# Codornices Creek
# Fish Passage and Habitat Improvement Project

## Conceptual Restoration Plan
## San Pablo Avenue to Monterey Avenue

Codornices Creek
Berkeley, California

May 2005

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# 1.0 INTRODUCTION

## 1.1 PURPOSE AND SCOPE

This report presents results for the development and hydraulic analysis of measures proposed for the remediation of barriers to steelhead trout (*Oncorhynchus mykiss*) migration and measures proposed for the stabilization of the stream's banks in order to improve salmonid habitat in Codornices Creek. The report also describes efforts by the project team to inform the Codornices Creek community and to seek the community's counsel concerning the proposed restoration measures.

Codornices Creek contains a persistent population of native salmonid fish and remnant salmonid stream habitat within one of the most densely urbanized watersheds in the San Francisco Bay Area. The project reported here investigates the feasibility of restoring steelhead habitat in a highly urbanized environment.

The work reported here was enabled by the second of three Codornices Creek restoration grants awarded the Urban Creeks Council (UCC) by the State of California. The first, administered by the California Bay Delta Authority (CALFED) enabled development of the *Codornices Creek Watershed Restoration Action Plan*[1] (CCWRAP, Kier, 2004). The third grant project, also funded by CALFED, will enable implementation of the priority restoration measures identified in the CCWRAP and explored in the work of this project. This second "bridge grant"[2] enabled hydraulic (flooding) assessment of the priority fish migration barrier remediation measures contemplated in the Plan, together with further identification of measures for control of the priority streambank erosion problems identified in the CCWRAP.

A principal purpose of this bridge grant project was to explore alternative treatments to fish migration barriers between the San Pablo Avenue and Albina Avenue crossings of Codornices Creek, in order to identify structures that could ease fish migration without adversely impacting flood flow elevations. A closely related purpose of the project was to inform creekside landowners and the broader Berkeley and Albany publics of the project findings.

## 1.2 ABOUT THE URBAN CREEKS COUNCIL

The Urban Creeks Council (UCC) is a non-profit organization dedicated to the protection, preservation, and restoration of urban streams and their riparian habitat. UCC advocates on behalf of creeks, particularly in urban areas, and offers support and technical advice to grassroots "friends of" creek groups, public agencies, and private landowners. With a twenty-year track record and sustained presence in the San Francisco Bay Area, the organization is a resource to residents concerned about proposed development projects and their potential impacts on local creeks and wetlands, flooding, erosion, invasive vegetation, and other creek related issues.

[1] Contract No. 4600001722 between the California Department of Water Resources and the Urban Creeks Council

[2] Modification No. 1 to Contract No. 4600001722

UCC implements in-the-ground design/build stream restoration projects. UCC considers such projects to be educational in that they demonstrate a successful synthesis of multi-objective planning involving flood protection and ecological function. UCC's design approach is grounded in the principles of fluvial geomorphology, as well as the deliberate installation of appropriate plant materials to provide structure and stability to meandering stream banks and restored floodplains. Since its inception in 1982, UCC has restored literally thousands of feet of urban stream within the San Francisco Bay Area.

## 1.3 PROJECT PARTICIPANTS AND OBJECTIVES

As indicated above, the primary objective of the project was to advance key CCWRAP stream restoration measures toward implementation. The CCWRAP identified chronic erosion sites and potential fish passage barriers along Codornices Creek in its mid- and lower reaches (between San Pablo Avenue and Albina Avenue) and recommended restoration actions.

Specific objectives included in this contract were as follows:

- Evaluate flooding impacts for conceptual barrier culvert modifications for seven culverts identified in the CCWRAP as partial (temporal) or total barriers to fish passage. As feasible, develop preliminary designs for the remediation of potential fish passage barriers at the following sites:
    - San Pablo Avenue culvert
    - Kains Avenue culvert
    - Stannage Avenue culvert
    - Evelyn Avenue culvert
    - Neilson Street culvert
    - Peralta Avenue culvert
    - Albina Avenue Bridge

- Develop preliminary designs for bank stabilization projects at the following site:
    - St. Mary's College High School

- Conduct a hydraulic analysis of preliminary designs to evaluate flood flow elevations during 10 and 100 year flow frequencies.

- Develop an interactive community outreach program through public meetings and printed media to inform the community of the CCWRAP and the results of the bridge project work and to include them in the design process and proposed efforts.

In the completion of stated grant objectives, UCC utilized the services of Kier Associates and FarWest Restoration Engineering (FRE). Bill Kier of Kier Associates provided overall project management, administrative oversight, and fisheries expertise. Roger Leventhal of FRE conducted the hydraulic analysis of proposed measures using HEC-RAS modeling and standard protocols.

# 2.0 BACKGROUND AND EXISTING CONDITIONS

## 2.1 WATERSHED AND LAND USE

Codornices Creek (N 37.88˚, W 122.3˚) drains a 1.1 square mile watershed and flows for 2.9 miles from the Berkeley hills, through North Berkeley to Monterey Avenue where the creek serves as the border between Berkeley on the south and Albany to the north, and eventually reaches the San Francisco Bay near Golden Gate Fields (Figure 1). Elevations within the watershed range from sea level to approximately 1,340 feet at the summit of Grizzly Peak.

It has been estimated that 85 percent of the watershed has been urbanized (Kent, 1993; Kier, 2004). Land use in the watershed is primarily residential, with industrial and commercial uses dominating the lower watershed reaches. A few public parks line the stream. Throughout the reaches with which the CCWRAP is concerned, San Pablo Avenue to Monterey Avenue, land use is entirely residential except for the Ohlone Greenway under the BART tracks near Masonic Avenue and a private school located on Albina Avenue.

Due to urbanization the channel has been substantially culverted and channelized. Culverts span approximately 20 percent of the 2.9 miles of channel (Kent, 1993) and 39 percent of the 0.81 miles of the project reach. Kent also found that 35 percent of the above-ground channel length, or 0.8 miles of stream, has been channelized in concrete. Despite this, Codornices remains the only creek in the City of Berkeley where the majority of the stream remains in an open, natural channel.

## 2.2 HISTORIC CONDITIONS

Historically, Codornices Creek flowed from the Berkeley hills into a grassy marshland, bordering a salt marsh which extended from Virginia Street northwestwardly to the northeast corner of Fleming Point, the present site of the Golden Gate Fields racetrack (Friends of Five Creeks). During the 1920's Berkeley began filling the bay with waste. Due to bay fill and development demands, the creek's mouth was extended three quarters of a mile (Prunuske Chatham, 1990). In the 1930's, Codornices Creek's lower reach was forced to flow northwest into what appears to have been an old channel of Marin Creek (Friends of Five Creeks). This artificial stream course exists to this day.

## 2.3 STREAMFLOW RECORDS

No long term stream gage record exists for Codornices Creek. The Friends of Five Creeks and Balance Hydrologics, Inc. maintained a stream gage located under the BART tracks at Masonic Avenue from October 2000 until September 2001.

In January 2005, the stream gage was relocated and upgraded, as part of the project, to include remote accessing capabilities. The gage records stage height, flow rate, temperature, and specific conductivity. A rain gage was also installed at the new location in order to correlate rainfall with stream gage data. Data from the stream gage and rain gage may be accessed at: http://www.balancehydrologics.com/codornices/creek/index.php.

## 2.4 HISTORIC FLOODING

Neither Berkeley nor Albany has historic flooding data on record for Codornices Creek. Flooding is a reality, however, particularly in the lower reaches, as documented through anecdotal reports by current and past creekside residents. The degree of flooding became clear during conversations with property owners during the surveys conducted in the fall of 2004 and was emphasized at the community meeting held in April 2005. Flooding was reported at the upstream end of the Kains, Stannage, and Cornell Avenue culverts, as well as the downstream end of the Talbot Avenue culvert. In the upstream portion of the project area channel banks become higher and bank stability concerns replace those of flooding.

During the community meeting, additional outreach was conducted to further identify flooding concerns. Surveys (Appendix A), designed for both creekside and watershed residents, were completed by 25 attendees (11 creekside residents and 14 watershed residents). Based upon survey responses flooding ranked as a “major concern” to only one creekside resident who resides at Santa Fe Avenue. Another resident, along Summer Street in the upper watershed, reported that they experience flooding “every time it rains”. The majority of flooding related occurrences, according to completed surveys, were flooding of homes, erosion, and the accumulation of trash and debris (Table 1). One resident vocalized flooding occurrences and concerns in the existing concrete channel section upstream of the Albina Avenue Bridge, an area of potential barrier modifications. Additional outreach to identify areas of flooding should be conducted under the next phase of project work.

Below is a list of flooding occurrences as reported anecdotally from property owners.

<u>Kains Avenue</u>

Recurring flooding is evident upstream of Kains Avenue by the façade of sandbags along the top of the right bank. The sandbags run within inches of the corner of the home at 1131 Kains. Residents reported frequent flooding due to the flashiness of the creek and the trash rack located 43 feet downstream of the Kains Avenue culvert outfall. They felt that often the flooding could be avoided if the trash rack was maintained regularly during the rainy season. Due to their previous experiences with the stream and flooding, residents expressed concern over proposed restoration activities in the channel, any plans for channel modification, and the effects which might result.

<u>Stannage Avenue:</u>

Upstream of the Stannage Avenue culvert flooding is a concern of property owners along the left bank. Water has rarely topped the 7’ concrete wall lining the channel; however, water levels rise quickly and flow swiftly during storms.

<u>Cornell Street:</u>

Flooding is experienced regularly upstream of the Cornell Avenue culvert by property owners on both the left and right banks. Flooding water levels are evident by debris lines left during two storms in the winter of 2004 on the door of the structure along the right bank (Figure 2). The elevations of these flows were surveyed in fall 2004 and recorded at 53.79’ and 49.82’. To put these elevations in perspective, the elevation of the top of the Cornell Avenue culvert intake is 49.07’ and the base is 43.38’.

Talbot Avenue:
The resident along the left bank on the downstream end of the Talbot Avenue culvert reported that streamflow had topped the 5’ concrete wall alongside the channel and had reached an elevation approximately 2’ higher than the concrete wall.

## 2.5 EXISTING BIOLOGICAL RESOURCES

Codornices Creek connects with the San Francisco Bay and serves as habitat for anadromous fish. The stream supports a small, self-sustaining *O. mykiss* population.

A study conducted in 1981 by Leidy and a survey in 1989 by Rich identified no *O. mykiss* within Codornices Creek (Leidy, 1984; Rich, 1990). Beginning in the mid 1990’s anecdotal reports of trout observations at Stannage Avenue, Masonic Avenue, 10th Street, and 9th Street were recorded (Leidy, 2003). An electrofishing survey conducted in 1999 by Friends of Five Creeks and in 2000 by a University of California researcher, Thomas Dudley, confirmed the presence of *O. mykiss* in the watershed (Kier, 2004).

Work on the Lower Codornices Creek Improvements Project required the removal of over 100 *O. mykiss* from that project’s reach between the Union Pacific Railroad and 5th Street in fall 2004. Four of these fish succumbed during handling and were sent to the University of California, Davis’ Aquatic Ecosystems Analysis Laboratory for analysis to determine whether they had developed entirely in freshwater or whether they might have begun their development at sea.

For information concerning electron analysis of Sr:Ca in juvenile steelhead otoliths to determine anadromy see: http://johnmuir.ucdavis.edu/aeal/presentations/EH2003_NavarroOtoliths.pdf. None of the four lower Codornices Creek *O. mykiss* tested by the University in 2004 showed signs of early development at sea, of having been, therefore, progeny of sea-run steelhead (Jeff Hagar, personal communication).

During the spring of 2002 and 2003, in conjunction with the CCWRAP, Kier Associates installed a downstream migrant trap between 6th and 8th Streets. All the fish collected were identified, measured, and released daily. A total of 55 juvenile salmonids were collected during this study, 33 in 2002 and 22 in 2003.

The majority of sampled salmonids were less than 75mm fork length (FL). This small size during the periods of collection suggests young-of-the-year steelhead. A total of five *O. mykiss* ranged in size from 76mm to 105mm FL. There were eight salmonids in the collection larger than 105mm FL. The largest individual in the sample measured 200mm FL and was likely three years old. In addition to *O. mykiss*, the survey also captured 62 *Gasterosteus aculeatus* (threespine stickleback) and 13 *Hesperoleucus symmetricus* (California roach) (Kier, 2004).

During geomorphic surveys conducted under the current project, trout were observed in pockets throughout the project reach (Figure 3). Populations were noted downstream of the Cornell Avenue, Curtis Street, and Peralta Avenue culverts, under the BART tracks near Masonic Avenue, and in the pool downstream of the Albina Avenue Bridge.

Based upon these studies together with the substantial anecdotal information, Codornices Creek has a successfully reproducing, albeit small, population of *O. mykiss*.

## 2.6 Prior Stream Habitat Assessments

A salmonid habitat survey of Codornices Creek from Golden Gate Fields to Euclid Avenue was completed in March 2003 by Kier Associates in conjunction with the CCWRAP. The survey identified and measured essential habitat units; pools, riffles, runs, and the subcategories of each. This study concluded that steelhead habitat is limited in Codornices Creek due to the lack of pools of significant depth. The California Department of Fish and Game suggests that pools comprise 40% or more of channel habitat in streams having good salmonid habitat (California Department of Fish and Game, 1998). Pools accounted for only 20% of the 3.2 miles of channel length surveyed in 2003. Furthermore, most pools were less than 2.5 feet in depth. (Kier Associates, 2004)

In addition to these habitat units, the Kier Associates' habitat survey also identified areas of erosion and estimated their volume. This information was compared to an erosion site inventory conducted in Codornices Creek by Prunuske Chatham, Inc. in 1990 with funding from the California Department of Water Resources.

The 2003 survey identified fifteen sites where more than 500 cubic feet of streambank erosion had occurred. Twelve of these fifteen sites were also identified in the Prunuske Chatham report. These locations were, therefore, labeled as chronic sites of erosion. The most significant site, located at St. Mary's College High School at the end of Albina Avenue, has experienced an estimated 500,000 $ft^3$ of erosion (Kier, 2004).

Information was also collected regarding streambed particle size. The optimal streambed particle size for successful steelhead spawning ranges from 10-45mm (Kondolf, 1993). The median streambed particle size distribution ($D_{50}$) was evaluated for the identified Codornices Creek habitat units. Wolman pebble counts showed that gravel size was not adequate for steelhead downstream of St. Mary's College High School. Furthermore, this was the only habitat unit upstream of tidal influence where gravel size was not suitable for spawning habitat (Figure 4). This suggests that the chronic erosion site identified at St. Mary's College High School contributes sediment to the system which is adversely affecting steelhead spawning opportunity downstream of that point.

A water quality assessment, conducted by Hydroikos Associates in conjunction with CCWRAP concluded that Codornices Creek could successfully support a spawning steelhead population. The following parameters were assessed: dissolved oxygen, hardness, toxicity, organophosphates diazinon and chlorphyrifos, and the heavy metals copper, nickel, zinc, and lead. Diazinon and copper levels were the only parameters that exceeded water quality criteria, however neither exceeded concentrations known to adversely affect steelhead (Hydroikos Associates, 2003).

## 2.7 PRIOR FISH BARRIER ASSESSMENTS

A previous preliminary assessment of culvert barriers through the project reach was performed by FRE in September 2003 as part of the CCWRAP (FRE, 2003). This work involved the hydraulic analysis of the creek culverts identified by Kier Associates as potential barriers or impediments to fish passage within the creek. The preliminary barrier assessment report evaluated 11 culverts using Fish Xing and determined that 7 culverts posed some kind of partial barrier to passage of adult or juvenile salmonids, typically for low flow or excessive velocity results. This previous work recommended installation of fish baffles and outlet step-pools to raise water surface elevations and reduce velocities to acceptable levels for passage of salmonids.

Note that the scope of this previous fish passage work did not include evaluation of impacts to flooding or flood control. Previous reports explicitly stated that installation of baffles or other backwatering controls to raise water levels and reduce velocities would have an impact on the flood conveyance capacity of the culverts. Evaluation of flooding due to installation of fish passage mitigation measures was conducted under this phase of work as described below. This model was intended to evaluate impacts due to installation of the proposed barrier modifications and is not a comprehensive flood model. The model does not include inflows from storm drains. In addition, the development of flood flows was outside the scope of this work and therefore flows generated by previous studies were utilized in the flood evaluations.

# 3.0 SUMMARY OF WORK PERFORMED UNDER THIS PROJECT

Under this contract UCC and its partners performed work to develop comprehensive, multi-objective habitat restoration and barrier modification conceptual designs for sites identified within the CCWRAP area in order to enhance habitat and remove barriers of migration for existing *O. mykiss* populations, and to address the interests and concerns of creekside landowners and the larger Berkeley and Albany communities.

A survey of existing channel geomorphology was conducted from San Pablo Avenue to Monterey Avenue in order to populate the HEC-RAS model used to complete the hydraulic analysis. Using the data collected and restoration technology recommended by the responsible fisheries agencies, a HEC-RAS model was constructed for the entire project reach.

Work conducted under this phase of the project included:

- Survey existing channel profile and cross-sections from San Pablo Ave to Monterey Avenue.0
- Conduct hydraulic modeling of flood flows through the project reach under both existing and proposed conditions.
- Develop conceptual designs for habitat improvements and fish passage.
- Provide preliminary cost estimates for potential feasible alternatives.

# 4.0 STREAMBANK STABILIZATION AND FISH BARRIER REMEDIATION ALTERNATIVES

This section describes the preliminary designs and hydraulic analysis for streambank stabilization to improve fish habitat at St. Mary's College High School and for in-stream fish barrier modifications at the Albina Street Bridge, channel culverts, and the concrete section downstream of Monterey Avenue.

All proposed designs will be advanced and finalized through funding obtained from CALFED. Once final designs are developed, permits will be submitted to all regulatory agencies as required. All work is to be completed in such a manner as to ensure that implementation occurs during the summer/fall of 2006.

Note that the designs presented herein may change significantly during final design. Designs may alter due to budget allowances, property owner cooperation, requirements imposed by the Cities of Berkeley and Albany and regulatory agencies, and further analysis of existing infrastructure.

## 4.1 EXISTING CHANNEL CONDITIONS

October through December 2004, UCC staff conducted longitudinal profile and cross-sectional surveys of Codornices Creek from San Pablo Avenue to the concrete section which terminates at the Monterey Avenue culvert, as needed for hydraulic modeling and preliminary design. Surveys were conducted using standard protocols with a transit level and stadia. All elevations were recorded in the City of Berkeley Datum and tied into the City of Berkeley benchmark located in the median of San Pablo Avenue at Harrison Street. The longitudinal profile recorded thalweg and the then-current water surface elevations throughout the 4,000 foot stretch (Figures 5-16). Fifty-five cross-sectional surveys were conducted to capture channel dimensions. Cross-sections were taken at the intake and outfall of each culvert, a 1:1 ratio upstream of culverts with headwalls, a 2:1 ratio downstream of culverts with headwalls, along the road above culverts to indicate the relative depth of the culvert, and at points within the channel where there was a change in geomorphology or roughness.

## 4.2 PRELIMINARY DESIGN FOR HABITAT IMPROVEMENTS

This section presents the preliminary design for bank stabilization at St. Mary's College High School. As this site was identified in the CCWRAP-2004 as a chronic site of erosion which appears to be impacting downstream gravel, habitat improvement efforts were focused in this location.

All proposed work will be done with the collaboration and consent of St. Mary's College High School. In addition to addressing the largest erosion site noted in the 2003 habitat survey, many educational opportunities exist at this location. Revegetation efforts are to be supplemented by students to capitalize on this opportunity and encourage environmental stewardship.

### 4.2.1 St. Mary's College High School

St. Mary's College High School is located along the top of the right bank, downstream of the Albina Avenue Bridge. The channel in this reach is incised with top of slope elevations 30-35 feet above thalweg elevations. Vegetation is comprised largely of non-native and invasive species. A stand of approximately 30 mature Eucalyptus trees dominates the right bank, while the left bank (private property) is covered with cape ivy. Currently erosion is undercutting three eucalyptus trees/stumps along the right bank, which are in danger of falling (Figure 17). When this occurs a significant load of sediment will be contributed to the system. Erosion has created a "lip" of soil which extends along the top of bank. Additionally, the school's paved access road which runs parallel to the top of slope appears to be contributing to the bank's instability. Runoff may be creating downslope erosion.

#### 4.2.1.1 Proposed Bank Stabilization

In order to stabilize the bank and improve instream habitat for steelhead populations, UCC proposes to remove the invasive vegetation present along the right bank, grade the bank to a gentler slope, and vegetate the slope using native plant species and soil bioengineering techniques. To ensure that downslope erosion does not persist, a curb is to be installed along the edge of the road to direct runoff into an existing storm drain system. Figure 18 illustrates a typical cross-sectional view of the existing bank and proposed stabilization measures.

Existing infrastructure, the adjacent road, will determine the slope at which the bank can be regraded, the number of lineal feet which can be stabilized, and the necessity of additional bioengineering techniques. UCC will explore logistics of this in detail with the school and work to develop a project with the greatest benefit possible to the creek. Cost estimates developed for this project do not include costs to alter or relocate the road in any way and assume that 75 lineal feet of streambank will be addressed.

In addition to providing stability to the regraded bank and decreasing the amount of sediment entering the channel, installed vegetation will also improve habitat by providing channel cover. Due to the acidity of the Eucalyptus stand, there are no plants immediately adjacent to the channel and existing ground cover is limited throughout the area. Installation of willows at the toe will provide cover for fish and will in time add woody debris to the system and create complexity of habitat for aquatic life.

All proposed work will be done with the collaboration and approval of St. Mary's College High School and revegetation efforts are to be supplemented by students in an outdoor classroom setting.

## 4.3 Preliminary Design for Fish Barrier Modifications

This section presents the preliminary designs and hydraulic evaluations for the mitigation of the identified fish passage barriers within Codornices Creek. Proposed barrier modifications were modeled using HEC-RAS under steady-state conditions to evaluate the resultant rise in water level under 100-year flood conditions. Appendix B contains a technical memorandum describing the flood modeling methods and results.

The proposed barrier modifications have not been reviewed or approved by the Cities of Berkeley or Albany, nor have they been reviewed by the regulatory agencies. Permitting of the barrier modifications is to be accomplished under the third Codornices grant following final design.

### 4.3.1 Culvert Modifications

Seven culverts along Codornices Creek within the project reach were previously identified as partial barriers to fish passage due to low depth and/or high velocity. Previous design solutions to the high velocity and low flow depth barriers in culverts involved installation of baffles and construction of outlet weirs. Both of these solutions have impacts to flood conveyance that were evaluated under this phase of work.

Field assessments have shown that localized flooding currently occurs regularly at several culverts within the creek, especially upstream of the Kains, Stannage, and Cornell Avenue culverts. Codornices Creek throughout the project reach is a highly urbanized environment with homes built right up to the edge of the creek channel.

#### 4.3.1.1 Evaluation of Culvert Barrier Modifications under Flood Flow Conditions

As previously noted, several culverts already cause flooding of adjacent properties at locations along Codornices Creek. Fish passage baffles add hydraulic roughness (i.e. increase Manning's n) to culverts which reduces water velocities and increases flow depths. To assess the hydraulic impacts to water level from installation of 6-inch and 12-inch fish baffles or an outlet weir system, the selected culverts were modified and evaluated using the culvert routine in HEC-RAS.

The culverts evaluated under this scope of work include those identified in the previous fish passage work as either total or partial barriers to fish passage in Codornices Creek. The culverts evaluated for water elevation changes due to baffle installation during this phase of the project included the following:

- San Pablo Avenue
- Kains Avenue
- Stannage Avenue
- Evelyn Avenue
- Masonic Avenue
- Neilson Street
- Peralta Avenue

Table 2 displays culvert details, including slope, length, and dimension, as recorded in the fall 2004 surveys.

There are no standard analysis methods to evaluate increases in culvert friction and corresponding flooding impacts due to fish baffle installation. To account for the loss of hydraulic conveyance due to the use of corner baffles, culvert friction changes were analyzed using two different approaches; 1.) assume that the culvert was embedded six inches or one foot and reduce the hydraulic capacity of the culvert by this amount and increase the Manning's n value to 0.04 (natural channel bottom); and 2.) increase the Manning's n friction values to 0.07 to account for the baffle roughness. The value of 0.07 is based upon unpublished data provided by State of Washington Department of Fish and Wildlife (Powers, 2004). Note that the Manning's n friction value used for the culverts as they currently exist was 0.015, typical for worn concrete surfaces.

For this analysis, the rise in water level was analyzed under the 10 and 100-year flow estimates previously developed by Philip Williams and Associates, Ltd. (PWA) in 1997. These estimates were developed for the lower Codornices Creek reach below San Pablo Avenue. PWA estimated the 10-year flow at approximately 690 cfs and the 100-year flow at approximately 1,020 cfs. The City of Albany used other methods to estimate flood flows for Codornices Creek which produced estimates that differ from PWA's (City of Albany, 1998). As PWA's estimates are felt to be the most accurate, they were used in this agreement to evaluate baffles under flood conditions.

The hydraulic analysis for smaller baffles, 6 inches in height, was conducted to evaluate impacts of lower baffles on flood conveyance. These smaller baffles would provide increased culvert roughness and a corresponding rise in water level; however, they would not provide the depth nor decrease the velocity to levels satisfactory to DFG requirements.

#### 4.3.1.2 Previous Hydraulic Analysis of Culverts

The City of Albany evaluated the hydraulic capacity of its Codornices Creek culverts as part of their watershed management plan (City of Albany, 1998). The results of the analyses concluded that the hydraulic capacity of the culverts as they exist was approximately 450 cfs; less than the 10-year flow of 685 cfs, as estimated by PWA. Therefore, previous studies have shown that the flood capacity of the existing culverts is exceeded by 10-year storm events. Note that the City of Albany estimated the 10-year flow at 480 cfs using a method different than that used by PWA. However, to be consistent with previous flooding analysis, PWA flow numbers were used for this project.

#### 4.3.1.3 Results of the Hydraulic Modeling of Baffled Culverts

Table 3 displays the results of the hydraulic analysis assuming both 6-inch and 12-inch cross-baffles using both methods of analysis for the 10-year and 100-year flood events. As previously described the first method of analysis assumed a culvert friction to 0.07 and the second assumed a culvert embed depth of 6 and 12 inches.

The results indicate a potential increase in water levels from 5 to 18 inches due to barrier modification implementation depending on the assumption method. Note that the flood model does not account for the effects of debris collection on the baffles. Debris blockage is a primary cause of backwater flooding of culverts and would be worsened by the installation of baffles within the culvert.

The results of the modeling show overtopping of culverts under existing conditions for both the 10-yr and 100-yr flood flows. Therefore, there is no excess capacity within the culverts. Given the calculated impacts to flood conveyance due to baffle installation, it is not recommended to install fish baffles or other barrier modification systems that raise water levels within the culverts at this time. The modeling shows existing creek flooding with less than 10-year flood flow conditions. As homes are built along the edge of the creek banks, liability for real or even a perceived rise in water level by adjacent property owners is too great to justify for fish passage concerns. In addition, it is doubtful that the Cities of Berkeley or Albany would permit any culvert modification that results in a significant rise in water level for this project.

The long-term goal of the Cities of Berkeley and Albany should be the replacement of these culvert barriers with natural bottom bridges. Such structures would increase channel capacity thus decreasing flooding impacts, and would not impede fish passage.

### 4.3.2 Albina Street Bridge

The Albina Street crossing is a concrete bottom bridge that essentially acts as a box culvert across the creek. At the downstream end of the concrete bridge crossing, there is an approximate 3 foot vertical barrier due to the formation of a scour pool from the bridge outlet (Figure 19). This forms an almost total barrier to fish passage at this location. Currently this jump acts as the limiting barrier for upstream migration (Kier, 2004).

The structural supports for the bridge are not known at this time. As it is unclear if the concrete bottom in the channel acts as a structural support to the bridge, no plans were developed to remove the concrete section. The potential opportunity to remove the concrete bottom will be investigated further during final design. If it is determined that the concrete can be removed without sacrificing the integrity of immediate structures, designs will be developed to capitalize on the opportunity.

#### 4.3.2.1 Proposed Barrier Modification

The proposed barrier modification to the Albina Street Bridge crossing involves the installation of a downstream step-pool system to allow fish to pass through a series of cross-vein rock weirs and into the bridge crossing. Two alternatives were developed under this agreement. Alternative A requires eight step-pools and results in a slight backwater effect at the outlet end of the bridge. Alternative B does not provide for backwatering of the bridge bottom and involves less fill within the creek than Alternative A. For fish passage, Alternative A is preferred as it provides better conditions for migration due to its backwatering effect. However, as discussed below, this results in a higher impact on hydraulic conveyance through the bridge.

Figures 20 and 21 show profiles of the proposed step-pool system for Alternatives A and B. The maximum height of the steps will be approximately 8 inches to allow for adult and some juvenile fish passage. Pool lengths are on the order of 10 feet. The steps will be constructed of a combination of half and one ton boulders placed across the channel in a curved V formation to direct flows towards the center of the creek channel. All weirs will be properly keyed into the channel bed and bank to ensure stability.

#### 4.3.2.2 Results of Flood Modeling

The proposed barrier modification, Alternative A, was modeled using HEC-RAS to evaluate the rise in water level under 100-year flood conditions. The results of the model study for Alternative A are shown in Table 4 and indicate a significant rise in water level, approximately 3 feet, just downstream of the bridge. The modeling does indicate that there is sufficient capacity to contain the 100-year flow in this area without overtopping of the bridge. However, it is unclear if the Cities of Berkeley or Albany will allow such a rise in water level solely to improve fish passage. The results of this analysis are contained in a technical memorandum attached as Appendix B that describes the flood modeling methods and results. Note that Alternative B will have a lower flooding impact and may be developed further during the final design phase of the project if necessary.

### 4.3.3 Concrete Channel Section Upstream from Albina Street Bridge

There is an approximate 230 foot section of straightened, concrete-lined channel 224 feet upstream of the Albina Street Bridge. At the downstream terminal of this concrete section there is a vertical step, approximately 1.6 feet in height (Figure 22). Together, the height of the step and the concrete channel section prone to high velocities and low flows, form either a partial or total barrier to fish passage.

The concrete section is approximately 8 feet wide and extends from edge to edge in the creek channel and likely acts as a structural support to the adjacent creek channel walls. The existing retaining walls forming the sides of the straightened channel are a mixture of concrete and rock rubble walls, some of which look to be very old and in mixed condition.

The thickness of the base concrete is unknown but there has been some breakage of the concrete bottom in a few locations. More detailed coring and structural analysis of the condition of the concrete bottom will be required before proceeding through final design into construction.

#### 4.3.3.1 Proposed Barrier Modification

The proposed barrier modification to this section includes the construction of low 6-inch cross-baffles along the left bank wall of the concrete channel. In addition, an engineered log structure, or equivalent stepped sections, will be required below the concrete section to bridge the step barrier. Figure 23 shows a plan view of the proposed barrier modification and Figure 24 a cross-sectional view of the engineered log structure.

As part of this work, a structural engineer (Ken Hughes) visited the site on April 7, 2005 to evaluate the option of notching the concrete channel bottom to install a low flow fishway down the middle of the channel. As explained in the attached letter (Appendix C), the costs for constructing such a low flow channel would likely be substantial due to the need to provide structural support for the adjacent retaining walls along the length of the channel.

Note that the thickness of the concrete bottom in this section needs to be at least 4 inches thick to support the proposed baffles. A thinner concrete bottom would not support the baffles under flood conditions and would result in undermining the concrete bottom and retaining wall supports.

### 4.3.3.2 Results of Hydraulic Modeling

Flood Modeling

The flooding impacts of the proposed steps-pools and cross-baffles were analyzed by FRE as part of the HEC-RAS flood model for the Albina Street Bridge. The results indicate a rise in water level of approximately 8 to 12 inches above existing conditions. However, the results indicate that the concrete channel section currently floods under 10- and 100-year flood conditions. Therefore, there is no unused flood storage capacity within the channel and installation of the engineered log structure and baffles would result in an increase in flooding within an area that already floods.

UCC will investigate the possibility of installing some of these improvements with the Cities of Berkeley and Albany and adjacent property owners during the next phase of the project. It is unknown whether the Cities of Berkeley and Albany would allow a project in this area that increases water surface elevations in order to facilitate fish passage. Although we have prepared a preliminary cost for this item, the flooding issue may prohibit implementation. Pending the approval of the cities, permitting would be conducted under the next phase of the work.

Fish Passage Modeling

Table 4 shows the results of the HEC-RAS modeling for the modified concrete channel for fish passage flows previously developed under the first phase of the project. For the upper value of fish passage flows, 18 cfs, the velocity results are within DFG guidelines for acceptable velocities. At the lower passage flow, 3 cfs (minimum flow), the depths within the concrete lined channel do not meet the DFG criteria of one foot depth. Therefore, the concrete channel with proposed modifications may not be passable due to depth constraints.

The results of the fish passage analysis should note the following.

- Codornices Creek is an extremely flashy system (typical of urban streams). Since the hydrograph changes so rapidly, using a single value for fish passage analysis is problematic.
- In our experience, a depth limitation for fish passage is less of a barrier than other types of barriers. Steelhead have been known to swim through depths of flow much less than the one foot DFG minimum. However, low depth does result in additional stress on the organism. Due to the length of the concrete channel section, such a low depth would likely retain this section as a partial or total barrier.

The proposed baffles would provide some resting areas for fish, but it is unknown if sufficient resting areas could be provided without a significant increase in flooding levels. The proposed 6-inch baffles were selected to provide some resting areas and result in water level rise of no more than a one foot. Additional analysis of fish passage should be conducted in the next phase if the potential flooding impacts are acceptable.

# 5.0 PRELIMINARY COST ESTIMATES

Preliminary cost estimates for the habitat improvement and barrier modifications designs as reported within this document are itemized in Table 5. These estimates are based on UCC's and FRE's experience with restoration projects of this type. However, actual construction costs may vary significantly due to numerous reasons.

The cost estimate reflects the following assumptions:

- No hazardous waste or environmental issues are involved in the project.
- Any excess fill will be stockpiled on-site. No costs for removal of excess soils have been included.
- Minimal permitting costs have been assumed. No CEQA permitting costs have been included (i.e. no EIR required).
- No costs have been included for acquisition of additional right-of-way or preparation of additional studies.

Note that construction costs may increase significantly following recommendations by the project structural engineer as part of final design activities.

# 6.0 COMMUNITY OUTREACH

## 6.1 CCWRAP WORKING GROUP

In an attempt to work collaboratively with all watershed stakeholders, UCC organized a "Working Group" in October 2004. This group held its inaugural meeting that November and has continued to meet every other month. The group is open to anyone that is interested, although meetings are not publicly advertised other than on the UCC's website. Representatives from the City of Berkeley, City of Albany, State Water Resources Control Board, CALTRANS, U.S. Environmental Protection Agency, Friends of Five Creeks, Live Oaks Codornices Creek Neighborhood Association, St. Mary's College High School, Balance Hydrologics, other local creek organizations (Friends of Strawberry Creek, Friends of Baxter Creek), Waterways Restoration Institute, FarWest Restoration Engineering, Kier Associates, and homeowners within the project area have participated in these meetings. During the first meeting the group defined themselves and their role. They are to act as a feedback loop on proposals and ideas, offer suggestions, and voice opinions based upon their concerns.

In addition to contributing valuable feedback and input regarding this agreement and the larger project, the Working Group realized the many proceedings along Codornices Creek and recognized the need for a comprehensive Codornices Creek Watershed Council. Building upon the group's discussion, members attended lectures regarding watershed councils and circulated literature on how to create and sustain an effective council. In response to this need UCC applied for and obtained funds to hire a Watershed Coordinator to develop the Codornices Creek Watershed Council. Hiring for this position is expected to occur by fall 2005 pending funding logistics.

## 6.2 COMMUNITY MEETINGS

UCC obtained address databases from the City of Berkeley and the City of Albany for all residents within 25 meters of Codornices Creek, all residents adjacent to the projected project area between San Pablo Avenue and Albina Avenue, and all residents within the watershed. These compiled lists were used to generate mailings regarding the activities of this project.

Two community meetings were held regarding this project's proceedings, the first in January 2003 and the second in April 2005. The December 2003 meeting was held at St. Mary's College High School with an agenda to inform creek-side landowners of the project, upcoming habitat and fish surveys, and to encourage active involvement by the community. Three-hundred landowners were directly invited via mail to this evening meeting which had an attendance of approximately two dozen.

A second meeting was held on April 27, 2005 at the same location to inform the larger community of the preliminary designs developed and modeled under this agreement. Notification of the meeting was sent by mail to a total of 3,316 residents throughout the watershed (Appendix D). Flyers were posted in the shopping areas in the Westbrae and Northbrae neighborhoods and at the Berkeley Earth Day Celebration on April 22 (Appendix E), and an announcement was printed in the local newspaper, The Berkeley Daily Planet. A total of 47 citizens attended the 7:00 PM meeting. Attendees not only learned about the project but interacted through discussions, surveys (Appendix A), and maps (Figure 25).

Speakers during the April 2005 meeting included Friends of Five Creeks, Waterways Restoration Institute, Kier Associates, FRE, and UCC (Figure 26). Topics covered during the meeting agenda included: an overview of activities occurring throughout the watershed, introduction to the CCWRAP, CCWRAP-Phase I proceedings and results, proposed barrier modifications and hydraulic modeling, proposed bank stabilization, demonstration riparian vegetation demonstration projects to occur during CCWRAP-Phase II, and how the community can be involved.

## 6.3 Homeowner Interaction

Realizing the importance of interaction with the property owners adjacent to the project reach, UCC worked to capitalize on the potential for interaction while conducting field surveys.

Prior to surveying postcards were designed and mailed to properties adjacent to the creek between San Pablo and Albina Avenues to notify them that a field crew would be conducting channel surveys (Appendix F). These postcards also provided contacts for obtaining additional information regarding the CCWRAP and advertised free consultations to homeowners regarding creekside concerns. In response UCC received seven phone calls from homeowners between October and December 2004. Some inquired about project proceedings while others requested personalized site visits of their property by staff. UCC staff conducted requested visits to five properties located on Cornell Avenue, Curtis Street, Neilson Street, Sonoma Avenue, and Beverly Place. At each site we listened to homeowner concerns, walked along the channel with them, observed their situation, and compiled a letter stating observations and recommendations. Each letter was accompanied by reference sheets and other informational materials relevant to the situation. All visits were photo-documented and filed with a copy of all correspondence.

While conducting channel surveys, staff interacted with many homeowners throughout the project reach. Flyers were presented to everyone who was encountered (Appendix G). The majority of people were aware of restoration actions to some degree and had received CCWRAP mailings. Landowners told many stories of fish sightings and flooding. Where pertinent these stories were recorded in the field survey notes.

## 6.4 Media

Articles discussing the objectives and proceedings of this agreement were composed and published in *Creek Currents*, UCC's biannual newsletter. This newsletter is mailed to 2,000 subscribers, including residents identified by the City of Berkeley as living within 25-30 feet of Codornices Creek. March and December 2004 editions each contained project update articles and directions for obtaining additional information.

A project update also appeared in the March-April 2005 edition of the Sierra Club Yodeler.

UCC maintained a webpage regarding this project which can be accessed from their webpage, www.urbancreeks.org. This page includes a project overview, the CCWRAP, raw data from the CCWRAP, developed conceptual designs for habitat restoration and barrier remediation, and links to related resources on salmon and restoration.

## 7.0 NEXT STEPS

The next steps for the project include the following:

- Finalize fish passage modeling of the proposed barrier modifications
- Evaluate upstream culverts for fish passage into habitat areas.
- Determine the thickness of the concrete bottom of the concrete channel section upstream of Albina Avenue to determine if it is thick enough to support baffle installation.
- Work with the Cities of Berkeley and Albany and adjacent property owners for permission to implement designed modifications.
- Develop final designs.
- Obtain regulatory permits.
- Produce plans and specifications for construction.

# 8.0 References


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Powers, Pat. 2004. State of Washington Department of Fish and Wildlife. Email conveying Manning's n values for baffled culverts to Roger Leventhal.

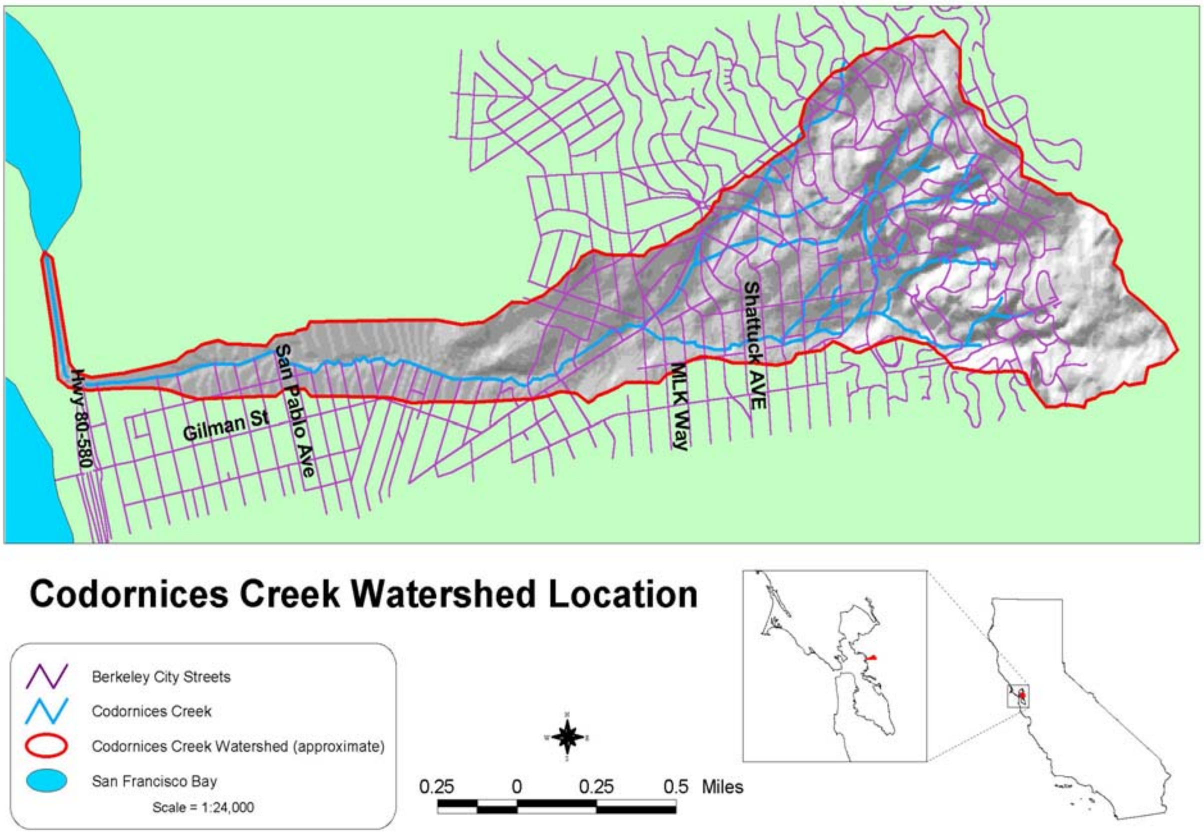


**Figure 1.** Location of the Codornices Creek Watershed.

**Figure 2.** Flooding elevation, as indicated by debris line on a resident's door, experienced upstream of the Cornell Avenue culvert in a January 2004 storm.

**Figure 3.** *O. mykiss* seen in the Cornell Avenue Culvert in Berkeley/Albany, California in November 2004.

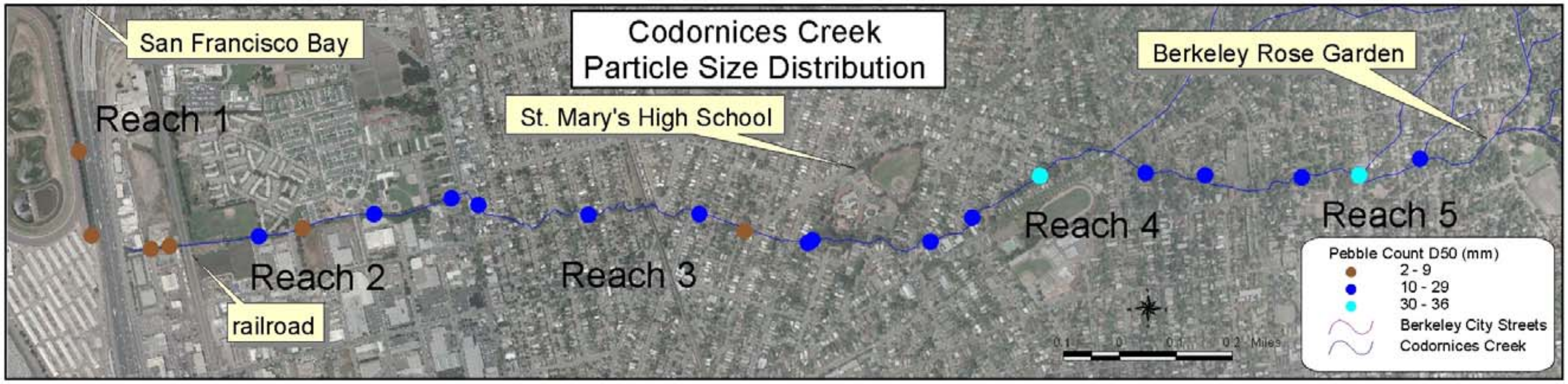


**Figure 4.** Median gravel size ($D_{50}$) for Codornices Creek as determined through Wolman pebble counts conducted in 2003. Areas of suitable (blue) and unsuitable (brown) gravels are indicated.

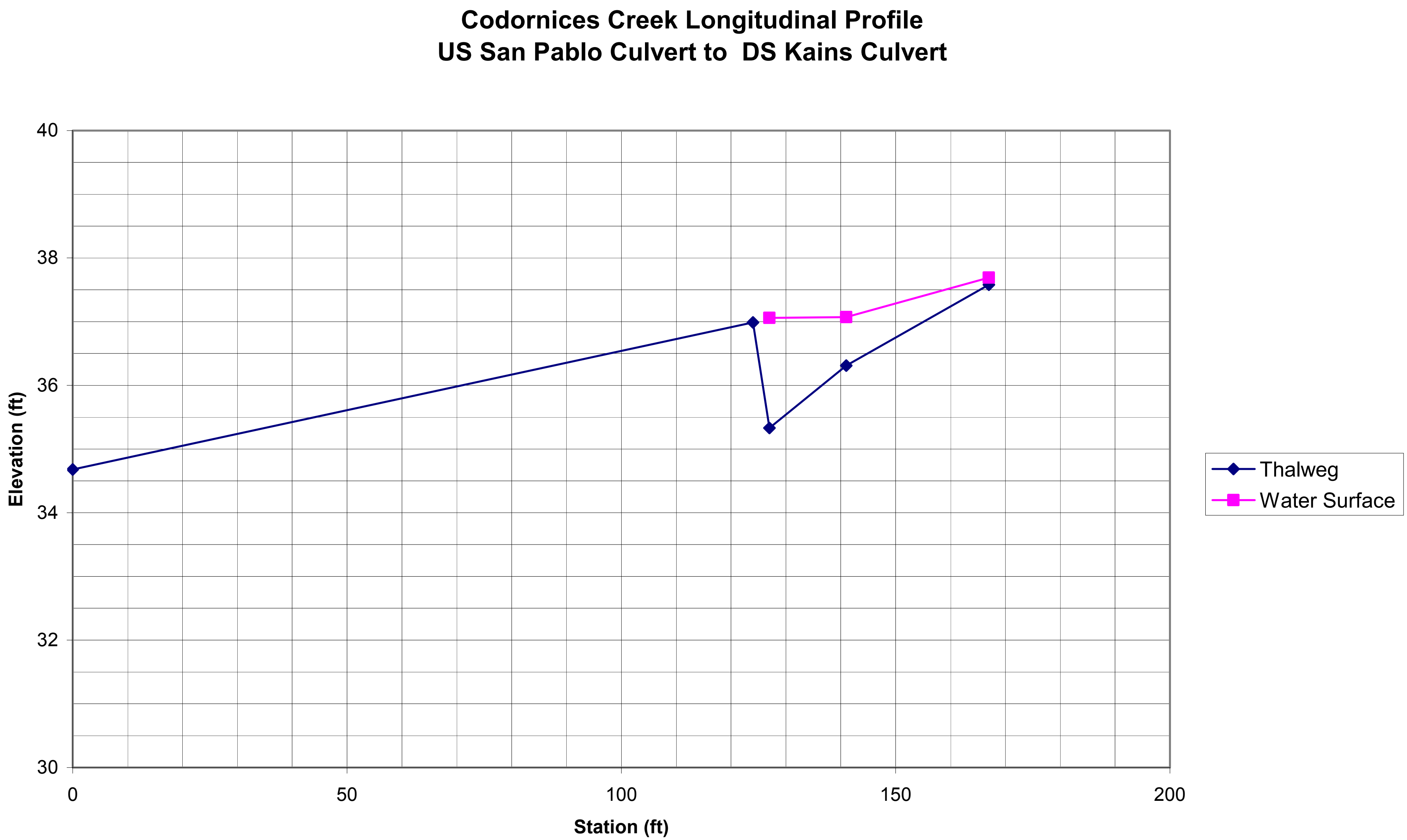


**Figure 5.** Profile of Codornices Creek in Berkeley and Albany, California from San Pablo Avenue to Kains Avenue as recorded in the winter of 2004. All elevations are recorded in the City of Berkeley Datum.

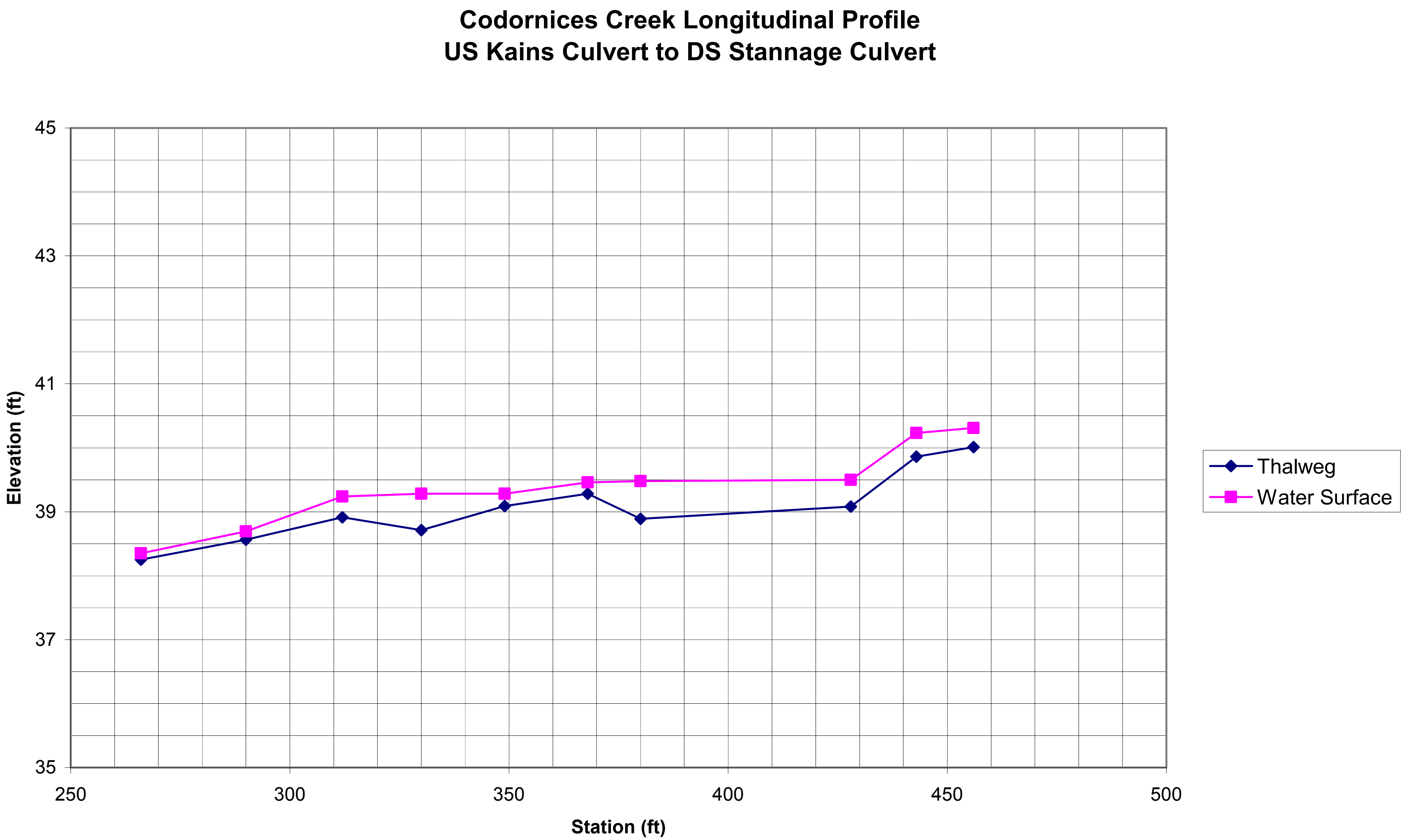


**Figure 6.** Profile of Codornices Creek in Berkeley and Albany, California from Kains Avenue to Stannage Avenue as recorded in the winter of 2004. All elevations are recorded in the City of Berkeley Datum.

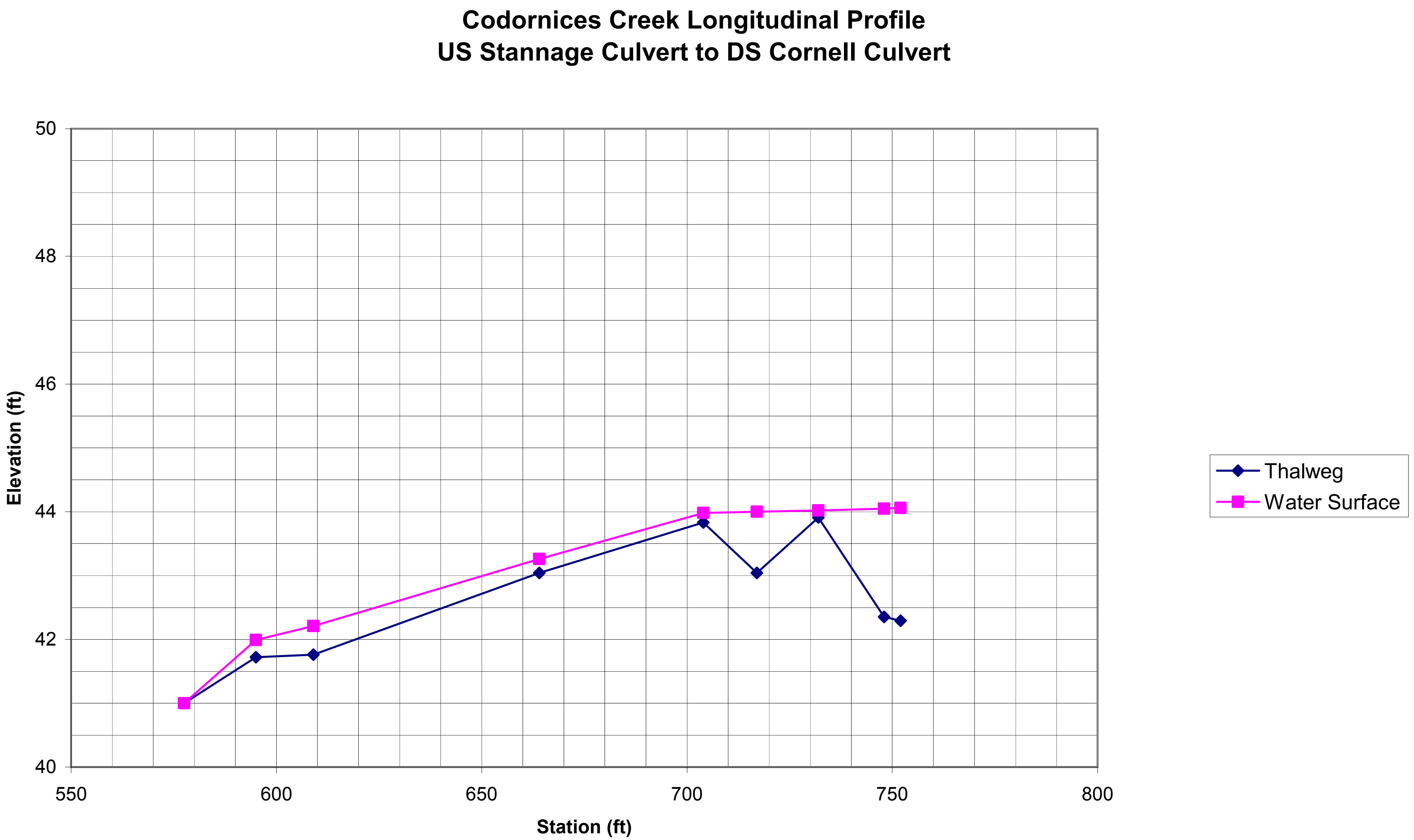


**Figure 7.** Profile of Codornices Creek in Berkeley and Albany, California from Stannage Avenue to Cornell Avenue as recorded in the winter of 2004. All elevations are recorded in the City of Berkeley Datum.

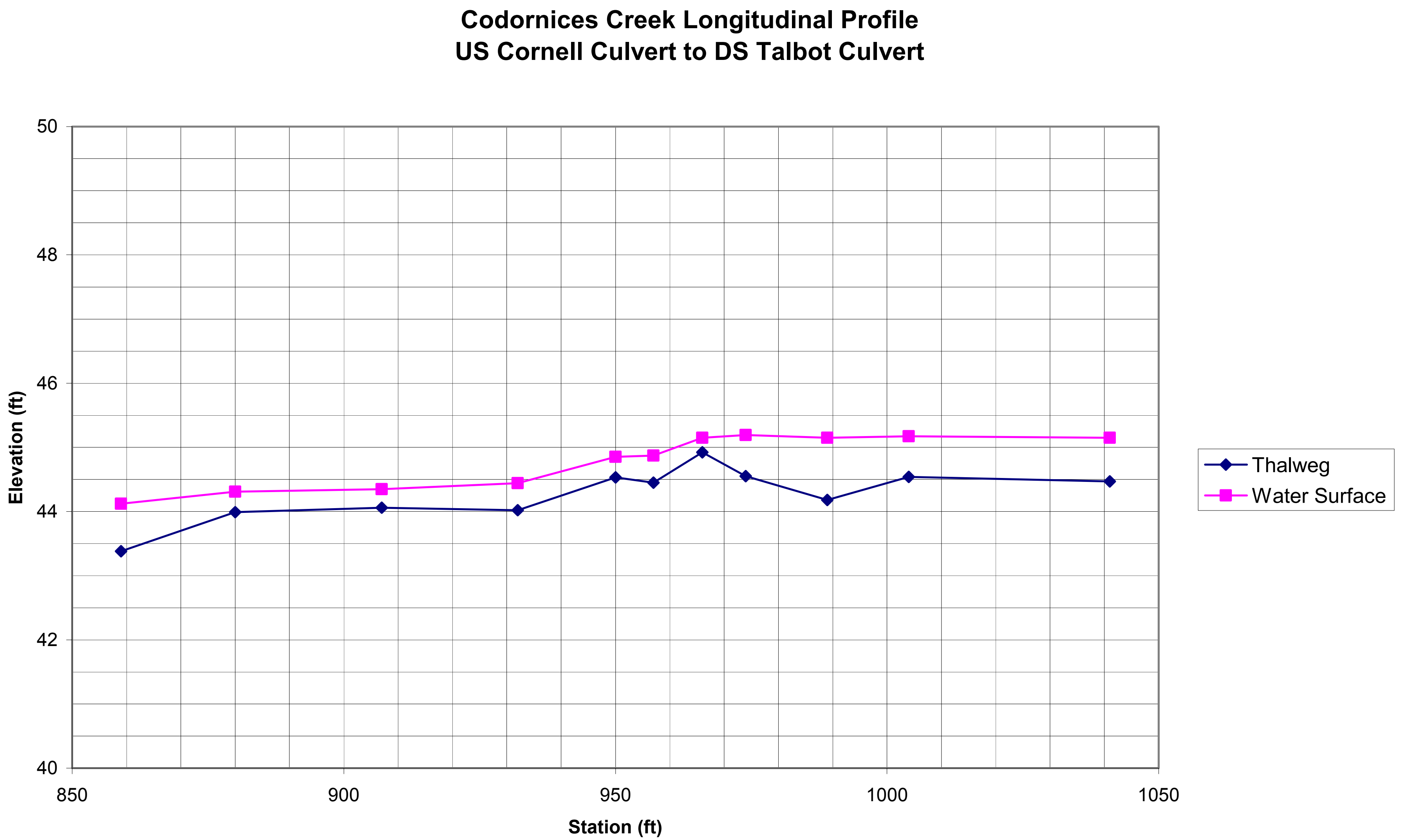


**Figure 8.** Profile of Codornices Creek in Berkeley and Albany, California from Cornell Avenue to Talbot Avenue as recorded in the winter of 2004. All elevations are recorded in the City of Berkeley Datum.

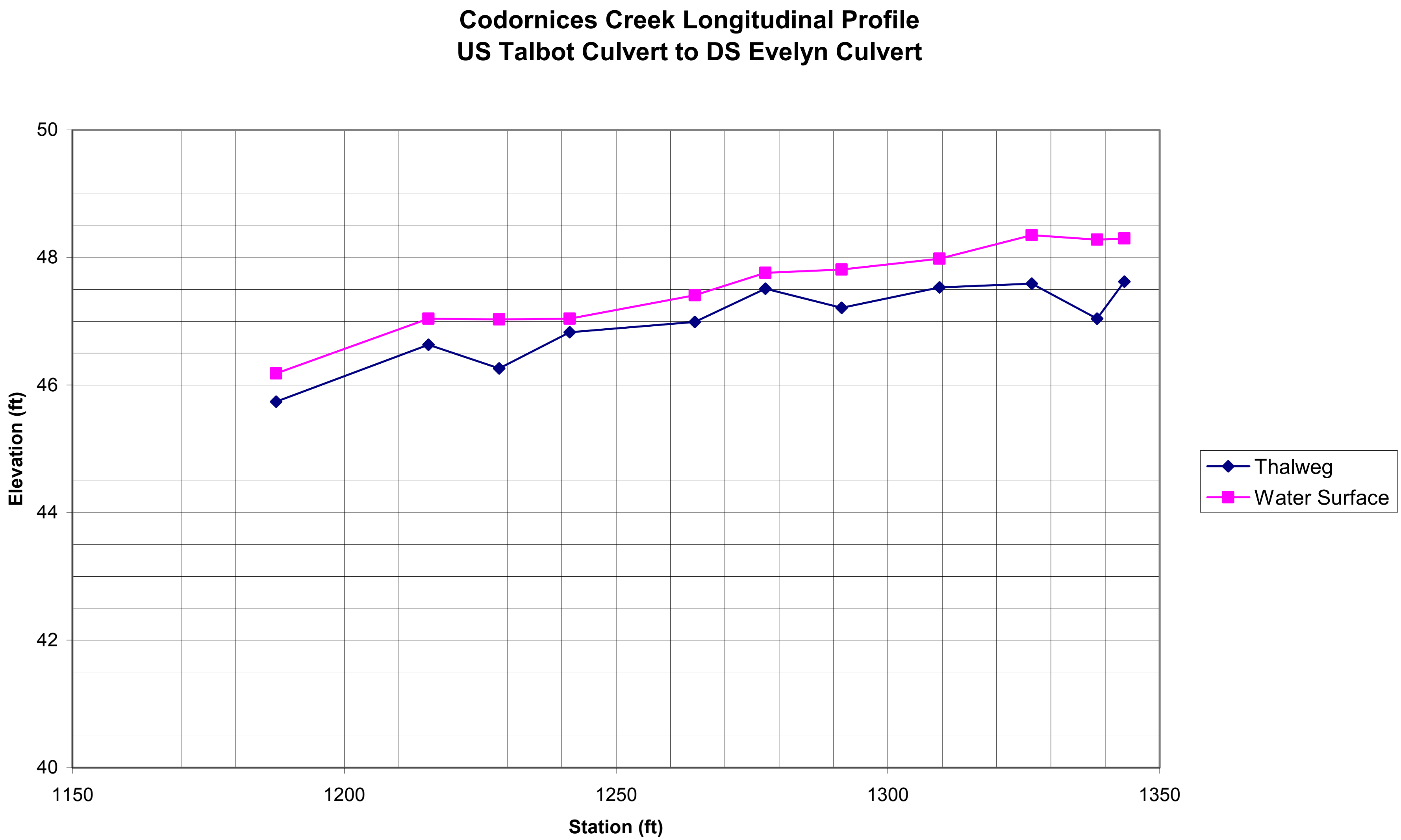


**Figure 9.** Profile of Codornices Creek in Berkeley and Albany, California from Talbot Avenue to Evelyn Avenue as recorded in the winter of 2004. All elevations are recorded in the City of Berkeley Datum.

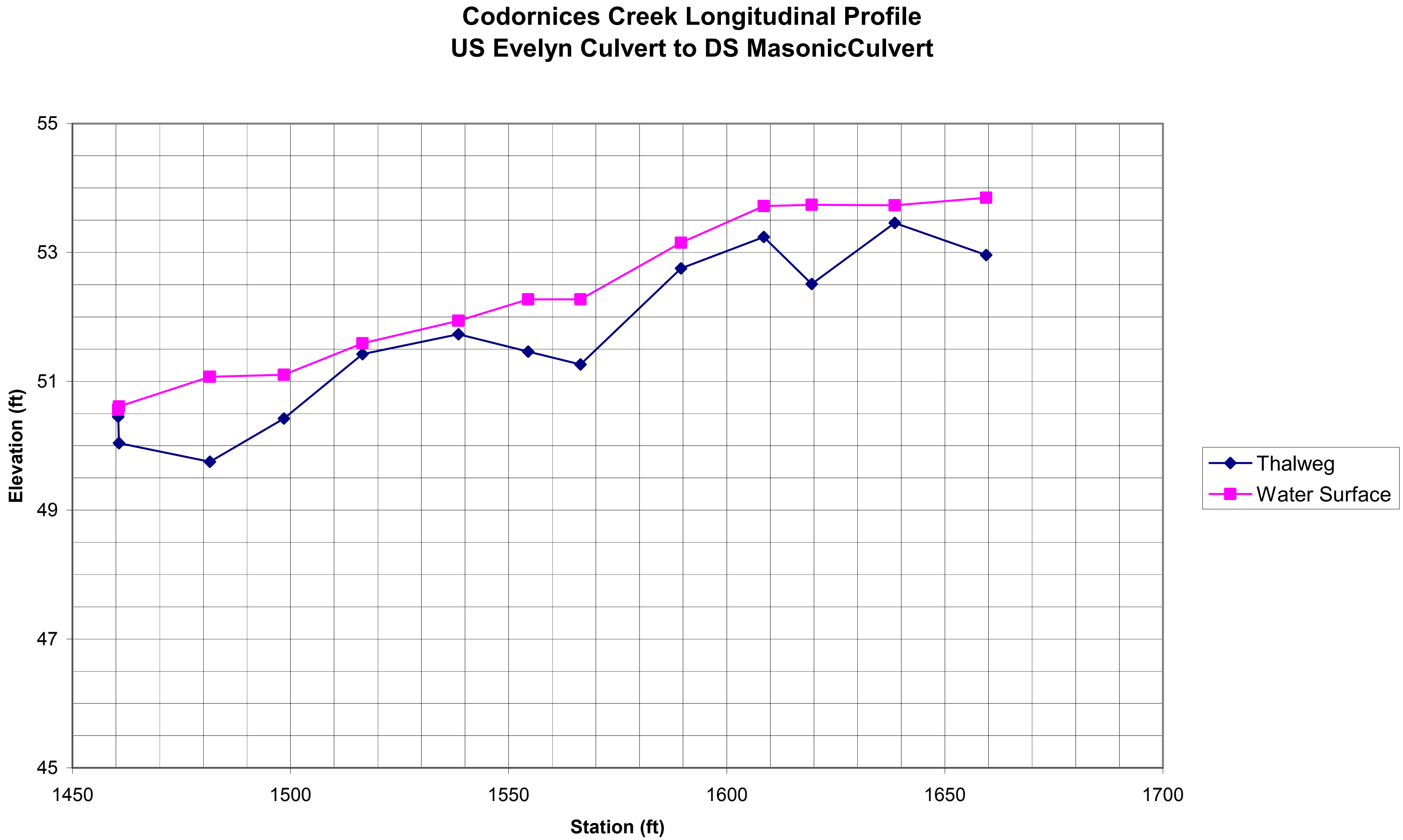


**Figure 10.** Profile of Codornices Creek in Berkeley and Albany, California from Evelyn Avenue to Masonic Avenue as recorded in the winter of 2004. All elevations are recorded in the City of Berkeley Datum.

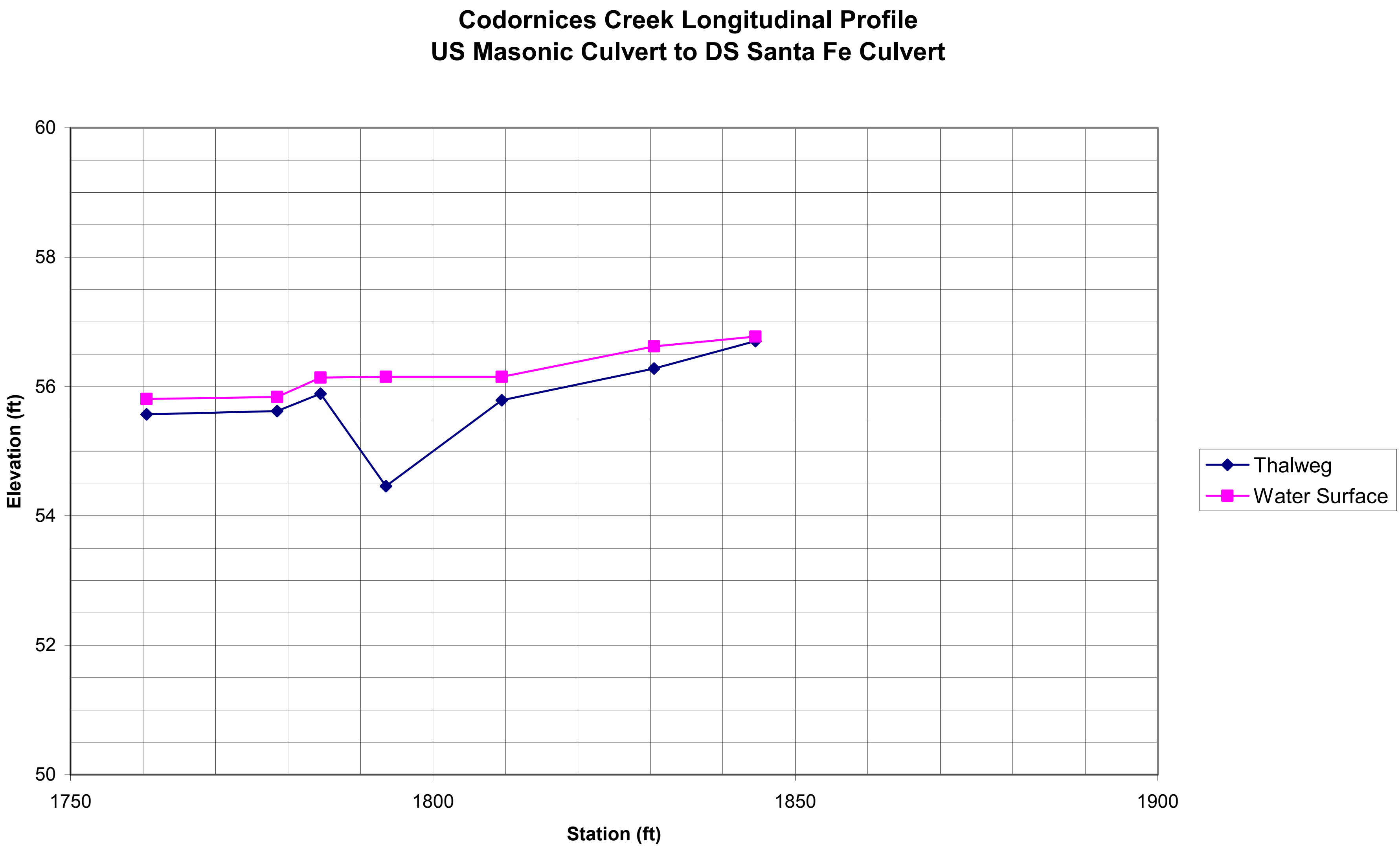


**Figure 11.** Profile of Codornices Creek in Berkeley and Albany, California from Masonic Avenue to Santa Fe Avenue as recorded in the winter of 2004. All elevations are recorded in the City of Berkeley Datum.

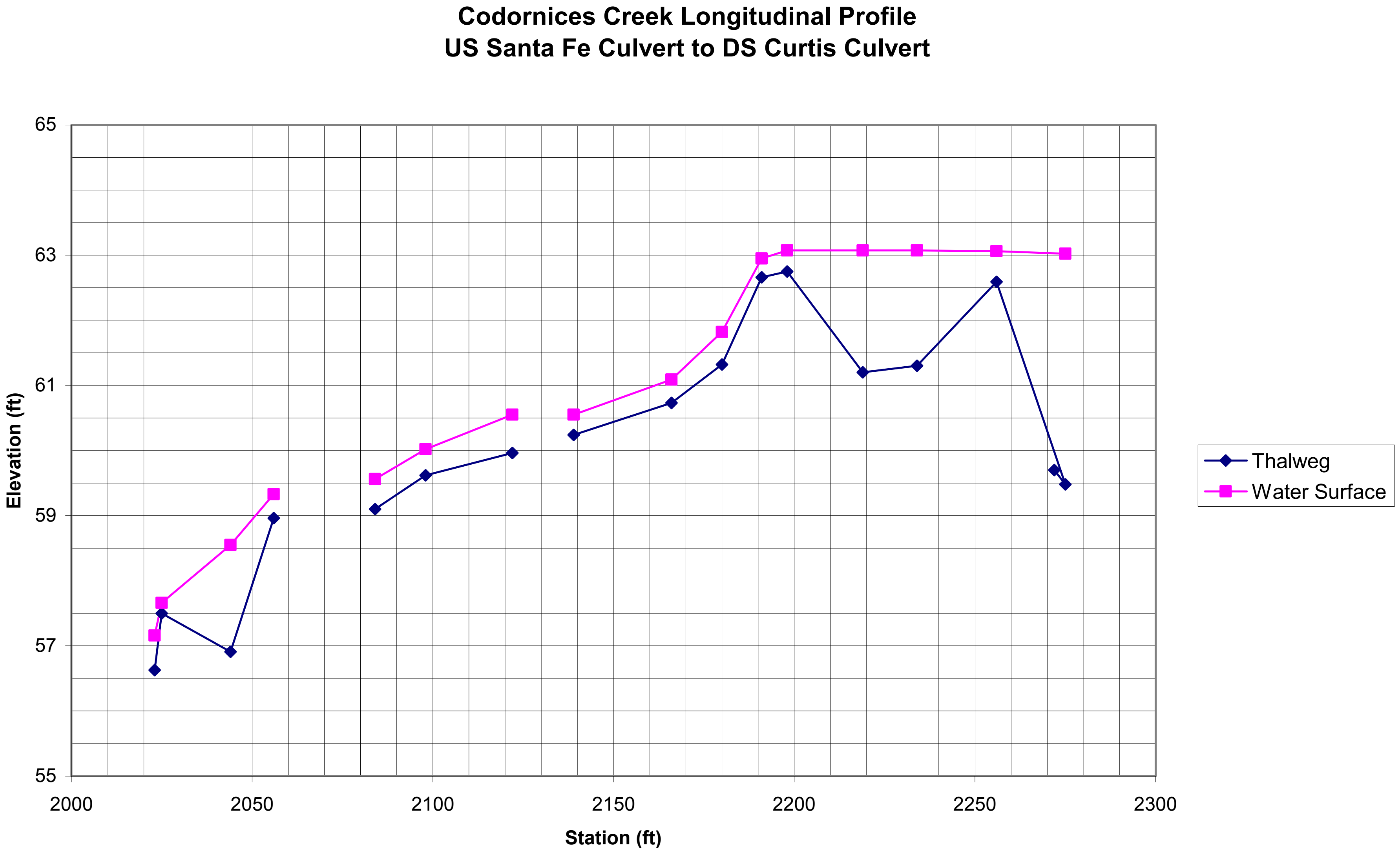


**Figure 12.** Profile of Codornices Creek in Berkeley and Albany, California from Santa Fe Avenue to Curtis Street as recorded in the winter of 2004. All elevations are recorded in the City of Berkeley Datum.

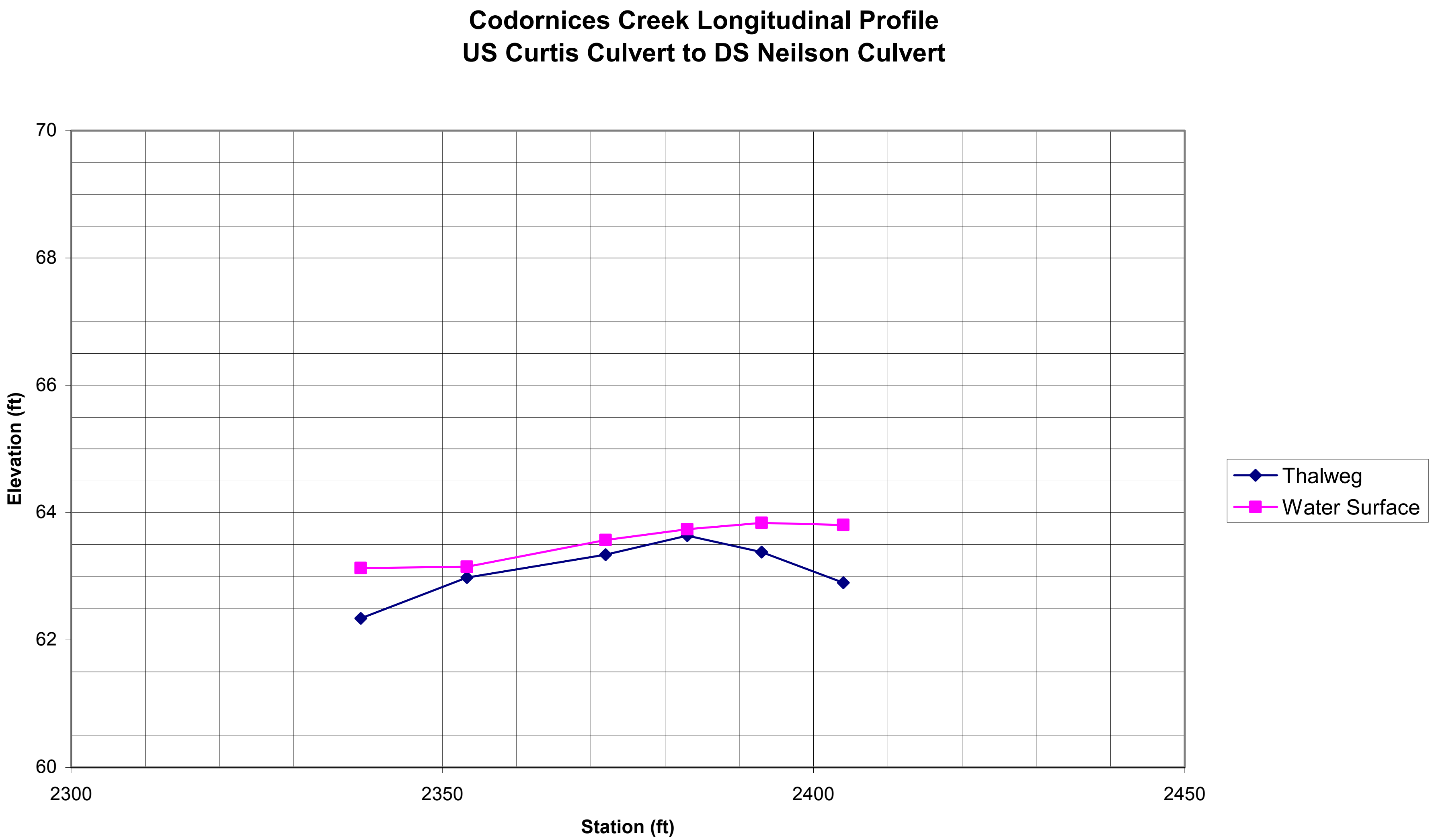


**Figure 13.** Profile of Codornices Creek in Berkeley and Albany, California from Curtis Street to Neilson Street as recorded in the winter of 2004. All elevations are recorded in the City of Berkeley Datum.

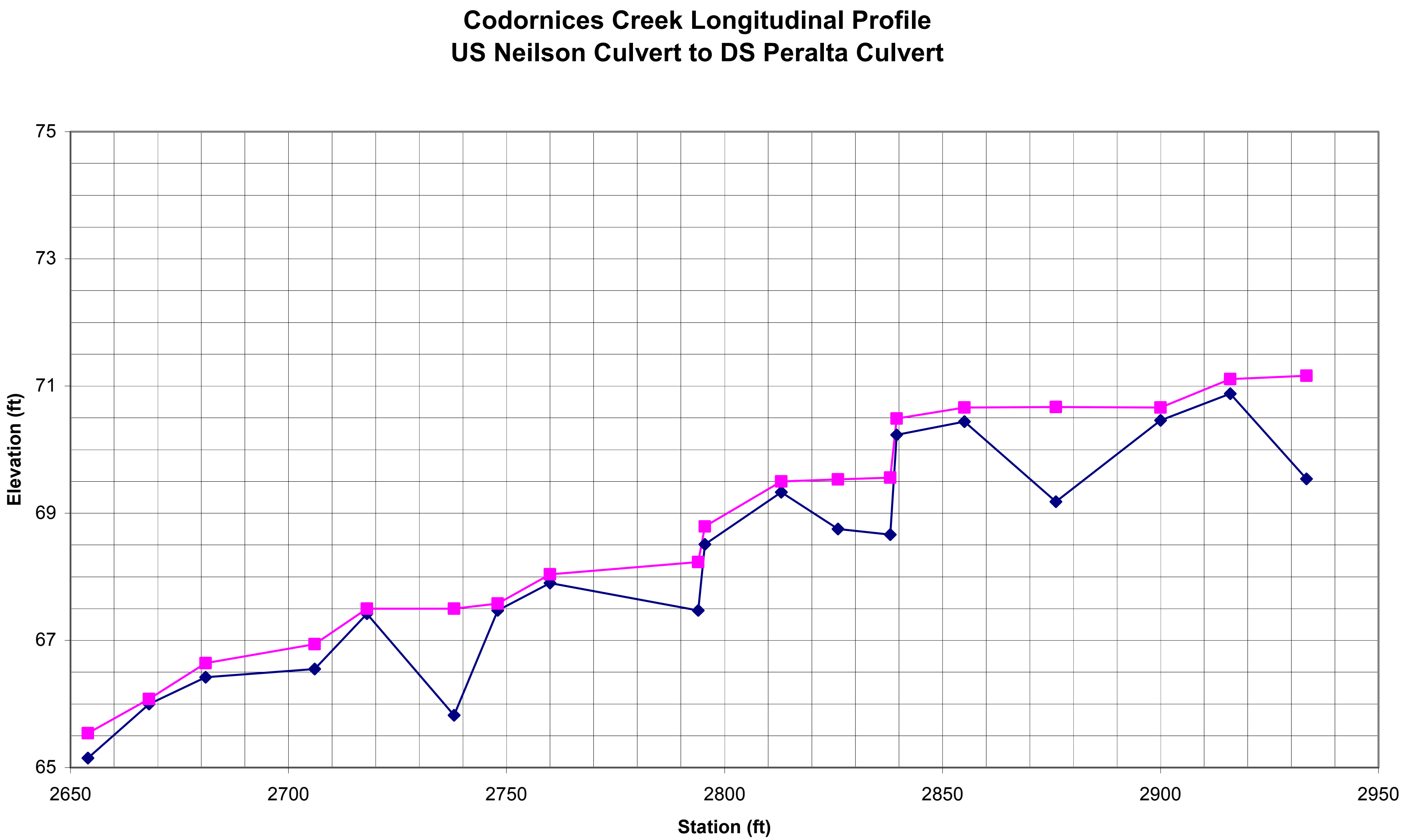


**Figure 14.** Profile of Codornices Creek in Berkeley and Albany, California from Neilson Street to Peralta Avenue as recorded in the winter of 2004. All elevations are recorded in the City of Berkeley Datum.

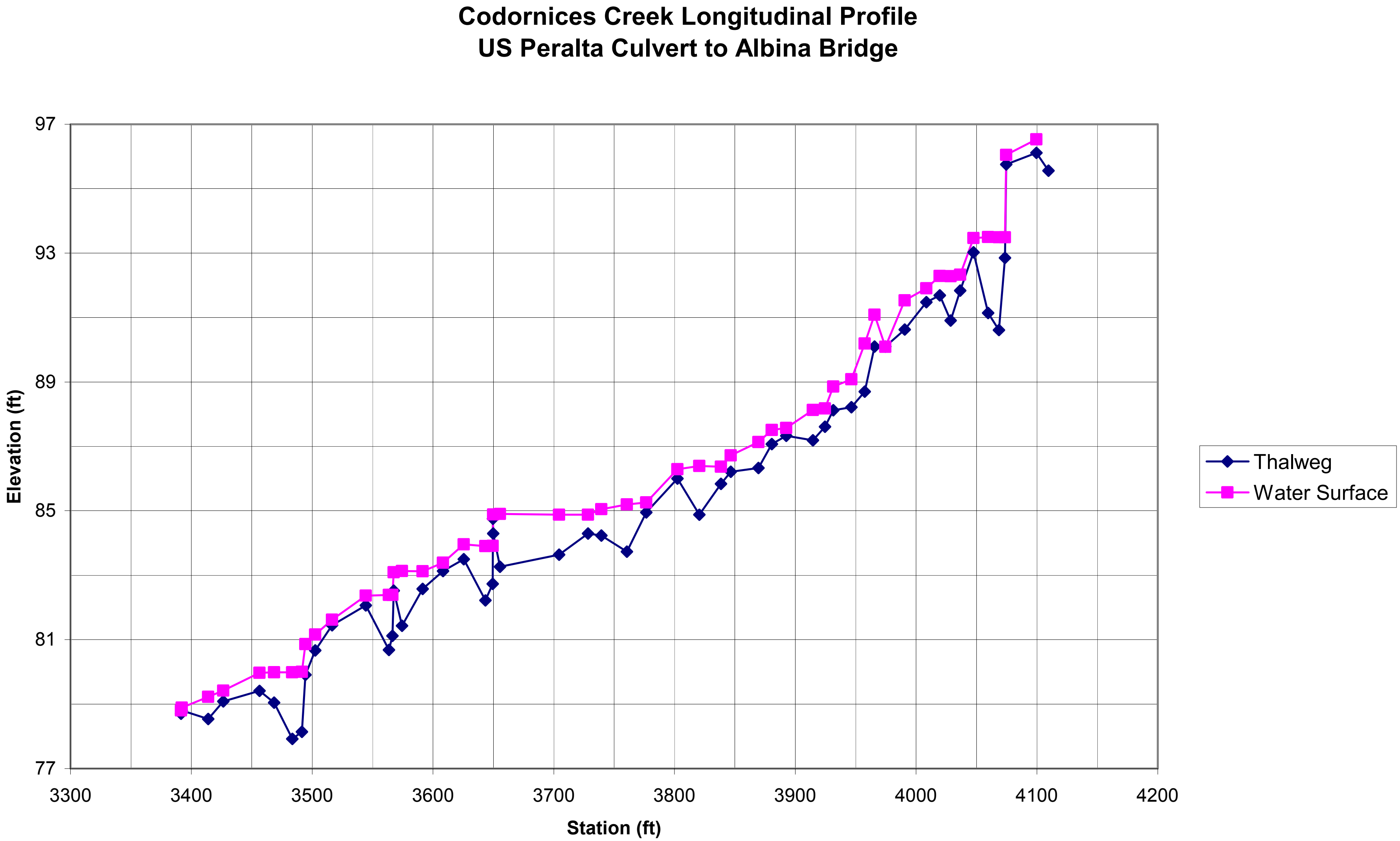


**Figure 15.** Profile of Codornices Creek in Berkeley and Albany, California from Peralta Avenue to Albina Avenue as recorded in the winter of 2004. All elevations are recorded in the City of Berkeley Datum.

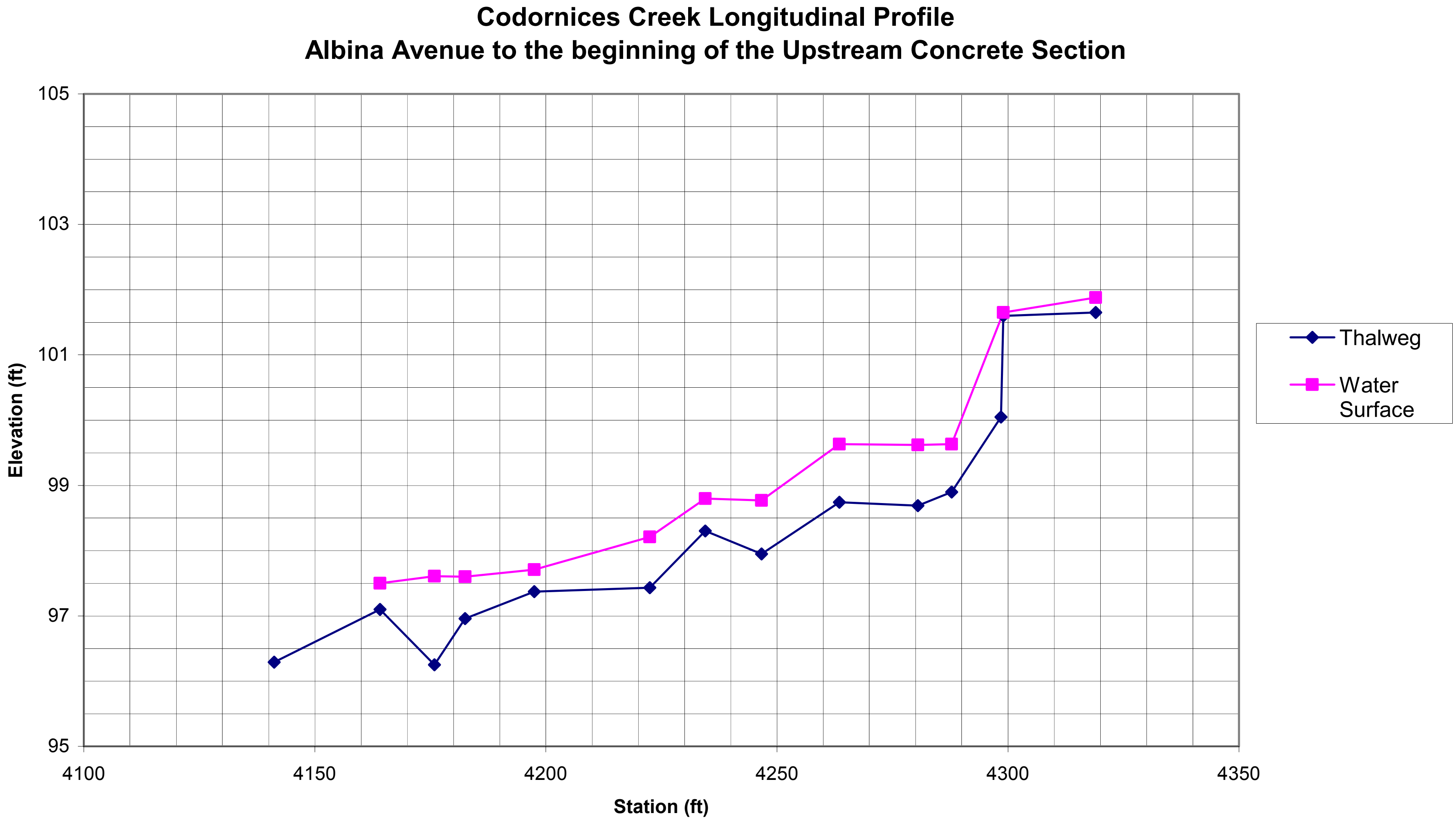


**Figure 16.** Profile of Codornices Creek in Berkeley and Albany, California from Albina Avenue to the beginning of the concrete section upstream of Albina Avenue as recorded in the winter of 2004. All elevations are recorded in the City of Berkeley Datum.

**Figure 17.** Undercut Eucalyptus trees along the top of right bank at St. Mary's College High School.

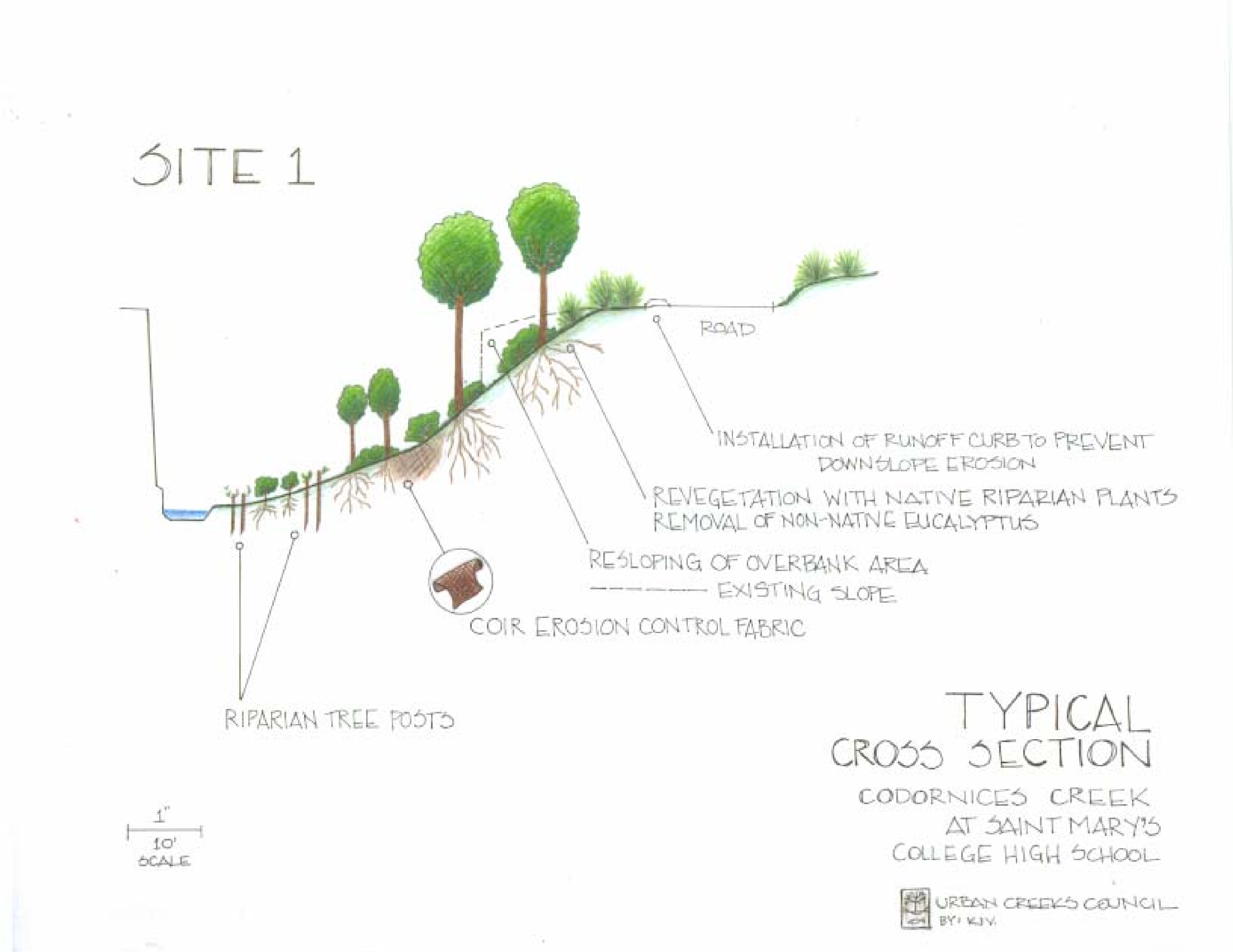


**Figure 18.** Typical section view of bank stabilization proposed for St. Mary's College High School to reduce erosion and sedimentation of Codornices Creek. The existing eucalyptus trees are to be removed, the bank resloped, a curb installed adjacent to the driveway, and native vegetation species planted throughout.


**Figure 19.** Albina Avenue Bridge crossing and the 4’ plunge pool at the outfall.

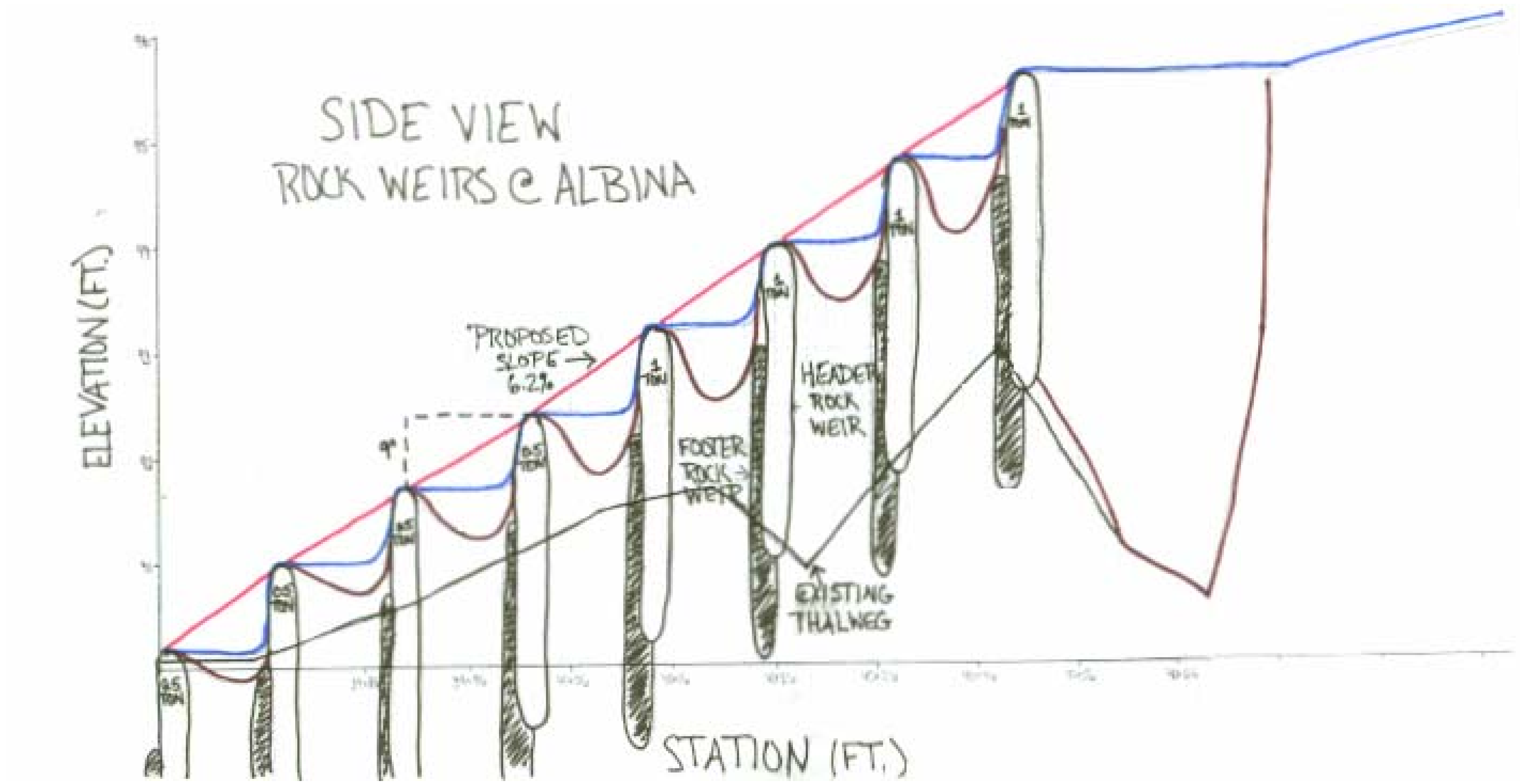


**Figure 20.** Profile of Alternative A step-pool system proposed to modify the existing fish passage barrier at the Albina Avenue Bridge in Berkeley, California. This design involves the placement of eight rock cross-vein weirs which create a series of steps and slightly backflood the bridge crossing.

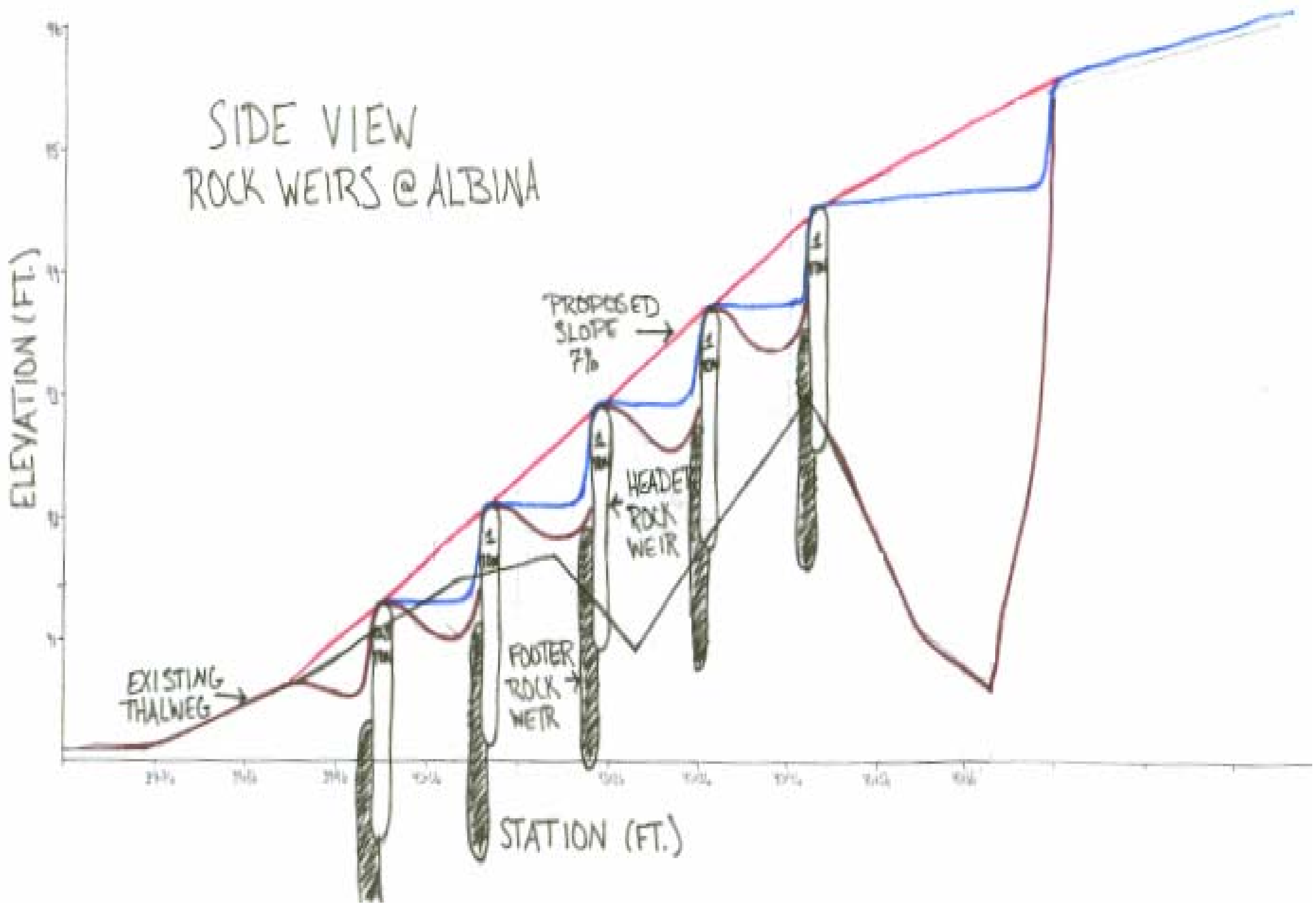


**Figure 21.** Profile of Alternative B of step-pools proposed to modify the fish passage barrier downstream of the Albina Avenue Bridge in Berkeley, CA. This design involves the placement of five weirs to create a series of six jumps into the concrete section underneath the bridge crossing.

**Figure 22.** Concrete step, 1.6' in height, at the downstream edge a straightened concrete lined channel. The concrete channel begins at the outfall of the Monterey Avenue culvert and extends downstream for 232'.

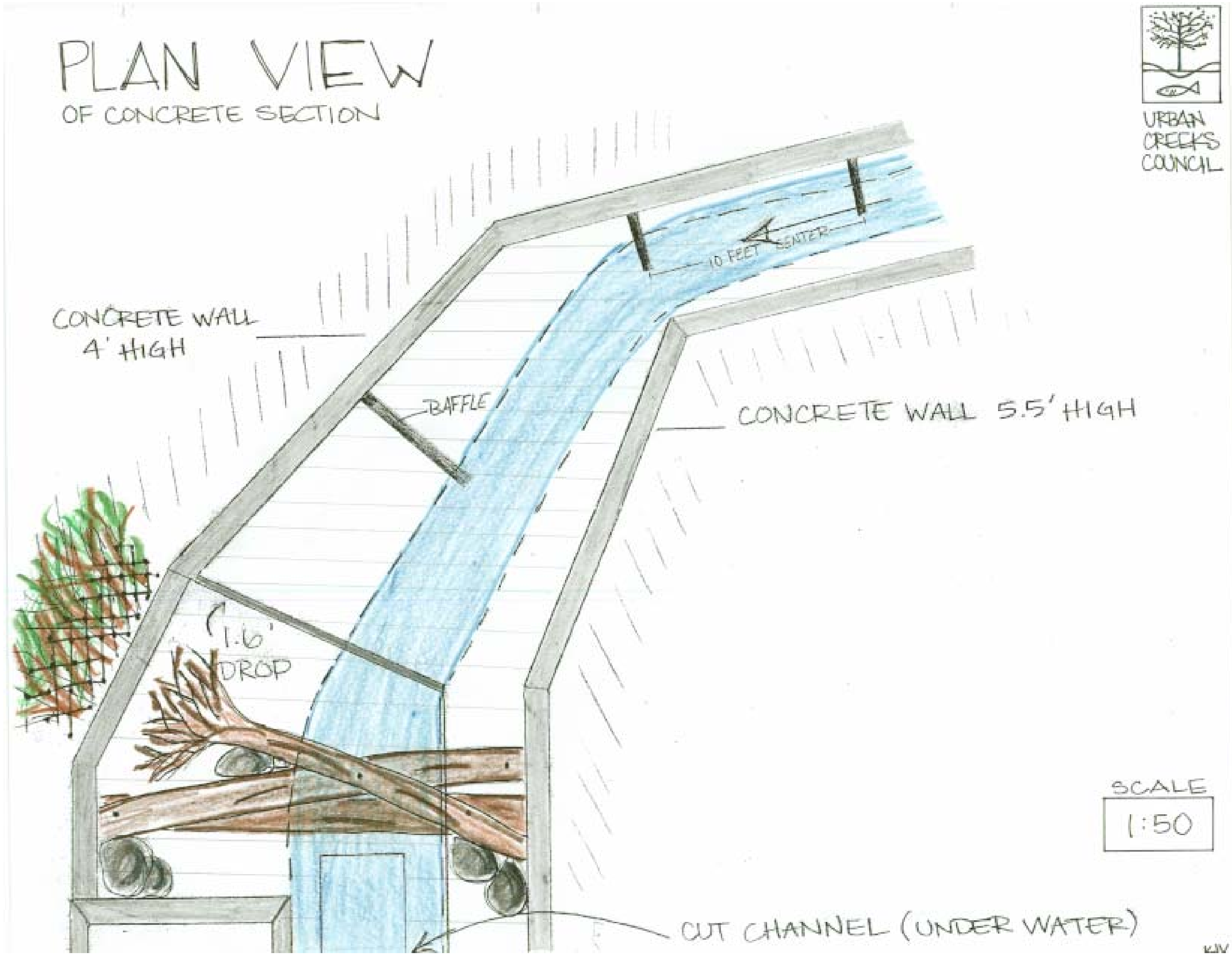


**Figure 23.** Plan view of engineered log structure and baffles to be installed to modify the concrete channel which acts as an existing barrier to fish passage.

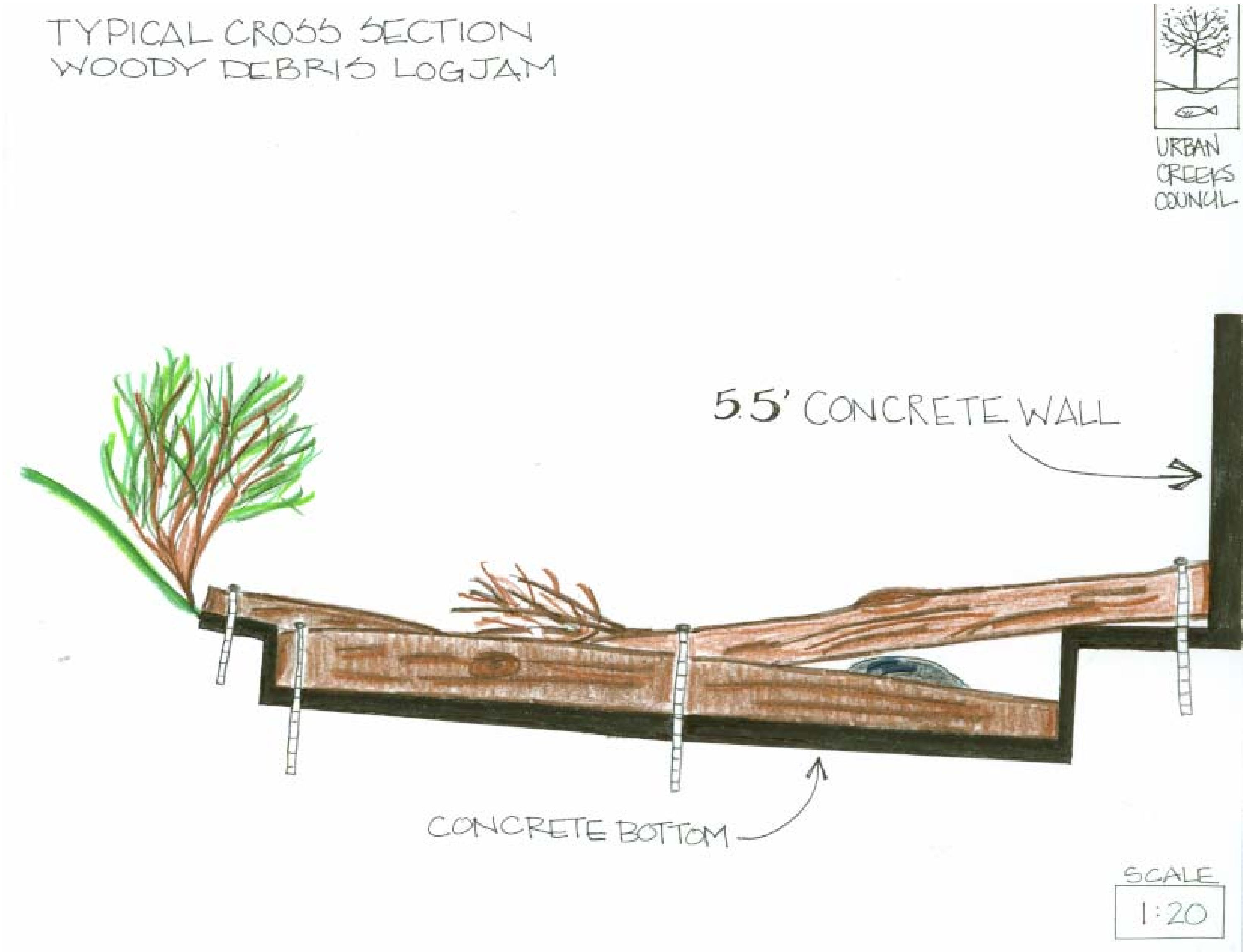


**Figure 24.** Typical section view of engineered log structure to be installed downstream of the concrete section to modify the existing barrier.

**Figure 25.** Community members complete surveys and identify themselves on a watershed map as they enter the April 27, 2005 community meeting.


**Figure 26.** Presentation at April 27, 2005 community meeting, held at St. Mary's College High School.

**Table 1.** Results from survey distributed at the April 27, 2005 community meeting. A total of 25 citizens completed the survey (11 creekside residents and 44 watershed residents)

| 1. Were you aware of CCWRAP before this meeting? | Y | N | Blank |
|---|---|---|---|
| Creekside Resident | 8 | 2 | 1 |
| Watershed Resident | 6 | 6 | 2 |

| 2. How did you find out about this meeting? | Postcard | Flyer | Earth Day | Listserv | Berkeley Planet | Website | Door | F5C | Other | Friend's email | Blank |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Creekside Resident | 8 | | | 1 | | | 1 | | 1 | | |
| Watershed Resident | 7 | | | 2 | 1 | | | 1 | 1 | 1 | 1 |

| 3. How often spend time at creek | Daily | Weekly | 1-2 month | 3-5 year | During rain | Never | Blank |
|---|---|---|---|---|---|---|---|
| Creekside Resident | 9 | 1 | | | | 1 | |
| Watershed Resident | 2 | 1 | 2 | 4 | 1 | 2 | 2 |

| 4. Experienced flood issues | Flooding in yard | Flooding in house | Erosion | Tree Loss | Trash | Structure Damage | Culvert block | Leaning tree over bank | Erosion of driveway | Flooding of street /parking lot | None | Blank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Creekside Resident | 1 | 4 | 3 | 1 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Watershed Resident | 1 | 3 | 1 | 1 | 2 | 1 | 2 | | | | 1 | 6 |

| 5. Frequency of flooding issues | Every rain | Monthly | 1 a season | 1 in 2 years | Not in 2 years | Blank |
|---|---|---|---|---|---|---|
| Creekside Resident | 1 | | | 2 | 8 | |
| Watershed Resident | | | | 2 | 7 | 5 |

| 6. Rate your concern on the following: | Flooding | Pollution | Erosion | Invasives | Trash | Runoff | Animal Habitat | Fish | Culvert Instability | Creeks Ordinance | Homeless | Other | Children smoking dope | Rats |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 (no need to be concerned) | 3 | | | | | | | | 1 | 1 | 1 | | | |
| 2 (not concerned) | 1 | | 1 | 1 | | | | | | 1 | | | | |
| 3 (no opinion) | 2 | 1 | 1 | 2 | | | 3 | | 2 | | 3 | | | |
| 4 (somewhat concerned) | 1 | 6 | 3 | 1 | 4 | 4 | 3 | 5 | 1 | | 3 | | | |
| 5 (very concerned) | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 5 | | | | |
| Blank | 3 | 1 | 2 | 3 | 3 | 3 | 2 | 2 | 4 | 2 | 3 | | | |
| Check | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | | | |

| 7. Animals seen at creek | Fish | Raccoons | Turtles | Frogs | Ducks | Newts | Mice | Snakes | Deer | Dragonflies | Crayfish | Opossum | Skunk | Birds | Water bugs | Turkey | Blank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Creekside Resident | 4 | 9 | 0 | 1 | 1 | 5 | 5 | 2 | 4 | 8 | 5 | 3 | 2 | 1 | 1 | | 2 |
| Watershed Resident | 4 | 7 | 0 | 3 | 2 | 2 | 2 | 0 | 4 | 3 | 1 | | 1 | | | 1 | 5 |

| 8. Opportunities to improve your backyard | Invasive removal | Bank Stabilization | Removal hardscape | Erosion control | Natives | Willingness of Neighbors | Diversion | Reduce Pesticide | Blank |
|---|---|---|---|---|---|---|---|---|---|
| Creekside Resident | 5 | 4 | 1 | 3 | 5 | 6 | 2 | 1 | 1 |

| 9. Requested more info on | CCWRAP | Native plants | Erosion Control | UCC | Creek Groups | Blank |
|---|---|---|---|---|---|---|
| Creekside Resident | 6 | 8 | 5 | 4 | 4 | 2 |
| Watershed Resident | 5 | 3 | 2 | 3 | 3 | 8 |

| 10. Interested in | Making your backyard fish friendly | Hosting a workshop | Participating in Hands-on | Watershed Council | Working Group | Learning about water quality monitoring | Learn about fish monitoring | Blank |
|---|---|---|---|---|---|---|---|---|
| Creekside Resident | 5 | 5 | 6 | 4 | 4 | 3 | 3 | 3 |
| Watershed Resident | | 1 | 4 | 3 | 2 | 2 | 3 | 9 |

**Table 2.** Culvert specifications of Codornices Creek culverts between San Pablo and Albina Avenue. Unless specified data was obtained during the fall of 2004 by UCC.

| Culvert | Outlet Station (ft)* | Outlet Elevation (ft)° | Inlet Station (ft)* | Inlet Elevation (ft)° | Culvert Distance (ft) | Culvert Slope | Inlet Shape** | Outlet Shape** | Bottom Material** | Inlet Installation** | Outlet Installation** | Inlet Height** | Outlet Height** | Inlet Width** | Outlet Width** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kains Avenue | 167 | 37.58 | 266 | 38.25 | 99 | 0.0068 | arch | arch | gravel, sand | at grade | at grade | 5.8 | 5.6 | 6.1 | 6.5 |
| Stannage Avenue | 456 | 40.01 | 578 | 41.00 | 122 | 0.0081 | arch | arch | gravel | sunken | sunken | 5.8 | 5.1 | 6.3 | 6.3 |
| Cornell Avenue | 754 | 42.29 | 859 | 43.38 | 105 | 0.0104 | arch | arch | gravel | sunken | sunken | 5.0 | 3.9 | 6.2 | 6.0 |
| Talbot Avenue | 1041 | 44.47 | 1188 | 45.74 | 147 | 0.0086 | arch | arch | gravel | at grade | sunken | 6.0 | 4.2 | 6.0 | 6.2 |
| Evelyn Avenue | 1346 | 47.62 | 1461 | 50.45 | 115 | 0.0246 | arch | arch | concrete | 1' lip | at grade | 6.0 | 6.0 | 6.1 | 6.0 |
| Masonic Avenue | 1660 | 52.96 | 1761 | 55.57 | 101 | 0.0258 | arch | arch | concrete | at grade | at grade | 6.5 | 6.3 | 6.2 | 6.0 |
| Santa Fe Avenue | 1845 | 56.70 | 2023 | 56.63 | 178 | -0.0004 | arch | arch | concrete | 6" lip | sunken | 6.0 | 4.3 | 6.0 | 7.7 |
| Curtis Street | 2275 | 59.48 | 2339 | 62.34 | 64 | 0.0447 | arch | arch | sand | sunken | sunken | 2.6 | 3.2 | 5.5 | 6.0 |
| Neilson Street | 2404 | 62.90 | 2652 | 65.06 | 248 | 0.0087 | arch | circular | gravel | at grade | at grade | 6.6 | 3.9 | 6.1 | 6.0 |
| Peralta Avenue | 2934 | 69.54 | 3392 | 78.70 | 458 | 0.0200 | arch | arch | sand | at grade | sunken | 5.7 | 3.9 | 6.0 | 6.1 |
| Albina Avenue Bridge | 4075 | 95.75 | 4100 | 96.11 | 25 | 0.0144 | | | | | | | | | |

*** Station 0 is located at the inlet of the San Pablo Avenue culvert.**
**° Elevations reported in the City of Berkeley Datum.**
**** Data obtained from CCWRAP, Kier 2004.**

**Table 3.** Evaluation of flooding impacts from fish baffle installation on culverts from San Pablo Avenue to Peralta Avenue. May 12, 2005.

| | Existing Conditions | | 12-Inch Baffles | | | | | | | | 6-inch Baffles | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | evaluation assuming embedded culvert and n=0.04 | | | | evaluation assuming increased Manning's n of 0.07 | | | | evaluation assuming embedded culvert | | evaluation assuming increased Manning's n of 0.04 | |
| River Station | Existing 10-yr Water Surface elevation (ft CB datum) | Existing 100-yr Water Surface elevation (ft CB datum) | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation |
| 3402 | 86.96 | 89.59 | 89.02 | 2.06 | 89.59 | 0.00 | 89.26 | 2.30 | 90.21 | 0.62 | 87.57 | 0.61 | 89.59 | 0.00 |
| 3163 | Peralta St Culvert | | | | | | | | | | | | | |
| 2934 | 80.77 | 82.92 | 81.74 | 0.97 | 83.76 | 0.84 | 81.86 | 1.09 | 83.85 | 0.93 | 81.29 | 0.52 | 83.34 | 0.42 |
| 2928 | 80.78 | 82.94 | 81.75 | 0.97 | 83.77 | 0.83 | 81.86 | 1.08 | 83.86 | 0.92 | 81.30 | 0.52 | 83.35 | 0.41 |
| 2883 | 80.45 | 82.40 | 81.50 | 1.05 | 83.33 | 0.93 | 81.62 | 1.17 | 83.43 | 1.03 | 81.01 | 0.56 | 82.87 | 0.47 |
| 2872 | 80.43 | 82.38 | 81.49 | 1.06 | 83.32 | 0.94 | 81.61 | 1.18 | 83.41 | 1.03 | 81.00 | 0.57 | 82.85 | 0.47 |
| 2827 | 80.36 | 82.27 | 81.44 | 1.08 | 83.24 | 0.97 | 81.56 | 1.20 | 83.34 | 1.07 | 80.94 | 0.58 | 82.76 | 0.49 |
| 2812 | 80.51 | 82.54 | 81.56 | 1.05 | 83.47 | 0.93 | 81.68 | 1.17 | 83.56 | 1.02 | 81.08 | 0.57 | 83.01 | 0.47 |
| 2690 | 80.55 | 82.59 | 81.58 | 1.03 | 83.50 | 0.91 | 81.70 | 1.15 | 83.60 | 1.01 | 81.10 | 0.55 | 83.05 | 0.46 |
| 2653 | 79.88 | 81.42 | 81.09 | 1.21 | 82.60 | 1.18 | 81.22 | 1.34 | 82.71 | 1.29 | 80.54 | 0.66 | 82.03 | 0.61 |
| 2528 | Neilson Ave Culvert | | | | | | | | | | | | | |
| 2404 | 75.93 | 77.30 | 75.95 | 0.02 | 77.32 | 0.02 | 75.96 | 0.03 | 77.29 | -0.01 | 75.93 | 0.00 | 77.30 | 0.00 |
| 2339 | 75.92 | 77.31 | 75.94 | 0.02 | 77.34 | 0.03 | 75.94 | 0.02 | 77.31 | 0.00 | 75.92 | 0.00 | 77.32 | 0.01 |
| 2307 | Curtis Street Culvert | | | | | | | | | | | | | |
| 2275 | 72.19 | 73.84 | 72.29 | 0.10 | 73.92 | 0.08 | 72.33 | 0.14 | 73.91 | 0.07 | 72.25 | 0.06 | 73.87 | 0.03 |
| 2257 | 72.11 | 73.74 | 72.21 | 0.10 | 73.82 | 0.08 | 72.26 | 0.15 | 73.81 | 0.07 | 72.17 | 0.06 | 73.76 | 0.02 |
| 2181 | 72.08 | 73.69 | 72.19 | 0.11 | 73.78 | 0.09 | 72.23 | 0.15 | 73.77 | 0.08 | 72.15 | 0.07 | 73.72 | 0.03 |
| 2143 | 72.10 | 73.72 | 72.20 | 0.10 | 73.80 | 0.08 | 72.25 | 0.15 | 73.80 | 0.08 | 72.17 | 0.07 | 73.75 | 0.03 |
| 2023 | 72.05 | 73.61 | 72.15 | 0.10 | 73.70 | 0.09 | 72.19 | 0.14 | 73.69 | 0.08 | 72.11 | 0.06 | 73.64 | 0.03 |
| 1934 | Santa Fe Culvert | | | | | | | | | | | | | |
| 1845 | 68.83 | 70.49 | 69.45 | 0.62 | 70.99 | 0.50 | 69.56 | 0.73 | 71.04 | 0.55 | 69.10 | 0.27 | 70.75 | 0.26 |
| 1840 | 68.83 | 70.54 | 69.46 | 0.63 | 71.04 | 0.50 | 69.58 | 0.75 | 71.09 | 0.55 | 69.11 | 0.28 | 70.80 | 0.26 |
| 1791 | 68.81 | 70.50 | 69.44 | 0.63 | 71.01 | 0.51 | 69.56 | 0.75 | 71.06 | 0.56 | 69.09 | 0.28 | 70.77 | 0.27 |
| 1764 | 68.75 | 70.45 | 69.41 | 0.66 | 70.97 | 0.52 | 69.52 | 0.77 | 71.02 | 0.57 | 69.04 | 0.29 | 70.72 | 0.27 |
| 1761 | 68.57 | 70.11 | 69.25 | 0.68 | 70.66 | 0.55 | 69.37 | 0.80 | 70.72 | 0.61 | 68.87 | 0.30 | 70.40 | 0.29 |

| | Existing Conditions | | 12-Inch Baffles | | | | | | | | 6-inch Baffles | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | evaluation assuming embedded culvert and n=0.04 | | | | evaluation assuming increased Manning's n of 0.07 | | | | evaluation assuming embedded culvert | | evaluation assuming increased Manning's n of 0.04 | |
| River Station | Existing 10-yr Water Surface elevation (ft CB datum) | Existing 100-yr Water Surface elevation (ft CB datum) | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation |
| 1711 | Masonic Culvert | | | | | | | | | | | | | |
| 1659 | 66.43 | 68.18 | 67.46 | 1.03 | 69.22 | 1.04 | 67.67 | 1.24 | 69.45 | 1.27 | 66.9 | 0.47 | 68.66 | 0.48 |
| 1618 | 66.68 | 68.7 | 67.68 | 1 | 69.67 | 0.97 | 67.88 | 1.2 | 69.89 | 1.19 | 67.13 | 0.45 | 69.15 | 0.45 |
| 1607 | 66.66 | 68.68 | 67.67 | 1.01 | 69.65 | 0.97 | 67.87 | 1.21 | 69.87 | 1.19 | 67.12 | 0.46 | 69.12 | 0.44 |
| 1585 | 66.67 | 68.69 | 67.68 | 1.01 | 69.67 | 0.98 | 67.87 | 1.2 | 69.88 | 1.19 | 67.13 | 0.46 | 69.14 | 0.45 |
| 1548 | 66.88 | 69.1 | 67.86 | 0.98 | 70.03 | 0.93 | 68.05 | 1.17 | 70.24 | 1.14 | 67.32 | 0.44 | 69.52 | 0.42 |
| 1506 | 66.88 | 69.1 | 67.86 | 0.98 | 70.03 | 0.93 | 68.05 | 1.17 | 70.24 | 1.14 | 67.32 | 0.44 | 69.52 | 0.42 |
| 1465 | 66.88 | 69.09 | 67.86 | 0.98 | 70.03 | 0.94 | 68.05 | 1.17 | 70.24 | 1.15 | 67.32 | 0.44 | 69.52 | 0.43 |
| 1461 | 66.42 | 68.26 | 67.48 | 1.06 | 69.32 | 1.06 | 67.69 | 1.27 | 69.55 | 1.29 | 66.9 | 0.48 | 68.75 | 0.49 |
| 1404 | Evelyn Culvert | | | | | | | | | | | | | |
| 1346 | 63.06 | 64.5 | 63.06 | 0 | 64.49 | -0.01 | 63.07 | 0.01 | 64.48 | -0.02 | 63.06 | 0 | 64.48 | -0.02 |
| 1343 | 63.04 | 64.46 | 63.05 | 0.01 | 64.45 | -0.01 | 63.06 | 0.02 | 64.44 | -0.02 | 63.04 | 0 | 64.44 | -0.02 |
| 1220 | 63.38 | 65.2 | 63.39 | 0.01 | 65.2 | 0 | 63.4 | 0.02 | 65.19 | -0.01 | 63.39 | 0.01 | 65.19 | -0.01 |
| 1215 | 63.38 | 65.21 | 63.39 | 0.01 | 65.2 | -0.01 | 63.4 | 0.02 | 65.19 | -0.02 | 63.39 | 0.01 | 65.19 | -0.02 |
| 1210 | 63.33 | 65.11 | 63.34 | 0.01 | 65.11 | 0 | 63.35 | 0.02 | 65.09 | -0.02 | 63.33 | 0 | 65.09 | -0.02 |
| 1203 | 63.33 | 65.11 | 63.34 | 0.01 | 65.11 | 0 | 63.35 | 0.02 | 65.1 | -0.01 | 63.34 | 0.01 | 65.1 | -0.01 |
| 1193 | 63.33 | 65.12 | 63.34 | 0.01 | 65.11 | -0.01 | 63.35 | 0.02 | 65.1 | -0.02 | 63.34 | 0.01 | 65.1 | -0.02 |
| 1188 | 63.3 | 65.08 | 63.31 | 0.01 | 65.07 | -0.01 | 63.32 | 0.02 | 65.06 | -0.02 | 63.31 | 0.01 | 65.06 | -0.02 |

| | Existing Conditions | | 12-Inch Baffles | | | | | | | | 6-inch Baffles | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | evaluation assuming embedded culvert and n=0.04 | | | | evaluation assuming increased Manning's n of 0.07 | | | | evaluation assuming embedded culvert | | evaluation assuming increased Manning's n of 0.04 | |
| River Station | Existing 10-yr Water Surface elevation (ft CB datum) | Existing 100-yr Water Surface elevation (ft CB datum) | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation |
| 1115 | Talbot Culvert | | | | | | | | | | | | | |
| 1041 | 59.41 | 61.75 | 59.45 | 0.04 | 61.76 | 0.01 | 59.48 | 0.07 | 61.75 | 0 | 59.41 | 0 | 61.75 | 0 |
| 1029 | 59.4 | 61.74 | 59.44 | 0.04 | 61.75 | 0.01 | 59.48 | 0.08 | 61.75 | 0.01 | 59.41 | 0.01 | 61.74 | 0 |
| 993 | 59.4 | 61.73 | 59.44 | 0.04 | 61.74 | 0.01 | 59.47 | 0.07 | 61.74 | 0.01 | 59.4 | 0 | 61.73 | 0 |
| 987 | 59.52 | 61.9 | 59.56 | 0.04 | 61.91 | 0.01 | 59.59 | 0.07 | 61.91 | 0.01 | 59.53 | 0.01 | 61.9 | 0 |
| 951 | 59.51 | 61.89 | 59.55 | 0.04 | 61.9 | 0.01 | 59.58 | 0.07 | 61.89 | 0 | 59.52 | 0.01 | 61.88 | -0.01 |
| 939 | 59.54 | 61.93 | 59.58 | 0.04 | 61.94 | 0.01 | 59.61 | 0.07 | 61.93 | 0 | 59.55 | 0.01 | 61.93 | 0 |
| 924 | 59.53 | 61.92 | 59.57 | 0.04 | 61.93 | 0.01 | 59.61 | 0.08 | 61.93 | 0.01 | 59.54 | 0.01 | 61.92 | 0 |
| 921 | 59.44 | 61.74 | 59.48 | 0.04 | 61.75 | 0.01 | 59.51 | 0.07 | 61.75 | 0.01 | 59.44 | 0 | 61.74 | 0 |
| 904 | 59.43 | 61.73 | 59.47 | 0.04 | 61.74 | 0.01 | 59.5 | 0.07 | 61.74 | 0.01 | 59.44 | 0.01 | 61.73 | 0 |
| 883 | 59.43 | 61.73 | 59.47 | 0.04 | 61.74 | 0.01 | 59.5 | 0.07 | 61.74 | 0.01 | 59.44 | 0.01 | 61.73 | 0 |
| 882 | 59.06 | 61.04 | 59.11 | 0.05 | 61.05 | 0.01 | 59.14 | 0.08 | 61.04 | 0 | 59.07 | 0.01 | 61.03 | -0.01 |
| 862 | 59.05 | 61.02 | 59.1 | 0.05 | 61.03 | 0.01 | 59.13 | 0.08 | 61.02 | 0 | 59.06 | 0.01 | 61.02 | 0 |
| 859 | 59.08 | 61.08 | 59.12 | 0.04 | 61.09 | 0.01 | 59.16 | 0.08 | 61.08 | 0 | 59.08 | 0 | 61.07 | -0.01 |
| 806 | Cornell Culvert | | | | | | | | | | | | | |
| 753 | 54.18 | 57.12 | 54.8 | 0.62 | 57.17 | 0.05 | 54.89 | 0.71 | 57.12 | 0 | 54.46 | 0.28 | 57.12 | 0 |
| 741 | 54.07 | 57.01 | 54.71 | 0.64 | 57.07 | 0.06 | 54.81 | 0.74 | 57.02 | 0.01 | 54.37 | 0.3 | 57.01 | 0 |
| 717 | 54.03 | 56.97 | 54.68 | 0.65 | 57.02 | 0.05 | 54.77 | 0.74 | 56.97 | 0 | 54.33 | 0.3 | 56.97 | 0 |
| 708 | 54.35 | 57.45 | 54.97 | 0.62 | 57.5 | 0.05 | 55.06 | 0.71 | 57.46 | 0.01 | 54.64 | 0.29 | 57.46 | 0.01 |
| 656 | 54.36 | 57.45 | 54.97 | 0.61 | 57.5 | 0.05 | 55.06 | 0.7 | 57.46 | 0.01 | 54.64 | 0.28 | 57.45 | 0 |
| 578 | 53.96 | 56.89 | 54.62 | 0.66 | 56.95 | 0.06 | 54.72 | 0.76 | 56.9 | 0.01 | 54.27 | 0.31 | 56.89 | 0 |

| | Existing Conditions | | 12-Inch Baffles | | | | | | | | 6-inch Baffles | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | evaluation assuming embedded culvert and n=0.04 | | | | evaluation assuming increased Manning's n of 0.07 | | | | evaluation assuming embedded culvert | | evaluation assuming increased Manning's n of 0.04 | |
| River Station | Existing 10-yr Water Surface elevation (ft CB datum) | Existing 100-yr Water Surface elevation (ft CB datum) | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation |
| 517 | Stannage Culvert | | | | | | | | | | | | | |
| 456 | 52.48 | 56.14 | 52.48 | 0 | 56.14 | 0 | 52.48 | 0 | 56.14 | 0 | 52.48 | 0 | 56.14 | 0 |
| 380 | 49.19 | 51.64 | 49.19 | 0 | 51.64 | 0 | 49.19 | 0 | 51.64 | 0 | 49.19 | 0 | 51.64 | 0 |
| 379 | 47.95 | 50.38 | 48.17 | 0.22 | 50.38 | 0 | 48.21 | 0.26 | 50.38 | 0 | 47.99 | 0.04 | 50.38 | 0 |
| 366 | 47.24 | 49.2 | 47.84 | 0.6 | 49.2 | 0 | 47.92 | 0.68 | 49.2 | 0 | 47.54 | 0.3 | 49.2 | 0 |
| 349 | 47.11 | 49.1 | 47.79 | 0.68 | 49.1 | 0 | 47.88 | 0.77 | 49.1 | 0 | 47.46 | 0.35 | 49.1 | 0 |
| 348 | 48.33 | 50.28 | 48.72 | 0.39 | 50.21 | -0.07 | 48.78 | 0.45 | 50.21 | -0.07 | 48.51 | 0.18 | 50.23 | -0.05 |
| 308 | 47.41 | 48.06 | 48.14 | 0.73 | 48.54 | 0.48 | 48.23 | 0.82 | 48.66 | 0.6 | 47.8 | 0.39 | 48.27 | 0.21 |
| 270 | 47.27 | 47.63 | 48.08 | 0.81 | 48.39 | 0.76 | 48.17 | 0.9 | 48.54 | 0.91 | 47.71 | 0.44 | 48.03 | 0.4 |
| 267 | 47.41 | 48.97 | 48.46 | 1.05 | 49.49 | 0.52 | 48.55 | 1.14 | 49.6 | 0.63 | 48.06 | 0.65 | 49.23 | 0.26 |
| 216.5 | Kains Culvert | | | | | | | | | | | | | |
| 167 | 45.95 | 47.63 | 46.6 | 0.65 | 48.01 | 0.38 | 46.81 | 0.86 | 48.24 | 0.61 | 45.99 | 0.04 | 47.54 | -0.09 |
| 165 | 44.98 | 46.14 | 46.29 | 1.31 | 47.64 | 1.5 | 46.57 | 1.59 | 47.93 | 1.79 | 45.38 | 0.4 | 46.73 | 0.59 |
| 100 | 45.49 | 46.8 | 46.48 | 0.99 | 47.8 | 1 | 46.72 | 1.23 | 48.06 | 1.26 | 45.74 | 0.25 | 47.1 | 0.3 |
| 90 | 45.52 | 46.82 | 46.49 | 0.97 | 47.81 | 0.99 | 46.73 | 1.21 | 48.07 | 1.25 | 45.76 | 0.24 | 47.11 | 0.29 |
| 70 | San Pablo Culvert | | | | | | | | | | | | | |
| 50 | 37 | 38.42 | 37 | 0 | 38.42 | 0 | 37 | 0 | 38.42 | 0 | 37 | 0 | 38.42 | 0 |
| 30 | 34.33 | 35.5 | 34.33 | 0 | 35.5 | 0 | 34.33 | 0 | 35.5 | 0 | 34.33 | 0 | 35.5 | 0 |
| 10 | 33.3 | 34.2 | 33.3 | 0 | 34.2 | 0 | 33.3 | 0 | 34.2 | 0 | 33.3 | 0 | 34.2 | 0 |

**Table 4.** Model results for the Albina Avenue alternative A step-pool design and the concrete section baffles upstream of Albina Avenue.  May 12, 2005.

| | | | flood modeling results | | | | fish passage results | | |
|---|---|---|---|---|---|---|---|---|---|
| River Station | Existing WSE 10-year flow conditions | Existing WSE 100-year flow conditions | Modeled 10-yr WSE with baffles and Albina Street Step-Pools Alt A WSE | Change in WSE (ft) | Modeled 100-yr WSE with baffles and Albina Street Step-Pools Alt A WSE | Change in WSE (ft) | velocity at 18 cfs (ft/s) | depth at 3 cfs (ft) | Comments |
| 4531 | 112.56 | 114.82 | 112.97 | 0.41 | 115.11 | 0.29 | 2.99 | 0.34 | 6-inch baffle section |
| 4334 | 109.27 | 111.53 | 110.1 | 0.83 | 112.23 | 0.7 | 2.62 | 0.41 | 6-inch baffle section |
| 4299 | 108.97 | 111.23 | 108.7 | -0.27 | 110.53 | -0.7 | 4.54 | 0.21 | |
| 4298 | 106.98 | 109.32 | 106.84 | -0.14 | 109.06 | -0.26 | 2.42 | 0.45 | engineered log structure |
| 4250 | 105.06 | 106.61 | 104.89 | -0.17 | 106.74 | 0.13 | 3.78 | 0.29 | |
| 4206 | 103.89 | 105.1 | 104.66 | 0.77 | 106.57 | 1.47 | 3.18 | 0.33 | |
| 4110 | 102.28 | 103.74 | 104.44 | 2.16 | 106.46 | 2.72 | 3.55 | 0.24 | |
| 4101 | 102.55 | 103.89 | 104.49 | 1.94 | 106.47 | 2.58 | 1.65 | 0.31 | |
| 4087 | Albina Street Bridge | | | | | | | | |
| 4073 | 101.59 | 103.36 | 104.51 | 2.92 | 106.42 | 3.06 | 0.45 | 2.85 | scour pool below bridge |
| 4060 | 101.7 | 103.53 | 104.55 | 2.85 | 106.53 | 3 | 0.42 | 2.77 | |
| 4056 | 101.69 | 103.55 | 104.54 | 2.85 | 106.52 | 2.97 | 0.42 | 2.77 | end step-pool |
| 4050 | 101.21 | 102.98 | 102.44 | 1.23 | 104.16 | 1.18 | 4.6 | 0.37 | step 8 |
| 4046 | 99.84 | 101.56 | 103.08 | 3.24 | 104.86 | 3.3 | 2.04 | 0.61 | |
| 4040 | 100.11 | 101.87 | 103.02 | 2.91 | 104.81 | 2.94 | 1.92 | 0.66 | |
| 4037 | 100.11 | 101.87 | 101.63 | 1.52 | 103.36 | 1.49 | 4.6 | 0.37 | step 7 |
| 4033 | 100.47 | 102.28 | 102.44 | 1.97 | 104.25 | 1.97 | 1.6 | 0.85 | |
| 4027 | 100.34 | 102.13 | 102.08 | 1.74 | 103.86 | 1.73 | 2.27 | 0.55 | |
| 4024 | 100.18 | 101.95 | 100.84 | 0.66 | 102.56 | 0.61 | 4.60 | 0.37 | step 6 |
| 4021 | 99.87 | 101.60 | 101.62 | 1.75 | 103.42 | 1.82 | 1.71 | 0.77 | |
| 4016 | 99.47 | 101.17 | 101.26 | 1.79 | 103.03 | 1.86 | 2.27 | 0.55 | |
| 4013 | 99.40 | 101.10 | 100.14 | 0.74 | 101.91 | 0.81 | 4.60 | 0.37 | step 5 |
| 4010 | 99.14 | 100.80 | 100.92 | 1.78 | 102.72 | 1.92 | 1.66 | 0.80 | |
| 4004 | 98.95 | 100.63 | 100.46 | 1.51 | 102.22 | 1.59 | 2.44 | 0.51 | |
| 4000 | 98.77 | 100.46 | 99.24 | 0.47 | 100.96 | 0.50 | 4.60 | 0.37 | step 4 |
| 3998 | 98.82 | 100.52 | 99.93 | 1.11 | 101.70 | 1.18 | 2.20 | 0.56 | |
| 3993 | 98.79 | 100.51 | 99.84 | 1.05 | 101.62 | 1.11 | 2.08 | 0.60 | |
| 3990 | 98.79 | 100.51 | 98.74 | -0.05 | 100.47 | -0.04 | 4.60 | 0.37 | step 3 |
| 3987 | 98.75 | 100.47 | 99.33 | 0.58 | 101.10 | 0.63 | 2.12 | 0.59 | |
| 3979 | 98.60 | 100.33 | 97.84 | -0.76 | 99.56 | -0.77 | 4.16 | 0.41 | step 2 |
| 3966 | 97.04 | 98.76 | 97.04 | 0.00 | 98.76 | 0.00 | 4.60 | 0.37 | begin step pool alt A |

| | | | flood modeling results | | | | fish passage results | | |
|---|---|---|---|---|---|---|---|---|---|
| River Station | Existing WSE 10-year flow conditions | Existing WSE 100-year flow conditions | Modeled 10-yr WSE with baffles and Albina Street Step-Pools Alt A WSE | Change in WSE (ft) | Modeled 100-yr WSE with baffles and Albina Street Step-Pools Alt A WSE | Change in WSE (ft) | velocity at 18 cfs (ft/s) | depth at 3 cfs (ft) | Comments |
| 3946 | 94.88 | 96.57 | 94.88 | 0 | 96.57 | 0 | 4.6 | 0.37 | |
| 3940 | 94.33 | 96.15 | 94.33 | 0 | 96.15 | 0 | 2.62 | 0.29 | |
| 3902 | 93.11 | 94.75 | 93.11 | 0 | 94.75 | 0 | 3.54 | 0.23 | |
| 3850 | 92.25 | 93.89 | 92.25 | 0 | 93.89 | 0 | 2.94 | 0.24 | |
| 3740 | 92.02 | 93.89 | 92.04 | 0.02 | 93.91 | 0.02 | 4.2 | 0.24 | |
| 3697 | 92.06 | 93.93 | 92.04 | -0.02 | 93.92 | -0.01 | 4.35 | 0.23 | |
| 3668 | 92.08 | 93.95 | 92.07 | -0.01 | 93.95 | 0 | 1.86 | 0.41 | |
| 3662 | 91.64 | 93.53 | 91.63 | -0.01 | 93.52 | -0.01 | 1.81 | 0.44 | |
| 3645 | 90.76 | 92.73 | 90.76 | 0 | 92.75 | 0.02 | 1.59 | 0.62 | |
| 3568 | 89.36 | 91.87 | 89.49 | 0.13 | 91.92 | 0.05 | 4.18 | 0.22 | |
| 3482 | 89.84 | 92.19 | 89.84 | 0 | 92.19 | 0 | 2.9 | 0.3 | |
| 3431 | 89.45 | 91.74 | 89.45 | 0 | 91.74 | 0 | 2.59 | 0.38 | |
| 3417 | 88.62 | 90.91 | 88.62 | 0 | 90.91 | 0 | 2.26 | 0.73 | |

Notes: Interpolated cross-sections not shown

**Table 5.** Estimated costs for the permitting and implementation of the barrier modification and streambank stabilization measures as proposed within the May 2005 report. Note that the budgets below do not include funds for final design nor the development of construction documents.

| *project* | *quantity* | *units* | *unit cost* | *approx cost ($)* | *comments* |
|---|---|---|---|---|---|
| ***Step-Pools Below Albina Street Bridge*** | | | | | |
| construct haul road into creek | 2 | days | $ 1,500.00 | $ 3,000.00 | |
| import 150 tons rock | 150 | tons | $ 150.00 | $ 22,500.00 | cost includes delivery and placement into creek |
| rebuild slope rock | 50 | tons | $ 90.00 | $ 4,500.00 | estimate |
| misc. clean-up and restoration | 1 | ls | $ 5,000.00 | $ 5,000.00 | |
| dewatering system | 1 | ls | $ 20,000.00 | $ 20,000.00 | |
| restore haul road | Assumes costs for slope repair included as part of St Mary's slide repair work; if slope repair work is required an additional $15,000 to $20,000 may be required. | | | | |
| permitting | 1 | ls | $ 8,000.00 | $ 8,000.00 | assumes no EIR work/no additional flood modeling |
| contingency | 10 | % | $ 63,000.00 | $ 6,300.00 | |
| | | | **total:** | **$ 69,300.00** | |
| ***Engineered Log Structure Below Concrete Section*** | | | | $ - | |
| import and place 5 tons rock | 5 | tons | $ 125.00 | $ 4,000.00 | |
| remove trees and make logs | 2 | days | $ 1,500.00 | $ 3,000.00 | |
| install and bolt logs and place rocks | 1 | ls | $ 5,000.00 | $ 5,000.00 | |
| dewatering system | costs included within Albina Street Bridge cost | | | | |
| permitting | 1 | ls | $ 8,000.00 | $ 8,000.00 | assumes no EIR work/no additional flood modeling |
| contingency | 10 | % | $ 20,000.00 | $ 2,000.00 | |
| | | | **total:** | **$ 22,000.00** | |
| ***6-Inch Baffles Installation in CC Channel Section*** | | | | | |
| install baffles | 30 | ea | $ 700.00 | $ 21,000.00 | |
| dewatering system | costs included within Albina Street Bridge cost | | | | |
| permitting | 1 | ls | $ 8,000.00 | $ 8,000.00 | assumes no EIR work/no additional flood modeling |
| contingency | 10 | % | $ 29,000.00 | $ 2,900.00 | |
| | | | **total:** | **$ 31,900.00** | |
| ***Slope Repair at St. Mary's College High School*** | | | | | |
| tree removal | 20 | ea tree | $ 2,000.00 | $ 40,000.00 | |
| general materials | | | | $ 2,900.00 | includes storage space, tool acquisition, and water wagon rental |
| dewatering materials | | | | $ 8,125.00 | includes visquene, sand, sand bags, straw bales, pump, hoses, generator and fuel |
| dewatering system installation/maintenance/removal | 65 | hours | $ 85.00 | $ 5,525.00 | |
| construction staking | 16 | hours | $ 85.00 | $ 1,360.00 | |
| excavation/resloping of bank | | | | $ 20,000.00 | subcontractor |
| excavation oversight | 32 | hours | $ 85.00 | $ 2,720.00 | |
| trucking | | | | $ 8,000.00 | subcontractor |
| bioengineering materials | | | | $ 6,370.00 | includes coir, wattles, container stock, native seeds, soil amendment |
| harvest plant material | 90 | hours | $ 85.00 | $ 7,650.00 | |
| install posts/poles | 40 | hours | $ 85.00 | $ 3,400.00 | |
| install erosion control fabric | 60 | hours | $ 85.00 | $ 5,100.00 | |
| broadcast native seeds, organic fertilizer, mycorrhizal inoculants | 16 | hours | $ 85.00 | $ 1,360.00 | |
| install container stock | 20 | hours | $ 85.00 | $ 1,700.00 | |
| design and install drip irrigation system | | | | $ 15,000.00 | subcontractor |
| | | | **total:** | **$ 129,210.00** | |

# Creekside Resident Survey

This survey is being conducted by Urban Creeks Council as part of the Codornices Creek Watershed Restoration Action Program (CCWRAP). This program is working to improve the overall health of Codornices Creek with a focus on increasing habitat and passage for steelhead trout. CCWRAP is funded by CALFED and the California Department of Water Resources.

1. Were you aware of the CCWRAP prior to this meeting?

   _____ Yes _____ No

2. How did you find out about this meeting?

   _____ Postcard _____ Flyer in the Community _____ Earth Day
   _____ Listserv _____ Berkeley Daily Planet _____ UCC's Website
   _____ Other

3. How often do you spend time at Codornices Creek?

   _____ Daily _____ 3-5 times a year
   _____ Weekly _____ Only when it rains
   _____ 1-2 times a month _____ Never

4. Have you experienced any of the following flood issues? (check all that apply)
   Please note the storm if you can, year and month.
   Note your address, or at least street, on the back of the survey so we can track flooding.

   _____ Flooding in your yard
   _____ Flooding in your house/basement/garage
   _____ Erosion/Loss of soil
   _____ Loss of trees
   _____ Accumulation of trash
   _____ Structural damage
   _____ Culvert blocked with debris
   _____ Other: ________________________________________________

5. How often have you experienced flooding issues during the past two winters?

   _____ Every time it rains
   _____ Monthly
   _____ Once a season
   _____ Once in the past 2 winters
   _____ Did not experience in the past 2 winters

6. Rate the following creek issues with your level of concern.
   (1=no need to be concerned, 2=not concerned, 3=no opinion, 4=somewhat concerned, 5=very concerned)

   _____ Flooding
   _____ Pollution/ Water Quality
   _____ Erosion/Bank stability
   _____ Invasive and/or non-native plants
   _____ Trash/Litter

(OVER)

6. (Continued) Rate the following creek issues with your level of concern.
(1=no need to be concerned, 2=not concerned, 3=no opinion, 4=somewhat concerned, 5=very concerned)

_____ Runoff from backyards (fertilizers, pesticides, etc)
_____ Lack of animal/plant habitat
_____ Fish (Population Health, Habitat, Passage)
_____ Culvert Instability
_____ Creeks Ordinance
_____ Homeless Encampments
_____ Other ______________________________________________

7. Which of the following animals have you seen in/around the creek?
(check all that apply)

_____ Fish
_____ Frogs
_____ Mice, Rats
_____ Dragonflies
_____ Raccoons
_____ Ducks
_____ Snakes
_____ Turtles
_____ Newts
_____ Deer
_____ Other ______________________________________________

8. What opportunities do you think exist to improve your back yard?

_____ Invasive plant removal (Ivy, Blackberry, Eucalyptus, Acacia)
_____ Bank stabilization to reduce sedimentation of the channel
_____ Removal of hardscape (concrete, walls) to improve habitat
_____ Erosion control to reduce sedimentation
_____ Planting of natives to provide cover and shade to the channel
_____ Willingness of adjacent neighbors to participate
_____ Diversion of bank runoff
_____ Reduction of pesticide use

9. Please send more information about the following:

_____ CCWRAP
_____ Creekside Native Trees/Plants
_____ Erosion Control
_____ Urban Creeks Council
_____ Creek Groups in the Watershed (Friends of 5 Creeks, LOCCNA)

10. Check all the following in which you may be interested

_____ Making your backyard fish-friendly
_____ Hosting a workshop on your property
_____ Participating in a hands-on demonstration project
_____ Participating in a Watershed Council (a group of stakeholders)
_____ Participating in a planning group for this project
_____ Learning about water quality monitoring
_____ Learning about fish population monitoring

Street Address: ______________________________________________
Name (optional): ______________________________________________

FarWest Restoration Engineering

# Technical Memo

To: Emma Gutzler, Urban Creeks Council

From: Roger Leventhal, FRE

Date: May 10, 2005

Re: Flood Modeling Report, Codornices Creek Fish Barrier Modifications Project, Codornices Creek, Berkeley/Albany, California

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**Introduction**

This technical memorandum presents the results of steady-state flood modeling of the proposed Codornices Creek Fish Barrier Modification Project in Berkeley/Albany, California. This project is intended to model potential changes in water level due to proposed modifications within both culverts and the work proposed at the Albina Avenue Bridge and upstream concrete channel section. This modeling work was intended to evaluate changes in water surface elevation between the existing channel and the proposed restoration channel under the 10-year and 100-year flood flow conditions. The report is not a flood study of the Codornices Creek channel as inflows from side drains and other sources were not considered.

**Assumptions and Model Limitations**

The following assumptions were included in the development and computation of the flood modeling.

- Modeled flow rates were as developed by Philip Williams Associates (PWA). Development of site hydrology and flood flows were not part of the scope of this project.
- Flows from other sources such as inlet storm drains were beyond the scope of this modeling effort. This modeling work is intended only to enable a comparison of the change in water surface elevation under flood conditions between the existing and proposed conditions with barrier modifications. Actual water surface elevations may vary from the modeled results.
- As typical of almost all flood models, HEC-RAS does not include the effects of sedimentation or debris build-up in the creek channel or on the inlet trash

rack to the San Pablo culvert. Excessive debris or sediment could result in backwater flood elevations that exceed the modeled results.

**Description of the Proposed Project**

The Codornices Creek fish barrier modification project proposes to prepare preliminary designs for the modifications of barriers within Codornices Creek between San Pablo Avenue and the concrete section upstream of the Albina Avenue Bridge. Specifically, the barrier modifications evaluated under this model included the following:

- Installation of 6-inch or 12-inch fish baffles at the seven culverts previously identified as forming either a partial (i.e. temporal) or total barrier to fish passage. As described below, the additional friction caused by fish baffle installation was modeled by two different methods to provide a range of expected values.
- A series of step-pools below the Albina Avenue Bridge barrier was modeled.
- A series of step-pools below the upstream concrete section from the Albina Avenue Bridge were modeled along with a series of low concrete baffles installed across the bottom of the concrete channel section.

**Flood Flows**

Flows for the project modeling were obtained from hydrology work previously conducted by PWA for the Codornices Creek watershed.

The flow rates modeled under this project are as follows:

10-yr flow = 685 cfs
100-yr flow = 1085 cfs

**Existing Site Conditions**

<u>Culverts From San Pablo Avenue to Peralta Avenue</u>

Previous studies (Kier, 2004) identified seven of the eleven culverts along Codornices Creek from San Pablo Avenue to Albina Avenue as partial barriers to fish passage within the creek. At that time, it was recommended to evaluate the installation of fish baffles to provide low enough velocity and high enough depth to provide for fish passage. The existing culverts are primarily 6 ft by 6 ft arch concrete culverts with inverts, lengths and other characteristics as shown in the 2004 Kier report.

Albina Avenue Bridge Area

The length of creek modeled for the Albina Avenue Bridge modifications is approximately 100 linear feet downstream of the bridge (Alternative A). The modeled reach starts upstream of the Peralta Avenue culvert and continues through the concrete channelized section upstream of the Albina Avenue Bridge. The creek flows through the modeled reach in a channelized and confined condition with residential development up to the edge of the creek channel in all locations except right at St Mary's High School. The channel is generally straight, with depths ranging from several inches to about 3 ft deep and generally has a channel width of about 8 to 12 feet.

Land adjacent to the stream channel is highly disturbed. The adjacent channel consists of weedy species, different types of retaining walls and some trees and brush in the upper sections. Private homes are built right up to the edge of the channel in most locations.

## Existing Survey Information

Survey information was provided by field surveys conducted by Urban Creeks Council (UCC) staff in November and December 2004 and March 2005. The cross-sections and creek profile surveys conducted by UCC were used as the basis for the flood modeling work. There was no topographic basemap provided by the cities of Berkeley or Albany. FarWest Restoration Engineering (FRE) did no independent surveying work.

## Proposed Conditions

A preliminary design of the proposed barrier modification is provided in the main report prepared by UCC (UCC and FRE, 2005). The modification consists of a series of eight step-pools constructed with ½ and one-ton rocks placed immediately downstream of the bridge. The height of the steps in the pools was set at 8 inches.

## HEC-RAS Model Development

Model Geometry

Cross sections for the proposed site conditions were provided by the UCC. Figure 1 shows the location of the hydraulic modeling cross-sections utilized in the model located on the site profile.

A channel station line was developed that follows along the approximate centerline of the proposed creek alignment as measured from the survey. Section 10 the most downstream (west) end of the project and section 4462 is the most upstream section of the project. Approximately 70 cross-sections were developed for the modeling work.

Ineffective Flow Limits

Ineffective flow areas can be set in HEC-RAS to define the boundaries of the active cross-sectional conveyance area. Ineffective areas often occur where there are large variations in the cross-sectional width between adjacent upstream and downstream sections. Ineffective flow limits were set at sections just downstream of the Albina Street Bridge.

Hydraulic Roughness

Manning's 'n' coefficients were used to define the roughness of the channel and overbank areas. Characteristics such as surface roughness, vegetation height and spacing, irregularities in geometry, and flow depths were assessed to estimate the Manning's n coefficients of existing Codornices Creek conditions. The selection of the creek roughness coefficient can impact modeling results significantly. Vegetation characteristics and densities were assumed for the conceptual channel configuration.

For this model study, the table below shows the Manning's n values used for the model sections:

Manning's n Values Used in Modeling

| *Description* | *Manning's n* |
|---|---|
| natural stream bottom w/ gravel and weeds | 0.04 |
| ivy covered banks | 0.05 |
| exposed dirt | 0.045 |
| concrete banks | 0.03 |
| mature eucalyptus grove | 0.07 |
| acacia trees and low grasses and weeds | 0.065 |
| outcropping bedrock with grass and blackberries | 0.06 |
| blackberry, ivy, grass | 0.05 |
| riprap, ivy, grass | 0.06 |
| ivy and small trees | 0.055 |
| concrete rough | 0.015 |
| concrete w/ bare banks | 0.035 |
| hardened with no vegetation | 0.04 |

Downstream Boundary Condition

In a standard step model such as HEC-RAS the water surface elevation at the downstream model boundary must be specified for sub-critical analysis. For this analysis, the downstream slope was taken from previous profile surveys conducted below San Pablo Avenue. The slope was set at approximately 0.0017 although backwater from the downstream 10th Street culvert may reduce the slope.

## Flood Modeling Results

This section presents the modeling results for water surface elevation for the existing and proposed channel conditions. Tables 1 and 2 are summaries of the water surface elevations under both conditions.

Water Surface Elevations

*Existing Conditions*

Figure 2 shows the calculated water surface elevations through the project site under existing conditions. The results indicate that there is existing flooding at all the culvert locations under 10-year storm existing conditions. Note that previous hydraulic analysis by the City of Albany (October 1998) also confirmed this finding.

*Proposed Conditions – Culverts Analysis*

Figure 3 shows the 100-year calculated water surface elevations through the project site under the proposed restoration conditions by analyzing the seven selected culverts, using two methods; 1) embedding the culvert to the depth of the baffle and increasing the Manning's n value to 0.04 and 2) increasing Manning's n to a value of 0.07 in accordance with preliminary measurements obtained in baffled culverts by Washington State Department of Natural Resources staff. The results indicate that there would be a rise in water surface elevation of 8- to 15 inches due to the baffle installation in most of the culverts. Since there is no spare capacity in the culverts under current conditions, it is anticipated that baffles might increase an existing flooding problem. Figure 4 shows the water surface elevations under the 10-year flow conditions.

Note that this flood study was intended to evaluate the change in water surface elevation between the existing and proposed channel conditions. Therefore, it is important to understand that the absolute water surface elevations shown in report tables and associated figures may not be the actual water surface elevations under flood conditions but are calculated values because they are at the boundary limits of the flood model cross-sections and that inflows from storm drains are not included in the model study. Table 1 shows the results of the flood modeling for the culverts analysis under 10 and 100-yr flow conditions compared to existing conditions.

*Proposed Conditions – Albina Avenue Bridge and Upstream Concrete Section Analysis*

The proposed barrier modifications at the Albina Avenue Bridge and upstream concrete section include the following:

- Construction of a step-pool system (alternative A) downstream of the bridge approximately 100 feet with steps set at 8 inches. Each step pool was modeled with three cross-sections as shown in Figure 1.
- Construction of an engineered log structure on the downstream end of the 18-inch step below the concrete channel section.
- Installation of 6-inch baffles across the left hand bank of the concrete channel section.

Table 2 shows the results of the flood modeling under 10 and 100-yr flow conditions compared to existing conditions.

**Conclusions**

The following summarizes the results of the preliminary flood modeling of the proposed creek daylighting and restoration project.

- The culverts are currently undersized for the 10-year flood flows. Installation of baffles is anticipated to increase water levels by 8- to 15 inches which might exacerbate existing conditions.
- The proposed fish barrier modifications at the Albina Avenue Bridge show an increase of approximately three feet under flood flow conditions, however, the modeling shows that there is sufficient capacity in this section to contain the flood flows.
- The upstream concrete channel section is currently undersized for the 10-year flood flows. Installation of the proposed 6-inch side baffles will increase flood flows by 8- to 12 inches.

**References**


1. City of Albany, *Watershed Management Plan*, David Mattern and Associates, October 1998.
2. Kier Associates. 2004. Codornices Creek Watershed Restoration Action Plan. Urban Creeks Council, Berkeley, CA. 37 pp. + 4 apps.
3. Pat Powers, Washington Department of Fish and Wildlife, email communication 2004.
4. Philip Williams and Associates. *Codornices Creek Flood Modeling.* Prepared for the University of California Berkeley, 1997.
5. Urban Creeks Council and FarWest Restoration Engineering. 2005. *Codornices Creek Fish Passage and Habitat Improvement Report*, In progress.

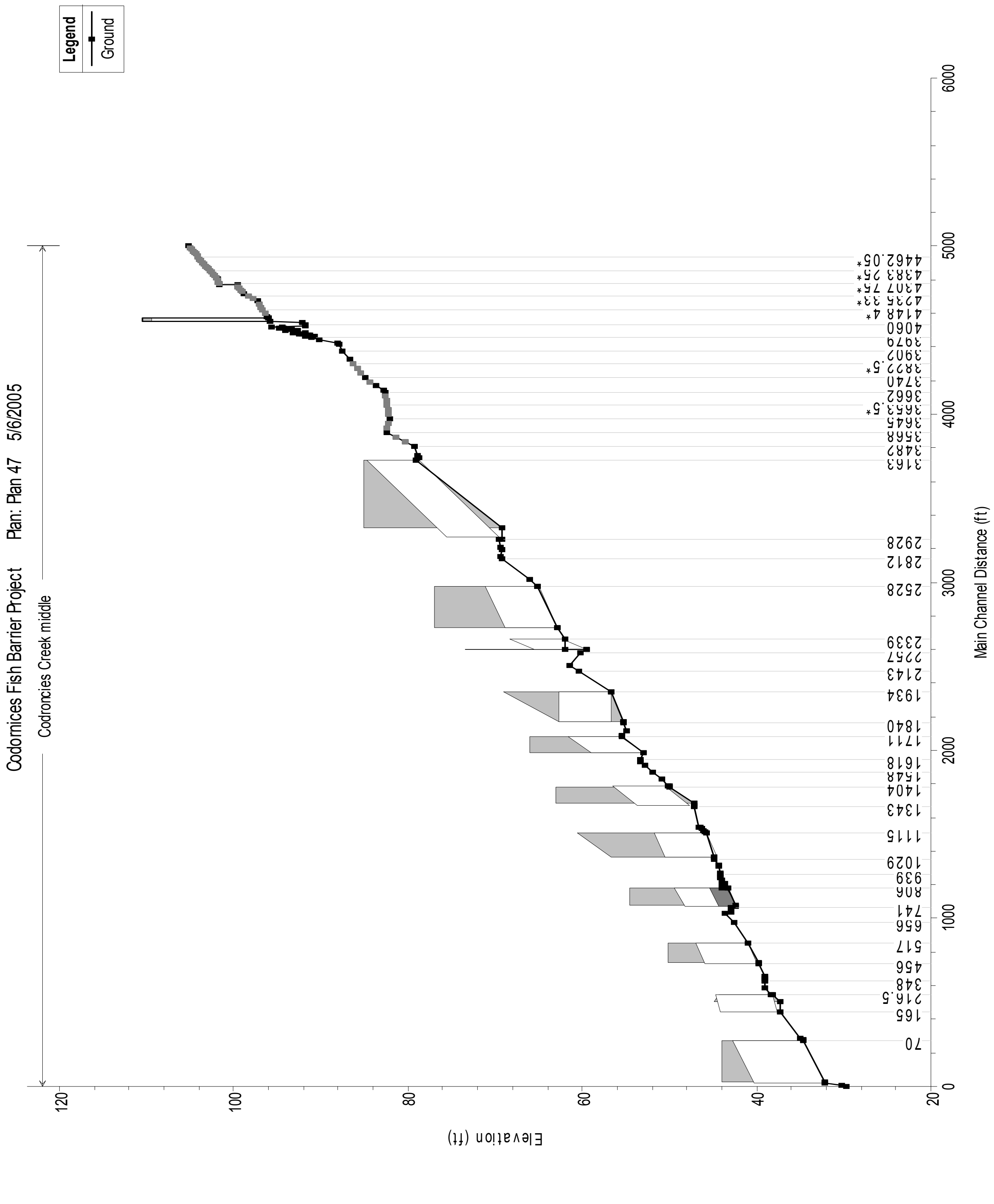



Figure 1: Hydraulic Modeling Cross-Section Locations

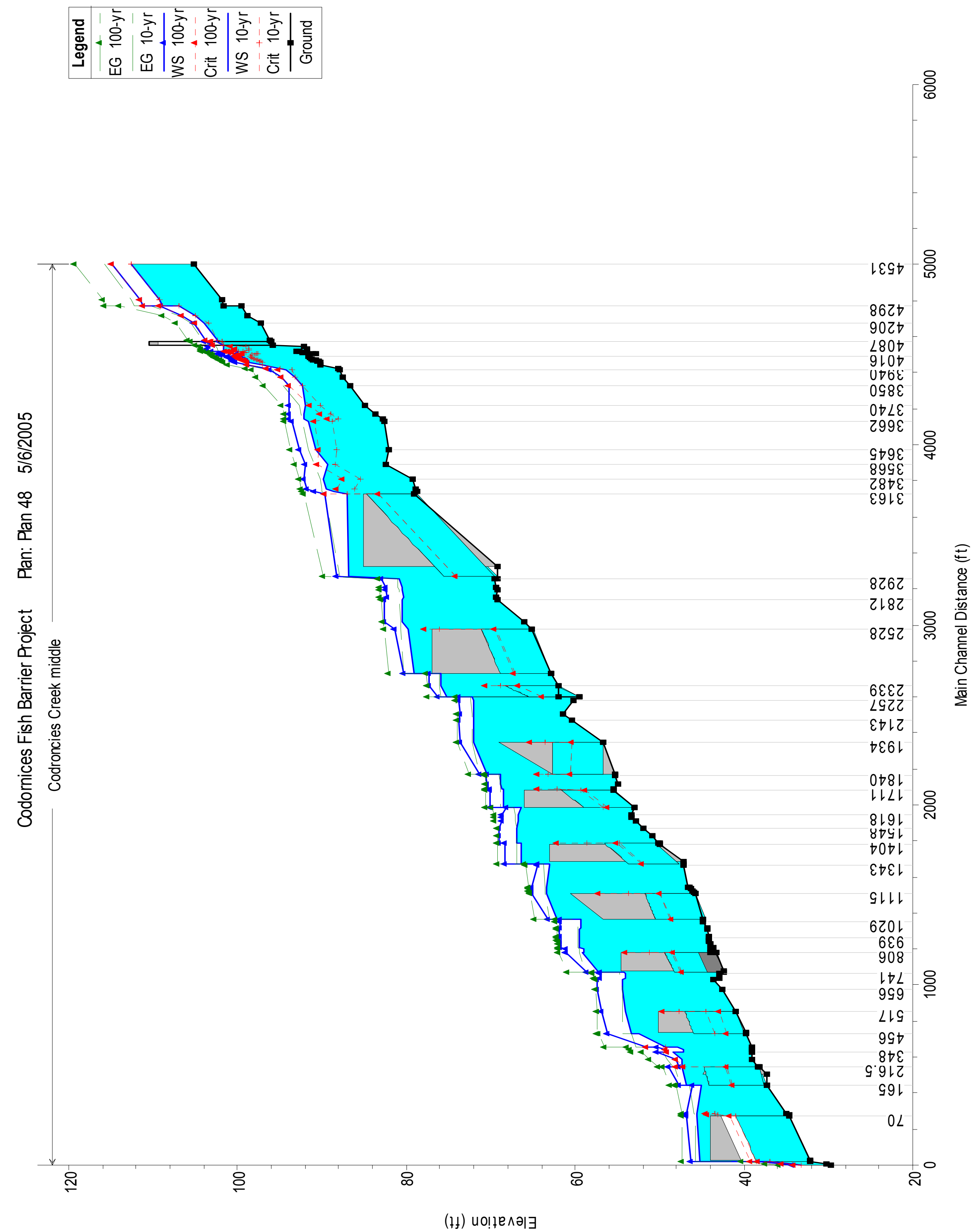



Figure 2: 10-year and 100-year Existing Conditions Water Levels

Appendix B

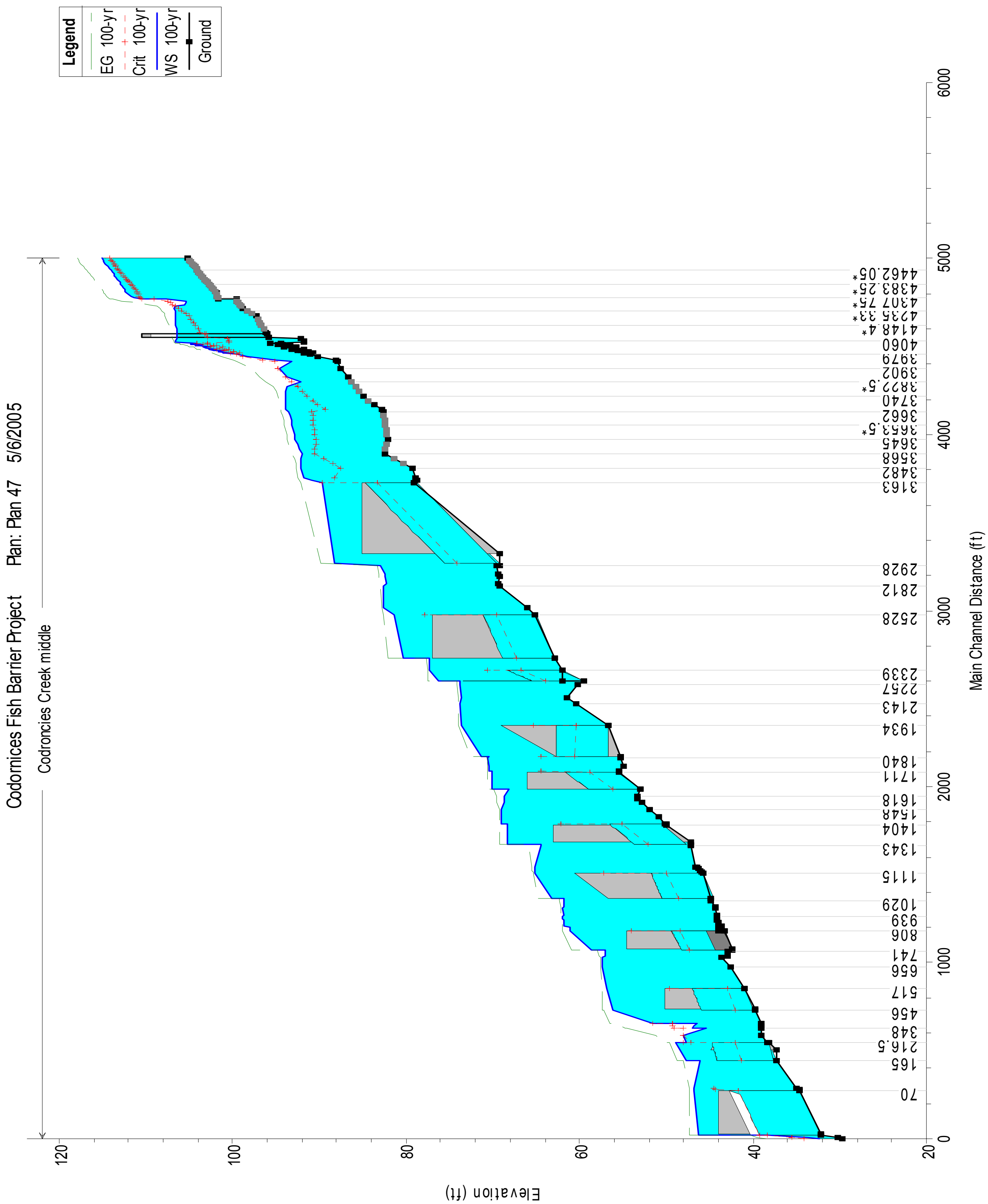



Figure 3: 100-yr Water Surface Elevations under Proposed Conditions

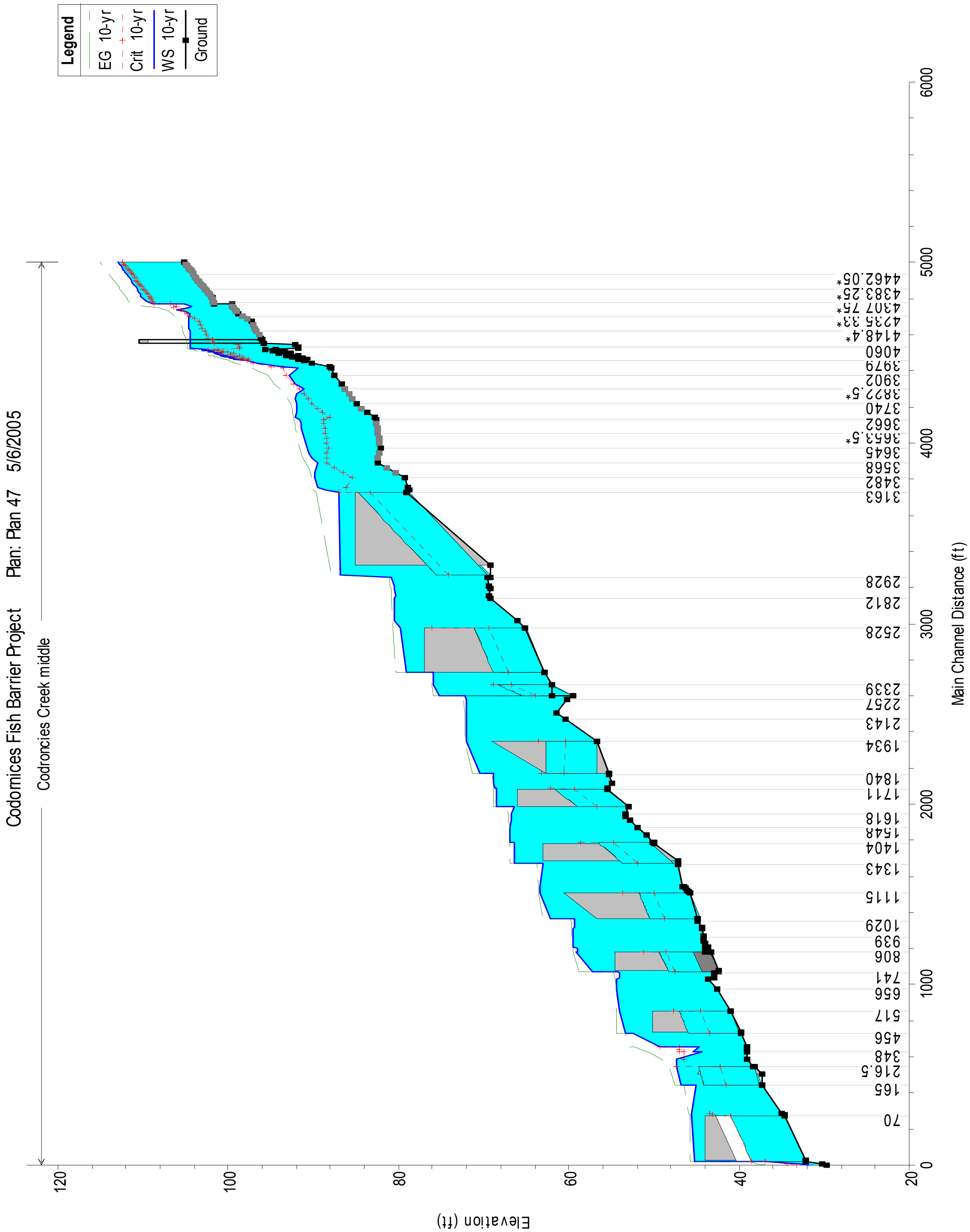



Figure 4: 10-Year Water Surface Elevation under Proposed Conditions

**Table 1.** Evaluation of flooding impacts from fish baffle installation on culverts from San Pablo Avenue to Peralta Avenue. May 12, 2005.

| | Existing Conditions | | 12-Inch Baffles | | | | | | | | 6-inch Baffles | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | evaluation assuming embedded culvert and n=0.04 | | | | evaluation assuming increased mannings n of 0.07 | | | | evaluation assuming embedded culvert | | evaluation assuming increased mannings n of 0.04 | |
| River Station | Existing 10-yr Water Surface elevation (ft CB datum) | Existing 100-yr Water Surface elevation (ft CB datum) | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation |
| 3402 | 86.96 | 89.59 | 89.02 | 2.06 | 89.59 | 0.00 | 89.26 | 2.30 | 90.21 | 0.62 | 87.57 | 0.61 | 89.59 | 0.00 |
| 3163 | Peralta St Culvert | | | | | | | | | | | | | |
| 2934 | 80.77 | 82.92 | 81.74 | 0.97 | 83.76 | 0.84 | 81.86 | 1.09 | 83.85 | 0.93 | 81.29 | 0.52 | 83.34 | 0.42 |
| 2928 | 80.78 | 82.94 | 81.75 | 0.97 | 83.77 | 0.83 | 81.86 | 1.08 | 83.86 | 0.92 | 81.30 | 0.52 | 83.35 | 0.41 |
| 2883 | 80.45 | 82.40 | 81.50 | 1.05 | 83.33 | 0.93 | 81.62 | 1.17 | 83.43 | 1.03 | 81.01 | 0.56 | 82.87 | 0.47 |
| 2872 | 80.43 | 82.38 | 81.49 | 1.06 | 83.32 | 0.94 | 81.61 | 1.18 | 83.41 | 1.03 | 81.00 | 0.57 | 82.85 | 0.47 |
| 2827 | 80.36 | 82.27 | 81.44 | 1.08 | 83.24 | 0.97 | 81.56 | 1.20 | 83.34 | 1.07 | 80.94 | 0.58 | 82.76 | 0.49 |
| 2812 | 80.51 | 82.54 | 81.56 | 1.05 | 83.47 | 0.93 | 81.68 | 1.17 | 83.56 | 1.02 | 81.08 | 0.57 | 83.01 | 0.47 |
| 2690 | 80.55 | 82.59 | 81.58 | 1.03 | 83.50 | 0.91 | 81.70 | 1.15 | 83.60 | 1.01 | 81.10 | 0.55 | 83.05 | 0.46 |
| 2653 | 79.88 | 81.42 | 81.09 | 1.21 | 82.60 | 1.18 | 81.22 | 1.34 | 82.71 | 1.29 | 80.54 | 0.66 | 82.03 | 0.61 |
| 2528 | Neilson Ave Culvert | | | | | | | | | | | | | |
| 2404 | 75.93 | 77.30 | 75.95 | 0.02 | 77.32 | 0.02 | 75.96 | 0.03 | 77.29 | -0.01 | 75.93 | 0.00 | 77.30 | 0.00 |
| 2339 | 75.92 | 77.31 | 75.94 | 0.02 | 77.34 | 0.03 | 75.94 | 0.02 | 77.31 | 0.00 | 75.92 | 0.00 | 77.32 | 0.01 |
| 2307 | Curtis Street Culvert | | | | | | | | | | | | | |
| 2275 | 72.19 | 73.84 | 72.29 | 0.10 | 73.92 | 0.08 | 72.33 | 0.14 | 73.91 | 0.07 | 72.25 | 0.06 | 73.87 | 0.03 |
| 2257 | 72.11 | 73.74 | 72.21 | 0.10 | 73.82 | 0.08 | 72.26 | 0.15 | 73.81 | 0.07 | 72.17 | 0.06 | 73.76 | 0.02 |
| 2181 | 72.08 | 73.69 | 72.19 | 0.11 | 73.78 | 0.09 | 72.23 | 0.15 | 73.77 | 0.08 | 72.15 | 0.07 | 73.72 | 0.03 |
| 2143 | 72.10 | 73.72 | 72.20 | 0.10 | 73.80 | 0.08 | 72.25 | 0.15 | 73.80 | 0.08 | 72.17 | 0.07 | 73.75 | 0.03 |
| 2023 | 72.05 | 73.61 | 72.15 | 0.10 | 73.70 | 0.09 | 72.19 | 0.14 | 73.69 | 0.08 | 72.11 | 0.06 | 73.64 | 0.03 |
| 1934 | Santa Fe Culvert | | | | | | | | | | | | | |
| 1845 | 68.83 | 70.49 | 69.45 | 0.62 | 70.99 | 0.50 | 69.56 | 0.73 | 71.04 | 0.55 | 69.10 | 0.27 | 70.75 | 0.26 |
| 1840 | 68.83 | 70.54 | 69.46 | 0.63 | 71.04 | 0.50 | 69.58 | 0.75 | 71.09 | 0.55 | 69.11 | 0.28 | 70.80 | 0.26 |
| 1791 | 68.81 | 70.50 | 69.44 | 0.63 | 71.01 | 0.51 | 69.56 | 0.75 | 71.06 | 0.56 | 69.09 | 0.28 | 70.77 | 0.27 |
| 1764 | 68.75 | 70.45 | 69.41 | 0.66 | 70.97 | 0.52 | 69.52 | 0.77 | 71.02 | 0.57 | 69.04 | 0.29 | 70.72 | 0.27 |
| 1761 | 68.57 | 70.11 | 69.25 | 0.68 | 70.66 | 0.55 | 69.37 | 0.80 | 70.72 | 0.61 | 68.87 | 0.30 | 70.40 | 0.29 |

| | Existing Conditions | | 12-Inch Baffles | | | | | | | | 6-inch Baffles | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | evaluation assuming embedded culvert and n=0.04 | | | | evaluation assuming increased mannings n of 0.07 | | | | evaluation assuming embedded culvert | | evaluation assuming increased mannings n of 0.04 | |
| River Station | Existing 10-yr Water Surface elevation (ft CB datum) | Existing 100-yr Water Surface elevation (ft CB datum) | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation |
| 1711 | Masonic Culvert | | | | | | | | | | | | | |
| 1659 | 66.43 | 68.18 | 67.46 | 1.03 | 69.22 | 1.04 | 67.67 | 1.24 | 69.45 | 1.27 | 66.9 | 0.47 | 68.66 | 0.48 |
| 1618 | 66.68 | 68.7 | 67.68 | 1 | 69.67 | 0.97 | 67.88 | 1.2 | 69.89 | 1.19 | 67.13 | 0.45 | 69.15 | 0.45 |
| 1607 | 66.66 | 68.68 | 67.67 | 1.01 | 69.65 | 0.97 | 67.87 | 1.21 | 69.87 | 1.19 | 67.12 | 0.46 | 69.12 | 0.44 |
| 1585 | 66.67 | 68.69 | 67.68 | 1.01 | 69.67 | 0.98 | 67.87 | 1.2 | 69.88 | 1.19 | 67.13 | 0.46 | 69.14 | 0.45 |
| 1548 | 66.88 | 69.1 | 67.86 | 0.98 | 70.03 | 0.93 | 68.05 | 1.17 | 70.24 | 1.14 | 67.32 | 0.44 | 69.52 | 0.42 |
| 1506 | 66.88 | 69.1 | 67.86 | 0.98 | 70.03 | 0.93 | 68.05 | 1.17 | 70.24 | 1.14 | 67.32 | 0.44 | 69.52 | 0.42 |
| 1465 | 66.88 | 69.09 | 67.86 | 0.98 | 70.03 | 0.94 | 68.05 | 1.17 | 70.24 | 1.15 | 67.32 | 0.44 | 69.52 | 0.43 |
| 1461 | 66.42 | 68.26 | 67.48 | 1.06 | 69.32 | 1.06 | 67.69 | 1.27 | 69.55 | 1.29 | 66.9 | 0.48 | 68.75 | 0.49 |
| 1404 | Evelyn Culvert | | | | | | | | | | | | | |
| 1346 | 63.06 | 64.5 | 63.06 | 0 | 64.49 | -0.01 | 63.07 | 0.01 | 64.48 | -0.02 | 63.06 | 0 | 64.48 | -0.02 |
| 1343 | 63.04 | 64.46 | 63.05 | 0.01 | 64.45 | -0.01 | 63.06 | 0.02 | 64.44 | -0.02 | 63.04 | 0 | 64.44 | -0.02 |
| 1220 | 63.38 | 65.2 | 63.39 | 0.01 | 65.2 | 0 | 63.4 | 0.02 | 65.19 | -0.01 | 63.39 | 0.01 | 65.19 | -0.01 |
| 1215 | 63.38 | 65.21 | 63.39 | 0.01 | 65.2 | -0.01 | 63.4 | 0.02 | 65.19 | -0.02 | 63.39 | 0.01 | 65.19 | -0.02 |
| 1210 | 63.33 | 65.11 | 63.34 | 0.01 | 65.11 | 0 | 63.35 | 0.02 | 65.09 | -0.02 | 63.33 | 0 | 65.09 | -0.02 |
| 1203 | 63.33 | 65.11 | 63.34 | 0.01 | 65.11 | 0 | 63.35 | 0.02 | 65.1 | -0.01 | 63.34 | 0.01 | 65.1 | -0.01 |
| 1193 | 63.33 | 65.12 | 63.34 | 0.01 | 65.11 | -0.01 | 63.35 | 0.02 | 65.1 | -0.02 | 63.34 | 0.01 | 65.1 | -0.02 |
| 1188 | 63.3 | 65.08 | 63.31 | 0.01 | 65.07 | -0.01 | 63.32 | 0.02 | 65.06 | -0.02 | 63.31 | 0.01 | 65.06 | -0.02 |

| | Existing Conditions | | 12-Inch Baffles | | | | | | | | 6-inch Baffles | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | evaluation assuming embedded culvert and n=0.04 | | | | evaluation assuming increased mannings n of 0.07 | | | | evaluation assuming embedded culvert | | evaluation assuming increased mannings n of 0.04 | |
| River Station | Existing 10-yr Water Surface elevation (ft CB datum) | Existing 100-yr Water Surface elevation (ft CB datum) | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation |
| 1115 | Talbot Culvert | | | | | | | | | | | | | |
| 1041 | 59.41 | 61.75 | 59.45 | 0.04 | 61.76 | 0.01 | 59.48 | 0.07 | 61.75 | 0 | 59.41 | 0 | 61.75 | 0 |
| 1029 | 59.4 | 61.74 | 59.44 | 0.04 | 61.75 | 0.01 | 59.48 | 0.08 | 61.75 | 0.01 | 59.41 | 0.01 | 61.74 | 0 |
| 993 | 59.4 | 61.73 | 59.44 | 0.04 | 61.74 | 0.01 | 59.47 | 0.07 | 61.74 | 0.01 | 59.4 | 0 | 61.73 | 0 |
| 987 | 59.52 | 61.9 | 59.56 | 0.04 | 61.91 | 0.01 | 59.59 | 0.07 | 61.91 | 0.01 | 59.53 | 0.01 | 61.9 | 0 |
| 951 | 59.51 | 61.89 | 59.55 | 0.04 | 61.9 | 0.01 | 59.58 | 0.07 | 61.89 | 0 | 59.52 | 0.01 | 61.88 | -0.01 |
| 939 | 59.54 | 61.93 | 59.58 | 0.04 | 61.94 | 0.01 | 59.61 | 0.07 | 61.93 | 0 | 59.55 | 0.01 | 61.93 | 0 |
| 924 | 59.53 | 61.92 | 59.57 | 0.04 | 61.93 | 0.01 | 59.61 | 0.08 | 61.93 | 0.01 | 59.54 | 0.01 | 61.92 | 0 |
| 921 | 59.44 | 61.74 | 59.48 | 0.04 | 61.75 | 0.01 | 59.51 | 0.07 | 61.75 | 0.01 | 59.44 | 0 | 61.74 | 0 |
| 904 | 59.43 | 61.73 | 59.47 | 0.04 | 61.74 | 0.01 | 59.5 | 0.07 | 61.74 | 0.01 | 59.44 | 0.01 | 61.73 | 0 |
| 883 | 59.43 | 61.73 | 59.47 | 0.04 | 61.74 | 0.01 | 59.5 | 0.07 | 61.74 | 0.01 | 59.44 | 0.01 | 61.73 | 0 |
| 882 | 59.06 | 61.04 | 59.11 | 0.05 | 61.05 | 0.01 | 59.14 | 0.08 | 61.04 | 0 | 59.07 | 0.01 | 61.03 | -0.01 |
| 862 | 59.05 | 61.02 | 59.1 | 0.05 | 61.03 | 0.01 | 59.13 | 0.08 | 61.02 | 0 | 59.06 | 0.01 | 61.02 | 0 |
| 859 | 59.08 | 61.08 | 59.12 | 0.04 | 61.09 | 0.01 | 59.16 | 0.08 | 61.08 | 0 | 59.08 | 0 | 61.07 | -0.01 |
| 806 | Cornell Culvert | | | | | | | | | | | | | |
| 753 | 54.18 | 57.12 | 54.8 | 0.62 | 57.17 | 0.05 | 54.89 | 0.71 | 57.12 | 0 | 54.46 | 0.28 | 57.12 | 0 |
| 741 | 54.07 | 57.01 | 54.71 | 0.64 | 57.07 | 0.06 | 54.81 | 0.74 | 57.02 | 0.01 | 54.37 | 0.3 | 57.01 | 0 |
| 717 | 54.03 | 56.97 | 54.68 | 0.65 | 57.02 | 0.05 | 54.77 | 0.74 | 56.97 | 0 | 54.33 | 0.3 | 56.97 | 0 |
| 708 | 54.35 | 57.45 | 54.97 | 0.62 | 57.5 | 0.05 | 55.06 | 0.71 | 57.46 | 0.01 | 54.64 | 0.29 | 57.46 | 0.01 |
| 656 | 54.36 | 57.45 | 54.97 | 0.61 | 57.5 | 0.05 | 55.06 | 0.7 | 57.46 | 0.01 | 54.64 | 0.28 | 57.45 | 0 |
| 578 | 53.96 | 56.89 | 54.62 | 0.66 | 56.95 | 0.06 | 54.72 | 0.76 | 56.9 | 0.01 | 54.27 | 0.31 | 56.89 | 0 |

| | Existing Conditions | | 12-Inch Baffles | | | | | | | | 6-inch Baffles | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | evaluation assuming embedded culvert and n=0.04 | | | | evaluation assuming increased mannings n of 0.07 | | | | evaluation assuming embedded culvert | | evaluation assuming increased mannings n of 0.04 | |
| River Station | Existing 10-yr Water Surface elevation (ft CB datum) | Existing 100-yr Water Surface elevation (ft CB datum) | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation | Proposed 10-yr Water Surface elevation (ft CB datum) | Increase in 10-yr Water Surface Elevation | Proposed 100-yr Water Surface elevation (ft CB datum) | Increase in 100-yr Water Surface Elevation |
| 517 | Stannage Culvert | | | | | | | | | | | | | |
| 456 | 52.48 | 56.14 | 52.48 | 0 | 56.14 | 0 | 52.48 | 0 | 56.14 | 0 | 52.48 | 0 | 56.14 | 0 |
| 380 | 49.19 | 51.64 | 49.19 | 0 | 51.64 | 0 | 49.19 | 0 | 51.64 | 0 | 49.19 | 0 | 51.64 | 0 |
| 379 | 47.95 | 50.38 | 48.17 | 0.22 | 50.38 | 0 | 48.21 | 0.26 | 50.38 | 0 | 47.99 | 0.04 | 50.38 | 0 |
| 366 | 47.24 | 49.2 | 47.84 | 0.6 | 49.2 | 0 | 47.92 | 0.68 | 49.2 | 0 | 47.54 | 0.3 | 49.2 | 0 |
| 349 | 47.11 | 49.1 | 47.79 | 0.68 | 49.1 | 0 | 47.88 | 0.77 | 49.1 | 0 | 47.46 | 0.35 | 49.1 | 0 |
| 348 | 48.33 | 50.28 | 48.72 | 0.39 | 50.21 | -0.07 | 48.78 | 0.45 | 50.21 | -0.07 | 48.51 | 0.18 | 50.23 | -0.05 |
| 308 | 47.41 | 48.06 | 48.14 | 0.73 | 48.54 | 0.48 | 48.23 | 0.82 | 48.66 | 0.6 | 47.8 | 0.39 | 48.27 | 0.21 |
| 270 | 47.27 | 47.63 | 48.08 | 0.81 | 48.39 | 0.76 | 48.17 | 0.9 | 48.54 | 0.91 | 47.71 | 0.44 | 48.03 | 0.4 |
| 267 | 47.41 | 48.97 | 48.46 | 1.05 | 49.49 | 0.52 | 48.55 | 1.14 | 49.6 | 0.63 | 48.06 | 0.65 | 49.23 | 0.26 |
| 216.5 | Kains Culvert | | | | | | | | | | | | | |
| 167 | 45.95 | 47.63 | 46.6 | 0.65 | 48.01 | 0.38 | 46.81 | 0.86 | 48.24 | 0.61 | 45.99 | 0.04 | 47.54 | -0.09 |
| 165 | 44.98 | 46.14 | 46.29 | 1.31 | 47.64 | 1.5 | 46.57 | 1.59 | 47.93 | 1.79 | 45.38 | 0.4 | 46.73 | 0.59 |
| 100 | 45.49 | 46.8 | 46.48 | 0.99 | 47.8 | 1 | 46.72 | 1.23 | 48.06 | 1.26 | 45.74 | 0.25 | 47.1 | 0.3 |
| 90 | 45.52 | 46.82 | 46.49 | 0.97 | 47.81 | 0.99 | 46.73 | 1.21 | 48.07 | 1.25 | 45.76 | 0.24 | 47.11 | 0.29 |
| 70 | San Pablo Culvert | | | | | | | | | | | | | |
| 50 | 37 | 38.42 | 37 | 0 | 38.42 | 0 | 37 | 0 | 38.42 | 0 | 37 | 0 | 38.42 | 0 |
| 30 | 34.33 | 35.5 | 34.33 | 0 | 35.5 | 0 | 34.33 | 0 | 35.5 | 0 | 34.33 | 0 | 35.5 | 0 |
| 10 | 33.3 | 34.2 | 33.3 | 0 | 34.2 | 0 | 33.3 | 0 | 34.2 | 0 | 33.3 | 0 | 34.2 | 0 |

**Table 2.** Model results for the Albina Avenue alternative A step-pool design and the concrete section baffles upstream of Albina Avenue. May 12, 2005.

| | | | flood modeling results | | | | fish passage results | | |
|---|---|---|---|---|---|---|---|---|---|
| River Station | Existing WSE 10-year flow conditions | Existing WSE 100-year flow conditions | Modeled 10-yr WSE with baffles and Albina Street Step-Pools Alt Awse | Change in WSE (ft) | Modeled 100-yr WSE with baffles and Albina Street Step-Pools Alt Awse | Change in WSE (ft) | velocity at 18 cfs (ft/s) | depth at 3 cfs (ft) | Comments |
| 4531 | 112.56 | 114.82 | 112.97 | 0.41 | 115.11 | 0.29 | 2.99 | 0.34 | 6-inch baffle section |
| 4334 | 109.27 | 111.53 | 110.1 | 0.83 | 112.23 | 0.7 | 2.62 | 0.41 | 6-inch baffle section |
| 4299 | 108.97 | 111.23 | 108.7 | -0.27 | 110.53 | -0.7 | 4.54 | 0.21 | |
| 4298 | 106.98 | 109.32 | 106.84 | -0.14 | 109.06 | -0.26 | 2.42 | 0.45 | engineered log structure |
| 4250 | 105.06 | 106.61 | 104.89 | -0.17 | 106.74 | 0.13 | 3.78 | 0.29 | |
| 4206 | 103.89 | 105.1 | 104.66 | 0.77 | 106.57 | 1.47 | 3.18 | 0.33 | |
| 4110 | 102.28 | 103.74 | 104.44 | 2.16 | 106.46 | 2.72 | 3.55 | 0.24 | |
| 4101 | 102.55 | 103.89 | 104.49 | 1.94 | 106.47 | 2.58 | 1.65 | 0.31 | |
| 4087 | Albina Street Bridge | | | | | | | | |
| 4073 | 101.59 | 103.36 | 104.51 | 2.92 | 106.42 | 3.06 | 0.45 | 2.85 | scour pool below bridge |
| 4060 | 101.7 | 103.53 | 104.55 | 2.85 | 106.53 | 3 | 0.42 | 2.77 | |
| 4056 | 101.69 | 103.55 | 104.54 | 2.85 | 106.52 | 2.97 | 0.42 | 2.77 | end step-pool |
| 4050 | 101.21 | 102.98 | 102.44 | 1.23 | 104.16 | 1.18 | 4.6 | 0.37 | step 8 |
| 4046 | 99.84 | 101.56 | 103.08 | 3.24 | 104.86 | 3.3 | 2.04 | 0.61 | |
| 4040 | 100.11 | 101.87 | 103.02 | 2.91 | 104.81 | 2.94 | 1.92 | 0.66 | |
| 4037 | 100.11 | 101.87 | 101.63 | 1.52 | 103.36 | 1.49 | 4.6 | 0.37 | step 7 |
| 4033 | 100.47 | 102.28 | 102.44 | 1.97 | 104.25 | 1.97 | 1.6 | 0.85 | |
| 4027 | 100.34 | 102.13 | 102.08 | 1.74 | 103.86 | 1.73 | 2.27 | 0.55 | |
| 4024 | 100.18 | 101.95 | 100.84 | 0.66 | 102.56 | 0.61 | 4.60 | 0.37 | step 6 |
| 4021 | 99.87 | 101.60 | 101.62 | 1.75 | 103.42 | 1.82 | 1.71 | 0.77 | |
| 4016 | 99.47 | 101.17 | 101.26 | 1.79 | 103.03 | 1.86 | 2.27 | 0.55 | |
| 4013 | 99.40 | 101.10 | 100.14 | 0.74 | 101.91 | 0.81 | 4.60 | 0.37 | step 5 |
| 4010 | 99.14 | 100.80 | 100.92 | 1.78 | 102.72 | 1.92 | 1.66 | 0.80 | |
| 4004 | 98.95 | 100.63 | 100.46 | 1.51 | 102.22 | 1.59 | 2.44 | 0.51 | |
| 4000 | 98.77 | 100.46 | 99.24 | 0.47 | 100.96 | 0.50 | 4.60 | 0.37 | step 4 |
| 3998 | 98.82 | 100.52 | 99.93 | 1.11 | 101.70 | 1.18 | 2.20 | 0.56 | |
| 3993 | 98.79 | 100.51 | 99.84 | 1.05 | 101.62 | 1.11 | 2.08 | 0.60 | |
| 3990 | 98.79 | 100.51 | 98.74 | -0.05 | 100.47 | -0.04 | 4.60 | 0.37 | step 3 |
| 3987 | 98.75 | 100.47 | 99.33 | 0.58 | 101.10 | 0.63 | 2.12 | 0.59 | |
| 3979 | 98.60 | 100.33 | 97.84 | -0.76 | 99.56 | -0.77 | 4.16 | 0.41 | step 2 |
| 3966 | 97.04 | 98.76 | 97.04 | 0.00 | 98.76 | 0.00 | 4.60 | 0.37 | begin step pool alt A |

| | | | | flood modeling results | | | | | fish passage results | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| River Station | Existing WSE 10-year flow conditions | Existing WSE 100-year flow conditions | | Modeled 10-yr WSE with baffles and Albina Street Step-Pools Alt Awse | Change in WSE (ft) | | Modeled 100-yr WSE with baffles and Albina Street Step-Pools Alt Awse | Change in WSE (ft) | | velocity at 18 cfs (ft/s) | depth at 3 cfs (ft) | Comments |
| 3946 | 94.88 | 96.57 | | 94.88 | 0 | | 96.57 | 0 | | 4.6 | 0.37 | |
| 3940 | 94.33 | 96.15 | | 94.33 | 0 | | 96.15 | 0 | | 2.62 | 0.29 | |
| 3902 | 93.11 | 94.75 | | 93.11 | 0 | | 94.75 | 0 | | 3.54 | 0.23 | |
| 3850 | 92.25 | 93.89 | | 92.25 | 0 | | 93.89 | 0 | | 2.94 | 0.24 | |
| 3740 | 92.02 | 93.89 | | 92.04 | 0.02 | | 93.91 | 0.02 | | 4.2 | 0.24 | |
| 3697 | 92.06 | 93.93 | | 92.04 | -0.02 | | 93.92 | -0.01 | | 4.35 | 0.23 | |
| 3668 | 92.08 | 93.95 | | 92.07 | -0.01 | | 93.95 | 0 | | 1.86 | 0.41 | |
| 3662 | 91.64 | 93.53 | | 91.63 | -0.01 | | 93.52 | -0.01 | | 1.81 | 0.44 | |
| 3645 | 90.76 | 92.73 | | 90.76 | 0 | | 92.75 | 0.02 | | 1.59 | 0.62 | |
| 3568 | 89.36 | 91.87 | | 89.49 | 0.13 | | 91.92 | 0.05 | | 4.18 | 0.22 | |
| 3482 | 89.84 | 92.19 | | 89.84 | 0 | | 92.19 | 0 | | 2.9 | 0.3 | |
| 3431 | 89.45 | 91.74 | | 89.45 | 0 | | 91.74 | 0 | | 2.59 | 0.38 | |
| 3417 | 88.62 | 90.91 | | 88.62 | 0 | | 90.91 | 0 | | 2.26 | 0.73 | |

Notes: Interpolated cross-sections not shown

Kenneth R. Hughes
Structural Engineer
3620 Mt. Diablo Blvd. #203
Lafayette, CA 94549
Tel.# 925-284-2808

4-11-2004

Roger Leventhal, P.E.
FarWest Restoration Engineering
( farwesteng@aol.com )

**Re: Codornices Creek**

Roger,

This is a summary of my observations and recommendations regarding the concrete channel section of Codornices Creek above the Albina Street Bridge. I reviewed this section of the Creek on April 7th. It is about 230 feet long and the lower end starts a couple hundred feet above the Bridge. The concern that you expressed is in the fast flow and shallow depth of water through this area and the vertical drop at the lower end. All of this makes it difficult or impossible for fish to migrate upstream.

The concrete creek channel in this area is structurally significant in that it is contiguous with the base of the adjacent retaining walls and appears to be acting as a foundation for these retaining walls. The retaining walls boarder multiple private residences and are a mixture of construction varying from concrete to concrete block. Much of the retaining wall construction appears old and of questionable structural integrity.

One consideration is to notch the concrete creek in order to create a deeper channel thus slowing the flow and deepening the water. My concern is that cutting such a notch will compromise the foundation of the already tenuous retaining wall structures. To do this properly would require buttressing the adjacent retaining walls. This could be done by construction a series of vertical soldier beams along the face of the walls - each soldier beam would consist of a reinforced concrete pilaster extending up from a drilled and cast-in-place concrete pier. The cost of doing this would be very expensive especially considering the limited access for construction equipment and need to work in a water environment.

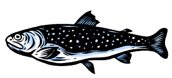
A more practical solution would be to add cross-baffles in the concrete channel then deal with the vertical drop at the downstream end by building up and reconfiguring the bottom of the creek just below the step. From our rough field measurements the vertical drop of the creek bottom from the end of the concrete channel (the top of the step you are most concerned about) to a point about 40 feet downstream is about 2.5 to 3 feet. If building this area up can be done without detrimentally affecting the flood height of the creek I feel that it will be the most cost effective solution.

Kenneth R. Hughes
Structural Engineer

# *You Are Invited...*

*Join Urban Creeks Council for a*
***Community Meeting***
*regarding the*
***Codornices Creek Watershed Restoration Action Plan**.*

*Learn about current activities throughout the watershed, planned restoration measures, existing steelhead populations, water quality, and how you can get involved.*



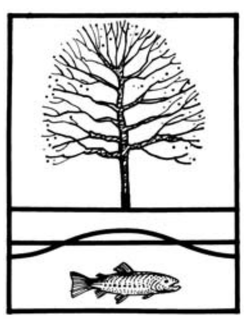
***Community Meeting***
***Date: April 27, 2005***
***Time: 7:00 PM***

*Shea Center*
*St. Mary's College High School*
*1294 Albina Avenue, Berkeley*

For More Information Contact:

Urban Creeks Council
510.540.6669
emma@urbancreeks.org

## *The Codornices Creek Watershed Restoration Action Program*



*Learn more at*
*www.urbancreeks.org/CCWRAP.html*

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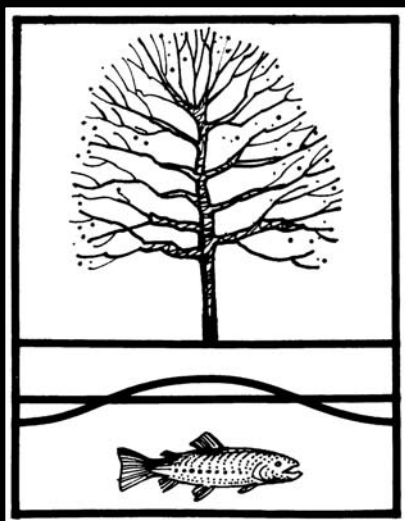
*Codornices Watershed Resident*

# Want more fish in your backyard?



**Codornices Creek**
**Watershed Restoration Plan**

**Funded by CALFED and**
**Department of Water Resources**

Berkeley CA 94702

Phone: 510.540.6669
Fax: 510.848.2219
www.urbancreeks.org

*So do we.*

*Join Urban Creeks Council for a*

*Community Meeting.*

*Come discuss plans to improve the habitat and increase the distribution of steelhead within Codornices Creek.*

*Learn about planned activities,*
*existing steelhead populations,*
*water quality, and*
*how you can be involved.*

*Refreshments will be provided.*

***Date: 04/27/2005***
***Time: 07:00 PM***

*St. Mary's College High School*
*Shea Center*

*1294 Albina Avenue*

***Contact: 510 540 6669***
***emma@urbancreeks.org***

**Urban Creeks Council will be surveying Codornices Creek during October and November to identify how we can improve fish habitat.**

This is in conjunction with the Codornices Creek Watershed Restoration Action Program funded by CALFED and Department of Water Resources.

If you have any questions or concerns, please call us.
**(510)540-6669**

| |
|---|
| Interested in an onsite evaluation of your creekside property complete with recommendations on how to improve the quality of both your property and Codornices Creek? **Free of charge.** Contact us. |

**The Codornices Creek Watershed Restoration Action Program Continues!**

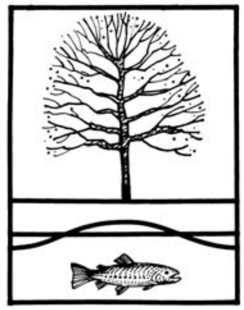
Learn more about this CALFED project:
http://www.urbancreeks.org/CCWRAP.html

*<<Address>>*

*Look for future updates!!*

Urban Creeks Council
1250 Addison St #107 · Berkeley CA 94702

# Codornices Creek Watershed Restoration Action Plan (CCWRAP)



**Who We Are:**
Urban Creeks Council Staff
Urban Creeks Council is a grassroots, non-profit in Berkeley working to protect, preserve, and restore urban streams

**What's Going On:**
Currently, we are obtaining elevations of the Codornices creek corridor and its nearby surroundings. This information will be used in developing a design for the CCWRAP.

CCWRAP is a restoration plan for Codornices Creek from San Pablo Avenue to Albina Avenue. The goal is to restore habitat and passage for the steelhead/trout population that is present within the creek.

Fish and habitat studies were conducted in 2002 and 2003. Based upon these findings, we are developing a design to reduce sedimentation and pesticide runoff while making the culverts passable to fish and stabilizing the banks.

**Funding:**
CALFED and the California Department of Water Resources

**How You Can Get Involved:**

- Contact us with questions, concerns at 540-6669
- Come to community meetings (look for mailings)
- Call us to do a FREE onsite evaluation of your creekside property
- Reduce your use of pesticides
- Learn more at http://www.urbancreeks.org/CCWRAP.html