-Sacramento, and a B.A. in Economics from the University of California-Davis, and is completing his Master of Science in Biological Conservation from the California State University-Sacramento. Michael's experience includes habitat sampling; scheduling and data management; vertebrate sampling of mammals, reptiles and amphibians; monitoring of avian species. His publications include 2001 and 2002 California Department of Transportation –Carmel River Mitigation Bank Report. Michael's thesis will be titled "Small Mammal Microhabitat Analysis of a Restoration Site." Michael will work directly with all project participants to monitor their work and measure their progress toward project monitoring goals.

**AGENCY REPRESENTATIVES**

**Matthew Brown**, Fisheries Biologist, US Fish and Wildlife Service, has a M.S. in Biology from Arizona State University and a B.A. in Biology from the University of California-Santa Cruz. His work is focused on Chinook salmon with a concentration on habitat restoration under the CVPIA and evaluating the impacts of water development.

Matthew is a member of the Restoration Team and oversees all fisheries monitoring on Clear Creek.

**Jim DeStaso**, Fisheries Biologist, US Bureau of Reclamation, has a Master's Degree in zoology and Physiology from the University of Wyoming and a B. S. in Biology from William Paterson University. Jim has worked for the Bureau of Reclamation since 1995 and his responsibilities include project implementation of multi-agency river ecosystem restoration projects, including channel improvements, budget oversight of restoration projects, contract administration and environmental compliance.

Jim is a member of the Restoration Team and is a BOR Program and CVPIA Manager for Clear Creek.

**Francis Berg,** Assistant Field Manager, Bureau of Land Management, has graduate courses in Environmental Administration and Archaeology from the University of California-Riverside; a B.A. in

Anthropology (Highest Honors, Phi Beta Kappa) from Riverside City College, Riverside, CA; and an Associate of Arts (Greatest Distinction) Francis has been the Assistant Field Manager at the Redding Field Office since 1991. He supervises a team in wildlife, fisheries, botany, range conservation, forestry, archaeology, geology, recreation management and planning, and leads the implementation of the restoration of Lower Clear Creek and sections of the Sacramento River in Tehama and Shasta Counties.

Francis is a member of the Restoration Team and is directly responsible for all BLM lands on Clear Creek.

**SUBCONTRACTORS** – Each of these subcontractors was selected because they have been active participants on the Lower Clear Creek Floodway Rehabilitation Project involved in project design, implementation, and monitoring. They are highly qualified and have produced excellent peer-reviewed reports and analysis on time and within budget. Biographical details on each subcontractor are included in appendix F.

**Geoffrey R. Geupel,** Director of Terrestrial Ecology Division of Point Reyes Bird Observatory since 1989

**Ryan D. Burnett**, Terrestrial Ecologist with Point Reyes Bird Observatory since 1997

**Graham Matthews**, Principal Hydrologist with Graham Matthews & Associates since 1990

**Aaron (Smokey) Pittman,** Hydrologist/Geomorphologist with Graham Matthews & Associates since 2000

**Jeff Souza**, Principal Biologist for Souza Environmental Solutions

**Gregory Treber,** Principal Botanist with Terrestrial Connections

**Neil Schwertman,** Professor Emeritus, Department of Mathematics and Statistics, California State University, Chico

**Organizational Structure:** The WSRCD organizational structure begins with the Board of Directors, the District Manager, followed by the Project Manager, who facilitates the monthly meetings of the Technical Advisory Committee (TAC), a group of scientific representatives from multiple agencies and other interested parties. The TAC operates on a consensus basis when reviewing each step of the Lower Clear Creek Floodway Rehabilitation project since its inception. The Project Manager negotiates agreements with the Subcontractors, who are also actively involved with the TAC. The subcontractors identified for this project have a proven track record and are the same subcontractors currently conducting monitoring on this project.

**D. Cost**

The total estimated cost to complete three years of monitoring of the lower Clear Creek Floodway Rehabilitation Project is **$1,308,449.**

**E. Cost Sharing**

There is a cost share associated with this proposal through the Technical Advisory Committee. This cost share is $72,000.00 based on 20 people per three hour TAC meeting. The TAC meetings are scheduled 10 times a year for three years, totaling 1800 hour at a rate of $40 per hour.

**F. Long Term Funding Strategy**

Future funding for monitoring is likely to come from the CVPIA and through monitoring components funded as part of future ongoing restoration projects in the watershed.

**E. Compliance with Standard Terms and Conditions**

The WSRCD will comply with all state and federal standard terms.

**G. Literature Cited**

See Literature Cited Section

Literature Cited.

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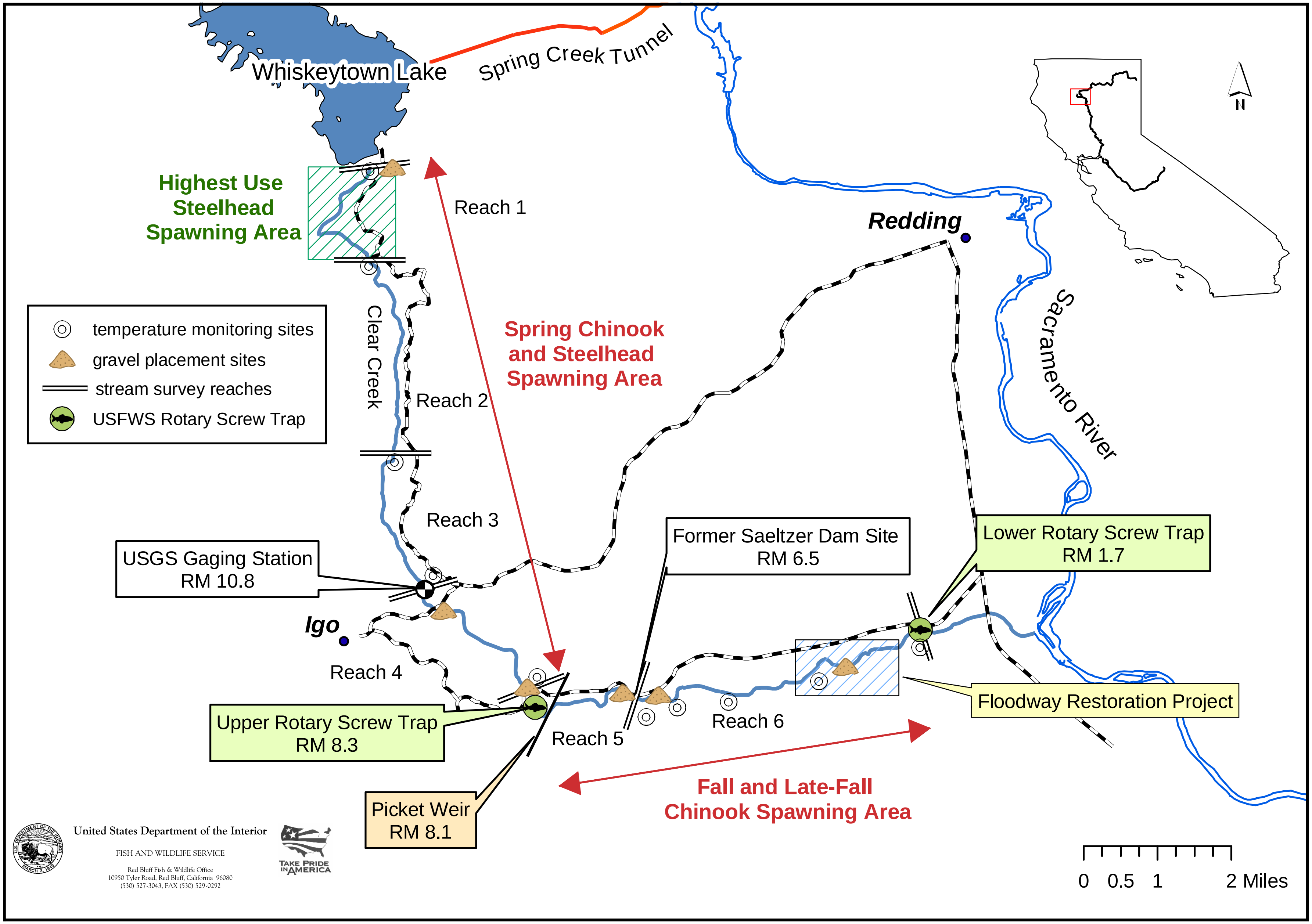
# APPENDICES

# APPENDIX A



Whiskeytown Lake
Spring Creek Tunnel
Highest Use Steelhead Spawning Area
Reach 1
Redding
Sacramento River
N
temperature monitoring sites
gravel placement sites
stream survey reaches
USFWS Rotary Screw Trap
Clear Creek
Reach 2
Spring Chinook and Steelhead Spawning Area
Reach 3
Former Saeltzer Dam Site RM 6.5
Lower Rotary Screw Trap RM 1.7
USGS Gaging Station RM 10.8
Igo
Reach 4
Upper Rotary Screw Trap RM 8.3
Reach 5
Reach 6
Floodway Restoration Project
Picket Weir RM 8.1
Fall and Late-Fall Chinook Spawning Area
United States Department of the Interior
FISH AND WILDLIFE SERVICE
Red Bluff Fish & Wildlife Office
10950 Tyler Road, Red Bluff, California 96080
(530) 527-3043, FAX (530) 529-0292
TAKE PRIDE IN AMERICA
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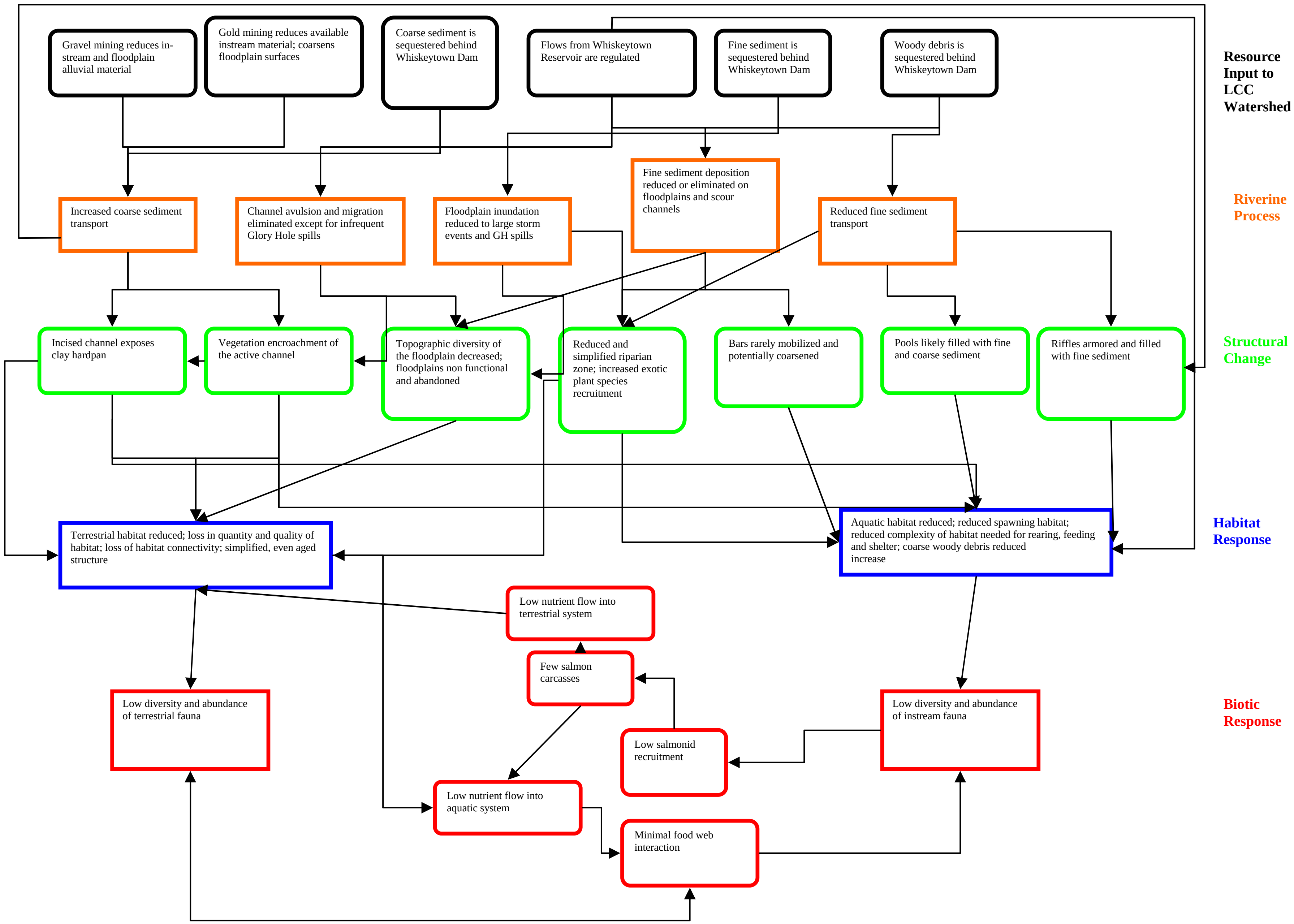
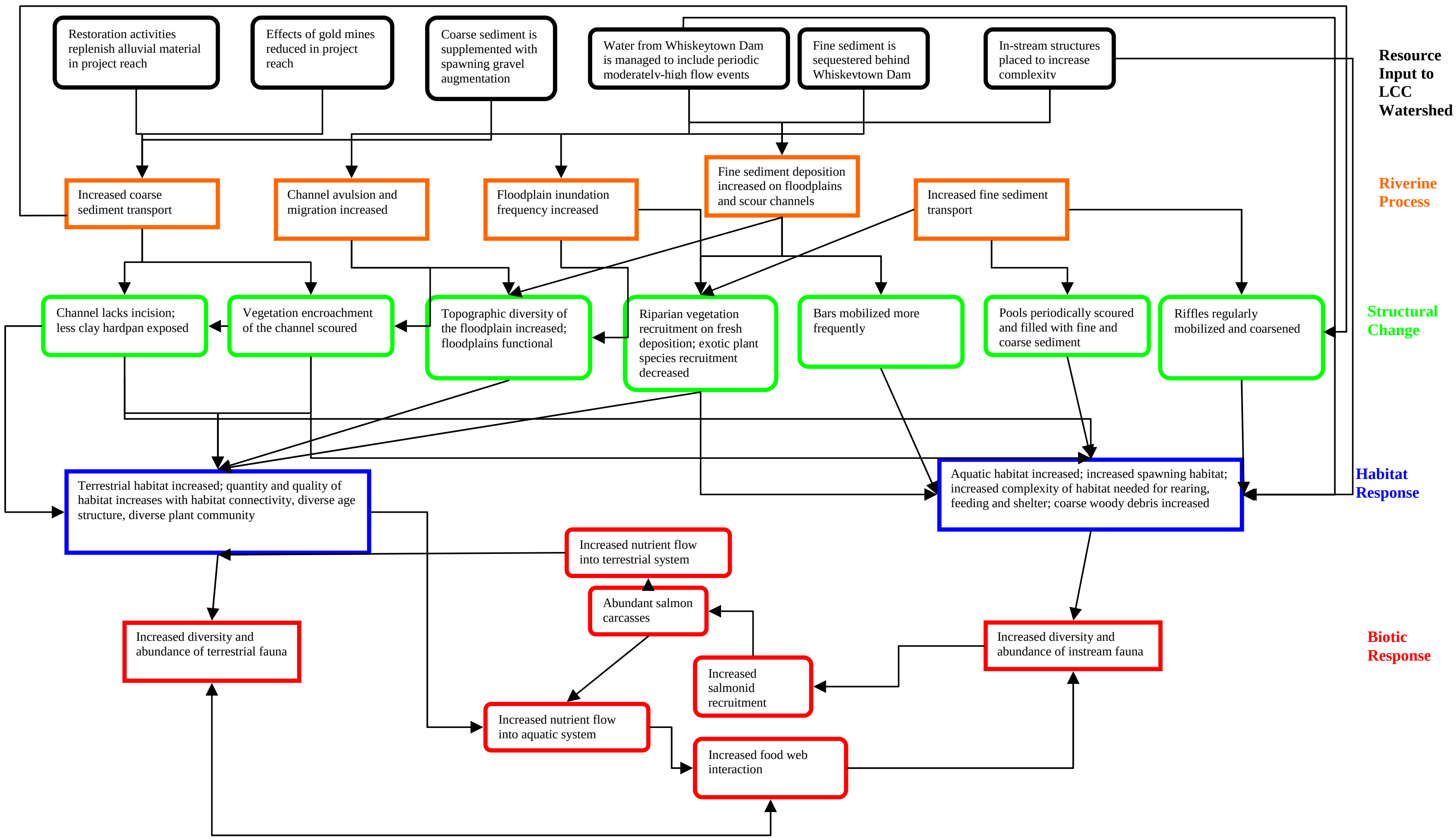
# APPENDIX B




**Overarching conceptual model linking the impacts of dams and gravel mining to physical processes, habitat structure, and biotic response on lower Clear Creek**




**Overarching conceptual model linking the impacts of restoration activities to physical processes, habitat structure,and biotic response on lower Clear Creek**

APPENDIX C

**Hypothesis Sub-hypothesis**

**H1: Reconstructing the channel morphology and restoring geomorphic processes will increase the quality and quantity of salmonid (chinook salmon and steelhead) habitat within the project study area**

Raising the channelbed above the clay hardpan and restoring an equilibrium grade through reach by adding large volumes of gravel will increase spawning gravel quantity

Constructing the bankfull channel with sorted (clean) cobbles and gravels will greatly increase spawning gravel quality and egg-to-emergence success

Raising the channelbed above the clay hardpan and restoring an equilibrium grade through reach by adding large volumes of gravel will maintain gravel storage in the reach, providing long-term habitat value

**H2: Filling mining pits and restoring bankfull channel geometry will decrease stranding-induced mortality of juvenile salmonids within the project reach, and reduce predation mortality**

Filling mining pits will eliminate predatory piscivores, increasing smolt production from lower Clear Creek

Filling mining pits will reduce fry and juvenile stranding, increasing smolt production from lower Clear Creek

Creating sideslopes greater than 3% on terrace surfaces, scour channels to assist juvenile travel from floodplains back to primary channels, and a defined thalweg in the scour channels will reduce fry and juvenile stranding on floodplains during high flow releases.

**H3: Filling mining pits and restoring bankfull channel geometry will improve upstream migratory passage and survival through the project reach for adult salmon and steelhead**

Recreating one to two primary channels will reduce adult stranding mortality, increasing spawning success and fry production

**H4: Revegetation of reconstructed floodplains will increase the quantity and diversity of native riparian vegetation, as well as terrestrial and avian fauna**

Planting vegetation in large dense patches with some open cobble bar will reduce cowbird predation, increase migratory songbird habitat, and as the canopy species mature, will create habitats for cavity nesters and raptors.

Planting vegetation in large patches with some open cobble bar will provide habitat for killdeer, doves, and other species dependent on open gravel bar habitats

A combination of riparian plantings and natural regeneration will result in additional species and age diversity than if the entire site were planted.

Planting cuttings in the late winter to the depth of the winter groundwater table elevation will encourage cutting roots to follow the declining water table into the summer, increasing the cuttings ability to survive the hot and dry summer months, increasing planting success

Planting container stock in topsoil will increase the ability of the soil to hold moisture, increase the capillary fringe, and require less frequent irrigation, all increasing planting success

Drip irrigation on container stock will provide more substantial and deeper watering than water truck application, resulting in greater container stock survival

**H5: Reconstructing the bankfull channel and floodplain surfaces at a scale consistent with the post-dam flow regime will increase natural regeneration of native riparian species on reconstructed floodplain surfaces**

Reconstructing floodplains to begin inundating during the contemporary 1.5 year flood will result in natural riparian regeneration to occur

Reconstructing floodplains to begin inundating during the contemporary 1.5 year flood will result in fine sediment deposition during larger floods, creating new seedbeds and encouraging riparian regeneration

Reconstructing floodplains will allow larger floods to cause channel migration, avulsion, and scour channel creation, creating new seedbeds and encouraging riparian regeneration and channel complexity

Creating scour channels that are 1-3 feet deeper than the floodplain will create moist seedbeds in all years during the cottonwood and willow seed dispersal period, allowing natural regeneration to occur during most water years

Allowing and encouraging channel migration and avulsion will greatly increase the riparian regeneration process on new floodplains and scour channels

**H6: Filling mining pits, creating floodplains, and restoring bankfull channel geometry will improve the geomorphic processes responsible for creating and maintaining high quality aquatic and terrestrial habitats**

Recreating the bankfull channel using substrates finer than 128 mm (5-inch) diameter will allow these particles to be mobilized by 2.0-year flood (3,000 cfs)

Recreating the bankfull channel and floodplain by refilling the valley bottom with alluvium will allow channel migration and avulsion to occur during moderate to large floods, rather than remaining in a stable location incised within clay hardpan.

Recreating the bankfull channel and floodplain by refilling the valley bottom with alluvium will reduce or eliminate channel degradation in upstream and downstream reaches.

Channel migration and avulsion during moderate to large floods will create a complex alternate bar channel morphology with one to three primary channels, increasing salmonid spawning and rearing habitat

# APPENDIX D

# ECOLOGICAL MONITORING PLAN
# FOR
# LOWER CLEAR CREEK
# FLOODWAY REHABILITATION PROJECT

***Please Note That Some Figures Have Been Removed To Reduce File Size**

***Presented To*:**

**CALFED Bay Delta Program**
**1416 Ninth Street, Suite 1155**
**Sacramento, California 95814**

**Contract Number: 114209J022**

***Prepared By*:**

**Bureau of Reclamation**
**Northern California Area Office**
**16349 Shasta Dam Blvd.**
**Shasta Lake City, CA 96019**
**&**
**Western Shasta**
**Resource Conservation District**
**3294 Bechelli Lane**
**Redding, CA 96002**

**January 2000**

## TABLE OF CONTENTS

## INTRODUCTION

On behalf of the Lower Clear Creek Restoration Team (Restoration Team) the Western Shasta Resource Conservation District (WSRCD) applied for a grant to CALFED in May of 1998 to begin restoration of the lower Clear Creek stream channel and floodplain. The Restoration Team is comprised of representatives from various federal, state and local resource agencies as follows:

Bureau of Reclamation
U.S. Fish and Wildlife Service
National Marine Fisheries Service
Bureau of Land Management
National Park Service
Clear Creek CRMP Group
Natural Resources Conservation Service
California Department of Fish and Game
California Department of Water Resources
Western Shasta Resource Conservation District
Central Valley Water Users Association
Central Valley Hydro-power users
Horsetown Clear Creek Preserve

The grant application proposed to restore a severely degraded reach of lower Clear Creek impacted by extensive gold and gravel mining activities. The project was logically divided into four phases and includes restoration of floodplains and upland habitats upstream of the project where borrow activities are planned. Phase 1 of the project was completed in 1998 with funds provided through the Central Valley Project Improvement Act (CVPIA) and included construction of a natural bar (plug) to reduce stranding of juvenile salmon and improve passage conditions for adult salmon migrating upstream. Phase 2 will initiate restoration of floodplains and further reduce stranding of juvenile salmonids by filling aggregate extraction pits within the stream channel and floodplain. Phase 3 will focus on rehabilitating the active stream channel, improving floodplain connectivity, and revegetation of natural riparian communities. Phase 4 will restore flow into a section of historic stream channel diverted by aggregate extraction. The grant proposal submitted to CALFED requested funds to implement Phases 2 through 4 however, only Phase 2 of the project was funded during the 1998 solicitation process. A second CALFED grant application was submitted in the Spring of 1999 for funding of Phases 3 and 4. This monitoring plan encompasses monitoring activities for all phases under the assumption that all four phases of the project will be implemented.

## CALFED MONITORING PLAN REQUIREMENTS

CALFED requires successful grant applicants to complete ecological and biological monitoring plans where appropriate. For the *Lower Clear Creek Floodway Rehabilitation Project* a monitoring plan must be submitted, reviewed and approved by CALFED. The CALFED Proposal Solicitation Package under which Phase 2 of the *Lower Clear Creek Floodway Rehabilitation Project* was selected states that at a minimum the monitoring plan shall include:

- objectives of the monitoring;
- questions to be addressed through monitoring (hypothesis);
- personnel conducting the monitoring and their related experience;
- duration of monitoring;
- constituents to be monitored;
- sampling methods;
- locations and frequencies of measurement; and
- reporting formats.

The monitoring plan must also incorporate a Quality Assurance Project Plan (QAPP) and annual monitoring reports must be submitted to CALFED presenting findings and a determination as to whether monitoring objectives have been achieved. This monitoring plan was prepared on behalf of the WSRCD by the U.S. Bureau of Reclamation (BR) to comply with CALFED monitoring requirements.

## PROJECT MONITORING OBJECTIVES

The primary objective of the *Lower Clear Creek Floodway Rehabilitation Project* is to initiate rehabilitation by restoring a natural channel and floodplain morphology, and native riparian vegetation. Restoration of a natural channel and floodplain in combination with appropriate flow releases will initiate and sustain natural sediment transport processes and channel migration; restore aquatic, wetland, and riparian habitats; improve floodplain connectivity and riparian regenerative processes; and ecological function to the riverine ecosystem. Successful achievement of this objective is anticipated to provide several ecological benefits within the lower Clear Creek Floodway. These ecological benefits are expected to:

- Reduce juvenile stranding mortality and improve adult salmonid passage conditions;
- Increase salmonid spawning habitat;
- Improve geomorphic processes that create and maintain habitat for salmonids and other aquatic species;
- Improve channel-to-floodplain connectivity, improving nutrient and fine sediment cycling throughout the floodway;

- Increase native riparian vegetation, particularly canopy species (cottonwood) important for avian habitat;
- Reduce exotic vegetation through active removal and replacement with native species, and;
- Improve wetland values.

To evaluate project success relative to the ecological benefits stated above specific monitoring objectives were developed and logically divided into three categories for evaluation (Table 1). The three categories developed include fishery resources, geomorphology, and riparian communities.

**FISHERIES MONITORING OBJECTIVES**

Under current conditions fishery habitat within the project reach has been degraded by removal of alluvial material from the channel and floodplain. Clay and bedrock surfaces have become exposed within the channel reducing the quality and quantity of spawning habitat. The occurrence of shallow braided channels may hinder adult salmon migration upstream during low flow periods that persist during the fall. Several remnant aggregate excavation pits and lowered floodplain surfaces strand fry and juvenile salmonids during periods of fluctuating flow, which are common during the late winter and spring rearing periods. Creation of a restored naturally functioning stream channel and floodplain are anticipated to improve salmon spawning and rearing habitat, reduce the juvenile salmonid stranding, and improve adult passage conditions through the reach.

To evaluate project success in restoring degraded fishery habitat the Restoration Team developed three primary objectives to monitor and evaluate. The objectives were developed to answer specific questions relative to salmonid habitat and survival. The three specific monitoring objectives are:

F1. Improve salmonid rearing and spawning habitat within the project reach.

F2. Reduce juvenile salmonid stranding mortality.

F3. Improve adult passage conditions through the project reach upstream.

**Table 1. Ecological objectives, hypotheses, and study parameters for Lower Clear Creek Floodplain Rehabilitation Project.**

| I) Biological/Ecological Project Objectives For Fishery Resources. | | | | |
|---|---|---|---|---|
| OBJECTIVE/HYPOTHESIS | MONITORING PARAMETER (S) AND DATA COLLECTION APPROACH | DATA EVALUATION APPROACH | MONITORING AGENT, COMMENTS, STUDY PRIORITY | FUNDING |
| Objective F1: Improve salmonid rearing and spawning habitat within the project reach.<br><br>Hypothesis F1. Implementation of channel restoration project will increase the quality and quantity of salmonid (chinook salmon and steelhead trout) habitat within the project study area. | Map meso-habitats and conduct habitat transect measurements for meso-habitats throughout the project study area. Monitor meso-habitat use by rearing juvenile and spawning adult salmonids using direct observation methods, bank observations and snorkel divers, within project site. | Use established IFIM-PHABSIM methodologies to describe habitat availabilities for rearing and spawning salmonids prior to and after habitat restoration. Compare total habitat area and weighted usable area (WUA) for each life stage before and after channel restoration. Compare habitat use in meso-habitats prior to and after habitat restoration. | USFWS<br><br>Spawning use has been monitored over a three year period and some baseline data is available.<br><br>High Priority. | CVPIA 3406(b)(12). |
| ObjectiveF2: Reduce juvenile salmonid stranding mortalities<br><br>Hypothesis F2. Implementation of channel restoration project will decrease stranding induced mortality of adult and juvenile salmonids within the project reach. | Survey stream channel and floodplain locations using direct observation, electrofishing and seining techniques throughout project study area immediately following flood events to determine extent of juvenile stranding. | Compare stranding survey data before and after channel and floodplain restoration efforts are complete. | USFWS<br><br>Stranding of juvenile salmonids is recognized as a serious problem by resource agencies.<br><br>High Priority. | CVPIA 3406(b)(12) |
| ObjectiveF3: Improve adult passage conditions through the project reach upstream.<br><br>Hypothesis F3. Implementation of channel restoration project will improve passage conditions for adult salmon and steelhead trout through the project reach upstream. | Visually assess adult salmon passage during upstream migration through the project over critical riffles to determine if current conditions inhibit adult passage upstream. If passage problems occur, map problem areas and establish transects across critical riffles to quantify hydraulic parameters, water depth and velocity, during the migration period. | If passage problems are identified, describe existing passage conditions and compare hydraulic conditions over critical riffles prior to and after habitat restoration. | USFWS<br><br>Implementation of Phase 1 during 1998 corrected the most serious adult passage concern. Other areas within the project site are not considered to be significant passage problems.<br><br>Moderate Priority. | CVPIA 3406(b)(12) |

**Table 1. Ecological objectives, hypotheses, and study parameters for Lower Clear Creek Floodplain Rehabilitation Project. Continued.**

**II) Biological/Ecological Project Objectives for Geomorphology.**

| Objective/Hypothesis | Monitoring Parameter (s) and Data Collection Approach | Data Evaluation Approach | Monitoring Agent, Comments, Study Priority | Funding |
|---|---|---|---|---|
| Objective G1: Recreate a properly sized alluvial channel morphology.<br><br>Hypothesis G1: Coarse sediment will be mobilized by design bankfull flow (the bed moves) | The monitoring parameter will be percentage of tracer rocks mobilized for different alluvial features (point bars, riffles, pool tails, etc). Tracer rocks will be installed on at least two point bars and two riffles within the project reach, and monitored for mobilization and distance after each discrete high flow event sufficient to cause mobilization. | Tracer rocks will be evaluated by: 1) whether they moved, and 2) how far they moved. The former will allow us to evaluate whether the bed is mobilized by design bankfull discharge, and the latter will provide information on particle travel distance as a function of flow and duration of flow. | WSRCD<br><br>Will allow designers to improve bankfull channel design for later projects.<br><br>Moderate priority | Currently CVPIA, CALFED is anticipated future source. |
| Objective G2: Recreate a properly sized alluvial channel morphology.<br><br>Hypothesis G2: The bankfull channel will migrate or avulse during flows approaching bankfull discharge and larger (the channel migrates) | The monitoring parameter will be bankfull channel location within the valley-wide cross section, and planform location over time. Cross sections will be installed throughout two alternate bar sequences (targeting meander bends). Post-construction aerial photographs will be rubber-sheeted and channel location digitized and overlain on previous channel locations. | Migration or avulsion of the bankfull channel will be evaluated by comparing channel response (feet moved, rate of movement) with the magnitude and duration of flow that caused the channel to migrate. | WSRCD<br><br>Much of this will be collateral information gathered with other geomorphic monitoring activities.<br><br>Moderate priority | Currently CVPIA, CALFED is anticipated future source |
| Objective G3: Recreate a properly sized alluvial channel morphology.<br><br>Hypothesis G3: Flows exceeding design bankfull discharge will begin inundating constructed floodplains. | The monitoring parameter will be water surface elevation within the bankfull channel, and flow discharge for that water surface elevation. At one site assessable during high flows at the project site and borrow site water surface elevations will be predicted during the design phases, and elevations will be measured during high flow events after construction. | Measured water surface elevations will be compared to constructed floodplain elevations, and hydraulic parameters will also be collected to refine hydraulic model. | WSRCD<br><br>Will allow designers to improve bankfull channel design for later projects.<br><br>Moderate priority | Anticipated CALFED Grant |

**Table 1. Ecological objectives, hypotheses, and study parameters for Lower Clear Creek Floodplain Rehabilitation Project. Continued.**

| II) Biological/Ecological Project Objectives for Geomorphology. | | | | |
|---|---|---|---|---|
| OBJECTIVE/HYPOTHESIS | MONITORING PARAMETER (S) AND DATA COLLECTION APPROACH | DATA EVALUATION APPROACH | MONITORING AGENT, COMMENTS, STUDY PRIORITY | FUNDING |
| Objective G4: Recreate a properly sized alluvial channel morphology.<br><br>Hypothesis G4: Flows exceeding design bankfull discharge will begin depositing fine sediments (sand and silt) on constructed floodplains | The monitoring parameter will be water surface elevation within the bankfull channel, flow discharge for that water surface elevation, and fine sediment deposition on floodplains At one site accessible during high flows at the Borrow Site and Project Site water surface elevations will be measured during high flow events after construction, and a depth flow threshold for fine sediment deposition will be sought. | Water surface elevations will be compared to constructed floodplain elevations (to get water depths); then, fine sediment deposition will be measured by cross sections and scour nails, and sediment composition will be documented by bulk substrate sampling. The source of the high flow (tributary derived vs dam spill) will be considered and when feasible (safe), depth integrated suspended sediment samples will be collected and analyzed for particle size distribution. | WSRCD<br><br>Fine sediment deposition on floodplains is critical for natural riparian regeneration. There may also be significant depositional differences between tributary generated flood events and dam generated flood events.<br><br>Moderate priority | Anticipated CALFED Grant |
| Objective G5: Raise channel above bedrock hardpan, increasing alluvial storage within the bankfull channel.<br><br>Hypothesis G5: Subsequent high flows and reductions in sediment supply upstream available upstream of the project will cause bankfull channel to begin incision. | Longitudinal thalweg surveys. Bedrock contacts along the proposed channel centerline will be surveyed as part of the design phase, as-built channel thalweg will be surveyed to document elevation above bedrock contacts, and subsequent surveys will track whether (and how much) incision occurs after specific high flow events that exceed bed mobility thresholds | Compare longitudinal profiles and cross sections prior to and after high flow events to determine patterns of aggredation and deposition. | WSRCD<br><br>Without removing Saeltzer Dam and/or manually adding coarse sediment, reconstructed channel not controlled by bedrock will again begin to incise during high flow events large enough to transport coarse bed material. This monitoring will document where incision occurs and how much.<br><br>Moderate priority | Anticipated CALFED Grant |

**Table 1. Ecological objectives, hypotheses, and study parameters for Lower Clear Creek Floodplain Restoration Project, Continued.**

| II) Biological/Ecological Project Objectives for Geomorphology. | | | | |
|---|---|---|---|---|
| OBJECTIVE/HYPOTHESIS | MONITORING PARAMETER (S) AND DATA COLLECTION APPROACH | DATA EVALUATION APPROACH | MONITORING AGENT, COMMENTS, STUDY PRIORITY | FUNDING |
| Objective G6: Recreate a properly sized alluvial channel morphology with adequate coarse sediment supply.<br><br>Hypothesis G6: As the bankfull channel migrates, coarse and fine sediments will deposit on the inside of meander bend, creating a new functional floodplain. | The monitoring parameter will be bankfull channel width, bankfull channel depth, and perhaps estimates of bankfull channel boundary shear stress. These parameters will be obtained from cross sections installed throughout two alternate bar sequences (targeting meander bends.) | Evolution of cross section shape, dimensions, and perhaps boundary shear stress will be documented before and after discrete high flow events. Channel adjustment will also be considered in light of changing sediment loads, high flow magnitude, and high flow duration. | WSRCD<br><br>Much of this will be collateral information gathered with other geomorphic monitoring activities. Channel dimension evolution will be used to improve future channel designs.<br><br>Moderate priority. | Currently CVPIA, CALFED is anticipated future source. |

**Table 1. Ecological objectives, hypotheses, and study parameters for Lower Clear Creek Floodplain Restoration Project, Continued.**

| III) Biological/Ecological Project Objectives for Riparian Communities. | | | | |
|---|---|---|---|---|
| OBJECTIVE/HYPOTHESIS | MONITORING PARAMETER (S) AND DATA COLLECTION APPROACH | DATA EVALUATION APPROACH | MONITORING AGENT, COMMENTS, STUDY PRIORITY | FUNDING |
| Objective R1: Restore native riparian vegetation on newly created floodplain surfaces.<br><br>Hypothesis R1. The revegetation phase of channel restoration activities will increase the quantity and diversity of native riparian vegetation on reconstructed floodplain surfaces. | Map and describe the composition of riparian vegetation within the project study area prior to and after stream channel and floodplain restoration activities. Continue to monitor project site for a minimum five year period following the completion of restoration activities. | Planform Mapping:<br>Construct maps of riparian vegetation coverage and compare riparian vegetation communities before and after restoration efforts.<br><br>Cross Section:<br>Establish cross sections and sample plots to monitor planting success, natural recruitment, species composition, distribution and density. Duplicate data collection efforts (cross sections, plots, mapping) at control sites located outside of project study area, monitor over time and compare results. | WSRCD<br><br>Moderate Priority | CALFED funding is anticipated |
| Objective R2: Create favorable physical conditions for regeneration of native riparian species on restored floodplains.<br><br>Hypothesis R2. Implementation of channel and floodplain restoration activities, combined with favorable hydrologic conditions during seed dispersal period, will increase natural regeneration of native riparian species on constructed floodplain surfaces. | Monitor natural recruitment of riparian species on newly created floodplain surfaces for a minimum of five years following completion of restoration activities. | Establish cross sections and sample plots on newly restored floodplains. Monitor natural recruitment of riparian vegetation. Compare recruitment, density, distribution and species composition to that observed at control sites. | WSRCD<br><br>Moderate Priority | CALFED funding is anticipated |

## GEOMORPHIC MONITORING OBJECTIVES

Construction of Whiskeytown Dam, Saeltzer Dam and gravel extraction have significantly reduced the magnitude and frequency of natural fluvial geomorphic processes that are necessary to maintain healthy ecological functions in lower Clear Creek. Gravel excavation removed point bars, floodplains, and riparian vegetation, leaving an unconfined stream channel with multiple channels and numerous open extraction pits. In addition, gold dredging at the Reading Bar borrow site destroyed the floodplain and presently confines the low flow channel between dredger tailings.

The overall geomorphic objective at both the project site and borrow site is to create a single thread channel morphology that is properly sized to the anticipated future sediment transport and flow release regimes. To achieve this desired condition, the Restoration Team developed two basic questions to be addressed by geomorphic monitoring: (1) Are natural geomorphic processes being restored by the project (Restoration of Processes), and (2) how is the channel location and morphology adjusting during high flow events (Project Performance)? The first question addresses project performance as it relates to ecological and geomorphic restoration objectives, while the second addresses how well the channel was built by targeting critical channel locations most susceptible to undesired channel adjustment. For monitoring purposes these two basic geomorphic questions were further broken down into more specific process related objectives that can be readily quantified and evaluated.

Specific geomorphic restoration objectives include:

G1. Riffle matrix particles ($D_{84}$) are mobilized by design bankfull discharge (3,000 cfs)

G2. Bankfull channel migrates across floodway

G3. Bankfull channel capacity is 3,000 cfs; as flow exceeds 3,000 cfs, flow begins to spread across constructed floodplains

G4. Flows inundating floodplain to a depth > 1 ft causes fine sediments to deposit on floodplain.

G5. Introducing gravel via the restoration project will reduce bedrock exposure in the channel and upstream gravel augmentation will help maintain this condition.

G6. As bankfull channel migrates across floodway, point bars and new floodplains are formed as it migrates

Recall that two sites are being restored adjacent to the creek; the gravel mining reach project site, and the Reading Bar borrow site. All six geomorphic process objectives are adopted for the gravel mining reach project site; however, because the Reading Bar site will be strictly a floodplain and bank rehabilitation project, only Objectives 2, 3, 4, and 6 apply.

### RIPARIAN MONITORING OBJECTIVES

Understanding that the overall goal of the project is to rehabilitate natural form and function of the stream channel and floodplain, the first step is to re-create the physical form of the channel and floodplain.  Following completion if the initial step, riparian restoration objectives to help achieve the project goal include revegetation of reconstructed floodplains, promotion of natural regeneration/recruitment by creating favorable physical conditions for natural riparian regeneration, minimizing disturbance of existing riparian vegetation, and removal of exotic plant species within the project area.

The riparian revegetation component is as important to project success as proper geomorphic channel design.  Riparian vegetation provides much of the terrestrial and aquatic habitat in healthy river ecosystems, while stabilizing riverbanks, dissipating floodwaters, trapping fine sediment, and creating hydrologic complexity that creates channel diversity.  The long-term goal of the riparian revegetation component is to restore the extent, morphology, and dynamics of riparian vegetation within the floodway that can be maintained by the current flow regime.  An additional short-term goal is to provide floodplain stability for the floodway rehabilitation project.

Wetland revegetation will include a combination of natural plant colonization (i.e., passive revegetation) and artificial planting (i.e., active revegetation).  Natural plant colonization will be conducted by creating favorable physical conditions for natural regeneration, while artificial planting will occur on the emergent bench habitats by planting native emergent wetland plant species.  Following removal of borrow material, the primary goal of creating off-channel wetlands is creation of higher quality wetland habitats than those currently existing on-site and throughout the lower Clear Creek corridor that resulted from historic gold and gravel mining disturbances.

Restoration areas occur along portions of the project site and at each borrow site.  These areas include locations for both natural colonization and active planting efforts.  The Project Site consists of approximately 70 acres of riparian planting areas, 23 acres that will be part of the restored active Clear Creek stream channel, and approximately 100 acres of frequently flooded floodplain surfaces left for natural riparian plant recolonization.  The Reading Bar borrow site consists of approximately eight acres of riparian planting areas, a 0.30 acre emergent wetland, and approximately15 acres that will be part of the restored active Clear Creek stream channel and/or open areas left for natural plant recolonization.  The Former Shooting Gallery borrow site will consist of approximately 11 acres of riparian planting areas, approximately three acres of emergent wetland, approximately seven acres of open water wetlands, and 36 acres for natural plant recolonization.

The revegetation goal is to encourage natural regeneration wherever possible, while revegetating where necessary, to restore riparian vegetation coverage and complexity on lower Clear Creek. Monitoring efforts will focus not only on the revegetation success, but also on how revegetation develops into a multiage, structurally diverse and species rich riparian forest. Specific objectives related to riparian stand function and recovery are:

R1. Restore native riparian vegetation on newly created floodplain surfaces by planting patches of native riparian hardwoods on surfaces that are inundated at a frequency appropriate for each species life history requirements. The hydraulic roughness on the outside bends of the floodplain will be elevated at critical locations to reduce the potential of catastrophic channel avulsion immediately following construction.

R2. Promote natural regeneration/recruitment on reconstructed floodplains, by creating areas where favorable physical conditions for natural riparian hardwood regeneration can evolve.

## MONITORING ENTITIES AND EXPERIENCE

Monitoring efforts are anticipated to include multiple agencies, environmental consulting firms, academia, and resource volunteers working cooperatively under the guidance of the WSRCD, BR, USFWS, Bureau of Land Management (BLM), and California Department of Fish and Game (CDFG). Fishery resource monitoring elements will be conducted by USFWS offices in Red Bluff and Sacramento. The WSRCD will be responsible for implementation of monitoring elements identified for the riparian and geomorphic monitoring parameters. McBain and Trush, fluvial geomorphologists, and North State Resources, Inc., consulting environmental scientists, assisted the WSRCD in the development of specific monitoring plans for riparian and geomorphology. A more thorough description of monitoring entities relative to fishery resources, geomorphology, and riparian habitats are discussed below.

### FISHERY RESOURCES

The U.S. Fish & Wildlife Service's Ecological Services Division Instream Flow Branch in Sacramento and the Northern Central Valley Fish and Wildlife Office in Red Bluff will work cooperatively to conduct the fishery resources monitoring effort.

Mark Gard PhD, is the Instream Flow Branch Chief for the U.S. Fish and Wildlife Service and will supervise data collection and habitat modeling efforts described under element F1 of the monitoring plan.  Mark is a recognized expert in the use of IFIM and has over 10 years of experience in fisheries research.

Mr. Matt Brown received a Bachelors of Arts Degree in Biology from the University of California at Santa Cruz in 1986 and a Master of Science Degree from Arizona State University in 1990.  He worked as a non-game fish biologist for the Arizona Game and Fish Department from 1990 to 1991.  He worked for the Fish and Wildlife Service on threatened and endangered fish in New Mexico from 1991 to 1993.  Matt began work on chinook salmon at the Northern Central Valley Fish and Wildlife Office in January 1994.  His current work focuses on habitat restoration under the Central Valley Project Improvement Act and evaluating the impacts of water development. Matt Brown will assist and coordinate with Mark Gard's habitat modeling efforts and will supervise monitoring of juvenile stranding and adult passage.

### GEOMORPHOLOGY AND RIPARIAN VEGETATION

The WSRCD will be responsible for implementation, coordination and management of project monitoring efforts for the riparian and geomorphology elements of the Monitoring Plan.  Mr. Jeff Souza is currently the Projects Manager for the Western Shasta Resource Conservation District (RCD) in Redding and has been with the RCD  for the last four years.  He has a Bachelor of Science degree in Environmental Biology from California Polytechnic State University, San Luis Obispo and a Masters degree in Agriculture from California State University at Chico.  Jeff is a native of the northern Sacramento Valley and has been working in the fields of  resource management and restoration for over ten years.  As Projects Manager for the RCD, Jeff has successfully managed over two dozen projects in the areas of wildlife and fisheries restoration, erosion control, fuels reduction, and coordinated resource planning.

## MONITORING DURATION, CONSTITUENTS, AND METHODS

### FISHERY RESOURCES

***Objective F1- Improve salmonid rearing and spawning habitat within the project reach*.**
Modeling of spawning and rearing habitat will occur in the restoration site prior to and after restoration actions are completed.  Restoration actions are currently scheduled to begin in the summer and fall of 1999 with the initiation of Phase 2.  Completion of Phase 4, which is the final Phase, is planned to occur in the summer of 2001.  Prior to implementation of restoration activities (Spring of 1999) USFWS will conduct a field reconnaissance survey to determine specific study site boundaries, transect locations and develop meso-habitat maps.  Hydraulic data on water surface elevations, bed topography, cover and substrate will be collected for input into a 2-dimensional hydraulic and habitat model.  Following construction and calibration of hydraulic data sets the 2-dimensional model will be used to predict water velocities and depths present in

the study site over a range of discharges that are likely to occur within study site under future flow release conditions. This output, along with the substrate and cover distribution in the site and Habitat Suitability Criteria previously developed on Clear Creek or other streams, will be used to predict the amount of spawning and rearing habitat present over a range of discharges in the restoration site prior to restoration actions.

Implementation of restoration actions will create a new channel alignment and floodplain throughout the project site. Therefore, a second survey (2002) will be required to map habitat conditions and identify new transect locations. Hydraulic data on water surface elevations, bed topography, cover, and substrate will be collected for the restored channel configuration for input into a 2-dimensional hydraulic and habitat model. Data sets will then be assembled for input and calibration of the 2-dimensional hydraulic model. Following model calibration, the 2-dimensional model will be used to predict water velocities and depths over a range of expected flows. This hydraulic output will then be used with cover and substrate distribution data and Habitat Suitability Criteria to predict the amount of salmonid spawning and rearing habitat present within the study site under restored conditions.

A Final Report will be completed at the end of the study comparing the amount of rearing and spawning habitat for a range of discharges present in the study site before and after restoration actions. Habitat comparisons will be conducted for fry, juvenile and spawning life stages of chinook salmon and steelhead trout. Information developed from this study may result in additional restoration recommendations and may assist in development of flow release patterns.

***Objective F2- Reduce juvenile salmonid stranding mortality.***
The current degraded conditions of the lower Clear Creek channel create favorable conditions for stranding juvenile salmonids. USFWS and CDFG have documented stranding of juvenile salmonids in several locations within the Project Site. Implementation of channel and floodplain restoration actions is expected to reduce stranding mortality. To evaluate the success of the restoration effort the USFWS will continue existing surveys of the project site through implementation of the project. A description of survey methods follows.

The USFWS's Northern Central Valley Fish and Wildlife office currently conducts surveys to document the occurrence of salmonid stranding throughout the Project site. The entire Project site topography has been mapped and digitized aerial photographs are used to depict locations of all potential stranding sites. Each potential stranding site has been described based on location, physical characteristics and hydrology (isolated pond, inundated at high flow, or connected to main channel).
Pedestrian surveys are conducted of the entire Project site by qualified biologists throughout the rearing season. Data recorded for each survey include date, time, Clear Creek Flow, and weather conditions. Observations recorded during each survey for each location include: 1) presence of juvenile chinook salmon at each location; 2) qualitative estimate of the number of juvenile

chinook salmon observed; 3) description of current hydrologic characteristics; and, 4) water temperature.

New project topographic maps and aerial photographs will be developed following completion of the restoration project. USFWS biologists will survey the project site during periods of high flow and throughout the juvenile rearing season to identify and map potential stranding locations that may exist under restored conditions. Should potential stranding locations exist, USFWS will continue surveys, quantify the magnitude of the stranding problem and develop potential solutions for recommendation to the Lower Clear Creek Restoration Team.

Because restoration efforts are designed to restore natural fluvial processes through creation of a dynamic channel morphology, channel migration is expected to occur over time. However, if the restored channel is not in balance with future flow and sediment transport rates there is a potential that major channel migration could occur during flood events. Should large scale shifts in the location of the channel be observed USFWS will again survey the project area and document potential stranding locations.

Annual progress reports will be submitted to the Restoration Team and CALFED describing survey methods, frequency of surveys, and results. A final report will be submitted to the Lower Clear Creek Restoration Team one year after construction of the restoration project. The final report will describe survey methods, summarize annual survey results, and compare stranding conditions prior to and after restoration.

***Objective F3- Improve adult passage conditions through the project reach upstream.***
The existence of braided channels and gravel extraction pits in and adjacent to the creek channel may hinder passage of adult salmon upstream during low flow. To document impacts to adult passage the Northern Central Valley Fish and Wildlife office will visual assess adult salmon passage conditions during upstream migration over critical riffles within the project site prior to implementation of restoration efforts. If passage problems are observed, problem areas will be mapped and evaluated in more detail as follows. Transects will be established across critical riffles to collect hydraulic data (water depth, velocity, water surface elevation and discharge) to fully describe existing passage conditions.

After restoration of the project site is completed USFWS biologists will again visually assess adult passage conditions through the site. Should passage problems be observed transects will be established at each location and hydraulic data collection efforts will be repeated. Additional hydraulic data will then be collected under different flow release conditions for development of hydraulic models to describe the relationship between passage conditions and stream discharge for each critical riffle within the restored channel. Results of hydraulic modeling, will provide information to assist development of recommendations to correct passage conditions through implementation of mechanical restoration actions or improved flow releases. Hydraulic modeling efforts for fish passage will be coordinated with hydraulic and habitat modeling efforts described under Objective F1.

A final report will be submitted to the Restoration Team and CALFED describing the effectiveness of restoration actions to improve fish passage conditions. The report will include detailed descriptions of methods used, results, and recommendations for corrective measures if necessary.

### GEOMORPHOLOGY

***Objective G1-Riffle matrix particles ($D_{84}$) is mobilized by design bankfull discharge (3,000 cfs)***. The bankfull channel morphology was designed so that the $D_{84}$ particle size in riffles would be just mobilized by the design bankfull discharge (3,000 cfs). Bed mobility models were used to predict the channel dimensions necessary for a 3,000 cfs flow to mobilize the $D_{84}$ particle size. In the two long-straight riffles shown on Plate 1, tracer rocks representing the local $D_{84}$ particle size (and other particle sizes) will be used to evaluate whether bed mobility objectives are being met in the design channel. Cross sections will also be established through two alternate bar sequences, which will include cross sections and marked rocks through point bars, pool tails, and riffle crests to document bed mobility on other geomorphic features. Surface pebble counts will be collected for as-built conditions, and marked rocks inserted at many cross sections shown on Plate 1. After each peak flow larger than 2,000 cfs, the marked rocks will be monitored. We expect changes in particle size as the constructed bed surface adjusts during high flows, therefore, after the first water year, we will re-document particle size with repeat pebble counts, and set out new sets of tracer rocks. Tracer rocks in subsequent years will be monitored after each peak flow greater than 2,000 cfs. The objective is to determine if $D_{84}$ tracer particles are being mobilized by flows up to and exceeding the design bankfull discharge (3,000 cfs).

***Objective G2-Bankfull channel migrates across floodway.***
As-built topographical surveys will be conducted as part of construction implementation verification; cross section pins established at the end of construction will serve as long-term cross section monitoring endpoints. Ground level photographs will be taken of each cross section and aerial photographs will be flown after construction to document as-built conditions at both the project site and Reading Bar borrow site. Using the tracer rocks as an indicator of bed movement and potential for channel migration, cross sections will be resurveyed after flows that mobilize the tracer rocks. Subtle channel migration will be documented by these repeat cross sections, while repeat aerial photographs will be used to document more dramatic shifts in channel location. Ground level photographs and aerial photographs will be re-taken every three years or after a high flow that causes dramatic changes to channel morphology, whichever is sooner.

***Objective G3-Bankfull channel capacity is 3,000 cfs; as flow exceeds 3,000 cfs, flow begins to spread across constructed floodplains***.

The bankfull channel morphology was also designed to convey the design bankfull discharge (3,000 cfs); flows larger than 3,000 cfs should begin to spill onto the floodplains. The HEC-2 hydraulic model was used to develop the channel dimensions at the gravel mining reach project site to achieve this objective, while at the Reading Bar site, we were fortunate to have monitored water surface profiles during a 2,900 cfs flow, so design floodplain elevations should be very accurate. Monitoring water surface elevations on cross sections through both the project reach and Reading Bar reach during 3,000 cfs magnitude flows will evaluate whether this conveyance objective is being met. This will be conducted at all sampling sites shown on Plate 1. At the Reading Bar borrow site, eleven cross sections were established in 1998 to monitor Phase 1 reclamation (these are not shown on Plate 1). These cross sections will continue to be monitored and ground level photographs taken to evaluate final reclamation of the Reading Bar site as Phase 2 is implemented.

***Objective G4-Flows inundating floodplain to a depth > 1 ft causes fine sediments to deposit on floodplain.***

Streams typically transport most of their sediment load (up to 95 percent) as finer sediments suspended in the water column during high flows. Under natural conditions, a large proportion of this fine sediment may deposit on floodplain surfaces, which creates seed-beds for riparian regeneration and reduces fine sediment deposition within the bankfull channel. Stream reaches downstream of a large storage reservoir (e.g., Whiskeytown Dam) often have very little fine sediment transported in suspension because the reservoir traps sediments derived from the upstream watershed. We are concerned that the finer components of the suspended sediment load (<0.1 mm) in Clear Creek is small due to Whiskeytown Dam, which will reduce fine sediment deposition on floodplain surfaces. We will monitor fine sediment deposition on floodplains by taking detailed elevation measurements and photographs at a subset of the cross sections shown on Plate 1. Surveys will be conducted before and after high flow events that inundate the floodplains, and water surface elevations will be monitored to evaluate whether there is a depth threshold for fine sediment deposition. Detailed elevation measurements will also be conducted at selected permanent vegetation plots shown in Plate 2. This information will be used in conjunction with the riparian monitoring to evaluate potential correlations between natural riparian regeneration and areas of fine sediment deposition.

***Objective G5-Introducing gravel via the restoration project will reduce bedrock exposure in the channel and upstream gravel augmentation will help maintain this condition.***

Gravel mining and the impact of upstream dams in reducing coarse sediment supply have cumulatively caused channel downcutting in the reach, and increased exposure of clay hardpan bedrock in the low flow channel. Because salmon cannot spawn in bedrock, and aquatic insect production in bedrock is low, raising the channelbed above the bedrock by massive gravel introduction will greatly improve aquatic habitat conditions. Our primary concern is, because Whiskeytown Dam will continue to trap coarse sediment from the upstream watershed into the future, the restoration site will begin downcutting a short time after project completion. Removal of Saeltzer Dam and continuing the gravel introduction program will reduce the risk or degree of downcutting, but it still may occur. The primary method of monitoring channel grade through the reach will be collective cross sections, thalweg profiles through the entire reach, and substrate mapping at the alternate bar monitoring sites supported with photographs of each site (Plate 1). Monitoring will again be triggered by flows that exceed bed mobility thresholds, as described under other objectives. In addition, we will continue measuring coarse sediment transport in Lower Clear Creek, but move the sampling site to a reach immediately upstream of the gravel mining reach project site (Plate 1). This sampling will provide empirical sediment transport input for applying a HEC-6 bedload transport model for predicting scour and fill at the project site, and evaluating how well the model predicts scour and fill compared to actual channel response.

***Objective G6-As bankfull channel migrates across floodway, point bars and new floodplains are formed as it migrates***.
As a stream migrates across the floodway, they build bars and floodplains on the inside of the migrating meander bend. This floodplain formation is not solely dependent on the channel migrating; an upstream sediment supply is needed to physically construct the point bar and floodplain on the inside of the bend. Restoration efforts on lower Clear Creek (including this project) will continue to add coarse sediment to the stream corridor to help create and maintain point bars and floodplains. Cross sections will again be the foundation for monitoring whether this objective is being met. At the two alternate bar monitoring sites and Reading Bar borrow site, cross sections will be established/monitored at certain locations where migration is expected to occur: at the outside of meander bends. In addition photo monitoring sites will established at each cross section. This monitoring will repeat the methods used to evaluate Objective 3, except that it will focus on the inside of the bend (in the depositional area) rather than the outside of the bend (erosional area).

**Project Performance Objectives**

There are two primary project performance objectives:

1. Provide short-term stability at two critical meander bends to prevent immediate channel recapture into old location

2. Design channel should convey bankfull discharge (3,000) cfs before spilling onto floodplain.

Evaluating these two objectives, the six geomorphic process objectives, and riparian vegetation objectives described in later sections, requires an accurate measure of streamflow to establish cause and effect relationships between stream response and discharge. Therefore, streamflow monitoring is also described below.

**Short-Term Stable Meander Bends**

The overarching geomorphic objective of the project is to restore the ability of the channel to move sediment, adjust its dimensions, and migrate across the floodway. However, we would prefer, at least for the first five years while the riparian vegetation grows, that the channel remain relatively stable in two locations within the project reach where the stream is susceptible to re-occupy its pre-restoration channel. These locations are at Stations 214+00 and 180+00 on Plate 1. In these two locations, cross sections will be established through the apex of the meanders to monitor lateral migration, bank undercutting, and adjustments in channel morphology.

**Hydraulic Conveyance**

Channel geometry to convey the design bankfull discharge is a primary design objective. As flows begin to exceed 3,000 cfs, flow should begin to inundate floodplain surfaces and deposit fine sediments being transported in suspension. If flows exceeding 3,000 cfs are still contained within the bankfull channel, then higher than designed for shear stresses could occur, causing larger bedload transport rate, increased risk of channel downcutting, and increased risk of habitat loss. A HEC-2 water surface profile model was used to help design the bankfull channel dimensions to convey the design bankfull discharge; it will also be used to evaluate hydraulic conveyance performance. At all cross sections shown on Plate 1, water surface elevations for distinct high flow events will be monitored and compared to floodplain elevations. These cross sections will also be included in the HEC-2 model, and the roughness values in the HEC-2 model can be calibrated to improve the predictive capability of future designs.

**Streamflow Gaging**

Evaluating the response of the channel to a given flow requires two additional measures in addition to measuring the response itself: the magnitude of the flow that caused the channel response, and the flood frequency of that flood for perspective. For example, we would not expect the channel to avulse across the floodway during a 1.5 year flood, but would expect the bed surface to be mobilized. Long-term streamflow gaging has been conducted by USGS at the Igo gaging station a few miles upstream, and this gage will provide the primary flow measurement point for evaluating the project. We have installed a second continuous recording gaging station at the downstream end of the project site (see Plate 1) to provide more local flow data and serve as a backup to the USGS gaging station. In addition, we have installed and will continue to monitor four staff plates installed throughout both the gravel mining restoration site and Reading Bar borrow site to document local water surface elevations for a given discharge.

**Monitoring Schedule and Reports**

All data and reports will be available in electronic format, and will be archived on CDROM for distribution to interested parties.  Cross section, longitudinal profile, and most other field data will be entered and archived in Microsoft Excel spreadsheets. Planform maps will be digitized into and archived in AutoCAD using NAD 1927 horizontal and vertical datum.

Because geomorphic processes occur during high flow events in the fall and winter, progress reports will be prepared at the end of the fall/winter high flow season (June). Monitoring at the Reading Bar borrow site will begin in the winter of 1999/2000, while monitoring at the project site will not occur until Phase 3 is completed in the fall of 2001. Therefore, progress reports will be produced as follows:

June 2000: Reading Bar borrow site year 1 progress report.
June 2001: Reading Bar borrow site year 2 progress report.
June 2002: Reading Bar borrow site year 3 progress report, Phase 3 project site year 1 progress report.
June 2003: Phase 3 project site year 2 progress report, Phase 4 project site year 1 progress report.
June 2004: Phase 3 project site year 3 progress report, Phase 4 project site year 2 progress report.

A final report of geomorphic monitoring at the project site and Reading Bar borrow site will be completed by December 2004 provided project implementation occurs on schedule. Should delays in the implementation schedule occur the geomorphic monitoring schedule will be adjusted accordingly.

## RIPARIAN VEGETATION

***Objective R1-Restore native riparian vegetation on newly created floodplain surfaces by planting patches of native riparian hardwoods on surfaces that are inundated at a frequency appropriate for each species life history requirements. The hydraulic roughness on the outside bends of the floodplain will be elevated at critical locations to reduce the potential of catastrophic channel avulsion immediately following construction.***

Some riparian plant species are sensitive to inundation (Fremont cottonwood, Oregon ash, etc.) while others are more sensitive to deposition (white alder). These sensitivities, combined with seed dispersal times are often the major physiologic factors driving vegetation patterns adjacent to streams; in regulated rivers these relationships lead to riparian vegetation encroachment. Plant success after revegetation will be determined by whether planted riparian hardwoods were thriving in their planted environments. Riparian plant recruitment into revegetated floodplains should be similar in composition to revegetated stands in the same inundation regime. A thriving riparian stand will have an increasing canopy cover and understory that is increasing in species richness, while riparian encroachment into the low water channel should be nonexistent.

To evaluate revegetation development, 10 meter radius circular plots will be established within each patch type planted, and band transects will be used (Bonham 1989, Kent and Coker 1992). Circular plots shall be randomly placed within any of the patches of a specific patch type using CAD software. The number of randomly sampled circular plots is determined by the total area of each patch type planted within a construction phase divided by 2 acres (Figure 2). Because plot number is determined by the *total area* of a patch type, some patches do not have circular plots. For example, if a singular patch is smaller than the radius of the circular plot it will not sampled, or if the total acreage of a patch type is less than 2 acres only one circular plot will be used. Within each circular plot, plant species, each species estimated percent cover, maximum and average height, youngest, and oldest hardwood age, stem number (for hardwoods < 7.5cm) and diameter at breast height and stem number (for plants > 7.5 cm) will be measured. Photo monitoring will also occur at each circular plot to help document conditions. Additionally, permanent 2 meter wide band transects will be sampled along valley wide cross sections established in alternate bar reaches during geomorphic sampling, and along cross sections where piezometers have been established (Figure 2). Plant species, estimated plant species cover, hardwood age class, average and maximum canopy height, substrate transitions, and visible soil moisture will be quantified during band transect sampling. Photo monitoring stations will also be established across each cross section to help describe changing conditions to riparian vegetation through the monitoring period.

Fine sediment deposition during floods is a response to elevated hydraulic roughness over floodplains caused by maturing riparian vegetation. Fine sediment accumulation is an important ecosystem process on floodplains because it promotes the development of seed beds where regeneration can occur and provides richer soils for the needs of plants that can not live closer to the channel where substrate is coarser and where groundwater is more responsive to rapid drops in river stage. As fine sediment continues to deposit channel confinement increases, which leads to greater pool depths and fish habitat complexity.

Sediment deposition and channel confinement related to vegetation will be monitored using a combination of square permanent plots and previously established band transects. Permanent 10 x 10 meter plots will be established on floodplains and in scour channels to evaluate sediment deposition (Plate 2). Substrate composition, stem density within the plot and upstream from the plot (or in the direction of flood flow), plant growth habits, plant species, and substrate size will be evaluated.

***Objective R2-Promote natural regeneration/recruitment on reconstructed floodplains, by creating areas where favorable physical conditions for natural riparian hardwood regeneration can evolve.***

Riparian hardwood recruitment is vital to the perpetuation and structural diversity within riparian vegetation. Riparian rehabilitation success could be easily gauged in an ecosystem context by the presence or absence of willow and cottonwood seedlings, and the reduction of riparian vegetation encroachment. Not only is fine sediment deposition important for seedling recruitment, but hydrologic conditions in the year of germination and subsequent years must provide the water that developing seedlings need without scouring or in some other way killing them. If recruited plants cannot be semi-annually scoured from within the active channel riparian vegetation will begin to encroach in the rehabilitated channel. While the project has some control over the physical conditions leading to successful hardwood recruitment on floodplains and reducing riparian encroachment, the project has no control over where and how much fine sediment will deposit, and over what annual flood magnitudes/timing and flow recession rates sedimentation occurs.

Data collected while monitoring objective R1 will be used to evaluate hardwood recruitment and encroachment. Groundwater elevations in piezometers will be monitored and related to changes in river stage, which will complement band transect based vegetation data. Evaluating the groundwater river stage relationship will help in understanding the physical variables that relate to the presence (or absence) of naturally recruited hardwoods.

Exotic plants pose the greatest threat to riparian rehabilitation success. Exotic plants could potentially out compete plantings and colonize open areas where natural recruitment could occur. If post project conditions favor exotic plant species over native hardwoods, than the environmental conditions that promote exotic species over natives will be evaluated. Micro-climatic measurements of relative humidity and air temperature will be taken within all monitoring plots using a sling psychrometer. Trends in species composition will be evaluated in context to geomorphology, distance from the active channel, and microclimate. Additionally, data collected while monitoring objective R1 will be used to evaluate exotic plant species success, recruitment, and inter/intra specific competition that could lead to the exclusion of native hardwood species.

### Monitoring Schedule and Reports

Monitoring will begin immediately following the revegetation of each construction phase. Monitoring will occur again towards the end of each growing season in October for a period of five years. Progress reports will be produced as follows:

June 2000: Reading Bar and Phase 2a site as-built report
January 2001: Reading Bar and Phase 2a 1-year progress report, and 2b site as-built report
January 2002: Reading Bar and Phase 2a 2-year progress report, Phase 2b 1-year progress report, and Phase 3 as-built report
January 2003: Reading Bar and Phase 2a 3-year progress report, Phase 2b 2-year progress report, Phase 3 1-year progress report, and Phase 4 as-built report
January 2004: Reading Bar and Phase 2a 4-year progress report, Phase 2b 3-year progress report, Phase 3 2-year progress report, and Phase 4 1-year progress report

A final report of riparian monitoring at the project site and Reading Bar borrow site will be completed by December 2004 provided that implementation occurs on schedule. Should delays in the implementation schedule occur, the riparian monitoring schedule will be adjusted accordingly.

## QUALITY ASSURANCE PROJECT PLAN

All field data collection will occur under the supervision of qualified resource professionals, i.e. fish and wildlife biologists, geomorphologists, botanists, and/or engineers where appropriate. All work conducted on this design to date has used State Plane Coordinate System and NAD 1927 datum; future monitoring will continue this standard. Because this base control has been established by licensed surveyors, vertical and horizontal accuracy should continue to be excellent. Cross sections and longitudinal profiles will be collected by skilled technicians with an engineers level, which provide excellent vertical accuracy. Data will be recorded in hardbound water-resistant transit books, and study site setup, survey, and field note recording will follow standard stream monitoring protocols published by Harrelson et al., 1994. Field data will be entered into Excel spreadsheets by a member of the survey crew, and independently reviewed by a senior member of the survey crew for quality control.

# REFERENCES

Harrelson, C.C., Rawlins, C.L., and Potyondy, J.P. 1994. *Stream channel reference sites:an illustrated guide to field technique.* Gen. Tech. Rep. RM-245. Fort Collins, CO. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61p.

# CHANNEL GEOMORPHOLOGY MONITORING METHODS

## PHASES 2 AND 3 OF THE LOWER CLEAR CREEK FLOODWAY REHABILITATION PROJECT

# LIST OF FIGURES AND ATTACHMENTS

## Figures



## Attachments (on CD provided with this appendix)

a. Bed scour template.xls - Scour core installation and monitoring data form
b. Pebble Ct V2.xls - Pebble count analysis template
c. Photomonitoring Example.pdf - Completed photopoint data sheet for a Trinity River location
d. Photopoint Data Sheet.doc - Sample photopoint data sheet
e. Piezomonitor TemplateV3.xls - Filed data form for reading piezometers
f. Sieve Template-1phi.xls - Particle size analysis template
g. TRACERS.xls - Marked rocks inventory data form
h. XS-templ.xls - Survey data entry and graphical plotting template

## INTRODUCTION

The monitoring component of a functional adaptive management program requires field monitoring, data compilation and analysis, and interpretation of results in order to improve designs and implementation. This appendix provides a detailed description of the methods required to complete the field monitoring tasks for Phases 2 through 4 of the Ecological Monitoring Plan for the Lower Clear Creek Floodway Rehabilitation Project. It is intended to provide enough detailed discussion and description of technique so that monitoring personnel can use it as a guide for developing field monitoring programs to satisfy the Fisheries Resources and Geomorphology monitoring objectives. These objectives are described in the Ecological Monitoring Plan and the reader should be familiar with them.

Please note that many of the methods and techniques presented in this appendix are also presented in the U. S. Forest Service General Technical Report RM-245, *Stream Channel Reference Sites: An Illustrated Guide to Field Technique* (Harrelson et al. 1994). This guide is periodically referenced herein as RM-245. Monitoring personnel are encouraged to obtain and read RM-245 as many of the following topics are discussed in greater detail than presented in this appendix. In addition, other fundamental techniques not discussed in this appendix are presented in RM-245 that may prove beneficial for monitoring personnel (e.g., surveying, measuring discharge, characterizing bed and bank material). Copies of RM-245 can be obtained From the U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado 80526.

In addition to describing monitoring procedures for Clear Creek, this appendix provides materials lists to complete the installation of monitoring stations. Most of the materials that are listed can be purchased at a conventional hardware store, however others (e.g., aluminum tags, field notebooks, surveying gear) must be purchased from survey supply houses. One such supply house is Forestry Suppliers, Inc., a company specializing in tools, instruments, and equipment for natural resource sciences. Where applicable, the Forestry Suppliers catalog number will follow an item in parentheses, for example: (FS #49217). Forestry Suppliers usually offers several brands or types of the same general item; the catalog number provided is merely an example of the type of equipment recommended for the monitoring task. Forestry Suppliers, Inc. can be contacted at (800) 360-7788, or via the Internet at: http://www.forestry-suppliers.com.

# MONITORING METHODS

## 1.0 FIELD NOTEBOOKS

A field notebook may very well be the most important piece of equipment used for any project. Most, if not all site observations, sketches, and measurements will be recorded in the field notebook. As described in RM-245, most hydrologists use bound field notebooks that are about 5” x 7”, with alternate graph pages, ledger pages, and various tables and equations at the back for reference. Laid flat, they photocopy onto standard 8 ½” x 11” sheets for standard filing. Each field book should be assigned its own unique number (e.g., Clear Creek Monitoring Field book No. 1). If field notebooks contain weatherproof paper, (e.g., “Rite in the Rain” brand (FS #49326)), then a harder #4 lead pencil is recommended as #2 lead tends to smudge on weatherproof paper.

Field notes should always be written clearly and legibly. It is likely that numerous field personnel will use the same notebook before it is completely filled, therefore, it is imperative that all notes and sketches be written with the intent that others will need to interpret them (possibly years in the future). Always begin notes for a new site visit on a fresh page, and include the names of all field crew members, date, time, and weather conditions. All notes and sketches should be made dark enough so that they photocopy well, and should always be written in pencil. Notes should never be erased (particularly survey notes); they should be lined out and any corrections should be noted and initialed.

Clearly label the inside front cover or first page of the field notebook with a name, address, and phone number in case the book is lost. Including a written offer for a reward is also a good idea. Leave the first two or three pages blank to list the book’s contents and any other special notes (e.g., symbols, abbreviations, etc.). After returning to the office from the field, always photocopy the day’s field notes and archive them in an off-site location (in case of fire, theft, or some other unfortunate catastrophe). When finished, store all field notebooks in the office so they are available for reference and for the next field session.

## 2.0 AERIAL PHOTOGRAPHS

Aerial photographs provide a planform view of project sites and serve as a basis for documenting changes in site conditions over time. Careful analysis of the aerial photos can be used to interpret changes in channel location, channel morphology, vegetation, or other variables.

### *Monitoring*

Aerial photographs should be flown after construction to document as-built conditions at both the project site and Reading Bar borrow site. While there can not be a set rule for the frequency of taking aerial photographs, we suggest they be re-taken as each phase of the restoration project is completed, every three years, or after a high flow that causes dramatic changes to channel morphology, whichever is sooner. All aerial photos should be taken at a 1” = 350’ (1:4,200) scale, because this scale provides excellent visibility of the floodway, excellent image quality of enlargements (scale can be increased by 10x to 1” = 35’ without losing much photographic resolution), and is consistency with previous aerial photo scale.

Stereoscopic aerial photos are those that can be overlapped and viewed through a stereoscope, which renders a three-dimensional image by adding topographic relief to the viewer's field of vision. This technique is very useful in interpreting landforms and other features that can otherwise be indistinguishable, especially at sites such as river channels and floodplains that have little topographic relief. Because individual aerial photographs must be overlapped to view in stereo, the total number of photos taken to cover one site is greater than non-stereo coverage (and therefore cost more). However, the resolution offered by stereo pairs, particularly along a channel and over a floodplain, is superior to non-stereo coverage, and allows the photos to be orthorectified if desired. In addition, color aerial photos will provide further resolution to a site and aid in interpreting certain features that may appear different in black-and-white.

Based on June, 2001 price estimates from Hedges Aerial Surveys of Redding, CA (the same contractor who provided 1997 and 2000 photo coverage for the Clear Creek project), the cost for various types of aerial photographic coverage is presented in the following table:

| | Non-stereo black and white | Non-stereo color | Stereo black and white | Stereo color |
|---|---|---|---|---|
| 1"=350' scale prints of restoration project only | $900 | $1,300 | $1,000 | $1,500 |
| 1"=350' scale prints from Sacramento River to Clear Creek Bridge | $1,200 | $1,500 | $1,800 | $2,300 |
| 1"=350' scale prints from Sacramento River to Whiskeytown Dam | $1,700 | $2,750 | $3,400 | $5,500 |

The above listed costs are provided for budget purposes only, and the actual cost may vary.

A conventional aerial photograph contains image displacements caused by the tilting of the camera and the terrain relief. The stated scale is approximate and is not uniform across the photo; therefore, measurements made from the photograph may not be accurate. Orthorectification is a process that corrects photo distortion. Once an aerial photograph has been orthorectified, it becomes a photographic map that contains a uniform scale across the photo. The 1997 digitally orthorectified photos produced by ENPLAN has served as the base map photo for the work done on lower Clear Creek. At minimum, we recommend that color stereo pairs be taken from the Sacramento River to Clear Creek bridge, but not be orthorectified due to significant cost. We also recommend that once all construction activities and revegetation are completed, that the next photo set be digitally orthorectified to serve as the next base map (replacing the 1997 photo base map).

## 3.0 PHOTO POINT MONITORING

Photomonitoring is the process of taking landscape or feature photographs repeatedly over time from the same location (i.e., the photopoint), perspective, and frame so that differences between years can be compared (Elzinga et al. 1998). In general, a photomonitoring program consists of: selecting, and installing photopoints; developing a standardized protocol for photopoint relocation and photography; taking photographs at all photopoints and taking standardized notes, and; documenting and archiving all photographs taken during photomonitoring.

### *Materials*

Quality and consistent photomonitoring equipment are the basis of good, standardized photographs. The pieces of equipment used for a photomonitoring program include:

- camera, shutter release cable, tripod
- hand pruners, machete, and pruning saw for clearing vegetation
- blank photomonitoring data sheets, to be filled out after every photograph
- photomonitoring fieldbook, with photopoint location descriptions
- scale pole marked in 0.5 ft increments (FS #40046)
- plumb bob (or fishing weights and line for constructing a plumb bob)
- chalk board and chalk for writing relevant photopoint data
- flagging tape to mark photopoint location (FS #57905)
- compass for measuring the focal point bearing (FS #37182)
- clinometer for measuring the focal point angle (FS #43830)
- engineer’s measuring tape (in 0.01 increments) for measuring the camera height above the observation monument (FS #71175)
- two 300-ft survey tapes for triangulating observation points (FS #39532 or #39851)

The camera used for photomonitoring should either be digital or 35mm. Digital cameras are attractive choices because the photographs can be easily archived and reproduced. No matter what camera is selected for the project, it is best if the same camera is used throughout the project history and the same settings (e.g., ASA or image quality) are used for successive photographs.

### *Methods*

A photomonitoring program must take repeated photographs from the same location. To be able to effectively compare photographs taken at the same point on different dates, the photographs must be as equivalent to each other as possible. A photomonitoring program must consider the time of year that the lighting and vegetation will be in a similar condition as the first photograph at the photopoint. In addition, photomonitoring timing must consider river discharge and plant growth. Once a photomonitoring program is developed (locations selected, monitoring schedule developed), the actual benchmark for where photographs are to be taken, or photopoints, must be selected.

The first type of photopoint consists of two rebar pins, a line of site pin, and an observation pin (Figure 3.1). Rebar pins monument both the observation point and the line of sight, and are labeled with aluminum tags. The camera and tripod are setup over the observation pin and centered over it using a plumb bob. The line of sight pin is 25 ft away along a fixed compass bearing (the compass bearing is recorded on the photopoint data sheet which is in the fieldbook). The field of view and focal point (in the cameras viewfinder), is centered on the chalkboard sitting atop the scale pole. No declination compensation (to adjust for difference in true and magnetic north) is required to the bearing recorder on the data sheet.

The second type of photopoint consists of a nail with a washer (the observation point), and a fixed point demarcating the line of sight (Figure 3.2). This photopoint type is commonly used on hillsides. The camera and tripod are setup and centered (using a plumb bob) over the nail. The field of view is determined by a compass bearing and an inclination. In some cases a line of sight monument is described in for the photopoint, in other cases no line of sight monument was used. Therefore, the field of view is centered using the line of sight monument, compass bearing and inclination.

The third type of photopoint consists of two pins from which an observation point is triangulated, and a fixed point demarcating the line of sight (Figure 3.3). This photopoint type is typically used were the observation point occurs in the river. Two 300-ft surveying tapes are attached to triangulation points (usually rebar pins), and using distances from each triangulation point the observation point is relocated and the tripod and camera are setup at this point. The field of view is determined by a compass bearing and an inclination. It is especially important to use the most recent photograph taken from that photopoint to help reestablish the same field of view as the previous monitoring. In some cases a line of sight monument is described in for the photopoint. Therefore, the field of view is centered using the line of sight monument, compass bearing and inclination.

All photopoint monuments must be photographed at the time of installation and should be GPS surveyed by the Department of Water Resources to precisely locate the photopoint on the Clear Creek base map. The monument photographs are intended to capture the monument's immediate surroundings, the monument itself, and any other relevant information that could prove useful in relocating the monument. The monument photographs are included the photomonitoring fieldbook, with other location information.

The photomonitoring fieldbook is the result of the first year's photomonitoring effort. For each site, the photomonitoring fieldbook contains photopoint location descriptions, photographs and descriptions of monuments (both line of site and observation pin), the most recent photopoint data sheets, and the most recent photograph taken from each photopoint. A sample photopoint data sheet is included on the CD that accompanies this appendix.

*Installation*

The following table lists materials required to install photopoint monuments (note that this list includes materials for all three photopoint types). Where applicable, a Forestry Suppliers catalog number follows the item in parentheses.

- ½" rebar, for photopoint monuments, cut at 3' to 5' lengths
- 1" washers for photopoint monuments
- 12" galvanized spikes for photopoint monuments
- 1"-diameter (or similar size) aluminum tags for labeling photopoint monuments (FS #79360 or FS #79500)
- plastic tarp, to paint washers and monuments on
- wire, wire cutters and pliers for affixing the tags
- putty Epoxy, to affix monuments to bedrock or concrete if needed
- "PK" nails to for installing monuments into asphalt
- orange paint, for painting monuments (FS #57561)
- small sledge hammer for installing photopoints (FS #67244)
- stamp kit, for stamping the photopoint numbers on the tags or washers

Most of the above listed materials can be purchased at a conventional hardware store, however others (e.g., aluminum tags) can be purchased from Forestry Suppliers, Inc., a company specializing in tools, instruments, and equipment for natural resource sciences.

*Monitoring*

Several Photopoints may be clustered around a site, or one site may contain only a single photopoint. For each site, or where a single photopoint occurs, the specific site location is sketched in the photomonitoring program field book. After locating the photopoint monuments, the photomonitoring equipment can be set up and the photopoint (re)occupied. The camera and tripod are set directly over the observation monument at the predetermined height stated on the photopoint data sheet, and centered over the pin using a plumb-bob. The specific procedures are:

1. Using the site description and/or aerial photos, find the observation point/monument, and line of sight monument.
2. Set up the tripod over the observation point/monument.
3. Using a fishing line and lead weight plumb bob hanging from a central point on the tripod, center tripod over the observation monument.
4. Attach camera to tripod, on the chalkboard write the date, the discharge and the initials of the location where the discharge was measured, and the photopoint number.
5. Using an engineers tape (marked in increments of feet and tenths of feet) raise or lower the base of the camera such that the camera height is the specified distance above the observation monument (indicated on the photopoint data sheet).

6. Using a compass, determine the direction the camera's viewfinder will be aiming, specified as a bearing from magnetic north (indicated on the photopoint data sheet)
7. Center the camera's viewfinder on the chalkboard and scale pole or some other line of sight monument (indicated on the photopoint data sheet).
8. Using a clinometer, determine the angle that the camera's viewfinder will be tilted up or down, specified as inclination or angle
9. Using a line bubble level, check to ensure the horizon in the photograph framed in the viewfinder is level
10. Check the camera settings listed on the photopoint data sheet to ensure that the lens (wide angle or telephoto) settings are the same as the previous photo monitoring, and that the camera's image settings allow the photograph to be taken at full size, fine quality
11. Using the last photograph taken from the photopoint (included in the photomonitoring fieldbook), check to make sure the photographs are equivalent (with the exception of physical or vegetative changes), make any fine tuning adjustments necessary
12. Three photos should be taken at each photopoints to assure a quality photograph equivalent to the last monitoring (this setting is automatic if the camera has been properly checked before going into the field). Two photographs should be taken at different F-stops, bracketing the correct F stop (assure proper light balance in the photograph). One photograph should be taken at one F stop above the suggested F stop (as measured by a light meter), one photograph should be taken at the setting suggested by the light meter, and one photograph should be taken at one F stop below the suggested setting.
13. Fill out a new photopoint data sheet, noting any changes to the photopoint monuments, camera settings, physical disturbances etc.

Once photopoint monitoring begins, a database can be created. One way of creating a searchable database is through the use of accession numbers. This is accomplished by naming all photopoint monuments with a unique moniker according to river mile, site, photopoint number, and whether the pin is the observation or line of sight pin. This unique name is called the photopoint accession number and is also used as the database reference number for the photopoint. For example, the following accession number "PPT#816CC3LS" means:

PPT# = Photopoint number
816 = River mile 81.6
CC = Clear Creek
3 = third photopoint
LS = line of sight pin

The accession number can be looked up in the photomonitoring fieldbook to get specific details about the point and its location and can also be placed on an aluminum tag attached to the photopoint pin. By establishing this protocol, all photographs can be accessed by using the photopoint accession number.

## 4.0 CROSS SECTION INSTALLATION AND MONITORING

The monumented cross section serves as the location for measuring physical channel characteristics, such as channel form (e.g., location, grade, position), stream discharge, and particle size distributions. Because the cross section serves as the location from where hydraulic measurements and calculations are performed, its orientation is across the channel, perpendicular to the direction of flow.

*Materials*

The following materials are required to install monitoring cross sections at Clear Creek project sites (note that the following materials list is for a single cross section only).

- rebar: 4 pieces, 5/8”-diameter, cut at 3’ to 5’ lengths
- sledge hammer to install rebar (FS #67244)
- 1”-diameter (or similar size) aluminum tags (FS #79360)
- wire, wire cutters and pliers for affixing the tags
- stamp kit, for stamping the aluminum tags
- surveyor’s plastic rebar caps (FS #39496)

*Installation*

One of the primary purposes of establishing a cross section is to perform hydraulic calculations and document topographic change over time. To do this, set the rebar (often referred to as “pins”) along a transect that is perpendicular to flow. Drive each pin vertically into the ground to a depth where no more than 4” is exposed above the ground surface (for safety as well as to reduce risk of disturbance). Install at least two 5/8” rebar pins on each side of the stream, one that is 2-3 ft above the summer low flow water surface (preferably within 20 feet of the low flow water edge), and one at the base of the bluffs at the edge of the floodway. Pins are installed at the base of the bluffs so that the risk of them eroding in the future is minimal. Rebar on opposite sides of the channel should be set at similar elevations such that a tape stretched between pins is reasonably horizontal (Figure 4.1). Place a plastic surveyor’s rebar cap on each pin immediately after it is installed.

The exact location of each pin should be tied to the NAD83 California State Planes, Zone 1, US Foot coordinate system, as established by the Department of Water Resources. To locate the pins accurately, each pin should be initially surveyed with a survey-grade Global Positioning System (GPS). The elevation of all pins should reference the datum of the primary benchmark at each site (NAVD 88). Figures 4.2 and 4.3 show the location of primary benchmarks at each site. After the pins are installed, label them using the 1”-diameter aluminum tags. Tags are wire-attached to each pin, and the following information is stamped onto the tag: cross section name (based on longitudinal stationing established from the 1997 ENPLAN base map), date installed, and elevation of the top of the pin referenced to the primary site benchmark. The river location and longitudinal station from the 1997 ENPLAN base map is included as Figures 4.4 and 4.5 for the Restoration Grove project site and Reading Bar borrow site, respectively.

*Monitoring*

Monitoring is intended to document the changes along a transect either perpendicular to flow (cross section) or along the length of the channel (longitudinal and thalweg profile). In addition to the active channel, the technique described below also includes methods to monitor the scour channels.

All channel surveying, including new and existing cross sections, longitudinal profiles, and scour channels, should be re-surveyed on an annual basis and following high flow events capable of causing topographic (and therefore geomorphic) change. The channel cross section is measured by surveying the ground surface and channel topography along a tape stretched between the rebar pins. The following list includes the basic materials required to complete a topographic cross section survey:

- engineer's surveying level, tripod, and 25-foot stadia rod (e.g., FS #37748, FS #37677, and FS #43259, respectively)
- long, flexible measuring tape (commonly 300' long) with clips or similar fasteners to affix tape to rebar pins (FS #39532 or #39851)
- "Rite in the Rain" brand field notebook (FS #49326)
- waders and wading boots
- hand pruners, machete, or pruning saw for clearing vegetation

The rebar pins at the base of the bluffs serve as survey endpoints. First, attach the zero end of the tape to the left bank (facing downstream) rebar pin. Stretch the tape tight and level across the channel, and attach it to the upper right bank rebar pin. Record the distance between pins.

After beginning the survey by establishing elevation from the primary benchmark, begin the cross section survey at the upper left bank rebar (station zero) by surveying both the top of the rebar pin and then the ground surface. From this point, the survey progresses along the tape by recording ground surface elevations at significant topographic (breaks-in-slope), geomorphic (particle size or vegetation changes), and hydrologic features (water surface elevations and high water marks). We do not recommend using a total station for cross section surveys as they do not provide the elevational precision of engineers levels, and this precision is needed to document subtle floodplain evolution. First-time surveys should record ground surface elevations at 2-foot intervals, then subsequent surveys can follow significant breaks caused by topographic changes, with spacing not exceeding 10 feet. Continue the survey across the channel to the right bank rebar pin. As with the left bank pin, survey both the ground surface at the base of the pin as well as the top of the pin. When finished, survey elevation of the primary benchmark to close the survey (do turning points if needed) and record closure error in the field notebook. If closure error is greater than 0.05 feet, repeat the turning point loop to locate and remove the survey error.

Next, survey the water surface slope (longitudinal profile) through the reach. Because water surface slope varies with discharge, slope should be surveyed each time the site is visited during different flows. In addition, water surface slope during peak flows can be reconstructed using debris lines or other high water indicators (also see Section 5.0). Water surface slope is measured by stretching the tape along the channel at the water's edge. Ideally, the length required to obtain a representative slope incorporates one complete riffle-pool sequence (Harrelson et al. 1994). For Clear Creek project sites, slopes should be

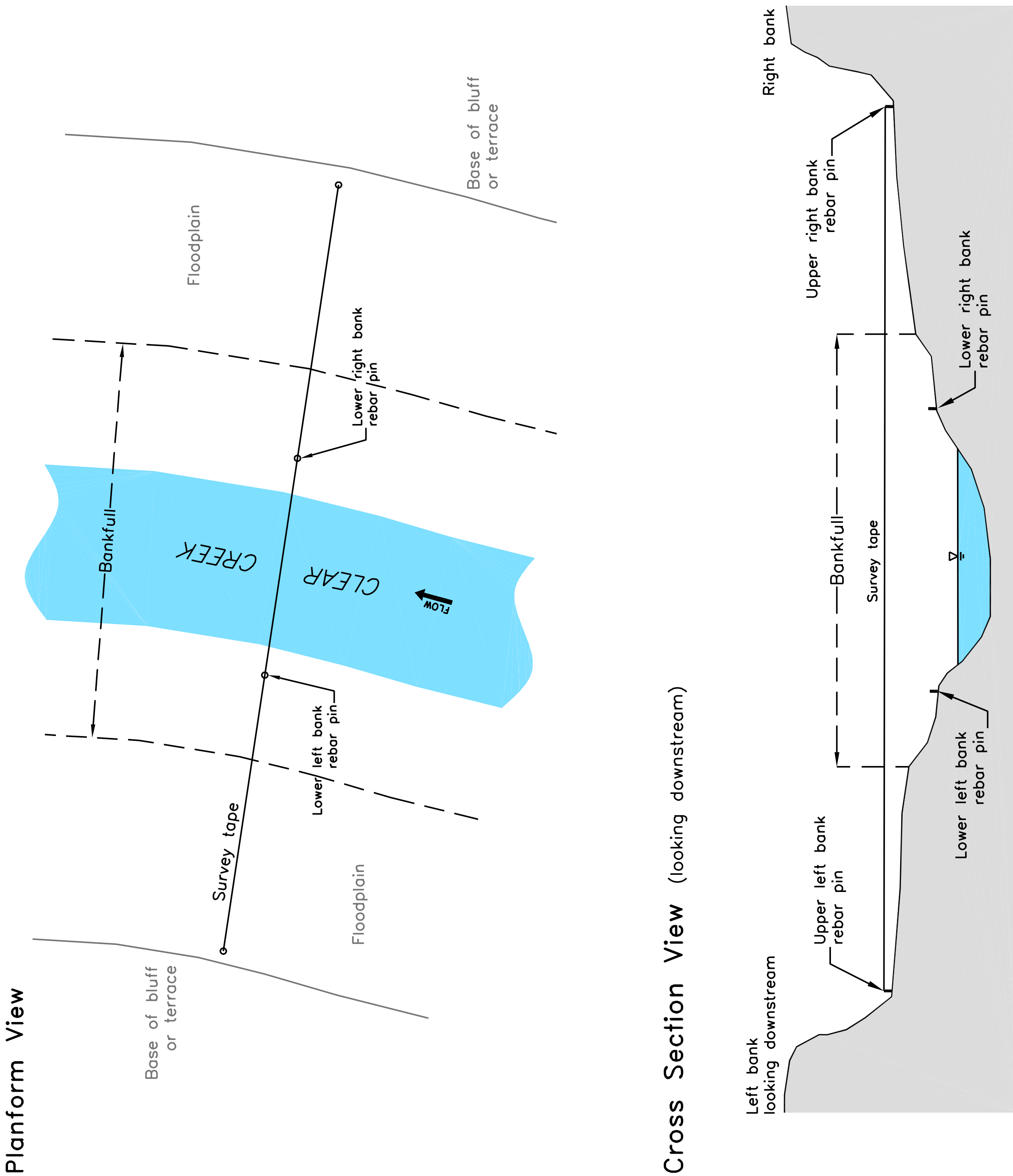



*Figure 4.1: Schematic diagram of channel cross section.*

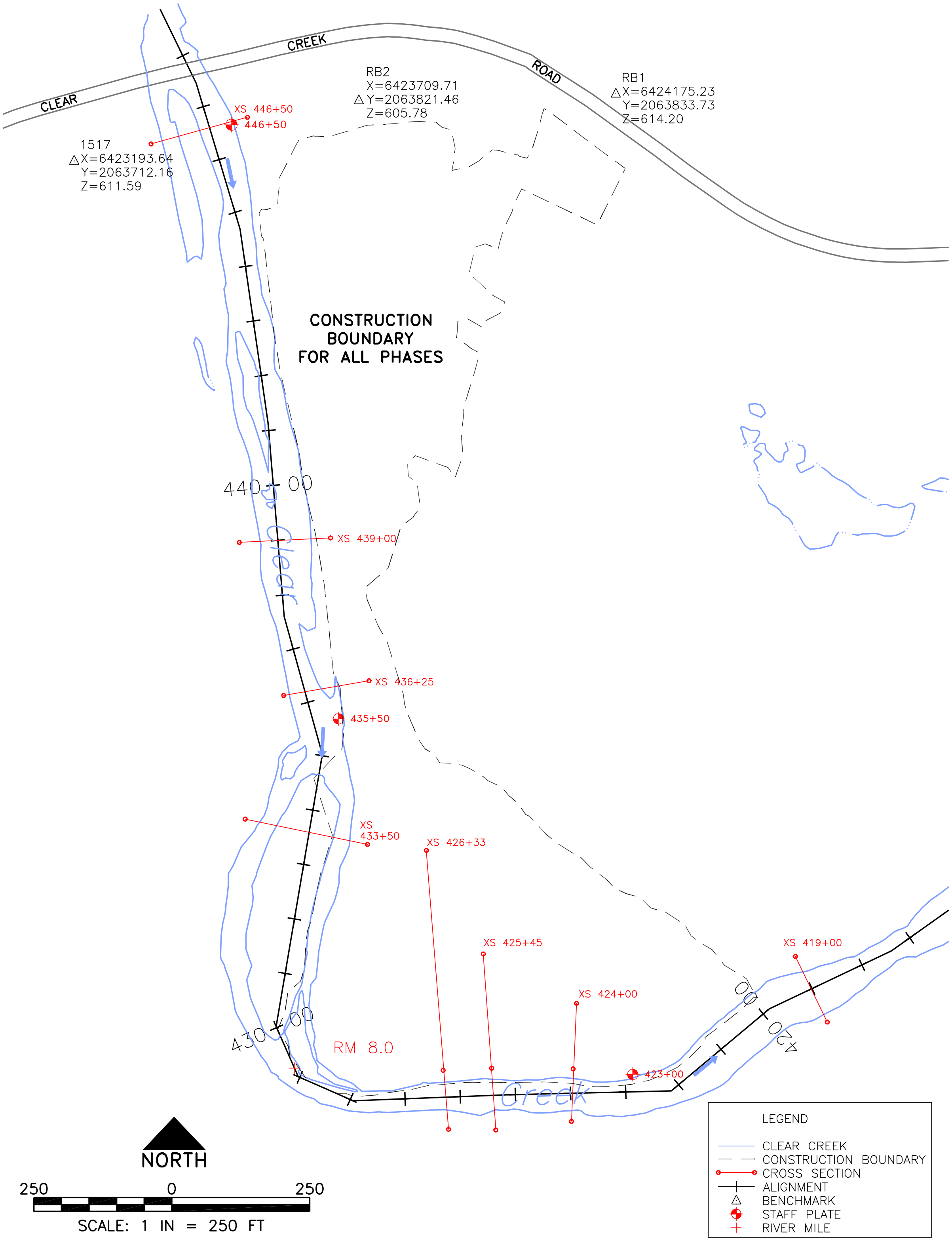



*Figure 4.2: Reading Bar site map showing location and elevation of primary benchmarks, longitudinal stationing, and 1997 channel location.*

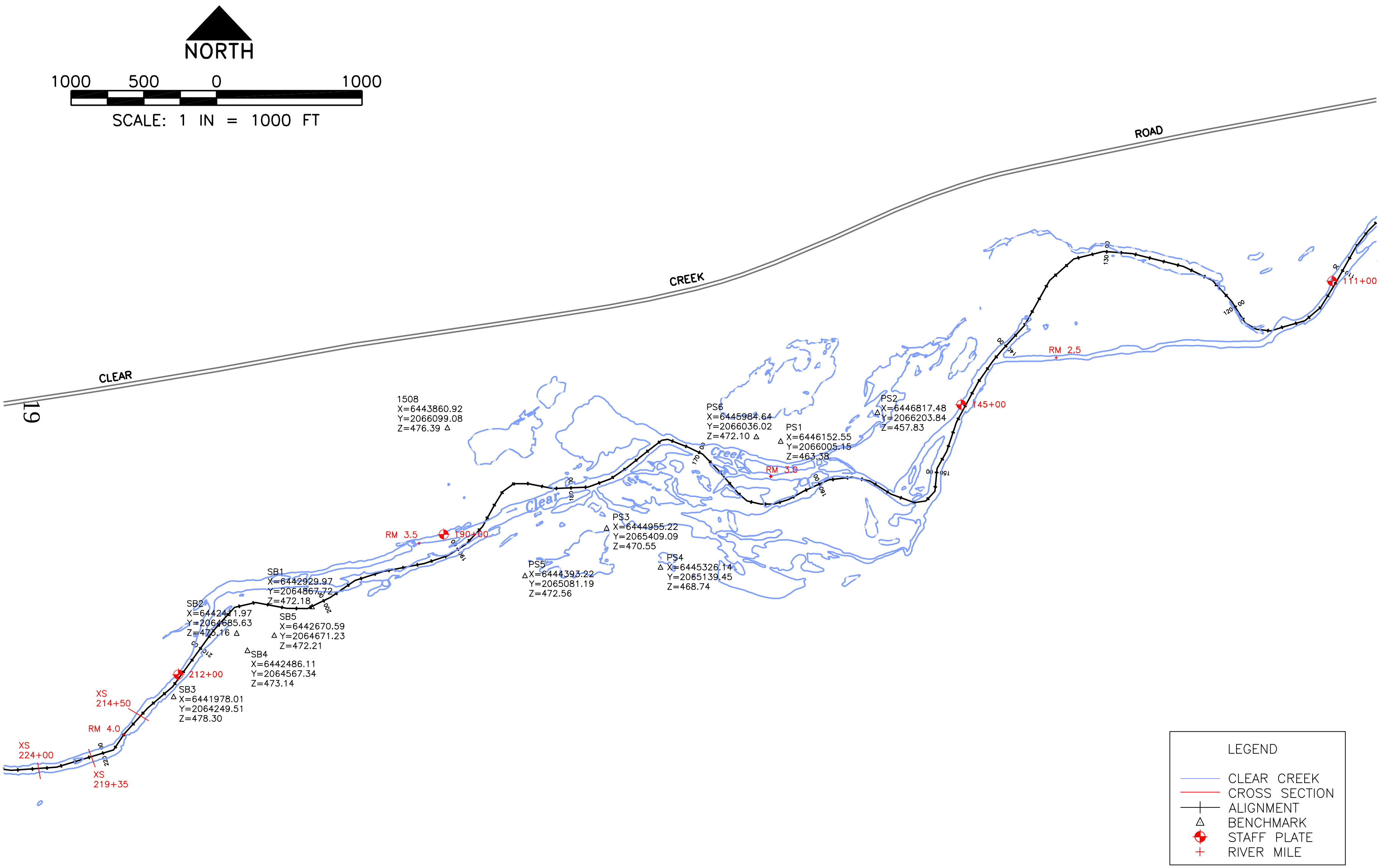



*Figure 4.3: Restoration Grove site map showing location and elevation of primary benchmarks, longitudinal stationing, and 1997 channel location.*

surveyed over a 300 to 400 foot length centered on the cross section (e.g., 150 feet upstream and downstream). After the tape is laid out, elevations are surveyed at approximately 20- to 50-foot intervals for the entire length of tape, concentrating on topographic changes in the water surface (i.e., breaks-in-slope) rather than equally spaced points. When the end of the tape is reached, close the survey by returning to and surveying the primary benchmark, taking turning points if needed and recording the survey error in the field notes.

After fieldwork is complete, photocopy the field notes. Then enter the survey data into an Excel workbook and plot the results. An Excel worksheet should be created for each cross section survey, such that all surveys for a given cross section are contained within a single workbook file. A survey data entry template and graphical plotting template are included with the CD that accompanies this appendix.

## 5.0 THALWEG PROFILE AND WATER SURFACE SURVEYS

The thalweg is the deepest portion of the channel at any given longitudinal station. Thalweg profile surveys are similar to water surface slope surveys (Section 4.0); however, in addition to surveying water surface elevations, channel topography is surveyed along its deepest portion. Similar to cross section surveys, thalweg profile surveys document the topographic changes through a given reach.

*Materials*

The following materials are required to conduct thalweg profile and water surface surveys at Lower Clear Creek project sites:

- Total Station (optional)
- engineer's surveying level, tripod, and 25-foot stadia rod (e.g., FS #37748, FS #37677, and FS #43259, respectively)
- long, flexible measuring tape (commonly 300' long) with clips or similar fasteners to affix tape to rebar pins (FS #39532 or #39851)
- 5/8" rebar cut at 5-foot lengths
- sledge hammer to install rebar (FS #67244)
- "Rite in the Rain" brand field notebook (FS #49326)
- flagging (FS #57905)
- waders and wading boots
- hand pruners, machete, or pruning saw for clearing vegetation

*Monitoring*

Thalweg profiles are measured by surveying the channel bed surface along the deepest portion of the channel during periods of low flow. Thalweg profiles should always begin and end at the same upstream and downstream location (based on longitudinal stationing established from the 1997 ENPLAN base map). Endpoints can also be referenced to permanent features on the bank or floodplain, such as a large tree or channel cross section, provided they are spatially documented within the site coordinate system per survey-grade GPS or Total Station.

The water surface is also surveyed at the same time as the thalweg, thereby providing longitudinal channel topography and a corresponding water surface elevation with the same survey. Moreover, debris lines may be present especially following a flood event. It is important to survey these "high water mark" elevations if they are present, because they will provide water surface elevations and a slope of the flood discharge that deposited them.

To survey the thalweg and water surface, first walk the length of the channel to be surveyed and set temporary rebar vertically along the banks, beginning at the upstream end of the profile. Depending on the sinuosity of the reach, space the rebar at intervals so that a tape strung between rebar remains along the channel (slightly less than 300 ft if a 300 ft survey tape is used). Install each piece of rebar so that at least one foot is exposed above the water surface, and tie flagging to the rebar so it doesn't produce a boating hazard during the survey. The length of channel to be surveyed should extend through the particular study reach. Next, affix the zero end of the tape to the upstream channel rebar (upstream endpoint) and connect the tape to the next downstream rebar.

After beginning the survey by establishing elevation from the primary benchmark, begin surveying the thalweg and water surface at the upstream endpoint. If using a level, assume a longitudinal station of "zero" at this point, with stationing increasing in the downstream direction. Again if using a level, survey the thalweg elevation, and document the water depth at the thalweg elevation to get the water surface elevation (thalweg elevation + water depth = water surface elevation). Water surface elevations are easiest to survey at the water's edge if using a total station, rather than trying to survey this surface at the thalweg. Continue downstream along the tape, carefully surveying important topographic features such as the boundaries of riffles and pools. Surveying should focus on the topographic features that define the reach and how these features change with time and/or discharge; therefore, survey points should not be spaced at even intervals. When the last rebar is reached, close the survey by returning to and surveying the elevation of the primary benchmark. Record closure error in the field notebook. If closure error is greater than 0.05 feet, repeat the turning point loop to remove the error. Finally, remove the temporary rebar used to string the tape.

As mentioned above, a total station is an alternative to the level surveying method. In contrast to an engineer's surveying level, total station surveys topographic data electronically in three dimensions with respect to the established site coordinate system. Data can therefore be plotted on a planform map and are very illustrated. The total station data logger records coordinates and elevations as individual topographic points are surveyed. Because of this, total station surveys are recommended for the thalweg profile surveys because precision is not as important as the cross section surveys, the thalweg surveys can be performed faster with a total station than an engineer's surveying level, and thalweg location changes can be shown on a map.

Although water surface slopes can be surveyed under most flow conditions, thalweg profiles should only be surveyed during low flows when the channel is safe to wade and the flow is generally clear enough to see the channel bed. Profiles should be re-surveyed on an annual basis, and if possible, following high flow events capable of causing topographic (geomorphic) change. Keep in mind that flood debris should be present following a high flow event and this slope should be surveyed as well.

As with the cross sections, thalweg and water surface profile surveys should be transferred upon returning to the office. Photocopy the field notes and then transfer the survey data to a computer and plot the results. An Excel workbook should be created for each given profile such that the results of each field survey is contained on a worksheet within that workbook.

If a total station is used rather than an engineers level, then the "distance and elevation" data should be exported into an ASCII file that can be imported by Excel. The cross section survey data entry template and graphical plotting template on the attached CD can also be used for the thalweg profiles.

## 6.0 PIEZOMETERS

A piezometer is a small-diameter well constructed to measure the height of groundwater. Piezometer design for Clear Creek project sites consists of a PVC pipe that is set vertically into the ground that allows water to flow into the lower portion of the casing through a well screen. "Piezometer" and "well" are used interchangeably in this section.

*Materials*

The following materials are required to construct a piezometer for floodplain groundwater monitoring at lower Clear Creek monitoring sites:

- backhoe
- solid casing: 2"-diameter schedule 40 PVC pipe, threaded to accept well screen and cap
- well screen: 2"-diameter schedule 40 PVC pipe, factory slotted at 0.01" or 0.02" openings, threaded to accept solid casing and plug
- breathable cap for the top of the casing (to prevent rain or foreign materials from entering the well), and a plug for the bottom
- a pump or hand bailer to "develop" the well
- survey equipment (engineer's level, tripod, stadia rod, field notebook) (e.g., FS #37748, FS #37677, and FS #43259, respectively)
- 3 clear glass jars (4oz. or larger)
- a roll of string
- plastic 5-gallon bucket
- "Rite in the Rain" brand field notebook (FS #49326)

The piezometer materials (casing, screen, cap, plug, and bailers) can be purchased from manufacturers specializing in groundwater development and sampling products, such as Boart-Longyear. Boart-Longyear can be contacted at (800) 241-9468 or via the Internet at: http://www.boartlongyear.com/usregion/.

Because of the simple piezometer design proposed for this project, piezometers should be located in areas that are not subjected to ponding surface water as this water can infiltrate vertically and give a false water table elevation. If this setting cannot be avoided, an impervious material (e.g., bentonite or concrete grout) should be backfilled around the uppermost few feet of the well casing. The reader is encouraged to consult an appropriate technical reference such as Groundwater and Wells by F. G. Driscoll (1986) for these installation techniques.

*Installation*

The following procedure installs piezometers at the Lower Clear Creek site using a backhoe and is illustrated in Figure 6.1. The procedure assumes pits will be excavated on the floodplain by a backhoe, that the piezometers will be set in these pits, and the pits will be backfilled by the backhoe with the same excavated materials. Because the lowest groundwater elevations occur during the late summer months, the piezometers should be installed during this time to ensure the groundwater elevation does not drop below the depth of the piezometer (resulting in a dry well).

Instruct the backhoe contractor to excavate a pit in the desired monitoring location. The pit should extend below the summer groundwater table, which is located where water begins to flow freely into the bottom of the excavation. Stop the excavation when the depth of the pit is at least two feet below the surface of the late summer water table.

Next, assemble the PVC pipe according to the depth of the pit and the depth to groundwater. Thread the solid casing into the well screen (slotted casing), thread (or cap) the plug into the bottom of the screen, and stand the assembly vertically in the pit, alongside one of the pit walls (it does not necessarily need to be placed directly in the center of the pit). Set the assembled well in the pit such that approximately 2 to 3 feet of well screen sits *below* the lowest expected groundwater table elevation. In addition, no more than 1 foot of solid casing should remain sticking up above the ground surface. Once the well is sitting in the pit and meets this criteria, have the backhoe operator carefully backfill the pit so that large gravels and cobbles do not damage the screen or solid casing. It will be necessary to hold the piezometer vertically in place with a rod as the pit is backfilled. Continue to backfill until the original ground surface is reached.

*Well development*

After the well is installed, it needs to be “developed”. This process is necessary because excavating and backfilling the pit disturbs the native ground and sets fine sediments into suspension, which can enter the well and/or clog the screen. Developing the well consists of removing water from the well immediately after it is set to draw the turbid water and surrounding fine sediments into the well so that they can be removed. To do this, use either a portable pump or a hand bailer. A hand bailer is an instrument used to collect groundwater from a well. The hand bailer is usually a cylinder, 1 to 2 feet long with a diameter that allows it to slide inside the monitoring well, and contains a check valve at its base.

Development for drinking water wells is considered complete when the water being removed from the well clears of turbidity (Driscoll, 1986). However, clear water may not be an achievable condition following the backhoe installation method (i.e., a large area of disturbance relative to the diameter of the well). Because of this, and because these wells will not serve as a drinking water source, the following well development method is suggested.

To develop the well with a bailer, tie string to the top of the bailer and lower it into the well. As the bailer sinks, it will fill with water. After it fills, remove the bailer from the well (the check valve will keep the water from flowing out). Empty the first bailer into a glass jar, cap the jar, and set it aside, then proceed with developing the well by removing 3 well volumes of water (approximately 5 gallons for a 10 foot deep, 2 inch-diameter well). When the final bailer of water is removed, empty it into a second glass jar. Compare the sediment content of both jars. If the water is significantly less turbid than the initial sample, development can be considered complete. If there is no appreciable decrease in turbidity, repeat the process by removing an additional 3 well volumes of water. If there is still no change, then the sediment concentration present in the samples is likely representative of the sediment concentration of groundwater in the vicinity of the well, and the well can be considered developed (to develop the well with a portable pump, follow the same instructions). Record all measurements and observations in the field notebook.

After development is complete, measure the depth of the inside of the well from the top of the casing. Some sediment will unavoidably be present in the bottom of the well, and this depth to the top of the sediment should be recorded. Next, make a notch on the top of the well casing on its north side. Using a hacksaw or similar device, cut a small (0.5 cm) “v” notch into the well casing, and survey the casing elevation at the notch. This notch will represent a measuring reference point that will serve as the location from which all water level measurements are read and groundwater elevations calculated. To avoid any confusion by other monitoring personnel, label the well with a sharpie, both on the inside rim of the well casing and on the inside of the well cap.

*Monitoring*

All wells should be measured (or “read”) every month to document the temporal groundwater fluctuations at each site. To do this, measure the depth to water in each well using either an electronic water meter, a tape measure, or a stadia rod. If using a tape measure or stadia rod, it is helpful to shine a flashlight down the well to note exactly when the water surface is contacted. The depth to water in each well should always be measured from its “v” notch. Water depths are recorded either in the field notebook or on a special field data form that converts depth-to-water measurements to true elevations. A field data form for recording and converting these measurements is included with the CD that accompanies this appendix. The advantage of using the field form is that true groundwater elevations are instantly available on-site.

In addition, one well per site should be selected for continuous monitoring. To do this, install a “down hole” pressure transducer and data logger to record groundwater elevations on a daily basis. The data collected by the data logger will provide an accurate account of groundwater fluctuations at the site and will supplement the measurements taken at the other wells. The data logger and monitoring assembly should be weatherproof, and a locking well cap should be used to prevent tampering with the equipment. There are several manufacturers of monitoring equipment, such as Global Water Instrumentation, Inc (http://www.globalw.com), who specialize in equipment made for these applications (e.g., Global Water model WL15).

Periodically, the total depth of the inside of each well should be re-measured to determine if there is any significant sedimentation inside the well. Because the piezometer is set in the ground without a filter pack[1], sediment may accumulate in the well over time and the well may need to be re-developed to remove excess fine sediment and clear the well screen.

A filter pack consists of sand or gravel that is smooth, uniform, clean, well-rounded, and siliceous. It is placed in the annulus of a well between the borehole wall and the well screen to prevent formation material from entering the screen (Driscoll 1986).

## 7.0 SURFACE SEDIMENTS MAPPING AND SAMPLING

To quantify surface particle size at a monitoring site, a sample of the streambed or floodplain substrate is collected and the distribution of particle size measured by number (e.g., pebble count) or by weight (e.g., sieve analysis). The pebble count technique is best suited for documenting particle size distributions of gravels and cobble substrates typically found within the bankfull channel, and is one of the most common due to its relative simplicity. The pebble count technique is discussed in detail in RM-245. Monitoring personnel should be familiar with the pebble count technique to document size parameters of surface sediment populations.

The channelbed surface within the bankfull channel often contains a mosaic of coarse substrates. For example, a Clear Creek meander bend may contain large cobbles in the riffles, and gravels and cobbles on point bars. Outside the bankfull channel, the floodplain would likely eventually be composed of sand and silt deposited by high flows. In this case, the channel and floodplains may each have separate distinct textural populations, or facies. Because each facies will yield its own unique particle size distribution, each must be sampled separately in order to document representative particle size information.

*Materials*

The following materials are required to delineate and document textural facies at lower Clear Creek monitoring sites:

- large-scale map or aerial photographs of the monitoring site; for example, a 1” = 25’ scale map is recommended for in-channel mapping and a 1” = 50’ scale map is recommended for floodplain mapping
- clipboard or map board (FS #51035)
- pencils and erasers
- long, flexible measuring tape (commonly 300’ long) with clips or similar fasteners to affix tape to rebar pins (FS #39532 or #39851)
- “Rite in the Rain” brand field notebook (FS #49326)
- ruler (metric scale) (FS #47450)
- Total Station (optional)

*Technique*

To collect representative particle size information at a monitoring site, textural facies must be first delineated and then mapped. Following this task, each facies can be sampled and its particle sizes measured.

To delineate the textural facies at a site, Lisle and Madej (1992) suggest stratifying the bed into recognizable areas whose bed surface grain size composition falls into certain predetermined grain size ranges. Develop the grain size ranges to represent those that make up the bed surface at the site, then delineate facies boundaries based on a visual estimate of a large size parameter. For example, Lisle and Madej (1992) used the $D_{75}$ (particle size in a cumulative distribution for which 75 percent is finer) as a large size parameter to delineate four facies:

| Size Range | Facies Description |
| --- | --- |
| $D_{75}$ > 64 mm | Cobble |
| 64 mm > $D_{75}$ > 22 mm | Coarse pebble |
| $D_{75}$ < 22 mm | Fine pebble |
| Surface covered with > 25% sand | Sand |

The above table shows an example of how facies can be delineated at a site, and can be used for in-channel and floodplain mapping. In addition to the above-listed size ranges, a silt size range is recommended for Clear Creek project sites (e.g., surface covered with > 25% silt = silt facies). Because particle size distributions are site-specific, facies size ranges and reference size parameters should be developed for each site.

Once facies are delineated, they should be mapped. Depending on the particular objectives at each site, mapping can rage from a hand-drawn sketch map to a Total Station survey. Hand-drawn sketch maps are typically sufficient to document facies locations, and should be constructed by drawing facies borders on a scaled topographic map, survey-controlled base map, or enlarged orthorectified aerial photograph of the site. A tape strung across a cross section is helpful for locating position on a bar or floodplain, and mapping should focus on plotting facies contacts (with facies labeled). Figure 7.1 presents a sample facies map.

*Monitoring*

In addition to aiding in the collection of representative bed samples due to textural variation at a site, surface sediments mapping provides a means to document textural evolution at that site (e.g., bed coarsening or fining, silt deposition on floodplains). Moreover, repeated mapping compliments other work performed and can aid in interpreting geomorphic processes at that site. A specific pebble count technique is presented in RM-245 on page 49, and a particle size analysis template for both pebble counts and volumetric bulk samples is included on the CD that accompanies this appendix.

Surface sediments mapping should follow any high flow event capable of causing geomorphic change at a site, or at least on an annual basis. In the case of in-channel monitoring, a monitoring trigger may be a flow exceeding a bed mobility threshold (perhaps 2,000 to 3,000 cfs), whereas on a floodplain, a monitoring threshold may be overbank flows (exceeding 3,000 cfs). Because each facies has its own unique particle size distribution, facies should be recognized (and mapped) prior to conducting pebble counts so that representative areas will be sampled and correct particle size parameters documented.

## 8.0 MARKED ROCKS

Marked rocks, or tracer rocks, are used to document channelbed surface mobility on alluvial features (e.g., point bars, medial bars, pool tails, etc.). Specific particle size classes representative of the area to be monitored are painted a bright color, such as fluorescent orange, and placed at discrete locations in the channel along a monitoring cross section. Following a discrete high flow, the cross section is revisited to document whether mobility of the marked rocks occurred, and if so, how far they moved. The marked rocks are then re-set or replaced as initially installed for the next high flow event. In addition, marked rocks should be also set at a "control" cross section, located upstream of a restoration site, to compare and contrast bed mobility thresholds between unrestored channel areas and restoration sites.

*Materials*

The following materials are required to set and monitor marked rocks for channelbed surface mobility on alluvial features:

- bright paint, at least 3 cans of spray paint (e.g., Krylon brand "invert-a-can" or 1 quart of canned paint per cross section
- disposable paint brushes (if using canned paint)
- "sharpie" brand waterproof marker for labeling rocks
- tarp for painting rocks
- long, flexible measuring tape with clips or similar fasteners to affix tape to cross section rebar pins (FS #39532 or #39851)
- "Rite in the Rain" brand field notebook (FS #49326)
- particle size distributions from a pebble count or sieve analysis at the monitoring cross section
- waders and wading boots

*Installation*

Marked rocks should be grouped into "sets", with each set consisting of a $D_{84}$, $D_{50}$, and $D_{31}$ (particle sizes in a cumulative distribution for which 84, 50, and 31 percent is finer, respectively). The size of the $D_{84}$, $D_{50}$, and $D_{31}$ for each facies are based on the results of a pebble count or other sediment sampling technique as described in Section 7.0. First, collect rocks from a nearby exposed bar that represent each size class. Collect enough rocks so that sets can be placed on a cross section at three-foot intervals along the bankfull width (i.e., if the width of an exposed point bar on the cross section is 60 feet, collect 20 rocks each of the $D_{84}$, $D_{50}$, and $D_{31}$ size class).

It is common for the monitoring cross section to pass through more than one facies due to particle sorting during high flows. If these conditions exist, it is best to split the marked rock sets into no more than two separate populations according to the major facies changes.

Once the rocks are collected, group them by size class and place them on the tarp to air dry (if needed), making sure their surfaces are clean and free of any fine sediment. This procedure works best when performed on a hot summer day. After the rocks have dried, paint one side, allow to dry, flip the rocks over, and paint the other side. After the paint has dried, use a thick "sharpie" brand waterproof marker to label each rock set. Label each rock set with a sequential letter or number, identify which lateral tape station on the cross section upon which it was originally placed, and record this data in the field notebook or data form. Each cross section should have its own unique marked rock-labeling scheme, such as numbers, letters, and/or paint color (see Figure 8.1).

Next, string the long tape tight across the cross section in the same manner as if the cross section was to be surveyed (affix the zero end of the tape to the left bank rebar pin and pull the tape tight across the stream). Begin placing rock sets by starting at one end of the bankfull channel, placing rock sets at two-foot intervals: place the $D_{84}$ on the cross section, the $D_{50}$ one foot upstream of the $D_{84}$, and the $D_{31}$ one foot upstream of the $D_{50}$ (Figure 8.1). This placement scheme prevents artificial shielding of smaller tracers by larger tracers. Each marked rock should rest on the bed surface so that its exposure mimics that of the surrounding rocks. To do this, place each marked rock on the bed surface by removing a similar sized rock from the bed and setting the marked rock in its place. This allows marked rock placements to reasonably maintain natural bed surface conditions and avoid unnaturally over-exposing or under-exposing the marked rocks. Record the precise station each mark rock set is located in the fieldbook.

*Monitoring*

The primary monitoring objectives are to determine at what streamflow discharge the marked rocks move, which alluvial features are mobilized, where rocks move on each feature, and how far the rocks move. Because the $D_{84}$ at the Clear Creek project sites is designed to move at flows slightly less than the bankfull discharge (3,000 cfs), marked rocks should be checked for movement following flows greater than 2,000 cfs. Past studies using marked rocks suggest that after its initial placement, the rock sometimes reorients itself to a more hydraulically stable location rather than being truly mobilized (McBain and Trush 1997). Therefore, a marked rock should not be considered “mobilized” if its travel distance does not exceed two feet from its initial set position.

To record movement after a high flow, string the tape between cross section rebar pins and note whether each marked rock set was mobilized, and measure how far downstream they traveled. Next, inventory which rocks are missing. If they can be found downstream and have adequate paint and labeling, replace them on the cross section for the next monitoring event. However, many marked rocks that move downstream cannot be recovered due to substantial distance mobilized downstream, burial, and/or paint abrasion. New rocks of the appropriate size class must be gathered, dried, re-painted and labeled, and set on the cross section to await the next transporting flow. Record in the field book which rocks moved from the cross section and which were replaced. A marked rock data form is included on the CD that accompanies this appendix.

## 9.0 SCOUR CORES

Scour cores are used to document channelbed scour and redeposition on alluvial features (e.g., point bars, medial bars, riffles, pool tails). To measure this, a core of channel bed substrate is removed and backfilled with brightly painted, uniform size "tracer gravels" that are slightly smaller than the surrounding bed materials. When discharge increases and scours the surrounding bed, the tracer gravels also become entrained and are transported downstream. Following high flows capable of causing scour and redeposition, the scour core location is revisited to document scour and redeposition depths. Two to three scour cores are typically installed at a site where scour and redeposition is to be measured.

*Materials*

The following materials are required to install and monitor scour cores (note that the following materials list is for one scour core only):

- McNeil-type sampler, 6", 8", or 12" diameter (depending on size of substrate), 18" to 24" deep (see Figure 9.1)
- pre-painted tracer gravels approximating the $D_{31}$ size class (enough to backfill the volume of the McNeil sampler); this size is required to ensure complete tracer gravel mobilization when the surrounding bed scours. For Clear Creek, small gravels finer than 1 inch should work.
- survey equipment (engineer's level, tripod, stadia rod, field notebook) (e.g., FS #37748, FS #37677, and FS #43259, respectively)
- long, flexible measuring tape with clips or similar fasteners to affix tape to cross section rebar pins (FS #39532 or #39851)
- waders and wading boots
- neoprene gloves
- small hand tools (e.g., gardening trowel) to excavate the substrate
- plastic 5-gallon bucket
- "Rite in the Rain" brand field notebook (FS #49326)

*Installation*

Choose a location to measure scour. Scour cores are commonly placed on a cross section to provide precise stationing and easiest to install on exposed bars. Survey the elevation of the bed surface (referenced to the site primary benchmark) and record this elevation in the field notes. Next, manually work the McNeil sampler approximately 1.5 feet into the bed, and place the excavated substrate in the 5-gallon bucket for disposal away from the scour core. This process can be tedious; best results are obtained by iterations of working the sampler a few inches into the bed, excavating some substrate, and repeating the process until the excavation is roughly 1.5 feet deep. Once the target depth is reached, survey the elevation of the bottom of the core, then backfill the core to roughly the original bed elevation with the tracer gravels. After backfilling the core, remove the McNeil sampler, smooth the surface of the tracer gravels with your hand, and survey the elevation of the top of the tracer gravels (see Figure 9.1, steps 1 through 5, and Figure 9.2).

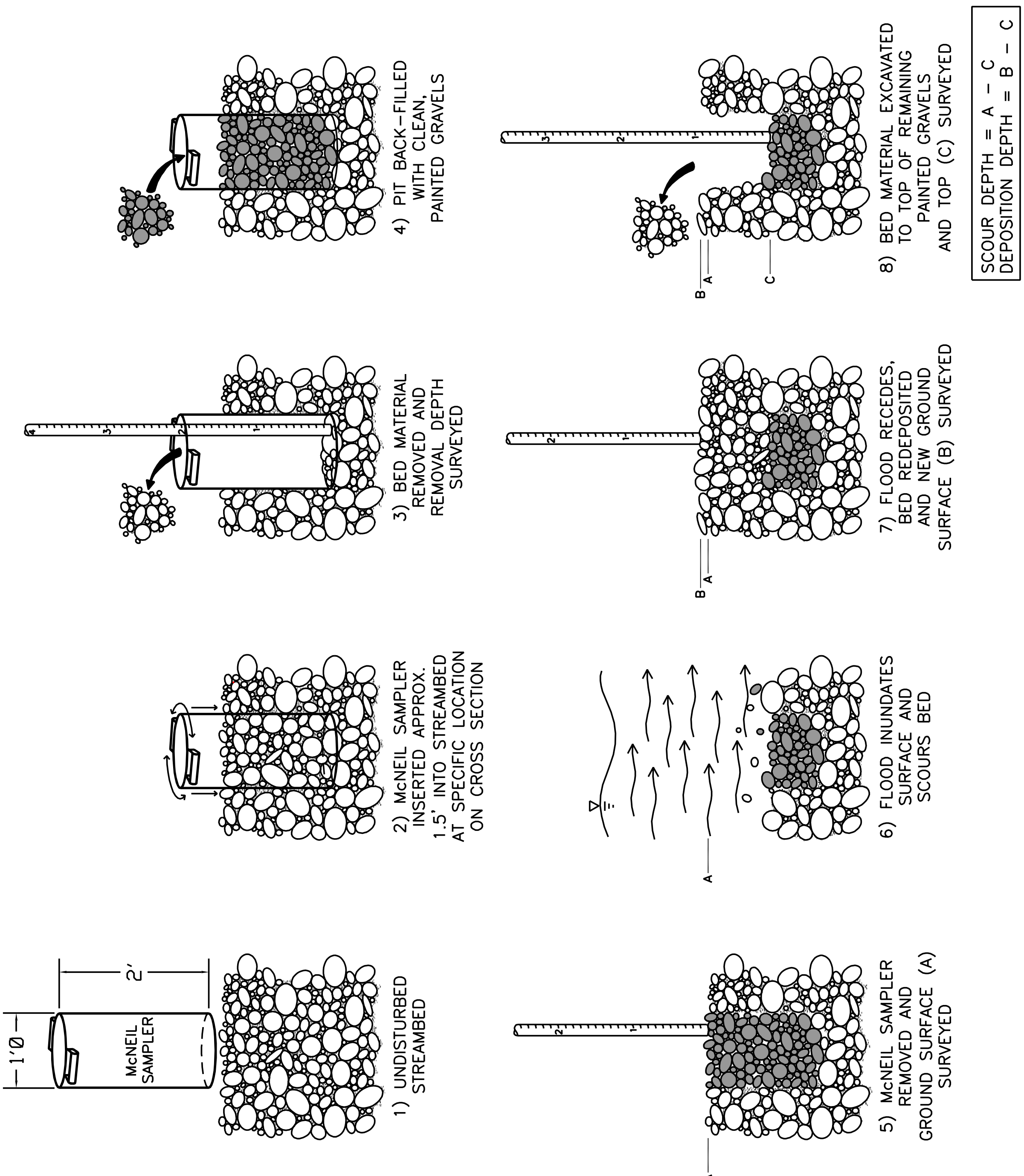



*Figure 9.1: Scour core installation and monitoring procedure.*

*Figure 9.2: Photograph of freshly installed scour cores (yellow tracer gravels are exposed on the bed surface) on the Trinity River. A long tape is stretched perpendicular across the channel, and blue flagging is tied to the tape delineating precise scour core stationing. Note that there are 5 scour cores visible in the photograph; Clear Creek sites should only contain 2 or 3 on each cross section due to its smaller channel dimension.*

Monitoring

During a high flow event that scours the bed, the tracer gravels will became entrained and transported away from the scour core. To document scour and redeposition depths following a scouring event, reoccupy the scour core location by stringing the tape across the cross section. Once the tape is strung, locate the precise station the core was installed, and survey the bed surface elevation. Using the McNeil sampler, carefully re-excavate the core until the tops of the tracer gravels are found It is important to re-excavate slowly, so the surface of the tracer gravels is not disturbed; if the excavation extends into the tracer gravels, an inaccurately large scour and redeposition depth will be recorded. Once the surface of the tracer gravels is exposed, survey the elevation of the top of the tracer gravels. Differences in surveyed bed elevations and surface tracer gravel elevations document scour and redeposition depths (Figure 9.1, steps 6 through 8). A scour core installation and excavation form is included on the CD that accompanies this appendix.

## 10.0 STAFF GAGE

Staff gages are used to measure the river's water surface elevation (stage) and are commonly associated with stream gaging stations to establishing stage-discharge relationships. However, staff plates can be installed independent of gaging stations for visual stage observations (to correlate to discharge) at any location of interest.

*Materials*

The following materials are required to install a single staff gage:

- enameled steel staff plate, marked in feet and tenths (FS #39732)
- 3 inch "channel iron", 7 feet long, with one end cut at a 45° angle (see Figure 10.1)
- custom-made 3-inch channel iron pounder (similar in design to a standard metal fence post pounder)
- economy heartwood redwood 2x4, ripped to fit snugly into channel iron and provide a flush surface to mount the staff plate (see Figure 10.1)
- survey equipment (engineer's level, tripod, stadia rod) (e.g., FS #37748, FS #37677, and FS #43259, respectively)
- "Rite in the Rain" brand field notebook (FS #49326)
- stainless steel carriage bolts and wood screws
- drill with 3/8" bit for mounting holes in channel iron and redwood

*Installation*

Choose a location to install the staff gage. The staff gage should be located in low-velocity water and out of the path of debris, and should also be located in a position that can record the lowest anticipated stage in the channel (Harrelson et al. 1994). If possible, the staff gage should also be installed in a location where the riffle crest that controls the low flow water surface elevation is fairly stable.

After a suitable location is selected, install the channel iron approximately 3 feet vertically into the substrate such that the wood and staff plate can be affixed after the iron is set into the bed, keeping in mind that the staff gage will be read from the bank (i.e., be sure that the staff plate will face the bank from which stage will be observed and recorded). Next, drill four 3/8" diameter holes in the upper 3-½' of channel iron and redwood, and use stainless steel carriage bolts to attach the wood to the channel iron. Then use stainless steel wood screws to attach the staff plates to the redwood (see Figure 10.1). When affixing the staff plates to the wood, be sure that the plates are positioned low enough so that they will record stage at the lowest anticipated flow in the channel.

After the staff gage is set, survey the elevation of the top of the staff plate (the 3.33' or 6.66' elevation) to establish the real elevation of the staff plate by surveying from the primary site benchmark. This will establish a real elevation of the staff plate and thereby establishing a datum to convert all stage readings to real elevation if needed. Establishing the elevation of the staff gage also provides control in case the staff gage is damaged or disturbed. In addition, it may be necessary to set more than one staff gage in order to cover the expected range of flows at the site (i.e., if stage varies more than 3.33' over the range of flows of

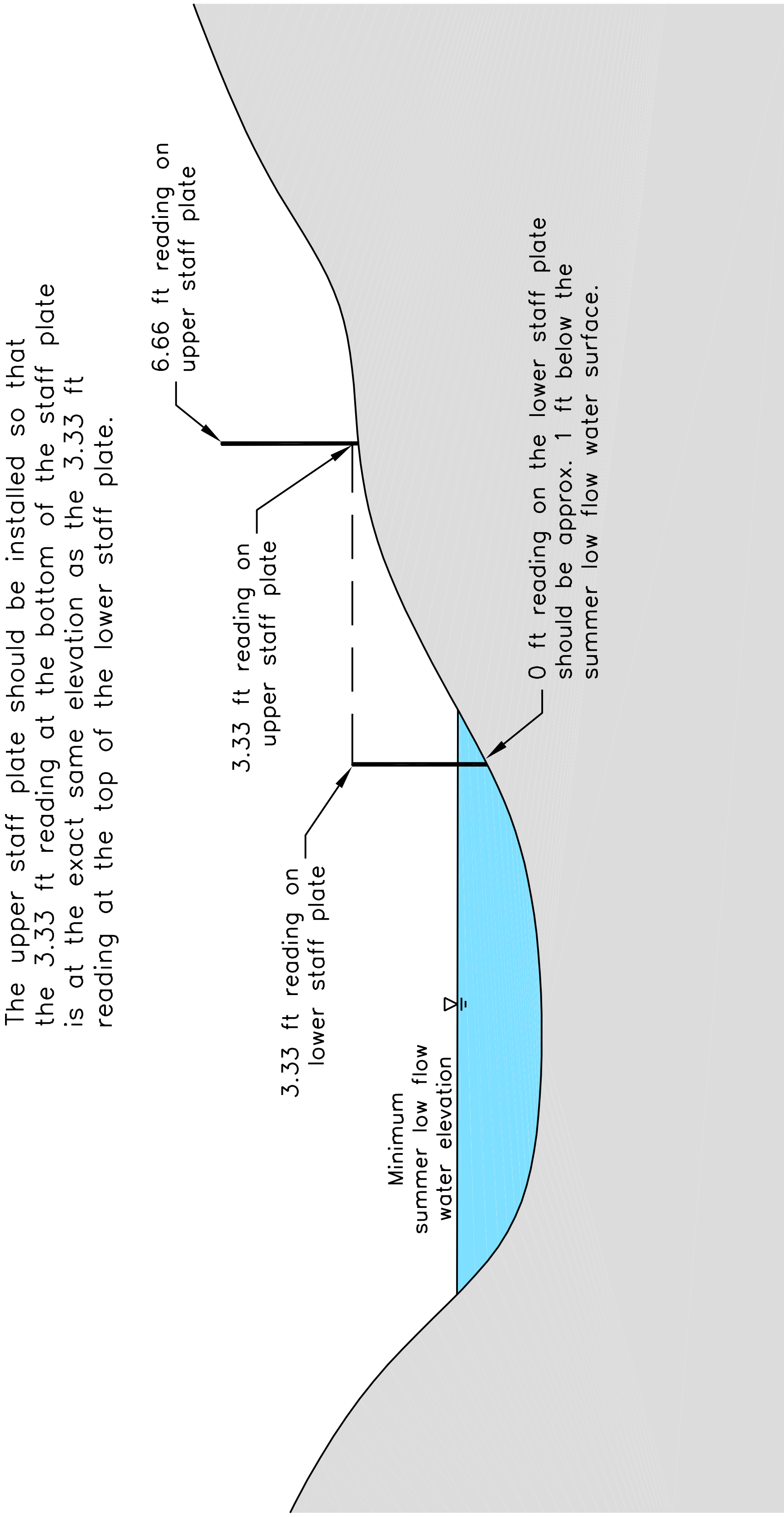



*Figure 10.2: Multiple staff plate placement schematic*

interest). In this case, it is important to set the second staff plate using survey control so that the elevation of the 3.33' line on the top of the lower staff plate is the same elevation as the 3.33' line on the bottom of the upper staff plate (see Figure 10.2).

*Monitoring*

The water surface should be read from the staff gage whenever the site is visited. This reading is commonly referred to as "gage height". Gage height and time of the reading should be recorded in the field notes.

Because the fundamental purpose of the staff gage is to correlate stage to discharge, should be measured at the time the staff gage is installed and at later times during various stages. Moreover, discharge must always be measured near the staff gage, whether at the location of the staff gage or at a location up- or downstream (as long as discharge is neither gained or lost between where discharge is measured and the staff gage). Generally, the closer the discharge is measured to the observed stage, the better.

When total discharge for a cross section is computed, its value is plotted against the gage height. Successive measurements of stage and discharge are plotted on what is called a discharge rating curve (Leopold 1994). On log-log graph paper, plot the gage height on the ordinate (Y-axis) and the discharge on the abscissa (X-axis) (Harrelson et al. 1994). An example rating curve is presented as Figure 10.3.

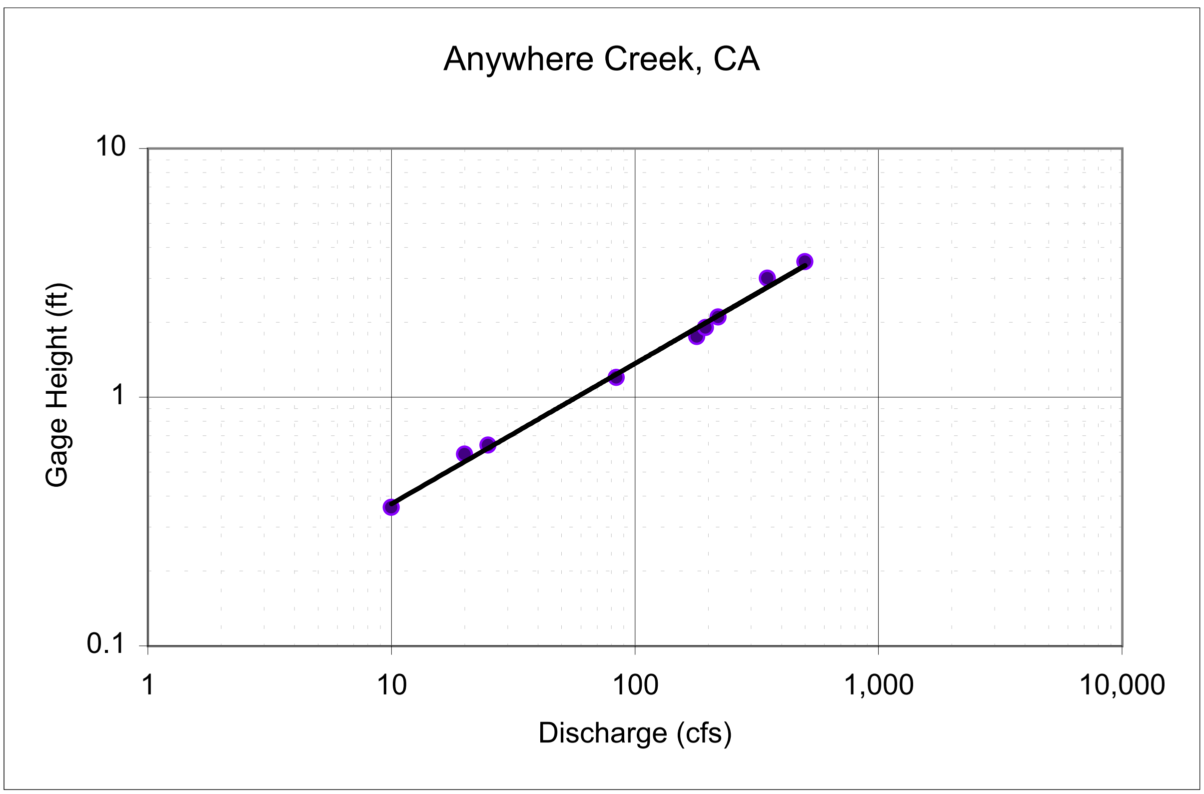



*Figure 10.4. Example rating curve showing a power function fit of measured gage heights and discharges.*

The goal of placing staff plates is to develop a stage-discharge rating curve for the location where the plate is set, upon which we can evaluate flow-stage relationships important for project performance (i.e., do the constructed flood plains inundate at 3000 cfs?). Because several staff gages have already been installed at Clear Creek project sites, (see figures 4.2 and 4.3) it would be impractical to take a discharge measurement at every staff gage to develop the rating curves. Instead, a single discharge measurement approximately halfway between the two Clear Creek project sites (Reading Bar and Restoration Grove) is sufficient to plot against stage recorded at all staff gages. The recommended location for this discharge measurement location is at Renshaw Riffle (river mile 5.3) and assumes that this measurement at Renshaw Riffle accurately depicts discharge at both project sites.

To accurately document stage-discharge relationships for a measured discharge at Renshaw Riffle to water stage recorded at each staff gage, we recommend first taking a discharge measurement, then immediately collecting staff plate readings at all staff gages. Alternatively, if discharge cannot be measured at Renshaw Riffle, discharge can be obtained from the U.S. Geological Survey Clear creek near Igo, CA gage (Gage ID# 11372000). However, because the Igo gage is located further from the project sites than the Renshaw Riffle, stage-discharge relationships will not be as representative of local site conditions if there is a tributary derived runoff event occurring. In addition, the discharge recorded at Igo will be different than discharge measured at Renshaw Riffle. If discharge data is used from both sources (Renshaw Riffle and Igo), the stage-discharge data can be plotted on the same graph, but each discharge source should have its own data point symbol. The Igo data points should be closely scrutinized to see if they can be reasonably used in developing rating curves at staff plates in the project reach.

Because the channel geometry can change where discharge is measured (thereby affecting the area-velocity relationship for discharge computation), the relationship between stage and discharge can change. Changes in the stage-discharge relationship will cause subsequent stage-discharge points to deviate from the rating curve. This is called a “shift” in the rating. After such a change takes place, such as after a large flood, a new rating curve will have to be constructed via a new series of discharge measurements and staff gage readings.

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# Monitoring Plan for Neotropical and Resident Songbirds in the Clear Creek Restoration Project.

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## Project Need

Riparian areas throughout California have been identified as the single most important habitat for conservation of resident and neotropical migrant birds (Miller 1951, Gaines 1977, Manley and Davidson 1993, RHJV 2000). Data gathered by PRBO Conservation Science (PRBO) on the distribution and abundance of songbirds in the lower Clear Creek corridor from 1999-2004 indicate that it is an important riparian area for the conservation of birds in the Sacramento Valley (Burnett and Harley 2004).

Clear Creek is of special conservation interest to breeding birds for multiple reasons. First, the riparian bird community includes three species currently uncommon to rare on the Sacramento River and its tributaries (below Shasta Dam), making it a more "complete" bird community. Yellow Warblers, fairly common breeders at Clear Creek, have become extremely rare and local breeders in the Sacramento Valley since the mid 1970s (Gaines 1977). Clear Creek (and its confluence with the Sacramento River) is the only known place Song Sparrows occur as breeders on the Sacramento River between Colusa County and Shasta Dam. Additionally, Yellow-breasted Chat, a California Bird Species of Special Concern is more abundant along Clear Creek than any other riparian site in the Central Valley (Burnett and Harley 2004, PRBO unpublished data).

Understanding why these species continue to breed at Clear Creek will have broad conservation implications regarding effective land management and restoration extending out to the broader Sacramento River watershed.

Management and restoration activities for riparian areas require detailed plans for implementation and regular evaluation to determine the effectiveness of the actions. Restoration activities that focus on a single species are not addressing the needs of the broader ecological community. Because birds occupy an extremely diverse range of niches within an ecosystem and occupy a relatively high position in the food chain they are ideal indicators of environmental conditions (DeSante and Geupel 1987, Rich 2002, Temple and Wiens 1989). Thus, birds are a model organism to measure success of restoration and changes in land management (Martin 1995). Finally, birds are both cost effective and perhaps the easiest community of organisms to monitor (RHJV 2004).

To date, our work has provided over 15 scientifically based - site specific recommendations to improve the restoration process to incorporate the needs of the riparian bird community - working closely as a member of the Clear Creek Technical Advisory Committee.

**Qualifications**

The Terrestrial program of PRBO has been conducting long-term monitoring of landbird populations for more than 30 years. Ongoing programs at PRBO (Palomarin and Southeast Farallon Island field stations) represent two of the oldest databases on landbird populations in Western North America. Results of these studies have contributed significantly to current protocols used to monitor and assess bird populations throughout the New World (Pyle et al. 1987, Ralph et al. 1993, Geupel and Nur 1993, Martin and Geupel 1993, Nur et al. 1999). PRBO biologists have been instrumental in the development, standardization and validation of methods of demographic monitoring (nest monitoring and constant-effort mist netting) and migration monitoring.

PRBO is a leader in riparian bird monitoring in California and on CalFed projects, currently working on seven major central valley riparian restoration projects including nine and eleven years of monitoring on the Cosumnes and Sacramento Rivers respectively. Having now continually tracked the response of birds to restoration over relatively long time periods we are in a unique position to truly evaluate the success of efforts to restore critical riparian bird habitat and provide feedback to future restoration efforts.

**General Objectives**

- To contribute to restoration and management design and implementation using current "state-of-the-science" knowledge of the requirements of birds in riparian habitats based on 6 years of data collection at Clear Creek and over 10 years experience throughout the Cal Fed area.
- Evaluate the effectiveness of restoration activities in creating high quality riparian bird habitat as part of a functional and sustainable ecosystem.
- Provide information ("targets") on the amount and proportion of each type of riparian habitat necessary to maintain a diverse and healthy bird community.
- Provide outreach to educate the community about conservation, restoration, and the specifics of the Clear Creek project.

**Table 1. Avian monitoring metrics, field methods, scale of data analysis, and the species that will be used to measure each.**

| Metric | Field Method | Scale | Target Species |
|---|---|---|---|
| Annual Adult Survival | Constant Effort Netting | Site | Focal Species |
| Nest Success | Nest Monitoring | Site and Creek Wide | Most Species |
| Breeding Densities | Territory Mapping | Site and Creek Wide | Focal Species |
| Abundance | Point Counts | Site and Creek Wide | Focal Species |
| Species Richness | Point Count | Site and Creek Wide | All Species |

**Table 2. Avian monitoring sites along Clear Creek and the methods employed at each site (point counts, nest monitoring, territory mapping, constant effort mist-netting).**

| Site | Point Count | Mist-net | Nest Monitoring | Territory Mapping |
|---|---|---|---|---|
| Reading Bar | X | | X | X |
| Shooting Gallery | X | | | |
| Saeltzer Dam | X | X | X | X |
| Old Mill | X | | | |
| Phase 4 (Project Area) | X | X | X | X |
| Phase 2A Plug (Project Area) | X | | X | X |
| Phase 2B North (Project Area) | X | | | |
| Phase 2B South | X | | X | X |
| Phase 3A | X | | X | X |
| Sacramento River Confluence | X | | | |
| Whiskeytown Dam | X | | | |

## Quantitative Objectives

We will use five metrics as quantified targets for evaluating restoration efforts: nest success, adult survival, focal species breeding densities, focal species abundance, and riparian bird species richness.

The specific metrics were chosen to provide us with the necessary information to evaluate response on multiple scales. We are interesting in using these metrics to evaluate site level response and individual project performance as well as the system level response to the suite of restoration actions occurring. Additionally, results from all of these measures will elucidate the appropriate actions to take if targets are not being met. Many of these measures will only be obtained for a suite of focal species, following Chase and Geupel (in press). A list of focal species and the habitat conditions they will be used to indicate are listed in Appendix 1.

Our monitoring approach employs four standardized methodologies: nest monitoring, territory mapping, point counting, constant-effort mist-netting (Table 1). The individual target values are based upon five years of data collection and analysis of Clear Creek songbird populations from 1999-2003 as well as PRBO data from other riparian sites in the Sacramento Valley (PRBO unpublished data).

**Table 3. Nest survival (Mayfield estimates) targets for focal bird species at Clear Creek and actual estimates from 1999-2003. Targets will be evaluated creek wide, for all restoration sites combined, and for individual reference sites, as sample sizes allow.**

| Nest Success | Poor | Fair | Good | Very Good | 1999-2003 |
|---|---|---|---|---|---|
| Black-headed Grosbeak | <20% | 20-30% | 30-40% | >40% | 29% |
| Song Sparrow | <15% | 15-25% | 25-35% | >35% | 15% |
| Spotted Towhee | <10% | 10-20% | 20-30% | >30% | 12% |
| Yellow-breasted Chat | <15% | 20-30% | 30-40% | >40% | 24% |
| Yellow Warbler | <15% | 15-25% | 25-35% | >35% | 20% |
| Bewick's Wren | <30% | 30-45% | 45-60% | >60% | 93%* |
| Tree Swallow | <30% | 30-45% | 45-60% | >60% | 93%* |

*= proportional nest success

**Table 4. Apparent adult annual survival targets for focal bird species at Clear Creek.**

| Species | Poor | Fair | Good | Very Good |
|---|---|---|---|---|
| Black-headed Grosbeak | < 30% | 30% to 40% | 50% to 70 | >70% |
| Song Sparrow | < 30% | 30% to 40% | 50% to 70 | >70% |
| Spotted Towhee | < 30% | 30% to 40% | 50% to 70 | >70% |
| Yellow-breasted Chat | < 30% | 30% to 40% | 50% to 70 | >70% |
| Yellow Warbler | < 30% | 30% to 40% | 50% to 70 | >70% |
| Bewick's Wren | < 30% | 30%to 40% | 50% to 70 | >70% |

**Table 5. Breeding density (territories/10 hectares) targets for focal species at Clear Creek with the highest recorded numbers from 1999-2003.**

| Species | Poor | Fair | Good | Very Good | 1999-2003 Highest |
|---|---|---|---|---|---|
| Black-headed Grosbeak | <3 | 3 to 4.5 | 4.5 to 7 | >7 | 8 |
| Song Sparrow | <3 | 3 to 4.5 | 4.5 to 6 | >6 | 4.4 |
| Spotted Towhee | <3 | 3 to 5 | 5 to 7 | >7 | 6.7 |
| Yellow-breasted Chat | <3 | 3 to 5 | 5 to 7 | >7 | 6.3 |
| Yellow Warbler | <2 | 2 to 3.5 | 3.5 to 5 | >5 | 4 |
| Bewick's Wren | <3 | 3 to 5 | 5 to 7 | >7 | 7 |
| Tree Swallows | <3 | 3 to 5 | 5 to 8 | >8 | 8 |
| Spotted Sandpiper* | 0 | 1 to 2 | 3 to 4 | >4 | NA |

* estimates are for breeding territories per river mile.

**Table 6. Breeding bird abundance targets for focal species at Clear Creek with the highest recorded from any one site in 2003 or 2004 for reference.**

| Species | Poor | Fair | Good | Very Good | '03-'04 High |
|---|---|---|---|---|---|
| Black-headed Grosbeak | <0.3 | 0.3 to 0.5 | 0.5 to 0.7 | >0.7 | 0.67 |
| Song Sparrow | <0.3 | 0.3 to 0.6 | 0.6 to 0.9 | >0.9 | 1.08 |
| Spotted Towhee | <0.4 | 0.4 to 0.7 | 0.7 to 1.0 | >1.0 | 1.13 |
| Yellow-breasted Chat | <0.3 | 0.3 to 0.6 | 0.6 to 0.9 | >0.9 | 0.63 |
| Yellow Warbler | <0.3 | 0.3 to 0.5 | 0.5 to 0.8 | >0.8 | 0.83 |
| Bewick's Wren | <0.4 | 0.4 to 0.7 | 0.7 to 1.0 | >1.0 | 0.7 |

**Table 7. Breeding bird species richness targets for Clear Creek for 4 point transects with the highest recorded from 1999-2003 presented for reference.**

| Site | Poor | Fair | Good | Excellent | 2004 |
|---|---|---|---|---|---|
| Phase 2A Plug/3A | <10 | 11 to 15 | 16 to 20 | >20 | 13 |
| Phase 2B South | <10 | 11 to 15 | 16 to 20 | >20 | 12 |
| Reading Bar | <10 | 11 to 15 | 16 to 20 | >20 | 17 |
| Phase 4 (PRAR) | <10 | 11 to 15 | 16 to 20 | >20 | 18 |
| Old Mill | <10 | 11 to 15 | 16 to 20 | >20 | 16 |
| Saeltzer Dam | <10 | 11 to 15 | 16 to 20 | >20 | 15 |
| Shooting Gallery | <10 | 11 to 14 | 15 to 18 | >18 | 14 |
| Whiskeytown Dam | <10 | 9 to 12 | 13 to 16 | >16 | 11 |

## Study Sites

Our study sites extend from the base of Whiskeytown Dam to the confluence with the Sacramento River. However, our intensive study plots where densities, reproductive success, and survival data is being recorded encompasses all restoration sites from Reading Bar (2A Borrow) to the end of the project area (downstream end of proposed Phase 4). Additionally, we are collecting intensive data at a reference site above the former Saeltzer Dam.

## Monitoring Methodology and Data Sampling Procedures

We will continue to monitor nests and map territory densities at the six previously established nest plots (Phase 4 (PRAR), Saeltzer Dam, Reading Bar, Phase 2A Plug, Phase 2B South, and Phase 3A North. In addition we will begin monitoring the proposed Phase 3B area in order to gather baseline data before proposed restoration efforts begin there. All sites will be monitored in accordance with the nationally standardized, Breeding Biology Research and Monitoring Database (BBIRD; http://pica.wru.umt.edu/bbird/). Nest monitoring requires biologists on sight throughout the breeding season (approximately mid April through July).

Territory mapping involves tracking the movements of territorial birds in a pre-defined area multiple times throughout the breeding season in order to determine the extent and number of territories at a site following methodologies outlined in Ralph et al. (1993).

We will continue all of the point count transects previously established along Clear Creek. The point count method is a standardized and widely applied census technique (see Ralph et al. 1993) that includes a vegetation assessment component. The point count method is used to monitor population changes of breeding landbirds over time and is the standard method of obtaining information on the diversity and richness of birds in a given area. The vegetation component relates changes in bird composition and abundance to differences in vegetation. Point counts at Clear Creek cover the majority of riparian habitat within the project area as well as several reference sites outside the project area.

Finally, we will continue the constant-effort-mist netting stations established at the Project Area and Saeltzer Dam nest monitoring plots. At these sites an array of 10 mist nets will be opened and operated in a consistent manner, according to the methodology outlined in Ralph et al. (1993) and coordinated by the Monitoring Avian Productivity and Survival (MAPS) program.

## Analysis

### Abundance and species richness

Results from point counts censuses provide relative measures of abundance for various species, as well as estimates of species richness. Abundance and species richness will be compared among and within sites, with respect to habitat and vegetation features. In particular, we will use on site comparisons of treated and untreated areas as well as comparisons to reference sites located elsewhere. Such comparisons allow us to determine how birds respond to vegetation and habitat changes associated with management, restoration and disturbance (Burnett and DeStaebler 2002). We have developed quantitative targets for both the abundance of focal species and overall species richness (Table 6 & 7). Measures of species richness will be calculated using four point subsets from each point count route in order that sample sizes, which can significantly influence species richness, are equal between reference and restored sites which are often only contain four points.

### Focal Species Density

We will use the breeding densities to evaluate the response of our focal species to restoration actions, this data will complement that described above. By comparing densities across years and to reference sites, where no restoration has occurred, we will be able to measure the response to restoration as well as be able to evaluate when sites have met or exceeded our target levels (Table 5). Additionally, density measures provide real numbers of birds present so that we will be able to determine just how many new territories restoration efforts have created for a suite of the most important species at Clear Creek (e.g. Yellow Warbler and Yellow-breasted Chat).

### Nest Success and Adult Survival

Bird productivity (reproductive success) is a critical demographic component that can determine whether or not a species can maintain itself at a given site, rebound from past losses, or produce enough young to repopulate newly restored sites. Two measures of productivity will be analyzed; the first measure is based on results from nest monitoring and the second is based on results from constant-effort mist-netting. Nest monitoring will allow us to quantify nest success (the probability a nest successfully fledges at least one young) in both treated and untreated areas (on site) as well as at reference sites located elsewhere. In addition, we will investigate the relationship between habitat, landscape and/or vegetation features and nest success on restoration plots and compare them to results from reference sites (Burnett and Harley 2004). Our quantitative targets for nest survival are limited to species for which we are able to achieve sufficient sample sizes (Table 3). We will continue to monitor nests for most species breeding at Clear Creek; this approach will allow us to make specific management and restoration recommendations that will optimize the health of populations, on a species by species basis as well as at the community level.

Constant-effort mist-netting provides an index of productivity (reproductive output) by sampling fledged young that have reached independence. Productivity, as indicated by results from mist-netting, will be compared with results for nest success (sampled by nest monitoring). Whereas the two measures of productivity are usually concordant (Nur & Geupel 1993), there can be differences if, for example, survival during the nestling period is high, but low in the post-fledging period. The latter period represents a critical transition from parental dependence to independence for passerine young, and may be influenced by habitat quality.

Furthermore mist net data collected over 5 years can also give indices of annual adult survivorship of bird species breeding in the area (Nur et al. 1999). We will determine survivorship indices of key species and combine results with productivity indices to model the source/sink status of species at Clear Creek. These analyses allow us to determine where populations are limited and thus focus our restoration recommendations to address these limitations.

## Education and Outreach

Bird monitoring projects provide an excellent outlet for public education. We plan to continue our public outreach effort to include field trips to study sites for local schools and community groups, work with local educators on incorporating birds and riparian curriculum into their study presentation to local groups (e.g. Audubon Society, Horsetown Clear Creek Preserve, etc.). Through these efforts we will be able to provide environmental education to the youth of the Redding area as well as inform local citizens and groups about the importance of the Clear Creek restoration. In order to meet these objectives we plan to hire an education intern who would be in charge of coordinating these efforts under the supervision of the project supervisor.

## Reporting

Annual reports summarizing data collection, status of bird response to restoration, including progress towards meeting quantitative objectives, as well as a list of recommendations based on results will be completed each year and results will be presented to the Clear Creek Technical Advisory Committee. Following the 2008 season a final report synthesizing 10 years of data collection will be made. Additionally, relevant results will be presented at CalFed conferences and through other scientific venues (e.g. conference and journals). Data will also be added to regional, valley wide, state wide and national databases and analyses to evaluate bird and riparian conservation efforts at various scales (e.g. Riparian Habitat Joint Venture).

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**Appendix 1. Clear Creek Focal Bird Species, preferred habitat age, and habitat conditions they are associated with at Clear Creek.**

| Species | Habitat Age Association | Habitat Associations* |
|---|---|---|
| Tree Swallow | Old seral | Snags, open water, emergent aquatic insects |
| Bewick's Wren | Mid to late seral | Woody debris, snags, shrub layer foliage volume |
| Yellow Warbler | All ages | Large alders, streamside habitat, oxbows, mature canopy oak forest, shrubby willows. |
| Yellow-breasted Chat | Mid to late seral | Dense understory foliage, blackberry cover, cottonwoods. |
| Common Yellowthroat | Early seral | Wetlands, marsh, backwaters, oxbows, understory vegetation. |
| Spotted Towhee | Mid to late seral | Herbaceous vegetation, leaf litter, closed canopy, mugwort, grape, and blackberry cover, valley oak terraces. |
| Song Sparrow | Early to mid seral | Wetlands, herbaceous veg. cover, oxbows, backwaters, streamside habitat. |
| Black-headed Grosbeak | Mid seral | 3 to 10 year old tree regeneration, mugwort, blackberry, and elderberry cover. |
| Spotted Sandpiper | Early seral | Alluvial dynamics, gravel bar regeneration, aquatic insects, herbaceous veg. |

* Based on Riparian Bird Conservation Plan, Birds of North America Species accounts, Burnett and DeStaebler 2002, Burnett and Harley 2004, and expert opinion based on 6 years of field work at Clear Creek.

# APPENDIX E

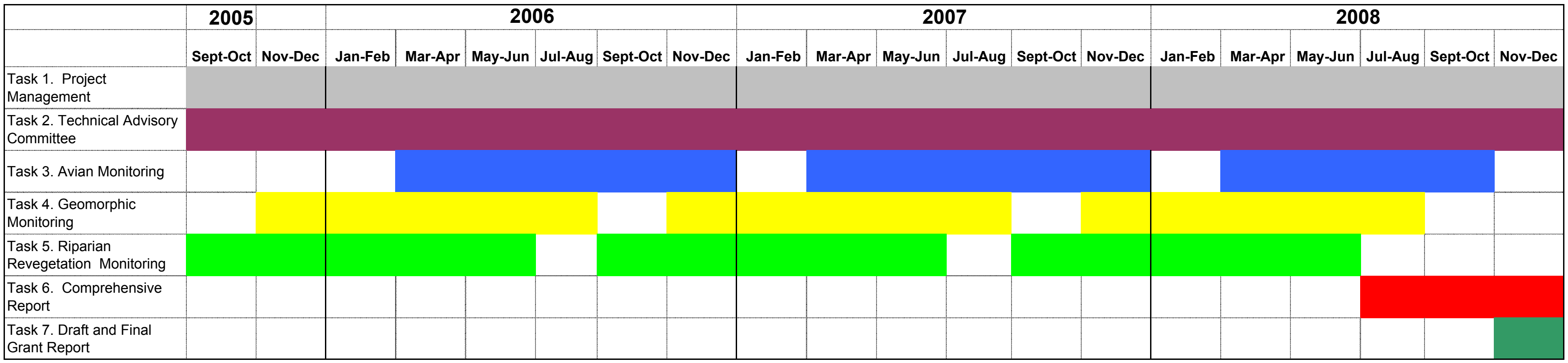


Table 2. Timeline for Implementation

# APPENDIX F

**SUBCONTRACTORS –** Each of these subcontractors was selected because they have been active participants on the Lower Clear Creek Floodway Rehabilitation Project involved in project design, implementation, and monitoring. They are highly qualified and have produced excellent peer-reviewed reports and analysis on time and within budget.

**Geoffrey R. Geupel**, Director of Terrestrial Ecology Division of Point Reyes Bird Observatory since 1989, has a B.S. in Biology from Lewis and Clark College in Portland, Oregon and some post graduate course work from the University of New Mexico in Albuquerque. His research interests are bird conservation, population ecology and regulation, monitoring, planning and adaptive management and life history strategies and has published numerous papers.

**Ryan D. Burnett**, Terrestrial Ecologist with Point Reyes Bird Observatory since 1997, has a B.S. in Wildlife, Fish and Conservation Biology from the University of California-Davis. His duties include designing and implementing research and monitoring projects, hiring, training, and managing field crews, data analysis, compiling reports, and presenting results at conferences. He has been a Co-Principal Investigator of the Lower Clear Creek Songbird Monitoring Project since 2001.

**Graham Matthews**, Principal Hydrologist with Graham Matthews & Associates since 1990, has an M.S. in Earth Sciences from the University of California- Santa Cruz, and a B.A. in Geology and History, cum Laude, from Pomona College, Claremont, California. He has over 22 years experience in hydrology and fluvial geomorphology and 19 years experience in the design and construction of stream and riparian restoration projects.

**Aaron (Smokey) Pittman,** Hydrologist/Geomorphologist with Graham Matthews & Associates since 2000, has a M.S. in Watershed Management from California State University-Humboldt, and a B.S. in Environmental Planning and Management from the University of California-Davis. He is the project manager for geomorphology projects that include Clear Creek, responsible for installation and operation of streamflow gages, collection of streamflow and sediment transport data, leading field survey crews, analysis of streamflow and sediment transport records.

**Jeff Souza**, Principal and Biologist for Souza Environmental Solutions, has a M.S. in Agriculture with an emphasis on Range and Wildland Management from California State University-Chico, and a B.S. in environmental and Systematic Biology with a concentration in fish and wildlife biology from California Polytechnic State University in San Luis Obispo. He has 17 years of professional experience in the assessment, restoration, monitoring and project permitting of terrestrial and aquatic habitats associated with stream, riparian, and wetland systems and has been actively involved in the Clear Creek restoration program since 1995.

**Gregory Treber,** Principal and Botanist with Terrestrial Connections, has both a M. S. in Agriculture-Plant Ecology with natural resource management emphasis and a B.S. in

Agriculture with a Botany Minor from California State University-Chico. His responsibilities include botanical surveys, wetland delineations, riparian restoration monitoring with associated reports and evaluations.

**Neil C. Schwertman**, Professor Emeritus California State University, Chico, has a Ph.D. from the University of Kentucky in Applied Statistics and a B.S., U.S. Naval Academy in Mathematics with a minor in Engineering. His responsibilities include working with the restoration team with study design and statistical analysis of project monitoring data

# Tasks And Deliverables

*Lower Clear Creek Monitoring Program*

| Task ID | Task Name | Start Month | End Month | Deliverables |
|---|---|---|---|---|
| 1 | Project Management | 1 | 36 | Subcontracts, monitoring reports, presentation documentation, quarterly status reports, periodic invoices. |
| 2 | Technical Adivisory Commitee | 1 | 36 | Agendas,sign in sheets, and minutes from each TAC meeting, annual workshops, and documentation of presentations. |
| 3 | Avain Monitoring | 2 | 35 | Draft and final annual monitoring reports, copies and documentation of public education programs and field trips for local schools and community groups; presentation materials on the final monitoring report given at a CALFED Science Conference. |
| 4 | Geomorphic Monitoring | 2 | 35 | Draft and final annual monitoring reports, presentation materials from the final monitoring report given at a CALFED Science Conference. |
| 5 | Riparian Revegetation Monitoring | 2 | 35 | Draft and final annual monitoring reports, presentation mateirals from the final monitoring report given at a CALFED Science Conference. |
| 6 | Comprehensive Report | 34 | 36 | Comprehesive Monitoring Report on the Lower clear Creek avian, geomorphic, and riparian revegetation monitoring programs. |
| 7 | Final Grant | | | Draft and Final grant reports. |

| | | | | |
|---|---|---|---|---|
| | **Report** | **28** | **36** | |

# Comments

If you have comments about budget justification that do not fit elsewhere, enter them here.

# Budget Summary

## Project Totals

| Labor | Benefits | Travel | Supplies And Expendables | Services And Consultants | Equipment | Lands And Rights Of Way | Other Direct Costs | Direct Total | Indirect Costs | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| $18,956 | $5,308 | $3,191 | $2,608 | $1,056,955 | $0 | $0 | $21,837 | $1,108,855 | $199,594 | $1,308,449 |

Do you have cost share partners already identified?
**Yes.**

If yes, list partners and amount contributed by each:

**Members of the Technical Advisory Committee who represent agencies with a long−term interest in the success of this project. These "In Kind" Contributions will be from: CA Department of Fish and Game US Fish and Wildlife Service Bureau of Reclamation Bureau of Land Management CA EPA Regional Water Quality Control Board Whiskeytown National Park City of Redding ESSA Technologies Ltd. CA Department of Water Resources Natural Resources Conservation Service Shasta County NOAA Lower Clear Creek CRMP UC Cooperative Extension Shasta College Shasta Tehama Bioregional Council Average TAC meetings 20 people, 3 hrs ea, 10 meetings/year, = 1800 hours @ $40/hr = $72,000**

Do you have potential cost share partners?
**No.**

If yes, list partners and amount contributed by each:

Are you specifically seeking non−federal cost share funds through this solicitation?
**No.**

*Lower Clear Creek Monitoring Program*

# Year 1 ( Months 1 To 12 )

| Task | Labor | Benefits | Travel | Supplies And Expendables | Services And Consultants | Equipment | Lands And Rights Of Way | Other Direct Costs | Direct Total | Indirect Costs | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1: project management (12 months) | 2880 | 806 | 619 | 175 | 0 | 0 | 0 | 3059 | $7,539 | 1357 | $8,896 |
| 2: Technical Adivisory Commitee (12 months) | 960 | 269 | 94 | 150 | 0 | 0 | 0 | 1459 | $2,932 | 528 | $3,460 |
| 3: Avain Monitoring (11 months) | 576 | 161 | 94 | 75 | 83923 | 0 | 0 | 686 | $85,515 | 15393 | $100,908 |
| 4: Geomorphic Monitoring (11 months) | 576 | 161 | 94 | 75 | 150000 | 0 | 0 | 686 | $151,592 | 27287 | $178,879 |
| 5: Riparian Revegetation Monitoring (11 months) | 576 | 161 | 94 | 75 | 119930 | 0 | 0 | 686 | $121,522 | 21874 | $143,396 |
| **Totals** | **$5,568** | **$1,558** | **$995** | **$550** | **$353,853** | **$0** | **$0** | **$6,576** | **$369,100** | **$66,439** | **$435,539** |

## Year 2 ( Months 13 To 24 )

| Task | Labor | Benefits | Travel | Supplies And Expendables | Services And Consultants | Equipment | Lands And Rights Of Way | Other Direct Costs | Direct Total | Indirect Costs | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1: project management (12 months) | 2981 | 835 | 641 | 181 | 0 | 0 | 0 | 3166 | $7,804 | 1405 | $9,209 |
| 2: Technical Adivisory Commitee (12 months) | 994 | 278 | 97 | 155 | 0 | 0 | 0 | 1510 | $3,034 | 546 | $3,580 |
| 3: Avain Monitoring (12 months) | 596 | 167 | 97 | 78 | 88340 | 0 | 0 | 710 | $89,988 | 16198 | $106,186 |
| 4: Geomorphic Monitoring (12 months) | 596 | 167 | 97 | 78 | 155250 | 0 | 0 | 710 | $156,898 | 28242 | $185,140 |
| 5: Riparian Revegetation Monitoring (12 months) | 596 | 167 | 97 | 78 | 113275 | 0 | 0 | 710 | $114,923 | 20686 | $135,609 |
| **Totals** | **$5,763** | **$1,614** | **$1,029** | **$570** | **$356,865** | **$0** | **$0** | **$6,806** | **$372,647** | **$67,077** | **$439,724** |

## Year 3 ( Months 25 To 36 )

| Task | Labor | Benefits | Travel | Supplies And Expendables | Services And Consultants | Equipment | Lands And Rights Of Way | Other Direct Costs | Direct Total | Indirect Costs | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1: project management (12 months) | **3085** | **864** | **663** | **187** | **0** | **0** | **0** | **3277** | $8,076 | **1454** | $9,530 |
| 2: Technical Adivisory Commitee (12 months) | **1028** | **288** | **101** | **161** | **0** | **0** | **0** | **1563** | $3,141 | **565** | $3,706 |
| 3: Avain Monitoring (11 months) | **617** | **173** | **101** | **80** | **92757** | **0** | **0** | **735** | $94,463 | **17003** | $111,466 |
| 4: Geomorphic Monitoring (11 months) | **617** | **173** | **101** | **80** | **160684** | **0** | **0** | **735** | $162,390 | **29230** | $191,620 |
| 5: Riparian Revegetation Monitoring (11 months) | **617** | **173** | **101** | **80** | **92796** | **0** | **0** | **735** | $94,502 | **17010** | $111,512 |
| 6: Comprehensive Report (3 months) | **1500** | **420** | **100** | **865** | **0** | **0** | **0** | **1232** | $4,117 | **741** | $4,858 |
| 7: Final Grant Report (9 months) | **161** | **45** | **0** | **35** | **0** | **0** | **0** | **178** | $419 | **75** | $494 |
| **Totals** | **$7,625** | **$2,136** | **$1,167** | **$1,488** | **$346,237** | **$0** | **$0** | **$8,455** | **$367,108** | **$66,078** | **$433,186** |

# Budget Justification

*Lower Clear Creek Monitoring Program*

## Labor

**TASK 1. PROJECT MANAGEMENT.**

**Project Manager − Year 1: 10 hrs/month = 120 hrs/yr @ $24.00/hr =$2880. Year 2: 10 hrs/month = 120 hrs/yr @ $24.84/hr =$2981. Year 3: 10 hrs/month = 120 hrs/yr @ $25.71/hr =$3085.**

**District Manager − Year 1: 50 hrs/yr @ $25.00/hr = $1250. Year 2: 50 hrs/yr @ $25.88/hr = $1294. Year 3: 50 hrs/yr @ $26.79/hr = $1340.**

**Project Coordinator − Year 1: 40 hrs/yr @ $21.00/hr = $840. Year 2: 40 hrs/yr @ $21.74/hr = $870. Year 3: 40 hrs/yr @ $22.50/hr = $900.**

**Secretary − Year 1: 20 hrs/yr @ $15.00/hr = $300. Year 2: 20 hrs/yr @ $15.53/hr = $311. Year 3: 20 hrs/yr @ $16.07/hr = $321.**

**TASK 2. TECHNICAL ADVISORY COMMITTEE.**

**Project Manaager − 10 TAC meetings/yr @4hrs ea = 40 hrs/yr. Year 1: 40 hrs @ $24.00/hr =$960. year 2: 40 hrs @ $24.84/hr =$994. Year 3: 40 hrs @ $25.71/hr =$1028.**

**Project Coordinator − 10 TAC meetings/yr @ 4 hrs ea = 40 hrs. Year 1: 40 hrs @ $21/hr = $840. Year 2: 40 hrs @ $21.14 = $846. Year 3: 40 hrs @ $22.50 = $900.**

**Secretary − 10 TAC meetings, assist 2 hrs each, 20 hrs/yr total. Year 1: 20 hrs @ $15.00/hr = $300. Year 2: 20 hrs @ $15.53/hr = $311. Year 3: 20 hrs @ $16.07/hr = $321.**

**TASK 3. AVIAN MONITORING.**

**Project Manager − Reviewing documents, presentations, reviewing annual reports, 6 hrs 4x/yr = 24/hrs/yr. Year 1: 24 hrs $24.00/hr = $576. year 2: 24 hrs $24.84/hr = $596. Year 3: 24 hrs $25.71/hr = $617.**

**Project Coordinator − Reviewing documents, presentations, reviewing annual reports, 4 hrs 4x/yr = 16/hrs/yr. Year 1: 16 hrs @ $21.00/hr = $336. Year 2: 16 hrs @ $21.14/hr = $338. Year 3: 16 hrs @ $22.50/hr = $360.**

**District Manager − Reviewing documents, presentations, reviewing annual reports, 2 hrs 4x/yr = 8/hrs/yr. Year 1: 8 hrs @ $25.00/hr = $200. Year 2: 8 hrs @ $25.88/hr = $207. Year 3: 8 hrs @ $26.78/hr = $214.**

**TASK 4. GEOMORPHIC MONITORING. PROJECT MANAGER − Reviewing documents, presentations, reviewing annual reports, 6 hrs 4x/yr = 24 hrs. Year 1: 24 hrs @ $24.00/hr = $576. year 2: 24 hrs @ $24.84/hr = $596. Year 3: 24 hrs @ $25.71/hr = $617.**

**Project Coordinator − Reviewing documents, presentations, reviewing annual reports, 4 hrs 4x/yr = 16 hrs. Year 1: 16 hrs @ $21.00/hr = $336. Year 2: 16 hrs @ $21.14/hr = $338. Year 3: 16 hrs @ $22.50/hr = $360.**

**District Manager − Reviewing documents, presentations, reviewing annual reports, 2 hrs 4x/yr = 8/hrs/yr. Year 1: 8 hrs @ $25.00/hr = $200. Year 2: 8 hrs @ $25.88/hr = $207. Year 3: 8 hrs @ $26.78/hr = $214.**

**TASK 5. RIPARIAN MONITORING.**

**Project Manager − Reviewing documents, presentations, reviewing annual reports, 6 hrs 4x/yr = 24 hrs. Year 1: 24 hrs @ $24.00/hr = $576. Year 2: 24 hrs @ $24.84/hr = $596. Year 3: 24 hrs @ $25.71/hr = $617.**

**Project Coordinator − Reviewing documents, presentations, reviewing annual reports, 4 hrs 4x/yr = 16 hrs. Year 1: 16 hrs @ $21.00/hr = $336. Year 2: 16 hrs @ $21.14/hr = $338. Year 3: 16 hrs @ $22.50/hr = $360.**

**District Manager − Reviewing documents, presentations, reviewing annual reports, 2 hrs 4x/yr = 8/hrs/yr. Year 1: 8 hrs @ $25.00/hr = $200. Year 2: 8 hrs @ $25.88/hr = $207. Year 3: 8 hrs @ $26.78/hr = $214.**

**TASK 6. COMPREHENSIVE MONITORING REPORT.**

**Project Manager − Compile report. Year 1: NA. Year 2: NA. Year 3: 60 hrs @ $25.00/hr = $1500.**

**District Manager − Review draft and final comprehensive report. Year 1: NA. Year 2: NA. Year 3: 10 hrs @ $26.78/hr = $268.**

**Project Coordinator − Review draft and final comprehensive report. Year 1: NA. Year 2: NA. Year 3: 20 hrs @ $22.50/hr = $450.**

**Secretary − Assist in processing and printing draft and final comprehensive report. Year 1: NA. Year 2: NA. Year 3: 20 hrs @ $16.07/hr = $321.**

**TASK 7. DRAFT AND FINAL REPORT.**

**Project Manager − Assist in completing draft and final grant report. Year 1: NA. Year 2: NA. Year 3: 4 hrs @ $26.78/hr = $107.**

**Secretary − Assist in processing and printing draft and final grant reports. Year 1: NA. Year 2: NA. Year 3: 2 hrs @ $16.07/hr = $32.**

**District Manager − Complete draft and final grant reports. Year 1: NA. Year 2: NA. Year 3: 6 hrs @ $26.75 = 161.**

# Benefits

**District Manager @ 28%. Projects Manager @ 28%. Projects Coordinator @ 28%. District Secretary @ 28%.**

## Travel

**All travel decribed in this section is within CALFED Bay Delta Regions.**

**TASK 1. PROJECT MANAGEMENT. Year 1: $619. Year 2: $641. Year 3: $663.**

**TASK 2. TECHNICAL ADVISORY COMMITTEE Year 1: $94. Year 2: $97. Year 3: $101.**

**TASK 3. AVIAN MONITORING. Year 1: $94. Year 2: $97. Year 3: $101.**

**TASK 4. GEOMORPHIC MONITORING. Year 1: $94. Year 2: $97. Year 3: $101.**

**TASK 5. RIRPARIAN REVEGETATION MONITORING Year 1: $94. Year 2: $97. Year 3: $101.**

**TASK 6. COMPREHENSIVE MONITORING REPORT. Year 1: NA. Year 2: NA. Year 3: $100.**

**Task 7. DRAFT AND FINAL GRANT REPORT. Year 1: NA. Year 2: NA. Year 3: NA.**

## Supplies And Expendables

**TASK 1. PROJECT MANAGEMENT. Year 1: Office and presentation supplies $175. Year 2: Office and presentation supplies $181. Year 3: Office and presentation supplies $187.**

**TASK 2. TECHNICAL ADVISORY COMMITTEE. Year 1: Office and presentation supplies $15/meeting, 10 meetings/year = $150. Year 2: Office and presentation supplies $15.50/meeting, 10 meetings/year = $155. Year 3: Office and presentation supplies $16.10/meeting, 10 meetings/year = $161.**

**TASK 3. AVIAN MONITORING. Year 1: Office and presentation supplies $75. Year 2: Office and presentation supplies $78. Year 3: Office and presentation supplies $80.**

**TASK 4. GEOMORPHIC MONITORING. Year 1: Office and presentation supplies $75. Year 2: Office and presentation supplies $78. Year 3: Office and presentation supplies $80.**

**TASK 5. RIPARIAN REVEGETATION MONITORING. Year 1: Office and presentation supplies $75. Year 2: Office and presentation supplies $78. Year 3: Office and presentation supplies $80.**

**TASK 6. COMPREHENSIVE MONITORING REPORT. Year 1: NA. Year 2: NA. Year 3: Office and presentation supplies 25 color copies $25 ea = $625; 15 black and white copies @ $12 ea = $180; Postage $25; misc other $35. Total $865.**

**TASK 7. DRAFT AND FINAL GRANT REPORT. Year 1: NA. Year 2: NA. Year 3: Office and presentation supplies $35.**

## Services And Consultants

**The following three tasks will be subcontracted to specific contractors by Western Shasta RCD. These contractors have previously conducted these specific monitoring tasks.**

**TASK 3. AVIAN MONITORING. Avain monitoring is subcontracted to the Point Reyes Bird Obsrvatory (PRBO)and is directly supervised by Geoffrey R. Guepel and Ryan Burnett of PRBO. Services provided by PRBO are system−wide monitoring of avian species in Lower Clear Creek including project specific monitoring and management recomendations. Annual monitoring of nests and territory densities at six established nest plots; monitoring the proposed Phase 3B area for baseline avian data; continuing all point count transects previously established, including a vegetation assessment component to monitor population changes of breeding landbirds over time and obtain information on the diversity and richness of birds in those areas; continuing the constant−effort−mist netting stations already established (10 mist nests to be operated; public education programs and field trips for local schools and community groups. Results will be documented in 3 annual monitoring reports with a presentation at a CALFED Science Conference. The principal staff assigned to this project includes: Geoffrey R. Geupel, Director, Terrestrial Ecology**

**Division and Ryan D. Burnett, Terrestrial Ecologist. The aspects of their work to be charged to the grant include salaries, travel, supplies, etc. The compensation rate for this service is: Year 1: $89,923. Year 2: $88,340. Year 3: $92,757.**

**TASK 4. GEOMORPHIC MONITORING. Geomorphic monitoring is subcontracted to Graham Matthews and Associates (GMA). Services provided by GMA are system−wide monitoring of geomorpholgy in Lower Clear Creek, including project specific monitoring and management reccomendations. Results are presented in 3 annual monitoring reports with a presentation at a CALFED Science Conference. The principal staff assigned to the project includes: Graham Matthews, Principal Hydrologist; Aaron (Smokey) Pittman, Hydrologist/Geomorphologist; Keith Barnard, Fisheries Biologist, Digital Terrain Mapping, CAD Specialist; Cort Pryor, Hydrologist. The aspects of the work to be charged to the grant includes salaries, travel, supplies, etc. The compensation rate per year for this service is: Year 1: $150,000. Year 2: $155,250. Year 3: $160,684.**

**TASK 5. RIPARIAN REVEGETATION MONITORING. Riparian Revegation monitoring is subcontracted to Souza Environmental Solutions (SES) and is directly supervised by Jeff Souza. Services provided by SES are project specific monitoring of revegetation efforts on Clear Creek, native vegetation recruitment, soils/hydrology/plant response analysis and management reccomendations. Results are presented in 3 annual monitoring reports with a presentation at a CALFED Science Conference. The principal staff assigned to the projects includes: E. Jeffrey Souza, Principal Fish and Wildlife Biologist; Gregory A. Treber, Botanist; Neil C. Schwertman, Statistician. The aspects of their work to be charged to the grant includes salaries, travel, supplies, etc. The compensation rate per year for this service is: Year 1: $119,930. Year 2: $113,275. Year 3: $92,796.**

## Equipment

**No equipment is purchased in this proposal.**

## Lands And Rights Of Way

**No costs for lands and rights of way are associated with this grant.**

## Other Direct Costs

**All costs are accounted for in the above catagories.**

## Indirect Costs/Overhead

**As local government, WSRCD has an indirect rate of 18% of direct costs, based on Circular A-87. The indirect cost for this project proposal is applied to all costs, including labor, benefits, travel, supplies and expendables, services and consultants, other direct costs and for this project totals $199,594. The indirect costs associated with this project include: accounting, office support staff, communications, liability insurance, general office expense, postage, professional services (computer repair, accounting temporary employees, office security), leased office equipment (postage machine), rent for office space, printing and library, utilities, office equipment.**

## Comments

# Environmental Compliance

*Lower Clear Creek Monitoring Program*

## CEQA Compliance

Which type of CEQA documentation do you anticipate?
**X** none
**−** negative declaration or mitigated negative declaration
**−** EIR
**−** categorical exemption

If you are using a categorical exemption, choose all of the applicable classes below.
**−** Class 1. Operation, repair, maintenance, permitting, leasing, licensing, or minor alteration of existing public or private structures, facilities, mechanical equipment, or topographical features, involving negligible or no expansion of use beyond that existing at the time of the lead agency's determination. The types of "existing facilities" itemized above are not intended to be all−inclusive of the types of projects which might fall within Class 1. The key consideration is whether the project involves negligible or no expansion of an existing use.
**−** Class 2. Replacement or reconstruction of existing structures and facilities where the new structure will be located on the same site as the structure replaced and will have substantially the same purpose and capacity as the structure replaced.
**−** Class 3. Construction and location of limited numbers of new, small facilities or structures; installation of small new equipment and facilities in small structures; and the conversion of existing small structures from one use to another where only minor modifications are made in the exterior of the structure. The numbers of structures described in this section are the maximum allowable on any legal parcel, except where the project may impact on an environmental resource of hazardous or critical concern where designated, precisely mapped, and officially adopted pursuant to law by federal, state, or local agencies.
**−** Class 4. Minor public or private alterations in the condition of land, water, and/or vegetation which do not involve removal of healthy, mature, scenic trees except for forestry or agricultural purposes, except where the project may impact on an environmental resource of hazardous or critical concern where designated, precisely mapped, and officially adopted pursuant to law by federal, state, or local agencies.
**−** Class 6. Basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource, except where the project may impact on an environmental resource of hazardous or critical concern where designated, precisely mapped, and officially adopted pursuant to law by federal, state, or local agencies. These may be strictly for information gathering purposes, or as part of a study leading to an action which a public agency has not

yet approved, adopted, or funded.
– Class 11. Construction, or placement of minor structures accessory to (appurtenant to) existing commercial, industrial, or institutional facilities, except where the project may impact on an environmental resource of hazardous or critical concern where designated, precisely mapped, and officially adopted pursuant to law by federal, state, or local agencies.

Identify the lead agency.

Is the CEQA environmental impact assessment complete?

If the CEQA environmental impact assessment process is complete, provide the following information about the resulting document.

**Document Name**
**State Clearinghouse Number**

If the CEQA environmental impact assessment process is not complete, describe the plan for completing draft and/or final CEQA documents.

# NEPA Compliance

Which type of NEPA documentation do you anticipate?
X none
– environmental assessment/FONSI
– EIS
– categorical exclusion

Identify the lead agency or agencies.

If the NEPA environmental impact assessment process is complete, provide the name of the resulting document.

If the NEPA environmental impact assessment process is not complete, describe the plan for completing draft and/or final NEPA documents.

Successful applicants must tier their project's permitting from the CALFED Record of

Decision and attachments providing programmatic guidance on complying with the state and federal endangered species acts, the Coastal Zone Management Act, and sections 404 and 401 of the Clean Water Act.

Please indicate what permits or other approvals may be required for the activities contained in your proposal and also which have already been obtained. Please check all that apply. If a permit is *not* required, leave both Required? and Obtained? check boxes blank.

| **Local Permits And Approvals** | **Required?** | **Obtained?** | **Permit Number (If Applicable)** |
|---|---|---|---|
| **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** | **Required?** | **Obtained?** | **Permit Number (If Applicable)** |
|---|---|---|---|
| **scientific Collecting Permit** | – | – | |
| **CESA Compliance: 2081** | – | – | |
| **CESA Complance: NCCP** | – | – | |
| **1602** | – | – | |
| **CWA 401 Certification** | – | – | |
| **Bay Conservation And Development Commission Permit** | – | – | |
| **reclamation Board Approval** | – | – | |
| **Delta Protection Commission Notification** | – | – | |
| **state Lands Commission Lease Or Permit** | – | – | |
| **action Specific Implementation Plan** | – | – | |

| | | | |
|---|---|---|---|
| **other** | – | – | |

| **Federal Permits And Approvals** | **Required?** | **Obtained?** | **Permit Number (If Applicable)** |
|---|---|---|---|
| **ESA Compliance Section 7 Consultation** | – | – | |
| **ESA Compliance Section 10 Permit** | – | – | |
| **Rivers And Harbors Act** | – | – | |
| **CWA 404** | – | – | |
| **other** | – | – | |

| **Permission To Access Property** | **Required?** | **Obtained?** | **Permit Number (If Applicable)** |
|---|---|---|---|
| **permission To Access City, County Or Other Local Agency Land**<br>**Agency Name** | – | – | |
| **permission To Access State Land**<br>**Agency Name** | – | – | |
| **permission To Access Federal Land**<br>**Agency Name**<br>Bureau Of Land Management | X | X | |
| **permission To Access Private Land**<br>**Landowner Name** | – | – | |

If you have comments about any of these questions, enter them here.

# Land Use

*Lower Clear Creek Monitoring Program*

Does the project involve land acquisition, either in fee or through easements, to secure sites for monitoring?
**X** No.
**–** Yes.

How many acres will be acquired by fee?

How many acres will be acquired by easement?

Describe the entity or organization that will manage the property and provide operations and maintenance services.

Is there an existing plan describing how the land and water will be managed?
**–** No.
**–** Yes.

Will the applicant require access across public or private property that the applicant does not own to accomplish the activities in the proposal?
**–** No.
**X** Yes.

Describe briefly the provisions made to secure this access.

**`All access for this project is on Bureau of Land Management for which access has been granted.`**

Do the actions in the proposal involve physical changes in the current land use?
**X** No.
**–** Yes.

Describe the current zoning, including the zoning designation and the principal permitted uses permitted in the zone.

Describe the general plan land use element designation, including the purpose and uses allowed in the designation.

Describe relevant provisions in other general plan elements affecting the site, if any.

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?
**X** No.
**–** Yes.

| Land Designation | Acres | Currently In Production? |
|---|---|---|
| **Prime Farmland** | | – |
| **Farmland Of Statewide Importance** | | – |
| **Unique Farmland** | | – |
| **Farmland Of Local Importance** | | – |

Is the land affected by the project currently in an agricultural preserve established under the Williamson Act?
**X** No.
**–** Yes.

Is the land affected by the project currently under a Williamson Act contract?
**X** No.
**–** Yes.

Why is the land use proposed consistent with the contract's terms?

Describe any additional comments you have about the projects land use.