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- Chuck Schultz, US BLM
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- Dennis Beardsley, City of Chico
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Project Description and History of the Alliance

Introduction

The Existing Conditions Report and Stakeholders Inventory have been prepared for the Big Chico Creek Watershed Alliance (Alliance). The Alliance is comprised of private and public landowners, state and federal resource managers, city and county government representatives, conservation groups, educational institutions, and other interested parties. This chapter explains the purpose of the Existing Conditions Report and Stakeholders Inventory, provides background information regarding the grant that funded these documents, presents a brief history of the Alliance, and discusses results.

PURPOSE OF EXISTING CONDITIONS REPORT AND STAKEHOLDERS INVENTORY

The preparation of the Existing Conditions Report and Stakeholders Inventory is Phase I of the development of a Watershed Management Strategy, also called an Adaptive Management Plan, for the Big Chico Creek watershed. The purpose of the Watershed Management Strategy is to enhance and maintain the watershed ecosystem so that economic and ecological productivity in the watershed can be sustained indefinitely.

The Stakeholdes Inventory included a series of public workshops in Chico, Forest Ranch, and Cohasset/Richardson Springs. The first set of workshops was held in July 1998. These workshops provide a forum for stakeholders to express their views regarding the overall condition of watershed resources.

Stakeholders are people and organizations who have a "stake" in the management of the watershed. Some stakeholders have a financial stake, such as farmers who depend upon access to water, timber companies concerned about the costs of regulation, and local governments attempting to deal with flooding and water quality issues. Others with a financial stake are businesses serving people who fish, hunt or ride bicycles in the watershed, and landowners who want to protect their property values. Stakeholders can also be people who care about the watershed for any reason, whether they like to participate in recreational activities, study the natural environment, live in or visit the watershed, have friends who live here, or just like to know this place exists.

The results from the Stakeholders Inventory and this Existing Conditions Report will be used in Phase II to create the Watershed Management Strategy. The specific projects and programs of the Management Strategy will be developed based on thorough consultations with those living in the watershed, and the technicians and engineers serving as their advisors.

Phase III will be the implementation and monitoring of the Watershed Management Strategy. This phase will be ongoing as projects and stakeholders identify programs and funding becomes available. Outreach to stakeholders will also be an ongoing process, and stakeholders may change or become more or less active as their personal or agency needs are met during the process.

This entire project is intended to give more opportunity for local participation in watershed management. In the past, local, state and federal agencies have mandated planning for water quality, forestry, flood management, agriculture, and fishing but left out valuable concerns of landowners and the public.

The Big Chico Creek Watershed Alliance is committed to organizing a long-term Watershed Management Strategy that avoids government-mandated planning and that utilizes adaptive watershed management. In adaptive watershed management, voluntary restoration actions such as the removal of dams, fish ladder improvements, streamside fencing, forest management practices, flood plain improvements, habitat easements, water quality testing, and other options are planned, funded and monitored by trained volunteers or technical experts. Based on how successful the action is in achieving identified goals, the restoration effort is repeated elsewhere and tested again.

Individuals joining together to improve and protect creeks, forests, fish and wildlife through a consensus process takes some getting used to. But once agreement is reached that a self-determined plan can help protect the watershed resources and other local interests, people find the consensus process does work.

BACKGROUND INFORMATION REGARDING THE CALFED/EPA GRANT

The grant proposal for this project was initiated and written by the Big Chico Creek Watershed Alliance. Phases I and II were approved for funding through the CALFED grant process in 1997. The CALFED Bay-Delta Program is a cooperative, interagency effort involving fifteen state and federal agencies with management and regulatory responsibilities in the San Francisco Bay-Sacramento/San Joaquin River Bay-Delta. The mission of the CALFED program is to develop a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta system. The objective of the collaborative CALFED planning process is to identify comprehensive solutions to the problems of ecosystem quality, water supply reliability, water quality, and Delta levee and channel integrity.

One of the elements of the CALFED program is the encouragement of locally led watershed management activities that benefit Bay-Delta resources. The Big Chico Creek Watershed is recognized as a priority watershed for restoration by CALFED in its *Ecosystem Restoration Program Plan*. The Watershed is also considered a restoration priority in management plans of the U.S. Fish & Wildlife Service and the California Department of Fish & Game. (See the Existing Management Plans chapter for more information.) Big Chico Creek is one of only four streams in the Sacramento Valley that still provide habitat for both spring-run salmon and steelhead trout. The creek and its tributaries also serve as habitat for fall- and late-fall-run Chinook salmon, the endangered winter-run Chinook salmon, and other native species.

Funding of Phase I of this project began in April 1998 and is being provided by the U.S. Environmental Protection Agency. To carry out the project, the Big Chico Creek Watershed Alliance has formed a partnership with California State University, Chico in order to utilize the broad-based knowledge and experience of the faculty, staff and graduate students. The California State University, Chico Research Foundation provides fiscal management of the grant through the Office of Sponsored Programs.

HISTORY OF THE BIG CHICO CREEK WATERSHED ALLIANCE

The creation of the Big Chico Creek Watershed Alliance, as well as other watershed groups in the Sacramento River Valley, has been one of the responses to severe declines in anadromous fish populations and riparian habitat throughout the valley. In 1989, the California Department of Fish and Game estimated that the wild strain of spring-run salmon numbered only a few hundred and existed in only a few tributary streams. Populations of winter-run salmon had declined nearly 98 percent from historic numbers, and the fall run and late fall run had declined about 50 percent. Steelhead populations had declined from about 18,000 in 1966 to less than 2,000 in 1988. Less than 5 percent of the Sacramento River's original riparian acreage remained (California Resources Agency, 1989, p1). In Big Chico Creek at that time, the most recent estimates indicated only a remnant spring-run population, a depressed steelhead population, and a highly variable spawning population of fall-run salmon (California Resources Agency, 1989, p115).

The specific impetus for the creation of the Big Chico Creek Watershed Alliance can be traced back to 1990 and the dispute over pumps owned by the M&T Chico Ranch that removed water from Big Chico Creek near its confluence with the Sacramento River. The water was being diverted to irrigate the M&T and Parrot Ranches. A 1989 report prepared for the Resources Agency of the State of California, the *Upper Sacramento River Fisheries and Riparian Habitat Management Plan*, had identified the pumps as a major obstacle to restoring fisheries in Big Chico Creek. The report stated that the unscreened pumps actually caused streamflow reversals during the critical downstream out-migration period in approximately one out of four years. A 100 percent loss of downstream migrants occurred during these periods of flow reversal. In addition adult spring-run Chinook salmon migrating up the Sacramento River had difficulty locating the mouth of Big Chico Creek when flows were reversed (California Resources Agency, 1989, p115-116). The management plan called for the Department of Fish and Game and the Department of Water Resources to seek a cooperative solution with the M&T Ranch to alleviate the problem. (California Resources Agency, 1989, p119).

In a letter dated May 12, 1990, Chicoan Les Gerton asked the Chico City Council to consider legal action to shut down the M&T Ranch pumps to help restore the salmon. On June 19, 1990 the Chico City Council discussed Gerton's request and asked the City Attorney to submit a report regarding the Council's legal options (City of Chico, June 19, 1990). In his report dated Sept. 19, 1990, City Attorney Robert Boehm stated that of "all the man-made and natural conditions adversely affecting the salmon fishery in Big Chico Creek, the M&T diversion appears to be the most significant adverse effect." The city attorney also stated that given trends in water rights law, "it is quite likely that M&T could be compelled to relocate or modify their diversion in a manner which would diminish or eliminate its adverse effect on the salmon fishery in Big Chico Creek." The city attorney concluded that the most appropriate remedy would be to file a petition with the State Water Resources Control Board to adjudicate the water rights in Big Chico Creek (Boehm, 1990, p1-5).

The City Attorney's report was discussed by the Council at its meeting of Oct. 2, 1990 and at a work session on Nov. 14, 1990. While some speakers and letters supported the Council taking legal action, others were opposed. The attorney for M&T Ranch acknowledged the pumps contributed to the fisheries problem but stated that many other factors were involved, including increased urban population, increased water runoff, and commercial fishing (Farrell, 1990). Others told the Council that legal action was contrary to the cooperative approach urged by the 1989 *Upper Sacramento River Fisheries and Riparian Habitat Management Plan* and could undermine legislative efforts to secure funds for these types of projects. A motion to move forward with legal action failed on a 2-3 vote. Instead, the Council voted unanimously to conduct a cooperative study to more specifically identify the reasons for the loss of fisheries (City of Chico, Nov. 14, 1990). More than a year later, in December 1991, the City of Chico, M&T Ranch and Parrot Ranch entered into an agreement to jointly fund the study, later named the *Assessment of Big Chico Creek Salmon and Steelhead Production*. The consulting firm CH2M HILL was hired to conduct the study, and M&T Ranch agreed to administer the contract.

ASSESSMENT OF BIG CHICO CREEK SALMON AND STEELHEAD PRODUCTION

On June 22, 1992, M&T Ranch and Parrot/Phelan Ranch held a press conference to present the completed study. Conclusions promoted at the press conference were that a review of the data indicated the M&T pumps probably had a low impact on spring-run Chinook salmon in most years and that a new water delivery system and new management of the Parrot Ranch were likely to reduce or eliminate impacts from pumping (M&T Ranch, 1992).

The report and its conclusions, however, came under criticism. In an August 10, 1992 letter, the Department of Fish and Game called the report a "literature review" and stated that "the conclusions and recommendations of the report are not supported by the available information" (California Dept. of Fish and Game, 1992, pl). The Department of Fish and Game letter, CH2M HILL's responses, and some revisions were incorporated into a revised final report dated April 1993.

Although the report failed to resolve the controversy regarding the M&T pumps, it prompted the formation of a new structure to address the problems of Big Chico Creek. The final recommendation of the report called for the development of a Coordinated Resource Management Plan for Big Chico Creek to allow for a comprehensive resolution of resource issues "based on resource boundaries in Big Chico Creek rather than individual, agency, or political boundaries" (CH2M HILL, 1993, p7-3).

At its June 23, 1992 meeting, the City Council referred the study to the Bidwell Park and Playground Commission. The Council asked the Commission to review the study and report back to the Council with recommendations. The recommendations were initially developed by the Park Commission Stream Committee and subsequently approved by the full Park Commission at its Sept. 28,1992 meeting. The Park Commission's recommendations were then discussed by the City Council during a joint meeting with the Park Commission on Feb. 10, 1993. The first of the four recommendations state the following:

Establish a stream task force consisting of representatives from the Department of Fish & Game, Department of Water Resources, Regional Water Quality Control Board, Sacramento River Preservation Trust, Chico Fly Fishers, Streaminders, Park Commission and City staff. The task for this group is to develop a comprehensive stream management plan for Big Chico Creek, including Lindo Channel as described in the ... Big Chico Creek Salmon and Steelhead Production Study ... (City of Chico. Feb. 10, 1993, p1).

On Feb. 23, 1993, on a motion by Mary Andrews, the Council unanimously approved the formation of a subcommittee of the Park Commission that would meet with representatives of the various entities plus a water user. The new subcommittee would prepare guidelines and timelines for a stream management plan (City of Chico, Feb. 23,1993). The Big Chico Creek Task Force was born and held its first meeting on April 21, 1993.

BIG CHICO CREEK STRFAM TASK FORCE

The Big Chico Creek Task Force adopted five goals as its mission-

1. Evaluate problems and implement actions to eliminate the obstructions to fish migration.
2. Re-establish the recruitment of gravel downstream to restore spawning areas there.
3. Evaluate existing water quality and take action to restore and preserve stream water quality of the Chico urban area and upper watershed. Determine and set quality standards. Determine what contaminants will be tested.
4. Resolve issues related to flow management in Big Chico Creek and Lindo Channel; and
5. Riparian habitat is essential to fish migration. Preserve riparian habitat in the Chico urban area. Restore riparian corridors where possible.

Numerous objectives to help achieve these goals were also adopted by the Task Force, and several studies and projects were undertaken. These included water quality studies of the creek within Bidwell Park, a hydrological study of the One-Mile and Five-Mfle areas, studies of flood management and revegetation opportunities for Undo Channel, and the development of a Geographic Information System (GIS) for the upper Big Chico Creek watershed.

Among the concrete results achieved wholly or partially as a result of the work of the Task For and its members were the eventual relocation of the M&T pumps to the Sacramento River, the construction of a bypass to prevent release of siltatiori from the One-Mile pool during cleaning and the installation of a new stream gauge on Big Chico Creek at the golf course.

The Big Chico Creek Task Force's last meeting as an official City task force was March 20, 1996. The City of Chico continues to participate as one of the stakeholders on the Alliance. A staff member continues to attend meetings on behalf of the City, and two members of the Park Commission also attend as liaisons.

BIG CHICO CREEK WATERSHED ALLIANCE

After becoming independent from the City of Chico, the Task Force adopted a new name, the Big Chico Creek Watershed Alliance, and extended its area of concern to include the entire Watershed, from the headwaters to the Sacramento River. The Watershed includes Big Chico Creek and Lindo Channel as well as Sycamore, Mud and Rock creeks, their various tributaries, and all the land they drain.

The Alliance's main areas of focus since independence have been creating a stable organization, finding funding sources to determine the health of the watershed, and identifying restoration needs (Gibbs, 1998). In 1997, the Alliance received a grant from For the Sake of the Salmon, a group that had received federal dollars to fund 33 watershed coordinators in the states of Oregon, Washington, and California. For the Sake of the Salmon was looking for grassroots organizations, such as the Alliance, that were attempting to represent all stakeholders and interests in a watershed. Suzanne

Gibbs, who had been the volunteer chair of the Alliance since its beginnings as a City subcommittee, wrote the grant and became the watershed coordinator. This grant lasted from April 1997 through March 1998. The CALFED/EPA grant discussed above began the following month.

Recently, the Alliance has also been awarded a grant from the National Fish and Wildlife Foundation for a cooperative project with the Boy Scouts of America at Camp Lassen in Chico Meadows, near the headwaters of Big Chico Creek. This two-year project involves excluding cattle from the creek by building fences and providing off-stream watering for the cattle. There will be pre- and post-fencing evaluations of the creek to evaluate the success of the project.

The Big Chico Creek Watershed Alliance has also been involved in several other projects and programs, including joint efforts with the City of Chico to remove the invasive species Arundo donax (giant reed) from sites along Big Chico Creek and Lindo Channel without the use of herbicides. Other activities include the training of 1 1 people in aquatic bioassessment, a restoration project with Streaminders in Bidwell Park, the co-sponsoring of the annual Creeks of Chico Conference, and the sponsorship of local presentations by world-renowned experts in watershed management and restoration.

RESULTS

As discussed above, a letter from Les Gerton to the Chico City Council initiated a series of events that eventually led to the creation of the Big Chico Creek Watershed Alliance. When asked recently what had prompted him to write the letter back in 1990, Les explained, "I kept having dreams that the fish were coming back to our local streams and that I was helping - so I did" (Gerton, 1998).

Les' dreams may become a reality. Although much work and study remains to be done, the efforts of the Alliance seem to be paying off. ne creek's spring-run salmon, which had been reduced to only a remnant population, now appear to be making a comeback, with more than 350 counted in a September 1998 survey (Hill, 1998).

The Big Chico Creek Watershed Alliance invites you to join this cooperative effort to maintain

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WATERSHED HISTORY

—INTRODUCTION —

Couple on the Flume, just above current location of golf course clubhouse, circa 1890s.

From the John Nopel Collection.

The purpose of this chapter is to summarize the cultural and political prehistory and history of the Big Chico Creek Watershed and to provide information regarding remaining archaeological and historical resources. The list of Works Cited for this chapter identifies key resources for stakeholders who want more information on these topics.

This chapter is divided into five sections, including this introduction. The second section looks at the Watershed's prehistory and the lives of the Konkow and Yahi as discussed in a study of the cultural resources of Bidwell Park prepared for the City of Chico, a participating partner in the Big Chico Creek Watershed Alliance.

The third section looks briefly at the impacts upon the native populations as a result of people of European descent entering the area. This section is taken from a cultural resources study prepared for the Master Environmental Assessment for the Chico General Plan in 1994.

The fourth and longest section discusses the historical period. It begins with early explorers, distribution of lands, and the beginnings of agriculture. The reader is then taken on a brief historical tour of the Watershed. This tour begins in the Chico area, heads west to the

Sacramento River, north to the community of Nord, and then to the eastern ridges, canyons and mountains, from Cohasset to Chico Meadows. This broad historical approach, presenting short summaries of the early history of numerous parts of the Watershed, was chosen over a more in-depth examination of any particular location. This was done to emphasize the inclusiveness of the Big Chico Creek Watershed Alliance, which seeks participation from stakeholders throughout the Watershed, people with links to the Watershed's beautiful creeks, canyons, ridges, and places in between.

The final section of the chapter discusses remaining archaeological and historical resources and key resources for readers who would like more information on the topics discussed in this chapter.

—— PREHISTORY AND NATIVE AMERICANS ——

The Big Chico Creek Watershed lies within lands claimed by the Konkow, also known as the Northwestern Maidu, at the time of white settlement of the area. It is also near the boundary that historically divided the Konkow from the Yahi, the southernmost group of the Yana.

Jensen & Associates and Jones & Stokes Associates prepared a Cultural Resources Management Plan for Bidwell Park for the City of Chico's Park Division in July 1996. Its discussion of the prehistory of the Chico area and Bidwell Park and the cultures of the Konkow and Yahi Indians is applicable to the entire Big Chico Creek Watershed. That discussion is presented here in abbreviated form with minor changes in wording for clarification:

> The first European settlers in the Chico area observed that the resident Native American village populations followed a common lifestyle and spoke a fairly uniform dialect. These Indians have been variously referred to as the Northwestern Maidu, Konkow, Valley Maidu, or Michoopda. These are the Indian peoples who would most likely have occupied sites [within the Big Chico Creek watershed] during the past 500 or so years.
>
> Admittedly, questions abound concerning the cultural-historical sequence in the Chico area, and the nature of the relationships between Chico and Oroville to the south and the Yana territorial boundary to the north. It is precisely for this reason that the sites along Big Chico Creek are potentially important. They may hold the key to understanding late prehistoric relationships between the Yana and the much larger Maidu populations, which occupied the Chico area when John Bidwell first arrived….
>
> [The Big Chico Creek watershed] lies within lands claimed by the Konkow at the time of European contact (circa. A.D. 1850), but near the boundary which historically divided the Yahi to the north from the Konkow to the south…. Prior to the Nineteenth Century, the Yana (of which the Yahi represent the southernmost group) inhabited the Upper Sacramento River Valley, east of the Sacramento River, south of the Pit River, and possibly as far south as Butte Creek (Johnson, 1978, Figure 1), along the western slopes of the southern Cascade Range. Waterman (1918: Map 1) places the southern boundary near Pine Creek (Johnson, 1978, p361), while Dixon locates the southern boundary further south, near Rock Creek….
>
> Primarily a foothill people, the Yahi, like their linguistic relatives to the north, settled in villages several miles east of the Sacramento River. (Johnson, 1978, Figure 1)…

Similar to other California Indian groups, Yahi life was based on the nuclear family. Families lived in small, dome-shaped structures fashioned with poles, and covered with branches, brush, and skins. Temporary shelters and caves were also used by single and multiple families. Several family units, together, formed a village. Several villages in an area were represented by a major village which governed the whole, known as a tribelet. The tribelet was ruled by a chief of lineal descent.

Woman collecting acorns to assist the Yahi's "gathering" economy.
From Special Collections, Meriam Library, California State University, Chico.

Maintaining a hunting and gathering economy, the Yahi sought deer, salmon, slow-water fish, rabbit, quail, rodents, and various other animals in addition to a wide variety of plant resources. Acorns were intensively gathered and processed, as were tubers, roots, nuts, berries, and bulbs.

Generally, Yahi populations were small in size. Kroeber (1925, p341) estimates the Yahi population prior to Euro-American contact at around 200 to 300 individuals. This small population facilitated/required a relatively high degree of mobilization in order to procure needed resources…. And so it was with the Yahi that a pattern of seasonal exploitation was implemented, whereby roots, tubers, and other plant and animal resources were gathered/hunted during the spring; medium and large game animals were actively hunted in the mountainous regions of their domain during the summer months; and salmon and acorns were procured during the late summer and early autumn months. Winter was a season of marginal productivity, but the Yahi were able to maintain minor food stores, and foraged for additional sustenance.

While the origin and tenure of Yahi occupation near the valley floor is [uncertain], the Konkow did occupy that region at the time of Euroamerican contact. The Konkow occupied a portion of the Sacramento Valley floor, as well as the foothills east of Chico and Oroville, near the confluence of the south, middle, north, and west branches of the Feather River, Big and Little Chico Creeks, Butte Creek, and a large portion of the Sacramento River (Riddell, 1978, p370-372). On the basis of linguistic data and geographical distribution, the Maidu have been divided into three primary groups: the Southern Maidu, or Nisenan; the Northeastern Maidu, or Mountain Maidu; and the Northwestern Maidu, or Konkow (Shipley, 1978, p83). It is this latter group which laid claim to all the territory located within the [Big Chico Creek watershed] region at the time of Euro-American contact….

The basic social unit for the Konkow was the nuclear family, although the village may also be considered a social, as well as a political and economic unit. Villages were usually located on flats adjoining streams, and on ridges high above rivers and creeks, or along midslope benches, and were most intensively occupied during the winter months (Dixon, 1905, p175). Villages typically consisted of a scattering of conical bark dwellings, numbering from four or five to several dozen in larger villages, each house containing a single family of from three to seven people (Riddell, 1978, p373). Larger villages, with from twelve to fifteen or more houses, might also contain a kumi, a semisubterranean earth-covered lodge. The village containing the largest of these structures acted as the ceremonial assembly center (Riddell, 1978, p373). Between three and five villages comprised a "village community" which defended, controlled and exploited a known territory.

Resource exploitation for the Konkow was diverse if not prolific. A variety of plant and animal species was readily available for collection, processing and consumption, with several different food types complementing one another during various seasons. During the spring, a variety of herbs, tubers, roots, and grass seeds were collected from various environments within close proximity to the winter village. Jensen's (1994) recent investigation of lands immediately adjacent to Bidwell Park supports a hypothesis wherein prehistoric populations living along Big Chico Creek, within Bidwell Park, were actively exploiting wild onion rhizomes and Brodea, which were contained within vernal pools. This level of plant resource exploitation has not been investigated intensively within the Northern Sacramento Valley, and collectable data on this food resource alone offers great potential for additional study and interpretation of food collecting strategies.

During the summer months, individuals and groups would venture into the higher elevations in order to procure various plant and animals. Small, medium, and large mammals were actively hunted within the mountainous regions east of Chico, with only the coyote, dog, wolf, and bear avoided. Several types of insects were collected during the summer, including yellow jacket larvae, grasshoppers, locusts, and crickets; all of which could be eaten dry, or roasted, the bulk of which were often stored for the winter months.

The transition between summer and autumn brought with it an abundance of food resources. Late summer fish runs were actively exploited, with salmon providing a large portion of the spoils. In addition to salmon, suckers, eels, and a variety of small, slow water fish were actively exploited, especially during the Late Prehistoric periods (Broughton, 1988). Fresh water mussels were also collected by the Konkow year-round, but were intensively exploited during periods of low water volume [late summer/early autumn] (Eugster, 1990, p114). Several types of nut seeds were collected during the early autumn months, with acorns provided by various oak species representing the greatest volume of nut meat harvested. While several varieties of acorn producing oaks exist, the Konkow preferred the following respectively: black oak, golden oak, and the interior live oak. Other acorn producing varieties include the valley oak, blue oak, and the tan oak. The acorns were collected and then crushed in mortars to form acorn flour. Tannic acid had to be leached from the flour with warm water before consumption could take place. Bland bread was baked from the acorn flour, acting as a carbohydrate staple for the Konkow.

Technological adaptations by the Konkow allowed for a quasi-sedentary lifestyle, especially within the Bidwell Park area where food resources were abundant. Storage played a primary factor in the sedentary portion of their settlement pattern. With storage devices, structures, and methods, resources collected during the summer and autumn months could be consumed throughout the lean winter months. Mammals, fish, and mussels were still exploited during the winter, but few plant food resources were available, which made storage necessary… (Jensen & Associates, 1996, p14-16)

— EFFECTS OF EUROPEAN CONTACT ON — NATIVE AMERICANS

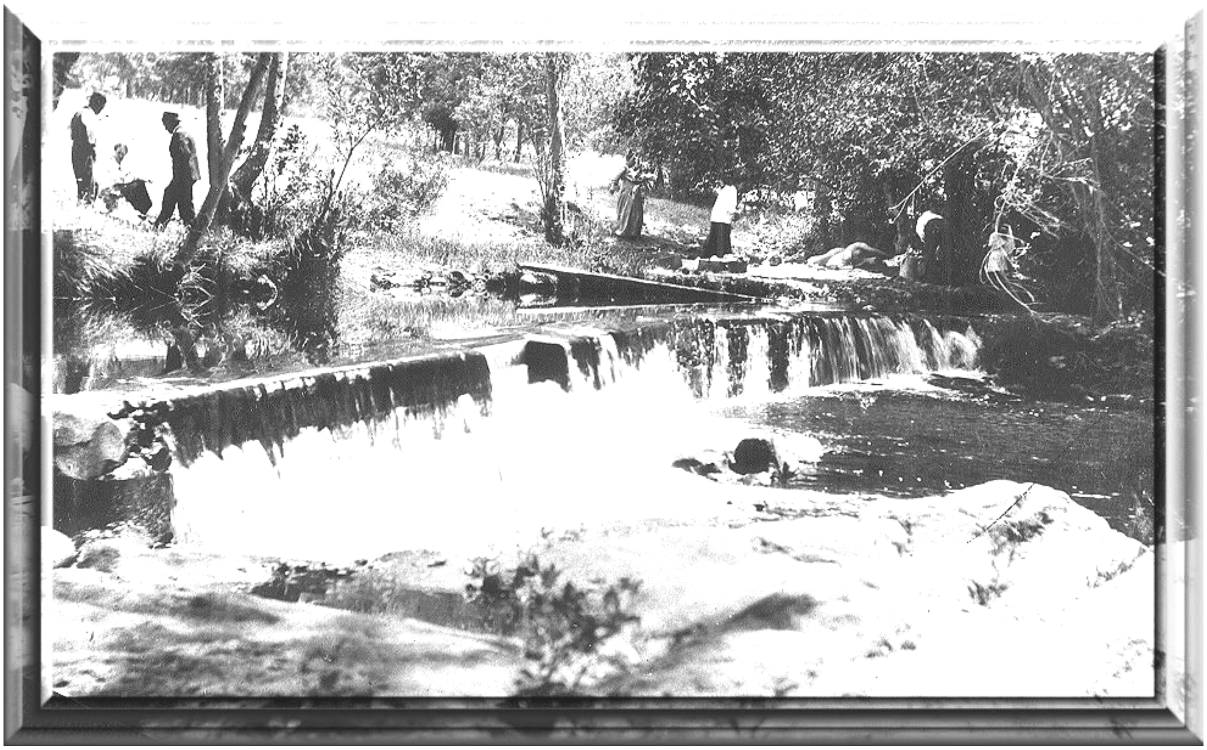
An excellent summary of the European Contact period in California and Butte County was prepared by Blayney Dyett and Michael Brandman Associates as part of the Master Environmental Assessment for the Chico General Plan in 1994 and is presented here:

> After 1770, Indian populations and settlements were disrupted as a result of Spanish colonial expeditions and trappers from the Hudson Bay Company (Moratto, 1984). A malaria epidemic, brought by early explorers in 1783, greatly diminished the Indian population. Further reductions in local Indian populations occurred over the next thirty years due to diseases such as small-pox, typhoid, tuberculosis, and pneumonia. During this period, the Anglo-Saxon (white) population of Butte County grew dramatically from fewer than twelve persons in 1848 to 3,541 persons in 1850. (Hill, 1978)
>
> The growing white population upset the long-standing ecological balance that the Indians had established. Miners and trappers (particularly those associated with the Hudson Bay Company) created scarcities of game by killing large numbers of deer, salmon, duck, and rabbit. Some species such as the condor, elk, antelope, and grizzly bear disappeared from the area. The introduction of domestic animals, such as cattle and hogs, further changed the environment and reduced the Indians' traditional food sources by eating the plants, roots, grasses, seeds, and acorns on the best food-bearing lands. (Hill, 1978)
>
> Conflicts between the Indians and the white population were most common between 1851-1863 (Hill, 1978). Probably as a result of the diminished food supply, Indians killed livestock belonging to the white population. Ranchers often retaliated to these and other types of incidents by indiscriminately shooting Indians on sight. During this time, many Indians sought refuge from lawless elements by working for various ranchers, most notably John Bidwell at Rancho Chico (Hill, 1978). In 1863, the infantry rounded up 461 Indians (429 survived the trip) in the Chico area for removal to the Round Valley Reservation, a two-week journey west. (Blayney Dyett. 1994. p8-3, 8-4)

— History of Big Chico Creek Watershed —

SPANISH EXPLORERS

The first explorers of European descent to approach the Big Chico Creek watershed were Spaniards coming up the Sacramento Valley. Spain had laid claim to the region, along with the rest of present-day California, since conquering the Mexico region in 1519. In 1808 a Spanish expedition, led by Gabriel Moraga, looking for a new inland mission site traveled up the Sacramento River to a point that was probably the outlet from Stony Creek. The expedition then headed east, crossing the Feather River near today's location of Oroville (McGie, 30). Based on this route, Moraga probably passed just south of the Big Chico Creek Watershed. In 1820 Captain Louis A. Arguello, on a journey of exploration, passed just west of the Watershed as he traveled north along the west bank of the Sacramento River.



Five-Mile Dam, Bidwell Park, circa 1908.
From Special Collections, Meriam Library, California State University, Chico, and Mrs. Jessie Cougar.

American Explorers

In 1828 a party of American fur trappers led by Jedediah Strong Smith entered the area. By this time the region had become part of the Mexican Empire as a result of Mexico overthrowing Spain and gaining independence in 1821. Smith and his party of 18 men and a herd of approximately 315 horses were traveling north along the east side of the Sacramento River when they crossed Big Chico Creek, which Smith named the Pen-min. In this area, Smith's party encountered Indian villages, observed Mount Shasta for the first time, and killed two elk and a grizzly (McGie 1957).

John Bidwell

The most influential of the early visitors to the watershed was John Bidwell, who became the founding father of the City of Chico. In 1841, he was part of the first land migration of American settlers to California, the Bidwell-Bartleson Party. In March 1843, Bidwell was working at Sutter's Hock Farm on the west bank of the Feather River just north of the present location of Marysville when a party of settlers headed to Oregon stole some of the farm's horses. Bidwell and two other men went after the settlers and retrieved the horses at the present site of Red Bluff. On this trip, Bidwell crossed the Big Chico Creek area for the first time (McGie 33). He was so impressed by what he saw that he mapped the region. This map later became the basis for the original Mexican land grants.

Mexican Land Grants

Three Mexican land grants were made on land that is part of the Big Chico Creek Watershed: the 22,214-acre Arroyo Chico (Little Creek) grant on the north side of Big Chico Creek and the Farwell and Aguas Nieves (Snow Waters) grants on the south side (Deal, 1978, Map 3). John Bidwell purchased the Arroyo Chico lands in 1849 and 1851 (Lydon, 1997, p27).

In 1846, a group of Americans led by John Fremont captured two Mexican generals and declared the independence of California as part of the Bear Flag Revolt. This uprising was cut short by the war between Mexico and the United States, which ended with the signing of the Treaty of Guadalupe Hidalgo in 1848, in which California was ceded to the United States. Under the treaty, the United States agreed to honor the Mexican land grants. A Board of Land Commissioners and appeals to federal courts determined the validity of the grants (Trussell 70-71). The Farwell and Arroyo Chico grants were upheld, but the Aguas Nieves was denied.

Distribution of Other Lands

Outside of the Mexican land grants, land was distributed to settlers under various United States public land laws, including the Act of 1820, the Homestead Act, and the Preemption Act. The United States government also made grants to the states of school lands, swamp lands, and lands for agricultural colleges; to individuals as a reward for military service; and to railroads. Rights to these lands were readily purchased throughout the pioneer period (Trussell, p69).

Counties of Butte and Tehama

In 1850, California became the 31st state of the union, and the entire Big Chico Creek Watershed was made part of Butte County, one of the state's original 27 counties. Tehama County was formed in 1856 from land that had belonged to Shasta, Colusa and Butte counties. As a result, parts of the Big Chico Creek Watershed became part of Tehama County. A stretch of Rock Creek north of Keefer and Cohasset ridges forms part of the present-day border of the two counties, and several northern tributaries of the creek drain out of Tehama County. In addition, much of the upper parts of Big Chico Creek itself, including its headwaters on Colby Mountain, are in Tehama County. As of Jan. 1, 1998, Butte County had a population of 201,600 and Tehama a population of 55,400 (Calif. Dept. of Finance, 1998).

Beginnings of Agriculture in the Watershed

Livestock grazing was the dominant economic activity on the early land grants of Butte County during the late 1840s and the 1850s. Animals raised included cattle, horses, sheep and hogs (McGie, p90). John Bidwell's ranch was the first center of agricultural activity other than grazing. In 1853 Bidwell was raising so much wheat that he built the area's first flour mill. Among the other crops Bidwell grew over the years, were hay, barley, oats, peaches, apples, quince, pears, figs, and grapes (McGie p83). Agriculture in the valley parts of the Big Chico Creek Watershed continued to grow and prosper. To this day, agriculture remains the dominant use of the valley areas of the Watershed, with almonds and walnuts among the most common crops.

Origins of Chico

A few months after the discovery of gold at Coloma on the American River in January 1848, Bidwell found gold at what is now Bidwell Bar on the Feather River. In addition to profiting from the gold he mined, he also established a successful trading post used by other miners flocking to the area. By 1852, Bidwell held title to the entire Rancho Arroyo Chico. In 1860, Bidwell purchased John Potter's ranch on the south side of Big Chico Creek and arranged for the county surveyor to lay out streets on this area between Big Chico and Little Chico creeks. Bidwell believed the establishment of a nearby community would help his farming enterprise fulfill its potential and offered free lots to people who would agree to build homes and settle there (McGie p92-93). The community of Chico was born and became an incorporated city in 1872. Today, the City of Chico has a population of about 52,700 (California Dept. of Finance, 1998) and an urban area population of about 94,000 (Sellers, 1998).

CALIFORNIA STATE UNIVERSITY, CHICO

John Bidwell and his wife Annie continued to play a key role in the development of the community of Chico for many years and their impact is felt to this day. Among John Bidwell's important contributions was successfully advocating for, and donating land to, the establishment of Chico Normal School. Now California State University, Chico, the school was authorized by the state legislature in 1887 and accepted its first students in 1889. CSU, Chico is one of the oldest institutions of public higher education in California. Today, the university has more than 14,000 students and approximately 1,900 faculty and staff.

BIDWELL MANSION STATE HISTORIC PARK

Bidwell Mansion, the home of John and Annie Bidwell, was built between 1865 and 1868. The Bidwells lived in the mansion until their deaths in 1900 and 1918 respectively. Annie Bidwell willed the mansion to the Presbyterian Church to be used as a co-educational Christian school. The mansion was then sold to private interests, who sold it to the State for use by the Chico Normal School, which later became Chico State College. Over the years the school used the mansion as a dormitory, classrooms and offices. In 1963, it was transferred to the California Department of Parks and Recreation, and it is now a state historic park (Calif. Dept. of Parks and Recreation, 1983, p15). The mansion and its grounds are being restored to the 1868-1900 historic period. A visitor center was constructed in 1993, and guided tours are available of the mansion itself. The park receives approximately 30,000 visitors a year (Holman, 1998).

BIDWELL PARK

Perhaps the most magnificent legacy of the Bidwells is the park that bears their name. In 1905 Annie Bidwell deeded more than 1,900 acres of land to the City of Chico for the purpose of establishing the park. The park stretched along the north side of Big Chico Creek to a boundary just beyond the end of today's Upper Park dirt road. On the south side of the creek, the park stretched to a point west of Bear Hole. In 1911 Annie added another 300 acres along the north side of Upper Park and a smaller area between the Esplanade and the present-day Camellia Way, now known as Lost Park. The next addition to the park came in 1921 when the City purchased the Forestry Station parcel, the current location of the Chico Creek Nature Center and World of Trees Nature Trail (McKee, 1983, p18 and Lydon, 1997, p27). The Kennedy tract, now a Walnut Orchard along North Park Drive, was added in 1934 (McKee, 1983, p21). Finally, in 1995, the City acquired more than 1,400 acres, most of it between Big Chico Creek and Highway 32 (Lydon, 1998).

Some other notable events in the history of the park include the construction of the One-Mile and Five-Mile recreation facilities in 1918, the opening of the golf course in 1921, and the development of a rifle range in 1926 (Jensen & Associates, 1996, p17-18; McKee, 1983, p39).

From approximately 1925 until the early 1930s, the Boy Scouts had a camp on what was called Scout Island, located about midway between One Mile and Five Mile (Nopel, John, 1998). In the late 1930s or early 1940s, the Diversion Dam and ditch were built to divert water from just upstream of Bear Hole to a reservoir at the current site of Horseshoe Lake. The purpose of the project was to supply irrigation water for the golf course (McKee, 1983, p43 and Lydon, 1997, p28-29). Upstream of Salmon Hole, in Iron Canyon, the State Department of Fish and Game built a fish ladder in 1958. The construction of the Iron Canyon fish ladder reestablished migratory fish access to the upper part of the creek. Access had been blocked by 14-foot falls created by a rock slide that occurred about the time of the 1906 San Francisco earthquake (CH2M Hill, 1993, p3-2 and Lydon, 1997, p28). In the 1960s, a horse-riding arena was built just west of Live Oak Grove, between the Diversion Channel and Manzanita Avenue (Lydon, 1997, p30-31).

Today, Bidwell Park covers approximately eight linear miles of Big Chico Creek and encompasses roughly 3,740 acres. It is now the third largest municipal park in the United States (Jensen & Associates, 1996, p 1).

Chico and Mud Creeks and Sandy Gulch Flood Control Project

The U.S. Army Corps of Engineers completed this flood control project in 1965 as part of the Sacramento River and Major and Minor Tributaries Project. Three diversion structures were constructed on Big Chico Creek at Five-Mile Recreation Area and near the head of Lindo Channel to divert peak flows, and a diversion channel was built to connect Lindo Channel with Sycamore Creek.

The purpose of the project is to carry peak flows around the City of Chico via the Diversion Channel, Sycamore and Mud Creeks. Mud Creek eventually reunites with Big Chico Creek shortly before it enters the Sacramento River. The project also included the construction of a levee on the left bank of the diversion channel and 23 miles of levees along both banks of Mud Creek, Sycamore Creek, and tributaries (U.S. Army Corps of Engineers, 1975, p5). The flood control structures are operated and maintained by Butte County in conjunction with the Department of Water Resources.

Bidwell River Park, including Lindo Channel and North Bank of Big Chico Creek

In 1908, Annie Bidwell deeded additional property to the State of California. One part of the property was a strip of land along the east bank of the Sacramento River and Pine Creek, extending north from Big Chico Creek. Another portion of the deeded property included the channel and both banks of Lindo Channel, also known as Sandy Gulch, from Bidwell Park to its western junction with Big Chico Creek. The third part was along the north side of Big Chico Creek, from the Southern Pacific Railroad right of way to the Sacramento River. In width, it extended from the center of the creek to the Second, Seventh and Meridian subdivision of the Bidwell Rancho (approximately the top of the creek bank in most locations). Annie's deed explains her intentions:

> The object of the grantor in conveying this property to the State of California is to preserve after her death the forest growth along said water courses; to prevent the diversion and use of the water for private purposes; to minimize the loss of water by evaporation so that the sub-irrigation of the

Sandy Gulch (Lindo Channel), shown circa 1905, became part of
Bidwell River Park in 1908.
From Special Collections, Meriam Library, California State University, Chico
and Glady Pelleties.

> adjoining lands may be maintained to the natural extent and to maintain the natural beauty of said streams and the integrity of their banks. It is understood that the State of California in accepting this conveyance shall retain the title to the lands herein granted in perpetuity. (Bidwell, 1908)

The lands in this grant became known as Bidwell State Park. In 1928, survey maps, complete with orientation markers and boundaries, set to scale, were prepared for the State Department of Natural Resources by the Chico firm of Polk & Robinson. These maps, which remain on file with the Butte County Department of Public Works, include a Key Map and five sheets each for what are called the Sacramento River, Lindo and Big Chico divisions. The Sacramento River Division was surveyed its entire length, the Lindo Division was surveyed from the Esplanade to Grape Way, and the Chico Creek Division was surveyed from the railroad tracks to just past Lindo Channel.

Complicating the issue of the park's boundaries, however, was the fact that in 1882, Butte County had also received a conveyance of land extending north from Big Chico Creek along the Sacramento River. This deed of 11.45 acres was to be used for road purposes (Bidwell, 1882). Partly because of the possible overlapping of areas in deeds and conveyances, and the resultant clouding of titles between the State and the County, it was decided in 1950 that the State would convey its portion to the County and thereby merge the deeds (Stewart et. al, 1997).

Assembly Bill 141, passed in 1950, transferred all of the Bidwell State Park lands to Butte County and included the following conditions:

> a) Said lands shall be used by the County of Butte and by its successors solely for the establishment, improvement and conduct of a public park for the use and benefit of the people of the State….
>
> b) Said park shall be improved by said county without expense to the State and shall always remain a public park for recreational use by the people of the State of California…. (State of California, 1950)

After it was transferred to the County, the park became known as Bidwell River Park. The next part of this history focuses primarily on the Sacramento River Division, where boundary uncertainties persisted because of historic river course changes, bank erosion, and accretion lands:

> The County did not want to get into parks and recreation and so leased some to the Chico Area Recreation and Park District (CARD). CARD in turn leased nearly all of the property to a rod and gun club. The merged deeds only resolved some intra-governmental issues for Butte County and for Chico Area Recreation District, the lessee. By the 1960s boundary disputes with neighboring landowners frustrated efforts at developing a master facilities plan. By the 1970s the park was under budgeted. A planned cadastral survey of disputed boundaries was not completed. Hunting, shooting, wood-cutting, dumping, and the intrusion of off-road vehicles defiled the park. In 1972, at the request of petitioning local government, the California Department of Parks and Recreation was mandated by the legislature to study alternative methods to preserve Bidwell River Park. A resulting 1974 report recommended that (the Sacramento River Division of) Bidwell River Park be acquired by the state as part of the State Park System. (Stewart et. al., 1997, p2)

A 1977 state bill authorized the reacquisition of the Sacramento River Division of the park (State of California, 1977, p1738-1739). The transfer agreement was signed in 1978 (State of California, 1978), and the Sacramento River Division became part of the state park system in 1979. It became known as Bidwell-Sacramento River State Park (Stewart et. al. 1997, p2).

The 1978 transfer document specifically stated that the Sacramento River Division was being transferred to the State and that the Lindo Channel portion of the park was being retained by the County. The transfer document made no mention of the Big Chico Creek section, creating some uncertainty about whether it had been transferred or not. In a 1983 letter to the Board of Supervisors, CARD stated that the transfer document clearly delineates the extent of the properties transferred back to the State and that CARD is confident that the properties so described do not include the north bank of Big Chico Creek (CARD, 1983, p1-2). The 1974 study that recommended the transfer specifically stated that the Big Chico Creek section should remain with the County (Calif. Dept. of Parks and Recreation, 1974, p11). The 1977 legislation that authorized the transfer did not include authorization for transfer of the Big Chico Creek section (State of California, 1977, p1738-1739).

CARD's responsibilities for Bidwell River Park ended when CARD let its lease with the County expire in 1983 (CARD, 1983, p1-2). In July 1995, the section of Bidwell River Park on Lindo Channel from Manzanita Avenue to the City's western sphere of influence line, just west of Highway 32, was deeded by the County to the City (Sellers 1998). It is designated as a Creekside Greenway in the Chico General Plan. The remainder of Bidwell River Park remains under the jurisdiction of Butte County. In addition to Bidwell's deed and the 1950 state legislation, the park's use is governed by Chapter 16, Article II of the Butte County Code.

BIDWELL-SACRAMENTO RIVER STATE PARK

The portion of the park adjacent to the mouth of Big Chico Creek is now a day use location called the Big Chico Creek Riparian Area. For many years, the gravel bar here was a boat launching area and popular takeout location for Sacramento River "tubers." (See the Recreation chapter of this report for more information about current use.) In 1997, a 58.5-acre parcel known as the Peterson Property, north of where River Road crosses Big Chico Creek, was added to the park. This new addition, which includes the right bank of Mud Creek at its confluence with Big Chico Creek, was deeded to State Parks by the Sacramento River Preservation Trust. The Trust purchased it with grant funds received from the U.S. Fish and Wildlife Service from the Central Valley Project Improvement Act Restoration Fund (Sacramento River Preservation Trust, 1997, p2). Other parts of this state park are the Irvine Finch River Access, Pine Creek, Indian Fishery, and Chico Landing areas, which are outside of the Big Chico Creek Watershed.

CHICO LANDING

Prior to the arrival of the railroad in 1870, stage roads and the Sacramento River were the primary transportation links between the Big Chico Creek Watershed and areas to the south and north. Chico Landing, also known as Bidwell Landing, was a hub for river transportation. It was probably originally located at the mouth of Big Chico Creek and moved several times with changing conditions on the river (Stewart et. al, 1997). The California Steam Navigation Company provided an almost daily steamboat service from the landing. (Chang, 1993, p11; Wells & Chambers, 1973, 240). Agricultural products produced in the area were sent from Chico Landing to Sacramento and San Francisco and then by ship to other destinations. A piano on display in Bidwell Mansion was shipped to Annie Bidwell from New York around Cape Horn of South America, to San Francisco, through the Bay, and up the Sacramento River to Chico Landing (Hearne, 1998).

ORIGINS OF NORD

Another important Sacramento River transportation site was Colby's Landing, a shipping point for products going by boat to Sacramento, established in 1858 about seven miles northwest of Chico (McGie, p95). When the California and Oregon Railroad reached Butte County in 1870, it greatly increased the speed by which products could be sent south to the larger cities and thus began to replace river transportation.

To take advantage of the new transportation link, a train station and the community of Nord were established east of Colby's Landing along the path of the new railroad, just east of Rock Creek. Today, Nord is a rural community of about 326 people (1990 census per Betts, 1998). To the north and east of Nord, Rock Creek and its tributaries drain the northwestern region of the Big Chico Creek Watershed, including Sugarloaf Mountain in Tehama County, Keefer Ridge and much of Cohasset Ridge.

ORIGINS OF COHASSET

The community of Cohasset lies on the ridge between Mud and Rock creeks. The ridge became a lumbering area in the late 1850s and was called the Campbell Pinery and later the Keefer Pinery. J.L. Keefer was a rancher and farmer on lower Rock Creek who became the first large-scale mill operator on the ridge and built the first road to the valley down what is today Keefer Ridge. This original road was so steep and dangerous, however, that another was built east of

Anderson Fork, a tributary of Rock Creek, along the top of Cohasset Ridge (Nathan, 1966, p60-62, 70).

Store, Post Office and Train Depot, Nord, circa 1895.
From Special Collections, Meriam Library, California State University, Chico
and the John Nopel Collection.

The first permanent settlers of the ridge were farmers who came in the late 1860s and early 1870s. Their early farms were generally at a subsistence level with cattle, sheep, hogs, a garden plot and land for cultivation. For cash, farmers worked at the mills on the ridge or walked to other mills on Big Chico Creek (Nathan, 1966, p85). In the late 1800s and early 1900s, apples became a successful crop, with local farmers growing prize-winning varieties (Nathan, 1966, p89).

In 1878 a school district was formed and given the name North Point, which eventually became the name of the entire ridge. In 1887 residents requested the establishment of a post office but were told that there were already too many postal stations with “North” and “Point” in their names. Ridge residents gave two women, Marie Wilson and schoolteacher Electa Welch, the task of selecting a new name. Their choice was “Cohasset,” which means “City of Pines” in the Algonquin Indian language (Nathan, 1966, p82). Today, Cohasset is an unincorporated community of Butte County with a population of approximately 741 people (1990 census per Betts, 1998).

COHASSET RIDGE TO MUSTY BUCK RIDGE

To the south of Cohasset Ridge, along Mud Creek, is Richardson Springs. The mineral springs at this location were first discovered and used by Native Americans. In the early 1860s, a Rock Creek rancher by the name of Solomon Gore came across the area and called it Nepheling

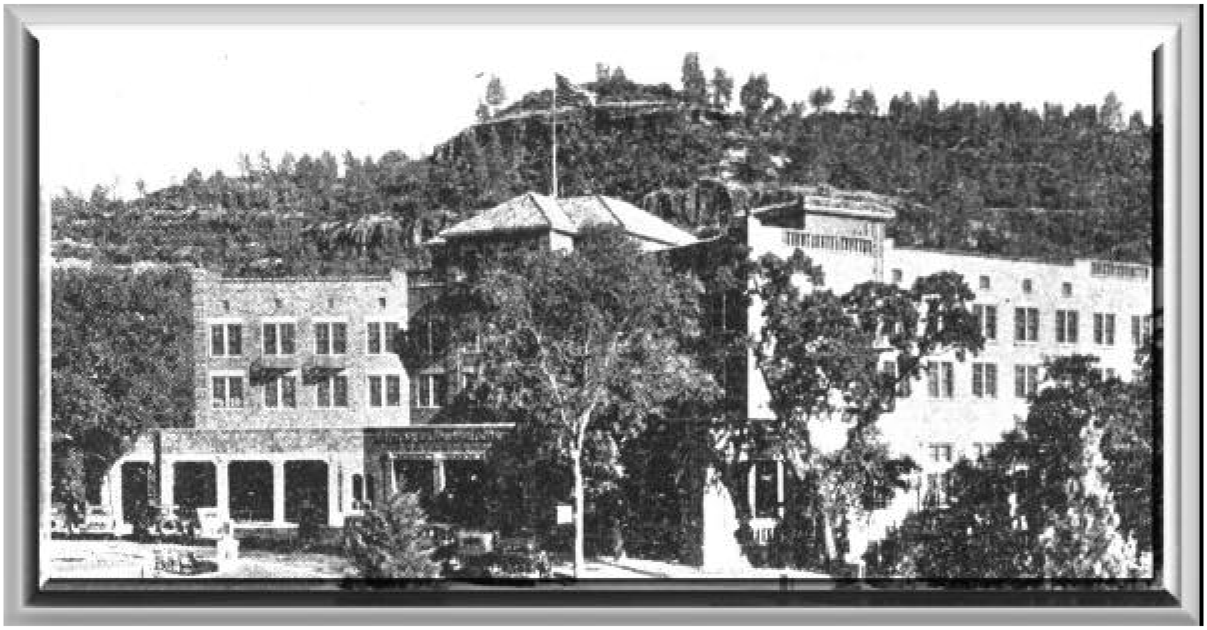
Samuel Sorenson's General Merchandise store, Cohasset, 1910.
Donald Sorenson in foreground.
From Special Collections, Meriam Library, California State University, Chico.

Springs. The Richardson family, which had moved west from Iowa, purchased the land in 1868, and a resort and health spa was begun in 1903 (McGie 164-165). The spa offered steam and mineral baths and in its heyday was promoted as a playground for the rich and famous. In 1968, the resort was leased to Springs of Living Water Christian Ministries, which purchased the land in 1969. The Springs of Living Water at Richardson Springs is now a nondenominational nonprofit Christian conference center. Its beautiful hotel, built in 1923, is still in use. In 1985, the California Historical Resources Commission listed the site as a Point of Historical Interest. (Please see the Recreation chapter of this report for more information.)

Bordering Richardson Springs is the largest portion of two sections of privately owned lands managed as the 9,300-acre Musty Buck Preserve, which extends down into the Big Chico Creek Canyon. Given the same name as the ridge that separates Mud Creek and Big Chico Creek, this area has historically been used for grazing, a use that continues today. This preserve has been managed as a hunting club under the Department of Fish and Game's Wildlife Habitat Enhancement and Management Area Program since 1986.

HUMBOLDT ROAD

On the opposite side of the canyon from Musty Buck is the ridge that forms the eastern border of the Big Chico Creek Watershed. Separating the Big Chico Creek Watershed from Little Chico Creek and Butte Creek, this ridge played an important role in the development of the region. In 1861 silver was discovered in the West Humboldt Mountains of the Nevada Territory. In response to the opportunity for commerce with this new mining area, John Bidwell and four partners purchased a road-building franchise and began construction of Humboldt Wagon Road, which was in use by 1864 (Chang, 1993, p10-15). The wagon road generally followed the path of today's Humboldt Avenue and Humboldt Road in the City of Chico, Highway 32 along the southeast rim of Big Chico Creek Canyon, and the continuation of present-day Humboldt Road



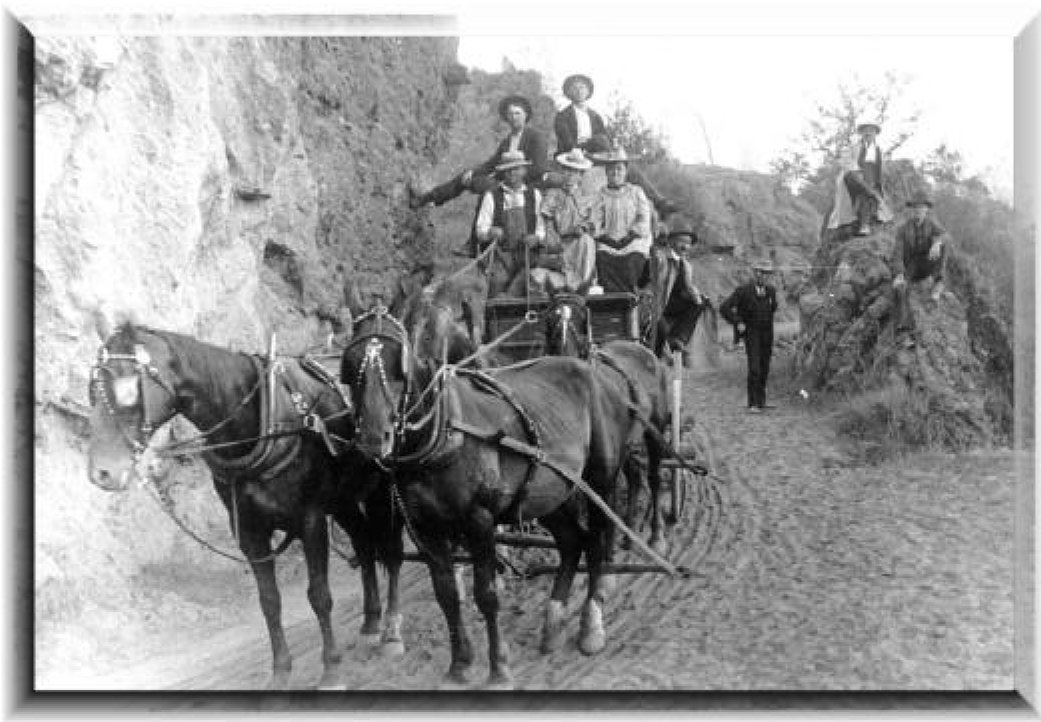
Richardson Springs Resort, circa 1930s.
From Special Collections, Miriam Library, California State University, Chico
and Condensed History of Butte County, p134.

from Lomo to Butte Meadows and beyond. Although the wagon road's original destination was the mining areas of the Humboldt range, it was later routed to Silver City, Nevada in response to other mining strikes (Chang, 1993, p19). Many of the places on today's map of the corresponding stretch of Highway 32 were stage stops on the old Humboldt Wagon Road, including Ten-Mile House Trail, Fourteen-Mile House Road, Forest Ranch and Lomo.

FOREST RANCH

In 1853, Paul Lucas, a native of St. Louis, drove his ox teams into Chico Canyon (Mansfield, 1918, p873). The Lucas family purchased land 14 miles east of Chico and established a ranch that supplied beef to miners who were drawn by the gold rush. According to one researcher, the Lucas Ranch was sometimes referred to as the Forest Ranch and may be the origin of the community's name (Lucas, 1992, p46), but this issue remains uncertain (Nopel, John, 1998).

With the opening of the Humboldt Wagon Road, the area became one of the leading logging areas in Butte County until becoming less competitive than mills upstream utilizing the new flume (Lucas, 1992, p47-49). Increased travel on the road also increased the demand for temporary lodging. The Lucas family operated what was known as the 14-Mile House Hotel, and Horace Weld built the Forest Ranch Hotel at what is now the town center in 1865 (Nopel, John, 1998). In May 1878, the Forest School District was formed, and in June the United States Postal Service opened a post office, giving Forest Ranch "a legitimate standing as a new and lasting community" (Lucas, 1992, p49). Today, Forest Ranch is an unincorporated community straddling Highway 32. It has a population of approximately 947 people (1990 census per Betts, 1998). Only that part of the community on the Big Chico Creek side of the ridge is actually



Stage at County Seat Grade on Humboldt Road, circa 1890s.
From the John Nopel Collection.

within the Watershed. The remainder of the community is within the Little Chico Creek and Butte Creek watersheds.

MINNEHAHA MINE

Upstream from Forest Ranch along Big Chico Creek is the Minnehaha Mine, located on property owned by the U.S. Bureau of Land Management. Intermittent gold mining at the Minnehaha site goes back to at least the 1930s and involved underground placer mining of an ancient stream bed high above the current drainage (Rogers, 1998). The mine site created a chronic siltation problem in the creek, especially when dikes on settling ponds failed, releasing selenium, mercury, chromium, and other pollutants. In one incident in the 1980s, 135,000 gallons of serpentine clay slurry were released into the creek (CH2M HILL, 1993, p4-12, 4-13; Bishop, 1998). In response to this incident, the Department of Fish and Game cited the mine operators, and the Bureau of Land Management issued an emergency closure. Local citizens who visited the site reported finding remnants of old cabins, at least 15 refrigerator carcasses, piles of machinery, bulldozers and other garbage on the property (Nopel, Dave, 1998, personal communication). The mine operators did not have the resources to clean it up, however, and eventually the BLM and other public agencies paid for a cleanup costing more than $35,000. The miners responsible for the incident relinquished their claim, but others reclaimed the mining rights. Today, vehicle access is still prohibited, erosion has been stabilized, and the property is being revegetated through natural processes (Rogers, 1998).

CHICO MEADOWS, LUMBERING AND CATTLE

Further upstream, not far from Big Chico Creek's headwaters on Colby Mountain, is Chico Meadows, one of the centers of early logging operations in the Watershed. The opening of the Humboldt Road opened up vast tracts of previously inaccessible timber (Hutchinson, 1974). Markets for lumber from the Watershed continued to grow with the arrival of the California and Oregon Railroad in Chico in 1870 and then the completion of a V-shaped flume extending from Chico Meadows to just outside Chico in 1874. A branch of the flume also connected with mills on Cascade Creek. The flume carried lumber down the entire length of the Big Chico Creek Canyon to a point just above today's Five-Mile Dam in Bidwell Park, where a small community called Oakvale sprang up to process the lumber (Nopel, 1998, Pioneering Families).

Later, the flume was extended into Chico "along the south side of what is now East Eighth Street to Pine Street, where it turned north to discharge its water back into Big Chico Creek. There was good trout fishing in this Pine Street section of the flume…" (Hutchinson, 1974). A factory to process the cut was built east of Pine Street between the flume and Humboldt Road (Hutchinson, 1974). According to local historian Dave Nopel, a "virtual torrent of wood began pouring down the flume, and the Chico Meadows mill became one of the most storied of its time. Butte County became the state leader in pine production (and) Chico called itself the Pine Capitol of California…" (Nopel, 1998, Pioneering Families).

The New Arcade Mill in Chico Meadows was operated through 1894. The Sierra Lumber Company then shifted operations to the Providence Mill, also called the West Branch Mill. This mill, which operated between 1895 and 1906, was located near the junction of Big Chico Creek and Campbell Creek (Hutchinson, 1974). In addition to the flume, the mill also utilized a narrow-gauge railroad that ran upstream about 4-5 miles to where Little Smoky Creek enters Big Chico Creek (Nopel, Dave, 1998, personal communication). In 1907, the Sierra Lumber Company was acquired by the Diamond Match Company, which built a new mill in Stirling City. Today, most of the private forestry lands in the Watershed are owned by Sierra Pacific Industries. Lower Chico Meadows is now occupied by Camp Lassen, which is operated by the Boy Scouts of America. (Please see the Recreation chapter for more information.)

From the John Nopel Collecton.
May not be reproduced without permission.

Chico Meadows, especially the upper meadow, has a long history as one of the numerous cattle summer pastures in the mountains. A primary cattle trail of the region, the Campbell Trail, passed nearby. Valley ranchers would gather their cattle together in the spring and drive them up the trail to Butte Meadows. The drives consisted of several hundred to several thousand head of

Mechoopda kumi or assembly house.
From Special Collections, Meriam Library, California State University, Chico
and Dorothy J. Hill.

cattle and lasted from seven to ten days, depending on the number and type of cattle being driven (Butte Creek Watershed Project, 1998; Roney, 1998). From Butte Meadows the cattle would be sorted into smaller herds and driven to one of the various summer pasturing areas in the mountains (Jessee, 1998).

EXISTING CULTURAL RESOURCES AND SOURCES OF ADDITIONAL INFORMATION

ARCHAEOLOGICAL RESOURCES

Numerous archaeological resources are located in the Big Chico Creek Watershed. They include bedrock mortars, petroglyphs, lithic scatters, temporary and permanent habitation sites, and burials. Other resources that may remain include middens, mortars and pestles, arrowheads, grinding stones, knives, pipes, and a variety of hand implements. A records search conducted by the Northeast Center of the California Historical Resources Information System for the Chico General Plan found 112-recorded prehistoric sites in the planning area. Areas considered to be highly sensitive for archaeological resources in the Chico area include the entire area within the City of Chico, areas along the major creeks between the foothills and the Sacramento River, and the foothills above 300 feet in elevation (Blayney Dyett and Michael Brandman Associates, 1994, p8-4). One area of the Watershed, the Mud Creek Canyon Archaeological District, is currently listed on the National Register of Historic Places (U.S. Department of the Interior, 1996, p12),

Chico, east side of Broadway between 3rd and 4th streets, circa 1866.
From Special Collections, Miriam Library, California State University, Chico

and a 1996 study concluded that sites within Bidwell Park should also be nominated for the Register (Jensen and Jones & Stokes, 1996, p35).

—— HISTORICAL RESOURCES ——

Numerous historical resources are also present in the Big Chico Creek Watershed, including remnants of mines and timber mills, historic buildings, cemeteries, rock walls, watering troughs, and roads. Bidwell Mansion, the South of Campus Neighborhood, and several buildings in the downtown Chico area are listed on the National Register of Historic Places (U.S. Dept. of the Interior, 1996, p12). The sites of the old Hooker Oak and the Chico Forestry Station and Nursery in Bidwell Park are listed as California Historical Landmarks (Calif. Dept. of Parks and Recreation, 1996, p19-20), and Chico Flour Mill and Richardson Springs are listed as California Points of Historical Interest (Calif. Dept. of Parks and Recreation, 1992, p5-6).

Chico, near Post Office on First Street and Broadway, circa 1895.

From Special Collections, Meriam Library, California State University, Chico and Dorothy J. Hill.

—— SOURCES OF ADDITIONAL INFORMATION ——

Readers interested in additional information regarding the rich prehistory and history of the Big Chico Creek Watershed and existing resources are encouraged to utilize the list of Works Cited following this chapter. In addition, the following are especially valuable local sources of additional information:

Special Collections, Meriam Library
California State University, Chico
Chico, CA 95929-0295
(530) 898-6342

The Northeast Center of the California Historical Resources Information System
Department of Anthropology
California State University, Chico
Chico, CA 95929
(530) 898-6256
Note: The Northeast Center charges for its services.

Bidwell Mansion State Historic Park
525 Esplanade
Chico, CA 95926
(530) 895-6144

Chico Heritage Association
336 Broadway
Chico, CA 95928
(530) 345-7522

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HYDROLOGIC / GEOLOGIC PROCESSES

INTRODUCTION

Big Chico Creek originates from a series of springs, at an elevation of about 5,400 feet, northeast of the City of Chico on the southwest flanks of Colby Mountain. The watershed also encompasses three smaller drainages to the north: Sycamore, Mud, and Rock Creeks. Closest to Big Chico Creek is Sycamore Creek, which originates at around 1,600 feet and is a tributary to Mud Creek. Mud and Rock Creeks, further north, originate between 3,600-3,800 feet. Mud Creek drains off Cohasset Ridge to the south, flowing 26 miles to its confluence with Big Chico Creek. Rock Creek drains the north side of Cohasset Ridge and flows 28.5 miles before it joins Mud Creek. Big Chico Creek flows a distance of 45 miles from its origin, crossing portions of Butte and Tehama counties, to its confluence with the Sacramento River, at an elevation of 120 feet, west of the City of Chico.

CLIMATE

The watershed is located in an Interior Mediterranean Climate that is defined by its moist, cool winters and hot, dry summers (Critchfield, 1974). The average yearly precipitation varies from 70-80 inches at Colby Mountain to about 20 inches at the Sacramento River (see Precipitation Map). Most of the precipitation falls as rain between the months of November to May, although during some of the colder winter storms a large amount of snow may fall above 3,000 feet. These events can bring snow to the headwaters of Mud and Rock Creeks as well. The snow pack adds to the regular base flow until it completely melts, usually by late spring. Snowpack can vary greatly, depending on how long and intense each winter is. Year to year climatic fluctuations can dramatically affect the flows in Big Chico Creek and its tributaries. Drought cycles and wet cycles have lasting effects and change the flow characteristics in the watershed and alter other interrelated natural processes. The temperatures for the area can drop well below freezing (<32°F) in the upper watershed during the winter and commonly rise above 100°F during July and August in the valley and foothill sections of the watershed.

GEOLOGY

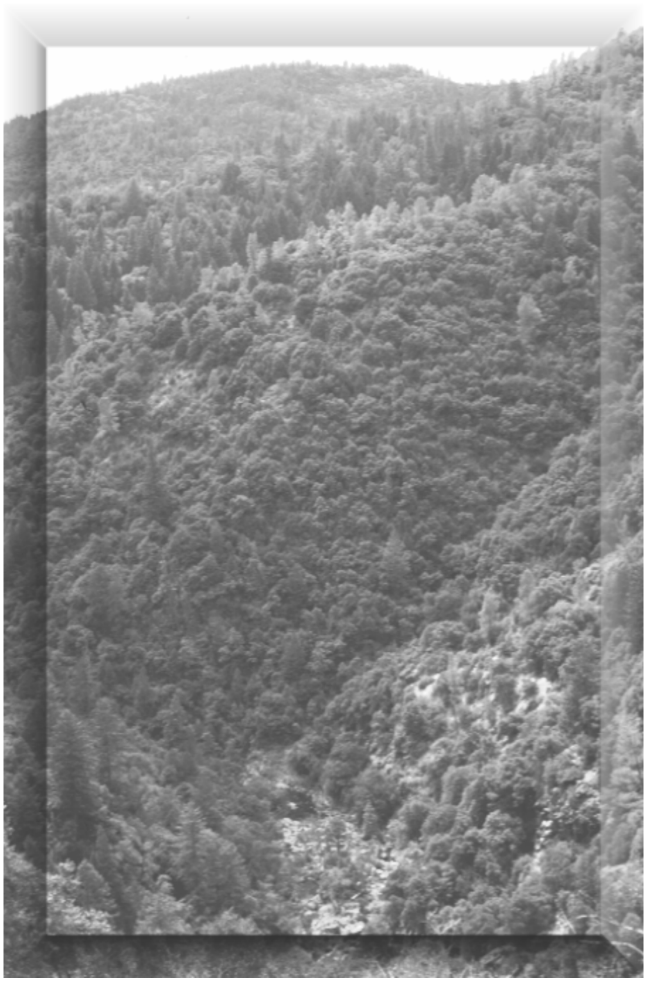
The Big Chico Creek watershed is located in a region that includes the interface between the Sierra Nevada Range to the south, and the remnant volcanic flows of the Cascade Range to the north. Big Chico Creek originates in volcanic rocks, referred to as the Tuscan Formation. The Tuscan Formation, about 4 million years old, is the dominant geologic formation in the watershed as it is the most recent layer of material deposited on the landscape. The upper portions of the watershed are covered by the Tuscan, which as a relatively softer rock, allows the creek to disperse its energy more laterally than vertically, resulting in a flatter creek bottom.

About one mile downstream of the confluence with Web Hollow, Big Chico Creek has eroded through enough of the Tuscan to expose a small stretch of “Sierran” rock (see Geology map). These rocks are also referred to as “Metavolcanic”, which means they originally came from volcanic processes but over time have been metamorphosed (changed) by heat and/or pressure. The Metavolcanic rocks are most likely old sea floors - ocean sediments, and associated materials - 225 to 500 million years old, that formed out in the Pacific Ocean. Over time there were many episodes of small landmasses being pushed up against the edge of the continent, each time adding to the coastal terrain. These rocks are much harder than the Tuscan, restricting the creek and forcing it to disperse its energy by down cutting into the creekbed. The creek becomes more constricted in this area and the gradient (slope) of the creek increases. This approximately 4-mile stretch of metavolcanics is buried under the next geologic formation, the Chico Formation near Higgins Hole. The metavolcanics are the oldest rocks exposed in the watershed.

The Chico Formation is the second oldest geologic formation in the watershed, which is first exposed between Higgins Hole and where Ponderosa Way crosses Big Chico Creek (see Geology map). It is made up of sedimentary rocks composed of sands, silts, pebbles, and cobbles that made up the ancient shorelines when the Pacific Ocean reached into the Sacramento Valley. The Chico Formation is much softer rock than the metavolcanics and once again allows the creek to flatten out, dissipating its energy laterally. This results in a gentler gradient for this stretch of the creek. The Chico Formation is about 75 million years old and numerous marine fossils can be found within the sandstone.

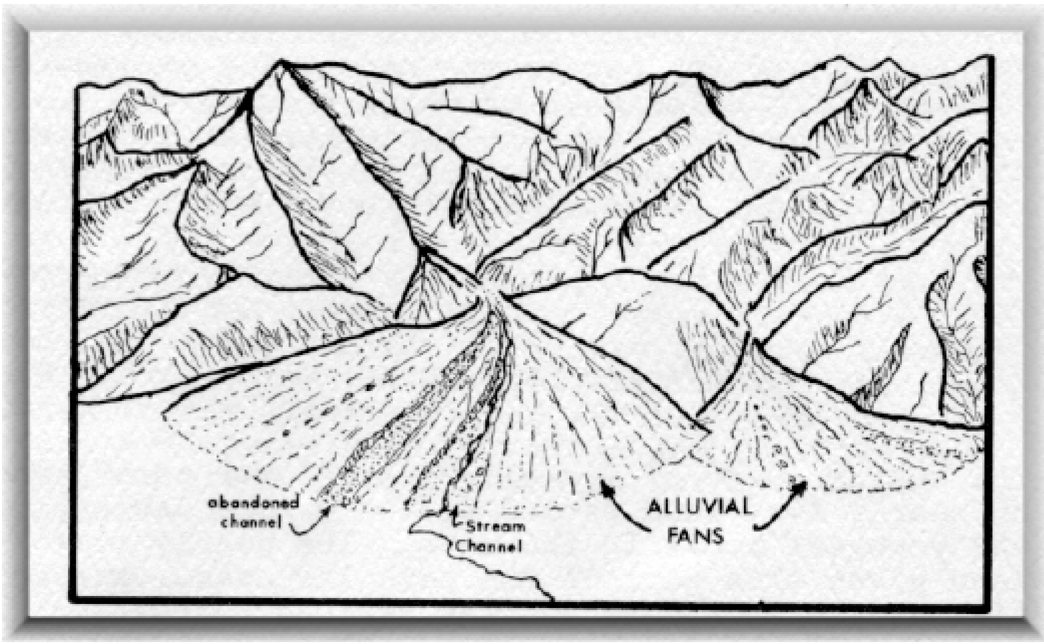
Continuing downstream, the next oldest geologic formation, the Lovejoy Basalt, estimated at 20 million years, appears in the creekbed, upstream of the end of Upper Bidwell Park. The Lovejoy actually first appears as a layer between the Tuscan and the Chico, higher up on the canyon walls near Forest Ranch, where there is a small “volcanic neck” that is most likely the source of the Lovejoy in Big Chico Creek canyon. From this point, down to where the Lovejoy layer is exposed in the creek, is mapped on the geology map as the Chico Formation. It is difficult to see the Chico Formation on the side slopes of the canyon due to large amounts of Lovejoy colluvium covering the area. The Lovejoy up in the cliffs is very fractured and breaks apart easily. Over time, pieces of the basalt, ranging from small cobbles to large boulders, have fallen off the cliff faces and covered large sections of the much gentler slopes of the Chico Formation below. Once the basalt is exposed along the creek, it once again restricts the stream, due to its hardness, and the gradient of the creek increases, forming Iron Canyon. Iron Canyon is the stretch of the creek from Brown's Hole to Bear Hole in Upper Bidwell Park, with large piles of black basalt boulders in the creek.

The gradient of the creek is also likely affected by a series of northwest trending faults that cross the area. These faults are part of the Chico Monocline, which stretches along the foothills from Red Bluff to Chico.



In the northern part of the Monocline, closer to the City of Red Bluff, the faults are in much closer proximity to each other, causing a much steeper entrance to the valley. This pattern can be seen in Deer and Mill Creeks. Deer and Mill Creeks alluvial fans are much smaller because the flows, especially the geomorphically significant flows, are constricted in the valley reach by the Red Bluff Formation; a very resistant formation made up of cemented cobbles and gravels. This phenomenon occurs due to the high gradient of the creeks as they enter the valley, which causes most of the waters erosional force to be dispersed down vertically and less laterally. Therefore, the creeks incise down into the Red Bluff becoming entrenched and restricted from meandering. Where the monocline crosses Big Chico Creek the faults are spaced out much further and do not have such a steepening effect (see Geology Map). Since Big Chico Creek's entrance to the valley is at a gentler gradient than that of Deer and Mill Creeks, the Red Bluff Formation has been eroded away in most of the area around Chico. Having less downcutting, erosional force entering the valley Big Chico Creek did not experience as much of an entrenching effect from the Red Bluff Formation. Instead the creek meandered more and eventually eroded away a much larger surface area of the Red Bluff Formation. Also the simple fact that the mouth of Big Chico Creek is further east of the Sacramento River than Deer and Mill Creeks allows more distance for the suspended sediment to be dropped out, creating a large alluvial fan.

The alluvial fan formed at the mouth of the canyon where the gradient of the creek lessens, allowing for deposition of sediments.

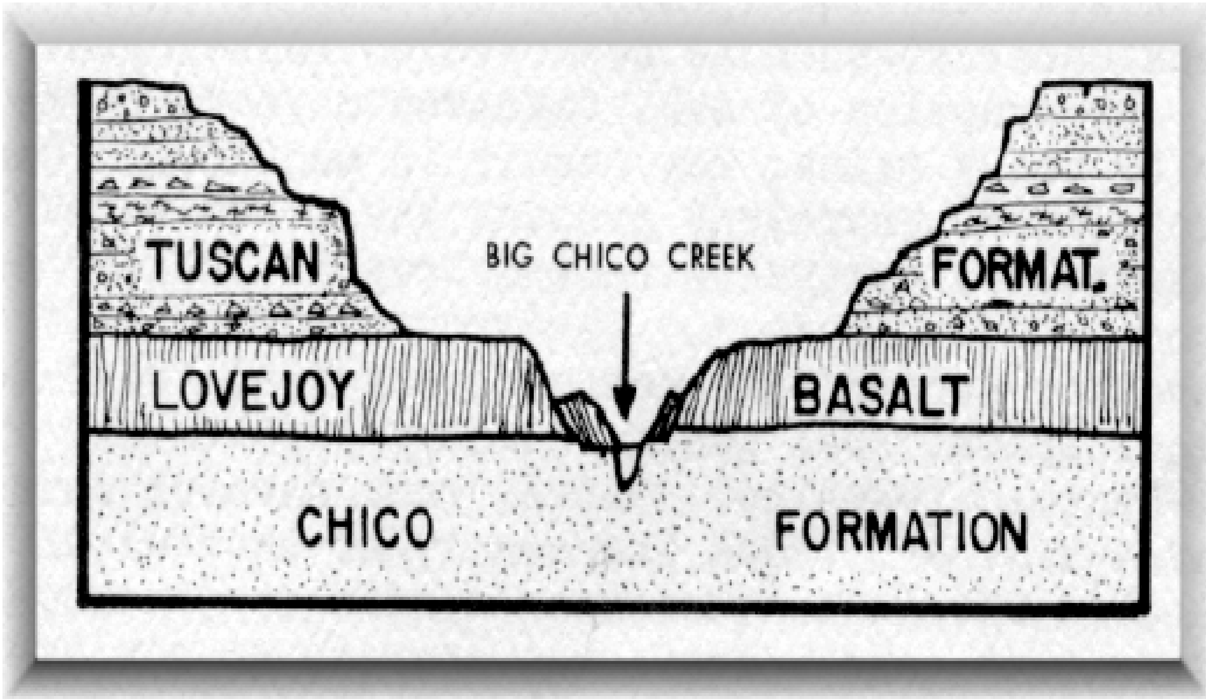


Alluvial fans developed at the margins of a mountain range.
From Guyton, 1978

Seen from the air the deposit looks like a fan with the apex at the mouth of the canyon. As the fan developed through time, existing channels were filled and abandoned as new channels were formed. At one time or another, Big Chico Creek has flowed through most parts of Chico. The alluvial fan formed by Big Chico Creek is composed of extremely fertile soils, and these soils are a major contributor to the development of the agricultural economy in the area.

As Big Chico Creek flows from the mountains toward the valley its gradient changes many times, coinciding with the specific type of geology it is flowing over. The hard rock sections of the metavolcanics and the Lovejoy Basalt result in more varied, steeper sections, with harsher drops and deeper pools being formed. In the softer rock of the Chico and Tuscan Formations the creek's gradient is much more gentle, as its flow velocity is decreased, through its lateral dispersal of energy. Big Chico Creek is continually incising (eroding down), through the different layers, exposing them in the canyon walls. One can see an example of this process very clearly in Upper Bidwell Park.

Mud and Rock Creeks have simpler geology. Being much smaller watersheds, results in lower flows and have less erosional force to cut down through the different layers. Therefore, are primarily made up of the Tuscan Formation. However, there is a small exposure of Lovejoy Basalt near Richardson Springs on Mud Creek, and portions of both the Lovejoy and the Chico Formation are exposed in Rock Creek. In addition, there is a small strip of "Cohasset Ridge Basalt" on the ridge that is younger and overlying the Tuscan.

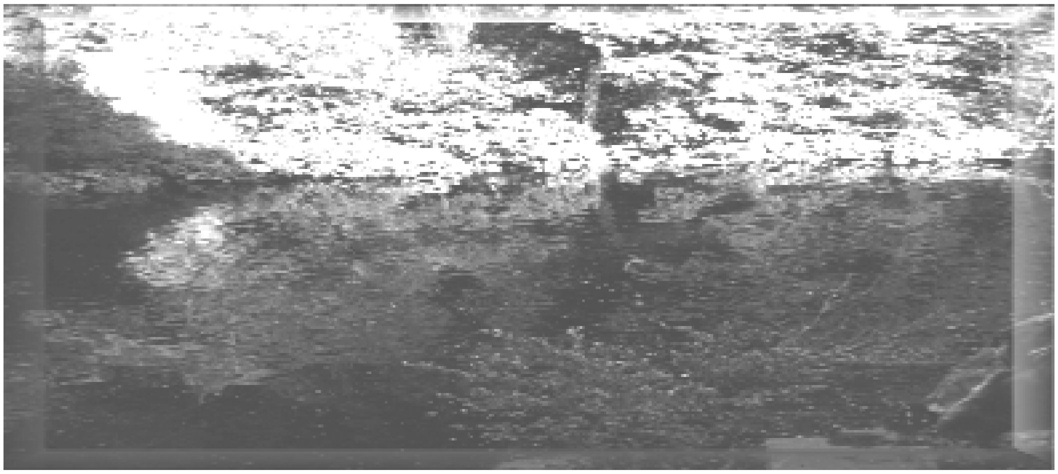


Profile of canyon in upper Bidwell Park.
From Guyton, 1978

HYDROLOGY

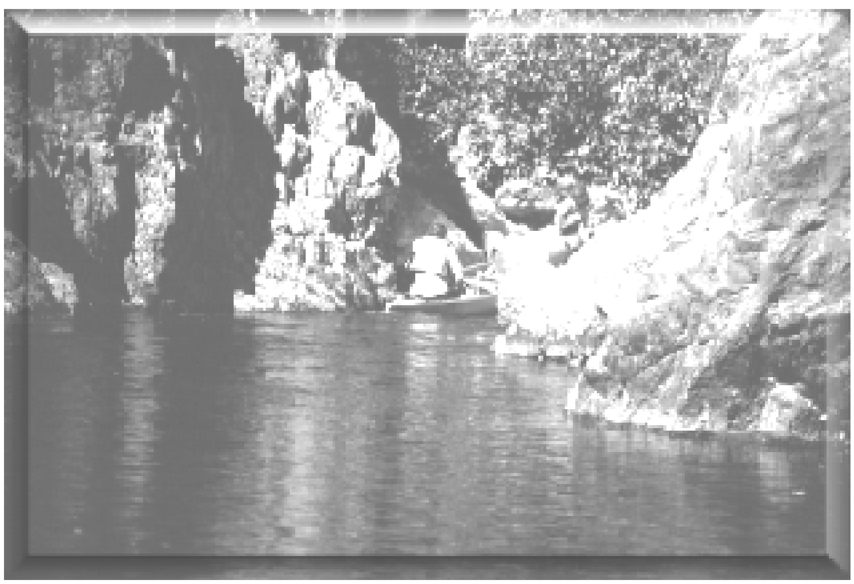
Big Chico Creek originates from a series of springs, which flow off of Colby Mountain come together to form a main channel at Chico Meadows. From Chico Meadows, below the human-made lake at Camp Lassen at about 4,400 feet elevation, Big Chico Creek is a free flowing stream, down to Five-mile dam in Bidwell Park. After leaving Chico Meadows the creek turns and flows in a westerly direction for a short stretch before its confluence with Cascade Creek, the first main tributary, at Soda Springs Campground. From here the creek turns to the southwest and begins to follow the valley to the north of Highway 32. Downstream of the Cascade Creek confluence to Upper Bidwell Park, Big Chico Creek has six primary tributaries: Little Smokey Creek, Nine-mile Creek, Big Bear Creek, Little Bear Creek, Campbell Creek, and Web Hollow (see Hydrology map).

Downstream of Web Hollow, which drains off the uppermost portion of Cohasset Ridge, the creek flows freely for 3-4 miles before reaching Bear Lake, a large plunge pool formed by a waterfall. In this area Musty Buck Ridge becomes the watershed divide to the northwest, splitting flows between Big Chico Creek and Mud Creek. About 1/3 of a mile above the Ponderosa Way bridge the creek has another significant waterfall which forms Higgins Hole, the generally agreed upon uppermost barrier to anadromous fish migration. The creek continues toward the valley passing just north of Forest Ranch in a deep, wide topped canyon before reaching Upper Bidwell Park. As Big Chico Creek enters Upper Bidwell Park, it assumes a pool and drop morphology, due to a steeper gradient. This area, referred to as Iron Canyon, is



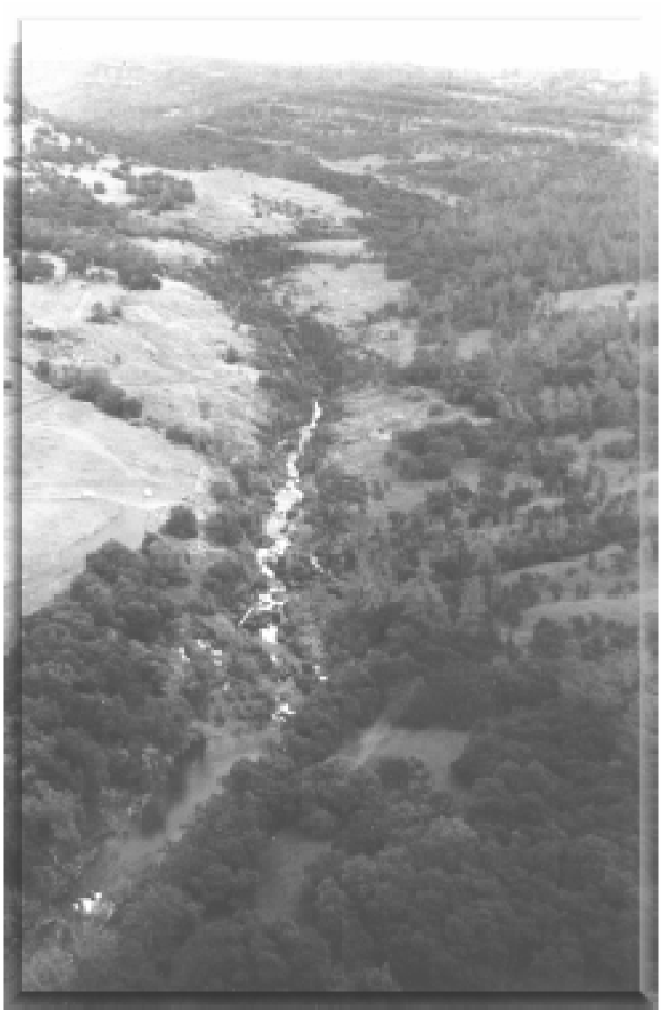
Bear Lake.

characterized by classic wildland swimming holes, such as Browns Hole, Salmon Hole, Bear Hole, and other unnamed holes (see Hydrology map).



Higgins Hole

These holes may also serve as over-summering grounds for adult spring-run Chinook salmon, especially during drought years. Just below Browns Hole, above Salmon Hole, sits the Iron Canyon fish ladder. The ladder was built in the 1950's to assist the salmon over a significant barrier on their journey upstream (Maslin, 1999). The only other fish ladder on the creek is located at One-Mile dam to assist the fish in passing over the dam.



Iron Canyon

At the Five-Mile dam, Big Chico Creek's flow is partially diverted into Lindo Channel, or Sandy Gulch, as it was historically known. Lindo Channel is an ephemeral stream that formed as a natural channel on the Chico alluvial fan, but was historically modified above Manzanita Avenue for flood control purposes in the early 1960's (Phipps, 1988). Lindo Channel runs parallel to Big Chico Creek for almost eight miles before rejoining the creek about 2.5 miles from Big Chico Creek's confluence with the Sacramento River (see Hydrology Map). Lindo Channel is still used as a diversion channel to relieve flood flows in Big Chico Creek.

The channel carries water during the rainy season and is important for groundwater recharge as well as aquatic and riparian habitat. Another flood control channel, the Sycamore Diversion, was constructed off of Lindo Channel. It can be seen running to the northwest at the entrance to Upper Bidwell Park. This diversion brings flood flows off of Lindo Channel to Sycamore Creek, which drains into Mud Creek. Where Lindo Channel splits off at Five-Mile the flow capacity is 14,500 cubic feet per second (cfs), until the Sycamore Diversion split which is capable of receiving 8,500 cfs, leaving the rest of Lindo Channel with the design capacity of 6,000 cfs (U.S. Army Corp, 1961). These channels divert potentially damaging flood flows around the City of Chico. More hydrology information is available regarding the Big Chico Creek/Lindo Channel/Sycamore Diversion site and the One-Mile and Five-Mile facilities in Mitchell Swanson and Associates report for the City of Chico Parks Department (see bibliography).

Big Chico Creek enters the City of Chico flowing through Lower Bidwell Park and reaching One-Mile dam just east of the Vallombrosa and Mangrove/Pine intersection. One-Mile dam creates the Sycamore Swimming Pool; a public recreational area commonly referred to as One-Mile pool. The creek then flows directly through the California State University, Chico campus, providing a living laboratory for research at the University. The banks of the creek as it runs through the City of Chico remain in a relatively natural state with few cemented or rocked sections. There are two stream-flow gauging stations located on Big Chico Creek; one is located at Bidwell Golf Course and the other at the Rose Avenue bridge. The golf course station was a U.S.G.S. station from 1931 to 1986, when it was abandoned. It was not in use again until 1997 when it was moved downstream about ¾ of a mile and the Department of Water Resources (DWR) took it over its monitoring (see Appendix A for flow data).

After leaving Chico the creek continues to the west, passing through agricultural lands on its way toward the Sacramento River. Big Chico Creek has a levee running along its southeast bank from just above where Lindo Channel reenters, down to its confluence with the Sacramento River. About one mile from its confluence with the Sacramento River, Mud Creek joins Big Chico Creek (see Levee and FEMA Zone map).

As stated earlier, Mud Creek is a spring fed stream originating around 3,600 feet, draining off the south side of Cohasset Ridge and confined to the south by Musty Buck Ridge. The creek is perennial in most years down to where it meets Cohasset Highway. Mud Creek has two main tributaries, Maple and Cave Creeks, that originate at about 2,400 and 2,000 feet respectively, and both join Mud Creek near Richardson Springs. There are also many other springs in the area, some perennial and others intermittent that contribute water to Mud Creek. Moving downstream from its headwaters, Mud Creek has a series of small waterfalls located about one mile upstream of Richardson Springs. At Richardson Springs, at an elevation of about 600 feet, there is a 69-foot waterfall, which is the uppermost barrier to any fish migration. There is a group of mineral springs, which have a combined flow of approximately 15 gallons per minute in the vicinity of Richardson Springs (Chapla, 1973, Pg.26). These springs are what brought development to Mud Creek Canyon in the late 1800's. The springs are saline springs, and since the time the Indians occupied the area they have been known for their healing qualities. Above Richardson Springs there is a small diversion dam, which was used to divert water for domestic use as well as generate electricity. The diversion is no longer in use but the dam is still in place, holding back water in a small reservoir (Gallaway & Shellberg, 1996).

Downstream of Richardson Springs, Mud Creek flows to the west, passing just north of the Chico Airport. Just beyond the airport, the creek becomes restricted between levees, on the westside to the confluence with Rock Creek, via Kusal Slough, about one mile from where it joins Big Chico Creek. On the eastside the levee reaches to about a 1/5 of a mile from Big Chico Creek. Sycamore Creek flows just to the south of the airport and joins Mud Creek approximately 1/5 of a mile before it passes under Highway 99. Sycamore Creek is also restricted by levees from the confluence with Mud Creek upstream to just above Cohasset Highway (see Levee & FEMA Zone map). The Sycamore Creek diversion channel, which receives water from Big Chico Creek, has eroded away a great deal of material within its channel. This material has been transported down the system and formed depositional areas near Cohasset Highway and Meridian Road. There is one stream flow gauge located on Mud Creek just downstream of the Highway 99 Bridge (see Appendix B for flow data).

Mitchell Swanson and Associates

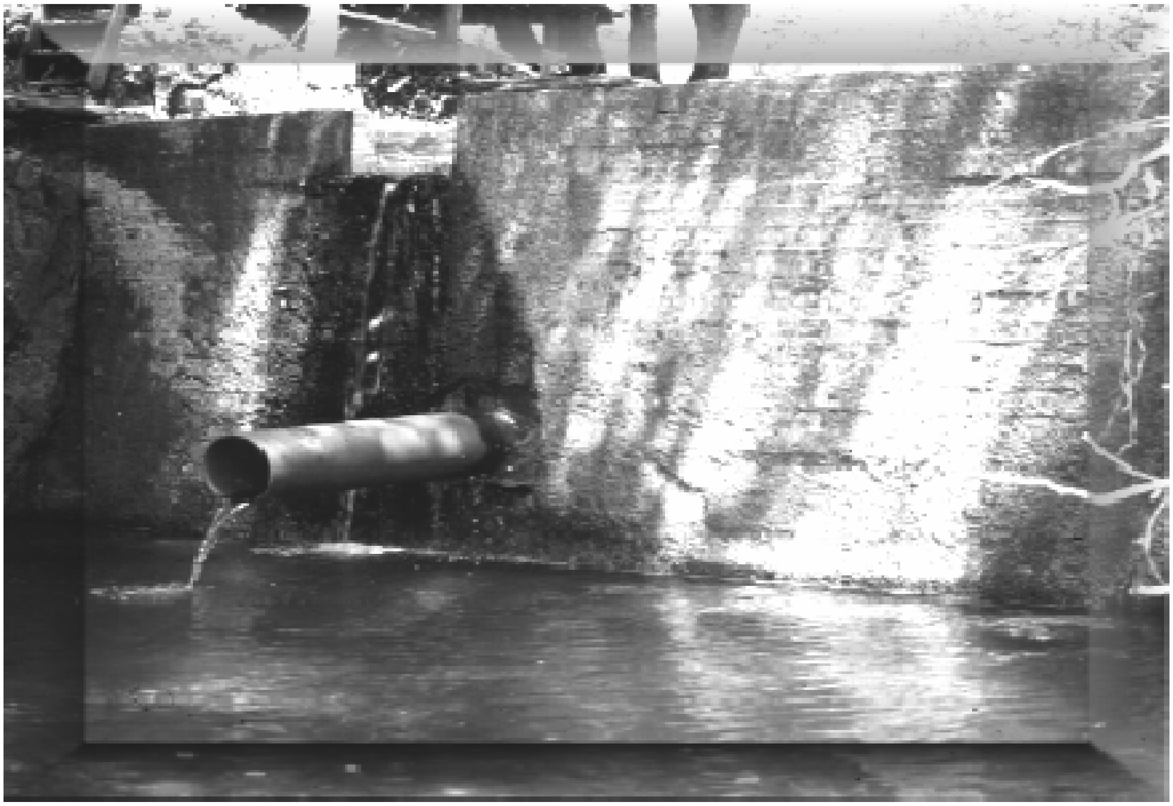
Big Chico Creek
November 9, 1994
Page 32

Table 3. Big Chico Flood Frequencies

Recurrence Interval (Years)	Discharge (cfs)
1.01	303
1.02	454
1.05	787
1.11	1220
1.25	1940
2	3900
5	6320
10	7540
20	8430
25	8670
50	9280
100	9740
200	10100
500	10400

HYDROLOGY · GEOMORPHOLOGY · WATER RESOURCES · ENVIRONMENTAL PLANNING

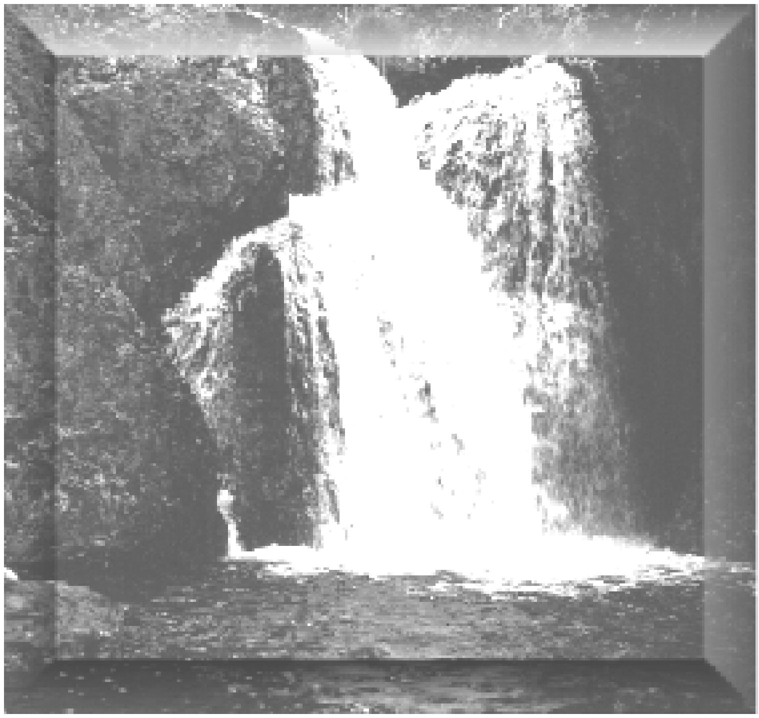
Flood Frequencies.
From Mitchell Swanson & Associates, p 32. 1994



Rock Creek

Rock Creek flows off the north side of Cohasset Ridge, originating around 3,800 feet. The creek flows just north of Cohasset Ridge for about six miles to where Keefer Ridge spurs off Cohasset and forms the headwaters of the Anderson Fork to the east, at around 2,400 feet, and drains the bottom portion of Cohasset ridge.

Anderson Fork, the main tributary, flows along Cohasset Road down to the edge of the foothills and joins Rock Creek at approximately 425 feet elevation. Rock Creek forms the Tehama/Butte County line from near its headwaters downstream approximately 6-7 miles. There is one small diversion dam in the valley section of the creek, just upstream of the Anderson Fork confluence, which is in use from April to November. The lower valley section of the creek is heavily channelized to protect urban and agricultural lands (Gallaway & Shellberg, 1996). Recent development in the Rock Creek floodplain has led to significant flooding problems. These problems are currently under investigation by the Army Corp of Engineers and Butte County. Rock Creek formerly flowed out onto the valley floor and into a large marsh, somewhere near Nord, which most likely drained into Pine Creek (Maslin, 1999). Presently Rock Creek drains into the human made Kusal Slough, which delivers the water to Mud Creek, about one mile upstream of the confluence with Big Chico Creek. Currently there is no stream flow gauging station located on Rock Creek (Clements, 1999).



Rock Creek Falls.

SOILS AND VEGETATION

The soils within the Big Chico Creek watershed have been formed over long periods of time, originating from their parent material, the existing geologic formations. These parent materials have been influenced by many different factors in the process of soil formation. The five soil forming factors are Time, Parent Material, Climate, Biota, and Topography.

The different types of soils that are formed in turn support different compositions of vegetation. The following are general soil and vegetation descriptions for different zones within the Big Chico Creek watershed, taken from information provided by the local Natural Resource Conservation Service office, which is currently conducting the Butte County Soil Survey (Conlin, June 23,1999). These descriptions are for ridge top characteristics only. The soil properties within canyons and along the creek can be very different and, due to their complexity, are not addressed in this section. Starting in the uppermost reach of the watershed the first soil zone covers the area from just above Colby Mountain down onto the flanks of the mountain. This area is characterized by moderately coarse soils, ranging from shallow to very deep. This area supports a mixed conifer forest, which is made up of ponderosa pine, sugar pine, incense cedar, Douglas fir, and some large stands of white fir. Due to the higher elevation, this region also supports some red fir. The next zone reaches down from Colby Mountain to near the confluence with Cascade Creek and over to Lomo, the turn off from Highway 32 to Butte Meadows. This area has moderately coarse through moderately fine soils ranging in depth from shallow to very deep. These soils also support a mixed conifer forest.

The next zone reaches down to near the Web Hollow confluence, essentially the top end of Cohasset Ridge, over to near the Platte Mountain lookout, near the CDF station on Highway 32. The soils here have texture ranging from loamy through fine and can be shallow to very deep. A mixed conifer forest covers this area with smaller numbers of white fir.

The next region covers down to about 3,000 feet on Cohasset Ridge and around 2,000 feet along Highway 32 below Forest Ranch. The soils here are loamy through fine texture and range from very shallow to deep. Ponderosa pines dominate this area, mixed with some Douglas fir, sugar pine, black oak. Manzanita and shrubs cover the harsher areas.

The next zone drops down to about 1,500 feet. The soils in this zone are classified as loamy through moderately fine texture and range from very shallow to moderately deep. In general they support black oak, grey pine, buckbrush, manzanita and associated shrubs, and a few ponderosa pine.

The next zone, which occurs a few hundred feet downslope, is characterized by loamy through moderately fine soils that range from very shallow to moderately deep. The general vegetation cover is made up of blue oak, grey pine, buckbrush, manzanita and associated shrubs.

The final zone, which covers down to the confluence with the Sacramento River, could actually be split into several different regions but for the ease of description will be lumped into two sections. The foothill section of this zone, reaching down to about 500 feet near Horseshoe Lake in Upper Bidwell Park, is comprised of loamy textured soils that range from shallow to very shallow. These soils support blue oak and large expanses of grasslands, made up of various annual grasses. These grasslands, which are void of trees, such as near the Highway 32/Bruce Road intersection, are shallow remnant terraces. There is also an occasional grey pine scattered around near streams and on the ridge tops. The bottom section of this zone is made up mostly of the Big Chico Creek alluvial fan and Sacramento River flood deposits. These soils can be very deep and are considered Class I agricultural soils, supporting varied orchard and row crops. The richness of the land is key to Butte County's economy, providing a unique agricultural assest. The alluvial fan may be have additional importance as a significant groundwater recharge area. This is being studied by the CA Department of Water Resources.

Once again these descriptions are very general and it should be recognized that there is more variability in the canyon settings. For example in the canyon from Forest Ranch down through Upper Bidwell Park, there are many fractures in the rocks that allow enough water to seep out to support various species of shrubs and small trees, which grow on the canyon walls. Also along the contacts of the different layers of geology water is seeping out resulting in linear stretches of vegetation.

For more information on the soils in the watershed please contact the Natural Resource Conservation Service Chico Soil Survey office, which is currently conducting the new Butte County Soil Survey and has much more precise data available. The phone number is (530) 343-2731.

From almost 6,000 feet on Colby Mountain to 120 feet at the Sacramento River, Big Chico Creek watershed covers a diverse area. From dense stands of coniferous forest in the highest elevations to extremely fertile agricultural fields in the valley, the soils in the region, and the vegetation they support, are an important natural resource. Understanding the characteristics of the water from all the local springs, ranging from the healing waters of Richardson Springs to the clear, cool pools of Iron Canyon, is essential to planning for the health of the entire ecosystem. The geology of the area, which can be seen quite clearly in Upper Bidwell Park, gives a good insight to how the entire landscape within the watershed was formed. This simplified chapter on some of the physical characteristics of the watershed should provide a better overall understanding of the natural processes involved in forming the landscape we see today.

DATA GAPS

1. There is a flow gauge on the Chico State campus near the upstream side of campus that is not in use and could provide good data and could be monitored by University students and faculty.

2. Currently there is no stream flow gauge located on Rock Creek. Due to the flooding concerns in this area, it would be beneficial to install a gauge on the creek.

3. The potential ground water recharge through infiltration in the watershed is currently unknown and would benefit from further research.

The changes in the movement of bedload materials in relation to the flood control structures around Chico have not been thoroughly examined, especially the lack of gravel recruitment in Lindo Channel and Big Chico Creek over the last few years.

5 It also would be beneficial to have more knowledge of gravel movement and storage in the upper part of the watershed, focusing mostly on the tributaries and the Minnehaha Mine site.

4. The effects of channel incision in Big Chico, Mud Creek, Rock Creek, Lindo Channel, Sycamore Creek and the Sycamore Diversion Channel are points of interest that could be studied further.

5. On the smaller drainages of Mud and Rock Creeks, the effects of undersized culverts, acting like dams and barriers to fish passage, should be studied.

6. The Butte County Soil Survey is currently in progress and when completed will be a much more thorough resource about soil conditions in Butte County.

7. The effects of expanding impervious surfaces, which come with new development, on flooding needs further research.

8. Since there is only one precipitation gauge located within the watershed it would be helpful to add a couple others to gather more data.

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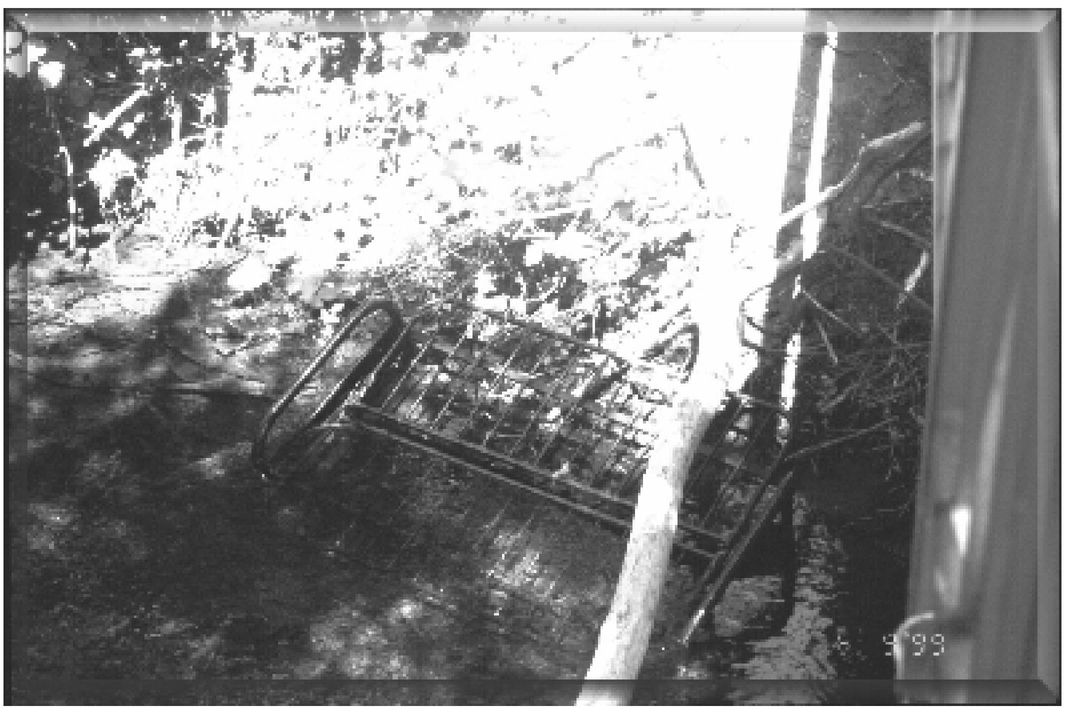
REVIEW OF WATER QUALITY MONITORING DATA

— INTRODUCTION —

This chapter addresses historic and current water quality monitoring efforts in the Big Chico Creek watershed. It chronicles the agencies, organizations, and (when applicable) the individuals responsible for the monitoring, outlines what monitoring parameters were examined, and gives locations and times of the monitoring. A matrix of historic and current water quality monitoring, tied to a Geographical Information System (GIS), is included. Issues and concerns regarding the water quality of the watershed's streams are discussed. Finally, by analyzing current and past monitoring, in conjunction with the issues and concerns identified by stakeholders, data gaps are identified regarding water quality monitoring.



While fairly "common" creek litter such as cans, bottles and food packaging, or the bike rack shown here, do little to degrade the actual quality of the stream's water, it is indicative of a general lack of regard for the creek and results in a degradation of esthetic qualities. Broken glass is a widespread hazard to pets and humans swimming or wading.

WATER QUALITY GOALS

The Department of Water Resources (DWR), Department of Health Services, State Water Resources Control Board and the U.S. EPA have compiled a set of Water Quality Goals provided by DWR Water Quality, Red Bluff. DWR retains water quality monitoring data in Big Chico Creek watershed and is responsible for field data collection and coordination of the monitoring. These goals provide the tools needed to evaluate current conditions and plan for the future accordingly.

The Alliance may choose to adopt these goals as its own and it may also choose to evaluate the water quality of the system by its effects on the ecosystem itself, as illustrated through bioassesment, riparian and physical stream surveys and other methods.

DWR's Water Quality Goals were created using various sources, including the California Department of Health Services Maximum Contaminant Levels, and the U.S. Environmental Protection Agency (EPA) National Ambient Water Quality Criteria for Freshwater Aquatic Life Protection. These goals do not have any statutory basis other than being included in criteria established primarily by the US EPA and the State Water Resources Control Board. They are however, useful as a benchmark against which water quality in Big Chico Creek can be compared.

HISTORIC AND CURRENT WATER QUALITY MONITORING

Table 1 was created for quick and easy viewing of the water quality monitoring that has been undertaken on Big Chico Creek. The table is meant to be used in conjunction with the Water Quality Monitoring Sites Map to provide a spatial and temporal view of what has been and is being monitored. The table is referred to as the "Water Quality Monitoring Matrix," "Monitoring Matrix," or simply as "the Matrix" in the following sections.

UNITED STATES GEOLOGICAL SURVEY

The United States Geological Survey (USGS) has recently, and the past, conducted water quality monitoring on Big Chico Creek. At USGS stream gauge #113840000 (in Upper-Park), during the period October 10, 1960 through September 25, 1979, the USGS monitored water quality. DWR, as well, monitored at this station from 1952 through 1989, with some interruptions. During the time of the USGS sampling at this site, data collection was undertaken cooperatively between the agencies. The raw data is best accessed through DWR Bulletin No. 130-68 Volume II: Northeastern California (1970, p408). Parameters are discussed in the description of the DWR's Historic Monitoring, the next section of this report.

More recently, the USGS, with Jason May of the Water Resources Division, Sacramento, as the primary field data collector and contact person, conducted bioassessment and water quality monitoring on Big Chico Creek as a part of its National Water-Quality Assessment (NAWQA) Project. This program, started in 1991 in select basins, undertakes annual sampling of waterways nationwide, in order to establish baseline information regarding water quality trends in the United States. The project monitors Big Chico Creek near Bidwell Avenue; upstream of the Big Chico Creek gauge (Chico Canyon Road); near Ponderosa Way; and near Soda Springs Campground. Parameters monitored include temperature, pH, dissolved oxygen, electrical conductivity, alkalinity, minerals, nutrients, benthic macroinvertabrates, fish tissue analysis, bed sediment toxicity, a survey of fish and algal species, as well as an assessment of habitat. Although the program began in 1991, the Sacramento River basin monitoring program was slated to begin in 1994.

Unfortunately, it only began last year (1997), the first year monitoring was conducted on Big Chico Creek by the USGS in many years. The USGS Water Resources, Sacramento website for NAWQA has some excellent information, including GIS maps and analysis results regarding water quality, water supply, water use, crop production, soils, etc. for the Sacramento River and its tributaries.
The web address is: http://water.wr.usgs.gov/sac_nawqa/index.html

CALIFORNIA STATE DEPARTMENT OF WATER RESOURCES

The California State Department of Water Resources (DWR) has been the major contributor in terms of consistent and ongoing water quality monitoring. Jerry Boles, DWR Water Quality in Red Bluff, is the primary contact for DWR's water quality monitoring in the watershed. Gail Kuenster contributed the sources for historic and current monitoring data.

HISTORIC DWR MONITORING

An examination of the Water Quality Monitoring Matrix (Table 1) reveals many of the historic monitoring sites were maintained by DWR. Several reference this text for periods of record and parameters monitored. This is due to the extremely transitory nature of the adding and dropping of monitoring sites and parameters. The following is the explanation of the monitoring history for these sites:

Big Chico Creek at Rose Avenue

Monthly monitoring began in January of 1969. It included physical monitoring, and some mineral analysis. In 1960 (no month given), Ca, Mg, K, SO_4, and NO_3 were dropped as parameters. Sampling went to May and September only. In July of 1966, the station was dropped until it was reinstated for bimonthly monitoring in 1992, presumably with full physical analyses. This routine was changed to monthly monitoring in 1997, and is ongoing. In 1993, a temperature data logger was installed and yearly benthic macroinvertabrate sampling began. Both continue to the present.

Big Chico Creek at River Road near Chico

This station was sampled for temperature, pH, electrical conductivity, dissolved oxygen, and some mineral analysis on the following months, with no specified dates: 5/88, 9/88, 3/89, and 8/89.

Big Chico Creek near Chico (One-Mile upstream of golf course clubhouse)

This station began monthly physical and mineral sampling on July 9, 1952. This process continued until May of 1957, when both parameter groups switched to monitoring in May and September only. Partial mineral analysis was conducted in the other months. In 1969, March and November received standard mineral analyses and physical monitoring went to bimonthly. In May of 1989 the station was discontinued.

Big Chico Creek above Chico (by golf course)

This station was supplemental to (it appears to be below) the Big Chico Creek Near Chico station. It monitored physical parameters bimonthly from May 28, 1987 through March 27, 1991. Mineral parameters were analyzed only in the following months: 5/87, 12/87, and 1/89.

Big Chico Creek near Forest Ranch

This station was sampled only once, on October 2, 1952. It examined physical and mineral parameters as well as aluminum.

Big Chico Creek at Highway 99E At Chico

This site had sporadic sampling of electrical conductivity, some minerals, pH and temperature during the following months, dates not specified: 11/73, 1/74, 5/77, 12/77, 1/79, and 2/86. During the field visit in December 1977, dissolved NO_3, total NH_3, organic nitrogen, and total orthophosphate were sampled in addition to the above parameters.

Lindo Channel At Highway 99E At Chico

The sporadic sampling at this site included pH, electrical conductivity, and some mineral analysis. Sampling occurred during the following months, with no specified dates: 1/74, 12/77, 1/80, 1/83, and 2/86. The December 1977 analysis looked at dissolved NO_3, total NH_3, organic nitrogen, and total orthophosphate in addition to the parameters listed above.

CURRENT DWR MONITORING

With a limited budget and a strong push from numerous watershed groups to have water quality monitoring in their streams, DWR is forced to focus on a group of creeks for about three years and then switch to another group after the analysis of the current group is complete. In this way they hope to profile the water quality of a particular stream over the course of what is hoped to be a variety of hydrologic conditions. During the three years, the data will hopefully show seasonal trends in water temperature, nutrients, pollutants, etc. This information is then available to groups such as the Alliance for management purposes. The three-year water quality-monitoring program on Big Chico Creek is set to end in May, 2000.

Currently there are thirteen stations in the watershed where water quality monitoring is conducted by DWR (see Water Quality Monitoring Matrix, Table 1). One of these thirteen, the Minnehaha Mine site, does not have a temperature data logger, is only monitored after storm events, and then only for those parameters outlined in the Matrix. The other twelve are monitored continuously for temperature via data loggers and are visited monthly for basic physical sampling. Five of these twelve stations (Big Chico Creek above Mud Creek; Mud Creek above Big Chico Creek; Big Chico Creek at Rose Avenue; Big Chico Creek near Iron Canyon (flow); and Big Chico Creek at Highway 32) are additionally sampled monthly to collect for mineral, nutrient, and minor element data.

The stations at Big Chico Creek above Mud Creek; Mud Creek above Big Chico Creek; Big Chico Creek at Rose Avenue; Big Chico Creek near Iron Canyon (flow) have been monitored twice during the year for agricultural runoff contamination, beginning in January, 1999. The first monitoring takes place just after the first rain in order to focus on accumulated residues from the past spring and summer, and the second occurs in January, to catch any runoff from the dormant spraying season. They test for the following biocides: carbofuran, chlordane, chlorpyrifos, DDT, diazinon, PCBs, and toxiphene.

Other parameters and their sampling frequencies are presented in the Matrix. Water column toxicity testing is conducted in conjunction with the University of California, Davis Toxicology Laboratory.

CALIFORNIA STATE DEPARTMENT OF FISH AND GAME (DFG)

Charles B. Brown (1994), working in the “Bay-Delta and Special Water Projects Division,” released “A Review of Water Quality in Big Chico Creek.” While this report did not take on any sampling of its own, it displays historic water quality monitoring results for water temperatures (the main topic of the report), flow, dissolved oxygen contents, pH, electrical conductivity, boron content, turbidity, sodium, potassium, chloride, sulfate, calcium carbonate, and total hardness for the waters of Big Chico Creek. It covers the years 1959 through 1966, on a nearly monthly basis, and on through 1994 on a much more scattered basis, with chunks of 15 or more years missing for various parameters. The location is given only as “in Bidwell Park,” and the text mentions that it is “below Iron Canyon.” The reference for this data is simply “DWR File Data.” Regardless of the origin, the data is there, and although an exact sampling location is not defined, it may prove useful in looking at long-term trends.

Kathy Hill, Associate Biologist, Marine/Fisheries, Region II, DFG Rancho Cordova, has placed Ryan brand “Tempmentor” temperature data loggers in Iron Canyon just above Salmon Hole (since October 1996), in Higgins Hole (since October 1996; though it failed October, 1997 through May, 1998), and in Hennings Hole (October 1996 through April 1997, when the recorder was lost and not replaced). The Higgins Hole and Iron Canyon sites have been secured and have been recording consistently since the spring of 1998. There is currently no data logger at Hennings Hole.

THE IZAAK WALTON LEAGUE OF AMERICA

Streaminders, a chapter of the Izaak Walton League, has undertaken some independent analysis of data collected by other agencies. Scott Murphy, as Streaminders’ conservation chair, released a report in 1994 titled “Big Chico Creek Fecal Coliform Analysis” (Murphy, 1994). The report analyzed data collected by Butte County Environmental Health Department and City of Chico Parks Department employees over the course of seven years, from 1987 through 1993. The report, using standard statistical means, reaches a variety of conclusions, discussed further in the Issues and Concerns section of this chapter.

CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD (CVRWQCB), REDDING

The CVRWCB does not usually test water quality unless there is a complaint or violation of a discharge permit reported. Oftentimes, waste discharge permits require that the permit holder provide for water quality monitoring and analysis of the stream or water body that it discharges into. This is usually through a third party consulting and/or laboratory firm. An example of this is the case with Big Chico Creek and the City of Chico related to water sampling for fecal coliform in One-Mile Recreation Area’s Sycamore Pool (referred to as One-Mile Pool in this report and other documents). Fecal coliform and issues related to cleaning the pool are covered in greater detail in the Issues and Concerns section of this chapter.

While it does not normally sample or analyze water unless there is a violation, an examination of the case file for Big Chico Creek at the Redding office of the CVRWQCB found that the

CVRWQCB, utilizing the laboratory services of North Coast Labs (5680 West End Rd., Arcata CA 95521; (707) 822-6831), conducted water quality testing on Big Chico Creek for selected parameters in October of 1995. This sampling was undertaken in conjunction with the work of Glen Foley, Graduate Student, CSU, Chico. North Coast Labs under EPA standards examined copper, cadmium, chromium, zinc, and lead as parameters. The sites monitored are not described in any detail, but appear to be either the side creeks themselves as listed, Big Chico Creek at the location described, or at the confluence of Big Chico Creek and the creeks listed, samples were taken from mixing of the two waters. The sites are as follows: Big Chico Creek 0.5 miles upstream of Campbell Creek, Web Hollow Creek, Soda Creek, Campbell Creek, Big Chico Creek and Cascade Creek, and Big Chico Creek at Ninemile Creek. The only constituent found above the limit of detection was zinc. The CVRWQCB has sampled and tested for turbidity numerous times related to violations connected with the cleaning of One-Mile pool. This is discussed further in the Issues and Concerns section of this chapter.

THE CITY OF CHICO PARK DEPARTMENT / BUTTE COUNTY DEPARTMENT OF ENVIRONMENTAL HEALTH

As mentioned earlier in this section, the City of Chico conducted water sampling for subsequent analysis by the Butte County Department of Environmental Health for fecal coliform counts from 1987 through 1994. In 1994, the Department of Environmental Health no longer offered the laboratory services for the City and it subsequently contracted with Monarch Laboratories and Alliance Environmental for analysis. Daily sampling at One-Mile Pool from June 1 through September 30 is required by CVRWQCB “Waste Discharge Requirements” and “Monitoring and Reporting Program,” Order 94-140, implemented May 20, 1994 (CVRWQCB, 1994).

The City of Chico conducts monitoring daily during the “summer use period” (Memorial Day through Labor Day) and steps that monitoring up to three samples/day during June 1 through July 23. This past year (1998), the extra testing began May 23 (Dennis Beardsley, 1998). The “redundancy testing” (three tests/day) is undertaken to verify the readings that are submitted for any particular day, as readings in the past have fluctuated depending on time of day of sampling. City staff is concerned that data from “once a day sampling” may not accurately represent the role of recreation and other factors that may influence fecal coliform counts. With the cost for testing each sample running at $102, the redundancy testing is undertaken to the greatest extent possible relative to funding allocated for monitoring and compliance with Order 94-140. Order 94-140 states that the City must monitor monthly for the rest of the year, and all sampling, results must be submitted to the CVRWQCB by the 15th day of the month following testing.

THE CITY OF CHICO / CSU, CHICO ENVIRONMENTAL LABORATORY / DR. STEWART OAKLEY

Dr. Stewart Oakley, Department of Civil Engineering CSU, Chico Environmental Laboratory, contracted with the City of Chico with funding from EPA 205j grant to explore water quality including urban stormwater runoff and fecal coliform in Big Chico Creek. Oakley has monitored Big Chico Creek for the City of Chico, resulting in several documents. There are several drafts of these reports in agency and City offices, and caution should be used when examining these reports due to different dates and drafts. Final versions, with the appropriate dates, are included in this chapter’s bibliography. Possibly adding to the confusion is the fact that data and analysis of fecal coliforms in the creek that first appears in the August 1997 report discussed below is also contained in later reports, seemingly as “new” work done.

In August of 1997, Oakley and Matt Lee submitted the final report of "Bacteriological Monitoring Program for Big Chico Creek, Bidwell Park: November 1995 - June 1997" (Oakley and Lee, 1997) to the City of Chico. The program consisted of sampling for fecal coliforms using grab samples and subjecting samples to the membrane filter technique.

In the September, 1997 "Water Quality Management Plan, Big Chico Creek, Butte County, CA: A Preliminary Assessment for Urban Stormwater Runoff and Fecal Coliform Contamination" (Oakley, et al. 1997) Oakley and associates set up a monitoring plan for urban stormwater runoff as well as fecal coliform in Big Chico Creek. This plan was implemented during seven differing flow events, beginning on October 12, 1996 and ending April 18, 1997. The plan was to sample, during low-flow conditions, first and second major storm events, again during low-flow conditions, and then for another series of three storm events, including the first major storm of the second season.

Storm drain outlets such as this one are the primary mechanism for the introduction of pollutants such as petroleum hydrocarbons coming from street surfaces. Chico is fortunate that testing has shown the majority of pollutants in urban stormwater runoff are below the national average.

The urban stormwater runoff sampling analyzed the following parameters: temperature, pH, electrical conductivity, turbidity, dissolved oxygen, and total amounts of the following constituents: suspended solids, cadmium, copper, chromium, lead, zinc, and petroleum hydrocarbons. Sampling sites were selected storm drains (exact outfall locations and their drainage basins are outlined in the report), and upstream and downstream control points on the creek.

The fecal coliform component of this report shared the same monitoring and data from the "Bacterialogical Monitoring Program for Big Chico Creek, Bidwell Park: November 1995 - June 1997" done by Oakley and Lee earlier in 1997 and outlined previously in this section.

CSUC, Chico Geosciences Department / Dr. Gina Johnston

From 1988 to the present (1998), Johnston has instructed the fall session of her Environmental Science Laboratory course in water sampling techniques and analysis. Students begin sampling in October and sample weekly at least four or five times until the end of November. The goal is to observe conditions prior to precipitation and then again after the first event of the season occurs. Sampling is undertaken at five locations (Golf Course Bridge, Manzanita Bridge, in Annie's Glen upstream of the Camellia Avenue Bridge, downstream of the Esplanade Bridge, and at the Warner Street Bridge) although when class size dictates fewer survey teams, the Manzanita Bridge has not always been sampled. The teams estimate flow, take temperatures, identify benthic invertebrates, and measure dissolved oxygen, electrical conductivity, pH, alkalinity, nitrate, phosphate, calcium, magnesium, chloride, and fecal and total coliforms. But no known statistical analysis of the data is available.

Most of the storm drains in downtown Chico, such as this one on the corner of Fourth and Main Streets actually carry runoff south to Little Chico Creek. Most of the drains leading to Big Chico Creek do not have stenciling on them acknowledging the stream to which they flow. Labeling the drains reminds citizens that everything spilled or left on the streets, flows to one of our local waterways.

DONALD ROBERT WILLIAM'S 1978 THESIS: ANALYSIS OF COLIFORM AND FECAL STREPTOCCOCAL BACTERIA IN BUTTE AND BIG CHICO CREEKS

Williams (1978, p13) sampled three sites on Big Chico Creek (near the Oaklawn Avenue and Bidwell Avenue junction, at One-Mile Pool, and at the end of the paved park road in Upper-Park) for fecal coliform and fecal streptococcal bacteria. Williams' seventeen samples began on 10/14/76, were approximately 15 days apart, and ended 8/27/77. Williams found no salmonella or viruses. In 1971, the CVRWQCB Water Quality Control Plan (interim) for the Central Valley (and specifically the Sacramento River and its tributaries) stated essentially what it does today: water used for recreational purposes (with contact) should contain no more than 200 fecal coliform units/100 ml. Williams found that Big Chico Creek exceeded this level four times, with three of these times on the same day (May 27, 1977) at three different sites.

The author's thesis sought to determine the origin of the fecal coliforms by examining the combined results from the following tests: methyl red, Voges-Proskauer, and two citrate tests. The results showed 62% of the coliforms were fecal in origin, 25% were from soil, and 19% were "intermediate." This intermediate category comes from the analysis of the tests coming out indeterminate. Raw data is located in Table 7 on page 35 of the thesis, located in the CSU, Chico Meriam Library.

JAMES L. ROBERT'S 1989 THESIS: A SURVEY OF GIARDIA IN FOUR MAJOR BODIES OF WATER USED FOR PUBLIC RECREATION IN BUTTE COUNTY

Roberts sampled once a month, from May 1987 through April 1988 for the presence of Giardia cysts. Big Chico Creek had the least number of cysts (0.16 +/- 0.06 per gallon) out of the four water bodies tested (Oroville Lake, Butte and Big Chico Creeks, and the Sacramento River). Sampling methods are included in the thesis, available at the CSU, Chico Meriam library.

—— CURRENT CONDITIONS ——

MOST RECENT MONITORING - RESULTS AND DISCUSSION

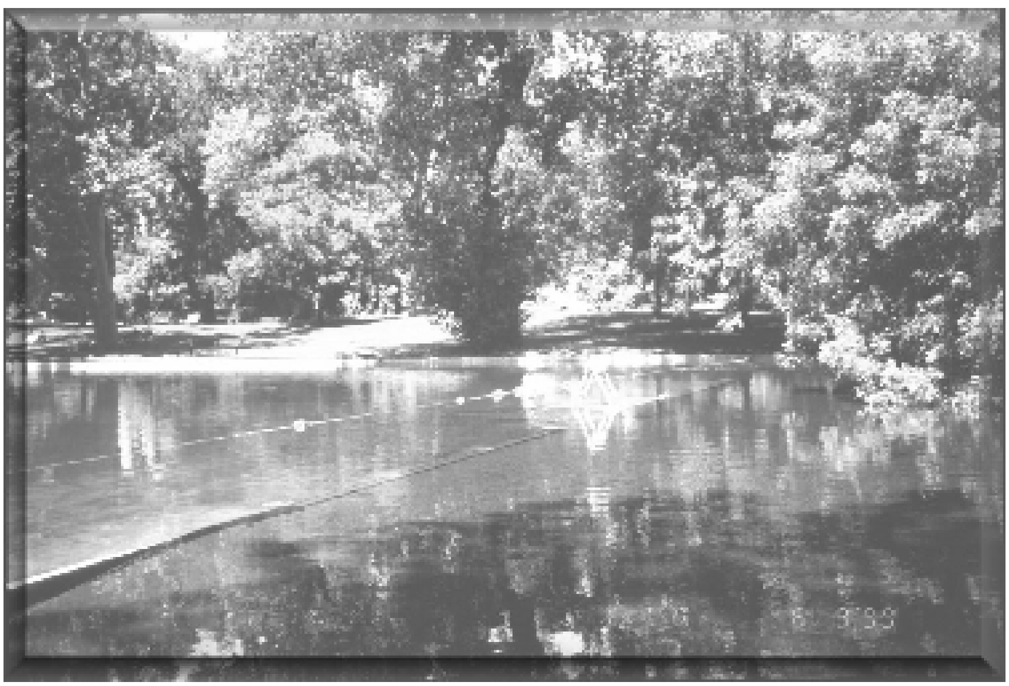
Gail Kuenster, DWR Red Bluff, provided a hard copy of the results of the monitoring that has been conducting in the watershed since May 1997. This information (see Water Quality Monitoring Matrix, Table 1) gives roughly a one-year picture of the water quality trends in Big Chico Creek, as point-in-time samples. Counter to this, data loggers tracking temperature provide continuous readings of temperature, allowing the generation of thermographs such as the one provided in the Water Quality Monitoring Matrix, Table 1. This data is from point-in-time field monitoring, is not a continuum, and may not represent extremes for the time period monitored. Continuously logging data recorders for parameters such as turbidity can capture these dynamics better than point-in-time sampling. Sampling through a storm would lend itself to trend analysis, allowing observations to be made on the differences in water quality in the creek between the rising and falling limbs of the hydrograph.

— ISSUES AND CONCERNS —

The monitoring that has been done so far has identified several issues and concerns for water quality. For nearly 15 years, local newspapers have followed these issues closely and local conservation groups have voiced their concerns to the City of Chico, the CVRWQCB, and other applicable agencies.

One-Mile Pool Cleaning

For many years the One-Mile Pool was cleaned of coarse and fine-grained sediment by simply pulling up the flashboards on the dam to drain the water, with loaders and other equipment used to remove the sediment. The pool was then usually swept with a mechanical sweeper to finish the job. The problem was that the draining of the pool and subsequent work elevated turbidity levels and increased sedimentation downstream. This was due to increased water velocities entraining sediment when the flashboards were removed, and when the creek continued to flow through the muddy work area after the pool was drained.



Cleaning the One-Mile Pool is now a much cleaner endeavor for water quality. After the pool is drained for cleaning, the creek is diverted under the pool itself, through a tunnel (the inlet structure has a construction barricade on top of it in this photo). This keeps the creek from carrying sediment downstream and causing turbidity increases above levels set by the State.

In 1994, "Waste Discharge Requirements" and a "Monitoring and Reporting Program," both under Order 94-140 from the CVRWQCB, were issued and implemented. The City was (and still is) required to abide by these Waste Discharge Requirements and the Monitoring and Reporting Program. However, the City violated Order 94-140 at least six times in 1994 and 1995

(CVRWQCB 1998a). This prompted a July 21, 1995 letter from Dennis C. Wilson, Chief of the CVRWQCB Regulatory Unit, to the City referencing a previous letter from the Board stating that if the summer 1995 inspections revealed continued violation of the Waste Discharge Requirements the Board would recommend issuing a Cease and Desist Order. Since violations occurred, the Board began formulation of (a) Cease and Desist Order.

In July of 1997, the City began exploring options to solve the problem by constructing diversion structure at the top of the pool in order to funnel water into a pipe flowing under the pool itself. This would keep the creek isolated from the pool during cleaning operations, greatly reducing sedimentation of the creek downstream. It is noteworthy that even during the construction to correct the problem, a Notice of Violation was issued to the City due to turbidity levels reaching 48 NTU within 300 feet downstream of the One-Mile Pool (CVRWQCB 1998a).

Fecal Coliform Contamination

In 1993, Scott Murphy of Streaminders wrote to Jerrold Bruns at the CVRWQCB in Sacramento to "...request that the Board take the necessary action to change the water quality classification of Big Chico Creek from *good* to *impaired* for approximately eleven miles of its course (from the Bidwell Golf Course foot bridge, to the confluence with the Sacramento River)." Scott cited degraded fisheries habitat and spawning grounds, agricultural pumps (now removed), and most importantly that "contact recreation is impaired due to poor sanitary water quality from consistently high levels of fecal coliform bacteria.…" He also included a letter from DFG Regional Manager James Messersmith that supported his request for the waterway classification to be reduced to *impaired*.

The CVRWQCB's inclusion of fecal coliform in Order 94-140 required the City to begin monitoring One-Mile Pool "...for fecal coliform immediately upstream and immediately downstream of the pool weekly from 1 June through 30 September and monthly throughout the rest of the year." The City has complied with this requirement as per the Reporting section of Order 94-140 (Ron Dykstra, 1998).

At this time the City also began to commission reports from Dr. Stewart Oakley and the CSU, Chico Environmental Laboratory. Oakley and Reed (1994) submitted a preliminary version of their "Fecal Coliform Source Identification Study for Big Chico Creek," finalizing it in January 1995 (Oakley and Reed, 1995). In August of 1997, Oakley and Lee (1997) submitted the "Bacteriological Monitoring Program for Big Chico Creek, Bidwell Park: November 1995 - June, 1997."

Sampling in June, July, and August 1996 was conducted daily on the creek. While the Oakley report notes that "intensive" sampling was done (during select periods of July, August, and September 1996), data collection for 1997 occurred in the form of weekly sampling from September 1996 through June 1997. This weekly format was set up to "develop a more rigorous database for monthly fecal coliform concentrations throughout the year. This database is necessary to more accurately calculate monthly geometric means...," according to the Board's water quality objective (WQO). The WQO actually dictates that, "...a minimum of not less than five samples for any 30-day period shall not exceed a geometric mean of 200/ 100 ml, nor shall more than ten percent of the total number of samples taken during any 30-day period exceed 400/ 100 ml" (CVRWQCB, 1992)."

Concerns over fertilizers and biocides used at the golf course relative to its proximity to Big Chico Creek and its associated riparian communities have not been extensively explored.

The Oakley report stated that the data is the most thorough to date attained for use in assessing exceedences in monthly geometric means per the WQO. Although the Streaminders report (Murphy, 1994) has large quantities of daily, weekly, and monthly data, the data used was of questionable validity due to the sampling methods. The Streaminders report was the catalyst that prompted the City of Chico to investigate water quality in Big Chico Creek.

Dennis Beardsley, Park Director, explained current practices for pool closure on Big Chico Creek. He related that if fecal coliform counts reach 200/ 100 ml, the maximum for the State's water quality objective, the City is on "alert," but does not necessarily take action. At 1000/100 ml they still take no action, but are on alert preferring to look at things temporally, and check to see how that day's reading relates to those in previous days. At 5000/100 ml the pool is closed with no questions, coinciding with the Butte County "Recreational and Swimming Area Monitoring/Closure Policy."

Even though there has been much controversy and publicity over fecal coliform contamination in Big Chico Creek, it is unlikely that this particular bacterium is the greatest threat to humans. While fecal coliform bacteria has been used as a cost-effective indicator of sanitary water conditions in countless water quality surveys, it is important to remember it is merely an indicator of the potential presence of disease organisms. A fecal coliform bacterium is present in the intestines of all mammals and its presence is to be expected in highly populated areas (Henry Evers, DVM,1998). As protozoa and viruses require a lower infectious dose to initiate an infection than do bacteria, a single bacterial indicator is not sufficient to assess the sanitary nature of public waterways used for contact recreation (Murphy, 1994). One of the recommendations from the Oakley report August 1997, states:

> Fecal colifoms alone may not be the most appropriate indicator at One-Mile and Five-Mile Recreation Area from the standpoint of health risks to bathers. Even with low fecal coliform concentrations, other bacteria may pose a much more significant health risk in the absence of disaffection. The results of heterotrophic bacteria monitoring show that non-fecal bacteria concentration increases within One-Mile Pool. Without monitoring for specific pathogens, however, it is impossible to assess any public health risks based on heterotrophic concentration alone. Prudence would dictate that One-Mile Pool (and possibly Five-Mile) be operated as untreated flow-through swimming pools, using the equation $Q = 6.25\ T^2$ (where Q equals the quantity of fresh water required per bather per day, in gallons; and T equals the turnover period in hours (i.e., the hydraulic retention time)) to manage the number of bathers at any given time; this strategy could be coupled with the frequency of pool cleaning. Continued heterotrophic bacteria monitoring during the swim season would still be an important tool to determine the effect of management strategies on in-pool bacteria concentrations.

The Oakley report, September 1997, listed four conclusions:

- The results of the intensive sampling program from November, 1995 through June, 1997 show that fecal coliform concentrations, when calculated as the monthly geometric mean, only exceeded the WQO during the month of June, 1996 (and possible during September, 1996 although the data for this month are only based on two days of sampling over Labor Day weekend).

- There is a consistent increase in fecal coliform concentrations from Five-Mile to One-Mile throughout the year that implicates cumulative use along the creek.

- The data show that septic systems are an unlikely source of fecal coliform.

- The relative role of animals or humans as contributing sources of fecal coliform could not be ascertained either from intensive upstream-downstream studies or from pulsed field gel electrophoreses analysis.

Part of a Water Quality Management Plan for Fecal Coliform Exceedances suggested by the Oakley report include:

PERFORMANCE STANDARDS

Water Quality Goals	Future Loadings	Future Water Quality
1. No significant Degradation	Minimize increase	Minimize deterioration
2. Non-degradation	No increase	No deterioration
3. Improved water quality	Lower than existing	Better than existing

The Oakley report also stated:

> Until the exact source of the periodic fecal coliform exceedances can be unequivocally determined, it would seem that a water quality goal of no significant degradation would be best at this point in time. Even this goal, however, could entail management decisions that curtail the use of Big Chico Creek during summer months, especially if population pressures for water-related recreation continue to rise with in the Chico Urban Area. Community interests thus also need to be incorporated into the decision-making process, especially where management decisions affect public use.

Urban Stormwater Runoff

Currently, stormwater flows are quickly directed to the creek, but flushing and diluting flows, coming from farther up in the watershed, may lag by almost eight hours with the interim time being critical for aquatic organisms. Further, when the Chico urban area reaches a population of 100,000, the City will be required to develop a Stormwater Management Program (SWMP) to comply with the 1990 US EPA National Pollution Discharge Elimination System permitting regulations regarding stormwater runoff (US EPA, 1990).

Stewart Oakley, through the CSU, Chico Environmental Laboratory, developed a report for the City of Chico on urban stormwater runoff titled “Water Quality Management Plan, Big Chico Creek, Butte County, CA: A Preliminary Assessment for Urban Stormwater Runoff and Fecal Coliform Contamination,” (Oakley, et al. 1997). The fecal coliform section is a reiteration of the work presented in the “Bacteriological Monitoring Program for Big Chico Creek, Bidwell Park: November 1995 - June, 1997” by Oakley and Lee (1997).

The data presented in this report involves a two year study with sampling of selected storm drain out-falls on seven different occasions, including low-flow periods for background, the first two storm events for the first winter, and the first three storms for the second winter. Due to budget constraints, selected sub-areas of the creek were monitored.

Conclusions from the Oakley 1997 report include the following:

- With the exception of turbidity, concentrations of all constituents measured (temperature, electrical conductivity, pH, turbidity, dissolved oxygen total suspended solids total cadmium, total copper, total chromium, total lead, total zinc, total petroleum hydrocarbons) within Big Chico Creek at the Bidwell Avenue Control sampling location were well below the California State Water Resources Control Board’s Water Quality Objectives (WQO) for surface water or the Maximum Containment Level for drinking water in the cases where WQO has not been established.

- Although the percent increase of turbidity for all storm events was greater than the allowable WQO of 20%, the increase is a transient event during stormwater runoff and does not likely affect water quality in a significant manner.

- Measured concentrations of Total Suspended Solids, Total Copper, Total Lead, and Total Zinc in stormwater out-falls were all below the lowest range of concentrations found in a nationwide EPA study at 81 sites in 22 cities for all storm events.

- The results of this limited study suggest that stormwater run-off—from the types of storm events sampled—does not have a significant water quality effect on Big Chico Creek from Five-Mile Recreation Area to the Bidwell Ave. Control. It must be remembered, however, that this conclusion is based on a very limited database using grab samples. It is highly desirable, when funds permit, to continue stormwater monitoring in future years using an automated composite sampler and flow-measuring device.

The reports continues:

> Urban stormwater runoff, for the five storm events sampled, does not appear to be a serious problem for water quality degradation for the stretch of Big Chico Creek monitored in this project. This conclusion is based on the limitations of this study and could change if more rigorous sampling procedures were used for a larger number of storm events in future studies. Prudence would dictate that Best Management Practices for stormwater runoff be employed now in order to protect water quality . . .

Groundwater Contamination

In 1979, DWR found elevated nitrate levels in 21 of the 69 private wells it tested in the Chico area. Additional studies in 1983 identified four nitrate plumes, each having concentrations over 60 mg/L (DWR, 1984). The Federal Environmental Protection Agency and the World Health Organization have set the nitrate regulatory level for groundwater contamination at 45 mg/L for $NO3_3$, and 10 mg/L for N. The State of California has adopted identical standards.

Nitrate contamination in Chico was attributed to on-site septic systems for wastewater disposal. However, the point has been made that if dry cleaning chemicals leaking through sewer pipes (as discussed below) are causing PCE contamination, then those same pipes are presumably leaking nitrates as well (Boles, 1999). In response to the nitrate plumes, the CVRWQCB issued Prohibition Order No. 90-126 on April 27, 1990. This order affects approximately 30,000 residents on 9,800 parcels, and represents nearly 12,000 dwelling units, all utilizing on-site septic systems. Of these 12,000 dwelling units, Order 90-126 identified approximately 7,300 dwelling units in areas of relatively high density that it recommends be added to the City of Chico's sewer system.

The bulk of these on-site septic systems fall into three areas: neighborhoods in north Chico (the Lassen Avenue corridor) central Chico (the Avenues), and south Chico (Chapman-Mulberry area). These three zones represent areas with large amounts of unincorporated parcels within the City, resulting in numerous single-family dwellings, apartment complexes, and mobile home parks relying on on-site septic rather than the City sewer system. A political problem regarding the connection of these areas to the City sewer system revolves around the policy of the City to require annexation of County areas that are connected to the City's sewer. Once these areas are annexed, the City may not deny residents the use of the sewage treatment plant, a facility that is currently inadequate and is being upgraded.

Another legacy problem is the contamination of the local groundwater in certain areas of Chico from perchloroethylene (PCE), a by-product from chemical dry-cleaning operations. Dry-cleaning operations often disposed of PCE by pouring it down the drain. Being highly soluble and heavier than water, leaky sewer pipes allowed the substance to contaminate the shallow, unconfined groundwater aquifer. This has created a 1.5-mile long plume stretching from approximately the corner of Mangrove Avenue and Big Chico Creek down to the railroad tracks near Nord Avenue. Two older wells, located on the Chico Junior and Senior High School campuses, allowed the contaminants to travel to the middle and deep aquifers. These wells have since been closed (Don Mandell, September, 1998).

The State of California Department of Toxic Substances Control has spent $5 million to facilitate a treatment plant at the Junior High School and at the Chico Cemetery sites. They have also installed a carbon unit for cleaning water on one California Water Service well. During this time the department also developed a draft Remedial Action Plan, completed in late 1995. The plan was not finalized as the "possible responsible parties" named in that plan wished to develop their own remediation plan. These parties cited the high expense of proposed remediation activities ($14 million for treatment of the entire plume) as a main reason for developing their own. The plan was due to the Department of Toxic Substances Control by August 30, 1998, but is now being slated for delivery in October 1998 (Don Mandell, 1998).

Agricultural Runoff

One topic that has not been addressed in any of the literature found during research for this chapter is agricultural runoff. Orchards or row crops surround much of the area around lower Big Chico Creek, lower Lindo Channel, and lower Mud Creek.

The spraying of biocides and the use of fertilizers on the CSU, Chico campus and in Bidwell Park in near-creek areas has been a water quality issue for some time. On the CSU, Chico campus, cooperative efforts between Plant Operations personnel (especially grounds person Eric Adams, shown here) and the Arboretum Club has reduced the amount and changed the application practices in near-stream areas.

With relatively level ground in many of these areas, chemicals applied may be carried into the ground. Storm events and irrigation practices may allow biocides to leave the crop site and be delivered to one of these waterways. This is recognized as a data gap in the following section.

<u>Minnehaha Mine</u>

See History chapter of this report for a detailed history on the Minnehaha Mine.

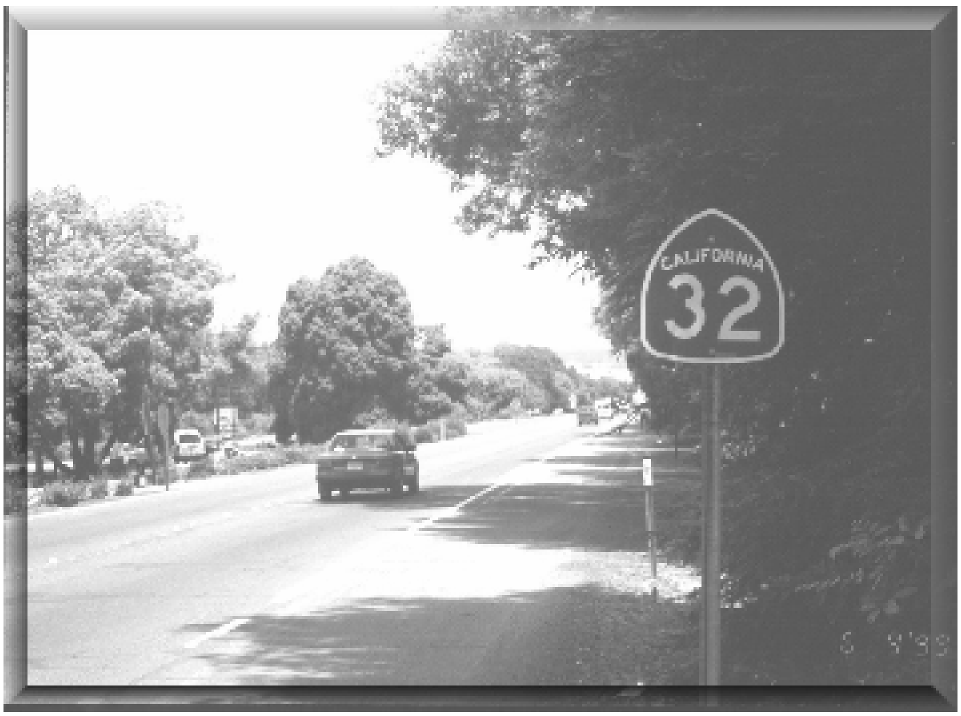
Urban development can have impacts on water quality. It increases impermeable surfaces, creates more roads, the potential for polluted runoff, and effectively extends the drainage network. This combines to rapidly carry more potentially polluted water into the creek itself before diluting flows from the upper watershed can reach the urban area and reduce levels of pollutants potentially harmful to aquatic organisms. Here, an old orchard with vast amounts of area for infiltration is converted into a subdivision with large amounts of impermeable surfaces.

<u>Boy Scouts of America Camp at Chico Meadows</u>

The Boy Scouts of America (BSA) maintain a camp at Chico Meadows involving cabins, recreation areas, and an earthen dam on Big Chico Creek that forms a pond for canoeing and swimming. The dam has washed out during high flow events, contributing sediment to the stream. Excavation of the hillside near the site to provide for fill for dam replacement may lead to possible hill-slope erosion as well, leading to possible water quality concerns. Also, the concentration of septic systems in the Chico Meadows area could be a source of water contamination. The lack of this data is identified as a data gap in the following section.

POSSIBLE HIGHWAY 32 PETROLEUM SPILLS

Highway 32, heading east from Chico, forms a portion of the Big Chico Creek watershed divide, and runs directly along the stream itself in a portion of the upper watershed. The combination of daily transport of petroleum products and a narrow canyon road has led the neighboring Deer Creek Watershed Conservancy to formulate a Spill Contingency Plan for Highway 32 in their watershed. Emergency services personnel in Butte County anticipate the plan being expanded to include the rest of the highway, including the portions along Big Chico Creek (Don Holtgrieve, 1999).



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— DATA GAPS —

FECAL COLIFORM SOURCE IDENTIFICATION

While there has been a study to identify the source of fecal coliform contamination in Big Chico Creek (Oakley and Reed, 1994 and 1995), future examinations might provide data focused on perimeters such as:

- Groundwater movement and its effect on septic systems;
- Intensive sampling both spatially and temporally (especially during precipitation events, both early and later in the season with full ground saturation) of surface water runoff, particularly in the areas where livestock kept by residents may drain to the creek;
- Investigation of the numerous septic systems after heavy rains that could possibly be the source of effluents from surface failures to enter Big Chico Creek through the stormwater drainage system. (Although the amount and rate of precipitation required to move this effluent to the creek is not specified, it is probably safe to state that heavy rains can be, and are, experienced in Chico on a basis frequent enough to merit additional investigation into this issue.)

CONTINUOUS WATER QUALITY MONITORING

Currently there are a substantial number of temperature data recorders, continuously logging data. Recorders for parameters other than temperature can capture the dynamics of other stream qualities better than point-in-time sampling. Real-time monitoring (with the sampling device coupled to a satellite or telecommunications uplink that then feeds into the Internet) of turbidity for example, can help fisheries biologists to identify times when juvenile salmonids may be out-migrating.

URBAN STORMWATER RUNOFF MONITORING

With the highly mixed nature of the City of Chico (residential City and County parcels mixed with agriculture, light industry, and commercial) relative to what is found in particular storm drain basins, a comprehensive monitoring program for stormwater runoff should be implemented. Past reports (Oakley et al. 1997) suggest that a more comprehensive effort may be merited. With the amount of growth expected, and pending requirements by the US EPA for monitoring, a program started now could be highly cost effective from the City's perspective and begin to create what is currently an inadequate historic record for urban runoff monitoring data.

UPPER WATERSHED WATER QUALITY MONITORING

Water quality monitoring of the upper watershed exists as a spatial data gap. While monitoring is conducted at the Highway 32 crossing, reconnaissance sampling above, below, and in the Chico Meadows area would be helpful in order to investigate any possible water quality problems in that area. If problems are found, additional sampling and/or remediation could be a possible next step.

AGRICULTURAL RUNOFF MONITORING

Water quality monitoring of agricultural runoff has been identified as an additional data gap.

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AQUATIC / BIOTIC RESOURCES INVENTORY

—— INTRODUCTION ——

Big Chico Creek originates on Colby Mountain and flows 45 miles to its confluence with the Sacramento River. Watershed elevation ranges from about 120 feet at the mouth to 6000 feet on Colby Mountain Mean precipitation ranges from 25 inches in the valley to 80 inches in the headwater region, where much of it falls as snow. Because of the precipitation gradient, the majority of the flow of Chico Creek enters in the upper third of the drainage. At base flow, discharge increases in a downstream direction from the headwater to the Sacramento Valley. As the creek flows across its out-wash delta and the valley floor, water is lost rapidly to infiltration so that, during many summers, no surface flow reaches the Sacramento River.

Mud and Rock Creeks originate at around 3800 feet elevation in foothills north of the Big Chico Creek drainage. Mud Creek flows 26 miles before joining Big Chico Creek. Rock Creek flows 28.5 miles before joining Big Chico Creek. Mud Creek, Rock Creek, and Big Chico Creek all join just before entering the Sacramento River. Rock Creek and Mud Creek are similar to each other but quite different from Big Chico Creek. Their channels are shorter and dendritic (branched like a tree). They drain from the surface of the tilted Tuscan Formation at relatively lower elevations than most of the Big Chico Creek drainage, and receive their precipitation chiefly as rain. Accordingly, they are more seasonal (flowing from about November to June in the Central Valley portion of their channels) and warm up much faster in spring.

FISH ZONES

These gradients can be broken into three zones based largely on fish populations. Boundaries to the zones are formed partly by physiological limitations of the organisms but mostly by geological barriers. As the creeks carved their canyons, they cut down through tilted layers of rock to their present gradients. The harder layers, being less readily eroded, formed narrow canyons with rapids or waterfalls that may act as barriers to upstream movement of aquatic life. In Big Chico Creek, the most downstream barrier occurs where the creek crosses the Lovejoy basalt (Bear Hole to Brown's Hole in Bidwell Park). In this stretch, known as Iron Canyon, the valley narrows abruptly and the stream gradient increases. At its upper end, the basalt is undercut and huge boulders have tumbled into a jumble in the creek bed. This jumble of boulders acts as an impassable barrier to upstream movement of fish during normal creek flows. Under conditions of high flow, water fills in around the boulders and Iron Canyon may be no barrier at all. Steelhead, moving upstream between November and February, can usually pass the barrier. Spring-run salmon, squawfish, hardheads, and suckers, which migrate in March and April, are less likely to pass it most years. Smallmouth bass, which are inactive during the cold months, would never be expected to cross it. The Iron Canyon fish ladder, constructed in the 1950's, and currently being evaluated for a possible upgrade, provides better access for salmonids, but requires continual maintenance.

The next upstream barrier begins at Higgin's Hole (about 1/3 mile upstream of Ponderosa Way) where the creek begins carving harder metamorphic rock. Again, the canyon narrows with big boulders, bedrock potholes, and waterfalls. In very unusual years when migration corresponds exactly with high flow, salmon or steelhead might get through this canyon to the waterfall at Bear Lake; there is one record of salmon being sighted at Bear Lake, but no evidence that other fish species ever got above Higgin's Hole.

The physical barriers divide Big Chico Creek into a mountain zone from the headwaters to Higgin's Hole, a foothill zone between Higgin's Hole and Iron Canyon, and a valley zone between Iron Canyon and the river. A fourth or river zone could be described for the deep slow channel from the confluence of Mud and Big Chico to the Sacramento River. This channel is part of the river at high flow and supports a diverse fauna derived from the river.

Mud and Rock Creeks can similarly be divided into biologic zones, but their mountain and foothill zones are shorter than those in Big Chico Creek. In Mud Creek, the main barrier is the 69-foot waterfall at Richardson Springs, which stops all upstream movement of fish, ending the valley zone. The Mud Creek foothill zone is extremely short, only extending from the top of the waterfall 1.1-mile to another series of falls. In Rock Creek, the upstream end of the valley zone for many years has been the diversion dam about 0.3 mile upstream of the Anderson Fork confluence. The Foothill Zone in Rock Creek is also short, ending in about 3 miles, but more gradually than the other creeks, first hardhead and squawfish drop out, then sculpin, and finally the roach until only rainbows remain, beginning the Mountain Zone (see Appendix A for species list).

MOUNTAIN ZONE

The mountain zone of Big Chico Creek supports only resident rainbow and brown trout; at its lower end the two are more or less co-dominant, but the brown gradually becomes more dominant in an upstream direction and is the only fish species in small headwater tributaries. The rainbow/brown combination is biologically interesting. The two species are very similar in habitat requirements, but the brown wins the competition, possibly because it also preys on the rainbows. However, the brown spawns in fall while the rainbow spawns in early spring. The older (larger) young-of-the-year browns always control the best feeding stations. Over a series of years with no major winter floods, browns gradually become more and more prevalent. However, in years with winter floods (96-97 and 97-98), brown reproduction fails because eggs and fry are scoured out, and rainbow numbers increase because of reduced predation/competition. However, in the headwaters where the streams are spring fed and/or most precipitation is as snow, winter floods aren’t severe and browns have become the only fish (Maslin,1997b).

Brown trout were apparently never introduced into Mud and Rock Creeks. The mountain zones of both contain populations of little rainbows (maximum size 8-12 inches), which are probably comparable to what has been there for millennia.

FOOTHILL ZONE

Historically the foothill zone was dominated by migratory fish including three anadromous species, the spring run Chinook salmon, steelhead rainbow trout, and Pacific lamprey. Before populations were decimated by downstream and ocean events migratory salmonids were probably the dominant fish in the foothill zone. Unfortunately, there are no accurate records of historical populations of fish in Chico’s Creeks. In a September 1980 letter to the Army Corps former Game Warden Gene Mercer stated that good populations of salmon and steelhead trout were found in Big Chico Creek when he was transferred to Chico in 1938. In the same letter, he also stated that in 1938 and for many years after there were runs of steelhead and some salmon in Rock and Mud Creeks. Other long-time local residents have made similar statements. Sporadic estimates of run size for spring run Chinook in Big Chico Creek have been done since 1956 and are reproduced in Table 1. Only scattered anecdotes of people catching or observing steelhead and lampreys exist. The California Department of Fish and Game (DFG) has planted both spring run Chinook and steelhead trout in Big Chico Creek on a casual basis at least as far back as 1959. In the 1980s DFG began making attempts to count adult spring run Chinook and sporadic attempts to trap down-migrant juveniles. By then populations of spring run Chinook and steelhead trout were extremely low and continuing sporadic hatchery plantings made evaluation of the sustainability of populations difficult.

Table 1. Estimates of Spring-run Chinook Size for Big Chico Creek.
(California Department of Fish and Game, 1998)

Year	Estimate	Year	Estimate	Year	Estimate
1956	500	1971	0	1986	NE
1957	248	1972	NE	1987	NE
1958	1000	1973	50	1988	NE
1959	200	1974	100	1989	7
1960	NE	1975	NE	1990	0
1961	NE	1976	NE	1991	NE
1962	200	1977	332*	1992	0
1963	500	1978	NE	1993	38
1964	100	1979	NE	1994	2
1965	50	1980	NE	1995	200
1966	50	1981	NE	1996	2
1967	150	1982	NE	1997	2
1968	175	1983	NE	1998	369
1969	200	1984	0		
1970	NE	1985	0		

Methods for estimation were neither consistent nor well documented, particularly in early years….
**transferred from Red Bluff ….NE no estimate.*

Electrofishing samples by DFG biologists in 1983 and 1984 demonstrated large populations of Sacramento sucker, hardhead, California roach, Pacific lamprey, and riffle sculpins. Also found were modest populations of Sacramento squawfish, low populations of rainbow trout (probably steelhead), and a few brown trout in the foothill zone of Big Chico Creek. (The July-September timing of the sampling precluded finding salmon.) In October 1986, DFG personnel used the pesticide, rotenone to kill all fish in the foothill zone of Big Chico Creek. Subsequent to the pesticide treatment, excess fry from the Feather River Hatchery were planted at Ponderosa Way to try to re-establish populations of anadromous (sea-run) salmonids. Each spring from 1987 to 1992, 100,000 to 500,000 spring run Chinook salmon fry were planted. In years 1987, 1988, and 1990 from 50,000 to 100,000 steelhead fry were planted. Although surveys by DFG were not consistently done, lay observers noted that few, if any, of the planted fish returned to Big Chico Creek to spawn. General drought conditions at this time certainly did not help, but the hybridized Feather River stock may also have been unsuited to Big Chico Creek conditions.

No estimates of steelhead spawners have ever been made for Big Chico Creek. Populations of both rainbow and brown trout have increased in the foothill zone since the rotenone treatment, especially in the lower end. No studies have been done to determine whether the rainbows are migratory (steelhead) or resident fish..

Re-establishment of native non-salmonid fish populations in the Big Chico Creek foothill zone has been slow. While all the other original species have been observed in the zone, hardheads, squawfish and suckers are scarce and the riffle sculpin has rebuilt its population only in the upper part of the zone. Only the California roach, with its high fecundity and short generation time, has re-established populations equal or above those present before treatment. (Maslin, 1997a)

The foothill zone of Rock Creek supports populations of Sacramento sucker, Sacramento squawfish, hardhead, California roach, riffle sculpin, Pacific lamprey and rainbow trout (all native species). The foothill zone of Mud Creek supports only California roach and rainbow trout. Anecdotal accounts suggest existence of former populations of steelhead and spring run Chinook salmon in both creeks. Although no formal counts have ever been done, probably only a few adults stray into Mud and Rock Creeks under present conditions. In summer 1998, 23 adults were counted in a single pool in Rock Creek and several anecdotes placed additional groups in other pools in both Rock and Mud Creeks. Mud Creek was probably never a very good stream for spring run Chinook salmon or steelhead trout because the Richardson Springs waterfall prevents them from reaching cooler waters at higher elevation. Perhaps a few might over-summer in the plunge pool of the waterfall itself. Except for the barrier created by a small diversion dam, Rock Creek seems to have greater potential, as there are several accessible deep pools. However, it is unlikely that either creek could sustain its own salmon population indefinitely; historical populations existed by they were probably lost in each series of drought years then re-established by strays from Big Chico Creek.

The inability of resident populations of Sacramento sucker, Sacramento squawfish, and hardhead to rebuild after the rotenone treatment in the foothill zone of Big Chico Creek and their absence above the Mud Creek waterfall suggest that maintenance of foothill populations may depend on migration from downstream or even from the Sacramento River. These species are certainly highly migratory, often moving in mixed groups from pool to pool for nearly a mile (Grant, 1992). Possibly, after reconstruction of the Iron Canyon Fish Ladder, migrations will again occur and populations will rebuild in the foothill zone of Big Chico Creek. The post-treatment equilibrium community that will ultimately develop there is still uncertain 12 years after the treatment.

Valley Zone

The valley zones of creeks in winter are salmonid streams, being utilized by migratory members of the salmon/trout family for spawning and/or rearing. The migratory Chinook salmon and steelhead rainbow trout are anadromous; they spend much of their life in the ocean but migrate into fresh water to spawn. The warm water-loving minnows and smallmouth bass are relatively dormant in winter, resting under cover such as cut-banks and root wads. Fall and late-fall run Chinook salmon spawn in the valley zone, typically between November and February. Salmon rarely came up Big Chico Creek before Thanksgiving historically, and valley reaches of the creeks are seldom cold enough for them to spawn successfully before that time.

Spawned Salmon
From Suzanne Gibbs

In winter and early spring, juvenile Chinook salmon of all races move from the Sacramento River where they were spawned into the tributaries for rearing (Maslin, et al. 1997). Some move upstream substantial distances (to Hicks Lane in Mud Creek; to Highway 99 in Rock Creek), although they are more numerous closer to the river. Maslin, 1998, estimated that around 50,000 juvenile Chinook salmon from the Sacramento River rear in the watershed. This number includes about 10,000 of the federally listed winter run salmon race. Juvenile Chinook salmon rearing in the tributaries grow faster and are in better condition than those remaining in the river, but in dry years they may become trapped. Spring-run juvenile Chinook, spawned in the foothill zone of Big Chico Creek, often move as fry down to the warmer and less turbulent valley zone where they rear to smolt size. Big Chico Creek spawned juvenile Chinook also move into Mud and Rock Creeks for rearing.

In summer the valley zone of Big Chico Creek is too warm for salmonids and supports native suckers, hardheads, squawfish, and sculpins as well as the exotic smallmouth bass, and green sunfish. Smallmouth bass are abundant in the valley reach of Big Chico Creek and the short (about 4.5 miles) permanent reach of Mud Creek just below Richardson Springs, but otherwise are generally absent except near the mouth of Mud and Rock Creeks. The predatory smallmouth bass eliminates the bite-sized California roach (found in valley reaches of many local streams) although the cryptic riffle sculpin, with its classic camouflage and habit of hiding, manages to coexist. In a series of drought years, smallmouth bass and green sunfish become more dominant and may consume nearly all young-of-the-year suckers and minnows during the summer. They probably also consume many juvenile salmon, particularly in late spring. However, in years with high winter flows most green sunfish and many smallmouth bass are scoured out of the streams. When several high flow years occur sequentially, it is particularly hard on the smallmouth bass. They spawn later due to delayed warming of the higher flows and consequently the young-of-the-year fish are smaller next winter and less able to withstand those high flows. Consequently, the exotic smallmouth is a severe problem for native species during dry years and only a minor nuisance after a series of wet winters (Maslin, 1997a).

Mud Creek's tributary, Sycamore Creek, contains a small anthropogenic marsh in the region of the Cohasset Highway Bridge. This marsh has some permanent water with reproducing populations of mosquito fish and green sunfish and seasonal influxes of juvenile squawfish, hardheads, and suckers.

Many Sacramento River fish (see Table 2 and Appendix A) use the lower reaches of Big Chico (including Lindo Channel), and Mud and Rock Creeks as spawning and rearing channels in spring. They usually migrate back to the river before the seasonal creeks dry up, but sometimes become trapped, serving as a bonanza for egrets, herons, and raccoons. Seasonal stream reaches seem to be preferred over permanent water reaches for spawning and rearing, perhaps because they warm earlier in the season or because they don't support resident populations of predators. Adult suckers, squawfish, and hardheads all migrate from the river into tributaries to spawn. Most spawn in the valley zone, although some move all the way into the foothill zone. Some, particularly the late-spawning hardheads, will remain in the tributary over summer and return to the river when the creek comes up again in fall. The hitch, a medium sized minnow, uses the lower 2-6 km for spawning. There also is a localized resident hitch population in the upper valley zone of Rock Creek.

INVERTEBRATES

Most aquatic invertebrates can move over land or through the air during part of their life cycle, so are not restricted by barriers to specific zones. Instead, they are found wherever the habitat is suitable. In general, one finds relatively more stoneflies, mayflies, caddisflies, and blackflies in colder, swifter, upstream areas, and more dragonflies, damselflies, beetles, bugs, midges, and mollusks in the warmer, lower-gradient areas. To some extent, the separation shifts downstream in winter, particularly for species with a short life cycle. The invertebrate fauna found in the seasonal reaches of Mud and Rock Creeks is quite different than that found in comparable elevation reaches of Big Chico Creek, being composed of species tolerant of warm temperatures and seasonal de-watering. Appendix B lists invertebrates that have been identified in the watershed.

AMPHIBIANS

Amphibians also are restricted by habitat conditions rather than by physical barriers. The California newt and foothill yellow-legged frogs are creatures of the foothills, probably because the cooler habitat suits them better. Big Chico Creek is listed in the Status of the Sierra Nevada report as a watershed with especially high value for the conservation of foothill yellow-legged frogs (Jennings, 1996). The introduced bullfrog will eliminate the yellow-legged frog in reaches

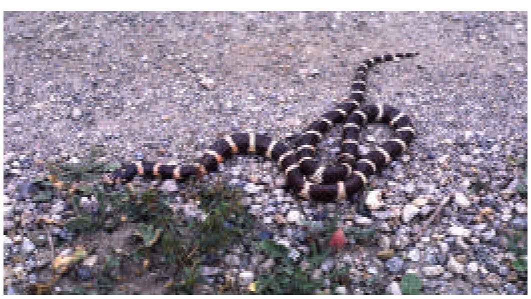
Table 2. Approximate time of spawning for selected fish in the Big Chico Watershed (modified from Moyle, 1976).

Species	Spawning Period
Pacific Lamprey	March - May
Rainbow Trout (Steelhead)	February
Spring-run Chinook	Mid Sept.-Oct.
Fall-run Chinook	Late Oct.–Dec.
Late Fall-run Chinook	Jan.-Feb.
Brown Trout	Oct.-Nov.
Sacramento Sucker	Jan.-March
Sacramento Squawfish	Feb. - April
CA Roach	May-June
Hardhead	April - June
Hitch	April-May
Riffle Sculpin	March-April
Smallmouth Bass	Late April-June

with low gradients. Since the bullfrog spends two or more years as a relatively weak-swimming tadpole, it is limited to low-gradient permanent water reaches of the streams. The transition zone between bullfrogs and yellow-legged frogs moves upstream during a series of dry years, when bullfrog survival is high and downstream during wet years when bullfrog tadpoles are scoured out by high flows.

The western toad can spawn in warm, slow areas of streams or ponds. The black, slow-moving tadpoles require about 2 months until metamorphosis. The Pacific chorus frog spawns in temporary water where its tadpoles are safe from predatory fish. Seasonal streams, backwater pools, and vernal pools all work for tadpole development as long as they hold water for at least two months. The western spadefoot toad favors open, arid environments. It needs pools or temporary streams to hold water for about a month for its fast growing tadpoles. Spadefoot breeding has been recorded in Sycamore Creek and the upper valley zone of Rock Creek.

REPTILES



Four reptiles are commonly associated with Chico area creeks: the western pond turtle, common garter snake, western terrestrial garter snake, and western aquatic garter snake. The western pond turtle lives in pools of streams and ponds and leaves the water only to bask on rocks or logs or to lay eggs in adjacent sandy or silty areas. The three garter snakes are all common around water. They feed on insects, tadpoles, frogs and small fish.

MAMMALS

Beavers are common along the creeks, especially in the valley and foothill zones. While their dams can limit fish migration, they can be passed during high water events and seldom last through the winter season. River otters commonly move along the creeks, often following spawning runs of suckers or minnows, but sometimes taking up temporary residence. Muskrats are common in or near marshy habitats. Raccoons are common throughout the watershed, even in urban areas.

BIRDS

Many birds are associated with the Big Chico Creek watershed. Being highly mobile, all are part of larger populations. Birds found in association with streams in the watershed are listed in Appendix A. Some, such as most egrets and herons, breed elsewhere and just visit the watershed for feeding. (The green-backed heron nest locally.) Common mergansers and wood ducks are common nesters in the Foothill zone. Remnant pools in Mud and Rock Creeks and their surrounding riparian vegetation in the valley zone are used as breeding areas for mallard, cinnamon teal and wood ducks as well as many songbirds. Songbirds use the riparian corridors associated with these creeks as migratory routes.

— PROBLEMS FOR AQUATIC AND RIPARIAN POPULATIONS — OF THE BIG CHICO WATERSHED

Professionals and watershed residents have listed the following as potential problems:

BIOLOGIC CONCERNS

Smallmouth bass definitely exclude California roach from the valley zone. They also take a significant toll of young-of-the-year hardhead, squawfish, and suckers, and probably prevent steelhead trout from rearing downstream of Iron Canyon (although temperatures there are above optimum for steelhead). Smallmouth bass become more of a problem after a series of dry years since high winter flows tend to scour out many of them.

Green sunfish also impact populations of native fishes, particularly in isolated pools of the seasonal reaches of Mud, Rock, and Sycamore Creeks.

Brown trout eliminate rainbow trout in the headwater tributaries, and substantially reduce their populations in other parts of the Mountain zone of Big Chico Creek.

Bullfrogs are probably responsible for the local extinction of the native red-legged frog from valley zones. They also restrict yellow-legged frogs from the lower ends of their natural range, and probably reduce populations of other species. Ponds, created by human-built dams, can extend bullfrog habitat to the destruction of native species.

Genetic contamination from hatchery raised stocked spring run Chinook salmon and steelhead trout may have reduced viability of the native strains.

Although there was notably more in the last two (floods) years, very little reproduction of western sycamore trees is occurring in the watershed.

Particularly in the urban area, native riparian vegetation is being replaced by invasive exotics such as tree-of-heaven, giant reed, Himalayan blackberry, catalpa, fig and mulberry. These exotics species provide less habitat food value for native animals than would the native plants they are replacing. Giant reed and broom turn the riparian corrider into a fire-carrying instead of a fire-stopping zone.

PASSAGE PROBLEMS FOR MIGRATORY FISH

The Lindo Channel Weir blocks upstream movement under low-flow conditions.

The fish ladders in Iron Canyon on Big Chico Creek need reconstruction and continued maintenance to remain functional.

Under spring low-flow conditions, down-migrant salmon and steelhead can enter the upper end of Lindo Channel but unable to proceed to the river because of high temperature or insufficient water. They then perish during the summer due to lack of water or elevated temperature.

The diversion dam at stream mile 18 in Rock Creek prevents further upstream movement of migratory fish under low and intermediate flow conditions.

A diversion dam between Ponderosa Way and Higgin's Hole limits upstream movement of fish under low flow conditions.

Various undersized culverts at logging or ranch crossings have caused downstream scouring, creating waterfalls that limit upstream movement.

HABITAT PROBLEMS

Some valley reaches of Lindo Channel, Mud and Rock Creeks that are maintained by government agencies or landowners as floodways, lack sufficient riparian vegetation to maintain stream structure, provide shade to moderate temperatures, and provide input of terrestrial food for fish. There has been marked improvement in riparian habitat in Lindo Channel between Manzanita Avenue and Mangrove Avenue. Since 1983, the state and county government have been following the COE maintenance manual for Lindo Channel, i.e., as an unimproved waterway, except for some hand removal of vegetation judged to be an imminent threat in 1997. The stream is configuring itself into a more efficient stream for doing the two things streams do: moving water and sediment. Riparian vegetation is reclaiming the streamside areas and beginning to provide shade and habitat. Migratory birds, in particular, have benefited by the recovery of the riparian vegetation.

Water diversion at stream mile 18 in Rock Creek causes de-watering or reduced flows in downstream reaches, reducing fish habitat and contributing to the trapping of migrant salmonids.

Gravel recruitment downstream of the Five-Mile Flood Diversion Complex is reduced, perhaps impacting spawning by fall-run salmon. Gravel also becomes trapped in the One-Mile Pool, from which it is customarily removed, rather than moved downstream.

Extreme flows sent down Mud Creek from Big Chico Creek via the Sycamore Bypass scour out gravel, reducing spawning areas for fall run Chinook salmon, suckers, squawfish, and hardheads. The tributaries and distributaries of Big Chico Creek may strand juveniles of anadromous and river migrant fish. Depending on the gravel configuration at Five-Mile and the amount of rainfall, Lindo Channel dries up between April and August.

Early de-watering of Lindo Channel in dry years may strand juveniles of anadromous and river migrant fish, tadpoles of western toads, and juveniles of many aquatic insects. The resultant failure of emergence of adult insects reduces the food supply for riparian bats and fly catching birds. This de-watering is caused by diversion of low-flow due to buildup of gravel in the Five-Mile area just upstream of the Big Chico weir. By contrast, increase in flow down Lindo Channel reduces the volume flowing via the Big Chico Creek channel, reducing habitat volume and permitting more temperature fluctuation, thereby degrading conditions for salmonids. While some sort of optimal flow split may be possible, there will never be enough flow to maintain “live” streams in both channels in summer.

Summer temperatures in Big Chico Creek are marginal at best for holding spring run salmon. Relatively high temperatures limit their ability to tolerate other stresses such as harassment by swimmers. This is most severe in drought years when temperatures tend to be higher and salmon may have been forced by passage problems to over-summer in pools downstream of the Iron Canyon ladder. Any watershed changes that might further increase summer temperatures would exacerbate this problem.

The practice of removal of large woody debris from urban and floodway stream reaches has reduced habitat and increased scouring.

Low-flow silt transport in the Big Chico Creek channel has been increased by swimming pool clean-out and summer water activity by humans, horses and dogs. Unlike high flow conditions in which silt only deposits where flow velocity is reduced in backwater and overflow sites, silt carried during low flow settles out in riffles and pools where it degrades the habitat for both fish spawning and fish-food organisms.

UPLAND INTERACTIONS

Grazing by cattle on stream banks in headwater meadows has resulted in stream incision with associated loss of local habitat and reduction of bank storage that, in turn, leads to reduced summer flow which, in turn, leads to increased temperature in downstream reaches.

Grazing by cattle on stream banks in the foothills zone, particularly in parts of Mud and Rock Creeks, has depleted riparian vegetation and increased scouring.

Overgrazing or grazing at wrong times of the year results in soil compaction, leading to increased runoff and erosion, contributing to flood scouring and reduced summer base flow downstream.

Home-site development and road building in the foothill zone of Mud and Rock Creeks has increased sediment transport and flood peaks.

Timber harvest, particularly clear-cutting, in the upper watershed has the potential to increase siltation and runoff, in turn leading to reduced summer flow.

— NOTES ON FISH SPECIES —

ANADROMOUS SPECIES

Adult spring run Chinook salmon enter Big Chico Creek between March and June although late arrivals often have difficulty getting upstream because of low flow. Even early arriving individuals are blocked by waterfalls from reaching high elevation. They spend the summer in deep pools from Iron Canyon to Higgin's Hole and spawn in adjacent riffles when temperatures drop in early fall. Since water is relatively warm at the low elevation where they are forced to spawn, their eggs hatch quickly and juveniles grow rapidly. Nearly all juveniles have emigrated by the following spring unlike Deer and Mill Creeks where many juveniles emigrate in the wet season more than a year after being spawned.

Conditions for adult fall run Chinook salmon are less dependable. Fall run salmon can only spawn in the watershed when fall rains raise the flow enough so that they can get upstream. This could be as early as mid October, but may not occur before December. Fall run Chinook salmon spawn shortly after entering the creek and usually in the lower reaches, including Lindo Channel. When a large storm event brings many fish into the creek, some may go as far upstream as Bear Hole. In some years, when early rainfall starts Mud and Rock Creeks running in time, fall run Chinook salmon may also spawn in them. On April 25, 1988 Maslin's ichthyology class captured two juvenile Chinook salmon (Fork Length 42 and 50 mm) in a pool on the Hall Ranch on Rock Creek. On April 18, 1988, five juvenile Chinook salmon (Fork Length 52-58 mm) were captured in Mud Creek at Hicks Lane. Considering the size of the fish and distance upstream, these fish were almost certainly spawned in the creeks. Those sites were not sampled in other years so there is no way to know if the presence of locally spawned juveniles represented a rare or common event.

A few late fall run Chinook salmon enter the watershed under the high flow conditions typical of January and February. They spawn in the valley zone with juveniles being stimulated by rising spring temperature to migrate out as fry.

Steelhead trout adults migrate into the creeks between October and January. They usually spawn in the Foothill zone, but in low-flow years may spawn in the valley zone. Juveniles behave like resident trout, establishing home ranges and feeding stations and competing with resident trout for one to three years before emigrating.. Historically, steelhead were probably predominant when the habitat was adequate. The decline of steelhead has permitted their replacement by resident rainbows.

The third anadromous species, the Pacific lamprey, is not as limited by dams and waterfalls as typical fish. They will struggle part way up the face of a dam or waterfall, then attach with their oral sucker and rest before struggling further up and finally over. Lampreys spawn in both valley and foothill zones in March through May. The lamprey juvenile is a true larval form, having neither eyes nor teeth and remaining burrowed into sandy or silty backwater areas where they filter-feed on detritus. After about six years of this life style, they metamorphose into a free-swimming, parasitic form (with eyes and teeth), which migrates to the ocean. Substantially fewer larval lampreys have been collected in Big Chico Creek in the last two years. This could be due to the high winter flows or could reflect some change in the population.

NATIVE FRESHWATER SPECIES

The large native dominants of the valley and foothill zones (Sacramento sucker, hardhead and Sacramento squawfish) are similar in size and are highly migratory, often moving from pool to pool in mixed schools. The sucker is clearly demarcated by its under-slung mouth with fleshy lips for scrubbing algae and detritus from rocks. The squawfish and hardhead look superficially similar but have teeth (located back in their throats) specialized for quite different foods. The squawfish has long, piercing teeth for subduing active prey such as other fish, crayfish, and aquatic insects. The hardhead has blunt, molar-like teeth for crushing snails and grinding filamentous algae.

The much smaller (adult size about 4 inches) California roach and riffle sculpin are truly resident, probably completing their life cycle within a few meters of where they were spawned. The roach frequents the edges of pools, feeding on algae and small insects, while the sculpin hides under rocks in swifter water, eating any animal life that will fit into its cavernous mouth.

DATA GAPS FOR AQUATIC SPECIES

Inadequate information exists on the following topics to allow them to be integrated into management decisions:

- Amphibian breeding areas, particularly for spadefoot toad, California newt, and yellow-legged frog.
- Fish communities in the mountain tributaries of Big Chico Creek.
- Habitat loss due to flood control diversions and channel maintenance.
- Current ability of Mud and Rock Creeks to support spring run Chinook salmon.
- Numbers of steelhead spawners in the watershed.
- Degree of small-mouth predation on anadromous salmonids.
- Importance of tributaries in the life cycle of Sacramento splittail.
- Efficiency of fish passage through the Iron Canyon ladders at different flow volumes.

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APPENDIX A

AQUATIC VERTEBRATES

AQUATIC VERTEBRATES

Common Name	Scientific Name	Native?	Habit*	Zone**	Status'
	PETROMYZONTIDAE Lamprey family				
Pacific Lamprey	*Lampetra tridentatus (Richardson)*	yes	Ad	V, FH	common
River Lamprey	*Lampetra ayrsi (Gunther)*	yes	Rs	V	??
	SALMONIDAE Salmon and Trout family				
Chinook Salmon	*Oncorhynchus tshamytscha (Walhaum)*	yes	Ad	V, FH	common
Rainbow Trout (includes Steelhead)	*Oncorhynchus mykiss*	yes	Ad, Rs	V, FH, Mt	abundant (Mt)
Brown Trout	*Salmo trutta Linnaeus*	no	Rs	Mt FH,	abundant (Mt)
	CYPRINIDAE Minnow family				
Carp	*Cyprinus carpio Linnaeus*	no	Rs	NR	common
Goldfish	*Carassius auritus (Linnaeus)*	no	Rs	NR	occasional
Golden Shiner	*Notemigonus crysoleucas (Mitchill)*	no	Rs	NR	common
Sacramento Blackfish	*Orthodon microlepidotus (AyRs)*	yes	Rs	NR	occasional
Hitch	*Lavinia exilicauda Baird& Girard*	yes	Rs RM	NR	common
Hardhead	*Mylopharodon conocephalus (Baird& Girard)*	yes	Rs RM	V, FH	abundant
Sacramento Splittail	*Pogonichthys macrolepidotus (AyRs)*	yes	RM	V	occasional
Sacramento Squawfish	*Ptychocheilus grandis (AyRs)*	yes	Rs RM	V, FH	common
California Roach	*Lavinia symmetricus (Baird& Girard)*	yes	Rs RM	FH	abundant
Speckled Dace	*Rhinichthys osculus (Girard)*	yes	Rs	FH	??
	CATOSTOMIDAE Sucker family				
Sacramento Sucker	*Catostomus occidentalis AyRs*	yes	Rs RM	V, FH	abundant
	ICTALURIDAE Catfish family				
White Catfish	*ktalurus catus (Linnaeus)*	no	Rs	V	occasional
Channel Catfish	*ktalurus punctatus Rafinesque*	no	Rs	NR	common
Brown Bullhead	*Ictalurus nebulosus (LeSueur)*	no	Rs	NR	common
Black Bullhead	*Ictalurus melas (Rafinesque)*	no	Rs	NR	common
	POECILIEDAE Livebearer family				
Mosquitofish	*Gambusia affinis (Baird& Girard)*	no	Rs	V	common
	GASTEROSTEIDAE Stickleback family				
Threespine stickleback	*Gasterosteus aculeatus Linnaeus*	yes	Rs	NR	common
	PERCICHTHYIDAE Temperate Bass family				
Striped Bass	*Morone saxatilis (Walhaum)*	no	Ad	NR	occasional
	CENTRARCHIDAE Sunfish and Black bass family				

AQUATIC VERTEBRATES

Common Name	Scientific Name	Native?	Habit*	Zone**	Status***
Bluegill	*Lepomis macrochirus Rafinesque*	no	Rs	NR	common
Redear Sunfish	*Lepoinis microlophus (Gunther)*	no	Rs	NR	uncommon
Green Sunfish	*Lepomis cyanellus Rafinesque*	no	Rs	V	common
Warmouth	*Lepomis gulosus (Cuvier)*	no	Rs	NR	occasional
White Crappie	*Poinoxis annularis Raftnesque*	no	Rs	NR	uncommon
Black Crappic:	*Poinoxis nigromaculatus (Lesueur)*	no	Rs	NR	uncommon
Largemouth Bass	*Micropterus salmoides (Lacepede)*	no	Rs	NR	common
Smallmouth Bass	*Micropterus dolomieui Lacepede*	no	Rs	V	abundant
ENIBIOTOCIDAE Surfperch family					
Tule Perch	*Hysterocarpus traski Gihbons*	yes	RS	NR	common
COTTUDAE Sculpin family					
Prickly Sculpin	*Cottus asper Richardson*	yes	Rs	NR	common
Riffle Sculpin	*Cottus gulosus (Girard)*	yes	Rs	V, FH	abundant
SALAMANDRIDAE Newt family					
California Newt	*Taricha torosae*	yes	Rs	FH	common
BUFONEDAE Toad family					
Western Toad	*Bufio horeas*	yes	Rs	V. FH	abundant
HYLIDAE Treefrog family					
Pacific Tree Frog	*Hyla (Pseudacris) regila*	yes	Rs	V, FH, Mt	abundant
RANIDAE True Frog family					
Foothill yellow-legged Frog	*Rana boy I ii*	yes	Rs	FH~ Mt	common
Bullfrog	*Rana catesbeiana*	no	Rs	V	abundant
PELOBATIDAE Spadefoot Toad family					
Western Spadefoot Toad	*Scaphiopus hammondii*	yes	Rs	V, FH	uncommon
TESTUDINIDAE Turtle family					
Pacific Pond Turtle	*Clemmys marmorata*	yes	Rs	V, FH	uncommon
COLUBRIDAE Colubrid snake family					
Common Gartersnake	*Thamnophis sirtalis*	yes	Rs	V, FH, Mt	common
Western Terrestrial Gartersnake	*Thamnophis elegans*	yes	Rs	V, FH, Mt	common
Western Aquatic Gartersnake	*Thamnophis couchi*	yes	Rs	V. FH. Mt	common
CASTORIDAE Beaver family					
Beaver	*Castor canadensis*	yes	M	V, FH, Mt	common
PROCYONIIDAE Raccoon family					
Racoon	*Procyon lotor*	Yes	M	V, FH, Mt	abundant

AQUATIC VERTEBRATES

Common Name	Scientific Name	Native?	Habit*	Zone**	Status***
	CRICETIDAE Mouse family				
Muskrat	*Ondatra zibethica*	yes	M	V, FH	uncommon
	MUSTELIDAE Weasel family				
River Otter	*Lutra canadensis*	yes	M	V, FH, Mt	uncommon
	CINCLIDAE Dipper family				
American Dipper	*Cinclus mexicanus*	yes	M	FH, Mt	common
	ALCEDINIDAE Kingfisher family				
Belted Kingfisher	*Ceryle alcyon*		M	V, FH, Mt	common
	ARDEIDAE Heron family				
Great Blue Heron	*Ardea herodias*	yes	M	V, FH	common
Great Egret	*Casmerodius albus*	yes	M	V, FH	occasional
Green-Backed Heron	*Butorides striatus*	yes	M	V, FH	common
	SCOLOPACIDAE Sandpiper family				
Greater Yellowlegs	*Tringa melanoleuca*	yes	M	V, FH	occasional
	CHARADRIIDAE Plover family				
Killdeer	*Charadrius vociferus*	yes	M	V, FH, Mt	abundant
	PODICIPEDIDAE Grebe family				
Pied-billed Grebe	*Podilymbus podiceps*	yes	M	V, FH	occasional
	ANATIDAE Waterfowl family				
Wood Duck	*Aix sponsa*	yes	M	V, FH, Mt	common
Mallard	*Anas platyrhynchos*	yes	M	V, FH, Mt	common
Common Merganser	*Mergus merganser*	yes	M	V, FH, Mt	common

Habit*

Rs	*Resident*
RM	*River Resident (migrates into creek for spawning or rearing)*
Ad	*Anadromous*
M	*Mobile, not confined to the creek*

Zone**

NR	*Near River (within 2 miles)*
V	*Central Valley Zone of Creek*
FH	*Foothill Zone of Creek*
Mt	*Mountain Zone of Creek*

Status***

abundant	*Many found in each appropriate habitat unit*
common	*A few in each appropriate habitat unit*
uncommon	*One or two in every 10 appropriate habitat units*
occasional	*Unusual, but has been reported from the creek or is common in the river nearby*
??	*Reported from similar habitats in the area, but not yet from the Big Chico creek watershed.*

AQUATIC INVERTEBRATES OBSERVED IN THE BIG CHICO WATERSHED

Phylum	**Class**	**Order**	**Family**	Sci ***Name***	**Site**	**Drainage**
Platyhelminthes		Tricladia		*Dugesid sp.*	many	Chico Creek
Nematoda				*Nematoda*	many sp.	Chico Creek
Annelida		Oligochaeta	Nandidae	*Chaetogaster* sp.	Foothill & Valley	Chico Creek
Annelida		Oligochaeta	Lumbriculidae	*Unid. Lum.*	many	Chico Creek
Arthropoda	Crustacea	Decapoda	Astacidae	*Orconectes virifis*	river to upper end Bidwell	Chico Creek
Arthropoda	Crustacea	Decapoda	Astacidae	***Pacifastacus leniusculus***	*Up*. Bid. Detox	Chico Creek
Arthropoda	Crustacea	Decapoda	Astacidae	***Procambarus clarkii***	lower creek	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Siphloneuridae	*Ameletus sp.*	Warner St	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Siphlonuridae	***Siphlonurus occidentalis***	valley	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Baetidae	***Baefis bicaudatus***	foothills	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Baetidae	***Baefis tricaudatus***	foothills	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Callibaefis sp.*	seasonal reaches	Mud Creek
Arthropoda	Insecta	Ephemeroptera	Baetidae	***Centroptilium*** *sp.*	foothills	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Pseudocloeon sp.*	foothills	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Oligoneuridae	*Isonychia velma*	foothills	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	*Cinygma sp.*	Ponderosa Way	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	*Epeorus longimanus*	many	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	*Ironodes nifidus*	foothills	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	***Leucrocuta*** *sp.*	seasonal reaches	Mud Creek
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	***Rhithrogena doddsi***	foothills	Chico Creek
Arthropoda	Insecta	Ephemeroptera,	Ephemerellidae	***Attenella*** *sp.*	NR	Chico Creek
Arthropoda	Insecta	Ephemeroptera.	Ephemerellidae	***Caudatella heterocauda***	Campbell Cr	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	***Caudatella hystrix***	Ponderosa way	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Ephernerellidae	***Drunella coloradensis***	foothills and valley	Chico Creek
Arthropoda,	Insecta	Ephemeroptera	Ephemerellidae	***Drunella doddsi***	foothills and valley	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	***Drunellaflavilinea***	valley	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	***Drunella grandis***	many	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	***Ephemerella inermis***	foothills	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	***Ephemerella maculata***	seasonalreaches	Mud Creek
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	***Eurylophella lo&***	seasonal reaches	Mud Creek
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	***Seratella micheneri***	many	Chico Creek
Arthropoda	Insecta	Ephemeroptera,	Tricoryffiidae	***Tricorythodesfallax***	foothills	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Caenidae	*Caenis sp.*	Upper Bidwell	Chico Creek
Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae	*Paraleptophlebia sp.*	Ponderosa Way up	Chico Creek

AQUATIC INVERTEBRATES OBSERVED IN THE BIG CHICO WATERSHED

Phylum	Class	Order	Family	Sci Name	Site	Drainage
Arthropoda	Insecta.	Ephemeroptera	Ephemeridae	*Hexagenia limbata*	mouth	Chico Creek
Arthropoda	Insecta	Odonata	Cordulegasteridae	*Cordulegaster dorsalis*	Chico Meadows, Upper Bidwell	Chico Creek
Arthropoda	Insecta	Odonata	Gomphidae	*Gomphus conftaternus*	Valley	Chico Creek
Arthropoda	Insecta.	Odonata	Gomphidae	*Octogomphus specularis*	Ponderosa Way up	Chico Creek
Arthropoda	Insecta	Odonata	Gomphidae	*Ophiogomphus bison*	Ponderosa Way down	Chico Creek
Arthropoda	Insecta	Odonata	Gomphidae	*Progomphus borealis*	Valley	Chico Creek
Arthropoda	Insecta.	Odonata	Aeshnidae	*Aeshna interrupta*	many	Chico Creek
Arthropoda	Insecta	Odonata	Aeshnidae	*Anoxjuneus*	many	Chico Creek
Arthropoda	Insecta	Odonata	Macromiidae	*Macromia magnifica*	Hall Ranch	Rock Creek
Arthropoda	Insecta.	Odonata	Macromiidae	*Macromia magnifica*	Upper Park	Chico Creek
Arthropoda	Insecta.	0donata.	Corduliidae	*Neurocordulia sp.*	Hall Ranch	Rock Creek
Arthropoda	Insecta	Odonata	Libellulidae	*Brechmorhoga mendax*	foothills/valley	Chico Creek
Arthropoda	Insecta.	Odonata	Libellulidae	*Libellula luctosa*	seasonal reaches	Mud Creek
Arthropoda	Insecta	Odonata	Libellulidae	*Pachydiplax longipennis*	seasonal reaches	Mud Creek
Arthropoda	Insecta	Odonata	Libellulidae	*Plathemis subornata*	seasonal reaches	Mud Creek
Arthropoda	Insecta	Odonata	Libellulidae	*Tarnetrum corruption*	Higgins Hole	Chico Creek
Arthropoda	Insecta	Odonata	Calopterygidae	*Hetaerina americana*	Upper Park	Chico Creek
Arthropoda	Insecta	Odonata	Lestidae	*Archilestes californica*	Higgins Hole	Chico Creek
Arthropoda	Insecta	Odonata	Coenagrionidae	*Argia emma*	foothills/valley	Chico Creek
Arthropoda	Insecta	Odonata	Coenagrionidae	*Argia vivida*	foothills/valley	Chico Creek
Arthropoda	Insecta	Odonata	Coenagrionidae	*Isnura* sp.	seasonal reaches	Mud Creek
Arthropoda	Insecta	Plecoptera	Pteronarcidae	*Pteronarcys californica*	many	Chico Creek
Arthropoda	Insecta	Plecoptera.	Peltoperlidae	*Sierraperla cora*	Highway 32 (Mt), Campbell Creek	Chico Creek
Arthropoda	Insecta.	Plecoptera	Peltoperlidae	*Yoraperla brevis*	Highway 32 (Mt)	Chico Creek
Arthropoda	Insecta	Plecoptera	Taeniopterygidae	*Taenionema sp.*	Upper Bidwell up	Chico Creek
Arthropoda	Insecta	Plecoptera	Nemuridae	*Amphinemura* sp.	Upper Bidwell up	Chico Creek
Arthropoda	Insecta	Plecoptera	Nemouridae	*Malenka* sp.	Upper Bidwell up	Chico Creek
Arthropoda	Insecta	Plecoptera	Nemouridae	*Zapada sp.*	Upper Bidwell up	Chico Creek
Arthropoda	Insecta	Plecoptera	Leuctridae	*Moselia infitscata*	Upper Bidwell	Chico Creek
Arthropoda	Insecta	Plecoptera	Capniidae	*Mesocapnia werneri*	Mud Creek (valley)	Chico Creek
Arthropoda	Insecta	Plecoptera	Perlidae	*Calineuria californica*	many	Chico Creek
Arthropoda.	Insecta	Plecoptera	Perlidae	*Claassenia sebulosa*	Ponderosa way up	Chico Creek
Arthropoda	Insecta	Plecoptera	Perlidae	*Doroneuria theodora*	Ponderosa way up	Chico Creek
Arthropoda	Insecta	Plecoptera	Perlidae	*Hesperoperla hoguei*	Highway 32 (Mt), Cascade Creek	Chico Creek

AQUATic INVERTEBRATES OBSERVED IN THE BIG CHICO WATERSHED

Phylum	Class	Order	Family	Sci Name	Site	Drainage
A.rthropoda	Insecta	Plecoptera	Perlidae	Hesperoperlapacifica	many	Chico Creek
Arthropoda	Insecta	Plecoptera	Perlodidae	cultus SP.	many	Chico Creek
Arthropoda	Insecta.	Plecoptera	Perlodidae	Isoperla sp	many	Chico Creek
Arthropoda	Insecta	Plecoptera	Perlodidae	Oroperla sp.	Highway 32 (Mt), Chico Meadows	Chico Creek
Arthropoda	Insecta	Plecoptera	Perlodidae	Osobenus sp.	Golf Course	Chico Creek
Arthropoda	Insecta	Plecoptera	Perlodidae	Perfinodes sp.	Ponderosa Way up	Chico Creek
Arthropoda	Insecta	Plecoptera	Perlodidae	Pictetiella sp.	NR	Chico Creek
Arthropoda	Insecta	Plecoptera	Perlodidae	Setvena sp.	Ponderosa Way	Chico Creek
Arthropoda	Insecta	Plecoptera	Chloroperlidae	Sweltza pac ifi ca	Upper Bidwell	Chico Creek
Arthropoda	Insecta	Plecoptera	Chloroperlidae	Sweltza townesi	Soda Springs	Chico Creek
Arthropoda	Insecta	Herniptera	Gerridae	Gerris remigis	many	Chico Creek
Arthropoda	Insecta	Hemiptera	Veliidae	Microvelia sp.	Bidwell Pk	Chico Creek
Arthropoda	Insecta	Hemiptera	Veliidae	Rhagovelia sp.	many	Chico Creek
Arthropoda	Insecta	Herniptera	Corixidae	Graptocorixa californica	Valley	Chico Creek
Arthropoda	Insecta	Herniptera	Belostomidae	Abedus indentatus	foothills & Mts.	Chico Creek
Arthropoda	Insecta	Hemiptera	Belostomidae,	Abedus indentatus	Hall ranch	Rock Creek
Arthropoda	Insecta	Hemiptera	Naucoridae	Ambrysus mormon	Valley	Chico Creek
Arthropoda	Insecta	Hemiptera	Belostomidae	Belostomaflumineum	Upper Park	Chico Creek
Arthropoda	Insecta	Herniptera	Gelastocoridae	Gelastocoris oculatus	Upper Bidwell	Chico Creek
Arthropoda	Insecta	Megaloptera	Sialidae	Sialis californicus	Bidwell Park	Chico Creek
Arthropoda	Insecta	Megaloptera	Sialidae	Sialis californicus	many	Chico Creek
Arthropoda	Insecta	Megaloptera	Corydalidae	Corydalus cognata	Bidwell lower Park	Chico Creek
Arthropoda	Insecta	Megaloptera	Corydalidae	Dysmicohermes	Mountain tributaris	Chico Creek
Arthropoda	Insecta	Megaloptera	Corydalidae	Neohermes californicus	Hall Ranch	Rock Creek
Arthropoda	Insecta	Megaloptera	Corydalidae	Neohermes californicus	seasonal reaches	Mud Creek
Arthropoda	Insecta	Megaloptera	Corydalidae	Orohermes crepusculus	Highway 32 (Mt)	Chico Creek
Arthropoda	Insecta	Trichoptera	Philopotamidae	Chimarra sp.	many	Chico Creek
Arthropoda	Insecta	Trichoptera	Philopotamidae	Dolophilodes sp.	Chico Meadows	Chico Creek
Arthropoda	Insecta	Trichoptera	Philopotamidae	Wormaldia sp.	Ponderoas Way up	Chico Creek
Arthropoda	Insecta	Trichoptera	Psychomyiidae	Tinodes sp.	Upper Bidwell	Chico Creek
Arthropoda	Insecta	Trichoptera	Polycentropodidae	Polycentropus sp.	Ponderosa Way up	Chico Creek
Arthropoda	Insecta	Trichoptera	Polycentropodidae	Polypplectropus sp.	Campbell Creek	Chico Creek
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Arctopsyche sp.	Ponderosa Way up	Chico Creek
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche sp.	foothills & valley	Chico Creek

AQUATIC LWERTEBRATES OBSERVED IN THE BIG CHICO WATERSHED

Phylum	Class	Order	Family	Sci Name	Site	Drainage
Arthropoda	Insecta	Trichoptera	Hydropsychidae	*Hydropsyche sp.*	many	Chico Creek
Arthropoda	insecta	Trichoptera	Rhyacophilidae	*Rhyacophila spp.*	many	Chico Creek
Arthropoda	Insecta	Trichoptera	Glossosomatidae	*Agapetus sp.*	many	Chico Creek
Arthropoda	Insecta	Trichoptera	Glossosomatidae	*Anagapetus sp.*	many	Chico Creek
Arthropoda	Insecta	Trichoptera	Glossosomatidae	*Glossosoma sp.*	many	Chico Creek
Arthropoda	Insecta	Trichoptera	Glossosomatidae	*Protoptilla sp.*	Upper Bidwell up	Chico Creek
Arthropoda.	Insecta	Trichoptera	Hydroptilidae	*Hydroptila sp.*	Upper Bidwell up	Chico Creek
Arthropoda	Insecta	Trichoptera	Hydroptilidae	*Leucotrichia* sp.	Upper Bidwell up	Chico Creek
Arthropoda	Insecta	Trichoptera	Hydroptilidae	*Mayatrichia sp.*	Upper Bidwell up	Chico Creek
Arthropoda	Insecta	Trichoptera	Hydroptilidae	*Ochrotrichia sp.*	Upper Bidwell up	Chico Creek
Arthropoda	Insecta	Trichoptera	Hydroptilidae	*Orthrotrichia sp.*	Ponderosa Way	Chico Creek
Arthropoda	Insecta	Trichoptera	Hydroptilidae	*Palaeagapetus sp.*	NR	Chico Creek
Arthropoda	Insecta	Trichoptera	Brachycentridae	*Amiocentrus sp.*	Upper Bid Prk	Chico Creek
Arthropoda	Insecta	Trichoptera	Brachycentridae	*Brachycentrus americana*	Ponderosa Way, Campbell Creek, etc	Chico Creek
Arthropoda	Insecta	Trichoptera	Brachycentridae	*Micrasema sp.*	many	Chico Creek
Arthropoda	Insecta	Trichoptera	Linmephilidae	*Apatania sp.*	Chico Meadows	Chico Creek
Arthropoda	Insecta	Trichoptera	Linmephilidae	*Dicosmoecus sp.*	Campbell Cr	Chico Creek
Arthropoda	Insecta	Trichoptera	Linmephilidae	*Goera sp.*	Chico Meadows	Chico Creek
Arthropoda	Insecta	Trichoptera	Linmephilidae	*Neophylax sp.*	Campbell Cr.	Chico Creek
Arthropoda	Insecta	Trichoptera	Limnephilidae	*Clostoeca sp.*	Chico Meadows	Chico Creek
Arthropoda	Insecta	Trichoptera	Limnephilidae	*Psychoglypha sp.*	Campbell Cr.	Chico Creek
Arthropoda	Insecta	Trichoptera	Lepidostomatidae	*Lepidostoma sp.*	many	Chico Creek
Arthropoda	Insecta	Trichoptera	Sericostornatidae	*Gumaga sp.*	many	Chico Creek
Arthropoda.	Insecta	Trichoptera	Odontoceridae	*Marilia sp.*	Upper Bidwell	Chico Creek
Arthropoda	Insecta	Trichoptera	Helicopsychidae	*Helicopsyche borealis*	Upper Bidwell up	Chico Creek
Arthropoda	Insecta	Trichoptera.	Calarnoceratidae	*Heteroplectron californicum*	Campbell Creek	Chico Creek
Arthropoda	Insecta	Trichoptera	Leptoceridae	*Ceraclea sp.*	NR	Chico Creek
Arthropoda	Insecta	Trichoptera	Leptoceridae	*Mystacides sp.*	Campbell Cr	Chico Creek
Arthropoda	Insecta	Trichoptera	Leptoceridae	*Mystacides sp.*	Lindo Channel	Chico Creek
Arthropoda	Insecta	Trichoptera	Leptoceridae	*Oecetis sp.*	Upper Bidwell up	Chico Creek
Arthropoda	Insecta	Lepidoptera	Pyralidae	*Petrophila confusialis*	Upper Bidwell up	Chico Creek
Arthropoda	Insecta	Coleoptera	Gyrinidae		upper watershed	Chico Creek
Arthropoda	Insecta	Coleoptera	Dytiscidae	*Agabusjugens*	Chico Meadows	Chico Creek
Arthropoda	Insecta	Coleoptera	Dytiscidae	*Agabus linealus*	Chico Meadows	Chico Creek

AQUATIC INVERTEBRATES OBSERVED IN THE BIG CHICO WATERSHED

Phylum	**Class**	**Order**	**Family**	**Sci Name**	Site	**Drainage**
Arthropoda	Insecta	Coleoptera.	Hydrophilidae	*Hydrophilus triangularis*	Upper Bidwell down	Chico Creek
Arthropoda	Insecta	Coleoptera.	Hydrophilidae	*Tropisternus sp.*	seasonal reaches	Mud Creek
Arthropoda	Insecta	Coleoptera	Psephenidae	*Acneus sp.*	Highway 32 (Mt)	Chico Creek
Arthropoda	Insecta	Coleoptera	Psephenidae	*Eubrianax edwardsi*	Upper Bidwell up	Chico Creek
Arthropoda	Insecta	Coleoptera	Psephenidae	*Psephenus haldemani*	Upper Bidwell down	Chico Creek
Arthropoda	Insecta	Coleoptera	Dryopidae	*Helichus sp.*	Upper Bidwell	Chico Creek
Arthropoda	Insecta	Coleoptera	Elmidae	*Ampumixus sp.*	Highway 32 (Mt)	Chico Creek
Arthropoda	Insecta	Coleoptera	Elmidae	*Cleptelmis sp.*	Highway 32 (Mt)	Chico Creek
Arthropoda	Insecta	Coleoptera.	Elmidae	*Gonielmis sp.*	Highway 32 (Mt)	Chico Creek
Arthropoda	Insecta	Coleoptera	Elmidae	*Heterlimnius sp.*	Highway 32 (Mt)	Chico Creek
Arthropoda	Insecta	Coleoptera	Elmidae	*Lara* sp.	Highway 32 (Mt)	Chico Creek
Arthropoda	Insecta	Coleoptera	Elmidae	*Macronychus sp.*	Ponderosa Way	Chico Creek
Arthropoda	Insecta	Coleoptera	Elmidae	*Narpus angustus*	many	Chico Creek
Arthropoda	Insecta	Coleoptera	Elmidae	*Optioservus quadrimaculatus*	many	Chico Creek
Arthropoda.	Insecta	Coleoptera	Elmidae	*Ordobrevia nubifera*	Upper Bidwell	Chico Creek
Arthropoda	Insecta	Coleoptera	Ehnidae	*Promoresia sp.*	*Hy* 32	Chico Creek
Arthropoda	Insecta	Coleoptera.	Sphaeriidae	*Sphaerius sp.*	Ponderosa Way	Chico Creek
Arthropoda	Insecta	Coleoptera	Elmidae	*Zaitzevia parvula*	many	Chico Creek
Arthropoda	Insecta.	Coleoptera	Ptilodactilidae	*Stenocolus scutellaris*	many	Chico Creek
Arthropoda	Insecta	Diptera	Blephariceridae	*Blepharicera* sp.	Upper Bidwell	Chico Creek
Arthropoda	Insecta	Diptera	Psychodidae	*Mariuina sp.*	Upper Park	Chico Creek
Arthropoda	Insecta	Diptera	Tipulidae	*Antocha* sp.	many	Chico Creek
Arthropoda	Insecta	Diptera	Tipulidae	*Dicranota sp.*	Upper Bidwell up	Chico Creek
Arthropoda	Insecta	Diptera	Tipulidae	*Heratoma sp.*	Upper Bidwell up	Chico Creek
Arthropoda	Insecta	Diptera	Tanyderidae	*Protanyderus sp.*	NR	Chico Creek
Arthropoda.	Insecta	Diptera.	Tipulidae	*Tipula sp.*	Warner St	Chico Creek
Arthropoda	Insecta	Diptera	Simulidae	*simulium* SP.	many	Chico Creek
Arthropoda	Insecta	Diptera	Chironomidae	*Cardiocladius sp.*	NR	Chico Creek
Arthropoda	Insecta	Diptera	Chironomidae	*Chironomids*	many	Chico Creek
Arthropoda	Insecta	Diptera	Chironomidae	*Orthocladiinids*	many	Chico Creek
Arthropoda	Insecta	Diptera	Chironomidae	*Tanytarsus sp.*	many	Chico Creek
Arthropoda	Insecta	Diptera	Chronomidae	*Zavrelimyia sp.*	NR	Chico Creek
Arthropoda	Insecta	Diptera	Ceratopogonidae	*Bezzia sp.*	Ponderosa Way	Chico Creek

AQUATIC INVERTEBRATES OBSERVED IN THE BIG CHICO WATERSHED

Phylum	**Class**	**Order**	**Family**	**Sci Name**	Site	**Drainage**
Arthropoda.	Insecta	Diptera	Dixidae	*Dixa sp.*	Ponderosa Way	Chico Creek
Arthropoda.	Insecta	Diptera	Tabanidae	silvius SP.	NR	Chico Creek
Arthropoda,	Insecta	Diptera	Athericidae	*Atherix variegata*	many	Chico Creek
Arthropoda	Insecta	Diptera	Stratiomyidae	*Euparyphus sp.*	Upper Bidwell	Chico Creek
Arthropoda	Insecta	Diptera	Stratiomyidae	*Stratiomys sp.*	Upper Bidwell	Chico Creek
Arthropoda	Insecta	Diptera	Empididae	*Chelifera sp.*	Ponderosa Way	Chico Creek
Arthropoda	Insecta	Diptera	Empididae	*Hemerodromia sp.*	Ponderosa Way	Chico Creek
Arthropoda	fnsecta	Diptera	Empididae	*Weidmannii sp.*	Ponderosa Way	Chico Creek
Arthropoda	Arachnida	Hydracarina			many	Chico Creek
Mollusca	Gastropoda	Mesogastropoda	Pleuroceridae	*Juga nigrina*	upper watershed	Chico Creek
Mollusca	Gastropoda.	Mesogastropoda		*Lithophagus turbidiformes*	upper watershed	Chico Creek
Mollusca	Gastropoda	Lymnophila	Ancylidae	*Ferresia californica*	Upper Bidwell	Chico Creek
Mollusca	Gastropoda.	Lymnophila.	Planorbidae	*Gyraulus parvus*	Upper Bidwell	Chico Creek
Mollusca	Gastropoda	Lymnophila	Physidae	*Physa gyrina*	Ponderosa Way and downstream	Chico Creek
Moll/Bivalvia	Bivalvia	Unionoida	Anodontidae	*Anodonta californica*	Ponderosa Way	Chico Creek
Moll/Bivalvia	Bivalvia		Corbiculidae	*Corbicula mandensis*	Five Mile and downstream	Chico Creek
Moll/Bivalvia	Bivalvia	Veneroida	Sphaeridae	*Sphaerium sp.*	Chico Meadows	Chico Creek

WILDLIFE RESOURCES INVENTORY

— INTRODUCTION —

The Big Chico Creek watershed contains an excellent diversity of wildlife and wildlife habitats. Wildlife populations and distributions are a reflection of habitat quality and quantity. As would be expected, areas within the watershed that have received a relatively high amount of impact contain lower quality wildlife habitat than relatively undisturbed areas.

The watershed has been divided into four broad sections: Mountain, Canyon, Foothill, and Valley. Habitat conditions and wildlife populations associated with each section are discussed. Information gathered from the literature, consultations with agency personnel, USFWS data queries, and information from Version 7.0 of the California Wildlife Habitat Relationships System (CWHR) were used to describe the existing conditions of wildlife habitat and wildlife distributions in the watershed. A complete inventory of known and expected wildlife, their habitat associations, status, and seasonal occurrence within the watershed are presented in Appendix A. Scientific names for all wildlife mentioned in the text are also presented in Appendix B. Extremely rare or occasional migrants were not included in the Appendix A.

— WILDLIFE HABITATS —

The watershed contains a wide diversity of wildlife, which is maintained by unique and critically important habitats. General habitats within each section follow habitat classification from Mayer and Laudenslayer (1988). General habitat characteristics as they apply to wildlife are described. For more detailed descriptions of vegetation communities refer to the Stream/Vegetation Inventory chapter.

MOUNTAIN HABITATS

Mountain habitats are those found above 4,000 feet and usually contain well established conifer communities. Primary land uses are recreation and timber production. Sierran mixed conifer, montane hardwood-conifer, montane riparian, and ponderosa pine are habitats typical of the mountain section. Within the watershed ponderosa pine, montane riparian, and montane hardwood-conifer provide migratory habitat for deer and can be extremely important in migration holding areas and in the development of migratory routes. Ownership of this section is divided between public and private interests. See the Land Use Chapter of this report for additional information.

CANYON HABITATS

Canyon habitats are those found below 4,000 feet and above 2,000 feet elevation. Primary land uses are cattle ranching, recreation and residential development. Ponderosa pine, montane hardwood-conifer, montane hardwood, mixed chaparral, and montane chaparral are habitats typical of the canyon section. Rock and Mud Creek both originate within this zone. Big Chico Creek begins to narrow within this section and narrow strips of riparian habitats are characteristic of this section. Ownership of the canyon section is primarily private and little development has occurred in this section. Cattle grazing and limited timber harvesting occur in this area.

FOOTHILL HABITATS

Foothill habitats are those found below 2,000 feet elevation and end at the valley floor. Primary land uses are cattle ranching, recreation and residential development.

Blue oak-grey pine, blue oak, valley foothill riparian, and annual grassland habitats are typical of the foothill section. Blue oak, scrub oak, live oak, and canyon oak assemblages provide critical habitat for wintering deer herds. Animals with strong habitat associations for acorns are also found in these habitats. Ownership of this section is primarily private and urbanization has occurred in the transitional region between foothill and valley. Urban area growth has allowed development to encroach upon riparian habitats in the foothill section. This encroachment has impacted wildlife communities that rely on riparian components to meet their life history needs. Amphibians are most affected by this development (Jennings 1996). A hunting operation, the Musty Buck Preserve, operates on a large portion of the foothill section. The Musty Buck Gun Club is primarily managed for spring/summer cattle grazing and for black-tailed deer hunting. The club, which is comprised of many property owners, has been enlisted in the CDFG private lands wildlife management program for 12 years

VALLEY HABITATS

Valley habitats are those found on the valley floor. Primary land uses are cattle grazing, farming and residential development. Fresh emergent wetland, annual grassland, valley oak woodland, valley foothill riparian, riverine, cropland, and urban areas are typical of the valley section. The valley section of the watershed has received the most agricultural and urban encroachment relative to the other sections. The conversion of annual grasslands, riparian areas, and wetlands by urban development and agriculture has greatly impacted wildlife assemblages on the valley floor. It is estimated that only 10% of historical riparian forest and less than 10% of wetlands remain in the Sacramento Valley (Katibah 1984). There are limited opportunities to enhance wildlife habitats in urban landscapes. However, agricultural crops such as rice, wheat, milo, and safflower provide habitat for wildlife and many opportunities exist for incorporating wildlife habitat into farming operations. Flooded agricultural fields provide critically important habitat to migrating waterfowl and shorebirds.

— WILDLIFE —

Three hundred and fifty wildlife species are known or expected to occur in the watershed (please see Appendix B). Nine percent (33) of the wildlife that are known or expected to occur within the watershed are special status species. Special Status Species are those defined by the following categories:

- Species listed or proposed for listing as threatened or endangered under the federal Endangered Species Act (50 CFR 17.11, and various notices in the Federal Register [proposed species]).

- Species that are candidates for possible future listing as threatened or endangered under the federal Endangered Species Act (61 FR 40: 7596-7613, February 28, 1996).

- Species listed or proposed for listing by the State of California as threatened or endangered under the California Endangered Species Act (14 CCR 670.5).

- Animal species of special concern to the California Department of Fish and Game.

- Animals fully protected in California (Cal. Fish and Game Code, Section 3511 [birds], 4700 [mammals], and 5050 [reptiles and amphibians]).

ECOLOGICALLY IMPORTANT WILDLIFE

Ecologically important wildlife are specific species or groups of species that serve as indicators of the health of wildlife populations and wildlife habitat within the watershed.

Black-Tailed Deer

Black-tailed deer, visually, represent the most important wildlife within the watershed. Consequently, their value as representatives of the watershed's wildlife resources and habitat are high. In addition, deer are an integral component of the food web as grazers and as a prey item for mountain lion, black bear, and coyote.

Black-tailed deer are dependent on early successional habitats and seasonally available items such as acorns for food resources (Loft et al. 1998, Leach and Hiehle 1957). The quality of deer habitat is influenced by the availability of cover and its proximity to food. Chaparral and riparian areas provide hiding, escape, and thermal cover, which is of critical importance to deer especially in dry hot periods. Blue oak woodlands provide primary feeding sites. Riparian habitats also serve as fawning areas and dense vegetation provides hiding cover for vulnerable fawns.

The majority of black-tailed deer that utilize watershed are from the Eastern Tehama deer herd and the remaining deer are resident. The herd is the largest migratory herd in California and occupies the most extensive range (Longhurst et al. 1952, Ramsey 1981).

They migrate the longest distance of any herd in the state, over 100 miles. The herd uses BCCW as a critically important migration and wintering area (October-March). The importance of documented migration corridors within the watershed cannot be overstated. These corridors are the key to successful migrations, and hence are the backbone to the survival of the Tehama deer herd.

The black-tail deer population in the watershed has declined steadily since the mid-1960's and dramatic declines have been recorded since 1991 (Loft et al. 1998). Longhurst et al. (1952) estimated the Tehama deer herd population to be 69,000, currently CDFG estimates the population to be 35,000-45,000. The decline in deer population reflects conditions of their habitat. Factors that have contributed to the reduction of quality deer habitat include urban encroachment, fire suppression policies, intense cattle grazing, feral dogs, and logging practices such as biomass thinning and herbicide spraying. Former CDFG biologist Jim Snowden and Musty Buck manager Noel Owens believe that feral dogs may contribute to lower deer numbers locally more than any other cause.

Black Bear, a representative of the watershed's wildlife.

<u>Amphibians</u>

No other group of organisms within the Sierra/Cascade foothills are more at risk than amphibians (Jennings 1996). In a 1996 report to congress regarding the Sierra Nevada Ecosystem Project, the watershed was categorized as a watershed with especially high values for foothill yellow-legged frog conservation (Jennings 1996). The foothill yellow-legged frog is listed by the CDFG as a Species of Special Concern. They are found mainly in permanent streams and occasionally in backwater habitats, isolated pools, and slow moving rivers. Historically, this frog occurred in most Pacific drainage's west of the Sierra/Cascade Crest in Oregon but over the years it has disappeared from more than 50% of it's historic range (Jennings 1996). Foothill yellow-legged frogs have been observed within the Big Chico Creek and Mud Creek (personal observation). Historically, California red-legged frogs occurred within the watershed. The frogs require deep (>70cm) cool pools and were found in ponds and intermittent and permanent streams with slow or still water. California red-legged frogs have disappeared from 90 percent of their historic range (Jennings et al. 1993) and may have been eradicated from the watershed. Habitat for the California red-legged frog occurs in the watershed but no thorough surveys have been conducted. Amphibian surveys conducted in 1997, in adjacent watersheds, found no evidence of mountain yellow-legged frogs or California red-legged frogs (Fellers 1997). The western spadefoot toad and Cascades frog both inhabit the watershed and are both Species of Special Concern (Maslin personal communication, and McFarland personal communication). These species have also experienced dramatic declines in their respective ranges.

Raptors
Many raptors utilize the watershed for wintering, migration, and breeding. Due to the remoteness and relatively little urban development in the mountain and canyon section of the watershed raptors have excellent opportunities to develop sustainable and healthy populations. American peregrine falcons, bald eagles, golden eagles, and California spotted owls have all been observed using the watershed primarily as winter grounds (Snowden personal observation). Breeding habitat for all four raptors exists within the watershed. The American peregrine falcon is currently listed as Endangered by CDFG and federally as Endangered (it is also proposed federally for delisting). The golden eagle is currently listed as a Species of Special Concern by CDFG. Bald eagles winter along Mud and Rock creeks foraging for stranded prey following flood events or natural draw-downs. Sharp-shinned hawks and Coopers hawks use the watershed as both breeding and wintering grounds (personal observation). Sharp-shinned and Coopers hawks are currently listed by CDFG as Species of Special Concern. Burrowing owls have been observed in the valley section near the Sacramento River (personal observation). Burrowing owls are Species of Special Concern with special status primarily associated with burrowing sites.

SPECIAL STATUS WILDLIFE SPECIES

STATE AND/OR FEDERAL ENDANGERED WILDLIFE SPECIES
Conservancy Fairy Shrimp (*Branchinecta conservatio*). The conservancy fairy shrimp is listed as a federally endangered species. Vernal pool habitat was once much more extensive throughout California's Central Valley, probably allowing a much broader distribution of the species. Vernal pools, temporary ponds formed by seasonal rainfall upon small watersheds, provide the sole habitat for the fairy shrimp. A water impermeable layer just below the surface of the ground assures the collection of water during the winter, while the drying effects of spring cause a complete drawdown of the pool by evapotranspiration. The fairy shrimp survives the hot, dry summer by depositing drought resistant "resting eggs" or cysts in the pond soil. The crustaceans represent a food resource for water birds, and birds may possibly disperse the shrimp's cysts on their bodies over their migratory route; the cysts may also be transported within the avian digestive tract. Population densities within individual ephemeral pools may be quite high. Habitat loss is the primary factor for the decline of this species.

Vernal Pool Tadpole Shrimp (*Lepidurus packardi*). The vernal pool tadpole shrimp is a federally endangered species. This shrimp exclusively inhabits vernal ponds in Northern California, and is present 4 out of 5 months that the ponds are flooded. They are often found in shallow depressions in open, treeless rangeland that is frequented by livestock and migrating waterfowl. The margins of ponds may vary from cobbly hardpan to soft clay mud, with some areas receiving strong wave actions from prevailing winds. Tadpole shrimp are often present in the greatest abundance along wave-disturbed shores.

American Peregrine Falcon (*Falco peregrinus anatum*). The American Peregrine Falcon is a Federal and State endangered species. Peregrine falcons are infrequently found from annual grassland up through high elevation coniferous forest of the Coast Range. They typically require cliffs for nesting and perching, and prefer nearby lakes or rivers. During the 1960s and early 1970s populations of Peregrine falcons drastically declined but indications from studies in Baja to Canada suggest that the local populations are recovering (Castellanos, et al., 1997). The high natural productivity and large releases of captive-raised young should continue the recovery of the Peregrine falcon.

Western Yellow-Billed Cuckoo (*Coccyzus americanus occidentalis*) The western yellow-billed cuckoo is a USFS Sensitive species and a state endangered species. Riparian forests host this endangered species. They are restricted to broad expanses of cottonwood-willow forest. The wide removal of this essential habitat has caused the decline of this sinuous bird (Gaines and Layman, 1984). Western yellow-billed cuckoos have been recorded nesting within riparian habitats at the confluence of Big Chico Creek and the Sacramento River (NDDB).

STATE AND/OR FEDERAL THREATENED WILDLIFE SPECIES

Valley Elderberry Longhorn Beetle (VELB) (*Desmoecerus californicus dimorpus*). The Valley elderberry longhorn beetle is a federally threatened species. VELB are habitat specific and will inhabit only mature elderberry shrubs. Elderberry shrubs are sporadically located in riparian habitats in the Valley and Butte Basin. The beetle has been observed ranging in elevation from the valley floor to 2,940 feet (Barr 1991). VELB has been recorded in elderberry shrubs along Big Chico Creek, and within Bidwell Park (Barr 1991). Habitat loss is the primary factor for the population decline of this species.

Vernal Pool Fairy Shrimp (*Branchinecta lynchi*). The vernal pool fairy shrimp is a federally threatened species. In California, these crustaceans inhabit ephemeral wetlands, such as vernal pools, mountain meadows, and desert playas with wet/dry cycles. The shrimp hatch and mature during the aquatic phase and deposit dormant cysts that remain in the soil through the dry phase. In some habitats, due to the variable nature of local rainfall patterns, pools at times fill only partially and dry quickly before the shrimp are able to mature and reproduce. Species in such unpredictable environments produce cysts that do not all hatch when first hydrated; a portion remains dormant and hatch in later pool fillings.

California Red-Legged Frog (*Rana aurora draytonii*). The California red-legged frog is the largest native frog in California and inhabits still or slow moving water in intermittent and permanent streams, ponds, and marshes (Hayes and Jennings 1988). It is listed as a federal threatened species and as a Species of Special Concern by CDFG. It has also been proposed for listing as endangered. Historically, range extended from Shasta County south to northern Baja California, occurring mainly in the foothill regions. It was extirpated from the floor of the Central Valley by 1960. The California red-legged frog has disappeared from more than 90 percent of its historical range. It is extremely rare in the Cascade/Sierra foothills and the only large populations (>350 adults) exist within the Coast Ranges near San Francisco (Jennings et al. 1993). The primary threats to California red-legged frogs include habitat loss, water diversion projects, introduced non-native predator fishes and bullfrogs, and livestock grazing. Jennings et al. (1993) reports that the introduction of non-native predators is probably responsible for the decline of California red-legged frogs from most of their historical range.

Giant Garter Snake (*Thamnophis counchi gigas*). The giant garter snake is a federal and state threatened species. They are found on the valley floor and inhabit densely vegetated streambanks, marshes, and riparian sloughs. The giant garter snake is now considered rare.

<u>Aleutian Canada Goose</u> (*Branta canadensis leucopareia*). The Aleutian Canada goose is a federal threatened species. The entire population winters in the Sacramento Valley with a substantial number of those wintering in the Butte Basin. Aleutian Canada geese may use flooded rice fields within the valley section of the watershed.

<u>Greater Sandhill Crane</u> (*Grus canaensis tabida*). The greater sandhill crane is a state-threatened species. This crane migrates to California wintering areas in October and November. Large winter roosting colonies are present on federal and state wildlife areas in the valley. The cranes use flooded rice fields as foraging, courting, and loafing areas.

<u>Bald Eagle</u> (*Haliaeetus leucocephalus*) The bald eagle is a state and federally threatened species. Historically, bald eagles nested along the Sacramento River. Currently, bald eagles winter on the river and within the watershed valley section.

<u>Swainson's Hawk</u> (*Buteo swainsoni*). The Swainson's Hawk is a state-threatened species. Historically, Swainson's hawks were common throughout the valley section. The Swainson's hawk utilized riparian forests for nesting sites, preferring to nest in the crown of tall oaks and foraging in nearby grassland and agricultural lands. Swainson's Hawk nest sites have been observed sporadically along the Sacramento River. Although the principle causes for the decline of Swainson's hawks occur on their wintering habitat, ongoing enhancement of riparian habitats in the watershed could benefit the Swainson's hawk.

— CURRENT THREATS TO WILDLIFE AND THEIR HABITAT —

NEST PARASITISM

Brown-headed cowbirds arrived in the valley after 1900, and the spread of agriculture has allowed cowbirds to penetrate into new regions where they have access to host populations that have had little or no ancestral experience through which to evolve effective defenses against them (Gaines and Layman, 1984). Cowbirds employ obligate parasitism (i.e. they only lay their eggs in the nests of other birds) as a reproductive strategy. Since cowbirds reproduce ferociously, not having to feed their young, a single female can lay as many as 50 eggs in a breeding season. Cowbird parasitism may be a factor in the decline of willow flycatcher, Bell's vireo, warbling vireo, spotted towhee, yellow warbler, blue grosbeak, Lazuli bunting, lesser goldfinch, and common yellowthroat in the watershed. Management efforts such as riparian restoration, cover cropping in agricultural habitats, and revegetation projects may reduce parasitism.

HABITAT LOSS

As mentioned, less than 10% of historical riparian forest remains and less than 5% of historical freshwater habitat remains. The loss of habitat and habitat fragmentation are the primary factors for the decline in resident and breeding birds, amphibians, reptiles, and mammals. Water diversion and flood control projects have contributed to the decline of amphibians throughout the watershed (Jennings 1996). Continued habitat loss would result in many species being extirpated from the Sacramento Valley. Mallards and wood ducks have adapted to the loss of riparian habitat by switching to waste grains for food reserves. However, many birds do not have this option. For birds that are obligate riparian nesters, further reduction in habitat could be devastating for these species.

INTRODUCED NON-NATIVE PREDATORS

Introduced predators such as the fish, bullfrog, feral cat, and feral dog pose threats to wildlife populations. Brown trout, brook trout, and hatchery rainbow trout have been introduced into the upper watershed. Jennings (1996) reports that the introduction of non-native predators is probably responsible for the decline of California red-legged frogs, western spadefoot frogs, and foothill yellow-legged frogs from most of their historical range.

Feral dogs have been a major problem for wildlife for many years and have gone largely unnoticed by the public. Noel Owens observed over 30 feral dogs within or near the Simmons Ranch between 1997-1998, and retired CDFG biologist Jim Snowden attributes dogs as the main cause for deer disturbances. Feral dogs prey on deer, small mammals, and nesting birds. Jim Snowden, retired CDFG biologist, attributes dogs as the main cause for deer disturbances in the winter range of the Tehama deer herd.

EARLY FIRE SUPPRESSION

Fire is essential to the health of foothill vegetation communities. The canyon and foothill sections of the watershed have not experienced a substantial fire for more than 30 years (portions of the upper Rock Creek drainage have experienced several large fires within the last 12 years). The lack of fire is most obvious within the chaparral habitats. Thick extensive stands of poison oak, buck brush, California buckeye, California bay, and manzanita with large basal areas are found throughout the canyon and foothill section. Buck brush is an important food item for deer but deer only use newly developed shoots, which are most abundant on younger plants. As buck brush matures, available browse grows beyond the reach of deer, which reduces the value of buckbrush to feeding (Biswell and Gilman 1961). In addition, many chaparral plants within the mixed chaparral communities have evolved adaptations, which allow them to survive, reproduce, and thrive in a system that frequently burns. Historically, blue oak/pine woodlands burned at 2 to 18 year intervals with an average fire frequency of 7.8 years (Stephens 1997).

CATTLE GRAZING

Cattle grazing is often blamed for reducing habitat quality for most wildlife, especially those dependent on riparian areas. However, it is the intensity of grazing which has the most impact. Intense grazing, which occurred for approximately 30 years within portions of the canyon section, is the most destructive of all grazing. In a study conducted by Kie and Boroski 1995, they found the effect of cattle grazing to be minimal on black-tailed deer home range and time spent feeding. This may be a result of different food preferences between cattle and deer (Barrett 1982). Cattle grazing can be beneficial as a habitat management tool. Substantial literature has been written regarding the effects of cattle grazing on riparian areas and bird communities. Generally, the results of grazing are species and site specific.

Data Gaps

Information regarding the status of nocturnal animals, mainly owls and bats, is lacking. The occurrence of the majority of these animals within the watershed currently can only be estimated based on habitat parameters. Current information regarding the status of Swainson's hawks and yellow-billed cuckoo breeding within riparian areas at or near the confluence of Big Chico Creek and the Sacramento River is also lacking. In addition, anecdotal information exists that there may be American peregrine falcons nesting within the Rock Creek tributary. Due to the special status of this bird, a thorough survey should be conducted throughout the watershed to verify any nesting activity.

Habitat for several special status amphibians and the northwestern pond turtle occur within the watershed, but their existence, distribution and reproductive status in the watershed is unknown, especially within the canyon and mountain sections. Amphibian surveys in Rock, Mud, and Big Chico Creek should be conducted to verify special status amphibians. It would be highly desirable to identify populations of special status species so they can be managed and protected appropriately.

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APPENDIX A

ENDANGERED, THREATENED AND CANDIDATE SPECIES

— ENDANGERED AND THREATENED SPECIES — AND CANDIDATE SPECIES THAT MAY OCCUR IN OR BE AFFECTED BY PROJECTS IN THE AREA OF BIG CHICO CREEK WATERSHED

(Quads: Onion Butte, Butte Meadows, Devils Parade Ground, Cohasset, Campbell Mound, Richardson Springs, Nord, Ord Ferry, Paradise West, Paradise East)

May 13, 1999

LISTED SPECIES

Birds
Aleutian Canada goose, *Branta canadensis leucopareia*(T)
American peregrine falcon, *Falco peregrinus anatum*(E)
bald eagle, *Haliaeetus leucocephalus*(T)

Reptiles
giant garter snake, *Thamnophis gigas*(T)

Amphibians
California red-legged frog, *Rana aurora draytonii*(T)

Fish
Central Valley steelhead, *Oncorhynchus mykiss*(T)
Sacramento splittail, *Pogonichthys macrolepidotus*(T)
delta smelt, *Hypomesus transpacificus*(T)
spring-run chinook salmon, *Oncorhynchus tshawytscha(PE)*
winter-run chinook salmon, *Oncorhynchus tshawytscha*(E)
winter-run chinook salmon critical habitat, *Oncorhynchus tshawytscha*(E)

Invertebrates
Conservancy fairy shrimp, *Branchinecta conservatio*(E)
valley elderberry longhorn beetle, *Desmocerus californicus dimorphus*(T)
vernal pool fairy shrimp, *Branchinecta lynchi*(T)
vernal pool tadpole shrimp, *Lepidurus packardi*(E)

Plants
Butte County (Shippee) meadowfoam, *Limnanthes floccosa ssp. californica*(E)
Greene's tuctoria, *Tuctoria greenei*(E)
Hoover's spurge, *Chamaesyce hooveri*(T)
hairy Orcutt grass, *Orcuttia pilosa*(E)
slender Orcutt grass, *Orcuttia tenuis*(T)

PROPOSED SPECIES

Fish
Central Valley fall/late fall-run chinook salmon, *Oncorhynchus tshawytscha*(PT)

SPECIES OF CONCERN

Mammals

Marysville Heermann's kangaroo rat, *Dipodomys californicus eximius*(SC)
Pacific fisher, *Martes pennanti pacifica*(SC)
Pacific western big-eared bat, *Corynorhinus (=Plecotus) townsendii townsendii*(SC)
San Joaquin pocket mouse, *Perognathus inornatus*(SC)
Sierra Nevada snowshoe hare, *Lepus americanus tahoensis*(SC)
Yuma myotis bat, *Myotis yumanensis*(SC)
fringed myotis bat, *Myotis thysanodes*(SC)
greater western mastiff-bat, *Eumops perotis californicus*(SC)
long-eared myotis bat, *Myotis evotis*(SC)
long-legged myotis bat, *Myotis volans*(SC)
pale Townsend's big-eared bat, *Corynorhinus (=Plecotus) townsendii pallescens*(SC)
small-footed myotis bat, *Myotis ciliolabrum*(SC)
spotted bat, *Euderma maculatum*(SC)

Birds

California spotted owl, *Strix occidentalis occidentalis*(SC)
ferruginous hawk, *Buteo regalis*(SC)
tricolored blackbird, *Agelaius tricolor*(SC)
western burrowing owl, *Athene cunicularia hypugea*(SC)
white-faced ibis, *Plegadis chihi*(SC)

Reptiles

California horned lizard, *Phrynosoma coronatum frontale*(SC)
northwestern pond turtle, *Clemmys marmorata marmorata*(SC)

Amphibians

Cascades frog, *Rana cascadae*(SC)
foothill yellow-legged frog, *Rana boylii*(SC)
mountain yellow-legged frog, *Rana muscosa*(SC)
western spadefoot toad, *Scaphiopus hammondii*(SC)

Fish

longfin smelt, *Spirinchus thaleichthys*(SC)
river lamprey, *Lampetra ayresi*(SC)

Invertebrates

Antioch Dunes anthicid beetle, *Anthicus antiochensis*(SC)
California linderiella, *Linderiella occidentalis*(SC)
Sacramento anthicid beetle, *Anthicus sacramento*(SC)

Plants

Ahart's whitlow-wort, *Paronychia ahartii*(SC)
Butte County (western) catchfly, *Silene occidentalis ssp. longistipitata*(SC)
Butte County morning-glory, *Calystegia atriplicifolia ssp. buttensis*(SC)
Butte County sidalcea, *Sidalcea robusta*(SC)

Butte fritillary, *Fritillaria eastwoodiae*(SC)
California beaked-rush, *Rhynchospora californica*(SC)
Ferris's milk-vetch, *Astragalus tener var. ferrisiae*(SC)
Jepson's onion, *Allium jepsonii*(SC)
Tracy's sanicle, *Sanicula tracyi*(SC)
adobe lily, *Fritillaria pluriflora*(SC)
adobe lily, *Fritillaria pluriflora*(SC)
valley sagittaria, *Sagittaria sanfordii*(SC)
veiny monardella, *Monardella douglasii ssp. venosa*(SC)

— KEY —

(E)	*Endangered*	Listed (in the Federal Register) as being in danger of extinction.
(T)	*Threatened*	Listed as likely to become endangered within the foreseeable future.
(P)	*Proposed*	Officially proposed (in the Federal Register) for listing as endangered or threatened.
(C)	*Candidate*	Candidate to become a *proposed* species.
(SC)	*Species of Concern*	May be endangered or threatened. Not enough biological information has been gathered to support listing at this time.
Critical Habitat		Area essential to the conservation of a species.

APPENDIX B

BIG CHICO CREEK WILDLIFE

Wildlife known (k) or expected (e) to occur within the Big Chico Creek Watershed, California.

Common Name	Scientific Name[b]	(k) (e)	Area code[c]	Primary Habitat Association				Special Status[d]			
				Mountain	Canyon	Foothill	Valley	USFS	Federal	State	Harvest
black salamander	*Aneides flavipunctatus*	e	r		X						
long-toed salamander	*Ambystoma macrodactylum*	e	r	X	X						
California slender salamander	*Batrachoseps attenuatus*	e	r		X						
ensatina	*Ensatina eschscholtzii*	k	c	X	X						
California newt	*Taricha torosa*	k	C	X	X						
rough skinned newt	*Taricha granulosa*	e	c	X	X						
western spadefoot	*Scaphiopus hammondi*	k	r			X			FSC	CSC	
western toad	*Bufo boreas*	k	c	X	X	X	X				
bullfrog	*Rana catesbeiana*	k	c			X	X				x
pacific treefrog	*Hyla regilla*	k	c	X	X	X	X				
mountain yellow-legged frog	*Rana muscosa*	e	r	X					FSC	CSC	
foothill yellow-legged frog	*Rana boylei*	e	r	X	X	X			FSC	CSC	
California red-legged frog	*Rana aurora draytonii*	e	r		X	X			Threat.	CSC	
Cascades frog	*Rana cascadae*	k	c	X					FSC	CSC	
western pond turtle	*Clemmys marmorata*	k	c			X	X		FSC	CSC	
western fence lizard	*Sceloporus occidentalis*	k	c	X	X	X	X				
western skink	*Eumeces skiltonianus*	k	r	X	X	X	X		Cand.		
California whiptail	*Cnemidophorus tigris*	k	r		X	X			Cand.		
northern alligator lizard	*Gerrhonotus coeruleus*	k	c	X	X						
pacific rubber boa	*Charina bottae*	k	c	X	X			SENSITIVE			
ringneck snake	*Diadophis punctatus*	k	R		X						
chaparral whipsnake	*Masticophis lateralis*	e	R		X	X			Cand.		
yellow-bellied racer	*Coluber constrictor*	k	C	X	X	X	X				
gopher snake	*Pituophis melanoleucus*	k	C	X	X	X	X				
common kingsnake	*Lampropeltis getulus*	k	C	X	X	X	X				
garter snake	*Thamnophis sirtalis*	k	C	X	X	X	X				
aquatic garter snake	*Thamnophis couchi*	k	C	X	X	X	X				
giant garter snake	*Thamnophis gigas*	e	r			X	X		Threat.	Threat.	
night snake	*Hypsiglena torquata*	k	r		X	X					
western rattle snake	*Crotalus viridis*	k	c	X	X	X	X				

Common Name	Scientific Name[b]	(k) (e)	Area code[c]	Primary Habitat Association				Special Status[d]			
				Mountain	Canyon	Foothill	Valley	USFS	Federal	State	Harvest
Bald eagle	*Haliaeetus leucocephalus*	k	w			x	x		Threat.	End.	
golden eagle	*Aquila chrysaetos*	k	w,m		x	x			Prot.	CSC	
red-shouldered hawk	*Buteo lineatus*	k	c	x	x	x	x				
red-tailed hawk	*Buteo jamaicensis*	k	c				x		Prot.	Prot.	
Swainson's hawk	*Buteo swainsoni*	k	r,b,m			x	x			Threat.	
Ferruginous hawk	*Buteo regalis*	k	w			x	x		FSC	CSC	
coopers hawk	*Accipiter cooperii*	k	c	x	x	x	x		Prot.	CSC	
sharp-shinned hawk	*Accipiter striatus*	k	c	x	x	x	x		Prot.	CSC	
northern goshawk	*Accipiter gentilis*	e	r	x				Sensitive	FSC	CSC	
northern harrier	*Circus cyaneus*	k	c			x	x			CSC	
American peregrine falcon	*Falco peregrinus anatum*	k	r		x	x	x		FPD End.	End.	
American kestrel	*Falco sparverius*	k	c		x	x	x				
merlin	*Falco columbarius*	k	w,m		x	x				CSC	
prairie falcon	*Falco mexicanus*	k	m		x	x				CSC	
ring-necked pheasant	*Phasianus colchicus*	k	c			x	x				x
morning dove	*Zenaida macroura*	k	c	x	x	x	x				x
band-tailed pigeon	*Columba fasciata*	k	c	x	x						x
California quail	*Callipepla californica*	k	c	x	x	x	x				x
mountain quail	*Oreortyx pictus*	k	c	x							
wild turkey	*Meleagris gallopava*	k	c	x	x	x					x
western screech owl	*Otus kennicottii*	k	c		x	x	x				
California spotted owl	*Strix occidentalis*	e	c	x	x			Sensitive	FSC	CSC	
barn owl	*Tyto alba*	k	c			x	x				
long-eared owl	*Asio otus*	e	r	x	x	x				CSC	
great horned owl	*Bubo virginianus*	k	c	x	x	x	x		Prot.		
northern pygmy-owl	*Glaucidium gnoma*	e	r	x	x						
northern saw-whet owl	*Aegolius acadicus*	e	r	x	x		x		Prot.		
flammulated owl	*Otus flammeolus*	e	r	x							
burrowing owl	*Athene cunicularia hypugea*	k	r				x		FSC	CSC	
yellow-billed cuckoo	*Coccyzus americanus*	e	r			x	x			End.	
common poor-will	*Phalaenoptilus nuttallii*	e	c	x							
Common nighthawk	*Chordeiles minor*	k	c	x							
black-chinned hummingbird	*Archilochus alexandri*	e	r,m				x				
Anna's hummingbird	*Calypte anna*	k	c	x	x	x	x				

Common Name	Scientific Name[b]	(k) (e)	Area Code[c]	Primary Habitat Association				Special Status[d]			
				Mountain	Canyon	Foothill	Valley	USFS	Federal	State	Harvest
Calliope hummingbird	*Stellula calliope*	k	b	X	X						
Rufous hummingbird	*Selasphorus rufus*	k	B,m	X	X						
belted kingfisher	*Ceryle alcyon*	k	c		X	X	X				
acorn woodpecker	*Melanerpes formicivorus*	k	c		X	X	X				
Lewis's woodpecker	*Melanerpes lewis*	k	r		X	X					
northern flicker	*Colaptes auratus*	k	c		X	X	X				
hairy woodpecker	*Picoides villosus*	k	r	X	X	X	X				
downy woodpecker	*Picoides pubescens*	k	c		X	X	X				
pileated woodpecker	*Dryocopus pileatus*	k	r		X						
red-breasted sapsucker	*Sphyrapicus ruber*	k	w	X	X						
Nuttall's woodpecker	*Picoides nuttallii*	k	c			X	X				
white-headed woodpecker	*Picoides albolarvatus*	k	c	X							
ash-throated flycatcher	*Myiarchus cinerascens*	k	b		X	X	X				
black phoebe	*Sayornis nigricans*	k	c		X	X	X				
olive-sided flycatcher	*Contopus borealis*	k	b		X	X	X				
dusky flycatcher	*Empidonax oberholseri*	e	b	X							
western wood pewee	*Contopus sordidulus*	e	b	X							
pacific slope flycatcher	*Empidonax difficilis*	k	b		X		X				
western kingbird	*Tyrannus verticalis*	k	b			X	X				
American pipit	*Anthus rubescens*	k	w			X	X				
loggerhead shrike	*Lanius ludovicianus*	k	b			X	X		FSC	CSC	
Huttons vireo	*Vireo huttoni*	k	b		X	X	X				
solitary vireo	*Vireo solitarius*	k	b		X	X					
warbling vireo	*Vireo gilvus*	k	b	X	X						
white-throated swift	*Aeronautes saxatalis*	k	b		X	X					
tree swallow	*Tachycineta bicolor*	k	b	X	X	X	X				
violet-green swallow	*Tachycineta thalassina*	k	b	X	X	X	X				
northern rough-winged swallow	*Stelgidopteryx serripennis*	k	b		X	X	X				
cliff swallow	*Hirundo pyrrhonota*	k	b			X	X				
barn swallow	*Hirundo rustica*	k	b	X	X	X	X				
Steller's jay	*Cyanocitta stelleri*	k	c	X							
scrub jay	*Aphelocoma coerulescens*	k	c		X	X	X				
Yellow-billed magpie	*Pica nuttalli*	k	c			X	X				
American crow	*Corvus brachyrhynchos*	k	c			X	X				
common raven	*Corvus corax*	k	c	X	X						

Common Name	Scientific Name[b]	(k) (e)	Area code[c]	Primary Habitat Association				Special Status[d]			
				Mountain	Canyon	Foothill	Valley	USFS	Federal	State	Harvest
mountain chickadee	*Parus gambeli*	k	c	X							
American dipper	*Cinclus mexicanus*	k	c	X	X						
western bluebird	*Sialia mexicana*	k	c		X	X	X				
American robin	*Turdus migratorius*	k	c	x	X	X	X				
Townsend's solitaire	*Myadestes townsendi*	e	m								
Swainson's thrush	*Catharus ustulatus*	e	b,m	x							
hermit thrush	*Catharus guttatus*	k	c	x	X	X	X				
european starling	*Sturnus vulgaris*	k	c		X	X	X				
American pipit	*Anthus rubescens*	k	w			X	X				
northern mockingbird	*Mimus polyglottos*	k	b			X	X				
California thrasher	*Toxostoma redivivum*	e	r		X						
brown creeper	*Certhia americana*	k	c	x	X						
white-breasted nuthatch	*Sitta carolinensis*	k	c	x	X	X					
red-breasted nuthatch	*Sitta canadensis*	k	c	x	X						
Pygmy nuthatch	*Sitta pygmaea*	k	c	x	X						
house wren	*Troglodytes aedon*	k	b	x	X	X	X				
Canyon wren	*Catherpes mexicanus*	k	c		X	X					
rock wren	*Salpinctes obsoletus*	k	b		X						
marsh wren	*Cistothorus palustris*	k	b				X				
Bewick's wren	*Thryomanes bewickii*		b			X	X				
ruby-crowned kinglet	*Regulus calendula*	k	c		X	X	X				
golden-crowned kinglet	*Regulus satrapa*	k	c	x	X						
wrentit	*Chamaea fasciata*	k	r		X						
bushtit	*Psaltriparus minimus*	k	c		X	X	X				
titmouse	*Parus inornatus*	k	c		X	X	X				
orange-crowned warbler	*Vermivora celata*	k	c								
Wilson's warbler	*Wilsonia pusilla*	k	b	x							
common yellowthroat	*Geothlypis trichas*	k	b			X	X				
Townsend's warbler	*Dendroica townsendi*	e	m	x							
hermit warbler	*Dendroica occidentalis*	k	b	x	X						
yellow warbler	*Dendroica petechia*	e	b,m	x						CSC(n)	
yellow breasted chat	*Icteria virens*	k	b		X	X				CSC(n)	
Nashville warbler	*Vermivora ruficapilla*	k	m								
yellow-rumped warbler	*Dendroica coronata*	k	w,b	x	X	X	X				
Macgillivray's warbler	*Oporornis tolmiei*	k	m,b	x	X						

Common Name	Scientific Name[b]	(k) (e)	Area code[c]	Primary Habitat Association				Special Status[d]			
				Mountain	Canyon	Foothill	Valley	USFS	Federal	State	Harvest
mountain chickadee	*Parus gambeli*	k	c	X							
American dipper	*Cinclus mexicanus*	k	c	X	X						
western bluebird	*Sialia mexicana*	k	c		X	X	X				
American robin	*Turdus migratorius*	k	c	x	X	X	X				
Townsend's solitaire	*Myadestes townsendi*	e	m								
Swainson's thrush	*Catharus ustulatus*	e	b,m	x							
hermit thrush	*Catharus guttatus*	k	c	x	X	X	X				
european starling	*Sturnus vulgaris*	k	c		X	X	X				
American pipit	*Anthus rubescens*	k	w			X	X				
northern mockingbird	*Mimus polyglottos*	k	b			X	X				
California thrasher	*Toxostoma redivivum*	e	r		X						
brown creeper	*Certhia americana*	k	c	x	X						
white-breasted nuthatch	*Sitta carolinensis*	k	c	x	X	X					
red-breasted nuthatch	*Sitta canadensis*	k	c	x	X						
Pygmy nuthatch	*Sitta pygmaea*	k	c	x	X						
house wren	*Troglodytes aedon*	k	b	x	X	X	X				
Canyon wren	*Cantherpes mexicanus*	k	c		X	X					
rock wren	*Salpinctes obsoletus*	k	b		X						
marsh wren	*Cistothorus palustris*	k	b				X				
Bewick's wren	*Thryomanes bewickii*		b			X	X				
ruby-crowned kinglet	*Regulus calendula*	k	c		X	X	X				
golden-crowned kinglet	*Regulus satrapa*	k	c	x	X						
wrentit	*Chamaea fasciata*	k	r		X						
bushtit	*Psaltriparus minimus*	k	c		X	X	X				
titmouse	*Parus inornatus*	k	c		X	X	X				
orange-crowned warbler	*Vermivora celata*	k	c								
Wilson's warbler	*Wilsonia pusilla*	k	b	x							
common yellowthroat	*Geothlypis trichas*	k	b			X	X				
Townsend's warbler	*Dendroica townsendi*	e	m	x							
hermit warbler	*Dendroica occidentalis*	k	b	x	X						
yellow warbler	*Dendroica petechia*	e	b,m	x						CSC(n)	
yellow breasted chat	*Icteria virens*	k	b		X	X				CSC(n)	
Nashville warbler	*Vermivora ruficapilla*	k	m								
yellow-rumped warbler	*Dendroica coronata*	k	w,b	x	X	X	X				
Macgillivray's warbler	*Oporornis tolmiei*	k	m,b	x	X						

				Primary Habitat Association					Special Status[d]		
Common Name	Scientific Name[b]	(k) (e)	Area code[c]	Mountain	Canyon	Foothill	Valley	USFS	Federal	State	Harvest
black-throated gray warbler	*Dendroica nigrescens*	e	m,b	x							
western tanager	*Piranga ludoviciana*	k	b	x	X						
blue grosbeak	*Guiraca caerulea*	k	r			X	X				
Black-headed grosbeak	*Pheucticus melanocephalus*	k	b	x	X	X	X				
lazuli bunting	*Passerina amoena*	k	R		X	X	X				
Green-tailed towhee	*Pipilo chlorurus*	k	W		X	X					
spotted towhee	*Pipilo maculatus*	k	C		X	X	X				
California towhee	*Pipilo fuscus*	k	C		X	X	X				
golden-crowned sparrow	*Zonotrichia querula*	k	W		X		X				
white-crowned sparrow	*Zonotrichia leucophrys*	k	W		X	X	X				
chipping sparrow	*Spizella passerina*	k	B	X							
song sparrow	*Melospiza melodia*	k	B	X	X						
fox sparrow	*Passerella iliaca*	k	W,b	X	X	X	X				
Lincoln's sparrow	*Melospiza lincolnii*	k	r,b,w			X	X				
savannah sparrow	*Passerculus sandwichensis*	k				X					
dark-eyed junco	*Junco hyemalis*	k	W,b	X	X	X	X				
western meadowlark	*Sturnella neglecta*	k	C		X	X					
Lawerence's goldfinch	*Carduelis lawrencei*	e	M		X						
lesser goldfinch	*Carduelis psaltria*	k	C		X	X					
American goldfinch	*Carduelis psaltria*	k	W		X	X					
pine siskin	*Caruelis pinus*	e	M			X					
house finch	*Carpodacus mexicanus*	k	B		X	X	X				
Cassin's finch	*Carpodacus cassinii*	e	M	X	X						
Bullock's oriole	*Icterus bullockii*	k	B		X	X	X				
Brewer's blackbird	*Euphagus cyanocephalus*	k	B		X	X	X				
red-winged blackbird	*Agelaius phoeniceus*	k	B	X	X	X	X				
tricolored blackbird	*Agelaius tricolor*	k	w,m			X	X		FSC(n)	CSC(n)	
brown-headed cowbird	*Xanthocephalus xanthocephalus*	k	B			X	X				

Common Name	Scientific Name[b]	(k) (e)	Area code[c]	Primary Habitat Association				Special Status[d]			
				Mountain	Canyon	Foothill	Valley	USFS	Federal	State	Harvest
Evening grosbeak	Coccothraustes vespertinus	k	W,b	X	X						
House sparrow	Passer domesticus	k	c				X				
Mammals											
Opossum	*Didelphis virginiana*	k	C	X	X	X	X				
dusky shrew	*Sorex monticolus*	e	r	X	X						
water shrew	*Sorex palustris*	e	r	X							
trowbridge's shrew	*Sorex trowbridgii*	e	r	X	X						
vagrant shrew	*Sorex vagrans*	e	r	X	X	X					
broad-handed mole	*Scapanus latimanus*	k	c	X	X	X	X				
big brown bat	*Eptesicus fuscus*	e	b		X	X					
hoary bat	*Lasiurus cinereus*	e	b		X	X	X				
California myotis	*Myotis californicus*	e	b		X	X	X				
western small-footed myotis	*Myotis ciliolabrum*	e	b		X	X			FSC		
western pipistrelle	*Pipistrellus hesperus*	k	b	X	X	X					
little brown myotis	*Myotis lucifugus*	e	b			X	X				
Yuma myotis	*Myotis yumanensis*	k	b	X	X	X	X		FSC	CSC	
Mexican free-tailed bat	*Tadarida brasiliensis*	k	b		X	X	X				
black-tailed hare	*Lepus californicus*	k	c		X	X	X				x
desert cottontail	*Sylvilagus audubonii*	k	c		X	X					x
snowshoe hare	*Lepus americanus*	e	r	X						CSC	x
brush rabbit	*Sylvilagus bachmani*	e	r				X		FPE	End.	
Townsend chipmunk	*Eutamias townsendii*	e	c	X							
Yellow pine chipmunk	*Eutamias amoenus*	e	c	X							
western gray squirrel	*Sciurus griseus*	k	c		X	X	X				x
California ground squirrel	*Spermophilus beecheyi*	k	c		X	X	X				x
Belding's ground squirrel	*Spermophilus beldingi*	k	c	X							x
golden-mantled ground squirrel	*Spermophilus lateralis*	e	c	X	X						x
Douglas squirrel	*Tamiasciurus douglasii*	e	c	X							x
pocket gopher	*Thomomys bottae*	k	c	X	X	X	X				
muskrat	*Ondatra zibethica*	k	c			X	X				
California kangaroo rat	*Dipodomys californicus*	e	r		X	X					

Common Name	Scientific Name[b]	(k) (e)	Area code[c]	Primary Habitat Association				Special Status[d]			
				Mountain	Canyon	Foothill	Valley	USFS	Federal	State	Harvest
beaver	*Castor canadensis*	k	c	X	X	X	X				
dusky-footed woodrat	*Neotoma fuscipes*	k	c	X	X	X	X				
brush mouse	*Peromyscus boylei*	k	c		X						
deer mouse	*Peromyscus maniculatus*	k	c	X	X	X	X				
Pinyon mouse	*Peromyscus truei*	e	c		X						
western harvest mouse	*Reithrodontomys megalotis*	k	c		X	X	X				
house mouse	*Mus musculus*	k	c	X	X	X	X				
black rat	*Rattus rattus*	e	c			X	X				
Norway rat	*Rattus norvegicus*	k	c			X	X				
western jumping mouse	*Zapus princeps*	e	r	X							
porcupine	*Erethizon dorsatum*	k	c	X	X						
mink	*Mustela vison*	k	c		X	X	X				x
long-tailed weasel	*Mustela frenata*	e	r	X							
river otter	*Lutra canadensis*	k	r			X	X				
coyote	*Canis latrans*	k	c		X	X	X				x
gray fox	*Urocyon cinereoargenteus*	e	r	X	X						x
red fox	*Vulpes vulpes*	e	r	X	X			SENSITIVE			
black bear	*Ursus americanus*	k	c	X	X						x
ringtail	*Bassariscus astutus*	k	c	X	X	X	X			Prot.	
raccoon	*Procyon lotor*	k	c	X	X	X	X				x
striped skunk	*Mephitis mephitis*	k	c	X	X	X	X				
western spotted skunk	*Spilogale gracilis*	e	r	X	X						
mountain lion	*Felis concolor*	k	c	X	X	X	X			Prot.	
bobcat	*Felis rufus*	k	c	X	X						
feral cat	*Felis sylvestris*	k	c	X	X	X	X				x
wild pig	*Sus scrofa*	k	c		X						x
mule deer	*Odocoileus hemionus*	k	c	X							x
black-tailed deer	*Odocoileus hemionus columbianus*	k	c	X	X	X	X				x

— KEY —

a) List derived from Version 5.0 of the California Wildlife Habitat Relationships System (CWHR), observations during site visits, range maps from Zeiner et al. (1990),

b) Taxonomic names from Peterson.R.T. (1990), and Ingles, L. G. (1965).

c) Area codes:
C = Common throughout the year
W = Winters in the area
M = Primarily migrates through the area
B = Breeds/nests in the area
R = Rare (occurring in small numbers)

d) Special Status Codes derived from the CDFG, Natural Diversity Database, March 1998.
Cand. = candidate species
End. = Endangered species
CSC = species of special concern
Prot. = protected species
Thret. = threatened species
FPD = federally proposed delisting

(a) = Species or subspecies with special status primarily associated with wetlands, marshes, and riparian areas.

(n) = Species or subspecies with special status primarily associated with nesting.

Stream and Riparian Inventory

INTRODUCTION

The Stream and Riparian Inventory is dedicated to the memory of Garrett Gibson. Garrett was an enthusiastic botanist, a gourmet cook, and a good person. He is missed.

The objective of the Stream and Riparian Inventory is to determine and quantify existing conditions on Big Chico Creek and its major tributaries, Mud, Rock and Sycamore Creeks. Specific attributes, demonstrated to be indicative of stream condition, were tested using accepted scientific protocols. The seasonal sampling of these attributes can be expected to be useful in describing physical condition differences with a moderate to high level of confidence (Stream Condition Inventory 3.4, 1996, pg8). In the future, it is expected that volunteers will conduct this inventory.

This Stream and Riparian Inventory utilizes two established survey protocols: *The Stream Condition Inventory*, and *The Greenline Protocol. The Stream Condition Inventory* (SCI), a survey methodology developed by the United States Forest Service (USFS), is a way to measure stream conditions with statistical validity. The *Greenline Protocol*, which is in the process of being implemented nationally, monitors riparian plant community composition to determine the overall health of the stream corridor.

METHODOLOGY

Stream Survey Inventory

Surveys were completed at 8 stream reaches with 3 permanent cross-sections installed per reach (see Map Valley Study Sites).

Stream Reaches:

BIG CHICO CREEK - UPPER BIDWELL PARK REACH
BIG CHICO CREEK - LOWER PARK REACH
BIG CHICO CREEK - BIDWELL AVENUE REACH
LINDO CHANNEL - FIVE-MILE REACH
LINDO CHANNEL - MADRONE REACH
SYCAMORE CREEK REACH
MUD CREEK REACH
ROCK CREEK REACH

These permanent cross-sections will help in the long term monitoring of stream and channel trends, as well as monitor the creek's suitability as salmonid and other wildlife habitat. Stream cross-section measurements taken include: percent of banks that are stable, pebble size, percent of shade by vegetative cover, and numbers of large woody debris. Pool measurements taken consist of maximum pool depth, water depth at end of pool, and percent of fine particles in the pool tail. Floodplain measurements include bankful width and depth and size of the streamside floodplain.

Stream Type
Cross-section measurements contribute to the ability to classify the stream using Dave Rosgen's system. Rosgen identifies 7 major stream types, A-G, and uses modifier numbers to indicate the dominant bed material (e.g., A1). Stream types A, B, C and F are found in this inventory:

- An A stream has a steep slope, little or no floodplain and is narrow
- A B stream has less slope, more floodplain, and is wider compared to its depth: a mountain stream with a more defined valley
- A C stream is quite flat, with a channel that tends to be wider than B's and a wide floodplain: a classic meandering valley stream
- A F stream is a valley stream that has downcut to the point it can no longer access its floodplain and is in the process of building new floodplains by eroding away its banks.

Pebble Count
Pebble size is, among other things, indicative of the stream's power to move material and to cause erosion. Salmonids need gravel of about 2-4"in diameter in order to spawn. High concentrations of fine materials deposited in stream gravel reduce the amount of oxygen available to the eggs, causing them to be smothered.
Measurement: substrate composition (pebble count).

Large Woody Debris
Large woody debris (LWD) is an important component for fisheries habitat when available (Rosgen, 1996, pg.5-72). LWD provides nutrients to aquatic insects, encourages the formation of pools, and provides shelter and cover for fish.
Measurement: # Large Woody Debris.

Pool Measurements
Pools are essential habitat for fish. Deeper pools provide cover from predators and help maintain the cool water temperatures necessary for salmonids. Pool tail fines (particles <2mm) were measured, as the pool tails are a favored spawning area for salmonids. Fines in pool tails clog gravel and prevent water from flowing through, limiting oxygen supply to salmon eggs.
Measurements: maximum and pool tail depths, pool tail fines, pool residual depth.

Shade
Shade is essential to keep water temperatures low, as well as providing cover for fish. Fallen leaves and large woody debris from trees growing along stream banks provide food and cover for aquatic insects and fish. Historically, the United States Fish &Wildlife Service (USFWS) has used 70% shade as an optimal goal for salmonid streams.
Measurement: percent shade.

Bank Stability, Width/Depth
A high width/depth ratio (shallow stream) may be an indicator of unstable bank conditions. Water flowing in a stream always has a certain amount of energy, which is used for 1) overcoming internal friction (turbulence) and 2) overcoming friction with the bed and banks or

vegetation. If the energy available to the stream is not fully used in overcoming internal friction, bed, banks or vegetation friction it will be used for transporting sediment or eroding the bed or banks (J. Castro, NRCS unpublished handout, 4/24/98). When the stream reach is very wide and shallow, it has a tendency to deposit gravel and can easily transfer that energy to eroding banks. Unstable banks are a major source of fines.
Measurement: transect.

RIPARIAN VEGETATION INVENTORY

The *Greenline* monitoring method was selected for documenting vegetation characteristics along Big Chico Creek and its tributaries. The U.S. Bureau of Land Management (BLM) and the U.S. Forest Service (USFS) originally developed the methodology. The greenline is defined as *that specific area where a more or less continuous cover of vegetation is encountered when moving away from the center of an observable channel.* The percent of each different plant community type along the greenline is determined and then used to evaluate the riparian vegetation. The advantage of the *Greenline* method is that it is a variable plot method, repeatable and independent of peak flow events. In fixed plot methods, the plots are vulnerable to being washed out or silted over.

The *Greenline* method has three components:

- Greenline transect
- Woody species regeneration
- Riparian cross-section

Note: A modified BLM/USFS protocol was instituted, so that the Greenline method could be used in conjunction with the SCI.

Recording plant community types is an integral part of the *Greenline* method. Extensive work has been done in portions of the Western United States to classify the community types and determine stability class ratings for each type. In those areas, each community type has been assigned a stability class rating, which indicates its ability to anchor and protect the stream bank from the erosive action of flowing water. The scale for stability classes ranges from 0 to 10 where 10 has the greatest stabilizing ability. Unfortunately, the plant community types and stability class ratings have not been developed specifically for the Big Chico Creek study area. Stability class ratings were assigned based on tentative recommendations noted in the course of gathering data in the field and in follow-up meetings with local botanists and stream restorationists.

Vegetation studies for each reach began with the compilation of a species list. Most of the reach was traversed (on foot along the banks and/or in the stream), and all of the plant species were noted, or collected for later identification. Thorough familiarity with the flora was helpful when data for the actual transects was collected (see Appendix A. Stream and Riparian Inventory Species List).

The standard BLM/USFS protocol for the length of a *Greenline* transect is 363 feet along one bank, and then 363 feet back along the opposite bank. A typical SCI study reach is about 1,600 feet in length. SCI data collection includes selecting and measuring channel cross-sections at three sites within the 500-meter study reach. To adapt the *Greenline* method for use with SCI, the Greenline transect footage was divided into thirds. Specifically, the plant community types were recorded for 121 feet along the banks, with each 121-foot segment beginning at one of the three SCI cross-sections. Plant community types were described in the course of collecting the data, based on the dominant and subdominant species present along the transect. A result of adapting the *Greenline* method to SCI is that Himalayan blackberry and other dense vegetation types are probably under-represented in the percentages of community types. The exact location of SCI channel cross-sections is partly determined by ease of accessibility, thus creating a bias in the vegetation data results when that data is collected in the vicinity of dense blackberry thickets.

The Woody Species Regeneration data is collected by retracing the greenline transect, and recording the individual trees and shrubs rather than the community types. The individual plants are tallied by age class (i.e., seedling, and sapling, mature, decadent, dead) and species. Blackberries and California pipevine were not considered woody species in the Woody Species Regeneration portions of the Stream Inventory.

A riparian vegetation cross-section was established 15 feet from each of the three SCI channel cross-sections in each of the study reaches. The SCI cross-sections were completed first as a precaution against any trampling or other vegetation disturbance created by data gatherers. The end-points for each of the riparian vegetation cross-sections were selected based on site-specific features such as the top of a levee, a road or other constructed feature, or the point on a slope where upland vegetation community types occur. The riparian vegetation data was recorded in the same manner as the greenline transect and Woody Species Regeneration portions, except that the transects cut across the stream rather than running along it.

Throughout this document, the riparian cross-section located furthest downstream in the study reach is referred to as the lower cross-section, and the one located furthest upstream within the study reach is referred to as the upper cross-section.

BIG CHICO CREEK - UPPER BIDWELL PARK REACH

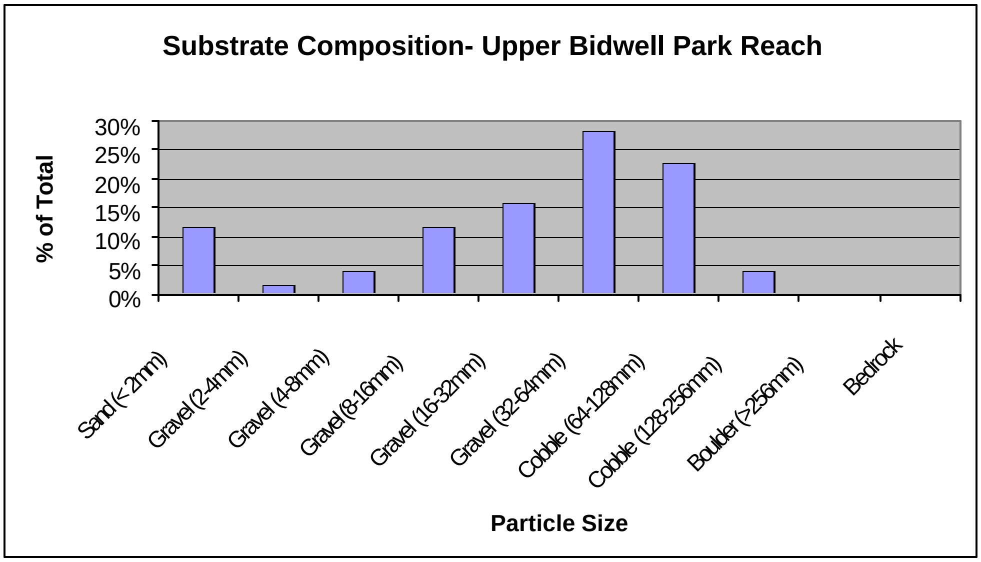
Stream Inventory

The Upper Bidwell Park Reach (Upper Park) is located just upstream of the 5-Mile pedestrian bridge in the 5-Mile Recreation Area and extends upstream to the 17th Hole on the Bidwell Golf Course. The reach is 548 m long.

Table Average SCI inventory for Upper Park Reach

Reach	Length (m)	Stream Type	% fines in pool tails	Gradient	Bankfull Width	W/D ratio	Streambank stability (% stable)	Shading (%)
Upper Park	548	B4c	3.2	0.3	33.9	49.4	52	26.2

Large woody debris (LWD) counts in the Upper Park Reach were low at 31 pieces/mile, with one aggregate of 3 pieces. The January 1997 storm, estimated to be a 75-100 year event, moved out a considerable amount of LWD and placed it against the Lindo Channel Diversion Dam and the Wildwood Avenue Bridge. If the Wildwood Avenue Bridge were made "Large Woody Debris Friendly", LWD might move downstream to the "Sycamore By-Pass Canyon", where it could be beneficial in resisting the large active erosion taking place.



The pebble count found 13% of the substrate composition to be fines. This reach has 3.1% pool tail fines. This low number of pool tail fines can be considered a base line from which to compare lower reaches.

This reach has an average maximum pool depth of 1.5 m with an average pool tail depth of 0.3 m. Pools are long, with only four being found throughout the reach.

Big Chico Creek - Upper Bidwell Park

According to Rosgen's classification system, The stream type is B4c. Entrenchment decreases and slope increases as the survey progresses upstream. This would be expected as the stream ascends higher into its canyon, thus increasing confinement. At the lowermost cross-section, the north bank is composed of erosion-resistant materials while the south side has a wide accessible floodplain. Progressing upstream the north bank is riprapped in several areas as it flows along the golf course and the stream becomes more entrenched with a less accessible floodplain. The result is the stream assuming more B-type characteristics of confinement and entrenchment.

This reach's width/depth ratio is higher than Rosgen's statistics for B4 streams. The very high Width to Depth ratio may reflect the stream exiting the canyon and depositing bedload (Maslin, 1999, pers. Comm.). It may also be a result of channel scouring during the 1997 storm. A high width/depth ratio has the result of spreading water over shallow riffles, which may cause it to heat up, especially when coupled with very low (26%) shade for this reach. The high width/ depth however, may be beneficial rearing habitat for salmonid fry.

According to the USFS, a stream bank stability problem exists if stability is less than 80% in response reaches (generally C streams) or less than 75% in transport reaches (generally B streams). The upper park reach may be 52% stable, 23% below the USFS threshold. The instability in this reach may be partially due to the January 1997 storm event and from impacts of recreation.

The variability in shading in this reach is characteristic of meandering streams. In this reach the mean shade is 26%. Shade may be low in this reach partially because of the 1997 storm event, which swept away dozens of alders. The proximity of the paved road on the south side of the creek and the golf course on the north also limits the shading in this reach.

Riparian Vegetation Inventory

The vegetation along this reach of Big Chico Creek can generally be described as riparian forest. The most noticeable plants are towering sycamores and valley oaks, alders, and gray pines and live oaks in the adjacent uplands. Shrub and herbaceous vegetation types are present where the tree canopy is thin, or in gaps of the tree canopy. Gravel bars, and similar areas of exposed substrate immediately adjacent to the stream, are nursery sites for large numbers of riparian tree and shrub seedlings.

A total of 116 plant species were observed at the Upper Park reach. One third of these were trees or shrubs, and two thirds were herbaceous species. Of the 37 woody species, 22% were non-native species. In the herbaceous category, 79 (53%) were non-natives. Such a high percentage of non-native herbaceous species is typical for much of the California Central Valley and surrounding foothills (see Appendix A for a detailed species list).

Several highly invasive wildland plant species exist in this reach including giant reed, Yellow star-thistle, English-ivy, and Himalayan blackberry.

The giant reed, star thistle, and blackberry were present in sufficient amounts to be considered community types in the Greenline transect. The English-ivy is not common at this time. Other potentially degrading exotic species include Eastern hackberry, edible fig, privet, and white mulberry.

GREENLINE TRANSECT

A diverse mix of plant community types was encountered in the course of the Greenline transect, and is a reflection of the large number of species present at the Upper Park Reach. To summarize, 24%of the transect was essentially un-vegetated (although the right bank of the lower section, which was all bedrock, did support a noticeable amount of deergrass). Native trees and shrubs accounted for 31%, and the corresponding value for non-natives was 19 percent (giant reed is included in this value due to its unusually large stature for a herbaceous species). At the herbaceous level, native species community types constituted 15½ % of the transect, while 12% was non-native. The left bank of the lower section of the transect had some un-vegetated public trails accessing the stream. This bare ground is approximately 4% of the transect, however, these sections were ignored, and the transect was extended an equivalent distance for vegetation data gathering purposes.

The stability rating for the Upper Park Reach is 5.67; thus the vegetation along this section of stream has a moderate ability to stabilize the banks.

BIG CHICO CREEK - LOWER PARK REACH

Stream Inventory

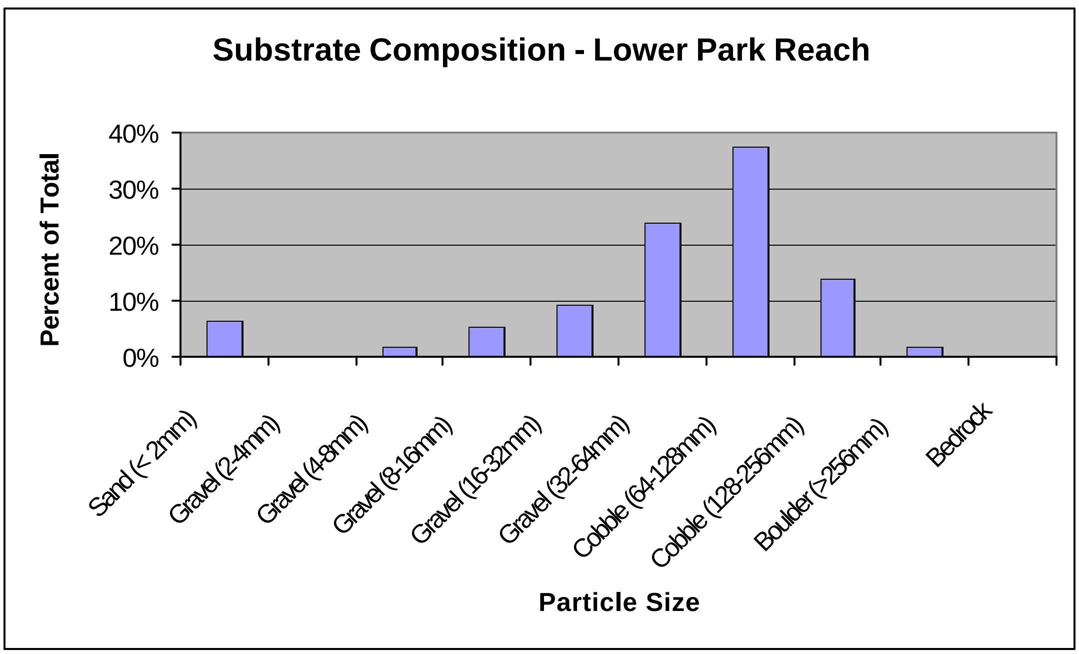
The Lower Park Reach begins just downstream of the Madrone Avenue Bikeway Bridge and extends downstream 532 m just above the Cedar Grove Bike Bridge. This well-shaded stretch is 63.2% shallow pools, with a significant amount of LWD and steep banks. The average maximum pool depth (which is affected by cobble dams created by recreationists) is 0.79 m with an average pool tail depth of 0.41m. Pool depth is not optimal for salmonid habitat and bears monitoring. Pool tail fines are low in this reach, but should be monitored due to the percentage of unstable banks.

Table Average SCI inventory for Lower Park Reach

Reach	Length (m)	Stream Type	% fines in pool tails	Gradient	Bankfull Width	W/D ratio	Streambank stability (% stable)	Shading (%)
Lower Park	532	B3c	5.6	.7	14.9	49.35	63	82.3

The substrate consists primarily of small cobbles with a significant amount of gravel. Bank stability is rated as low. This reach is characterized by deeper entrenchment than expected for this stream type (B3c). This could indicate that the stream is down cutting below the point where it can access its floodplain. This could bring about a significant cycle of degradation where the stream erodes the banks extensively and creates a new streamside floodplain incised well below the existing one.

City of Chico Park Management has decided to leave LWD in the system unless it threatens infrastructure. The resulting increase in LWD may lead to variability in shade figures as channel meandering takes place. This may also open the canopy in patches for willow and alder regeneration. The existing 82.3% shade may limit regeneration of shade intolerant riparian species such as willows and cottonwoods.



Riparian Inventory

Both surrounding residential landscaping and managed stream flows in the Lower Park Reach have, in different ways, promoted non-native tree and shrub species. Since Lower Bidwell Park is contiguous to the backyards of many residences, the introduction of horticultural species is inevitable. The relevance of managed flows is discussed in the section on woody species regeneration.

The stream here is lined with mature trees, with mature canopies reaching completely over the channel. Typical tree species immediately adjacent to the stream are alder, ash, sycamore, and catalpa. The vegetation here falls within the California sycamore series vegetation type (*A Manual of California Vegetation*).

Outside the immediate stream margins is a riparian forest type categorized as valley oak series. This series typically becomes established where the soils are intermittently flooded, but only seasonally saturated. In this reach, the valley oaks and other tree species, such as sycamore and northern California black walnut, form a towering canopy covered with wild grape. Below the high canopy, the shrubs present are scattered thickets of elderberry, pipevine, and other species. The herbaceous layer is dense with annual grasses and forbs.

The plant list for this reach has 65 species; 27 are herbaceous and 38 are tree or shrub species. This is quite different than the findings in the Upper Park Reach which had nearly twice the number of species, and where herbs outnumbered trees and shrubs two to one. Forty percent of the tree and shrub species and 48% of the herbaceous species in the Lower Park Reach were non-native.

The number of non-native herbaceous species present is similar to results found during biological assessments conducted on Deer Creek, Toomes Creek, Mill Creek, Dye Creek, Antelope Creek and Butler Slough. However, the number of woody species, 40%, is significantly higher than the 18% reported in the comparable assessment. This comparison suggests an unusually high level of non-native trees and shrubs in the Lower Park Reach.

Non-native species are so prominent in this reach that they are addressed separately below. Northern California black walnut is categorized as a native species in this report, however its status as a native or non-native is currently a matter of debate. Re-analyzing the data with black walnut as non-native would not substantially alter the results, although this species does appear regularly in the Lower Park Reach data set.

NON-NATIVE SPECIES CONCERNS

The flora of the Lower Park Reach, and Lower Bidwell Park in general, has been significantly infiltrated by non-native species. The level and type of impact of each non-native species is different, but exotic species are seldom ecologically beneficial.

All of the non-native species observed in the course of the field studies are indicated on the list of plants in Appendix A. Some of the more invasive or rampant species are discussed here. It should be noted that there are numerous other non-native species in Lower Bidwell Park beyond the borders of the study area. They have not been included on the plant list.

Periwinkle (*Vinca major*) often forms a nearly continuous ground cover below the tree canopy along the stream. It and Himalayan blackberry have displaced nearly all native herbaceous species in this densely shaded, relatively moist environment.

Big Chico Creek - Lower Bidwell Park Reach

Himalayan blackberry (*Rubus discolor*) is widespread, and probably underrepresented in This study due to the previously discussed bias against it in the selection of Stream Condition Inventory cross-section sites. The park roads do appear to serve as a deterrent to the vegetative spread of periwinkle and Himalayan blackberry in many instances.

A substantial infestation of a thorn-less blackberry cultivar was encountered in this study. It is of particular concern because it has a much more clambering growth habit, spreading substantially and unusually high into the tree canopy, in comparison to the Himalayan blackberry or native California blackberry. The infestation is located on the south side of the stream in the vicinity of Picnic Site 8.

English-Ivy (*Hedera helix*) was only documented in the Lower Park Reach during the initial botanical survey. While it was not significantly represented in the study reach, large (often over a hundred feet in diameter) infestations were noticed in other areas of Lower Bidwell Park. Two specific sites are 1) the south side of Big Chico Creek just west of the freeway and 2) on the north side of the stream, downstream from the Cedar Grove Bicycle Bridge (just downstream from the study reach).

Numerous non-native tree species are present and competing with the native species. The non-natives present in higher numbers include catalpa, hackberry, hawthorn, fig, mulberry, privet, and pistachio. There are at least five more species present in lower numbers.

A potentially useful management suggestion would be to census the English-Ivy and privet in the winter, as their evergreen habit makes them readily visible in comparison to the majority of the other riparian species which are deciduous.

On a positive note, tree-of-heaven (*Ailanthus altissima*) was absent. This is an admirable result of the park management non-native, eradication program.

GREENLINE TRANSECT

Nearly 90% of the stream margin is lined with riparian tree and shrub community types (70% tree, about 20% shrub). This is quite high, and for comparison, the Upper Park Reach had only 50% tree and shrub community type footage along the greenline.

In Lower Park, 73% of the transect intercepted native community types, and 25% was vegetated with non-native species community types. The non-native woody species in this study area are generally not as tall as the natives, thus they often get recorded as subdominant and their significance is underestimated. Looking at the data in a slightly different perspective to compensate for this limitation of the *Greenline Protocol*, non-native species were dominant or subdominant for 40% of the transect length.

Tree species are generally good at stabilizing stream banks; thus the stability class rating in the Lower Park Reach was relatively high among the reaches in this study at 6.77.

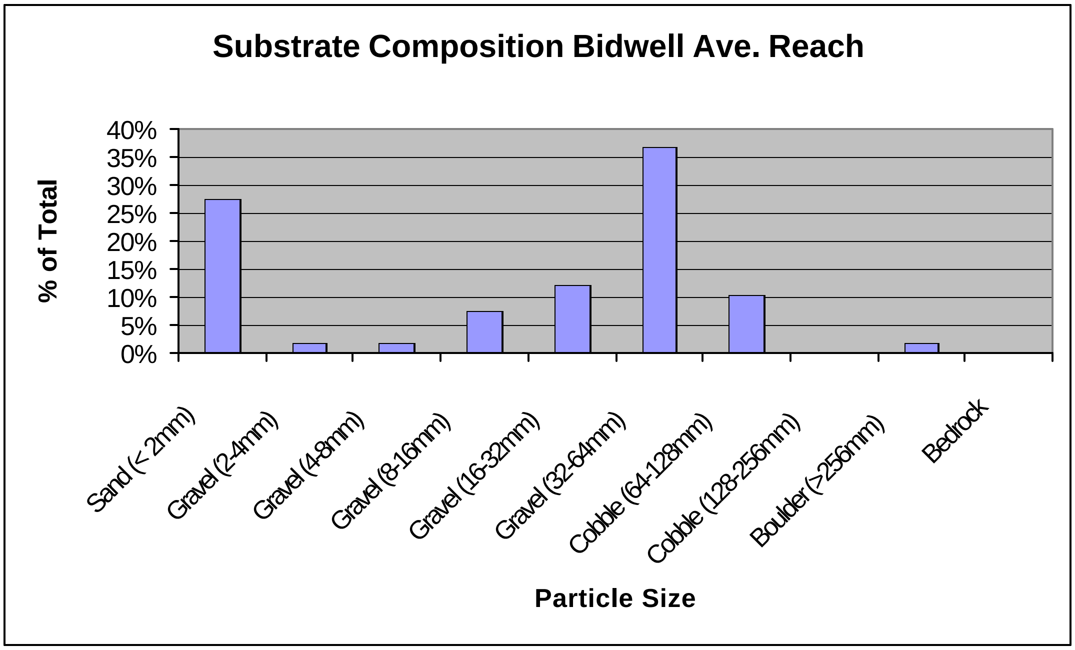
BIG CHICO CREEK - BIDWELL AVENUE REACH

The Bidwell Avenue Reach begins 72 m downstream of the Nord Avenue Bridge, and extends 534 m. Big Chico Creek is more entrenched here than in other reaches, with floodwater unable to access a floodplain. This sensitive reach is actually less entrenched than downstream towards Rose Avenue. Banks are generally fine soil particles or riprap.

Table Average SCI inventory for Big Chico Creek - Bidwell Ave. Reach

Reach	Length (m)	Stream Type	% fines in pool tails	Gradient	Bankfull Width	W/D ratio	Streambank stability (% stable)	Shading (%)
Bidwell Ave.	534	B4c-F4	16.8	.6	11.4	29.3	25	72.1

The reach cross-sections are on the cusp between B4c and F4. This reflects the F4 stream type process of forming a new geomorphic floodplain at its current level. Overall cross-section characteristics correspond with Rosgen's description of the F4 stream type, "...incised in alluvial valleys resulting in the abandonment of former floodplains... slopes less than 2%, ...and have width/depth ratios that are high to very high" (Rosgen 1996, pg5-154). Width/depth ratios though, fall slightly higher than the mean for an F4 stream.



The pebble count showed significant concentration of fines in this reach (particles < 2mm). In fact, 27% of the total substrate was surveyed as fines, second only to the Sycamore Creek Reach for fine levels. This is indicative of the reach's deep entrenchment in fine depositional soils. Rosgen describes F4 sediment supply as "moderate to high depending on stream bank stability. " Stream bank erosion rates are very high due to side slope rejuvenation and mass wasting processes, "…unless, riparian vegetation ... covers the entire slope face of the channel banks"

Big Chico Creek - Bidwell Avenue Reach

(Rosgen, pg. 5-154). Pebble size here is smaller than Lower Park. LWD count for this reach was 113 pieces/mile, and could be regarded as generally good.

This reach is 57% pools, higher than the USFS ratio for transport reaches. The stream is well shaded. The percentage of wood formed pools is also high at 75%. Large wood contributes to pool formation. Residual pool depths are substantially greater than Lower Park's, averaging 0.9 m deeper. This may be partially because of the additional storm drain flows added to the creek between the two reaches, and may also reflect the additional confinement of this reach which is over 1.6 m more entrenched in valley soils.

In this reach only 15% of the banks are stable. Since it tends to form a new geomorphic floodplain at its lower level, the creek cuts into its banks. The high width/depth ratio is indicative of and contributes to this process. The stream tends to be shallow and wide, especially at riffles and runs, putting more erosive pressure (shear stress) on its banks. The percentage of unstable banks is also evidence of the process of floodplain formation. According to Region 5 USFS data, a problem of stream bank stability exists if the percentage of stable banks is less than 75% in transport reaches (generally B streams), which include the F4 stream type.

The stream is bound by Bidwell Avenue to the north. Since Butte County is obligated to protect the road from undercutting, riprap has been placed at several locations, making the bank progressively "harder" and more resistant to erosion. That riprap design does not usually provide for vegetation or soil in the voids, riparian canopies are usually absent. It was difficult to locate riffles for the cross-section and still avoid north bank riprap. Private property owners to the south have backyards that are deep and thus far have not hardened their banks with riprap. This has allowed the stream to create some streamside floodplain to the south and has limited down cutting.

Significant levels of fines were discovered in this reach. It is second only to the Sycamore reach in terms of fines. Additionally, 85% of its banks rated unstable or vulnerable.

Rosgen describes the F4 stream type as, "…extremely sensitive to disturbance with a poor recovery potential, … a very high sediment supply and stream bank erosion, …vegetation's controlling influence on stream bank erosion and stream stability is moderate due to the difficulty of vegetation growing up the entire inner banks." Therefore, preliminary indications show that Big Chico Creek is very sensitive to changes in stream flow magnitude, timing, and/or sediment increases.

A critical problem that complicates the analysis of the Bidwell Avenue Reach and the Lower Park Reach is the altering of the natural water flow cycles below the Five-Mile Diversion Dam. The peaks are cut off. The diversion structure only allows flows up to 1500 cfs to pass. Determining bankfull flow level is difficult because the water volume never exceeds a certain level.

Standard bankfull determination methods were used. One difference between the Lower Park Reach and the Bidwell Avenue Reach is that a number of storm drains enter the creek upstream of the Bidwell Avenue Reach, ultimately increasing water levels.

Riparian Inventory
This reach is the lowest site on Big Chico Creek, located immediately downstream from the Nord Avenue Bridge (State Route 32). It is surrounded by residential development. The northwest side is bound by Bidwell Avenue with residences immediately behind it. There is also a small area of abandoned floodplain on this side. The southeast side has residential development often reaching to the top of the bank, and a short stretch of commercial development just off of Nord Avenue. In this reach the banks are very steep.

The vegetation can be described as riparian forest, though only a few mature specimens of native trees remain. Like the Upper Park Reach, this reach would best be described as a community of exotic invasive vegetation including the Tree-of-Heaven (*Ailanthus altissima*) which is moving aggressively into the mix from the upper end of the reach.

Greenline Transect
The coverage of the transect by woody community types is 88%. Of this coverage, 69% is still dominated by native trees and shrubs. This high percentage of native plants reflects the long-lived valley oaks that remain on this site.

Only 32% of the 22% in herbaceous coverage are native. This native coverage is one native species, rice cutgrass.

The stability rating was 5.69. This is a moderate level of stability in terms of the vegetation's ability to protect the banks from erosion or disturbance.

FIVE-MILE REACH

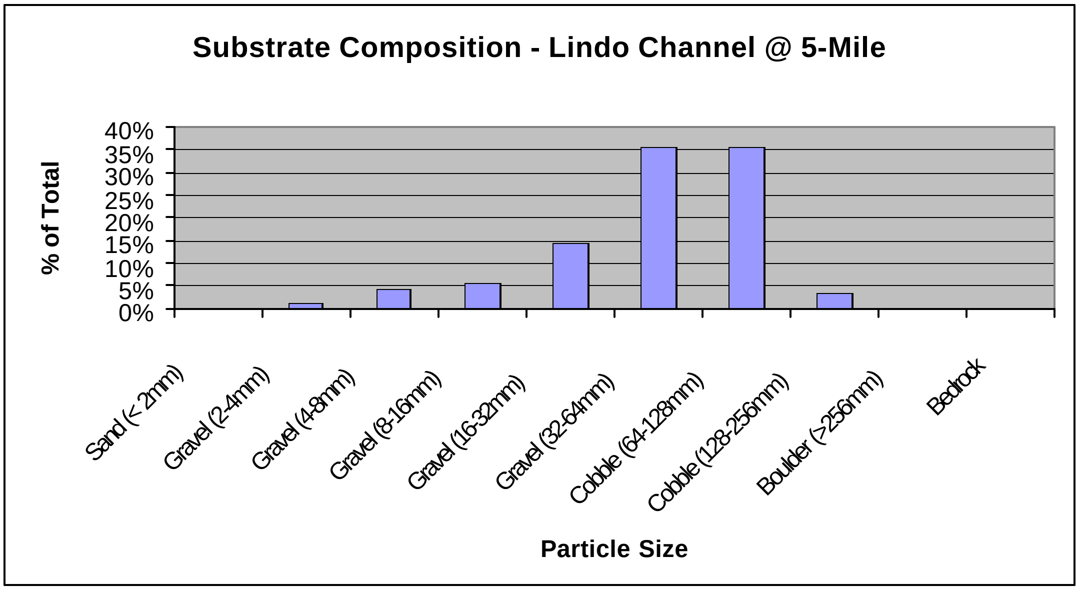
Stream Inventory
The Lindo Channel - Five-Mile Reach is located immediately downstream of the Five-Mile Recreation Area, extending for 470 m. This reach connects Big Chico Creek with Lindo Channel. The upper portion of this reach is affected by gravel removal by Butte County for flood control purposes. This reach was re-configured in the 1960 flood control project with a wide, flat, shallow bottom intended for sailing and water skiing activities. During the period of 1965-1991, gravel removal and the building of a gravel dam for swimming affected it. In 1990 the golf course installed wells and stopped building another gravel dam upstream that contributed to gravel deposits at Five-Mile Reach until 1990. Since 1991, there has been no gravel removal or building of a gravel dam for swimming in the Five-Mile Reach. The surveys were performed in late November 1998 and April 1999.

Table Average SCI inventory for Lindo Channel - Five-Mile Reach

Reach	Length (m)	Stream Type	% fines in pool tails	Gradient	Bankfull Width	W/D ratio	Streambank stability (% stable)	Shading (%)
Lindo Channel / 5-Mile	470	B4c	2.0	.85	28.67	63.27	38	11.2

This reach has no large woody debris, as it is washed through to the Lindo Channel Diversion Dam and Wildwood Avenue Bridge. The Five-Mile Reach is a wide and shallow gravel stream. The first cross-section was placed in the area affected by gravel removal, the second just beyond the area and the third above the Lindo Channel diversion dam.

The first cross-section data reflects the influence of gravel removal; the channel is undeveloped and wider (34.7m) in proportion to its depth. Its stream side floodplain is only 1.56 times as wide as the channel although the floodplain is nearly 60 m wide. It is a B4c stream, and is 3 times as steep as the rest of the reach (1.56% slope).



The channel is more developed at the second cross-section. It's 30% narrower here (24.6 m) and twice as deep. The channel is almost exactly the same width at the third cross-section (24 m) and slightly deeper still. When the channel is deeper it can move more gravel in the bed. When a channel is allowed to maintain itself, it provides for deeper water. Deeper water can move more of the bedload through the reach, thus reducing or eliminating the need for gravel removal and replacing some of the gravel that has moved downstream in Lindo Channel.

Water flowing in a stream always has a certain amount of energy available and can be used for:

- Overcoming internal friction
- Overcoming friction with the bed and banks or vegetation
- Transporting sediment
- Eroding the bed or banks

(J. Castro, NRCS unpublished handout)

Since the reach is very wide and shallow (width / depth Ratio average 84), it has a tendency to deposit gravel and can easily transfer that energy to eroding banks.

The Five-Mile Reach's pool/non pool ratio (p/np) is very low at 28.9%, considering the USFS average pool/non-pool ratio for C streams is 71.1%. Pool residual depth depends on many factors but the 0.38 m figure is a baseline figure and very low for a stream of this size. For example, the Bidwell Avenue reach is 8 m wide and has pools 2 m deep. At a very low 2%, fines are not currently a problem in the reach.

Five-Mile Recreation Area

A problem exists if stream bank stability is less than 80% in response reaches (generally C streams). Only 38% of Lindo Channel's banks are stable in this reach, a very low stability rating. This is partially due to gravel manipulation, which have destroyed the channel in the past, and also because of the immense amount of gravel that Big Chico Creek deposits at 5-Mile. It takes a series of smaller events to cut through the remaining gravel to recreate a new channel.

There is only 11.2% shade in this reach, much lower than the 70% that USFWS recommends. Management of Lindo Channel for flood capacity removes vegetation, leaving little shade, and not much cover for rearing salmonids, or other aquatic life.

Riparian Inventory

This 5-mile reach of Lindo Channel has many mature trees including valley oaks, cottonwoods, and sycamores. They are mostly on the streamside floodplain set back from the creek and do not shade it. Himalayan blackberry is beginning to invade here.

Greenline stability rating for this reach is 5.43 or moderately resistant to erosion. By far the largest percentage of stream bank vegetation is annual grasses 40.9%, followed in abundance by Pale spike rush 12.5%, cottonwood 8.3%, and willow leafed *Baccharis* 6.6%. Increasing the abundance of cottonwood and willow leafed Baccahris could help to shade and prevent bank erosion.

NON-NATIVE INVASIVE PLANTS

Spanish broom is present on the floodplain. Botanists observed approximately 100 juveniles and a few adults up to 9 feet high. A few giant reed (*Arundo donax*) clumps exist. It is normally spread by high water events that spread corms and canes which then root.

Privet also occurs here, apparently spreading from the landscaped area by the Five-Mile Recreation Area where several large trees are located near the restrooms. Close to a large privet tree in the reach, the ground is carpeted with seedlings. Ripgut brome was also present in appreciable quantities.

LINDO CHANNEL AT MADRONE REACH

Stream Inventory

The Lindo Channel - Madrone Reach is located downstream of the Madrone Avenue Bicycle Bridge, and is 492 m long. The reach has no LWD. Here, Lindo Channel is a gravel stream with very few fine soil particles. The stream in this reach is very wide and shallow. In the area close to the bridge it is a relatively flat, meandering gravel stream (C4c). It can flood onto a wide streamside floodplain where sand and fines deposit. The floodplain contains an overflow channel that flows to a pond that remains filled into the summer, providing habitat for the mallards and frogs that were observed in April. The stream is also wide here because of changes in the stream that have occurred the last few years.

Table Average SCI inventory for Lindo Channel - Madrone Reach

Reach	Length (m)	Stream Type	% fines in pool tails	Gradient	Bankfull Width	W/D ratio	Streambank stability (% stable)	Shading (%)
Upper Park	492	C4c-B4c	3.2	.27	33.32	83.97	58	4.8

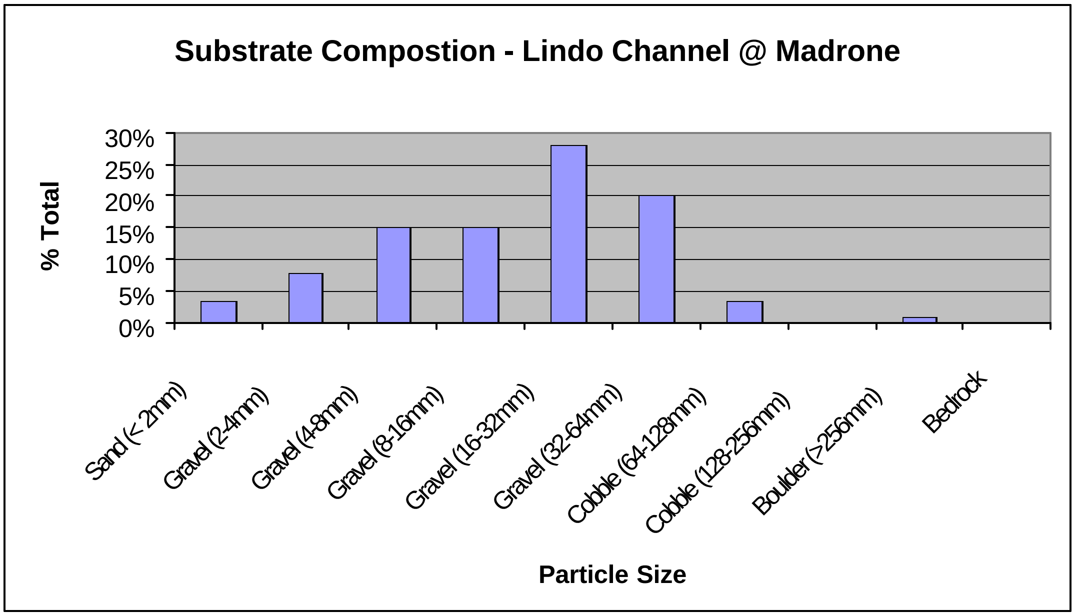
As it flows downstream the channel narrows by 50%. This constriction is due to old tailing piles at the First Avenue and Verbena open space area, and also because some of the gravel has settled out. Here the stream changes to a B4c stream, a straighter (less meandering) stream. The total streamside floodplain changes in width from 123 m near Madrone to only 33.7 m near Verbena.

Lindo Channel - Madrone Avenue Reach

The Madrone reach was the most dynamic of all the reaches on Lindo Channel. In November, during the course of the survey, a 1.7 meter pool filled and another 1.7 meter pool was created almost 100 m upstream during a storm. Possible explanations for these manifestations are:

- California Department of Water Resources cut willows the previous summer. Many willows died. The willows previously had slowed stream flows. Killing them increased water speed, thus moving more gravel.
- The new bike bridge restricts the stream's access to its stream side floodplain, again, increasing the depth and speed of flows during storms. Approximately 2 foot additional down cut in the stream gravel was observed under the bridge.
- A cement bike path was removed from the channel after the bridge was installed. This had been stabilizing the stream's bedload. Removed, it allowed a gully to travel upstream moving more gravel.

Moving gravel have moved two riffles downstream 20 m and buried 3.2 m of rip rap since 1990. So far this has created only minor problems for the stream or adjacent property owners.



The reach has a good number of pools and they are adequately deep. Only 58% of Lindo Channel's banks are stable. There is less than 5% shade in Lindo Channel, much lower than the 70% that USFWS recommends. Management of the channel over the years has removed quite a bit of vegetation, leaving little shade, and not much cover for rearing salmonids. In fact, where there were willows or cottonwoods growing next to the water, the field staff found schools of young salmon.

Riparian Inventory

Lindo Channel currently is used as a diversion for flood waters from Big Chico Creek. It is an intermittent stream with its flow controlled by the dam at the Five-Mile Recreation Area and the Lindo Channel Diversion Dam. The reach is bounded by what may be a natural bank on the southeast side and extensive areas of fill. The northwest side is a stabilized high bank that is bordered by residential housing.

In this reach there are fairly well-developed willow thickets and some different-sized cottonwoods. However, the most striking feature is the open dry meadows of annual grass, johnsongrass, star-thistle and mugwort. There are several groups of giant cane and a fair number of Spanish broom from two to six feet in height spread over the left bank floodplain. One tamarisk was found in a storm drain channel. The number and dispersion of Spanish broom shows a developing problem with this invasive exotic plant.

Because it is a diversion, the stream dries up as the flow of Big Chico Creek declines in the spring. There is active ground flow during the summer that sustains the riparian trees and shrubs. There is only one seasonal pond and a small seasonal wetland dominated by deer grass.

Most active seed regeneration of woody vegetation occurs in the streambed where lingering moisture allows seedlings to establish themselves sufficiently to pursue the water table as it drops. This reach and the Sycamore Creek Reach are the driest, most intermittent, sections in this survey.

However, active runoff from yards and streets, and even watering by homeowners, has created some mesic, or wet, areas on the northwest bank. In addition, active planting of native and non-native species by homeowners has added to the complexity of the site.

GREENLINE TRANSECT

Trees and shrubs, all native species, compose 36% of the greenline coverage. Of the remaining coverage (64%) of herbaceous community types, 27% of these are dominated by native species.

The stability rating of 4.23 for this reach is in the poor range. As such, the vegetation offers only “poor” ability to stabilize the banks against erosion.

THE RE-SURVEY OF THE GREENLINE PROTOCOL

As a requirement of the funding agency one reach was to be re-surveyed using the standard *Greenline* protocol that was modified for use in this study. The Lindo Channel Madrone reach was chosen for this re-examination.

The re-survey yielded a stability rating of 4.23. This value is only 0.09 more than the original value of 4.14. This verifies the accuracy and repeatability of the modified *Greenline* protocol that was used. Below is a rough breakdown of the results of the two trials on this reach. Since they were completed a month later, little water remained in the stream save for a few isolated pools.

Three variables likely account for the variation in the feet per general community type. First, warm season perennial grasses and forbs, and actively growing grapevine and roses displaced annual grasses. Changes in the lay of the greenline and alternative interpretation by the examiners are the other two possible variables.

SYCAMORE CREEK REACH

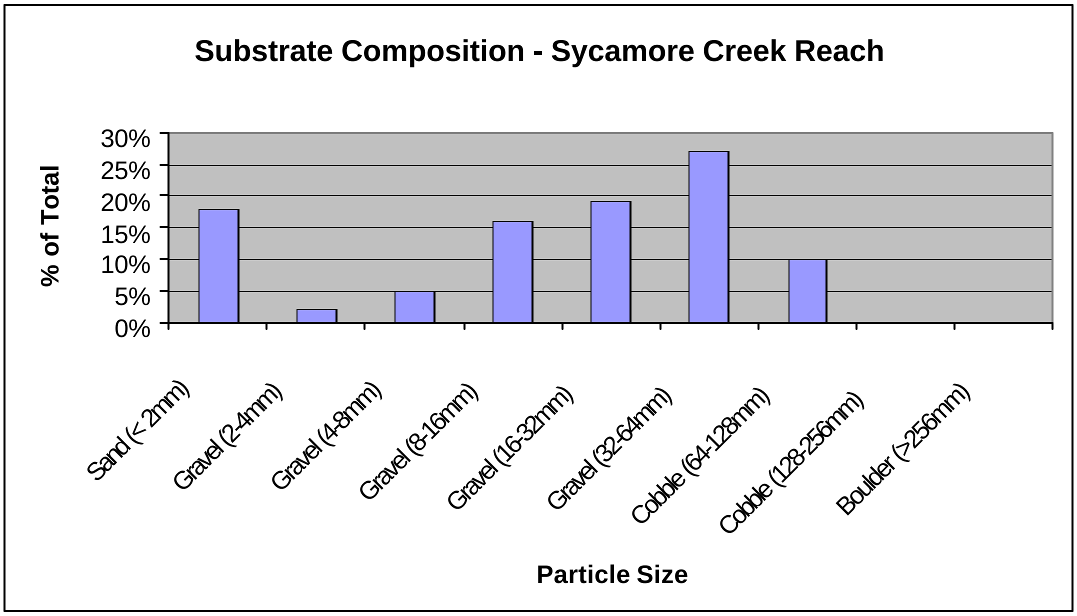
Stream Inventory

The Sycamore Creek Reach is just upstream of Cohasset Road. Surveys were performed in December 1998 and May 1999. Sycamore Creek joins the Sycamore by-pass Channel at the upper boundary of this 392 m reach. The Sycamore By-Pass Channel contains water from a small (unnamed) drainage and overflow water from Big Chico Creek and Lindo Channel.

Table Average SCI inventory for Sycamore Creek Reach

Reach	Length (m)	Stream Type	% fines in pool tails	Gradient	Bankfull Width	W/D ratio	Streambank stability (% stable)	Shading (%)
Sycamore	392	B4c-C4c	71.1	.38	20.47	58.77	24	.74

This reach had three pieces of LWD. Overflows from Big Chico Creek and Lindo Channel sweep all large pieces of wood downstream to the Cohasset Road Bridge where it is normally removed by equipment during and after large storms. The design of the bridge is such that it catches most of the large wood during high flow. Sycamore Creek is a gravel stream with many fines; 18% of the pebble count were fines.



At the upper end of this reach, Sycamore Creek cuts through a large gravel and cobble floodplain/bar. The stream is more confined here by this gravel bar than elsewhere in the reach. It forms a B4c stream. The rest of the reach has a much wider streamside floodplain, which averages 3.4 times the width of the stream channel. This type of stream, a C4c, or relatively flat meandering gravel stream, tends to deposit gravel and create meanders in some areas. Sediment supply in this type of stream has a tendency to be moderate to high unless stream banks are in very stable condition. The stream's lowest cross-section has a narrower channel.

Sycamore Creek Reach

Only 24% of Sycamore Creek's banks are stable in this reach. It is interesting to note that the upper section of the reach where the stream is more of a transport stream (B4c) it is much more stable. In the lower two-thirds the banks are much more unstable.

At a mean shade value of 0.74%, shade is very low in Sycamore. This reach dries up much earlier than the other reaches studied. It generally ceases flowing by mid-May.

Fines were at 71% in our pool tails, by far the highest figure in the survey. Fines are mobilized elsewhere in the system and drop out where ever the stream flattens out. These fines are then colonized by vegetation, such as reeds and sedges. One large source of fines is the new "Sycamore By-Pass Canyon" forming upstream about 1/2 mile of this reach. Overflow waters from Lindo Channel and Big Chico Creek flow into what was a small stream (before By-Pass was completed). At times, this overflow can reach 8,000 cfs. These waters have cut a channel 6 m deep by 12 m wide. This reach is one area where these fines drop out of suspension. Other fines come from unstable banks.

Reeds, sedges and annuals, grasses, and star thistle dominate vegetation here.

Riparian Inventory
The Sycamore Creek Reach is the only reach still under heavy grazing as pastureland. The site is generally barren. Only a few large cottonwoods and willows remain on the northwest bank. The upland area is exclusively grassland with annual grass and a heavy star thistle component.

The southeast side is a “natural” slope rising to Eaton Avenue, which has not yet experienced urban development. The northwest side has a steep bank that rises from the channel to a fairly level upland that has a small service road setback about 100 to 150 feet.

GREENLINE TRANSECT
The few trees on this site are all native, making 7% of the total coverage. Of the total herbaceous coverage of 92%, only 17% are native with the remaining 83% dominated by non-native species.

Cattle have trampled the upland areas under the few trees. By the time the lower greenline transect section had been performed the vegetation was trampled that the composition and location were to some extent estimations.

This reach was found to have a very low stability rating of 3.03, which is at the very bottom of the “poor” category. This indicates that the ability of the vegetation to stabilize the banks of this reach is very poor. This correlates with the stream survey finding of only 24% stable banks.

The lower third of the greenline has more mesic or moisture dependent vegetation. This is reflected in the cross-section with rushes, perennial grasses and mugwort growing in the channel. This is due to a rise in the water table that is a result of runoff from the local residential areas and roads.

The major factors in the condition of this reach's vegetation are intermittent flows, the large amount of fines washing in from above, and cattle grazing. The stream stopped flowing in early May, about when the cattle arrived. As the area dried down, the cows spent more and more time adjacent to and in the stream. Perennial herbaceous plants like *Eleocharis macrostachya*, which formed 14.4% of the Greenline, can become well established in this regime. They thrive in an area where fines are deposited and moisture is seasonal.

MUD CREEK REACH

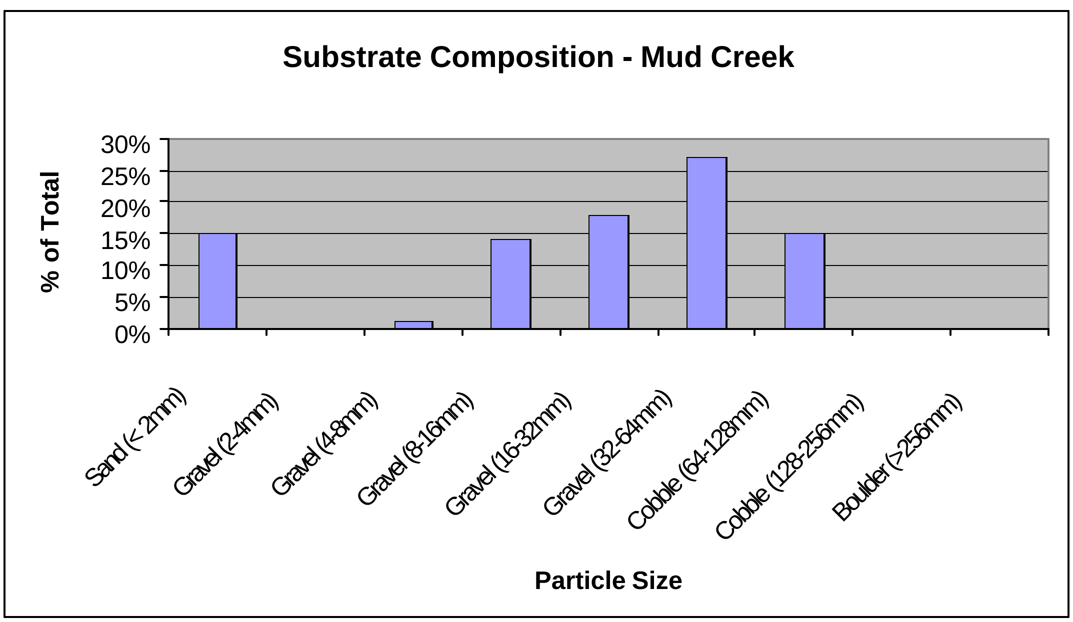
Stream Inventory

The Mud Creek Reach is located several hundred meters upstream of the Sycamore / Mud Channel confluence and extends for 560 m. The surveys were performed in late April and early May. Mud Creek was where the team repeated the SCI portion of our survey (as required by EPA), in order to evaluate the consistency of survey techniques. In general, repeat figures followed very closely the original survey figures.

Table Average SCI inventory for Mud Creek Reach

Reach	Length (m)	Stream Type	% fines in pool tails	Gradient	Bankfull Width	W/D ratio	Streambank stability (% stable)	Shading (%)
Mud Creek	560	C	4.8	.35	14.43	28.70	44	3.1

This reach has no large pieces of wood. Since it is part of the flood control system, large wood is removed or burned by California Department of Water Resources. This is done because large wood tends to get caught on bridge pilings. Unfortunately, this deprives the stream and its ecosystem of an important food and energy source. Mud Creek is a gravel stream with 15% fines.



The floodway appears to have plenty of capacity to carry flood flows here, with its average width of 101.7 m.

Pool/non-pool ratio for this reach would be considered quite good for fishery purposes.

There are significant numbers of fines in Mud Creek, though the percentage is not high enough to present a problem at this time. Since the stream has excellent access to its floodplain, the fines may be settling out on it. Due to large wood removal from the creek, only one of the pools was formed by wood.

Only 45% of Mud Creek's banks are stable in this reach, which is a little more than half the optimum percentage. This may be contributing some of the fines found in the pebble count.

Mud Creek Reach

The USFWS has recommended 70% shade for salmonids. The USFS has documented 30% shade occurs in response reaches (like this C stream). The shade on Mud Creek is very low at 47.5%. Management of the creek for floodway capacity has destroyed quite a bit of vegetation, leaving little for cover for fish. Indeed, wherever willows or cottonwoods were growing next to the water, young minnow schools were found.

Riparian Inventory

This portion of Mud Creek is bounded by setback levees. Outside the right bank levee, or north side, is a residential development. The south side is in agricultural use as a recently planted orchard.

Visually the levees are the dominating feature of this reach. However, despite maintenance for flood control, the stream banks and some portions of the floodplain within the levees have begun to develop towards a riparian forest. Upstream from the reach large cottonwoods and willow thickets are well-developed and moderately extensive in coverage. This vegetation thins downstream, through the reach, and becomes largely absent by its end. The riparian forest tree and shrub species are largely native.

Introduced grasses -- johnsongrass, ripgut brome, medusa-head and other annual grasses -- dominate the floodplain. There are scattered patches of mugwort and lower wet areas have extensive population of iris-leafed rush, both native species. Only one small Himalayan blackberry was observed while the presence of yellow star-thistle seed stocks from last season shows it occurrence in this reach. For unknown reasons this season star thistle has not survived and is present only as scattered plants. It is unclear if this is a result of spraying for noxious weed control, an effect of the severe cold spell of December 1998, or due to other causes.

Despite its confinement in a flood control structure the stream meanders somewhat naturally within its channel and has a small floodplain. It is one of the more “natural” reaches in the valley portion of the watershed and it may provide a unique opportunity to recreate a native riparian forest as long as flood control concerns are addressed.

GREENLINE TRANSECT

The tree and shrub species encountered on the greenline were all native, although they have only 14% of the total coverage. Only one non-native tree, an *Osage* orange, was observed on the floodplain outside of the greenline. The coverage occurred primarily in the upper segment of the greenline.

Of herbaceous coverage of the greenline, 32% was of communities dominated by native species and 45% by non-native. The remainder of the greenline, 9%, was bare ground, johnsongrass, thatch and cobble.

The stability rating of 4.32 for this reach is in the poor range. As such, the vegetation offers only “poor” ability to stabilize the banks against erosion.

ROCK CREEK REACH

Stream Inventory

The Rock Creek Reach is off Keifer Lane, close to where Keifer Slough crosses. Surveys were performed in late May 1999. The reach is 435 m long

This cobble stream reach is 57% shallow pool, with no large woody debris and moderate shade. Fine particles are present in the pool tails in only small amounts. In the upper end of the reach the stream has a well-maintained bankfull channel, with willows on some of the banks and a very well vegetated overflow channel. Downstream the creek is wider and shallower, as it is in other areas observed while searching for a reach to survey. Here, with a high width to depth ratio averaging 48.37, it is wider than 82% of Rosgen's C3 streams.

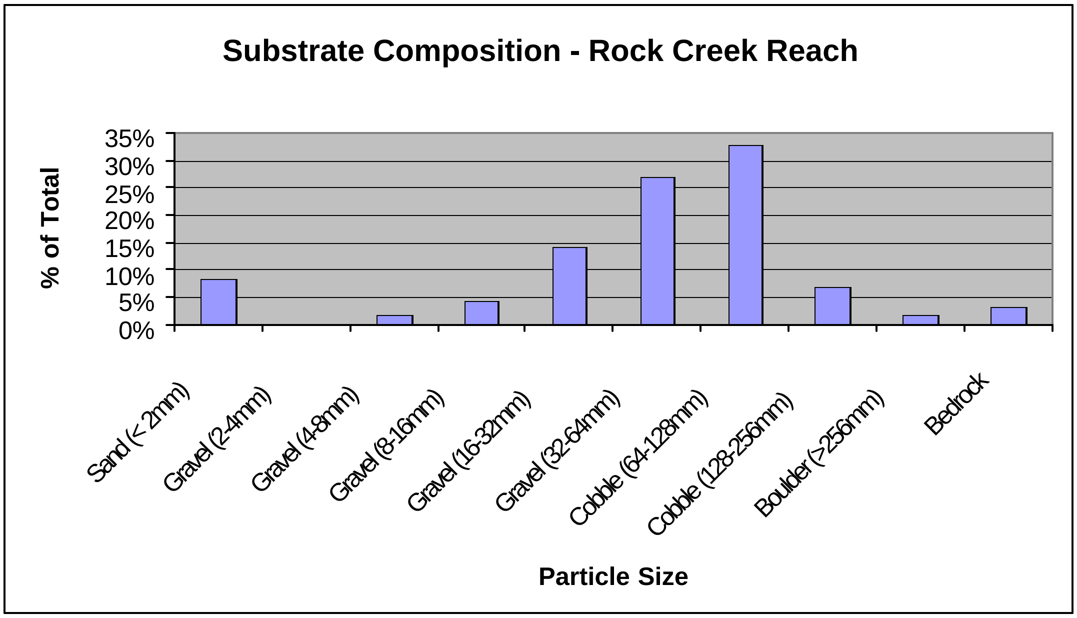
Table Average SCI inventory for Rock Creek

Reach	Length (m)	Stream Type	% fines in pool tails	Gradient	Bankfull Width	W/D ratio	Streambank stability (% stable)	Shading (%)
Rock Creek	435	C3c	3.5	.53	20.87	48.37	46	47.5

The landowner explained that this reach has not been modified for 25 years with the exception of the lowermost 50 m where he had pushed stream gravel up against the banks to protect a large oak tree and orchard from bank erosion. Just above the reach, the landowner has done the same thing for approximately 25 m. Pushing gravel against the banks has in some ways protected the banks. The bulldozing has helped to create the wide flat channel observed in the lower end of the reach. In this wide flat channel, stream gravel tends to be deposited. This can force the stream to put more stress on its banks. This is countered by the energy it takes Rock Creek to remove the stream gravel from the bank.


Rock Creek Reach

This C3c stream, or relatively flat meandering cobble stream, tends to deposit gravel and create new meanders in some areas. Sediment supply in this type of stream has a tendency to be low unless stream banks are in a very erodible condition (Rosgen, 1996, pg. 5-92).



Only 46% of Rock Creek's banks are stable in this reach. It is interesting to note that the upper and middle sections of the reach are more stable in general. The lower third banks are much more unstable. Examination of entrenchment figures show that in the stable section the streamside floodplain is wide, whereas at the lower end the streamside floodplain is 25% narrower. This narrower floodplain coupled with fewer willows, means the stream has more energy to put into eroding the banks. The C3 stream channel explains Rosgen "... is susceptible to accelerated bank erosion".

At the upper end of the reach mature willows are common. Part of the streamside floodplain is in a well-vegetated overflow channel. Other reaches of Rock Creek have only a few mature trees. The landowner indicated that the ranch had little vegetation 25 years ago.

Riparian Inventory
This stream has seen a substantial impact by human activity. Immediately upstream of the reach, all shrub and tree vegetation has been removed from the channel in an attempt to improve flood control. The land owner along this reach, however, has refused access to allow vegetation clearing.

Just above the reach the streambed has been entered with heavy equipment to plow cobble and gravel from the channel. Mounds of stream deposits form the right bank of the creek. In addition, a windbreak composed of non-native species of cypress, cottonwood and *Osage* orange tops the left bank. These provide most of the shade on the stream.

Despite these factors, the streambed itself has native willows and to some extent has a “natural” feel. The south bank is un-leveed with willow, valley oak and California wild grape in front of the windbreak. Behind the windbreak is a large kiwi orchard. The right or north bank has evidence of some plowing in the past, and now has extensive willow thickets and other riparian vegetation. Just beyond the top of the north bank is a dirt road and extensive open grasslands that are used for grazing.

GREENLINE TRANSECT

Woody species are dominant in a total 56% of this reach's vegetation. Of this, 77%, was of woody community types dominated by a native species. Herbaceous communities covered 42% of the reach with only 7% of that dominated by natives. The remaining 1% was bare ground.

The stability rating of this reach is 5.63, which is considered to be “moderately” stable in terms of vegetation development. The better condition of this reach is likely due to the remaining vegetation in place as well as wise ranching management on site.

APPENDIX A. SPECIES LIST

Upper Park Reach

Observed November 5, 11, 12, 16, and 19, 1998
Boldface type indicates a non-native species

SCIENTIFIC NAME	COMMON NAME
TREES & SHRUBS	
Alnus rhombifolia	white alder
Aristolochia californica	California pipevine
Baccharis salicifolia	mule's-fat
Brickellia californica	California brickellbush
Calycanthus occidentalis	***western spicebush***
Ceanothus cuneatus var. *cuneatus*	buckbrush
Celtis occidentalis	**eastern hackberry**
Cephalanthus occidentalis var. *californicus*	California button-willow
Cercis occidentalis	western redbud
Clematis ligusticifolia	virgin's-bower
Ficus carica	**edible fig**
Fraxinus latifolia	Oregon ash
Hedera helix	**English-ivy**
Heteromeles arbutifolia	toyon
Keckiella breviflora var.*glabrisepala*	gaping keckiella
Ligustrum vulgare	**privet**
Morus alba	**white mulberry**
Pinus sabiniana	gray pine
Platanus racemosa	western sycamore
Populus fremontii ssp. *fremontii*	Fremont's cottonwood
Pyracantha fortuneana	**Chinese firethorn**
Quercus kelloggii	California black oak
Quercus lobata	***valley oak***
Quercus wislizenii	***interior live oak***
Rhamnus tomentella ssp. *tomentella*	hoary coffeeberry
Rosa californica	California rose
Rosa multiflora	*rambler rose*
Rubus discolor	**Himalayan blackberry**
Rubus ursinus	California blackberry
Salix exigua	sandbar willow
Salix gooddingii	Goodding's black willow
Salix laevigata	red willow
Salix lasiolepis	arroyo willow
Salix melanopsis	dusky willow

Toxicodendron diversilobum	poison-oak
Umbellularia californica	California bay
Vitis californica	California wild grape

HERBACOUS PLANTS

Agrostis capillaris	**colonial bentgrass**
Amaranthus albus	**tumbleweed**
Ammannia coccinea	valley redstem
Artemisia douglasiana	mugwort
Arundo donax	**giant reed**
Avena barbata	**slender wild oat**
Avena fatua	**wild oat**
Bromus diandrus	**ripgut brome**
Carex nudata	torrent sedge
Centaurea solstitialis	**yellow star-thistle**
Chenopodium ambrosioides	**Mexican tea**
Chenopodium botrys	**Jerusalem-oak**
Conyza floribunda	**many-flowered horseweed**
Crypsis schoenoides	**swamp pricklegrass**
Cynodon dactylon	**bermuda-grass**
Cynosurus echinatus	**hedgehog dogtail**
Cyperus difformis	**small-flowered cyperus**
Cyperus eragrostis	tall cyperus
Cyperus niger	black cyperus
Cyperus strigosus	false nutsedge
Digitaria sanguinalis	**hairy crabgrass**
Echinochloa colona	**jungle-rice**
Eleocharis macrostachya	pale spike-rush
Elymus glaucus ssp. *glaucus*	blue wild-rye
Epilobium ciliatum ssp. *ciliatum*	fringed willowherb
Equisetum arvense	common horsetail
Equisetum laevigatum	smooth scouring-rush
Eremocarpus setigerus	turkey-mullein
Eriogonum nudum var. *pubiflorum*	hairy-flowered buckwheat
Gnaphalium luteo-album	**weedy cudweed**
Grindelia hirsutula var. *davyi*	foothill gumplant
Helianthus bolanderi	Bolander’s sunflower
Heterotheca oregona	Oregon golden-aster
Hirschfeldia incana	**Mediterranean hoary-mustard**
Holcus lanatus	**common velvetgrass**
Hypericum perforatum	**Klamathweed**
Juncus ensifolius	sword-leaved rush
Juncus (*patens*?)	spreading rush
Kickxia elatine	**sharp-leaved fluellin**
Lactuca serriola	**prickly lettuce**
Lathyrus sp.	pea

Leersia oryzoides	rice cutgrass
Lipocarpha aristulata	awned lipocarpha
Lotus corniculatus	**bird's-foot-trefoil**
Lotus purshianus var. *purshianus*	Spanish lotus
Lythrum hyssopifolium	**hyssop loosestrife**
Marah sp.	manroot
Marrubium vulgare	**horehound**
Medicago lupulina	**black medick**
Melilotus alba	**white sweet-clover**
Melissa officinalis	**bee-balm**
Mentha arvensis	American wild mint
Mentha spicata* var. *spicata	**spearmint**
Mentzelia laevicaulis	giant blazingstar
Mimulus cardinalis	scarlet monkey-flower
Mimulus (*guttatus*?)	seep monkey-flower
Muhlenbergia rigens	deergrass
Panicum capillare	witchgrass
Panicum miliaceum	**broom-corn millet**
Paspalum dilatatum	**dallisgrass**
Plantago lanceolata	**English plantain**
Plantago major	**common plantain**
Poa annua	**annual bluegrass**
Polygonum hydropiper	**water-pepper**
Polygonum punctatum	dotted smartweed
Polypogon monspeliensis	**annual beardgrass**
Prunella sp.	selfheal
Rumex crispus	**curly dock**
Saponaria officinalis	**bouncing-bet**
Scirpus (*acutus* var. *occidentalis*?)	hard-stemmed tule
Setaria pumila	**yellow bristlegrass**
Solanum americanum	American black nightshade
Sorghum halepense	**Johnsongrass**
Trichostema lanceolatum	vinegar-weed
Typha latifolia	broad-leaved cattail
Verbascum thapsus	**woolly mullein**
Verbena hastata	halberd-leaved vervain
Verbena litoralis	**shore vervain**
Xanthium strumarium	cocklebur

Lower Park Reach

Observed October 15, 20 and November 2, 1998
Boldface type indicates a non-native species

SCIENTIFIC NAME	COMMON NAME
TREES & SHRUBS	
Acer saccharinum	**silver maple**
Alnus rhombifolia	white alder
Aristolochia californica	California pipevine
Baccharis salicifolia	mule's-fat
Calocedrus decurrens	incense-cedar
Calycanthus occidentalis	western spicebush
Catalpa speciosa	**northern catalpa**
Celtis occidentalis	**eastern hackberry**
Cephalanthus occidentalis var. *californicus*	California button-willow
Cinnamomum *sp.*	*camphor*
Crataegus laevigata	**smooth hawthorn**
Eucalyptus camaldulensis	**red gum**
Ficus carica	**edible fig**
Fraxinus latifolia	Oregon ash
Hedera helix	**English-ivy**
Heteromeles arbutifolia	toyon
Juglans californica var. *hindsii*	northern California black walnut
***Juglans regia* (hybrid)**	**English walnut hybrid**
Ligustrum vulgare	privet
Lonicera japonica	**Japanese honeysuckle**
Morus alba	**white mulberry**
Pistacia chinensis	**Chinese pistache**
Platanus racemosa	western sycamore
Populus fremontii ssp. *fremontii*	Fremont's cottonwood
Prunus mahaleb	**mahaleb cherry**
Quercus lobata	***valley oak***
Quercus wislizenii	***interior live oak***
Rhamnus tomentella ssp. *tomentella*	hoary coffeeberry
Rosa sp.	rose
Rubus discolor	**Himalayan blackberry**
***Rubus* (thornless cultivar)**	**blackberry**
Rubus ursinus	California blackberry
Salix lasiolepis	arroyo willow
Salix lucida ssp. *lasiandra*	yellow willow
Sambucus mexicana	blue elderberry
Toxicodendron diversilobum	poison-oak
Umbellularia californica	California bay
Vitis californica	California wild grape

HERBACOUS PLANTS

Agrostis viridis	**water bentgrass**
Artemisia douglasiana	mugwort
Arundo donax	**giant reed**
Bromus diandrus	**ripgut brome**
Carex barbarae	Santa Barbara sedge
Carex nudata	torrent sedge
Cynodon dactylon	**Bermuda-grass**
Cyperus eragrostis	tall cyperus
Cyperus strigosus	false nutsedge
Darmera peltatum	Indian-rhubarb
Daucus carota	**Queen Anne's lace**
Juncus patens	spreading rush
Leersia oryzoides	rice cutgrass
Melilotus alba	**white sweet-clover**
Melissa officinalis	**bee-balm**
Mentha arvensis	American wild mint
***Oxalis* sp.**	**wood-sorrel**
Panicum acuminatum var. *acuminatum*	western panicgrass
Panicum capillare	witchgrass
Paspalum dilatatum	**dallisgrass**
Polygonum punctatum	dotted smartweed
Rumex pulcher	**fiddle dock**
Setaria pumila	**yellow bristlegrass**
Solanum americanum	American black nightshade
Verbascum thapsus	**woolly mullein**
Vinca major	*periwinkle*
Xanthium strumarium	*cocklebur*

Bidwell Avenue Reach

Observed May 22, 1999
Boldface type indicates a non-native species

SCIENTIFIC NAME	COMMON NAME
Tree and Shrub Species	
***Acacia* sp.**	**Wattle sp.**
Acer negundo	Box-Elder
Acer saccharinum	**Silver Maple**
Ailanthus altissima	**Tree-of-Heaven**
Alnus rhombabolia	White Alder
Calycanthus occidentalis	Western Spicebush
Catalpa speciosa	**Norhern Catalpa**
Celtis occidentalis	**Western Hackberry**
Faxinus latifolius	Oregon Ash
Ficus carica	**Edible Fig**
Hedera helix	**English-Ivy**
Juglans californica var. *hindsii*	Northern California Black Walnut
Juglans regia	**English Walnut**
Ligustrum vulgare	**Common Privet**
Morus alba	**White Mulberry**
***Pistacia* sp.**	**Pistachio sp.**
Platanus racemosa	Western Sycamore
Quercus lobata	Valley Oak
Quercus sp.	Oak sp.
Robinia	**Black Locust**
Salix sp.	Willow sp.
Sambucus mexicana	Blue Elderberry
Vitis californica	California Wild Grape
Herbaceous Species	
Artemisia douglasiana	Mugwort
***Avena* sp.**	**Wild Oat sp.(all non-native)**
Bromus dianderus	**Ripgut Brome**
Galium sp.	Bedstraw sp.(some native)
Hedera helix	**English Ivy**
***Latuca* sp.**	**Lettuce sp.(all non-native)**
Leersia oryzoides	Rice Cutgrass
Lolium multiflorum	**Annual Ryegrass**
Marah sp.	Manroot sp.(all native)
Marrubium vulgare	**Horehound**
Melilotus sp.	**Sweet-Clover sp.(all non-native)**
Phytolacca americana	**American Pokeweed**

Polyganum persicaria	**Lady's Thumb**
Rubus discolor	**Himalayan Blackberry**
Setaria pumila	**Yellow Bristlegrass**
Vinca major	**Periwinkle**
Xanthium strumonium	**Cocklebur**

Lindo Channel - 5 Mile Reach

Observed May 16 and 18, 1999
Boldface type indicates a non-native species

SCIENTIFIC NAME	COMMON NAME
TREES AND SHRUBS	
Acer macrophyllum	big-leaf maple
Aristolochia californica	California pipevine
Baccharis salicifolia	mule's-fat
Ceanothus cuneatus var. *cuneatus*	buckbrush
Ceanothus interiginus	deer grass
Cercis occidentalis	western redbud
Fraxinus latifolia	Oregon ash
Ligustrum vulgare	**privet**
Morus alba	**white mulberry**
Pinus sabiniana	gray pine
Platanus racemosa	western sycamore
Populus fremontii ssp. *Fremontii*	Fremont's cottonwood
Quercus lobata	valley oak
Quercus wislizenii	interior live oak
Rhamnus tomentella ssp. *Tomentella*	hoary coffeeberry
Rhus trilobata	skunkbrush
Rubus discolor	**Himalayan blackberry**
Rubus ursinus	California blackberry
Salix exigua	sandbar willow
Salix gooddingii	Goodding's black willow
Salix laevigata	red willow
Salix lasiolepis	arroyo willow
Salix melanopsis	dusky willow
Sambucus mexicana	blue elderberry
Toxicodendron diversilobum	poison-oak
Vitis californica	California wild grape
HERBACOUS PLANTS	
Achrachaena mollis	blow-wives
Aira caryophyllea	**silver European hairgrass**
Artemisia douglasiana	mugwort
Arundo donax	**giant reed**
Avena fatua	**wild oat**
Bromus diandrus	**ripgut brome**
Bromus hordeaceus	**soft chess**
Cardamine oligosperma	western bittercress
Carex barbarae	Santa Barbara sedge

Carex nudata	torrent sedge
Centaurea solstitialis	**yellow star-thistle**
Claytonia parviflora* ssp. *parviflora	**small-flowered miner's lettuce**
Cynodon dactylon	**bermuda-grass**
Cynosurus echinatus	**hedgehog dogtail**
Daucus sp.	
Equisetum arvense	common horsetail
Erodium brachycarpum	**short-fruited stork's-bill**
Geranium molle	**dove's-foot geranium**
Limnanthes sp.	meadowfoam
Lotus corniculatus	**bird's-foot-trefoil**
Lotus purshianus var. *purshianus*	Spanish lotus
Lotus sp.	lotus
Lupinus bicolor	bicolored lupine
Lythrum hyssopifolium	hyssop loosestrife
Marah fabaceus	manroot
Melissa officinalis	**bee-balm**
Mimulus glausescens	shield-bracted monkey-flower
Nemophila sp.	nemophila
Penstemon sp.	beardtongue
Petrorhagia dubia	**grass-pink**
Phacelia sp.	phacelia
Plantago sp.	plantain
Poa annua	**annual bluegrass**
Potentilla sp.	cinquefoil
***Rumex* sp.**	**curly dock**
Saponaria officinalis	**bouncing-bet**
Scirpus acutus var. *occidentalis*	hard-stemmed tule
Senecio vulgaris	**old-man-in-the-spring**
Spartium junceum	**Spanish-broom**
Spergularia rubra	**ruby sandspurry**
Stachys sp.	hedge-nettle
Verbascum thapsus	**woolly mullein**
Veronica arvensis	**field speedwell**
Vulpia bromoides	**six-weeks fescue**

LINDO CHANNEL-MADRONE REACH

Observed May 23, 1999
Boldface type indicates a non-native species

SCIENTIFIC NAME	COMMON NAME
Trees & Shrubs	
Alnus rhombafolia	White Alder
Baccharus salicifolia	Mule's-Fat
Calycanthus occidentalis	Western Spicebush
Ficus carica	**Edible Fig**
Fraxinus latifolia	Oregon Ash
Juglans californica var. hindsii	Northern California Black Walnut
Pinus echinata	
Populus fremontii	Fremont's Cottonwood
Prunus dulcis	**Almond**
Quercus lobata	Valley Oak
Rosa californica	California Rose
Rosa multiflora	**Rambler Rose**
Salix exigua	Sandbar Willow
Salix gooddingii	Goodding's Willow
Salix laevigata	Red Willow
Salix lasiolepis	Arroyo Willow
Salix melanopsis	Dusky Willow
Sambucus mexicana	Blue Elderberry
Sparteum junceum	**Spainish Broom**
Tamarix gallica	**French Tamarisk**
Vitis californica	California Wild Grape
Herbaceous	
Amaranthus albus	**Tumbleweed**
Artemisia douglasiana	Mugwort
Arundo donex	**Giant-Reed**
Aster chilensis	California Aster*
Avena fatua	**Wild Oat**
Bromus diandrus	**Ripgut Brome**
Bromus hordeaceus	**Soft Chess**
Carex nudata	Torrent Sedge*
Castilleja attenuata	Valley-Tassel*
Castilleja exserta ssp. *exserta*	Purple Owl-Clover*
Centauria solstitialis	**Yellow Star-Thistle**
Cerastium glomeratum	**Sticky Mouse-Eared Chickweed**
Chamaesyce nutans	**Large Spurge**

Chamaesyce maculata	**Spotted Spurge**
Chenopodium ambrosioides	**Mexican-Tea**
Chenopodium botrys	**Jerusalem-Oak**
Chenopodium strictum* var. *glancophyllum	**Glaucus-Leaved Goosefoot**
Convolvulus arvensis	**Bindweed**
Conyza canadensis	Canadian Horseweed*
Cynodon dactylon	**Bermuda-Grass**
Cynosurus echinatus	**Hedgehog Dogtail**
Cyperus erogostis	Tall Cyperus*
Datura wrightii	Thorn Apple*
Digitaria sanguinalis	**Crabgrass**
Echinochloa colona	**Jungle-Rice**
Eleocharis macrostachya	**Pale Spike-Rush**
Elymus glaucus ssp. *glaucus*	Blue Wild-Rye*
Elymus glaucus ssp. *jepsonii*	Jepson's Wild-Rye*
Epilobium brachycarpum	Tall Annual Willowherb*
Eremocarpus setigerus	Turkey-Mullein*
Erodium botrys	**Long-Beaked Stork's-Bill**
Escholtzia californica	California Poppy*
Filago gallica	**Narrow-Leaved Filago**
Galium aparine	Cleavers*
Geranium dissectum	**Cut-Leaved Geranium**
Grindelia sp.	Gum-Plant sp.(most native)*
Heterotheca oregona var. compata	Oregon Golden-Aster*
Hirschfeldia incana	**Mediterranean Hoary-Mustard**
Hordeum matinum* ssp. *gussoneanum	**Mediterranean Barley**
Hordeum murinum* ssp. *leporinium	**Hare Wall Barley**
Hypericum perforatum	**Klamathweed**
Isomeris arborea	Bladder-Pod*
Juncus bifonius	Toad-Rush*
Kickxia elatine	**Sharp-Leaved Fluellin**
Latuca serriola	**Prickly Lettuce**
Lolium multiflorum	**Annual Ryegrass**
Lotus purshianus var. *purshianus*	Spanish Lotus*
Lupinus bicolor	Bicolored Lupin*
Medicago praecox	**Mediterranean Bur-Clover**
***Melilotus* sp.**	**Sweet-Clover sp.(all non-native)**
Mentha arvensis	American Wild Mint*
Mentha spicata* var. *spicata	**Spearmint**
Mimulus bicolor	Yellow-and-White Monkey-Flower*
Mimulus glaucescens	Shield-Bracted Monkey-Flower*
Mollugo verticillata	**Indian Chickweed**
Muhlenbergia sp.	Muhly sp.(all native)
Panicum sp.	Panicgrass sp.(some native)
Paspalum dilitatum	**Dallisgrass**
Petrorhagia dubia	**Grass-Pink**
Plagiobothrys stipitatus var. micranthus	Small-Flowered Stalked Popcorn-

	Flower*
Plantago elongata	Elongated Plantain*
Plantago lancelata	**English Plantain**
Polygonum hydropiper	**Water-Pepper**
Polygonum persicaria	**Lady's-Thumb**
Polypogon monspeliensis	**Annual Beardgrass**
Portulaca oleracea	**Common Purslane**
Rubus discolor	**Himalayan Blackberry**
Rubus ursinus	California Blackberry*
Rumex conglomerata	**Green Dock**
Rumex crispis	**Curly Dock**
Rumex salicifolius	Willow Dock*
Sagina apelata	Dwarf Pearlwort*
Scirpus acutus ver occidentalis	Hard-Stemmed Tule*
Setaria pumila	**Yellow Bristelgrass**
***Solanum* sp.**	**Nightshade sp.(some native)**
Sorghum halepense	**Johnsongrass**
Tricostemma (lanceolatum?)	Bluecurls sp.(all native)*
Trifolium dubium	**Little Hob Clover**
Trifolium hirtum	**Rose Clover**
Triphysaria eriantha	Johnnytuck*
Verbascum blatteria	**Moth Mullein**
Verbascum thapsus	**Woolly Mullein**
Veronica peregrina ssp. xalapensis	Purslane Speedwell*
Vicia sativa	**Garden Vetch**
Vicia villosa	**Winter Vetch**
Vulpia myuros var. myuros	**Rattail Fescue**
Xanthium strumonium	**Cocklebur**

Sycamore Creek Reach

Observed May 23, 1999
Boldface type indicates a non-native species

SCIENTIFIC NAME	COMMON NAME
Trees and Shrubs	
Amaranthus cruentus	**Amaranth sp.**
Aira caryophyllea	**Silver European Hairgrass**
Aristida oligantha	Prairie Three Awn
Artemisia douglasiana	Mugwort
Arundo donax	**Giant Reed**
Avena sp.	**Wild Oat sp.**
Brassica rapa var. campetris	**Field Mustard**
Bromus hordeaceus	Soft Chess
Centaurea solstitialis	**Star-Thistle**
Chenopodium botrys	**Jerusalem Oak**
Claytonia parvifolia ssp. parvifolia	Small Flower Miner's Lettuce
Claytonia rubra ssp. rubra	Red-stemmed Miner's Lettuce
collinsia sparsiflora var. collins	Few-Flowered Collinsia
Clarkia purpurea ssp. quadrivulnera	Purple Clarkia
Crucianella angustifolia	Crosswort
Cynosurus echinatus	Hedgehog Dogtail
Cyperus eragrostis	Tall Cyperus
Draba verna	**Spring Whitlow Grass**
Eleocharis macrostachya	Pale Spike-Rush
Epilobium brachycarpum	Tall Annual Willowherb
Epilobium sp.	(Too many kinds of common name to be specific, all native)
Erigonum nudum var. ??	Buckwheat sp.
Eremocarpus setigerus	Turkey-Mullein
Eschscholzia californica	California-Poppy
Hirschfeldia incana	**Mediterranian Hoary-Mustard**
Hordeum marinum ssp.leporinum	Hare Wall Barley
Hypericum perforatum	**Klamathweed**
Leersia oryzoides	Rice Cutgrass
Lamium amplexicaule	**Giraffehead**
Lepidium nitidum var. nittidum	Shining Pepper-grass
Lindernia dubia	False Pimpernel
Lotus purshianus var. purshianus	Spanish Lotus
Lolium multiflorum	Annual Ryegrass
Lupinus bicolor	Bicolored Lupine
Lupinus succulentus	Succulent Lupine
Madia sp.	Tarweed sp. (all native)
Mentzelia laevicaulis	Giant Blazingstar

Mimulus glaucescens	Shield-Bracted Monkey-Flower
Mollugo verticillatta	**Indian-Chickweed**
Muhlenbergia rigens	Deergrass
Nemophila hetrophylla	Variable-Leaved Nemophila
Nemophila menziesii ssp. menziesii	Baby Blue-Eyes
Phlox gracilis	Slender Phlox
Plantago lanceolata	English Plantain
Polygonum persicaria	Lady's-Thumb
Populus fremontii	Fremont Cottonwood
Petrorhagia dubia	**Grass-Pink**
Rumex crispus	Curly Dock
Salix exigua	Sandbar Willow
Salix lasiolepis	Arroyo Willow
Salix lucida ssp.lasialandra	Yellow Willow
Salix melanopsis	Dusky Willow
Senecio vulgaris	Old-Man-In-The-Spring
Stellaria media	**Common Chickweed**
Trichostema lanceolatum	Vinegar-Weed
Typha sp.	Cattail sp. (all native)
Verbascum blattaria	**Moth Mullein**
Verbascum thapsus	**Woolly Mullein**
Veronica anagallis aquatica	**Great Water Speedwell**
Vicia villosa ssp. varia	**Winter Vetch**
Xanthium strumarium	Cocklebur

MUD CREEK REACH

Observed May 23, 1999

Boldface type indicates a non-native species

SCIENTIFIC NAME	COMMON NAME
Tree and Shrub Species	
Baccharis salicifolia	Mule's-Fat
Cephalanthus occidentalis	California Botton-Willow
Faxinus latifolius	Oregon Ash
Populus fremontii	Fremont's Cottonwood
Spartium junceum	**Spainish-Broom**
Herbaceous Species	
Artemisia douglasiana	Mugwort
Avena sp.	**Wild Oat sp.(all non-native)**
Briza minor	**Lesser Quaking-Grass**
Bromus dianderus	**Ripgut Brome**
Bromus hordeaceus	**Soft Chess**
Centauria solstitialis	**Yellow Star-Thistle**
Daucus sp.	Daucus sp. (2 sp. 1 is native)
Eleocharis sp.	Rush sp. (most native)
Erodium sp.	**Erodium sp. (all non-native)**
Geranium dissectum	**Cut-Leaved Geranium**
Hirshfeldia incana	**Mediterranean Hoary-Mustard**
Juncus xiphioides	Iris-Leaved Rush
Latuca sp.	**Lettuce sp. (all non-native)**
Lolium multiflorum	**Annual Ryegrass**
Plantago sp.	**Plantain sp. (most non-native)**
Polyganum hydropiper	**Water-Pepper**
Polygonum persicaria	**Lady's-Thumb**
Rubus discolor	**Himalayan Blackberry**
Rumex crispus	**Curly Dock**
Rumex salicifolius	Willow Dock
Taeniatherum caput-medusea	**Medusa-Head**
Trifolium sp.	Clover sp. (most native)
Vicia sp.	**Vetch sp. (most non-native)**
Xanthium strumonium	**Cocklebur**

Rock Creek Reach

Observed May 23,1999
Boldface type indicates a non-native species

SCIENTIFIC NAME	COMMON NAME
TREES & SHRUBS	
Acacia sp.	**wattle**
Alnus rhombifolia	white alder
Aristocholia californica	California pipevine
Baccharis salicifolia	mule's-fat
Calycanthus occidentalis	western spicebush
Ceanothus cuneatus	buckbrush
Cercis occidentalis	western redbud
***Cupressus* sp.**	**Cypress (cultivar)**
Ficus carica	**edible fig**
Fraxinus latifolia	*Oregon ash*
Maclura pomifera	**osage-orange**
Morus alba	**white mulberry**
Pinus sabiniana	gray pine
Platanus racemosa	western sycamore
Populus fremontii ssp. *fremontii*	Fremont's cottonwood
***Populus* sp.**	**cottonwood (cultivar)**
Quercus lobata	valley oak
Quercus wislizenii	interior live oak
Rhamnus tomentella ssp. *tomentella*	hoary coffeeberry
Salix exigua	sandbar willow
Salix laevigata	red willow
Salix lasiolepis	arroyo willow
Salix melanopsis	dusky willow
Sambucus mexicana	blue elderberry
Vitis californica	California wild grape
HERBACEOUS PLANTS	
Artemisia douglasiana	mugwort
***Avena* sp.**	**wild oat**
Bromus diandrus	**ripgut brome**
Carex feta	green-sheathed sedge
Carex nudata	torrent sedge
Carex subfusca	rusty slender sedge
Centaurea solstitialis	**yellow star-thistle**
Cerastium glomeratum	**sticky mouse-eared chickweed**

Chenopodium sp.	goosefoot
Clarkia purpurea ssp. *quadrivulnera*	purple clarkia
Crucianella angustifolia	**crosswort**
Cynosurus echinatus	**hedgehog dogtail**
Cyperus eragrostis	tall cyperus
Dianthus armeria* ssp. *armeria	**deptford pink**
Digitaria sanguinalis	**hairy crabgrass**
Eleocharis macrostachya	pale spike-rush
Epilobium sp.	willowherb
Eremocarpus setigerus	**turkey-mullein**
Eschscholzia californica	California-poppy
Galium sp.	cleavers
Heterotheca oregona	Oregon golden-aster
Hypericum perforatum	**Klamathweed**
Juncus bufonius	toad rush
Juncus tenuis	slender rush
Juncus xiphioides	iris-leaved rush
***Lactuca* sp.**	**lettuce**
Leersia oryzoides	rice cutgrass
Lolium multiflorum	**annual ryegrass**
***Medicago* sp.**	**bur-clover**
Melilotus sp.	sweet-clover
Mentha arvensis	American wild mint
Mentha spicata* var. *spicata	**spearmint**
Mimulus cardinalis	scarlet monkey-flower
Mimulus glaucescens	shield-bracted monkey-flower
Mimulus guttatus	seep monkey-flower
Mimulus sp.	monkey-flower
***Oxalis* sp.**	**wood-sorrel**
Panicum sp.	panicgrass
Petrorhagia dubia	**grass-pink**
Plantago lauceolata	**English plantain**
Polygonum persicaria	**lady's-thumb**
Polygonum sp.	smartweed
***Polypogon* sp.**	**beardgrass**
Ranunculus sp.	buttercup
Rorippa nasturtium-aquaticum	watercress
Rumex crispus	**curly dock**
Rumex salicifolius	willow dock
Solanum sp.	nightshade
Sorghum halepense	**Johnsongrass**
Stachys sp.	hedge-nettle
Trifolium hirtum	**rose clover**
Typha sp.	cattail
Verbascum blattaria	**moth mullein**
Verbascum thapsus	**woolly mullein**
Veronica anagallis-aquatica	**great water speedwell**

Cascade Creek Reach

Observed October 22, 27, 30, and November 3, 1998
Boldface type indicates a non-native species

SCIENTIFIC NAME	COMMON NAME
TREES & SHRUBS	
Abies concolor	white fir
Alnus incana ssp. *tenuifolia*	mountain alder
Calocedrus decurrens	incense-cedar
Ceanothus integerrimus	deerbrush
Cornus sessilis	black-fruited dogwood
Corylus cornuta var. *californica*	California hazelnut
Pinus contorta ssp. *murrayana*	Sierra lodgepole pine
Pinus lambertiana	sugar pine
Pinus ponderosa var. *ponderosa*	Pacific ponderosa pine
Pseudotsuga menziesii var. *menziesii*	douglas-fir
Quercus chrysolepis var. *chrysolepis*	canyon live oak
Quercus kelloggii	California black oak
Rhamnus purshiana	cascara
Rosa gymnocarpa	bald-hip rose
Rubus discolor	***Himalayan blackberry***
Salix lucida *ssp*. lasiandra	*yellow willow*
Salix melanopsis	dusky willow
Smilax californica	California greenbrier
HERBACEOUS PLANTS	
Achillea millefolium	yarrow
Agrostis exarata	spiked bentgrass
Agrostis stolonifera	***creeping bent***
Aquilegia formosa	crimson columbine
Aster eatonii	Eaton's aster
Carex amplifolia	ample-leaved sedge
Carex bolanderi	Bolander's sedge
Carex jonesii	Jones' sedge
Carex subfusca	rusty slender sedge
Cirsium sp.	thistle
Darmera peltata	Indian rhubarb
Epilobium ciliatum ssp. *ciliatum*	fringed willowherb
Equisetum arvense	common horsetail

Equisetum hyemale ssp. *affine*	common scouring-rush
Galium triflorum	sweet-scented bedstraw
Geum macrophyllum	big-leaved avens
Glyceria elata	tall mannagrass
Holocus lanatus	**common velvetgrass**
Juncus effusus	bog rush
Juncus xiphioides	***iris-leaved rush***
Lilium pardalinum ssp.	lily
Lotus oblongifolius var. *oblongifolius*	streambank lotus
Oxypolis occidentalis	western cowbane
Plantago lanceolata	*English plantain*
Platanthera leucostachys	white bog orchid
Poa pratensis* ssp. *pratensis	**Kentucky bluegrass**
Prunella vulgaris var. *lanceolata*	mountain selfheal
Rumex salicifolius var. *denticulatus*	smooth-valved willow dock
Scirpus microcarpus	small-fruited bulrush
Stachys sp.	hedge-nettle
Trifolium sp.	clover
Trifolium wormskioldii	springbank clover
Veronica sp.	speedwell or brooklime
Viola sp.	Violet

FIRE AND FIRE HISTORY / MANAGEMENT

— INTRODUCTION —

This chapter addresses the history of fire and fire management within the Big Chico Creek watershed. It also summarizes the urban and wildland fire response systems in place within the watershed.

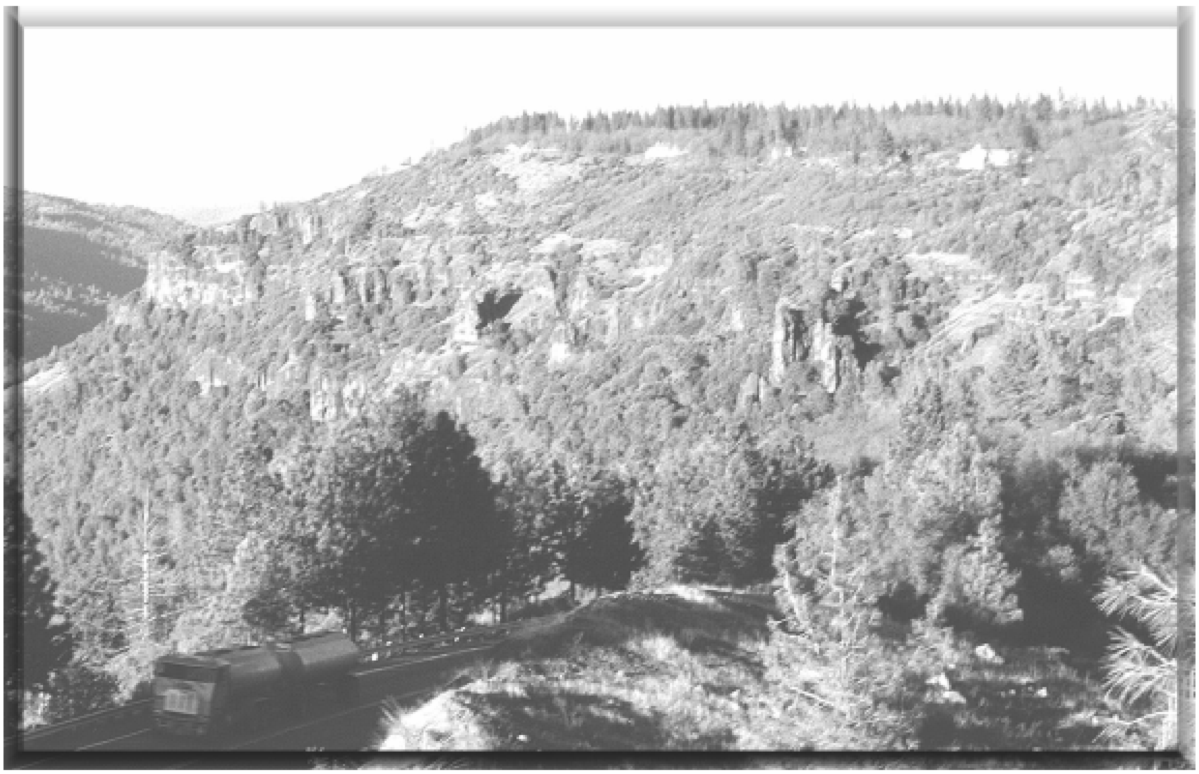
AREA OVERVIEW

Big Chico Creek originates on Lassen National Forestlands on the southern slopes of conifer-covered Colby Mountain, 40 creek-miles northeast of the City of Chico at an elevation of about 6,000 ft. It enters the Sacramento River at river-mile 193, 5 miles west of Chico at an elevation of about 120 ft. The watershed reflects this 5,880 ft. elevation change with a diversity of vegetation types that includes members of nearly every plant series found in the Sierra Nevada Foothills. Plant series are used to describe groups of associated plant communities, and series are named for the species that dominate the vegetation. Some examples found within the watershed include the blue oak, interior live oak shrub, and ponderosa pine series. Each series has its own unique characteristics when it comes to flammability and density of vegetation per acre, and these attributes have a major impact on the intensity of a wildfire burning in any given vegetation type. In general, annual precipitation increases and average temperature decreases in direct relationship to elevation in the watershed, and these factors are the dominant mechanisms affecting the distribution of plant series types within the watershed (USDA Forest Service, Ecological Subregions of California, 1997).

A drive up Highway 32 or the Cohasset Highway, with their constant increase in elevation, provides an excellent introduction to the distribution of Foothill vegetation types. Starting from Bruce Road on Highway 32 or around the Airport on the Cohasset Highway, the grasslands of the lowest slopes of the foothills gradually begin to include scattered patches of blue oak, and within 2 or 3 miles, gray pine and live oak are present in the gullies. As precipitation increases with elevation, the size of the brush increases as well. Within 4 miles of Bruce Road (Highway 32), or within 6 miles of the Airport (Cohasset Highway), you have climbed 1,000 feet, and are well into the “chaparral” zone.

In the Big Chico Creek Watershed, “chaparral” describes a plant series dominated by brushy plants such as manzanita, whitethorn, and scrub and shrubby live oaks. These types of brush coincide with a wet-in-the-winter, dry-in-the-summer, Mediterranean climate. Throughout the Sierra Nevada Foothills, the chaparral occurs in the transition between the grasslands and oak woodlands of the lower elevations and the conifer forests of the wetter, cooler, higher elevation slopes. Chaparral vegetation is highly influenced by the aspect, or direction that a slope faces. On south facing slopes, where there is little competition for sunlight, the brush tends to grow denser and with a lower canopy. On north facing, shady slopes, increased competition for available light results in a taller canopy. Here easily ignited grass and brushy fuels intermix beneath gray pine and dense stands of oak to form a multiple-storied and highly flammable landscape. Chaparral plant communities have evolved in conjunction with frequent fires, and historically, this vegetation type has burned regularly.

In the Big Chico Creek Watershed, the chaparral zone is found starting around the Keefer Road turnoff from the Cohasset Highway, in the gullies above Horseshoe Lake and the golf course in Upper Bidwell Park, and about 4 miles above Bruce Road on Highway 32. On the Vegetation Map in the Appendix, this zone shows up where the Shrub, Montane Hardwood, and Oak Woodland classifications intermix. Within the lower and middle reaches of the watershed, the south facing walls of many of the small ravines and the Big Chico Creek, Rock Creek, and Mud Creek Canyons are covered with a mixture of brush, gray pine, and oak. The shadier north facing slopes tend to be covered with similar types of vegetation, but have a taller canopy. In areas such as Upper Bidwell Park, the amount of fuel per acre is much higher on the north facing slopes because of this.



The oak/conifer forest and chaparral vegetation types meet at the edge of the canyon rim.
By Zeke Lunder

At an elevation of around 2,000 ft. there is a fairly dramatic increase in annual precipitation, and the corresponding increase in weathering has helped to create the deep and well-drained soils of the ridgetops. The deeply weathered soils found on the ridgetops around the towns of Forest Ranch and Cohasset are recognized as having some of the highest site-productivity for forestland in the state, and are predominately covered with mixed-conifer pine forests. (Conlin, personal communication, 1998) The effects of slope and precipitation on vegetation type and size are readily apparent where the steep canyon walls meet the flat ridgetops. A good example of this can be found about a mile and a half south of Forest Ranch, where the highway leaves the narrow ridge between Big and Little Chico Creeks and climbs onto the top of the widening ridge. A similar vegetation break occurs on the Cohasset Highway about ½ a mile south of Vilas

Road where the road leaves the canyon of the Anderson Fork of Rock Creek and climbs into the flatter forestlands of Cohasset Ridge. In these areas, vigorous ponderosa pine, douglas fir, and black oak enjoy the deeper soils of the flat ridgetop. This rapid transition from oak woodland and chaparral to a mixed-conifer forest illustrates the variability of fuel types and fuel densities within the watershed.

A continuous loading of fuel from the forest floor to the crowns of the tallest trees makes these junctions of chaparral and conifer forest critical zones when it comes to fuel planning. An example of this fuel combination can be seen just below the trailer park on Cohasset Road, about 1 mile north of Vilas Road, or 1.5 miles south of Forest Ranch on the east side of Highway 32. Here, 6-8 foot tall manzanita bushes are growing densely below mixed-age ponderosa pine. Under the quite common late-summer combinations of low fuel-moisture and afternoon upslope winds, these zones represent an area in which brush fires burning up from the canyons can move into the upper canopy of conifer forests on the ridgetops. If the canopy of the conifer forest is of sufficient density, the fire can burn through the forest, leaping from crown to crown of the trees. This is called a “crown fire”. Crown fires occur when there is a continuous column of fire from the ground level to the tops of the larger trees. Initially, crown fires can’t burn without thick fuels in the understory, as without these there is usually insufficient heat to dry and ignite the wet needles and branches in the canopy of adjacent trees.

Once a fire has established itself in the crowns, however, it can generate sufficient heat to ignite adjacent trees.

Since the turn of the century, Californians have been aggressively suppressing fire, and this activity, coupled with the selective harvest of conifer trees, has resulted in a landscape that has a much higher density of fuel per acre than it had 100 years ago. The selective harvest or “overstory removal” of the larger trees in the forest has the effect of opening up the canopy of the forest and letting more light shine down on the forest floor. This increases the viability of tree seedlings, which leads to more trees per acre. Historically, low intensity wildfires would periodically burn through the forestlands, killing small, suppressed trees while leaving the taller trees unburned. Now that this natural “weeding” mechanism is gone, the suppressed understory trees are able to grow up below the crowns of the larger trees, creating a “fire ladder” effect which can easily deliver small ground fires up into the crowns of the larger trees.

Crown fires usually burn with “stand-replacing” intensity. “Stand-replacing,” describes fires that burn and kill all of the trees within a given area. The large columns of smoke and superheated air rising off of a large crown fire can have a major influence on local weather conditions; creating strong hot winds which preheat adjacent fuels and accelerate the spread of the fire. The intensity at which these fires burn makes them very difficult to extinguish.

— RECENT FIRE HISTORY —

The attached Fire History Map shows fires greater than 300 acres that have occurred within the area in the last 100 years. If the reader of this document notices missing fires that fit this description, please call Jeff Harter at the Oroville CDF office (538-7111). Data for the map was taken from CDF fire reports dating back to the 1950’s and from the United States Geological

Survey National Aerial Photography Program, which flies high altitude photo flights of the entire U.S. every 5 years. The US Forest Service provided information on fires occurring before the 1950s.

Historically, fires were started by Native Americans and by lightning. Native Americans started fires for hunting purposes to kill acorn worms in acorns that were on the ground and to make travel through the wildlands easier. The many overlapping fires within the Ishi Wilderness area west of Campbellville are the product of lighting strikes, powerline failures, and other human caused ignitions. This area is in a drier climatic zone than that of the Big Chico Creek watershed and has few roads for firefighter access. Some areas within the Ishi wilderness area have burned seven times in this century. The large fire that covered this region most recently is the Campbell fire, which burned 131,000 acres in 1990.

Looking at the distribution of fire throughout the decades, perhaps more important than areas that have burned are the areas that have not. Aside from the fires that occurred in the Campbell Creek area in the 1950s, most of the area within the main canyon of Big Chico Creek has not burned catastrophically since the 1910s or 1920s. That the entire area between Forest Ranch and Cohasset is white on the map might lead to questions about when this area will burn. Natural ignitions from lightning tend to start fires atop ridges, but historically, once these fires took off, many of them carried down into adjacent canyons. Examples of this behavior are seen in many of the larger fires on the Fire History map, and in the “Bidwell Fire” of the 1980s. This fire was started by powerlines near the junction of Humboldt Road and Highway 32 and burned down across Little Chico Creek, up Doe Mill Ridge, and then down into Butte Creek Canyon. Notice that many of the fires on the Fire History map that follow waterways such as Pine Creek, Rock Creek, and Campbell Creek are elongate with the direction of the creek’s flow. The large 1910s fire that started low on Rock Creek and the 1950s fire on Campbell Creek are good examples of fires that spread upstream. This might indicate that fires ignited in the valley or in the Bidwell Park area could have burned up the canyons.

Limited access to Big Chico Creek canyon above Bidwell Park may be one of the reasons that the area has not burned recently, and the recent addition of gates on many of the private roads in the area further decreases the risk of ignition. Decreased ignition risk is not necessarily equated with long-term benefits though, as it can only add to an already heavy level of fuel loading.

— WILDFIRE SUPPRESSION —

Butte County has contracted the services of CDF since 1931 to provide unincorporated areas with structural and wildland fire protection, technical rescue, and basic life support through the Butte County Fire Department (BCFD). Combined, CDF and the BCFD operate 42 Fire Stations, 65 Engines, 1 Airbase, 1 Fire Center, approximately 100 career personnel, 160 seasonal employees, and approximately 455 volunteers at 21 volunteer fire companies. Through the Interagency Emergency Command Center (ECC) in Oroville, CDF/BCFD acts as the 911 dispatching center for all non-law enforcement emergency services in Butte County, an area is referred to as the Butte Ranger Unit (BTU) (Hawkins, personal communication, 1998).

Effective fire suppression requires the coordination of many different resources. In an aggressive initial attack on a fire, aircraft, engines, bulldozers and fire-crews all play a vital role. However, each wildland fire situation is different, and in some cases, one resource can play a more important role than the others. For example, it is difficult to run a bulldozer on many of the mudflow slopes of the foothills as the “lavacap” is steep, rocky, and interrupted by numerous gullies. To effectively link the broken lines cut by bulldozers here, hand crews are needed, but as many areas within the watershed haven’t burned in the last 100 years, thick accumulations of fuel, coupled with upslope afternoon winds that are typical during fire season make many of the foothill slopes very dangerous places to deploy hand crews without the support of airtankers to slow the spread of the fire(McAdams, personal communication, 1998).

WATER AVAILABILITY

COHASSET AREA

In many of the upland areas, water can be hard to find. Cohasset station personnel can fill their engines and water tenders from 10,000-gallon tanks at the CDF or volunteer stations, but these tanks are refilled by pumps that run only at 20-30 gallons per minute. There is a drafting pit for engines and water tenders on Maple Creek at the old CDF station on Vilas Road, and several private ponds in the Cohasset area. Above Cohasset, there are fewer sources, and many of Big Chico Creek's tributaries, such as Campbell Creek, can dry up in the summer. There is a 5,000-gallon water tank at Cold Spring on Cold Spring Hill at the top of the 150 G Line. Above this point, as the H-Line follows the ridgeline between Deer and Big Chico Creeks, there are few water sources, and water tenders must go down the H-Line to Big Chico Creek at Soda Springs.

FOREST RANCH AREA

Around the Forest Ranch area, there is a 10,000 gallon water tank at the CDF station, 3 10,000-gallon tanks at the volunteer station, a 4,600-gallon tank off of Headwaters Road, 65,000 gallons in tanks at the Humboldt Woodlands subdivision below Forest Ranch on Highway 32, and 30,000 gallons at the Humboldt Highlands subdivision at 14 Mile House. There is also a 50,000-gallon reservoir at the Forest Knolls Tract in Forest Ranch. These tanks are all on wells, and take many hours to refill. There is a water tank at the Forest Ranch School, and some of the private landowners in the area have ponds or tanks that CDF can use (Marcum, personal communication, 1998).

ACCESS

Firefighter response times in the watershed reflect the topography and the distribution of human habitation. As most recreation and resource related activity occurs close to transportation corridors, most human-caused fires occur in areas that are accessible to firefighters and their equipment. There is little human habitation in the upper watershed of Big Chico Creek above Campbellville**.** This decreases the risks of ignition in these areas, but also means that detection of and response to fires in these areas will be slower. In many cases, a fire caused by woodcutters or logging equipment will get a quick enough response to keep it relatively small. Naturally ignited (lightning) fires often occur in remote areas and access problems can give the fire a chance to establish itself before suppression efforts can begin.

On the ridgetops along both sides of Big Chico Creek, much of the area above Ponderosa Way and extending northward to the top of the watershed is managed for industrial timber production and is heavily roaded. The landscape here is characterized by flat ridgetops covered in conifer forests, which are cut by the steep tributaries to Big Chico Creek. The main canyon of Big Chico Creek above the 150 G Line features slopes covered with Pine, Fir, and Oak forests. Sierra Pacific Industries (SPI) owns or manages most of this land, and their predecessors, Diamond Lands, built an extensive network of railroad grades for log-hauling trains in the early part of this century. These grades became the arterial routes when they were converted to haul roads for log trucks. Many spur roads branch off of these main roads, and these provide good access for fire equipment to the flatter areas of the upper watershed.

Topography, resource values, and road density are related, as many of the canyon walls are too precipitous for road building, or are lacking in merchantable timber, which would justify the construction of logging roads. The areas lacking roads are places where a slowed response can give a fire the chance to establish itself before any suppression can take place. The few roads that access the bottom of the canyon are narrow with tight corners, with few or no turnaround points. These are dangerous areas within which to deploy fire equipment. Fire equipment can easily become trapped in the path of the fire if vehicles are unable to turn around or if equipment above them becomes stalled or stuck.

There are few roads that access the bottom of Big Chico Creek Canyon between the end of Upper Bidwell Park and Highway 32, nearly 20 miles upstream. Access points from Highway 32 for Forest Ranch firefighters include: The “Greengate” Road at “10-Mile House” off of Highway 32, the “14-Mile House” Road, Ponderosa Way from Forest Ranch to Cohasset, the “150 G Line”, which runs from Highway 32 down to Big Chico Creek, and then up Campbell Creek to the “H-Line”, and the “90 G Line”, which leaves Highway 32 one mile south of Lomo and accesses the area south of where Nine-Mile Creek enters Big Chico Creek. The only accesses to the bottom of the canyon for Cohasset firefighters are Ponderosa Way and the “150 G Line”. Ponderosa Way is in very poor condition, and fire engines must travel very slowly over it. Bulldozer transports can’t negotiate the road and bulldozers must be brought in on the ground (Kielhorn, personal communication, 1998). *(Fire History map has road names on it.)*

BIDWELL PARK

The City of Chico Fire Department (Chico FD) is responsible for an initial attack on all fires originating within Bidwell Park. If a fire is reported which poses a threat to the CDF State Responsibility Area, the Butte County Fire/CDF Emergency Command Center (ECC) in Oroville will dispatch CDF resources. It takes at least 20 minutes for a Chico City engine to reach the bottom of the canyon on the “Greengate” Road off of Highway 32 at the northeastern end of Upper Park. City engines responding from Station 1 on Salem Street take 15 minutes to reach the end of the Upper Park Road, and the construction of the new station at Wildwood and Manzanita Avenues will cut five to seven minutes off of this time. For rescues and time-critical medical calls to these areas, a CDF or Butte County Sheriff’s Department Search and Rescue helicopter may be dispatched.

The north portion of the park running along the Upper Park Road is considered to be the area at greatest risk of ignition due to its dry fuels and heavy use. There is good access to the base of the north side of the canyon, and the north rim trail has historically been maintained as a fire road and can still be used by CDF. The road has been widened in many places by erosion and can be used as a firebreak. The fuels are generally thicker on the north-facing slopes of the South Rim, but less use here means that there is a lower threat of ignition. (Beardsley, personal communication, 1998) Public acquisition of the Simmons Ranch property in the area north of Upper Park raises issues relating to the impacts of increased human access on wildfire ignition risk (Harter, personal communication, 1998).

As City-owned wildlands within Bidwell Park are protected by the Chico FD, their lack of specialized wildland firefighting equipment is an issue of concern. The city has no bulldozers, large water tenders, aircraft, or fire crews. These resources are available through mutual-aid from CDF/BCFD, but they are not automatically dispatched to fires occurring within the park.

CANYONS

The canyons of Big Chico Creek and its tributaries are as deep as 1,000 feet below the ridgetops in some places, and the steep canyon walls present many obstacles to firefighting equipment. In the lower to middle stretches of the canyon, the steep walls are often covered with chaparral and other fire-adapted vegetation that is thicker now than it was before European settlement and the suppression of wildfire. The steep slopes of the canyons make it difficult if not impossible to engage in fuel modification (brush thinning) as well. There are few safe ways to thin the chaparral vegetation in many of the steep areas within the canyons.

There are few roads that access the steep slopes of Big Chico Creek Canyon between the end of Upper Bidwell Park and Highway 32, nearly 20 miles upstream. By Zeke Lunder

On the steepest slopes of the canyons, the usefulness of bulldozers to construct a fireline is minimal, and airtankers are unable to fly low enough to attack fires directly, and must “stairstep” bands of retardant along the canyon walls as low as they can fly. In these areas, helicopters with large “monsoon” buckets are the most effective equipment. Their usefulness is limited by access to deep, calm pools, as moving water can fill the bucket and drag a helicopter down. The ponds at California Park, Horseshoe Lake, and ponds around Cohasset are all bodies of water from which the helicopters can fill their buckets. Winds and powerlines are factors that can restrict the usefulness of aircraft, especially in the canyons. In Upper Bidwell Park the powerlines limit the usefulness of airtankers because the pilots like to drop their retardant while headed down toward the valley. While a rapid response by helicopters and airtankers can slow the spread of a fire, containing a blaze usually requires hand-crews that will have to hike into the area (Davis, personal communication, 1998).

The west-facing canyon walls below the town of Forest Ranch are vegetated with a thick cover of chaparral that is intermixed with live oak, manzanita, and gray pine. The late afternoon sun dries these fuels, and the heating of the upper rim of the canyon relative to the shade in the bottoms creates upslope breezes. Many expensive homes have been built along the rims of the canyons to take advantage of the views out over the Sacramento Valley 2,000 feet below. The steep slopes below the ridgetops present access problems for ground-based firefighting equipment, in many cases, CDF can be put in the position of having to attack fires burning up from the canyons right at the ridgeline. Structures have priority over other resources in the urban-wildland interface, and this means that CDF often has its hands full protecting structures and evacuating residents, rather than having time to aggressively attack a blaze before it can establish itself as a crown fire that jeopardizes forestlands and other homes atop the ridge.

RESPONSE SYSTEM

CDF and the BCFD have divided the county into over 100 Fire Response zones. These areas are usually defined by natural features such as ridgelines and creeks, and also reflect where the nearest firefighting resources are located. When a vegetation fire is reported, the dispatcher can use a countywide database to determine which response zone the fire falls within, and print out a sheet that lists the closest resources to be dispatched to the call.

Dispatch levels are a rating of the fire hazard for an area. For example, during the winter and spring months, grasses are usually green, and fuel moisture levels high, making brush and twigs more resistant to ignition. Dispatch levels during these months are usually low. During fire season, CDF uses information from telemetric climate stations several times a day to establish dispatch levels for each response area. These stations collect data at the Mendocino National Forest Genetic Research Center off of Skyway, on Cohasset Ridge, and in Butte Meadows. The dispatch level is based on factors such as fuel moisture, time of day, recent temperatures, and recent precipitation. The BCFD/CDF uses the dispatch level to decide how many resources to send to a fire reported in any specific area. For example, a vegetation fire reported in the area south of Forest Ranch under a Low dispatch level would result in the scrambling of 2 Fire Engines carrying 3-6 firefighters and a Battalion Chief. Under a High dispatch level, the same call would result in the dispatch of: 1 Air-Attack Group Operations Supervisor in a spotter plane, 2 airtankers, 1 helicopter, 1 battalion chief, 6 fire engines, 2 bulldozers, 2 fifteen-person hand crews, and 2 water tenders.

— FIREFIGHTING RESOURCES —

CHICO URBAN AREA FIRE RESOURCES

The City of Chico Fire Department has 42 full-time firefighters, 35 volunteers, 5 administrators (including 2 chiefs), 3 fire prevention officers, and a training director. These employees staff four stations, and work has begun on a fifth. Each station staffs an engine, and has a reserve engine on hand to cover the station when the primary engine is called out.

1. Station 1 is located between 8th and 9th streets on Salem.
2. Station 2 is located one block east of the Esplanade on E. 5th Avenue.
3. Station 3 is on Boeing Avenue at the Chico Airport.
4. Station 4 is located on Notre Dame Avenue in the Skypark Shopping Center.
5. Station 5 is located at the intersection of Wildwood and Manzanita Avenues.

- Station 1 has two engines, a wildland fire engine, a ladder truck, a hazmat truck, and a 4x4 patrol vehicle with a 300 gallon tank and pump used on brushfires.
- Station 2 has two engines, a ladder truck, a rescue unit, and a utility pickup truck.
- Station 3 has two engines and a aircraft crash-rescue unit.
- Station 4 has two engines and a foam trailer unit.
- Station 5 will have two engines.

As Chico continues to grow toward the northwest, probable sites for new Chico FD stations include one at Eaton Road and the Esplanade, and one on Highway 32 at East Avenue. A new station on the west side of the City is a priority for both the County and the City, and if the City builds one first, the county might not need to do so.

BUTTE COUNTY FIRE STATIONS IN THE CHICO CITY AREA

The BCFD currently operates four stations in the greater Chico urban area. They are:

1. Station 41, located a mile north of the Esplanade on Highway 99.
2. Station 42, located 2 miles north of Highway 99 on Cohasset Road.
3. Station 43 (a volunteer station), ¼ mile north of East Avenue on Highway 32.
4. Station 44, at 2334 Fair Street in South Chico.

- Station 41 staffs an engine, and staffs a bulldozer during fire season only, they use volunteers to staff a reserve engine, and a water tender.
- Station 42 staffs an engine, and uses volunteers to staff a rescue unit, a water tender, and a utility pickup.
- Station 43 uses volunteers to staff an engine, a communications unit, and a breathing support unit.
- Station 44 staffs an urban engine, and a state Office of Emergency Services (OES) urban engine.

VOLUNTEERS

There are five volunteer fire companies within the upper Big Chico Creek watershed. They serve the Chico City, Cohasset, Forest Ranch, and Butte Meadows areas.

- The Chico City FD has 40 volunteers.
- Company 42 in North Chico has 55 members. They staff equipment at stations 42,43, and 44, and may staff an engine at station 44 during extreme fire conditions.
- Company 22 is the Cohasset Volunteers. This company has 12-15 members who staff 2 4x4 engines, a 4x4 squad vehicle, and a 3700-gallon water tender.
- Company 24 refers to the combined forces of Butte Meadows/Forest Ranch Volunteers. This company operates Stations 10 and 24.
- The Forest Ranch Company has 14 to 15 volunteers who operate a 4WD engine, a 3,500-gallon water tender, and a 4WD-squad vehicle at station 24.
- Station 10 is the volunteer station in Butte Meadows. Their 8-15 personnel (less in the winter) staff a 4WD engine and a squad (rescue) vehicle.

All of these volunteer companies are dispatched through the Emergency Command Center (ECC) in Oroville.

CDF Butte County Fire Department Stations

Within the State Responsibility Area (SRA) of the watershed, the closest CDF/BCFD resources will respond to an initial attack on a fire. In addition to the three stations within the Chico Urban area, CDF/BCFD career personnel staff stations in Forest Ranch, Cohasset, Paradise, Butte College, Durham, and an interagency CDF/US Forest Service Station in Butte Meadows. See the Fire History map for a list of all CDF/BCFD stations within the Big Chico Creek area.

Cohasset Station 22

Station 22 staffs one wildland fire engine. The station is closed when the first rains set in, usually by November 1st.

Forest Ranch Station 23

Station 23 is a CDF station, and the BCFD pays the operating expenses in the winter so they can be staffed year-round as the primary emergency service provider for Forest Ranch, Butte Meadows, and Highway 32 East. They staff 2 engines during fire season, and one engine during winter (Davis, personal communication, 1998).

Butte Meadows Interagency Fire Station

The CDF and USFS engines (one of each) based at the Butte Meadows interagency fire station usually respond simultaneously to fires within their respective response areas, regardless of land ownership. The interagency station is staffed from May through October and closed for the winter. The Butte Meadows Forest Service engine is often called up to fires in Lassen and Modoc Counties, as this is where the bulk of the Lassen National Forest is located. The next closest USFS fire station is located in Chester, about 30 air miles to the north. Some of the areas in the headwaters receive their primary air support from the Chester Helitack and Air-Attack

Stations. The Butte Meadows Station is the first responding station into areas in the reaches of the watershed between the headwaters and the 150 G Line into Campbell Creek.

BUTTE FIRE CENTER

CDF/BCFD operates the Butte Fire Center (Station 17) for brushfire protection. This station staffs an engine only during extreme fire activity, but operates 5 crew transport vehicles, a Mobile Kitchen Unit, and 2 pickups. Butte County's three 15-person hand crews are stationed at the Center on Stieffer Road in Magalia and are run by the California Conservation Corps. The Fire Center also runs a training fire crew. When they are not busy fighting fires, they work on a variety of "reimbursible projects" for other state and federal agencies.

Butte County has no inmate fire crews, and the closest available crews are from Ishi Camp in Paynes Creek, Tehama County and Antelope Camp in Susanville, Lassen County. CDF captains run these 15-man crews. While the Tehama and Lassen inmate crews are available to work on pre-fire prevention projects such as fuels-thinning, they only work for 2 hours a day after travel time and lunch breaks. Because of this, the Butte Firesafe Council has asked the Butte County Board of Supervisors to consider establishing a work camp within the county. These crews would be available for fuel reduction and other project work, as well as for fire fighting (Harter, personal communication, 1998).

AERIAL RESOURCES AND THE CHICO AIRBASE

The Chico Air-attack base is part of a larger network of aerial fire resources in Northern California. There are Air-attack bases in Fortuna, Redding, Chico, Chester, Ukiah, Santa Rosa, Grass Valley, Reno, and Klamath Falls, Oregon. While all of these resources are shared among agencies, many of the aircraft are privately owned and operated on a contract basis. As using large newer planes is cost prohibitive, almost all of the airtankers in service today are refitted military aircraft. The planes out of Chico are about 30 years old. Factors limiting the usefulness of airtankers include powerlines, broadcasting aerials, steep canyons, high winds, shadows, and daylight, as they don't fly at night.

The Chico Airbase has two airtankers assigned to it, Tanker 18 and Tanker 74. Tanker 18 is capable of carrying 2,000 gallons of retardant and has constant-flow tanks that can regulate the amount of retardant applied on each drop. It is owned by Aero-Union Corp. and is operated on contract to the Mendocino National Forest. Tanker 74 is owned by CDF. It carries 800 gallons of retardant and has four drop-doors. This means that it is capable of dropping 4-200 gallon loads before it must return to the base for reloading. The air-attack base is in the process of converting Tanker 74 to a constant flow system similar to the one that is on Tanker 18. It takes between 10 and 15 minutes on the ground to refill an air-tanker, and this does not include time for refueling the plane.

Contracts with other air-attack bases in the area provide crews with 15 minutes from the time that their call arrives until they have to be in the air. If air-attack resources are used to fight fires within the Chico FD's jurisdiction, their services are paid for by the state only if the City has committed all of its available resources prior to requesting the aircraft. The City must pay the cost of *any* services provided by the federally owned Mendocino National Forest plane (Brown, personal communication, 1998).

Tankers based in Chico cover an area extending roughly from Wilbur Springs near Highway 20 on the west side of the Valley, north to Dairyville on Highway 99, northeast to Belden, and down to around Bangor on the southeast. This is their initial attack zone. Like all other fire resources, they are moved around the state as needed. There is one tanker based in Chester, two in Grass Valley, and three planes in Redding. A large wildland fire may require the use of many airtankers, and all of the Air-attack bases in the state are capable of supporting (refilling and refueling) multiple aircraft from other bases (Iverson, personal communication, 1998).

Concerns have been raised regarding the encroachment of residential development around the Chico Airport. During a large fire campaign, up to 75 air-tanker flights per day may take off from the Chico Airport. While engine-noise is a definite concern for local residents, another major concern is related to public safety. If a twin-engined air-tanker carrying 2000 gallons of retardant at 10 lbs. per gallon loses an engine during takeoff, they are forced to either dump their 20,000 lbs. of payload immediately or crash. If development fills the areas under the flight corridor for the tankers, they will have no place to safely dump their retardant.

The Airport Landuse Commission is empowered by the State Public Utility Commission and makes recommendations to the City and County Planning Commissions regarding the needs of the airport community. How development may affect the viability of the air-attack base is one issue that they are attempting to address. (Baldridge, personal communication, 1998) CDF has plans to expand their airbase operations to accommodate National Guard C-130 based airtankers. Chico will serve as a regional hub for these aircraft to use when they are in the area, which is only during very large wildfires (Holmes, personal communication, 1998).

HILICOPTER

The Vina Helitack base is located about 12 miles northwest of Chico on Highway 99. The staff consists of a crew of 7 helitack firefighters plus pilots and helicopter maintenance personnel. Their Bell Super Huey Helicopter can carry 11 people plus a pilot, and when used with a monsoon bucket, it is capable of carrying 324 gallons of water at a time. They can respond to calls within 2-5 minutes, and be above Cohasset within 6-10 minutes of receiving a call (Costa, personal communication, 1998).

As the entire western slope of the Sierra Nevada and large areas of Southern California have vegetation types similar to those of the Big Chico Creek watershed, late-summer fire hazards are often similar throughout the state. As any large wildland fire suppression effort will require resources beyond what are available in the local area, the California Department of Forestry and Fire Protection (CDF), the U.S. Forest Service (USFS), Bureau of Land Management (BLM), and many local fire departments share resources. This means that during periods of high fire activity, resources such as aircraft, engines, bulldozers, and personnel may be sent to areas outside of their normal response areas. If resources leave the area, equipment from other local stations or from adjacent Ranger Units will move to cover the empty stations left behind.

— EXISTING FIRE MANAGEMENT PLANS —

CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION

CDF is required by Section 4114 of the California's Public Resources Code to periodically update the California Fire Plan. This is a planning document that sets forth a framework for the development of more specific wildland fire protection plans. The current California Fire Plan was approved in September of 1996 by the State Board of Forestry. The California Fire Plan has five strategic objectives. They are:

1. To create wildfire protection zones that reduce the risks to citizens and firefighters.
2. To assess all wildlands, not just the state responsibility areas. Analyses will include all wildland fire service providers — federal, state, local government, and private. The analysis will identify high risk, high value areas, and develop information on and determine who is responsible, who is responding, and who is paying for wildland fire emergencies.
3. To identify and analyze key policy issues and develop recommendations for changes in public policy. Analysis will include alternatives to reduce total costs and losses by increasing fire protection system effectiveness.
4. To have a strong fiscal policy focus and monitor the wildland fire protection system in fiscal terms. This will include all public and private expenditures and economic losses.
5. To translate the analyses into public policies.
   (CDF, California Fire Plan, Executive Summary, 1996)

A key component of the Fire Plan framework is to identify for state, federal and local officials, and for the public those areas of concentrated assets and high risk. Most of the responsibility of quantifying assets at risk falls upon the local Ranger Units. (Harter, personal communication, 1998)

The Butte Ranger Unit is currently in the process of developing the Butte Fire Plan. This document is mandated by the State Fire Plan, and concentrates its efforts on fulfilling the requirements of objective number 2, listed above. Much of the work entailed in this process involves field-checking data, which has been provided by CDF's Fire and Resources Assessment Program (FRAP) offices in Sacramento. For example, FRAP compiles vegetation maps from a variety of sources to generate an estimate of what type of fuels are on the ground in any given area. Data sources for these vegetation maps include Landsat Satellite imagery, existing paper maps of vegetation types, and aerial photographs. Accurately mapping surface fuels requires on-the-ground field checking of the classifications derived from the in-office mappings that FRAP has produced. *Very limited* field checking has occurred for the data within the Butte County area.

The vegetation maps created by FRAP are used to designate "fuel models" - a general description of a site's characteristics such as the predominant type of fuel, (grass, brush, oak thickets, logging slash, small conifers, or large conifers) and the density of the fuel in tons per acre. Computer simulations of fire behavior use fuel model maps, slope maps, and historic weather information from the area to make rough predictions on how intensely a fire will burn or how fast it will spread if it ignites in a certain area. As fire-influencing environmental conditions such as wind-speed and direction, air temperature, and relative humidity all change throughout the day, many Fire Behavior Analysts are hesitant to model fire behavior over a time interval of more than 1-3 hours. Fire modeling is a relatively young science, and it requires very detailed, site-specific information to produce credible results. Current data being used by CDF locally is only accurate enough for a very regional scale of analysis.

Most of the CDF "risk to resources" analysis is being conducted at a scale in which data is averaged for 450-acre partitions of land. These areas are defined by dividing 7.5-minute USGS quad maps into a 9x9 cell grid. These segments are referred to as "quad 81sts". Stakeholder input is needed to determine values for each grid cell based on the property values, timber volumes, proximity to domestic water supplies, rangeland grazing values, recreation values, hydropower facilities, wildlife habitat values, and "other resource-related values." This information will be used in an analysis, which compares the resource values of the given area to the fuel level that has been computed for the same area, with the aim of identifying areas of "high-value/high-risk."

Stakeholder input is an important part of the planning process that is currently under way within Butte County. Jeff Harter is the County pre-fire engineering Fire Captain with CDF/BCFD in Oroville, and is responsible for the development of the Butte County Fire Plan. He is interested in getting any input on what County residents consider to be especially hazardous accumulations of fuels. Key components of the Butte County Fire plan are to identify areas with critical fire hazards or a strategic location on the landscape, to seek assistance and funding for private landowners to undertake Vegetation Modification Plans (VMPs) on their own land, and to implement fire education programs. An example of a strategic location might be a 10 acre parcel of land that happens to be in a location (maybe a ridgetop) where thinning its fuels could provide an important local fuelbreak.

BIDWELL Park

The *Wildfire Management Plan for Bidwell Park* was commissioned by the City of Chico, Parks Department in 1991. Among its findings were that the Park presented a serious potential wildfire threat to life, the "magnificent valley oak woodlands" of Lower Park, and private property for the following reasons:

- A growing accumulation of hazardous wildland vegetation, especially in Lower Park.
- Mediterranean weather conditions with periodic winds that dry the vegetation and can fan wildfires.
- An increasing risk of ignition due to increased use of the park.

The management plan proposed:

- A fire education plan for park users. (To reduce the number of wildfires.)
- Improving the wildfire reporting system.
- Improving the ability of the Park staff to fight fires, and
- Managing the Park's vegetation to perpetuate natural values while modifying the accumulations of fuels.

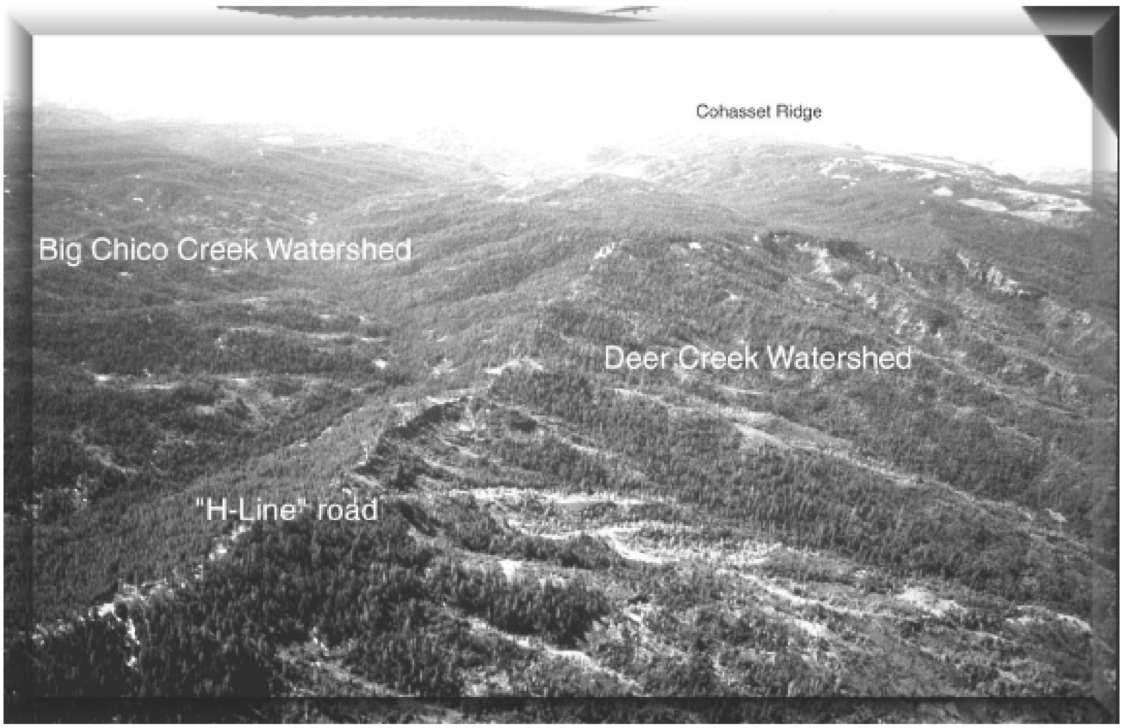
In Bidwell Park, CDF has proposed establishing fuel breaks in the area around Greengate (or 10 Mile House Road) to protect areas above the intersection of this road and Highway 32, such as Forest Ranch, from fires originating in the park. The park currently burns 40-80 acres of grasslands a year, with the aim of benefiting the native plants that have evolved to be fire adapted. The control of Star Thistle is one aim of the current burning program, but the plants must be burned for several consecutive years in an area to kill the seed, and the effectiveness of these projects remains unclear. Most of the burns conducted in the park are financed with training dollars from the various agencies that conduct the burns.

A mix of oak groves and foothill pine groves in the background, with star thistle and grasses of the oak Savannah in the foreground in Upper Bidwell Park. By Zeke Lunder

PRIVATE FORESTLANDS

Sierra Pacific Industries (SPI) is currently undertaking a "shaded fuelbreak" project in the Upper Big Chico Creek watershed. This project will thin the understory vegetation in a strip 200-400 feet wide running from the area just above the radio towers on Cohasset Ridge along the H-Line through Campbellville, and then along the Deer Creek/Big Chico Creek watershed divide to Highway 32 near the passing lanes two miles south of Transfer. The aim of this project is to create an area where large fires burning out of the Ishi Wilderness area along Deer Creek could be stopped before they burned into large tracts of land managed by SPI for timber production. Future SPI fuels projects might include extending this type of project down along the 150 G Line from the H-line down Campbell Creek to Highway 32 three miles north of the Forest Ranch CDF Station (Bean, personal communication, 1998).

In areas such as the campbell creek sub-watershed off of the 150 g line, spi plans to re-enter some of the older burns that have regenerated with tan oak. these operations will begin in the next five to fifteen years and entail removing the deciduous trees in ten- to sixteen-acre clearcuts, and then controlling the re-growth of brush in new plantations using the hand application of herbicides. Using these methods, SPI plans to do "as much fuel modification as time and money will allow" (Bean, 1998). Most of these projects will involve biomass-chipping projects and not broadcast burning. Other than these projects, SPI doesn't plan to alter their fire management strategies significantly in the near future. They will continue to advocate the aggressive suppression of all fires, and perform limited underburning following thinning, selective harvest, or oak removal operations.



A Sierra Pacific Industries fuelbreak project on the "H-Line" road along the divide between the Deer and Big Chico Creek watersheds. By Zeke Lunder

—— BUTTE COUNTY WILDLAND FIREFIGHTING —— ORGANIZATION

CDF ORGANIZATION

CDF is authorized to exist as a State department under the Public Resources Code. Its duty is to protect private and state-owned parcels of land that are declared a state responsibility by the State Board of Forestry. To be considered a State responsibility area, land has to have value as a forest, brush, grassland or watershed resource. These lands cannot be Federally owned or fall within the boundaries of an incorporated town or city. CDF is legally responsible for the protection of the watersheds of Butte County (John Hawkins, BCFD Division Chief, personal communication, September 1998).

Within the CDF organization, The State of California is divided into North and South Regions. The North Region Headquarters is located in Santa Rosa. Within these regions are multiple Ranger Units similar to the Butte Ranger Unit, which are usually delineated on a countywide level. The Butte Range Unit is divided into North and South Divisions, which are further divided into 7 battalion areas. The North Division is divided into 4 Battalions. Each of these has its own Battalion Chief who is responsible for coordinating between the 3 to 6 fire stations within the battalion area. Battalion Chiefs supervise the Fire Captains who run the individual Stations.

Butte County has contracted the services of CDF since 1931 to provide unincorporated areas with structural fire protection, technical rescue, and basic life support through the BCFD. Combined, CDF and the BCFD operate 42 Fire Stations, 1 Airbase, 1 Fire Center, approximately 200 career personnel (including seasonals), and approximately 400 volunteers at 21 volunteer fire companies. CDF/BCFD is responsible for all non-law enforcement emergency services in unincorporated areas of Butte County, and in some areas of Plumas and Tehama. These areas are referred to as the Butte Ranger Unit (BTU). Butte Ranger Unit resources are the first to respond to any fires on non-federal lands.

As each fire season presents planners with new dispatching challenges, CDF must coordinate between its many stations on a statewide level, assigning cover crews for stations that have gone to cover a station somewhere else. It is the primary responsibility of the Ranger Unit Headquarters at the Emergency Command Center (ECC) in Oroville to ensure that areas within a Ranger Unit aren't left without fire protection during intense periods of fire activity. In the event that engines and personnel are needed in another Ranger Unit, the local dispatch will usually assemble "strike teams" of five engines to leave as a group. To fill the empty stations, the Butte Ranger Unit can then request outside resources from adjacent units or through the CDF North Operations Dispatch in Redding. The Redding Dispatch acts as a coordinating agency for all Ranger Units within the Northern Region. If there are insufficient numbers of resources within the CDF organization, the BTU chief coordinates the Butte County Office of Emergency Services and can request local government resources. The State Office of Emergency Services coordinates the State's Master Mutual Aid System, which can dispatch City and County fire resources around the entire state.

As each Ranger Unit has multiple Batallion Chiefs, the fire dispatch tries to make sure that when engines and staff are sent out of the county, some of the veteran staff are left in each Division. Each CDF station develops detailed "cover guide" booklets with maps of their response areas for crews that will be covering their station if they are out of the area. In most cases, the volunteer fire companies within the Big Chico Creek watershed will not be called out of the county, though when needed, they and their engines may be put "on-call" at their station.

—— SUMMARY ——

The Fire response system within the Big Chico Creek watershed relies on well-coordinated, timely efforts by many different specialists. A rapid response by all participants is vital in containing wildland fires before they can grow into uncontrollable conflagrations. Any successful firefighting effort must maximize the strengths that each different resource has to offer. Some firefighting efforts occur in areas that are accessible only to fire crews, while others can maximize their use of airtankers and helicopters. In the canyon areas, steep ground and low road-densities are the main factors that restrict access for fire equipment. While roads provide access for firefighters, they can also provide access for recreation users, therefore increasing the chances of accidental ignition. Aircraft are a vital component of the watershed's fire protection program. In many cases, these resources are able to slow the advance of wildfires until hand crews and heavy equipment can be moved into an area to contain the fire.

The task of accurately mapping fuels is very time consuming. A large scale planning effort such as the State Fire Plan project is only as accurate as the method of data collection. The method of fuels mapping being used by CDF relies heavily on satellite imagery that doesn't recognize features smaller than 100 feet square. Data gaps include a lack of detailed fuels/vegetation maps, which are especially important in the development of community fire protection plans.

Historical fire regimes and their ecological impacts are not well documented within the watershed. Additional information is needed to advance understanding of historical watershed functions related to hydrology, sediment transport, and wildlife habitats, and would be helpful in the development of fire management plans. As the Big Chico Creek, Butte Creek, Deer and Mill Creek watersheds all share similar ecological zones, any research collected on the fire ecology of the Big Chico Creek watershed will be useful to researchers working on the other local watersheds as well.

The lengthy negotiations to move toward a City of Chico/BCFD automatic-aid agreement has illustrated the difficulty of seeking to coordinate between the efforts of large, complex organizations. Developing a successful landscape-scale fire management strategy will require addressing a patchwork of federal, state, and private land management practices.

An aggressive fire suppression program doesn't necessarily correlate with reduced fire danger. The slopes below Forest Ranch have a low threat of ignition, but the cumulative effects of 100 years of fire suppression have created an area with an extremely high potential for a severe wildfire. In this context, what is the definition of effective fire suppression? As the amount of development in the wildland/urban interface increases statewide, and the costs of fire suppression escalate, pre-fire management projects such as fuel-reduction thinnings and other vegetation modification projects will be issues of increasing visibility. Fire issues within the Big Chico Creek watershed are similar to the concerns of watersheds throughout the Sierra Nevada, and any fire management plan must maintain a perspective on how growth statewide will affect public fire policy, and the availability of funds for private fuel reduction projects statewide.

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RECREATION INVENTORY

INTRODUCTION

One Mile Pool.

PURPOSE

The overall purpose of this Recreation Inventory is to provide information that will help stakeholders evaluate the Big Chico Creek watershed and develop an Adaptive Management Plan.

Specifically, this Recreation Inventory provides a comprehensive summary of recreational use locations, the types of recreational use, and time period of use based on current studies. This inventory also describes possible impacts of recreation on fisheries, other environmental resources, economic resources, and private property rights based on current studies. The final purpose of this inventory is to identify gaps in the current data.

ORGANIZATION

This Recreation Inventory is divided into five sections. Following the first section, which is an introduction of the study, the second section explains the recreational opportunities map and matrices, which cover 21 sites. The third section gives an overview of the same 21 sites plus nine additional sites. Recreational impacts or data gaps for each site are also identified. The fourth section addresses other impacts and studies, and the final section provides a summary.

CRITERIA FOR SELECTION OF RECREATIONAL SITES

Only commonly used recreational sites with legitimate public access are included on the map and matrices in order not to encourage inappropriate use or trespassing. Some other recreational sites are presented in the text only.

In the Chico Urban Area, there are numerous recreation sites in the watershed managed by the City of Chico and the Chico Area Recreation and Park District (CARD). Only those sites adjacent to a creek are specifically referenced in this report. For example, Wildwood Park (adjacent to the Sycamore Creek Diversion Channel) and the CARD Community Center (adjacent to Big Chico Creek) are included, while Oak Way Park and the Pleasant Valley Recreation Center are not. For more information regarding all of the public recreational sites in the Chico Urban Area, readers are encouraged to contact City of Chico Park Department at 895-4972 and CARD at 895-4711.

Most private recreational facilities, such as sports clubs, are not included. Because of their size and locations along important streams, however, three private recreational sites outside of Bidwell Park are discussed. These exceptions are Camp Lassen and Springs of Living Waters at Richardson Springs, both managed by nonprofit organizations, and the Musty Buck Preserve, a private membership facility. In Bidwell Park, five sites leased from the City or managed by other groups are listed separately from the Park: Bidwell Park Golf Course, Chico Rod & Gun Club, Hooker Oak Recreation Area, Chico Creek Nature Center, and Sycamore Field.

ASSUMPTIONS / LIMITATIONS OF METHODS USED TO DETERMINE POSSIBLE IMPACTS

This Recreation Study is limited primarily to the review of existing studies on recreation in the Big Chico Creek Watershed, interviews of recreation site representatives, and field observations. Formal new research regarding specific sites or impacts is outside the scope of this study. Conclusions of previous studies and the statements of representatives for the recreation sites are assumed to be accurate. For most sites, current studies regarding the impacts of recreation are not available.

ACKNOWLEDGMENT

Parts of this recreation study were modeled after the Recreation Opportunities Report prepared for the Butte Creek Watershed Project by Steve Dennis, Ph.D.; Lisa Jorgensen, B.S.; of the Department of Recreation and Parks Management, California State University, Chico and Kamie Polo, M.R.T.P., Department of Geology and Planning, California State University, Chico. The Big Chico Creek Watershed Alliance is especially grateful to Steve Dennis for his advice regarding this study.

RECREATIONAL OPPORTUNITIES MAP AND MATRICES

A Recreational Opportunities Map is presented showing the locations of the recreational sites presented in the matrices (Figure 1). Two recreational matrices were prepared: a Facilities Matrix (Table 1) and an Activities Matrix (Table 2). Each matrix lists selected recreational sites within the watershed as well as their corresponding Map Identification Numbers. The Facilities Matrix

FIGURE 1

TABLE 1

Table 2. Activities Matrix.

Map Identification No.	ACTIVITIES MATRIX	Walking/Hiking	Biking (unpaved)	Biking (paved)	Skating/Rollerblading, etc.	Horseback Riding	Cross-Country Skiing	Snowshoeing	Snowmobiling	Driving/Sightseeing	Swimming or Wading	Canoeing/Kayaking/Tubing	Nature Study/Birding	Picnicking	Camping	Fishing	Hunting	Rock or Wall Climbing	Playground Activities	Ball Games	Golfing/Putting	Shooting	Historical Tours	Reservable Site Activities	Year-Round Use
1	Colby Mountain Lookout	X	X			X	X	X	X	X			X	X			X								X
2	Camp Lassen	X	X			X	X	X			X	X	X	X	X	X		X				X		X	X
3	Musty Buck Preserve	X								X	X		X	X	X		X								X
4	Springs of Living Waters at Richardson Springs ***a***	X		X	X	X					X		X	X		X		X	X	X			X		X
5	Upper Bidwell Park	X	X	X		X				X	X	X	X	X		X		X							X
6	Bidwell Park Golf Course																				X				X
7	Chico Rod & Gun Club																					X			X
8	Middle/Lower Bidwell Park	X	X	X	X	X				X	X	X	X	X		X			X	X				X	X
9	Hooker Oak Recreation Area	X	X			X					X			X					X	X					X
10	Chico Creek Nature Center	X											X	X									X	X	X
11	Sycamore Field																			X				X	X
12	CARD Community Center	X		X	X																			X	X
13	Bidwell Ranch												X												
14	Wildwood Park	X		X	X								X	X						X					X
15	Lindo Channel Section Bidwell River Park	X	X	X	X	X					X		X	X		X									X
16	First Avenue and Verbena Lane Future Park Site	X									X		X												X
17	Bidwell Mansion St. Historic Park	X											X										X	X	X
18	Children's Playground	X		X	X									X					X						X
19	Bidwell Bowl Ampitheater																							X	X
20	CSU, Chico	X		b	b						X		X	X				X		X	X		X	X	X
21	Big Chico Creek Riparian Area Bidwell-Sacramento River St. Pk.	X									X	X	X	X		X									X
---	Bike Ways	X	X	X	X																				X

a. Recreational activities outside of developed areas are only available to members of groups providing their own insurance.

b. Subject to time and location restrictions.

identifies the management and types of developed or constructed facilities that are located at that particular site. The Activities Matrix identifies the various types of recreational opportunities that can be found at a particular site. Interviews, secondary data and field observation identified the activities that occur at a site. It should be noted that each site is not limited to the types of activities indicated on the matrix. It is possible that recreational users may partake in other forms of recreation or depreciative behavior. The matrix identifies the types of activities that were commonly identified to occur at that particular site.

— OVERVIEW OF RECREATIONAL OPPORTUNITIES —

This section provides additional information on each of the recreational sites identified in the matrices and several sites not included in the matrices. Each site description is followed by information regarding the impacts of recreation at that site.

RECREATION SITES ON MATRICES

These are commonly used recreational sites with legitimate public access. They are numbered to correspond to the matrices and Recreational Opportunities Map.

1. Colby Mountain Lookout

Managed by Lassen National Forest, the primary function of Colby Mountain Lookout (6,200 feet) is fire protection. The site is accessible to vehicular traffic and is popular with cyclists in summer, and skiers and snowmobilers in winter. The lookout commands exceptional views of the Big Chico Creek, Butte Creek and Deer Creek watersheds.

Impacts: No studies were found regarding impacts from recreational use of the Colby Mountain Lookout.

2. Camp Lassen

This is a private nonprofit recreational site operated by the Boy Scouts of America in lower Chico Meadows near the headwaters of Big Chico Creek. The land is leased from Sierra Pacific Industries and the camp is used for Boy Scout camps during six weeks in the summer, and is available for rental by other groups throughout the rest of the year. Some of the groups that have used the camp include the Girl Scouts, Camp Fire Girls, church organizations, Butte County Sheriff's Posse, Chico Unified School District, and California State University, Chico (Wakefield, 1998, p101-102). Facilities include a lodge, cabins, three-story wall climbing center, a rifle range, and a small (3-4 acres) lake formed by a dam across Big Chico Creek.

Impacts: No studies were found regarding impacts from recreational use of Camp Lassen. A possible impact is the obstacle presented by the dam, which may block native trout from moving upstream and interfere with the movement of other creek organisms (Maslin, 1998). Other potential impacts include disease transmission from planted hatchery fish to native fish, construction impacts from the dam, and general trampling and erosion impacts resulting from heavy use of the area (Taylor, 1998). Because dams often result in negative impacts, a focused study could resolve the importance, magnitude and possible remedies for negative impacts.

3. Musty Buck Preserve

Musty Buck is privately owned and managed primarily as a hunting club. Memberships are required and are available for public purchase. The club operates under certain preserve-specific hunting permits and seasons in exchange for managing the property in a manner that enhances its wildlife habitat, especially for deer. Permits are available for hunting deer, upland birds, turkey, and bear. Hunting in the preserve is not permitted below the north rim of Big Chico Creek canyon (Owens, 1998). This area has historically been used for grazing, a use that continues today.

Impacts: No studies were found regarding the impacts of recreational use of the Musty Buck Preserve.

4. Springs of Living Water at Richardson Springs

This conference center is owned and managed by Youth With a Mission/Springs of Living Water, Inc. as a nondenominational nonprofit Christian conference center. The facilities can be rented by anyone willing to abide by contract to Christian standards, for example, no alcohol. The facility includes a hotel that can be rented by groups and cabins that can be rented by individuals. It is commonly used by churches and organizations for retreats, conferences and a variety of programs. Summer camps are held for children ages 8-18. Day-use picnicking is permitted with advance permission (Plunk, 1998).

Impacts: No studies were found regarding the impacts of recreational use of the Springs of Living Water at Richardson Springs.

5. Upper Bidwell Park

Upper Bidwell Park in the City of Chico experiences extensive recreational use and has received the most study regarding the impacts of recreation. Jones & Stokes Associates, Inc. prepared an Assessment of Visitor Use on the Natural Resources of Upper Bidwell Park for the City of Chico in March 1997. That report's "Overview of Park Facilities and Use" is presented here:

> The Upper Park contains few facilities. Upper Park Road, a two-lane gravel road, provides access to the Upper Park area from the gate at the Horseshoe Lake parking area and runs approximately 4 miles along the length of the Big Chico Creek corridor. On Sunday and Monday of each week, the road is closed to vehicles and open only to hikers, bicyclists, and equestrians. The rest of the week this road provides the only public vehicle access to the Upper Park area.
>
> Several unimproved dirt-parking areas are located along Upper Park Road, primarily next to creek pools. Parking areas have a dirt surface and do not have defined parking stalls or perimeters. They range in size from small pullouts that accommodate only a few vehicles to extensive areas that can accommodate 40 or more vehicles. The larger parking areas are provided at Alligator, Bear, Salmon, and Brown's Holes, which are locations along the creek corridor where the water is deep and therefore attracts users.
>
> The only other road in the Upper Park area is the North Rim Trail. Although it is not open to public vehicle access, it is used for maintenance access by park rangers. It is also a popular route for hikers, bicyclists, and equestrians.
>
> The Yahi Trail runs the length of the Upper Park area between Big Chico Creek and the Upper Park Road. Only foot traffic is permitted on this trail. The Lower, Middle, and Upper Trails, open to hikers, bicyclists, and equestrians, also run the length of the park along the south-facing slope of

the canyon, between Upper Park Road and the North Rim Trail. Upper Trail is also open to hikers, bicyclists, and equestrians. The Live Oak and Ishi Trails connect the Upper Park Road and the North Rim Trail at the far end of the canyon. Together, these primary trails form loop trail systems that offer a variety of distances and terrain to trail users.

Levels of use of Upper Park facilities vary by day of week and time of year. As expected, summer brings the highest use levels, especially along the Upper Park Road corridor, by groups and individuals that visit the pools along Big Chico Creek. On some weekends and holidays, parking areas along the road are filled to capacity. If the entrance gate is closed, the parking area at Horseshoe Lake reaches capacity. Use levels at the creek pools can remain high in fall and spring. Students from California State University, Chico, many of who leave during summer, frequently use the park during warm days in the spring and fall months.

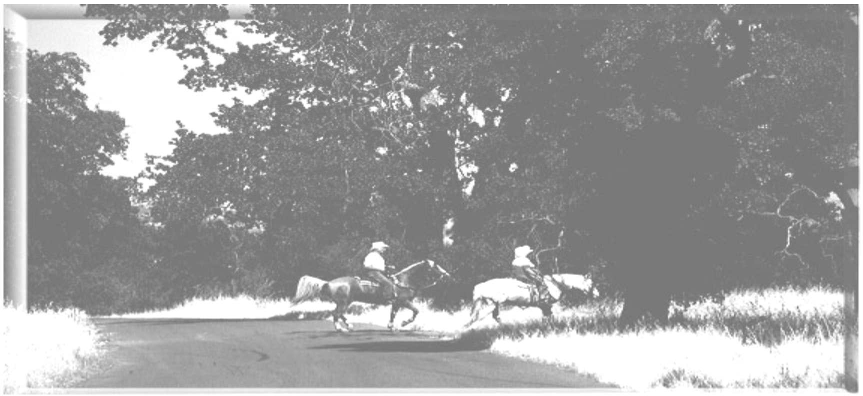
It is expected that use of the trails by joggers, hikers, bicyclists, and equestrians is relatively consistent throughout the year although somewhat higher in the warmer months. An analysis of vehicle trip counts taken in summer 1995 suggests that most vehicles enter the Upper Park area in the warmer afternoon hours and peak use by hikers and bicyclists occurs in the cooler morning hours.

In 1993, a graduate student from California State University, Chico, studied trail use in the Upper Park for a master's thesis (Maser, 1993). Over 600 trail users were surveyed at four sites throughout the Upper Park area. Most trail users were hikers (53%), followed by bicyclists (39%), then, runners and joggers (7%), and finally, equestrians (1%). Almost 90% of recreational users were from the City and its surrounding urban area. The average age of park users was 30 years (data was not collected for individuals under 15 years of age). Over 70% of the trail users were male. Recreation users visited Upper Park an average of 8 days per month. The average duration of use was 1 hour and 50 minutes. The largest party of trail users was 17 people; however, over 80% of the trail users come alone or in pairs. (Jones & Stokes, 1997, p9-10

Impacts: The Assessment of Visitor Use study also discusses impacts to natural resources in each of the five management zones within the Upper Park area. Figure 2 illustrates the locations of these management zones, while Table 3 provides a summary of park use assessment by management zones.

FIGURE 2

TABLE 3



There are several equestrian trails throughout Bidwell Park.

Following are excerpts from the study's discussion of these impacts:

Upper Rim (Management Zone 28)
Overall, damage to resources by park use in this area is not excessive. However, additional management efforts are needed in specific areas to avoid damage to sensitive resources.

Soils in this zone, which have developed over volcanic mudflow formations, are thin and prone to erosion. Several special-status plant populations, which are sensitive to disturbance, have been identified near the North Rim Trail. The rocky conditions along the road cause bicyclists to seek smoother, less-eroded routes that are easier to pass over; thus, the dirt road is gradually being widened, which is resulting in the loss of the thin soil layer and sensitive vegetation.

South Facing Slope (Management Zone 29)
Overall, the damage to resources by park use in this zone is not excessive. However, additional management efforts are needed in specific areas to avoid further damage to resources.

The primary resource issues in this area are soil erosion on existing trails and the creation of bootleg trails. Downhill mountain bike travel has the greatest potential for impact on existing trails (caused by skidding and poorly executed braking). However, the most substantial impacts result from the creation of new non-designated trails. Vegetation has difficulty reestablishing in areas where use has compacted and eroded soils on the steep slopes within this zone. Soils are especially prone to compaction when they are wet.

Upper Park Road/Parking Corridor (Management Zone 30)
This zone is one of the most heavily visited areas within the Upper Park. The only vehicle access in the Upper Park (Upper Park Road and its associated parking areas) is located within this zone. Some of the park's most sensitive habitat types, including mixed oak woodlands, perennial grasslands, wetlands, and riparian forests are found within this zone. Sensitive resources are being damaged by heavy use. Because of the extent of damage to resources that is occurring in this area, more intensive management efforts are needed.

The poor condition of the road and parking areas and the high level of use they receive is resulting in excessive dust generation and runoff from these areas. The poor condition of the road also restricts emergency vehicle access. Because parking area limits are not well defined, motorists park beyond already established areas, further disturbing vegetation and compacting soils. (Note: Since the draft was written, the Park Department has graded and improved drainage on the section of Upper Park Road between Parking Lot E and the Diversion Dam Parking lot to reduce erosion. In addition, a gate has been installed at the Diversion Dam Parking Lot to restrict vehicular access during the wet season. This action was specifically approved by the Park and Playground Commission to reduce erosion and road damage during the winter.)

North-Facing Slope (Management Zone 31)

Overall, the damage to resources by existing park use in this zone is not excessive. However, additional management efforts are needed to avoid damage to sensitive resources.

The primary issues in this area include soil erosion on existing trails, the creation of bootleg trails, and the increased wildfire danger because of the dense vegetation and difficulty of emergency vehicle access to this area. Various trails in the north slope area, including the area of the new addition, are highly eroded. The Police Pistol Range Trail, a popular trail to access the new addition, is in very poor condition; it is highly eroded, steep and rocky along its entire length.

Big Chico Creek (Management Zone 32)

This zone is the most heavily visited area within Upper Park. Riparian vegetation along the creek is highly sensitive to trampling and erosion, especially on steep creek banks. Sensitive resources are being damaged by heavy use in this zone. Because of the extent of damage to resources that is occurring in this area, more intensive management efforts are needed.

Access trails from parking areas to creek-side use areas are currently unmarked. In many areas, park users have established multiple access routes, which is damaging vegetation and causing soil erosion, especially on steep slopes. Additionally, vegetation loss, soil erosion, and soil compaction is occurring in areas where park use is concentrated around creek pools. Creek-bank erosion resulting from trampling of vegetation increases sedimentation in the creek and could affect the water quality, especially in the lower reaches of the Upper Park area. (Jones & Stokes, 1997, p15-17)

A group led by the Chico Creek Nature Center explores a rock shelter in Upper Bidwell Park.
Source: Chico Creek Nature Center

OTHER STUDIES OF USE AND IMPACTS IN UPPER BIDWELL PARK

A 1993 thesis by a California State University Geography student investigated The Effects of Use Patterns on Trail Impacts in Chico's Upper Bidwell Park (Maser, 1993). The study, which included use surveys, found erosion impacts and concluded that lack of trail planning, designation and maintenance, combined with unclear use regulation and limited enforcement capability had more influence on trail impacts than the patterns of usage (frequency, numbers of people, etc).

A 1994 thesis, The Environmental Effects of All-Terrain Bicycles on Chico's Upper Bidwell Park, counted trail use by bicyclists, hikers and equestrians and found significant erosion and trampling of vegetation in numerous areas of the Upper Park (St. Sure, 1994). The author also concluded that a lack of restrictions on hikers, especially when the ground is wet, has resulted in serious damage to the terrain.

A 1996 CSU, Chico class study, Bidwell Park Acquisition Site Analysis & Recommendations included a survey of users of the 1995 park acquisition (Site Planning Class, 1998). Objectives of the survey included determining the environmental qualities and characteristics that are important to users of the new park addition and determining the physical needs of the various recreational user groups. The study recommended that the Police Pistol Range Trail off Centennial Avenue eventually be closed and returned to a natural state, partly because of the massive erosion impacts on the trail (Site Planning Class, 1998, p.23, 27).

A 1998 Upper Park Road Visitation Study gathered baseline data on the use and user patterns of Upper Park Road (Wilson, 1998). The report noted extensive rule violations, including dogs in swimming holes, smoking during the non-smoking period, speeding, alcohol consumption, and broken glass and other litter around swimming holes. The report also stated that the "physical area surrounding Upper Park Road and the swimming holes show signs of physical deterioration caused by overuse and misuse. Fragile wetlands areas at Bear Hole have been trampled, causing erosion and potential loss of species" (Wilson, 1998, p iv). The purpose of the observations was to develop the survey instrument and training manual.

Impacts from Swimming in Upper Park

Swimmers may significantly impact salmon health. A California Department of Fish and Game warden identified swimming in Bidwell Park as the single biggest impact to fisheries from recreational use of Big Chico Creek (Bishop, 1998). This can be a major factor during drought years when water levels and the amount of dissolved oxygen in the water available to fish are low. Disturbance of the fish by swimmers (see Aquatic/Biotic chapter) may cause the fish to be much more active, using up their limited supply of dissolved oxygen (Bishop, 1998). Stress from disturbance by swimmers can cause the release of hormones that cause disease or reduced fertility among salmon (Hill, 1998).

Trespassing

A California State University, Chico class study of the 1995 Upper Park acquisition identified trespass through Canyon Oaks, a private gated community south of the park, as a concern. A survey of users of the new section of the park found that five percent had entered through Canyon Oaks (Site Planning Class, 1996, p28). Interviews with landowners in Big Chico Creek canyon above Bidwell Park indicated only a few trespassing problems. One of the owners of the property immediately upstream from Bidwell Park said there have been very few problems with trespassing. The only ones using the road regularly, he said, seem to be bicyclists who throw their bikes over the locked gates, but they don't seem to be disturbing anything else (Source 1, 1998). Higher in the canyon, another property owner said there have been occasional problems, including an incident at Higgins Hole in October 1996 involving about eight people poaching salmon and using a large grill with a raging fire during the height of the fire season. There have also been some mountain bikers, she added, but they have not been a major concern (Source 2, 1998). Higher still, in the canyon below Forest Ranch, a landowner reported that the closing of Ponderosa Way approximately 4-5 years ago has pretty much eliminated trespassing problems. She said the road was closed after it was washed out and became impassable. The county did not continue maintenance, and private property owners in the area paid to make it passable and gated it off (Source 3, 1998).

6. Bidwell Park Golf Course

The Bidwell Park Golf Course site in Bidwell Park is leased from the City of Chico by the Bidwell Park Golf Club, Inc., a nonprofit organization. The Club contracts with American Golf Corporation for the maintenance and operation of the golf course facilities, which are open to the general public for a fee.

Bidwell Golf Course.
From City of Chico Park Department

Impacts: The golf course once obtained water from pumps eight feet below the streambed of the creek but now uses a 1,000-foot well that has eliminated impacts to the creek (Boza, 1998). Water quality in the creek is tested three times a year above and below the golf course. The tests are currently showing no impacts from the golf course (Boza, 1998).

7. Chico Rod & Gun Club

An indoor pistol range is located next to Horseshoe Lake in Middle Bidwell Park. This building was funded and constructed by the Chico Rod and Gun Club, a nonprofit organization that leases the land from the City of Chico. The building has a lobby, a kitchen for use by members, and a pay telephone. The range is open for use by the general public for a fee (Jones, 1998). The Bidwell Park Master Management Plan calls for the phasing out of the pistol range in the long term (Hardesty Associates, 1990, p146).

Impacts: No studies were found regarding the impacts of recreational use of the Chico Rod & Gun Club facility.

8. Middle and Lower Bidwell Park

Middle Park, from Horseshoe Lake down to the Hooker Oak Recreation Area, is the location of substantial recreational activity. The parking lot on the upper side of Horseshoe Lake serves as a staging point for hikers and bicyclists entering the Upper Park, especially when the gate on the road is closed. The area around Horseshoe Lake is a popular location for picnicking, fishing, feeding ducks, and hiking. An annual "Hooked on Fishing Not Drugs" event for kids is held here. Downstream from the golf course is the Five-Mile Dam Area, where water used to be backed up each summer to form a large swimming pool. The area is still used for shallow-water swimming and wading and receives extensive use from picnickers, walkers and bicyclists. A group picnic area here can be reserved for a fee. Between the Sycamore Creek Diversion Channel and Manzanita Avenue is a horse-riding arena.

The following description of Lower Park is taken from the Bidwell Park Master Management Plan:

> Lower Park is a narrow, predominantly Oak/Sycamore riparian corridor along Big Chico Creek. Lower Park is accessible from several streets along its perimeter. The magnificent woodlands, alluvial meadows and occasional turf areas are actively used for recreation and constitute a 400-acre 'front yard' for park users. Lower Park is divided into two sections by the Mangrove Avenue Bridge across the creek. The western end (Lower Park West) includes narrow areas on both sides of the creek. Lower Park East includes wider areas and receives much greater use intensity (Hardesty Associates, 1990, p11).

Recreational use of Lower Park is substantial. The highest concentration of use is in the One-Mile Dam Area. This area contains a swimming area on Big Chico Creek with cement floor and walls, a large children's playground called Caper Acres, a group picnic area, horseshoe pits, walking and biking trails, Sycamore Ball Field, and large grassy areas used for picnicking and sunbathing. The Cedar Grove area of Lower Park receives episodic intense use when it is used for special events, including concerts, fairs, and theatrical performances. Adjacent to Cedar Grove is the World of Trees Nature Trail, a self-guided path with interpretive signs winding through the location of a former forestry station. This trail is wheelchair accessible and contains signs with Braille for people with visual impairments. The roads running along both sides of the creek in Lower Park receive extensive use from a varied collection of drivers, walkers, joggers, skaters, and bicyclists. South Park Drive is closed to automobiles from Caper Acres to Cedar Grove. On the north side of the creek are a Vita Course and numerous unpaved footpaths, picnic areas, and swimming holes. Sites that can be reserved for group activities are the One-Mile Picnic Area, Sycamore Grove, Council Ring and two Birthday Rings in Caper Acres. Lower Park is truly the hub of recreational activity in the Big Chico Creek Watershed.

Middle and Lower Bidwell Park Impacts: Extensive recreational activity in this part of the watershed has had significant impacts upon the natural environment. The 1990 Bidwell Park Master Management Plan identified some of these impacts:

- Existing uses and management are causing significant impacts to mature oaks and sycamores and natural conditions (soil compaction, dust, over-watering, etc.)

- The riparian corridor of Big Chico Creek is one of the primary attractions of Bidwell Park. Shaded picnic sites close to the creek provide relief from afternoon heat. However, intensive use of sensitive riparian areas is causing soil compaction, loss of vegetation, encroachment by invasive plants, creek-bank erosion, siltation, and wildlife habitat degradation.

- Invasive plants such as Tree of Heaven (Ailanthus) and Himalayan Blackberry are displacing and disrupting native plant communities in Bidwell Park.

- Intensive use of recreation areas and corresponding maintenance activities such as irrigation, mowing and installation of improved surfaces have disrupted natural germination and development of oaks, native grasses and other plants in Bidwell Park. Long term perpetuation of natural vegetation characteristics is threatened.

- The frequency, duration and extent of natural fires have been reduced as a response to protect the facilities and resources that have been introduced into Bidwell Park. Habitat responses to altered fire conditions are changing the visual and biological character of Lower, Middle and Upper Park.

- The wildlife habitats of Bidwell Park have been influenced by a variety of factors. Human intrusion and facility development is the primary cause of habitat degradation, but no reliable data exist to demonstrate neither what changes have occurred nor what such changes could mean.

- Hydrologic and geologic conditions in Bidwell Park have been disrupted by flood control activities, irrigation practices and park uses.

- The aquatic habitat of Big Chico Creek has been altered by flood control facilities, swimming facilities and disruption of creek banks and water quality degradation. (Hardesty Associates, 1990, p54-56, 107)

Other problems include littering and human waste. The impacts described above are the target of management recommendations in the Bidwell Park Master Management Plan and continue to be addressed by the Park and Playground Commission and Park Department.

Siltation Impacts from Cleaning of Sycamore Pool

The One-Mile Dam/Sycamore Pool Complex consists of a 700-foot long in-stream swimming pool and a flash-board dam fitted with a fish ladder. The dam is operated for swimming from Memorial Day through Labor Day and the pool is often used by hundreds of people daily. Past pool cleaning practices resulted in discharges of sediment downstream, violating state waste discharge requirements and adversely impacting fish habitat and other environmental quality factors (Mitchell Swanson, 1994, p19). In September 1995, the California Regional Water Quality Control Board issued a cease and desist order requiring the city to halt all pool cleaning or implement an approved alternative cleaning method. In 1997 a bypass culvert was constructed. The flow of the creek is now temporarily diverted through the culvert while the sediment is removed and the pool is cleaned. The new pool cleaning system appears to have helped the siltation problem, and the City is continuing siltation and coliform monitoring required by the California Regional Water Quality Control Board permit (Dykstra, 1998). A possible impact that has not been solved by the new cleaning procedure is the interception of gravel transport, which may reduce the amount of gravel available for downstream spawning areas (Maslin 1998). Please refer to Chapters on Water Quality, Hydrology and Aquatic/Biotic Inventories for additional information.

Five Mile Recreation Area.
From the City of Chico Park Department

Fish Passage at the One-Mile Dam

There is adequate fish passage at the One-Mile Dam as long as it is managed properly. Under very low flow conditions, the dam may cause some problems (Ward, 1998). Alternative dam configurations were studied in 1995. The Park Department is proposing that replacement of the existing dam will be pursued. Benefits would include improved fish passage and worker safety. (Beardsley)

Impacts on Fecal Coliform Concentrations

Recreation may contribute to fecal coliform concentrations in Big Chico Creek. People swimming in the water, and dog and horse feces are possible sources. A 1997 report, prepared by the California State University, Chico Environmental Laboratory, found that from November 1995 through June 1997 concentrations of fecal coliform calculated as the monthly geometric mean exceeded standards in June 1996 and possibly during September 1996, although the data for this month are only based on two days of sampling over Labor Day weekend (Oakley, 1997, p54). The study (see Water Quality chapter) also found that fecal coliform concentration increases from the Five-Mile Recreation Area to the outflow below the One-Mile Dam throughout the year, and especially during the summer months. The relative role of animals or humans as contributing sources could not be ascertained (Oakley, 1997, p54-55). The City of Chico Park Department is conducting additional testing during the summer of 1998 (Beardsley, 1998).

Economic Impacts of Bidwell Park Runs

Although not documented by formal study, there is evidence of economic benefits from recreational running in Bidwell Park. Each year, there are approximately 20 organized runs in Bidwell Park. Most of the local runs are organized by local nonprofit charitable organizations, which use them as fund-raisers (Stearns, 1998). One of the largest races is the Bidwell Classic, a half marathon held annually on the first Saturday in March, attracting 800-1,300 participants. For bigger runs, about 30-40 percent of the participants come from out of town, usually staying in local motels and hotels and eating at local restaurants, especially in the downtown area (Berman, 1998).

Impact of Bidwell Park on Housing Values

No current studies were found regarding impacts of recreation in the watershed on housing values. Interviews with five local realtors and two real estate appraisers regarding the impact of Bidwell Park on housing values, indicated that although definitive studies have not been conducted, there is general agreement that the park positively affects housing values. One realtor stated that Bidwell Park is part of the overall quality of life in Chico and adds to the area's value for homebuyers (Tichinin, 1998). An appraiser said there is no question that houses near the park bring higher sales prices than comparable houses elsewhere and that rentals near the park also go for a higher price (Granicher, 1998). Houses within walking distance of either side of the park, according to another realtor, not only sell for a higher price but also sell more quickly (Shelton, 1998). There is a group of homebuyers in the local market, often baby boomers, who will only buy homes near the park (Stephens, 1998). The significance of the park's impact varies in different parts of the community, the supply and demand situation at the time of the sale, and the numerous other factors affecting the value of homes (Andrews, 1998; Gregoire, 1998; Bernedo, 1998).

9. Hooker Oak Recreation Area

This site is located in Bidwell Park but is managed and maintained by CARD. It contains a children's playground, a picnic area, one lighted baseball field, two lighted softball fields, restrooms and a parking area.

Impacts: No studies were found regarding the impacts of recreational use of the Hooker Oak Recreation Area. This area is designed and maintained for high levels of recreational use.

10. Chico Creek Nature Center

The Chico Creek Nature Center location is leased from the City of Chico by a nonprofit organization of the same name. The Center's programs include a Living Animal Museum and other educational exhibits, a native plant garden, environmental education programs, nature walks and activities, and Camp Chico Creek for children 5 to 12 years old. The Center functions as the interpretive and information center for Bidwell Park.

Impacts: No studies were found regarding the impacts of recreational use of the Chico Creek Nature Center.

11. Sycamore Field

Sycamore Field is a softball field in the One Mile Dam Area of Bidwell Park. The ballfield area, containing about 3.5 acres of land, is leased from the City of Chico and managed by CARD.

Impacts: No studies were found regarding the impacts of recreational use of Sycamore Field.

12. CARD Community Center

This site contains the Community Center Building, parking lot and some surrounding landscaping. A bike path runs along the creek. It is adjacent to Bidwell Park and is owned and managed by CARD. CARD's Senior Program Office and Administration Office are located here. A variety of recreational programs are held here, and parts of the facility are available for rental, including a large main hall, kitchen and patio area, craft room, and one large meeting room that can be divided into two smaller rooms.

Impacts: No studies were found regarding impacts of recreational use of the CARD Community Center.

13. Bidwell Ranch

The City of Chico purchased this 750-acre property adjacent to Bidwell Park in 1997 following citizen protests over proposed development and the threat of a lawsuit from the developer should development be denied. The Chico City Council has not made a final decision about what to do with the property. There has also been no decision regarding general public access. The City Council approved the use of the property during the spring of 1998 only for field trips for school classes and for guided public wildflower tours led by Stop Bidwell Ranch, Sierra Club and Butte Environmental Council. Because of the history of this piece of property, its proximity to Bidwell Park, and the presence of vernal pool wetlands and the endangered species Butte County Meadowfoam, parts of the property are likely to remain open to public use even if some development occurs. For the purposes of this report, nature study/birding is considered the only recreational activity because it is the only activity that has been approved by the City Council.

Impacts: No studies were found regarding impacts from recreational use of the Bidwell Ranch property.

14. Wildwood Park

This is a 19-acre City of Chico community park on Wildwood Avenue across the street from Bidwell Park. It includes facilities for active recreation as well as vernal pool nature preserve areas. It is adjacent to the Sycamore Creek Diversion Channel and has a short trail that connects to a longer trail on the Diversion Channel's levee.

Impacts: No studies were found regarding impacts from recreational use of Wildwood Park.

15. Lindo Channel Section of Bidwell River Park

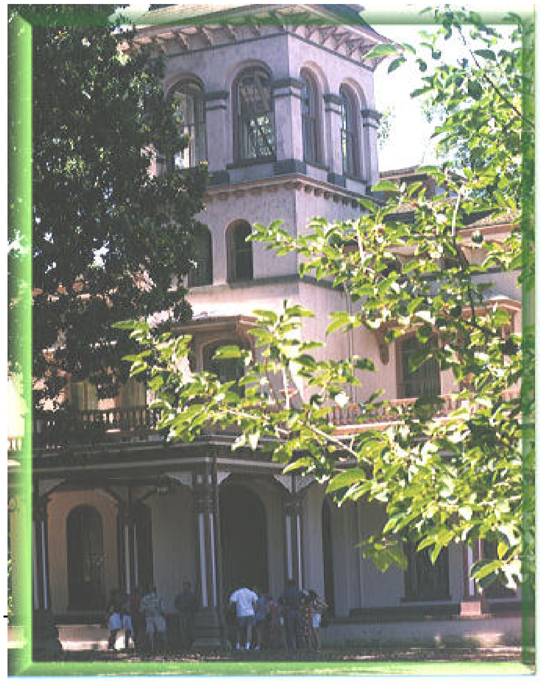
Lindo Channel and its banks, from Bidwell Park to where it rejoins Big Chico Creek, are part of Bidwell River Park, established as a result of Annie Bidwell's deed of 1908. From Manzanita Avenue to the City's western sphere of influence line, just west of Highway 32, the park is now owned by the City of Chico. From the City's sphere of influence until Lindo Channel rejoins Big Chico Creek, the park is owned by Butte County. The CARD Comprehensive Park and Recreation Plan identifies the channel as a recommended lineal park, and the City of Chico General Plan identifies the section within the City's sphere of influence as a Creekside Greenway. Recreational activities on Lindo Channel are dispersed and informal, varying in intensity based upon access. Activities include hiking, biking and horseback riding. A seasonal waterway, it also receives some use for fishing and wading. Bike paths cross the channel at a number of locations in Chico.

Impacts: No studies were found regarding impacts from recreational use of Lindo Channel.

16. First Avenue and Verbena Lane Future Park Site

The City of Chico has acquired a parcel at this location along Lindo Channel for the future development of a neighborhood park. Although plans have not been finalized, it will probably be used for passive recreational facilities (Boza, 1998).

Impacts: No studies were found regarding the impacts of recreational use of the First Avenue and Verbena Lane Future Park Site.



17. Bidwell Mansion State Historic Park

Bidwell Mansion was the home of John and Annie Bidwell from 1868 until the end of their lives in 1900 and 1918 respectively. Now a state historic park, it receives about 30,000 visitors a year. The park includes the mansion itself, a visitor center, a carriage shed displaying carriages owned by the Bidwells, and surrounding grounds. The area along the bank of Big Chico Creek is the site of a native plant restoration project. The mansion and its grounds are being restored to the 1868-1900 historic period. Visitors may tour the visitor center and grounds on their own and receive a guided tour of the mansion. A gazebo area is often rented for weddings.

Impacts: No studies were found regarding impacts from recreational use of Bidwell Mansion State Historic Park.

Bidwell Mansion on The Esplanade.

18. Children's Playground

Along Big Chico Creek across a footbridge from Bidwell Mansion and adjacent to California State University, Chico and Bidwell Memorial Presbyterian Church is the Children's Playground. This 2.7-acre urban park has a playground, picnic tables, turf area and bicycle paths.

Impacts: No studies were found regarding impacts from recreational use of Children's Playground.

19. Bidwell Bowl Amphitheater

This amphitheater straddling Big Chico Creek is owned and managed by the City of Chico. It seats approximately 300-350 people. The seating area is on the south side of the creek, and the small stage area is on the north side. The amphitheater is rented primarily for weddings, graduation ceremonies, orientations and similar activities. The area is rarely used for live performances because of amplification restrictions (Tobin, 1998).

Impacts: No studies were found regarding impacts from recreational use of Bidwell Bowl. The amphitheater itself has displaced riparian habitat, and the portion of the creek passing through the amphitheater has been channelized.

20. California State University, Chico

California State University, Chico has more than 14,000 students and offers a full range of recreational opportunities on campus and off campus, many of which are available to the general public. For more information regarding the university's recreational facilities and activities, contact the Recreational Sports office at 898-5170 or Adventure Outings at 898-4011.

Impacts: No studies were found regarding impacts from recreational use of California State University, Chico.

21. Big Chico Creek Riparian Area and Peterson Property
Bidwell-Sacramento River State Park

The Big Chico Creek Riparian Area consists of approximately 45 acres of land located between River Road, the Sacramento River, and Big Chico Creek. This park area preserves an especially lush riparian habitat, representative of what once dominated the rivers and streams of California. In 1997, an adjacent 58.5-acre parcel known as the Peterson Property, north of where River Road crosses Big Chico Creek, was added to the park. This new addition to the park includes the right bank of Mud Creek at its confluence with Big Chico Creek. The gravel bar at the Big Chico Creek Riparian Area was for many years a boat launching area and popular takeout location for Sacramento River "tubers," most of whom began their inner-tube float down the Sacramento at Irvine Finch Day Use Area. Tubing on this section of the river was extremely popular, sometimes drawing in excess of 10,000 people on summer holidays (Hearne, 1998).

Use of the area by tubers and motorized boats has substantially declined, however, due to colder river temperatures from release changes at Shasta Dam, new restrictions prohibiting alcohol consumption and open containers in the park, and the elimination of vehicle access to the gravel

bar after the Sacramento River eroded away the dirt road. The combination of cold water, strong currents, and alcohol consumption on the river make recreational safety on the water an important issue here. In addition, a nearby stretch of River Road has been one of the most dangerous roads in all of Butte County (Hearne, 1998).
Impacts: Vehicular use of the gravel bar interrupts the natural cycle as the gravel bar provides environment for fish fry, fry feeders, ground nesting birds, and pioneer forests (Stewart et. al, 1997; Hearne 1998). Impacts to the gravel bar have been reduced since vehicle access was lost but could return in the future if a gravel bar returns to the end of the dirt road.

22. Bike Ways (not on map)
In addition to the many bicycling opportunities in Bidwell Park, there are also official bike paths and bridges, bike lanes and bike routes throughout the Chico urban area as well as popular bicycle rides on roads throughout the watershed. Many of these local bikeways run alongside or cross creeks in the watershed and provide excellent views of creeks and their canyons. For more information, Chico Area Bike Maps provided by Butte County Rideshare can be picked up at most local bike shops and the Chico Chamber of Commerce.
Impacts: Other than the previously discussed Bidwell Park studies, no current studies were found regarding impacts on natural resources from recreational bicycling in the watershed. As discussed in another section of this chapter, bicyclists not using official roads and bike routes do contribute to incidents of trespassing. Although there are no formal studies regarding economic impacts, there are approximately a dozen bicycle shops listed in the Pacific Bell Smart Yellow Pages for the Chico area. Bidwell Park in particular acts as a destination point for bicyclists from around the area and is beneficial to local bike business (O'Bryan, 1998). The largest local bike ride is the annual Chico Wildflower Century, which draws approximately 3,000 participants in a typical year, about half from out of the area. Demand for local lodging has been so high that cyclists have had to use motels in Glenn and Tehama counties (McLaughlin, 1998).

SITES NOT ON MATRICES
These are sites that are dispersed, not commonly used for recreation, do not have legitimate public access, or have other concerns associated with their use. The numbering continues from the previous section, but these sites have not been included on the matrices and map in order not to encourage inappropriate use or trespassing.

23. Soda Springs Area
Although the Soda Springs site receives recreational use, it has been omitted from the Facilities and Activities matrices because of problems in the area. This recreation site is part of the Lassen National Forest. Formerly a developed campground site, this area is still frequently used as an unofficial dispersed campground with no facilities. The Forest Service allows dispersed camping in most areas of the National Forest for up to 14 days.

Impacts: The area is heavily impacted by vehicle usage with substantial erosion of a steep hillside as a result of the use of off-road vehicles. Although no official studies have been conducted regarding the impacts at this location, it faces some of the problems common to heavily used areas without facilities. These problems include negative impacts from fire wood collection, littering, and improper disposal of human waste. Because of the isolated nature of this 40-acre parcel, it has been proposed for exchange with Sierra Pacific Industries.

24. Other Lassen National Forest Lands

In addition to the Colby Mountain Lookout and the Soda Springs parcel, other small sections of the Big Chico Creek Watershed are within the boundaries of Lassen National Forest. They include additional land on Colby Mountain, land that borders the Deer Creek Watershed, and several scattered parcels along Web Hollow, Big Chico, Cascade and Smoky creeks. Because of limited or difficult access, they receive relatively little recreational use. Most of the scattered parcels are proposed for land exchange with Sierra Pacific Industries.

Impacts: No studies were found regarding impacts from recreational use of these National Forest lands in the watershed.

25. Unpaved Roads

In areas with substantial public lands, especially national forest lands, unpaved roads can provide significant dispersed recreational opportunities. These roads provide access for activities such as driving trucks and off-road vehicles, and hiking, picnicking, fishing, and hunting.

Impacts: In the Big Chico Creek Watershed, most of the unpaved roads and surrounding lands are privately owned, most by Sierra Pacific Industries. Therefore, dispersed recreation in these areas often involves trespassing. Inappropriate recreational use of trucks, four-wheel-drive and off-road vehicles on unpaved roads has resulted in road damage and increased erosion. Such damage to Sierra Pacific's H-Line road, which runs from Ponderosa Way north of Cohasset to Highway 32 near Soda Springs, has increased the company's cost of maintaining the road, and as a result Sierra Pacific will be increasing the use of gates to prevent access (Bean, 1998). Sierra Pacific and other private property owners have reported similar problems elsewhere. In addition to the economic impacts, road erosion may have fisheries and environmental resource impacts by reducing the water quality of watershed streams.

Other problems have occurred in some of these remote areas, including illegal hunting and fishing, dumping of trash, the growing of marijuana, and methamphetamine production. All of these problems, combined with what is perceived as a lack of road maintenance and law enforcement by public agencies, has led Sierra Pacific and other private landowners to gate off access to some of these roads. This, in turn, has generated concern from area residents who were not the source of the problems but who have now lost their traditional access to the area. Some have questioned the legality of some of the road closings, claiming that some of the roads are public and that legal public access has been established on others. Evaluation of the legal issues involved is beyond the scope of this study.

26. BLM Properties

BLM properties have been left off the recreation matrices because most of the properties are scattered with poor access and because BLM is planning to dispose of most of the properties. Some minor recreational activities probably do occur on some of these properties, but the BLM does not regularly monitor such use. If the stretch of Big Chico Creek between Campbell Creek and Ponderosa Way, which has been preliminarily classified as eligible, is added to the National Wild and Scenic River System by Congress, demands for recreational use could increase in the future.

Impacts: No studies were found regarding impacts of recreational use of BLM property in the watershed. There have been some problems with the dumping of trash on the parcels off of

Highway 32, but it is uncertain whether this problem is related to recreational use of those properties.

27. Old Trapshooting Range next to Horseshoe Lake

An area next to Horseshoe Lake in Bidwell Park was formerly used as an outdoor trapshooting range.

Impacts: There has been some concern expressed about possible impacts to Horseshoe Lake and the surrounding area resulting from lead shot remaining in the area. Studies have not been conducted to evaluate potential impacts (Boza, 1998).

28. Big Chico Creek Section of Bidwell River Park

In addition to Lindo Channel, another part of Bidwell River Park created by Annie Bidwell's deed of 1908 is a strip of land from the Sacramento River to the Southern Pacific Railroad right of way along the north side of Big Chico Creek (Bidwell, 1908). Part of this is now in Bidwell-Sacramento River State Park, which was discussed above. This section of Bidwell River Park extends from the midpoint of the creek to approximately the top of the bank. Except for a stretch along Bidwell Avenue, the narrow boundaries and adjoining properties make it impractical for general public access. Therefore, it has not been included in the Recreation Facilities and Activities matrices.

Impacts: No studies were found regarding impacts from recreational use of the Big Chico Creek Section of Bidwell River Park.

29. Levees

Levees along the Sycamore Creek Diversion Channel, Sycamore Creek, Mud Creek, and the lower part of Big Chico Creek are owned by the Department of Water Resources and maintained by Butte County. Some parts of this levee system are commonly used for recreational activities such as walking and biking. The Chico General Plan designates these streams as creek-side greenways within the City's sphere of influence while the CARD Comprehensive Park and Recreation Plan identifies them as recommended lineal parks. The county, however, does not manage them for recreation. They are gated and have signs prohibiting unauthorized vehicular use. The County has no plans to make these areas available for official recreation use; an issue that would have to be addressed would be keeping people off the levees during high-water events (Greenlaw, 1998).

Impacts: No studies were found regarding impacts from recreational use of the levees.

Fishing on the Sacramento River

30. Mud Creek
Mud Creek is not included separately on the recreation matrices because many portions are covered in other sections of this chapter and because the vast majority of Mud Creek is on private property. Parts of upper Mud Creek are used for dispersed recreation similar to that described above in Unpaved Roads and Sierra Pacific Industries Land. Mud Creek also flows through the Musty Buck Preserve and Springs of Living Waters at Richardson Springs, both of which are discussed elsewhere in this chapter. Lower portions of the creek are included in the Levees section above. The right bank of Mud Creek at its confluence with Big Chico Creek is now part of Bidwell-Sacramento River State Park. A significant amount of hunting occurs along the lower sections of the creek, mostly for pheasant and dove (Taylor, 1998).

Impacts: No studies were found regarding impacts from recreational use of Mud Creek. Potential impacts related to hunting include shooting of other species and other violations of hunting regulations (Taylor, 1998).

31. Rock Creek
Rock Creek is also not included on the recreation matrices because most of it is also on private property. In the upper watershed, it is subject to some of the same dispersed recreation uses described above in Unpaved Roads and Sierra Pacific Industries Land. Levees on Rock Creek are privately owned (Greenlaw, 1998). A significant amount of hunting, especially pheasant and dove, also occurs on Rock Creek (Taylor, 1998).

Impacts: No studies were found regarding impacts from recreational use of Rock Creek. Potential impacts related to hunting include shooting of other species and other violations of hunting regulations (Taylor, 1998).

— OTHER POTENTIAL IMPACTS AND STUDIES —

IMPACTS FROM ILLEGAL FISHING

In previous years, the impact from poaching has been significant on already low populations of salmon (Taylor, 1998). Grant funds from the U.S. Fish and Wildlife Service and other sources, however, have allowed expanded California Department of Fish and Game enforcement efforts in the salmon areas of Big Chico and Butte Creeks. This effort, which is funded until the year 2000, has been successful in deterring illegal fishing (Taylor, 1998). Illegal angling may be a problem in the Chico urban area because of easy access to streams by inexperienced fishers with little knowledge of applicable regulations (Brown, 1998). Fishing may also contribute to trespassing problems. There is some trespassing onto private property upstream of Bidwell Park from people fishing, but there have been few complaints from landowners (Bishop, 1998).

INTRODUCTION OF NONNATIVE SPECIES

Past planting of nonnative fish has impacted Big Chico Creek, creating competition for native species and altering the local ecosystem. Brown trout were planted directly into the creek in the past, and small mouth bass, originally introduced elsewhere in the state, have also made their way into the local stream (Maslin, 1998). The bullfrog, considered a game species and originally introduced into California as a food source, has also had impacts on the creek (Maslin, 1998). (see Appendix A in the Aquatic/Biotic Inventory chapter)

TOURISM IN BUTTE COUNTY

Tourism, most of which is related to recreation, is a $277 million a year industry in Butte County (Goodwin, 1998). Additional research would be necessary to determine what portion is attributable to recreation with the Big Chico Creek Watershed.

MISCELLANEOUS IMPACTS

Numerous miscellaneous environmental impacts result from recreational use of creeks in the watershed, including changes in flows caused by people building small rock dams, trampling of vegetation and erosion caused by people walking up and down the creek banks, and mountain bikes eroding trails adjacent to the creeks. Other impacts include bank erosion and siltation caused by dogs jumping in and out of the streams fetching sticks, and litter and human waste from careless creek users (Maslin, 1998).

MISCELLANEOUS STUDIES

A 1995 Opinion Survey for the City of Chico conducted by Regional and Economic Sciences gathered information regarding use and support of park and recreational facilities in the Chico area. The most frequently used facilities were 1) Lower Bidwell Park, 2) Upper Bidwell Park, 3) One-Mile Recreation Area, and 4) Hooker Oak Recreation Area (Ebeling et al, 1995, p8).

Summary

Although there are numerous recreational sites and activities in the Big Chico Creek watershed, Bidwell Park receives the heaviest use and is the location of most known impacts to fisheries and other natural resources. Bidwell Park should therefore be part of any plan to reduce these types of recreational impacts. Several studies have already been conducted for the City of Chico that partially address these issues.

Impacts and conflicts regarding the use of unpaved roads in the upper watershed appear to be significant and are worthy of further research or consideration in a watershed management plan. Private property impacts, i.e. trespassing, from recreational activities are also occurring upstream from Bidwell Park and in the Canyon Oaks area.

There are substantial gaps in the current data regarding the impacts of recreation in the watershed. Outside of Bidwell Park, there has been very little study of the impacts from recreation on fisheries and other natural resources. There has also been very little study anywhere in the watershed regarding recreation impacts on private property and economic resources. However, use levels, retail establishments for recreational equipment, community programs and special events indicate that there are probably substantial economic benefits resulting from recreation.

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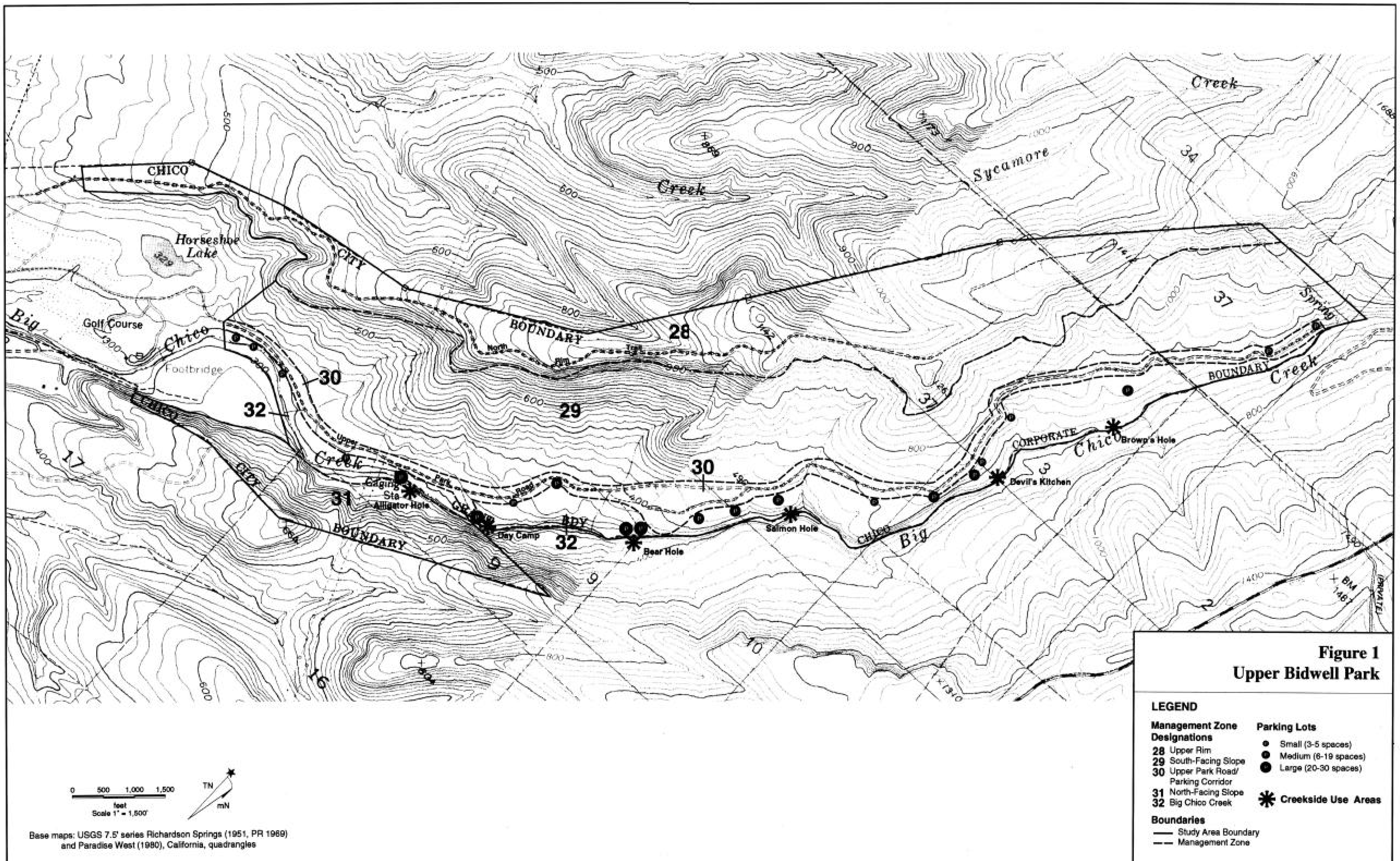

Figure 1. Upper Bidwell Park Recreational Opportunities Map.
Credit: Jones & Stokes Associates, Inc. (1997).

Table 1. Facilities Matrix.

Map Identification No.	FACILITIES MATRIX	Managed by Public Agency	Managed by Nonprofit/ Public Use Available	Private Membership Facility	Fee Area	Fees for some programs	Road Access (paved)	Road Access (unpaved)	Trails (maintained)	Trails (not maintained)	Wheelchair Accessible	Visitor Center	Other Interpretive Facilities	Picnic Tables	BBQ	Potable Water	Toilets	Trash Receptacles	Signs	Store/Lodge/Cabins	Outstanding View	Playground	Ball Fields
1	Colby Mountain Lookout	X						X		X	a			X			X	X	X		X		
2	Camp Lassen		X		X			X	X	X	X			X	X	X	X	X	X	X			
3	Musty Buck Preserve			X	X			X		X				X		X	X		X	X	X		
4	Springs of Living Waters at Richardson Springs		X		X		X		X		X	X	X	X	X	X	X	X	X	X	X	X	X
5	Upper Bidwell Park	X					X	X	X	X			b				X	X	X		X		
6	Bidwell Park Golf Course		X		X	X	X							X	X	X	X	X	X	X	X		
7	Chico Rod & Gun Club		X		X		X				c					X	X	X	X				
8	Middle/Lower Bidwell Park	X				d	X		X	X	X	X	X	X	X	X	X	X	X		X	X	X
9	Hooker Oak Recreation Area	X				X	X		X		X		X	X	X	X	X	X	X			X	X
10	Chico Creek Nature Center		X			X	X		X		X	X	X	X		X	X	X	X				
11	Sycamore Field	X				X	X				X	X				X		X	X				X
12	CARD Community Center	X				X	X		X		X					X	X	X	X				
13	Bidwell Ranch	X						X					e								X		
14	Wildwood Park	X					X		X		X		X			X	X	X	X		X		X
15	Lindo Channel Section Bidwell River Park	X								X													
16	First Avenue and Verbena Lane Future Park Site	X					X																
17	Bidwell Mansion St. Historic Park	X			X		X				f	X	X			X	X	X	X				
18	Children's Playground	X									X			X				X	X			X	
19	Bidwell Bowl Ampitheater	X			X													X					
20	CSU, Chico	X				X	X		X		X	X	X	X	X	X	X	X	X	X			X
21	Big Chico Creek Riparian Area Bidwell-Sacramento River St. Pk.	X						X	X	X	g						X	X	X		X		
---	Bike Ways	X					X	X	X	X											X		

a-g Please see notations.

Notations for Table 1: Facilities Matrix

a. The restroom at the Colby Mountain Lookout is wheelchair accessible but is surrounded by a rough surface, making access difficult.

b. A Yahi Trail Map and Guide is available from the Chico Park Department or Chico Creek Nature Center.

c. Shooting area is accessible, but entrance doors may not be official width and parking lot is gravel. People with wheelchairs do use the facility (Jones 1998).

d. Certain areas of the park may be reserved for group activities with payment of a fee: One-Mile Picnic Area, Council Ring, Cedar Grove and Five-Mile Picnic Area. Groups using these facilities charge admission to some events. Two Birthday Rings in Caper Acres may be reserved with no fee.

e. A science unit for grades 1-3 with suggested lessons and supplies is available from Stop Bidwell Ranch, 345-4865.

f. The visitor center and first floor only of the mansion are accessible by wheelchair. A film is available of the 2nd and 3rd floors.

g. The parking lot, restroom, and trail to the gravel bar in the Big Chico Creek Riparian Area are wheelchair accessible.

Table 3. Summary of Park Use Assessment by Management Zones

Management Zone	Sensitive Resources	Existing Facilities	Types of Users	Relative Levels of Use	Peak Use Period	Assessment of Effects of Park Use on Sensitive Resources
Upper Rim (Zone 28)	Oak woodlands, oak savanna, and grassland species found on thin soils along North Rim trail are sensitive to trampling and erosion	North Rim Trail (maintenance road and trail)	Bicyclists Equestrians Hikers	Moderate Moderate Low	Year round Year round Year round	Measures should be implemented to keep users on the designated trail to reduce the erosion and expansion from inappropriate trail use. Monitoring of the trail should be conducted periodically to assess whether further erosion is occurring.
South-Facing Slope (Zone 29)	Oak woodlands and savanna formed on thin soils and steep slopes are sensitive to trampling, soil erosion, and wildfire	Various trails	Hikers Equestrians Bicyclists	Moderate Moderate Moderate	Year round Year round Year round	Further measures should be implemented to control trail erosion, keep bicyclists on existing trails, and deter the establishment and use of non-designated trails. Monitoring of the area should be conducted periodically to assess whether further trail erosion is occurring and whether additional bootleg trails are being created.
Upper Park Road/ Parking Corridor (Zone 30)	Wetland areas are sensitive to disturbances that cause sedimentation; perennial grasslands are sensitive to soil disturbance; and oak woodlands are sensitive to trampling and soil compaction	Upper Park Road (public road) and associated parking areas	Motorists Bicyclists Equestrians Hikers	High Low High Low Moderate	Summer Other months Year round Year round Year round	Measures are needed either to improve the condition of the road and parking areas to accommodate existing use levels, or to reduce vehicular use along the entire length or portions of the road. Methods should be considered for concentrating vehicular use in a more limited area of the park to reduce impacts and restore disturbed areas. Measures are needed to contain vehicular use in existing parking areas.
North-Facing Slope (Zone 31)	Oak woodlands developed on steep, rocky slopes are sensitive to soil erosion and wildfire	Various trails	Hikers	Low	Year round	Measures should be taken to establish the trail system, control erosion on existing trails, and deter the creation of non-designated trails. Trails should be monitored to periodically assess the need for trail maintenance or closures.
Big Chico Creek (Zone 32)	Riparian areas, especially along steep creekbanks, are sensitive to vegetation loss, soil erosion, and wildlife disturbance	Yahi Trail and creek access trails	Swimmers Hikers	High High	Summer Year round	Measures are needed to contain use in existing creekside use areas, especially during the summer peak season. Methods should be considered for directing use to more defined areas within the riparian corridor and to restore already disturbed areas within the zone. Monitoring should be conducted at creekside use areas to periodically assess the extent of disturbance to sensitive resources.

Credit: Jones & Stokes Associates, Inc.

INVENTORY OF ENVIRONMENTAL EDUCATION PROGRAMS

— INTRODUCTION —

This component of the Existing Conditions Report (ECR) provides a comprehensive profile of those environmental programs currently in progress within the schools. Once clearance to talk to school administrators was granted by Chico Unified School District, educators from each school were contacted and asked to provide information about or profiles of their environmental education programs. This was achieved in the form of an interview questionnaire that each teacher/principal who was consulted answered to the best of his/her knowledge. The results of this survey are found in Table 1.

The results of this survey provide an overview of the environmental education programs that exist within the schools within the Big Chico Creek Watershed. This information has been condensed and clarified for the convenience of the reader. The next component is a description of the individual environmental education programs. At the end of the section are additional facts about the programs that may be unique to the school or are in the planning strategies of the individual schools.

— PUBLIC AND PRIVATE SCHOOL ENVIRONMENTAL EDUCATION PROGRAMS IN THE BIG CHICO CREEK WATERSHED —

ADOPT-A-WATERSHED

Adopt-A-Watershed is a comprehensive curriculum source for educators, k-12th grade, who are interested in involving students in local watershed activities. Adopt-A-Watershed provides a way for teachers to weave together projects and programs with an overall environmental theme in order to focus on local watersheds. Seminars offer educators new activities, literature and knowledge of how to use equipment in conjunction with the curriculum.
For more information contact: Adopt-A-Watershed (530) 628-5334.

BUTTE CREEK WATERSHED EDUCATION PROGRAM

Butte Creek Watershed Education Program is involved in training Chico area teachers interested in the Adopt-A-Watershed program. The program has plans for starting restoration projects, and is developing walking field trips in Bidwell Park which focus on watershed education (Stephens, 1998). The project is also involved in providing educational opportunities for teachers and students at the Butte Creek McAmis Property and at the Butte Creek California Fish and Game Ecological Preserve.
For more information contact: Anne Stephens (530) 891-3080.

Table 1. Environmental Education Programs and Projects Offered at Watershed Schools.

Public Schools	Ameri-Corp	AAW	Eco-life	Endangered Species Fair	Garden/ Life Lab	Nature Bowl	Learn & Serve Chico	Recycle	Salmon in Classroom	District Science Fair	Community Service
Chapman			Y	Informal	Plans		Y	Y		Y	Y
Citrus	Y			Informal	Plans		Y	Y	Y	Y	Y
Emma Wilson		Y	Y	Y	Y		Y	Y	Y	Y	Y
Hooker Oak			Y	Y	Y		Y	Y	Y	Y	Y
Jay Partridge		Y		Informal	Y			Y		Y	Y
John McManus		Y	Y	Informal	Y		Y	Y	Y	Y	Y
Marigold			Y	Informal		Y		Y	Y	Y	
Neal Dow		Y	Y	Informal	Y			Y		Y	
Little Chico	Y	Y	Y	Informal	Y	Y		Y	Y	Y	Y
Parkview				Informal	Y			Y	Y	Y	Y
Rosedale				Informal	Y			Y	Y	Y	
Shasta			Y	Informal	Y			Y	Y	Y	
Sierra View			Y	Informal				Y		Y	
Cohasset			Y	Informal	Y						Y
Forest Ranch			Y	Informal	Y			Y		Y	Y
Nord				Informal				Y		Y	
Bidwell Junior				Y	Y		Y	Y	Y	Y	Y
Chico Junior		Y		Informal			Y	Y		Y	Y
Chico Senior		Y		Y	Y		Y	Y		Y	Y
Pleasant Valley		Y		Y			Y	Y		Y	Y

Table 1. Environmental Education Programs and Projects Offered at Watershed Schools.

Public Schools	Ameri-Corp	AAW	Eco-life	Endangered Species Fair	Garden/ Life Lab	Nature Bowl	Learn & Serve Chico	Recycle	Salmon in Classroom	District Science Fair	Community Service
Fair View Continuation High				Y	Y			Y	Y		Y
Center for Alternative Learning					Y			Y			Y
Chico Country Day School				Informal	Plans			Y	Y	Y	Y
Four Winds		Y		Y	Y				Y	Y	Y

Private Schools	Ameri-Corp	AAW	Eco-life	Endangered Species Fair	Garden/ Life Lab	Nature Bowl	Learn & Serve Chico	Recycl e	Salmon in Classroom	Science Fair	Community Service
Notre Dame								Y		Y	
Chico Montessori				Y	Plans			Y		Y	Y
Champion Christian				Informal	Y			Y		Y	Y
Chico Christian				Informal				Y		Y	
Chico Oaks Adventists				Informal	Plans			Y		Y	Y
Kings Christian								Y		Y	
Redeemer Lutheran					Y			Y		Y	Y

CHICO SCIENCE FAIR FOUNDATION

The Chico Science Fair is organized by the Chico Science Fair Foundation (CSFF), a non-profit organization founded by dedicated science enthusiasts who wanted to build local awareness of, and provide support for, informal science education.

The purpose of the Chico Science Fair is to offer local students, both at public and private schools, an opportunity to carry out hands-on science experiments which help them acquire valuable critical thinking and problem solving skills. The students, k-12th grade, research, plan and implement their projects as individuals, or in small groups. Then the experiments are shared with the community. The emphasis of the fair is on education, not competition, although the projects are judged and prizes are awarded. During the two and a half days that the fair is open to the public approximately 3,000 people visit the exhibits (Whitegon, 1998).
For more information contact: Leonard Whitegon at (530) 343-0448.

CHICO UNIFIED SCHOOL DISTRICT

Chico Unified School District (CUSD) has two programs. The first program is Learn and Serve Chico, which is coordinated by Cindy Triffo at Chico High School. The focus is on coordinating community needs with student projects. Although this program is to provide a variety of service learning opportunities, the current focus is on watershed education.

Two main goals of service learning are to enhance academic learning and to encourage civic responsibility. The main elements of service learning are:

- Integrated learning
- High Service
- Student Voice
- Reflection
- Collaboration

Learn and Serve Chico has just completed its first year of a three year funding cycle. The specific focus of year one was the environment. Learn and Serve Chico plans to establish and maintain liaisons with environmental agencies such as the Butte Creek Education Project, the City of Chico Volunteer Program, Big Chico Creek Watershed Alliance, Community Action Volunteers in Education (CAVE) and others. In year one students from Chico High Senior High, Pleasant Valley Senior High, Bidwell Junior High and Hooker Oak Elementary school all participated at different levels to enhance environmental curriculum. Additionally, five elementary schools have implemented Community Garden Projects. The focus of future years will include Social Services, Health Services, Literacy projects, and a Cross-Age Tutoring program. Funding could last for two more years after which the Chico Unified School District will be expected to sustain the program (Triffo, 1998).
For more information contact: Cindy Triffo at (530) 891-3026.

The second program at Pleasant Valley Senior High School emphasizes watershed studies. Teacher Steve Hostettler has been working on the concept of developing "Field Schools" in different disciplinary areas such as Early Childhood, Education, Medicine, and Watershed Studies. Both Steve Hostettler and Dan Beadle work with the Colegio Program, which provides students with a personalized plan for academic achievement based on objective assessments, parent input, and student goals. Dan Beadle has incorporated a study of Lindo Channel into his classroom studies. The students have visited the channel a number of times to study it and record changes they observe. Students collaborate to construct essential questions, develop reasonable hypotheses, and evaluate solution objectives. Learning experiences integrate theory and practice; school and community; science, technology, humanities and the Spanish language (Hostettler, 1998).
For more information contact: Steve Hostettler at (530) 891-3050.

ECOLIFE

EcoLife is a program offered cooperatively by California State University, Chico (CSUC) and the Butte Environmental Council (BEC). EcoLife was started as a club for CSUC Associated Students. Volunteer students worked with BEC to give in-class presentations concerning environmental topics to local schools. Students from Dr. Jon Hooper's Environmental Education class joined the club and became involved in presenting environmental education lessons. Over time, the general student body membership dwindled, so Dr. Hooper decided to simply incorporate EcoLife into his RECR/EDCI 251 "Methods and Materials for Environmental Education" class.

In the RECR/EDCI 251 class, Dr. Hooper requires students to complete an out-of-class teaching assignment. The idea is to give college students first-hand experience working with younger people. The college students work in teams to teach a 1-to-2 hour session on an environmental topic. BEC advertises the program and provides a list of interested teachers to Dr. Hooper. Dr. Hooper provides the students with the list of potential teachers, who make a selection, and then initiate contact with the individual teachers. The teacher and the students figure out exactly what will be done in the classroom. While a few teachers have "canned" programs that the students can present, most leave it primarily up to the students to decide what to cover. Most students incorporate a Project WILD activity, since all students are trained on the use of this environmental education guide (Hooper, 1998).
For more information contact: Dr. Jon Hooper (530) 898-5811.

ENDANGERED SPECIES FAIR (ESF)

The Endangered Species Fair, sponsored by the Butte Environmental Council (BEC), is the area's largest networking link between k-12 grade school teachers; students concerned with environmental education and issues; regional environmental organizations like the Sierra Club; and government agencies such as the U.S. Fish and Wildlife Service. The 19th annual Endangered Species Fair in 1998 was a success with over 5,000 attendees, 14 school booths and 20 nonprofit groups in attendance. Between 6,000 and 10,000 attendees enjoy this annual event (Vlamis, 1998).
For more information contact: BEC (530) 891-6424.

GARDEN / LIFE LAB

A number of schools have either started gardens (which can include native plants, flowers or vegetables) or are planning to develop a garden in the near future. The idea of gardening is financially supported by several different funding sources both locally and at the state level.

Life Labs are ideal for classrooms that do not have space or support for a full garden area. Life Lab provides the teacher with the necessary equipment to set up a miniature green house in the classroom where students have the opportunity to grow plants and conduct various studies.

NATURE BOWL

The Nature Bowl is an annual environmental education event sponsored by the California Department of Fish and Game and funded through the California Department of Education. It is a cooperative learning team program for 3rd through 6th grade students. Questions and activities focus on regional environmental science and issues, correlating with the State Science Framework.

The Nature Bowl serves to reinforce concept comprehension, introduce new information, and motivate students and teachers to further study in the field of science. Classes become involved in the conservation of natural resources, and in understanding local environmental issues. The goal of the Nature Bowl is to motivate students and inspire teamwork, and to train future environmental leaders.

An in-service class is offered to the teachers or adults who will be leading the nature bowl teams. The coaching workshop introduces the Nature Bowl format and gives suggestions for incorporating and improving environmental education in classroom activities.

During the school year, there are two individual events. At the county level, the schools are given the option of having one team participate at each of these grade levels: 3rd/4th, and 5th/6th grade. Our local county competition takes place at Gray Lodge Wildlife Area. The event lasts a half-day at which time the students participate in six to eight different events. At the end of the day two teams are chosen to go on to state finals at California State University, Sacramento. The cost for participating in the Nature Bowl is $5.00 a year per team (Foreman, 1998).
For more information contact: California Department of Fish and Game (916) 358-2353.

NORTH VALLEY DISPOSAL AND RECYCLING PROGRAM

North Valley Disposal and Recycling has an established recycling program with Chico Unified School District. They have organized a district wide paper recycling competition. The paper recycled from each school is tracked for the quarter, and the school recycling the most paper per quarter is awarded a large, laminated recycling poster. The contest is broken down into three groups: junior and senior high schools; elementary schools; and the two small schools of Fair View and Nord. The posters are awarded at the end of each quarter. Last year a number of different schools won posters. Chico Unified School District was responsible for recycling 44, 575 lbs. of paper.

North Valley Disposal also sponsors several other recycling programs that many schools participate in, such as cardboard and kitchen recycling. Kitchen recycling includes tin cans,

plastic bottles/buckets, glass bottles/jars, and newspapers/magazines. The amount of recycled materials is weighed and calculated and the winning schools in the different categories are presented awards from North Valley Disposal and Recycling (Barker, 1998).
For more information contact: Ginger Barker (530) 893-8053.

OUTDOOR EDUCATION PROGRAMS

Sixth graders attending public school have the opportunity to spend several days at an outdoor education program at some point during the school year. Individual schools decide which local outdoor education school they will attend. The local outdoor education schools are Butte Meadows, Whiskey Town and Woodleaf Outdoor Education School. Some schools attend outdoor education programs on the coast or choose to create their own outdoor education experience. The local outdoor education school for the Chico area is Butte Meadows Outdoor Education School.
For more information on Butte Meadows Outdoor Education School contact: Judy Johnson at Emma Wilson Elementary (530) 891-3297.

STREAMINDERS

Streaminders was founded in 1980 as a citizens stream advocacy group. In 1990, it became a chapter of the Izaak Walton League of America (IWL). The Streaminders Chapter of the IWL is dedicated to preserving, enhancing, and restoring Butte County streams, watersheds, and urban forests through educational program advocacy, and hands-on activities for the public. Streaminders has received a number of grants to do restoration, care for the shade trees of Chico, as well as teach classes on creek ecology.
For more information contact: Roger Cole (530) 895-0866

SALMON AND STEELHEAD FROM EGGS TO FRY PROGRAM

The Streaminders hands-on Salmon and Steelhead from Eggs to Fry Program builds on the fascinating environments of local streams to provide students an opportunity to learn first hand about the wonder of the salmon/steelhead life cycle and habitat needs. They also learn about the challenges facing these fish and the roles humans play in helping them to thrive in our local creeks and streams.
For more information contact: Roberta Walker-Forest (530) 899-8101

THE AMERICORP WATERSHED PROJECT

"The Watershed Project," an AmeriCorp's program and a partnership between the California Conservation Corps and Adopt-A-Watershed, is a breakthrough in science education. It combines an integrated, hands-on science curriculum known as Adopt-A-Watershed with an innovative implementation model based on school/community collaboration.

Kindergarten students adopt a local watershed and use it as a focal point for their science curriculum through 12th grade, doing at least 3 service learning projects a year. Adult volunteers from a broad range of organizations in the community work closely with the students, lending their expertise in the planning and implementation of the service learning projects. Post-secondary students serve as mentors to the younger students and have the opportunity to participate in certification and apprenticeship programs.

Teachers need support in identifying, planning and implementing service learning projects. The Watershed Project is designed to bring resources and expertise of the community into the classroom. Site-Based Coordinators oversee the interface between schools and the community and develop Adopt-A-Watershed curricula into a total watershed education model. AmeriCorp's crewmembers act as mentors on field trips and help with restoration projects.

Participants in the Watershed Project will develop an ethic of service and enthusiasm for and applied knowledge of science. In collaboration with local professionals, educators, students, citizens, and other resource workers, they will be empowered to get things done. They will be given the tools and the opportunity to make a genuine and enduring impact on their shared watershed. (Hamer, 1998).
For more information contact: Todd Hamer (530) 384-7900.

—— PUBLIC WATERSHED EDUCATION ——

Opportunities to learn about the Big Chico Creek Watershed through public environmental education or natural history programs are abundant in our area. This list of organizations includes an overview of locally offered programs. However, the purpose of this report is to focus on programs, projects, and activities, which are directly related to watershed education or environmental education. A brief description of each of the organizations is provided and then the focus narrows specifically to those activities, which relate directly to educating people about watershed issues.

ALTACAL AUDUBON SOCIETY, INC.

The Altacal Chapter of the National Audubon Society is a conservation and educational organization concerned with all aspects of nature and wildlife with a priority on birds. Altacal provides a range of educational opportunities for its members and the community.

- Monthly meetings are held at which guest speakers provide presentations on a variety of topics related to bird life.

- Altacal is participating in two watershed restoration projects. The first site is a 23-acre parcel called the Arneburg Sanctuary that is owned by Altacal. This site is located beside Kopta Slough next to Woodson Bridge State Park on the Sacramento River. Altacal has formed a partnership with Corning High School to put up Wood Duck boxes, songbird boxes, and Barn Owl boxes in the sanctuary. This partnership provides an important way for students to gain first-hand experiences working in their watershed. The second restoration site is located at the Chico oxidation ponds near the Sacramento River. There was area on the creek that lacked any vegetation and Altacal restored that section of the creek with native riparian plants.

- Altacal members lead 2-4 field trips each month throughout the state of California. Field trips are for birders of all levels - beginners through advanced.

- Monthly newsletters can be obtained at the Chico Creek Nature Center, the Chico Library, or on the Altacal web site.

Each December Altacal holds an annual bird count that is open to public participation.

- Altacal is also forming a library containing a variety of slideshows on birding (Tinker, 1998).

For more information contact: Dave Tinker (530) 894-5960.

BIDWELL MANSION STATE HISTORIC PARK

The Bidwell Mansion Association is dedicated to the restoration, preservation and interpretation of the Bidwell Mansion. The association is composed of citizens working under the guidelines provided by the State Department of Parks and Recreation. Bidwell Mansion State Park's visitor center has a detailed exhibit on the Bidwells that shows their influence on the history of Sacramento Valley. The State Park provides a variety of social events and living history presentations while conducting daily public and school group tours of the mansion. Tours are held Monday through Friday (12:00-4:00) and Saturday through Sunday (10:00 - 4:00) (Kendall, 1998).
For more information contact: Bidwell Mansion State Historic Park (530) 895-6144.

BOYS AND GIRLS CLUB OF CHICO

The Boys and Girls Club of Chico is part of the national organization. The Boys and Girls club offers both summer camp and after-school programs. During the school year the club has "Power Hour" where young people have the chance to focus on science, art & crafts, and the computer lab. Summer time activities include programs for a broad range of interests.

The program designed to teach environmental education, "Earth Protectors," was created to nurture environmentally responsible behavior in children while increasing environmental awareness. The most important aspect of Earth Protectors is that it is educational and fun. The current theme of Earth Protectors is fun and games with recyclable items, which includes activities like Kick the Can, Newspaper Dodge Ball, and Hot Box. (Pierce, 1998).
For more information contact: Boys and Girls Club of Chico (530) 899-0335

GOLDEN EMPIRE COUNCIL, BOY SCOUTS OF AMERICA

As a member of the Boy Scouts, a young person can earn badges by studying a number of different subjects, many of which are based on the natural sciences. Scouts also attend Camp Lassen located at the headwaters of Big Chico Creek. There scouts study a variety of conservation subjects while being immersed in the natural beauty of the Sierra Nevada/Cascade Range (Lewis, 1998).
For more information contact: Golden Empire, Boy Scouts of America (530) 342-7460.

BUTTE ENVIRONMENTAL COUNCIL

Butte Environmental Council (BEC) is a local non-profit environmental education and advocacy organization active in the Chico area for the past 23 years. BEC's focus as an environmental watchdog has been on timber, water, land, and planning conservation issues in the greater Northern California region. As an active environmental advocacy organization, BEC has four main educational and community outreach activities.

- BEC organizes cleanups of local creeks and Bidwell Park. Volunteers who participated in spring '98 Cleanup grossed over 2,251 lbs. of trash and recyclable materials.

- BEC sponsors the Endangered Species Fair. This educational event is the area's largest networking link between k-12 grade school teachers, students concerned with environmental education and issues, regional environmental organizations, and government agencies.

- BEC publishes a quarterly newsletter, Environmental News, which is free.

- BEC maintains a local web site at www.becnet.org. The web site provides information about recycling, local endangered species, and conservation groups. It also provides access to local Environmental Impact Reports and the Chico General Plan.

- BEC serves as a referral for issues dealing with toxins, recycling, and wetland destruction.

For more information contact: BEC (530) 891-6424 / fax: (530) 891-6426.

CALIFORNIA STATE UNIVERSITY, CHICO

California State University of Chico has a number of different programs that focus on providing environmental education to the campus as well as the local community.

The Arboretum Club

The Arboretum Club is a student-run organization that focuses on keeping Chico State a "campus wide arboretum," and is progressing towards educating the community as a whole about the treasures within the campus area. The Arboretum Club is involved in a number of projects.

- The students in the club lead tours through the "campus wide arboretum" with a focus on environmental education for area youth.

- The Arboretum Club has established a relationship with the Upward Bound Program to give local students the chance to participate in restoration on Big Chico Creek.

- The club has been actively restoring a section of Big Chico Creek that runs through the campus back to its original native riparian habitat. By replacing exotic plants with native plants, encourages the return of native insects, birds and other animals, all of which help to support the native salmon runs on Big Chico Creek.

- The club facilitates studies of practical research of environmental problems which focus on the arboretum.

- Currently, the club is also helping to establish an Environmental Action Resource Center (EARC) at the Chico State campus in cooperation with the Environmental Affairs Council (EAC). (Lennox, 1998).

For more information contact: The Arboretum Club through EARC (530) 898-5676.

The Arboretum Committee of California State University Chico

The Arboretum Committee of California State University Chico makes recommendations to the University Senate and works closely with the Campus Division of Buildings and Grounds with regards to any woody plants that grow on campus. The Arboretum Committee has three main areas of emphasis:

- Tours
- Safety Hazards
- Memorial Tree Planting

The Arboretum Committee runs public tours from October to May. The tours are given at various locations on campus and the topics include, but are not limited to, origins of the trees found on campus and care and maintenance of the trees and shrubs.
For more information contact: Wes Dempsey (530) 342-2293.

Environmental Affairs Council

The Environmental Affairs Council (EAC) was established to act as an advocate for the general health of the Earth's physical and biological environment, and to raise and address specific issues associated with the environment. To that end, the council strives to advocate and educate at several levels: within the corporate structure of the Associated Students; within the student body; on campus generally; within the University administration; and within the larger community.

EAC is involved in a long list of programs and events. Earth Week is a major community activity that EAC is in charge of planning for Chico State. Activities for Earth Week include:

- Information Faire
- Children's Faire
- Music in the Free Speech Area
- Sunrise Ceremony
- Speakers
- Forums

EAC created an Environmental Action and Resource Center on campus. This center provides the community with a tool for accessing a wide variety of information and allows networking resulting in an enhanced educational experience (Oetinger, 1998).
For more information contact: Environmental Affairs Council (530) 898-5701.

California Native Plant Society, Mt. Lassen Chapter

The California Native Plant Society is dedicated to the preservation of California's native flora. The local Mt. Lassen Chapter provides a variety of activities throughout the year for its members and the general public.

- Monthly meetings are commonly attended by a guest speaker with a slideshow focusing on the local area.

- A copy of the monthly newsletter can be found on the Community Bulletin Board at the Butte County Library - Chico Branch.

- Every two years the Mt. Lassen Chapter hosts a Native Plant Show. This show gives the public an opportunity to view the dramatic and varied native plant life in our area.

- The education committee is currently compiling a report which lists places in the area for teachers to take their students to view native plants.

- The Lassen Chapter is also involved in restoration projects throughout the area as well as the removal of exotic plants species (Guardino, 1998).

For more information contact: Josephine Guardino (530) 895-0349.

CHICO AREA FLYFISHERS

Since 1972, Chico Area Flyfishers, a non-profit organization, has been involved in community activities that support and promote the art of fly-fishing, and provide maintenance of local fisheries and fish habitats. The club promotes the preservation and restoration of streams, rivers and lakes. The Chico Area Flyfishers offer numerous activities and services to the community.

- Hooked on Fishing Not on Drugs

- Classroom Salmon and Steelhead Rearing

- Big Chico Creek Watershed Restoration

- Feather River Restoration

- Oroville Wildlife Area Restoration

- McCloud River Preservation

- Yellow Creek Restoration

- Little Blakeless Creek Restoration

- Monthly Meetings, Newsletter, Fly Tying and Fishing Trips

- Web Site: www.stormnet.com/caf

For more information contact: Lyonal Valley (530) 343-7364.

CHICO CREEK NATURE CENTER

The Altacal Audubon Society constructed the Chico Creek Nature Center building. In 1996, the Chico Creek Nature Center separated from the Audubon Society to form its own non-profit entity. It is located in of Bidwell Park and serves as a center for nature education with a living animal museum, park interpretation, and information center. It is the philosophy of the Chico Creek Nature Center that through knowledge and education, individuals learn to protect and preserve natural resources, especially in Bidwell Park.

The Chico Creek Nature Center offers:

- Environmental education programs for classrooms that can be taught at either the nature center or in the classroom. These programs have been designed within the Science Framework of the California Department of Education.

- Camp Chico Creek is open to young people 5-12 years of age. Participants spend a week exploring the local area, and participating in games and crafts that focus on specific themes such as Ponds.

- Living animal museum, in addition to housing a variety of non-releasable animals, also displays traveling exhibits from around the country, which focus on different environmental education themes.

- A variety of nature walks throughout the year. These walks are usually free and are scheduled on Saturdays year round.

- Supports a native plant garden.

- Volunteer and internship opportunities in a variety of fields (White, 1998).

For more information contact: The Chico Creek Nature Center (530) 891-4671.

CHICO MUSEUM ASSOCIATION

The Chico Museum building was originally constructed in 1904 as the city library through a monetary gift from Andrew Carnegie. In 1980, the Carnegie Library's use was changed from a library to a museum and the City council unanimously agreed to commit the library to the Chico Museum Association, a local non-profit organization. The primary purpose of the Chico Museum is collecting and preserving artifacts representing the history and culture of Chico and Butte County. The museum has shown over sixty exhibits while providing two permanent displays. The Chico Museum offers:

- Traveling exhibits, which can be hands-on/ interactive and usually weave natural history and cultural history together.

- Guest speakers who serve as an additional source of information for the current exhibit.

- A Maidu Indian traveling trunk, which is available to teachers, interested in studying about the local indigenous people in their classroom. It contains baskets, artifacts, music, and tapes.

- A quarterly newsletter to the membership, and a newsletter for teachers.

- The museum is a source for the Yahi Trail Flyer. This brochure is an excellent source of information on this popular hiking trail located in Upper Bidwell Park (McHugh, 1998).

For more information contact: The Chico Museum (530) 891-4336.

CITY OF CHICO

The City of Chico supports a number of programs that are involved to some degree in environmental education/watershed education. These areas are Bidwell Park, Bidwell Ranch, and Wildwood Park.

Bidwell Park

Bidwell Park is a 3,670-acre park distributed between the valley and foothill communities of the Chico area. Big Chico Creek runs directly through the middle of Bidwell Park that the city of Chico has been built around. The park is an excellent resource for the local community, both in professional education functions as well as informal processes. Many school and university classes use Bidwell Park to learn about the watershed. (Beardsley, 1998).
For more information contact: Park Department (530) 895-4972.

Bidwell Ranch

Bidwell Ranch is 750 acres of grassland and vernal pool habitat that was recently purchased by the City of Chico. It is located to the east of Wildwood Park and borders the northwest side of Bidwell Park. The City of Chico purchased it in 1997. The rare vernal pool communities and the unique animal and plant species that are supported by them have inspired a group of local citizens to organize and develop both public and school group tours to educate the area's populace on this unique resource. These tours were available for the spring season of 1998. There is also an excellent manual that can be purchased called The Vernal Pools of Butte County, available through Butte Environmental Council. (Beardsley, 1998).
For more information contact: Park Department (530) 895-4972.

Wildwood Park

Wildwood Park is located at the entrance to Upper Bidwell Park. The city has erected interpretive signs which provide general information about the adjacent vernal pools explaining how various geologic, hydrologic and biological components create these rare and unique communities (Beardsley, 1998).
For more information contact: Park Department (530) 895-4972.

CHICO AREA RECREATION AND PARK DISTRICT

Established in Chico in 1948 the Chico Area Recreation and Park District (CARD) is a public agency funded by local property taxes and user fees.

CARD programs are geared toward all age groups. CARD covers a 230 square mile area and serves a population of over 80,000. CARD facilities have been designed to enhance the recreation programs we offer and the recreation opportunities of the community.

Many different camps are offered to young people. One camp that focuses on environmental education is Camp Chi-Di-Ca. This is a day camp which focuses on nature skills, camp crafts, hiking, outdoor cooking, archery, games, and swimming and is held at Hooker Oak Recreational

Area which is located in Upper Bidwell Park. This area is leased from the City of Chico by CARD. The area is maintained and operated by CARD and provides a space to host a variety of recreational programs (Kehoe, 1998).
For more information contact: CARD (530) 895-4711.

CHICO COMMUNITY CHILDREN'S CENTER

Chico Community Children's Center is a non-profit organization established in 1974 to address the concerns of low-income families. The center has four programs to meet the needs of children. These programs are:

- Infant Program
- Toddlers Program
- Preschool Program
- After-school program K-4th grade

The major component of the after-school program is nature study. Children in this program study local habitat, animals, plants, national parks, wildlife, Native Americans, and recycling. Young people have also had the opportunity to participate in the local Endangered Species Fair (McGuire, 1998).
For more information contact: Chico Community Children's Center (530) 891-5363.

CHICO DUCKS UNLIMITED

Ducks Unlimited is recognized as the world's largest private waterfowl and wetlands conservation organization.

Fund-raising proceeds go to programs to help preserve wetlands or provide habitat for endangered species. There are membership options for young people and participants have a variety of opportunities including: learning the process of banding birds, how to work with hunting dogs and how to make bird nest boxes. (Miller, 1998).
For more information contact: Dana Miller (530) 342-6463 or 345-3266.

4-H YOUTH DEVELOPMENT PROGRAM

The Cooperative Extension branch of the University of California offers the 4-H Youth Development Program.

The 4-H Educational Goals are:

- Acquisition of life, leadership and problem-solving skills to enhance individual development and well-being.
- Acquisition of knowledge and skills in the production and wise use of food and fiber, and the conservation of the world's natural resources.
- Understanding of and responsible participation in, community affairs.

The 4-H clubs within this area offers a number of projects for young people to become involved with. Along with the traditional projects, five main projects focus on different aspects of ecology:

- Creek Watchers
- Wetland Protectors
- Fresh Water Guardians
- Water Inspectors
- Plastic Eliminators

Within each of these fields, the 4-H members have a variety of different projects in which they can choose to participate. The completed projects can then be shown in competition at the local and state levels (Meade, 1998).
For more information contact: 4-H Advisor (530) 538-7201

FUTURE FARMERS OF AMERICA

FFA makes a positive difference in the lives of students by developing their potential for premier leadership, personal growth and career success through agricultural education.

There are several programs offered by the FFA which focus on environmental science:

- Proficiency Award - Environmental Sciences: This award is designed to recognize members who have developed skills and gained valuable knowledge in specific areas of the environmental sciences.
- Extemporaneous Public Speaking Topics include and are not limited to Ground Water Contamination, Soil Contamination, and Rural/Urban Development.
- Curriculum Development: Materials are developed for agricultural teachers who include information about environmental stewardship. There are curricula and textbooks available in this area.
- Agri-Science Fair. At the national and state levels an Agri-Science Fair is conducted where one of the five categories in each fair is Environmental Science (Dobson, 1998).

For more information contact: Agricultural Education - California Department of Education (530) 342-7541

KZFR

Local community radio station KZFR airs the weekly program Eco-Talk hosted by Randy Larson whose focus is on environmental issues. Larson interviews environmental leaders and authors providing listeners with updated information on environmental issues. His program has provided such a valuable service to the community that it received the 1996 California Sierra Club Environmental Journalism of the Year Award and was recently syndicated by KPF and can

be heard on sixty radio stations nationally. Eco-Talk can be found locally at 90.1 FM from 5:30 - 7:00 on Fridays (Larson, 1998).
For more information contact: KZFR (530) 895-0706.

PARKS & PRESERVES FOUNDATION

Parks & Preserves Foundation is a non-profit conservation organization specializing in the preservation of land for new parks and nature preserves. The organization also protects land for agricultural, recreational, historical, and/or scenic purposes. It recognizes that there needs to be a balance between the need for timber, agriculture, and development - while maintaining a healthy environment and high quality of life for generations to come. Parks & Preserves offer economically viable ways to preserve open spaces. The four main ways the foundation preserves land are:

- Direct Ownership
- Conservation Easements
- Cooperation
- Mitigation

Parks and Preserves is involved in numerous activities while at the same time providing a regular newsletter to keep the membership informed of local activities and news. It also provides brochures and sources of information on the program (Weston, 1998).
For more information contact: Parks and Preserves (530) 894-7738.

SACRAMENTO RIVER PARTNERS

Sacramento River Partners is a local community based non-profit group that works with farmers, landowners, non-profits, and government agencies to establish the Sacramento River Conservation Area and meander belt; to protect and restore the aquatic and riparian habitats of the river; and to promote the economic sustainability of the watershed. The main objective is to build partnerships with agencies and local stakeholders that result in on-the-ground conservation solutions, increased local capacity, and community buy-in. Sacramento River Partners has four main programs:

Land Acquisition

- Acquire fee title and conservation easements on lands within the SB1086 Sacramento River Conservation Area.
- Pre-acquire lands within the Conservation Area for public ownership.
- Support agencies acquisition funding efforts.

Land Management

- Manage agricultural properties that are erosion prone or in transition to riparian habitat.
- Actively plant riparian forest on flood prone agricultural land within the meander belt.
- Manage frequently flooded properties to promote passive riparian restoration.
- Hold and manage conservation easements.
- Employ floodplain management to reduce flood damage to landowners and local communities.
- Support sustainable farming practices.

Building Local Support

- Lease agricultural properties to local farmers.
- Provide riparian restoration contracts that employ farmers and support local businesses.
- Include neighboring landowners, flood and agricultural interests in land management decisions.
- Use on the ground projects to demonstrate the value of riparian habitat to local communities.

Education

- Cooperate with CSUC Sacramento River Program
- Inform the public on Sacramento River conservation efforts (Carlon, 1998)

For more information contact: Sacramento River Partners (530) 894-3474.

SACRAMENTO RIVER PRESERVATION TRUST

The Sacramento River Preservation Trust (Trust) is a non-profit tax-exempt membership organization dedicated to environmental advocacy and education programs focused on the Sacramento River and its environs. The Trust is involved in a variety of projects:

- Organize conferences on watershed awareness.
- Review environmental documents on river projects and recommends mitigation measures.
- Conduct monitoring activities along the Sacramento River.

- Keep close watch on the legislative process at local, state, and federal levels.

- Initiate legislation to enhance the Sacramento River environment.

- Publish River Run newsletter (Merz, 1998).

For more information contact: The Trust (530) 345-1865.

SIERRA-CASCADE GIRL SCOUT COUNCIL

Sierra-Cascade Girl Scout Council is a "youth serving organization providing educational activities, leadership development, and community service for girls ages 5-17, in grades k-12."

Scouting offers a variety of experiences and adventures. The Girl Scout program is divided into five-interest areas to provide the basis for troop activities:

- World of Well Being

- World of People

- World of Today & Tomorrow

- World of Art

- World of the Out-of-Doors

For more information contact: Sierra-Cascade Girl Scout Council (530) 343-1904.

THE MOTHER LODE CHAPTER OF THE SIERRA CLUB, YAHI GROUP

John Muir founded the Sierra Club in 1892. The Mother Lode Chapter of the Sierra Club, Yahi Group:

- Publishes quarterly newsletter filled with local news, activities and general articles.

- Organizes and conducts a variety of outings and events for the local community.

- Conducts monthly meetings, which involve a guest speaker and a focus on conservation issues.

Lassen Forest Preservation Group is a committee of the Yahi Group affiliated with the Sierra Nevada Forest Protection Campaign. The Lassen Forest Preservation Group holds meetings once a month, which are advertised in the Sierra Club newsletter. They organize public outings and comment on timber sales (Stuckley, 1998).

For more information contact: Linda Stuckley (530) 345-2696.

STREAMINDERS CHAPTER OF THE IZAAK WALTON LEAGUE

Streaminders was founded in 1980 as a citizens stream advocacy group. In 1990, it became a chapter of the Izaak Walton League of America (IWL). The Streaminders Chapter of the IWL is dedicated to preserving, enhancing and restoring Butte County streams, watersheds, and urban forests through educational program advocacy, and hands-on activities for the public. Streaminders has received a number of grants to do restoration, as well as teach classes on creek ecology.

C TREE - Chico Tree Enhancement and Education

As one of the founders of Streaminders, Roger Cole has coordinated many restoration projects through this organization. C TREE is a program funded by a grant in cooperation with the City's Park Department. Currently, Cole is teaching tree pruning while doing formative pruning of Chico's young shade trees through state and federal grants known as CA ReLeaf. Cole organized volunteer restoration workshops in Bidwell Park with grants from the Department of Water Resources in cooperation with the City's Park Department. He has received four grants from the National Urban Forestry funds that are a combination of United States Forest Service and California Department of Forestry funds. The City has also contributed to educational workshops with the C Tree Program. The program has pruned over 2,000 trees in the last five years (Cole, 1998).
For more information contact: Roger Cole (530) 895-0866.

VALLEY WATER PROTECTION ASSOCIATION

The Valley Water Protection Association strives to inform people about political issues surrounding ground water hydrology and the part it plays in the surface and ground water interchange. The association is comprised of farmers, agriculture-related businessmen, environmental advocates, domestic well owners, and the Durham Irrigation District (a municipal water supplier reliant on groundwater). Association supporters span watershed groups, sportsmen, realtors, economists, natural historians, and Farm Bureau members.

The Valley Water Protection Association purposes include:

- Advocating for the study and recognition of groundwater as a critical component for sustainable economic, and social activity in Northern California.

- To reinforce Area of Origin Assurances given fifty years ago when government water projects were allowed to harness surplus winter flows.

- Provide a voice for groundwater rights that depend on common law history and torte law in California.

- To protect our natural systems and the life they support (Cole, 1998).

For more information contact: Linda Cole (530) 343-0916.

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McHugh, Eileen. (1998, August 12). Manager. Chico Museum. Personal Communication.

Meade, Barbara. (1998, August 13). Program Representative. 4-H Youth Development Program - Butte County. Personal Communication.

Merz, John. (1998, August 12). Chair. Board of Directors. Sacramento River Preservation Trust. Personal Communication.

Miller, Dana. (1998, August 12). District Chairman. Ducks Unlimited. Personal Communication.

Miller, Kenneth. (1998, August 7). Principal. Marigold Elementary School. Personal Communication.

Navejas, Luisa. (1998, August 18). Teacher. Four Winds of Indian Education School. Personal Communication.

Neumann, Art. (1998, August 5). Principal. Shasta Elementary School. Personal Communication.

Oetinger, Robin. (1998 August 13). Commissioner. Environmental Affairs Council. Personal Communication.

Pierce, Denise. (1998, August 20). Secretary. Chico Christian School. Personal Communication.

Pierce, Maureen. (1998, August 12). Executive Director. Boys and Girls Club of Chico. Personal Communication.

Rincon, Jane. (1998, August 7). Principal. Hooker Oak Elementary School. Personal Communication.

Robertson, Le Nan. (1998, August 20). Secretary. Kings Christian School. Personal Communication.

Shepard, Sandy. (1998, August 20). Program Coordinator. Resources in International Studies Education of Northern California. Personal Communication.

Sloan, Jeff. (1998, August 5). Principal. Chico Junior High School. Personal Communication.

Spini, Larry. (1998, August 5). Principal. Jay Partridge Elementary School. Personal Communication.

St. Jean, Dotty. (1998, August 20). Director. Redeemer Lutheran School. Personal Communication.

Stephens, Anne. (1998, August 18). Teacher. Bidwell Junior High School. Personal Communication.

Stone, Rod. (1998, August 5). Assistant Principal. Neal Dow Elementary School. Personal Communication.

Strode, Glenda. (1998, October 20). School Secretary/Nurse. Nord Elementary School. Personal Communication.

Stuckley, Linda. (1998, August12). Chair. The Mother Lode Chapter of the Sierra Club, Yahi Group. Personal Communication.

Sullivan, Ted. Assistant Principal. (1998, August 6).Chapman Elementary School. Personal Communication.

Thompson, Linda. (1998, August 4). Branch Librarian. Butte County Library - Chico Branch. Personal Communication.

Tindill, Sherrie. (1998, August 10). Secretary. Sierra View Elementary School. Personal Communication.

Tinker, Dave. (1998 August 12). President. Altacal Audubon Society, Inc. Personal Communication.

Triffo, Cindy. (1998, August 20). Service Learning Coordinator. Learn and Serve Chico. Personal Communication.

Valley, Lyonal. (1998, August 12). President. Chico Area Flyfishers. Personal Communication.

Vlamis, Barbara. (1998, August 12). General Manager. Butte Environmental Council. Personal Communication.

Wakefield, Ren. (1998, August 5). Teacher. Pleasant Valley High School. Personal Communication.

Waldsmith, Pam. (1998, August 6). Teacher. Little Chico Creek Elementary School. Personal Communication.

Watters, Mary. (1998, August 15). President. League of Women Voters of Butte County. Personal Communication.

Waugh, Colleen. (1998, August 5). Principal. Notre Dame School. Personal Communication.

Weston, Christine. (1998, August 13). Administrative Director. Parks and Preserves Foundation. Personal Communication.

White, Judy. (1998, August 12). Executive Director. Chico Creek Nature Center. Personal Communication.

Whitegon, Leonard. (1998, August 14). Science Fair Administrator. Chico Science Fair Foundation. Personal Communication.

Williams, Jodie. (1998, August 20). School Secretary. Champion Christian School. Personal Communication.

Williams, Roger. (1998, August 5). Principal. Chico High School. Personal Communication.

Wilson, Greg. (1998, August 7). Teacher. Center for Alternative Learning. Personal Communication.

Table 1. Environmental Education Programs and Projects Offered at Watershed Schools.

Public Schools	**Ameri-Corp**	**AAW**	**Eco-life**	**Endangered Species Fair**	**Garden/ Life Lab**	**Nature Bowl**	**Learn & Serve Chico**	**Recycle**	**Salmon in Classroom**	**District Science Fair**	**Community Service**
Chapman			Y	Informal	Plans		Y	Y		Y	Y
Citrus	Y			Informal	Plans		Y	Y	Y	Y	Y
Emma Wilson		Y	Y	Y	Y		Y	Y	Y	Y	Y
Hooker Oak			Y	Y	Y		Y	Y	Y	Y	Y
Jay Partridge		Y		Informal	Y			Y		Y	Y
John McManus		Y	Y	Informal	Y		Y	Y	Y	Y	Y
Marigold			Y	Informal		Y		Y	Y	Y	
Neal Dow		Y	Y	Informal	Y			Y		Y	
Little Chico Creek	Y	Y	Y	Informal	Y	Y		Y	Y	Y	Y
Parkview				Informal	Y			Y	Y	Y	Y
Rosedale				Informal	Y			Y	Y	Y	
Shasta			Y	Informal	Y			Y	Y	Y	
Sierra View			Y	Informal				Y		Y	
Cohasset			Y	Informal	Y						Y
Forest Ranch			Y	Informal	Y			Y		Y	Y
Nord				Informal				Y		Y	
Bidwell Junior High				Y	Y		Y	Y	Y	Y	Y
Chico Junior High		Y		Informal			Y	Y		Y	Y
Chico Senior High		Y		Y	Y		Y	Y		Y	Y
Pleasant Valley Senior High		Y		Y			Y	Y		Y	Y

Table 1. Environmental Education Programs and Projects Offered at Watershed Schools.

Public Schools	Ameri-Corp	AAW	Eco-life	Endangered Species Fair	Garden/ Life Lab	Nature Bowl	Learn & Serve Chico	Recycle	Salmon in Classroom	District Science Fair	Community Service
Fair View Continuation High				Y	Y			Y	Y		Y
Center for Alternative Learning					Y			Y			Y
Chico Country Day School				Informal	Plans			Y	Y	Y	Y
Four Winds		Y		Y	Y				Y	Y	Y

Private Schools	Ameri-Corp	AAW	Eco-life	Endangered Species Fair	Garden/ Life Lab	Nature Bowl	Learn & Serve Chico	Recycle	Salmon in Classroom	Science Fair	Community Service
Notre Dame								Y		Y	
Chico Montessori				Y	Plans			Y		Y	Y
Champion Christian				Informal	Y			Y		Y	Y
Chico Christian				Informal				Y		Y	
Chico Oaks Adventists				Informal	Plans			Y		Y	Y
Kings Christian								Y		Y	
Redeemer Lutheran					Y			Y		Y	Y

EXISTING MANAGEMENT PLANS

— INTRODUCTION —

Big Chico Creek just before it enters the Sacramento River.

From: Dave Ross

PURPOSE

The purpose of this chapter is to identify existing management plans that affect the Big Chico Creek Watershed and to summarize the key components of those plans. Watershed stakeholders will use this information as they develop an Adaptive Management Plan addressing their priorities.

INCORPORATION OF DEER CREEK STUDY

Environmental Laws, Regulations, and Policies Pertaining to the Protection and Enhancement of Natural Resources in the Deer Creek Watershed, compiled by the Habitat Restoration Group for the Deer Creek Watershed Action Committee, is a comprehensive inventory and summary of measures that may also affect the Big Chico Creek Watershed. Because these laws, regulations and policies are important components of watershed management, the Deer Creek study is incorporated into this report (Appendix C of Laws and Regulations chapter).

SCOPE

Identification and summary of all existing management plans that could potentially affect the Big Chico Creek Watershed would exceed the resources of this project and create an unwieldy document. This chapter identifies the most important management plans addressing the following topics: fisheries, the upper watershed, flood control, storm water, and ground water. In addition, city and county general plans, and several other plans addressing large geographic areas of the Watershed are identified and summarized. The last section of this chapter identifies plans from the draft CALFED program. In addition to official “management plans,” some key ordinances and legislation are also included in this chapter.

—— FISHERIES MANAGEMENT PLANS ——

The old diversion dam on Big Chico Creek.
From: Tthe City of Chico

Some of the most important management plans affecting the Big Chico Creek Watershed are those that have a goal of restoring anadromous (fish that are born in fresh water, migrate to the sea and return to fresh water to spawn) fisheries, especially salmon and steelhead trout. These plans are especially important because of the substantial historical decline in the numbers of these species, strong federal and state laws requiring their restoration, and the fact that significant funding is being provided to carry out parts of these plans. In this section, four important State plans and one Federal plan are presented. Specific provisions are presented only for the most recent plan.

The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1988, Senate Bill 2261, established a goal of doubling the 1988 natural production of salmon and steelhead trout in the State of California by the end of the century. The following California management plans are part of the State's efforts to achieve this and related goals.

UPPER SACRAMENTO RIVER: FISHERIES AND RIPARIAN HABITAT MANAGEMENT PLAN (1989)

This management plan was prepared for the Resources Agency of California as a result of Senate Bill 1086, passed in 1986. It contains nine recommended solutions intended to preserve remaining riparian habitat and restore high-quality riparian ecological systems on tributary streams throughout the Sacramento Valley. It also contains nine recommended solutions specifically intended to restore the Big Chico Creek salmonid fishery.

CENTRAL VALLEY SALMON AND STEELHEAD RESTORATION AND ENHANCEMENT PLAN (1990)

The California Department of Fish & Game prepared this plan. Many of the management criteria, positions, and policies in this plan apply generally to all Central Valley streams. The plan does not include actions specific to the Big Chico Creek Watershed.

RESTORING CENTRAL VALLEY STREAMS: A PLAN FOR ACTION (1993)

Also prepared by the Department of Fish and Game, this management plan builds upon the previous plans by identifying and prioritizing specific actions. It presents a multi-species approach to the restoration of anadromous fish populations. The specific goals of this plan, as presented in Governor Pete Wilson's April 1992 water policy statement, are to restore and protect California's aquatic ecosystems that support fish and wildlife, and to protect threatened and endangered species. The goals of this plan also incorporate the mandate to double populations of anadromous fish in California. The plan recommends actions for riparian preservation and restoration that apply to streams throughout the Central Valley. It also makes 12 recommendations specific to Big Chico Creek to improve fish passage and flow management, and restore spawning habitat.

STEELHEAD RESTORATION AND MANAGEMENT PLAN FOR CALIFORNIA (1996)

This plan was prepared by the Department of Fish and Game to identify restoration requirements specific to steelhead and is intended to augment other anadromous fish restoration plans. It provides guidelines for steelhead restoration and management that can be integrated into current and future planning for specific river and stream systems. It includes recommendations regarding timber harvest, grazing, instream flows, instream habitat, mining, estuaries and land acquisition. The plan does not include management objectives specific to the Big Chico Creek Watershed.

REVISED DRAFT RESTORATION PLAN FOR THE ANADROMOUS FISH RESTORATION PROGRAM (1997)

The Central Valley Project Improvement Act, passed by Congress and signed by President George Bush in 1992, requires the U.S. Department of the Interior to develop and implement a program that makes all reasonable efforts to double natural production of anadromous fish in Central Valley streams. This program is known as the Anadromous Fish Restoration Program.

In June 1997, the Department of the Interior released the Revised Draft Restoration Plan for the Anadromous Fish Restoration Program. Although referred to as a draft, the plan has already undergone extensive and formal review and is considered by the Department to be an advance copy of what will be the final plan. A final plan will be formally adopted following the completion and approval of a Programmatic Environmental Impact Statement. The plan established a production target of 800 fall run Chinook salmon in Big Chico Creek and includes eight specific actions and two evaluations for the Big Chico Creek watershed:

Action:

1. Relocate and screen the M&T Ranch diversion. This project was completed in 1997 at a cost of approximately $4.8 million. Funding was provided by the Central Valley Project Improvement Act, CALFED Bay Delta Program, California Wildlife Conservation Board, Ducks Unlimited, local landowners, California Department of Fish and Game, and U.S. Fish and Wildlife Service.

2. Repair the Iron Canyon Fish Ladder.

3. Replenish spawning gravel in reaches modified for flood control.

4. Repair the Lindo Channel weir and fishway at the Lindo Channel box culvert at the Five-Mile Diversion.

5. Improve cleaning procedures at One-Mile Pool. (See FY ‘96 and ’97 funded projects described below.)

6. Protect spring-run Chinook salmon summer holding pools by obtaining from willing sellers titles or conservation easements on lands adjacent to the pools.

Evaluation:

1. Evaluate the water management operations between Big Chico Creek and Lindo Channel.

2. Evaluate the replenishment of gravel in the flood-diversion reach of Mud Creek (U.S. Fish and Wildlife Service, Revised Draft Restoration Plan, 1997, p58-60).

While awaiting preparation and adoption of the final plan, funding has been made available for projects consistent with the plan. In the Big Chico Creek watershed, the following projects have already been funded (U.S. Fish and Wildlife Service, Draft Annual Work Plan (FY98), 1997):

Projects Funded in Fiscal Year 1996

Peterson Property Acquisition and Restoration

This property with riparian habitat bounded by the Sacramento River, Big Chico and Mud Creeks has been added to the Bidwell-Sacramento River State Park and will be managed by the California Department of Parks and Recreation.

Big Chico Creek One Mile Pool Bypass water quality enhancement project

This project is intended to eliminate downstream siltation in Big Chico Creek that adversely affects fall-run salmon spawning habitat. It was completed in 1997.

Real-time flow monitoring and feed-back systems for Deer, Mill, Big Chico, and Butte Creeks

This project provides real-time monitoring of physical parameters necessary to predict spring-run salmon migration patterns and assure adequate fish passage conditions.

Projects Funded in Fiscal Year 1997

Big Chico Creek One Mile Pool Bypass water quality enhancement project

This is the remaining funding for the project described above and was completed within budget and on schedule.

Funded in Fiscal Year 1998 contingent upon additional funding

Develop a comprehensive watershed management strategy.

This project involves development of a comprehensive plan to restore naturally spawning populations of spring-run and fall-run Chinook salmon and steelhead. The Big Chico Creek Watershed Alliance anticipates that this will be part of the watershed management strategy developed by the Alliance and local stakeholders using data gathered for this Existing Conditions Report.

—— UPPER WATERSHED MANAGEMENT PLANS ——

LASSEN NATIONAL FOREST LAND AND RESOURCE MANAGEMENT PLAN (1992)

The purpose of this plan is to 1) define the resources to be emphasized in different management areas of the Forest, 2) establish goals and objectives for commodities and services to be provided, and 3) prescribe standards, guidelines, and practices to achieve the goals and objectives (Habitat Restoration Group, Draft Land Use, 1997, p3-2). Several small sections of the Big Chico Creek Watershed are within the boundaries of Lassen National Forest. They include the upper reaches of the Watershed on Colby Mountain in the Jonesville Management Area, several scattered parcels along Web Hollow, Big Chico, Cascade and Smoky creeks in the Lomo Management Area, and a few very small sections in the Lower Deer Creek Management Area (U.S. Forest Service, 1992, p4-250 to 4-260). All are located in the Almanor Ranger District. Most of the scattered parcels are proposed for exchange with Sierra Pacific Industries. Except for a fire lookout on the top of Colby Mountain, there are no developed National Forest sites in the watershed. A former campground at Soda Springs has been discontinued (Charlton, 1998).

Chico Meadows near the headwaters of Big Chico Creek.
From: Suzanne Gibbs

BLM Redding Resource Management Plan (1993)

The Big Chico Creek watershed is located in the Ishi Management Area within the Redding Resource Area of the Bureau of Land Management (BLM). There are more than a dozen scattered parcels of BLM land in the Big Chico Creek watershed. The Redding Resource Management plan has a goal of transforming the scattered land base of the Redding Resource Area into consolidated management units. This is to be pursued primarily by two methods. One method is by transferring scattered parcels to governmental or nonprofit groups under the authority of the Recreation and Public Purposes Act. This act allows BLM to lease or patent public land for public parks, building sites, correctional centers or for other public purposes. The second method is by exchanging isolated BLM parcels for more strategically located lands currently owned by other parties, public or private. Specific plans for BLM property in the Big Chico Creek watershed are presented next.

Minnehaha Mine Parcel

The Minnehaha Mine parcel is currently classified by BLM as Recreational. Because of the problems caused by past mining activities (see History chapter), the Minnehaha Mine has site-specific management objectives:

1. Stabilize the ongoing erosion due to past mining practices.
2. Enhance water quality of Big Chico Creek.
3. Enhance the safety of human users of this area. (U.S. Bureau of Land Management, 1993, p51)

The BLM and other public agencies paid for a cleanup of trash and mining waste on this site, costing more than $35,000. Vehicle access has been prohibited, erosion has been stabilized, and the property is being revegetated through natural processes (Rogers, 1998).

The plan calls for withdrawing the Minnehaha parcel from mineral entry (U.S. Bureau of Land Management, p52). However, there is a current mining claim on the property (Rogers 1998), and until the withdrawal process is completed, additional mining claims can be made. Official withdrawal will prevent subsequent claims, but existing claims will remain valid (Truden, 1998).

Parcels Along Big Chico Creek from Campbell CREEK to Ponderosa Way

Big Chico Creek between the road crossing near Campbell Creek and the Ponderosa Way Bridge has been preliminarily classified as eligible for inclusion in the National Wild and Scenic Rivers System. This stretch of the creek has been classified by the BLM as wild except for the Minnehaha Mine parcel, which has been classified as recreational. All public land within ¼ mile of normal high water is to be managed to protect the outstanding remarkable values and free flowing character which led to the determination of eligibility (U.S. Bureau of Land Management, 1993, p26-27). Five BLM parcels totaling 520 acres on this stretch of the creek have been set aside pending the final determination of National Wild and Scenic River status by Congress. If Congress designates a section of the stream as a component of the National Wild and Scenic River System, the BLM will consider acquisition of available, unimproved private land within the designated corridor (U.S. Bureau of Land Management, 1993, p 27). If this portion of Big Chico Creek does not receive the designation, the City of Chico, County of Butte or other qualified organizations will be given two years to submit Recreation and Public Purpose applications prior to the land being offered for exchange to any party (Truden, 1998).

REMAINDER OF BLM PARCELS IN WATERSHED

The remaining BLM parcels within the Watershed are available for Recreation and Public Purposes Act transfer or exchange. At least two land trusts have become involved in assisting BLM with this process.

One is the nonprofit American Land Conservancy (ALC), which uses money from the sale of BLM properties to acquire other lands along the Sacramento River and its tributaries for environmental benefits (Reid, 1998). ALC will sell to buyers wishing to preserve the properties if such buyer are available but will sell to others on the private market as well (Reid, 1998). In 1996, eight BLM parcels totaling about 576 acres were transferred to the ALC and then purchased by a local landowner and are now part of the Musty Buck Preserve (Owens, 1998). Another exchange proposal from the ALC for three BLM parcels off of Highway 32 has already been approved pending the finding of ultimate buyers for the properties.

The other land trust active in the Watershed is the Trust for Public Land, which has submitted a proposal for exchange involving three BLM parcels along Rock Creek near and above Cohasset. If approved by BLM, these parcels could be sold by the Trust for Public Land on the private market. Money obtained from exchanges in this proposal, which also involves other BLM parcels in Tehama County, will be used to fund land acquisition in the Sacramento River/Bend Area of Critical Environmental Concern north and east of Red Bluff (Reeves, 1998).

PACFISH (1995)

In 1995, the Lassen Land and Resource Plan and Redding Resource Management Plan were amended by the Interim Strategies for Managing Anadromous Fish-Producing Watersheds in Eastern Oregon and Washington, Idaho, and portions of California (commonly referred to as PACFISH). PACFISH is an ecosystem-based strategy to stop habitat degradation from land-use activities and begin restoration of aquatic habitat and riparian areas in fish-producing watersheds. It is intended to improve aquatic habitat conditions on U.S. Forest Service (USFS) and BLM administered lands outside the range of the northern spotted owl (Calif. Dept. of Fish and Game, 1996, p67).

PACFISH focuses on the maintenance and restoration of entire watersheds, specifically, those features required for healthy aquatic ecosystems: cool water temperatures, adequate amounts of woody debris, reduced sedimentation, increased streambank stability, and appropriate pool habitat attributes. Components of the strategy include: identifying and analyzing Key Watersheds; determining goals, site-specific riparian management objectives and associated standards and guidelines; creating riparian habitat conservation areas and restoring watersheds (Calif. Dept. of Fish and Game, 1996, p68).

USFS and BLM are developing geographic-specific environmental impact statements and analyzing long-term management strategies. The environmental impact statements may result in amendments to BLM land-use plans and USFS forest plans to provide greater protection and restoration of anadromous fish habitats in fish-producing watersheds. While the environmental impact statements are being developed, USFS and BLM are implementing an interim policy so that restoration can begin immediately (Calif. Dept. of Fish and Game, 1996, p68).

MANAGEMENT OF PRIVATE FORESTRY LANDS

The California State Board of Forestry regulates the harvesting of timber from private and state lands. Under the Z'berg-Nejedly Forest Practices Act, the Board is responsible for developing Forest Practice Rules to guide the preparation of timber harvesting plans, which must be approved by the California Department of Forestry and Fire Protection before logging can occur. These rules are meant to ensure the continued productivity of forest land in the state and to protect values impacted by timber harvesting, such as watershed, recreation, wildlife, range, fisheries, and aesthetics.

The Board of Forestry may also classify watersheds as "sensitive" to additional operations, if there is substantial evidence that specified resources are not being protected by the Forest Practice Rules. The Board may then apply additional mitigation measures to protect the affected resource (California Dept. of Forestry, 1998, p74).

FLOOD CONTROL MANAGEMENT PLANS

Alliance members remove the dreaded Arundo donax along Lindo Channel.
From Suzanne Gibbs

OPERATION AND MAINTENANCE MANUAL FOR CHICO AND MUD CREEKS AND SANDY GULCH SACRAMENTO RIVER AND MAJOR AND MINOR TRIBUTARIES FLOOD CONTROL PROJECT (1965)

This management plan prepared by the U.S. Army Corps of Engineers, guides current operation and maintenance activities on a project designed to provide flood protection from flows in Big Chico Creek, Lindo Channel, Sycamore and Mud Creeks. This project includes the following:

1. The cleared channel and levees of Big Chico Creek upstream to Mud Creek; the enlarged channel and levees of Mud Creek upstream to near Hicks Lane; the channel and levees of Sycamore Creek upstream to the Diversion Channel; and the Diversion Channel from Sycamore Creek to Big Chico Creek. The project also includes channel improvements and levees on the lower reaches of Sycamore Creek, Sheep Hollow, Dry Creek, North Sycamore Creek and on the lower end of Channel Slough.

2. The Five-Mile Dam (Big Chico Creek Culvert), the Lindo Channel Dam (Lindo Channel Culvert), and the Sycamore Weir.

3. The unimproved channels of Big Chico Creek and Lindo Channel that lie between the diversion structures at the upper end of the project and the Sacramento River.

4. Intermittent irrigation and drainage structures and intermittent bank protection along the above described reaches of streambed. (U.S. Army, 1965, p2)

HOW IT WAS DESIGNED TO WORK

The two dams, at Five-Mile and Lindo Channel, are designed to limit flows down Big Chico Creek below Five-Mile Dam to no more than 1,500 cubic feet per second (cfs) and down Lindo Channel to a maximum of 6,000 cfs. The Sycamore Diversion Channel is designed to carry up to 8,500 cfs. Thus, the system is constructed to handle a design flow of 16,000 cfs of water coming down Big Chico Creek to Five Mile. The channel alterations and levees increase the capacity of the other involved sections of creeks.

FEMA STUDY

A 1993 flood insurance study prepared by the Federal Emergency Management Agency (FEMA) found that the system was not operating during wet years at the diversion structures as predicted by the Corps. It appeared that large flows caused substantial backwater in Lindo Channel and forced more flow toward the Diversion Channel (Schaaf & Wheeler, 1993, p6).

The most recent flood insurance study for Butte County identifies the 100-year peak discharge upstream of Five Mile as 11,000 cfs. One-hundred-year peak discharges are 1,400 cfs below the Five-Mile Dam, 4,000 cfs below the Lindo Channel Dam, and 5,600 cfs below the Sycamore Weir (FEMA, 1998, Table 1). The FEMA-identified 100-year floodplain for Big Chico Creek, from the dam to just downstream of Rose Avenue, shows water staying within riparian areas (Thompson, Matt, 1998).

The same study found the 100-year discharge for Lindo Channel is contained within the creek channel for the entire study reach, from the dam to approximately 2,000 feet downstream of the Highway 32 bridge. The report also states that:

> . . . downstream of the Esplanade, however, Lindo Channel is near bank capacity for the 100-year discharge. Within this reach the channel is perched, so flows that overtopped the banks would tend to run away from the channel as shallow overland flooding. It should be noted that, while the estimated 100-year discharge is significantly less than the channel's design capacity, that capacity was based on a clean channel. Vegetation growth has since reduced that capacity. (FEMA, 1998, p39-40)

Department of Water Resources models, however, indicate that even without the vegetation, Lindo Channel downstream of the Esplanade would not take 6,000 cfs. Downstream of the Esplanade is an unimproved waterway, and there is no indication that it was ever capable of handling flows in excess of its current capacity. (Cepello, 1998)

FEMA also studied the Diversion Channel, Sycamore Creek and Mud Creek stretch of the project down to the Highway 32 bridge. The study concluded that the estimated 100-year discharge is contained within the leveed channel.

PEAK FLOWS OF DECEMBER 31, 1996 AND JANUARY 1, 1997

For this peak-flow event, the highest on record, the U.S. Geological Survey has estimated a flow of 13,100 cfs 1.6 miles upstream of the Bidwell Park Golf Course Clubhouse. This estimate was based on measurement of the outside high water mark (Hunrichs, 1998). Other peak flow measurements were 1,370 cfs in Big Chico Creek at the Rose Avenue gauge at 8:45 a.m. on Dec. 31, an estimated 4,570 cfs in Lindo Channel at the Cussick Avenue gauge at 1:30 a.m. on Dec. 31, and an estimated 10,100 cfs at the Sycamore Weir at 6:30 a.m. on Jan. 1 (Calif. Dept. of Water Resources, 1997). Water stayed in the channel or within riparian areas of Big Chico Creek, in the channel of Lindo Channel, and only over-flowed the leveed sections of the system at the Cohasset Bridge, where debris obstructed the water flow.

OPERATION AND MAINTENANCE

Operation and maintenance responsibility is shared primarily by Butte County and the State Department of Water Resources (DWR). The County is responsible for ensuring that flashboards are removed and gates on the dams are fully open during the flood season from October 15 to April 15, or as directed by DWR. The County is also responsible for maintenance of the dams, the weir and the levees consistent with the Operations and Maintenance Manual. This responsibility includes removal of any debris that accumulates at these structures. This has primarily been an issue at the Lindo Channel Dam, where substantial debris can accumulate. During high flows, the County uses a crane or hires a private crane operator to keep the dam clear (McCollum, 1998). Levee maintenance includes removal of vegetation and dragging the slopes of the levees to maintain a clean surface to check for rodents or other degradation (McCollum, 1998).

DWR is responsible for maintaining channel capacity throughout the project consistent with the Operations and Maintenance Manual. This includes removal of debris and vegetation that reduce channel capacities below the Manual's requirements. For example, the Manual requires that the capacity of unimproved channels of Big Chico Creek and Lindo Channel be maintained at 1,500 and 6,000 cfs respectively. Except for the capacity difference, maintenance requirements for Big Chico Creek and Lindo Channel are equivalent.

Eliminating debris accumulation at bridges is the responsibility of Butte County or the City of Chico, whichever has legal responsibility for the bridge (McCollum, 1998).

MANAGEMENT OF ROCK CREEK AND KEEFER SLOUGH FLOODING

There are no existing management plans for flooding in this area. Private property owners maintain natural flood channels and private levees and in 1985 formed the Rock Creek Reclamation District, covering 4,604 acres. The U.S. Army Corps of Engineers is conducting a preliminary investigation to determine if a more extensive flood control project feasibility study is warranted (Ellena, 1998).

MANAGEMENT AFTER A FLOOD

Although there are no local management plans for dealing with damage caused by floodwaters, the Federal Emergency Watershed Protection Program has from time to time fulfilled this role. The Butte County Office of Emergency Services has acted as a local sponsor under this program, which operates in presidential declared disaster areas. Butte County has been under this designation four times since January 1995 (Madden, 1998).

The Emergency Watershed Protection Program provides funds to help restore watersheds to the condition they were in prior to a natural disaster. It is not intended for regular maintenance activities or problems occurring gradually over time (Thompson, Lyle, 1998). The primary efforts are aimed at preventing erosion and retarding runoff. Sediment removal, levee repair, and bank protection are the three categories of projects most common in this area (Thompson, Lyle, 1998). Permanent or long-term measures, such as dams, channel modification, and grade-stabilization structures, may be installed only if they are the most expeditious way to safely obtain emergency protection. In addition, the value of the property saved must be greater than the cost of the project.

The U.S. Forest Service administers funds for emergency work on national forest lands and in holdings within national forest boundaries. The U.S. Natural Resource Conservation Service (formerly SCS) administers funds on all lands outside of national forest boundaries, in cooperation with local sponsors (Habitat Restoration Group, Draft Environmental Laws, 1997, pI-15).

—— STORM WATER MANAGEMENT PLANS ——

CITY OF CHICO

Although two of the following plans, the Preliminary Storm Drainage Master Plan and its Addendum, must still undergo environmental review and then go before the Chico City Council, their provisions are being implemented during the interim period (Hayes, 1998).

PRELIMINARY STORM DRAINAGE MASTER PLAN (1987)

The purpose of this Master Plan was to establish and determine, at a conceptual level, the ultimate storm drainage collection system needs under ultimate buildout of a major portion of the urban area. This Storm Drainage Master Plan focused on the major pipes and improved channels of the urban area storm drain system and their ability to adequately convey storm runoff. It did not address improvement needs associated with the major waterways that pass through the City, collecting runoff from the urban area storm drain system (City of Chico, Draft Report, 1997, p1).

City of Chico General Plan (1994)
The City of Chico General Plan established guiding policies and implementing policies associated with storm drainage, water quality, and resource based thresholds. More specifically, the following types of implementing policies were established:

- Explore storm water runoff volume reduction and undertake efforts to minimize runoff.
- Require no net increase in peak flow in all creeks.
- Establish a storm drain fee structure compatible with General Plan policies.
- Use natural drainage techniques where feasible.
- Enhance surface water quality.
- Establish a means to fund ongoing facility maintenance. (City of Chico, Draft Report, 1997, p2).

Storm Drainage Master Plan Addendum (1997)
The purpose of the Addendum is to address omissions in the Storm Drainage Master Plan and to implement, as appropriate, General Plan Policies. Among the projects addressed in the Addendum that may affect the Big Chico Creek Watershed are 1) channel stabilization in all waterways passing through the urban area, 2) best management practices throughout the urban area, and 3) design and data collection projects that are a necessary precursor to the aforementioned projects, the future Storm Water Management Program, and water quality monitoring (City of Chico, Draft Report, 1997, p3).

Butte County
Although Butte County does not have a formal storm water management plan, the County implements best management practices through environmental review of individual projects (Edell, 1998).

Agricultural Element, Butte County General Plan (1994)
The Agricultural Element includes a provision for management of storm drainage.

> Program 4.3 To protect adjacent downstream properties and the public from flooding, require all development to provide the following information:

- Historic peak flow
- Drainage designs which do not increase the historic peak flow
- Suggested offsite improvements as mitigation for increases in historic peak flow
- Drainage plans prepared by a registered civil engineer
- Mechanisms for maintenance (Butte County Farm Bureau, 1994, pAE-16)

TEHAMA COUNTY

Tehama County does not have a storm water management plan. Storm water is dealt with through the environmental review process for individual projects (Stoufer, 1998).

GROUNDWATER MANAGEMENT PLANS

Alliance volunteers learn biocassessment techniques.
From Suzanne Gibbs

DRAFT CHICO URBAN AREA NITRATE COMPLIANCE PLAN (1998)

This County plan was prepared in response to nitrate contamination of groundwater in the Chico Urban Area from the use of septic systems and a 1990 Prohibition Order from the Central Valley Regional Water Quality Control Board. This Prohibition order, requiring cessation of the use of the septic systems, affects approximately 30,000 residents on 9,800 parcels, representing nearly 12,000 dwelling units.

The Nitrate Compliance Plan study found that only developments with a housing density equivalent to four or more dwelling units per acre are contributing to violation of nitrate standards. The Plan states that approximately 60 percent of the 12,000 dwelling units affected are within high-density areas and recommends that these areas be connected to the City of Chico's sewer system. The Board of Supervisors and the Regional Water Quality Control Board must still approve this Plan.

MEASURE G (1996)

Approved by Butte County voters in 1996, this measure requires permits for the extraction of groundwater for use outside the County or to substitute for surface water normally used within the County but transferred or proposed to be transferred for use outside the County. It also required the establishment of a County Water Commission, establishment of a countywide groundwater-monitoring program, and annual reports analyzing the amount of groundwater pumping that can occur without exceeding the "safe yield" for sub-basins in Butte County.

TEHAMA COUNTY GROUNDWATER ORDINANCE (1992)

This ordinance prohibits the "mining" of groundwater within the County or extraction of groundwater for export without a permit granted by the Board of Supervisors. It further prohibits the operation of a well in a manner that would result in the radius of influence of the well transgressing the property lines of the parcel on which the well was located, excluding all wells in operation prior to 1991 (Habitat Restoration Group, Draft Environmental Laws, 1997, pI-33).

— GENERAL PLANS —

State law requires each California city and county to prepare a general plan. General plans are intended to guide the long-range physical development of cities and counties. A county general plan, for example, will identify existing uses of land, such as urban, agricultural, grazing, forestry, and others, and then identify which areas of the county should be used for these purposes in the future. A city general plan will do the same for residential, commercial, industrial, parks, open space, and other uses. Although land use is often the heart of a general plan, other related issues must also be addressed. State law requires that all general plans address at least the seven following elements: land use, circulation (traffic), conservation, housing, open space, safety, and noise. Cities and counties vary in the relative emphasis they give to these required elements and may also choose to add additional elements to their general plans.

In the Big Chico Creek Watershed, three general plans are applicable: City of Chico General Plan, County of Butte General Plan, and County of Tehama General Plan.

CITY OF CHICO GENERAL PLAN (1994)

The Planning Area for the Chico General Plan consists of approximately 155 square miles of land located in western Butte County, including the Chico urban area and surrounding lands. The Planning Area includes a substantial portion of the Big Chico Creek Watershed, including Big Chico Creek from Bidwell Park to the Sacramento River, all of Lindo Channel, and most of Mud and Rock creeks, from the 500 kV power lines to their juncture with Big Chico Creek. The City of Chico General Plan projects a buildout population of approximately 134,000 people, an increase of 66 percent over the 1992 population of 80,580. The time at which full development or "buildout" will occur is not specified in or anticipated by the Plan, but it is expected to take place over a 15 to 25-year period (Blayney Dyett et al., 1994, p3-1).

The Chico General Plan contains numerous policies that may affect the Big Chico Creek watershed. The most significant of these policies are found in five elements.

1. Land Use
2. Community Design
3. Parks and Public Facilities Services
4. Open Space
5. Environmental Conservation

Each element contains guiding and implementing policies. Guiding policies are the City's statements of its goals and philosophy. Implementing policies represent commitments to specific actions. Some of the most important General Plan objectives and supporting policies for the Big Chico Creek watershed are summarized here.

SETTING URBAN GROWTH LIMITS

The Chico General Plan calls for a compact urban form, with new development contiguous to existing urban areas. On the westside, the plan calls for maintaining the Greenline, a joint city-county policy to limit urban development in order to protect agriculture. On the eastside, the General Plan responds to concerns expressed about the need to limit development in the foothills and establishes an urban limit line, based in part on elevation, to protect vernal pools and oak woodlands and preserve views of hillsides and open space (Blayney Dyett et al., 1994, p1-2 to1-3). Expansion north and south will also be limited to maintain a compact urban form. In the future, portions of Mud Creek, Little Chico Creek diversion, Butte Creek, and the transmission line corridor, as well as the foothills on the east and agricultural lands on the west, although not contiguous, will generally define the physical extent of the city (Blayney Dyett et al., 1994, p2-9). Multiple approaches to restrict urbanization outside the City's sphere of influence will be used, including large-lot-zoning and possibly acquisition of land for a greenbelt (Blayney Dyett et al., 1994, p3-12).

PROTECTION OF AGRICULTURAL AND NATURAL RESOURCES

The General Plan states that the City is committed to protecting viable agricultural and natural resources. Fieldwork undertaken as part of the General Plan helped identify and prioritize significant biotic resources in the Planning Area. The Plan outlines strategies for land acquisition and preservation of sensitive habitats and creekside greenways and stipulates criteria for development in resource-sensitive areas (Blayney Dyett et al., 1994, p3-4). The General Plan classifies certain habitats in the Planning Area into either Resource Conservation Areas (RCAs) or Resource Management Areas (RMAs). RCAs are supposed to contain the most sensitive and valuable habitats that require protection and that would be conserved in perpetuity. RMAs generally contain some resources that are determined to merit long-term preservation, but for which further study is necessary before a precise delineation of acreage to be preserved can take place. RMAs, unlike RCAs, would allow some level of development if proposed projects can demonstrate that sensitive resources would be protected. Both the RCAs and RMAs are intended to be of sufficient size to ensure the long-term viability of the habitats and species included (Blayney Dyett et al., p7-10 to 7-13).

USING PERFORMANCE-BASED STANDARDS FOR SERVICES TO ENSURE SUSTAINABILITY

The General Plan establishes policies linking growth to standards for capital facilities and public services, such as streets, parks, storm drainage and fire safety. Development is not to be permitted if performance standards cannot be adequately met. The standard for creekside greenways, for example, is 2.5 acres per 1,000 residents. Development is to be approved only if dedications of land and/or in lieu fees meet the standards. The General Plan calls for the adoption of an "adequate public facilities" ordinance to implement these standards (Blayney Dyett et al., 1994, p5-27 to5-28). To date, such an ordinance has not been adopted, but according to city staff the standards are being implemented on a project-by-project basis as part of the environmental review process (Hayes, 1998).

PROTECTING THE CREEKS

The General Plan contains numerous policies acknowledging the importance of Chico's creeks and calling for their protection and integration into the community. Following are a few examples:

COMMUNITY DESIGN ELEMENT, IMPLEMENTING POLICY 6

Adopt design guidelines for development adjacent to creeks. These may include consideration for the following:

- Single-loaded streets along at least one bank
- Discouraging backup development along creeks
- Public access and visual easements to creeks
- Linkages to open space and open space systems
- Trails for multi-use purposes such as pedestrians and bicyclists• Planting for erosion control and riparian enhancement with native shrubs, groundcover, and tall riparian trees
- Benches, trash receptacles, lighting and pedestrian amenities, where appropriate (Blayney Dyett et al., 1994, p2-19)

OPEN SPACE AND ENVIRONMENTAL CONSERVATION (OS&EC) ELEMENT, IMPLEMENTING POLICY 22

Ensure that open space corridors along creeks include protective buffers (non-development setbacks), preserve existing riparian vegetation through the environmental review process, and continue to require a minimum of 25-foot dedication of land and acquisition of 75 feet of land for a total of 100-foot setback from top-of-bank along creeks… (Blayney Dyett et al., 1994, p7-16).

OS&EC IMPLEMENTING POLICY 35
Work with the California Department of Fish and Game to ensure the preservation and enhancement of species of resident and anadromous fish in creeks in the Planning Area (Blayney Dyett et al., p7-22).

OS&EC IMPLEMENTING POLICY 40
Periodically monitor and prepare reports on surface water quality in Big Chico, Butte, Little Chico, Mud, Sycamore, and Comanche Creeks (Blayney Dyett et al., 1994, p7-24).

OS&EC GUIDING POLICY 15
Preserve and enhance Chico's creeks and the riparian corridors adjacent to them as open space corridors for the visual amenity, drainage, fisheries, wildlife habitats, flood control, and water quality value (Blayney Dyett et al., 1994, p7-26).

BUTTE COUNTY GENERAL PLAN

The Butte County General Plan is comprised of various documents dating from 1977 to 1994. Following are some of the Plan's more important provisions that may affect the Big Chico Creek Watershed.

AGRICULTURAL ELEMENT (1994)

The purposes of the Agricultural Element include the following:

- To preserve agricultural lands for continued agriculture uses
- To strengthen and support the agricultural sector of the economy
- To protect the natural resources that sustain agriculture in Butte County
- To consolidate agricultural policies required in mandated general plan elements into one document (Butte County Farm Bureau, 1997, pAE-1)

Some of the provisions of the Agricultural Element of particular interest to the Big Chico Creek Watershed Project include the following:

3.3 Utilize mitigation banks, environmental mitigation sites, wildlife refuges, and other natural resource preserves, within or adjacent to land designated or used for agricultural lands, to allow the continuation of standard farming or ranching practices.

6.1 Recognize state and federal legislation designed to preserve soil and protect agricultural land.

6.2 Encourage protection measures from catastrophic and uncontrolled flooding of permanent crops, such as orchards, nurseries, and other major agricultural investments.

4.5 Ensure an abundant supply of high quality water.

5.2 Actively encourage the use of voluntary and open space easements with the County or appropriate private land trusts as a means of preserving land in agricultural and open space use. (Butte County Farm Bureau, 1997, pAE-15 to AE-17)

CHICO AREA GREENLINE

The Greenline defines the limits of future urban development that may occur on agricultural lands in the Chico Area of Butte County. Except in limited areas designated for Agricultural Residential land use, all land on the Agricultural Side of the Chico Area Greenline is to consist solely of Agricultural land uses (Butte County, 1982, p70-75).

OTHER GENERAL PLAN PROVISIONS/RELATED POLICIES

Policies of the 1977 Open Space Element and 1979 Land Use Element call for the regulation of development in migratory deer winter range. Existing County policies acknowledge the importance of riparian habitat and state that development in significant riparian habitats should be regulated. Existing County policies also state that development should be regulated to facilitate the survival of rare, threatened, or endangered plants and animals. In addition, the 1979 Land Use Element encourages the creation and expansion of natural, wildlife, conservation, and wilderness areas (Mintier & Associates et al., 1993).

Tehama County General Plan (1983)

Provisions of the Tehama County General Plan pertaining to the neighboring Deer Creek Watershed were identified in a recent study (Habitat Restoration Group, Draft Land Use, 1997). Most of the same provisions affect the Big Chico Creek Watershed and are presented here.

AG-1
Preservation of lands of viable agricultural capabilities according to soil characteristics, with consideration given to access, water, location, and other relevant factors.

AG-2
Protection of lands currently being used for agriculture, but which have marginal agricultural capability characteristics unless their need for non-agricultural use is demonstrated.

AG-3
Protection of agricultural lands, whenever possible, from non-agricultural development through separation by natural buffers and land use transition areas that mitigate or prevent land use conflicts.

AG-4
Protection of agricultural lands from development pressures or uses which will adversely impact or hinder existing or foreseeable agricultural operations.

AG-5
Recognition that preservation of agricultural lands emphasizes community understanding of the agricultural practices utilized by agriculturalists and ranchers.

T-1
Preservation of prime timber lands.

T-2
Protection of prime timber lands from adjacent development which has the potential to adversely impact timber growing and harvesting operations.

T-3
County recognition of the various timber management improvement and education programs as a means to improve timber yields and protect wildlife habitat and watershed lands.

W-1
Protection and conservation of water resources and supply streams.

W-2
Protect surface water quality and stream flows for water supply, recreation, and aquatic ecosystem maintenance.

W-7
Insure the high quality of groundwater by emphasizing programs that minimize erosion and prevent the intrusion of municipal and agricultural wastes into water supplies.

WR-1
Preserve environmentally sensitive and significant lands and water valuable for their plant and wildlife habitat, natural appearance and character.

WR-2
Afford, to the extent feasible, adequate protection to areas identified by the California Department of Fish and Game and the California Natural Diversity Data Base as critical riparian zones.

WR-3
Support and coordinate County plans with interjurisdictional programs for the proper management of riparian resources in the County.

NRR-1
Protection of resource lands for the continued benefit of agriculture, timber, grazing, recreation, wildlife habitat, and quality of life.

NRR-2
Provide access to resource land areas when neither the integrity of the natural resource nor private property rights will be adversely affected.

HA-1
Preserve the historic and archaeological resources of the County for their scientific, educational, aesthetic, and recreational values.

CO-1
Plan development within the County in a manner which will provide opportunities for current and future residents to enjoy small-scale, community oriented living environments that are similar to those currently found in the County. Encourage higher densities, where appropriate, to reduce agricultural land conversion demands.

CO-2
Protect private property rights and insure that an individual(s) action(s) do not adversely impact the health, safety, and welfare of the County's citizens.

CO-3
Promote a development pattern which, whenever possible, maximizes the use of existing public roads prior to constructing new roads.

CO-4
Encourage compact development and discourage linear development patterns.

CO-8
Accommodate growth in a manner that preserves the predominate rural lifestyle and unique qualities that make the County an attractive place to live and that recognizes that a rural lifestyle does not always necessitate the provision of the full complement of services normally found in urban communities.

CO-12
Accommodate urban growth and other non-agricultural development by utilizing, whenever possible lands which do not have agricultural viability.

— OTHER MANAGEMENT PLANS —

BIDWELL PARK MASTER MANAGEMENT PLAN (1990)

This Plan addresses 1) General Management Issues, 2) Management Zones, 3) Management Units, and 4) Design Standards for Bidwell Park. It states that developed recreation opportunities should be shifted to other outside park resources, while improvements in Bidwell Park would emphasize passive uses and maintenance of existing facilities where appropriate. The Plan also recommends that the Chico Area Recreation and Parks District manage Bidwell Park under a joint powers or lease agreement with the City of Chico. The tax burden for operation and maintenance would be extended to the CARD boundaries.

BIDWELL RIVER PARK MANAGEMENT REQUIREMENTS

Annie Bidwell's deed of July 1, 1908 (Appendix A of this chapter) and Chapter 73 of the Statutes of California of 1950 (Appendix B of this chapter) contain management requirements for this park located on Lindo Channel and Big Chico Creek. Those sections of the park within the City of Chico are also subject to the creekside greenway requirements of the Chico Municipal Code and the Chico General Plan. (See the corresponding sections of Appendix B of Laws and Regulations chapter.) Those sections of the park outside of the City of Chico are subject to Chapter 16, Article II, of the Butte County Code (Appendix C of this chapter).

COMPREHENSIVE PARK AND RECREATION PLAN: CARD (1988)

The Chico Area Recreation and Park District Master Plan identifies existing park resources, proposes locations for future parks, and describes improvements for existing facilities. Recommended lineal parks include the length of Lindo Channel and Sycamore, Mud and Big Chico creeks to the Sacramento River.

NORTH CHICO SPECIFIC PLAN (1995)

The 3,590-acre North Chico Specific Plan area is located north of the City of Chico, adjacent to and easterly of State Route 99. The area is generally bounded by Sycamore Creek on the south, State Route 99 on the west, and Rock Creek on the north. The Chico Municipal Airport generally abuts the eastern perimeter of the Plan area with a portion of the Plan area extending northeasterly along Keefer Road. Two small portions of the Plan area, consisting of approximately 180 acres, are located south of Sycamore Creek, within the Chico Sphere of Influence. Land uses proposed are primarily residential with a mix of commercial, office, heavy industrial, light industrial, public (elementary school, park and fire station), and open space. Intensive development is concentrated south and east of Mud Creek. Approximately 480 acres are designated for open space and parks, some of which are located along area creeks and drainages. Open space corridors are located throughout the Plan area and serve as recreational corridors, protect drainages and resources, and establish buffers between land uses.

CALFED BAY-DELTA PROGRAM

Although not completed at the time this report was prepared, management plans that are expected to be adopted as a result of the CALFED program will significantly affect the Big Chico Creek Watershed. The CALFED Program is a cooperative, interagency effort involving 15 state and federal agencies with management and regulatory responsibilities in the Bay-Delta Estuary. The mission of the program is to develop a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta. The alternatives being considered by CALFED include two variable program elements and six common program elements.

VARIABLE PROGRAM ELEMENTS

CONVEYANCE: This program element deals with various alternatives for moving water through the Delta and to the major export facilities in the southern Delta. Although this element does not directly impact the Big Chico Creek Watershed, the choice of conveyance is one of the key decisions of the overall program and will indirectly affect everyone in the problem and solution areas. (CALFED, Phase II Interim Report, 1998, p70-72)

STORAGE: The Storage program element addresses possible new or expanded water storage in surface reservoirs or groundwater basins. None of the surface storage facilities currently being evaluated by CALFED are within the Big Chico Creek Watershed. CALFED has not yet determined which areas are going to be used for groundwater storage operations. (CALFED, Phase II Interim Report, 1998, p62-70; CALFED, Phase II Storage and Conveyance, 1998)

COMMON PROGRAM ELEMENTS

These common program elements remain relatively unchanged from one alternative to another.

LONG-TERM LEVEE PROTECTION PLAN: This plan provides improvements in the reliability of Delta levees and will not directly impact the Big Chico Creek Watershed (CALFED, Long-Term Levee Protection, 1998).

WATER QUALITY PROGRAM: This program makes reductions in point and non-point pollution. This program's actions to reduce urban and industrial runoff, agricultural drainage and runoff, and toxicity of unknown origin will probably affect the Big Chico Creek Watershed (CALFED, Water Quality Program, 1998).

WATER USE EFFICIENCY PROGRAM: This program provides policies for efficient use of water in agricultural, urban and environmental settings (CALFED, Water Use Efficiency, 1998). These policies will probably affect the Big Chico Creek watershed but are unknown at this time.

WATER TRANSFER FRAMEWORK POLICY: This program element provides a policy framework to facilitate and encourage a regulated water market to move water between users, including for environmental use, on a voluntary and compensated basis (CALFED, Water Use Efficiency, 1998). This element is of great concern to many stakeholders in the Big Chico Creek watershed.

WATERSHED MANAGEMENT COORDINATION: This program element encourages locally led watershed management activities that benefit all Delta system resources (CALFED, Watershed Management Strategy, 1998). The activities of the Big Chico Creek Watershed Alliance, including the preparation of this report, are examples of what this element encourages.

ECOSYSTEM RESTORATION PROGRAM: This program provides improvements in habitat for the environment, restoration of some critical flows, and attempts to reduce conflict with other Delta system resources. This program includes measures generally applicable to streams throughout the affected areas as well as specific recommendations for Big Chico Creek. (CALFED, Ecosystem Restoration, 1998).

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APPENDIX A

ANNIE BIDWELL'S INDENTURE

DEED OF TRUST

Annie E. K. Bidwell

-to-

The State of California.

This Indenture, Made the first day of July one thousand nine hundred and eight between Annie E. K. Bidwell of the County of Butte, State of California the party of the first part, and The State of California the party of the second part,

Witnesseth, That the said party of the first part, in consideration of the sum of One dollar lawful money of the United States of America, to her in hand paid, by the said party of the second part, the receipt whereof is hereby acknowledged, does by these presents grant, bargain and sell, unto the said party of the second part forever, all those certain lots, pieces or parcels of land situate in the County of Butte, State of California, and bounded and described as follows, to wit:--

All that strip of land varying width bounded on the west by the Sacramento River and an Inlet thereof; on the East by the west line of Sutter Avenue and the West line of the County Road, said strip of land extending from the North boundary of Rancho Arroyo Chico in the N. W. 1/4 of Section 22 Township 22 North of Range one west, M. D. B. and M. to the southerly extremity of said Rancho Arroyo Chico on the North bank of Chico Creek near its confluence with the Sacramento River in Section 2 Township 21 North of Range 1 West M. D. B. and M. excepting and reserving therefrom Lot Thirty two (32) of the Meridian Subdivision of the John Bidwell Rancho. Also all that strip of land varying width including both banks and the channel of Lindo Channel otherwise called Sandy Gulch, from the point where said Lindo Channel intersects the line of the Park deeded by Annie E. K. Bidwell to the City of Chico, July 10, 1905, to the point where said Lindo Channel disembogues into Chico Creek.)

Said strip of land herein conveyed includes all lands lying between the Seventh, Sixth and Third subdivisions of the John Bidwell Rancho, the Cussick Tract, the lands of E. B. Reed and Park Henshaw, the Twelfth and Fifteenth subdivision of the John Bidwell Rancho, and a body of land between the said Fifteenth subdivision and the said Park line all on the North and West side of Sandy Gulch or Lindo Channel and the Seventh, Second, Fourth, Fourteenth and Sixteenth subdivisions of the John Bidwell Rancho and a body of land between the said Sixteenth subdivision and the said Park line, all on the south and East side of said Lindo Channel or Sandy Gulch. Also all that strip of land varying width on the North side of Chico Creek and running to the center of said Creek, extending from the point where the Southern Pacific Railroad right of way crosses said Creek, westwardly and down said stream, following the courses of the same to the mouth thereof; said strip of land being bounded on the North by the Second, Seventh and Meridian subdivisions of the

This conveyance is made upon the following conditions and should all or any o
said conditions be broken, the title herein granted by this deed shall cease, revert to
be vested in the said Annie E. K. Bidwell, her heirs or assigns.

The grantee shall not use, cause to be used or allow to be used directly or indirectly said land or any part thereof for the purpose of making or selling intoxicat liquors or of giving the same away.

The grantor reserves to herself during her lifetime the use and control of su of said lands above described as lie East of the Shasta or Oregon road for all purposes she reserves during her said lifetime all present water rights in both Lindo Channel an Chico Creek together with the right to use or sell any sand, gravel, earth or timber within any of said above described tracts, as she may deem wise and proper and further it is one of the conditions of this conveyance that nothing herein shall interfere with abridge now or hereafter, the custom of closing Lindo Channel during the summer months its point of exit from Chico Creek in order that a steady and continuous flow of water be maintained in the channel of said Chico Creek throughout the entire year.

The object of the grantor in conveying this property to the State of Califorı is to preserve after her death the forest growth along said water courses; to prevent diversion and use of the water for private purposes; to minimize the loss of water by evaporation so that the sub-irrigation of the adjoining lands may be maintained to its natural extent and to maintain the natural beauty of said streams and the integrity of banks. It is understood that the State of California in accepting this conveyance shal retain the title to the lands herein granted in perpetuity.

Together with the tenements, hereditaments and appurtenances thereunto belong or appertaining, and the reversion and reversions, remainder and remainders, rents, is and profits thereof.

To have and to hold, the said premises, together with the appurtenances unto said party of the second part forever.

In Witness Whereof, the said party of the first part has hereunto set her ha day and year first above written.

Signed and delivered in the)
presence of)

Annie E. K. Bidwell

State of California,)
County of Butte.) ss

On this 1 day of July in the year one thousand ni hundred and eight, before me, Guy R. Kennedy, a Notary Public in and for said Butte Co residing therin, duly commissioned and sworn, personally appeared Annie E. K. Bidwell to me to be the person whose name is subscribed to the within instrument, and she ackn to me that she executed the same.

In Witness Whereof, I have hereunto set my hand and affixed my official seal my office in the County of Butte, the day and year in this Certificate first above wri

(seal) Guy R. Kennedy, Notary P
and for said Butte County, State of Californi

Filed for record at the request of S. B. Lull Aug 20, A. D. 1909 at 45 min. past 9 o'clock A. M., and recorded in Book 111 of Deeds, page 320 Butte County Records

Recorder

WHEREAS, CORPORATION OF AMERICA is now the Trustee under said Deed of Trust;

NOW, THEREFORE, the CORPORATION OF AMERICA, a corporation as said Trustee, does hereby grant, remise, release and reconvey to the person or persons legally entitled thereto, all the estate and interest derived to it, by or through said Deed of Trust, in the lands therein described, together with the appurtenances; special reference being hereby made to said Deed of Trust and the record thereof, for a particular description of said lands.

IN WITNESS WHEREOF, said CORPORATION OF AMERICA, as such Trustee, has caused these presents to be executed by an officer, to-wit: Manager of the BANK OF AMERICA NATIONAL TRUST AND SAVINGS ASSOCIATION and ex-officio agent of said CORPORATION OF AMERICA, by virtue of a resolution of the Board of Directors of said Corporation heretofore recorded in the aforesaid County.

DATED: July 19, 1950.

CORPORATION OF AMERICA, a Corporation,
Trustee.

By H. J. COCHRAN, Its Agent

STATE OF CALIFORNIA)
COUNTY OF BUTTE)ss

On this 19th day of July, 1950, before me, LAURA LEE CASAGRANDE, a Notary Public in and for Butte County, personally appeared H. J. COCHRAN, an officer to-wit: Manager of the BANK OF AMERICA NATIONAL TRUST AND SAVINGS ASSOCIATION, and ex-officio agent of CORPORATION OF AMERICA, a corporation, known to me to be the person who executed the within instrument on behalf of CORPORATION OF AMERICA, a corporation, therein named, and acknowledged to me that said CORPORATION OF AMERICA, a corporation, executed the same, as such trustee.

WITNESS my hand and official seal.

(SEAL) LAURA LEE CASAGRANDE, Notary Public
in and for said County and State.

My Commission expires, May 8, 1951.

Recorded at the Request of OROVILLE TITLE COMPANY, JUL 25, 1950 at 13 min. past 10 o'clock A.M., Vol. 536, page 273, Official Records of Butte County, California.

No. 1106 Compared { Book MR / Doc AL } ETHEL M. ESTES........County Recorder
Fee $2.00 By Shirley G. Cox Deputy Recorder

ASSEMBLY BILL NO. 141

Passed the Assembly April 11, 1950.

Arthur A. Ohnimus, Chief Clerk of the Assembly

Passed the Senate April 13, 1950

J. A. Beek, Secretary of the Senate.

This bill was received by the Governor this 14th day of April, 1950, at 10 o'clock A.M.

HELEN R. MACGREGOR, Private Secretary of the Governor.

CHAPTER 73

An act granting certain lands owned by the State of California to the County of Butte for public park purposes upon certain trust and conditions.

THE PEOPLE OF THE STATE OF CALIFORNIA DO ENACT AS FOLLOWS:

SECTION 1. There is hereby granted to the County of Butte of the State of California, and to its successors, all the right, title and interest of the State of California in and to all those certain lots, pieces or parcels of land situate, lying and being in the County of Butte, known as General Bidwell State Park, and more particularly described in that certain indenture executed July 1, 1908, between Annie E. K. Bidwell and the State of California, and recorded August 20, 1909, at page 320 of Book 111 of the Records of Butte County, to be forever held by the County of Butte, and by its successors, in trust for the uses and purposes, and upon the express conditions following, to wit:

(a) Said lands shall be used by the County of Butte and by its successors solely for the establishment, improvement, and conduct of a public park for the use and benefit of the people of the State, and said county, or its successors, shall not at any time grant, convey, give, or alien said lands or any part thereof to any individual, firm or corporation for any purpose whatsoever; provided, that said county or its successors may lease portions of said lands for a period not exceeding 25 years for purposes consistent with the trusts upon which said lands are held by the State of California and consistent with the use thereof for public park and recreational purposes.

(b) Said park shall be improved by said county without expense to the State and

536 shall always remain a public park for recreational use by the people of the State.

(c) The use of said lands is further subject to all of the conditions, restrictions, and limitations contained in the indenture hereinabove referred to whereby said lands were conveyed to the State of California.

(d) There is hereby excepted and reserved to the State of California all deposits of minerals, including oil and gas, in said land, and to the State of California, or persons authorized by the State of California, the right to prospect for, mine, and remove such deposits from said land; provided, that said excepted and reserved power shall be exercised in a manner not inconsistent, or imcompatible with the use of said lands by grantee for public park purposes.

SEC. 2. It is the intent of this act in transferring to the County of Butte the lands described herein that they shall henceforth be utilized by the county for the benefit of the people of the State in accordance with the conditions and restrictions contained in the instrument whereby said lands were conveyed to the State and subject to the proviso that if it is determined by any court of competent jurisdiction that conveyance of such lands to the County of Butte as provided in Section 1 of this act would consitute a breach of the conditions of such conveyance, then the provisions of this act are void and ineffective as a transfer of title or right of possession as of the effective date of this act.

SAM L. COLLINS, Speaker of the Assembly
HAROLD J. POWERS, President of the Senate, pro tempore

Approved May 5th, 1950.
EARL WARREN, Governor

Filed in the office of the Secretary of State of the State of California, May 5, 1950 at 11 o'clock A.M..

FRANK M. JORDAN, Secretary of State
By CHAS. J. HAGERTY, Deputy

STATE OF CALIFORNIA
OFFICE OF THE SECRETARY OF STATE

I, FRANK M. JORDAN, Secretary of State of the State of California, hereby certify:

That I have compared the annexed transcript with the RECORD on file in my office, of which it purports to be a copy, and that the same is a full, true and correct copy thereof.

IN WITNESS WHEREOF, I hereunto set my hand and affix the Great Seal of the State of California, at Sacramento, this 18th day of July, 1950.

(SEAL OF STATE OF CALIFORNIA) FRANK M. JORDAN, Secretary of State.
By CHAS. J. HAGERTY, Deputy

Recorded at the Request of DIVISION OF BEACHES & PARKS, Dept. of Natural Resources. JUL 25, 1950 at 35 min. past 10 o'clock A.M., Vol. 536, page 274, Official Records of Butte County, California.

No. 1114 Compared {Book MR / Doc AL} ETHEL M. ESTES.............County Recorder
No Fee By Shirley E. Cox Deputy Recorder

ARTHUR BROWN ET UX
TO
ANDREW DONOFRIO ET UX
GRANT DEED (JOINT TENANCY)

For Value received ARTHUR BROWN and MARION BROWN, husband and wife, GRANT to ANDREW DONOFRIO and LORRAINE DONOFRIO, husband and wife, as JOINT TENANTS all that real property situate in the County of Butte, State of California, described as follows:

BEGINNING at the Southwest corner of Lot 30, as shown of the Official map of the subdivision of Section 1, Township 22 North Range 3 East, M.D.B. & M.; thence along the South line of Lot 30 North 89° 40' East 269.4 feet to the center line of a private road; thence along said road center line the following courses:

North 6° 12' East 100.0 feet; North 24° 21' E. 100.00 ft. North 46° 06' E. 121.5 feet; North 32° 45' E. 144.7 feet North 27° 29' E. 113.0 feet; North 68° 59' E. 140.0 feet; North 83° 03' E. 313.0 feet; South 56° 02' E. 91.68 feet North 49° 54' E. 53.5 feet; North 4° 36' W. 240.2 feet North 21° 48' E. 210.7 feet; North 64° 17' E. 60.0 feet; South 84°19' E. 79.0 feet; North 42° 15' E. 85.3 feet; and North 19° 09' E. 9.6 feet; thence South 50°32' East 21.3 feet to the point of beginning for the following description:

WHEREAS, CORPORATION OF AMERICA is now the Trustee under said Deed of Trust;

NOW, THEREFORE, the CORPORATION OF AMERICA, a corporation as said Trustee, does hereby grant, remise, release and reconvey to the person or persons legally entitled thereto, all the estate and interest derived to it, by or through said Deed of Trust, in the lands therein described, together with the appurtenances; special reference being hereby made to said Deed of Trust and the record thereof, for a particular description of said lands.

IN WITNESS WHEREOF, said CORPORATION OF AMERICA, as such Trustee, has caused these presents to be executed by an officer, to-wit: Manager of the BANK OF AMERICA NATIONAL TRUST AND SAVINGS ASSOCIATION and ex-officio agent of said CORPORATION OF AMERICA, by virtue of a resolution of the Board of Directors of said Corporation heretofore recorded in the aforesaid County.

DATED: July 19, 1950.

CORPORATION OF AMERICA, a Corporation,
Trustee.

By H. J. COCHRAN, Its Agent

STATE OF CALIFORNIA)
COUNTY OF BUTTE)ss

On this 19th day of July, 1950, before me, LAURA LEE CASAGRANDE, a Notary Public in and for Butte County, personally appeared H. J. COCHRAN, an officer to-wit: Manager of the BANK OF AMERICA NATIONAL TRUST AND SAVINGS ASSOCIATION, and ex-officio agent of CORPORATION OF AMERICA, a corporation, known to me to be the person who executed the within instrument on behalf of CORPORATION OF AMERICA, a corporation, therein named, and acknowledged to me that said CORPORATION OF AMERICA, a corporation, executed the same, as such trustee.

WITNESS my hand and official seal.

(SEAL) LAURA LEE CASAGRANDE, Notary Public in and for said County and State.

My Commission expires, May 8, 1951.

Recorded at the Request of OROVILLE TITLE COMPANY, JUL 25, 1950 at 13 min. past 10 o'clock A.M., Vol. 536, page 273, Official Records of Butte County, California.

No. 1106 Compared { Book MR / Doc AL } ETHEL M. ESTES........County Recorder
Fee $2.00 By Shirley E. Cox Deputy Recorder

ASSEMBLY BILL NO. 141

Passed the Assembly April 11, 1950.

Arthur A. Ohnimus, Chief Clerk of the Assembly

Passed the Senate April 13, 1950

J. A. Beek, Secretary of the Senate.

This bill was received by the Governor this 14th day of April, 1950, at 10 o'clock A.M.
HELEN R. MACGREGOR, Private Secretary of the Governor.

CHAPTER 73

An act granting certain lands owned by the State of California to the County of Butte for public park purposes upon certain trust and conditions.

THE PEOPLE OF THE STATE OF CALIFORNIA DO ENACT AS FOLLOWS:

SECTION 1. There is hereby granted to the County of Butte of the State of California, and to its successors, all the right, title and interest of the State of California in and to all those certain lots, pieces or parcels of land situate, lying and being in the County of Butte, known as General Bidwell State Park, and more particularly described in that certain indenture executed July 1, 1908, between Annie E. K. Bidwell and the State of California, and recorded August 20, 1909, at page 320 of Book 111 of the Records of Butte County, to be forever held by the County of Butte, and by its successors, in trust for the uses and purposes, and upon the express conditions following, to wit:

(a) Said lands shall be used by the County of Butte and by its successors solely for the establishment, improvement, and conduct of a public park for the use and benefit of the people of the State, and said county, or its successors, shall not at any time grant, convey, give, or alien said lands or any part thereof to any individual, firm or corporation for any purpose whatsoever; provided, that said county or its successors may lease portions of said lands for a period not exceeding 25 years for purposes consistent with the trusts upon which said lands are held by the State of California and consistent with the use thereof for public park and recreational purposes.

(b) Said park shall be improved by said county without expense to the State and shall always remain a public park for recreational use by the people of the State.

(c) The use of said lands is further subject to all of the conditions, restrictions, and limitations contained in the indenture hereinabove referred to whereby said lands were conveyed to the State of California.

(d) There is hereby excepted and reserved to the State of California all deposits of minerals, including oil and gas, in said land, and to the State of California, or persons authorized by the State of California, the right to prospect for, mine, and remove such deposits from said land; provided, that said excepted and reserved power shall be exercised in a manner not inconsistent, or imcompatible with the use of said lands by grantee for public park purposes.

SEC. 2. It is the intent of this act in transferring to the County of Butte the lands described herein that they shall henceforth be utilized by the county for the benefit of the people of the State in accordance with the conditions and restrictions contained in the instrument whereby said lands were conveyed to the State and subject to the proviso that if it is determined by any court of competent jurisdiction that conveyance of such lands to the County of Butte as provided in Section 1 of this act would consitute a breach of the conditions of such conveyance, then the provisions of this act are void and ineffective as a transfer of title or right of possession as of the effective date of this act.

SAM L. COLLINS, Speaker of the Assembly
HAROLD J. POWERS, President of the Senate, pro tempore

Approved May 5th, 1950.
EARL WARREN, Governor

Filed in the office of the Secretary of State of the State of California, May 5, 1950 at 11 o'clock A.M..

FRANK M. JORDAN, Secretary of State
By CHAS. J. HAGERTY, Deputy

STATE OF CALIFORNIA
OFFICE OF THE SECRETARY OF STATE

I, FRANK M. JORDAN, Secretary of State of the State of California, hereby certify:

That I have compared the annexed transcript with the RECORD on file in my office, of which it purports to be a copy, and that the same is a full, true and correct copy thereof.

IN WITNESS WHEREOF, I hereunto set my hand and affix the Great Seal of the State of California, at Sacramento, this 18th day of July, 1950.

(SEAL OF STATE OF CALIFORNIA) FRANK M. JORDAN, Secretary of State.
By CHAS. J. HAGERTY, Deputy

Recorded at the Request of DIVISION OF BEACHES & PARKS, Dept. of Natural Resources. JUL 25, 1950 at 35 min. past 10 o'clock A.M., Vol. 536, page 274, Official Records of Butte County, California.

No. 1114 Compared { Book MR / Doc AL }
No Fee

ETHEL M. ESTES..............County Recorder
By Shirley E. Cox Deputy Recorder

ARTHUR BROWN ET UX
TO
ANDREW DONOFRIO ET UX
GRANT DEED (JOINT TENANCY)

For Value received ARTHUR BROWN and MARION BROWN, husband and wife, GRANT to ANDREW DONOFRIO and LORRAINE DONOFRIO, husband and wife, as JOINT TENANTS all that real property situate in the County of Butte, State of California, described as follows:

BEGINNING at the Southwest corner of Lot 30, as shown of the Official map of the subdivision of Section 1, Township 22 North Range 3 East, M.D.B. & M.; thence along the South line of Lot 30 North 89° 40' East 269.4 feet to the center line of a private road; thence along said road center line the following courses:

North 6° 12' East 100.0 feet; North 24° 21' E. 100.00 ft. North 46° 06' E. 121.5 feet; North 32° 45' E. 144.7 feet North 27° 29' E. 113.0 feet; North 68° 59' E. 140.0 feet; North 83° 03' E. 313.0 feet; South 56° 02' E. 91.68 feet North 49° 54' E. 53.5 feet; North 4° 36' W. 240.2 feet North 21° 48' E. 210.7 feet; North 64° 17' E. 60.0 feet; South 84°19' E. 79.0 feet; North 42° 15' E. 85.3 feet; and North 19° 09' E. 9.6 feet; thence South 50°32' East 21.3 feet to the point of beginning for the following description:

tree growing in any public park, playground or public place in the county excepting by an employee in the regular course of his employment. (Code 1952, § 33)

Sec. 16-6. Grass, etc.

It is unlawful to injure any grass plot, edging of grass, border or ornamental ground along any sidewalk or in any park, playground or public place in the county. (Code 1952, § 35)

Sec. 16-7. Speed limit of vehicles.

The maximum rate of speed of any vehicle traveling in any park or playground in the county shall be twenty (20) miles per hour. (Code 1952, § 36)

Sec. 16-8. Fires.

It is unlawful to build a fire in any park or playground in the county, excepting at those places designated and appointed by the board of supervisors, and unless such places are designated plainly by a sign stating that fires are permitted. (Code 1952, § 37)

Sec. 16-9. Discharge of firearms; killing birds or animals.

It is unlawful to discharge a firearm, or injure or kill any bird or animal in any park or playground owned or controlled by the county. (Code 1952, § 38)

Cross reference—Similar provisions relating to Bidwell River Park, § 16-19.

ARTICLE II. BIDWELL RIVER PARK

Sec. 16-10. Designation and dedication.

(a) The hereinafter described real property situated in the county is hereby designated as a public park and dedicated for the recreational use and benefit of the people of the state, subject to the limitations prescribed in the deed or conveyance thereof and those prescribed by law.

(b) The real property is designated and named "Bidwell River Park." (Code 1952, § 111)

Sec. 16-11. Description of boundaries.

The real property comprising Bidwell River Park is more particularly described as follows:

All that certain real property, situated in the county, and bounded as described as follows:

All that strip of land varying width bounded on the west by the Sacramento River and an inlet thereof; on the east by the west line of Sutter Avenue and the west line of the county road, the strip of land extending from the north boundary of Rancho Arroyo Chico in the NW ¼ Section 22, T22N, R1W; M.D.B. & M. to the southerly extremity of the Rancho Arroyo Chico on the north bank of Chico Creek near its confluence with the Sacramento River in Section 2, T21N, R1W, M.D.B. & M., excepting and reserving therefrom Lot 32 on the meridian subdivision of the John Bidwell Rancho. Also all that strip of land of varying width including both banks and the canal of Lindo Channel otherwise called Sandy Gulch, from the point where the Lindo Channel intersects the line of the park deeded by Annie E. K. Bidwell to the City of Chico, July 10, 1905, to the point where the Lindo Channel disembogues into Chico Creek.

The strip of land includes all lands lying between the seventh, sixth and third subdivisions of the John Bidwell Rancho, the Cussick Tract, the lands of H. B. Reed and Park Henshaw, the twelfth and fifteenth subdivisions of the John Bidwell Rancho, and a body of land between the fifteenth subdivision and the park line all on the north and west side of Sandy Gulch or Lindo Channel and the seventh, second, fourth, fourteenth and sixteenth subdivisions of the John Bidwell Rancho and a body of land between the sixteenth subdivision and the park line, all on the south and east side of the Lindo Channel or Sandy Gulch. Also all that strip of land of varying width on the north side of the Chico Creek and running to the center of the creek, extending from the point where the Southern Pacific Railroad right-of-way crosses the creek, westwardly and down such stream, following the courses of the same to the mouth thereof; the strip of land being bounded on the north by the second, seventh and meridian subdivisions of the John Bidwell Rancho and on the south by the center of the channel of Chico Creek. (Code 1952, § 111)

Sec. 16-12. Director of public works to control.

The director of public works is vested with the supervision, control and management of Bidwell River Park. (Code 1952, § 111)

Sec. 16-13. Flowers, trees, etc.

It is unlawful to cut, break or otherwise injure any flower, bush, vine, shrub or tree growing in Bidwell River Park, excepting by an employee of the county in the regular course of his employment. (Code 1952, § 111)

Sec. 16-14. Soil, earth removal and excavation.

It is unlawful to remove any earth or soil or to perform or commit any excavation within the boundaries of Bidwell River Park without the permission of the director of public works first had and obtained. (Code 1952, § 111)

Sec. 16-15. Garbage, glass, broken ware, rubbish, etc., deposits.

It is unlawful to throw or deposit in Bidwell River Park any garbage or filth, glass, broken ware, hay, straw, dirt, rubbish, or cuttings from plants or trees. (Code 1952, § 111)

Sec. 16-16. Fires.

It is unlawful to build a fire in Bidwell River Park except at those particular places designated and appointed by the director of public works and which designated and appointed places are plainly marked with a sign stating that fires will be permitted there. (Code 1952, § 111)

Sec. 16-17. Camping; house trailers.

It is unlawful to camp in Bidwell River Park.

It is unlawful to park a house trailer in the park for a period longer than six (6) hours in any calendar month. (Code 1952, § 111)

Sec. 16-18. Buildings or structures.

It is unlawful to build or construct or place on Bidwell River Park property any structure of any kind without a written permit to do so first had and obtained from the director of public works. (Code 1952, § 111)

Sec. 16-19. Discharge of firearms; killing or injuring birds or animals.

It is unlawful to discharge firearms or kill or injure any bird or animal in Bidwell River Park without permission to do so first had and obtained from the director of public works. (Code 1952, § 111)

Sec. 16-20. Horses, mules, cows, etc.

It is unlawful for any person owning or having control of or being the keeper of any horse, mule, cow, goat, sheep, ass, hog or domestic fowl to permit the same to run at large in or graze or feed in Bidwell River Park without permission to do so first had and obtained from the director of public works. (Code 1952, § 111)

ARTICLE III. RIDER AND HIKERS TRAILS

Sec. 16-21. "Rider and hikers" trail defined.

A "rider and hikers" trail as used in this article is defined to mean and refer to:

(a) Any trail established pursuant to article 6, chapter 1, division 5 of the state Public Resources Code (section 5070 et seq.), which trail has been posted with the officially adopted riding and hiking trail signs.

(b) Any rider and hikers trails within the county which have been designated pursuant to the state Public Resources Code and are commonly known and referred to as the "Master-Loop Trail, " a portion of which is in the county, and the "Oroville-Feather Falls Secondary Trail," all of which is in the county. (Ord. No. 753, § 1)

LAWS AND REGULATIONS INVENTORY

— INTRODUCTION —

The purpose of this chapter is to provide a detailed inventory of federal, state, and local regulations to determine agency notification requirements, fees, permits, or other applicable requirements that need to be adhered to during restoration projects. This data is summarized and includes contacts, addresses and telephone numbers.

— FEDERAL AND STATE —

Laws and Regulations

The *Handbook of Regulatory Compliance for the Anadromous Fish Restoration Program (1997)* with *Appendix B: Examples of Regulatory Compliance Documents and Permit Applications (1997)* provides a detailed inventory of state and federal regulations to be adhered to during restoration projects and a general overview of local regulatory compliance. This handbook also provides flow diagrams to describe requirements and strategies for compliance with particular federal and state laws and regulations. It also addresses issues and options for implementing each category of actions in compliance with the National Environmental Protection Act (NEPA), the California Environmental Quality Act (CEQA), and other pertinent environmental regulations. Agency addresses and telephone numbers are also included. This handbook meets all the objectives of this chapter for federal and state laws and regulations except for the provision of contact names at the agencies. The handbook is available at Butte County Public Library, California State University Chico library, UC Davis library, U.S. Fish and Wildlife Service, etc. (see Appendix A).

AGENCY CONTACT INFORMATION

Following are contact names and information for important federal and state agencies identified in the Handbook of Regulatory Compliance.

FEDERAL AGENCIES

Army Corps of Engineers:	Mike Finan U.S. Army Corps of Engineers Sacramento District Regulatory Section 1325 J Street Sacramento, CA 95814-2922 (916) 557-5324 phone (916) 557-6877 FAX

Bureau of Land Management:	Francis Berg Redding Resource Area Bureau of Land Management 355 Hemsted Drive Redding, CA 96002 (530) 224-2100 phone (530) 224-2172 FAX fberg@ca.blm.gov
Environmental Protection Agency:	Eugene Bromley Water Division U.S. EPA Region 9 75 Hawthorne Street, W-TR3 San Francisco, CA 94105 (415) 744-1906 phone (415) 744-1873 FAX bromley.eugene@epamail.epa.gov
Fish and Wildlife Service:	Jan Knight U.S. Fish and Wildlife Service 331 El Caiman, Suite 130 Sacramento, CA 95821 (916) 979-2710 phone (916) 979-2273 FAX jan_knight@fws.gov
Lassen National Forest:	Ken Roby Lassen National Forest P.O. Box 767 Chester, CA 96020 (530) 258-2141 phone (530) 258-5194 FAX kroby/r5_lassen@fs.fed.us

NATURAL RESOURCES CONSERVATION SERVICE

Butte County projects:	Dennis Nay Willows Field Office Natural Resources Conservation Service 132 N. Enright, Suite B Willows, CA 95988 (530) 934-4601 phone (530) 934-8667 FAX

Tehama County projects:	Larry Branham Red Bluff Field Office Natural Resources Conservation Service 2 Stutter Street, Suite D Red Bluff, CA 96080 (530) 527-3013, Ext. 3 phone (530) 527-7451 FAX

CALIFORNIA AGENCIES

Air District:	Lawrence Odle Butte County Air Quality Management District 2525 Dominic Drive, Suite J Chico, CA 95928 (530) 891-2882 phone (530) 891-2878 FAX
Department of Fish and Game:	Department of Fish and Game 1701 Nimbus Road Rancho Cordova, CA 95670-4599 (916) 358-2874 phone (916) 358-2912 FAX
Department of Water Resources:	Stacy Cepello Department of Water Resources 2440 Main Street Red Bluff, CA 96080 (530) 529-7352 phone (530) 529-7322 FAX cepello@water.ca.gov
Lands Commission:	Linda Fiack The State Lands Commission 100 Howe Avenue, Suite 100 South Sacramento, CA 95825-8202 (916) 574-1818 phone (916) 574-1835 FAX fiack@slc.ca.gov

Office of Historic Preservation:	Dr. Makoto Kowta Northeast Center of the California Historical Resources Information System Department of Anthropology California State University, Chico Chico, CA 95929-0400 (530) 898-6256 phone (530) 898-4413 FAX neinfocntr@campuspo.csuchico.edu
Reclamation Board:	Ricardo Pineda The Reclamation Board Floodway Permit Section 1416 Ninth Street Sacramento, CA 95814 (916) 653-5440 phone (916) 653-5805 FAX pineda@water.ca.gov
Water Quality Control Board	Ron Dykstra Redding Branch Office Central Valley Regional Water Quality Control Board 415 Knollcrest Drive, Suite 100 Redding, CA 96002 (530) 224-4858 phone (530) 224-4857 FAX dykstrre@gwgate.swrcb.ca.gov

— CITY OF CHICO —

LAWS AND REGULATIONS

The *City of Chico Best Practices Manual (1997)* and its accompanying *Technical Manual* provide a detailed inventory of the City's laws and regulations, including those to be adhered to during restoration projects. They meet the objectives of this chapter and are incorporated into this report (available at the City Planning Department).

CONTACT INFORMATION

Tony Baptiste
Community Development Director
City of Chico
P.O. Box 3420
Chico, CA 95927
(530) 895-4845 phone
(530) 895-4726 FAX
tbaptiste@ci.chico.ca.us

— TEHAMA COUNTY —

LAWS AND REGULATIONS

Environmental Laws, Regulations and Policies Pertaining to the Protection and Enhancement of Natural Resources in the Deer Creek Watershed (1998) includes a detailed inventory of Tehama County regulations, including those to be adhered to during restoration projects. It meets the objectives of this chapter and is incorporated into this report (Tehama County Public Works Department).

CONTACT INFORMATION

Dana Hall
Water Resources
Department of Public Works
County of Tehama
9380 San Benito Avenue
Gerber, CA 96035
(530) 385-1462 phone
(530) 385-1189 FAX
danahall@pobox.tco.net

Streaminders restoration site on Big Chico Creek in Bidwell Park
Photo by Roger Cole

BUTTE COUNTY

LAWS AND REGULATIONS

Restoration projects within the unincorporated areas of Butte County should be reviewed for consistency with the following:

GRADING (CHAPTER 13, ARTICLE I, CODE OF BUTTE COUNTY)

Grading permits may be required for restoration projects involving earthmoving activities. This Article of the Butte County Code requires permits for grading and establishes standards.

BIDWELL RIVER PARK (CHAPTER 16, ARTICLE II, CODE OF BUTTE COUNTY; ANNIE BIDWELL'S DEED OF 1908)

Restoration projects within Bidwell River Park and outside of the City of Chico must comply with Article 16 of the Butte County Code as well as the terms of Annie Bidwell's deed of 1908 (Appendices A and B in the Existing Management Plans chapter). The director of public works is vested with the supervision, control and management of the county sections of Bidwell River Park.

SUBDIVISION MAPS (CHAPTER 20, ARTICLE IV, CODE OF BUTTE COUNTY)

If a restoration project involves land division, it may be subject to the State Subdivision Map Act, which provides the legal basis for local governments to regulate land divisions for the purposes of sale, lease, or financing. This Article of the Code provides the County's criteria for lot sizes, subdivision design, and the types of improvements that are required.

ZONING (CHAPTER 24, CODE OF BUTTE COUNTY)

Special or conditional use permits often are required by local governments when a project applicant proposes use of property for which it is not designated. In addition, a zoning ordinance amendment may be required if the proposed use of the land is not permitted conditionally or by right in the land use zone in which the property is located. Restoration projects involving these types of uses would be subject to Chapter 24 of the Butte County Code.

FLOOD HAZARD PREVENTION (CHAPTER 26, ARTICLE IV, CODE OF BUTTE COUNTY)

Restoration projects in flood hazard areas may be subject to this Article of the Building Code.

GROUNDWATER CONSERVATION (CHAPTER 33, CODE OF BUTTE COUNTY)

If a restoration project involves groundwater, it should be reviewed for compliance with Chapter 33 of the Code, which is a result of the passage of Measure G by County voters in 1996. Chapter 33 requires permits for the extraction of groundwater for use outside the County or to substitute for surface water normally used within the County but transferred or proposed to be transferred for use outside the County. It also requires the establishment of a County Water Commission, establishment of a countywide groundwater monitoring program, and annual reports analyzing the amount of groundwater pumping that can occur without exceeding the "safe yield" for subbasins in Butte County.

Development Policies for Cohasset Area (Ordinance 2526, County of Butte)

Restoration projects in the Cohasset Area should be checked for compliance with this ordinance. Among the pertinent policies are those addressing erosion, slope and flood hazard.

North Chico Specific Plan (1995)

Restoration projects in the area covered by the North Chico Specific Plan should be reviewed for consistency with the Plan. This 3,590-acre area is located north of the City of Chico, adjacent to and easterly of State Route 99. The area is generally bounded by Sycamore Creek on the south, State Route 99 on the west, and Rock Creek on the north. The Chico Municipal Airport generally abuts the eastern perimeter of the Plan area with a portion of the Plan area extending northeasterly along Keefer Road. Two small portions of the Plan area, consisting of approximately 180 acres, are located south of Sycamore Creek, within the Chico Sphere of Influence.

Butte County General Plan

General plans for cities and counties set forth policies to guide local land development. General plans typically include a map of allowable uses and major public works and transportation facilities. A restoration project would need a general plan amendment if the proposed project would be inconsistent with the General Plan.

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Volunteers prepare to remove the invasive species Arundo donax.
Photo by Suzanne Gibbs

LAND USE REVIEW

— INTRODUCTION —

WATERSHED PLANNING

In order to protect and restore riverine ecosystems, it is crucial that current local land uses be analyzed in the context of their greater watershed. Management of riverine systems, absent from the watershed context, run the risk of being ineffective at best and counterproductive at worst.

Land use is a term used to describe all aspects of human occupancy or modification of the face of the earth. Scientific and technological advances in this century have provided us with certain knowledge that degradation of water quality is the result of various land uses including mining, agriculture, forestry, construction, residential development, and stream channel modifications (York and Speakman). This chapter is intended to provide stakeholders with an understanding of the historic and current land uses in the Big Chico Creek watershed, identify the impacts of particular land uses upon riverine ecosystems, and identify the land use policies which guide future development.

JURISDICTIONS / LAND USE OVERVIEW

The Big Chico Creek Watershed area is well known for its abundant natural resources and related rich quality of life. The watershed, which is comprised of three local government jurisdictions: the City of Chico, the County of Butte, and the County of Tehama, (See Table 1, for Geographic Information System (GIS) area calculations for each jurisdiction) has experienced steady, and at times rapid, growth since the 1970s. The 5% growth rate during the 1970s can mostly be attributed to the increase enrollment at California State University, Chico (CSUC) and the expansion of Enloe Hospital. The area's growth returned to a more moderate rate during the 1980s where it currently remains fluctuating between 2 and 3%.

Table 1. Jurisdictions of Big Chico Creek.

Jurisdiction	Acreage in Watershed	% of Total
Butte County	104,193	68%
Tehama County	32,750	22%
City of Chico	15,311	10%
Total	152,254	

Source: GIS analysis from the Geographic Information Center, CSUC.

The community of Chico, which includes incorporated and unincorporated lands, comprises the largest urbanized portion of the Watershed area, and as such, will generally serve as the focus area for the study. Because the lands within the Watershed that are under Tehama County jurisdiction are limited in size (32,750 acres) and use (mainly timber production), the study will not provide an in-depth discussion of this area. For a detailed description of the polices and regulations of Tehama County please see the *Deer Creek Watershed Existing Conditions Report*.

MAJOR EMPLOYERS IN THE WATERSHED

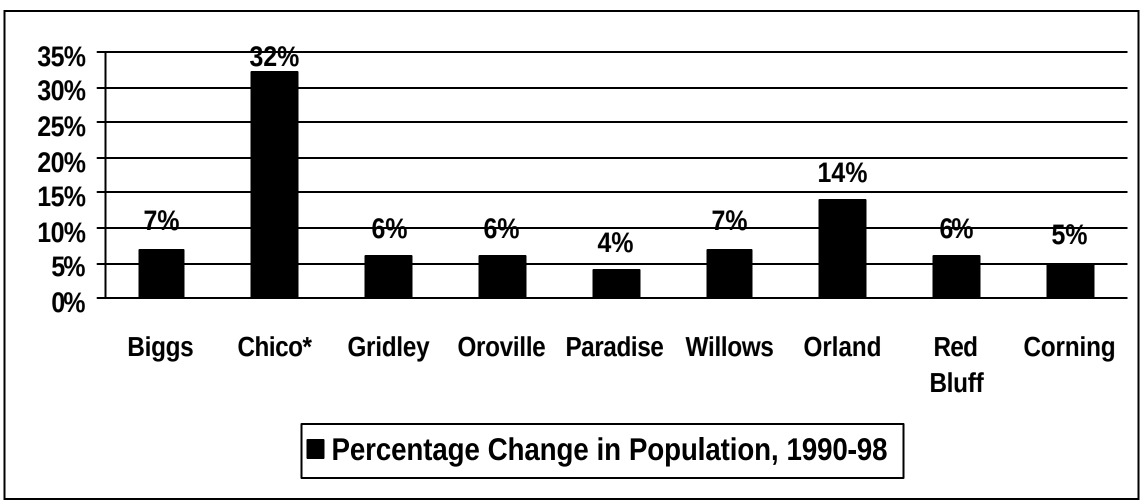
CSUC was established as the Chico State Normal School in 1887. Since then, it has grown from a normal school, to a teacher's college, a state college, and now a university. Today the campus has about 16,000 students and about 1,900 staff and faculty.

Enloe Hospital was established in 1913 and has grown to become Chico's largest private sector employer. Located on the Esplanade and clinics in other parts of Chico, Enloe Hospital employs 2,200 area residents and provides 391 beds. The hospital serves patients throughout the greater North Sacramento Valley area.

With first-rate educational and medical resources, Chico has emerged as the center of economic activity of the tri-county area that includes Butte, Glenn and Tehama Counties (City of Chico, 1994, p1-1). It is also the portion of the Watershed that has experienced the greatest population change.

POPULATION GROWTH

Only a small percentage of the Watershed's population growth represents a natural increase (Butte County, 1995). Reasons for population migration to the watershed, in addition to the obvious population stimulus of the University, range from a variety of housing opportunities to a perceived high quality of life which attracts retirees and other refugees from metropolitan areas. A significant segment of the population increase may be attributed to "amenity" migration, a recent demographic trend where small towns and rural areas have experienced growth (Burgess, 1997). Also known as the "rural rebound," "rural renaissance," or "booming boondocks," this growth phenomenon is expected to be particularly significant in the Sierra Nevada foothills and San Joaquin Valley. Population levels are expected to triple



Source: Department of Finance.
*A significant portion of the growth rate can be attributed to annexation.

in the greater Central Valley (including the North Sacramento Valley) by the year 2040 (Los Angeles Times, 1996). Significant growth can be expected in the Big Chico Creek Watershed as well, where affordable housing, environmental quality, and outdoor recreational access attract metropolitans in search of simpler lifestyles and prime destinations to "cash out."

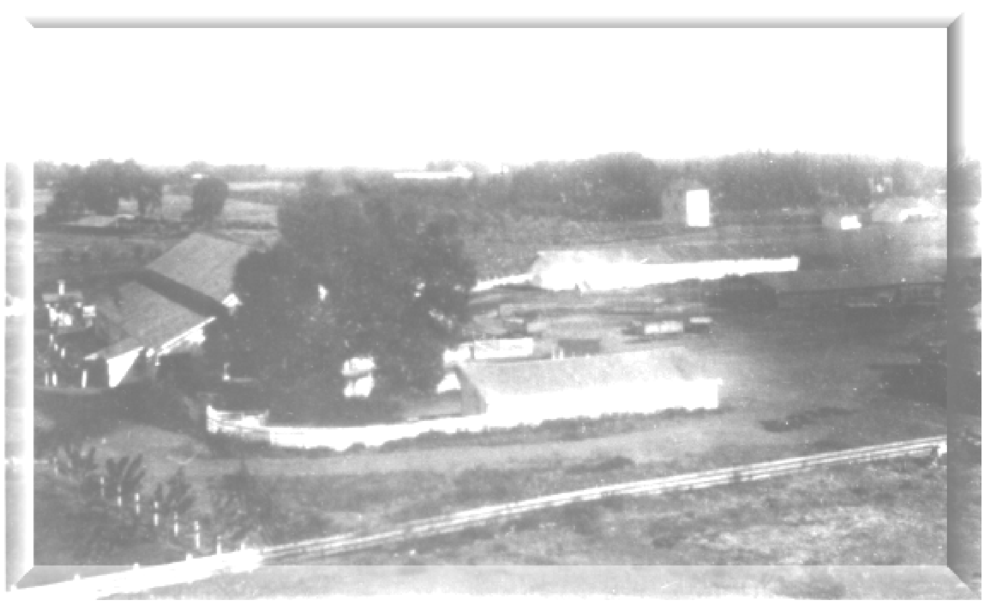
The diversity of residents (stakeholders) within the watershed is apparent. Agricultural and timber production still exists amid the new, more urbane population who are attracted to the University, employment and recreational opportunities found in the region.

Today's immigrants resettle in the Chico area in search of their own version of the good life: minimal traffic, pollution, and crime; a relaxed lifestyle; and the availability of affordable land (Hardwick & Holtgrieve, 1995, p4). While lifestyle immigration dominates much of the in-migration today, economic prosperity that attracted the early settlers.

— LAND USE HISTORY —

PREHISTORY

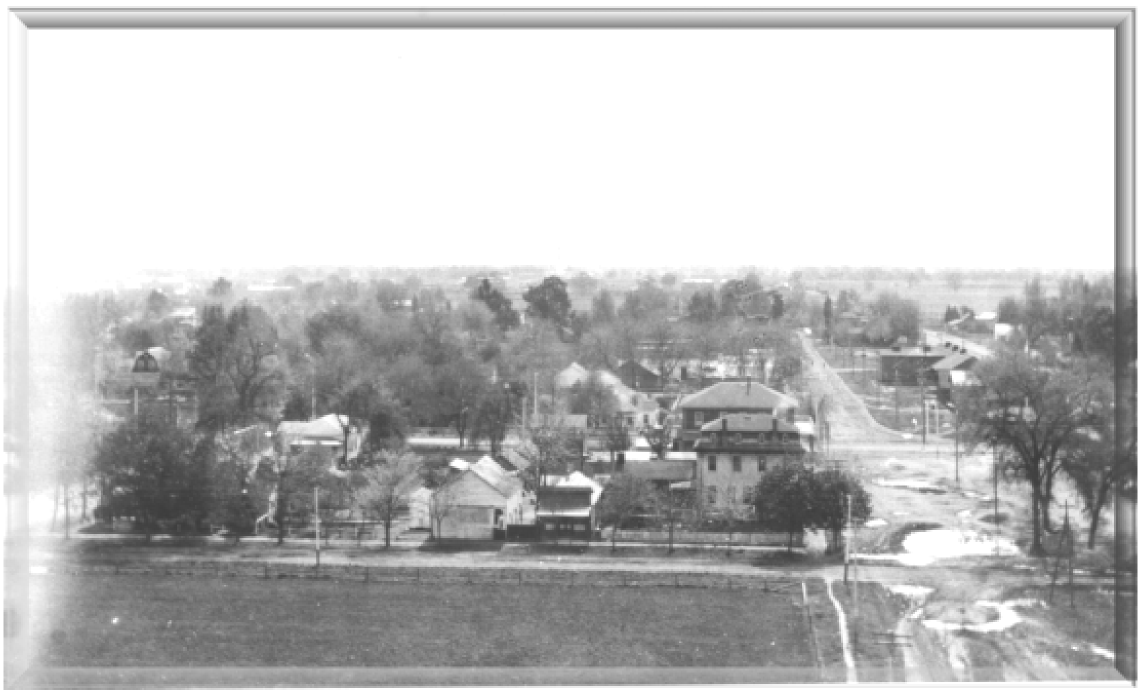
Before the arrival of Europeans, Northwestern Maidu people (see History Chapter), occupied the watershed. It is estimated that less than 7,000 Maidu people lived north of the Marysville Buttes (McGie, 1983, p7). As these local natives were primarily a hunting/gathering society, impacts on the land were mostly non-significant. However, the Maidu periodically burned in the watershed to control fuel loads and stimulate new growth, which could be seen as having an impact on the overall health of the watershed, albeit most likely a positive one.



Rancho del Arroyo Chico.
Special Collections, Meriam Library

THE LAND USE HISTORY AND IMPACTS TO THE WATERSHED

e first settlers arrived in the Big Chico Creek watershed area during the 1840s. Their primary interest for migrating to the area was ranching. In 1844, William Dickey received a 22,214-acre land grant called Rancho del Arroyo Chico. Also that same year, Edward A. Farwell received a 22,193-acre grant for property that is currently the City of Chico. In 1849, John Bidwell bought half of the Rancho del Arroyo Chico land and the remainder in 1851. In 1860, Bidwell purchased a portion of the Farwell land south of Big Chico Creek, where he planned to develop the town of Chico (Cheal and Forester, 1989). Once in his ownership, Bidwell commissioned County Surveyor J.S. Henning to create a town site of 50 blocks between Big and Little Chico Creeks. Henning centered the town grid on the Shasta/Tehama Road (Main Street-Esplanade), which was part of the main stage route through Northern California. The business district was centrally located on Main and Broadway Streets with the original residential neighborhood stretching from Salem Street west to Orange Street.

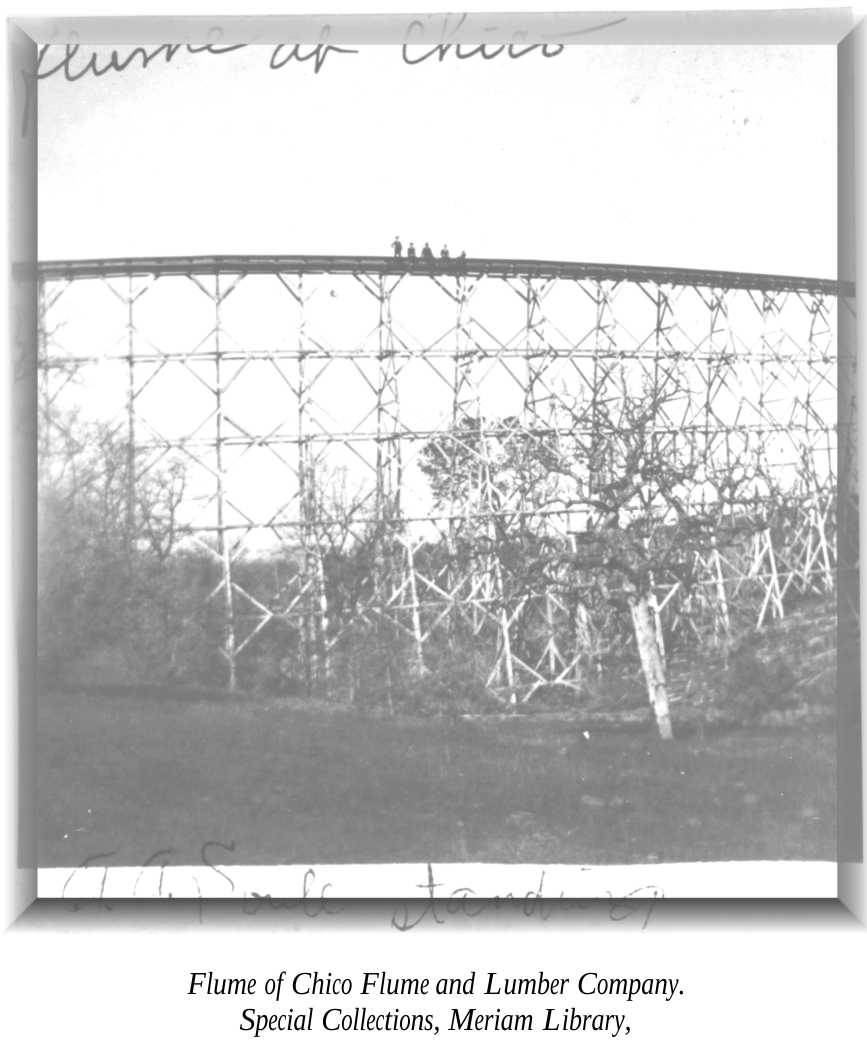


Chico looking east from Orange Street. Circa 1905.
Special Collections, Meriam Library and Gladys Pelletier

At this time, Bidwell offered free lots to people who agreed to immediately build homes. The first building was the Duncan Neal Saloon on the corner of Main and 3rd Streets, built in 1861. The area was quickly developed and grew into a typical pioneer town. The people living within the town had small family farms consisting of a garden plot and some livestock such as chickens, hogs, cattle, sheep and horses (Farley, 1993, p26). The regular occupations for many of the people consisted of raising livestock or growing fruits and grains on the outskirts of town, mining along Butte Creek or the Feather River or working in one of the local businesses (Chico Heritage Association, 1984). In 1867, Chico was selected as the site for the first agricultural fair in Butte County. It is assumed that Chico was chosen due to the influence of John Bidwell, who served as president of the Butte County Agricultural Association and had introduced many varieties of plants to the Chico area from all over the world. The population of Chico in 1869 was approximately 2,500 (McGie, 1983, p93).

During the peak of the mining activities from the 1850s to the 1880s, there were two Chinatowns in the community. The “Old Town” was on Flume Street between 5th and 6th Streets and the “New Town” was located on Cherry Street between West 7th and 8th Streets. Local people destroyed both of these towns after all the Chinese had died or moved away (Sharpe, 1972, p8).

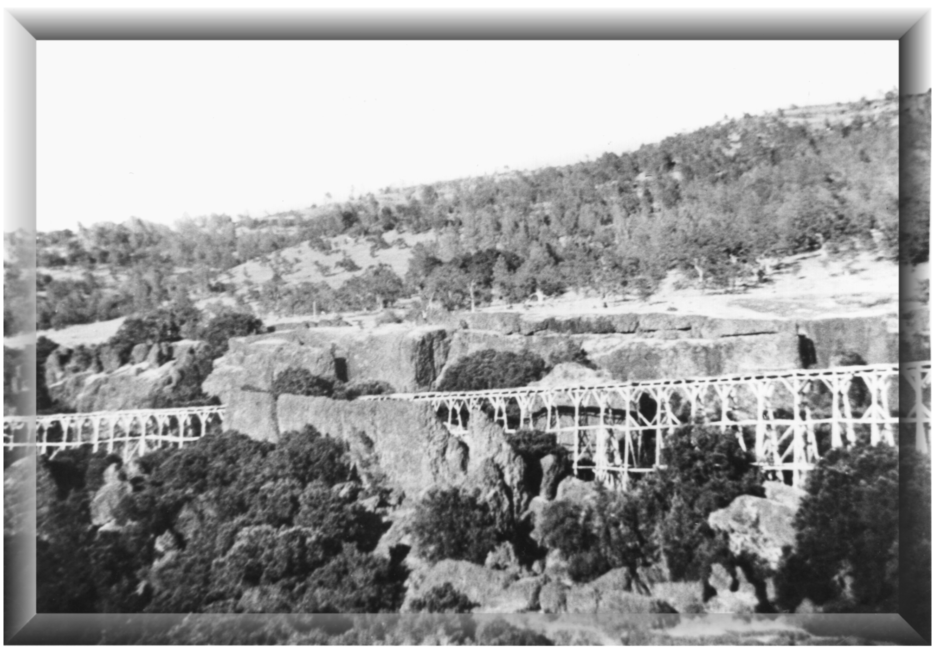
The town continued to grow as Bidwell made the community attractive to potential settlers and ensured the current residents would feel attached to the new town. He even rode 1,200 miles by horseback to Mission San Luis Rey to obtain the first fruit trees and grapevines in Chico. Bidwell imported oriental and tropical shrubs, rare flowers and casaba melons (Farley, 1993, p4).



Flume of Chico Flume and Lumber Company.
Special Collections, Meriam Library,

TIMBER

The first commercial land use, which produced an economic base for the area, was the cutting of timber in the upper watershed. Chico Meadows was the site of one of the first large scale mills in the area. In 1859, John Bidwell and George Wood built the mill, which operated until the early 1900's. In 1864, the Humboldt Road was completed and lessened the amount of time and effort it took to get the cut timber to Chico. The principal industry in the 1870s was the cutting and shipping of lumber. In 1871, the Chico Flume and Lumber Company erected two sawmills at the headwater of Big Chico Creek (McGie, 1983, 116). The construction of the flume through Big Chico Creek canyon to the Sierra Lumber Company followed this. The flume was completed in 1874. It connected the mill to a processing mill at the present day site of Five-mile Recreation Area. Later the flume was extended to a finishing factory at the corner of Pine and East 8th Streets. The flume was in existence until the early 1900's when it was demolished and the lumber was made available to local people to be used at their discretion. Some of the wood was used to build the Rotunda building near the cemetery, which was originally an indoor swimming pool that later became a dance hall. Today, there is no visible sign of the flume that was once an integral part of the "most complex lumber operation in the world" (Nopel, 1998).

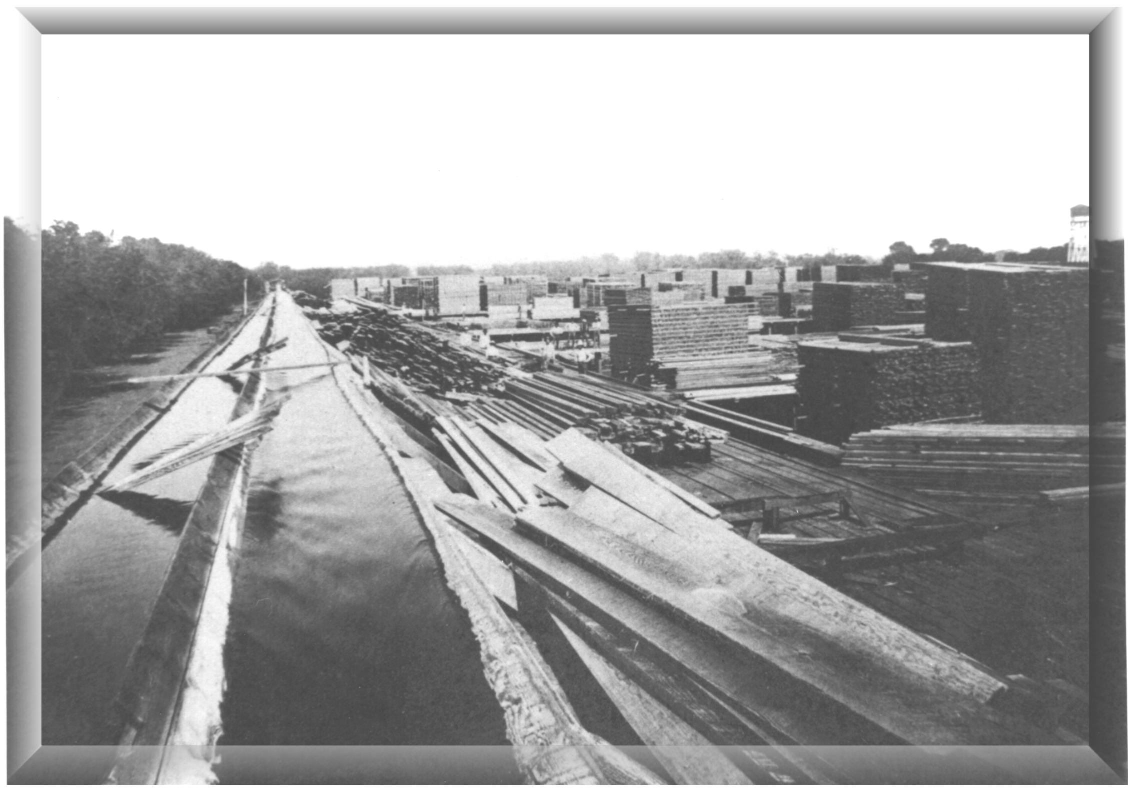


Chico flume, Iron Canyon, Big Chico Creek.
Special Collections, Meriam Library

By 1872, the City of Chico had incorporated. More people continued to move to the area and by 1901, the Diamond Match Company, one of the largest manufacturing companies in America, arrived in Chico. The company had a major growth impact on Chico and the surrounding area. In 1900, the Chico Township population was 4,799. A decade later, the population had more than doubled to 11,775. This tremendous growth was a direct result of the economic boom the Diamond Match Company brought to the area. A Chico Enterprise newspaper article in the December 25, 1903 edition noted:

> Two years ago, Chico stood in careless repose, with two straggling suburbs. Two years ago, vacant houses abounded, now people are living in tents. Two years ago, not more than half a dozen new houses were being erected. Today there are over two hundred. Every business place is occupied. Two years ago, the Chico city department had three buildings. Today it has five. Two years ago, three employees took care of all post office business. Today there are eleven.

During this time, a plant located on Del Norte Avenue (West 16th Street) housed a machine shop and foundry, powerhouse, dry lumber storage, dry kilns, sash and door factory, a box factory, match factory, apiary, office buildings, employee social hall, and baseball diamond. The Diamond Match plant continued in operation until 1975-76. The plant was later sold to the Louisiana-Pacific Corporation, which operated the plant for a few years and eventually closed the facility, by the end of 1989 (McGie, 1983, p161).



Flume between East 8th Street & Humboldt Road.. Circa 1990.
Special Collections, Miriam Library

In 1989, it was determined through soils testing that the historic use of the Diamond Match property has resulted in soil and groundwater contamination. Remediation of the site began in 1992 with the removal of contaminated soils. Under the oversight of the California Department of Toxic Substances Control, most of the soil remediation has been accomplished with the exception of a small-capped area. Remediation of the groundwater is still in the design stage and is expected to take ten to twenty years to complete. Development of the site would require a public water service connection to the California Water Company facilities (City of Chico, 1996).

The City of Chico has designated the site for Planned Mixed Use (PMU) and will require the preparation of a specific plan for the 133-acre site. Currently, the Louisiana-Pacific Corporation is advertising the property for sale. The site, however, is within the Butte Creek Watershed and is not being analyzed in this study.

The historical impacts of timber production in the watershed are not known. A study of logging roads is planned for the upper watershed to determine what, if any, impacts are related to timber road development and use.
Generally, impacts from timber production can include ecological changes, erosion and sedimentation, and even channel change. Many long-term studies suggest that logging and other human disturbances can cause persistent impacts 20 years after the disturbance (Williams, 1997, p103). The impacts of modern timber practices are discussed later in this report.

CATTLE AND ANIMAL HUSBANDRY

Livestock ranching was the major land use in the foothill section of the watershed during the early days of settlement and is still practiced today on a much smaller scale. Cattle, sheep and some hogs were raised on the larger ranches. The large ranches were mainly in the hill and rangeland pastures found to the east and northeast, as well as some south and southwest of the community of Chico. The cattle and sheep had a significant impact on the land, especially during the drives up the foothill ridges around the area, including Cohasset Ridge (Campbell Trail) and the Butte Meadows during the summer months. These drives consisted of hundreds to thousands of animals and continued until the 1930's (Roney, 1998, p22).

The specific impacts of historical grazing in the Watershed are not known. Generally, grazing has the potential to disturb riparian habitat and contribute significant levels of pollutants to receiving waters. "Overgrazing has the potential to compact soil, leading to increased runoff and erosion and decreased groundwater recharge, all of which are unfavorable to perennial grasses. Cultural implications include greater flood damage, reduced livestock production, and fewer options for land use." (Williams, 1997, p61).

Additionally, there were several dairy farms to the west of Chico, mostly along the Sacramento Avenue corridor. These dairies were a short-lived venture. In operation from roughly 1925-1960, all the larger dairies were closed by 1958. There was also a concentration of chicken farms in operation along the Sacramento Avenue corridor around the same time as the dairies (Farley, 1993, p26).

The historical impacts of these confined animal facilities in the Watershed are not known. Generally, they have the seepage potential to contaminate groundwater, and can contribute pathogens and nutrients to water resources (EPA, No.6).

AGRICULTURE

The first agriculture in the watershed, outside of animal husbandry, was the growing of grain. In 1853, John Bidwell built the first flourmill in the area to process the large amount of wheat he was growing. This mill was powered from Big Chico Creek water transported by a flume constructed along the present day Flume Street (Sharpe, 1972, p2). The valley section of the watershed quickly became an agricultural center with grains giving way to orchard produce such as citrus fruit, olives and nuts. Today, orchard crop production continues to be the dominant agricultural land use in the valley section of the watershed.

The historical impacts of agricultural land use in the watershed are not known. Agricultural activities have the potential to significantly impact water quality by increasing stream sedimentation from erosion, and increasing nutrients, pesticides, and salt concentration in runoff (Rau and Wooten, 1980, p6-50). The impacts of current agricultural land uses are discussed later in this report.

RECREATION

Almost the entire Big Chico Creek watershed has been used historically for recreation (see Recreation chapter). In the 1860s, Solman Gore discovered the area along Mud Creek that eventually was bought by J.H.R. Richardson and became "Richardson Springs" (McGie, 1983, p60). A resort was constructed on the site in 1868. The natural mineral springs on the site attracted vacationers and those in search of health benefits. The resort survived several fires in the early 1920s. In 1968 the resort became property of a religious organization, "The Springs of Living Water" (Butte County Historical Society, 1974).

The most intensely used recreational area is the present day site of Bidwell Park. The park was established in 1908 when Annie Bidwell deeded 1,900 acres to the City of Chico. Other additions to the park were made in 1911, 1921, 1934 and 1995—making it 3,740 acres—and currently the second largest municipal park in the United States. Several recreational sites have been established within the park boundaries. In 1918, One-mile and Five-mile recreation areas were built, followed by the opening of the golf course in 1921 and the rifle range in 1926 (Jensen and Associates, 1996, p.17-18).

In May 1931, the Sycamore Swimming Pool at the One-Mile dam opened. In the early 1990s, this popular swimming pool became the focus of concern by the California Department of Fish and Game (DFG) and the Central Valley Regional Water Quality Control Board (CVRWQCB) for discharges of suspended sediment and organic debris due to the City's cleaning practices (see Water Quality chapter). A hydrology management plan was prepared for One-Mile, Five-Mile and Lindo Channel in 1994. Several issues were addressed in addition to the sedimentation occurring at One-Mile, including the development of plans to protect and enhance salmon spawning and juvenile survival at Five-Mile and Lindo Channel and the need for on-going monitoring of the high fecal coliform measurements (taken since 1987) in Big Chico Creek. As a result of the study, the City constructed a bypass culvert at Sycamore Pool to be used during clean-out operations in 1997. The Central Valley Project Improvement Act, Anadromous Fish Restoration Program, provided part of the funding for this project. Other programs and plans recommended in the management plan are currently being implemented or studied.

To escape the heat of the valley, local residents have historically retreated to the upper watershed area of Chico Meadows. In 1934-35 Camp Lassen, a Boy Scouts of America camp was built on the site of an old lumber mill. The camp has been in continuous use and provides a recreational facility for hundreds of people each year (Nopel, 1998). Big Chico Creek continues to provide good swimming holes and fishing opportunities.

Another historical form of recreation within the watershed is hunting. During the first years the area was settled, hunting provided a form of subsistence. In modern times, hunting became more of a recreational activity. There are many historical accounts of the abundant wildlife in the foothills of this area. The foothills and upper watershed areas with their forest canopy, interspersed with open meadows, provide good deer hunting as well as bear and mountain lion hunting in earlier times. The valley region provides the opportunity to hunt pheasants, ducks and other fowl.

The Recreation Chapter of this report describes in more detail the numerous recreational opportunities in the watershed. It also discusses environmental impacts of recreational use in the watershed.

MILITARY / AIRPORT

Another area within the watershed, which has experienced intensive land use, is the Chico Municipal Airport. The operation of the original airport began in 1935 with the grading of runways and by 1937 hired an airport manager to oversee the facility. At this time, the entire complex covered 160 acres. The airport quickly changed jurisdiction at the beginning of World War II in 1940 when it became an Army Basic Training School named the Chico Army Flying School. The facility quickly expanded to over 1,000 acres and included over 150 buildings and barracks, along with water and sewage facilities on site. During the height of World War II, the base housed 4,000 men and brought hundreds of additional residents to Chico (Caywood, 1971, p18). During this time, there was a housing shortage in Chico and the population continued to swell due to the influx of construction workers and families of the cadets stationed at the base. The end of 1945 officially inactivated the base. The City of Chico negotiated with the Federal Government to re-acquire the facility for use as a commercial airport. In 1948, three years after it was officially closed, the City of Chico once again assumed control of the airport (Dieter, 1963, p78).

The 1943 Basic Flight School drawings indicated that 83 underground storage tanks (UST) were installed on the base. The USTs contained aviation fuel, motor fuel, and waste oil. The Department of Defense was responsible for the clean up of these facilities. However, an inventory study prepared in 1992 under a contract with the U.S. Army Corp of Engineers revealed that twenty additional USTs had been installed at the airport since the U.S. Army's presence and therefore, clean up was the responsibility of the City of Chico (Metcalf & Eddy). Phase II Hazardous Materials Site Investigations were performed and the USTs were removed and closed. Sites that were contaminated with petroleum hydrocarbons received biovent remediation of the vadose zone soils.

Contamination of the soils at the Municipal Airport was 25-30 feet below the ground surface and therefore, could have had an adverse impact on the ground water within the watershed. However, remediation of the contaminated sites has been completed and periodic testing is ongoing.

MINING / HYDROELECTRIC

The Big Chico Creek watershed is identified with a variety of urban, agricultural and resource-based land uses that are not uncommon in other areas of the country. However, when compared to other local watersheds, such as Butte Creek and the Feather River, the Big Chico Creek watershed has been spared some of the most intensive and land form altering operations—mining and hydroelectric power generation. The development of hydroelectric power was closely associated with mining activities as much of the infrastructure required for hydraulic mining could be easily converted to hydroelectric generation. Only one significant attempt at mining in the watershed was reported at Minnehaha Mine, located upstream from Forest Ranch (see History chapter). The area around the mine was very unstable and, due to a chronic siltation problem, it was ordered to be closed in 1998 (Nopel, 1998). Consequently, there has been no hydroelectric generation on Big Chico Creek or the associated watershed.

RESIDENTIAL DEVELOPMENT

Population growth in the watershed area (mostly within the Chico community) has resulted in significant impact on local surface water resources. In the ten-year period between 1950 and 1960, Chico's population grew 21%. During the decade between 1980 and 1990, the population grew by over 50% (U.S. Census).

Mangrove Avenue of Chico, California. 1965.
Special Collections Meriam Library

In the early days of settlement, homes were built along the creek-sides and drained directly into the waterways. However, impervious surfaces were limited to the roof area of the structures. For residential properties, rooftop imperviousness has less hydrological impact than paved driveways, roads and parking lots because stormwater can be filtered through lawns and landscaping. Generally, stormwater runoff from streets and parking areas is conveyed directly into a storm drain system. (Schueler, 1994). Additionally, pollutants from vehicles, heavy metals and other toxins associated with urbanization were not a by-product of new housing in the nineteenth century. By the turn of the century, piped out-falls into the creeks accommodated the stormwater runoff. In 1929, the City of Chico built major sewer and storm drain systems to serve the growing population (Kuykendall, 1998).

As growth continued in the watershed and the mass production of automobiles made owning a car affordable for most Americans, impervious surfaces appeared. Large public expenditures were made to pave streets and new highways while property owners covered their dirt driveways and parking lots with hard surfaces (Kunstler, 1989). Runoff continued to drain into swales and waterways of the watershed, but now the stormwater introduced new pollutants and toxins into the creeks. Additionally, as the population increased and impervious surfaces covered more of the watershed, the peak flow into the creeks and tributaries was increased. The increase in peak flow advanced the likelihood of downstream flooding.

In 1991, a study funded by the City of Chico, *Technical Report, 100 Year Runoff from the Chico Urban Area* (Jones & Stokes, Inc.), revealed that Little Chico Creek within the Butte Creek Watershed was currently at capacity during peak flow. The City determined that no net increase in peak stormwater runoff could occur in Little Chico Creek or its tributary, Dead Horse Slough. Proposed development projects within this drainage basin are required to prepare stormwater runoff designs, which would result in no net increase in peak stormwater runoff (City of Chico, 1993).

In the Big Chico Creek Watershed peak runoff studies conducted for the City of Chico and Butte County determined that the attenuation of the urban peak would not reduce the total watershed peak. In fact, if urban discharge is delayed it would increase the total watershed flow. For this reason, the General Plan implementing policy, “Require no net increase in peak flows in all creeks”, has not been incorporated into City policy (City of Chico/Butte County, 1997).

During the last twenty-five years, unincorporated areas north of the City of Chico have been developed for low-density rural residential use within floodplain areas. Base Flood Elevations (BFE) established criteria for construction of these homes. BFE is the elevations of a flood having a one percent chance of being equaled or exceeded in any given year (100 year event). In 1985, due to flooding from Rock Creek, farmers in the area led the support for the formation of the Rock Creek Reclamation District. The district has taken a position to oppose additional development east of State Highway 99 unless a solution to the flooding is adopted. According to Butte County Supervisor, Mary Anne Houx, there have been four “100-year” storm events that damaged or destroyed 200 structures for a loss of $14 million in agricultural land values.

The U.S. Corps of Engineers is preparing a reconnaissance investigation to determine if a feasibility study should be undertaken to analyze the construction of a flood control project for the area. Butte County is working with the California Department of Water Resources, the State Reclamation Board and the California Department of Transportation on funding sources (Enterprise-Record, 1998).

In the *History of Butte County, Volumes I and II*, local historian Joe McGie noted several instances of drought within the watershed area. “Each instance the following year, brought floods and heavy storms.” Not unlike Marc Reisner’s “a camel with gills,” which he described as the “ideal animal" for the Los Angeles region in his book *Cadillac Desert*. This same adaptive animal might also be suitable for the Big Chico Creek watershed.

The use of septic tank leach lines for individual sanitary disposal and the use of agricultural fertilizers in the Chico Urban Area (generally, unincorporated area), prior to the mid-1980s, resulted in documented nitrate contamination of the soil and ground water. In response, the City and County adopted a "Nitrate Action Plan for the Greater Chico Urban Area" in 1985. The plan includes certain actions that must be taken by both jurisdictions for properties on individual septic systems. In addition to prohibiting new septic systems on properties smaller than one acre, a timetable for properties less than an acre for conversion to sanitary sewer was set by the California Department of Water Resources. The timetable has been extended and additional studies have been conducted since the adoption of the plan (City of Chico, 1985).

Earlier in this century when present day environmental controls were not in place, point-source contamination from dry cleaners, gasoline service stations and other land uses associated with hazardous or toxic substances occurred nationwide. The Big Chico Creek watershed also contains these uses. "Many elements, organic, inorganic, and radioactive, which were not considered harmful in the past or for which there were no standards within states, are now subject to federal regulation" (Tabers, 1979, p196). These sources of potential contamination of the watershed are reviewed on a case-by-case basis and are remediated in compliance with local, state and federal regulations.

— EXISTING LAND USES —

GIS MAP

The Land Use Map, on the following page, was created by the Geographical Information Center (GIC) at CSUC using data from local, state, and federal sources. The local data is generalized information derived from land use surveys. The land use classifications on the map often represent a range of specific uses and land use intensities. For example, the industrial class is composed of warehousing, manufacturing, and industrial uses. Because of the generalizations of map, it is recommended that the map be used for regional, as opposed to site specific, analysis.

Today, Big Chico Creek watershed has a significant segment of its land use devoted to natural resource production. An analysis conducted by the GIC indicates the amount of land devoted to forestry is 37,726 acres or 27% of the watershed. This land is located exclusively in the upper watershed where Butte and Tehama Counties are coterminous. Approximately 45,800 acres (33%) of the watershed are devoted to grazing. This land is located in the foothill zone of the watershed between elevations of 1,000 and 3,000 feet (Table 2).

Combining the agricultural-related land uses from the GIC query, dry farming, field & row crop production, miscellaneous agricultural operations, and orchards, a total of 17,234 acres of land (13%) are in agricultural use. The majority of this land is located on the valley floor west and northwest of Chico.

The urban-related land uses, residential, commercial, industrial, public, and park, compose 30,370 acres (22%) of the watershed. This land is located in the City of Chico, the unincorporated areas of Butte County in the Chico Urban Area, and in the unincorporated rural towns of Nord, Cohasset, and Forest Ranch.

Table 2. Generalized Land Uses of the Big Chico Creek Watershed.

Land Use	Acreage	% of Total
Urban		
Residential	23,086	17%
Commercial	2,159	2%
Industrial	525	<1%
Park	3,622	3%
Public	258	<1%
Agriculture-Related		
Dry Farming	2,670	2%
Field & Row Crops	2,149	2%
Misc. Agriculture	1,259	1%
Orchards	10,613	8%
Rice	6	<1%
Forestry	37,726	28%
Grazing	45,796	33%
Unknown	6,631	5%
Total	136,500*	

Source: GIC, CSUC.
*The total acreage from the land use database differs from the total watershed acreage (152,254) due to the absence of land use value for roads, rivers, and creeks.

— LAND USE REGULATIONS —

PRIVATE LAND USE: BUTTE COUNTY, TEHAMA COUNTY, CITY OF CHICO, AND CALIFORNIA DEPARTMENT OF FORESTRY

Three local jurisdictions regulate land use planning for privately owned lands in the Big Chico Creek Watershed are shown in Table 3. The local jurisdictions are Butte and Tehama County and the City of Chico. Each of these local governments has adopted comprehensive, long-term general plans for the physical development within their boundaries as required by California law. In the upper watershed where timber harvesting is the primary land use activity, several state agencies regulate prospective logging operations through the Timber Harvest Planning process.

Table 3. Jurisdictions in the Big Chico Creek Watershed.

Jurisdiction	Acreage in Watershed
Butte County	104,193
Tehama County	32,750
City of Chico	15,311
Total	152,254

Source: GIC, CSUC.

THE GENERAL PLAN

The General Plan presents a policy framework in which local agencies review proposals for developing their resources. The broad goals and policy statements contained in the plan are implemented through a series of clear statements that must be met prior to physical development of the community. Additionally, the plan contains directives for development standards and programs for financing, operating, and maintaining facilities that service existing and new development. California law provides local governments with a variety of methods to implement general plans. These implementation tools must, however, be based upon the policies contained in the plan. Implementation measures most commonly used by cities and counties include, but are not limited to, zoning and subdivision regulations, specific plans, capital improvement plans, building and housing codes, environmental impact procedures, and citizen participation in decision making.

All discretionary decisions regarding land use, resource management, development approvals, environmental impact assessment and related matters must be considered by the local public officials, elected and appointed, in the context of their current General Plan.

Butte County

The local regulatory agency, which has the largest jurisdiction in physical area in the Big Chico Creek watershed, is the County of Butte. The policy making body is the Butte County Board of Supervisors with advisory input from the Butte County Planning Commission. The current Land Use Element of the Butte County General Plan was adopted in 1979. The total land area of Butte County is approximately 1,670 square miles. 104,193 acres of the Big Chico Creek Watershed lie within Butte County boundaries.

BUTTE COUNTY GENERAL PLAN: LAND USE ELEMENT

The Butte County Land Use Element notes that Butte County is part of the Sacramento River Basin watershed and within the county, “numerous waterways (streams and rivers) flow from the western slopes of the Sierra Nevada and Cascade Ranges to the Sacramento River.” The element states, “surface water is good to excellent except for local degradation as streams pass through urbanized areas.”

As part of the adoption of the 1979 Butte County General Plan Land Use Element, an “area plan” process was envisioned which divided the county into sixteen “area plans.” The area plan concept was designed to refine the designations depicted on the countywide Land Use Plan, and to provide policy better tailored to the needs and conditions of the specific areas. With the exception of the "Special Development Standards" for the Cohasset area as contained in the Zoning Code, this has not been formally done. Three areas identified in the Land Use Element are located in the Big Chico Creek Watershed. The Butte County Master Environmental Assessment (BCMEA), 1996, summarizes the existing land uses in these three areas as follows:

> Nord: Located in the northwest corner of the county, the Nord planning area occupies over 60,000 acres, most of which is developed with agricultural uses and some industrial and residential development. The primary development constraint in the Nord area is the shallow, impervious soil east of State Route 99. Nord does not have a completed [area] plan.
>
> Forest Ranch-Cohasset: Located in the lower foothills adjacent to Chico and the mountain areas around Butte Meadows, the Forest Ranch-Cohasset planning area occupies 139,000 acres. Land use in the area is dominated by forestry, livestock, and rural residential development. Forest Ranch and Cohasset are the two small communities in the area and development is expected to concentrate in these communities particularly for commuters to Chico. Development constraints in this area include steep slopes, poor erodable soils, limited groundwater, poor access, and high to extreme fire hazard. Forest Ranch-Cohasset has the text of a plan.
>
> Chico: Located in the northern portion of the valley adjoining the foothills, the Chico planning area occupies 22,300 acres. Urban land uses with significant public and regional retail uses predominate the area. Existing policies seek to preserve agricultural land, centralize development, and steer new urban growth to the north, east, and southeast. Development constraints include agricultural lands and poor soils in the foothill area. Chico has an area plan.

The Land Use element of the Butte County General Plan also contains several policies that relate to the protection of the Big Chico Creek Watershed:

- 1.7.c Encourage development in and around existing communities with public facilities.
- 2.4.a Maintain quantity and quality of water resources adequate for all uses in the County.
- 2.4.c Control development in watershed areas to minimize erosion and water pollution.
- 5.3.d Direct future urban growth away from flood-plain areas.
- 6.4.c Encourage compatible land use patterns in scenic corridors and adjacent to scenic waterways, rivers, and creeks.
- 6.5.b Prevent development and site clearance other than bank protection of marshes and significant riparian habitats.
- 6.6.a Encourage the creation and expansion of natural and wilderness areas.
- 7.3a Limit development in areas with significant drainage and flooding problems until adequate drainage or flood control facilities are provided.

The following policies from the Land Use Element of the Butte County General Plan may be significant in future land use decisions:

- 1.4.a Based upon continuous analysis of population trends, provide plans which allow reasonable “freedom of choice” of sites and facilities for the population growth of the County, both in the County as a whole and in its various sections.

- 2.2.a Maintain extensive areas for primary use as livestock grazing land.

- 2.2.b Allow livestock grazing on all suitable sites not needed for development or crop production.

- 4.2.a Maintain economic use and value of private property.

- 2.7.a Encourage expansion, construction and efficiency of hydroelectric power plants in the county.

BUTTE COUNTY GENERAL PLAN: CONSERVATION / OPEN SPACE ELEMENTS

Most regulatory or development policy is located in the land use element of general plans. Additionally, the Open Space and Conservation Elements as set forth in the California Planning and Zoning Law (Government Code section 65000 et seq) must contain information and analysis of the community’s natural resources. Specially, the Conservation Element must address “water and its hydraulic force, forests, soils, rivers and other waters, harbors, fisheries, wildlife, minerals, and other natural resources.” Additionally, it may also cover “protection of watersheds.” The Open Space Element is mandated to address areas required for the preservation of plant and animal life. This includes habitat for fish and wildlife species; areas required for ecologic and other scientific study purposes; rivers, streams, bays and estuaries; and coastal beaches, lakeshores, banks of rivers and streams, and watershed lands.”

The Open Space Element of the Butte County General Plan was adopted in 1976 and the Conservation Element was adopted in 1971. The following recommendations in the Open Space Element have significance for the watershed:

- The County should allow urban development only in areas physically suited to such use.

- The County should not allow urban development of open space land described in this plan.

- The County should discourage urban development isolated from existing development and urban centers unless such a need can be determined.

- The County should encourage the owners of timberland to enter open space agreements.

- Studies should be conducted to determine erosional characteristics of mountain watersheds of the County.

- No urban development should be permitted on highly erodible land.

- The County should control land use and water pollution in accordance with state water quality control guidelines.

- Logging, mining, recreational vehicles and other open space uses should be regulated to prevent erosion and protect water resources.

- The County should not allow any urban development in the Butte Sink area, the marshes near the Sacramento River and the barrow area along Feather River.
- The County should permit the creation of residential parcels near large numbers of vacant sites of similar characteristics only if such a need can be demonstrated.
- The County should not allow any urban development that would increase sediment loads in prime fishing waters.
- The County should not allow urban development in designated flood plains.

The Conservation Element presents the following principles:

- That it is desirable for the County to obtain the optimum development of conservation, flood control and drainage facilities to protect the public welfare and aid in the orderly development of the County.
- That metropolitan urban areas will be developed to varying population densities and urban uses with resulting drainage variable. This urban development should be coordinated with an overall drainage and flood control development plan since there are many topographic and man-made obstructions to efficient drainage that will be limiting factors to the size of individual drainage areas. Precise plan, capacities, numbers and locations should be determined by the concerned public agencies.
- If drainage entities are defined and mapped, and storm and waste water disposal facilities precisely located in advance of anticipated construction, many projects can be timed into a single development thereby reducing the incidence of later disruption to existing facilities and consequent rebuilding.
- All storm water disposal facilities should be reviewed with the other considerations of the General Plan. This will ensure that water control sites and storm drainage lines will be adequate for planned future urban growth without the necessity of expensive enlargements or parallel facilities.

The element contains sections that relate to land use and the watershed including: flood control, water pollution, urban encroachment on soils, fisheries and wildlife, and soil erosion. Under the Urban Encroachment on Soils, Fisheries, and Wildlife section, it is stated, "the impacts of erosion, sedimentation and flooding that arise from urbanization and/or subdivision construction are, in many cases, not limited to the development sites. It is especially disconcerting that the overall effect of a development is not fully considered before the development is permitted. A significant factor of urbanization and the resulting subdivision development is the irreversible preemption of other land uses and the resulting danger of soil and vegetative related problems, wildlife habitat and waterway pollution." (Butte County, pCon8-9)

However, the element does not contain specific action programs or implementation measures. No formal plans or regulations have been adopted by the County to address stormwater run-off issues. The County does require, upon parcel map and subdivision review, that projects detain or retain peak run-off to pre-development levels or below (Edell, 1998).

BUTTE COUNTY SPECIFIC PLANS

A specific plan is a planning tool used by local governments to implement general plan policies. Specific plans offer an opportunity to combine zoning regulations, site development standards, and capital improvements into one document tailored for a particular area.

There are two county-approved specific plans located in the Big Chico Creek Watershed, the East Avenue Specific Plan and the North Chico Specific Plan.

The East Avenue Specific Plan of 1987 was not implemented as the majority of the East Avenue corridor has been designated, pre-zoned and annexed to the City of Chico.

The North Chico Specific Plan was prepared in 1993. The plan area is located north of Chico in mostly unincorporated Butte County. The 3,590-acre specific plan area is bounded by Sycamore Creek on the south, State Route 99 on the west, Rock Creek on the north and the Chico Municipal Airport on the east.

The plan sets forth a mixture of uses including residential, commercial, office and public. The majority of the plan area is designated for low-density suburban residential development (1 to 3-acre lots). Higher density residential development is planned south of Mud Creek. Approximately 3,093 housing units would be constructed at plan build-out. (Residential development potential in this area may be limited due to flooding and drainage issues, as well as airport use conflicts.)

Today, there have been a few parcel and subdivision maps approved for projects within the North Chico Specific Plan Area, though none have been built (Sanders, 1998).

BUTTE COUNTY ZONING AND SUBDIVISION REGULATIONS

The Butte County Comprehensive Zoning Ordinance contains the full range of zoning classifications similar to other county land use regulations within California. Approved in January 1995, the ordinance provides for a total of 70 districts. Many of these zoning districts have varying regulations within the same basic zoning district. For example, zoning districts A-5 and A-10 are both Agricultural zones but differ according to their minimum lot sizes, in this instance, five (5) and ten (10) acres.

The following is a list of the basic zoning districts in the County of Butte:

Agricultural Zones
Timber Mountain Zones
Foothill Recreation Zones
Agricultural-Residential Zones
Suburban Residential Zones
Residential Zones
Commercial Zones
Industrial Zones
Resource Conservation Zone
Scenic Highway Zone
Timber Reserve Zone
Public Utility District Zone
Mobile Home Park Zone
Public, Quasi-Public Zone
Unclassified Zone

The R-C Resource Conservation Zone provides for resource protection of environmentally sensitive areas and habitats such as “the preservation of water resource areas, including streams, rivers, lakes, swamps, ponds beaches, riverbanks, lakeshores and watershed areas." In addition to "natural, wilderness and study areas" and "preserves for native fish, birds and wildlife", the R-C zoning district allows, "mining and quarrying" with use permit approval. Approximately 17,025 acres within Butte County have been classified as R-C Resource Conservation (Butte County Planning Division, 1998).

The WP Watershed Protection Overlay Zone is intended to establish the boundaries of a watershed by utilizing an overlay zone that is combined with the base zoning classification. The following purposes are listed for the WP zoning district:

1. To protect the County's surface and ground water resources.

2. To reduce future governmental costs by preserving public water supplies.

3. To recognize the essentially public nature of the land and water resources of a watershed, and that their continued vitality is directly related to the social and economic welfare of the County and its communities.

4. To protect the public health, safety and welfare by requiring such additional restrictions upon the use of the land as are necessary to retain the natural balance and integrity of a watershed.

5. To recognize the uniqueness of each watershed by basing the selection of the most effective measures for their protection upon an evaluation of the soils, climatic conditions, topography, vegetation, drainage patterns, and any other specific conditions unique to the watershed.

6. To allow the County or its citizenry to identify watersheds where a natural or man-made imbalance in the environmental system occurs and provide a means for repairing or restoring the natural functions of these watersheds.

Only one area has the WP Watershed Protection Overlay Zone within Butte County. This overlay area, 11.2 square miles in the upper Butte Creek watershed, was established to protect the water quality of the Paradise Reservoir, Magalia Reservoir, and Firhaven Creek.

A similar zoning amendment was proposed for the Butte Creek Canyon which would have specified development standards as far as 300 feet from the top of the bank of Butte Creek and created a "No Development Zone" within 100 feet from the creek. The County Planning Commission rejected the zoning amendment (Butte Creek watershed, 1998, p116).

Appendix E of the zoning regulations contains "Development Policies for the Cohasset Area." Specific regulations regarding the protection of surface and ground water are included within this section. The section also includes environmental policies to ensure that erosion does not occur with new development by encouraging construction in areas which have less than 15% slope, and limiting grading and vegetation removal.

Within the county zoning regulations, there are no specific building setback requirements for parcels adjacent to creeks. Additionally, there are no creek-side development standards within the county zoning regulations. Special building setbacks from watercourses are applied in response to environmental analysis during review of a land division by the Butte County Development Review Committee (Parilo, 1999).

The Butte County Subdivision Ordinance was adopted on March 14, 1995. The California Subdivision Map Act (California Government Code, Section 66410 et seq) provides local jurisdictions with the authority to require public land dedication or reservation and/or access to public lands as conditions of land division approval. Butte County subdivision regulations do not include requirements for dedication (either in fee or by easement) for creek-side areas; however, the Advisory Agency may require designation of "no-building areas" or of building setbacks more restrictive than those required by the subdivision regulations. This section allows the county to require additional setback when "structural development would damage or destroy water resources, historical and archaeological sites, rare plant and animal habitats, unique geologic features, or similar environmental resources." (County of Butte, 1995, p44).

Through the environmental review and subdivision approval processes, the county may require specific setbacks from waterways and sensitive riparian habitat. The County is beginning to implement Best Management Practices or BMP's in the review process on larger projects; however, it is not an established procedure of the County. (Betts, 1998).

— OTHER REPORTS —

REPORT OF THE BUTTE COUNTY DEER HERD STUDY

A significant land use constraint in the eastern foothill/mountains of Butte County is the presence of migratory deer herds. In order to protect the deer ranges from subdivision encroachment a study was conducted by a committee appointed by the Board of Supervisors known as the "Deer Herd Study Panel."

The panel developed a series of overlay constraint maps identifying various facets of the migratory deer issues.

CITY OF CHICO

The City of Chico holds regulatory authority over 80,000 acres within the watershed.

The City of Chico is Butte County's largest urban community. The City grew rapidly during the 1960s and the first half of the 1970's mostly due to increased student enrollment at California State University, Chico. Later, during the period between 1985 and 1995, population increased rapidly through new migration and annexation. According to the City of Chico Planning Division, the City's population as of January 1, 1997 was 50,116. The total population for the Chico urban area was 92,500.

Prime agriculture soils are found on the West Side of the city. In the unincorporated portion of the Chico Urban Area, the predominant land use on the valley floor is agriculture production of a variety of crops. Generally, soils to the east of the city are suitable only for grazing. In the foothill areas, the predominant uses are low-density housing, marginal agricultural activity, and recreation/open space.

CITY OF CHICO GENERAL PLAN

The City of Chico adopted an updated and revised General Plan on November 16, 1994. The following policies are found in the "Guiding Policies: Growth and Physical Expansion" chapter of the Chico General Plan:

> Promote orderly and balanced growth by working with the County and LAFCO to establish long-term growth boundaries for the Planning Area consistent with Plan objectives.

- Promote in-fill development
- Ensure that new development is at an intensity to ensure a long-term compact urban form.
- Maintain long-term boundaries between urban and agricultural use in the west, and urban uses and the hillside in the east, and limit expansion north and south to maintain compact urban form. Multiple approaches to restrict urbanization outside the City's sphere of influence will be used, including large-lot zoning, and possibly acquisition of land for a greenbelt.

The City of Chico General Plan has numerous goals, guiding policies and implementation programs that may pertain to the protection of the Big Chico Creek Watershed.

The Community Design Element has recently been deleted as a separate element of the Chico General Plan; however the policies within the element will be retained elsewhere in the plan; therefore the reference numbers noted below will change when the amendment has been completed.

(Please note that initials identify the element (i.e.: CD - Community Design). Goals are noted as "G", policies as "P" and program implementation as "I" followed by the specific goal, policy or implementation number.)

<u>Community Design (CD)</u>

- CD-G-10 Heighten the visual prominence of the creek corridors that help to establish a sense of orientation and identity within the City.
- CD-G-11 Open up creeks to public view and access.
- CD-G-12 Extend the amenity value of creeks.
- CD-G-12 Within the developed core of the city, diminish the barrier effect of the creeks.
- CD-I-6 Adopt design guidelines for development adjacent to creeks.

<u>Parks and Public Facilities and Services</u>

- Use the creeks as a framework to provide a network of open space.

Open Space (OS) and Environmental Conservation

- OS-G-5 Protect habitats that are sensitive, rare, declining, unique, or represent valuable biological resources in the Planning Area. These include Resource Conservation and Resource Management areas identified in Figure 7-1.

- OS-G-7 Minimize impacts to sensitive natural habitats throughout the Planning Area.

- OS-G-8 Preserve and protect areas determined to function as regional wildlife corridors, particularly those areas that provide natural connections permitting wildlife movements between sensitive habitats and areas being considered for future conservation because of their high value.

- OS-G-9 Provide for no net loss of overall wetland acreage; where such losses may be unavoidable at the project level, require mitigation that meets the no net loss goal.

· OS-I-15 Protect and preserve areas identified for Resource Conservation in Figure 7-1, and amend the Zoning Ordinance to include a Resource Conservation zoning district and habitat protection standards, particularly buffering, for sites abutting Resource Conservation Areas. [There are several implementation policies that apply to Resource Conservation Areas and Resource Management Areas. These designated areas on the Chico General Plan Land Use Diagram are generally located adjacent to creeks and the associated riparian habitat area or where known wetlands and/or special status species are present.]

- OS-I-18 Explore and implement, where feasible, linking Resource Conservation Areas with interconnecting open space corridors, particularly those which provide access to water sources and enhance overall biological diversity of the resource area.

- OS-I-20 Explore and implement, where feasible, means to minimize or avoid interference with sensitive wildlife on the urban fringe by domestic pets.

- OS-I-21 Ensure that all new developments restrict the use of fencing in locations essential for wildlife movement and place structures so as to minimize interference with wildlife corridors.

- OS-I-22 Ensure that open space corridors along creeks include protective buffers (non-development setbacks) preserve existing riparian vegetation through the environmental review process, and continue to require a minimum of 25-foot dedication and acquisition of 75 feet for a total of 100-foot setback from top-of-bank along creeks.

- OS-I-35 Work with the California Department of Fish and Game to ensure the preservation and enhancement of species of residents and anadromous fish in creeks in the Planning Area.

Water Quality

- OS-G10 Enhance the quality of surface water resources of the Planning Area and prevent their contamination.

- OS-G-11 Comply with the Regional Water Quality Control Board's regulations and standards to maintain and improve groundwater quality.

- OS-G-12 Where feasible, given flood control requirements, maintain the natural condition of waterways and flood plains and protect watersheds to ensure adequate groundwater recharge and water quality.

- OS-I-36 Continue to work with the Central Valley Regional Water Quality Control Board and Butte County Environmental Health Department in the implementation of the Nitrate Action Plan and land use controls for the protection of groundwater quality and the foothill primary recharge area.

- OS-G-15 Preserve and enhance Chico's creeks and the riparian corridors adjacent to them as open space corridors for the visual amenity, drainage, fisheries, wildlife, habitats, flood control and water quality value.

<u>Open Space</u>

- Maintain hillsides and viable agricultural lands as open space for resource conservation and preservation of views.

- OS-G-16 Where feasible, integrate creek-side greenways with the City's open space system and encourage public access to creek corridors.
- OS-G-17 Protect aquifer recharge areas needed to maintain adequate groundwater supplies.

- OS-G-18 Maintain oak woodlands and habitat for sensitive biological resources as open space for resource conservation/resource management.

<u>Transportation (T) (reduction of impervious surfaces)</u>

- T-I-32 Adopt street standards that provide flexibility in design, especially in residential neighborhoods. Revise right-of-way and pavement standards to reflect adjacent land use and/or anticipated traffic, and permit reduced right-of-way dimensions where necessary to maintain neighborhood character.

- T-I-45 Reduce the overall amount of land devoted to parking by encouraging shared parking and examining reduction of parking requirements that apply to individual uses for mixed-use developments.

- T-I-52 Investigate opportunities for shared parking facilities whenever possible to reduce the number of new parking stalls required.

<u>Safety and Safety Services (S) - Flooding and Dam Inundation</u>

- S-G-1 Minimize threat to life and property from flooding and dam inundation.

- S-I-1 As part of project review, ensure that structures subject to the 100-year flood provide adequate protection from flood hazards.

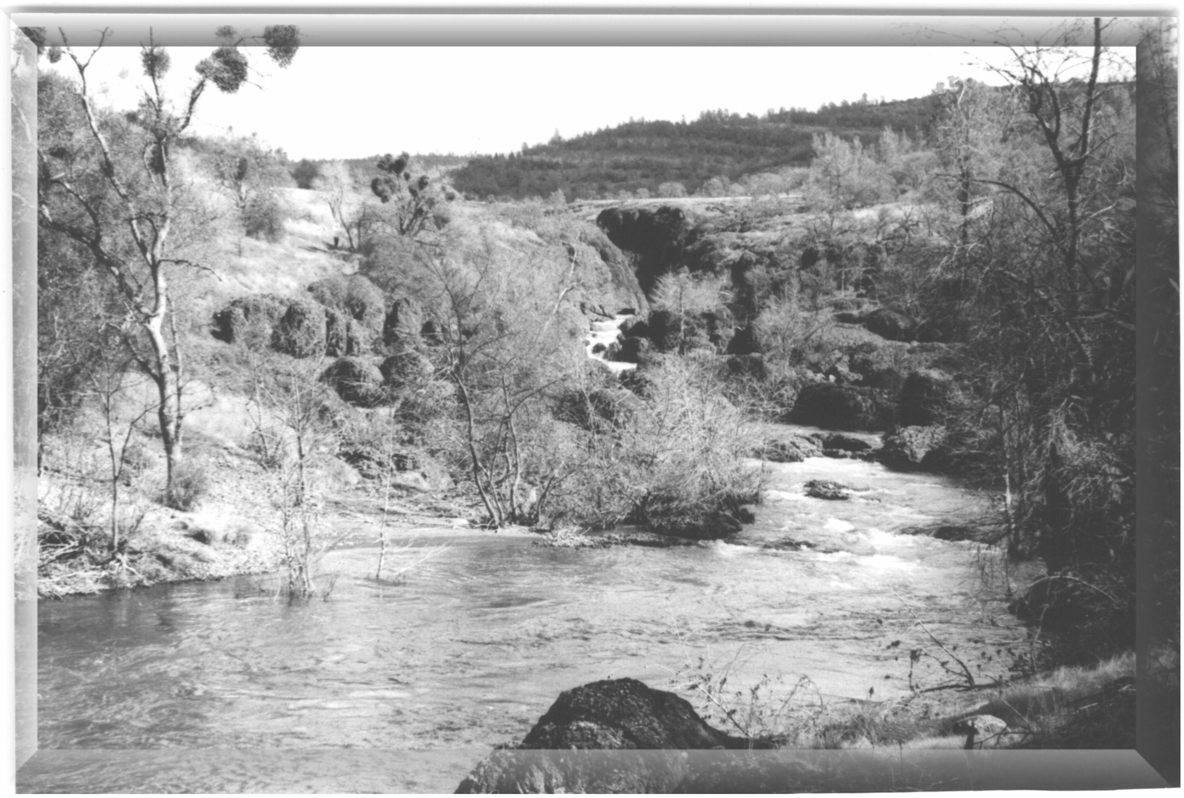
- When considering areas for future urban expansion ensure that impacts for flooding are adequately analyzed.

- In designing flood control facilities, consider the need to protect anadromous fisheries and allow for adequate water passage to ensure the survival of downstream riparian ecosystems.

ZONING AND SUBDIVISION REGULATION

The City of Chico's zoning ordinance (Title 19 Land Use Regulations) establishes creek-side setbacks for the following waterways within the Big Chico Creek Watershed:

- Sycamore Creek
- Lindo Channel
- Big Chico Creek
- Little Chico Creek



Scenic creekside view of Big Chico Creek.
By: Pam Figge

The minimum creek-side setback required in all zoning districts is 25 feet from the top of bank. The top of bank is defined as "the upper elevation of land, having a slope not exceeding ten percent (10%), which confines to the channel waters flowing in a watercourse in their normal course of winter flow." The setback area shall remain in non-developed open space. Buildings, parking spaces, swimming pools, access drives and accessory building are prohibited within the creek-side setback area (City of Chico, 19.26.120). For development projects adjacent to the aforementioned waterways and for which discretionary approval such as a use permit or land division is required, the City can require the 25- foot creek-side setback be dedicated to the City.

The City may acquire additional creek-side area up to 100 feet or more if riparian habitat is beyond the 25-feet and/or recreational use is appropriate such as the provision of bicycle and pedestrian facilitation.

The City is currently in the process of updating and revising the zoning ordinance to bring the document into full consistency with the General Plan. The creek-side setback regulations have been expanded to require a streambed analysis (City of Chico).

The City of Chico subdivision ordinance (Title 18 Subdivisions and 18R Subdivision Design and Improvement Standards) provides for the dedication of land for riparian habitat (Chapter 18.32). This chapter sets forth the purpose of the dedication as "the preservation and/or propagation of riparian habitats within and along the banks of the watercourses." Several findings regarding the value of riparian habitats and need for dedication of land adjoining designated watercourses are stated within the chapter.

The City of Chico has been requiring a 100-foot dedication/setback on all new subdivisions where corridors of creek-side greenways can be linked for public access. Additionally, the City has purchased older properties along creek-sides in the developed sections of town as they have become available. Most of these properties are located along Little Chico and Big Chico Creeks. According to current City Council policy, purchasing properties adjacent to the creeks will eventually result in public access along extended lengths of creek-side greenways (Enterprise Record, October 8, 1998). However, the City has not adopted a master plan to designate which greenways will have public access or describe what improvements if any will be constructed along the creek-sides. The City of Chico adopted a Master Bicycle Plan in 1995, which does include several paths along Little Chico Creek, the Diversion Channel and Big Chico Creek. The jurisdiction of Lindo Channel was recently transferred from Butte County to the City of Chico. The Chico Area Recreation District Comprehensive Park and Recreation Plan identifies Lindo Channel as a recommended lineal park (See Recreation Chapter).

Lindo Channel is presently the subject of debate within the City of Chico Council Chambers. At issue are complaints of encroachment by adjacent property owners, creek-side stabilization, and public access concerns. The Bidwell Park and Playground Commission has the authority to determine uses within public creek-side greenways and is vested with the supervision, control and management of all public parks and playgrounds within the City (Chico Municipal Code 12.04.030), however, the City Council ultimately has authority to review and rescind decisions made by the Commission. The Park Commission has developed bank stabilization standards for lands under their jurisdiction. The Parks Commission also has a draft vegetation management plan for Lindo Channel, which cannot be completed until further hydrologic studies are produced.

BEST MANAGEMENT PRACTICES

The City of Chico has produced a "Best Management Practices Manual" and "Best Practices Technical Manual" as recommended in the Chico General Plan. Known collectively as the "BPM", this manual contains design and construction information that help minimize adverse impacts to the natural environment and community resulting from development. The BMP was recently updated to include new information and changes (City of Chico, October 1998). The document contains City regulations, policies, programs and measures for "project design and/or development to avoid or minimize impact to natural resources."

The document includes several design recommendations and environmental mitigation actions pertaining to wetland preservation, creek-side greenways, water conservation, stormwater management (quantity and quality), groundwater quality and other areas of environmental concern. The BMP also includes documents and guidelines from other jurisdictional agencies that the city uses in project review.

STATE HIGHWAY 32 BYPASS STATUS

The City of Chico and the California Department of Transportation (CalTrans) are presently discussing the construction of a new State Route 32 through Chico. Presently, State Highway 32 passes south of downtown on 8th and 9th Streets. A new bypass is planned that would traverse the north side of Chico to allow a more direct route through the City. In addition to the construction impacts of highway development, such as erosion and sedimentation, the highway has the potential to contribute materials from automotive exhaust, oils and grease from car and truck engines, and heavy metals from worn tires, engine parts, and brake linings into both the air and water. The new highway construction may ultimately contribute to the urban expansion of north Chico as highway development tends to spur urban/suburban expansion (York and Speakman, 1980, p6-46).

The route for the new bypass has been determined. Currently, the City and Caltrans are discussing the specific design and maintenance requirements for the new by-pass (Meyers, 1998).

TIMBER HARVEST PLANS

The Timber Harvest Plan (THP) allows a critical review of prospective logging operations by the California Department of Forestry and Fire Protection (CDF), the Department of Fish and Game (DFG), the Division of Mines and Geology, the Department of Parks and Recreation and the Regional Water Quality Control Board. The THP is equivalent to a streamlined Environmental Impact Report (EIR).

Before any harvesting occurs, a THP musty be prepared by a registered professional forester, and submitted to CDF. CDF has 45 days once the plan is filed to convene a review team, analyze the plan for conformance with the State's objectives and approve or reject the plan (Little Hoover Institute, 1994). THP review teams consist of representatives of the following agencies: Department of Fish and Game, the Regional Water Quality Board, a county representative if requested by the county, CDF, and a representative of the Department of Parks and Recreation if the plan affects publicly owned parks.

THP's are prepared in accordance to the *California Forest Practice Rules*, a compilation of Title 14, California Code of Regulations Chapter 4 and 4.5. Plans include information about the silviculture method, the existing condition of the forest, and the proposed timber operation.

— PUBLIC LAND MANAGEMENT —

Government land in the watershed amounts to approximately 5,280 acres or 4% of the area. Federal land is managed by the United States Forest Service, located in the Lassen National Forest in the upper watershed; and the Bureau of Land Management, whose scattered parcels are located mostly in the middle section of the watershed. The State of California controls the rivers of the watershed as well as several other land holdings in the watershed, including CSUC.

UNITED STATES FOREST SERVICE (USFS)

The Lassen Land and Resource Management Plan (LMRP) provides direction for planning and conducting resource management activities on National Forest land, including those public lands within the Big Chico Creek Watershed, which are managed by the USFS. The USFS has the authority to dictate land use activities for the Forestlands that are consistent with the Forest Plan. The LRMP was formally adopted in 1993 after several years of data gathering and public input.

USFS MANAGEMENT AREA(S)

Several small sections of the Big Chico Creek Watershed are within the boundaries of Lassen National Forest. They are Lomo, Jonesville, and Lower Deer Creek Management areas. Each management area provides specific management prescriptions for each acre. Please see the LMRP for specific planning prescriptions for land in the Big Chico Creek Watershed.

In general, the Lassen National Forestland within the Big Chico Creek Watershed consists of scattered and remote parcels. There is a “dispersed” campground at Soda Springs that due to budget constraints is now closed. Due to the size and location of the land within the watershed, there is little timber use or grazing. All the remote, non-contiguous, parcels of the Lassen National Forest are available for exchange with interested parties (approximately 2,140 acres or about 1.5%) (Charlton, 1998).

BUREAU OF LAND MANAGEMENT

The Bureau of Land Management owns and manages various small land holdings throughout the Big Chico Creek Watershed. The Watershed lies in the Ishi Management Area of the Redding Resource Area. The Redding Resource Management Plan (RMP) guides the Bureau of Land Management (BLM) in managing its public land and mineral reserve estate within the Redding Resource Area of Northern California.

It is a goal of the BLM, stated in the RMP, to sell their scattered sites while retaining and acquiring land in specific areas with high recreational value. The Big Chico Creek Watershed has no land designated for acquisition or retainment. The numerous scattered BLM sites throughout the Watershed are all for the most part available for purchase or exchange with interested parties.

The following “Resource Condition Objectives” are identified in the RMP and are relevant to the Big Chico Creek watershed:

> I.D.1. Minnehaha Mine: Stabilize the ongoing erosion due to past mining practices.

I.D.2. Minnehaha Mine: Enhance water quality of Big Chico Creek.

I.D.3. Minnehaha Mine: Enhance the safety of human users of this area.

I.G.1. Remainder of Management Area: Enhance the resource management efficiency and public service mission of local, state, and federal agencies via transfer of specific public lands from BLM.

G.2. Remainder of Management Area: Enhance the ability to acquire high value resource lands within the Redding Resource Area by disposal of scattered public land interests within the Ishi management area.

The following "Land Use Allocations" are identified in The RMP and are relevant to the Big Chico Creek Watershed:

II.D.1 Minnehaha Mine: Withdraw from mineral entry.

II.D.2. Minnehaha Mine: Public land is available for transfer to the State of California or local government via the Recreation and Public Purpose Act (R&PP) or exchange.

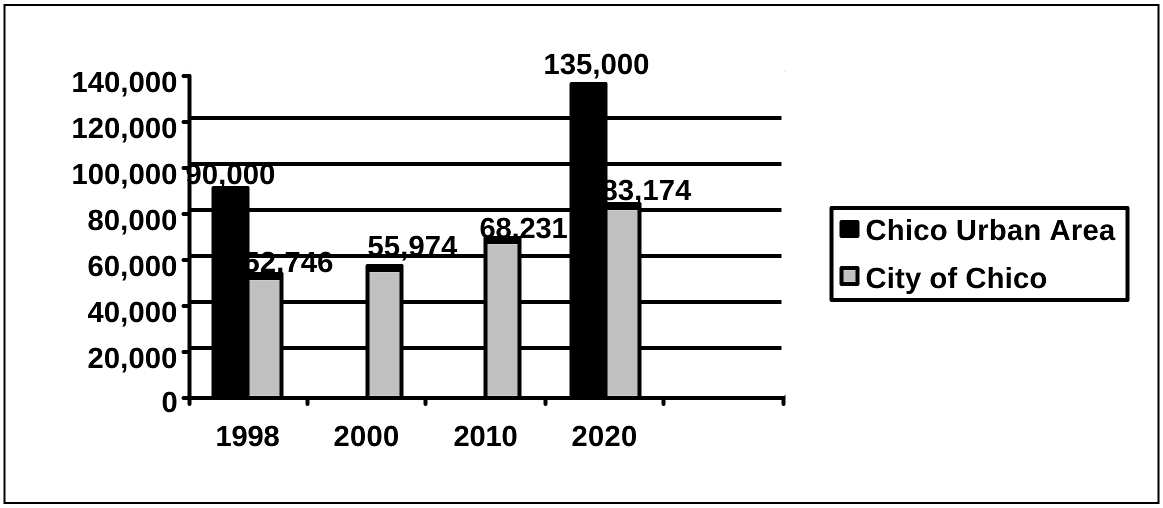
II.G.3 Remainder of Management Area: Transfer via exchange or R&PP to the City of Chico, the County of Butte or other qualified organization title to seven parcels of public land in Big Chico Creek Canyon (between Highway 32 and Musty Buck Ridge) encompassing approximately 520 acres. Within two years from approval of the Final RMP, the government entities or organizations mentioned above will be given an opportunity to submit R&PP applications for specific parcels prior to the land being offered for exchange. Offer for exchange to any party after two years from approval of the final RMP. If Big Chico Creek is not designated as a component of the National Wild and Scenic River System, an additional five parcels and 520 acres would be available for exchange and R&PP under the above conditions.

II.G.3 Remainder of Management Area: All public land interests not noted above in II A-H (1-10) are available for exchange.

— PROJECTED LAND USES AND ZONING —

GROWTH PROJECTIONS

City of Chico and Chico Urban Area Growth Projection



Source: BCAG (City of Chico), Chico MEA from Department of Finance (Chico Urban Area)

IMPACTS OF EXISTING AND PROJECTED LAND USES

As the Chico Area grows and consequently urbanizes, there are several potential impacts that need to be addressed to protect the water resources of the Big Chico Creek Watershed. Land use changes, shifts from one type to another, and changes in intensification, have the potential for water resource degradation. Much of these impacts have been found to be related to the amount of impervious surface added to the natural landscape.

As urbanization occurs, the percentage of the land covered by impervious surfaces increases. Impervious surfaces are defined as any material that prevents the infiltration of water into the soil such as rooftops, roads, and parking lots. Impervious surfaces are both an indicator of urbanization and a major contributor to the environmental impacts of urbanization.

"Although impervious surfaces do not generate pollution, they: (1) are a critical contributor to the hydrologic changes that degrade waterways; (2) are a major component of the intensive land uses that do generate pollution; (3) prevent natural pollutant processing in the soil by preventing percolation; and (4) serve as an efficient conveyance system transporting pollutants into the waterway." (Arnold, 1996, p3-4) Research over the last fifteen years indicates that imperviousness is also a useful indicator to measure the impacts of land development.

URBANIZATION AND IMPERVIOUS SURFACES

One result of land development is an increase in impervious surfaces. These surfaces come in the form of rooftops, roads, parking lots, sidewalks, and compacted soils. "Roofs and roads have been around a long time, but the ubiquitous and impervious pavement we take for granted today is a relatively recent phenomenon. A nationwide road census showed that in 1904, 93 percent of the roads in America were unpaved" (Arnold, 1996, p2). While imperviousness is often synonymous with human presence and population growth, some urban populations have been experiencing a paving explosion without the corresponding population growth. In the Philadelphia metropolitan area for example, total developed acreage increased by 20% in the 1980s while population remained virtually constant (Cahill, 1994, p77).

HOW URBANIZATION AFFECTS RUNOFF

Urbanization affects water resources in two major ways: through increased runoff and increased pollutant loads.

Increased runoff is caused by impervious ground cover described above. Impervious surfaces such as bridges, parking lots, and buildings prevent runoff from slowly percolating into the ground. Instead, water remains above the surface, accumulates, and runs off in large amounts. A typical city block generates 9 times more runoff than a woodland area of the same size (EPA no. 7).

This increased runoff results in increased stormwater discharges. "Even with careful design, the use of detention basins for stormwater management, which only control the peak rates of stormwater discharge site-by-site, increase the total volume of stormwater discharged." (Cahill, 1994, p78) In addition to adding to the threat of flooding, increased runoff aggravates stream bank and channel erosion, damaging streamside vegetation and widening stream channels (Cahill)(EPA no.7). The change in stream morphology causes a substantial loss of in-stream habitat as the varied natural streambed of pebbles, rock ledges, and deep pools is covered by a uniform blanket of eroded sand and silt (Schueler, 1992). Engineered responses to flooding such as stream diversion, channelization, damming, and piping further destroys streambeds and related habitats like ponds and wetlands. Native fish cannot survive in urban streams severely impacted by urban runoff.

Increased runoff also impacts the other side of the natural hydrologic system. By preventing percolation, impervious surfaces significantly reduce groundwater infiltration and aquifer recharge. "Reduced recharge, by definition, results in lowering the water table with a corresponding reduction in stream base flow—the life of the stream for most of the year. As base flow decreases during dry periods, crucial first-order tributaries literally dry up, with drastic ecological consequences." (Cahill) This process also impacts shallow wells and springs.

Urbanization also increases the pollutant loads to receiving waters. Water runoff efficiently conveyed by paved, impervious surfaces, carries significant pollution including hydrocarbons, metals, other toxins, BOD/COD, and others. These pollutants are generated from new construction, automobile use, landscaping, sewer systems, and other urban land uses. This non-point source pollution is regarded as the nation's leading threat to water quality (EPA, 1994).

IMPERVIOUS SURFACES AS A WATER QUALITY INDICATOR

Imperviousness has become a very useful indicator to measure the impacts of land development on water resources (Schueler, 1994, p100). In studying imperviousness, scientists total the measurements of roads, parking lots, sidewalks, rooftops, and other impermeable surfaces. The result is a measurement of an area that is not "green". Schueler concludes, "[research] has yielded a surprisingly similar conclusion—stream degradation occurs at relatively low levels of imperviousness (10-20%)" (Schueler, 1994, p100).

Schueler goes on to propose thresholds to classify potential stream quality in an urban watershed:

- Stressed Streams (1 to 10% impervious cover)
- Impacted streams (11 to 25% impervious cover)
- Degraded streams (26 to 100% impervious cover)

LAND USE AND IMPERVIOUS SURFACES

The amount of land covered by impervious surfaces varies significantly with land use. Generalizations can be made about land uses and their corresponding impervious cover. A 1975 Soil Conservation Service study identifies strip commercial as the most impervious land use with 95% coverage, with other businesses and industrial development slightly less; commercial at 85%, and industrial at 75% coverage. Residential coverage ranges from 20% on one-acre lots to 65% on 1/8-acre lots.

The City of Olympia conducted a thorough study finding that low-density residential development (3-7 units/acre) covers 40% of the land, multi-family residential development (7-30 units/acre) covers 48%, and commercial /industrial sites average 86% (City of Olympia, 1995) (Arnold, 1996).

Land use studies have also concluded that not all-impervious coverage contributes equally to the pollution load. "Pollutant or land-use-specific studies are relatively new to the scientific community, but existing information supports the common sense assumption that some land uses are more contaminating than others; for instance, runoff from gasoline stations contains extremely high levels of hydrocarbons and heavy metals." (Arnold, 1996)

A study of specific types of impervious surfaces was conducted by Bannerman et al. (Bannerman, 1993.) The study concludes that streets contribute the greatest amount of pollutant loads in most of the land uses. Roofs were generally low in pollutant loads except for zinc from industrial roofs. Parking lots showed moderate levels of pollutants. The study included one unpaved surface, residential lawns, which showed high levels of phosphorus (see Table 4).

In addition to the impacts associated with urbanization, there are several other land uses that have potential to degrade the environment. Impacts from these usually "non-urban" land uses include agriculture, forestry, and recreation.

AGRICULTURE

Agricultural non-point source pollution is the leading source of water quality impacts to surveyed rivers and lakes (EPA, 1996, p004F). Agricultural activities that contribute to non-point source pollution include confined animal facilities, grazing, plowing, pesticide spraying, irrigation, fertilization, planting, and harvesting. Major pollutants from these activities include sediment, nutrients, pathogens, pesticides, and salts.

Sedimentation occurs when wind or water runoff carries soil particles from farms or fields to a water body. Sedimentation clouds water, reducing the amount of sunlight reaching aquatic plants, and covering fish spawning areas. Other pollutants such as phosphorus, pathogens, and heavy metals also attach to sediments compounding the impacts (EPA, 1996, p004F).

Nutrients applied in agricultural production such as phosphorous, nitrogen, potassium, manure, sludge, legumes, and crop residues are washed into receiving waters when they are applied excessively. These nutrients can cause extravagant plant growth, create a foul taste in drinking water, and kill fish. Poorly managed confined animal facilities likewise contribute nutrients to receiving waters. These facilities also can contribute pathogens like bacteria and viruses to water resources.

Pesticides, herbicides, and fungicides can contaminate water through direct contact, runoff, wind transport, and atmospheric deposition. These chemicals can kill fish and wildlife, poison food sources, and destroy habitat (EPA, 1996, p004F).

Livestock overgrazing exposes soils, increases erosion, encourages invasion by undesirable plants, destroys fish habitat, and reduces natural filtration.

FORESTRY

Non-point source pollution from forestry includes activities such as removal of streamside vegetation, road construction and use, timber harvesting, and mechanical preparation of planting of trees. Of these activities road construction and use are the primary source of pollution, contributing up to 90 percent of the total sediment from forestry activities (EPA, 1996, p004H). Harvesting trees in the area adjacent to streams has the potential to reduce stream shading that regulates water temperature and removes vegetation that stabilizes the stream banks. These changes harm aquatic life that depends on cool, shaded water for survival.

As previously mentioned, 28% of the Big Chico Creek Watershed is timberlands. Private timberlands are regulated by the CDF through the Timber Harvest Plan process. Intensive logging activities are located primarily in the flatter terrain of the Big Chico Creek Watershed, such as Cohasset Ridge area where access and soils permit. In the main drainage of Big Chico Creek the steep terrain of the canyon limits logging activities.

RECREATION

Recreational land uses have the potential to impact water resources through the activities and number of the users, and type of land cover. Active recreation such as swimming, field recreation, golf, and biking usually require various degrees of land development. In addition to the site-specific impacts associated with construction such as sedimentation, the resulting landscaping often has the potential to convey pollutants. Altered landscapes in recreational facilities like parks and golf courses can contribute phosphorous and pesticides used in maintenance. Incorrectly functioning sewer systems found in remote recreational locations also can contribute to water degradation. As described previously, bridges, roads, and other structures associated with developed recreational land uses prevent percolation and increase runoff. For more information on the recreational activities associated with the Big Chico watershed as well as specific sources that investigate known recreational impacts, please see the Recreation chapter.

IMPLICATIONS FOR THE BIG CHICO CREEK WATERSHED

Land use activities have direct impacts on water resources both through pollution and increased runoff. There is a clear correlation between the degree of urbanization- land uses such as relatively dense residential, commercial, and industrial- and the degradation of water resources (Schueler, 1994). The common factor in these land uses is their degree of imperviousness. While not pollution in itself, impervious surfaces affect the natural hydrologic cycle and efficiently convey pollutants.

Fortunately, the degree of imperviousness is identifiable and possibly manageable on a watershed basis and definitely manageable on a neighborhood and site planning level. (see Table 5)

Presently the City of Chico requires new development construction and design to adhere to the "Best Management Practices Manual" (BMP) as recommended in the Chico General Plan. This manual contains design and construction information that helps minimize adverse impacts to the natural environment and community resulting from development. The document includes several design recommendations and environmental mitigation pertaining to wetland preservation, creek-side greenways, water conservation, stormwater management (quantity and quality), groundwater quality and other areas of environmental concern. The County of Butte has recently begun administering BMP's on larger projects, though this is not a formalized process.

Much of the current planning regulations in Chico and Butte County are still based upon the impacts of population growth. Residential development is limited by considering population densities, dwelling units, or other factors. Perhaps a better analysis would be to use a watershed approach where sensitive streams are identified, future growth is considered, and then specific policies regarding impervious surface limits, BMPs, and buffers are instituted. The City of Olympia, Washington has been a leader in municipal watershed planning, beginning in 1994 with their study "The Impervious Surface Reduction Study" (ISRS). This study and the ISRS Final Report (1995) conclude that a 20% reduction in impervious cover is a feasible and practical goal.
Table 5. Twenty-eight strategies to minimize impervious area at the site level.
Table 5. Imperviousness manageability.

1. Narrower residential roads	17. Open space requirements (residential)
2. Reduced road lengths	18. Open space landscaping requirements (commercial)
3. Hourglass streets	19. Sidewalks only on one-side of streets
4. Cluster development	20. Reduced side and rear yard setbacks
5. Shared driveways	21. Decrease distance between lots
6. Angled parking with one-way traffic flow	
7. Smaller parking stalls	
8. Reduced parking stalls	

9. Shared parking facilities in commercial areas	(frontage)
10. Shorter residential driveways	22. Hammerhead-shaped turnarounds
11. Reduced cul-de-sac radii	23. Rear yard grading to buffer
12. Cul-de-sac donuts	24. Permeable spillover parking areas
13. Vertical parking structures	25. Decrease distance between lots (frontage)
14. Two and three story buildings	26. Hammerhead-shaped turnarounds
15. Stream buffers	27. Rear yard grading to buffer
16. Grass swales rather than curbs/ gutters	28. Permeable spillover parking areas

Source: City of Olympia, 1994

The ISRS recommends a 10 to 20% reduction in impervious surfaces using site specific strategies, growth management policies that encourage in-fill and reduce urban sprawl, and transportation improvements that reduce the need for streets and parking. Many of the recommendations suggested in the report have potential benefits that go beyond simply protecting water resources. For example, the recommendation "to encourage joint parking, shared and coordinated parking" has the potential to be more cost efficient for business owners, reduce the heat that trapped by asphalt, and provide a more pedestrian-friendly business district.

The Chico General Plan contains several policies that likewise encourage in-fill development, as well as other strategies to provide a compact urban form. These policies range from supporting alternative modes of transportation to maintaining the downtown's vitality. The land use element proposes to achieve this compact form through development of neighborhood centers or villages, which are accessible by walking and provide a wide-range of housing choices. The element suggests higher density housing to be in the neighborhood centers with a mix of densities ranging from 12-15 units per acre to be located adjacent to the centers (City of Chico, 1994, p3-26). This urban strategy to accommodate growth has merit, however, it may have further impact to local water resources.

This paradoxical situation may be the most crucial one facing stakeholders in the Big Chico Creek Watershed. On one hand, urbanization and additional impervious surface is known to impact water resources, especially when imperviousness reaches more than 26%. The solution would appear to be to limit or restrict high-density development in the watershed. On the other hand, this approach would spread the effects of urban or suburban development, which includes roads, to a much broader geographic area. To use an example from the information cited previously, a one-acre residence covers 20% of the land, while an 1/8 acre home site covers 65%. Using rough estimates of these assumptions, a home on one acre has nearly 2 ½ times the impervious surface coverage impacts as a home does on an 1/8-acre site (assuming eight homes are built on the one-acre lot.)

A report conducted by the Charleston Harbor Project entitled the Belle Hall Plantation Charrette, examines tradeoffs between various types of development in South Carolina. The study evaluates three different growth scenarios: undeveloped, town development, and sprawl development using GIS modeling. The sprawl growth scenario was developed using nearby examples - single family, low-density detached homes including a large commercial area. The town was modeled after traditional towns such as Charleston, South Carolina and Savannah, Georgia with higher density housing, mixed-use commercial areas, and narrower streets. The study concluded that the sprawl scenario created runoff flows with eight times greater runoff than the undeveloped watershed and was 43% higher than the town scenario. The sprawl development also has three times greater sediment loads than the town scenario (Charleston Harbor Project, 1994 p1-12).

If past growth trends continue, (especially if the population boom in California is realized) urbanization will continue to impact the water resources in the Big Chico Creek Watershed. The key question is how can we accommodate growth while protecting the watershed's high quality of life and natural environment? Serious scrutiny will need to be directed toward land use policies in all jurisdictions, from general plan policy to zoning and enforcement.

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ANALYSIS OF
SPAWNING GRAVEL AVAILABILITY

—— INTRODUCTION ——

This purpose of this chapter is to address the long-term goal of stabilizing and enhancing the viability of the spawning habitat for spring and fall run salmon and steelhead trout in Big Chico Creek and Lindo Channel, specifically with respect to gravel beds suitable for spawning.

—— BIG CHICO CREEK'S MANAGED FLOWS ——

Big Chico Creek emerges onto the Chico fan at the Five-Mile Recreation Area on the northeast side of the Central Valley from a foothill canyon. Flows at Five-Mile are regulated for flood control by diversion of high flows from a single stilling basin into Big Chico Creek and two bypass channels: Lindo Channel and the Sycamore Creek Bypass Channel. The flow control occurs by three diversion structures shown in Figure 1.

View of stilling basin at Five-Mile Area during a flow of approximately thirty-five cubic feet per second (cfs).

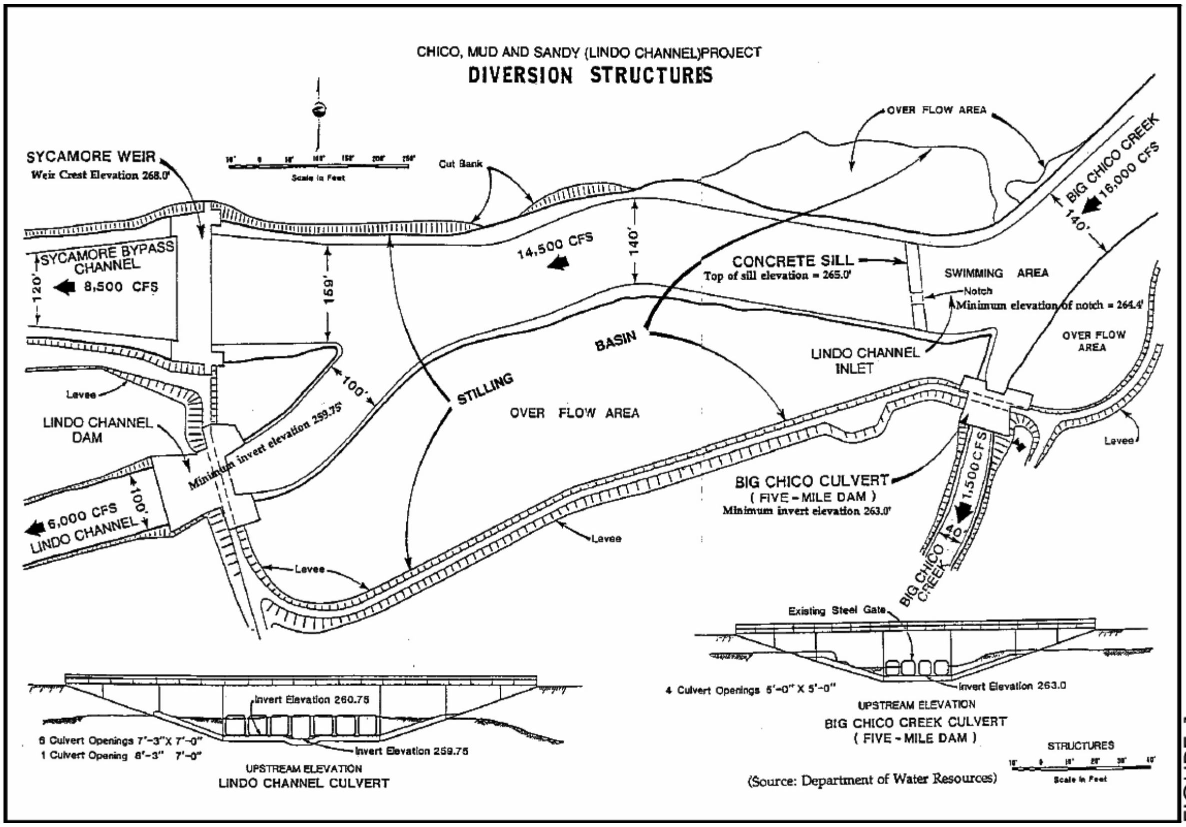

FIGURE 1

Figure 1

The invert elevations of Big Chico Creek and Lindo Channel diversion structures are similar, allowing both to carry summer low flows. However, the amount of water entering Lindo Channel, in particular during low flows, are strongly controlled by the size, height, and configuration of the gravel bar which forms within the stilling basin immediately upstream of the Big Chico Creek flow control structure. The included photo shows the stilling basin at the Five-Mile Area during a flow of approximately 35 cubic feet per second (cfs). From May to November of each year, there is little to no flow in Lindo Channel. Only large winter flows spill over the Sycamore Weir, when water is significantly ponded behind the Big Chico and Lindo Channel Flow Control Structures. Engineering plan and detail drawings of the diversion structures at the Five-Mile Area are provided in Figures 2 and 3.

Flows are controlled by pool and flood control maintenance and by the temporal variability of high-energy gravel transporting floods. The DFG has stated that it considers Big Chico Creek as the primary resource and has been reluctant to split flows between Big Chico Creek and Lindo Channel during the summer months (Mitchell Swanson & Associates [MSA], 1994, p38)

—— FLOOD CONTROL —— PRIMARY PURPOSE OF HYDRAULIC MANAGEMENT

The Chico and Mud Creeks and Sandy Gulch Improvement and Levee Construction Project was completed by the Corps of Engineers in 1965 to provide flood protection for the growing City of Chico. This work is detailed in the summary report "Operation and Maintenance Manual for Chico and Mud Creeks and Sandy Gulch, Sacramento River and Minor Tributaries Project, California, 1965". Since that time, the public interest and natural resource needs have changed to include streamside vegetation and instream flows for salmonid runs.

In the 1993 Flood Emergency Management Act (FEMA) study prepared for the City of Chico, Schaaf & Wheeler (S&W) estimated the 100-year flow in Big Chico Creek to be 14,000 cfs, with 4,000 cfs entering Lindo Channel and 4,600 cfs passing under the Esplanade. Other studies indicate that the 100-year flow of Big Chico Creek could be less than 14,000 cfs. The COE estimated the 100-year flow to be 16,000 cfs (COE, 1965). For the purpose of this study, 3-month, 6-month, 1-, 2-, 5-, and 25-year flows were based on daily average and maximum flows collected at Big Chico Creek gauging stations between 1975 and 1999.

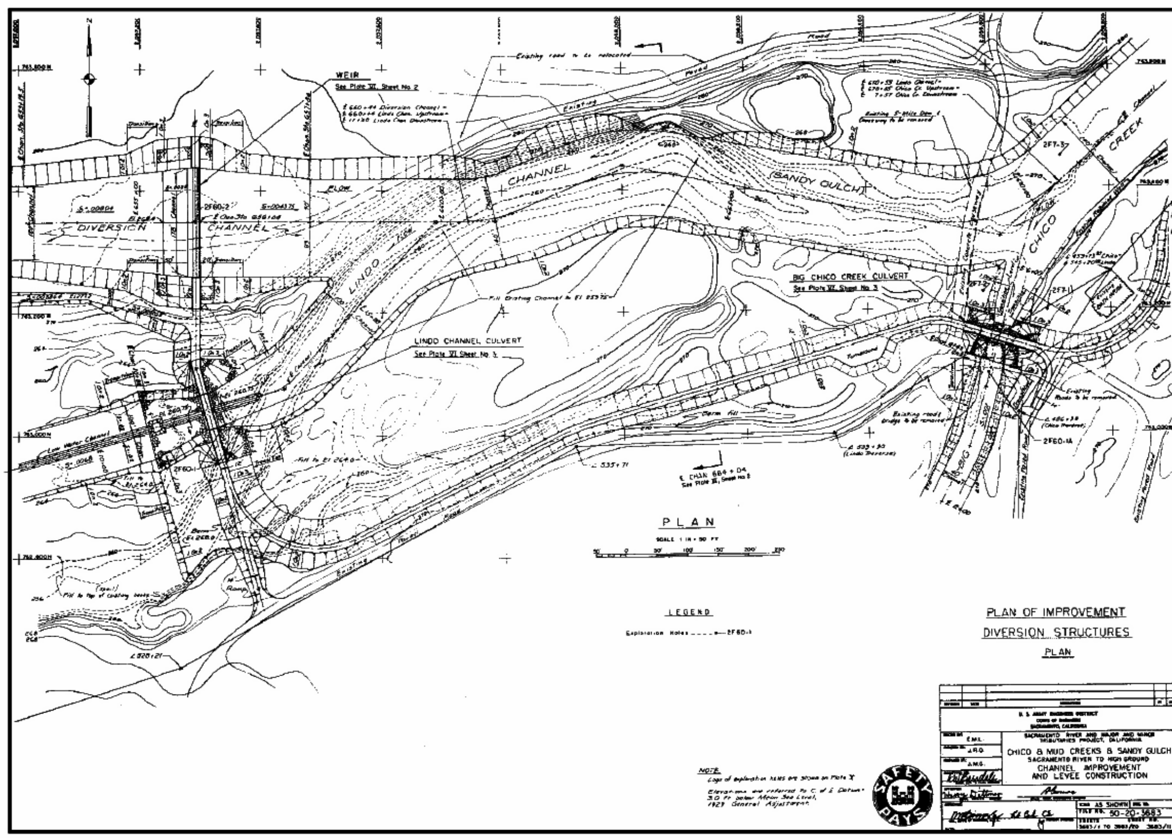

Figure 2

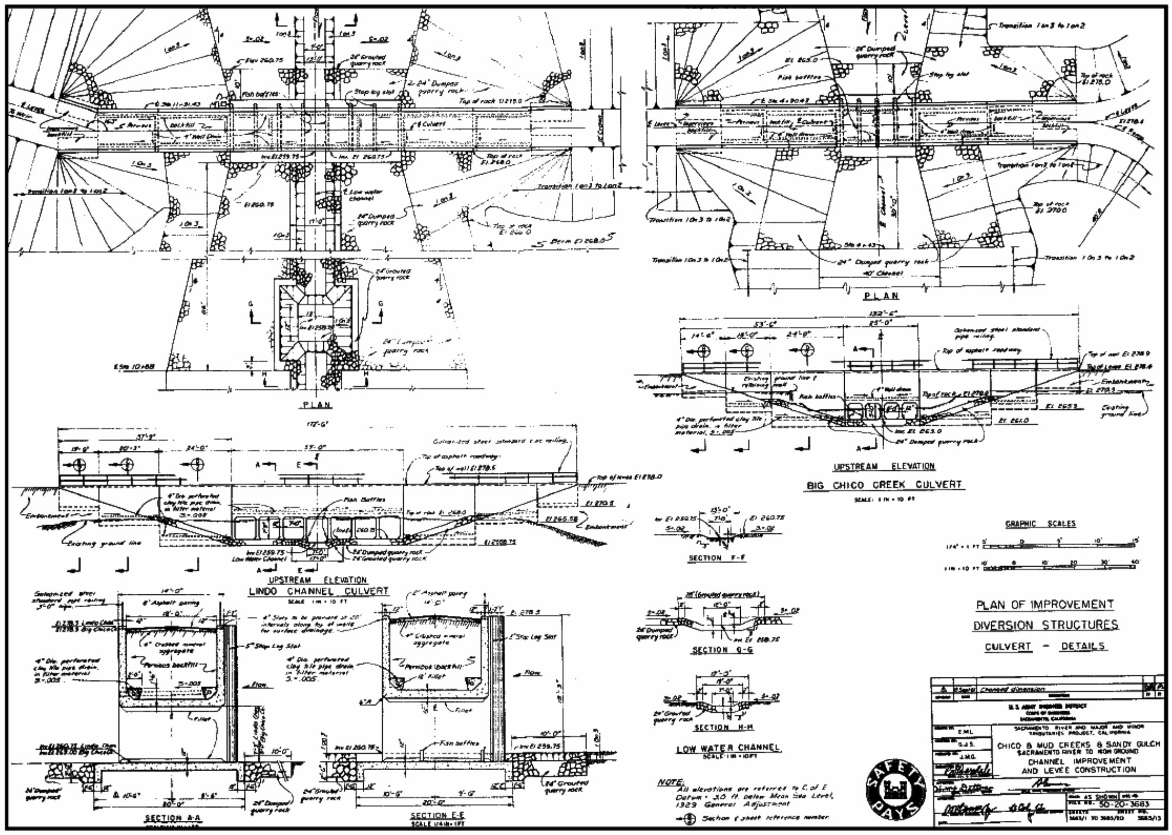

Figure 3

—— THE DOWNSTREAM EFFECTS OF DAMS ——

Aside from flood control, downstream effects of dams were of little concern during the design and construction of most historic dams in the western United States. Changes in channel morphology, fish populations or riparian vegetation were often unanticipated or were not taken seriously. Downstream effects include channel scouring and impacts on the biological ecosystem.

ALTERED SEDIMENTATION PATTERNS

In an undisturbed watershed, there is a dynamic equilibrium between supply and outflow of sediment in the stream system. Sediment to a stream is derived from three primary sources in a watershed: (1) mass wasting in which soil, rock, and other debris are moved down slope by gravity, (2) surface erosion by wind, water and chemical processes and (3) stream bank and stream channel erosion, in which sediment is entrained, transported, and re-deposited. This sediment load dictates the form and habitability of the stream and disruption of the load greatly affects the species dependent on it.

Sediment is an important and vital component of in-stream fish habitat; gravel, cobbles, and organic debris form the critical components. Salmonids are dependent upon stream reaches with sorted and well-distributed gravel to spawn successfully (a stream reach is a section of a stream extending from one point to another). The gravel must be reasonably free of fine sediment, such as clay and silt, in order for eggs and embryo to be sufficiently oxygenated and thus survive and emerge as fry. Young fry further depend on gravel and cobble areas for escape cover.

Human activity in a watershed, such as dam construction, disrupts the sediment budget. Dam construction limits the downstream magnitude and volume of flows, increases upstream supply and reduces the downstream supply of coarse and fine sediment. When large volume flows capable of moving coarse sediment encounter the pool/stilling area at the Five-Mile Area, the velocity and lift force is reduced such that the coarse sediment previously transported as bedload is deposited on the upstream side of the dam. The finer sediment remains entrained in the water column. Water leaving the Five-Mile stilling area to Big Chico Creek contains a reduced coarse sediment bedload, significantly diminishing downstream transport and supply. At Chico's One-Mile Recreation Area, the flow is again impeded and another portion of the bedload, along with suspended load, is deposited on the upstream side of that dam. Water leaving the One-Mile Area pool during high flows scour out the finer particles from the downstream bed, remove entire deposits of spawning gravels, and reduce particle size diversity.

PRESENT CONDITIONS

Factors affecting salmon production and survival include:

1. Spawning gravel supply and gravel quality
2. Juvenile rearing habitat availability and condition
3. Streamflow during fry, juvenile, and adult migration periods
4. Predation by non-native fish species
5. Bay/delta and ocean mortality (predation, pumping, and sport/commercial harvesting)
6. Water temperatures and water quality

Chinook salmon generally spawn in water from one to three feet deep. Other criteria include water velocities of 1 to 3 feet per second, a gradient of 0.2 to 1.0 percent, and substrate from 0.5 to 10 inches thick dominated by 1 to 3-inch cobble (DFG, 1998). Additional information regarding spawning, incubation, and rearing periods in Big Chico Creek and Lindo Channel are provided in Aquatic / Biotic Inventory.

HYDROLOGY

Salmonids are dependent upon different flows during various life stages; their presence, absence, and movements are influenced by flows. Therefore, hydrographic data are useful for fisheries assessment.

For all gauged streams a hydrograph can be generated. A hydrograph is a graph showing, for a given point on a stream, the discharge, stage, velocity, or other property of water with respect to time (Bedient & Huber, 1988, p69). Depiction of long periods such as an annual hydrograph can be used to determine low flow, summer base flow, winter base flow, and flood discharges.

Data presented in hydrographs for Big Chico Creek were obtained from the California Department of Water Resources (DWR) stream gage station AO-42105 located 50 feet upstream from the intersection of Rose Avenue and Bidwell Avenue. Data presented in hydrographs for Lindo Channel were obtained from DWR's stream gage station AO-0165 located at the right abutment of the Cussick Avenue Bridge, 2.25 miles northwest. Flow data presented in this study comprise data collected between the periods of October 1975 to March 1999.

In addition to hydrographs, flood frequency curves were generated based on four periods that correspond to the four spawning periods of Chinook salmon and steelhead trout. Flood frequency is the average number of times a flood of a given magnitude is likely to occur over a specified number of years. The spawning periods for these species are consistent with the ECR and include the following:

- Spawning Period 1 – February (Steelhead Trout)
- Spawning Period 2 – January to February (late fall run Chinook)
- Spawning Period 3 – Mid September to October (spring run Chinook)
- Spawning Period 4 – Late October to December (fall run Chinook)

For each spawning period, average and maximum daily flows were tabulated and utilized in the hydrologic modeling and associated sediment transport analysis discussed below.

ANNUAL HYDROGRAPHS FOR BIG CHICO CREEK

Hydrograph characteristics (magnitude, duration, timing, and frequency) were obtained by plotting and inspecting annual hydrographs for each water year (Appendix A). An example hydrograph for Big Chico Creek for Water Year (WY) 1994-1995 is shown in Figure 4.

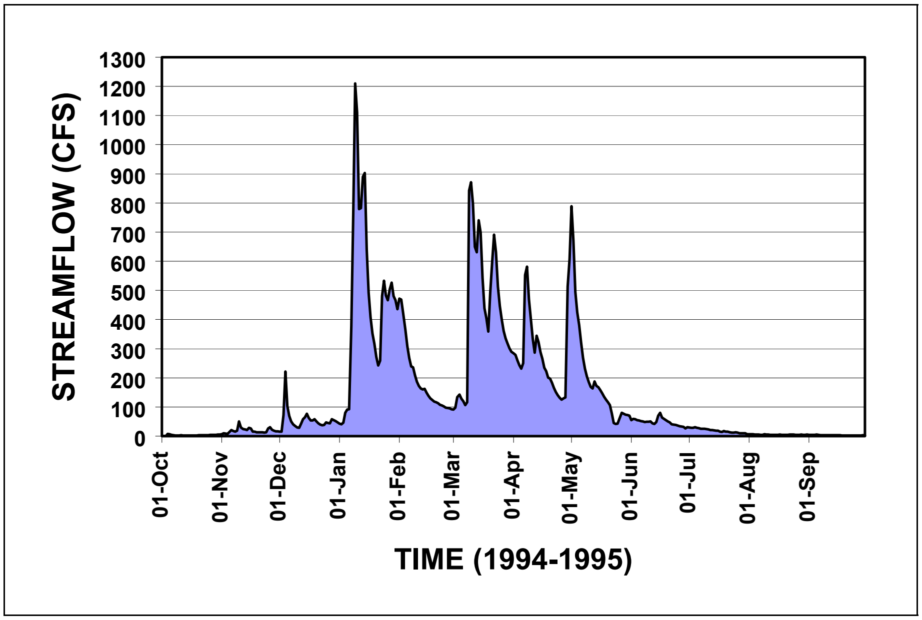

Figure 4. Annual Hydrograph for Big Chico Creek for WY 1994-1995.

Seasonal streamflow patterns can be fairly predictable, but specific flow magnitudes, durations, and frequencies are unpredictable due to runoff patterns produced by storms, droughts, and snowmelt. As is shown in Figure 4, winter storms produced high flows in January and February. Streamflow variability is important to overall river ecosystem health.

In addition to the hydrographs, annual instantaneous peak discharges at each stream were compiled and plotted by return period (the time interval for which an event of a given magnitude will occur once on the average). The flow data were then fit to the Gumbel Distribution (Bedient et al, 1988) and plotted to produce annual maximum flood frequency curves. During the four spawning periods addressed in this section, annual maximum flood flows for Big Chico Creek ranged from a low of 8 cfs in WY1979 to a high of 1,210 cfs in WY1995. An example flood frequency curve for Big Chico Creek during Spawning Period I is provided in Figure 5.

From this curve, a 2-, 5-, and 25-year return period maximum discharge for each spawning period was used in the hydrologic and sediment transport analysis. For example, flows of a 2-, 5- and 25-year maximum discharge in Big Chico Creek for Spawning Period 1 was 462, 773, and 1,242 cfs, respectively. In addition to these higher flows, annual daily flows over the past 24 years were averaged to obtain 1-year, 6-month, and 3-month flows to be used in the hydrologic and sediment transport analysis. Hydrographs and frequency curves generated from the 1975-1999 data are provided in Appendix A.

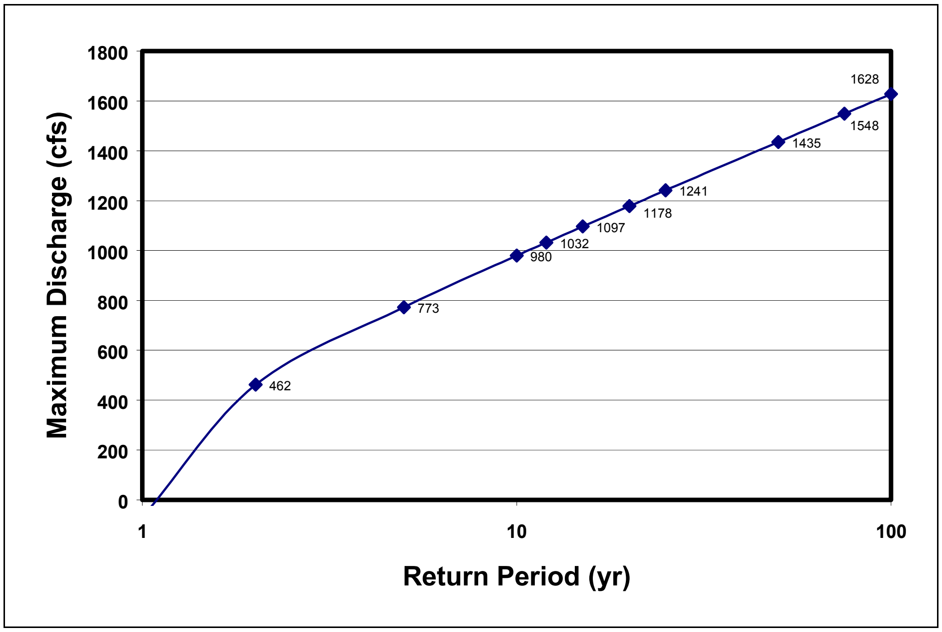

Figure 5. Flood Frequency Curve for Big Chico Creek during Spawning Period 1 (February).

These flows were selected to determine the amount of erosion or bed mobility that would occur at these flows for gravel sizes of 1/16-inch, 1-inch, and 4-inches in mean diameter. These gravel sizes were selected based on the range of gravel sizes from 0.5- to 4-inches of mean diameter that are adequate for salmonid spawning habitat (DFG, 1997, p. VII-47).

Annual Hydrographs for Lindo Channel

A hydrograph for Lindo Channel for WY1995-1996 is shown in Figure 6. During this water year, flow was present in Lindo Channel from mid-December 1995 to early June 1996 (typical due to the natural diversion of flow to Big Chico Creek during the summer and fall seasons). (see Existing Management Plans and Water Quality Monitoring Data chapters.)

Similar to Big Chico Creek, a 2-, 5-, and 25-year return period maximum discharge for each spawning period was used in the hydrologic and sediment transport analysis. From Figure 5, flows of a 2-, 5-, and 25-year maximum discharge in Lindo Channel for Spawning Period 1 was 808, 1,656, and 2,297 cfs, respectively (see Figure 7). Hydrographs and frequency curves generated from the 1975-1999 data are provided in Appendix A.

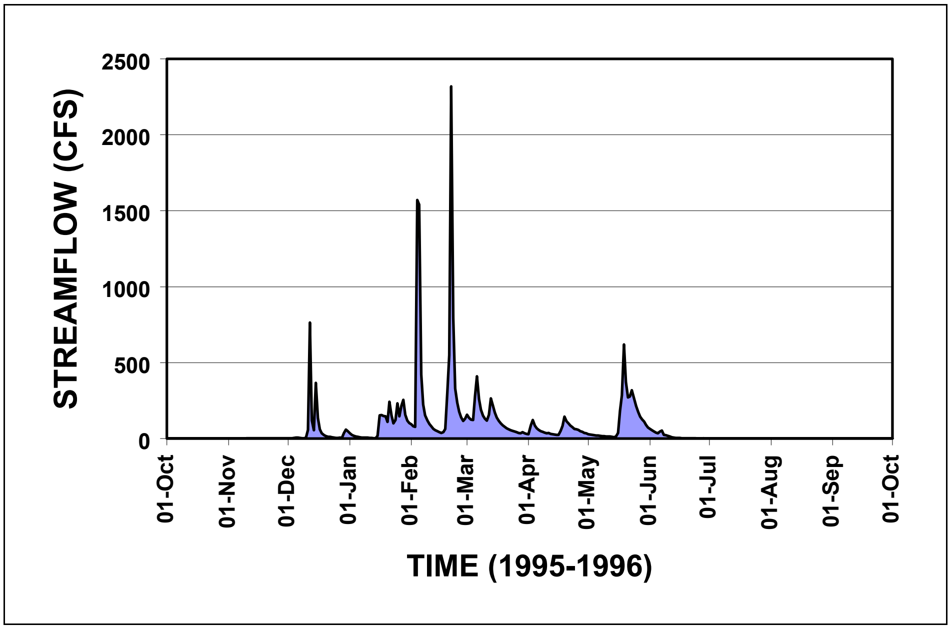

Figure 6. Annual hydrograph for Lindo Channel during WY1995-1996.

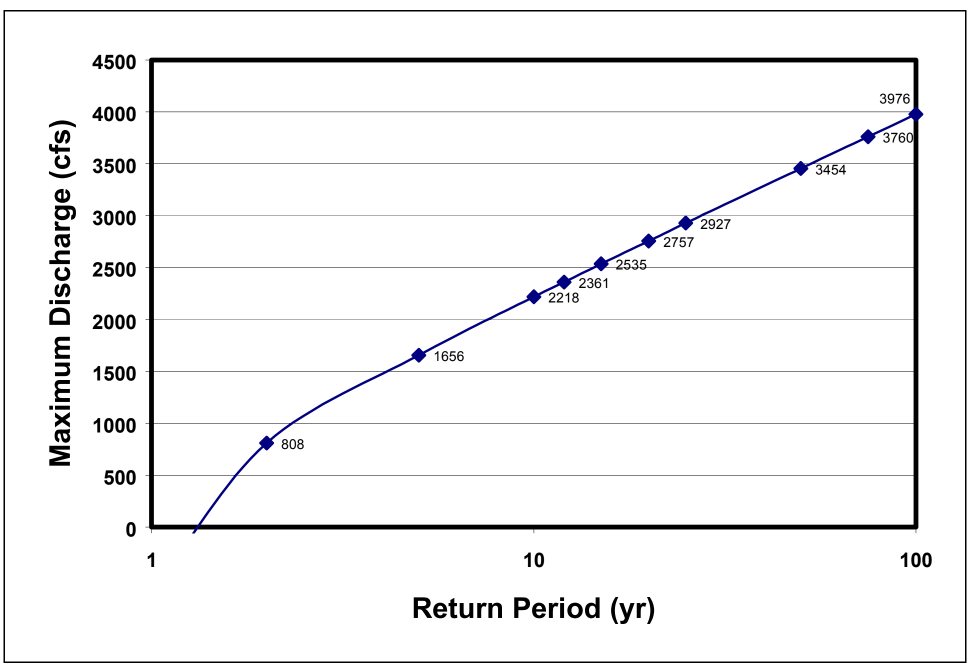

Figure 7. Flood frequency curve for Lindo Channel during Spawning Period 1 (February).

As previously mentioned, these flows were selected to determine the amount of erosion or bed mobility that would occur at these flows for gravel sizes of 1/16-inch, 1-inch, and 4-inches in diameter.

—— FLUVIAL GEOMORPHOLOGY ——

Geomorphology should be considered at both the watershed and reach scales. This study focused on the reaches of Big Chico Creek and Lindo Channel below the Five-Mile Recreation Area. However, discussion of the geomorphology of the whole watershed is presented in other sections of the ECR. An analysis of flow and bedload transport sediment was conducted to assure sufficient sediment is conveyed to maintain channel capacity and prevent adverse impacts to banks and riparian vegetation from sediment accumulation in the channel.

GEOMORPHIC PROCESSES

Geomorphic processes include the following:

- **Flow Regime**. Flows in streams consist of subcritical (referred to as tranquil or upper stage) flow, supercritical (referred to as rapid or lower-stage) flow, and/or mixed flow regimes. For this analysis, the flow was assumed to be subcritical based on the gradual slopes of the channel bed downstream of the Big Chico Creek and Lindo Channel flow control structures.

- **Bed Mobility**. Bed mobility is important for restoring and maintaining alluvial river morphology. Mobilization initiates bedload transport and routing, discourages riparian vegetation from colonizing, periodically cleanses spawning gravel deposits, and rejuvenates alluvial features.

- **Sediment Budget**. Sediment budget is the change in sediment storage defined by the difference between the amount of sediment entering a stream and the amount leaving a stream.

- **Gravel Supply**. Gravel/coarse sediment supply represented by coarse sand to small boulder sized particles are transported as bedload (particles that are in almost continuous contact with the streambed when transported, also known as saltation). Gravel losses occur when gravel input is less than the output or when storage decreases.

- **Fine Sediment Transport**. Fine sediment transport is by suspension (particles that are suspended in the water column and rarely contact the streambed).

During wet water years, substantial bedload transport, transport of large bedload particles, floodplain deposition, side channel creation, and significant channel migration can occur.

The dominant geomorphic processes during a normal water year are flows associated with moderate winter floods and snowmelt runoff that transport sands and moderate volumes of coarse bedload. This results in limited turnover of gravel deposits and modest channel migration.

Dominant geomorphic processes associated with dry water years are small winter floods and modest snowmelt runoff that transports sand in secondary alluvial features and minor course bedload. This results in little to no channel migration.

AGGREGATE SOURCE INVENTORY

As mentioned previously, the ideal range of spawning gravels is between 0.5- to 4-inches in mean diameter (DFG, 1997, p. VII-47). To determine the gravel size distribution at several spawning gravel sites in Big Chico Creek, an Aggregate Source Inventory was conducted by the California Department of Water Resources (DWR) in November 1997 (DWR, 1997). The sites were located along the Big Chico Creek at Highway 32, below the Five-Mile Area Flow Control Structure, and at Rose Avenue. To analyze the bulk sample data from each site, DWR plotted the percent by weight passing each sieve as a curve on a semi-logarithmic scale. The plotted data show the percentages of particles retained and passing through each sieve. Particle distribution curves for these three sites are provided in Appendix A.

The shape and location of a curve shows the general particle size distribution characteristics of the gravel. A very steep curve, with no tail, indicates relatively well-sorted, uniform gravel with a small range of particle sizes. Conversely, a low-slope curve indicates poorly sorted gravel with a wide range of particle sizes.

For example, Figure 8 shows a fairly steep curve, indicating relatively uniform gravel. Along the x-axis of the graph, grain size in millimeters is arranged in logarithmic succession. Along the y-axis the arithmetic scale is divided into percentage values of the cumulative percent finer by weight of grain sizes ranging from 0.01 millimeters (mm) to greater than 512 mm. Particle size diameters were determined values of 95%, 50%, and 5% were determined from the curves. The D_{50} represents the median grain size at which 50% of the sample is coarser and 50% is finer. The D_{95} is the grain size at which 95% of the sample is finer. The D_{95} and D_5 dimensions fall two standard deviations from the median.

The range of acceptable spawning gravel sizes on each curve is represented as the area that lies between the solid lines (Figure 8). Summaries of the range of gravel sizes are presented in the following table.

Table 1. Gravel Size Distribution in Big Chico Creek.

Sample Location Big Chico Creek	Gravel Size D_5 (mm)	Gravel Size D_{50} (mm)	Gravel Size D_{95} (mm)
Hwy 32	1.3	23	70.0
Five-Mile	.60	24	100.0
Rose Avenue	.75	20	85.0

The gravel sizes ranged from 20 mm to 100 mm (or approximately 1 to 4 inches) in mean diameter. Based on gravel sizes alone, this data indicates that these sites contain gravel sizes that represent good potential for salmonid spawning habitat.

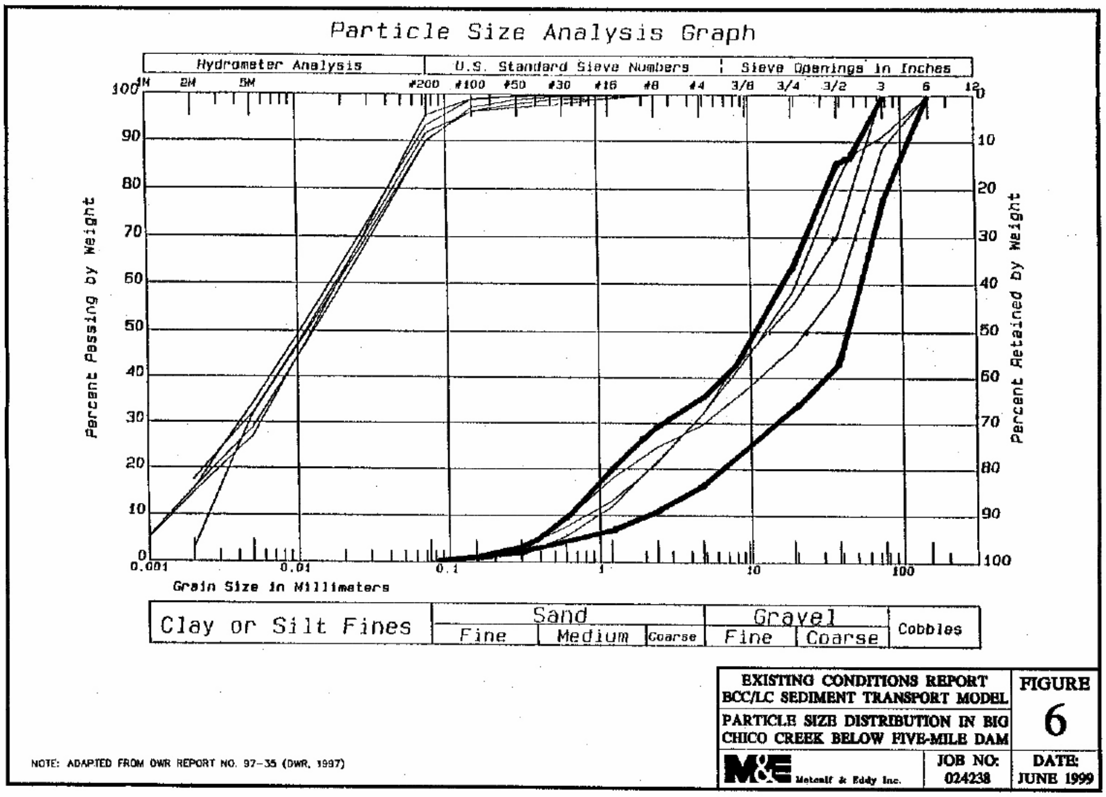

Figure 8

—— BEDLOAD FORFEITURE AT ONE-MILE AND FIVE-MILE —— FLOW CONTROL STRUCTURES

FIVE-MILE AREA FLOW CONTROL STRUCTURES

The Five-Mile flood control system is designed to create a pool in the stilling basin thereby allowing controlled flows through the Big Chico Creek and Lindo Channel flow control structures and the Sycamore Bypass Channel. During high flow periods Upper Big Chico Creek exits the narrow foothill canyon at very high velocities carrying a large bedload until it encounters the Five-Mile Area stilling basin. Velocity and bedload mobilizing capacity is significantly reduced, allowing for the larger, entrained sediment to quickly fall out of the water column depositing the large gravel just upstream of the Five-Mile Area Flow Control Structures. During the next high flow period the previously deposited gravels flow in the direction of least resistance, bypassing Big Chico Creek proper and flowing down Lindo Channel or Sycamore Bypass instead.

View looking upstream at the Big Chico Creek flow control structure.

One-Mile Area Flow Control Structure

The flow control structure at the One-Mile Recreation Area (also known as Sycamore Pool) was constructed within Big Chico Creek in 1929. It consists of a 700-foot long in-stream, flow-through swimming pool with a flashboard dam. The dam is fitted on the north side with a concrete-step pool/flashboard fish ladder that DFG found to be adequate for year round fish passage. The One-Mile Area flashboard dam lies on a concrete apron and is formed by an angle iron frame holding removable timber flashboards. From mid-September to mid-May, the flashboards are removed in anticipation of high winter flows. During high flow periods pooling of water behind the One-Mile channel restriction occurs and allows entrained/suspended sediment to drop out of the water column. However, with a portion of the bedload and suspended having already been deposited at the Five-Mile Area results in a minimum amount of gravel to cobble-sized sediment being deposited at the One-Mile Area.

The city of Chico's current maintenance practices include cleaning out sediment and debris at the start of the summer season, setting up the dam, and performing weekly cleaning. In the past, the DFG and Regional Water Quality Control Board (RWQCB) raised concerns over the city's spring-cleaning practices, which result in notable discharges of suspended sediment and organic debris (Mitchell Swanson and Associates, 1994). During 1997, the city of Chico designed and installed a box culvert beneath the Sycamore Pool to decrease downstream turbidity from pool cleaning activities.

View looking upstream at the downstream side of One-Mile Dam.

—— BIOLOGICAL RESOURCES ——

Big Chico Creek and Lindo Channel are salmonid streams that are utilized by migratory members of the salmon/trout family for spawning and/or rearing. Specific salmonoid runs, spawning, incubation, and rearing periods are discussed below.

ANADROMOUS FISHERIES OF BIG CHICO CREEK WATERSHED

Four salmonoid runs use Big Chico Creek and Lindo Channel for spawning: three runs of Chinook Salmon and one of Steelhead Trout. Chinook salmon and steelhead trout are anadromous, having a river-to-ocean, ocean-to-river life cycle. Young salmon migrate to sea shortly after emerging from spawning gravels, and spend most of their life in coastal waters where there are abundant food supplies. Fall run Chinook adults return to spawning grounds in the fall and early winter, after 1.5 to 3.5 years in the ocean. The female digs a trough (also known as a redd) in river gravels and deposits her eggs as the male fertilizes them. Juveniles emerge from spawning gravels between December and April and rear in deep, slow portions of the creek. Historically, high spring flows during the snowmelt runoff helped juveniles migrate out to sea before high summer temperatures made river conditions less hospitable. Figure 9 and Figure 10 show the life cycle of Chinook salmon with respect to the annual hydrograph flows for Big Chico Creek and Lindo Channel, respectively.

—— PROCEDURES USED FOR HYDROLOGIC MODELING AND GEOMORPHOLOGIC ANALYSIS ——

The overall objective of the Big Chico Creek Watershed Alliance's Watershed Management Strategy is to improve the spawning and migration habitat for spring run and fall run salmon and steelhead trout in Big Chico Creek and Lindo Channel. To accomplish this objective, one task was to perform a hydrology and sediment transport evaluation to assist in the preparation of a gravel placement and maintenance plan.

—— HYDROLOGIC MODELING ——

TOPOGRAPHICAL CROSS-SECTION DATA

Channel cross-sections are a very important part of hydrologic analysis. A quick walk up Big Chico Creek or Lindo Channel reveals that even over short distances stream cross-sections can take on a wide variety of shapes and sizes. Additional data of particular importance comprise wetted-perimeter, slope of stream channels, roughness, and average velocity.

A Flood Insurance Study was conducted for FEMA on behalf of the City of Chico in August 1993 (S&W, 1993). The purpose of the study was to conduct hydrologic modeling for streams in the Chico area. The study presented discharge estimates for Big Chico Creek and Lindo Channel, and documented the hydrologic calculations behind these estimates. S&W based their

FIGURE 9

FIGURE 10

study on photogrammetric contouring/cross-sectioning to obtain cross-sectional data with a resolution of 2-foot elevation contour intervals. The cross-sectional data and other model parameters used in the hydrologic modeling and sediment transport analysis are discussed in detail below.

Prior to hydrologic modeling, a topographic survey of approximately twenty additional cross-sections was made to supplement the S&W cross-sections. The additional cross-sections were approximately equidistant; some co-located with the FEMA cross-sections, were generally representative of the nature of the creek, and were surveyed in the field by a Professional Land Surveyor to an accuracy of 0.5-foot. The co-located cross-sections were generally similar and are provided in Appendix B. Figure 11 shows the stream cross-section locations along Big Chico Creek and Lindo Channel.

HEC-RAS MODELING

The COE Hydrologic Engineering Center's River Analysis System (HEC-RAS) model was used to determine flow velocities and depths as a function of distance along the streams for different flows. Based on these, erosion factors were determined in Big Chico Creek and Lindo Channel. Channel cross-sections were specified at various intervals and these were used to estimate the size of gravel that would be mobilized for different flow conditions (as discussed earlier in this chapter). The HEC-RAS outputs are included as Appendix C.

SEDIMENT BEDLOAD TRANSPORT ANALYSIS

The potential quantities of sediment capable of being transported were estimated as a function of distance using analytical formulae for the different modes of transport. The shear stress, Shield's parameter, and bedload transport were calculated from the results of the HEC-RAS outputs. The calculated Shield's parameter was then compared to the critical Shield's parameter to determine if erosion would occur for particular gravel sizes at a particular cross-section. Results of these calculations are discussed in this section and are included in Appendix D.

BEDLOAD PARAMETERS

The result of the HEC-RAS modeling generates data, which are necessary in calculating the amount of bedload transport along Big Chico Creek and Lindo Channel. HEC-RAS outputs include the slope of the energy grade line, channel velocity, flow area, and other parameters for each cross section. From these parameters and an assumed gravel size (e.g., 1/16-inch, 1-inch, and 4-inches in mean diameter), the hydraulic radius (R_h), shear stress (*??*), Shield's parameter (?), Reynolds number (R_e), critical depth (y_c), and bedload transport (q_s) were calculated.

In addition, the bedload transport potential (cubic feet or cubic yards) was calculated by multiplying the bedload transport (ft^2/sec) by the width of the channel (ft) by the duration of the maximum discharges during each spawning period (seconds). For this study, a channel width of 30 feet and 60 feet were assumed for Big Chico Creek and Lindo Channel, respectively.

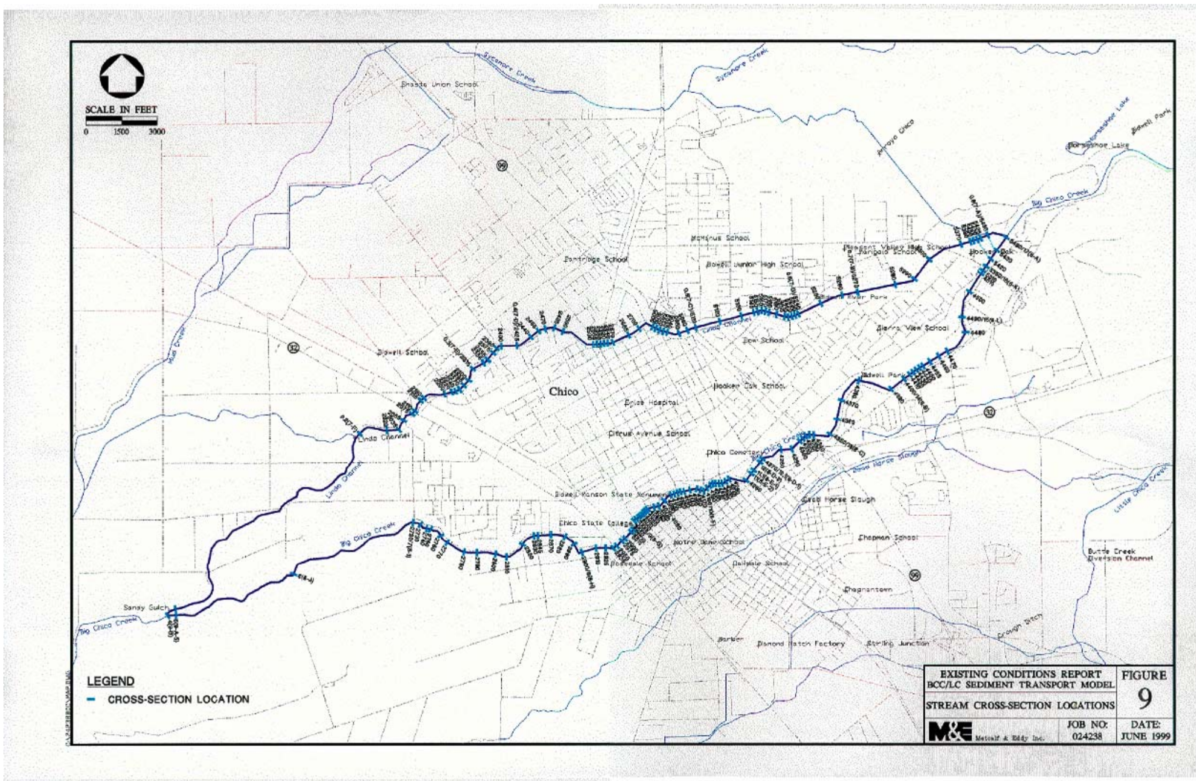

Figure 11.

BEDLOAD SHEAR STRESSES

Assuming steady flow, calculations were performed for water surface slope and cross-sectional area for each flow. The estimated cross sectionally averaged boundary shear stress is:

$$\tau = \rho g S Y \tag{1}$$

where τ = bottom shear stress (lb/ft^2)
ρ = density of water = 2 $slug/ft^3$
g = acceleration of gravity = 32.2 ft/s^2
S = channel slope, dimensionless (ft/ft)
Y = hydraulic radius of entire cross section (obtained from Mannings equation), ft.

Equation 1 is the most common way to estimate boundary shear stress. The boundary shear stress is necessary in order to calculate the Shield's parameter and ultimately, the bedload transport.

MODELING TRANSPORT WITH SHIELD'S PARAMETERS

There are a large number of methods that have been developed to estimate bedload transport rates. The first question, however, is whether sediment motion will occur and the most recognized method for establishing this is the Shield's diagram (Vanoni, 1975). The most important parameter is the Shield's parameter, defined as follows:

$$\Psi = \frac{\tau}{(s-1)\rho g d} \tag{2}$$

where Ψ = Shield's parameter, dimensionless
$s = \rho_s/\rho = 2.65$ for quartz particles
ρ_s = sediment density, slug/ft^3
d = particle diameter, ft.

Sediment motion occurs when the Shield's parameter is larger than the critical Shield's parameter, Y_c. The critical Shield's parameter is the hydraulic threshold at which channelbed surface particles begin to mobilize, occurring when the drag force exceeds the gravitational force resisting downstream motion of the particle. For fully developed and turbulent flow (Reynolds number greater than 450), which could be expected in the streams of interest, the critical Shield's parameter (Y_c) is approximately constant and equal to 0.06 (Vanoni, 1975). Therefore, sediment motion occurs when $Y > Y_c$. Comparing Sheild's parameter with the predicted critical Shield's parameter provides a method to estimate whether conditions could be achieved at a given discharge and hydraulic setting.

Particle sizes of 1/16-, 1-, and 4-inches in diameter were used to calculate the Shield's parameter. The interest lies with gravel and coarse sand with the relevant modes of transport being rolling and saltation, also referred to as bedload. A widely accepted formula for bedload transport is that of Meyer-Peter and Müller (Madsen, 1991):

$$q_s = 8\sqrt{(s-1)gd}\,d(\Psi - \Psi_c)^{3/2} \tag{3}$$

where q_s = sediment volume transport per unit of time, per unit width, ft^2/s.

The above equations can be combined to give:

$$q_s = \frac{8g^{½}S^{3/2}}{(s-1)}(y - y_c)^{3/2} \tag{4}$$

$$y_c = \frac{0.06(s-1)d}{S} \tag{5}$$

where y_c = critical depth.

The transport rate given by the above equation is a potential transport rate; the actual rate depends on the availability of sediment, either in place or transported from upstream. Also, if the transport exceeds the upstream supply, the channel bottom will drop, reducing velocities and further transport. Thus, a balance is established, which can only be simulated using a full sediment transport model and transient flow records. The results of this evaluation allow estimation of the transport of different sized gravel introduced at different locations within the streams.

Hydrologic Modeling Results

The results of the HEC-RAS model runs include cross section profile data and the necessary parameters to analyze sediment bedload transport in reaches of Big Chico Creek and Lindo Channel. Three flow scenarios for each spawning period was used to generate the HEC-RAS modeling data. Results are presented in Appendix C.

Rationale for Site Selection

One viable option to increase salmonid spawning habitat is to place gravel in areas that do not experience significant transport potential for coarser gravels (i.e., 1- to 4-inch gravels) but do have sediment transport probability for fine-grained sediments (i.e., 1/16-inch gravels). Based on this approach, the reaches of Big Chico Creek and Lindo Channel were evaluated for potential areas of gravel placement. It is also important to mention that there are other factors in addition to hydrology and gravel size distribution to consider regarding a site's viability for salmonid spawning habitat. These other factors include stream cover, streamside vegetation, water temperature, etc., and are discussed in other chapters of the ECR.

Results of Sediment Bedload Transport Analysis

The results of the sediment transport modeling are presented in Appendix D. For the basis of this analysis, gravel sizes of fine-grained and coarse gravels were used to assess areas of sediment transport potential. Based on these results, each cross section on Big Chico Creek and Lindo Channel was evaluated for high, medium, and low bedload transport areas.

Big Chico Creek Reaches

Generally, higher flows correspond to a higher calculated Shield's parameter. For example, average Shield's parameters for a 1-inch gravel ranged from 0.06 to 0.19 for flows of 38 to 1,374 cfs, respectively. These values compare to a critical Shield's parameter of 0.06 (Vanoni, 1975), above which sediment motion will occur. At a flow of 460 cfs, energy grade (or channel) slopes ranged from 7.0E-06 to 0.12. Higher channel slopes resulted in higher shear stresses, and have higher Shield's parameters.

At a flow of 460 cfs, channel velocities ranged from 0.20 to 9.4 feet per second (fps). Higher channel velocities resulted in higher shear stresses. Reaches that had high shear stresses and Shield's parameters resulted in high bedload transport potential. Locations where the model predicted potential bedload transport was categorized into high, medium, and low bedload transport potential (or high, medium, and low potential energy) for each cross-sectional area. It should be stressed that the volumes presented in Appendix D have the potential for movement at that particular cross-section. However, this does not necessarily correlate to the amount of bedload that is being deposited downstream and therefore is available for use. More sophisticated transport modeling (beyond the scope of this study) must be performed to determine the mass balances of the stream ecosystem.

There were several locations noted along Big Chico Creek where the model predicted medium to high transport potential for gravels equal to or less than 4-inches in diameter at various flows.

These are areas where gravel, if deposited, would be transported further downstream. Therefore, it may be useful to place gravel at these areas for entrainment. However, they would not be considered necessarily suitable for spawning redds. The locations consist of the following:

- Immediately downstream of the Big Chico Creek flow control structure
- Immediately downstream of the Manzanita Bridge
- Between Madrone Avenue and Crister Avenue
- Immediately downstream of Highway 99 footbridge
- Immediately downstream of Glenwood Avenue

In addition to areas that were likely to have low to high sediment transport potential, the HEC-RAS model predicted stream reaches that experience little to no sediment transport. There were several areas on Big Chico Creek where the HEC-RAS model predicted little to no transport of coarser gravels (1- to 4-inch) and medium to high transport potential for fine-grained sediments. These were the potential gravel placement areas recommended, and are discussed in the gravel placement plan section. It is important to note that these areas are <u>potential</u> gravel placement areas based on the HEC-RAS model. As mentioned previously, there are many other factors that influence the selection of a stream reach for salmonid spawning habitat viability.

<u>Lindo Channel Reaches</u>

Generally, higher flows correspond to a higher calculated Shield's parameter. Average Shield's parameters for a less than or equal to 2-inch gravel ranged from 0.02 to 0.08 for flows corresponding to 13 to 3,082 cfs, respectively. At a flow of 141 cfs, channel slopes ranged from 2.07E-4 to 0.075. Higher channel slopes resulted in higher shear stresses.

At a flow of 141 cfs, channel velocities ranged from 0.79 to 6.0 fps. Reaches that had high Shield's parameters also had high bedload transport potential. As mentioned previously, locations where the model predicted bedload transport were categorized into high, medium, and low bedload transport potential.

There were several locations along Lindo Channel where the model predicted moderate to high bedload transport potential for gravels less than 4-inches in diameter for various flows. The locations consist of the following:

- Immediately downstream of the Lindo Channel flow control structures
- Immediately downstream of the Manzanita Bridge
- Immediately downstream of Highway 99 Bridge
- Downstream of Cussick Avenue
- Downstream of Nord Avenue

Currently there appears to be adequate coarse gravel in Lindo Channel for spawning habitat. However, spawning habitat is limited due to the lack of summer and fall flows in Lindo Channel. Although Mitchell Swanson and Associates has recommended to the City to consider diverting water to Lindo Channel during low flow months, DFG has stated that it desires to manage Big Chico Creek as the primary resource. Until this priority changes, focusing on gravel placement in Big Chico Creek is recommended.

RESTORATION THROUGH GRAVEL MANAGEMENT

GRAVEL PLACEMENT PLAN

Presently, a reduced percentage of the available gravel passes through the Big Chico Creek and Lindo Channel flow control structures due to the gravel deposition in the stilling basin when gravel-transporting flows occur. Since the flood control project was initiated at Five-Mile Area in 1963, gravel has been removed from the stilling basin and used as road cover and for other construction purposes (MSA, 1994, p63). Removal of gravel from the stilling basin was discontinued in 1995 due to concern by DFG about downstream sedimentation.

The purpose of a gravel placement plan is to develop an adaptive management plan for improving gravel areas for salmonid spawning and migration. Optimal locations for gravel placement, gravel placement volumes, timeline, and a maintenance program are discussed below.

GRAVEL PLACEMENT FUNCTIONS

Just as water is essential to the Big Chico Creek Watershed, gravel and cobbles are important elements of channel geomorphology. The coarse gravel sediment forms riffles, pools, and other alluvial features that provide salmonid spawning and rearing habitat.

Although it is commonly thought that fine sediments are detrimental for the river ecosystem, this is not always the case. For example, fine sediments deposit on the inside of migrating meander bends and encourage riparian revegetation (McBain & Trush, 1998, p294). However, chronic fine sediment loading can greatly increase instream fine sediment storage rather than floodplain storage, which can severely impact salmonid habitats.

Introducing potential bedload with a significant component of fine sediment is not recommended to improve salmonid spawning and rearing habitat. Based on the preferred spawning sizes for fall and spring-run Chinook salmon as well as steelhead trout, the suitable gravel size range for placement is 0.5 to 4 inches mean diameter (MSA, 1994; DFG, 1997, p.VII-47).

The lower reaches of Big Chico Creek and Lindo Channel were evaluated for potential areas of gravel placement. As previously mentioned, there are several other factors in addition to hydrology and bedload transport that should be considered in the selection of viable salmonid spawning habitat locations (e.g., stream cover, streamside vegetation, water temperature, etc.). These issues are addressed separately within the ECR.

Optimal Locations for Gravel Placement

The use of gravels for placement as spawning gravel beds was evaluated at appropriate reaches below Five-Mile Area Big Chico Creek and Lindo Channel flow control structures. Based on the HEC-RAS model results, several potential sites for gravel placement were found.

Big Chico Creek Reach Locations

There were several areas on Big Chico Creek where the model predicted little to no transport of coarser gravels (1- to 4-inch) and moderate to high transport of fine-grained sediments. Placement of gravel downstream of certain pools is proposed to eventually create stream riffle habitat. These potential gravel placement areas are shown as cross-sections on Figure 12 and include the following:

- Cross-section 5430 to 5420, approximately half way between Manzanita Bridge and the Big Chico Creek flow control structure.
- Cross-sections 4500, 4480, and 4460, downstream of Manzanita Bridge.
- Cross-section 4370 to 4360, upstream of Highway 99 Bridge.
- Cross-section 4280, upstream of One-Mile Area's Sycamore Pool. Although the model shows that this location may be a possible location for gravel placement, introduction of gravel immediately upstream of the One-Mile Area is not recommended due to increased sedimentation within the pool and resultant maintenance efforts required for removal.

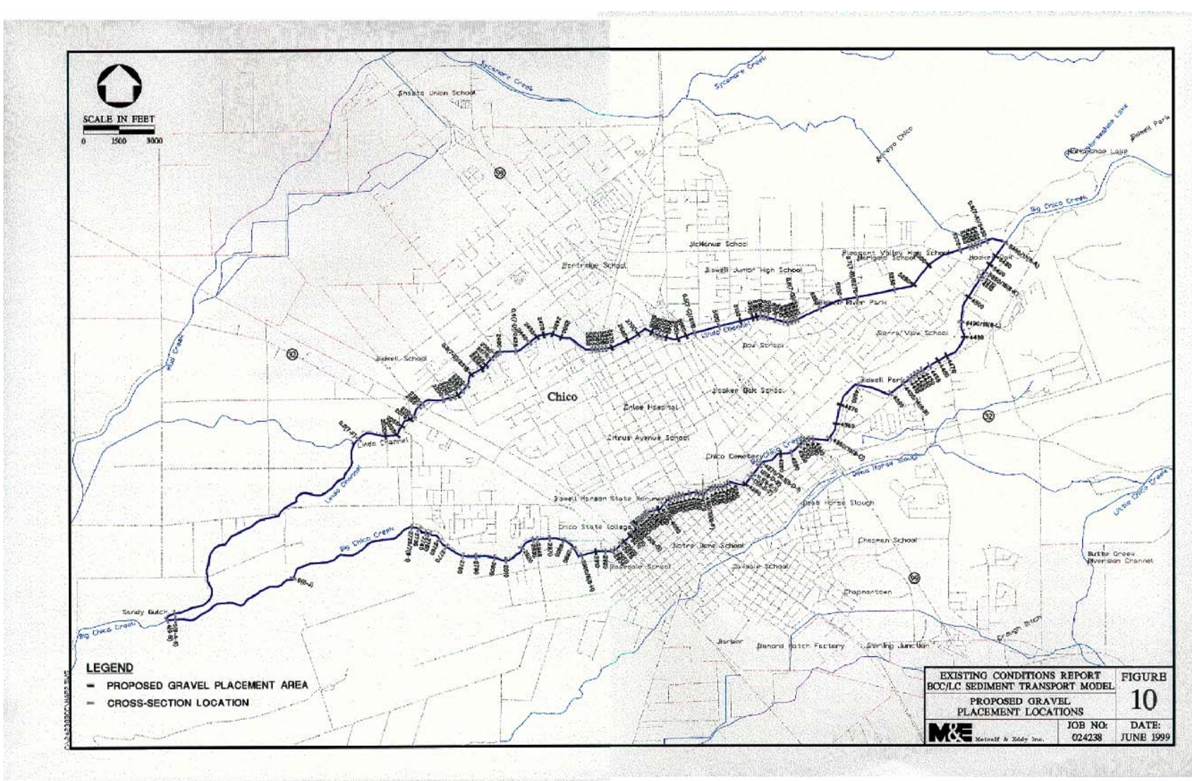

Figure 12.

- Cross-section 4260, downstream of One-Mile Area's Sycamore Pool. Bank erosion is evident on the south side of the stream in this area. One option may be to place gravels in this area of high sediment transport potential (high potential energy) to transport gravels downstream where the model predicts minimal coarse gravel transport potential. A secondary benefit of this option would be to reduce the undercutting of the concrete apron and streambank erosion in this area.

- Cross-section 4070 to 4066, upstream of the Warner Street Bridge between Acardian Avenue and Citrus Avenue.

- Cross-section 4010 to 3049, between the Warner Street Bridge and Rio Chico Street.

- Cross-section 3016 to 2990, downstream of the Warner Street Bridge between Rio Chico Street and the Railroad Tracks.

- Cross-section 2910, downstream of the Nord Avenue Bridge.

Field observations of these locations generally indicated the presence of pools and riffles that could be enhanced for salmonid habitat. In most cases, adequate stream cover exists. Several of these areas are also consistent with MSA's findings of potential gravel placement areas, such as below Big Chico Creek flow control structure, below Manzanita Road, and below the One-Mile Area's Sycamore Pool flashboard dam (MSA, 1994, p65).

Although the HEC-RAS model included reaches downstream of Glenwood Avenue to the junction of Big Chico Creek and Lindo Channel, the data is not reliable due to the large distances between these cross-sections.

It is important to note that the potential gravel placement reaches identified are solely based on the modeling effort. As mentioned previously, many other factors should be considered in order to select specific stream reaches for salmonid spawning habitat restoration.

LINDO CHANNEL REACH LOCATIONS

Potential gravel placement areas on Lindo Channel are shown as cross-sections on Figure 12 and include the following:

- Cross-section 5310 to 5290, downstream of the Manzanita Avenue Bridge.

- Cross-section 5150 to 5130, downstream of the Floral Avenue Bridge.

- Cross-section 5070 to 5040, between the Mangrove Avenue Bridge and Highway 99 Foot Bridge.

- Cross-section 5010 to 2670, between The Esplanade Bridge and the Mangrove Avenue Bridge. However, the model predicted coarse gravel movement at moderately higher flows for a few of the cross-sections in this reach (e.g., cross-sections 2685 and 2640). As such, these particular cross-sections may be inadequate for gravel placement.

There are several potential sites between The Esplanade and Cussick Avenue. Possible cross-sections include 2515, 2500, and from 2485 to 2455.

- Cross-section 2355 to 2315, immediately downstream Cussick Avenue.
- Cross-section 2270, located upstream of Guynn Avenue.
- Cross-section 2140, upstream of the Nord Avenue Bridge.
- Cross-section 2075 to2020, downstream of the Nord Avenue Bridge.

Although there are potential gravel placement areas on Lindo Channel, spawning habitat is limited due to the lack of summer and fall flows. Unless conditions were to change, it is recommended that the focus on gravel placement be directed towards Big Chico Creek.

METHODS FOR GRAVEL PLACEMENT

Spawning gravel for salmon should be clean, creek-run from 0.5- to 4-inches diameter. It is proposed that gravel would be dumped at a staging area on the bank and then picked up and placed with a small front-end loader. It is recommended that naturally deposited gravels be used from the Five-Mile Area stilling basin above Big Chico Creek and Lindo flow control structures. In addition, it is recommended that the gravel portion of sediments removed from the One-Mile Area's Sycamore pool-cleaning effort be screened and used.

One placement option is to input gravel in the area of high water velocity to allow the stream to more naturally distribute the gravel downstream during high flows. Possible areas include downstream of the Big Chico Creek and Lindo Channel flow control structures and the other potential stream reaches mentioned above. An area of active bank erosion may also be a good candidate site for gravel placement because the stream has already demonstrated high energy and the ability to move substrate material (Cross-section 4260 is one such site). However, the sites selected must have good equipment access and have adequate transport capacity so that gravels do not cause flow obstruction and potential flooding.

GRAVEL PLACEMENT VOLUMES

Proposing initial placement volumes without specific placement locations is not recommended. The volume of gravel placement for the areas recommended in this chapter will vary from site to site. However, it is recommended that a small amount of gravel be placed initially and monitored to assess whether the placed gravels are stable or transported downstream. This is consistent with an adaptive management approach. Generally, volumes should be characterized based on the thickness of the added gravel. A thickness of twice the mean gravel diameter seems reasonable. For example, placement of a 2-inch gravel at a particular cross section in Big Chico Creek would translate to a volume of 0.4 cubic yards per linear foot of stream (assuming 30-foot width).

In 1994 MSA made recommendations to place small amounts of gravel at the downstream end of pools where it could immediately be useable as spawning gravel. In general, Mitchell, Swanson & Associates recommended that approximately 0.25 to 0.5 cubic yards of gravel would be required per site (MSA, 1994, p65).

Timeline for Initial Gravel Placement

In order to minimize the disturbance of the benthic invertebrate community and salmonids in Big Chico Creek, it is recommended that placement of gravel occur in the late summer. Placement during this time would also benefit from low flows and have the least impact on the salmonid spawning and rearing periods.

Initially, it is recommended that gravel placement occur once per year. Gravel placement frequency may be revised based on observations in actual bedload transport and the results of gravel placement monitoring. Again, this approach is consistent with the WMS goal of operating an adaptive management program.

Maintenance Program

Butte County has historically removed loads of gravel at the Five-Mile Recreation Area and placed them on levee roads or used them for other construction purposes. In 1992, the City of Chico took over gravel removal and flood control management in the stilling basin from Butte County (MSA, 1994, p20).

After a high flow or watershed disturbance, fine sediment may be deposited in spawning gravel substrates. In order to avoid deposition of fine sediment, this study recommended choosing stream reaches where fine sediment transport potential was identified. However, periodic maintenance might be required to reduce fine sediment in spawning areas (i.e., spawning riffles). Plowing the gravel with a ripper attachment on a tractor then adding fresh gravel can do this. Gravel ripping has been used before as a method of loosening and cleaning gravels by the DFG in the Sacramento River, by the USFWS on the Feather River, and by the Turlock and Modesto Irrigation Districts (in cooperation with the DFG) on the lower Tuolome River below La Grange Dam (Vyverberg et al, 1997).

Monitoring Methods

The following monitoring methods are recommended:

- Visual survey of bed material.
- Cross-sectional surveys at various reaches to monitor channel degradation and aggradations.
- Tracer gravels to monitor travel distance downstream. Different colored and sized gravels can be placed in gravel placement areas to assess the physical horizontal transport of gravels over time.

The purpose of monitoring is to assess the accuracy of the measures performed and to modify the adaptive management plan as needed.

GRAVEL REPLENISHMENT

After the gravels are initially placed in the streams, it is recommended that gravel be replenished every year during the late summer to minimize impacts to the stream ecosystem. It is recommended to use gravels that are deposited in the stilling basin at the Five-Mile Area for gravel replenishment below the Big Chico Creek and Lindo Channel flow control structures. In addition, it is recommended that the gravels from the fine and coarse-grained sediments removed from the One-Mile Area Sycamore Pool be considered for gravel replenishment below the One-Mile Dam. This would require some type of mechanical separation and could be implemented following the annual pre-summer cleaning event at Sycamore Pool.

LONG-TERM MAINTENANCE RECOMMENDATIONS

Long-term maintenance depends upon the success of the initial and on-going gravel placement, monitoring, and maintenance recommendations presented above. It is recommended that feedback from these activities be evaluated by the appropriate agencies including the DFG, RWQCB, City of Chico, Butte County, and other interested parties consistent with the BCCWA's adaptive management objective.

It has already been recommended that a combined fish passage and structural design investigation be undertaken to identify a solution to problems associated with the Lindo Channel flow control structure (MSA, 1994, p68). The damaged concrete apron immediately downstream of the dam prevents fish from entering the fish passage channel. In addition to structural design changes, increasing flows to Lindo channel and enhancement of the vegetation in the stream corridor should be considered to promote additional salmonid spawning habitat.

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Available Upon Request

APPENDIX A - BIG CHICO CREEK AND LINDO CHANNEL FLOW DATA

APPENDIX B - CROSS-SECTION DATA

APPENDIX C - HEC-RAS MODELING RESULTS

APPENDIX D - SEDIMENT TRANSPORT RESULTS

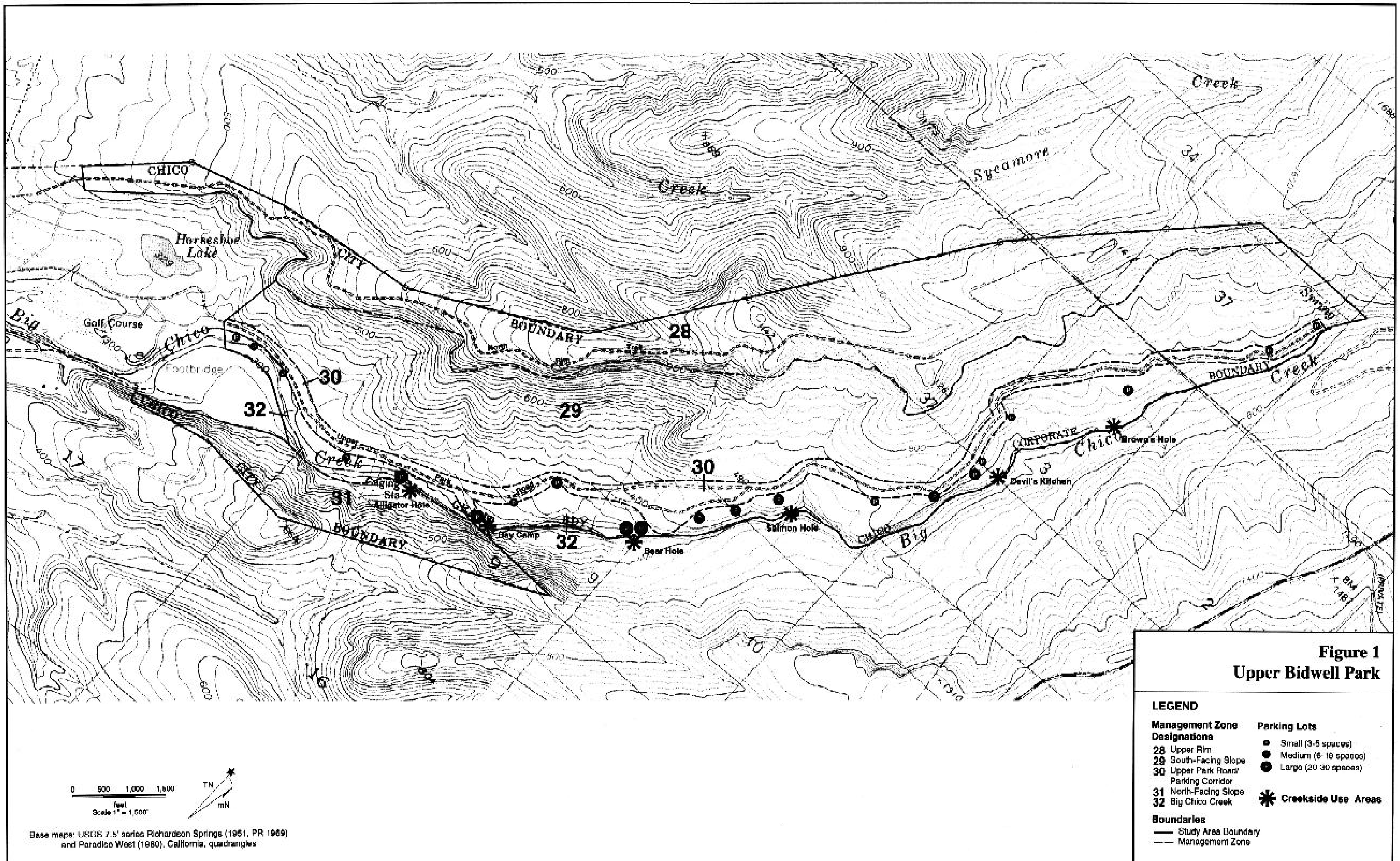

Figure 1
Upper Bidwell Park

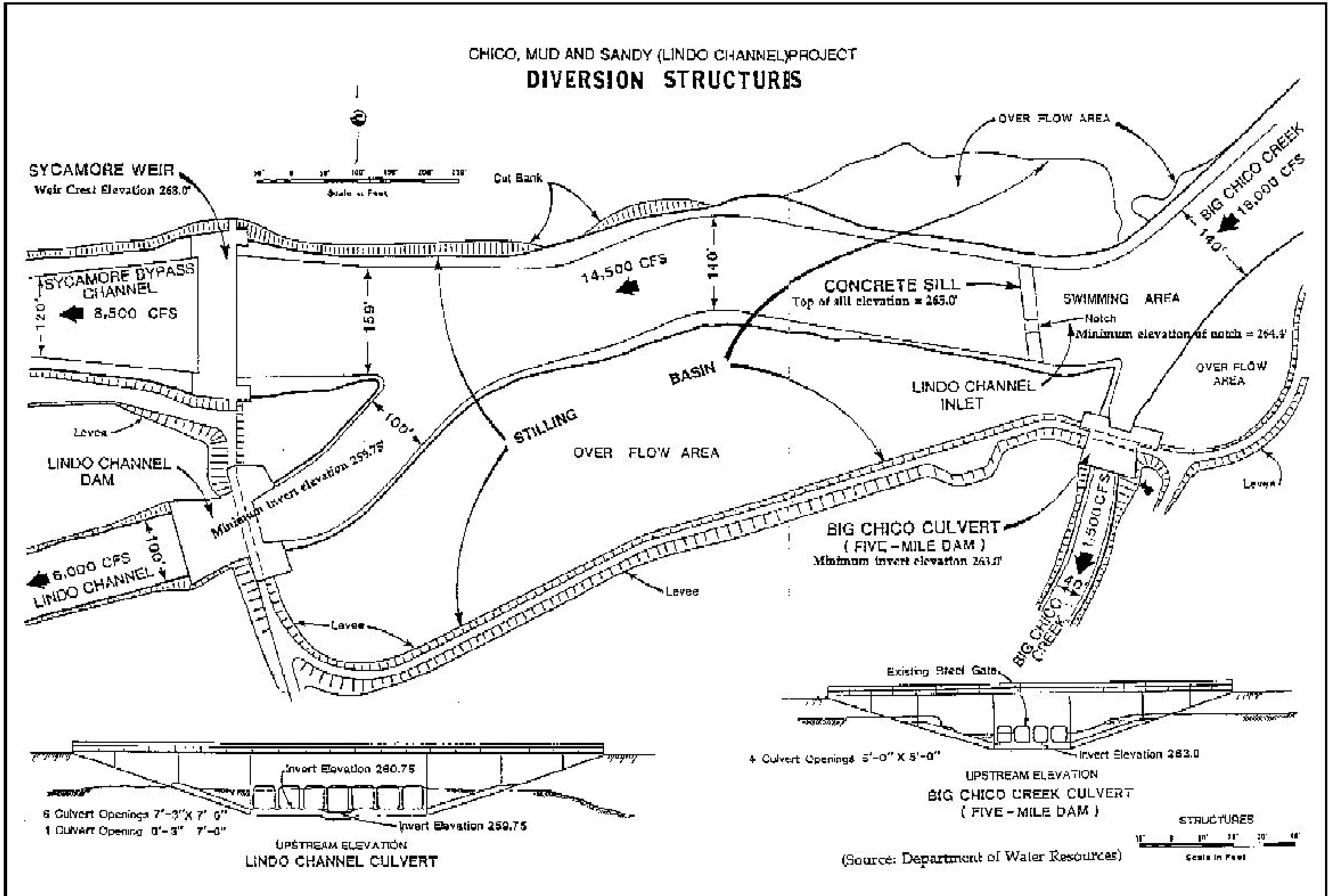

Figure 1. Diversion Structures

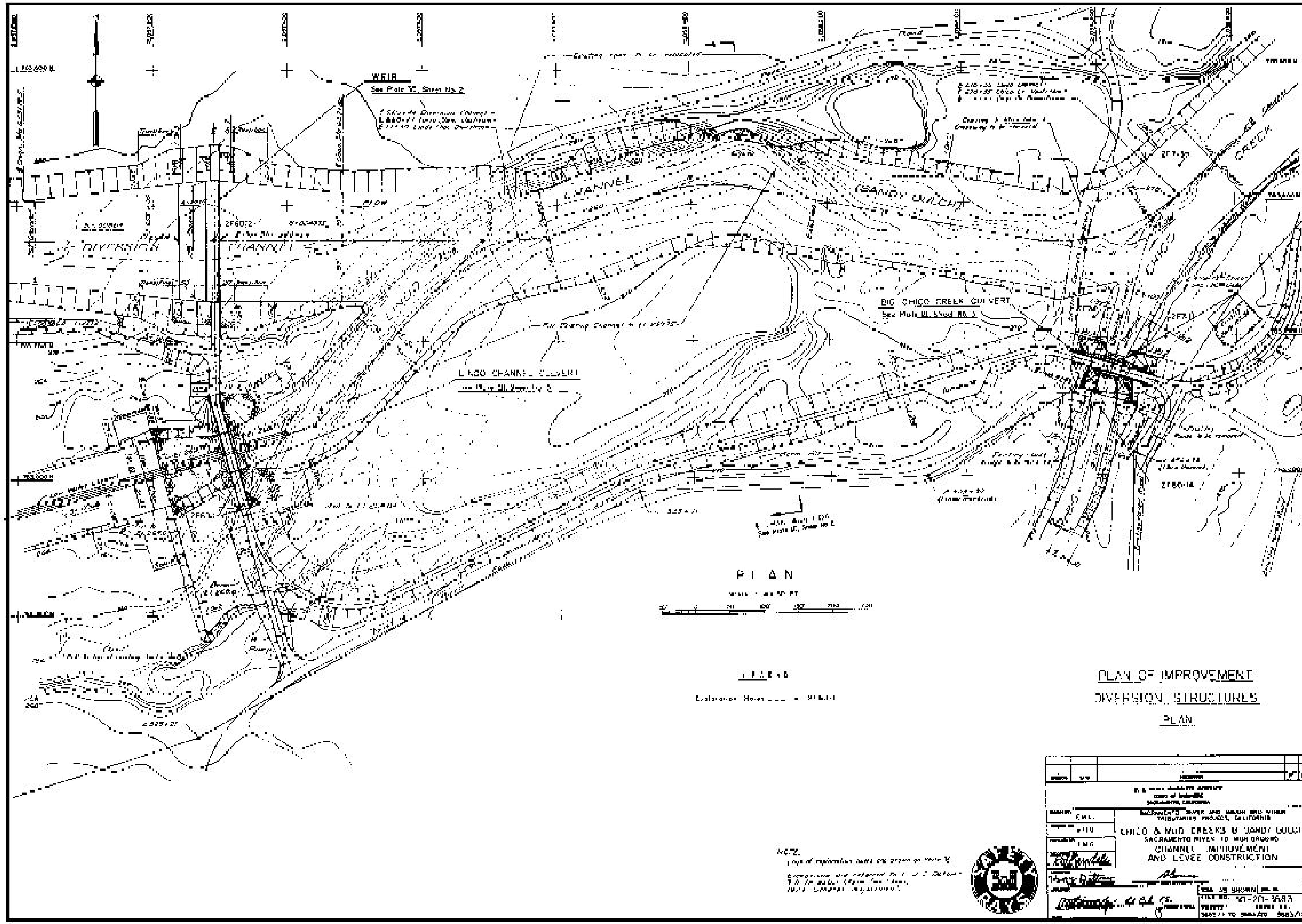

Figure 2. Diversion Structure Plan - Engineering and detail drawings.

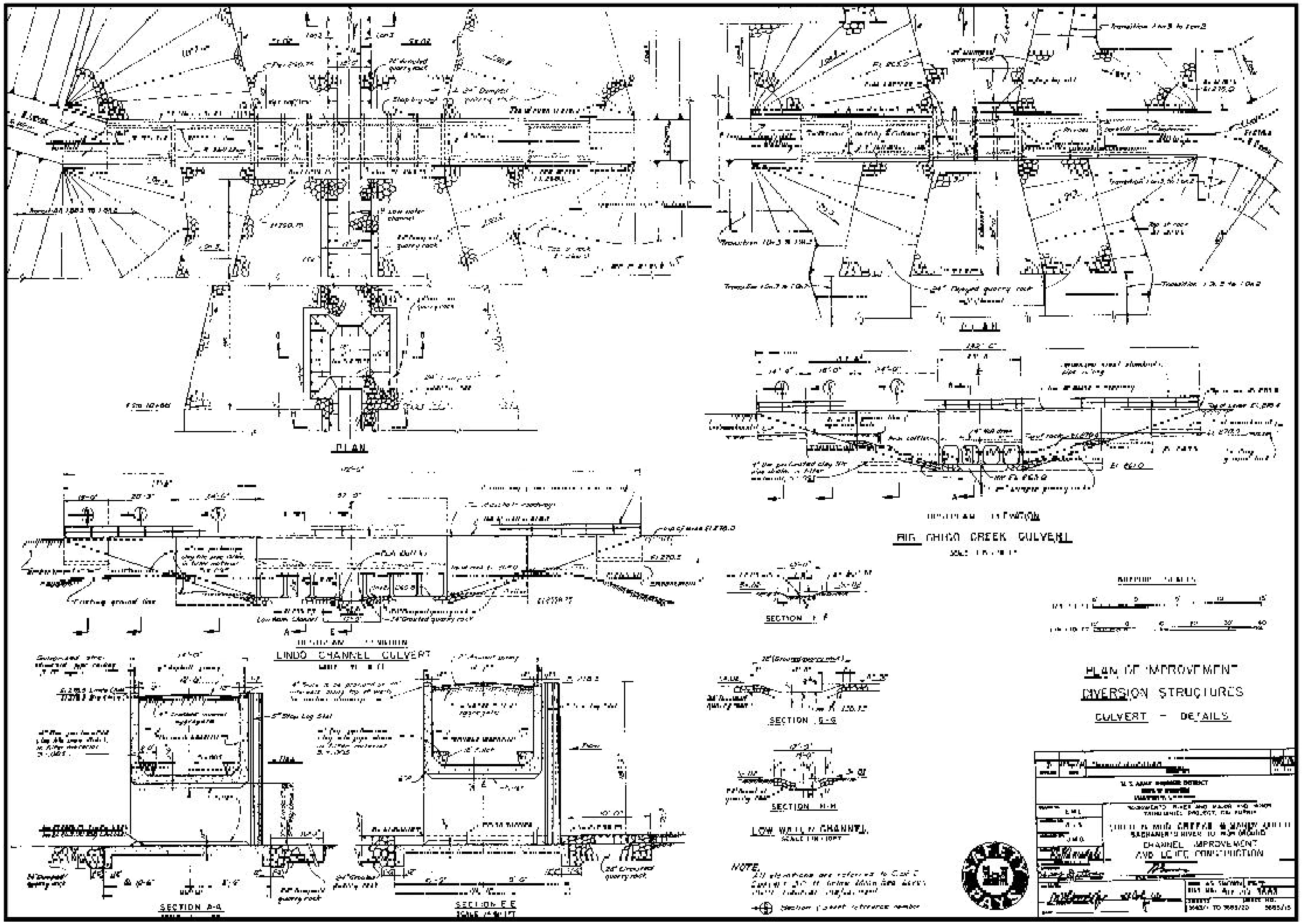

Figure 3. Diversion Structures Improvement Plan - Culvert Details.

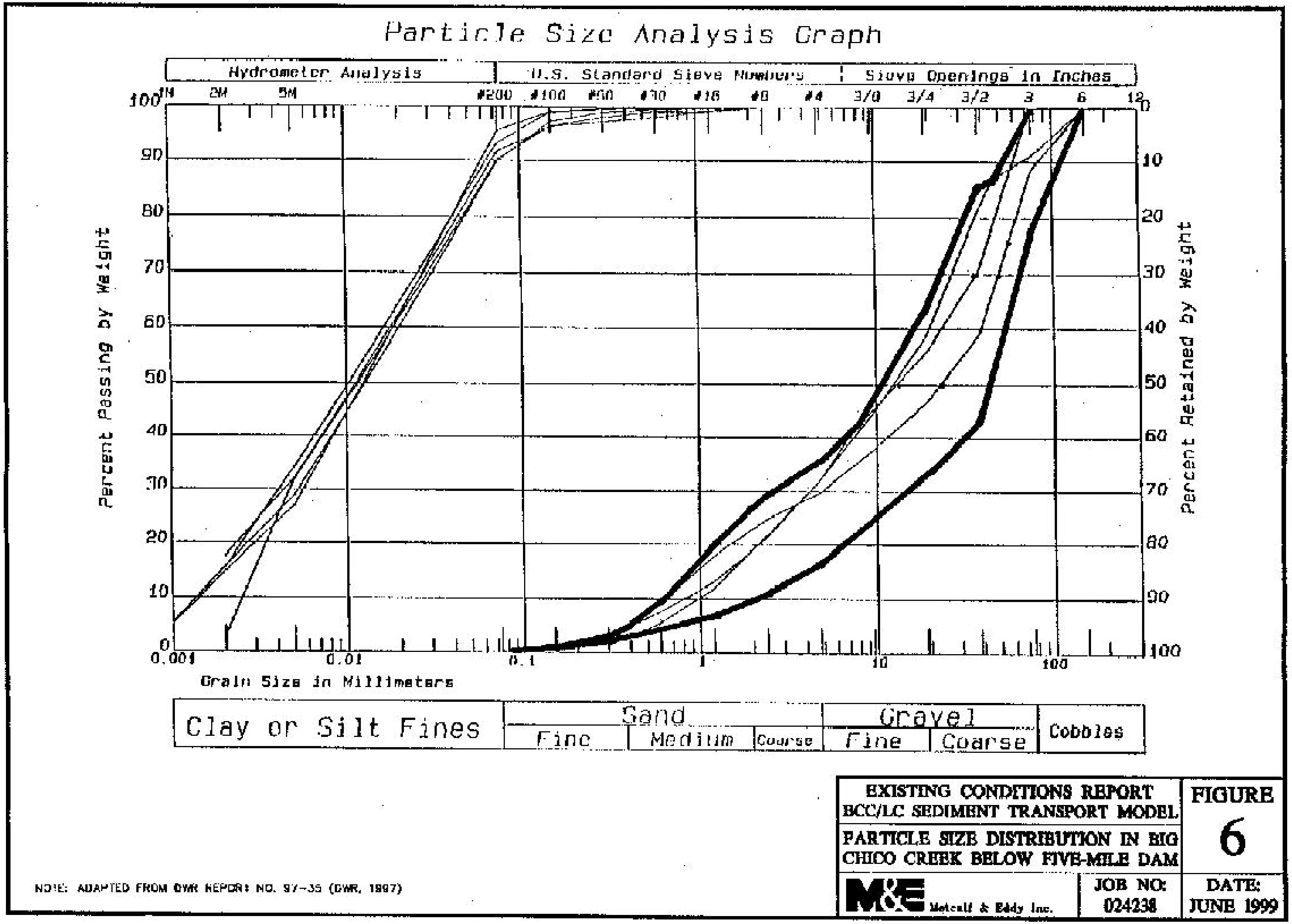

Figure 8. Particle size distribution in Big Chico Creek below Five-Mile Dam.
Source: Medcalf & Eddy Inc. (June 1999)

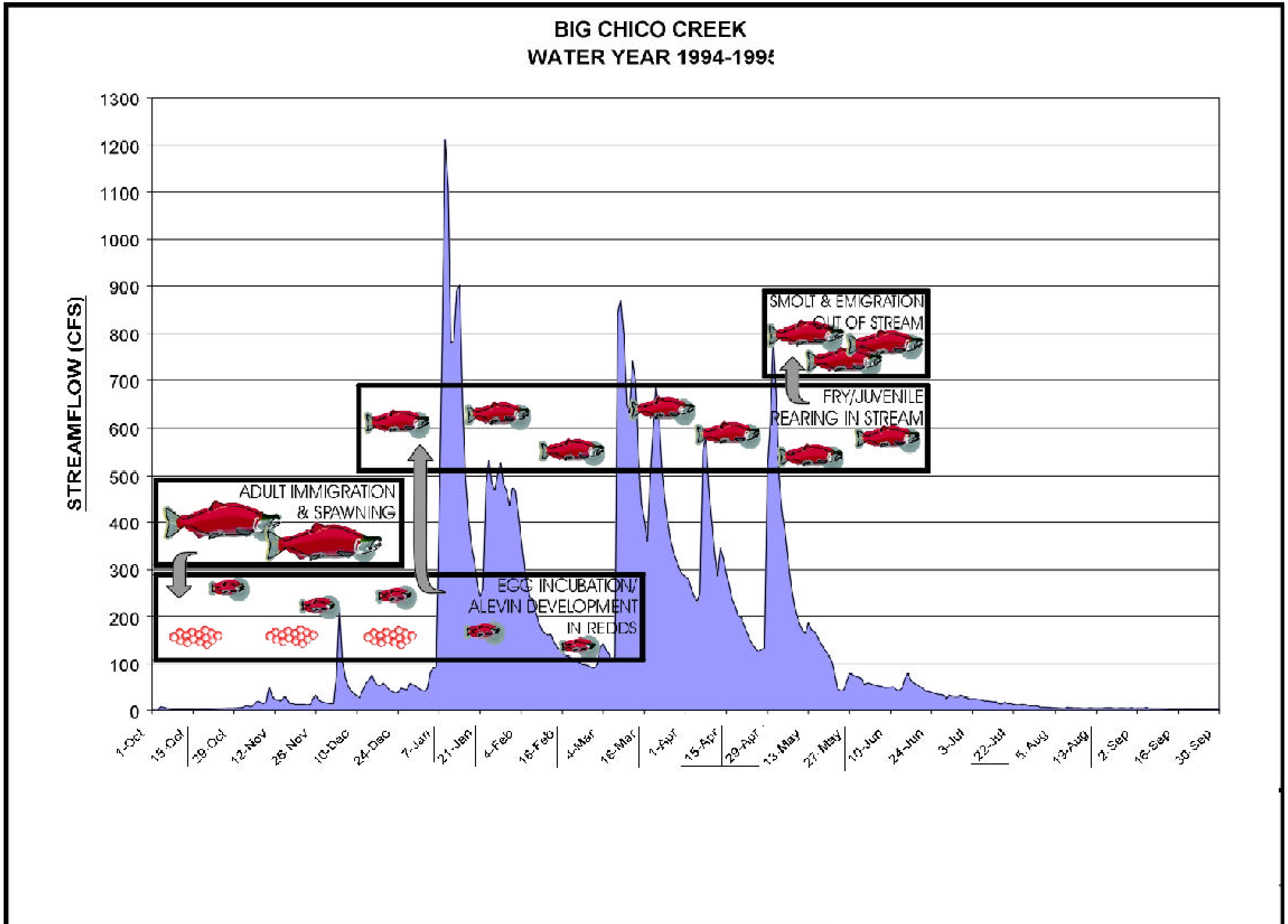

Figure 9. Anadromous fish life cycle versus Big Chico Creek annual hydrograph.
Source: Metcalf & Eddy, Inc. (June 1999).

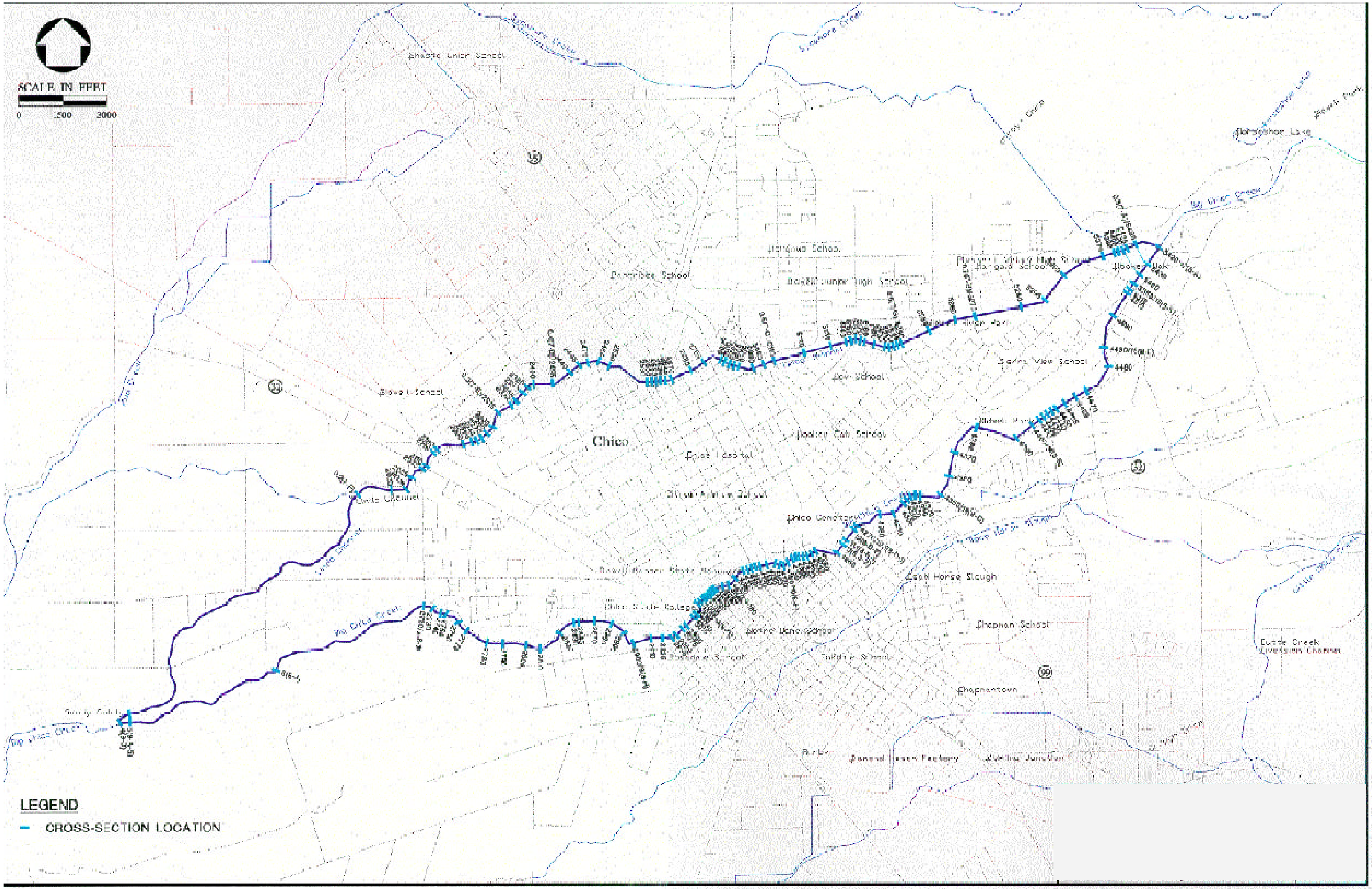

Figure 11. Stream cross-secton locations.
Source: Metcalf & Eddy Inc. (June 1999).

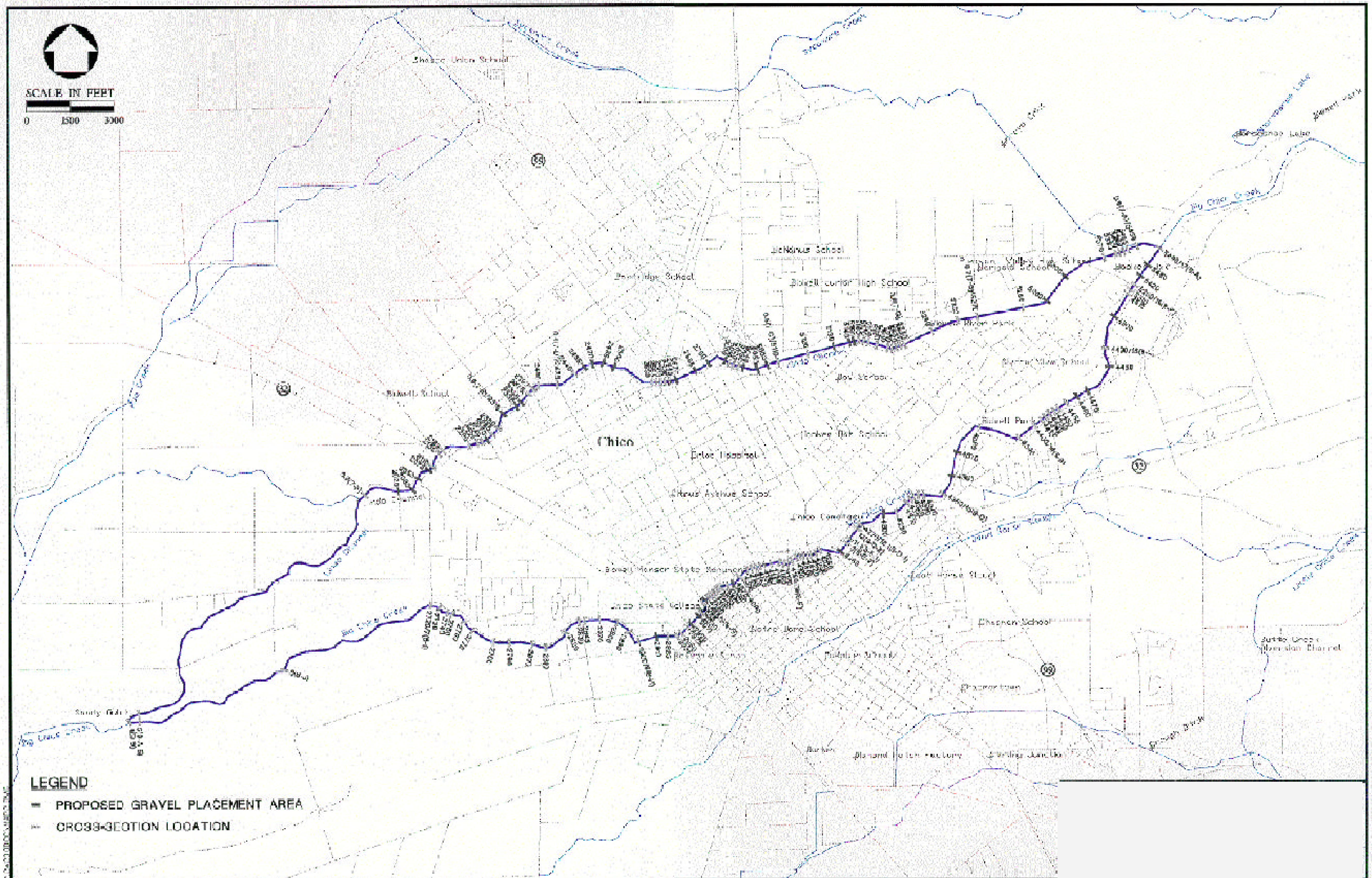

Figure 12. Proposed gravel placement locations.
Source: Metcalf & Eddy, Inc. (June 1999).