LOWER ALHAMBRA CREEK WATERSHED MANAGEMENT PLAN

MARTINEZ, CALIFORNIA

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Submitted to:

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1.0 PLAN DEVELOPMENT

This plan has been developed by the City of Martinez to guide future maintenance, management, and enhancement of Alhambra Creek. It focuses on the reach of the creek in the downtown area of Martinez between Green Street and the Union Pacific Railroad tracks and refers to this reach as "Lower Alhambra Creek". The preparation of the plan has involved representatives of the Alhambra Watershed Council, Friends of Alhambra Creek, the California Native Plant Society, other community members and organizations, representatives of the City engineering and planning departments, California Department of Fish and Wildlife, and the San Francisco Bay Regional Water Quality Control Board (RWQCB). The plan was prepared in order to meet a regulatory requirement of the RWQCB to produce a community-based plan which would: (1) guide future flood management measures; (2) streamline future maintenance activities and permitting; (3) provide a transparent plan for both maintaining and enhancing the creek to prevent unintended conflicts between community groups enhancing the creek by planting new riparian vegetation and City crews maintaining riparian vegetation and flood capacity; and (4) provide community-based oversight of wildlife management, including beaver management.

This plan formalizes on-the-ground technical protocols to guide creek maintenance, management, and enhancement. The plan also provides a process for coordination among interested community groups, City representatives, and representatives of state agencies with oversight over creek resources and water quality on all future lower watershed management and habitat protection activities. Although this plan focuses on the watershed below Green Street, it is the appropriate approach for also addressing upstream flooding, sediment production, and other watershed management issues.

Development of this plan has created two opportunities for the City. The first is the compilation of previous plans and studies conducted on Alhambra Creek, including studies related to 1998 Intermodal Railroad and Wetland Improvements, Philip Williams Associates hydraulics reports from 2005-2008, and reports from the City-established flood management committee associated with the beaver management issue in 2008, all of which provides the City with data and information to make appropriate management decisions for the creek.

The second opportunity this plan presents is that it could serve as the basis for a City of Martinez Stream Management Plan adopted by regulatory agencies that addresses routine maintenance needs and actions to streamline permitting for routine maintenance.

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2.0 PART I – SEDIMENT REMOVAL PLAN

2.1 SITE AND SETTING

The Alhambra Creek Watershed is shown in Figure 1. Alhambra Creek drains a total area of approximately 16.5 square miles of the Coast Range foothills. The City Limits enclose approximately the lower 1/3 of this watershed. Rainfall runoff in Alhambra Creek originates in Briones, Alhambra Valley, and Franklin Canyon and flows along and adjacent to Alhambra Avenue, through downtown Martinez and the tidal wetlands by the Amtrak station and Waterfront Park and discharges to the Carquinez Strait. Franklin Creek, a major tributary of Alhambra Creek drains an area of about 5.2 square miles in Franklin Canyon. Franklin Creek joins Alhambra Creek about a half mile north of State Route 4. Upstream of the confluence with Franklin Creek, the upper reach of Alhambra Creek originates in the Briones Hills at an elevation of about 1,100 feet and drains an area of about 8.9 square miles. At the confluence, about 38% of the peak flows are generated in the Franklin Canyon subwatershed and about 62% originate in the upper reach of Alhambra Creek.

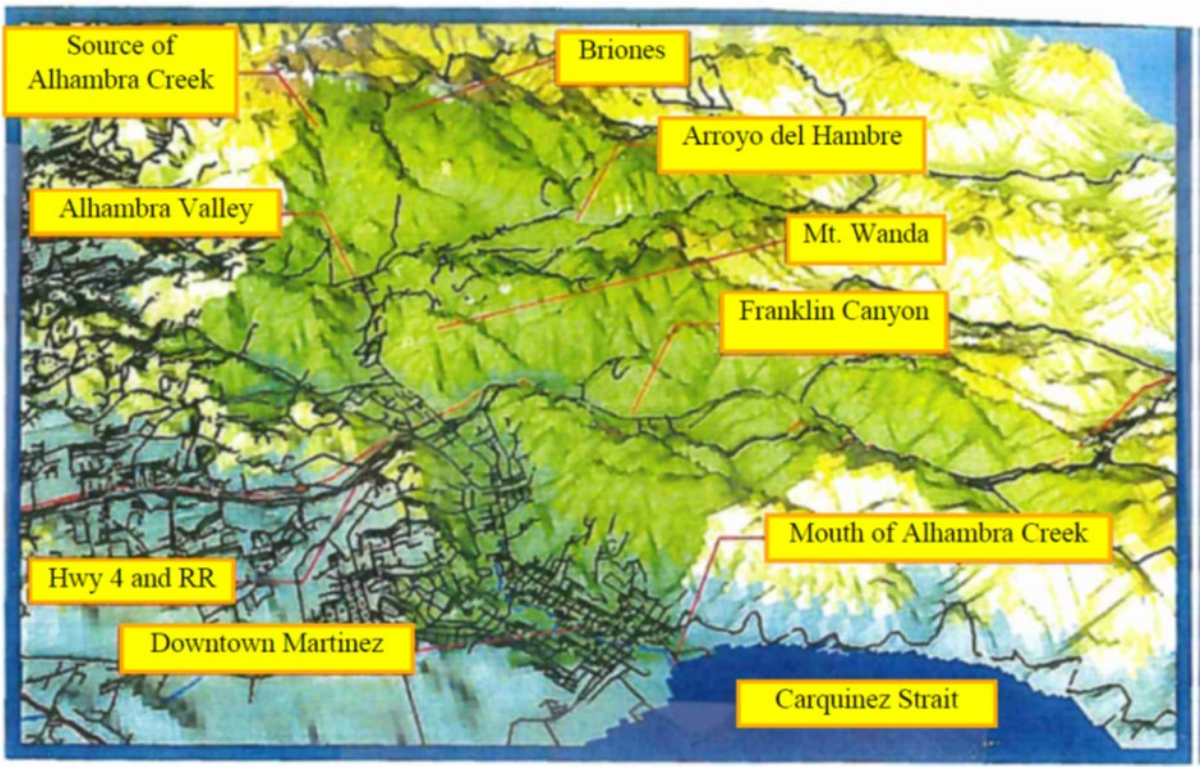

Figure 1: Alhambra Creek Watershed

Water in the creek travels about 8 miles north through the City of Martinez and discharges to the Carquinez Strait. Flows in Alhambra Creek are highly variable, ranging from low/no flow conditions in the late summer to bank full/flood conditions during moderate to intense storms in the rainy season. Alhambra Creek meanders through downtown Martinez, primarily in an open channel, passing beneath bridges at several locations. In general, the creek has incised the terrain over the

years; as the creek channel bottom has eroded over the years, bank failures have occurred. In response, creek-side landowners have implemented a variety of bank protection schemes with varying levels of success. In some areas, attempts to stabilize the banks have included placement of broken concrete, engineered riprap, sacked concrete riprap, concrete, wood retaining walls, Gunite, and rock-filled gabions. Areas of Alhambra Creek under this study are located between Ward Street and the UPRR tracks and are shown in the figures provided at the end of the report.

2.2 FLOODING HISTORY

2.2.1 Flood Hazard

Alhambra Creek has a history of flooding. Heavy rainfall produces runoff volumes that exceed the capacity of the channel, causing flooding in downtown Martinez. The lower portions of the City adjacent to the creek are also susceptible to inundation by coastal hazards, such as tsunamis, extreme high tides, or sea level rise. The most serious flooding has historically occurred when the peak storm flow coincides with high tides, typically in the spring. The "Alhambra Creek Watershed Management Plan, A User's Manual" prepared by the Alhambra Creek Watershed Planning Group, the First Edition of which was produced in April 2001, indicated the following regarding flooding in downtown Martinez:

> "*This section of the creek has a 2-year capacity and frequently floods. Sometimes the creek 'jumps its banks' upstream and runs down the streets parallel to the channel until it meets the creek again. This is what caused the standing wave at Castro and Main [Streets]. The floods typically last from a few hours to a day and are exacerbated by high tides and onshore winds. Typically, the water is 1 to 2 feet deep and leaves mud behind when it recedes."*[1]

A City sponsored flood reduction assessment district was constructed at the turn of the century (2000). The project provided for improvements in creek conveyance and capacity; however, several low-lying areas of the City within the Alhambra Creek Watershed are still located within the 100-year and 500-year special flood hazard zones, as mapped by the Federal Emergency Management Agency (FEMA). These areas, primarily found along the Alhambra Creek floodplain, which varies in width but averages about 1,000 feet, are still subject to flooding.

Reducing flood hazards can be achieved by increasing channel conveyance (e.g., providing a larger channel, reducing flow resistance) or by decreasing the amount of flow that the channel must convey. This latter approach can be accomplished by either storing rainfall-runoff in the upper watershed (using detention basins) or bypassing a portion of the flood flows around the channel. The first approach (increased conveyance) was accomplished through the downtown reach with projects implemented by the City that replaced the old railroad bridge with a longer span and expanded the channel width downstream of Green Street. The 1980 U.S. Army Corps of Engineers (USACE) study included an alternative that examined the benefits of possible locations for flood control reservoirs, but the plan was not pursued. In 2002, the Contra Costa County Flood Control and Water Conservation District (CCCFCD) approved construction of a detention basin near Pleasant

[1] The standing wave at Castro and Main streets described here occurred during a 1997 storm event.

Hill Road East and Nancy Boyd Park (LSA, 2004). Identifying other potential storage facilities within the watershed could help reduce flood hazards.

2.2.2 Hydrologic and Hydraulic Assessments

The 10 highest estimated peak flows are presented in Table A below. The four highest estimated peak flows are all between 2,200 and 2,379 cubic feet per second (cfs) at D Street. The December 30-31, 2005, storm resulted in peak flow of about 2,225 cfs which was like the 1997 and 1982 events. Estimated return periods for the 10 highest estimated flows in Alhambra Creek included in an analysis prepared by Phillip Williams Associates (PWA) are included in Table A.

Table A: Peak Flow and Return Period at the D Street Gaging Station

Water Year	Estimated Peak (cfs)	Return Period[1] (yrs)	Data Source
1958	2,379	11.1	Estimated from SPRR – PWA[2]
1997	2,235	10.1	D Street Gage – PWA[3]
2006	2,225	10.0	D Street Gage Measurement – PWA
1982	2,200	9.7	D Street Gage Measurement – USGS
1973	1,960	7.4	D Street Gage Measurement – USGS
1980	1,920	7.1	D Street Gage Measurement – USGS
1995	1,870	6.8	Estimated – PWA[4]
1986	1,840	6.3	D Street Gage Measurement – USGS
1963	1,794	6.1	Estimated – PWA[4]
1975	1,770	6.2	D Street Gage Measurement – USGS

[1] Return period based on results of HEC-FFA flood frequency analysis (PWA, 1997).
[2] Adjustment between SPRR estimate and D Street described in Alhambra Creek Flood Frequency Analysis (PWA, 1997).
[3] Estimated based on high water marks near the D Street Gage.
[4] Estimated based on measurements at Pinole and Walnut Creeks (1963) or Wildcat Creek (1995) (PWA, 1997.

In the past 60 years, numerous damaging flood events have occurred along Alhambra Creek. Since gaging in adjacent watersheds began in 1939, the highest estimated peak flow on Alhambra Creek was 2,379 cfs (at D Street) in 1958, and the resulting flood inundated about 420 acres in the vicinity of Martinez (LSA, 2004).

In 1980, the USACE estimated that the capacity of Alhambra Creek was limited to 500 cfs at the most constrained portion of the reach through the downtown area prior to the improvements implemented by the City. The USACE developed a flood frequency analysis based on data collected at the D Street gage between 1965 and 1978 and an estimate of peak flow from 1958 at the SPRR but did not include low peak flows from 1972 and 1976 (USACE, 1980).[2] Adding the 1958 peak flow and dropping low flows from 1972 and 1976 added a bias to the 1980 USACE flood frequency estimates, resulting in high estimates of peak discharge for each return period. In 1986, the CCCFCD utilized 22 years of data collected at the D Street gage between 1965 and 1986 to develop revised flood frequency estimates (CCC, 1986).

In 1997, PWA prepared a HEC-FFA flood frequency analysis to statistically estimate 10-year through 500-year peak flows based on a 59-year extended record that covered 1939 through 1997. The

[2] The railroad tracks by the train station were owned by the Southern Pacific Railroad (SPRR) at the time.

extended flood records included measured data from the D Street gage collected by the U.S. Geological Survey (USGS) between 1965 and 1986, estimates of peak flows from high water observations, and estimates of peak flows in Alhambra Creek based on transfer of information (measured peak flows in neighboring watersheds) (PWA, 1997). Results of the USACE, CCCFCD, and PWA flood frequency analyses are presented in Table B.

Table B: Peak Flow at Various Recurrence Intervals

Recurrence Interval (years)	PWA Study (at SPRR[1]) Peak Flow (cfs)	PWA Study (at D Street[2]) Peak Flow (cfs)	CCCFCD Study (at D Street[2]) Peak Flow (cfs)	USACE Study (at D Street[2]) Peak Flow (cfs)
500	7,146	6,610	NA	9,990
100	5,222	4,830	5,200	6,420
50	4,368	4,040	3,450	5,080
25	3,618	3,350	NA	NA
10	2,400	2,220	2,330	2,480
5	1,600	1,480	NA	1,580
2	634	586	NA	575

[1] Contributing watershed at SPRR Bridge = 16.5 square miles
[2] Contributing watershed at D Street = 15.1 square miles

Since the 1997 PWA analysis was based on a 58-year record, we rely on those results for design purposes along Alhambra Creek. The HEC-FFA analysis indicated that the 100-year peak flow for Alhambra Creek is 4,830 cfs at D Street and 5,222 cfs at the Union Pacific Railroad (UPRR), and the 10-year flow is 2,220 cfs at D Street and 2,400 cfs at the UPRR.

2.3 CAPITAL IMPROVEMENT PROJECT IMPACTS

Beginning in the mid-1990s, the City implemented several Capital Improvement Plan (CIP) projects aimed at reducing the frequency of flooding in the downtown area. These projects, which involved grant funding and property owner assessments are listed in Table C.

Table C: Alhambra Creek Downtown Martinez CIP Projects

Year	CIP Project Name
1998	Intermodal (Creek Widening from Marina Vista to UPRR)
1999	Alhambra Channel Improvements
2004	Trail Bridge
2005	Salt Marsh Enhancement
2008	Emergency Bank Stabilization Escobar to Marina Vista
2021	Bank Stabilization at Escobar Street Bridge

In March of 2007, PWA prepared a memorandum which studied the feasibility of constructing the Alhambra Creek Bypass Culvert previously considered by the USACE. That memorandum summarized the improvements in creek capacity in downtown Martinez as follows:

"The Downtown Improvement Project included widening the creek corridor, creating a floodplain bench, and widening a number of bridge crossings between Marina Vista and Green Street. At the intermodal facility, a wide marsh-plain bench was created adjacent to the low flow channel and the Southern Pacific Railroad bridge (SPRR) was replaced with a longer span [and] higher bridge deck. Finally, the Salt Marsh Enhancement project at Grainger's Wharf included widening the creek corridor, creating marsh plain benches adjacent to the channel, and providing a secondary outlet for discharge of high flows to the Carquinez Strait."

With regard to capacity, the March of 2007 PWA memorandum went on to say:

"Collectively, these projects have improved flood conveyance in Alhambra Creek from about the 2-year peak discharge to about the 8- to 10-year flood event. While these improvements have provided a dramatic decrease in flood hazards and damage, much of the city is still vulnerable to flooding during extreme rainfall-runoff events."

In summary, the implemented improvement projects in downtown Martinez, at the Intermodal Facility (train station), and at the Martinez Regional Shoreline (East Bay Regional Park District) were intended to increase the capacity of the channel from about a 2-year peak discharge to about an 8-to-10-year peak discharge (~1,900 to 2,100 cfs) between Green Street and Marina Vista Avenue, and to about a 100-year capacity between Marina Vista Avenue and the UPRR tracks.

The December 3—31, 2005, storm event provided a good test of the Alhambra Creek capacity with the then recently implemented improvement projects. Historically, an event of this size would have caused significant overbank flooding in Martinez. During the December 31, 2005 peak flow (10-year peak flow estimated at 2,225 cfs at D Street), Alhambra Creek experienced overbank flooding upstream of downtown Martinez with reports of out-of-bank flows at D Street, Brown Street, and in the vicinity of Alhambra Way. However, it appeared that the channel improvements downtown, at the Intermodal Facility, and at the Martinez Regional Shoreline were successful in preventing additional flooding within downtown Martinez. Floodwaters did reach downtown by conveyance of water along north/south streets including Berrellesa Street, Alhambra Avenue, and Castro Street. A portion of the floodwaters from Castro Street re-entered Alhambra Creek at the Main Street Plaza via Ward Street and at the end of Castro Street, at Marina Vista Avenue, where floodwaters flow directly into the creek. Floodwater flow resulted in the deposit of silt in downtown streets and businesses. Streets, businesses, and government buildings were impacted for a couple of days to a couple of weeks for silt clean-up.

Based on the results from the December 2005 storm, it is estimated that the capacity of the existing Alhambra Creek channel is about 2,000 cfs in the vicinity of D Street. Out of bank flows primarily originated at the D Street crossing. The May 17, 2007, PWA report recommended further research to determine whether the lack of capacity was due to the bridge or possibly two large trees just downstream of D Street.

Within downtown Martinez, the capacity is also dependent upon tidal conditions. HEC- RAS modeling indicates that the capacity within downtown should be about 2,160 (at the SPRR Bridge) with tidal conditions in Carquinez Strait at Mean High Higher Water.

2.4 MANAGEMENT ISSUES

Lower Alhambra Creek is a significant asset to downtown Martinez, providing opportunities for members of the public, property owners, businesses, and their clientele to benefit from the beauty and serenity of nature within the built environment. The merger of the built and natural environments, however, does not happen easily and creates several issues. For example, the accumulation of silt and vegetation overgrowth in the channel increases the risk of flooding and the resulting damage to adjacent property. Unmanaged removal of silt and vegetation, on the other hand, poses a threat to the ecology of the stream and may ultimately reduce the value of the natural assets of the creek and property values. Primary issues include the following:

2.4.1 Recurring Flooding

Prior to implementation of the first four Capital Improvement Projects listed above in Table C, Lower Alhambra Creek frequently flooded. The four projects alleviated flooding by increasing channel capacity:

- North of Marina Vista the channel now has 100-year storm capacity when silt free.
- Between Green Street and Marina Vista the channel now has 10-year storm capacity when silt free.

2.4.2 Upper Watershed Erosion

The upper watershed, particularly Briones, contains undeveloped highly erosive slopes. These slopes, which are primarily privately owned, produce the silts that are carried through natural creeks and drainages and storm drain facilities through downtown Martinez to the Carquinez Strait. Control of the generation of naturally occurring erosion on private property is difficult to accomplish. Much of the watershed is outside of the City limits. When opportunities for erosion control present themselves, the City should work cooperatively with the County to require property owners to incorporate silt reduction requirements through conservation measures in permits for any permitted improvements.

2.4.3 Siltation

There is very little development potential in the Alhambra Creek Watershed. Development only contributes a very minor amount of overall silt during rain events. Most of the silt deposited in the lower watershed originates from natural erosion in the upper undeveloped hillside areas. The 100-year and 10-year capacities of the creek are significantly reduced when silt accumulates. When the flow exceeds the creek banks, the uncontrolled stormwater may cause, and historically has caused, significant property damage. In addition, the removal of silt from the flooded streets requires a significant cleanup effort by City maintenance crews. Implementing silt reduction measures upstream, which include discouraging overgrazing, logging, clearing, burning and other activities which could reduce vegetation cover, as well as the construction of impermeable surfaces over permeable soil and geologic areas or the removal of permeable soils by extensive grading and scraping practices, over time, will help to reduce silt loading in Lower Alhambra Creek.

2.4.4 Beavers

Beaver management along Alhambra Creek must consider the recent history of how the City of Martinez succeeded in resolving difficult community issues caused by a beaver that appeared within the City limits in 2007. The beaver occupation of a City creek created a formative experience of resolving conflicts between City land use needs and aquatic wildlife protection. The process used to develop a community-approved plan for management of the beaver is what this plan recommends. The first step is to notify the public of the issue; develop the hydraulic information needed to establish whether there is an actual flood or erosion risk; thoroughly consider alternative actions if there are risks that need to be addressed, such as measures to lower beaver dam elevations; and adopt short- and long-term flood damage reduction measures in the creek and floodplain corridor. Contra Costa County Public Works Department recently adopted most of the features of this approach with a letter to state regulatory agencies (Appendix A).

The beaver in this 2007 instance occupied the creek between Escobar Street and the railroad station bridge and built a dam upstream of Marina Vista Avenue. The beaver became an immediate attraction in downtown Martinez and developed a public following. In the meantime, some property owners raised concern that the beaver dam could exacerbate the downtown flooding hazard. The initial response by the City was supported by a technical memorandum dated October 16, 2007 by PWA (Appendix A). City officials recommended extermination of the beaver because of feared potential flood and erosion hazards. Over 200 of the Martinez public became involved and several City committees were established to address the issues and opportunities the beaver presented. The committees ultimately recommended that the City not pursue depredation permits, but instead protect the beaver as a net benefit to the City. Although there was not technical consensus on the level of erosion hazard created by the beaver, the City responded with engineering conservatism and installed a stream bank sheet wall on the right bank. The newly formed citizen's organization Worth a Dam contacted a beaver management expert from Vermont, who recommended a solution to lower the level of the pond behind the beaver dam and increase channel capacity using a Castor Master™ pond leveler.

The City supported installing this pond leveling device and hired consulting engineers to conduct a hydraulic analysis on the options for managing the beaver and the beaver dam to address potential flood hazards. A subsequent analysis prepared by PWA, dated April 10, 2008 (Appendix A), indicated that if a pond leveler were to lower the beaver dam by 2 feet, the 10-year flood could almost be contained in the channel upstream of Escobar Street. The report found that the flood elevation is largely controlled by the downtown bridges, except that adding the beaver dam could affect a low point upstream of Escobar Street that could overflow at a 7-year event. The PWA model indicated that a 3-foot lowering of the dam would come close to adhering to the 10-year flood event protection objective of the City. In January 2008, the installed Castor Master lowered the dam crest by two feet and the City found that the pond elevation remained constant. PWA's second management option for the City was to carry out a modest floodplain excavation between Escobar and Marina Vista Avenue. The PWA model indicated that this measure would offset a beaver dam crest elevation of six feet. The third option was to remove material from the dam in the event of a forecast of a major storm.

One of the City beaver committees explored flood reduction concepts that could be feasible and effective for continuing the already effective work by the City to lower flood risk in lower Alhambra Creek (2008). The committee's report provided a concept design for floodplain restoration below Escobar Street, as suggested by the PWA report, and also identified adding low floodwalls and berms, controlled flow (overflows) over Marina Vista Avenue and reentry of flows to the creek downstream of Marina Vista Avenue, and upstream detention at Nancy Boyd Park. This beaver committee report is relevant with or without beaver as one of the influences on flooding and should be adopted as a part of this Lower Alhambra Creek Watershed Management Plan.

Beaver families have come and gone along the lower creek since 2007 and are reported to be in the upstream portion of the watershed as this plan is being adopted. Flood damages have not been attributed to Alhambra Creek beaver to date. The community process and creative problem solving with the use of the Castor Master provides a model for the other communities in Contra Costa County which may have beaver management needs. The issue of cities needing to manage for beaver appearing in urban creeks became a nationwide phenomenon in the 2000s, and publications are now available to give guidance on managing city beavers.

Marsh Creek was occupied by beaver in 2020 in the Clayton- Oakley area, renewing the need for the County to formalize a beaver management approach with regulatory agencies, cities, and the public. Appendix A contains the following documents relating to Beaver Management: (1) a letter from the Contra Costa County Public Works Department to the San Francisco Bay Regional Water Quality Control Board and the California Department of Fish and Wildlife that establishes a beaver management protocol involving the need for approvals from state agencies for actions they may take to manage beavers and their dams; (2) a draft Beaver Dam Management Flow Chart for use when beaver dams are initially perceived to be a potential public hazard; and (3) a Draft Beaver Management Protocol that balances flood risk and wildlife management needs. The protocol references a nationally used beaver management publication: The Beaver Restoration Guidebook. Chapters 5 and 7 of the guidebook address options for lowering flood risks from beaver dams and include a flow chart that is based in part on the Martinez experience.

The Lower Alhambra Creek Watershed Management Plan adopts the cited County management protocol negotiated with the state regulatory agencies along with the beaver management guidebook as a part of this plan. The plan adds a step to the County protocol which encourages the City to notify community groups such as the Alhambra Creek Watershed Council, Friends of Alhambra Creek, and Worth a Dam to request feedback should a beaver management issue present itself.

2.5 SEDIMENT REMOVAL

2.5.1 Sediment Removal Projects: Past and Present

As noted above, since the mid-1990s, the City has invested millions of dollars of grant funds, City funds, and downtown property owner assessments in major Capital Improvement Projects aimed at improving stormwater conveyance in Lower Alhambra Creek. The areas of Alhambra Creek generally north of Green Street are influenced by tidal action and are subject to siltation. As the silt naturally accumulates, it reduces the flow capacity of the creek. Every 3 to 5 years, the silt accumulates to the

point that it reduces flood flow capacity and becomes problematic, primarily north of Ward Street. Based on observations from the last two flood events (2005 and 2017), silt equivalent to five years of natural siltation can accumulate during a single flood event.

In the past, the silt has been removed by mechanical means. The last permitted silt removal project occurred in 2008. Reaches between Green Street and Marina Vista Avenue can be desilted with large excavators working from the top of bank and roadway bridges. Silt removal of the lower reach (north of Marina Vista Avenue) and west of the Amtrak Station is done with equipment working on the upper portions of the floodway. Silt removal is performed on the flood terrace and does not occur in the low flow channel. A narrow ribbon of silt and vegetation is left untouched between the low flow channel and silt removal zone.

Vegetation along the floodplains ranges from brackish marsh (e.g., RRMR-1) to ruderal upland (e.g., MVES-1), depending, in part, on the level of sediment deposition that has occurred since the last sediment removal project. These areas will be excavated regularly to maintain or increase floodwater storage capacity in the reaches in which they occur. Sediment removal on the lower tidally influenced creek will be restricted to removing sediment deposited by tidal flows and sediment-laden fluvial flows to maintain a channel invert elevation and cross section as determined by channel capacity estimates.

A cross-section survey of the Creek will be performed to determine the hydraulics of the channel before sediment maintenance occurs and will tie channel capacity to the hydrology at the D Street USGS gage station. The hydraulics of Alhambra Creek were established in Hydrology and Hydraulic (H&H) Studies performed by Phillip Williams Associates and others over the last 30 years. These reports are appended to this plan (Appendix B). The studies were, in part, based upon the USGS gage station at D Street. The CCCFCD routinely monitors this gage; the City will check County records from time to time to see if any measurable reduction (or increase) in ten-year event storm flows is observed. Any reduction in flows that may occur due to conservation measures upstream can be documented along with any cumulative increase in flows resulting from development. The sediment removal will be based upon the historic requirements established by historical H&H reports plus any new CCCFCD gage data from the D Street gage and new information to be developed with a proposed new gage station at the Ward Street bridge. Details regarding the proposed gage are included in Section 3.9, NEXT STEPS IN ALHAMBRA CREEK WATERSHED PLANNING.

An effort will be made by the City/County or community members to record high water elevations in the downtown reaches to develop a rating curve of stage vs. discharge. Sediment removal should be informed by whether the ten-year discharge is nearing the top of the terrace/creek bank. The City will look for opportunities to fund additional hydraulic modeling in this tidal reach to supplement the 2008 reports by Phillip Williams Associates. The community will be informed as to the strategy the City is employing to address overbank flooding. The roles of the downtown bridges and road crown at Marina Vista Avenue are to be described as the ultimate controls on the flood elevations of the creek for a better-educated public.

Removal of woody vegetation from the channel side slopes will be avoided when possible. In the event vegetation is removed it may be possible to salvage portions of the removed plantings and replace or replant them following sediment removal operations. A conceptual revegetation plan will

be added to the current FEMA / Cal OES sediment removal application and will show, schematically, the limits of plant removal and plant re-establishment zones.

Excavation will be performed to ensure that the low flow channel and floodplain conform to the original design grades for the channel established by the previous H&H studies, although work in the low flow channel will be restricted.

The area next to the railroad station normally has a 100-year flood capacity, so it can serve as a mitigation area with a restored floodplain that can increase channel capacity and avoid future sediment removal projects. Section 3.0 includes a conceptual plan for willow plantings and other revegetation efforts in that location. Details not shown in the conceptual plan will be developed as part of project planning for the sediment removal project in that location.

2.5.2 Future Sediment Removal Projects

Silt Removal Plans are included in Appendix C. The following are general guidelines for preparing plans, obtaining permits and performing sediment removal and subsequent revegetation and vegetation management work:

1. Perform topographic survey of creek
2. Determine volumes of sediment (silt) to be removed using plans established by prior Capital Improvement Projects
3. Determine proposed scope of vegetation management (clearing and grubbing) and revegetation
4. Develop scope of work and cost estimates
5. Provide preliminary plans to interested community groups for feedback prior to submission to permit authorities
6. Submit preliminary plans, scope of work, and estimates to permit authorities after addressing comments from interested community groups
7. Incorporate requirements of the permits into the plans and the scope of work
8. Determine what (if any) portion of the work is to be performed by City forces
9. Advertise for public bids the portion of work not performed by City forces
10. Provide notice to permitting authorities of anticipated notice to proceed
11. Contract with a consulting firm as necessary to provide biological review and monitoring
12. Perform all dewatering as required under the supervision of the biological consultant
13. Begin clearing and sediment removal work (summer months only)
14. Complete sediment removal and restoration
15. Complete revegetation of channel as recommended in Part II of this plan
16. Develop final reports as required by permits
17. Maintain vegetation as generally recommended in Part II of this plan

2.5.3 Permits

The sediment removal will include a significant permit process. These permits include but are not limited to the following:

- US Army Corps of Engineers (404)
- Regional Water Quality Control Board (401)
- California Department of Fish and Wildlife (1600)

It is intended that future silt removal be conducted under a five-year permit with advance notice of annual permit activities provided each year. Once the sediment has been removed, it will be necessary to revegetate the disturbed areas. Revegetation of the excavated areas will conform to Part II of this plan.

2.6 HOMELESS MANAGEMENT

The City is committed to protecting the natural resources and habitat of Alhambra Creek while at the same time protecting the health and safety of property owners and the public. Persons who occupy or inhabit the creek without access to proper sanitary facilities and shelter may pose a threat to public health and safety. Property owners are responsible for creek maintenance and preservation of the free passage of water across and through their land. This responsibility may include pruning brush and trees and removing fallen trees and debris from the watercourse.

Property owners are also responsible for mitigating unsafe, unsanitary, and unhealthy conditions resulting from persons who are camped or otherwise occupy creek properties. The absence of sanitary waste and trash disposal may pose a threat to public health. Maintaining lines of sight from the street may be a tool for discouraging illegal vagrancy, loitering, and occupation of public and private property and for maintaining public safety and security. This tool, however, should be carefully assessed for actual benefits before vegetation removal is carried out.

Routine removal of vegetation with the objective of discouraging homeless settlement should not be the first priority action of government or property owners in addressing homeless encampments. Vegetation management should not be substituted for homeless management. Property owners will be encouraged to contact the City of Martinez Police Department (MPD) for assistance. The MPD has established a program for outreach to homeless persons and may be able to assist with the relocation of unhoused persons.

The City of Martinez has focused resources on assisting the homeless population in collaboration with various stakeholders, including Contra Costa County, the faith-based community, and non-profit service providers. The Martinez Police Department has one full-time officer assigned to coordinate assistance for the homeless population and focuses efforts on linking the homeless community with the resources they need. The City of Martinez also contracts with the Contra Costa County Division of Health, Housing, and Homelessness to provide the City with two part-time homeless outreach coordinators from their CORE (Coordinated Outreach Referral and Engagement) Team that focuses on building relationships with the homeless community in Martinez with the goal of connecting them to services; this program is designed to facilitate better outcomes in getting people housed.

The Martinez Police Department also temporarily provides hotel rooms for homeless families or those that are at high risk until they can be assessed by CORE and placed into shelter. The main focus of the police department is getting homeless connected to appropriate services rather than displacing them from one location to another. The community also has the ability to have CORE respond to homelessness related issues by calling 211 – this County sponsored service dispatches to CORE for a response to homelessness related issues rather than sending the police. The community can contact the Martinez Police Department as well on their non-emergency line and the Community Resources Officer assigned to work on homelessness related issues will be notified for follow-up.

3.0 PART II – VEGETATION MANAGEMENT PLAN

3.1 INTRODUCTION

This Vegetation Management Plan provides guidance on how to plant, manage, and maintain desirable riparian vegetation cover along lower Alhambra Creek (Figures 2 and 3). The Vegetation Management Plan is Part 2 of the Lower Alhambra Creek Watershed Management Plan. Part 1 addresses sediment removal and flood control.

The Vegetation Management Plan includes recommended plant species, plant placement, soil amendments, temporary irrigation, performance criteria for revegetation efforts, and recommendations for the long-term maintenance of riparian habitats. The primary objective of this plan is, through project mitigation for work done in the creek, to reproduce a more native and robust wild riparian habitat along the creek without compromising channel capacity for flood protection. A second objective is to facilitate coordination between City workers and community volunteers when vegetation work is initiated in the creek.

This Vegetation Management Plan has benefited greatly from feedback provided by Friends of Alhambra Creek, the Alhambra Watershed Council, the San Francisco Regional Water Quality Control Board (RWQCB), and others. It is intended to be a living document, allowing planting and management adjustments to be made as conditions change, in cooperation with all stakeholder groups.

3.2 APPROACH

The Vegetation Management Plan addresses four specific reaches between the Union Pacific Railroad (UPRR) Bridge and Ward Street (Figures 2 and 3). Specific Vegetation Management Zones and appropriate prescriptions are identified for each reach. Planting locations for individual plants will be field fit within each Vegetation Management Zone according to local conditions (e.g., shade, soil, soil moisture availability).

3.3 VEGETATION MANAGEMENT ZONES

This section describes the Vegetation Management Zones and recommends specific revegetation and management prescriptions for each zone. Vegetation Management Zones are shown in Figures 4-7. Typical cross sections and planting palettes are shown in Figures 8-14.

3.3.1 Woody Riparian Planting Zone

The Woody Riparian Planting Zone includes relatively narrow areas along the low-flow channel that currently lack woody riparian vegetation. This zone occurs on the east bank between the UPRR Bridge and Marina Vista Avenue (RRMR-2; Figure 4), between Marina Vista Avenue and Escobar Street (MVES-2, MVES-5, MVES-7; Figure 5), and between Escobar Street and Main Street (ESMS-2, ESMS-4, ESMS-6; Figure 6). Currently, this zone is dominated by typical brackish marsh vegetation, including common reed (*Phragmites australis*) and bulrush (*Schoenoplectus sp*.).

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LSA

FIGURE 2

N

0 0.25 0.5
MILES

SOURCE: National Geographic (c) 2018; Esri World Street Map (c) 2018.

Alhambra Creek Sediment Removal and Vegetation Management Plan

Regional Location

LSA

LEGEND

Project Location

FIGURE 3

N

0 150 300

FEET

SOURCE: Esri World Imagery (08/2017).

Alhambra Creek Sediment Removal and Vegetation Management Plan

Plan Area

LSA

Vegetation Management Zone Types

- Floodplain
- Weed Control and Native Plantings
- Woody Riparian Plantings

N

0 40
FEET

SOURCE: Use Upper and Lower Case Fonts (MM/YY)

I:\CMA1801\GIS\Maps\Figure 1 UPRR to Marina Vista.mxd (1/20/2020)

FIGURE 4

Alhambra Creek Sediment Removal and Vegetation Management Plan

UPRR to Marina Vista

LSA

Vegetation Management Zone Types

- Floodplain
- Tree Preservation and Weed Control
- Weed Control and Native Plantings
- Woody Riparian Plantings

0 10
FEET

SOURCE: Use Upper and Lower Case Fonts (MM/YY)

I:\CMA1801\GIS\Maps\Figure 2 Marina Vista to Escobar.mxd (1/21/2020)

FIGURE 5

Alhambra Creek Sediment Removal and Vegetation Management Plan

Marina Vista to Escobar Street

LSA

LEGEND

- Floodplain
- Tree Preservation and Weed Control
- Weed Control and Native Plantings
- Woody Riparian Plantings

0 5 10
FEET

FIGURE 6

Alhambra Creek Sediment Removal and Vegetation Management Plan

Escobar Street to Main Street

SOURCE: Use Upper and Lower Case Fonts (MM/YY)

I:\CMA1801\GIS\Maps\Figure 5 Escobar to Main.mxd (2/4/2020)

LSA

LEGEND

- Floodplain
- Tree Preservation and Weed Control
- Weed Control and Native Plantings

0 10 20
FEET

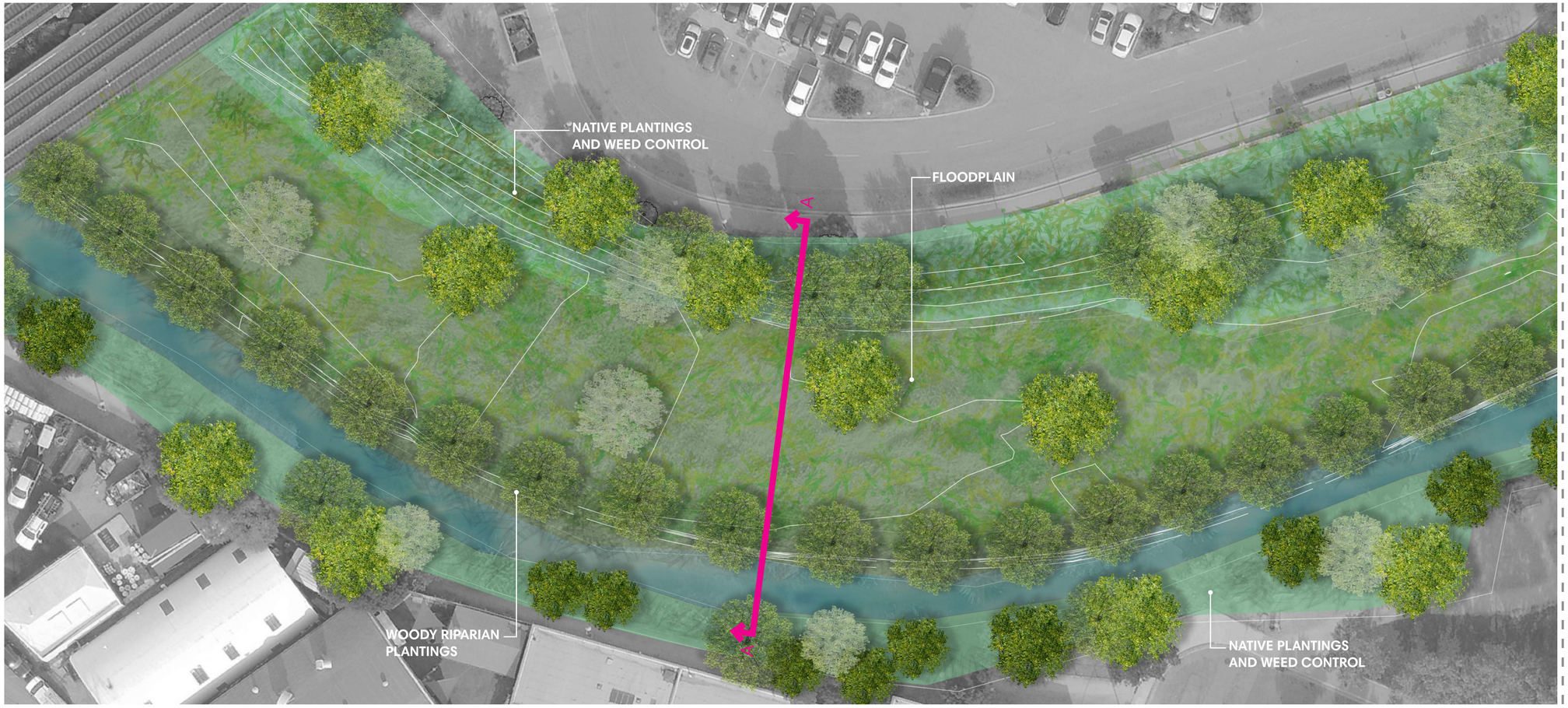
FIGURE 7

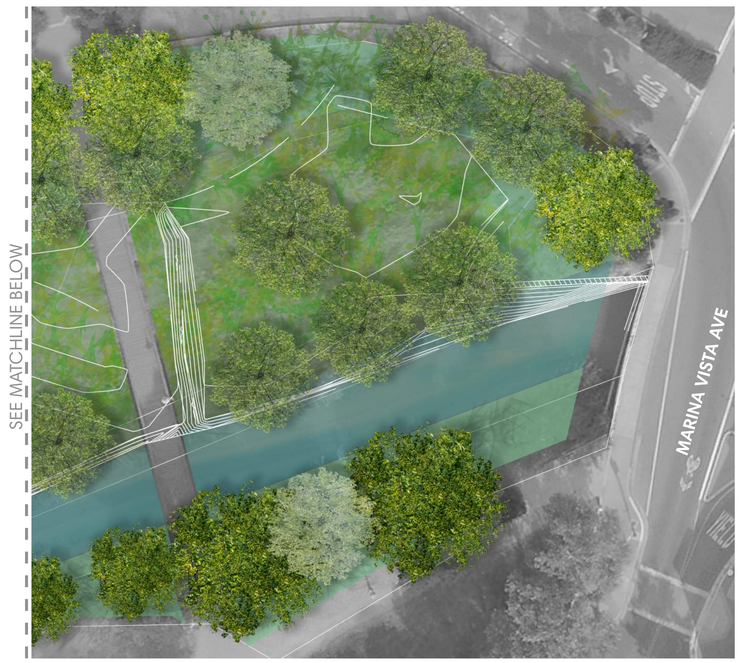
Alhambra Creek Vegetation Management Plan

Main Street to Ward Street

SOURCE: RHAA (05/2022); Esri World Imagery (Metro 11/04/2019).

I:\CMA1801\GIS\Maps\Figure 7 Main to Ward.mxd (6/2/2022)





REACH 1 CONCEPT PLAN

N

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1 inch = 20 feet

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REACH 1 PLAN

Figure 8a

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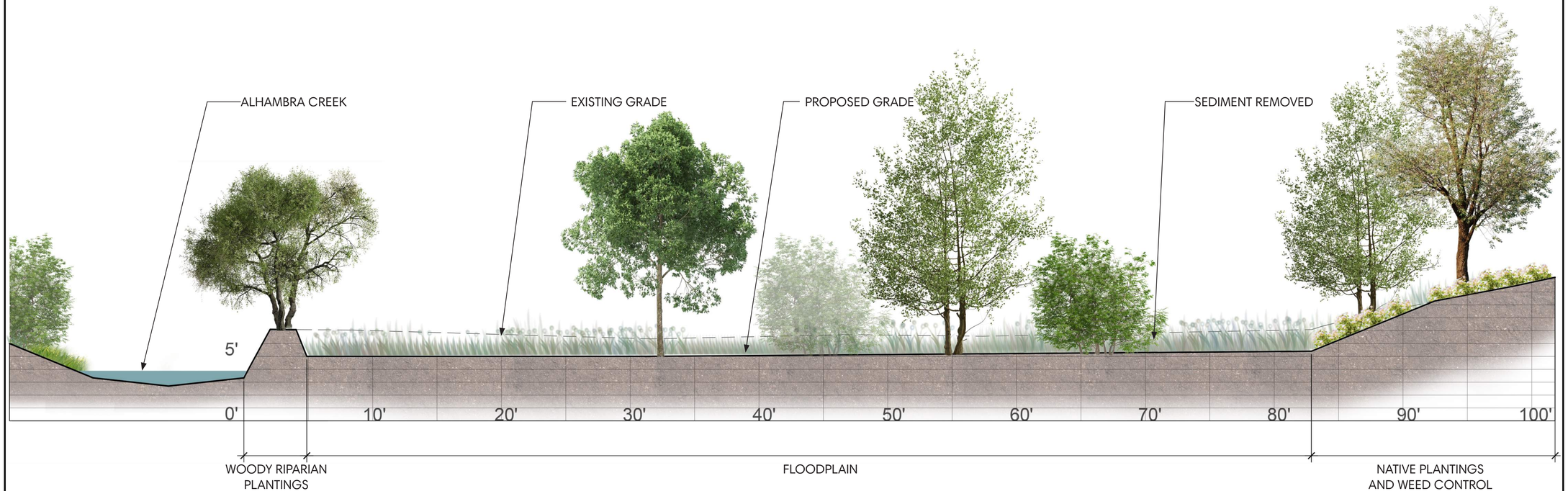

REACH 1 SECTION A

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1 inch = 4 feet

SHEET TITLE

REACH 1 SECTION

Figure 8b

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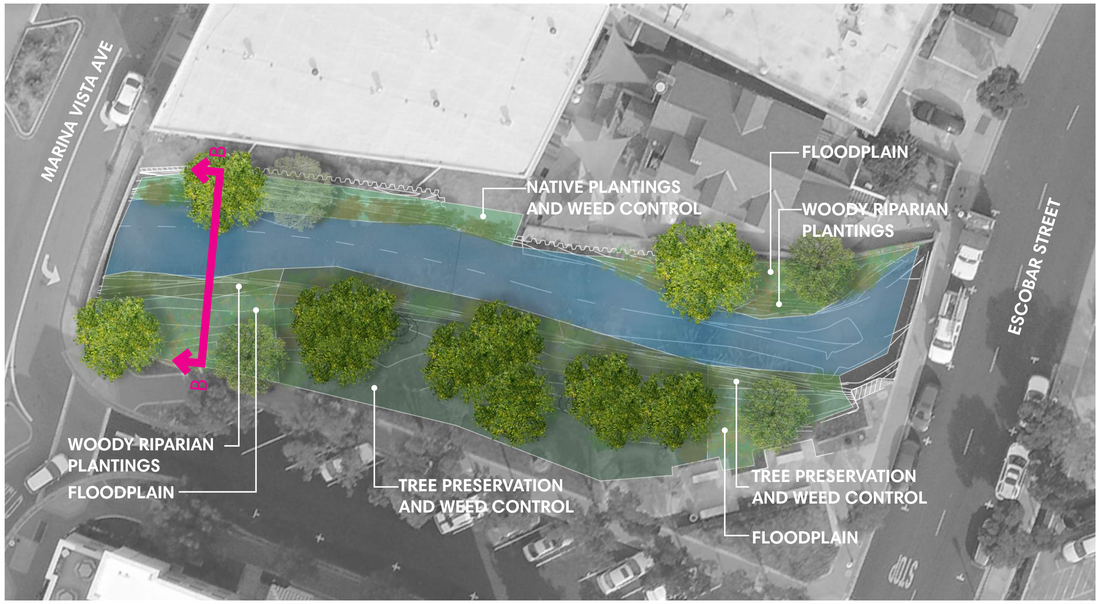

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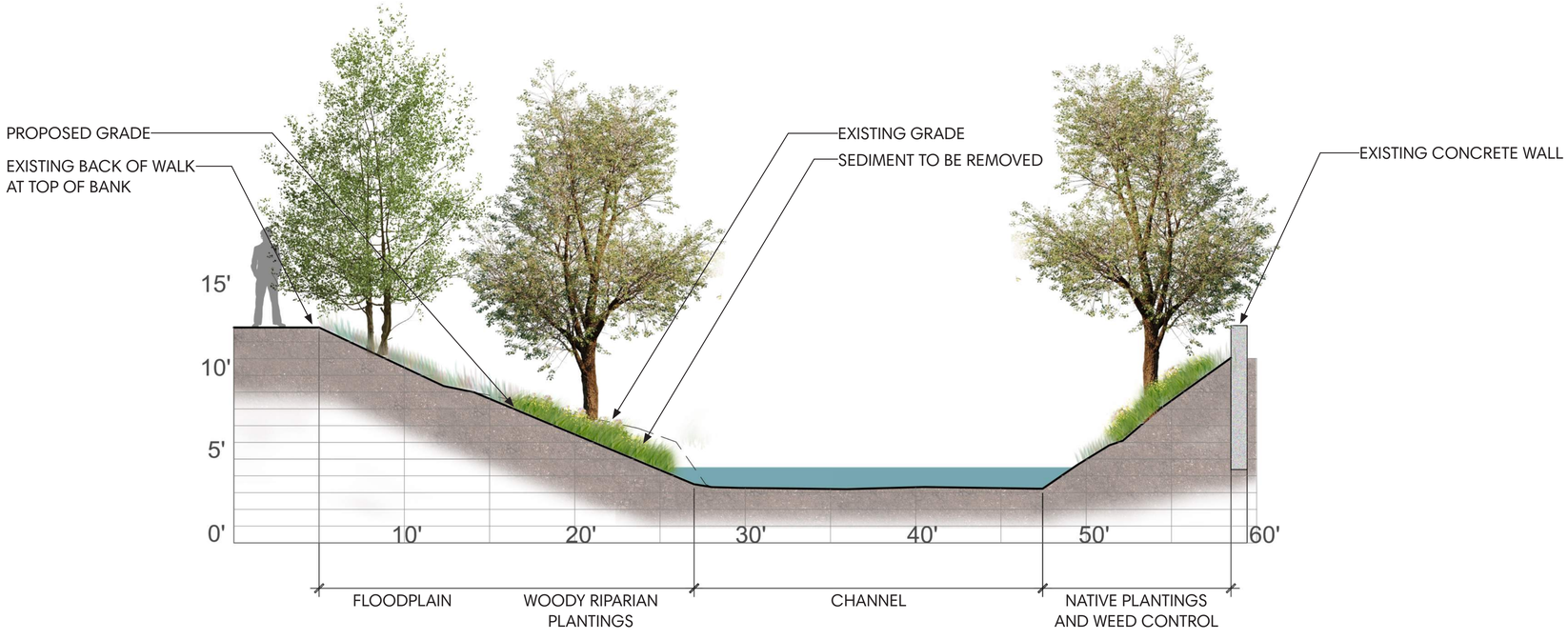

REACH 2 SECTION B

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REACH 2
PLAN & SECTION

Figure 9

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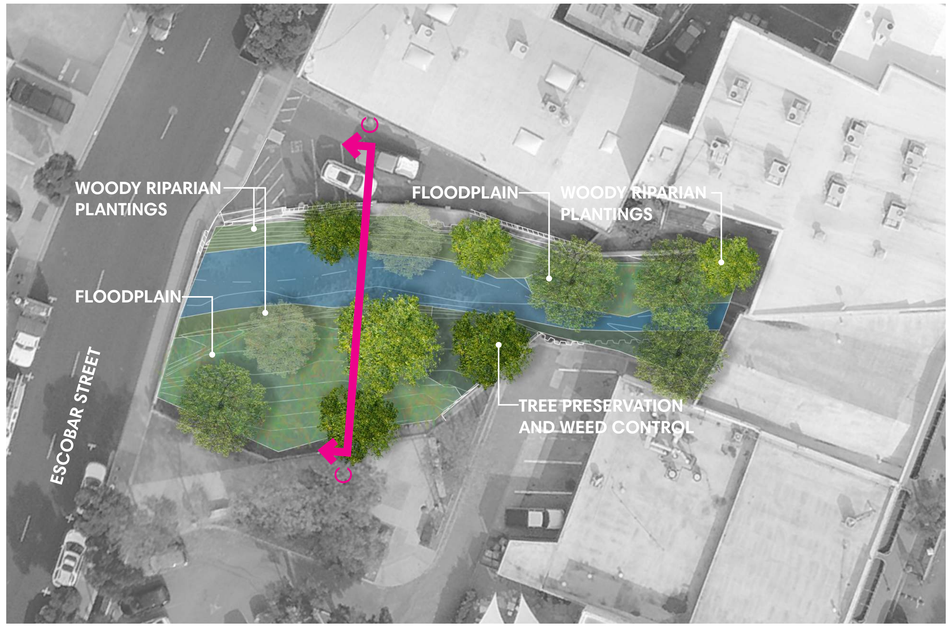

REACH 3 CONCEPT PLAN

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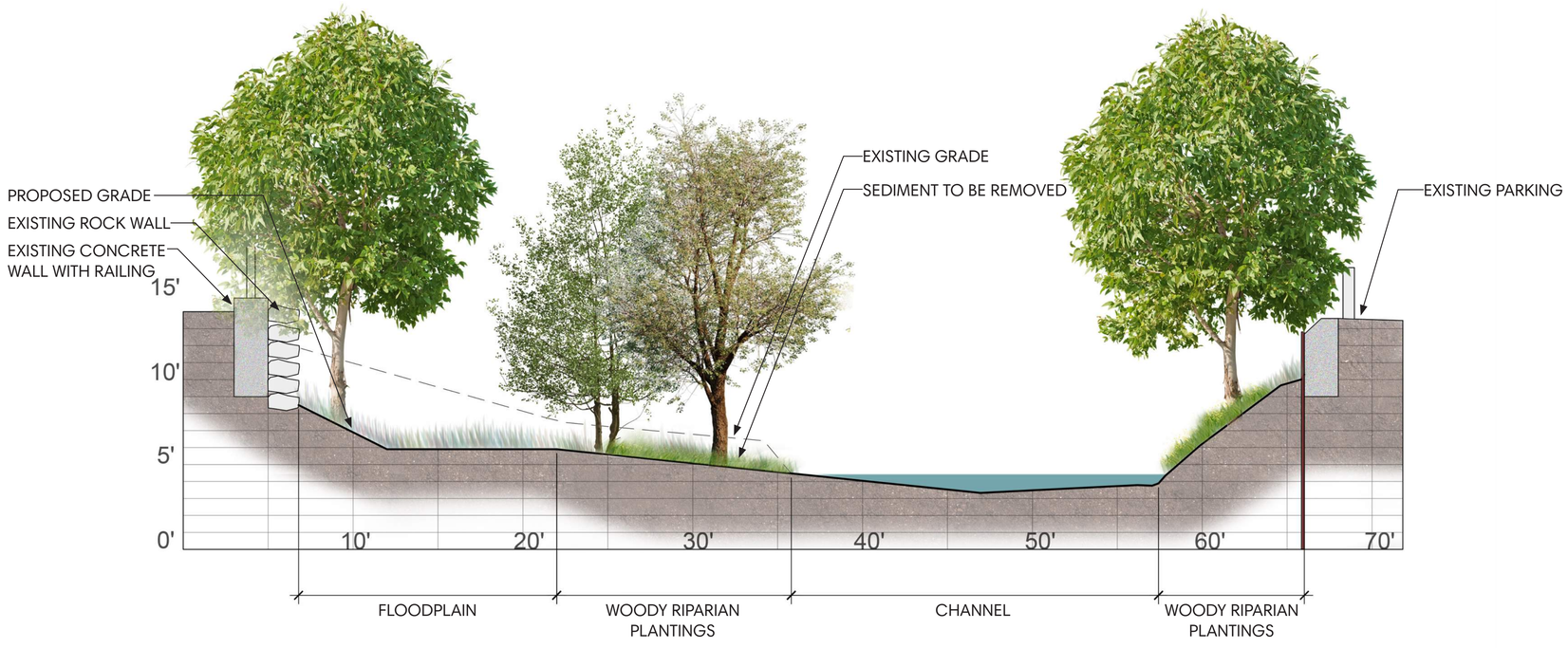
1 inch = 20 feet



REACH 3 SECTION C

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1 inch = 4 feet

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SHEET TITLE

REACH 3
PLAN & SECTION

Figure 10

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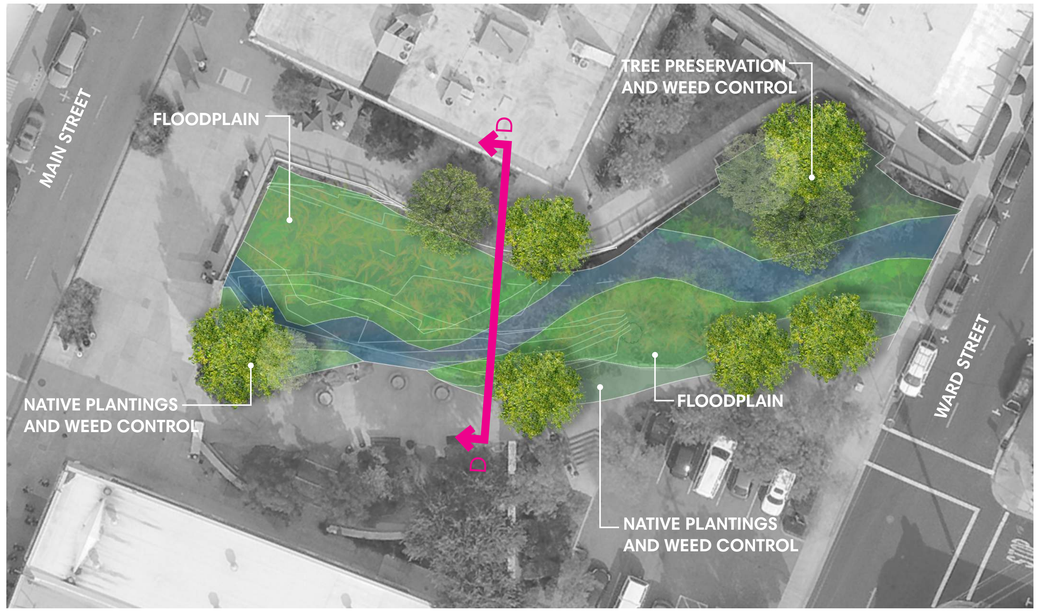

REACH 4 CONCEPT PLAN

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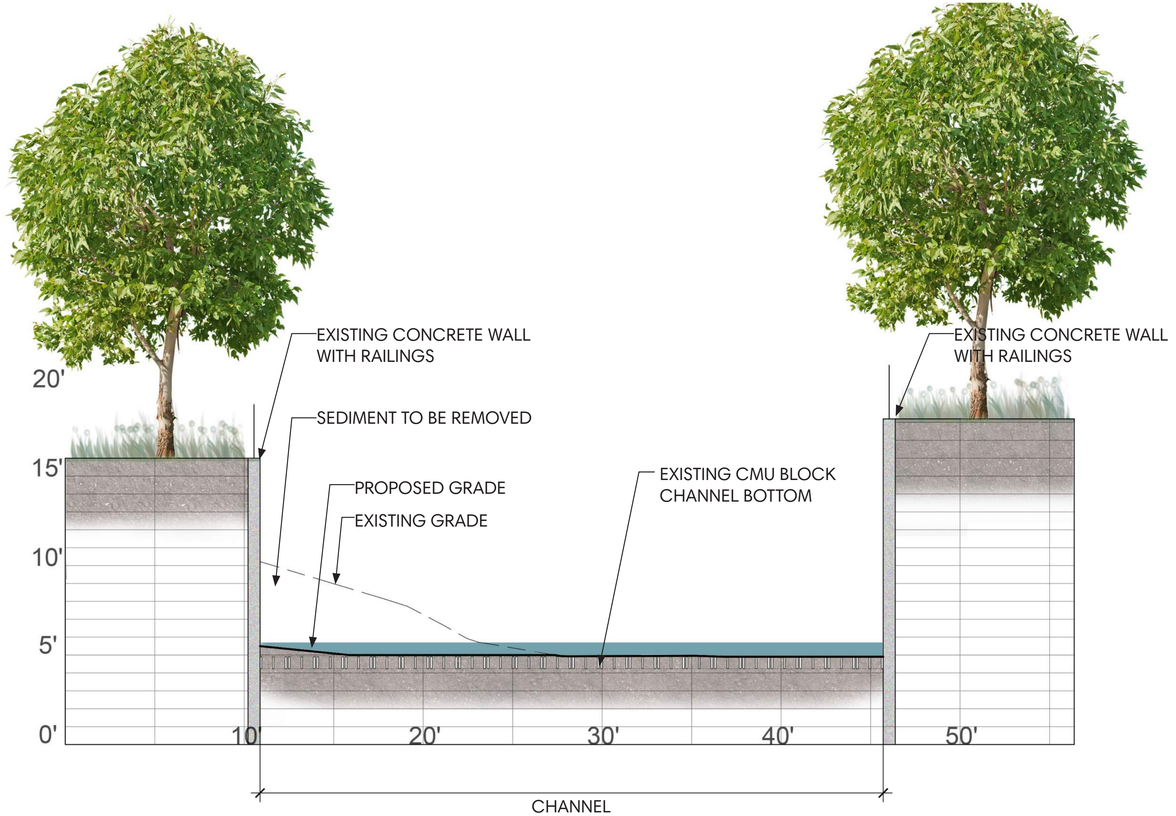

REACH 4 SECTION D

0' 2' 4' 8'

1 inch = 4 feet

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REACH 4
PLAN & SECTION

Figure 11

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ANNUALS AND PERENNIALS

Saltmarsh fleabane | Pluchea odorata
Preferred Creek Bank Elevation: Lower brackish water

California mugwort | Artemisia douglasiana
Preferred Creek Bank Elevation: Lower to mid

Cardinal monkey flower | Erythranthe cardinalis
Preferred Creek Bank Elevation: Lower to mid

Yellow monkey flower | Erythranthe guttata
Preferred Creek Bank Elevation: Lower to mid

Western goldenrod | Euthamia occidentalis
Preferred Creek Bank Elevation: Lower to mid

Coastal gumweed | Grindelia stricta
Preferred Creek Bank Elevation: Lower to mid

California sunflower | Helianthus californicus
Preferred Creek Bank Elevation: Mid

Sneezeweed | Helenium spp.
Preferred Creek Bank Elevation: Mid to Upper

GRASSES, SEDGES, AND RUSHES

Baltic rush | Juncus balticus
Preferred Creek Bank Elevation: Lower to mid

Common rush | Juncus patens
Preferred Creek Bank Elevation: Lower to mid

Santa Barbara sedge | Carex barbarae
Preferred Creek Bank Elevation: Lower to upper

Blue wildrye | Elymus glaucus
Preferred Creek Bank Elevation: Mid to upper

California fescue | Festuca californica
Preferred Creek Bank Elevation: Upper

Idaho fescue | Festuca idahoensis
Preferred Creek Bank Elevation: Upper

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PLANTING PALETTE

Figure 12a

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VINES

Western virgin's bower | Clematis ligusticifolia
Preferred Creek Bank Elevation: Lower to mid

California pipevine | Aristolochia californica
Preferred Creek Bank Elevation: Mid to upper

California blackberry | Rubus ursinus
Preferred Creek Bank Elevation: Mid to upper

California grape | Vitis californica
Preferred Creek Bank Elevation: Upper

SHRUBS

Pacific ninebark | Physocarpus capitatus
Preferred Creek Bank Elevation: Lower to mid

Thimbleberry | Rubus parviflorus
Preferred Creek Bank Elevation: Lower to mid

Canyon gooseberry | Ribes menziesii
Preferred Creek Bank Elevation: Mid to upper

Wood rose | Rosa gymnocarpa
Preferred Creek Bank Elevation: Mid to upper

Common snowberry | Symphoricarpos albus
Preferred Creek Bank Elevation: Mid to upper

California gooseberry | Ribes californicum
Preferred Creek Bank Elevation: Upper

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SHEET TITLE

PLANTING PALETTE

Figure 12b

SHRUBS AND SMALL TREES

Willow | Salix spp.
Preferred Creek Bank Elevation: Lower to upper

Creek dogwood | Cornus sericea
Preferred Creek Bank Elevation: Mid to upper

Brown dogwood | Cornus glabrata
Preferred Creek Bank Elevation: Mid to upper

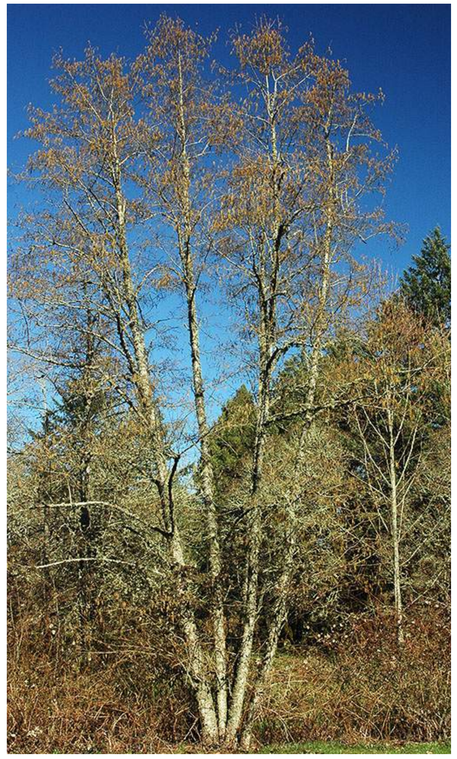
Mountain mahagony | Cercocarpus betuloides
Preferred Creek Bank Elevation: Upper

Beaked hazelnut | Corylus cornuta
Preferred Creek Bank Elevation: Upper

Coast silktassel | Garrya elliptica
Preferred Creek Bank Elevation: Upper

Black elderberry | Sambucus nigra
Preferred Creek Bank Elevation: Upper

TREES



White alder| Alnus rhombifolia
Preferred Creek Bank Elevation: Lower to mid

Fremont's cottonwood | Populus fremontii
Preferred Creek Bank Elevation: Upper

California sycamore | Platanus racemosa
Preferred Creek Bank Elevation: Upper

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SHEET TITLE

PLANTING PALETTE

Figure 12c

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3.3.1.1 Prescription for Woody Riparian Planting Zones

The perennial low-flow channel of Alhambra Creek and all the species utilizing this aquatic habitat will benefit from the shade and bank stabilization provided by additional woody riparian vegetation. Because of the saline conditions, the following trees and shrubs should be planted according to the Planting Guidelines in this plan, at approximately 20-foot intervals.

- Arroyo willow (*Salix lasiolepis*; moderate saline conditions, < 9.4 mmhos/cm)
- Red willow (*Salix laevigata*; slightly saline conditions, < 4.7 mmhos/cm) or other endemic saline-tolerant willow species
- White alder (*Alnus rhombifolia*) or other endemic saline-tolerant alder species

Additionally, invasive plant cover (including common reed[3]) should be removed as needed, but at least once per year in the spring, at and around planting locations to increase survival rates for newly planted trees. Additional removal of common reed in Zone RRMR-2 (Figure 4) is advised, if practicable. Common reed does provide habitat and cover for wildlife, bank stabilization, shade, filtration, and other beneficial functions. Therefore, common reed should be removed in sections, and each section should be replanted with native species. The native species should be allowed to become established in the removal area before additional sections of common reed are removed and replaced with native species. Over time, the riparian tree canopy cover will decrease the dominance of common reed at these locations, resulting in increased structural diversity and enhanced habitat diversity. Where openings in the tree canopy exist, this zone would also be suitable for establishing populations of saltmarsh fleabane (*Pluchea odorata*).

3.3.2 Weed Control and Native Planting Zone

The Weed Control and Native Planting Zone includes creek banks containing a mix of established mature riparian trees (both riparian and upland species) and an understory of typically non-native, invasive herbaceous species. This zone occurs on both banks between the UPRR Bridge and Marina Vista Avenue (RRMR-1, RRMR-4; Figure 4), between Marina Vista Avenue and Escobar Street (MVES-6, MVES-5, MVES-7; Figure 5), and between Main Street and Ward Street (MSWA-1, MSWA-2; Figure 7).

3.3.2.1 Prescription for Weed Control and Native Planting Zones

This Vegetation Management Zone will benefit from targeted removal of invasive, non-native species, including giant reed (*Arundo donax*), English ivy (*Hedera helix*), Himalayan blackberry (*Rubus armeniacus*), thornless elmleaf blackberry (*Rubus ulmifolius*), greater periwinkle (*Vinca major*), stinkwort (*Dittrichia graveolens*), sweet fennel (*Foeniculum vulgare*), tree of heaven (*Ailanthus altissima*), poison hemlock (*Conium maculatum*), perennial pepperweed (*Lepidium latifolium*), and Smilo grass (*Stipa miliacea*) (see Appendix D for more details and photographs). All of these species

[3] A recent genetic analysis of common reed in the southwestern United States found that the lineage occurring in Martinez has been introduced into the area and is not a native species (Williams, J., A.M. Lambert, R. Long, and K. Saltonstall. 2019. Does hybrid *Phragmites australis* differ from native and introduced lineages in reproductive, genetic, and morphological traits? American Journal of Botany 106 (1): 29-41).

will be controlled to the extent possible in the weed control zones based on specific recommendations for weed control in the Weed Control section (Section 3.5.2) and considering restrictions on the use of herbicides (Section 3.5.3). Species rated as highly invasive by the California Invasive Plant Council (Cal-IPC) will be prioritized for removal, followed by those rated as moderately invasive. Any areas that are replanted or seeded to re-establish cover will be subject to performance criteria listed in Section 3.6. New invasive species may expand into the Lower Alhambra Creek Watershed. If they do and are considered a high risk to existing native vegetation, wildlife habitat, water flow, or erosion, then they will be controlled.

Where openings between already established trees allow or where openings are created during weed control activities, additional plantings of native species (both herbaceous and woody) are recommended. For these plantings, species need to be placed according to their salt tolerance (i.e., plants with a higher salt tolerance can be planted closer to the brackish low-flow channel), drought tolerance (i.e., plants with better drought tolerance can be planted at the top of bank, farther from the channel), shade tolerance, soil depth and texture requirements, and other species-specific factors.

Also, mature sycamores and poplars have been cut down and sprayed with herbicides at the top of the terrace along the creek on the left bank across from the railroad station. These tree removals should be mapped and replaced with similar species.

Friends of Alhambra Creek recommends considering all species listed in Table D as suitable for this Vegetation Management Zone. Overall, there is a lot of invasive sheoak (*Casuarina*) near the entrance of the shoreline park, and Mexican feather grass (*Nassella tenuissima*) has been planted. Friends of Alhambra Creek has encouraged the City and the East Bay Regional Park District (EBRPD) to remove both when possible and replace them with local native species, emphasizing the importance of the use of native plants and the benefits they bring to the community. The recommended plant list and suggested placement in this plan should be shared with landowners adjacent to revegetation work areas to keep them informed about why vegetation is being replaced or added.

Table D: Friends of Alhambra Creek-Recommended Species for Revegetation Plantings

Plant Type	Preferred Elevation on Creek Bank	Scientific Name	Common Name	Notes
Annuals and Perennials	Lower brackish water	*Pluchea odorata*	Saltmarsh fleabane	Sun, moist
	Lower to mid	*Artemisia douglasiana*	*California m*ugwort	Sun to shade, moist
		Erythranthe cardinalis	Cardinal monkey flower	Part shade/sun, moist
		Erythranthe guttata	Yellow monkey flower	Part shade/sun, moist
		Euthamia occidentalis	Western goldenrod	Sun, moist
		Grindelia stricta	*Coastal gumweed*	Sun, moist
	Mid	*Helianthus californicus*	California sunflower	Sun, moist

Table D: Friends of Alhambra Creek-Recommended Species for Revegetation Plantings

Plant Type	Preferred Elevation on Creek Bank	Scientific Name	Common Name	Notes
	Mid to upper	*Epilobium canum*	California fuchsia	Sun, low water requirements
		Helenium spp.	Sneezeweed	Sun, moist
Grasses, Sedges, and Rushes	Lower to mid	*Juncus balticus*	*Baltic* rush	Part shade, moist
		Juncus patens	Common rush	Sun, moist
	Lower to upper	*Carex barbarae*	Santa Barbara sedge	Part shade, moist
		Distichlis spicata	Saltgrass	Sun, moist
	Mid to upper	*Elymus glaucus*	Blue wildrye	Sun, part shade, low water requirements
	Upper	*Festuca californica*	California fescue	Sun/part shade, low water requirements
		Festuca idahoensis	Idaho fescue	Sun, low water requirements
		Melica californica	California melic	Part shade, low water requirements
		Native erosion control seed mix, including e.g., *Bromus carinatus, Elymus glaucus, hordeum brachyantherum, Festuca microstachys, Elymus trachycaulus, Trifolium willdenovii*		
Vines	Lower to mid	*Clematis ligusticifolia*	Western virgin's bower	Shade/part shade, winter deciduous
	Mid to upper	*Aristolochia californica*	California pipevine	Part shade, moist, winter deciduous
		Rubus ursinus	California blackberry	Sun/shade, moist
	Upper	*Vitis californica*	California grape	Part shade/full sun, winter deciduous
Shrubs	Lower to mid	*Physocarpus capitatus*	*Pacific* ninebark	Shade/part shade, moist
		Rubus parviflorus	Thimbleberry	Part shade, moist
	Mid to upper	*Ribes menziesii*	Canyon gooseberry	Shade, low water requirements
		Rosa gymnocarpa	Wood rose	Sun to shade, low water requirements
		Symphoricarpos albus	Common snowberry	Shade, part shade, low/moist
	Upper	*Atriplex lentiformis*	Big saltbush	Sun, low water requirements
		Ceanothus maritima	Maritime ceanothus	Sun, low water requirements
		Ribes californicum	California gooseberry	Part shade, low water requirements

Table D: Friends of Alhambra Creek-Recommended Species for Revegetation Plantings

Plant Type	Preferred Elevation on Creek Bank	Scientific Name	Common Name	Notes
Shrubs and Small Trees	Lower to upper	*Salix* spp.	Willow	Sun, moist
	Mid to upper	*Cornus sericea*	*Creek* dogwood	Shade to sun, moist
		Cornus glabrata	Brown dogwood	Part shade, moist
	Upper	*Cercocarpus betuloides*	Mountain mahogany	Part shade/sun, low water requirements
		Corylus cornuta	Beaked hazelnut	Shade/part shade, low water requirements
		Garrya elliptica	*Coast* silktassel	Part shade/sun, low water requirements
		Sambucus nigra	Black elderberry	Sun/part shade, low water requirements, winter deciduous
Trees	Lower to mid	*Alnus rhombifolia*	White alder	Sun/part shade, moist
	Upper[1]	*Populus fremontii*	Fremont's cottonwood	Sun, moist
		Platanus racemosa	California sycamore	Sun, moist

[1] Quercus agrifolia and Quercus lobata may be planted where appropriate conditions are found.

3.3.3 Floodplain Zone

This Vegetation Management Zone includes all floodplains, specifically RRMR-3 between the UPRR Bridge and Marina Vista Avenue (Figure 4), between Marina Vista Avenue and Escobar Street (MVES-1, MVES-4, and MVES-8; Figure 5), between Escobar Street and Main Street (ESMS-1, ESMS-5; Figure 6), and between Main Street and Ward Street (MSWA-3, MSWA-4; Figure 7).

3.3.3.1 Prescription for Floodplain Zones

Because of the regular excavation of floodplains to remove sediment buildup, no additional plantings are proposed for these areas. Pioneer species such as willow, alder, and cottonwood will be protected on the floodplain and channel-side slopes when excavation of sediment on the channel invert is underway). If it is necessary to remove some vegetation to gain access to channel sediment removal areas, the excavator or front loader will salvage willow root balls, which will then be replaced after the excavation is complete. Until more data is available on the stage-discharge relations with roughness coefficient, the channel from Ward Street to the railroad tracks will be managed with moderate vegetative cover near the channel invert. Ongoing weed control between excavation efforts should be implemented to avoid noxious weeds (e.g., giant reed) from becoming established in these areas.

3.3.4 Tree Preservation and Weed Control Zone

The Tree Preservation and Weed Control Zone includes areas that currently have an established or could establish a closed canopy of mature and robust riparian trees. This zone is found between

Marina Vista Avenue and Escobar Street (MVES-3; Figure 5), between Escobar Street and Main Street (ESMS-3; Figure 6), and between Main Street and Ward Street (MSWS-5; Figure 7).

3.3.4.1 Prescription for Tree Preservation and Weed Control Zones

Within this zone, all native trees will be preserved. Non-native trees will be replaced with native trees listed in Table D, as needed. Non-native, weedy understory will be removed and replaced with suitable shade-tolerant understory plants listed in Table D. Highly invasive plants will be prioritized for removal and replacement. Priority invasive plants to be removed include giant reed, English ivy, Himalayan blackberry, and stinkwort. The intention of this plan is to reproduce a more native, wild riparian forest in which trees overlap and create a complex habitat structure. This helps reduce wind throw and can introduce a better micro-climate for understory plants. The goal is to accomplish this without compromising the hydraulic capacity of the channel.

3.4 REVEGETATION PROTOCOLS

Revegetation efforts for the Vegetation Management Zones defined above will be implemented through the following sequence of activities consisting of site protection measures, manual weed removal, soil preparation, planting, and seeding:

3.4.1 Site Preparation

3.4.1.1 Site Protection Measures

The site protection measures presented below will be implemented prior to weed removal.

- Highly visible tape or temporary fencing will be installed to protect existing riparian habitat outside of revegetation areas during revegetation activities in order to limit potential impacts from equipment and foot traffic.
- Soil compaction or other disturbance to the root zones of existing riparian trees will be avoided.
- New native replacement trees will not be planted within the dripline of existing trees.

3.4.2 Manual Weed Removal

Weed eradication along Alhambra Creek and within the revegetated area will be implemented by hand, using a variety of methods. The project restoration specialist or other qualified personnel will determine the appropriate method for removal of the different weed species. Digging out invasive species such as Himalayan blackberry, pampas grass, giant reed, common reed, English ivy, stinkwort, French broom, and others will be performed with a variety of appropriate hand tools (e.g., weed wrench for broom).

3.4.3 Soil Preparation

After the non-native trees and invasive plants are removed, the soil will be prepared as follows:

- An amendment will be lightly tilled into the soil. The amendment will be composed of nitrolized organic woodchips or ash with neutral pH.

- If feasible, portions of banks that are seeded will be hand-watered after seeding to encourage germination of seeds.
- Soils above the top of creek banks will be scarified to a depth of 6 inches in the areas to be seeded. The seedbed area will be cleared of weeds and clods and will be raked smooth.

3.4.4 Native Container Planting

Native planting zones will be enhanced by removing invasive plants and planting native riparian plant species, following the recommendations outlined in Table D. The origin of the container plant stock should be from the Alhambra Creek watershed, if possible. Willow pole cuttings will be harvested from mature willow trees presently growing along Alhambra Creek. Due to anticipated mortality of the willow pole cuttings, extra willow poles will be planted. Plants will be installed in the fall, preferably during the months of October and November, depending on the weather and expected onset of winter rains.

3.4.4.1 Planting Guidelines

The guidelines presented below will be used during plant installation to promote successful plant establishment. These guidelines may be modified and refined based on input from the project restoration specialist or other qualified personnel.

- Plantings will be installed on the project site in natural groupings under the supervision of the project restoration specialist or other qualified personnel. Planting holes may be dug by hand or augured with a hand-held auger. Holes will equal the depth of the root ball and will be 1.5 times the width of the root ball.
- Plants will be placed with the roots untangled and laid out in the planting hole to promote good root growth and prevent the plant from becoming root bound.
- Roots will be adequately protected at all times from sun and/or drying winds.
- After excavation and before planting, the planting holes will be filled approximately half full with water, and partially backfilled with 70 percent thoroughly broken-up native topsoil and 30 percent organic amendment, and then completely filled with water.
- Slow-release fertilizer will be applied to the backfill soil.
- Plants will be set in the planting hole so that the crown of the root ball is 0.5 to 1.0 inch above finished grade. The crown of the plant will not be depressed. Larger plants will be set higher above the finished grade to allow for more settling.
- A watering basin approximately 3 feet in diameter with a 3-inch berm will be provided around each plant.
- Each plant will be individually watered to reach the lower roots (12 inches) at the time of planting. The approximate amount of water will be determined in the field based on the size of the plant. Expected water amounts in order to reach the lower root zones of 1-5-gallon container plants are 2-4 gallons of water per plant, and the expected amounts needed for 15-gallon to 24-inch box container plants are 4-8 gallons of water per plant.

- Weed control cloth made of decomposable woven fabric will be installed around each plant. After planting, the cloth will be tacked flush to grade using wire staples.
- Browse protection for planted shrubs and trees will be installed on an as-needed basis. Two types of browse protection may be installed around the plants: 1) browse protection cages (4-foot-tall with welded wire grid) will be installed for the plants that have been browsed by deer; and 2) hardware cloth will be installed for plants that have been browsed by small mammals (e.g., voles). If hardware cloth proves to be ineffective against browsing small mammals, trunk protectors or another browse protection device will be installed.
- Refer to Appendix A to Part I for the article "Worth a Dam" which recommends treating streamside vegetation to protect from beavers. In addition to cages specified above, paint the trees as suggested to protect plantings from beaver damage. Consider the use of yellow willows.

3.4.4.2 Hand-Watering of Plants

All container plants will be hand-watered directly after planting. The frequency of hand-watering will vary depending on the season. During the warmest months (May through August), plants will be hand-watered every 3 to 5 days. Plantings using posts and stakes may or may not need more attention than container stock plantings, depending on site conditions. Provisions for temporary hoses and water sources should be made prior to planting.

3.4.5 Live Willow Poles

Live willow poles will be planted in accordance with the specifications described below and shown in Figure 15.

All live willow cuttings are to be harvested and planted to the following specifications:

- All live poles will be collected within the vicinity of the project site. Tree-form willows, such as red willow, are preferred.
- Live poles will be harvested and planted during the dormant season (usually in January and February).

Collection of live poles will be made no more than two weeks prior to installation on the project site and will be soaked in fresh water and kept moist until installation.

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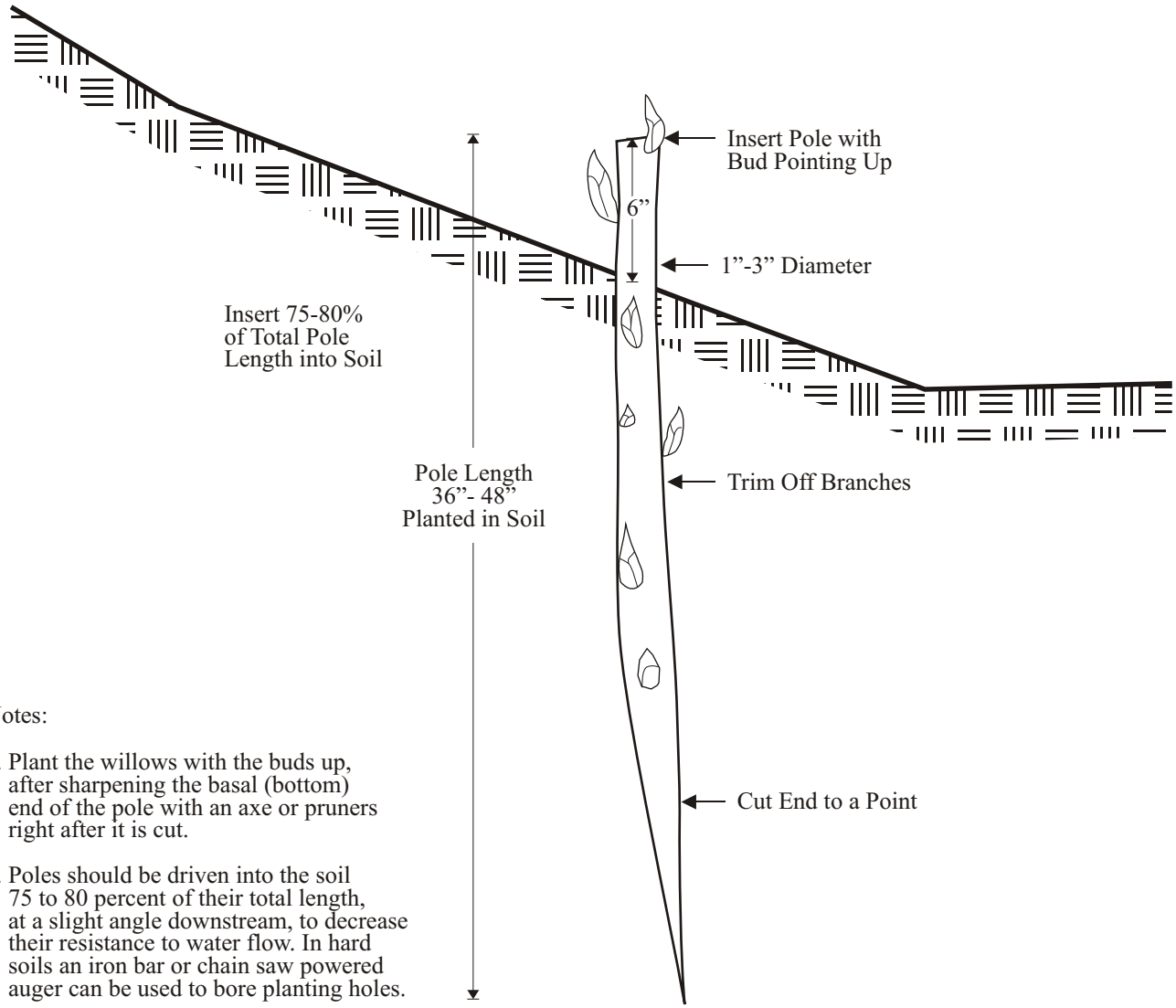

Notes:

1. Plant the willows with the buds up, after sharpening the basal (bottom) end of the pole with an axe or pruners right after it is cut.
2. Poles should be driven into the soil 75 to 80 percent of their total length, at a slight angle downstream, to decrease their resistance to water flow. In hard soils an iron bar or chain saw powered auger can be used to bore planting holes.
3. After placing the poles in the hole, tamp firmly around the poles to remove air pockets in the soil. In soft soils, poles can be driven with a wooden mallet or sledge hammer.
4. Cut off the tops of the poles if they should split while hammering.
5. Leave only one or two buds exposed.

LSA

FIGURE 13

NOT TO SCALE

Alhambra Creek Sediment Removal and Vegetation Management Plan

Willow Pole Planting Detail

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- Live stakes will be harvested from healthy, straight, and live wood that is at least one year old and 18 inches long.
- Live pole cuttings will be harvested and cut clean from willow branches. Live poles may be 1 to 5 inches in diameter and from 3 to 6 feet in length. Cuttings should be a minimum of 1 to 2 inches in diameter and 12 to 24 inches long.
- Live poles will be dipped in a root hormone and vitamin powder immediately prior to planting.
- Live poles will be planted vertically in planting holes. The person planting the poles will ensure that the polarity of the cutting is correct by ensuring that the bud scars are pointing upward. Seventy-five percent of the length of the cutting will be planted below the soil's surface. The person planting the poles will ensure that three to five bud scars are above ground level.
- An 18-inch to 24-inch diameter watering basin will be provided around each live pole.
- Watering basins will be filled with water immediately after planting.

3.4.6 Seeding

A local California native riparian seed mix of known genetic origin like those sold at Hedgerow farms (e.g., as described in Table D) will be applied to exposed disturbed creek banks within the limits of construction activity. Seeding will take place during the months of October or November to ensure adequate soil moisture and temperature conditions for establishing the native plantings. The native riparian seed mix will be broadcast evenly on all exposed disturbed areas.

3.4.6.1 Site Preparation of Seeded Areas

The soil will be watered, and the upper 3 inches of the banks will be scarified to prepare the soil for application of the seed mix.

3.4.6.2 Pre-watering of Seeded Areas

Seeding will occur on moist soils. If recommended for good establishment by the project restoration specialist or other qualified personnel, the seeded area will be watered prior to application of the seed mix.

3.4.6.3 Incorporation of Seed into Soil

Following seeding, the seeds will be incorporated into the soil to a minimum depth of 1/4 inch and a maximum depth of 1/2 inch. This can be achieved by hand-raking or using a chain harrow or tine harrow.

3.4.6.4 Initial Watering After Seeding

Unless otherwise directed, thorough watering will occur two weeks and four weeks after seeding. Care will be taken to avoid creating rills and furrows resulting from watering.

3.5 MAINTENANCE OF PLANTING IN VEGETATION MANAGEMENT ZONES

The activities described below will be implemented within the revegetation area of the creek to ensure appropriate management and maintenance. Planting in Vegetation Management Zones will be maintained until plants have become established. Maintenance will include the repair of areas damaged by erosion. Techniques for repairing eroded banks may include regrading the area, adding fill, and/or covering the area with an erosion control blanket, depending on the severity of the erosion. The areas will be reseeded prior to the installation of the erosion control blanket, if necessary.

3.5.1 Maintenance Schedule

Management and maintenance activities will occur on both an as needed and a routine basis by the City during the first five years following installation of the plantings. In general, management and maintenance activities will be conducted by qualified City staff and will consist of activities that are conducted according to an established schedule (Table E). Maintenance and management activities consist of the following: weed control, browse protection, and native planting maintenance.

Table E: Annual Maintenance Schedule

Maintenance Tasks	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Remove invasive weeds				X		X		X				
Inspect and repair browse protection cages			X	X	X	X	X	X	X	X		
Weed within the watering basins				X						X		
Repair watering basins			X			X			X			X
Replace dead plantings, if necessary to meet performance criteria										X	X	X
Seed bare areas, if necessary										X	X	

3.5.2 Weed Control

Weed control will be implemented throughout the planted and seeded areas; control will consist of weeding the watering basins and immediately around the plants (outside the weed fabric perimeter) and will extend to the full extent of weed control areas to the degree feasible. Weed control will be performed in early spring, late spring, and mid-summer.

Weed control will be implemented using hand removal techniques. Weed control activities will be timed to occur just prior to the flowering period of the target species to prevent seed development and dispersal. All plant material will be removed from the site and disposed of at an appropriate off-site location to avoid the spread of viable seeds within the creek corridor.

A component of weed control will be the identification of reaches that will benefit from shading out rushes and reeds that conflict with flood management needs. Shade species will be planted to

provide long-term control of invasion by rushes and reeds that are determined to conflict with channel capacity.

3.5.3 Herbicides and Pesticides

No use of herbicides or pesticides shall occur on the creek banks or within the riparian vegetation zone at the top of the banks, except as specifically needed to ensure removal of giant reed. Herbicide use for the removal of giant reed would require permission from the appropriate regulatory agencies.

If herbicide application is approved, the following additional recommendations shall be considered:

- Herbicide application requires training and licensing to ensure proper and safe use, handling, and storage of materials.
- Only personnel with the appropriate license are allowed to use chemicals to treat vegetation.
- Personal protection equipment is essential to limit exposure to chemicals and includes long pants and long-sleeved shirts, gloves, safety goggles, hard hats, sturdy boots, face masks, and, in some instances, respirators.
- Herbicides, if used, will be painted on cut stems of giant reed plants. Herbicides will not be sprayed.

If other invasive species rated as moderately or highly invasive by the Cal-IPC are found within the plan area, are spreading and are determined to be a threat to the creek ecosystem, and cannot be controlled through mechanical means, the City may consider expanded use of herbicides after consultation with interested community groups and approval from regulatory agencies.

3.5.4 Grazing

Goats may be used to control weeds in some areas if there are large enough areas that can be fenced in for targeted grazing.

3.5.5 Browse Protection

Browse protection will be installed, if determined necessary by the project restoration specialist or other qualified personnel, and thereafter maintained on a regular basis according to the schedule in Table E. Browse protection cages will be removed after the trees have become well established and tolerant of browse damage. The project restoration specialist or other qualified personnel will monitor signs of browse damage on the plants and will determine the effectiveness of and need for additional or larger browse protection cages.

3.5.6 Maintenance of Plants

The native plants will be inspected and properly maintained according to the schedule in Table B. Maintenance activities will include repairing watering basins, removing weeds around the watering basins, and replacing/re-fastening weed fabric, among other tasks. Structurally compromised trees (e.g., broken branches, limbs) will be trimmed as necessary to remove structural damage that has the potential to cause tree mortality.

3.5.7 Irrigation

Planting will be conducted in the fall after the first rains to provide the most favorable conditions for plant survival. The uncertainties of climate change create the risk that plant survival will plummet in drought years. The managers of planting projects will be responsible for monitoring plant condition and hand watering or installing irrigation to ensure plant survival through the dry season. The watering will occur for no less than three years or until plants become established and are able to survive without assistance.

3.6 PERFORMANCE CRITERIA

Native plant revegetation will be considered successful if the following criteria are met.

3.6.1 Survival

Success criteria for survival will be met if 80% of container plants are surviving six years after being planted (Table F). If 80% survival is not achieved, dead plants will be replaced in kind, unless the restoration specialist (or other qualified personnel) determines that site conditions are not conducive to the survival of a particular plant species, in which case, an alternate native plant species will be planted. An alternate native plant species will only be proposed after the restoration specialist, or other qualified personnel, has determined that plant mortality was not due to poor maintenance or other external factors. If the proposed alternate plants are successful, then the plan should be revised to include the new plant species. Replanting would occur in the fall after the first rains.

Table F: Revegetation Plan Success Criteria

Success Criterion	Target Percentage
Target annual plant survivorship of container plants after six years	80%
Absolute ground cover for areas with seeded native plants after six years	90%
Cover of non-native invasive plant species within seeded areas after six years	< 5%

The performance standard for planting project functionality will be based on whether the plants are functioning to protect and provide habitat for steelhead and other aquatic and terrestrial wildlife; provide shade; suppress non-native plant growth; support water quality; and reduce excessive erosion. In the event that it is not possible to sustain 80% survival of all container plant species in the long term, a riparian corridor functional equivalent proposal with fewer species can be prepared by the restoration specialist or other qualified personnel (i.e., a less diverse mix of species may be approved if the lower diversity is providing sufficient ecological benefit to the creek). The City would seek input from interested community groups prior to accepting the proposal.

3.6.2 Cover

- The seeded areas should achieve 90% cover of seeded vegetation after six years (Table F).
- Vegetation cover within the seeded areas shall consist of no more than 5% non-native invasive plant species after six years (Table F).

3.7 MONITORING AND REPORTING

Qualified City staff or a qualified consultant will monitor the native plant revegetation areas for six years. The City will submit an annual monitoring report to the RWQCB. The first annual report will be submitted 12 months after the start of implementation of this plan. Annual reports will include the results of a survey of all of the installed container and live stake plants, including summaries of survival, condition, general plant health, vigor, approximate size, and canopy cover. The reports will also include an overview of the planting effort, the need for additional watering of the plants, other maintenance needs, and modification of methods used for installation of any replacement plants. Reports should also be sent to the California Department of Fish and Wildlife (CDFW).

Plant cover in the seeded areas will be quantitatively and qualitatively monitored during the spring in Monitoring Years 1, 3, and 6. Quantitative monitoring will be conducted by recording plant cover and species composition in each planting area. The annual reports will compare data to previous years and detail progress toward meeting the success criteria. Photographs from four permanent photo-documentation points will be included to document progress. Photographs from these locations will be taken in Monitoring Years 1, 3, and 6. At the end of six years, a final report will be prepared that includes summaries of all monitoring data and representative photographs from the photo-documentation points. Annual reports can be combined with the reports on tree survival described above.

3.8 ADAPTIVE MANAGEMENT AND REMEDIAL MEASURES

If success criteria are not being achieved, the project restoration specialist or other qualified personnel will recommend adaptive management methods and remedial measures based on monitoring results from Monitoring Years 1, 3, and 6. Adaptive management and remedial measures may include increasing hand-watering to improve plant establishment, increasing the frequency of weeding (especially of invasive weeds), changing browse protection techniques in response to browse damage, and replacing dead plants with plant species that perform better at the site.

3.9 REVEGETATION MAP

The City will develop a revegetation map showing all known and/or active restoration areas currently being managed along the creek. The City will update the map with new restoration/revegetation areas as they arise and will make the map available to City maintenance crews and other groups undertaking restoration projects along the creek.

3.10 ALHAMBRA CREEK HEALTH

Vigorous trees and vegetation are an important element of a healthy creek and watershed. The City will replace any trees that die on City-owned property within the plan area. A changing climate means that some tree species in Martinez are no longer compatible with warmer temperatures and drier conditions, and this should be considered when replacing dead trees. Riparian trees should be replaced in accordance with this plan. The City should also require development projects in the plan area to plant trees, properly maintain the trees, and replace them if they do not survive. Clean water and a clean channel are also important for a healthy creek and watershed. Litter and trash in the creek are a highly visible pollutant and should be removed. The City should remove trash and

litter from the creek in the plan area at least twice per year. This can be done by City personnel, by volunteers assisted by the City (e.g., picking up trash at designated sites), or by some other means. The City will also look for opportunities to engage private landowners and educate them about the health of the creek and actions they can take to support the health of the creek ecosystem. Pamphlets provided in Appendix E may be used as a basis for this outreach.

3.11 NEXT STEPS IN ALHAMBRA CREEK WATERSHED PLANNING

Next steps in Alhambra Creek Watershed Planning efforts initiated by the City, in coordination with community stakeholder groups, should include the following:

- **Training.** Trainings should be provided to City of Martinez maintenance staff on effective vegetation management for public safety and environmental benefit. The trainings will be organized in partnership with the Contra Costa Resource Conservation District, Friends of Alhambra Creek, and the Alhambra Watershed Council. A group of representatives from the City and the above-mentioned groups will meet to establish the goals of the trainings and set a schedule for future meetings and trainings. It is expected that the trainings will include strategies for balancing flood reduction needs with the environmental needs of the creek; vegetation management approaches that reduce weed and cattail invasion while providing for bank stability and flood management objectives; the use of soil bioengineering techniques to stabilize stream banks and provide habitat; identification of beneficial native plants and detrimental non-native invasive plants; and experience from other San Francisco Bay Area cities on managing homeless populations in riparian zones. Trainings may be combined with planned trainings organized and presented by the California Urban Streams Partnership (CUSP) under the Contra Costa County Streamside Management Program for Landowners (SMPL). In addition to City and County staff, the trainings will be open to members of the Friends of Alhambra Creek, the Alhambra Watershed Council and its local and state members, Contra Costa Resources Conservation District staff, and members of the public. Trainings will be conducted every three to five years, or often enough to maintain competency. The first CUSP training sessions are tentatively scheduled to be held in September of 2022. A 2- to 3-hour classroom training session at the Martinez City Hall will be followed by a field trip and 2-hour on-site training session.
- **Sediment Control.** Development of a sediment control strategy for the upper watershed (not covered in Part 1 of this document).
- **Hydrological Modeling.** Seeking opportunities to fund an updated hydrological model to better inform lower creek flood capacities.
- **Ward Street/Green Street Reach.** Inclusion in the Plan of the reach from just downstream of Ward Street to Green Street where break out flood flows originate. The areas on the north and south side of the Ward Street Bridge are not addressed in this plan due, in part, to the density of existing foliage. These areas will be addressed with an update to the plan during the 2022-2023 fiscal year.
- **Proposed New Stream Gage.** Following the presentation of the draft report to the City Council in March of 2022, the City budgeted funds for flow monitoring in Lower Alhambra Creek. In April and May of 2022, City engineering staff met with the CCFCD and discussed options and methods utilized by the CCCFCD in other watersheds. The City and County engineers agreed to

embark upon a program for flow monitoring in Lower Alhambra Creek. The initial goal of the monitoring efforts would be to establish an N-value (roughness coefficient) for this reach of the creek during the winter of 2022-2023, if possible, or not later than the winter of 2023-2024. Over time, a rating curve would be developed to better understand flow capacity for a given storm. The stream gage equipment would be a solar-powered, cell-modem, radar-level sensor and would include:

- transmitter in NEMA 4x enclosure with terminal strip
- 22-amp hour battery
- wireless radio modem
- radar level sensor
- cable
- solar panel, 50 watts (3.0 amp), with regulator and mounting bracket.

Installation may be performed by County personnel, or by a consultant, depending on availability of County staff. The preferred location for the stream gage would be on the south side of the Ward Street bridge. Options for two different layouts and details regarding the proposed equipment are included as Appendix F, showing a series of PowerPoint slides. The downtown data will supplement and support the USGS Gage station at D Street. The estimated cost of the equipment, not including installation or monitoring, is approximately $15,000.

- **Watershed Tree Preservation.** Trees are an important element of a healthy watershed, and every tree that dies and isn't replaced diminishes watershed health. Trees convert carbon dioxide into oxygen, sequester carbon, provide important habitat, and reduce "heat island" effects. The City owns acres of open space, parks, and other properties in the Alhambra Creek watershed that have a significant number of trees on them. The City should develop a tree policy and program to properly maintain and preserve its trees and replace any dead or dying trees on City property in the watershed. The tree policy would outline the goals of planting and maintaining trees on City property, the proper species to plant, and proper maintenance; the program would implement the policy. A changing climate means that some tree species in the City are no longer compatible with warmer temperatures and drier conditions, and this should be considered when replacing dead trees. Replacement of riparian trees would be covered under this plan. The City should also ensure that development projects throughout the watershed are required to plant and maintain trees as part of their project and to replace trees that subsequently die in accordance with the City tree policy.

- **Watershed Benefits through Beaver Ponds.** Watershed health benefits greatly by the introduction of beaver ponds. Beaver ponds retain water for habitat, recharge groundwater, filter out nutrients and pollutants, and remove sediment particles from water flowing through the system. The frequency of the City's regular sediment removal projects in Lower Alhambra Creek could be reduced in frequency if sediment was kept in the upper watershed in beaver ponds. The City should seek funding for and, if funding is secured, conduct a feasibility study to determine locations in the upper watershed where the conditions are conducive to beavers building a pond, or where conditions could be made conducive to building a pond. For example, if all conditions are perfect but there aren't any or enough willows available, but willows could be planted and would thrive, then all conditions can be met by planting willows. The study

would analyze conditions looking at the needs of a beaver regardless of any human-imposed restrictions, such as land use or property ownership. Once a complete list of potential pond sites is developed, the locations can be prioritized to reduce conflict with human land uses and activities. If the study identifies feasible locations, the City can talk with property owners that have property suitable for a beaver pond to discuss the benefits a beaver pond can provide to their property and the surrounding area. Temporary rights and permission to enter upon the lands of property owners would be required. Responsibility for maintenance of the beaver habitat would have to be established, including removal if necessary. Indemnities may be required. If property owners agree, the City can arrange for beavers to be introduced onto the property to build a beaver pond. Currently, it is illegal to introduce beavers into the watershed. However, the State is working on legislation that would allow limited legal introduction of beavers and, in time, a feasibility study described above will be able to be implemented. The feasibility study should only be undertaken when it becomes legal to introduce beavers into the watershed.

3.12 COMMUNITY INVOLVEMENT

This plan outlines a process whereby the City engages with interested community groups prior to initiating new projects within the plan area and prior to making changes to the plan. The Alhambra Watershed Council has been identified as a community group with extensive knowledge of the Lower Alhambra Creek Watershed and has agreed to provide a forum for community input into City projects that fall under this plan. The Alhambra Watershed Council and other interested community members will have the opportunity to comment on projects initiated under the plan, as well as recommended adaptive management methods and remedial measures proposed under the plan before they are adopted. In addition to any project-specific adaptive management measures, the City will assess its management activities and how well the plan is meeting its objectives approximately every three years and will provide any proposed revisions to the plan to the Alhambra Watershed Council for review and discussion with other interested parties. In some instances, the City may proceed with emergency work without involvement by the Alhambra Watershed Council or other community groups if not doing the work would jeopardize public safety or public or private property.

4.0 GENERAL PLAN CONFORMANCE

On October 26, 1992, the City Council adopted Resolution No. 160-92 (a) amending the Open Space/Conservation Element (OS/CE) of the General Plan (GP) the "Alhambra Creek Enhancement Plan – The Greenways" and b) adopting the Alhambra Creek Enhancement Plan as a guideline for implementation of the goals and objectives identified in the Integrated Greenway Plan. The Draft Enhancement Plan proposed an integrated approach to the design of a creekside greenway and set forth six goals for implementing the policy. While the creation of the Greenway has for the most part not been achieved, a number of the goals which include preservation and enhancement of natural habitat, restoration of creek banks and reduction in threats to flooding have been realized. Relevant sections of the Open Space/Conservation Element are indicated in *italics* below. Comments regarding the conformance of this Lower Alhambra Creek Watershed Management Plan (LACWMP) to the Open Space Element of the General Plan are indicated below each italicized provision.

> *GP Section 22.21. The Alhambra Valley Conservation Zone should remain essentially devoted to open space land use… It is important to watershed conservation and the control of flooding along the Alhambra Creek and possesses natural vegetation and wildlife habitat resources, valuable scenic amenity, and agricultural land value.*

Section 2.4.2 of this LACWMP encourages the City and County to include siltation reduction measures in permits for permitted improvements.

> *GP Section 22.47. The riparian vegetation of the Alhambra Creek is an important community asset and must be preserved and enhanced.*

Identification of riparian values as community assets and preservation of these assets are recurrent themes in this LACWMP.

> *GP Section 22.48. Within the Alhambra Creek Drainage Basin factors which could contribute to increased run-off rates of surface water should be prevented or regulated. Such factors include overgrazing, logging, clearing, burning and other activities which could reduce vegetation cover, as well as the construction of impermeable surfaces over permeable soil and geologic areas or the removal of permeable soils by extensive grading and scraping practices.*

Section 2.4.3 of the LACWMP encourages implementation of conservation measures that will reduce siltation when opportunities present themselves.

> *GP Section 22.49. Within the Alhambra Creek Basin, sites in the first and second order tributary sub-basins should be developed for flood retention purposes and for additional recreation or livestock watering uses where appropriate. Retention dam sites should be chosen with due consideration to soil and geologic conditions related to slide hazard.*

Section 2.2.1 of the LACWMP notes the construction of the stormwater detention project constructed near Pleasant Hill Road and encourages construction of similar facilities when opportunities arise.

GP Section 22.A Alhambra Creek Enhancement Plan. Pursuant to Resolution No. 160-92, adopted by City Council October 26, 1992, the Open Space/Conservation Element of the General Plan was amended by: a) adding the "Alhambra Creek Enhancement Plan – The Greenways"; and b) by adopting the remainder of the 1992 Alhambra Creek Enhancement Plan as a guideline for in implementation of the goals and objectives identified in the Integrated Greenway Plan below.

The Draft Enhancement Plan reflects an integrated approach to the design of a creekside greenway. The trails, habitat enhancements and bank stabilization designs proposed have been developed together so that each individual element supports the other. The greenway will unite the City with its creek and reestablish a natural, self-sustaining landscape. A continuous trail system will connect the neighborhoods with downtown, schools, parks and with the regional recreational trail network. People will be encouraged to walk or bicycle in safety to the downtown, with opportunities to stop and enjoy the restored natural setting. Educational exhibits will be available to describe the natural processes of the creek, its historic importance and the process of habitat restoration and bank stabilization. The improved habitat will bring a rich biological diversity into the center of Martinez. Stabilization treatments for the channel, its banks and the adjacent properties will work in concert with habitat restoration and will accommodate trail construction.

Biological diversity, stabilization treatments for creek banks and adjacent properties are stated goals in the LACWMP.

4.1 GOALS AND OBJECTIVES

The City of Martinez has gathered the community, consultants and staff to create a vision for the creek. One of the first steps was to develop the goals and objectives to guide the process of creating this vision. The goals and objectives were developed from the record of citizen input on past and current creek planning, from consultation with the City Staff, and after a thorough analysis of the existing conditions within the study area. The goals and objectives provide a summary of the desires of the community and the recommendations of the consultants with regard to enhancement of Alhambra Creek. Each goal has been listed here accompanied by related objectives and a discussion of the way in which the Enhancement Plan responds to that goal.

***Goal 1:** Create a greenway corridor along Alhambra Creek which balances the community desires for public access, natural area restoration, wildlife habitat value enhancement, flood protection and bank stabilization…Alhambra Creek is a prime candidate for creation of a restored greenway corridor in the one mile stretch of the study area. Restoration and wildlife value enhancement can be achieved with some modification of the creek banks, removal of invasive exotic vegetation, and revegetation with native plants. Public access has been carefully integrated with the goals of bank stabilization, revegetation and wildlife protection. Where the disturbance to wildlife would be excessive, public access is restricted or curtailed. A continuum of natural and urban experiences is provided within the greenway corridor.*

The LACWMP develops guidelines or planting that will support wildlife and fish habitat restoration. It develops guidelines for a tree planting program consistent with the riparian corridor planting for streets and other open spaces adjacent to the creek, to visually enhance the spaces, provide shade and widen the riparian corridor for portions of this reach of Alhambra Creek. The recent project at the Escobar Street bridge removed invasive species as it improved the hydraulics and arrested the further erosion of the creek bank at the bridge abutment.

> ***Goal 2:*** *Create an access and enhancement plan which maintains the privacy and security of creekside properties and residents and the safety of those using the creek. Objectives:*
>
> - *Develop a public access system which is easily monitored for the safety of the users.*
> - *Develop a public access system which encourages active use by residents and visitors, and minimal conflict with property owners.*
> - *Develop measures to secure the safety and privacy of residents, students and property owners where a public trail or overlook occurs near a residence or school.*
>
> *To protect the privacy and security of property owners, access to the bank top is primarily restricted to existing public property. The few parcels where access is recommended on private property occur mainly in the downtown area where owners may benefit commercially from the presence of trail users or an enhanced creek environment. Providing for the safety of those visiting the creek is an important security concern. The recommended trail system can be monitored from public streets or populated areas.*

While this LAWCMP does not include specific plans for trails or public access, it does not preclude them. Its objectives are again consistent with Goal 2 of the Alhambra Creek Enhancement Plan of the Conservation Element of the General Plan. Access to the creek is currently from and will continue to be from public property such as the Intermodal Station, the parking lot at Castro and Escobar and the plaza between Ward and Main Streets. The plan calls for providing sight lines for security while at the same time preserving habitat values.

> ***Goal 3****: Improve the habitat values for wildlife in the riparian corridor and for fish in the creek. Objectives:*
>
> - *Preserve the existing healthy riparian habitat.*
> - *Establish an overall vegetation management plan that supports the habitat restoration, bank stabilization, flood capacity, and aesthetic enhancement goals.*
> - *Enhance and restore fish habitat values in the creek.*
> - *Widen the riparian and marsh zones beyond the narrow channel corridor wherever possible, creating buffer/transition zones between the creek and urban areas.*
> - *Buffer fish and wildlife habitat from public use and other urban adverse impacts.*
> - *Create guidelines for consistent bank stabilization treatments for public and private land along Alhambra Creek. Treatments should improve habitat values and aesthetic quality of the creek.*
> - *Improve water quality, minimize water quality hazards and protect public safety.*

The riparian corridor is currently quite narrow and isolated from surrounding habitats. Improving habitat values for fish and wildlife can be accomplished primarily by reestablishing and expanding the layered vegetation canopy of the riparian corridor. This revegetation provides habitat for animals, with a variety of native plants offering shelter and food. In addition, trees will provide a dense canopy over the creek, shading it and reducing water temperatures for fish. In many stretches of the creek, where natural banks have been stabilized with manmade structures and the vegetation removed, alternative means of bank stabilization which include revegetation and wildlife enhancement are recommended. Hazardous waste sites which could potentially leak into the creek, affecting water quality and public safety have been identified in the Plan. In the downstream reaches, alternative means of expanding the wetland habitats are explored.

The objectives of Goal 3 are consistent with the objectives of the LACWMP.

Goal 4: *Create an access and enhancement plan that maintains or improves, where possible, the existing level of flood protection along the creek. Objectives:*

- *Conduct a detailed hydraulic study of the project area to ensure that the treatments recommended as part of this Enhancement Plan do not alter existing flood levels.*
- *Develop a monitoring and maintenance program of the enhancement work for Alhambra Creek for debris and silt build-up and invasive vegetation in conjunction with the City maintenance program.*
- *Where possible, widen the creek to increase the flood capacity without decreasing minimum summertime depth critical for fish.*
- *Reduce the flood potential of constrained reaches or "bottlenecks" such as the Southern Pacific Railroad bridge.*
- *Create a flexible Enhancement Plan to accommodate possible future flood control projects.*

The detailed hydrologic study and monitoring and maintenance programs mentioned in the objectives are not a part of this project and should be conducted separately. As a part of this project, the existing flood hazard has been reviewed. The Plan is not intended to create new solutions to the flooding problem, but should maintain or improve, where possible, the existing level of flood protection. This issue comes into play where revegetation is suggested in the creek channel, reducing the flood capacity. When revegetation is suggested it should be balanced by increasing the flood conveyance. At the Southern Pacific Railroad bridge, where the creek's flow is most constricted, several alternatives are suggested for improving the flow capacity to at least equal that of the new upstream bridges.

Many of the goals identified in the 1992 amendments to the Conservation Element under GP Section 22.A have been realized. For example, the UPRR Railroad bridge was replaced and the channel between the bridge and Marina Vista Avenue widened to provide 100-year capacity and the section between Ward and Main Streets straightened and lined to provide 8- to 10-year capacity

when sediment free. This LACWMP also proposes to develop a monitoring and maintenance program from debris and silt build-up, removal of invasive species, and balancing revegetation with increasing flood conveyance.

> ***Goal 5:*** *To the extent consistent with wildlife habitat, flood protection and public safety, create a safe route for pedestrians and bicyclists along the greenway corridor linking the neighborhoods, existing trails, public open spaces and the downtown commercial core of the City of Martinez. Objectives:*
>
> - *Create a publicly accessible trail system which follows the creek where possible.*
> - *Where the creekside trail cannot accommodate bicycles, develop a separate trail adjacent to the creek for cyclists.*
>
> *Because the creek runs through the center of town, it forms a natural link between the residential area, the downtown and the waterfront, providing an excellent opportunity for a pedestrian corridor. Since the creek corridor is too narrow to accommodate a combined bicycle/pedestrian trail, it is recommended that bicycle trails be developed in city streets, reserving the creekside trail for pedestrians. Regional bicycle routes and hiking trails such as the Bay Area Ridge Trail pass through Martinez. Connections between these regional trails and the greenway corridor are recommended along City streets, encouraging visitors to explore the downtown area.*

This LACWMP does not address the design or construction of adjacent trails, however, it encourages interaction between the public and the natural environment.

> ***Goal 6:*** *Create public, creek related educational options throughout the greenway corridor. Objectives:*
>
> - *Near the Junior High School, provide secured access to the streambed, thereby creating an outdoor laboratory for use in public school and adult education.*
> - *Where appropriate, and consistent with wildlife habitat goals, create overlooks at the banktop with educational exhibits explaining the history and ecology of the creek.*
> - *Develop methods to increase community awareness of the creek.*
> - *Where possible, provide a banktop trail which will allow pedestrians to stroll along the creek corridor without disturbing the riparian habitat.*
>
> *Along the creek, as it moves from freshwater stream to brackish and saltwater marsh, alternative locations for educational exhibits are suggested at special stations or overlooks. At the upstream end of the study area, on the Junior High School property, an outdoor classroom is suggested in the hillside above the top of bank, with a trail leading into the creek (with a locked gate for security), continuing up the stream to provide direct views of aquatic life. The outdoor classroom and trail are intended to be used by the school or other organized groups on a closely monitored basis. The process of restoration itself can be educational, as Martinez residents witness and participate in the revegetation and bank stabilization efforts.*

This LACWMP is consistent with the goal to provide opportunities to install interactive panels and passive recreation opportunities when consistent with the preservation of habitat and the natural assets that the creek holds.

> ***Goal 7:*** *Enhance the economic health of the downtown area through the creek enhancement process. Objectives:*
>
> - *Promote creek related uses which will attract visitors to the downtown area, such as restaurants, shops and parks.*
> - *Encourage the modification of existing creekside buildings and outdoor spaces, where appropriate, to improve their relationship to the creek. Improvements could include new doors and windows to provide views and access to the creek, and creekside patios.*
> - *Encourage creek-related development of under-utilized public and private creekside parcels. Appropriate improvements would include the development of creek-related open spaces such as parks, markets or landscaped parking lots. All development should include wildlife habitat enhancements of the riparian zone.*
>
> *Creation of a greenway can stimulate further revitalization of the downtown. Bicycle and pedestrian trails will provide a new transportation corridor drawing people to the downtown commercial area. As shown in the plan, modification of creekside buildings and properties can stimulate more commercial activity. For example, at the old theater property at Ward and Ferry Streets, the owner could renovate the existing building and create a plaza-like open space near the creek, encouraging pedestrians to pass along the creek while visiting the theater. Similarly the auto showroom on Ward Street and the south side of the Old City Hall building could be renovated to take advantage of the sunny open areas overlooking the creek.*

One of the state goals of this LACWMP is to improve the downtown by creating a healthy and attractive flourishing natural environment for business patrons, employees, and the general public to enjoy.

4.2 MAINTENANCE AND MONITORING

> *An important issue implicit in the goals above is that of maintenance and monitoring of the creek, keeping it free of debris, maintaining the existing and future bank stabilization structures, as well as the vegetation along the corridor and the future trails and overlooks. The greenway and trail will be a new open space resource of the City requiring ongoing maintenance. In the Hydrology and Bank Stabilization and the Habitat Restoration and Enhancement sections of this report, maintenance and monitoring recommendations are made.*

Maintenance and monitoring are among the expressed goals of the LACWMP.

4.3 PHASING AND PRIORITIES

> *The Enhancement Plan is a vision for the creek which will be realized in phases over a period of time. The Plan can be broken down into discrete projects which may be funded individually and taken through the steps of design refinement, construction documents and implementation. In*

general, first priority projects should be high visibility improvements on public land. Such projects can be completed without the need for land purchases. Fortunately, a good deal of property along the creek is owned by the City, County, or the school district. Because the Enhancement Plan is integrated in its approach to access, habitat enhancement and bank stabilization, improvements to each segment of the creek should incorporate all of those aspects at once. Construction of trails or overlooks should occur along with changes to the creek banks and revegetation, as recommended by the Plan.

Access improvements can occur in two overall phases. The first phase would include all sidewalk improvements and street tree planting for the trail, as well as the high visibility improvements to the City-owned parking lots with corresponding development of the areas adjacent to the creek. In addition, the changes recommended on school district property, such as the outdoor classroom and the trail in the creekbed could be part of the first phase. These enhancements should be comprehensive and include educational exhibits, bank stabilization and revegetation as recommended in the Plan. The second phase of access improvements would involve projects where private ownership of creekside property or privacy of adjacent residents may be an issue. The trail behind the Senior Housing connecting the Senior Center with the existing and proposed housing, would be second phase projects. Also in this category are the recommended changes to the land around the Southern Pacific railroad.

In the areas of hydrology and bank stabilization, two top priorities will be to adopt a creek ordinance, and to conduct hydraulic studies to establish the existing channel capacity in Alhambra Creek. Information on existing channel capacity will be necessary before any modifications in the channel configuration or any significant revegetation within the channel can occur. In addition, water quality testing should be conducted, and sources of pollution, including the hazardous waste sites mentioned above, should be fully identified, investigated and removed. Along the banks where there is no access proposed, bank stabilization improvement will occur as the need arises or as funds become available.

Habitat restoration, like bank stabilization, should occur in tandem with access improvements in the same area. In other areas where there are no access improvements on public property, revegetation may occur as funding becomes available. Where revegetation is recommended on private property adjacent to the creek, planting must occur with concurrence (and participation) of the owner and technical assistance from the City.

Implementation of the Enhancement Plan will require the ongoing commitment of volunteers and staff to continue their involvement as "creek keepers". Ultimately the creation of the greenway as envisioned in the goals must be a cooperative venture among the public entities, dedicated citizens and staff, and the private property owners along the creek.

Many of the initial projects have been completed. Several hydrology and hydraulic reports, included by reference, were prepared between 1998 and 2008. Additional flow monitoring and reporting will result from the adoption of this report. A number of major Capital Improvement Projects were constructed that served to reduce the potential for flooding and enhance access to the creek. They also improved habitat in several locations. These projects are referenced in Section 2.3 above. Future projects to implement a bicycle and pedestrian trail will largely be dependent upon right of

way opportunities. These projects will require significant environmental and hydraulic analysis in order to determine consistency with the GP Open Space Element and the LACWMP.

In summary, the LACWMP has been determined to be consistent with the goals and objectives of the conservation element of the City's General Plan and in particular with the provisions of Section 22.A, the "Alhambra Creek Enhancement Plan".

APPENDIX A

BEAVER MANAGEMENT RECOMMENDATIONS

Available online at: https://www.cityofmartinez.org/departments/engineering/clean-water-program.

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APPENDIX B

PRIOR HYDROLOGY AND HYDRAULIC AND MITIGATION STUDIES

Prior Hydrology, Hydraulic and Mitigation studies included in this report by reference.

Appendix_B1_2001_WPG_pgs69-76_WatershedMgmtPlan_Downtown
Appendix_B2_2007_0308_PWA_AlhambraCreekBypassAssessment
Appendix_B3_2007_0517_PWA_Flooding&SedimentationStudy
Appendix_B4_2007_1016_PWA_BeaverDamAssmt
Appendix_B5_2008_0410_PWA_BeaverDamAssmt_Narrative
Appendix_B6_2008_MitigationProposalTemporalImpactsWetlands
Appendix_B7_LSA_Desilting_Sample_Application
Appendix_B8_LSA_Cultural_Resources_Study

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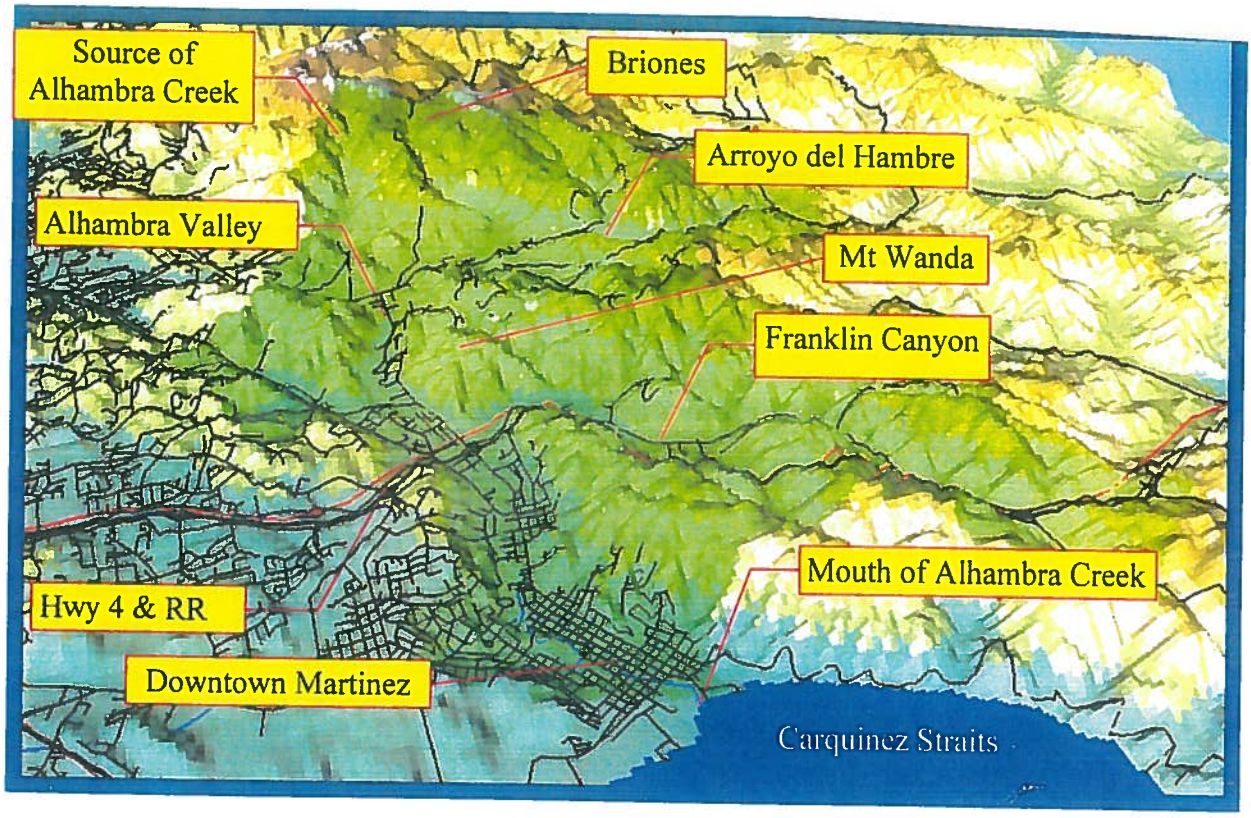
HARRIETT BURT
835 ROBINSON ST
MARTINEZ, CA 94553



Alhambra Creek Watershed (shaded in green)
Looking South from above Carquinez Straits

Alhambra Creek Watershed Management Plan

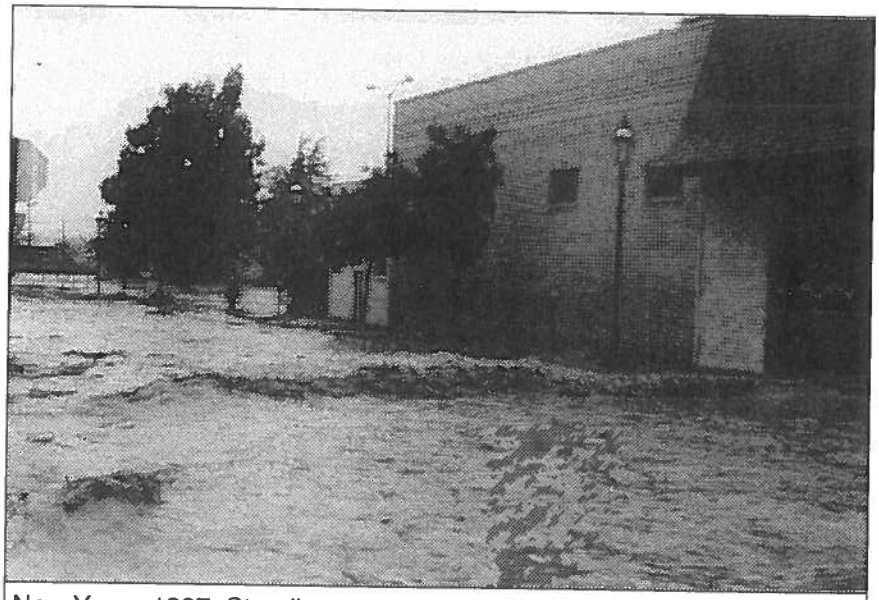
A Users Manual

Prepared by:
Alhambra Creek Watershed Planning Group
First Edition, April 2001

Downtown Martinez

The downtown area from Green Street to the Railroad Bridge occupies about ½ mile of the lower section of the creek.

This is the most densely developed section of the creek; significant portions had been undergrounded in large concrete box culverts.



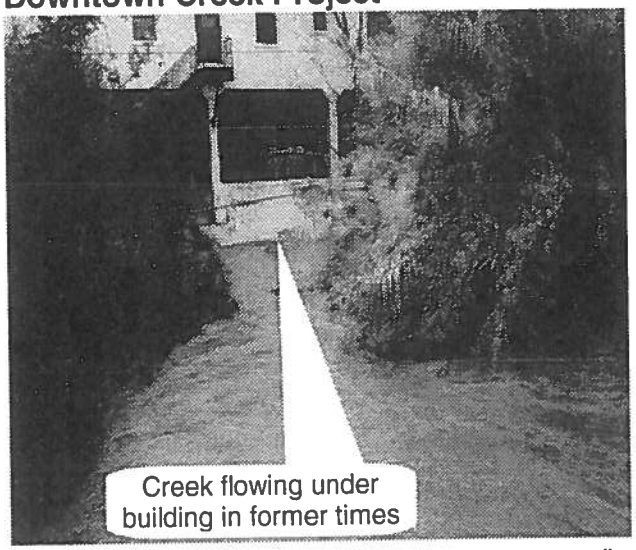
New Years 1997: Standing wave where the downstream flow meets the upstream tidal surge at Castro & Main Streets.

Castro & Main during drier times

The floodplain contains numerous buildings and is extensively paved. This section of the creek has a 2-year capacity and frequently floods. Sometimes the creek "jumps it's banks" upstream and runs down the streets parallel to the channel until it meets the creek again. This is what caused the standing wave at Castro and main. The floods typically last from a few hours to a day, and are exacerbated by high tides and onshore winds. Typically, the water is 1 to 2 feet deep and leaves mud behind when it recedes.

Adding to the flooding is runoff from side-watersheds such as Green Street. The water from these small sub-basins runs off rapidly, since much of the surface area is impervious roofs and pavement. In spite of the significant amount of impervious surface, considerable mud is also brought down these side channels, which in many cases are the streets themselves. There are typically no storm drains in the areas west of downtown.

Downtown Creek Project



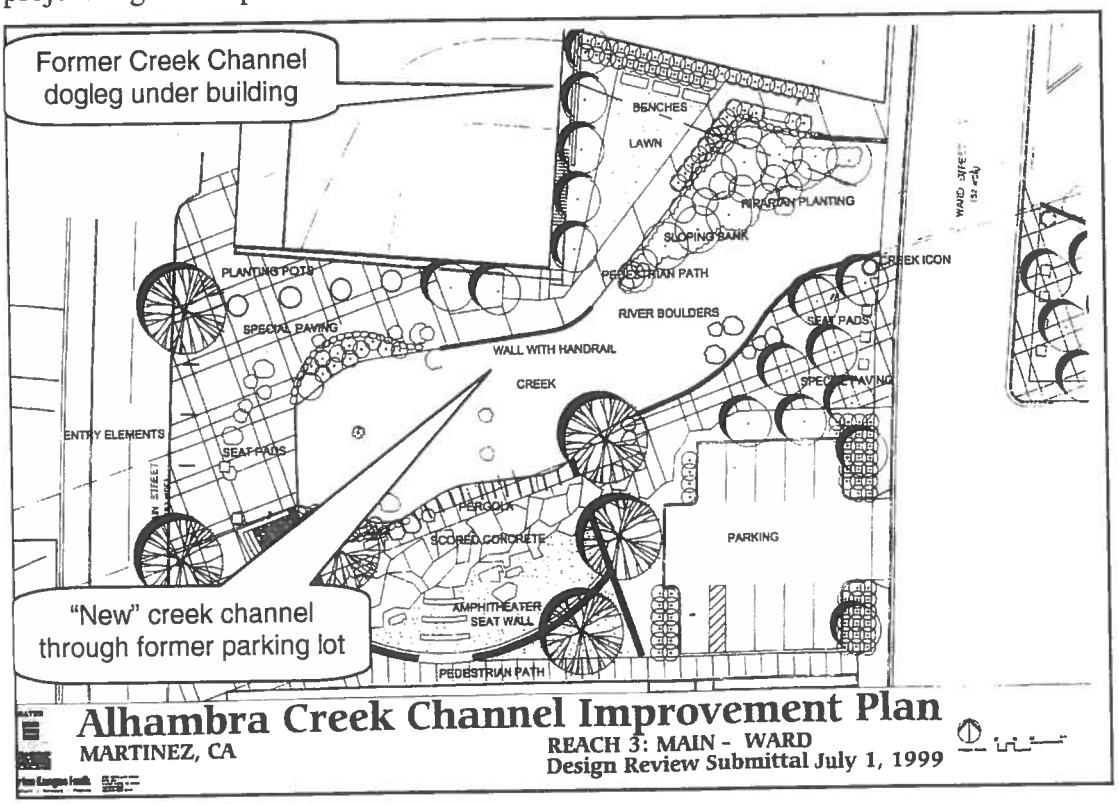
Alhambra Creek under the "City Hall Apartments" building in former times. The creek is being taken out from under this building in the new project.

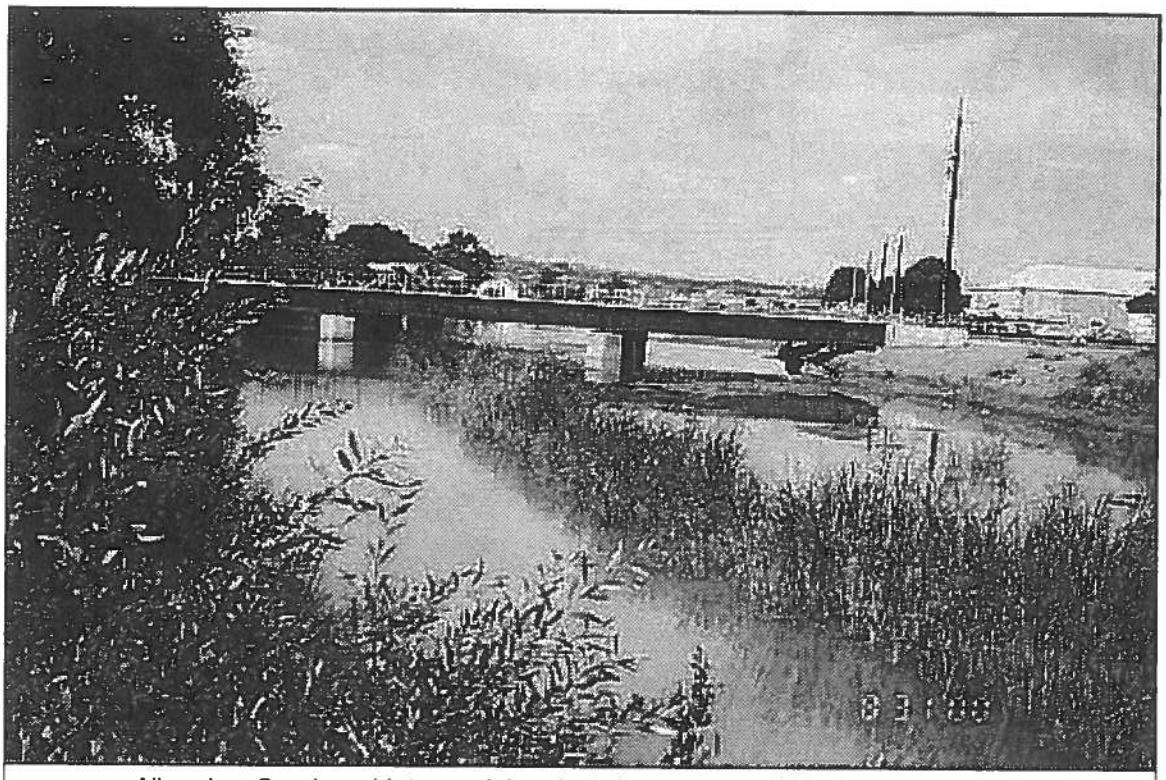
Alhambra Creek through downtown Martinez is being rehabilitated. Much of it is being daylighted and floodplains and terraces are being restored. The dogleg in the creek under the old "City Hall Apartments" building has been removed and replaced with a sinuous "S" curve through a former parking lot.

This downtown segment is combined with two other segments downstream to improve the flood protection to a 10-15 year level while also restoring some of the natural function of the creek.

The cost of this project is in excess of $6,000,000. The funding is from a combination of FEMA, the City of Martinez and from a self-assessment election in which the property owners in the flood-prone area voted to tax themselves to help pay for the project.

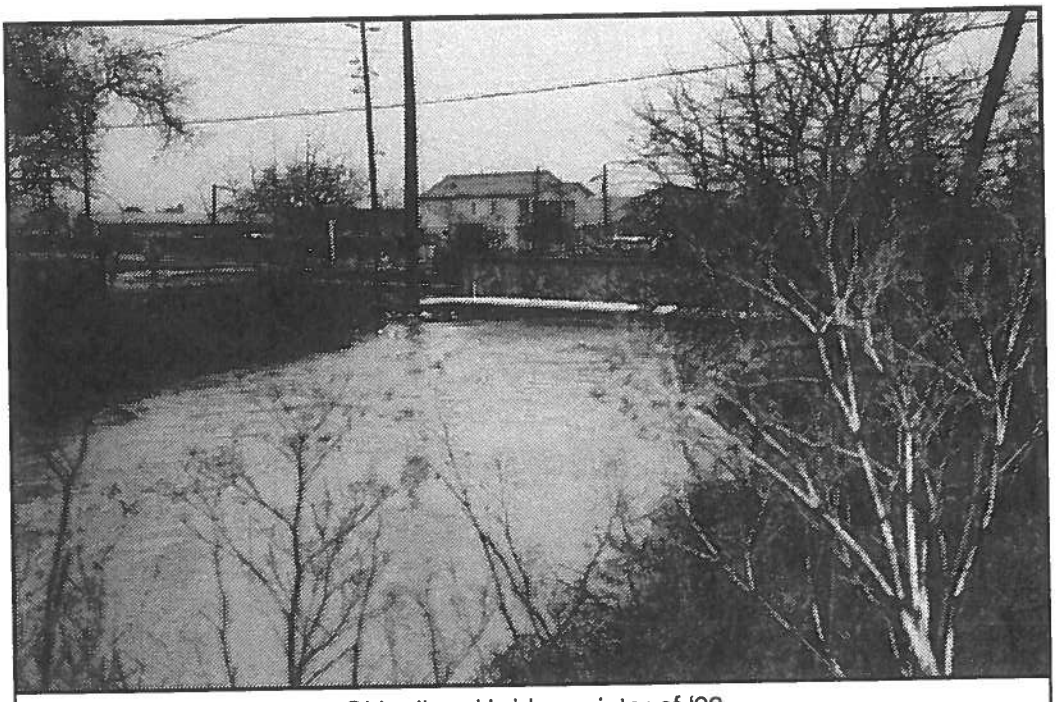
The daylighted sections, of the creek channel and the designated overflow areas will be developed as a scenic park-like area that can tolerate inundation. Construction of this project began in April 2000.



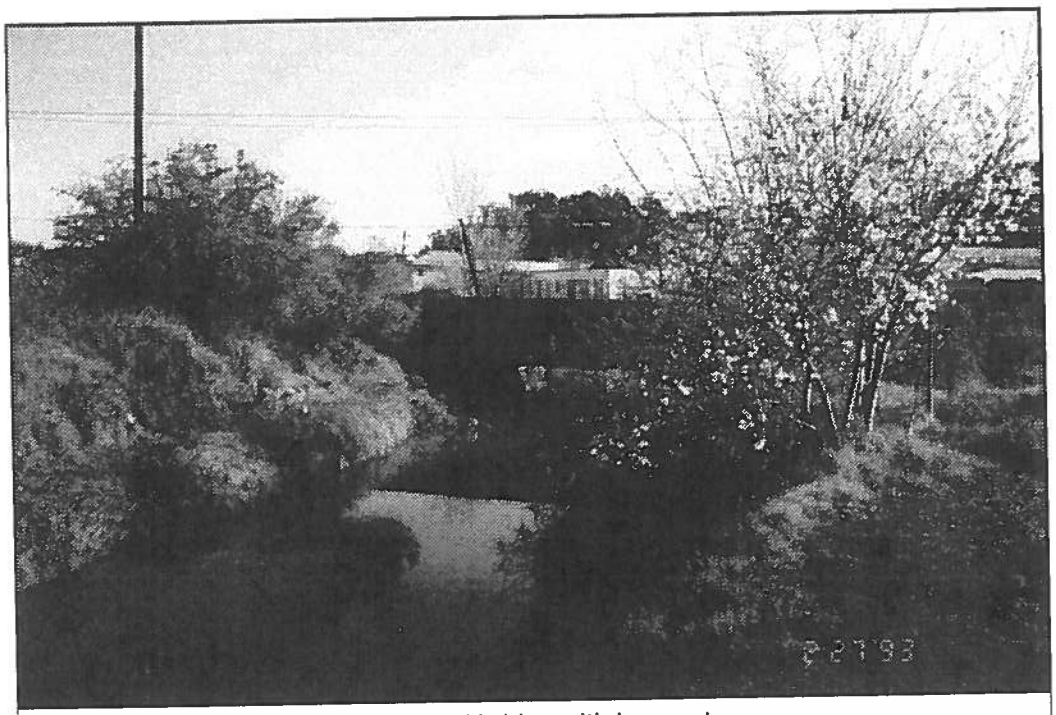


Alhambra Creek and Intermodal project downstream of Marina Vista Bridge

Pedestrian Bridge downstream of Marina Vista



Old railroad bridge, winter of '93

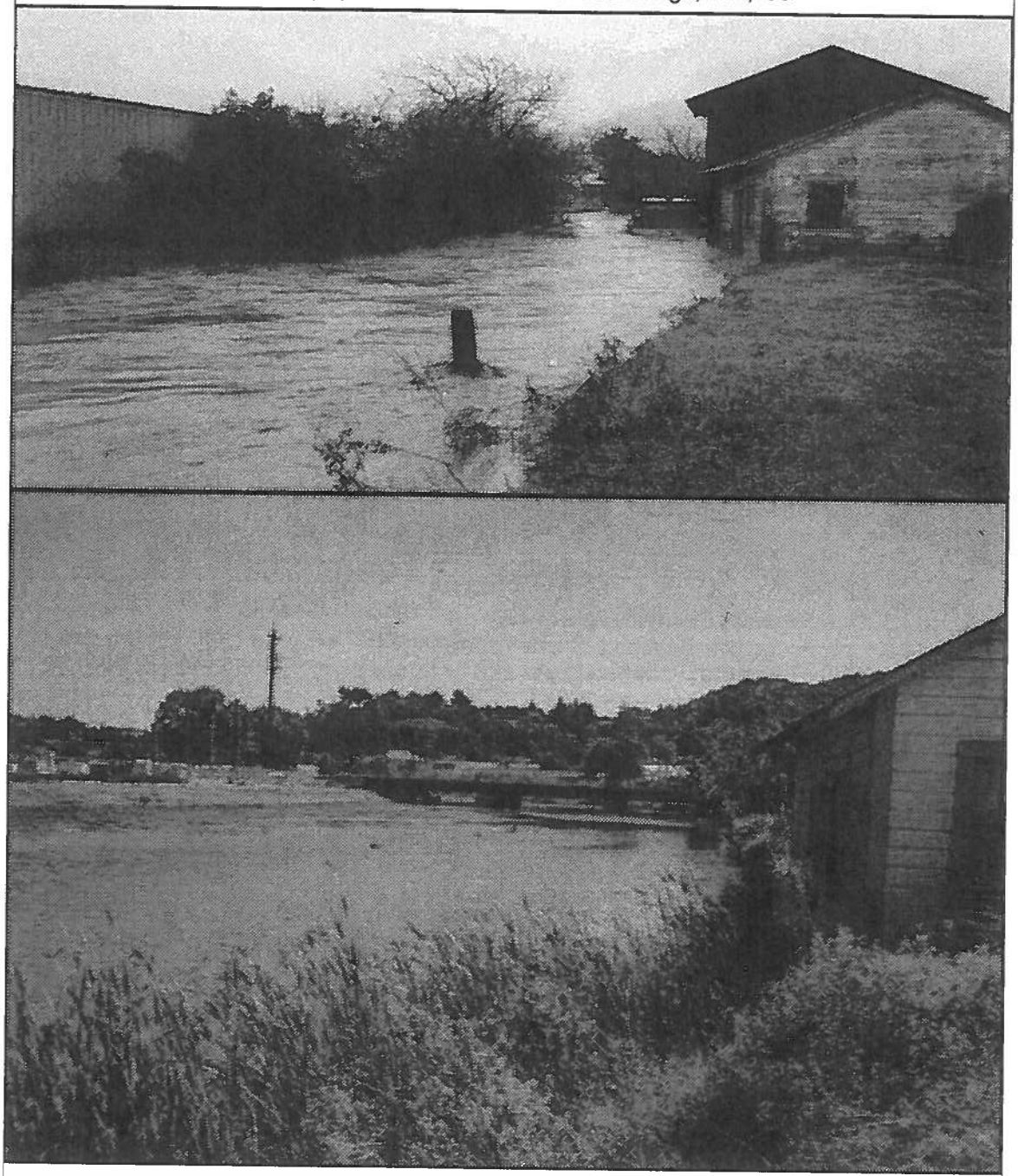


Old railroad bridge with less water

Intermodal Area

This is the section between downtown and the wetlands at the mouth of the creek. It is a single channel flowing through a flat, low-lying area. Low levees are on either side of the channel. The bottom of the channel from Escobar Street to the mouth is at or below sea level. High tides regularly reverse the flow in this channel up to Main Street. "Plus" tides (higher than average) reverse the flow up to Green Street.

Looking upstream toward old railroad Bridge, Feb, '93



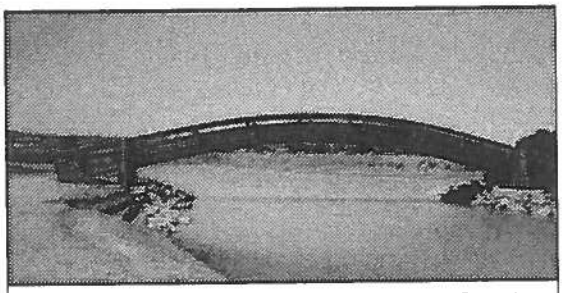
New railroad bridge. Fall 2000

Prior to 1999, the creek flowed through an area of warehouses, a corporation yard and light industry. A low railroad bridge crossed this section. Downstream of the bridge, a small neighborhood occupies the west bank of the creek.

View toward mouth of the creek at high tide from the Rainbow Bridge

In 1999 and 2000, the Intermodal Development Project significantly altered this section of Alhambra Creek. This project has moved and enlarged the rail passenger station and built roads and parking lots. The neighborhood and some of the light industry remain; however, the warehouses and corporation yard have been removed. As part of the project, the creek channel was widened and its outside bends were armored, floodplain terraces were enlarged and parking lots were designed to function as floodplains. Runoff from the site is routed through a water quality treatment pond, which also provides an overflow area. Replanting with willow and reeds provides bank stability and riparian canopy.

An issue of concern is the deposition of silt on these newly 'liberated' floodplains. In the winter of 1999-2000, about a foot of silt smothered the tules on the 'intermodal floodplain'. If this deposition continues at this pace, the floodplains will soon be built back up and will not function as intended. The silt will need to be regularly removed and/or excessive erosion upstream will need to be controlled to keep this floodplain functional.



Rainbow Bridge over Alhambra Creek in Martinez Regional Shoreline Park

The Railroad Bridge was a channel restrictor, especially when it collected debris. At times, rail traffic was delayed when this bridge was overtopped or debris-laden. The Railroad Bridge has been raised and enlarged to accommodate 100-year stream flows.

Mouth of the Creek

The reach downstream of the Railroad Bridge is a single channel that flows through wetlands and then discharges into the Carquinez Straits. This section is in the Martinez Regional Shoreline Park, administered by the East Bay Regional Park District.

The levels and flows in this section are greatly affected by the tides of San Francisco Bay. The levels vary by several feet and the flows regularly reverse. It is widely accepted that creek outflow is restricted in this section, especially at high tide. Because of the low elevation of the streambed, deepening the channel is not considered a viable means of increasing flow capacity.

The creek flows through wetlands that have been modified by levees and other landfills. As a result, the wetland is partially brackish and partially freshwater. Some of the land has been raised by fill and is no longer marshy. It is vegetated with upland plants.

Mouth of the creek at low tide, before widening and marsh restoration

In 1999 the floodplain was restored to this section of the creek and in 2000, a Regional Park District project will expand the marsh, restore the wetland to a brackish state and restore tidal channels for Delta Smelt habitat. Some of the "artificial upland" created by past filling may be excavated as part of the marsh restoration. Widening of the channel and providing low-lying marshes and terraces for creek overflow are seen as aids in getting water moved out of Downtown. These improvements may be short-lived, however, if siltation continues at the 1999-2000 rate.

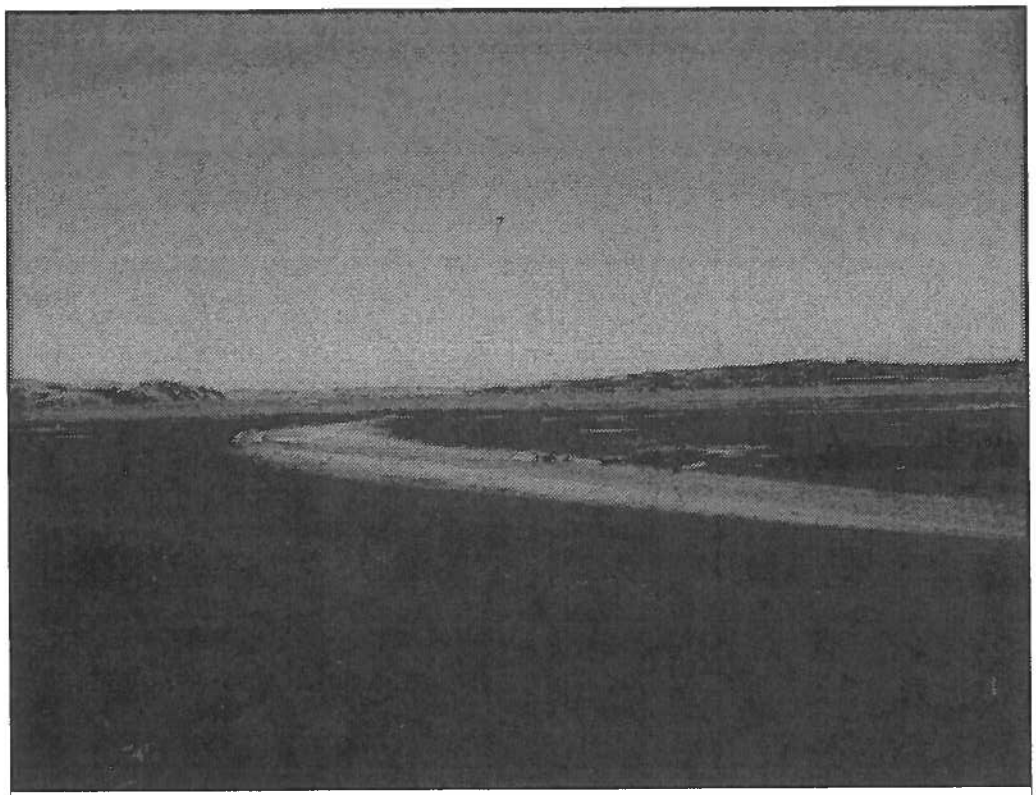
The source of funding for this project is mitigation for the construction of the replacement span of the Carquinez Bridge. (Some wetlands will be destroyed in the bridge project, so some wetland needs to be restored elsewhere to "mitigate" this loss.)

The creek discharges into the Carquinez Straits. At low tide, the channel can be seen extending through the mudflats beyond the wetlands.

Martinez Shoreline Wetlands

A remnant 150-acre tidal wetland at the mouth of Alhambra Creek is a place of shoreline passive recreational activities. The marsh has a typical assemblage of fresh, brackish and salt tolerant plants that create significant wildlife habitat. However, past human activities, including filling, development and colonization by non-native weedy species such as pepper weed *(Lepidium sp.),* has resulted in a degraded functional wetland with limited habitat value, especially for threatened and endangered species (e.g. clapper rail, salt marsh harvest mouse, alameda whipsnake etc.).

The Alhambra Creek channel and wetlands proper are being intentionally modified to accommodate larger peak flows to alleviate flooding in Martinez and to create a system of tidal channels that will provide beneficial habitat for Delta smelt *(Hypomesus transpacificus)*, a Federal threatened species. In addition, other marsh enhancement activities include removal of dense stands of pepper weed. Lowering the elevation of portions of the marsh plain and dredging activities will enhance the habitat values of this important ecosystem and help alleviate flooding in Martinez.



Channel through the mudflats at mouth of Alhambra Creek at low tide

PWA
PHILIP WILLIAMS & ASSOCIATES, LTD.
ENVIRONMENTAL HYDROLOGY
720 California St., Suite 600
San Francisco, California 94108-2404
tel 415.262.2300 fax 415.262.2303
www.pwa-ltd.com

MEMORANDUM

Date:	March 8, 2007
To:	Timothy Tucker
Organization:	City of Martinez, Engineering Department
From:	Mark Lindley, PE and Vince Geronimo, PE, CFM
PWA Project:	1823.01 – Martinez - Alhambra Creek Bypass Assessment
Subject:	**Draft Alhambra Creek Bypass Culvert – Initial Assessment**
Copy(ies) To:	

Introduction

Philip Williams & Associates (PWA) has assisted the City of Martinez (City) on issues related to flood management and habitat enhancement over the past 15 years. The City has implemented several projects since 1998 to improve flood conveyance and habitat values along the Alhambra Creek corridor. The Downtown Improvement Project included widening the creek corridor, creating a floodplain bench, and widening a number of bridge crossings between Marina Vista and Green Street. At the Intermodal Facility, a wide marsh-plain bench was created adjacent to the low flow channel and the Southern Pacific railroad bridge (SPRR) was replaced with a longer span with a higher bridge deck. Finally, the Salt Marsh Enhancement project at Grainger's Wharf included widening the creek corridor, creating marsh-plain benches adjacent to the channel, and providing a secondary outlet for discharge of high flows to the Carquinez Strait. Collectively, these projects have improved flood conveyance in Alhambra Creek from about the 2-year peak discharge to about the 8- to 10-year flood event. While these improvements have provided a dramatic decrease in flood hazards and damage, much of the city is still vulnerable to flooding during extreme rainfall-runoff events.

The purpose of this memorandum is to provide a brief assessment of a conceptual flood reduction plan that includes diverting a portion of the Alhambra Creek flow into a by-pass culvert system routed around downtown Martinez directly to the Carquinez Strait. The US Army Corps of Engineers (USACE) examined use of a by-pass culvert in combination with the Alhambra Creek channel capacity in an initial study from 1967 and a more detailed 1980 study. Using the USACE assessment as a basis, PWA 1) identified two potential bypass routes, 2) developed rough estimates of project costs, and 3) estimated the reduction of the 100-year floodplain area for by-pass culverts sized to convey the 12-year, 15-year, 25-year, and 100-year flood events. We have also included a short discussion of the design and construction issues of the bypass concept.

Approach

PWA's assessment consisted of the following primary tasks:

1. Review existing studies to determine current hydrology, channel hydraulics, and flood hazards associated with Alhambra Creek through the City of Martinez;
2. Identify the existing flow capacity of Alhambra Creek and additional flow capacity required for a by-pass system to manage 12-year, 15-year, 25-year, and 100-year rainfall events;
3. Identify potential bypass routes and pipe size requirements;
4. Develop cost estimates to implement the bypass alternatives by updating prior cost estimates provided by the USACE and using typical current unit costs; and
5. Estimate the reduced area of inundation resulting from implementing various by-pass systems.

Site Setting

Alhambra Creek drains an area of approximately 16.5 square miles of Coast Range foothills. Franklin Creek, a major tributary of Alhambra Creek drains an area of about 5.2 square miles in Franklin Canyon. Franklin Creek joins Alhambra Creek about a half mile north of Highway 4. Upstream of the confluence with Franklin Creek, the upper reach of Alhambra Creek originates in the Briones Hills at an elevation of about 1,100 feet and drains an area of about 8.9 square miles. At the confluence, about 38% of the peak flows are generated in the Franklin Canyon watershed and about 62% originate in the upper reach of Alhambra Creek (USACE, 1980).

Water in the creek travels about 8 miles north through the City of Martinez and discharges to the Carquinez Strait. Flows in Alhambra Creek are highly variable, ranging from low/no flow conditions in the late summer to bank full/flood conditions during moderate to intense storms in the rainy season. Alhambra Creek meanders through the downtown area mainly in an open channel. In general, the creek is incised; as the creek has downcut, bank failure has also occurred. In response, creekside landowners have implemented a variety of bank protection schemes with varying levels of success. In some areas, attempts to stabilize the banks have included placement of broken concrete, engineered riprap, sackrete, concrete, wood retaining walls, gunite, and rock-filled gabions (LSA 2004).

Flood Hazards

Alhambra Creek has a history of damage-causing floods. Heavy rainfall and subsequent runoff volumes that cannot be adequately conveyed by the existing channel cause flooding in the City. The lower portions of the City may also be susceptible to inundation by coastal hazards, such as tsunamis, extreme high tides, or sea level rise, due to the City's relatively low elevation and proximity to the Carquinez Strait. The most serious flood problems historically occur during the joint occurrence of a high peak flow and a high (spring) tide.

Despite the benefits of the recent flood reduction projects, much of the City is still located within the 100-year and 500-year special flood hazard zones, as mapped by the Federal Emergency Management Agency (FEMA) and is susceptible to regional flooding hazards. Areas subject to flooding are mainly found along Alhambra Creek floodplain (varying in width, but averaging about 1,000 feet) and are designated as the 100-year flood hazard zone.

Reducing flood hazards can be achieved by increasing channel conveyance (by providing a larger channel, reducing flow resistance, etc.) or by decreasing the amount of flow that the channel must convey. This latter approach can be accomplished by either storing rainfall-runoff in the upper watershed (with detention basins) or bypassing a portion of the flood flows around the channel. The first approach (increased conveyance) was accomplished through the downtown reach with the projects implemented by the City that replaced the railroad bridge and expanded the channel downstream of Green Street. The 1980 USACE study included an alternative that examined the benefits and possible locations for flood control reservoirs, but the plan was not pursued. In 2002, the Contra Costa County Flood Control District approved construction of a detention basin near Pleasant Hill Road and Nancy Boyd Park (LSA 2004). Details of the detention facility were not provided. Identifying other potential storage facilities within the watershed could help reduce flood hazards.

Hydrologic and Hydraulic Assessment

In the past 60 years, numerous damaging flood events have occurred along Alhambra Creek. Since gaging in adjacent watersheds began in 1939, the highest estimated peak flow on Alhambra Creek was 2,379 cfs (at D Street) in 1958, and the resulting flood inundated about 420 acres in the vicinity of Martinez (LSA 2004). The 10 highest estimated peak flows are presented in Table 1 below, the four highest estimated peak flows are all between 2,200 and 2,379 cfs (at D Street). The December 30-31, 2005 storm resulted in peak flow of about 2,225 cfs which was similar to the 1997 and 1982 events. Estimated return periods for the 10 highest estimated flows in Alhambra Creek based on the PWA flood frequency analysis are included in Table 1, below.

Table 1: Peak Flow and Return Period at the D Street Gaging Station

Water Year	Estimated Peak (cfs)	Return Period[1] (yrs)	Data Source
1958	2,379	11.1	Estimated from SPRR – PWA[2]
1997	2,235	10.1	D Street Gage – PWA[3]
2006	**2,225**	**10.0**	**D Street Gage Measurement – PWA**
1982	2,200	9.7	D Street Gage Measurement – USGS
1973	1,960	7.4	D Street Gage Measurement – USGS
1980	1,920	7.1	D Street Gage Measurement – USGS
1995	1,870	6.8	Estimated – PWA[4]
1986	1,840	6.3	D Street Gage Measurement – USGS
1963	1,794	6.1	Estimated – PWA[4]
1975	1,770	6.2	D Street Gage Measurement – USGS

[1] Return period based on results of HEC-FFA flood frequency analysis (PWA, 1997)

[2] Adjustment between SPRR estimate and D Street described in Alhambra Creek Flood Frequency Analysis (PWA, 1997)

[3] Estimated based on high water marks near the D Street Gage

[4] Estimated based on measurements at Pinole and Walnut Creeks (1963) or Wildcat Creek (1995) (PWA, 1997)

In 1980, the USACE developed a flood frequency analysis based on data collected at the D Street gage between 1965 and 1978 and an estimate of peak flow from 1958 at the SPRR, but did not include low peak flows from 1972 and 1976 (USACE, 1980). Adding the 1958 peak flow and dropping low flows from 1972 and 1976 added a bias to the 1980 USACE flood frequency estimates resulting in high estimates of peak discharge for each return period. In 1986, the Contra Costa County Public Works Department (CCCPWD) utilized 22 years of data collected at the D Street gage between 1965 and 1986 to develop flood frequency estimates (CCC, 1986).

In 1997, PWA prepared a HEC-FFA flood frequency analysis to statistically estimate 10-year through 500-year peak flows based on a 59 year extended record that covered 1939 through 1997. The extended flood record included measured data from the D Street gage collected by USGS between 1965 and 1986, estimates of peak flows from high water observations, and estimates of peak flows in Alhambra Creek based on transfer of information (measured peak flows in neighboring watersheds) (PWA, 1997).

Results of the USACE, CCCPWD, and PWA flood frequency analyses are presented in Table 2 below. Since the 1997 PWA analysis was based on a 58 year record, we rely on those results for design purposes along Alhambra Creek. The HEC-FFA analysis indicated that the 100-year peak flow for Alhambra Creek is 4,830 cfs at D Street and 5,222 cfs at the SPRR and the 10-year peak flow is 2,220 cfs at D Street and 2,400 cfs at the SPRR.

Table 2: Return Period and Peak Flow Comparison

Recurrence Interval (years)	PWA Study (at SPRR[1]) Peak Flow (cfs)	PWA Study (at D Street[2]) Peak Flow (cfs)	CCC-PWD Study (at D Street[2]) Peak Flow (cfs)	USACE Study (at D Street[2]) Peak Flow (cfs)
500	7,146	6,610	NA	9,990
100	5,222	4,830	5,200	6,420
50	4,368	4,040	3,450	5,080
25	3,618	3,350	NA	NA
10	2,400	2,220	2,330	2,480
5	1,600	1,480	NA	1,580
2	634	586	NA	575

[1] Contributing watershed at Southern Pacific Railroad Bridge = 16.5 square miles.
[2] Contributing watershed at D Street = 15.1 square miles.

In 1980, the USACE estimated the capacity of the Alhambra Creek was limited to 500 cfs (USACE 1980) at the most constrained portions of the reach through the downtown area prior to the improvements implemented by the City. The recently implemented improvement projects in downtown, at the Intermodal Facility, and at the Martinez Regional Shoreline were intended to increase the capacity of the channel from about the 2-year peak discharge to about a 7- to 8.5 year peak discharge (~1,900 to 2,100 cfs).

The December 30-31, 2005 storm event provided a good test of the Alhambra Creek capacity including the recently implemented improvement projects. Historically, an event of this size would have caused significant overbank flooding in Martinez. During the December 31, 2005 peak flow (10-year peak flow estimated at 2,225 cfs at D Street), Alhambra Creek experienced overbank flooding upstream of downtown with reports of out of bank flows at D Street, Brown Street, and in the vicinity of Alhambra Way. However, it appeared that the channel improvements downtown, at the Intermodal Facility, and at the Martinez Regional Shoreline were successful in preventing significant flooding within downtown Martinez. Based on the results of the December 2005 storm, we estimate that the capacity of the existing Alhambra Creek channel is about 2,000 cfs upstream of downtown in the vicinity of D Street. Within downtown, the capacity is somewhat dependent upon tidal conditions in the Carquinez Strait, but the channel was able to convey the December 31, 2005 storm peak discharge. HEC-RAS modeling indicates that the capacity within downtown should be about 2,000 cfs (at D Street) or about 2,160 cfs (at SPRR Bridge) with tidal conditions in Carquinez Strait at Mean High Higher Water.

Bypass Options

One method to reduce flood hazards in the City of Martinez would be implementation of a bypass culvert system to route a portion of the flows in Alhambra Creek originating upstream of City directly to the Carquinez Strait.

Design Flow Rates

With the capacity of the Alhambra Creek channel established at 2000 cfs in the vicinity of D Street, the bypass storm drain culvert must to provide sufficient additional capacity to convey a given design flow rate without over bank flows causing significant flood damages within the City of Martinez. We examined three design storms for the capacity of a bypass culvert system:

1. 100-year event (4,830 cfs at D Street). A bypass culvert sized to convey 2,830 cfs in addition to the capacity within the Alhambra Creek channel would provide sufficient capacity to remove the entire City of Martinez from the 100-year flood hazard zone identified by FEMA. This would require approximately a 12 x 12 feet wide box culvert and a 16 x 32 feet wide outfall. This option would significantly reduce flood risks for property within the City and provide substantial savings on flood insurance premiums. However, a 2,830 cfs bypass culvert would cost between $21 million and $41 million which may be prohibitively expensive for the City to implement.

2. 25-year event (3,350 cfs at D Street). This moderate option would require a bypass culvert with a 1,350 cfs capacity which is about half the capacity of a bypass culvert sized to convey the 100-year event. This moderate option would also provide substantial benefits for the City of Martinez by providing sufficient capacity to convey about 970 cfs more than the highest estimated peak flows along Alhambra Creek over the past 67 years. The 25-year option would require approximately a 10 x 9 feet wide box culvert and a 16 x 18 feet wide outfall. This option would address the periodic floods that have impacted the City of Martinez during the measurement record. However, since the floodplain adjacent to Alhambra Creek is relatively flat, only properties along at the base of the surrounding hills along the boundary of the floodplain would

be removed from the 100-year flood hazard zone. A 1,350 cfs bypass culvert would cost between $15 million and $31 million requiring significant funding to implement.

3. 15-year event (2,740 cfs at D Street). This smaller moderate option would require a bypass culvert with a 740 cfs capacity would provide sufficient capacity in addition to the capacity in Alhambra Creek to convey about 360 cfs more than the highest peak flow observed over the past 67 years. This 15-year option would require about an 8 x 7 feet wide box culver with a 12 x 15 feet wide outfall and would cost between $12 million and $27 million to implement.

4. 12-year event (2,470 cfs at D Street). A much smaller bypass culvert sized to convey 470 cfs in addition to the capacity in Alhambra Creek would provide sufficient discharge capacity to convey the highest peak flow observed over the past 67 years. This 12-year option would require an 8 x 5 feet wide box culvert with a 12 x 11 feet wide outfall. This smaller option would allow the City of Martinez to address the periodic peak discharges that have caused floods and related damage in the past. However, based on the existing flood frequency analysis, this option offers very little additional capacity beyond the highest flow on record. A future extreme event beyond a 12-year design discharge will cause flooding that impacts the City of Martinez. This smaller option will have a negligible impact on the area included in the 100-year flood hazard zone. However, this smaller option costing between an estimated $9 million and $25 million may be more realistic given limited funding resources. In addition, this smaller option may work well if the City plans to implement one or more detention facilities in the upper reaches of the watershed to address peak flows and sediment production.

Bypass Route

Two potential bypass routes are presented in Figure 1. The longer route is based on the recommendations from the USACE 1980 study and a shorter alternative route identified by PWA.

1. The Longer Route (identified by the USACE) includes diverting floodwaters from Alhambra Creek at the John Swett School to a pipe under Alhambra Valley Road. Flood flows in Franklin Creek would be diverted to a pipe under Franklin Canyon Road. At the intersection of Franklin Canyon Road and Alhambra Valley Road, the flows would be routed in a single pipe under Franklin Canyon Road, crossing State Highway 4, to Alhambra Way. North of State Highway 4, the pipeline route would continue along Alhambra Way, under the creek, through Montecito School to Alhambra Avenue. The route would continue below Alhambra Avenue to Berrellesa Street, and under Berrellesa Street, under the SPRR, with an outfall to Alhambra Creek near the Salt Marsh Enhancement Project at Grainger's Warf. In total, the Longer Route would require a storm drain pipeline approximately 17,900 feet long.

2. The Shorter Route (identified by PWA) involves diverting flood flows from Alhambra Creek and Franklin Creek north of Highway 4 with a significantly shorter total bypass route. The shorter option includes diverting floodwaters from Alhambra Creek at the Alhambra Way crossing into a pipe under Alhambra Way to Alhambra Avenue. Flood flows from Franklin Creek would be

diverted at the Alhambra Avenue crossing into a pipe running under Alhambra Avenue and would join with the Alhambra Creek diversion pipe at Alhambra Way. The route would continue below Alhambra Avenue to Berrellesa Street, and under Berrellesa Street, under the SPRR, with an outfall to Alhambra Creek near the Salt Marsh Enhancement Project similar to the Longer Route option. In total, the Shorter Route would require a storm drain pipeline approximately 10,900 feet long saving the installation of about 7,000 feet of pipeline as compared to the Longer Route.

The Longer Route was studied in detail by the USACE in preparation for their 1980 Study of Alternatives. This route bypasses flow further upstream in Alhambra Creek, potentially addressing portions of the channel upstream of Highway 4 that have limited conveyance. By comparison, the Shorter Route identified by PWA bypasses flows upstream of areas known to have overtopped during the December 2005 events. This shorter route has not been studied in detail, and may not address areas of the existing channel that have limited capacity upstream of Alhambra Way and Alhambra Avenue creek crossings. The Shorter Route is more cost effective and eliminates crossing Highway 4 and the existing Alhambra Creek channel with a storm drain pipeline included in the Longer Route. Additional study would be required to determine the capacity of the channel upstream of the diversion locations to identify and address areas with limited capacity to help limit the potential for flooding originating upstream of the diversion locations.

Bypass Culvert Size

PWA developed estimates of the required storm drain pipeline lengths and culvert sizes for six potential options using the Longer Route and Shorter Route for each of the three (100-year, 25-year, 15-year, and 12-year) design events. We utilized pipeline length and size information identified by the USACE for a 2,870 cfs bypass pipeline for the 100-year (2,830 cfs) bypass. For smaller bypass options, culvert sizes were adjusted using Manning's equation taking into account flow area and hydraulic radius assuming that hydraulic slope and pipeline roughness would remain unchanged. Estimates for pipeline lengths and sizes are presented in Tables A-1 through A-8. Pipeline sizes for each design event include:

1. 100-year event (2,830 cfs Bypass). Using the Longer Route, the diversion at the John Swett School utilizes 8 feet diameter culvert expanding to a 9 feet diameter culvert and the Franklin Creek diversion uses a 10 feet diameter culvert. The two culverts converge into a 10 x 11 feet box culvert south of Highway 4. North of Highway 4 to Alhambra Way, the box culvert expands to 10 x 13 feet wide. Using the Shorter Route, the Alhambra Way and the Franklin Creek diversions utilize 10 feet diameter culverts that combine into a 12 x 11 feet wide box culvert at Alhambra Avenue. North of Alhambra Way and Alhambra Avenue, both routes utilize similar pipeline sizes. Between Alhambra Way and Allen Street, a 12 x 11 feet wide and 12 x 12 feet wide box culverts would be required under Alhambra Avenue. Between Allen Street and the SPRR Bridge, 12 x 12 feet wide and 12 x 18 feet wide box culverts are required under Berrellessa Street. The discharge under the SPRR Bridge requires a 16 x 32 feet wide box culvert.

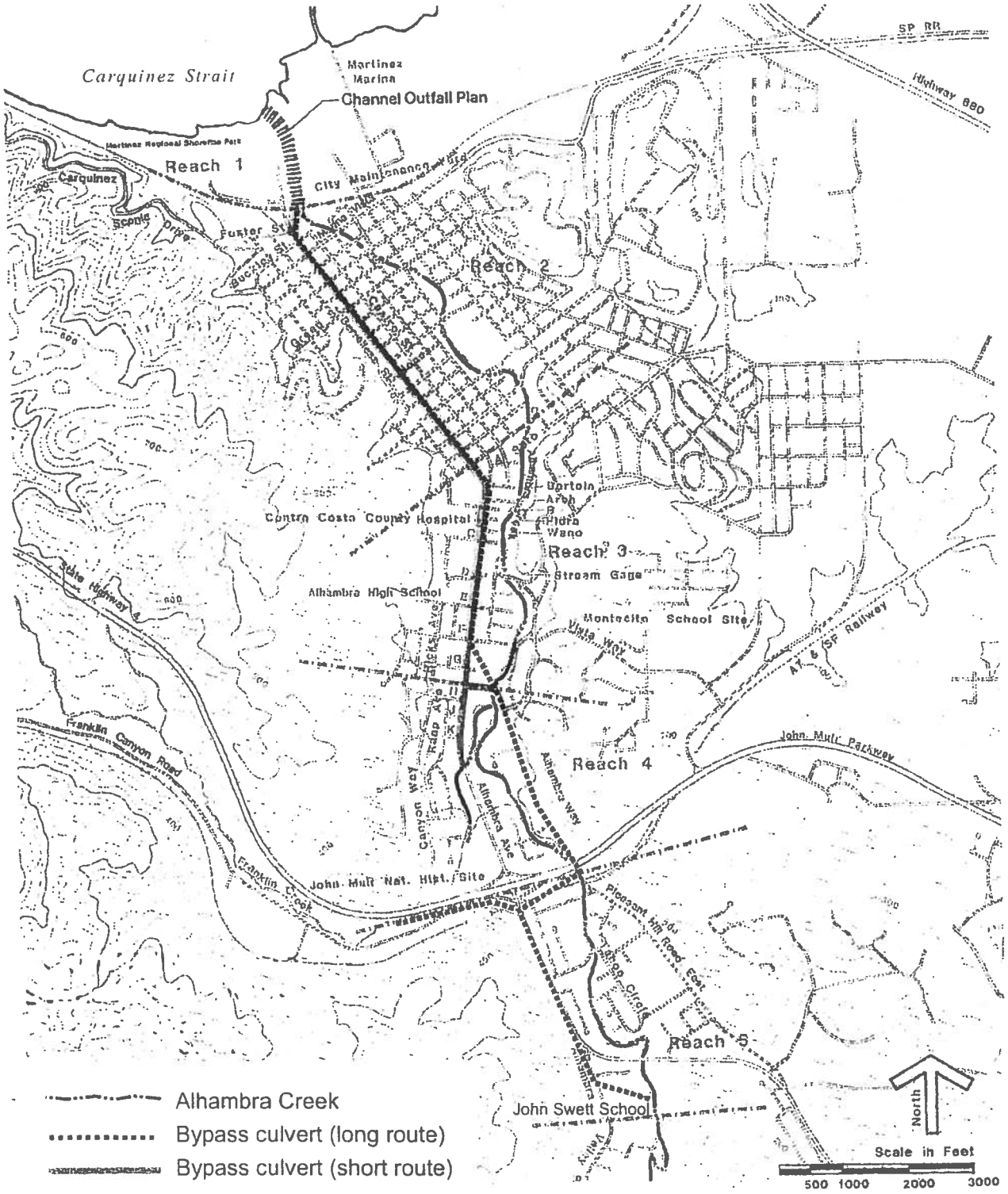


figure 1

Martinez-Alhambra Avenue Bypass Assessment

Alhambra Creek Bypass Culvert

Base Map Source: ACOE 1980

Project # 1823.01 Alh_Ck_Byp_Clvt.cdr

PWA

2. 25-year event (1,350 cfs Bypass). The Alhmabra Creek and Franklin Creek diversions require 6 feet to 8 feet diameter culverts. South of Highway 4, the two culverts converge into a 10 x 6 feet wide box culvert that expands to 10 x 8 feet wide north of Highway 4 to Alhambra Way. Under Alhambra Avenue, 10 x 8 feet wide and 10 x 9 feet wide box culverts would be required between Alhambra Way and Allen Street. Under Berrellessa Street between Allen Street and the SPRR Bridge, 10 x 9 feet wide and 12 x 11 feet wide box culverts are required. The discharge under the SPRR Bridge requires a 16 x 18 feet wide box culvert.

3. 15-year event (740 cfs Bypass). The Alhambra Creek and Franklin Creek diversions require 6 diameter culverts. An 8 x 5 feet wide box culvert is required South of Highway 4, and a 8 x 6 to 8 x 7 feet wide box culvert is required north of Highway 4 to Alhambra Way. From Alhambra Way to the SPRR Bridge, 8 x 7 and 8 x 10 feet wide box culverts are required and the discharge under the SPRR Bridge requires a 12 x 15 feet wide box culvert.

4. 12-year event (470 cfs Bypass). The Alhambra Creek and Franklin Creek diversions require 5 feet to 6 feet diameter culverts. An 8 x 4 feet wide box culvert is required South of Highway 4, and a 8 x 5 feet wide box culvert is required north of Highway 4 to Alhambra Way. From Alhambra Way to the SPRR Bridge, 8 x 5 and 8 x 7 feet wide box culverts are required and the discharge under the SPRR Bridge requires a 12 x 11 feet wide box culvert.

Culvert sizes increase as the storm drain pipeline traverses through downtown and discharges north of the SPRR Bridge because the slope of the watershed flattens as it approaches the Carquinez Strait. At the SPRR Bridge, we recommend that the storm drain culvert be installed under Berrellessa Street to maintain the existing conveyance within the restored creek channel. Discharge from the storm drain pipeline requires a wider culvert to overcome backwater effects caused by high tides in the Carquinez Strait. The discharge location should be downstream of the SPRR Bridge either into the restored Salt Marsh or into a separate marsh area.

Project Cost Assessment

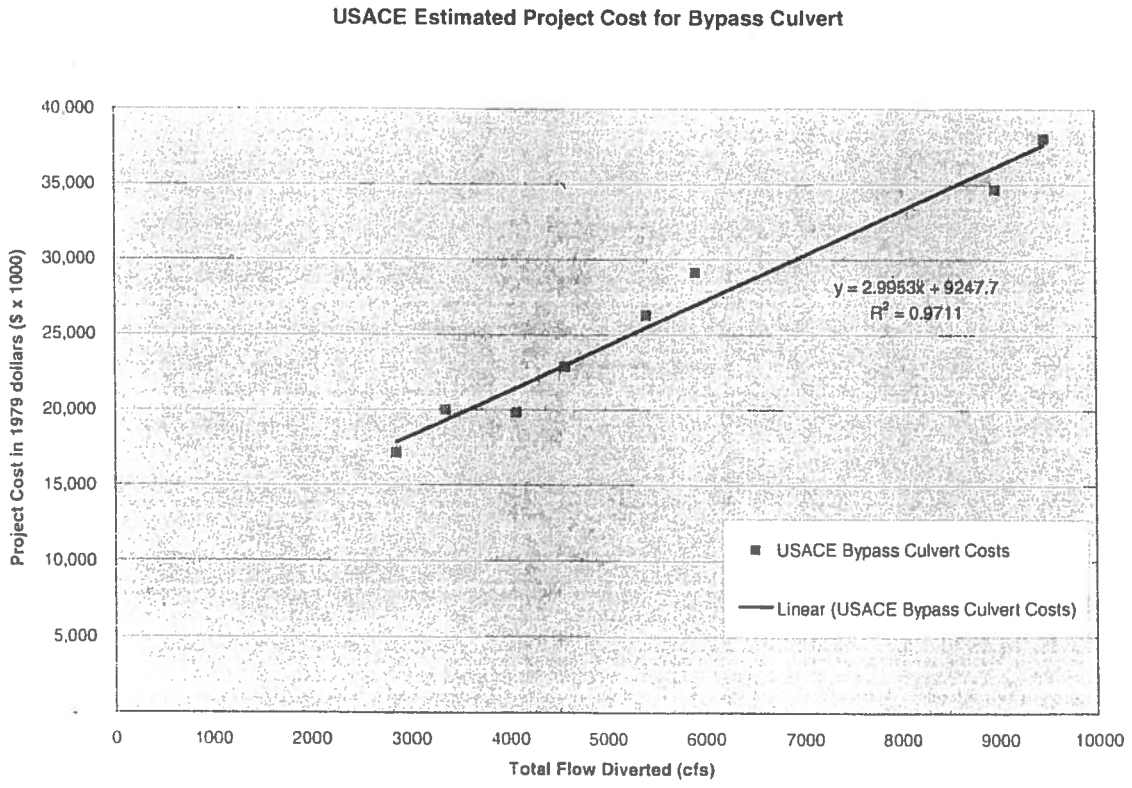
Implementation of a bypass culvert project requires funding to cover total project costs for engineering and design; construction; supervision and administration; lands, easements, and right of way; and relocations. The USACE 1980 study provided detailed cost estimates for several bypass options based on the required culvert size and length for each option. PWA updated prior estimates to provide project cost estimates in 2007 dollars for the eight bypass options described above. To estimate these project costs, we utilized two methods:

1. For the three longer route bypass options that reflect the route studied by the USACOE, we directly adjusted costs provided in the USACE study to 2007 dollars and adjusted those costs based on the bypass flow rates identified above.

2. For all six bypass options, we utilized unit costs for reinforced concrete storm drain culverts provided by the Contra Costa Transportation Authority with estimated culvert sizes and lengths.

The USACE 1980 study provided detailed cost estimates for several bypass culvert options with varying design flow rates based on the required bypass culvert size and length for each option. These estimates included eight bypass options with design flow rates ranging from 2,870 to 9,490 cfs to address 25-year through 500-year return period peak discharges (based on the USACE 1980 flood frequency analysis in conjunction with the estimated creek capacity). The USACE cost estimates for each bypass option included construction costs with a 20% contingency, engineering and design (15% of construction costs), supervision and administration (10% of construction costs), lands, easements, and rights-of-way (1.5% of construction costs), and relocations (3.5% of construction costs) to provide an estimate of the total project implementation cost in 1979 dollars. To forecast the potential cost to construct a diversion and by-pass system the USACE 1979 costs were plotted against the flowrate diverted from Alhambra Creek. A linear estimate of the project cost vs. flowrate diverted was determined based on the eight bypass options identified by the USACE in their 1980 study. See Figure 2 below.

Figure 2: Estimated Project Costs vs. Bypass Flowrate



Source: USACE 1980 Study

To estimate the costs to for the three proposed bypass options with the Longer Route that was proposed by the USACE, PWA used the linear relationship of project costs vs. flowrates presented in Figure 2. The linear relationship reflects about $9.25 million in baseline costs for implementation of a bypass culvert system with minimal capacity. The methods defined in the Civil Works Construction Cost Index System (CWCCIS) (USACE, 2000) were used to escalate these estimates to 2007 dollars. Our estimate of escalation is based on the Civil Work Breakdown Structure (CWBS) Feature Code for Floodway Control & Diversion Structures for the analysis. According to the CWCCIS average costs for flood control infrastructure have risen 233% across the 28 year span. Costs such as land may have increased at greater rates. Estimated project costs using escalated USACE cost estimates adjusted for design flow rate for the three Longer Route options ranged from $24.8 million to $41.3 million and are presented below in Table 3.

PWA also used unit costs provided by the Contra Costa Transportation Agency (CCTA) for installation of reinforced concrete box culverts to develop independent estimates of project costs for the six proposed bypass options. CCTA unit costs were escalated from $80 per square foot in 2003 dollars to $98.83 per square foot in 2007 dollars using the CWCCIS. With the storm drain culvert lengths and sizes determined for each option, we applied the escalated CCTA unit costs to determine estimated construction costs. Similar to the USACE project cost estimates, we applied a 20% contingency to estimated construction costs. We also provided estimates for engineering and design (20% of construction costs), supervision and administration (10% of construction costs), lands, easements, and rights-of-way (5% of construction costs), and relocations (10% of construction costs) to provide an estimate of the total project implementation cost in 2007 dollars. As compared to the 1980 USACE project cost estimates, we increased the engineering and design costs from 15% to 20% to cover the perceived difficulties of working along Alhambra Avenue and Berrellessa Street, two major streets in Martinez that are likely to present design and engineering complexities related to significant existing subsurface utility lines. We also increased the allowance for lands, easements, and rights-of-way from 1.5% to 5% and relocations from 3.5% to 10% of construction costs to account for the increase in land values, potential for significant utility relocations, and traffic control issues along the Alhambra Avenue and Berrellessa Street with numerous businesses that will need to be accommodated during construction. Detailed breakdowns of the estimated project costs are presented in Tables A-1 through A-8, and a summary is provided in Table 3, below.

Table 3: Bypass Culvert Project Cost Estimates

Return Period	Bypass Design Flowrate (cfs)	Bypass Route	Bypass Length (feet)	CCTA[1] Unit Costs	USACE[2] Escalated Costs
100-year	2,830	Longer	17,900	$36,700,000	$41,300,000
100-year	2,830	Shorter	10,900	$21,300,000	NA
25-year	1,350	Longer	17,900	$25,600,000	$31,000,000
25-year	1,350	Shorter	10,900	$15,100,000	NA
15-year	740	Longer	17,900	$19,900,000	$26,700,000
15-year	740	Shorter	10,900	$11,800,000	NA
12-year	470	Longer	17,900	$16,400,000	$24,800,000
12-year	470	Shorter	10,900	$9,000,000	NA

[1] CCTA – Project costs based on Contra Costa Transportation Agency unit costs for concrete box culverts. Detailed breakdowns provided in Tables A-1 through A-8.

[2] USACE – Project costs based on project cost estimates provided by the USACE in 1980 adjusted from lower proposed bypass capacity and escalated to 2007 dollars.

Project Benefit Assessment

The City of Martinez lies along the relatively flat floodplain of Alhambra Creek. As such, large portions of the City are subject to flooding during an extreme runoff event. Efforts implemented by the City to increase the capacity of Alhambra Creek between downtown and the Carquinez Strait have helped reduce flooding and damages resulting from smaller events up to about a 10-year return period. Implementation of a bypass culvert could help further reduce flooding and damages for more extreme return period events depending on the size of the culvert system. Developing a hydraulic model to determine the affects of various bypass culvert options on areas and depths of flooding within the City was beyond the scope of this study. However, to help demonstrate an approximate reduction in areas subject to flooding for each bypass option, we adjusted inundation areas provided by the USACE in their 1980 study. To estimate actual flood reduction benefits a benefit analysis should be conducted using current USACE methods. Anticipated damages and residual damages should be re-estimated and affluent benefits and ecological benefits should all be considered.

Inundation areas were estimated by the USACE based on the flow rates they identified for 25-year through 100-year peak discharges in their 1980 study. These inundation areas and flow rates were used to estimate the reduced area of flooding in the City with the current channel improvements and implementation of each proposed bypass culvert option.

1. The portion of discharge that flowed out-of-bank was determined based on the USACE's estimate for Alhambra Creek capacity of about 500 cfs in 1980 to provide a relationship of out-of-bank

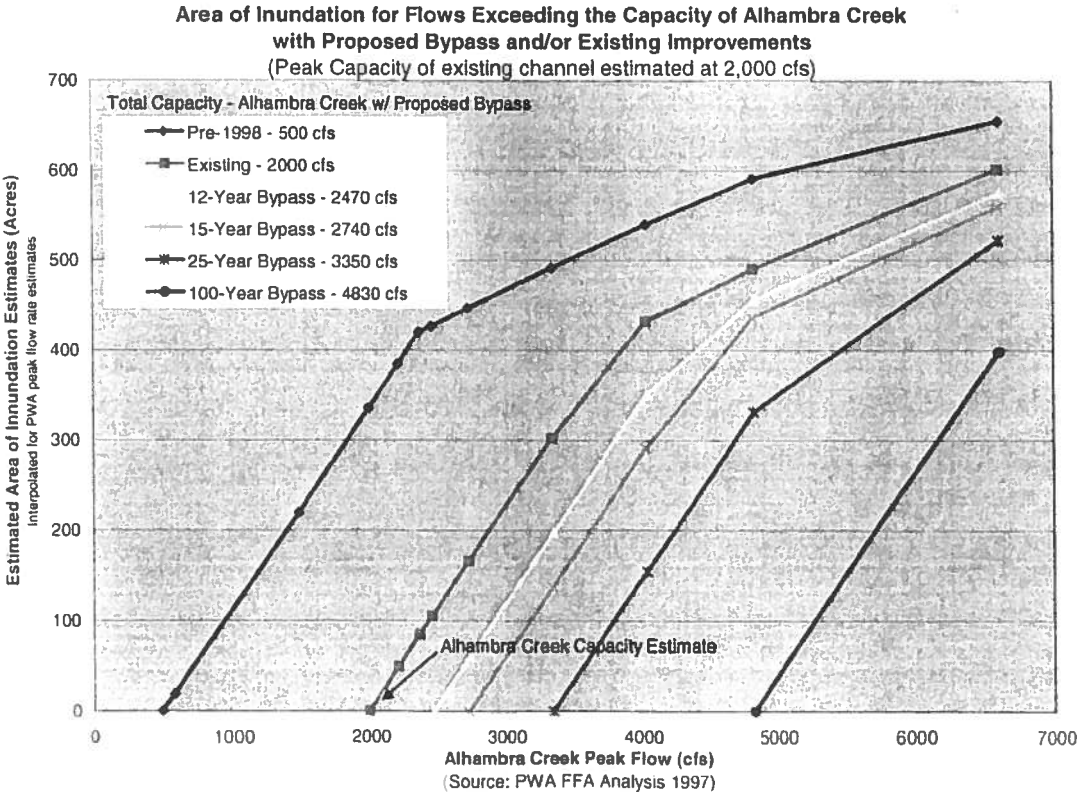
flow to flood area. LSA's estimate of 420 acres of flooding resulting from the 2,379 cfs event in 1958 was also added to the relationship.

2. For the range of peak flows through the 500-year return period identified by PWA, we estimated the portion of the flow that was out-of-bank based on the capacity of the pre-1998 channel, the existing channel, and the existing channel augmented with the four proposed bypass capacities (12-year through 100-year).

3. For the resulting out-of-bank portion of flow for each scenario, we used the relationship of out-of-bank flow and flooded area to estimate flooded area for the range of peak flows with each channel/bypass capacity.

Plots of the resulting inundation areas for a range of flows for the pre-1998 channel, the existing channel, and the exiting channel with the four proposed bypass options is presented below in Figure 3.

Figure 3: Area of Inundation



The inundation curves plotted above demonstrate the approximate level of flood reduction achieved through the implementation of the improvements between downtown and the Carquinez Strait and the increase level of flood reduction if the City was to implement a bypass culvert option. Using the figure above, it is assumed that a 100-year flood event (4,830 cfs at D Street) would inundate an area of about 490 acres with the current Alhambra Creek channel with 2000 cfs capacity. Implementing the 12-year bypass (470 cfs) would reduce this area by about 45 acres (9.2%), the 15-year bypass (740 cfs) would reduce the 100-year floodplain to about 440 acres (an 11% reduction), the 25-year bypass would reduce the 100-year floodplain to about 330 acres (a 32% reduction), and the 100-year bypass would theoretically remove the entire City from the 100-year floodplain. Depths of out-of-bank flooding would also be reduced.

Constraints

Design and construction constraints would be typical for implementing a large bypass culvert system through an urbanized area. Below are a few design and constructed related constraints:

- The by-pass flow rate assumes a 2,000 cfs capacity of Alhambra Creek. The area of reduced flooding depends on the local storm drain system and its ability to function under peak flow (high tailwater) conditions in Alhambra Creek. Storm drain infrastructure improvements were not part of the cost assessment.
- Buried utilities could be impacted by the selected alignment.
- Defining the construction corridor and obtaining the required right of way along the creek could be costly. The City of Martinez has several historic sites in the vicinity of Alhambra Creek.
- High tides presently affect the capacity of Alhambra Creek to outfall at Carquinez Strait. Similar tailwater conditions will affect the outfall for any bypass culvert option.
- Environmental concerns may also factor into the feasibility of the by-pass.
- The site topography was not reviewed as part of this assessment. It is assumed that all by-pass options can maintain a positive (gravity controlled) slope and remain below grade.
- Sedimentation and sediment removal may become problematic for a system that currently transports heavy sediment loads. Shoaling may occur at the diversion or inside the storm drain pipe near the outfall. The sedimentation problems that currently impact the lower reaches of Alhambra Creek would similarly impact a bypass culvert.
- Because the bypass option will run the length of the existing creek the maintenance requirements including sediment removal would increase.
- Continued urbanization within the watershed could further increase runoff and exacerbate flood hazards along the City's creek.
- Construction of a bypass system could cause disruption to business and traffic. This public concern should be recognized in future planning.

Funding Sources

The following funding options may provide a resource for implementing the bypass or fund further flood reduction studies. The Governor's Office of Emergency Services (OES) has funding to mitigate for flooding. Here are a few resources for various OES/FEMA grants:

Pre-Disaster Mitigation – California OES administers the FEMA's Pre-disaster Hazard Mitigation (PDM) Program. The purpose of this program is to support local communities in becoming disaster resistant. Communities who wish to participate must demonstrate commitment to implementing hazard mitigation activities within their jurisdiction.
http://www.oes.ca.gov/Operational/OESHome.nsf/1?OpenForm

Hazard Mitigation Grant Program (HMGP) - FEMA makes this program available to states after each disaster declaration. The HMGP provides up to 75% in funding for hazard mitigation measures to support cost-effective measures to reduce the risk of damage and human suffering from future disasters.

Flood Mitigation Assistance (FMA) - the FMA program provides assistance and grants to states and repetitive loss communities for activities that will reduce the risk of flood damage to repetitive loss structures insurable under the National Flood Insurance Program (NFIP). FMA provides grants up to 75% for both planning and projects on an annual basis.
http://www.fema.gov/government/grant/fma/index.shtm

Conclusions

Historically, peak flood flows in the Alhambra Creek Watershed have generally not exceeded the 12-year event based on the available gaging station readings. These may not include all bypassing flows that exit the channel upstream. While the 500-, 100-, and even the 50-year flood events increase areas of inundation, these areas are not significantly different than those associated with the 25-year event due to the relatively flat nature of the existing floodplain. Our estimates show that providing protection for the 100-year event (up to $41 million) would provide a greater level of flood protection, reduce flood hazards and flood damage and remove property within the City from the regulated floodplain. However, PWA's examination of the 12-year through 25-year peak flow bypass culverts illustrate that implementation of a smaller bypass culvert would have relatively high costs ($9 million to $31 million) for a flood reduction project that will not significantly reduce the area of the FEMA designated floodplain (only by about 9% to 32%). The feasibility of any solution at this scale would clearly require a major evaluation of the design and construction constraints; not just the costs constraints. A smaller bypass culvert option would be less expensive. While the smaller options explored in this memorandum will not remove considerable areas from the 100-year floodplain, these options could offer considerable flood reduction benefits for the smaller flood events that have occurred regularly over the past 60 plus years.

Sediment generation in the upper watershed and sediment deposition along the lower reaches of Alhambra Creek remains an issue resulting in considerable periodic maintenance costs for the City. Similarly, any bypass culvert would be subject to the same sedimentation issues as the existing creek channel.

Implementation of one or more detention facilities in the upper reaches of Alhambra Creek could potentially decrease peak flows and provide opportunities to trap sediment to limit deposition in the lower reaches of the watershed. The City may wish to consider implementation detention facilities either in-conjunction with or ahead of a smaller bypass option to address peak flow mitigation and sedimentation

issues. It appears that a preliminary assessment of possible detention basin sites (in-line or off-line) would be useful given the severity of flood hazards and the constraints of a bypass option.

Given the costs of implementing a complete bypass project, the City may wish to explore an alternative approaches that could involve reducing damages during out of channel flow events by using existing streets to convey flows during major floods. Installing a system of temporary barriers along key city streets like Alhambra Avenue, Berrellessa Street, Castro Street, etc. could allow for these streets to convey out of bank flows. Flood proofing could include:

1. Designation of key streets as flood routes,
2. Installation of overflow outlets at key street crossings to divert high flows onto flood route streets,
3. Raising existing curbs along flood route streets,
4. Modification of driveways to allow installation of temporary barriers when extreme storm events are approaching.

Using streets as flood routes with flow depths of up to one to two feet, could provide sufficient excess capacity to control periodic out-of-bank flows limiting flood related damages within the City. While not offering comprehensive flood protection, a flood proofing program could limit damages to structures. This option would require more in-depth assessment of overland flood routes through the City.

Recommendations – Next Steps

A flood management plan can be developed that provides flood protection and maintains the goals of the Alhambra Creek Enhancement Plan. The plan should identify all options to protect homes, businesses, critical facilities, and utilities. The plan should include a more detailed investigation of the feasibility of the options (detention facilities, a bypass system, or flood routing in streets) in a detailed flood study or engineer's report. The study should include a sediment transport analysis to determine the source and quantity of sediment conveyed through the Alhambra Creek.

The report could include two-dimensional hydraulic modeling to improve estimates of the area of inundation and provide a comprehensive flood map that reports the depth of inundation and other flood hazards such as high flow velocity. An assessment of how the out-of-bank flood flows are diffused through the City may present additional solutions and options for conveyance. An out-of-bank flood study could identify flow depths so that flood proofing measures can be developed to reduce reoccurring flood damages for properties along the path of the flow. These permanent flood proofing measures could be instituted for additional properties within the FEMA flood zone.

The City could explore options for addressing the limited capacity along Alhambra Creek, with the following steps:

- Explore the possibilities for implementing one or more detention facilities in the upper reaches of the Alhambra Creek and Franklin Creek watersheds. Detention facilities may offer a more cost effective option to mitigate flood risks for the City as compared to a conveyance based bypass culvert project. In addition, detention facilities could help trap sediment originating in the upper

watershed to help address the ongoing maintenance requirements along the lower reaches of the Alhambra Creek corridor related to sediment removal. Addressing sediment delivery from the upper watershed will also be important for maintaining capacity in any future bypass culvert. PWA can work with the City to identify possible locations for flood control detention facilities.

- Explore the possibilities for utilizing city streets for additional conveyance during extreme events through the implementation of a flood proofing system. While not offering the level of protection that a large bypass culvert or a series of detention facilities, a flood proofing project may be a more cost effective approach to managing the impacts from periodic extreme runoff events.

- A watershed study to examine the source of sediment in the upper watershed and to identify best management practices that can be implemented by property owners to limit sediment delivery to the lower reaches of Alhambra Creek within downtown. By limiting sediment generation at the source, the City would benefit from decreased costs for maintaining the existing creek channel, a future bypass, and/or future detention facilities.

Following assessment of the options available to increase conveyance along the channel and storage within the upper watershed, an informed decision about which actions would most cost effectively address the existing flood risks along Alhambra Creek can be made.

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Table A-1

PROJECT COST ESTIMATE

100-year Bypass (2,830 cfs) - Longer Route

Costs Based on Contra Costa County Transportation Authority Unit Costs*
Pipe Sizes based on US ACOE Estimates (1980)

Reach 5 - South of Highway 4				
5A	8' dia pipe	1600 LF	$1,265,000	
5B	9' dia pipe	1600 LF	$1,423,000	
5C	10' x 11' Box	1200 LF	$1,304,000	
Franklin Creek	10' dia pipe	1800 LF	$1,779,000	
Subtotal Reach 5				$5,771,000
Reach 4 - Highway 4 to Alhambra Way				
	10' x 13' Box	2800 LF	$3,597,000	
				$3,597,000
Reach 3 - Alhambra Way to Allen Street				
3A	12' x 11' Box	2400 LF	$2,609,000	
3B	12' x 12' Box	1300 LF	$1,542,000	
				$4,151,000
Reach 2 - Allen Steet to SPRR Bridge				
2A	12' x 12' Box	4200 LF	$4,981,000	
2B	12' x 18' Box	400 LF	$712,000	
				$5,693,000
Reach 1 - SPRR Bridge to outfall				
Bridge Crossing	16' x 32' Box	100 LF	$316,000	
Outfall Channel	16' x 32' Box	500 LF	$1,581,000	
				$1,897,000
Subtotal - Longer Option		17,900 LF		$21,109,000
Contingency (20%)				$4,222,000
Construction Cost				$25,331,000
Engineering and Design (20%)				$5,066,000
Supervision and Administration (10%)				$2,533,000
Lands, Easements, and Rights-of-Way (5%)				$1,267,000
Relocations (10%)				$2,533,000
Total - 100-year bypass - Longer Option				**$36,730,000**

* Concrete Box Culvert = $98.83 per Square Foot
(converted to 2007 dollars from 2003 estimate of $80 per sq. ft.)

Table A-2

PROJECT COST ESTIMATE

100-year Bypass (2,830 cfs) - Shorter Route

Costs Based on Contra Costa County Transportation Authority Unit Costs*
Pipe Sizes based on US ACOE Estimates (1980)

Reach 4 - Highway 4 to Alhambra Way				
Franklin Creek	10' dia pipe	1500 LF	$1,482,000	
Alhambra Way	10' dia pipe	500 LF	$494,000	
				$494,000
Reach 3 - Alhambra Way to Allen Street				
3A	12' x 11' Box	2400 LF	$2,609,000	
3B	12' x 12' Box	1300 LF	$1,542,000	
				$4,151,000
Reach 2 - Allen Steet to SPRR Bridge				
2A	12' x 12' Box	4200 LF	$4,981,000	
2B	12' x 18' Box	400 LF	$712,000	
				$5,693,000
Reach 1 - SPRR Bridge to outfall				
Bridge Crossing	16' x 32' Box	100 LF	$316,000	
Outfall Channel	16' x 32' Box	500 LF	$1,581,000	
				$1,897,000
Subtotal - Shorter Option		10,900 LF		$12,235,000
Contingency (20%)				$2,447,000
Construction Cost				$14,682,000
Engineering and Design (20%)				$2,936,000
Supervision and Administration (10%)				$1,468,000
Lands, Easements, and Rights-of-Way (5%)				$734,000
Relocations (10%)				$1,468,000
Total - 100-year bypass - Shorter Option				**$21,288,000**

* Concrete Box Culvert = $98.83 per Square Foot
(converted to 2007 dollars from 2003 estimate of $80 per sq. ft.)

Table A-3

PROJECT COST ESTIMATE

25-year Bypass (1,350 cfs) - Longer Route

Costs Based on Contra Costa County Transportation Authority Unit Costs*
Pipe Sizes based on US ACOE Estimates (1980)

Reach 5 - South of Highway 4				
5A	6' dia pipe	1600 LF	$949,000	
5B	7' dia pipe	1600 LF	$1,107,000	
5C	10' x 6' Box	1200 LF	$712,000	
Franklin Creek	8' dia pipe	1800 LF	$1,423,000	
Subtotal Reach 5				$4,191,000
Reach 4 - Highway 4 to Alhambra Way				
	10' x 8' Box	2800 LF	$2,214,000	
				$2,214,000
Reach 3 - Alhambra Way to Allen Street				
3A	10' x 8' Box	2400 LF	$1,897,000	
3B	10' x 9' Box	1300 LF	$1,156,000	
				$3,053,000
Reach 2 - Allen Steet to SPRR Bridge				
2A	10' x 9' Box	4200 LF	$3,735,000	
2B	12' x 11' Box	400 LF	$435,000	
				$4,170,000
Reach 1 - SPRR Bridge to outfall				
Bridge Crossing	16' x 18' Box	100 LF	$178,000	
Outfall Channel	16' x 18' Box	500 LF	$889,000	
				$1,067,000
Subtotal - Longer Option		17,900 LF		$14,695,000
Contingency (20%)				$2,939,000
Construction Cost				$17,634,000
Engineering and Design (20%)				$3,527,000
Supervision and Administration (10%)				$1,763,000
Lands, Easements, and Rights-of-Way (5%)				$882,000
Relocations (10%)				$1,763,000
Total - 25-year bypass - Longer Option				**$25,569,000**

* Concrete Box Culvert = $98.83 per Square Foot
(converted to 2007 dollars from 2003 estimate of $80 per sq. ft.)

Table A-4

PROJECT COST ESTIMATE

25-year Bypass (1,350 cfs) - Shorter Route

Costs Based on Contra Costa County Transportation Authority Unit Costs*
Pipe Sizes based on US ACOE Estimates (1980)

Reach 4 - Highway 4 to Alhambra Way				
Franklin Creek	8' dia pipe	1500 LF	$1,186,000	
Alhambra Way	8' dia pipe	500 LF	$395,000	
				$395,000
Reach 3 - Alhambra Way to Allen Street				
3A	10' x 8' Box	2400 LF	$1,897,000	
3B	10' x 9' Box	1300 LF	$1,156,000	
				$3,053,000
Reach 2 - Allen Steet to SPRR Bridge				
2A	10' x 9' Box	4200 LF	$3,735,000	
2B	12' x 11' Box	400 LF	$435,000	
				$4,170,000
Reach 1 - SPRR Bridge to outfall				
Bridge Crossing	16' x 18' Box	100 LF	$178,000	
Outfall Channel	16' x 18' Box	500 LF	$889,000	
				$1,067,000
Subtotal - Shorter Option		10,900 LF		$8,685,000
Contingency (20%)				$1,737,000
Construction Cost				$10,422,000
Engineering and Design (20%)				$2,084,000
Supervision and Administration (10%)				$1,042,000
Lands, Easements, and Rights-of-Way (5%)				$521,000
Relocations (10%)				$1,042,000
Total - 25-year bypass - Shorter Option				**$15,111,000**

* Concrete Box Culvert = $98.83 per Square Foot
(converted to 2007 dollars from 2003 estimate of $80 per sq. ft.)

Table A-5

PROJECT COST ESTIMATE

15-year Bypass (740 cfs) - Longer Route

Costs Based on Contra Costa County Transportation Authority Unit Costs*
Pipe Sizes based on US ACOE Estimates (1980)

Reach 5 - South of Highway 4				
5A	5' dia pipe	1600 LF	$791,000	
5B	5' dia pipe	1600 LF	$791,000	
5C	8' x 5' Box	1200 LF	$593,000	
Franklin Creek	6' dia pipe	1800 LF	$1,067,000	
Subtotal Reach 5				$3,242,000
Reach 4 - Highway 4 to Alhambra Way				
	8' x 6' Box	2800 LF	$1,660,000	
				$1,660,000
Reach 3 - Alhambra Way to Allen Street				
3A	8' x 6' Box	2400 LF	$1,423,000	
3B	8' x 7' Box	1300 LF	$899,000	
				$2,322,000
Reach 2 - Allen Steet to SPRR Bridge				
2A	8' x 7' Box	4200 LF	$2,905,000	
2B	8' x 10' Box	400 LF	$395,000	
				$3,300,000
Reach 1 - SPRR Bridge to outfall				
Bridge Crossing	12' x 15' Box	100 LF	$148,000	
Outfall Channel	12' x 15' Box	500 LF	$741,000	
				$889,000
Subtotal - Longer Option		17,900 LF		$11,413,000
Contingency (20%)				$2,283,000
Construction Cost				$13,696,000
Engineering and Design (20%)				$2,739,000
Supervision and Administration (10%)				$1,370,000
Lands, Easements, and Rights-of-Way (5%)				$685,000
Relocations (10%)				$1,370,000
Total - 15-year bypass - Longer Option				**$19,860,000**

* Concrete Box Culvert = $98.83 per Square Foot
(converted to 2007 dollars from 2003 estimate of $80 per sq. ft.)

Table A-6

PROJECT COST ESTIMATE

15-year Bypass (740 cfs) - Shorter Route

Costs Based on Contra Costa County Transportation Authority Unit Costs*
Pipe Sizes based on US ACOE Estimates (1980)

Reach 4 - Highway 4 to Alhambra Way				
Franklin Creek	6' dia pipe	1500 LF	$889,000	
Alhambra Way	6' dia pipe	500 LF	$296,000	
				$296,000
Reach 3 - Alhambra Way to Allen Street				
3A	8' x 6' Box	2400 LF	$1,423,000	
3B	8' x 7' Box	1300 LF	$899,000	
				$2,322,000
Reach 2 - Allen Steet to SPRR Bridge				
2A	8' x 7' Box	4200 LF	$2,905,000	
2B	8' x 10' Box	400 LF	$395,000	
				$3,300,000
Reach 1 - SPRR Bridge to outfall				
Bridge Crossing	12' x 15' Box	100 LF	$148,000	
Outfall Channel	12' x 15' Box	500 LF	$741,000	
				$889,000
Subtotal - Shorter Option		10,900 LF		$6,807,000
Contingency (20%)				$1,361,000
Construction Cost				$8,168,000
Engineering and Design (20%)				$1,634,000
Supervision and Administration (10%)				$817,000
Lands, Easements, and Rights-of-Way (5%)				$408,000
Relocations (10%)				$817,000
Total - 15-year bypass - Shorter Option				**$11,844,000**

* Concrete Box Culvert = $98.83 per Square Foot
(converted to 2007 dollars from 2003 estimate of $80 per sq. ft.)

Table A-7

PROJECT COST ESTIMATE

12-year Bypass (470 cfs) - Longer Route

Costs Based on Contra Costa County Transportation Authority Unit Costs*
Pipe Sizes based on US ACOE Estimates (1980)

Reach 5 - South of Highway 4				
5A	5' dia pipe	1600 LF	$791,000	
5B	5' dia pipe	1600 LF	$791,000	
5C	8' x 4' Box	1200 LF	$474,000	
Franklin Creek	6' dia pipe	1800 LF	$1,067,000	
Subtotal Reach 5				$3,123,000
Reach 4 - Highway 4 to Alhambra Way				
	8' x 5' Box	2800 LF	$1,383,000	
				$1,383,000
Reach 3 - Alhambra Way to Allen Street				
3A	8' x 5' Box	2400 LF	$1,186,000	
3B	8' x 5' Box	1300 LF	$642,000	
				$1,828,000
Reach 2 - Allen Steet to SPRR Bridge				
2A	8' x 5' Box	4200 LF	$2,075,000	
2B	8' x 7' Box	400 LF	$277,000	
				$2,352,000
Reach 1 - SPRR Bridge to outfall				
Bridge Crossing	12' x 11' Box	100 LF	$119,000	
Outfall Channel	12' x 11' Box	500 LF	$593,000	
				$712,000
Subtotal - Longer Option		17,900 LF		$9,398,000
Contingency (20%)				$1,880,000
Construction Cost				$11,278,000
Engineering and Design (20%)				$2,256,000
Supervision and Administration (10%)				$1,128,000
Lands, Easements, and Rights-of-Way (5%)				$564,000
Relocations (10%)				$1,128,000
Total - 15-year bypass - Longer Option				**$16,354,000**

* Concrete Box Culvert = $98.83 per Square Foot
(converted to 2007 dollars from 2003 estimate of $80 per sq. ft.)

Table A-8

PROJECT COST ESTIMATE

12-year Bypass (470 cfs) - Shorter Route

Costs Based on Contra Costa County Transportation Authority Unit Costs*
Pipe Sizes based on US ACOE Estimates (1980)

Reach 4 - Highway 4 to Alhambra Way				
Franklin Creek	6' dia pipe	1500 LF	$889,000	
Alhambra Way	6' dia pipe	500 LF	$296,000	
				$296,000
Reach 3 - Alhambra Way to Allen Street				
3A	8' x 5' Box	2400 LF	$1,186,000	
3B	8' x 5' Box	1300 LF	$642,000	
				$1,828,000
Reach 2 - Allen Steet to SPRR Bridge				
2A	8' x 5' Box	4200 LF	$2,075,000	
2B	8' x 7' Box	400 LF	$277,000	
				$2,352,000
Reach 1 - SPRR Bridge to outfall				
Bridge Crossing	12' x 11' Box	100 LF	$119,000	
Outfall Channel	12' x 11' Box	500 LF	$593,000	
				$712,000
Subtotal - Shorter Option		10,900 LF		$5,188,000
Contingency (20%)				$1,038,000
Construction Cost				$6,226,000
Engineering and Design (20%)				$1,245,000
Supervision and Administration (10%)				$623,000
Lands, Easements, and Rights-of-Way (5%)				$311,000
Relocations (10%)				$623,000
Total - 15-year bypass - Shorter Option				**$9,028,000**

* Concrete Box Culvert = $98.83 per Square Foot
(converted to 2007 dollars from 2003 estimate of $80 per sq. ft.)

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MEMORANDUM

Date:	May 17, 2007
To:	Joseph Enke and Tim Tucker
Organization:	City of Martinez
From:	Mark Lindley, P.E. and Jeffery Haltiner, P.E.
PWA Project:	1823/1535-04 – Martinez Flooding and Sedimentation
Subject:	December 2005 Flood and Sedimentation Assessment: Alhambra Creek, Martinez, California

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Introduction/Overview

Philip Williams & Associates (PWA) has been assisting the City of Martinez (City) on Alhambra Creek with the management of flood issues since 1991. Projects include:

1. The 1991 Conceptual Enhancement Plan,
2. The Intermodal Facility Project from the design phase through the annual monitoring,
3. The Alhambra Creek Channel Improvements Project including hydraulic modeling services for the channel enhancements in the downtown reach,
4. The Martinez Salt Marsh Enhancement Project including the planning and design through post-construction mitigation monitoring,
5. An assessment of the performance of the Alhambra Creek improvements including the downtown enhancements and the restoration projects at the Intermodal Facility and at the Martinez Salt Marsh during the December 30 - 31, 2005 storm event, and
6. Provide recommendations related to sediment build up and removal along Alhambra Creek to limit the potential for flooding along Alhambra Creek.

This most recent study/memorandum includes:

1. A review rainfall and flow data to determine return periods for the New Year's Eve 2005 storm event and peak discharge in Alhambra Creek.
2. An assessment of the performance of Alhambra Creek within the downtown enhancement project reach, along the restored reach at the Intermodal Facility, and at the salt marsh enhancement project at the Martinez Regional Shoreline.
3. Documentation of locations along the upper reach of Alhambra Creek between Alhambra Way and Brown Street where creek flows exceeded channel capacity.

4. Results of a visual reconnaissance of accumulated sediment in the downtown reach of Alhambra Creek between Ward Street and Marina Vista Avenue to provide an estimate of the reduction in flow capacity within the Alhambra Creek channel along the downtown reach.
5. Recommendations for remedial actions including sediment removal within the downtown reach of Alhambra Creek and at the Intermodal Facility to reduce the potential for flooding along Alhambra Creek.
6. Preliminary discussion of any opportunities to improve conveyance upstream of the downtown reach.

December 2005 Storm Event: Rainfall

On December 30 - 31, 2005, a high intensity rainfall event produced 4- to 4.5-inches of rainfall over a 24-hour period in the Alhambra Creek watershed. PWA obtained hourly rainfall data for the New Year's storm collected at two nearby rain gage stations from Contra Costa County. The Arroyo Del Hambre station is located in the upper reaches of the Alhambra Creek watershed at elevation 800 feet, and the Contra Costa County Flood Control District station is located in a neighboring watershed at elevation 160 feet. Figure 1 includes a plot of hourly rainfall at the Arroyo Del Hambre station and Table 1 summarizes rainfall totals and return periods for various durations at the Contra Costa County Flood Control District and Arroyo Del Hambre gaging stations. Return periods were computed based on the average annual rainfall at each station and precipitation-duration-frequency-depth curves provided by the Contra Costa County Public Works Department.

As seen in Figure 1, the New Year's storm included three periods of progressively more intense rainfall within about 15 hours on December 30 and 31. At the Arroyo Del Hambre station, 0.35 inches of rain fell during the first intense portion of the storm between 6 and 7 pm on December 30. This was followed by another intense period later that night with 0.78 inches of rainfall between 11 pm and 1 am. The peak period of rainfall came early the next morning with 1.43 inches falling between 2 and 5 am on December 31 which equates to a 5-year, 3-hour rainfall event for the upper Alhambra Creek watershed just after two periods of significant and intense rainfall.

In total, the three periods of intense rainfall produced 3.81 inches in 12 hours and 4.19 inches in 16 hours at the Arroyo Del Hambre station resulting in a 25-year rainfall event. At the Contra Costa County Flood Control District station in the neighboring watershed, the peak intensity rainfall December 30 and 31 had a 50-year return period for a 16-hour duration and a 25-year return period for durations between 2 hours and 12 hours.

Table 1. Rainfall Totals and Return Period

At Contra Costa County Flood Control District
Glacier Drive, Martinez, el. 160 ft

Duration (hours)	Rainfall (inches)	Return Period (years)	Date	Time
2	1.29	25	12/31	4 - 6 am
3	1.53	25	12/31	4 - 7 am
6	1.97	25	12/31	1 - 7 am
12	3.21	25	12/30 - 12/31	7 pm - 7 am
16	**3.76**	**50**	**12/30 - 12/31**	**5 pm - 9 am**
24	3.95	25	12/30 - 12/31	10 am - 10 am
26	3.98	10 – 25	12/30 - 12/31	9 am - 11 am

At Arroyo Del Hambre
Ferndale Rd, Martinez, el. 800 ft

Duration (hours)	Rainfall (inches)	Return Period (years)	Date	Time
2	0.99	5	12/31	3 - 5 am
3	1.43	5	12/31	2 - 5 am
6	2.40	10	12/30 – 12/31	11 pm - 5 am
12	**3.81**	**25**	**12/30 – 12/31**	**6 pm - 6 am**
16	**4.19**	**25**	**12/30 – 12/31**	**3 pm - 7 am**
24	4.47	10 – 25	12/30 – 12/31	9 am - 9 am
29	4.57	10	12/30 – 12/31	7 am - 12 pm

Runoff

PWA measured water levels at the D Street gage to determine flow rates in Alhambra Creek. Water level measurements for 2006 began on December 27, 2005 to capture the upcoming storm event. Water levels measured at the D Street gaging station were converted to USGS gage feet using surveys of the existing staff gages at the gaging station. Runoff flow rate was computed from water levels using a rating curve developed from the USGS peak flow record collected between 1965 and 1986. Runoff flow rate measured at the D Street gaging station are plotted along with rainfall in Figure 1. Water level data collected at the D Street gage and at the Union Pacific Railroad Bridge are presented in Figure 2.

As seen in Figure 1, the New Year's storm event produced three periods of peak runoff closely matching the precipitation patterns. Runoff peaks reached the D Street gage 2 to 3 hours after each rainfall peak, illustrating the time lag of the watershed. The first peak flow of about 670 cfs occurred at 11:10 pm on

December 30. Before flows from the first period of intense rainfall had subsided, the second period of rainfall added additional discharge to the creek and produced a peak flow of about 1,600 cfs at 3 am on December 31. When the third and most intense period of rainfall occurred between 3 and 5 am on December 31, Alhambra Creek was already flowing above 50% capacity at about 1,130 cfs and 6-feet deep at the D Street gage. This final period of intense rainfall, in addition to the runoff already flowing in the creek, produced an overall peak flow of about 2,225 cfs at 6 am at the D Street gage. Flow rates were above 2,000 cfs between 5:15 and 7:55 am on December 31.

There were some reports of out of bank flows between Alhambra Way and D Street near the Monticito School. However, it is unclear to what extent flows went out of bank, and there was not evidence of significant out of bank flows above the D Street gage. Using Manning's equation, we estimate that up to an additional 50 to 75 cfs may have been transported in the streets upstream of the D Street gage assuming a 30-feet wide street flowing 6-inches deep. Given the limited information available, we are not including this extra flow in our estimate of peak discharge associated with the December 30 – 31, 2005 storm event.

Table 2 presents the measured peak flow along with top five historic flood flows in the extended record for Alhambra Creek. The measured peak flow of 2,225 cfs is the third highest peak flow on record, behind estimates from the 1958 and 1997 events. The December 31, 2005 peak flow was roughly similar to the 1997 and 1982 events.

Table 2. Peak Discharge and Return Period at the D Street Gaging Station

Water Year	Estimated Peak (cfs)	Return Period* (years)	Data Source
1958	2379	11.1	Estimated from UPRR – PWA**
1997	2235	10.1	D Street Gage – PWA***
2006	**2225**	**10.0**	**D Street Gage Measurement – PWA**
1982	2200	9.7	D Street Gage Measurement – USGS
1973	1960	7.4	D Street Gage Measurement – USGS
1980	1920	7.1	D Street Gage Measurement – USGS

* Return period based on results of HEC-FFA flood frequency analysis (PWA, 1997)

** Adjustment between Union Pacific Railroad Bridge estimate and D Street described in Alhambra Creek Flood Frequency Analysis (PWA, 1997)

*** Estimated based on high water marks near the D Street Gage

In 1997, PWA prepared a flood frequency analysis on an extended flood record that covered 1939 through 1997. The extended flood record included measured data from the D Street gage collected by USGS between 1965 and 1986, estimates of peak flows from high water observations, and estimates of peak flows in Alhambra Creek based on transfer of information (measured peak flows in neighboring watersheds) (PWA, 1997). Using a flood frequency curve based on this 59-year extended flood, we estimate that the December 31, 2005 peak flow was about a 30-year flood event on the creek. However,

the flood frequency plot that only includes data in the 59-year extended flood record flattens out at the highest return period flows because the data set is relatively limited and does not include enough low frequency, high discharge events to provide reliable estimates of the higher return period events (greater than 5-year peak discharge).

To more reliably estimate higher return period peak flow rates, a HEC-FFA flood frequency analysis was performed to statistically estimate 10-year through 500-year peak flows based on the 59-year extended record (PWA, 1997). The HEC-FFA analysis indicated that the 100-year peak flow for Alhambra Creek is 4,830 cfs and the 10-year peak flow is 2,220 cfs. Based on the HEC-FFA predicted flood frequency, the December 31, 2005 peak discharge was about a 10-year flood event.

Alhambra Creek Performance

The December 31, 2005 peak flow was about a 10-year event in the Alhambra Creek watershed based on the HEC FFA analysis. Historically, an event of this size would have caused significant overbank flooding in Martinez. During the December 31, 2005 event, Alhambra Creek experienced overbank flooding upstream of downtown. However, it appears that the channel improvements within the downtown reach, at the Intermodal facility, and at Martinez Regional Shoreline were successful in preventing significant flooding within downtown Martinez. The intent of the downtown project was to increase the channel capacity from about a 2- to 4-year peak flow to about a 7- to 8.5-year peak flow. It appears that the project was successful in providing this level of conveyance during the late December storms.

Upper Reach

Within the Upper Reach, Alhambra Creek flowed out of its banks in several locations. Reports of flooding from City officials and local residents indicated that the creek flowed out of bank at D Street, Brown Street, and in the vicinity of Alhambra Way.

The primary location of out of bank flows was at the D Street crossing where water levels overtopped the drainage slots in the D Street Bridge and flowed down Castro Street and Alhambra Avenue towards downtown. Sediment from the out of bank flow was deposited on the streets, curb/gutter, sidewalks and at some homes along D Street and Castro Street as shown in Figure 3, as well as, in the curb and gutter along Alhambra Avenue. In addition, there was debris trapped in the curb slots on the D Street Bridge. Using Manning's equation we estimate that about 200 cfs flowed down Castro Street assuming flows about 1 foot deep and about 50 cfs flowed down Alhambra Avenue assuming flows about 0.5 feet deep. PWA noted two possible issues at the D Street crossing. First, the trapezoidal channel section under the bridge appears to have a smaller cross-section than much of the creek channel (Figure 4). Second, just downstream of the D Street Bridge, the channel becomes very confined with a constriction formed by two large trees 10 to 15 feet apart on opposite banks (Figure 4).

Although there was not evidence of significant out of bank flows at Brown Street, it appears to be the location of the most significant blockage at a culvert crossing along Alhambra Creek. The Brown Street

creek crossing is formed by two culverts approximately 9 feet wide and 9 feet high. These culverts have a capacity of about 1,500 cfs flowing full and a maximum capacity of about 2,000 cfs flowing under pressure with water levels at the elevation of Brown Street. During extreme events when these culverts are flowing under pressure, energy loss at the entrance to the culverts can cause considerable turbulence and scour. During the December 30 - 31, 2005 storm event, the retaining wall on the west bank of the creek failed and a large tree fell into the creek and became lodged into one of the culverts as shown in Figure 5. Both the property on the west bank and the neighboring property on the east bank suffered considerable damage due to scour and erosion during the storm event, and these properties contributed 50 to 100 cubic yards of sediment and debris to the channel. The partial blockage of one of the Brown Street culverts decreased the hydraulic capacity at this crossing, and resulted in increased water levels upstream of Brown Street. It is not clear to what extent water levels upstream of the Brown Street crossing were elevated or if the partial blockage of the Brown Street culverts contributed to the out of bank flows at D Street.

There were also reports of some out of bank flows downstream of Alhambra Way in the vicinity of Monticito School in an area where some bank restoration has occurred. However, we did not note any evidence of significant out of bank flows in this area and cannot verify those reports.

Downtown Reach

As part of a design team led by David Gates and Associates, PWA conducted a hydraulic analysis of the downtown Alhambra Creek channel improvement project (Alhambra Creek Hydraulic Study: Marina Vista to Green Street, PWA, January 2000). This report addressed the potential flow conveyance of the channel under existing conditions and assessed additional conveyance that could be achieved with the planned channel modifications. The downtown channel improvements project was designed to increase channel conveyance in the downtown reach from about a 4-year peak flow capacity to approximately a 7- to 8.4-year peak flow capacity with a downstream boundary condition at Mean High-Higher Water (MHHW = 3.08 feet NGVD) in Carquinez Strait.

The recent improvements within the downtown reach, at the Intermodal Station, and at the Martinez Regional Shoreline salt marsh enhancement project provided sufficient capacity for the flood flows on December 31, 2005. Out of bank flows conveyed along Alhambra Avenue, Castro Street, and Estudillo Street from upstream of downtown were able to re-enter the creek channel between Ward Street and Main Street. The full 10-year peak flow was conveyed to Carquinez Strait without significant flooding within downtown.

However, it should be noted that this peak flow fortunately coincided with a low tide in Carquinez Strait which allowed the downtown reach to convey additional flow above the design conditions. Had this storm coincided with a high tide, it is likely that downtown Martinez would have experienced some level of flooding consistent with the modeling results provided during the design phase that indicated that the improved downtown reach of the creek had a 7- to 8.4- year capacity with downstream water levels at MHHW.

In response to the high levels of sediment production from the upper watershed, sediment deposition continues to be a problem in the downtown reaches of the creek. Between 2003 and December 2005, Alhambra Creek formed a defined low flow channel and developed flood benches with wetland and riparian vegetation due to sediment deposition within the improved downtown channel reach. During the December 31 storm event, the wetland vegetation on existing flood benches tended to bend over providing limited excess roughness, and to a lesser extent, riparian vegetation also bent over. Although water levels within and upstream of downtown were likely elevated somewhat as a result of this existing sedimentation and vegetation within the improved channel reach, this issue did not appear to contribute significantly to the flooding upstream because the D Street crossing is located approximately one mile upstream of downtown and upstream of the blocked culvert at Brown Street.

Intermodal Facility

The December 31, 2005 peak flow was conveyed through the Intermodal Site without flowing out of bank. Water levels measured at the Union Pacific Railroad Bridge are presented in Figure 2 and peak water surface elevations are summarized in Table 3.

Table 3. Measured Water Levels at Union Pacific Railroad Bridge

Time on 12/31/05	Measured WSE @ UPRR (feet NGVD)	Predicted WSE @ Benicia (feet NGVD)	Est. Benicia Storm Effects* (feet)	Est. WSE @ Benicia (feet NVGD)	Water Level Drop UPRR to Strait (feet)
7:10 am	5.92	0.48	2.3	2.8	3.1
12:10 pm	6.37	4.23	1.8	6.0	0.3

* Storm effects in Carquinez Strait estimated by the difference between measured and predicted water levels at the Port Chicago Station.

** Water level drop is the difference between the measured water level at the UPRR Bridge and the estimated water level in the Carquinez Strait at Benicia/Martinez.

At 7:10 am on December 31, the peak flow resulted in a water surface elevation of 5.92 feet NGVD at the UPRR Bridge, which was about 1.7 feet below the bridge deck invert (~7.6 feet NGVD). By comparison, our most recent HEC-RAS modeling results predicted a 10-year water surface at the UPRR Bridge of 6.26 feet NGVD with a downstream boundary condition of 3.54 feet NGVD in the Carquinez Strait (PWA, 2002). Therefore, the HEC-RAS modeling results indicated that a drop in water levels of 2.7 feet between the UPRR Bridge and the outlet of Alhambra Creek was required to convey the 10-year peak flow under design conditions.

However as seen in Figure 2, the peak flow on December 31 coincided with a predicted low tide of 0.48 feet NGVD for 7:10 am at Benicia/Martinez. Measured water levels at the nearby Port Chicago station indicated that rainfall-runoff and storm effects added approximately 2.3 feet to predicted water levels in the Carquinez Strait at 7:10 am. Conditions would have been roughly similar at Benicia/Martinez, and we estimate that the downstream water surface at the outlet of Alhambra Creek was about 2.8 feet NGVD at 7:10 am. Based on the 5.92 feet NGVD measured peak water surface during 10-year peak flow event on

December 31, we estimate that a drop in water levels of about 3.1 feet between the UPRR Bridge and the outlet of Alhambra Creek was required to convey the 10-year peak flow event under the existing conditions.

The highest water surface measured at the UPRR Bridge coincided with the high tide later on December 31. A water surface elevation of 6.37 feet NGVD was measured at 12:10 pm on December 31, which was about 1.2 feet below the bridge deck elevation. This water surface includes the effects of high tide, storm surge, flows in the Carquinez Strait, and approximately 285 cfs of residual runoff conveyed in Alhambra Creek from the December 30 - 31 storm event. The predicted high tide was about 4.23 feet NGVD at Benicia. At the Port Chicago Station, the difference between measured and predicted water levels was about 1.8 feet at 12:10 pm due to rainfall-runoff and other storm effects. Thus, we estimate that the high water level in Carquinez Strait was about 6.03 feet NGVD and that runoff in Alhambra Creek accounted for an increase in water levels at the UPRR Bridge of about 0.3 feet.

The highest measured water surface elevation of 6.37 feet NGVD produced by the combination of the high spring tide, rainfall-runoff, and other storm effects approaches HEC-RAS predictions of the 100-year high water surface following restoration of Alhambra Creek and the Salt Marsh Enhancement Project of 6.66 feet NGVD. Our HEC-RAS predictions utilized FEMA recommendations for estimating downstream boundary conditions based on adjustments to MHHW (3.08 feet NGVD at Martinez). Our 10-year and 100-year model predictions were based on downstream boundary water surfaces of 3.54 and 3.86 feet NGVD including a 0.46 and 0.78 feet adjustments to account for runoff and storm effects in Carquinez Strait. While these downstream boundary conditions follow FEMA design criteria, a "worst case" scenario would include elevated high tides, with the tidal peak coinciding with the fluvial hydrograph peak. The measured runoff and storm effects at Port Chicago at high tide on December 31 were about 1.8 feet. Combined with a spring high tide, the increased water levels could have a significant impact of conveyance through the lower reaches of Alhambra Creek including downtown.

If the December 31 storm event had peaked five hours later during the high spring tide, water levels at the UPRR Bridge may have exceeded 9 feet NGVD and flows would have been blocked by the UPRR Bridge deck. Although much of the Intermodal Facility parking lot is above 10 feet NGVD, it is possible that the lowest portions of the lot could have experienced some flooding. Some property east of the Intermodal Site could also experience some flooding. Also, if flows back up behind the UPRR and the Marina Vista Bridges, the downtown reach may have experienced increased water levels and flooding due to backwater effects.

Salt Marsh Site

The Martinez Regional Shoreline Salt Marsh Enhancement Project was designed to remove confining channel levees and to allow peak flows to exit from the Alhambra Creek channel and flow under the long pedestrian bridge and across the marsh-plains towards Carquinez Strait. Based on deposited sediment and debris, flows were above the main path leading to the long pedestrian bridge during extreme high tide at

12:10 pm and possibly during the peak flow earlier on December 31. It appears that flows were able to exit the channel at "break out" areas as desired.

There were some reports of flooding at properties at the far downstream end of Berrellesa Street. During the high tide at 12:10 pm on December 31, high water along Alhambra Creek reportedly flowed through an existing culvert and onto the curb and gutter on the east side of Berrellesa Street. This culvert conveys drainage from Berrellesa Street under a path that connects the parking lot to the Regional Shoreline Park. The culvert does not have a flap gate to prevent backflows. In addition, high water in the salt marsh restoration area reportedly flowed through an existing drainage ditch into the backyards of the homes on the west side of Berrellesa Street. In both these cases, these homes are located at topographic low points that are below the high water levels recorded at the UPRR Bridge. These pre-existing flooding issues were anticipated and discussed in the Preliminary Design Addendum (PWA, 2002).

Sedimentation

Historic land use changes in the upper reaches of the Alhambra Creek watershed (primarily grazing, but also residential development and road construction) have resulted in widespread gullying, and a relatively high sediment yield to the Alhambra Creek channel. This sediment is transported through the steep upper reaches of the watershed by high velocity flows and is deposited in the lower reaches where the channel slope flattens, flow velocities decrease, and fluvial flows meet tidal water.

During typical rainfall years, deposition along the lower reaches of Alhambra Creek increases the elevations of flood benches by several inches each year in the downtown reach and at the Intermodal Facility. In December 2005, the high intensity New Year's rainfall event produced landslides, erosion, and bank failures throughout the Alhambra Creek watershed. The extended period of frequent rainfalls in March and April also produced significant erosion as saturated hillslopes and channel banks failed. This erosion in the upper portion of the watershed resulted in significant sediment deposition along the lower reaches of Alhambra Creek. In several areas, one to two feet of sediment has deposited on flood benches during the 2005/06 rainy season. Deposited sediment within downtown reach and at Intermodal Facility is decreasing cross sectional area resulting in decreased channel conveyance.

<u>Downtown Reach</u>

Following construction of the downtown channel improvements, Alhambra Creek has developed a defined low flow channel with flood benches that support wetland and riparian vegetation. Sediment deposition is concentrated on the inside of meander bends and upstream of bridges, which are common locations for sediment buildup. In 2003, deposited sediment was removed from the flood benches between Main Street and Ward Street to maintain conveyance. Between 2003 and 2005, deposition continued throughout the downtown reach building up flood benches 2 to 4 feet above the base of the low flow channel. The December 30-31, 2005 storm event and 2006 rainy period resulted in an additional 1 to 3 feet of deposition in many locations.

At the request of the City, PWA provided informal visual observations along the downtown reach of Alhambra Creek to assess sedimentation from Green Street down to Marina Vista Street in August 2003, August 2005, January 2006, and April 2006. The purpose of these visits was to document the amount of deposited sediment to determine if the level of deposition could significantly impact conveyance within Alhambra Creek. Informal measurements of sediment levels were performed upstream and downstream of bridge crossings to allow for an estimate of the portion of the bridge section blocked by deposited sediment.

Green Street

At the outfall of the Green Street Bridge culvert, the creek channel forms a significant bend. Eddy action appears to be causing erosion of the toe of the creek bank on the inside of the bend and a scour hole has developed just past the culvert wing-wall. Photographs of the developing scour-hole collected in May 2005 and April 2006 are presented in Figure 6. Following the December 30-31, 2005 storm event, the scour hole appears to have expanded, exhibiting some evidence of increased toe scour and formation of an erosional scarp as seen in the photograph collected in April 2006.

Ward Street

Sediment has been depositing on the flood bench upstream of the Ward Street Bridge since construction of the downtown channel improvements. During visual observations in 2003, PWA noted that the flood bench at the Ward Street Bridge reduced the bridge section by about 10-percent. Our 2005 visual observations indicated that the flood bench was about 2 to 4 feet above the low flow channel and reduced the bridge section by about 10-percent indicating that little additional sediment had deposited since 2003.

In April 2006, we noted additional sediment deposited on the flood bench along west bank of the channel upstream of the Ward Street Bridge and marsh vegetation was flattened during the December storm event. This area of the channel supports a large tree just upstream of the bridge that blocks a considerable portion of the bridge section as seen in the photos presented in Figure 7. This tree limits conveyance and tends to increase deposition. Measurements of the bridge section collected in April 2006 are presented in Figure 8. Our measurements indicate that deposition during the 2005/06 rainy season raised the flood bench to between 4 and 5+ feet above the low flow channel and the capacity of the bridge section is reduced by about 17-percent.

Downstream of the Ward Street Bridge, the channel section is relatively open. Measurements and observations in August 2005 and April 2006 indicated that the channel cross section was reduced by less than 5-percent between Ward Street and the depositional bar that forms just upstream of the Main Street Bridge (discussed below).

Main Street

The Main Street Bridge is located at a bend in the Alhambra Creek channel and has been an area that is subject to considerable deposition. The channel forms a bend to the west below the Main Street Bridge and the eastern half of the channel is a relatively ineffective flow area, essentially a zone of limited

conveyance. During low flows, flows are routed through the open portion of the bridge west of the supporting pile, and depositional conditions are created on the east bank.

In 2003, PWA noted that the deposition at the Main Street Bridge reduced the cross section by about 15-percent. To maintain flood conveyance, the City removed deposited sediment between Main Street and Ward Street. By August 2005, our measurements indicated that the depositional bar had reformed and built up to between 3 and 4 feet above the low flow channel and reduced the bridge section by about 18- to 20-percent.

Deposition from the December 30-31, 2005 storm event added up to 2+ feet of additional sediment to the existing depositional bar as seen in the photos presented in Figure 9. Measurements of bridge section are presented in Figure 10. The January 2006 measurements indicate that the depositional bar was over 6 feet above the low flow channel and reduced the bridge section by up to 29-percent at the widest and deepest portion of the bar. The City removed the depositional bar in February 2006 to maintain flood conveyance.

Following the City's removal efforts, the depositional bar quickly reformed as a result of significant erosion and sediment delivery during the prolonged rainy period in March and April 2006. The existing depositional bar and horizons of sediment removed by the City in February are visible in the photo from April presented in Figure 9. The formation of the depositional bar may be related to either the ineffective flow area on the east side of the channel at the bridge or sediment accumulation under the bridge that was not removed in February. Measurements of the bridge section collected in April indicate that between 2 to 4 feet of sediment deposited along the east bank, and the depositional bar currently reduces the bridge section by about 15- to 17-percent.

Escobar Street

Similar to the Ward Street Bridge, sediment has deposited on flood benches upstream of the Escobar Street Bridge since construction of the downtown channel improvements. To date PWA is not aware of any sediment removal activities in the vicinity of the Escobar Street Bridge. In 2003, we did not observe significant deposits of sediment at the Escobar Street Bridge. In 2005, we noted 2 to 3 feet of sediment had deposited along the 10 to 15 feet wide flood bench along the west bank that supported dense marsh vegetation. Along the east bank, the 10 to 15 feet wide flood bench supported dense riparian tress.

Following the December 2005 storm event, the marsh vegetation and riparian trees were bent over and an additional 1 to 2 feet of sediment has deposited on the flood benches as seen in the April 2006 photos presented in Figure 11. Measurements of the bridge section collected upstream of Escobar Street are presented in Figure 12. The measurements indicate that up to 4 feet of sediment has deposited on the flood benches upstream of Escobar Street since construction reducing the bridge section by about 28-percent.

Downstream of Escobar Street, the channel section is relatively open. Measurements and observations in August 2005 and April 2006 indicate that the channel cross section is reduced by about 6-percent between Escobar Street and Marina Vista Avenue.

Marina Vista Avenue

Up stream of the Marina Vista Avenue Bridge, we noted 2 to 3 feet of sediment deposited on the flood benches adjacent to the low flow channel and on the sloped banks of the concrete trapezoidal channel section. Photos collected at the Marina Vista Avenue Bridge in April 2006 are presented in Figure 13 and measurements of the bridge section upstream of Marina Vista Avenue are presented in Figure 15. The photos illustrate that marsh vegetation bent over and some riparian trees bent over or were uprooted during the December 2005 storm event. Deposited sediment can be seen covering the marsh and riparian vegetation and scour through the deposited sediment from a storm drain outfall is apparent. The cross section indicates that 2 to 4 feet of sediment has deposited on the flood benches and bridge section is reduced by about 15-percent.

Intermodal Facility

PWA has been monitoring sediment deposition on the restored marsh-plain at the Intermodal Facility since 2000. Detailed monitoring data for the Intermodal Facility collected since project construction, including 2006, are presented in the current monitoring report (PWA, 2007). We have been monitoring the development of a depositional berm at the low flow channel top of bank since 2003. In 2004, this berm was approximately 2 feet above the design marsh-plain elevation, but the overall marsh-plain was generally at MHHW and conveyance was not significantly impacted.

Photos of the marsh-plain and channel at the Intermodal Facility taken at the UPRR Bridge in April 2006 are presented in Figure 15. These photographs illustrate the affects of the December 30-31, 2005 storm event at the Intermodal Facility including marsh vegetation flattened and buried under mounds of sediment throughout the marsh-plain. Surveys conducted in May of 2006 indicate that 1 to 2 feet additional sediment has deposited on the marsh-plain at the Intermodal Facility since our 2004 surveys. The marsh-plain is now 1 to 2 feet above MHHW. The berm at the low flow channel top of bank is up to 3 feet above MHHW and up to 4 above the original design elevation. This deposited sediment could significantly decrease conveyance during flood events. In addition, marsh-plain elevations considerably above MHHW could impact the ecological function of the site limiting the development of marsh vegetation.

Salt Marsh Enhancement Project

PWA is also monitoring sediment deposition at the Salt Marsh Enhancement Project downstream of the Intermodal Facility. Our monitoring surveys in July 2006 indicate that about 0.7 feet of sediment deposited on the restored marsh-plain and a depositional berm 1 to 1.5 feet of sediment deposited at the low flow channel top of bank during the December 2005 storm event and the subsequent March and April rainfall events. This deposition will be monitored to determine if flood conveyance could be impacted.

Generally, opportunities for flood flow conveyance occur over a wider area, and sediment deposition is less of a concern in these lower reaches.

Sedimentation Summary

In the downtown reach, sediment deposition is concentrated along the inside of meander bends and upstream of bridges. Deposition upstream of bridges is of particular concern because flood conveyance is limited by the bridge section and any significant reductions in the bridge sections should be minimized within downtown Martinez. Upstream of bridges in the downtown reach, 2 to 4 feet of sediment has accumulated above design flood bench elevations reducing channel cross section. Based on our visual observations in the downtown reach sediment deposition is not significantly impacting conveyance between bridge crossings.

The restoration project at the Intermodal Facility was intended to provide marsh-plain habitat and increase flood conveyance through this reach of Alhambra Creek. Deposited sediment has raised the marsh-plain elevation by 2 to 4 feet above design grades and 1 to 3 feet above MHHW. The current marsh-plain elevation limits flood conveyance through the Intermodal Site and could impact flood control function of the restoration project.

In areas where sediment has accumulated 2 to 4 feet above design flood bench/marsh-plain elevations, ecologic function of the channel may also be impacted. Design elevations for flood benches in the downtown reach were chosen to allow for periodic inundation of benches during flow events and/or extreme high tides. At the Intermodal Facility, design marsh-plain elevations were targeted at or below MHHW to support healthy brackish tidal marsh vegetation and habitat. Excess sediment will limit inundation of flood benches and marsh-plain and affect establishment of vegetation adjacent to the low flow channel. Areas intended to support marsh vegetation that tends to bend over during flood flows may transition to riparian vegetation that is more resistant to flows.

Based on observations of the evolution along the downtown reach and at the Intermodal Facility since project construction, marsh vegetation can be expected to rapidly reestablish if accumulated sediment is removed to design flood bench and marsh-plain elevations. Ecological impacts related to removal of sediment and vegetation in the vicinity of bridges and at the Intermodal Facility marsh-plain are expected to be limited and short-term. At the Intermodal Facility, marsh vegetation had established at top of bank within one year following construction in 2000. By 2002, the marsh-plain was nearly completely vegetated, and by 2003 the marsh-plain had 100-percent vegetative cover with dense native marsh vegetation. In the longer term, maintaining flood benches and marsh-plain with marsh vegetation is expected to add to the complexity of the habitat mix and enhance ecologic function of the creek channel.

Recommendations

The objectives for the management of the Alhambra Creek corridor involve a balance between 1) maintaining and improving flood performance, 2) maintaining ecological function to meet Department of Fish and Game mitigation requirements, and 3) minimizing costs to the City. The following

recommendations have been developed based on consideration of hydraulic performance and our understanding of ecologic objectives and criteria including the establishment of vegetation planted for mitigation along the downtown reach. Our recommendations are intended to assist the City in managing Alhambra Creek. This report provides guidance and recommendations for the City related to sediment removal along the downtown reach and at the Intermodal Facility. Secondarily, we identify opportunities for management actions in the upstream reach of Alhambra Creek and the upper reaches of the Alhambra Creek and Franklin Canyon watersheds.

I. Sediment Removal

In our 2000 hydraulic assessment of the proposed creek improvement design, it was recognized that the upper watershed produced high quantities of sediment and pre-project sediment deposition would continue to occur, particularly during high flow events, and this deposited sediment would require ongoing removal when it significantly reduced the channel/bridge capacity. Some general guidelines were provided that sediment should be removed from bridges when it exceeds about 2 feet and removed from channel flood benches when it exceeds about 3 feet above the bottom of the low flow channel. Regular monitoring of channel capacity was recommended, and it was suggested that provisions for conducting required channel maintenance be included as part of the U.S. Army Corps permit, so that special permits would not be required for sediment removal.

Management Approach

Consistent with our previous recommendations within the downtown reach, sediment and excess vegetation including trees should be removed down to about 2 feet above low flow channel to reestablish design flood bench elevations within about 20 to 30 feet upstream of and under bridges. Away from bridges in the downtown reach, sediment should be removed down to about 3 above the low flow channel in areas where access is practicable. Within the Intermodal Facility reach, accumulated sediment should be removed from the marsh-plain to down to original design grades between 2 feet NGVD at top of bank sloping to 3 feet NGVD at the back of the marsh-plain. Specific recommendations at locations along the downtown reach and at the Intermodal Facility are provided below and summarized below in Table 4.

Given the undulating slope of the channel, with varying widths and meander features, and the high sediment production in the upper watershed, some deposition of sediment in the downtown channel reaches will continue to occur during high flow events. Thus, ongoing periodic maintenance will be required. The City should continue to monitor sediment accumulation and plan for regular maintenance activities including sediment removal. Sediment removal activities are likely to be needed following years with significant rainfall-runoff events like 2005/06.

Table 4. Recommendations: Downtown Reach and Intermodal Facility

Location	Recommended Action	Estimated Quantities
Green Street	Toe stabilization with rock boulder and/or vegetated toe scour protection.	20 – 30 linear feet
Ward Street	Remove sediment 20 – 30 feet upstream and under bridge down to 2 feet above low flow channel. Remove trees on flood bench within 20 feet of upstream face of bridge.	30 – 60 cubic yards 2 – 3 trees
Main Street	Remove sediment 20 – 30 feet upstream and under bridge down to 2 feet above low flow channel.	25 – 50 cubic yards
Escobar Street	Remove sediment 20 – 30 feet upstream and under bridge down to 2 feet above low flow channel. Remove trees on flood bench within 20 feet of upstream face of bridge.	60 – 120 cubic yards 1 – 2 trees
Marina Vista Ave.	Remove sediment 20 – 30 feet upstream and under bridge down to 2 feet above low flow channel.	20 – 40 cubic yards
Intermodal Facility	Remove sediment along marsh-plain down to 3 feet NGVD sloping to 2 feet NGVD at top of bank.	3000 – 4000 cubic yards

Green Street Bridge

Monitoring of the scour hole at Green Street Bridge culvert outfall should continue. PWA provided a range of potential options to stabilize the creek bank toe to help limit the progression of the scour hole in an October 2004 memorandum to the City. Since the scour hole is exhibiting some signs of expanding, implementing toe stabilization measures should be considered.

Ward Street Bridge

Accumulated sediment upstream of and below the Ward Street Bridge should be removed down to the design flood bench elevation of about 2 feet above the low flow channel as shown in Figure 8. We also recommend removing the tree(s) that have established immediately upstream (within 20 feet) of the bridge (shown in Figure 7). We estimate that about 30 to 60 cubic yards of material is deposited above design flood bench elevations within 20 to 30 feet upstream of and under the Ward Street Bridge.

Main Street Bridge

Deposited sediment upstream of and below the Main Street Bridge should be removed to re-establish the design flood bench elevation of about 2 feet above the low flow channel as shown in Figure 10. To the extent practicable, deposited sediment below the Main Street Bridge should be removed to limit deposition directly upstream of the bridge and to maintain flood capacity. We estimate that about 25 to 50 yards of material has deposited above the design flood bench elevations, primarily below the Main Street Bridge. However, given ineffective flow area on the east side of the channel, the depositional bar can be expected to reform over time.

Escobar Street Bridge

Accumulated sediment upstream of and below the Escobar Street Bridge should be removed down to the design flood bench elevation of about 2 feet above the low flow channel as shown in Figure 12. We also recommend removing the damaged tree that is immediately upstream of the bridge (shown in Figure 11). We estimate that about 60 to 120 cubic yards of material is deposited above design flood bench elevations within 30 feet upstream of and under the Escobar Street Bridge.

Marina Vista Avenue Bridge

Upstream of the Marina Vista Avenue bridge, accumulated sediment should be removed down to the design flood bench elevation of about 2 feet above the low flow channel as shown in Figure 14. We also recommend removing the tree(s) that are establishing immediately upstream of the bridge (shown in Figure 13). We estimate that about 20 to 40 cubic yards of material is deposited above design flood bench elevations within 20 to 30 feet upstream of and under the Marina Vista Avenue Bridge.

Intermodal Facility

Marsh-plain elevations should be lowered to original design grades, sloping from 3 feet NGVD down to 2 feet NGVD at the low flow channel top of bank. In addition, accumulated sediment should be removed from below the UPRR Bridge to the extent practicable down to reestablish marsh-plain design grades similar to the adjacent marsh-plain. We estimate that about 3000 to 4000 cubic yards of material is deposited above design marsh-plain elevations at the Intermodal Facility.

II. Upper Reach Improvements

In the upper reach of Alhambra Creek between downtown and Highway 4, flood flows went out of bank at D Street resulting in sediment and flood damage to streets and some properties along Alhambra Avenue, Castro Street and Estudillo Street. The City and private property owners may consider improvements in this upper reach to limit the potential for out of bank flows upstream of downtown. If improvements are made, the design goal should be to provide approximately the same conveyance as the downtown project (2000 – 2400 cfs).

Culvert/Bridge Crossings

Out of bank flows during the December 30 – 31, 2005 storm event primarily originated at the D Street crossing. It is not clear if the cause of these out of bank flows was the reduced channel section at the D Street Bridge or the constriction caused by two large trees just downstream of D Street. We recommend examining the capacity of the channel in the vicinity of the D Street Bridge to determine the location of the decreased capacity so that it can be addressed. To identify and address the inadequate capacity in the vicinity of D Street, we recommend:

- Surveys of channel profiles and cross sections upstream, under, and downstream of the D Street Bridge,
- HEC RAS modeling to identify the location of the decreased capacity,
- Possible expansion of the D Street Bridge to increase conveyance at D Street.

We also examined the Brown Street crossing and determined that the two 9 feet by 9 feet culverts at this location had limited capacity (approximately 1,500 cfs flowing full and about 2,000 cfs maximum capacity). If the D Street crossing had sufficient capacity to convey the December 31 peak flow, flows may have gone out of bank at Brown Street. Improvements could include replacement of the two 9 feet by 9 feet culverts with an open span bridge or arch culver with sufficient capacity to convey at least the 10-year peak flow.

Retaining Walls

Numerous properties along the Alhambra Creek channel rely on retaining walls to protect adjacent property from scour and erosion caused by flows in the creek. Many of these retaining walls are non-engineered structures that were informally implemented during past decades. Over time, creek incision, scour, and structure age reduce the integrity of these structures and failure becomes more likely during extreme runoff events. A significant retaining wall failure during an extreme event can cause significant property damage and lead to out of bank flooding along the Alhambra Creek corridor.

A retaining wall failure at Brown Street during the December 31 storm event caused significant property damage and generated 50 to 100 yards of sediment to the creek system. In addition, a tree was uprooted and clogged the Brown Street culvert restricting flow during the storm event.

To limit the potential for failure during an extreme event, we recommend that retaining walls adjacent to the Alhambra Creek channel be inspected by a qualified engineer, and if necessary, replaced with engineered structures.

Upstream Detention Facility

The development of a long-term solution to both the sediment deposition and flooding issues could include implementation of one or more detention facilities in the upper reaches of the Alhambra Creek and Franklin Canyon watersheds. Detention facilities can be designed to reduce peak flows during extreme events and limit flood hazards along Alhambra Creek. In addition, detention facilities can provide a location for eroded sediments from the upper watersheds to be captured (and subsequently removed) prior to transport to the lower reaches of Alhambra Creek. This could significantly reduce flood hazards and maintenance costs and permitting issues related to sediment removal in the downtown and Intermodal Facility reaches of Alhambra Creek.

Figures

References

PWA, October 1997. "Alhambra Creek Flood Frequency Analysis." Prepared for the City of Martinez.

PWA, January 2000. "Alhambra Creek Hydraulic Study: Marina Vista to Green Street." Prepared for David Gates and Associates.

PWA, May 2002. "Martinez Regional Shoreline Salt Marsh Enhancement Project, Phase 2 Preliminary Design Addendum to Conceptual Plan Elements." Prepared for the City of Martinez.

PWA, May 2007. "Year 7 Hydrologic Monitoring Report: Alhambra Creek, Martinez Intermodal Facility Project." Prepared for the City of Martinez.

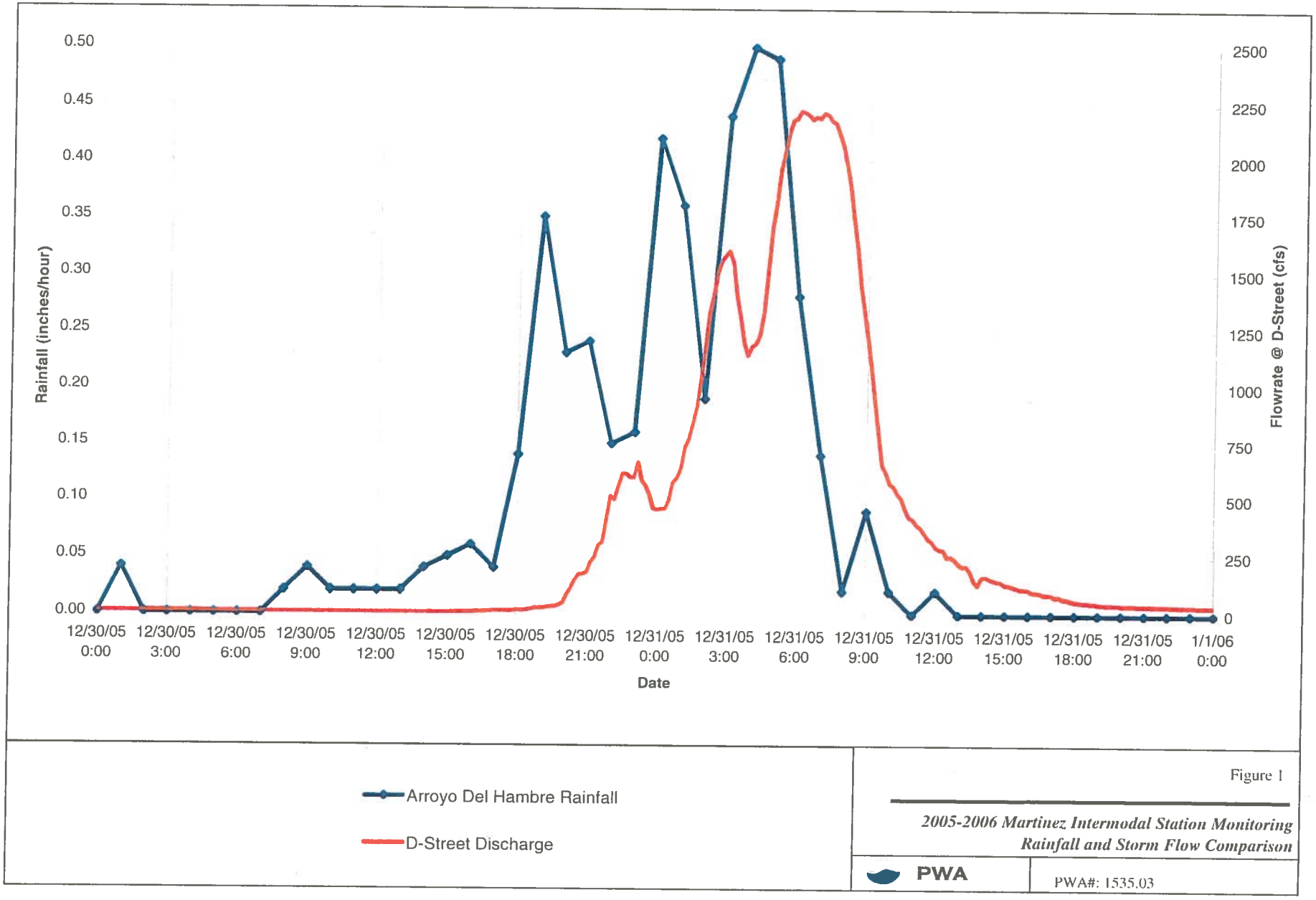

Figure 1

2005-2006 Martinez Intermodal Station Monitoring
Rainfall and Storm Flow Comparison

PWA

PWA#: 1535.03

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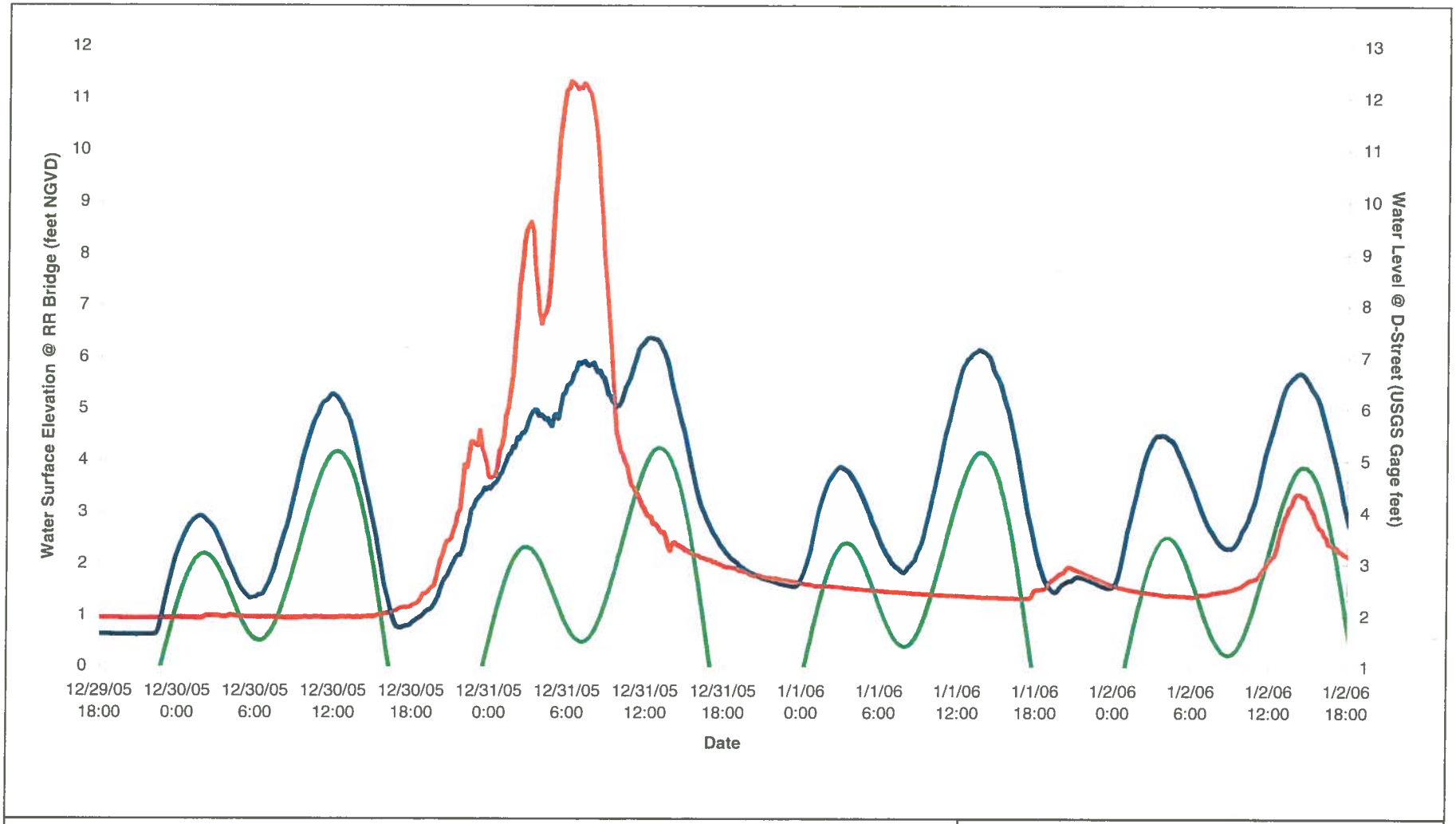

Figure 2

2005-2006 Martinez Intermodal Station Monitoring
Water Levels at UPRR and D St.

PWA

PWA#: 1535.03

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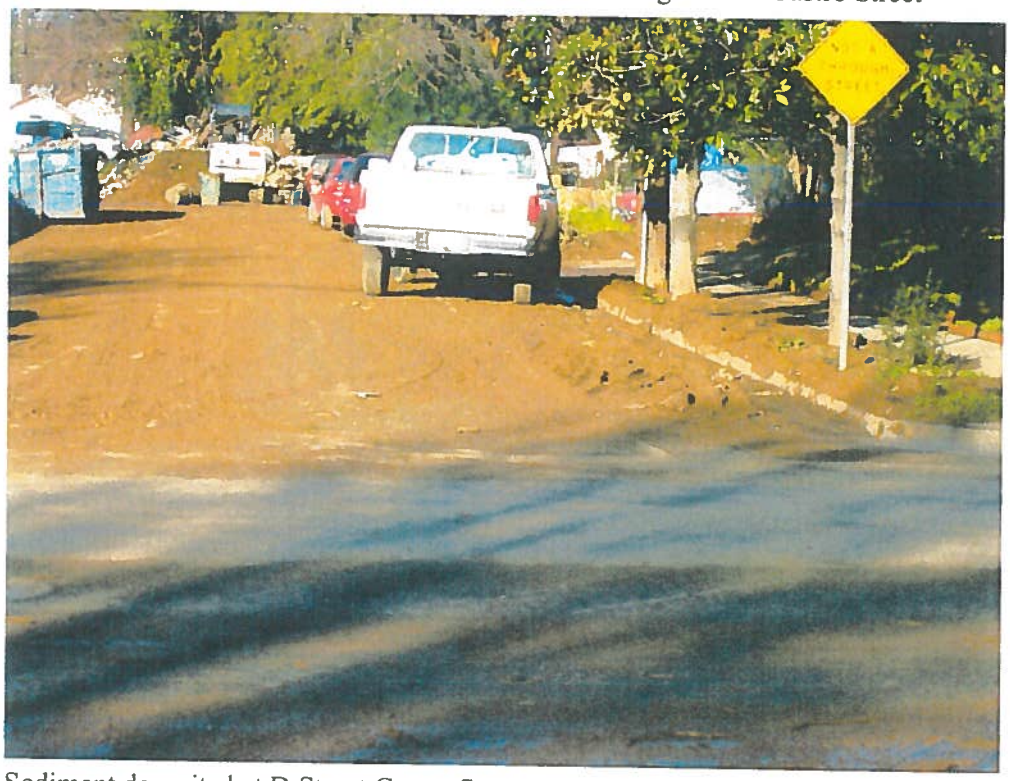
Sediment deposited along D Street and in the curb and gutter on Castro Street



Sediment deposited at D Street Castro Street

figure 3

Martinez Flooding and Sedimentation Assessment

Sediment Deposited at D Street and Castro Street

Alhambra Creek Channel - D Street Bridge is narrower than upstream channel section. Debris trapped in drainage slots.

Alhambra Creek downstream of D Street - Large trees 10-15 feet apart constrict channel and limit conveyance.

figure 4

Martinez Flooding and Sedimentation Assessment

D Street Crossing

Retaining wall failure on east bank upstream of Brown Street culverts

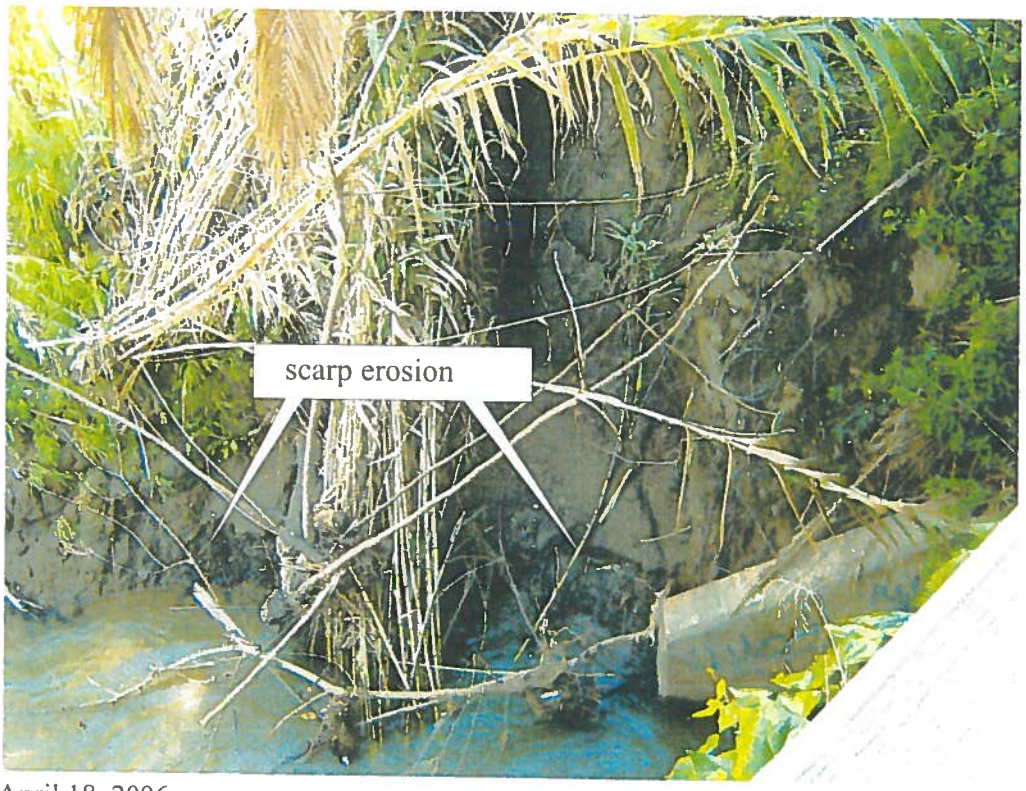
Uprooted tree lodged in culvert blocking flow and limiting conveyance

figure 5

Martinez Flooding and Sedimentation Assessment

Brown Street Crossing

May 26, 2005



April 18, 2006
Erosional scarp at Green Street Bridge scour hole toe increased following December 30-31, 2005 storm event.

figure 6

Martinez Flooding and Sedimentation Assessment

Green Street Bridge Inspection

Trees blocking part of Ward Street Bridge

Trees blocking Ward Street Bridge

figure 7

Martinez Flooding and Sedimentation Assessment

Ward Street Crossing

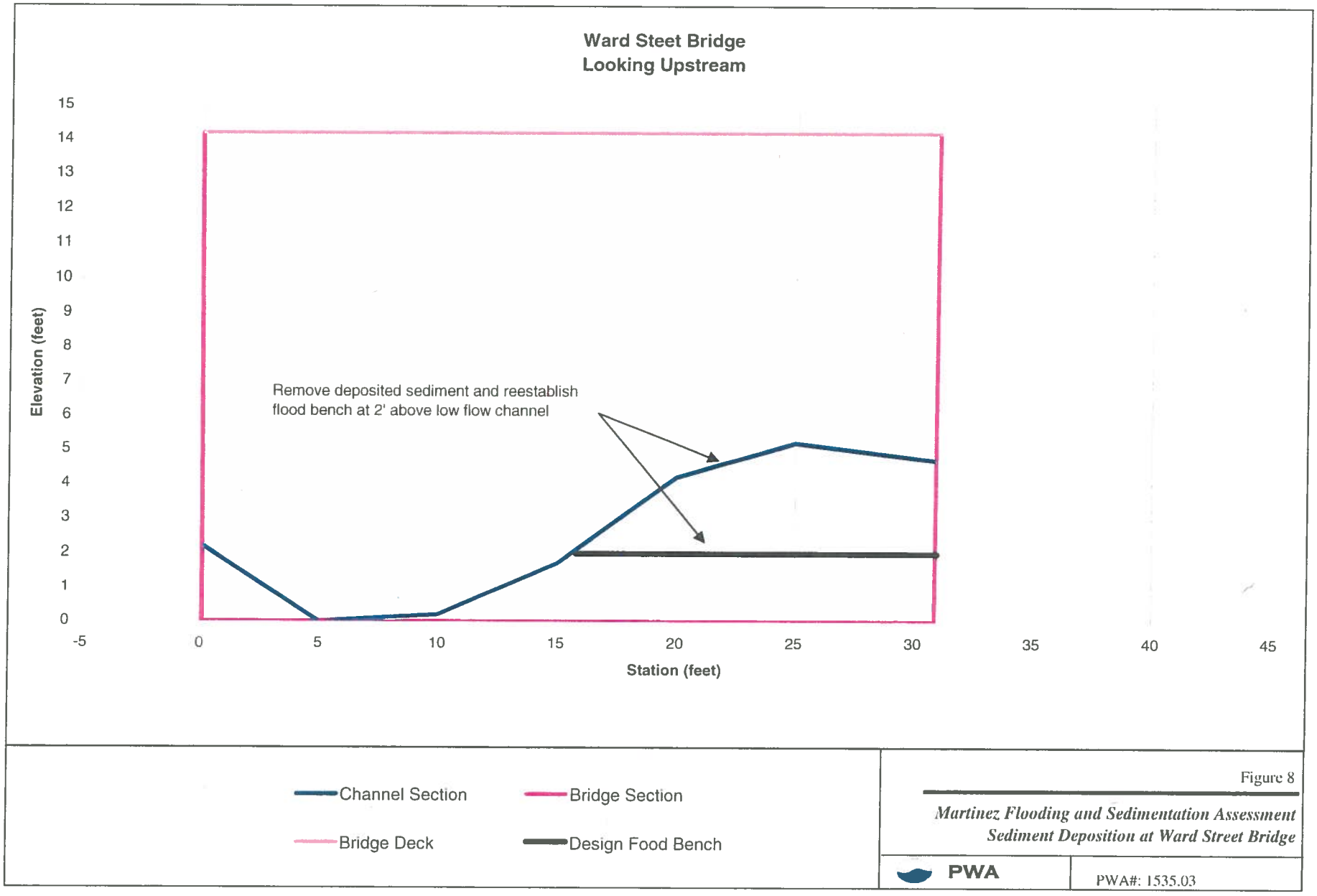


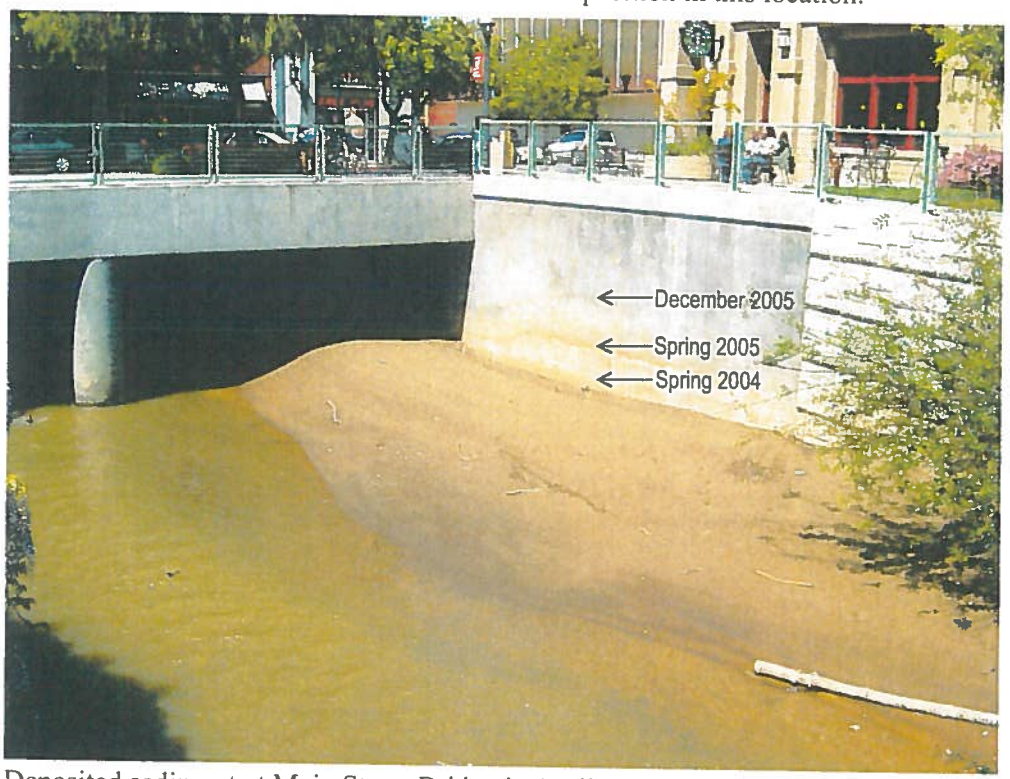
Figure 8

Martinez Flooding and Sedimentation Assessment
Sediment Deposition at Ward Street Bridge

PWA

PWA#: 1535.03

Deposited sediment at Main Street Bridge in January 2006. The December 30-31, 2005 storm resulted in 1 to 2 feet of sediment deposition in this location.



Deposited sediment at Main Street Bridge in April 2006 following sediment removal in February. Stains on concrete wall illustrate annual sediment deposition.

figure 9

Martinez Flooding and Sedimentation Assessment

Main Street Crossing

PWA

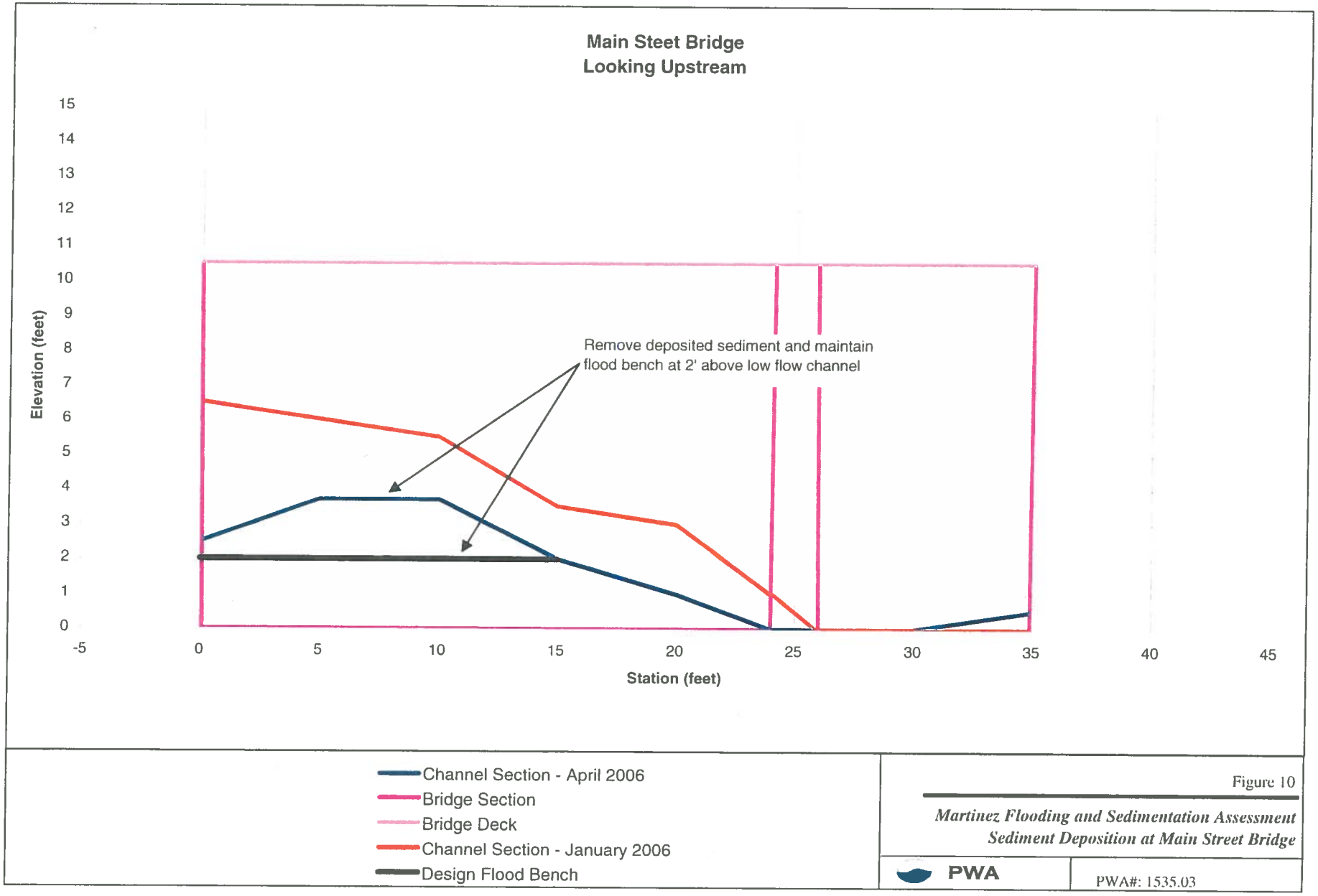


Figure 10

Martinez Flooding and Sedimentation Assessment
Sediment Deposition at Main Street Bridge

PWA

PWA#: 1535.03

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Wetland vegetation bent over and up to 1 foot of sediment deposits on west bank at Escobar Street

1 to 2 feet of sediment deposited on east bank at Escobar Street from December 30-31, 2005 storm

figure 11

Martinez Flooding and Sedimentation Assessment

Escobar Street Crossing

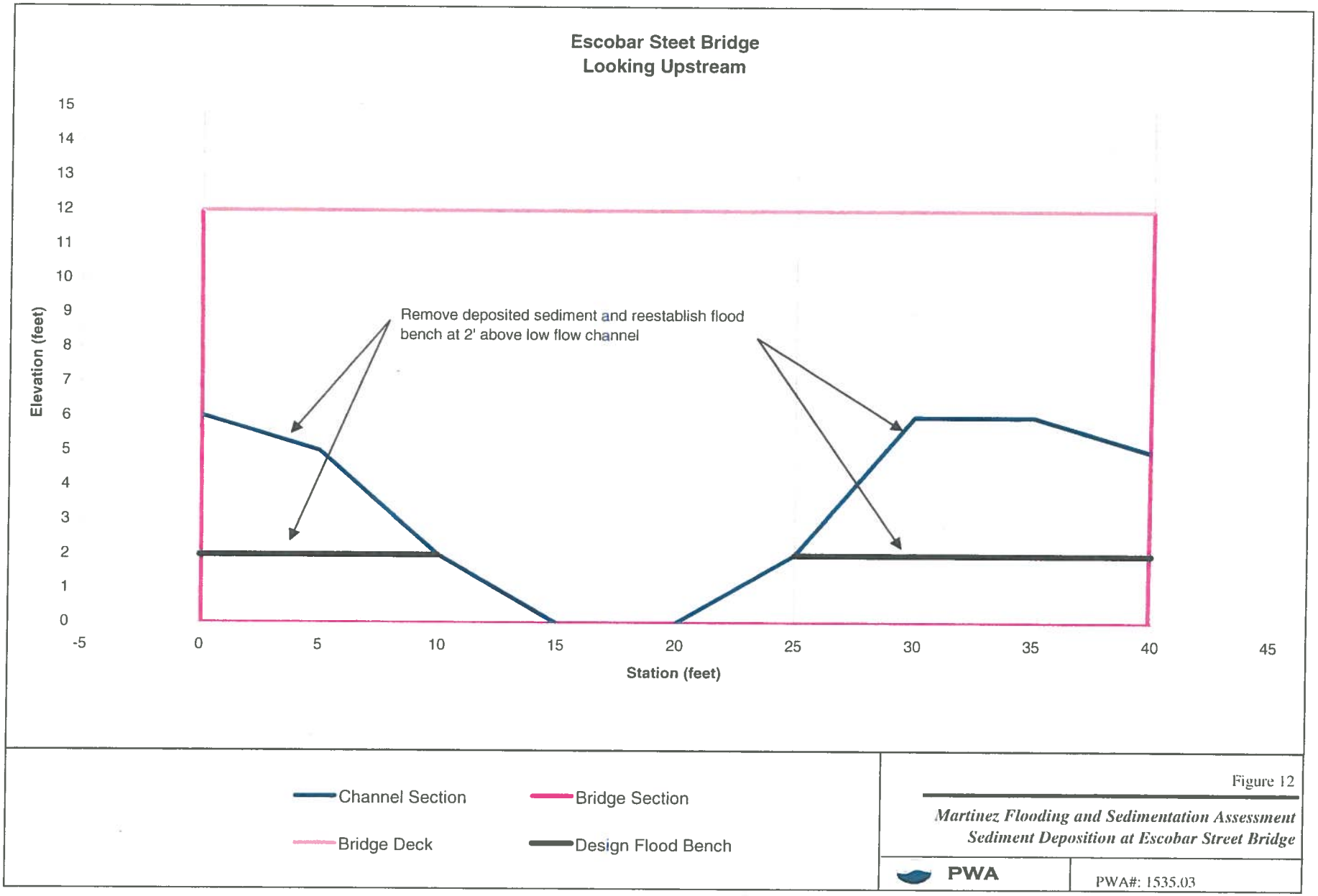

Figure 12

Martinez Flooding and Sedimentation Assessment
Sediment Deposition at Escobar Street Bridge

PWA

PWA#: 1535.03

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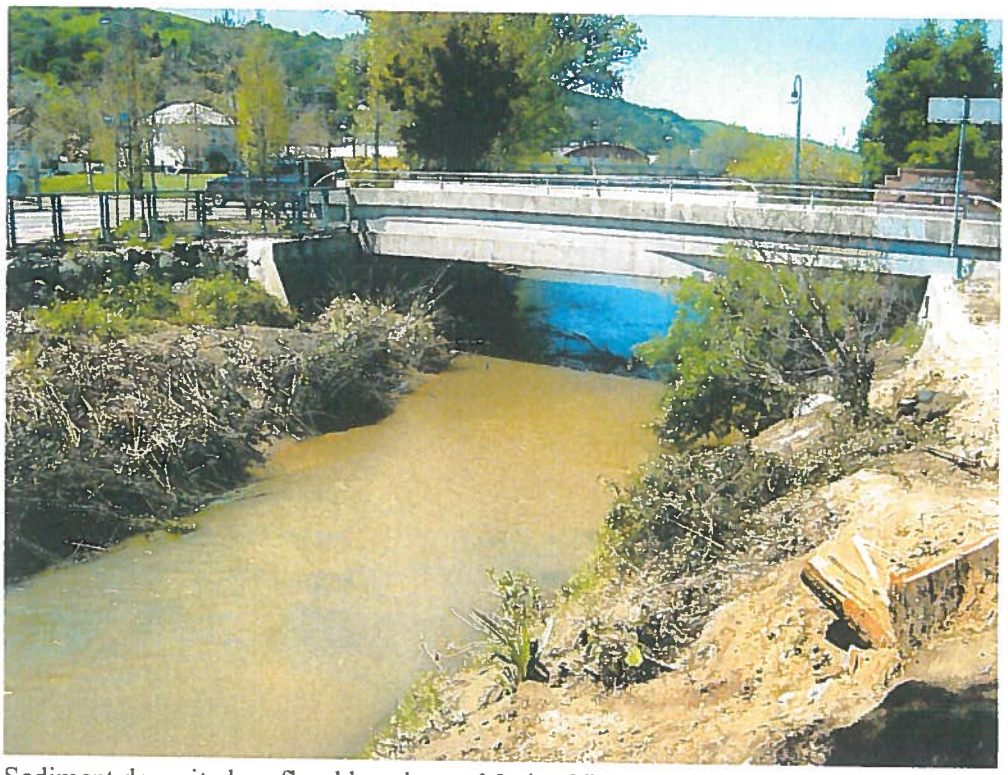
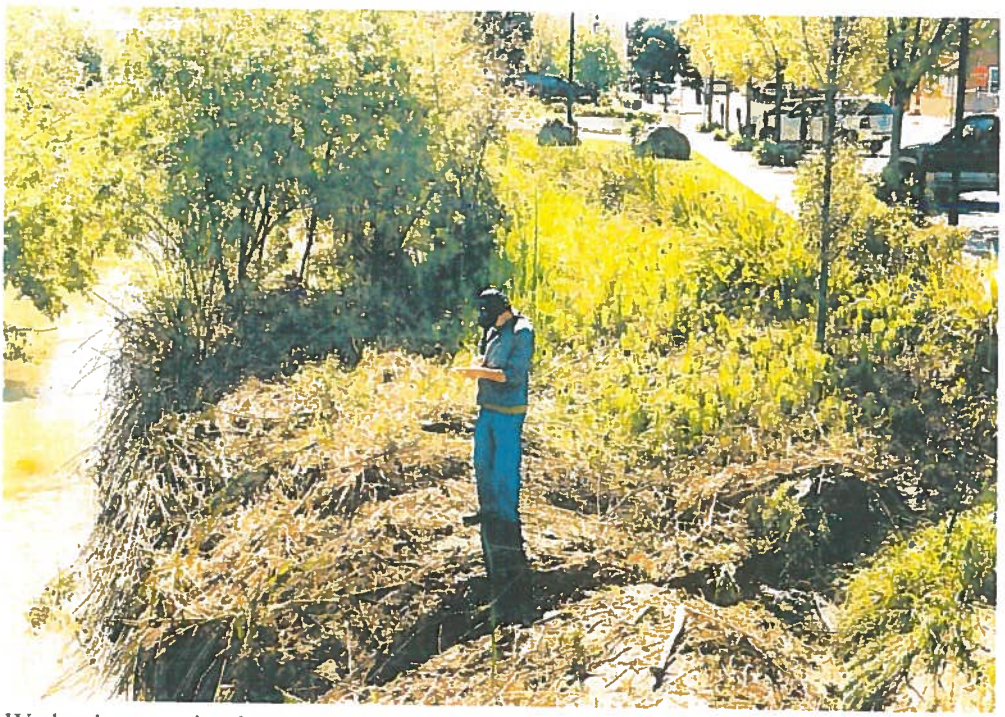


Sediment deposited on flood benches at Marina Vista Avenue



Wetland vegetation bent over and 1-2 feet of sediment deposited on west bank following December 2005 storm

figure 13

Martinez Flooding and Sedimentation Assessment

Marina Vista Avenue Crossing

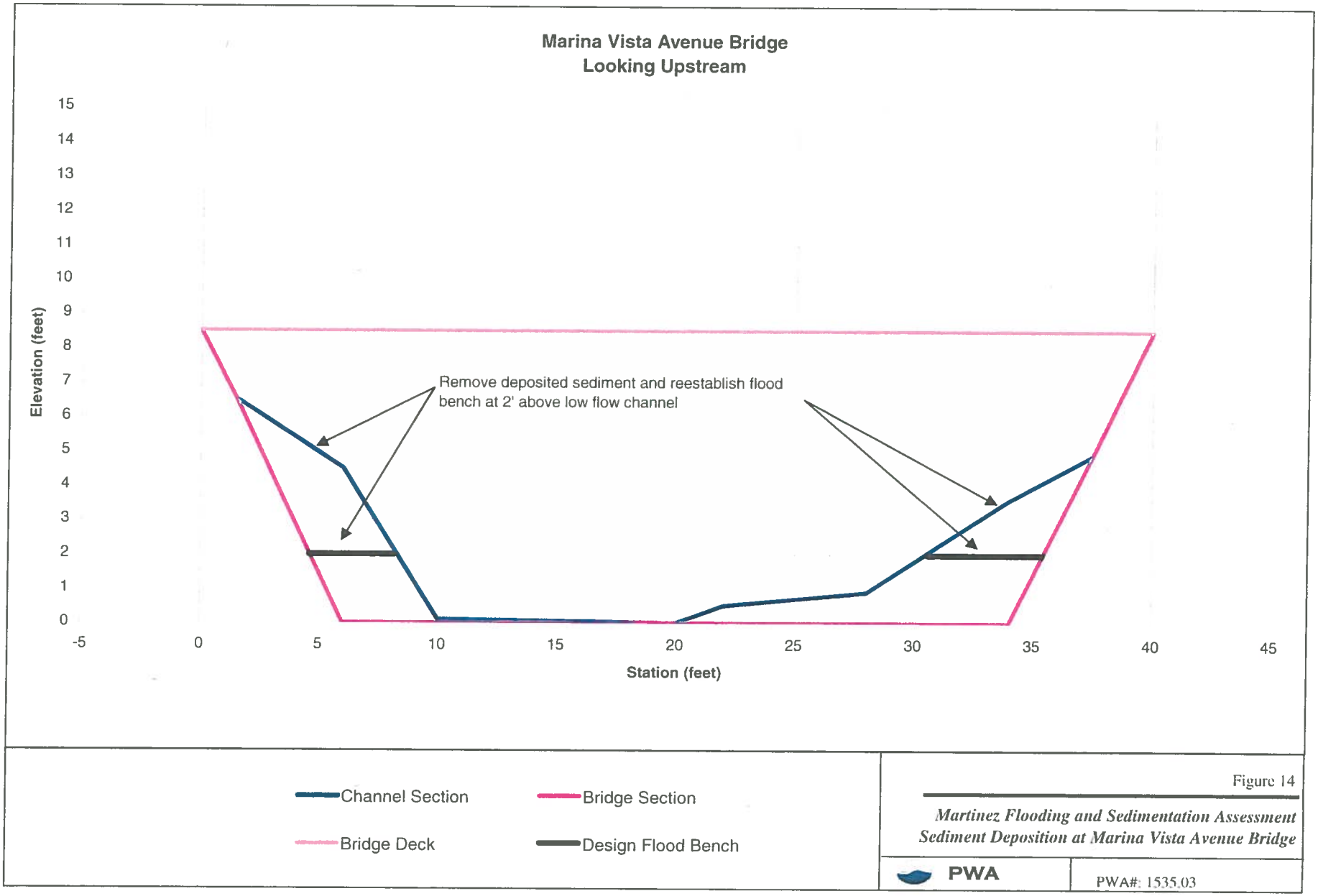


Figure 14

Martinez Flooding and Sedimentation Assessment
Sediment Deposition at Marina Vista Avenue Bridge

PWA

PWA#: 1535.03

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April 18, 2006

April 18, 2006

Marsh vegetation bent over and buried under sediment deposition in December 30-31, 2005 storm

figure 15

Martinez Intermodal Monitoring

Marsh Vegetation Impacts

PWA

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MEMORANDUM

Date:	October 16, 2007
To:	Timothy Tucker
Organization:	City of Martinez, Engineering Department
From:	Mark Lindley, PE and Christian Nilsen, PE
PWA Project:	**Martinez - Alhambra Creek Beaver Dam Assessment (1823.02)**
Subject:	**Alhambra Creek Beaver Dam Assessment**
Copy(ies) To:	

Introduction

Philip Williams & Associates (PWA) has assisted the City of Martinez (City) on issues related to flood management and habitat enhancement over the past 15 years. The City has implemented several projects since 1998 to improve flood conveyance and habitat values along the Alhambra Creek corridor. The Downtown Improvement Project included widening the creek corridor, creating a floodplain bench, and widening a number of bridge crossings between Marina Vista and Green Street. At the Intermodal Facility, a wide marsh-plain bench was created adjacent to the low flow channel and the Southern Pacific railroad bridge (SPRR) was replaced with a longer span with a higher bridge deck. Finally, the Salt Marsh Enhancement project at Grainger's Wharf included widening the creek corridor, creating marsh-plain benches adjacent to the channel, and providing a secondary outlet for discharge of high flows to the Carquinez Strait. Collectively, these projects have improved flood conveyance in Alhambra Creek from about the 2-year peak discharge to approximately the 10-year flood event (PWA, 2000). While these improvements have provided a decrease in flood hazards, much of the city is still vulnerable to flooding during extreme rainfall-runoff events.

In 2006, a family of beavers took up residence on Alhambra Creek constructing a dam within the downtown reach of the channel between Escobar and Marina Vista Streets. The City has asked PWA to study the impacts of this beaver dam on flood elevations. The purpose of this memorandum is to provide a brief assessment of the impact that the beaver dam could have on flood conveyance and estimated water levels along the downtown reach of Alhambra Creek.

Approach

PWA previously developed a HEC-RAS hydraulic model to assess the conveyance through the downtown reach of Alhambra Creek including both the Downtown Improvement and the Intermodal Facility Projects. The City provided survey information defining the size and location of the existing beaver dam. Using city-provided survey information, we estimated the impact that the dam would have on flow area

and the resulting conveyance in Alhambra Creek based on an average channel velocity predicted from our original HEC-RAS model for the downtown reach. We also updated the original HEC-RAS hydraulic model to include the geometry of the beaver dam to examine water levels for 2- through 25-year return period flows under design conditions and with the beaver dam.

Beaver Dam

The beaver dam is located in Alhambra Creek, between Marina Vista and Escobar Streets. The City provided measurements of the beaver dam indicating that the dam was about 6 feet above the existing channel thalweg (low point) with slopes of about 4:1 (H:V) on the upstream face and 1:1 on the downstream face. The City also indicated that about 1 foot of sediment has accumulated upstream of the dam. A cross section of the beaver dam based on survey data provided by the City is presented in Figure 1. Photos shot in June 2007of the dam and ponding behind the dam are presented in Figure 2. In addition, the City noted that the beavers have been rapidly expanding their dam. The crest of the dam has been increasing steadily through out the summer and fall, and the dam continues to expand.

We have not assessed the stability of the beaver dam. Since the dam is located within the tidal portions of Alhambra Creek assessing the stability of the dam would be difficult. The dam would be more vulnerable to failure during a high flow event corresponding with a lower tide. Flows over the top of the dam could initiate toe scour due to high velocities flowing down the face of the dam. The dam is expected to be more stable during higher tides when flows over the top of the dam are drowned out by the high tides on the downstream side. It is possible that during a significant flow event that the beaver dam could fail, potentially sending debris downstream. An analysis of the potential impacts related to debris flow down stream is beyond the scope of this assessment. However, we would expect significant quantities of sediment, woody debris, etc would be washed downstream. This debris flow could initiate additional erosion and/or damage property along the banks of the creek. Debris could also become lodged in bridges downstream potentially increasing flood hazards and/or damaging bridge pilings. In addition, the dam itself creates a location where debris may collect further reducing creek capacity.

Scenarios studied

We examined four scenarios to assess the impacts of the beaver dam on conveyance and water levels:

1. Design channel geometry without the beaver dam. This scenario reflects the restored Alhambra Creek channel under design conditions intended to provide baseline estimates of conveyance and water levels. The model was not updated to reflect changes in the channel since construction, including sediment deposition and the establishment of dense vegetation along the banks.

2. Design channel geometry with the six feet high beaver dam and one foot of sediment upstream of the dam to Escobar Street. This scenario represents the current conditions at the beaver dam including sediment deposition in the low flow channel upstream of the dam.

3. Design channel geometry with a seven feet high dam and one foot of sediment. This scenario represents a likely future condition at the beaver dam as the dam continues to expand with a one foot increase in the current crest elevation.

4. Design channel geometry with an eight feet dam and one foot of sediment. This scenario represents a potential future condition with an increase of 2 feet over the current crest elevation.

Flow Area Analysis

A simple cross-section analysis was performed to estimate the flow that Alhambra Creek can convey at the location of the beaver dam. The area available for flow was calculated based on the cross-section at the beaver dam provided by the City. Cross-sectional area was calculated for four scenarios described above. Velocity at this cross section was obtained from the HEC-RAS hydraulic analysis (described below) and was assumed to remain the same for each scenario studied. The capacity at the Marina Vista Avenue Bridge was also calculated based on the velocity from the HEC-RAS hydraulic analysis at the bridge for reference. The Marina Vista Avenue Bridge is the hydraulic constriction immediately downstream of the beaver dam, and may control channel capacity at this location. Results from this analysis are presented in Table 1 below:

Table 1: Flow Area Analysis, Alhambra Creek, Martinez, CA

Scenario	Area	Channel Velocity	Capacity
	(ft^2)	*(ft/s)*	*(cfs)*
Without beaver dam	359	6.0	2150
Existing beaver dam	195	6.0	1170
Beaver dam +1 foot	150	6.0	900
Beaver dam +2 feet	103	6.0	615
Marina Vista Ave Bridge	286	7.3	2075

Hydraulic Modeling

A hydraulic model of Alhambra Creek was prepared by PWA in 1999 to assess conveyance related to the Downtown Improvement and Intermodal Facility Projects. This model was developed in the US Army Corps of Engineers' HEC-RAS modeling environment. HEC-RAS is a gradually-varied-flow hydraulic model that calculates water surface profiles based on solutions of the one-dimensional energy equations.

It is an industry standard model and is employed, among other applications, for FEMA flood hazard evaluations.

The four scenarios described above were analyzed. Beaver dam geometry was taken from City of Martinez survey information, and was modeled as a broad-crested weir with a four-foot wide crest. For the scenarios that include the beaver dam, one-foot of sediment was assumed extending from the dam to Escobar Street.

The design scenario of the 1999 study was used for the existing conditions (design channel without beaver dam) model. Channel geometry was assumed conform to this scenario. Although channel geometry has evolved since construction, including sediment deposition and the establishment of dense vegetation along the banks, these changes are not expected to significantly alter the conditions modeled because the roughness coefficient in the model reflected a moderately vegetated channel. This geometry was then updated to include the existing beaver dam geometry, and the potential future conditions of one and two extra feet on the dam crest. Runs were performed with down stream water level at MHHW in the Carquinez Strait with a minor adjustment for larger 10-year and 25-year events.

The model was run for the 2-, 5-, 7-, 10-, and 25-year return period peak flows based on the 1997 flood frequency analysis performed by PWA. Peak stream flows and their return periods are given below:

Table 2: Peak Flow Rates at Southern Pacific Railroad Bridge, Alhambra Creek, Martinez, CA

Return Period	Peak Flow
	(cfs)
2-year	634
5-year	1600
7-year	2000
10-year	2400
25-year	3618

Hydraulic modeling results are presented in Figures 3 through 9. Figures 3 through 7 compare the modeled flood elevations with and without the beaver dam in its current condition for the 2- through 25-year return periods. Modeling suggests that the level of protection of this stretch of Alhambra Creek is less than the five-year flood event with the beaver dam (meaning that the chance of flooding to occur in a given year is predicted to be about 20 percent). The level of protection without the beaver dam is estimated at around the seven-year flood event with a high tide in the Carquinez Strait. As compared to design conditions, the HEC-RAS modeling indicates that:

1. The 2-year water surface will be elevated by 2 to 3 feet upstream of the dam.

2. The 5-year water surface is elevated by about 2 feet upstream of the dam. The beaver dam may cause the 5-year event to flow out-of-bank in the vicinity of Escobar Street, where the right bank, looking upstream, is low.

3. The 7-year water surface is elevated by about 2 to 2.5 feet upstream of the dam. With the beaver dam, water levels go out of bank in the vicinity of Escobar for the 7-year event, while under the design conditions, the channel contains the 7-year event.

4. The 10-year water surface is elevated by about 2 feet and comes out of bank in the vicinity of Escobar Street with the beaver dam.

5. The 25-year flow floods in several locations regardless of the beaver dam.

Figure 8 illustrates modeling results for the 2-year event for the three scenarios that include the beaver dam: existing conditions and the two potential future conditions (+1 and +2 feet at the crest). While modeling results indicate that the potential future scenarios are able to convey the 2-year event without flooding, the resulting water levels upstream of Escobar are at top of bank for the crest +2 feet scenario and about 1 foot below top of bank the crest +1 foot scenario. The 5-year event causes flows to go out of bank with the current beaver dam as well as the two future scenarios as seen in Figure 9.

Conclusions

Based on this analysis we can draw the following conclusions:

1. The beaver dam has a significant impact on conveyance and water levels in the downtown reach of Alhambra Creek increasing flood risks for downtown Martinez.

2. The flow area analysis indicates that the capacity of the channel (about 2,100 cfs) is reduced by about 1,000 cfs with the current beaver dam. Potential future scenarios further decrease capacity by about 1,250 cfs (crest +1 foot) and about 1,500 cfs (crest +2 feet).

3. Hydraulic modeling indicates that the beaver dam increases the annual chances of flooding in downtown Martinez from approximately one in ten (10-year event) to about one in four (4-year event).

4. Potential future scenarios of +1 and +2 feet on the dam crest raise the water surface for the 2-year event to within 1 foot and at top of bank upstream of Escobar.

5. The study assumes that the beaver dam will remain intact during flooding events.

6. If beaver dam failure does occur, debris accumulation may occur on downstream bridge structures, potentially increasing flood hazards or damaging downstream structures.

7. The beaver dam creates a new location where debris may be trapped during storm events increasing the likelihood of flooding.

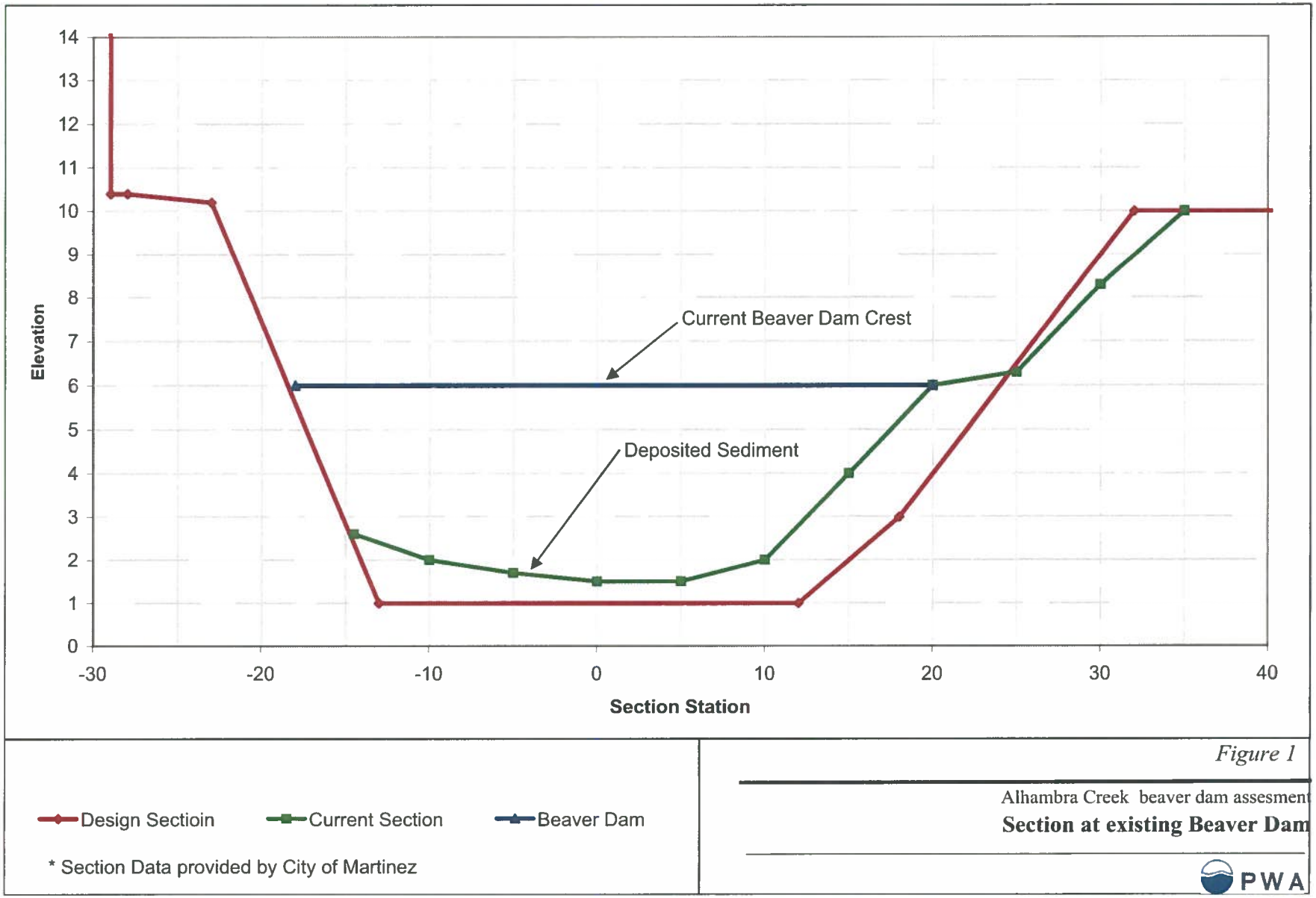


Figure 1

Alhambra Creek beaver dam assesment

Section at existing Beaver Dam

PWA

figure 2a
Alhambra Creek beaver dam assessment

Beaver Dam and Ponding Behind Beaver Dam

PWA Ref# 1823.02

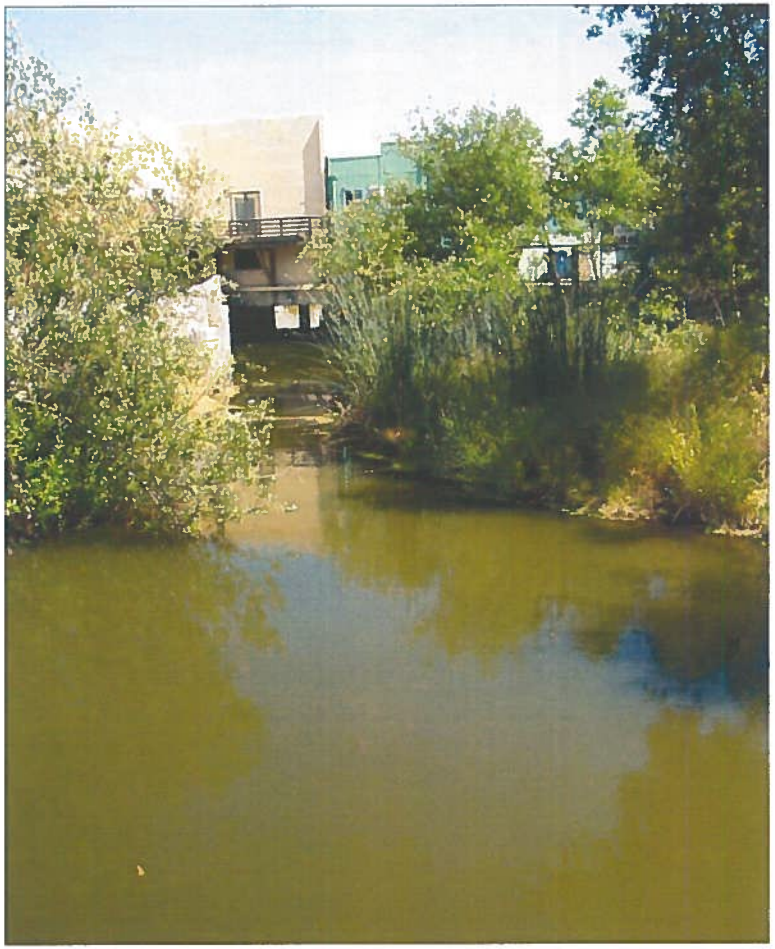
PWA

figure 2b
Alhambra Creek beaver dam assessment

Beaver Dam and Ponding Behind Beaver Dam

PWA Ref# 1823.02

PWA



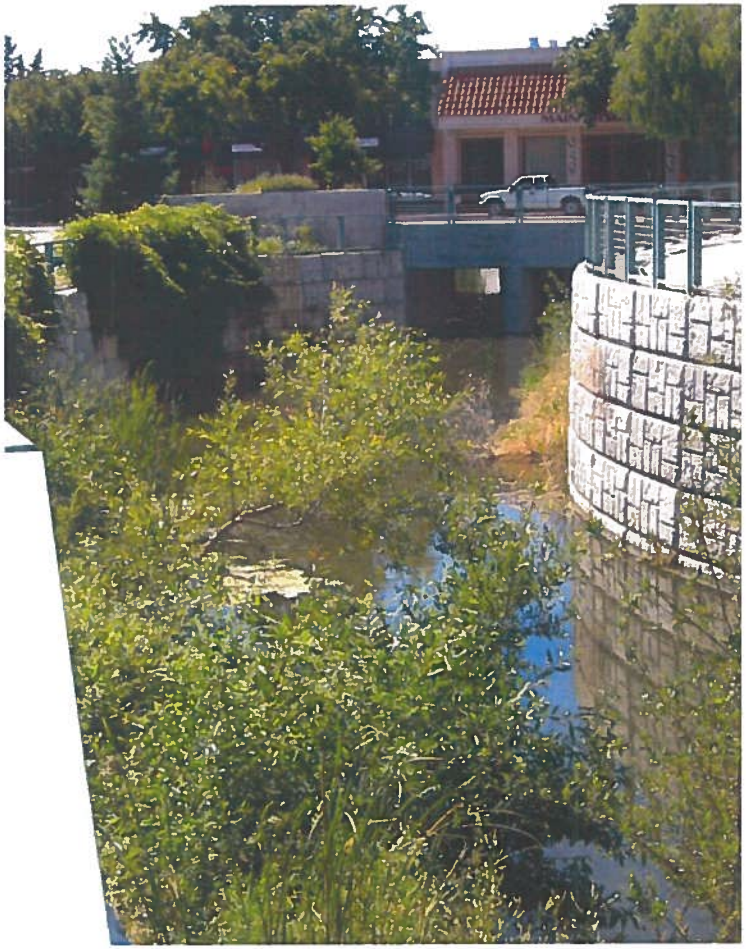


figure 2c
Alhambra Creek beaver dam assessment

Beaver Dam and Ponding Behind Beaver Dam

PWA Ref#1823.02

PWA

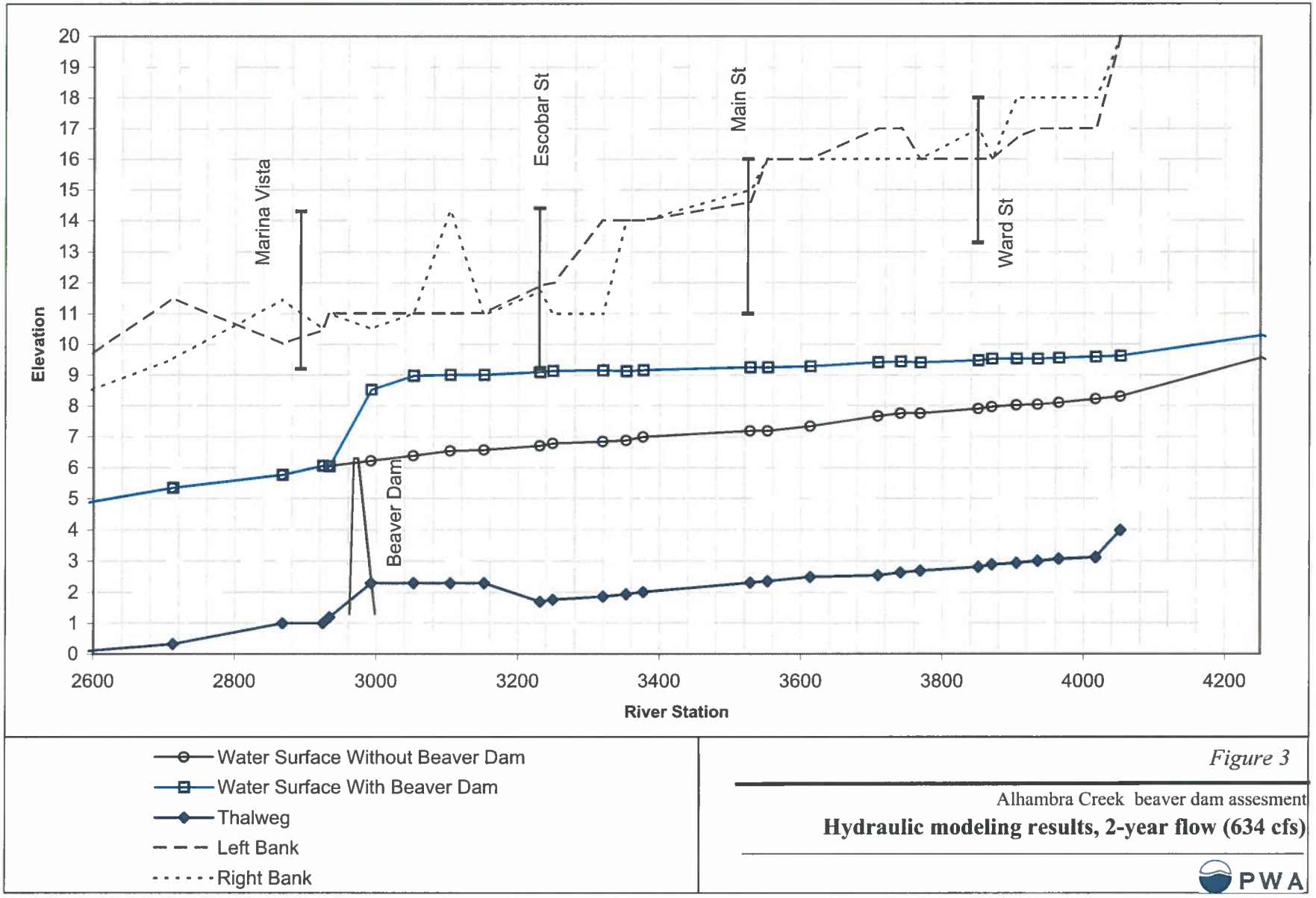


Figure 3

Alhambra Creek beaver dam assesment

Hydraulic modeling results, 2-year flow (634 cfs)

PWA

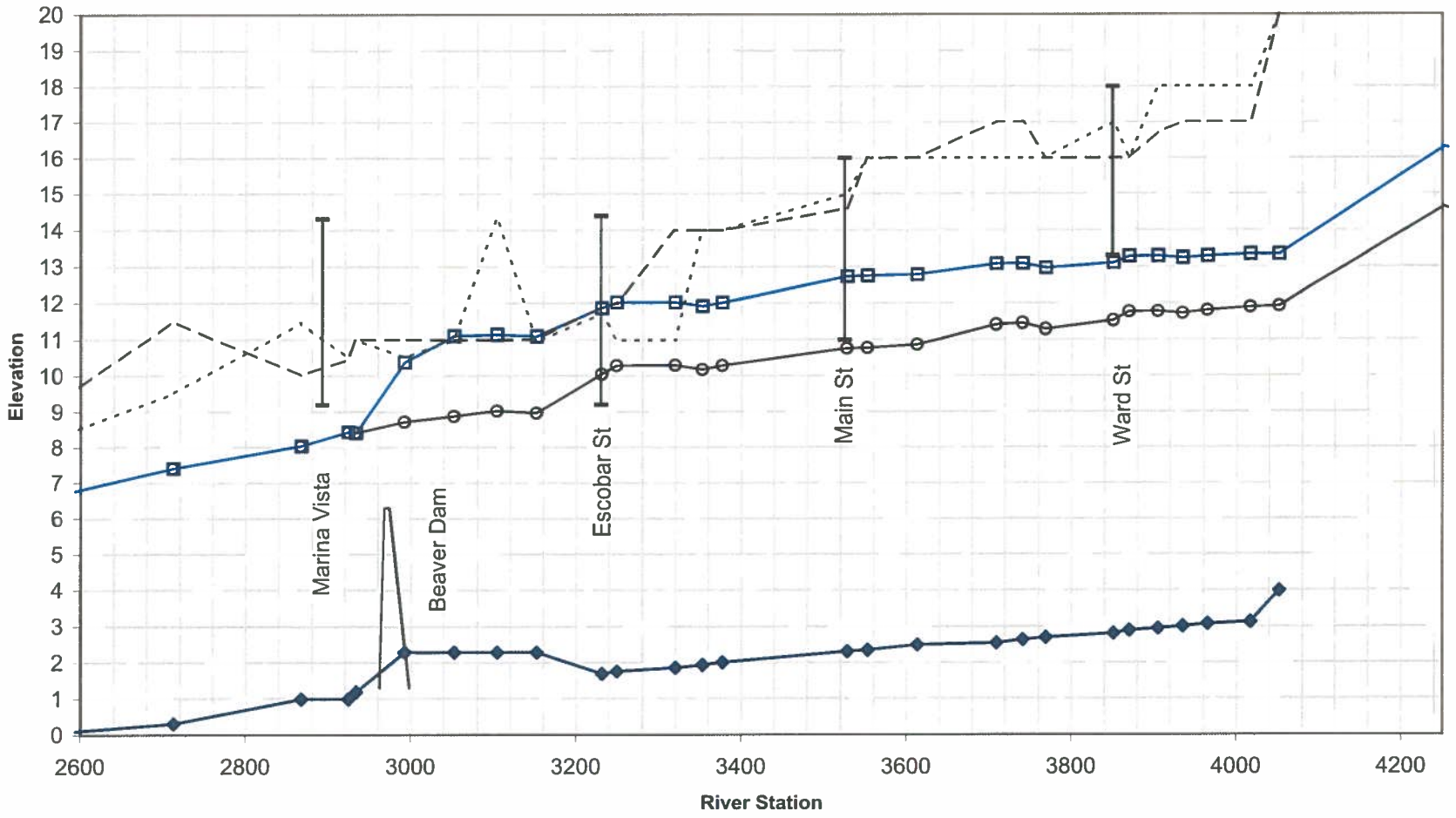


Figure 4

Alhambra Creek beaver dam assesment

Hydraulic modeling results, 5-year flow (1600 cfs)

PWA

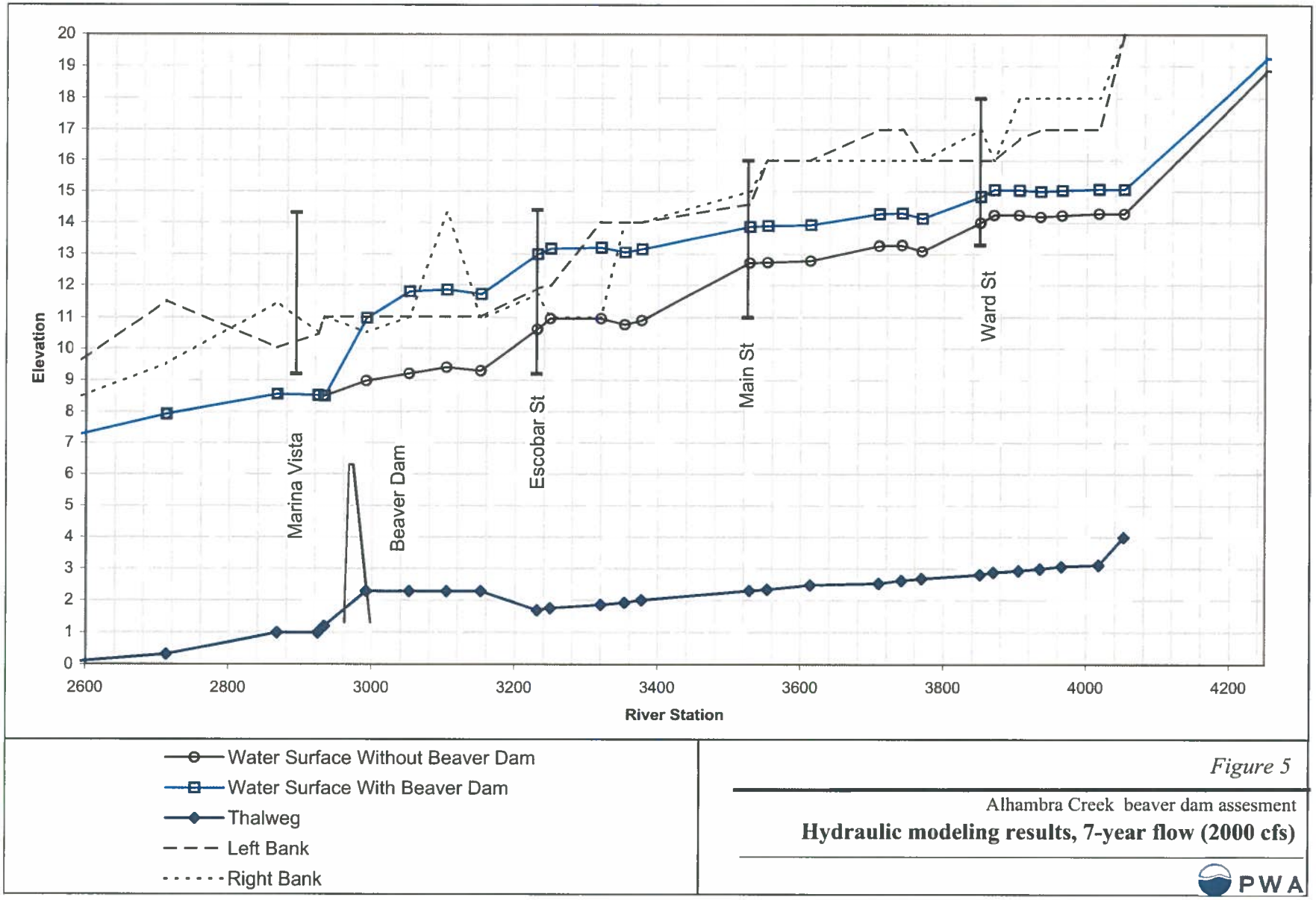


Figure 5

Alhambra Creek beaver dam assesment

Hydraulic modeling results, 7-year flow (2000 cfs)

PWA

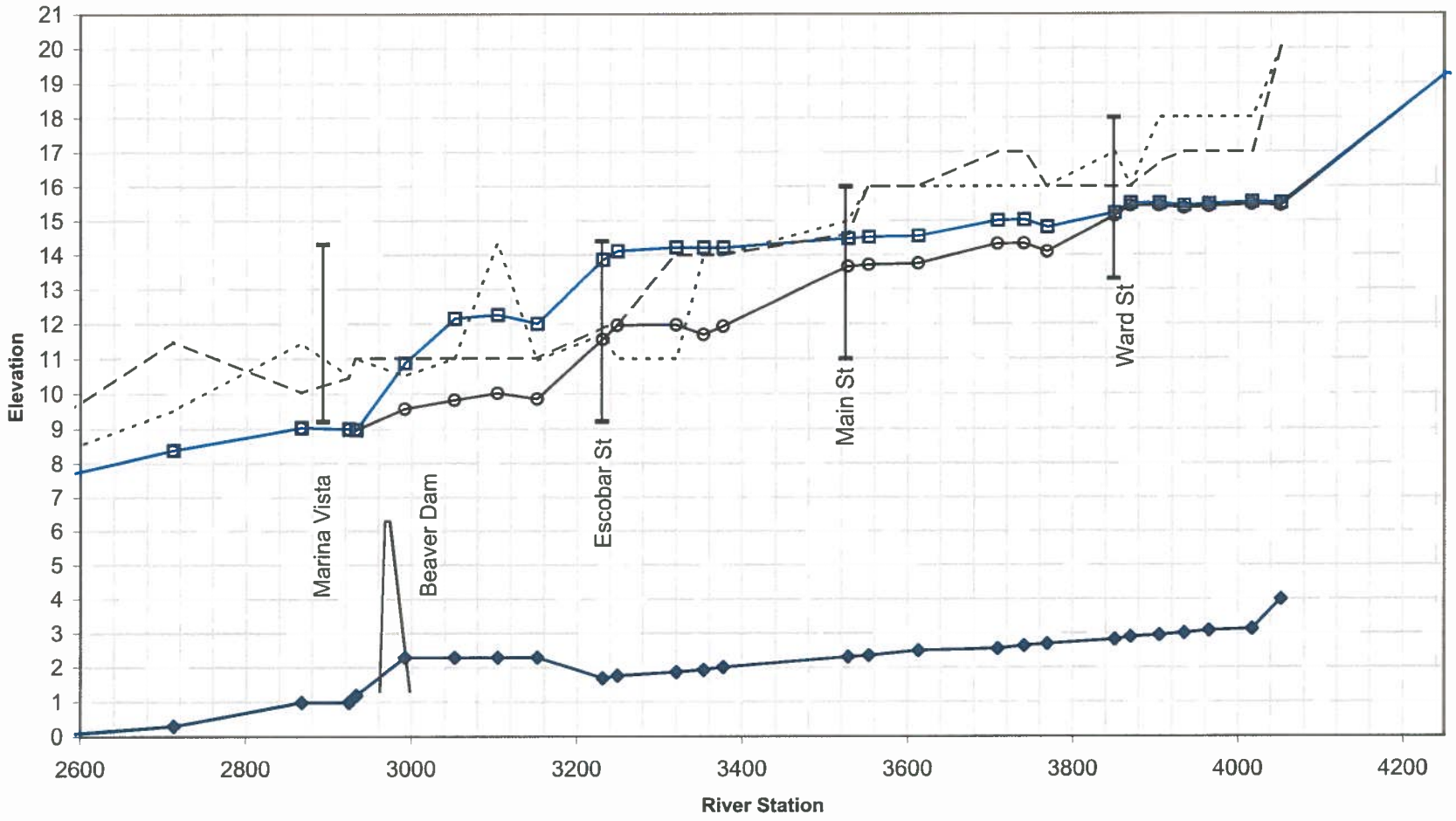


Figure 6

Alhambra Creek beaver dam assesment

Hydraulic modeling results, 10-year flow (2400 cfs)

PWA

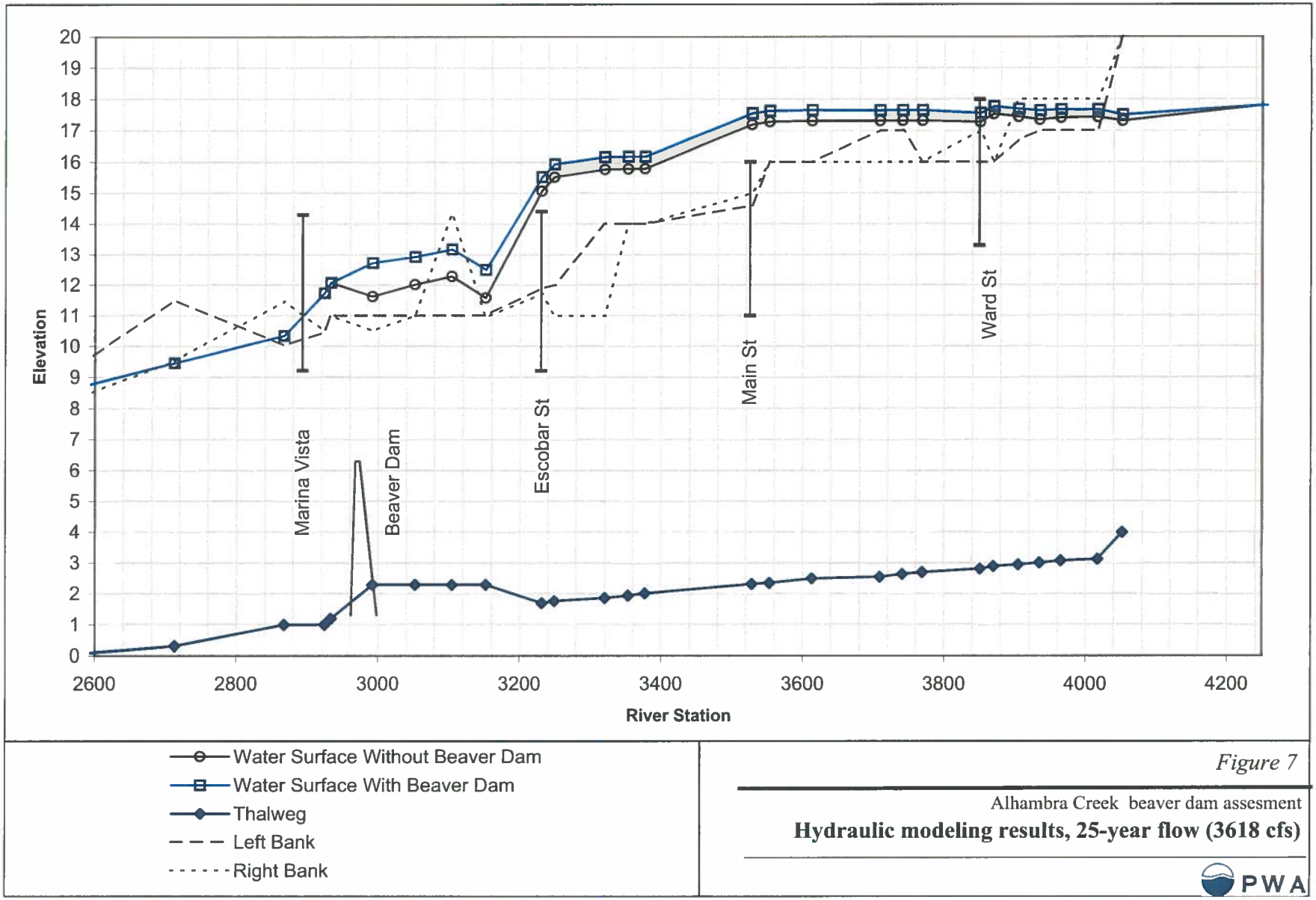


Figure 7

Alhambra Creek beaver dam assesment

Hydraulic modeling results, 25-year flow (3618 cfs)

PWA

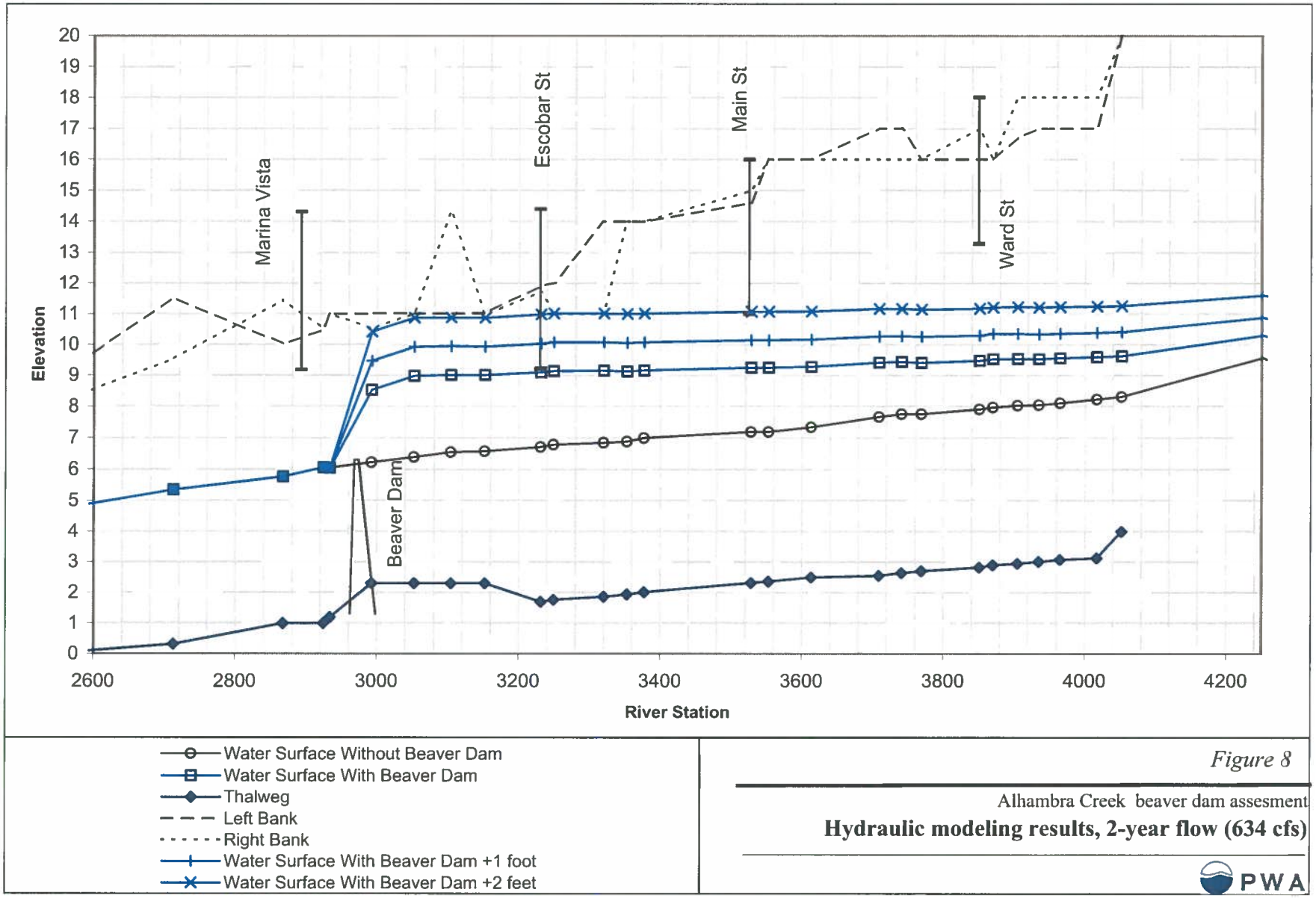


Figure 8

Alhambra Creek beaver dam assesment

Hydraulic modeling results, 2-year flow (634 cfs)

PWA

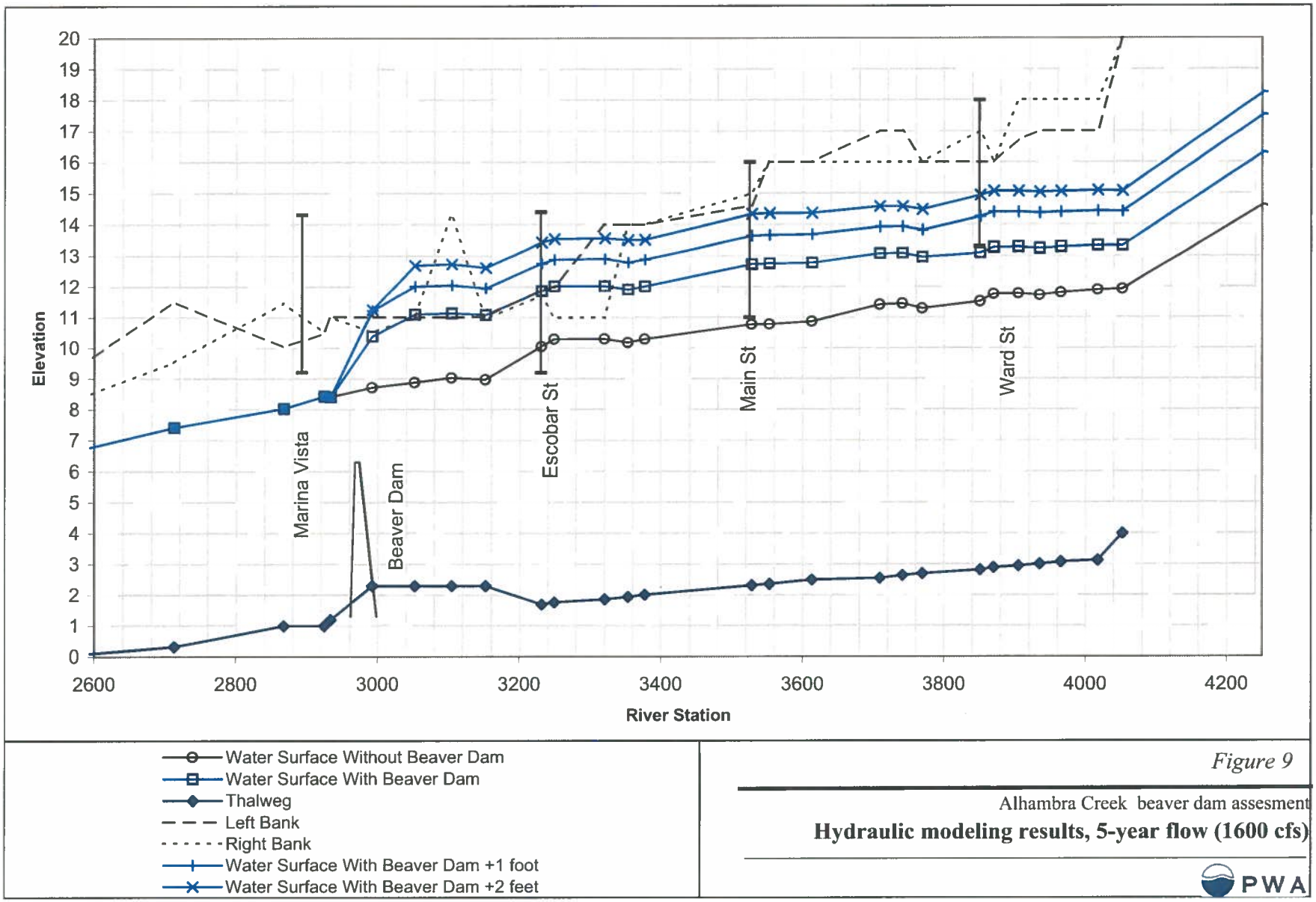


Figure 9

Alhambra Creek beaver dam assesment

Hydraulic modeling results, 5-year flow (1600 cfs)

PWA

PWA
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MEMORANDUM

Date:	April 10, 2008
To:	Timothy Tucker
Organization:	City of Martinez, Engineering Department
From:	Mark Lindley, PE
PWA Project:	**Martinez - Alhambra Creek Beaver Dam Assessment (1823.02)**
Subject:	**Alhambra Creek Beaver Dam - Management Options**

Introduction

Philip Williams & Associates (PWA) has assisted the City of Martinez (City) on issues related to flood management and habitat enhancement over the past 15 years. The City has implemented several projects since 1998 to improve flood conveyance and habitat values along the Alhambra Creek corridor. The Downtown Improvement Project included widening the creek corridor, creating a floodplain bench, and widening a number of bridge crossings between Marina Vista and Green Street. At the Intermodal Facility, a wide marsh-plain bench was created adjacent to the low flow channel and the Southern Pacific railroad bridge (SPRR) was replaced with a longer span with a higher bridge deck. Finally, the Salt Marsh Enhancement project at Grainger's Wharf included widening the creek corridor, creating marsh-plain benches adjacent to the channel, and providing a secondary outlet for discharge of high flows to the Carquinez Strait. Collectively, these projects have improved flood conveyance in Alhambra Creek from about the 2-year peak discharge to approximately the 10-year flood event (PWA, 2000). While these improvements have provided a decrease in flood hazards, much of the city is still vulnerable to flooding during extreme rainfall-runoff events.

In 2006, several beavers relocated to Alhambra Creek constructing a dam in the downtown reach of the channel between Escobar and Marina Vista Streets (Figures 1 and 2). PWA assessed the potential effects of this beaver dam on flow conveyance and flood elevations in October 2007. The results of that initial study indicated the beaver dam could increase flood risks along Alhambra Creek within downtown Martinez. The City requested that PWA develop potential management strategies to mitigate increases in flood risks while maintaining the beaver dam. This memorandum provides several options to manage flood risks while maintaining the beaver dam at its current location.

Potential Beaver Dam Impacts

In October 2007, the beaver dam was at a crest elevation of about 6.0 feet above MSL as measured by the City. This was approximately about 5 feet above the channel thalweg (low point) spanning the creek between two trees (Figure 3). The dam caused water to pond upstream along several blocks through downtown Martinez past Ward Street. In addition, the beavers continued to raise and strengthen the dam. By December 2007, the dam had increased in height by about two feet to a crest elevation of about 8 feet MSL according to the City as evidenced by staining on the concrete abutments at the Escobar Street culvert wing walls.

In October 2007, the City asked PWA to study the impacts of this beaver dam on creek conveyance and flood elevations. The results of that initial study are documented in an October 16, 2007 memorandum. We examined the decrease in flow area caused by the beaver dam which indicated that the creek capacity could decrease by as much as 1000 cfs, dropping from a design capacity of about 2150 cfs down to about 1170 cfs with the beaver dam. We also updated the original HEC-RAS model for the downtown reach of Alhambra Creek to estimate potential impacts on flood elevations associated with the beaver dam at its October 2007 elevation. The HEC-RAS modeling indicated that the flood elevations could be elevated by about 2 to 3 feet with the dam with a crest elevation of 6 feet MSL. We estimated that in channel flow capacity would decrease from about a 10-year peak discharge down to approximately a 4-year peak discharge.

Since the beaver dam was increasing in height over time, we also looked at the impacts on conveyance and flood elevations associated with increases in dam height of 1 and 2 feet to account for possible future scenarios. Using the flow area analysis, we estimated that the creek capacity would decrease further to about 900 cfs with a crest elevation of 7 feet MSL and 600 cfs with an 8 feet MSL crest elevation. The HEC-RAS modeling indicated that the flows may go out of bank during a 2-year peak discharge event with an 8 feet MSL crest elevation dam, and would be within about one foot of top of bank with a dam at a 7 feet MSL crest elevation.

While it was recognized that some portion of the dam may erode during a major flood event, it was not possible to quantify this with any certainty, and the analysis was conducted with the dam intact. The above results indicated that the beaver dam could significantly increase flood risks along Alhambra Creek within the City of Martinez.

Management Options

In discussions with the City, we identified three management options:

1. Lower the beaver dam and maintain it at a lower elevation by using a flexible leveler.

2. Lower the beaver dam as in option 1, and excavate an expanded floodplain terrace adjacent to the low flow channel to provide extra flow area and capacity to offset the flow area loss associated with the beaver dam.

3. Develop an active flood response plan using rainfall measurements to alert City staff of the need to remove or lower the beaver dam during an extreme event.

Management Option #1 – Maintain Lower Dam with Flexible Leveler

Lowering the beaver dam would increase conveyance to help mitigate increases in flood risks. However, based on the City's experience to date, the beavers tend to rebuild the dam up to and possibly higher than the original dam height. The City contacted Skip Lisle from Snohomish County, Vermont to install a flexible leveler ("beaver deceiver") to allow the dam to be maintained at a lower height (Figure 4).

To aid in the estimation of a beaver dam height with lower flood hazards, PWA examined the dam under three scenarios – lowering the dam crest by one, two and three feet from the October 2007 crest elevation (6 feet MSL). Using the same approach described in our October 16, 2007 memorandum, we initially estimated conveyance using a flow-area analysis. In addition, we updated the HEC-RAS model of the downtown reach of Alhambra Creek to more accurately estimate conveyance and flood elevations.

Flow Area Analysis

The flow-area analysis involved calculating the channel cross-sectional area of the original design section at the beaver dam, the reduced flow area with the beaver dam, and the flow area with the dam lowered one, two and three feet. To compute flow capacity we utilized the velocity at this cross section obtained from the HEC-RAS hydraulic analysis, which was assumed to remain the same for each scenario studied. The capacity at the Marina Vista Avenue Bridge was also calculated based on the velocity from the HEC-RAS hydraulic analysis at the bridge for reference. The Marina Vista Avenue Bridge is the next hydraulic constriction immediately downstream of the beaver dam, and may affect channel capacity at this location. Results from this analysis are presented in Table 1 below:

Table 1. Channel Flow Area Analysis - Lowered Beaver Dam

Scenario	Channel Flow Area (ft^2)	Channel Velocity (*ft/s*)	Capacity (*cfs*)
Without beaver dam	359	6.0	2150
October 2007 beaver dam (6' MSL crest)	195	6.0	1170
Beaver dam lowered 1 foot	240	6.0	1440
Beaver dam lowered 2 feet	265	6.0	1590
Beaver dam lowered 3 feet	298	6.0	1785
Marina Vista Ave Bridge	286	7.3	2075

Hydraulic Modeling

A hydraulic model of Alhambra Creek was prepared by PWA in 1999 to assess channel flow conveyance related to the Downtown Improvement and Intermodal Facility Projects. This model was developed in the US Army Corps of Engineers' HEC-RAS modeling environment. HEC-RAS is a gradually-varied-flow hydraulic model that calculates water surface profiles based on solutions of the one-dimensional energy equations. It is an industry standard model and is employed, among other applications, for FEMA flood hazard evaluations.

We examined original design capacity, the reduced capacity with the beaver dam, and with the dam lowered one, two and three feet. Beaver dam geometry was taken from City of Martinez survey information, and was modeled as a broad-crested weir with a four-foot wide crest. For the scenarios that include the beaver dam, one-foot of sediment was assumed extending from the dam to Escobar Street.

The design scenario of the 1999 study was used for the existing conditions (design channel without beaver dam) model. Channel geometry was assumed to conform to this scenario. Although channel geometry has evolved since construction, including sediment deposition and the establishment of vegetation along the banks, these changes are not expected to significantly alter the conditions modeled because the roughness coefficient in the model reflected a moderately vegetated channel. This geometry was then updated to include the October 2007 beaver dam geometry (6 feet MSL crest elevation), and the potential conditions with the dam crest lowered one, two, and three feet. Runs were performed with down stream water level at MHHW in the Carquinez Strait with a minor adjustment for larger 10-year and 25-year events.

The model was run for the 2-, 5-, 7-, and 10-year return period peak flows based on the 1997 flood frequency analysis performed by PWA. Peak stream flows and their return periods are given below:

Table 2. Peak Flow Rates at Southern Pacific Railroad Bridge

Return Period	Peak Flow *(cfs)*
2-year	634
5-year	1600
7-year	2000
10-year	2400
25-year	3618

Hydraulic modeling results are presented in Figures 5 through 8, comparing modeled flood elevations with and without the beaver dam in its October 2007 height (6 feet MSL crest elevation) condition and

lowered by one, two, and three feet for the 2- through 10-year return periods. The modeling results indicate that the level of flood protection along this stretch of Alhambra Creek is decreased to less than the five-year flood event with the beaver dam (i.e. the chance of flooding to occur in a given year is predicted to be about 20 percent). Lowering the dam offers improvements in flood elevations:

1. Lowering the dam by one foot, lowers flood elevations by about one foot, sufficient to provide capacity for a 5-year flood event.

2. Lowering the dam by two feet, lowers flood elevations by about 1.7 to 1.8 feet just upstream of the dam. However, the 7-year event would still flow out of bank at the low point just upstream of the Escobar crossing.

3. Lowering the dam by 3 feet, provides greater than a 7-year storm capacity, with flood elevations within about 0.25 feet of design conditions for the 7-year and 10-year flood events.

These results were provided to the City preliminarily in December 2007. PWA recommended that if the City decided to maintain the beaver dam, it should be lowered by 2 to 3 feet from the October 2007 height. In January 2008, the City indicated that the flexible leveler was installed and dam was lowered by about 2 feet from the October 2007 height. The City indicates that the beaver dam height has remained relatively constant since it was lowered in January 2008.

Management Option #2 – Maintain Lower Dam and Excavate Expanded Floodplain

To help provide additional flow capacity to offset the capacity lost to the beaver dam, PWA suggested excavation of an expanded floodplain between the low flow channel and Castro Street as shown in Figure 9. This floodplain would provide extra cross-sectional area for flood waters to flow adjacent to the beaver dam (Figure 10). The dam would continue to be maintained at the lower height with the flexible leveler to help maximize conveyance and limit flood risks while maintaining the dam and beaver habitat. The excavated floodplain area would also support marsh and riparian vegetation to expand habitat conditions adjacent to the dam.

If desired, an overlook could be created along Castro Street to allow views of the dam. The excavation would result in a steep bank between Castro Street and the excavated flood plain. The slope would need to be stabilized either with a retaining wall system (similar to those used between Main Street and Escobar Street) or with a rock wall (similar to the rock wall used at Marina Vista). We assumed that the flood plain would be excavated to a full width and supported with the retaining/rock wall along about 60 feet of the channel centered on the existing beaver dam. The floodplain would taper out with slopes to match grades along about 30 feet upstream and downstream. The primary construction costs related to this approach would be from excavation of the floodplain and construction of the retaining wall or rock

wall. The City beaver dam subcommittee has estimated construction costs of about $50,000 to $100,000 to implement the expanded floodplain.

Flow Area Analysis

To estimate increases in flow conveyance with the expanded floodplain bench, we used the same flow area analysis and HEC-RAS procedures described above. We assumed that the floodplain and beaver dam would be maintained at similar elevations either two feet or three feet below the October 2007 dam height (6 feet MSL crest elevation). The results of the flow area analysis are provided below:

Table 3. Flow Area Analysis - Lowered Beaver Dam with Expanded Floodplain

Scenario	Area (ft^2)	Channel Velocity (*ft/s*)	Capacity (*cfs*)
Without beaver dam	359	6.0	2150
October 2007 beaver dam (6' MSL crest)	195	6.0	1170
Beaver dam lowered 2 feet	265	6.0	1590
Dam lowered 2 feet with expanded floodplain	290	6.0	1740
Dam lowered 3 feet with expanded floodplain	319	6.0	1913
Marina Vista Ave Bridge	286	7.3	2075

Hydraulic Modeling

For the HEC-RAS modeling, we assumed that the dam and floodplain would be lowered by 2 feet compared to the October 2007 dam height to match the actions that the City took in January 2008. A design section similar to the schematic section presented in Figure 10 was inserted into the HEC-RAS channel geometry along a 60 foot reach centered on the beaver dam.

Plots comparing model results with the lowered beaver dam and expanded floodplain to the design channel with and without the lowered beaver dam are provided in Figures 11 through 14 for the 2-, 5-, 7-, and 10-year flood events. For the 5-, 7-, and 10-year events, predicted water levels for the lowered dam with an expanded floodplain are within about 0.1 foot of the design water levels immediately upstream of the dam and are virtually identical at the low point in the channel bank just upstream of Escobar Street. These model results indicate that the potential increases in flood risks associated with the beaver dam can be offset by excavating an expanded floodplain 2 to 3 feet below the October 2007 beaver dam crest elevation of 6 feet MSL.

Management Option #3 – Remove or Lower Dam in Response to Extreme Rainfall Event

In the event of an extreme storm that could result in a discharge greater than the 5-year flow prior to excavation of an expanded floodplain, the City may opt to remove or further lower the beaver dam to

limit the potential for flooding in downtown Martinez. To help identify a threshold for management action during a major rainfall event, we obtained Contra Costa County rainfall records and identified key rainfall gages for the City to monitor during extreme rainfall events.

The Arroyo Del Hambre raingage (Station 37) is located in the headwaters of the Alhambra Creek watershed at Elevation 800'. This would provides the best indicator of flows in Alhambra Creek. The Contra Costa County Flood Control District raingage (Station 11) is located in an adjacent watershed at Elevation 160 feet, and can provide a back up if the Arroyo Del Hambre gage fails.

When heavy rainfall is predicted for the East Bay including rainfall amounts greater than 2 inches in the next 24 hours and/or urban small stream advisories are issued by the National Weather Service, the City should monitor Contra Costa County's real time hydrology data web page:

http://www.co.contra-costa.ca.us/depart/pw/content/Hydrology.html#Antecedent

Since hydraulic modeling indicated that Alhambra Creek with the beaver dam lowered by about 2 feet has about a 5-year capacity, we identified 5-year rainfall depths as a threshold for potential high creek flows (and channel management activity). Key rainfall depths to monitor for to initiate management actions are presented in Table 4.

Table 4. Rainfall Depth Thresholds

Duration	Arroyo Del Hambre Depth (Station 37)	CCC Flood Control Depth (Station 11)
1-hour	0.7"	0.60"
2-hour	1.0"	0.85"
6-hour	1.2"	1.00"
12-hour	2.3"	1.90"
24-hour	3.2"	2.50"

Time of Concentration

The Alhambra Creek watershed has approximately a 3 hour time of concentration (time between peak rate of rainfall and the highest flowrate in the lowest reaches of Alhambra Creek). Therefore, a 3 hour duration event is very critical. However, if the channel is already carrying flow from an earlier event, it's possible that a 3 hour rainfall event with less than 1.2 inches at Arroyo Del Hambre could cause flooding. Thus, it's important to monitor shorter 1-hour and 2-hour duration events that occur within a larger event, as well as the longer 6-hour and 12-hour events. Lower intensity 24-hour or longer events will likely not cause peak flowrates in Alhambra Creek given the short time of concentration.

When considering removal or lowering of the beaver dam in the event of a flood threat, there are a number of key issues to consider:

- The 3 hour time of concentration provides a relatively short window to take action. When the threshold rainfall depth is noted, there will be limited response time for action (1 to 2 hours) before peak flows reach downtown Martinez.
- When the threshold rainfall depth is noted, it is likely that the creek will already be carrying considerable flows which will limit equipment access to the creek channel.
- Removal of dam material may take longer than anticipated due to the extreme weather conditions, difficult access, and other unforeseen circumstances that occur during emergency situations. Equipment access and working conditions will be extremely challenging.
- Dam debris may not readily move downstream, and could possibly cause some obstruction at the down stream bridge at Marina Vista or the railroad bridge and increasing flood risks at these locations.

Conclusions

Based on this analysis, we can draw the following conclusions:

1. The beaver dam continues to have a significant impact on conveyance and water levels in the downtown reach of Alhambra Creek.

2. Hydraulic modeling indicates that the action taken by the City in January to lower the dam by about 2 feet below October 2007 height (6 feet MSL crest elevation) has decreased the risks of a flood in downtown from about 1 in 4 (4-year event) to about 1 in 6 (6-year event).

3. Excavating an expanded floodplain adjacent to the lowered beaver dam could further increase conveyance and decrease flood risks to near pre-dam conditions (between an 8-year and 10-year event depending on tide levels). This approach is recommended to help offset the potential increased flood risks associated with the beaver dam.

4. Creating an overlook at Castro Street could provide public access for viewing the beaver dam.

5. Removal or further lowering of the beaver dam during an extreme flood event could further reduce flood hazards to downtown. However, site access and working conditions would likely be very difficult.

figure 1
Alhambra Creek Beaver Dam – Management Options

Beaver Dam and Ponding Behind Beaver Dam

PWA Ref# 1823.02

PWA

figure 2
Alhambra Creek Beaver Dam – Management Options

Beaver Dam in November 2007

PWA Ref# 1823.02

PWA

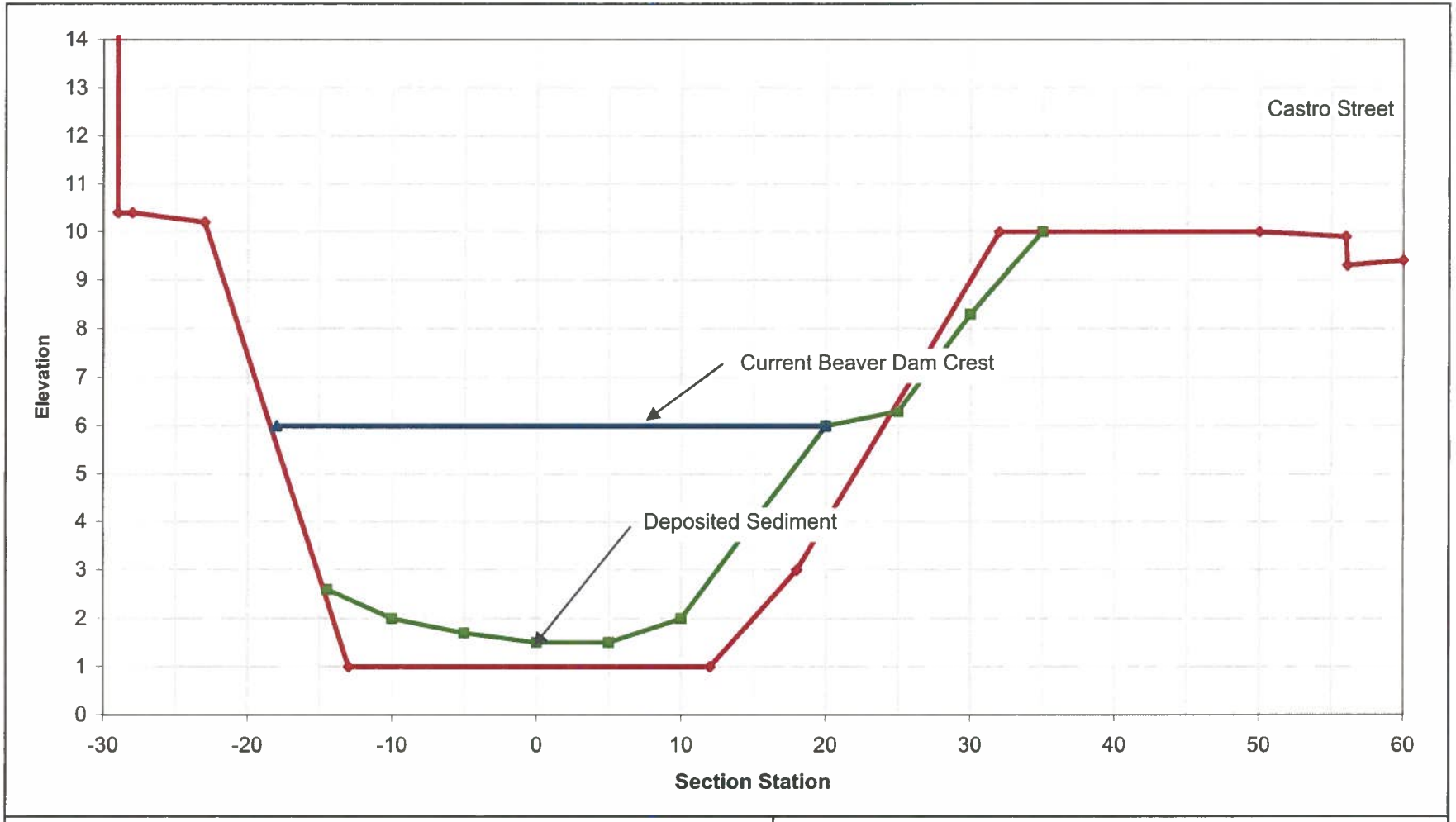


Figure 3

Alhambra Creek Beaver Dam - Management Options

Section at Beaver Dam - October 2007

PWA

figure 4
Alhambra Creek Beaver Dam – Management Options

Lowered Beaver Dam with Beaver Deceiver

PWA Ref# 1823.02

PWA

MITIGATION PROPOSAL

for

TEMPORAL IMPACTS TO WETLANDS

2008 ALHAMBRA CREEK SEDIMENT REMOVAL PROJECT

from

MARINA VISTA TO UPRR BRIDGE

Prepared by the City of Martinez

July 2008

TABLE OF CONTENTS

MITIGATION PROPOSAL SUMMARY

The City of Martinez desires to implement the 2008 Alhambra Creek Sediment Removal Project, from Marina Vista to the UPRR Bridge. More specifically, this project will remove sediment from the tidal floodplain and revegetate the disturbed areas to restore the floodplain to what was originally designed and constructed as part of the Martinez Intermodal Facility (Martinez Amtrak Station) in 1999. The purpose of this original project was to enhance the level of flood protection to the 100-year event and to enhance habitat. Recent storms have deposited approximately 4,000 cubic yards of sediment over the floodplain reducing the capacity of Alhambra Creek to convey runoff during heavy storms and reducing the value of the floodplain habitat. The City proposes to remove this sediment from the creek floodplain during this year's construction season, and mitigate any impacts to the affected wetland habitat during 2009.

The California Department of Fish and Game (F&G) is in the final stages of issuing a Notification for a Streambed Alteration Permit, and the U.S. Army Corps of Engineers (ACOE) has determined that its authorization is not required for the proposed work. The Staff at the Regional Water Quality Control Board (RWQCB) has determined that the project results in temporal impacts to wetlands and mitigation is required. The proposed project encompasses approximately 1.2 acres (53,300 s.f.). The Staff at the RWQCB has indicated that the required mitigation area needs to be between 0.22 and 0.33 acres based on the assumption that the sediment is removed in 2008 and the mitigation is installed in 2009. The mitigation will require consultation with F&G and ACOE, as well as the property owner, the East Bay Regional Park District (EBRPD). Although the City does not anticipate any major hurdles in obtaining approval from these agencies, the proposed mitigation will require either permits and/or environmental determinations that will require time to process. Therefore, it is anticipated that the proposed mitigation will not be permitted for construction until next year.

To satisfy the mitigation requirements for the temporal impacts on wetlands resulting from the proposed project, the City offers to accomplish one of two proposals outlined below:

Proposal No. 1

Create approximately 0.275 acres (12,000 s.f.) of tidal wetlands next to a wetlands mitigation site that was accomplished in 2005. The proposed area is located on EBRPD property, just downstream and west of the proposed project. A vicinity map showing the mitigation site is attached at the end of this proposal. Furthermore, the mitigation area is compatible and in concert with the existing and future phases of the Martinez Salt Marsh Project. Pending approvals from the affected agencies, this work would be completed in 2009.

Proposal No. 2

Provide for a monetary payment to the RWQCB in an amount equal to the estimated cost to create the necessary tidal wetlands. Based on the bid results of the proposed 2008 Alhambra Creek Sediment Removal Project, and the cost of wetland mitigation projects that the City has previously undertaken, it is proposed that a reasonable amount for a monetary payment is $25,000. These funds could be used to further enhance other wetlands projects currently underway.

The City prefers this proposal because it would reduce the amount of staff resources required to implement Proposal No. 1. The City of Martinez has very limited staff resources to manage and administer mitigation projects.

BACKGROUND

The original creek enhancement work was performed as part of the Martinez Intermodal Facility in 1998 under the California Regional Water Control Board Waiver of Discharge Requirements, issued on June 16, 1997, Site No. 02-07-C0235, U.S. Army Corps of Engineers 404 Permit No. 22386S, and California Department of Fish and Game Stream Alteration Permit 209-97. The work included the grading of a 100-foot wide high flow terrace and revegetating the disturbed areas. The project is currently in the 8th year of a 10-year monitoring program.

In 2000, sediment from winter storms was deposited in the flood terrace. This sediment was removed to restore the hydraulic capacity and to allow tidal flows onto the terrace.

Similarly, during the past few years, approximately 4,000 cubic yards of sediment has been deposited on this flood terrace. The proposed work includes the removal of this sediment and revegetating the disturbed areas. The depth of excavation will range from 1 to 3 feet. The intent of the work is to restore the flood terrace and vegetation to what was originally designed and approved. It is proposed that the excavation be conducted during low tide, and a silt fence be placed along the west edge of the flood terrace to filter sediment, which may be generated by the excavation. Furthermore, it is further proposed that all excavation be limited to the perimeter fence. Based on field observation, we expect that the work will be above ordinary high water (approximately elevation 2 NGVD.

The City has obtained a permit from F&G and the ACOE has determined that the proposed sediment removal work will not require a permit. The City has opened construction bids and will consider awarding a contract sometime later this month. The City proposes to begin

construction upon RWQCD approval of the mitigation proposal presented herein. The City is hopeful that this approval by the RWQCB will occur at the September 15, 2008 Board Meeting so that construction can be completed prior to the rainy season.

In order to receive project approval from the RWQCB, the temporal impacts to the affected wetlands areas need to be mitigated. The proposed mitigation work involves the removal of sediment and vegetation to enhance wetland habitat at a location that is near the proposed 2008 Alhambra Creek Sediment Removal Project and adjacent to future phases of the Martinez Regional Shoreline Salt Marsh Enhancement Project. The first two phases of this Salt Marsh Enhancement Project were completed in 2000 and 2001, and are in the 5th year of monitoring. The proposed mitigation site is also adjacent to a mitigation project that was completed in 2005, providing for an enhanced tidal wetland area. Attached are a vicinity map and a USGS map showing the location of the proposed mitigation site, as well as the location of the 2008 Alhambra Creek Sediment Removal Project? Also attached for reference is a copy of the Martinez Regional Shoreline Salt marsh Enhancement Project – Phases 1 and 2, Mitigation and Monitoring Plan, dated December 27, 2002.

MITIGATION PROPOSAL DETAILS

Project Description

The proposed mitigation project encompasses an area of approximately 12,000 s.f. and is located one-half mile west of the 2008 Alhambra Creek Sediment Removal Project. This project involves excavating existing uplands to create tidal wetlands that would connect to a similar enhancement project that was completed in 2005. A 2007 Aerial Color Photograph is attached showing the location of the proposed mitigation project, the mitigation project that was completed in 2005, as well as the Salt Marsh Enhancement Project. The proposed project would allow the tidal flows from the Carquinez Strait and an existing channel to flood the excavated area. The excavated area would be revegetated with appropriate plant materials. Based on a high tide level of 4.4 NGVD, it is anticipated that the upland area would be excavated to an elevation of approximately 3 to provide for a suitable tidal wetland area.

Timeline

To allow a reasonable period to consult with the affected environmental agencies having jurisdiction over the proposed mitigation area, it is proposed that this work occur during the summer of 2009.

Project Objectives and Success Criteria

The project objectives are to mitigate the temporal impacts on wetlands resulting from the construction of the 2008 Alhambra Creek Sediment Removal Project. It is proposed that the project's success criteria is consistent with the appropriate performance standards set forth in the Salt Marsh Enhancement Project and refined based on consultations with the affected environmental agencies. For example, on page 25 of the Salt Marsh Enhancement Project Mitigation and Monitoring Plan, there is a performance standard that involves controlling the perennial pepperweed (*Lepidium latifolium*) so that it does not exceed 10 percent of the vegetated area. Project photographs of the proposed mitigation site and the adjacent 2005 Mitigation Project area are attached at the end of this report. More specifically, these photographs of the proposed mitigation site clearly show an abundant amount of perennial pepperweed. Therefore, this mitigation proposal would remove the perennial pepperweed and enhance the tidal wetland habitat.

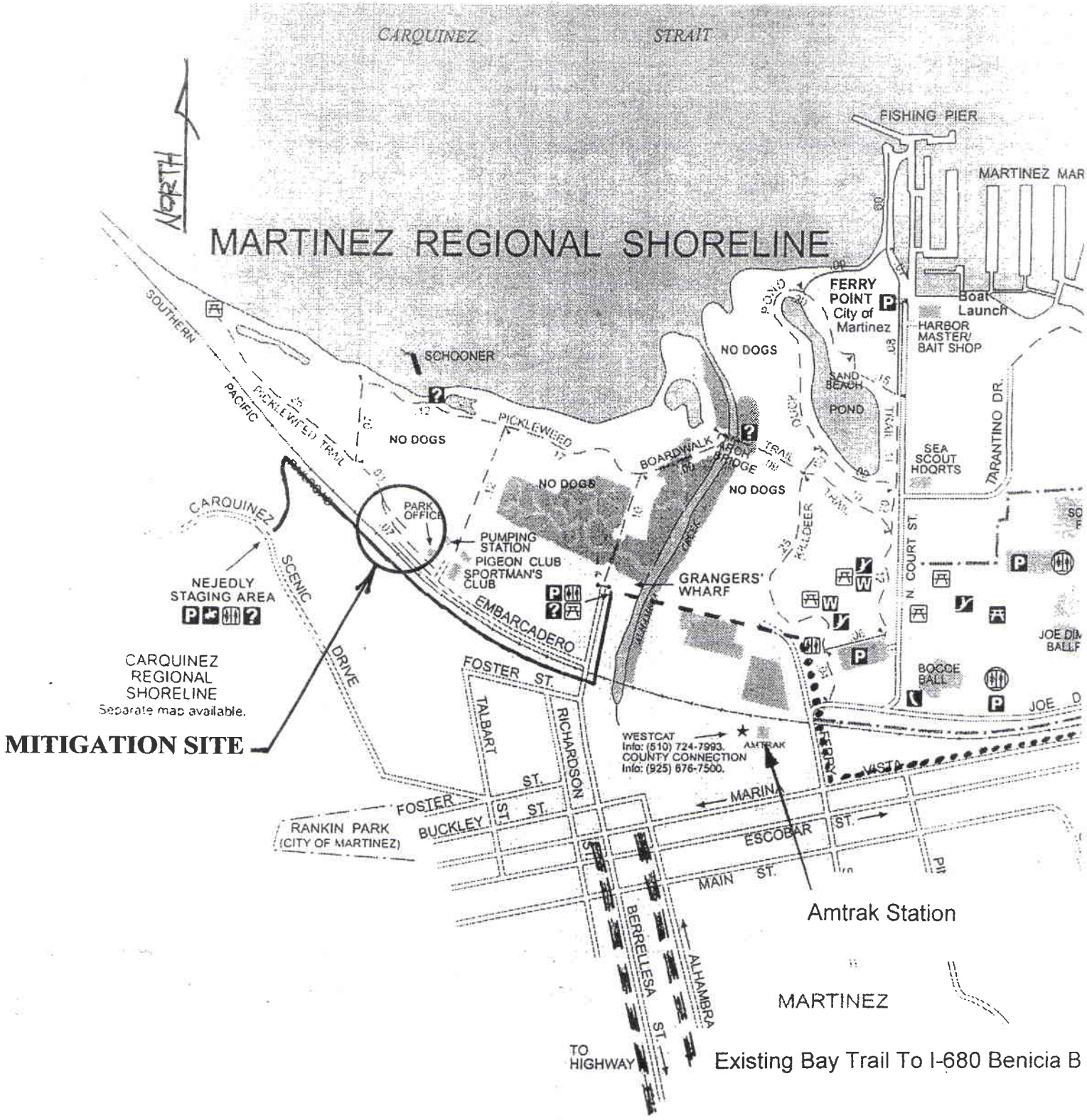
Planting Concept

It is proposed that all unwanted vegetation within the mitigation area be removed and the disturbed area be replanted with bulrush and/or cattails or other plants that are suitable for tidal wetlands. It is further proposed that the exact planting concept can be established based on consultation with the affected environmental agencies.

CONCLUSION

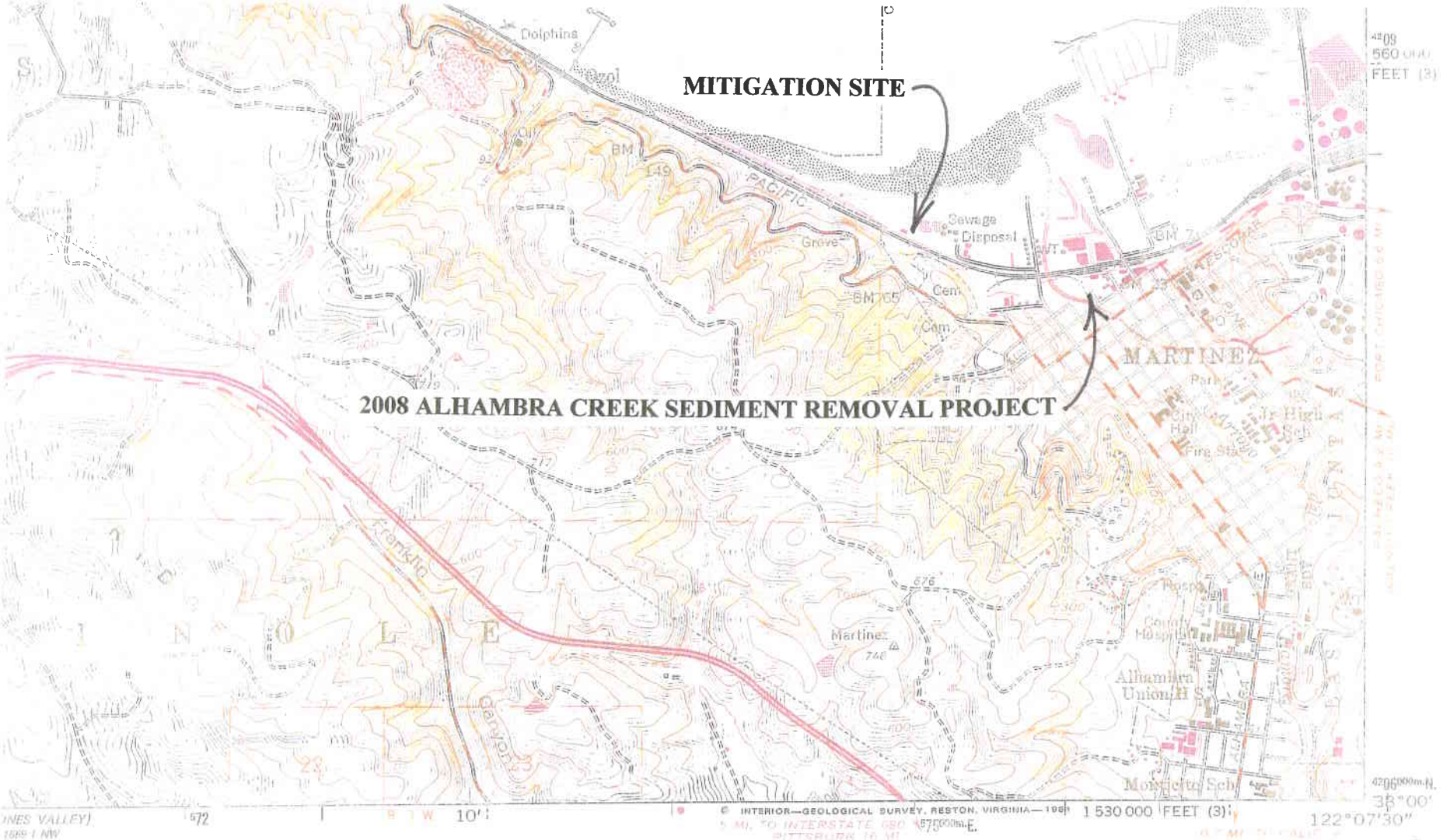
The City of Martinez proposes to remove approximately 4,000 cubic yards of sediment from the tidal floodplain along the eastside of Alhambra Creek, from Marina Vista and the UPRR Bridge. This removal of sediment will provide and an acceptable level of flood protection and enhance tidal wetlands. The City further proposes to mitigate the temporal affects on these wetlands through monetary compensation (preferred), or by enhancing the tidal wetlands near the Martinez Salt Marsh at a location approximately one-half mile from the proposed creek project. The City desires to reach an agreement with the RWQCB on the mitigation requirements and be permitted to remove the sediment from Alhambra Creek during the 2008 construction season with the required mitigation work to follow in 2009.

ATTACHMENTS



VICINITY MAP

NOT TO SCALE



NTERVAL 20 FEET
RESENT 5-FOOT CONTOURS
VERTICAL DATUM OF 1929
IN FEET—DATUM IS MEAN LOW WATER
N THE TWO DATUMS IS VARIABLE
APPROXIMATE LINE OF MEAN HIGH WATER
TIDE IS APPROXIMATELY 2 FEET

ATIONAL MAP ACCURACY STANDARDS
S. GEOLOGICAL SURVEY
25, OR RESTON, VIRGINIA 22092
APS AND SYMBOLS IS AVAILABLE ON REQUEST

Revisions shown in purple and woodland compiled from aerial photographs taken 1979 and other source data
This information not field checked. Map edited 1980
Purple tint indicates extension of urban areas

ROAD CLASSIFICATION

Heavy-duty
Medium-duty
Light-duty
Unimproved dirt
Interstate Route
State Route

BENICIA, CALIF.
N3800—W12207.5/7.5

1959
PHOTOREVISED 1980
DMA 1560 II SW—SERIES V895

figure 5

Martinez Regional Shoreline
Salt Marsh Enhancement Project

2007 Aerial Color Photograph

PWA

N
1"=200'±

MITIGATION PROPOSAL

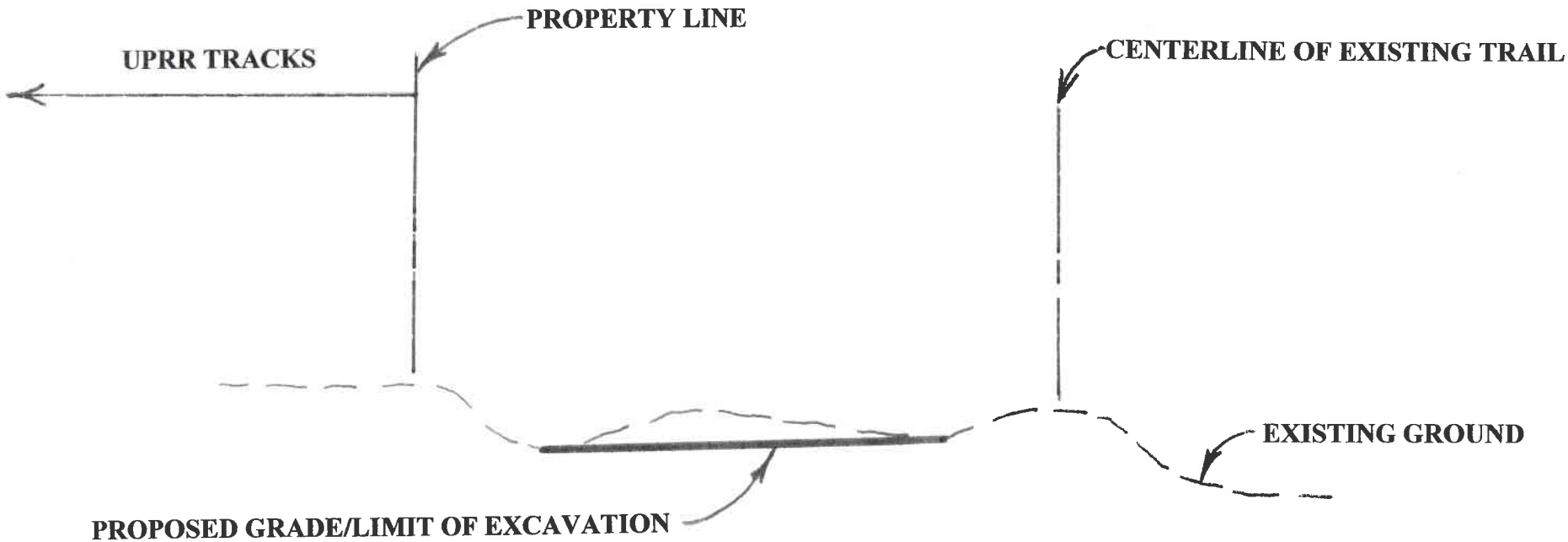
CITY OF MARTINEZ

July 2008

LEGEND

1. 2005 Wetlands Restoration Project (7,500 s.f.)
2. Proposed Mitigation Project (12,000 s.f.)
3. Existing Channel
4. Future Salt Marsh Enhancement
5. Existing Salt Marsh Enhancement (2000-2001)

#1633.04 Tk04



MITIGATION PROPOSAL

TYPICAL SECTION (CONCEPTUAL)

SCALE: 1" = 20' H

1" = 2' V

PROPOSED MITIGATION PROJECT SITE (LOOKING EAST)

JULY 2008

2005 WETLANDS RESTORATION PROJECT (FROM THE WEST EDGE OF THE PROPOSED MITIGATION SITE, LOOKING WEST)

JULY 2008

2005 WETLANDS RESTORATION PROJECT

JULY 2008

APPENDIX C

2018 PERMIT APPLICATION PLAN SET

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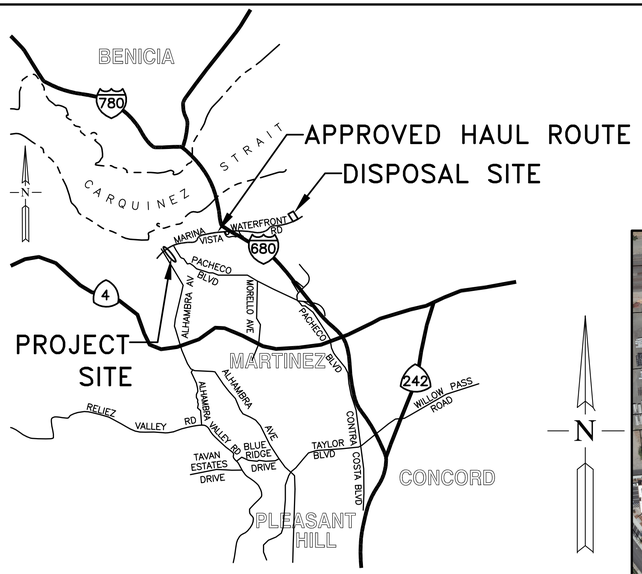
CITY OF MARTINEZ
2018 FEMA LOWER ALHAMBRA CREEK SEDIMENT REMOVAL PROJECT
MAIN STREET TO UPRR BRIDGE



VICINITY MAP

N.T.S.

LOCATION MAP WITH ACCESS POINTS & STAGING AREAS

N.T.S.

INDEX TO SHEETS

GENERAL NOTES

1. THE CONTRACTOR SHALL COMPLY WITH ALL STATE, COUNTY AND CITY LAWS AND ORDINANCES RELATING TO SAFETY AND CHARACTER OF WORK, EQUIPMENT AND LABOR PERSONNEL. THIS SHALL INCLUDE, BUT IS NOT LIMITED TO, THE SHORING OF TRENCHES, THE VENTILATION OF CONFINED SPACES, CONFORMANCE TO THE WATCH MANUAL FOR TRAFFIC CONTROL INCLUDING THE PROVISION AND MAINTENANCE OF BARRICADES AS REQUIRED.
2. THE CONTRACTOR SHALL POSSESS A CLASS "A" LICENSE AT THE TIME THE BID IS OPEN.
3. THE CONTRACTOR SHALL VERIFY THE EXACT LOCATION OF EXISTING UTILITIES AND SHALL NOTIFY UNDERGROUND SERVICE ALERT AT "811" TWO WORKING DAYS PRIOR TO COMMENCEMENT OF EXCAVATION.
4. UTILITIES SHOWN ON PLANS ARE FOR INFORMATION ONLY AND BASED UPON AVAILABLE DATA. ANY UTILITIES EXPOSED OR DAMAGED BY THE CONTRACTOR SHALL BE REPAIRED BY HIM AT HIS EXPENSE.
5. ELEVATIONS AND HORIZONTAL LOCATIONS OF ALL EXISTING UTILITIES, INCLUDING ALL OVERHEAD UTILITIES, SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO START OF CONSTRUCTION. THE CONTRACTOR SHALL PROCEED WITH DUE CAUTION DURING UNDERGROUND OPERATIONS AND SHALL REPAIR OR REPLACE ALL UTILITIES DAMAGED DURING CONSTRUCTION AT THE CONTRACTOR'S EXPENSE.
6. THE CONTRACTOR ASSUMES SOLE AND COMPLETE RESPONSIBILITY FOR THE JOB SITE CONDITIONS AT ALL TIMES. THE CONTRACTOR SHALL PROVIDE ADEQUATE LIABILITY INSURANCE TO DEFEND, INDEMNIFY AND HOLD HARMLESS THE CITY OF MARTINEZ AND ITS EMPLOYEES AND CONSULTANTS FROM ANY CLAIMS OR DAMAGES THAT MAY ARISE FROM THIS CONSTRUCTION.
7. APPROXIMATE STAGING AREAS AND ACCESS POINTS AT EACH AREA ARE SHOWN IN THE LOCATION MAP ON THIS SHEET. THE CONTRACTOR SHALL SUBMIT A PLAN TO THE CITY'S REPRESENTATIVE FOR ACCESS AND STAGING AT THE PRE-CONSTRUCTION MEETING FOR APPROVAL.
8. THE CONTRACTOR SHALL REMOVE AND DISPOSE OF ALL SURPLUS EXCAVATION, MATERIALS AND DEBRIS FROM THE SITE AND SHALL MAINTAIN THE SITE IN A NEAT AND ORDERLY CONDITION.
9. NO STOCKPILING OR SPREADING OF MATERIALS ON-SITE.
10. AS PROVIDED IN THE SPECIAL PROVISIONS CONTRACTOR MAY DISPOSE CLEAN SEDIMENT MATERIAL AT A CITY DISPOSAL SITE ON WATERFRONT ROAD (JUST EAST OF THE ENTRANCE DRIVEWAY TO 2801 WATERFRONT ROAD ALSO SHOWN IN VICINITY MAP ABOVE).
11. THE CONTRACTOR IS RESPONSIBLE FOR ARRANGING FOR ALL REQUIRED INSPECTIONS. THE PRESENCE OR ABSENCE OF AN INSPECTOR WILL NOT RELIEVE THE CONTRACTOR OF FULL RESPONSIBILITY FOR THE PROPER PERFORMANCE OF THE WORK.
12. ANY CONFLICTS WITH THE DESIGN OR ANY CHANGES TO THE PLANS SHALL BE SUBMITTED TO THE CITY ENGINEER AND AUTHORIZED BY THE CITY'S REPRESENTATIVE BEFORE CONTINUING WITH WORK IN THAT AREA.
13. ANY PUBLIC OR PRIVATE PROPERTY DAMAGED BY THE CONTRACTOR OR ANY SUB-CONTRACTOR'S EXPENSE. ALL PUBLIC IMPROVEMENTS FOR THE PROJECT THAT ARE DAMAGED OR DISPLACED SHALL BE REPAIRED OR REPLACED BY THE CONTRACTOR AT HIS EXPENSE.
14. TAKE CARE TO PROTECT AND PRESERVE THOSE TREES AND PLANTINGS OUTSIDE OF THE PROJECT LIMITS. THE PROPOSED PROJECT DEMOLITION AND CLEARING AND GRUBBING LIMITS SHALL BE APPROVED BY THE CITY'S REPRESENTATIVE IN THE FIELD BEFORE ANY WORK WILL BE ALLOWED TO BEGIN.
15. ALL NOTES APPEARING ON THESE PLANS SHALL BE CONSIDERED INCIDENTAL WORK AS PART OF THE CONTRACT AND NO ADDITIONAL COMPENSATION WILL BE ALLOWED.
16. WORK SHALL NOT BEGIN UNTIL ADEQUATE TEMPORARY BARRICADES, BARRIERS, FENCES, WARNING AND CONTROL DEVICES ARE IN PLACE AS REQUIRED IN THE SPECIAL PROVISIONS.
17. UPON COMPLETION OF THE WORK THE CONTRACTOR SHALL CERTIFY THAT ALL WORK WAS PERFORMED IN ACCORDANCE WITH THE REQUIREMENTS OF THE CONTRACT DOCUMENTS. VARIATIONS SHALL BE DECLARED AND PRESENTED TO THE DISTRICT'S REPRESENTATIVE ON RECORD DRAWINGS (AS-BUILTS) UPON COMPLETION OF CONSTRUCTION.
18. CONTRACTOR WILL BE SOLELY AND COMPLETELY RESPONSIBLE FOR WORKING CONDITIONS ON THE JOB SITE, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY DURING PERFORMANCE OF THE WORK. THIS REQUIREMENT WILL NOT BE LIMITED TO NORMAL WORKING HOURS.
19. CONTRACTOR SHALL VERIFY ALL CONDITIONS IN THE FIELD BEFORE COMMENCING ANY WORK AND REPORT ANY DISCREPANCIES BETWEEN PLANS AND ACTUAL CONDITIONS TO THE CITY'S REPRESENTATIVE.

GRADING AND DRAINAGE NOTES

1. THE CONTRACTOR WILL BE RESPONSIBLE FOR ON-SITE QUALITY CONTROL OF GRADING OPERATIONS. ALL REVISIONS MUST BE APPROVED IN WRITING PRIOR TO CONSTRUCTION BY THE CITY'S REPRESENTATIVE PRIOR TO CONTINUING WITH WORK IN THAT AREA.
2. THE CONTRACTOR SHALL CONTROL THE DUST RESULTING FROM HIS OPERATIONS THROUGH WATERING OR OTHER SUITABLE METHODS ON THE SITE AND HAUL ROUTES.
3. PROPOSED GRADES SHOWN ON PLANS (SPOT ELEVATIONS AND CONTOURS) ARE FINISHED GRADES.
4. COMPLETE ALL GRADING TO PROVIDE POSITIVE DRAINAGE FOR ALL AREAS. REGRADE ANY AREA WITH POTENTIAL FOR STANDING WATER. MAKE ADEQUATE ALLOWANCES FOR SOIL SETTLEMENT. CONTRACTOR SHALL INSURE POSITIVE DRAINAGE TO EXISTING DRAINAGE FACILITIES FROM NEW IMPROVEMENTS.
5. CONSTRUCT SMOOTH AND EVEN GRADE TRANSITIONS AT CHANGES OF SLOPE OR GRADE AND TRANSITIONS BETWEEN DISTURBED AND UNDISTURBED AREAS. GRADE TO MAINTAIN SMOOTH TRANSITIONS IN ALL AREAS.
6. CONFORM LINES ARE APPROXIMATE ONLY. CONTRACTORS SHALL MATCH EXISTING GRADE AND MAKE SMOOTH TRANSITIONS.
7. COMPLETED ROUGH GRADING SHALL BE REVIEWED IN THE FIELD BY THE CITY'S REPRESENTATIVE. WORK SHALL NOT CONTINUE UNTIL THE GRADING IS ACCEPTED BY THE CITY'S REPRESENTATIVE. AT THAT TIME, MINOR CHANGES IN GRADING AND SHAPING SHALL BE MADE AT NO ADDITIONAL COST.
8. IF APPLICABLE - MINIMUM SLOPE FOR ALL DRAIN LINES IS 0.5% EXCEPT AS NOTED.
9. UNLESS OTHERWISE NOTED, SET SURFACES TO BE EVEN SLOPE BETWEEN PROPOSED SPOT ELEVATIONS.

SURVEY CONTROL NOTES

1. THE COORDINATE SYSTEM IS BASED ON A RTK GPS ESTABLISHED CONTROL NETWORK ON SITE, USING NAD83 CCS ZONE 3 COORDINATES (EPOCH 2010.00). BASELINE CONTROL POINTS ESTABLISHED ON-SITE ARE AS FOLLOWS FOR EACH PROJECT AREA:

   AREA 1 – LCC CP #1003 (N 2197528.4420, E 6089274.2490) A CUT + IN THE TOP OF CURB AT THE WEST EDGE OF THE AMTRAK PARKING LOT AND LCC CP #1004 (N 2197443.3620, E 6089532.7870) A CUT + IN THE TOP OF CURB AT THE SOUTH EDGE OF THE AMTRAK PARKING LOT.

   AREA 2 & AREA 3 – LCC CP #1013 (N 2197270.1800, E 6089719.9670) A CUT + IN THE SIDEWALK ON MARINA VISTA AVE AT CASTRO STREET AND LCC CP #1014 (N 2197130.3218', E 6089902.7929) A CUT + IN THE SIDEWALK ON THE ON THE NORTH SIDE OF ESCOBAR STREET BRIDGE.

   AREA 4 – LCC CP #1017 (N 2196890.2340, E 6090238.8760), A CUT + IN THE CONCRETE WALL, AND LCC CP#1018 (NOT SHOWN ON SHEET, N 2196757.0499', E 6090311.3475') A MAG-NAIL THE PAVEMENT AT THE SOUTH CORNER OF THE INTERSECTION OF WARD ST AND ESTUDILLO STREET..

   DISTANCES AND COORDINATES AS SHOWN ON THIS SURVEY SHOULD BE CONSIDERED AS GROUND DISTANCES AND COORDINATES.

2. ELEVATIONS ARE BASED ON NAVD88, PER RTK GPS SURVEY ESTABLISHED CONTROL POINTS. SITE BENCHMARK WAS HELD AT LCC CP #1003 (SEE ABOVE FOR DESCRIPTION), ELEVATION HELD AS 12.38 FEET, (NAVD88).

Know what's **below.**
Call before you dig.

REVIEWED BY:
CITY OF MARTINEZ

TIM TUCKER, PE
CITY ENGINEER

DATE

PRELIMINARY PLANS - NOT FOR CONSTRUCTION
100% PLANS - JUNE 8, 2018

NO.	BY	CK	APP	DATE	REVISIONS AND RECORD OF ISSUE

FILE NAME: XREF1:
SOFTWARE: XREF2:
SAVED: XREF3:
PLOTTED: XREF4:
USER: cparks DWG VER: XREF5:

ENGINEERING & SURVEYING, INC.
930 Estudillo Street
Martinez, California 94553-1620
(925) 228-4218 Fax (925) 228-4638
www.lcc-inc.com

LCC Project No. 2018.007.00

06/08/2018

CITY OF MARTINEZ
2018 FEMA LOWER ALHAMBRA CREEK
SEDIMENT REMOVAL PROJECT
MAIN STREET TO UPRR BRIDGE

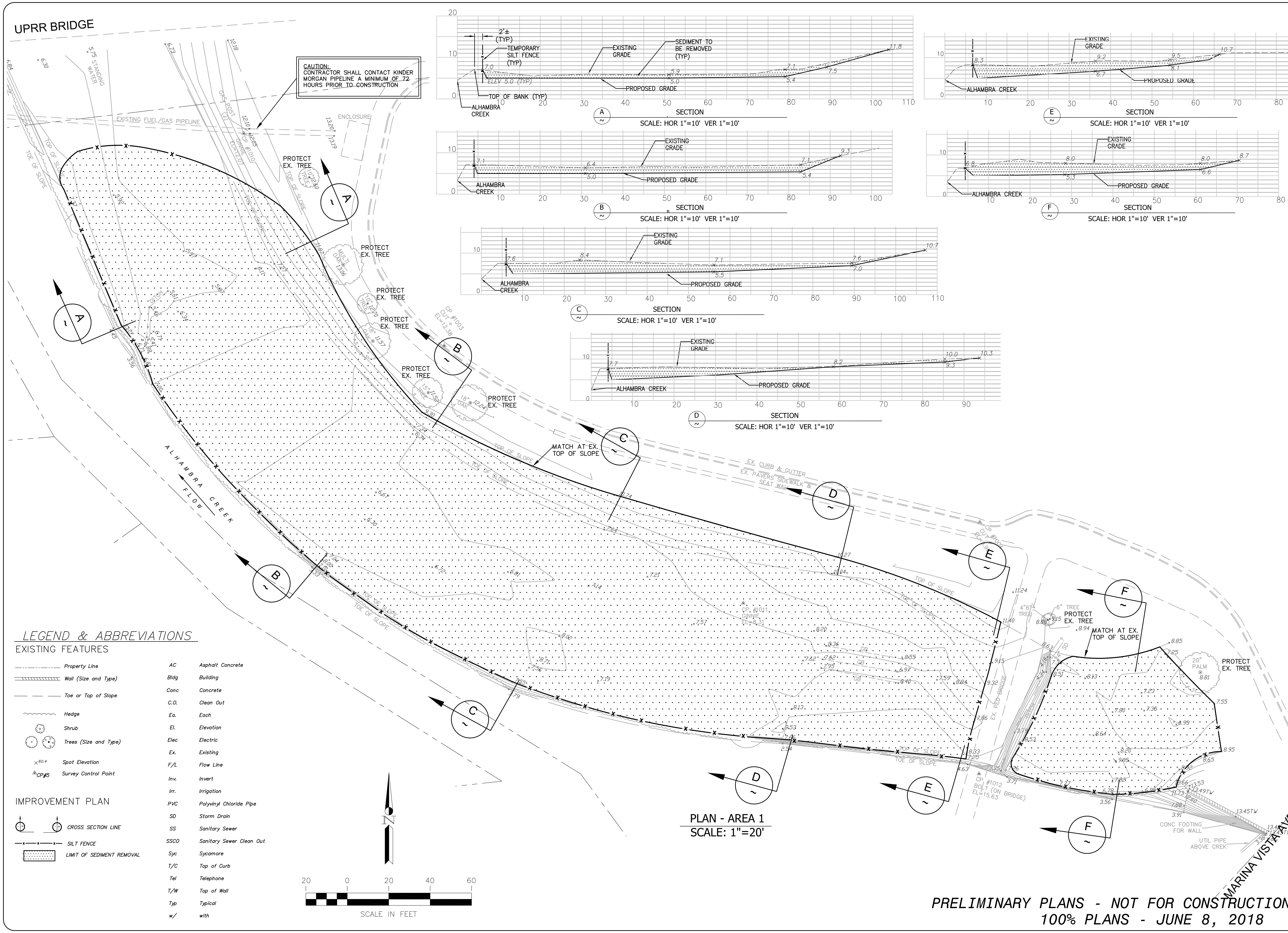
TITLE SHEET & GENERAL NOTES

DESIGNED: cmp
DETAILED: njb
CHECKED: mmv
APPROVED: cmp
DATE: 06/08/2018

0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE

PROJECT NO.
M5004

T-1
SHEET
1 OF 3



UPRR BRIDGE
CAUTION:
CONTRACTOR SHALL CONTACT KINDER MORGAN PIPELINE A MINIMUM OF 72 HOURS PRIOR TO CONSTRUCTION
EXISTING FUEL/GAS PIPELINE
ENCLOSURE
TOE OF SLOPE
TOP OF SLOPE
PROTECT EX. TREE
MATCH AT EX. TOP OF SLOPE
EX. CURB & GUTTER
EX. PAVERS SIDEWALK & SEAT WALL
ALHAMBRA CREEK FLOW
EX. PED BRIDGE
CONC FOOTING FOR WALL
UTIL PIPE ABOVE CREEK
MARINA VISTA AVE
20" PALM
2'± (TYP)
TEMPORARY SILT FENCE (TYP)
EXISTING GRADE
SEDIMENT TO BE REMOVED (TYP)
ELEV 5.0 (TYP)
TOP OF BANK (TYP)
PROPOSED GRADE
ALHAMBRA CREEK
SECTION A
SECTION B
SECTION C
SECTION D
SECTION E
SECTION F
SCALE: HOR 1"=10' VER 1"=10'
PLAN - AREA 1
SCALE: 1"=20'
SCALE IN FEET
LEGEND & ABBREVIATIONS
EXISTING FEATURES
Property Line
Wall (Size and Type)
Toe or Top of Slope
Hedge
Shrub
Trees (Size and Type)
Spot Elevation
Survey Control Point
IMPROVEMENT PLAN
CROSS SECTION LINE
SILT FENCE
LIMIT OF SEDIMENT REMOVAL
AC Asphalt Concrete
Bldg Building
Conc Concrete
C.O. Clean Out
Ea. Each
El. Elevation
Elec Electric
Ex. Existing
F/L Flow Line
Inv. Invert
Irr. Irrigation
PVC Polyvinyl Chloride Pipe
SD Storm Drain
SS Sanitary Sewer
SSCO Sanitary Sewer Clean Out
Syc Sycamore
T/C Top of Curb
Tel Telephone
T/W Top of Wall
Typ Typical
w/ with

PRELIMINARY PLANS - NOT FOR CONSTRUCTION
100% PLANS - JUNE 8, 2018

REVISIONS AND RECORD OF ISSUE

DATE		NO.	BY	CK	APP

FILE NAME: LOWER ALH CREEK DESEDIMENTATION

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(925) 228-4218 Fax (925) 228-4638
www.lcc-inc.com
LCC Project No. 2018.007.00

06/08/2018

CITY OF MARTINEZ
2018 FEMA LOWER ALHAMBRA CREEK
SEDIMENT REMOVAL PROJECT
MAIN STREET TO UPRR BRIDDGE

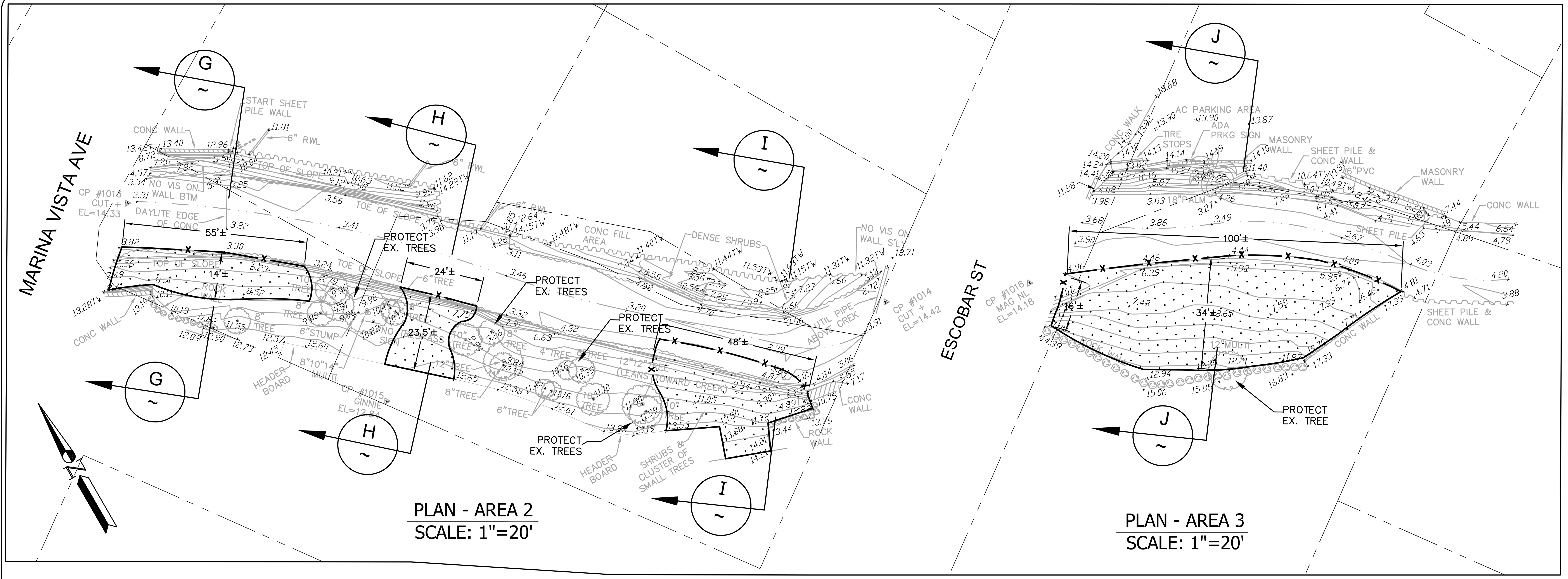
AREA 1 - PLAN & TYPICAL SECTIONS

DESIGNED: MMV
DETAILED: NBC
CHECKED: CMP
APPROVED: RWL
DATE: 06/08/2018

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE

PROJECT NO.
M5004

C-1
SHEET
2 OF 3



PLAN - AREA 2
SCALE: 1"=20'

PLAN - AREA 3
SCALE: 1"=20'

LEGEND & ABBREVIATIONS

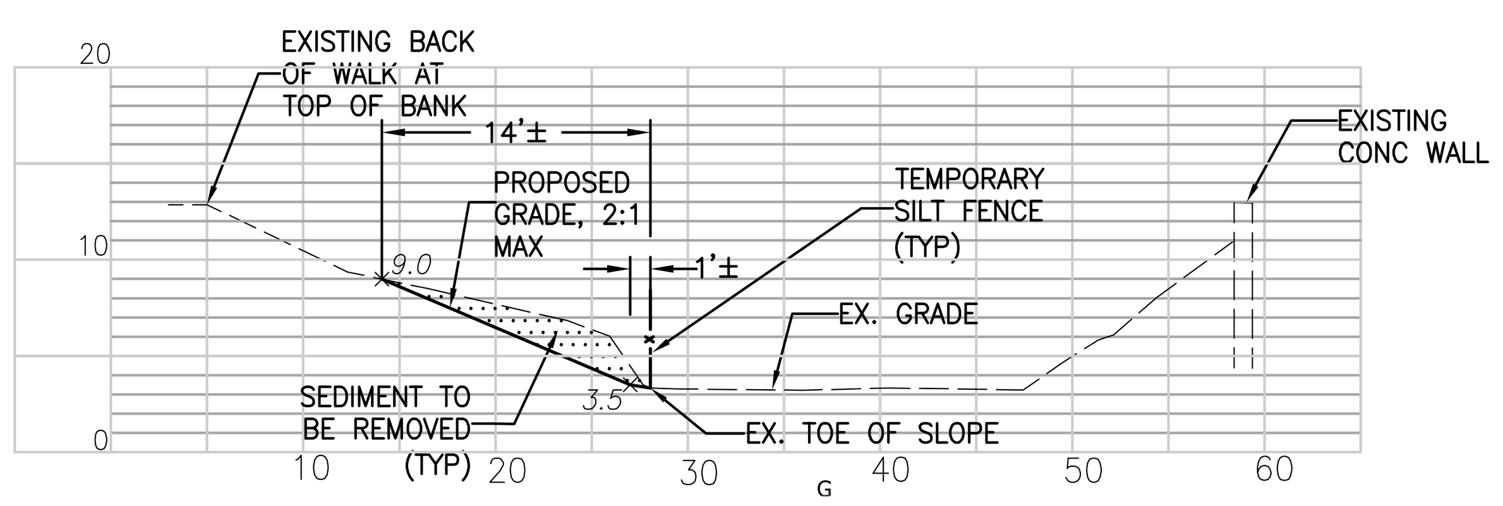
EXISTING FEATURES

- Property Line
- Wall (Size and Type)
- Toe or Top of Slope
- Hedge
- Shrub
- Trees (Size and Type)
- Spot Elevation
- Survey Control Point

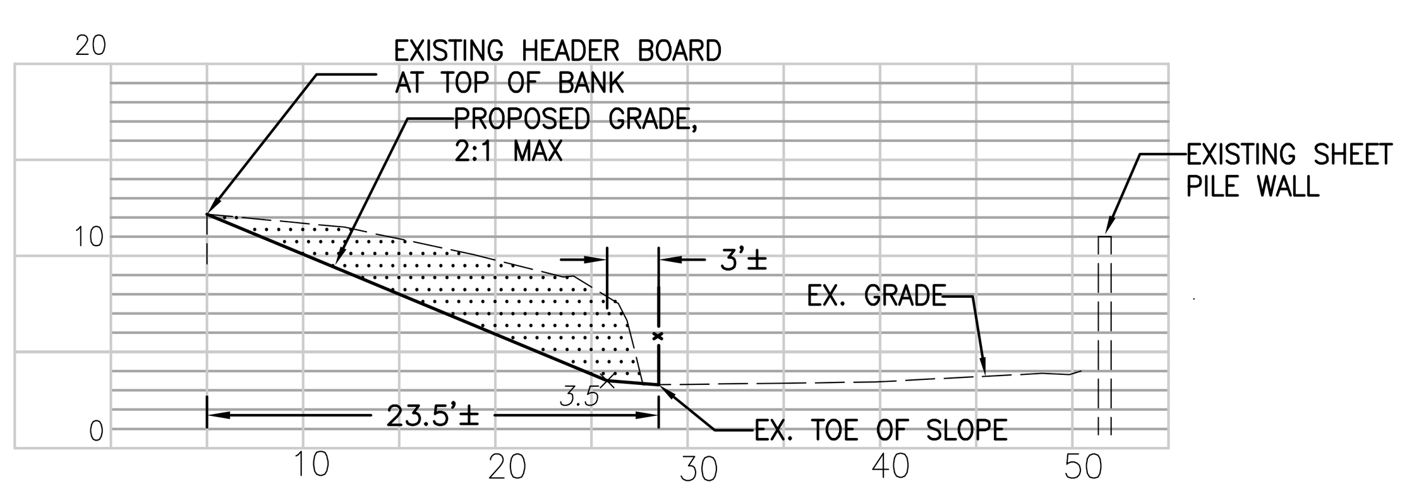
IMPROVEMENT PLAN

- CROSS SECTION LINE
- SILT FENCE
- LIMIT OF SEDIMENT REMOVAL

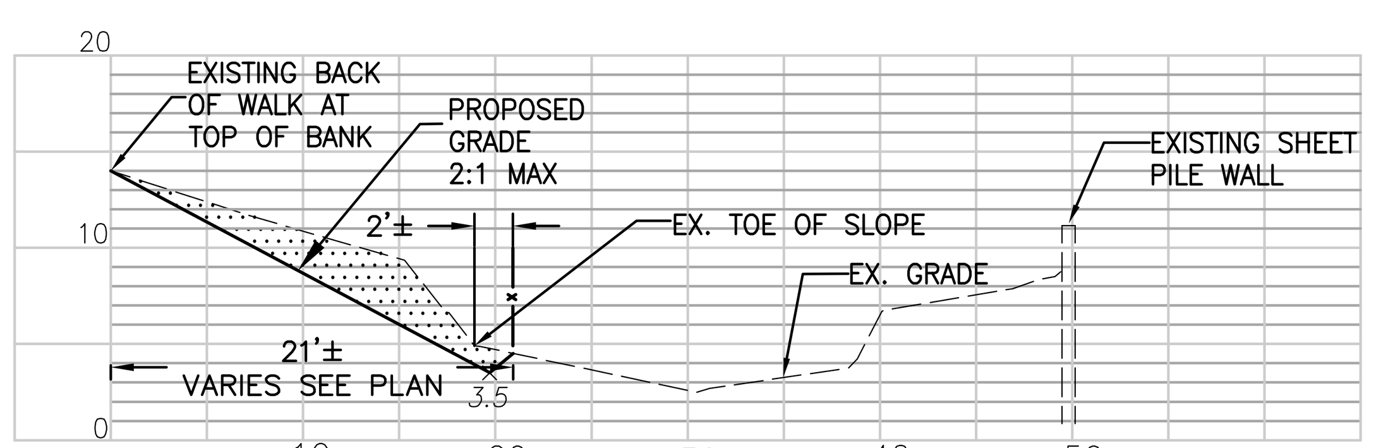
AC	Asphalt Concrete
Bldg	Building
Conc	Concrete
C.O.	Clean Out
Ea.	Each
El.	Elevation
Elec	Electric
Ex.	Existing
F/L	Flow Line
Inv.	Invert
Irr.	Irrigation
PVC	Polyvinyl Chloride Pipe
SD	Storm Drain
SS	Sanitary Sewer
SSCO	Sanitary Sewer Clean Out
Syc	Sycamore
T/C	Top of Curb
Tel	Telephone
T/W	Top of Wall
Typ	Typical
w/	with



SECTION G
SCALE: HOR 1"=10' VER 1"=10'



SECTION H
SCALE: HOR 1"=10' VER 1"=10'



SECTION I
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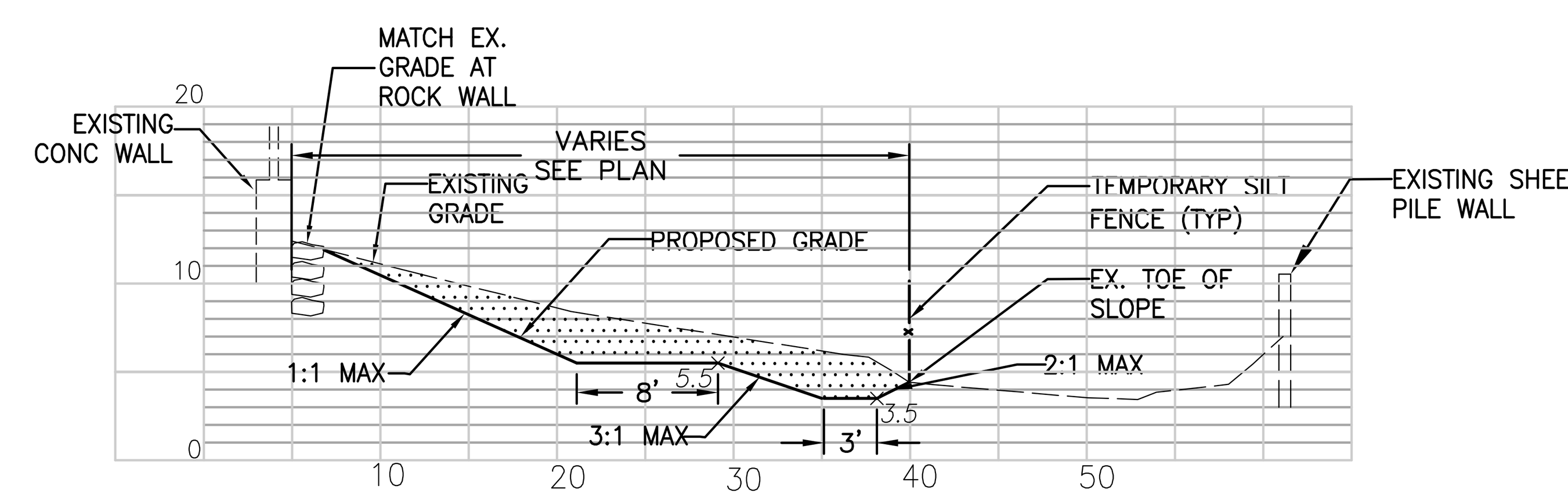
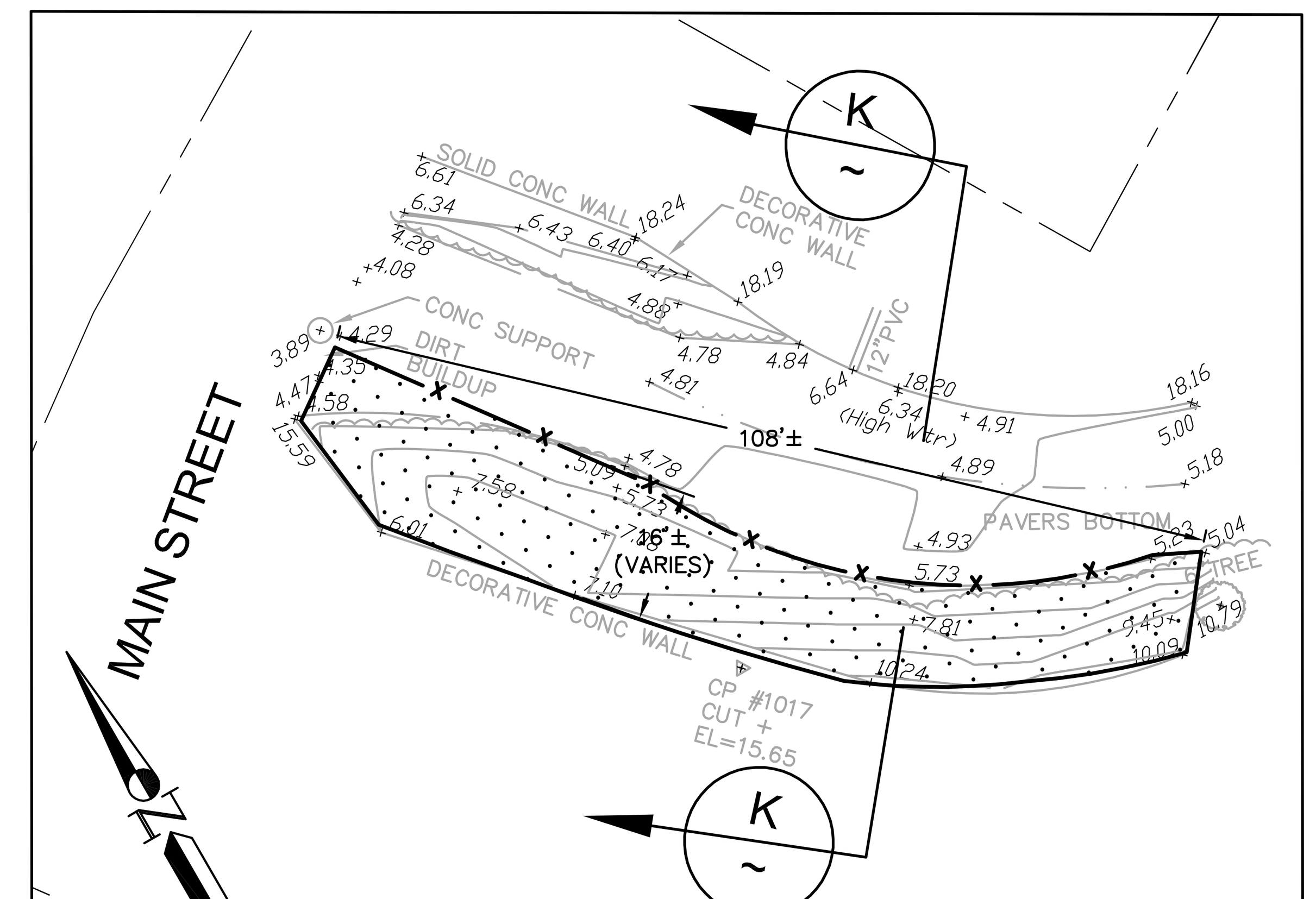
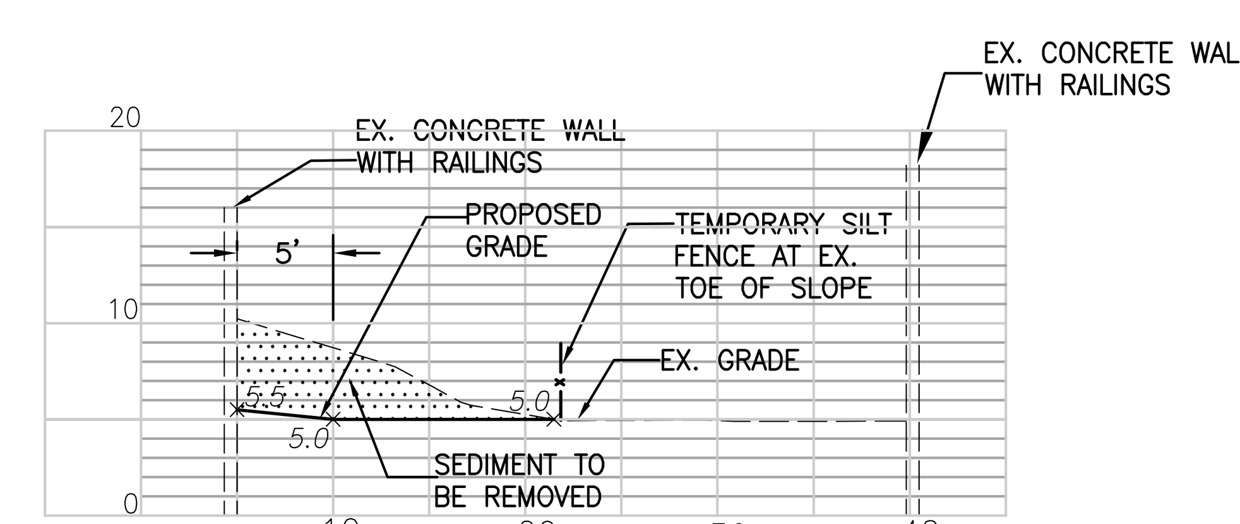


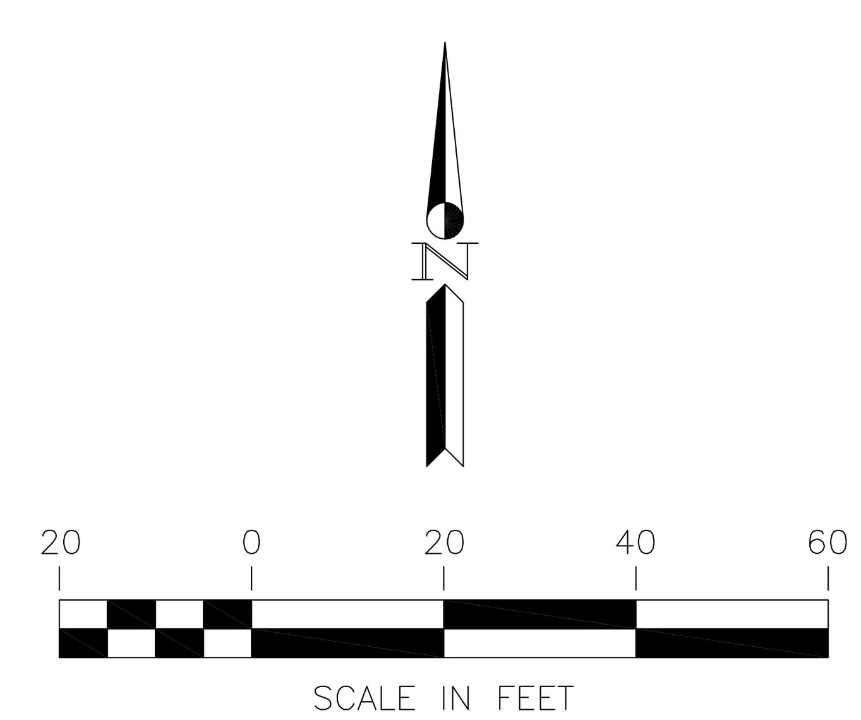
TYPICAL SECTION J
AREA 3
SCALE: HOR 1"=10' VER 1"=10'



PLAN - AREA 4
SCALE: 1"=20'



TYPICAL SECTION K
AREA 4
SCALE: HOR 1"=10' VER 1"=10'



PRELIMINARY PLANS - NOT FOR CONSTRUCTION
100% PLANS - JUNE 8, 2018

NO.	BY	CK	APP

DATE | REVISIONS AND RECORD OF ISSUE
FILE NAME: LOWER ALH CREEK DESEDIMENTATION
SOFTWARE: | SAVED: | PLOTTED: | USER: WVIRANI | DWG VER:
XREF1: XREF2: XREF3: XREF4: XREF5:

PRELIMINARY PLANS
06/08/2018

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LCC Project No. 2018.007.00

CITY OF MARTINEZ
2018 FEMA LOWER ALHAMBRA CREEK
SEDIMENT REMOVAL PROJECT
MAIN STREET TO UPRR BRIDDGE

AREA 2, 3, & 4 PLAN & TYPICAL SECTIONS

DESIGNED: MMV
DETAILED: NBC
CHECKED: CMP
APPROVED: RWL
DATE: 06/08/2018

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE

PROJECT NO.
M5004

C-2
SHEET
3 OF 3

APPENDIX D

NON-NATIVE SPECIES LIST AND PHOTOGRAPHS

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Invasive plant list for the Lower Alhambra Creek Watershed Plan

Species[1]	Common Name	Plant Type	Preferred Elevation	Cal-IPC Rating[3]	CDFA Rating[4]	Notes
Ailanthus altissima[2]	Tree of Heaven	Tree	High	MOD	C, Noxious	Outcompetes native vegetation; propagates easily by suckers
Arundo donax	Giant reed	Grass	Low, Mid	HIGH	B, Noxious	Contributes to erosion; blocks water flow; consumes water; minimal wildlife value; fragments easily
Conium maculatum	Poison hemlock	Perennial forb	Low, Mid, High	MOD	None	Poisonous; outcompetes native plants
Dittrichia graveolens	Stinkwort	Annual forb	High	MOD	Noxious	Outcompetes native plants; fragments easily
Foeniculum vulgare	Sweet fennel	Perennial forb	Mid, High	MOD	None	Outcompetes native plants
Hedera helix, Hedera canariensis	English ivy, Algerian ivy	Vine	Low, Mid, High	HIGH	None	Overtops and kills trees and understory vegetation; minimal wildlife value; both species look similar and have the same impact
Lepidium latifolium[2]	Perennial pepperweed	Perennial forb	Low, Mid, High	HIGH	Noxious	Outcompetes native plants; fragments easily
Rubus armeniacus	Himalayan blackberry	Vine/shrub	Mid, High	HIGH	None	Overtops and kills subcanopy vegetation
Rubus ulmifolius	Elmleaf blackberry	Vine/shrub	Mid, High	NONE	None	Essentially identical to *R. armeniacus* but without spines
Stipa miliacea	Smilo grass	Grass	Mid, High	LIMITED	None	Outcompetes and overtops native herbaceous vegetation
Vinca major	Periwinkle	Vine	High	MOD	None	Outcompetes native plants; fragments easily

Source: Jutta Burger and Friends of Alhambra Creek

[1]Other invasive trees such as Canary Island date palm (*Phoenix canariensis*), blackwood Acacia (Acacia melanoxylon), Chinese Privet (*Ligustrum lucidum*), beach sheoak (*Casuarina equisetifolia*), and tree tobacco (*Nicotiana glauca*) that occur within the project area are presumably planned for removal and subsequent control as per the plan. Other sections of the plan indicate that common reed (*Phragmites australis*), which is known to be an invasive genotype regionally and covers extensive portions of the Lower Watershed, will be selectively removed and replaced with native vegetation during revegetation activities. Mexican feathergrass (*Stipa tenuissima*) is an ornamental grass planted locally that has a high risk of becoming invasive; it should be removed from the project site if it is found to be expanding locally.

[2]Some invasive species, such as tree of heaven and perennial pepperweed, will be extremely difficult to control without herbicides. Mechanical removal has the potential to increase populations by stimulating root sprouting and fragmenting plants. Maintenance crews should have a clear plan for how to manage these species before initiating removal. The only potentially successful non-chemical control technique at scale for both species is long-term cutting and tarping (see WeedCUT webtool) for methodology.

[3]California Invasive Plant Council (Cal-IPC) ratings are state-wide ratings that refer to invasiveness in wildland habitats.

[4]California Department of Food and Agriculture (CDFA) ratings are state-wide ratings weighted more towards impacts on human health, agriculture, economics, and infrastructure and typically do not consider plants that are sold commercially.

Ailanthus or Tree of Heaven

Arundo or Giant reed

Poison hemlock

Stinkwort

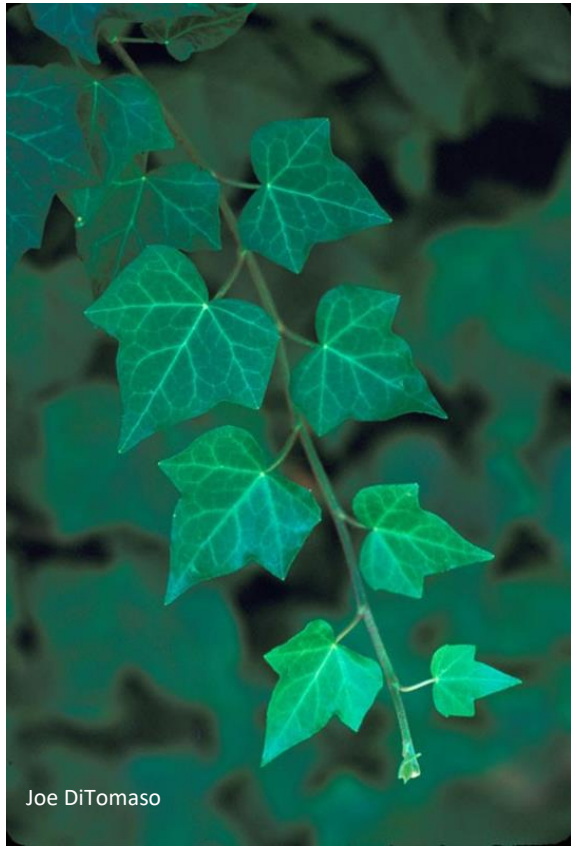

2006 Tom Cochrane


2015 John Doyen

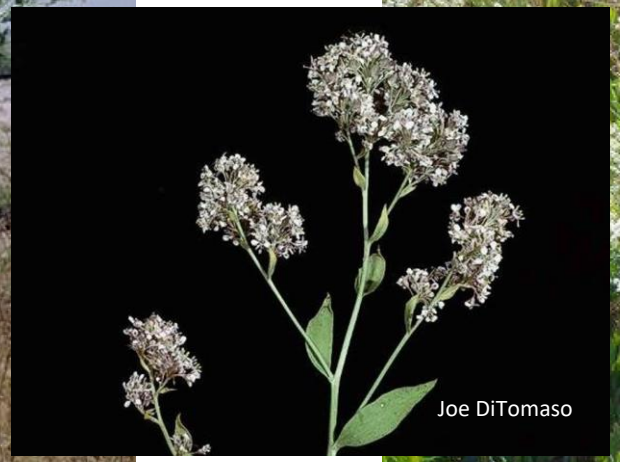

2014 Neal Kramer

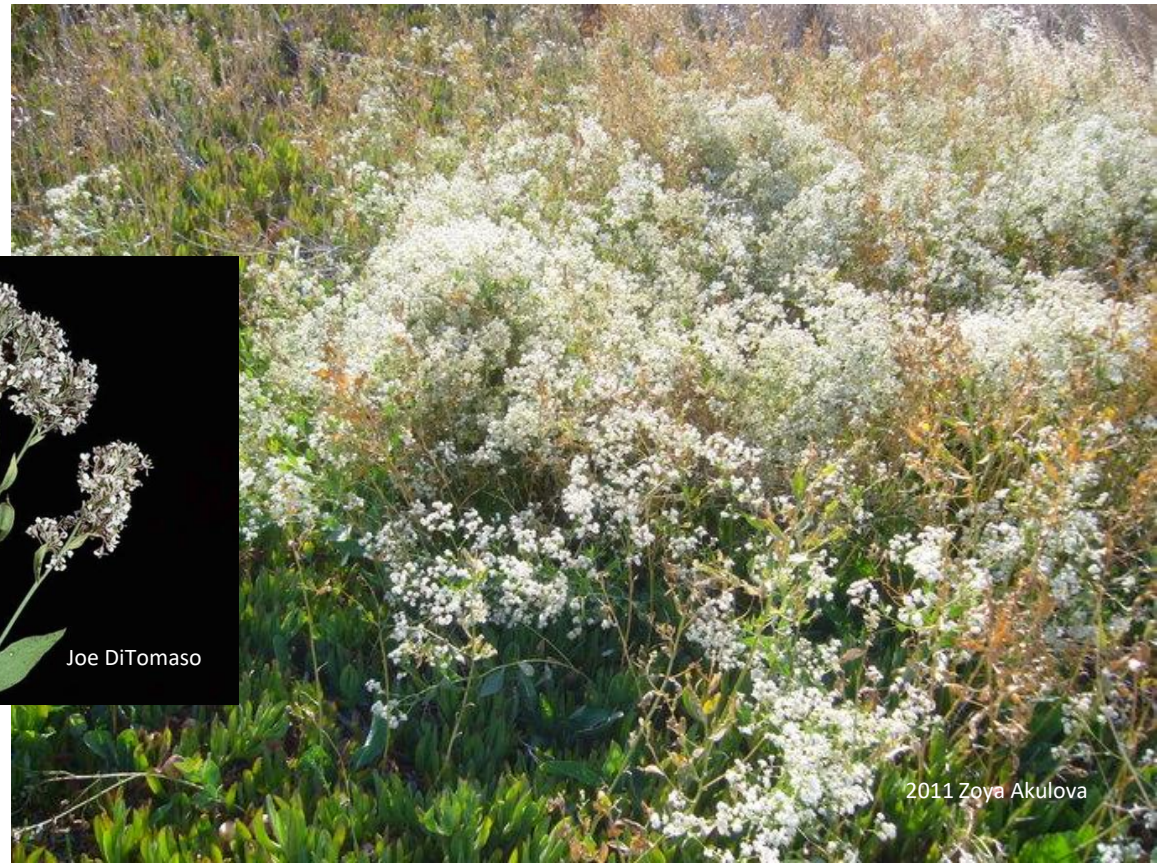
Fennel or Sweet fennel

English ivy



Perennial pepperweed

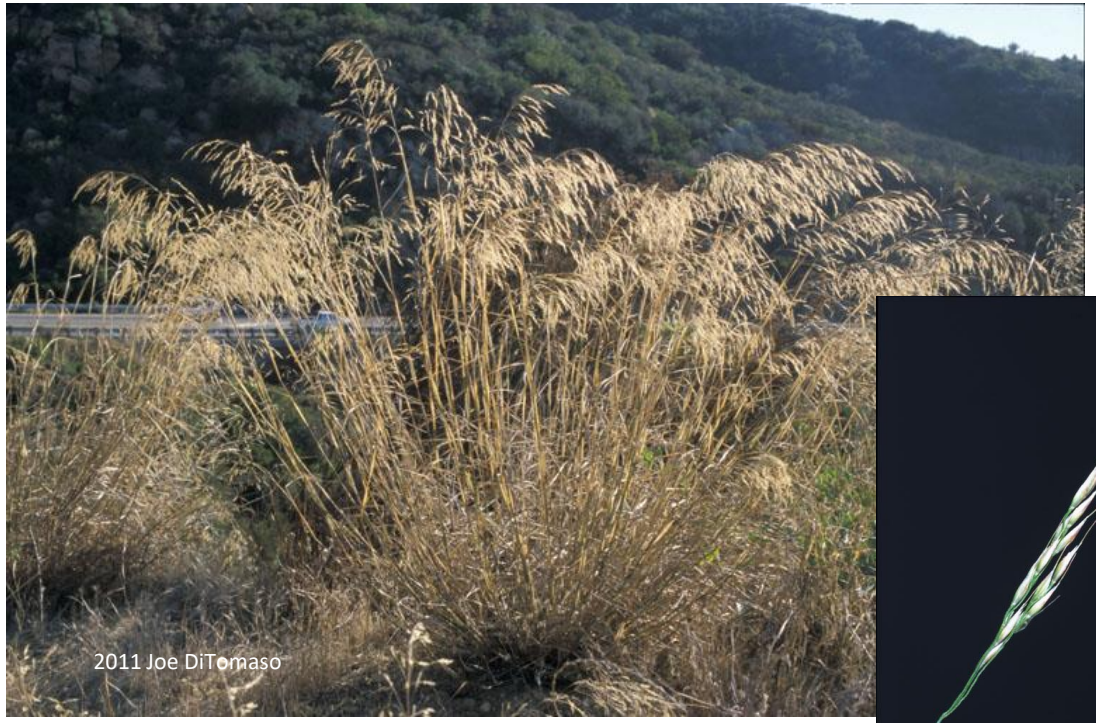




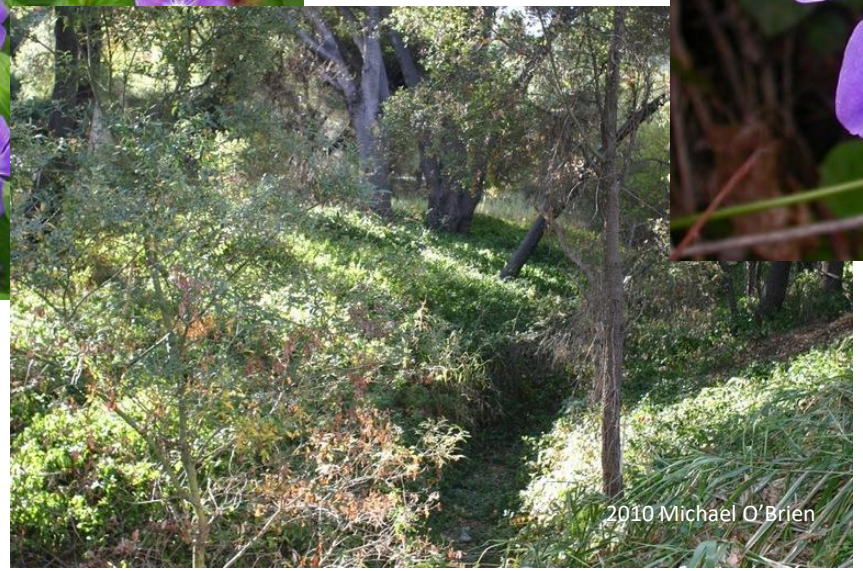
Himalayan blackberry

Elmleaf blackberry

Smilo grass



Vinca or Greater periwinkle



APPENDIX E

ALHAMBRA CREEK FACT SHEETS

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Fact Sheet

Alhambra Creek Watershed Flooding

PRODUCED BY THE ALHAMBRA WATERSHED COUNCIL

The Alhambra Watershed Council

The Alhambra Watershed Council (AWC) was formed in response to the severe storms of 1997–98, which caused serious erosion and major flooding in the City of Martinez and other parts of the watershed. These events highlighted problems with land-use practices in the watershed and the need for coordinated watershed-wide planning to protect and conserve natural resources and the infra-structure and property of its human occupants. The AWC's goal is to address watershed problems by recommending solutions that benefit the watershed and its users.

Stakeholders

The AWC is comprised of diverse groups and interests in the water-shed. These stakeholders include residents, landowners, the City of Martinez, Contra Costa County, community organizations, East Bay Regional Park District, the National Park Service, and many more.

Alhambra Creek Watershed Management Plan

The AWC produced a watershed management plan outlining goals and many recommendations in 2001. The plan promotes striking a balance between human use of the watershed and protection and preservation of the area's natural resources.

The Alhambra Creek Watershed

The Alhambra Creek Watershed covers 16.5 square miles. Its major tributaries are Arroyo del Hambre, Alhambra Creek, Franklin Creek, and Vaca Creek. All surface runoff from the watershed flows into the main stem of Alhambra Creek, passes through downtown Martinez, and empties into the Carquinez Strait.

Flooding History

Martinez has had a history of flooding since its founding in 1849, with the most recent major flood event occurring in the winter of 1997-98. Downtown Martinez structures are built in the floodplain of Alhambra Creek and are located within the 100-year floodplain established by FEMA (Federal Emergency Management Agency). Local flooding occurs upstream of the 100-year floodplain when seasonal creeks, storm drains, and waterways become obstructed with fallen trees, trash, and invasive plants.

Flood Frequency and Severity in a Changing Climate

Climate change affects flooding frequency in at least two ways; weather is becoming more erratic, and sea levels are rising. Climatologists predict more frequent cycles of extended drought and extreme storms that will likely cause flooding. Studies vary on the rate of sea level rise, but they all conclude that sea levels are rising. Sea level rise will increase the elevation of water at the mouth of Alhambra Creek, which in turn will reduce the rate at which stormwater drains from the watershed, backing up water in the lower watershed. This will be especially pronounced during high tide. Climate change will increase the frequency and severity of flooding in downtown Martinez.

Future Flooding

The amount of rainwater that falls in the watershed and the speed with which that rainwater reaches the creek determines if and when downtown Martinez floods. As new development occurs, more hard surfaces, such as roads and roofs, accelerate and increase flood runoff. If the increased flood runoff is not managed properly, downstream neighborhoods will experience deeper floods extending into wide areas. Flood protection gained by improving the downtown creek may be lost due to increased impervious surfaces and runoff from the upper watershed.

Rev. 2022

Goals

The AWC outlined nine major goals in the watershed management plan. The following is a condensed list of goals:

- CONSERVE stormwater, soil resources, and wildlife habitat.
- REDUCE flood damage, wildland fire damage, and erosion.
- PROTECT AND IMPROVE water quality and peoples' quality of life by providing opportunities to enjoy watershed resources.
- PROMOTE a sense of watershed community.

Community Resources

There are numerous groups working toward a healthier Alhambra Creek Watershed. Please consider volunteering with or donating to these groups to ensure their efforts can continue.

FRIENDS OF ALHAMBRA CREEK

friendsofac@gmail.com
www.ccrcd.org/friends-of-alhambra-creek

NEW LEAF COLLABORATIVE

info@newleafcollaborative.org
www.newleafcollaborative.org

WORTH A DAM

mtzbeavers@gmail.com
www.martinezbeavers.org

For more information on flooding or other watershed-related concerns, contact:

Alhambra Watershed Council
c/o Contra Costa Resource Conservation District
925-672-4577
www.ccrcd.org

Cost of Living in a Floodplain

The entire community pays to clean up streets and other public property after a flood. Everyone is impacted by the disruptions to businesses and civil services. The greatest damage and recovery costs are shouldered by those who own the public and private properties in the designated floodplain. Property owners with flood insurance pay yearly even if it doesn't flood. FEMA tracks the number of policies and the costs of those polices in each floodplain.[1] Recent data indicate that our costs are going up. Since 1968, FEMA has partially subsidized the cost of flood insurance. In 2021, FEMA developed a new risk rating methodology, "RISK RATING 2.0," which includes additional factors besides the defined floodplain.[2] The objective is to more accurately predict risks while reducing subsidies. Existing insurance policies are expected to be reevaluated in coming years. FEMA provides more information for specific addresses via an internet form.[3]

Flooding at Castro and Main Streets, January 1997

What Can Be Done to Reduce Flooding and Flood Damage?

- Reduce peak runoff by: holding the water in detention basins or seasonal wetlands and allowing more water to percolate into the ground by 1) limiting/ reducing impervious surfaces, 2) installing pervious surfaces whenever possible, and 3) planting vegetation that improves soil permeability.
- Create designated overflow areas and bypasses so that floodprone areas are less vulnerable to flooding.
- Create more efficient ways to move water through floodprone areas.
- Design development to withstand flooding with less damage and disruption.
- Minimize or avoid new development in the most floodprone areas, such as floodplains. Remove or retrofit existing development in these areas.
- Restore and enhance the natural function of floodplains.

Alhambra Creek: Lifeblood of Our Watershed

Alhambra Creek, running through the heart of downtown Martinez, is the lifeblood of our watershed. It can bring flood water during heavy storms, but if we plan and develop our community with an understanding of how human activities interact with the surrounding environment, Alhambra Creek can be a beautiful riparian corridor and an asset to the community.

[1] https://nfipservices.floodsmart.gov/reports-flood-insurance-data
[2] https://www.fema.gov/flood-insurance/risk-rating
[3] https://floodfind.com/flood-zone-report/

Watershed Terms

Detention basin	An impoundment or excavated area for the short-term detention of stormwater runoff.
Floodplain	A strip of relatively flat and normally dry land alongside a stream, river, or lake that is covered by water during a flood.
Impervious surface	A surface such as pavement or asphalt that does not allow water to pass through. Pervious surfaces, such as vegetated areas or pervious pavement, allow water to infiltrate into the ground.
Peak flow	The maximum instantaneous discharge of a stream or river at a given location. Peak flows are greatly increased by impervious surfaces.
Runoff	Precipitation, snow melt, or irrigation water that flows into surface streams, rivers, drains, or sewers.
Watershed	The land area that drains to a particular stream, river, or bay, and is bounded by the surrounding highest elevations, such as ridges.

Fact Sheet

Arundo donax in the Alhambra Creek Watershed

PRODUCED BY THE ALHAMBRA WATERSHED COUNCIL

The Alhambra Watershed Council

The Alhambra Watershed Council (AWC) is comprised of diverse groups and interests in the Alhambra watershed. These stakeholders include residents, landowners, City of Martinez, Contra Costa County, community organizations, East Bay Regional Park District, National Park Service, and many more.

The AWC was formed in response to the severe storms of 1997–98, which caused serious erosion and major flooding in the City of Martinez and other parts of the watershed. These events brought residents together to develop a coordinated watershed-wide planning effort to protect and conserve natural resources, infrastructure, and property.

To that end, the AWC adopted a Watershed Management Plan in 2001. The Plan has several goals that relate to Arundo removal, such as reducing flood damage, reducing fire fuel loads, restoring native plant communities, conserving stormwater, and improving water quality.

The AWC's primary goal is to address watershed problems by recommending solutions that benefit the watershed and its users. The AWC recommends that Arundo be removed throughout the watershed.

What Is Arundo?

Arundo (*Arundo donax*), also known as "giant reed," is a non-native plant that is highly invasive in California. The plant's stems resemble bamboo, and its leaves resemble corn leaves. Arundo is incredibly fast-growing and can grow four inches a day and up to thirty feet tall. To sustain its rapid growth, Arundo usually grows along streams or other waterways. Arundo consumes a lot of water—about five times more than a native plant uses. The plant displaces native plants and provides little-to-no food or habitat for wildlife. In the Alhambra Creek Watershed, there are many stands of Arundo along Alhambra Creek and its tributaries.

A stand of Arundo in Martinez

Why Is Arundo Harmful?

- **Arundo causes erosion.**
  The plant's shallow roots are easily undercut by nearby streamflow. The roots then break off from creek banks and take soil along with them. Large Arundo infestations can encroach on waterways, diverting water and causing additional erosion on the opposite bank.

- **Arundo destroys fish and wildlife habitat.**
  Numerous animal species that depend on riparian areas are in decline. According to the California Invasive Plant Council, Arundo is "threatening California's riparian ecosystems by outcompeting native species, such as willows, for water." Arundo displaces native plants that provide food, shelter, and breeding habitat for fish and wildlife.

- **Arundo is a flood hazard.**
  Arundo grows in thick stands that can partially or completely block the flow of water in waterways. This can cause creek banks to overflow, posing a risk to nearby inhabitants and property.

Removing Arundo Alice's Way: A Legacy of Determination

Long-time Martizians fondly remember the late Alice Alderette as a determined Arundo warrior. Alice guaranteed her signature method eradicated Arundo stands without chemical use. Her method takes perseverance, but it gets the job done. If you have a small stand of Arundo on your property and do not want to use herbicides, consider trying Alice's method.

- Using a hand saw, cut the Arundo stalks down as close as possible to the ground.
- Check the Arundo stand often to look for new shoots.
- Once new shoots grow about 4–5 inches tall, stomp on them with your sturdiest boots by attacking the shoots from the side and bending them over with your boot to break the stalk.
- Pick up and remove all broken shoots from the site.
- Keep returning to the Arundo stand and stomp on new shoots until they stop re-sprouting.

Resources

For more information on Arundo and creek bank erosion, please visit:

UC Davis's Giant reed Weed Report from *Weed Control in Natural Areas in the Western United States*

wric.ucdavis.edu/information/natural%20areas/wr_A/Arundo.pdf

California Invasive Plant Council

cal-ipc.org
www.cal-ipc.org/using_herbicides/

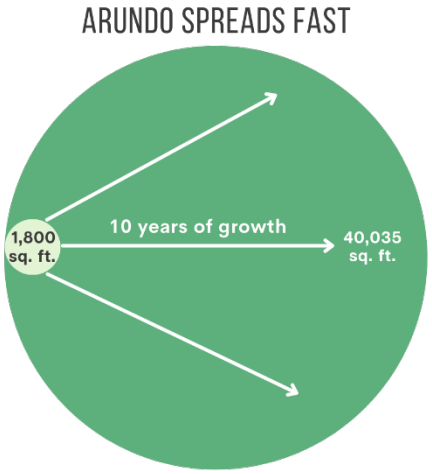
Streamside Management Program for Landowners in Contra Costa County

www.californiaurbanstreamspartnership.com/smpl-program

For questions or watershed-related concerns, contact:

Alhambra Watershed Council
c/o Contra Costa Resource Conservation District
925-672-4577 ext. 4
www.ccrcd.org

❖ **Arundo is a fire hazard.**
Although Arundo uses a lot of water, it burns readily even when green. Dense stands pose a fire hazard to nearby wildlife habitat and neighborhoods. After a fire, Arundo rapidly grows back even thicker from its rhizomes, and with little or no competition from native plants that burn less easily but are fire sensitive. Arundo transforms the less fire prone native plant buffers along our waterways into potential wildfire threats to our environment and homes.



In 2013, one stand of Arundo in Martinez took up 1,800 square feet of space. Ten years later, the same stand now takes up over 40,000 square feet of space.

Arundo leaves

Removing Arundo

The serious threat that Arundo poses to our streams can be controlled. Many small or mid-sized Arundo infestations throughout our watershed can be eliminated now before becoming more problematic. Larger infestations can be controlled, but such efforts are costly and usually require coordination among multiple stakeholders. The easiest and most economical way to control Arundo is to treat it early before it becomes well established.

An effective method to remove Arundo is to do an initial cutting and complete removal of cut stems from a waterway in early summer. The Arundo will send up new shoots, which can be hand-sprayed with an approved herbicide by fall (or cut and removed again). Treatment needs to be repeated at least annually until the infestation is gone. After each treatment, the infestation should be smaller and the task easier. Please note that permits may be required.

For further herbicide use information, visit www.cdpr.ca.gov/docs/dept/factshts/factmenu.htm

What You Can Do to Help

Please be mindful of the fact that this plant propagates vegetatively, meaning that if even a small piece of the plant falls into a waterway, it can sprout into a new plant. When sections of the stem or root break off, they float downstream and start new colonies. New shoots can grow from any of the plant's nodes, and rooting can take place when an Arundo stem droops and encounters water.

The AWC recommends removing Arundo from your property using the methods described in this Fact Sheet. After Arundo removal, replant the area with native plants. Consult the Streamside Management Program for Landowners in Contra Costa County at custreams@gmail.com, or 510-932-2370.

Special thanks to the Walnut Creek Watershed Council and the Sonoma Ecology Center for their informative Arundo brochures, which were used in preparing this 2022 Fact Sheet.

Living with Alhambra Creek

Alhambra Creek and the Martinez Community

The most severe storm in recent years dumped a lot of water in a hurry on the Alhambra Watershed last winter. As Alhambra Creek carried this water through our community, it raced through Alhambra Valley and Franklin Canyon, through neighborhoods, through downtown and into Carquinez Straits. Stream banks were eroded, undercutting structures and trees. Floodwaters overflowed in four places, causing significant damage.

Most of Downtown Martinez, however, did not flood. The downtown flood control project was based on understanding how creeks and watersheds work. It succeeded because it provided a proper working channel and flood plain. When we accommodate the Creek, we protect the community. Now we need to apply these principles higher up in the watershed. If we do this right, we will protect the community and enhance the natural creek.

Alhambra Creek Flooding and Erosion Task Force

In the absence of a coordinated plan, some individual landowners have tried to protect their own properties by doing things to the channel bordering their parcels. Many of these projects have either failed or are in the process of failing. In many cases, the projects have made things worse. Some have been done with permits, some have not. Permits are required for any work to be performed on the creek that is below the top of the creek bank. Working in the creek without permits can result in substantial fines.

The Mayor and City Council of Martinez have set up a Flooding and Erosion Task Force to develop a plan for protecting the upstream community. The plan will be based on understanding the watershed as an integrated system. We need this plan to coordinate, design and build projects that will work and that will continue working.

To succeed, projects need to apply these understandings to substantial reaches of the creek rather than piecemeal to individual parcels. We will need to work together as an informed and engaged community to make this happen. We have much better odds of getting money if we have a watershed-function-based community plan. We will also have much better odds of our projects actually providing long-term protection.

Permits:

Working within creeks requires permits from various agencies. There are substantial fines for dumping anything into creeks or working without the proper permits. Some important contacts you should make before planning creek repair are as follows:

City of Martinez Engineering Department	(925) 372-3515
Department of Fish and Game	(707) 944-5500
US Army Corps of Engineers	(415) 977-8462
Water Quality Control Board (SF Bay Area Region)	(510) 622-2300

What can we do?

Making a plan and developing projects will take time, money and involvement. What can we do to protect ourselves while we are doing this? Each creekside landowner is responsible for taking care of the creek bordering their parcel. What can or can't creek side landowners do?

- ***DO*** inspect your section of creek – look for obstructions, erosion problems, and vulnerability of structures.
- ***DO*** talk with your neighbors – explore ways to work together.
- ***DO*** report erosion problems, obstructions or flooding exposure to the City of Martinez Engineering Department.
- ***DO*** consult with City of Martinez Engineering Department before doing work in the creek.
- ***DO*** prune trees and bushes to remove low-growing branches, but retain canopy.
- ***DO*** remove trash.
- ***DO*** remove obstructions such as fallen trees, lumber, tires, appliances.
- ***DO*** plant appropriate native plants on the banks for stability. A list of appropriate plants is available.
    - Work within creeks requires permits. The City of Martinez Engineering Department staff can help guide you in the process.
- ***DO*** report dumping in the creek to 1-800 NODUMPING.
- ***DO NOT*** build anything that will obstruct flow in the creek or reduce the channel capacity.
- ***DO NOT*** plant in the streambed.
- ***DO NOT*** dump any material into the creek such as rock, concrete, building materials, lumber, yard waste, pet waste, gray water or swimming pool drainage.
- ***DO NOT*** undertake construction work or other streambed alteration work in the creek channel without first consulting with City of Martinez Engineering Department.
    - Work within creeks requires permits. The City of Martinez Engineering Department staff can help guide you in the process.
- ***DO NOT*** plant invasive plants such as ivy, vinca, Arundo (giant cane). These plants do not stabilize the banks, and choke out other plants that do.
- ***DO NOT*** place exotic species such as goldfish into the creek.

For more information contact the City Engineer at:

City of Martinez
Engineering Department
525 Henrietta Street
Martinez, CA 94553
(925) 372-3515

APPENDIX F

STREAM GAGE EQUIPMENT

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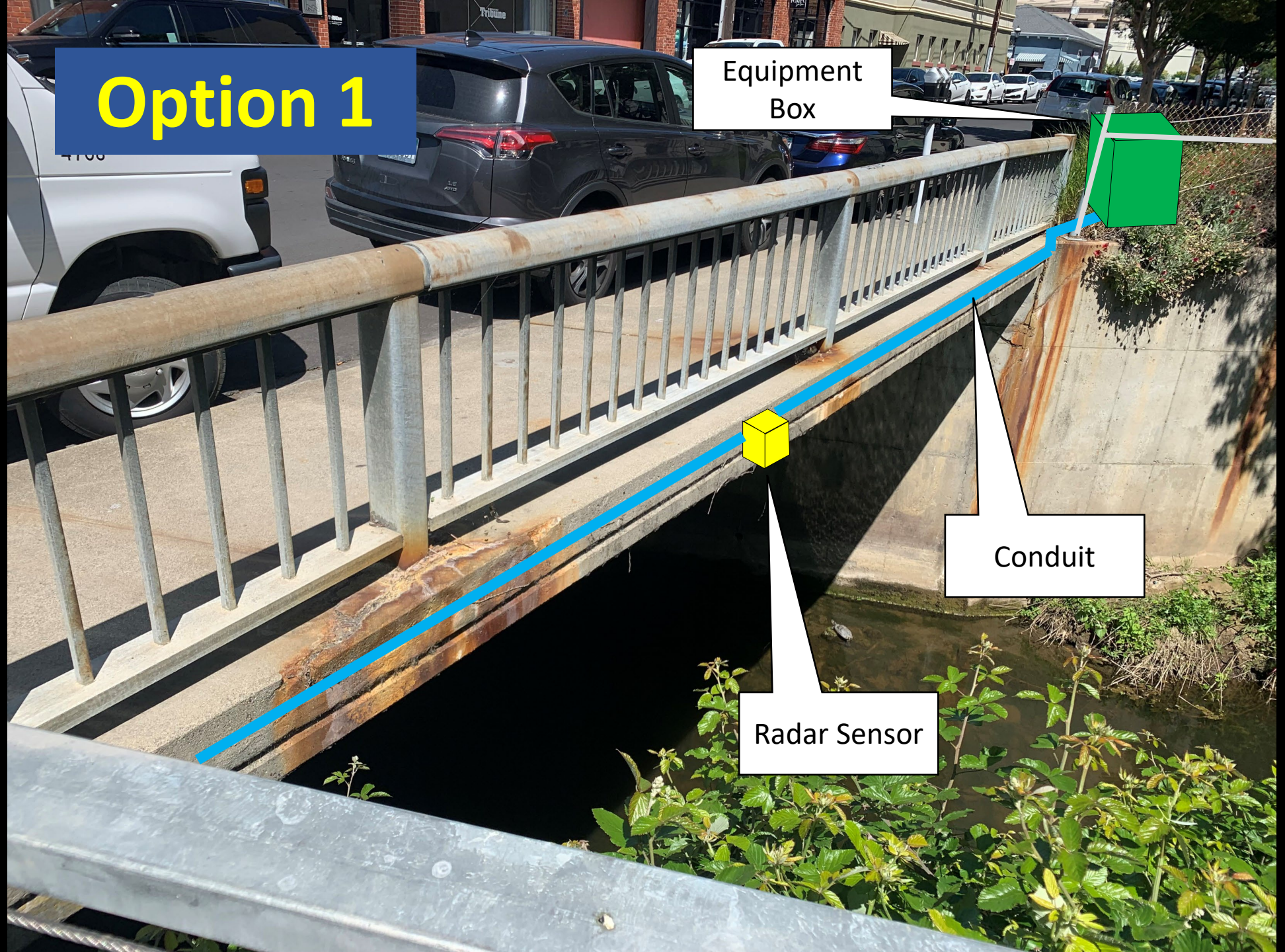
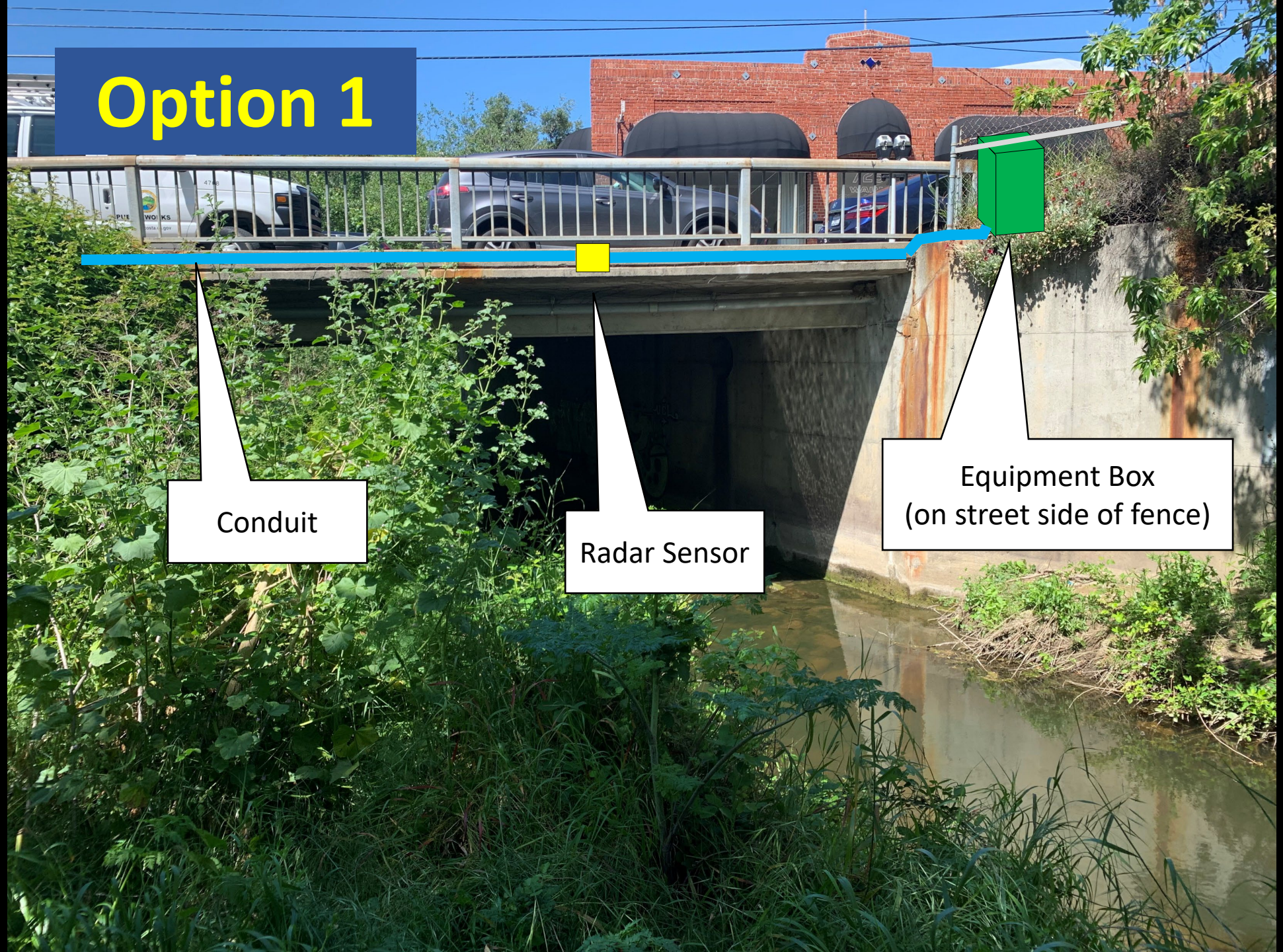
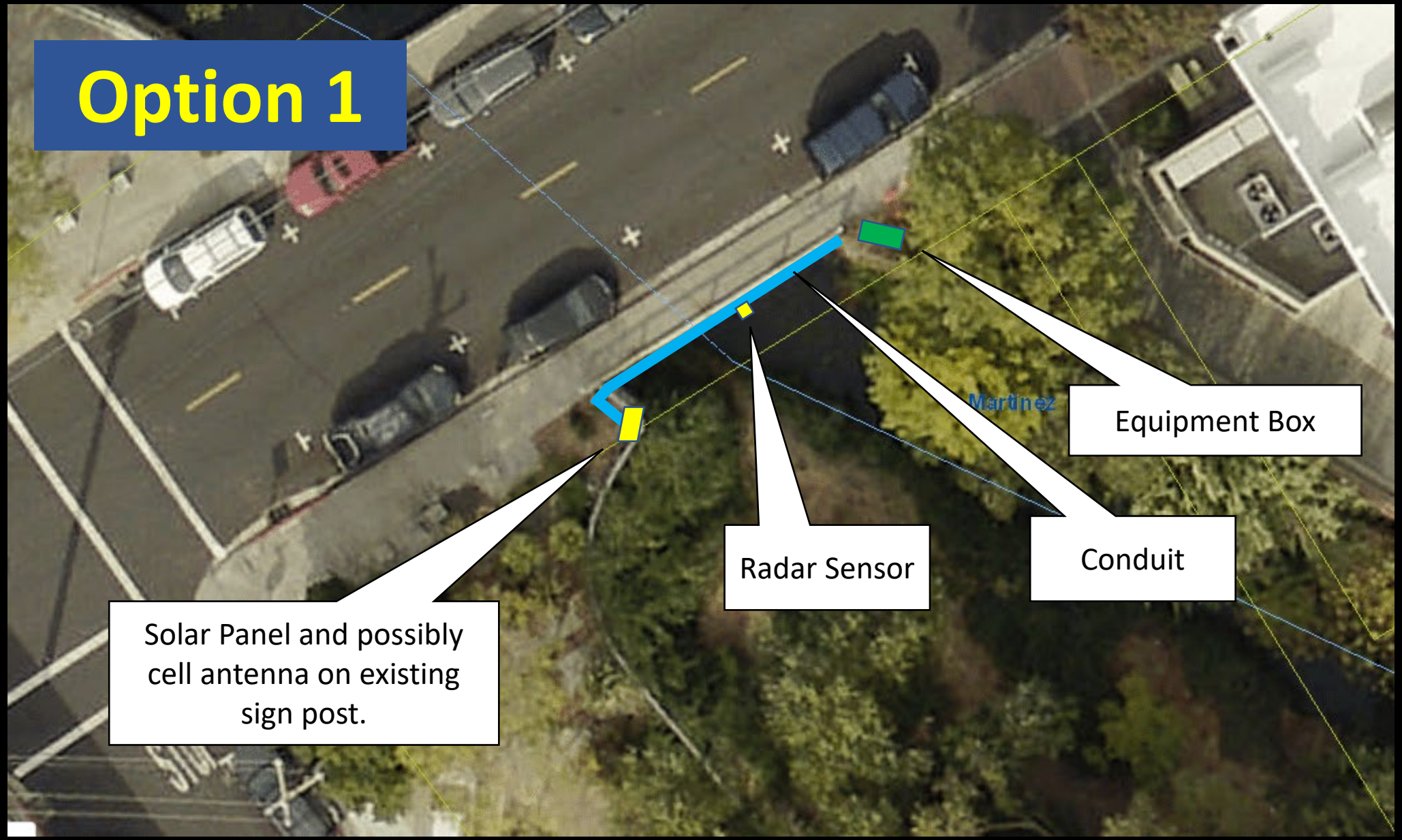
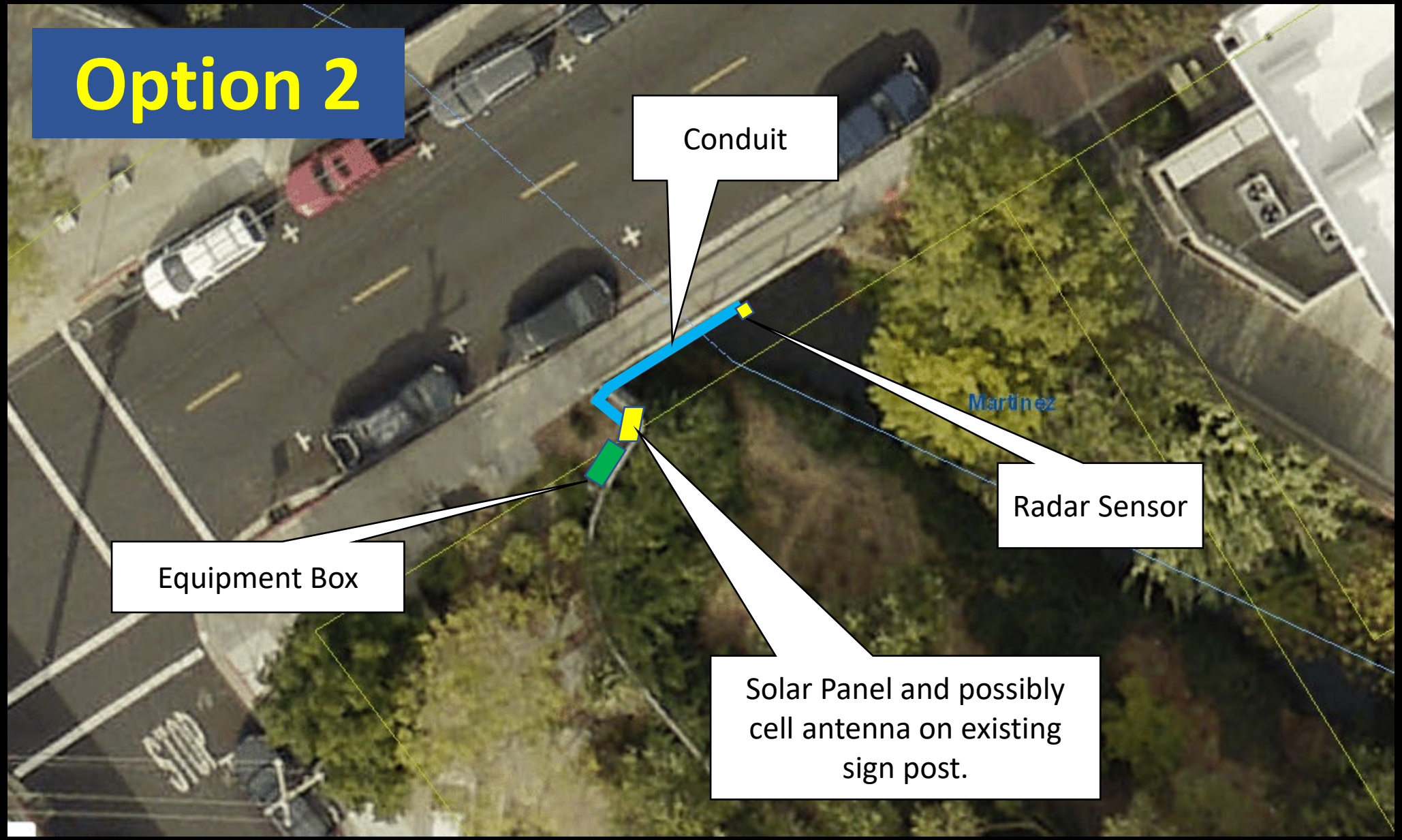
Alhambra Ck @ Ward Street Stream Gage


Proposed stream gauge location.
-
Alhambra Ck @ Ward Street.
Proposed Hobo gauge general deployment location
-
During winter flow periods
Alhambra Creek (a.k.a Arroyo del Hambre)
Del Cielo Brewing Co
Knots and Found
The Spotted Cow - Vintage, Antiques &...
Antique store
Lights of Diablo
Lighting store
Pak Mail
Shipping company
Barrelista Coffee Hous
Troy
Greek · $$
Roxx On Main
American · $$
The Mud Room
Starbucks
Slow Hand BBQ - Martinez
American · $$
Luigi's Deli and Market
Citrus Salon
Five Suns Brewing
Ward St. Stream Gage
Lemongrass Bistro
Asian Fusion · $$
States Coffee x Bread
Pacifica Pizza
Slice of Italeigh Pizza & Cheesestea
Nu-Rays Bar
Contra Costa County Office of the...
Marina Vista Ave
Alhambra Ave
Castro St
Escobar St
Estudillo St
Ferry St
Main St
Ward St
Google

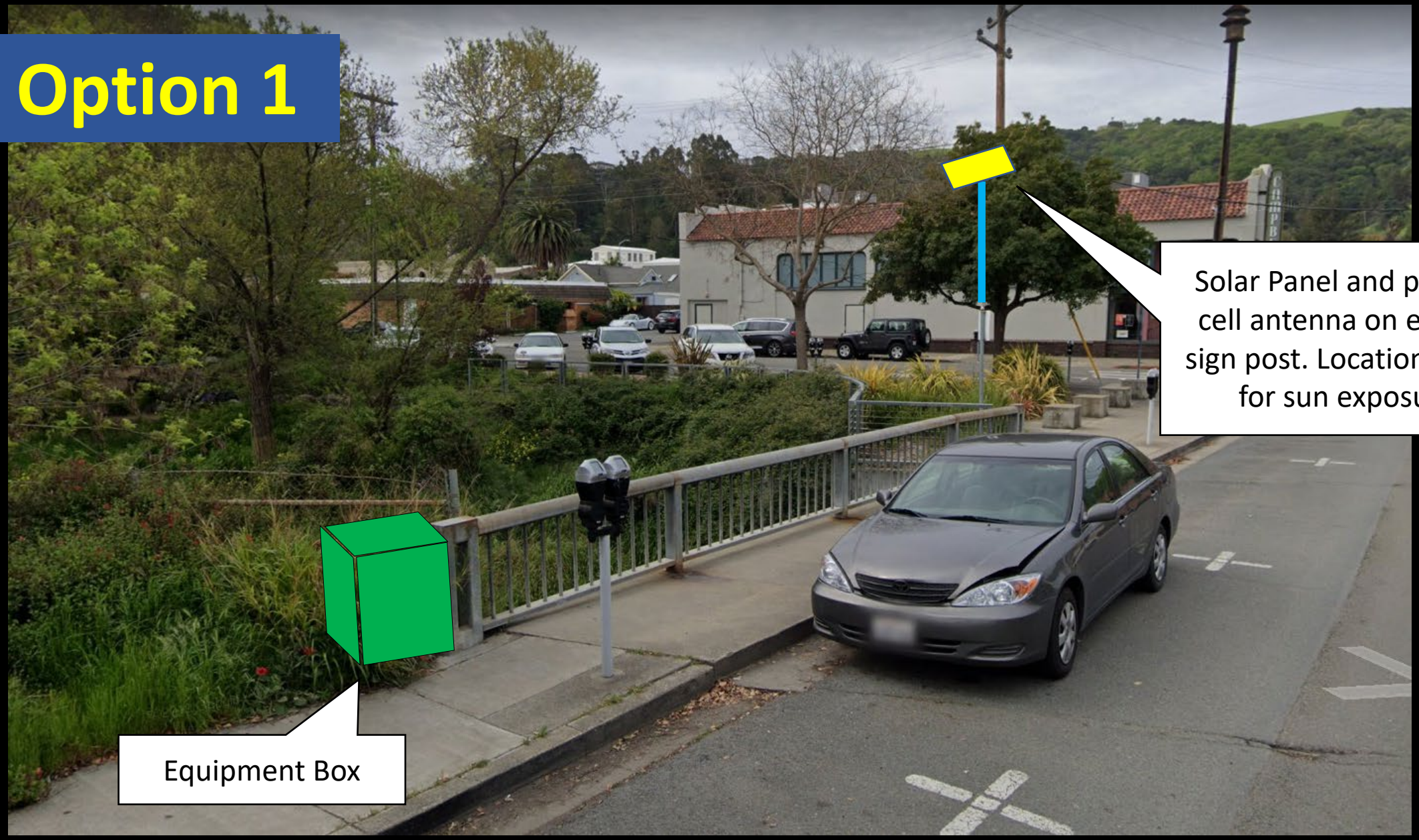

Option 1
Equipment Box
Conduit
Radar Sensor

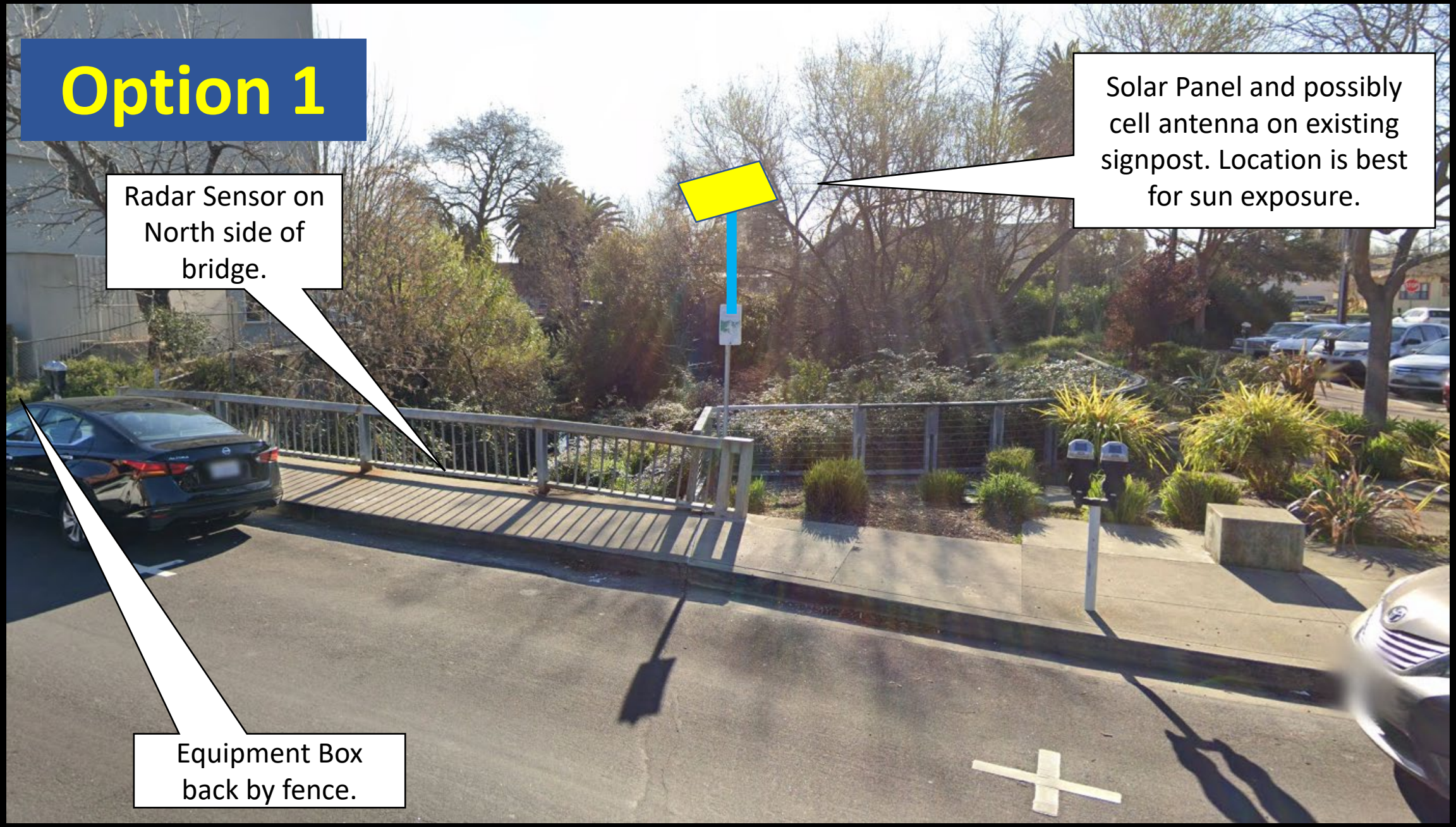

Option 1
Conduit
Radar Sensor
Equipment Box
(on street side of fence)

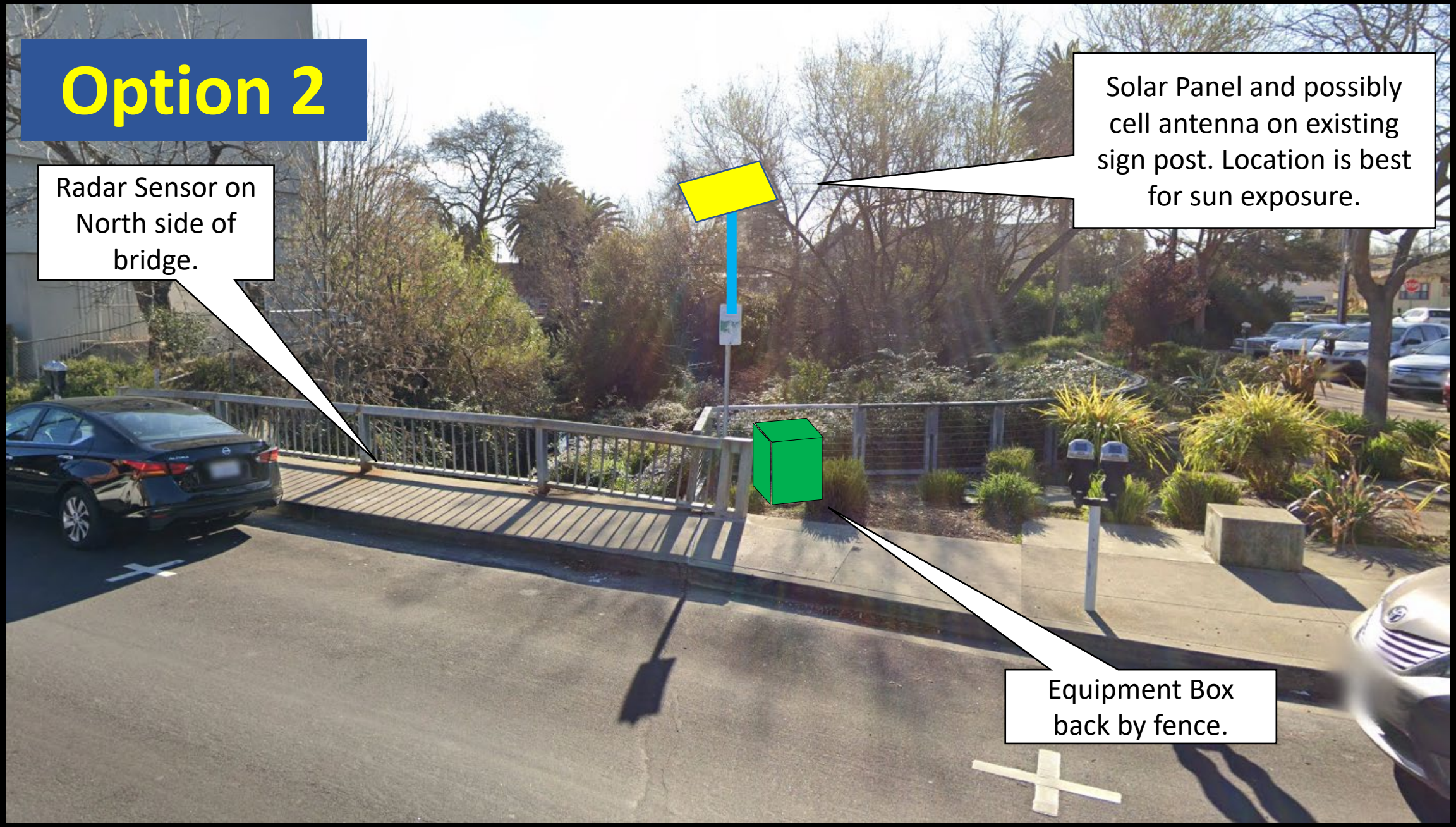

Option 1
Martinez
Equipment Box
Conduit
Radar Sensor
Solar Panel and possibly cell antenna on existing sign post.


Option 2
Conduit
Radar Sensor
Equipment Box
Solar Panel and possibly cell antenna on existing sign post.
Martinez

Option 1


Solar Panel and possibly cell antenna on existing sign post. Location is best for sun exposure.
Equipment Box


Option 1
Radar Sensor on North side of bridge.
Solar Panel and possibly cell antenna on existing signpost. Location is best for sun exposure.
Equipment Box back by fence.


Option 2
Radar Sensor on North side of bridge.
Solar Panel and possibly cell antenna on existing sign post. Location is best for sun exposure.
Equipment Box back by fence.

Radar Sensor Top view

Hobo sensor to be deployed in a pipe with holes secured to creek bed/bank. A second identical Hobo sensor is placed securely nearby to allow adjustment for barometric changes.