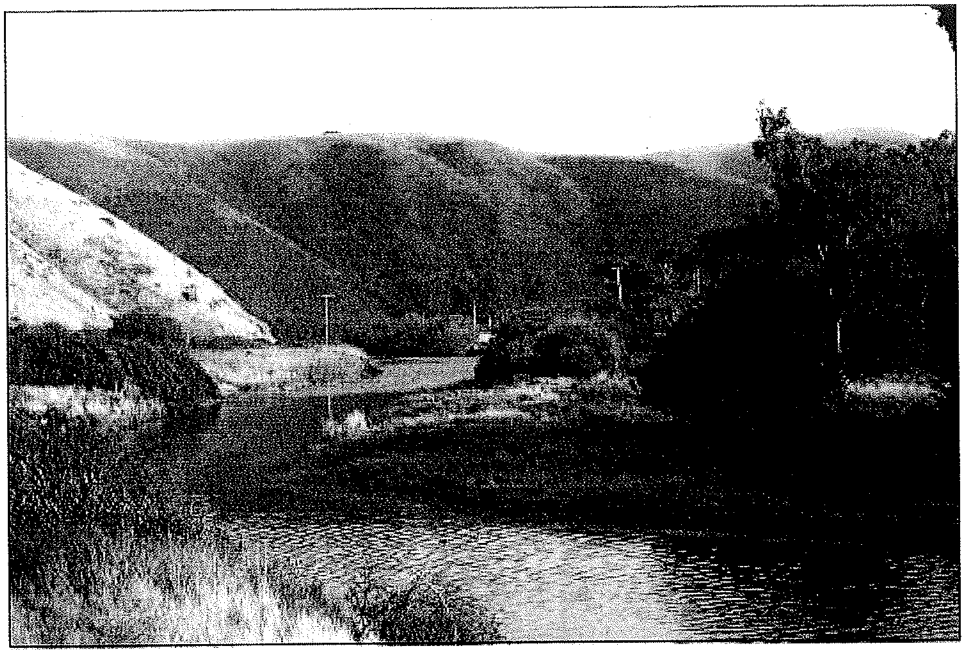
WALKER CREEK WATERSHED ENHANCEMENT PLAN



Prepared for

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ACKNOWLEDGEMENT

The principals and staff at Prunuske Chatham, Inc. wish to express our gratitude to the many Walker Creek landowners and residents who contributed to this plan. Many invited us and other Marin County Resource Conservation District representatives into their homes and ranches and generously shared information about the landscape and its history. Others participated in watershed meetings and workshops. We acknowledge all for their commitment to this place and their willingness to help create a future that keeps it healthy, productive, and beautiful.

1. INTRODUCTION

The *Walker Creek Watershed Enhancement Plan* has three primary components: a list of goals and next steps developed through community participation, recommendations for reducing sediment based on an erosion site inventory, and recommendations for enhancing riparian habitat based on a survey of existing and historic riparian plant communities. The development of the goals and next steps was funded through grants to the Marin County Resource Conservation District (MCRCD) from the National Fish and Wildlife Foundation, the Marin Community Foundation, and the Inverness Foundation. The erosion and riparian surveys were funded by a grant from the California Department of Fish and Game (DFG).

This plan is meant to be a dynamic document that changes as the community's goals change and that grows as new technical information is added to our knowledge of the watershed. Ongoing water quality monitoring, a proposed geomorphic analysis, and the salmonid population studies requested by the landowners are examples of information that can be incorporated into this plan in the future.

The goals and next steps were generated through one-on-one visits to landowners and a series of meetings and workshops. They were published three times at different stages in their development in *Walker Creek News*, the MCRCD's newsletter that is mailed to about 100 watershed residents, agency personnel, and other interested parties. The erosion site inventory was conducted on 58% of the watershed below Laguna Lake and Soulajule Dam where landowners granted access. Aerial photographs and observations from adjacent public roads provided additional information for the riparian survey.

The plan has two purposes. The first is to guide the MCRCD in selecting and implementing projects to restore and conserve the natural habitat of the watershed. The second is to create a cohesive set of directions for everyone who takes action that may affect the resources, from ranchers to policy makers, so that the community's goals for enhancing and protecting the landscape can be realized.

1.1 Watershed Description

The Walker Creek watershed drains into the northern end of Tomales Bay. Except for a tiny portion in Sonoma County, the 76 square mile drainage lies completely in northwestern Marin County. Topography ranges from 1,500 feet to sea level. The watershed contains some of western Marin County's wildest, most undisturbed landscape, along with some of the most degraded.

Since European settlement, the land use has been almost exclusively agricultural. Almost all of the watershed is in private ownership. Cattle ranching is the predominant industry, along with a few sheep ranches and dairies. In recent years, vineyard development has spread into the eastern edge of the watershed. Many of the current families have lived and worked in the watershed for generations and have a deep knowledge of the landscape and a strong commitment to the way of life that created it. The only concentrated development in the watershed occurs in the small town of Tomales.

The Walker Creek watershed has four main subwatersheds with distinctive characteristics. Keys Creek and Chileno Creek flow through grassy valleys with gentle hills; Salmon Creek and mainstem Walker Creek have much more rugged topography and extensive areas of coast live oak forest. The watershed still has significant stands of native perennial grasses and a 220-acre natural lake, Laguna Lake, at the top of Chileno Valley. Soulajule Reservoir, constructed in 1968 in Arroyo Sausal and enlarged in 1980, is managed by the Marin Municipal Water District (MMWD).

The watershed is home to several endangered and threatened species, including the tidewater goby (*Eucyclogobius newberryi*) and the freshwater shrimp (*Syncaris pacifica*). Walker Creek once supported both steelhead *(Oncorhynchus mykiss)* and coho salmon *(O. kisutch)* runs. Although declining, steelhead are still present, particularly in the area near the confluence of Chileno and mainstem Walker Creeks. DFG electroshocking of this area in the summer of 1997 found both young-of-the-year and older steelhead. Coho sightings have been very rare in the last fifteen years with the last two occurring in 1992 and1998 (Doss, 2000).

Walker Creek is listed as an impaired water body by the San Francisco Bay Regional Water Quality Control Board, with causes listed as sediment, high nutrients, and high fecal coliform. Fisheries studies undertaken in the 1970s and 1980s indicated that sedimentation and high temperatures were limiting salmonid populations (Kelley, 1976; Bratovich, 1984; Rich, 1989).

1.2 Summary of Recommendations

Specific recommendations are described in detail in the Goals and Next Steps (Section 2), Erosion Inventory and Recommendations (Section 4.4), and the Riparian Assessment and Recommendations (Section 5.5). Following is an overview of the major recommendations from each of these sections.

MCRCD's landowner outreach effort generated five goals for the enhancement of the Walker Creek watershed:

A. Support a strong agricultural economy.
B. Provide clear, factual information on the issues facing Walker Creek.
C. Help landowners implement land management practices that support a healthy environment.
D. Provide education for the public.
E. Work with regulatory agencies to reduce the burden on the watershed's private landowners.

Under each goal, the participating community members created a list of next steps—actions to implement the goal. These are divided into immediate (1-2 years), short-term (5 years), long-term (10-20 years), and ongoing actions. The next steps are also shown in the Timeline in Section 3.

One of the immediate actions under Goal C is to "Develop a 5-year workplan of projects submitted by landowners. Focus on projects that repair erosion, promote good grazing management practices, … restore riparian corridors, and reduce nutrient pollution." The erosion and riparian recommendations identify and prioritize sites to meet this goal.

The erosion inventory identified 196 sites on 58% of the watershed below Soulajule Reservoir and Laguna Lake. Gullies and headcuts accounted for 56% of the sites, streambanks for another 28%. The remaining sites consisted of road erosion and slides. Each site was described and evaluated for erosion activity, the potential for future sediment loss, access, and repair costs. The field inventory also identified possible repair strategies for each site. Of the 196 sites, 59 received a high priority for erosion repair based primarily upon their capacity to deliver sediment to aquatic habitat. These 59 sites were then ranked into eight groups depending on their impact to salmonid habitat. Table 3 in Section 4.4 shows the fisheries enhancement ranking.

The riparian assessment makes six broad recommendations and then identifies site-specific enhancement opportunities. The recommendations are:

- Revegetate high and medium priority sites with cooperative landowners. Priorities were assigned based on the opportunity to provide contiguous riparian habitat, to expand existing habitat, and to provide cover in areas of high erosion potential.
- Manage livestock access to creeks, especially during the wet season.
- Control invasive exotic species.
- Protect intact sections of riparian corridor.
- Maintain drainage structures such as culverts and ditches to prevent additional erosion in stream areas.
- Avoid depleting in-stream pools.

Although Walker Creek has not been a major salmonid fishery for many years, it has tremendous potential for restoration. First, the land use throughout the watershed is uniform and adaptable to water quality improvements, erosion control, and riparian habitat restoration. Second, with only one major reservoir high in the watershed, much of the historic salmonid habitat remains accessible. And last, over a third of the watershed's major landowners have expressed their willingness to cooperate with MCRCD on enhancement projects.

2. WALKER CREEK WATERSHED LANDOWNER GOALS

From 1998 through 2000, the MCRCD undertook an outreach effort in the watershed with funding from the Marin Community Foundation, the National Fish and Wildlife Foundation, and the Inverness Foundation. The purpose of the effort was to listen to what residents want for the future of their ranches and of their home landscape. Two public meetings, two workshops and two tours, 45 one-on-one visits to landowners, and a series of newsletters formed the structure of the outreach. In addition, many more landowners were interviewed during the inventories of riparian habitat and erosion sites. The following goals and next steps were generated from these meetings and visits.

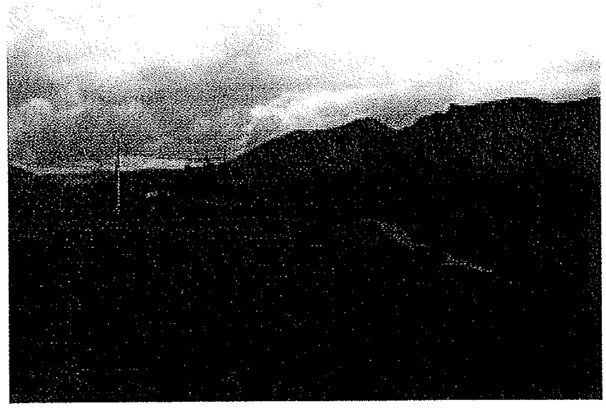
Over 95% of the watershed is in private ownership, more than any other watershed in Marin County. The families of many of the people who were interviewed or participated in meetings have made their living in this watershed for generations. The goals reflect their independence and their steadfast commitment to a strong agricultural economy. Underlying this need to maintain an economic base is a deep connection to this landscape—to their neighbors, to the wildlife and oak forests they grew up with, to keeping the open views and way of life that ranching provides.

The goals and the specific actions that follow each one were developed by the community as a part of this *Walker Creek Watershed Enhancement Plan*. The erosion and riparian habitat surveys include specific lists of sites where landowners have requested MCRCD assistance. The water quality monitoring and the songbird monitoring occurring on cooperating ranches with completed enhancement projects will also contribute to the larger plan.

A draft of the goals, without the specific actions, was printed in the May 2000 *Walker Creek News*, the watershed newsletter. The goals and actions were extensively reviewed in a landowner meeting on June 27, 2000. Their current form reflects landowner comments and revisions from that meeting. A couple of actions were moved from one goal to another; and two actions regarding public education (C5 and D4) were added. The next steps reviewed at that meeting have been divided into four categories. Immediate actions are underway or planned for the near future. Short-term actions can be completed within the next five years, long-term within the next ten to twenty years. Ongoing actions begin now and continue for the life of the program.

These goals are meant to be a dynamic, adaptable tool to help guide conservation and enhancement in the watershed. As current issues are addressed or new ones emerge, the goals and their actions will change.

2.1 Goal A. Support a strong agricultural economy.



Most watershed landowners want their area to stay in agriculture; many want productive grazing to continue as the primary land use. The deep commitment to the landscape gained from generations of living and working on one place is evident throughout the watershed. Walker Creek still supports a steelhead run and a rich diversity of bird life. Many ranches maintain healthy stands of native grasses, a testimony to a history of careful grazing. The Marin Agricultural Land Trust (MALT) holds agricultural easements on 19 watershed ranches. Year after year, landowners continue to participate in USDA cost-share programs to maintain and improve their ranches.

The current land use has kept native plant and animal communities relatively intact. In many cases, the habitat responds very quickly to minimal effort—a fence and a couple of new water troughs along a bare creek reach, for example, can spur lush riparian growth. Once the land use changes to more intensive, non-agricultural development, the experience and knowledge held within the residents diminish, and the ability of the land to heal itself quickly declines.

The key to saving family farms is keeping them financially sound. Protective land use policies, educating the general public, support with regulatory compliance, and a pro-active, well-informed agricultural community all help. This goal is deeply integrated into several others; additional specific actions are listed under Goals C, D, and E.

Ongoing Actions

A1. Design restoration projects to support agricultural activities, or at a minimum to not interfere with them. For example, grade control structures in gullies can provide livestock crossings, or riparian fencing can be designed with the rancher to create new grazing cells.

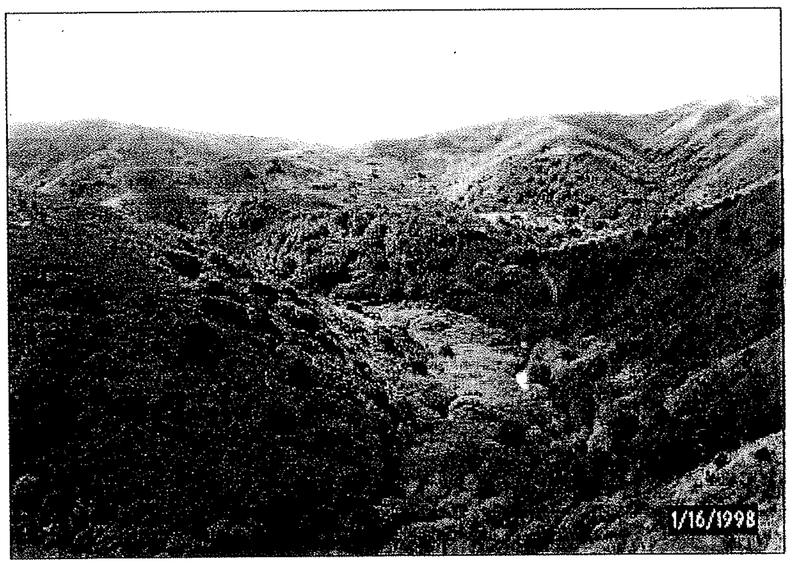
A2. Provide opportunities at least once a year for watershed landowners to review and comment on upcoming projects and to tour completed projects.

A3. Support and participate in programs that educate the public about agriculture and the consumption of local products. During the 1999/2000 school year, MCRCD helped bring STRAW (Students and Teachers Restoring a Watershed)—a program that takes school children and their parents, often from urban areas, out to ranches for restoration projects— to three Walker Creek ranches. In 2001, MCRCD is planning to team with STRAW and the Marin County Office of Education Program at Walker Creek Ranch to incorporate restoration projects into the regular curriculum. Other efforts are discussed in Goal D.

A4. Support and participate in programs and practices that keep ranchers on the land. Encourage codes and zoning that support agriculture.

2.2 Goal B. Provide clear, factual information on the issues facing Walker Creek.

Landowners have many questions about why Walker Creek is considered an impaired watershed. Has Soulajule Dam contributed to the fishery decline? What is the source of *E. coli* bacteria in Tomales Bay? Is past erosion control work making a difference? Where are the ducks? How much manure and sediment can Walker Creek and the Bay tolerate?



Although most landowners want to see the bulk of MCRCD's grant funding go to on-the-ground projects instead of extensive studies, they do need information in order to form their own opinions and make smart choices about managing their ranches. Some expressed concern that agriculturists are held responsible for nearly every problem in the watershed with little science to back up such claims.

Immediate Actions (1-2 years)

B1. Complete inventories of erosion sites and riparian habitat. Develop a list of potential work sites that have willing landowners.

B2. Request that the MCRCD Board send a letter to MMWD identifying landowner concerns and long-time observations regarding Soulajule Reservoir's impact on the Walker Creek fishery. Send a copy of the letter to DFG. Refer to the history of the dam, including one of the original intentions to benefit fish habitat. Landowners wished to explore eliminating summer releases as a possible solution to the poor water quality issue. They also expressed concerns about the release of trapped sediment and the loss of a significant water source if the dam was removed. Several questioned if the mines drowned by the reservoir might be contributing to downstream mercury.

Short Term Actions (5 years)

B3. Develop a water monitoring program with volunteer landowners at 5-10 sites. Train, equip, and support volunteer landowners. Monitor above and below Soulajule Reservoir. Coordinate with Regional Water Quality Control Board effort.

B4. Develop and begin implementation of a monitoring program for sediment.

B5. Request that DFG monitor fish populations and/or fish habitat, or work with other agencies and residents to develop and begin implementing such a program.

B6. Work with the Regional Water Quality Control Board and DFG to sample macro-invertebrates as an indicator of habitat quality. Provide training for interested landowners.

B7. Promote education of homeowners and boaters on Tomales Bay about how they can help reduce *E.coli* and other pollution.

Long Term Actions (10-20 years)

B8. Continue sediment monitoring.

B9. Continue fish or fish habitat monitoring.

Ongoing Actions

B10. Keep watershed landowners and residents updated on all ongoing studies, including the Regional Water Quality Control Board's mercury study, U.C. Cooperative Extension Service's cockle study, Tomales Bay Watershed Council proposed studies, and others.

2.3 Goal C. Help landowners implement land management practices that support a healthy environment.

Work on the land itself is at the heart of the enhancement efforts in the Walker Creek watershed. Almost all of the landowners interviewed want to control erosion on their ranches. They would like to see cleaner water in Walker Creek and more trees in the tributaries. Many remember huge runs of steelhead; they want to know why the fishery has declined and are concerned that agriculture is getting more than its fair share of the blame. In spite of this concern, ranchers want to be pro-active, to implement cost-effective projects that conserve soil and protect waterways. They also want these projects to be compatible with their management practices, so that they are simple to maintain and can be sustained over a long period of time.

Although many landowners have requested assistance with limiting livestock access to creeks, they want riparian fencing projects to be carefully designed so as not to create new problems. In most cases, fencing creek areas also requires developing alternative water sources for livestock and providing bridges or protected crossing areas. Noxious weeds, such as distaff thistle and poison hemlock, can thrive in excluded areas. Some willow species can grow into the channel and cause flooding or even additional erosion. Allowing controlled grazing within fenced areas (riparian pastures) at certain times of the year reduces weed growth, keeps willows trimmed so that they don't encroach across the channel, and contributes to the rancher's available forage. Other riparian species appropriate to the ecology of Walker Creek can be planted where willows would be too aggressive.

Landowners also expressed interest in fencing off dams from livestock, planting windbreaks, creating wetlands to filter runoff, and restoring fish passage to reaches of creek blocked by dams.

Immediate Actions (1-2 years)

C1. Develop a 5-year workplan of projects submitted by landowners. Focus on projects that repair erosion, promote good grazing management practices (springs, fencing, crossings, weed control, etc.), restore riparian corridors, and reduce nutrient pollution. Work closely with landowners to design projects that fit their individual site and management practices. Look for funding sources for projects.

C2. Develop a maintenance and evaluation plan for all projects. Include long-term maintenance and monitoring in funding requests.

C3. Develop a protocol for maintaining fenced areas. Educate regulators about the benefits of maintenance. If permits are needed for maintenance activities, incorporate them into the one-stop process described in Goal E.

Short Term Actions (5 years)

C4. Complete projects developed in workplan. Begin maintenance and monitoring.

C5. Along with tours (see A2), publish results of projects in the newsletter to keep landowners informed of how different practices are working.

Long Term Actions (10-20 years)

C6. Revise workplan and continue implementation.

C7. Continue maintenance and monitoring of completed projects.

Ongoing Actions

C8. Consider cost-effectiveness and compatibility with agricultural practices when selecting projects. Be careful not to waste watershed funding on "natural erosion" such as landslides.

C9. Keep watershed residents informed of new funding sources through the newsletter.

C10. Coordinate education and implementation efforts with NRCS, U.C. Cooperative Extension Service, Tomales Bay Watershed Council, Marin County Agricultural Commissioner, Tomales Bay Watershed Council, and others. Work together to create a coherent, thoughtful effort that supports watershed landowners in being excellent land stewards.

2.4 Goal D. Provide education for the public.

Many Walker Creek watershed agricultural landowners are very interested in helping the public – non-ranching residents of Marin County, environmentalists, elected official, and regulators – to understand their efforts to maintain open space and a healthy environment, while at the same time generating a decent living from their land. On the other hand, public concerns over shared resources, such as clean water in Tomales Bay or steelhead runs in Walker Creek, can have a profound impact on day-to-day ranching. Ongoing opportunities for dialogue between people in the ranching and non-ranching communities are needed to keep both groups informed and cooperating.

Immediate Actions (1-2 years)

D1. Continue to work with STRAW (see A3). Coordinate with U.C. Cooperative Extension Service, Walker Creek Ranch, Marin Summer Agricultural Curriculum Workshop, and other programs.

Ongoing Actions

D2. Publicize successes. Be aggressive about getting news coverage of positive actions undertaken by agriculture to conserve and improve the natural environment.

D3. Hold tours for the general public. Organize the tours with plenty of opportunities for landowners and participants to talk. Encourage citizens to come to producers first whenever possible with their concerns, instead of going straight to a regulator.

D4. Share technical information gained from implementing enhancement projects through handouts, the newsletter, and presentations.

D5. Use the watershed newsletter to keep the local community updated on MCRCD projects as well as efforts by the Tomales Bay Advisory Group, the Tomales Bay Watershed Council, U.C. Cooperative Extension Service, Marin County, the National Park Service, the Natural Resource Conservation Service, and other organizations and agencies.

2.5 Goal E. Work with regulatory agencies to reduce the burden on the watershed's private landowners.

A continual theme running through meetings and conversations with Walker Creek landowners is the growing pressure of environmental regulation on operating a ranch or farm. Controlling invasive weeds, repairing gullies or eroding streambanks, upgrading dairy waste treatment facilities, and developing new water sources to keep livestock out of stream corridors are among the management activities that are now highly regulated, usually by more than one agency. Although it appears many years away for Walker Creek, the TMDL (Total Maximum Daily Load) process required by the Clean Water Act will likely set limits on nutrients and sediment entering Walker Creek and its tributaries. Even though many of the ranchers might support the fundamental intent behind environmental laws, the cost and time required to keep up-to-date and fully compliant with all of them can be overwhelming. Once the proper permits are submitted, it can take months or even a year to receive approval, seriously delaying weather-dependent construction and driving up costs.

Sustainable Conservation, a non-profit organization that successfully developed a one-stop permit program for farmers in Elkhorn Slough, has offered to help develop a similar program to simplify permitting for standard practices used in Marin County agricultural watersheds. The newly formed Tomales Bay Watershed Council is bringing together 25 agencies and organizations to better understand the Bay and its tributaries and to coordinate regulatory and implementation activities.

Short Term Actions (5 years)

E1. Work with regulatory agencies and other organizations to simplify environmental permitting. Develop a one-stop permitting process for standard agricultural activities.

Ongoing Actions

E2. Encourage the development of ranch plans as a planning tool for ranchers' own use, but do not require them for participation in the MCRCD watershed program. Ranch plans developed with MCRCD assistance will be private and held by the landowner.

E3. Use the watershed newsletter to keep landowners updated on new legislation and changes in existing laws, and to keep regulators informed about landowner efforts.

3. WALKER CREEK WATERSHED ENHANCEMENT PLAN TIMELINE

All actions will be incorporated into the Marin County RCD Annual and Long Range Plans and evaluated on a yearly basis.

Immediate Actions (1-2 Years)	Progress Made	Next Steps
Complete inventory of erosion sites and riparian habitat. Develop list of potential work sites that have willing landowners.	✓ Performed erosion site inventory on 20 ranches, identified 196 erosion sites. ✓ Performed riparian assessment, identified opportunities to restore riparian corridor. ✓ Completed project list consisting of 25 willing landowners.	✓ Expand list of project sites through the recruitment of willing landowners.
Request that MCRCD Board send letter to MMWD identifying landowners' concerns and long-time observations regarding Soulajule Reservoir's impact on the Walker Creek fishery. Landowners wished to explore eliminating summer releases as a possible solution to the poor water quality issue. They also expressed concerns about the release of trapped sediment and the loss of a significant water source if the dam were removed. Several landowners questioned if the mine drowned by the reservoir might be contributing to downstream mercury.	✓ Held landowner workshop with MMWD staff explaining management of Soulajule and impact on fishery. ✓ MMWD is researching historical records to determine if information is available pertinent to the old mercury mine.	✓ Draft letter to MMWD referring to history of the dam, including one of the original intentions to benefit fish habitat. ✓ Publish results of mercury mine research data from MMWD in upcoming *Walker Creek News*.

Immediate Actions (1-2 Years)	Progress Made	Next Steps
Develop a 5-year work plan of projects submitted by landowners. Focus on projects that repair erosion, promote good grazing management practices, restore riparian corridors, and reduce nutrient pollution. Work closely with landowners to design projects that fit their individual site and management practices. Look for funding sources for projects.	✓ Completed 3-year work plan based on participation of 25 landowners and availability of funding sources. ✓ Submitted grant to State Coastal Conservancy in the amount of $200,000. Year 1 funding pending approval. ✓ Submitted grant to California Department of Fish and Game in the amount of $300,000. Not awarded. Will resubmit proposal for $400,000+ on May 18, 2001. ✓ Submitted grant to State Water Resources Control Board in the amount of $750,000.	✓ Complete years 4 and 5 of work plan for projects submitted by landowners. ✓ Complete CEQA for SCC year 1 projects. ✓ Work with SCC to solidify funding for years 2 and 3. ✓ Resubmit DFG grant by May 18, 2001, after consultation with DFG staff. ✓ Resubmit SWRCB grant after consultation with SWRCB staff if grant is not awarded.
Develop a maintenance and evaluation plan for all projects. Include long-term maintenance and monitoring in funding requests.	✓ Completed maintenance of 3 projects with AmeriCorps members. ✓ Evaluated 7 restoration projects based on bird populations and diversity of species. ✓ Expanded monitoring program into neighboring watersheds to include 30 sites in year 2. ✓ Included partial maintenance program in State Coastal Conservancy grant. ✓ Included water monitoring program in State Water Resources Control Board Grant. ✓ Developed riparian and erosion monitoring programs.	✓ Recruit additional AmeriCorps staff to complete maintenance program of additional projects. ✓ Recruit intern to accommodate for additional bird monitoring sites. ✓ Distribute water monitoring equipment to landowners and follow up with progress. ✓ Revise maintenance and evaluation plan in landowner agreements. ✓ Incorporate maintenance and evaluation in future implementation grants.
Develop a protocol for maintaining fenced areas. Educate regulators about the benefits of maintenance. If permits are needed for maintenance activities, incorporate them into the one-stop permitting process.	✓ Worked with Sustainable Conservation to determine permit applicability for stream areas. ✓ Initiated one-stop permitting process in consultation with Sustainable Conservation.	✓ Complete protocol for maintaining fenced areas.

Short Term Actions (5 Years)	Progress Made	Next Steps
Develop a water monitoring program with volunteer landowners at 5-10 sites. Train, equip, and support volunteer landowners. Monitor above and below Soulajule Reservoir. Coordinate with Regional Water Quality Control Board effort.	✓ Purchased 10 water monitoring kits for landowners that monitor for the following parameters: pH, temperature, ammonia, dissolved oxygen, and conductivity. ✓ Conducted Mercury Mine Workshop with RWQCB staff presentations on mercury monitoring.	✓ Distribute all monitoring kits, advertise via watershed newsletter. ✓ Follow up on monitoring progress with site visits. ✓ Continue to update landowners on status of RWCQB findings of mercury concentrations of fish in Soulajule Reservoir.
Develop and begin implementation of a monitoring program for sediment.	✓ Contacted Regional Water Quality Control Board staff regarding geomorphology proposal and coordination with current monitoring program.	✓ Update landowners on RWQCB monitoring of downstream sediments. ✓ Submit geomorphology proposal to SWRCB.
Request that DFG monitor fish populations and/or fish habitat, or work with other agencies and residents to develop and begin implementing such a program.	o Made initial contact with DFG Fisheries Biologist.	✓ Continue to work with DFG and other agency staff.
Work with the Regional Water Quality Control Board and DFG to sample macro-invertebrates as an indicator of habitat quality. Train interested landowners.	✓ Discussed benthic survey being conducted by RWQCB staff in 2001-2002 and possible coordination with RCD project sites.	✓ Talk to RWQCB staff and RCD Board regarding possibility of a macro invertebrate workshop for landowners.
Promote education of homeowners and boaters on Tomales Bay about how they can help reduce *E.* coli and other pollution.	✓ Worked with Tomales Bay SepTAC to address septic issues for homeowners on the Bay.	✓ Work with the Tomales Bay Watershed Council to produce educational materials. ✓ Work with the Tomales Bay SepTAC to develop materials for educational purposes.

Short Term Actions (5 Years)	Progress Made	Next Steps
Complete projects developed in work plan. Begin maintenance and monitoring.	✓ Completed five restoration projects.	✓ Complete half of high priority projects as identified in the erosion site inventory.
Along with the tours, publish results of projects in the newsletter to keep landowners informed of how different practices are working.	✓ Published results of 5 new restoration projects in Walker Creek News.	✓ Continue to follow up on the progress of old and new restoration sites by highlighting one project per newsletter. ✓ Hold annual tour of restoration projects with landowners.
Work with regulatory agencies and other organizations to simplify environmental permitting. Develop a one-stop permitting process for standard agricultural activities.	✓ Held meeting and tour with regulatory agencies regarding possibility of permit coordination program. ✓ Identified list of practices to be included in program. ✓ Coordinated effort with Sustainable Conservation.	✓ Have meeting with regulatory agencies to review practices and permit conditions. ✓ Notify members of the Tomales Bay Watershed Council and collect public input.

Ongoing Actions:

✓ Design restoration projects to support agricultural activities, or at a minimum to not interfere with them. For example, grade control structures in gullies can provide livestock crossings, or riparian fencing can be designed with the rancher to help better manage grazing in adjacent pastures.

✓ Provide opportunities at least once a year for watershed landowners to review and comment on upcoming projects and to tour completed projects.

✓ Support and participate in programs that educate the public about agriculture and the consumption of local products. During the 1999/2000 school year, MCRCD helped bring STRAW (Students and Teachers Restoring A Watershed) – a program that takes school children and their parents, often form urban areas, out to ranches for restoration projects – to three Walker Creek ranches. This year, MCRCD is planning to team with STRAW and the Marin County Office of Education Program at Walker Creek Ranch to incorporate restoration projects into the regular curriculum.

- ✓ Support and participate in programs and practices that keep ranchers on the land. Encourage codes and zoning that support agriculture.
- ✓ Keep watershed landowners and residents updated on all ongoing studies, including the Regional Water Quality Control Board's mercury study, U.C. Cooperative Extension Service's cockle study, Tomales Bay Watershed Council proposed studies, and others.
- ✓ Consider cost-effectiveness and compatibility with agricultural practices when selecting projects. Be careful not to waste watershed funding on "natural erosion" such as landslides.
- ✓ Keep watershed residents informed of new funding sources through the watershed newsletter.
- ✓ Coordinate education and implementation efforts with NRCS, U.C. Cooperative Extension Service, Tomales Bay Watershed Council, Marin County Agricultural Commissioner, and others. Work together to create a coherent, thoughtful effort that supports landowners in being excellent land stewards.
- ✓ Publicize successes. Be aggressive about getting news coverage of positive actions undertaken by agriculture to conserve and improve the natural environment.
- ✓ Hold tours for the general public. Organize the tours with plenty of opportunities for landowners and participants to talk. Encourage citizens to come to agricultural producers first whenever possible with their concerns, instead of going straight to the regulator.
- ✓ Share technical information gained from implementing enhancement projects through handouts, the newsletter, and presentations.
- ✓ Use the watershed newsletter to keep the local community updated on MCRCD projects as well as efforts by the Tomales Bay Advisory Group, the Tomales Bay Watershed Council, U.C. Cooperative Extension Service, Marin County, the National Park Service, the Natural Resources Conservation Service (NRCS), and other organizations and agencies.
- ✓ Encourage the development of ranch plans as a planning tool for rancher's own use, but do not require them for participation in the MCRCD watershed program.
- ✓ Use the watershed newsletter to keep landowners updated on new legislation and changes in existing laws and regulators updated on landowner efforts.

4. WALKER CREEK WATERSHED EROSION SITE INVENTORY

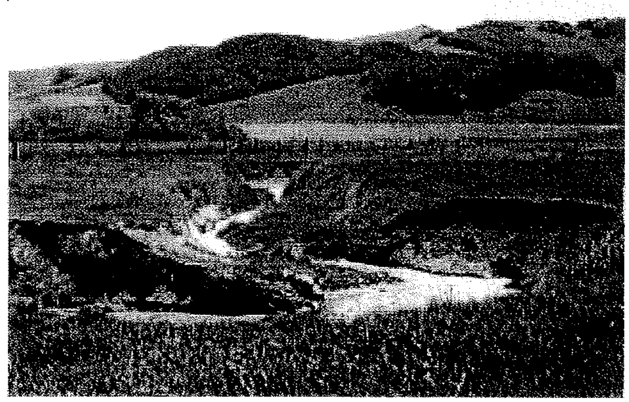
4.1 Introduction

Erosion is a natural process that brings nutrients and beneficial substrates to aquatic ecosystems. However, accelerated erosion can overload watercourses with sediment. Too much sediment reduces flood capacity, fills wetlands and in-stream pools, and settles in the spaces between gravel and cobble to form a cemented, uniform surface on the stream bottom—poor habitat for young fish and aquatic insects. Accelerated erosion is often directly or indirectly caused by human disturbance in the landscape.

Erosion and sedimentation are important contributors to the decline of many animal species, including steelhead and coho salmon in Walker Creek and its tributaries (Rich, 1989; Bratovich, 1984). Huge slugs of sediment from erosion in the upper watershed have destabilized downstream channel banks and filled in critical rearing habitat.

W.W. Haible, in his 1976 geomorphology study of Walker Creek, stated that the inner terrace in the upstream reaches of Walker Creek, a floodplain only 60 years earlier, stood 1-5 meters above the current floodplain. Longtime Marin County rancher Boyd Stewart, who lived at the Walker Creek Ranch, illustrated this with his memory of driving a horse and buggy easily across a section of the main channel that is now deeply incised (Stewart, 1995). Small landings cut into the bluffs over Keys Creek downstream of Tomales show where farmers once brought potatoes to be loaded onto barges. The reach is now so choked with sediment that it would be difficult to navigate through it in anything much larger than a canoe.

According to research on sedimentation in Tomales Bay, many of these changes occurred episodically following intensive farming in the late 1800s and early 1900s, as well as during the big storms of the 1980s and early 1990s (Daetwyler, 1966; Hollibaugh, 1995; UCCE, 1995). To analyze the effects of these historical events, MCRCD is proposing to work with the Tomales Bay Watershed Council to undertake a comprehensive, current geomorphologic analysis of the watershed.



Even if the dramatic rates of erosion and sedimentation in the watershed are slowing down, the past destabilization is still causing

erosion that imperils the fragile salmonid fishery. Small drainages throughout the watershed continue to downcut to reach the incised stream channels. Until new and stable floodplain terraces form, streambanks in many reaches are actively eroding.

The site survey brings a very pragmatic approach to erosion in the watershed. The basic intention of the survey was to identify erosion repairs that would provide immediate benefit to aquatic habitat with the added urgency to protect and enhance existing salmonid habitat. In addition, the survey notes where other benefits, such as creation of songbird corridors or community education, could be served by enhancement projects.

Because the survey focused on salmonid habitat, the 24.3 square miles above Soulajule Dam and Laguna Lake were not included. Of the remaining 51.4 square miles in the watershed, 21 landowners on 29.9 square miles granted permission to the MCRCD for survey access. These landowners represent approximately 35% of the watershed's agricultural landowners, an amazing percentage for a voluntary survey. We acknowledge them for their cooperation and commitment to conservation.

4.2 Survey Methods

A field inventory was conducted in the Walker Creek watershed below Soulajule Dam and Laguna Lake on ranches whose owners chose to participate. Figure 1, Walker Creek Watershed Erosion Sites, shows the areas of the watershed surveyed and the locations of high, medium and low priority erosion sites within these areas.

The field inventory focused on mapping sites of significant accelerated erosion, which is defined using CEQA (California Environmental Quality Act) guidelines as follows:

> Highly active, bare soils with a chronic yield of fine sediment and a high potential to continue to erode at a rapid rate into downstream watercourses and which may reasonably be expected to negatively impact water quality or habitat values on or off-site.

A field investigator walked all tributaries, drainages, and existing roads on the participating ranch properties. Aerial photos and USGS topographic maps were also reviewed. Information was recorded for each site on individual field data sheets and compiled in a database (see Appendix A for examples of several records from the erosion survey database). The inventory also included a photograph of each site and for some sites, a sketch. Additional notes were made describing unique situations where other benefits would result from the repair of a site, such as the value of a community demonstration project or restoration for non-salmonid wildlife habitat. The erosion sites were classified as high, medium, or low priority based on an assessment of each of the following variables and how they combine to provide a functional opportunity to reduce sediment delivery to the system.

The following information was collected for each site:

Subwatershed. The watershed was divided into the following subwatersheds: Walker Creek (main channel), Chileno Creek, Salmon Creek, Arroyo Sausal, lower Walker Creek, and Keys Creek.

Landowner. The name of the property owner who voluntarily participated in the MCRCD's Walker Creek Erosion and Sediment Source Inventory was recorded on each field form. To respect the privacy of the landowners, specific names have been omitted from Figure 1 and the database and replaced with record numbers.

Location. The site location was briefly described relative to structures and land features of the ranch being surveyed. Locations were also mapped onto USGS topographic maps.

Land Use. The dominant land use at the erosion site was recorded. In the case of livestock grazing, this field was occasionally broken down further into feed lot, corral, pasture, riparian pasture, riparian, or rangeland.

Description. The description briefly indicates the erosion process occurring at the site. Listed below are terms used to describe erosion sites:

- **Toe scour.** Parallel flow along the base of a streambank where increased velocities and shear stress remove bank material.
- **Impinging flow.** A concentrated flow of water angled towards the bank causing increased turbulence and scour. Often caused by woody debris or episodic sediment deposition.
- **Piping.** Groundwater seepage that forces an opening around or through soil, which leads to bank failure. As water flows through the opening, it carries away sediment, and the hole grows larger.
- **Sheet or rill erosion.** Sheet erosion is caused by non-channelized, overbank flow over bare or poorly vegetated soil; it often leads to rill erosion. Rill erosion occurs when sheet flow begins to concentrate and follow the path of least resistance, thus developing small gully systems.
- **Gully erosion.** Gully erosion occurs when runoff concentrates and becomes channelized through unstable soils.

- **Geotechnical.** Applies to bank failures or upland erosion caused by slope mechanics other than flowing water. Examples include rock/soil falls, shallow slides, rotational slips (slumps), slab/block failure, cantilever failures, pop-out failures, etc.
- **Vertical instability.** Streambank erosion that occurs as a result of channel downcutting leading to over-steepening of the vertical banks.
- **Headcut or nick point.** A break in the slope at the top of a gully or section of channel that forms a step or "waterfall." As the flowing water scours away soil, the step moves upslope.
- **Channel incision.** Occurs when a channel's streambed has downcut or degraded, changing the channel to an entrenched geometry with over-steepened vertical banks and abandonment of adjacent flood plains. Often associated with headcutting.
- **Scour.** The localized removal of bed material from the streambed by flowing water. The opposite of fill. Bed scour can be beneficial—contribute to pool development, for example—or a threat to vertical stability. Bed scour that occurs downstream of installed boulder steps, rock weirs, or erosion control structures should be repaired if the scour threatens to undermine and destabilize the upstream structures.
- **Debris jam.** Log jam. Accumulation of logs and other organic debris.
- **Sediment deposition.** The settling or accumulation of material out of the water column and onto the streambed. Sediment deposition will be considered significant if the deposited material reduces the channel's capacity such that frequent flooding occurs and threatens stream function or private property. Sediment deposition may also lead to lateral instability or bank erosion.
- **Road erosion.** Includes inboard ditches, ditch relief culverts, stream crossings, road surface rilling, fill slope failures, cut slope erosion, and more. Road erosion is considered if its sediment delivery is connected to the stream channel through gullies, road ditches, culverts, or other drainage features. Road erosion is not as major a source of sediment in the Walker Creek watershed as it is in most north coast watersheds.

Predominant Material. An erosion site's predominant material (bedrock, boulder, cobble, gravel, sand, silt/clay, or topsoil) is recorded to help determine repair priority. Since sediment particles smaller than 0.6 mm in diameter are usually considered impairing to salmonid habitat, sites comprised of mostly fine sediments will have a higher repair priority. Erosion sites comprised of larger gravel and cobbles may actually be beneficial to downstream aquatic habitats.

Erosion Type. Chronic erosion is erosion that is constant and occurs during significant to normal rainfall events on a yearly basis. Common types of chronic erosion are sloughing, sheet erosion, rilling, and headcutting. Episodic erosion occurs occasionally, often in a big pulse. A landslide is an example of episodic erosion. Erosion problems can be both chronic and episodic, such as a landslide that continues to erode.

Erosion Activity. A highly active site will be characterized by newly exposed, bare soil, lack of vegetation, vertical or unstable slopes, and/or fresh, loose sediment deposited at the base of the site.

Erosion Potential. This is a field estimate of how much soil could potentially move down from the erosion site in the future. Erosion potential is determined by considering the cause of the erosion, the future erosion process likely to take place, and the stability of the threatened upslope material. Upslope stability (i.e., soil resistance to erosion, presence of bedrock, drainage area, vegetation, and grade control) is the key factor to determining whether a site has high, medium, or low erosion potential. A headcut at the top of an unstable gully, for example, with the potential to deliver high quantities of sediments downstream would be assigned a high priority.

Access Rating. Access is ranked either high, medium, or low. High access means materials and equipment can be delivered to the site easily and in a timely manner. Medium access requires a 4-wheel drive vehicle or construction of a temporary road to repair the site. Material may need to be stocked piled off-site and moved in with specialized equipment such as 4-wheel drive or track loaders. Low access sites can be reached by hand crews only. Project materials need to be collected on site or delivered by other means such as a helicopter or pack animals.

Estimated Repair Costs. These are quick field estimates of the cost range to repair the erosion site. The cost estimate is an order-of-magnitude number for future funding and planning purposes. Actual repair cost estimates can only be developed after construction plans are completed. Field sheet cost estimates do not include permitting, design, or construction supervision.

Repair Priority. The most significant factor in assigning a high, medium, or low repair priority is a site's ability to deliver sediments that will negatively affect water quality and aquatic habitat value. Further considerations include the erosion potential and activity rate of the site and the cost to control the erosion. Access rating is a key factor to repair costs and must also be considered when developing repair priorities. For example, a headcut with a high potential to deliver large amounts of sediment, good access, and low repair costs might have a higher priority then a landslide in a remote location with large repair costs and the same sediment delivery potential.

Repair Type. The reverse side of the inventory worksheet has a list of typical repairs, including biotechnical repairs. Sample specifications of many of these are included in Appendix B.

Other Benefits. The erosion inventory database includes a category to describe benefits of repairing a site other than a direct improvement to aquatic habitat from erosion control. Except for fisheries value, these benefits were not considered when ranking fisheries enhancement opportunities for this report (see Table 3, Section 4.4). However, they were noted and assigned their own value-rating category to be used by the MCRCD for future projects. In the long term, these benefits may indirectly impact fisheries habitat. Developing projects with key community leaders, for example, can inspire neighboring landowners. Choosing an initial project that supports the agricultural operation of a particular ranch or dairy operation may open the door for more extensive restoration projects at that site.

- **Rancher Value.** This rating reflects a site's importance to ranch or farm operations. An example of a project with high rancher value might be installation of a bridge to maintain year-round pasture access.
- **Wildlife Value.** Wildlife value reflects a site's potential to provide cover, forage, and contiguous habitat for a wide range of wildlife including amphibians, reptiles, waterfowl, and neotropical songbirds.
- **Educational Value.** Sites utilizing new technology, highly visible from nearby roads, or done in conjunction with other ranch planning and best management practices would receive a high educational value even though they might produce little sediment. Also considered in this category were sites appropriate for student or volunteer participation.
- **Community Value.** Repair of sites with a high community value would build community support for watershed enhancement. An example of this would be assisting a rancher who is testing a new best management practice before others invest time and funding.
- **Fisheries Value.** Sites that would be suitable for fisheries habitat enhancement projects beyond the control of sediment. Projects at these sites could include the placement of large woody debris, boulders, gravels, or vegetation for salmonid spawning and rearing habitat.

4.3 Watershed Characterization

For the purpose of this investigation, the watershed was subdivided into six major subwatersheds: Keys Creek, Chileno Creek, Salmon Creek, Arroyo Sausal, mainstem Walker Creek, and lower Walker Creek. All of the surveyed erosion sites are shown on Figure 1. Table 1 shows the type of erosion identified in the surveyed areas of each subwatershed. Appendix A provides examples of records from the erosion survey database.

Table 1. Erosion Sites Identified by Subwatershed

	Subwatershed						
Erosion Type	**Keys Creek**	**Chileno Creek**	**Salmon Creek**	**Arroyo Sausal**	**Mainstem Walker Creek**	**Lower Walker Creek**	**Subtotals**
Headcut/Gully	25	32	8	4	40	10	119
Bank Failures	8	19	7		21	2	57
Road Erosion/Culverts			1	2	6	1	10
Slide/Slip		1			8	1	10
Totals	33	52	16	6	75	14	196

4.3.1 Keys Creek

Keys Creek is the northernmost subwatershed. Like its neighbor to the north, Stemple Creek, it is an area of grassy, gentle hills and low-gradient streams. Gully erosion accounts for 76% of the sites surveyed. Some of the deepest and most active gullies in the watershed drain into Keys Creek. Although these sites were given a high erosion priority (see Table 2), they were not assigned a high fisheries enhancement ranking (see Section 4.4) for two reasons. First, neither steelhead trout nor coho salmon are found in Keys Creek, and, second, Keys Creek enters Walker Creek just before Tomales Bay so its sediment has little impact on critical salmonid habitat in mainstem Walker Creek. However, sediment from Keys Creek likely has a significant impact on the function and ecology of Tomales Bay and the mouth of Walker Creek.

Table 2. Erosion Priorities by Subwatershed

	Subwatershed						
Priority Ranking	**Keys Creek**	**Chileno Creek**	**Salmon Creek**	**Arroyo Sausal**	**Mainstem Walker Creek**	**Lower Walker Creek**	**Subtotals**
High	7	7	1	2	20	3	40
High/Medium	2	4	3	1	7	0	17
Medium	13	18	5	1	25	7	69
Medium/Low	7	8	3	1	8	2	29
Low	4	16	3	2	14	2	41
Totals	33	53	15	7	74	14	196

4.3.2 Chileno Creek

Chileno Creek is the largest subwatershed of the Walker Creek watershed below a major impoundment. The erosion survey did not include the 4.4 square miles above Laguna Lake, a shallow, 200-acre natural lake at the Sonoma/Marin County line. The area near the confluence of Chileno and Walker Creeks has been identified as the best remaining salmonid habitat in the watershed (Cox, 1999; Rich, 1989). Upstream, the channel is largely devoid of woody vegetation with many areas of active channel erosion.

MCRCD has been focusing restoration efforts in Chileno Valley for a number of reasons. First and foremost, water quality in Chileno Creek has a profound effect on the remaining healthy salmonid habitat downstream. Second, since many landowners in the valley are anxious to work with MCRCD and NRCS on conservation projects, the probability of improving and extending existing habitat is very high. The largest, most active gully in the valley was repaired by MCRCD with a 1986 grant from the State Coastal Conservancy. MCRCD has also installed livestock control fencing along 5,000 linear feet of mainstem Chileno Creek and its tributaries with grants from DFG, National Fish and Wildlife Foundation, Marin Community Foundation, and National Emergency Assistance Program (NEAP). Steelhead trout were observed by landowners in and below the restored reaches in the 1999/2000 winter (Bettman, 2000; Gale, 2000). Point Reyes Bird Observatory (PRBO) has identified 6 of California's 14 riparian focal bird species on the restored reach along mainstem Chileno Creek, as compared with only one species in riparian areas that have not been restored (RHJV, 2000).

4.3.3 Salmon Creek

The Salmon Creek watershed is characterized by a deeply-incised channel and active bank erosion. The topography is much steeper than in the Chileno and Keys Creek valleys, and the landscape is a mix of annual grassland and coastal oak woodland. Because access was allowed to only small portions of the subwatershed, the inventory data does not reflect the full extent of channel erosion in Salmon Creek. Landowners at the top of the subwatershed and at the confluence with mainstem Walker Creek have installed erosion control and riparian restoration projects with support from MCRCD and remain interested in continuing enhancement work.

4.3.4 Arroyo Sausal

Less than a mile of Arroyo Sausal remains below Soulajule Reservoir before its confluence with mainstem Walker Creek. This reach is heavily vegetated with willow, California bay laurel, and coast live oak. Much of the property draining

into this short reach of Arroyo Sausal is leased by a motorcycle club, which has repaired some of the trail and gully erosion.

4.3.5 Mainstem Walker Creek

Most of the remaining surveyed portion of the watershed was classified as mainstem Walker Creek, although it included many small tributaries. The top part of this reach is characterized by a highly sinuous channel with sheer, actively eroding streambanks. This reach is densely forested and provides some of the best terrestrial habitat in the watershed. The aquatic habitat has been severely degraded by huge amounts of sediment eroding from an old mercury mine. The mine site has been stabilized with funding by the San Francisco Bay Regional Water Quality Control Board and EPA, but the sediment remains in the channel. The proposed geomorphic analysis of Walker Creek would investigate the impact of this sediment on downstream habitat and channel formation.

Because the streambed has incised in the upper reaches of mainstem Walker Creek, most of the side tributaries are also downcutting. Some were stabilized with the 1986 State Coastal Conservancy grant and other programs; much work remains. One of the most severely eroding areas is approximately two miles upstream of the Highway 1 bridge, just at the downstream end of the reach identified as the best salmonid habitat by Rich (1989). Major channel adjustment is occurring in this reach with rapid erosion through the alluvial terrace. The series of erosion sites here received high rankings for erosion activity and erosion potential. Since the repair of the mercury mine, this area has become one of the largest contributors of sediment to the system. However, additional geomorphic analysis is needed before designing an effective repair.

4.3.6 Lower Walker Creek

Lower Walker Creek refers to those areas that drain into Walker Creek below Keys Creek. As in the Keys Creek sites, these projects were assigned a low fisheries enhancement ranking although they are important contributors of sediment to Tomales Bay.

4.4 Enhancement Recommendations and Opportunities

The following restoration recommendations, shown in Table 3, are based on opportunities for fisheries enhancement, primarily by reduction of sediment delivery. High priority sites make up about one-third of all the sites recorded in the inventory, with the remaining two-thirds spread almost equally between medium and low priority sites.

Table 3. Fisheries Enhancement Ranking of High Priority Sites

Rank ✝	Project #	Description	Subwatershed	Activity	Erosion Potential	Access	Fisheries Value	Repair Priority
1	103	RIPARIAN CORRIDOR	CHILENO	H	H	H	***	H
1	189	STREAMBANK	WALKER	H	H	H	***	H
1	196	RIPARIAN CORRIDOR	CHILENO	H	H	H	***	H
2	161	STREAMBANK/RIPARIAN CORRIDOR	WALKER	H	H	M	***	H
2	162	STREAMBANK/RIPARIAN CORRIDOR	WALKER	H	H	M	***	H
2	163	STREAMBANK/RIPARIAN CORRIDOR	WALKER	H	H	M	***	H
2	164	STREAMBANK/RIPARIAN CORRIDOR	WALKER	H	H	M	***	H
2	165	STREAMBANK/RIPARIAN CORRIDOR	WALKER	H	H	M	**	H
3	74	GULLY/HEADCUTS	CHILENO	H	H	H		H
3	93	RIPARIAN CORRIDOR/ERODED FILL	CHILENO	H	H	H		H
3	141	GULLY/ MAINTENANCE	WALKER	H	H	H		H
3	146	CHANNEL INCISION/BANK EROSION	WALKER	H	H	H		H
3	166	HEADCUT	WALKER	H	H	H		H
3	167	ROAD RILLING/GULLY	SALMON	H	H	H		H
4	142	HEADCUTS	WALKER	H	H	M		H
4	144	GULLY/HEADCUTS	WALKER	H	H	M		H
4	178	STREAMBANK	WALKER	H	H	L	**	H
5	10	GULLY/HEADCUTS	WALKER	M	H	H		H
5	15	HEADCUT	WALKER	M	H	H		H
5	18	HEADCUTS	WALKER	M	H	M		H
5	83	HEADCUT	CHILENO	M	H	M		H
5	139	GULLY/HEADCUTS	WALKER	M	H	H		H
5	157	GULLY/HEADCUTS	WALKER	M	H	H		H
5	170	HEADCUT	ARROYO SAUSAL	M	H	H		H
6	56	STREAMBANK	CHILENO	H	M	H		H
6	57	STREAMBANK	CHILENO	H	M	H		H
6	118	GULLY/HEADCUTS	WALKER	H	M	H		H
6	140	HEADCUT	WALKER	H	M	H		H
6	181	ROAD/TRAIL EROSION	WALKER	H	H	L		H
6	186	RIPARIAN CORRIDOR	SALMON/WALKER	M	M	H	***	H
6	188	WATER DEVELOPMENT	WALKER	L	H	H		H
7	9	GULLY/HEADCUT	WALKER	M	H	M		HM
7	11	GULLY/HEADCUTS	WALKER	H	H	L		HM
7	36	HEADCUTS	KEYS	L	H	H		HM
7	38	HEADCUTS	KEYS	M	H	M		HM
7	60	HEADCUT	CHILENO	M	H	H		HM
7	65	INCISED CHANNEL	CHILENO	M	M	H		HM

Rank †	Project #	Description	Subwatershed	Activity	Erosion Potential	Access	Fisheries Value	Repair Priority
7	84	STREAMBANK	CHILENO	L	M	H		HM
7	87	HEADCUTS	CHILENO	M	H	H		HM
7	97	HEADCUTS	SALMON	M	H	M		HM
7	100	GULLY/HEADCUTS	SALMON	M	M	H		HM
7	148	LARGE SLIP	WALKER	H	H	M		HM
7	149	GULLY/HEADCUT	WALKER	H	H	L		HM
7	153	CONCRETE APRON FAILURE	WALKER	M	H	H		HM
7	154	HEADCUT	WALKER	H	M	H		HM
7	157	HEADCUTS	WALKER	M	H	H		HM
7	172	HEADCUT	ARROYO SAUSAL	M	H	H		HM
7	175	STREAMBANK	SALMON	H	M	H		HM
7	187	RIPARIAN CORRIDOR	WALKER	L	L	H	***	HM
NF	21	GULLY/HEADCUTS	KEYS	H	H	H		H
NF	22	GULLY/HEADCUTS	KEYS	M	M	H		H
NF	22	GULLY/HEADCUTS	KEYS	H	H	H		H
NF	28	HEADCUT	KEYS	M	H	H		H
NF	37	HEADCUT	KEYS	H	H	H		H
NF	45	HEADCUT	KEYS	H	H	H		H
NF	108	HEADCUT	LOWER WALKER	M	H	H		H
NF	110	HEADCUT	LOWER WALKER	M	H	H		H
NF	112	GULLY/HEADCUTS	LOWER WALKER	M	M	M		H
NF	116	GULLY/HEADCUT	KEYS	H	H	M		H

† Based on best opportunities for fisheries enhancement primarily by sediment reduction.
Fishery Values: *** High, ** Medium, * Low
NF = No salmonid fisheries, but high priority erosion sites.

The 59 high or high/medium priority sites are ranked on a scale of 1 to 7. Within each ranking, the sites are listed numerically, not necessarily in order of greatest benefit. Nearly half of all the high priority sites (49%) can be found along mainstem Walker Creek or within its subwatershed. The Chileno Creek subwatershed contains 19% of high priority sites, followed by Keys Creek with 15%. The Salmon Creek, lower Walker Creek, and Arroyo Sausal subwatersheds each recorded less than 10% of the total number of high priority erosion sites.

Repairing those sites with a fisheries enhancement ranking of 1 or 2 will yield the greatest benefit to water quality and aquatic habitat values. Sites ranked 1 have easier access and present stellar opportunities for synergy. For example, fencing a riparian corridor along 6,500 linear feet of creek at Project #196 will connect restored riparian reaches of Chileno Creek with planned and naturally vegetated reaches of lower Chileno Creek, linking over 3 miles of riparian corridor immediately adjacent to the best salmonid habitat in the watershed.

The sites with a 2 ranking have more difficult access. All of these sites, along with project #189 from the rank 1 list, comprise a large-scale channel reconstruction project along mainstem Walker Creek. As described in Section 4.3.5, geomorphic analysis is needed before any stabilization is attempted. With fish habitat structures incorporated into the new channel design, this area has great potential for fisheries habitat restoration.

Sites ranked 3 through 7 diminish in priority based on 1) their direct ability to provide fish habitat, 2) vehicle accessibility, 3) erosion activity rating, and 4) erosion potential.

As discussed in Section 4.2, the erosion inventory also included an assessment of other benefits beyond the reduction of sediment delivery to the stream channel that could be provided by making the recommended repairs. These other benefits are identified as an added value for fisheries habitat, ranch operations, wildlife habitat, educational opportunities, and building community support for such projects within the watershed (see Table 4).

Table 4. Other Benefits

Other Benefits	No. of Sites	% of all sites
Fisheries Value	24	12%
Rancher Value	75	38%
Wildlife Value	57	29%
Educational Value	54	28%
Community Value	68	35%

The added value of other benefits warrants careful consideration when selecting projects for implementation. In almost 20 years of watershed restoration work, MCRCD has found that the greatest benefits to natural resources often begin with a first step that may not seem quite as important as a less visible project, or one that is not whole-heartedly supported by the landowner. However, if the first step builds trust and knowledge within the community, it can lay a durable foundation for more comprehensive efforts.

By including the assessment of other benefits in the erosion inventory database, a tool has been created that acknowledges these values and can be used to select future projects for a variety of conservation funders.

5. WALKER CREEK WATERSHED RIPARIAN ASSESSMENT

5.1 Introduction

One purpose of the *Walker Creek Watershed Enhancement Plan* is to characterize the riparian plant community within the watershed and identify opportunities for habitat improvement. This study is intended to be an overview of existing riparian conditions with recommendations for potential restoration and enhancement to be considered by interested landowners.

Before European settlement, California's landscape was described as a sea of rolling hills traversed by clear, rushing rivers with contiguous, dense forest corridors. Land use practices and urban development during the last 150 years has decimated these forests. Today the corridors have become fragmented and tapered, and the water is often mixed with silt and sand from eroding hillsides and streambanks. In many areas, the riparian plant community has been converted into annual grassland dominated by European species. Biological diversity has declined as a result of this conversion and loss of habitat.

The riparian plant community is a complex association of canopy and understory trees, shrubs, vines, and herbs. Each layer plays a dynamic role in providing shelter and food for hundreds of species of insects and other invertebrates, birds, fish, amphibians, reptiles, and mammals. The extensively layered root systems have co-evolved with micro and macro organisms such as bacteria and fungi that enhance soil fertility and nutrient accessibility. This fibrous subsoil network is the "living rebar" that helps to sustain hillside and streambank integrity, thus maintaining water quality.

This report describes the methods used in conducting the overview survey, the historic and current riparian communities and conditions in the watershed, and a list of recommendations to enhance the riparian corridors. A characterization of each of the subwatersheds that are contained in the greater Walker Creek watershed follows, including specific enhancement opportunities. Appendix C includes descriptions of habitat types found in the Walker Creek watershed from the California Wildlife Habitat Relationships (WHR) System (Mayer and Laudenslayer, 1988). Appendix D is a list of common plant species for the Walker Creek watershed. Figure 2 is the Walker Creek Watershed Existing Riparian Characterization map.

5.2 Survey Methods

An overview of riparian conditions was developed through on-site field reconnaissance, inspection of aerial photographs, and a review of existing literature and maps. Literature reviewed included *The Marin Coastal Watershed*

Enhancement Project (1995) and historical and recent aerial photographs. Soil maps in the *Soil Survey of Marin County, California* (1985) were consulted to assist in analyzing potential or existing erosion hazards and to help assess historical plant community conditions.

Stream lengths and widths were scaled off the aerial photos. Acreages were derived from various stream lengths and widths ranging from 50 to 250 feet. In the field, plant communities were described by identifying dominant plant species, tree size and density, understory conditions and composition, streambank stability, and the presence or absence of exotic plant species.

Specific reaches of creeks within the watershed were characterized using the WHR system. This system allows for a broadly based characterization of vegetation types, which includes dominant species, size or age of the vegetation, and percent of vegetative canopy closure. The WHR vegetation classification system is intended to provide an umbrella classification for more detailed analysis and also allows for prediction of potential wildlife habitat, as well as access to wildlife and habitat information through a computerized database that is maintained by the Wildlife Management Division of DFG. More information on the WHR system is contained in Appendix C.

For the purpose of this report, vegetation was characterized as either Valley Foothill Riparian (VRI), Eucalyptus (EUC), Annual Grassland (AGS), or Perennial Grassland (PGS), depending on the presence or absence of trees and shrubs and dominant species (see Table 5 and Appendix C). Valley Foothill Riparian habitats occur in valleys with deep alluvial soils within the Central Valley and in the lower foothills of the Cascade, Sierra Nevada, and Coast ranges. Eucalyptus groves have been planted in monotypic stands on variable sites throughout California. Annual Grassland habitat is generally found on flat plains and rolling hills that surround Valley Foothill Riparian. Perennial Grassland habitats are dominated by perennial grass species and occur in coastal prairies of northern California that are under maritime influence, in wet meadows, and as relics in valley grasslands that are presently dominated by annual grass species (Mayer and Laudenslayer, 1988).

The WHR system allowed identification of specific areas on the Existing Riparian Characterization map (see Figure 2) that could potentially be enhanced. For example, sparsely or openly vegetated areas identified as VRI 4S or VRI 4P on the map are generally accompanied by recommendations for restoration or enhancement that include planting riparian trees. Many areas identified as AGS are likely to have been VRI before European settlement, and they too may be accompanied by specific recommendations for restoration (see Section 5.6 below, Creek and Subwatershed Characterizations and Enhancement Opportunities).

Table 5: Summary of WHR System Habitat Classifications

WHR Classification	Size (for trees) Height (for grasses)	Canopy Cover Density (trees) Cover Density (grasses)
Valley Foothill Riparian (VRI) Found in valleys bordered by low foothills and coastal plains (see Appendix C for more information).	**1:** Seedling tree (dbh<1″) **2:** Sapling tree (hardwood crown diameter < 15′, dbh = 1″-6″) **3:** Pole tree (hardwood crown diameter 15′-30′′, dbh = 6″-11″) **4:** Small trees (hardwood crown diameter of 30′-45′, dbh = 11″-24″) **5 or 6:** Large or medium trees or a two-storied forest (hardwood crown diameter greater than 45′, dbh >24″)	**D:** Dense (60-100% of canopy is closed) **M:** Moderate (40-59% of canopy closed) **P:** Open (25-39% of canopy is closed) **S:** Sparse (10-24% of canopy is closed)
Eucalyptus (EUC) Found throughout California in locations with a variety of site characteristics.		
Annual Grassland (AGS) Found on flat plains and rolling hills that surround Valley Foothill Riparian.	**1:** Short herb (< 12″ when mature) **2:** Tall herb (> 12″ when mature)	**D:** Dense (60-100% of ground is covered **M:** Moderate (40-59% of ground covered) **P:** Open (10-39% of ground is covered) **S:** Sparse (2-9% of ground is covered)
Perennial Grassland (PGS) Occurs in coastal prairies of Northern California that are under maritime influence, in wet meadows, and as relics in valley grasslands.	**1:** Short herb (< 12″ when mature) **2:** Tall herb (> 12″ when mature)	**D:** Dense (60-100% of ground is covered **M:** Moderate (40-59% of ground covered) **P:** Open (10-39% of ground is covered) **S:** Sparse (2-9% of ground is covered)
Examples: VRI 4M means that the site is classified as Valley Foothill Riparian with small trees and a moderate canopy cover. AGS 1D means that the site is classified as Annual Grassland and is densely covered with short grasses.		

5.3 Historic Riparian Plant Communities

The Walker Creek watershed covers approximately 76 square miles and includes mainstem Walker Creek and four additional subwatersheds: Keys Creek, Chileno Creek, Salmon Creek, and Arroyo Sausal.

In general, the riparian corridors historically varied in width between approximately 100 to 300 feet and consisted of an overstory of shrub and tree willows (*Salix* sp.), ash (*Fraxinus latifolia*), and alder (*Alnus rhombifolia*) in the wettest areas with a mixture of buckeye (*Aesculus californica*), California bay (*Umbellularia californica*), and coast live oak (*Quercus agrifolia*) along the steeper banks of the upper reaches of the main tributaries. Dense oak and bay woodlands emanated from the upper banks at these higher elevations, increasing the depth and value of the corridor for a multitude of wildlife. Much of these dense woodlands remains on the steep and rugged hillsides and along tributaries within the watershed, especially in the upper reaches of Walker Creek.

Before the introduction of European agricultural practices, the grasslands that emanated from the riparian corridor, on hillsides, and in the valleys were dominated by perennial species. Wet meadows and streambanks were composed of a variety of perennial grasses such as creeping wildrye (*Leymus triticoides*) and meadow barley (*Hordeum brachyantherum*), along with a number of sedges (*Cyperus* spp.) and rushes (*Juncus* spp.) Less wet areas were dominated by bunchgrasses such as California oat grass (*Danthonia californica*) and Pacific hairgrass (*Deschampsia cespitosa* ssp. *holciformis*).

Two of the creeks within the watershed, Keys Creek near Tomales and Chileno Creek in the Chileno Valley, flow through low, flat floodplains. Here the soils have a high clay content that lowers permeability and impedes drainage. It is likely that the historic riparian corridors in these areas were not as broad as they were in areas with more topography but were instead more closely confined to the stream channel. Keys Creek joins Walker Creek near its entrance into Tomales Bay. This portion of creek, up to the town of Tomales, is subject to tidal influence from the bay. The influx of salt water into fresh water here reduces the likelihood of an historic occurrence of dense and broad corridors.

Prior to European settlement, the human inhabitants of the Walker Creek watershed were Miwok. The hunting and gathering practices of these indigenous people did not require major alteration of the native vegetation. The character of the California landscape began to significantly change, however, in the early 1800s with the establishment of the missions and introduction of European agricultural practices. Potato farmers settled in and near the town of Tomales in the mid 1800s and began farming the valleys and low rolling hills. Perennial grasslands surrounding Keys Creek where it flows through the valley were tilled in spring for planting and again in fall after the harvest. Winter rains washed loosened soil into the local creeks causing increased sedimentation and filling in of the lower reaches (UCCE, 1995).

Potato farming declined substantially in the middle of the nineteenth century as dairy farmers moved into the region. By 1866, Marin County accounted for about 75% of California's dairy production (USDA, 1985). With dairy farming came a gradual conversion from native perennial grasses to introduced annual grasses in the valleys and low rolling hills. Riparian vegetation growing in accessible areas along creeks was reduced by livestock grazing and trampling. Eventually, the removal of vegetation and compaction of soil from overgrazing, along with the tilling practices for crops, caused slope failure and slumping and the formation of gullies. Downcutting in the upper reaches of creeks and sediment resulting from an increase in fast moving runoff filling in lower reaches caused significant changes in the riparian plant communities. Riparian vegetation on unstable vertical banks was undermined upstream while increased sedimentation downstream created shallow channels and a change in plant composition (UCCE, 1995).

Several studies since the 1960s have attempted to address these physical changes in the Walker Creek watershed. A study performed by Haible in the 1970s documents a decrease in the stream gradient due to incision in the upper reaches and sediment filling in the lower reaches. This increase in sedimentation has resulted in a decrease in channel depth and widening of the channel. Even tall riparian canopies failed to cover the width of the channel, leaving the middle of the stream exposed to the hot sun, which results in significant increases in water temperature (UCCE, 1995).

The increase in grazing and farming in the watershed had dramatic effects on the native grasslands as well. Unlike their annual counterparts, perennial grasses do not transfer the major portion of their food energy into production of seed. Instead, the energy goes into the development of a long-lived root system that absorbs water and minerals and into well-developed leaves and stems for photosynthesis, which yields the material to produce seeds, roots, and the storage of energy. Grazing on early leaf growth and storage reserves weakens the perennial bunchgrasses, thus allowing annual species to gain hold and become dominant. This change from perennial species to annual species also had an effect on the soils. Perennial plants created a cover of live material and organic mulch that protected the soil. This cover breaks the force of raindrops and promotes moisture while it shades the topsoil and reduces evaporation. The extensive fibrous root system stabilizes the soil. In contrast, exposed soils that are created when annual species die and break down tend to develop puddles from the driving rain. These puddles form a semi-impervious film that encourages runoff. Often, the runoff carries topsoil with it, and the storage capacity of the soil is reduced. The soil gradually becomes shallow and less productive (Zumwalt, 1972).

By the late 1800s, a significant number of acres of hardwood had been logged. Half of this was due to agricultural clearing (California State Agricultural Society, 1870). The other half of the hardwood harvesting supplied fuels for heating and cooking into the early part of the twentieth century. Starting in the 1940s, significant rangeland clearing was practiced throughout California with assistance from government subsidies, technical help from the University of California Cooperative Extension and Soil Conservation Service, and the advent of bulldozers and herbicides. Clearing and channelizing streams for flood control were practiced by agencies and individuals within a number of watersheds.

There are still suggestions of the width of historic riparian forests on the 1998 aerial photos. For example, along portions of streams that are deeply incised, making access difficult (i.e., upper and middle reaches of Walker Creek), an average riparian forest canopy width of 200 feet continues to exist.

5.4 Present Riparian Plant Communities

Today the major portion of the Walker Creek watershed is largely used as rangeland for cattle. Approximately 93 miles of dense Valley Foothill Riparian (VRI) habitat remain. The widest corridors with the densest two-storied forests are found on steep topography mostly along the upper reaches of creeks and their tributaries. These forests are dominated by an overstory of large coast live oak and California bay trees. The understory is comprised primarily of buckeye on the upper banks with willow and alder in-stream. Dense thickets of native and non-native blackberry (*Rubus ursinus* and *R. discolor*) with snowberry (*Symphoricarpos albus* var. *laevigatus*), twinberry (*Lonicera involucrata*), honeysuckle (*Lonicera* sp.), and poison oak (*Toxicodenron diversilobum*) characterize the shrub layer along the streambanks. Groundcovers and small herbs are sparse, either being shaded out by the dense canopy or displaced by rambling vines. Streambank stability in these uppermost reaches is

usually high due to the well-established, extensive root systems and only minor cattle grazing due to the steep topography.

Along reaches of creeks where the land is more accessible and suitable for grazing and crops (usually along the main channels), many of the historically dense corridors have been reduced to areas of open and sparse riparian canopy cover that are dominated by an overstory of willow with occasional coast live oak and California bay laurel. Where an understory exists, it is usually composed of native and non-native blackberry with native sedges and annual grasses. Much of the corridor in these areas has been converted to annual grassland that is dominated by introduced grasses such as annual rye grass (*Lolium multiflorum*), Mediterranean barley (*Hordeum marinum*), and oats (*Avena* sp). Perennial grasses have been reduced to occasional small populations in some of the more protected wet areas. Regeneration of woody plants is low in these areas due to ongoing grazing by livestock. Where the riparian canopy remains dense, the corridors are narrow and generally restricted to the stream channel. These remnant stretches of creek with moderate and dense forest canopies allude to the landscape potential of the area.

Along the main channels and tributaries, the reduction of woody plant cover has left streambanks open and unprotected. Bank slumping and headcuts are common along many of the creeks. Vigorous exotic plants such as gorse (*Ulex europaea*), anise (*Foeniculum vulgare*), and poison hemlock (*Conium maculatum*) are displacing native species in the most disturbed areas.

Habitat loss and degradation over the past 150 years has had an important impact on wildlife. Manley and Davidson (1993) identified riparian areas as the most important habitats to landbird species in California. The loss of riparian habitat may be the primary cause of decline in populations of landbird species in North America (Ballard, et al., 2000).

Table 6 below summarizes the approximate miles of streamside Annual Grassland and Valley Foothill Riparian habitat for each of the subwatersheds within the Walker Creek watershed.

Table 6: Summary of Miles of Streamside Annual Grassland and Valley Foothill Riparian Habitat in the Walker Creek Watershed.

Habitat Characterizations	Keys Creek	Chileno Creek	Walker Creek	Salmon Creek	Arroyo Sausal
AGS 1,2D	11 miles	11 miles	4.5 miles	2.7 miles	5.7 miles
VRI P	1.4 miles	0.4 miles	3.4 miles	—	1 mile
VRI S	5.5 miles	2.7 miles	1 mile	—	1 mile
VRI M	—	2 miles	2 miles	—	3.4 miles
VRI D	1 mile	18 miles	13.5 miles	9 miles	19.5 miles
Note: mileages are approximate					

5.5 Enhancement Recommendations and Opportunities

A recommended goal of the *Walker Creek Watershed Enhancement Plan* is to restore the riparian corridor to suitable conditions for wildlife. Several steps to achieve this goal are listed below. Erosion control measures described in the Walker Creek Watershed Erosion Site Inventory (see Section 4) will also help to restore riparian areas.

- **Revegetate high and medium priority riparian sites with cooperative landowners.** Approximately 35 miles of converted annual grassland and 24 miles of open to moderately dense riparian forest have been assigned a medium to high priority for potential restoration. Criteria for prioritizing enhancement sites include the opportunity to provide contiguous riparian forest habitat between a lower and upper reach of the watercourse, to expand existing habitat, to fill out areas of sparse cover, and to provide cover in areas of higher erosion potential. Benefits would include reduction in erosion hazard, increased water quality, wildlife habitat expansion, and aesthetic improvement. Restoration sites that occur near existing high quality sites have a higher probability of being recolonized by extirpated wildlife species (Ballard, et al., 2000).

  Only native riparian species should be used for restoration. Native plants are adapted to the conditions that exist within the local watershed, such as soil type, water regime, and weather. Tree species should include willow and alder in the wettest areas with California bay laurel and coast live oak along the upper banks. Many indigenous animals and insects are dependent upon their association with native plants. When native plant species are diminished or compromised by exotic varieties, the delicate ecological balance of the riparian system is disrupted and often destroyed. Concentrating plantings into clumps will create more productive patches for nesting birds (Ballard, et al., 2000). Understory shrubs such as snowberry, native blackberry, or twinberry can be planted along with trees if irrigation is installed.

Revegetation and restoration activities that could destroy nests or nesting habitat or cause nest abandonment should be limited to the nonbreeding season (Ballard, et al., 2000).

- **Manage livestock access to the creeks, especially during the wet season.** Livestock can have a serious effect on riparian vegetation and streambank stability by reducing plant cover and compacting the soil. Controlling livestock access to creeks during times of the year when the ground is saturated and subject to compaction can help reduce damage. Installing livestock control fencing with livestock crossings and off-stream water development is one way to protect the riparian habitat. Riparian pastures can allow controlled grazing in riparian areas by excluding livestock until creekside vegetation is well-established. Carefully managed grazing in riparian areas can be successful. Cross-fencing can allow rest periods for sections of corridor while livestock have access to others. Developing off-stream water and shade sources can help reduce the time livestock spend in and near streams.

  Livestock fencing design and floodgates for livestock crossings can be obtained from local ranch suppliers, the Natural Resources Conservation Service (NRCS), MCRCD, or consultants.

- **Control invasive exotic species.** Exotic plant species have displaced native species in disturbed areas within the watershed. The most extensive and difficult to control of these plants is gorse, an introduced shrub from western Europe. Gorse is a very vigorous plant that will crown sprout when cut back to the ground. In addition, its seeds are fire adapted and are stimulated to sprout after the event of fire, making burning almost useless as a method of control. Several areas where dense populations of gorse are established and spreading are located near the town of Tomales. Dense populations grow along the lower reach of Keys Creek where it joins Walker Creek as it enters Tomales Bay and

along the surrounding hillsides. Established populations are located on hillsides above Walker Creek just south of Tomales as well.

- **Protect intact sections of the riparian corridor.** Healthy riparian vegetation remains in areas along several of the creeks within the Walker Creek watershed. Installation of livestock control fencing along these stretches will help to preserve existing vegetation, allow regeneration, and increase streambank stability, thus reducing potential and existing erosion problems. Undisturbed vegetation is less susceptible to invasion by exotic plant species and has high wildlife value.

- **Maintain drainage structures** such as culverts and ditches to avoid overtopping and erosion of soils into the streams. Other erosion prevention recommendations are included in the Walker Creek Watershed Erosion Site Inventory (see Section 4).

- **Avoid depleting in-stream pools of water during the summer** that may be needed to sustain aquatic life until the winter rains resume.

5.6 Creek and Subwatershed Characterizations and Enhancement Opportunities

The Walker Creek watershed covers 76 square miles and includes the mainstem of Walker Creek and four additional subwatersheds. These additional subwatersheds include Keys Creek, Chileno Creek, Salmon Creek, Walker Creek, and Arroyo Sausal (UCCE, 1995).

Figure 2 depicts the WHR system classifications for mainstem Walker Creek and each subwatershed. Table 5 above provides a key to the abbreviations from the WHR system that are used throughout the following descriptions.

5.6.1 Keys Creek

Characterization

Keys Creek is located in the northern portion of the Walker Creek watershed south of the town of Tomales (see Figure 2). The main channel flows east to west for about 3 miles through low rolling hills and valley to its confluence with Walker Creek near its entrance into Tomales Bay.

According to the *Soil Survey of Marin County, California* (1985), soils along Keys Creek are in the Blucher-Cole complex and consist mostly of deep, poorly drained silt and clay loams. Vegetation associated with soils having low permeability is primarily grasses, forbs, and specialized trees that have the capability to tolerate long periods of saturation.

A large portion of Keys Creek and its tributaries (approximately 6.8 linear miles) is characterized as annual grassland. The main channel flows through a low floodplain that remains saturated during much of the winter. Here, the channel is narrow and the vegetation is dominated by annual grasses and perennial sedges (*Juncus* sp.) that are adapted to soils with high water tables and seasonal saturation. Where woody riparian vegetation exists, it is contained within the narrow stream channel and is dominated by an overstory of arroyo willow (*S. lasiolepis*) with an understory of native and non-native blackberry.

Tributaries in the upper reach of creek support more woody vegetation than along the floodplain, although trees remain generally small, and canopies are sparse to open. Several of the uppermost portions of the tributaries contain eucalyptus groves. Where the main stem of the creek leaves the town of Tomales and flows west to its confluence with Walker Creek, the channel widens. Riparian vegetation remains significantly reduced to an occasional willow along the streambank. The invasive, introduced shrub, gorse, grows profusely on both sides of the channel.

The Keys Creek subwatershed supports less than 2.5 acres of dense riparian forest. This remaining corridor is located along a tributary that flows parallel to Highway 1 north of Tomales.

Enhancement opportunities

- **High priority restoration opportunities**
    1. **Install livestock fencing, develop off-stream water sources, and plant natives in the 3 miles of converted annual grassland (AGS 1,2D) located along the main channel of Keys Creek and adjacent tributaries.** Two primary areas for enhancement are located along the main stem where it flows parallel to Tomales-Petaluma Road and along Highway 1 as it travels west toward Tomales Bay from the town of Tomales (see AGS 1,2D sites on Figure 2). Fencing will help reduce

erosion by protecting the streambanks from disturbance by livestock. Planting native sedges, grasses, and willow will increase plant diversity, expand the canopy cover and shade to lower water temperatures, and create a natural filter for sediment runoff along the main channel.

2. **Fence and plant willow and sedges in areas of annual grassland (AGS 1D) adjacent to headcuts and gullies.** Revegetation and protection of these areas is essential for bank stabilization, erosion control, and reduction of sedimentation downstream.

3. **Install livestock fencing and plant willow in tributaries with sparse to open canopies (see VRI 2,3S or 2,3P sites on Figure 2).** Reducing fragmentation of habitat by restoring a contiguous corridor will benefit wildlife and increase water quality.

4. **Control invasive exotic plants within the subwatershed.** Reducing populations of gorse will increase available grazing land while enhancing native habitat. Primary areas for control are located along the main channel of Keys Creek where it flows parallel to Highway I near the confluence with Walker Creek and on hillsides surrounding the upper reach of creek. Gorse is very difficult to control and will eventually fill in an entire area of grassland or woodland if left unattended. Removal or control is essential for maintaining pasture and ecosystem diversity.

- **Medium priority restoration opportunities**
  1. **Install livestock fencing along the moderately dense riparian corridor (VRI 3M) near the quarry just south of Dillon Beach Road (see Figure 2).** Protecting this portion of corridor with fencing will help connect it to restored annual grassland above and dense vegetation below.

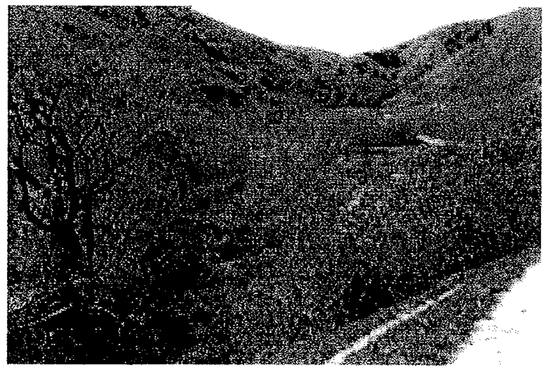
- **Low priority restoration opportunities**
  1. Restoring dense riparian corridor (VRI 3,4D) within the watershed was given low priority.

5.6.2 Chileno Creek

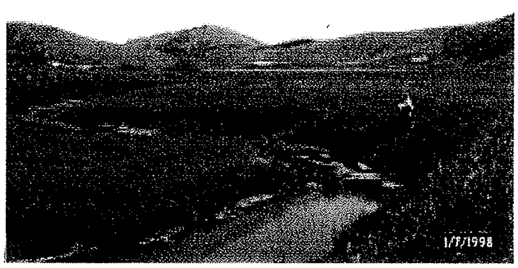
Characterization

Chileno Creek has its origin at Laguna Lake – a shallow, natural freshwater lake. It flows west through the Chileno Valley until it converges with Walker Creek approximately 7 miles upstream of Tomales Bay.

Soils along Chileno Creek are Fluvent in the lowest reach, Clear Lake clay in the middle reach, and Blucher-Cole complex in the upper reaches near Laguna Lake. Fluvent soils are stratified layers of water-deposited sand, gravel, stones, and cobbles. Clear Lake clay and Blucher Cole soils are both very deep and poorly drained with slow permeability. Vegetation associated with these soils is primarily annual grasses and forbs (USDA, 1985).



Vegetation along the lower reach of the main channel of Chileno Creek is dominated by willow in a dense, narrow corridor that is contained within the stream channel. Adjacent tributaries support moderate to dense vegetation, also dominated by willow. The middle to upper reaches of the main stem flow about 3 miles through a broad, open floodplain that is primarily annual grassland. Adjacent tributaries are flanked by steeper slopes and sustain relatively wide riparian corridors that consist of a dense mixture of willow, California bay laurel, and coast live oak. Here, where steep topography reduces accessibility to cattle, the corridor is naturally protected and maintained. The area surrounding Laguna Lake is open and relatively flat grassland. Seasonal drying of the lake is conducive to annual plant species associated with vernal pool habitats. DFG recognizes this area as a sensitive habitat (Northern Vernal Pool).



Enhancement opportunities

- **High priority restoration opportunities**
    1. **Install livestock fencing, develop off-stream water sources, and plant willow, native perennial grasses, and sedges along the approximate 13 miles of annual grassland (AGS 1,2D) that borders the main channel of Chileno Creek and its tributaries as it flows parallel to Chileno Valley Road (see Figure 2).** Fencing will help reduce erosion by protecting the streambanks from disturbance by livestock. The soils in this floodplain are Clear Lake clay and are unsuitable for riparian trees that require good drainage. Native willows are capable of tolerating many saturated soil conditions and are the best candidates for surviving in clay soils. Planting willow on the upper banks along

with native grasses and sedges will increase plant diversity, expand the canopy cover and shade to lower water temperatures, and create a natural filter for sediment runoff along the main channel.

2. **Fence and plant willow, live oak, and California bay laurel in areas within tributaries where woody vegetation is scarce or absent (VRI 3,4S & 3,4P and AGS 1,2D) (see Figure 2).** Restoring these stretches of creek will connect fragmented portions of corridor with the main channel.

3. **Control exotic plants.** Special attention should be given to the control of gorse growing in the subwatershed.

- **Medium priority restoration opportunities**
  1. **Install livestock fencing and develop off-stream water sources along tributaries where moderate woody vegetation remains (VRI 2M).** Two large tributaries that flow south into Chileno Creek in the lower reach have moderate corridors of small willow. Protecting these areas with exclusionary fencing will aid in a natural recovery of the corridor.

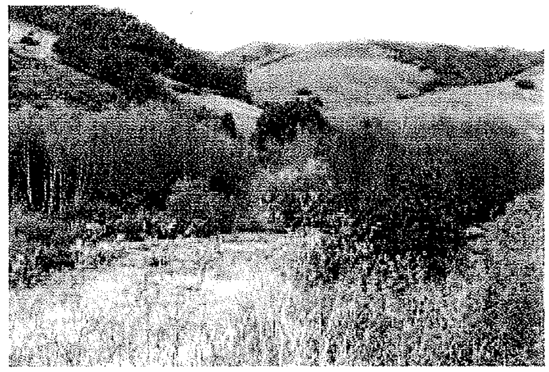
- **Low priority restoration opportunities**
  1. **Riparian enhancement in the areas marked AGS 1D surrounding Laguna Lake is not recommended at this time.** Laguna Lake dries in the summer months, and the California Natural Diversity Database has identified it as a sensitive habitat (Northern Vernal Pool). Certain vernal pool plant species that have been listed as rare, threatened, or endangered (RTE) have been sighted growing in the vicinity.

  2. **Riparian corridors along the tributaries in the steeper areas of the subwatershed have been naturally protected.** These areas that resemble historic riparian conditions (VRI 3,4D) have been given a low priority rating for enhancement.

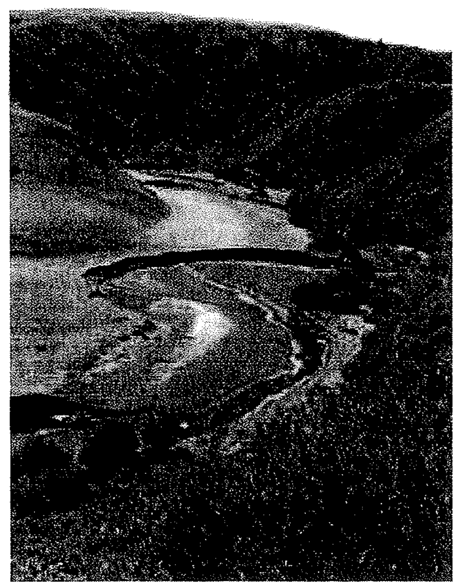
5.6.3 Walker Creek

Characterization

Soils along mainstem Walker Creek and its tributaries are varied. Along much of the channel, the soil is channeled Fluvents consisting of stratified layers of water-deposited sand, gravel, stones, and cobbles. Soils of the steepest and most rugged hillsides belong to the Tocaloma-Saurin association. These are well-drained soils that occur on north and east facing slopes. Vegetation is characteristically made up of hardwoods. Other commonly occurring soils of hilly uplands along the creek include Yorkshire clay loam, Saurin-Bonnydoon complex, and Los Osos-Bonnydoon complex. All are relatively well-drained and are associated with annual grasses and forbs with scattered shrubs. Bonnydoon soils are particularly susceptible to slippage, and livestock grazing should be carefully managed to protect from erosion (USDA, 1985).



Much of the main stem and tributaries of Walker Creek support relatively dense riparian corridors. An overstory of willow, ash, and alder is found streamside in the wettest areas with California buckeye, coast live oak, and California bay laurel dominating the steeper banks and slopes. Regeneration of woody plants along the main channel is moderate. Where steep topography exists, corridors have remained wide and in good condition. Common understory shrubs include native and non-native blackberry, snowberry, American dogwood (*Cornus sericea*), poison oak, and coyote brush (*Baccharis pilularis*).



The most disturbed stretches of creek are found along the lower reaches of the main channel. The first occurs just upstream of Tomales Bay where riparian vegetation has been significantly removed, and gorse is abundant. The second is located approximately 3.5 miles upstream of the mouth of the bay where the basin widens into floodplain. Natural changes in the creek meander and livestock grazing and trampling have resulted in the removal of a great deal of woody vegetation. Unvegetated banks continue to erode, impacting both riparian vegetation and water quality. The most heavily grazed adjacent hillsides support extensive populations of gorse and thistle.

Enhancement opportunities

- **High priority restoration opportunities**
    1. **Install livestock fencing, develop off-stream water sources, and plant willow in the annual grassland (AGS 1D) located along the main stem adjacent to Highway 1 near the entrance to Tomales Bay (see Figure 2).**

2. **Install livestock fencing, develop off-stream water sources, and plant willow, California bay laurel, and coast live oak along tributaries where woody vegetation is sparse or open (VRI 3,4S & 3,4P) (see Figure 2).** Restoring these stretches of creek will help connect fragmented portions of corridor with the main channel.

3. **Install livestock fencing, develop off-stream water sources, and plant willow, California bay laurel, and coast live oak along the lower reach of the main channel (near the town of Tomales) where woody vegetation is sparse (VRI 4S) (see Figure 2).** This section of the creek is very active and may not be conducive to fencing or revegetation. Further investigation into the dynamics that contribute to the changeable nature of this portion of creek should be performed before any restoration activities are put into place.

4. **Control gorse and thistle on hillsides near Tomales and along the main channel near Tomales Bay.**

- **Medium priority restoration opportunities**
  1. **Install livestock fencing and develop off-stream water sources along tributaries where moderate woody vegetation remains (VRI 2M) (see Figure 2).** Moderately dense riparian corridor occurs in the upper reaches of Frink Canyon and Verde Canyon. Another occurance is in the upper reach of a southern tributary that is located near the end of Clark Road. Protecting these areas with exclusionary fencing will aid in the natural recovery of the corridor.

- **Low priority restoration opportunities**
  1. In general, most of the riparian corridor along Walker Creek is in relatively good condition, supporting dense corridors (VRI 4D) of varying widths (see Figure 2). The steep terrain that occurs throughout most of the subwatershed has naturally protected the riparian vegetation from the impacts of overgrazing and tilling. Further protection of the corridor by fencing was given low priority. This should not underrate the value of landowners seeking ways to preserve the integrity of this habitat. Installing livestock control fencing to limit access to the creek will help to insure creek protection and limit existing or potential erosion hazards.

5.6.4 Salmon Creek

Characterization

Salmon Creek is located in the southern half of the watershed. It flows through Hicks Valley westward to its confluence with Walker Creek.

Soil along the lower reach of the main channel of Salmon Creek is Cortina gravelly sandy loam. The soil is deep and well-drained with rapid permeability. It is considered unsuitable for livestock because of its low fertility and its inability to hold water (USDA, 1985). The upper reach of creek flows through the Blucher-Cole soil complex that is characteristic of floodplain areas along Keys Creek and Chileno Creek. Soils of adjacent tributaries and hillsides include the Tocaloma-Saurin association, Saurin-Bonnydoon complex, and Los Osos-Bonnydoon complex described above.

Most of the riparian corridor along the middle and lower reaches of Salmon Creek is well-vegetated. Dense canopies of willow and alder dominate the overstory along the main channel, and California blackberry, coyote brush, poison oak, and California rose (*Rosa californica*) are common understory shrubs. A variety of ferns and California bee plant (*Scrophularia californica*) are commonly found groundcovers. In some of the more disturbed areas along the main channel, the invasive shrub, French broom *(Genista monspessulana)*, grows along with some invasive periwinkle (*Vinca major*). Steeper elevations support hardwoods such as buckeye, California bay laurel, and coast live oak. The vegetation along the uppermost reach of the main stem where the basin widens into floodplain and soils have low permeability is primarily annual grassland. A remnant of perennial grassland, dominated by creeping wildrye and meadow barley, occurs adjacent to Hicks Valley Road just east of its intersection with the Marshall Petaluma Road.

Enhancement opportunities

- **High priority restoration opportunities**
    1. **Install livestock fencing, develop off-stream water sources, and plant willow, California bay laurel, and coast live oak in areas identified as annual grassland (AGS 1,2D) on Figure 2.** Only three sites along

Salmon Creek have been identified as potential high priority restoration sites. The first is located along a tributary near the confluence with Arroyo Sausal. The second and third occur in the upper reach near the intersection of Marshall Petaluma Road and Wilson Road. Here, the floodplain widens, and the creek is more suitable for livestock and crops. Revegetating these sections of creek will help to connect the riparian corridor with adjacent dense corridors, thus increasing water quality and wildlife value throughout the subwatershed.

2. **Control exotic plants such as French broom and periwinkle that grow near or in the riparian corridor.** Without removal, populations of invasive plants will only increase, resulting in the displacement of pasture and native riparian vegetation.

- **Medium priority restoration opportunities**
  1. No medium priority restoration sites were identified.

- **Low priority restoration opportunities**
  1. Restoration or enhancement within the dense riparian corridors throughout the subwatershed were given low priority. This, however, should not underrate the value of landowners seeking ways to preserve the integrity of this habitat.

5.6.5 Arroyo Sausal

Characterization

Arroyo Sausal is the southernmost creek in the Walker Creek watershed. It flows through Hicks Valley west to its confluence with Salmon Creek.

Soils along Arroyo Sausal are similar to those found along Salmon Creek. They include the highly permeable Cortina gravelly sandy loam along the middle reach of the main stem that underlies the Soulajule Reservoir and along the lower reach just downstream of the reservoir. A mixture of the different complexes described above occurs on the adjacent slopes and tributaries (USDA, 1985). Where the channel flows through Hicks Valley in the upper reaches, soils are a combination of the Blucher-Cole complex and Ballard gravelly loam in the low floodplains and Los Osos-Bonnydoon

complex on the hilly uplands. Ballard gravelly loam is a deep, well-drained soil that occurs on alluvial fans and bench terraces. Vegetation associated with this soil includes annual grasses and forbs (USDA, 1985).

The construction of the Soulajule Reservoir along the main stem of Arroyo Sausal in 1968 and its expansion in 1980 has resulted in significant changes to an already changing native riparian corridor. Before the 1980 expansion, a reduction in fall and winter flows had impacted habitat and native fish populations downstream (UCCE, 1995). A decrease in available water led to a reduction in dense corridors, leaving streambanks more open and exposed. These conditions were changed again after the expansion when summer releases increased flows and greatly enhanced regeneration and expansion of riparian vegetation (Prunuske, 2001).

The riparian corridor is characterized by willow in-stream and California bay laurel and coast live oak on the upper banks. Non-native blackberry is common in the understory shrub layer. The most disturbed areas in the subwatershed occur in the floodplains within Hicks Valley and in the uppermost reach near the stream's headwaters. These low-lying areas are suitable for livestock grazing and crop production. Much of the riparian corridor has been removed and opened up or converted to annual grassland.

Enhancement opportunities

- **High priority restoration opportunities**
    1. **Install livestock fencing, develop off-stream water sources for cattle, and plant willow, California bay laurel, and coast live oak in areas marked AGS 1D on Figure 2.** Primary areas include three sites along the main channel in the upper reach of creek, a site south of Hicks Valley Road, the floodplain area in Hicks Valley, and a small site located in a small valley west of Hicks Valley. Restoring the riparian corridor in the floodplains would greatly increase water quality and help reduce summer water temperatures that result from the absence of riparian canopy and lack of shade.

    2. **Install livestock fencing, develop off-stream water sources, and plant willow in the sparse and open sites (VRI 4S & 4P) identified on Figure 2.** Revegetating the corridor will reduce erosion hazards that may be a problem due to the patchy habit. Filling in the corridor with woody vegetation would aid in connecting dense habitat within the tributaries with the main stem.

- **Medium priority restoration opportunities**
    1. **Install livestock fencing and develop off-stream water sources along tributaries where moderate woody vegetation remains (VRI 2M) (see Figure 2).** Moderately dense riparian corridors occur in the upper reach of Arroyo Sausal south of Hicks Valley Road and west of Point Reyes-Petaluma Road and across from Lincoln School north of Hicks Valley Road. Protecting these areas with exclusionary fencing will aid in a natural recovery of the corridor.

- **Low priority restoration opportunities**
    1. A large portion of the main stem of Arroyo Sausal has been flooded to form the Soulajule Reservoir. Restoring riparian vegetation surrounding the reservoir was given low priority. Many of the tributaries that enter the reservoir support dense riparian forests that are relatively stable. Further protection of these areas by fencing was also given low priority.

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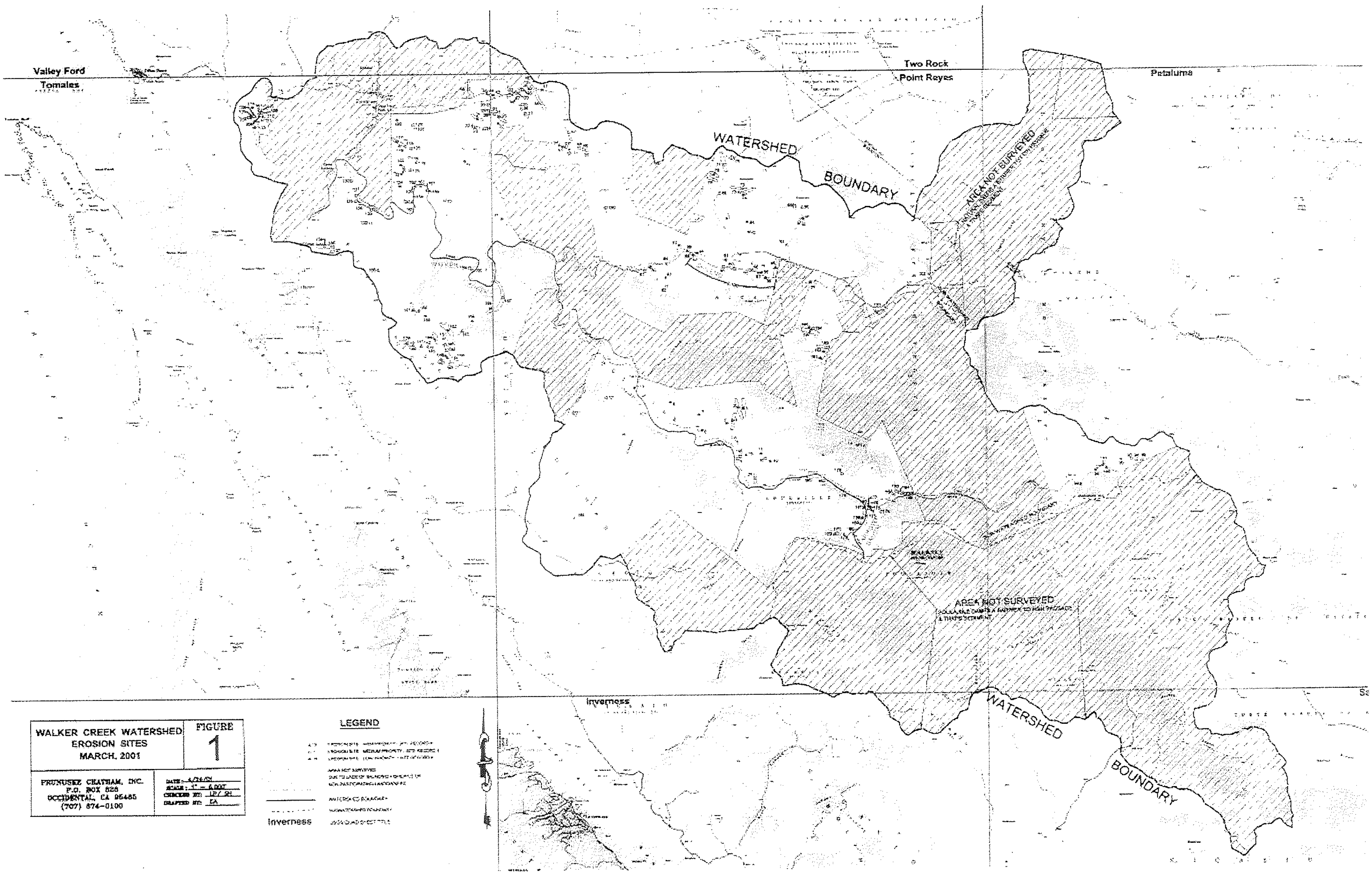

WALKER CREEK WATERSHED
EROSION SITES
MARCH, 2001

FIGURE 1

PRUNUSKE CHATHAM, INC.
P.O. BOX 828
OCCIDENTAL, CA 95465
(707) 874-0100

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8. FIGURES

9. APPENDICES

Appendix A: Example Records from the Erosion Survey Database

Appendix B: Sample Erosion Repair Specifications

Appendix C: California Wildlife Habitat Relationships System
Valley Foothill Riparian (VRI)
Eucalyptus (EUC)
Annual Grassland (AGS)
Perennial Grassland (PGS)

Appendix D: Commonly Found Plants of the Walker Creek Watershed

APPENDIX A

EXAMPLE RECORDS FROM THE EROSION SURVEY DATABASE

MCRCD
Walker Creek Watershed Enhancement Plan
Erosion & Sediment Source Inventory

RECORD #: 010 SURVEYOR'S NAME: JF/MJ DATE OBSERVED: 4/27/2000

SUBWATERSHED: WALKER CREEK

LOCATION: NEAR LEFT BANK TRIBUTARY BY CORRAL

LAND USE: GRAZING

DESCRIPTION: 180′ GULLY WITH 3′ HEADCUT AND 8′ HEADCUT AT TOP

APPROX. LENGTH: 180′ APPROX. WIDTH: 3-8′ APPROX. HEIGHT: 3-8′

EROSION TYPE: ☒ Chronic ☐ Episodic

PREDOMINANT BANK MATERIAL: ☐ Bedrock ☐ Boulder ☐ Cobble ☒ Gravel ☐ Sand ☐ Silt/Clay ☒ Topsoil

EROSION POTENTIAL:	ACTIVITY RATING:	ACCESS RATING:	ESTIMATED REPAIR COST:	
☒ High	☐ High	☒ High	☐ Minor $0-$5,000	☐ Large $25,000-$50,000
☐ Med	☒ Med	☐ Med	☐ Small $5,000-$10,000	☐ Major + $50,000
☐ Low	☐ Low	☐ Low	☒ Medium $10,000-$25,000	☐ Eng'r Design/Survey

COMMENTS: Photo #0453: gully with 8′ headcut at top.

Approximately 70 tons of rock to repair headcuts in a sort of step pool arrangement. Place gravel/cobble in bed between headcuts.

4′ headcut downstream of fence partially stabilized with vegetation.

Sketch is included.

OTHER BENEFITS: (HIGH = ***, MEDIUM = **, LOW = *)

☐ FISHERIES VALUE ______
☐ RANCHER VALUE ______
☒ WILDLIFE VALUE __*__
☐ EDUCATIONAL VALUE ______
☐ COMMUNITY VALUE ______

REPAIR PRIORITY:
☒ High
☐ Medium
☐ Low

MCRCD

Walker Creek Watershed Enhancement Plan
Recommendations for Erosion Repair

RECORD #: 010

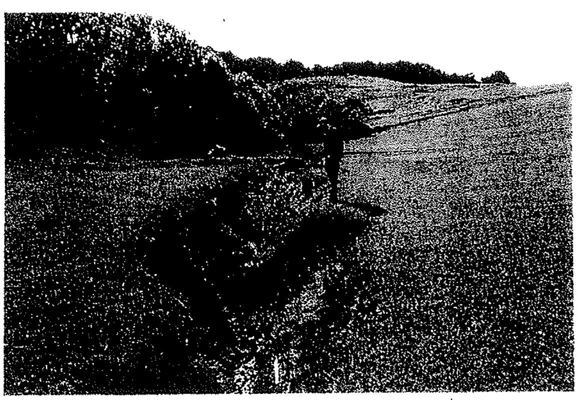
REPAIR TYPE

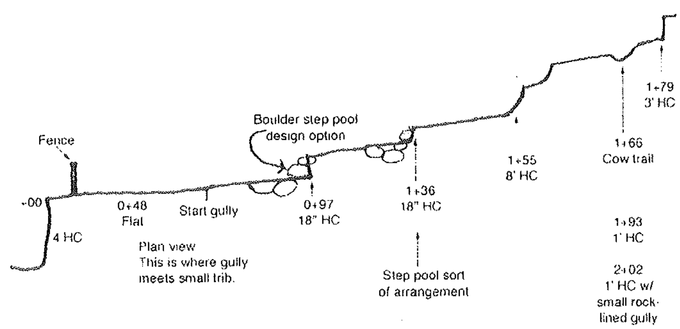
- ☐ Boulder cross vein
- ☐ Boulder vein
- ☐ Boulder vortex weir
- ☐ Channel diversion
- ☐ Culvert debris traps
- ☐ Culvert installation
- ☐ Culvert maintenance
- ☐ Culvert removal
- ☐ Engineered fill/buttress
- ☒ Fencing for humans/animals
- ☐ Gabion bank stabilization
- ☒ General grading
- ☐ Geoweb headcut repair
- ☐ Geoweb wet crossing
- ☐ Irrigation: drip/other
- ☐ Log and boulder bank armoring
- ☐ Log or boulder weirs
- ☐ Loose rock checkdam (grade control)
- ☐ Loose rock culvert inlet & outlet protection
- ☐ Loose rock energy dissipator
- ☒ Loose rock headcut repair
- ☐ Loose rock lined channel
- ☐ Loose rock revetment
- ☐ Loose rock toe protection
- ☐ Loose rock wing deflector
- ☒ Natural channel reconstruction
- ☐ Outslope road grading
- ☐ Redwood checkdams
- ☐ Rock and Gravel wet crossing
- ☐ Rolling dips
- ☐ Sack-crete repair
- ☐ Sediment basin
- ☐ Subsurface drains
- ☐ Waterbars
- ☐ Water Development: Spring/other
- ☐ Wetcrossing
- ☐ Other...

BIOTECHNICAL REPAIR

- ☐ Biolog toe protection
- ☐ Brush mattress
- ☐ Brush packing slope stabilization
- ☐ Earth-reinforced fill
- ☒ Erosion control blanket
- ☐ Hydroseed
- ☐ Native material revetment
- ☒ Native plant reforestation
- ☒ Seed, fertilize and mulch
- ☐ Straw checkdams
- ☐ Straw punching
- ☐ Straw wattles
- ☐ Vegetated geogrids
- ☐ Wetland plug planting
- ☐ Willow baffles
- ☐ Willow brush checkdams
- ☐ Willow crib walls
- ☐ Willow or brush headcut repair
- ☐ Willow poles
- ☐ Willow revetment
- ☒ Willow sprigging
- ☐ Willow wattles
- ☐ Other...

PHOTOS/SKETCH:





+00
4' HC ds of fence partially stabilized w/ vegetation

See scratch sheet for option specs

MCRCD
Walker Creek Watershed Enhancement Plan
Erosion & Sediment Source Inventory

RECORD #: 021 SURVEYOR'S NAME: J FORT/MJ DATE OBSERVED: 5/10/2000

SUBWATERSHED: KEYS CREEK

LOCATION: HEADWATER SECTION OF PROPERTY ADJACENT TO CERINI CORNER

LAND USE: GRAZING

DESCRIPTION: LARGE UPLAND GULLY DRAINAGE W/ MULTIPLE HEADCUTS

APPROX. LENGTH: APPROX. WIDTH: 15 - 40' APPROX. HEIGHT: 2 - 16' EROSION TYPE: ☒ Chronic ☒ Episodic

PREDOMINANT BANK MATERIAL: ☐ Bedrock ☐ Boulder ☐ Cobble ☐ Gravel ☐ Sand ☒ Silt/Clay ☒ Topsoil

EROSION POTENTIAL:	ACTIVITY RATING:	ACCESS RATING:	ESTIMATED REPAIR COST:	
☒ High	☒ High	☒ High	☐ Minor $0-$5,000	☐ Large $25,000-$50,000
☐ Med	☐ Med	☐ Med	☐ Small $5,000-$10,000	☒ Major + $50,000
☐ Low	☐ Low	☐ Low	☐ Medium $10,000-$25,000	☒ Eng'r Design/Survey

COMMENTS: Photos #1017, 1018, 1019

Headcut at top near spring box: 8' H x 25' W @ 0 +00'
Multiple 1-3' headcuts @ 0 + 90' and 1 + 50'
16'H x 40' W headcut in middle section of channel @ 2 + 00'
18" headcut at property line.

Headcut would likely need to be laid back and a boulder step pool channel installed down the face at a 3:1 slope. The rock voids would be filled with gravel and soils and planted with native vegetation. Subsurface drains may need to be required for spring activity.

This gully has the potential to produce over 3000 cy. of sediment into Keys Creek.
***High Priority.

Sketch is included.

OTHER BENEFITS: (HIGH = ***, MEDIUM = **, LOW = *)

☐ FISHERIES VALUE ____
☒ RANCHER VALUE ***
☒ WILDLIFE VALUE **
☐ EDUCATIONAL VALUE ____
☒ COMMUNITY VALUE **

REPAIR PRIORITY:
☒ High
☐ Medium
☐ Low

MCRCD

Walker Creek Watershed Enhancement Plan
Recommendations for Erosion Repair

RECORD #: 021

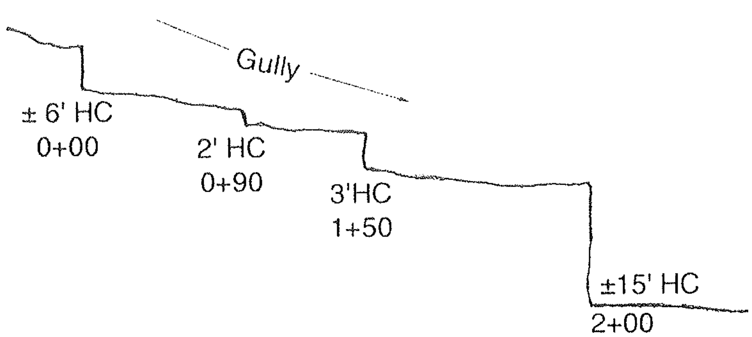
REPAIR TYPE

- ☐ Boulder cross vein
- ☐ Boulder vein
- ☐ Boulder vortex weir
- ☐ Channel diversion
- ☐ Culvert debris traps
- ☐ Culvert installation
- ☐ Culvert maintenance
- ☐ Culvert removal
- ☐ Engineered fill/buttress
- ☒ Fencing for humans/animals
- ☐ Gabion bank stabilization
- ☒ General grading
- ☐ Geoweb headcut repair
- ☐ Geoweb wet crossing
- ☐ Irrigation: drip/other
- ☐ Log and boulder bank armoring
- ☐ Log or boulder weirs
- ☐ Loose rock checkdam (grade control)
- ☐ Loose rock culvert inlet & outlet protection
- ☐ Loose rock energy dissipator
- ☒ Loose rock headcut repair
- ☒ Loose rock lined channel
- ☐ Loose rock revetment
- ☐ Loose rock toe protection
- ☐ Loose rock wing deflector
- ☒ Natural channel reconstruction
- ☐ Outslope road grading
- ☐ Redwood checkdams
- ☐ Rock and Gravel wet crossing
- ☐ Rolling dips
- ☐ Sack-crete repair
- ☐ Sediment basin
- ☒ Subsurface drains
- ☐ Waterbars
- ☐ Water Development: Spring/other
- ☐ Wetcrossing
- ☐ Other...

BIOTECHNICAL REPAIR

- ☐ Biolog toe protection
- ☒ Brush mattress
- ☐ Brush packing slope stabilization
- ☐ Earth-reinforced fill
- ☒ Erosion control blanket
- ☐ Hydroseed
- ☐ Native material revetment
- ☒ Native plant reforestation
- ☐ Seed, fertilize and mulch
- ☐ Straw checkdams
- ☐ Straw punching
- ☐ Straw wattles
- ☐ Vegetated geogrids
- ☐ Wetland plug planting
- ☐ Willow baffles
- ☐ Willow brush checkdams
- ☐ Willow crib walls
- ☐ Willow or brush headcut repair
- ☐ Willow poles
- ☐ Willow revetment
- ☒ Willow sprigging
- ☐ Willow wattles
- ☐ Other...

PHOTOS/SKETCH:



MCRCD
Walker Creek Watershed Enhancement Plan
Erosion & Sediment Source Inventory

RECORD #: 057 SURVEYOR'S NAME: JF DATE OBSERVED: 5/17/2000

SUBWATERSHED: CHILENO

LOCATION: UPSTREAM ABOUT 150' OF SITE JCB-2

LAND USE: GRAZING

DESCRIPTION: LEFT BANK, OUTSIDE BEND ERODING AND VERTICAL BANKS

APPROX. LENGTH: 101' APPROX. WIDTH: APPROX. HEIGHT: EROSION TYPE: ☒ Chronic ☒ Episodic

PREDOMINANT BANK MATERIAL: ☐ Bedrock ☐ Boulder ☐ Cobble ☐ Gravel ☐ Sand ☒ Silt/Clay ☒ Topsoil

EROSION POTENTIAL:	ACTIVITY RATING:	ACCESS RATING:	ESTIMATED REPAIR COST:	
☐ High	☒ High	☒ High	☐ Minor $0-$5,000	☐ Large $25,000-$50,000
☒ Med	☒ Med	☐ Med	☐ Small $5,000-$10,000	☐ Major + $50,000
☐ Low	☐ Low	☐ Low	☒ Medium $10,000-$25,000	☐ Eng'r Design/Survey

COMMENTS: Photo #1073

Sketch is included.

OTHER BENEFITS: (HIGH = ***, MEDIUM = **, LOW = *)

☐ FISHERIES VALUE ______
☐ RANCHER VALUE ______
☐ WILDLIFE VALUE ______
☐ EDUCATIONAL VALUE ______
☐ COMMUNITY VALUE ______

REPAIR PRIORITY:

☒ High
☐ Medium
☐ Low

MCRCD
Walker Creek Watershed Enhancement Plan
Recommendations for Erosion Repair

RECORD #: 057

REPAIR TYPE

- ☐ Boulder cross vein
- ☐ Boulder vein
- ☐ Boulder vortex weir
- ☐ Channel diversion
- ☐ Culvert debris traps
- ☐ Culvert installation
- ☐ Culvert maintenance
- ☐ Culvert removal
- ☐ Engineered fill/buttress
- ☐ Fencing for humans/animals
- ☐ Gabion bank stabilization
- ☒ General grading
- ☐ Geoweb headcut repair
- ☐ Geoweb wet crossing
- ☐ Irrigation: drip/other
- ☐ Log and boulder bank armoring
- ☐ Log or boulder weirs
- ☐ Loose rock checkdam (grade control)
- ☐ Loose rock culvert inlet & outlet protection
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- ☐ Waterbars
- ☐ Water Development: Spring/other
- ☐ Wetcrossing
- ☐ Other...

BIOTECHNICAL REPAIR

- ☐ Biolog toe protection
- ☒ Brush mattress
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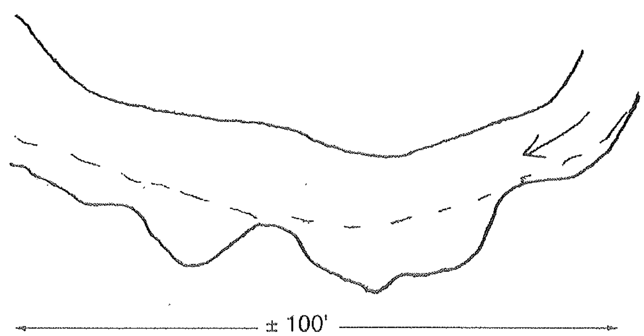
- ☐ Willow poles
- ☐ Willow revetment
- ☐ Willow sprigging
- ☐ Willow wattles
- ☐ Other...

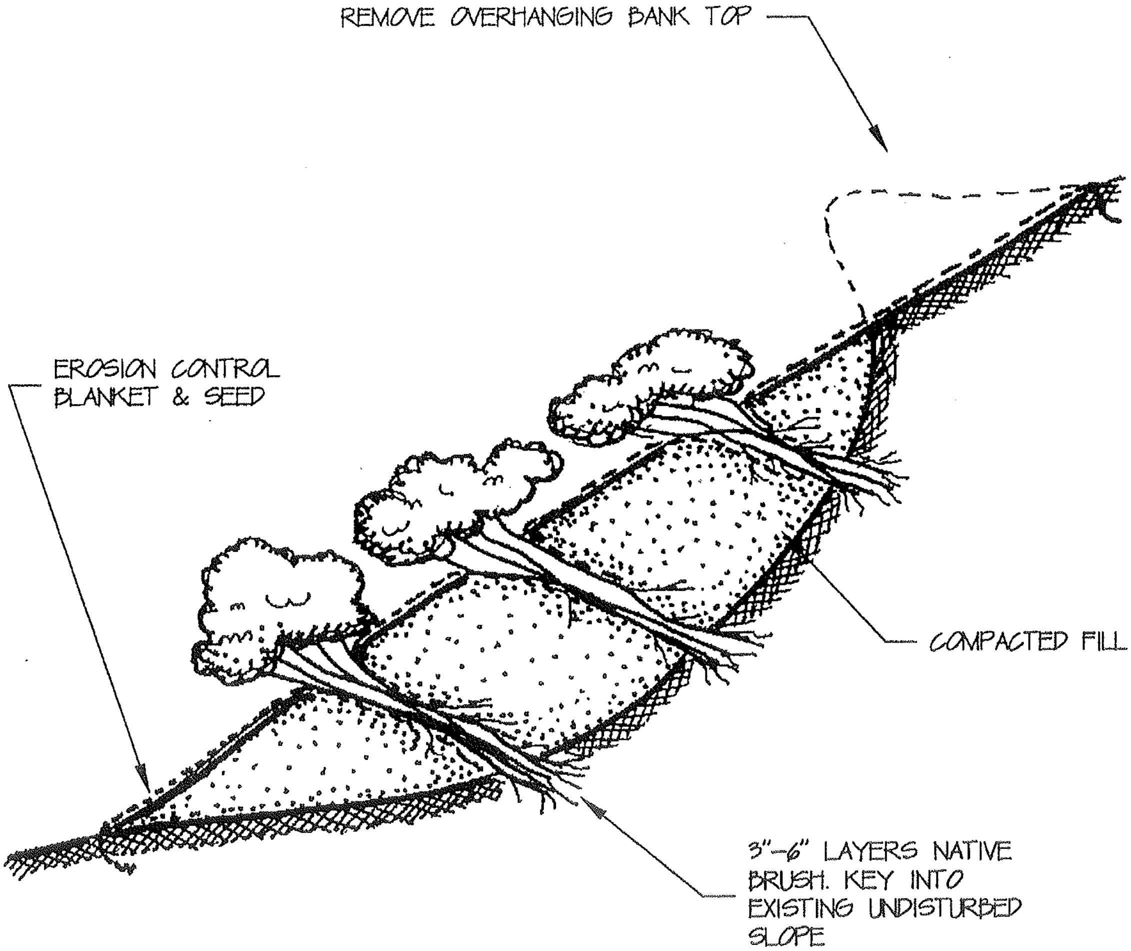
PHOTOS/SKETCH:



APPENDIX B

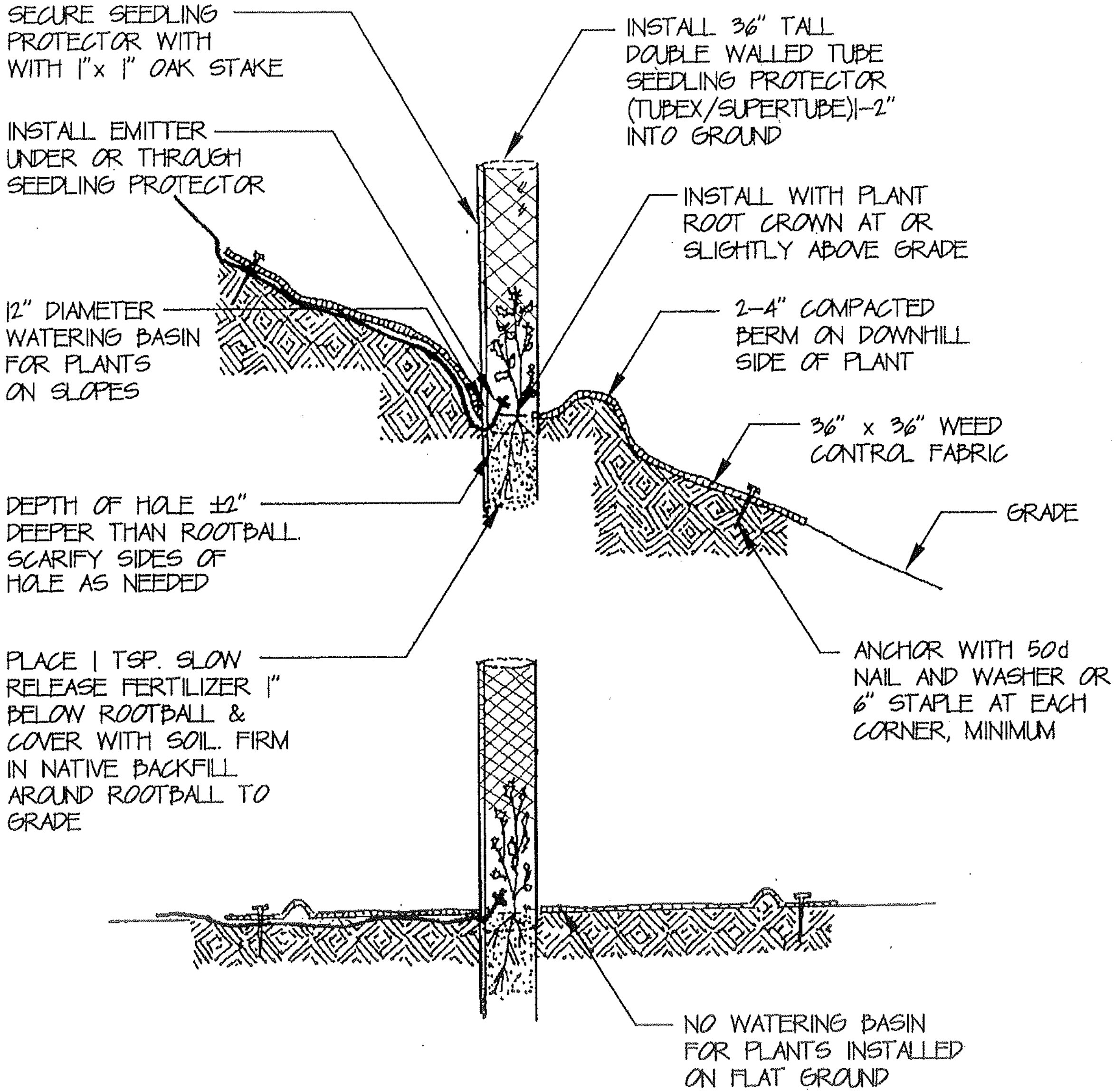
SAMPLE EROSION REPAIR SPECIFICATIONS

CONCEPTUAL - NOT FOR CONSTRUCTION



AREAS TO BE GRADED SHOULD BE CLEARED OF BRUSH, RUBBLE, DEBRIS AND OLD FILLS. SCARIFY EXISTING SURFACE BEFORE PLACEMENT OF FILLS.

PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: JUNE 1, 1999 SCALE: NTS CHECKED BY: DRAFTED BY: DESIGNED BY:	BIOTECHNICAL TREATMENTS BRUSH LAYERING	Sheet



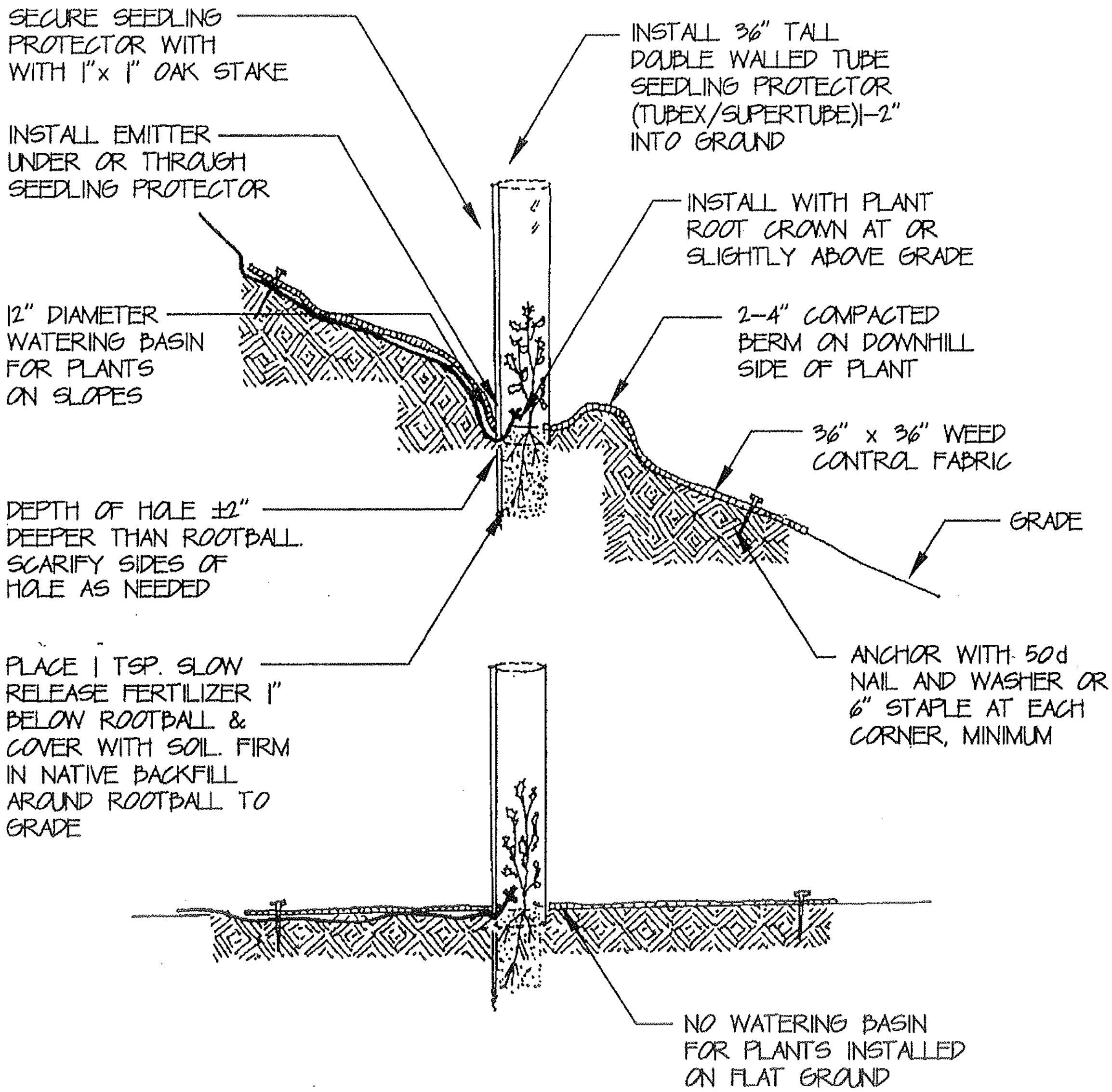
NOTE: REMOVE SEEDLING PROTECTOR AFTER 3 YEARS OR WHEN PLANT IS WELL ESTABLISHED.

PRUNUSKE CHATHAM, INC.
P.O. BOX 828
OCCIDENTAL, CA 95465
(707) 874-0100

DATE: JUNE 1, 1999
SCALE: NTS
CHECKED BY: HA
DRAFTED BY: MH/DP
DESIGNED BY: MH

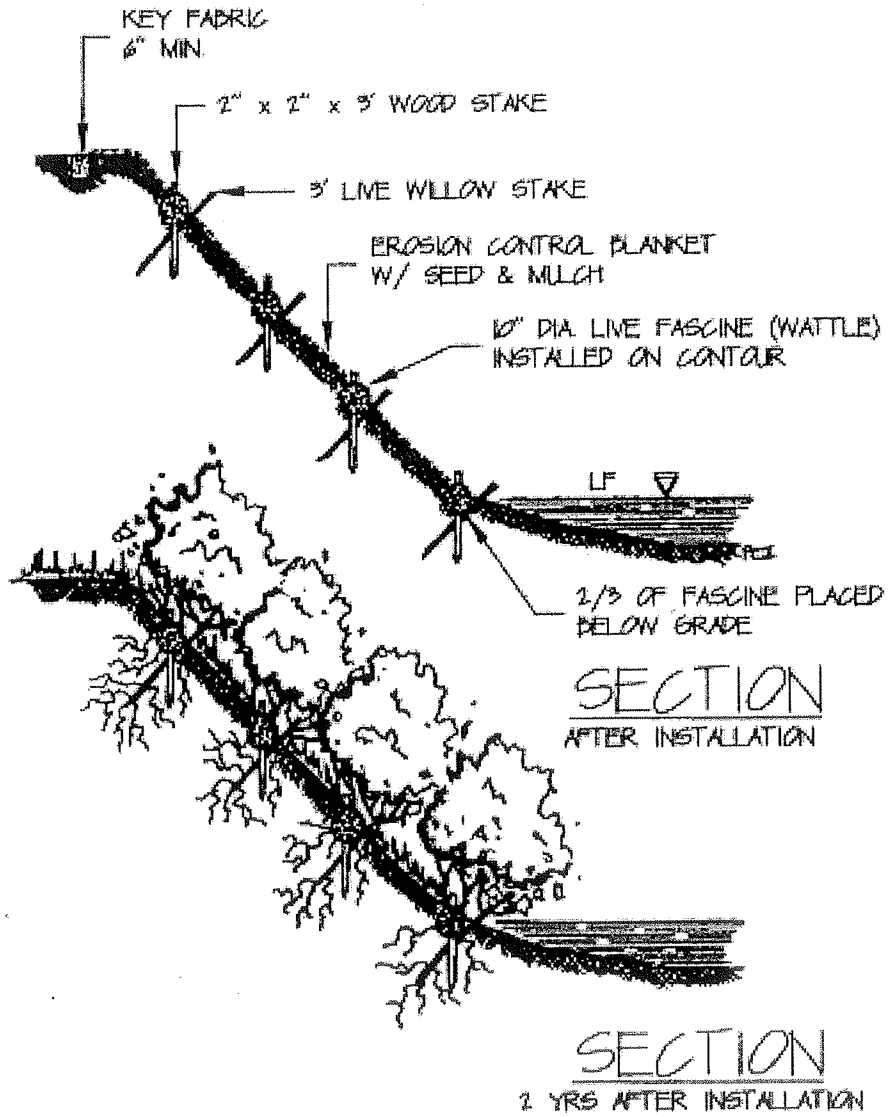
BIOTECHNICAL TREATMENTS
NATIVE SPECIES REVEGETATION

Sheet



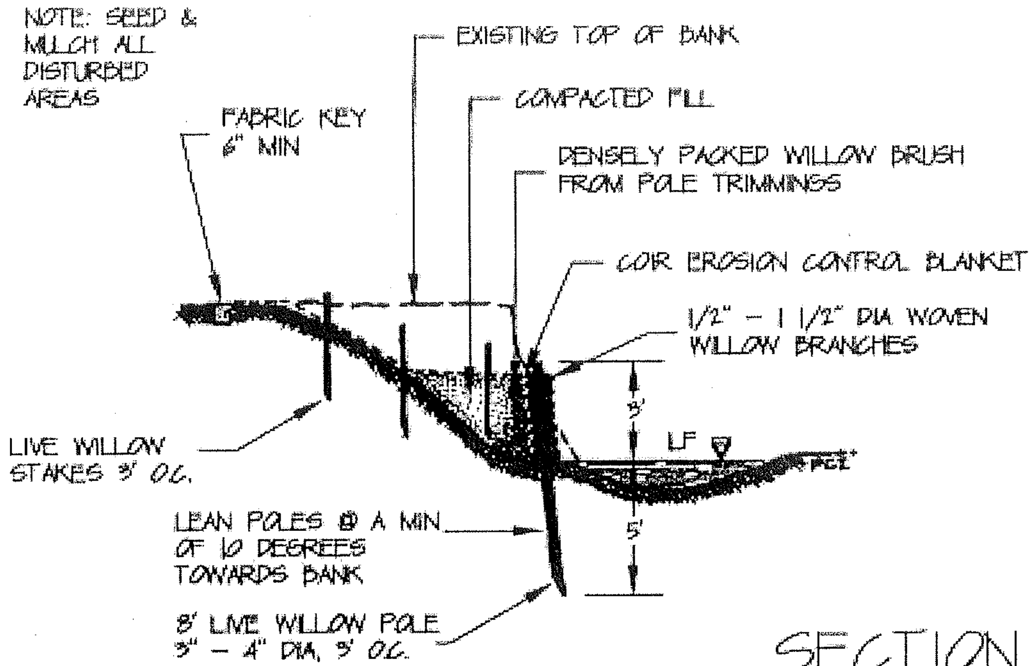
NOTE: 1. REMOVE SEEDLING PROTECTOR AFTER 3 YEARS OR WHEN PLANT IS WELL ESTABLISHED.
2. SEEDLING PROTECTORS TO BE PLACED ON TREES ONLY.

PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: JAN. 2000 SCALE: NTS CHECKED BY: HA DRAFTED BY: MH/DP DESIGNED BY: MH	CONTAINER PLANTING DETAIL W/ BROWSE PROTECTION WEED CONTROL FABRIC	SHEET



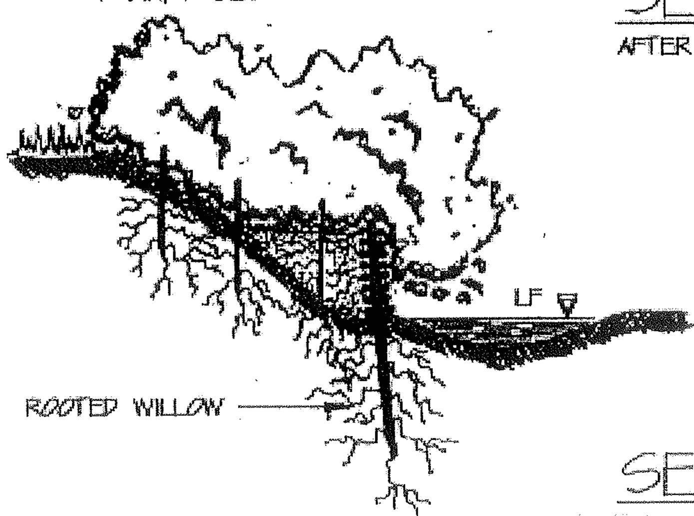
CONCEPTUAL - NOT FOR CONSTRUCTION

PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: MAY 1999 SCALE: NTS CHECKED BY: DRAFTED BY: DESIGNED BY:	BIOTECHNICAL TREATMENTS WILLOW WATTLE STREAMBANK REPAIR	Sheet



SECTION

AFTER INSTALLATION

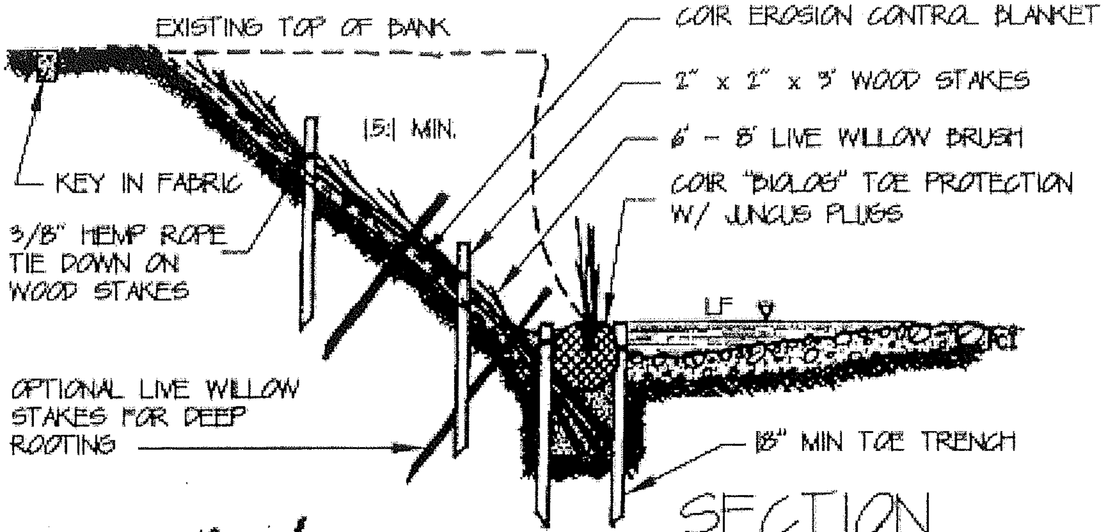


SECTION

2 YRS AFTER INSTALLATION

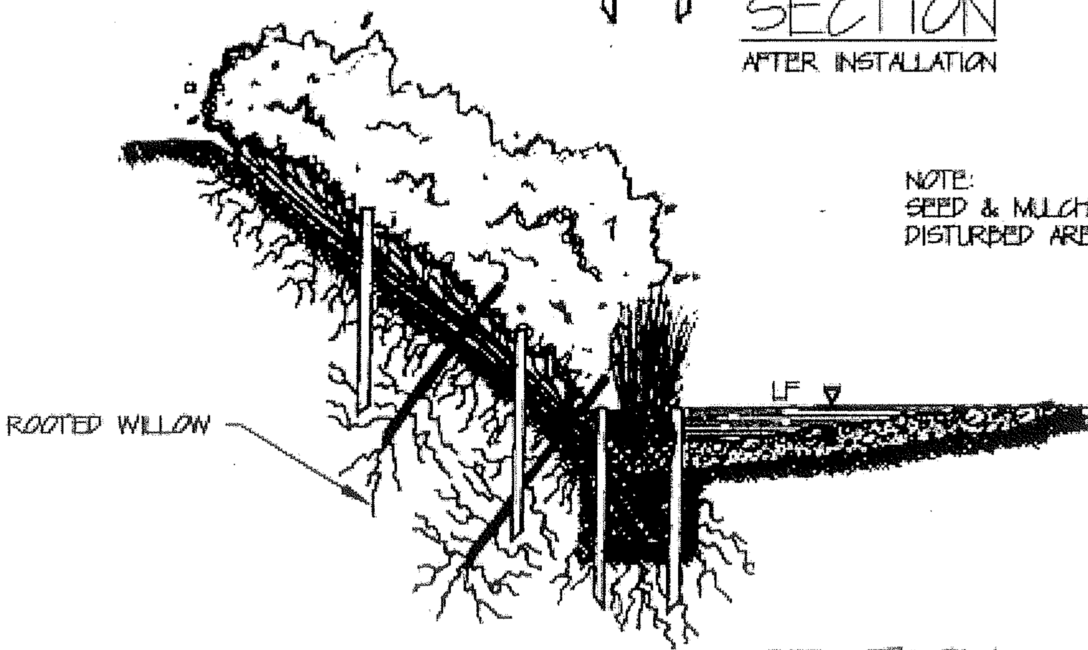
CONCEPTUAL - NOT FOR CONSTRUCTION

PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: JUNE 1, 1999 SCALE: CHECKED BY: DRAFTED BY: DESIGNED BY:	BIOTECHNICAL TREATMENTS WILLOW WALL REVETMENT	Sheet



SECTION
AFTER INSTALLATION

NOTE:
SEED & MULCH ALL DISTURBED AREAS

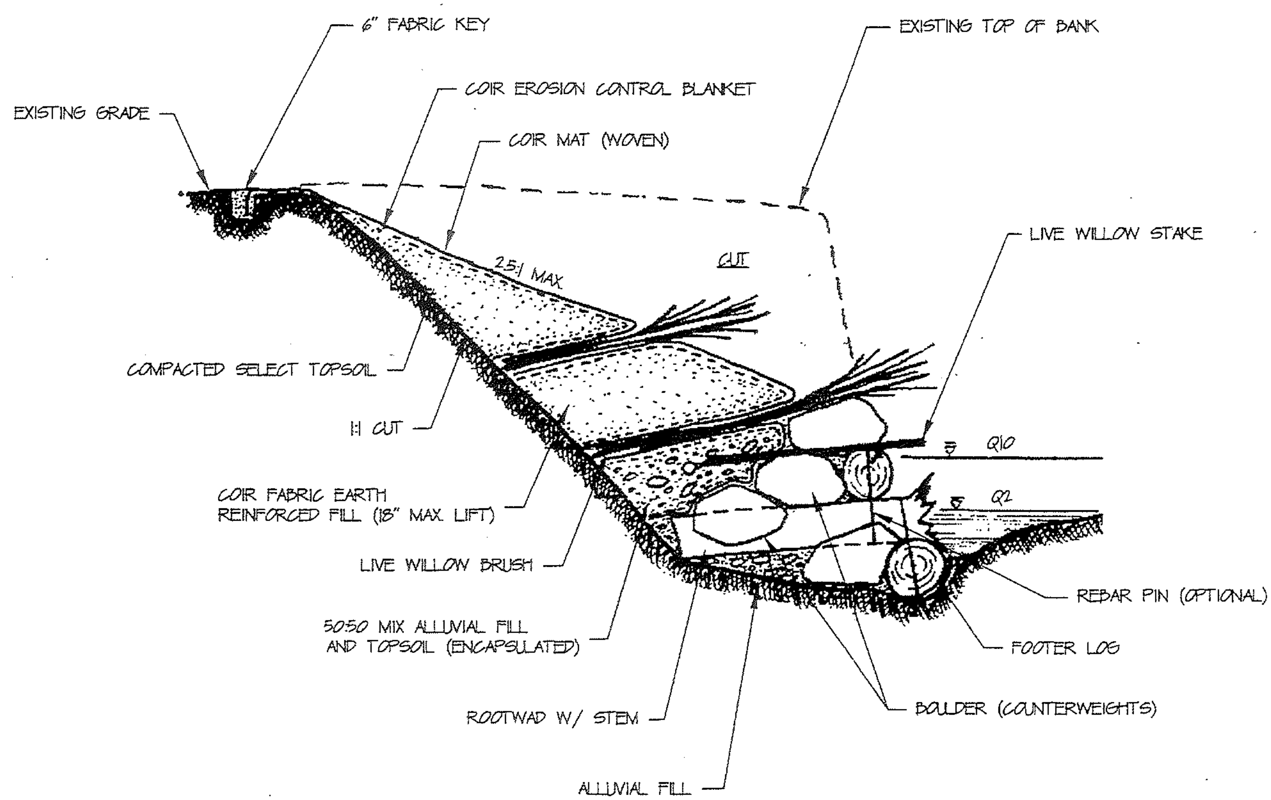


SECTION
2 YRS AFTER INSTALLATION

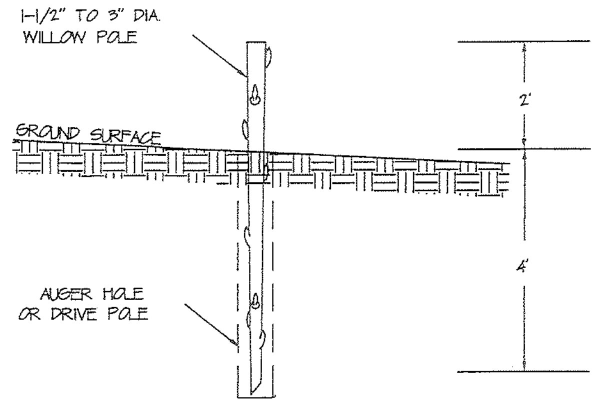
CONCEPTUAL – NOT FOR CONSTRUCTION

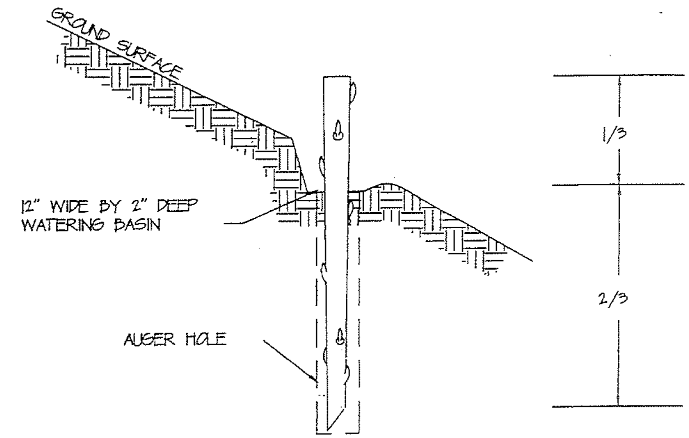
PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: JUNE 1, 1999 SCALE: NTS CHECKED BY: SC DRAFTED BY: MJ DESIGNED BY: MJ	BIOTECHNICAL TREATMENTS BRUSH MATRESS	Sheet

CONCEPTUAL – NOT FOR CONSTRUCTION



PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: SCALE: CHECKED BY: DRAFTED BY: DESIGNED BY:	REVISIONS	DATE	BY	PREPARED FOR:	BIOTECHNICAL TREATMENTS NATIVE MATERIAL REVETMENT





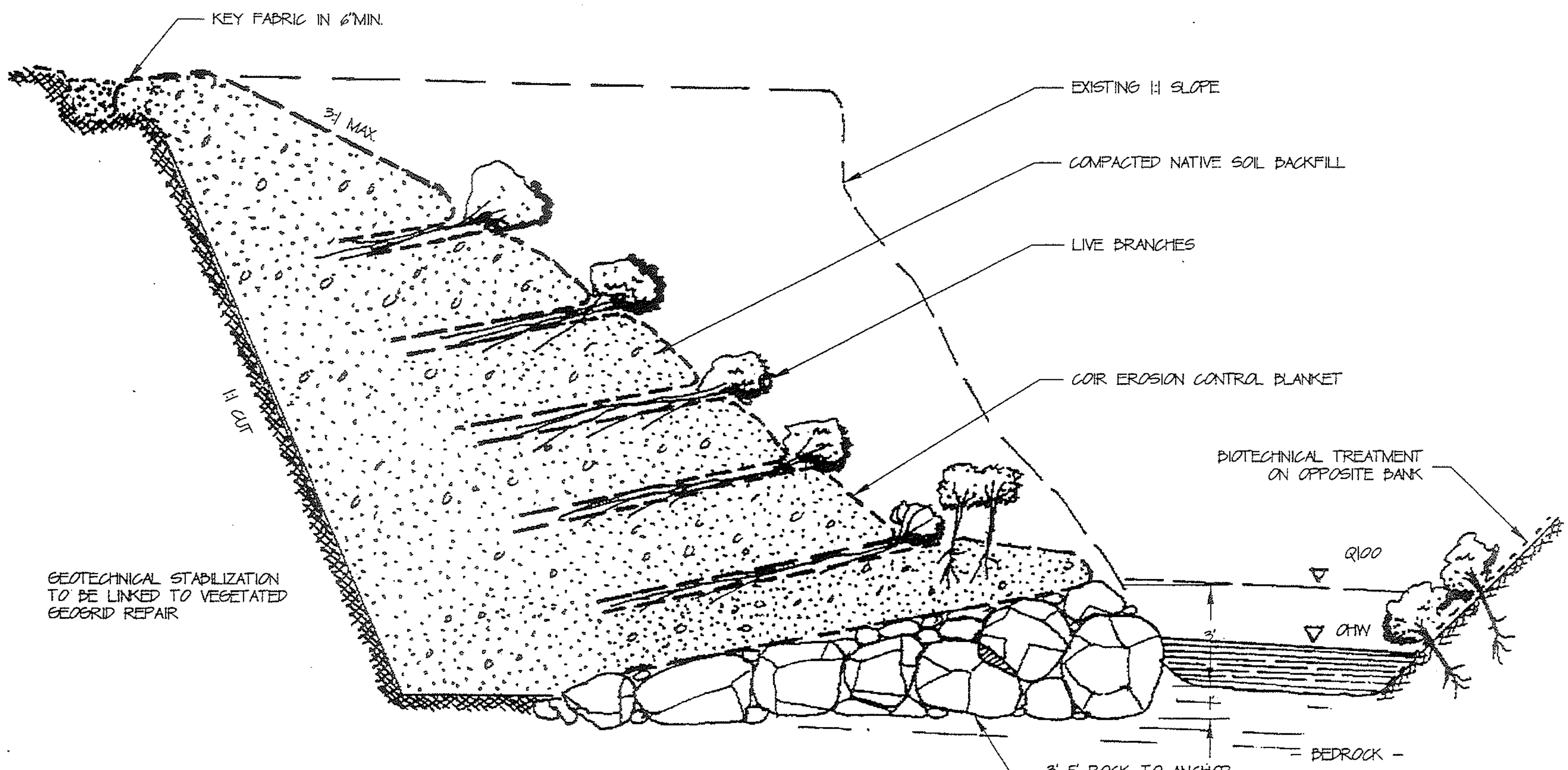
1. CUT AND INSTALL WILLOW POLES AFTER WILLOWS HAVE GONE DORMANT, GENERALLY DECEMBER TO FEBRUARY.
2. POLES SHOULD BE CUT AND INSTALLED ON THE SAME DAY. KEEP THE POLES COVERED AND MOIST CONTANTLY DURING TRANSPORT. IF STORED OVERNIGHT, POLES MUST BE IMMERSED IN WATER.
3. POLES SHOULD BE 1-1/2" TO 3" DIAMETER AND 6' LONG MINIMUM.
4. A LEAD HOLE SHOULD BE AUGERED OR DRIVEN EQUIVALENT TO THE DEPTH OF THE POLE
5. CUT THE TOP OF EACH POLE SQUARE AND THE BOTTOM SLANTED TO INSURE THE PROPER END IS PLACED DOWN. BUDS MUST BE POINTED UP.
6. PRUNE SPLIT TOPS THAT RESULT FROM DRIVING POLES.
7. TRIM ALL BRANCHES OFF OF POLE WITH LOPPERS OR HAND PRUNERS BEFORE PLANTING.
8. IF AUGER IS USED TO DRILL HOLES, COMPACT FILL IN 2" LIFTS.
9. LOCATION OF WILLOW POLES TO BE STAKED AND PIN FLAGGED IN FIELD BY APPROVED INSPECTOR BEFORE PLACEMENT OF ANY WILLOWS.
10. WILLOW POLES MUST BE ALIVE AT TIME OF INSTALLATION.

WILLOW POLE
PLANTING DETAIL

WILLOW POLE

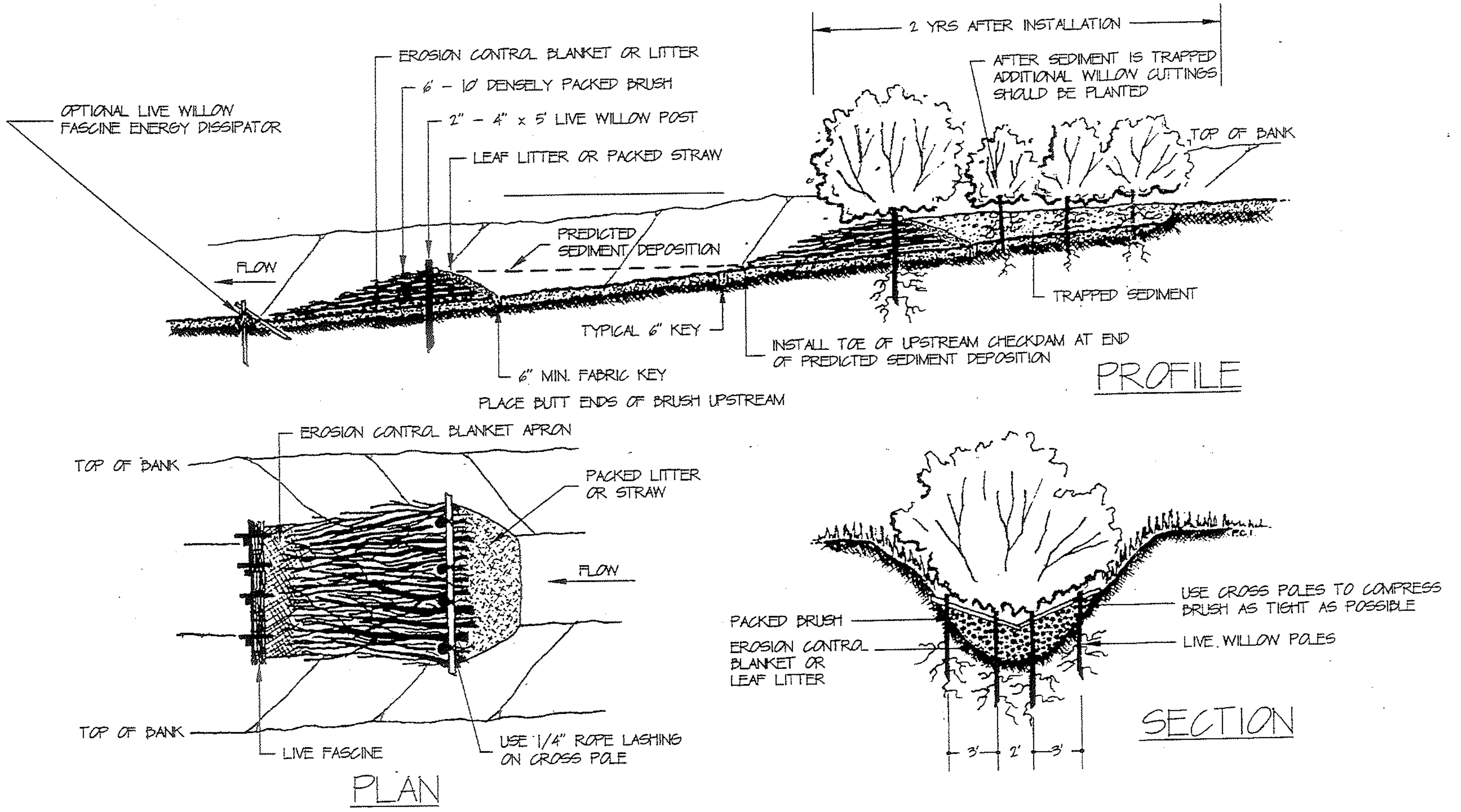
PLANTING DETAIL

PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: JUNE 1, 1999 SCALE: NTS CHECKED BY: DRAFTED BY:	REVISIONS	DATE	BY	PREPARED FOR:	BIOTECHNICAL TREATMENTS PLANTED WILLOW STAKES	SHEET



CONCEPTUAL - NOT FOR CONSTRUCTION

PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: MAY 28, 1999 SCALE: NTS CHECKED BY: DRAFTED BY:	REVISIONS	DATE	BY	PREPARED FOR:	BIOTECHNICAL TREATMENTS VEGETATED WRAPAROUND GEOGRID	SHEET



CONCEPTUAL – NOT FOR CONSTRUCTION

PRUNUSKE CHATHAM, INC.
P.O. BOX 828
OCCIDENTAL, CA 95465
(707) 874-0100

DATE: MAY 13, 1999
SCALE: NTS
CHECKED BY:
DRAFTED BY:

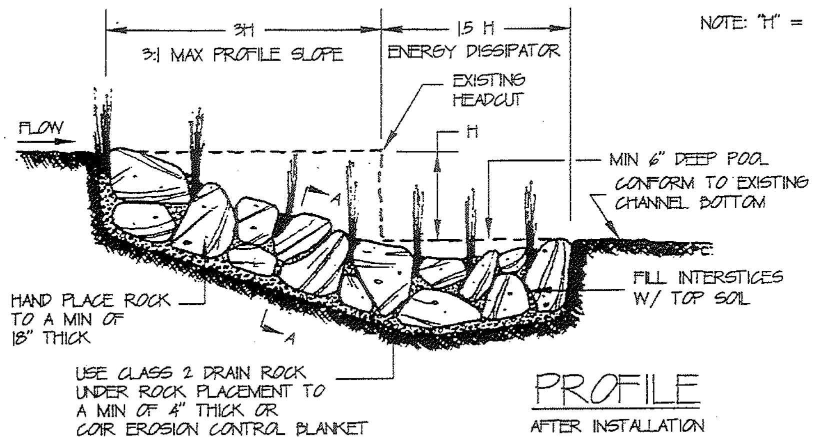
REVISIONS	DATE	BY

PREPARED FOR:

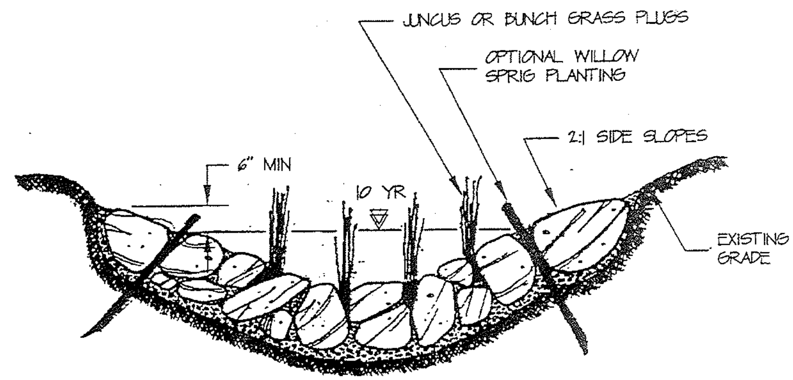
BIOTECHNICAL TREATMENTS
BRUSH CHECKDAM

SHEET

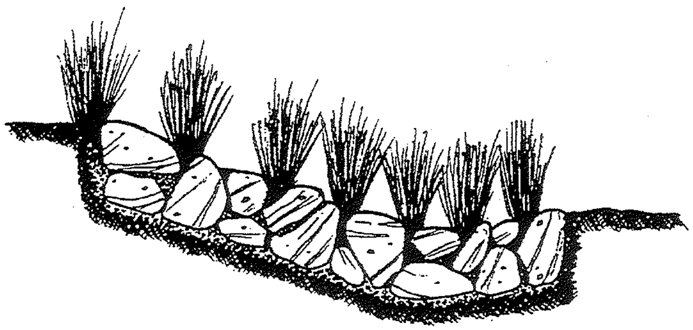
NOTE: "H" = HEIGHT OF EXISTING HEADCUT



PROFILE
AFTER INSTALLATION



SECTION AA



PROFILE
2 YRS AFTER INSTALLATION

CONCEPTUAL - NOT FOR CONSTRUCTION

PRUNUSKE CHATHAM, INC.
P.O. BOX 828
OCCIDENTAL, CA 95465
(707) 874-0100

DATE: MAY 13, 1999
SCALE: NTS
CHECKED BY:
DRAFTED BY:

REVISIONS	DATE	BY

PREPARED FOR:

BIOTECHNICAL TREATMENTS
PLANTED LOOSE ROCK
HEADCUT REPAIR

SHEET

CONCEPTUAL – NOT FOR CONSTRUCTION

NOTES:

1. Fabric shall be Mirafi 700. Fabric shall be in one piece. Install loosely to allow it to move into voids as rock is placed. Place rock fill slowly and carefully, hand shift as needed, do not tear the filter fabric during placement. The objective is to create an interlocking matrix with each rock supported at a minimum of three points. Fill voids between large rock with small rock. Rock shall have a specific gravity of 2.7 minimum. Rock to be used in checkdams and headcut repairs shall average [illegible] to [illegible] inches in diameter, check specifications. All rock 6 inches in diameter and smaller shall be screeened out. Erosion control blanket shall be biogradeable coir or excelsior, mimimum 0.7 #/sqyd. sewn with natural fiber netting.

2. Soil cement shall be one part dry cement with 6 parts local sand and gravel material. Moisten the soil cement mixture during compaction. Moisture level shall be sufficient such that a hand full of moistened soil cement mix will stick together when firmly gripped.

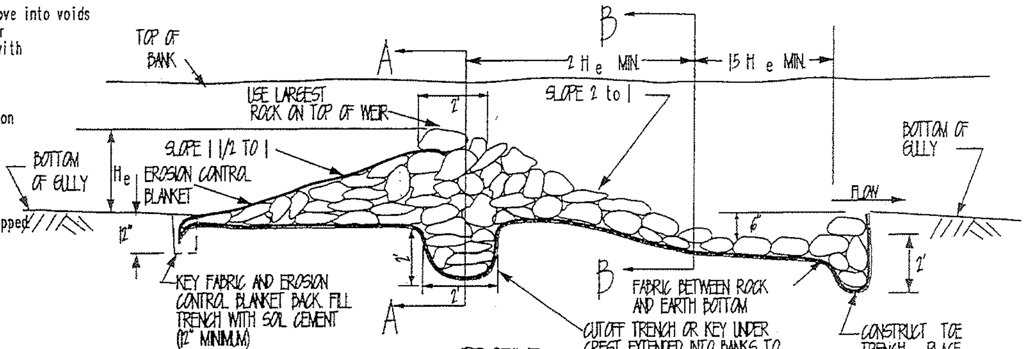
3. Definitions:

He is the effective height of the dam, the height of the spillway above the bottom of the gully.

Df is the depth of flow of the design storm over the spillway of the dam and is designated by the designing engineer. It is the dimension for determining the height of the side walls of the dam above the spillway.

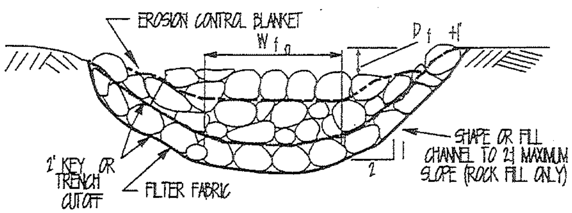
Wf is the top width of the weir opening.

T is the thickness of the rock.

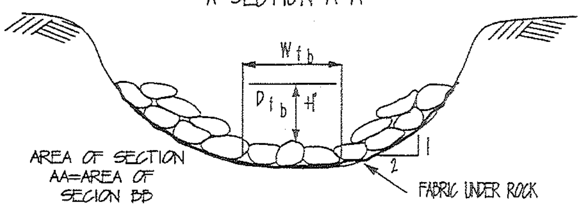


PROFILE

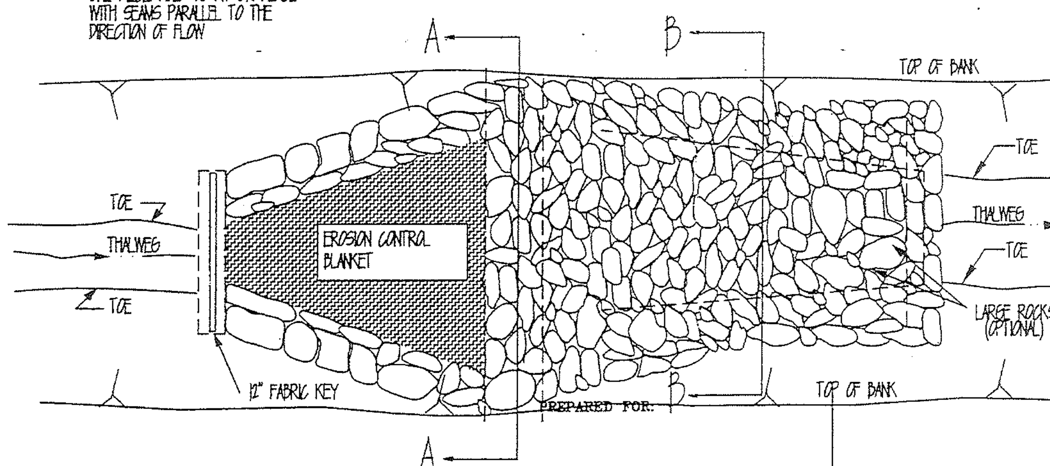
FILTER FABRIC SHOULD BE ONE PIECE FOLD TO FIT OR PLACE WITH SEAMS PARALLEL TO THE DIRECTION OF FLOW



X-SECTION A-A



X-SECTION B-B

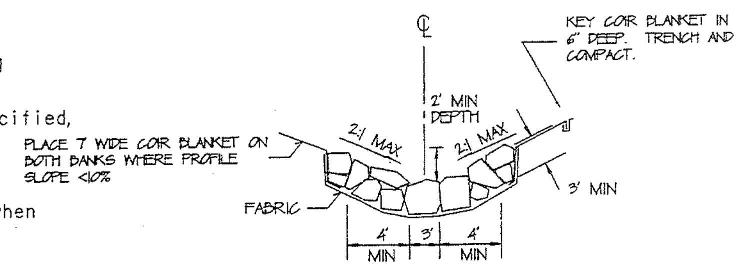


PLAN VIEW

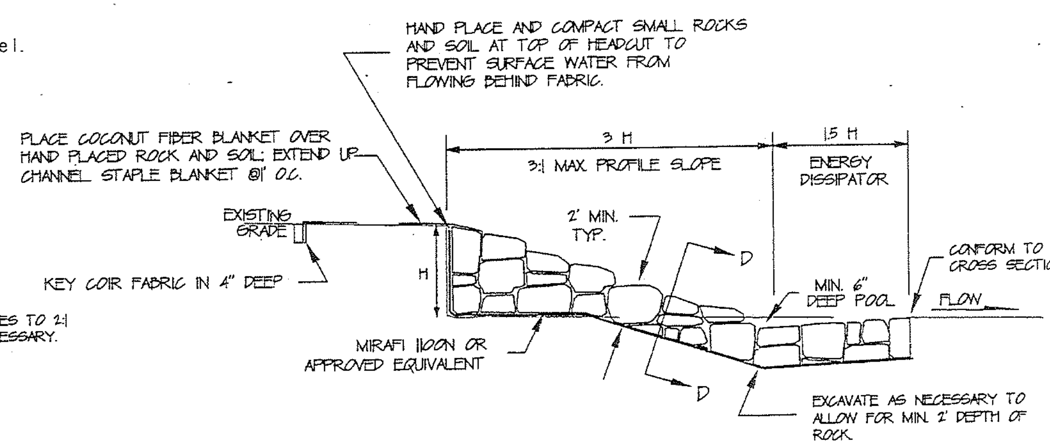
PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: JUNE 11, 1999 SCALE: NTS CHECKED BY: DRAFTED BY:	REVISIONS	DATE	BY	PREPARED FOR:	EROSION CONTROL TREATMENTS LOOSE ROCK CHECKDAM	SHEET

NOTES:

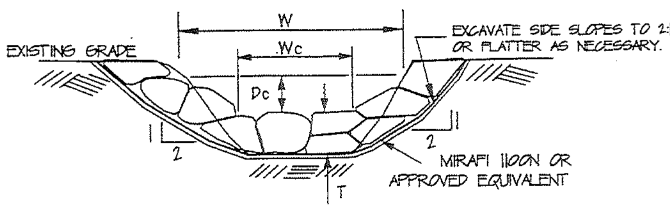
1. Fabric should be in one piece. Install loosely to allow it to move into voids as rock is placed. Place rock fill slowly and carefully, hand shift as needed, do not tear the filter fabric during placement. The objective is to create an interlocking matrix with each rock supported at a minimum of three points. Fill voids between large rock with small rock. Rock shall have a specific gravity of 2.6 minimum. Rock gradation shall be as specified in construction notes. If gradation is not specified, 12"– 24" well graded rock shall be used. Rock under 6" shall be rejected.
2. Soil cement shall be one part dry cement with 6 parts onsite soil (sand and gravel). Moisten the soil cement mixture during compaction. Moisture level shall be sufficient such that a hand full of moistened soil cement mix will stick together when firmly gripped.
3. The rock channel sides shall be placed at 2:1 or flatter.
4. Definitions:
   H = The original height of headcut.
   W = The original width of headcut.
   Dc = The designed min. depth of rock channel.
   Wc = The designed min. bottom width of rock channel.
   T = The thickness of rock
   Td = The depth of rock toe.
5. Seed and mulch all disturbed areas.



TYPICAL SECTION A–A
ROCK CHANNEL



PROFILE



CROSS SECTION D–D

CONCEPTUAL – NOT FOR CONSTRUCTION

PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: SCALE: CHECKED BY: DRAFTED BY:	REVISIONS	DATE	BY	PREPARED FOR:	EROSION CONTROL TREATMENTS LOOSE ROCK HEADCUT	SHEET