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SECTION 1: INTRODUCTION

1.1 PROJECT INTRODUCTION

The San Francisquito Creek Bank Stabilization and Revegetation Master Plan was created with four primary goals in mind:

1) To preserve and/or enhance the natural character of San Francisquito Creek by increasing the presence of native vegetation. This will improve habitat value, water quality, and bank stability – while protecting or improving creek conditions for state and federally listed species.

2) To stabilize banks in an environmentally sensitive manner that protects property and infrastructure, without significantly changing the conveyance of the creek.

3) To enhance the value of the creek as a community amenity by improving access to public areas, enhancing interpretive and education opportunities, and improving visual connections.

4) To develop a unified approach to implementation of the Plan that promotes consistency across jurisdictional boundaries and streamlines the permitting process for participating landowners.

This project is a multi-jurisdictional effort, intended to assist agencies and landowners' consultants in the planning, conceptual design and permitting of San Francisquito Creek stabilization and revegetation projects. The recommendations herein are based on analyses of site conditions by a multidisciplinary team that has considered the entire creek system and has recommended treatments that are consistent with the needs of that system.

1.2 PROJECT HISTORY

In January of 1998, the City of Menlo Park issued a request for proposals for the San Francisquito Creek Bank Revegetation Project. This project called for the preparation of a general Master Plan to revegetate and remove non-native plants in the creek from Junipero Serra Bridge in Menlo Park to University Avenue in Palo Alto.

Effects of the record flows of February 1998 prompted an increased interest in developing methods for creek bank stabilization to work in conjunction with the Plan's revegetation recommendations. Several other agencies and municipalities joined the effort and the project scope expanded to include the creek downstream of University Avenue to Highway 101. The full study area encompasses an approximately 6.5-mile length of San Francisquito Creek. The project has evolved into a collective effort funded by the Cities of Menlo Park, Palo Alto, and East

Palo Alto, San Mateo County, and the Santa Clara Valley Water District.

The project consisted of two phases. Phase One included the collection of existing conditions data by the consultant team via on-site investigations, detailed mapping, and historical research. Phase Two included development of this Master Plan Report and its companion document, the Existing Conditions Report. Site data were collected and summarized in the two-volume Existing Conditions Report. Recommendations in this Master Plan are based on a synthesis of this extensive data. Although flood events have played a major role in San Francisquito Creek's history, this project does not address flood control issues specifically.

1.3 MASTER PLAN ORGANIZATION

The Master Plan consists of five main components, divided into sections, which cover the following subjects:

- Project and Purpose

  Section 1 – *This Introduction;*

  Section 2 – *Project Overview*, describes site conditions, benefits of compliance with Report recommendations, Report use, and the anticipated approval process;

  Section 3 – *Contextual Setting,* describes the study area, urban edge, cultural/historical context, and archaeological concerns;

- The Master Plan

  Section 4 – *Revegetation and Bank Stabilization Treatments and Plans,* recommends concept-level bank stabilization treatments and associated vegetation restoration, with maps illustrating appropriate treatments by location along the creek;

- Implementation Guidelines

  Section 5 – *Vegetation Restoration Guidelines,* describes the elements involved in planning habitat restoration that may follow bank stabilization;

  Section 6 – *Fisheries and Wildlife Protection and Enhancement Guidelines,* discusses methods for protecting and enhancing wildlife habitat relative to the recommended bank stabilization technique;

  Section 7 – *Access Guidelines,* describes methods for improving the community's relationship to the creek;

- Permitting Scenarios

  Section 8 – *Current Permitting Process for Proposed Projects on San Francisquito Creek*, outlines the current steps required for project approval by agencies;

  Section 9 – *Programmatic Permitting/Conservation Banking*, describes the proposed mitigation/conservation banking method of project implementation, and the Regional General Permit;

- Appendices

  Appendix A – Glossary of Terms ;

  Appendix B – Additional Reference Materials;

  Appendix C – The Compliance Evaluation Checklist, key factors to consider when evaluating proposed project compliance with the Master Plan;

  Appendix D – Cost considerations and summary of treatments by lineal feet;

  Appendix E – Methodology Guiding the Application of the Stabilization /Revegetation Treatment Alternatives.

SECTION 2: PROJECT OVERVIEW

2.1 BACKGROUND

The quality of an urban creek is dependent upon the interaction of many physical and biological processes. Over the years, a loss of native vegetation and improper bank stabilization along San Francisquito Creek has caused severe bank erosion in several locations. In addition, invasive non-native plants have displaced many of the native plant species. These non-native plants reduce the diversity necessary to support a rich riparian habitat, and may have limited erosion control properties as compared to native, woody species. This combination of unplanned bank stabilization and the uncontrolled spread of non-natives influenced the creek's capability to successfully withstand flood events. A properly designed bank stabilization project will be an effective method of reducing erosion and flood damage while at the same time improving habitat, limiting maintenance costs, and minimizing effects on water velocities. Replacement of non-native plant species with native species will help improve water quality and promote proper absorption of rainfall, reducing erosion and damage to property.

A creek in its natural state enhances the urban area by providing shade, wildlife habitat, and aesthetic quality, building value in the community and enhancing property values. A 1985 study compared the tax value of similar homes located along two nearly identical creeks, different in one way: one's banks were mostly natural and the other's banks were engineered. The value of homes adjacent to the natural channel were assessed 331 percent higher than the homes adjacent to the engineered channel (Riley, 1998). By implementing environmentally sound and aesthetically pleasing stabilization measures where possible, landowners will minimize the creek's threat to existing structures, reduce erosion, increase property values, and restore habitat. An additional benefit of compliance with Report recommendations includes an implementation program that streamlines the permitting process for landowners whose projects are consistent with the plan.

Landowners who choose not to comply with plan recommendations will be required to obtain permits from each individual regulatory agency, a time-consuming and potentially expensive process. Those who do not comply will also not be eligible take advantage of the proposed mitigation bank and will be required to fund their required mitigation independently (refer to Section 9 for more information). Additionally, an alternative treatment not considered as part of the overall plan may disturb bank stability at adjacent properties.

Because compliance with the plan is elective, there is no assurance that public or private landowners will implement any specific recommendation. The recommendations do not imply public responsibility for improvements on private property. In general, individual landowners will be responsible for funding improvements on their property.

2.2 REPORT USE AND APPROVALS

2.2.1 REPORT USE

The Master Plan and Existing Conditions Reports are the property of the sponsoring agencies: the Cities of Menlo Park, Palo Alto, and East Palo Alto, the Santa Clara Valley Water District, and County of San Mateo. They are public documents, available at the main libraries of the participating cities, on city web pages (www.menlopark.org or www.city.palo-alto.ca.us/sfcreek), and at the library of the Peninsula Conservation Center (3921 East Bayshore Road, Palo Alto).

Permitting agencies use these documents as a tool to evaluate the general suitability of proposed bank stabilization treatments to a given site. Proposed projects that comply with Plan recommendations will be preferred by agencies, as there is general consensus that the menu of recommended treatments for a given site are the least damaging to the overall health of the creek. Landowners who choose not to comply with the recommended treatment for their site will be required to provide compelling proof that the treatment they propose is more appropriate. Recommendations herein are general and require individual landowners to consult with the appropriate trained professionals - such as geomorphologists, engineers, geologists - to develop a detailed project design, construction documents, and maintenance plans.

This document is based on site evaluations conducted during late 1998 through early 1999. Issues that have arisen since then, such as the Chinese mitten crab (*Eriocheir sinensis*) infestation, may have a significant impact on bank stability, but are not referenced in this document. For this reason, the Existing Conditions Report and this Master Plan are loosely bound, dynamic documents that can be easily updated. Appendix D contains an outline of the methodology used to guide the application of the stabilization/revegetation treatment alternatives. This methodology may be replicated to update recommendations as site conditions change.

To clarify, station points are used in the text to maintain precision in referencing exact locations on the Master Plan maps. On each 100-scale map (1 inch = 100 feet), the creek centerline is marked with a station (e.g., 98+00, 99+00, etc.). Stationing increases in the upstream direction, with station point 0+00 at the mouth of San Francisquito Creek. A station point of 99+25 indicates a location that is 25 feet upstream of station 99+00; station point 89+75 falls 25 feet downstream of station 99+00.

2.2.2 REPORT APPROVAL PROCESS

A Joint Powers Authority or JPA was formed in May 1999 as a cooperative effort to improve community storm preparation and flood management at San Francisquito Creek. The JPA, comprised of representatives from several cities and government agencies/municipalities with interests along San Francisquito Creek, is functioning as the central oversight body on this project. Upon completion and acceptance by the funding agencies, the Master Plan documents will be presented to the JPA Board for acceptance.

In December 1999, consultants presented a summary of the project at a monthly gathering of representatives from regional state and federal regulatory agencies involved in the permitting of projects on San Francisquito Creek. The group discussed the project and agreed it would be a potential candidate for a Regional General Permit. If adopted, the document will undergo a CEQA analysis and public review, and will be refined further to include recommendations on mitigation and monitoring programs. The CEQA process will help identify a quantifiable, permittable project, which will then be submitted to the environmental review agencies for Regional General Permit consideration.

2.3 ACKNOWLEDGEMENTS

In addition to the dedicated Client group whose involvement informed and inspired the process, many individuals lent their expertise to the creation of this document. The authors wish to acknowledge Pat Showalter, P.E., Peninsula Conservation Center Foundation; Phillippe S. Cohen, Ph.D., Jasper Ridge Biological Preserve; Jim Johnson, San Francisquito Creek's "Streamkeeper"; Laura Jones, Ph.D., Stanford University's Campus Archaeologist/Cultural Resources Planner; the Joint Powers Authority (JPA) Technical Committee and JPA Board members.

The authors also thank those who have reviewed and commented on early drafts of this Report. Their comments helped to improve the content and clarity of the final product.

2.4 REFERENCES

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SECTION 3: CONTEXTUAL SETTING

3.1 REGIONAL SETTING

San Francisquito Creek is the last open-channel urban creek in the area and is a vital natural resource to the communities that border it and to the larger ecology.

The deeply incised creek flows through both natural and urban settings. The area of focus for this study is an approximately 6.5-mile reach of San Francisquito Creek, top of bank to top of bank, from Junipero Serra Boulevard to Highway 101. The creek and adjacent lands are both publicly and privately owned and development exists, or is planned, on all borders within the study area.

The San Francisquito Creek watershed area is approximately 45 square miles extending from Skyline Boulevard to the San Francisco Bay. The watershed contains three manmade lakes (Searsville, Lagunita, and Felt) and creeks including San Francisquito, Los Trancos, West Union, Alambique, Bear, and Corte Madera, as well as many smaller tributaries that drain into the creeks. San Francisquito Creek drains into Searsville Lake in Upper Portola Valley and resumes as a dam overflow, flowing through communities from Portola Valley to the San Francisco Bay.

San Francisquito Creek establishes the boundary between Santa Clara and San Mateo Counties within the study area. It is located within the Santa Clara Valley Water District's Northwest Flood Control Zone and San Mateo County's San Francisquito Creek Flood Control Zone. In the study area, the City of Palo Alto and Stanford University border the creek on the southeast; to the northwest are the Cities of Menlo Park and East Palo Alto.

3.2 LOCAL SETTING

San Francisquito Creek provides a lush backdrop to residences, businesses, and institutions. The creek in the 6.5-mile study area flows through the Stanford Golf Course, through developed Stanford lands, into the urban center, and low-rise commercial and residential communities. Roadway crossings occur at Junipero Serra Boulevard, Sand Hill Road, El Camino Real, Middlefield Road, Chaucer Street, University Avenue, Newell Road, and Highway 101.

The creek edge is defined in most cases by public streets and parking easements, commercial development, backyards, paths, parks or fences, walls, and levees. Its steeply sloping banks limit access into the creek with few formal accessible routes to the water. Erosion continues to jeopardize top-of-bank access. Several small public parks adjoin the

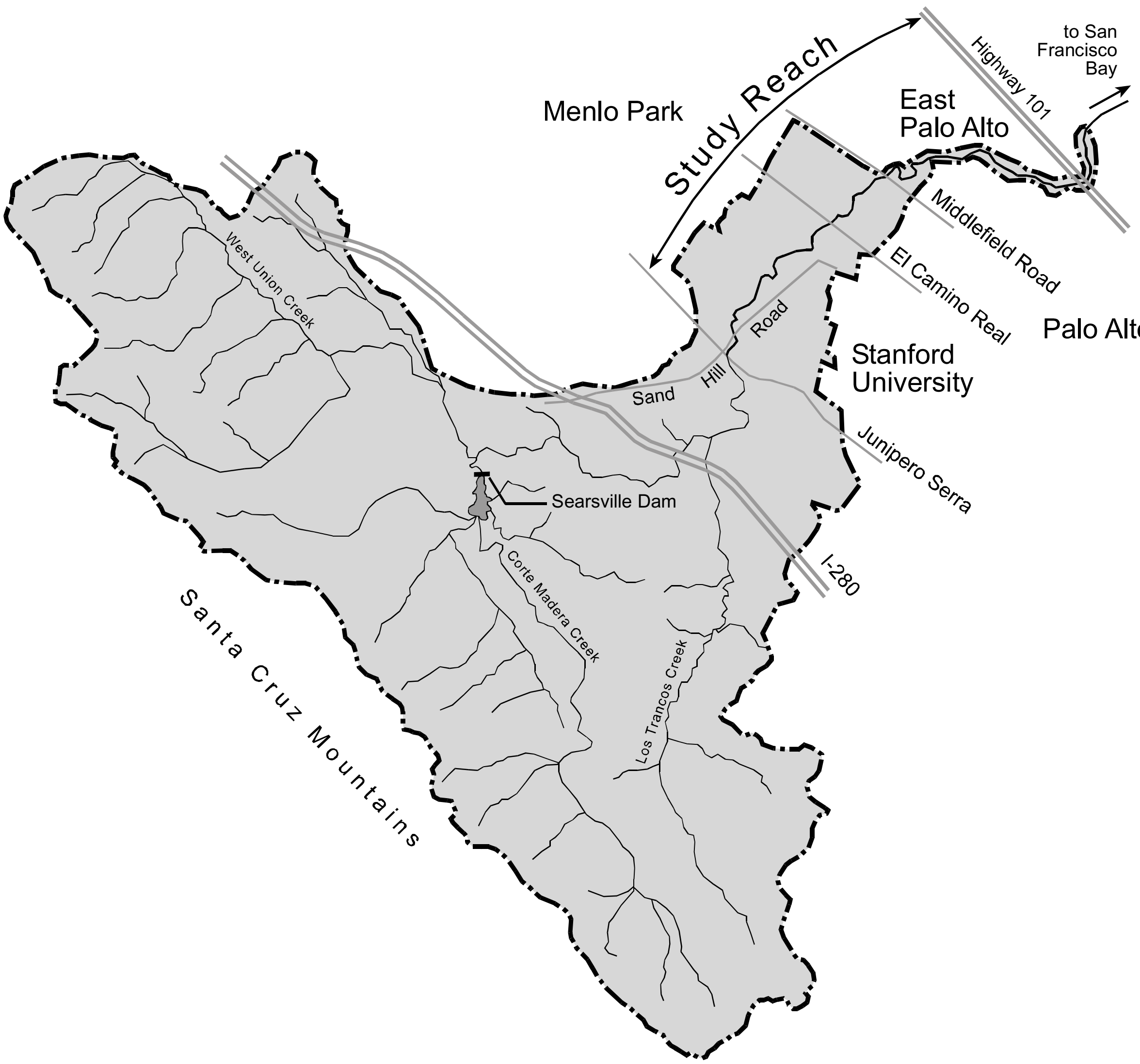

Figure 3A   Map of San Francisquito Creek watershed . Not to scale.

creek including El Palo Alto Park, Timothy Hopkins Creekside Park, and a City of Palo Alto Community Garden.

The heavily wooded edge consists of a diverse group of plant types, including a significant presence of non-native species. The character of the creek has evolved over time in part due to human intervention and associated land use pressures. Pesticide and roadway runoff, homeless encampments, vandalism, graffiti, and litter adversely affect the creek.

3.3 HISTORICAL CONTEXT

The entire length of San Francisquito Creek is rich with historical significance. The following is an abridged look at activity along San Francisquito Creek having historical and/or cultural impact, presented chronologically.

3.3.1 PREHISTORIC CULTURE (PRE-1750)

Remains of the native Ohlone Indian culture in the San Francisquito Watershed have been radiocarbon dated at more than 5000 years old (Jones, 1998). With an abundant food source and year-round water flow, numerous Ohlone villages populated the banks of the San Francisquito Creek and adjacent meadows until Spaniard settlement in the mid-1700s. Grasses, bulbs and legumes such as red maids (*Calandrinia ciliata*), miner's lettuce (*Claytonia perfoliata*), goosefoot (*Chenopodium* spp.), and sunflower (*Helianthus* spp.) seeds as well as fruit from the holly-leafed cherry (*Prunus ilicifolia*), hazlenut (*Corylus cornuta*), and buckeye (*Aesculus californica*) were all a part of the Ohlone diet and the rich botanical context of the study area (Reese, 1995A). Historical records of native vegetation are helpful in selecting native species as part of the habitat restoration plan.

3.3.2 EARLY SETTLERS (1769 TO 1876)

Spaniard Don Gaspar de Portolá came to the area in 1769, searching for the Monterey harbor in an attempt to establish the first California Missions (Spector, 1994). Modern lore tells of his party camping under El Palo Alto, the renowned redwood tree and Palo Alto City icon, located near the banks of San Francisquito Creek. While his expedition did not achieve its goal, by 1777 Mission Dolores and Mission Santa Clara were established with the creek forming the boundary between the two properties (PCC, 1994).

In the 1830s, lands surrounding the creek were divided into large Ranchos, including Rincon de San Francisquito, Rinconanda del Arroyo de San Francisquito and San Francisquito (Spector, 1994), and granted by the Mexican government to Don Rafael Soto, and Don Antonio Buelna. Buelna's Rancho San Francisquito land tract was located on the southwest side of San Francisquito Creek and extended upstream from "El

Palo Alto" and today comprises much of the Stanford University campus (Wood & Cawston, 1939). The Buelna adobe and grounds (later the Buelna/Rodrigues adobes) were established along the northern end of the study area, near what is now the Stanford Golf Course and Oak Creek Apartments. The Buelna Adobe survived into the 1890s, with ruins of the adobe still visible in the creek well into the 20th Century (Johnson, 2000).

A creek ford still present at the site of the present Middlefield Road bridge was a popular oxcart crossing (Johnson, 2000). A crossing near present-day Sand Hill Road was used as a "doubling-up station." Teams of oxen, hauling redwood logs from the mountain, could take on a double load for the easy stretch southward to San Jose and north to Redwood City (Wood & Cawston, 1939).

By the early 1850s squatters had settled on many choice portions of Rancho San Francisquito hoping that the U.S. Government would open the land to homesteaders. Five Gold Rush-era squatters settled near the creek during the 1850s: Mr. Julian, William Little, Thomas Bevins, Jerry Eastin, and Thomas "Sandy" Wilson (Reese, 1995A). At this time, San Francisquito Creek was navigable by small boat, during winter, approximately to where Newell Road is today (Spector, 1994).

3.3.3 GOVERNER LELAND STANFORD'S INFLUENCE (1876 TO EARLY 1900)

Former Governor Leland Stanford expanded his influence on this area in 1876 when he acquired 8,800 acres to make up his stock farm and later the University. His property spanned approximately from El Camino Real to Junipero Serra with San Francisquito Creek as the border (Jones, Reese, & Rick, 1996).

Stanford's stately Palo Alto Home, built around 1863, was located near the present-day Stanford Shopping Center. Land on which the home sat, acquired from squatter William Little, was called Mayfield Grange. Converted in the 1920s for use as the Stanford Convalescent Home for children, it was torn down in the 1960s to make way for the modern Children's Health Council complex. Remnants of the building structure and the Stanford's life were unearthed in a 1995 dig (Jones, Reese, & Rick, 1996).

Stanford's Old Carriage House, constructed between 1878 and 1879, is still located approximately 700 feet west of the Children's Health Council buildings. This is the last remaining outbuilding of the Stanford's stately Palo Alto residence, and probably moved to its present location from a site at Mayfield Grange (Reese, 1995B). Another significant structure located adjacent to the creek was the Cedro Cottage, formerly the Country Home of Leland Stanford's brother Ariel and his family. Cedro Cottage and gardens, constructed in the 1870s, were located on 24 acres of land bordering the creek and fronted by Vine Avenue in Menlo Park. Stanford faculty occupied the quaint cottage until it was bulldozed in 1952 to make way for Oak Knoll Elementary School.

3.3.4 SEARSVILLE DAM AND TOWN GROWTH (1877 TO 1930)

In 1887, the Manzanita Water Company (later the Crystal Springs Water Company) constructed Searsville Dam on San Francisquito Creek, located near the west end of Stanford University property in Woodside (PCC, 1994). The dam, completed in 1891, was intended to supply water to Stanford University. Due to fine suspended sediment and odor, the water was non-potable and used for irrigation only (Johnson, 2000).

In the early 1900s, gravel and rocks left in the creek after the winter rains were excavated the following summers to be used for roads, sidewalks, etc. (Palo Alto Historical Association, 1993). After the 1906 earthquake, fragments of the destroyed architecture of Memorial Church were dumped into the creek, portions of which still can still be found after floods recede (Johnson, 2000). Menlo Park was a railroad stop that eventually developed into a small town and, along with newly formed Palo Alto, continued to grow and prosper in the 20th century.

3.3.5 MODERN INFLUENCES ON SAN FRANCISQUITO CREEK (1930 TO PRESENT)

Presently there are a variety of land uses along the creek: single- and multi-family residences, commercial buildings, recreation, Stanford University and its holdings, among others.

Several parks have been established along the creek including El Camino Park and El Palo Alto Park, which honors the redwood 'El Palo Alto' and the historic significance of the site. In the 1960s, the Native Sons of the Golden West deeded land surrounding El Palo Alto to the City of Palo Alto. By the late 1980s, the redwood was in poor health, but recent restorative efforts have improved the tree's new growth (Johnson, 2000).

Timothy Hopkins Creekside Park is a collection of small parks and pathways extending along the Palo Alto edge between El Camino Park and Chaucer Street. Much of the streamside portion of the linear park has been lost to bank erosion. A City of Palo Alto community garden is also located adjacent to the creek. Refer to the map in Section 7 for an illustration of park locations.

Local residents struggle with management of flooding and erosion at their creek-fronting properties and have taken measures to preserve their property with a variety of bank stabilization techniques. Highly engineered solutions are apparent throughout the reach.

In 1991, studies showed a hazardous level of human waste found in the creek. In October of 1997, police evacuated a large homeless encampment under the El Camino bridge, after reports by the County Health Department that the encampment was a health hazard. Enforcement by the cities of new trespassing laws continues, and the amount of trash and debris in the creek continues to decrease.

In recent years, there has been significant public involvement in the preservation and rehabilitation of San Francisquito Creek. The community-based Friends of San Francisquito Creek was formed in 1989 by a group of citizens to clean, preserve, and enhance the creek's natural setting. The San Francisquito Creek Coordinated Resource Management and Planning group (CRMP) was formed in November 1993 by a group of concerned individuals, organizations, and local agencies, providing a forum for collaborative issues related to the creek. Sponsored by the Peninsula Conservation Center, CRMP published their 'Draft Watershed Management Plan' in 1997, which set forth watershed-planning goals and proposed implementation actions. Published in early 1998, their 'Reconnaissance Investigation Report of San Francisquito Creek' discussed flood-related issues.

3.4 ARCHAEOLOGICAL RESOURCES

Archaeological resources located in an urban setting are under constant threat. The volatile nature of this urban creek site, with constantly shifting and eroding soil, further endangers archaeological resources.

In a historically important setting such as this, it is difficult to prioritize the archaeological importance of individual sites. The entire length is of some archeological concern particularly since many areas have not yet been fully studied. The proximity of the creek to Stanford University increases the creek's importance as a learning tool. In the interest of preservation, archaeologically sensitive sites are not specifically identified or mapped in this Report. A general area of concern lies between El Camino Real and Chaucer Street.

The lowest impact method of stabilization within an area of archaeological sensitivity is preferred, with excavation avoided where possible. From an archaeological perspective, heavily engineered solutions are not preferred. Contrary to popular belief, it is considered better to allow the creek to behave naturally, where possible, rather than "cap" the bank's archaeological resources with concrete. Additionally, debris removal should be limited (Jones, 2000).

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SECTION 4: RESTORATION AND BANK STABILIZATION TREATMENTS AND PLANS

4.1 INTRODUCTION

This Master Plan defines the range of bank stabilization and revegetation techniques that are most appropriate for San Francisquito Creek. The Master Plan emphasizes minimizing structural approaches or adapting them to include revegetation techniques (non-native species removal, native planting), where possible.

The comprehensive stabilization and revegetation plan set forth in the Master Plan builds upon an Existing Conditions Report[1] that details the current state of San Francisquito Creek, and is based upon systematic documentation and analyses of existing conditions.

Bank stabilization and revegetation techniques in this Master Plan are described at a conceptual level of detail. A landowner who elects to implement one of the techniques would also need to conduct a site-specific, detailed study to verify the appropriateness and suitability of a technique to adapt the treatment to conditions specific to the property. The detailed design could be developed by a team of professionals hired by the landowner. The final design team may include a professional civil engineer, geomorphologist, geotechnical engineer, revegetation specialist, and fish/wildlife biologist. The design would then be reviewed and subject to approval by the entity administering the Master Plan.

4.2 OBJECTIVES

The primary goal of the Master Plan is to develop stabilization schemes for eroding banks that allow vegetation establishment for habitat development, streamside shading, and fisheries enhancement. Where bank protection currently exists, the plan provides a range of approaches, from complete removal and replacement to partial vegetation cover establishment using planting collars and other plant installation techniques. Where bank erosion is severe and close to existing structures, fewer approaches generally apply and tend to be less habitat-friendly.

Given the urbanized nature of the stream corridor, there are many constraints to bank stabilization and enhancement of riparian habitat. The guiding principles of the Master Plan are:

- To preserve and/or enhance the natural character of the urbanized

[1] It is not necessary to have a copy of the Existing Conditions Report to understand and use the Master Plan. However, the Existing Conditions Report does provide additional background data useful for revegetation and bank stabilization design. A copy of the Existing Conditions Report is available for review at the main libraries of the Cities of Menlo Park, Palo Alto, and East Palo Alto, on city web pages (www.menlopark.org or www.city.palo-alto.ca.us/sfcreek), and at the Peninsula Conservation Center library.

San Francisquito Creek by increasing the presence of native vegetation. This will improve overall habitat value and stabilize banks - while protecting or improving creek conditions for state- and federally-listed species.
- To stabilize banks to protect property without reducing floodwater conveyance of the creek.
- To enhance the value of the creek as a community amenity through access to public areas, interpretation and educational opportunities, and improved visual connections.
- To develop a unified approach to implementation of the plan within the project area as a means of creating consistency across jurisdictions, and to streamline the permitting process for participating landowners.

4.3 EXISTING CONDITIONS

The natural habitats along the creek in the study area are mostly degraded. Bank instability is driven in large part by the predominant high banks, which range between 15 to 30 vertical feet in the study reach. Steep banks are a natural condition for a "deep arroyo" cut into an alluvial fan (Palou, P., 1926). The high banks are primarily a matter of concern due to their instability, coupled with the presence of nearby buildings and infrastructure. High banks that we see today are a result of this geomorphic setting, as well as anthropogenic changes in the watershed within the last century.

Bank conditions range from stable and well vegetated to nearly vertical and eroding. Most of the existing banks in the project reach are partially to mostly vegetated with native and non-native species, with the exception of those reaches with bank protection. Many sparsely vegetated banks are failing, either partially or completely.

Bank protection has generally been the responsibility of the individual landowner, except where large channel modifications were implemented. Agencies and individual property owners have responded with a variety of engineered and non-engineered bank protection schemes, some of which are failing or are incompatible with the upstream and downstream bank protection structures (see Existing Conditions Report data).

4.4 METHODS

4.4.1 GEOMORPHIC APPROACH

In the development of this Master Plan, a geomorphic approach to river management was adopted. This approach applies a holistic view of the watershed and river system, and interprets channel change in relation to basin-wide processes. This perspective was employed in the Existing

Conditions report to develop the context for bank instability in the study reach. In a more natural stream environment, the geomorphic approach could be applied through the Master Plan stage to characterize and predict at-risk banks based on existing and likely future geomorphic processes.

However, due to the superimposition of human development on the geologic context, bank stability cannot be easily predicted based on current fluvial processes alone. Instead, future bank instability will be a result of the interplay of the patchwork of bank stabilization projects in time and space, fluvial processes, and existing and future land uses. Therefore, the bank stabilization methods suggested in this Master Plan are based primarily upon existing bank conditions and adjacent land uses rather than long-term geomorphic processes. This decision-making process was selected for the following reasons:

1) Bank stabilization structures currently line most of the areas where the most extreme bank instability was observed in the 1950s (CRMP, 1998), including along the outside of meander bends in the study reach. Therefore, many of these areas actually are well protected and overall less prone to erosion.

2) Banks are so steep and high that bank erosion potential is pronounced along the majority of the study reach, rather than simply concentrated in areas where hydraulic forces are maximized.

3) City and County representatives requested specific help in identifying priority sites for bank stabilization and revegetation for existing conditions, given the current pronounced bank erosion problems.

4) Erosion risks in the future will depend strongly on the interrelation of individual projects implemented along the study reach. Because it is unknown which methods of bank stabilization and revegetation projects ultimately will be implemented and in what order, it is impossible to project where risks will increase with time in a meaningful way.

4.4.2 FIELD WORK

The existing geomorphic and vegetation conditions of the banks were documented during field inventories of bank, channel, and vegetation conditions. Using extensive site investigation and detailed field mapping, the following items were recorded by location on the topographic maps: 1) geomorphic conditions of the creek banks and bed, 2) existing bank stabilization projects, eroded areas, and sediment types, and 3) existing vegetation along the banks, including habitat types, dominant native and non-native, invasive species.

Maps displaying key observations appear in the Existing Conditions Report. The record of existing physical and vegetation conditions laid the groundwork for bank stabilization and revegetation recommendations made in this Master Plan report.

4.5 RESULTS

Ten bank stabilization and revegetation treatment alternatives are presented in this Master Plan. The treatments are adapted to the conditions found within the project reach to address the current range of physical and biological constraints. The treatments are at the conceptual level of detail. The treatments are described in order of increasing structural complexity and grading requirements. In general, costs increase as well. To the extent possible, a treatment should consider the establishment of some riparian habitat in the design. A description of the structural and vegetation components of each alternative is provided in Section 4.5.1. These treatment alternatives include the following:

- No Action
- Vegetation Only
- Repair Protection
- Vegetate Structure
- Remove Structure
- Regrade and Replant
- Terrace
- Riprap Toe
- Vegetated Riprap
- Vegetated Wall

The Master Plan also identifies: 1) those areas where bank stabilization is a priority (Section 4.5.2), and 2) which of the 10 stabilization techniques are possible at each site given the existing land use and topography (Section 4.5.2).

4.5.1 TREATMENT ALTERNATIVES

"NO ACTION" ALTERNATIVE (A)

Conceptual Description
This treatment alternative includes leaving existing vegetation and/or structural bank protection in place with no revegetation. While in general the removal of exotics is recommended along San Francisquito Creek, there may be certain mature, well-established species that are not invasive, provide moderate habitat, and help to stabilize the existing banks. For these reasons, in some locations existing vegetation should be retained even if composed of non-native species.

Where Appropriate
This alternative is appropriate where: 1) bank erosion is not sufficiently serious and threatening to adjacent property to warrant bank improvements or changes, 2) existing structural bank protection does not readily permit revegetation and 3) replacement of existing structural bank protection would be too costly, and/or 4) certain mature, well-established species are not invasive, provide good habitat, or stabilize banks.

The prioritization of bank stabilization projects is based upon the erosion severity rating given for segments of the study reach, as outlined in Appendix E. Specifically, those 200-foot sub-reaches of the study reach that received low erosion severity ratings from "3" to "5" were assigned this no-action alternative as a possibility.

How to Implement
No action will be taken. Existing vegetation and structural bank protection will be left in place. Non-native species will not be removed if they are deemed not invasive or provide limited wildlife habitat.

Advantages
No short-term costs. Preserves existing habitat. No disturbance to soil, thus preventing erosion. Special access is not required.

Disadvantages
Does not actively improve bank stability. Eroded areas may worsen with time.

Additional Considerations
Obviously, if funding is available, it would be possible to replace any existing structures with types permitting native vegetation growth. In addition, as structures degrade with time or as funding becomes available, existing structures can be replaced, preferably with treatment alternatives that incorporate native vegetation.

"VEGETATION ONLY" ALTERNATIVE (B)

Conceptual Description
This treatment alternative includes removal of non-native species and/or revegetation with native species according to restoration guidelines (Section 5.0). This is a purely vegetative treatment and widely recommended where structural bank protection is unnecessary.

Where Appropriate
This alternative would be implemented in those reaches where banks are stable and erosion is not a serious problem (such as along the Stanford Golf Course). In many areas, this effort will be at the top of bank to provide shade, rather than along the face of the bank.

How to Implement
Specific non-native removal and revegetation approaches are described in detail in "Vegetation Restoration Guidelines," Section 5.0.

The removal of non-native vegetation will need to be designed cautiously so as not to result in a large-scale reduction of channel shading or increase erosion potential. For example, phased removal of non-native vegetation (e.g., staggered over several seasons) and concurrent replanting with native species, as appropriate, would minimize the reduction in shade levels over the creek which is important to maintaining steelhead habitat.

Advantages
Reduces non-native vegetation populations. Relatively inexpensive provided that the native plantings can be collected within the vicinity of the site and contract grown by a native plants nursery. Straightforward. Most operations can be carried out by hand. The use of live materials ensures a long-lasting effectiveness with generalized habitat benefits.

Disadvantages
This alternative is only feasible in areas with good access when slopes are safe to work upon. May initially reduce bank stability following non-native removal; not viable where bank stability is expected to worsen considerably.

Common Reasons for Failure
Lack of maintenance to control non-native species re-establishment or native plant establishment.

Additional Considerations
Although much revegetation under this alternative is aimed at the top of the channel bank, some planting should also be placed along the face of

the slope and close to the wetted channel, if possible, so as to increase the amount of shading and vegetation. However, because extensive revegetation (large tree and shrub plantings) may reduce the transport capacity of the channel by slowing and thereby deepening flow, care should be taken in the planting design to minimize these adverse effects on channel conveyance or allow for additional conveyance by increasing the channel cross-sectional area.

"REPAIR PROTECTION" ALTERNATIVE (C)

Conceptual Description
Existing structural bank protection would be repaired. This approach is strictly structural and recommended only in local problem zones. It does not include non-native species removal or native revegetation as vegetation is not typically present at these sites. If not addressed, these erosion hotspots may significantly reduce the lifetime of the existing structure.

Where Appropriate
This treatment would be applied in those areas where existing structural bank protection is in good condition overall but small erosion problems have developed along the upstream or downstream end or toe of the existing revetment.

How to Implement
In these cases, the existing revetment can be fixed by reforming the damaged area and extending the structure an adequate distance back into the bank or bed to prevent repeated, local problems. Because no significant change will occur to the structure's position and form, revegetation and non-native species removal is typically not feasible with this type of treatment. However, in some cases it may be feasible to combine this alternative with the "Vegetate Structure" alternative.

Advantages
Extends lifetime of existing structure. Requires only local labor.

Disadvantages
May require complex implementation techniques.

Common Reasons for Failure
Structure not securely keyed into banks and bottom or adjacent structures. Incompatible techniques juxtaposed.

Additional Considerations
Where local erosion hotspots are proposed to be fixed along existing bank protection that otherwise appears stable, the installation of in-stream structures such as wing deflectors is discouraged. Modifying channel characteristics along such reaches may further compromise the integrity of bank protections that are already prone to erosion.

"VEGETATE STRUCTURE" ALTERNATIVE (D)

Conceptual Description
This treatment alternative includes leaving existing bank protection in place and revegetating using planting collars or cuttings inserted between existing bank protection near the toe of the slope, if possible. This treatment is a cost-effective approach to providing some vegetation cover and creek shading without removing the existing bank protection.

Where Appropriate
This treatment is appropriate where sacked concrete (or some other articulated structural bank stabilization) currently exists, provided that the structure would remain stable if altered.

How to Implement
The existing bank protection (riprap, sacked concrete, etc.) is removed at a specific location, a planting collar is inserted and backfilled, and vegetation is planted.

Planting collars are described in the section entitled "Vegetation Restoration Guidelines" (Section 5). They can be designed from a variety of materials including wooden beams and concrete boxes. Specific collars should be tailored to each individual site based on the unique needs and conditions of that site. However, only small trees and shrubs will be planted within the planting collars to minimize disturbing the existing bank protection.

Where possible, planting areas up to 6-feet long, 3-feet wide, and 2-feet deep are preferable over smaller planting areas to encourage the development of larger habitat pockets. Soil addition and/or decompaction and scarification of the edges of the planting area should be performed to foster vegetation establishment. Some type of irrigation, as outlined in the "Vegetation Restoration Guidelines" (Section 5.0), would be initially required. Cuttings may be planted along the upstream and downstream edges of sacked concrete to prevent erosion along the existing structure. Installation may be difficult, and equipment (backhoe, crane) may be needed to remove sections of the existing bank protection.

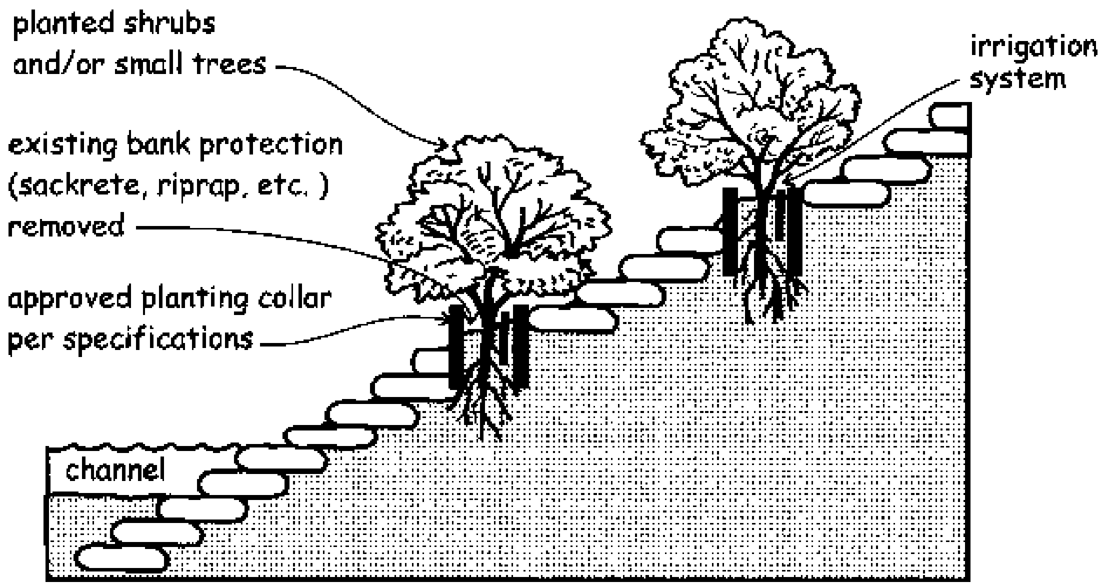
Advantages
Provides a means of incorporating vegetation in pre-existing structure.

Disadvantages
This is considered a very constrained revegetation technique, for a number of reasons. The planting collar site is unlikely to be naturally colonized by desirable native trees after the eventual death of the original planting. Replanting of the collars from time to time would thus be necessary. The alteration of existing structural bank protection could

figure 4A

"Vegetate Structure" Alternative

Revegetate Within Existing Bank Protection



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compromise the stability of the protection. This treatment is more likely to be successful where there is no filter or geotextile fabric underlying existing structural bank protection that would prevent root penetration into the soil below. Where riprap forms a thick layer, this method is not advisable since planting would be difficult. As a result of these numerous limitations, this treatment is not preferable and may not be possible in most situations.

Common Reasons for Failure
Vegetation mortality.

Additional Considerations
As with the "Vegetation Only" Alternative, placing plantings close to the wetted part of the channel would be preferable if the structural integrity of the existing bank protection or flow conveyance is not compromised in the process.

"REMOVE STRUCTURE" ALTERNATIVE (E)

Conceptual Description
This alternative includes removal (and replacement) of existing structural bank protection. In general, this will be a more expensive option than previous replanting approaches. It would involve the extensive use of some hard labor and heavy equipment (backhoes, cranes, etc.) to remove the structures.

Where Appropriate
This alternative would be implemented where an alternative form of bank protection is strongly preferred and/or existing structural bank protection is in poor condition or has failed. In all cases, this alternative is recommended along with another treatment to replace the existing structure.

How to Implement
The existing structural bank protection would be removed manually and/or by heavy equipment.

Advantages
Maximizes opportunities for revegetation.

Disadvantages
Labor-intensive. May require dumpsite for materials that cannot be recycled or reused.

Additional Considerations
Revegetation and non-native species removal can also be performed concurrently if non-native species removal does not require extensive phasing. If existing material is suitable (high quality riprap, for instance), it can be reused elsewhere on the project for bank or channel work. Other types of material (sackrete, broken concrete, etc.) would be hauled offsite. The type of alternative bank treatment chosen would be based on the constraints posed by each site.

“REGRADE AND REPLANT” ALTERNATIVE (F)

Conceptual Description
This alternative uses regrading and biological techniques to provide bank stabilization. Existing vertical or near-vertical banks would be modified to a moderate (3H:1V or less) angle and replanted with native species. Roots of riparian vegetation, rather than structural measures, would provide bank stability. This regrading will disturb some existing vegetation, but will provide a more stable long-term riparian setting and will improve local hydraulic conveyance. *This method is considered a preferred method for enhancing aquatic and terrestrial habitat.*

Where Appropriate
Where sufficient right of way exists, a regraded bank is desirable. Regrading and replanting is most appropriate on higher portions of the banks, less frequently affected by high flows, or along lower banks where the water velocities are sufficiently low (less than 5 to 7 feet per second) during the design flow event. Regrading would be necessary where existing slopes are too steep (>3H:1V) to allow vegetation to become established.

How to Implement
Banks will be regraded, so that the top of bank is located back from the current top of bank. In no cases, should the toe of the regraded slope extend into the existing channel.

Vegetation re-establishment can be accomplished using fabrics, cuttings, seed material, or planting containers as per the “Vegetation Restoration Guidelines” in Section 5.0. Plastic netting, which can trap birds and other animals, is not to be used.

Advantages
Provides extensive aesthetically pleasing revegetation and habitat enhancement opportunities. Future root growth will perpetuate slope stability.

Disadvantages
Disturbance of existing vegetation and soil. Only feasible in areas with good access. Lag time between implementation and stability from established root networks.

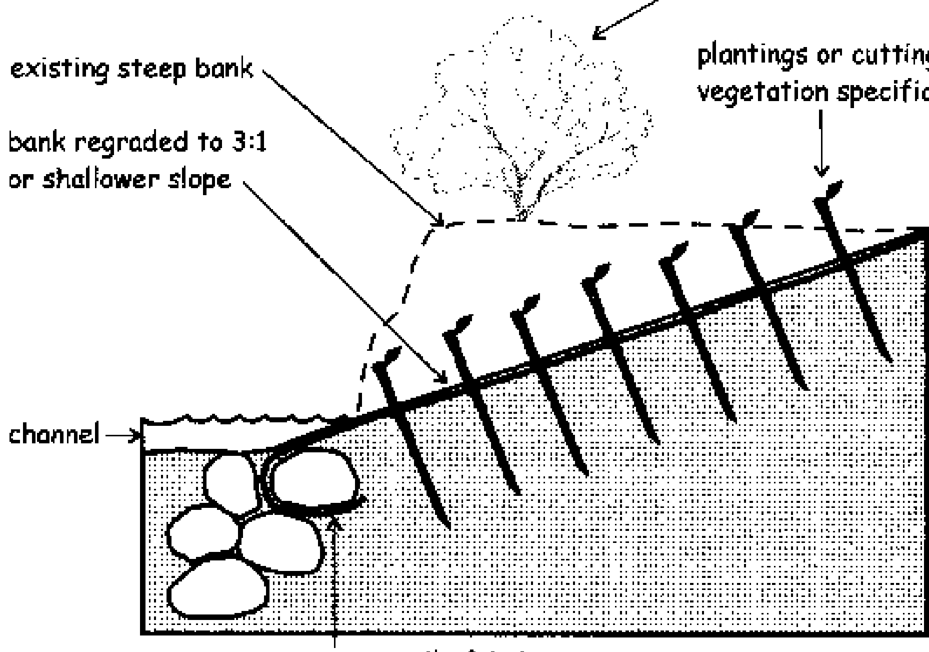
Common Reasons for Failure
Occurrence of large flood before vegetation is well-colonized. Inadequate maintenance of plantings which can lead to plant mortality.

Additional Considerations
Regrading stream banks to achieve a less steep angle and replanting

figure 4B

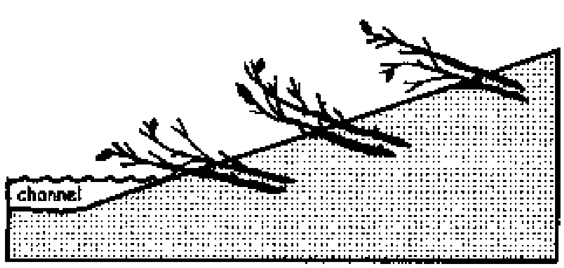
"Regrade and Replant" Alternative

Regrade Existing Banks and Revegetate

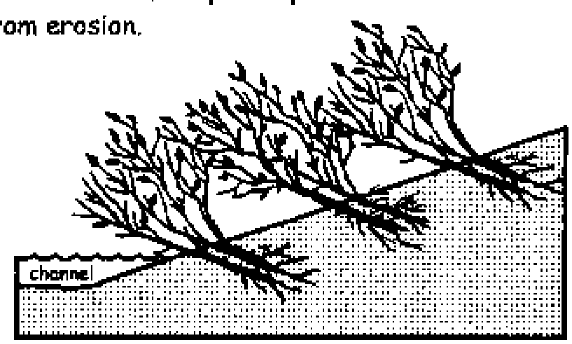


Brush Layering with Native Species

Brush layering is an effective means of stabilizing a bank where there is sufficient space. When live willow or cottonwood cuttings are used in the dormant season, they will sprout to form a protective stand of vegetation to protect the bank from erosion.



initial planting



established planting

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native riparian vegetation is a preferred stabilization alternative with regards to aquatic and terrestrial habitat as it avoids the use of fixed structures. Less steeply graded banks allow for the establishment of a more natural riparian zone. Stabilizing the banks with the roots of riparian vegetation also allows for naturally undercut banks, which provide important steelhead habitat without compromising the overall integrity of the bank. Thus, this stabilization alternative will have beneficial impacts on aquatic habitats in itself.

"TERRACE" ALTERNATIVE (G)

Conceptual Description
This alternative includes stabilizing banks by creating one or more terraces—wide benches cut into the streambank. The slope will be excavated and backfilled, as appropriate, to form the terraces. Revegetation techniques will be used to provide habitat and stability to the new bank surface. During floods, water will inundate the terrace(s) and interact with vegetation. *This method is considered a preferred method for enhancing aquatic and terrestrial habitat.*

Where Appropriate
Where sufficient right-of-way exists, a terraced bank is desirable. Terraces are often preferred over the creation of a smooth slope to the toe of bank as described in the "Regrade and Replant" alternative. Terraces are constructed without disturbing the lowest portion of the bank, which is often desirable for habitat reasons.

How to Implement
One or more terraces are created at increasing elevations above the channel bed, each one supporting a different mix of vegetation species suited to the corresponding inundation frequency, physical setting, and biological conditions. The existing channel is not disturbed below a 1.5- to 2.0-year flow event, thereby maintaining a more confined low flow channel. During floods of greater magnitude, waters flows over the bank onto a wide terrace. The toe of the created terrace must not extend into the existing active channel or impinge upon the 1.5 to 2-year flow. The terrace should be gently sloped (e.g., 2% grade) to drain to the main channel.

Riparian vegetation shall be planted on all terraces, including the lowest one, in order to increase shading and the penetration of root masses into the low-flow channel. These features can increase the value of the creek for aquatic and terrestrial wildlife species by providing habitat and mitigating water temperatures.

Advantages
Long lasting protection. Permits maximum interaction between high flows and riparian vegetation. Mimics channel shape likely in a less incised stream and can facilitate access for maintenance.

Disadvantages
Labor-intensive. Terrace design constrained by available setback distance.

Common Reasons for Failure
Mobilization of terrace materials by high flow before vegetation is well

established. Inadequate sizing of terrace.

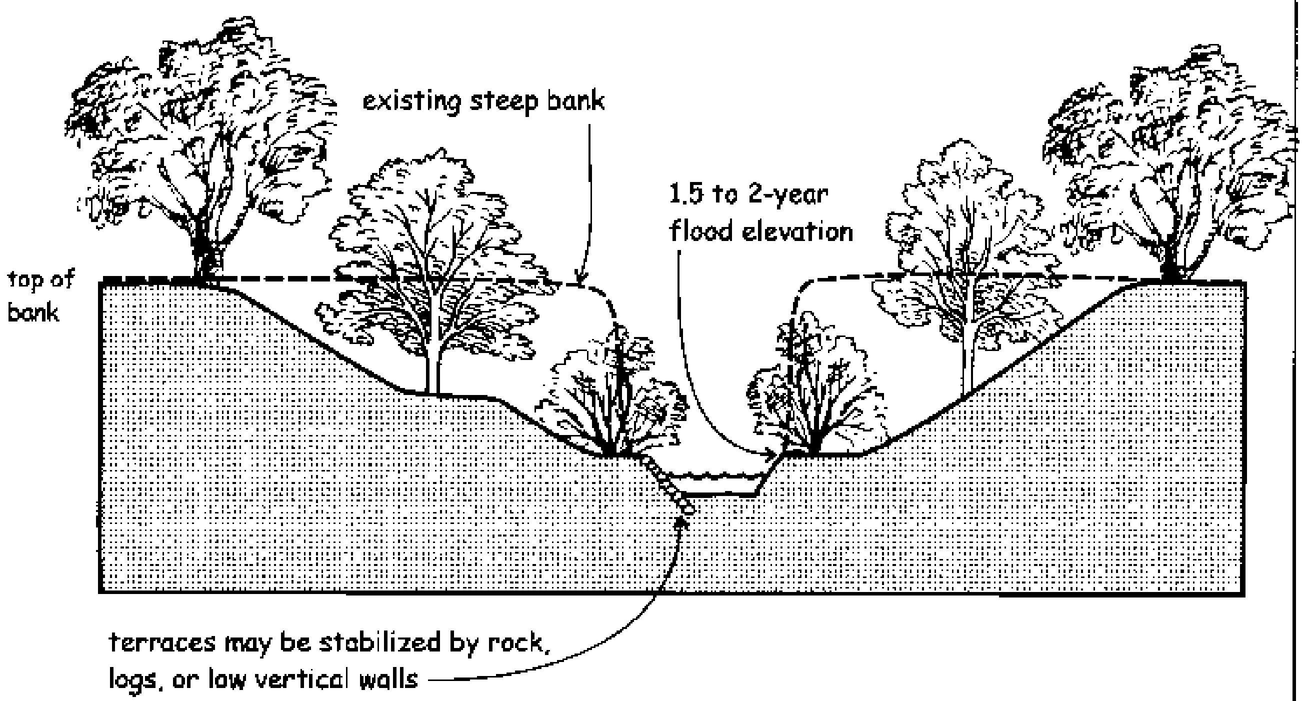
Additional Considerations
If necessary, terrace slopes can be stabilized by large rock, vertical walls (rock, timber, concrete) or logs.

If sufficiently long and wide, terraces often provide benefits in terms of flood conveyance and revegetation opportunities. Hydraulic roughness due to revegetation can be offset by the additional conveyance of terraces cut into the pre-existing banks.

figure 4C

"Terrace" Alternative

Stabilize Banks by Creating One or More Terraces and Revegetate



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"RIPRAP TOE" ALTERNATIVE (H)

Conceptual Description
This technique combines a biotechnical approach to bank stabilization with toe placement of sufficiently large rocks to prevent bank washout and toe scour. This alternative includes backfilling of the slope and revegetation within and above the riprap.

Where Appropriate
This technique is recommended where erosion problems are pronounced at the toe of the bank and may compromise overall bank stability if not addressed. It may also be a suitable approach to reducing potential damage due to borrowing of mitten crabs.

How to Implement
Excavate portions of bank, as necessary. Regrade lower portion of bank to consistent slope. Slopes of 1.5H:1V are acceptable only if rock is placed meticulously to achieve three-point contact between each rock (not dumped); otherwise, more gradual grading is required. The stones should be at the same angle as the slope of the designed streambank, and the total thickness of the stone layer should be at least the thickness of two times the rock diameter, with design diameter depending on the velocity of the design flow event at that location.

If desired, the riprap can be extended up the bank to the elevation of the design flow event. The riprap should extend below the predicted scour level and be on a solid foundation. The rock is underlain with filter layer or geotextile fabric, which also extends below the scour level and is secured around the lowest rocks. The entire installation should be keyed into the bank at each end to prevent upstream and downstream scour.

Vegetation should be planted on the top of the bank, as well as among the riprap. During rock placement, cuttings are placed between the rock close to the stream channel as per the "Vegetation Restoration" (Section 5.0) and earth backfill is used to fill voids between the rocks. The riprap would be carefully fitted with planting collars during installation to establish suitable areas for later planting of larger plant materials. The planting collars would provide a barrier between the rock riprap to allow the plants to access native soils below the riprap. Cutting can also be placed between the riprap. Biodegradable erosion control fabric and plantings extend above the rock to the elevation of the 100-year flood level.

Advantages
Immediate stabilizing effect. Does not involve more rock than necessary for stabilization.

Disadvantages
Could be expensive if rock is not available locally. Labor-intensive; requires use of machinery for rock placement.

Common Reasons for Failure
Rock too small. Not securely keyed into banks and bottom or adjoining structures. Rocks dumped, not placed. Rocks impinge upon pre-construction channel. Poor maintenance of plantings leading to vegetation mortality.

Additional Considerations
A number of variations of this alternative are feasible. The rock along the banks can be continued into the channel at some locations to create riffle-pool sequences or form scour pools for resting fish, where conditions on the opposite bank permit. In addition, where the cost of access or slope stability issues make the removal of existing bank protection works impractical or inadvisable, a steep section of large rock could be used to build a wall, which could then be backfilled and planted. Planting collars and/or the selective removal of the underlying bank protection could be used to introduce vegetation. Since bank erosion is generally more extensive, this option was recommended only at one location along the Stanford Golf Course, given existing conditions. Additional locations may become appropriate for this treatment with time.

It should be noted that the placement of large rocks at the toe of a bank is considered generally nonbeneficial to aquatic habitats, as it does not generally allow for bank undercutting or other natural variations in bank structure. However, large rock can provide cover and hiding for some fish species. As discussed in Section 6.0, it may be possible to incorporate cover structures to provide some protected pools in underbank areas.

figure 4D

"Riprap Toe" Alternative

Stabilize Only Toe of Bank with Large Riprap and Revegetate

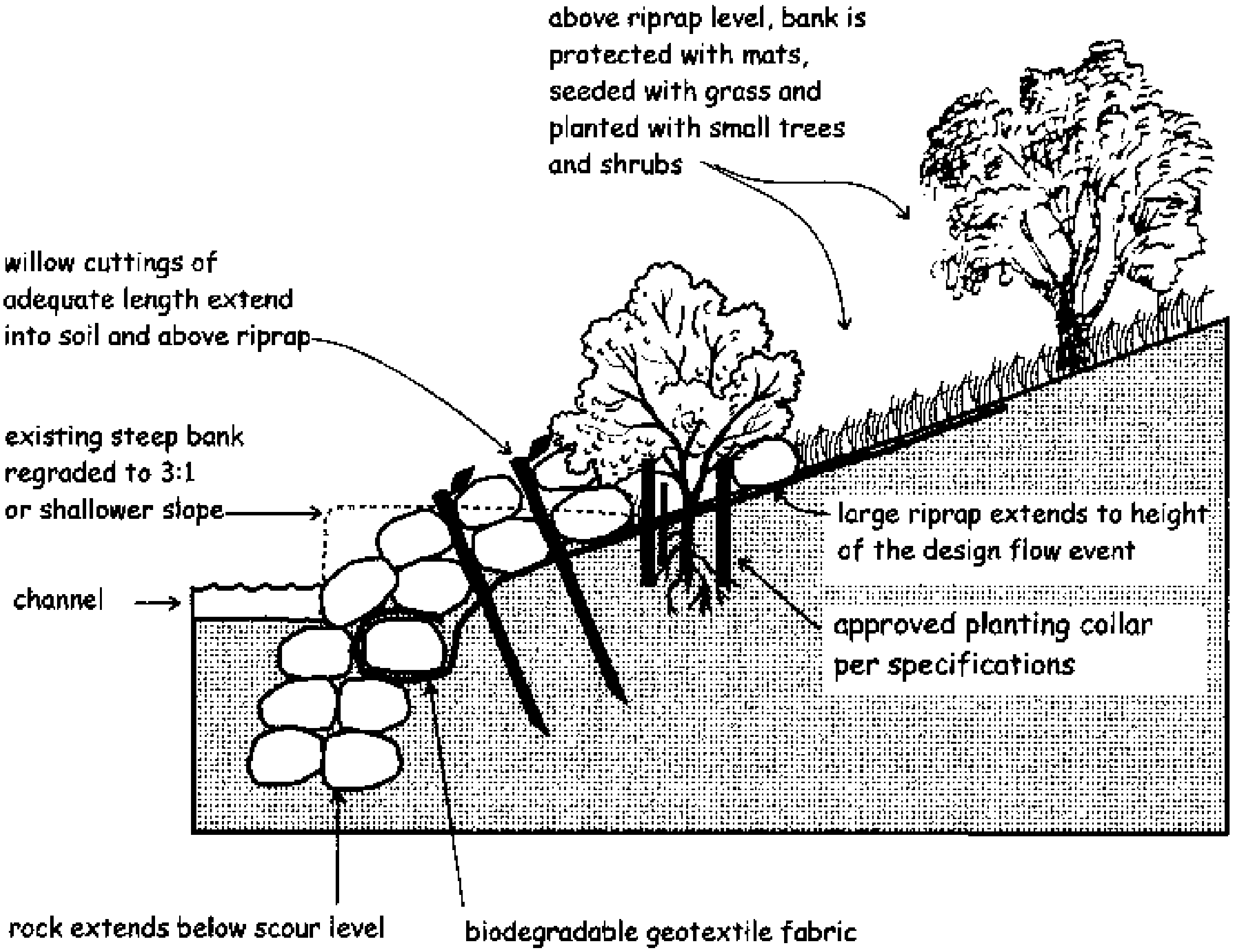

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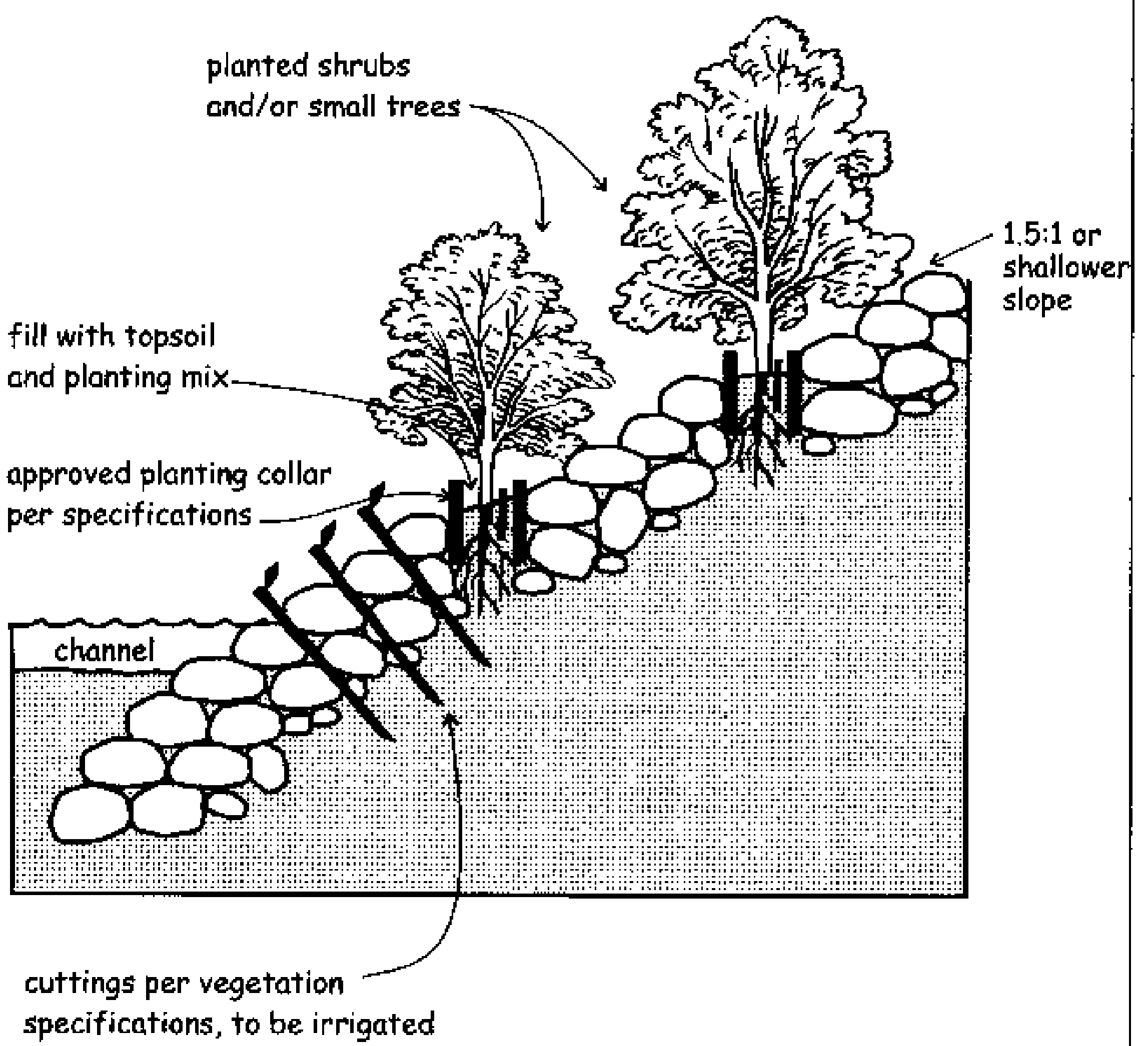
figure 4E

"Vegetated Riprap" Alternative

Stabilize Banks with Large Riprap and Revegetate



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"VEGETATED RIPRAP" ALTERNATIVE (I)

Conceptual Description

This alternative involves placing large riprap along the streambank to stabilize the bank surface, backfilling, and revegetating. The technique is effective in immediately securing a bank, and it provides stability while plants become established.

Where Appropriate

This alternative can also be applied where open space at the top of bank permits regrading of the channel banks to a slope of less than 1.5H:1V and steeper than 3H:1V. (For banks at 3H:1V or less, other, more desirable treatments are appropriate.)

In locations where banks are steep (up to 1.5H:1V) and the proximity of existing buildings/roads precludes the wider corridor necessary for regrading at a milder slope or terracing, this alternative represents the preferred methods of structural bank protection.

In addition, where flow strongly impinges upon an eroding bank, riprap can be used to minimize erosion hazards by directly armoring the bank.

How to Implement

Excavate portions of bank, as necessary for construction surface and to maintain flow conveyance. Regrade bank to consistent slope. Slopes of 1.5H:1V are possible only if rock is placed meticulously for three-point contact between rocks. Dumping of rock is not recommended. The stones should be at the same angle as the slope of the designed streambank, and the total thickness of the stone layer should be at least the thickness of two times the design rock diameter, with design diameter depending on the velocity of the design flow event at that location.

The uppermost riprap should reach above the elevation of the design flow event. The riprap should extend to the bottom of the bank and be on a solid foundation. The rock is underlain with filter or geotextile fabric, which also extends below the scour level and is secured around the lowest rocks. The entire installation should be inserted into the bank at each end to prevent upstream and downstream scour.

Vegetation should be planted on the top of the bank, as well as among the riprap. During rock placement, cuttings are placed between the rock close to the stream channel as per the "Vegetation Restoration Guide-lines" (Section 5.0) and earth backfill is used to fill voids between the rocks. The riprap would be carefully fitted with planting collars during installation to establish suitable areas for later planting of larger plant materials. The planting collars would provide a barrier between the rock riprap to allow the plants to access native soils below the riprap. Erosion control fabric and plantings extend above the rock to the elevation of the 100-year flood level.

Advantages
Immediate stabilizing effect.

Disadvantages
Poor aesthetics. Could be expensive if rock is not available locally. Labor-intensive; requires use of machinery for rock placement.

Common Reasons for Failure
Rock too small. Not securely keyed into banks and bottom or adjoining structures. Rocks dumped, not placed. Rocks impinge upon pre-construction channel. Poor maintenance of plantings leads to plant mortality.

Additional Considerations
Long-term habitat restoration under this scenario would be somewhat difficult due to the limited surface soil available for the plants to root in.

The placement of large rocks at the toe of a bank is considered generally nonbeneficial to aquatic habitats, as it does not allow for bank undercutting or other natural variations in bank structure. As discussed in Section 5.0, it may be possible to incorporate cover structures to provide some overhanging features at the toe of the bank.

"VEGETATED WALL" ALTERNATIVE (J)

Conceptual Description
This alternative involves stabilizing near-vertical to vertical banks using planted cribwall, planted gabion baskets, or vertical retaining wall. The slope would be backfilled to the design grade, structural elements constructed, and then soil areas revegetated.

A planted cribwall is a rectangular framework of logs or other columnar members and woody cuttings designed to protect an eroding streambank.

Gabions are large, rock-filled wire cages that can be used to stabilize steep, badly eroding streambanks. Gabions are constructed from wire, filled with rock and interspersed soil, and embedded into the streambank.

Vertical retaining walls are constructed of grouted rock blocks, stacked and anchored timber beams, or concrete. A wall can consist of one feature or several offset, smaller walls.

Each of these alternatives would incorporate non-native species removal and revegetation, where possible, to promote local habitat enhancement. Plant selection would have to consider available planting and bank locations and abiotic conditions. *Of the three wall approaches described here, the planted cribwall is considered a preferred method for enhancing aquatic and terrestrial habitat.*

Where Appropriate
Steep banks caused by erosion, slumping or undercutting by the current will require additional stabilizing elements before planted vegetation can become firmly established. In locations where banks are exceptionally steep (>1.5H:1V) and the available setback distance is limited, these more intensive structural elements should be applied to protect the banks. High vertical walls should be avoided, except where an important feature (e.g., road or home) is located directly on the edge of the creek bank.

Of the three types of walls described here, vegetated cribwalls are generally preferred due to their greater aesthetic value, inclusion of adequate soil for plant growth, and habitat value. A timber or log cribwall may deteriorate more rapidly than walls constructed using metal or concrete materials. However, during this time period, planted riparian vegetation may become established, leaving a bank stabilized primarily by roots.

How to Implement: Cribwalls
Cribwalls would be constructed using timber or redwood logs, with openings between logs backfilled with soil and planted. Logs should be selected for soundness, durability, uniformity of size, and ease of handling

and delivery. Timber can be interlocked progressively up the designed elevation along the bank. Concrete cribbing is also available, though less aesthetically pleasing than logs.

Cribbing should be embedded below the streambed. The cribwall base is dug parallel to the bank and below the existing streambed. The base log(s) (or other appropriate materials) are placed within this toe trench below stream grade to prevent undercutting of the structure. Base logs should be as long as can be manipulated while conforming to the contour of the stream bank. A good base log is necessary to ensure stability and durability of the treatment.

The next series of logs ("tieback logs") is placed at right angles to the first log. The ends of each log overlap the right angle log below. Each log is secured in place by cutting notches in the wood. Holes can be drilled through the overlapping logs, and steel pins are used to hold them securely. The openings are filled with cuttings and soil.

Tieback logs are embedded into the slope 4 to 6 feet, at grade with the base log. There should be at least two tiebacks per base log. Tiebacks can be secured to the base log using threaded rebar. Approximately halfway up the backside of the base log, geotextile fabric is stapled every six inches, and placed to seal the bedding of the structure. Once the first row of logs has had tiebacks and geotextile fabric installed, and has been backfilled to the top of the log, a second face log is placed on top of the tiebacks. This log is set back approximately 6 inches. The same procedure is repeated until desired height is reached. Stacked face-logs used in cribbing must be secured together.

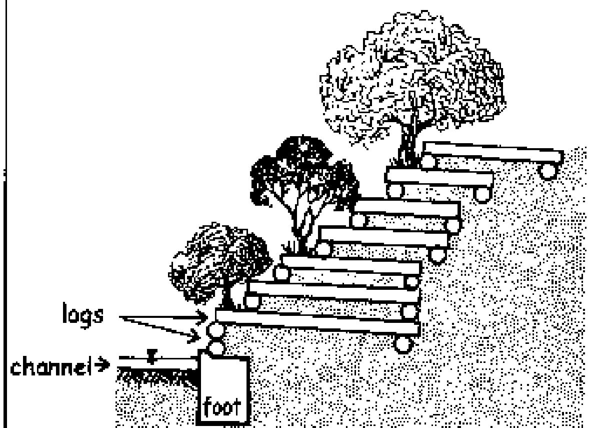
A live vegetated cribwall can be built as either single or double walled structures. The double crib wall has far greater resistance to flows. As with most stabilization methods, cribwall works best when used with vegetation. As each lift of the crib wall is installed, long cuttings of riparian plants are inserted on top of each fill layer. The live branches must reach through the crib and into the soil of the bank to ensure rooting. The tips of the branches should protrude from the crib wallface. The tips should stick out from the wall no more than one quarter of the cuttings total length. They must not be packed too closely and bedded in soil for their total length in the crib in order to facilitate rooting over their whole length. The live plants function to replace the crib logs as they decay with time. Riparian plants can grow very rapidly and provide stream shade canopy and wildlife habitat during their first growing season.

How to Implement: Gabions

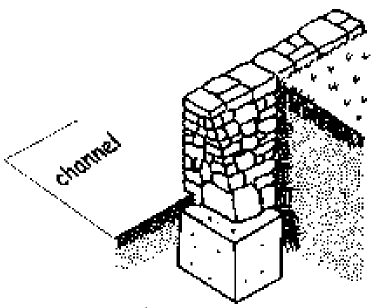
Gabion baskets should be filled with a mixture of soil and rock, and then planted with planting collars installed between gabions. Gabion backets that do not incorporate vegetation are discouraged. Implementation of *figure* 4F

"Vegetated Wall" Alternative

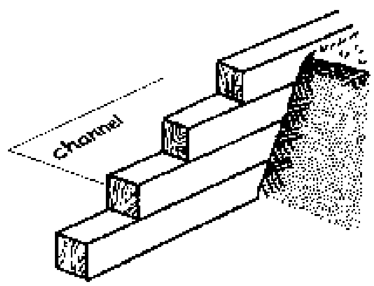
Stabilize Banks Using Planted Cribwall,
Vertical Retaining Wall(s),
or Planted Gabion Baskets



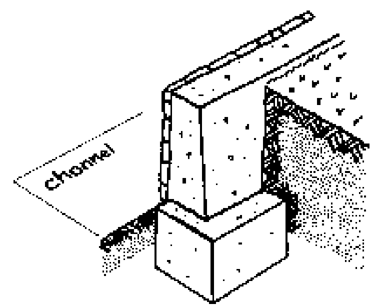
Planted log cribwall
Space between logs backfilled with soil and planted



Stone wall

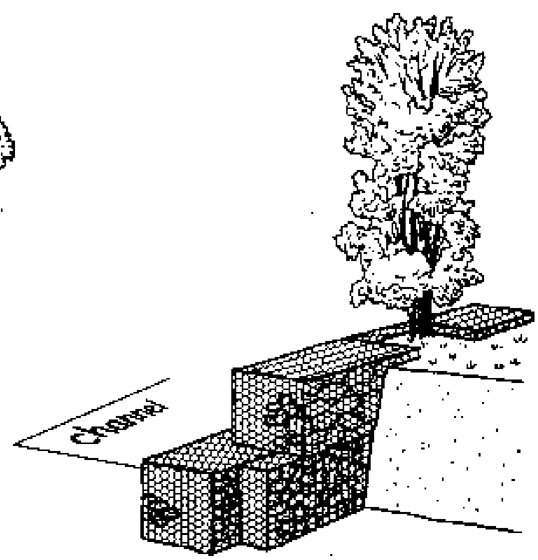


Treated timber retaining wall



Reinforced concrete

Multiple retaining walls



Planted gabion baskets

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gabion baskets should follow manufacturer specifications.

How to Implement: Vertical Retaining Wall
While generally undesirable due to habitat considerations, in some locations vertical walls are the necessary or preferred form of bank stabilization. In general, a series of low walls are preferred to a single high wall, as shown in the schematic cross section. Vertical retaining walls can be stepped progressively so that areas between walls could be backfilled and planted. The walls can be constructed of rock, timber beams, or concrete. Concrete walls can (and should where cost permits) be faced with stone or textured to look like rock. This can improve aesthetics and provide more roughness to slow erosive flood flows.

Each of these treatments should be installed during the stream's low water periods to prevent disturbance to the stream and simplify construction logistics. Each treatment must include keying the bottom and ends of the structure into the bed and banks.

Advantages
Provides immediate protection from erosion. Reinforcing action when plants take root results in the formation of a stable rows of mixed vegetation.

In some cases of the timber cribwall, ultimately the established vegetation will completely replace the function of the crib wall when after many years, it finally decays. However, where the banks are nearly vertical, the stability provided by root systems may be insufficient to secure the bank alone.

Disadvantages
Long-term habitat establishment under this alternative may be difficult depending upon the amount of soil available for plant establishment with the treatment chosen. Provision of extensive vegetation cover after completion is almost impossible.

Vegetated walls can be expensive if materials (rock, timber) are not available locally. Creating and installing vertical walls can be expensive, complicated, and labor-intensive.

Compared with previous alternatives, this approach has a "hard" or developed appearance, and is more appropriate where a more urbanized look is acceptable. Of the three types of vegetated walls suggested here, the vegetated timber cribwall offers the best aesthetics.

Gabion baskets are prone to overall breakage once the structure is locally disturbed. Over time, the wire from gabions may corrode and fall apart. Once broken, the smaller rock inside the wire baskets is subject to washout. In addition, where wire mesh breaks, hazardous conditions may exist for fish, other wildlife species, and children.

In general, vertical retaining walls do not enhance aquatic or riparian habitat and can create redirected flows and excessive water velocities. Therefore, vertical retaining walls are not preferred.

Common Reasons for Failure
Not securely keyed into banks and bottom. For timber walls, poor quality wood used. Poor maintenace of installed plantings can lead to plant mortality.

Additional Considerations
In each case, cover structures may be incorporated to provide some protected areas for use by fish.

4.5.2 MASTER PLAN MAPS

These detailed maps were developed to illustrate the recommended application of the conceptual treatment alternatives. Suggested treatment alternatives are shown superimposed on the existing topography of the project reach and listed by letter. In cases where erosion is not extreme, the "No Action" alternative is listed generally along with one or more other alternatives. These areas are considered relatively low-priority bank stabilization sites. The worst erosional hotspots have generally been assigned as the "Vegetated Riprap" and/or "Vegetated Wall" alternatives with the "No Action" alternative not listed as a possibility. These areas are high priority bank stabilization sites.

The Master Plan uses existing and potential slope conditions and native and non-native vegetation cover to outline appropriate revegetation alternatives, such as non-native species removal, by location. A detailed description of the step-by-step process by which appropriate treatments were selected is provided in Appendix E. As creek conditions change in the future, it may be necessary to re-evaluate which treatments are appropriate at a given location.

It should be noted that in-channel structures can also be used in combination with the bank stabilization methods presented in this Master Plan. In San Francisquito Creek, the main fisheries concern is that of migration (Section 6.0). Wing deflectors are commonly used in-channel structures that act to narrow and deepen flow locally. Stream reaches where bank stability and riparian habitat are sound enough to leave untreated also may be appropriate areas to install wing deflectors in the channel, primarily because it is unlikely that they will cause significant changes to the channel. Wing deflectors would help concentrate low flows into a narrower channel that would facilitate steelhead smolt migration. The structures are discussed in more detail in Section 6.0. As with any structure, wing deflectors would need to be designed and installed with caution so as to avoid creating new erosion problems or exacerbating existing ones.

4.5.3 GENERAL OBSERVATIONS

In the Existing Conditions report, the study reach was divided into four sections of generally similar physical condition. Those reaches are summarized in Table 4A.

Table 4A. Subreach categories

Sub-reach	Extent of Sub-reach (in feet by station notation)	Downstream Extent Description	Upstream Extent Description
A	Station 80+00 to 178+00	Upstream face of U.S. Highway 101	Upstream face of Pope/Chaucer Street Bridge
B	Station 178+00 to 244+00	Upstream face of Pope/Chaucer Street Bridge	Downstream of a pedestrian bridge over the Creek
C	Station 244+00 to 372+00	Downstream of a pedestrian bridge over the Creek.	Downstream of Sand Hill Road
D	Station 372+00 to 404+00	Downstream of Sand Hill Road.	Just downstream of USGS gage along Stanford Golf Course

The maps showing treatment recommendations (Section 4.5.2) show similar patterns at the sub-reach spatial scale.

In Sub-reach A, it is generally recommended that either the “No Action” alternative or an alternative emphasizing revegetation or non-native species removal (“Vegetation Only” or “Vegetate Structure”) be applied at present. This is due to the prevalence of sacked concrete along the majority of the streambanks, and the assumption that stabilization of less stable banks will have a higher priority than replacement of existing bank structures. As the sacked concrete deteriorates in the future, other alternatives will also be appropriate. Sufficient funding could permit the complete replacement of sacked concrete with a more habitat-friendly alternative at any time.

In Sub-reach B, bank conditions are highly variable. Most banks are not currently protected and are very steep and eroded, with insufficient setback to allow regrading. In the absence of regrading, vegetation is unlikely to re-establish along the entire bank. However, where dense vegetation is present, banks are secured by networks of roots and do not currently require structural stabilization. As a result, the “No Action” and “Vegetated Wall” alternatives are recommended at different locations along the banks. The creek is at its greatest sinuosity in this sub-reach, which may also contribute to the highly variable conditions.

In Sub-reach C, the following alternatives are the most commonly recommended: “No Action,” “Vegetation Only,” and “Vegetated Wall.” In addition, from STA 278+00 to 344+00, the absence of adjacent development currently permits regrading or terracing of the right bank (“Regrade and Replant” and “Terrace” alternatives). However, future development along the creek in this area could pose additional constraints on bank stabilization alternatives. Alternatively, if the property is declared open space, it would be appropriate to take "No Action" and allow erosion natural erosion processes to continue.

In Sub-reach D, there are no areas urgently requiring bank stabilization. There are zones where removal of non-native species could be undertaken to improve habitat conditions.

4.6 OPPORTUNITIES

Given the existing conditions of the study reach, there are several locations that should first be targeted for bank stabilization and revegetation and offer the greatest opportunity to preclude future erosion hazards.

4.6.1 REGRADING

The right bank of San Francisquito Creek from Station 278+00 to STA 344+00 poses the greatest opportunity to enhance physical processes and reduce bank erosion. The left bank (when facing downstream) along this stretch is very steep and eroded. The Master Plan calls for regrading and/or terracing the right bank in this area. This would stabilize the right bank, enhance riparian vegetation, improve the conveyance of the channel in these sections, and diminish shear stresses along the adjacent banks. The feasibility of regrading the bank will depend in part upon the future land use and stewardship of this area, and the potential to remove mature, non-native eucalyptus trees from the top of the bank. As such, there are alternate recommendations for this bank if regrading and/or terracing are not feasible.

4.6.2 REVEGETATION

Because revegetation will frequently occur in tandem with bank stabilization, it is difficult to predict the top priority areas for revegetation. In general, revegetation priority should be given to large, contiguous areas where adequate space at the top-of-bank enables steep, eroding banks to be laid back and a gentler, planting slope created ("Regrade and Replant" and "Terrace" alternatives). Revegetation efforts could then occur on the resulting large, planting surface. Opportunities for this type of revegetation work exist along areas upstream of El Camino Real. Specifically, the area between stations 278+00 and 292+00 and between 316+00 and 344+00 on the right bank facing downstream offer the best opportunities for this type of large-scale habitat restoration. The portion of San Francisquito Creek traversing the Stanford Golf Course also presents high revegetation opportunities on both banks. These areas are between stations 382+00 to 404+00.

4.6.3 NON-NATIVE SPECIES REMOVAL

The San Francisquito Creek project area has a high component of invasive, non-native species. Generally, non-native species removal efforts should be prioritized starting from upstream locations and moving downstream since dispersal of non-native seeds, stems, and roots occurs in that direction. In addition, priorities should be set with the aim of minimizing the total, long-term workload and preserving existing high quality habitat. Non-native management actions are most cost-effective when efforts are focused on detecting and eradicating small colonies of invaders before they alter ecosystem function and degrade native communities. Eradication of islands of noxious, non-native species occurring within areas dominated by native species should be the first priority.

4.7 REFERENCES

Palou, P., 1926. Memoirs of California, as translated by Bolton, Vol. 3, UC Press, 264 p.

CRMP (Flood and Erosion Control Task Force), 1998. *Reconnaissance Investigation Report of San Francisquito Creek*, March.

SECTION 5: VEGETATION RESTORATION GUIDELINES

5.1 INTRODUCTION

The previous chapter introduced 10 bank stabilization and revegetation treatment alternatives for the San Francisquito Creek Master Plan project area. These treatments included the following:

- No Action
- Vegetation Only
- Repair Protection
- Vegetate Structure
- Remove Structure
- Regrade and Replant
- Terrace
- Riprap Toe
- Vegetated Riprap
- Vegetated Wall

The following sections describe the steps involved in planning habitat restoration that may or may not follow bank stabilization efforts. These sections focus on revegetation work linked to all the treatments except the "No Action" and "Repair Protection". Methods for non-native species removal and revegetation planning techniques applicable to these 8 bank stabilization treatments are described. In general, the recommendations are appropriate for each bank stabilization treatment. However, modifications may be required at individual sites depending on site-specific opportunities or constraints.

It should be noted that each individual project affiliated with the San Francisquito Creek Master Plan would present a unique set of issues and concerns. The following recommendations are designed to provide *general* restoration concepts on weed management and revegetation planning that would apply to the majority of the projects and would operate in harmony with the bank stabilization work. A final detailed revegetation plan should be developed for each site using the recommendations herein as guidance.

5.2 WEED MANAGEMENT

5.2.1 THREATS POSED BY NON-NATIVE SPECIES

The term "non-native plants" refers to those species introduced and occurring in locations beyond their known historical natural range. As such, they often have no natural grazers or pathogens to limit their reproduction and spread. Non-native plants that spread rapidly, displacing native and/or desired agricultural species, are referred to as invasive species. The proliferation of invasive species within an area leads to the loss of biodiversity since they displace native plants and frequently decrease the habitat value for wildlife. Invasive, non-native species also

Table 5A. Invasive species of greatest concern within the San Francisquito Creek project area, Santa Clara County, CA 1999

Common Name	Scientific Name	Live Form	CalEPPC
acacia	*Acacia* spp.	Rhizomatous tree	--
black locust	*Robinia pseudoacacia*	Rhizomatous tree	B
broom	*Cytisus* spp., *Genista* spp.	Woody shrub	1A
Cape ivy (formerly German ivy)	*Delairea odorata* (formerly *Senecio mikaniodes*)	Climbing vine	1A
English ivy	*Hedera helix*	Climbing vine	1A
eucalyptus	*Eucalyptus* spp.	Rhizomatous tree	1A
fennel	*Foeniculum vulgare*	Perennial herb	1A
giant reed	*Arundo donax*	Perennial cane grass	1A
Himalayan blackberry	*Rubus discolor*	Climbing vine	1A
pampas grass	*Cortaderia jubata*	Perennial grass	1A
periwinkle	*Vinca major*	Creeping vine	B
tree-of-heaven	*Ailanthus altissima*	Rhizomatous tree	B

California Exotic Pest Plant Council (CalEPPC) List Ratings:
1A = Most Invasive Wildland Pest Plants; Widespread
B = Wildland Pest Plants of Lesser Invasiveness

alter basic ecosystem functions such as nutrient cycling, flood duration and extent, and fire frequency. In riparian systems, species such as giant reed (*Arundo donax*) clog stream channels, increasing the severity of flood-erosion events (Hoshovsky 1986). This species is also highly flammable. In addition, blue gum eucalyptus (*Eucalyptus globulus*) has been implicated in a number of urban wildfires (Bean and Russo 1988).

From field surveys documenting the existing conditions present along San Francisquito Creek, it was determined that approximately 65% of the riparian habitat within the San Francisquito Creek project area is highly threatened by invasive plant species. Non-native infestation of native plant communities is greatest along the lower portions of the creek where concrete-lined banks abut residential development. Those species most likely to displace native vegetation and/or alter ecosystem functions are listed in Table 5A.

These species share a number of biological characteristics that complicate management within riparian systems. All spread via water and animal dispersal of seeds, stems, and roots. All establish readily on disturbed soil and in canopy gaps created by construction, bank erosion, flood scouring, or removal of other invasive species. All are capable of expanding exponentially in extent from a single established plant. All persist in the soil—either as seeds or as rhizomes—after the aboveground biomass has been removed or killed. Consequently, management of these species requires a multi-seasonal commitment in which invaded habitats are treated repeatedly to prevent re-infestation (Bean and Russo 1988, Morisawa 1999, Trumbo 1999, Tuniso and Hoshvsky 1989).

Benefits of controlling non-native species within the San Francisquito Creek project area include restoring native plant communities, preserving and enhancing existing native habitat, and reducing flood/erosion events exacerbated by dense non-native vegetation in the channel.

5.2.2 GENERAL APPROACH TO INVASIVE SPECIES MANAGEMENT WITHIN RIPARIAN CORRIDORS

- A licensed California pest control advisor should be consulted prior to implementing weed eradication efforts to devise site-specific weed control strategies.

- Management actions should focus on the desired outcome (i.e., wildlife habitat enhancement, bank stabilization) rather than on the absolute elimination of select invasive species. Quantifiable objectives should be established to serve as benchmarks toward success (The Nature Conservancy 1999).

- Riparian corridors should be addressed as a whole since seeds and reproductive plant parts are continually transported downstream from upstream source populations. Removal of canopy species such as eucalyptus trees should be phased to prevent broad scale bank destabilization and loss of shade. When possible, management actions should proceed from the upstream source to downstream sites (Hamingson 1999).

- Priorities should be set with the aim of minimizing the total, long-term workload and preserving existing high quality habitat. Weed management actions are most cost effective when efforts are focused on detecting and eradicating small colonies of invaders *before* they alter ecosystem function and degrade native communities. Initial actions should be directed at monitoring high quality habitat, preventing new infestations, and slowing the spread of existing invasive populations (Moody and Mack 1988).

- Management actions within a particular project site should address multiple invasive species simultaneously. Removal or containment of a single species often encourages the expansion of other invaders in close proximity (The Nature Conservancy 1999).

- Manual, chemical, and biological control methods should be integrated to reduce cost, labor, and potential deleterious effects on existing native vegetation and wildlife (The Nature Conservancy 1999).

- Management actions must be repeated with sufficient frequency to prevent re-establishment of invasive species from rhizomes and/or seeds. Typically, three to four treatments are required annually during the first three years of management with annual to bi-annual maintenance needed thereafter. New project sites should not be initiated until existing ones enter a maintenance phase (Klein et al 1995, Albert et al 1995).

- Once reproductively mature members of an invasive population have been removed, follow-up treatment must be sufficiently frequent to prevent seedlings and saplings from maturing and repopulating the seed bank (Klein et al 1995, Albert et al 1995).

- Following the eradication of non-native species, appropriate native species should be established once the need for herbicide application or aggressive manual weeding has been reduced.

5.2.3 PROJECT AREA CONSTRAINTS TO NON-NATIVE SPECIES MANAGEMENT

5.2.3.1 Bank Stabilization

Erosion control and revegetation with native species should accompany weed management activities. Thick mulch, landscape fabric, straw wattle, and/or cover crops such as local native grasses should be applied following the removal of aboveground biomass. These actions reduce erosion and suppress re-infestation by some weed species. In general woody, native species should not be introduced until the need for herbicide application or aggressive manual weeding has been reduced (Hamingson 1999, Nelson 1993). Weed eradication efforts are generally required for a full growing season to sufficiently control non-native species before planting can begin. In some cases, two or more seasons of eradication may be required before planting. However, in some instances, this may be too long of a timeline, and planting may occur sooner.

5.2.3.2 Herbicide Restrictions

Chemical applications must be restricted to those products approved by the Environmental Protection Agency (EPA) for use in riparian settings and should be applied by a Qualified Licensed Applicator following a written recommendation from a California pest control advisor.

5.2.3.3 Other Wildlife Considerations

Some invasive species such as blue gum eucalyptus and Himalayan blackberry provide limited foraging and nesting habitat to select wildlife species. Even non-native, canopy trees shade the creek channel, which in turn, moderates stream temperatures and potentially enhances the aquatic habitat. Thus, removal of all non-native, canopy trees in an area should be restricted, and instead, a phased approach undertaken. This method will allow sufficient time for native canopy to regenerate before additional patches of invasive canopy are removed (Adelman 1998).

5.2.4 RECOMMENDATIONS

5.2.4.1 Containment Rather Than Eradication

The extensive stands of non-native vegetation within the project area do provide some function by stabilizing steep creek banks, moderating stream temperatures, and supporting some wildlife habitat, although usually of lower quality. These reasons preclude the eradication of all non-native species at one time within the San Francisquito Creek corridor. A more realistic goal is the containment and gradual reduction of invasive species abundance in association with a steady re-establishment of native species. Containment lines should be established around invasive populations that cannot be removed for logistical, economical, or ecological reasons. Permanent monitoring stations should be established at the boundaries of containment lines and revisited frequently (annually for tree species, bi-monthly for vine species) to ensure that the population does not expand. Saplings, suckers, and tendrils radiating out from core stands should be pruned back. To gradually reduce population size, treatments should be applied from the outer edge, inward (Hamingson 1999).

5.3 REVEGETATION PLANNING

There are eight basic steps involved in developing and implementing a revegetation project, whether the project consists of multiple sites or a single area. These steps generally follow the selection of an appropriate bank stabilization plan. The revegetation steps include the following:

1. Site assessment
2. Revegetation plan preparation
3. Plant selection
4. Plant procurement
5. Site preparation
6. Plant installation techniques
7. Maintenance
8. Monitoring

The following sections provide brief descriptions of the technical elements and approach for each of those eight key steps.

5.3.1 SITE ASSESSMENT

The goal of site assessment is to identify the basic physical opportunities and constraints posed by a site with respect to successfully establishing the target plant species. Optimally, this assessment is conducted by, or with assistance from, an experienced habitat restoration specialist. The site assessment should focus on several key characteristics and address the following general questions:

- Soil suitability: Are the soils sufficiently fertile and of a suitable texture? Will soil amendments or mechanical tillage to loosen compaction be required? Is the soil prone to erosion?

- Aspect and exposure: Is the site heavily shaded or in full sun? Is it north facing or south facing?

- Hydrology: Will the site be frequently inundated by creek flow or rarely wetted, except by incidental rainfall? Will it be subject to scouring flows or sedimentation? How close to the surface is groundwater and how does its position relate to the soil profile?

- Access: Can workers and/or equipment access the site to install and maintain vegetation?

- Existing vegetation within and adjacent to the site: Are there noxious, non-native species within or adjacent to the site that will threaten the ultimate success of the proposed revegetation unless they are effectively eradicated? Are there native trees or shrubs that need to be protected from damage during site installation?

For this project it will also be essential to carefully consider the type of bank stabilization treatment proposed for each site when developing the site-specific revegetation plan. The bank stabilization treatment to be applied will dictate the availability of planting locations and the characteristics of the planting substrate. Some bank stabilization treatments may limit revegetation to certain regions along the bank. Others may present more challenging planting settings such as within gabion baskets, rock rip-rap, or retaining walls.

5.3.2 REVEGETATION PLAN PREPARATION

Information on plant selection, plant procurement, site preparation, plant installation techniques, maintenance, and monitoring should be addressed in a revegetation plan. This plan should be prepared prior to the start of any revegetation project since it will guide project implementation. This plan can be detailed and complex when prepared for large, multiple, or difficult restoration sites. Conversely, it can be a relatively simple and brief plan when prepared for small sites. A revegetation plan serves as a useful guide for landowners and contractors, facilitates the permitting process, and may help to garner funding. A detailed discussion of the components of any revegetation plan (plant selection, plant procurement, site preparation, plant installation techniques, maintenance, and monitoring) follows in the remainder of this chapter.

5.3.3 PLANT SELECTION

One of the key steps in designing a restoration site is selecting a plant palette appropriate to each site's individual physical characteristics. Plant palette selection should occur as early as possible in the site design process to allow adequate lead-time for plant procurement. The selection of appropriate plants for a site is founded on: 1) a careful assessment of the site's physical characteristics (see Section 5.3.1) that will influence the establishment and growth of the plants, 2) consideration of how plants will be integrated into bank stabilization measures/materials, and 3) plant species that maximize habitat values for wildlife.

Table 5B lists the recommended native tree and shrub species appropriate for use in revegetation projects associated with the San Francisquito Creek Master Plan, as well as their preferred position relative to the creek channel. The list was derived from field observations of native tree and shrub species within San Francisquito Creek's riparian corridor.

Bank Location. The 5 bank locations (toe-of-slope; lower, mid, or upper bank; and upland) listed in Table 5B refer to where each recommended tree or shrub species generally occurs with respect to the creek channel. Particular tree and shrub species to be planted and their locations should be selected based upon the bank configuration of the restoration site. These divisions for bank location are fluid categories

Table 5B. Appropriate plant species and bank locations

Common Name	Scientific Name	Bank Location *				
		TOE	LB	MB	UB	UP
Trees:						
arroyo willow	*Salix lasiolepis*	x	x			
big-leaf maple	*Acer macrophyllum*			x	x	
box elder	*Acer negundo*			x	x	x
California bay	*Umbellularia californica*			x	x	x
California buckeye	*Aesculus californica*			x	x	x
California sycamore	*Platanus racemosa*		x	x		
coast live oak	*Quercus agrifolia*			x	x	x
Fremont cottonwood	*Populus fremontii* ssp. *fremontii*	x	x	x		
holly-leafed cherry	*Prunus ilicifolia*				x	x
Mexican elderberry	*Sambucus mexicana*				x	x
Oregon ash	*Fraxinus latifolia*		x	x		
red willow	*Salix laevigata*	x	x	x		
sand bar willow	*Salix exigua*	x	x			
valley oak	*Quercus lobata*			x	x	x
western dogwood	*Cornus sericea* ssp. *occidentalis*		x	x		
white alder	*Alnus rhombifolia*	x	x			
Shrubs:						
California blackberry	*Rubus ursinus*	x	x	x	x	
California coffeeberry	*Rhamnus californica*			x	x	x
California rose	*Rosa californica*		x	x	x	
coyote brush	*Baccharis pilularis*			x	x	x
mugwort	*Artemisia douglasiana*	x	x	x		
mule fat	*Baccharis salicifolia*	x	x	x	x	
pipestems	*Clematis lasiantha*			x	x	x
red flowering current	*Ribes sanguineun*		x	x	x	
snowberry	*Symphoricarpos rivularis*		x	x	x	x
thimbleberry	*Rubus parviflorus*		x	x	x	
toyon	*Heteromeles arbutifolia*			x	x	x
wood strawberry	*Fragaria vesca* ssp. *californica*		x	x	x	

* TOE: toe-of-slope; LB: lower bank; MB: middle bank; UB: upper bank; UP: upland

and do not represent rigid classes. The bank locations are described below:

- The Toe-of-Slope (TOE) position occurs closest to the channel. Plant species chosen for this site should be very tolerant of frequent inundation, hydric conditions, and varying levels of scouring.

- The Lower Bank (LB) position occurs close to the channel just above the toe-of-slope. Plant species chosen for this site should generally be tolerant of occasional inundation and hydric conditions.

- The Mid Bank (MB) position occurs midway along the bank above the toe-of-slope. Plant species chosen for this site should be tolerant of occasionally moist soil conditions but possess some degree of drought tolerance.

- The Upper Bank (UB) position occurs above the mid bank. Plant species chosen for this site should be relatively drought tolerant since little moisture input from the creek can be expected to occur.

- The Upland (UP) position occurs above the upper bank at the top-of-bank or beyond and is situated the furthest from the channel. Plant species chosen for this site should be drought tolerant and adapted to drier conditions since minimal moisture inputs from the creek can be expected to occur.

Table 5C describes the soil, moisture, and exposure requirements, preferences, and tolerances for each recommended tree and shrub species. Site conditions should, to the extent possible, meet these criteria proposed for each species to be installed to ensure the success of the restoration site. Descriptions were derived from the *Revegetation Manual for the Alameda County Flood Control and Water Conservation District Revegetation Program* (Harvey & Stanley 1983) and from observations of plant conditions and communities within the project vicinity.

Soil Tolerance. This category describes soil type preferences and tolerances.

Moisture Requirements. This category describes the plants' moisture needs, as well as tolerances for drought conditions.

Exposure. This category describes how shade or sun tolerant a species is at a particular stage of growth (young or mature).

Table 5C. Soil, moisture, and light conditions

Common Name	Plant Requirements		
	Soil Tolerance	Moisture Requirements	Exposure
Trees:			
arroyo willow	Tolerates: clay hardpan, shallow soil and sandy soil, but not heavy soils	Requires: high soil moisture initially to establish; somewhat drought tolerant once established Tolerates: inundation	Prefers: full sun Tolerates: shade
big-leaf maple	Prefers: deep loam with a high humus content Tolerates: clay hardpan and sandy soil	Requires: relatively high soil moisture Tolerates: drought conditions once established	Prefers: full sun Tolerates: shade when young
box elder	Prefers: soils with a high humus content Tolerates: sandy or gravelly soil	Prefers: moist, well-drained conditions Tolerates: drought conditions once established	Prefers: full sun or partial shade Tolerates: some shade when young
California bay	Prefers: deep soils Tolerates: other soil types including alkaline and serpentine	Requires: well-drained soil with relatively high soil moisture Tolerates: inundation, drought conditions once established	Prefers: full sun or partial shade; deep shade when young
California buckeye	Prefers: moist, well-drained loam	Prefers: moist areas Tolerates: drought conditions once established	Prefers: full sun when mature; some shade during seedling stage
California sycamore	Prefers: deep, moist soils Tolerates: many soil types including alkaline and rocky soils	Prefers: moist sites, Tolerates: drought conditions once established	Prefers: full sun; fairly shade intolerant
coast live oak	Prefers: loam with a gravelly subsoil Tolerates: many soil types, even heavy soils	Requires: good drainage Tolerates: drought conditions once established	Prefers: sun Tolerates: some shade when young
Fremont cottonwood	Prefers: sandy, humus soil in river bottoms Tolerates: many soil types	Requires: constant moisture Tolerates: drought conditions if roots tap a good underground water source	Prefers: full sun; shade intolerant
holly-leafed cherry	Prefers: coarse, well-drained soils Tolerates: most soils	Prefers: dry conditions Tolerates: drought conditions once established	Tolerates: full sun or partial shade
Mexican elderberry	Tolerates: many soil types	Requires: good drainage but can thrive with or without year-round moisture Tolerates: drought conditions once established	Prefers: full sun or very light shade; shade intolerant except when young
Oregon ash	Tolerates: many soil types, including alkaline	Tolerates: drought conditions once established	Prefers: full sun when mature, filtered shade when young
red willow	Tolerates: many soil types including clay hardpan, shallow soil, and sandy soil	Requires: high soil moisture to establish, somewhat drought tolerant once established Tolerates: inundation	Prefers: full sun Tolerates: shade
sand bar willow	Prefers: moist, well-drained soils	Requires: high soil moistures	Prefers: full sun

Table 5C. Soil, moisture, and light conditions

Common Name	Plant Requirements		
	Soil Tolerance	Moisture Requirements	Exposure
Trees:			
valley oak	Prefers: deep, loamy soils Tolerates: many soil types including moderately alkaline soils	Requires: good drainage Tolerates: drought conditions once established	Prefers: full sun Tolerates: shade when young
western dogwood	Tolerates: many soil types	Requires: moist conditions	Prefers: full to partial shade
white alder	Prefers: rich soil with a high humus content Tolerates: clay hardpan or sandy soil	Requires: ample, perennial moisture	Prefers: full sun Tolerates: shade
Shrubs:			
California blackberry	Prefers: deep soils	Requires: ample water to establish Tolerates: inundation, drought conditions once established	Prefers: shady areas Tolerates: full sun in areas of high soil moisture
California coffeeberry	Prefers: rocky, well-drained soils Tolerates: many soils	Tolerates: semi-dry conditions once established.	Prefers: partial shade Tolerates: full sun
California rose	Tolerates: many soil types including alkaline and acidic soils	Prefers: moist areas Tolerates: drought conditions once established	Prefers: full sun
coyote brush	Prefers: light, sandy soils Tolerates: wide range of soil conditions including serpentine and slightly saline soils	Prefers: moist or dry habitats Tolerates: drought conditions once established	Prefers: full sun or partial shade
mugwort	Tolerates: many soil types	Prefers: moist conditions Tolerates: inundation and drought conditions once established	Prefers: partial shade Tolerates: sunnier locations
mule fat	Tolerates: many soil types	Prefers: moist conditions Tolerates: drought conditions once established	Prefers: full sun
pipestems	Prefers: deep, well-drained soils	Requires: moist conditions Tolerates: drought conditions once established	Prefers: full sun Tolerates: full shade
red flowering current	Tolerates: many soil types	Requires: moist conditions Tolerates: drought conditions once established	Prefers: partial shade Tolerates: full shade
snowberry	Tolerates: many soil types	Requires: summer water and relatively moist conditions	Prefers: partial shade Tolerates: full sun in moist locales
thimbleberry	Tolerates: moist soils	Prefers: moist conditions	Prefers: partial shade
toyon	Tolerates: most soils	Prefers: drier habitats Tolerates: drought conditions once established	Prefers: full sun or partial shade when mature, filtered sun when young
wood strawberry	Tolerates: most soils	Prefers: moist conditions	Prefers: partial shade

5.3.4 PLANT PROCUREMENT

5.3.4.1 Plant Procurement

After a planting palette has been selected, a source of plant propagules should be identified and plants should be ordered with adequate lead-time to collect and grow plant material (seed, cuttings, etc.). Plants should originate from propagules (seeds and cuttings) collected from the San Francisquito Creek project area or within Santa Clara or San Mateo Counties from sites close to San Francisquito Creek when propagules are not directly available on the creek. Plants should be contract grown to ensure that locally collected plants are available when required. Native plant nurseries such as Cornflower Farms (916) 689-1015, Circuit Rider Productions, (707) 838-6641, Central Coast Wilds, (831) 459-0656, Elkhorn Native Plant Nursery, (831) 763-1207, and Native Revival Nursery, (831) 684-1811, are experienced at custom-collecting and growing the required native plant material. These nurseries generally need approximately 12 months lead-time to contract grow the desired plants. Rana Creek Habitat Restoration, (831) 659-3811, has also been involved with the collection and growth of native California grasses for projects on San Francisquito Creek. In addition, Jim Johnson and Pat Showalter of the Coordinated Resource Management and Planning group (CRMP), (650) 962-9876 have coordinated the propagation of native plants collected from San Francisquito Creek and should be considered as another source of native plant material.

Valley oak and coast live oak plantings can be established by seeding acorns directly or through installation of container stock. Acorns can be harvested from trees located near the project vicinity, along San Francisquito Creek, or in Santa Clara or San Mateo Counties the year the site is to be planted. Generally, acorns mature in the fall between late September and late October. Following collection, all acorns should undergo the “float test”. Those acorns that float to the top should be discarded while those that sink should be dried and retained. The retained acorns should then be visually examined, and acorns showing evidence of insect damage should be discarded. If planting is delayed, acorns should be stored in plastic bags in a mixture of 50% acorns, 50% perlite and refrigerated until ready for planting.

Buckeye can be established through direct seeding or through installation of container stock. Seeds can be harvested from trees located near the project vicinity, along San Francisquito Creek, or in Santa Clara or San Mateo Counties the year the site is to be planted. Buckeye seeds typically mature in late fall. Because buckeye seeds do not generally store very well, they should be planted immediately following collection. However, the seeds can be stored in the refrigerator up to 3-4 months after collection in moist peat moss. Seeds should be planted immediately after the radicle begins to emerge from the seed (A. Pohl pers. comm.).

Red willow, arroyo willow, sand bar willow, and Fremont cottonwood can be established using container plants or by directly installing cuttings. If cuttings are used, they should be harvested in mid-winter (January-February) when the trees are dormant and installed directly into the ground. Additional information regarding cutting installation can be found in the "Plant Installation Techniques" section (5.3.6).

5.3.4.2 Container Design and Size

Before plants are contract grown, the appropriate type of container design and size should be specified. Most native plant nurseries offer plant materials in a wide range of container designs and sizes. Often, native plants used for habitat restoration projects are grown in special containers instead of conventional nursery containers to enhance survival following transplanting. These unique containers are used to promote deep and straight root systems, improving plant survival following installation. Many of these containers have some or all of the following features:

- A pot depth that is several times larger than pot width;
- Root training ridges to encourage straight, vertical root growth;
- An open bottom to induce air pruning of roots.

These container types help revegetation and restoration projects by limiting circular root growth and helping the plant to overcome the harsh conditions that often exist following planting. A range of container designs and sizes for recommended tree and shrub species related to the San Francisquito Creek project appears in Table 5D. The recommended container sizes are presented in order of preference. A definition for each type follows below:

TreePot-4. This container type measures 4 inches square by 14 inches long. It is appropriate for growing tree species with long, full root development. This container type is recommended for the majority of the tree species.

DeePot. This container type measures 2½ inches in diameter by 10 inches long. It is appropriate for growing tree species with slower and less full initial root development such as California bay, and Mexican elderberry. This container type is also recommended for the majority of the shrub species.

Treeband. This container type measures 2¼ inches square by 5 inches long. It is appropriate for propagating California blackberry, which tends to have shallower, more fibrous roots.

Table 5D. Recommended container sizes or propagule types

Common Name	Recommended Container Size or Propagule Types
Trees:	
arroyo willow	TreePot-4, Deepot, Cuttings
big-leaf maple	TreePot-4, Deepot
box elder	TreePot-4, Deepot
California bay	Deepot
California buckeye	TreePot-4, Deepot, Seeds
California sycamore	TreePot-4, Deepot
coast live oak	Acorns, TreePot-4, Deepot
Fremont cottonwood	TreePot-4, Deepot, Cuttings
holly-leafed cherry	TreePot-4, Deepot
Mexican elderberry	Deepot
Oregon ash	TreePot-4, Deepot
red willow	TreePot-4, Deepot, Cuttings
sand bar willow	TreePot-4, Deepot, Cuttings
valley oak	Acorns, TreePot-4
western dogwood	TreePot-4, Deepot
white alder	TreePot-4, Deepot
Shrubs:	
California blackberry	Treeband, Deepot
California coffeeberry	Deepot
California rose	Deepot
coyote brush	Deepot
mugwort	Deepot
mule fat	Deepot
pipestems	Deepot
red flowering current	Deepot
snowberry	Deepot
thimbleberry	Deepot
toyon	Deepot
wood strawberry	Deepot

Cuttings, Acorns, and Seeds. Cuttings, acorns, and seeds are not propagated in a nursery. Instead, propagules are collected and installed directly into the restoration site. Separate discussions of these materials appear in the "Plant Procurement" (5.3.4) and "Plant Installation" (5.3.6) sections.

5.3.5 SITE PREPARATION

Before plants or propagules are installed at a site, some reworking of the soil surface may be required to create a planting surface appropriate for revegetation. Some sites may require extensive site preparation work while others may necessitate no additional site preparation. The need for the following tasks will be based on individual site considerations.

5.3.5.1 Grading
Minor or major grading operations may be required at some sites to form a planting surface appropriate for revegetation. The need for grading will be based upon individual site considerations such as access opportunities and will be linked to the bank stabilization treatments employed at the site. Heavy machinery used to construct bank stabilization features or create an appropriate planting surface can adversely affect the soil surface through compaction. Thus, grading should occur during the dry season, to the extent possible, when soil moisture is relatively low. If possible, heavy machinery exerting low ground pressure should be used to grade the sites, and measures should be taken to minimize soil compaction.

5.3.5.2 Soil Compaction
Care should be taken to minimize soil compaction during site construction and grading, to the extent possible. While specific recommendations to avoid soil compaction should be developed during the design-phase of a project, bank stabilization and grading work should occur during the dry season when soil moisture is relatively low, if possible. If soil compaction does occur, soil can be decompacted using a combined treatment of ripping in two directions to a depth of about 2 feet at most, followed by discing. Because San Francisquito Creek has very steep banks and poor access, there will likely be limited opportunities to incorporate decompaction measures using heavy equipment.

5.3.5.3 Soil Amendments
Soil amendments can be added to the restoration planting soils to improve site conditions. However, it is generally desirable to plant into native soils. If bank stabilization work results in topsoil removal, it can be saved and respread over the planting surface once bank stabilization work is completed. Organic matter can also be blended into existing soil to improve soil fertility and drainage. Stream bottom gravel should not be used for purposes of backfill.

5.3.5.4 Weed Eradication
Habitat restoration sites with significant non-native species present will require one or more growing seasons of eradication efforts before planting can commence. Initiation of planting before weeds are controlled will likely require significantly greater resources as maintenance crews will be required to simultaneously maintain the native plant species installed while controlling large numbers of non-native resprouts that will likely follow initial eradication. Thus, restoration planting should generally commence following the conclusion of weed eradication if bank stability is not compromised. Section 5.2.2 provides further detail on invasive species management.

5.3.5.5 Surface Erosion Control

If surface erosion poses a threat following site preparation activities, the site should be seeded with a native grass seed mix between September 15 and October 15. Native grasses that can be used in the hydroseed mix include: California brome (*Bromus carinatus*), meadow barley (*Hordeum brachyantherum*), and blue wildrye (*Elymus glaucus*). Seeds should be hydroseeded at a combined rate of at least 60 pounds of pure live seed per acre.

5.3.6 PLANT INSTALLATION TECHNIQUES

5.3.6.1 On-Center Spacing

Part of any restoration design consists of choosing where, how far apart, and what species should be installed in the site. How close restoration plantings are initially spaced will help dictate the ultimate density and character of the resulting restoration site. When choosing a planting density, considerations include the unique morphologies and growth structures of each species, the habitat type to be created, and the bank stabilization treatment to be applied. These factors will ultimately dictate the on-center spacing plan for the chosen planting palette.

Table 5E lists a range of recommended on-center spacing dimensions for each tree and shrub planting. The dimensions refer to the distance between plantings. Planting densities should be determined using the triangular spacing methodology where plants are installed on a triangular not a square grid system. The triangular spacing arrangement results in a slightly denser planting region per unit area than the square grid system.

Trees such as valley oak, coast live oak, California sycamore, Fremont cottonwood, and California bay which can assume a large crown when mature, should be spaced farther apart than medium size trees such as white alder, big-leaf maple, Oregon ash, California buckeye, holly-leafed cherry, box elder, and Mexican elderberry. Smaller trees such as the three willow species naturally form dense thickets and thus have closer on-center spacing. Due to their smaller morphologies and denser growth forms, the shrub species have closer on-center spacing. This tighter spacing regime will promote the development of a dense shrub layer, which is an important component of high quality riparian habitat.

The overall planting densities for riparian habitat restoration on San Francisquito Creek should approach approximately 400-500 plants per acre. In general, individual species should be planted in small groups. Tree species should be planted in groups of 2-3, and shrubs should be planted in groups of 3-5 between the tree species with the goal of ultimately establishing riparian habitat with dense tree and shrub layers.

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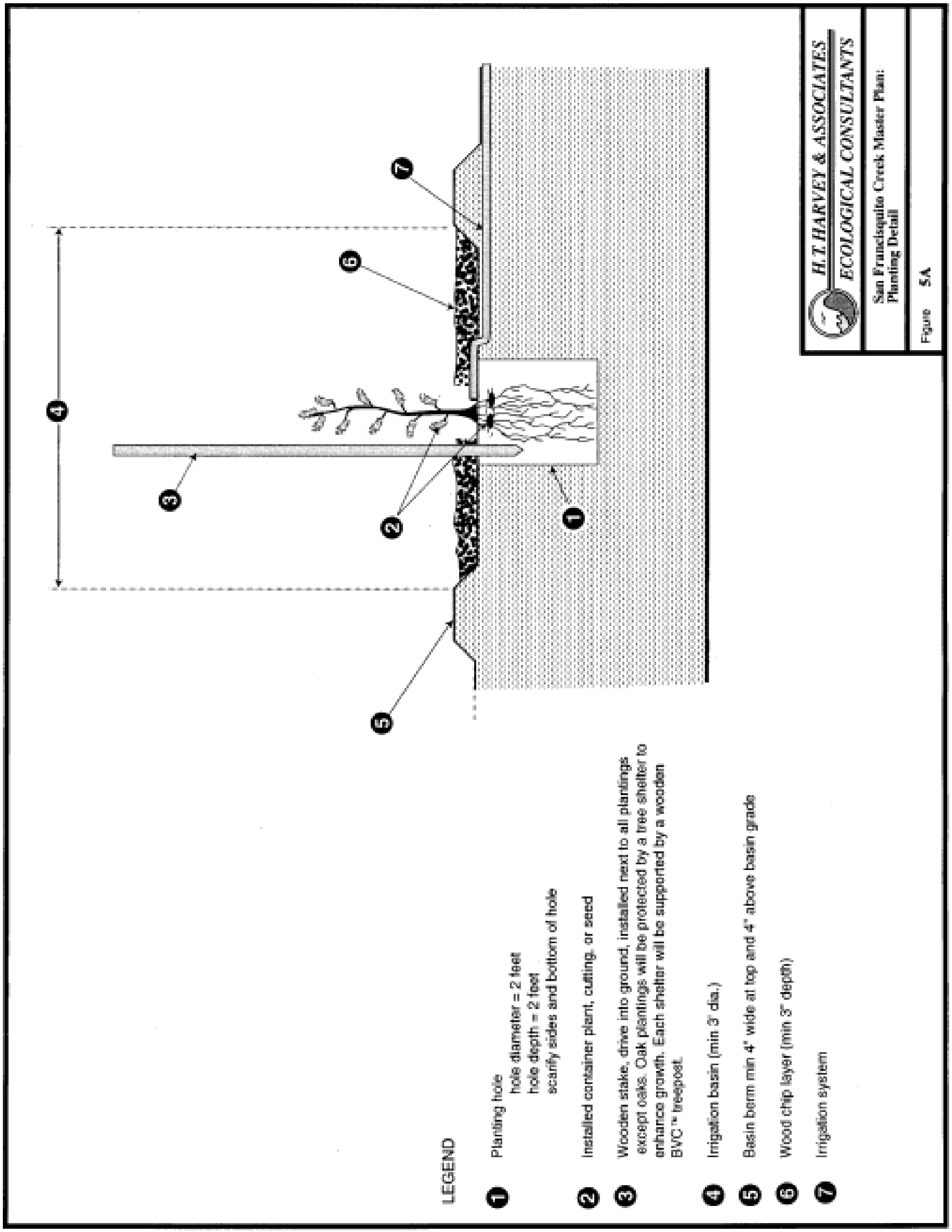
Table 5E. Recommended on-center spacing

Common Name	Recommended On-Center Spacing (Feet)
Trees:	
arroyo willow	8 to 12
big-leaf maple	12 to 18
box elder	12 to 18
California bay	16 to 20
California buckeye	12 to 18
California sycamore	16 to 25
coast live oak	16 to 25
Fremont cottonwood	16 to 25
holly-leafed cherry	6 to 10
Mexican elderberry	12 to 18
Oregon ash	12 to 18
red willow	10 to 12
sand bar willow	8 to 12
valley oak	16 to 25
western dogwood	12 to 18
white alder	12 to 18
Shrubs:	
California blackberry	5 to 10
California coffeeberry	6 to 10
California rose	6 to 10
coyote brush	8 to 10
mugwort	5 to 10
mule fat	8 to 10
pipestems	6 to 10
red flowering current	6 to 10
snowberry	6 to 10
thimbleberry	6 to 10
toyon	6 to 10
wood strawberry	5 to 10

5.3.6.2 Plant Installation

To maximize plant survival and growth, the container plants, acorns, cuttings, and seeds should be installed between approximately October 1 and January 1 to the extent possible. However, container plants can be installed year-round with proper irrigation (see Section 5.3.2.7 "Irrigation") if project scheduling does not allow for planting in fall or early winter. Figure 5A provides a typical planting detail that incorporates the major elements of a planting design.

Container Plant Installation. The container plants should be installed so that their root crowns are at or slightly above (½ inch) the soil surface following planting, soil settlement, and initial irrigation. Planting holes should be at least 2 feet wide and 2 feet deep to the extent possible.


LEGEND
1 Planting hole
hole diameter = 2 feet
hole depth = 2 feet
scarify sides and bottom of hole
2 Installed container plant, cutting, or seed
3 Wooden stake, drive into ground, installed next to all plantings except oaks. Oak plantings will be protected by a tree shelter to enhance growth. Each shelter will be supported by a wooden BVC™ treepost.
4 Irrigation basin (min 3' dia.)
5 Basin berm min 4" wide at top and 4" above basin grade
6 Wood chip layer (min 3" depth)
7 Irrigation system
H.T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS
San Francisquito Creek Master Plan:
Planting Detail
Figure 5A

Deeper and wider holes may be appropriate in difficult planting areas such as those present in the "Vegetate Structure" and "Vegetated Wall" treatments. A 3-foot diameter irrigation basin should be constructed around each plant, and the irrigation basins should be surrounded by 4-inch high, 4-inch wide berms (Figure 5A). The plants should be irrigated immediately following installation.

Acorn and Buckeye Seed Installation. Acorn seeds should be installed 2 inches below the ground while buckeye seeds should be installed barely beneath the surface. Acorns should be placed parallel to the soil surface while buckeye seeds should be positioned with the radicle facing down. Two seeds should be installed in each planting hole. Tree shelters (see "Plant Protection" section below) should be placed around the oak plantings to enhance growth. A 3-foot diameter irrigation basin should be constructed around each plant, and the irrigation basins should be surrounded by 4-inch high, 4-inch wide berms. The plants should be irrigated immediately following installation.

Cuttings. Cuttings from willow or cottonwood plants should be harvested and installed in the mid-winter (January-February) when the trees are dormant. Cuttings should be approximately 18-inches long and one-half to one inch in diameter. Each cutting harvested should be examined and those with insect damage should be discarded. The cuttings can be treated with rooting hormone immediately prior to installation to enhance rooting. However, this is not a requirement as these species readily root without the use of hormone. The cuttings should be installed so that the lower 2/3 of the cutting (12 inches) is buried. The cuttings should be installed immediately following harvesting, if possible. However, they can be stored up to 48 hours after harvesting, if necessary. If stored, the cuttings should be placed in barrels of water in a cool, shady location between harvest and installation.

Planting Collars. Planting collars will be used to support, stabilize, and protect plants (small trees and shrubs) that are installed within rock rip-rap, gabion baskets, and sacked concrete. Planting collars will most likely be used in the "Vegetate Structure", "Rip-Rap Toe", and "Vegetated Rip-Rap" treatments, which all incorporate some amount of revegetation embedded within hardscape areas. Planting collars will provide a barrier between plants and adjacent hardscape features while not compromising the integrity of the bank revetment. They can be designed from a variety of materials including wooden beams and concrete boxes. Specific collars should be tailored to each individual site based on the unique needs and conditions of each site. Although the use of planting collars is not optimal due to the difficulty in establishing plants, they will provide a means of potentially establishing native, vegetation in locations that are currently devoid of woody cover.

5.3.6.3 Weed Control

Herbaceous weeds around individual plants should be controlled with woodchip mulch. A 3- to 4-inch thick layer of mulch should be placed around each plant within the 3-foot diameter irrigation basin (Figure 5A). Invasive species throughout the planting areas should be controlled as described in the "Maintenance" section (5.3.7).

5.3.6.4 Plant Protection

Root damage by small mammals could be a threat at some locations. The need for root protectors should be assessed on a site-by-site basis at the time of individual project implementation and used on an as-needed basis. Root protectors are generally constructed of wire mesh formed into cylindrical baskets with open bottoms. They are placed within the planting hole prior to the installation of the plant to protect the roots from damage by small mammals.

Tree shelters are frequently used to protect plantings from animal damage to shoots or roots and provide an environment conducive for plant growth and development (Figure 5A). Because deer do not occur in the project area, browse protectors will be unnecessary for the majority of the tree and shrub species. However, four-foot tall photodegradable tree shelters should be installed around the valley oak and coast live oak plantings to enhance growth. A protective wire cover should be woven into the tops of each shelter to prevent birds from inadvertently falling down the shelters. Tree shelters have been shown to increase the percent survival and height increment for oak plantings when implemented in concert with weed control (McCreary and Tecklin 1997). Tree shelters also help to conserve soil moisture, promote tree growth, and provide protection against animal damage. The bottom 3 inches of the tree shelters should be buried in the ground. A cylindrical BVC™ tree post should be installed to support each tree shelter. Tree shelters should be removed when they start to impede plant growth, approximately 3 years following installation, and disposed of off-site. Care should be taken when removing shelters and tree posts to not damage foliage or roots. Thus, shelters should be clipped in several locations to facilitate their removal, and tree posts should be removed gently to avoid damaging root systems.

A wooden stake should be placed next to all plants to help prevent incidental damage to the plantings during maintenance. This stake will also help identify the restoration plantings.

5.3.6.5 Erosion Control Seeding

Erosion control seeding should be considered to control surficial and splash erosion due to rainfall on the banks. Native grasses that can be used in the seed mix include: California brome, meadow barley, and blue wildrye. Seeds should be hydroseeded at a combined rate of at least 60 pounds of pure live seed per acre. The restoration site should be hydroseeded between September 15 and October 15. Other methods to control surficial erosion include biodegradable erosion control blankets or blown mulch.

5.3.7 MAINTENANCE

Once site installation and planting are complete, the restoration site should be maintained on a regular basis to ensure the success of the site for at least 3 years. The frequency of maintenance activities required depends on the size of the site, the type of plantings installed, the complexity of the site, the invasive species present, and other factors. In general, maintenance will be required 2-4 times per month between March and October and approximately once per month between November and February for at least the first 3 years following site installation. Maintenance activities should include replacing dead plants, irrigating the plants, maintaining the tree shelters in an upright position, maintaining the irrigation basins and woodchip mulch, and monitoring and removing non-native species. The different maintenance tasks are outlined below.

5.3.7.1 Plant Replacement

Dead plants should be replaced annually to the extent possible during the 3-year maintenance period to help achieve a general plant survival goal of 80% for all plants installed five years following initial installation. An adaptive management approach towards plant replacement should be instituted. Thus, the plant species chosen for replacement should be based upon a critical evaluation of the vigor and growth of the plantings installed. Those species that are well adapted to the planting sites and are rapidly establishing should generally be used to replace dead plants.

5.3.7.2 Irrigation

The restoration site plantings will require irrigation for at least the first 3 years during the plant establishment period. The type of irrigation system to be used at each site will depend on site constraints imposed by the bank stabilization treatment, the plant species installed, cost, and other factors. Drip and bubbler irrigation systems have proven to be effective in other habitat restoration projects, and are recommended for the San Francisquito Creek projects. However, other irrigation systems, including water trucks, may be deemed appropriate at specific sites.

After the first year following plant installation (Year 1), the plants should be irrigated with enough regularity (approximately 2-4 times per month) to keep the soils within the root zone moist from approximately March through October. The irrigation schedule in Year 2 should be based on the water requirements of the plants and is anticipated to be substantially less (approximately 1-2 times per month). In Year 3, little irrigation (0-1 times per month) should be required. The progress of the restoration site should be considered before irrigation is discontinued following Year 3.

Actual irrigation of the site will vary depending upon site conditions. Precise irrigation requirements should be determined through site observations using an adaptive management approach toward irrigation. Thus, the frequency of irrigation can be modified as site conditions and plant needs become apparent following site-establishment.

The irrigation system should be regularly maintained during the 3-year plant establishment period. Any component of the system deemed to be non-functioning should be subsequently repaired as part of regular site maintenance. When irrigation is deemed unnecessary, the irrigation system will subsequently be removed and disposed of properly off-site.

5.3.7.3 Weed Control

Weeds within the restoration site should be controlled around each plant and throughout the site as a whole. The irrigation basin around each installed tree and shrub should be kept weed free by maintaining the wood chip mulch layer and manually removing the weeds that become established in the mulch. Weeds throughout the site should be kept to a maximum height of 1-2 feet year round using a mower and/or “weed eater”. Weed control activities should occur before seed set, to the extent possible. Care should be taken to avoid impacting any native woody species that colonize the gaps between plantings. Therefore, maintenance personnel should be trained to differentiate between native and non-native species.

Particularly noxious non-native and invasive species should continue to be controlled throughout the site as a whole as part of the non-native species removal program. Non-native species should be identified as they appear and a program for their removal should be devised in accordance with the techniques outlined in the “Weed Management” section (5.2). Spot treatment of weeds using herbicides approved by the EPA for use in riparian settings is also outlined in that section.

5.3.7.4 Plant Protection

The restoration site’s tree shelters should be maintained in good working order during approximately the first 3 years of the plant establishment period or until they start to impede the plant’s growth. Following Year 3, the conditions of the tree shelters and the plants should be evaluated and the tree shelters removed, if appropriate. At a minimum, the tree shelters should be removed and disposed of off-site when they start to photodegrade (~ Year 5).

5.3.7.5 Natural Recruitment

Care should be taken to avoid damaging naturally recruiting native tree and shrub seedlings during maintenance and non-native species removal activities. Fostering natural recruitment will aid in rapid habitat development.

5.3.8 MONITORING

Monitoring of the revegetation site is a useful tool to evaluate habitat development and could be required by the permitting agencies. Specific elements of habitat development that may be monitored include:

- Percent survival of installed plants
- Percent cover
- Tree height
- Natural recruitment of native and non-native, woody vegetation
- Plant health and vigor
- Photo-documentation
- Non-native reestablishment
- Site maintenance

Prior to the start of site monitoring, a monitoring plan should be developed that includes a monitoring timeline, a monitoring protocol, and specific target functions and values to be measured. Because each restoration site will differ in size and scope, the specific elements contained within each monitoring plan should be tailored to the unique constraints of each site.

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SECTION 6: FISHERIES AND WILDLIFE PROTECTION AND ENHANCEMENT GUIDELINES

6.1 INTRODUCTION

As discussed in the previous chapters, the San Francisquito Creek Bank Stabilization and Revegetation Master Plan is aimed at providing guidelines for reducing the level of bank erosion and failure along the lower reaches of the creek while also restoring the riparian corridor to consist of a more native plant assemblage. While the overall project is expected to have a net beneficial impact on the fish and wildlife species associated with San Francisquito Creek, any type of construction within a channel or its adjacent riparian corridor, even if aimed at restoring degraded habitats, inherently involves potentially significant direct and/or indirect impacts to fish and wildlife species.

Section 5 described general restoration concepts for revegetation planning during and after stabilization treatments, with the stipulation that detailed revegetation direction is developed for each site. Similarly, this chapter discusses general protection measures intended to minimize the potential for such impacts during the implementation of individual bank stabilization and revegetation projects, as well as guidelines on how to possibly improve aquatic habitat conditions within the creek. It should be understood that these guidelines will also need to be further refined as any individual project proceeds through the environmental review and permitting stages.

There are numerous biological and botanical resources associated with the creek, and many of them have been accorded special status by state or federal resource managers. The term "special status" indicates some level of concern for an organism's survival, and of these a number have been listed as threatened or endangered under the state or federal endangered species acts. A compilation of all special status species both directly and indirectly potentially affected can be quite extensive, especially when downstream (i.e. Bay edge) species are concerned. Table 6A represents the kind of comprehensive list of species which must be addressed in the environmental documentation for a project. For most projects, and for most of these species, there will be a conclusion of a less-then significant effect.

As a practical matter, the individual landowner or public entity undertaking bank stabilization concentrates on avoiding harm to species both known to be present in the immediate area *and* protected by endangered species laws. This is because the issuance of a permit requires that the California Department of Fish and Game (CDFG) and the U.S. Fish and Wildlife Service (USFWS) concur that no adverse impacts will result to listed species. This section will therefore largely limit recommendations to known listed fish and wildlife species in the creek (steelhead and California red-legged frog), with the assumption that mitigation for other species will be covered by programmatic or individual documents prepared under the California Environmental Quality Act (CEQA).

The protection and enhancement guidelines discussed below are not directly linked to the bank stabilization and revegetation recommendations made in the previous chapters. Rather, this discussion is focused on a range of pre- or post stabilization conditions that may require the use of protective measures or warrant the incorporation of certain aquatic enhancement techniques. References are made, where appropriate, to the stabilization recommendations described in Section 4 to aid future individual project designers in choosing an appropriate method of protecting and/or enhancing aquatic habitat within the project reach.

Table 6A. Special status species of wildlife that could occur within the San Francisquito Creek project area of impact.

Common Name	*Scientific Name*	Status Federal/State	General Habitat
Mammals			
Greater western mastiff bat	*Eumops perotis californicus*	SS/CSC	Crevices and openings in woodlands, buildings, caves and cliffs.
Pacific western big-eared bat	*Plecotus townsendii townsendii*	SS/CSC	Crevices and openings in woodlands, buildings, caves and cliffs.
Saltmarsh harvest mouse	*Reithrodontomys raviventris*	FE/CE	Occurs in saline emergent wetlands of San Francisco Bay and tributaries. Pickleweed is the primary habitat.
Saltmarsh wandering shrew	*Sorex vagrans halicoetes*	SS/CSC	Occurs in saline emergent wetlands of San Francisco Bay and tributaries. Pickleweed is the primary habitat.
Birds			
Cooper's hawk	*Accipiter cooperi*	-/C SC	Nests in hardwood and conifer habitats.
Sharp-shinned hawk	*Accipiter striatus*	-/C SC	Nests in hardwoods and conifers or coastal scrub habitats.
Tricolored blackbird	*Agelaius tricolor*	SS/CSC	Nests in emergent plants or thickets adjacent to freshwater source.
Golden eagle	*Aquila chrysaetos*	BEPA/CSC	Requires large, open foraging habitats near hilly or windy areas.
Short eared owl	*Asio flammeus*	-/CSC	Marshes and low-lying area
Ferruginous hawk	*Buteo regalis*	SS/CSC	Winters in grasslands. Does not breed in California.

Table 6A (continued). Special status species of wildlife that could occur within the San Francisquito Creek project area of impact.

Common Name	*Scientific Name*	Status Federal/State	General Habitat
Northern harrier	*Circus cyaneus*	-/C SC	Nests in scrubby vegetation on edges of marshes.
Yellow warbler	*Dendroica petechia brewsteri*	-/CSC	Nests in riparian woodlands.
White-tailed kite	*Elanus leucurus*	-/CS C	Nests in dense topped trees in vicinity of marshes and grasslands.
Prairie falcon	*Falco mexicanus*	-/CSC	Nests in cliffs and forages over grasslands.
Saltmarsh common yellowthroat	*Geothlypis trichas sinuosa*	SS/CSC	Nests in fresh and salt water marshes with thick, continuous cover down to water.
Loggerhead shrike	*Lanius ludovicianus*	SS/CSC	Nests in shrubs and trees associated with open fields and woodlands.
California black rail	*Laterallus jamaicensis coturniculus*	FSC/CT	Nests and forages in salt water marshes transversed by tidal sloughs.
Long-billed curlew	*Numenius americanus*	-/CS C	Nests near water in prairies and grassy meadows.
Double crested cormorant	*Phalacrocorax auritus*	-/CSC (rookery sites)	Colonial nester along the coast on sequestered islets or other areas.
California clapper rail	*Rallus longirostris obsoletus*	FE/CE	Nests and forages in salt water marshes transversed by tidal sloughs.

STATUS CODES:

Federal Status

FE = Species in danger of extinction throughout all or significant portion of its range (Mandatory).
FT = Species likely to become endangered within foreseeable future throughout all or significant portion of its range (Mandatory).
PE = Species proposed endangered (Mandatory)
FC = Candidate information now available indicates that listing may be appropriate with supporting data currently on file (Discretionary).
SS = Former category 2 candidates for listing as threatened or endangered. Now unofficially considered federal sensitive species (Discretionary).
BEPA = Bald Eagle Protection Act (1940) (50 CFR 22) (Mandatory, with limitations).

California State Status

CE = State listed as endangered. Species whose continued existence in California is jeopardized (Mandatory).
CT = State listed as threatened. Species, although not presently threatened with extinction, is likely to become endangered in the foreseeable future (Mandatory).
CR = State listed as rare. Plant species, although not presently threatened with extinction, may become endangered in the foreseeable future (Mandatory, with limitations).
CSC = California species of special concern. This is a management designation used to track animal species with declining breeding populations in California (Discretionary).
CP = Fully Protected by the State of California under Sections 3511 and 4700 of the Fish and Game Code (Mandatory, with limitations).

SOURCES: CNDDB, 2000; USFWS, 1993; Environmental Science Associates, 1998.

Table 6A (continued). Special status species of wildlife that could occur within the San Francisquito Creek project area of impact.

6.2 FISHERIES PROTECTION GUIDELINES

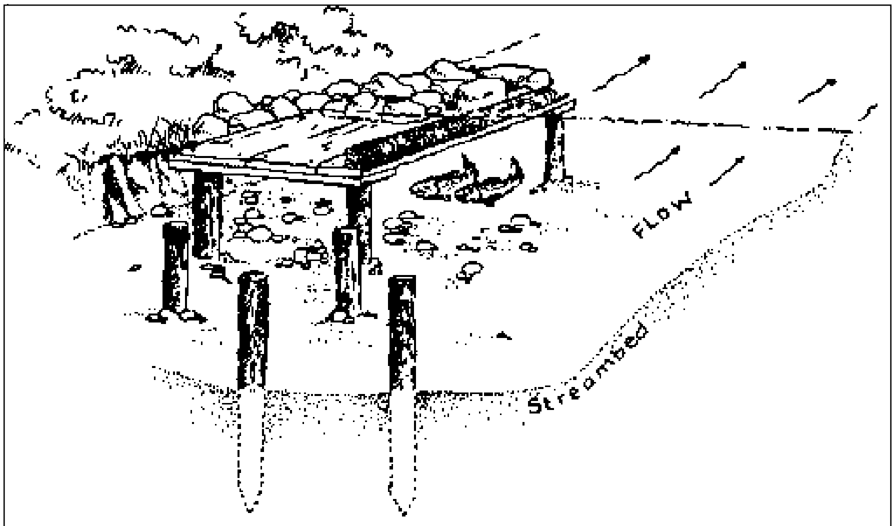
6.2.1 DESIGN CONSIDERATIONS

The removal of non-native vegetation according to the “Vegetation Only” treatment described in Section 4 will need to be designed cautiously (e.g., staggered over several seasons) so as not to result in a large-scale reduction of channel shading. In areas where revegetation is recommended and the danger of greatly reducing the water transport capacity of the channel is low, some plantings should also be placed along the face of the slope and close to the wetted channel so as to increase the amount of shading and vegetative debris for the stream.

Terracing stream banks (“Terrace” treatment) is a highly effective method of increasing channel capacity without adversely impacting aquatic habitats within the channel. However, terracing should not extend beyond the toe of the bank so as not to alter the width or shape of the existing channel. Riparian vegetation should be planted on all terraces, including the one closest to the water line, to increase shading, leaf litter, and the penetration of root wads into the normal-flow channel. This stabilization alternative is also expected to have beneficial impacts on aquatic habitats in itself and no further instream enhancements are recommended.

The use of log crib walls (“Vegetated Walls” treatment) is highly preferable to the installation of vertical concrete retaining walls and gabion baskets. Vertical concrete retaining walls do not provide any habitat, aquatic or riparian, and create excessive water velocities downstream. Gabion baskets (wire mesh cages filled with rock and set into the stream bank) eventually deteriorate and require repair. Log crib walls, in contrast, are designed to temporarily (10-15 years) stabilize the banks, giving the newly planted riparian vegetation an opportunity to become established. The logs eventually deteriorate, leaving a natural bank stabilized by roots. Cover structures can be easily incorporated into the design of the crib wall (see Figure 6A).

Regrading stream banks to achieve a less steep angle and replanting native riparian vegetation (the “Regrade and Replant” treatment) is a preferred stabilization alternative with regards to aquatic habitat as it avoids the use of unnatural permanent structures. Shallower banks allow for the establishment of a more natural riparian zone. Stabilizing the banks with the roots of riparian vegetation also allows for naturally undercut banks, which provide important steelhead habitat without compromising the integrity of the bank. Thus, this stabilization alternative will have beneficial impacts on aquatic habitats in itself and no further protective measures are recommended.



Cover/deflector structure construction. *Cover/deflector structure showing the various stages of construction prior to placement of sod.*

Figure 6A. A typical cover/deflector construction (Source: Hunter, 1991).

6.2.2 CONSTRUCTION-RELATED IMPACTS TO BE AVOIDED OR MITIGATED

The construction of any bank stabilization, revegetation, or instream restoration will have to be conducted in a manner consistent with standard protection measures and Best Management Practices typically applied to projects involving work in and around streams (see for example *Manual of Standards for Erosion and Sediment Control Measures,* Association of Bay Area Governments and *California Storm Water Best Management Practice Handbook- Construction Activity,* Stormwater Quality Task Force). While the following list of measures is intended to give an overview of the types of practices that may be necessary to minimize the potential for construction-related impacts, not all will be applicable to each individual project and in some cases measures other than the ones presented may be more appropriate. A final set of measures will have to be determined during the final environmental review stage for each project, and site specific biological surveys may also have to be conducted in order to ensure a clear understanding of the local resources to be protected (see Section 4.0, below). In the interim, these measures should be considered general guidelines.

- All construction within the channel should be conducted during the period April 15 to October 15 when stream flows are low or absent to avoid impacts such as direct death of fish and other aquatic organisms, excessive siltation, and other form of water contamination.
- If work sites require dewatering, the intake screens should be

screened with a maximum mesh size of 5 millimeters.
- Exclusionary fencing may be necessary around work sites known to be within the range of sensitive species.
- Best Management Practices identified by the appropriate Regional Water Quality Control Board should be implemented.
- The number and size of access routes, staging areas, and total area of activity should be limited to the minimum necessary to achieve the project goal.
- The removal of existing riparian vegetation should exclude trees with raptor nests. Such trees may potentially be removed during the non-breeding season.

6.3. FISHERIES ENHANCEMENT GUIDELINES

Physical conditions within stream channels can be modified to improve or increase particular habitats and the overall mix of habitat types for salmonids. It may not be necessary for any individual landowner to attempt to improve conditions—if well designed, there may be no impacts from a stabilization project and no need to consider enhancement projects as a way to offset them. However, proponents of larger scale efforts may wish to consider enhancements as a way to expedite permitting.

The value of an enhancement depends on the correct identification of critical stream habitat needs affecting the species in question. In the case of San Francisquito Creek, the species is usually the federally listed steelhead and the critical habitat within the proposed project reach is most commonly considered to be a migratory corridor (Johnson, pers. comm.). Thus only improvement structures that will protect or enhance steelhead passage and resting areas will be addressed in this section.

While the following discussion will recommend potential instream habitat improvement structures that could be implemented in conjunction with the bank stabilization and revegetation treatment alternatives discussed earlier, decisions about the appropriate type, location, and installation of improvements will need to be made during the final design phases of individual stabilization projects. Site specific analyses that will need to be conducted prior to the installation of any improvement structure include their potential impacts on stream-flow parameters (volumes and velocities), passage of bankfull flows, and bedload and debris transport.

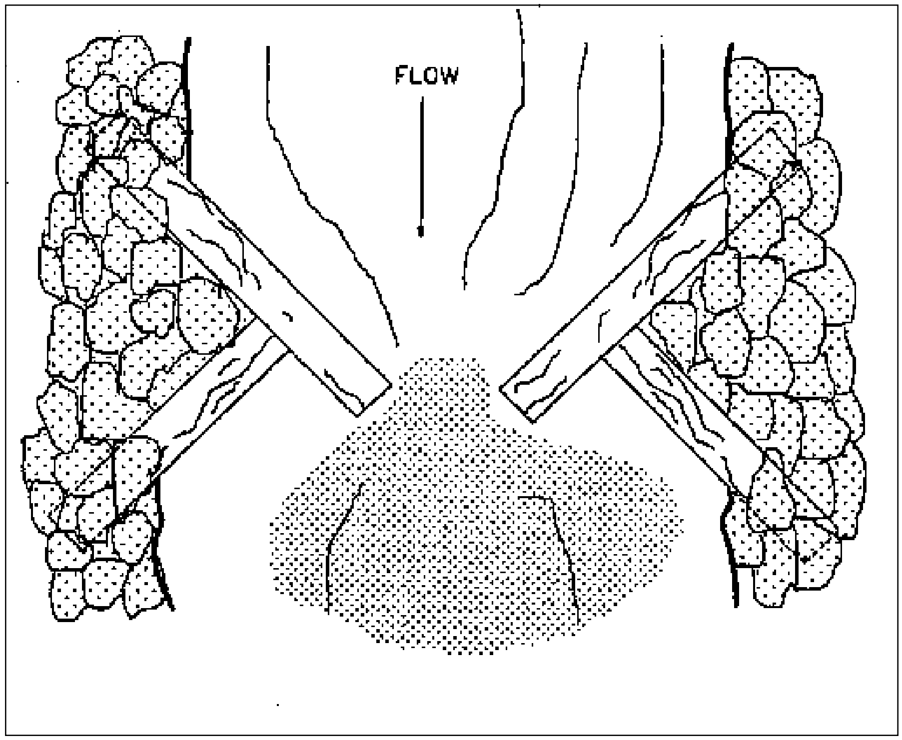
There is a second and equally important *caveat* to habitat improvement structures. The San Francisquito Creek project may achieve bank stabilization and revegetation in a discontinuous manner, i.e., whenever individual property owners decide to conduct a specific project along their land. This may raise questions about the condition of the adjacent and downstream banks at the time of project initiation. For example, an instream structure may help to concentrate flows and therefore increase water velocity and/or depth, which may be an appropriate restoration feature at the site of a planned stabilization project. However, if a severely unstable bank on the opposite side of the channel has not yet received any treatment, the structure may exacerbate scouring and erosion along that bank. This concern will likely be resolved when more comprehensive implementation/mitigation procedures are in place (in a CEQA document for the Plan or in a Regional General Permit).

As discussed in the existing conditions report, San Francisquito Creek is a deeply incised channel (although there is evidence that the channel has recently aggraded to some degree) with a very narrow riparian corridor. The actual instream portion of the creek is fairly undisturbed and currently functions relatively effectively as a migratory corridor for steelhead. There is a general consensus that the primary existing conditions suboptimal for steelhead are (1) the existence of several migration barriers (blocking smolt out-migration during late spring), (2) a lack of shading, and (3) a lack of a well-defined low-flow channel through some reaches (Anderson, 1995; Johnson, pers. comm.; Launer, pers. comm.; Roper, pers. comm.)

The migration barriers (Condition 1) at the Palo Alto grade stabilization structure near El Camino Real and the rubble/concrete structure near 1849 Woodland Avenue currently present the most significant adverse habitat condition for steelhead. The possibility of removal of these structures is currently being pursued by CRMP but is not directly related to this Master Plan. Alleviating the lack of stream shading (Condition 2) is one of the primary goals of the revegetation component of this Master Plan, as reflected by the recommendation discussed in the previous chapters. The lack of a well-defined low-flow channel (Condition 3) may be remedied in certain areas through the installation of "wing deflectors" (see Figure 6B). Single, opposing, or alternating log wing deflectors are commonly used in shallow channel reaches where they help to concentrate low late-spring and summer flows into a more narrow and deeper channel, thus facilitating steelhead smolt migrating to the ocean. The low profile of wing deflectors typically allows high flows to pass over without significantly impeding water transport.

Stabilizing the toe of the channel with large rocks or other materials is generally considered to be counterproductive to the establishment of aquatic habitats as it does not allow for bank undercut or other natural variations in bank structure. Areas in which stabilization recommendations include armoring the toe of the slope (the "Riprap Toe" treatment), or stabilizing the majority of the bank (the "Vegetated Riprap" and the "Vegetated Wall" treatments) may be suitable for installing cover structures Figure 6A) adjacent to the rehabilitated bank stabilization in order to mitigate for the potential loss of undercut banks.

Figure 6B. Opposing log wing deflector.



Cover structures typically consist of posts driven into the substrate, planks placed on top of the posts, and sod containing native riparian grasses placed onto the planks. These structures emulate undercut banks and provide fish with thermal refugia as well as escape from predation. The sod gives the structure a natural appearance. Instream restoration methods such as the placement of large boulders or boulder/ log combinations that help to create scour pools, resting areas, and cover may also be appropriate in areas where banks are armored. Another option is to construct the proposed enforcement such that it would protrude into the channel at the normal water line and angle back towards the bank below the water (i.e., with a nose profile). As discussed under the structural variations that are feasible for the “Riprap Toe” treatement, extending the rocks into the channel would emulate a rock outcrop and provide valuable cover and resting areas for steelhead. This would allow fish to seek cover under the structure.

Areas where local erosion hotspots are proposed to be fixed along existing bank protection features that appear otherwise stable (the “Repair Protection” treatment) may not present optimal enhancement opportunities. Modifying channel characteristics along such reaches may further compromise the integrity of bank protections that area already prone to erosion but are not recommended for complete replacement.

Stream reaches where bank stability and riparian habitat are sound enough to leave untreated (“No Action”) may be appropriate areas for the installation of wing deflectors, primarily because the threat of causing significant changes to the channel is minimal in these areas. Although reaches that do not require any bank stabilization projects are unlikely to generate any instream habitat improvement work, these sites may present opportunities for mitigating projects conducted in other reaches where impacts to aquatic habitat are unavoidable.

6.4. WILDLIFE PROTECTION GUIDELINES

6.4.1. DESIGN CONSIDERATIONS

As with the fisheries concerns expressed above, terrestrial wildlife such as nesting birds could be adversely affected by the removal of non-native vegetation (the "Vegetation Only" treatment). Design which staggers removal over several seasons will help to mitigate for these species as well. In general, project activities should not be allowed to reduce canopy cover (the amount of shade in an area at midday) more than 50% during any project year. Vegetation structure is also a concern. Maintenance of 4" diameter limbs is considered important by CDFG as cover and nesting substrate. Although some removal of trees and large limbs is inevitable, selection of large planting stock (e.g., 15-gallon as opposed to 5-gallon planting stock) should be considered to return shading and structure to pre-project conditions as soon as possible.

6.4.2. CONSTRUCTION-RELATED IMPACTS TO BE AVOIDED OR MITIGATED

As discussed above, there are many special status terrestrial species, and as many as six listed species, which may be considered in project planning, CEQA review, and permitting for stabilization or revegetation projects. For most San Francisquito efforts in the near future, agency attention will likely focus on the Calfornia red-legged frog. The species was listed in 1996, is a well-known creek resident, and is directly and indirectly vulnerable to project actions, either through direct mortality or the disturbance or displacement of the animal which may affect its survival. The following measures are recommended to avoid or minimize the potential for impacts to California red-legged frog during bank stabilization and revegetation treatments. These measures are adapted from the USFWS Biological Opinion for California red-legged frog issued on January 26, 1999. They would serve to avoid unnecessary harassment of other special status wildlife species as well, such as western pond turtle. Measures like these will likely be part of individual permit documents. Other measures may be made part of more general, project-wide permits secured on behalf of individual landowners.

- The creekside construction boundary should be fenced to prohibit the movement of frogs into or out of the construction area and to control creek siltation and disturbance to riparian habitat. At no time during construction should vegetation be removed or disturbance occur beyond the fenced construction boundary.

- During project activities, all trash that may attract predators should be properly contained, removed from the work site and disposed of regularly. Following construction, all trash and construction debris should be removed from work areas.
- All fueling and maintenance of vehicles and other equipment and staging areas should occur at least 20 meters (approximately 65 feet) from the creek. Prior to the onset of work, all workers should be informed of the importance of preventing spills and of the appropriate measures to take should a spill occur.
- During dewatering, intakes should be completely screened with wire mesh not larger than five millimeters (mm) to prevent California red-legged frogs from entering the pump system. Water should be released or pumped downstream at an appropriate rate to maintain downstream flows during construction. Upon completion of construction activities, any barriers to flow should be removed in a manner that allows flow to resume with the least disturbance to the substrate.

In addition, in some situations (and where practicable in the field), an amphibian exclosure fence may be installed in the creek channel both upstream and downstream of construction activities.

6.5 REFERENCES

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SECTION 7: ACCESS GUIDELINES

7.1 INTRODUCTION

The comprehensive nature of this planning document looks beyond the impact of a single restoration project on an individual landowner, maximizing the benefits of restoration efforts to the community. This section discusses methods of communicating the value of San Francisquito Creek's resources through improved access. The term "access" is used broadly here to include the many ways individuals can connect with the creek environment. Through improved pedestrian and visual access, enhanced public education, and interpretation, the community's relationship to the creek will be strengthened.

Existing and proposed access sites identified in this Section by approximate station point are also illustrated on the Master Plan Maps in Section 4.

7.2 SUMMARY OF EXISTING ACCESS

7.2.1 EXISTING ACCESS INTO THE CREEK

Currently, access into the creek by pedestrians is limited to a few informal narrow paths and service roads extending down the banks. Many of the informal paths were created for purposes of cleanup and police patrol. In addition, homeowners have constructed their own private bridges and paths into the creek.

There is agreement that some access into the creek is necessary and should be encouraged within limits. In general, there is a need and desire for safe access into the creek for police patrol, debris and litter pick up, and exotic plant removal (particularly in densely wooded areas). However, random access by the general public has impacted the environment and caused liability and privacy concerns among landowners. Regular

Table 7A: Existing public pedestrian access into the creek channel

Station Point	Site Description
123+50	At Woodland Avenue, appx. 250' upstream (u/s) of Cooley Avenue
137+80	At Woodland Avenue, appx. 120' downstream (d/s) of Manhattan
182+20	At Woodland Avenue, appx. 400' u/s of Chaucer Street
218+20	At Woodland Avenue, appx. 300' d/s of Baywood Avenue
224+50	Appx. 150' u/s of Middlefield Road
270+00	At El Palo Alto Park
294+30	At Creek Drive, 100' u/s of University Drive
377+50	At Oak Creek Apartments Road

creek patrols in conjunction with resident neighborhood watch programs have curbed the use of the creek as an encampment.

Existing public pedestrian access into the creek is focused primarily at the locations listed in Table 7A (identified by approximate station point at which the path begins):

Table 7B: Existing creekside access locations

Station Point	Length	Site Description
From 81+00 to 95+00	1400'	SCVWD paved easement
From 178+70 to 189+50	1080'	Palo Alto Ave. (beginning at Marlowe Street)
From 193+00 to 200+00	700'	Along Palo Alto Avenue
From 223+00 to 266+00	4300'	At Timothy Hopkins Creekside Park
From 319+40 to 345+00	2560'	Along new Sand Hill Road development
From 345+00 to 374+00	2900'	At Oak Creek Apartments

7.2.2 EXISTING CREEKSIDE ACCESS

In addition to access into the creek, creekside access occurs at parks, road overcrossings and pedestrian bridges with nearly 2.5 miles of formal public linear access exists along the creek at several intermittent locations along the study reach, as detailed in Table 7B.

Because of the floodwall barrier, the existing shoulder that stretches along Woodland Avenue in East Palo Alto has not been included in the existing access linear footage number.

A multi-use pedestrian path is under construction at the new Sand Hill Road development. This new, compacted soil path will be ten feet wide and set back twenty feet from top of bank, with a split rail barrier between the trail and bank edge. This path follows the historic alignment of old Sand Hill Road (Jones, 2000).

A few park sites exist along the creek, including El Palo Alto Park (at station point 270+00), two pocket parks within the Timothy Hopkins Creekside Park system (station points 236+00 and 228+50), and a community garden (station point 173+00). An existing pedestrian bridge near San Mateo Avenue is also a creekside access point of note.

7.2.3 EXISTING VISUAL ACCESS

Visual access allows the community to feel closer to their creek and appreciate the natural corridor within the urban setting. Currently, while the creek functions as a green backdrop to many of the adjacent land uses, focus generally is directed *away* from the creek. Erosion has damaged many of the existing formal and informal trails and fences have been erected for security purposes, restricting a sense of connection to the creek.

7.3 RECOMMENDATIONS FOR IMPROVED ACCESS

Types of access discussed here include paths/trails along the top of bank, overlooks, small pocket parks at top of bank, and improved visual access. The following recommendations focus on access and interpretation opportunities within the public right-of-way and are not specific to property or parcel lines.

7.3.1 ACCESS INTO THE CREEK CHANNEL

Additional formalized access into the creek channel is not recommended as part of this Report. Access down the steep slopes may exacerbate bank instability, disturb restoration efforts and sensitive habitat, opposing the Master Plan's goal of preserving the creek's resources. The moderate slope and adequate bank width required to allow safe, universal access is rarely available on public lands within the study reach. Additionally, with the proximity of public to private property, increased access into the channel would aggravate the trespassing problem.

7.3.2 PROPOSED LINEAR CREEKSIDE ACCESS IMPROVEMENTS

Linear paths along the top of banks or parks adjacent to the creek are the preferred methods of connecting the community with the creek without threatening the natural resource. Creekside paths also offer an attractive means of pedestrian travel from neighborhoods to the urban core.

As shown in the Master Plan Maps, some public top-of-bank access is possible along almost the entire length of the study reach. Table 7C summarizes proposed top of bank pedestrian access paths that, if imple-

Table 7C: Proposed top of bank access path locations

Station Point	Length	Site Description
From 80+50 to 86+50	600'	At new development
From 166+00 to 169+00	300'	Palo Alto Avenue 100' u/s of Marlowe Street
From 176+00 to 177+50	150'	Along Palo Alto Ave. d/s of Chaucer Street
From 189+50 to 193+00	350'	Along Palo Alto Ave. u/s of Hale Street
From 200+00 to 202+00	200'	Along Palo Alto Ave. d/s of Everett Street
From 207+00 to 222+00	1500'	Along Palo Alto Ave. d/s of Middlefield Road
From 277+00 to 306+00	2900'	Creek Drive u/s of El Camino Real (formalize)

mented in conjunction with bank stabilization projects, would create a nearly continuous pedestrian route along the top of bank from West Bayshore Road to Sand Hill Road.

Restoring the top of bank access along Palo Alto Avenue would return Timothy Hopkins Creekside Park to a true continuous linear park. A new creek crossing downstream of the Children's Health Council (station point 306+00) between Stanford lands and Creek Drive in Menlo Park would allow pedestrian travel on the new path through Sand Hill Road development, along Oak Creek Apartment's footpath, to Sand Hill Road. Pedestrians could also continue along Woodland Avenue upstream from Chaucer Street in Menlo Park to the new crossing. Additional top-of-bank access may also be provided at the new Windriver development in East Palo Alto.

This combination of new and existing creekside access should integrate with urban pedestrian routes of travel at Chaucer Street, Middlefield Road, and El Camino Real as well with the many local roads in Palo Alto and Menlo Park.

A floodwall at the upper reaches of the study area adjacent to the Stanford Golf Course inhibits access into the creek, although there are several pedestrian bridge crossings in this area. Because it is a private course, public access is not proposed.

7.3.3 PROPOSED POCKET PARKS AND OVERLOOKS

New overlooks and parks may be located in areas of stable banks or in conjunction with bank stabilization projects. Overlooks are small, level areas that provide better views into the creek, particularly at high-water season. Pocket parks are landscaped destination points oriented toward the creek. Both can be rustic, should feature an appropriate barrier at the top of bank, and may include seating and/or interpretive elements.

Table 7D: Proposed pocket park and outlook locations

Station Point	Park or Overlook	Site Description
101+50	Overlook	At Woodland Ave., appx. 1100' d/s of Newell Road
198+00	Park	At Palo Alto Ave., 500' u/s of Seneca Street
203+00	Overlook	At Palo Alto Avenue and Everett Street
210+30	Overlook	At Woodland Avenue and Lexington Road
353+00	Overlook	At Oak Creek Apartments Road

City of Palo Alto Park, with San Francisquito Creek as backdrop.

Table 7D summarizes the proposed pocket park and outlook locations illustrated on the Master Plan Maps in Section 4.

7.3.4 PROPOSED VISUAL ACCESS IMPROVEMENTS

Currently, many of the existing parks "turn their backs" on the creek, focusing toward the road with the creek as a backdrop. Relocating benches to face the creek and adding interpretive amenities (as discussed later in this section) would improve the relationship of the park user to the creek. Replacement of tall fences with lower barriers where safe, and in conjunction with bank stabilization projects, would also allow the community better visual access to the creek corridor.

Providing creek identification at major road crossings and in locations where local streets terminate at the creek would enhance public awareness of San Francisquito Creek. This roadway identification would be effective at locations listed below (illustrated on the Master Plan Maps in Section 4):

- West Bayshore Road
- Newell Road
- University Avenue
- Manhattan Street
- Marlowe Street
- Chaucer Street
- Seneca Street
- Everett Street
- Middlefield Road
- Emerson Street
- El Camino Real
- University Drive
- Sand Hill Road
- Junipero Serra Boulevard

In general, any access improvements should comply with the guidelines and recommendations set forth in this Master Plan and great care should be taken to protect existing native vegetation and habitat.

7.4 THE CREEK'S COMMUNITY IMAGE

In a move to cross jurisdictional boundaries and address issues related to the creek with a singular mind, a Joint Powers Authority (JPA) formed in May 1999.

This collective effort presents an opportunity to create a unified image for the creek corridor that is immediately identifiable and effective in establishing the creek corridor as a unit. A thematic connection that threads throughout any future signage, interpretive panels, benches, communications, and other site amenities would emphasize the positive aspects of the creek, improve its visibility, and potentially reduce abuses of the resource. This image should be developed in conjunction with the interpretive program discussed in the section below. Figure 7A provides an example of typical trail system imagery.

Figure 7A: Example of a trail system's logo/ imagery, Sanctuary Scenic Trail, Monterey, CA. Courtesy Leslie Stone Associates

7.5 SAN FRANCISQUITO CREEK AS AN EDUCATIONAL RESOURCE

Many groups have acknowledged the importance of the creek as a community resource and an opportunity for public education. CRMP recommends several educational and interpretive programs in the "Public Education and Involvement Task Force" chapter of their Draft Watershed Management Plan (CRMP, 1997). To reconnect people to the creek, and to its story, is an integral part of the restoration effort.

An effective interpretive program promotes a sense of discovery among visitors. It provides enough information to stir visitor's interest and encourage them to pursue further research or involvement. It is designed to work in conjunction with companion orientation and regulation signage and is contiguous with the image that has been established for the overall park. An interpretive program for the creek should be developed in conjunction with image identification as discussed in Section 7.6.

Because there are so many topics of interest on which to focus, locating interpretive panels at various sites along the creek within the public access zones is recommended. These panels may be developed in conjunction with a descriptive brochure as part of a self-guided tour. Possible interpretive topics include:

Figure 7B: Example of interpretive panel design, Yosemite Indian Village, Yosemite, CA. Courtesy Leslie Stone Associates

Bird Watching
Endangered Animals
Geomorphology
History of Floods in the Creek
Hydrology
Creek Mammals
Native American History
Native Vegetation
The Creek's Relationship with the Bay
The Early Explorers and Mission System
The Urban Stream
Victorian Era History
The Stanford Family
A Watershed Overview

Interpretive and creek image-building elements provide an excellent opportunity for partnership with local businesses along the creek, for private donations in memorial, and a myriad of public involvement opportunities. There is a prime opportunity to create an interpretive trailhead at El Palo Alto Park that identifies all of the interpretive sites and kicks-off a self-guided tour.   Interpretive elements need not be linked or linear, as creekside pathways do not necessarily have a beginning, middle and end.

Locate interpretation at parks and formal trails and at points of interest where users may have questions. Many existing and proposed pocket parks/overlooks would be excellent sites for interpretation. The Master Plan Maps in Section 4 identify nineteen potential interpretive sites. Table 7E summarizes these proposed sites.

Table 7E: Proposed interpretive panel sites

Station Point	Site Description
80+90	At beginning of SCVWD easement in Palo Alto
95+20	500 feet upstream of Clarke Avenue, East Palo Alto
138+20	At Manhattan Street in East Palo Alto
166+00	At Palo Alto Avenue and Marlowe in Palo Alto
169+30	At Palo Alto Avenue in Palo Alto
177+60	At Chaucer Street and Palo Alto Avenue in Palo Alto
180+80	At Palo Alto Avenue near Hale Street in Palo Alto
198+00	At Palo Alto Avenue near Seneca Street in Palo Alto
203+00	At Palo Alto Avenue near Everett Street in Palo Alto
223+00	At Middlefield Road in Palo Alto
228+40	At Existing Park, Palo Alto Avenue and Webster Street in Palo Alto
236+00	At Existing Park, Palo Alto Avenue near Cowper Street in Palo Alto
259+00	At Palo Alto Avenue near Emerson Street in Palo Alto
270+60	At Pedestrian Bridge in El Palo Alto Park in Menlo Park
292+30	At Creek Drive and University Drive in Menlo Park
306+00	At Creek Drive in Menlo Park
319+40	At Pedestrian Bridge in Menlo Park
345+00	At Existing Trailhead, Oak Creek Apartments in Palo Alto
377+50	At Oak Creek Apartments in Palo Alto

Permanent interpretive site materials used must be unimposing, consistent with the surroundings, low maintenance, and able to withstand effects of seasonal high flows and flooding.

7.6 REFERENCES

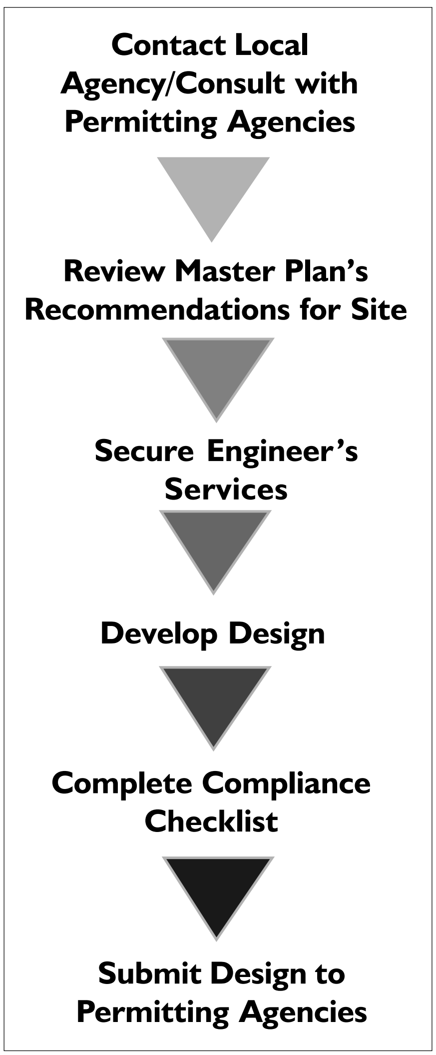
San Francisquito Creek Coordinated Resource Management and Planning (CRMP). 1997. Draft Watershed Management Plan. Palo Alto, CA. January.

SECTION 8: THE CURRENT PERMITTING PROCESS FOR PROJECTS PROPOSED ON SAN FRANCISQUITO CREEK

8.1 THE PROJECT PERMITTING PROCESS FOR THE PRIVATE LANDOWNER

Creeks are important ecological resources regarded as sensitive habitats. Several federal, state and local agencies oversee regulations that protect creeks in the San Francisco Bay Area. The U.S. Army Corps of Engineers, the California Department of Fish and Game, the Regional Water Quality Control Board, the Santa Clara Valley Water District, and San Mateo County Flood Control District are among the agencies requiring permits and other approvals for any project that may affect creek habitat, including bank stabilization.

Figure 8A The project planning process



A landowner must follow several steps to obtain permits or approvals for a project in or near San Francisquito Creek ('project' being defined as buildings, bank stabilization projects, grading, major landscaping, pool, deck, or wall construction and concrete paving). Currently, he or she must contact all appropriate agencies, whether or not the agency ultimately will be involved in the proposed project. Local city planning and/or public works departments can be of assistance in beginning this process and should be contacted as a first step, as illustrated in Figure 8.1. Any landowner planning modifications within fifty feet of the top of bank should also consult the recommendations in this Master Plan report to determine potential upstream and downstream impacts.

8.2 CURRENT PERMITTING AGENCIES AND REQUIREMENTS

City Grading Permits
A permit is required for any excavation or fill that will encroach on or alter a natural drainage channel or water course, up to and including the top of bank. There is a sliding fee schedule depending upon earthwork volume. Landowners should contact the City of Palo Alto, Public Works Engineering at (650) 329-2151, the City of Menlo Park, Building Division at (650) 858-3390, or the City of East Palo Alto, Building Department at (650) 853-3129.

Santa Clara Valley Water District Construction/Encroachment Permit
A permit is required for projects located within 50-feet of top of creek bank in Santa Clara County. No fee is required. Landowners should contact the Santa Clara Valley Water District at (408) 265-2600.

San Mateo County Flood Control District
A permit is required for projects within 15-feet of the top of creek bank in San Mateo County. Landowners should contact the San Mateo

County Flood Control District at (650) 363-4100 to determine permit requirements.

U.S. Army Corp of Engineers (ACOE)

The ACOE may authorize bank stabilization projects that meet certain conditions under a Nationwide Permit, a relatively simple and streamlined permitting process for specific activities. Penalties for unauthorized fill of wetlands or creeks are significant. Nationwide Permit #13 authorizes projects that meet all of the following criteria:

- Are less than 500-feet in length;
- Result in less than one cubic yard of material per linear foot placed below the high water mark;
- Result in the minimum amount of fill required to achieve bank stabilization goals;
- Do not jeopardize the continuing ability of an endangered species to inhabit the creek.

Applicants should contact the South Section Chief of the Regulatory Branch at (415) 977-3324 to ensure that the proposed project meets Nationwide Permit requirements. Projects that do not meet the four criteria above may still be permittable but are required to go through a more lengthy permit review process.

U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS)

These two federal agencies comment on ACOE permit applications where the proposed project may affect an endangered species that uses the creek as habitat. For example, bank stabilization projects that change the flow or water quality of a creek could adversely affect the steelhead trout and, possibly, the red-legged frog. While bank stabilization at a single property would not likely affect these species, the combined impact of many similar projects within a relatively concentrated area of the creek could be significant. If several similar projects are proposed, FWS and ACOE will require that the combined impact on endangered species be assessed as if they were a single project. Only after the ACOE determines that impacts to endangered species are adequately avoided or mitigated will the use of a Nationwide Permit be approved. The FWS Endangered Species Office may be reached at (916) 979-2710.

California Department of Fish and Game (CDFG)

The CDFG regulates projects along creeks that could diminish the value of habitat for fish and wildlife. The CDFG uses Streambed Alteration Agreements (SAA) to ensure that impacts to habitat values are mitigated by revegetation after the work is completed. An SAA may also require that the work be timed to avoid impacts. The SAA is a permit by which the applicant agrees to certain conditions for any project affecting the creek bed or bank. Typically, the CDFG asserts its authority over riparian vegetation or the projected limit of the 100-year flood elevation, whichever is greater. Therefore, bank stabilization that necessitates the removal of trees at the top of the bank, well above the ordinary water line, may still require an SAA. The CDFG may be contacted at (707) 944-5520 for more information and an application.

Regional Water Quality Control Board (RWQCB)
The RWQCB regulates the discharge of any material into creeks and other water bodies that could diminish water quality. Bank stabilization often requires working in the channel and can result in sediments and other materials entering the water and affecting water quality. The RWQCB issues certifications of compliance with water quality standards to applicants for ACOE permits. The RWQCB can be contacted at (510) 286-1255 for a Waiver of Water Quality Certification.

Landowners are encouraged to cooperate with each other to develop plans for stabilization of their properties. By working together, groups of landowners can share the costs of planning, engineering, and environmental consultants. Local city planning or engineering departments should be contacted for assistance.

8.3 SPECIAL CONSIDERATIONS FOR PALO ALTO LANDOWNERS

For property owners in the City of Palo Alto, the responsibility for creek bank restoration and/or revegetation may fall into either case below:

Case 1: Santa Clara Valley Water District (District) has ownership or easements rights on the creek.
If creek bank repair/restoration is required to maintain the channel capacity and stabilize the bank, the District may perform and pay for the work (subject to funding and existing workload constraints). The landowner may undertake a privately funded project, subject to obtaining a District Construction/Encroachment Permit and other regulatory approvals.

Case 2: Creek bank is privately owned.
The landowner may undertake a privately funded project, subject to obtaining a District Construction/Encroachment Permit and other regulatory approvals. After repairing the creek bank to the satisfaction of the District, the owner may offer the District easement rights to the creek bank. Acceptance of the easement is at the District's discretion.

8.4 PROPOSED PERMITTING SCENARIO

Section 9 of this report will discuss a proposed mitigation/conservation banking method of project implementation that is currently in development.

SECTION 9 – PROGRAMMATIC PERMITTING/ CONSERVATION BANKING

9.1 BACKGROUND

The Master Plan describes the revegetation and stabilization of San Francisquito Creek in adequate detail for facilitating obtaining permits for individual landowners in accordance with the scenarios described in Section 8. It provides a range of design criteria and considerations for direct incorporation into permit application and CEQA documents. For many, perhaps the majority of projects, stabilization will take place in a severely degraded situation, where, for example, a bank has collapsed to bare ground. The project then becomes self-mitigating, by eliminating a source of excess sediment and encouraging some kinds of riparian vegetation. In these instances, the permit process can be relatively straightforward, although time consuming and expensive.

The Master Plan can also function to coordinate public and private actions, so that public or private entities carrying out stabilization would be linked with projects where the goal was to remove non-native vegetation and restore native habitat. When projects which are purely enhancement are linked to projects which are mainly directed towards stabilization, the benefits of a watershed-wide approach are clear. One of these benefits is the possibility and applicability of a larger permit strategy, one which would streamline the process and relieve the permit burden from individuals.

9.2 PROGRAMMATIC PERMITTING FOR THE SAN FRANCISQUITO CREEK MASTER PLAN

As the recommendations of this Master Plan are implemented, an applicant for a wetlands permit (which includes work on San Francisquito Creek) is required to "avoid" destruction of wetlands to the extent possible. In addition, an applicant must "minimize" any wetland impacts. Finally, if wetland losses are unavoidable, an applicant must "mitigate" for the wetland losses. Of these three requirements, the first two are integrated into the recommended stabilization designs.

Suitable mitigation, which ensures no net loss of wetland function, must be part of the overall program. Mitigation which is planned in a way as to guarantee a net *benefit* to the creek can produce an implementation *program* for the project area as a whole. It would be accepted by the Corps, the Department of Fish and Game, and the Regional Water Quality Control Board as a stream enhancement project, with a much shorter permitting timeline. Specifically, this may result in the program being authorized as a Nationwide Permit 27 (Wetland and Riparian Restoration and Creation Activities), or by the more flexible Regional General Permit (RGP) as opposed to Nationwide Permit 13 (Bank

Stabilization).[1] The benefits to the watershed are self-evident. The benefits to individual landowners would be relief from both CEQA compliance and permit application.

The Master Plan provides guidance and direction for future action, but since no individual project is proposed, net benefits cannot be calculated. There is, however, a process by which a quantity of mitigation can be identified in advance, then incrementally assigned to projects as they occur. The process is called "mitigation banking."

9.3 MITIGATION BANKING

Since the mid-1980s both federal and state wetland regulators have actively sought to prevent the inadequate, fragmented habitat conservation that often results from project-specific mitigation by allowing project proponents to secure mitigation "credit" in advance of a specific project. Mitigation land is set aside and committed in perpetuity. For example, the 20,000 linear feet of San Francisquito creekside in public ownership could be the mitigation "bank." An agreement is reached (e.g., through a Memorandum of Understanding) that the enhancement and permanent protection of the conservation land will account for a specified amount of impact. Since stabilization permits assess impacts in terms of linear feet, the bank credits would likely be similarly calibrated. For example, the implementation of a project which installed gabions along 100 feet of bank would be considered no-net loss if it was assigned an equivalent amount of enhancement credits from the mitigation bank. If it acquired significantly more credits (e.g. 150 feet), it would be considered a stream enhancement. The costs of enhancement would be allocated through a fee structure, but any fees would be less costly to individuals than paying for project specific permitting and CEQA compliance.

Mitigation banking offers clear advantages. Compared to traditional mitigation, mitigation banks are easier for resource agencies to monitor, and mitigation banks bring greater expertise and long-term financial and commitment to mitigation efforts. In addition, the opportunity to offset project impacts through a locally sponsored mitigation bank provides strong incentives to implement the bank stabilization and revegetation treatment recommendations of the Master Plan. Lastly, it provides a vehicle for resolving all of the endangered species issues at one time, making the compliance process simpler even for those projects which would be self-mitigating.

[1] The structure and content of the nationwide permit system is currently under review, and these generic permit types are being revised by the Corps during 2000.

To qualify for approval under an RGP, the mitigation bank sponsor will need to identify specific areas to "capitalize" the bank. In addition, the total linear feet of implemented projects would need to be projected for a five to ten year period. Each year, the program administer would record the linear feet of all stabilized streambanks which are considered riparian impacts (some projects would be deemed self-mitigating), and report on the associated linear feet for which improvement funds have been collected and projects carried out. It is possible that the amount of available bank credits would be insufficient to meet the demands. At this point, landowners would need to negotiate their own mitigation with the Corps and the CDFG, or the program could shift to a type of ecosystem improvement unrelated to land: control of invasive species, such as mitten crabs, for example.

If a Memorandum of Understanding based on the Master Plan would thus coordinate public and private actions, so that public or private entities carrying out stabilization are linked with projects where the goal was to improve stream function, the result would be a program with its own internal stewardship accountability. It would thus facilitate permitting while engaging the support of the active conservation community.

APPENDIX A: GLOSSARY OF TERMS

Anthropogenic Changes related to human actions;

Bank Stabilization Securing of a stream bank by use of vegetation, vegetation materials, or some man-made structure;

Bar An alluvial ridge-like deposit of sand, gravel, or other material at any point in the stream, where a decreases in velocity induces deposition;

Berm A raised bank of soil constructed to contain water;

Biotechnical Combining structural, biological, and ecological concepts to construct living structures for erosion, sediment, and flood control;

Canopy The overhead branches and leave of stream-side vegetation;

Conveyance Flow capacity of a watercourse dependent on cross-sectional characteristics including friction created by bankside vegetation;

Container Receptacle used by nurseries to grow plant material used in revegetation projects;

Cover Structure Any structure designed to provide aquatic species from predators or ameliorate adverse conditions of streamflow and/or seasonal changes in metabolic costs to aquatic species; often installed at the toe of a bank;

Cross-Sectional Geometry The 2-dimensional shape of the channel considered perpendicular to flow;

Cutting A plant section originating from stem, leaf, or root and capable of developing into a new plant;

Design Flow Event/Flow Event The given flow for which an engineering project (e.g., bank stabilization) is designed to withstand. A design flow is generally referred to in terms of the long-term frequency of recurrence, in years, e.g., the "25-year design flow;"

Discharge Volume of water flowing for a given unit of time, usually expressed as cubic feet per second (cfs);

Erosion The wearing away of soil and rock by weathering, mass wasting, and the action of streams, glaciers, waves, wind and underground water;

Filter Layer The layer of fabric, sand, gravel, and/or graded rock placed between a bank revetment and soil for the purpose of prevent the soil erosion through the bank revetment while allowing natural subsurface seepage through the bank;

Fluvial Produced by moving water in a river, creek, or stream;

Gabion A stone-filled box or tube formed from galvanized wire mesh panels or rolls having great flexibility and strength;

Geomorphology The geologic study of the evolution and configuration of landforms;

Geotechnical Involving the scientific and engineering principles of soil and rock mechanics;

Geotextiles Durable high tensile strength synthetic construction fabrics used for separation, filtration, drainage, reinforcement and erosion control of soils and crushed aggregates; biodegradable fabrics are make from natural fibers such as coir, jute, flax, remie, etc. and are used primarily for erosion control, also as soil reinforcement in conjunction with brush layering (live gabions) or short-term subsurface filters or as separators holding back soil behind geogrids in steep slopes pending establishment of vegetation;

Ground Pressure The amount of physical force that a piece of heavy machinery imposes on the earth; to avoid soil compaction, typically machinery should be used that exerts low ground pressure;

Herbicide A chemical agent used to destroy or inhibit plant growth;

Humus Decayed organic matter that lies beneath the litter layer and above the mineral soil;

Hydraulic Refers to water, or other liquid(s), in motion and its action;

Invasive Species Non-native species that spread rapidly, displacing native and/or desired agricultural species;

Keyed A structure is said to be "keyed into" a bank if the upstream, downstream, and/or toe of the structure is embedded and secured within the bank material. If a structure is keyed in, the risk of scour along the edges of the structure is significantly reduced;

Left Bank The stream bank to the left as one is facing downstream;

Meander Bend One of a series of sinuous curves in the course of a stream, produced as the stream shifts its course laterally toward the convex side of an original curve;

Non-Native Species Species introduced and occurring in locations beyond their known historical and natural range;

Noxious A particularly invasive, non-native species that effectively outcompetes native plants;

Perlite A soil amendment of volcanic origin; also used as a desiccant;

Planform Channel Pattern The two-dimensional pattern of the channel as it appears from the air;

Propagule A plant structure (as a cutting or a seed) used to propagate plants;

Radicle Belonging to or proceeding from a root; the embryonic root of a seedling;

Revegetation The planting of vegetation following either manual removal of existing vegetation or gradual dying off of once-present vegetation;

Rhizome Underground stem, usually lateral, sending out shoots above ground and roots below;

Right Bank The stream bank to the right as one is facing downsteam;

Riprap A layer of rock placed along a surface to prevent erosion, scour, or sloughing of a structure or surface;

Root Protector Structure usually fabricated from metal wire and fitted in planting hole; used to protect plant roots from damage from small mammals including voles and gophers;

Scour The localized removal of material from the stream bed by flowing water;

Seed Set Time when seed matures and becomes viable, usually occurring on the parent plant;

Shear Stress Force per area acting over a wetted surface inducing by flow in a watercourse;

Soil Compaction An increase in soil density generally resulting from human activity such as use of heavy equipment over soils;

Stage The elevation of a water surface above or below an established datum or reference;

Terrace A relatively level bench or step-like surface that breaks the continuity of a slope. Ledge or step formed in banks by natural processes or artifically created, usually wider than 5 ft;

Thalweg The line connecting the lowest points along a stream bed in the direction of flow;

Toe Base of bank or wall;

Wing Deflector A linear structure designed to deflect streamflow to a different location, usually away from an eroding bank. When wing deflectors extend from each bank toward the thalweg, the structures act to focus and deepen the low flow channel;

APPENDIX B: ADDITIONAL REFERENCE MATERIALS

The following books and Internet websites are intended to provide additional information on several topics related to the Master Plan Report. The authors of this Master Plan have provided these references as sources for additional information; however, the authors do not necessarily endorse all of the information contained within these materials.

GENERAL SAN FRANCISQUITO CREEK WATERSHED MANAGEMENT ISSUES

San Francisquito Creek Coordinated Resource Management and Planning (CRMP). 1997. Draft Watershed Management Plan. Palo Alto, CA.   January.

BANK STABILIZATION AND REVEGETATION TECHNIQUES

Firehock, K. and Doherty, J., 1995. A Citizen's Steambank Restoration Handbook, Save Our Streams Program, the Izaak Walton League of America, Inc., January.

Gray, D. and Leiser, A., 1982. Biotechnical Slope Protection and Erosion Control, Van Nostrand Reinhold Company.

Johnson, A.W. and J.M. Stypula. Eds., 1993. Guidelines for Bank Stabilization Projects in the Riverine Environments of King County. King County Department of Public Works, Surface Water Management Division, Seattle, WA.

Natural Resource Conservation Service (NRCS), 1998. Stream Corridor Restoration: Principles, Processes, and Practices.

Riley, A., 1998. Restoring Streams in Cities: A Guide for Planners, Policymakers, and Citizens, Island Press, 423 p.

Scheichtl, H.M., 1980. Bioengineering for land reclamation and conservation, University of Alberta Press, 404 p.

Scheichtl, H.M. and Stern, R., 1994. Water Bioengineering Techniques for Watercourse Bank and Shoreline Protection, Blackwell Science, Ltd., 186 p.

WEED ERADICATION AND NON-NATIVE SPECIES

California Exotic Pest Plant Council. 2000. http://www.caleppc.org (May 3, 2000).

The Nature Conservancy. 2000. Wildland Invasive Species Program. http://www.tncweeds.ucdavis.edu (May 3, 2000).

UC IPM Online. 2000. http://www.ipm.ucdavis.edu (May 3, 2000).

Whitson, Tom D., ed. 1996. Weeds of the West. University of Wyoming, Jackson, Wyoming.

NATIVE SPECIES AND REVEGETATION

Emery, Dara E. 1988. Seed Propagation of Native California Plants. Santa Barbara Botanic Garden, Santa Barbara, California.

Harvey & Stanley Associates, Inc. 1983. Revegetation Manual for the Alameda County Flood Control and Water Conservation District Revegetation Program. Prepared for the County of Alameda Public Works Agency.

Hickman, James C., ed. 1993. The Jepson Manual: Higher Plants of California. University of California Press, Berkeley.

Schmidt, Marjorie G. 1980. Growing California Native Plants. University of California Press, Berkeley and Los Angeles.

Sunset Editors. 1995. Western Garden Book. Lane Publishing Co., Menlo Park, California.

Young, James A. and Cheryl G. Young. 1992. Seeds of Woody Plants in North America. Dioscorides Press, Portland, Oregon.

PROJECT PERMITTING

Guide to Creek Project Permitting on San Francisquito Creek and its Tributaries. This pamphlet outlines the various permitting agencies and the roles they play in protection of this sensitive habitat. You can obtain a copy by contacting the San Francisquito Creek Watershed Coordinated Resource Management and Planning Group (CRMP) at

(650) 962-9876.

Guide to Creek and Wetland Project Permitting. A document containing information similar to the CRMP pamphlet noted above. Call the County of San Mateo at (650) 991-8246 to receive a copy.

How to Get a Permit for Working around Water Courses/Stream Care Guide for Santa Clara County. Contact Santa Clara Valley Water District at (408) 265-2600 or the City of Palo Alto, Public Works Department at (650) 329-2151.

Streamside Planting Guide for San Mateo and Santa Clara County Streams. Contact the San Francisquito Creek CRMP Group at (650) 962-9876.

ACCESS AND INTERPRETATION

Trapp, S., M. Gross, & R. Zimmerman. (1994). Signs, Trails, and Wayside Exhibits – Connecting People and Places. UW-SP Foundation Press, University of Wisconsin, Stevens Point, WI. p

APPENDIX C:
THE COMPLIANCE EVALUATION CHECKLIST

The following lists factors to consider when evaluating the application of treatment alternatives. This checklist is to be completed by the permittee or their engineer, and submitted with permit applications.

The treatment alternatives are as follows: No Action, Vegetation Only, Repair Protection, Vegetate Structure, Remove Structure, Regrade and Replant, Terrace, Riprap Toe, Vegetated Riprap, Vegetated Wall.

APPLICABILITY
(All Treatments)

• Is this alternative listed as a treatment alternative for this property in the Master Plan maps? If not, is the rationale for its application justified, given changed existing conditions since the preparation of the Master Plan?

Explanation: The proposed treatment should be consistent with the Master Plan.

REGRADING
(Regrade and Replant, Terrace, Riprap Toe, Vegetated Riprap, Vegetated Wall)

• Is the design slope appropriate to the treatment?

Explanation: Treatments should be applied according to the table below:

Design Slope		Appropriate Treatment
(H:V)	Degrees	
= 3.0H:1.0V	= 18	Regrade and Replant, Terrace
3.0H:1.0V < x = 1.5H:1.0V	18 < x = 34	Riprap at Toe or Vegetated Riprap
> 1.5H:1.0V	> 34	Vegetated Wall

If treatments are applied at higher than recommended slopes, they will be prone to failure. For example, rocks places on slopes steeper than 1.5H:1V typically are not effective, because rocks placed at high slopes tend to shift and tumble into the stream during high flows. If a more intensive treatment is applied to a slope less than recommended, then revegetation opportunities will not be realized.

- Has a geotechnical engineer evaluated the local soil characteristics and/or design stability?

Explanation: A geotechnical engineer will provide additional information for the design, such as soil properties and likely failure planes. Based on geotechnical information, a bank stabilization design may need to be adjusted.

POSITION OF TOE OF BANK

(Repair Protection, Regrade and Replant, Terrace, Riprap Toe, Vegetated Riprap, Vegetated Wall)

- Is the toe of the altered bank at the same position (or set back farther from the thalweg)?

Explanation: Regrading and the addition of materials should not extend the toe of the bank into flow, since that could alter streamflow patterns and exacerbate erosion elsewhere along the channel.

TERRACE DESIGN

(Terrace Treatment)

- Has the basis/calculation for sizing (width, elevation) of the terrace(s) been stated/shown?

Explanation: The lowermost terraces should be sized to contain the 1.5- to 2.0-year flow. Additional terraces can be designed to hold any design flow event, at the discretion of the design team. Another logical terrace elevation would be at the stage of the 10-year flood, for example. Terrace widths (dimension perpendicular to channel) should generally be at least 10 feet wide to accommodate shrubs and 15 feet wide for trees.

ROCK PLACEMENT AND SIZING

(Riprap Toe, Vegetated Riprap)

- In steep areas (slopes ~1.5H:1V), will rocks be placed, rather than dumped?

Explanation: Rocks that are placed carefully by hand or machinery are more stable than dumped rock. Slopes of 1.5H:1V are possible only if rock is placed meticulously for three-point contact between rocks.

• Has the rationale for rock size been explained with supporting calculations?

Explanation: Rock should be sized to remain stable at a design flow. Neither Santa Clara nor San Mateo currently have guidelines for a design flow event for rock sizing. However, a minimum design flow assumption of at least a 25-year flood should be used. A higher design flow event should be adopted in the event of significant costs or hazards associated with project failure. Design for a higher flow rate, less-frequent flood event, such as a 100-year peak flow, will significantly reduce the likelihood of structural failure over the lifetime of the project. Santa Clara Valley Water District can provide can provide hydraulic data (from FEMA) to estimate flow velocities through a given reach.

• Has the basis for the upper limit of the rock been stated?

Explanation: Rock should extend up to (and preferably at least 1 foot above) the elevation of the design flow event. We recommend that, at minimum, a 25-year design flow be used as a guideline. Hydraulic information for the 25-year design flow is available through SCVWD.

• Has a filter layer been incorporated into the design?

Explanation: A filter layer is a blanketing layer that acts to prevent erosion of finer soil particles from the bank through the interstices of the overlying riprap. A filter layer can consist of smaller sized, graded rock material or a geotextile fabric.

KEYING IN THE STRUCTURE
(Riprap Toe, Vegetated Riprap, Vegetated Wall)

• Has the bottom of the structure been "keyed into" the channel bed? Have scour calculations been provided that support the depth to which the structure extends below the thalweg?

Explanation: Structural elements must extend to some design depth below the streambed. This prevents undermining of the structure from scour. Scour calculations can be done based upon existing hydraulic information available through SCVWD. We recommend that, at minimum, a 25-year design flow be used as the basis for scour calculations.

• Have the upstream and downstream ends of the structure been "keyed into" the channel banks?

Explanation: Structural elements must extend to some design depth below the streambed. This prevents localized scour alongside the structure. Scour calculations can be done based upon existing hydraulic information available through SCVWD. We recomment that, at minimum, a 25-year design flow event be used as the basis for scour calculations.

GEOMORPHIC

(Repair Protection, Regrade and Replant, Terrace, Riprap Toe, Vegetated Riprap, Vegetated Wall)

- Has the cause of erosion been identified?

Explanation: The Master Plan is conceptually designed so that recommended treatments are appropriate to currently active geomorphic processes. The design consultant(s), however, should reexplore the active geomorphic processes to fine-tune the design. Understanding the local cause for erosion, and predicting future geomorphic processes, can help inform the design and minimize later maintenance requirements.

Despite the emphasis on existing conditions in this Master Plan, it will be important for future stakeholders to consider then-current fluvial processes as projects are proposed on an individual basis. It is therefore recommended that, in addition to other scientific personnel, a geomorphologist participate in the design of all bank stabilization projects. This will help ensure that local fluvial processes are properly considered for a bank stabilization design. To design a site-specific bank stabilization and revegetation technique, the following items be addressed: planform channel pattern, upstream and downstream conditions, conditions on the opposite bank, erosion at the edges of hard structures, bed conditions, and any major hydrologic changes in the watershed since release of the Master Plan.

- What is the likely potential of the design to exacerbate erosion upstream, downstream, or on the opposite bank?

Explanation: Changes to the shape of and materials after implementation of a bank stabilization/revegetation project may alter local flow direction and hydraulics. As a result, a design may affect erosion risks in nearby areas. A design should reduce erosion risks at a location without transferring risks upstream, downstream, or to the opposite bank.

CONSTRUCTION/IMPLEMENTATION CONSIDERATIONS

(Vegetation Only, Repair Protection, Vegetated Structure, Remove Structure, Regrade and Replant, Terrace, Riprap Toe, Vegetated Riprap, Vegetated Wall)

- Has the design considered access for any necessary machinery?

Explanation: Some types of machinery may not be able to access and work within areas necessary for implementation of a bank treatment. Equipment cannot be moved across property if permission has not been granted.

- Has an erosion control plan been submitted with the design?

Explanation: Disturbance to the bank surface during implementation can move soil into the stream and degrade water quality essential to fish and wildlife.

FLOODING

(Vegetation Only, Vegetate Structure, Regrade and Replant, Terrace, Riprap Toe, Vegetated Riprap, Vegetated Wall)

- Given the existing conditions, would the treatment exacerbate flooding upstream?

Explanation: The Master Plan is conceptually designed so that treatments will not exacerbate flooding locally. However, the actual final design of any treatment has the potential to increase flood hazards if this design factor is not explicitly considered. Therefore, each design team should consider the net effect of the proposed design, particularly in those zones of the creek where flooding is already a high risk.

Hydraulic modeling can be used to estimate any local changes in water surface elevations associated with changes in channel geometry and/or roughness. Hydraulic modeling can utilize existing hydraulic models, with changes in appropriate variables to account for changes with the proposed bank treatment. These models (currently in HEC-2 format) are available through FEMA or SCVWD.

CHANNEL IMPROVEMENTS

(Vegetation Only, Repair Protection, Vegetate Structure, Regrade and Replant, Terrace, Riprap Toe, Vegetated Riprap, Vegetated Wall)

- Does the bank stabilization design preserve the low-flow channel?

Explanation: a low-flow channel, in which water continues to move as flows diminish, is essential to providing passage for fish, including the migratory steelhead. Design elements, such as wing deflectors, may be required.

- Does the design avoid creating new barriers to the migration of fish?

Explanation: Steelhead spend a portion of their lives in the ocean, and return to streams, including San Francisquito Creek to spawn. As such, they require free-flowing passage to the bay to be able to complete their life cycle.

- Does the design minimize the removal of riparian vegetation?

Explanation: Riparian vegetation provides valuable shaded cover of the creek channel and helps to keep the water temperature low, which is beneficial to steelhead.

- Is construction limited to the period between April and October?

Explanation: Protection of fish and other aquatic organisms benefits from limiting construction to the period with the lowest flows. This limitation is likely to be a condition of applicable state and federal permits for the purpose of protecting critical habitat for steelhead.

- Does the design incorporate Best Management Practices (BMPs) governing erosion and sedimentation control, de-watering, and exclusion fencing?

Explanation: State and federal permitting agencies require BMPs to ensure that projects will have minimal effects on aquatic organisms and their habitat. Of particular importance is the prevention of sediments from fouling the stream, preventing aquatic organisms from passing through de-watering pump systems, limiting work to the minimum area necessary and preventing special status species from entering the work area during construction.

WEED REMOVAL

(Vegetation Only, Repair Protection, Vegetate Structure, Regrade and Replant, Terrace, Riprap Toe, Vegetated Riprap, Vegetated Wall)

- Does the plan include provisions to off-haul cut vegetation?

- If herbicide application is proposed, does the Environmental Protection Agency (EPA) approve of the herbicide for use in aquatic settings?

- Does the plan address future weed removal efforts including follow-up treatments?

- Does the plan identify native species to be retained?

PLANT SELECTION

(Vegetation Only, Repair Protection, Vegetate Structure, Regrade and Replant, Terrace, Riprap Toe, Vegetated Riprap, Vegetated Wall)

- Are the plants selected contained within Table 5B of the Master Plan?

PLANT PROCUREMENT

(Vegetation Only, Repair Protection, Vegetate Structure, Regrade and Replant, Terrace, Riprap Toe, Vegetated Riprap, Vegetated Wall)

- Does the plant material proposed originate from propagules (seeds and cuttings) collected from the San Francisquito Creek project area or within Santa Clara and San Mateo Counties?

- Are the proposed plants of the correct container size as shown in Table 5D of the Master Plan?

SITE PREPARATION

(Vegetation Only, Repair Protection, Vegetate Structure, Regrade and Replant, Terrace, Riprap Toe, Vegetated Riprap, Vegetated Wall)

- Does the plan include site preparation methods such as soil decompaction and amendments?

PLANT INSTALLATION

(Vegetation Only, Repair Protection, Vegetate Structure, Regrade and Replant, Terrace, Riprap Toe, Vegetated Riprap, Vegetated Wall)

- Are plants spaced according the on-center spacing recommendations given in Table 5E of the Master Plan?

- Has the need for root protectors been assessed for the plants?

- Does the plan include irrigation basins such as those detailed in Figure 5A of the Master Plan?

- Does the plan include utilizing wood chip mulch to control weeds as shown in Figure 5A of the Master Plan?

- If container plants, cuttings, acorns or buckeye seeds are being used, does the plan follow the planting recommendations of Figure 5A of the Master Plan?

- Does the plan include tree shelters if acorns are installed?

- Does the plan include hydroseeding of native grasses?

MAINTENANCE/MONITORING

(Vegetation Only, Repair Protection, Vegetate Structure, Regrade and Replant, Terrace, Riprap Toe, Vegetated Riprap, Vegetated Wall)

- Has a 3-year (or more) monitoring plan been included?

Explanation: A rigorous monitoring program following project implementation is essential. The early identification of any local problems will permit adjustments in the project implementation that will extend the lifespan of the structure and/or plantings. Monitoring and adaptive management is particularly important when applying any innovative biotechnical treatments within a design. Significant maintenance and even re-construction may be needed in the future.

A monitoring plan should include pre-construction ("as-is") surveys and yearly post-construction surveys for at least 3 years. Items to be monitored should include plant survival, performance of bank stabilization structure, cross-sectional geometry, and photographic documentation, at minimum as applicable.

- Does the plan include a 3-year maintenance plan that includes irrigation, non-native, invasive species control, dead plant replacement, and irrigation basin and foliage protector maintenance?

- Does the project include provisions for biological monitoring of endangered species?

Explanation: Permit conditions likely will require specific measures prior to and during construction of individual projects, to be completed by experienced biologists. Biological monitors are essential to ensuring that endangered species are not present in a work site, that adequate protection measures for the creek will be place, and that the terms and conditions of the applicable permits are being met. This will protect the member agencies and the local sponsor of a Regional General Permit to ensure that individual projects comply with the permit.

- Does the design avoid removal of trees with nesting birds?

Explanation: Nesting birds are protected during the breeding season. A qualified biologist should be consulted to identify the potential for nesting birds. Trees with nests may be removed following breeding season. In such cases where removal is postponed, an experienced biologist should be consulted to ensure that young birds have left the nest.

OWNERSHIP OVERVIEW

The following charts illustrate ownership percentages, based on approximate linear footages along the top of both north and south creek banks.

Figure D1: Summary of property ownership adjacent to San Francisquito Creek

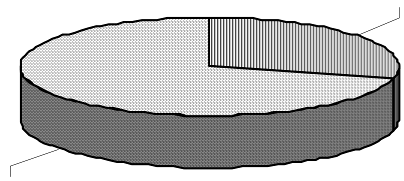


Figure D2: Summary of publicly owned land adjacent to San Francisquito Creek. Source: Assessor's parcel maps, Santa Clara and San Mateo counties.

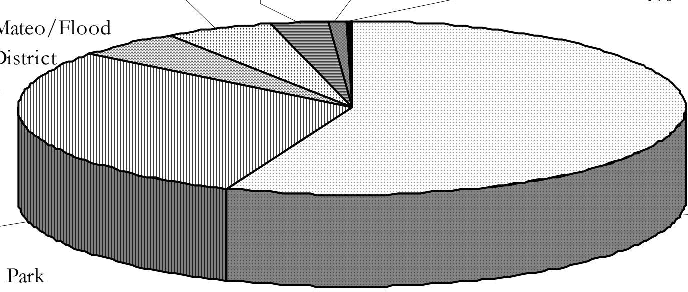
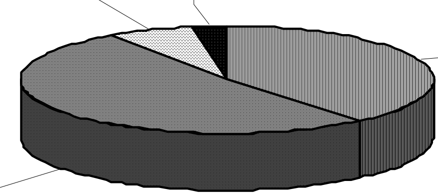


Figure D3: Summary of privately owned land adjacent to San Francisquito Creek. Source: Assessor's parcel maps, Santa Clara and San Mateo Counties



QUANTITATIVE SUMMARY OF STABILIZATION AND REVEGETATION RECOMMENDATIONS

The following figures summarize total linear feet for categories of specific alternatives. This data is further delineated by publicly and privately owned lands. Please note, treatments are not exclusive to an individual category. For example, a treatment may fall into the category of "revegetation only" and also "lower-impact stabilization solutions involving revegetation"

Linear feet of structural bank protection (Alternatives C, I, and J):

Public	5,803	Private	11,765

Linear feet of creek bank on which no action *only* is proposed (Alternative A):

Public	3,325	Private	13,375

Linear feet of lower-impact stabilization solutions involving revegetation (Alternatives B, D, E, F, G, or H, with A also an option):

Public	10,030	Private	43,440

MISCELLANEOUS COST INFORMATION

Table D outlines an approximate cost estimate for various revegetation activities. This estimate assumes a 90-foot plantable surface that equates to approximately 484 linear feet per acre along the study reach. Because each site is unique, the cost per acre will vary significantly.

This estimate does not include bank stabilization cost data. Detailed analysis would need to be conducted to develop cost estimates for structural bank stabilization techniques. For a representative channel cross section, costs would include engineering, design, and construction of a given bank stabilization technique along a defined distance. Factors would include mobilization and demobilization of equipment and materials, volumes of excavation and fill, cost of materials, permitting costs related to fill, and access constraints.

Revegetation cost estimate per acre for weed management, revegetation, installation and three years of maintenance

TASKS	MATERIALS	LABOR	TOTAL
1. Mobilization	$1,000	$1,000	$2,000
2. Weed Management			
2a. Year 1 non-natives species removal		$2,700	$2,700
2b. Year 1 herbicide application (3x/year)	$300	$1,080	$1,380
2c. Straw mulch installation	$2,000	$360	$2,360
2d. Year 2 weed management (1/2 level of effort of year 1)	$1,150	$2,070	$3,220
2e. Year 3 weed management (1/2 level of effort of year 2)	$575	$1,035	$1,610
3. Site preparation			
3a. Soil decompaction		$500	$500
3b. Soil amendments		$900	$900
3c. Erosion control			$3500
4. Restoration site installation			
4a. Collect/contract grow restoration plants	$2,250	$2,400	$4,650
4b. Install irrigation system			$15,750
4c. Install 450 irrigation basins		$3,050	$3,050
4d. Install 450 plants		$3,400	$3,400
4e. Install 25 oak tree shelters and 425 I.D. stakes	$750	$300	$1,050
4f. Install woodchip mulch	$450	$1,700	$2,150
4. Site maintenance			
5a. Year 1 site maintenance	$2,000	$18,720	$20,720
5b. Year 2 site maintenance (90% level of effort of year 1)	$1,800	$16,848	$18,648
5c. Year 3 site maintenance (90% level of effort of year 2)	$1,620	$15,163	$16,783
Subtotal	$13,895	$15,163	$81,621
15% Contingency			$12,243
TOTAL			**$93,864**

Cost Estimate Assumptions:

1. Restoration site installation estimates based on 450 plants/acre;
2. Average landscape contractor labor rate = $45.00/hour;
3. Existing water sources are relativelyc lose to restoration sites and easily accessible;
4. Weed management costs onlya pply to the Alternative B treatments;
5. Cost per acre will varyby site depending upon constraints present.