Attachment A

Napa County Flood Control and Water Conservation District

Napa County Stream Maintenance Manual

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Horizon
WATER and ENVIRONMENT

Napa County
Stream Maintenance Manual

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ACRONYMS

BAAQMD	Bay Area Air Quality Management District
BASMAA	Bay Area Stormwater Management Agencies Association
BMP	Best Management Practice
CDFG	California Department of Fish and Game
CDPR	California Department of Pesticide Regulation
CEQA	California Environmental Quality Act
CIP	Capital Improvement Project
CNDDB	California Natural Diversity Database (established by the CDFG)
Corps or USACE	U.S. Army Corps of Engineers
CWA	Clean Water Act
dbh	diameter at breast height
EPA or USEPA	U. S. Environmental Protection Agency
ESA	Endangered Species Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
GIS	Geographic Information System
ISA	International Society of Arboriculture
LWD	Large Woody Debris
MLD	Most Likely Descendent
MOU	Memorandum of Understanding
NAHC	Native American Heritage Commission
NCMAD	Napa County Mosquito Abatement District
NCSPPP	Napa County Stormwater Pollution Prevention Program
NCSWMP	Napa County Storm Water Management Plan
NHPA	National Historic Preservation Act of 1966
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Services, a division of the U.S. Department of Agriculture
OHWM	Ordinary High Water Mark
PCN	Preconstruction Notification Report
RMA	Routine Maintenance Agreement
RWQCB	Regional Water Quality Control Board
SHPO	State Historic Preservation Officer
SMP	Stream Maintenance Program
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load (under Clean Water Act)
USACE	U.S. Army Corps of Engineers
USEPA	U. S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WDR	Waste Discharge Requirement

GLOSSARY OF SIGNIFICANT TERMS

Arboriculture	The art, science, technology and business of tree care. Arboriculture is practiced by arborists. Arborists are trained to promote tree health, discern tree problems and take measures to correct them.
Adaptive management	Learning from experience by adjusting management practices based on the feedback received through monitoring.
Aggradation	To build up a land surface or streambed through the natural deposition of material.
Alluvial fan	A landscape feature that is formed by the accumulation of sediment and organic material deposited by flowing water, and formed at the point where a stream enters a valley or plain or another, larger stream.
Amphibian	A cold-blooded vertebrate that spends some time on land but must breed and develop into an adult in water. Frogs, salamanders, and toads are amphibians.
Anadromous fish	Fish that are born and rear in freshwater, move to the ocean to grow and mature, and return to freshwater to reproduce. Salmon, steelhead, and lamprey eel are examples of anadromous species.
Armoring	Protective coverings or structures (natural or man-made) used to dissipate the erosive energy of water.
Aspect	The horizontal direction to which a slope faces. For example, a slope which falls down to a deep valley on its western side and a shallower one on its eastern side has a *westerly aspect* or is a *west-facing slope*.
Bank failure	Occurs where a significant portion of the sreambank has failed, slumped, eroded into the creek below, or has been removed entirely.
Bank stabilization	The act of preventing erosion or repairing an eroded bank in order to provide a stable streambank.
Bankfull elevation	The upper level of water that occurs approximately every 2 years during a high flow event.
Baseflow	Groundwater discharge to the stream; the flow not accounted for by storm runoff.
Bedform	A feature of a river or other flowing body of water that is formed by the movement of sediment and other material due to the flow of water.

Best Management Practices (BMPs)	A technique or series of techniques, which is the best known practice available to be effective in protecting water quality and stream habitat.
Brackish water	Somewhat salty, especially from being a mixture of fresh and salt water.
Channel	A stream or river bed; generally refers to the physical form where water commonly flows.
Channel reach	See: Stream reach.
Cofferdam	A temporary watertight structure that is pumped dry to enclose an area underwater and allow construction work to be carried out.
Coir logs	Durable biodegradable erosion prevention logs made of fiber from the husk of coconuts.
Culvert	A transverse drain, usually a metal pipe, set beneath the road surface which drains water from the inside of the road to the outside of the road. Culverts are used to drain ditches, springs, and streams across the road alignment.
Detritus	Organic debris formed by the decomposition of plants or animals; fragments of rock that have been worn away.
Dewatering	The temporary diversion of water away from a work site to protect water quality and allow progression of work. Diversion is accomplished with coffer dams, pipes, or other means. Water is removed from the work site only, and not the entire stream or body of water.
Downed tree	Trees and large branches that naturally fall into stream channels. Such debris can promote recruitment of woody in channels to benefit instream habitat. However, downed trees may threaten flood conveyance capacity or channel stability.
Drainage basin	See: Watershed.
Drop inlet	A vertical riser on a culvert inlet, usually of the same diameter as the culvert, and often slotted to allow water to flow into the culvert as streamflow rises around the outside. Drop inlets are often used on stream or ditch relief culverts where sediment or debris would otherwise threaten to plug a traditional horizontal inlet.
Easement	A limited right to make use of a property owned by another, e.g. a right of way across the property.
Ecology	The study of the relationships between living organisms and their interactions with their natural or developed environment.
Emergency	"A sudden, unexpected occurrence, involving a clear and imminent danger, demanding immediate action to prevent or mitigate loss of, or damage to, life, health, property or essential public services. Emergency includes such occurrences as fire,

	flood, earthquake, or other soil or geologic movements, as well as such occurrences as riot, accident, or sabotage." (CEQA 15359).
Emergent plant	A rooted herbaceous plant species that has parts extending above the surface of the water.
Endangered Species	Any species which is in danger of extinction throughout all or a significant portion of its range; an official designation of the California and/or Federal Endangered Species Acts.
Energy dissipator	A device or material (often rocks) used to reduce the energy of flowing water, typically used at and below culvert outlets and other drainage structures to prevent erosion.
Erosion	The wearing away of land surface primarily by wind or water. Erosion occurs naturally as a result of weather or runoff, but can be intensified by clearing, grading, or excavation of the land surface. Erosion usually refers to processes of surface erosion (rain drop erosion, rilling, gullying, and ravelling) and not to mass soil movement (landsliding).
Erosion protection	The act of preventing erosion from occurring or repairing an eroded bank in order to provide a stable streambank that will not require additional maintenance in the foreseeable future
Estuary	The wide lower course of a river where the tide flows in, causing fresh and salt water to mix.
Filamentous algae	Single algae cells that form long threads, or filaments that intertwine to form a mat that resembles wet wool.
Filter fabric (geotextile)	A synthetic fabric manufactured and designed for use in, among others, subsurface and surface drainage applications. Filter fabric is especially useful in maintaining a separation between coarse aggregate and finer native soil particles.
Floodplain	A nearly level alluvial plain that borders a channel and is occasionally inundated by floods (unless artificially protected). The landform is formed by sediment transport and deposition from flows over the streambank and lateral movement of the stream. The '100-year floodplain' represents the area potentially inundated for an unusual but possible flood event with the probability of occurring once every 100 years on the average.
Geographic information system (GIS)	A computer system designed for storing, manipulating, analyzing, and displaying data in a geographic context, usually as maps.
Geomorphology	The study of the physical features of the surface of the earth, including their form, nature, origin, and development. See also Fluvial geomorphology.
Geotextile	See: Filter fabric.
Gravel bars	Accumulations of small rocks deposited by moving water.

Groundwater	The standing body of water beneath the surface of the ground, consisting largely of surface water that has seeped down into the earth.
Hardscape	Inanimate, engineered elements of landscaping, such as rock.
Headwater	The place from which the water in the river or stream originates.
Hydraulic roughness	The amount of frictional resistance water experiences when passing over land and channel features.
Hydro-seeding (hydraulic seeding)	An erosion control technique for applying a slurry of seed, fertilizer and mulch by hydraulically spraying the mixture on the ground surface. Hydro-seeding is typically performed on slopes that are too steep for dry seeding.
Hydrology	The scientific study of the properties, distribution, use, and circulation of the water on Earth and in the atmosphere in all of its forms.
Hydromodification	The "alteration of the hydrologic characteristics of waters, which in turn could cause degradation of water resources (source: EPA).
Invasive species	Species that show a tendency to spread out of control.
Invertebrate	An animal that does not have a backbone, e.g. an insect or worm.
Large woody debris (LWD)	Portions of downed trees, such as large branches and root wads, that collect in the stream and provide channel structure and habitat for aquatic animals.
Limbing	The removal of unwanted branches from a tree.
Loppers	A large type of scissors used for pruning twigs and small branches. They are usually operated with two hands.
Microclimate	A microclimate is the climate of a small, specific place within an area as contrasted with the climate of the entire area. For example, a small sunny area that is sheltered from harsh winds and frost of the surrounding region. Such a microclimate provides a different habitat than its surroundings.
Ordinary High Water Mark (OHWM)	“That line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of the soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding area.” [33 CFR 328.3(e)]
Outfall	The location where discharge from a culvert (drainage pipe) occurs.
Out-migration	The life cycle phase of anadromous salmonid fish, where juveniles move downstream from fresh water to the estuary and then the ocean for their salt water phase.

Propagule	Any of various usually vegetative portions of a plant, such as a bud or other offshoot, that aid in dispersal of the species and from which a new individual may develop.
Pruning	To cut branches away from a plant to manipulate growth.
Rearing	The phase of a life cycle for a salmonid fish, where juveniles emerge from eggs and grow to large enough size to become adults or migrate to the ocean (for anadromous forms).
Reach	See: Stream reach.
Reconnaissance	A preliminary inspection of an area to obtain geographic, hydrographic, or similar data prior to a detailed survey.
Refugia	An isolated place of relative safety from danger and hardship used by aquatic species, such as fish; the only remaining high quality habitat within an area.
Riffle	An area of rocks or a sandbar lying just beneath the surface of the water.
Rip-rap	Large rocks or other suitable material placed on the ground or along streambanks as an armoring device to prevent or reduce erosion.
Riparian	The banks and other lands adjacent to lakes, watercourse, estuaries, and wet areas. Often refers to water-loving vegetation along the water's edge.
Runoff	Rainfall which flows overland across the surface or hillslopes and along roads and trails.
Salmonid	A species of fish that is a member of the salmon and trout family. Also see: Anadromous fish.
Scour	To clear something out by passing water through it; a place that has been scoured, especially by water.
Sediment	Organic or inorganic material that is carried or suspended in water and that settles out to form deposits in the stream system or receiving waters.
Shade tolerance	A plant's abilities to tolerate low light levels.
Silt fence	A constructed barrier used to contain soil eroded from a construction site. The barrier is made from filter fabric stretched between fence posts placed on contour along a slope.
Siltation	Fine-grained sediment, especially of mud or clay particles at the bottom of a river or lake.
Spawning	The phase of adult salmonid fish where redds (nests) are made and eggs are laid in gravels of streams.
Species of Special Concern	A designation used by California (CSC) and federal (FSC) agencies to refer to those species of animals (and sometimes plants) that have declining population levels, limited ranges, and/or continuing threats that have made them vulnerable to

	extinction. They may soon reach the point where they meet criteria for listing as threatened or endangered under the State and/or Federal Endangered Species Acts. No special legal protections are associated with this designation alone.
Stream	A natural waterway that transports water in a perennial, intermittent, or ephemeral circumstance.
Streambank	That portion of the channel bank cross-section that controls the lateral movement of water.
Streambank erosion	A natural process driven by stream bank characteristics (erodibility) and hydraulic/gravitational forces. Many land use activities can affect both of these components and lead to accelerated bank erosion. Acceleration of this natural process leads to a disproportionate sediment supply, stream channel instability, land loss, habitat loss and other adverse effects.
Streambank stabilization	See: Bank stabilization.
Stream channel incision	The deepening of the channel of a stream by erosion.
Stream reach	A continuous portion of a stream between two designated points.
Swale	A depression or low area on a hillslope which rarely carries runoff except during high rainfall events.
Terrace	A low-gradient surface formed by fluvial aggradation or erosion when the stream flowed at a higher elevation in the landscape. The term implies that the surface is rarely inundated by floods in the current climate.
Threatened Species	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range; an official designation under the California and/or Federal Endangered Species Acts.
Toe-of-slope	The base of an embankment; the base of the streambank where it meets the channel bed..
Total Maximum Daily Load (TMDL)	A process under the federal Clean Water Act that provides a tool for implementing State water quality standards and is based on the relationship between pollution sources and instream water quality conditions.
Tree snags	A dead or dying tree that is still standing in place.
Tributary	A stream or river that flows into a larger stream, river, or lake.
Turbidity	Water that is cloudy or muddy usually due to suspended sediment.
Understory	Lower vegetation in a forest; a layer of small trees and bushes below the level of the taller trees.
Watershed	The area or drainage basin contributing water, organic matter, dissolved nutrients and sediments to a stream or lake.

Wetlands	Areas that are inundated by surface water or ground water with a frequency sufficient to support, and under normal circumstances do or would support, a prevalence of vegetative or aquatic life that require saturated or seasonally saturated soil conditions for growth and reproduction (Executive Order 11990, signed 1977, U.S. President Carter).
Winterize	To perform erosion prevention and erosion control work on a work site in preparation for winter rains.

Chapter 1
INTRODUCTION

1.1 District's Mission

The Napa County Flood Control and Water Conservation District (District) was formed in 1951 with the dual goals of providing flood protection and water conservation to Napa County. More specifically, the District's principal objectives are to:

- Provide protection from flood events to life, property, and infrastructure in the District,
- Enhance and construct storm drainage systems and flood control prevention facilities, and
- Assure that Napa County's domestic, municipal, industrial, and agricultural water needs are met.

Over the years since the District's forming, flood protection and water conservation approaches have evolved, particularly with regard to an increased focus on the protection of natural resources within the District's boundaries. Napa County's land use is a mix of rural and urban uses comprising small cities and towns with a significant agricultural presence. Large areas of the County are also undeveloped and natural, and unaltered stream reaches are plentiful in the District. Local streams provide habitat for a range of flora and fauna including certain rare, threatened or endangered species.

In 1996, the District created the Maintenance and Watershed Management Program (96-1) allowing the District to annually approve a budget for watershed maintenance and management activities in the County. To finance annual budgets, the District assesses all County properties in proportion to the direct benefits received from the watershed maintenance and management program. A summary of the annual maintenance workplan, budget, and required funding by assessments is provided in the annual fiscal Project Report.

The District's Maintenance and Watershed Management Program enables the District at its discretion to attempt to reduce the potential for flood damage along the riparian corridors on private and public lands throughout Napa County. The District responds to citizen and government alerts to potential flooding or erosion problems, and conducts annual creek and river surveys to assess and prioritize potential issues that can be addressed through maintenance. Through its periodic surveys the District can also identify illegal dumping activities or non-authorized streambed construction projects. Among other things, the Maintenance and Watershed Management Program funds and supports:

- Maintenance of the District's approximate 13 miles of flood control channels and easements,

- Managing debris and vegetation for flood damage reduction and resource protection throughout the District, particularly within the Napa River and its tributaries, and
- Erosion protection for river and stream banks.

The above three programs are the focus of this Stream Maintenance Manual (Manual). Other District programs include:

- Installation and operation of rainfall and stream stage gages throughout the County,
- Cost share funding for upgrading major storm drain trunk lines owned by local cities and the County,
- District funded "50/50" and "75/25" local Bank Stabilization Cost Share Program, where the District funds and assists local private property owners with bank erosion projects. (these projects are permitted separately from the SMP),
- Participation in federal/state flood protection grant programs,
- Dredge spoil site management as the local sponsor for the Army Corps of Engineers navigational dredging of the Napa River (south of Third Street Bridge to the County line),
- Groundwater monitoring,
- Oversight of adjudicated watersheds,
- Preparation of special studies for flood protection and watershed management,
- Development of standardized and integrated floodplain management regulations, and
- Assistance for the local community with National Pollutant Discharge Elimination System (NPDES) stormwater compliance requirements.

In 1998, Napa County voters approved Measure A which provides local funding for flood protection and watershed improvement projects throughout Napa County. This initiative, which is supporting the award-winning Napa River/Napa Creek Flood Protection Project, also established Napa County's commitment to so-called "Living River" Principles as the basis for all watershed and riparian activities. This Manual demonstrates the District's commitment to sustain the river, its tributaries and all waterways throughout Napa County as natural living watercourses. Maintenance will be performed on an adaptive management approach and be prescriptive rather than routine in nature.

In addition to these roles described above, the District plays a very important role in the County in providing guidance, education, and stewardship for creek issues to private landowners and other agencies operating within the County. While this role is not formally defined in any statute, this role of providing leadership through example is very important to the District. For example, if a private landowner calls the District regarding a fallen tree or other issue. District staff will visit the site, meet with the landowner, and discuss potential treatment approaches. Whereas private landowners may (or may not) be knowledgeable on environmental regulations, best management practices (BMPs), or overall watershed functions; District staff play an important role in educating landowners and watershed stakeholders on undertaking sound stream management practices that consider and avoid potential environmental effects. Similarly, the District plays a similar role with other County agencies if and when issues arise that involve County creeks. For example, the District provides guidance to the County Roads Department regarding the maintenance of roadside drainage issues.

For these reasons and because the District considers itself as "creek stewards" for the County, the District sees this Manual as not only an internal reference manual for District staff, but also an important educational and guidance document for the County at large.

1.2 Maintenance Needs and Manual Purpose

The District has maintenance responsibilities for flood control channels that the District owns in fee title, as well as other channels for which the District has a maintenance agreement or easement. The location and channel ownership types for District maintenance are presented in the maps described in Section 1.3 below. Besides routine and prescriptive channel maintenance, the District also provides discretionary maintenance in other county channels, maintains instream facilities for their proper functioning, and responds to public requests for maintenance activities at other stream and channel locations.

This Manual was developed by the District with the primary purpose of providing clear and consistent guidance to staff administering the stream maintenance program. Drafting this Manual has enabled the District to review existing approaches and streamline and improve maintenance protocols. An equally important objective for this Manual is to provide clearly articulated guidance to avoid and minimize environmental impacts while conducting maintenance. This Manual also describes the program's organizational framework to oversee routine maintenance activities and ensure that maintenance is compliant with the terms and conditions of regulatory permits.

As stated above, the District's approach and perspective toward stream management has expanded over the years to include resource protection and environmental sustainability in addition to just flood control and channel maintenance. The District now sees itself not merely as a flood management bureau, but more broadly as a resource management agency with a duty to integrate environmental benefits (such as habitat protection and enhancement) into stream maintenance activities.

This evolution in stream maintenance approach is consistent with the expansion of local, state, and federal regulations which have increased environmental requirements for maintenance projects. Compliance with federal environmental laws and regulations such as the federal Endangered Species Act (ESA) and Clean Water Act (CWA), and state laws and regulations administered by the California Department of Fish and Game (CDFG) and Regional Water Quality Control Boards (Regional Boards or RWQCBs) has resulted in an increasingly extensive project review and authorization process. This Manual also importantly serves as a program description to support programmatic permits to authorize the District's maintenance activities.

Another purpose of this Manual is to provide other Napa County stakeholders such as individual towns, community groups, or private landowners with a reference manual which they can use to plan their own specific maintenance needs. However, this Manual is intended to provide "coverage" for county maintenance activities only. Private landowners and city-sponsored

projects would require separate permits and regulatory approvals. It is also envisioned that a parallel volume to this Stream Maintenance Manual will be developed by Napa County to describe and guide the maintenance of watershed roads and culverts, as part of Napa County's compliance with the Napa River Sediment Total Maximum Daily Load (TMDL) according to the Clean Water Act. The goal is to have a collaborative approach among local stakeholders to preserve Napa County's riparian and stream resources while protecting life and property from flood damage.

1.3 Program Area and Channel Types

Figure 1-1 presents the stream maintenance program area within Napa County, California. The overall county map of Figure 1-1 is presented in larger-scale sub-county regional maps in Figures 1-2 through Figure 1-5. More specifically, **Figure 1-2** shows the northern portion of the Napa River watershed including survey and maintenance reaches on the Napa River, Sulpher Creek, Conn Creek, Beard Ditch, and Hopper Creek**. Figure 1-3** depicts the Yountville region including survey and maintenance reaches on Beard Ditch, Hopper Creek, Yountville Outfall and Collector, Dry Creek, and the Salvador Collector (Solano Ditch). **Figure 1-4** shows the survey and maintenance reaches in the City of Napa region. This region is the most active stream maintenance area in the County and involves several creeks and waterways as shown in Figure 1-4. **Figure 1-5** depicts the area near the Napa County airport including survey and maintenance reaches on Sheehy and Fagan creeks.

Channel Types

This Manual describes three types of flood control channels and streams that the District where the District may conduct maintenance activities, including: engineered channels and "collectors", modified channels, and natural streams. **Table** 1-1 lists the channel types for the channels that the District directly owns or has maintenance easements for. Engineered flood control channels are typically v-shaped or trapezoidal channels (or ditches where they are small). In some locations, such channels are referred to as "collectors" where they may typically collect runoff from other small local drainages. The District owns and maintains (or provides maintenance on an easement) for approximately 5.3 miles of engineered collector channels. Examples of engineered flood control channels include the Yountville Collector and Solano Ditch. "Collector" channels in Napa County, such as the Yountville Collector or Salvador Collector channels typically collect and convey flows near roads and rail lines that may intersect the original pathway of the creek. Collectors were designed with steepened banks (generally 2:1 or less), little to no riparian corridor vegetation, and currently support poor quality habitat for species such as salmonids. These channels are typically filled with aquatic vegetation, such as cattails. **Figure 1-6** illustrates a typical cross section for engineered channels or collectors.

Modified channels are channels that have been typically widened or straightened to increase channel conveyance capacity, but not necessarily engineered to a specific design flow or specification. Examples of modified channels include the Yountville Outfall and lower reach of Salvador Creek. The District owns and maintains (or provides maintenance on an easement) for

approximately 3.1 miles of modified channels. A typical cross section for a modified creek is shown in **Figure 1-7**. These channel reaches were primarily modified to prevent flooding of adjacent agricultural and residential developments. The banks and overall alignment of the creek channel is wider and straighter than typical natural channel to allow for increased flow conveyance capacity. Modified channels often support a low flow channel nested within the channel bed and some riparian corridor vegetation.

Semi-modified channels maintained by the District are illustrated in **Figure 1-8**. Examples of these channel types are found at Conn Creek and Tulocay Creek. These channels have natural, un-modified stream beds and support a higher percentage of native vegetation to non-native vegetation, and a moderate to mature riparian corridor. The banks of these channels may have been modified to prevent flooding or bank erosion. The District owns and maintains (or provides maintenance on an easement) for approximately 4.5 miles of semi-modified channels.

The District's maintenance of natural channels (as illustrated in **Figure 1-9**) is much more limited than its maintenance activities in modified and engineered channels. Maintenance activities in natural channels are generally limited to vegetation and LWD management, invasive species eradication support, removal of trash, debris, and abandoned structures, and consultations on erosion and bank stabilization. District staff typically does not conduct sediment removal or bank stabilization activities in natural channels.

Channel Ownership Types

The District's maintenance activities are conducted within five different channel ownership-maintenance arrangements that comprise the maintenance program as shown in Figures 1-1 through 1-5. These ownership-maintenance arrangements are described below:

District Owned Channels / Easements Maintained (Red Channels): The District is responsible for maintenance of the 7.3 miles of flood control channels that it owns and has maintenance easements for. Many of these District owned channels are engineered channels, typically built by other agencies and deeded to the District. Although a few were designed and built to convey a specific design discharge (i.e. the 100-year flood event), most have no available specific discharge design. Most of these engineered channels were constructed with a trapezoidal cross-section with earthen banks and streambeds. However, some channels have sections with hardened banks and beds formed in rock or concrete. Bed and bank hardening typically occurs at or near road and culvert crossings to protect these structures. Typical maintenance activities in District owned channels includes vegetation thinning and pruning, grass mowing (maintenance roads), erosion protection and bank stabilization, sediment and debris removal, trash removal, exotic and invasive vegetation removal, and native tree and shrub planting. Structures and facilities such as access roads, drop inlet culverts, outfalls, flap gates, and road crossing culverts constructed in association with the District's flood control channels may also require routine maintenance. Often, intersecting drainage structures, bridges and adjacent roadways or other infrastructure is owned by an entity other than the District. District owned channels are surveyed annually for their maintenance condition. An annual maintenance workplan is developed based on the annual survey to identify and prioritize maintenance activities.

County Owned Channels / Easements Maintained (Green Channels): These channels (4.2 mi) are owned by Napa County (not the District), but the District performs channel maintenance on

them on behalf of the County. Although the District conducts maintenance, it is not obligated to do so, or to maintain any specific level of hydraulic capacity. These channels are generally engineered channels or ditches, but also include some modified streams. County owned and District maintained channels include a portion of lower Salvador Creek, Maher-Trent Ditch, Sandra-Kathleen Ditch, and West Pueblo Ditch (Figure 1-4) and Fagan Creek near the Napa County Airport (Figure 1-5). In general, the level of maintenance and the activities performed on these County owned creeks is very similar to those described above for District owned blue channels. The District surveys these County owned orange channels annually and determines their maintenance needs and priorities in coordination with the County.

Other Public Owned Channels / Easements Maintained (Purple Channels): These channels (1.5 mi) are similar to the above, but owned by other public entities such as towns or cities, school districts and the District provides consultations and offers maintenance support upon request by the public entity owner. Example green channels include a section of lower Salvador Creek, portions of the Salvador Creek Tributary, and a small reach of Camille Creek that are owned by the City of Napa. (Figure 1-4). Maintenance activities, and the survey and maintenance prioritization process described above for District and County owned channels generally also applies to purple channels.

Privately Owned Streams Annually Surveyed for Possible Maintenance (Orange Channels): Most of Napa County's natural streams are owned by private landowners. The District has identified several flood prone reaches of streams (26 mi), generally within urban areas which it surveys regularly to monitor for potential problems. If problems are identified, the property owner is contacted and permission is requested prior to the District conducting any maintenance. Example red channels include portions of the Napa River and Sulpher Creek in northern Napa County (Figure 1-2), Hopper and Dry creeks in the Yountville region (Figure 1-3), and Browns Valley, Redwood creeks, and some portions of Tulocay creek in the City of Napa region (Figure 1-4). Maintenance activities are generally limited to vegetation and LWD management, invasive species eradication support, removal of trash, debris, and abandoned structures, and consultations on erosion and bank stabilization. District staff typically would not conduct sediment removal or bank stabilization activities in these privately owned streams. This is particularly true in non-urban areas. However funding support is available to support such maintenance, if it is warranted, and if the owner obtains all required regulatory permits.

Other Streams – Maintenance upon Request: The remaining creeks in Napa County, shown as a thin blue line in the maps of Figures 1-1 through 1-5 are privately owned creeks where District maintenance activities may take place only following a specific owner request and District staff evaluation of the appropriateness of the request. Maintenance work in these channels may typically involve clearing debris or vegetation management to address a flow obstruction or erosion concern. Similar to surveyed reaches of privately owned streams described above, District staff typically would not conduct sediment removal or bank stabilization activities in these streams; however funding support is available for such if the owner obtains all required regulatory permits.

The District offers its support to both public and private landowners within the District to provide technical assistance for stream-related problems and develop a consistent local strategy for sustaining natural streams. Such District involvement helps to reduce potentially more impacting maintenance approaches by often well-meaning but untrained property owners.

District staff regularly conducts public outreach to educate stream owners about stream care.

1.4 Summary of Maintenance Activities

The stream maintenance program has four primary activities: vegetation management, downed tree management, erosion protection and bank stabilization, and sediment and debris removal. These core maintenance activities occur mainly in District, County, or City owned engineered flood control channels shown as red, green, and purple channels in Figures 1-1 through 1-5, and in a limited manner in other streams.

The four primary maintenance activities are summarized below and described in more detail in Chapters 4 through 7. Other minor and less frequent maintenance activities are described in Chapter 8. Chapter 9 describes the District's habitat protection and enhancement activities conducted as part of the stream maintenance program.

While this Manual focusses on describing maintenance activities, the District also recognizes it is important to identify the underlying causes that that lead to maintenance. To this end, the District is committed to understanding the reasons why maintenance is needed, including tracking the frequency of maintenance, monitoring which activities are conducted where, and identifying whether locations are inherently more prone to certain maintenance activities. Chapter 10 includes a general workplan that the District will undertake to improve its understanding of channel conditions, identify potential underlying causes for maintenance, and develop channel discharge and vegetation objectives.

Vegetation Management

Vegetation management refers to the trimming, pruning, mowing, and removal of flow-constricting vegetation within the flood control channels and other constructed facilities. Vegetation management activities are conducted to maintain flow conveyance capacity, establish a canopy of riparian trees, and control invasive vegetation. Management methods include hand removal, mechanical removal, and herbicide applications. Vegetation management and removal activities are relatively consistent from year to year, though locations change depending on recent growth and blockages. On average, 1,000 linear feet of vegetation is managed each year. Vegetation management also includes the planting of new trees and shrubs along District channels. Vegetation management is performed in a manner to prevent loss of habitat and erosion and does not include clear cutting or wholesale removal of vegetation or use of herbicides to control submerged vegetation.

Downed Tree Management

The District manages trees and large branches that naturally fall into stream channels to maintain channel capacity and minimize flow obstructions in channels. This is one of the most frequently conducted stream maintenance activities by the District and is thus described as a separate chapter from vegetation management. In alignment with the Sediment Total Maximum Daily Load (TMDL) for the Napa River watershed, the District seeks to promote

recruitment of woody debris in channels to benefit instream habitat. The District's preference is to leave downed trees in place and encourage formation of channel features such as scour pools and slack water areas which are used by juvenile salmonids. However, if the tree threatens flood conveyance capacity or channel stability (i.e., stream banks destabilization), the District will modify the downed tree by trimming off branches or cutting it into smaller pieces. If further action is need to ensure flood protection, the tree may be repositioned in the channel, such as moved from perpendicular to parallel to stream flow, or remove the tree entirely. Downed tree management is generally conducted during the dry season, but can occur year-round to prevent flooding or erosion. Downed tree management is conducted using hand-held tools and heavy equipment on occasion.

Erosion Protection/Bank Stabilization

The repair and stabilization of stream banks is undertaken when a bank is weakened, unstable, or failing. If left untreated, eroding or failing streambanks can cause damage to adjacent properties; increase the flood hazard and threaten public safety; threaten and impair roads, transportation, and access; generate erosion and increase downstream sediment yields; and impacts riparian habitat and other natural resources. The District repairs and stabilizes eroding or failing streambanks to address these issues and prevent further degradation of stream conditions. Up to five bank stabilization projects are conducted annually, with each project covering approximately 25 to 50 linear feet of stream bank. Bank stabilization activities are generally conducted between June 15th and October 31st when streams are at their driest. When possible, bank stabilization is conducted in a preventative manner by planting exposed banks with appropriate native species. If a more engineered approach is needed biotechnical approaches are preferred. Limited prescriptive biotechnical designs are included in this manual. More involved projects are subject to individual project permits.

Sediment and Debris Removal

Deposited and accumulated excess sediment in District maintained channels can reduce flow capacity and thereby increase the potential for flooding. Sediment removal activities are focused to target channels whose conveyance capacity is significantly limited due to accumulated sediment and debris. Besides improving flow conveyance for flood management, sediment removal activities may provide other beneficial outcomes including improved fish passage, improved circulation and water quality, enhanced geomorphic functions, and improved aquatic habitat. Sediment and debris removal activities are generally conducted from June 15th to October 31st when streams are typically at their driest. The number of sediment removal projects undertaken annually and the quantity of sediment removed in a given year depend on recent weather and hydrologic conditions, as well as the frequency and extent of past maintenance activities.

The District typically implements small scale localized sediment removal activities in channel segments roughly 100-200 ft long. On average 100 to 500 cubic yards of sediment is removed from two to five sites per year. Most commonly, the District needs to alleviate a specific flow concern at an individual crossing, culvert, or other in-channel facility that experiences moderate sediment accumulation. In general the District does not undertake large (over 500 linear feet) reach-scale sediment removal projects. Because reach-scale projects are infrequent, they are not considered routine maintenance and are not covered under the programmatic permits for the maintenance program. Removed sediment and debris is taken to appropriate disposal sites

based on the quality and conditions of the collected sediment and debris. Chapter 7 describes the program's disposal activities.

Activities Compared by Channel Type

Figure 1-10 summarizes the array of maintenance activities according to channel type. Figure 1-10 includes photographs of relevant District creek examples and a summary of the key maintenance issues with the different channel types. The degree and intensity of maintenance is least for natural channels and semi-modified channels and more involved for modified channels and collector channels.

Activities Not Covered

Activities not covered under the District's routine stream maintenance program include:

- Capital improvement projects (CIPs),
- Large sediment removal or dredging projects involving more than 500 linear feet of sediment removal,
- Redesign or reshaping of channels,
- Maintenance of restoration projects outside of flood control channels for which maintenance and monitoring is performed per project-specific permits,
- Maintenance of the USACE Napa River/Napa Creek Flood Protection Project, and
- Emergency activities and procedures.

Routine stream maintenance does not include projects that would alter the designed flood conveyance capacity of a channel. Large construction projects and CIPs are not considered routine stream maintenance and are not included in this Manual. However, future CIPs will consider using, or adapting the protocols in this Manual once their project becomes operational and requires maintenance. This manual and its associated permits do not cover large reach-scale sediment removal projects greater than 500 ft in length. The maintenance of restoration projects outside of flood control channels (e.g. Rutherford Reach Restoration Project, Oakville to Oak Knoll Restoration Project) will have their own specific maintenance requirements. Minor vegetation management work, including Arundo removal at the Oakville-Oak Knoll project will be covered under the Stream Maintenance Program during the interim period while the project permits are finalized. Similarly, the landmark Lower Napa River Flood Control Project and the Lower Napa Creek Flood Control Project have their own specific maintenance requirements and guidance. These projects represent a strong partnership between the District, City of Napa, and the U.S. Army Corps of Engineers (USACE).

A situation is considered an "emergency" if it is a sudden, unexpected occurrence involving a clear and imminent danger that demands immediate action to prevent or mitigate loss of or damage to life, health, property, or essential public services (Public Resource Code Section 21060.3). Although emergency situations will not be covered by the permits authorizing the routine maintenance activities of this Manual, the District will make every effort to follow the guidance provided in this Manual when implementing activities under emergency conditions.

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Table 1-1. List of Maintenance Channel Reaches and Channel Type

District Easements	Engineered	Modified	Semi-Natural	Natural
Conn Reach 1-3		X		
Beard	X			
Yountville Collector	X			
Yountville Oufall Reach 1	X			
Yountville Outfall Reach 2		X		
Solano Ditch	X			
Salvador Collector	X			
Salvador Creek Reach 1-2		X		
Salvador Creek Reach 3				X
Tulocay Creek Reach 1			X	
Tulocay Creek Reach 2		X		
Camille Creek				X
Sheehy Creek		X		
Fagan Creek	X			
Other Creeks Surveyed Annually				
Browns Valley Creek				X
Redwood Creek				X
Milliken Creek				X
Sarco Creek				X
Dry Creek				X
Sulphur Creek				X
York Creek				X
Napa River In Calistoga				X
Murphy Creek				X

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1.5 Impact Avoidance and Minimization

The District's maintenance approach requires clearly understanding the maintenance need at a site and identifying the specific location, extent, and suite of maintenance activities to be implemented. The District's approach is also built on having a comprehensive understanding of the stream system's functioning, its site-specific process, and the natural and aquatic resources at the maintenance reach.

Chapter 2 of this Manual provides a description of the program area's geomorphic and biological setting. More precisely, Chapter 2 provides reach characterizations ("reach sheets") that describe the District's channels for their geomorphic, hydrologic, habitat, and species conditions. Each reach is considered within its sub-basin and watershed context. The reach sheets also summarize the key maintenance considerations at each reach and what may be environmental enhancement opportunities. Defining this baseline of what physical processes operate and what biological resources are found at a given reach is fundamental to the District's adaptive management approach. Understanding these resources, their locations and how they interact guides the District on how to avoid, minimize, and mitigate environmental impacts. Understanding these resources also influences how, where, and when maintenance activities should occur.

As described in Chapter 3, impact avoidance and minimization is a 3-part process that begins with broad level activity planning and focuses down to the details informing maintenance activities at a given project site. At the broadest scale, the District developed Maintenance Principles to provide overarching first-stage impact reducing guidance for maintenance activities (see Chapter 3, Section 3.2). The following Maintenance Principles were chartered to guide the maintenance program and avoid and reduce potential environmental impacts:

1. Apply the minimum maintenance necessary
2. Avoid mechanized maintenance, favor hand maintenance
3. Large scale sediment removal, streambank grading or vegetation clearing is outside of program
4. Understand and monitor the river system and use adaptive management
5. Protect and enhance riparian habitat
6. Manage stream resources for long-term sustainability

From this basis more targeted impact avoidance and minimization measures are then applied during the maintenance planning phase (second-stage) when the annual maintenance workplan is developed (see Chapter 10). Additionally, the District developed specific channel maintenance best management practices (BMPs) to guide operational activities during maintenance implementation (third-stage) to reduce remaining potential environmental impacts (see Section 3.4).

Chapter 9 of the Manual describes the many habitat protection and enhancement activities that

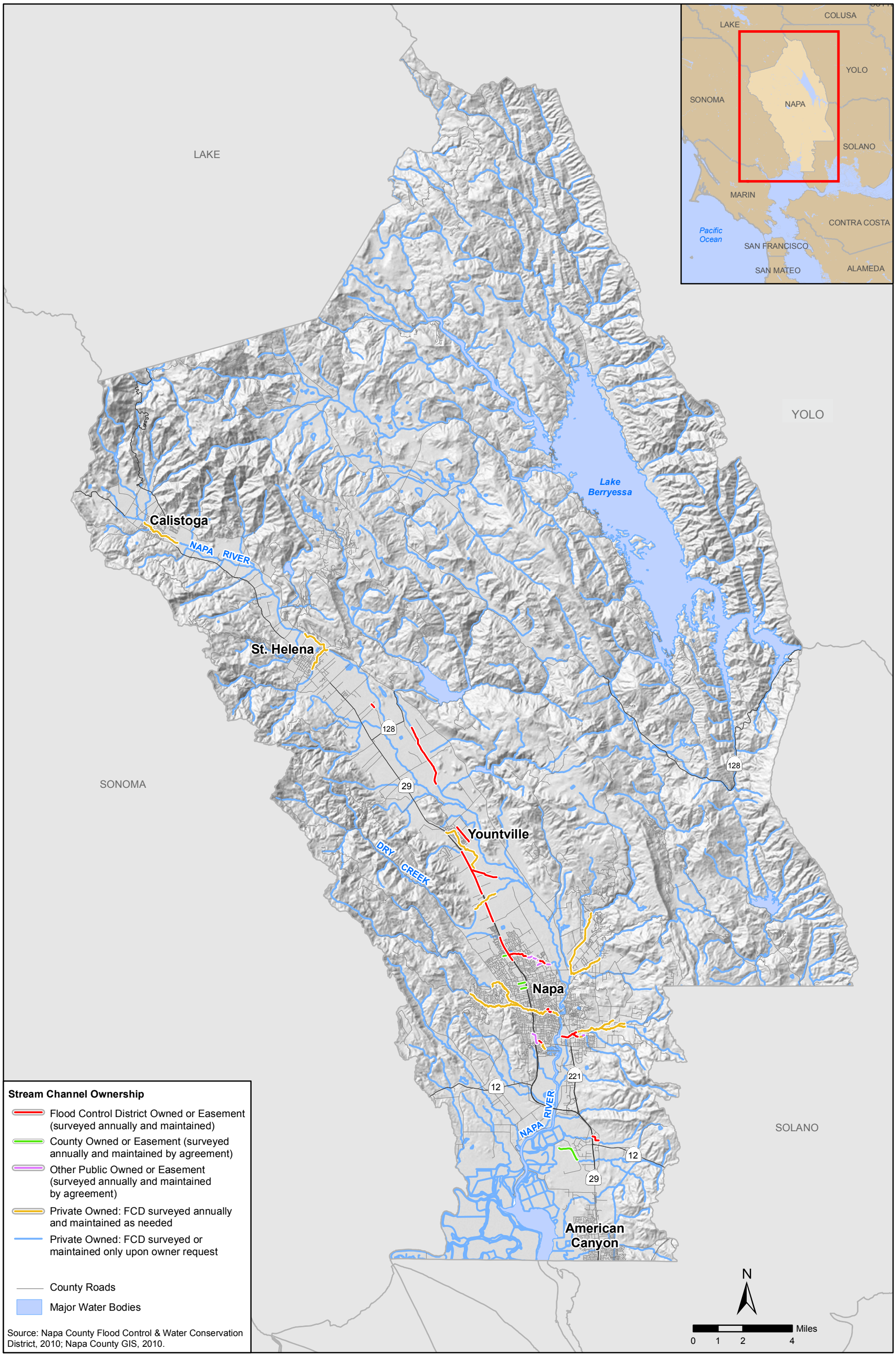
the District undertakes as part of the Stream Maintenance Program. The District sees stream maintenance as an integrated stream management approach that involves protecting and enhancing existing instream resources while providing for necessary flood conveyance capacity in the channel. The District undertakes expansive riparian planting projects, develops instream habitat complexity features (including large woody debris (LWD)), and may undertake gravel augmentation projects where appropriate.

The avoidance and minimization measures and Maintenance Principles outlined in chapter 3 reduce the potential impact of maintenance work. However, where the District conducts ground disturbing stream maintenance activities, they will also implement the channel habitat enhancement and restoration activities including tree and understory plantings and invasive species removal that are described in Chapter 9.

Ground disturbing maintenance activities, including sediment removal and bank stabilization, are limited to 1,000 combined linear feet per year. Mitigation for such ground disturbing maintenance activities will occur at a 1:1 ratio according to the length of the maintenance work. If the area where maintenance activities is occurring already has sufficient planting, or is in good condition regarding invasive plants, such that restoration activities are not needed on-site, then the District will undertake the enhancement and restoration activities at another channel location. The objective of the mitigation planting is to enhance the complexity and diversity of the riparian canopy cover, improve channel shading, and develop a functioning understory along the channels that are currently dominated by non-native invasive species.

The District's routine vegetation management activities will have temporary impacts. The District rarely removes trees from the riparian zone. As described in Chapter 4 *Vegetation Management*, the District would only remove a tree if it is causing a flood or erosion hazard, is trapping a significant volume of debris, or is otherwise a hazard to people or existing infrastructure. If the District removes a tree (greater than 6" dbh (diameter at breast height)) they will mitigate for this impact by replanting at a 1:1 ratio with a suitable riparian tree species at the same location or somewhere else along the same stream. Mitigation and tree planting activities will be reported in the District's annual maintenance summary report.

Taken together, the application of the Maintenance Principles, additional pre-maintenance planning avoidance measures described in Chapter 10, the BMPs (shown in Table 3-1), and the habitat protection and enhancement activities as described in Chapter 9 provide a comprehensive and integrated approach to avoiding and minimizing program impacts. As structured and implemented, the Stream Maintenance Program would not result in any permanent environmental impacts. In compliance with CEQA, an Initial Study was completed and a Notice of Determination for a Negative Declaration was filed on February 10, 2012 (State Clearinghouse No. 2011122050). Maintenance activities that would result in permanent impacts (e.g. bank hardening) are not covered or included under this program. If such activities are necessary, they would be authorized through individual project permits outside of the routine maintenance program. Temporary impacts from stream maintenance activities are avoided and minimized through the approaches described above and detailed further in this Manual. The District's long history of habitat protection and enhancement activities as described in Chapter 9 serve as "self-mitigating" actions integrated with the maintenance activities.



Project: 10.004\NapaSMP\Aug2011

Figure 1-1
Napa County Stream Maintenance Program Area and Maintenance Reaches

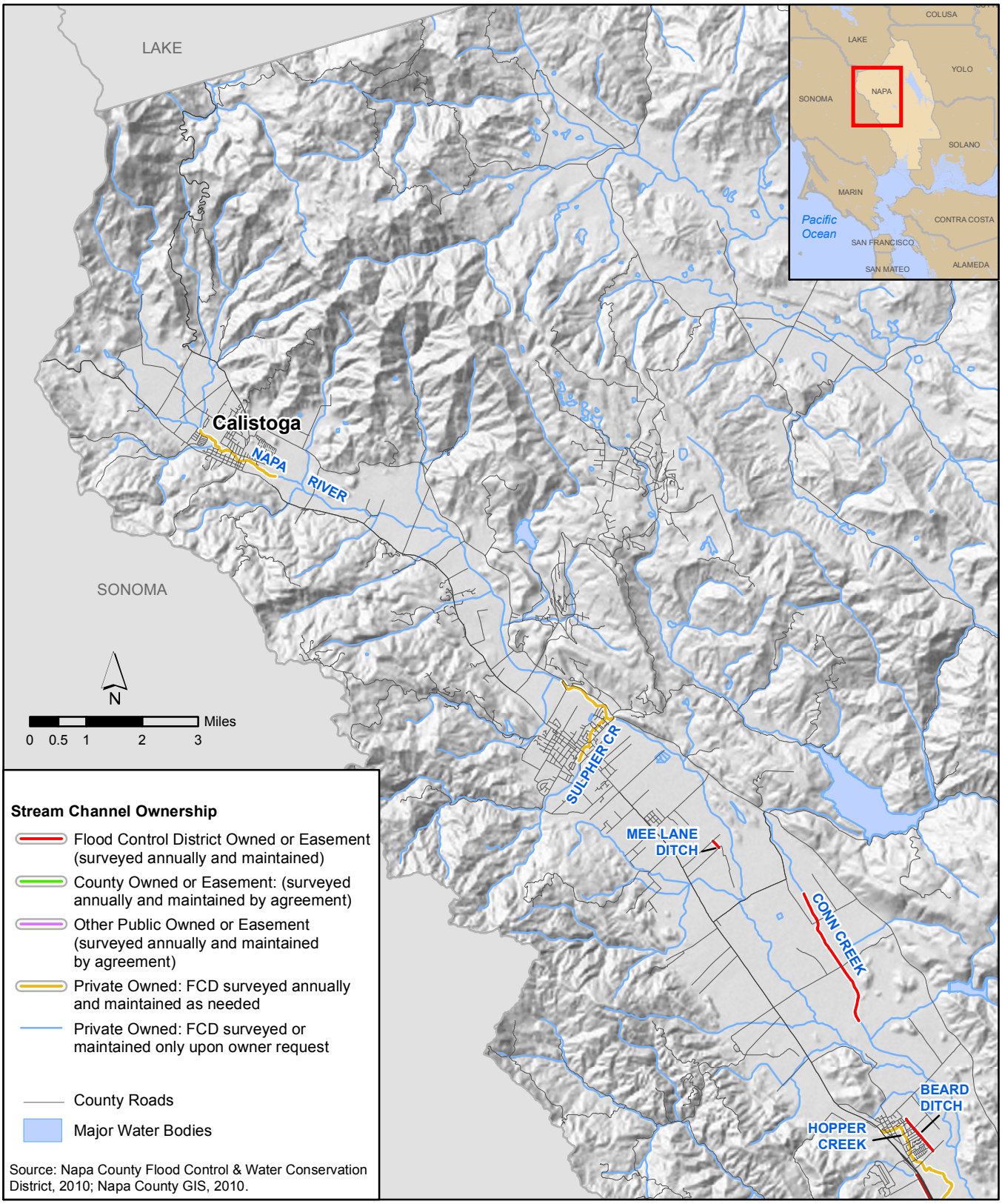


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Figure 1-2
Napa County Stream Maintenance Program: Northern Region

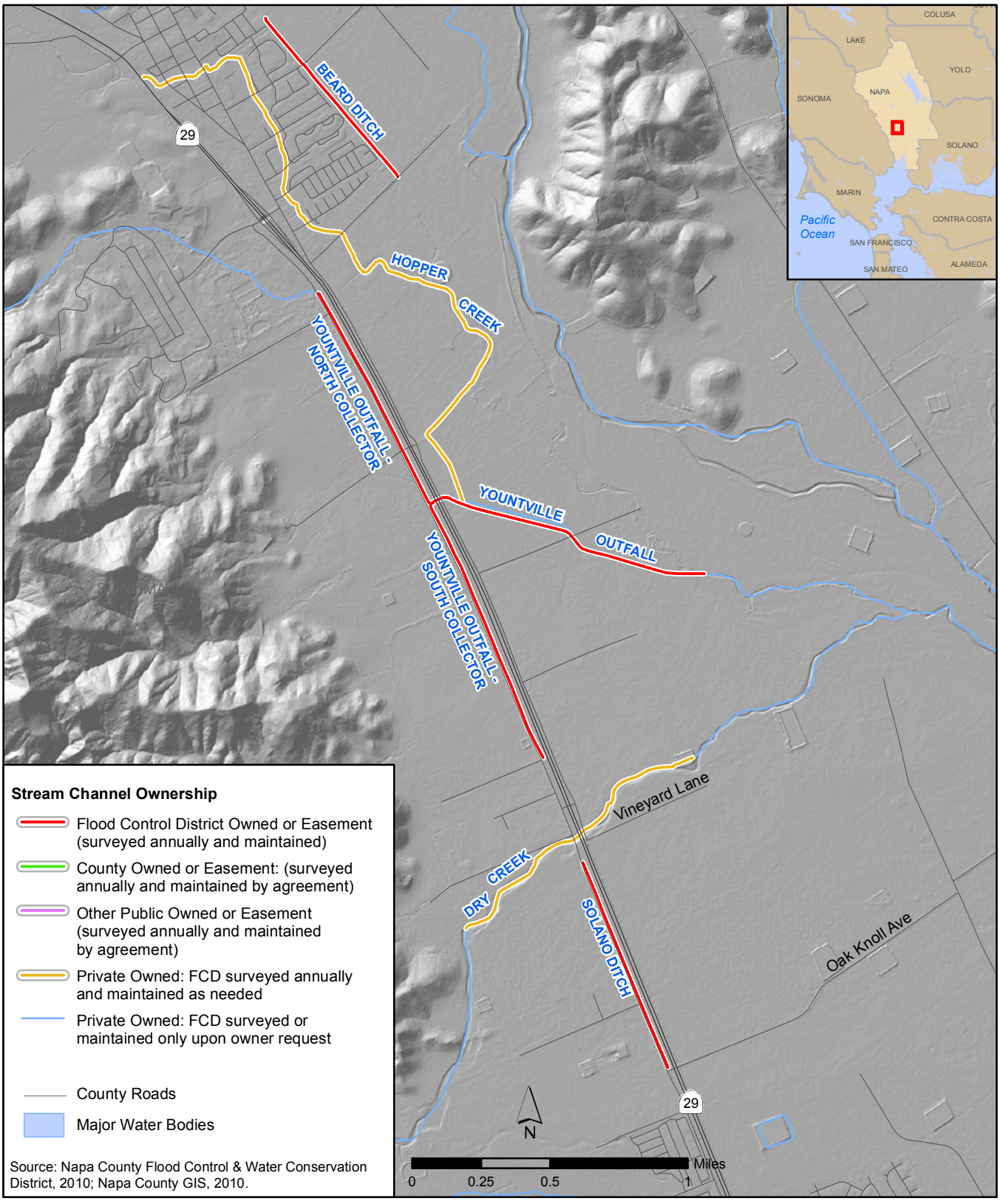

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Figure 1-3
Napa County Stream Maintenance Program: Yountville Region

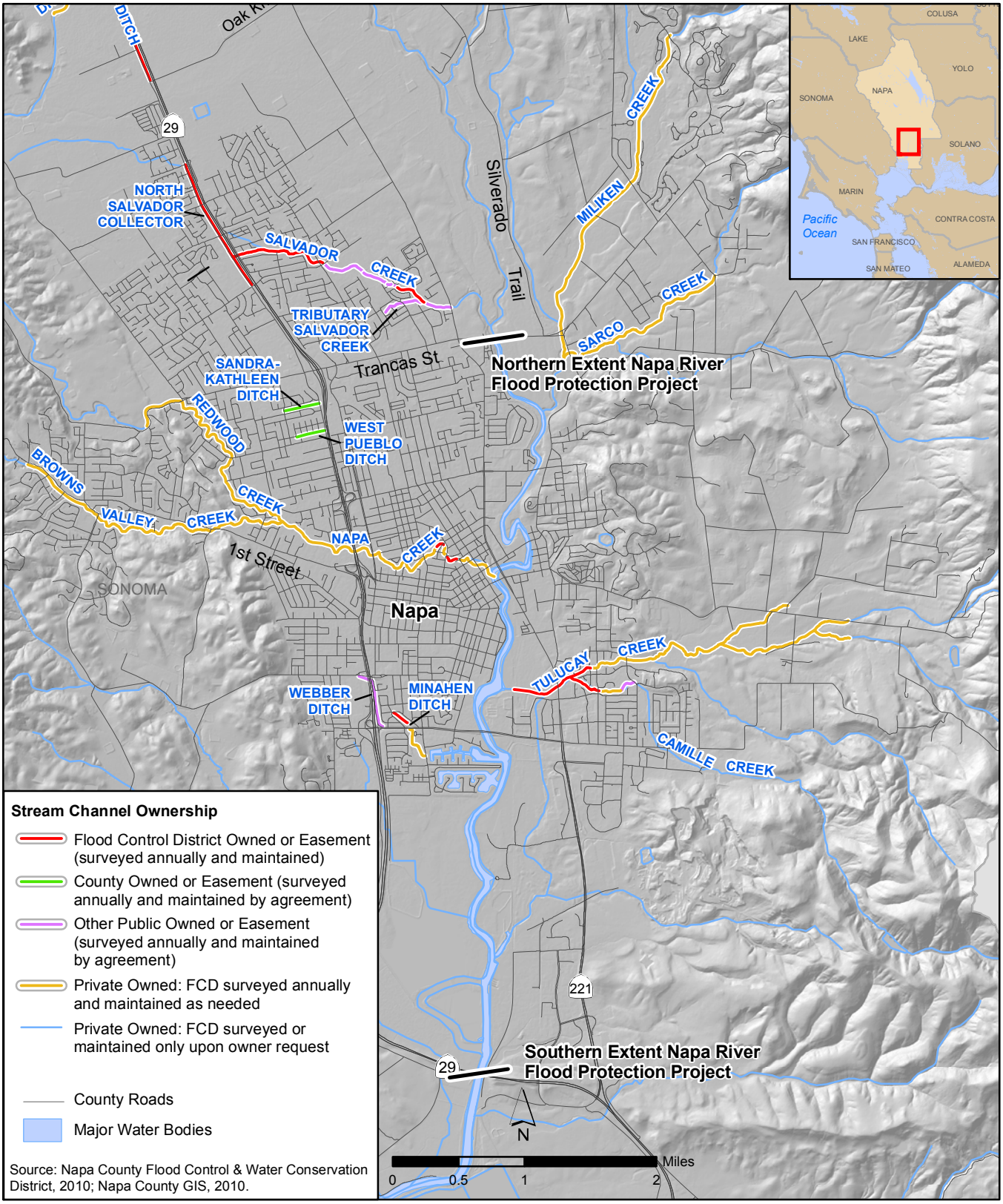

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Figure 1-4
Napa County Stream Maintenance Program: City of Napa Region

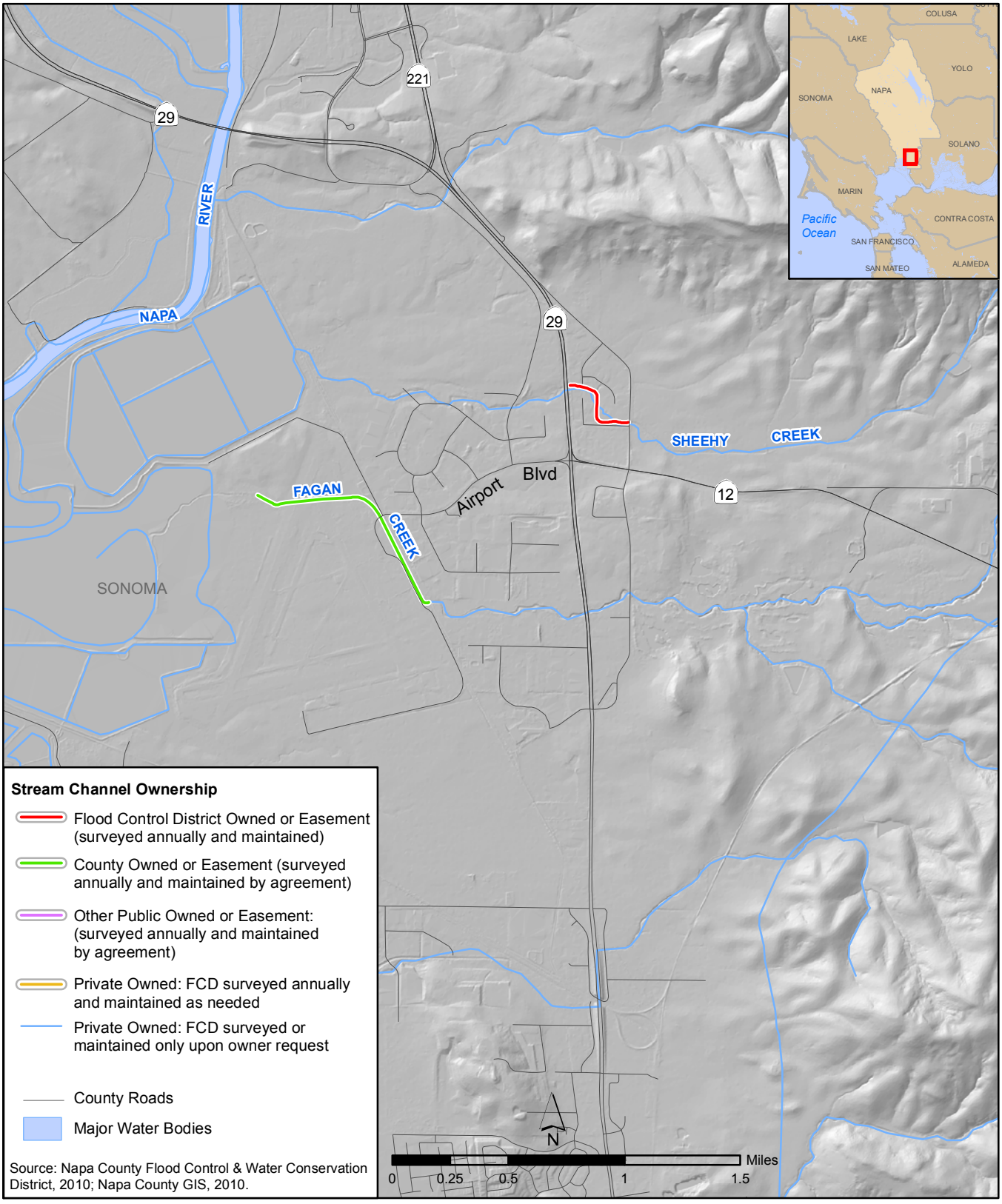

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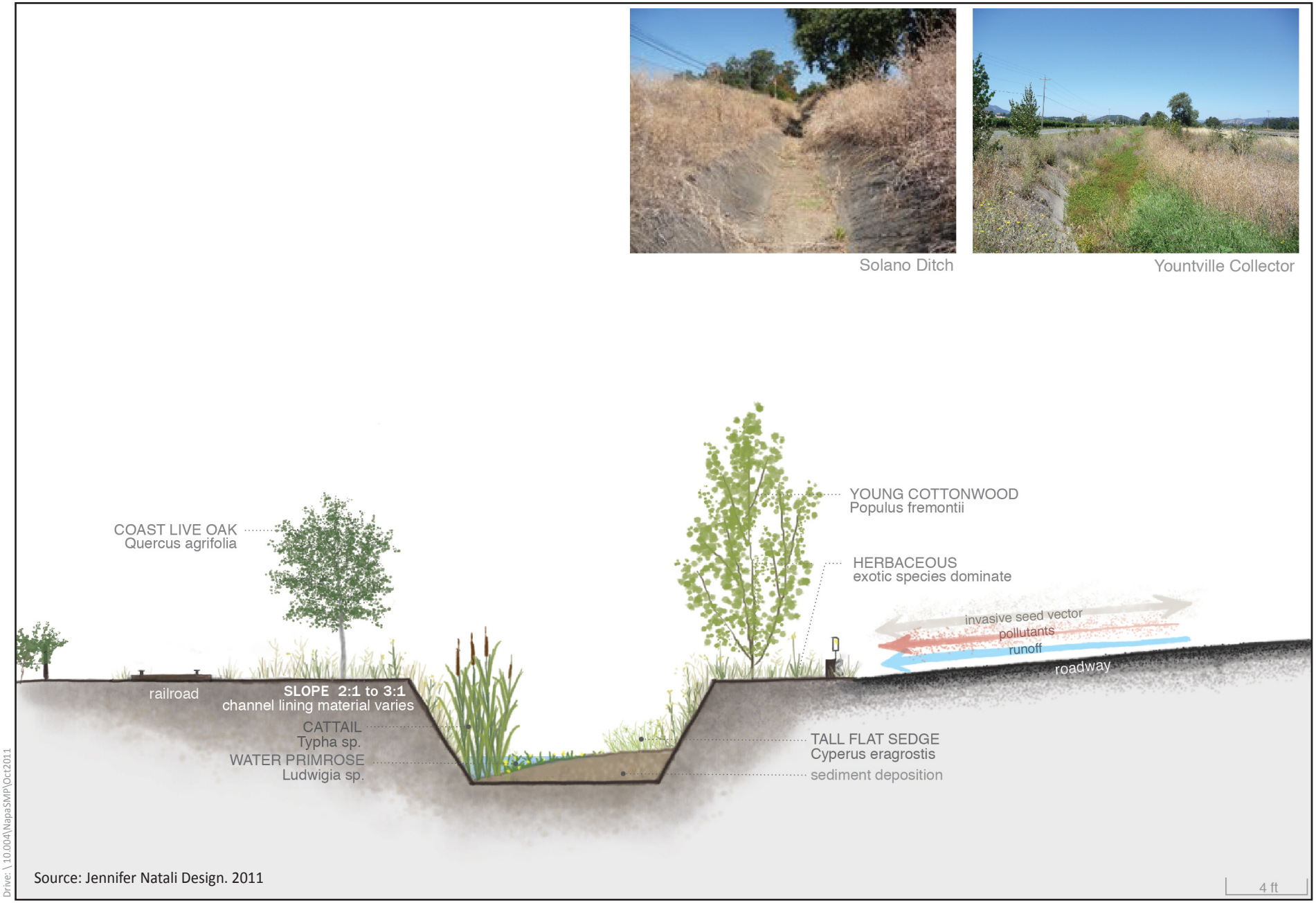
Figure 1-5
Napa County Stream Maintenance Program: Airport Region



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Horizon WATER and ENVIRONMENT

Figure 1-6
Typical Channel Cross Section - Collector

Salvador Creek: Reach 1

Yountville Outfall: Reach 1

Source: Jennifer Natali Design. 2011

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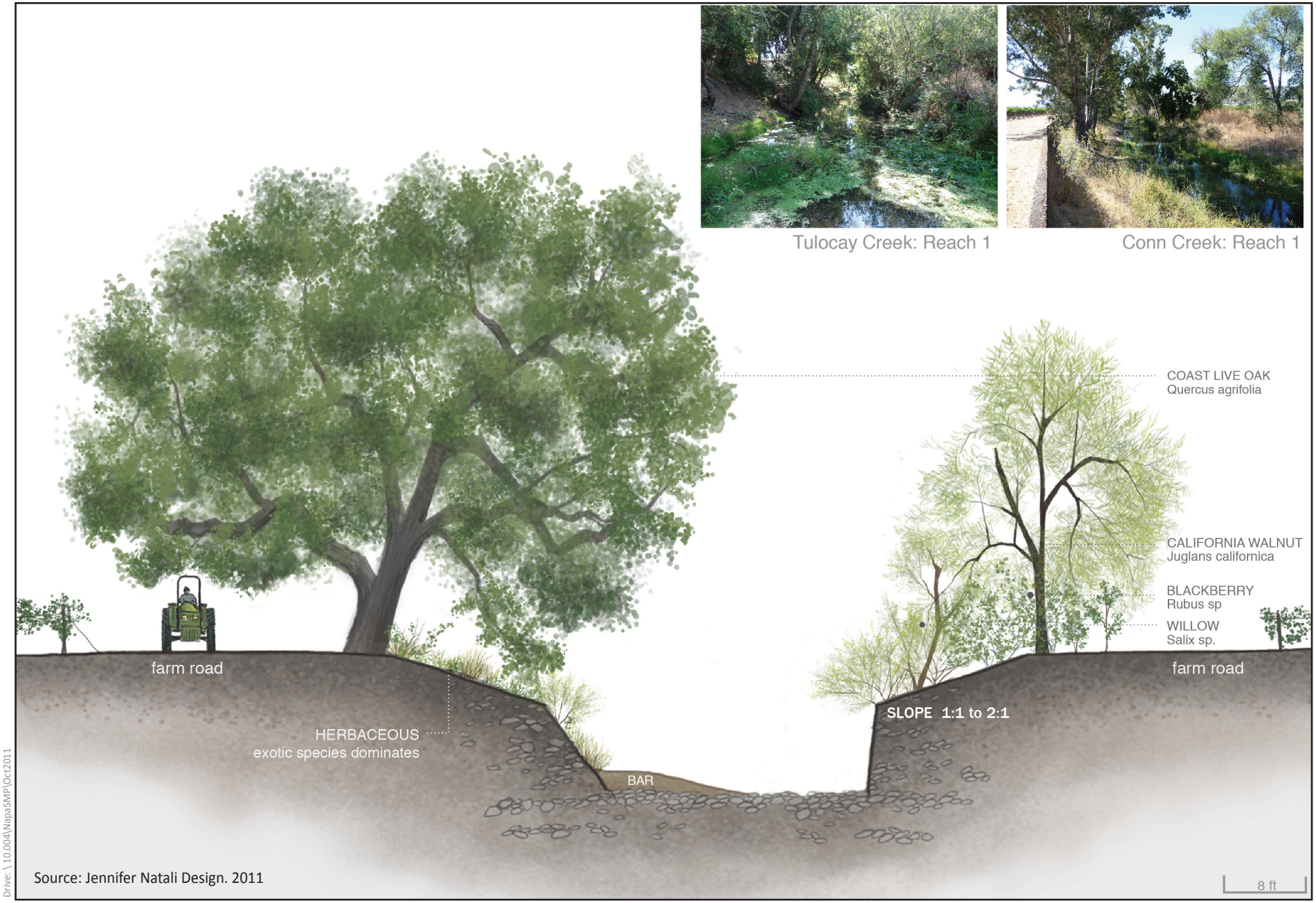
Horizon WATER and ENVIRONMENT

Figure 1-7
Typical Channel Cross Section - Modified



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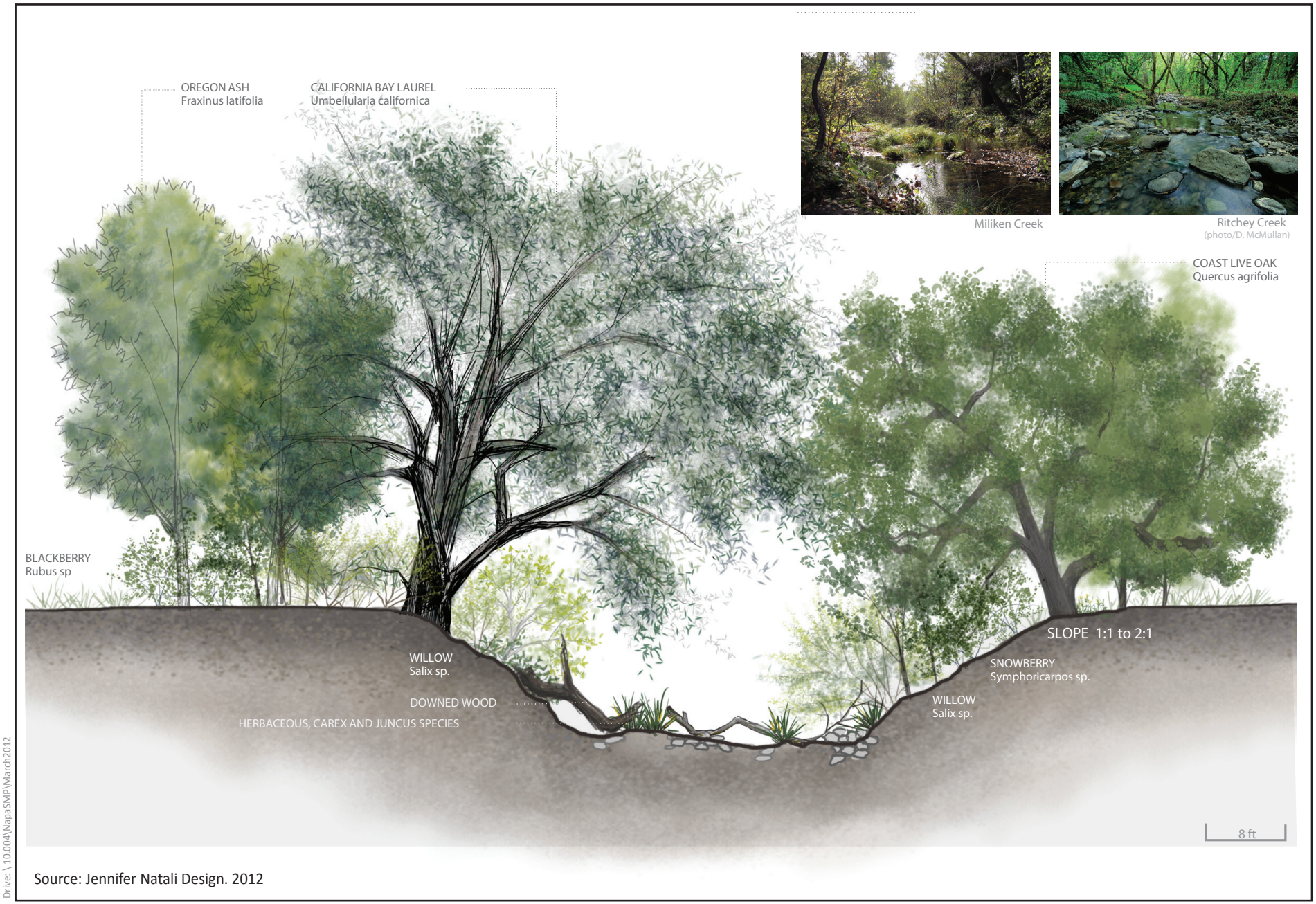
Horizon WATER and ENVIRONMENT

Figure 1-8
Typical Channel Cross Section - Semi-modified and Natural



Source: Jennifer Natali Design. 2012

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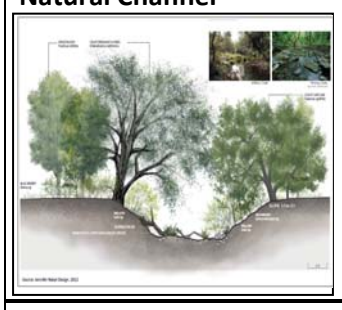
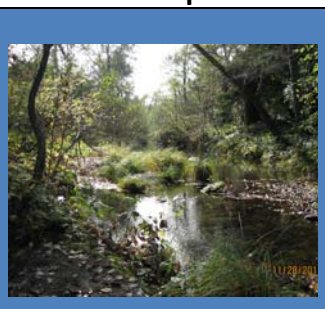
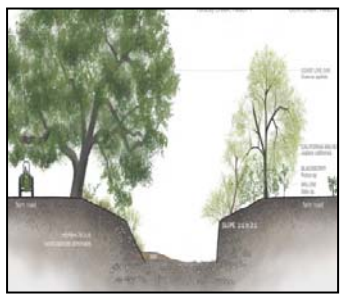
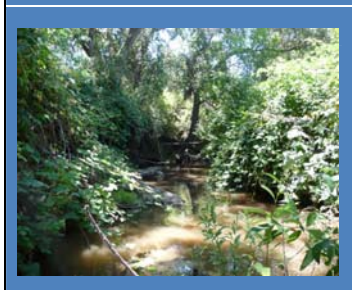
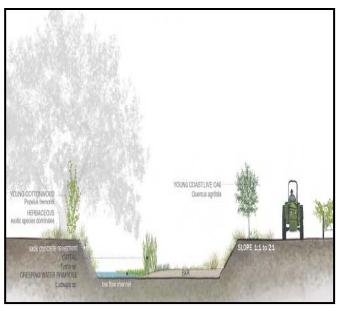
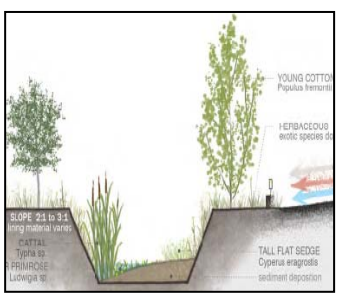
Horizon WATER and ENVIRONMENT

Figure 1-9
Typical Channel Cross Section - Natural Channel

Figure 1-10. Stream Maintenance Activity by Channel Type

Channel Type	District Example	Creek	Key Issue	Maintenance Activities: Vegetation Management	Downed Tree Management	Large Woody Debris (LWD) Recruitment	Invasive Removal	Sediment Removal	Debris Removal	Bank Stabilization	Habitat Enhancement
Natural Channel 		Natural Channel	Invasive Exotic Species (Arundo), Downed Tree, Bank Instability, Dumping, Flooding, Native Plant Restoration Maintenance	O	O	●	●	O	●	O	●
Semi-Modified 		Conn 1,2,3, Camille, Tulocay 1	Invasive Exotic Species (Ivy, Privet, Eucalyptus, Blackberry), Bank Instability, Incision, Downed Tree, Flooding	●	●	●	●	O	●	●	●
		Salvador 3	Invasive Exotic Species (Ludwigia, Blackberry, Ivy), Willow Pruning Sediment Accumulation, Dumping, Downed Tree, Bank Instability Poor Canopy Structure	●	●	●	●	O	●	●	●
Modified 		Salvador 1,2	Invasive Exotic Species (Blackberry, Ludwigia, Harding grass, Periwinkle), Flooding, Dumping, Downed Tree, Willow Pruning, Native Plant Restoration Maintenance	●	●	●	●	●	●	●	●
		Sheehy, Fagan	Invasive Exotic Species (Blackberry, Sweet Fennel, Poison Hemlock), Flooding, Dumping, Downed Tree, Willow Pruning	●	●	●	●	O	●	●	●
		Yountville Outfall,	Poor Canopy Structure, Sediment Accumulation, Downed Tree, Invasive Exotic Species(Ludwigia, Harding Grass, Wild Radish), Flooding, Native Plant Restoration Maintenance	●	●	●	●	●	●	O	●
Collector 		Yountville, Salvador Collectors	Poor Canopy Structure, Bank Instability, Invasive Exotic Species (Ludwigia, Harding Grass), Sediment Accumulation, Dumping, Flooding, Native Plant Restoration Maintenance	●	●	●	●	●	●	●	●
		Beard, Solano, Webber Ditch	Invasive Exotic Species (Periwinkle, Harding Grass, Blackberry), Poor Canopy Structure, Bank Instability, Stormwater Runoff, Dumping	●	●	O	●	●	●	●	●

● Maintenance Activity May be Implemented
O Maintenance Activity Will Not be Implemented

Chapter 2
ENVIRONMENTAL SETTING

The District's stream maintenance approach relies on recognizing fundamental hydrologic, geomorphic, and biologic processes that affect a given stream reach and adaptively managing and maintaining streams based on the underlying processes. Understanding the physical and biological setting of a particular stream reach and other contributing factors is key to determining the timing, frequency, strategy and need for various maintenance elements. In this chapter, an overview of the geomorphic setting and biological resources are provided in Sections 2.1 and 2.2. In Section 2.3 the chapter continues with individual stream reach characterizations for the District's primary maintenance reaches.

2.1 Geomorphic Setting

As described in Chapter 1, Section 1.3 *Program Area and Channel Ownership Types*, and shown in the maps of Chapter 1, the District's maintenance activities are focused in the Napa River watershed. The Napa River watershed is a generally northwest-southeast oriented drainage basin whose shape and alignment follows the regional geologic structure. The watershed is defined by the Mayacamas Mountains to the west, which provides a ridgeline with several steep eastward and southeastward flowing tributaries that descend to the valley floor. The eastern watershed boundary is formed by an unnamed ridgeline formed of several individual peaks including Howell Mountain, Atlas Peak, and Mt. George. Similar to the west side of the watershed, numerous tributary streams emerge from the eastern slopes and descend toward the valley floor. The northern watershed boundary is formed in the headwaters of Mt. St. Helena north of Calistoga and the southern watershed boundary is formed by the tidally influenced marshes of the Napa River near San Francisco Bay.

The watershed structure and its stream network are relevant in considering sediment delivery and stream maintenance needs. The higher mountains that ring the Napa River watershed provide the headwater source areas for runoff and sediment that accumulate in the tributary and valley floor streams below. The steep canyons and headwater mountain streams deliver flows and sediment to the valley floors and often build characteristic alluvial fans at the base of the mountains. Historically, these alluvial fans functioned as depositional areas that stored sediments in the topographic transition between the higher and steeper headwater areas and the more gently sloping floodplain of the Napa Valley floor. Historically, during large flood events, streams migrated across these alluvial fan and valley floor floodplain and distributed sediments evenly across the surface. Over time, fans prograded downstream onto the valley floor at variable rates depending upon sediment sources, climatic conditions, and tectonic activity (earthquakes and motion along fault lines).

The topographic transition between mountain, fan, and plain is important in considering maintenance needs for the channels that the District maintains. As shown in the maps of Chapter 1, many of the maintenance channels begin in the historic alluvial fan zone, most often in the lower fan areas. Historically these were reaches that received abundant sediment from

upstream sources. Over time these reaches may have stored this sediment in the channel, distributed and deposited it along the fan or floodplain surface, or carried it in the channel toward the next larger river confluence downstream.

The historic geomorphic system was altered and affected greatly by land use practices and infrastructure developed in the 19th and 20th centuries. Grazing, agriculture, vegetation conversion, road development, flood protection, river navigation and many other activities combined to change the physical system. Under existing conditions with many developed land uses adjacent to creeks that are maintained by the District, many of the streams have been channelized and are engineered and maintained for flood control purposes. Streams that previously migrated and deposited their materials across a broad fan or plain surface are now contained in generally more linear channels with gradients that are typically governed by hardened road crossings upstream and downstream.

Development of the larger north-south highways and roadways of the County like Highway 29 on the west side of the valley and Silverado Trail on the east side of the valley resulted in the culverting of several streams and the development of "collector" ditches and creeks that run parallel to the highway. Collector channels like the Yountville Outfall North Collector, Yountville Outfall South Collector, Solano Rd. Ditch, and North Salvador Collector channels collect flows from multiple tributaries draining from the west, collect these flows into a single channel that parallels Highway 29, and then pass the flows beneath the highway in generally larger culverts. The District maintains these collector channels for sediment accumulation, bank stabilization, and vegetation management.

Stream channel incision is another geomorphic legacy that affects some of the channels maintained by the District. Different to the situation of abundant sediment deposition described above, incising channels are actively eroding and down-cutting into their floodplain. There are several possible causes for channel incision including hydromodification effects (due to land use changes) whereby runoff and streamflows are more erosive due to higher peak volumes and velocities. Sometimes channels incise because the "base" or "trunk" stream into which they flow has itself "sunk" or incised, and therefore the tributary follows this lead by incising to meet the elevation of the downstream receiving water. Alternatively, sometimes channels incise because there is an active "headward migrating knickpoint" that moves upstream through a system eroding and lowering the channel bed as it moves upstream. Channel incision is another geomorphic process that affects the District's maintenance needs. Incised channels are typically at greater risk for bank destabilization and in need of bank repair.

2.2 Biological Resources

This section describes the biological resources that occur in aquatic and terrestrial habitats that are potentially affected by stream maintenance activities.

2.2.1 Biotic Communities

Aquatic Habitats

Aquatic habitats in Napa County are highly diverse in size, type, and function. The streams that form the drainage network within the County are the primary aquatic habitat relevant to program activities. To a lesser extent, freshwater wetlands, including seeps and springs, may also be affected by program activities. The extensive saline wetlands (i.e., salt and brackish marsh) that occur in the southern part of the County are not included in the program area, and are not addressed in this manual. Likewise, vernal pools are not likely to be affected by the activities conducted under the stream maintenance program, and are not addressed in this manual.

Streams and Drainages

Streams and drainages in the program area include tributaries to the Napa River and San Pablo Bay, and other smaller water conveyance features such as ditches and swales. The characteristics of the aquatic habitat associated with these features vary considerably. Several of the Napa River tributaries provide perennial aquatic habitat for fish and wildlife. Many smaller streams and drainages experience periods of low flow or no surface flow during summer and fall.

Photo 2-1: Aquatic vegetation, primarily Ludwigia, in the Yountville Outfall.

Only a few species of vascular plants typically grow within fast-flowing streams. Species that may be found in or adjacent to such streams in the program area include torrent sedge (*Carex nudata*), giant chain fern (*Woodwardia fimbriata*), spicebush (*Calycanthus occidentalis*), and small-fruited bulrush (*Scirpus microcarpus*). Certain non-vascular plants, such as aquatic mosses and filamentous algae that are tightly attached to rocks by strong holdfasts, can survive the fast current. Low gradient, slow flowing streams and drainages in the program area support dense growth of aquatic vegetation such as *Ludwigia* (Photo 2-1), water plantain (*Alisma plantago-aquatica*), and smartweeds (*Polygonum* spp.).

Common, widespread bird species that use streams habitats in the program area include herons, egrets, and waterfowl. Some species of amphibians use stream habitats for breeding, particularly bullfrogs (*Lithobates catesbeianus),* which are not native to California. Native amphibians that may be present in and around aquatic habitats in the program area include Coast Range newt (*Taricha torosa torosa*), Pacific treefrog (*Hyla regilla*), California red-legged

frog (*Rana draytonii*), foothill yellow-legged frog (*Rana bolyii*), and California toads (*Bufo boreas halophilus*). Pacific pond turtles (*Actinemys marmorata*) also use these habitats, often concentrated in areas of optimal habitat such as side channel and backwater areas. California freshwater shrimp (*Syncaris pacifica*) are found in pools in low-gradient streams such as the Napa River, Garnett Creek and Huichica Creek (Jones & Stokes and EDAW 2005). Fish species occurring in the program area found are described in Section 2.2.2.

Functions and values provided by instream aquatic habitat include the following:

- Maintenance of surface and groundwater quality through filtration and decomposition of pollutants;
- Groundwater aquifer recharge;
- Water for human, animal, and wildlife use;
- Wildlife habitat;
- Opportunities for recreation, including fishing and boating; and
- Opportunities for conservation and restoration of fish and wildlife habitat.

Freshwater Wetlands

Freshwater wetlands are distributed throughout the program area in swales, low-lying areas and around ponds and reservoirs. Freshwater wetlands in the program area are typically characterized by monocots—grasses and grass-like plants in the sedge and rush families—that are tolerant of extended exposure to saturated soils or inundation by surface water. Perennial wetlands that hold water for most or all of the year are characterized by dense stands of cattail (*Typha* spp.) and bulrush or tule (*Schoenoplectus [=Scirpus]* spp). Ponds and other open water areas may support plants with floating leaves, such as pondweeds (*Potamogeton* spp.), mosquito fern (*Azolla* spp.), and duckweed (*Lemna* spp. and *Wolfia* spp.), or submerged plants, such as Canadian pondweed (*Elodea canadensis*) and *Najas* spp. Associated species in perennial wetlands include other bulrush species, creeping spikerush (*Eleocharis macrostachya*), mannagrass (*Glyceria* spp.), floating water-primrose, water-plantain, umbrella flatsedge (*Cyperus eragrostis*), mint (*Mentha* spp.), buttercup, and smartweeds. Wetlands with more seasonal water supply support sedges (*Carex* spp.) and rushes (*Juncus phaeocephalus, J. effusus, J. balticus,* and others). Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*), Italian ryegrass, curly dock (*Rumex crispus*), and hyssop loosestrife (*Lythrum hyssopifolia*) are common associated species in seasonal wetlands.

Freshwater wetlands, particularly those with native vegetation and high structural complexity, provide high-quality wildlife habitat that offers nesting, foraging, roosting, and cover for a variety of species. The high plant productivity typical of freshwater wetlands offers abundant food sources and cover for wildlife. The wildlife community that receives the most evident benefit from freshwater wetlands is birds. Common and uncommon bird species typically associated with emergent freshwater wetlands that may be found in the County include grebes, rails (e.g., Virginia rail [*Rallus limicola*], American coot [*Fulica americana*]), herons, egrets, ducks (e.g., wood duck [*Aix sponsa*], cinnamon teal [*Anas cyanoptera*]), shorebirds, marsh wren (*Cistothorus palustris*), and common yellowthroat (*Geothlypis trichas*). In addition to the abundance of birds, other vertebrates found in freshwater wetlands include amphibians, reptiles, and mammals. Amphibians and reptiles that use freshwater wetlands include Pacific

chorus frogs, western toads (*Bufo boreas*), and garter snakes (*Thamnophis* spp.), which in turn provide food for animals including birds and mammals. Mammal visitors to freshwater wetlands include deer mouse (*Peromyscus* spp.), California meadow vole (*Microtus californicus*), river otter (*Lutra canadensis*), and mule deer (*Odocoileus hemionus*). Muskrats (*Ondatra zibethicus*) and beaver (*Castor canadensis*) may use freshwater wetlands for cover, food, and/or hut construction. Many bat species forage for insect prey over wetlands. Freshwater wetlands typically contain many invertebrates—such as dragonflies, craneflies, and snails—that provide an important food source for other species.

Functions and values provided by freshwater wetlands include the following:

- Maintenance of surface water quality through filtration and decomposition of pollutants,
- Groundwater recharge,
- Flood control, due to storage of flood and storm surge waters,
- Water for stock and wildlife use,
- Wildlife habitat, and
- Recreation, including bird watching, hunting, and fishing.

Maintenance of native communities, connectivity with the watershed, and a natural hydrologic regime are necessary to maintain these values. Aquatic habitats and wetlands are frequently colonized by invasive species of plants, invertebrates, fish, and amphibians. Invasive species readily displace native species and commonly prey upon them. Ponds, reservoirs, canals, and lowland rivers are often the sites of exotic or nonnative species introductions and concentrations, including many aquatic invertebrates (e.g., insects, snails, clams, crayfish,), many nonnative fish species, and bullfrogs (Jones & Stokes and EDAW 2005).

In general, alteration of hydrology and environmental change resulting from dams, water withdrawals, and land use conversion of riparian and floodplain areas are the primary threats to streams in the program area. Altered hydrology has been identified as the primary cause or a contributing factor in the decline of several fish species (Moyle et al. 1996), and low summer flows in Napa River tributary streams have been shown to reduce feeding and growth opportunities for rearing steelhead (Stillwater Sciences 2007).

Terrestrial Habitats

Riparian Woodlands

Riparian woodlands and forests are found along waterways throughout the County. Valley oak riparian woodlands and mixed willow riparian forest are the most common riparian vegetation community types in the Napa Valley, Carneros, and Jameson/American Canyon areas (Jones & Stokes and EDAW 2005). Valley oak riparian woodlands in Napa County are characterized by valley oak (*Quercus lobata*) and one of two suites of co-dominant tree species, either California bay (*Umbellularia californica*), coast live oak (*Q. agrifolia*), walnut (*Juglans californica* var *hindsii*) and Oregon ash (*Fraxinus latifolia*), or Fremont cottonwood (*Populus fremontii*) and coast live oak (Jones & Stokes and EDAW 2005). Valley oak riparian woodlands constitute only a small fraction of the County's overall area, but are particularly valuable in terms of providing wildlife

habitat. Valley oak riparian woodlands that are not heavily grazed typically contain a variety of plant species in the understory, such as bracken fern (*Pteridium aquilinum*), Santa Barbara sedge (*Carex barbarae*), arroyo willow (*Salix lasiolepis*), California rose (*Rosa californica*), common snowberry (*Symphoricarpus albus*), California blackberry (*Rubus ursinus*), and wild grape (*Vitus californica*) (Jones & Stokes and EDAW 2005). Valley oak woodland and savanna also occurs on the open valley floor, where it was historically quite extensive (Jones & Stokes and EDAW 2005, SFEI 2008).

Mixed willow riparian woodlands and scrub includes Pacific willow (*Salix lucida ssp. lasiandra*), red willow (*Salix laevigata*), black willow (*Salix gooddingii*), narrowleaf or sandbar willow (*Salix exigua*), and arroyo willow (Jones & Stokes and EDAW 2005). These species may be found in pure or mixed stands. Other species found in mixed willow riparian forests include Fremont cottonwood, valley oak, coast live oak, California rose, California blackberry, common snowberry, white alder (*Alnus rhombifolia*), and big-leaf maple (*Acer macrophyllum*).

Riparian woodlands and forests are valuable for wildlife since they provide shade, water, favorable microclimates, and important movement corridors. In-stream woody debris from riparian trees and shrubs also provides important habitat elements, forming scour pools and logjams used by insects, amphibians, and fish (Riparian Habitat Joint Venture 2004). Riparian forests are particularly important for California landbird species, providing breeding habitat, over-wintering grounds, migration stopover areas (Riparian Habitat Joint Venture 2004), and movement corridors for bird species with somewhat limited mobility such as California quail (*Callipepla californica*). Multilayered, structurally complex vegetation enhances quality of riparian habitat.

Wildlife associated with riparian forests include amphibians such as Pacific tree frog (*Pseudacris regilla*); reptiles such as ring-necked snake (*Diadophis punctatus*) and sharp-tailed snake (*Contia tenuis*); birds such black phoebe (*Sayornis nigricans*), yellow-breasted chat (*Icteria virens*), bushtit (*Psaltriparus minimus*), Pacific-slope flycatcher (*Empidonax difficilis*), and orange-crowned warbler (*Vermivora celata*); and mammals such as raccoon (*Procyon lotor*), ringtail (*Bassariscus astutus*), bobcat (*Lynx rufus*), and shrews (*Sorex* spp.). In recent years beavers have established a colony on Salvador Creek near Vintners High School (See Chapter 8, Figure 8-2). A variety of bat species may roost in riparian trees including the western red bat (*Lasiurus blossevillii*), a state species of special concern. Riparian habitat also contributes essential functions to aquatic habitats that support steelhead (*Oncorhynchus mykiss*), Chinook salmon (*O. tshawytscha*), and other fish species.

Functions and values provided by riparian woodlands and forest include the following:

- Stabilization of stream banks;
- Maintenance of stream water temperatures through shading of the channel;
- Movement corridors for wildlife;
- Habitat for wildlife, and inputs of coarse woody debris and detritus to streams;
- Opportunities for recreation, including hunting, bird-watching, hiking, and horseback riding.

2.2.2 Fish Resources

The Napa River, its estuary, and its tributaries provide habitat for a wide variety of fresh water, marine, and anadromous fish species. All fish communities in the Napa River watershed include both native and non-native (introduced) fish species. Native fish species found primarily in fresh water habitats in the Napa River watershed include river lamprey (*Lampetra ayresi*), Western brook lamprey (*L. richardsoni*), Pacific lamprey (*L. tridentata*), Sacramento splittail (*Pogonichthys macrolepidotus*), Sacramento pikeminnow (*Ptychocheilus grandis),* hardhead (*Mylopharodon conocephalus*), California roach (*Hesperoleucus symmetricus*), Sacramento sucker *(Catostomus occidentalis)*, steelhead/rainbow trout, Chinook salmon, threespine stickleback (*Gasterosteus aculeatus*), riffle sculpin (*Cottus gullosus*), prickly sculpin *(Cottus asper*), and tule perch *(Hysterocarpus traski*) (Leidy 2007, Koehler and Blank 2010). Of these fishes, the Pacific and river lampreys, steelhead, and Chinook salmon are anadromous, meaning that adults reside in the ocean but spawning and rearing takes place in fresh water. Sacramento splittail have a similar life history, residing in salt water estuarine habitats as adults and migrating into large rivers to spawn in fresh water.

Non-native freshwater species include common carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), fathead minnow (*Pimephales promelas*), golden shiner (*Notemigonus crysoleucas*), channel catfish (*Ictalurus punctatus*), white catfish (*Ameiurus catus*), brown bullhead (*Ameiurus nebulosus*), wakasagi (*Hypomesus nipponensis*), inland silverside (*Menidia beryllina*), western mosquitofish (*Gambusia affinis*), striped bass (*Morone saxatilis*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), bluegill (*Lepomis macrochirus*), redear sunfish (*Lepomis microlophus*), green sunfish (*Lepomis cyanellus*), white crappie (*Pomoxis annularis*), and black crappie (*Pomoxis nigromaculatus*) (USACE 2006, Leidy 2007, Koehler and Blank 2010). Some non-native fishes found in fresh water habitats in the Napa River watershed also use salt water or brackish water during a portion of their life cycle. These include inland silversides and striped bass.

Anadromous salmonids

Steelhead are relatively widespread in Napa Valley streams (Ecotrust and Friends of Napa River 2001 and 2002, Stillwater Sciences and Dietrich 2002, Leidy et al. 2005, Koehler and Blank 2010), but current abundance is thought to be only a small fraction of historical levels. Fall-/late fall-run Chinook salmon also spawn and rear in the Napa River (Koehler and Edwards 2008, Koehler and Blank 2010). Annual observations in the Napa River of spawning adults and juvenile Chinook salmon by the Napa County Resource Conservation District from 2004–2010 indicate that successful spawning occurs in most years (Koehler and Blank 2010).

Small numbers of juvenile chum salmon (*Oncorhynchus keta)* have been found in the Napa River estuary (USACE 2006), but a spawning population has not been documented in the Napa River watershed. In 2010, several hundred juvenile sockeye/kokanee salmon (*O. nerka*) were identified in outmigrant traps in the Napa River (Koehler and Blank 2010). These fish are believed to have originated from a landlocked population in an upstream reservoir (J. Koehler, pers. comm., 2010).

Despite considerable habitat degradation and loss of anadromous fish habitat relative to historical conditions, the Napa River watershed still contains extensive areas of relatively high-quality spawning and rearing habitat for steelhead and salmon (Koehler and Blank 2010). The

Napa River watershed is considered one of the most important watersheds in the San Francisco Bay Area for conservation and restoration of the Central California Coast Distinct Population Segment (DPS) of steelhead (Becker et al. 2007).

Carneros Creek, a tributary to the Napa River located in the southwestern part of the program area, is an example of a potentially important conservation and restoration opportunity for steelhead. Compared to many other Napa Valley streams, Carneros Creek has a relatively unaltered channel and no fish passage barriers separating it from San Francisco Bay (Grossinger et al. 2004). Management actions to conserve the value of this stream for steelhead and other species include the restoration of riparian vegetation and the management of surface and groundwater withdrawals to ensure adequate baseflow is maintained year-round (Carneros Creek Stewardship 2005).

2.2.3 Special-Status Species

There are several special-status species that utilize aquatic and riparian habitats present in the Napa River watershed, and have the potential to occur in the program area. Special-status species include those:

- listed as endangered, threatened, or candidate under the federal Endangered Species Act;
- listed as endangered, threatened, or candidate under the California Endangered Species Act;
- designated as Species of Special Concern by CDFG; and/or
- designated as Fully Protected by the California Fish and Game Code (Sections 3511, 4700, 5050 and 5515).

In addition, plant species are included if they are designated as Special Vascular Plants in the CDFG Natural Diversity Database (CDFG 2011). California Department of Fish and Game (CDFG) also recognizes several sensitive natural communities that occur in the program area, including: Coastal and Valley Freshwater Marsh, Mixed Willow Riparian forests and Fremont Cottonwood Riparian Forests and several additional types of willow riparian forest.

Information on special-status species that may occur within the program area was gathered from Jones & Stokes and EDAW (2005). This list was cross-checked and updated with results from the USWFS list of federally listed and proposed endangered and threatened species for the three USGS quadrangles (Cuttings Wharf, Yountville, and Napa) overlapping the program area (USFWS 2010), and a California Natural Diversity Database (CNDDB) search for Napa County (CDFG 2010). The special-status species list was then refined to include only those species associated with riparian forest/woodland, freshwater wetland, and open water/stream habitats (**Table 2-1**).

Table 2-1: Special-Status Plant and Animal Species Potentially Occurring in the Program Area

Common Name *Scientific name*	**Status[a] Federal/ State/Other**	**Riparian Forest/ Woodland**	**Freshwater Wetland**	**Open Water/ Stream**
Plants				
Suisun Marsh aster *Symphyotrichum lentum [=Aster lentus]*	SC/–/1B		✓	
Marsh horsetail *Equisetum palustre*	–/–/3, LR		✓	
Northern California black walnut *Juglans californica* var *hindsii*	SC/–/1B	✓		
Delta tule pea *Lathyrus jepsonii* var *jepsonii*	SC/–/1B		✓	
Legenere *Legenere limosa*	SC/–/1B		✓	
Mason's Lilaeopsis *Lilaeopsis masonii*	SC/R/1B	✓	✓	
California loosestrife *Lythrum californicum*	–/–/LR		✓	
Marin knotweed *Polygonum marinense*	SC/–/3		✓	
Lobb's aquatic buttercup *Ranunculus lobbii*	–/–/4, LR	✓		✓
California beaked rush *Rhynchospora californica*	–/–/1B		✓	
Marsh checkerbloom *Sidalcea oregana* ssp. *hydrophila*	SC/–/1B	✓	✓	
Saline clover *Trifolium depauperatum* var. *hydrophilum*	SC/–/1B		✓	
Invertebrates				
California freshwater shrimp *Syncaris pacifica*	FE/SE	✓		✓
Fish				
River lamprey *Lampetra ayresi*	–/SSC			✓
Pacific lamprey *Lampetra tridentata*	FSC/–			✓
Sacramento splittail *Pogonichthys macrolepidotus*	–/SSC			✓
Hardhead *Mylopharodon conocephalus*	–/SSC			✓
Delta smelt *Hypomesus transpacificus*	FT/SE			✓
Longfin smelt *Spirinchus thaleichthys*	–/ST			✓

Common Name *Scientific name*	Status[a] Federal/ State/Other	Riparian Forest/ Woodland	Freshwater Wetland	Open Water/ Stream
Steelhead (Central California Coast DPS) *Oncorhynchus mykiss*	FT/–			✓
Chinook salmon (fall/late fall-run) *O. tshawytscha*	FSC/–			✓
Amphibians				
California red-legged frog *Rana draytoni*	FT/ SSC	✓	✓	✓
Foothill yellow-legged frog *Rana boylii*	–/ SSC			✓
Western spadefoot *Scaphiopus hammondii*	–/ SSC			✓
Reptiles				
Pacific pond turtle *Actinemys marmorata*	–/ SSC	✓	✓	✓
Birds				
White-tailed kite *Elanus leucurus*	–/ SFP	✓	✓	
Northern harrier *Circus cyaneus*	–/ SSC		✓	
Swainson's hawk *Buteo swainsoni*	–/ST	✓		
American peregrine falcon *Falco peregrinus anatum*	FD/ SD, SFP		✓	
Western snowy plover *Charadrius alexandrinus nivosus* (coastal populations)	FT/ SSC (interior population)			✓
Short-eared owl *Asio flammeus*	–/SSC		✓	
Purple martin *Progne subis*	–/ SSC	✓		
Yellow warbler *Dendroica petechia*	–/ SSC	✓		
Salt marsh common yellowthroat *Geothlypis trichas sinuosa*	–/ SSC		✓	
Yellow-breasted chat *Icteria virens*	–/ SSC	✓		
San Pablo song sparrow *Melospiza melodia samuelis*	–/ SSC			
Tricolored blackbird *Agelaius tricolor*	–/ SSC		✓	
Yellow-headed blackbird *Xanthocephalus xanthocephalus*	–/ SSC		✓	
Mammals				
Pallid bat *Antrozous pallidus*	–/ SSC	✓		

Common Name *Scientific name*	Status[a] Federal/ State/Other	Riparian Forest/ Woodland	Freshwater Wetland	Open Water/ Stream
Western red bat *Lasiurus blossevillii*	–/ SSC	✓		
Greater western mastiff bat *Eumops perotis californicus*	–/ SSC	✓		
California ringtail *Bassariscus astutus raptor*	–/ SFP	✓		

[a] Status codes for plants include Federal/State/other (CNPS, CNDDB, or local rarity) categories while those for animals include Federal/State categories only:

Federal:

FE = Listed as endangered under the federal Endangered Species Act
FT = Listed as threatened under the federal Endangered Species Act
FD = Federally delisted
PD = Federally proposed for delisting
FSC = Federal species of concern

State:

SE = Listed as endangered under the California Endangered Species Act
ST = Listed as threatened under the California Endangered Species Act
SD = State delisted
SSC = Considered a species of special concern by the State of California
SFP = Fully protected by the State of California

California Rare Plant Ranks (CDFG 2011):

1A. Presumed extinct in California
1B. Rare or endangered in California and elsewhere
2. Rare or endangered in California, more common elsewhere
3. Plants for which we need more information – Review list
4. Plants of limited distribution – Watch list

Other:

LR = Considered by local experts to be rare in the Napa County portion of its range, although it may be more common elsewhere (see Table 4-7 in Jones & Stokes and EDAW (2005).

2.3 Channel Characterization

Reach characterization sheets that describe channel conditions at the District's primary maintenance locations are provided on the following pages. These sheets are provided to describe the existing/baseline conditions of the channels at the time of this manual. The sheets are presented in a north to south order as follows:

- Conn Creek Reaches 1, 2, and 3
- Beard Ditch
- Yountville Outfall – North Collector
- Yountville Outfall – South Collector Reaches 1 and 2
- Yountville Outfall Reaches 1 and 2
- Solano Ditch
- North Salvador Collector Reaches 1 and 2
- South Salvador Collector
- Salvador Creek Reaches 1, 2, and 3
- Tulucay Creek Reaches 1 and 2
- Camille Creek
- Sheehy Creek
- Fagan Creek

Conn Creek – Reach 1

OWNERSHIP: Private with District easement

LOCATION: From Beckstoffer Vineyards offices to Skellenger Lane

ADJACENT LAND USE: Vineyards

UPSTREAM: Channel conditions immediately upstream are similar to those described for this reach. Streamflow is controlled by Conn Creek Dam approximately 3.5 miles upstream.

LENGTH: 2,890 ft

AVERAGE TOP-OF-BANK WIDTH: 70-80 ft

(1) Looking downstream from the upstream end of the reach (*Photo taken from the bridge on the Beckstoffer Vineyards property, August 4, 2010*).

REACH SETTING:

Reach 1 of Conn Creek is a modified channel that appears to have been dredged and/or straightened for agricultural land use and/or flood control. The upstream portion of the reach is generally in poor condition with respect to aquatic and riparian habitat (Photos 1 and 2). In the middle and downstream portions of the reach, some mature trees (predominantly eucalyptus) line the banks and the channel has geomorphic features (e.g., low flow channel, floodplain surfaces) that are indicative of recovery of natural channel processes (Photo 4).

(2) In the upstream portion of the reach, the channel has a trapezoidal cross-section with minimal riparian habitat. A thick layer of algae covers the channel bed. Vegetation along the banks is primarily non-native, invasive herbaceous species and eucalyptus. (*Looking east from the west bank, August 4, 2010*).

PHYSICAL CONDITIONS

Active channel: channel width is 30-40 ft; the bed is 12-15 ft beneath the top of banks. A bankfull channel (18-20 ft wide by 2-4 ft deep) is distinguishable in the downstream section of the reach (Photo 4). The bed slope is approximately 0.3%.

Bed sediments/texture: The bed is largely composed of 2 to 6 inch cobble, often covered by sand and algae.

Bank structure: The channel has 10-15 ft high earthen banks; slopes range from 1:1 to 2:1 (all photos); the west (right) bank is very steep in some sections (Photos 5 and 6). Concrete retaining walls line a short section (50-75 ft) of banks at the upstream portion of the reach (Photo 1).

Water quality: On August 4, 2010 the upstream portion of the reach had isolated pools covered with algae and aquatic vegetation (Photo 2). The low flow channel in the middle and downstream portions of the reach had standing water approximately 2 ft in depth. All water appeared stagnant and eutrophic (all photos).

Channel processes: Sediment supply is limited by the dam upstream. In locations where sediment deposition does occur, in-channel bars have formed within an over-widened flood control channel. An inset channel develops and migrates laterally, causing some bank erosion (Photo 5).

MAINTENANCE HISTORY

This reach of Conn Creek was a Soil Conservation Service (SCS) flood control project.

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: The streambed is largely a uniform and linear "run" without any significant in-channel habitat features, with the exception of some small scour pools. Aquatic macrophytes and algae are widespread (all photos). Bed substrate is dominated by small to medium sized cobble. Conn Creek is known to support steelhead (*Oncorhynchus mykiss*). The lower portion of this reach may provide suitable rearing habitat.

Vegetation composition:

Channel: algae and unidentified macrophytes

Banks: Understory: Predominantly herbaceous non-natives. There are some coast live oak (*Quercus agrifolia*) saplings along the banks, as well as some recruitment of willow on the lower banks (Photos 4 and 6). Overstory/Canopy: Mature eucalyptus are dominant, with interspersed with a few cottonwoods (*Populus fremontii*) and willow (*Salix* spp.).

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<td>(3) In late summer, much of the reach has relatively stagnant water with considerable algae and aquatic vegetation growth (Looking east near the middle portion of the reach, August 4, 2010).</td>
<td>(4) In the middle to downstream portion of the reach a bankfull channel has formed within the larger flood conveyance channel; mature trees (predominantly eucalyptus) shade the channel (Looking upstream near Skellenger Lane, August 4, 2010).</td>
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Map A. Reach 1 of Conn Creek.

Conn Creek – Reach 2

OWNERSHIP: Private with District easement

LOCATION: From Skellenger Lane to Oakville Road

ADJACENT LAND USE: Vineyards

UPSTREAM: Conn Creek – Reach 1. Approximately 4 miles upstream streamflow is controlled by Conn Creek Dam

LENGTH: 4,900 ft

AVERAGE TOP-OF-BANK WIDTH: 70-110 ft

(1) Looking upstream near the upstream end of Reach 2 *(August 4, 2010).*

REACH SETTING:

Downstream of Skellenger Lane (i.e., at the Reach 1-2 transition) conditions along Conn Creek change markedly. A mature, diverse riparian forest lines the banks and the channel is less modified than in Reach 1. It appears that the channel has not been dredged, straightened or otherwise modified in recent years (Photo 1). The channel has well established bed forms (e.g., in-channel bars) and inset floodplain benches (Photo 1). In the middle of the reach there is a small headcut that maintains approximately 2 to 3 ft of grade in the channel (Photo 3 and Map A). Downstream of the headcut, the streambed is more uniform than in the upstream section due to relatively recent incision (perhaps 5-10 years) (Photo 4).

(2) Typical streambed substrate, medium sized pebbles in Reach 2 *(August 4, 2010).*

PHYSICAL CONDITIONS

Active channel: channel width is 30-40 ft; the bed is 12-15 ft beneath the top of banks. The bankfull channel is 18-20 ft wide by 2-4 ft deep. Bed slope is approximately 0.3%.

Bed sediments/texture: The bed is composed of 2 to 4 inch cobble (Photo 2).

Bank structure: The channel has 10-15 ft high earthen banks; slopes are approximately 3:1. There is a substantial levee along the upstream portion of the west (right) bank.

Water quality: On August 4, 2010, the upstream portion of the reach had isolated pools (Photo 1). The low flow channel in the downstream portion of the reach had standing water approximately 2 – 3 ft in depth (Photo 4). Water temperature was not measured, but felt cool to moderate (~60s). Water quality/clarity appeared better in this reach than in Reach 1, likely due to the shading provided by the well-developed riparian canopy.

Channel processes: Sediment supply is limited by the dam upstream. This reach has likely undergone periods of incision due to historic downcutting of the mainstem Napa River, reduction in sediment supply, and historic channel modifications. Streambed erosion at the active headcut (Photo 3) appears to occur at a relatively slow rate. This assumption is based on the condition of the bed and bank, as well as vegetation, downstream of the headcut.

Conn Creek – Reach 2

MAINTENANCE HISTORY

This reach of Conn Creek was a Soil Conservation Service (SCS) Flood Control Project.

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: Upstream of the headcut the streambed has a generally well developed pool-riffle sequence, though pools tend to be shallow. Downstream of the headcut the streambed is largely a uniform "run" without significant in-channel habitat features. Bed substrate is dominated by large gravel to small cobble. Conn Creek is known to support steelhead (*Oncorhynchus mykiss*). This reach may provide suitable rearing habitat.

Vegetation composition:

Channel: algae and unidentified macrophytes

Banks/Riparian Corridor- Understory: Predominantly native and non-native vines including Himalayan blackberry (*Rubus discolor*), California blackberry (*Rubus ursinus*), and periwinkle (*Vinca major*). Overstory/Canopy: Mature trees form a contiguous riparian corridor. Species include eucalyptus, cottonwood (*Populus fremontii*), willow (*Salix* spp.), oak (predominantly *Quercus agrifolia*), black walnut (*Juglans californica*) and California buckeye (*Aesculus californica*). There is some recruitment of white alder (*Alnus rhombifolia*), willow, and Oregon ash (*Fraxinus latifolia*) along the lower and mid banks.

(3) 2-3 ft deep headcut is found midway through Reach 2. Tree roots provide bed stability at this location and the rate of headward migration appears slow (*Looking upstream near the middle portion of the reach, August 4, 2010).*

(4) As a result of recent bed incision, the bankfull channel in the downstream portion of the reach is deeper and straighter than in the upstream portion. The riparian corridor remains intact, with mature native riparian trees lining the banks (*Looking upstream near Oakville Road, August 4, 2010*).

Map A. Approximate location of headcut in Reach 2 of Conn Creek.

Conn Creek – Reach 3

OWNERSHIP: Private with District easement

LOCATION: From Oakville Road to end of District maintenance easement (Map A).

ADJACENT LAND USE: Vineyards

UPSTREAM: Conn Creek – Reach 2. Approximately 5 miles upstream streamflow is controlled by Conn Creek Dam

LENGTH: 5,700 ft

AVERAGE TOP-OF-BANK WIDTH: 70-90 ft

(2) Looking upstream in the lower portion of Reach 3 *(August 4, 2010).*

REACH SETTING:

Downstream of Oakville Road (i.e., at the Reach 2-3 transition) conditions along Conn Creek change again markedly. The mature riparian forest in Reach 2 gives way to a less dense, less diverse, younger age stand of oaks and willows. The channel bed is far less complex than in Reach 2, largely lacking riffles, pools and/or bars (Photo 1). This plane bed form suggests that the channel may have been dredged, straightened or otherwise modified for flood control in recent history.

(1) Looking upstream near the upstream end of the reach *(August 4, 2010).*

PHYSICAL CONDITIONS

Active channel: channel bed width is 25-35 ft wide; the bed is 12-15 ft beneath the top of banks. The bankfull channel is the width of the bed (20-25 ft) and 2-3 ft deep, marked by a low bench along the bank. The bed slope is approximately 0.3%.

Bed sediments/texture: The bed is composed predominately of coarse gravel, pebbles, and up to medium size cobbles (Photo 4).

Bank structure: The channel has 10-12 ft high earthen banks; slopes are approximately 3:1. Approximately 2/3rds downstream through the reach the channel turns to the west. At this location riprap has been placed to protect the east (left) bank from erosion (Photo 3).

Water quality: In contrast to Reaches 1 and 2, Reach 3 was nearly entirely dry in August 2010, with the exception of some isolated small, shallow pools (Photo 2 and 4). A thick layer of algae covered much of the stream substrate (Photos 1 and 4), suggesting that stagnant water persists well into the dry season.

Channel processes: Sediment supply is limited by the dam upstream, yet this reach appears to be depositional. The channel is also less incised than in Reaches 1 and 2. It is plausible that this reach is depositional because the cross-section of the active channel is wider than in Reach 2. The transition from a narrow to wide section often results in sediment deposition.

Conn Creek – Reach 3

MAINTENANCE HISTORY

This reach of Conn Creek was a Soil Conservation Service (SCS) flood control project.

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: The streambed is largely a uniform linear "run" without significant in-channel habitat features. Bed substrate is dominated by coars gravel, pebbles, up to medium sized cobble. Conn Creek is known to support steelhead (*Oncorhynchus mykiss*). This reach likely provides suitable rearing habitat.

Vegetation composition:

Channel: algae; cattail (*Typha latifolia*), nut sedge (*Cyperus* sp.), rushes (*Juncus* sp.) and hardstem bulrush (*Schoenoplectus* [=*Scirpus*] *acutus*) along the margins.

Banks/Riparian Corridor- Understory: Herbaceous non-natives such as bristly oxtongue (*Picris echioides*) and poison hemlock (*Conium maculatum*) are dominant. Other species include rabbit's foot grass (*Polypogon monspeliensis*), curly dock (*Rumex crispus*), and stinging nettle (*Urtica dioica*). Overstory/Canopy: Mature oaks (predominantly *Quercus agrifolia*) and eucalyptus are dominant along the top of bank. Willows (*Salix* spp.) are abundant along the toe.

Listed species with potential to occur:

Many (6 to 10) Snowy Egrets, Great Egrets and Great Blue Heron were observed in one location, suggesting this site may serve as a rookery.

(3) Looking upstream at the riprap section where the channel turns towards the west. Erosion-resistant riprap sloughed into the channel has resulted in some local bed scour and pooling (*August 4, 2010).*

(4) Typical streambed substrate in Reach 3. Note the algae cover on substrate *(August 4, 2010).*

Conn Creek – Reach 3

Map A. Conn Creek- Reach 3 begins at Oakville Road and flows approximately 5,900 feet to the end of the District maintenance easement. Conn Creek meets the Napa River approximately 1.5 miles further downstream.

Beard Ditch

OWNERSHIP: Town of Yountville with District easement

LOCATION: Eastern boundary of Town of Yountville, between Finnell Road and Land Lane.

ADJACENT LAND USE: vineyard (to east); single-family residential, park (to west).

UPSTREAM: Residential and agricultural drainage

LENGTH: 2,780 ft

AVERAGE TOP-OF-BANK WIDTH: 20-25 ft

(1) Looking downstream from Finnell Road. Dense emergent vegetation occludes the culvert at this crossing (*August 4, 2010*).

REACH SETTING

Beard Ditch is a trapezoidal engineered channel that collects runoff primarily from residential development to the west. There is a stormwater detention outfall near Land Lane (Photo 3). Discharge is routed downstream into a swale that flows through vineyards.

(2) Looking downstream from the mid-point of the Beard Ditch (near Oak Circle). Photo depicts typical conditions in the reach. Adjacent land uses include vineyards along the east (left) bank and residential development along the west (right) bank (*August 4, 2010*).

PHYSICAL CONDITIONS

Active channel: channel bottom is 8-10 ft wide, with a 2 ft wide low flow channel. The channel bed is 3 ft. beneath the top of banks. The bed slope is approximately 1%.

Bed sediments/texture: The bed is formed in native soils. Bed sediments appear to be fine textured.

Bank structure: The banks are formed of native soils that generally slope at 2:1 to 3:1 (Photo 2).

Water quality: water was present at the downstream end of the reach in a pool below the bridge at Land Lane. The water in the pool was clear (Photo 4).

Channel processes: runoff and fine sediment transported from developed areas to west are routed to the ditch. There may also be some drainage/sediment entering the ditch from adjacent vineyards. There appears to be some deposition of sediment at the Finnell Road crossing (Photo 1). Sediment deposition at this location is likely the result of an abrupt change in hydraulics at the culvert outlet.

Beard Ditch

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: Instream habitat is dominated by hydrophytic vegetation (Photo 2). The low flow channel is not well defined. There is a perennial pool at the downstream end of the reach (Photo 4). This pool had some small fishes present; no bullfrog (*Rana catesbeian*) tadpoles were observed.

Vegetation composition:

Channel: Vegetation in the channel is dominated by tall flat sedge (*Cyperus eragrostis*). Broad-leaved cattail (*Typha latifolia*) is dominant in the section just downstream of Finnell Road (Photo 1). Other species present include curly dock (*Rumex crispus*), rushes (*Juncus* spp.) and Italian ryegrass (*Lollium* sp.)

Banks: Understory: Predominantly herbaceous non-native species such as bristly oxtongue (*Picris echioides*), periwinkle (*Vinca major*), prickly lettuce (*Lactuca serriola*), and Himalayan blackberry (minor component). There is also some sporadic willow (*Salix* sp.) recruitment. Overstory/Canopy: Minimal overstory component; there are a few mature oaks adjacent to the ditch.

Map A. The District's maintenance easement on Beard Ditch extends from Finnell Road to Land Lane

North Yountville Collector (NYC)

OWNERSHIP: Private with County easement

LOCATION: Between Hwy 29 (to east) and Solano Ave (to west), reach begins about 1/3 mi south of California Drive, continues to Yountville Outfall confluence.

ADJACENT LAND USE: Hwy 29 and railroad transportation corridor to east; vineyard and golf course to west.

UPSTREAM: Hinman Creek; flows through Vintners Golf Club.

LENGTH: 5,400 ft

AVERAGE TOP-OF-BANK WIDTH: 30-35 ft

(1) Looking downstream from upstream end of the NYC. Two concrete box culverts pass flows from the main upstream tributary into the NYC. Note the dense aquatic and emergent vegetation in the channel (*August 4, 2010*).

REACH SETTING:

The North Yountville Collector (NYC) is a trapezoidal engineered channel that collects runoff from natural drainages, vineyards and Vintners golf course to the west. The NYC begins at twin concrete box culverts that cross under Solano Ave. (Photo 1). The NYC joins the South Yountville Collector and flows east becoming the Yountville Outfall.

(2) Looking downstream near Vineyard View Drive. The channel supports interspersed patches of aquatic vegetation dominated by Ludwigia (foreground) and emergent vegetation dominated by broad-leaved cattail (background). Note cottonwoods planted by District on east (left) bank (*August 4, 2010*).

PHYSICAL CONDITIONS

Active channel: channel bed is 15-20 ft. wide; no low flow channel is distinguishable. The channel bed is 4-6 ft. beneath the top of banks. Bed slope is approximately 0.2%

Bed sediments/texture: Bed sediments are mostly fine sands, silts, some mud.

Bank structure: trapezoidal channel has 4-6 ft. high earthen banks, generally sloped at 2:1 - 3:1 (Photo 2). Concrete has been placed at the transition to the Yountville Outfall (Photo 5).

Water quality: On 8/4/10 nearly the entire channel was inundated, with maximum depths (~ 2 ft.) in the lower portion of the reach. Water clarity appeared poor-fair (Photo 3); water was stagnant at locations.

Channel processes: Deposition of fine sediment appears to be significant in this reach. Dense aquatic and emergent vegetation traps sediment and reduces stormflow velocities, which further encourages sediment deposition. There are limited areas of minor bank erosion, but flow conditions do not appear fast or deep enough to cause widespread bank failure.

North Yountville Collector (NYC)

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: Instream habitat is dominated by aquatic and emergent vegetation (All Photos). The low flow channel is not well defined. Hundreds of bullfrog (*Rana catesbeiana*) tadpoles were observed in perennial pools.

Vegetation composition:

Channel: Dominant or sub-dominant species include *Ludwigia*, broad-leaved cattail (*Typha latifolia*), and tall flat sedge (*Cyperus eragrostis*). Hardstem bullrush (*Scirpus* [*Schoenoplectus*] *acutus*) occurs in isolated patches.

Banks: Understory: Predominantly herbaceous non-natives. Overstory/Canopy: Extensive planting of native trees along both banks; predominantly coast live oak (*Quercus agrifolia*) and cottonwood (*Populus fremontii*). Many trees are well established and thriving; trees range from approximately 5-15 ft in height. There are some mature oaks and *Eucalyptus* on east bank (Photos 1 and 4).

Map A. North Yountville Collector.

South Yountville Collector (SYC) – Reach 1

OWNERSHIP: Private with County easement

LOCATION: Between Hwy 29 (to east) and Solano Ave. (to west), from Hillview Lane downstream (north) to tributary at Mile Marker 2.0.

ADJACENT LAND USE: Hwy 29 and railroad transportation corridor (east); vineyard (west).

UPSTREAM: Drainage from vineyards and natural areas.

LENGTH: 3,300 ft

AVERAGE TOP-OF-BANK WIDTH: 30-35 ft

(2) Looking downstream in the upper portion of the SYC. The channel is formed in native soils. The channel bottom and banks are dominated by non-native herbaceous vegetation (*August 4, 2010*).

REACH SETTING:

The South Yountville Collector (SYC) is a trapezoidal engineered channel that collects runoff from natural drainages and vineyards to the west. The SYC begins at a concrete box culvert that crosses under Solano Ave. (Photo 1). Reach 1 of the SYC flows for approximately 2,760 ft before a major tributary enters from the west, which marks the transition to SYC – Reach 2.

(1) Upstream end of the SYC. A concrete box culvert passes flows (beneath Solano Ave.) from an unnamed tributary to the west into the SYC (*August 4, 2010*).

PHYSICAL CONDITIONS

Active channel: channel bed is 5 ft. wide; the low flow channel is indistinguishable. The channel bed is 6-8 ft. below the top of banks. The bed slope is gentle, less than 0.5%.

Bed sediments/texture: Fines/native soils.

Bank structure: trapezoidal channel has 6-8 ft. high earthen banks, generally sloped at 2:1 - 3:1 (Photo 2). Sack concrete and riprap are placed along the east (right) bank at the upstream end of the reach (Photo 1)

Water quality: no water present on 8/4/10.

Channel processes: runoff and fine sediment are transported from adjacent vineyards and roadways into the channel. No significant sediment deposition was observed. The road grades directly to the top of bank, allowing stormwater from adjacent roads to flow directly into channel (Photo 3).

South Yountville Collector (SYC) – Reach 1

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: There is limited, if any, aquatic habitat in this reach.

Vegetation composition:

Channel: Predominantly herbaceous non-native species such as bristly oxtongue (*Picris echioides*), wild radish (*Raphanus sativus*), and wild oats (*Avena fatua*). Some wetland-associated species such as tall flat sedge (*Cyperus eragrostis*) and curly dock (*Rumex crispus*) are present in the lower portion of the reach (Photo 4).

Banks: Understory: Predominantly herbaceous non-natives. Overstory/Canopy: Extensive planting of native trees, predominantly cottonwood (*Populus fremontii*), along both banks (Photo 3). There are many mature oak trees, and a few eucalyptus trees, along the east bank (Photos 2 and 3).

(3) Looking upstream from the mid-point of SYC Reach 1. Note the cottonwoods planted along both banks (*August 4, 2010*).

(4) The lower section of the reach has some wetland-associated plant species in the channel bed (*August 4, 2010*).

Map A. Reach 1 (red line) and Reach 2 (yellow line) of the South Yountville Collector. The tributary that joins at Solano Ave MM 2.0 marks the reach break.

South Yountville Collector (SYC) – Reach 2

OWNERSHIP: Private with County easement

LOCATION: Adjacent to (east of) Solano Ave., from tributary at Mile Marker 2.0 downstream (north) to Yountville Outfall.

ADJACENT LAND USE: Hwy 29 and railroad transportation corridor (east); vineyard (west).

UPSTREAM: Reach 1 of SYC; Drainage from vineyards and natural areas.

LENGTH: 2,080 ft

AVERAGE TOP-OF-BANK WIDTH: 30-35 ft

(1) Upstream end of the SYC- Reach 2. The culvert at Mile Marker 2.0 marks the upstream end of the reach. Note the cottonwoods planted along the channel (*Looking downstream, August 4, 2010*).

REACH SETTING:

The South Yountville Collector (SYC) is a trapezoidal engineered channel that collects runoff from natural drainages and vineyards to the west. Reach 2 of the SYC joins the North Yountville Collector and flows east becoming the Yountville Outfall.

(2) Looking upstream in the mid-portion of SYC Reach 2. The channel is formed in native soils. Dense aquatic vegetation, such as *Ludwigia*, grows in the channel (*August 4, 2010*).

PHYSICAL CONDITIONS

Active channel: channel bed is 12-15 ft. wide; the low flow channel is indistinguishable. The channel bed is 4-8 ft. below the top of banks. The bed slope is less than 0.5%.

Bed sediments/texture: Fines/native soils.

Bank structure: trapezoidal channel has 4-8 ft. high earthen banks, generally sloped at 2:1 - 3:1 (Photo 2). Concrete has been placed at the transition to the Yountville Outfall (Photo 4).

Water quality: On 8/4/10 the channel appeared saturated, but limited standing water was observed due to the dense cover of aquatic vegetation.

Channel processes: Deposition of fine sediment likely occurs in this reach, but channel capacity does not appear to be significantly compromised. An assessment of as-built versus current cross-sectional area would help assess the extent of sedimentation that has occurred in the channel.

South Yountville Collector (SYC) – Reach 2

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: Instream habitat is dominated by aquatic and emergent vegetation (All Photos). The low flow channel is not well defined.

Vegetation composition:

Channel: Dominant or sub-dominant species include *Ludwigia*, broad-leaved cattail (*Typha latifolia*), and tall flat sedge (*Cyperus eragrostis*).

Banks: Understory: Predominantly herbaceous non-natives. Overstory/Canopy: Extensive planting of native trees along both banks; predominantly cottonwood (*Populus fremontii*). Many trees are well established and thriving (Photo 1).

(3) Looking upstream from mid-reach area. Note the cottonwoods planted along banks and cattails in channel (*August 4, 2010*).

(4) Looking upstream from the confluence with the Yountville Outfall. Note dense *Ludwigia* in the channel (*August 4, 2010*).

Map A. Reach 1 (red line) and Reach 2 (yellow line) of the South Yountville Collector. The tributary that joins at Solano Ave MM 2.0 marks the reach break.

Solano Ditch

OWNERSHIP: Private with County easement

LOCATION: Adjacent to (east of) Solano Ave., from Oak Knoll Ave. (upstream and south end) to approximately 500 feet south of Darms Lane (downstream and north end).

ADJACENT LAND USE: Hwy 29 and railroad transportation corridor (east); vineyard (west)

UPSTREAM: no defined tributary upstream, runoff catchment areas to west

LENGTH: 4,250 ft

AVERAGE TOP-OF-BANK WIDTH: 25 ft

(1) Looking downstream near Oak Knoll Ave [Solano Ave to west (left)]. Mature oaks grow along the upstream portion of the Solano Ditch corridor (*August 4, 2010*).

REACH SETTING

Solano Ditch is a linear trapezoidal channel that collects runoff from vineyards and upland areas to the west and routes this discharge to north to Dry Creek. The channel bottom is lined with concrete. Consequently, runoff is transported rapidly through the ditch and no aquatic habitat is present along the bed of the ditch.

(2) Looking downstream from the mid-point of the Solano Ditch. The channel bottom and low banks are lined with concrete. The upper banks are formed in native soils. Vegetation on the upper banks consists of non-native herbaceous species (*August 4, 2010*).

PHYSICAL CONDITIONS

Active channel: channel bottom is 3.5 ft wide; the top width of the concrete channel is approximately 10 ft. The channel bed is 4-8 ft. beneath the top of banks.

Bed sediments/texture: The bed is formed of concrete. There is minimal sediment deposition within the channel (Photo 2).

Bank structure: Lower banks are formed of concrete (Photo 2). The upper banks are formed in native soils, generally sloped at 2:1 (Photo 2).

Water quality: no water present on 8/4/10.

Channel processes: runoff and fine sediment are transported from adjacent vineyards, natural drainages, and roadways to the west into the channel. The concrete lined channel appears to efficiently convey runoff and sediment; no significant deposition was observed (Photo 2).

Solano Ditch

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: There is limited, if any, aquatic habitat present in this reach due to the concrete lining of the channel.

Vegetation composition:

Channel: None.

Banks: Understory: Predominantly herbaceous non-native species such wild radish (*Raphanus sativus*), prickly lettuce (*Lactuca serriola*), bull thistle (*Cirsium vulgare*) and Harding grass (*Phalaris aquatica*). There is some Himalayan blackberry (*Rubus discolor*) growing along the west (left) bank (Photo 3); it appears that the District may be managing this patch of invasive blackberry. Overstory/Canopy: Upstream portion of the reach has mature oaks (predominantly *Quercus agrifolia*) lining the channel. A few oaks have been planted by the District along the channel.

Map A. North Yountville Collector.

North Salvador Collector (NSC) – Reach 1

OWNERSHIP: City of Napa and Private with District easement

LOCATION: Adjacent to (east of) Solano Ave., between Luke Dr. upstream (north) and Salvador Ave. downstream (south)

ADJACENT LAND USE: Hwy 29 and railroad transportation corridor to east; medium/high density residential, senior citizens community, and light commercial use to west

UPSTREAM: Culverted tributaries capture runoff from developed areas and vineyards to west

LENGTH: 1,820 ft

AVERAGE TOP-OF-BANK WIDTH: 40 ft

(1). Reach 1 is an intermittent stream that is dry much of the year. In channel vegetation is dominated by mesic species. Riparian trees, predominately oaks, planted by the District line the east side of channel (right side of the photo) (*Looking upstream from mid-point in the reach, August 4, 2010*).

REACH SETTING

North Salvador Collector (NSC) is a linear trapezoidal channel that collects runoff from developed areas, vineyards, and natural drainages to the west and routes this discharge downstream (southward) into NSC Reach 2. The catchment area for Reach 1 is relatively limited. Consequently, this reach is intermittent (or ephemeral) and conveys less runoff than Reach 2 downstream which has larger tributary areas.

(2) Looking downstream from Luke Road (Solano Ave to west (left). Note riparian enhancement plantings (primarily oaks) on the left bank and retaining wall on right bank (*August 4, 2010*).

PHYSICAL CONDITIONS

Active channel: channel bed is 8-10 ft. wide; no distinguishable low flow channel. The channel bed is 4-6 ft. beneath the top of banks. The bed slope is less than 0.5%.

Bed sediments/texture: Alluvial fine sediment over native soils (Haire loam) with some riprap placed in the bed and lower banks.

Bank structure: trapezoidal channel has 4-6 ft. high earthen banks, generally sloped at 2:1 - 3:1 (Photo 1). There is a concrete retaining wall/floodwall in the upper portion of the reach (near Luke Dr.) on the right bank (Photo 2).

Water quality: no water present on 8/4/10.

Channel processes: runoff and fine sediment are transported from upstream vineyards, development, and roadways into the channel. Channel transport capacity appears in relative balance with sediment delivery, with no significant deposition occurring. The road grades directly to the top of bank, allowing stormwater from adjacent road to flow directly into channel (Photo 1).

North Salvador Collector – Reach 1

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: There is limited, if any, aquatic habitat in this reach. Due to the lack of flows, the streambed does not exhibit distinct morphology that could provide aquatic habitat (e.g., pools, riffles, bank alcoves, etc).

Vegetation composition:

Channel: Predominantly herbaceous non-native species such as bristly oxtongue (*Picris echioides*), wild radish (*Raphanus sativus*) and wild oats (*Avena fatua*). Some wetland associated species are present such as tall flat sedge (*Cyperus eragrostis*) and curly dock (*Rumex crispus*).

Banks: Understory: bristly oxtongue, wild radish, wild oats, and Harding grass (*Phalaris aquatic*). Overstory/Canopy: Extensive planting along left bank by District. Predominantly coast live oak (*Quercus agrifolia*); also cottonwood (*Populus fremontii*) and big leaf maple (*Acer macrophyllum*). These trees are well established and thriving; trees range from approximately 10-15 ft in height, and 2-5 inches dbh.

Map A. Reach 1 (yellow line) and Reach 2 (red line) of the North Salvador Collector. The confluence of Salvador Creek, just south of Salvador Ave, marks the reach break.

North Salvador Collector (NSC) – Reach 2

OWNERSHIP: City of Napa and Private with District easement

LOCATION: Adjacent to (east of) Solano Ave., Salvador Ave. (upstream) runs south to South Salvador Collector confluence.

ADJACENT LAND USE: Hwy 29 and railroad transportation corridor to east; single-family residential to west

UPSTREAM: North Salvador Collector- Reach 1; upper Salvador Creek.

LENGTH: 2,400 ft

AVERAGE TOP-OF-BANK WIDTH: 45-50 ft

(1) Near the upstream end of Reach 2, two 60-inch concrete culverts deliver flows from upper Salvador Creek, which originates in the Mayacamas Mountains to the west (*August 4, 2010*).

REACH SETTING:

The North Salvador Collector (NSC) is a linear trapezoidal engineered channel that collects runoff from vineyards and natural drainages to the west. Reach 2 of the NSC begins at the Salvador Ave. crossing. Approximately 60 feet downstream of the crossing, twin concrete culverts enter the channel from the west (right bank, Photo 1). These culverts convey flows from a culverted reach of (upper) Salvador Creek. Downstream, Reach 2 joins the South Salvador Collector and then flows east beneath Hwy 29, becoming (lower) Salvador Creek.

(2) Looking downstream near the mid-point Reach 2. Reach 2 NSC collects more runoff than Reach 1 NSC. Consequently, hydrophytic vegetation is present through most of the channel (*August 4, 2010*).

PHYSICAL CONDITIONS

Active channel: channel width is 15-20 ft. with low flow channel 2-4 ft wide (when present). The channel bed is 6-8 ft. beneath the top of banks at the upstream end, and 3-5 ft beneath the top of banks at the downstream end. The bed slope is less than 0.5%.

Bed sediments/texture: Native soils (Haire loam) with some riprap placed in the bed and lower banks. Sack concrete has been placed opposite the Salvador Creek culvert outfall (Photo 1) at the upstream end of the reach to stabilize portions of the west bank (Photo 4).

Bank structure: trapezoidal channel has 4-6 ft. high earthen banks, generally sloped at 2:1 - 3:1 (Photo 1). Sack concrete has been placed along extensive portions of the western bank in the lower reach.

Water quality: Some areas of ponding were observed in Aug 2010. Water clarity appeared poor-fair at the upstream end (Photo 2), and good at the downstream end. Small areas of sheen were observed (less than 5 ft^2).

Channel processes: Deposition of fine sediment appears to be significant in this reach. A "wedge" of fine sediment has developed in the lower reach, where it is deepest, and is less deep in the upstream direction. This depositional pattern is caused by the concrete weir at the downstream end of the reach that traps sediment and establishes channel grade.

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: Aquatic habitat consists of isolated shallow-ponded depressions surrounded by tall emergent vegetation. The low flow channel is not well defined.

Vegetation composition:

Channel: A diverse assemblage of hydrophytes. Dominant or sub-dominant species include in the upstream portion include tall flat sedge (*Cyperus eragrostis*) and penny royal (*Mentha pulegium*); broad-leaved cattail (*Typha latifolia*) is dominant in the section downstream of Wine District Road. Other species present include curly dock (*Rumex crispus*), Himalayan blackberry (*Rubus discolor*), and rushes (*Juncus* spp.)

Banks: Understory: Predominantly herbaceous non-native species such as bristly oxtongue (*Picris echioides*), wild radish (*Raphanus sativus*) and wild oats (*Avena fatua*). Overstory/Canopy: Planting of native trees along left bank, predominantly coast live oak (*Quercus agrifolia*); trees are smaller than those planted in Reach 1 (Photo 3). Some mature oaks on left bank (Photo 1).

Map A. Reach 1 (yellow line) and Reach 2 (red line) of the North Salvador Collector. The confluence of upper Salvador Creek, just south of Salvador Ave, marks the reach break.

South Salvador Collector (SSC)

OWNERSHIP: Private with District easement

LOCATION: Adjacent to Solano Ave. (to west), between Trower Ave. upstream (to south) and confluence with North Salvador Collector downstream to north

ADJACENT LAND USE: Hwy 29 and railroad corridor to east; Public school and fire station to west

UPSTREAM: Culverted drainage

LENGTH: 1,360 ft

AVERAGE TOP-OF-BANK WIDTH: 30-40 ft

(1). Typical section of the SSC (*Looking downstream from upper portion of the reach; August 4, 2010*). Note dense emergent vegetation growing in the channel.

REACH SETTING:

The South Salvador Collector (SSC) is a linear trapezoidal drainage channel that collects runoff from vineyards, residential development and natural drainages to the west. The SSC is a north flowing channel that joins the North Salvador Collector to form Salvador Creek, which then flows east toward the Napa River. Only one reach was identified for the SSC.

(2) Culvert outlet at upstream end of the SSC. Water clarity at this location was good (*August 2010*). Note emergent vegetation growing immediately downstream of outfall.

PHYSICAL CONDITIONS

Active channel: channel bed is 10-20 ft. wide; no low flow channel present. The channel bed is 5-7 ft. beneath the top of banks at the upstream end, and 3-5 beneath the top of banks at the downstream end.

Bed sediments/texture: alluvial fine sediment.

Bank structure: trapezoidal channel. 4-6 ft. high earthen banks, generally sloped at 2:1 - 3:1 (Photo 1).

Water quality: Some ponding throughout the reach. Water clarity near the upstream culvert appeared good on 8/4/10 (Photo 2).

Channel processes: Deposition of fine sediment appears to be significant in this reach, with associated growth of emergent vegetation in the freshly deposited material. Deposition in the downstream portion of the reach is likely related to flood-stage hydraulics. The Highway 29 culvert crossing restricts flow during flood events, which causes backwatering of the North and South Salvador Collectors. The SSC is backwatered to a greater extent than the NSC because discharge in the NSC is greater. Low velocities of sediment-laden flood waters create ideal conditions for deposition.

South Salvador Collector (SSC)

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: Aquatic habitat consists of isolated shallow ponded depressions surrounded upstream and downstream by tall emergent vegetation. The low flow channel is not well defined.

Vegetation composition:

Channel: Broad-leaved cattail (*Typha latifolia*) is dominant in this reach. Knotweed (*Polygonum* sp.) also occurs in perennial inundated portions of the channel.

Banks: Understory: Predominantly herbaceous non-native species; unidentified *Apiaceae* dominant. Overstory/Canopy: Planting of native trees along right bank, several planted cottonwoods (*Populus fremontii*) are thriving (Photo 2). There are a few mature Monterey cypress (*Cupressus macrocarpa*) on right bank (Photo 1).

Map A. South Salvador Collector.

Salvador Creek – Reach 1

OWNERSHIP: District owned

LOCATION: From Highway 29 downstream to Trower Ave. crossing

ADJACENT LAND USE: Vineyards and residential development to north; residential development to south.

UPSTREAM: North and South Salvador Collectors

LENGTH: 3,910 ft

AVERAGE TOP-OF-BANK WIDTH: 40-50 ft

(1) Typical conditions in the upstream portion of the reach (*Looking downstream, July 2010*).

REACH SETTING:

Reach 1 of Salvador Creek is a modified channel that conveys runoff from the North and South Salvador Collectors. The reach begins at Hwy 29, and flows southeasterly through residential development and vineyards on the valley floor. The channel has been highly modified for flood control purposes. Consequently, the channel has a simple cross-sectional form with relatively uniform bed and banks.

(2) Looking upstream from a bridge approximately 1,600 ft downstream of Hwy 29. Dense growth of *Ludwigia* covers the channel. The District has planted native trees along the south bank (right side of photo) (*July 2010*).

PHYSICAL CONDITIONS

Active channel: channel bed is 25-30 ft. wide; no low flow channel is distinguishable. The channel bed is 5-7 ft. beneath the top of banks. The bed slope is less than 0.5%.

Bed sediments/texture: Bed sediments appear to be sands and fines.

Bank structure: trapezoidal channel has 5-7 ft. high earthen banks, generally sloped at 1:1 - 1.5:1 (All Photos). Riprap has been placed at the toe of slope along much of the channel (Photo 4), and armors several isolated stretches of streambank.

Water quality: On 7/8/10 the nearly the entire channel was inundated with approximately 2 ft. of standing/stagnant water. Water clarity appeared good.

Channel processes: Reach characterized by deep trapezoidal channel, with sequences of depositional patches and deeper pools. Channel alignment follows bends (which may follow historic channel alignment). Outer bends are more erosive with higher velocity flows, inner bend areas are depositional. Sediment collects at downstream end of reach between crossings where channel is widened.

Salvador Creek – Reach 1

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: Instream habitat is dominated by aquatic vegetation (All Photos). The low flow channel is not well defined.

Vegetation composition:

Channel: *Ludwigia* is dominant (Photo 4). Broad-leaved cattail (*Typha latifolia*) present.

Banks: Understory: Predominantly herbaceous non-natives including bristly oxtongue (*Picris echioides*), Harding grass (*Phalaris aquatica*), and periwinkle (*Vinca major*); Himalayan blackberry (*Rubus discolor*) also common. Overstory/Canopy: Planting of native trees along south bank; predominantly coast live oak (*Quercus agrifolia*), willow (*Salix* sp.) and cottonwood (*Populus fremontii*). There are many mature trees, predominantly oaks and black walnut (*Juglans californica*), along the banks in the lower portion of the reach..

Map A. Reach 1 of Salvador Creek extends from Highway 29 to Trower Avenue.

MAINTENANCE CONSIDERATIONS AND MANAGEMENT OPPORTUNITIES

There is some relatively minor streambank erosion in several locations, generally at outer bend locations along the reach. At this time, this erosion does not warrant direct treatment, but the District will continue to monitor these sites.

There is sediment accumulation in the short section between the Jefferson Street and Trower Ave. crossings (Photo 5), including some culvert blockage at the Trower Ave. crossing. The sediment at these locations is targeted for removal during the summer of 2012. The underlying cause of sediment deposition at this site (as shown in Photo 5) is the widening of the overall channel area between the

Trower Ave. and Jefferson St. This channel section is culverted and the combination of the slight gradient, widened channel, and channel bend (creating a point bar on the inner bend between Jefferson St. and Trower Ave. has resulted in the observed deposition.

The District has taken steps to enhance ecological conditions in this reach through extensive planting of native trees (Photo 6). Additional planting on the north bank may be beneficial and worth consideration. There is dense growth of aquatic vegetation in the reach. *Ludwigia* management strategies could be considered, along with other management approaches for the existing invasive plant species.

(3) Looking downstream from a bridge approximately 1,600 ft downstream of Hwy 29 (*July 2010*).

(4) Looking upstream from Jefferson St. Note riprap at the toe of slope on south bank (left side of photo) (*July 2010*).

(5) Sediment accumulation along the south bank (right side of photo) between Jefferson St. and Trower Ave. (*December 2009*).

(6) Extensive planting of native trees along the south (right) bank (*July 2010*).

Salvador Creek – Reach 2 (no District easement)

OWNERSHIP: Napa Valley Unified School District; City of Napa. No District easement.

LOCATION: From Trower Ave. downstream to Garfield Lane

ADJACENT LAND USE: Vintners High School and recreational facilities.

UPSTREAM: Salvador Creek - Reach 1

LENGTH: 2,730 ft

AVERAGE TOP-OF-BANK WIDTH: 50-60 ft

(1) Typical conditions in the upstream portion of the reach. Water is pooled downstream due to beaver dam seen in Photo 2 (*Looking downstream from Trower Ave, July 8, 2010*).

REACH SETTING:

Reach 2 of Salvador Creek is a transitional reach between the modified channel of Reach 1 and the more natural channel in Reach 3. The upstream portion of the reach maintains a modified form, but has more variability and diverse habitat than in Reach 1; the lower section of the reach is more characteristic of a natural channel. Multiple beaver dams at the high school create flow and debris blockages that reduce conveyance capacity and increase the flood risk.

(2) The first beaver dam located approximately 600 ft downstream of Trower Ave. Dam pools water upstream as seen in Photo 1 (*July 8, 2010*).

PHYSICAL CONDITIONS

Active channel: channel bed is 20-25 ft. wide; no low flow channel is distinguishable. The channel bed is 5-7 ft. beneath the top of banks. The bed slope is less than 0.5%.

Bed sediments/texture: Bed sediments appear to be sands and fine sediment.

Bank structure: 5-7 ft. high earthen banks, generally sloped at 1:5-2:1 (All Photos). Concrete has been along the north bank in a section in the downstream portion of the reach (Photo 4).

Water quality: On 7/8/10 the entire channel was inundated. Water depths varied with distance from beaver dams with the deepest water pooling occurring immediately upstream of dams. Water was generally stagnant. Water clarity appeared poor-fair.

Channel processes: Sediment deposition occurs in sequence of small instream bars and benches. Beaver dams trap sediment and debris (Photo 2), dams also reduce flow velocities upstream, which favors the deposition of suspended sediment.

Salvador Creek – Reach 2 (no District easement)

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: Deep pools formed by beaver dams. Some aquatic vegetation in shallower areas. The low flow channel is not well defined. Significant large woody debris (LWD) from beaver activity.

Vegetation composition:

Channel: *Ludwigia* in shallow ponded areas. Broad-leaved cattail (*Typha latifolia*) along margins of channel.

Banks: Understory: Predominantly herbaceous non-natives including bristly oxtongue (*Picris echioides*), Harding grass (*Phalaris aquatica*) and curly dock (*Rumex crispus*); blackberry (*Rubus spp.*) also common. Overstory/Canopy: Willow (*Salix* sp.) and cottonwood (*Populus fremontii*); many trees have been damaged/destroyed by beaver activity.

(3) Downed trees crossing the channel from beaver activity (*July 8, 2010*).

(4) Looking downstream from a bridge in the lower portion of the reach. Note concrete lining on north bank (left side of photo) (*July 8, 2010*).

Salvador Creek – Reach 2 (no District easement)

Map A. Reach 2 of Salvador Creek (shown as blue line above) extends from Trower Avenue to Garfield Lane.

Salvador Creek – Reach 3

OWNERSHIP: District, City of Napa, and Private with District easement.

LOCATION: From Garfield Lane to Big Ranch Road. District easement includes Summerbrooke Circle to private automobile bridge (Map A).

ADJACENT LAND USE: Residential development.

UPSTREAM: Salvador Creek- Reach 2 development.

LENGTH: 3,110 ft

AVERAGE TOP-OF-BANK WIDTH: 45-55 ft

(1) Typical conditions in the upper portion of the reach (*Looking downstream, September 22, 2010*).

REACH SETTING:

Compared to upstream Reaches 1 and 2, Reach 3 of Salvador Creek is a more natural channel that flows through a well established riparian corridor. The upstream portion of Reach 3 has dense riparian vegetation on both banks and relatively good floodplain connectivity. Bank angle and height gradually increase in the downstream direction. The downstream portion of the reach is deeply incised with very steep streambanks (Photos 3, 4 and 5). Many streambanks are highly unstable (Photo 5).

(2) An active headcut marks the upstream extent of the incised portion of the reach (*Looking upstream, July 8, 2010*).

PHYSICAL CONDITIONS

Active channel: channel bed is 12-15 ft wide. In the upper portion of the reach the channel bed is 6-10 ft beneath the top of banks, and 12-18 ft in the lower portion of the reach. The bed slope is approximately 0.3%.

Bed sediments/texture: Bed sediments are composed of a wide range of grain sizes, from fines to large boulders.

Bank structure: 6-20 ft high earthen banks. 2:1 to 3:1 in the upper portion transitioning to near vertical in the lower portion of the reach (All Photos).

Water quality: The entire reach was inundated on July 8, 2010. Water depths were approximately 1-3 ft in the upstream portion of the reach. There were many deep pools (~6 ft) in the lower portion. Water clarity was turbid, likely due to organic constituents (i.e., not mineral sediment).

Channel processes: Mid-way through the reach there are a series of headcuts that suggest the channel is actively incising. The stability of these headcuts and the rate of migration were not assessed. The downstream portion of the reach has clearly undergone recent incision as evidenced by the steep streambanks and recruitment of large trees into the channel (Photos 3, 4, and 5).

Salvador Creek – Reach 3

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: Predominantly pool and run habitat with a few riffles. Many pools are shaded with root assemblages and other habitat features.

Vegetation composition:

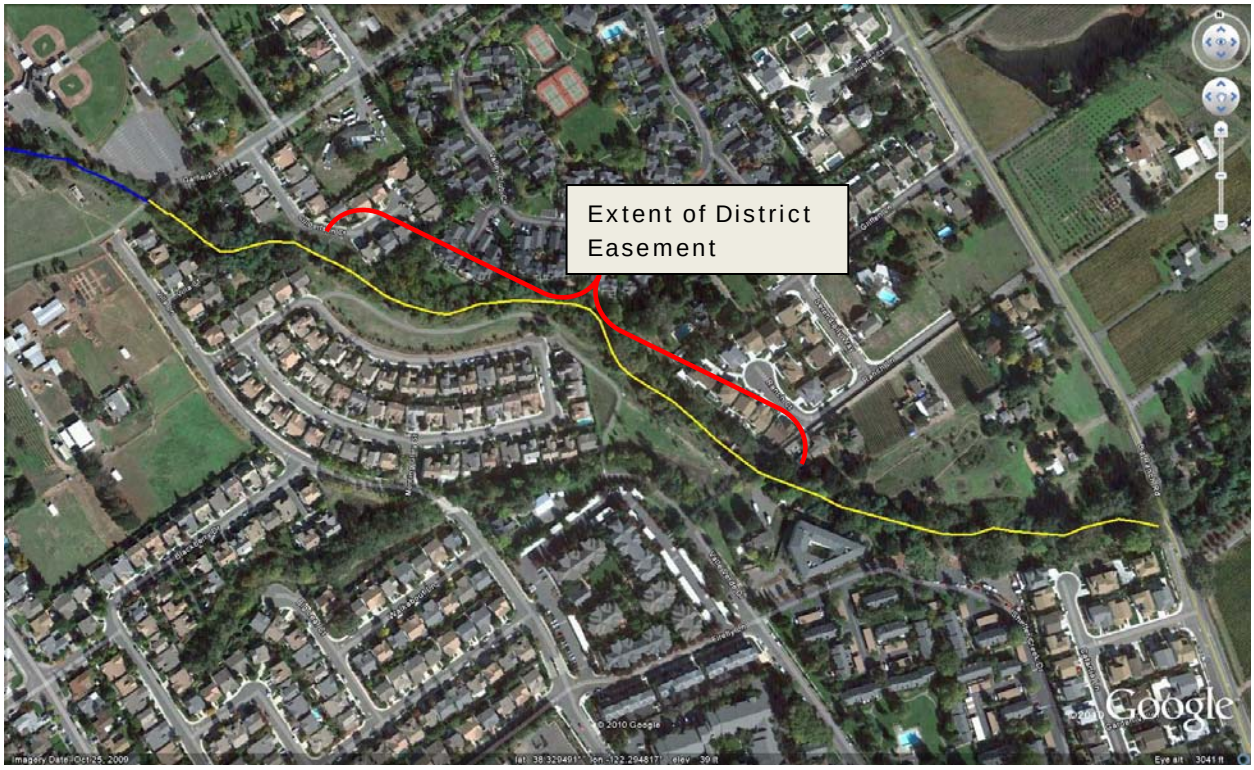
Channel: Limited vegetation in the channel. Some rushes (*Juncus* sp.) on the channel margins.

Banks: Understory: Predominantly herbaceous non-natives including bristly oxtongue (*Picris echioides*) and Harding grass (*Phalaris aquatica*) in open areas adjacent to the channel. A few Arundo patches in the downstream area (Photo 6). Many native trees and shrubs planted as part of the Salvador Creek habitat restoration project. Dense Himalayan blackberry (*Rubus discolor*) thickets in the lower portion of the reach. Overstory/Canopy: Mature, diverse canopy dominated by willow (*Salix* spp.); oaks (*Quercus spp.*) are sub-dominant.

(3) Typical conditions in the lower portion of the reach, with deep pools and undercut streambanks (to right). (*Looking downstream, July 8, 2010*).

(4) Looking upstream from Big Ranch Road. Note streambank erosion on left side of photo, undercutting the streambank (*July 8, 2010*).

Salvador Creek – Reach 3



Map A. Reach 3 of Salvador Creek (shown as yellow line above) extends from Garfield Lane to Big Ranch Road. The District's maintenance easement extends from Summerbrooke Circle downstream to a private automobile bridge.

Tulocay Creek – Reach 1

OWNERSHIP: Private with District easement

LOCATION: From upstream portion of District easement near Twin Creeks Court to Soscol Ave.

ADJACENT LAND USE: Residential development in the upstream portion; commercial development in downstream portion.

UPSTREAM: Natural stream with well developed riparian corridor

LENGTH: 1,530 ft

AVERAGE TOP-OF-BANK WIDTH: 60-80 ft

(1) Looking downstream from the upstream end of reach (*September 22, 2010*).

REACH SETTING:

Reach 1 Tulocay Creek begins as a natural/semi-natural channel surrounded by residential development. The channel appears to have been modified in the past, but has recovered from historical disturbance. There is well developed instream and riparian habitat in this portion of the reach (Photo 1). This condition persists for approximately 500-700 ft as the creek gradually transitions to a more modified channel with uniform bed and banks. Between the confluence of Camille and Soscol Ave (Map A), the creek is a highly modified drainage channel, with the exception of the well established riparian trees on the south (left) bank (Photo 3).

(2) Near confluence of Camille Creek, the more natural Tulocay Creek section transitions to a more modified flood control type channel (*Looking downstream from the Tulocay-Camille Creek confluence, September 2010*).

PHYSICAL CONDITIONS

Active channel: channel bed is 15-20 ft wide (Photo 1); the bed is 12-15 ft beneath the top of banks. The bed slope is less than 0.5%.

Bed sediments/texture: The bed is composed of 2 to 4 inch cobble in the upstream portions of the reach. There is abundant sand and fine sediment accumulation in a large mid channel bar just upstream of the Soscol Avenue crossing (Photo 4).

Bank structure: The channel has 10-15 ft high earthen banks; generally sloping at 2:1 to 3:1 (all photos). The south (left) bank near Soscol Ave is formed by a concrete retaining wall (Photo 4).

Water quality: On September 22, 2010, nearly the entire reach was inundated. Water quality/clarity appeared fair-good. Pools were generally covered with duckweed.

Channel processes: Sediment transport in the upstream portion of the reach appears balanced (no evidence of substantial erosion or deposition). In the relatively recent past (less than 50 years), it appears that the channel incised through this reach, as evidenced by tall, steep banks off-set from the contemporary channel and development of an in-set floodplain. There appears to be substantial sediment deposition at the Camille Creek confluence and at the Soscol Ave crossing. Deposition in these areas is caused by localized hydraulic conditions (i.e., decrease in slope, increase in channel width causes deposition).

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: The upstream portion of the reach has relatively well developed pool-riffle habitat that quickly transitions to a uniform "run" without any significant in-channel habitat features. Bed substrate is dominated by large gravel to small cobble. In the middle and downstream portions of the reach there is minimal development of aquatic habitat; vegetation such as cattail (*Typha latifolia*) is abundant in the channel.

Vegetation composition:

Channel: Duckweed and cattail are dominant. Pennywort (*Hydrocotyle* sp.) also observed.

Banks: Understory: Himalayan blackberry (*Rubus discolor*) is dominant in areas with a dense riparian canopy; stinging nettle (*Urtica dioica*) and wild grape (*Vitis californica*) are also common. In areas without a well developed canopy, herbaceous non natives are dominant. The canopy in the upstream portion of the reach is dominated by coast live oak (*Quercus agrifolia*) and black walnut (*Juglans calfornica*) in the mid-upper bank range, with willow (Salix spp.) and white alder (*Alnus rhombifolia*) occupying the inset floodplain. In the lower portion of the reach there are some new riparian plantings on the north (right) bank (Photo 3), and some mid-seral riparian trees on the south (left) bank.

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(3) Tulocay Creek - typical channel conditions between Camille Creek and Soscol Ave. (*Looking downstream, September 22, 2010*).

(4) Looking upstream from Soscol Ave crossing. Abundant sediment collects in a large and well developed mid channel bar (sediment wedge). Vegetation grows on deposited sediment, debris is caught on bar too. *September 22, 2010).*

Tulocay Creek – Reach 1

Map A. Reach 1 of Tulocay Creek is depicted as the blue line. Camille Creek (pink line) joins Tulocay Creek mid-way through Reach 1. Reach 2 of Tulocay Creek (red line) begins downstream of Soscol Ave.

Tulocay Creek – Reach 2

OWNERSHIP: Private with District easement

LOCATION: From Soscol Ave. upstream (east) to UPRR bridge downstream (west)

ADJACENT LAND USE: Commercial development along Soscol Ave. corridor at upstream portion; Open space in downstream portions.

UPSTREAM: Tulocay Reach 1

DRAINAGE AREA: 12.6 mi^2 at old USGS gauging station.

LENGTH: 1,900 ft

AVERAGE TOP-OF-BANK WIDTH: 65-85 ft

(1) Looking downstream from Soscol Ave. abundant instream vegetation over deposited sediment. (*September 22, 2010*).

REACH SETTING:

Reach 2 Tulocay Creek is a modified drainage channel with uniform bed and banks. The upper 2/3rd of reach is a freshwater drainage; the lower 1/3rd is a tidally influence brackish channel (Map A). There is commercial development adjacent to the channel in the upper 400 ft of the reach (Map A); in the downstream portion the adjacent land use is largely open space, areas that may serve as a floodplain for the Napa River.

(2) Looking upstream in the upper portion of the reach, Dense aquatic and emergent vegetation in the upstream portion of the reach. Note USGS gauging station on right side of photo (*September 22, 2010*).

PHYSICAL CONDITIONS

Active channel: channel bed is 25-35 ft wide (Photo 1); the bed is 15 ft beneath the top of banks. The bed slope is less than 0.5%.

Bed sediments/texture: The bed is composed of fine alluvial and marine sediments.

Bank structure: The channel has 15-18 ft high earthen banks that slope more gently along northern bank 2:1 to 3:1, and steeper at outer bend on south bank 1:1 to 2:1 where bank erosion is observed just upstream of the USGS gage (Photo 5).

Water quality: In September 2010, nearly the entire reach was inundated. Water quality/clarity appeared fair-good.

Channel processes: Sediment transport in the upstream portion of the reach appears to be impeded by dense vegetation growth in the channel. The low flow channel is either not present or poorly defined. Most low flows occur as shallow diffuse flows across channel bed. During high flows it is likely that suspended sediment is transported through the upper portion of the reach, but much bed load delivered from Tulocay Reach 1 is likely deposited. The modified cross-section (i.e., over-widened) and lack of riparian canopy promotes emergent marsh vegetative conditions that cause fine sediment accumulation.

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: In the freshwater portion of the reach there is minimal development of aquatic habitat; vegetation such as cattail (*Typha latifolia*) and smartweed (*Polygonum* sp.) occlude the channel. The tidal portion has a small, open-water slough bounded by tall emergent vegetation (Photo 4).

Vegetation composition:

Channel: Cattail, smartweed, rice cut grass *(Leersia oryzoides*) are dominant in the freshwater portion. California bulrush (*Schoenoplectus* [=Scirpus] *californicus*) is dominant in the tidal section.

Banks: Understory: Predominantly herbaceous non-native species such bristly oxtongue (*Picris echioides*), field mustard (*Brassica* or *Hirschfeldia* sp.), wild radish (*Raphanus sativus*), prickly lettuce (*Lactuca serriola*), and bull thistle (*Cirsium vulgare*); many coyote bush (*Baccharis pilularis*) shrubs near the top of bank. Overstory: Extensive planting of native trees along both banks; predominantly cottonwood (*Populus fremontii*). These trees are well established and thriving (Photos 3 and 4).

(3) Typical channel conditions near the mid-point of the reach. Note, some isolated sections of riprap are found along the banks (*Looking downstream, September 22, 2010*).

(4) Bulrush line the lower channel banks in the tidal portion of the reach. Cottonwoods have been planted along the upper banks throughout the length of the reach (*Looking upstream from the UPRR bridge., September 22, 2010).*

Map A. Reach 2 of Tulocay Creek is depicted as the red line above. Reach 2 begins at Soscol Ave. and extends downstream to the UPRR bridge. The approximate extent of tidal influence is denoted above.

Camille Creek

OWNERSHIP: Private with District easement

LOCATION: From South Terrace Dr. to Tulocay Cr. confluence (Map A)

ADJACENT LAND USE: Residential development (single family homes).

UPSTREAM: Natural section of Camille Cr. through residential area.

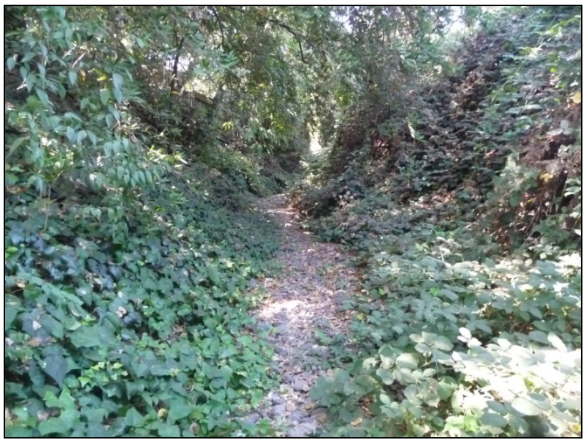
LENGTH: 1,250 ft

AVERAGE TOP-OF-BANK WIDTH: 35-45 ft

(1) Looking upstream at the South Terrace Road culvert crossing. Note the significant drop in bed elevation at the culvert and steep streambanks bounding the channel (*September 2010*).

REACH SETTING:

Camille Creek is a natural channel tributary to Tulocay Creek. The upstream portion of the reach is deeply incised with very steep streambanks (Photos 1 and 2). Bank angle and height gradually decrease in the downstream direction (Photos 3 and 4). The reach has good riffle-run habitat and a well established riparian corridor.



(2) Looking downstream near South Terrace Drive. Note the well defined low flow channel, coarse bed material and steep streambanks (*September 2010*).

PHYSICAL CONDITIONS

Active channel: channel bed is 8-10 ft. wide with a well defined 3 ft. wide low flow channel. In the upper portion of the reach the channel bed is 18-20 ft. wide beneath the top of banks, and 12-15 ft wide in the lower portion of the reach.

Bed sediments/texture: Gravel bed stream with rock size ranging up to medium cobble.

Bank structure: 12-20 ft. high earthen banks. Near vertical in the upper portion of the reach transitioning to gentler sloping 3:1 in the lower portion (All Photos).

Water quality: Upstream portion of the reach was dry on September 22, 2010, with the exception of a few small isolated pools (Photo 5). Water in the pools was turbid. The downstream portion had a small volume of continuous flow. Water quality appeared good.

Channel processes: The channel has incised over the last several decades as evidenced by the perched culvert and steep banks in the upstream portion of the reach (Photos 1, 5 and 6). The streambed appears to have stabilized more recently with no apparent localized degradation (e.g., headcuts) observed. During large flow events, discharges exiting the culvert at South Terrace Road likely have the potential to cause significant bed and bank erosion.

Camille Creek

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: Good riffle-run habitat; few large pools. Clean, loose cobble in the upper section. Some deposition of fines over gravel/cobble in the lower section.

Vegetation composition:

Channel: English ivy (*Hedera helix*) encroaching on channel in upper section.

Banks: Understory: English ivy is dominant in the upper section. Himalayan blackberry (*Rubus discolor*) and stinging nettle (*Urtica dioica*) are also common. Streambanks in the lower section are often bare ground (Photo 4). Overstory/Canopy: Mature, diverse canopy including coast live oak (*Quercus agrifolia*), black walnut (*Juglans californica*), big leaf maple (*Acer macrophyllum*), blue elderberry (Sambucus mexicana), and a few white alder (*Alnus rhombifolia*) sprouts/saplings; some *Acacia* trees in the lower section.

(3) Typical conditions in the middle portion of the reach (*Looking upstream, September 22, 2010*).

(4) Typical conditions in the lower portion of the reach (*Looking upstream, September 22, 2010*).

Map A. Camille Creek is denoted by the pink line in the map above. Tulocay Creek is shown as the blue line.

Sheehy Creek

OWNERSHIP: Private with District easement

LOCATION: From North Kelly Road downstream (west) to Highway 29.

ADJACENT LAND USE: Office and light-industrial Park

UPSTREAM: Agricultural fields; Reach receives surface runoff and subsurface flow from Chardonnay Country Club and irrigated fields.

LENGTH: 1,965 ft

AVERAGE TOP-OF-BANK WIDTH: 70-80 ft

(1) Looking downstream (west) from the bridge at North Kelly Road *(September 2010).* Stagnant water and poor water quality observed.

REACH SETTING:

The District-maintained reach of Sheehy Creek is significantly modified for drainage and flood control. The channel generally has a trapezoidal cross-section, and a planform alignment that appears to have been modified to accommodate the development of the industrial park. The District has planted native trees along the banks, which has substantially enhanced the riparian habitat along the drainage corridor.

MAINTENANCE HISTORY:

In 2010, bank stabilization work was performed at the downstream end of the reach (Photos 3 and 4). Cattails in the middle of the main channel are mowed on a routine basis.

(2) Looking upstream from the pedestrian footbridge in the middle portion of the reach. Note well established riparian plantings on both banks *(September 2010).*

PHYSICAL CONDITIONS

Active channel: channel bed is 20-30 ft wide; the bed is 10-15 ft beneath the top of banks.

Bed sediments/texture: The bed is composed of sands and fine sediment (Photo 4). Some riprap has been placed in the channel bed at the downstream portion of the reach.

Bank structure: The channel has 10-12 ft high earthen banks; slopes are typically 3:1. Slopes on the right bank in the downstream portion of the reach are considerably steeper (~1:1). Riprap has been placed on the banks on the outer bends of meanders and near the culverts at North Kelly Road and Highway 29.

Water quality: On September 22, 2010 water in the upstream portion of the reach appeared stagnant and was covered with aquatic vegetation (Photo 1). In the middle and lower portions of the reach the water was flowing and appeared clear (Photos 2 and 3). The observation of significant streamflow (estimated to be 0.25 to 0.5 cfs) within a drainage of this size in late September suggests the creek receives runoff and/or subsurface flow from agricultural sources or the adjacent golf course. The golf course and adjacent fields are irrigated with recycled water from the Napa County Sanitation District.

Sheehy Creek 1

Channel processes: The channel is depositional and traps fine sediment delivered from the upper watershed. There is a significant sediment "wedge" that begins at the downstream end of the reach near Highway 29 (Photo 3), and continues upstream.

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: Aquatic habitat consists of shallow open water areas (Photo 1), as well as long stretches of dense cattail (*Typha latifolia*) growth (Photo 2). The low flow channel is not well defined.

Vegetation composition:

Channel: Duckweed and pennywort (*Hydrocotyle* sp.) in pools; cattail, horsetail (*Equisetum* sp.), and hardstem bulrush (*Schoenoplectus* [=*Scirpus*] *acutus*) along the margins of the channel.

Banks/Riparian Corridor- Understory: primarily herbaceous non-natives such as bristly oxtongue (*Picris echioides*), wild oats (*Avena fatua*), Harding grass (*Phalaris aquatic*), bull thistle (*Cirsium vulgare*), *and* periwinkle (*Vinca major*). Overstory/Canopy: A diverse assemblage of native trees and shrubs planted from mid to top of bank. Species include cottonwood (*Populus fremontii*), oaks (predominantly *Quercus agrifolia*), big leaf maple (*Acer macrophyllum*), California buckeye (*Aesculus californica*), dogwood (*Cornus* sp.), white alder (*Alnus rhombifolia*), blue elderberry (*Sambucus Mexicana*), coyote brush (*Baccharis pilularis*), toyon (*Heteromeles arbutifolia*), and wild rose (*Rosa californica*).

(3) Looking upstream near Highway 29 crossing. Recent riprap was placed along banks and channel bed. Channel bed and riprap crossing create depositional area upstream where sediment accumulates and cattails grow (*September 22, 2010).*

(4) Recent bank stabilization work performed by District included riprap placement upstream of the Highway 29 culvert crossing *(view is looking downstream, September 22, 2010).*

Map A. Reach receives surface runoff and subsurface flow from upgradient irrigated fields and golf course.

Fagan Creek

OWNERSHIP: Napa County

LOCATION: Adjacent to (west of) Airport Road, from UPRR tracks through Napa County Airport.

ADJACENT LAND USE: Napa County Airport (west and south); Industrial park and UPRR tracks (east).

UPSTREAM: Semi-natural portion of Fagan Creek with mid-seral riparian corridor.

CONTRIBUTING DRAINAGE AREA: 6.8 mi^2 at downstream end.

LENGTH: 5,350 ft (see Reach Setting for details).

AVERAGE TOP-OF-BANK WIDTH: 70-80 ft

(1) Looking upstream from Airport security fence in the upper portion of the reach. Areas upstream of this point were not surveyed by foot due to access limitations, but from a distance, this section appeared to be of similar character to the channel immediately downstream (*September 22, 2010*).

REACH SETTING:

The District-maintained portion of Fagan Creek is a trapezoidal engineered channel. The entire reach lies adjacent to or within the boundaries of the Napa County Airport. The upper 3,400 ft is open channel, which transitions to a 1,350 ft culverted section that flows underneath the airport runways, followed by 600 ft of open channel that discharges to Fagan Slough (Map A). Fagan Slough is a tidal channel that is tributary to the Napa River. The Fagan Creek watershed is approximately 6.8 mi^2 and includes open space, vineyards, a golf course, portions of Highways 12 and 29, as well some commercial and residential development.

(2) Looking downstream from the bridge at Airport Road. Note willow and blackberry growing on channel banks. (*September 22, 2010*)

PHYSICAL CONDITIONS

Active channel: channel bed is 10-12 ft. wide. The channel bed is 15-18 ft. beneath the top of banks.

Bed sediments/texture: Bed sediments are predominantly sands and fines.

Bank structure: trapezoidal channel has 15-18 ft. high earthen banks, generally sloped at 2:1 (Photo 2). There is a concrete section approximately 250 ft downstream of the bridge at Airport Road (Photo 3).

Water quality: In Septemer 2010 nearly the entire channel was inundated. Water clarity appeared fair (Photos 2 and 3); water was stagnant at most locations.

Channel processes: Deposition of fine sediment appears to occur in this reach, particularly in the area between the Airport Road crossing and the concrete reinforced cross-section downstream (Photo 4). Areas upstream of the Airport Road bridge do not appear to have significant sediment accumulation.

Fagan Creek

BIOLOGICAL CONDITIONS

Aquatic or instream habitat: Instream habitat is dominated by aquatic and emergent vegetation (All Photos).

Vegetation composition:

Channel: Dominant or sub-dominant species include duckweed and broad-leaved cattail (*Typha latifolia*)

Banks: Herbaceous/Understory: Predominantly herbaceous non-natives including poison hemlock (*Conium maculatum*), sweet fennel (*Foeniculum vulgare*), and mustard (*Brassica* or *Hirschfeldia* sp); there are large patches of Himalayan blackberry (*Rubus discolor*) (Photo 2). Overstory/Canopy: Willow (*Salix* spp.) and black walnut (*Juglans californica*) saplings throughout the channel.

(3) A sediment "plug" has accumulated upstream of a concrete-reinforced cross-section of the channel. (*Looking west, September 2010*).

(4) In the lower portion of the reach the open channel transitions to a culverted section (background) that flows beneath the airport runways (*Looking west, September 22, 2010*).

Map A. The upper 3,400 ft of the reach is open channel, which transitions to a 1,350 ft culverted section that flows underneath the airport runway, followed by 600 ft of open channel that discharges to Fagan Slough.

Chapter 3
IMPACT AVOIDANCE AND MINIMIZATION

3.1 Overview

This chapter describes planning steps taken prior to maintenance work to ensure that activities are conducted effectively and environmental impacts are avoided and minimized to the maximum extent practicable.

Impact avoidance and minimization is a 3-part process. At the broadest scale, *Maintenance Principles* (described below in Section 3.2) provide overarching first-stage planning level guidance to reduce impacts associated with maintenance activities (described in Section 3.2). Second-stage impact avoidance measures are then applied during development of the annual maintenance workplan, still prior to any maintenance work being done (described in Section 3.3). Third-stage impact avoidance measures include several best management practices (BMPs) that are implemented during maintenance activities to further avoid or reduce impacts (described in Section 3.4).

3.2 Environmental Principles for Maintenance

The following Maintenance Principles were developed to guide District maintenance activities and ensure that environmental impacts are avoided or reduced as much as possible:

1. Apply the minimum maintenance necessary
2. Avoid mechanized maintenance, favor hand maintenance
3. Non-routine large scale maintenance is outside of program
4. Understand and monitor the river system
5. Protect and Enhance Physical Processes, Landforms, Riparian Habitat, and Ecology
6. Manage stream resources for long-term sustainability

Principle 1: Apply the Minimum Maintenance Necessary

This basic principle is foundational to the entire maintenance program - that no unnecessary intervention in streams will occur and that maintenance is restricted to only necessary and appropriate activities. The following questions are asked by District maintenance managers prior to any potential stream work to clarify the specific need and objective of potential work activities:

- Is there a maintenance need due to a known flood occurrence in the area or an elevated flood risk due to lack of maintenance? Has overbank flooding occurred at the reach threatening or causing damage to property? If so, was the flooding due to a lack of

maintenance, or an overall deficiency in the channel capacity for the storm which occurred?

- If flooding has occurred, was it due to reduced channel capacity caused by potential maintenance issues of sedimentation, vegetation growth, or bank failure?
- Is there a clearly identified flow impediment (e.g., sediment or shrubs blocking a culvert, a downed tree, etc.) that is increasing the flood risk or hazard?
- Has streambank erosion or a bank failure occurred at the potential maintenance site that threatens adjacent structures such as bridges, roads, or homes?
- Has streambank erosion or bank failure occurred at the potential maintenance site that leads to increased sediment yields into the channel and downstream receiving waters?

If answers to any these questions are "yes" then maintenance may be necessary. The annual channel survey and reconnaissance process (described in Chapter 10 – *Program Management*) provides the basis for maintenance planning and prioritizing. Answering the above questions may not be a simple yes/no response, as the site-specific situation may be intermediate or conditional. The District will be prudent in initiating maintenance activities. The District will only plan maintenance projects when a clearly identified need is established.

To further support Principle 1, the District will be undertaking a field-based effort to collect additional stream channel information for all of its owned maintenance channels and easements. The goal of the additional data collection effort is to develop channel capacity and vegetation management objectives for District channels. Having channel specific (or reach specific) objectives for channel capacity and vegetation conditions will assist the District in understanding when thresholds are exceeded whereby maintenance may be required. Understanding such thresholds will assist the District in developing a consistent approach for maintenance work identification and prioritization. The District's proposed workplan to conduct this data collection effort is described in Chapter 10.

Principle 2: Avoid Mechanized Maintenance, Favor Hand Maintenance

In conducting routine maintenance the District favors approaches that use hand tools rather than large mechanized equipment. For vegetation management activities, this means that District work crews will preferably use hand tools such as sheers, loppers, hand saws, mowers, and chainsaws. The District will use other mechanized means only when the vegetation is too thick or robust such that hand tools are not feasible. Similarly, for sediment removal and bank stabilization activities, the District will first seek to implement small-scale actions using hand tools including shovels and picks. If the maintenance project requires mechanized equipment to conduct grading or earth moving activities, then they will occur similar to the activities description provided in Chapters 6 and 7. BMPs described below in Section 3.4 will guide the use of mechanized equipment.

Principle 3: Non-Routine Large Scale Maintenance is Outside of Program

Large scale maintenance projects that are extensive in their area or distance are considered outside of the routine maintenance program and its programmatic permits. Such non-routine projects due to their large size will be developed and permitted independently to the routine stream maintenance program. The following guidance is provided to generally describe what

would be extensive maintenance projects beyond the scope of routine maintenance described in this Manual and accompanying permits:

- Sediment removal activities that involve more than 500 feet of linear channel are considered beyond routine and outside of the program.
- Bank stabilization activities for an individual project site that is greater than 200 feet of linear channel are considered beyond routine and outside of the program.

Principle 4: Understand and Monitor the River System

When stream maintenance is necessary, the identified project reach should be studied and evaluated as to why instream conditions now require active maintenance. The following questions help the District focus the reach assessment:

- What are the governing hydraulic and geomorphic conditions at the reach? Is the reach primarily depositional or erosional? Are there observed depositional features such as mid-channel bars, point bars, or other deposits? Are there observed erosional features such as undercut banks or a channel incision? Does the channel slope represent a significant change from either upstream or downstream conditions? Are hardened structures present such as channel crossings, bank protection, or drop structures that strongly influence channel conditions?
- Do the existing channel cross section form, in-channel features (such as bars and benches, etc.) and reach slope suggest the channel is in dynamic equilibrium with a relative balance of erosional and depositional forces. Or, is the reach strongly depositional or erosional, thus suggesting a non-equilibrium condition?
- What is the relationship between this reach and upstream and downstream conditions? In particular, what are upstream sediment inputs to this reach and how are those inputs either stored in the reach or transported further downstream?
- Have historic maintenance activities at this reach strongly influenced its current functioning? Do such influences affect conditions either upstream or downstream?
- Has maintenance at this reach been on-going in past or recent years indicating a chronic condition?

This principle of understanding the stream system and its processes is demonstrated in the channel characterization sheets, or reach sheets, provided in Chapter 2. In developing the reach sheets of Chapter 2 the questions above (and others) were asked at each of the District's owned in fee and maintenance easement channels. In addition to the descriptive reach sheets, where available - channel as-built designs, streamflow records, historic maps and cross sections, photographs, and hydraulic modeling results may all be used to evaluate reach conditions and set the most appropriate maintenance course.

As maintenance is conducted at particular reaches, the District will review the existing channel characterization sheets for their accuracy and update the sheets as necessary. Additionally, as maintenance work occurs, the District will be revising the characterization sheets to include a discussion of underlying causes for the maintenance activities that occur at the particular reach. For example, issues at a particular reach may be identified as chronic and routine as related to some upstream cause, or perhaps described as more episodic and not regular. There may be

watershed-scale issues, like sediment sources or upstream land uses, leading to the maintenance need; or more localized structural issues like a culvert or crossing that requires some immediate local treatment. Depending upon the underlying causes, more targeted long-term watershed based approaches or shorter-term on site solutions may be sought for a particular maintenance issue.

As part of the stream maintenance program the District will monitor channel conditions through their annual survey and reconnaissance activities (Chapter 10). Through an evolving database maintained by the District, channel conditions will be tracked from year to year to further inform the system understanding and thereby make the best maintenance decisions (see Chapter 10 for further discussion on the District's database).

As described above under Principle 1, the District will be undertaking a field-based effort to collect additional stream channel information to develop channel capacity and vegetation management objectives for District channels. This effort will further support Principle 4 in providing improved understanding of the river system. The District's proposed workplan to conduct the data collection effort is described in Chapter 10.

Principle 5: Protect and Enhance Physical Processes, Landforms, Riparian Habitat, and Ecology

The District's flood management objective is to provide a balance between flood protection and also protecting and enhancing river physical and biological processes and riparian habitat. Functioning geomorphic features and processes including floodplains, benches, and other instream features should be considered when undertaking any maintenance activities. For example, maintenance activities should consider channel dimensions, sediment loads, and existing landforms when considering sediment removal or erosion treatments. Any channel maintenance should ensure that it is "working with" the dominant channel processes and not counter to those processes.

Similarly, how the channels physical processes and landforms support instream habitat should also be considered prior to any instream maintenance. Over time, the maintenance approach will manage channels to provide both flood protection and ecologic functions with reduced maintenance needs. This management approach recognizes each reach's existing functional condition and flood management needs, but also looks forward toward improving each reach's ecologic condition.

The following questions are asked by District stream managers at each maintenance reach to help guide District maintenance activities toward protecting and enhancing the riparian ecology of the channel and its easement corridor.

- What do the observed physical landforms or channel shape infer about channel processes? How might such processes affect the post-maintenance condition? Will the inferred physical processes "work with" the planned maintenance activities, or be counter to those activities?
- What do the observed physical landforms infer about the rate and magnitude of depositional or erosional processes? Do potential maintenance activities incorporate

the rate and magnitude of such instream processes and landforms into their design? Do potential maintenance activities make sense in light of the dominant channel processes?

- What are the existing natural habitats and aquatic resources at the reach (see reach sheets of Chapter 2)? How are these features supported by the physical processes?
- Are particular in-channel features such as large woody debris (LWD) or gravel bars present that provide valuable habitat?
- Do the presence of these features or resources influence how, where, and when maintenance activities might occur?
- Which habitat features and functions can be preserved in the context of hydraulic capacity?
- Are there known occurrences of threatened or endangered species at the reach?
- Can habitat conditions at the reach be improved to support additional species or enhanced to improve the quality of existing habitat?
- What would be the best way to preserve habitat function and advance vegetative succession toward a desired climax community?

The stream maintenance program includes follow-up monitoring to evaluate the progress of the gradual stepwise ecological improvement at each maintenance reach (see Chapter 10).

Principle 6: Manage Stream Resources for Long-Term Sustainability

The District's approach for channel maintenance seeks to integrate activities that in time will reduce the overall need for channel maintenance. For example, a feedback sequence is observed in some District channels whereby: (1) fine sediments are trapped by emergent vegetation such as cattails; (2) this deposition in turn raises the streambed uniformly, lowers bed slope, creates a shallow and diffuse flow condition – and this encourages additional sediment trapping; which (3) ultimately reduces habitat quality and flood conveyance capacity. A sustainable approach to this problem aims to prevent or break this depositional sequence in place of just continuing to remove sediment and vegetation. The District has identified three potential approaches to remedy this situation. Planting canopy vegetation along streambanks to shade the channel and inhibit emergent marsh vegetation is one approach to address this condition. Another potential approach might be to develop low-flow sediment transport channels to maintain an active low-flow channel and convey fine sediment through the reach. A third approach involves identifying and limiting key watershed sediment sources and reducing sediment delivery from upper watershed source areas to the District's channels. All three of these approaches increase environmental sustainability and reduce the overall need for in-channel maintenance activities.

3.3 Impact Avoidance and Minimization Measures

Consistent with the maintenance principles presented above, the District identifies maintenance sites during the annual work planning process described in Chapter 10 *Program Management.* As part of standard operation procedures, the District implements impact avoidance and minimization measures referred to as Best Management Practices or BMPs. BMPs are operational or procedural practices, and structural or engineered controls which are implemented to protect natural resources. These measures are an integral part of the stream maintenance program and are implemented to ensure that maintenance activities protect and enhance existing habitat and also protect maintenance workers and the community from equipment hazards.

The stream maintenance BMPs are included in **Table 3-1** and were developed to protect the natural resources of Napa County and the creeks, channels, other facilities maintained by the District. Table 3-1 includes general BMPs applicable to all maintenance activities and project-specific BMPs for vegetation maintenance activities, bank stabilization projects, sediment removal activities, post-project restoration, and minor activities. Many of these measures, such as biological or cultural resource surveys, coincide with permit compliance requirements (see Chapter 11 *Regulatory Compliance*). The general groups of BMPs are described below.

The BMPs contained in this manual are intended for application program-wide, as directed by District staff. Measures may be adjusted and modified on a site-by-site basis and as needed to provide the most protection of the site and surrounding area. Implementation and functioning of the BMPs will be evaluated and revised annually, or as needed, to ensure the most adequate and appropriate protection of natural resources. Adjustments to BMPs are reported to regulatory agencies as part of the annual reporting process (see Chapter 10).

Work Windows

Channel maintenance activities occurring during the rainy season can result in potential environment impacts, particularly to aquatic habitats. Potential impacts could include erosion from stockpiled sediments or pollutants from work equipment entering the creek. To prevent such wet season impacts, all maintenance activities occur during the dry season when rain and flows are minimal. Additionally, regulatory permitting conditions restrict the period and location of certain activities to protect biological resources. Listed below are the current work windows for the maintenance program[1]. Note these work windows may change as new permits are issued or amended.

[1] These work window restrictions are stated in the District's 2007 Routine Maintenance Agreement with CDFG.

Maintenance Activity	Maintenance Period
• Maintenance on any creek, except Dry Creek, Walsh Creek, and the Napa River (due to special-status species restrictions)	April 15 – October 15
• Ground-disturbing activities and any maintenance on Dry Creek, Walsh Creek, and the Napa River	June 15 – October 31
• Debris removal immediately necessary to prevent flooding	Any time

Additionally, removal of standing trees is avoided between March 1 and August 15 to avoid impacts to nesting birds. However, if a standing tree must be removed due to the presence of hazard conditions (see Chapter 4, Section 4.5 *Tree Removal and Relocation*) during the March 1 to August 15 period, then a nesting bird survey would be conducted by a qualified biologist according to standard District protocols to avoid any potential impact to nesting birds. Results of any nesting bird survey would be included in the annual summary maintenance report.

Channel Roughness and Capacity Objectives to Guide Maintenance

In support of Maintenance Principle 1 (apply the minimal amount of maintenance) as described above, the District is developing a channel roughness and capacity assessment protocol. This protocol will be used to guide the annual evaluation of streams, identify which streams require maintenance, and prioritize the District's efforts. The assessment protocol will involve a field-based checklist of conditions, similar to the triggers described above and in Chapter 4. For vegetation management activities, such as tree pruning, this will involve assessing current roughness conditions compared to an allowable roughness criterion for the individual reach. Similarly, the District will develop capacity criteria for individual reaches to guide if/when sediment removal activities are potentially warranted.

Biological Surveys

The majority of maintenance activities are conducted in areas which are natural and minimally modified by hardscape features such as concrete, and therefore maintenance activities could affect biological resources. Maintenance activities are conducted in creek channels that provide habitat for a variety of species, including some special-status species which are protected under federal and state regulations. Based on possible occurrence of species as listed in Table 2-1 in Chapter 2, species-specific impact avoidance and minimization measures will be applied prior to conducting maintenance activities in those reaches.

Activities conducted under this Program will comply with applicable federal, state, and local laws and policies that protect biological resources, including but not limited to the federal Endangered Species Act, federal Migratory Bird Treaty Act, the California Endangered Species Act, the California Environmental Quality Act, and the California Fish and Game Code. Compliance with these regulations is described in Chapter 11 *Regulatory Compliance*. Avoidance measures for special-status species would ultimately be issued by regulatory agencies, but the measures provided in the BMP Table (Table 3-1) are implemented by the District as standard practice.

Aquatic Species Impact Avoidance Approaches

Federal and state listed special-status species, including salmonids (Chinook and steelhead),

California freshwater shrimp (*Syncaris pacifica*), California red-legged frog, and Northwestern pond turtles (*Clemmys marmorata marmorata*), may be present in stream reaches maintained under this program.

If maintenance activities would disturb habitat of these species, such as maintenance of in-channel vegetation or bank stabilization or sediment removal activities that require channel dewatering, the District would notify and consult, if necessary, with state and federal agencies to obtain their approval of the maintenance activities. The agency coordination process would occur as part of the annual work notification procedure, as described in Chapter 10. The District may establish avoidance, minimization, and mitigation measures with regulatory agencies on a case-by-case basis.

Typical avoidance and minimization measures used by the District and typically prescribed by regulatory agencies to protect aquatic species include:

- Restricting the work window to avoid critical lifestage periods
- Pre-maintenance surveys
- Dewatering protocols, including species relocation
- Monitoring during maintenance
- Post-maintenance restoration
- Post-maintenance monitoring

As standard practice, the District implements these measures, particularly for projects involving channel dewatering (dewatering protocols are included in the **Table 3-1)**. However, where there is a potential to disturb habitat for federal or state listed special-status species, no maintenance activities would be conducted without first notifying the appropriate regulatory agency.

Herbicide Application Restrictions

Herbicides can be toxic to people and wildlife if not handled properly. However, the safe use of herbicides is a critical method for stream maintenance, especially to control invasive and exotic plants. All herbicide applications conducted by the District occur in accordance with federal, state, and local regulations. As described in Chapter 4 *Vegetation Maintenance Activities*, the District applies herbicides to plants in upland areas (vegetation growing along and on top of stream banks). Herbicide application on submerged vegetation (plants growing in or adjacent to the water, such as cattails) is not conducted under the maintenance program.

Measures to avoid and minimize effects of herbicide application include:

1. Application will occur when the climate is dry (between June 15 and November 15), wind is not above 5-10 mph, and no rain is forecast for the next 24 hours.
2. Targeted spot spraying and hand painting of cut stumps are the primary methods of herbicide application. Foliar spraying may be conducted to control growth on larger plants such as exotic trees or large stands of pampas grass.

Cultural Resource Survey

Most activities identified in this Manual would have little or no potential to affect cultural resources. However, bank stabilization or other activities that require disturbance or compaction of native soils could disturb or damage buried resources, if any are present. Consequently, ground-disturbing activities conducted under this program must comply with federal, state, and local laws and policies protecting cultural resources and human remains, including but not limited to the National Historic Preservation Act, Native American Graves Protection and Repatriation Act, and the California Public Resources Code. Compliance with these regulations is discussed in Chapter 11 *Regulatory Compliance*.

For maintenance activities that require excavation or repair into soils beyond the channel design (e.g., bank stabilization, culvert replacement), a cultural resources investigation will be conducted by a qualified professional archaeologist prior to performing the maintenance activity. The cultural resources investigation will include the following elements:

1. Background research and Native American consultation
2. Pedestrian survey
3. Documentation
4. Management requirements, if necessary

Pollution Safety Planning

As creeks are common locations for illegal dumping of trash containing hazardous waste, such as tires, oil filters, paint cans, and electronic devices, project activities could encounter hazardous waste. Creek channels also receive runoff from streets and urbanized areas which carry non-point source contaminants like oil and paint that are poured down storm drains. Thus, indirect contamination of creeks occurs when contaminants are transported through the storm drain network and deposited directly to streams. Presence of these contaminants can sometimes be observed as an oily sheen, a discoloration of the soil, or an unnatural chemical odor. If presence of potential contaminants is observed at the site, the area will be treated as if a hazardous spill occurred. In addition, any observed contamination as evidenced by chemical-like odors, oily sheens, or irregularly colored sediment will be immediately reported to the local fire department's hazardous materials team.

Soil testing may be conducted prior to sediment removal projects. Soil testing is primarily conducted where quantities of excavated sediment would be taken to a permitted disposal site or landfill. Soil testing and disposal approvals would be coordinated with the appropriate regulatory agencies, such as the Regional Water Quality Control Board. Should soils be encountered during maintenance that contain concentrations of substances that exceed hazardous waste levels, the contaminated area will be treated as if a hazardous spill occurred (i.e., a Spill Prevention and Response Plan will be implemented) and all measures to ensure compliance with federal, state, and local regulations will be taken.

Public Outreach

Many District maintenance areas are located in residential areas or in close proximity to business, schools, and libraries. Maintenance activities would have very little potential to disrupt traffic circulation except in situations when it is necessary to close travel lanes

temporarily (e.g., to remove debris from a bridge or culvert), or where maintenance vehicles are traveling to and from the maintenance sites (e.g., fill hauling). Most District maintenance channels have on-site roads adjacent to the channel that provide access for maintenance.

To reduce potential inconvenience to the public and protect their safety during maintenance activities, measures such as keeping the work site clean, reducing loud noises, and maintaining vehicle and pedestrian access. The duration of maintenance activities at a particular project site or reach will vary from a less than a day to a week. To minimize the effects of noise on neighboring homes and businesses, work will be limited to normal business hours (8:00 a.m.–5:00 p.m.). Routine activities in residential areas will not occur on Saturdays, Sundays, or County holidays. Sound control devices will be actively used on all power equipment.

As an effort to keep the public informed about pending stream maintenance work (why the maintenance is necessary, when it occurs, and what a neighborhood can expect when crews arrive to conduct maintenance work), the District may conduct an annual presentation of general maintenance activities to the public for information purposes. Prior to the Districts Annual stream surveys an educational flyer is sent out to all private property owners adjacent to the creeks that are surveyed. The flyer informers private property owners of the Districts Stream Maintenance Program, the date of the annual creek survey, the Districts contact info, and other watershed management services. Additionally, the District will develop materials for public information and education through its website and brochures to inform the community about the Districts watershed management programs. The District will continue to host creek cleanup events and partner with other local agencies and watershed stakeholders to assist and guide private property owners with riparian enhancement and management techniques.

Table 3-1: Stream Maintenance Best Management Practices

General BMPs

These BMPs will be implemented by the stream maintenance crew, as appropriate and as overseen by site managers, for all activities associated with the maintenance program. These BMPs are grouped according to use of general maintenance practices, dewatering activities, public safety, and reporting procedures. The majority of these BMPs are implemented prior to and during maintenance operations, though the level of activity varies depending on the work type.

BMP Number	BMP Title	BMP Description
General Maintenance Practices		
GEN-1	Work Windows	▪ Maintenance on any creek, except Dry Creek, Walsh Creek, and the Napa River (due to special-status species restrictions), will generally occur between April 15 and October 15. ▪ All ground-disturbing maintenance activities (i.e., tree removal, mechanized vegetation management, bank stabilization, and sediment removal) occurring in the channel will take place between June 15 and October 15. ▪ Hand pruning and hand removal of vegetation will occur year round, except when: o Wheeled or tracked equipment needs to access the site by crossing a creek, ponded area, or secondary channel; or o Work occurs in streams that support salmonids. In these streams, instream vegetation maintenance will cease on December 31 or when local rainfall greater than 0.5 inches is predicted within a 24-hour period of planned activities, whichever happens first. ▪ Removal of standing trees will not occur between February 15 and August 15 to avoid impacts on nesting birds, except after implementation of Measure BIO-1. ▪ Modification and removal of large wood, such as downed trees, is generally conducted during the dry season, but can occur at any time of the year, if imminent danger of a flood threat precludes leaving the wood in place. ▪ Herbicide applications will occur between June 15 and November 15, with an extension through December 31 or until the first occurrence of any of the following conditions; whichever happens first: o Local rainfall greater than 0.5 inches is forecasted within a 24-hour period from planned

BMP Number	BMP Title	BMP Description
		application events; or o When salmonids begin upmigrating and spawning, as determined by a qualified biologist (typically in November/December)
GEN-2	Minimize the Area of Disturbance	To minimize impacts to natural resources, soil disturbance will be kept to the minimum footprint necessary to complete the maintenance operation.
GEN-3	Erosion and Sediment Control Measures	▪ Upland soils exposed due to maintenance activities will be seeded and stabilized using erosion control fabric or hydroseeding. The channel bed and areas below the Ordinary High Water Mark (OHWM) are exempt from this BMP. ▪ Erosion control fabrics will consist of natural fibers that will biodegrade over time. No plastic or other non-porous material will be used as part of a permanent erosion control approach. Plastic sheeting may be used to temporarily protect a slope from runoff, but only if there are no indications that special-status species would be impacted by the application. ▪ Erosion control measures will be installed according to manufacturer's specifications. ▪ Appropriate measures include, but are not limited to, the following: o Silt Fences o Straw Bale Barriers o Brush or Rock Filters o Storm Drain Inlet Protection o Sediment Traps o Sediment Basins o Erosion Control Blankets and Mats o Soil Stabilization (i.e. Tackified straw with seed, jute or geotextile blankets, broad cast and hydro-seeding, etc.) ▪ All temporary construction-related erosion control methods (e.g., silt fences) shall be removed at the completion of the project. The following Bay Area Stormwater Management Agencies Association (BASMAA) BMPs provide guidance and specifications on implementation of the erosion control measures listed above (see also www.basmaa.com):

BMP Number	BMP Title	BMP Description
		o SC-3. Sediment Basins o SC-4. Straw or Sand Bag Barriers o SC-5. Sediment Traps o SC-6. Silt Fences o SS-1. Erosion Control Blankets, Mats, and Geotextiles o VR-1. Brush or Rock Filters o VR-4b. Temporary Outlet Protection o VR-4b. Storm Drain Inlet Protection o WD-1. Earth Dike o WD-1. Slope Drain o WD-3. Temporary Drains and Swales
GEN-4	Dust Management Controls	The District will implement the Bay Area Air Quality Management District's (BAAQMD) Basic Dust Control Measures (www.baaqmd.gov) at maintenance sites less than four acres in size. Current measures stipulated by the BAAQMD Guidelines include the following: 1. All exposed surfaces (e.g., parking areas, staging areas, soil piles, graded areas, and unpaved access roads) shall be watered two times per day. 2. All haul trucks transporting soil, sand, or other loose material off-site shall be covered. 3. All visible mud or dirt track-out onto adjacent public roads shall be removed using wet power vacuum street sweepers at least once per day. The use of dry power sweeping is prohibited. 4. All vehicle speeds on unpaved roads shall be limited to 15 mph. 5. All roadways, driveways, and sidewalks to be paved shall be completed as soon as possible. Building pads shall be laid as soon as possible after grading unless seeding or soil binders are used. 6. Idling times shall be minimized either by shutting equipment off when not in use or reducing the maximum idling time to 5 minutes (as required by the California airborne toxics control measure Title 13, Section 2485 of California Code of Regulations [CCR]). Clear signage shall be provided for construction workers at all access points. 7. All construction equipment shall be maintained and properly tuned in accordance with

BMP Number	BMP Title	BMP Description
		manufacturer's specifications. All equipment shall be checked by a certified visible emissions evaluator. 8. Post a publicly visible sign with the telephone number and person to contact at the lead agency regarding dust complaints. This person shall respond and take corrective action within 48 hours. The Air District's phone number shall also be visible to ensure compliance with applicable regulations.
GEN-5	Staging and Stockpiling of Materials	▪ To the extent feasible, staging will occur on access roads, surface streets, or other disturbed areas that are already compacted and only support ruderal vegetation. Similarly, all maintenance equipment and materials (e.g., road rock and project spoil) will be contained within the existing service roads, paved roads, or other pre-determined staging areas. Staging areas for equipment, personnel, vehicle parking, and material storage will be sited as far as possible from major roadways. ▪ To prevent sediment-laden water from being released back into waterways during transport of spoils to disposal locations, truck beds will be lined with an impervious material (e.g., plastic), or the tailgate blocked with wattles, hay bales, or other appropriate filtration material. ▪ Building materials and other maintenance-related materials, including chemicals and sediment, will not be stockpiled or stored where they could spill into water bodies or storm drains. ▪ No runoff from the staging areas may be allowed to enter water ways, including the creek channel or storm drains, without being subjected to adequate filtration (e.g., vegetated buffer, hay wattles or bales, silt screens). The discharge of decant water to water ways from any on-site temporary sediment stockpile or storage areas is prohibited. ▪ During the dry season, no stockpiled soils will remain exposed and unworked for more than 7 days. During the wet season, no stockpiled soils will remain exposed, unless surrounded by properly installed and maintained silt fencing or other means of erosion control.

BMP Number	BMP Title	BMP Description
GEN-6	Stream Access	District personnel will use existing access ramps and roads to the extent feasible. If necessary to avoid large mature trees, native vegetation, or other significant habitat features, temporary access points will be constructed in a manner that minimizes impacts according to the following guidelines: 1. Temporary access points will be constructed as close to the work area as possible to minimize equipment transport. 2. In considering channel access routes, slopes of greater than 20 percent will be avoided, if possible. 3. Disturbed areas will be revegetated or filled with compacted soil, seeded, and stabilized with erosion control fabric immediately to prevent future erosion. 4. Personnel will use the appropriate equipment for the job that minimizes impacts. Appropriately-tired vehicles, either tracked or wheeled, will be used depending on the site and maintenance activity.
GEN-7	In-Channel Minor Sediment Removal	For in-channel minor sediment removal activities, work will be conducted from the top of the bank if access is available and there are flows in the channel.
GEN-8	On-Site Hazardous Materials Management	1. An inventory of all hazardous materials used (and/or expected to be used) at the worksite and the end products that are produced (and/or expected to be produced) after their use will be maintained by the worksite manager. 2. As appropriate, containers will be properly labeled with a “Hazardous Waste” label and hazardous waste will be properly recycled or disposed of off-site. 3. Contact of chemicals with precipitation will be minimized by storing chemicals in watertight containers or in a storage shed (completely enclosed), with appropriate secondary containment to prevent any spillage or leakage. 4. Petroleum products, chemicals, cement, fuels, lubricants, and non-storm drainage water or water contaminated with the aforementioned materials will not contact soil and not be allowed to enter surface waters or the storm drainage system. 5. All toxic materials, including waste disposal containers, will be covered when they are not in use, and located as far away as possible from a direct connection to the storm drainage

BMP Number	BMP Title	BMP Description
		system or surface water. 6. All trash that is brought to a project site during maintenance activities (e.g., plastic water bottles, plastic lunch bags, cigarettes) will be removed from the site daily.
GEN-9	Existing Hazardous Materials	1. For any proposed ground disturbing activities, the District will conduct a search for existing known contaminated sites on the SWRCB's GeoTracker website (http://www.geotracker.waterboards.ca.gov) upon selection of project location. 2. For any proposed ground disturbing maintenance sites located within 1,500 feet of any "open" sites where contamination has not been remediated, the District will contact the Regional Water Quality Control Board case manager identified in the database. The District will work with the case manager to ensure maintenance activities would not affect cleanup or monitoring activities or threaten the public or environment 3. If hazardous materials, such as oil, batteries or paint cans, are encountered at the maintenance sites, the District will carefully remove and dispose of them according to the *Spill Prevention and Response Plan* (forthcoming). District staff will wear proper protective gear and store the waste in appropriate hazardous waste containers until it can be disposed at a hazardous waste facility.
GEN-10	Spill Prevention and Response	The District will prevent the accidental release of chemicals, fuels, lubricants, and non-storm drainage water into channels following these measures: 1. New District field personnel will be appropriately trained in spill prevention, hazardous material control, and cleanup of accidental spills. 2. Equipment and materials for cleanup of spills will be available on site and spills and leaks will be cleaned up immediately and disposed of according to guidelines stated in the *Spill Prevention and Response Plan* (forthcoming). 3. Field personnel will ensure that hazardous materials are properly handled and natural resources are protected by all reasonable means. 4. Spill prevention kits will always be in close proximity when using hazardous materials (e.g., at crew trucks and other logical locations). All field personnel will be advised of these locations.

BMP Number	BMP Title	BMP Description
		5. District staff will routinely inspect the work site to verify that spill prevention and response measures are properly implemented and maintained. *Spill Response Measures:* For small spills on impervious surfaces, absorbent materials will be used to remove the spill, rather than hosing it down with water. For small spills on pervious surfaces such as soil, the spill will be excavated and properly disposed rather than burying it. Absorbent materials will be collected and disposed of properly and promptly.
GEN-11	Fire Prevention	1. All earthmoving and portable equipment with internal combustion engines will be equipped with spark arrestors. 2. During the high fire danger period (April 1–December 1), work crews will: a) Have appropriate fire suppression equipment available at the work site. b) Keep flammable materials, including flammable vegetation slash, at least 10 feet away from any equipment that could produce a spark, fire, or flame. c) Not use portable tools powered by gasoline-fueled internal combustion engines within 25 feet of any flammable materials unless a round-point shovel or fire extinguisher is within immediate reach of the work crew (no more 25 feet away from the work area).
GEN-12	Vehicle and Equipment Maintenance	1. All vehicles and equipment will be kept clean. Excessive build-up of oil and grease will be prevented. 2. All equipment used in the creek channel will be inspected for leaks each day prior to initiation of work. Action will be taken to prevent or repair leaks, prior to use. 3. Incoming vehicles and equipment will be checked for leaking oil and fluids (including delivery trucks, and employee and subcontractor vehicles). Leaking vehicles or equipment will not be allowed onsite. 4. No heavy equipment will operate in a live stream (see Dewatering BMPs). 5. No equipment servicing will be done in the creek channel or immediate floodplain, unless equipment stationed in these locations cannot be readily relocated (i.e., pumps and generators). 6. If necessary, all servicing of equipment done at the job site will be conducted in a designated,

BMP Number	BMP Title	BMP Description
		protected area to reduce threats to water quality from vehicle fluid spills. Designated areas will not directly connect to the ground, surface water, or the storm drain system. The service area will be clearly designated with berms, sandbags, or other barriers. Secondary containment, such as a drain pan, to catch spills or leaks will be used when removing or changing fluids. Fluids will be stored in appropriate containers with covers, and properly recycled or disposed of offsite. 7. If emergency repairs are required in the field, only those repairs necessary to move equipment to a more secure location will be conducted in the channel or floodplain. 8. Equipment will be cleaned of any sediment or vegetation before transferring and using in a different watershed to avoid spreading pathogens or exotic/invasive species. 9. Vehicle and equipment washing can occur onsite only as needed to prevent the spread of sediment, pathogens or exotic/invasive species. No runoff from vehicle or equipment washing is allowed to enter water bodies, including creek channels and storm drains, without being subjected to adequate filtration (e.g., vegetated buffers, hay wattles or bales, and silt screens). The discharge of decant water from any onsite wash area to water bodies or to areas outside of the active project site is prohibited. Additional vehicle and equipment washing will occur at the approved wash area in the District's corporation yard.
GEN-13	Vehicle and Equipment Fueling	1. No fueling will be done in the channel (top-of-bank to top-of-bank) or immediate floodplain unless equipment stationed in these locations cannot be readily relocated (e.g., pumps and generators). 2. All off-site fueling sites (i.e., on access roads above the top-of-bank) will be equipped with secondary containment and avoid a direct connection to soil, surface water, or the storm drainage system. 3. For stationary equipment that must be fueled on-site, secondary containment, such as a drain pan or drop cloth, will be used to prevent accidental spills of fuels from reaching the soil, surface water, or the storm drain system.

Dewatering

BMP Number	BMP Title	BMP Description
GEN-14	Dewatering Measures	When work in flowing streams is unavoidable, streamflow will be diverted around the work area by construction of a temporary dam or bypass. 1. Prior to dewatering, the best means to bypass flow through the work area will be determined to minimize disturbance to the channel and avoid direct mortality of fish and other aquatic vertebrates. 2. The area to be dewatered will encompass the minimum area necessary to perform the maintenance activity. 3. The period of dewatering will extend only for the minimum amount of time needed to perform the maintenance activity. 4. Depending on the channel configurations, sediment removal activities may occur where the flows are not bypassed around the work site as long as a berm is left between the work area and stream flows to minimize water quality impacts during excavation activities. 5. In reaches that contain deep pools, the District will maintain these pools, as is practical, by constructing temporary fencing surrounding the pool and avoid pool dewatering. Pools in construction sites may be isolated by upstream or downstream barriers, such as culverts. This approach does not apply to sediment removal activities that require removal of all sediment to restore the design capacity. *Construction*: 1. Where feasible and appropriate, dewatering will occur via gravity driven systems and diversion structures shall be installed on concrete sections of the channels, such as concrete box culverts often used at road crossings. 2. Construction of cofferdams will begin in the upstream area and continue in a downstream direction, and the flow will be diverted only when construction of the dams is completed. 3. Coffer dams will be installed both upstream and downstream not more than 100 feet from the extent of the work areas. 4. Instream cofferdams will only be built from materials such as sandbags, clean gravel, or rubber bladders which will cause little or no siltation or turbidity. No earthen fill will be used to construct the cofferdam. Plastic sheeting will be placed over sandbags to minimize water

BMP Number	BMP Title	BMP Description
		seepage into the maintenance areas. The plastic sheets will be firmly anchored to the streambed to minimize water seepage. If necessary, the footing of the cofferdam will be keyed into the channel bed at an appropriate depth to capture the majority of subsurface flow needed to dewater the streambed. 5. Stream flows will be allowed to gravity flow around or through the work site using temporary bypass pipes or culverts. Bypass pipe diameter will be sized to accommodate, at a minimum, twice the volume of the summer baseflow. 6. When use of gravity-fed dewatering is not feasible and pumping is necessary to dewater a work site, a temporary siltation basin and/or use of silt bags may be required to prevent sediment from re-entering the wetted channel. *Implementation*: 1. A qualified biologist will be present to ensure that fish and other aquatic vertebrates are not stranded during construction and implementation of channel dewatering. 2. If necessary to remove stranded fish or other aquatic vertebrates, electrofishing will be used to collect and relocate fish from the work area. If relocation is necessary, Measure GEN-15 will be implemented. 3. Downstream flows adequate to prevent fish or vertebrate stranding will be maintained at all times during dewatering activities. 4. Diverted and stored water will be protected from maintenance activity-related pollutants, such as soils or equipment lubricants or fuels. 5. If necessary, discharged water will pass over some form of energy dissipater to prevent erosion of the downstream channel. Silt bags will be equipped to the end of discharge hoses and pipes to remove sediment from discharged water. 6. For full channel dewatering, filtration devices or settling basins will be provided as necessary to ensure that the turbidity of discharged water is not visibly more turbid than in the channel upstream of the maintenance site. If increases in turbidity are observed, additional measures will be implemented such as a larger settling basin or additional filtration. If increases in turbidity persist, the District's Stream Maintenance Program Manager will be alerted since

BMP Number	BMP Title	BMP Description
		turbidity measurements may be required. *Deconstruction*: 1. When maintenance is completed, the flow diversion structure will be removed as soon as possible but no more than 48 hours after work is completed. Impounded water will be released at a reduced velocity to minimize erosion, turbidity, or harm to downstream habitat. Cofferdams will be removed such that surface elevations of water impounded above the cofferdam are lowered at a rate greater than one inch per hour. 2. When diversion structures are removed, to the extent practicable, the ponded flows will be directed into the low-flow channel within the work site to minimize downstream water quality impacts. 3. The area disturbed by flow bypass mechanisms will be restored at the completion of the project. This may include, but is not limited to, recontouring the area and planting of riparian vegetation.
GEN-15	Relocation of Aquatic Species for Dewatering	As identified above, before a work area is dewatered, fish and other aquatic vertebrates such as California freshwater shrimp will be captured and relocated to avoid injury and mortality and minimize disturbance. The following guidelines will apply. ▪ Before removal and relocation begins, a qualified fisheries biologist will identify the most appropriate release location(s). Release locations should have water temperatures similar to the capture location and offer ample habitat for released fish and aquatic vertebrates, and should be selected to minimize the likelihood of reentering the work area or becoming impinged on the exclusion net or screen. ▪ The means of capture will depend on the nature of the work site, and will be selected by a qualified fisheries biologist who has a current CDFG scientific collecting permit and is experienced with capture and handling protocols for fish and aquatic vertebrates, including California freshwater shrimp. Complex stream habitat may require the use of electrofishing equipment, whereas in outlet pools, vertebrates may be captured by pumping down the pool and then seining or dipnetting. Electrofishing will be used only as a last resort; if electrofishing is necessary, it will be conducted only by properly trained personnel following the NMFS guidelines dated June 2000.

BMP Number	BMP Title	BMP Description
		▪ To the extent feasible, relocation will be performed during morning periods. Air and water temperatures will be measured periodically, and relocation activities will be suspended if temperatures exceed the limits allowed by NMFS guidelines. ▪ To prevent aquatic vertebrates from reentering the work area, the channel will be blocked by placing fine-meshed nets or screens above and below the work area. To minimize entanglement, mesh diameter will not exceed 1/8 inch. The bottom edge of the net or screen will be secured to the channel bed to prevent fish from passing under the screen. Exclusion screening will be placed in low velocity areas to minimize impingement. Screens will be checked periodically and cleaned of debris to permit free flow of water. ▪ Handling of aquatic vertebrates will be minimized. When handling is necessary, personnel will wet hands or nets before touching them. ▪ Fish will be held temporarily in cool, shaded water in a container with a lid. Overcrowding in containers will be avoided; at least two containers will be used and no more than 25 fish will be kept in each bucket. Aeration will be provided with a battery-powered external bubbler. Fish will be protected from jostling and noise, and will not be removed from the container until the time of release. A thermometer will be placed in each holding container and partial water changes will be conducted as necessary to maintain a stable water temperature. Fish will not be held more than 30 minutes. If water temperature reaches or exceeds NMFS limits, fish will be released and relocation operations will cease. ▪ If fish are abundant, capture will cease periodically to allow release and minimize the time fish spend in holding containers. ▪ Fish will not be anesthetized or measured. However, they will be visually identified to species level, and year classes will be estimated and recorded. ▪ Reports on fish relocation activities will be submitted to CDFG and NMFS in a timely fashion. ▪ If mortality during relocation exceeds 5%, relocation will cease and CDFG and NMFS will be contacted immediately or as soon as feasible. ▪ When feasible, initial fish relocation efforts will be performed several days prior to the scheduled start of construction. The fisheries biologist will perform a survey on the same

BMP Number	BMP Title	BMP Description
		day before construction begins to verify that no fish have moved back into the project area.
GEN-16	Pump/Generator Operations and Maintenance	When needed to assist in channel dewatering, pumps and generators will be maintained and operated in a manner that minimizes impacts to water quality and aquatic species. 1. Pumps and generators will be maintained according to manufacturers' specifications to regulate flows to prevent dryback or washout conditions. 2. Pumps will be operated and monitored to prevent low water conditions, which could pump muddy bottom water, or high water conditions, which creates ponding. 3. Pump intakes will be screened to prevent entrainment of fish and other vertebrates. If pumping is necessary in streams that support steelhead, a minimum of 2.28mm screens will be installed to prevent entrainment.
GEN-17	Testing and Disposal of Sediment	For projects involving sediment removal, and as specified in the Sediment Sampling and Analysis Guidelines (Stream Maintenance Manual Appendix D), the District will test the sediment to be removed to determine the suitability for disposal or reuse based on its chemical qualities. The test results and proposed disposal or reuse locations will be submitted to the Regional Water Board for review and approval. As specified in the Sediment Sampling and Analysis Guidelines, samples will be analyzed according to the *Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines* (RWQCB 2000), as appropriate for the proposed disposal or reuse site. The results will be compared against federal and state environmental screening levels (ESLs) for protection of human health, groundwater quality, and terrestrial receptors. If hazardous levels of contaminants (as defined by federal and state regulations) are present, the material will be taken to a permitted hazardous waste facility. The waste discharge requirements included in the discharge orders issued by the Regional Water Board dictate the degree of sediment sampling and testing required to obtain approval for sediment disposal or reuse. This mitigation measure incorporates these requirements by reference to ensure adequate protection of water quality.
Public Safety		
GEN-18	Planning for Pedestrians, Traffic Flow, and Safety Measures	1. Work will be staged and conducted in a manner that maintains two-way traffic flow on public roadways in the vicinity of the work site. If temporary lane closures are necessary, they will be coordinated with the appropriate jurisdictional agency and scheduled to occur outside of peak traffic hours (7:00 – 10:00 a.m. and 3:00 – 6:00 p.m.) to the maximum extent

BMP Number	BMP Title	BMP Description
		practicable. Any lane closures will include advance warning signage, a detour route and flaggers in both directions. When work is conducted on public roads and may have the potential to affect traffic flow, work will be coordinated with local emergency service providers as necessary to ensure that emergency vehicle access and response is not impeded. 2. Bicycle and pedestrian facility closures will be scheduled outside of peak traffic hours (7:00 – 10:00 a.m. and 3:00 – 6:00 p.m.) to the maximum extent practicable. 3. Public transit access and routes will be maintained in the vicinity of the work site. If public transit will be affected by temporary road closures and require detours, affected transit authorities will be consulted and kept informed of project activities. 4. Adequate parking will be provided or designated public parking areas will be used for maintenance-related vehicles not in use through the maintenance period. 5. Access to driveways and private roads will be maintained. If brief periods of maintenance would temporarily block access, property owners will be notified prior to maintenance activities.
GEN-19	Public Safety Measures	The District will implement public safety measures during maintenance as follows: 1. If necessary, construction signs will be posted at job sites warning the public of construction work and to exercise caution. 2. Where work is proposed adjacent to a recreational trail, warning signs will be posted several feet beyond the limits of work. Signs will also be posted if trails will be temporarily closed. 3. If needed, a lane will be temporarily closed to allow for trucks to pull into and out of access points to the work site. 4. Fencing, either the orange safety type or chain link will be installed above repair sites on bank stabilization projects. 5. When necessary, District or contracted staff will provide traffic control and site security.
GEN-20	Minimize Noise Disturbances to Residential Areas	The District will implement maintenance practices that minimize disturbances to residential areas surrounding work sites. 1. With the exception of emergencies, work will be conducted during normal working hours (8:00 a.m. – 5:00p.m). Maintenance activities in residential areas will not occur on Saturdays,

BMP Number	BMP Title	BMP Description
		Sundays, or District observed holidays except during emergencies, or with approval by the local jurisdiction and advance notification of surrounding residents. 2. Advanced notification will be provided 1 week prior to the start of construction to adjacent properties within 180 feet of a proposed maintenance site where heavy equipment will be used. 3. Powered equipment (vehicles, heavy equipment, and hand equipment such as chainsaws) will be equipped with adequate mufflers. 4. Excessive idling of vehicles will be prohibited beyond 5 minutes.
GEN-21	Work Site Housekeeping	▪ District employees and contractors will maintain the work site in neat and orderly conditions on a daily basis, and will leave the site in a neat, clean, and orderly condition when work is complete. Slash, sawdust, cuttings, etc. will be removed to clear the site of vegetation debris. As needed, paved access roads and trails will be swept and cleared of any residual vegetation or dirt resulting from the maintenance activity. ▪ For activities that last more than one day, materials or equipment left on the site overnight will be stored as inconspicuously as possible, and will be neatly arranged. ▪ The District's maintenance crews are responsible for properly removing and disposing of all debris incurred as a result of construction within 72 hours of project completion and as directed by the Stream Maintenance Program Manager.

Vegetation Management BMPs

These BMPs provide specific and detailed guidance on the variety of vegetation management procedures implemented by the District. BMPs for the following maintenance techniques are included: tree pruning, plant removal, herbicide application, and site restoration. It is assumed that these measures will be implemented by field crews trained in these procedures. To avoid potential impacts on biological resources, none of these measures will be implemented until authorization from the Stream Maintenance Manager is received.

BMP Number	BMP Title	BMP Description
Tree Pruning		
VEG-1	Routine Pruning Measures	1. Pruning will be performed according to the most recently published National ANSI A300 Pruning Standards and International Society of Arboriculture (ISA) BMPs for Tree Pruning, which include guidance on pruning practices, pruning objectives, pruning methods (types), palm pruning, and utility pruning. 2. Pruning activities will follow National ANSI Z133.1-2006 Standards for safe operation of tree care machinery, and safety equipment such as carabiners, helmets, and arborist ropes to ensure the safety of the tree climbers.
Non-Native and Invasive Plant Removal		
VEG-2	Minimize Local Erosion Increase from In-channel Vegetation Removal	To minimize the potential effect of localized erosion, the toe of the bank will be protected by leaving vegetation to the maximum extent possible.
VEG-3	Arundo and Tamarisk Removal	Removal of arundo and tamarisk will be conducted according to the *Team Arundo del Norte Arundo Eradication and Coordination Program*. This program provides guidance on hand removal and herbicide treatment methods developed by a consortium of local, state, and federal organizations in Northern and Central California. Program documents are available at: http://teamarundo.org/. Removal of tamarisk may follow the same guidelines as for arundo but may be modified based on further research of effective treatment methods (i.e. mixture of imazapyr and glyphosate).
Herbicide Application		
VEG-4	Standard Herbicide Use Requirements	▪ Only herbicides and surfactants that have been approved for aquatic use by the EPA and are registered for use by the CDPR will be used for aquatic vegetation control work. ▪ Herbicide application will be consistent with Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) label instructions and use conditions issued by the US EPA, CDPR, and the Napa

BMP Number	BMP Title	BMP Description
		County Agricultural Commissioner. ▪ Herbicide application in upland areas will not be made within 48 hours of predicted rainfall. ▪ The lowest recommended rate to achieve project objectives of both herbicides and surfactants will be utilized to achieve desired control. ▪ An indicator dye may be added to the tank mix to help the applicator identify areas that have been treated and better monitor the overall application. ▪ No application to plants whose base is submerged in the channel. Application of herbicides to plants growing directly in the water is not covered under this program and require additional authorizations according to state and local regulations.
Site Restoration		
RESTOR-1	Restore Channel Features	Low-flow channels within streams will be returned as closely as possible to their original location and form after sediment removal activities. The restored low-flow channel will be configured with the appropriate depth for fish passage without creating a possible future bank erosion problem. The depth and size of the low flow channel and pools will emulate the pre-construction conditions as closely as possible, within the finished channel topography.
RESTOR-2	Seeding	Sites where maintenance activities result in exposed soil will be stabilized to prevent erosion and revegetated with native vegetation as soon as is appropriate after maintenance activities are complete. For most sites, an erosion control seed mix will be applied to exposed soils, and down to the ordinary high water mark (OHWM). 1. The seed mix will consist of California native grasses (e.g., *Hordeum brachyantherum ssp. californicum*, *Elymus glaucus* , *Bromus carinatus*, *Danthonia californica, and Melica californica*). 2. One or two nonnative sterile grass species may be added to the seed mix provided that the amount does not exceed 25% of the total seed mix by count. 3. Locally native wildflower and/or shrub seeds may also be included in the seed mix. 4. Temporary earthen access roads will be seeded when site and horticultural conditions are suitable.
RESTOR-3	Planting Material	Revegetation and replacement plantings shall consist of locally collected native species or native species acquired from native plant nurseries within the bay area. Plant selection will be

BMP Number	BMP Title	BMP Description
		developed based on surveys of natural areas on the same creek that have a similar ecological setting. These "reference sites" provide information as to what species would be found in the area and an approximate population density.
RESTOR-4	Bank Protection Plantings	1. New trees will have an average spacing of 10-12 feet and shrubs an average spacing of 6-8 feet. 2. Pole plantings shall be collected on site and installed wherever possible depending on soil and water conditions.
RESTOR-5	Site Maintenance	Follow-up maintenance will be performed on sites that have been seeded and planted. 1. Maintenance will include replacing dead or dying plants where appropriate, weeding, removing non-native plant colonizers, and ensuring that all plants receive sufficient water. 2. Irrigation will be implemented as needed throughout the establishment period. The District may maintain or repair bank stabilization projects that are less than 2 years old that are damaged by winter flows. The District will report post construction maintenance work at individual sites as part of the Post-Construction Report submitted by January 15 of each year or if necessary, the subsequent year. Appropriate BMPs will be applied during maintenance repairs.

Biological Resource BMPs

These BMPs will be implemented as appropriate to avoid and minimize impacts on special-status species. These BMPs may be modified during project permitting and agency approvals of annual projects. Additional measures for protection of aquatic species during dewatering activities are described in Measures GEN-14 through GEN-16. None of these measures will be implemented until authorization from the Stream Maintenance Manager is received.

BMP Number	BMP Title	BMP Description
BIO-1	Minimize Impacts to Nesting Birds via Site Assessments and Avoidance Measures	1. For activities occurring between February 15 and August 15, project areas will be checked by a qualified biologist, for nesting birds within 2 weeks prior to starting work. If a lapse in project-related work of 2 weeks or longer occurs, another focused survey will be conducted before project work can be reinitiated.

BMP Number	BMP Title	BMP Description
		2. If nesting birds are found, a buffer will be established around the nest and maintained until the young have fledged. Appropriate buffer widths are 250 feet for raptors, herons, and egrets; 25 feet for ground-nesting non-raptors; and 50 feet for non-raptors nesting on trees, shrubs and structures. A qualified biologist may identify an alternative buffer based on a site specific-evaluation. No work within the buffer will occur without written approval from a qualified biologist, for as long as the nest is active. 3. If a pre-activity survey in high-quality San Francisco common yellowthroat breeding habitat (as determined by a qualified biologist) identifies more singing male San Francisco common yellowthroats than active nests, then the inconspicuous nests of this species might have been missed. In that case, maintenance activities in that area shall be delayed until the San Francisco common yellowthroat non-breeding season (i.e., August 16–March 14). 4. The boundary of each buffer zone will be marked with fencing, flagging, or other easily identifiable marking if work will occur immediately outside the buffer zone. 5. All protective buffer zones will be maintained until the nest becomes inactive, as determined by a qualified biologist. 6. If monitoring shows that disturbance to actively nesting birds is occurring, buffer widths will be increased until monitoring shows that disturbance is no longer occurring. If this is not possible, work will cease in the area until young have fledged and the nest is no longer active.
BIO-2	Avoid and Minimize Impacts to Special-Status Invertebrate Species	1. A District qualified biologist will conduct a desk top audit of the CNDDB, vegetation maps, soils maps, and aerial photos to determine whether suitable special-status invertebrate habitat is potentially present in or adjacent to a maintenance activity. 2. If the District wildlife or fisheries biologist determines that a special-status invertebrate could occur in the activity area, a qualified biologist will conduct a habitat suitability assessment at the maintenance site. 3. If the District wildlife or fisheries biologist determines that: a. suitable habitat is present for valley elderberry longhorn beetle, then no maintenance would be conducted within 100 feet of an elderberry tree/shrub b. suitable habitat is present for California freshwater shrimp, then no maintenance

BMP Number	BMP Title	BMP Description
		would be conducted under the program in this area.
BIO-3	Protection of Sensitive Fauna Species from Herbicide Use	Approved herbicides and adjuvants may be applied in habitat areas for sensitive wildlife species (including salmonids, California red-legged frog, California freshwater shrimp); all applications will occur in accordance with federal and state regulations. There will be no direct application of herbicides to water, such as to control submerged invasive vegetation. For sprayable or dust formulations: when the air is calm or moving away from sensitive wildlife habitat, applications will commence on the side nearest the habitat and proceed away from the habitat. When air currents are moving toward habitat, applications will not be made within 200 yards by air or 40 yards by ground upwind from occupied habitat. However, these distances may be modified for the control of invasive species on salmonid streams if the following measures are implemented: ▪ A qualified biologist will determine presence/absence of sensitive resources in designated herbicide use areas and develop site-specific control methods (including the use of approved herbicide and surfactants). Proposed herbicide use would be limited to the aquatic formulation of glyphosate (Rodeo or equal). Surfactant would be limited to Agri-dex, Competitor, or another brand name using the same ingredients. ▪ A qualified fisheries biologist will review proposed herbicide application methods and stream reaches. The fisheries biologist will conduct a pre-construction survey (and any other appropriate data research) to determine whether the proposed herbicide application is consistent with SMP approvals concerning biological resources and determine which BMPs would be instituted for work to proceed.
BIO-4	Avoid and Minimize Impacts to Special-Status Plant Species and Sensitive Natural Vegetation Communities	A qualified botanist will identify special status plant species and sensitive natural vegetation communities and clearly map or delineate them as needed in order to avoid and/or minimize disturbance, using the following protocols: 1. A qualified botanist will conduct a desktop audit of the CNDDB, vegetation maps, soils maps, and aerial photos to identify if suitable habitats for special status plants and sensitive natural vegetation communities are potentially located within or near work areas. 2. Surveys of areas identified as sensitive natural communities or suitable habitat for special status plant species will be conducted by a qualified botanist prior to commencement of

BMP Number	BMP Title	BMP Description
		work. 3. Surveys will be conducted during the appropriate time of the year to adequately identify plants. 4. The qualified botanist will ensure avoidance and minimize impacts by implementing one or more of the following, as appropriate, per the botanist's recommendation: a) Flag or otherwise delineate in the field the special status plant populations and/or sensitive natural community to be protected; b) Allow adequate buffers around plants or habitat; the location of the buffer zone will be shown on the maintenance design drawings and marked in the field with stakes and/or flagging in such a way that exclusion zones are visible to maintenance personnel without excessive disturbance of the sensitive habitat or population itself (e.g., from installation of fencing). c) Time construction or other activities during dormant and/or non-critical life cycle period; d) Store removed sediment off site; and e) Limit the operation of maintenance equipment to established roads whenever possible. 5. No herbicides, terrestrial or aquatic, will be used in areas identified as potential habitat for special status plants species or containing sensitive natural communities, until a qualified botanist has surveyed the area and determined the locations of special status plant species present. 6. If special status plant species are present and maintenance cannot avoid impacts to the species, then a qualified botanist will determine the ecologically appropriate minimization measures for the species. Minimization measures may include transplanting, seed collection, or both, depending on the physiology of the species. 7. The District will not conduct maintenance activities that would result in the reduction of a plant species range or compromise the viability of a local population.
BIO-5	Protection of Special-Status Amphibian and Reptile Species	1. A District qualified biologist will conduct a desk audit of the CNDDB, vegetation maps, soils maps, and aerial photos to determine whether suitable special-status amphibian or reptile habitat is present in or adjacent to a maintenance activity. 2. If the District Wildlife or Fisheries Biologist determines that a special-status amphibian or

BMP Number	BMP Title	BMP Description
		reptile could occur in the activity area, a qualified biologist will conduct one daytime survey within a 7 day period preceding the onset of maintenance activities. a. If no special status amphibian or reptile is found within the activity area during a pre-activity survey, the work may proceed. b. If a special-status amphibian or reptile, or the eggs or larvae of a special status amphibian or reptile, is found within the activity area during a pre-activity survey or during project activities, the qualified biologist shall notify the District's program manager about the special-status species and conduct the following work specific activities: i. For minor maintenance activities and for vegetation removal activities that will take less than 1 day, the qualified biologist shall conduct a special status species survey on the morning of and prior to the scheduled work. A. If no special status species is found, the work may proceed. B. If eggs or tadpoles of a special status species are found, a buffer will be established around the location of the eggs/tadpoles and work may proceed outside of the buffer zone. Work within the buffer zone will be rescheduled until the time that eggs have hatched and/or tadpoles have metamorphosed. C. If an active western pond turtle nest is detected within the activity area, a 25 ft-buffer zone around the nest will be established and maintained during the breeding and nesting season (April 1 – August 31). The buffer zone will remain in place until the young have left the nest, as determined by a qualified biologist. D. If adults or juveniles of a special status species are found, one of the following two procedures will be implemented: i. If, in the opinion of the qualified biologist, capture and removal of the individual to a safe place outside of the work area is less likely to result in adverse effects than leaving the individual in place and rescheduling the work (e.g., if the species could potentially hide and be missed during a follow-up survey), the individual will be captured and relocated by a qualified biologist (with USFWS and/or CDFG approval, depending on the listing status of the species in question), and work may proceed. ii. If, in the opinion of the qualified biologist, the individual is likely to leave the work area on its own, and work can be feasibly rescheduled, a buffer

BMP Number	BMP Title	BMP Description
		will be established around the location of the individual(s) and work may proceed outside of the buffer zone. No work will occur within the buffer zone will be rescheduled. ii. For minor maintenance and vegetation removal activities that will take more than 1 day, the qualified biologist shall conduct a special-status species survey on each morning of and prior to the scheduled work commencing. E. If eggs or tadpoles of a special status species are found, a buffer will be established around the location of the eggs/tadpole and work may proceed outside of the buffer zone. Work within the buffer zone will be rescheduled until the time that eggs have hatched and/or larvae have metamorphosed. F. If an active western pond turtle nest is detected within the activity area, a 25 ft-buffer zone around the nest will be established and maintained during the breeding and nesting season (April 1 – August 31). The buffer zone will remain in place until the young have left the nest, as determined by a qualified biologist. G. If adults or juveniles of a special status species are found, the individual will be captured and relocated by a qualified biologist (with USFWS and/or CDFG approval, depending on the listing status of the species in question), and work may proceed.
BIO-6	Protection of Bat Colonies	1. A District Wildlife Biologist will conduct a desk audit to determine whether suitable habitat (appropriate roost trees or anthropogenic structures) is present for bat colonies within 100 feet of the work site, staging areas, or access routes. 2. If potential bat colony habitat is determined to be present, within two weeks prior to the onset of work activities a qualified biologist will conduct a survey to look for evidence of a bat use. If evidence is observed, or if potential roost sites are present in areas where evidence of bat use might not be detectable (such as a tree cavity), an evening survey and/or nocturnal acoustic survey may be necessary to determine if the bat colony is active and to identify the specific location of the bat colony. 3. If an active bat maternity colony is present then the qualified biologist will make the following determinations: a. The work can proceed without unduly disturbing the bat colony.

BMP Number	BMP Title	BMP Description
		b. There is a need for a buffer zone to prevent disturbance to the bat colony, and implementation of the buffer zone will reduce or eliminate the disturbance to an acceptable level. c. Work cannot proceed without unduly disturbing the bat colony; thus, the work will be postponed until after July 31. 4. If a non-breeding bat hibernaculum is found in a tree or structure that must be removed or physically disturbed, the qualified biologist will consult with DFG prior to initiating any removal or exclusion activities.
BIO-7	Protection of dusky-footed woodrats	1. If a woodrat nest is identified in a work area, the District will attempt to preserve the nest and maintain an intact dispersal corridor between the house and undisturbed riparian habitat. 2. If the woodrat nest cannot be avoided, a qualified biologist shall deconstruct the nest by hand and relocate the nest materials to the nearest undisturbed suitable riparian habitat.

Cultural Resource BMPs

This group of BMPs are intended to be implemented specifically during ground-disturbing activities, including bank stabilization, sediment removal, and tree removal activities. Implementation of these BMPs will be coordinated by the Stream Maintenance Manager and directed by qualified cultural resource specialists. The review is also directed to review the Cultural Sensitivity Maps included in Appendix A of the SMP Manual.

BMP Number	BMP Title	BMP Description
CUL-1	Review Cultural Sensitivity Maps	During the early phases of the Annual Work Plan development, the District will review the Cultural Sensitivity Maps (Appendix A of the SMP Manual) for all locations where ground-disturbing activities are proposed. Based on the location of such projects, BMPs CUL -2 through CUL-4 shall be implemented as follows: ▪ High Sensitivity: BMP CUL-2 and CUL-3 ▪ Moderate Sensitivity: BMP CUL-2 ▪ Low Sensitivity: *BMPs CUL-2 through CUL- 4 not required* ▪ Unknown Sensitivity: BMP CUL-4

BMP Number	BMP Title	BMP Description
		BMPs CUL-5 and CUL-6 are applicable to all ground-disturbing projects, no matter the sensitivity level of the project location.
CUL-2	Field Inventory for High or Moderately Sensitive Areas	A cultural resources specialist will conduct a field inventory of the project area to determine the presence/absence of surface cultural materials associated with either prehistoric or historic occupation. The results along with any mitigation and/or management recommendations would be presented to the District in an appropriate report format and include any necessary maps, figures, and correspondence with interested parties. A summary table indicating appropriate management actions (e.g., monitoring during construction, presence/absence testing for subsurface resources; data recovery, etc.) will be developed for each project site reviewed. The management actions will be implemented onsite to avoid significant impacts to cultural resources.
CUL-3	Construction Monitoring for Highly Sensitive Cultural Areas	The District will retain a qualified archaeologist to be present onsite during any ground disturbing activities within highly sensitive cultural areas (as indicated in the maps of Appendix A). If any cultural resources are discovered during these or any other project activities, the measures developed under BMP CUL-2 or as described for BMP CUL-6 will be implemented as appropriate.
CUL-4	Review of Projects with Native Soil	A cultural resources specialist will conduct a review and evaluation of those sites that would involve disturbance/excavation of soil to determine their potential for affecting significant cultural resources. The evaluation of the potential to disturb cultural resources will be based on an initial review of archival information provided by the California Historical Resources System/Northwest Information Center (CHRIS/NWIC) in regard to the project area based on a 0.25 mile search radius. It is recommended that this initial archival review be completed by a professional archaeologist who will be able to view confidential site location data and literature to arrive at a preliminary sensitivity determination. If necessary, a further archival record search and literature review (including a review of the Sacred Lands Inventory of the Native American Heritage Commission); and a field inventory of the project area may be conducted. The results along with any mitigation and/or management recommendations would be presented as described above in BMP CUL-2.
CUL-5	Pre-Maintenance Educational Training	At the beginning of each maintenance season and before conducting ground disturbing stream maintenance activities, all personnel will participate in an educational training session conducted by a qualified cultural resources specialist. This training will include instruction on how to identify

BMP Number	BMP Title	BMP Description
		historic and prehistoric resources that may be encountered, and the appropriate protocol if any resources are discovered during maintenance work.
CUL-6	Discovery of Cultural Remains or Historic or Paleontological Artifacts	Examples of cultural remains are: obsidian and chert flaked-stone tools (e.g., projectile points, knives, scrapers) or significant areas of tool making debris; culturally darkened soil ("midden") containing heat-affected rocks, artifacts, or shellfish remains; and stone milling equipment (e.g., mortars, pestles, handstones, or milling slabs); and battered stone tools, such as hammerstones and pitted stones. Historic-period artifacts might include stone, concrete, or adobe footings and walls; filled wells or privies; and deposits of metal, glass, and/or ceramic refuse. Paleontological artifacts include fossilized remains of plant and animals. Work in areas where remains or artifacts are found will be restricted or stopped until proper protocols are met. 1. Work at the location of the find will halt immediately within 50 feet of the find. A "no work" zone shall be established utilizing appropriate flagging to delineate the boundary of this zone, which shall measure at least 50 feet in all directions from the find. 2. The District shall retain the services of a Consulting Archaeologist or Paleontologist, who shall visit the discovery site as soon as practicable, and perform minor hand-excavation to describe the archaeological or paleontological resources present and assess the amount of disturbance. 3. The Consulting Archaeologist shall provide to the District and the U.S. Army Corps of Engineers (Corps), at a minimum, written and digital-photographic documentation of all observed materials, utilizing the guidelines for evaluating archaeological resources for the California Register of Historic Places (CRHP) and National Register of Historic Places (NRHP). Based on the assessment, the District and Corps shall identify the CEQA and Section 106 cultural-resources compliance procedures to be implemented. 4. If the find appears to not meet the CRHP or NRHP criteria of significance, and the Corps archaeologist concurs with the Consulting Archaeologist's conclusions, construction shall continue while monitored by the Consulting Archaeologist. The authorized maintenance work shall resume at the discovery site only after the District has retained a Consulting Archaeologist to monitor and the Stream Maintenance Manager has received notification

BMP Number	BMP Title	BMP Description
		from the Corps to continue work. 5. If the find appears significant, avoidance of additional impacts is the preferred alternative. The Consulting Archaeologist shall determine if adverse impacts to the resources can be avoided. 6. When avoidance is not practical (e.g., maintenance activities cannot be deferred or they must be completed to satisfy the SMP objective), the District shall develop an Action Plan and submit it to the Corps within 48 hours of Consulting Archaeologist's evaluation of the discovery. The action Plan may be submitted via e-mail to the Corps at: (rstradford@spd.usace.army.mil). The Action Plan is synonymous with a data-recovery plan. It shall be prepared in accordance with the current professional standards and State guidelines for reporting the results of the work, and shall describe the services of a Native American Consultant and a proposal for curation of cultural materials recovered from a non-grave context. 7. The recovery effort will be detailed in a report prepared by the archaeologist in accordance with current archaeological standards. Any non-grave artifacts will be placed with an appropriate repository. 8. The Consulting Paleontologist will meet the Society for Vertebrate Paleontology's criteria for a "qualified professional paleontologist" (Society of Vertebrate Paleontology Conformable Impact Mitigation Guidelines Committee 1995). 9. The paleontologist will follow the Society for Vertebrate Paleontology's guidelines for treatment of the artifact. Treatment may include preparation and recovery of fossil materials for an appropriate museum or university collection, and may include preparation of a report describing the finds. The District will be responsible for ensuring that paleontologist's recommendations are implemented. 10. In the event of discovery of human remains (or the find consists of bones suspected to be human), the field crew supervisor shall take immediate steps to secure and protect such remains from vandalism during periods when work crews are absent.) 11. Immediately notify the Napa County Coroner and provide any information that identifies the remains as Native American. If the remains are determined to be from a prehistoric Native

BMP Number	BMP Title	BMP Description
		American, or determined to be a Native American from the ethnographic period, the Coroner shall contact the Native American Heritage Commission (NAHC) within 24 hours of being notified of the remains. The NAHC then designates and notifies within 24 hours a Most Likely Descendant (MLD). The MLD has 24 hours to consult and provide recommendations for the treatment or disposition, with proper dignity, of the human remains and grave goods. 12. Preservation in situ is the preferred option. Human remains shall be preserved in situ if continuation of the maintenance work, as determined by the Consulting Archaeologist and MLD, will not cause further damage to the remains. The remains and artifacts shall be documented and the find location carefully backfilled (with protective geo-fabric if desirable) and recorded in District project files. 13. Human remains or cultural items exposed during maintenance that cannot be protected from further damage shall be exhumed by the Consulting Archaeologist at the discretion of the MLD and reburied with the concurrence of the MLD in a place mutually agreed upon by all parties.

Chapter 4
VEGETATION MAINTENANCE ACTIVITIES

4.1 Overview

Vegetation maintenance refers to the selective trimming, thinning, and removal of instream vegetation that is increasing the flood risk. The District's routine vegetation maintenance activities seek to trim, thin, or remove vegetation that is causing flow blockages or significantly increasing hydraulic roughness and thereby reducing channel conveyance capacity. Vegetation maintenance activities also include planting trees, shrubs, and grasses in District maintained channels. See Chapter 9 *Habitat Protection and Enhancement* for a discussion of revegetation activities. This chapter describes the District's techniques and procedures for vegetation maintenance, including invasive plant management and tree pruning. Chapter 5 *Downed Tree Management* describes maintenance activities specifically related to downed trees within stream channels.

The types of vegetation maintenance activities are relatively consistent from year to year, though the work locations change. On average a total of 1,000 linear feet of vegetation management is conducted by the District throughout the county. Years that experience high flows, flooding or strong winds may require additional work to clear downed trees or vegetation debris (see maintenance discussion in Chapter 5). Conversely, vegetation maintenance needs following dry or drought years are generally reduced. Some channels may require annual vegetation maintenance while others do not. This largely depends on the type of vegetation in the channel. For example, channels characterized by early seral cattails or young willows may need annual pruning while channels with a later seral mature riparian canopy (especially on the upper bank) generally require less vegetation thinning and removal to maintain flow capacity.

Vegetation maintenance techniques include hand removal using hand-held tools and equipment, mechanical removal using heavier equipment, and herbicide applications. The District conducts the majority of vegetation maintenance using hand removal methods. However, on occasion larger equipment used for vegetation removal may include a flail mower attachment on an excavator or Bobcat® to cut cattails or blackberries, or a backhoe or rubber-tracked excavator that is used for removing material from the channel.

Vegetation maintenance activities vary depending on the type of stream channel or facility involved. While the methods described here are the common practices of the District, maintenance techniques may shift over time and by location depending on site constraints and new techniques. As discussed in Chapter 1 and again Chapter 10, maintenance practices are adaptive and this manual will be revised periodically to accurately reflect the District's maintenance approach and techniques.

Erosion protection and streambank stabilization activities are discussed in Chapter 6 and include an integrated vegetation planting approach to bank repairs. Vegetation maintenance at other non-channel facilities, including channel access road maintenance is described in Chapter 8.

The following sections of this chapter describe more specific vegetation maintenance activities, including:

Section 4.2 Maintenance Goals and Triggers

Section 4.3 Invasive Plant Management

Section 4.4 Tree Pruning and Management

Section 4.5 Tree Removal and Relocation

4.2 Maintenance Goals and Triggers

Maintenance Goals

The primary vegetation maintenance goals are to:

- ensure that adequate flood conveyance capacity is provided,
- minimize flow obstructions,
- maintain stable streambank conditions, and where possible
- enhance instream ecologic conditions through:
    - reducing and removing exotic and invasive species,
    - encouraging the growth and presence of native vegetation,
    - developing a mature and complex riparian canopy of native species,
    - managing and enhancing bank vegetation to improve streambank stability, and
    - managing emergent vegetation in the channel.

In most channels, meeting these goals requires balancing flood protection needs with habitat protection or enhancement opportunities. Although it is possible to identify an "ideal" or "target" vegetation configuration, it may not be possible to achieve this condition in all reaches of all channels. As described in Chapter 2 *Environmental Setting*, a range of existing channel vegetation conditions is observed in the program area. Additionally, Figure 9-1 in Chapter 9 illustrates the wide range of riparian vegetation zones that potentially occur in District channels.

Maintenance Triggers

In general, vegetation management is appropriate when any of the following conditions occur:

- Vegetation growth is significantly decreasing flood conveyance capacity, particularly where infrastructure or adjacent properties are at risk.
- Vegetation growth obstructs access to channels and facilities or threatens District facilities or neighboring property,
- Invasive nonnative plants are reducing the success of native vegetation,

- Vegetation management offers good opportunities to improve habitat value for fish and wildlife.

As described in Chapter 3, Maintenance Principles 1 and 3, and described in Chapter 10, the District will be developing channel capacity and vegetation objectives for individual reaches. These objectives will identify when growth has significantly reduced conveyance capacity such that maintenance is warranted.

The decision to remove, thin, or preserve individual trees will be made in the field by District field staff familiar with regional vegetation and riparian ecology. Consideration for individual tree removal or thinning will be based on several factors including:

- What is the degree of blockage across the channel and where is the tree located in the channel?
- What is the type and age of the tree? Are there a lot of these trees already in the channel reach? Are there better trees to preserve?
- Can the individual tree be pruned or thinned (before consideration of removal) to provide the necessary conveyance capacity?
- Does the tree under consideration provide shade or other habitat benefits?
- Does the tree under question provide longer-term canopy development or riparian corridor benefits?

The rationale to either thin, prune, or remove trees will be based on addressing these questions above. Answering these questions requires the oversight and guidance of a stream manager that is familiar with the Program Area's vegetation and knowledgeable of channel botanical conditions.

California Conservation Corps Vegetation Maintenance Crew

4.3 Invasive Plant Management

The primary invasive exotic weeds managed in the program area are *Arundo donax*, tamarisk (*tamarix spp.*), Scarlet Sesbania (*Sesbania punicea*), and Himalayan blackberry (*Rubus armeniacus* [syn. *Rubus discolor*]). These species rapidly invade stream channels, often growing aggressively to the exclusion of other riparian species. The rapid and voluminous growth of these invasive plants can significantly reduce channel capacity. The management of other invasive aquatic plants including cattails and water primrose (*Ludwigia*) is also conducted by the District in a limited number of creeks such as Salvador Creek. Managing invasive vegetation is a continuous, routine, and on-going activity of the District's stream maintenance program. **Table 4-1** summarizes invasive plant removal activities conducted by the District between 2000 and 2010. Where measured, the length of removal activities is also listed in the table.

Management of invasive species is an important ongoing activity to control and minimize environmental impacts from exotic species and encourage the reestablishment and ecological health of native plant species.

Table 4-1: Invasive Plant Management Activities Conducted 2000-2010

Creek or Project Site	Invasive Species Removed	Linear Feet Removed*
Blossom Creek	Arundo	90
Conn Creek	Eucalyptus, Arundo	
Dry Creek	Arundo	150
Garnet Creek	Arundo	40
Napa Creek	Arundo	400
Napa River	Arundo	Approx. 1 mile
Salvador Creek	Himalayan blackberry, Vinca	
Simmons Creek	Arundo	60
Sulphur Creek	Arundo, Tamarisk	200 (Arundo), 300 (Tamarisk)
Summerbrooke	Himalayan blackberry	
Tulucay/Camille Creeks	Himalayan blackberry, Fennel, Arundo, Tamarisk	

* blank rows indicate the length of invasive plant management activities was not recorded.

Herbicide Application for Invasive Species Control

Herbicides can be toxic to people and wildlife if not handled properly. However, the safe use of herbicides is a critical method for vegetation management, especially to control invasive and exotic plants. All herbicide applications conducted by the District occur in accordance with federal, state, and local regulations. The District applies herbicides to control invasive and exotic plants in upland areas (vegetation growing along and on top of stream banks). Herbicide application on submerged vegetation (plants growing in or adjacent to the water, such as cattails or Ludwigia) is not conducted under the maintenance program.

Note that in the future the District may seek regulatory approval for use of herbicides to control submerged vegetation, such as cattails and Ludwigia. However, at this time, herbicides are only used to control upland invasive and exotic plants.

Targeted spot spraying and hand painting of cut stumps are the primary methods of herbicide

application. Foliar spraying may be conducted to control growth on larger plants such as exotic trees or large stands of pampas grass. Herbicide application is conducted when the climate is dry (between June 15 and November 15), wind is not above 5-10 mph, and no rain is forecast for the next 24 hours. The maximum monthly average of herbicide use is 5 to 8 gallons over 3 to 5 acres annually. Typical herbicides used for control of invasive and exotic plants are glyphosate (trade name: Roundup®) and imazapyr (trade names: Arsenal®, Chopper®, and Stalker®). Herbicides are used on a site by site basis and only when necessary, such as when hand and mechanical methods are unsuccessful.

Invasive Species Profiles

In the paragraphs below summary species profiles for the primarily invasive and exotic plants managed by the District are presented along with stream management considerations and approaches. Other invasive species, such as yellow star thistle, are also managed by the District. Management approaches for control of other species are the same as those described below.

Arundo donax, also known as giant reed, is a bamboo-like plant targeted by the District as a priority weed. This species reproduces vegetatively and does not produce viable seed. When established within stream channels, Arundo can quickly reduce channel capacity, increase hydraulic roughness, and increase the flood risk. The plant's shallow roots encourage mobility in high flow events. Dislodged Arundo pieces move downstream, often plugging culverts or creating debris blockages at bridge crossings. Upon settling, Arundo will rapidly colonize at its new downstream location. In this manner, entire streams systems have been invaded in a relatively short time period. The dense lower stalks and root masses of Arundo are also effective at trapping fine sediment, whereby a positive feedback process occurs. Arundo settles, traps fine sediment, the channel bed elevates, more Arundo colonizes, more sediment is trapped, etc. Arundo favors stream beds and banks in full sun conditions. Developing a native riparian canopy that can shade the channel is an effective long-term strategy to reduce Arundo presence.

***Arundo donax* removal by California Conservation Corps team**

The District's approach to managing Arundo is to target removal activities by sub-watershed, beginning in upstream areas and eradicating Arundo colonies progressively downstream through each sub-watershed. Arundo is eradicated by either spraying the entire standing plant with herbicide or mechanically cutting the stalks and painting each stalk-stump by hand with herbicide. The District's standard Arundo herbicide mix includes glyphosate, a non-ionic surfactant, and ammonium sulfate. The herbicide mix is applied in the fall from September through early November. Dead canes are removed for fire safety in the fall (September or later) following herbicide application. Any bare soil remaining after cane removal is revegetated with native plants or seeds, such as the native species listed in Table 6-1 in Chapter 6.

Tamarisk, like Arundo, is a highly invasive plant that can rapidly reduce channel capacity, increase channel roughness, and thereby increase the flood risk. Currently, tamarisk is less common than Arundo in the Napa River watershed. However, conditions are favorable for Tamarisk presence to increase. To minimize the spread of Tamarisk, each occurrence of the plant is eradicated as found. In general, the eradication methods are the same as described above for Arundo including a standard herbicide mix of glyphosate, a non-ionic surfactant, and ammonium sulfate. Future treatment techniques for Tamarisk may vary as more effective treatment methods are developed.

Tamarisk removal

Scarlet Sesbania

Scarlet Sesbania, or red sesbania, is a popular landscape plant that has recently been discovered in riparian areas in the Napa Valley. Sesbania has the potential to dominate native riparian vegetation, a problem that has occurred in the Central Valley. The District eradicates sesbania whenever the plant is encountered. The eradication methods for Sesbania generally involves pulling individual plants by hand or with weed wrenches but in cases of large infestations cutting stalks and painting each stalk-stump by hand with a 50% diluted concentration of glyphosate is preferred.

Himalayan Blackberry is commonly found in reaches with little to no riparian canopy. This species generally grows from the bank slope, particularly near (or at) the toe-of-slope and can grow into and across the channel bed quickly, often within a single season. Exotic blackberries are generally removed by hand or mechanically removed using a bladed weed-eater, or an excavator or Bobcat® with a flail mower attachment. Stalks are then raked together, picked up, and removed from the site using a dump truck. If a mechanical technique is used such as a flail mower or other chopping machine, efforts to remove all slash, sawdust, cuttings, etc. will be taken to leave the site free of vegetative debris. Remaining cut stalks will then be painted with an herbicide (generally glyphosate) to control re-growth. The development of a canopy encouraged by tree planting also helps to reduce the re-growth of blackberries.

Cattails

Cattails are commonly (but not necessarily) found in reaches with little to no riparian canopy. Cattails generally establish in low-gradient channels in areas of slow-moving or stagnant flow. Finer sediments naturally settle out in these locations, but further sedimentation is encouraged by cattails which trap sediment and further reduce flow velocities. Cattails are often the climax community (the final stage in ecological succession) developed in channels in need of sediment removal. In the photo, cattails have established within a portion of the channel bed. When this growth expires at the end of the dry season, dead plant matter can settle and redirect flows to the opposite side of the channel, which can lead to bank erosion if not managed.

Cattails are generally removed using bladed weed-eaters. In areas where mature trees do not prohibit access, heavy equipment, such as an excavator with a flail mower extension positioned at top-of-bank, may be used. This approach to cattail management is a shorter-term solution as cattails readily grow back. Cattail removal may also be combined with sediment removal. In such cases, the channel is cleared of both sediment and cattails using methods described in Chapter 7 in order to increase channel capacity. This approach includes removal of cattail roots along with the sediment and can successfully reduce cattail re-growth for several years. Over the long-term, cattail growth is further discouraged by the development of a canopy over the channel and strategic planting of cattail competitors. The District anticipates the need to periodically manage cattails between June 15th and October 31st.

Ludwigia in Yountville Outfall

Water primrose (*Ludwigia peploides montevidensis*) is an invasive, exotic, aquatic weed found in apparently increasing occurrence on the west coast as well as nationally. The species occurs in tributaries to the Napa River, including Salvador Creek. Generally, winter streamflow rises above the Ludwigia patches or flushes the plants downstream. In most cases, Ludwigia patches are not problematic in conveying flood flows. However, accumulated Ludwigia is known to collect at downstream bridge piers where it can quickly grow, completely fill channels (as shown in the photo), and create flow blockages. Ludwigia also provides some beneficial functions similar to the native species (*Ludwigia peploides peploides*) including, bank toe stabilization, nutrient exchange and uptake, and cover for young fish and amphibians. While these functions may not be enough to support presence of Ludwigia in District flood control channels, it does provide sound reasoning for leaving it in a channel if there is no other emergent cover, or where the degree of Ludwigia present does not create a flow blockage.

Mechanical removal is the primary method to control Ludwigia and is generally conducted using a long-reach excavator from maintenance roads adjacent to the project site channel. Where the channel is too wide, the excavator may occasionally travel partially down the bank in areas that

will not impact existing native and riparian vegetation. The excavator will work from the mid-bank position, thus reducing the need for multiple trips along the bank slope by smaller equipment. The District anticipates the need to periodically manage Ludwigia between June 15th and October 31st.

Debris generated from invasive plant management activities are either left on site to decay and redistribute nutrients into the soil or, if plant and root clippings remain viable for regrowth, the debris it taken to the local landfill for disposal.

4.4 Tree Pruning and Management

Considerations and Rationale for Pruning

The District seeks to develop and preserve healthy native riparian vegetation along its stream courses to the degree allowable in consideration of potential flooding and erosion threats. Prior to any tree management activities, several issues are considered to minimize potential effects and to improve maintenance results.

- What is the type and age of the tree? Are there a lot of these trees already in the channel reach? Are there better trees to preserve? Are there any natives nearby that could replace the function of the tree in question in the next year?
- What is the degree of blockage across the channel and where is the tree in question located in the channel, and how is it related to any existing blockages?
- Can the individual tree be pruned or thinned (before consideration of removal) to provide the necessary conveyance capacity?
- Does the tree under consideration provide significant shade or other habitat benefits, such as refugia or foraging habitat?
- Does the tree under question provide longer-term canopy development or riparian corridor benefits?

The rationale to either thin, prune, or remove trees is based on addressing these questions above. Answering these questions requires the oversight and guidance of a biologist or arborist that is familiar with the vegetation in the area and is knowledgeable of channel botanical conditions. The degree or standard of pruning will be targeted to support channel capacity and vegetation objectives (to be developed for District channels per Chapter 10).

See Chapter 5 for a discussion of management of downed trees.

Managing Trees for Their Channel Function

In general, all types of trees (native or non-native) are managed according to their location and role in the channel. The following paragraphs provide additional detail for maintenance decisions for specific zones across the channel cross section.

1) **Upper Bank Zone**: in general, native trees located on the upper banks are retained unless they are a fall or safety hazard, have already fallen, are creating erosional or flow deflecting problems, or present a channel access issue. Depending on the level of invasiveness of a particular species, select non-native trees may be managed on a case by case basis in the upper bank zone, depending upon the health of the tree, its contribution to the riparian corridor, and what else is growing nearby (based on the approach described in Chapter 3).

2) **Mid Bank Zone**: in general, native trees and shrubs located on the side banks in the mid bank zone are retained unless they are causing significant debris accumulation, causing bank erosion or scour through tree falling or deflecting flows, presenting a fall hazard, or are limiting access. Often naturally recruited native shrubs are retained in this zone but are not actively planted. Similar to the upper bank zone, in the mid bank zone, moderately acceptable non-native species are managed on a case by case basis, based on an evaluation of the health of the tree, its contribution to the riparian corridor, and what else is growing nearby (based on the approach described in Chapter 3).

3) **Lower Bank Zone (toe of bank)**: in general, native and moderately acceptable non-native trees located at the toe and on the side bank are retained unless the following conditions occur:

    - the vegetation is growing excessively horizontal, blocking flows, and cannot be pruned or trained into a more upright posture to convey flows;
    - the vegetation is trapping significant debris or sediment (defined as a deposit greater than 2 ft deep or covering more than 100 sq ft of the lower bank or instream channel zone);
    - vegetation is causing bank erosion or scour; or
    - vegetation is presenting a considerable fall hazard.

4) **Instream Zone**: vegetation is targeted for thinning and removal when:

    - an aggressive stand of Arroyo willow is developing and significantly constricting channel capacity (based on the vegetation assessment described in Chapter 3);
    - instream vegetation is demonstrated to catch significant debris; or
    - instream vegetation is it causing excessive bank scour.

    Exceptions to this thinning and removal approach for the instream zone include:

    - when instream trees cause no evidence of bank scour and minimal debris accumulation.
    - when single trunk trees or readily prunable trees occur, such as willows, alder, Fremont cottonwood, and Oregon ash. These species are generally retained in the channel, especially if they provide significant shade or promote instream habitat that is not destabilizing the tree itself or the bank zone.

- when the channel has enough capacity to allow trees well-spaced and upright to establish and mature in the channel.

Across these channel zones, mature, healthy, native trees are generally only removed if channel capacity is significantly limited or if the tree is creating unacceptably high hydraulic roughness in the channel and the situation cannot be rectified though limbing or pruning. The rationale for removing a native tree is based on the pre-maintenance survey and the presence of the triggering conditions described in Chapter 3.

Tree Pruning Methods

Maintenance activities related to tree pruning focus on selectively thinning brush and multi-trunked trees. The preferred maintenance approach is to prune lower limbs up to the top of the channel banks, if possible. Multi-stemmed trees are pruned down to a single trunk and lower limbs are removed up to the top of the channel banks, if possible. The goal of this maintenance approach is to develop a native canopy over the channel but not to increase channel roughness such that the flood hazard is increased.

In the top-of-bank area outside the stream channel (including the access road and adjacent above channel area), healthy mature native trees are only trimmed if a limb is blocking the access road, hanging over a fence into a private yard, appears unbalanced or broken, or to maintain appropriate spacing for access (targeted ideal spacing). Enough space will be maintained along the access road to allow maintenance and emergency vehicles.

Tree pruning considers the extent of local riparian canopy and vegetation in general. For example, if the active channel is fully shaded by early seral arroyo willow, the complete removal of which would expose the channel to direct sunlight, pruning and thinning techniques, such as allowing a narrow strip of vegetation to persist on the sides of the banks to shade the channel, will be used. This process is repeated for each tree assessed for removal. For example, if an invasive privet bush is providing the only shade and vertical element along the channel, it will be retained until such time as a replacement has developed to replace and improve the ecologic function. In other words, vegetation removal may be phased to reduce potential impacts of reducing channel shade. The reach will also be identified for planting of more desirable trees the following planting season.

Pruning on the bank side slopes usually requires careful hand clearing using chainsaws, pole saws, pruners, and loppers. Hand clearing may also be used at the top-of-bank to remove hazard trees (e.g., snags, dying or dead trees, broken branches) from areas with high public use or that are adjacent to residences or other structures.

Willow Pruning and Removal

Willows are perhaps the most common channel vegetation type throughout the program area. Willows generally grow from the lower bank slope (near or at the toe-of-slope) and can grow into and across the channel bed quickly, often within a single season. Arroyo willows are the most prominent vegetation maintenance issue due to their rapid growth (over 1.5 inches in diameter per year) and the bushy structure of the plant which is effective at slowing flows and trapping debris. White alder, big leaf maple, Oregon ash, red and Pacific willow species are better suited to flood control channels because they generally form a single main trunk that can

be limbed up and pruned so as not to extensively block the channel cross section. The rapid growth, multi-stemmed base, and bushy nature of arroyo willow generally prevent this type of management approach, though in some cases (especially where arroyo willow is the dominant tree along a stretch of channel), these trees are being managed toward a more upright stature. In general, arroyo willow pruning to form an upright tree requires considerably more management effort since the form of the tree is not naturally upright and the attempt is working against the central tendency of the tree. Species like red, yellow, and Pacific willow are retained where they do not present issues for flows or roughness, or where possible, are transplanted when feasible.

Salvador Creek before willow pruning

The District generally conducts willow removal from June 15th to October 31st. Arroyo willows are removed wherever they are significantly impeding flows and reducing the channel conveyance capacity. If arroyo willows are not removed (in cases where the canopy is needed and channel integrity is not at risk), they are pruned to minimize their ability to catch debris and impede the flow of water. Red and yellow willows are generally retained, but pruned to reduce the number of branches and trunks below the top of the channel banks.

Salvador Creek after willow pruning

Willow removal generally requires hand clearing using chainsaws, pole saws, pruners, and loppers. Willow stumps may be hand treated with an herbicide such as glyphosate to prevent future growth. Cut vegetation must then be removed from the channel. This is achieved using a variety of methods including hand removal (passing branches up the slope), attaching a line to the cut limbs and pulling them up the slope with the aid of an excavator arm, using an excavator reaching into the channel from top-of-bank, by angled pulls using a line, or using a winch on a truck or tractor.

In cases where arroyo willow root wads protrude from the channel bottom after limbs have been pruned, these are generally left in place but depending on the channel size and geometry, the root wad may require removal to reduce roughness on the channel bed. See Chapter 9 for further details on large woody debris management.

Vegetation debris from pruning and removal activities is either chipped and left onsite for lanowners to use as mulching material, or chipped and hauled to the Napa Recycling and Waste Service Center for re-use and resale in their composting program.

4.5 Tree Removal and Relocation

Mature, healthy, native and non-native trees may be removed if channel capacity is significantly limited or if the tree is creating unacceptably high hydraulic roughness in the channel and the situation cannot be rectified through limbing or pruning. The rationale for removing a mature

tree is based on the pre-maintenance survey and the presence of the triggering conditions described above. The location of the channel and the channel type will also influence any decisions regarding tree removal, with a much higher sensitivity and reluctance to remove trees in non-engineered channel locations in non-urban areas.

Sick or dying mature trees may be removed if they reduce channel capacity, increase roughness, are prone to falling, or present a potential safety hazard to recreational users (where publicly accessible) or adjacent structures. On-site, District stream managers will evaluate tree health, channel capacity, and potential hazard conditions and decide upon the proper course of tree thinning, pruning, or removal. A tree is considered a hazard if in the professional judgment of District stream managers (based on previous experience) the tree has a high likelihood to fall within the coming year (due to storm, high wind, natural decay, or other causes) and the falling of that tree would pose a direct hazard to people, roads, infrastructure, or other facilities.

Tree snags will be left in place to provide habitat for birds and small mammals if the snags do not otherwise pose a flood or safety hazard. Sick, dying, or dead trees and snags may also be pruned to reduce the flood and/or safety hazard while also providing habitat. Dead or dying trees, or other trees that pose a risk of falling, that do not pose a threat to people, roads, infrastructure, or other facilities will be evaluated for their preservation on-site. This topic of downed tree management is the subject of Chapter 5.

Tree removal techniques use hand-held tools and occasional use of heavier mechanical equipment. Removed trees are chipped for mulch and either left onsite or taken to the Napa Recycling and Waste Service Center for composting. As described above in Chapter 3, if a standing tree must be removed due to the presence of hazard conditions during the March 1 to August 15 period, then a nesting bird survey would be conducted by a qualified biologist according to standard District protocols to avoid any potential impact to nesting birds. Results of any nesting bird survey would be included in the annual summary maintenance report.

Tree Relocation Opportunities

Native trees selected for removal will be evaluated for potential relocation to other channel sites. Desirable trees for relocation will typically have a single trunk, straight vertical orientation, and good long-term potential to provide riparian canopy. Target species for relocation include alders, red willow, or Pacific willow. The relocation site will be evaluated for channel roughness, existing flow conveyance, and erosion/sedimentation conditions to ensure that the introduced tree will not cause any increased flood threat. The tree removal process will preserve the tree's root structure, include pruning to compensate for root damage, and provide immediate planting and irrigation at the new site. The vacated tree site will be treated like a bank stabilization project, using bioengineered techniques (described in Chapter 6) to back fill and stabilize the excavated root zone. Some trees, like large red or Pacific willows can be cut into large sprigs and planted at other toe-of-bank or mid-bank sites using an auger. Sprig planting can reduce the need for full-scale tree removal and replanting. Non-native trees will not be considered for relocation; however, upon their removal the excavated root zone will also be treated and repaired. Also see discussion of downed tree management in Chapter 5.

Chapter 5
DOWNED TREE MANAGEMENT

5.1 Overview

Large trees varying in length from 20 to 70 feet tall and two to three feet in diameter fall into and across District-maintained channels every year. This natural process promotes recruitment of woody debris in channels and enhances instream habitat by providing channel shading, flow eddies, scour pools, refugia for aquatic species, and encouraging growth of streamside vegetation. However, downed trees and branches can also potentially increase the flood risk and raise flow elevations. Downed trees may collect debris, block flows, or redirect flows erosively towards a streambank. When these processes elevate the flood risk, increase erosion, or occur near a facility such as a stream crossing or culvert, the downed tree may require District management activities including tree removal, pruning, stabilization, or repositioning. The District considers downed trees (and their woody debris) a highly valuable ecologic resource to stream channels. The District manages downed trees and woody debris for flood control and habitat benefits.

Downed trees can provide valuable refuge and habitat opportunities if properly managed and left in place.

Downed tree management is one of the District's most frequent stream maintenance activities. In 2007, seven maintenance projects addressed downed trees and branches in District channels. Additionally, eight downed tree management projects were conducted in 2008. The District also conducts several restoration efforts in coordination with downed tree management activities to create and enhance instream woody debris structures throughout the county. These habitat enhancement activities are discussed further in Chapter 9 *Habitat Protection and Enhancement*.

While this chapter *Downed Tree Management* and the subject of Chapter 4 *Vegetation Maintenance Activities* are highly related and could have been combined; the District preferred to provide the subject of downed tree management its own chapter in this Manual because of its importance.

The District conducts the majority of downed tree maintenance using hand tools and equipment. However, on occasion heavy equipment including backhoes or rubber-tracked excavators is used to relocate or remove trees within a dewatered portion of the channel. Downed tree management is generally conducted during the dry season, but can occur year-round, as needed to prevent flooding or erosion.

Downed tree management activities vary depending on the type of stream channel or facility involved. While the methods described here are the common practices of the District, maintenance techniques may shift over time and by location depending on site constraints and new techniques. As discussed in Chapter 1 and again Chapter 10, maintenance practices are adaptive and this manual will be revised periodically to accurately reflect the District's maintenance approach and techniques.

The following sections describe more specific downed tree management planning and activities, including:

Section 5.2 Downed Tree Maintenance Goals and Triggers

Section 5.3 Downed Tree Preservation

Section 5.4 Downed Tree Repositioning

Section 5.5 Downed Tree Removal

5.2 Downed Tree Management Goals and Triggers

Management Goals

The primary downed tree management goals are similar to those for vegetation maintenance (presented in Chapter 4). However, downed tree management goals emphasize maintenance of instream habitat in addition to channel capacity, including to:

- ensure that adequate flood conveyance capacity is provided;
- minimize flow obstructions;
- maintain stable streambank conditions, and where possible;
- enhance instream ecologic conditions through:
  - providing instream habitat for aquatic species,
  - creating varied geomorphic and hydraulic conditions in flood control channels, and
  - encouraging the growth and presence of native vegetation.

In most channels, meeting these goals requires balancing flood protection needs and habitat enhancement opportunities.

Downed tree and woody debris recruitment efforts conducted by the District in Napa County align with other regional stream management goals, including the *Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance* (also known as the FishNet4C Manual - FishNet4C 2004) and the *Memorandum of Understanding for Woody Debris Management in Riparian Areas of the Lagunitas Creek Watershed* developed in 2007 by partner agencies in Marin County.

While maximizing habitat benefits of woody debris are sought in the program area, the benefits are evaluated in balance with the potential for flooding or erosion effects, or threats to infrastructure downstream due to the presence of the wood. The District's preference is to first retain woody debris on-site if possible, and if not possible then to reposition or relocate the wood to another suitable location. If the woody debris has the potential to significantly threaten bank stability, public safety, or channel conveyance capacity, the wood is removed from the channel. Wood removal is always considered a last resort.

Management Triggers

During the annual stream assessment process (described in Chapter 3 *Impact Avoidance and Minimization* and Chapter 10 *Program Management*) and as alerted by the public, the District's stream maintenance managers evaluate and prioritize management actions for downed trees. In general, downed tree management is appropriate when any of the following triggering conditions occur:

- The downed tree is significantly decreasing flood conveyance capacity (particularly where infrastructure or adjacent properties are at risk), or
- The downed tree is obstructing or deflecting streamflow causing bank destabilization (particularly where infrastructure or adjacent properties are at risk), or
- There is an opportunity to improve habitat value for fish and wildlife.

These triggers are evaluated in the field by the maintenance manager or trained personnel. The decision to preserve, reposition, or remove downed trees is made in the field by maintenance staff familiar with channel and wetland ecology conditions. The decision making process and rationale for downed tree management actions are described below.

5.3 Downed Tree Preservation

Considerations and Rationale for Retaining Wood on-site

The District's preference is to first retain woody debris on-site if the debris is providing habitat, geomorphic, or other channel stability benefits and is not increasing the flood threat. Key determinants include whether the woody debris is significantly obstructing flows, deflecting flow toward banks, or is located near a channel crossing, structure, or other facility. In deciding what to do with managing a downed tree, District stream managers consider several issues to minimize flood risks and improve habitat, including:

Downed tree across the Napa River in the Rutherford Reach from 2010 winter storm events.

- What is the type and age of the downed tree?
- Does the tree under review provide significant channel shading or other instream habitat complexity benefits (if submerged in the channel), such as fish refugia or foraging areas?
- What is the degree of blockage across the channel contributed by the downed tree, or by other factors?
- Where is the tree located in the channel and how is it positioned to flow currents?
- How secure is the tree across (or in) the channel?
- Can the individual tree be pruned or reduced in size (before consideration of removal) to provide the necessary conveyance capacity?

- What upstream and downstream conditions might influence or be influenced by the tree?

The rationale to retain downed trees is based on addressing the questions above. Answering these questions requires the oversight and guidance of a biologist or arborist that is familiar with the vegetation in the area and is knowledgeable of channel conditions.

Preservation Methods

The following three preservation methods are implemented by the District, in order of preference. Each method is illustrated in **Figure 5-1**.

1) **Leave in place**: based on the rationale evaluation described above, and if no management triggers are initiated - then the downed tree will be left in place and monitored in case conditions change that trigger the need for management actions. See Photo 1 in Figure 5-1.

2) **Limb branches**: if based on the rationale evaluation, the downed tree provides habitat functions, and does not significantly decrease flood capacity or alter streamflow – then the down tree will be left in place. But, if the downed tree exhibits branches that are perpendicular to flow, extend higher than two feet above the streambed, or has branches that could collect debris, those branches will be trimmed or limbed but the majority of the downed tree will be left in place. See Photo 2 in Figure 5-1.

3) **Cut into smaller pieces**: If the downed tree is in a position that does not immediately trigger the need for repositioning or removal, but may pose a threat in the future or a portion of the tree impedes flow or could catch debris, the tree may be cut into shorter lengths (not less than 12 feet long, if possible) or specific sections of the tree may be removed. See Photo 3 in Figure 5-1.

If necessary, hand-held tools will be used to limb or cut downed trees. No heavy equipment is involved with preserving downed trees within the channel environment.

5.4 Downed Tree Repositioning

Considerations and Rationale for Repositioning

The District's preference is to first retain woody debris on-site. However, if the downed tree triggers the need for maintenance, it may be repositioned within the channel. Key determinants include whether the woody debris is significantly obstructing flows, deflecting flow toward banks, or is located near a channel crossing, structure, or other facility. Several issues are considered to minimize potential effects and to improve habitat results while reducing the need for maintenance.

- What is the type and age of the downed tree?
- Does the tree under consideration provide significant channel shading or other instream habitat complexity benefits (if submerged in the channel), such as fish refugia or foraging areas?

- What is the degree of blockage across the channel contributed by the downed tree, or by other factors?
- Where is the tree located in the channel and how is it positioned to flow currents?
- How secure is the tree across (or in) the channel?
- What upstream and downstream conditions might influence or be influenced by the downed tree?

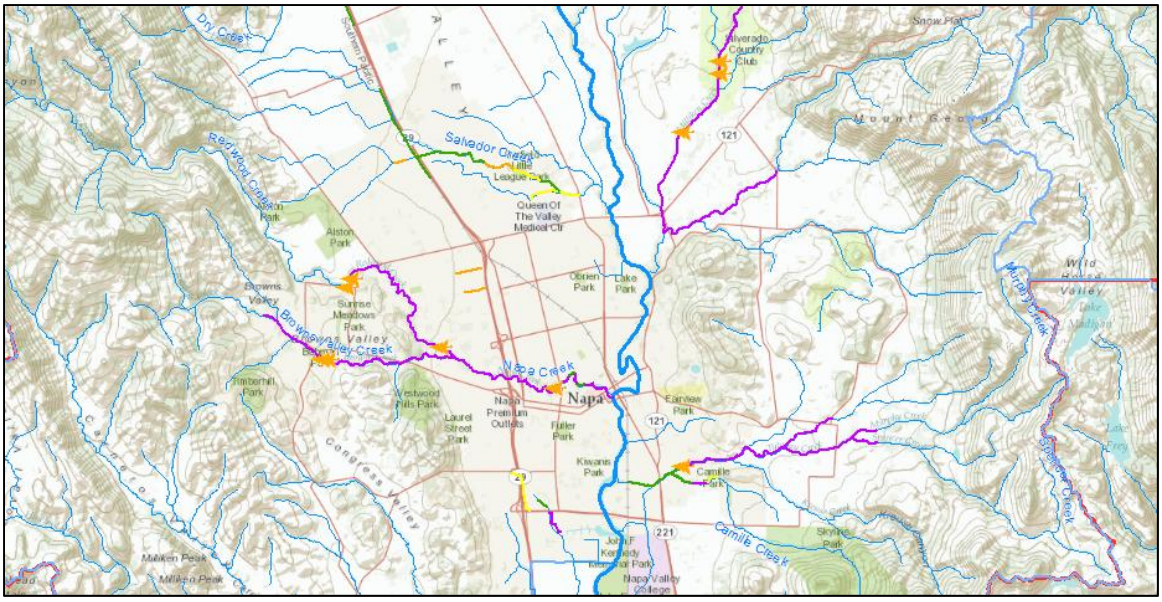
The rationale to retain but reposition downed trees is based on addressing these questions. Answering these questions requires the oversight and guidance of a biologist or arborist that is familiar with the vegetation in the area and is knowledgeable of channel conditions.

Methods for Repositioning

Depending on site specific conditions and the responses to the site assessment questions above the District may reposition a downed tree to improve flood conveyance or instream habitat benefits.

Field crew repositioning a downed tree in Wing Canyon

Trees that are repositioned to be more parallel to flow currents in the channel will not be secured in place, unless needed (see Photo 4 in Figure 5-1). In some cases, it may be necessary to secure wood in a specific place to create instream habitat, such as inducing a scour pool for use by salmonids. If necessary, the repositioned wood will be cabled or anchored in place to the banks or some other method with input from regulatory agencies, such as CDFG and NMFS (see Photo 5 in Figure 5-1). The District will retain root masses of the downed trees to the extent feasible. Repositioning of downed trees is conducted using hand-held tools and occasionally heavier mechanical equipment. All repositioned trees are assigned a tracking number and fitted with a metal numbered tag. The GPS location of the tree is entered into the District's database and the tree location and condition are monitored annually. If needed, the trees are adjusted to improve habitat conditions and prevent flooding. The map below illustrates the locations of the repositioned downed trees currently being monitored by the District.



Map of Downed Tree Monitoring Locations (shown in orange)

5.5 Downed Tree Removal

In the event that a downed tree cannot be retained on-site due to channel capacity issues, or if the tree cannot be repositioned favorably (as described above), then downed trees may be removed if channel capacity is significantly limited or if the tree is creating unacceptably high hydraulic roughness in the channel, or diverting flows and thereby causing a heightened erosion or flooding risk. The rationale for removing a downed tree is based on the pre-maintenance survey and the triggering conditions described above. The District's first preference is to retain downed trees on-site (if possible). The District's next preference is to reposition downed trees if necessary. Removing downed trees from channels is the District's lowest preference option.

At the time that District stream managers assess the downed tree for retaining it in the creek, and/or repositioning in the channel, they will also assess if the downed tree may need to be removed. As described in Chapter 4, tree snags will be left in place to provide habitat for birds and small mammals if the snags do not otherwise pose a flood or safety hazard. Downed tree removal techniques use hand-held tools and occasional use of heavier mechanical equipment. Removed trees are chipped for mulch and either left onsite or taken to the Napa Recycling and Waste Service Center for composting.

Photo 1. Example of a downed tree across the channel causing flow blockage.

Photo 2. Downed tree limbed, left in place, and modified slightly to function as a weir.

Photo 3. Downed tree, cut into smaller sections and repositioned in the channel to create instream complexity.

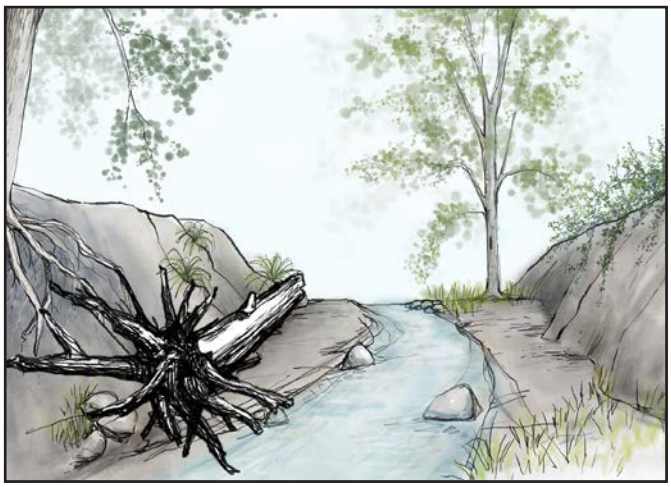


Photo 4. Downed tree repositioned parallel to direction of flow in the channel.

Photo 5. Downed tree repositioned parallel to direction of flow in the channel and secured in place with cables.

Source: Jennifer Natali Design 2011.

Horizon WATER and ENVIRONMENT

Figure 5-1

Preservation Techniques for Downed Trees

Chapter 6
EROSION PROTECTION AND BANK STABILIZATION

6.1 Overview and Purpose

Over several maintenance seasons, the District has made a concerted effort to implement preventative measures to reduce streambank erosion. These preventative measures include extensive planting of riparian vegetation along exposed streambanks (See Channel Characterization in Section 2.3) and removing non-native and invasive species along watercourses. Most of the vegetation planting along program area channels has occurred within the past 2 to 5 years and the erosion protection functions of vegetation are now beginning to take effect. The full benefit of erosion reduction and bank stabilization from the District's past planting activities will take several years (10-15) to achieve as the planted trees reach maturity. With time, these preventative measures not only reduce streambank erosion, but also improve ecological functions and values of channels in the program area.

However, it is impossible to prevent all channel bank erosion and instability. Even with the District's aggressive planting program, erosion protection and bank stabilization maintenance activities will be needed in program area channels to minimize soil loss and manage potential erosion that may still occur and threaten property or infrastructure.

This chapter details general erosion protection and bank stabilization practices that may be conducted as part of the District's stream maintenance program. Up to five bank erosion protection and bank stabilization projects may be conducted annually. Each project would encompass 25 to 50 linear feet of stream bank. Bank stabilization activities may occur in the District's flood control channels, at other facilities including culvert outlets or bridge abutments, and in natural stream banks. Repair and stabilization activities are initiated when a streambank is weakened, unstable, or failing.

Different mechanisms may cause bank erosion or destabilization. In the District's channels bank erosion most typically occurs from direct shearing due to erosive streamflows. An additional mechanism for erosion and overall bank instability includes rotational slumping of the bank following saturation conditions. This typically happens when bank soils are saturated following a sustained period of high flows. When flow elevations recede and the saturated bank begins to drain toward the creek, soil pore water pressure is elevated and this can cause instability through slumping. Stream banks can also fail through block separation and falling, which may have similar causes as for rotational slumping, but the failure mechanism is expressed differently.

In addition to these erosive "driving forces," bank stability is also dependent on the "resistant forces" that keep the bank in place. Factors that influence the bank's internal stability include the shear strength of the bank materials; the relative steepness of the bank slope; groundwater elevations; soil texture, porosity, and permeability; drainage and seepage issues; root strength provided by vegetation, etc. Understanding both the driving and resistant factors at a

streambank site is very important in developing an appropriate bank treatment and repair approach (see Section 6.3). Additional causes for potential bank destabilization may be found in previous channel modifications. For example, the removal of past vegetation may have weakened the bank. A culvert outfall may be directing erosive flows directly at a vulnerable bank. The channel alignment or hardening on an opposite bank may be directing erosive flows disproportionally against a vulnerable bank. Understanding such causal factors, within the framework of the balance of "driving erosive forces" and "resistant strengthening forces" applying at each bank site helps District stream managers assess destabilized streambanks and select appropriate treatments.

The number of bank stabilization projects undertaken by the District in a given year depends on weather and hydrologic conditions during the recent years. A higher number of bank stabilization projects are more likely to occur during or following wet years when streamflows are elevated, flow velocities are higher, and bank soils are saturated for longer periods with high soil pore water pressure.

If unattended, the consequences of not repairing a destabilized or failing stream bank include:

- increased flood risk and property damage to adjacent properties,
- undermining and loss of roads, bridges, transportation, and access,
- increased erosion and sediment yield from the eroded bank transported downstream, and
- impacts to riparian habitat and other natural resources at the eroded bank site, as well as downstream through increased sediment loading.

This manual presents standard treatments and repair approaches that will be applied as appropriate throughout the program area. When an erosion protection or bank repair project is identified, the selected treatment template and project design will be presented to the appropriate regulatory agencies for review and approval as part of the pre-maintenance notification process (see Chapter 10 *Program Management*). All bank repair activities will follow the impact avoidance and minimization approach and principles described in Chapter 3, including the best management practices presented in Table 3-1. Permits necessary to support these activities are described in Chapter 11 *Regulatory Compliance*. At specific reaches, as causes for bank erosion and destabilization are identified, these causes will be described in the reach characterization sheets provided in Chapter 2.

The following sections describe the District's maintenance goals and triggers for conducting bank repair work (Section 6.2), standard treatments and repair approaches (Section 6.3), construction approach (Section 6.4), and post-project restoration and monitoring activities (Section 6.5).

6.2 Maintenance Goals and Triggers

Erosion Protection/Bank Stabilization Goals

The goals of erosion protection and bank stabilization projects are to prevent erosion from occurring or to repair an eroded

bank and to provide a stable streambank that will not require additional maintenance in the foreseeable future. An equally important goal is to provide a stabilized bank that avoids using hardscape features and attempts to protect and maintain natural stream bank functions to the extent possible.

Achieving this balance between stability and environmental function is challenging. The standard treatments presented in Section 6.3 were designed to achieve these goals within a range of bank conditions and stability requirements. As described above, identifying and understanding the root cause (or causes) of instability in the affected reach is critical in developing the most appropriate treatment solution.

In general, bank stabilization and repair projects will be designed to achieve one or more of the following related outcomes.

- Improved channel and/or bank stability.
- Reduced need for future or repeated bank maintenance.
- Reduced loading of eroded sediment into the channel and to downstream reaches, reducing the need for sediment management.
- Improved bank conditions to support vegetation and increase habitat value.

Note, because improved bank stability reduces sediment input into the channel and supports developing a mature riparian corridor, bank stabilization can be used as a coordinated treatment with other sediment removal and vegetation maintenance activities. In this way, bank stabilization activities can provide several benefits to the overall health and function of the channel.

Bank Stabilization Triggers

In general, bank stabilization and repair activities are commonly required where one or more of the following conditions apply:

Bank stabilization and repair projects are only undertaken if certain conditions are met. Consideration is given to the improvement of the overall health and functioning of the channel in designing and implementing these projects.

1. Bank failure has occurred whereby a significant portion of the bank-toe, mid-bank, or bank-crest have failed, slumped, eroded into the creek below, or have been removed entirely. Under this condition, the bank must be repaired to re-establish the basic bank structure.
2. Chronic bank erosion is occurring, whereby a portion of the bank is exposed to on-going erosion and sloughing of its earthen materials. This condition may not represent as large a volume of lost material as Condition 1 described above, but untreated, this type of condition will typically progress and become increasingly erosive. Recreating the entire bank structure may not be necessary under this condition. More often, specifically applied, or localized rehabilitation may be adequate.
3. A channel facility such as a culvert outfall or culvert crossing that needs to be repaired, replaced, or improved. Under these circumstances, bank stabilization and repair activities may be required to integrate the facility maintenance improvement with the adjacent streambank. This District would conduct these activities with the roads

maintenance department, as necessary.

4. Existing bank protection measures have failed. In this situation, the District has an opportunity to replace past bank protection features with newer design approaches which may provide additional environmental benefits.
5. Bank erosion or failure poses a threat to existing infrastructure or adjacent land uses and/or increases the public risk of flooding.

These triggers are focused to guide maintenance decisions on District engineered stream channels, in generally urban areas. For non-engineered channels in non-urban areas these triggers will be evaluated more sensitively in light of sight conditions and adjacent flood concerns.

6.3 District Standard Treatments

6.3.1 Overview

In this section, the District presents five standard erosion protection and bank stabilization treatments to serve as templates for more specific site design needs. All of these standard treatments utilize biotechnical methods to provide erosion protection. Biotechnical erosion control incorporates live vegetation with other natural elements (e.g., wood, biodegradable erosion control products, rock) to provide structural stability to streambanks. Native riparian vegetation within the erosion control treatments increase bank sheer strength, and provide habitat benefits including increased shade canopy, nesting, foraging, etc.

For most of the reaches in the program area biotechnical stabilization approaches are preferable to hardscape engineered approaches (e.g., riprap, gabions). In some specific locations a limited amount of hardscape may be necessary, due to site conditions or constraints such as locally high flow velocities or sheer stresses, seepage, bank materials with poor strength/cohesion, or the presence of existing infrastructure. When hardscape is necessary, it will most often accompany or supplement one of the standard biotechnical treatments. The use of rock in specific capacities, such as at the toe of slope, in combination with other biotechnical measures and plantings on the higher bank can be a very effective approach for stabilizing a bank. Hardscape will only be used where no effective alternative is feasible due to the magnitude of the hydraulic forces involved, the need to protect infrastructure, or an adjacent land use constraint. Resource agencies will be notified in advance when rock or other hardscape elements are being proposed for stabilizing streambanks. The notification will include justification for the use of hardscape elements such as calculations of channel hydraulic forces.

Note that in some cases, bank stabilization may not offer the most effective (or the most cost-effective) solution over the long term. Where there is extensive bank and channel failure or where reliable bank protection cannot be provided, or where heavily engineered solutions would be the only option for reliable armoring, it may be preferable to remove or re-contour the channel bed or to realign a short segment of the channel. Such channel reshaping or grading approaches may provide a more effective, longer-term solution that supports overall stream health and function compared to more traditional bank stabilization approaches. Activities requiring a broad redesign or reshaping of the channel would not be considered

routine maintenance and are beyond the scope of this manual.

Chapter 10 provides more detailed information on management of the stream maintenance program, including the site reconnaissance, evaluation, prioritization, and design step processes that would be considered in developing a suitable bank stabilization design.

6.3.2 Treatment Options

The District has developed five standard bank stabilization and repair methods which can be customized **with detailed design elements to best suite site-specific conditions.**

Figures 6-1 through 6-5 present a range of biotechnical approaches to provide erosion protection or address streambank instability. Each of the treatment templates is described below.

Erosion Control Fabric with Coir Log (Figure 6-1)

Description: Figure 6-1 presents a relatively simple biotechnical approach to control bank erosion. The components of this treatment include: (1) a coir log, (2) erosion control fabric, (3) live woody cuttings, and (4) revegetation. Coir logs consist of tightly bound cylinders of coir fibers (coconut fiber) that are held together by fiber netting made from coir twine. Coir logs are generally available in 10 to 20 foot lengths and are 12 to 20 inches in diameter. Coir logs provide effective toe protection in areas of low velocity water flow.

Coir logs are effective in providing erosion and stream scour protection during the period of time it takes for larger woody vegetation to become established on the streambank. The coir log is anchored with live woody cuttings (e.g., willow, cottonwood), wood stakes, or both. Once established, live woody cuttings planted in the coir log and at the toe of slope provide long-term toe scour protection. Coir logs are constructed of 100% biodegrade materials (coconut husks) and will decompose over a 3 to 5 year period.

During coir log installation the bankslope is prepared for revegetation by ensuring that the soil provides a suitable growth medium for native plants; a revegetation specialist may be consulted to evaluate soil conditions. After installation, the coir fiber log may become saturated with water and vegetation can be planted directly on the logs. The soil on the slope above the coir log is scarified (roughened) to a depth of approximately 6 inches to prepare the seed bed. Following seed application the slope is mulched with a thin layer (approximately 1-2 inches) of weed-free straw, then covered with an erosion control fabric. The fabric is made from 100% biodegrade materials (typically jute). The fabric weight, typically expressed in grams per cubic meter (g/m^3), is determined by slope angle and site specific hydraulic conditions. Once the fabric is properly installed woody cuttings and container or nursery stock are planted in the appropriate revegetation zones (see Section 4.4.)

Applicability: This treatment is typically suitable for streambanks experiencing low to moderate flow velocities and have finished slopes of 2h:1v (i.e., the slope is 2 horizontal units to every 1 vertical unit) or shallower.

Considerations: While the bank is protected by erosion control fabric during the vegetation establishment period, high flows may exceed the erosion protection capabilities of the temporary treatments.

Variations: Modifications of the coir log template design include replacing the coir roll with a willow wattle (i.e., a bundle of live willow branches) and/or replacing the erosion control fabric

with a live brush mattress (i.e., willow poles laid in a crisscross pattern on the bank slope) as described below. These variants can be considered in locations where channel capacity can accommodate very high bank roughness conditions. These variants also require high water availability for woody riparian vegetation and a high confidence in the successful establishment of vegetation. For locations with high velocity and shear stress, the coir roll may be replaced with rock slope protection (i.e., riprap) to provide more robust scour protection. The rock slope protection may need to extend further up the bank than the coir log. A civil engineer should be consulted to determine appropriate sizing[1] and extents of rock slope protection.

Brush Mattress (Figure 6-2)

Description: The brush mattress (Figure 6-2) is a simple biotechnical approach that utilizes live willow pole cuttings to provide structure and stability to the streambank. Prior to installing the brush mattress, some minor grading, clearing and grubbing of the streambank may be necessary to prepare the slope. The brush mattress is constructed by placing a dense layer of willow pole cuttings parallel to the slope (i.e., perpendicular to stream flow). Wood stakes are then driven in between the pole cuttings at a close spacing (approximately 2-foot on center). Jute rope or twine is then woven between the stakes to create a grid or web to secure the pole cuttings. The stakes are then driven in fully to compress the brush mattress against the streambank. Soil may be placed on the slope to backfill voids and ensure good contact between the slope substrate and willow cuttings.

Applicability: The brush mattress is typically suitable for slopes up to 2h:1v. This treatment may be suitable for moderate to high energy settings. This treatment is a cost-effective stabilization approach and can often be constructed by hand, without the use of heavy equipment.

Considerations: This treatment is only suitable for locations with adequate soil moisture to support the growth of willows. For mesic or moderately dry sites that are at the threshold of suitability, supplemental irrigation may be useful to establish willows. Irrigation should be applied in a manner that will "train" root growth to shallow ground water. This requires a high volume, low frequency irrigation regime. This treatment is not recommended in locations where bank stability is required to protect infrastructure because the brush mattress is vulnerable to failure during the vegetation establishment period. This treatment will also result in dense vegetation growth, so channel capacity should be able to accommodate high roughness conditions (see Chapter 2).

Variation: Incorporating toe protection (e.g., rock or coir log) may be necessary in high energy settings. A civil engineer should be consulted to determine appropriate sizing and extents of rock slope protection.

Willow Wall (Figure 6-3)

Description: Figure 6-3 illustrates a biotechnical approach that utilizes live willow pole cuttings

[1] There are several standard procedures for sizing rock slope protection including methods developed by Caltrans (2000) and U.S. Army Corps of Engineers (1994). These methods require computation or measurement of site specific channel hydraulics. As such, rock size will be determined on a case-by-case basis.

to provide structure and stability to the streambank. The willow wall is constructed by planting a row of willow stakes (approximately 2 to 3 feet apart) near the toe of slope; long willow poles are then woven through the stakes to construct a willow "fence" at the toe of the slope. Soil is backfilled and compacted behind the fence, which creates a "terrace." A second willow fence is then constructed further up the embankment, then backfilled to create the next terrace. This process is repeated up the bank slope until the willow wall reaches the top of bank or transitions to another suitable erosion control treatment (e.g., erosion control fabric). The terraces between the willow fences can be seeded with native species and planted with container or nursery stock plants. Erosion control fabric and/or mulch may also be placed on the terraces to provide erosion protection during the vegetation establishment period.

Applicability: Since the wall can be constructed with hand tools and labor it is particularly useful for stabilizing banks that have limited access for construction equipment. Consequently, this type of biotechnical treatment is often used in remote locations with limited access, though it is suitable for use in some urban settings (see Considerations below). The willow wall can also be an effective stabilization treatment for steep banks and/or confined or right-of ways. This treatment also provides a relatively cost-effective stabilization option because the willow cuttings can be collected from adjacent areas and the wall may be constructed with the aid of volunteers.

Considerations: This treatment is only suitable for locations with adequate soil moisture to support the growth of willows. For mesic sites that are at the threshold of suitability, supplemental irrigation may be useful to establish willows. Irrigation should be applied in a manner that will "train" root growth to shallow ground water. This requires a high volume, low frequency irrigation regime. This treatment is not recommended in locations where bank stability is required to protect infrastructure because the willow wall is vulnerable to failure during the vegetation establishment period. This treatment will also result in dense vegetation growth, so channel capacity should be able to accommodate a high roughness conditions.

Variations: This treatment may incorporate a live brush mattress where willows are layered on the slope or on the terraces. The willow wall may transition to erosion control fabric (see Figure 6-1) in drier vegetation zones that do not support willow growth.

Encapsulated Soil Lifts (Figure 6-4)

Description: Figure 6-4 illustrates a biotechnical treatment that can be used to reconstruct a steep, eroded streambank in moderate to high energy flow environments. This treatment is constructed by stacking layers of soil that are encapsulated (wrapped) in erosion control fabric. The soil lifts are typically compacted in-place with heavy equipment. Willow cuttings are laid horizontally between the soil lifts, and planted perpendicularly into the soil. When the willows become established they provide stability to the embankment.

Applicability: Encapsulated soil lifts are useful for protecting or stabilizing steep banks in confined streams or narrow right-of-ways. This treatment allows for construction of vegetated slopes that exceed 2h:1v. This treatment may be suitable for high energy settings, particularly if a small amount of rock is provided at the toe of the slope.

Considerations: This treatment is best suited for locations with adequate soil moisture to support willow growth. The soil lifts generally requires construction access for heavy

equipment. When used in moderate and high energy settings, careful attention must be paid to construction of the transition to existing banks so that soil lifts do not destabilize; rock slope protection may be required.

Variations: Incorporating rock slope protection up to ordinary high water level on the channel may be necessary or desirable in some settings. A civil engineer should be consulted to determine appropriate sizing and extents of rock slope protection. Consider incorporating additional habitat features into the design such as LWD, root wads, and floodplain benches.

Crib Wall (Figure 6-5)

Description: A crib wall is an engineered structure that can be used to protect very steep banks in moderate to high energy flow environments. Crib wall construction typically begins with clearing and grubbing, then excavation of foundation base so the crib wall can be keyed into the bank and below the immediate depth of local scour (Figure 6-5). Vertical log piles or piers are driven into the streambed, followed by placement of the horizontal crib members. Steel cable or rebar pins are often used to join the crib piers and members. As successive lifts of the crib wall are constructed, they are filled with a rock-soil mix; this material should be derived from local stream substrate, when feasible. Erosion control fabric may be used to contain soil/substrate in the crib wall. Live woody cuttings are laid horizontally in the structure, as well as planted perpendicularly into the soil at the top. When the willows become established they provide additional stability and hold the soil/substrate in place.

Applicability: This treatment is useful for protecting or stabilizing very steep banks in confined streams or narrow right-of-ways, and allows for establishment of vegetation on slopes that exceed 1h:1v. The crib wall may be suitable for high energy settings provided that it is anchored properly. This treatment may be a suitable alternative to conventional hardscape approaches (e.g. riprap) that are typically used to protect infrastructure.

Considerations: This treatment requires construction access for heavy equipment. When used in moderate and high energy settings, careful attention must be paid to the construction of the transition to existing banks; rock slope protection may be required. This treatment is costly to design and construct.

Variations: The District may use a hybrid approach with encapsulated soil lifts in the crib matrix, or transition to encapsulated lifts above ordinary high water.

6.3.3 Selection and Design of Appropriate Bank Treatments

Figure 6-6 provides guidance for selecting appropriate erosion control and bank stabilization treatments. Figure 6-6 includes guidance for permissible shear stress and velocity, slope steepness, right-of-way width, construction access, and cost. Additional guidance for selecting suitable channel lining materials is provided in **Table 6-1** which lists permissible shear stress and velocity for various channel lining materials.

From the standard designs presented in Section 6.3.2, the District can customize these templates to accommodate site-specific conditions including bank width, bank height, channel alignment, vegetation type, and soil conditions. Prior to implementing any erosion protection or bank stabilization measures the District will evaluate and consider how reach-specific, as well as

watershed-scale geomorphic processes, influence erosion at each site. Additional site specific analyses to complete erosion protection designs may include: hydraulic modeling to estimate depth of flow, velocity and shear stress analysis at the bank protection site; and soil testing to determine geotechnical properties and suitability for revegetation.

6.4 Construction Approach

Bank stabilization activities are generally conducted from June 15th to October 31st when streams are at their driest. In dry years work may begin earlier than June 15th and extend past October 31st (usually not longer than an extra two weeks on either end), provided that the District has received permission from the appropriate regulating agencies. Bank stabilization projects typically require 3 to 5 days to complete. As is feasible and suitable, where earthen backfill is required for a bank stabilization project, the material will be collected from local stream deposits, such as blocked culverts or aggraded streambed locations.

Bank stabilization projects covered under this program will not affect more than 200 consecutive linear feet of bank. The majority of bank stabilization projects will encompass between 25 and 50 linear feet of bank. Repairs shall be confined to an area not to exceed 20 feet beyond (landward) of the failed or failing bank or structure. If a healthy and intact riparian zone is present adjacent to the bank failure site, care will be taken to disturb the least amount of vegetation possible, including mature trees. Access, staging, and project construction will be conducted to minimize impacts on existing riparian vegetation. Bank failure sites may contain exposed soils or be covered in shrub or ruderal vegetation such as grasses or blackberries. Overgrown vegetation will only be removed to the extent necessary to repair the bank.

When bank stabilization projects occur, banks will be recontoured to match the adjacent bank slope (i.e., returned to pre-failure condition.) Most District-maintained channels have bank slopes of 2:1 or steeper. As described above, if site conditions allow, the bank slope may be stabilized at a less steep slope (to reduce the likelihood of renewed failure), but only if the work is conducted within the confines of the original channel as-built condition and the District's maintenance easement. Stabilized banks will be flush with the existing bank slope, and only limited new material may protrude from the bank.

Equipment used for bank stabilization activities may include extending arm excavators, small bulldozers (Bobcat style), front-end loaders, and 10 cubic-yard dump trucks. Staging for repair activities will occur on adjacent access roads. Soil and rip-rap will be staged in areas that have been previously disturbed (i.e., service road, turn-outs, etc.)

BMPs and avoidance and minimization measures will be applied based on the equipment used, site conditions, and access to the site (see Table 3-1.) If repair activities affect the active channel, the work area will be isolated from flowing stream segments using silt fences, wattles, and/or cofferdams. Dewatering techniques and additional BMPs appropriate to bank stabilization projects are described in Table 3-1.

6.5 Post-Repair Revegetation

Bank stabilization sites will be revegetated with native riparian species regardless of whether the pre-project site was vegetated or not. Revegetation is a critical component of all biotechnical erosion control treatments. Successful revegetation projects typically use many types of plant materials including seed, live woody cuttings, and nursery stock. Guidelines for use of these plant materials in SMP projects are provided below. **Table 6-2** provides a basic seed mix that is suitable for riparian and streambank revegetation projects in the program area. The species in the seed mix provide a range of riparian habitat conditions. This list may be customized for individual erosion protection or stabilization projects.

Table 6-2: Basic Seed Mix for SMP Erosion Control and Bank Stabilization Projects

Scientific Name	Common Name	Application Rate (lbs/acre)	Growth Form
Achillea millefolium	yarrow	2	forb
Agrostis exarata	spike bentgrass	4	grass
Artemisia douglasiana	mugwort	4	forb
Baccharis salicifolia	mule fat	4	shrub
Bromus carinatus	California brome	4	grass
Collinsia heterophylla	Chinese houses	2	forb
Deschampsia cespitosa	tufted hairgrass	4	grass
Elymus glaucus	blue wildrye	4	grass
Eschscholzia californica	California poppy	2	forb
Festuca idahoensis	Idaho fescue	8	grass
Hordeum brachyantherum	California barley	8	grass
Leymus triticoides	creeping wild rye	4	grass
Nassella pulchra	Purple needle-grass	4	grass
Poa secunda	one sided blue grass	4	grass
Vulpia microstachys	vulpia	8	grass

Live woody cuttings provide an economical means to propagate plants and are especially useful for streambank erosion protection because they have high survival and growth rates. Woody species successfully propagated in the field from cuttings include willows (*Salix* spp.), dogwood (*Cornus* spp.), and cottonwood (*Populus Fremontii*). Numerous technical reports have been published by the NRCS Aberdeen Plant Materials Center that provide guidance for harvesting, storing, and planting, live woody cuttings.

Container plants or nursery stock are used to establish shrubs and trees that are difficult to propagate from seed or cuttings in natural settings. Figure 9-1 (Chapter 9) depicts riparian vegetation zones that occur along typical streambank cross sections in the program area and species that commonly occur in each zone. For each of the riparian vegetation zones there is a list of species that may serve as a planting palette for erosion control and bank stabilization projects. The planting palettes can be applied to all of the treatments. The appropriate species

to plant will vary based on several factors including soil conditions, water availability, slope angle, aspect, shade tolerance, and propagule sources. Native vegetation established in undisturbed adjacent areas is often a good indicator of species suitable for revegetation at erosion protection/stabilization sites.

For bank stabilization and repair projects, native riparian trees will be planted above the bankfull elevation (approximately, the 2-year event water level) and/or at the top-of-bank, spaced appropriately based on tree species and the desired canopy extent. Trees will be selected from the plant palettes provided in Figure 9-1. Tree selection will consider site location, how appropriate the site is for the tree type, and the potential for the tree to destabilize the bank slope in the future. Where appropriate, native grasses will be seeded or planted in areas disturbed by bank stabilization activities, including between existing or newly-planted trees.

Boundary Category	Boundary Type	Permissible Shear Stress (lb/sq ft)	Permissible Velocity (ft/sec)	Citation(s)
Soils	Fine colloidal sand	0.02 - 0.03	1.5	A
	Sandy loam (noncolloidal)	0.03 - 0.04	1.75	A
	Alluvial silt (noncolloidal)	0.045 - 0.05	2	A
	Silty loam (noncolloidal)	0.045 - 0.05	1.75 – 2.25	A
	Firm loam	0.075	2.5	A
	Fine gravels	0.075	2.5	A
	Stiff clay	0.26	3 – 4.5	A, F
	Alluvial silt (colloidal)	0.26	3.75	A
	Graded loam to cobbles	0.38	3.75	A
	Graded silts to cobbles	0.43	4	A
	Shales and hardpan	0.67	6	A
Gravel/Cobble	1-in.	0.33	2.5 – 5	A
	2-in.	0.67	3 – 6	A
	6-in.	2.0	4 – 7.5	A
	12-in.	4.0	5.5 – 12	A
Vegetation	Class A turf	3.7	6 – 8	E, N
	Class B turf	2.1	4 - 7	E, N
	Class C turf	1.0	3.5	E, N
	Long native grasses	1.2 – 1.7	4 – 6	G, H, L, N
	Short native and bunch grass	0.7 - 0.95	3 – 4	G, H, L, N
	Reed plantings	0.1-0.6	N/A	E, N
	Hardwood tree plantings	0.41-2.5	N/A	E, N
Temporary Degradable RECPs	Jute net	0.45	1 – 2.5	E, H, M
	Straw with net	1.5 – 1.65	1 – 3	E, H, M
	Coconut fiber with net	2.25	3 – 4	E, M
	Fiberglass roving	2.00	2.5 – 7	E, H, M
Non-Degradable RECPs	Unvegetated	3.00	5 – 7	E, G, M
	Partially established	4.0-6.0	7.5 – 15	E, G, M
	Fully vegetated	8.00	8 – 21	F, L, M
Riprap	6 – in. d_{50}	2.5	5 – 10	H
	9 – in. d_{50}	3.8	7 – 11	H
	12 – in. d_{50}	5.1	10 – 13	H
	18 – in. d_{50}	7.6	12 – 16	H
	24 – in. d_{50}	10.1	14 – 18	E
Soil Bioengineering	Wattles	0.2 – 1.0	3	C, I, J, N
	Reed fascine	0.6-1.25	5	E
	Coir roll	3 - 5	8	E, M, N
	Vegetated coir mat	4 - 8	9.5	E, M, N
	Live brush mattress (initial)	0.4 – 4.1	4	B, E, I
	Live brush mattress (grown)	3.90-8.2	12	B, C, E, I, N
	Brush layering (initial/grown)	0.4 – 6.25	12	E, I, N
	Live fascine	1.25-3.10	6 – 8	C, E, I, J
	Live willow stakes	2.10-3.10	3 – 10	E, N, O
Hard Surfacing	Gabions	10	14 – 19	D
	Concrete	12.5	>18	H

[1] Ranges of values generally reflect multiple sources of data or different testing conditions.

A. Chang, H.H. (1988).
B. Florineth. (1982)
C. Gerstgraser, C. (1998).
D. Goff, K. (1999).
E. Gray, D.H., and Sotir, R.B. (1996).
F. Julien, P.Y. (1995).
G. Kouwen, N.; Li, R. M.; and Simons, D.B., (1980).
H. Norman, J. N. (1975).
I. Schiechtl, H. M. and R. Stern. (1996).
J. Schoklitsch, A. (1937).
K. Sprague, C.J. (1999).
L. Temple, D.M. (1980).
M. TXDOT (1999)
N. Data from Author (2001)
O. USACE (1997).

Horizon WATER and ENVIRONMENT

TABLE 6-1: Table from Fischenich (2001) provides permissible shear stress and velocity for various channel lining materials.

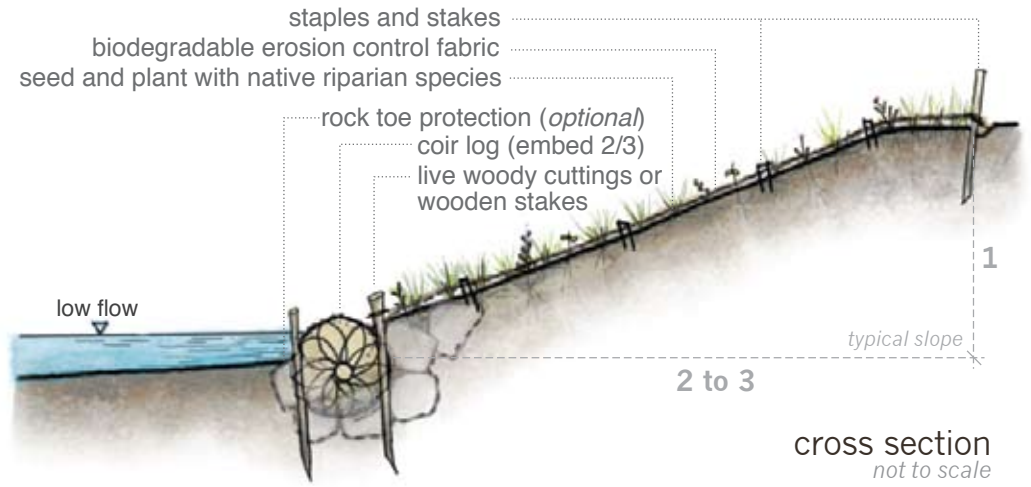
COIR LOG AND EROSION CONTROL FABRIC

DESCRIPTION
This treatment provides simple biotechnical erosion protection and bank stabilization. A coir log placed at the toe of the slope protects from scour. Erosion control fabric protects the bank slope from erosion during the vegetation establishment period.

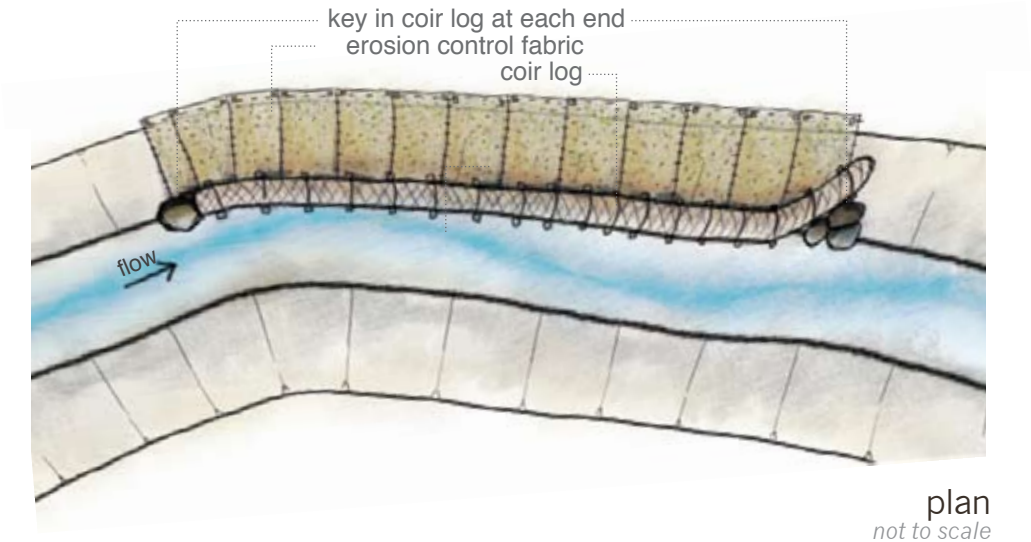
APPLICABILITY
Suitable for low to moderate velocity and shear stress conditions. Recommended for newly graded banks and existing banks with 2h:1v slopes or shallower.

CONSIDERATIONS
May require a wide right-of-way to accommodate broad bank slopes.

VARIATIONS
Replace coir log with willow wattle and/or replace erosion control fabric with live brush mattress to increase vegetation cover. Where feasible, consider including a floodplain bench to increase flood flow capacity, channel complexity and diversity of riparian vegetation. Provide rock toe protection in high energy settings.



cross section
not to scale



plan
not to scale

Source: Jennifer Natali Design. 2011

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Figure 6-1
Coir Log and Erosion Control Fabric Template

BRUSH MATTRESS

DESCRIPTION

This treatment protects slopes with a dense layering of live willow branches. Once established, the willow thickets provide roughness and cover for fish during high flows, and habitat for various riparian associated wildlife species.

APPLICABILITY

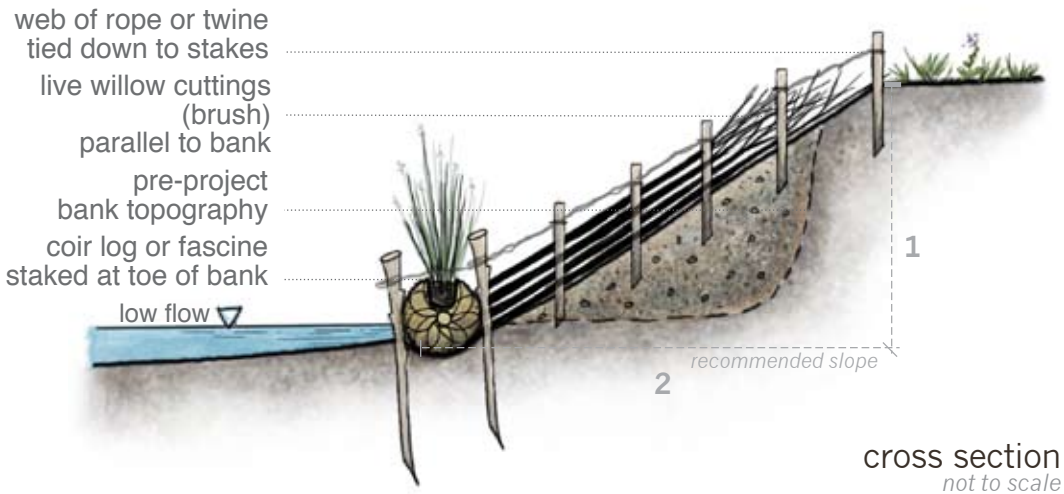
Suitable for moderate to high velocity and shear stress flow conditions for stream reaches with moderately sloped banks. Minimal construction access required. Discourages foot traffic in areas prone to informal trails.

CONSIDERATIONS

May require toe protection. Requires large amount of willow cuttings. Best installed during wet season to encourage willow rooting. Stream banks are vulnerable to erosion during establishment period. This labor-intensive technique requires some skill and care to tightly pin down branches. High roughness may reduce channel capacity.

VARIATIONS

Combine with toe protection such as coir logs, root wads, or live facines.



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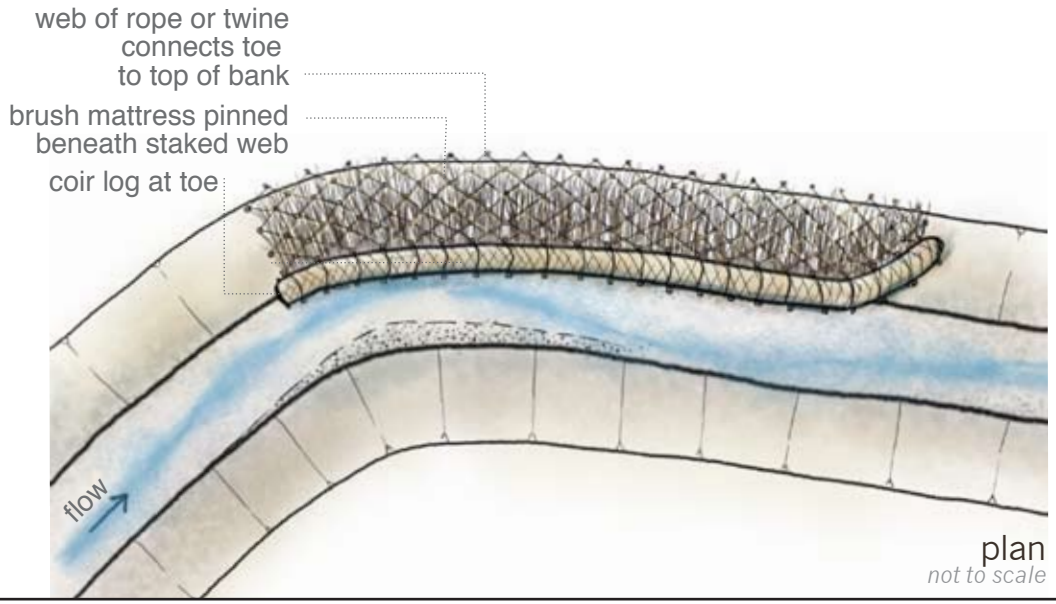

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Source: Jennifer Natali Design. 2011

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Figure 6-2
Brush Mattress Template

WILLOW WALL

DESCRIPTION
The willow pole cuttings are used as a biotechnical structural element to increase bank strength. Once established, willow pole cuttings will provide dense vegetated cover with high habitat value.

APPLICABILITY
Suitable for moderate velocity and shear stress flow conditions. Suitable for steep slopes. Can be constructed with hand tools and labor, especially useful where access is limited.

CONSIDERATIONS
Generally not suitable for protecting infrastructure. Mature willows will increase roughness and may require maintenance and thinning. Site should be appropriate for increased roughness.

VARIATIONS
Can be combined with brush mattress or soil lifts.

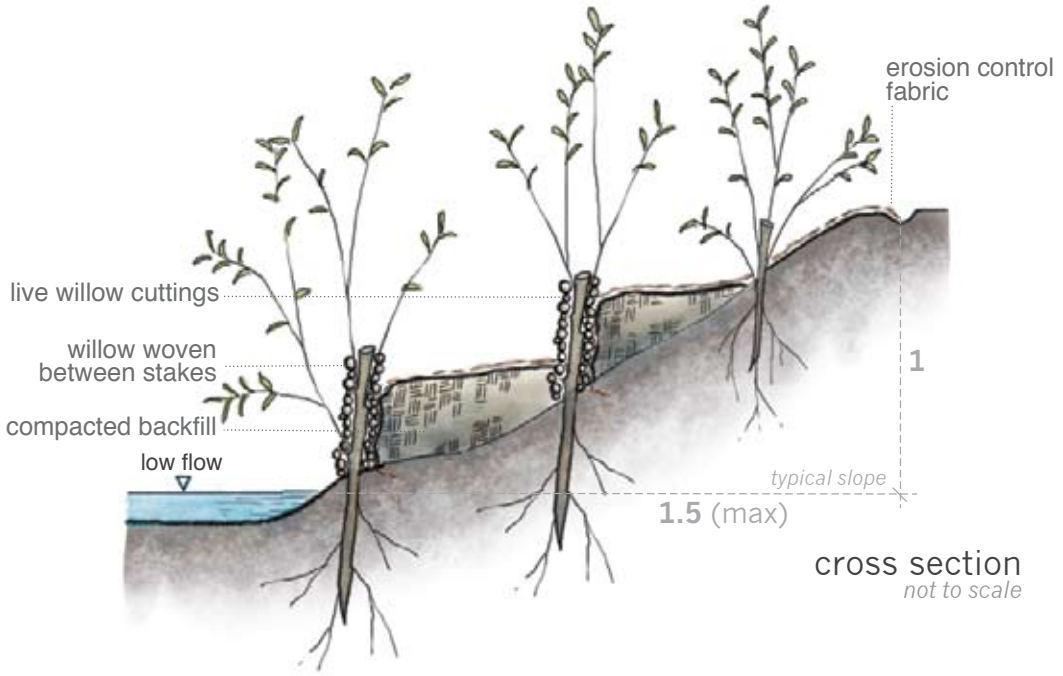

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Figure 6-3
Willow Wall Template

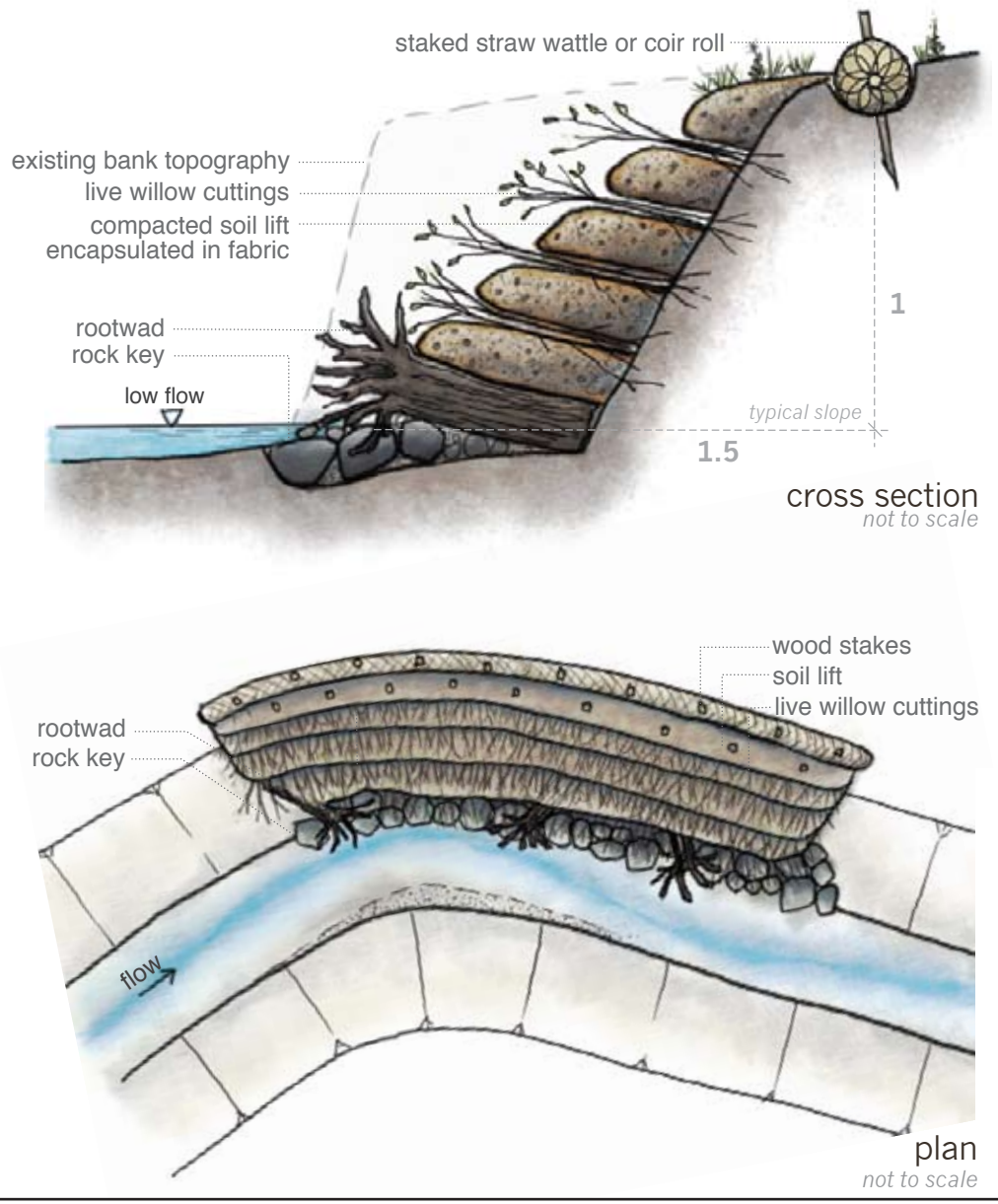
ENCAPSULATED SOIL LIFTS

DESCRIPTION
This treatment uses soil and sediment wrapped in erosion control fabric to reconstruct stream banks. Live willow cuttings are planted in interstitial spaces. Provides high habitat and aesthetic value once vegetation is established.

APPLICABILITY
Suitable for steep slopes with moderate to high velocity and shear stress flow conditions. Appropriate for confined areas or constricted right-of-ways.

CONSIDERATIONS
Costly to construct and requires good access. Reuse native bank soil when feasible. Incorporate root wads or large woody debris when feasible to increase habitat complexity.

VARIATIONS
Provide rock toe protection in high energy settings.



Source: Jennifer Natali Design. 2011

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Figure 6-4
Encapsulated Soil Lifts Template

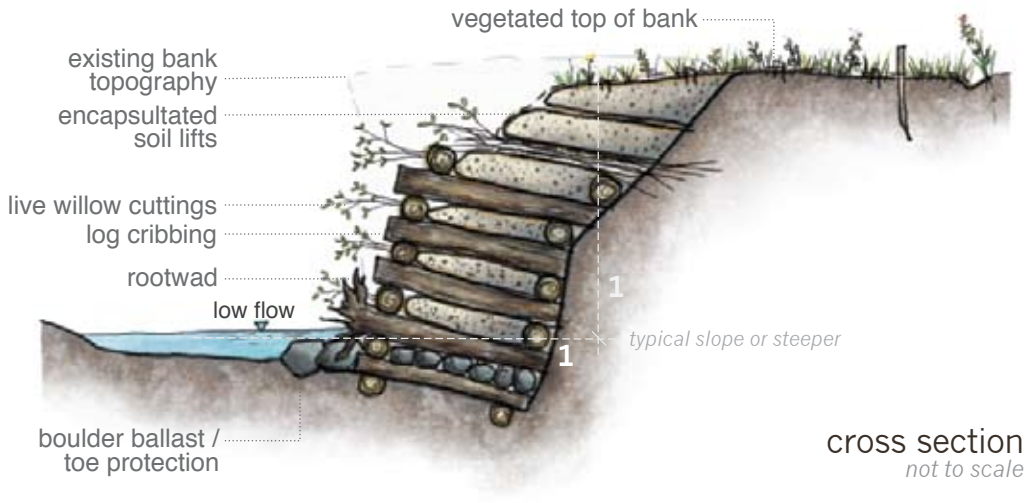
CRIB WALL

DESCRIPTION
This treatment involves construction of an engineered log crib structure filled with native soil and/or stream substrate. Suitable for restoring or establishing native riparian vegetation on extremely steep slopes. Provides high habitat value on confined, steep banks.

APPLICABILITY
Suitable for high velocity and high shear stress flow conditions for stream reaches with steep, overhanging banks. May be appropriate where right-of-way is highly constrained or where valuable infrastructure is threatened by erosion.

CONSIDERATIONS
Costly to construct and requires heavy equipment access. Requires boulder ballasts and anchoring. Risk of downstream impacts if crib wall is dislodged in high flows. Reuse native bank soil when feasible.

VARIATIONS
Transition to encapsulated soil lifts above ordinary high water.



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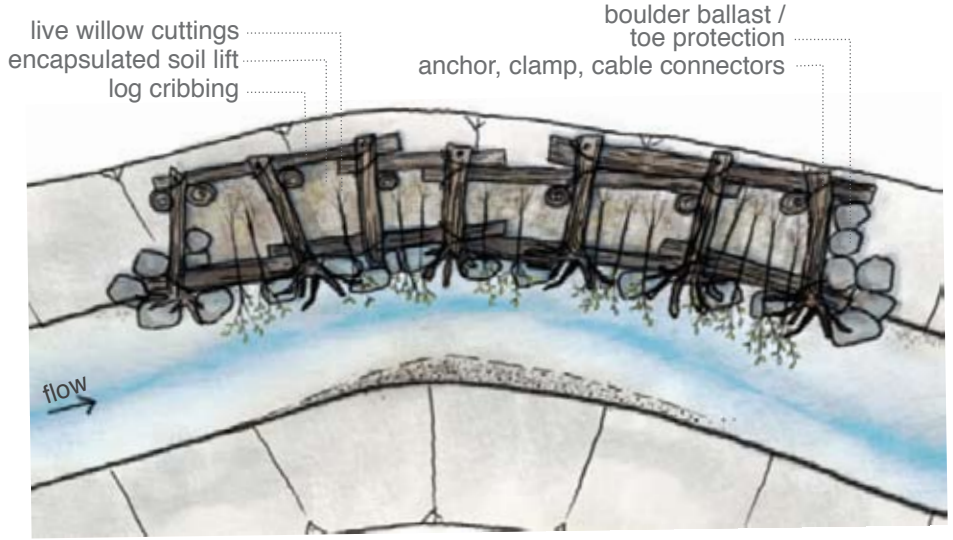

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Source: Jennifer Natali Design. 2011

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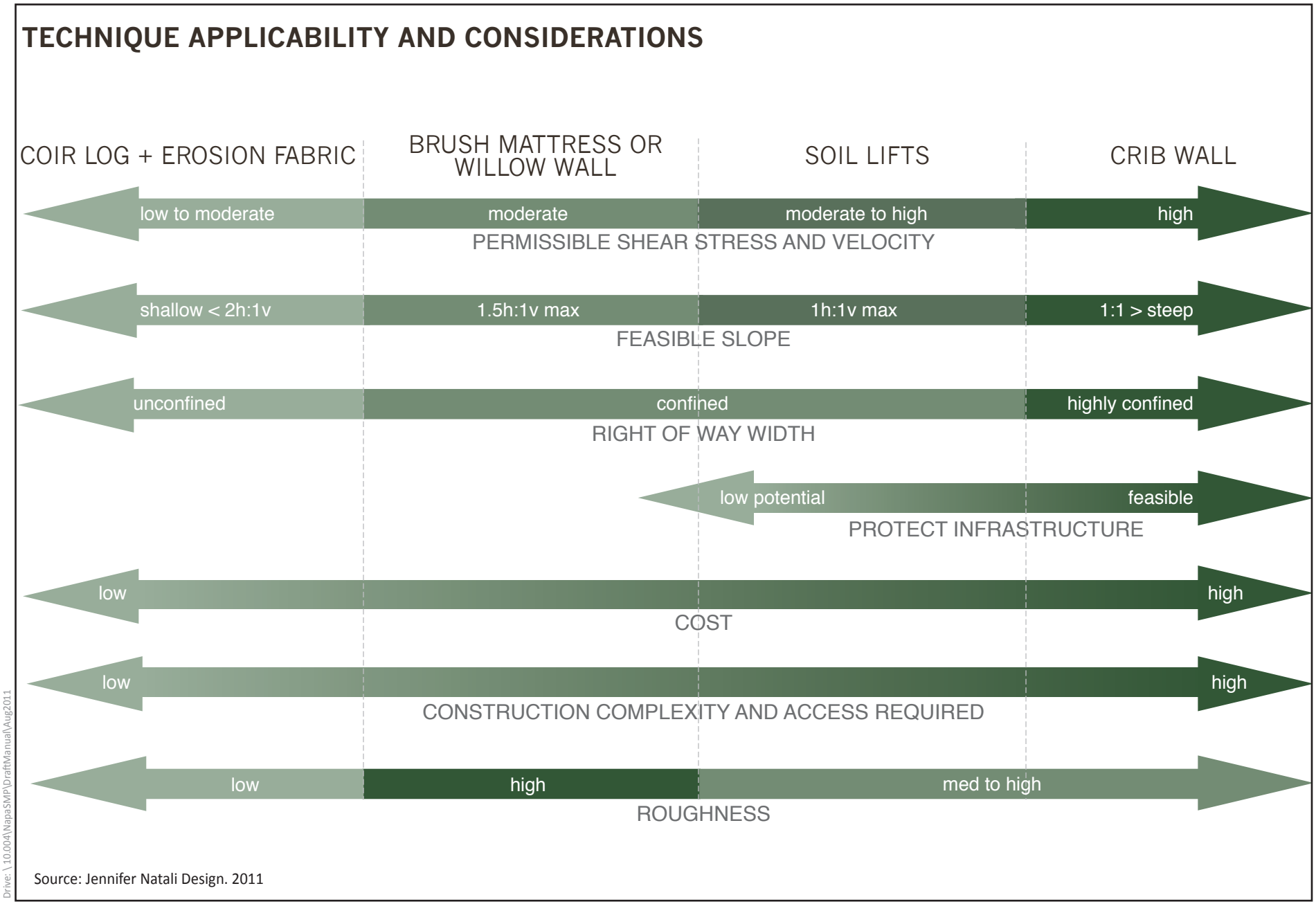
Figure 6-5
Crib Wall Template



Horizon WATER and ENVIRONMENT

Figure 6-6
Erosion Control and Bank Stabilization Technique Applicability and Considerations

Chapter 7
SEDIMENT AND DEBRIS REMOVAL ACTIVITIES

7.1 Overview

By filling a portion of the channel cross section, deposited or accumulated sediment and debris can reduce a channel's capacity to safely convey streamflow. To alleviate this flood risk, the District may remove excess sediment and debris from their flood control channels and facilities. Sediment and debris removal is limited to occur within the as-built channel design. The District's stream maintenance program does not include any expansion of channel capacity beyond the original functioning channel design.

The number of sediment and debris removal projects undertaken in a given year and the quantity of sediment removed depend on recent hydrologic and weather conditions, the frequency of past storm events, and the history and extent of past maintenance activities. Sediment and debris removal needs are generally greater following a wet winter with higher than usual runoff, slope erosion, and sediment delivery compared to an average or dry winter when sediment yields are less.

The District typically implements small-scale sediment removal activities in channel segments roughly 100-200 feet long. These projects typically occur only in District owned or maintained engineered flood control channels. On average 100 to 500 cubic yards of sediment is removed from two to five sites per year. Most commonly, the District needs to alleviate a specific flood concern at an individual crossing, culvert, or other in-channel facility that experiences moderate sediment accumulation. At crossings, culverts, or other facilities, sediment removal often occurs in concrete lined channels. The District may also undertake geomorphic shaping projects, where instream depositional features such as gravel bars or benches may be realigned or reshaped to reduce the flood hazard or redirect erosive flows away from vulnerable streambanks.

In general, the District does not undertake large reach-scale sediment removal projects, where sediment is removed from an entire length of channel reach. Because reach-scale projects are infrequent, they are not considered routine maintenance and are not covered under the programmatic permits for the Program. Under the SMP, the District limits sediment removal projects to no greater than 500 feet.

All channel sediment removal activities will follow the impact avoidance and minimization approach and principles described in Chapter 3, including the best management practices presented in Table 3-1. Permits necessary to support sediment removal activities are described in Chapter 11.

Maintenance of the lower Napa River from the Third Street Bridge in the City of Napa and downstream is overseen by the U.S. Army Corps of Engineers (USACE) and is not included in this

stream maintenance program. The USACE periodically dredges the Napa River to maintain navigational use. The District provides and manages dredge spoil sites at Edgerly Island and the Imola Site (also utilized by the Napa Sanitation District) for placement of material dredged by the USACE. Activities conducted on the lower main stem Napa River are authorized by regulatory agencies independently from the District's routine stream maintenance program.

7.2 Sediment Sources

Sediment delivered to the District's flood control channels has a variety of upstream sources. Transported sediment may be derived from upland erosive areas such as steep and exposed hillsides, active landslides, or gullies. Erosion may also occur in less steep locations, but due to land use practices or erosive soil types may provide abundant sediment loading to the downstream channel. Beside these watershed sources, sediment is also provided by instream channels sources, through bank erosion, transport of sediment previously stored in bars/benches, or incision of the channel bed. Such instream sediment sources may be a significant contributor to downstream sediment delivery. This effect is pronounced where "hydromodification" occurs, whereby development or land use practices reduce surface infiltration capacity, increase surface runoff, and thereby increase streamflow peak discharge and velocity. All these processes result in more erosive streamflows.

In developing the Total Maximum Daily Load (TMDL) for the Napa River Watershed, the San Francisco Bay Regional Water Quality Control Board (RWQCB) investigated sediment sources in the Napa River watershed between 1994 and 2004. The RWQCB (2009) concluded that:

1. More than half of fine sediment delivered to the Napa River is associated with land use activities, including roads, channel incision, vineyards, intensive livestock grazing, and urban stormwater runoff.
2. Channel incision, in addition to being a significant sediment source, is the primary cause of channels being isolated from their floodplains. Channels that are disconnected from their floodplains have reduced spawning and rearing habitat for salmon and steelhead.
3. Sediment loads vary greatly depending upon geologic conditions, land use activities, and the location of dams.
4. Thirty percent of the Napa River watershed drains into reservoirs which capture upstream gravel and sand, and most of the finer sediment input to upstream channels. However, human induced erosion downstream of dams is high. The fine sediment load in the lower Napa River downstream of the major reservoirs is substantially elevated.

The RWQCB studies concluded that between 1994 and 2004 the sediment load into the Napa River at Soda Creek was 466 metric tons per km^2 per year, or roughly 185% of the estimated natural (or baseline) erosion rate of 252 metric tons per km^2 per year. **Table 7-1** summarizes the RWQCB's findings on sediment sources in the Napa River Watershed.

Table 7-1. Mean Annual Sediment Delivery to Napa River at Soda Creek (1994-2004)

Source	Estimated Mean Annual Delivery Rate (metric tons/yr)
Land areas upstream of dams (fine sediment discharged from reservoirs)	
- Natural Processes	7,000
- Human Actions	11,000
Land areas downstream of dams	
- Natural Processes	92,000
- Human Actions	
Channel incision and associated bank erosion	37,000
Road-related sediment delivery (all processes)	55,000
Surface erosion associated with vineyards and/or livestock grazing	37,000
Gullies and shallow landslides associated with vineyards, and/or intensive historical grazing	30,000
Urban stormwater runoff and wastewater Discharges	2,500
Total	**272,000**

Notes: From (RWQCB 2009). Drainage area for Napa River at Soda Creek = 584 km^2. Estimates above do not include sediment deposited and retained in tributary reservoirs, which includes all gravel and sand, and most of the finer sediment input to channels located upstream of the reservoirs. Approximately 104,000 metric tons per year of sediment are deposited in tributary reservoirs, 48,000 metric tons per year of which is derived from natural processes (Above estimates are rounded to the nearest thousand).

As shown in Figure 1-1 and described in the channel characterizations of Chapter 2, the District's flood control channels are primarily located along the southern Napa Valley floor and along the lower alluvial fan reaches of the side valley tributaries that descend toward the Napa River.

The District's maintenance reaches are located in the more gently sloping valley floor region. From a watershed perspective, these areas are generally depositional environments. However, within the District's program area not all reaches are depositional. More site-specific in-channel hydraulic conditions determine whether sediment is eroded, transported, or deposited in a given reach. Factors such as channel gradient (slope), channel width, alignment, sinuosity, and depth of flow all influence instream sedimentary processes. Subtle transitions from higher gradient to lower gradient sections may favor sediment to fall out of suspension and deposit. Similarly, transitions from a narrower stream section to a wider channel may also may cause flow dispersion, reduced velocities, and result in net deposition and bed aggradation. Transitions from piped or culverted sections to an open-channel, or transitions at road crossings or structures may also favor sediment fall out and deposition.

The relevance of these site-specific sedimentary processes to maintenance is that certain locations in the District's program area are more prone to sedimentation and require routine and repeated maintenance. Many of these areas are identified in the channel characterization sheets of Chapter 2 *Environmental Setting*. When the underlying factors causing sediment deposition are understood and identified, maintenance activities can be tailored to be more effective. Focusing the sediment removal work specifically to deposition prone areas, and not to wholesale reaches, helps avoid and minimize potential environmental impacts associated with sediment removal activities. These approaches are further described in Chapter 3.

7.3 Maintenance Goals and Triggers

Sediment and Debris Removal Goals

The District's goals for sediment removal activities are to:

- identify and prioritize stream locations that require sediment and debris removal and maintenance to ensure adequate flood conveyance capacity;
- understand the underlying geomorphic processes at all of the District's maintenance channels to inform and guide appropriate maintenance actions;
- develop an appropriate maintenance target condition for sites that balances flood protection needs, economizes maintenance activities, and avoids and minimizes environmental impacts;
- improve water quality conditions through sediment management, including the removal of fine sediments; and to
- conduct maintenance that will enhance stream function while minimizing the need for repeat maintenance.

Where appropriate, target conditions for each reach are identified according to management needs, reach functioning, and other opportunities and constraints. In this way, stream sections are managed to maintain and enhance sediment conveyance, water quality, and habitat. To the extent possible, the District seeks to preserve and/or enhance beneficial instream bed forms and habitat features (including LWD) that support in-channel complexity, diverse cover, and local habitats.

The District's approach to sediment removal and management is to implement maintenance incrementally as needed. Incremental maintenance prevents sudden, drastic alterations in sediment load within individual reaches, which could accelerate further aggradation or incision. Incremental implementation also allows time for monitoring, evaluating channel conditions, and adaptively adjusting the maintenance approach as needed. The incremental maintenance approach has a spatial component and a temporal component, in that removal activities will occur in specific reaches at a given time and not throughout an entire stream system in any given year. Therefore, stream maintenance activities for specific reaches will be prioritized annually with only the reaches in highest need being treated.

Sediment Removal Triggers

In general, sediment removal activities are appropriate when any of the following conditions applies:

- The channel is systemically aggrading such that channel capacity is at risk. The degree to which channel capacity has been reduced is determined based on visual assessment (during dry season and wet season conditions), cross section comparisons to the as-built channel condition, and any past record of flooding conditions. The District will be supporting a stream data collection effort as described in Section 10.8 *Data Collection and Management*.

- Accumulated sediment is covering or blocking culvert outfalls, drop-inlets, drainage ditches, or filling box culverts, threatening to cause flooding.
- Sediment is accumulating in a way that supports excessive vegetation growth, threatening channel capacity or creating undue roughness.
- Sediment accumulation is impeding fish passage.
- Instream structures designed to direct flows for flood management are causing excessive sediment deposition. Examples include culverts that are filling with sediment.

The need for sediment management action is unlikely if none of these trigger conditions are present. The District may also need to evaluate the overall channel form including channel geometry and invert elevations to better understand why certain reaches are chronically depositional.

7.4 Sediment Removal Activities

As introduced above, sediment removal activities typically occur at small localized sites (less than 500 ft. long) that experience sediment deposition or blockages. Sediment removal activities may often occur at culverts and stream crossings (and immediately upstream and downstream of crossings) where sediments tend to collect and deposit. Sediment removal activities generally occur under dry channel conditions. However, if maintenance is necessary where water is in the channel, dewatering would be conducted (see discussion below).

Sediment removal projects will typically involve the following activities:

- removal of accumulated sediment from up to five channel, culvert, or pipe locations per year;
- typical project distance of 100-200 feet and 25-50 cubic yards of sediment removal per maintenance site;
- if mechanized sediment removal is necessary, the District's will locate excavation equipment outside of channel on maintenance access roads above high bank locations. From that location, excavators can remove sediment and place it directly onto hauling trucks, keeping all mechanized equipment outside of the channel;
- if using a long reach excavator is not possible (for example, within a covered box culvert), District staff may use small Bobcat®, skid-steer, or walk-behind power-shovel to remove sediment on concrete surfaces or hardened facilities. A vacuum truck is also used to remove sediment from smaller culverts and pipes;
- where possible, District will use non-mechanized hand tool approaches for smaller scale projects or in working around sensitive instream locations that are not hardened surfaces; and

- if repeated channel entrance is necessary, District staff will identify temporary access locations and develop access ramps along the stream banks, to minimize repeated disturbance to bank locations.

Smaller culverts (12 to 24 inches) made of corrugated metal pipe (CMP) often drain from adjacent properties directly into District channels. The District is not responsible for maintaining local private drainage culverts beyond the District's property or maintenance easement, but the District does maintain the outlet of such culverts when they enter flood control channels under their maintenance. A culvert outlet that is blocked with sediment or vegetation will not drain properly. Removing sediment from a small culvert outlet may require similar techniques as described above for culvert crossings, but may also simply require digging out the culvert outlet by hand.

The sections below discuss sediment removal operations and techniques. Regulatory compliance requirements for sediment removal are not reviewed in this chapter, but are presented in *Chapter 11 Regulatory Compliance*.

Channel Access and Staging

Access to the project site and staging of equipment and vehicles will take place on existing access roads adjacent to the channel. The District's flood control channels typically have at least one access road running along the top-of-bank on one side of the channel. Some channels have an access road on either side of the channel. Where feasible, mechanized sediment removal is conducted using an excavator from the top-of-bank access road. This reduces the need for equipment within the channel. Where feasible, instream work is conducted from the north side of the channel to avoid needing to remove vegetation (and the accompanying shade reduction) from the south side.

When the channel shape, bank height, or the presence of large mature trees prevents the use of the top-of-bank access roads, an access ramp (earthen or hardened, if already existing) may be used to move equipment lower on the bank of the channel, or move the equipment into the channel. Access ramp locations are selected to avoid impacts to vegetation, while providing efficient, safe equipment access to the work area. If used, access ramps are temporary and will be regraded and replanted following the sediment removal activities. Following maintenance, the ramps will be seeded with native grasses and erosion control fabric will be installed.

When necessary, sediment removal activities can be conducted from within the channel bed. This approach is favored where top-of-bank or side-bank access is unavailable, or would require unnecessary damage to trees along the riparian corridor. Scrapers, skid loaders, bulldozers, and smaller Bobcat® type loaders are used when working directly in the channel bed. All removed sediment, whether working from top-of-bank, mid-bank, or in channel will be placed in 10- or 20-cubic-yard dump trucks located on the access road or within the staging area.

Mechanized Sediment Removal

Aggraded sediment can be removed with a long-reach excavator, bulldozer, scraper, or front loader. As described above, the preferred approach is to have the long-reach excavator located on the access road adjacent to the channel. Once excavated, sediment is either placed directly into dump trucks parked on the access road. BMPs and avoidance and minimization measures will be applied to sediment removal activities based on equipment used, site conditions, and access to the site. If equipment is operated in such a way that loose sediment may possibly enter the active channel, erosion control fabric will be installed at the toe-of-slope or along the edge of the active channel to avoid delivery of any dislodged sediment into the channel and/or low-flow channel. If equipment is used within the channel, or if activities conducted from top-of-bank may affect the active channel, the work area will be isolated from flowing stream segments using silt fences, wattles, and/or cofferdams (see the *Dewatering* section below). Additional BMPs are identified in Table 3-1 and will be applied as appropriate to all sediment removal projects.

Dewatering

Dewatering of the stream may be required in order to conduct sediment removal in the channel. Many program area creeks are intermittent or ephemeral. Such creeks are dry in the summer maintenance season and therefore do not need dewatering for maintenance. Other creeks are perennial and carry flow year-round. Several of the channels in urbanized areas, or downstream of urbanized areas that were historically dry in summer, now receive flows from urban runoff and contain water year-round.

If the channel is conveying water or ponding at the time of maintenance, dewatering techniques will be used. The District typically uses a small-scale and flexible approach with a small coffer dam (typically made of sand bags) less than 1 ft deep, a small portable pump (5 horsepower or less), and 4 inch flexible pipeline to re-route flows around the work site downstream. Where dewatering occurs, work sections are kept short, less than 100 ft to minimize dewatering effects. Pumping rates are set to match inflows to the coffer dam with the downstream release of the diverted flows. Pump intake lines are protected with screens according to NMFS and CDFG criteria to prevent the entrainment of aquatic species. The diverted flows are released back into the channel as near as possible to the downstream end of the project area. Silt bags are used at the end of the diversion pipe to reduce any sediment discharge downstream and to dissipate flow velocity and prevent scour at the discharge site.

Channels will only be dewatered to the extent necessary to conduct sediment removal activities while protecting water quality and avoiding impacts to aquatic species. Specific BMPs for channel dewatering are described in Table 3-1.

7.5 Debris Removal

Debris removal involves removing non-sedimentary materials that are deposited in channels as a result of high flows or through human activity. Such debris includes tires, shopping carts, trash, furniture, clothing, homeless encampments, and other substances. Whereas sediment accumulation typically involves the

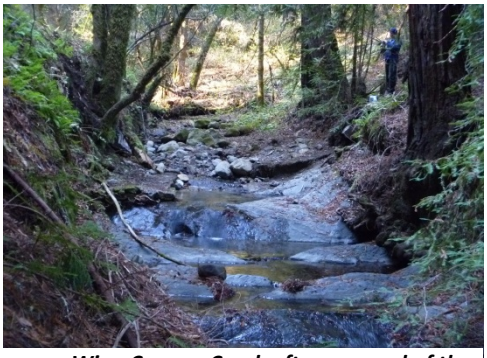
raising of the stream bed in a uniform manner and the development of instream depositional features such as instream bars; non-sedimentary debris typically occurs in the form of isolated objects or debris mounds or snags. However, such debris whether in the form of a snag, mound, or isolated object can significantly reduce channel conveyance capacity and affect hydraulic conditions. In particular, debris jams can divert and redirect flows into streambanks and thereby increase bank erosion. Large debris is also problematic when caught against crossings and bridge abutments which leads to raised water elevations and blocked culvert entrances and outfalls.

The District routinely monitors its flood control channels to remove debris that impairs hydraulic conditions or reduces channel conveyance capacity. Based on these routine inspections, debris removal occurs on an as-needed basis. Debris removal may also be required to provide access for minor maintenance activities at stream gages, culvert outfalls, flap gates, and grade control structures.

Debris removal activities are generally conducted by work crews using hand tools and occasionally a winch. Heavy equipment is typically not used for debris removal. Non-vegetative debris is removed from the site via dump truck for disposal at a solid waste landfill. However, containers of hazardous waste, such as paint and oil, are sealed in protective containers and disposed at an appropriate hazardous waste facility. BMPs identified in Table 3-1 will be applied, as appropriate.

Abandoned instream dam on Wing Canyon Creek before removal

As a creek and watershed steward, the District assists private property owners and other local partners (including agencies) in assessing existing instream obstructions and abandoned structures for possible removal. As feasible, the District will assist local watershed stakeholders through removing such obstructions and abandoned facilities using hand tools and approaches as described in this Manual. Related to debris removal, the District also coordinates with local law enforcement to control the establishment of homeless encampments on the flood control channels that the District owns. Such encampments can be major sources for debris, garbage, and water pollution. Signs are posted 48 hours in advance of homeless encampment removal.



Wing Canyon Creek after removal of the abandoned instream dam in 2012

There are many abandoned instream dams that remain in County creeks. These abandoned dams (generally small in nature) have typically outlived their purpose and now remain as instream barriers. Other constructed instream facilities considered for potential removal will be evaluated on a case by case basis for consistency with the management objectives and principles of the Stream Maintenance Program. The photos to above illustrate before and after photos of an instream dam on Wing Canyon creek in 2012. This structure was removed by hand-held tools and with approval from CDFG.

7.6 Sediment and Debris Disposal

For projects involving sediment removal, and as specified in the Sediment Sampling and Analysis Guidelines included in **Appendix D**, the District will test the sediment to be removed to determine the suitability for disposal or reuse based its chemical qualities. The discharge orders issued by the Regional Water Board dictate the degree of sediment sampling and testing required for sediment disposal or reuse associated with this maintenance program. This Manual incorporates these requirements by reference. As specified in the Sediment Sampling and Analysis Guidelines, sediment samples will be collected and analyzed according to the *Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines* (RWQCB 2000), as appropriate for the proposed disposal or reuse site. Sediment testing results will be submitted to the Regional Water Board for review and approval.

Sediment disposal and reuse sites are identified when the need for sediment removal activities arise; sediment removal and disposal activities may not be necessary every year. In general, sediment disposal sites can be characterized into five categories based on potential reuse or disposal opportunities. These categories include (1) on-site reuse, (2) other wetland, channel, or floodplain restoration reuse, (3) upland agricultural or commercial reuse (dry), (4) landfill disposal, and (5) hazardous waste disposal. These five options will be evaluated in decreasing preference with site selection based on the quality of sediment. The preference is to select disposal options that most beneficially reuse the sediment with the least environmental effects. If hazardous levels of contaminants are present, the material is taken to a permitted hazardous waste facility.

The District maintains two sediment disposal sites for the county in association with the U.S. Army Corps of Engineers dredging activities for navigation along the Napa River. These sites are the Edgerly Island and Imola sites. The disposal sites are approved to receive sediment spoils from Napa River dredging in perpetuity, and are approved to receive sediment spoils from District maintenance activities.

Edgerly Island Disposal Site. The Edgerly Island Disposal Site was reconfigured to receive sediment spoils in 2004. The total capacity of this site to receive sediment spoils is 300,000 cu.yds. The site was only utilized once and has not been active since; the site is nearly empty.

Napa Sanitation District Imola Site. The Napa Sanitation District's Imola Site was reconfigured to receive sediment spoils in 2006. The total capacity of this site to receive sediment spoils is 55,000 cu.yds. This site has not been utilized for sediment disposal since it was reconfigured.

Further detail on sediment sampling methods, sediment chemical analysis, and disposal and reuse options are discussed in Appendix D.

Trash debris removed from District channels is taken to one of two places depending on the nature of the debris. Non-hazardous material is taken to the Napa County Corporation yard at 933 Water Street in Napa, while large bulky items and hazardous materials including tires are taken to the Napa County Waste Transfer station at 889 Devlin Road in American Canyon.

Chapter 8
OTHER MINOR MAINTENANCE ACTIVITIES

8.1 Overview

In addition to the primary maintenance activities described in Chapters 4 through 7, the District conducts several other maintenance activities as part of their overall maintenance program. Though routine and expected, these other activities occur on a less frequent basis and include replacing culverts, maintaining access roads and drainage ditches, and managing beaver activities.

The frequency and location of minor maintenance projects in a given year is uncertain and will depend on past maintenance activities, recent hydrologic conditions, the age of engineered structures, and other factors.

The District anticipates that on average, the maintenance program will involve between 2 and 3 minor maintenance projects per year. All minor maintenance activities will follow the impact avoidance and minimization approach and principles described in Chapter 3, including the best management practices presented in Table 3-1.

The District shares some maintenance responsibilities with the *Napa County Roads Maintenance Department* for maintaining roads, bridges, or other engineered facilities that have a flood control purpose. In general, the District maintains only the instream component of such features or facilities that has a specific flood control purpose. The Napa County Roads Maintenance Department will be developing a separate independent manual describing their maintenance activities.

In general, minor maintenance activities can be conducted anywhere within the District's maintenance jurisdiction. The sections below describe minor maintenance activities in more detail.

8.2 Channel Access Roads Maintenance

Channel access road maintenance includes vegetation management and removal. Access road maintenance work is done with hand tools, mechanized equipment, or herbicide application equipment (for vegetation treatments). The potential timing for road maintenance activities is:

- Access road tree/shrub pruning – All year.
- Herbicide spraying of dirt/gravel access roads – March 1st to April 30th.
- Mowing access roads – March 1st to August 30th.

Vegetation removal will be accomplished by mowing grasses, pruning limbs and branches that overhang the road, and/or applying contact herbicides approved for use in aquatic environments. The access road and the area between the access road and adjacent fence lines that enclose the District's right-of-way or easement will be maintained using mowers or hand tools to reduce fire hazards and protect the roadway and fence. Hand tools such as pole saws, loppers, and chainsaws will be used to remove tree limbs that overhang the road or otherwise block access.

The District may use glyphosate (trade names: Rodeo ® or AquaMaster®) or imazapyr (trade names: Habitat®, Arsenal®, Chopper®, and Stalker®) herbicide or a similar product on the surfaces of gravel access roads to discourage weeds from establishing in the roadway and protect the integrity of the road. Spraying is limited to as a narrow a corridor as possible, and only gravel road surfaces will be treated.

As described in Chapter 4, all herbicide application activities will be conducted in accordance with applicable federal, state, and local regulations (under regulatory authority of the USEPA, State Water Resources Control Board, State Department of Pesticide Regulation, and the Napa County Agricultural Commissioner, respectively) and the District will utilize BMPs identified in Table 3-1 when applying herbicides.

Roadside Drainage Ditches

Roadside drainage ditches, also known as V-ditches, may be located above and beyond the top-of-bank zone of the stream channel, on the outer edge of the channel access road. These facilities were designed as local collectors to route runoff from the access roads and adjacent upland areas to the stream channel below. Flow from roadside ditches is often conveyed beneath the access roads and discharged into the adjacent channel via culverted outlets. Roadside ditches may require maintenance including clearing of leaf litter and overgrown grasses, re-grading ditch banks following failure or erosion, and/or sediment removal. Maintenance work may also require repositioning culverts that drain roadside ditches (see culvert discussion below).

8.3 Culvert Replacements

Culverts in the program area occasionally require repair or replacement. The installation and repair of drop-inlet culverts and the clearing, repair, or replacement of road crossing culverts are the most common routine culvert maintenance activities. A discussion of these culvert activities is provided below.

Drop-Inlet Culverts

Drop-inlet culverts are typically used to route local drainage from local collectors or ditches to the stream channel below. Commonly these drop-inlet culverts cross beneath the access road and exit into the channel bank a few feet above the toe-of-slope. Repairing existing drop-inlet culverts is a routine maintenance activity. **Figure 8-1** shows an example design detail of how drop-inlet culverts may be repaired at sites where bank failure has occurred around the culvert.

In this example, a small amount of hardscape is included at the toe-of-slope to provide added erosion protection for the bank. However, hardscape is not always required and would be utilized on a site-specific basis. Installing a new drop-inlet culvert may be appropriate when existing drainage ditches and routing systems are not adequate. Pooled water along maintenance access roads above channels can overtop the streambank, and flow directly down the bank into the channel. Such overtopping flows (due to poor drainage) can increase the opportunity for bank erosion or bank failure due to saturated soils.

The following impact avoidance guidance applies to the District's maintenance of drop-inlet culverts:

- Repair or replacement of an existing culvert will occur within the same footprint as the original culvert.
- The culvert outfall path, from the culvert edge down to toe-of-slope will be protected with erosion control material as needed to dissipate energy and reduce the erosion potential.
- The culvert placement and outfall will be installed to minimize outfall velocity and reduce the potential for future bank erosion and scour from outfall. Energy dissipation approaches will be used as needed.

Road-Crossing Culverts

The County Roads Department and the District share responsibility to maintain culverted road crossings. In addition to the sediment removal activities described in Chapter 7, on occasion these culverts may require repair or replacement due to structural failures of the culvert or problems with supporting footings or headwalls. Causes of failures may include improper sizing, misalignment, the road design and its loadings, and/or the age of materials. Culvert failure typically reduces hydraulic capacity due to flow obstruction and blocking by the culvert, sediment, or debris that collects as a result of the failure. Failure may also lead to increased erosion downstream of the culvert where concentrated flows may become more erosive.

Repair or replacement of an existing culvert will occur within the same footprint as the original culvert. Culvert replacement will include replacing the culvert (generally CMP or reinforced concrete pipe) and anchoring it in place with steel reinforced concrete or grouted rip-rap depending upon the road crossing situation. Dewatering of the stream may be required. Culverts will generally be installed using an excavator working above the channel from top-of-bank. Culverts will be placed at grade and anchored to subgrade. Backfill and road material will be laid, graded, and compacted.

Similar to other maintenance projects, staging will occur to the extent possible on the access road adjacent to the stream channel. As appropriate, exposed soil on streambanks that remains after culvert maintenance activities will either be seeded with grass and covered with erosion control fabric or planted according to District on-site restoration planting designs.

This Manual intends to cover repair activities for existing culverts of typical sizes within the County and District's jurisdiction. However, the installation of new or replacement culverts is limited up to a 48" size diameter for purposes of this program. Required culvert installation larger than 48" would occur outside of the program.

8.4 Beaver Controls

Heavy beaver activity, such as observed in Salvador Creek (Reach 2) (see Photo 1 in **Figure 8-2**), presents several maintenance concerns. Beaver dams block the channel and introduce woody debris into the creek. The beaver felled logs become the basis to catch debris and develop a more solid dam as seen in Photo 1 of Figure 8-2. Beaver activity also reduces riparian habitat at rates that exceed the recruitment and growth of trees, as the beavers target younger trees (Photo 2 in Figure 8-2) and larger and older trees (Photo 3 in Figure 8-2). If left unabated, this activity will likely continue through the reach and multiple flow obstruction dams will develop. As an area becomes backwatered (ponded) by the beaver dams, sediment may begin to accumulate in the ponded area. Ponded environments encourage the growth of aquatic vegetation, such as Ludwigia and cattails, which further reduces flood carrying capacity and degrades in-channel habitat.

Beaver activities are monitored as part of the annual stream reconnaissance surveys (see Chapter 10). The District's approach to managing beaver activity is to generally allow it to occur. The District recognizes the habitat benefit of beaver debris jams, especially for species that like to outhaul on perched debris such as western pond turtles. However, when debris dams build up to a degree that adversely impacts a significant reach upstream and downstream, such as shown in Photo 1 of Figure 8-2, the District will trim branches and cut through long sections with a chain saw so the blockage will break up during the next large flow event. Management activities are conducted to be the least invasive to not disturb the beaver's habitat while ensuring flood conveyance capacity is maintained.

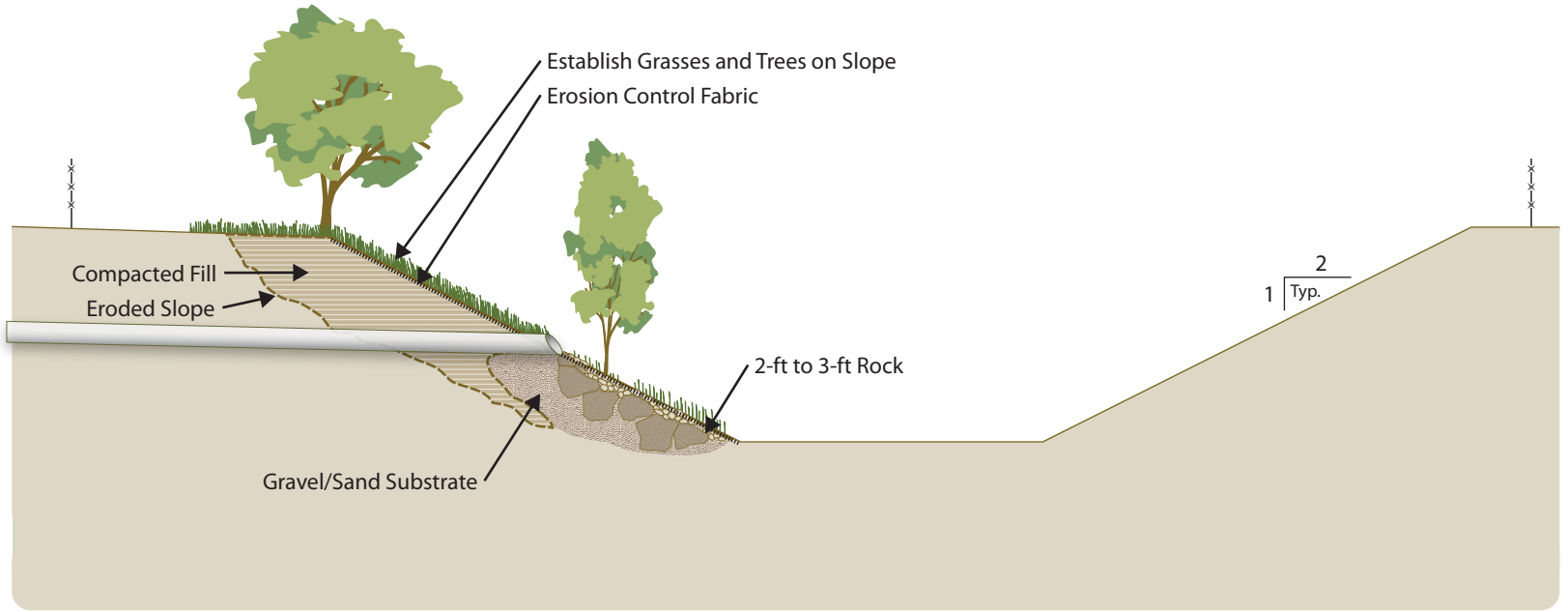


Photo1. Example of a Culvert Failure.

Photo 2. Same site as Photo 1 after bank repair using minimum necessary rock rip-rap.

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Horizon WATER and ENVIRONMENT

Figure 8-1
Bank Stabilization Treatment Design—Culvert Repair

Photo 1. Beaver dam located in Salvador Creek, approximately 600 ft downstream of Trower Avenue (July 8, 2010).

Photo 2. Downed trees crossing the channel from beaver activity (July 8, 2010).

Photo 3. Beaver activity on large cottonwoods (July 8, 2010).

Horizon WATER and ENVIRONMENT

Figure 8-2
Photos of Beaver Activities on Salvador Creek

Chapter 9
HABITAT PROTECTION AND ENHANCEMENT

9.1 Overview

The following sections describe habitat protection and enhancement activities conducted as part of the stream maintenance program, including:

Section 9.2 Self-Mitigating Approach of Program

Section 9.3 Habitat Enhancement Goals

Section 9.4 Riparian Planting

Section 9.5 Instream Habitat Complexity Features (including LWD)

Section 9.6 Gravel Augmentation

9.2 Self-Mitigating Approach of Program

The District sees its stream maintenance program as an integrated stream management approach that involves protecting and enhancing existing instream resources and creating opportunities for improved future resources while maintaining necessary flood conveyance and bank stability condition in the District channels.

As described in this chapter, the District undertakes expansive riparian planting projects, develops instream habitat complexity features (including large woody debris (LWD)), and undertakes gravel augmentation projects where appropriate, in addition to conducting other measures to improve stream habitat conditions.

Taken together, the application of the Maintenance Principles (Chapter 3), implementing additional pre-maintenance planning avoidance measures (Chapter 10), and following the protective BMPs (shown in Table 3-1) provides a comprehensive and integrated approach to avoid and minimize program impacts. However, where the District conducts ground disturbing stream maintenance activities they will conduct the habitat enhancement and restoration activities described further below in this chapter to mitigate for temporary effects.

Ground disturbing maintenance activities, including sediment removal and bank stabilization, are limited to 1,000 combined linear feet per year. Mitigation for such ground disturbing maintenance activities will occur at a 1:1 ratio according to the length of the maintenance work. If the area where maintenance activities is occurring already has sufficient planting, or is in good condition regarding invasive plants, such that restoration activities are not needed on-site, then the District will undertake the enhancement and restoration activities at another channel location. The objective of the mitigation planting is to enhance the complexity and diversity of the riparian canopy cover, improve channel shading, and develop a functioning understory along the channels that are currently dominated by non-native invasive species.

The District's routine vegetation management activities will have temporary impacts. The District rarely removes trees from the riparian zone. As described in Chapter 4 *Vegetation Management*, the District would only remove a tree if it is causing a flood or erosion hazard, is trapping a significant volume of debris, or is otherwise a hazard to people or existing infrastructure. If the District removes a tree (greater than 6" dbh (diameter at breast height)) they will mitigate for this impact by replanting at a 1:1 ratio with a suitable riparian tree species at the same location or somewhere else along the same stream. Mitigation and tree planting activities will be reported in the District's annual maintenance summary report.

As structured and implemented, the Stream Maintenance Program would not result in any permanent environmental impacts. In compliance with CEQA, an Initial Study was completed and a Notice of Determination for a Negative Declaration was filed on February 10, 2012 (State Clearinghouse No. 2011122050). Maintenance activities that would result in permanent impacts (e.g. bank hardening) are not covered or included under this program. If such activities are necessary, they would be authorized through individual project permits outside of the routine maintenance program. Temporary impacts from stream maintenance activities are avoided and minimized through the approaches described above and detailed further in this Manual. The District's long history of habitat protection and enhancement activities as described in this chapter serve as "self-mitigating" actions integrated with the maintenance activities.

9.3 Habitat Protection and Enhancement Goals

The District's primary habitat enhancement goals are to:

- Protect and enhance instream physical processes that create or maintain diverse flow conditions and a range of instream landforms including bars, riffles, pools, and benches (where these landforms are appropriate).
- Protect and enhance instream water quality conditions. While water quality conditions greatly depend on watershed source areas and land uses, instream flow blockages, debris, and other pollution negatively effects water quality. The District protects and enhances instream water quality through alleviating flow blockages to maintain circulation, and removing debris and trash.
- Protect and enhance riparian vegetation to develop more continuous vegetated corridors and more complete and complex canopy structure along the District's stream courses. The District's streamside vegetation enhancement program involves aggressive planting of native vegetation, removing invasive plants, and managing emergent vegetation on the channel bed to reduce flow blockages.
- Protect and enhance aquatic instream habitats used by benthic macro invertebrates, fish, amphibians, birds and other wildlife along the District's stream courses. Instream habitats for wildlife reflect a complex ecology, integrating the physical processes, water quality, and vegetation conditions as described in the other goals above. The District will avoid and minimize maintenance activities to the minimum necessary in areas of known/observed sensitive species and employ best management practices and restoration activities in such areas to leave them in better ecologic condition following maintenance.

9.4 Riparian Planting

Riparian planting will enhance habitat for birds, amphibians, and other wildlife using terrestrial riparian areas while providing shading, sources of organic matter and coarse woody debris, and water quality benefits to aquatic species. The planting palette for the Riparian Planting Program is shown in **Table 9-1**. This list of species may evolve as the program adapts to improve riparian restoration efforts. Riparian planting may also include site preparation, including minor grading and topsoil preparation, and incorporation of soil amendments.

Table 9-1: Riparian Planting Palette

Botanical Name	Common Name
TREES	
Acer macrophyllum	Big leaf maple
Aesculus californica	California buckeye
Alnus rhombifolia	White alder
Fraxinus latifolia	Oregon ash
Juglans hindsii	Black walnut
Populus fremontii	Fremont's cottonwood
Quercus agrifolia	Coast live oak
Quercus lobata	Valley oak
Salix laevigata	Red willow
Salix lasiandra	Arroyo willow
Salix lucida	Shining willow
Umbellularia californica	Bay laurel
SHRUBS	
Baccharis pilularis	Coyote bush
Calycanthus occidentalis	Western spice bush
Heteromoles arbutifolia	Toyon
Rhamnus californica	Coffeeberry
Rosa californica	California wild rose
Symphoricarpos albus	Snowberry
LOW HERBACEOUS PLANTS	
Carex barbarae	Santa Barbara sedge
Carex praegracilis	California field sedge
Elymus glaucus	Blue wildrye
Euthamia occidentalis	Western goldenrod
Festuca idahoensis	Idaho fescue
Juncus balticus	Baltic rush
Juncus effusus var. brunneus	Pacific rush
Leymus triticoides	Creeping wildrye
Lonicera hispidula	Honeysuckle
Muhlenbergia rigens	Deergrass
Melica Californica	California melic

Figure 9-1 illustrates riparian vegetation zones according to bank location in cross section view and lists targeted tree planting types. Figure 9-1 is used by the District as a general palate to identify suitable trees for replanting in the aquatic/streamside, riparian bench, riparian banks, and higher bank/terrace zones. Figure 9-1 is also referenced in Chapter 6 as is used to guide revegetating streambanks following bank stabilization and erosion control projects as well.

Table 9-2 summarizes the District's riparian planting efforts to-date. As shown in the table, over the past 10 years, the District has planted 6,495 trees along 31,650 linear feet (nearly 6 miles) of streams throughout the county. A portion of these planting activities were specifically conducted to revegetate bank stabilization projects on Conn Creek, Tulucay Creek, and Salvador Creek. On average, 650 trees are planted as part of the District's stream maintenance program. The District maintains two willow farms (in St. Helena and Napa) to support planting and revegetation activities throughout the county.

Table 9-2: Summary of Riparian Planting Activities 2000-2011

Creek or Project Site	Linear Feet Planted	Number of Trees Planted	Number of Understory Species Planted
Conn Creek	300		
Napa Creek	150	200	
Napa River	1,500	350	
Oak Knoll Ditch	4,700	100	
Salvador Creek	3,500	2,000	
Salvador Outfall at Summerbrooke	1,300	400	200
Solano/Salvador Avenue Collector	5,600	750	30
Tulucay/Camille Creeks	2,200	95	25
Yountville Collector	9,800	2,000	
Yountville Outfall	2,600	600	
Totals	**31,650**	**6,495**	**255**

Opportunities for riparian planting and restoration will be evaluated on a case-by-case basis at all maintenance locations. Specific revegetation plan details are highly dependent on site-specific conditions at each planting site, particularly with regard to hydrology and soils. Riparian planting restoration sites will be prioritized toward:

- Stream reaches where the existing vegetation is void or of low quality, or there is a gap in the riparian canopy/corridor, such that vegetation growth will improve connectivity between existing patches of high-quality riparian habitat.
- Stream reaches where invasive plant species have been removed and native riparian plant establishment is a priority to establish prior to potential recolonization by the invasive plants.

Volunteer riparian planting

- Stream reaches where overall vegetation planting and canopy development will provide functions (shade, refugia, etc.) for sensitive fish and/or wildlife species.

9.5 Instream Habitat Complexity Features (including LWD)

A complex instream and channel bed environment provides habitat heterogeneity, cover, and refugia during a range of flow conditions. In coordination with other maintenance activities, District stream managers will evaluate District channels and maintenance sites for opportunities to enhance or develop instream complexity features. Examples of instream complexity features include:

- Enhancing an existing, or developing new large woody debris (LWD) features that provide cover and refugia during high flow events as well as channel diversity in lower flow events.
- Enhancing existing, or developing new deep channel pools that provide rearing habitat and refugia during high flow events as well as habitat during extreme low water times.
- Enhancing existing, or developing new cobble/gravel bars and benches that provide spawning and rearing habitats for fish, refugia during higher flow events, and areas suitable for good invertebrate drift.
- Developing other instream geomorphic features that increase channel bedforms, increase the range of channel velocities, and increase the overall range of habitat conditions.

The goal of these projects is to enhance existing instream complexity features and/or create new features within fish bearing streams in the program area. New instream features may be developed to achieve several habitat objectives, including: increasing pool habitat in homogenized stream reaches, providing escape cover for rearing and spawning fish, deepening feeding areas in riffle habitat, creating a variety of stream flow velocities for cover, sorting gravel, and providing resting areas for upstream migration. Additionally, improving instream function can benefit other aquatic flora and fauna by improving the overall stream complexity for which these species depend upon for survival. If effective, new instream complexity features (particularly in highly modified, urban streams) can augment or replace existing structural features required for successful spawning and rearing of salmonids in the freshwater environment. The District anticipates that two instream habitat projects would be implemented per year.

Newly developed instream habitat improvements may use log structures, boulder structures, or a combination of both log and boulder structures to achieve more complex habitats. Possible configurations of boulders or logs include weirs, clusters, single and opposing wing deflectors, spider logs, and digger logs. The construction materials selected for each instream complexity feature would depend upon the target objective and site conditions.

The new instream complexity features will be monitored and reported upon in annual monitoring reports. If site appropriate, new instream complexity features can be integrated with gravel augmentation projects as described below.

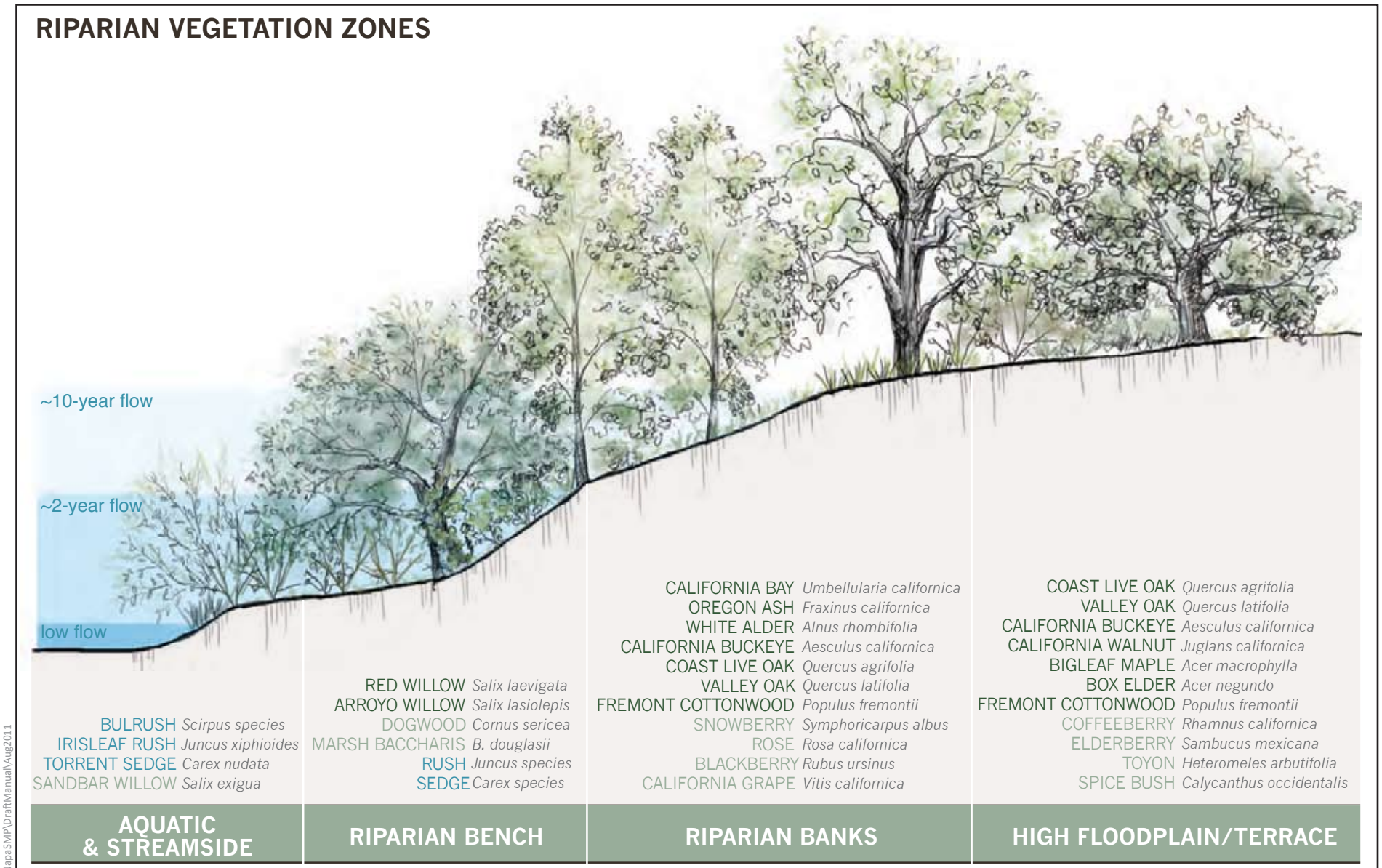
9.6 Gravel Augmentation

Instream gravel and course sediment along a streambed can be a fundamental habitat element to a healthy functioning stream directly supporting life-cycle needs of fish, amphibians and other aquatic wildlife. Often, gravel and course streambed sediment supply is reduced due to dams or other upstream barriers that trap sand, gravel, and course bed materials upstream behind the barrier. In addition to curtailing sediment supply, dams, reservoirs, and other upstream barriers also moderate or reduce the magnitude of stream flows such that natural gravel mobilization and transport processes are diminished. Flood control dams or other facilities reduce flow magnitude and duration resulting in less frequent (or non-occurrence) of flows strong enough to mobilize sediments along the channel bed.

Gravel augmentation provides direct benefits for improving fish spawning and rearing habitat. Gravel augmentation helps mitigate for general instream impacts related to sediment removal activities for spawning and rearing salmonids.

The general goal of gravel augmentation projects is to improve fish spawning and rearing habitat by enhancing sedimentary materials within the channel bed. The District can reuse watershed specific gravels collected through sediment removal activities as a source for the gravel augmentation projects. The District would collect, sort, separate, and reuse clean, appropriately sized gravel. When designing a gravel augmentation project, several factors will be considered, including: the existing channel conditions; the grain size distribution of the sediment to be added; the volume of gravel to deposit; the frequency of gravel addition that will be required in light of sediment transport; how the added gravel will interact with to the existing flow regime and/or channel geometry; and the extent of augmentation effects within the channel reach.

Opportunities to augment gravel in non-tidal salmonid streams will be assessed annually. The District will assess stream reaches that are particularly diminished of gravel and assess the feasibility for gravel augmentation. The District anticipates that two to five gravel augmentation projects will be implemented per year.



Source: Jennifer Natali Design. 2011

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Horizon WATER and ENVIRONMENT

Figure 9-1
Riparian Vegetation Zones

Chapter 10
PROGRAM MANAGEMENT

10.1 Annual Work Cycle

This chapter outlines and describes how the stream maintenance program will be implemented and administered by the Napa County Flood Control and Water Conservation District (District). The management and operation of the maintenance program occurs as an annual cycle of activities described in this chapter as the "work cycle." The components of the maintenance work cycle are shown in **Figure 10-1** and described in the sections below.

The work cycle begins with the program-wide stream reconnaissance and assessment. The stream assessment process guides the development of that year's workplan. Projects such as vegetation maintenance, downed tree management, localized sediment removal at culvert crossings, or minor bank repairs represent the large majority of maintenance projects conducted by the District. All maintenance activities utilize the appropriate programmatic impact avoidance, minimization, and mitigation programs outlined in this manual.

Stream reconnaissance and assessment begins in the early spring with the development of the project workplan later in the spring. Project descriptions are then developed, and project planning occurs through June. The relevant regulatory agencies are notified of the year's projects in late spring and provided information on project locations, activities, surveys, and any other key issues. Projects are then implemented during the summer season with follow up annual reporting activities occurring in the fall.

The District administers and oversees the maintenance program throughout all steps of the work cycle. It is recognized that a successful program is based on continuous management and oversight. The District has appointed a stream maintenance manager whose central responsibility is to supervise and guide the program. A key responsibility for the Manager is to provide communication and coordination between District and the relevant regulatory agencies throughout all steps of the work cycle. The Program will be administered consistently with the goals, principles, and activities as described in this manual. In addition to the annual work cycle, every five years the Program will be reviewed for its overall effectiveness and adequacy.

Another key element to supporting an effective stream maintenance program is to establish and maintain a comprehensive data management system. Data management is required throughout the maintenance work cycle from organizing the initial stream assessment and inventory, to charting reach conditions and project requirements, to providing post project monitoring and reporting. Data collection and management for the Program is described below in Section 10.8.

10.2 Stream Reconnaissance and Assessment

In the early spring around April, a reconnaissance of the District-maintained channels is conducted on a reach-by-reach basis to assess potential maintenance needs. The reconnaissance includes a field assessment of maintenance needs in District-owned, County-owned, and other publically owned channels (as shown in the Chapter 1 maps).

Conditions in privately owned channels are assessed on an as-needed basis. As described in Chapter 1, Section 1.3, maintenance activities in privately owned channels occur less frequently and typically follow specific landowner requests. When requested or planned, maintenance activities are included in the annual workplan along with other program maintenance activities.

District staff familiar with the guidelines and principles of the program conduct the stream channel assessments. The assessment process evaluates the need for maintenance and follows the guidance and maintenance principles described in Chapter 3. During the survey, the channel characterization sheets (provided in Chapter 2) are referenced in the field, reviewed for their accuracy, and updated as appropriate. The channel characterization sheets will also be updated to include an appraisal of underlying causes for the maintenance situation. The stream assessment process is also supported by information provided by Geographic Information System (GIS) mapping, aerial photography, and the District's stream maintenance data management system. The data management system is accessed during the stream assessment process to query past maintenance activities, identify specific resource conditions, and prioritize maintenance activities by reach to develop the year's workplan.

For each reach, the District completes an assessment checklist. Photographs are also taken of each reach and archived in the maintenance database (see data management discussion below in Section 10.8). The information documented in the checklist is then entered into the maintenance database where a report can be generated for the creek assessed. A sample assessment checklist report is shown in **Figure 10-2**. Site conditions and resources are assessed in terms of the potential need for vegetation management, bank stabilization, and sediment removal. Channel vegetation conditions are assessed for the presence of cattails, blackberries, willows, exotics, etc. and the need for vegetation removal or management to prevent flooding.

As shown in the sample assessment report, assessment categories receive rankings ranging from high priority to low priority. The maintenance prioritization is initially identified based on the site assessment. The prioritization is further refined as part of the planning process described in Section 10.3 below. High priority sites indicate that maintenance may be needed that year, whereas low priority sites may not require immediate maintenance. Based on the field reconnaissance, review of the channel characterization sheets, completion of the reach assessment checklist, and subsequent prioritization using the maintenance database, an initial list of reaches requiring maintenance for the current work cycle is compiled. Based on past experience, in a typical year, approximately 10-15 sites (out of 21 total reaches in the Program Area) may be identified as potential candidates for maintenance activities through the assessment process.

10.3 Work Planning

The preliminary list of project sites developed during the reconnaissance process is reviewed and further prioritized based on:

- guidance provided by Maintenance Principles (Chapter 3);
- the relative severity of reach conditions and need for maintenance;
- Program considerations, management goals, and management triggers, as described under the corresponding approaches in Chapters 3 through 8;
- consideration of past/recent flooding conditions; and
- overall maintenance needs in the Program Area.

Following this prioritization, the stream maintenance manager may consolidate the list of potential projects into a smaller set of projects to serve as the workplan for the given year. The number of projects prioritized in any given year is dependent on several factors, most notably climatic conditions of the preceding years. Projects marked as low priority and not included in the current cycle's workplan are noted for inspection and reassessment during the next work cycle.

The following list provides an estimated range and number of project types anticipated to be conducted annually. However, actual maintenance needs in any given year are largely dictated by climate conditions in the given year or recent years. It is expected that annual work plans may include:

- an average of 1,000 linear feet vegetation management at multiple reaches on an ongoing, annual basis
- up to 5 bank stabilization projects per year,
- 2-5 localized sediment removal projects at culverts and crossings per year,
- 2 instream habitat enhancement projects per year,
- 2-5 gravel augmentation projects per year, and
- Numerous downed tree management actions which would be recorded and reported in the annual post-maintenance report.

Maintenance activities are expected to generate from 20 to 200 cubic yards of sediment and debris per year. Sediment is disposed at the Edgerly Island Disposal Site or the Napa Sanitation District Imola Site and debris is taken to local landfills (as described in Chapter 7).

10.4 Project Description

A brief project description is developed to describe the maintenance activities proposed for the year. The project description includes an evaluation of the maintenance sites in context with the surrounding drainage area and identifies maintenance needs and impact avoidance measures.

Identify Site Context

Site maintenance begins with considering the reach setting and context, as discussed in Chapter 3. Relevant site information to be reviewed (as available) includes reach descriptive sheets, reach assessment database entries, channel engineering designs and as-built designs, the most recent channel cross section surveys, hydraulics and flow capacity conditions, and information on environmental resources and adjacent land uses. If necessary, these existing data sources are updated, or data gaps completed as needed. For example, reach sheets are updated based on current conditions of the site, maintenance work from the previous year, and any changes in occurrence data for special-status species.

To further guide the maintenance process, reach- and site-based constraints are identified. For example, site- or reach-scale constraints such as a narrow corridor width, the presence of infrastructure like pipelines or road crossings, the presence of threatened or endangered species, or the existing channel already being in a degraded or incised condition could all influence the maintenance approach and which treatments to use. Site and reach constraints may also influence the need for special access or equipment that may differ from the approaches described in this manual. If site constraints and environmental considerations result in the need to use equipment or approaches other than those described in the manual, a detailed description of the necessary approach is included in the project description and discussed with regulatory agency staff during the notification process (see Chapter 11 for more detail on the regulatory compliance process).

The stream maintenance manager uses all relevant information including the observed field conditions, understanding of sediment and reach processes, results of channel cross section surveys, hydraulic analysis (as available), and the consideration of site constraints to develop an appropriate approach for maintenance activities.

Identify Treatments and BMPs

Treatment approaches are identified based on the site conditions, the key fluvial process, and other influencing constraints. Vegetation management projects, including downed tree maintenance, are designed to remove enough vegetation to provide necessary flood control while maintaining as much habitat and creek shading as possible. Bank stabilization projects utilize bioengineered treatments that respond to the cause and degree of the bank failure to develop a sustainable design.

Following the identification of the treatment approach, activity-specific Best Management Practices (BMPs) are identified based on the practices listed in Table 3-1. For example, tree

trimming activities may be required to occur outside the migratory bird and raptor nesting period. All projects will utilize appropriate program-wide BMPs for impact avoidance and minimization as identified in Chapter 3 and Table 3-1.

Develop Project Description

Following the analysis of site context and the development of treatment designs, a summary project description will be developed for each maintenance project. The project description serves as the formal characterization of project activities and supports permitting requirements. The project description will include the following information:

- Project type (i.e., vegetation management, downed tree management, sediment removal, bank stabilization, or other minor maintenance)
- Project location address and/or location description
- Project site map
- Updated channel characterization sheet for project reach (as needed)
- Short description of activities including treatments selected, equipment used, access, staging, etc. If activities will be conducted differently from the activity description in the Manual, identify differences and provide an explanation of why the different approach is required.
- Short description of why the selected treatment is appropriate for the reach.
- Length (linear feet) and area (acres) of creek channel that will be disturbed by activities.
- For vegetation management projects, identify the extent of invasive species control and native species management will be conducted.
- For bank stabilization projects, identify how much fill material (including vegetation fill materials) will be placed in the bank slope
- For sediment removal projects, identify quantity (cubic yards) of sediment to be removed and provide cross section of existing channel condition vs. as-built condition
- For all projects, identify how much (cubic yards) sediment and other debris requires disposal and identify the disposal location
- Any appropriate figures including cross sections, design details of structures to be maintained, and plan view maps for activities as appropriate.
- A brief summary of the activity-specific BMPs to be implemented with the project.

10.5 Agency Notification

By June 15th of each year, the District notifies the relevant regulatory agencies of the planned projects for that year's maintenance workplan (see Figure 10-1) through submittal of a workplan notification packet. The notification packet will contain the workplan, project descriptions, sediment disposal plan, and supporting materials described above.

The notification packet may include details of any planned maintenance activities that deviate from the description of routine activities as described in this manual. Any deviations from standard routine maintenance methods will be described in detail along with any relevant impact avoidance measures, BMPs, or mitigation considerations necessary to minimize environmental impacts. Similarly, if during implementation of maintenance activities, an issue arises that requires a different treatment or approach than described in the notification package, the stream maintenance manager will send an updated notification to the relevant agencies with this project change.

The annual workplan must be approved by the relevant regulatory agencies as described in the project permits. If requested, the District will host a tour of the identified maintenance sites. The regulatory agencies have 30-days to review the notification packets. Agency confirmation of the annual workplan and approvals to proceed with maintenance are commonly received before July 15th.

10.6 Project Implementation

Once the District receives a notice to proceed from the relevant regulatory agencies, maintenance activities may be initiated. If the District does not receive a response to the notification packet by July 15th, the District will assume that the workplan was reviewed and will proceed with initiating the planned maintenance work. All maintenance activities will be conducted in accordance with the project description, program wide and activity-specific BMPs, and terms of the maintenance permits. This includes conducting preconstruction surveys for fish and wildlife and other resources, if activities may affect these resources.

An on-site project supervisor trained in the maintenance manual will oversee and guide all maintenance activities and ensure that the proper maintenance principles and avoidance and minimization approaches as described in Chapter 3 are employed.

When projects are implemented, data will be collected at the project site prior to, during, and immediately after, project implementation, or as required by regulatory permits. Data collected may include: before, during, and after photos; quantification of material removed (for sediment removal projects) or placed (for bank stabilization projects); length and area of vegetation maintenance activities (herbicide application, tree trimming, native plantings); sensitive species or other resources encountered at the site during preconstruction surveys or during project implementation; and any additional information as required to update the maintenance database. Monitoring data will be collected within seven working days of final maintenance activities.

10.7 Annual Reporting

At the conclusion of the maintenance season (after October 31st and before January 31st), the District will send the relevant regulatory agencies a summary report describing the workplan status and confirming which projects from the workplan were completed. The report will include the following information and will comply with permitting requirements issued by relevant regulatory agencies.

- The extent to which the workplan was completed during the maintenance season (i.e., identify projects that were or were not implemented). If projects were not implemented, note why and if the project will be incorporated into the next year's workplan or if the project will be placed on a watch list.
- If activities were conducted according to the project description, and if not, how the actual project varied from the project description.
- Site photos before and after project completion.
- Total length of stream channel that was maintained for the individual projects in the workplan.
- How much sediment and vegetation was removed and acres affected, if applicable.
- The extent of invasive species controls implemented, including the quantity of herbicides applied.
- How much material was placed on-site and acres affected, if applicable such as for bank stabilization projects.
- How much material was disposed off-site, disposal locations, and acres affected, if applicable.
- If any species or other sensitive resources were encountered during construction and if so, what impact avoidance steps the District took in response.
- A brief description of site monitoring, including bank stabilization and revegetation monitoring.
- Any lessons learned from that year's activities including treatments that were not effective, administrative difficulties, and proposed steps to facilitate the process.
- Recommended updates (if any) to the program BMPs.

At the conclusion of the annual work cycle, the District shall also update and verify the maintenance database, and the BMP list (Table 3-1) as appropriate to include any updates or changes made over the recent work cycle. In this way, developing the next year's workplan will be built on updated information across the program.

10.8 Data Collection and Management

Data collection and monitoring efforts are critical to measuring the success of program implementation. The District currently maintains an extensive GIS database which includes location data on stream channels managed under their authority. The majority of the maps included in this Manual were generated from the District's GIS database. The District also maintains a Microsoft Access® database for tracking stream maintenance activities that is linked to the District's existing GIS database so that data, such as new species occurrences, are mapped and compared against maintenance activities. To properly track the progress of management activities towards achieving the maintenance program's goals and compliance with programmatic permit conditions, these databases will be upgraded or revised as the stream maintenance program adapts to best meet the stream maintenance goals. The following data are collected or updated at various stages in the implementation process:

- GIS reach mapping
- maintenance activities to date
- BMP tracking
- pre- and post-project photos
- channel characterizations
- invasive species
- channel cross sections (if necessary)
- specific data required by permits (if necessary)
- notification packages
- annual reports

Data or documentation of the maintenance projects are entered into the database during each cycle of the work plan, as described in Section 10.1 above. The database can be queried to chronicle past maintenance activities or prioritize future actions. The maintenance database is an important tool for the stream maintenance manager. The database contains back-up technical information to compile the agency notification packages and annual reports. The database will include checklists to ensure all conditions of programmatic permits are met. As described in the BMPs in Table 3-1 and in Chapter 11, program implementation requires tracking of important items or tasks to protect sensitive species and for permit compliance, such as pre-construction survey dates. The database will ensure this information is gathered, used, and documented to meet permit compliance. The regulatory agencies will receive necessary information on maintenance activities (based on the permit requirements and the description of activities in this manual). Information saved in the database will also provide insight into future Manual updates, as discussed in Section 10.9 below.

Data Collection to Develop Channel Maintenance Objectives

As described above in several locations of this Manual, an improved understanding of channel conditions, including causal factors for maintenance, flow capacity objectives, and vegetation maintenance objectives for specific channel reaches will help target the District's maintenance efforts. Such information will assist the District in providing a more consistent standard by which to assess and prioritize maintenance activities.

1. Develop Channel Capacity and Vegetation Objectives Methodology

   The District will develop a methodology by which to assess District owned and maintained reaches for their flow capacity objective and vegetation target condition. Flow capacity objective refers to a desired channel area capacity that the channel would be maintained for, in order to convey a certain discharge (or range of discharges). The reduction in available channel capacity due to vegetation growth, debris, or sediment accumulation below the target capacity objective may then require maintenance to restore the desired capacity objective. The methodology to develop the channel capacity objective will consider channel geometry conditions, the observed flow record (or estimated flow condition), history of past flooding (as available), history and cause of past maintenance activities, and other factors.

   Vegetation target condition is related to the capacity objective but concentrates on the target vegetation structure, density, and composition in the channel.

   The District will develop a protocol or methodology to assess channel capacity and vegetation objectives for the engineered flood control channels for which it owns and maintains over the course of two maintenance seasons. During the first maintenance season a draft approach will be developed and field tested. The draft approach will be provided to the RWQCB for review and comment. A revised draft approach will be tested during a second maintenance season to refine and finalize the methodology.

2. Assess Channels to Develop Channel Capacity and Vegetation Objectives

   Using the revised channel capacity and vegetation objectives methodology as described above in (1), the District will then apply the methodology to the engineered flood control channels for which it owns and maintains to develop the objectives. Channel capacity and vegetation objectives will be developed for specific channel reaches. It is anticipated that it will require 3-5 years to develop these objectives for the District channels, following the development of the methodology. The District will focus channel capacity and vegetation objectives data collection on the following streams in order of highest priority to lowest: Salvador, Tulocay, Camille, Yountville Outfall, Fagan, Sheehy, and Conn.

3. Augment Existing Streamflow Data Collection

   As described throughout this Manual, understanding the record of streamflows on maintained creeks is a valuable tool to help guide stream maintenance. The Napa Valley Regional Rainfall and Stream Monitoring Program maintains a network of several

stream gages in Napa County. A few of these gages (approximately 5) directly calculate stream discharge values in real time. (http://napa.onerain.com/home.php)
More often, the gages record stream elevation (stage), which can be used to then calculate discharge if a stage/discharge relationship exists.

While this existing gage network is a valuable resource throughout the County, there are only a few creeks within the District's Stream Maintenance Program area that are included in the existing network, these include Salvador Creek at Big Ranch Road and at Hopper Creek at Highway 29 (near the Yountville Collector channel).

To augment this existing flow record and to build a more focused flow record for District maintained channels, the District will undertake the following tasks:

- Identify key locations along District creeks where water surface elevation (creek height or stage) will be representative and indicative of the general flow conditions in the reach. Sites with stable cross-sections are preferred. These sites will be referred to as "flow measuring sites" below.
- At or near the identified flow measuring sites, District will survey a benchmark, or collect available elevation information from an existing benchmark, to develop an elevational datum for flow measuring sites.
- During significant flow events, when streamflows are elevated, District staff shall observe and record flow levels throughout the District owned and maintained channels. When possible, District staff shall take a field estimate of flow velocities across the channel cross-section. District will attempt to collect two flow measurements annually from reaches in District owned and maintained channels.
- At representative stations (not during elevated streamflow events), District staff will collect channel geometry, roughness, and other information so as to calculate discharge values from previously taken stage and velocity measurements at flow measuring sites.
- Over time, as enough data are collected, the District will seek to develop stage-discharge relationships for certain channel reaches. Existing stream gage data can be used for comparison, and as a basis for checking flow estimates.
- District collected stage and discharge information used together with the channel objective information developed in (2) above will be used to inform District maintenance needs.

4. Update Channel Characterization Sheets to Incorporate Causal Factors

As maintenance occurs, the District will update the channel characterization sheets provided in Chapter 2 of this manual to accurately portray current conditions, as well as, log past or recent maintenance activities. Additionally, the District will add a description of the factors that are causing the need for maintenance at the specific reach.

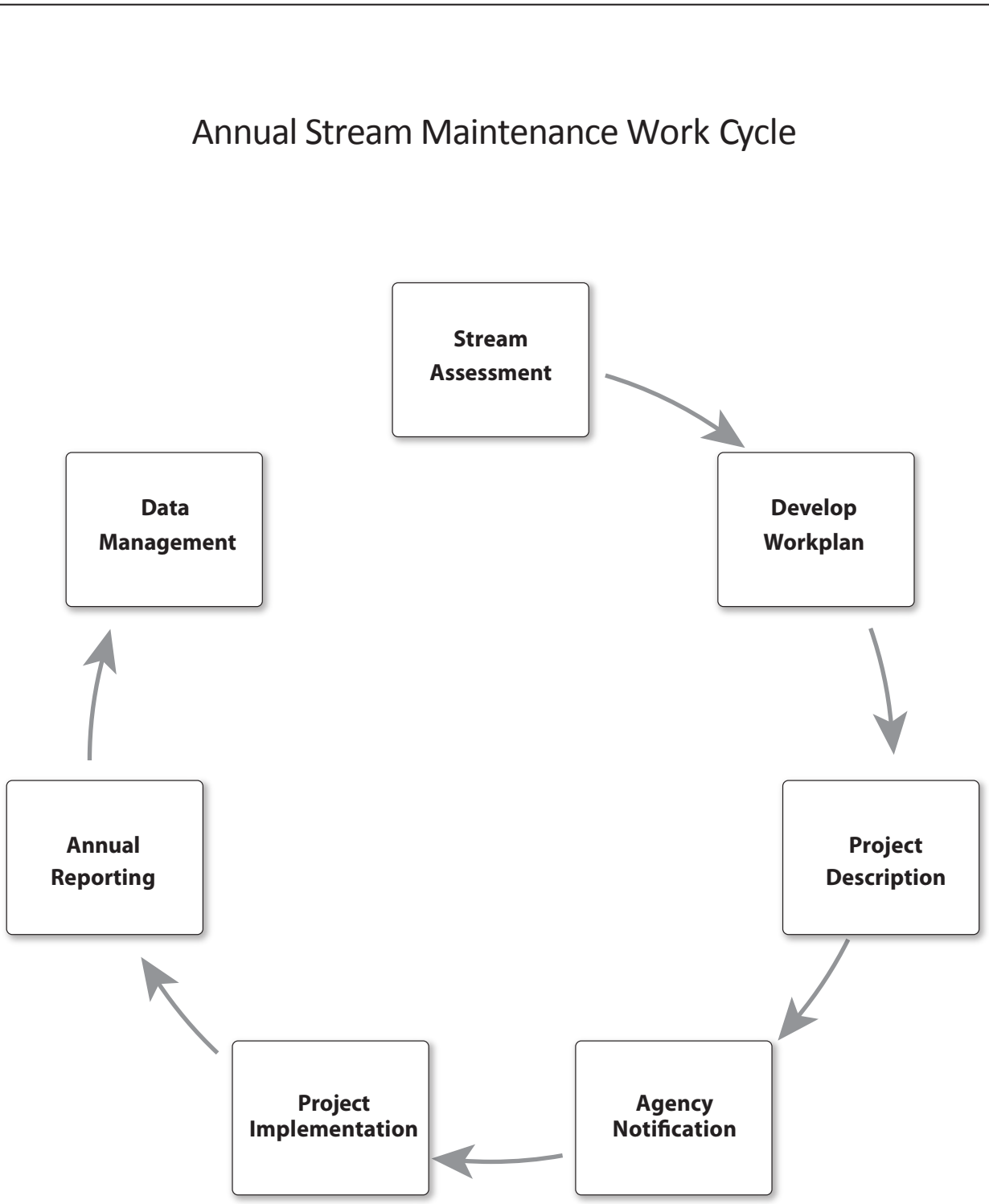
Maintenance causes may vary in both time and space. Spatially – causes that drive maintenance may be diffuse (systemic) throughout the watershed (as in non-point source fine sediment generation), or more specifically located (endemic, as in a local landslide or bank failure that leads to higher sediment yield downstream). Temporally, some causes for maintenance may occur over several decades (channel adjustments following change in stream alignment due to channel modification) or may be more near term (rapid growth of invasive species).

District staff will attempt to describe underlying causes for conditions that require maintenance as a way to target the most appropriate maintenance approaches. The solutions for some causes may be better addressed through non-maintenance activities such as restorative land-use changes or restorative stream channel actions. Such activities are beyond the scope of this Manual, but may be very beneficial.

10.9 Five-Year Program Review

Every 5 years, the District and the relevant regulatory agencies will review the stream maintenance program for its overall effectiveness. This review will include an assessment of maintenance activities conducted to date, BMPs employed, data management, adequacy of adaptive updates and revisions to the manual, and overall program coordination and communication between the District and the regulatory agencies.

The stream maintenance manager will collect and organize the above review information and provide a summary report to the regulatory agencies. These findings will be discussed with regulatory agencies as part of the permit renewal process. As a result of these discussions, potential program changes or updates shall be integrated into the Manual through an addendum or revision process. The updated Manual will be redistributed to regulatory agencies and program partners. Program changes or updates made at the 5-year reviews may require additional California Environmental Quality Act (CEQA) review. Manual revisions may also require an updating of permit terms, which would occur through a collaborative process between the District and the relevant permitting agencies.



Horizon WATER and ENVIRONMENT

Figure 10-1
Annual Work Cycle

Stream/Channel Assessment Report

Browns Valley Creek

Date 5/28/2009 **Survey Time (hr)** 3.00 **Surveyor** Sauer, Chris **Type** Routine **Survey ID** **1243552259**

Upstream Location Borette Ave. tee, **Downstream Location** Thompson Ave

Comments BV Creek had quite a lot of problems that have occurred and need to be addressed.

WP	Problem Category	Bank	Observations	Recommendation	Priority	Crew Time (hr)
100	Encroachment	Left	6'to8' wide path has been cut into bank from top of bank down to the creek bed.	Send letter. Notify Fish and Game.	Medium	
101	Dumping	Left	10'x30' pile of garden debris has been dumped down the creek bank and to the creek bed.	Send educational letter	Low	
102	LWD	Right	1'x30' log is lying on creek bank and down into the creek bed.	Remove if there is time.	Medium	2.0
103	Dumping	Right	15'x20' pile of garden debris has been dumped down the bank and into the creek bed.	Send educational letter		
104	Bank Erosion	Right	Vertical wall, 15' hi x 70' long has just fallen over and into the creek bed. Has left eroding bank behind.	Notify property owner re. County Bank Repair Program	Low	
321	Bank Erosion	Right	Gabion basket wall has had the bottom basket rust out and has lost all the stones from the basket. The toe of this wall is now destabilized and the entire wall is in danger of falling apart.	Send letter to property owner re: the County Bank Repair Program.	High	
322	Other	Center	Bridge culvert is filling with gravel, has filled perhaps one quarter of its capacity.	Monitor	Medium	
325	LWD	Right	8"x20' broken branch is lying across the creek and is propped 2' over the creek bed. It could catch debris and create a jam.	Remove from center of creek and move to the side of creek.	High	1.0

Source: NCFCWCD 2009.

Horizon WATER and ENVIRONMENT

Figure 10-2
Example Stream Assessment Report

Napa County Flood Control and Water Conservation District
Watershed Maintenance

Creek Survey Form

Survey #: _____ **Date:**_____ **Time Start:** _____ **Time End:** _____

Survey Type: ☐ Routine ☐ Public Request **Request ID#:** _____

Stream/Channel Name:_____

Upstream Location (Required if surveying a reach of stream/channel):

WP:_____ Lat: 38._____ Long: -122._____

Description:_____

Downstream Location (Required if surveying a reach of stream/channel):

WP:_____ Lat: 38._____ Long: -122._____

Description:_____

Survey Notes: _____

WP: **Location:**	
Problem: ☐ SWD ☐ LWD ☐ Channel Growth ☐ Bank Erosion ☐ Dumping ☐ Encroachment ☐ Non-native Invasive Species ☐ Other	**Position:** ☐ Left Bank ☐ Right Bank ☐ Center (downstream) **Priority:** ☐ High ☐ Medium ☐ Low **Photos:**
Access:	
Nature of the problem/threat and habitat value:	
Recommendations: **Requires Prior Approval from:** ☐ **DFG** ☐ **USFWS/NOAA** **Crew time required (person hours):**_____	

WP: **Location:**	
Problem: ☐ SWD ☐ LWD ☐ Channel Growth ☐ Bank Erosion ☐ Dumping ☐ Encroachment ☐ Non-native Invasive Species ☐ Other	**Position:** ☐ Left Bank ☐ Right Bank ☐ Center (downstream) **Priority:** ☐ High ☐ Medium ☐ Low **Photos:**
Access:	
Nature of the problem/threat and habitat value:	
Recommendations: **Requires Prior Approval from:** ☐ **DFG** ☐ **USFWS/NOAA** **Crew time required (person hours):**_____	

Napa County Flood Control and Water Conservation District
Watershed Maintenance

Creek Survey Form

WP: **Location:**

Problem: ☐ SWD ☐ LWD ☐ Channel Growth ☐ Bank Erosion ☐ Dumping ☐ Encroachment ☐ Non-native Invasive Species ☐ Other

Position: ☐ Left Bank ☐ Right Bank ☐ Center (downstream)

Priority: ☐ High ☐ Medium ☐ Low

Photos:

Access:

Nature of the problem/threat and habitat value:

Recommendations:

Requires Prior Approval from: ☐ **DFG** ☐ **USFWS/NOAA** **Crew time required (person hours):_______**

WP: **Location:**

Problem: ☐ SWD ☐ LWD ☐ Channel Growth ☐ Bank Erosion ☐ Dumping ☐ Encroachment ☐ Non-native Invasive Species ☐ Other

Position: ☐ Left Bank ☐ Right Bank ☐ Center (downstream)

Priority: ☐ High ☐ Medium ☐ Low

Photos:

Access:

Nature of the problem/threat and habitat value:

Recommendations:

Requires Prior Approval from: ☐ **DFG** ☐ **USFWS/NOAA** **Crew time required (person hours):_______**

WP: **Location:**

Problem: ☐ SWD ☐ LWD ☐ Channel Growth ☐ Bank Erosion ☐ Dumping ☐ Encroachment ☐ Non-native Invasive Species ☐ Other

Position: ☐ Left Bank ☐ Right Bank ☐ Center (downstream)

Priority: ☐ High ☐ Medium ☐ Low

Photos:

Access:

Nature of the problem/threat and habitat value:

Recommendations:

Requires Prior Approval from: ☐ **DFG** ☐ **USFWS/NOAA** **Crew time required (person hours):_______**

Survey #: ______ LWD = logs ≥ 12” diameter and ≥6’ length or stumps with rootwads. Page ____ of ____

Chapter 11
REGULATORY COMPLIANCE

11.1 Overview

This chapter describes the principal federal and state environmental regulations and policies applicable to the District's maintenance activities. This chapter is not intended to provide an exhaustive review of environmental regulations. Rather, a summary overview of the directly applicable regulations is provided together with the District's compliance approach. Regulatory compliance is also described in Chapter 3 *Impact Avoidance and Minimization* and Chapter 10 *Program Management*.

Table 11-1 lists federal, state, and local regulations which are applicable to the District's stream maintenance activities.

Table 11-1: Summary of Regulations

Regulatory Agency	Law/Regulation	Purpose	Permit/Authorization Type
U.S. Army Corps of Engineers (USACE) – San Francisco District	Clean Water Act (CWA) Section 404	Regulates placement of dredged and fill materials into waters of the United States.	Individual/General Permit Nationwide Permits
	Rivers and Harbors Act Section 10	Regulates work in navigable waters of the U.S.	Section 10 Compliance
San Francisco Bay Regional Water Quality Control Board (Regional Board)	Clean Water Act Section 401	Water quality certification for placement of materials into waters of the United States.	401 Water Quality Certification is required for federal permits, including Nationwide Permits
	Clean Water Act Section 402	National Pollutant Discharge Elimination System (NPDES) program regulates discharges of pollutants.	- NPDES Municipal General Permit – Phase II - NPDES Aquatic Pesticides General Permits
	Clean Water Act Section 303	Recognition and remediation of impaired water bodies through establishment of Total Maximum Daily Loads (TMDLs) to track and reduce pollutants and restore beneficial uses.	Napa TMDLs - Sediment (adopted by Regional Board in 2009 and by the State Board in 2010; Awaiting Federal approvals) - Pathogens (approved by USEPA in 2006) - Nutrients (currently under development)

Regulatory Agency	Law/Regulation	Purpose	Permit/Authorization Type
	Porter-Cologne Water Quality Control Act	Regulates discharges of materials to land and protection of beneficial uses of waters of the State.	Waste Discharge Requirements (WDRs)
California Department of Fish and Game – Bay Delta Region (CDFG)	Fish and Game Code Section 1600	Applies to activities that will substantially modify a river, steam or lake. The Agreement includes reasonable conditions necessary to protect those resources.	Routine maintenance activities are covered under a Routine Maintenance Agreement (RMA)
	CESA (F&G Code Section 2081[b])	CESA compliance: Consistency determination with USFWS/NMFS Biological Opinions	
U.S. Fish and Wildlife Service (USFWS) NOAA-NMFS	ESA	USACE must consult with USFWS and NMFS if threatened or endangered species may be affected by the project.	In most cases, Biological Opinions are issued.
State Historic Preservation Officer	NHPA Section 106	USACE must consult with SHPO if historic properties or prehistoric archaeological sites may be affected by the project.	In most cases, Programmatic Agreements or Memorandums of Agreement are prepared.

The permits and regulatory compliance requirements for the Maintenance Program are described below by permitting agency including the California Department of Fish and Game (CDFG), Regional Water Quality Control Board (RWQCB or Regional Board), U.S. Army Corps of Engineers (USACE), and others.

11.2 Department of Fish and Game

California Fish and Game Code Section 1602 - Streambed Alteration Agreement

In 2002 the District and CDFG entered into a Routine Maintenance Agreement (RMA) to provide permitting coverage and terms for the District's general maintenance activities. The 2002 RMA (Notification No. R3-2001-0610), as amended in 2007, provides guidance, terms, and conditions for the implementation of vegetation management and culvert maintenance activities, required impact avoidance and minimization approaches, and notification responsibilities. Key provisions of the RMA require:

- submittal of notification for proposed maintenance activities
- quarterly maintenance reports

- work window restrictions:
  - Dry Creek, Walsh Creek, and the Napa River: June 15 – October 31
  - All other creeks: April 15 – October 15
  - Debris removal immediately necessary to prevent flooding: Any time
  - Woody Debris Removal: March 1 – August 15, or after surveys do not identify nesting birds.
- Arundo removal restrictions
- No coverage for capture and relocation of California red-legged frog
- No trees greater than 4 inches dbh may be removed except with prior approval
- Replacement of culverts less than 12 inches in diameter

Additionally, the 2002 RMA does not provide regulatory coverage for sediment removal activities. The 2002 RMA was amended in 2007 for another 5-year period and expires on December 31, 2011. The amendment updated the District's list of maintenance activities and locations, methods for arundo and tamarisk removal, and application of herbicides to bank vegetation.

Through development of this maintenance manual the District and CDFG revised the 2002/2007 RMA to update the terms and conditions to be more applicable to the current maintenance program. Key additions and revisions to the 2012 RMA include:

While the District is the primary stream maintenance agency in the County, there are other channels throughout the county which are owned and maintained by other local landowners, incorporated towns, and cities. These entities maintain their stream channels under similar regulatory requirements as the District and likewise have to apply for and receive approval from regulatory agencies to conduct instream maintenance. For example, the Town of Yountville maintains channels within their jurisdiction under an RMA issued by CDFG on May 22, 2009 (Notification No. 1600-2008-0297-3). Yountville's Agreement covers vegetation maintenance, debris removal, minor sediment removal, and erosion control and bank stabilization activities.

11.3 Regional Water Quality Control Board

CWA Section 401 Water Quality Certification and Waste Discharge Requirements

The Regional Board issues water quality certifications and waste discharge requirements (WDRs) for stream maintenance projects. Water quality certifications are issued when a project occurs within the jurisdiction of waters of the U.S. and a CWA Section 404 permit is required from the U.S. Army Corps of Engineers (see Section 11.4 below.) Section 401 water quality certifications are issued by the Regional Boards to complete Section 404 permits, including the use of applicable Nationwide permits. In general, for stream maintenance projects, Section 404 permits authorized by the USACE are required when

maintenance work affects jurisdictional wetlands and/or occurs within or below the ordinary high water mark (OHWM[1]) along a stream course.

Waste discharge requirements (WDRs) are issued when the project occurs outside of federal jurisdiction, but occurs within Waters of the State under state jurisdiction. Waste discharge requirements are issued for discharges to land and waters of the state. For example, the Regional Board issues WDRs for disposal of sediment and vegetation removed from the channels as part of maintenance activities.

Through the development of this maintenance manual the District and San Francisco Bay Regional Board staff coordinated closely to develop appropriate permits to authorize the program. This included developing a template Section 401 certification permit for District use in conjunction with using USACE Nationwide permits for Section 404 coverage. The Regional Board also issued a programmatic WDR to provide the District with regulatory coverage for maintenance activities occurring within Waters of the State.

Clean Water Act Section 402 – NPDES Stormwater Program

All the incorporated and unincorporated areas within the Napa River watershed are covered under the *General Permit for the Discharge of Storm Water from Small Municipal Separate Storm Sewer Systems* WQO No. 2003-0005-DWQ (Small MS4 General Permit or Phase II Municipal General Permit), issued by the State Water Resources Control Board (SWRCB). The County of Napa, cities of American Canyon, Napa, St. Helena and Calistoga, and the Town of Yountville are each co-permittees of the general permit. These organizations partnered to form the Napa County Stormwater Pollution Prevention Program (NCSPPP). The NCSPPP is administered by the District's Stormwater Program Coordinator who ensures that all the NCSPPP partners develop, implement and enforce a stormwater management program to reduce pollutants. The Napa County Storm Water Management Plan (NCSWMP) provides for consistent methods to prevent stormwater pollution; protect and enhance water quality in creeks and wetlands; preserve beneficial uses of local waterways; and comply with state and federal regulations. These goals are met through development of annual action plans, adoption and enforcement of local ordinances, education and outreach efforts, monitoring, and other activities. Compliance efforts are documented in reports submitted to the SWRCB annually.

The SWRCB plans to reissue the Phase II Municipal General Permit in 2011. The new Phase II General Permit is anticipated to include additional and more stringent requirements for stormwater management efforts. Compliance with adopted TMDL pollutant reduction and monitoring requirements may be included as Phase II General Permit requirements for Napa County.

Implementation of the NCSWMP directly influences the quantity and quality of stormwater received in the channels maintained by the District. In turn, stream maintenance activities

[1] OHWM - Defined by USACE as that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of the soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas. The USACE is the final arbitrator in determining the OHWM.

described in this manual function to ensure compliance with NPDES permits through enhancement of riparian and in-channel features which filter storm runoff and improve water quality. Additionally, maintenance activities include trash and debris clearing and consistent implementation of maintenance BMPs throughout the watershed. Stream maintenance efforts will also assist with TMDL compliance requirements.

Clean Water Act Section 402 – NPDES Aquatic Pesticide Application Program

The *Statewide General NPDES Permit for the Discharge of Aquatic Pesticides for Aquatic Weed Control in Waters of the U.S.* (Water Quality Order 2004-0009-DWQ; General Permit No. CAG990005) or the NPDES Weed Control Permit was adopted in May 2004 and modified in June 2006. Pollutants associated with aquatic pesticide application that require coverage under this permit include over-applied or misdirected pesticide products and pesticide residues. Residues are any pesticide byproduct, or breakdown product, or pesticide product that is present after the use of the pesticide to kill or control the target weed. This permit addresses the application of 2,4-D, acrolein, copper, diquat, endothall, fluridone, glyphosate, imazapyr, sodium carbonate, peroxyhydrate and triclopyr based aquatic pesticides to surface waters for control of aquatic weeds.

Key requirements of the General Permit include the following.

- Compliance with the requirements of California Toxics Rule (40 CFR Part 131) and the state's Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (State Water Resources Control Board 2005).
- Compliance with other applicable receiving water limitations and with effluent limitations.
- The permittee must be licensed by the California Department of Pesticide Regulation or work under the supervision of someone who is licensed if the aquatic pesticide is considered a restricted material.
- Preparation of, and adherence to, an Aquatic Pesticide Application Plan.
- Compliance with specific monitoring and reporting requirements of the permit.
- Adherence to all label instructions and terms of any applicable use permits.
- Maintenance of a Pesticide Application Log.
- Compliance with Public Notice Requirements.

To obtain coverage under this General Permit, a discharger must submit a completed Notice of Intent (NOI), a vicinity map, and the first annual fee to the appropriate Regional Water Quality Control Board. These items constitute a complete application package, the submittal of which authorizes the discharge of pollutants associated with the application of aquatic pesticides in compliance with the General Permit.

In conducting stream maintenance, the District controls growth of invasive plants such as cattails, *Ludwigia*, pepperweed, *Arundo donax*, tamarisk, and scarlet sesbania by applying herbicides. As described above, application of herbicides directly to waters of the U.S. is regulated under the NPDES General Weed Control Permit. The District does not have coverage under this permit and thus does not conduct in-water herbicide applications. However, the

District may seek coverage under this permit in the future.

Application of pesticides to control invasive plants on stream banks above the OHWM and within the riparian corridor (i.e., outside of federal jurisdiction, but within state jurisdiction) are not regulated under the NPDES General Weed Control Permit. Application of pesticides within waters of the state is regulated by the Regional Boards. The regulatory compliance process is identified case-by-case.

Napa River Sediment TMDL and Sediment Reduction and Habitat Enhancement Plan

More than half of fine sediment delivered to Napa River during the 10-year period 1994 to 2004 was associated with land use activities, including roads, human-caused channel incision, vineyards, intensive historical livestock grazing, and urban stormwater runoff (San Francisco Bay Regional Water Quality Control Board 2009). Other key sources of fine sediment included instream channel erosion. Under the authority of Section 303 of the Clean Water Act, the Regional Board evaluated the effects of increased sediment on beneficial uses within the Napa River watershed. Based on the evaluation, the Regional Board established a TMDL to reduce sediment loading and established the Napa River Sediment Reduction and Habitat Enhancement Plan restore beneficial uses. The Regional Board adopted both plans in September 2009. The plans have not yet been approved by the SWRCB or the U.S. Environmental Protection Agency (USEPA). As such, they cannot be implemented or enforced by the Regional Board. However, the County strives to implement the sediment reduction and habitat enhancement goals while the approval process continues.

The goals of the Napa River Sediment Reduction and Habitat Enhancement Plan are to:

- Conserve the steelhead trout population
- Establish a self-sustaining Chinook salmon population
- Enhance the overall health of the native fish community
- Enhance the aesthetic and recreational values of the river and its tributaries

To achieve these goals, specific actions are needed to:

- Attain and maintain suitable gravel quality and diverse streambed topography in freshwater reaches of Napa River and its tributaries
- Protect and/or enhance base flows in tributaries and the mainstem of the Napa River
- Reduce the number and significance of human-made structures in channels that block or impede fish passage
- Maintain and/or decrease summer water temperatures in tributaries to the Napa River

The District's stream maintenance program directly supports the goals of the TMDL by reducing sediment loading and sediment storage in Napa County channels. As discussed in Chapter 7, the District repairs and stabilizes eroding streambanks which are a key sediment source for downstream sediment accumulation. Similarly, the District removes accumulated sediment and debris blockages which cause further sediment trapping and deposition (see Chapter 7). Additionally, as described in Chapters 5 and 9, retention and enhancement of large woody debris in the channels maintained under this program directly meets the habitat enhancement

goals of the TMDL. Specifically, the Habitat Enhancement Plan component of the TMDL Implementation Plan (as stated in the Basin Plan Amendment) identifies the following stressors, management objectives, and actions:

Table 5-1 (of Basin Plan Amendment): Recommended Actions to Reduce Sediment Load and Enhance Habitat Complexity in Napa River and its Tributaries

Stressor	***Management Objectives***	***Actions***
Habitat degradation as a result of mainstem Napa River and lower reaches of its larger tributaries incising	▪ *Reduce rates of sediment delivery (associated with incision and accelerated bank erosion) to channels, by 50 percent.* ▪ *Enhance channel habitat as needed to support self-sustaining run of Chinook salmon and enhance the overall health of the native fish community.*	*1.1 Develop and implement plans to enhance stream-riparian habitat conditions, and reduce fine sediment supply in the mainstem Napa River and lower tributary reaches*
Habitat degradation as a result of reduction in large woody debris in stream channels	*Enhance quality of rearing habitat for juvenile salmonids*	*1.2 Develop and implement performance standards for protection of ecologically significant large woody debris in stream channels*

Table 5.4 (of Basin Plan Amendment): Recommended Actions to Protect and/or Enhance Stream Temperature

Stressor	***Management Objectives***	***Actions***
Stressful summer water temperatures in tributaries	*Enhance amount of ecologically significant large woody debris in channels*	*See Table 5.1*
	Enhance potential shade along riparian corridors	*4.3 Implement management actions to accelerate recovery of native riparian tree species*

The stream maintenance manual directly implements TMDL Actions 1.1, 1.2, and 4.3 identified as part of the Habitat Enhancement Plan. Vegetation management and habitat enhancement activities (described in Chapters 4 and 9, respectively) include planting and management of native riparian tree species. Stream maintenance activities seek to encourage development of a native riparian canopy over stream channels to reduce summer water temperatures. Downed tree management and LWD enhancement activities directly benefit instream complexity and salmonid habitat.

Through conducting the stream maintenance activities described in this manual, the District supports and enhances instream fish habitat as guided by the TMDL. Implementation of the maintenance BMPs provides for consistent management of stream channels and compliance with TMDL and NPDES requirements. Because the TMDL is not yet approved by the USEPA, the TMDL is not currently enforceable. However, it is anticipated that county compliance with the TMDL will be required in the new Phase II Municipal General Permit (as discussed previously).

11.4 Army Corps of Engineers

CWA Section 404 Nationwide Permits

Though infrequent, on occasion the District needs to conduct maintenance work below the ordinary high water mark (OHWM) of channels. These are areas within the Waters of the U.S. and fall within the jurisdiction of the U.S. Army Corps of Engineers (USACE). As described above in this manual, the district's maintenance work rarely involves extensive dredging or the placement of fill. However, critical sediment blockages or bank failures do need to be maintained and addressed. When work beneath OHWM is necessary, such as with bank stabilization or sediment removal projects, the District's maintenance activities are consistent with activities administered and permitted by the USACE's Nationwide Permit Program. More specifically, Nationwide Permits 3 (maintenance), 13 (bank stabilization), 18 (minor discharges), 19 (minor dredging), 27 (aquatic habitat restoration, establishment, and enhancement activities), and 43 (stormwater management facilities) are directly applicable to District activities and are utilized for stream maintenance activities.

The procedure for conducting activities under the Nationwide Permit Program generally involves submitting a preconstruction notification report or PCN to the USACE. The PCN must contain contact information for the permitted, location and description of the project, delineation of waters and wetlands, list of endangered or threatened species, and information on historic properties. The PCN is submitted to the USACE who then reviews and. If the USACE determines that minimal impacts would result from the project, they provide a written response whether the project can proceed under the terms and conditions of the Nationwide Permit. Approvals from the Regional Board, U.S. Fish and Wildlife Service, NOAA-NMFS, and State Historic Preservation Officer may be required in conjunction with using Nationwide permits.

If the District's maintenance activities in USACE jurisdiction becomes more frequent, it may be more appropriate for the District to conduct maintenance activities under a Regional General Permit. At that point, the District will conduct formal consultations with the USACE, and other agencies (described below) to obtain federal and state approvals for more frequent routine maintenance activities within waters of the U.S.

11.5 Other Agencies

U.S. Fish and Wildlife Service

If, as part of USACE permitting, it is determined that the maintenance project would have the potential to affect a threatened or endangered species or critical habitat, the USACE must comply with Section 7 of the Endangered Species Act (ESA), which requires consultation with the appropriate federal wildlife agency. The USACE will consult with the U.S. Fish and Wildlife Service (USFWS) either formally or informally to address the effects of the project to terrestrial species and their habitats. If necessary, a Biological Opinion with "incidental take" provisions will be distributed from USFWS to the USACE permit manager.

NOAA-National Marine Fisheries Service

For protected marine and aquatic fish species and habitat the USACE may need to consult with the National Marine Fisheries Service (NMFS). The federal consultation process between the USACE and NMFS is similar to the process described above for USFWS, whereby, NOAA-NMFS evaluates potential impacts on threatened and endangered fish species and their critical habitat.

State Historic Preservation Officer and Local Tribes

If during the federal permitting and review process, the USACE determines there is a potential to affect historic properties, compliance with Section 106 of the National Historic Preservation Act is required. Consultation under Section 106 may involve the State Historic Preservation Officer or Tribal Historic Preservation Officer as appropriate.

Chapter 12
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