5.4 Issues

It is understood that lower Stony Creek is a fluctuating, unpredictable waterway whose yearly varying conditions could affect the attempts at an adaptive management approach. This Plan accepts a high degree of variability and annual uncertainty in the system until, and if, flood flows are reduced through CALFED initiatives.

The issues and corresponding objectives listed below emerged as a result of Task Force input, and identify actions under current conditions which can be precursors to further enhancement activities.

5.4.1 Issue #1. Restoring, protecting, and enhancing riparian habitat.

Objective #1: Develop and implement a cooperative program to reduce populations of invasive non-native shrub and tree species which compete with native riparian vegetation and which affect the streambed system.

Discussion: It is understood that any riparian habitat enhancement efforts would require landowner input and consent prior to implementation, as lower Stony Creek borders primarily private land. Any member of the general public with an interest in lower Stony Creek may provide input into the planning process through the local planning efforts which are proposed through the Glenn County Planning Department. Appropriate environmental review would be pursued regarding proposed actions to analyze their impacts and determine their contribution to sound resource management. The actions listed below are suggestions which may be integrated into the planning efforts.

Action: Current. Responsible parties such as landowners, county agencies, DFG, and gravel miners could develop a noxious weed control program for lower Stony Creek. Planning efforts could be assisted by cooperative agencies, appropriate businesses, and knowledgeable individuals. Sections of each reach of lower Stony Creek could be identified for successful eradication efforts of predominantly arundo and tamarix which provide minimal cover and compete with more effective shade producing plants. Implementation of these efforts would be consistent with the Stony Creek Vision and Stewardship Plan which is being sponsored by the Glenn County Planning Department.

Action: Future. The program could be modified to include future restoration efforts.

Objective #2: Develop strategies and implement methods for reducing channel bed and bank erosion.

Action: Current. Responsible parties such as landowners, county agencies and the COE could work in a cooperative effort to identify channel and bank erosion control methods, and bank stabilization techniques to protect desirable vegetation and improve the stream channel for more desirable flow. Impacts of these activities would be evaluated prior to implementation. Modifications of current flood release operations could be evaluated. The modifications could include the magnitude and timing of releases which would not affect the flood control nature of the facility or compromise safety issues downstream.

Action: Future. The implementation of other restoration programs in the future may allow modification of the flood control operations of Black Butte. If so, efforts such as off-stream surface storage construction (i.e., Sites Reservoir, etc) could increase the watershed storage capacity and buffer fluctuations in Black Butte, potentially allowing for consistent releases when available, following the delivery of all water rights obligations. This may lead to modifications of the flood control diagram through legislative action.

Objective #3: Develop and implement a cooperative program to restore, protect and enhance riparian vegetation.

Action: Current. Responsible parties such as landowners, county agencies, DFG, and gravel operators could develop a cooperative restorative and maintenance program with the assistance and expertise of other cooperative entities, such as the USFWS. Selected plantings of cottonwoods, willows and other desirable vegetation would create vegetation corridors for bank protection and shaded riverine aquatic cover for native fish species and habitat for associated wildlife. Sections of each reach of lower Stony Creek could be identified by knowledgeable individuals for successful restoration efforts under current conditions.

Action: Future. The program could be modified once other restoration efforts are in effect and consistent flows are possible.

5.4.2 Issue #2. Modifying water releases in a reasonable, beneficial, and legal manner for fish and wildlife enhancement.

Objective #1: Determine suitable in-stream flows in lower Stony Creek to enhance the riparian habitat, and the native fish and wildlife species in combination with habitat enhancement activities.

Discussion: The Task Force (remaining members at the end of a September 3, 1998, meeting) agreed that once the riparian habitat of lower Stony Creek had been improved, or the objectives under Issue #1 are incrementally implemented, consideration could be given to management of flows for the enhancement of the riparian environment and associated resources. Recommendations for flow management would be sought from appropriate fisheries agencies, as existing data were insufficient to provide a range of flows agreeable to all parties. Other Task Force members did not agree to the incremental implementation of the objectives and deferment of supplemental flows. Agreement among the Task Force concerning the range of in-stream flows required for habitat enhancement also could not be reached. There was disagreement and speculation regarding the applicability and appropriateness of existing resource data, and of future conditions once the GCID Canal siphon is installed and the seasonal GCID berm is eliminated.

Based on historic Black Butte storage data, there appears to be sufficient excess water to increase flows from current conditions at some varying levels, depending on natural conditions of precipitation in the spring and, consequently, on storage. Since the range of instream flows which would benefit the resources of lower Stony Creek is unknown, the impact of the recommended flows which may be provided would need to be monitored.

The Screening Model, which was developed to help choose a direction to take in determining the viability of management proposals from a water availability and demand perspective has described varying degrees of low to moderate success for flow augmentation, based on conservative estimates. Flows used for the purposes of the Model have been disputed, therefore decisions based upon the Model are deferred to appropriate fisheries agencies. The results of the Model are provided in Appendix L, Section *A* (page L-6). Pending recommendations, additional scenarios for Models may be considered. Because the success of meeting the flows in the Model were minimal, together with the high incidence of failure in the spring due to inadequate rainfall, fall attraction flows would not be a likely priority. It is likely that any flow management recommendations would concentrate on the non-natal rearing of winter-run chinook salmon presently occurring near the confluence of the Sacramento River and the health of resident species in the creek.

Considerable discussion took place regarding the suitability of lower Stony Creek for the production of anadromous fish based on the limiting factors. Given the past and current unpredictability of suitable conditions in lower Stony Creek, coupled with the relatively small percentage of tributary use of anadromous spawners (5 -10%*) as compared to the main stem Sacramento River (90-95% production*), this creek has not been and is not considered to become a prime anadromous fish producer under current conditions, however, future cooperative programs may change conditions allowing reconsideration of management actions guided by the CVPIA and AFRP mandates. (*Anadromous fish production information was taken from the Working Paper on Restoration Needs, Volume 3, prepared under the direction of the AFRP Core group, May 1995). This determination is not unanimous among the Task Force. Water temperature data have shown there is a small window of opportunity for fall-run chinook salmon migration, but the other limiting factors of marginal substrate and lack of consistent flows due to flood control operations are important to consider. It is likely, however, that non-natal rearing of salmonid and other juveniles would occur in some manner, and that steelhead trout may be present in the system. The extent of this likelihood is unknown. If certain flows are recommended in the future, an adaptive water release management approach based on water availability could be pursued, and would rely on testing reasonable objectives and revising management actions based on monitoring, future conditions, periodic review, and assessments.

<u>Action: Current</u>. To make an informed decision regarding a change to existing water releases for the benefit of fish and wildlife resources, and to avoid any unnecessary negative impacts, a better understanding of the resource and additional data is needed. Reclamation proposes to initiate a 3-year monitoring study at legal access points, to collect baseline data for management decisions. Input from appropriate agencies and the stakeholders would be integrated into the objectives of the study to avoid duplication of effort and to maximize the credibility of the resulting data. Following

environmental compliance activities and when funding is obtained Reclamation would proceed with the study to document changes in physical and biological processes, and obtain information on resident fish and wildlife species. Eventually, pre-and post Plan success would be compared. This information, which would be used to assess the need to modify current water releases for beneficial uses, would be available to all the agencies and stakeholders.

Reclamation will continue with current operational releases until results of the study indicate a change could be made for the benefit of the resource. Should listed or other anadromous fish species be found, Reclamation would support the AFRP by consulting with and obtaining recommendations from the NMFS, USFWS and DFG concerning fishery needs, and with the OUWUA, TCCA, and the Federal Water Master concerning the logistics and impacts of meeting both fishery and agricultural needs. These recommendations for instream flows, if and when made, in combination with the local riparian habitat enhancement activities should compliment each other for successful habitat enhancement.

If preliminary results of the study determine that resident fish are not in good condition even with the current flow regime (the current operational flow of 30 cfs below the dam and the 40 cfs release below the CHO during rediversion), Reclamation would consult with NMFS, USFWS and DFG to determine what flows are recommended, and Reclamation, with the cooperation of the COE and the water users, would determine what excess CVP flows are available for that period of time prior to or following flood control releases, after satisfaction of contractual obligations. Release of excess CVP water would take into account the storage in Black Butte Reservoir and would take an adaptive management approach based on annual conditions. Pending consultation, Reclamation would manage available water, in cooperation with the COE, in a manner which would minimize the risk of a taking of a listed species, after satisfaction of contractual obligations, while maintaining managerial options for longer term actions. Task Force members argued both for and against water releases as the best means of avoiding a taking of listed species, and it is unclear what the ruling of the NMFS would be in such a situation. Reclamation would, therefore, make a good faith effort to minimize harm and maximize options on a case by case basis.

In addition, and in connection with these actions and results of the study, Reclamation would determine, if appropriate, the feasibility of providing and funding a supplemental fish passage structure on the North Canal Dam, as well as screening structures on the North Canal and the CHO to prevent entrainment, with the cooperation of the water users. Until a fish passage structure is constructed, OUWUA would be encouraged to raise gates as early in the fall as possible to allow for fish passage and to minimize any diversions from December until February for possible emigrating fry. If recommended and appropriate, Reclamation would also consider placement of suitable substrate below Black Butte Dam and in cooperation with the landowners. These actions would be in support of and based on CVPIA priorities for the valley.

Objective #2: Determine available water supply on a yearly basis to benefit riparian vegetation establishment, and native fish and wildlife.

Discussion: By June 15 of each year, Reclamation can determine, within a reasonable probability, water storage for the season to meet recommended flows from late October to at least December and possibly through April, after all obligations have been met (see Appendix L, Section *B,* Water Storage). Storage by June 15 will assist in determining year type conditions. Because of upstream exchange waters and basin precipitation fluctuations, predicting storage will not always be accurate. Reclamation would consider making excess CVP releases in consultation with fishery agencies, to attempt to meet recommended flows for the non-flood control season. Feasible release actions would be based on storage and conditions for the particular year until reservoir encroachment is reached and the COE assumes control of water releases. (Historically, this has occurred after the first major storm which has occurred in November/December.) Once the reservoir is encroached and flood season begins, water management would follow the flood control diagram until conditions permit a return to the release schedule. This would occur through early April, depending on conditions. The inconsistency of these actions can be predicted, and the wisdom of initiating a flow schedule that may not be able to be sustained through its proposed cycle can be questioned.

This method would continue until such time when the diagram is altered through cooperative efforts or other restoration programs. It is understood that modifying flows is a new frontier of water management on Black Butte, and estimations have no precedent on this highly variable system. Arrangements would be made to monitor the success of these "testing" efforts, once implemented, and make modifications as recommended to avoid fish losses and encourage fish and wildlife enhancement.

Action: Current. Within this highly variable watershed and predicted inconsistencies, Reclamation would attempt to describe yearly available water for an adaptive water management approach to meet recommended releases, when appropriate. Available water to meet the suggested flows (Issue #2, Objective #1) for the non-flood control season would be determined through cooperative efforts. CVP water available for this purpose has been generally described at approximately 56,000 acre-feet, less TCCA diversions and other constraints listed in chapter 4, but actual amounts would be evaluated on a yearly basis.

Based on current information or significant changes in existing conditions, the Plan could be updated yearly. This information would be provided to the stakeholders.

Action: Future. Reclamation would continue to determine the viability of conservation measures to increase available water. These efforts could include the installation of upstream monitoring devices, possible use of the CHO to release suitable flushing flows to prevent stranding should temperatures and costs prove suitable, assuming deliverability of water through the TCC system, and once a solution to the RBDD fish passage problems has been attained. These efforts would also include encouragement of lining the North and South Canals. Integration with other restoration programs to restore the creek to its highest biological potential would be sought. Any longer term releases could occur only if gravity diversions are possible at the RBDD when water temperatures are suitable. This is not the case under the present Biological Opinion.

5.5 Conclusions

The Task Force agreed to the importance of the riparian habitat enhancement activities, but as a whole did not agree as to whether the objectives for riparian habitat enhancement should be incremental and precursors to flow release modifications or if all the listed objectives should be initiated and implemented simultaneously as practicable. The Task Force did not agree on actions to take with respect to the second issue, modifying water releases, but opinions may converge as progress is made on actions to restore and enhance riparian habitat.

5.5.1 Actions by responsible and cooperative parties.

This plan, developed by Reclamation with the assistance of the Task Force, provides recommendations to local entities for riparian enhancement activities within the scope of the permit condition, if chosen to be implemented by local effort on lower Stony Creek. Implementation of land management recommendations are outside the scope of Reclamation's authority and the condition of the permit. The Task Force has agreed that: (1) reducing/eliminating/controlling invasive weed species, (2) reducing channel and bank erosion, and, (3) restoring riparian vegetation are important to the enhancement of lower Stony Creek.

Implementation of the enhancement measures are inherent upon independent landowner efforts and may be consistent with the Stony Creek Vision and Stewardship Plan sponsored by the Glenn County Planning Department.

5.5.2 Actions by Reclamation.

Reclamation supports and is willing to participate in enhancement activities the local entities decide to undertake, pending appropriate environmental documentation and adequate funding.

The Task Force agreed that management of flows for the enhancement of the riparian corridor, and native fish and wildlife species is an important measure to consider in meeting the goals of the Plan. It was not agreed what range of in-stream flows are required to support the fish and wildlife resources and when these flows should be provided. Existing resource data has been disputed and there is speculation regarding the current native fish resources and the future of the resources once the GCID Canal siphon is constructed, and no obstructions exist between the Sacramento River and the North Diversion Dam. Because the current data does not support making changes to the current flow operations at the present time, Reclamation will initiate a 3-year monitoring study, independent of the Task Force process. Based on the results of the study Reclamation would consult and cooperate with appropriate fishery agencies to provide suitable in-stream flows for riparian enhancement and fish and wildlife productivity, providing there is an adequate water supply available. Should it be determined that flows other than the current operational 30 cfs releases (and

40 cfs rediversion releases) are necessary to keep resident fish and wildlife in good condition, Reclamation would provide excess CVP water, when available based on consultations with the appropriate agencies, as Reclamation lacks the complete authority to independently implement these changes. Pending recommendations, Reclamation would manage available water in a manner which minimizes the risk of a taking of a listed species, if found, while maintaining managerial options for longer term actions, in cooperation with the COE and the water users. These flows, when provided, would be monitored through periodic reviews for effectiveness and would be revised to best enhance the resource.

Reclamation would also determine the feasibility, if appropriate, of installing fish screening and passage devices to enhance the existing fishery resource, and prevent entrainment, along with possible substrate supplementation on Reclamation land based on the results of the monitoring study and the priorities of the CVPIA.

The stakeholders will be kept informed and coordination will be maintained regarding any significant changes to operations or conditions which update the Plan and which reflect adaptive management modifications. Reclamation believes the actions outlined above present a reasonable and implementable approach to the management of lower Stony Creek for fish, wildlife and water use, and fulfill the intent of the condition of the Order issued by the SWRCB.

Chapter 6

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Appendix A
State Water Resources Control Board Order
Permit #13776

APPENDIX A

APRIL 1, 1996

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD
DIVISION OF WATER RIGHTS

ORDER

Application 18115 Permit 13776 License ________

ORDER APPROVING ADDITION OF POINT OF REDIVERSION AND PURPOSE OF USE, AND AMENDING THE PERMIT

WHEREAS:

1. Permit 13776 was issued to U.S. Bureau of Reclamation on November 19, 1962, pursuant to Application 18115.

2. A petition for change has been filed with the State Water Resources Control Board.

3. The State Water Resources Control Board has determined that the proposed project will not have a significant effect on the environment for the reasons specified in the Final Environmental Assessment (January 1995), and the Supplemental Environmental Assessment both prepared by the U.S. Bureau of Reclamation. The State Water Resources Control Board has prepared a Mitigated Negative Declaration for the proposed project. The mitigation measures contained therein shall be made a part of this order.

4. The petitioned change would not constitute the initiation of a new right nor operate to the injury of any other lawful user of water.

5. Permit Condition 10 regarding the State Water Resources Control Board's continuing authority should be updated to conform to Title 23, California Code of Regulations, Section 780(a).

NOW, THEREFORE, IT IS ORDERED THAT Permit 13776 is amended to include the conditions specified below:

1. The condition of the permit related to the point of diversion is amended to include:

   Point of Rediversion, at the Stony Creek Siphon to the Tehama-Colusa Canal, within the SW1/4 of NW1/4 of Section 13, T22N, R3W, MDB&M. California Coordinate System, Zone 2, N 763500 and E 1956500. {0000002}

2. The condition of the permit related to the purpose of use be amended to read:

   Domestic, Irrigation, Municipal, Industrial, Recreational and Fish and Wildlife Protection and Enhancement. (0000003)

3. Release of Central Valley Project water from Black Butte Reservoir for rediversion at the Constant Head Orifice under this permit shall not exceed 38,293 acre-feet annually. Rediversions at the Constant Head Orifice may occur for 45 days during each of the periods from April 1 through May 15 and from September 15 through October 29.

4. Permittee shall maintain a continuous bypass flow of not less than 40 cubic feet per second in Stony Creek immediately downstream of the Tehama-Colusa Canal when rediverting into the Constant Head Orifice for the period April 1 through May 15 and from September 15 through October 29. Permittee shall install and maintain a continuous recording device on Stony Creek immediately downstream of the Tehama-Colusa Canal siphon crossing.

5. Permittee shall take steps to minimize entrainment of fish into the Tehama-Colusa Canal through physical and operational efforts, including minimizing flow fluctuations in Stony Creek, and minimizing flow fluctuations in the rates of rediversion into the Tehama-Colusa Canal. Permittee shall provide a mean daily fish redistribution flow of not less than 100 cubic feet per second for a period of 24 hours prior to beginning the rediversion of water into the Tehama-Colusa Canal.

6. Releases of water for rediversion at the Constant Head Orifice, measured at Black Butte Dam, shall be ramped downward at a rate no greater than 30 percent per hour or 50 cubic feet per second per hour, whichever is greater. Upward ramping flows are not required.

7. The rediversion of water at the Constant Head Orifice on the Tehama-Colusa Canal shall be subject to prior rights of the Glenn-Colusa Irrigation District on Stony Creek.

8. On or before December 15 of each year, Permittee shall provide the State Water Resources Control Board with reports of any fishery or wildlife studies conducted, or funded or received by Permittee in connection with Permittee's operations at the Red Bluff Diversion Dam, the Tehama-Colusa Canal, and the rediversion at the Constant Head Orifice on the Tehama-Colusa Canal under this permit. These reports will serve as a basis for future review in the event of future changes to water diversion or distribution facilities in Stony Creek or at the Red Bluff Diversion Dam.

9. Permittee shall account for water as follows:

   A. the rate and total quantity of water diverted into the Tehama-Colusa Canal at the Red Bluff Diversion Dam;
   B. water released from Black Butte Reservoir and rediverted through the Constant Head Orifice into the Tehama-Colusa Canal; and
   C. the amount of the water bypassed downstream of the Constant Head Orifice during the period of April 1 through May 15 and September 15 through October 29.

   In accordance with the above, Permittee shall provide to the Chief of the Division of Water Rights on or before December 15 of each year, a complete accounting of water diverted, released, bypassed and rediverted at the Constant Head Orifice on the Tehama-Colusa Canal.

10. To facilitate the long-term management of lower Stony Creek, including the restoration of fish and wildlife resources, Permittee shall continue to participate in the Stony Creek Task Force. Permittee shall submit to the Chief of the Division of Water Rights a long-term fish, wildlife, and water use management plan for the portion of Stony Creek from Black Butte Reservoir downstream to the confluence of Stony Creek with the Sacramento River, as prepared with the advice and assistance of the Stony Creek Task Force. Permittee shall also submit an annual report of the Stony Creek Task Force and Stony Creek Fish and Wildlife Technical Group activities to the Chief of the Division of Water Rights by December 15 of each year. The plan shall be submitted by December 15, 1998. Upon conclusion of its review of the plan, the State Water Resources Control Board will assess the continued need for the Stony Creek Task Force annually after December 1998.

11. By the year 2002 or in the event of any environmental, physical, facility, or operational changes occurring at the Red Bluff Diversion Dam, the Tehama-Colusa Canal crossing of Stony Creek, in Stony Creek, or the Glenn-Colusa Irrigation District crossing of Stony Creek or that would alter the conclusions stated in the National Environmental Policy Act/California Environmental Quality Act documents used to develop the terms and conditions of this permit, Permittee shall notify the State Water Resources Control Board, for the purposes of modifying as appropriate the terms and conditions governing the rediversion of water at the Tehama-Colusa Canal authorized in this permit.

12. A minimum fishery pool of 20,000 acre-feet shall be maintained in Black Butte Reservoir to the extent that there is not a conflict with prior water rights.

13. In alternate years, Black Butte Reservoir shall be stabilized for warmwater fishery protection, except as limited by the need to make water deliveries to satisfy prior water rights, through the following methods:

    A. Measure and record surface water temperatures on the main body of water, on a daily basis from March 15 through at least May 31, on Black Butte Reservoir in years when it is stabilized for fisheries protection; and

    B. When springtime water temperatures reach 60 degrees Fahrenheit in Black Butte Reservoir, changes in water elevation shall be limited to plus or minus two feet for four to five weeks, in accordance with the mitigation measures in the U.S. Bureau of Reclamation's Final Environmental Assessment, Rediversion of Water to the Tehama-Colusa Canal at the Stony Creek Siphon, dated January 1995.

    C. In years when Black Butte Reservoir is being stabilized, and low in-basin storage conditions exist in combination with the occurrence of 60 degrees Fahrenheit water temperature before May 15 and natural inflow into Black Butte Reservoir is less than 150 cubic feet per second, Permittee shall limit releases for spring Constant Head Orifice rediversions to 17,000 acre-feet maximum when nesting bald eagles occur at Stony Gorge Reservoir. Low in-basin storage shall be considered to exist when storage in Black

Butte Reservoir is less than 60,000 acre-feet. In addition, Permittee shall:

1) Conduct two surveys annually to determine bald eagle presence, nest site location, nest activity, and nest success at Black Butte Reservoir. Surveys, one pre-Constant Head Orifice and one post-Constant Head Orifice rediversion, should be conducted during the breeding season (January 15-July 31).

2) Survey information should be recorded according to established California Department of Fish and Game protocols and reported to the U.S. Fish and Wildlife Service and California Department of Fish and Game in the annual reports.

14. Permittee shall document Tehama-Colusa Canal/Constant Head Orifice project site impacts with aerial photographs. Aerial photos should be taken between May 1-15 in years when spring Constant Head Orifice rediversions occur.

15. Permittee shall confine operation of heavy equipment used for impoundment and training dike construction to the streambed and existing access roads to avoid injury, disturbance and/or removal of native riparian vegetation, especially elderberry bushes. Permittee shall conduct a vegetation survey prior to impoundment/training dike construction to identify potential impacts to elderberry bushes. Elderberry bushes that could be disturbed or removed during construction activities shall be flagged and remain undisturbed.

16. The State Water Resources Control Board reserves jurisdiction to supervise the diversion of water pursuant to this permit, and to coordinate or modify terms and conditions for the protection of vested water rights, fish, wildlife, instream beneficial uses, and the public interest, as future conditions may warrant.

17. Condition 10 of the permit is amended to read:

Pursuant to California Water Code Sections 100 and 275, and the common law public trust doctrine, all rights and privileges under this permit and under any license issued pursuant thereto, including method of diversion, method of use, and quantity of water diverted, are subject to the continuing authority of the State Water Resources Control Board in accordance with law and in the interest of the public welfare to protect public trust uses and to prevent waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of said water.

The continuing authority of the State Water Resources Control Board may be exercised by imposing specific requirements over and above those contained in this permit with a view to eliminating waste of water and to meeting the reasonable water requirements of Permittee without unreasonable draft on the source. Permittee may be required to implement a water conservation plan, features of which may include but not necessarily be limited to (1) reusing or reclaiming the water allocated; (2) using water reclaimed by another entity instead of all or part of the water allocated; (3) restricting diversions so as to eliminate agricultural tailwater or to reduce return flow; (4) suppressing evaporation losses from water surfaces; (5) controlling phreatophytic growth; and (6) installing, maintaining, and operating efficient water measuring devices to assure compliance with the quantity limitations of this permit and to determine accurately water use as against reasonable water requirements for the authorized project. No action will be taken pursuant to this paragraph unless the State Water Resources Control Board determines, after notice to affected parties and opportunity for hearing, that such specific requirements are physically and financially feasible and are appropriate to the particular situation.

The continuing authority of the State Water Resources Control Board also may be exercised by imposing further limitations on the diversion and use of water by the Permittee in order to protect public trust uses. No action will be taken pursuant to this paragraph unless the State Water Resources Control Board determines, after notice to affected parties and opportunity for hearing, that such action is consistent with California Constitution Article X, Section 2; is consistent with the public interest; and is necessary to preserve or restore the uses protected by the public trust.

(0000012)

Dated: 9/1/96

Edward C. Anton, Chief
Division of Water Right

Appendix B
Public Trust Protest

State of California

Before the State Water Resources Control Board

U.S. Bureau of Reclamation, Petitioner

Permit No. 13776 (Application No. 18115)

Black Butte Dam and Reservoir
Tehama-Colusa Canal
Red Bluff Diversion Dam
Stoney Creek, Sacramento River and
San Francisco Bay - Sacramento/San Joaquin
Delta Estuary

Petition for New Point of Rediversion

Public Trust Protest and Public Trust Complaint by California Sportfishing Protection Alliance

We the California Sportfishing Protection Alliance (hereinafter known as "CSPA") of P.O. Box 357, Quincy, CA 95971, c/o Bob Baiocchi, Executive Director, CSPA, have carefully read a copy of, or a notice of February 9, 1993, relative to the above mentioned petition for a new point of rediversion filed by the U.S. Bureau of Reclamation (Bureau).

Water is collected to onstream storage behind Black Butte Dam, in an 160,000 acre-foot reservoir. Water is used for domestic, irrigation, municipal, industrial, and recreation purposes. According to the Division of Water Rights, - " Currently, the Bureau is unable to assure delivery of water to the Tehama Colusa service area, (on the west side of the Sacramento Valley; in Glenn, Colusa, and Yolo Counties) during periods when the Red Bluff Diversion Dam gates are up.

The CSPA desires to protest against the approval of the petition because the existing project and the proposed diversion has the potential to have significant direct, indirect and cumulative adverse impacts to the public trust resources of: (1) Stoney Creek, (2) Sacramento River, and (3) San Francisco Bay - Sacramento/San Joaquin Delta Estuary. This protest is being filed jointly with a public trust complaint.

Appendix C
Petition Dismissal Terms and Conditions

APPENDIX C

United States Department of the Interior

BUREAU OF RECLAMATION
Mid-Pacific Regional Office
2800 Cottage Way
Sacramento, California 95825-1898

IN REPLY REFER TO:

MP-440
WTR-4.10

MAY 0 5 1994

Mr. Edward Anton
Chief, Division of Water Rights
State Water Resources Control Board
PO Box 2000
Sacramento, California 95812-2000

Subject: Dismissal Terms and Conditions for Petition for Additional Point of Rediversion, Permit No. 13776 (Application 18115), Stony Creek, Black Butte Reservoir - Central Valley Project

Dear Mr. Anton:

This is a follow up letter to the one to you dated April 19, 1994 which was transmitted to you by facsimile machine. The enclosed document dated April 19, 1994, has been agreed to by Reclamation and the California Sportfishing Protection Alliance (CSPA) for dismissal of CSPA's public trust protest to Reclamation's petition for an additional point of rediversion from Stony Creek under Permit No. 13776.

If you have any additional questions you may contact Ms. Gale Heffler at (916) 978-5128 or TDD (916) 978-4417.

Sincerely,

Gary T. Sackett
Regional Supervisor of Water and Power Resources Management

Bob Baiocchi
Executive Director, California Sportfishing Protection Alliance

Enclosure

cc: See page 2

WR Permit 13776 (Application 18115)
U.S. Bureau of Reclamation
Petition for New Point of Rediversion
Public Trust Protest and Public Trust Complaint
by California Sportfishing Protection Alliance
of January 31, 1994

Dismissal Terms and Conditions
of April 19, 1994

Reclamation and the California Sportfishing Protection Alliance (CSPA) have agreed to the following to resolve CSPA's protest to Reclamation's petition to add the Constant Head Orifice on the Tehama-Colusa Canal (CHO) as a point of rediversion on Stony Creek water released from Black Butte Reservoir.

By December 31, 1994, Reclamation will complete the preparation of a final environmental assessment addressing the impacts on the environment of the permanent addition of the CHO as a point of rediversion of Stony Creek water released from Black Butte Reservoir including the need for a fish screen at that point of rediversion and the necessity, if any, of the ramping of releases from Black Butte Reservoir. To assist it in preparing such assessment, Reclamation will organize a task force and a fish and wildlife technical group (FWT). The object and goals of both groups will be to collectively develop a long term fish, wildlife and water use management plan for the portion of Stony Creek from Black Butte Dam and Reservoir downstream to its confluence with the Sacramento River. The plan will address the impacts of the operations of the Red Bluff Diversion Dam, the Tehama-Colusa Canal, and the Glen Colusa Irrigation District Canal on the fish, wildlife and waters of Stony Creek.

Each of the following entities will be requested to select a representative to serve as a member of the task force:

1. Reclamation
2. CSPA
3. U.S. Fish and Wildlife Service (FWS)
4. California Department of Fish and Game (CDFG)
5. U.S. Army Corps of Engineers (USCE)
6. U.S. National Marine Fisheries Service (NMFS)
7. California State Water Resources Control Board (SWRCB)
8. Tehama-Colusa Canal Authority
9. Glen-Colusa Irrigation District (GCID)
10. Orland Unit Water Users Association
11. City of Santa Clara
12. Sacramento River Preservation Trust (SRPT)
13. Stony Creek Watermaster
14. RCD

Additional interested parties may be invited to participate in the Task Force by a majority approval of members of the Task Force.

The task force will hold public meetings every four to eight weeks at the discretion of the task force members. Reclamation will select the location, prepare the agendas and notify the public and each of the members of the time and place of each meeting. Reclamation will use its best efforts to schedule the first meeting by June 15, 1994. The task force will prepare by unanimous agreement a recommended long-term management plan for submission to the SWRCB as soon as possible. Minutes will be taken at each meeting. A copy will be sent to each task force member, and to each member of the public who presents a written request to the task force for copies of the minutes.

Each of the following entities will be requested to select a biologist to serve as a member of the FWT group:

1. CSPA
2. CDFG
3. FWS
4. NMFS
5. USCE
6. City of Santa Clara
7. Tehama-Colusa Canal Authority
8. Glen-Colusa Irrigation District (GCID)
9. Orland Unit Water Users Association
10. SRPT
11. Reclamation

Additional interested parties may be invited to participate in the FWT group by a majority approval of members of the Task Force.

The FWT group will meet at the times and places selected by the members of the group. The FWT group will develop their own procedures. The FWT group will report the results of their meetings and activities to the Task Force. The FWT will provide the professional expertise in the development of studies and evaluations toward the formation of recommendations in the long-term management plan which may be adopted and recommended by the Task Force.

It is recognized by Reclamation and the CSPA that some of the studies, evaluations and recommendations to be considered by the task force may be part of on-going or proposed work performed by FWS, CDFG and others under the Central Valley Project Improvement Act, Title XXXIV of P. L. 102-575, and Reclamation's involvement in the task force and FWT group is contingent on the availability and allocation of federal funds. It is further recognized that the long-term management plan is to be prepared in accordance with all applicable Federal and State laws.

In exchange for the above, it is jointly requested by Reclamation and the CSPA that the CSPA's protest to Reclamation's pending petition by dismissed and the CSPA's Public Trust Complaint be held in abeyance by the SWRCB pending the completion and submission of the long-term management plan described above.

Appendix D
State Water Resource Control Board Letter
February 29, 1996
Outstanding Protest Resolution

APPENDIX D

STATE OF CALIFORNIA - CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

PETE WILSON, Governor

STATE WATER RESOURCES CONTROL BOARD

PAUL R. BONDERSON BUILDING
901 P STREET
SACRAMENTO, CALIFORNIA 95814
(916) 657-1359
FAX: 657-1485

Mailing Address
DIVISION OF WATER RIGHTS
P.O BOX 2000, Sacramento, CA 95812-2000

In Reply Refer to:333:PJM:18115

BUREAU OF RECLAMATION OFFICIAL FILE COPY RECEIVED
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February 29, 1996

Mr. Robert Stackhouse
Regional Supervisor of Water & Power Resources Management
U.S. Department of the Interior
Bureau of Reclamation
Mid-Pacific Regional Office
2800 Cottage Way
Sacramento, CA 95825-1898

Mr. Bob Baiocchi
California Sportfishing Protection Alliance
P.O. Box 357
Quincy, CA 95971

Mr. Steve Hirtzel
U.S. Fish and Wildlife Service
2800 Cottage Way
Sacramento, CA 95825

Gentlemen:

PERMITTED APPLICATION 18115--STONY CREEK TRIBUTARY TO SACRAMENTO RIVER IN TEHAMA COUNTY

On February 23, 1996, the State Water Resources Control Board (SWRCB) faxed revised dismissal conditions to all affected parties and requested that comments be received by February 27, 1996 at 5:00 p.m. The U.S. Bureau of Reclamation (petitioner) and California Sportfishing Protection Alliance (CSPA) contacted the SWRCB and verbally confirmed that the revised dismissal conditions were acceptable. The U.S. Fish and Wildlife Service (USFWS) did not respond within the specified time, therefore it is assumed they concur with the revised dismissal conditions. Since the revised permit terms are agreeable to all parties, the protests filed by the USFWS and CSPA are hereby dismissed with the understanding that the revised dismissal conditions will be incorporated into any Order issued pursuant to Permitted Application 18115. It should be noted that all existing terms and conditions of Permit 13776 will remain in effect, except as modified in SWRCB letter dated February 23, 1996.

The SWRCB is in the process of obtaining California Environmental Quality Act (CEQA) clearance. Pursuant to CEQA, the SWRCB can develop additional terms to mitigate for significant impacts not addressed through the water rights protest process. The Division of Water Rights anticipates that, through the preparation of the necessary CEQA documents, terms may be developed to mitigate for any significant adverse effects of this project on the upstream reservoir fisheries and the endangered bald eagles that depend on those reservoir fisheries.

If you have questions regarding this matter, please contact me at the above telephone number. The staff persons assigned to this matter are Patricia Meroney at (916) 657-1868 and Heidi Bratovich at (916) 657-2214.

Sincerely,

David R Beringer

for Edward C. Anton, Chief
Division of Water Rights

cc:

Ms. Julie Brown
California Department of
Fish and Game
P.O. Box 117
Hamilton City, CA 95951

Mr. Paul Ward
California Department of
Fish and Game
P.O. Box 578
Red Bluff, CA 96080

Mr. Nick Villa
California Department of
Fish and Game
1701 Nimbus Road
Rancho Cordova, CA 95670

Ms. Janice Jennings
Tehama-Colusa Canal Authority
P.O. Box 1025 Hwy 162
Willows, CA 95988

Milda Diaz-Soltero, Regional Director
National Marine Fisheries Service
Southwest Region
501 West Ocean Blvd., Suite 4200
Long Beach, CA 90802-4016

Ms. Sandy Denn
Glenn-Colusa Irrigation Dist.
P.O. Box 470
Willows, CA 95988

Appendix E
Stakeholder Needs and Expectations

APPENDIX E

For each group of stakeholders, a tentative list of items to be addressed by this Plan was assembled:

- Stakeholders **Needs and Expectations**
- **Key Questions** Stakeholders expect to be answered by the Plan
- **Actions** by Stakeholders as participants of the Plan

Responses from the various stakeholders are described in the following sections.

Agencies (federal, state, local)

Needs and Expectations

1. State Water Resources Control Board

- "Competent" Plan
- Broad Support; Resolve Protests
- Consistent with Permit Conditions
  - Explain rediversion and change to historical practice

2. U.S. Bureau of Reclamation

- Clearly define set of actions for use of CVP water
- Plan provides a vision for conservation and enhancement

3. U.S. Fish and Wildlife Service

- Restore habitat in Stony Creek pursuant to CVPIA
- Deliver a firm refuge water supply pursuant to CVPIA
- Fulfill requirements of the Fish and Wildlife Coordination Act
- Fulfill requirements of the ESA
- Assist the State in protecting the Black Butte Reservoir fishery

National Marine and Fisheries Service

- Plan to better manage CVP (Black Butte) water for fish and wildlife conservation and enhancement
- Management of Stony Creek to fulfill past RBDD compensation obligations
- Plan provides a vision for conservation and enhancement
- Fulfill Public Trust Doctrine

4. U.S. Army Corps of Engineers

- Plan should address the protection and enhancement of fish and wildlife habitat and protection of archaeological resources

- If an alternative is selected to be implemented in the future, enhancement plans would require federal congressional funding for the COE to work on fish and wildlife enhancement projects and/or studies.

- After review of the water control manual for Black Butte Dam and Reservoir, federal congressional re-authorization of flood control operations at Black Butte Reservoir would be necessary to include fish and wildlife habitat enhancement for the area downstream of the dam. Besides flood control, the project is currently authorized to only provide recreation at the reservoir and a fishery. At this time, the project is not authorized to provide fish and wildlife benefits such as maintaining minimum flows to enhance water quality for fish or and enhancing wildlife habitat by timing flow releases in the spring to promote natural regeneration of vegetation in the area below the dam.

5. California Department of Fish and Game

- Fish, wildlife, and water issues (conservation and enhancement) are addressed
- CVPIA water used for enhancement
- Generally consistent with Stony Creek action plan
- Protect upstream reservoir fisheries

6. Caltrans

- Maintain structural integrity and minimize operation and maintenance costs of infrastructure

7. Glenn County Resource, Planning, and Development Department

- Consistent with aggregate management policies and plans
- Consistent with Glenn County General Plan
- Plan clearly defines implementation program for enhancement and/or conservation of Stony Creek

8. Regional Water Quality Control Board/Environmental Protection Agency

- Meet water quality objectives

Key Questions

Are significant negative environmental impacts avoided?
Who pays for implementation?

1. State Water Resources Control Board

   - Does overall plan have broad support?
   - Is the Plan consistent with permit conditions?
   - Are fish, wildlife, and water issues adequately addressed?

2. U.S. Bureau of Reclamation

   - Does Plan provide information necessary for operation and permitting?

3. U.S. Fish and Wildlife Service/National Marine and Fisheries Service/California Department of Fish and Game

   - Does the Plan identify the actions required to select, implement, monitor, and revise the management options?

   - What are the impacts of Plan implementation on winter-run chinook salmon, fish and wildlife generally, and listed, proposed, and candidate species?

   - Does the selected management option include monitoring to evaluate Plan success?

4. U.S. Army Corps of Engineers

   - Are existing wetlands protected in the Plan? The Plan should include and emphasize protection of existing wetlands and enhancement of historic wetlands if possible. (There is no specific mention of wetlands in the management plan)

   - Could other flood control measures, such as a bypass system, be used besides relying only on flood control operation of Black Butte Dam?

   - Is the Plan flexible to incorporate modifications to address new issues or unforeseen problems that could arise in the future?

   - Considering that there are water diversions to satisfy water user's needs, is there available water to enhance and sustain Stony Creek's salmonid fisheries? Could water diversions be redesigned to minimize adverse effects on juvenile fish?

- **Is the Plan consistent with the flood control operation as authorized? If not, what is the impact on the flood control operation and the level of protection provided?**

- **How does the Plan affect reservoir levels in Black Butte Reservoir?**

5. Caltrans

   - Does the Plan afford adequate protection for infrastructure?

6. Glenn County Resource, Planning, and Development Department

   - Is the Plan consistent with the Glenn County General Plan?

   - Is the Plan consistent with the Glenn County Aggregate Resources Management Plan?

   - Does the Plan lead to a Stony Creek enhancement program?

7. Regional Water Quality Control Board/Environmental Protection Agency

   - Is water quality protected?

8. Glenn County Resource Conservation District

   - Is the Plan consistent with the upper Stony Creek management plan?

Actions

- Acknowledge receipt of Plan by SWRCB
- Constructive participation
- Endorsement of Plan in principle
- Fulfill commitments during implementation
- Public education

California Sportfishing Protection Alliance

Needs and Expectations

- Plan should address the protection and enhancement of chinook salmon, steelhead trout, and resident fisheries of lower Stony Creek.

- Plan should address reestablishment and protection of riparian habitat.

- Plan should address public access and recreation opportunities for lower Stony Creek.

- Plan should develop a funding program to implement management options.

Key Questions

- Does the Plan protect and enhance salmonid and resident fisheries?
- Does the Plan address public access and recreation opportunities?
- Does the Plan provide for riparian habitat improvement?
- Is funding for the implementation plan available?

Actions

- Constructive participation
- Endorsement of Plan in principle

Glenn County Resources Conservation District

Needs and Expectations

- Ensure that the private property rights of Stony Creek landowners remain unchanged and unchallenged.

- Provide a workable solution regarding aggregate mining that honors private mineral rights.

- Recommend a plan for the elimination of noxious plants from the channel.

- Incorporate within the Plan a method to minimize bank erosion.

- Provide a comprehensive analysis and action plan regarding creek specific water issues.

Key Questions

- How would the Plan affect historical property rights?

- Aggregate mining is an economic resource for Glenn County. How would this Plan address the balance between economic growth and prudent resource management?

- Will the Plan consider the abatement of problematic non-native plants, e.g., giant reed, tamarix?

- What remedies would the Plan consider appropriate for adequate bank stabilization?

- How will the Plan handle the following water concerns?

  - Groundwater recharge for aquifer
  - Local vs. distant flood management control
  - Perception of Stony Creek, i.e., creek vs. irrigation ditch
  - Zoning

Actions

- Constructive participation
- Endorsement of Plan in principle
- Implementation assistance

Gravel Operators Within Stony Creek Watershed

Needs and Expectations

- Instream gravel mining should be allowed to continue

- Plan should address local input into the timing and magnitude of releases from Black Butte Reservoir

- Plan should address control of giant reed and tamarix

Key Questions

- How does the Plan affect existing (grandfathered and vested) and future gravel mining practices?

- How does the Plan address the economic impact of gravel mining to the local area?

- Does the Plan allow for control of giant reed and tamarix?

Actions

- Constructive participation
- Endorsement of Plan in principle

Landowners Within Stony Creek Watershed

Needs and Expectations

- Protect long standing, traditional private property rights; ensure these rights remain unchanged and unchallenged
- Control of giant reed and tamarix
- Protect and enhance ecological values by continuing, encouraging, and expanding private stewardship of wildlife/habitat by landowners
- Modify Black Butte Dam releases to minimize:
    - Bank erosion
    - Destruction of riparian habitat (e.g., oak trees)
    - Endangerment of wildlife, pollution of waters, destruction of banks by dumping of public litter, and garbage from the lake
- Credible technical information where lack of need science is available must be produced by unbiased and reliable technical participants

Key Questions

- How does the Plan effect existing groundwater pumping?
- How does the Plan effect private property rights in terms of trespassing and recreation by others?
- How does the Plan protect and enhance ecological values under private stewardship?
- Does the Plan allow for control of giant reed and tamarix?
- How will the Plan effect releases from Black Butte Dam?
- How will the Plan decrease creek bank erosion?
- Is the Plan objective, rigorous, valid, and reliable?

Actions

- Constructive participation
- Endorsement of the Plan in principle

Water Users (TCCA and GCID)

Needs and Expectations

- Operations remain intact or improve

- Fully utilize CVP water in Black Butte Reservoir for irrigation

- Water rights and decrees are kept whole (honored) for surface water

- Protection of county of origin rights as noted in SWRCB D-1100

- Credible technical information where lack of real science is available must be produced by acceptably reliable technical participants

Key Questions

- What is the impact on water availability?
- Will the Plan negatively impact delivery and quantity of water for irrigation?
- Will the Plan impact water costs?
- Will the Plan identify economic impacts?
- Will the Plan address land devaluation as a result of a lack of accessible water?

Actions

- Constructive participation
- Endorsement of Plan in principle
- Implementation assistance

The previous section is summarized by the following:

1. Concerns over Reclamation's current management of lower Stony Creek:

   *Protecting creek resources during rediversion of CVP water at the TCC CHO;

   *Providing consistent, historic, and required irrigation deliveries in all water years;

   *Addressing lower Stony Creek management's current constraints and associated facility management operations;

   *Examining and providing long-term coordinated management of water releases and flow schedules to balance resource uses, within the required parameters;

2. Degradation of important/sensitive resources:

   *Protecting existing wetlands;

   *Encouraging private stewardship to reestablish and protect riparian habitat;

   *Identifying the environmental affects of gravel mining on fisheries and water quality;

   *Providing recommendations on controlling noxious weeds (Giant Reed, Tamarix);

   *Providing recommendations on minimizing bank erosion;

   *Providing recommendations on ensuring groundwater recharge and water quality;

   *Encouraging and assisting private stewardship of diverse wildlife habitat by landowners;

3. Concerns over the impacts of Black Butte operations on resident and anadromous fish populations in the lower Stony Creek system:

   *Determining the impacts of current and future operations of the lower Stony Creek system on the endangered winter-run chinook salmon, fish, and wildlife generally, and listed, proposed and candidate species;

   *Determining the availability and quality of water (water supply, sufficiently low water temperatures, hydrology, and spawning substrate) for a sustainable fishery;

*Providing information for an adaptive management approach to keep resident and anadromous fish in good condition in various water year types, in compliance with applicable State and Federal laws. A flow schedule would be developed to give reasonable consideration to all desired uses;

*Identifying and providing information on conservation management procedures to increase available water and improve operations;

4. Recreation and public access resulting in trespass of private property

*Providing recommendations regarding honoring private property rights;

*Evaluating the demand for public access corridors, and considering the impact of public access and recreation on fish and wildlife, private stewradship and private property rights.

Appendix F
Upper Stony Creek Watershed

APPENDIX F

UPPER STONY CREEK WATERSHED

General Geology

The Upper Stony Creek Watershed contains a wide variety of rock types. The oldest rocks are the pre-Cretaceous metasedimentary rocks that constitute approximately 20 percent of the upper watershed, principally in the western side of the valley. It includes phyllite, mica-quartz shist, and slate. Figure F-1 is a geologic map of the Upper Stony Creek Watershed.

Mesozoic ultrabasic rocks (serpentine and periodotite) occupy approximately 10 percent of the upper watershed in a narrow, continuous north-south belt on the western side of the valley. The Geologic Map of California (Jennings, 1977; Jennings and Strand, 1960) shows fault contacts between these rocks and adjacent formations. The Stony Creek Fault runs the length of the valley where the ultrabasic rocks contact the Knoxville Formation rocks.

The Knoxville Formation rocks occupy the central portion of the valley from north to south, and are Jurassic in age and consist of shale, sandstone, and conglomerate. Approximately 20 percent of the upper watershed is underlain by this formation.

Rocks of the Franciscan Formation crop out in about 20 percent of the upper watershed, most notably in the Grindstone Creek and Middle Fork Stony Creek watersheds. Both volcanic (greenstone) and classic Franciscan rock assemblages (sandstone, shale, chert, and conglomerate with minor greenstone, limestone, basalt, glaucophane shist, and other metamorphic rocks) are present. The Franciscan Formation rocks are Cretaceous/Jurassic in age.

The east side of the valley is underlain by marine sediments of the lower Cretaceous. Like the rocks of the underlying Knoxville Formation, these sediments dip eastward into the Sacramento Valley where sediment accumulation has caused their mild deformation. Sandstone, shale, and conglomerate are found in this formation.

Black Butte Reservoir is underlain by non-marine, upper-Pliocene sediments, typically referred to as the Tehama Formation. Silt, sand, gravel, and clay make up this formation. Three small areas of Quaternary non-marine terrace deposits are mapped at the upper end of Stony Gorge Reservoir and in the Stony Creek and Little Stony Creek channels near Black Butte Reservoir.

General Land Use

The upper watershed consists of approximately 198,000 acres of private land and approximately

270,000 acres of public land. Grass covers many slopes in the upper watershed, and most of the valley and foothill area is used for grazing cattle and sheep. An estimated 10 percent of the area is cultivated for grain production. There is little population in this area primarily because few areas exist where wells and septic tanks can be successfully located. Most property is zoned Exclusive Agriculture with minimum parcel sizes of 160 acres (Glenn County, 1985).

The upper watershed is partially bounded by a range of north-south trending hills composed of older alluvial deposits. Grindstone Creek, the principle tributary to Stony Creek above Black Butte Reservoir, drains a basin underlain by shattered Franciscan Formation and is the most prolific gravel producer in the Stony Creek Watershed (Swanson and Associates, 1993).

A gravel extraction operation is located in Stony Creek in the vicinity of Stony Gorge Dam. The operator, Leon Whitney, currently extracts little material. The operator's interest in keeping the County Use Permit active pertains to the potential development of a roadway proposed in the vicinity that would provide an alternate route for Highway 20 traffic between the valley and the coast. If and when construction begins on that roadway, the operator would increase the activity of his operation accordingly (Glenn County, 1996).

General Vegetation

The general vegetation associated within the greater Stony Creek watershed occurs in the mountains and canyons of the northern end of the Inner North Coast Ranges. At the higher elevations, such as Snow Mountain, and on north-facing slopes of the lower mountains, there are areas of mixed conifer forest with Douglas fir and ponderosa pine. The soil type is a controlling factor in the watershed where Franciscan formation melange is mixed with Mesozoic age ultramafics, such as serpentine (Kruckeberg, 1984). The Stony Creek thrust fault forms a nearly continuous band along the eastern side of the Inner Coast Ranges where there are distinct bands of vegetation reflecting the soil mineral conditions of the parent rock outcrops.

The vegetation on serpentine soils is either a dense mix of predominately chaparral vegetation, dominated by Jepson's buckbrush and white leaf manzanita, or is open low chaparral with leather oak and mixed with perennial grasses and herbaceous species. Some areas have dense stands of McNab cypress, which may be associated with localized outcrops of gabbro. The non-serpentine areas are either dense chaparral, dominated by chamise and buckbrush, or may have interior, blue, and scrub oak. On the lower slopes near Stony Creek, the vegetation developed on the alluvial and colluvial sediments of the Central Valley formation is predominately grassland that has been invaded by non-native species such as Mediterranean rye grass, non-grass species such as yellow star thistle, and other weedy species. Native grasses primarily include perennial bunch grasses; however, these have been mostly replaced by the non-native species particularly where there has been heavy cattle grazing. Blue oak woodlands were once more dominant in the area, but many oaks have been cut for firewood and few dense stands remain.

General Fisheries

Existing fisheries resources in Stony Creek's headwaters and its tributaries above Black Butte Dam include native rainbow trout and rainbow trout stocked by the California Department of Fish and Game (DFG) (Puckett, 1969). East Park, Stony Gorge, and Black Butte Reservoirs provide a warm water fishery that includes black, small mouth, and Alabama spotted bass; white and black crappie; channel and white catfish; and a trophy striped bass fishery (DFG unpublished files). A significant white crappie fishery exists in Black Butte Reservoir.

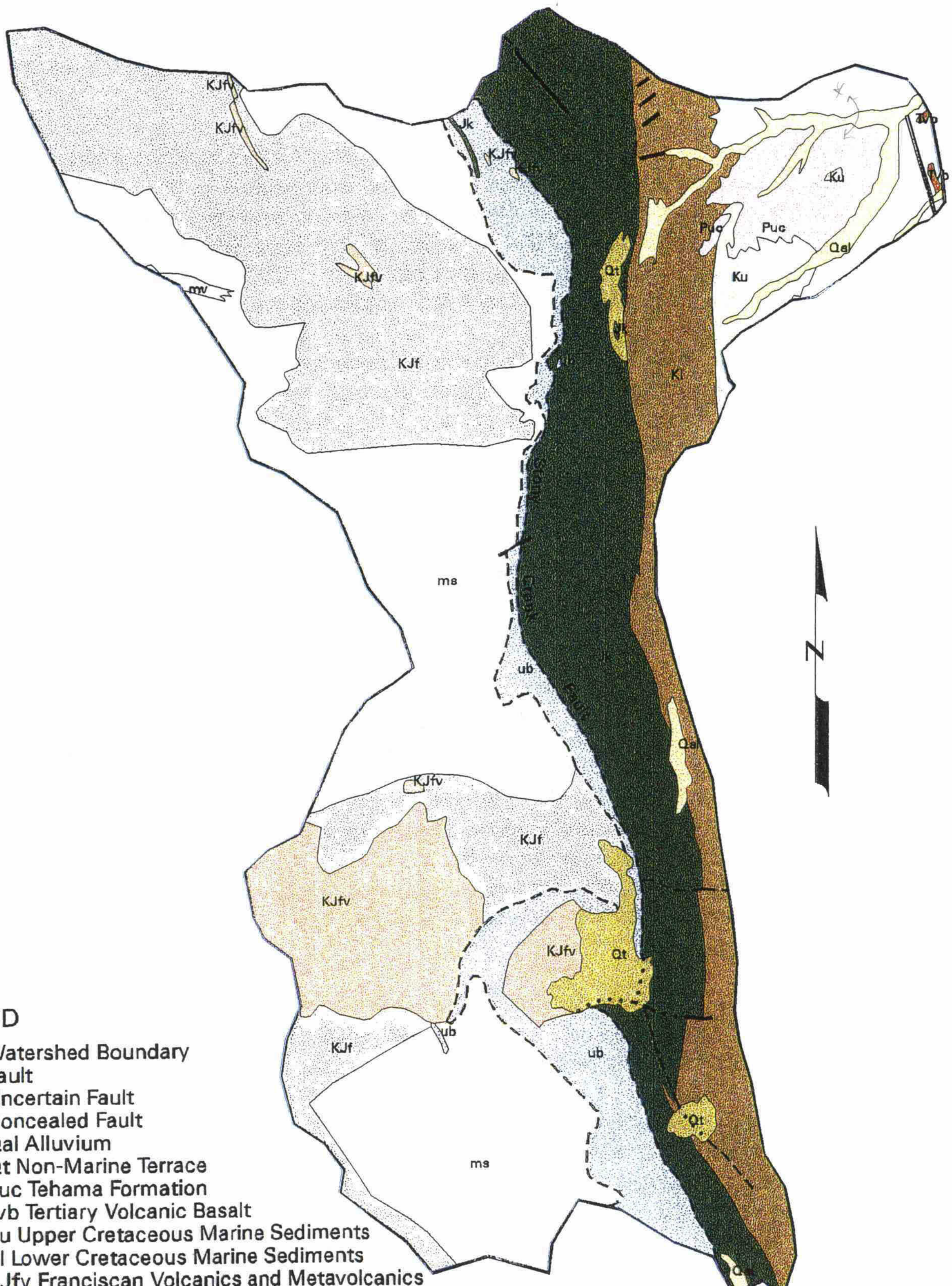
One function of the three reservoirs is to ensure minimum fishery. Pool elevation stabilization requirements (plus or minus two feet) to protect spring spawning fish are required in alternate years between Stony Gorge and Black Butte Reservoirs. The minimum reservoir fishery pools for East Park, Stony Gorge, and Black Butte Reservoirs are 5,000, 7,500, and 20,000 acre-feet, respectively.

The use of a permanent point of rediversion of Stony Creek water at the TCC is governed by the operational objectives as described in Table 1 of the Final and Supplemental Environmental Assessments (EA) dated January 1995 and March 1996 respectively. The objectives describe the minimum pool amounts, minimum live streams as well as other objectives. In addition to the EA, minimum pools for East Park and Stony Gorge were identified in the 1963 USFWS Fish and Wildlife Coordination Act report (Supplemental FWCA report-Red Bluff Diversion Dam and the Tehama-Colusa Canal, February, 1998), as enhancement measure recommendations associated with the CVP. These minimum pool amounts are also specified in the General Operating Objectives of Stony Creek Reservoirs (COE, May, 1971) as a memorandum of understanding between Reclamation, COE, CDFG and the OUWUA and as a result of a 1964 exchange agreement between Reclamation and the OUWUA.

Minimum streamflows in upper Stony Creek are required to maintain adequate fishery habitat conditions. These objectives, as described in the EA, include 5 cfs (cubic feet per second) downstream of East Park Reservoir (usually as a result of leakage) and 5 cfs downstream of Stony Gorge Reservoir. Reclamation has attempted to commit to these objectives with the cooperation of the OUWUA, as there is no formal agreement.

According to the Water Control Manual, COE, 1987, Black Butte Reservoir "normally stays relatively shallow during the summer months. Vertical temperature profiles indicate that the reservoir remains thermally unstable or weakly stratified and is easily mixed vertically by winds and diurnal heating and cooling. The waters are warm throughout the depths during the summer providing for a warm water fishery.

Historically, spring-run Chinook salmon were found in the Stony Creek Watershed above the present dams and reservoirs (Clark, 1929). More information concerning historical conditions will be discussed in the Existing Fisheries section of the study area.



LEGEND

- Watershed Boundary
- Fault
- Uncertain Fault
- Concealed Fault
- Qal Alluvium
- Qt Non-Marine Terrace
- Puc Tehama Formation
- Tvb Tertiary Volcanic Basalt
- Ku Upper Cretaceous Marine Sediments
- Kl Lower Cretaceous Marine Sediments
- KJfv Franciscan Volcanics and Metavolcanics
- KJf Franciscan Formation
- Jk Knoxville Formation
- ub Mesozoic Ultrabasic Rocks
- mv Pre-Cretaceous Metavolcanics
- ms Pre-Cretaceous Metasediments

Scale 1:340,000

FIGURE F-1
GEOLOGIC MAP OF THE UPPER STONY CREEK WATERSHED
U.S. BUREAU OF RECLAMATION
LOWER STONY CREEK FISH, WILDLIFE, AND WATER USE MANAGEMENT PLAN
Source: Jennings and Strand, 1960

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General Wildlife

The Stony Creek watershed offers important wildlife habitat and supports a diverse assemblage of native wildlife species (U.S. Fish and Wildlife Service, 1995). Riparian forests and riparian scrub habitats are especially valuable to the conspicuous migrant and resident birds and also to more secretive mammal, reptile, and amphibian species inhabiting these areas.

Most wildlife species in the Stony Creek watershed visit riparian vegetation along the creek and its tributaries for water, food, or cover. Native riparian trees and shrubs offer rich food sources including insects, fruit, and seeds. Tall riparian trees provide secure nesting sites for raptors, woodpeckers, and a variety of flycatchers, wrens, vireos, warblers, and finches. The complexity of microhabitats created by layering trees, shrubs, vines, and herbaceous vegetation promotes high wildlife diversity; breeding birds restricted to riparian vegetation may outnumber by sevenfold obligates of other habitats such as grasslands (Tubbs, 1980).

The NRCS "Upper Stony Creek Watershed" report (July 1989), Appendices B-F list specific resources information.

General Climate

Climate in the upper watershed is characterized by cool, wet winters and hot, dry summers. Snowfall accumulates above 5,000 feet from November through March. Average annual precipitation in the valley portion of the upper watershed is about 17.4 inches. The higher elevations in the mountainous upper watershed have over 60 inches of annual precipitation in an average year. The average annual precipitation for the entire watershed is about 32 inches.

Monthly mean air temperatures range from 45°F to 80°F in the valley areas with slightly cooler temperatures near the three reservoir surfaces. Maximum daily air temperatures on the valley floor in the summer usually exceed 100°F for a short period and are typically above 90°F.

The prevailing wind direction in the study area is from the south during the spring and summer months (April through September) and from the north during the fall and winter months (October through March). Average monthly wind speeds range from around 2.5 miles per hour (mph) to about 3.4 mph over the year. However, during storm events, the peak wind gusts can exceed 30 to 50 mph during almost any month of the year.

Other upper watershed sources include: "The Middle Little Stony Creek Watershed Analysis Report" which is being prepared by the Mendocino National Forest staff in Willows, and which is expected to be completed late in 1998; and "Watershed Plan and Environmental Assessment, Upper Stony Creek Watershed" dated July 1989, prepared by the Natural Resource Conservation Service (SCS) out of Davis, California.

The Division of Mines and Geology has prepared the " Mineral Land Classification of Concrete-Grade Aggregate Resources in Glenn County, California, 1997" which has extensive information regarding the geology of the Stony Creek Fan.

Glenn County has prepared an "Aggregate Resource Management Plan Initial Phase Report", October 1997, also has applicable information.

The Natural Resource Conservation Office in Willows, California has information regarding land uses in upper Stony Creek.

Appendix G
Interactions of Current Trends

APPENDIX G

Interactions of Current Trends

Lower Stony Creek's current condition can be improved by analysis and modification of current trends. This section summarizes the major trends observed for a more complete understanding of the interaction between land uses and the natural setting. Channel geomorphology, the current flood release program and mining operations are discussed. Estimations of impacts should be considered in resource management planning efforts on lower Stony Creek.

1. Channel Geomorphology

Impacts of Channel Geomorphology on Land Use

Land use near the creek influences the creek migration patterns. Patterns of channel migration on Stony Creek influence the land use near the creek. Some of the interactions between land use and channel migration have been quantified.

The current trends in channel migration (Table G-1) indicate how the creek interacts with stream-side land use. In the 18 miles of lower Stony Creek between Black Butte Dam and the GCID Main Canal, roughly 15 percent of the creek (longitudinal miles) is affected by local land use. Roughly 5 percent of the creek is impacting agricultural land. These rough estimates indicate the extent of interaction between natural channel migration and land use. Bank erosion associated with this migration is a concern for land use, with implications for property loss.

Lower Stony Creek is highly dynamic due to basin precipitation and water releases. Over one-third of its length was migrating or avulsing significantly between 1993 and 1996 (Table G-1). For future management planning, it is important to determine at each project site: (1) if the channel is migrating or avulsing, (2) if this is a trend that is likely to continue, and (3) where the areas of significant channel migration are concentrated. The reach-specific conceptual analysis performed in this study indicates possible approaches toward resolving those questions. A site-specific evaluation requires more thorough quantification using a wider range of years. With that evaluation, the interaction of the stream geomorphology and land use can be better understood.

Planning for appropriate bank stabilization needs to be carefully evaluated. Future bank stabilization projects can significantly alter the channel migration pattern both upstream and downstream from a stabilized bank. An example of this is the migration pattern that occurred at RM 22, where bank stabilization near an orchard has caused major changes to the channel migration pattern. Upstream and downstream migration patterns resulting from proposed bank stabilization can be predicted and evaluated in the planning process.

Table G-1
Interaction of Significant Channel Migration and Land Use on Lower Stony Creek Between 1993 and 1996

Reach	**Length**	**Significant Channel Migration**		**Effected Mature Riparian Vegetation**		**Migration Potentially Associated With Land Use**		**Migration Effecting Agricultural Land**	
	Miles	Miles	%	Miles	%	Miles	%	Miles	%
1	8.7	2.3	26	0.6	7	0.8	9	0.1	1
2	3.6	0.7	21	-	-	-	-	0.5	14
3	5.3	3.5	66			1.7	33	0.1	2
Subtotal	**17.6**	**6.5**	**37**	**0.6**	**3**	**2.5**	**14**	**0.7**	**4**
4	7.0	0	0	0	0	0	0	0	0
Total	**24.6**	**6.5**	**28**	**0.6**	**3**	**2.5**	**11**	**0.7**	**3**

Impacts of Channel Geomorphology on Vegetation

Point bars, the flat gravel bars occurring predominately on the inside of river bends, provide a natural habitat for the establishment of riparian vegetation. If point bars are unstable, meaning that they appear and disappear from one year to the next, seeds and small seedlings cannot be established. Deposition of fine material on bars also provides a necessary component of the habitat for vegetative establishment. Higher than average yearly flows tend to deposit fine material and create suitable growing habitat in over-bank areas (terraces). Roots from riparian vegetation provide stability to stream banks.

Channel migration between 1993 and 1996 removed existing mature riparian vegetation in less than 5 percent of the longitudinal RMs on Stony Creek (Table G-1). Most of the channel migration, which effected over one-third of the total RMs in Reaches 1 through 3, occurred through land that was gravel covered bars and floodplain. Future trends could be predicted with further analysis.

Impacts of Channel Geomorphology on Fisheries

This section discusses the impacts of the channel geomorphology on the fisheries of Stony Creek. The current observations focus primarily on channel migration patterns. Of great importance, and not addressed in this Plan, are the smaller scale habitats, like pools and riffles, for which data are not available.

Lower Stony Creek, although it is largely a single-channel meandering creek, exhibits significant channel migration and avulsion, which is more characteristic of braided channels. Over one-third of the length of Reaches 1 through 3 experienced significant migration from 1993-1996 (Table G-1).

The tendency for fine material to be "winnowed" from the bed of Stony Creek may be a positive influence for possible spawning substrate, which requires gravel relatively free of fine material. However, some areas sampled in the upper reaches are void of any spawning gravel which is a negative influence (Vogel, 1998). Lateral migration of this highly dynamic stream does create bank erosion. The extent of this bank erosion, and therefore the fine material that would tend to bury suitable spawning gravels, is not known. Bank erosion could possibly supply appropriately sized spawning gravel. The tendency for the bed of Stony Creek to become more coarse is also a positive trend for spawning gravels where the existing substrate is too small for suitable spawning gravels. Lack of in-stream woody debris and habitat complexity is a limitation.

2. Flood Control Releases

The current flow releases, with a decrease in magnitude and an increase in duration, tend to decrease overbank flooding and deposition of fine material, which is essential for the regeneration of plant seedlings. The reduction of sediment supply as a result of the dam reduces significantly the amount of fine material in the system and contributes to channel armoring and the winnowing of fine material from the bed and bar surfaces. This reduces effective habitat for plant regeneration. Any riparian enhancement program would require consideration of yearly efforts with the existing flood control criteria.

The timing and ramping of regulated flow releases, which do not replicate the natural pattern, decrease bar stability and reduce opportunity for seedling generation on point bars. Although it has been speculated that the width and the depth of the creek continue to change, the extent of this change is not clear. Such changes would not allow channel point bars to remain stable. However, the creek establishes a more sinuous single-thread meandering channel, offsetting these negative impacts. A more sinuous meandering channel will have more point bars and will tend to stabilize point bar locations.

The highly dynamic nature of this creek as a result of flood releases is likely to continue. Bank erosion associated with this migration is a concern for fisheries, with implications for habitat loss and substrate unsuitability. The current flood control diagram does not allow for releases which exceed 15,000-20,000 cfs. It has been suggested that occasional heavier flows than currently released could result in a natural flushing action of the stream, and a return to a natural state, enhancing the possibility of riparian and fishery habitat improvements, however flows greater than 15,000 cfs could cause "appreciable damage to agricultural areas and 40,000 cfs...could cause appreciable damage to urban areas" (COE, 1987).

3. Mining Operations

Current Effects of In-Channel Gravel Mining.

In-channel mining may affect the vegetation, channel geomorphology, and surface hydrology of the study area if not properly mitigated. The level of effect will vary by the extent of area mined annually within the active channel zone, the type of mining (i.e., bar skimming, deeper channel pit mining, or mining of outer bank terrace deposits), and the type of reclamation or special conditions that are required as part of future use permit. Gravel bar skimming is the typical gravel removal technique used in lower Stony Creek, however excavation below the level of seasonally replenished aggregate has occurred in the area east and west of the highway 32 bridge (Glenn County, 1997). Recently, Glenn County is attempting to regulate resource damage through its permitting process where "disturbance of banks, riparian vegetation, and flowing portions of the creek is usually prohibited" (Glenn County, 1997). Since 1977, DFG has allowed no pit mining in-stream, and encourages off-stream mining which is isolated from flowing water, maintains stream bank protection conditions, and limits elevations of gravel removal to maintain slopes of approximately ½%.

Long-Term Effects of In-Channel Gravel Mining.

In-channel mining may affect the vegetation, channel geomorphology, and surface hydrology of the study area if not properly mitigated. Mining affects in-stream hydraulics and impairs sediment transport, gravel recruitment, and stream channel meander processes. In-stream gravel removal affects water quality and can damage riparian vegetation. The level of effect will vary by the extent of area mined annually within the active channel zone, the type of mining, i.e., bar skimming, deeper channel pit mining, or mining of outer bank terrace deposits, and the type of reclamation or special conditions that are required as part of future use permits. Gravel bar skimming is the typical gravel removal technique used in lower Stony Creek. "In addition to skimming, mining can involve excavation below the level of seasonally replenished aggregate. This method is in use in the area east and west of the Highway 32 bridge" (Glenn County, ARMP, 1997) . Glenn County monitors these operations and mitigation measures.

Future Expansion of Mining Operations.

The maximum permitted extraction rates are double of current rates under existing vested rights not subject to SMARA regulations or local ordinances. Section 1603 requirements from DFG monitor the extraction rates. Most in-channel deposits at these sites have been depleted, not including recent gravel recruitment from major storm flows in 1995. Upstream recruitment rarely occurs because of Black Butte Dam, therefore current sources are predicted to be depleted by the year 2038 (DMG, 1997). Some recruitment is likely from lateral channel erosion processes. Inevitable depletions could change the pattern of existing operations which could increase the width and depth of the outer margins of existing mines to within permitted boundaries.

Other permitted mines near I-5 (four in Reach 2) could increase extraction rates, pending the outcome of negotiations with Caltrans over mining conditions imposed by the State to prevent channel incision under the I-5 bridge crossing. All mines in lower Stony Creek are permitted for bar skimming. Pit-mining is not allowed.

As Glenn County promotes a gradual shift to permitted gravel extraction in off-channel terrace mines, in-channel mining operations may taper to a lower level as sites with existing permits are further depleted. Future Streambed Alteration Agreements under Section 1603 of the California Fish and Game Code, renewed annually, may require additional conditions that also encourage an industry shift to off-channel mine sites. If in-channel mining was phased out by the industry or through county ordinance in future years, gradual gravel recruitment from bank erosion would occur at some level.

The Stony Creek alluvial fan includes extensive aggregate deposits (i.e., labeled Qrf in Figure 2-2, page A-2-3) on former historic channel courses south of the existing active zone of the creek.

Impacts of Gravel Mining to Vegetation.

In-channel mining may affect riparian and wetland vegetation in several direct and indirect ways if not properly mitigated, including:

- Disturbance of surface vegetation to gain access to bank, bar, and subsurface deposits.
- Indirect prevention of colonization by native tree and shrub seedlings through removal of silt deposits and point bars that provide germination and growth sites, and by channel flattening that prevents concentrations of low flows needed to irrigate young saplings.
- Frequent disruption of the active channel and floodplain which may promote the establishment of noxious weeds and exotic shrubs, such as tamarix and giant reed.
- Channel instability during high flows that may cause vegetated outer banks and bars to erode, undermining otherwise stable vegetation stands.

[The impacts of gravel mining on vegetation have been disputed by Task Force members]

Cessation or curbing of in-channel mining on all or part of Stony Creek may not necessarily result in the rapid reintroduction of riparian forest and scrub. Unstable channel conditions may persist for several years, altered hydrology may no longer support ideal conditions for forest establishment and succession, and rapid invasion by exotic shrubs may suppress native colonization of the bars and floodplain. Observations of forest regeneration test plots or at recently abandoned/reclaimed mine sites in Reaches 2 and 3 would provide additional information to help predict the potential for long-term reestablishment of riparian habitats.

Review of 1950s and 1960s aerial photographs by CH2MHILL geomorphologists, show that Reach 3 did not support much woody riparian vegetation; the channel floodplain was covered primarily by bare gravel deposits interspersed with small fingers of scrub or trees in discontinuous arcs growing in old channel meander scars. Pre-dam hydrologic records suggest that the lower reaches were dry from June through October in most years. Natural channel scour and reburial, coupled with drought-like conditions during the growing season, did not appear to support lush or late-seral riparian vegetation except in small stands or at the floodplain margins where finer soils provided greater moisture retention. This observation is consistent with personal recollections by Donald Thomas, President of Orlando Sand & Gravel, in his letter commenting on Working Draft No. 2 of Draft Plan dated January 31, 1996.

However, post-Black Butte Dam hydrology may support more in-channel vegetation, native and exotic, in former mined sites in Reaches 2 and 3 because of the increased availability of surface and subsurface water to plants during the growing season. Altered hydrology has resulted in a decrease in winter and spring flows, and a corresponding fivefold increase in releases to Stony Creek during the summer and fall. Although much of this water is diverted upstream of mining sites in Reaches 2 and 3, a percentage of irrigation water returns to the channel zone as agricultural or canal tailwater, or as groundwater gain in Reach 2 where the water table is assumed to be at or near the surface for all or part of most years. Subsurface flow may be present in Reach 2 where channel deposits are coarse and highly porous.

In general, at current levels and methods of in-channel mining, native riparian vegetation will not reestablish beyond existing cover, but giant reed and possibly tamarix are likely to expand to new areas faster than mine operators can control these weed species. Reductions of the extent of in-channel mining will likely result in more vegetated bars and low flow shorelines than were present historically. The causes of giant reed establishment has been disputed.

Giant reed control would probably be most effective if it were limited to upstream of the I-5 bridge. Downstream from there it may be difficult to control successfully without modified management of in-stream gravel mining and channel instability. Giant reed exists predominantly in the lower reaches in disturbed areas. The giant reed may be the only plant to survive the extreme levels of disturbance in the gravel mining operation areas and may provide some level of gravel bar and creek bank stability.

The Glenn County 1997 ARMP identifies provisions of creek channel protection and permitting requirements to attempt to ensure that mining does not adversely affect in-stream infrastructure. It is the intent of the ARMP to provide incentives for future mining to be conducted in areas less subject to land use conflict and environmental concerns.

Future Effects of Gravel Mining on Channel Morphology

Bar-skimming in Reach 2 may result in long-term conditions similar to existing conditions, unless operations are expanded to new areas of the channel. Extensive bar-skimming in Reach 3 could cause accelerated channel incision, increased rate of lateral bank migration, and existing channel braiding but with shallow braids connected by isolated pools during low flow conditions, unless more off-stream pit mining takes place as is currently encouraged by DFG conditions.

Future Effects of Gravel Mining on Hydrology.

Bar-skimming in Reach 2 is likely to result in long-term hydrologic conditions similar to existing conditions unless operations are expanded to new areas of the channel. Extensive bar skimming operations in Reach 3 have had an overall effect of lowering the streambed in the vicinity of the Highway 32 bridge, and could result in more discontinuous low flow conditions, because a greater portion of upstream releases will be captured by the low areas, and more surface flow will be lost to groundwater recharge or evaporation. This will affect onsite and downstream aquatic resources and fish passage.

Mining which results in the lowering of the thalweg could result in increased channel incision. If thalweg lowering extends below the shallow water table groundwater gain to surface flow will result, with a corresponding lowering of the local water table, decreasing with lateral distance from the low flow channel.

[The effects of gravel mining on vegetation and channel morphology and hydrology have been disputed by Task Force members]

Those responsible parties who wish to improve the current land-based conditions of lower Stony Creek may use the information stated above in their efforts.

Appendix H
Channel Geomorphology

APPENDIX H

Impact of Changing Geomorphology

Current Conditions

The hydraulic and fluvial geomorphic conditions in Table H-1 and Table H-2 are described below.

Hydraulic Conditions (Columns 1 through 9)

Discharge (Q_2 and Q_{10}). The discharge equaled or exceeded in one out of 2 and 10 years is depicted as Q_2 and Q_{10}, respectively. Q_2 is traditionally considered to be close in magnitude to the channel forming flow, and Q_{10} represents a moderate flood event.

From flood frequency analyses, Swanson and Kondolf (1991) showed that both the two-year flood (Q_2) and the 10-year flood (Q_{10}) have decreased in magnitude since construction of the dam. They indicated that the duration of these flows increased. "Regulation has effectively eliminated most large floods, while increasing the duration of bankfull flows." Because the dam tends to have sustained releases, we assumed that the duration of the 10-year flood also increases.

Hydrograph Pattern. The hydrograph pattern also influences the channel geomorphology. Natural flood hydrographs are smoothly varying curves with water levels rising during early flood stages, and falling continuously when storms end. When reservoir releases are regulated, more abrupt changes occur in the water surface elevation of the stream downstream from dams. This can accelerate bank erosion. The pre- and post-dam changes in the hydrograph pattern cause unstable conditions for the geomorphology of the creek.

Width (w) and Depth (H). The width and depth of the stream refer to the average top width at the water surface and the average depth of the water. The average depth is often computed by dividing the calculated area by the top width. Table H-1 does not provide numerical values for these magnitudes. These data exist in the appendixes to the Swanson and Kondolf (1991) report, but were not analyzed for this Plan because of time constraints. Arrows indicate the relative increase or decrease in width and depth.

Slope (S). The slope is the average water surface gradient (or gradient of the bed surface) of the creek. The magnitudes of these values were taken from USGS topographic maps by Swanson and Kondolf (1991). The overall slope of the channel is not appreciably changing. Reach 1 is decreasing because of the change in planform shape in that location. As the planform (shape as seen from the air) increases in sinuosity, slope decreases.

Median Particle Size (D_{50}). The median particle size is the size of the median bed surface particle. Swanson and Kondolf (1991) performed samples at characteristic locations on point bars using two methods, pebble counts and bulk samples. The magnitudes of the median size represent the general trends for particle sizes along the creek.

Fluvial Geomorphic Conditions (Columns 10 through 17)

Channel Planform Category. Channel planform category refers to the shape of the channel as seen from the air. The two main planform categories considered at Stony Creek are braided (multi-channeled with mid-channel bars) and meandering with point bars.

Sinuosity. Channel sinuosity is defined as the ratio of the distance measured along the channel centerline to the distance along the valley centerline. It measures the cumulative degree to which the channel is curved. An increase in channel sinuosity indicates that the channel is actively migrating. Values for the channel sinuosity were reported in Reach 1 only.

Stability. Channel stability refers to the rate of change of the channel pattern, where rapidly changing planforms are less stable than ones that change more slowly.

Depth from Floodplain (H_{fp}). Often called channel incision, the depth from the floodplain is the distance from the channel bed to the flat area, the floodplain, or the terrace, where overbank flows can escape the channel.

Floodplain Width (w_{fp}). Floodplain width refers to the width of the actively forming flat area adjacent to the river, which is being formed in the current flow regime.

Sediment Transport Rate (Q_s). The sediment transport rate is the sum of the bedload transport rate and the suspended load transport rate. Table H-1 refers to the annual sediment transport rate.

Sediment Transport Supply (Sed supp). The sediment supply refers to the amount of sediment available for transport.

Table H-1
Pre- and Post- Black Butte Dam Conditions and their Impacts on Channel Geomorphology

		Hydraulic Conditions									Fluvial Geomorphic Conditions							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
											Planform							
	Reach	Q_2 mag (cfs)	Q_2 dur	Q^{10} mag (cfs)	Q_{10} dur	Hydro-graph pattern	w	H	S	D_{50} (mm)	Category	Sinuosity	Stability	Rate of change	H_{fp}	w_{fp}	Q_s	Sed supp
Pre-dam conditions	1	14,500	*	45,000	*	smooth	*	x	x > .0024	x	braided	1.08	*	*	x	*	x	x
	2	14,500	*		*	smooth	*	x	.0018?	x	braided	x	*	*	x	*	x	x
	3	14,500	*		*	smooth	*	x	.0021?	x	braided	x	*	*	x	*	x	x
	4	14,500	*		*	smooth	*	x	.0010	x	meandering	*	*	*	x	*	x	x
Post-dam conditions	1	10,000	↑	15,000	↑	abrupt	↑	↓	↓ .0024	≈ 15 ↑?	single channel	1.18	lateral migration	*	↑ (1-3) ft	*	*	0 ↓
	2		↑		↑	abrupt	↓	?	.0018	↑?	braided but → single thread	↑	more stable (const.)	*	↓ (3) ft	*	*	20% ↓
	3		↑		↑	abrupt	↓	?	.0021	≈ 9 ↑?	narrower active channel	↑	*	*	↑ (3-15) ft	*	*	↓
	4		↑		↑	abrupt	↓	=	= .0010	≈ 7 ↑?	=	=	=	=?	=?	*	*	↓
Describes overall change		↓	↑	↓	↑ ?	stable ↓ unstable	↓	↑	↓	↑	braided → meander	↑	↓	↑	↑	↑	*	↓

(x) indicates that the quantity is unknown
(↑) indicates an increase in this quantity
(↓) indicates a decrease
(=)indicates that the quantity stays the same
(?) indicates speculation unconfirmed by data
(*) indicates that these data could be determined with further study

Table H-2
Changes in Current Conditions and their Impacts on Changing Channel Geomorphology

		Hydraulic Conditions									Fluvial Geomorphic Conditions							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
											Planform							
	Reach	Q_2 mag (cfs)	Q_2 dur	Q_{10} mag (cfs)	Q_{10} dur	Hydro-graph pattern	w	H	S	D_{50} (mm)	Category	Sinuosity	Stability	Rate of change	H_{fp}	w_{fp}	Q_s	Sed supp
Current conditions	1	10,000 (1)	* (1)	15,000 (1)	* (1)	abrupt	(5)	(5)	.0024	≈ 15 (6)	single channel	1.18	lateral migration	*	*	*	*	0
	2	(2) Reach 1 North Canal	* (2)	(2) Reach 1 North Canal	* (2)	abrupt	(5)	(5)	.0018	(x) (7)	braided but → single channel	*	more stable (const.)	*	*	*	*	20% of historic
	3	(3) Reach 2 TCC	* (3)	(3) Reach 2 TCC	* (3)	abrupt	(5	(5)	.0021	≈ 9 (6)	narrower active channel	*	unstable due to mining	*	*	*	*	(11)
	4	(4) Reach 3 GCID	* (4)	(4) Reach 3 GCID	* (4)	abrupt	(5)	(5)	.0010	≈ 7 (6)	sinuous	*	stable	*	*	*	*	(11)
Change in current conditions	1	**	**	**	**	** (8)	*	*	*	*	=	*	*	*	*	*	* (10)	(11)
	2	**	**	**	**	**	*	*	*	*	braided but → single channel	*	*	*	*	*	*	(11)
	3	**	**	**	**	**	*	*	*	*		*	*	*	*	*	*	(11)
	4	**	**	**	**	**	=	=	=	*	=	*	=	*	*	*	*	(11)
Describes overall change		**	**	**	**	**	*	*	*	*	(9)	*	*	*	*	*	*	(11)

Table H-2

Changes in Current Conditions and their Impacts on Changing Channel Geomorphology

Hydraulic Conditions											Fluvial Geomorphic Conditions							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
											Planform							
	Reach	Q_2 mag (cfs)	Q_2 dur	Q_{10} mag (cfs)	Q_{10} dur	Hydro-graph pattern	w	H	S	D_{50} (mm)	Category	Sinuosity	Stability	Rate of change	H_{fp}	w_{fp}	Q_s	Sed supp

These notes provide pre- and post-Black Butte Dam conditions and their impacts on channel geomorphology.
(↑) indicates an increase in this quantity
(↓) indicates a decrease
(=) indicates that the quantity stays the same
(*) indicates that these data could be collected in a future study
(**) indicates a management option

Comments

(1) The North Canal is located in the midpoint of the Swanson and Kondolf (1991) Reach 1. The hydrograph for part of this reach will differ from the inflow hydrograph from Black Butte Dam according to the operation of the North Canal.

(2) The TCC is located approximately 0.5 mile upstream from the end of Reach 2. The hydrograph for part of this reach will differ from the inflow hydrograph from Reach 1 according to the operation of the TCC.

(3) The South Canal, located in the mid-portion of Reach 3, will alter the hydrograph for part of this reach.

(4) The GCID, located in the middle of Reach 4, will alter the hydrograph of Reach 4.

(5) These values could be quantified from the surveyed cross-sections of Swanson and Kondolf (1991).

(6) Particle sizes are crude estimates that were derived from analysis of the Swanson and Kondolf (1991) data. These particle sizes were sampled from point bars.

(7) There is inadequate data available for a good estimate of the particle size in this reach.

(8) The current channel is continuing to migrate in selected locations, which are described by site in Chapter 2. This migration shows typical meander migration of sinuous channels and also possible avulsive patterns of braided channels (see site-specific discussion).

(9) The annual sediment transport rate is a direct result of the flow magnitude and duration, and the sediment supply. This could be calculated using a combination of field measurements and numerical modeling.

Note:

Flow release procedures can create a smoother hydrograph with "ramped" increases and decreases in discharge. In addition, the ramping can be made to occur at seasonal times that simulate the seasonal patterns of natural hydrographs.

Appendix I
Stony Creek Streambed Substrate

APPENDIX I

PRELIMINARY ASSESSMENT OF STREAMBED SUBSTRATE FOR SALMON SPAWNING IN STONY CREEK, CALIFORNIA

February 1998

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INTRODUCTION

The purpose of this project was to conduct a preliminary assessment of streambed substrate characteristics at potential anadromous salmonid spawning areas in Stony Creek in northern California (Figure 1). The study was conducted because of recent state and federal programs proposing implementation of measures to promote salmon spawning in Stony Creek.

METHODOLOGY

Streambed substrate samples were taken from potential salmon spawning areas (based on visual assessment) in Stony Creek downstream of Black Butte Reservoir (Figure 2). Emphasis was placed on the two-mile reach downstream of Black Butte Reservoir based on information provided in Puckett (1969). Samples were collected during December 1996 and November 1997. Streambed samples were collected by inserting a 20.3-cm-diameter McNeil core sampler approximately 28 cm into the streambed at areas considered potential suitable spawning habitat (e.g., the head of riffles exhibiting suitably sized substrate on the surface). Substrate materials within the core of the sampler were removed by hand down to the bottom of the sampler core (i.e., flush with the bottom of the sampler). Following removal of material by hand, a circular disc with an external O-ring was inserted down to the bottom of the sampler to create a water-tight seal at the base of the core sampler. Several 1.3 cm long pins protruding in the cylinder at the base prevented the disc from dislodging. All water with fine streambed material suspended within the sampler was then removed from the stream and added to a 19-liter bucket containing the larger-sized substrate removed by hand.

Substrate composition for each sample was determined by wet sieving through four U.S. Standard brass sieves (American Society for Testing and Materials - ASTM) of the following sieve sizes:

ASTM Sieve Number	Sieve Size Opening Millimeters	Sieve Size Opening Inches
½	12.5	0.5
4	4.75	0.187
8	2.36	0.0937
20	0.85	0.0331

For informational and illustrative purposes, Table 1 gives the particle size descriptions used by various agencies and in this report. Of particular importance is this study was the percent composition of particle sizes less than 4.75 mm (or the percent "fines" including very fine gravel and coarse sand) (discussed in the results and discussion section in this report). Percent

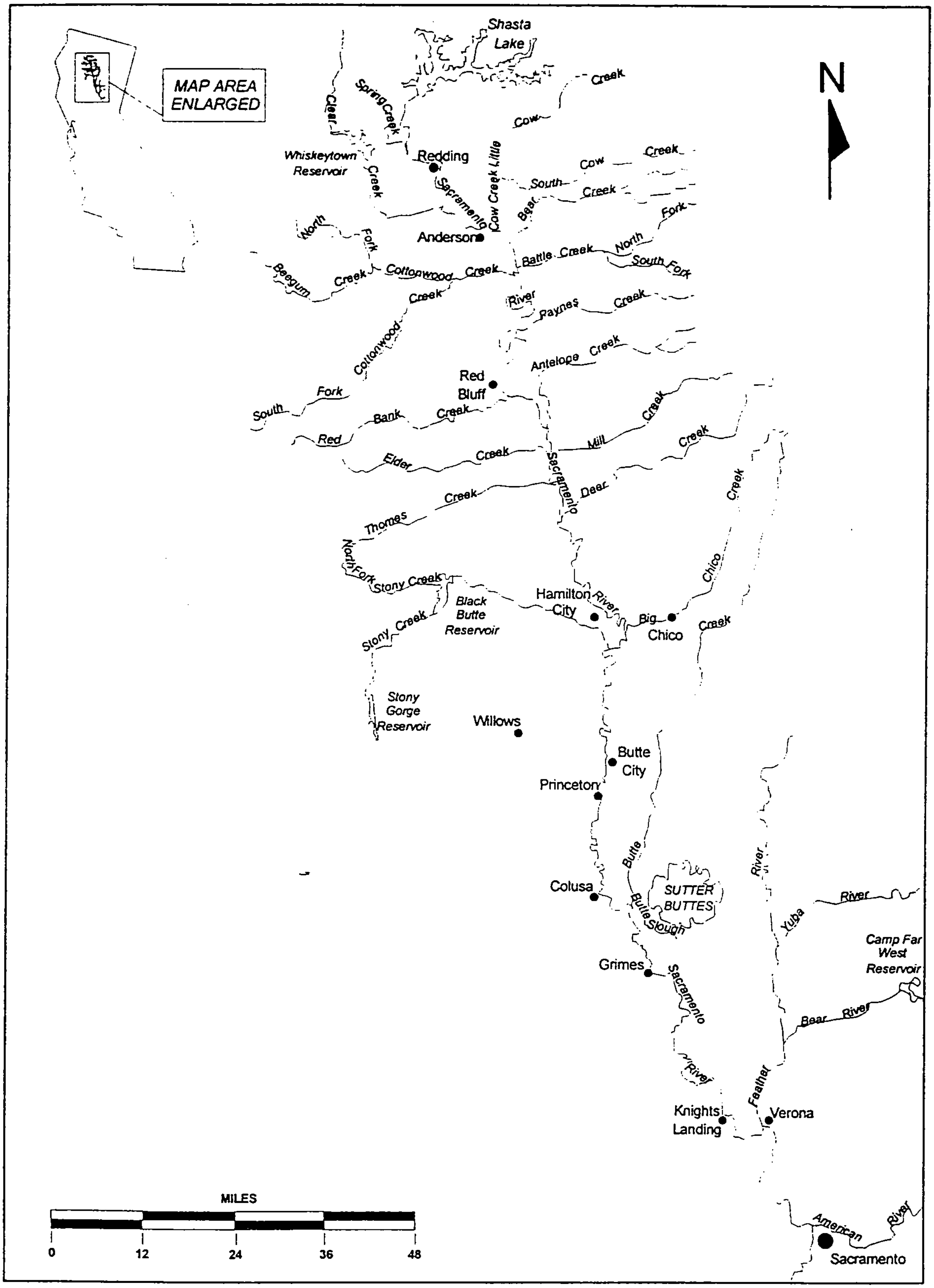


Figure 1. The Sacramento River and principal tributaries.

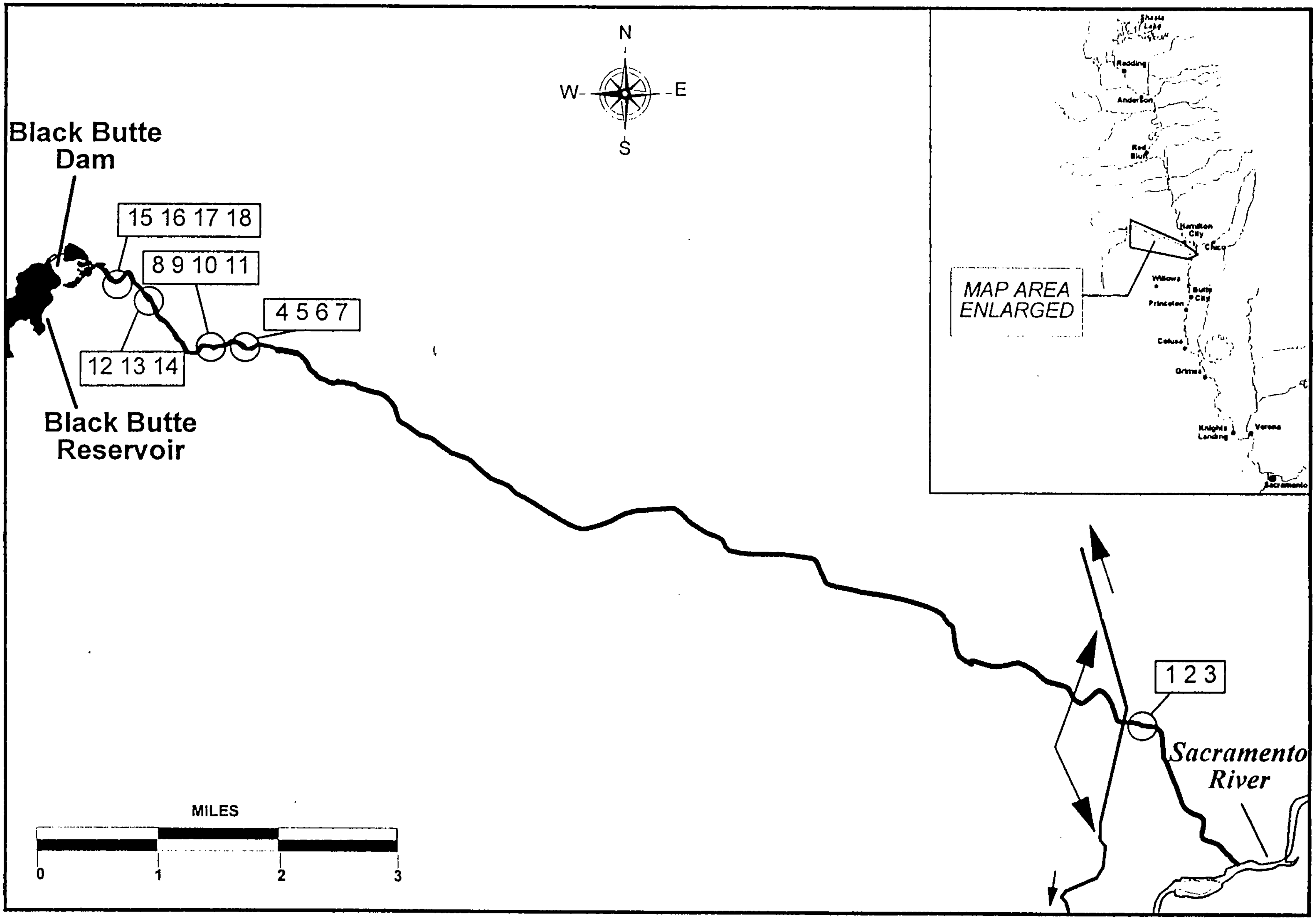


Figure 2. Stony Creek showing riverbed substrate sampling locations.

NPEG | Soil Mechanics | Soil Classification by Texture

Table 1. Comparison of Particle Sizes for Various Classification Systems

ASTM	Colloids*	Clay	Silt	Fine Sand	Coarse Sand	Gravel				
AASHO	Colloids*	Clay	Silt	Fine Sand	Coarse Sand	Fine Gravel	Medium Gravel	Coarse Gravel	Boulders	
USDA	Clay	Silt	V. Fine Sand	Fine Sand	Medium Sand	Coarse Sand	V. Coarse Sand	Fine Gravel	Coarse Gravel	Cobbles
FAA	Clay	Silt	Fine Sand	Coarse Sand	Gravel					
USCS	Clay**	Silt**	Fine Sand	Medium Sand	Coarse Sand	Fine Gravel	Coarse Gravel	Cobbles		

Sieve Numbers						200	140	60	40	20	10	4	1/2"	3/4"	3"
Particle Size, mm	.001	.002	.005	.02	.05	.074	.1	0.25	0.42	0.84	2.0	4.76	12.7	19.05	76.2

* Colloids included in clay fraction in test reports.

** The LL and PI of "Silt" plot below the "A" line on the pasticity chart and the LL and PI of "Clay" plot above the "A" line.

composition of each substrate size grouping by sample was determined by drying and weighing each sample.

RESULTS AND DISCUSSION

Results of the 18 substrate samples collected in Stony Creek are given in Table 2. The percent fines <0.85 mm-particle diameter in the samples collected was considerably less than that reported in the literature for many anadromous-salmonid producing rivers and streams on the west coast. However, the composition of fine particles less than 4.75-particle diameter (cumulative for all smaller classifications) is higher than desirable for salmon spawning and egg incubation.

Characteristics of Salmon Spawning and Egg Incubation

Because the principal concern on the potential effects of the presence of fines on salmonid reproductive success, it is useful to describe characteristics associated with salmon spawning. The basic components of salmonid spawning behavior are similar for most salmonids that spawn in streams (Tautz and Groot 1975). Salmonids select sites in the stream or river where suitable water velocities, depth, and substrate are present. High water velocities are necessary to provide inducement to spawning salmon and sufficient interstitial flow through salmon redds for egg incubation (Vogel 1983). Tautz and Groot's (1975) observations of chum salmon (*Oncorhynchus keta*) and rainbow trout spawning indicated that velocity and gravel size are important only insofar as they influence the ease with which a redd can be constructed. Their observations of rainbow trout spawning suggested that flow acceleration rather than velocity per se was a principal factor influence the selection of spawning sites. Sites selected by salmon and trout for redd construction are generally located just upstream of riffle crests (Lisle 1989).

Briggs (1953) has described in detail how anadromous salmonids construct redds in river gravels. The female turns on her side and digs vigorously by placing the tail flat against the substrate and suddenly lifting it upward with a powerful muscular contraction. The resultant hydraulic action is strong enough to loosen stones and finer material and to move them several inches upward. This redd-building activity removes some fine sediments from the redd prior to spawning (Everest et al. 1987). Coarse material is carried a short distance by the current and deposited a short distance downstream and fine material is swept out of the immediate vicinity of the redd. After repeating this process numerous times, a pit is formed, usually oblong in shape with the long axis parallel with the flow. Soon after excavation of the pit, the spawning act takes place when one or more males move along side of the female at the deepest portion of the pit and the gametes are released simultaneously. Once the eggs and milt have been released, the female moves just upstream of the pit and repeats the digging activity which dislodges coarse streambed material back onto the eggs, effectively burying them (Vogel 1989). The process generally

Table 2. Particle size composition for riverbed substrate samples taken in Stony Creek using a 20.3-cm diameter McNeil sampler.

			PERCENT RETENTION BY SIEVE SIZE				
McNeil Sample No.	Date of Sample	Sample Size(g)	12.5mm	4.75mm	2.36mm	0.85mm	<0.85mm
1	12/04/96	14920.5	42.6	32.6	17.1	5.5	2.2
2	12/04/96	16200.5	43.4	30.6	15.5	7.9	2.6
3	12/04/96	14226.1	42.9	29.4	15.3	9.7	2.7
4	10/17/97	14377.2	58.5	15.1	6.4	15.3	4.7
5	10/17/97	16710.7	47.4	20.5	16.3	12.3	3.4
6	10/17/97	12085.3	51.4	16.5	12.8	14.6	4.7
7	10/17/97	16023.0	58.4	12.0	9.0	16.8	3.7
8	10/17/97	13995.1	31.8	21.2	18.6	17.3	11.1
9	10/17/97	14979.9	29.0	41.0	14.3	8.4	7.2
10	10/17/97	12683.8	54.6	20.8	10.5	9.5	4.6
11	10/17/97	11402.7	45.8	24.4	12.9	10.5	6.4
12	10/17/97	12585.6	57.3	18.7	9.1	8.1	6.8
13	10/17/97	11470.4	63.7	15.1	7.7	8.1	5.3
14	10/17/97	9605.8	61.1	18.4	7.6	8.1	4.7
15	10/17/97	13781.7	50.2	21.8	13.1	11.8	3.1
16	10/17/97	11883.8	51.8	29.2	11.2	5.2	2.6
17	10/17/97	15065.6	54.7	22.7	13.0	7.5	2.0
18	10/17/97	14490.0	55.2	18.6	13.7	10.4	2.2
Average (S.D.)			50.0(9.5)	22.7(7.3)	12.5(3.5)	10.4(3.6)	4.4(2.3)

continues in a relative upstream direction until several or numerous eggs pockets are buried in the redd.

Once laid in the river gravels, eggs and larvae must receive sufficient supply of oxygenated water of suitable temperature and free from toxic contaminants. After water hardening, the egg capsule allows for the diffusion of oxygen molecules to the embryo but is impervious to water molecules. Wells and McNeil (1970) found that the largest and fastest developing embryos and alevins of pink salmon (*Oncorhynchus gorbuscha*) came from spawning gravels characterized by high levels of dissolved oxygen in intragravel water. Embryos are most susceptible to low dissolved oxygen at the time of hatching; larvae are more tolerant of low dissolved oxygen than are embryos[1] (McNeil 1965). Cooper (1956), as cited by Cooper (1965), concluded from his research on sockeye salmon (*Oncorhynchus nerka*) eggs that the period during or after hatching of the eggs are the most critical with respect to reductions in the flow of oxygen to the eggs. The delivery rate of oxygen to the egg is a function of intragravel water velocity and the concentration of oxygen (Wickett 1954).

Effects of Fine Sediments on Eggs and Alevins

Lisle and Eads (1991) state that the threshold of concern for fine sediment content vary between experiment, species, and grain size of fine sediment, but most commonly is around 20 percent. The amount of fine sediment which may be detrimental to naturally spawning salmonids is related to particle size, specific composition and spatial distribution of the spawning gravels, species or stock of fish, timing and amount of deposition, locations of the eggs and egg pockets in redds, and numerous other complex processes and interrelationships not entirely understood. Varying results between field and laboratory studies are largely attributable to the fact that physical features of natural streams and life history and behavioral adaptations of salmonids mitigate the effects of sediment on fish populations in natural environments (Everest et al. 1987). The general concern over the potential effects of fines on salmonid reproduction is widely recognized and should be assessed on a site-specific basis. The following discussion presents some of the reasons for that concern as well as a variety of considerations on this issue. The following information is not intended to be a comprehensive review of most scientific information applicable to this issue; other researchers have done so and the reader can obtain additional information from those sources (e.g., Cordone and Kelley 1961; Iwamoto et al. 1978; Everest et al. 1987; Chapman 1988).

Heavy siltation on the eggs can reduce intragravel water flow to lethal levels (Wickett 1954). Fine sediment has a large influence on gravel permeability; finer sediments can be more effective

[1] This phenomenon is attributable to the initiation of active respiration across gill membranes which greatly increases respiratory areas for larvae as compared to embryos in the egg capsule (McNeil 1965).

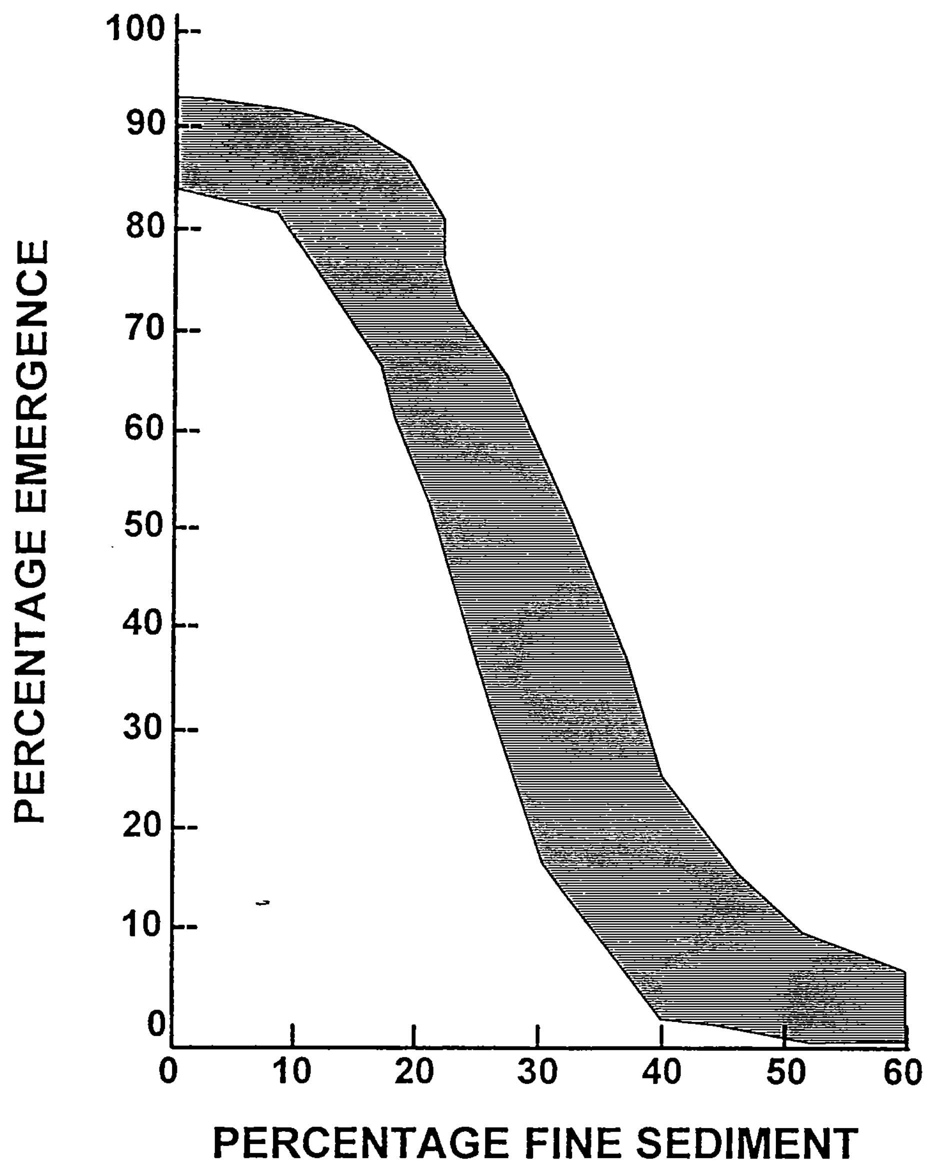


Figure 3. Percentage emergence of swim-up fry placed in gravel-sand mixtures in relation to the percentage of sediment smaller than 2-6.4 mm in studies by Bjornn (1968), Phillips et al. (1975), Hausle and Coble (1976), and McCuddin (1977). The stipled area includes data from eight tests on brook trout, steelhead, and chinook and coho salmon. (adapted from Bjornn and Reiser 1991)

in reducing intragravel flow than coarser sediments (Cooper 1965). Hausle and Coble (1976) found that excessive amount of fines surrounding incubating eggs can be deleterious to eggs and alevins by reducing intragravel water flow. The principal benefits resulting from adequate water velocity to incubating salmonid embryos are the concurrent functions of transferring sufficient dissolved oxygen to the surface of the egg membrane and the removal of the eggs' metabolic waste products (Brannon 1965; Hausle and Coble 1976.).

Much of the current understanding of the effects of varying degrees of percent fines related to salmonid survival has been derived from various laboratory studies. Bjorn (1969a) found that chinook salmon embryo mortality in gravel with 30-40 percent sand (interstices filled) may approach 50 percent and 30 to 50 percent for steelhead. Bjorn (1969a) found that the incubation and emergence success of steelhead did not decline unless percent sand in the gravels exceeded 20 percent (≥ 30 percent). Phillips et al. (1966), as cited by Bjorn (1969b), reported that survival to emergence of Oregon coho and steelhead in gravel-sand mixtures with 30 percent fines (1-3 mm) was approximately 40 and 65 percent, respectively. Bjorn (1969b) found that chinook salmon fry from green egg to emergence in laboratory studies was reduced in gravel with 18 percent or more sand. Rantz (1964) used a criteria of 20 percent silt and sand for favorable spawning conditions in streambed substrate in northern California coastal streams based on a composite of criteria derived from studies by CDFG and other Pacific Coast conservation agencies. In their studies of brown trout embryo and alevin survival relative to redd gravel composition, Witzel and MacCrimmon (1983) noted that the highest survival rate of alevins occurred at a concentration of 20 percent sand. Survival in their study was measured at 0 percent at 80 percent sand, 17 percent at 60 percent sand, 77 percent at 40 percent sand, 96 percent at 20 percent sand, and 84 percent at 0 percent sand. Figure 3 shows a composite of several investigations on the effects of fine particles on salmonid fry emergence in gravel-sand mixtures.

Field investigations have also contributed to current understanding of the effects of varying degrees of fines on salmonid reproductive success. In experiments conducted by Meehan and Swanston (1977), they did not find any apparent adverse effects on salmon egg survival with fine sediment (<0.833 mm) deposition up to 14 percent composition in the substrate; substantially lower egg survival occurred in most of their samples with much less sediment deposition (e.g. 5-6 percent) but they were unable to explain this phenomenon other than to hypothesize that eggs deposited in a natural stream environment are subject to gravel disturbance (where low sedimentation and low survival occurred) as compared to their artificial controlled flume where disturbance was minimal (where higher sedimentation and higher survival occurred). Koski (1966) studied survival of coho eggs and fry in three Oregon streams as related to several in-redd parameters and found that survival was inversely correlated with fine sediments smaller than 3.327 mm. A noticeable threshold in survival was evident when percent fines (<3.327 mm) exceeded 36 percent. Although both gravel permeability and dissolved oxygen concentration in the redds were directly related to survival, the relationship was not statistically significant; he speculated that this was attributable to the interrelationships of other environmental factors affecting survival. Tagart (1976), as cited by Tappel and Bjorn (1983), studied the survival of coho from egg deposition to emergence in the Clearwater River, Washington, and reported that survival in natural redds decreased when more than 20 percent of the substrate was composed of fines (<0.85 mm).

Platts (1991) indicates that it is inappropriate and misleading to assume that channel conditions characterized from channel core samples would indicate what conditions may be in a salmonid egg pocket. He further stated that salmonid egg-alevin mortality analysis should not be conducted simply from analysis of stream channel substrate core samples. Because streambed substrate characteristics can vary over time, one-time substrate analysis cannot accurately reflect temporal changes in fine sediments in spawning egg pockets or riffles (Platts 1991). Results of streambed substrate samples collected in Stony Creek should be examined recognizing these caveats (e.g., the samples do not represent substrate composition of egg pockets).

It is widely recognized that salmon reduce the level of fines in the spawning gravels during spawning activities. Fine sediments and organic materials in the streambed substrate tend to be washed downstream as a result of redd building (Bjorn and Reiser 1991). During the process of redd construction, the female removes fines from an area much wider than the egg pockets themselves and the completed redd contains less fine silt and sand than the surrounding undisturbed substrate (Chapman 1988). The removal of fine sediment present in undisturbed gravels during the spawning process provides two benefits for salmonid reproduction: a reduction in the potential entrapment of emergent fry; and increased intragravel permeability, water flow, and oxygen transport to developing embryos. The intragravel permeability within the egg pocket greatly exceeds that of the surrounding streambed substrate and that of redd areas outside of the egg pocket (Chapman 1988). Kondolf (1993) stated that the amount of fines in salmonid spawning gravels should not exceed a threshold level drawn from laboratory and field studies, adjusted for the probable reduction in fine sediment during spawning activities.

Comparisons with Other Sacramento River Tributaries

It is useful to compare the results of streambed samples obtained in Stony Creek to nearby Sacramento tributaries known to support salmon runs. Unpublished data were available for Battle Creek, Deer Creek, Mill Creek, and Big Chico Creek (Figure 1). However, these comparisons should be done with caution because as Everest et al. (1987) have pointed out, the parent material in a basin, its weathering rate, the texture of sediment and soils produced through weathering, and erodibility have a great influence on the amount, texture, and behavior of fine sediments in streams. They add that the ability of streams to move and store bedload sediments is directly related to basin relief and the regimen of annual runoff. Considerable research has identified the fact that the level of fines in streambed substrate can vary considerably between watersheds, annually, seasonally, within watersheds, riffles, egg pockets, and vertically within the substrate (Everest et al. 1987). This study was not intended to address all these factors but rather examine the general situation on a reconnaissance-level basis applicable to Stony Creek.. At the time this study was performed, the only relevant data available for Stony Creek were derived from a study conducted by the California Department of Fish and Game (DFG) in the late 1960s (Puckett 1969).

Stony Creek exhibited a considerably lower proportion of fines <0.85 mm than evident in Battle, Deer, Mill, and Big Chico creeks (Figure 4). However, the proportion of coarser fines <4.75 mm in particle diameter was considerably higher in Stony Creek as compared to the other Sacramento River tributaries. This level of fine material would probably adversely impact salmon fry emergence in Stony Creek.

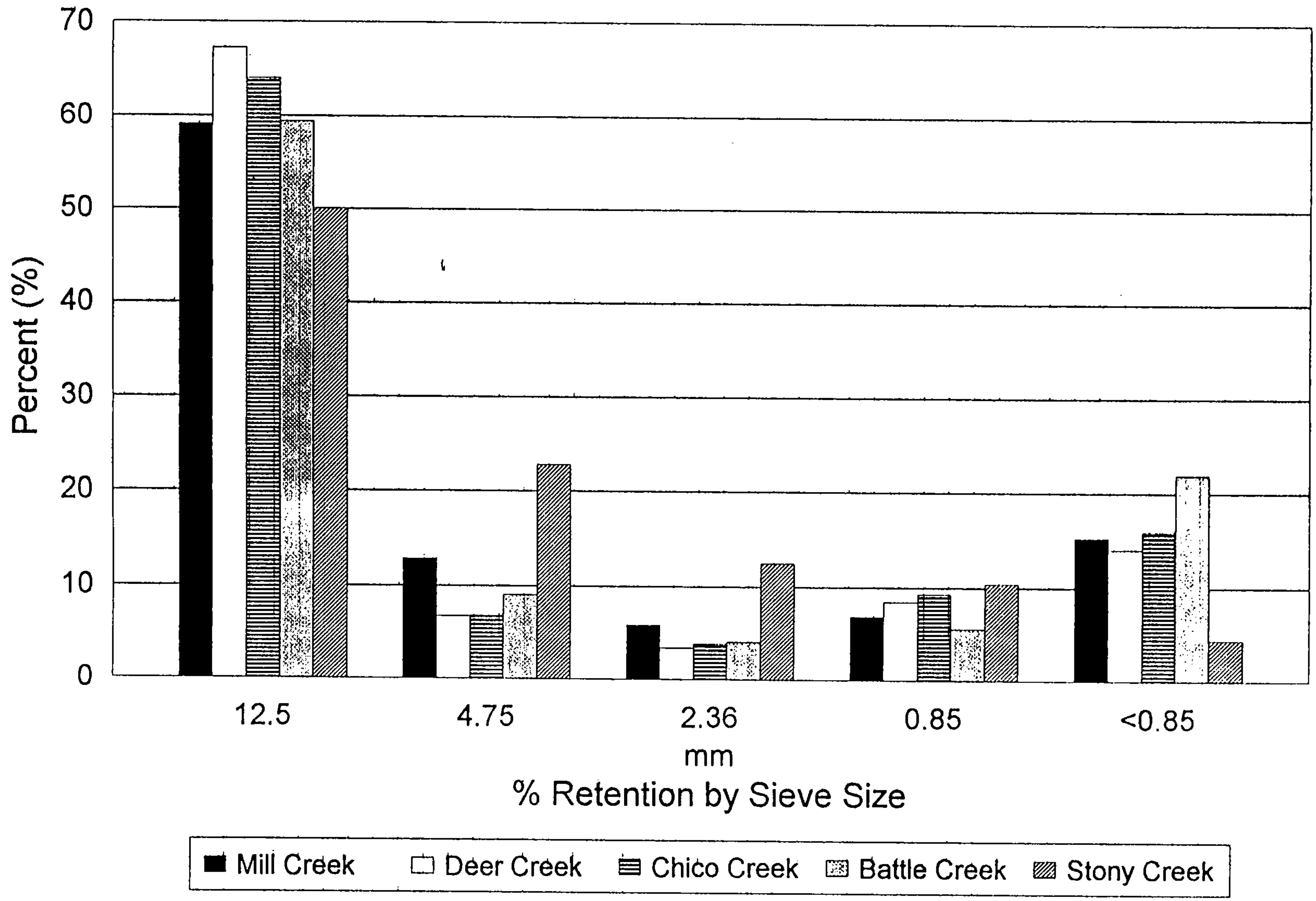
CONCLUSIONS

Results from streambed substrate samples taken in Stony Creek indicated that nearly all samples possessed a level of fine particles (mostly sand) within the level of concern for salmonid reproduction. Although the level of fines < 0.85 mm in particle diameter was less than many salmonid streams on the west coast reported in the scientific literature, the level of fines smaller than 4.75 mm in particle diameter is within the level of concern that would probably adversely impact salmon fry emergence success.

ACKNOWLEDGMENTS

The Tehama-Colusa Canal Authority funded this study. Appreciation is extended to Del and Holly Reimers, the Glenn-Colusa Irrigation District, and other landowners for providing access through their property to sample in Stony Creek.

Figure 4. Comparison of substrate composition in potential salmon spawning areas for five northern California tributaries.



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Appendix J
Special-Status Wildlife Species

Table J-1
Special-Status Wildlife Species with Actual or Potential Occurrence along Lower Stony Creek, Glenn and Tehama Counties

	Status[a]				
Species	**Fed/State**	**California Distribution**	**Habitats**	**Reason for Decline or Concern**	**Occurrence in Study Area**
Vernal pool fairy shrimp *Branchinecta lynchi*	T/--	Central Valley from Shasta County to Tulare County, along the Coast Ranges from Solano County to Santa Barbara County, and in southern California in Riverside and San Diego Counties	Vernal pools and other seasonal freshwater wetlands	Habitat loss to agricultural and urban development	None, vernal pools absent from lower Stony Creek (USFWS, 1994)
Vernal pool tadpole shrimp *Lepidurus packardi*	E/--	Shasta County south to Merced County	Vernal pools; ephemeral stock ponds	Habitat loss to agricultural and urban development	None, vernal pools absent from lower Stony Creek (USFWS, 1994)
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	T/--	Streamside habitats below 3,000 feet through the Central Valley of California	Riparian and oak savanna habitats with elderberry shrubs	Loss and fragmentation of riparian habitats	No records in NDDB (1996), but elderberry is present at Stony Creek, and the beetle is present in the study area (USFWS, 1994)
Western spadefoot toad *Scaphiopus hammondii*	C2/SSC	Sierra Nevada foothills, Central Valley Coast Ranges, coastal counties in southern California	Shallow streams with riffles and seasonal wetlands, such as vernal pools in annual grasslands and oak woodlands	Alteration of stream habitats by urbanization and hydroelectric projects; loss of seasonal wetlands and vernal pools	Observed at Rice Creek, north of Stony Creek (NDDB, 1996)
California red-legged frog *Rana aurora draytoni*	PE/SSC	Found along the coast and coastal mountain ranges of California from Humboldt County to San Diego County, and formerly in the Sierra Nevada foothills and midelevations from Butte County to Fresno County	Permanent and semipermanent aquatic habitats, such as creeks and cold water ponds, with emergent and submergent vegetation and riparian species along the edges; may estivate in rodent burrows or cracks during dry periods	Alteration of stream and wetland habitats, over harvesting (historically), habitat destruction, and competition and predation by fish and bullfrogs	No recent records in NDDB (1996), possibly extirpated from Glenn and Tehama Counties (Jennings and Hayes 1994); aquatic habitats along lower Stony Creek considered unsuitable for this species because of the presence of predatory fish and bull frogs (USBR, 1994)

Table J-1
Special-Status Wildlife Species with Actual or Potential Occurrence along Lower Stony Creek, Glenn and Tehama Counties

	Status[a]				
Species	**Fed/State**	**California Distribution**	**Habitats**	**Reason for Decline or Concern**	**Occurrence in Study Area**
Northwestern pond turtle *Clemmys marmorata marmorata*	C2/SSC	In California, range extends from Oregon border of Del Norte and Siskiyou Counties south along coast to San Francisco Bay, inland through Sacramento Valley, and on the western slope of Sierra Nevada; range overlaps with that of southwestern pond turtle through the Delta and Central Valley to Tulare County	Woodlands, grasslands, and open forests; occupies ponds, marshes, rivers, streams, and irrigation canals with muddy or rocky bottoms and with watercress, cattails, water lilies, or other aquatic vegetation	Loss and alteration of aquatic and wetland habitats; habitat fragmentation	Extant in Glenn and Tehama Counties based on verified sightings and museum records (Jennings and Hayes 1994); observed along lower Stony Creek (Maslin pers. comm.; USFWS, 1996)
Giant garter snake *Thamnophis gigas*	T/T	Central Valley from Fresno north to the Gridley/Sutter Buttes area; has been extirpated from areas south of Fresno	Sloughs, canals, and other small waterways where there is a prey base of small fish and amphibians; requires grassy banks and emergent vegetation for basking and areas of high ground protected from flooding during winter	Loss of habitat from agriculture and urban development	Observed in southwestern Butte County, but no records of this species exist in the NDDB (1996) near Stony Creek
Double-crested cormorant *Phalacrocorax auritus*	--/SSC	Winters along the entire California coast and inland over the Coast Ranges into the Central Valley from Tehama County to Fresno County; a permanent resident along the coast from Monterey County to San Diego County, along the Colorado River, Imperial, Riverside, Kern, and King Counties, and the islands off San Francisco; breeds in Siskiyou, Modoc, Lassen, Shasta, Plumas, and Mono Counties; also breeds in the San Francisco Bay Area and in Yolo and Sacramento Counties	Rocky coastlines, beaches, inland ponds, and lakes; needs open water for foraging, and nests in riparian forests or on protected islands, usually in snags	Loss of coastal and riparian breeding sites; human disturbance	No specific records in NDDB (1996), but probably regular along lower Stony Creek

Table J-1
Special-Status Wildlife Species with Actual or Potential Occurrence along Lower Stony Creek, Glenn and Tehama Counties

	Status[a]				
Species	**Fed/State**	**California Distribution**	**Habitats**	**Reason for Decline or Concern**	**Occurrence in Study Area**
White-faced ibis *Plegadis chichi*	C2/SSC	Both resident and winter populations on the Salton Sea as well as isolated areas in Imperial, San Diego, Ventura, and Fresno Counties; breeds at Honey Lake, Lassen County, at Mendota Wildlife Management Area, Fresno County, and near Woodland in Yolo County; winters in Merced County and along the Sacramento River in Colusa, Glenn, Butte, Sutter, and Yolo Counties	Prefers freshwater marshes with tules, cattails, and rushes, but may nest in trees and forage in flooded agricultural fields, especially flooded rice fields	Loss of wetlands to agriculture and urban development	None; suitable habitats are absent from the study area
Aleutian Canada goose *Branta canadensis leucopareia*	T/--	The entire population winters in Butte Sink, then moves to Los Banos, Modesto, the Delta, and East Bay reservoirs; stages near Crescent City during spring before migrating to breeding grounds	Roosts in large marshes, flooded fields, stock ponds, and reservoirs; forages in pastures, meadows, and harvested grainfields; corn is especially preferred	Introduction of predators on breeding grounds; loss of traditional wintering habitat	None; suitable habitats are absent from the study area
Osprey *Pandion haliaetus*	--/SSC	Nests along the north coast from Marin County to Del Norte County, east through the Klamath and Cascade Ranges, and the upper Sacramento Valley; important inland breeding populations at Shasta Lake, Eagle Lake, and Lake Almanor, and small numbers elsewhere south through the Sierra Nevada; winters along the coast from San Mateo to San Diego County	Nests in snags or cliffs or other high, protected sites near the ocean, large lakes, or rivers with abundant fish populations	Vulnerable to human disturbance at nest sites; pesticide contamination; breeding range and populations increasing in many areas	Regular along the Sacramento River; observed near Stony Creek confluence (Jones & Stokes Associates file data)
White-tailed kite *Elanus caeruleus*	--/FP	Lowland areas west of Sierra Nevada from head of Sacramento Valley south, including coastal valleys and foothills to western San Diego County at the Mexico border	Low foothills or valley areas with valley or live oaks, riparian areas, and marshlands near open grasslands for foraging	Loss of grassland and wetland habitats to agriculture and urban development	No specific records in NDDB (1996), but probably regular in upland habitats along Stony Creek

Table J-1
Special-Status Wildlife Species with Actual or Potential Occurrence along Lower Stony Creek, Glenn and Tehama Counties

Species	Status[a] Fed/State	California Distribution	Habitats	Reason for Decline or Concern	Occurrence in Study Area
Bald eagle *Haliaeetus leucocephalus*	E/E	Nests in Siskiyou, Modoc, Trinity, Shasta, Lassen, Plumas, Butte, Tehama, Lake, and Mendocino Counties and in the Lake Tahoe Basin; reintroduced into central coast; winter range includes the rest of California, except the southeastern deserts, very high altitudes in the Sierras, and east of the Sierra Nevada south of Mono County; range expanding	In western North America, nests and roosts in coniferous forests within 1 mile of a lake, a reservoir, a river, or the ocean	Nest sites vulnerable to human disturbance; pesticide contamination	Two active bald eagle nests were found during aerial surveys of Stony Creek, one at Stony Gorge Reservoir and a second at East Park Reservoir; nonbreeding birds observed at Black Butte Reservoir and occasionally along lower Stony Creek (USFWS, 1994)
Northern harrier *Circus cyaneus*	--/SSC	Throughout lowland California; has been recorded in fall at high elevations	Grasslands, meadows, marshes, and seasonal and agricultural wetlands providing tall cover	Loss of habitat to agricultural and urban development	No specific records in NDDB (1996), but probably regular in grasslands near Stony Creek
Sharp-shinned hawk *Accipiter striatus*	--/SSC	Permanent resident on the Sierra Nevada, Cascade, Klamath, and north Coast Ranges at midelevations, as well as along the coast in Marin, San Francisco, San Mateo, Santa Cruz, and Monterey Counties; winters over the rest of the state except very high elevations	Dense-canopy ponderosa pine or mixed-conifer forest and riparian habitats	Human disturbance at nest sites; pesticide contamination; timber harvesting near nesting sites	No specific records in NDDB (1996), but probably a regular winter visitor to the study area
Cooper's hawk *Accipiter cooperi*	--/SSC	Throughout California except high altitudes in the Sierra Nevada; winters in the Central Valley, southeastern desert regions, and plains east of the Cascade Range; permanent residents occupy the rest of the state	Nests primarily in riparian forests dominated by deciduous species; also nests in densely canopied forests from digger pine-oak woodland up to ponderosa pine; forages in open woodlands	Human disturbance at nest sites; loss of riparian habitats, especially in the Central Valley; pesticide contamination	No specific records in NDDB (1996), but probably a regular winter visitor and possible nester in the study area
Swainson's hawk *Buteo swainsoni*	--/T	Lower Sacramento and San Joaquin Valleys, the Klamath Basin, and Butte Valley; the state's highest nesting densities occur near Davis and Woodland, Yolo County	Nests in oaks or cottonwoods in or near riparian habitats; forages in grasslands, irrigated pastures, and grain fields	Loss of riparian, agriculture, and grassland habitats; vulnerable to human disturbance at nest sites	Recorded nesting along Sacramento River near confluence of Stony Creek at RM 190, west of Golden State Island at RM 190.5, opposite Phelan Island at RM 191.5 (NDDB, 1996)

Table J-1
Special-Status Wildlife Species with Actual or Potential Occurrence along Lower Stony Creek, Glenn and Tehama Counties

	Status[a]				
Species	**Fed/State**	**California Distribution**	**Habitats**	**Reason for Decline or Concern**	**Occurrence in Study Area**
Ferruginous hawk *Buteo regalis*	C2/SSC	Does not nest in California; winter visitor along the coast from Sonoma County to San Diego County, eastward to the Sierra Nevada foothills and southeastern deserts, the Inyo-White Mountains, the plains east of the Cascade Range, and Siskiyou County	Open terrain in plains and foothills where ground squirrels and other prey are available	Conversion of grasslands for agriculture and urban development	No records in NDDB (1996); possible winter visitor to lower Stony Creek (USBR, 1994)
Golden eagle *Aquila chrysaetos*	PR/SSC, FP	Foothills and mountains throughout California; uncommon nonbreeding visitor to lowlands such as the Central Valley	Cliffs and escarpments or tall trees for nesting; annual grasslands, chaparral, and oak woodlands with plentiful medium and large-sized mammals for prey	Habitat loss to urbanization; vulnerable to disturbance at nest sites	No records in NDDB (1996); probable year-round resident and observed along lower Stony Creek (Hughes pers. comm.)
Merlin *Falco columbarius*	--/SSC	Does not nest in California; rare but widespread winter visitor to the Central Valley and coastal areas	Forages along coastlines, open grasslands, savannas, and woodlands; often forages near lakes and other wetlands	Unclear; possible chemical contamination; illegal take of young	No records in NDDB (1996); possible winter visitor
American peregrine falcon *Falco peregrinus anatum*	E/E	Permanent resident on the north and south Coast Ranges; may summer on the Cascade and Klamath Ranges south through the Sierra Nevada to Madera County; winters in the Central Valley south through the Transverse and Peninsular Ranges and the plains east of the Cascade Range	Nests and roosts on protected ledges of high cliffs, usually adjacent to lakes, rivers, or marshes that support large populations of other bird species	Pesticide contamination; population recovering	No records in NDDB (1996); occasional visitor to lower Stony Creek, but suitable nesting habitat is absent in this area (USFWS, 1994)

Table J-1
Special-Status Wildlife Species with Actual or Potential Occurrence along Lower Stony Creek, Glenn and Tehama Counties

Species	Status[a] Fed/State	California Distribution	Habitats	Reason for Decline or Concern	Occurrence in Study Area
Prairie falcon *Falco mexicanus*	--/SSC	Found as permanent resident on the south Coast, Transverse, Peninsular, and northern Cascade Ranges; the southeastern deserts; Inyo-White Mountains; Modoc, Lassen, and Plumas Counties; and the foothills surrounding the Central Valley; winters in the Central Valley, along the coast from Santa Barbara County to San Diego County, and in Marin, Sonoma, Humboldt, Del Norte, and Inyo Counties	Cliffs or escarpments for nesting; adjacent dry, open terrain or uplands, marshes, and seasonal marshes for foraging	Possible pesticide contamination; robbing of eyriesowa by falconers and illegal shooting; human disturbance at nest site	No records in NDDB (1996); but nesting eyries photographed on the slopes of St. John Mountain in 1977 and 1978 (Wilson pers. comm.); possible year-round resident in study area
California gull *Larus californicus*	--/SSC	Winters along the Pacific coast from British Columbia to Mexico; in the interior of California, it frequents the Sacramento River Delta and Central Valley, the plains east of the Cascade Range, northern Plumas County and southwestern Mono County, the Lake Tahoe Basin, the Transverse and Peninsular Ranges, and the Salton Sea; nests at Great Basin lakes and at south San Francisco Bay; largest California breeding colony is at Mono Lake	Forages in a variety of habitats, including beaches, mudflats, freshwater and alkali marshes, rivers, lakes, and urban areas; nests colonially on islands isolated from mainland predators	Exposure of nesting islands at Mono Lake attributable to declining water levels; wintering populations are not considered sensitive and have increased in the past 50 years	Probable winter visitor below Black Butte Dam and elsewhere along lower Stony Creek; not considered sensitive in the nonbreeding season
Western burrowing owl *Athene cunicularia hypugea*	C2/SSC	Lowlands throughout California, including the Central Valley, northeastern plateau, southeastern deserts, and coastal areas; rare along south coast	Rodent burrows in sparse grassland or desert habitats	Loss of habitat; human disturbance at nesting burrows	No records in NDDB (1996); possible year-round resident in uplands near Stony Creek

Table J-1
Special-Status Wildlife Species with Actual or Potential Occurrence along Lower Stony Creek, Glenn and Tehama Counties

	Status[a]				
Species	**Fed/State**	**California Distribution**	**Habitats**	**Reason for Decline or Concern**	**Occurrence in Study Area**
Long-eared owl *Asio otus*	--/SSC	Permanent resident east of the Cascade Range from Placer County north to the Oregon border, east of the Sierra Nevada from Alpine County to Inyo County, along the coast from Sonoma County to San Luis Obispo County, and eastward over the north Coast Ranges to Colusa County; winters in the Central Valley, Mojave and Sonora Deserts, and the Inyo-White Mountains; summers along the eastern rim of the Central Valley and Sierra foothills from Tehama County to Kern County	Dense riparian stands of willows, cottonwoods, live oaks, or conifers; uses adjacent open lands for foraging; nests in abandoned crow, hawk, or magpie nests	Loss of riparian habitats	No records in NDDB (1996); possible roosting habitat in giant reed thickets and other riparian habitats along Stony Creek
Little willow flycatcher *Empidonax traillii brewsteri*	C2/E	Summer range includes a narrow strip along the eastern Sierra Nevada from Shasta County to Kern County, another strip along the western Sierra Nevada from El Dorado County to Madera County; widespread in migration	Riparian areas and large, wet meadows with abundant willows for breeding; usually occurs in riparian habitats during migration	Loss of riparian breeding habitat; nest parasitism by brown-headed cowbirds	No records in NDDB (1996); probable fall migrant along Stony Creek
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	--/E	Nests along the upper Sacramento, lower Feather, south fork of the Kern, Amargosa, Santa Ana, and Colorado Rivers	Wide, dense, riparian forests with a thick understory of willows for nesting; sites with a dominant cottonwood overstory are preferred for foraging; may avoid valley oak riparian habitats where scrub jays are abundant	Loss of riparian habitat to agriculture and water control development; possible pesticide contamination	Observed along Sacramento River, 3.6 miles southwest of Hamilton City, at Indian Fishery Slough, near mouth of Big Chico Creek, and near Golden State Island (NDDB, 1996)

Table J-1
Special-Status Wildlife Species with Actual or Potential Occurrence along Lower Stony Creek, Glenn and Tehama Counties

	Status[a]				
Species	Fed/State	California Distribution	Habitats	Reason for Decline or Concern	Occurrence in Study Area
Bank swallow *Riparia riparia*	--/T	The state's largest remaining breeding populations are along the Sacramento River from Tehama County to Sacramento County, and along the Feather and lower American Rivers, in the Owens Valley; nesting areas also include the plains east of the Cascade Range south through Lassen County, northern Siskiyou County, and small populations near the coast from San Francisco County to Monterey County	Nests in bluffs or banks, usually adjacent to water, where the soil consists of sand or sandy loam to allow digging	Loss of natural earthen banks to bank protection and flood control; erosion control related to stream regulation by dams	Nesting colonies along the Sacramento River at RM 184.8, RM 185.2-185.8, RM 187.9, RM 189, RM 190.5-190.7, RM 192.3, RM 192.6, RM 195.0, and RM 195.4 (NDDB, 1996)
Loggerhead shrike *Lanius ludovicianus*	--/SSC	Resident and winter visitor in lowlands and foothills throughout California; rare on coastal slope north to Mendocino County, occurring only in winter	Prefers open habitats with scattered shrubs, trees, posts, fences, utility lines, or other perches	Loss of habitat and pesticide use; still widespread	No records in NDDB (1996); probable occurrence in upland habitats along Stony Creek
California yellow warbler *Dendroica petechia brewsteri*	--/SSC	Nests over all of California except the Central Valley, the Mojave Desert region, and high altitudes in the Sierra Nevada; winters along the Colorado River and in parts of Imperial and Riverside Counties; two small permanent populations in San Diego and Santa Barbara Counties	Nests in riparian areas dominated by willows, cottonwoods, sycamores, or alders or in mature chaparral; may also use oaks, conifers, and urban areas near streamcourses	Loss of riparian breeding habitats; nest parasitism by brown-headed cowbirds	No records in NDDB (1996); probable migrant in riparian habitats, especially in fall
Yellow-breasted chat *Icteria virens*	--/SSC	Uncommon migrant in California; nests in a few locations with appropriate habitat such as Sweetwater and Weber Creeks, El Dorado County; Pit River, Shasta County; Russian River, Sonoma County; Little Lake Valley, Mendocino County; and Putah Creek, Yolo County	Nests in dense riparian habitats dominated by willows, alders, Oregon ash, tall weeds, blackberry vines, and grapevines	Loss of riparian breeding habitat	No records in NDDB (1996); possible occurrence along Stony Creek

Table J-1
Special-Status Wildlife Species with Actual or Potential Occurrence along Lower Stony Creek, Glenn and Tehama Counties

Species	Status[a] Fed/State	California Distribution	Habitats	Reason for Decline or Concern	Occurrence in Study Area
Tricolored blackbird *Agelaius tricolor*	C2/SSC	Largely endemic to California; permanent residents in the Central Valley from Butte County to Kern County; at scattered coastal locations from Marin County south to San Diego County; breeds at scattered locations in Lake, Sonoma, and Solano Counties; rare nester in Siskiyou, Modoc, and Lassen Counties	Nests in dense colonies in emergent marsh vegetation such as tules and cattails or upland sites with blackberries, nettles, thistles, and grainfields; nesting habitat must be large enough to support 50 pairs; probably requires water at or near the nesting colony; requires large foraging areas, including marshes, pastures, agricultural wetlands, dairies, and feedlots where abundant insect prey are available	Loss of wetland and upland breeding habitats from conversion to agriculture and urban development and to water development projects; pesticides contamination; human disturbance of nesting colonies	Nonbreeding flocks observed along the road to Black Butte Dam (Jones & Stokes Associates file data); not known to breed in study area
Fringed myotis *Myotis thysanodes*	C2/--	Sierra Nevada, Klamath Mountains, Coast Ranges, and Transverse and Peninsula Ranges	Open woodlands	Unknown	Unknown
Long-eared myotis *Myotis evotis*	C2/--	Sierra Nevada, Klamath Mountains, Coast Ranges, and Transverse and Peninsula Ranges	Woodlands	Unknown	Unknown
Small-footed myotis *Myotis ciliolabrum*	C2/--	Sierra Nevada, south Coast Ranges, Transverse and Peninsula Ranges, and the Great Basin	Open stands in forests and woodlands, as well as shrublands; uses caves, crevices, and abandoned buildings	Unknown	Unknown
Long-legged myotis *Myotis volans*	C2/--	Mountains throughout California	Most common in woodlands and forests above 4,000 feet, but occurs from sea level to 11,000 feet	Unknown	Unknown
Yuma myotis *Myotis yumanensis*	C2/--	Considered common and widespread in Northern California; colonies known from March and San Francisco counties.	Roosts colonially in a variety of human-made site, including caves, mines, buildings, bridges, and trees; in Northern California, maternity colonies are usually in fire-scarred redwoods, pines or oaks; forages for insects over main water.	Decline unclear; possible human disturbance to nest sites.	Unknown
Townsend's western big-eared bat *Plecotus townsendii townsendii*	C2/SSC	Coastal regions from Del Norte County south to Santa Barbara County	Roosts in caves, tunnels, mines, and dark attics of abandoned buildings; very sensitive to disturbances and may abandon a roost after onsite visit	Decline unclear; possible human disturbance to roost sites	Unknown; unlikely to occur along lower Stony Creek because of a lack of suitable roost sites (USBR, 1994)

Table J-1
Special-Status Wildlife Species with Actual or Potential Occurrence along Lower Stony Creek, Glenn and Tehama Counties

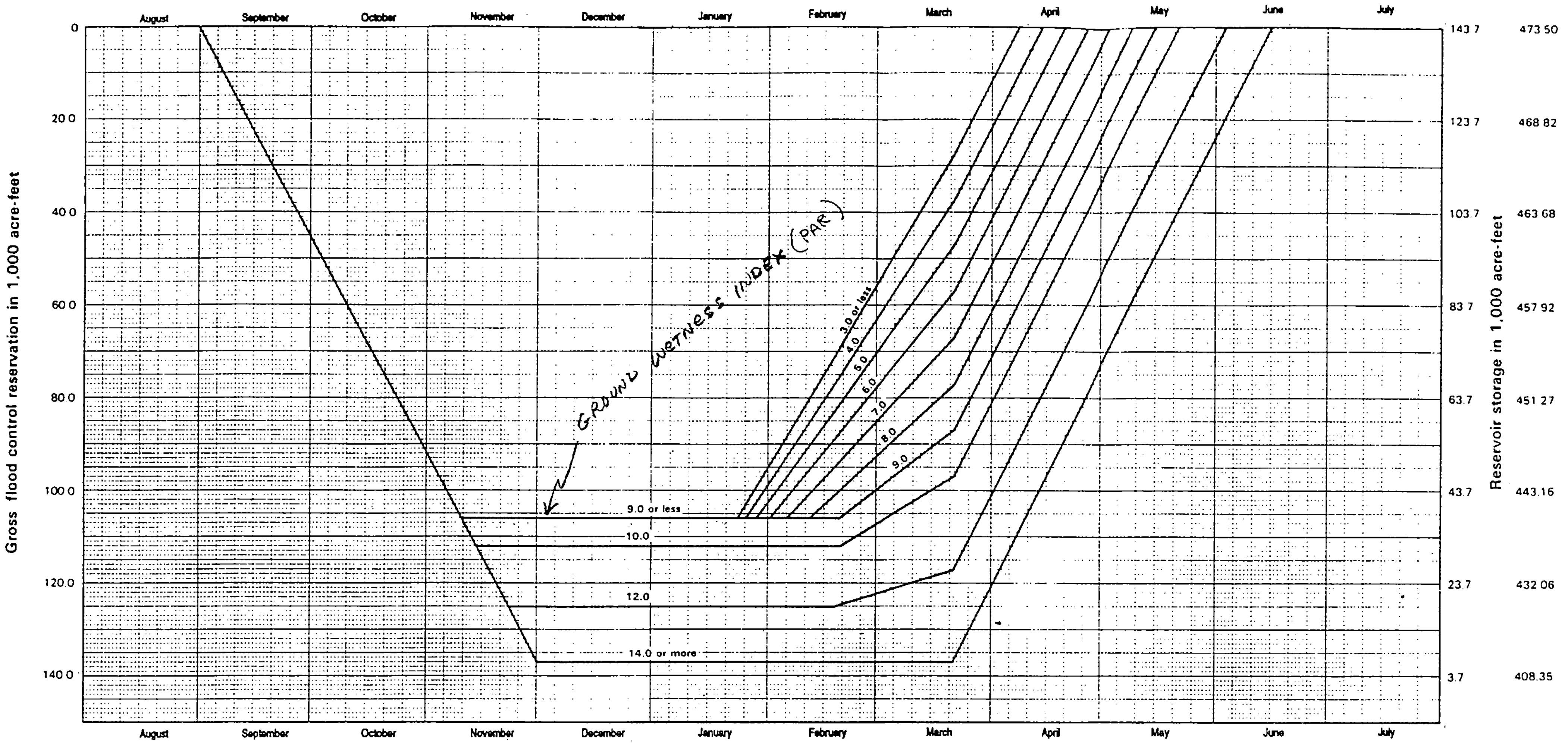
	Status[a]				
Species	**Fed/State**	**California Distribution**	**Habitats**	**Reason for Decline or Concern**	**Occurrence in Study Area**
Ringtail *Basariscus astutas*	--/FP	Sierra Nevada and Coast Ranges and the Central Valley; upper and middle portions of the Sacramento River, Feather River, and Bobelaine Sanctuary; potentially occurs in riparian woodlands in Chico area	Riparian forests, chaparral, brushlands, oak woodlands, and rocky hillsides	Loss and fragmentation of lowland riparian habitat	No records in NDDB (1996); possible occurrence along Stony Creek

[a]Status definitions:

Federal
- E = listed as endangered under the federal Endangered Species Act.
- T = listed as threatened under the federal Endangered Species Act.
- PE = proposed for listing as endangered under the federal Endangered Species Act.
- PR = protected under the Bald Eagle Protection Act.
- PT = proposed for listing as threatened under the federal Endangered Species Act.
- C2 = Category 2 candidate for federal listing. Category 2 includes species for which USFWS has some biological information indicating that listing may be appropriate but for which furthe biological research and field study are usually needed to clarify the most appropriate status. Category 2 species are not necessarily less rare, threatened, or endangered than Category 1 species or listed species; the distinction relates to the amount of data available and is therefore administrative, not biological.
- -- = no designation.

State
- E = listed as endangered under the California Endangered Species Act.
- T = listed as threatened under the California Endangered Species Act.
- FP = fully protected under the California Fish and Game Code.
- SSC = species of special concern.
- -- = no designation.

Appendix K
Flood Control Diagram



NOTES

1. Black Butte Lake shall be operated for flood control in accordance with this Flood Control Diagram.

2. Flood control reservation increases uniformly from a zero requirement on 1 September up to a maximum reservation of 137,000 acre-feet by 30 November (a minimum reservation of 106,400 acre-feet is required from 10 November to 23 January) Conditional flood control reservation up to a maximum of 137,000 acre-feet from 30 November to 20 March, decreasing again to zero on 15 June. The required reservation is determined by use of a ground wetness index during this period.

3. Gross flood control reservation is the total storage required for flood control operations within the Stony Creek Basin reservoir system.

4. Transferable space is that amount of space the required flood control reservation can be reduced by available space in upstream reservoirs—East Park and Stony Gorge. The amount of available space that can be credited to transferable space is discussed in the USE OF DIAGRAM.

SAMPLE COMPUTATION OF REQUIRED FLOOD CONTROL SPACE

1. Computation of today's basin precipitation (P) for Black Butte Lake:

PRECIPITATION STATIONS	NAP (IN.)	PRECIPITATION TODAY (P) (IN.)
Black Butte Dam	17.0	.99
Log Springs	34.0	3.00
Trough Springs	49 0	5.10
Noel Springs	42.0	1.40
Alder Springs	34.0	4.00
TOTAL	176 0(SNAP)	14.49(STAP)

Basin Normal Annual Precipitation (BNAP) = 32.0 in.

Basin precipitation computation for today

$P = \frac{BNAP}{SNAP}(STAP) = \frac{32\ 0}{176\ 0}(14.49)$

P = 2 63 in

2. Parameter and Required Flood Control Space Computation

a. PAR = P + 0.97 PAR'

where PAR is today's parameter

PAR' is yesterday's parameter

P is today's basin precipitation

MONTH	DAY	P (IN.)	PAR' (IN.)	PAR (IN.)	REQUIRED FLOOD CONTROL SPACE* (1,000 A.F.)
OCT	4	—	—	0	50.3
	5	1.78	0	1.78	51.8
	6	1.20	1.78	2 93	53.3
	7	0	2.93	2.84	54.8
DEC	19	—	—	2.49	106.4
	20	45	2.49	2.87	106 4
	21	1.39	2 87	4.17	106 4
	22	3 83	4 17	7 88	106 4
	23	2 96	7 88	10 60	116 2
	24	80	10 60	11.08	119 2

*Determined from flood control diagram

USE OF DIAGRAM

1. Rain flood parameters define the **gross flood control reservation** required on any given day and are computed daily from the weighted accumulation of the seasonal basin mean precipitation by adding the current day's precipitation in inches to 97 percent of the parameter computed the preceding day Sample calculation of required space is shown below

2. Required gross flood control reservation in Black Butte Lake may be reduced by creditable flood control space known to exist in East Park and Stony Gorge Reservoirs

3. **Creditable transfer flood control space** for East Park and Stony Gorge Reservoirs is determined as follows:

a. The amount of creditable flood control transfer space in East Park Reservoir is computed by taking the smaller of:

(1) 48,200 acre-feet minus the present storage at East Park or

(2) 10,000 acre-feet.

b. The amount of creditable flood control transfer space in Stony Gorge Reservoir is computed by the following

(1) Between 1 September and 1 February — 23,400 acre-feet (storage at spillway crest) minus the present storage at Stony Gorge.

(2) Remainder of flood control season -- 23,400 acre-feet minus the present storage at Stony Gorge, but not less than zero.

c. Total creditable transfer space is equal to the summation of items 3a and 3b but not to exceed 40,000 acre-feet.

4. The flood control requirement in Black Butte Reservoir is equal to the gross flood control reservation minus the total creditable transfer space.

5. When space available for flood control is less than required, as determined above, water shall be released from Black Butte Lake as rapidly as possible, subject to the following conditions:

a. That releases are made according to the RELEASE SCHEDULE hereon.

b. That flows in Stony Creek below Black Butte Dam do not exceed 15,000 cfs.

c. When Sacramento River flows at the latitude of Ord Ferry are forecasted to exceed 130,000 cfs (a stage of 116.2 feet at the Ord Ferry gage), releases from Black Butte should not be greater than inflow.

d. That no level of release above 1,000 cfs shall be held for more than 18 hours.

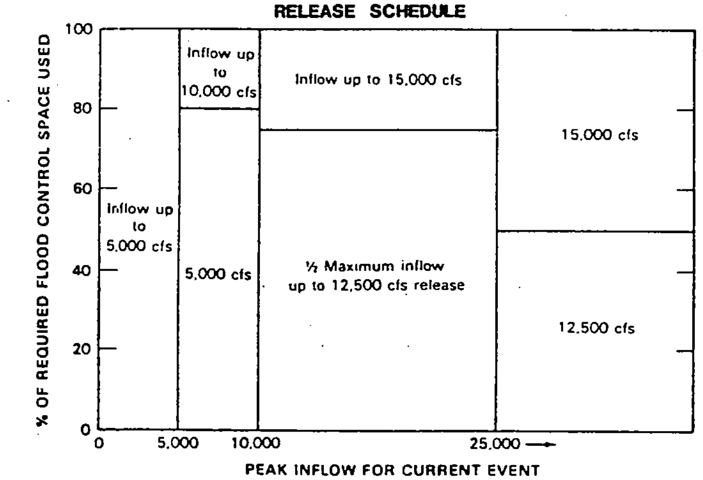
e. That rate of change for an increase in release shall not be more than 2,000 cfs in any 2-hour interval.

f. That the rate of change for a decrease in release shall be as follows:

(1) When existing release is between 15,000 cfs and 5,000 cfs, outflow shall be reduced in 1,000 cfs increments, with no release sustained for less than 2 hours.

(2) When existing release is between 5,000 cfs and 50 cfs, outflow shall be reduced in 500 cfs increments, with no release sustained for less than 2 hours.

RELEASE SCHEDULE



BLACK BUTTE LAKE
STONY CREEK, CALIFORNIA

FLOOD CONTROL DIAGRAM

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

CHART A-10

Appendix L
Water Availability and Demand

APPENDIX L

Water Availability and Demand

Changes in the current water release regime are deferred pending the outcome of locally initiated riparian enhancement activities, as discussed in chapter 5. The success of these activities will establish a basis for consideration of water release changes to enhance the riparian environment and benefit fish and wildlife resources. At that time, information provided below in the form of the Screening Model and Water Storage sections will be useful for evaluating options for use of available water.

A. The Stony Creek Screening Model - Introduction

The Stony Creek Model (Model) is a planning level tool, designed to provide a method of screening the viability of management proposals from a water availability and demand perspective. It is primarily intended to help refine the direction of future studies, in other words, to screen out infeasible actions and to identify those actions which may show promise and are deserving of further study. The Model is not intended to be used to determine or schedule actual deliveries for any purpose, modify existing contracts, or determine the yield of the watershed.

The Model simulates operations of Black Butte Reservoir in accordance with legal and contractual rules and demands which presently exist on the system or which may be exercised on the system in the reasonable future. Operations of the upstream reservoirs in the basin (East Park and Stony Gorge) are not explicitly modeled, but their operations are implicitly accounted for in the use of historic inflow to Black Butte. The Model can be used to estimate water availability for other purposes after all legal demands for irrigation have been met.

The Model will attempt to deliver as much of the prioritized demand as possible, given the user defined demand pattern and minimum storage targets. It has the advantage (unlike an operator in real life) of working with a known historic data set. This should be adequate as a comparative screening tool, but because real life operations do not have perfect foresight into the future, the results should not be considered to be easily attainable in an operational framework.

The Model uses the historic inflow into Black Butte Reservoir from water years 1964-1994. This record contains wet periods as well as the long drought of the mid 80's to early 90's, and represented the total data set available when the Model was constructed. The wet years in the recent record would probably slightly increase the percentage of success with the modeled fish and wildlife options but would not affect the decision process at the screening level.

The Model delivers water based on firm priorities, and it will not deliver water to a lower priority user if it will impact a higher priority user's water at any time. First priority was given to OUWUA demands. These were satisfied to the greatest extent possible given the hydrology and their demand pattern. Second priority was given to CVP demands such as TCCA and deliveries to GCID. Lowest priority was given to possible new releases which would include releases for fish and wildlife, as described in Table L-1. The GCID deliveries were limited to the smaller of Black Butte inflow minus OUWUA demands or their requested demand. This ensured that GCID deliveries did not come from CVP or OUWUA stored water, but from natural inflow. Existing minimum flow requirements (30 cfs below the dam) and the TCCA minimum flow requirement (40 cfs at the TCC when the CHO is in operation) are always met in the Model if they are not otherwise covered by another release such as flood control or OUWUA/CVP demand.

Reclamation has only discretion over CVP water and has no authority to modify water rights or non-CVP diversions.

No releases were made strictly for hydropower, although some or all of the computed releases could, in theory, be passed through the turbines. In addition, flood control requirements were followed without exception, and flood releases are made only in months when they are absolutely required.

A Model connectivity diagram is shown in Figure L-1.

Computational Procedure

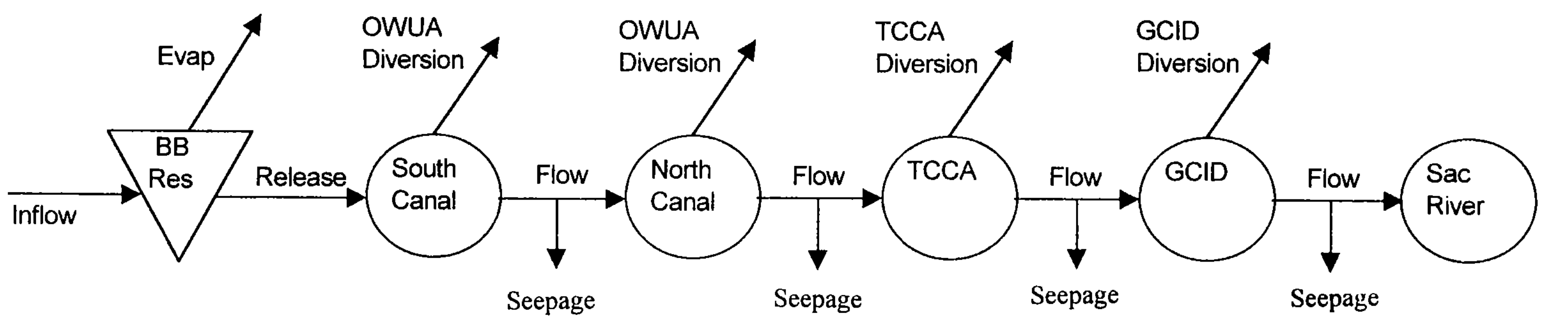
The Model begins by initially setting all demands on the system (other than the minimum flow requirement of 30 cfs) to zero. It then starts with the highest priority user (OUWUA), and at one water year at a time, attempts to deliver as much of the maximum annual legal demand as is possible, based on the demand pattern specified on the data sheet, while not drawing the reservoir below a user-specified minimum pool (presently set at 20,000 acre feet) at any time other than for a flood control requirement. Seepage and losses to evaporation are calculated in the Model. If 100 percent of the contract demands cannot be met (given the inflow and demand pattern), the Model will scale the delivery back to a percentage of the full demand which can be met. It then proceeds to the next water year and repeats the process. As the Model computes, it updates the summary table. At the conclusion of the simulation, the output may be viewed graphically or in tabular fashion. A maximum storage of 134,900 acre feet (current official capacity is 143,000 acre feet) for Black Butte has been used, assuming that this capacity is likely to be representative of the near future based on recent surveys.

Flow Management Options

Table L-1 identifies the following four Flow Options, or, more accurately, concepts which represent a range of suggested flows at the mouth of the creek, based on recommendations of some technical team members. These flows have been disputed as being overly conservative or unsuitable for the desired goals, but as no other suggestions for flows have been provided, are used for the purposes of this Model. Given the disputes over both the amounts of water available and the amounts needed, these Options, as defined, are only for planning purposes and may require modification before actual use.

Stony Creek Screening Model

Major Features and Connectivity



(Not to Scale)

Figure L-1

Table L-1
Potential Lower Stony Creek Flows and Water Temperatures

Management Option	Oct 15 - Oct 30 Temp (°F)	Oct 15 - Oct 30 Flow (cfs)	Oct 15 - Oct 30 Volume (acre-feet)	Nov 1 - Nov 15 Temp (°F)	Nov 1 - Nov 15 Flow (cfs)	Nov 1 - Nov 15 Volume (acre-feet)	Nov 15 - Dec 30 Temp (°F)	Nov 15 - Dec 30 Flow (cfs)	Nov 15 - Dec 30 Volume (acre-feet)	Dec 30 - Mar 30 Temp (°F)	Dec 30 - Mar 30 Flow (cfs)	Dec 30 - Mar 30 Volume (acre-feet)
1. No Change in Existing Practices	open	0 - 5	893	open	0 - 5 *	893	open	0 - 5 *	2,678	open	0 - 5 *	5,296
2. Enhancement of Existing Conditions	open	0 - 5+	893	open	10+	893	open	10+	2,678	open	10 +	5,296
3. Enhancement of Non-Salmonid Fish and Wildlife, Salmonid Non-natal Rearing and Opportunistic Salmonid Spawning Habitat	open	5 increasing to 30	1071	< 60	30+	1026	< 56	30+	3,079	< 56	base 30, pulses[a] to 150+	7,042
4. Intermittent Fall-Run Chinook Salmon Production	open	5 increasing to 50	1785	<60	base 50, pulse[a] to 100+	2,167	<56	50+	5,132	<56	50+	10,150

Management Option	Apr 1 - Apr 15 Temp (°F)	Apr 1 - Apr 15 Flow (cfs)	Apr 1 - Apr 15 Volume (acre-feet)	Apr 15 - May 1 Temp (°F)	Apr 15 - May 1 Flow (cfs)	Apr 15 - May 1 Volume (acre-feet)	May 1 - June 1 Temp (°F)	May 1 - June 1 Flow (cfs)	May 1 - June 1 Volume (acre-feet)	June 1 - Oct 15 Temp (°F)	June 1 - Oct 15 Flow (cfs)	June 1 - Oct 15 Volume (acre-feet)
1. No Change in Existing Practices	open	0 - 5 *	893	open	0 - 5 *	893	open	0 - 5	1844	open	0 - 5	8152
2. Enhancement of Existing Conditions	open	10+	893	open	10+	893	open	0 - 5	1844	open	0 - 5	8152
3. Enhancement of Non-Salmonid Fish and Wildlife, Salmonid Non-natal Rearing and Opportunistic Salmonid Spawning Habitat	< 65	30	1,026	open	30	1026	open	0-5	1844	open	0 - 5+	8152
4. Intermittent Fall-Run Chinook Salmon Production	<65	30+	1,026	<65	base 30, 2 pulses to 100+	1665	open	0 - 5 +	1844	open	0 - 5 +	8152

Fall-Run Chinook Salmon Lifestages:	Absent[b]	Attraction and Holding	Spawning	Incubation	Rearing	Outmigration
	Oct 15 - Nov 15	Nov 1 - Jan 1	Nov 1 - Apr 7	Jan 1 - May 1	Apr 1 - May 15	May 1 - Oct 15

[a]Pulses mimic natural spates, increase rapidly and fall off within 2 days. Assumed 2 pulses per time period with 2 days per cycle.
[b]Except spring-run chinook salmon adults.

Notes:

-The values presented in this table are potential required flows based on the professional judgement and experience of fisheries biologist represented on the technical team. Values should be considered to be approximate.
* -All flow values are in cfs for water reaching the Sacramento River, assuming a 30 cfs year-round release from the dam and not including flood releases.
-Except for pulses, planned flow increases should be gradual over at least a 36-hour period.
-Except for pulses, planned flow decreases should be gradual over at least a 3-week period.
-All volumes are computed with loss factor to reach the flow goal at the mouth
-All values are approximate.
-Flows will be provided past April, depending on conditions.
-Flows will be provided from December-April depending on flood releases.

Releases for fish, wildlife and riparian habitat enhancement purposes focus primarily on a November through April flow release schedule which mimics historical flow patterns. Flows at the mouth of the creek did not historically occur in the summer months, except in relatively wet years. Not surprisingly, such flows are also the most difficult to provide in the present Stony Creek system.

Releases for fish and wildlife purposes were, therefore, not modeled for the months May through October. It should be noted that computed flows at the mouth of the creek may occur in the absence of a fish and wildlife demand or may be in excess of a demand when flood control releases are being simulated.

Flow Management Option 1: No Change in Existing Practices. Releases from the dam would be made for irrigation and flood control purposes. A minimum flow of 30 cfs would continue to be released at the dam at all times. This flow alone would probably not be sufficient to reach the mouth of Stony Creek. When the CHO is in operation, sufficient flows would be released to maintain 40 cfs below the CHO, which would result in 0 to 5 cfs at the mouth of the creek. Flows may not reach the Sacramento River during the summer months and under dry conditions. Under wet conditions, flows at the mouth may occur regardless of CHO operation.

Flow Management Option 2: Enhancement of Existing Conditions. In addition to releases for irrigation and flood control purposes, releases from Black Butte for fish and wildlife purposes would result in approximately 10+ cfs at the mouth of the creek from November through April. Minimum flows would be maintained at the dam and the CHO (when in operation) as in Option 1 above. Flows at the mouth in the summer months are not expected but may occur in wet conditions.

Flow Management Option 3: Enhancement of Native Fish and Wildlife, and Non-Natal Rearing Habitat. In addition to releases for irrigation and flood control purposes, releases from Black Butte for fish and wildlife purposes would result in approximately 30+ cfs at the mouth of the creek from November through April. Minimum flows would be maintained at the dam and the CHO (when in operation) as in Option 1 above. Flows at the mouth during the summer months are not expected but may occur in wet conditions.

Flow Management Option 4: Intermittent Fall-Run Salmon Production. In addition to releases for irrigation and flood control purposes, releases from Black Butte for fish and wildlife purposes would result in approximately 50 cfs at the mouth of the creek from November through April, when temperatures are suitable, with two 2-day pulses to 100 cfs at the mouth in November for attraction and in late April for outmigration. Flows will be reduced to 30 cfs at the mouth in early April for fry rearing. Minimum flows of 30 cfs at Black Butte dam would continue to be released year-round and 40 cfs would be bypassed below the CHO when in operation. Flows at the mouth during the summer months are not expected but may occur in wet conditions.

No other Options were considered feasible from both a water availability and temperature standpoint.

[Agreement could not be reached between the Task Force on what in-stream flows are required to sustain or enhance a viable fishery. The technical team (not unanimous) suggested flows are used only for the purposes of the Model demonstration. Suitable in-stream flow recommendations are deferred, pending direction from the AFRP]

Results

The flashy, erratic nature of the Stony Creek watershed, available storage volume at Black Butte, and the constraints of flood control operations combine to make for difficult operations and a limited reliable water supply. Often, very wet years provide the poorest water supply outlook, since the reservoir must be drawn to minimum levels very quickly during flood control operations. This hinders rather than helps the water supply outlook for the subsequent summer period. Correlations between storage and supply projections are relatively poor until well into the water year, often as late as June. The results from the analysis with the Screening Model reflect these uncertainties.

In addition, it became clear in the analysis that flood control operations often "disconnect" the early parts of the water year from the later. In other words, a great deal of water may pass through the system during flood control operations and contribute little to nothing to the water supply of the following spring and summer. In worst cases, extremely low pools may be required for flood control in winter, while a dry spring may fail to refill the reservoir to target levels. Thus, it often appears that a Management Option might seem possible in November or December but become impossible to continue to implement in the spring.

The consequences of this are probably the most serious in Management Options where salmonids are involved. Option 4 was, therefore, evaluated to estimate the percentage of years which begin optimistically in November and December but fail to provide the consistent hydrology needed to follow through with the Plan the following spring. Depending on the other demands on the system, this failure rate ranges from about 33 percent to 57 percent. One-third to two-thirds of the years evaluated would require abandoning Option 4 after a good early winter. This could prove disastrous to salmon in the spawning, incubation, and rearing stages, and a significant failure rate must be expected with this option. It is recommended that Management Options be extremely flexible in keeping with the unpredictable nature of the watershed.

There is some uncertainty in the level of future GCID diversions from Stony Creek. In order to provide some level of representation of GCID, a range of 5,000 to 23,000 acre feet per year was used in the Model as "bookends." The 5,000 acre feet figure may even be optimistic once the GCID Main canal siphon is installed. As expected, the lower the GCID demand in the Model, the greater the estimated success with the fish and wildlife options. Success of management Options at both levels of GCID demand are tabulated below.

GCID Diversions limited to 5,000 acre feet/year.

Option	Percent of fully successful years - all flow targets met or exceeded.	Percent of years which initially appear possible, but subsequently fail.
2. Preservation Of Existing Values.	40%[1]	NA
3. Enhancement of Non-Salmonid Fish and Wildlife Habitat.	37%	NA
4. Intermittent Fall-Run Chinook Salmon Production.	33%	33%

GCID Diversions limited to 23,000 acre feet/year.

Option	Percent of fully successful years - all flow targets met or exceeded.	Percent of years which initially appear possible, but subsequently fail.
2. Preservation Of Existing Values.	30%[1]	NA
3. Enhancement of Non-Salmonid Fish and Wildlife Habitat.	23%	NA
4. Intermittent Fall-Run Chinook Salmon Production.	20%	57%

[1] Preservation of existing values is not the same as existing conditions. It requires additional flows at the mouth of Stony Creek on a set schedule and is, therefore, not "100%" achievable.

Conclusions

From a water availability perspective, there appears to be some limited opportunity to improve fish and wildlife values on lower Stony Creek. The flow components of Table L-1, if limited to the months of November through April, can be met with varying degrees of success. Note that flows at the mouth of Stony Creek may occur May through October but are incidental to flood control or other operations and, therefore, may or may not be present. The range of feasible alternatives appears to run from *Preservation of Existing Values* to *Intermittent Fall-Run Chinook Salmon Production.* The higher the level of fish and wildlife flow management attempted, the lower the probability of success.

Due to its public safety role during the flood control season, Black Butte Reservoir is operated to very tight flood control constraints. This may limit the recovery of the reservoir pool and the summer water supply if the subsequent spring is dry. This could adversely affect the success of Option 4, Periodic Fall-Run Chinook Salmon Production. Model runs indicate that a significant number of water years begin well but fail to have water available for target flows the following spring. Overall, the modeled success rate for Option 4 appears to range from 20 percent to 33 percent of years. Management Options should be as flexible as possible and should contain provisions for reducing flow targets in the light of real-life hydrologic and operational developments.

[Agreement could not be reached from the Task Force on the in-stream flows to be used for management actions. There was a concern the recommended flows were too conservative and the success of the Options too low to be given consideration. Even in those years when enough water were available in the fall, the successful completion of an Option the following spring was low due to the nature of Black Butte as a flood control facility. The flows used in the Options may or may not be completed successfully and could result in harming more fish than enhancing them once they entered the system through attraction flows.]

B. Water Storage

Based on the Flow Options outlined in the Model, the availability of stored CVP water necessary to meet each Option is described. Feasibility of the flow option can be determined using the storage in Black Butte Reservoir as of June 1 of each year. Storage as of June 1 can help to determine conditions for the season as most deliveries are met and because year-types based on precipitation alone are not useful in the Black Butte watershed (what may be considered a wet year based on precipitation or water availability for the CVP as a whole may be a poor storage year on Stony Creek, as water is released under wet conditions to make storage space. If heavy precipitation occurs too early, and storage space is not refilled by future rainfall, low storage may remain for the season). Depending on conditions in the watershed and water use by OUWUA, the exchange agreement with upstream water users which describes 12,500 acre feet of exchange water can also be used as a possible source of available water in all or part.

Flow Option 4: According to Reclamation's Water Operations Division a minimum storage of 86,000 acre feet in Black Butte Reservoir as of June 1 would be required to consider Flow Option 4. Excluding GCID diversions, a minimum storage of 86,000 acre feet has occurred in 25 out of 34 years or 73% of the time (Table L-2). Releases in October are calculated with an estimated 20 percent loss. All other releases through December are calculated with an estimated 15 percent loss. Flows of 50 cfs at the mouth would require releases of 75 to 85 cfs at the dam, depending on conditions. In dry years the aquifer is low and seepage would be high. In wet years the aquifer would be charged resulting in less seepage. Flow monitoring would be required to determine the success of this action, and adjustments would be made to reflect monitoring results.

Storage to consider Option 4 would result in an average of 9,084 acre feet of water from mid-October through December. This timeframe could vary but would be considered for all Options until the COE takes over operation of Black Butte for the flood season. Management flexibility and continual communication would be required between Reclamation and the COE to allow the operation of the flow option as long as possible without affecting the success of the flood control procedures.

Table L-2 identifies historical storage on June 1 in Black Butte Reservoir compared with storage without GCID diversions, which typically occurred in April and May. The original capacity of 160,000 acre feet for Black Butte Reservoir was used until 1982, at which time the capacity was reduced to 143,000 acre feet. In certain years, such as 1977, 1986, 1987, 1988, 1990, 1991, 1992, 1994 and 1997, GCID received no water due to lack of water or no demand. In the years 1965-1967, GCID did not get water until after June 1.

In wet years, releases would exceed those recommended. On June 15, 1998, for example, a storage of 135,000 acre feet was calculated. In order to avoid spilling, 1,100 cfs/day was released for several days then modified to 50 cfs/day for the GCID siphon construction until a storage of 120,000 acre feet was reached to avoid higher releases which would damage downstream irrigation facilities. This resulted in more water in lower Stony Creek in the early summer months than have historically occurred.

The comparison between the success for this Option based on the Screening Model (maximum of 33% which uses a GCID diversion amount of 5,000 acre-feet) and the predicted success based on historical storage conditions (73% without GCID deliveries) is quite discrepant. The additional likelihood of the failure of this Option in the spring is described as 33% according to the Model. The probability of the success of this Option is disputed.

Flow Option 3: A storage of 78,800 acre feet would be required to consider Flow Option 3. Excluding GCID diversions, this storage has occurred in 27 out of 34 years or 79% of the time (the Model indicated a success ratio of 37% with a GCID maximum diversion of 5,000 acre feet).

Flow Option 2: A storage of 75,800 acre feet would be required to consider Flow Option 2. Excluding GCID diversions, this has occurred in 27 out of 34 years or 79% of the time (the Model indicated a success ratio of 40% with a GCID maximum diversion of 5,000 acre feet).

Based on the past 34 years, excluding GCID diversions, the average storage capacity for Black Butte on June 1 has been 111, 800 acre feet. Removing minimum pool requirements, evaporation, and 30 cfs release requirements, an average of 59,000 acre feet of useable water has been available, but one must remember that storage space within Black Butte Reservoir has decreased by 25,000 acre feet over this period. Therefore, the average available volume may now be closer to 24,000 acre feet than 59,000 acre feet.

The COE takes control of Black Butte Reservoir according to the flood control diagram, usually by the first major rainfall event in the fall/winter. Flood control reservation increases uniformly from a zero requirement on September 1 up to a maximum reservation of 137,000 acre feet by November 30 (a minimum reservation of 106,400 acre feet is required from November 10 to January 23). Conditional flood control reservation up to a maximum of 137,000 acre feet from November 30 to March 20 is required, decreasing again to zero on June 15. The required reservation is determined by use of a ground wetness index during this period. When the COE releases control of the reservoir back to Reclamation, based on conditions and storage, the scheduled flows based on the selected Option could resume. Should conditions be such as to provide insufficient water to complete the releases as identified by the Options in the spring, reevaluation of the releases would be required to prevent extreme fish losses in the future. Inability to complete the required releases in the spring should also include investigations of other water sources for short-term use or flushing flows to prevent stranding.

It should be noted that reductions in storage space when combined with unchanging flood control requirements make late winter and early spring rains ever more critical for any plans based on use of CVP water stored in Black Butte Reservoir. It should also be noted that construction of a Sites Reservoir, now being studied by DWR and others, may reduce this increasing reliance on late rains.

[Agreement could not be reached on the in-stream flows to be used and the success of the Options for management purposes. Agreement was reached to defer any changes of current flow management until such time when the riparian habitat improvements are completed through local efforts.]

Conclusions

The Flow Options discussed above define the range of suggested flow management activities to change the current flow conditions of lower Stony Creek. The range of in-stream flows which would be required to enhance the fishery is lower Stony Creek is presently unknown. Because the suggested flows which define the Options are disputed, the success of the Options are also in question. The success of the Options as presented differ between the Screening Model and the historical storage predictions. It was agreed by the Task Force that any flow management changes from current conditions are deferred at the time of this writing. Recommendations for actions to be taken regarding in-stream flow requirements will be sought from applicable fishery agencies and the AFRP once the riparian habitat has been improved through local efforts, which will provide the foundation for successful flow augmentation.

Table L-2

STORAGE IN AC-FT ON JUNE 1 OF EACH YEAR IN BLACK BUTTE RESERVOIR WITH AND WITHOUT GCID DIVERSIONS		
YEAR	HISTORICAL STORAGE JUNE 1	STORAGE ON JUNE 1 WITHOUT GCID DIVERSIONS
1964	26,883	N/A
1965	131,864	131,864*
1966	117,243	117,243
1967	140,305	140,305
1968	60,177	108,939
1969	126,745	160,000
1970	68,860	79,660
1971	100,992	116,392
1972	76,957	95,257
1973	90,976	143,976
1974	112,808	153,908
1975	114,463	160,000
1976	64,406	88,106
1977	19,254	N/A
1978	125,155	160,000
1979	88,904	129,704
1980	81,120	139,970
1981	89,106	119,006
1982	76,843	143,000**
1983	114,107	143,000
1984	87,326	143,000
1985	72,245	107,945
1986	79,911	79,911
1987	65,374	65,374
1988	55.120	55,120
1989	107,510	116,010

STORAGE IN AC-FT ON JUNE 1 OF EACH YEAR IN BLACK BUTTE RESERVOIR WITH AND WITHOUT GCID DIVERSIONS		
1990	54,793	54,793
1991	86,627	86,627
1992	119,245	119,245
1993	138,956	143,000
1994	51,152	51,152
1995	128,362	143,000
1996	130,417	133,317
1997	56,442	56,442
* original storage capacity ** new storage capacity of 143,000 ac-ft		

Appendix to Chapter 2

Appendix To Chapter 2

A. Geology of Stony Creek Fan

Information in this section was compiled from the California Department of Water Resources (DWR) progress report on groundwater studies (DWR, 1976). The Stony Creek Fan is an alluvial fan formed as Stony Creek deposited sediments onto the plain of the Sacramento Valley. The fan occupies an area of approximately 30-miles long and 25-miles wide at its greatest extent, from Black Butte Dam to the Sacramento River. The fan consists of a total thickness of 1,400 to 1,600 feet of sediments deposited by fresh water. However, groundwater at a depth of approximately 1,200 feet is currently saline. Most available groundwater is in the upper 150-foot-thick unconsolidated alluvium deposited by Stony Creek and the Sacramento River and is of generally good quality. Groundwater at depths exceeding 1,200 feet tends to be brackish or saline. The Tehama Formation is at greater depths. Black sands of Tuscan Formation are found in the eastern part of the fan at depth.

Figure 2-2 is a geologic map of the Stony Creek Fan.

Non-Waterbearing Rocks

Non-waterbearing, Chico Formation Cretaceous age, marine sediments (K) bound the groundwater watershed and are the source of saline water in deep parts of the aquifer. Tertiary basalt (Tb) is exposed at Orland Buttes and is also non-waterbearing.

Older Continental Sediments

The Older Continental Sediments (TQc) include the Tehama, Red Bluff, and Tuscan Formations. The Tehama Formation is Pliocene in age and pale yellow to greenish gray in color. It consists of sandy, tuffaceous siltstone and claystone with channelized and lenticular sandstone and crossbedded conglomerate. It can reach a thickness of 2,000 feet.

The Pleistocene age Red Bluff Formation was deposited on the eroded surface of the Tehama Formation and occurs in the northern and western parts of the Stony Creek Watershed. This formation is typically less than 50-feet thick. It is distinctive and consists of moderately consolidated, poorly sorted, silicious cobbles and gravels with reddish clayey or sandy matrix. It is not a groundwater source. Tuscan Formation volcanic sediments and pyroclastics occur only at depth in the eastern part of study area where they may be interbedded with the Tehama Formation sediments.

Stony Creek Alluvial Fan Deposits

The Stony Creek alluvial fan sediments are mostly Pleistocene deposits from Stony Creek and are divided into three types according to soil profile development: Older Alluvial Fan Deposits, Young Alluvial Fan Deposits, and Recent Alluvial Fan Deposits.

Older Alluvial Fan Deposits. The Older Alluvial Fan Deposits (Qoal) occur on elevated terraces north of Artois and south of the Tehama County line. These sediments underlie the Capay area north of Stony Creek, and consist of unconsolidated to moderately consolidated clay, silt, sand, and gravel. They represent dissected remnants of an ancestral Stony Creek Fan. The Arbuckle-Kimball-Hillgate soil association is linked to this alluvium.

Young Alluvial Fan Deposits. The Young Alluvial Fan Deposits south of Stony Creek (Qyf) consist of unconsolidated silt, sand, and gravel. The Tehama and Plaza soils, which have slightly developed profiles, are associated with these deposits.

The Young Alluvial Deposits are found in the Stony Creek and Sacramento River channels (Qrsc), on flood plains (Qfl and Qofl), in flood basins (Qob), and associated with intermittent streams on low foothills southwest of Orland (Qal). In the stream channels, deposits consist of sand and gravel with high, to very high hydraulic conductivity. The flood plain deposits follow the west side of the Sacramento River and consist of unconsolidated clay, silt, and sand. They are associated with the Columbia soils. Flood watershed deposits lie southeast of the GCID Main Canal in the Colusa Watershed. The related soils are the Willows-Plaza-Castro association.

The Recent Alluvial Fan Deposits (Qrf) occur between Bayliss and Capay and consist of silt, sand, and gravel. The Cortina, Wyo, and Jacinto soils are also associated with these deposits. They have a high gravel content and a very high hydraulic conductivity. Gravel mining is typically associated with these deposits.

B. Groundwater

This section presents a summary of historical groundwater levels, groundwater elevation contours, and aquifer recharge.

The data sources used in the preparation of this section include a review of multiple contour maps and a review of reports by Fogelman (1978), Hull (1984), and DWR (1987).

Historical Groundwater Levels

Historical groundwater level data are available for four wells near Stony Creek. The locations and State well numbers for these wells are shown in Figure 2-3. Groundwater elevations for each of these wells over time are presented in Figure 2-4. The groundwater levels show a 5- to

FIGURE 2-2
GEOLOGIC MAP OF THE STONY CREEK FAN AREA
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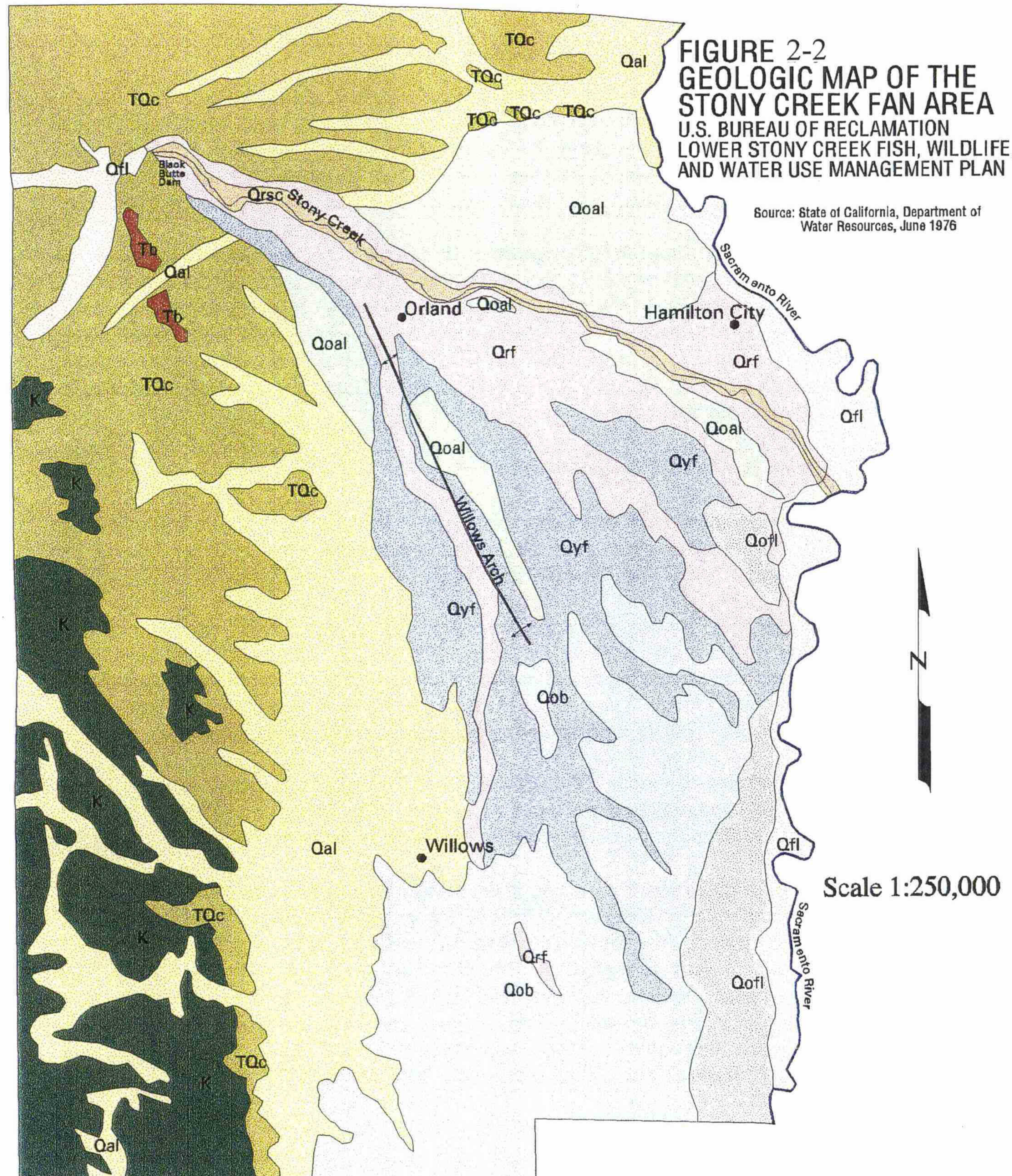
LOWER STONY CREEK FISH, WILDLIFE, AND WATER USE MANAGEMENT PLAN

Source: State of California, Department of Water Resources, June 1976



LEGEND

- Qrsc Recent Stream Channel Deposits
- Qfl Flood Plain Deposits
- Qofl Flood Plain Deposits
- Qob Basin Deposits
- Qal Alluvium
- Qrf Recent Alluvial Fan Deposits
- Qyf Young Alluvial Fan Deposits
- Qoal Older Alluvium
- TQc Tehama, Red Bluff, and Tuscan Formations
- Tb Tertiary Basalt
- K Chico Formation

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15-foot drop from spring to fall each year. The groundwater levels also show drops related to the droughts of 1977 and the late-1980's/early 1990's. Figure 2-4 compares the well elevation information with Black Butte monthly release data to examine the correlation between Stony Creek flows and aquifer recharge. Because of the frequency of data, (two data points per year for the spring/summer well elevation information versus average monthly release data) a strong statistical correlation cannot be made graphically, however it is known that the aquifer fills quickly by recharge from Stony Creek, and fluctuates seasonally with conditions.

Groundwater Elevation Contours

In general, groundwater flows from areas of higher groundwater elevation to areas of lower groundwater elevation. Groundwater elevations are raised by recharge and lowered by pumping as well as lack of recharge and other factors. Numerous groundwater elevation contour maps that include the study area have been published. Bryan (1923) presented a groundwater contour map showing 1913 conditions in the Sacramento Valley. These contours are generally taken to represent pre-development groundwater conditions. Contour maps for fall 1962 and spring 1963 were presented by the DWR (DWR, 1963). These maps, and maps for 1971, 1975, and 1980, published in other reports, show mounding of the groundwater beneath Stony Creek (Fogelman, 1978; Hull, 1984; DWR, 1987). This indicates the importance of Stony Creek as a groundwater recharge source.

Groundwater elevation data collected by the DWR was used to produce contour maps for dry, average, and wet years selected for this demonstration (1977, 1980, and 1993). Figures 2-5 through 2-7 show the groundwater elevation contours. The 1980 and 1993 contours are similar. They show mounding beneath Stony Creek, possible influence of the Willows arch, a structural geologic feature, and overall flow towards the southwest. Groundwater elevations are not significantly higher in 1993, despite wet conditions, because levels were particularly low before the rains of 1993 ended the drought. The 1977 contours were constructed from fewer data points and are not as reliable as those shown on the 1980 and 1993 maps.

The most important difference between the 1977 and 1980/1993 maps is the drop in elevations beneath Stony Creek. In the area where Stony Creek crosses the TCC, groundwater was 60-feet deeper, i.e., had less groundwater in 1977, a drought year.

Aquifer Recharge

The aquifer underlying Stony Creek receives recharge from a number of sources. The relative importance of each of these sources depends on hydrologic conditions, the specific geographical area, and land uses in that area. On the Stony Creek Fan, recharge comes from the following sources:

- Infiltration of winter rains
- Deep percolation of agriculturally applied water
- Seepage from Stony Creek

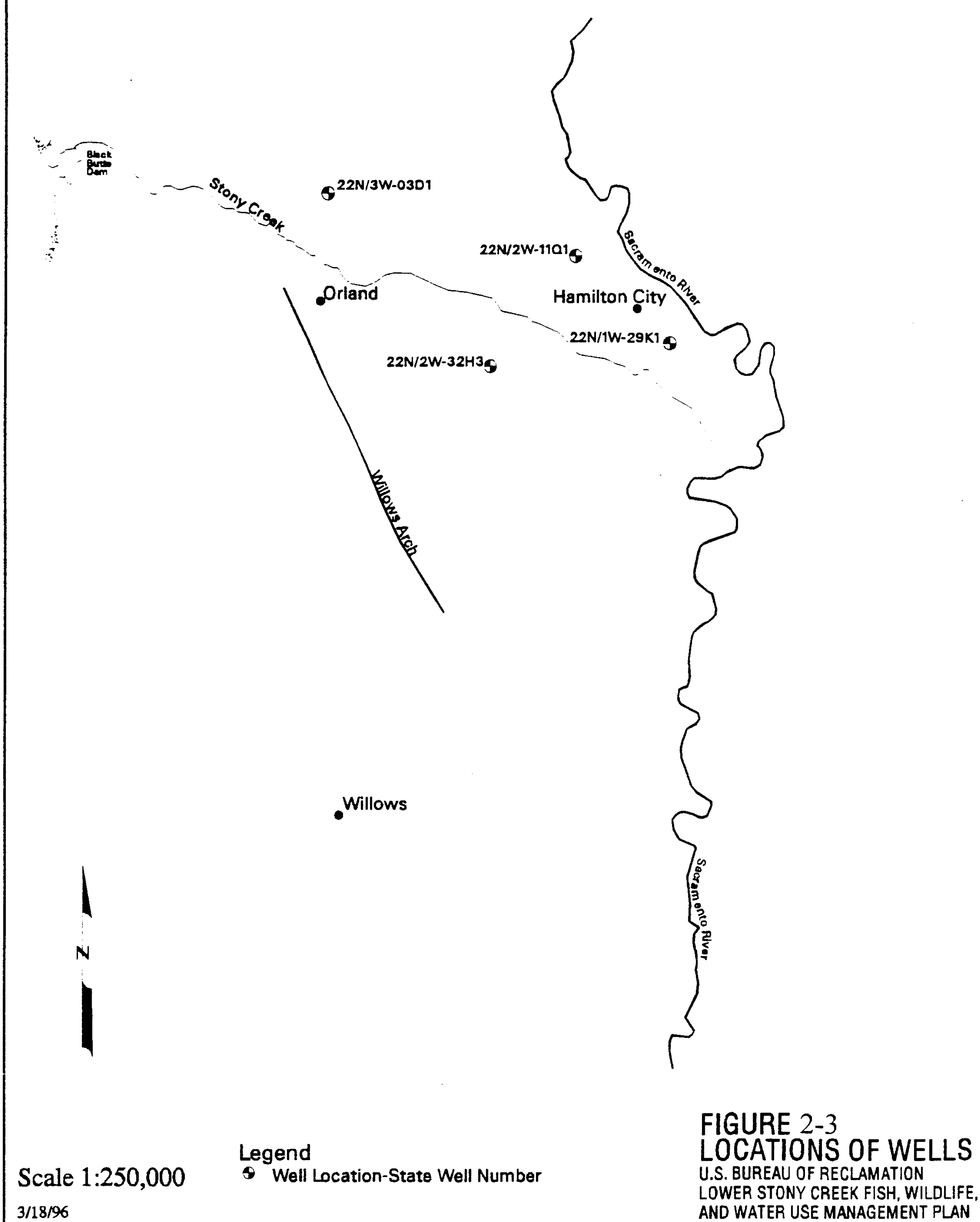

FIGURE 2-3
LOCATIONS OF WELLS
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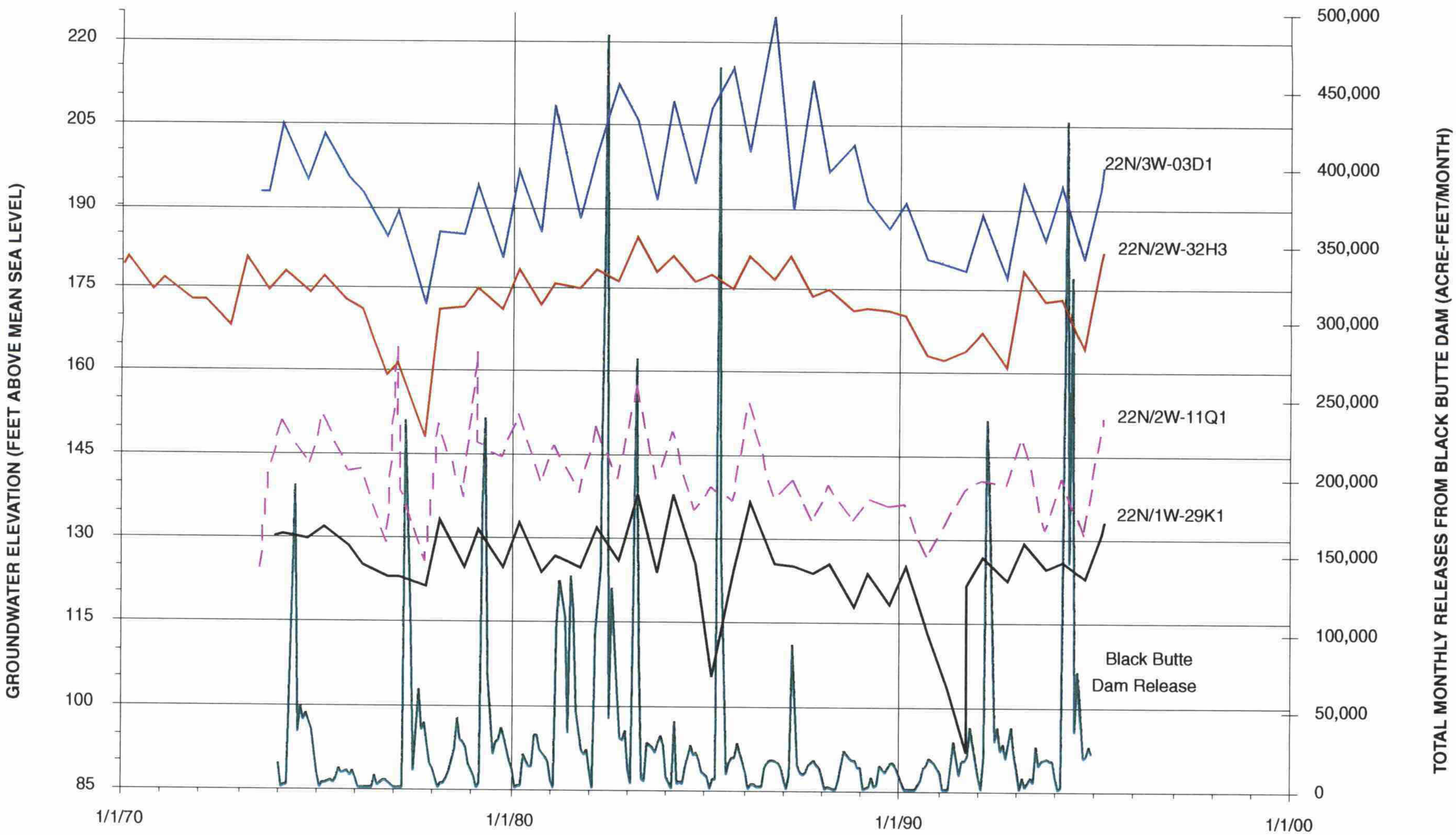

FIGURE 2-4
HYDROGRAPHS FOR WELLS NEAR STONY CREEK
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LOWER STONY CREEK FISH, WILDLIFE, AND WATER USE MANAGEMENT PLAN

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Recharge can be rejected by the aquifer when the water table is at the surface. General estimates of the area recharge rates are provided in this section. Comparison of these estimates with Stony Creek seepage can be found under the "Relative Importance of Stony Creek Seepage" section, page A-2-13.

Rainfall Infiltration. Under average conditions, when there is no long-term rise or decline in water levels, the approximate annual groundwater recharge for the Stony Creek Fan includes about four inches of rainfall infiltration, based on 18 inches of annual rainfall (Turner, 1991). The component of groundwater recharge that comes from precipitation is estimated by a relationship developed by Kenneth M. Turner that correlated the "yield" of water in a basin and the total precipitation.

Deep Percolation of Applied Water. The deep percolation of applied water was estimated assuming leaching fractions of 25 percent for land irrigated with surface water (ditch irrigation) and 15 percent for land irrigated with groundwater (sprinkler irrigation). The higher value for surface-water lands is intended to include conveyance losses of 10%, which demonstrate that surface water application is less efficient in uniformity of application as compared to application by sprinkler. In other words, the leaching fraction for ditch irrigation is higher because it takes into account the greater amounts of water needed to irrigate (percolate through) the same amount of land, as compared to lands irrigated by sprinkler, a more consistent application. The farm water requirement for irrigated lands near Stony Creek is 3.8 feet. Deep percolation associated with the surface-water irrigated lands is 3.8 feet times a leaching fraction of 25 percent or 0.95 foot (11 inches). For groundwater irrigated lands, the deep percolation is estimated to be 0.57 foot (7 inches).

Stony Creek Seepage. Reclamation estimates seepage, as well as evaporation, in daily water operations (evaporation estimated as 10-30% depending on conditions). Seepage from Stony Creek for the study area was estimated using two approaches. The first approach used Black Butte Reservoir releases, Orland Unit Water Users' Association (OUWUA) diversions, and stream gage data from the 1960's to calculate apparent seepage. The difference in streamflow between the flow measured below Black Butte Dam and the Stony Creek gage at Hamilton City was computed to measure seepage (U.S. Geological Survey (USGS) gage data). Data provided by the OUWUA for the Hamilton City gage needed to estimate seepage were compared for the years 1966, 1968, and 1969. Figure 2-8 shows the calculated seepage as a function of Stony Creek flow.

The seepage calculated using this approach has some dependence on flow in Stony Creek, but varies substantially at a given flow for a number of reasons. First, flow measurements in a braided stream like Stony Creek are notoriously difficult because new channels can be occupied during higher flows or due to shifting sands and gravels. Second, this approach does not

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FIGURE 2-5
FALL 1977 GROUNDWATER ELEVATION DATA AND CONTOURS
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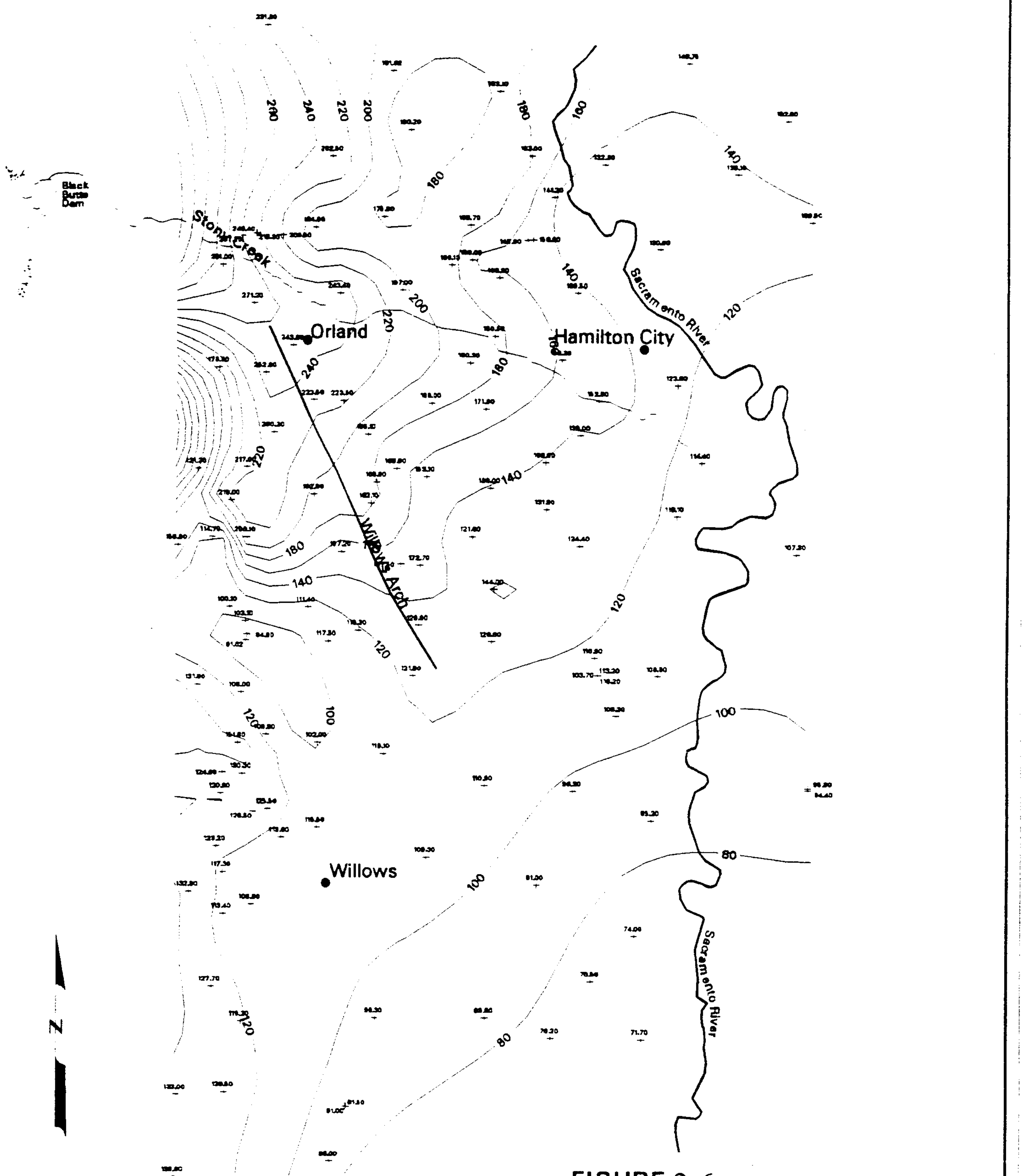

FIGURE 2-6
FALL 1980 GROUNDWATER ELEVATION DATA AND CONTOURS
U.S. BUREAU OF RECLAMATION
LOWER STONY CREEK FISH, WILDLIFE, AND WATER USE MANAGEMENT PLAN

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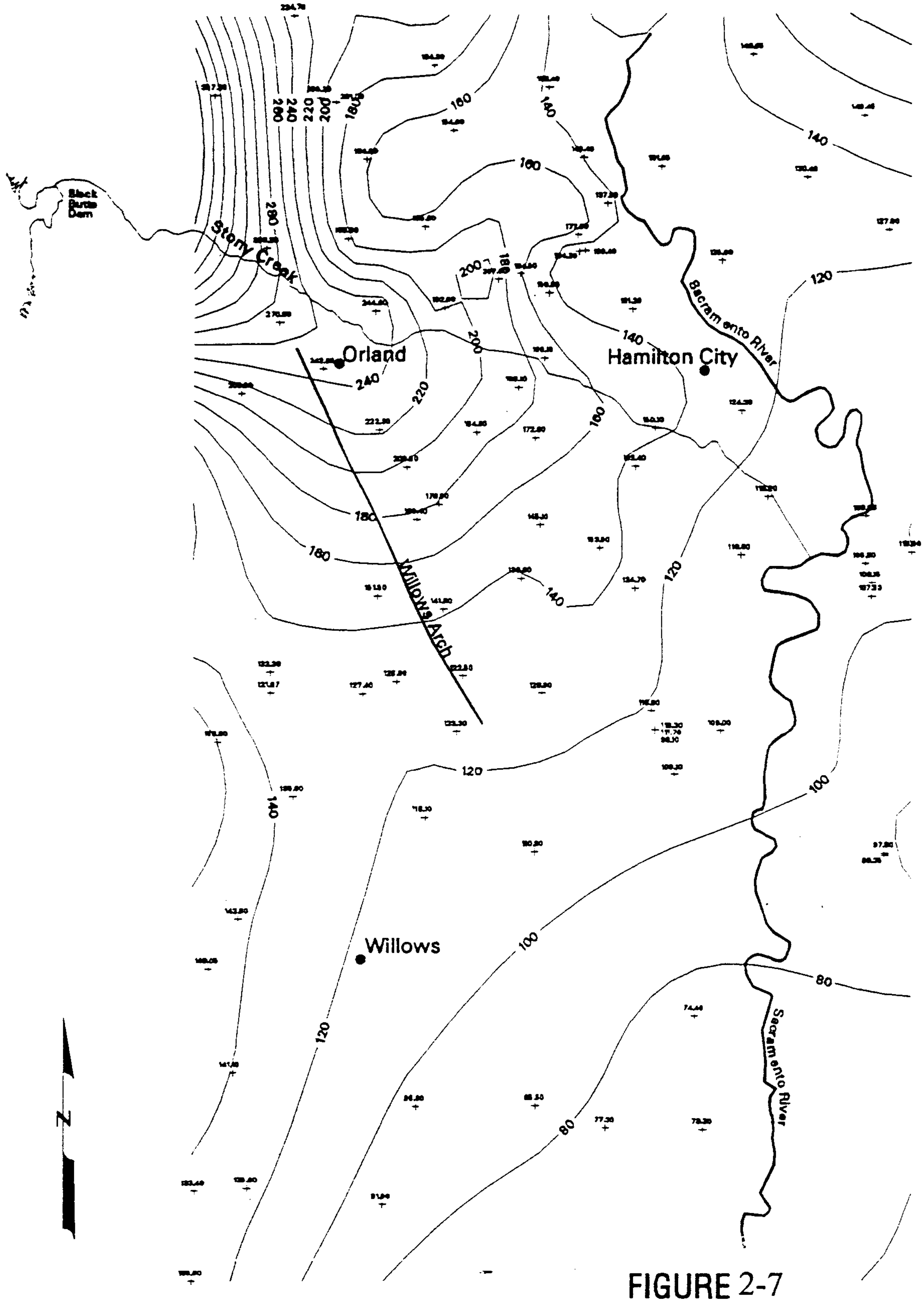

FIGURE 2-7
FALL 1993 GROUNDWATER ELEVATION DATA AND CONTOURS

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LOWER STONY CREEK FISH, WILDLIFE, AND WATER USE MANAGEMENT PLAN

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incorporate antecedent groundwater conditions. High flows following a dry summer and a low water table would be expected to cause the greatest seepage. High flows following a wet winter season when the water table is high could result in little or no seepage (Hughes, Reclamation).

The calculated seepages in the study area indicate that all water is lost to seepage for flows up to 65 cubic feet per second (cfs). At higher flow rates seepage is more variable. In some instances, the calculated seepages indicate that Stony Creek gains water (open triangle symbols in Fig. 2-8).The solid and dashed lines in Figure 2-8 are curves that were fitted to the positive calculated seepage (filled triangle symbols in Figure 2-8) and used to estimate seepage in this study. The solid line is used for average conditions and the dashed line is used for wet conditions.

The second approach for estimating seepage used a numerical model of the interaction of Stony Creek with the groundwater. In this model, seepage was calculated assuming a stream bed thickness of 10 feet, a bed hydraulic conductivity of about 10^{-4} cm/s (0.28 foot/day), and a head difference of 10 feet across the bed when the water table is below the bottom of the stream bed.

Stream bed width as a function of flow was calculated from an assumed base width of 125 feet and the formula $w = aQ_b$ where w is the width, Q is the flow, and a and b are empirical constants.Seepage is reduced when the water table rises above the stream bed bottom.The stream can get water from the aquifer if the water table rises above the level of the water surface in the stream.

The estimated total annual seepage is shown in Table 2-1, using year-types based on monthly precipitation obtained from Stony Gorge, Willows and Orland. 1977 represents one of the driest years on record.

Table 2-1
Estimated Stony Creek Seepage (acre feet/yr)

Hydrologic Condition	1960s Gage Data	Groundwater Model
Dry (1977)	1,000	Not estimated
Average (1980)	75,000	60,000
Wet (1993)	71,000	54,000

These estimates agree reasonably well considering limitations in each of the approaches. They also agree well with estimates made by others. Seepage of 12,000 to 63,000 acre feet/year has been estimated (Reclamation, 1995, July 14, letter from Charles L. Howard, Regional Engineer).

The groundwater model has some advantages over the use of historical gage data, because changes in water table elevation and its effect on seepage are considered directly and the water table elevation is driven by land use, Stony Creek seepage, and precipitation recharge. In addition, seepage varies along different portions of Stony Creek and the groundwater model can estimate this variability. However, the groundwater model is more difficult to apply and estimates of seepage used to evaluate alternatives in this report are taken from the curves of

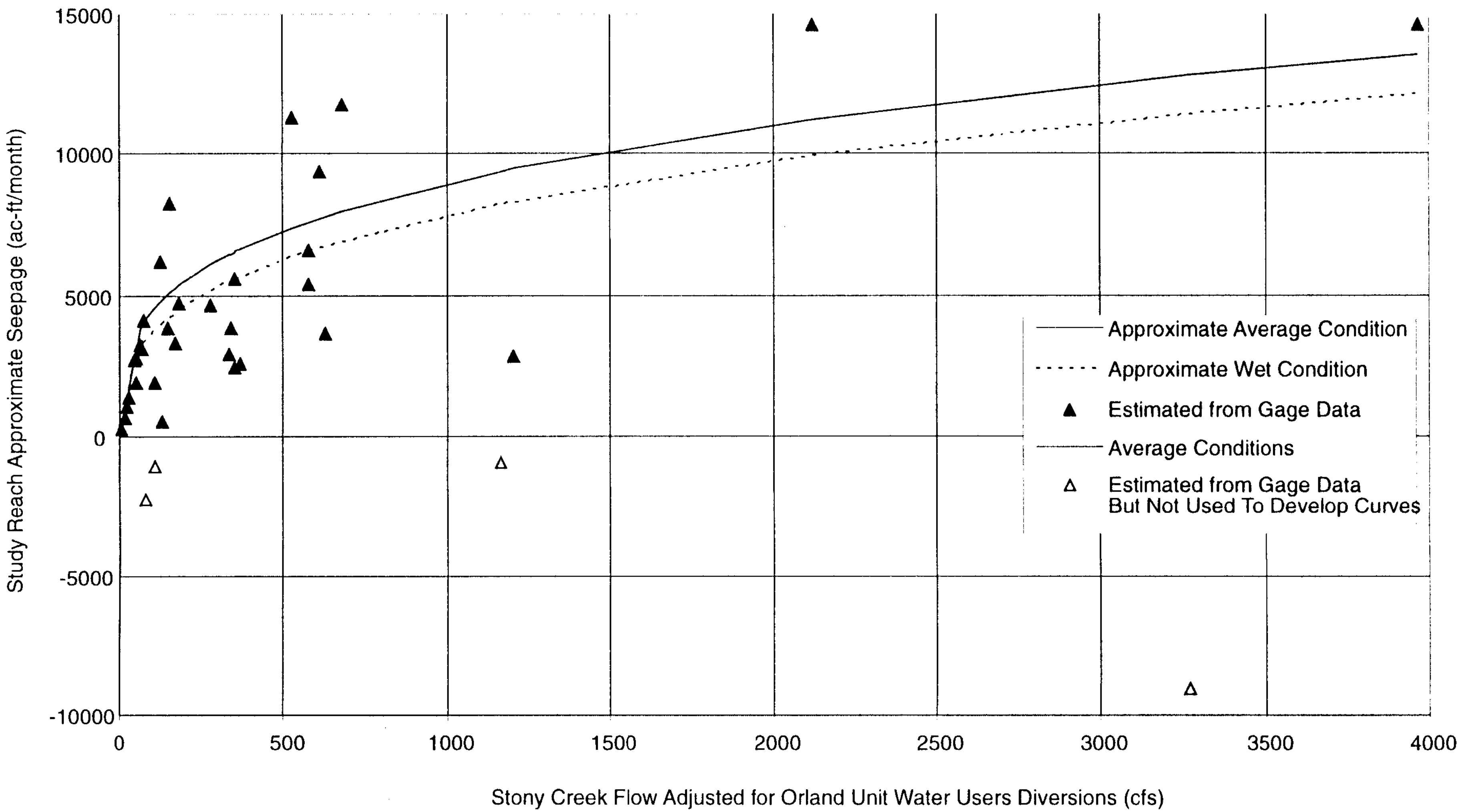

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FIGURE 2-8
STONY CREEK SEEPAGE ESTIMATED FROM GAGE DATA AND CURVES USED TO ESTIMATE SEEPAGE FOR ALTERNATIVES EVALUATION
U.S. BUREAU OF RECLAMATION
LOWER STONY CREEK FISH, WILDLIFE, AND WATER USE MANAGEMENT PLAN

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Figure 2-8. Estimated seepage for each reach is assumed to be proportional to the reach length.

Relative Importance of Stony Creek Seepage. The relative importance of Stony Creek seepage depends on the geographic area considered and land use. For example, if one considers the 500-square-mile Stony Creek Fan area from north and west of Black Butte Reservoir, east to the Sacramento River and south to about Willows, Stony Creek is estimated to account for about 25 to 30 percent of aquifer recharge. A total of 55 to 60 percent is estimated to come from the deep percolation of applied water and 15 to 20 percent is estimated to come from rainfall infiltration. Within the 27.6 square mile study area, seepage from Stony Creek dominates recharge sources.

C. Land Uses

This section presents a summary of existing land uses in the study area. The data sources used in preparation of this section include a literature review of the recent works of Kondolf and Swanson (1992, 1993); a review of pertinent environmental documents; a review of Glenn County's Land Use Element of the General Plan (Glenn County, 1993); and a review of the DWR 1993 Land Use Study (DWR, 1993).

Development in and around the study area is typified by scattered rural residences, a small section of urban-zoned properties associated with the City of Orland adjacent to Interstate 5, and agricultural fields committed to perennial and annual crops, irrigated pasture, and dryland grazing.

Private Land Uses Within the Study Area

The majority of land (94 percent of 16,600 acres) within the study area is privately owned. Private land uses within the study area include grazing, gravel mining, agriculture, and rural residential uses as shown in Figure 2-9, 2-10, and 2-11. There are also two sanctuaries, a conservancy, and Southern Pacific Railroad lands (near the Stony Creek Siphon/CHO).

Agriculture. The study area is zoned for agricultural use. One of the goals identified in Glenn County's Land Use Element of the General Plan is "to protect and maintain agricultural lands for the value of their products and economic impact and open space values" (Glenn County, 1993). Agriculture is by far the dominant land use in the study area. Perennial and annual crop distribution within the four reaches of the study area is described below in Table 2-2.

Grazing. Irrigated grazing pasture occupies approximately one-third of the study area. Irrigated grazing pasture dominates Reaches 1 and 2 of the study area, Black Butte to the TCC siphon, and occurs sporadically within Reaches 3 and 4, the TCC siphon to the Sacramento River (Glenn County, 1995; DWR, 1993)

Gravel Mining. Currently, six in-stream gravel mines operate within the study area. These are described in detail in the Aggregate Resources section.

Rural Residential. Approximately 85 residences associated with the agricultural operations, as identified in the DWR 1993 Land Use Study, are scattered throughout the study area. Their distribution is as follows:

- Reach 1 15 residences
- Reach 2 37 residences
- Reach 3 29 residences
- Reach 4 4 residences

Table 2-2
Cropping Distribution within Stony Creek Corridor

Crop	Reach 1	Reach 2	Reach 3	Reach 4
Perennial	Permanent Pasture Walnuts	Almonds Oranges Olives Prunes Peaches/Nectarines	Prunes Almonds Olives Walnuts Apricots Oranges Pistachios	Prunes Almonds
Annual	Wheat Hay	Grains Field corn	Field corn Sugar beets Grains Sudan grass Beans (dry)	Grains Rice Beans (green)

Source: DWR, 1993.

Environmental Management. Three parcels within the study area are currently managed to specifically protect environmental values. Just below Black Butte Dam, the Community of Compassion for Animals (CCFA) operates an all-species sanctuary on 360 acres, which includes approximately half a mile of Stony Creek. An important part of their mission is the protection of wildlife and habitat.

The Farm Sanctuary, a major national organization, operates their west coast animal sanctuary on 300± acres adjoining CCFA's lands. They, too, are concerned with the preservation of wildlife and habitat. Near the confluence with the Sacramento River, the Nature Conservancy owns a parcel, which is managed to protect environmental resources.

Private Stewards. The private stewards include:

- Foresters, such as Simpson Timber, whose extensive holdings provide wildlife