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Finding a Foothold on an Uncertain Bank: An Assessment of Cerrito Creek into the Blake Garden

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Finding a Foothold on an Uncertain Bank:
An Assessment of Cerrito Creek into the Blake Garden

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Abstract

An open reach of Cerrito Creek flows through The Blake Garden, owned by the University of California, Berkeley (UC Berkeley). The Blake Garden acts as a “landscape laboratory”, available for students and employees for experimentation in horticulture, creek restoration, and landscape architecture. Prior evaluations (since 2007) of the stability and behavior of the upper section of the reach of Cerrito Creek (the ‘Upper Reach’) have reflected diverse perspectives and made ambitious recommendations for creek improvements. We developed a comprehensive baseline that can serve as a reference for future studies by both students and staff at the Blake Garden. We surveyed a long profile through the reach, and built upon prior surveys. We compiled data on the natural history and physical setting of the Upper Reach, determined the catchment area of the upper reach, identified and analyzed influent sources, described the extent and dynamics of the floodplain, measured physical characteristics, and exhausted existing literature and eyewitnesses.

Introduction

UC Berkeley's Blake Garden sits in the town of Kensington, Contra Costa County, California. Just north of Berkeley in the Berkeley Hills mountain range, the garden spans 10.6 acres directly on top of and just below the Hayward Fault. Two approximately-900-foot reaches of Cerrito Creek flow southwest perennially flanking either side of the garden, the entire length of the property (Figure 1). The forks meet some ¾ of a mile downstream of the garden, underground, after a series of culverts, open streams and engineered channels. They join with other forks of Cerrito Creek in a network of culverts under the city of El Cerrito and enter the San Francisco Bay through an engineered channel to the Albany Mud Flats. We are most concerned with the reach that runs along the eastern borders of the Blake Garden property, particularly the upper 350 feet. The upper reach has shown and proven to be largely incised and unstable as this reach is the first instance of naturalesque open creek channel, downstream from a 60-year-old urban watershed. As we revisit this most studied reach, we will attempt to describe these headwaters of the creek system holistically. We have searched for clues of past connectivity and explored ideas for possible connectivity in the future.

The objective of this report is to assess, thoroughly examine, and describe the physical setting and natural history of Cerrito Creek as it pertains to Blake Garden and neighboring properties. In doing so, we anticipate providing an accurate template for future analysis and improvement propositions within Blake Garden as they pertain to Cerrito Creek. Our analysis includes literature reviews of previous academic investigations of the site. Our field measurements include surveying and pebble counts, hydrologic observations and calculations, water quality measurements at suspected point sources, and interviews with those impacted by Cerrito Creek within and near Blake Garden.

Background

Blake House and Gardens were donated to the Department of Landscape Architecture in 1958, and the property is maintained by a staff of three horticulturalists. It is open to the public during business hours and is regularly visited by walkers, dog walkers, neighbors, preschools, volunteers, garden enthusiasts, and students. In the 1960's, the Blake house became the official residence of the UC president. The garden also functions as a "landscape laboratory" where students study plants, produce landscape interventions, and conduct environmental analysis such as the study of the creek system's hydrology and morphology.

The primary stream reach that has been studied runs along the eastern and southern boundaries of the property. It also has perennial spring sources as it enters the property, traversing the Hayward fault zone. The largest flows occur during the rainy season as rapid runoff from the largely impervious surfaces upstream turn the nearly dry stream into a raging torrent. The rapid urbanization of the upper watershed in the 1950's increased the flashiness of the stream's hydrology. A number of improvements were made to the property in the 1960s including the installation of a wall made of concrete sacks and rip rap along the upper eastern reach. Today you can see ample evidence of the now failed retaining walls (Figure 2). The garden staff has begun repairing them within the last year. A large check dam downstream was repaired in 2012. A rubble and soil levee remain just beyond the inlet culvert at Rincon Rd., keeping heavy flows from flooding the neighboring property. The culvert itself has virtually no bottom and all flows described herein as coming "from the culvert" are in truth coming from the junction box and under the culvert.

In 2009-2012, the period of multiple studies by the UC Berkeley LA 227 Restoration of Rivers and Streams class, the garden staff were undertaking a few restoration activities. Mostly this has consisted of removing the invasive species Algerian ivy and thornless elm-leaved blackberry. This seemingly never ending task continues today. The banks on either side of a bridge that leads to the main office were landscaped with geo-textile netting and planted with native and riparian plants (Figure 3).

2018 saw a ⅔ turnover of staff and renewed interest in the creek. Again, stabilization is a concern as is planting riparian habitat, but also there is an emphasis on increasing social connectivity. After rebuilding a retaining wall in the upper reach, a new wooden bridge was built opening access to the formerly overgrown east bank of the upper reach.

Methods

We conducted physical measurements, analyzed literature, and performed interviews to clarify and fulfill the objectives of this report. In this section, we will describe the methods implemented in our study of Cerrito Creek as it pertains to the Blake Garden as follows:

Literature Review and Interviews

The reach of Cerrito Creek located within the Blake Garden is under the jurisdiction of UC Berkeley, making it an ideal section of stream for experimentation and analysis by university students. In the past decade, five studies have been conducted pertaining to the restoration of the creek at the garden. This collection of literature served as the initial filter for the comprehensive summary we are compiling in this report (Appendix 1).

In addition to the available reports mentioned above, we acquired multiple maps to supplement the literature. Maps include regional maps, plans of The Blake Garden (Blake Garden), drainage maps from Contra Costa County and the City of El Cerrito, and The Oakland Museum's Creek and Watershed Map of Richmond and Vicinity .

We held a formal interview with Marion Bardin. Marion owns and resides at the property to the east of the upper reach of Cerrito Creek within Blake Garden. She has owned the property since 1966 and has an intimate relationship with the floodplain since she moved in.

Field Measurements

We conducted multiple field measurements and observations to gain a baseline understanding of the geomorphology and form of the upper reach of Cerrito Creek in the garden. We decided to focus on the reach of Cerrito Creek that runs along the eastern and southern boundaries of the garden, particularly the Upper Reach upstream of the concrete bridge near the tool shed (Figure 4). We selected this site for multiple reasons. Information analyzed in the reports we reviewed focused on the upper reach, the upper reach is the most accessible reach of creek for visitors of the garden, any understanding of the upper reach will give better insights of the behavior of the lower reaches, and the upper reach appears to be the most geomorphologically dynamic.

We conducted a longitudinal survey from the influent pipe culvert at Rincon Road to the effluent pipe culvert at the south-west edge of the property along Highgate Road (the entire reach of Cerrito Creek within Blake Garden). We surveyed two cross sections on the upper reach, one on the north branch of the upper reach dominated by the flow from the culvert on Rincon road and the other on the east branch of the upper reach receiving water from the Bardin property adjacent to Blake Garden. We did not feel the need to perform a comprehensive cross-sectional survey since one was performed just last year (Sasaki, Wang, Yang, 2018). However, a longitudinal survey had not been performed since 2010 (Greenburg et al.). We used standard surveying techniques to measure and record the stream bed, gradient, and banks of the creek (Harrelson 1994).

Our group identified four reaches of interest in which to perform pebble counts. They were the East branch of the Upper Reach which we believe to be an older original stream flowing from the Bardin property, the North branch which we believe to be a younger, flashier stream draining urbanized areas upslope, which enters the garden through the culvert at Rincon Rd., and the stream just beyond the confluence. We would have also liked to perform pebble counts in the NW reach through the redwood canyon, however upon inspection, only fine sediment occurred there. Similarly, the east branch from the

Bardin property also only had fine sediment. This alone suggests that those streams have been experiencing less flow than they had historically. It would be easy to infer then, that those historical flows were redirected to the north branch during the urbanization of Kensington in the 1950's. For both the north branch and post-confluence counts, we analyzed one gravel bar area and subsequently remained in that location for the entirety of the sample process. To avoid any bias, the collector closed their eyes as they selected samples to be measured through a gravelometer. A total of 100 pebbles were counted were recorded for each reach. However, the gravel bar within the north branch was dangerously close to an active wasp nest consequently we collected pebbles in a bucket be measured away from the stream.

Water Sources

We selected six locations relevant to the Blake Garden to be analyzed using the "ClearPool 6 Way Test Strips" (Figure 5). These six locations included three within the Blake Garden, being the Australia hollow spring, reflection pool, and a seep that flows into redwood canyon via Jessen Ct. (formerly part of the neighboring Edwin Blake estate), and three outside of the garden being a wetland pool on Marion Bardin's property, an upstream drain in front of 15 Arlington, and a drain exiting the rear of the property of the Arlington Community Church and Guidepost Montessori School at 52 Arlington Ave. (the sample was collected near the property line by 71 Rincon Rd.). We further collected a tap water control from the garden headhouse for comparison. It should be noted that there is a confirmed spring on site (Australia Hollow) which can also be used in comparison to the other water samples. However, with the possibility of contamination, we primarily referenced the tap water as the control. We initially collected each sample in a designated cup, making sure that each cup was free of any debris that could bias the results of the test. Following this we obtained a bulk sample of water from each specified area, by holding the cup up to any drainage or trickling from the targeted water source until the cup was approximately ¾ full. We collected two separate samples for each location, to provide two trials per location.

After collecting all of the samples, we used the “ClearPool 6 Way Test Strips” litmus test to test for total chlorine, free chlorine, alkalinity, pH, and hardness of water. We dipped the litmus paper fully into the water so that it was completely submerged for approximately ten seconds, followed by a quick flick to remove excess water before placing it on a surface to read. We recorded each measurement immediately after initial color appeared on the litmus paper according to the colorimetric scale (Table 1&2).

Hydrological Assessment

Although all previous studies on this reach of the creek have presented a catchment area upstream of the creek, the reports vary considerably from 60 to 161 acres. To gain clarity from this convolution, we drove and walked through the potential catchment area to determine its boundaries. To account for human influence by way of engineered drainage, we amended the natural catchment area using storm drain maps provided by the Contra Costa County (the County) and the City of El Cerrito. At the time of this writing we have determined a more accurate catchment area, but are still resolving some potential additional areas.

Since the catchment area is still not resolved, we calculated a range maximum flows at return intervals of 5, 50, 100 years each. We retrieved all the hydrological parameters from the Public Works Department of Contra Costa County to maintain accuracy in our calculations. We used the rational method to calculate the maximum flows because this is the method that the County uses for planning and design (Greenberg et al, 2010). The rational method uses the catchment area (A) in acres, a runoff coefficient (C), and the intensity of precipitation (I) in inches per hour to determine the peak flows (Q) in cubic feet per second (cfs) through the formula $Q = CIA$.

We estimated the mean annual precipitation using a map with mean seasonal isohyets for the county (Contra Costa Public Works Department, 1977). We also retrieved the runoff coefficients from the documents and standards from the County. We used the maximum runoff coefficient as stated by the Contra Costa County Flood Control District that the largest coefficient resembles more closely the peak flows calculated for the County (CCCFCD Standard). We used the maximum intensity using the precipitation-duration-frequency curves of a recurrence interval of 5 years, 50 years, and 100 years. These curves are made for the County for a range of mean annual rainfall from 5 inches to 40 inches. Using the mean annual rainfall that we determined with the isohyet, we were able to find the maximum intensity for each of the recurring intervals.

Plant Species Survey

Lastly, we conducted a thorough catalog of plant species along the southeast reach (Figure 18 & Table 7). This included every specimen within the stream channel, on the sloped banks, and within 3 feet of either bank. Any part of a plant within the vertical boundaries of that zone was counted. For example, the trunks of trees that form the canopy over the creek were often found to be well beyond 3 feet from the bank, but the drip-line of the trees extended into the zone of the survey and they were counted. It can be presumed that the roots of trees extend as far as the drip line. Species were noted along with numbers, exact when possible but approximate when not. We logged the location of each plant on the same grid that the garden staff uses to inventory plants, and also the lateral location along the stream channel. Also, we noted Calflora's assigned designations of native, non-native, and invasive in regards to each species. We added information provided by the garden staff as to regular horticultural maintenance and when certain specimens were planted.

Discussion

We anticipate the results of our inquiries will give us a baseline understanding of the creek's physical setting and natural history. An understanding of the natural history and physical setting of the creek will better inform those who will further analyze the creek within Blake Garden in the future and those who maintain and improve the garden day-to-day. The following topics are discussed and interpreted, as they pertain to the methods, in this section:

Literature review and interviews

The existing literature on Cerrito Creek, in Blake Garden, dates back to 2007 (Ludy 2007). Over the last 12 years, additional reports outlining design recommendations for the creek have been compiled. A comprehensive report was written in 2010 outlining the hydrology of Cerrito Creek within Blake Garden using HEC RAS (Greenberg 2010). This particular report makes detailed design recommendations for the upper reach of Cerrito Creek, all of which far exceeded the budget of Blake Garden. Other reports recommend minor adjustments to the creek such as vegetating banks to increase stability (Ludy 2007) (Sasaki 2018). Historical restoration endeavors are well documented on the Blake Garden website and available as a timeline and source of progress reports and photographs (Blake Garden).

Marion Bardin shared insights on the development of the floodplain of upper Cerrito Creek. She related that she moved into the property adjacent to Blake Garden in 1966. Upon arrival, she noted that the western portion of the stayed wet for long periods of time, only to clear during warm months in the summer. Fearing the moisture would compromise the foundation of the swimming pool in the backyard, the Bardins had a french drain constructed around the perimeter of the swimming pool foundation. Since the installation of the drain in the late 1960s, Marion claims there have been no issues with the pool regardless of the flows through the floodplain. Marion explained that the property at one point was to be subdivided into four parcels, but the three regularly inundated parcels below her house remained were never developed. Previous studies have claimed to not have access to the Bardin property, but Marion was more than happy to share her knowledge about the area and we recommend an ongoing relationship with her.

Field Measurements

Longitudinal Survey

The part of the creek within the Blake Garden presents an average gradient of 10%. However, the upper and lower reaches of the creek have very different average gradients (Figures 6-8). The upper reach, which is flatter than the lower reach has an average gradient of 7%. The lower reach of the creek has an average gradient of 11%. The profile lower reach is more sinuous than the upper reach, since it exposes the bedrock in many points and accumulates debris, creating several pools. This is something that does not occur on the upper reach because the profile is much less sinuous than its lower counterpart. Even though, both reaches have had their channels reinforced with concrete, in many parts of the upper reach, this concrete is under a layer of soil and logs. Data for the longitudinal profile are shown in table 1.

Cross-Section

The cross-sectional profiles allowed us to see that both branches possess a wide channel. However, we could determine that vertical incision is occurring in the east branch of the upper reach, which, we have observed over the past year to carry less water (Figure 9). This might be an indication of regressive erosion in the east branch. In contrast, the bottom of the north branch has a wider bottom (Figure 10). This part of the channel was widened and its banks were reinforced with concrete (Sasaki et al), preventing incision on the channel, even though the north branch has a higher flow than the east branch. Data is shown in tables 2 and 3.

Pebble Count

We viewed the pebble count as an additional measure in characterizing the Blake Garden streams (Figure 11). There appears to be variability in the range of pebble sizes comparing the north reach to the area after the confluence with the east reach. The north reach gravel bar had reached pebble sizes as large as 44 mm, being very coarse gravel where as the largest pebble size downstream of the confluence ravel bar reached was 23.6 mm, coarse gravel (Figures 12&13). The majority of the pebble count for the north reach was at found at size 16, between coarse and medium gravel, in contrast to after the confluence at 11.6, one magnitude lower than 16 on the gravelometer, or medium sized gravel (Figures 12&13). Both reaches however display a reasonable distribution of sizes given their respective ranges. In considering the dp50 values for both pebble counts, the dp50 value for after the north branch is approximated at 12.5 mm whereas the dp50 value for after the confluence is approximated at 10.0 mm.

Water Sources

From our observations, the upper reach of Cerrito Creek within Blake Garden is fed by multiple perennial water sources (Figure 5). The north branch of the upper reach receives flows from the culvert below Rincon Road. These flows can be observed fluctuating in the dry season, evidently due to leaks in East Bay Municipal Utility District (EBMUD) water lines. Another water source originates from the west corner of Arlington Community Church, along Rincon Road, where a perpetual trickle of water runs into the ditch on the northside of Rincon Road. In dry conditions, this stream does not appear to flow to the culvert that feeds the main influent line, but flows into the ground and toward the Bardin property to the south. This stream most likely contributes to the east branch of the upper reach of Cerrito Creek within the Bardin property.

We believe that there are several things that could be elucidated in utilizing "ClearPool 6 Way Test Strips" on the various sources of water flowing toward, into, and within the Blake Garden. Official information of how the pool test works is patented by the company and thus unavailable to the public. The only explanation of the functionality of the pool test can be explained by the properties of a litmus test which relies on pH paper dyed by lichens. Additionally, the accuracy of the pool test can vary but is ultimately dependent on human contamination. Our initial intention was to focus purely on the chlorine content measurement. The availability of chlorine within a water source can lead to its potential classification and possible origin determination. However, given the results, we realized that the measured chlorine content was too low to deduce anything truly valuable (Tables 4&5). An explanation for this reading can be explained by the fact that the pool strips may be designed purely for reading chlorine levels in pools thus unable to detect smaller concentrations of chlorine. The non-substantial chlorine measurements shifted our focus to alkalinity and pH which similarly possess the ability to characterize a water source. Alkalinity refers to the capacity of water to neutralize an acid, by acting as a buffer, and can be predominantly composed of carbonates. Considering natural alkalinity, a primary source can be recognized by carbon dioxide in the atmosphere that can eventually dissolve in rain, surface water, and groundwater. Given the colorimetric scale of alkalinity, the majority of our water sources, five out of the six (Tables 4&5), contained a high alkalinity reading. These results led us to conclude that the primary sources of flow during the dry season are springs scattered along the Hayward fault zone which cross the upper reaches of the streams in the garden. The samples taken from a storm drain in front of 15 Arlington Ave. in addition to recent observations of fluctuating flow in that direction suggest a spring source that is mixed with domestic tap water, what some call "urban drool."

In addition to alkalinity, pH is a fundamental water quality parameter, measuring hydrogen activity on a logarithmic scale. Dissolved species that a water source has reacted with can further be approximated by using pH. In terms of of pure water pH can be measured at neutral pH or 7. Soil or groundwater containing heavy organic contaminants such as iron sulfide can have pH values as low as 4.0. The majority of the measured water sources fell on the higher, more basic range of the pH scale aside from the reflection pool (Tables 4&5). The reflection pool reading at a lower pH can be explained by the algae present in the pool as the algae decomposes and consumes dissolved oxygen, with a higher dissolved oxygen content the pH reading decreases (Minnesota Pollution Control Agency, 2009).

Hardness describes the potential for water to precipitate in insoluble levels which can be further defined as the concentration of dissolved calcium and magnesium as an equivalent of calcium carbonate. High alkalinity levels can be accompanied by heavy precipitation or “hard water.” Thus in line with this logic, increased alkalinity which is evident from the samples should directly correlate to increased hardness. However, out of all the other measures, hardness was the one factor that fluctuated most across sample sites(Table 4&5).

Hydrological Assessment

After two inspections of the watershed above the Blake Garden, we could not determine the exact catchment area. However we were able to delineate what we believe to be the most accurate estimations to date (Figure 14). Figure 14 shows the catchment area for the water that drains into the southeastern reach Blake Garden, and it is divided into three subsections. The section in the middle of the catchment, denominated “Urban Watershed”, is the area that certainly drains into the creek. This area includes the topographic catchment area and the area that drains into the creek by piping. The two areas (north and south of the Urban Watershed), denominated “Potential Urban Watershed” are areas that potentially and likely drain into the Blake Garden depending on certain conditions. These areas were included because the storm drains maps provided were inconclusive, the north being within the city limits of El Cerrito, and the south mostly consisting of Kensington Elementary School. The catchment area then could vary from 46.75 acres, the area which certainly drains into the garden, to 77.39 acres, which includes the other two potential areas. The drainage area is mainly residential with open spaces, and is approximately 50% impervious. With that in mind, we estimated a runoff coefficient of 0.6 Using the maximum rainfall intensity from the precipitation-duration-frequency curves, the selected runoff coefficient, and the estimated catchment area, we calculated peak flows for the section of the creek coming into the Blake Garden using 5-, 50-, and 100-year recurrence intervals. The peak flow for each recurrence interval was calculated estimating the catchment area of the zone that certainly drains into the garden (called A), area A and either one of the potential two areas (A+B, and A+C), and the entire potential catchment area (A+B+C), for a total of 12 cases. The peak flows varied from 387.09 to 1058.70 cfs. The peak flow estimates for the 12 cases are summarized in table 6. We recommend that future studies should be aimed at reducing the level of uncertainty regarding the catchment area and test the two potential areas to determine if these in fact drain into the Blake Garden.

Floodplain

We wanted to gain a better understanding of the floodplain influenced by the upper reach of Cerrito Creek within Blake Garden. No accurate measurements or interpretations of the upper reach were included in the literature reviewed, only recommendations to increase the width of the floodplain (Sasaki 2018). What *is* the current and historical extent of the floodplain? In order to determine this vital parameter, we made field observations, analyzed topographic maps, and dug into the history of the region.

In analyzing the floodplain it is important to note that there is a rudimentary levee to the east of the influent line at the north of the property. (Figure 15) It was constructed by Blake Garden staff at an unrecorded time (likely part of the late 1960's bank stabilization measures). This levee was probably constructed to prevent the north branch of the upper reach of Cerrito Creek within Blake Garden from migrating into the Bardin property. As a result of the levee construction nearly all flows from the junction boxes on Rincon Rd. run through the main creek channel. Exceptions to this have been observed, such as when the channel is overgrown with blackberry, the resulting impedance has caused flows to breach the levee. Also, in heavy rain events, a stream can be observed overflowing the ditch across Rincon Rd. and flowing into the Bardin property before the Blake Garden junction box.

Our initial thought was to analyze topographic maps of the region around the upper reach of Cerrito Creek in parallel with the drainage area maps (Figures 16 &17). We observed a relatively flat region depicted on the topographic map east of the reach of Cerrito Creek within Blake Garden. We suspected this region to be the extent of the floodplain. Upon field observation, our suspicions were confirmed. With the permission of Marion Bardin, owner of the property east of the Blake Garden, we examined the flat portion of land as shown on the topographic map. The plain included abundant riparian vegetation, standing water, and was level with the plain extending into Blake Garden, as shown in figure 14. It was also evident that there are active flows through the Bardin property, mostly in the subsurface. The water that originates in the Bardin property flows into the eastern branch of the upper reach of Cerrito Creek, which in reality originates from the Bardin property, not the Blake Garden.

As we further examined the topographic map, we observed the possibility of a connection between the two branches of Cerrito Creek (Figure 16). The extent of the floodplain and topography suggest at least a historical or possible (under certain conditions) connection between the two branches. Upon observation of the land between the two branches, we discovered riparian vegetation and standing water suggesting there is a belt of continuous moisture through the region and possibly flow in the subsurface. We expect that with high enough flows surface water would flow over the divide between the two branches of Cerrito Creek, feeding both branches as depicted in the topographic map detail (Figure 16).

Plant Species Survey

We believe that this is a useful first step in continuing to monitor the vegetation in the creek corridor. But, we can also draw some conclusions comparing what we found with interviews and historical photographs on the garden website. In terms of restoration, notably, a 2012 “restoration” project accompanied a new bridge, ADA ramp, and culvert repair. The banks were wrapped in geo-textile fabric and terraced with redwood limbs on contour to prevent erosion during the establishment of new plants. Some of drought tolerant native plants that were planted well beyond the bank remain, but very few of the riparian plants are extant. Specifically, many *Cornus sericea*, an attractive native riparian plant that is suggested in previous studies, were planted on either side of the bridge. On the west side, none remain where the gently sloped bank is dominated by Algerian ivy (O5-6 on the grid)(Figure 19). On the east side, a few remain but never established (O8 on the grid), rather they appear dessicated and stunted. These *Cornus sericea* are irrigation dependent. A deeply incised channel below drains the water table to a low level that is out of reach of the *Cornus sericea* roots, rendering their proximity the bank irrelevant. For contrast we can find towering verdant, established, and reproducing *Cornus sericea* in a gently sloped natural drainage swale away from any surface stream on the grid at K18-19.

Social Connectivity

While the Blake Garden provides public recreational space, it also provides educational space for the University of California, local community colleges, highschools, elementary schools and pre-schools. The space also functions to manage stormwater from the adjacent upstream neighborhoods in Kensington and the city of El Cerrito. Still, the creek corridor provides unique riparian wildlife habitat with a diversity of vegetation and complexity of its channel. Local governments, neighborhoods and schools are all the stakeholders in restoring the reaches in Cerrito Creek, with opportunities for making the streams more visible, safe, accessible, healthy, and beautiful.

In section “catchment area”, we discussed the urban watershed, dominated by engineered drainage and transportation infrastructure. The largest of the reaches in the 10.6 acre garden is the southeastern reach, managing stormwater from an urban catchment area ranging from 46.8 to 77.4 acres. Delineating the watershed provides opportunities for social connectivity with its residents. One such opportunity might be expressed in an education campaign, bringing awareness to the neighbors’ implicit relationship to the creek and the value of developing infrastructure that promotes a healthier watershed. Presenting the creek as a garden feature, focused on its ecological and social benefits, it can serve as the jewel of a neighborhood wide effort. In 1995, the cities of Albany, Berkeley, El Cerrito, and Richmond, the East Bay Regional Park District, and UC Berkeley, agree to join in partnership to revitalize the Cerrito Creek watershed of joint jurisdiction (City of El Cerrito).

Conclusions

The objective of this report was to assess, thoroughly examine, and describe the physical setting and natural history of Cerrito Creek as it pertains to Blake Garden and neighboring properties. This was accomplished through assessing several different measures in the field. There are several distinguishing observations and analysis we carried out that were only touched upon, incorrect, or not included in previous assessments of Cerrito Creek within Blake Garden. The hydrologic assessment we carried out is the most thorough and insightful description of the urban drainage area and floodplain dynamics of Cerrito Creek around the Blake Garden. We confirmed the existence of springs that perennially feed the branch of Cerrito Creek that runs through the Blake Garden. We compiled a detailed catalog of the riparian vegetation along the reach of Cerrito Creek corridor within Blake Garden.

The culmination of information and data collected will serve as a baseline for future evaluation of Cerrito Creek within Blake Garden. We recommend further studies interpreting the complex catchment area, dynamic nature of the floodplain on the adjacent property, and continued measurements and evaluations of the geomorphology and physical characteristics of the creek. While any major one-time restoration project would require additional funding approval, the garden staff can partake in small but regular interventions. Further studies done by students will benefit Blake Garden staff in better evaluating the current and future needs of Cerrito Creek within Blake Garden.

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Appendix

Appendix 1: Literature

Appendix 2: Figures

Appendix 3: Tables

Appendix 1: Cerrito Creek in Blake Garden Literature

- *Restoration With Reference: Rediscovering Cerrito Creek in Blake Garden* (Ludy and Podolak, 2007).
- *Cerrito Creek Step-Pools: An Opportunity for Restoration and Education at Blake Garden* (Behrends, 2008).
- *Towards a Stable Future: A Design Proposal for Cerrito Creek in Blake Garden, Kensington, California* (Greenberg, Sherraden, Pinto 2010).
- *Comparison of Winter Creek and Cerrito Creek: How Institutional Factors Determine Intervention Strategies* (Eason and Gonzalez 2013).
- *What's Past is Present: A Re-Evaluation of Cerrito Creek* (Sasaki, Wang, Yang 2018).

Appendix 2: Figures

Figure 1. Blake Garden, 2019 (Reach of Cerrito Creek of interest highlighted) (Blake Garden).

Figure 2. Failing sac-crete retaining wall along upper reach of Cerrito Creek within Blake Garden.

Figure 3. A student stakes down a geotextile fabric on the northern bank of the upper reach of Cerrito Creek within Blake Garden. Upper reach of Cerrito Creek Phase 1 restoration, February 2012 (Blake Garden).

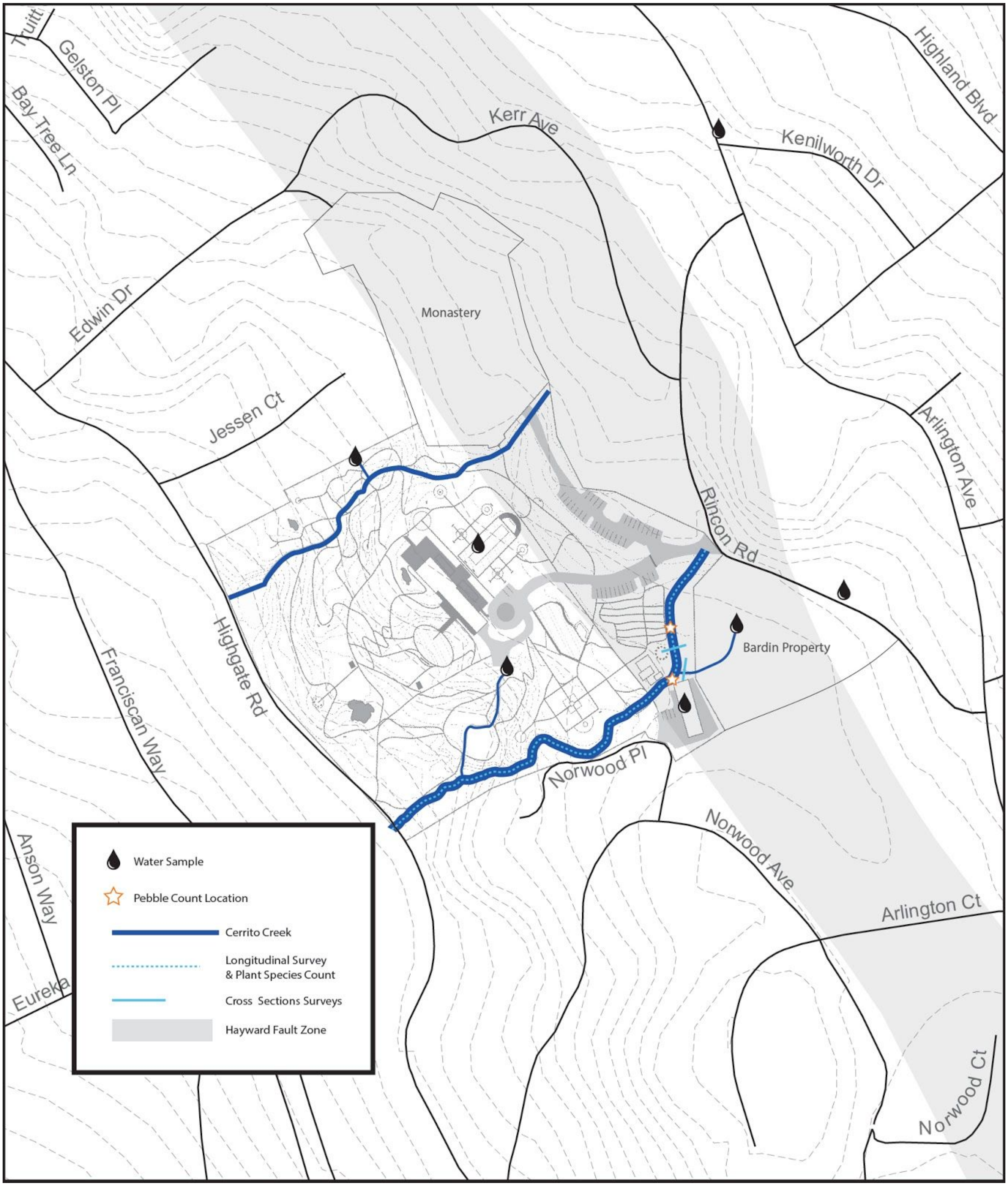


Figure 4. Locations of longitudinal survey, lateral surveys, pebble counts, and water samples.

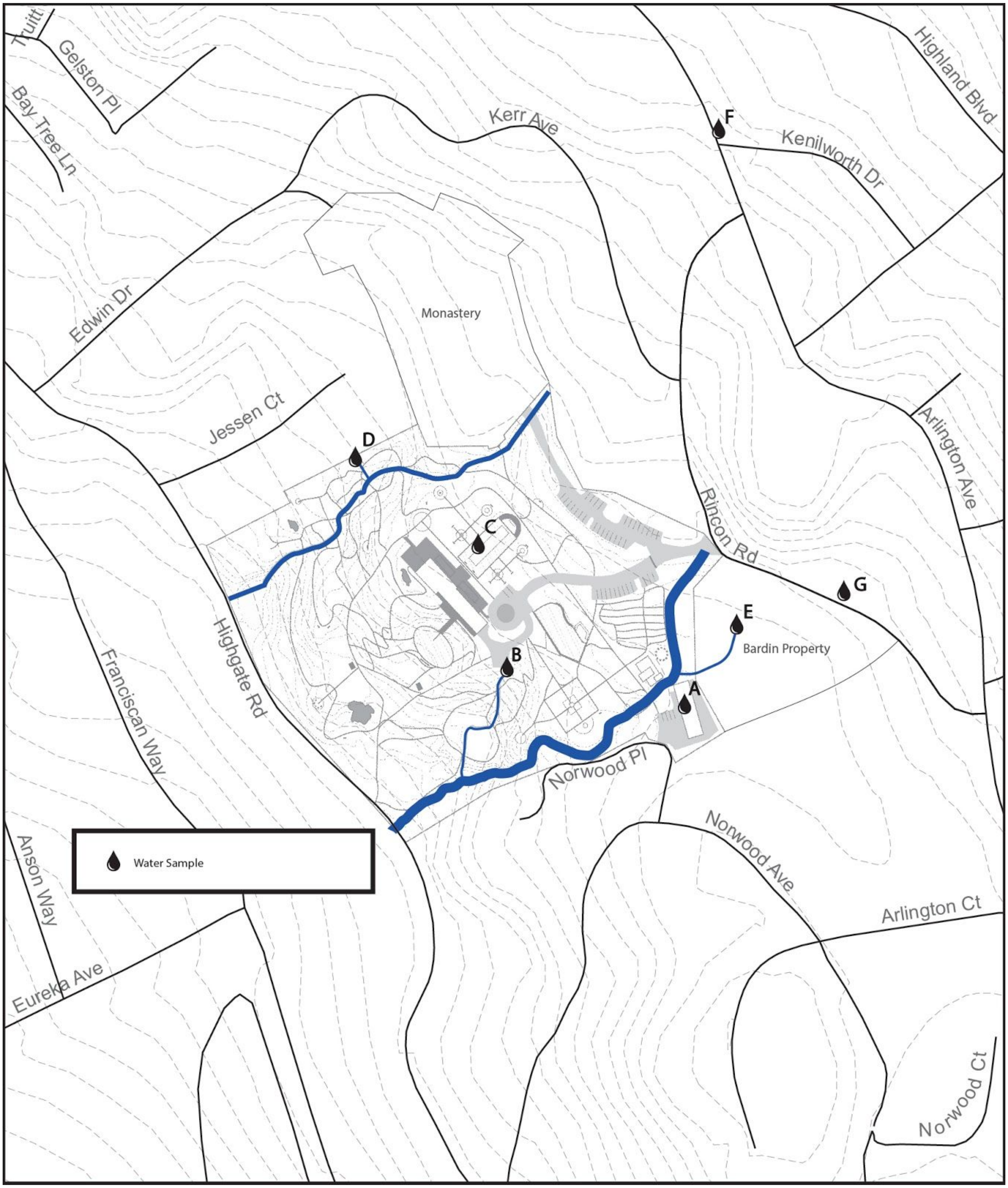


Figure 5. Locations of water samples (Tables 4&5)

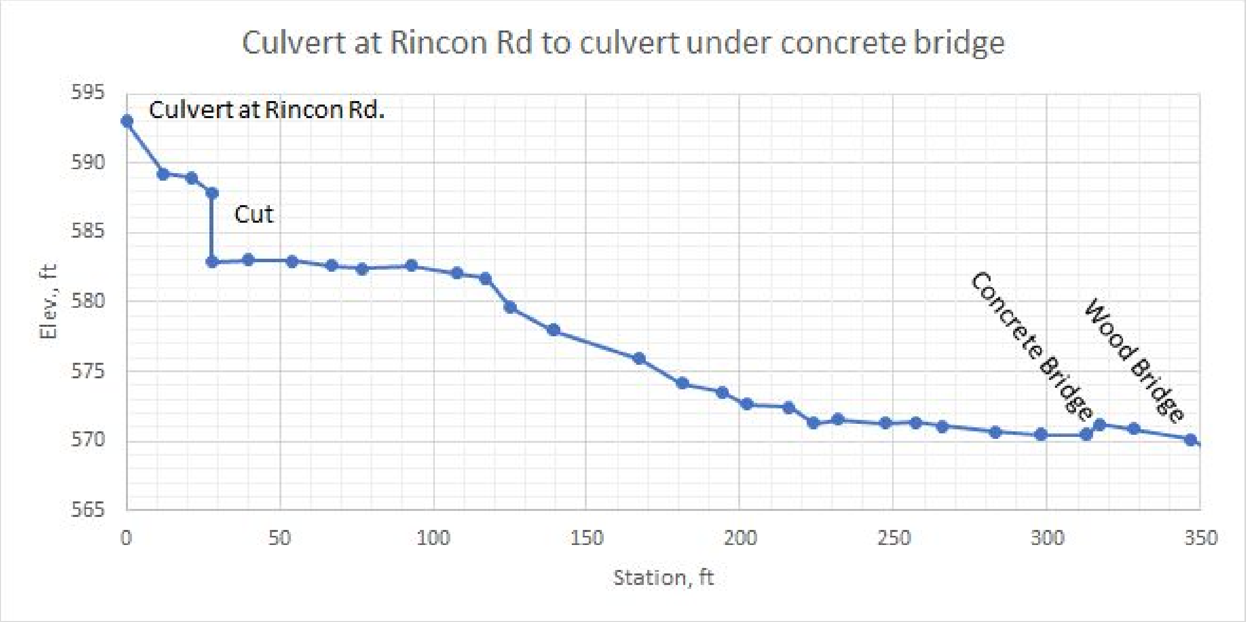


Figure 6. Longitudinal profile of Cerrito Creek, Rincon Rd to culvert under concrete bridge.

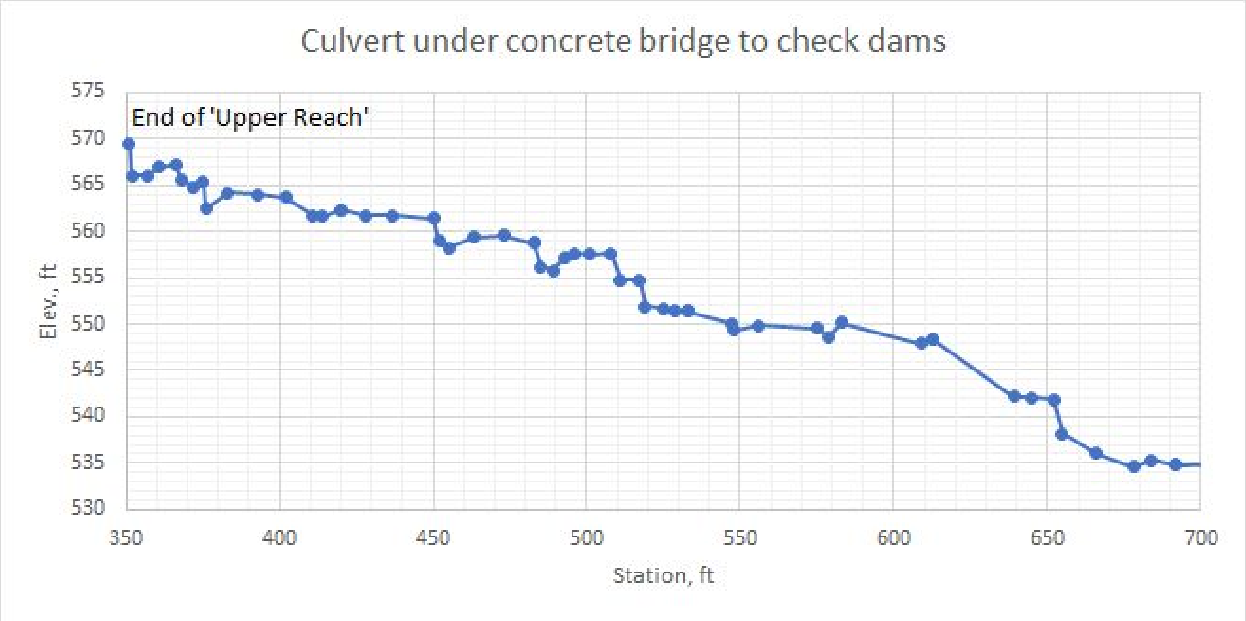


Figure 7. Longitudinal profile of Cerrito Creek, culvert under concrete bridge to check dams.

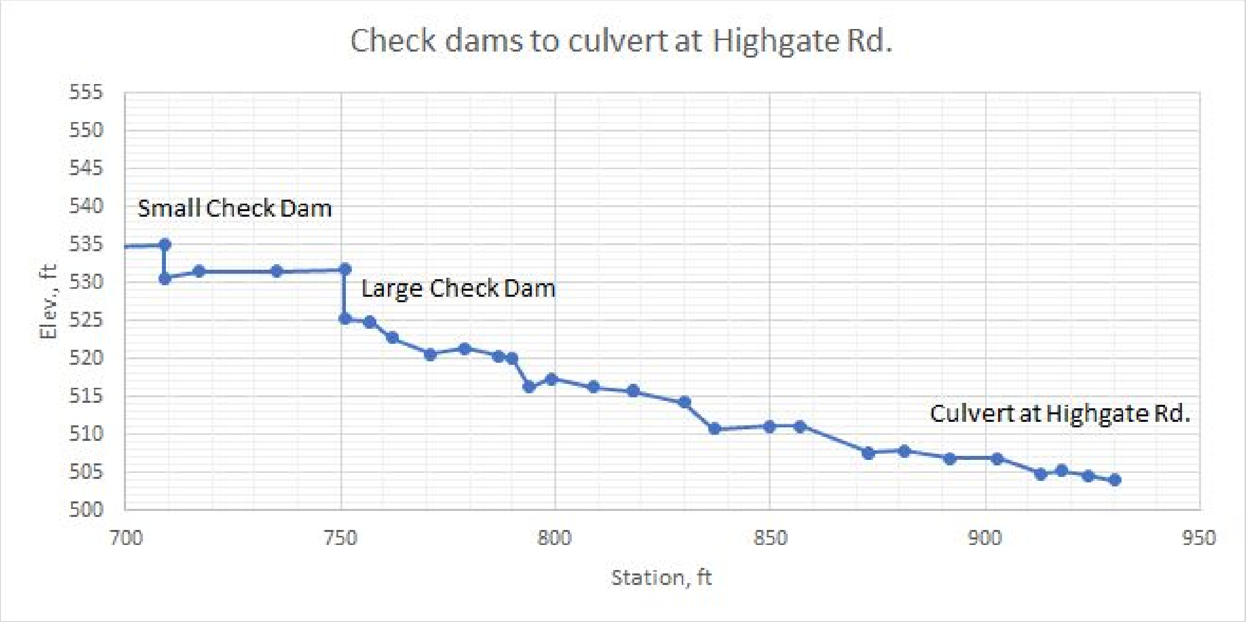


Figure 8. Longitudinal profile of Cerrito Creek, check dams to culvert at Highgate Rd.

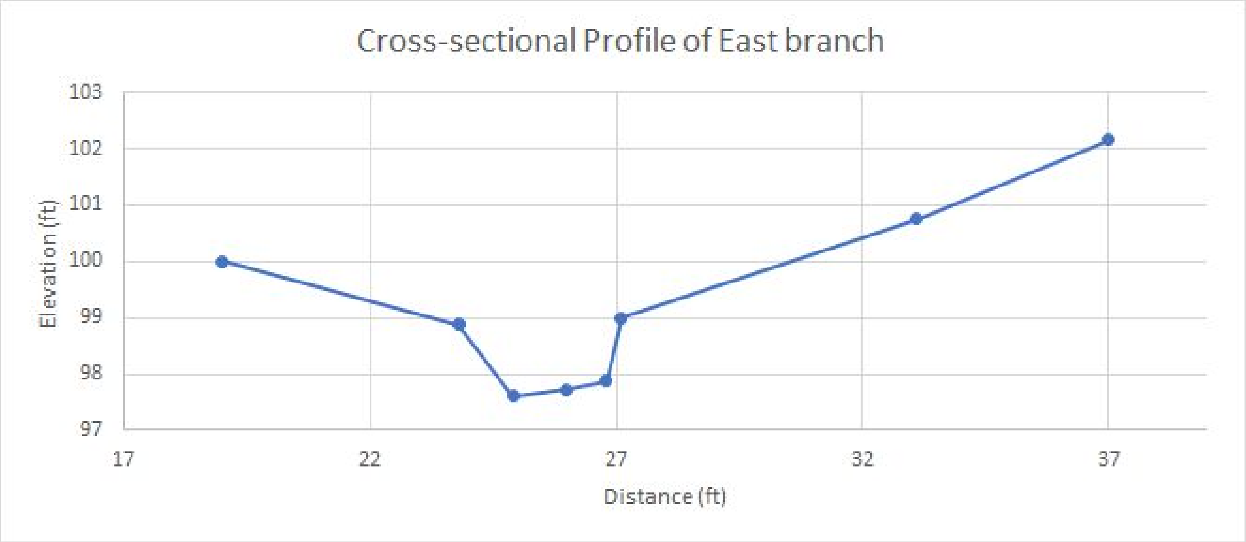


Figure 9. Cross sectional profile of the east branch of the upper reach.

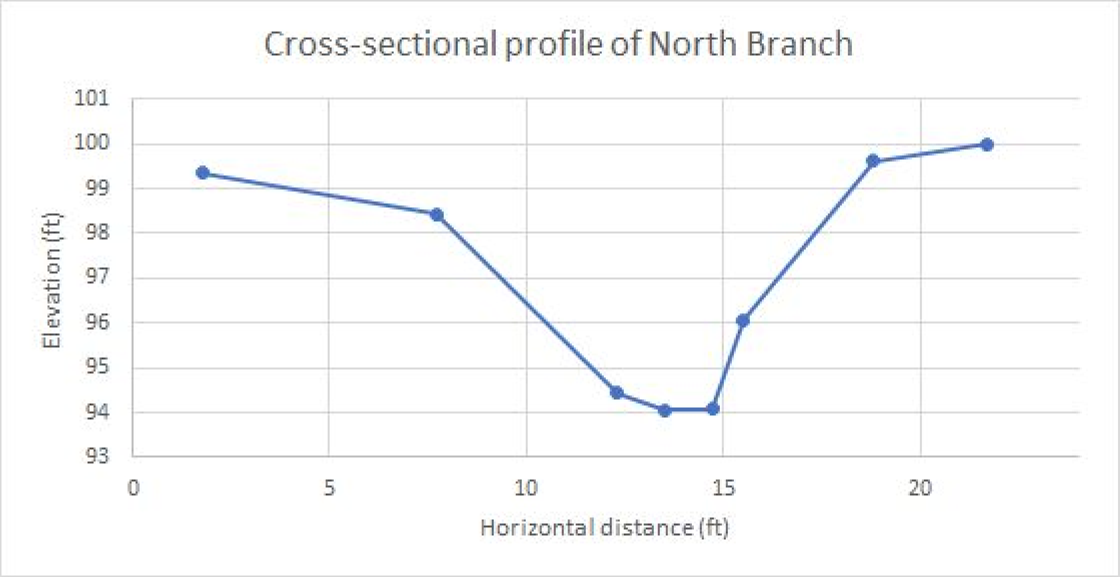


Figure 10. Cross-sectional profile of North Reach. All elevations are in respect to the last point, which was given an elevation of 100 ft.

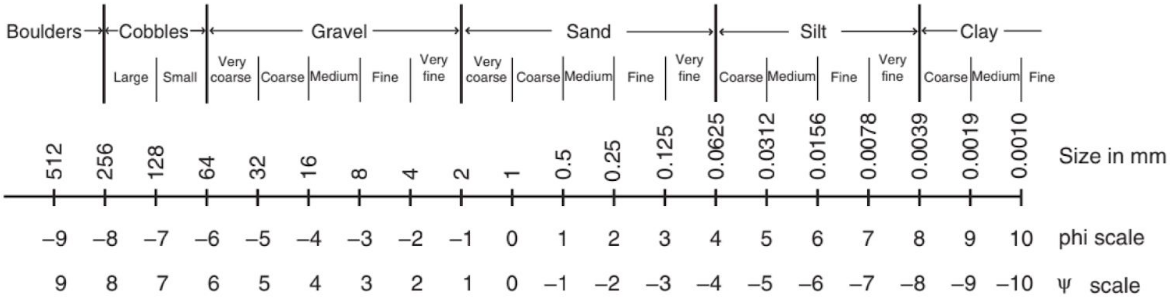


Figure 11. Grain size scale used to define pebble counts.

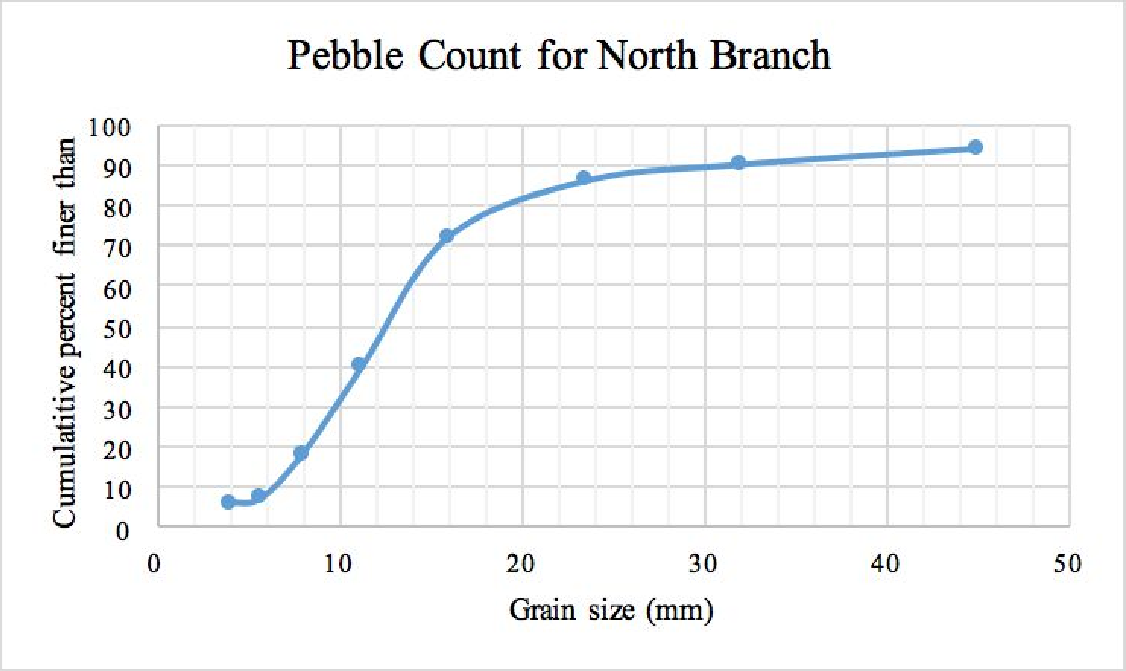


Figure 12. Histogram representation of pebble count for North Branch

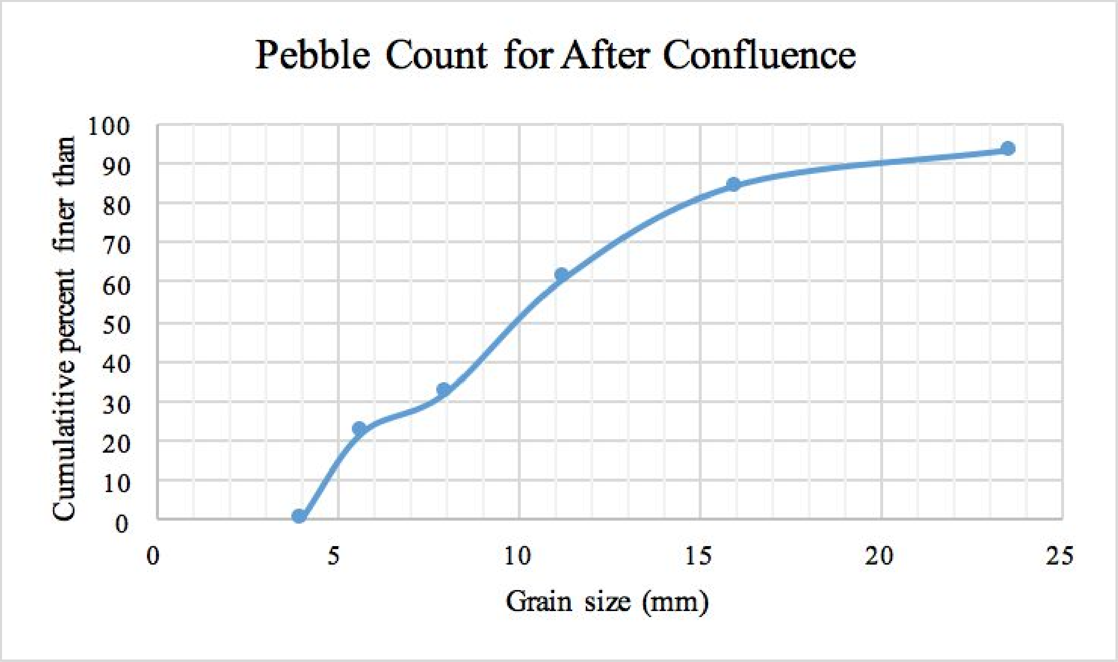


Figure 13. Histogram representation of pebble count for after confluence

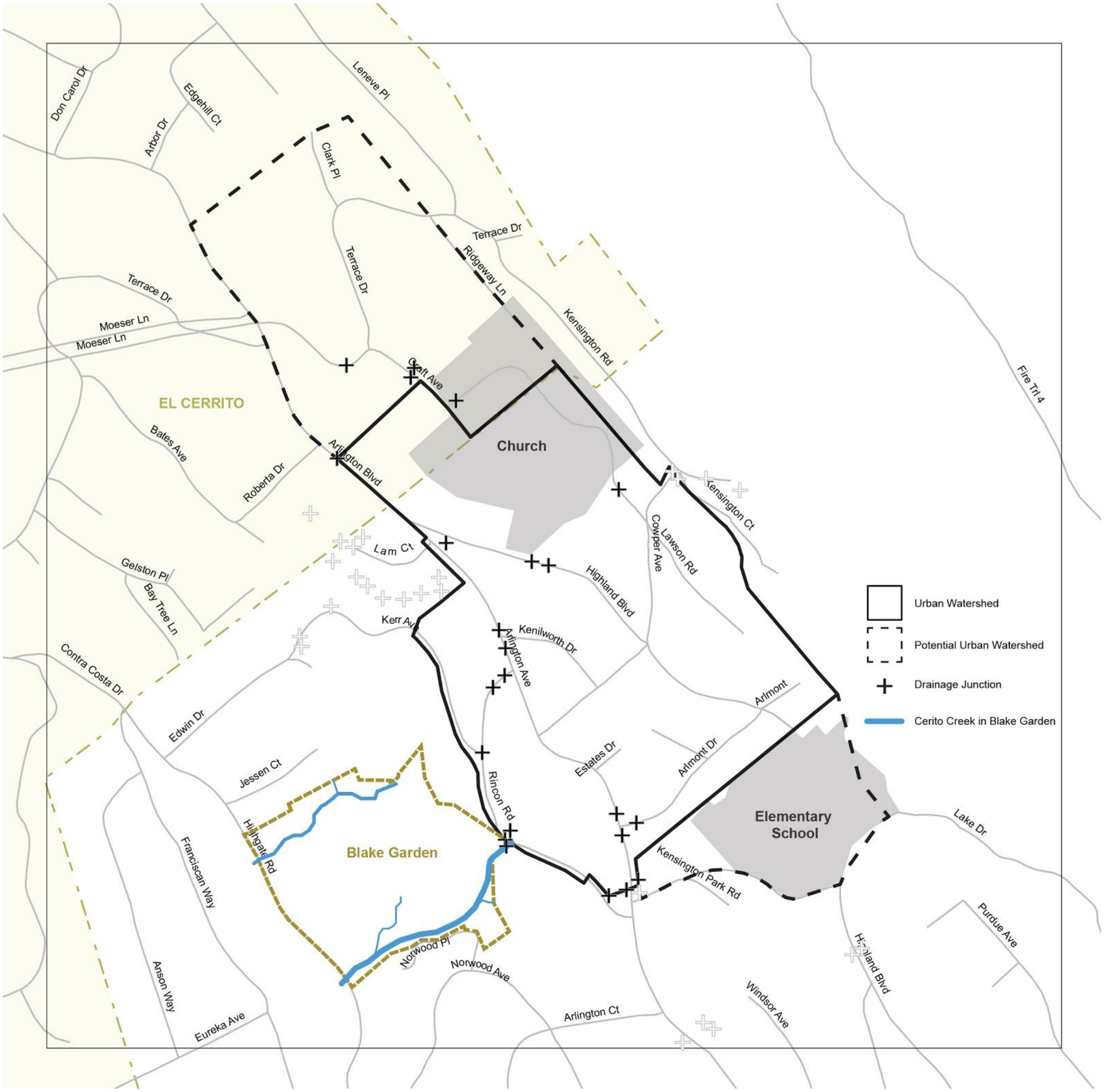


Figure 14. Delineation of Watershed/Catchment Area

Figure 15. Extent of floodplain influenced by the upper reach of Cerrito Creek within Blake Garden.

Figure 16. Potential flowpath between floodplain and lower branch of Cerrito Creek.

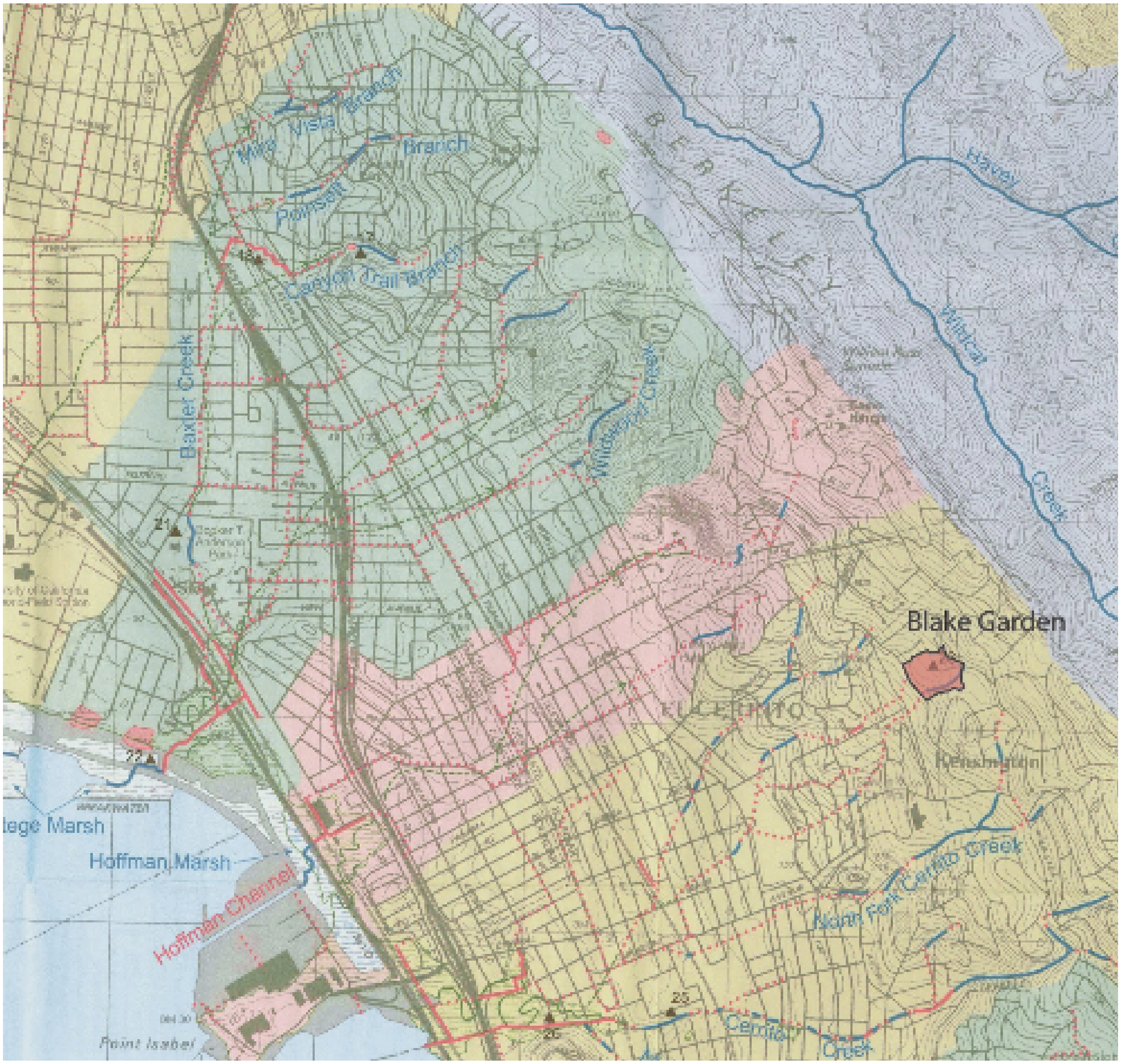


Figure 17. Cerrito Creek watershed (Oakland Museum).

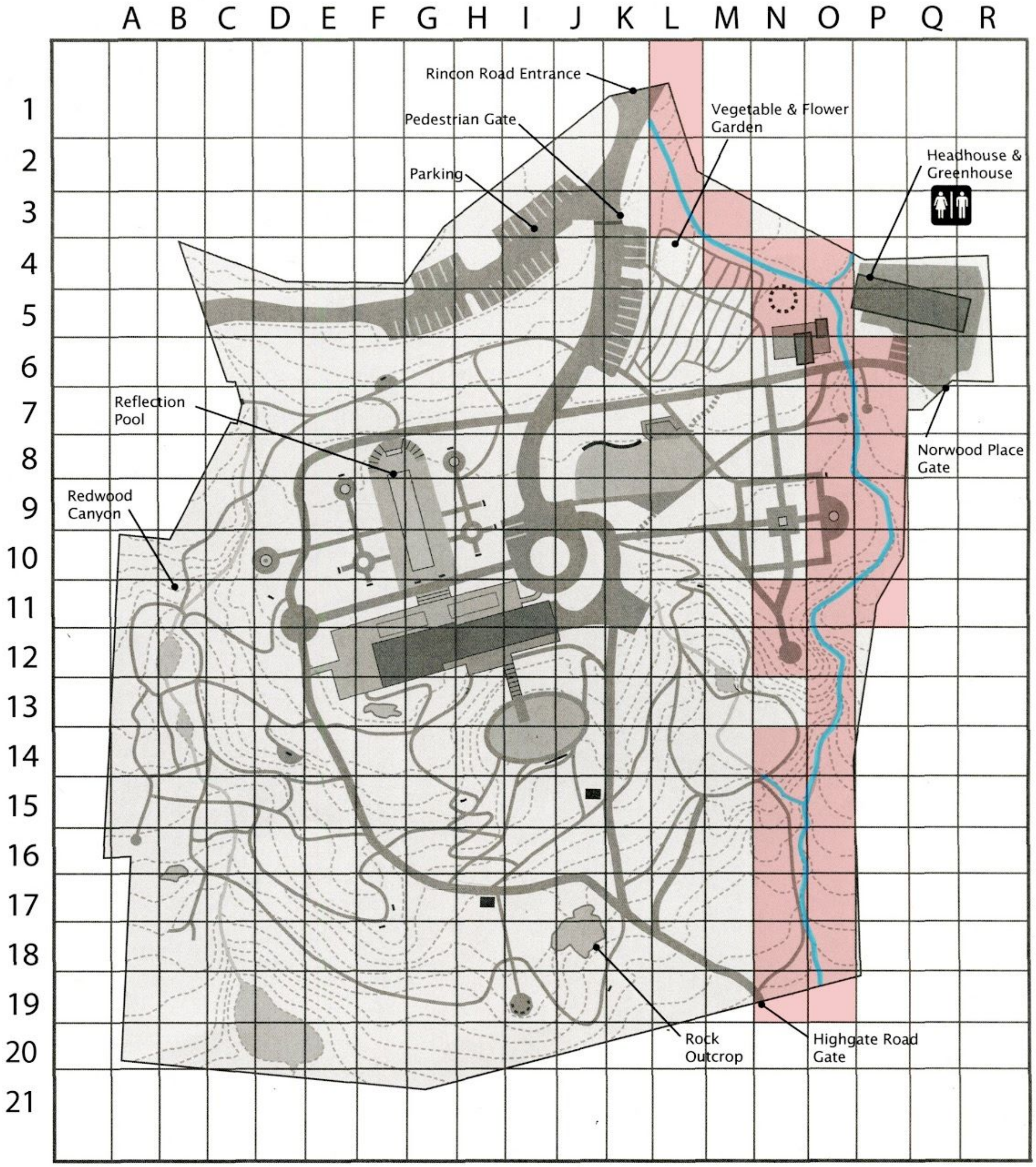


Figure 18. Blake Garden grid identifying areas referenced in plant species count

Appendix 3: Tables

Table 1. Longitudinal Profile Data.

STAT. ft		READ	ELEV. ft	ELEV. ft, real	NOTES	GRADIENT
TAPE	CUM.					
-	0	0.76	100	593	Culvert at Rincon Road	
-	12	3.74	96.26	589.26		
-	21	4.03	95.97	588.97		
-	28	5.11	94.89	587.89		
0	28	10.1	89.9	582.9	Pool	
12	40	9.94	90.06	583.06		
26	54	10.16	89.94	582.94		
39	67	10.38	89.62	582.62		
49	77	10.62	89.38	582.38		
65	93	10.38	89.62	582.62		
80	108	10.92	89.08	582.08	Pedestrian bridge (new)	
89	117	11.26	88.74	581.74		
97	125	13.38	86.62	579.62		
111	139	15	85	578	demolished pedestrian bridge referenced in the literature	
111	139	5.09	85	578	Bank stabilization	

139	167	7.13	82.96	575.96		
153	181	8.91	81.18	574.18		
166	194	9.55	80.54	573.54		
174	202	10.44	79.65	572.65		
188	216	10.64	79.45	572.45		
196	224	11.78	78.31	571.31	Confluence of north and east branch	
204	232	11.54	78.55	571.55		
219	247	11.78	78.31	571.31		
229	257	11.72	78.37	571.37		
238	266	11.98	78.11	571.11		
255	283	12.39	77.7	570.7		
270	298	12.64	77.45	570.45		
270	298	7	77.45	570.45	Bridge	
285	313	7	77.45	570.45	culvert	
0	313	5.6	77.45	570.45	HI	
4	317	4.85	78.2	571.2		
15	328	5.2	77.85	570.85		
34	347	5.95	77.1	570.1	ped bridge (wood)	
38	351	6.5	76.55	569.55	cut (top)	-7%
39	352	10.05	73	566	cut (bottom)	
44	357	10	73.05	566.05		
48	361	9.1	73.95	566.95	pool	

53	366	8.75	74.3	567.3	cut (top)	
55	368	10.45	72.6	565.6	cut (bottom)	
59	372	11.25	71.8	564.8	pool	
62	375	10.7	72.35	565.35	cut (top)	
63	376	13.65	69.4	562.4	pool	
70	383	11.83	71.22	564.22	end of pool	
80	393	12.05	71	564		
89	402	12.34	70.71	563.71		
98	411	14.35	68.7	561.7	pool	
101	414	14.47	68.58	561.58	deep pool	
107	420	13.75	69.3	562.3	end of pool	
107	420	11.35	69.3	562.3	HI	
115	428	11.97	68.68	561.68		
124	437	11.87	68.78	561.78		
137	450	12.27	68.38	561.38	top of drop	
139	452	14.69	65.96	558.96	end of drop	
142	455	15.4	65.25	558.25		
150	463	14.25	66.4	559.4		
160	473	14.1	66.55	559.55		
170	483	14.87	65.78	558.78	cut (top)	
170	483	6.97	65.78	558.78	HI	
172	485	9.57	63.18	556.18	pool bottom	
176	489	9.98	62.77	555.77		

180	493	8.5	64.25	557.25		
183	496	8.1	64.65	557.65	end of pool	
188	501	8.2	64.55	557.55		
195	508	8.1	64.65	557.65	top of fall	
198	511	10.98	61.77	554.77	bottom of fall	
204	517	11.03	61.72	554.72	concrete slab	
206	519	13.84	58.91	551.91	cut (bottom)	
212	525	14.07	58.68	551.68		
216	529	14.32	58.43	551.43		
220	533	14.35	58.4	551.4	log jam	
220	533	1.2	58.4	551.4	HI	
234	547	2.5	57.1	550.1	end of jam	
235	548	3.24	56.36	549.36		
243	556	2.78	56.82	549.82		
262	575	3.1	56.5	549.5		
266	579	4	55.6	548.6		
270	583	2.43	57.17	550.17		
296	609	4.73	54.87	547.87		
300	613	4.31	55.29	548.29		
8	613	0.8	55.29	548.29	new tape	
26	639	6.9	49.19	542.19	bedrock	
32	645	7.04	49.05	542.05	bedrock	
39	652	7.24	48.85	541.85	waterfall	

42	655	10.96	45.13	538.13		
53	666	13.07	43.02	536.02		
65	678	14.5	41.59	534.59	pool	
71	684	13.8	42.29	535.29	shallow pool	
79	692	14.32	41.77	534.77		
79	692	4.42	41.77	534.77		
96	709	4.15	42.04	535.04	check dam top	
96	709	8.57	37.62	530.62	check dam bottom	
104	717	7.74	38.45	531.45		
122	735	7.64	38.55	531.55		
138	751	7.4	38.79	531.79	check dam top	
138	751	13.98	32.21	525.21	check dam bottom	
144	757	14.33	31.86	524.86		
144	757	2.64	31.86	524.86		
149	762	4.8	29.7	522.7		
158	771	6.9	27.6	520.6		
166	779	6.14	28.36	521.36		
174	787	7.19	27.31	520.31	drop	
177	790	7.55	26.95	519.95		
181	794	11.25	23.25	516.25		
186	799	10.12	24.38	517.38		
196	809	11.29	23.21	516.21	hard ground, rectangular channel	

205	818	11.78	22.72	515.72		
205	818	1.99	22.72	515.72		
217	830	3.5	21.21	514.21	top of cut	
224	837	6.96	17.75	510.75		
237	850	6.56	18.15	511.15		
244	857	6.65	18.06	511.06		
260	873	10.15	14.56	507.56		
260	873	9.38	14.56	507.56		
268	881	9.09	14.85	507.85		
279	892	10.05	13.89	506.89		
290	903	10.1	13.84	506.84		
300	913	12.08	11.86	504.86		
305	918	11.78	12.16	505.16		
311	924	12.3	11.64	504.64		
317	930	12.94	11	504	Culvert at Highgate Rd.	-11%

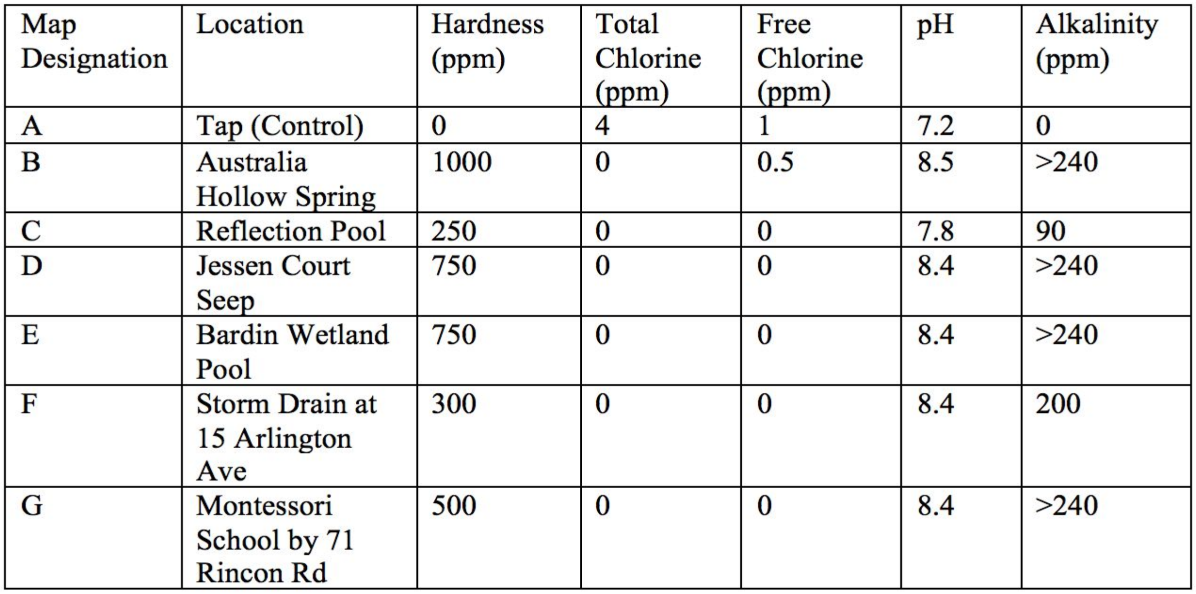
Table 2. Data for the cross-sectional profile of the east branch of the upper reach.

STAT, ft	**READ**	**ELEV**
19	6.71	100
23.8	7.82	98.89
24.9	9.1	97.61
26	8.98	97.73
26.8	8.83	97.88
27.1	7.71	99
33.1	5.95	100.76
37	4.55	102.16

Table 3. Data for the cross-sectional profile of the north branch of the upper reach.

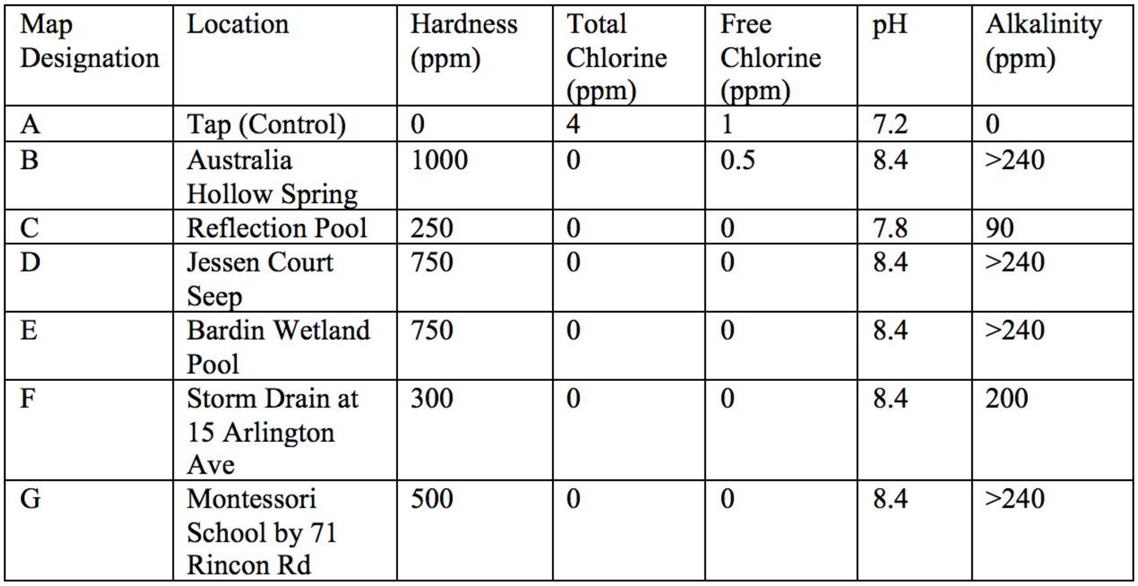
STAT, ft	**READ**	**ELEV**
21.7	4.22	100
18.8	4.6	99.62
15.5	8.16	96.06
14.7	10.14	94.08
13.5	10.17	94.05
12.3	9.79	94.43
7.7	5.78	98.44
1.8	4.88	99.34

Table 4. Water Quality Data, trial 1



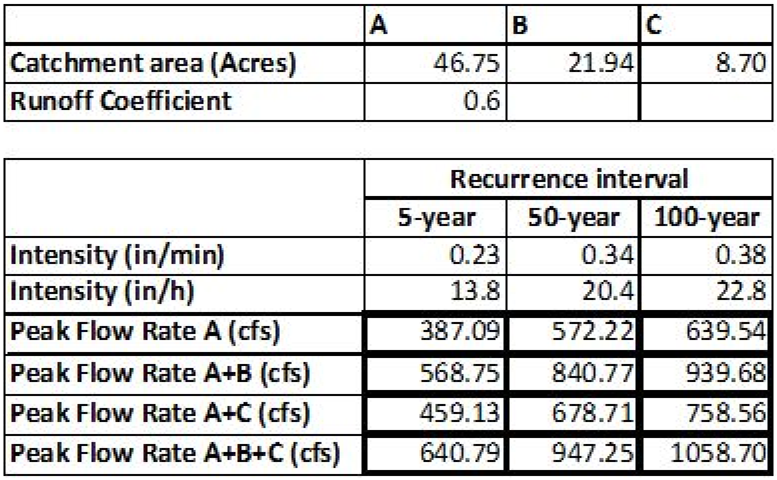
Map Designation	Location	Hardness (ppm)	Total Chlorine (ppm)	Free Chlorine (ppm)	pH	Alkalinity (ppm)
A	Tap (Control)	0	4	1	7.2	0
B	Australia Hollow Spring	1000	0	0.5	8.5	>240
C	Reflection Pool	250	0	0	7.8	90
D	Jessen Court Seep	750	0	0	8.4	>240
E	Bardin Wetland Pool	750	0	0	8.4	>240
F	Storm Drain at 15 Arlington Ave	300	0	0	8.4	200
G	Montessori School by 71 Rincon Rd	500	0	0	8.4	>240

Table 5. Water Quality Data, trial 2



Map Designation	Location	Hardness (ppm)	Total Chlorine (ppm)	Free Chlorine (ppm)	pH	Alkalinity (ppm)
A	Tap (Control)	0	4	1	7.2	0
B	Australia Hollow Spring	1000	0	0.5	8.4	>240
C	Reflection Pool	250	0	0	7.8	90
D	Jessen Court Seep	750	0	0	8.4	>240
E	Bardin Wetland Pool	750	0	0	8.4	>240
F	Storm Drain at 15 Arlington Ave	300	0	0	8.4	200
G	Montessori School by 71 Rincon Rd	500	0	0	8.4	>240

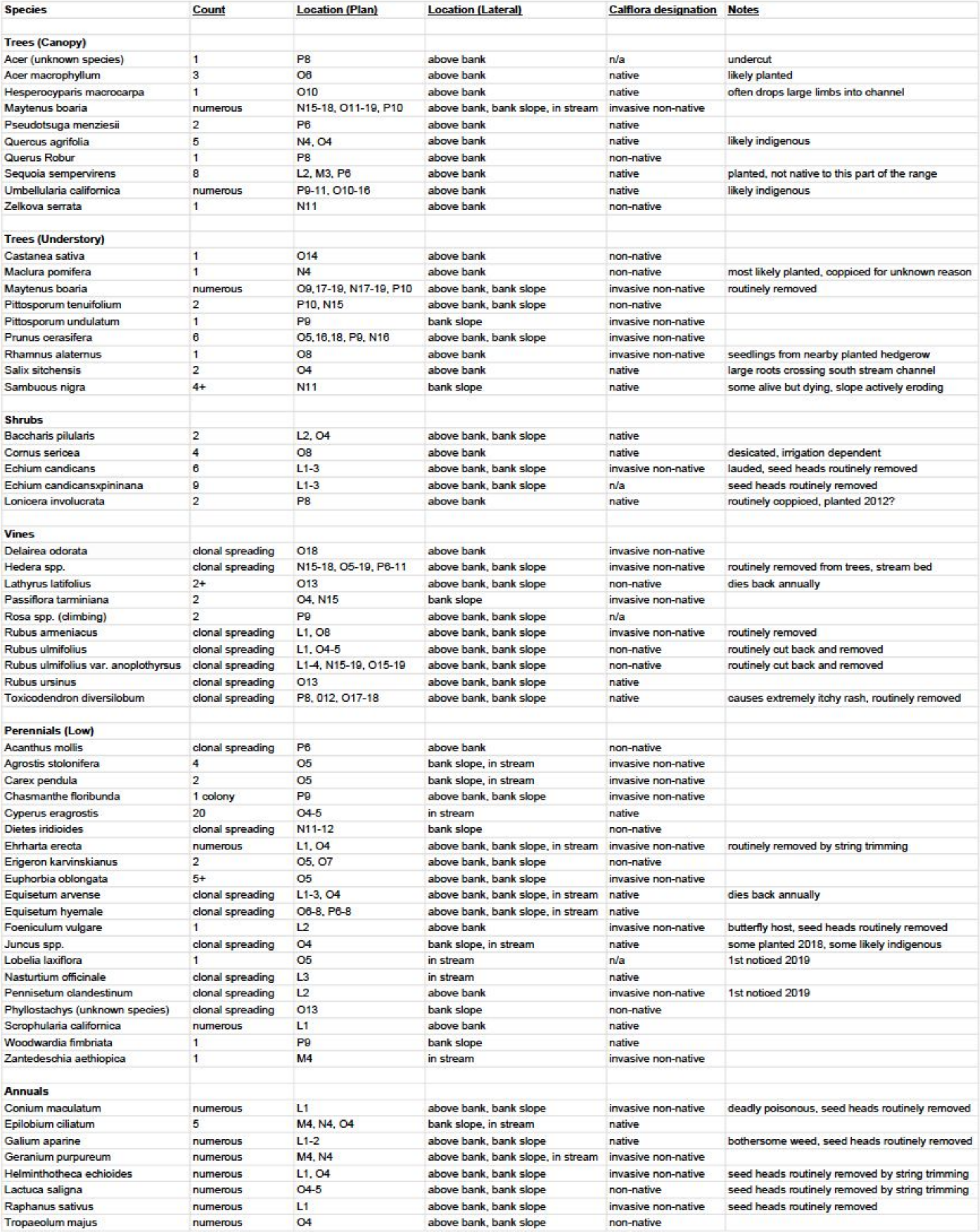
Table 6. Hydrologic calculations for the upper reach of the study area.



	A	B	C
Catchment area (Acres)	46.75	21.94	8.70
Runoff Coefficient	0.6		

	Recurrence interval		
	5-year	50-year	100-year
Intensity (in/min)	0.23	0.34	0.38
Intensity (in/h)	13.8	20.4	22.8
Peak Flow Rate A (cfs)	387.09	572.22	639.54
Peak Flow Rate A+B (cfs)	568.75	840.77	939.68
Peak Flow Rate A+C (cfs)	459.13	678.71	758.56
Peak Flow Rate A+B+C (cfs)	640.79	947.25	1058.70

Table 7: Blake Garden Southeast Stream Plant Inventory



Species	Count	Location (Plan)	Location (Lateral)	Calflora designation	Notes
Trees (Canopy)					
Acer (unknown species)	1	P8	above bank	n/a	undercut
Acer macrophyllum	3	O6	above bank	native	likely planted
Hesperocyparis macrocarpa	1	O10	above bank	native	often drops large limbs into channel
Maytenus boaria	numerous	N15-18, O11-19, P10	above bank, bank slope, in stream	invasive non-native	
Pseudotsuga menziesii	2	P6	above bank	native	
Quercus agrifolia	5	N4, O4	above bank	native	likely indigenous
Querus Robur	1	P8	above bank	non-native	
Sequoia sempervirens	8	L2, M3, P6	above bank	native	planted, not native to this part of the range
Umbellularia californica	numerous	P9-11, O10-16	above bank	native	likely indigenous
Zelkova serrata	1	N11	above bank	non-native	
Trees (Understory)					
Castanea sativa	1	O14	above bank	non-native	
Maclura pomifera	1	N4	above bank	non-native	most likely planted, coppiced for unknown reason
Maytenus boaria	numerous	O9,17-19, N17-19, P10	above bank, bank slope	invasive non-native	routinely removed
Pittosporum tenuifolium	2	P10, N15	above bank, bank slope	non-native	
Pittosporum undulatum	1	P9	bank slope	invasive non-native	
Prunus cerasifera	6	O5,16,18, P9, N16	above bank, bank slope	invasive non-native	
Rhamnus alaternus	1	O8	above bank	invasive non-native	seedlings from nearby planted hedgerow
Salix sitchensis	2	O4	above bank	native	large roots crossing south stream channel
Sambucus nigra	4+	N11	bank slope	native	some alive but dying, slope actively eroding
Shrubs					
Baccharis pilularis	2	L2, O4	above bank, bank slope	native	
Cornus sericea	4	O8	above bank	native	desicated, irrigation dependent
Echium candicans	6	L1-3	above bank, bank slope	invasive non-native	lauded, seed heads routinely removed
Echium candicansxpininana	9	L1-3	above bank, bank slope	n/a	seed heads routinely removed
Lonicera involucrata	2	P8	above bank	native	routinely coppiced, planted 2012?
Vines					
Delairea odorata	clonal spreading	O18	above bank	invasive non-native	
Hedera spp.	clonal spreading	N15-18, O5-19, P6-11	above bank, bank slope	invasive non-native	routinely removed from trees, stream bed
Lathyrus latifolius	2+	O13	above bank, bank slope	non-native	dies back annually
Passiflora tarminiana	2	O4, N15	bank slope	invasive non-native	
Rosa spp. (climbing)	2	P9	above bank, bank slope	n/a	
Rubus armeniacus	clonal spreading	L1, O8	above bank, bank slope	invasive non-native	routinely removed
Rubus ulmifolius	clonal spreading	L1, O4-5	above bank, bank slope	non-native	routinely cut back and removed
Rubus ulmifolius var. anoplothyrsus	clonal spreading	L1-4, N15-19, O15-19	above bank, bank slope	non-native	routinely cut back and removed
Rubus ursinus	clonal spreading	O13	above bank, bank slope	native	
Toxicodendron diversilobum	clonal spreading	P8, 012, O17-18	above bank, bank slope	native	causes extremely itchy rash, routinely removed
Perennials (Low)					
Acanthus mollis	clonal spreading	P6	above bank	non-native	
Agrostis stolonifera	4	O5	bank slope, in stream	invasive non-native	
Carex pendula	2	O5	bank slope, in stream	invasive non-native	
Chasmanthe floribunda	1 colony	P9	above bank, bank slope	invasive non-native	
Cyperus eragrostis	20	O4-5	in stream	native	
Dietes iridioides	clonal spreading	N11-12	bank slope	non-native	
Ehrharta erecta	numerous	L1, O4	above bank, bank slope, in stream	invasive non-native	routinely removed by string trimming
Erigeron karvinskianus	2	O5, O7	above bank, bank slope	non-native	
Euphorbia oblongata	5+	O5	above bank, bank slope	invasive non-native	
Equisetum arvense	clonal spreading	L1-3, O4	above bank, bank slope, in stream	native	dies back annually
Equisetum hyemale	clonal spreading	O6-8, P6-8	above bank, bank slope, in stream	native	
Foeniculum vulgare	1	L2	above bank	invasive non-native	butterfly host, seed heads routinely removed
Juncus spp.	clonal spreading	O4	bank slope, in stream	native	some planted 2018, some likely indigenous
Lobelia laxiflora	1	O5	in stream	n/a	1st noticed 2019
Nasturtium officinale	clonal spreading	L3	in stream	native	
Pennisetum clandestinum	clonal spreading	L2	above bank	invasive non-native	1st noticed 2019
Phyllostachys (unknown species)	clonal spreading	O13	bank slope	non-native	
Scrophularia californica	numerous	L1	above bank	native	
Woodwardia fimbriata	1	P9	bank slope	native	
Zantedeschia aethiopica	1	M4	in stream	invasive non-native	
Annuals					
Conium maculatum	numerous	L1	above bank, bank slope	invasive non-native	deadly poisonous, seed heads routinely removed
Epilobium ciliatum	5	M4, N4, O4	bank slope, in stream	native	
Galium aparine	numerous	L1-2	above bank, bank slope	native	bothersome weed, seed heads routinely removed
Geranium purpureum	numerous	M4, N4	above bank, bank slope, in stream	invasive non-native	
Helminthotheca echioides	numerous	L1, O4	above bank, bank slope	invasive non-native	seed heads routinely removed by string trimming
Lactuca saligna	numerous	O4-5	above bank, bank slope	non-native	seed heads routinely removed by string trimming
Raphanus sativus	numerous	L1	above bank, bank slope	invasive non-native	seed heads routinely removed
Tropaeolum majus	numerous	O4	above bank, bank slope	non-native	