What's Past is Present:
A Re-Evaluation of Cerrito Creek

University of California, Berkeley

LD ARCH 227 - Restoration of Rivers and Streams

by :
Matthew Sasaki
Mingyao Wang
Thea Yang

December 17, 2018

Abstract

A 2000-foot-long reach of Cerrito Creek runs through the University of California, Berkeley-owned Blake Garden. Past student groups have conducted surveys and hydrologic studies on this reach and in a 2010 study suggested recommendations for restoration. In this study, we assessed current creek conditions and compared them to the conditions surveyed in 2010 to determine whether the recommendations are still valid and feasible. To recreate the 2010 study, we attempted to conduct cross-section surveys at roughly the same points as the previous study. We also 3D modeled this reach on both time nodes to achieve the comparison. We found that most recommendations had not been implemented and as a result, the channel continued to experience erosion and incision. We concluded that most of the recommendations are still valid but must be adjusted to address the current conditions and the financial limitations. Taking all factors into consideration, we agreed that low-cost alternatives like biological stabilization using local riparian vegetation would be the most feasible solution. Therefore we did an existing plant

survey of the area along the creek and referenced the prior studies, came up with a plant species list and design suggestions in response to multiple purposes of the restoration plan.

1. Introduction

1.1 Background Information

Cerrito Creek, flowing from a deep ravine, was the largest of a number of creeks draining from the Berkeley Hills into a large salt marsh between Albany Hill and Point Isabel west of today's San Pablo Avenue (Oakland Museum of California website)(Figure 1). The watershed currently contains a total of 3.9 miles of open channel. However, stormwater routing, stream culverting, impervious surface increase, and channel construction have significantly altered the natural drainage of the creek.

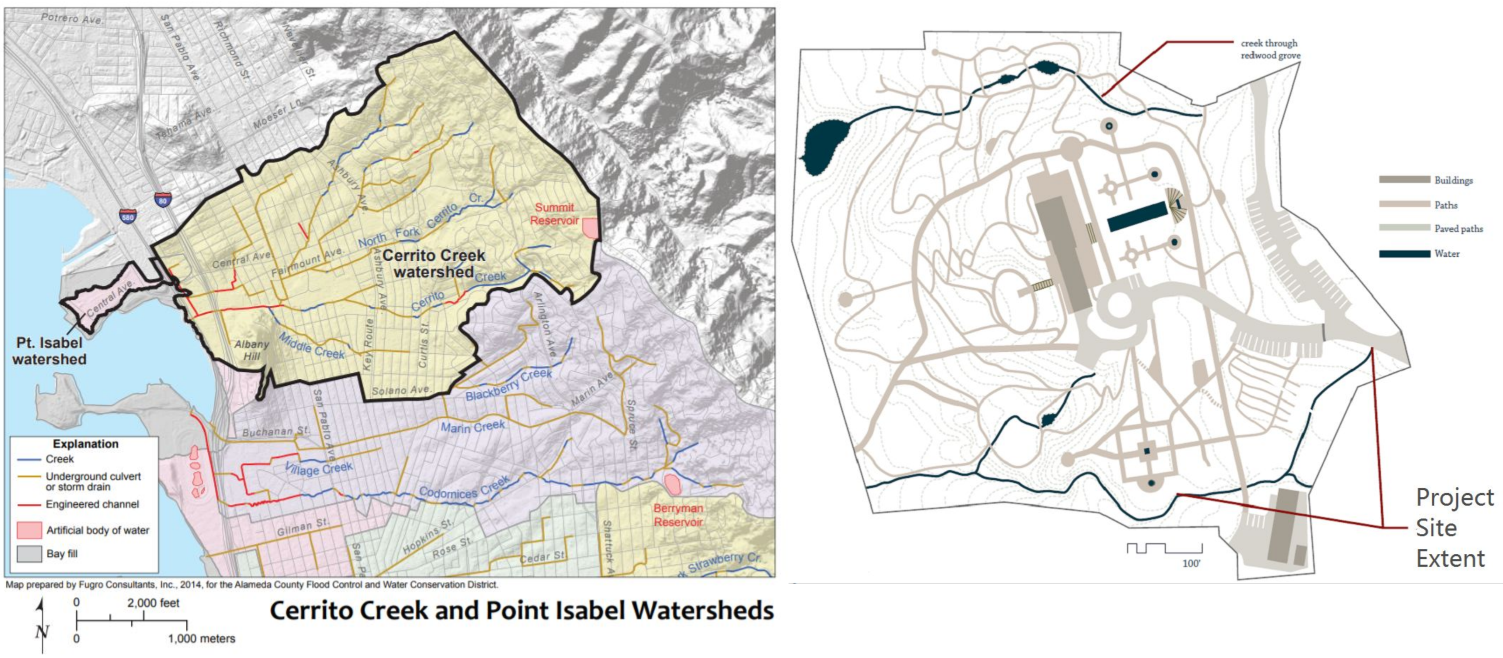


Figure 1 : Site location

Our project focuses on the upper part of Cerrito Creek within Blake Garden, a 10.6 acre public garden located in Kensington. Blake Garden sits in a watershed defined on the east by the ridge of the Berkeley hills and includes a series of small creeks that flow into the San Francisco

Bay. Although nearly all of the four creeks in Kensington were radically reshaped and/or placed in culverts, the sections of Cerrito creek flowing through Blake Garden remain mostly open (Jewell & Norcross, 2007).

Cerrito Creek suffers from a long history of instability. Evidence of channel stability projects in the 1960s and 1970s include broken concrete wall revetments and sac-crete in addition to more recent interventions (Miriam Eason & Daisy Gonzalez, 2013). During our field survey, we also witnessed the repairs of stone walls along some portions of the creek that were severely eroded.

1.2 Research Questions

Principal objective was to compare the creek current conditions with that in 2010 documented by Greenberg et al. 2010 and to identify what portions of the creek are becoming/have become hazardous due to deterioration (destabilization, undercutting, scouring) to determine if the previous recommendations made in prior projects would still be appropriate. To address the issue, we wanted to determine some low-cost restoration techniques that can be used on the creek.

Another issue we were concerned about is the public access and aesthetic of the creek. The garden serves as a community space and welcomes community members to learn more about the garden or just to take a relaxing stroll. We wanted to ensure that interventions on the creek will be integrated into the site and not disrupt the visitor experience of the garden.

Plants can be used as the primary structural component or in combination with inert materials like rock, concrete, and steel to help stabilize streambanks. The use of plants could reduce the erosive forces of water and increase soil's resistance to those erosive forces(Wells, 2002). Therefore, plant selection needs to be prudent to increase the aesthetic value and biodiversity while still maintaining visibility to ensure safety.

2. Methods and Approach

To re-evaluate the feasibility of the recommendations made in the 2010 report, "Towards a Stable Future:A Design Proposal for Cerrito Creek in Blake Garden, Kensington, California," our team used similar methods as those reported in the 2010 report. These methods included interviewing the Blake Garden administration and staff, taking inventory of past project reports, cross-section surveying, plant surveying, conducting GIS analysis and using interpolation and 3D Modelling to detect the change of surface of river bank from 2010 to current.

Our field work and analysis was conducted between October 1, 2018 and November 14, 2018. We planned to conduct all of our fieldwork prior to the beginning of the rainy season to avoid having the geometry of the creek change, mid-project, due to rain.

2.1 Interviews with the Administration and Staff

To gain a better understanding of the conditions of Cerrito Creek and how these conditions have changed the creek over time, we conducted interviews with the Blake Garden staff who have worked with the creek.

When we were first acquainted with the project at Blake Garden, we found out that most of the current staff had only recently joined and were relatively new to the site. Both the manager, Meghan Ray, and staff member, Timothy Cole, had been at Blake Garden for less than a year. The only staff member who had substantial experience with the creek was Mike Frappier. These interviews also helped us understand what the staff wanted from this project and how they envisioned the future of the creek.

2.2 Review Past Project Reports

Blake Garden has been the site of many projects as it is managed by the University of California, Berkeley Department of Landscape Architecture and Environmental Planning. There are four specific project reports that were produced by former UC Berkeley students focused on the same reach of Cerrito Creek that runs through Blake Garden. These reports include research, survey, and design proposals that provided a basis for our project. Our project is primarily focused on the 2010 project conducted on Cerrito Creek but we have taken into consideration other findings in previous reports. Consistent studies of the site enabled us to observe the change of the creek condition overtime and to examine the effectiveness of some creek restoration strategies.

In the 2007 report "Restoration With Reference: Rediscovering Cerrito Creek in Blake Garden", Jessica Ludy and Kristen Podalak identified incision and bank erosion, resulting from upstream urbanization and stream bank clearing of invasive species, as the main concerns. They also identified the desire of garden staff to increase the accessibility and visibility of the creek, which was echoed by staff during our visit 11 years later. They proposed a restoration plan with a dual focus on both the hydrologic function of the creek and the aesthetical function of the garden.

The 2008 proposal by Nathaniel Behrends "Cerrito Creek Step-Pools: An Opportunity for Restoration and Education at Blake Garden" developed a conceptual model of the restoration plan. It recommended a system of step pool to restore channel stability and physical access, as well as for aesthetic and educational considerations.

The 2013 study by Miriam Eason and Daisy Gonzalez, "Comparison of Winter Creek and Cerrito Creek: How Institutional Factors Determine Intervention Strategies," compared Winter Creek with Cerrito Creek, taking limited funding and technology interventions into consideration, recommended a feasibility study to identify opportunities and constraints.

The 2010 study by Karuna Greenberg, Pedro Pinto and Catherine Sherraden, which was our major reference, stated its goal to come up with a conceptual design for an eventual in-stream restoration project. It included comprehensive surveys, calculations and assessments, which lead to their proposals of interventions of bank stabilization, re-grading floodplains and introducing step pools through cross sections redesign.

All the prior studies together laid a base for our project, provided useful historic data and guided our research direction. Using the previous data and research, we compared findings with our newly collected data to reach a conclusion of the creek morphology transformation.

2.3 Cross-section Survey

The team who conducted the 2010 study on Cerrito Creek surveyed eighteen cross-sections as well as a longitudinal profile of the creek. Each cross-section survey point was marked by two wooden stakes, on either side of the creek, with the cross-section label (A-Q) (Figure 2). We had planned on taking cross-section surveys at these same points but found that over time, some of the stakes had either been rotted and washed away by prior rains, moved by groundskeepers. Of the eighteen original cross-sections, we were only able to find markers for sixteen of them. However, of these sixteen cross-sections, only four of them had markers on both sides of the creek. To address this, we used the original map from the 2010 report of the creek and location of the cross-sections to estimate where the original surveys were conducted. In addition, some cross-section surveys in 2010 were conducted on properties adjacent to the Blake Garden, which we did not have access to.

Figure 2: Example of non-permanent cross section marker left by the 2010 project team

We were unable to complete all the surveys we had originally planned on due to the Camp Fire in Butte County. The fire began on November 8, 2018 and caused the air quality at our project site to drop to hazardous levels. As a result, our team decided to end our fieldwork prematurely. In total, we were able to conduct twelve cross-section surveys. We were unable to conduct a longitudinal profile of the creek.

2.4 Planting Survey

Blake garden is characterized by its abundant collection of plant materials that grow in Mediterranean type climate (Blake garden official brochure). Together they create a unique and beautiful image that is greatly appreciated by the students and the public.

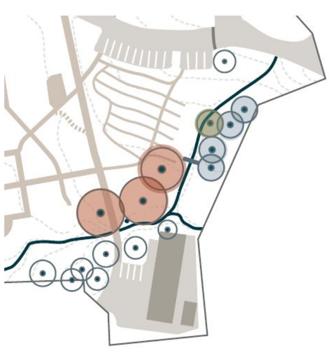
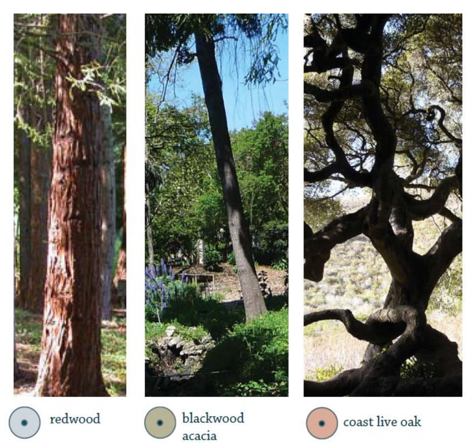


Figure 3: Exiting plant plan



The 2010 study included an existing plan within the reach (Figure 3). Based on the study, we identified the existing shrubs and groundcover planting species, as well as the invasive and poisonous species with the help of Timothy Cole. According to the prior studies and Timothy's opinions, we concluded the main problem of the planting would be tall shrubs blocking views and erosion on rhe barren bank.

2.5 GIS Analysis

Through our interviews with the Blake Garden staff, we found that most of the flow that enters Cerrito Creek is stormwater runoff that comes from upstream portions of the watershed. To get a better understanding of how much water was actually draining into Cerrito Creek, we conducted GIS analysis using files from the UC Berkeley GIS database as well as data from the Contra Costa County Public Works: Flood Control and Water Conservation District. We compiled maps of the stormwater drainage network, watershed delineations, rainfall data, and creek drainage areas to calculate how much water was entering the creek on average.

2.6 Interpolation and 3D Modelling

Interpolation is a mathematical method to construct new data based on known discrete survey points. In 3D modeling, interpolation often is used to create a continuous surface. As we could not find all the survey stations from the 2010 study, and considering that river bank has changed over time, it is not necessary and not possible to conduct cross section surveys in exactly the same locations as the previous project. Instead of comparing cross sections from two years that were not even at the same location, we decided to use the cross-section data that we and the 2010 team collected, to create continuous surfaces of the past and present river bank using the Sweep2 tool (importing flow line as the rail, and plotting survey points of each cross sections as multiple cross section curves in the order in which the surface will pass through them), to detect where banks have been eroded, and where there has been deposition over time, which will help us decide where the intervention should be applied.

3. Results

3.1 Interviews with the Administration and Staff

Interviews with Meghan Ray and Timothy Cole provided valuable background information on the conditions of Cerrito Creek, current stabilization concerns and ongoing projects in Blake Garden, and goals for the portion of the creek.

As mentioned above, most of the current staff at Blake Garden are relatively new and do not have an extensive knowledge of the creek that would come with time. However, they were able to make some key observations during their time there supplemented by information they received from Mike Frappier. Timothy Cole described his understanding of the flow that enters the channel running through our site. He differentiated between the two branches that enter the creek from the North and from the South. The North branch is primarily supplied by a storm drain culvert that drains a residential area. The South branch is primarily supplied by flow from a neighboring private residence. Cole noted that during the Summer the creek nearly dries out while in the Winter, during the rainy season, high flows enter the through the North branch. The incision and undercutting near the outflow of the stormwater culvert are evidence of these high flows.

Along with this, the outflowing water experiences an eight foot drop, causing greater erosion at the outlet. The resulting steep banks and potential bank failure has been cause for concern as it presents a potential safety hazard to visitors of the garden. As such, they have had to block off the area to visitors, reducing the accessibility of the creek.

Both Ray and Cole noted that the portion of the creek that they were currently most concerned about was the area near the greenhouse and the recreation area. This area has been experiencing high levels of erosion and has been slowly encroaching upon these key areas. Attempts to stabilize the banks of these areas have been made in the form of concrete reinforcement (Figure 3). Mike Frappier has been using concrete bricks and concrete cylinders to create an artificial bank that would be more resistant to erosion.

Figure 3: Concrete reinforcement of a portion of the creek.

During our interviews we also found that none of the recommendations or previous design proposals from the 2010 report were ever carried out on the creek due to financial limitations and concerns over permitting from the county.

Being new to the site, both Ray and Cole were mostly interested in gaining more knowledge about the stream. They also expressed an interest in increasing accessibility to the creek and integrating the creek into the design of the garden and would like to use multiple bank stabilization alternatives, in addition to the concrete reinforcement, so that it will be educational, aesthetically pleasing, and provide habitat along the creek.

3.2 Cross-Section Survey

As noted above, we were unable to conduct the exact same surveys as those conducted as part of the 2010 project. We surveyed a total of twelve cross-sections, labeled from “E” to “P”, illustrating the changing channel morphology. Cross section E from 2010 and 2018 show a consistent profile, demonstrating a relatively stable portion of the creek (Figure 5). Energy is dissipated at a bend before this point, reducing the possibility of erosion and incision. Cross section O was taken at a portion of the creek where they have reinforced the banks with concrete. Cross-section N was taken at the point right after the concrete reinforcement ended. As shown in Figure 6, The concrete reinforcement significantly reduces the width of the actual creek. Cross section K was also taken at a point where the creek had experienced significant erosion and was in the process of being stabilized using concrete cylinders (Figure 4). Cross section J was taken downstream of this point. Figure 7 shows that the bank has experienced erosion causing the channel to widen at this point.

Figure 4: Sac-crete reinforcement of the creek near the recreation area

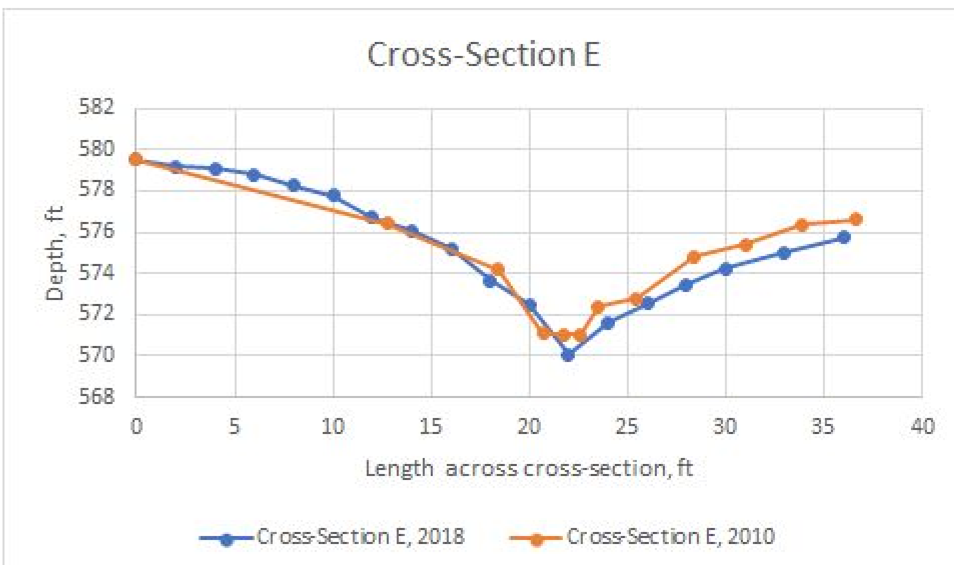


Figure 5: Survey results of cross-section E from 2010 and 2018 show a similar profile showing no large incision or erosion over the years.

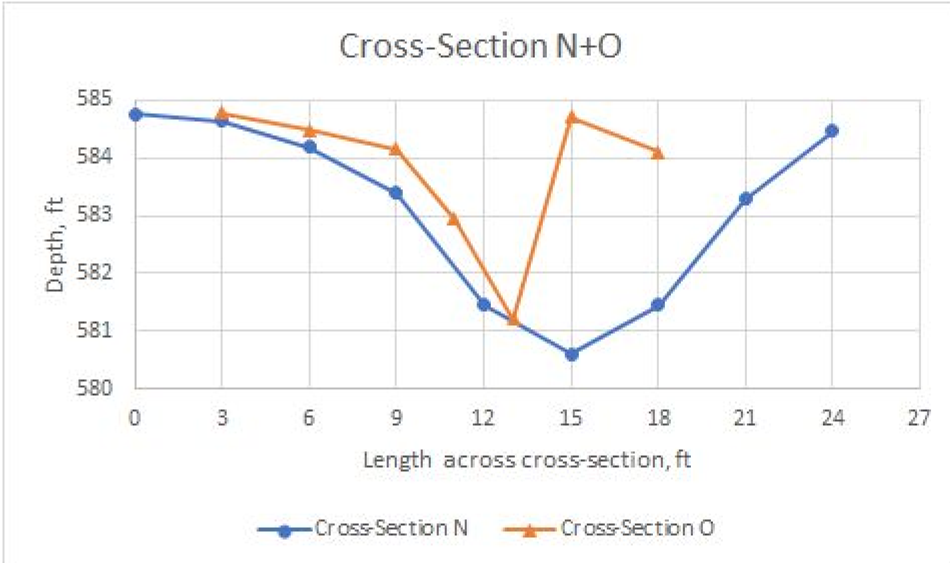


Figure 6: Survey results of cross-sections N and O that show the narrowing of the creek as a result of the concrete stabilization.

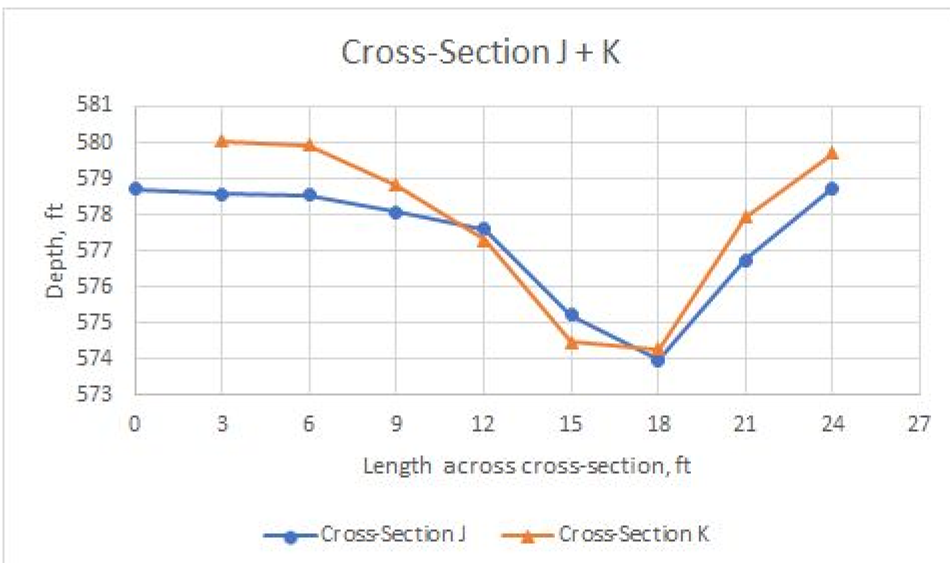


Figure 7: Survey results of cross-sections J and K that show the erosion taking place right after the concrete stabilized portion of the creek.

3.3 Planting Survey

We found a lot of horsetail being planted along the creek close to the greenhouse. The plants were around 1.2-1.5 m tall and in very dense stand which could lead to a decrease in visibility and potential unsafety. Cole also warned us about Poison Oak , which may cause severe rash to the skin. He also mentioned that they recently cleared nonnative invasive Himalayan blackberry (*Rubus discolor*) and seeked suggestions on plant species to fill the barren bank.

3.4 GIS Analysis

The Contra Costa County Public Works provided us with a GIS file of the stormwater drain network that ultimately drains into our portion of Cerrito Creek. Using the stormwater drain network, we were able to determine that the total area contributing to the creek was approximately 60 acres. We were then able to get GIS files of the annual rainfall that falls on the area of concern from the University of California, Berkeley, Geodata Library. This value showed that on average, the area gets 22 inches of precipitation. Using both of these data sets and the Alameda County Hydrology and Hydraulics Manual (Alameda, 2003), we were able to calculate the flow in the creek using the Rational Method. The Rational Method is indicated by the Contra Costa County as the preferred method for hydrological analysis for planning and design (Contra Costa County 2010) and the governing equation is Q=CIA, where Q is the flow in cubic feet per second, C is the runoff coefficient of the area, I is the rainfall intensity, and A is the area contributing to the flow in acres.We determined a C value of 0.6 based on the Type D soil type (Contra Costa County, 2010) and the approximately 65% impervious area for the county (CCCWP 2004). The time of concentration for the creek was calculated using a headlands slope of 15% for a flow distance of 500 feet to be around nine minutes plus the time in the channel which was calculated using a velocity of five fps for a channel length of 2020 feet to be about 6.7 minutes. The total time of concentration used was 15.7 minutes. The average rainfall used was 22 inches (CCCWP 2004). Using the Contra Costa County Precipitation- Duration- Frequency-

Depth charts for 5, 10, 25, 50 and 100 year storm, we were able to calculate the flow through the creek. The values for this analysis are shown in Table 1 below (Contra Costa County 1977).

Table 1: Flowrate values through Cerrito Creek based on the Rational Method

Return Period, years	Precipitation Intensity , in / hr	Flowrate, ft^3/s
5	1.45	52.2
10	1.72	61.92
25	1.91	68.76
50	2.22	79.92
100	2.48	89.28

Figure 8: Location map of Blake Garden used for the GIS analysis

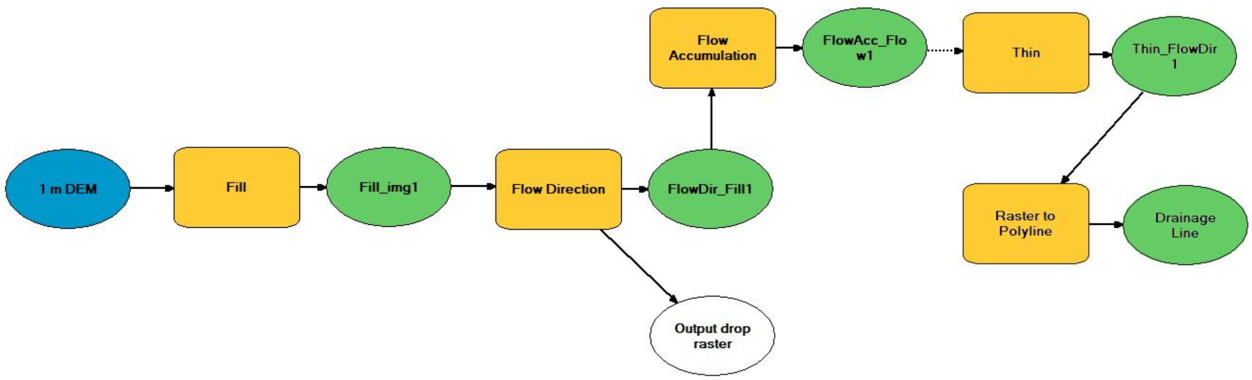


Figure 9: Flowchart of Hydrology Analysis process

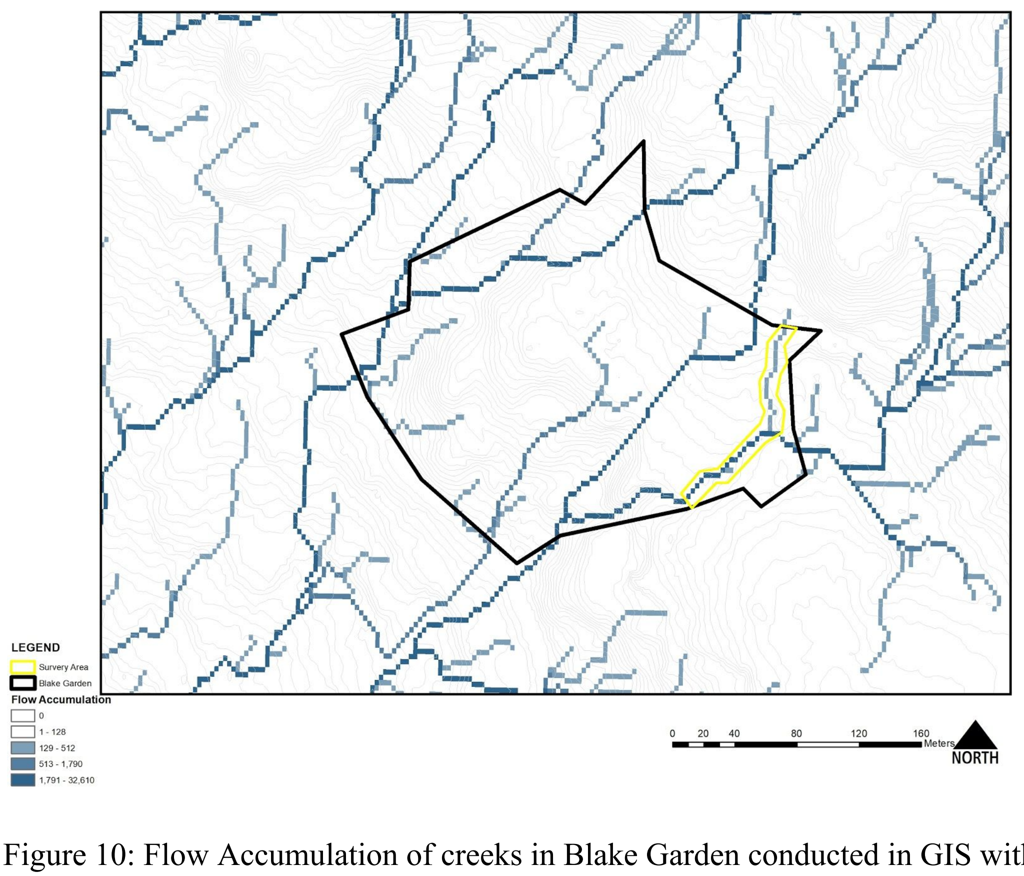


Figure 10: Flow Accumulation of creeks in Blake Garden conducted in GIS with 1m contour.

3.5 Detect the Change of River Bank Using Interpolation and 3D Modelling

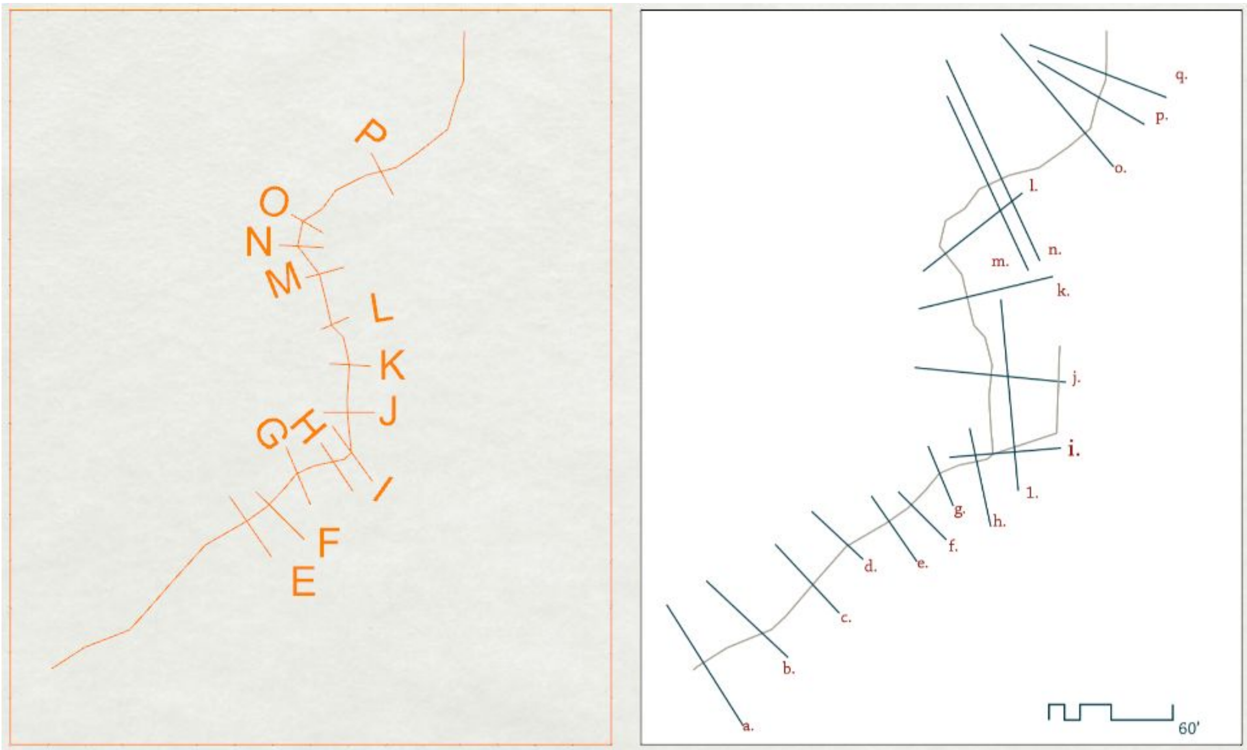


Figure 11: Left: Cross-section surveys conducted on this project. Right: Cross-section surveys conducted on the 2010 project

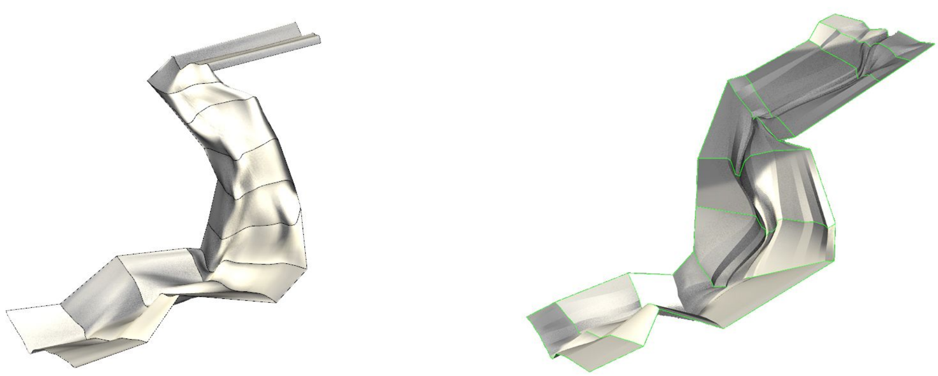


Figure 12: Left: Interpolation of 2018 cross-section in Rhino.

Right: Interpolation of 2010 cross-section in Rhino.

It can be seen the creek has been widened from 2010 to 2018. However, there are uncertainty and assumption using interpolation because the cross section survey were conducted at different locations in 2010 and 2018, and the 3D surface was generated based on algorithm.

4. Discussion/Analysis

Based on the results described above, it is clear that the portion of Cerrito Creek running through Blake Garden has degraded over time due to the high flows that occur during Winter. These high flows are the result of the increasing urbanization of the upper watershed area. In 2010, the watershed was approximately 50% impervious (Greenberg et al. , 2010) while the most recent estimate lists watershed as 65% impervious area (CCCWP 2004). Although efforts have been made to slow down the progression of the erosion, it is clear that they have not been as successful as the staff had hoped based on the broken down remnants of concrete used in past stabilization efforts present in the creek.

4.1 Evaluation of Design Solutions and Alternatives

In their 2010 report, Greenberg, Pinto, and Sherraden created a list of possible design solutions that could be employed on the creek to increase stabilization. As noted during our interviews, none of these alternatives have been implemented in the creek and with the creek degrading as it has been, it is appropriate to revisit these alternatives as potential solutions. Below, we examine whether these alternatives are still feasible or if they should be modified or thrown out completely.

Allowing Q2 overbank flow: The 2010 report suggests that the channelization of water has caused increased rates of incision. To alleviate this, they suggested removing a levee near the stormwater outlet that feeds the creek. During our site visits, we could not directly observe this levee and so we can not conclude if it has been removed or not. However, based on our interviews, we believe that it remains in its place. We believe that the removal of the levee is not feasible as it would cause flow from the creek to overtop the banks and enter the adjacent property. This would present legal issues which may require substantial payment if any damage was done. As such, we believe that the removal of the levee is not an appropriate solution.

Channel configuration: The 2010 design employs lateral expansion of the channel and the floodplain to decrease velocity of flow. The floodplain expansion would also provide some retention capability in situ. Based on what we observed, the widening of the channel and floodplains would be an appropriate measure to take in certain parts of the creek. However, most parts of the creek we had surveyed are bordering essential areas such as the greenhouse and recreation area. As such, it would not be appropriate to widen these areas. In addition, as noted in the 2010 report, “Blake Garden’s trees are an integral part of the Garden,...” (Greenberg et al., 2010) so widening areas that would threaten these trees is not appropriate.

Planting for bank and floodplain stabilization: Native riparian plants could be used to introduce a moderate additional roughness and resistance which would reduce velocities, stabilize banks, improve infiltration, and improve the aesthetics of the creek. We agree that this would be an effective method to stabilize the banks and is much cheaper than doing earthwork or using hard structural elements such as concrete. It would also achieve the goal of Timothy Cole in establishing more habitat along the banks of the creek. For the existing horsetail, we recommended a periodical pruning to maintain a good view along the creek, while the Poison Oak and invasive Himalayan blackberry should be removed. In order to achieve erosion control by slowing flow as well as to increase visibility, biodiversity and aesthetic value along the creek, we set our selection criterias to: 1. native to the eco-region, 2. easy to propagate and root readily to help slope stabilization, 3. fruiting food source for wildlife, 4.well-shaped and low-maintenance required. Combining all the above criterias, we came up with a plant list suggestion:

Trees: Willows are one of the most abundant and frequent species used to prevent bank erosion (Rohde et al., 2005). Considering the plant community, we proposed the Arroyo willow (*Salix lasiolepsis*) and the Red willow (*S. laevigata*) to be incorporated. The Coast live oak (*Quercus agrifolia*) trees have been growing here and should be kept. Additionally, the Valley oak (*Q. lobata*) and the Big leaf maple (*Acer macrophyllum*) could be introduced to the site.

Shrubs: Red twig dogwood (*Cornus sericea spp.*) could help stabilize the stream bank and be ornamental with its bright color. Other native species including Snowberry (*Symphocarpos albus var. laevigatus*), California blackberry (*Rubus ursinus*) and Toyon (*Heteromeles arbutifolia*) would also be recommended for the site.

Vines and Groundcovers: We suggested California's wild grape vine, California fescue (*Festuca californica*) for their nativeness and ecological functions.

*Implementation of Step-Pools:*Step-pools were considered for the area near the stormwater outlet with the eight foot drop. A step-pool system involves multiple pools of water at descending elevations. Water will flow from the highest pool and into the next pool. The point of these pools is to decrease the distance that was falls and dissipate the energy of the water slowly and reduce the amount of erosion as a result. We agree that it would achieve its goal and would provide areas for habitat, however, the amount of earthwork that would be needed to actually implement this would cost too much for the budget of the garden. In their proposal, they would need at least 750 cubic feet of earth moved.

Culverts: The 2010 proposal suggests that the culvert should be replaced as it is deteriorating, is undersized, and poses a threat to the road above. Based on both the 2010 hydrologic calculation and the one we conducted, the culvert is not sized properly to carry the resulting water during a storm event. The values from the 2010 study are slightly larger than ours due to a different interpretation of the IDF curves from Contra Costa county. This backs up the water and causes sheet flow across the parking lot and into the garden. They suggest that if the culvert is replaced and sized to be larger, then the downstream sections of the creek would also need to be redesigned to handle higher flows. We believe that it is still a good idea to properly size the culvert. To carry the flow resulting from the 50-year storm event, a 36-inch corrugated metal pipe could be used. This calculation was done using Manning's equation shown below:

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2} \qquad [1]$$

Where Q is the flow, n is the Manning's Roughness coefficient for the material used, A is the cross-section area of the pipe, R is the hydraulic radius of the pipe given by the wetted perimeter divided by the cross-section area, and S is the slope of the pipe. Assuming a slope of 0.012 which is the minimum slope needed for water flow ("Drainage and Sewer Pipe Slope"). The cross-section area and hydraulic radius values for corrugated metal pipes are given for available diameters in the "Corrugated Metal Pipe Design Guide" written by Contech Pipe Solutions. However, the full replacement would be outside of the jurisdiction of the garden and if they did take it up, would not be financially feasible for the garden. In addition, the installation of a larger culvert would cause more water to flow through the creek itself and this higher flow would also have to be addressed.

4.2 Evaluation of Recommendations

Along with their design alternatives, Greenberg, Pinto, and Sherradan created a list of recommendations which could be implemented as part of best management practices. Below, we examine these recommendations.

Neighborhood Stormwater Retention: They suggest that we reduce flows and increase retention and infiltration on the upstream portions of the watershed. They do recognize that it is beyond the scope of the project and would require change in land use policy which makes this not a feasible option. However, Timothy Cole has expressed interest in working with the community to reduce the impact on the creek. This could come in the forms of using pervious pavers on driveways, and planting rain gardens where possible.

Student Involvement/Coursework Integration: Since Blake Garden is managed by the UC Berkeley Landscape Architecture and Environmental Planning Department, they suggest that students continue to use the space as part of their course work. This would provide a unique opportunity to students as it would allow them to participate in the design and implementation of restoration work in Cerrito Creek. As is evident by this project, we believe that this should be continued. By conducting more of these studies and projects, the garden can keep improving and students can get real experience doing work in restoration, planting design, topography and grading, geotechnical engineering, hydrology, ecology, and structural engineering. One improvement to this suggestion would be to create an organization system specifically for projects in Blake Garden. This would allow students and staff to see a more clear progression of projects in the garden and get a better understanding of the work that was already conducted and how it has changed over time. Along with this, the markers used for any type of surveying should be made permanent to ensure consistency through projects. During our surveying, we were unable to find many of the cross-section markers as they were all non-permanent.

Program and Circulation: The 2010 team suggested creating a garden design that would integrate the creek with visitor circulation. Although this would be ideal, it would require an overhaul of the current garden configuration. It would also require the full stabilization of the creek to prevent erosion and bank instability. If unaddressed, visitors safety would be at risk as they might fall into the creek.

The team also recommends moving the children's play area as it is currently close to the creek and a steep drop. Again, this would require a major overhaul. A lower-cost option may be to erect some sort of barrier and signage that would prevent children from getting too close to the creek.

5. Conclusion:

The portion of Cerrito Creek that runs through Blake Garden will continue to experience bank erosion and channel incision without serious effort to stabilize the channel and restore its ecologic function. Although it will require considerable funding and hours of labor, we believe that the recommendations made in this paper can restore Cerrito Creek and allow it to become part of the garden design.

Almost all of the recommendations made in the 2010 report are still viable options that should be considered in the restoration of Cerrito Creek, with some adjustments to address the changes of the creek. Since funding will continue to be the primary challenge, low-cost alternatives, like biological stabilization using local riparian vegetation, that serve multiple purposes should be the primary focus of the garden.

The Blake Garden presents a unique opportunity to UC Berkeley as a potential site for students to experience what it is really like to work on projects from initial surveying to final implementation and evaluation. We hope that students will continue the work of not only this project, but all those that came before it so that this portion of Cerrito Creek will be restored and can serve as a beautiful attraction to all the visitors in the Garden.

References

Adlong, Michelle, Michael Cook, and Matthew Kennedy. 2011. "Post-Project Assessment of the 2003 Cerrito Creek Restoration and Recommendations for Additional Stormwater Management."

Alameda County Hydrology and Hydraulics Manual Hayward, CA (2003).

Behrends, Nathaniel. 2008. "Cerrito Creek Step-Pools: An Opportunity for Restoration and Education at Blake Garden."

CCCWP. "Baxter, Cerrito, and West Richmond Watersheds." *Contra Costa Clean Water Program* , Contra Costa Clean Water Program , May 2004, www.cccleanwater.org/userfiles/kcfinder/files/Baxter-Cerrito-and-West-Richmond-Watersheds-Cutdown.jpg.

"Cerrito Creek and Point Isabel Watersheds | ACFCD." n.d. Accessed November 17, 2018. https://www.acfloodcontrol.org/resources/explore-watersheds/cerrito-creek-and-point-isabel-watersheds/.

"Cerrito Creek Watershed Map." n.d. Accessed November 17, 2018. http://explore.museumca.org/creeks/1120-OMCerrito.html.

Contra Costa County, "www.co.contra-costa.ca.us" (May 2010). http://www.co.contra-costa.ca.us/index.aspx?NID=893

Contra Costa County . "Hydrology Standards | Contra Costa County, CA Official Website." *Contra Costa County*, 1977, www.co.contra-costa.ca.us/5747/Hydrology-Standards.

"Drainage and Sewer Pipe Slope." *Archtoolbox.com*, www.archtoolbox.com/materials-systems/plumbing/pipe-slope.html

Gary W. Wells. 2002. “Biotechnical Streambank Protection: The use of plants to stabilize streambanks”.

Jewell, Linda, and John Norcross. 2006. Blake Garden : A History of Landscape Change. [Berkeley, Calif. : University of California, 2006].

Karuna Greenberg, Pedro Pinto and Catherine Sherraden. 2010. “Towards a Stable Future: A Design Proposal for Cerrito Creek in Blake Garden, Kensington, California.”

Ludy, Jessica, and Kristen Podolak. 2007. “Restoration With Reference: Rediscovering Cerrito Creek in Blake Garden.”

Miriam Eason & Daisy Gonzalez. 2013. “Comparison of Winter Creek and Cerrito Creek: How Institutional Factors Determine Intervention Strategies.”

“Plants to Stop Erosion on Creek Banks.” n.d. Accessed November 17, 2018. https://homeguides.sfgate.com/plants-stop-erosion-creek-banks-30129.html

Rohde, S., M. Schütz, F. Kienast, and P. Englmaier. 2005. “River Widening: An Approach to Restoring Riparian Habitats and Plant Species.” River Research and Applications 21 (10): 1075–94. https://doi.org/10.1002/rra.870.

“Surveys · Blake Garden · Environmental Design Archives Virtual Collections.” n.d. Accessed November 17, 2018. http://virtualcollections.ced.berkeley.edu/exhibits/show/blake/surveys.

Appendices

A.1 Cross-Section Survey Data