~~*FINAL*~~*DRAFT REVISED*

CACHE CREEK

IMPROVEMENT PROGRAM (CCIP)

for LOWER CACHE CREEK

Yolo County

Updated ________, 2018

Amended March 15, 2011

Adopted August 20, 1996

DRAFT REVISED ~~***FINAL***~~

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Updated ________, 2018 (Board Resolution x.x)
Amended March 15, 2011 (Board Resolution 11-15)
Adopted August 20, 1996 (Board Resolution 96-132)

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CHAPTER 1.0 INTRODUCTION

1.1 PURPOSE

The Cache Creek Improvement Program (CCIP) was developed by ~~the~~ Yolo County ~~Community Development Agency~~ to implement the goals, objectives, actions, and performance standards of the Cache Creek Resource Management Plan (CCRMP) ~~as it relates~~related~~s~~ to the stabilization and maintenance of the Cache Creek channel. ~~It has been adopted as a component part of~~It implements the CCRMP, and may be amended as needed, without a general plan amendment. The CCIP provides the structure and authority for a Technical Advisory Committee (TAC), and defines the procedures and methodologies for creek~~stream~~ monitoring, ~~and~~ maintenance, and stabilization activities.~~, and identifies initial high priority projects for stream stabilization.~~

1.2 REGULATORY FRAMEWORK

One of the primary actions of the CCRMP initially ~~is~~was the elimination of commercial mining within the Cache Creek channel. Mining activities permitted in the past~~, under in-channel mining permits approved under the provisions of the Yolo County Mining Ordinance and the State Mining and Reclamation Act (SMARA), have~~ contributed to streambed lowering and the loss of riparian vegetation. Since creek instability is~~will~~ only ~~be~~ partially addressed by the elimination of in-channel commercial aggregate mining, the CCRMP ~~recognizes~~recognized~~s~~ the need for channel maintenance and improvement projects to promote stabilization of the creek channel and the protection of infrastructure elements along the creek. The CCRMP also ~~acknowledges~~acknowledged~~s~~ that the elimination of in-channel mining could result in sediment accumulation in the channel which could~~may~~ cause a reduction of channel capacity and increase in flood~~ing~~ hazard~~s~~. Modifications and maintenance of the Cache Creek channel are the obligation solely of individual landowners through an application process ~~would be managed~~ overseen by the County and the TAC subject to ~~and would occur under~~ the review and guidance procedures described in the CCIP. The improvements and maintenance projects recommended as a result of the CCIP process could require excavation and filling of areas under the jurisdiction of the following local, State, and Federal authorities:

Yolo County ~~Community Development Agency (YCCDA)~~

Any proposed improvements resulting in channel modifications within the 100-year flood hazard zone as defined by the National Flood Insurance Program shall require a Flood~~plain~~ Hazard Development Permit from the Yolo County Floodplain Administrator~~ (YCCDA Director)~~.

U.S. Army Corps of Engineers (COE)

Any proposed channel improvement project resulting in filling or excavation within "waters of the United States" shall require a Section 404 permit from the COE.

California Department of Fish and Wildlife (CDFW)~~Game (CDFG)~~

Any proposed channel improvement project resulting in disturbance of areas below the high water level of the creek shall require the applicant to secure~~negotiate~~ a Streambed Alteration Agreement with CDFW~~G~~ (Section 1601).

California Regional Water Quality Control Board (RWQCB)

Construction activities associated with channel improvement projects performed under the CCIP may require compliance with the requirements of the statewide General Permit for Storm Water Discharges Associated with Construction Activities. For projects meeting the criteria for permitting under the General Permit, the project sponsors would be required to file a Notice of Intent (NOI) with the State Water Resources Control Board (SWRCB) to comply with the requirements of the General Permit.

Since 1996, ~~T~~the County has ~~is currently~~ worked~~ing~~ with the State and Federal agencies noted above to secure and implement~~determine the feasibility of obtaining~~ regional or "general~~blanket~~" permits for the CCRMP program~~area~~. These~~If obtained, the~~ permits have~~would~~ been administered by the County~~YCCDA~~ as part of the Flood Hazard~~plain~~ Development Permit process. A history of these permits through the date of this plan update is provided below:

USACOE RGP #58 Section 404 Discharge Permit – Authorized July 1997 to July 2002; reauthorized May 2004 to May 2009; reauthorization requested June 2011; action pending.

USFWS Biological Opinion (VELB) – Authorized September 1996; tied to 404 permit; reauthorization requested June 2011; action pending.

CVRWQCB Section 401 Water Quality Certification – Authorized July 1999 to July 2002; reauthorized August 2002 to May 2009; reauthorized April 2016 to April 2021 (WDID# 5A57CR00093).

CDFG Streambed Alteration Agreement Section 1601/1603 – Authorized July 1997 to June 2002; reauthorized August 2002 to August 2007; extended to December 2007; replaced August 2008 with Section 1602 MOU implemented through individual project permits; replaced November

2015 with Routine Maintenance Agreement (Notification No. 1600-2014-0054-R2) which expires after 12 years (November 2027).

CDOC SMARA Compliance (PRC Section 2715.5) -- Pursuant to CCRMP Action 2.4-15 the County submitted a request in the fall of 1998 to the State Mining and Geology Board to grant an exemption from the requirements of SMARA for all channel improvement projects approved under the CCIP. The request was declined and the state determined the CCRMP was subject to SMARA, so a legislative solution was sought. In 1999 special legislation was passed to amend SMARA to recognize the CCRMP as the functional equivalent of a Reclamation Plan for purposes of SMARA compliance. The history of this legislative exemption is as follows: 1) First authorization Chapter 869 of the Statutes of 1999 (AB 297, Thomson), sunset December 31, 2003; 2) Second authorization Chapter 173 of the Statutes of 2004 (AB 1984, Wolk), sunset December 31, 2008; 3) Third authorization Chapter 604 of the Statutes of 2007 (AB 646, Wolk), sunset December 31, 2012; 4) Fourth authorization Chapter 145 of the Statutes of 2011 (SB 133, Wolk), sunset December 31, 2017; 5) Fifth authorization Chapter 235 of Statutes of 2016 (SB 1133, Wolk), sunset removed.

1.3 Program Implementation History

1999 Mercury Lawsuit

On August 20, 1995, the Board of Supervisors approved the Cache Creek Resources Management Plan ("CCRMP"). Action 6.4-3 of the CCRMP stated as follows: "…County shall coordinate with other government agencies that have authority over Cache Creek to obtain "blanket" permits for the entire length of the creek located within the plan area."

As a part of the implementation of this Action, on July 1, 1997, staff submitted an application to the Central Valley Regional Water Quality Control Board ("RWQCB") for a 401 certification for the CCRMP area. On December 16, 1998, the RWQCB recommended approval of the Certification to the State Water Resources Control Board ("SWRCB"). Certification for the CCRMP area was formally approved by the SWRCB on June 11, 1999. The approved Certification included a requirement (Condition 2 of the Cache Creek Erosion and Sediment Control Demonstration Project) for the County to implement a water quality monitoring program approved by the RWQCB at the Cache Creek Nature Preserve wetlands site. The monitoring program was to include the collection and analysis of water column and bioaccumulation (tissue) data for the presence of mercury.

On July 12, 1999, the Citizens For Responsible Mining ("CFRM") filed a lawsuit in Sacramento Superior Court (Case No. 99CS01395) against the SWRCB for approving the Certification. A Settlement Agreement regarding the Lawsuit was subsequently executed between CFRM, SWRCB, and the County on February 11, 2000. One of the provisions of the Settlement Agreement required the County to develop a Mercury and Water Quality Monitoring Protocol to be applied to projects implemented in channel under the approved Section 401 Water Quality Certification, in a joint effort with the RWQCB, as provided for in Exhibit A of the Settlement Agreement. Exhibit A also required that the Protocol be developed by a specified technical team. Under the Settlement Agreement, the County was required to cover the reasonable costs of developing the Protocol. The contract for that work was approved by the County Board of Supervisors in late August 2000 approving a three-year scope of work to test and analyze fish, invertebrate, and water samples along lower Cache Creek.

The purpose of the work was to provide information about the possible presence and biological interaction of mercury in shallow wetland habitats. The testing and analysis was intended also to provide the information necessary to ensure that the wetlands at the Cache Creek Nature Preserve were properly managed to eliminate any potential bioaccumulation, should sufficient mercury levels be determined to be present. The results of this analysis were published as Appendix F (Recommended Changes to Yolo County's Water Quality Monitoring Program for Lower Cache Creek) of the April 2002 Draft volume of the CCRMP Update EIR.

The settlement agreement and all requirements associated with it including interim participation on the TAC by a representative of the CVRWQCB expired in July 2002; however in the intervening time understanding, analysis, and regulation of mercury have continued.

2002 CCRMP Amendment

In 2002 in order to support requests for reauthorization of the various state and federal general permits necessary for implementation of the CCRMP/CCIP the County undertook an assessment of the effectiveness of the program. The County opted to demonstrate the effectiveness of the program through a Supplemental Environmental Impact Report (SEIR) in order to secure the necessary permit renewals. The project was defined in the CEQA document as "continued implementation of the CCRMP/CCIP".

The SEIR demonstrated that the 1996 program was working well. Amendments to the CCRMP were undertaken at the time to clarify components of the program, document the wetlands delineation, acknowledge recent changes in mercury regulation, and provide an overview on the status of implementation including where improvements could be made.

CHAPTER 2.0 CACHE CREEK IMPROVEMENT PROGRAM DESCRIPTION

2.1 PROGRAM ELEMENTS

The 1995 Technical Studies for the Cache Creek Resource Management Plan (CCRMP) included an extensive evaluation of existing and current hydrologic and hydraulic conditions along Cache Creek from the Capay Dam to just upstream of the I-5 bridge at Yolo, California. The results of the evaluation indicated that the Cache Creek channel hads been and was at the timeis currently in a state of hydraulic disequilibrium throughout much of this reach of the creek. The instability of the channel hads been caused by a combination of complex influences which have contributed to channel bed degradation and adverse lateral erosion. These influences included the reduction in channel width caused by the reclamation of floodplain areas to agriculture, construction of localized constrictions at bridge locations, prior in-channel aggregate mining of the channel bed, the diversion of streamflow for irrigation, and sediment deposition at dam sites. Updated technical evaluations completed in 2017 indicated that significant deposition of sediment has occurred in the CCRMP area and resulted in recovery of more natural channel sinuosity and slope in certain locations. While this recovery appears to be occurring faster than originally anticipated in 1996, To reduce the adverse effects of currentCache Creek still exhibits unstable hydraulic and sedinement transport conditions in the CCRMP area. , the Technical Studies proposed rRecommendationsrecommendations to improve channel stability along Cache Creek were identified in the 1995 Technical Studies and subsequently then refined by the 2017 Technical Studies conducted in support of the CCAP update.

The major recommendation from the 1995 Technical Studies was a proposed "reshaping" of the channel to develop more uniform hydraulic conditions and reduce the potential for adverse erosion. The 1995 Technical Studies proposed a conceptual channel configuration, referred to as the "Test 3" Run Boundary,model, which reflecteds more uniform channel conditions and included armoring of the channel bed underneath bridges to prevent scour. The Test 3 Run Boundarymodel would have served as a general goal for developing a more stable channel for Cache Creek. Projects implemented under the CCIP werewould required to be designed to support the development of this more stable condition.

Since adoption of the CCRMP in 1996, the County's ability to implement the Test 3 Run Boundary has been limited to those requests by private property owners to undertake projects in or adjacent to Cache Creek for which a FHDP has been required.

For off-channel mining applications implementation of the Test 3 Run Boundary has been linked to Section 10-4.429(d) of the Mining Ordinance which requires that off-channel excavations be set-back a minimum of 700 feet from the channel bank, unless an engineering analysis can demonstrate that measures incorporated into the project can ensure that a lesser setback will provide similar protection against channel destabilization. The minimum setback under the code is 200 feet from the existing channel bank. Where a setback of less than 700 feet has been allowed, the County has required the applicant to also implement the Test 3 Run Boundary along the creek frontage of their operation. For in-channel projects, which by definition are preventative or restorative rather than undertaken for commercial gain, implementation of the Test 3 Run Boundary should be considered but is not always feasible. Language has been added to the In-Channel Ordinance to reflect this.

The Test 3 Run Boundary was intended to be a dynamic tool for management of the active creek boundary, that would be updated and modified as appropriate based on data collected in the field and modeling conducted pursuant to the program. As the program has been administered over time, the County has allowed for "technical corrections" of the boundary to reflect site-specific conditions and engineering. As a part of the 2017 Technical Studies, the Test 3 Run Boundary was evaluated based on 2011 creek topography, 2015 aerial photography, new HEC-RAS modeling, and over 20 years of monitoring data. The new HEC-RAS model is a two-dimensional model that reflects changes in topography and monitoring data collected as part of the program to allow for more precise simulation over the entire lower creek study area rather than in singular locations within individual reaches. The sophisticated mapping capabilities associated with the new HEC-RAS model did not exist in 1996. Evaluation of the Test 3 Run Boundary also recognized that the assumed channel bed hardening under the bridges was not implemented. The result was an update to the Test 3 Run Boundary called the Channel Form Template. The Channel Form Template replaces the Test 3 Run Boundary, but provides similar guidance for smoothing abrupt channel width transitions.

The three ~~major~~ key elements of the CCIP intended to promote a more stable Cache Creek channel are as follows:

Identification of ~~Major~~ Channel Stabilization Projects

The CCIP shall prioritize projects that provide more room for the river wherever possible, and smooth channel transitions in areas with hydraulic conditions that could cause excessive and damaging bank erosion or bed scour.~~identify major creek stabilization projects to be undertaken over the following five year period~~. Implementation of the projects is intended to guide development of a more stable channel form and reduce the adverse affects of channel migration, while providing protection for existing infrastructure components.

Identification of Expected Channel Maintenance Activities

Maintenance of the Cache Creek channel shallwill be required to promote improvements related to channel stabilization projects and reduce the potential for development of unstable channel conditions. The CCIP shall identify expected short-term and long-term channel maintenance activities.

Establishment of a Hydrologic Monitoring Program

UnderstandingMonitoring of flow discharges and sediment transport in the Cache Creek channel is critical to designing and maintaining channel improvements. The CCIP shall provide a practical monitoring program for the evaluation of water flow in the creek and trends of sediment transport and deposition. This may include monitoring and/or modeling as feasible and appropriate. The monitoring program shall also address changes in vegetation that could impact channel capacity and stability.

The hydrologic monitoring program shall also include those flooding events on Cache Creek which can result in major channel adjustments. The CCIP shall develop a program to mobilize technical personnel from the TAC during flood periods for inspection of channel conditions to monitor development of potential channel instabilities and flooding problems, and to survey water surface elevations to improve the calibration of the hydraulic model of the CCRMP area.. Results from the flood watch program will also provide necessary information regarding project performance during floods and possible improved methods for maintaining and stabilizing the channel.

2.2 PROGRAM MANAGEMENT

Effective implementation of CCRMP requires coordinated management by an informed, experienced interdisciplinary group of professionals who are familiar with the processes and conditions within the Cache Creek system. Appropriate management structure and procedures are required to ensure continued collection of necessary information on channel conditions and prioritization of improvement and maintenance projects. The CCRMP establishes the need for a Technical Advisory Committee (TAC) for management of the CCIP. The following sections describe the management structure and responsibilities for the CCIP:

Natural Resources ManagerResource Management Coordinator

The Natural Resources Manager (NRM)Resource Management Coordinator (RMC), assigned by the Director of the YCCDA, will be is responsible for management of all activities conducted by the TAC. The NRM has ~~RMC will have~~ the responsibility for overall management and coordination of the CCIP. The duties of the NRM~~RMC will~~ include coordination of the TAC with the regulatory agencies having jurisdiction over activities performed under the CCIP and with ~~other~~ members of the Cache Creek Stakeholder Group (described below) if one is established. The NRM~~RMC will~~ also has~~ve~~ the responsibility to coordinate any necessary permit applications and maintenance of required permits for the CCIP. The NRM~~RMC~~ will oversee the review and issuance of permits for channel improvement and maintenance projects.

Technical Advisory Committee

The Technical Advisory Committee will ~~be established to~~ provide scientific and technical review and oversight for all projects conducted under the CCIP. The TAC will collect and evaluate scientific data on hydrologic, hydraulic, sediment transport, and biological conditions within the CCRMP area. These data and analyses will provide the basis for identification of annual maintenance needs and priority projects and critical review of the design and construction of improvement projects. The following tasks will be the responsibility of the TAC under the direction and supervision of the NRM~~RMC~~:

1. Implementation of a creek monitoring program;

2. Review of annual monitoring data;

3. Annual recommendations for channel maintenance activities that promote channel stability and environmental restoration;

4. Annual establishment of priorities for major channel stabilization projects;

5. Review of the design of projects requiring Flood Hazard~~plain~~ Development Permits within the CCRMP channel boundary;

6. Recommendations for periodic updates and refinements of existing hydraulic and sediment transport models, and annual update of online program data (CCAP Dashboard);

7. Review of riparian habitat restoration proposals and designs for consistency with the CCRMP and CCIP (see for example CCRMP Action 4.4-6);

8. Review of channel stabilization and annual maintenance activity performance;

9. Preparation of an annual report for submittal to the Board of Supervisors; and

10. Attendance at selected public meetings to describe channel management activities and the success of the improvement projects.

The science of river creek management is not so well advanced as to allow rigid formula-driven decision-making to dominate the planning and monitoring process in a dramatically changing river system such as Cache Creek. The members of the TAC must have a blend of specialized knowledge and experience that will enable them to develop environmentally sound and flexible strategies for balancing a wide range of resource needs. They must also have the skills to work effectively with a variety of stakeholders and the develop a shared vision of the creek's future. The TAC shawill consist of a three-person interdisciplinary group comprised of the following:

1. A qualified river engineering specialist with expertise in environmental water quality analysis (hydraulic engineer);

2. A qualified fluvial geomorphologist; and

3. A qualified biologist or ecologist with experience in riparian restoration.

Nominations for aAppointments to the TAC shall be made by the County Administrator, or his/her designee. will be approved by the Board of Supervisors. The TAC members may be compensated under a time-and-materials contract with the County, with a not-to-exceed amount. The term of the TAC member contracts will be two years with the opportunity for unlimited extensions subject topending approval by the County AdministratorBoard of Supervisors. The TAC will be required to submit a yearly budget to the NRMRMC for review and submittal for approval by the Board.

The TAC will be responsible for making recommendations related to the supervision of all three elements of the CCIP, based on the activities conducted by the TAC. However, Yolo County will be responsible for implementation of the NRMRMC recommendations.

Cache Creek Stakeholders Group

The RMC NRM and TAC have broad responsibilities for decisions related to creek management. However, tThese decisions may benefit from cannot be made without organized input from interested agencies, citizens groups, and industry. Therefore, the CCIP includes the optional establishment of athe Cache Creek Stakeholders Group (CCSG). The CCSG, if convened, will consist of representatives from various agencies and organizations and will provide a forum for the discussion of site-specific and general concerns regarding the resource management of Cache Creek. A preliminary list of potential participants, to be determined in the County's sole discretion. includes:

1. California Department of Fish and WildlifeGame;
2. Central Valley Regional Water Quality Control Board;
3. Yolo County Flood Control and Water Conservation District;
4. Yolo County Public Works Department;
5. Yolo County Office of Agricultural Commissioner;
6. Yolo County Resource Conservation District;
7. Yolo County Farm Bureau;
8. City of Woodland;
9. California Department of Water Resources;
10. Cache Creek Conservancy;
11. California Department of Transportation;
12. California Resources Agency;
13. California Department of Conservation;
14. Cache Creek Basin Coalition;
15. League of Women Voters;
16. Yolo County Aggregate Producers Association;
17. U.S. Army Corps of Engineers;
18. Property Owners along Cache Creek;
19. Communities of Capay, Esparto, and Madison, and Wild Wings;
20. Friends of Cache Creek;
21. U.S. Bureau of Land Management; and
22. Other interested stakeholdersWestern Yolo Grange.

This list is advisory and may be modified by the County during implementation as appropriate. Agencies or organizations identified in the above list which do not wish to participate in the CCSG should contact the YCCDA. Other groups not identified on the list which would like to participate should also contact the YCCDA.

2.3 PROGRAM IMPLEMENTATION

Implementation of the CCIP will require several important programmatic and procedural steps. The following sections describe the implementation process and procedures:

Implementation of Monitoring Program

The TAC will initiate and perform the monitoring program described in Chapter 6. The monitoring program will consist of annual collection of stream discharge and available sediment transport data, and annual analysis of changes in channel morphology, and annual analysis of changes in riparian vegetation and other biological resource elements (e.g., wildlife) as appropriate. All data and analysis will be summarized in an annual report submitted to the Board of Supervisors.

Notification offor Recommended Channel Improvement Projects

On an annual basis, the TAC will identify priority channel improvement projects (separate from annual maintenance) on the basis of the results of the Cache Creek monitoring program. In an annual report to the Board of Supervisors, the TAC will describe the need for and purpose of identified priority projects. The report will describe the specific location of the projects (identifying landowners) and the general aspects of proposed improvements. The NRM will annually send notification regarding the availability of the report to landowners along the creek, encouraging them to consider implementation of identified channel improvement projects for/on the property they control. With authorization by the Board, the RMC will submit a letter to landowners requesting participation in the implementation of the projects. The letters will describe the need and scope of the identified projects. The letters will also detail the type of permitting required for the projects and available resources for implementation of the project. Available resources may include hydrologic and hydraulic data compiled by the TAC which may be important for project design, design recommendations, or funding sources for implementation of all or parts of the recommended projects.

Permitting

All landowners proposing channel substantial channel modification projects within the CCRMP in-channel boundary will be required to submit applications to the CountyYCCDA for a Flood Hazardplain Development Permit. The permit applications will be reviewed by the County Floodplain Administrator and the TAC. The review will include consideration of potential effects of the proposed project on hydraulic conditions upstream and downstream of the proposed project site, as well as the consistency with the CCRMP, CCIP, and requirements of jurisdictional agencies that have issued "generalblanket permits" for the area. Following their review, the TAC will provide recommended changes in project design, if necessary. Prior to issuance of any FHDP for proposed in-channel activities the County shall consider whether these recommendations should be integrated into project design. Upon incorporation of the TAC recommendations into the project design, a Floodplain Flood Hazard Development Permit will be issued. Conditions of the permit shallwill require that completed projects be surveyed to provide a record of as-built conditions.

Regulatory Coordination

Successful implementation of the program requires the ongoing maintenance and renewal of general permits, described earlier, issued by various state and federal agencies including Section 404 (discharge) from the USACOE, Section 401 (water quality) from the CVRWQCB, and Section 2081 (streambed alteration) from the CDFW. These permits are critical for implementation of the CCRMP and CCIP. During the first year of implementation of the CCIP, the YCCDA, with support from the TAC, will pursue issuance by the COE of a general Section 404 permit for improvement projects conducted under the CCIP. The YCCDA will also petition the CDFG for issuance of a general permit for Section 1601 Streambed Alteration Agreements and Section 2081 Permits for CCIP projects. In addition, the RWQCB will be approached for the issuance of a General Permit for Storm Water Discharge. The issuance of these general permits would streamline permitting process for channel improvement and habitat restoration projects. Under these conditions, the County would be given authority to approve projects that are consistent with the provisions of the CCRMP and CCIP.

Funding

The iImplementation of the CCIP shall be funded in part would be funded initially through fees generated by a surcharge on the weight of aggregate resources sold (not mined) within the County. As established in the Gravel Fee Ordinance Aa $0.10 surcharge would be placed on each ton of processed aggregate in order to fund the CCRMP/CCIP. In addition, the County shall aggressively pursue other potential sources of funding, including user fees, benefit assessments, and state and federal grants for watershed management. The fees and other funding would be collected by the County Administrative Office (CAO) and placed in an interest-bearing account held by Yolo County, separate from the General Fund. The funds would be administered by the CAO with approval by the Board of Supervisors.

Implementation Schedule

The following samplepreferred schedule will guidebe met by the TAC for each year of program implementation unless high flow conditions preclude initiation of annual channel morphology monitoring:

15 January	Submittal of TAC annual progress report on previous year's monitoring results and completed channel improvement projects to Board of Supervisors.
15 February	Submittal of annual progress report to the Office of the Chief Clerk, California State Assembly, pursuant to AB 1585, Chapter 7, Statutes of 2010 and Government Code Section 9795.
15 March	County to coordinate implementation of priority projects as identified in annual report.~~Notification by TAC to landowners of high-priority recommended channel improvement projects.~~
~~1 April~~	~~Completion of annual aerocartography.~~
~~March/April~~	~~Discussions between TAC and interested landowners regarding potential projects, including maintenance activities.~~
April/May	Annual creek walk
~~1 May~~	~~Completion of Digital Terrain Model and channel cross-section and analysis of model by TAC.~~
31 May	Deadline for submittal of applications to County~~YCCDA~~ for Flood Hazard~~plain~~ Development Permits (FDP) related to channel modifications within the CCRMP planning area during the summer and fall.
30 June	Completion of TAC and County~~YCDPW~~ review of FHDP applications for proposed in-channel projects~~channel modification designs and recommendations for approval of FDPs~~.
30 August	Completion of aerial photography and LiDAR (every five years or in water years with peak flows exceeding 20,000 cfs).
1 Jul~~y~~ to ~~/~~31 Oct~~ober~~	Construction/Implementation of channel improvement projects[1].
30 November	Completion of Digital Terrain Model analysis by TAC (every five years or in water years with peak flows exceeding 20,000 cfs).

[1] Formal construction season determined by applicable state/federal permits.

1 Oct to 30 Sep	Ongoing TAC monitoring of stream discharge, sediment transport, flood conditions, and channel morphology during each water year.
1 November	Termination of in-channel improvement projects (may not apply to all projects depending on conditions of approval).
~~January-December~~	~~TAC monitoring of stream discharge, sediment load, flood conditions, and channel morphology.~~

CHAPTER 3.0 CHANNEL~~MAJOR~~ STABILIZATION PROJECTS

3.1 INTRODUCTION

The following discussions outline a plan for improving the overall stability and ability to maintain~~ability of~~ Cache Creek. The Cache Creek Improvement Program will be achieved through a series of steps orchestrated by the TAC. Steps include: 1) ~~design and~~ implementation of ~~localized~~ a channel management corridor that~~stabilization projects to~~ promotes "self improvement and increased stability" of the creek's morphology; 2) implementation of a comprehensive annual monitoring program (described in Chapter 6), and 3) implementation of channel maintenance activities (Chapter 4). ~~The plan basically calls for the design and implementation of a series of localized stabilization projects integral to the initiation of a more stable and homogeneous channel configuration.~~

The Technical Advisory Committee (TAC) will be responsible for collecting the required monitoring data and prescribing when and how further in-depth hydraulic engineering analyses and design activities will be carried out. As discussed in Chapters 2, 4, and 6 in this document, the TAC will identify and prioritize stabilization and maintenance projects along the creek. Engineering design of stabilization projects can be performed by the private land owners or public agencies. Through the processes of monitoring, ~~maintenance~~ and implementation of creek stabilization and maintenance projects developed by the TAC, the CCIP shall be used to ~~intends to~~ promote adjustments in the creek which meet the stated objectives of the CCRMP while allowing flexibility for the creek to recover and restore itself through natural processes acting in the absence of commercial in-channel mining ~~fashion its own recovery and restoration~~ over time.

The creek is a dynamic system that ~~is currently~~was substantially impacted by a variety of influences, including in-channel mining prior to 1996 (NHC, 1995). While significant sediment deposition has occurred and channel sinuosity has increased in the CCRMP area since 1996, the system is still in a state of dis-equilibrium. Implementation of the CCRMP and CCIP will continue to improve channel stability over the long term, but significant channel adjustments can be expected under present and future conditions, especially during periods of high flow. It is anticipated that channel maintenance requirements under the CCIP will decrease as the channel becomes more stable over time. However, some degree of channel maintenance will be required for the foreseeable future to ensure that existing flood flow~~carrying~~ capacity is preserved, and to reduce the risk of bank erosion, lateral channel migration, and significant degradation or aggradation of the ~~stream~~ creek bed in specific locations.

3.2 SUMMARY OF EXISTING CONDITIONS BY REACH

From its origin near Clear Lake to its terminus in the settling basin, Cache Creek ~~-~~exhibits great diversity in geologic and physiographic characteristics, with extreme swings in hydrologic and geomorphic processes from year to year. As described in the 1995 Technical Studies and reaffirmed in the 2017 Technical Studies, the historical geomorphic characteristics of Cache Creek from Capay Dam downstream to the settling basin were considerably different from today. The 1995 Technical Studies~~Streamway Investigation (NHC,1995)~~ identified~~s~~ nine geomorphically distinct ~~sub~~reaches in the 35 miles from upstream of the Capay Dam to the Settling Basin, as shown in Figure 1. The 2017 Technical Studies reaffirmed these as relevant geomorphic designations. From upstream to downstream the nine geomorphic ~~sub~~reaches are referred to as follows:

1. Capay Valley (~~Subr~~Reach 9), upstream from the Capay Dam (Upstream RM 28.3)
2. Capay (~~Subr~~Reach 8), from the Capay Dam to County Road 85 (RM 28.3 – 26.3);
3. Hungry Hollow (~~Subr~~Reach 7), from County Road 85 to County Road 87B(RM 26.3 – 23.5);
4. Madison (~~Subr~~Reach 6), from County Road 87B to Interstate 505(RM 23.5 – 21.1);
5. Guesisosi (~~Subr~~Reach 5), from Interstate 505 to a point upstream of Moore Crossing (RM 21.1 – 18.9);
6. Dunnigan Hills (~~Subr~~Reach 4), from a point upstream of Moore Crossing to County Road 94B (RM 18.9 – 16.1);
7. Hoppin (~~Subr~~Reach 3), from County Road 94B to County Road 97 (RM 16.1 – 12.9);
8. Rio Jesus Maria (~~Subr~~Reach 2), from County Road 97 to County Road 102 RM 12.9 – 5.4); and
9. Settling Basin (~~Subr~~Reach 1), from County Road 102 to the Bypass (RM 5.4 – 0).

The channel boundary, as defined in the CCRMP, extends from the Capay Dam downstream to a point near the I-5 bridge and the town of~~near~~ Yolo, a distance of approximately 14.5 miles (16.8 river miles). ~~The approximate lateral extent of the channel boundary of the study area coincides with the 100-year floodplain boundary defined in the Corps of Engineers' *Westside Tributaries Study*, 1994 or the channel banks. Therefore~~, T~~t~~he CCRMP channel boundary falls within ~~Subr~~Reaches 2 through 8~~, 7, 5, 4, 3, and the uppermost portion of Subreach 2~~ (see Figure 1).

~~Table 1 summarizes the present reach-averaged characteristics of each of the main subreaches in the study area, including reach-averaged hydraulic characteristics for 100-year flow conditions. Figures 2 and 3 show how the average channel widths and thalweg elevations under the bridges have narrowed and deepened, respectively in each subreach since the turn of the century. Section 3.2 in the Streamway Study (NHC, 1995) summarizes the present geomorphic and~~

hydraulic characteristics of each of the subreaches. Tables 2 through 9 below summarize present existing conditions for each of the major subreaches in the study area.

3.3 BACKGROUND

While significant sediment deposition and channel adjustment has occurred in the CCRMP area since 1996, the current Cache Creek channel system remains out of balance with respect to flow, sediment load, and channel conditions. The present Cache Creek channel system is out of balance with the flow and sediment loads entering it. If there is too much water in a river system and not enough sediment, scour will lower the streambed and/or erode the adjoining banks. If there is too much sediment, and not enough water, the creek will meander and flood. Bridges and in-channel levees continue to posecreate significant hydraulic controls (constrictions) in the system. and fFlow velocities can beare significantly greater through constrictions than in the wider portions of the creek upstream and downstream of bridges. These differences in hydraulic conditions at bridgesThis createss local high energy zones that contribute to channel bedwhere scour and bank erosion.ing is common and channel bed lowering occurs due to scour. The currentpresent channel configuration continues to confines the flow energy duringfor large flood events to a much narrower channel than existedhad occurred historically. Reduction of floodplain storage area and disconnection of the channel from its historical floodplain continues to alter local and reach-scale hydrology (including flood peak volumes and travel time) from historical conditions. Since 1996, the active channel has migrated into levees and channel banks in many reaches, indicating that the channel is adjusting by increasing in width. blockage of natural flood water escape routes have altered the local hydrology (flood peaks and travel time). In most subreaches, the channel is attempting to adjust itself to be wider than the current widths.

The increased hydraulic stresses within the creek system relative to historical conditions may limit the type and survival rate of some vegetation species formerly found in CCRMP area and associated floodplain. Since the elimination of in-channel commercial mining in 1996, monitoring of channel configuration and topography has shown that the creek is developing a more stable configuration with sinuosity and slope conditions evolving towards more natural conditions. However, the creek is still adjusting and it will still take decades to establish a new equilibrium. As in-channel maintenance projects and ongoing off-channel mining operations continue, opportunities to reconfigure the channel to smooth out abrupt changes in capacity and to reduce constrictions should be undertaken. River discharge within the confined banks, flow depths and velocities have increased through the study reach since the early 1900s, thus increasing the hydraulic stresses on the bed and banks. Increased hydraulic stresses within the channel may limit the type and survival rate of some vegetative species formerly found in the channel. Continuous long-term sediment transport simulations indicate that the creek will work on its own toward a more stable configuration (channel slope and compound cross sectional shape), but the

~~new equilibrium may take decades to establish itself. To improve channel stability in a shorter period of time, it is necessary to change the present in-channel mining procedures (see recommendations 1 through 8 in Chapter 6 of the Technical Studies) and reconfigure the channel to smooth out abrupt changes in capacity and to reduce constrictions.~~ Once major constrictions are removed or improved and channel smoothing and widening projects are complete, annual anticipated channel maintenance requirements will decrease as the creek becomes more stable over time. ~~This chapter of the CCIP describes types of channel improvement projects that will be considered by the TAC.~~

3.4 MANAGEMENT OF CHANNEL FORM (EXPLANATION OF THE TEST 3 RUN BOUNDARY~~CONCEPT~~ AND CHANNEL FORM TEMPLATE)

Test 3 Concept

The 1995 Technical ~~Streamway~~ Studies ~~(NHC, 1995)~~ described a series of hydraulic~~numerical~~ (computer modeling) sensitivity analyses that were performed to test the effects of widening and smoothing the channel. The Test 3 Run Boundary~~conceptual configuration~~ was ultimately recommended by the 1995 Technical Studies and integrated into the CCRMP as the appropriate management target for channel form. The ~~Test 3~~ channel configuration embodied in the Test 3 Run Boundary was~~is~~ conceptual; ~~at this time and~~ the sensitivity results presented in the 1995 Technical Studies were~~are~~ not intended for design purposes. The goal of the Test 3 Run Boundary was to ~~By~~ resculpt~~ing~~ the ~~present~~ channel shape to slightly widen constrictions, smooth out irregular bank lines, and eliminate abrupt changes in channel widths ~~(see Figure 4)~~, so that the hydraulic capacity and sediment transport characteristics would be~~are~~ smoothed to create a more stable and balanced creek system. Bridge crossings tend to be the most constricting features along the creek. The Test 3 Run Boundary~~concept also~~ called~~s~~ for smooth channel transitions into and out of the bridges to reduce energy losses and local scour. It assumed that fixed (hardened) bed elevations at bridge openings would be implemented a a part of then-planned major stabilization projects. The Test 3 Run~~Conceptual~~ Boundary provided~~s~~ a target channel shape for creek~~future~~ stabilization plans. ~~Reshaping and smoothing of the channel will help return the channel (on a reach-by-reach basis) to a form more similar to its historical morphology. In the long term, the Streamway Studies and CCRMP recommend that in-channel extraction be limited to the volume of sand and gravel delivered annually to the study reach. Also recommended as part of the Test 3 concept is abandonment of the theoretical thalweg concept and 1979 in-channel mining boundary. It is suggested that the old creek management criteria be replaced with target channel slopes and sinuosities listed in Table 10.~~

The Test 3 Run Boundary recognized that t~~T~~arget slopes and sinuosities would~~may~~ change over time as the channel adjusts to reshaping projects, ~~and~~ regular maintenance, and natural events.

Recommendations regarding where, when, and how adjustments to specific channel dimensions and hydraulic characteristics wouldmight be implemented wouldwill be made by the TAC following the evaluation of long term monitoring information (refer to Chapters 2, 4 and 6 below). Fixed standards and channel shapes should be avoided. It is impossible to anticipate exactly where and how the creek will respond to resculpting and smoothing projects as well as reduced in-channel mining. Management will focus on maintaining appropriate stable slopes and channel capacity rather than specific elevations.

A complete systems approach for the development of a channel improvement and stabilization plan is essential. All of the subreaches must be assessed as integral parts of the creek system, all connected together hydraulically with feed forward and feed back mechanisms relating to what has, or is occurring upstream or downstream from a particular location on the creek. The need and benefits of applying a complete systems approach for project design, monitoring and maintenance was described thoroughly in the Technical Studies (NHC, 1995). Current unstable channel conditions reflect the consequences of not having an integrated management program of channel modification activities.

The Test 3 modeling demonstrated what were considered at the time to be “much improved conditions over present conditions,” This meant that the modeling showed the Test 3 Run Boundary as having sediment supply closer to equilibrium with sediment transport capacity, and the elimination of sediment supply and transport imbalances at bridges largely because the channel bottom was assumed to be hardened.

It was recognized in 1996 that mMajor channel smoothing and shaping projects wouldmay be too extensive to implement simultaneously and wouldmay require phased implementation. Starting with the highest priority projects first, the overall creek improvement plan should be carefully implemented, phase by phase, with ongoing monitoring to record how well the various phases and projects work towards improving channel stability. The CCRMP establishes a mechanism for implementation of large segments of the channel improvements proposed under this program, through Development Agreements or other arrangements with off-channel aggregate producers. Through the notification process described in Chapter 2, it was anticipated that the TAC wouldwill promote and facilitate localized channel improvement projects.

Channel Form Template

While the Test 3 Run Boundary has been implemented with all applicable projects constructed since 1996, channel bed areas at bridges have not been hardened, and extensive smoothing of the channel boundary has not occurred. Because these major stabilization projects have not been realized, the Test 3 Run Boundary has not been fully achieved as envisioned. Despite the fact that these changes have not been implemented, channel evolution towards more stable conditions has occurred since 1996, and channel bed elevations at bridges have not experienced the extensive lowering from scour predicted by the Test 3 modeling on a long-term basis. Furthermore, significant aggradation has occurred in many places throughout the CCRMP area, resulting in more natural, active channel slope and sinuosity conditions.

As a part of the 2017 Technical Studies, the Test 3 Run Boundary was reviewed with a goal of refining it based on the latest available modeling techniques and over twenty years of observations of creek channel evolution without in-stream gravel mining. The Channel Form Template (Figure 2) replaces the Test 3 Run Boundary but carries forward many of the concepts of the original HEC-2 modeling upon which the 1996 CCAP relied.

The boundary of the Channel Form Template was determined using the new hydraulic model of the creek system and observations of channel change between 1995 and 2016. It reflects the following:

- At bridge crossings, the Channel Form Template follows the bridge abutments and generally tracks with the Test 3 Run Boundary at the bridge openings.
- Where there are existing spur dikes near bridge crossings, the Channel Form Template follows the endpoints of the training structures as they existed in 1996.
- The Channel Form Template generally follows existing top-of-bank lines where the latest modeling shows that 100-year flow is contained by such banks.
- Where the 100-year flow inundation boundary falls within the existing channel banks, the Channel Form Template tracks the outer bank line if the land between the inundation boundary and the outer high bank line is undeveloped and contains natural vegetation features.
- Where the 100-year flow inundation boundary falls outside the existing high bank, the Channel Form Template aligns with the inundation boundary unless such a location is near a bridge crossing or other location where a transition to a narrower channel is necessary.
- Similar to the Test 3 Run Boundary, the Channel Form Template smooths abrupt changes in channel width.
- Hydraulically-connected off-channel areas (e.g. the Woodland-Reiff breach site and reclaimed pit) are included in the Channel Form Template to allow room for flood detention, floodplain inundation, and other beneficial processes that could lessen erosion in downstream reaches.

Management of the Channel Form Template is similar to management of the Test 3 Run Boundary. For areas within the Channel Form Template boundary, natural channel processes should be allowed to occur and drive more natural channel evolution towards smoother transitions where there are abrupt changes in channel width. Immediately adjacent to or beyond the Channel Form Template boundary, interventions are allowed, and in some cases encouraged, to protect the multiple benefits and uses of the CCRMP area. When aggregate mining operators expand their facilities or otherwise require permitting from the County under the OCMP, the Channel Form Template shall be implemented.

Major channel smoothing and shaping projects have not been implemented extensively since 1996, and future implementation will likely remain relatively limited due primarily to challenges related to state and federal permitting, and to a lesser extent to the varying interests of private ownership along both banks. The CCRMP establishes a mechanism for implementation of some channel improvements proposed under this program, through Development Agreements or other arrangements with off-channel aggregate producers. Through the notification process described in Chapter 2, the TAC will promote and facilitate other localized channel improvement projects with other property owners.

3.5 DESIRABLE (TARGET) CHANNEL CHARACTERISTICS BY REACH

The ~~100-year~~ channel characteristics for each subreach were originally developed in the 1995 Technical Studies.~~Streamway Investigation for the Conceptual Test 3 channel configuration~~ and updated in the 2017~~6~~ Technical Studies. The~~se~~ hydraulic characteristics in 1995 and 2015, along with recommended channel slopes and sinuosities are listed in Table 1 (Summary of Reach Characteristics)~~0 as initial target channel characteristics recommended under the CCIP~~. As previously stated, ~~these target~~ values are targets that may be adjusted over time by the TAC, depending on how the creek responds to projects that are implemented under the CCIP. Regular monitoring and analysis is required (see Chapter 6). Creek management and maintenance will focus on maintaining the targeted channel slopes and sinuosities rather than specific elevations. ~~Significant efforts will be made to stop further channel bed lowering in all subreaches.~~ Figure 3 is a conceptual template that may be adapted to specific sites where removal of in-channel material has been identified to improve channel conditions. ~~Suggested adjustable mining templates for areas where the channel is wide, narrow channel areas with adjacent off-channel aggregate extraction pits, and areas where the channel is narrow are shown in Figures 5, 6 and 7, respectively. The template shown in Figure 5 is applicable to channel sections found in subreaches 6, 7, and 8. The template shown in Figure 6 is applicable to channel sections found in subreaches 3, 4 and 5, while the Figure 7 template is applicable to conditions found in subreaches 2 and 8.~~

Table 1, Summary of Reach Characteristics

	2017		**2011**		**1995**		**1905**		**Target**	
Reach	**Sinuosity**	**Slope**	**Sinuosity**	**Slope**	**Sinuosity**	**Slope**	**Sinuosity**	**Slope**	**Sinuosity**	**Slope**
Capay Reach	1.18	0.0015	1.09	0.0015	1.06	0.0019	1.11	NA	1.04	0.0019
Hungry Hollow Reach	1.18	0.0022	1.15	0.0023	1.20	0.0023	1.06	0.0015	1.10	0.0020
Madison Reach	1.08	0.0018	1.11	0.0018	1.08	0.0022	1.04	0.0018	1.15	0.0020
Guesisosi Reach	1.20	0.0013	NA	0.0014	1.18	0.0013	1.02	0.0014	1.05	0.0013
Dunnigan Hills Reach	1.08	0.0016	1.16	0.0016	1.09	0.0020	1.03	0.0014	1.05	0.0017
Hoppin Reach	1.07	0.0012	1.17	0.0013	1.07	0.0015	1.01	0.0010	1.15	0.0013
Rio Jesus Maria Reach	1.05	0.0013	1.05	0.0014	1.06	0.0013	1.00	0.0016	1.18	0.0013

~~All of the bridges within the CCRMP study area, with the exception of those bridges cross the narrow channel near Yolo, have experienced damage due to channel degradation and other problems. Several bridges have had multiple failures.~~ There are four bridges that cross Cache Creek within the plan area, all of which have been subjected to erosive forces from the creek:

Capay Bridge at CR 85
Esparto Bridge at CR 87
I-505 (state/federal)
Stevens Bridge at CR 94B

The Madison bridge at CR 89 collapsed in 1978 and was never~~has not been~~ replaced. Structural damage to the Capay bridge resulted in closure of the bridge to all traffic and pedestrians following high flows in March of 1995. ~~The Madison bridge collapsed in 1978 and has not been replaced.~~ All of the bridges in the CCRMP study area are critical components of the County's transportation system and damage to them represents substantial inconvenience to residents and significant economic impacts to the County. As described in the 1995 Technical Studies, bridges have an effect on the overall channel stability throughout the study area. They form high flow constrictions in the channel resulting in localized rapid changes in channel flow capacity~~conveyance~~ and sediment transport capacity. These abrupt changes in flow and sediment transport capacity could result in alternating areas of scour and deposition that lead to progressive changes in the channel ~~well beyond~~upstream or downstream of the immediate area of the bridge.

The 1995 Technical Studies demonstrated the benefits of widening narrow bridge openings but acknowledged the financial constraints on the feasibility of lengthening several bridges. Therefore, the CCRMP recommends that changes to bridges proposed by bridge owners arebe designed toincorporate designs and construction of smooth channel transitions into and out of bridge openings to improve local hydraulic conditions and reduce the abrupt changes that presently occur. The 2016 Channel Form Template provides guidance on smoothing these transitions. An example of a generalized transition treatment for bridges is presented in Figure 8. While bridge projects are outside the purview of the CCAP, Tthe TAC will coordinate assist with technical review of the design of individual bridge treatments with should County, State, and/or Federal agencies implement project(s) at bridge transitions.interests. The Channel Form Template should be amended as appropriate to reflect creek modifications over time.

3.6 PRIORITY PROJECTS

The TAC is required to produce an annual report that identifies maintenance projects and other priority improvement projects necessary to help stabilize the creek. The requirements of this report are discussed in further detail in Chapter 6.0. These reports are retained by the County and are available for review at the County's CCAP website: http://www.yolocounty.org/general-government/general-government-departments/county-administrator/county-administrator-divisions/natural-resources/the-cache-creek-area-plan-ccap-

Chapter 6 presents program descriptions for flood watch and annual monitoring activities. Perhaps the most important CCIP project is the installation of flow gages and the implementation of the annual monitoring program. Dependable data are critical to the design and implementation of any major channel stabilization project. It is therefore suggested that the tasks and program components described in Chapter 6 be considered as components of a high priority project.

Present and future channel stability problems continue to occur where channel capacity and hydraulic conditions change abruptly. Noticeable scour occurs through narrow constrictions and significant deposits of sediment occurs immediately upstream or downstream from constrictions resulting in potential deflection of flows at banks or important structures. The primary locations where these problems occur are in the vicinity of bridges. Therefore, all bridge locations are considered high priority sites for major stabilization projects.

Figures 9 through 12 present sketches of four different channel transition and stabilization projects prepared for the Capay bridge (Road 85). Figures 9, 10 and 11 show different methods of protecting the bridge abutments and providing three different methods for stabilizing the eroding north bank. Alternatives shown in Figures 9 through 11 are for an assumed bridge of the same length (opening) as the present bridge (Alternatives EBL1 - EBL3: *existing bridge length*). A key component of these project alternatives is the selective bar excavation along the right bank, upstream from the bridge. The point bar continues to grow in size and elevation, thus encouraging the creek to attack the left bank upstream from the bridge. Figure 12 presents a sketch of a channel transition project at the Capay bridge for a bridge lengthened by 150 feet to the north. As demonstrated in the Streamway Report (NHC, 1995) enlargement of bridge openings greatly improves the hydraulic characteristics and channel stability in the vicinity of the bridge.

Figures 13, 14, and 15 present generalized sketches of channel transition projects for the I-505 bridge, Stephens bridge (Road 94B), and Esparto bridge (Road 87), respectively. Each bridge transition project consists of channel smoothing upstream and downstream from the bridge. Channel transitions are created by building flow deflection works (spur dikes or groins) and/or biotechnical features that will equally guide high energy water to the bridge without an abrupt change in channel conveyance upstream or downstream from the bridge. Scour control (sills, aprons, rock donuts or mattresses) in the immediate vicinity of the bridges may be required for some sites, but design analyses are required to determine where and to what extent scour controls are required.

There are several locations in the CCRMP study area where past gravel excavation has occurred and low in-channel levees remain. Some of the levees are located downstream from significant high flow velocity areas at channel constrictions, creating hydraulic instability. The tendency for low-flow channels in these areas to braid or meander significantly presents potential streambank erosion hazards. Figures 5 through 7 present flexible maintenance mining templates which could be implemented in such locations. Partial removal of the low levees and regrading behind them provides the opportunity to establish the targeted compound channel shapes and dimensions recommended by the CCRMP. These areas are considered high priority project locations. Opportunities for groundwater recharge and reestablishment of valuable riparian features should be considered at all project sites. Figures 16 and 18 present plan view sketches of possible channel sculpting and smoothing projects located downstream from the Stephens and Esparto bridges, respectively. They consist of removal of portions of the existing low in-channel levees left from previous mining and the construction of terrace features adjacent to the channel banks. Figures 17 and 19 show cross section sketches of these two project areas. The proposed channel sculpting and smoothing complies with the target channel templates presented in Figures 5 and 6.

CHAPTER 4.0 CHANNEL MAINTENANCE

This section describes expected channel maintenance activities under the CCIP. Channel maintenance activities are in addition to the recommended activities described in the previous section as ~~high~~ priority channel improvement projects, and are based on the same objectives for creek~~stream~~ stability. In general, channel maintenance activities are smaller in scale than improvement projects, and would be performed to address local conditions that need to be corrected to prevent larger creek~~stream~~ stability problems.

4.1 ANTICIPATED NEED FOR CHANNEL MAINTENANCE

Implementation of the CCRMP and CCIP has~~will~~ improved channel stability ~~over the long~~since ~~term~~1996 ~~term~~, but significant additional channel adjustments caused by winter and spring high flows and sediment transport~~can~~ should be expected ~~under present conditions~~, especially during periods of ~~high~~ flow greater than 20,000 cubic feet per second. It is anticipated that channel maintenance requirements will decrease as the channel becomes more stable over time. However, some degree of channel maintenance will be required for the foreseeable future to assist with flood management, to ensure that existing flood flow capacity is not diminished ~~flood carrying capacity is preserved~~, and to reduce the risk of bank erosion, lateral channel migration, and significant degradation or aggradation of the streambed in specific locations.

The 1995 Technical Studies~~Streamway Study (NHC, 1995)~~ illustrated ~~the~~ non-uniformity in sediment transport capacities of the channel under then-present conditions. The updated 2017 CCRMP hydraulic model shows persistence of non-uniform hydraulic and sediment transport conditions in parts of the creek system.~~present conditions.~~ Even in the absence of aggregate extraction or other human influences, the channel can be expected to make significant adjustments by eroding or depositing sediments at various locations in the bed of the creek~~stream~~. ~~-~~These processes may lead to local changes in channel form and lateral instability. Although the channel might eventually adjust on its own to a more stable form, correction of the current imbalances in sediment transport capacity would likely take a very long time. ~~The improvement projects prioritized in Chapter 3 are intended to reduce the rapid changes in transport capacities that presently exist and thereby promote a more stable stream system. However, these projects will not immediately improve all areas of the stream, and the projects may not all be implemented for several years.~~ Therefore, ~~During the first 5 to 10 years of CCIP implementation, fairly substantial requirements for~~ channel maintenance should be implemented as needed~~be anticipated~~ to prevent sudden changes in the channel and erosion of its banks, and to help guide the creek~~stream~~ toward a more stable form.

The monitoring program described in Chapter 6 is designed to provide information that will assist in making decisions regarding channel management~~maintenance~~. Water and sediment discharge data will continue to be collected to better understand creek hydrologic and sediment transport processes, topographic data will continue to be collected to monitor changes in channel form and elevations, vegetation conditions will continue to be monitored, and the TAC will continue to make an annual evaluation of bed and bank stability in an annual monitoring report to the Board of Supervisors. This monitoring program will be used as the basis for making decisions regarding channel maintenance activities.

4.2 TYPICAL CHANNEL MAINTENANCE ACTIVITIES

~~The Streamway Study presented a Test 3 Concept (described in Chapter 3) to characterize the types of improvement projects that might be effective in improving channel stability. In addition,~~The generalized typical creek cross section template~~s~~ (Figure 3) ~~In addition, typical stream templates~~ ~~were presented that~~ prescribes~~d~~ proposed limits on channel shaping and smoothing within the channel to improve stability. ~~These~~ This ~~templates~~ templates ~~have~~ has been incorporated into the Floodway and Channel Stability~~Aggregate Resources~~ Element of the CCRMP ~~(refer to previous section of this report)~~. Removal of in-stream sand and gravel ~~beyond these purposes~~ is restricted to maintenance activities including maintenance of flood flow capacity, erosion protection, channel stabilization, protection of existing structures and infrastructure, riparian restoration, and to implement the Channel Form Template. In-stream excavation for any other purposes is precluded by the CCRMP. Use of the template~~s~~ to guide channel maintenance activities will result in formation of a more compound channel than presently exists. Specific maintenance activities will be recommended by the TAC based on an annual inspection and analysis of monitoring data. ~~However, it is possible to describe in~~ The following general ~~terms the types~~categories of activities are anticipated:

1. *Gravel Bar Skimming to Maintain Flood Flow ~~Hydraulic~~ Capacity or Reduce the Probability of Bank Erosion*

   The deposition of sediments in bars may reduce overall channel capacity, especially if dense vegetation develops on the bar. In some areas of the channel, reduction of capacity may not be adverse, or may even be beneficial. However, where existing flood flow~~channel~~ capacity would be ~~come~~ reduced ~~below the level of the 100-year flow, or where it would be reduced from a present capacity below this level~~, aggradation in the channel would not be acceptable, unless the loss of capacity is compensated by other channel modifications. Bar formation also influences the distribution of flow in the channel, and growth of bars on the inside of a bend can result in erosion of the opposite bank. In this case, skimming of the bar to reduce its size and height can reduce erosive force on the opposite bank. Mid-channel bars can result in erosive pressure on both banks. Care must be taken to make relatively minor changes in bar sizeprotect features of bars to avoid minimize the possibility ofpotential for major channel adjustment that could relocate transfer erosion or capacity problems to another location.

Originally the CCRMP anticipated the removal of approximately 1.2 million tons of material associated with major shaping within the creek during the first five years of implementation, and approximately 210,000 tons per year of ongoing maintenance (the rough equivalent of five to seven acres of work over a half mile area). In 1997, according to County records, approximately 40,000 tons were removed. In 1998 approximately 332,423 tons were removed. In 1999 no tonnage was removed. After 1999 there is no record of any excavation associated with in-channel projects implemented from 2000 to present. Implementation of the CCRMP was halted in 1999 during the resolution of a lawsuit related to mercury (see discussion of History in Chapter 1.0, Introduction). It was not resumed due to the philosophy of staff implementing the program at the time. More recently it has been precluded by expiration of the state and federal general permits.

2. *Vegetation Removal to Maintain Hydraulic Capacity or Reduce the Probability of Bank Erosion, or to Remove Undesirable Species*

Vegetation can potentially retardsdecrease flow velocities and reduces hydraulic capacity. The effect of vegetation is normally beneficial in reducing velocities and protecting streambanks from erosion. However, the presence of vegetation in the center of a channel may have has a significant effect on hydraulic capacity and can adversely affect flow distribution in the channel in a manner similar to mid--channel bars. Where hydraulic capacity is a concern, vegetation should be limited to the terraces of the channel, or to relatively narrow strips along the thalweg. Bar formation and vegetative growth are often interdependent. The formation of a bar provides sites for colonization by vegetation, which may reduces flow velocities and promotes further development of the bar. This process is a normal part of creek behavior, but can in some instances result in undesirable reductions in capacity or erosion of channel banks. Removal of vegetation or reduction of vegetation densities may be sufficient to prevent further bar formation or to promote scour of the bar surface by the creek. Undesirable species such as giant reed arundo and tamarisk are invasive in the Cache Creek watershed and are extremely resistant to scour. Vegetation removal may involve selective clearing and thinning by hand and machine, and chemical control of dense stands and/or undesirable species. Control of these species by chemical means is necessary in any location where dense stands would result in adverse changes in hydraulic capacity or bank erosion potential. (See Actions 4.4-2 and 4.4-3 of the CCRMP.)

3. *Minor Bank Protection Works*

   It is expected that bank erosion will occur in multiple locations along the channel on a small scale, as well as in a few locations on a larger scale. The larger problems, especially in the Jesus Maria Reach, are beyond the scope of channel maintenance solutions. However, smaller scale problems can be addressed in the channel maintenance program. While revetment may be necessary in some instances, maintenance activities should focus on changing hydraulic conditions that lead to the problem by promoting lower velocities close to the bank, and protecting banks with native vegetation or bio-technical erosion control techniques. Minor grading work, combined with strategic planting in suitable locations, can be used to promote the compound channel shape illustrated by the conceptual templates, reducing bank heights and resulting in lower velocities in the near-bank area. Maintenance activities need not always provide fail-safe protection against bank erosion, but rather should promote hydraulic conditions that reduce the potential for erosion. Experimentation with techniques that combine minor grading, native revegetation, and bio-technical protection techniques should be promoted. These types of projects may provide opportunities for landowner or citizen group participation. Included in this category are smaller revetments and smaller groins/spur dikes both for bank protection and channel shaping.

4. *Removal of Debris at Bridges or Upstream of Bridges Susceptible to Debris Accumulation*

   Debris is transported downstream in the Cache Creek channel during high runoff. In major floods, debris collection on bridges can significantly reduce hydraulic efficiency of the bridge opening and result in locally high velocities and bed scour. Problems with the stability of bridge foundations, abutments, and channel banks can result. A small amount of debris collected on a bridge can promote rapid accumulation of additional debris during flood flows, resulting in a situation that prevents debris removal until after the event has passed. Normal maintenance activities should include removal of debris from the bridge area, and from channel areas upstream of bridges. Bridges with narrow spans between piers and which are skewed to the flow are particularly susceptible to debris accumulation.

~~*Maintenance of a Defined Low Flow Channel*~~

~~Under present conditions, the low-flow channel of the creek is often obliterated or modified by aggregate extraction operations. This situation results in instability of the channel as flows increase in the fall and winter. The 1995 Streamway Study recommends recommended~~

maintenance of a low flow channel through controlled releases of water from upstream locations and by avoiding disturbance within 300 feet of the low flow channel. In addition, excavation in-channel maintenance mining is not permitted byper the conceptual design template must protectstemplates below a level of six feet above the thalweg elevation at the upstream and downstream extent of the excavation. These recommendations will allow a more stable, naturally armored main channel to develop. In some areas, this low flow channel may be temporarily filled with sediment deposits or vegetation in response to hydrologic conditions or channel conditions upstream. In these cases, additional in-channel maintenance mining that adheres to thea low flow channel should be maintained by excavation, in a form similar to the conceptual maintenance mining templates may be required.

Excavation is not permitted by the templates below a levee six feet above the thalweg elevation, except where the build-up of aggregate material would reduce channel capacity to below the 100-year flood capacity. Adjustments to the recommended cross-section templates may be necessary to permit aggregate removal under these circumstances.

5. *Non-Project Internal LeveeMaintenance Repair*

   Maintenance of Cache Creek flood control levees in the Hoppin and Jesus Maria reaches is the responsibility of the Department of Water Resources. Levees (including remaining in-channel levees) associated with active and inactive mining operations will also require maintenance from time to time. In most cases this maintenance will restore the structural integrity and level of protection of levees impacted by high flows. However, it is possible that at some reclaimed mine sites (like Granite Woodland Reiff), levee breaches will need to be maintained to provide controlled connectivity between Cache creek and off-channel habitat areas. In addition to these flood control levees, many internal levees are located on Cache Creek that were constructed to isolate gravel extraction pits from the main channel. Although it may be desirable to eventually remove or lower many of these levees as vegetated terraces are created in the restored pits, their immediate removal or failure could result in stream stability problems. Therefore, minor repair of these levees should be anticipated in the short term, to prevent rapid transitions in stream width at elevations associated with discharges less than the 2 to 5 year event.

The categories of cChannel maintenance activities described above involve working in the creek with heavy equipment, and therefore are subject to permitting constraints. Typical activities may include grading with dozers, hydraulic excavators, or scrapers; removal of aggregate materials from the channel by truck or scraper; removal and disposal of vegetation; removal of debris; and planting or placement of bio-technical erosion control materials.

Rights-of-way or rights-of-entry will be required for channel maintenance work. The TAC will coordinate the necessary landowner agreements and easements. It is anticipated that most, if not all, channel maintenance work will be landowner initiated. The CountyTAC will consider possibilities for cooperative design, financing, and construction of channel maintenance activities with interested landowners, and will serve as a technical resource for landowners planning these types of projects. The CountyTAC will attempt to secure grants and other alternative funding for this and other components of the CCIP

CHAPTER 5.0 DESIGN GUIDELINES FOR CHANNEL STABILIZATION AND MAINTENANCE

5.1 REVIEW PROCESS FOR CHANNEL STABILIZATION AND MAINTENANCE

The role of the TAC in the CCIP program is presented schematically in Figure 4~~20~~. The TAC will meet regularly to review~~discuss~~: 1) maintenance activities; 2) improvement projects; 3) ~~information from the~~ monitoring program~~,~~ data; 4) creek conditions and project priorities; and 5) in-channel activities and permit applications. ~~2) feedback and requests from the CCSG, and 3) recommendations and concerns from the Board of Supervisors.~~ Following review of annual maintenance activities, proposed improvement projects and annual monitoring information, the TAC will prepare recommendations for the coming construction and maintenance season. Depending on the amount of change in channel conditions observed from previous years, the TAC may recommend updating the County's ~~numerical~~ hydraulic models and re-evaluating the hydraulic and/or sediment transport characteristics through the study area. Results from the TAC's annual inspection, review of ~~the annual~~ aerial photos and review of updated hydraulic and sediment transport information will support the TAC's recommendations to the Board for various maintenance and channel improvement projects. Overall the role of the TAC is to integrate observations from the annual creek walk, the latest topographic and aerial photos, and hydraulic modeling, to assist with the prioritization of channel maintenance/improvements, and implement these activities guided by generalized cross-section templates and best practices for bank stabilization.

Significant channel improvement projects, such as those described in Chapter 3, will require detailed engineering design and must consider results from the hydraulic model for the CCRMP area. All projects ~~proposed by individual landowners which~~that would result in modifications to the channel within the 100-year flood hazard zone as defined by the National Flood Insurance Program ~~would~~ require a Flood Hazard~~plain~~ Development Permit (FHDP). Designs for these projects shall be~~would~~ be submitted to the Yolo County Community Services~~Development~~ Agency (or appropriate equivalent). The design of the projects would be reviewed by the TAC for conformance with the CCIP, and by staff for conformance with applicable state and federal permits, prior to approval of the FDP for the proposed project. Major projects may require the application of refined hydraulic and sediment transport models to specific creek reaches to develop design parameters. The TAC will make available flow and sediment discharge data collected under the CCIP, current versions of hydraulic and sediment transport models, and information on channel stability trends in the vicinity of the proposed project.

Annual channel maintenance activities will be smaller in scope than the significant channel improvement projects and can be accomplished based on the application of appropriate design parameters and best practices in the industry.a set of adopted standards. The TAC will develop and adopt a set of standards within one year of its formation. The design guidelines described below shall guide the TAC review. will form the basis for development of the standards.

5.2 DESIGN GUIDELINES

This section describes design guidelines based on results of the 1995 Technical StudiesStreamway Study, evaluation of changes in channel conditions between 1996 and 2016 as presented in the 2017 Technical Studies, and best management practices for creek stabilization standards ofbest management practices practice. The section applies to both major channel stabilization projects and channel maintenance activities.

Channel Stabilization

Present Current conditions on Cache Creek involve radical changesinclude discontinuities -in hydraulic conditions and sediment transport capacity along the stream's course. These changes and the constant disturbance induced by mining near the thalweg of the streamdiscontinuities can result in both vertical and lateral instability.

Many channel stabilization and erosion control techniques are available for controlling bed and bank erosion that occurs along alluvial streamscreeks. The literature is voluminous regarding these measures, often referred to as *erosion control countermeasures.* A countermeasure is defined as a technique used to control, inhibit, change, delay, or minimize creekstream stability problems. Countermeasures can be installed at the time of the initial development of a channel improvement project or retrofitted to resolve stability problems as they develop. Retrofitting and sound maintenance practices are practical because it is difficult to predict the location, magnitude and nature of potential instability problems. When selecting a countermeasure, it is necessary to evaluate how the creek might respond to the countermeasure at the site and as well as up-stream andor downstream from of the site. A very brief summary is presented here of some of the more viable methods for channel stabilization and erosion control for Cache Creek. Sketches of the some of the methods are provided for the convenience of the reader.

CreekStream stabilization and erosion control measures can be grouped into at least seven categories: *discharge control, revetments, dikes, vegetation (and biotechnical methods), alignment adjustments, bank drainage, and bed scour controls.* The following references provide guidance on design and implementation of these measures:

https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044574.pdf https://www.fs.fed.us/biology/nsaec/assets/yochumusfs-nsaec-tn102-2gudncstrmrstrtnrhbltn.pdf

1. *Discharge control* requires that the erosive stream flows isare routed through an upstream detention facility (dam or reservoir) to reduce the rate of flow, thus reducing the flow's erosion powerpotential. These types of projects are less likely to be undertaken because of state and federal permitting requirements. These are likely to be major projects that involve the impoundment of water (e.g. dams or reservoirs). Generally, areas with steep banks or canyons are the most likely locations for these types of projects and there are no areas like this along the creek from Capay to Yolo. It is possible that discharge control upstream of Capay could have beneficial effects for the downstream reaches covered under the CCRMP.

2. *Revetments* (Figures 21 and 22) include placing stone or concrete (see CCRMP Performance Standard 3.5-7) on the channel bank to resist the erosive forces of the flow. These types of "pre-emptive" projects are likely to be useful within the Plan area at locations where stream energy scours down and undercuts the bank toe, which then slumps allowing the creek to advance laterally.

   A windrow revetment is one example. This consists of a pile of stone or concrete built on the high bank above the water line. If the creek meanders, the pile is released onto the bank. Another example was utilized by the Collet operation in 1980 at a location approximately one mile upstream of the nature preserve where the creek was threatening the Moore Canal. The operator received approval to cut a keyway (trench) for installation of stone below grade to keep the creek from undercutting the canal.

   The work involves using an excavator in the creek to dig a trench perpendicular to the flow. The trench is filled with large material (stone or recycled concrete). Dump trucks are needed for hauling. There is no large material naturally occurring in Lower Cache Creek. The largest material is 12 to 14 inches in the upper creek area which is not large enough for high velocity major events but would work for low flow events. Options include importation of large rock from out of the area ("non-native natural material) or use of recycled concrete consistent with applicable local and state regulations. Recycled large material can be faced with smaller cobble for a natural appearance.

3. *Dikes*, commonly referred to as groins or spur dikes (Figures 23 and 24), direct flow away from eroding surfaces or reduce the erosive forces along the channel bank by diverting the stronger currents. *Permeable dikes* and *groins* are often called *flow retarder*

structures (Figure 25). Rock dike groins and revetments can be successfully combined to slow velocity, pick up fines, and create a planting medium which supports natural revegetation. These projects are not done while the water is flowing. Construction requires rerouting the creek using a diversion channel or temporary dam and pipe/pump depending on flows.

4. *Vegetation* can be substituted in place of stone, concrete, timber or other materials for some erosion/stabilization sites (Figure 26). It is often advantageous to combine structural (stone or concrete) features with vegetative alternatives in the form of "*biotechnical solutions*" (Figure 27) to erosion and/or stabilization problems. The success of vegetative measures depends on the survival of the vegetation and substrate stability. The vulnerability of vegetation should be considered in site selection.

   Use of vegetation-only controls are unlikely to be effective in Cache Creek. Under high flow conditions the improvements are likely to be washed out. The combination of vegetative solutions with "hard points" to slow velocity and protect plantings effective in lower Cache Creek, particularly in the lower downstream reaches where material is finer grain and there is more water closer to surface. Upstream the water table is lower and the material is coarser which makes establishment of vegetation difficult.

   This work is primarily done by hand although preparation work may be done with equipment such as a bull dozer, excavator, and/or motor grader. The scale of these projects is typically smaller -- two to three days over 50 to 200 foot areas is typical.

5. For some problems *alignment adjustments* are appropriate. The creek will naturally meander over time. Creek realignments involve repositioning the creek to protect infrastructure, agriculture, or mining operations. Care must be exercised, however, to ensure that the realignment does not result in the relocation of the problem elsewhere. Creek realignments usually require placement of spur dikes, groin fields and revetments to encourage the main thread of the creek's flow path to relocate.

6. *Bank drainage.* There are many locations along the study area of Cache Creek where rather significant gully erosion is occurring at locations where floodplain drainage enters the creek. This situation can also contribute to further saturation of the banks which increases the likelihood of bank failure due to mass wasting. Upper bank drainage should be collected and allowed to enter the creek in erosion resistant channels or inlets.

7. *Bed scour controls.* Channel incision and scour are very complex processes. Channel bed incision (erosion) occurs in locations where the hydraulic energy (flow) exceeds the ability

resistive strengths of the creek bed to remain stable. Rock, concrete, soil cement or biotechnical bed armoring procedures can help control bed erosion. Applications of channel bed *erosion control mattresses* (Figure 28) are common at bridge crossings where rapid flow acceleration results in local bed scour.

The construction of check dams or grade controls using large stone to create an at-grade sill could be effective to hold the elevation and protect the piers at bridges. A similar project was undertaken by the NRCS upstream of the Capay bridge in 1995 when the West Adams canal was threatened. A large amount of riprap was placed as an emergency measure during high flows. The project was successful and remains in place today obscured by vegetation and hidden from most views.

Selecting Countermeasures

Selection of an appropriate countermeasure to resolve a specific channel stability problem is dependent on many factors, including the erosion mechanism causing the problem, local and regional creek characteristics, construction and maintenance requirements, potential for vandalism, and costs. Creek characteristics that most influence the selection of countermeasures include: channel width; bank height, configuration and material properties; vegetative cover; channel bed sediment transport characteristics; channel bend radii; channel velocities; and flow depth.

5.3 CONDITIONS, TECHNIQUES, AND COUNTERMEASURE DESIGN CONSIDERATIONS

The two references provided above provide aApplicable repair and maintenance techniques for various problem types and physical/hydrologic settings. are summarized in Table 11. For example, bank erosion due to contraction at bridges is a problem type, and guide banks, bank revetment, bridge widening, and smooth channel transitions are applicable techniques. Table 11 lists typical channel stability problems found on Cache Creek in the first column. The second column suggests different countermeasure techniques to correct erosion and stability problems. The third column lists specific references where design criteria and design procedures are specified. The last column indicates whether these problems and solutions are categorized as significant priority type projects, or projects of lesser magnitude that can be accomplished through the annual maintenance program. Specific design dimensions for stabilization countermeasures listed in Table 11 cannot be anticipated and will require site-specific design by the TAC. As described in Chapters 3 and 5, the TAC will review annual needs for maintenance and improvement projects. As directed by the County, Tthe TAC, with the assistance of consultants as needed, maywill develop specific project designs in accordance with the goals of the Test 3 conceptChannel Form Template and the CCRMP.

5.4 SUMMARY OF RECOMMENDED DESIGN GUIDELINES

Recommended design guidelines wereare presented originally in the 1995 Technical Studies and carried over into the Technical Studies Report and the CCRMP. The guidelines, updated based on the 2017 Technical Studies, are summarized below:

1. Design and implement priority projects (see also discussion in Chapter 3) that promote beneficial adjustments in the creek which meet the stated objectives of the CCRMP, while allowing flexibility for the creek to shape its own recovery and restoration over time.

2. The TAC shall review topographic data and such other information as is appropriate to determine the amount and location of aggregate to be removed from the channel. Aggregate removal from the channel shall only be recommended in order to: maintain flood flow capacity; protect existing structures, infrastructure, and/or farmland; minimize bank erosion; implement the Channel Form Template; enhance creek stability; establish riparian vegetation; and recreation and open space uses consistent with the Parkway Plan. Except to implement the Channel Form Template, annual aggregate removal shall not exceed the average annual amount of sand and gravel deposited since the last prior year of removal in the CCRMP area, as determined by comparison of channel topography data. Recommendations shall take into consideration the desires of the property owner where excavation is to take place, as well as the concerns of property owners in the immediate vicinity.

32. Since 1996, tThe estimated average annual volume of annual sand and gravelsediment delivered to the CCRMP study area is 210,000690,800 tons per year of which 156,400 tons is estimated to be sand and gravel, and 534,400 is estimated to be fines (see Section 2.1, Introduction, of the CCRMP). Individual years and flood events may vary the supplyAnnual sediment delivery varies substantially from year to year based on hydrologic conditions, and aggregate extraction should follow that variability based on results from the annual monitoring program presented in Chapter 6. Aggregate extraction in local areas may be necessary on a one-time basis as part of priority channel stabilization projects (refer tosee also discussion in Chapter 3). Extraction would be performed in accordance with the target stable channel characteristics listed in Table 19 and cross section templates shown in Figures 5 through 8.

43. In the near term, aAllow in-channel reshaping and smoothing at rates at or belowgreater than the average annual deposition since the last prior year that extraction occurred, not

to exceed 690,800 annually~~supply in locations identified by the TAC~~, in order to implement the ~~Test 3 Model~~ Channel Form Template.

5. The County shall review and monitor removal of aggregate and/or plant material consistent with the CCRMP and CCIP. The County, at its discretion, may enlist the aid of gravel mining operators, other private property owners, or conduct the maintenance activities using County resources.

6~~4~~. Individual landowners can propose reshaping and smoothing projects to mitigate local channel instabilities. Project designs must comply with the target channel characteristics summarized in Table 1~~Table 9 and Figures 5 through 8~~, and conform to the Channel Form Template. Final designs will comply with local County design criteria and~~,~~ preserve channel stability and existing ~~100-year~~ flood flow capacity without adversely affecting neighboring creek reaches. Final designs must be reviewed by the TAC and Department of Public Works.

7~~5~~. Projects affecting the 100-year floodplain as defined by the National Flood Insurance Program within the CCRMP plan boundary will require review by the TAC,~~Technical Advisory Committee and~~ County approval of a Flood Hazard ~~plain~~ Development Permit (FHDP), and consistency with applicable state and federal permits.

8. The review by the TAC of all FHDP applications for Cache Creek improvement projects within the CCRMP area shall include an evaluation of potential upstream and downstream effects of the proposed channel modifications. The TAC shall evaluate data on hydraulic conditions presented in the permit application. The TAC shall also examine aerial photographs and perform a reconnaissance investigation of the site and surrounding areas to identify potential upstream and downstream effects.

9~~6~~. ~~Revoke the theoretical thalweg concept and 1979 mining boundary.~~ Use management targets for channel characteristics listed in Table 1~~Table 9~~.

10~~7~~. Manage grading within the channel (for priority projects or annual maintenance) in compliance with the target stable channel template~~s~~ shown in Table 1~~Figures~~6~~-5 through 8~~.

11~~8~~. Opportunities for groundwater recharge and reestablishment of valuable riparian features should be considered at all project sites. This measure will be implemented in concert with Action 4.4-6 of the CCRMP

129. Integrate native riparian vegetation into overall hydraulic and sedimentation design, and management plans.

1310. Use native riparian vegetation, where appropriate, to provide bank stabilization and to create smoother transitions between reaches with differing hydraulic capacities.

1411. Avoid channel bed lowering and permanent degradation through maintenance and channel management. Consider the design and installation of grade controls as major channel improvement projects if regular maintenance and channel management are unsuccessful in stopping further bed lowering in critical reaches or in the vicinity of bridges. Use vegetation and biotechnical measures wherever practical.

1512. Limit changes in channel form and mManagemanage the channel toward to encourage development of a compound cross sectional shape. Establish native vegetation and maintain at levels that will not result in overtopping of historical channel banks or increase in the 100-year flood elevation. Control weed invasion and adverse flow orientations by improving channel characteristics and performing regular maintenance.

1613. Manage and maintain in-channel vegetation to ensure it is part of the solution to channel stabilization and not contributing to the problems. Annual maintenance will be guided by the TAC and will include selective clearing and thinning of in-channel vegetation, in a manner sensitive to the surrounding riparian habitat.

1714. Use managed sand and gravelsediment removal (bar skimming) to promote and maintain channel stability and existing flood flow capacity. Use managed clearing and thinning of vegetation to promote and maintain channel stability and existing flood flow capacity. Channel maintenance will be managed by the TAC based on annual monitoring and hydraulic modelingnumerical analyses.

18. Existing flood flow capacity shall not be reduced and existing flood problems downstream shall not be exacerbated by channel reshaping. This shall be ensured through annual monitoring of channel geomorphology, distribution and density of plant material within the channel, and modeling to forecast changes in base flood elevations

1915. Plan, design, and implement priority projects listed in Chapter 3 to improve channel stability and promote more uniform hydraulic capacity with a stable compound shape.

2016. Require completion of reconnaissance-levelsite-specific biological inventories before implementation of priority projects, especially for special-status species.

2117. Promote the development of off-channel aggregate extraction to replace the present supply from the creek. If no flood protection or erosion control measures are proposed, a setback distance of 700 feet is requiredrecommended from the present bank line and the edge of off-channel pits. Where control measures are proposed, consistent with Section 10-4.429 (Setbacks) of the Mining Ordinance, a minimum setback of 200 feet is may be consideredrecommended only if no adverse eaffects onaffects to bank stability and groundwater can be demonstrated, and if the Channel Form Template is implemented along the project creek frontage. Project-induced creek capture associated with remaining in-channel pits are discouraged must not be allowed unless approved by the TAC to improve habitat in reclaimed mine sites or flood flow capacity.

2218. Implement smooth transitions through the bridges to reduce bed and bank scour and improve the overall hydraulics of the system (refer to Figures 6). Smooth and sculpt the channel to remove or reduce abrupt channel changes.

2319. Allow for flexible channel management of the creek so changes can be made to components of the CCIP, where and when necessary, based on new information in the future. Continuously collect monitoring data and analyze and document those data yearly. Review and revise the priority project list and maintenance management procedures every five years.

2420. Some priority projects may require the construction of sections of levees to smooth and resculpt the channel to a more stable configuration. Levee designs shallould follow the most current guidelines frompresented in the U.S. Army Corps of EngineersCorps, FHWA and Caltrans references listed in Table 11 should be used for design purposes. All levee designs will be based on thorough geotechnical engineering analyses based on the local bed and levee materials at the project site. All levees designed to confine and control creek flows will be designed for 100-year flow conditions with no less than 3 feet of freeboard.

2521. All levee projects must be reviewed by the TAC and Yolo Countythe YCCDA and receive pursuant to -a FHDPFlood Hazardplain Development Permit approval. Other State and Federal permits may also be required.

2622. Bank revetments, spur dikes, groin fields, hard points, toe revetments, bridge transition projects, rock sill, grade controls, biotechnical bank protection projects, and channel shaping (smoothing and widening) must comply with the design guidelines summarized in Table 1Table 9 and Figures 5 through 8. Final designs must comply with County design criteria, and be reviewed by the TAC, and the County Floodplain Administrator if the projects require modification to the 100-year floodplain. An FHDP permit may be required. Other State and Federal permits may also be required.

CHAPTER 6.0 MONITORING PROGRAM

This section describes a proposed monitoring program to collect and analyze data for the purpose of making resource management decisions for the Cache Creek channel on a continuing basis. A monitoring program is described to collect pertinent information regarding water and sediment discharge, changes in channel morphology, and changes in riparian vegetation. The monitoring program described herein is designed to be flexible and practical while assuring that essential data are regularly collected at key locations to support creek resource management decisions. Assuming the data collection program may be funded incrementally, allowing the monitoring program to possibly be expanded over time, the TAC shouldwill establish priorities for installation of gages and collection of data. The TAC will describe in their annual reports expected needs and recommended changes in the intensity and location of data collection activities as the channel adjusts over time. Data will be collected and analyzed under direction of the TAC, and integrated in a modern database paired with visual interfaces that facilitate retrieval and exploration of the data. the Thethe TAC will use the monitoring results to make decisions and recommendations for improvement projects, annual maintenance activities, and flood hazard reduction opportunities. In addition, the TAC will periodically review the monitoring program's effectiveness and costs, and suggestmake revisions as necessary to collect required quality information at minimum cost. The process by which monitoring results will be incorporated into TAC decisions iswas outlined in Chapter 2.

6.1 EXISTING DATA AND INFORMATION

Water and Sediment Discharge Data

The existing streamflow and sediment data available for Cache Creek were summarized originally in the 1995 Technical Studies, and data available since that time are identified and analyzed in the 2017 Technical Studies. Generally, streamflow data has been updated but sediment transport monitoring is not available. in the Cache Creek Streamway Study (NHC, 1995). On an intermittent basis, the United States Geological Survey (USGS) provides suspended sediment discharge monitoring from their gages at Yolo and Rumsey. The TAC has integrated this data into the annual reports, as it has become available. The 2017 Technical Studies applies the regional sediment transport model every year to estimate annual sediment transport throughout the system. While sediment transport monitoring would be helpful, it is both difficult and costly to implement on a system as large and flashy as lower Cache Creek, thus making it infeasible for this program. Prioritization of topographic (LiDAR) surveys after each water year with flows in excess of 20,000 cfs is a more important program task.

Figure 529 shows the location of existing stream gages for the portion of the Cache Creek basin upstream of Yolo. Table 12 summarizes existing streamflow data at several gages on lower Cache Creek (downstream of Clear Lake) and on Bear Creek, a major tributary of Cache Creek. Several gages have discontinuous records or are no longer in service. The gages of particular importance to the CCRMP area are the Rumsey, Capay, and Yolo gages. Data availability plays a role in limiting the current understanding of Cache Creek hydrologic and sediment transport processes. In spite of the importance of inflowing sediment loads to aggregate availability in the plan area, sediment discharge data on Cache Creek are extremely limited.. The USGS (USGS, 1989) collected 56 suspended sediment samples at Capay and Brooks, and also collected six bedload samples. Inflowing loads were estimated in the Streamway Study using a water-sediment discharge relationship for suspended sediment developed by least squares regression of the USGS data. Due to the scarcity of bedload measurements, inflowing bedload was estimated as a percentage of suspended load according to practices documented by the USGS (1989) and Lustig and Busch (1967).

Comparison of streamflow data for gages at Rumsey, Capay, and Yolo indicate that the discharge is diminished in downstream progression, although tributary area increases. The explanation for this decrease was beyond the scope of the Streamway Study, but has important consequences for flood control, bank stability, and sediment transport through the plan area.The most complete streamflow records available to characterize flows in the study area are from the Rumsey gage (upstream of Capay) and the Yolo gage (immediately downstream of the study area). Historical observations show that under most circumstances, peak discharge at Rumsey for a particular storm event is higher than peak discharge at Yolo. There are several possible explanations for this phenomenon, and it is likely that some combination of all these factors contributes to this behavior:

1. There are no significant tributaries adding to Cache Creek flow between Capay and Yolo. There are minor tributaries that contribute additional flow, but whether these tributaries would increase the peak at Yolo depends greatly on the relative timing of their peaks compared to the peak at Yolo.
2. Absent significant tributary inputs, storm discharge peaks tend to widen and decrease as the flow pulse moves downstream and encounters resistance to flow.
3. The bed of Cache Creek is made up of well-draining sediments and losses to groundwater between Rumsey and Yolo are likely great enough to be observed as a decrease in flow except for when several storm events occur in rapid succession. A series of storms can saturate the channel bed, raise the local groundwater table, and limit or stop losses to groundwater.
1.4. Inaccuracies in rating curves at both gages can contribute to a margin of error in predicting discharge for a given creek stage at the gage sites.

Topography and Channel Form

Since 1981, Yolo County has completed topographic mapping of Cache Creek between Yolo and Capay during the fall of the year. Mapping for the years 1981 to 1985 is available in hard copy format, and mapping for years 1986 to 1995 2011 is available in digital form. Figure 8 provides an overview of the format of available aerial data, by year. The 1995 - 2011 data has been incorporated into the County's GIS system, and was used during the 2017 CCAP update to evaluate changes in channel conditions before and after exclusion of mining from the channel in 1996.. The Streamway Study used historical maps and aerial photography to characterize changes in channel form from 1937 to the present. The results of these comparisons have been entered into the County's GIS system. The Streamway Study modified stream cross-section data from the Westside Tributaries Study (COE, 1994) to generate hydraulic and sediment transport computer models. These cross-sections were updated from 1992 data during the Streamway Study, but have not since been updated with information available from the 1995 aerial topography. The Streamway Study also summarized existing channel geomorphic and hydraulic characteristics by reach. Existing channel characteristics were summarized in Chapter 3 (Tables 2 through 8).

Riparian Vegetation and Riparian Habitat

Existing riparian habitat in the CCRMP area was first summarized in the 1995 Technical StudiesBiological Resources Study (EIP, 1995). The current extent and distribution of existing habitat typesriparian vegetation is shown on Figure 5.4-2 of the Technical Studies for the CCRMP (EIP, 1995).is described in detail in the 2017 Technical Studies (see also Figure 7).retrospective analysis of biological resources (Rayburn 2016).). Figure 7Table 13 summarizes habitat types and acreage within the plan area. These data have been incorporated into the County's GIS system. Information regarding the historical (pre–1995) extent of riparian habitat prior to 1995 is available from aerial photography (back to 1937) summarized in the 1995 Technical Reports. Biological Resources Study (EIP, 1995) but has not been compiled in map form.

Bridges and Infrastructure

The 1995 Technical StudiesStreamway Study summarized the history of bridges within the CCRMP area, and computed potential scour depths at all bridges. The TAC has not updated the calculations of scour depths at the bridges. The 2017 Technical Studies do not show any significant persistent scour at bridge locations. The new 2-D hydraulic model developed during the 2017 technical Studies can evaluate shear stress at any location within the plan area, including at bridge locations and thereby contribute to quantification of potential scour risk at bridges. Plans are available for the present bridges through the Yolo County Public Works

~~Department and Caltrans. Other infrastructure in the CCRMP area includes facilities operated by the Yolo County Flood Control and Water Conservation District (YCFCWCD) and Pacific Gas and Electric (PG&E). Plans are also available for the district facilities, and the district maintains operational records of diversions in various canals.~~

Water Quality

Water quality data collected from Cache Creek shall be regularly evaluated by a trained professional to determine whether the use of chemicals in the habitat restoration areas is affecting water quality. If chemicals are used and a correlation between chemical use and the degradation of water quality is established, the use of chemicals in the habitat restoration areas shall be reevaluated.

6.2 MONITORING PROGRAM OVERVIEW

The purpose of the monitoring program is to provide dependable, up-to-date channel condition data ~~on which~~that the TAC can use ~~base~~ to support recommendations for management of the creek. In particular, the results of monitoring will be used to evaluate the need for improvement projects, annual channel maintenance, and hazard response. The data will be used directly in the design of these projects and activities. ~~Due to the relative scarcity of existing data, a~~Analysis of monitoring program data ~~will~~ promotes a better general understanding of Cache Creek processes, and their importance in channel stability. ~~Therefore, c~~Changes in the recommended channel improvement program, and in the monitoring program itself, are expected based on this improved understanding. It is therefore anticipated that the annual monitoring program will be modified and refined over time as the TAC's understanding and management of the creek improves.

The objectives of the proposed monitoring program are to:

1. Improve present estimates of average annual inflowing sediment load;

2. Improve the present understanding of creek hydrology, including flood-frequency, flow-duration, and channel storage/loss relationships;

3. Estimate inflowing sediment load on an annual basis;

4. Monitor changes in channel form and topography, including those directly associated with improvement project and channel maintenance activities;

5. Monitor changes in biological resources annually, with a focus on both native and nonnative riparian vegetation vegetation and riparian habitat annually; and

6. Monitor bridges, levees, and other infrastructure to maintain awareness of detect and prevent damage related to creek conditions.

These data will be evaluated annually by the TAC in reviewingmaking designs and making recommendations for channel improvements, channel maintenance and hazard response activities.

6.3 RECOMMENDED MONITORING PROGRAM

Water and Sediment Discharge

The water and sediment discharges of the creek, and their pattern over time, interact with biological and human influences to determine channel morphology. Except for discharge at Yolo, these key factors are presently not measured in the plan area. The locations of proposed monitoring points for normal and flood flow measurements of water and sediment discharge are shown in Figure 30. These measurements will allow development of improved water-sediment discharge relationships, and will assist the TAC in developing a better understanding than presently exists of hydrologic and sediment transport processes. The importance of a long-term monitoring record can not be overemphasized. Due to the high degree of variability in Cache Creek discharge from year to year and through each annual cycle, long-term data records are necessary to determine evaluate statistical relationships and to determine identify trends. The monitoring locations shown in Figure 30 have been selected to take fullest advantage of existing data in developing long term relationships.

The monitoring program outlined here is intended to focus on specific needs of the CCRMP. In the long term, Yolo County may wish to implement an automated, "real-time" system of precipitation and runoff gage measurement. While the program described here is not a comprehensive automated system, its elements would be compatible with implementation of such a system.

The following data will be collected at the proposed monitoring locations:

Water Discharge, Continuous - A cContinuous creek stage recording gages areis located at the Rumsey Bbridge and near Yolo. Theseis gages areis currently maintained by the USGS Department of Water Resources, and their data are available in real-time on the respective website for each gage. A gage at the Capay Dam, including a cableway, should be installed and maintained by the County (or by agreement with another agency) as data from this location would significantly assist in understanding the timing and magnitude of flood flows within the CCRMP area. Data from the Capay and Yolo gage sites would provide information at both inflow and outflow boundaries to the study reach only. ~~has telemetry capabilities. As part of the CCIP, the TAC would arrange to obtain real time data telemetered to Yolo County from the Rumsey gage.~~

~~**Water Discharge, Continuous and**~~ **Sediment Discharge, Sampling Program** - In addition to continuous water discharge monitoring, periodic sampling of suspended and bedload sediments, ~~bed material, and bed load~~ over a range of flow conditions would improve the available ~~are required to develop a~~ sediment discharge rating curve~~.~~ and should be collected when the TAC has identified a need for additional data in the previous year annual report. Real time discharge data for lower Cache Creek is available on the internet. ~~would be telemetered to Yolo County.~~ Sediment transport measurements should be made to develop sediment transport rating curves. Sediment transport measurements (suspended and bedload) should be conducted at the same gage locations as continuous streamflow monitoring (or the closest feasible location) using appropriate techniques following the guidance of the USGS. The TAC should use these measurements to develop sediment transport (bedload and suspended load) rating curves for several locations in the program area at flows determined by the TAC in the prior year annual report. ~~Approximately five measurements per year are anticipated to be performed by field crews. Two gaging stations would be used to characterize inflow (Capay) and outflow (Yolo) from the CCRMP area.~~

~~In the future, a possible third station located at Madison to define changes in discharge and sediment transport through the CCRMP area would be installed. Flow and sediment load data at Madison are important because there are presently no data available to indicate channel hydraulics and sediment transport conditions in the main CCRMP study reach. Data from the Capay and Yolo gage sites will provide information at both inflow and outflow boundaries to the study reach only.~~

~~The gage at Yolo is currently maintained by the USGS, but does not have telemetry capability. The new gage at Capay, including a cableway, would be installed and maintained by the County (or by agreement with another agency).~~

Longitudinal Water Surface Elevation Profile Survey – When a flow at or exceeding 10,000 cfs is predicted at the Yolo stream gage, a field crew should be mobilized to survey a water surface elevation profile at no less than eight locations between Capay Dam and Yolo. This survey should be used to calibrate the program hydraulic model. The TAC undertook this in the winter of 2015/16 and 2016/17.

High Flow Water and Sediment Discharge - When funding is available and the TAC has identified a need for data, additional sediment transport measurements should be completed. Monitoring of water and sediment discharge during high flow events requires mobilization of field crews during winter runoff events to measure discharge, suspended sediment and bed load. ~~A staff gage and peak recording gages would be installed at each monitoring location. Comparison of high flow discharge and sediment measurements to continuous gaging location results would yield information regarding the relative timing and magnitude of peak flows at various points, transport of sediments through the Cache Creek system, and general channel sediment storage/losses. In addition to two stations on Cache Creek, one future station is proposed on Goodnow Slough to characterize inflows from this source. An average of approximately five measurements per high flow year at each site are anticipated.~~

Bed Material Sampling - After flow events greater than or equal to 20,000 cfs the TAC shall complete coarse level channel bed surface pebble counts at approximately one to three locations per reach, to determine grain size distribution. If possible, these pebble counts should be completed during the annual creek walk.

Sediment transport measurements (suspended and bedload) should be conducted at the same gage locations as continuous streamflow monitoring (or the closest feasible location) using best available technology according to guidance provided by the USGS (see the following website as an example:
https://water.usgs.gov/osw/techniques/Diplas_Kuhnle_others.pdf).

Sediment transport measurements should be conducted to develop sediment transport rating curves for the program that improve with time following guidance on the flow levels for sampling provided by the TAC in the previous years' annual report.

~~In addition to the samples collected during discharge and high flow measurements, bed material grab samples will be collected annually in each of the seven reaches identified in the Streamway Study within the CCRMP area. Two samples per reach will be collected. These samples will be collected at the time of the TAC's annual inspection (see below). Samples will be taken from exposed bar areas that are representative of the material being transported along the stream's bed during higher flows. Grain size distribution curves will be prepared for all samples annually.~~

Topography and Channel Form

Aerial surveying of the creek will be conducted every five years or after a major creek event defined as 20,000 cfs or greater at the Yolo gage. Changes in channel form will be monitored by comparison of ~~annual~~ aerial topography ~~and cross-section~~ surveys to prior years. ~~A set of cross-sections will be generated by aerial methods each year at fixed locations, selected by the TAC.~~ Aerial topography survey data (e.g., LiDAR) may be supplemented with additional field or aerially surveyed cross-sections in areas where increased accuracy is determined to be necessary by the TAC. Aerial survey data will be compiled in Digital Terrain Model (DTM) format (or files compatible with terrain model generation in the County's GIS system) to facilitate ~~cross-section generation for use in~~ updated hydraulic and sediment transport modeling, for use in volumetric comparisons, and for use in design of improvement projects and maintenance activities. ~~Aerial surveys will have a contour interval of 2 feet, and be prepared in hard copy format at a scale of 1 inch = 200 feet.~~ Horizontal coordinates will be based on the California Coordinate System, Zone 2. Existing survey control points will be used in ~~performance of~~ the aerial surveys, with annual checks to repaint and reset, where necessary, disturbed control points. Every five years the control net will be checked (resurveyed by the County surveyors or survey contractor) for vertical accuracy to detect variations due to land subsidence.

~~Aerial photography and compilation of the DTM will be performed once a year in the late spring (exact timing will depend on flow conditions). The TAC will specify locations for additional cross sections, if any, based on annual inspections (see below). In addition to the spring surveys, portions of the channel affected during the summer season by significant channel improvement or maintenance activities will be surveyed by the people performing the improvements or maintenance upon completion of those activities.~~

~~The aerial photography used for topographic mapping will be used to generate halftone mylar photo enlargements of the Cache Creek channel at a scale of 1 inch = 200 feet. These enlargements will be used by the TAC in annual inspections and for the purpose of monitoring changes in vegetation and riparian habitat.~~

~~Vegetation and~~ Riparian ~~Habitat~~Vegetation

Every five years, ~~the TAC will prepare a riparian habitat survey and map for incorporation into the County's GIS system. The riparian habitat survey will present measurements or estimates by subreach or subarea of the following:~~ the TAC riparian biologist shall conduct reconnaissance-level biological survey of lower Cache Creek annually at an appropriate time of the year to convey the maximum amount of useful biological data. In addition, the TAC Biologist will conduct a comprehensive riparian habitat survey at least every five years at the scale of the entire CCRMP area (and potentially at the scale of the broader CCAP area is deemed appropriate by the County and the TAC). Such a survey was last performed in 2016, and standardized survey and analysis methodologies are detailed in the 2017 Technical Studies. The survey should include classification of vegetation using consistent class descriptions) by reach from recent high-resolution aerial photography, preferably from within one year. Vegetation classifications should be verified through ground-truthing and corrected accordingly. Changes in native and nonnative vegetative characteristics from previous evaluations, including a discussion of implications for other biological resource elements (wildlife, invertebrates, and fish), should be presented by reach and for the CCRMP area overall, including detailed maps and databases of spatial data collected and analyzed during the survey. The riparian habitat survey may also include additional data, including but not limited to:

1. Percent cover of native or nonnative species (may be obtained from permanent monitoring plots if established);

2. Crown height of trees (by age or size class);

3. Vigor (e.g., die-back);;

4. Changes in the extent and/or distribution of priority invasive speciesInvasion by exotic species (or particular problem species of concern);

5. List of special--status species (plant, animal, invertebrate, or fish) present;

6. Natural Native species recruitment/regeneration; and

7. Instances of significant disturbance (e.g., fire, flooding, drought, OHV use) and impacts on biological resources

8. Status of previous revegetation or restoration projects, in addition to priority sites for future revegetation or restoration projects.

7. Changes in vegetative and habitat characteristics from previous evaluation.

These measurements will be recorded on maps in a format suitable for incorporation into the County's GIS system. Maps will be produced through a combination of field inspection and use of aerial survey informationphoto enlargements.

~~As part of the vegetation monitoring program, the TAC will install a series of piezometers in the creek channel to measure groundwater levels. At least one piezometer per stream reach is recommended, with locations to be determined by the TAC. Piezometers will be monitored twice each dry season (June through October).~~

Annual Inspections

At the end of each runoff season (ideally April or May if conditions allow), the TAC will make an annual inspection of the creek (referred to as the "creek walk") to document channel conditions. Conditions that will be noted include:

1. Evidence of changes in channel dimensions or bank erosion;

2. Evidence of bed degradation or aggradation;

3. Significant changes in the locations or sizes of bars and other channel features;

4. Degree of channel armoring and bed material imbrication;

5. Vegetation located within the center portion of the channel (within 100 feet of the low flow channel), including type, density, and size;

6. Conditions at bridges along levees and other major infrastructure;

7. Potentially hazardous conditions involving public safety or property damage;

8. General hydraulic condition of the channel based on qualitative comparison with previous years (e.g., restrictions due to vegetative growth, changes in bed form, etc);

9. General evaluation of channel and bank stability on a reach-by-reach basis;

10. Identification of areas where vegetation may be getting so thick as to adversely alter flow direction or reduce channel capacity; and

~~11. Areas where the existing capacity of the channel can no longer contain a 100-year flood event, or is nearing the loss of such capacity.~~

~~Notes from the annual inspection will be prepared on the photo base.~~

Flood Monitoring

Significant channel changes have historically occurred on Cache Creek during major floods. During periods of major floods in which the discharge at Rumsey exceeds 20,000 cfs, more intensive data collection is warranted to collect important ~~water and sediment discharge~~ data. The YCFCWCD monitors gages during high water events. ~~Although an average of five high flow monitoring measurements at each site is anticipated, adequate monitoring of a single flood might require more than this number of measurements. If possible, water and sediment discharge measurements should be made at all stations at least once a day for each day that the flow exceeds 20,000 cfs.~~ Depending on access and safety, additional efforts should be considered~~made~~ to conduct monitoring measurements during rising flow periods, ~~limits,~~ peak flows, and recession flow periods.

The Cache Creek channel has historically responded to major floods by ~~making major lateral and vertical adjustments~~adjusting ~~in~~ channel form both vertically and laterally. Bank migration, loss of riparian vegetation, damage to bridges and other infrastructures, overbank flooding, and channel incision are problems that occur during large floods. ~~At the present time, there are no procedures in place for monitoring and responding to flood events on Cache Creek. Both Yolo County and the Yolo County Flood Control and Water Conservation District are typically involved in monitoring flood situations that could threaten infrastructure or private property, but a coordinated proactive program for response to floods is lacking.~~

This section does not prescribe a comprehensive flood management plan, but outlines the participation of the TAC in flood watch activities and a high flow monitoring program. Such a program can become an integral component of a more comprehensive, County-wide flood management plan. The TAC does ~~will~~ not have responsibility or authority for flood hazard response, but is~~will be~~ available to participate, on behalf of the County, to monitor and analyze~~respond to~~ Cache Creek floods. Several elements of the monitoring program described will assist the County in monitoring flow conditions on a real time basis, and preparing for potential flood conditions.

Observation and measurement of how Cache Creek responds to high flow events is critical to the CCIP. Understanding how the creek responds during high flows is important for proper creek resource management and maintenance activities. Flood watch activities include monitoring creek flows, precipitation, and watershed conditions to determine when flood flows are likely to occur in the CCRMP area, mobilizing personnel and equipment to monitor conditions in the area, and coordinating the activities of these personnel.

The County Office of Emergency Services (OES) has designated the position of TAC Flood Coordinator as a Technical Specialist to the County OA EOC during periods of activation. On an ongoing basis, the TAC identifies a primary and alternate Flood Coordinator.

The TAC will develop a plan to accomplish these objectives, including the following basic elements:

1. Procedures for monitoring discharge at the Rumsey gage and precipitation in the upper watershed to determine when flood flows are likely. For the purposes of this program, a discharge greater than 20525,000 cfs is considered a flood flow. This discharge has about a 20 percent chance of occurring in any year (5-year flood). Procedures must include assignment of staff for 24-hour availability, and establishment of contact procedures with the National Weather Service for flood watch and flood forecast information.

2. Procedures for TAC contact with the Yolo County Public Works Department and YCFCWCD on a 24-hour basis to mobilize personnel and equipment necessary for monitoring purposes.

3. Selection of a TAC flood watch coordinator and an alternate to manage observations and monitoring of high flows .

4. Procedures for notification of other agencies (e.g., City of Woodland, Caltrans, DWR, USGS, etc.) of identified hydraulic problems or hazards, and advance notification of these agencies of flood watch and contact procedures. Although the CCIP has no authority or responsibility for flood hazard warning, the intent is that monitoring personnel will cooperate with other County emergency groups and notify them if problems are observed.

5. Establishment of flood flow monitoring and record keeping procedures for flood watch activities.

Data Analysis

Data compilation and analysis will be under the direction of the TAC. Data will be stored in a database integrated into with the County's GIS system, and such storage, data formatting, and quality control should be coordinated with the relevant TAC member to the extent possible. Retrieval of data for use by the private sector will be billed at standard rates or by hourly charge for the time spent by County employees. Collection of the data is the first step in assembling the database. However, data checking, compilation, and analysis must also be performed on an ongoing basis to result in useful long term data. This section describes the procedures for compiling the data into a database system and making preliminary analyses for use by the TAC.

Water and Sediment Discharge - Water discharge at continuous gages is computed by means of a stage-discharge rating curve. This curve relates stage in the stream (water surface elevation) to discharge. Changes in the channel at or in the vicinity of the gage will result in changes in the rating curve. Streams that are in the process of ~~incising~~ adjusting to changes in sediment supply and transport rates (like Cache Creek) may require annual adjustments in the rating curve. The rating curve is established and maintained with actual discharge measurements, usually involving measurement of velocity and flow area in segments of the creek's~~stream's~~ cross-section. To develop a rating curve, multiple measurements are required over a range of discharges. Therefore, initial installation of a continuous gage requires many measurements in the first few years to establish a reliable rating curve, and measurement of high flows continues to be important to the accuracy of the rating curve throughout the gage's service life. Data collected by continuous recorders or via telemetry must be checked to eliminate errors. In addition, the gage equipment itself must be periodically checked and maintained to ensure proper operation and to collect recorded data.

Sediment data collection requires field sampling and laboratory analysis. The field sampling work involves collection of suspended and bed sediment samples, organizing and labeling the samples, and transporting samples to a laboratory for analysis. Suspended sediment samples are analyzed for total weight of sediment per unit weight or volume of water, and for gradation of the sediment by size. Bed load samples may be analyzed for weight collected per unit time and for gradation. Laboratory analysis may be performed, as needed, to yield gradation of the collected samples. Bed load transport supplies aggregate to the CCRMP area in the sizes that were historically commercially mined, through 1996~~have been commercially mined~~. Bed load samples are useful in confirming the ratio of bed load to suspended load transport at various discharges (necessary to compute total load), and to confirm the accuracy of transport functions used in sediment transport modeling. However, at very high flows, bed load sampling may not be practical due to limitations in field equipment and methods. When possible as a component of the TAC monitoring of Cache Creek, ~~In addition to~~ bed load samples should be taken from the flowing creek~~stream~~, and dry bed material samples should be collected in each reach at the time of the annual inspection, for ~~will be~~ laboratory analysis~~zed in the laboratory for~~ of gradation. Bed load transport can be calculated from stream properties and bed material size. ~~Table 14 lists the type of compilation, analysis, and data storage required for each measurement type.~~

Topography and Channel Form - Changes in channel topography and form will be determined primarily from ~~annual~~ Digital Terrain Models (DTM) produced ~~annually by~~using LiDAR or aerial photogrammetry after peak flows greater than 20,000 cfs, or every five years, whichever occurs first. The ~~completed terrain~~DTM modeling will be used to ~~record~~ quantify key channel characteristics for comparisons~~comparison~~ ~~to~~ with previous years. In addition, a longitudinal profile of the stream within the entire CCRMP area will be ~~made~~ developed from this data and compared to previous years.

The DTM will be used to locate areas of aggradation and degradation in the ~~stream~~ creek by comparing DTM surface elevations for the current year with that of the previous year. A grid plot of elevation differences will be produced for areas within the channel. Where significant elevation differences (e.g., greater than two feet over areas exceeding one acre) are identified or suspected, the two surfaces will be compared digitally and a ~~-~~volumetric estimate of aggradation or degradation made. ~~This type of volumetric comparison is not required or recommended over the entire stream surface. In addition to comparison of terrain model surfaces, the TAC will establish cross-section locations for annual comparisons. Data for these cross-sections will be generated primarily from aerial photogrammetry, but a portion of the data may need to be produced by field survey in areas of vegetative cover or below the water surface. In addition to regularly measured cross-sections, the TAC may request additional cross-sections in areas of interest for channel improvement projects or problem areas.~~ The DTMs will also be used to update the hydraulic model and evaluate hydraulics to identify new areas of concern.

~~Vegetation and~~ Riparian ~~Habitat~~ Vegetation - Data generated during~~in~~ riparian ~~in~~ vegetation ~~and riparian habitat~~ monitoring will be compiled and stored in the County's GIS system. The TAC Biologist will review monitoring data to determine trends by subreach. Data will be compiled and plotted to illustrate changes in acreage by habitat type over the entire CCRMP area, and changes in specific characteristics by ~~sub~~reach. Data comparisons to be tabulated or plotted shall include but not be limited to area, percent cover, crown height of trees, number of species present, and level of invasion by ~~exotic~~non-native species. ~~Piezometer data will be recorded in the County's database.~~

Annual Inspection - Maps and notes from annual inspections will be stored in an appropriate ~~hard copy~~ format. Additional analysis of annual inspection results is not required. The observations of the annual inspections will be supplemented by analysis of digital terrain model data for the purpose of identifying and quantifying changes in the channel.

Flood Monitoring - Data from flood monitoring ~~will not normally require analysis, unless requested by the TAC. Discharge measurements~~should be reported in each year's annual report and ~~will~~ be compiled, stored, and analyzed as described for other water and sediment discharge measurements.

6.4 HYDRAULIC AND SEDIMENT TRANSPORT MODELING

The 1995 Technical Studies relied on ~~Streamway Study used~~ hydraulic (HEC-2) and sediment transport (HEC-6) model~~s~~ to evaluate ~~current~~ hydraulic and sediment transport conditions throughout lower~~in the~~ Cache Creek channel. In 2001/02 and again in 2006 HEC-2 modeling was conducted on a portion of the lower creek, from CR 94B to the I-5 bridge. The 2017 Technical Studies contain new HEC-RAS 2-D modeling to evaluate current hydraulic and sediment transport conditions throughout lower Cache Creek based on data collected since 1996. As changes occur in the creek~~'s channel~~, additional modeling will be required to maintain sufficiently accurate quantitative tools for making management decisions on the creek. Modeling is necessary both to support long-term management decisions and for use in the design of specific improvement projects or maintenance activities. Topics which can be addressed using hydraulic~~numerical~~ modeling include flood ~~carrying~~ flow capacity, bridge scour potential, channel stability, sediment transport characteristics, channel hydraulic characteristics (e.g., width, average velocity, and depth at two year flow frequency), and location of hydraulic constrictions or controls. As monitoring data are collected, the ability of hydraulic~~numerical~~ models to duplicate and predict observed conditions will improve.

The TAC shall regularly update the program hydraulic model and identify locations where the 100-year flood flow is no longer contained in the channel or has otherwise changed significantly. The TAC shall coordinate with interested parties to promote awareness of changes in flood flow capacity in Cache Creek over time. Flood flow capacity associated with Cache Creek near the city of Woodland shall not be exacerbated by in-channel activities conducted under either the CCRMP or the CCIP.

The use of ~~numerical~~ hydraulic modeling in the future will be at the discretion of the TAC, as necessary to evaluate significant changes in the creek's morphology (including changes in channel roughness due to vegetation and bar and terrace formation) or evaluate specific projects. The TAC will be responsible for maintaining a current versions of ~~both hydraulic and sediment transport models~~the hydraulic model for the entire CCRMP area. ~~The public will have access to these models (at a nominal cost to cover record keeping and reproduction) for use in evaluating specific channel improvement projects.~~The hydraulic model will be made available for landowners and/or their consulting engineers for use in the design of channel improvement projects.

6.5 PROJECT PERFORMANCE EVALUATION

The TAC will be responsible for evaluating and commenting on the performance of proposed improvement projects in the creek. Projects may be evaluated using normal annual monitoring data, or additional data may be collected for evaluation of specific projects. The TAC will include the costs for any applicablespecial monitoring requirements in the estimated budgets for review of proposed improvement projects. These costs shall be borne by each individual project applicant unless the County determines the TAC's review will result in program-wide value.

6.6 ANNUAL MONITORING REPORT

The TAC will produce an annual report in January of each year for the Board of Supervisors that describes the data collected and analysis conducted as part of the monitoring program. In 2013, the annual reporting period was changed from the calendar year (January 1 through December 31) to the water year (October 1 through September 30). This change was made to allow the TAC adequate time to respond to and analyze water events that may occur towards the end of the calendar year without delaying the publication of the annual report.

The annual report serves as a regular opportunity for the TAC to step back and take a larger perspective in looking at both the creek and at the CCRMP with a critical eye for improvement. Although this is a complex and ambitious project, it is designed to be adaptive, so that monitoring requirements and management techniques can appropriately address the ever-changing riparian creek system environment. In order to be effective, the annual report should not be seen as a chronicle of recent success or a lackluster recitation of dry data, but must reflect thoughtful self-evaluation. Is information being used? Are other forms of monitoring needed? Is there unnecessary or less-than-useful monitoring that can be eliminated or consolidated? Given the limited budget of the CCIP, are activities being carried out in a cost-effective manner and are the most important priorities being emphasized? Are objectives being met? Are the policy and technical assumptions still valid? Fundamental questions such as these should underlie the annual report, so that recommendations made by the TAC take into account the long-term benefit of both the creek and the community. Review of the report by the Board of Supervisors will provide the necessary policy direction, as well as provide an ongoing public forum for focussingfocusing the County's attention on the unique issues that concern Cache Creek. The format of the report will be as follows:

1. Brief description of annual monitoring activities, changes from previous years, and costs. Summary of significant findings, problems, and needs for upcoming year;

2. Summary of annual water and sediment discharge data and notable variations from previous years or period of record;

3. Summary of changes in channel topography and form, including identification of problem areas and summary of desirable and undesirable trends, including any areas where existing flood flow~~channel~~ capacity has been significantly reduced~~can no longer contain a 100-year flood event~~;

4. Estimate of location and volume of annual sediment replenishment;

5. Summary of changes in biological resources, with a focus on both native and nonnative vegetation~~ and riparian habita~~t;

6. Summary of flood monitoring results, if applicable;

7. Evaluation of bed and bank stability in the CCRMP area, considering data summarized above. A description of the relationship of problem areas to recommended improvement projects and maintenance activities (see Chapter 2);

8. Recommendations for changes in prioritization of channel improvement projects; and

9. Recommendations for changes in monitoring program in coming year.

~~Figure 31 schematically shows the annual schedule for the monitoring program~~

REFERENCES

1. EIP, 1995, Biological Resources Study, *Technical Studies and Recommendations for the Lower Cache Creek Resource Management Plan*, prepared for the Yolo County Community Development Agency, October 1995.

2. *2017 Technical Studies and 20-Year Retrospective for the Cache Creek Area Plan*,bpreapred for the Yolo County Administrator's Office, March 17, 2017.

3. Cache Creek Annual Status Reports (1998, 1999, 2006, 2010 through 2016)

4. *2006 Cache Creek Status Report and Trend Analysis, 1996-2006*, prepared for Yolo County Planning, Resources, and Public Works Department, July 25, 2006.

5. *Cache Creek Area Plan Program Audit and Management Tools*, September 22, 2011.

2. Lustig, Lawrence K., and Busch, Robert D., 1967, *Sediment Transport in Cache Creek Drainage Basin in the Coast Ranges West of Sacramento, California*, Geological Survey Professional Paper 562-A.

3. Harmon, Jerry G., 1989, *Streamflow, Sediment Discharge, and Streambank Erosion in Cache Creek, Yolo County, California, 1953-86*, U.S. Geological Survey Water Resources Investigations Report 88-4188.

4. NHC, 1995, Cache Creek Streamway Study, *Technical Studies and Recommendations for the Lower Cache Creek Resource Management Plan*, prepared for the Yolo County Community Development Agency, October.

5. U.S. Army Corps of Engineers, 1994, Reconnaissance Report, Westside Tributaries to Yolo Bypass, California, June.

ACKNOWLEDGEMENTS

2018 Update

Updated acknowledgement will be inserted here

1996 CCIP

Cache Creek has historically been a dynamic system, influenced by high flood flows, large sediment supplies, and steep slopes in the upper watershed. These dynamics have been exaggerated by the multiple demands placed upon the creek in the past few decades, as mining, agriculture, and infrastructure have intruded into the floodplain. As a result, the creek has become increasingly degraded and imbalanced. Left on its own, the creek will eventually heal itself and adjust to the artificial constraints placed upon it, but the healing would take decades and may threaten property and lives in the process. Instead, the CCIP provides a program for managing riparian resources in a responsible and sensitive manner, that allows the creek to establish a new, more natural equilibrium. As the process of reshaping the channel and restoring in-stream habitat progresses, the creek will respond to these changes, requiring adjustments in the CCIP to account for these changes. This process will be guided by professional judgement, science, and an extensive monitoring program to keep abreast of Cache Creek as it evolves. The elimination of commercial in-stream mining is an important first step in solving the serious concerns currently associated with the creek, but other problems will continue. In order to properly manage riparian resources, the County must take a larger perspective and look at all of the components of the creek as an integrated system. The CCIP is a broad-based and flexible program, that provides the County with such a perspective, and the means, for enhancing the precious natural resources of Cache Creek.

1996 Yolo County Board of Supervisors

Mike McGowan	District 1
Helen Thomson	District 2
Tom Stallard, Chair	District 3
Betsy Marchand	District 4
Frank Sieferman	District 5

1996 Yolo County Planning Commission

Bob Heringer	District 1
Barbara Webster	District 2
Harry Walker	District 3
Jim Gray, Chair	District 4
Henry Rodegerts	District 5

Nancy Lea — At Large
Kent Lang — At Large

1996 Key Members of Staff
Roy Pederson — County Administrative Officer
David Morrison — Resource Management Coordinator

Project management was provided by Heidi Tschudin of TSCHUDIN CONSULTING GROUP, under contract to the County as an extension of staff.

The primary technical basis for this Plan was provided by the *Technical Studies and Recommendations for the Lower Cache Creek Resource Management Plan* (October, 1995). Kevin O'Dea of Baseline Environmental Consulting was the primary author of this report, with assistance from Bob MacArthur of Northwest Hydraulic Consultants, Inc. The County is grateful for their involvement in this process.

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To find out more about this Program, or the process through which it was developed and updated, please contact:

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