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Hale Creek Pilot Enhancement Project

Planning Study Memo

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Summary

The memo documents the planning development of the Hale Creek Pilot Enhancement Project (Project). The aim of the Project is to test the restoration of geomorphic and habitat functions to a representative reach of a currently constricted and concrete-lined channel, thereby improving habitat and water resources while also maintaining and enhancing flood protection. The recommended Project removes approximately 650 feet of currently concrete channel bank and invert lining and replaces it with a vegetated earth channel with hardened outside retaining walls. The Project widens the flood prone area available to the stream, restores natural channel bank and invert lining, allows for natural stream recharge, reduces the channel slope, restores channel meander and allows meander development into the future, and lowers the one-percent and lower flood event water surface elevations. Finally, the pilot Project is located in a channel reach with good top of bank access to allow for relatively easy channel maintenance and monitoring of the pilot project.

Introduction

As a result of the Santa Clara Valley's rapid urbanization and rapidly increasing population particularly since the mid 1900's, the watersheds within northern Santa Clara County have experienced dramatic changes, which have affected their hydrologic and fluvial geomorphic setting. To provide flood protection for County residents in response to repeated and large scale floods through the 1950s, the Santa Clara Valley Water District (District) constructed many miles of flood protection projects, including concrete-lined channels. In essence, these channels were built to convey storm water runoff to the San Francisco Bay as efficiently as possible.

While these channels have generally achieved their main goal of reducing flood risk and damage, other problems and issues have developed over the years after construction which are of concern. Some of these issues include:

- Reduction in stream hydrologic and geomorphic functions including:
    - Sediment generation and transport
    - Natural aquifer recharge
    - Decreased water quality
- Increased velocity leading to an increase in scour, erosion, and damage to infrastructure
- Destruction of riparian habitats and perceived lack of ability for restoration due to restricted right-of-way

In light of these issues, many resource agencies now eschew the use of hardscape flood protection solutions because the negative impacts may outweigh the benefits and because the state of the science has improved, allowing alternative solutions. The preferred natural methods for flood protection include flood retention and stream restoration and involve the use of multi-stage earth-lined, vegetated channels that are more conducive to meeting multiple objectives.

Finally, much of the concrete-lined channels that were constructed by the District are now well over 50 years old and are reaching the end of their original planned useful life. Rather than replacing these soon

to be failing channels with similar hardscape replacements, a new approach implementing correctly-sized vegetated soft-bottom channels would be preferred, if possible. This pilot project provides the District an opportunity to partner with the San Francisco Regional Water Quality Control Board to develop a design and test a project to meet the following objectives:

- Stabilize banks subjected to scour and erosion
- Enhance creek habitat values and provide an ecosystem that promotes riparian diversity
- Promote stable geomorphic conditions allowing natural transport of sediment and active channel development
- Provide flood protection to the communities surrounding the creek
- Restore stream recharge capabilities within the project reach

The Project aligns with Safe Clean Water Program's (SCW) Project D6, "Creek Restoration and Stabilization," as outlined in the SCW Program, which was passed by County voters in a ballot measure in November 2012. Project D6 will provide funding for this project to design and build a geomorphic designed project to restore stability and stream function and promote sediment balance throughout the watershed.

Project Site Selection

The following considerations were used to determine the pilot project site location:

- For best use of public money, prioritize a project location where the existing concrete channels are towards the end of their projected useful life and will need eventual replacement shortly.
- Prioritize a reach that does not currently have 1% flood protection so that the project can serve flood protection objectives as well.
- As the District has little experience with the type of restoration project proposed, prioritize a project location that has good top of bank access. This would allow good channel observation vantage and allow routine and emergency maintenance action, if necessary.

The concrete channels along Hale Creek and Permanente Creek (see Figure 1: watershed map) were originally built in the early 1960s, one of the earliest District projects built after the 1950s floods. Under the Clean, Safe Creeks (CSC) program's Permanente Creek Flood Protection Project, a detailed planning study identified various improvements for these watersheds necessary to provide 1% flood protection. The recommended project elements to provide flood protection for Permanente Creek are to be constructed under that CSC project. Potential flood protection enhancements previously identified for Hale Creek are being deferred to potential future funding measures. However, the results of this pilot study may identify other alternatives for Hale Creek flood protection not considered feasible heretofore.

A structural stability study was conducted for the concrete reaches of Permanente and Hale Creeks in the early 2000s. The study identified almost all sections of Hale Creek as being in danger of structural failure in the near term, with some sections faring worse than others.

Most of the concrete-lined sections along Hale Creek have minimal top of bank access, as the creek basically flows between built-out residential parcels in 20 to 35 feet of existing District right-of-way. However, two sections of concrete-lined Hale Creek have good existing top of bank access (see Figure 2: Location Map). One section is from Rosita Ave to Arboleda Drive, along Springer Road. The other section is from (North) Sunshine Drive to Marilyn Drive, where the creek mostly flows through a large parking lot owned by the Seventh Day Adventist Church. Both of these creek reaches currently lack 1% capacity.

Comparing these two reaches:

Location:	Pros	Cons
Rosita to Arboleda reach	Upstream end of the concrete channel section; therefore restoration allows habitat connectivity with natural upstream reach. This section most in need of concrete channel replacement per structural study.	Minimal existing r/w: would need to acquire r/w from City of Los Altos along street. Impact to hundreds of planted oak trees along creek. Impact to four residential access bridges over creek. Would require floodwalls. Upstream end of flood protection needs; therefore would induce flooding downstream.
Sunshine to Marilyn reach	Excellent top of bank access. Widest existing District r/w at 35 feet would allow for most beneficial restoration. Downstream end of flood protection work needed, therefore no potential for induced flooding downstream. Comparatively few existing trees along top of bank area. Impacts very few private properties.	Concrete section not in imminent danger of structural failure yet. One residential access bridge needs replacement. Requires construction and long term maintenance easement from Church.

Based on these criteria, the recommended project site is the (North) Sunshine Drive to Marilyn Drive reach.

Existing Conditions

Hale Creek is a partially concrete-lined channel located in Mountain View that runs from the hills upstream of Foothill Expressway to its confluence with Permanente Creek, which then runs north towards San Francisco Bay, terminating in the Mountain View Slough. The Hale Creek channel has a bottom width that averages from 6-10 feet and a top width that ranges from 15-30 feet (see figures 3 and 4 for typical current channel).

In order to get a picture of bankfull conditions and to assist in sizing the pilot restoration channel, a field visit was made to observe the natural channel conditions upstream from the pilot reach. The downstream side of Rosita Avenue is the location at which the concrete lining for Hale Creek begins. Upstream of this road, the channel bottom width was determined to be an average of 7-8 feet, and the

bankfull top width was approximately 10-12 feet. Along this reach, a bankfull depth of 1.5 feet was measured. The channel slope along this reach was determined to be approximately 0.6%. The invert materials lining this portion was determined to be mostly gravel and sand, but there was also some quantity of quarry rock and cobble. There was not much evidence of on-going channel erosion or aggradation.

Going further upstream to Covington Road, the average natural channel bottom width was determined to be about 7-8 feet. Due to down-cutting that has been occurring within this reach, the bankfull depth was not consistently apparent; but it was decided that a bankfull depth of 1-2 feet was reasonable. The slope for this portion of the creek was determined to average about 0.5%. The invert sediment along this reach consisted mostly of fine gravels, with a small amount of larger rocks.

For the reach just downstream of Foothill Expressway, bankfull depths were difficult to determine due to the existing sacked concrete along the banks. The natural stream invert along this reach contained mostly sand, gravel, and a small amount of larger rock. Upstream of Foothill Expressway, bankfull depths were also difficult to determine due to extreme down-cutting that was observed through this portion of the creek. The slope along this area was greater than 1%, and an average bankfull width of 6-7 feet was measured. It was concluded that bankfull depths were about 1.5 feet, and possibly even deeper.

Conceptual Design

As described above, the proposed pilot enhancement would be constructed over approximately 650 linear feet of Hale Creek channel between Marilyn Drive and Sunshine Drive. The existing concrete lined channel within this reach would be removed. The middle 500-foot section of the reach would be replaced with a geomorphically appropriate, vegetated channel. The remainder 150 feet upstream and downstream of this section would serve as a transition zone consisting of an earthen bottom channel with rock banks.

With the concrete lining in the channel removed, steel sheet piles that are vertically aligned with the District's Right of Way would form the outer walls of the new channel. The conceptual design is to implement a meandering, appropriately-sized bankfull channel that would be lined with natural stream materials. The slope would be reduced to 0.5% in order to match the natural creek grade upstream of the project reach. While velocity was not a major concern for this reach, promoting dynamically stable geomorphic conditions is one of the major objectives of this project. For this reason, it is proposed to use natural riffles (Newbury Riffles, see Figure 8) at the cross-over points of the straight reaches of the bankfull channel. This is simply to expedite the formation of an appropriate riffle-pool system, which the natural hydrology would then modify.

Outside of the bankfull channel, the flood benches would slope gently up to the sheet pile walls and would be planted with appropriate native vegetation. This would promote the maintenance of the bankfull channel over time as well as provide a healthy riparian corridor. The vegetation along the benches would only require maintenance for emergencies (e.g. addressing downed/dead trees) or

control of non-natives. Selective trimming would also be used as needed to encourage vertical growth and shading and to keep the bankfull channel area clear to allow long term access through the reach.

Bankfull Channel Design

Field observations of the entire creek, as discussed above, provided a mean bankfull depth of 1.5 - 2 feet, and a bankfull width of 8-10 feet for existing natural channels upstream of the pilot project area. Regional curves comparing drainage area (about 4 square miles) versus average bankfull area for the South Bay (see Figure 5) show an approximate bankfull area of about 24 square feet. Finally, a bankfull width to depth ratio of about 4 has been found to be effective for Bay Area stream restoration projects. Based on all of this, the bankfull channel was designed to be approximately 10 feet wide and 2 feet deep.

SCVWD has gathered data on bankfull flow and created a regional regression curve of the South Bay (see Figure 6). Using this with the appropriate drainage area, bankfull discharge was estimated to be approximately 120 cfs. The stream gauge record for Hale Creek upstream of the project area was also analyzed revealing 1.25 and 2 year recurrent flow values as 51 and 100 cfs respectively. Although it is not a hard and fast rule, the 2 year return interval is usually deemed a reasonable estimate of bankfull discharges. Based on the regression curve and stream gauge readings, the range of flow for the pilot design was determined to be between 60 and 100 CFS. This range was also used in the hydraulic model to determine velocity and water surface elevations through the pilot reach.

Sinuosity was another element of the conceptual design to achieve the project objectives. Sinuosity for the channel was selected based on expert determination of average values of amplitude and curve radius associated with the design channel width. Based on discussion with the Regional Water Quality Control Board (RWQCB), a sinuosity of 1.25 was selected (i.e. for a direct horizontal distance of 10', there needs to be 12.5' of actual stream). See Figure 7 for bankfull channel design and layout.

Hydraulic Model

Once the conceptual design was developed, a hydraulic model was constructed to compare existing conditions to post-project conditions within the creek. The model also helped determined the hydraulic behavior (i.e. channel depth and velocity), and water surface elevations (WSE) when the channel was subjected to a 100-year storm event. An existing HEC-RAS model that was originally created for the Permanente Creek Flood Protection Project was used to analyze the conditions within Hale Creek. The model begins at the Permanente/Hale Creek confluence and ends at the Foothill Expressway Crossing.

For post-project conditions, cross sections between Marilyn Drive and N. Sunshine Drive were modified to reflect the dimensions determined through the conceptual design. A composite Manning's n of 0.045 was also used within the design reach to reflect the vegetated soft-bottom that is to be featured in the conceptual design. Flow rates of Q= 50, 60, 70, 80, 90, and 100 CFS were used in HEC-RAS to model bankfull conditions. By comparing both models, it was determined that the conceptual design will provide flow that will be moving at a slower, more controlled velocity with greater depth.

For high flow conditions, the model was subjected to a 100-year storm event. For this recurrence interval, the flow was determined to be 1100 CFS through this reach per the Permanente Creek project's hydrology. Once again, both existing and post-project conditions were compared side by side. The results for both models revealed some interesting conclusions. Post-project conditions once again showed the flow to be moving at a slower, more controlled velocity with greater depth when compared to existing conditions. It was ultimately determined that flow capacity would actually be improving through the pilot reach. Under existing conditions, the 7th Day Adventist pedestrian bridge was shown to be overtopping when it was subjected to a 100-year storm event. With the conceptual design implemented into the pilot reach, the post-project conditions model showed that this bridge was no longer overtopping. Thus, it was determined through the model that the project itself would not adversely affect flood capacity between Marilyn Dr. and N. Sunshine Dr.

Cost

Preliminary cost estimate for the proposed project was estimated to be $2,300,000 for design and construction.

Conclusion

This pilot project seeks to determine whether one technique to meet multiple objectives to enhance water resources under challenging right-of-way conditions would be effective. If successful, the project will serve as a model for restoring other, similar and larger-scale concrete channels within the South Bay which are also reaching the end of their structural life. It is recommended to proceed with this pilot project in order to meet all of the project objectives:

- Stabilize banks subjected to scour and erosion
- Enhance creek habitat values and provide an ecosystem that promotes riparian diversity
- Promote stable geomorphic conditions allowing natural transport of sediment and active channel development
- Provide flood protection to the communities surrounding the creek
- Restore stream recharge capabilities within the project reach

Upon completion of the project, the channel must be monitored to assess the effectiveness of the pilot design over time. Maintenance requirements should be tracked and recorded. If successful, the Hale Creek pilot project could serve as an important stepping stone in future restoration projects.

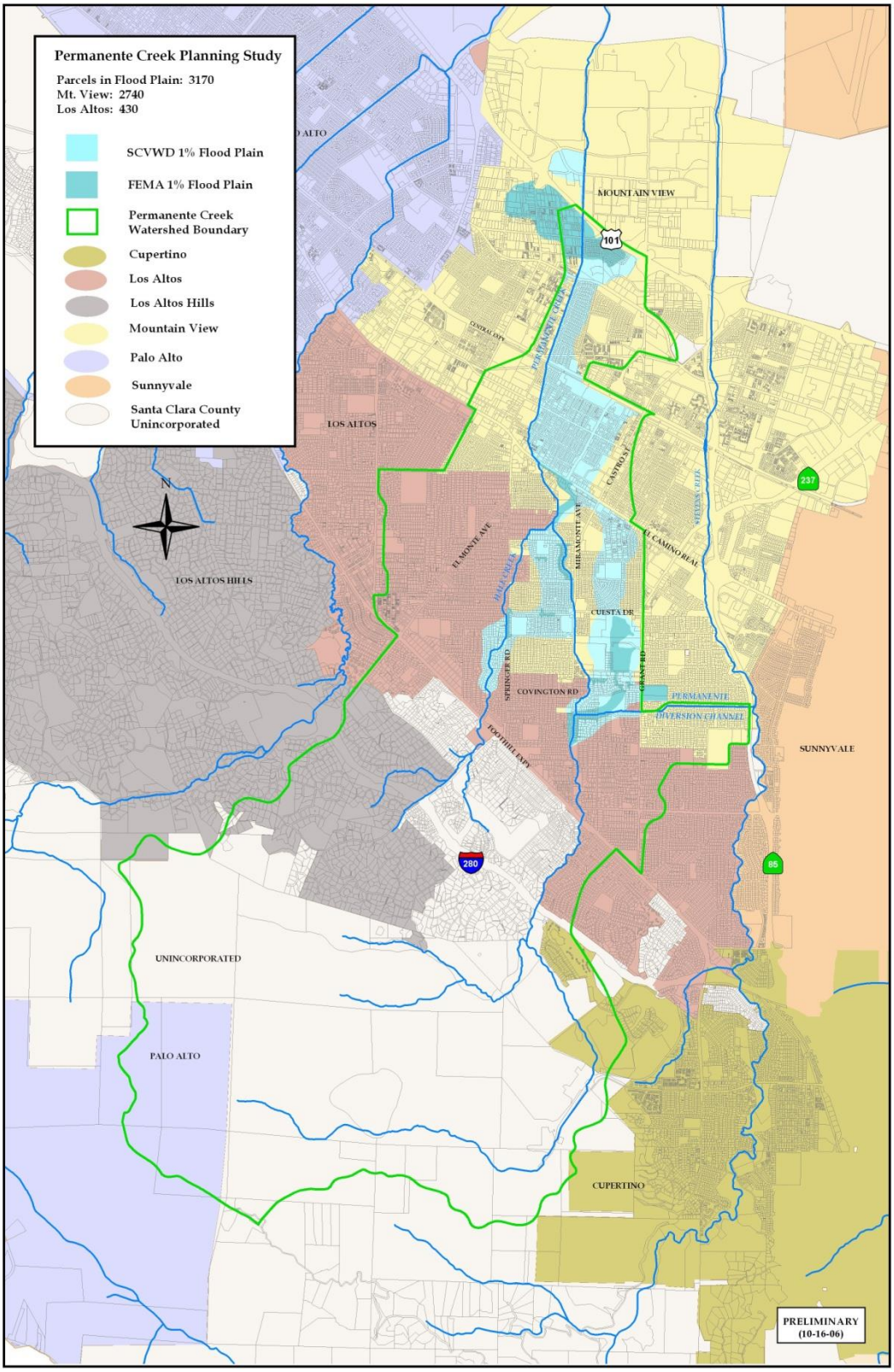

Figure 1: Watershed Map

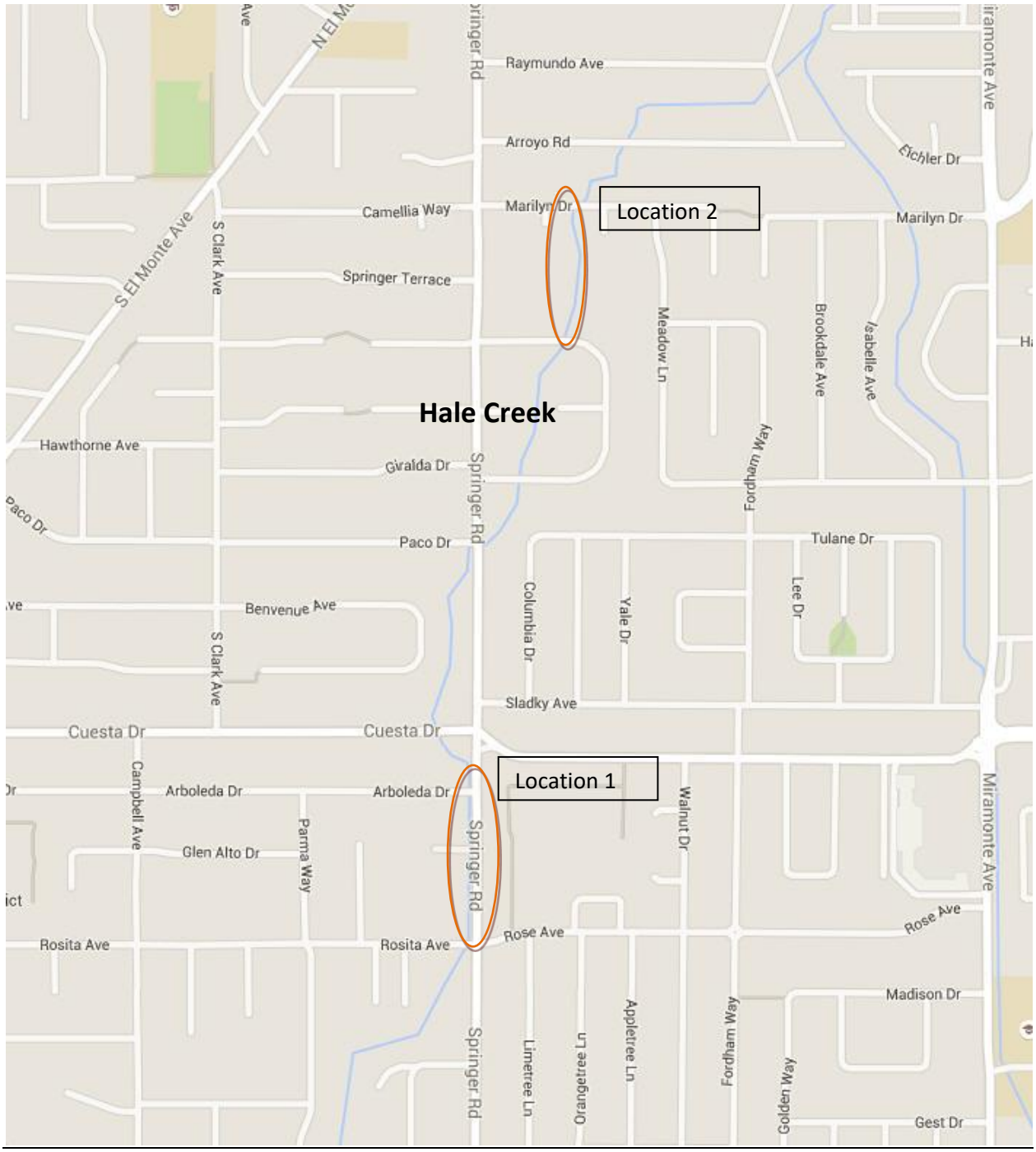

Figure 2: Location Map

Figure 3: Current Conditions at D/S of 7th Day Adventist footbridge

Figure 4: Current Conditions at D/S of North Sunshine Dr. Bridge

Figure 5: Bankfull Versus Drainage Area Curve

SMCWPPP Geomorphic Study in San Pedro Creek

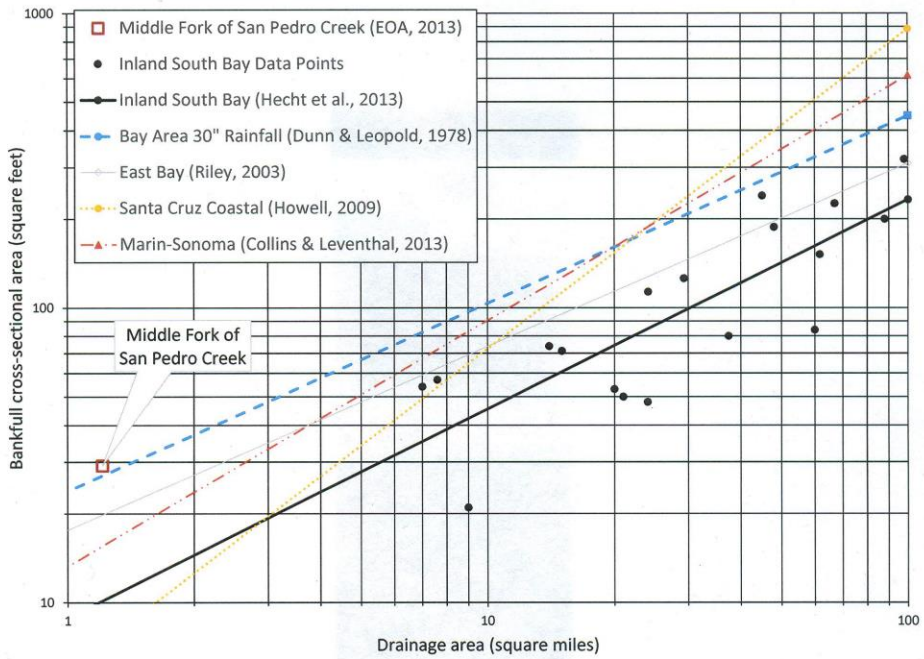

Figure 1. Bankfull cross-sectional area geometry relations, San Francisco Bay Region, California.

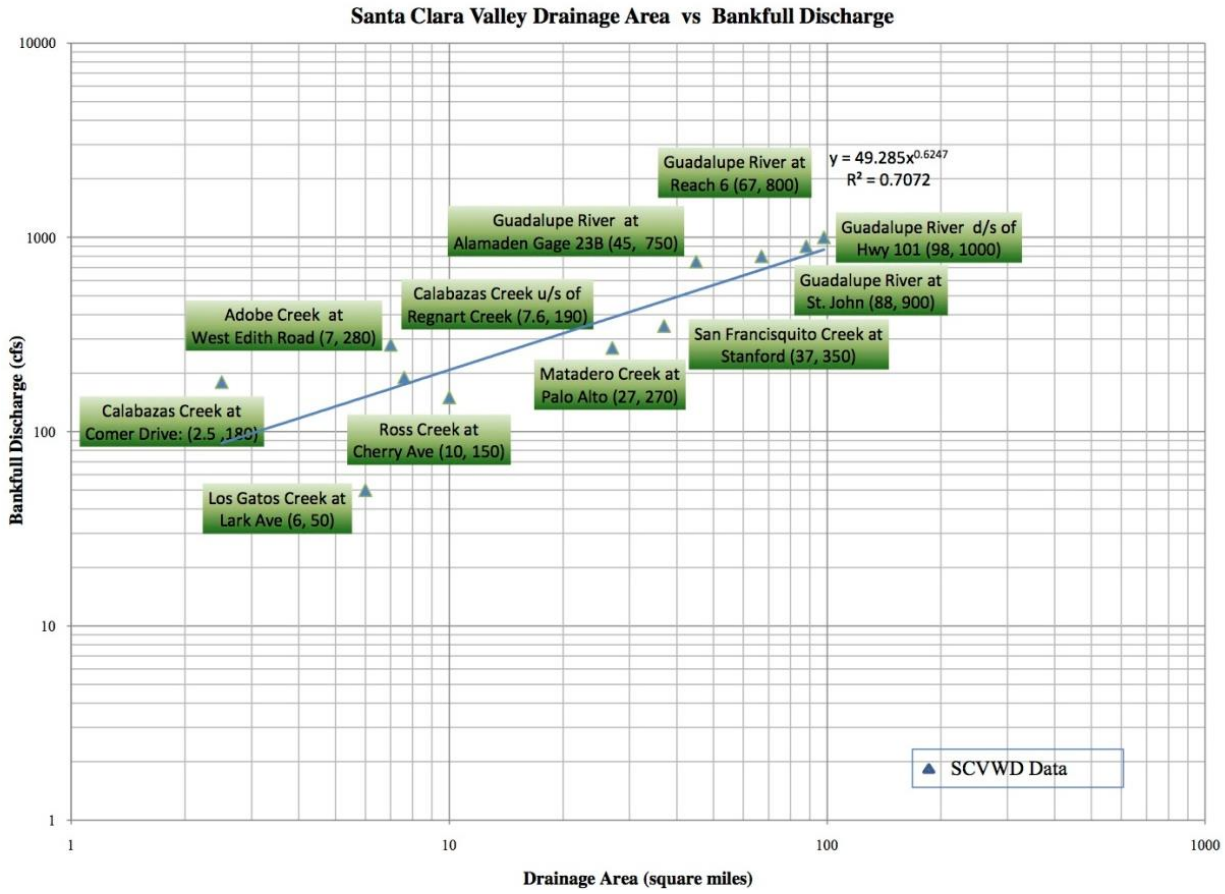

Figure 6: Bankfull Discharge Versus Drainage Area SCVWD Regional Curve

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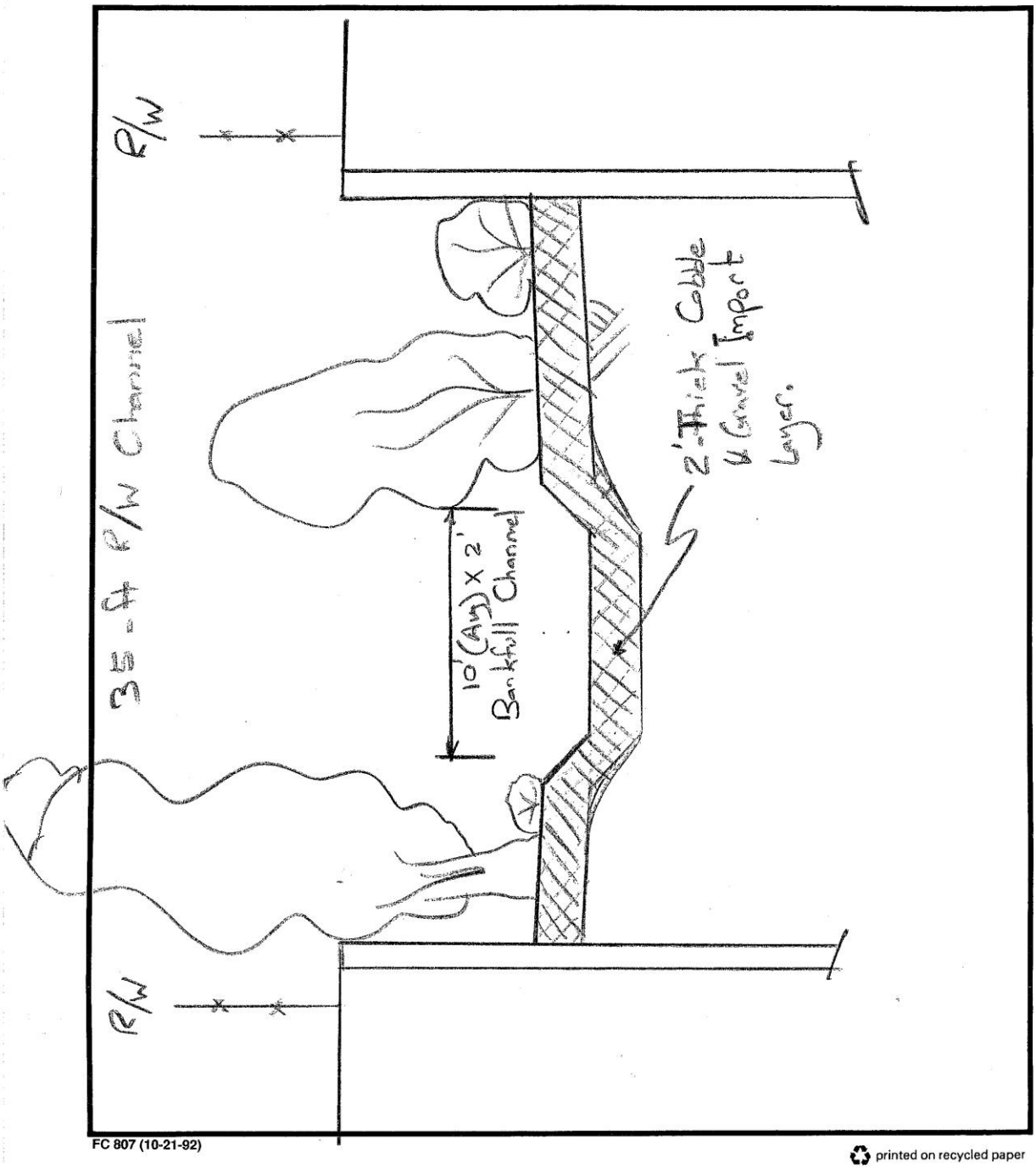

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Figure 7: Channel Section

Figure 8: Newbury Riffles