99B-142

4.5 PSP Cover Sheet (Attach to the front of each proposal)

FLUVIO-GEOMORPHIC DESIGN CRITERIA FOR THE

Proposal Title: COTTONWOOD CREEK WATERSHED

Applicant Name: COTTON, SHIRES AND ASSOCIATES, INC.

Mailing Address: 330 VILLAGE LANE, LOS GATOS, CA 95030

Telephone: (408) 354-5542

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Email: msmelser@cottonshires.com

Amount of funding requested: $ 69,300.00 for < 1 years

Indicate the Topic for which you are applying (check only one box).

- ☐ Fish Passage/Fish Screens
- ☑ Habitat Restoration
- ☐ Local Watershed Stewardship
- ☐ Water Quality
- ☐ Introduced Species
- ☐ Fish Management/Hatchery
- ☐ Environmental Education

Does the proposal address a specified Focused Action? ✓ yes _____ no

What county or counties is the project located in? Shasta and Tehama

Indicate the geographic area of your proposal (check only one box):

- ☐ Sacramento River Mainstem
- ☑ Sacramento Trib: Cottonwood Creek
- ☐ San Joaquin River Mainstem
- ☐ San Joaquin Trib: _____
- ☐ Delta: _____
- ☐ East Side Trib: _____
- ☐ Suisun Marsh and Bay
- ☐ North Bay/South Bay: _____
- ☐ Landscape (entire Bay-Delta watershed)
- ☐ Other: _____

Indicate the primary species which the proposal addresses (check all that apply):

- ☐ San Joaquin and East-side Delta tributaries fall-run chinook salmon
- ☐ Winter-run chinook salmon
- ☑ Late-fall run chinook salmon
- ☐ Delta smelt
- ☐ Splittail
- ☐ Green sturgeon
- ☐ Migratory birds
- ☐ Other: _____
- ☑ Spring-run chinook salmon
- ☑ Fall-run chinook salmon
- ☐ Longfin smelt
- ☐ Steelhead trout
- ☐ Striped bass
- ☐ All chinook species
- ☐ All anadromous salmonids

Specify the ERP strategic objective and target (s) that the project addresses. Include page numbers from January 1999 version of ERP Volume I and II:

Too many to list neatly. See page 6 of our proposal. In summary, Ecosystem Restoration Program (ERP) Volume 2, pages 221 to 230

I-015061

Indicate the type of applicant (check only one box):

☐ State agency	☐ Federal agency
☐ Public/Non-profit joint venture	☐ Non-profit
☐ Local government/district	☑ Private party
☐ University	☐ Other: _____

Indicate the type of project (check only one box):

☑ Planning	☐ Implementation
☐ Monitoring	☐ Education
☐ Research	

By signing below, the applicant declares the following:

1.) The truthfulness of all representations in their proposal;

2.) The individual signing the form is entitled to submit the application on behalf of the applicant (if the applicant is an entity or organization); and

3.) The person submitting the application has read and understood the conflict of interest and confidentiality discussion in the PSP (Section 2.4) and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant, to the extent as provided in the Section.

William R. Cotton

Printed name of applicant

W. William Cotton

Signature of applicant

Fluvio-Geomorphic Design Criteria for the Cottonwood Creek Watershed Management Plan

Shasta and Tehama Counties, California

A proposal submitted
to the

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

By

Cotton, Shires and Associates, Inc.
330 Village Lane
Los Gatos, California 95030

Primary Contact:

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Type of Organization: Corporation
Tax Identification Number: 942246887

Fluvio-Geomorphic Design Criteria
for the
Cottonwood Creek Watershed Management Plan

Table of Contents

FIGURES

TABLES **Page**

APPENDICES

EXECUTIVE SUMMARY

The Ecosystem Restoration Program (ERP) is one of the principal components of the CALFED Bay-Delta Program, and it is designed to restore the ecological health of the Bay-Delta ecosystem. In fiscal year 1998, Category III funds were allocated to form the Cottonwood Creek Watershed Group (CCWG). This group is composed primarily of long-time residents and property owners. The CCWG is in the initial stages of developing a watershed management plan. CALFED and CCWG have identified the following range of management and restoration goals for the Cottonwood Creek watershed.

- Establish low-flow regime channels for anadromous fish passage;
- Promote more efficient gravel transport to the Sacramento River;
- Evaluate and adaptively manage the physical, ecological, and cultural components of the floodplain;
- Maintain channel meanders and stable banks; and
- Relocate instream gravel mining operations out of the channel.

The next stage for CCWG is to identify and prioritize restoration targets and to then formally integrate the restoration targets into various management and restoration plan alternatives. In accordance with CALFED recommendations, restoration decisions and plans must be based on clearly defined goals, sound ecological models, and developed within a framework of adaptive management. CCWG is committed to developing management and restoration alternatives that are based on the best design criteria available. A fluvio-geomorphic data set that quantifies the historic and contemporary behavior of a stream channel is an excellent source of design criteria.

It is possible to quantify the geomorphic behavior of a stream channel by analyzing historic stream discharge measurements recorded by the U. S. Geological Survey. Cotton, Shires and Associates propose to quantify the geomorphic behavior of Cottonwood Creek by analyzing the historic discharge measurements recorded by the USGS at the Cottonwood Creek stream gaging station (number 11376000). This station has been continuously operated by the USGS since 1940. In addition to the analysis of historic records, we propose to survey and map a 4,000-foot long reach of stream adjacent to the gaging station. The surveying and mapping, in conjunction with the historic record analysis, will define the flows necessary to inundate and build (or degrade) the various alluvial surfaces that make up the floodplain and valley floor. This information is essential for the development of management and restoration alternatives.

Gaging station 11376000 is located in Shasta County on the north bank of Cottonwood Creek, approximately 2.2 miles east of Cottonwood and 2.5 miles

upstream from the Sacramento River. The study area overlaps both the Lower Cottonwood Creek Fan Ecological Management Unit and the Keswick to Red Bluff Diversion Dam Management Unit. The proposed project will result in a quantified understanding of the fluvio-geomorphic relations in the lower Cottonwood Creek watershed. This understanding will be an important tool that will help the CCWG prioritize and refine management and restoration alternatives. For example, our proposed project will quantify channel and floodplain interactions. This is essential information that supports efforts to manage the floodplain and design a low-flow channel to facilitate migration of anadromous fish. The proposed project also will support CALFED's water quality and storage objectives by providing data that can be used to identify minimum channel maintenance flows, design engineered solutions to protect private property from flooding and bank erosion, and also can be used to balance restoration arguments. Additionally, the results of this proposed project will serve as baseline data for monitoring the fluvio-geomorphic system after the implementation of management and restoration plans.

Cotton, Shires and Associates, Inc. is group of engineering geologists, geotechnical engineers, and watershed hydrologists located in Los Gatos, California. Most of our work is centered around the San Francisco Bay Area, but we work throughout California. We are well known throughout this region, and we are particularly proud of our position as Town Geologist for 10 of the smaller Bay Area communities. Our staff includes highly trained and licensed professional with advanced degrees in the fields of geotechnical engineering, engineering geology, hydrogeology, watershed science, wetland hydrology, and geophysics. The Principal Investigator for this proposed project is a fluvial geomorphologist who recently finished a research program with the U.S. Forest Service. The purpose of that research was to help quantify instream flows for channel maintenance purposes. One product of that research was a primer describing how to quantify the geomorphic behavior of streams using USGS discharge measurements. Our corporate philosophy combines commitment, motivation, teamwork and accomplishment, and we are dedicated to providing quality work in a timely and professional manner.

PROJECT DESCRIPTION

Introduction

The Ecosystem Restoration Program (ERP) is one of the principal components of the CALFED Bay-Delta Program, and is designed to restore the ecological health of the Bay-Delta ecosystem (Strategic Plan, 1999).

> "The goal of the ERP is to restore or mimic ecological processes and to increase and improve aquatic and terrestrial habitats to support stable, self-sustaining populations of diverse and valuable species". *Strategic Plan, p. 1, 1999*

CALFED and the Cottonwood Creek Watershed Group (CCWG) have identified the following range of restoration goals for the Cottonwood Creek Watershed in Shasta and Tehama counties.

- Establish low-flow regime channels for anadromous fish passage;
- Promote more efficient gravel transport to the Sacramento River;
- Evaluate and adaptively manage the physical, ecological, and cultural components of the floodplain;
- Maintain channel meanders and stable banks; and
- Relocate instream gravel mining operations out of the channel.

Cottonwood Creek is spawning habitat for chinook salmon and steelhead (U.S. FWS, 1997; Pacific Fishery Management Council, 1999), and has been described as having a braided point-bar channel pattern (McCaffrey, 1988). The development and design of alternatives to achieve management and restoration goals should be based on fluvio-geomorphic design criteria that quantify channel behavior over time in response to streamflow. It is possible to quantify the historic geomorphic behavior of streams by analyzing stream discharge measurements recorded by the U. S. Geological Survey (Schumm and Lichty, 1963; Burkham, 1972; Erman, 1992; Jacobson, 1995; James, 1991 and 1997; Smelser and Schmidt, 1988; Smelser, 1998).

Cotton, Shires and Associates, Inc. (CSA) proposes to quantify the geomorphic behavior of Cottonwood Creek near Cottonwood. We intend to collect and analyze the historic discharge measurements recorded by the USGS at the Cottonwood Creek stream gaging station (number 11376000). This station has been continuously operated by the USGS since 1940 in the same general location, approximately 2.5 miles upstream from the confluence with the Sacramento River (Figures 1 and 2). Data from approximately 700 discharge measurements will be entered into computer spreadsheets and then analyzed with conventional geomorphic and statistical methods (Smelser and

Schmidt, 1998). These analyses will quantify the amount of channel widening and/or narrowing, the amount of channel degradation and/or aggradation, and changes in the hydraulic geometry at the gaging station. These channel changes will then be plotted in various time series and combined with typical streamflow hydrographs to illustrate channel behavior over time in response to streamflow.

In addition to the analysis of historic records, we will conduct a topographic survey and map the reach of stream adjacent to the gaging station. One of the more important reasons for the field surveying and mapping is to determine the flows necessary to inundate and build (or degrade) the various alluvial surfaces (e.g., the 100-year, 50-year, and 2-year floodplains) that make up the valley floor. Once the alluvial surfaces are physically characterized, and distinguished from one another in the study reach, these same surfaces can be mapped throughout the valley floor. This type of information is essential for the development of realistic management and restoration alternatives. For example, this same type of analysis performed on Ashley Creek in the Uinta Mountains of Utah revealed that recent channel incision had been so great that even the 100-year flood was wholly contained within the active channel. The results of our analyses and mapping efforts will be combined into an easy to read technical data set that will help guide the development of restoration plans that integrate various restoration targets (i.e., efficient sediment transport, maintenance of channels and floodplains, and anadromous fish migration (ERPP Vol. II, pp. 229-231).

Project Location

The study area overlaps both the Lower Cottonwood Creek Fan Ecological Management Unit and Keswick to Red Bluff Diversion Dam Management Unit in Shasta and Tehama counties. The study reach will be approximately one mile long and immediately adjacent to the USGS gaging station on Cottonwood Creek near Cottonwood. This station is located in Shasta County, approximately 2.2 miles east of Cottonwood and 2.5 miles upstream from the Sacramento River (Figure 2).

Scope of Work

Task 1. **Collection of Historic USGS Records**

This task includes all activities related to getting the historic records out of the USGS archives and into our office in Los Gatos, California. The USGS has been contacted and preliminary arrangements have been made for us to acquire the records. Included in this task is a reconnaissance level survey of the gaging station and project area. *Task completed by August 15, 1999.*

Task 2. **Enter Discharge Measurement Data into Computer Spreadsheets.** CSA staff will enter the data from the approximately 700 monthly discharge measurements into Microsoft Excel spreadsheets. *Task completed by August 31, 1999.*

Task 3. **Geomorphic and Statistical Analyses of the Computerized Data** The computerized data will be analyzed in detail according to the methods described in Smelser and Schmidt (1998). The results of the analyses will be 1) conventional hydrographs, 2) regression relations that describe hydraulic geometry, 3) statistical flow computations, 4) comparative cross-sections, and 5) time series plots showing channel behavior through time. A list of the tabulated data to be presented is provided in Table 1 and examples of the various time series are shown in Figures 3 and 4. *Task completed by October 15, 1999.*

Table 1. **List of Tabulated Data to be Presented**

Watershed Characteristics
- Period of Record
- Drainage Area
- Stream Order
- Average Stream Gradient
- Mean Annual Discharge
- Mean Annual Flood Discharge

Mapped Reach Characteristics
- Datum Elevation
- Reach Gradient
- Reach Length
- Sinuosity
- Entrenchment
- D50 Particle Size
- D84 Particle Size
- Channel Type
- Average Hydraulic Geometry Relations
  (width, depth, and velocity as a function of discharge)

Bankfull Characteristics
- Discharge
- Flow Width
- Thalweg Depth
- Hydraulic Radius
- Mannings Roughness Coefficient
- Average Shear Stress

Task 4. **Topographic Survey and Geomorphic Mapping**
The reach of stream adjacent to the USGS gaging station will be topographically surveyed and geomorphically mapped at a scale of 1 inch = 200 feet (minimum). The reach will extend approximately 2,000 feet up- and downstream of the gaging station. Besides surveying the longitudinal profile and channel margins, cross-sections aimed at characterizing sequences of the alluvial landscape (in-stream bars, benches, floodplains, terraces, and abandoned channels) will be surveyed. In addition, we will resurvey representative cross sections measured in 1982-83 by McCaffrey et al. (1988). We will also characterize the bed and bank material. *Task completed by September 30, 1999.*

Task 5. **Fluivo-geomorphic Analysis and Preparation of Deliverables**
It is our intent to undertake: a comprehensive analysis of the historic and contemporary data; gravel transport modeling using conventional shear stress analyses; the preparation of preliminary maps, cross-sections, and graphs; the final drafting of drafting of the maps, cross-sections, and graphs; and the production of ten (10) copies of the project deliverables.

The deliverables from this technical study will be: one color geologic map (scale: 1-inch = 200 feet) with the longitudinal profile surveyed through the gaging station, an accompanying data sheet that summarizes the results of the historic records analyses and field mapping, and a technical memorandum that discusses our findings with regard to specific CALFED targets and actions related to sediment transport, channel/floodplain configurations, and fish passage (ERPP Vol. II, pp. 229-231). Examples of the map and data sheet are provided in Appendix A. We have based our budget on the production of a total of ten (10) package sets. *Project deliverables will be submitted by November 30, 1999.*

ECOLOGICAL/ BIOLOGICAL BENEFITS

Ecological/Biological Objective

The primary ecological/biological objective of this project is to provide scientists, engineers, and decision makers with a quantified understanding of streamflow and the geomorphic response to streamflow in the lower Cottonwood Creek watershed. Both CALFED (ERPP, Vol. 2 p. 229 - 231) and the CCWG (Swearingen, 1999) have identified the following range of restoration goals:

- Establish low-flow regime channels for anadromous fish passage;
- Promote more efficient gravel transport to the Sacramento River;
- Evaluate and adaptively manage the physical, ecological, and cultural components of the floodplain;
- Maintain channel meanders and stable banks; and
- Relocate instream gravel mining operations out of the channel.

A critical step forward in achieving these goals is the identification and quantification of instream flow requirements for the variety of cultural and ecological components that depend on the stream. At the root of these goals is the geomorphic response to flowing water in a valley. The proposed project will result in a quantified understanding of streamflow and geomorphic response and also will establish the baseline data necessary to identify the various instream flow needs.

Hypothesis and Rationale

Floodplain development, gravel recruitment, channel maintenance, channel migration, and bank erosion are all restoration concerns of the CCWG and CALFED (ERP, Vol. II, p. 229-231). They also are fundamental geomorphic responses to flowing water. The rationale for this study is that the best design of watershed management and restoration alternatives is based on a quantified understanding of streamflow and the geomorphic behavior of the channel over time. We believe that such an understanding will:

- Provide the baseline data necessary to identify instream flow requirements for the various cultural and ecological components that rely on the stream corridor;
- Serve as a foundation upon which restoration targets can be prioritized and integrated into restoration plan alternatives;; and
- Be used as tool with which to balance restoration arguments.

Our project does not test a hypothesis. Instead, we are developing a fluvio-geomorphic data set that will be assist the adaptive management of the Cottonwood Creek watershed. The analysis of historic USGS discharge measurements is a proven method to quantify the historic geomorphic behavior of streams (Schumm and Lichty, 1963; Burkham, 1972; Erman, 1992; Jacobson, 1995; James, 1991 and 1997; Smelser and Schmidt, 1998; Smelser, 1998). When such historic analyses are combined with field surveying and mapping, the result is a quantified understanding of the channel and its geomorphic behavior over time. One of the attractive aspects of this proposed project is that, when compared to paired basin studies or multi-decade studies, this project is much less costly and will be completed in approximately 4 months.

Linkages

This proposed project supports the efforts of the CCWG (CALFED grant 98-G1015) to develop a watershed restoration plan. More specifically, it provides a quantified understanding of geomorphic response to streamflow in the lower Cottonwood Creek watershed. This information will assist CCWG in the integration of restoration targets into management and restoration plan alternatives. Our project is linked to many ERP actions and goals. These include:

- Cottonwood Creek Management Zone, Central Valley Stream Flows, Target 1 (ERPP Vol. 2, p. 229)

  Our project is focussed research that can help evaluate whether or not the proposed flow increase of 20 to 50 cubic feet per second is an appropriate instream flow requirement for Cottonwood Creek.

- Cottonwood Creek Management Zone, Stream Meander, Target 1, Programmatic Action 1B (ERPP Vol. 2, p. 230)

  We intend to provide preliminary design criteria for the restoration of a low flow channel in lower Cottonwood Creek to facilitate fish passage.

- Cottonwood Creek Management Zone, Stream Meander, Target 1, Programmatic Action 1A (ERPP, Vol. 2, p. 230) and Cottonwood Creek Management Zone, Natural Floodplains and Flood Processes, Target 1, Stage 1 Action (ERPP Vol. 2, p. 230).

  The results of our project will identify and quantify various alluvial surfaces such as the 50- and 100-year floodplains and existing channel/floodplain interactions. This is design criteria that will assist in setting the areal limits of management and restoration alternatives to re-establish the floodplain and increase channel/floodplain interactions along lower Cottonwood Creek.

- Sacramento River Management Zone, Coarse Sediment Supply, Target 1 (ERPP, Vol. 2, p. 184, p. 221).

  We intend to use quantitative streamflow and bed material characteristics to model gravel transport through the lower Cottonwood Creek to the Sacramento River using conventional shear stress analyses.

System-Wide Ecosystem Benefits

Cottonwood Creek supplies almost 85 percent of the gravel supplied to the Sacramento River between Redding and Red Bluff, and is a critical source of Sacramento River spawning gravels (ERP Vol. 2, p. 221). Half of the proposed project site is within the Sacramento River Conservation Area, Keswick to Red Bluff Reach (Sacramento River Conservation Area Handbook, 1998). Because our proposed project will help guide restoration planning and management of the Cottonwood Creek watershed, there is likely to be downstream benefits for the Sacramento River that may assist restoration efforts by the Advisory Council (SB 1086).

Cottonwood Creek is a spawning stream for chinook salmon and steelhead (USFWS, 1995, 1997; Pacific Fishery Management Council, 1999; and Rectenwald, 1999). The Anadromous Fish Restoration Plan (USFWS, 1997) identifies the following high priority actions for Cottonwood Creek to benefit fall-, late fall-, and spring run chinook salmon and steelhead populations.

- Protect spawning gravel in the valley sections of Cottonwood Creek;
- Enhance recruitment of spawning gravel to the Sacramento River from Cottonwood Creek;
- Establish limits on instream gravel mining operations;
- Reduce water temperatures and siltation to improve salmonid spawning and rearing habitat; and
- Establish, restore, and maintain riparian habitat on Cottonwood Creek.

Our proposed project will provide a quantified fluvio-geomorphic data set and a preliminary assessment of sediment transport and stream bank stability. These data will provide scientists, engineers, and descion makers with an adaptive management tool with which to refine restoration targets and develop design elements necessary to address the items listed above.

Compatibility with Non-Ecosystem Objectives

The proposed project also will support CALFED's water quality and storage objectives by providing fluvio-geomorphic data that can be used to:

- Identify minimum channel maintenance flows;
- Design engineered solutions to protect private property from flooding and bank erosion;
- Balance arguments between restoration targets; and
- Will serve as baseline data for monitoring the fluvio-geomorphic system after the implementation of management and restoration plans.

TECHNICAL FEASIBILITY AND TIMING

One alternative that would provide the same level of site-specific quantitative data with a historic perspective, is a multi-decade field program consisting of annual or bi-annual field measurements. The primary drawback of this alternative is the decades-long time line for project completion. Such a time frame is incompatible with CALFED's time line as discussed in the Revised Phase II Report (1998). Another alternative might be a paired basin study. This alternative would require finding a nearby watershed that has been studied in depth; the Battle Creek watershed might be a candidate. However, developing restoration design criteria on the basis of extrapolations from a paired basin study is undesirable and would be subject to criticism. Furthermore, in order to make any extrapolations, extensive field studies would have to be undertaken to justify the various extrapolations. Our proposed project involves the collection and presentation of fluvio-geomorphic data for the purpose of developing preliminary management and restoration plan alternatives. Consequently, our project is not subject to regulation or permit requirements.

MONITORING AND DATA COLLECTION METHODOLOGY

The primary objective of this project is to identify and quantify the fluvio-geomorphic relationships of Cottonwood Creek and its floodplain. This will be accomplished by analyzing the archived USGS discharge measurements that have been made approximately once each month for the past 59 years. These measurements include a cross-section survey, flow velocity, and notes describing the local conditions. All quantitative data from each discharge measurement will be tabulated in computer spreadsheets and analyzed using several techniques. Prior experience has shown that time series of the thalweg elevation will be the most illustrative of historic channel adjustment because they show monthly changes in the streambed. Such resolution is not possible from typical analyses of the mean streambed elevations because mean streambed elevations are derived from calculated mean stream depths that are skewed by changes in channel width and flow velocity.

For specific 10-year time periods, we will develop thalweg adjustment plots. These are 10-year time series of thalweg elevation changes combined with flow statistics and bed material measurements that are designed to elucidate the relationship between discharge and streambed response (Figure 4). In addition, we will develop time series that more precisely depict the net annual changes in thalweg elevation and also show the temporal trends of each stream's bed adjustment. For each year, a summer/fall (S/F) thalweg elevation will be calculated by averaging the thalweg elevations measured each year in August, September, and October. Consequently, each data point represents the thalweg elevation for a particular year, and smooth-fit curves

through the data will show the overall trends in streambed adjustment (Figure 3). Thus, channel adjustments can be described quantitatively.

We will also analyze changes in channel width and compare cross sections measured at different times. Width analyses are performed to assess changes in the bank-to-bank channel morphology and to complement the analyses of the streambed. Because width measurements made during low flows and flood flows may not be representative of the bank-to-bank morphology, we will only analyze channel widths measured at discharges between 40 and 85% of bankfull. Like the analysis of thalweg elevation changes, width measurements will be plotted as a time series. The comparison of cross-sections measured at different times is strong evidence of adjustability or nonadjustability.

Table 2. Objectives and Methods of Attainment

Objective	Data Collection Approach	Data Evaluation Approach	Comments/ Data Priority
Characterize the historic behavior of lower Cottonwood Creek.	Collect USGS discharge records from archives, and histories of land use from counties.	Compile data into appropriate plots, conduct statistical analysis, compare to land use records	Essential
Characterize the contemporary geomorphology of lower Cottonwood Creek.	Detailed geologic and topographic surveying and mapping of a stream reach 4,000 feet long.	Develop detailed fluvio-geomorphic map of the project reach.	Essential
Provide preliminary design recommendations for the design of a, low-flow regime channel.	Use compiled fluvio-geomorphic data set.	Evaluate channel and floodplain characteristics with regard to minimum flow depths required for fish passage.	No additional data required
Perform preliminary modeling of gravel transport through the study reach.	Use compiled hydrologic and geologic data.	Calculate gravel transport thresholds using stream power and/or Shields type shear stress analyses.	No additional data required
Evaluate bank erosion, channel incision and floodplain stability.	Use compiled hydrologic and geologic data.	Compare and contrast geomorphic change against time and streamflow.	No additional data required

LOCAL INVOLVEMENT

We are assisting the Cottonwood Creek Watershed Group (CCWG), in its effort to develop a watershed management plan. We have developed the

proposed project based on our own research as well as input from the California Department of Water Resources (Buer, 1999), the U.S. Army Corps of Engineers (Rice, 1999), Shasta County (Minturn, 1999), and the CCWG (Swearingen, 1999). All of the above listed groups have supported the intent of this proposal and have indicated a willingness to collaborate on this project. Copies of letters to the various county boards of supervisors are included in Appendix B.

COST

The cost of our proposed project is $69,300.00 and the project will be completed within four months of the award notification. A summary of total budget costs is provided in Table 3. Please note that Cotton, Shires and Associates, Inc. overhead costs exceed 25 percent of direct salary and benefits. Our overhead costs are 46 percent of direct salary and benefits. This is calculated as a percentage of direct costs (employee compensation, medical insurance, dental insurance, long term disability insurance, worker's compensation insurance, and employee benefits) to the indirect costs (administrative and office salaries, business development costs, payroll taxes, accounting, advertising, continuing education, contributions and donations, dues and subscriptions, interest expenses, licenses and fees, reference materials, computer software, supplies and services, office and stationary expenses, postage, rent, repairs and maintenance, telephone, utilities and vehicle expenses). A quarterly budget summary is provided in Table 4.

SCHEDULE

We are prepared to begin work immediately upon notification of award. Assuming an award notification date of August 1, 1999, we will complete this project and submit the deliverables by November 30, 1999. Our proposed schedule is provided in Table 5. Please note that Task 4, the surveying and mapping of the stream channel can only be performed when streamflow is at its lowest level during the late summer and early fall.

Table 3. Summary of Total Budget Costs

TASK	Direct Labor Hours	Direct Salary And Benefits	Service Contracts	Material And Acquisition Costs	Miscellaneous And Other Direct Costs	Overhead And Indirect Costs	Total Costs
Task 1. Collect Records	75	3,144.50	0.00	500.00	2,055.44	471.68	$6,171.62
Task 2. Data Entry	50	1,587.61	0.00	0.00	839.85	238.14	$2,665.60
Task 3. Historic Record Analysis	50	2,461.23	0.00	0.00	1,301.99	369.18	$4,132.40
Task 4.1. Topographic Surveying	144	5,663.37	0.00	0.00	7,245.92	849.51	$13,758.80
Task 4.2. Geomorphic Mapping	180	8,081.10	0.00	0.00	8,034.90	1,212.16	$17,328.16
Task 5. Engineering Analysis and Deliverables	225	9,579.42	0.00	0.00	5,067.51	1,436.91	$17,883.85
Project Management	85	4,384.66	0.00	0.00	2,319.49	657.70	7,361.85
Totals	809	$34,901.89	$0.00	$500.00	$28,665.10	$5,235.28	$69,302.28

Table 4. Quarterly Budget Summary

TASK	Quarterly Budget Jul-Sep	Quarterly Budget Oct-Dec
Task 1. Collect Records	6,171.62	0
Task 2. Data Entry	2,665.60	0
Task 3. Historic Record Analysis	3,632.40	500
Task 4.1. Topographic Surveying	9,758.80	4,000
Task 4.2. Geomorphic Mapping	4,000	13,328.16
Task 5. Engineering Analysis and Deliverables	0	$17,883.85
Project Management	3,680.93	3,680.93
Totals	$29,909.35	$39,392.94

Table 5. Proposed Project Schedule

August 1, 1999	Award notification
August 15, 1999	USGS discharge measurements collected, field reconnaissance completed and data entry of records underway.
September 1, 1999	Computer entry of historic records completed, preliminary fluvio-geomorphic analysis underway, and , and field program in the final planning stages.
September 15, 1999	Preliminary fluvio-geomorphic analysis completed and topographic survey in progress.
October 1, 1999	Topographic survey completed and geomorphic mapping in progress.
October 15, 1999	Geomorphic mapping completed and engineering analysis underway.
November 1, 1999	Engineering analysis completed, development of final drawings in preparation, and technical memorandum in progress.
November 15, 1999	Final drawings and technical memorandum completed and in editorially review.
November 30, 1999	Deliverables submitted to CALFED Bay-Delta Program office.

APPLICANT QUALIFICATIONS

Cotton, Shires and Associates, Inc. (CSA) was incorporated in 1974, and is a full-service geotechnical consulting firm with offices in northern and southern California. The firm includes geotechnical, geologic, and hydrologic professionals in addition to technical illustrating and clerical/accounting support staff. As part of our facilities, we maintain a sophisticated soil testing laboratory, fluvial sediment sampling equipment, and an extensive in-house geotechnical reference library, as well as state-of-the-art technical illustrating and computer analysis equipment. Our senior staff are trained geotechnical engineers, engineering geologists, and watershed hydrologists with advanced degrees who have broad experience in producing, evaluating and utilizing geologic, hydrologic, and geotechnical data.

We have selected four individuals from our firm that have the professional qualifications to conduct a thorough fluvio-geomorphic analysis of Cottonwood Creek.

Mark G. Smelser, Fluvial Geomorphologist, will be the principal investigator for this project. He literally wrote the book (Smelser and Schmidt, 1998) on how to analyze USGS discharge measurements for the purpose of quantifying fluvio-geomorphic behavior. This methodology was a by-product of U.S. Forest Service research that was directed at quantifying channel maintenance flows for instream flow purposes. More recently, Mr. Smelser has managed the restoration of mountain watershed that was degraded by open-pit mercury mining. That project was conducted under joint jurisdiction of the Environmental Protection Agency and the California State Regional Water Quality Control Board. Mr. Smelser is currently involved with the development of management and restoration alternatives for a concrete channel in southern California. That project has required not only science and engineering, but has also required that scientific and engineering findings and design be incorporated into a sophisticated environmental documentation process required for regulatory compliance.

William R. Cotton, Principal Engineering Geologist, will be the principal geologist and manager for this project, and will supervise the field surveying and mapping program. He is a Registered Geologist and Certified Engineering Geologist in California with over three decades of professional experience in the field of engineering geology. He has performed and coordinated numerous geologic and geotechnical investigations, associated with a broad spectrum of land-use applications, ranging from site specific studies to broad, regional investigations. He has conducted or supervised hundreds of significant landslide and slope stability investigations throughout watersheds in California and Hawaii. He has studied landslides internationally, participating in field workshops on landslides in Japan, Australia, Tasmania, New Zealand, Switzerland, Austria, Italy, Canada,

Mexico, Puerto Rico, Czech Republic and Slovak Republic and Spain, as well as being retained by the U.S. Bureau of Reclamation and the Government of China to study landslides affecting (or affected by) the Three Gorges Dam project in the People's Republic of China. His extensive experience throughout California, and continual participation in scientific research, as well as private consultation, make him uniquely qualified to provide general guidance, as well as specific information, on projects conducted throughout the state. He recently held the position of Consulting Professor of Engineering Geology in the Department of Applied Earth Sciences at Stanford University.

Bryan G. Largay, Hydrologist, will work closely with Mr. Smelser through all phases of the project. Mr. Largay has over 5 years of experience in the fields of stream and wetland hydrology, hydrogeology and water quality. Mr. Largay recently provided consulting services to The Bay Institute to develop coupled computer models of the hydrologic and ecologic components of the Yolo Basin ecosystem. He has worked on projects in northern and southern California and in Massachusetts. He has been involved in numerous hydrologic investigations, including field and computer modeling studies to characterize flow rates and variability in wetlands, rivers, and aquifers. He has conducted wetland inventories, including classifying wetlands by their hydrogeomorphic type and evaluating wetland functions using rapid assessment methods. Current projects include the analysis of sediment transport and restoration opportunities in a highly engineered channel, and a hydraulics/flood stage study of the relationship between the failure of an earthen dam and downstream flooding at the transition from a natural to a concrete lined channel.

Patrick O. Shires, Principal Geotechnical Engineer and Geophysicist, will be the principal engineer for this project, and will be supervising the geotechnical evaluation aspects of this project. He is a Registered Professional Engineer in seven western states, a registered Geotechnical Engineer in California, and a Registered Geophysicist in California with over 26 years of professional experience in the field of geotechnical engineering and engineering geophysics throughout the western United States. Mr. Shires has significant project experience in watersheds of the Sierra Nevada-Modoc Plateau region, including work over a several year period on the North Fork Stanislaus Hydroelectric Project in Calaveras County; Paradise Dam for the Paradise Irrigation District in Butte County, the Rollins Hydroelectric Project for the Nevada Irrigation District in Placer County, the Pit River Hydroelectric Project, Caribou Penstocks and Grizzly Forebay for P.G.&E. in Modoc and Plumas Counties, the Pine Flat Hydroelectric Project for the Kings River Conservation District, proposed New Lyons Dam for the Tuolumne Water District in Tuolumne County, Pardee Dam for East Bay Municipal Utility District in Calaveras County and proposed or expansion landfills in Yuba and Mariposa Counties, as well as projects in the Lake Tahoe Basin.

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FIGURES

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