

University of California, Berkeley

LDARCH 227 : River and Stream Restoration

Post-Project Appraisal of Santa Rosa Creek Restoration

Final Draft

Authors:

Charlie Yue

Elizabeth Hurley

Elyssa Lawrence

Zhiyao Shu

Abstract:

The purpose of this project is to assess the success of past Santa Rosa Creek restorations as a form of post-restoration monitoring of previous projects. Core objectives of this creek restoration applied to the reach of the Santa Rosa Creek ranging from E Street to Pierson Street were analyzed to the extent possible with available resources. The overarching objectives were to improve and restore habitat, remediate and maintain a healthy creek ecosystem, and bolster community involvement within this specified reach. To measure the success of these objectives, the team gathered documentation of flora and fauna, pebble counts, and interviews with members of the community. Reported flora showed the creek was composed of about 79% of the original planted species, and of the total observed species, 16% were non-native and 84% were native. Interviews with the community indicated that the creek is used frequently for recreational purposes and that the community is concerned with litter and crime along the creek. With the results from this study, it was determined that the majority of past projects were successful though improvements could be made to maintain healthier, safer, and cleaner paths along the river.

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Chapter 1. Introduction

History of the Santa Rosa Watershed and Creek

Human populations have settled within the Santa Rosa Watershed, and specifically near its natural waterways, for centuries. During the time of European settlement, the indigenous Pomo tribe populated the area, and by 1937 the first non-indigenous home was constructed in the area. After the devastating 1906 earthquake in California, downtown Santa Rosa was leveled with rubble, where the debris of this natural disaster made its way into the rivers and creeks of the region which filled in the floodplain and heightened banks. Increasing urbanization in the Santa Rosa watershed led to increased contamination of the creeks, soil, and groundwater in the area. In this urbanized setting, creeks were further channelized and became steep and prone to erosion, biodiversity along the creek was damaged, and riverain vegetation dwindled. To manage this issue, the Sonoma County Water Agency (SCWA) and additional agencies established flood control zones for several restoration and water management programs. Flood control basins that helped to reduce peak flows were set upstream of the urban area, including Spring Lake and Matanzas Creek Reservoir. Creek alterations reduced flood risk and impact but led to quick flow of water in man-made channels, decreasing bank stability and fish and wildlife habitat. The steelhead trout which is designated as a threatened species under the federal Endangered Species Act was particularly affected. To address this, in the mid-1990's, the SCWA, "...revised its stream maintenance practices to promote habitat while still maintaining the designed level of flood protection" (The City of Santa Rosa, et al., 2013).

Santa Rosa Citywide Master Plan and Post-restoration Projects

The Santa Rosa Citywide Creek Master Plan addresses the revitalization of nine creek watersheds, including natural, artificial, and combination riverbanks. Of the creeks that comprise the Santa Rosa watershed, Santa Rosa Creek was chosen as the site of study due to the dense urban population which can attribute to several effects on overall creek health. Santa Rosa Creek is a twenty-two mile long stream located in Sonoma county. This creek falls within the Santa Rosa watershed (shown in Appendix A) where it first forms east of the Santa Lucia Mountain Range, continues down into the Santa Rosa urban area, and then joins the Russian River that eventually leads to the Pacific Ocean (The City of Santa Rosa, et al., 2013).

Among the eight reaches within Santa Rosa creek that were analyzed, the fourth reach of Santa Rosa Creek was easily accessible by the public, and thus our team chose to analyze this section of the creek. Reach four is located between E Street and Pierson Street in Santa Rosa, CA, and it flows through downtown Santa Rosa. This reach has been restored and improved over time primarily due to its close proximity to the urban districts. Restoring this section of the creek was seen as an opportunity to reconsider the role of Santa Rosa creek in modern urbanism.

Restorations were not only proposed to improve flood control and freshwater supplement, but also to maintain a sustainable urban development and socioeconomic benefits, such as providing for leisure activities and entertainment to surrounding communities (The City of Santa Rosa, et al., 2013).

Management strategies were identified in the citywide master plan which aimed to address post-restoration monitoring of sediment, vegetation, and bank stabilization of all of the creeks within the project. Sediment build up can cause impeded flow, thus removal of sediment may prove to be necessary to maintain required flow capacity and create natural creek cross sections. Vegetation can accumulate in the creek, impeding flow, which would warrant vegetation removal. Additionally, continuous trimming, weeding, removal of non-native species, and replanting are established to maintain sufficient creek vegetation. Bank stabilization is undertaken when a bank is weak, unstable, or failing, and any adjustments to these banks must be conducted from June 15th to October 31 during the driest part of the year (The City of Santa Rosa, et al., 2013).

Another creek restoration project which occurred in reach four of Santa Rosa Creek was the Prince Memorial Greenway. The City of Santa Rosa's Prince Memorial Greenway is a recreational area surrounding the creek that stretches from Santa Rosa Avenue to Railroad Street. After accepting a donation from the Prince family in 1989, the Santa Rosa city government and a group of citizens worked to implement the budget toward the creation of a series of open space projects along Santa Rosa Creek. The objectives of the restoration project were to recreate the urban function of the creek, increase community interaction with the creek, save extinct species and habitats, maintain flood control and hydraulic capacity, ensure proper stormwater management, improve water quality, and revitalize the surrounding urban areas. The restoration project removed existing artificial construction and created a low-flow channel with meanders,

waterfalls, pools and riparian vegetation, established bike paths, pedestrian walkways, and appropriate fencing where required, increased outdoor lighting, and constructed staircases which created creek access points to the public (County of Sonoma California, 2018).

Purpose of This Study

The purpose of this study is to evaluate the success of the Santa Rosa Creek restoration projects, the Santa Rosa Citywide Creek Master Plan and the Prince Memorial Greenway Project, and their established monitoring systems. Reach 4 of Santa Rosa Creek, as outlined above, was studied, where the portion of the reach ranging from E street to Santa Rosa Avenue was not considered in this study since this section of the creek is diverted into underground canals. The assessment will evaluate the nonindustrial use of Santa Rosa creek at its current state and serve as a measure of post-restoration management success. After conducting data collection and observation to assess the current condition of the Santa Rosa Creek and its surrounding community, future actions and proposals will be recommended to resolve existing issues and promote potential developments.

Considering the objectives of each restoration had aligned objectives, this study uses an amalgamation of project objectives from the restoration projects applied in this reach. Thus, the projects should have conserved, enhanced, and restored *habitat*, ensured *stormwater* infrastructure was improved to mitigate flood risk, improved *economic* value of the surrounding area, created natural *open space*, introduced *recreational* activities along the creek, provided as an *educational* opportunity for the community, enhanced *aesthetics* of the creek and surrounding

area, protected necessary *water quality* of the creek, respected *private property*, and protected public *health and safety* as well as *cultural and archaeological resources* (The City of Santa Rosa, et al., 2013). Each of these restoration goals can be grouped in the following categories:

Flora and Fauna: *Habitat*

Stream Composition: *Water Quality, Stormwater*

Community Interaction: *Economic, Open Space, Recreational, Educational, Private Property, Health and Safety, and Cultural and Archaeological Resources*

Some of these assessments were not addressed in detail due to an inability to obtain proper data and documentation of the assessment, including stormwater management analysis, extensive water quality testing, economic changes, private property communications, and in depth cultural and archaeological resources.

Chapter 2. Methods

To evaluate the post-restoration state in reach four of Santa Rosa creek, several metrics and fieldwork techniques were used:

Flora and Fauna Identification

To analyze the stability of the flora planted during the restoration process in the specified reach, plant identification was conducted via a phone app named *PictureThis* and from prior knowledge. Using *PictureThis*, once a picture of the unidentified plant was taken, several suggested plant species were generated within the app and displayed to the user to ensure correct species identification. The remainder of the identification was conducted with prior knowledge of plant names. Once a plant's common name was recalled, the species was determined via the internet.

Stream Composition

The Wolman pebble count was used to evaluate the riverbed of the project. This is completed by randomly picking rocks from one spot in each section and measuring the intermediate length of the rock as identified in Figure 2.1. Twenty-five specimens were measured in each section due to time constraint even though 100 specimens is typically the minimum number of measurements required at a creek cross section. Embedded rocks were also measured at when applicable in the

section. With embedded rocks, the smaller of the two axes exposed were measured and recorded (Harrelson, et al., 1994).

Additional aspects of water quality such as dissolved oxygen testing and pH testing were not conducted due to unavailability of functional equipment and thus will not be discussed in this review. Remaining water quality indicators were not analyzed due to lack of resources for high scale chemical testing.

Storm water analyses remained untouched due to the fact that it proved difficult to calculate riverbed cross sections and determine related variables since the equipment used could not measure large dips in elevation at certain sections of the reach and portions of the river were too deep to wade through in order to construct sufficient cross sectional areas. Therefore, this information was left unreported in this report.

Community Interaction

Community interaction with the creek was assessed through multiple interviews at and between all five locations of interest. Almost twenty interviews were conducted with over forty participants total. The interview questions can be found on the survey in Appendix B. The first part of the survey is filled out by the interviewer to note the age of the interviewee as well as their human or animal companions. Each interview focused on one person if there was more than one person. The next part of the survey asked basic questions about the interviewee's habits when visiting the creek. Question 1 was: "How far do you live from the creek?" The answers

they could select were: less than five minutes, less than 10 minutes, less than 30 minutes, and more than 30 minutes. Question 2 was: “How do you travel to the creek?” The answers they could select were: walking, biking, driving, or other. The third question was: “How often do you visit the creek?” The answers they could select were daily, weekly, monthly, or less than monthly. Finally the last question was “Do you have any comments or concerns about the creek?” The survey also contained a section for the interviewee to add any additional notes about the interview. The goal of these interviews was to determine how people are using the restored creek, who is using the creek, and identify any issues locals have with the creek. The interviews on average did not last more than 2 minutes. We also did not prompt any answers for question 4 so all answers are authentic.

With this interview outline, recreational outcomes of the river restoration were analyzed, where participant comments can be compiled with a few additional categories. Overlooking these comments, the remaining objectives of the restoration to be evaluated can be split into two categories: one which analyzed other community interactions via additional team observation and one which requires assistance from Santa Rosa city officials/urban planners. In the former category, open space, educational methods, and health and safety were witnessed. The latter case which would include cultural and archaeological resources, private property, economic effects, and potentially new perspectives on other community interaction goals, has yet to be successful, for the team has not been able to obtain information from city employees. Thus these last few objectives will not be reported in the data and analysis of this review.

In addition, photos were taken along the creek to indicate community interaction with the creek and surrounding area as seen in Appendix C.

GIS Data Application

In Santa Rosa region, Crime is one of the significant issues around the city, especially along the Santa Rosa Creek. In Appendix D, The flow chart for crime data analysis shown the GIS data application process. The crime information along the Santa Rosa Creek reach 4 is clearly shown when a one-year crime GIS data(from February 2017 to February 2018) is used. Then, this crime data be scaled down to the Reach 4 area. From the city of Santa Rosa GIS website, park and bike trail data be found. Those two data are especially related human activities adjacent the reach 4. From the census 2010, population density can be calculated using the number of population and block areas. Therefore, the parks system, bike trail, and population density became three main spatial data to represent local social factors.

The goal of using social factor GIS data is to observe and evaluate the spatial relationship between crime with social factors(park, bike trail, and population density). Before overlapping data, there are updates in each data. For crime data, the initial downloaded crime data only include crime points where the incidents happened. To obtain crime points clusters, those crime points need to be buffed at certain distances(60 feet buffer zones be chosen in this research). With the buffed crime points, crime points clusters can be observed along the creek reach 4. For park data, it records all the parks and other green spaces, but this research should be focused on

those parks in reach 4. The bike trail data provides existing bike trails all the Santa Rosa region. The observation should be addressed along the creek reach 4 and intersect with creek reach 4. For population density, it is necessary to adjust population density using different colors. The legibility of population density information makes a greater observation. Moreover, adjusting color coding for each data is very important to show the visual information. Besides, ordering each layer is for the greater legibility.

Chapter 3. Results

Flora and Fauna Identification

The flora identified in the reach sections are listed in Table 3.1 where thirty-one different species were reported. Many species identified were native to this region as specified in the Santa Rosa Master Plan (The City of Santa Rosa, et al., 2013). Non-native (invasive) species such as ivy, himalayan blackberry, fig trees, and watercress accounted for nearly 16% of the total species found, with the remaining 84% of the catalogued plants being native species. Additionally, the fauna observed in each reach section can be found in Table 3.2. The fauna recorded also indicated all species inhabiting the creek were native species.

Stream Composition

The pebble count data is reported in Tables 3.4, 3.5, 3.6, 3.7, and 3.8 respectively for each section of our reach that was analyzed. Overall, the data shows there is a noticeable difference in the pebble size ranges that are prominent in each section of the reach as displayed in Figure 3.1. In section one of the reach, a significant number of large boulders were recorded. All of the boulders were embedded in concrete. In section two of the reach there were slightly more pebbles in the smaller size ranges in comparison to the third and fourth reach. Section three had a mix of medium-large sized pebbles in the riverbed. Section four of the reach indicated a high frequency of medium sized rocks. Lastly, section five of the reach had peak frequency of pebbles with relatively smaller intermediate lengths.

Community Interaction

Overall there were eight interviews conducted on the first day of field work on October 28, 2018. Eleven interviews were conducted on the second day of field work. One interview from the second day was omitted because it became clear the interviewee was not a reliable source of information. We interviewed two adolescents, four young adults, and thirteen adults. The human companions consisted of six adults, ten children, one adolescent, and four young adults. In total, fifty-five percent of interviewees had at least one human companion. There were no elderly people interviewed because there were no elderly people at the creek. Twenty-two percent of interviewees had an animal companion (all dogs).

Question 1, “How far do you live from the creek?” had the following results: seven interviewees lived less than five minutes from the creek, six interviewees lived less than ten minutes from the

creek, three interviews live less than thirty minutes from the creek, and two interviewees live more than thirty minutes from the creek.

Question 2, “How do you travel to the creek?” had the following results: twelve interviewees walk to the creek, five interviews bike to the creek, one interviewee drove to the creek, and one interviewee took the bus. Some interviews use more than one mode of transportation to arrive to the creek.

Question 3, “How often do you visit the creek?” had the following results: three interviewees visit the creek daily, ten interviewees visit weekly, four interviewees visit monthly, and one interviewee visits less than monthly.

The last question was open ended, asking the interviewee if they have any comments or concerns about the creek. The following are all of the comments received: “It's been lovely since the restoration”, “We come a lot with the kids”, “This creek used to look like the LA River before they restored it, it looks a lot better. Water can reach top of path at least two times a year”, “Trash is a problem”, “It's a nice place to walk”, “There are a lot of weird people and murders here”, “[There's] lots of litter and mold at the top of the creek”, “There's trash and bad people”, “Muy bonito”, “[The creek is] a little lower than usual”, “Lots of littler and homelessness. We should have a community litter walk and focus on wildlife protection. I also saw a stork here once”, “We like to play on the rocks”, and “People dump litter”. One adolescent talked about an

event when he saw a fish gasping for oxygen in a part of the reach where the water level was low. An adult recounted a story of when she saw an otter playing in the creek.

The interviewee characterization data as well as the data from questions 1, 2, and 3 can be found in Figures 3.2, 3.3, 3.4, and 3.5, respectively.

While gaining this recreational data, many other areas of community interactions were witnessed. In regards to open space requirements, there were several areas in which an open space was created in this restoration. Stairways and ramps which allow community members to interact with the creek remain intact and used by the community. Many recreational activities were observed along the restored creek such as children playing in the creek water, groups and single persons biking, walking, and jogging along the creek, and other social activity occurrences.

Educational interaction was bolstered with several informational signs (shown in Appendix C) describing the creek restoration with some example topics expanding on why the restoration occurred, how it benefits the creek habitat, and what that habitat should include.

GIS Data Application

With observation on the overlapping of crime data and Santa Rosa city data, plenty of crime points can be found around the Santa Rosa Creek in Data Analysis 1: Crime data + Park System

(shown in Appendix D). Because of those crime points are buffered by 60 feet, they have a difference in density, and denser buffered points became clusters. There are several clusters in the reach 4 where the community life might impact by those crime clusters along the creek. The next step is to analyze those crime clusters with social factors. By exploring the crime clusters results and using GIS social related data (parks, bike trails, and population density), there are three main results to evaluate the success of the Santa Rosa Creek restoration reach 4.

Crime data and Parks

Parks in Santa Rosa offer places for citizens and visitors, They are hubs for human activity. Also, the relationship between parks and crime points are important for evaluation. The two parks around reach 4 are Oliva park and Juilliard park. In the Data Analysis 1: Crime data + Park System (shown in Appendix D), there are two clusters are shown along the creek recreation also on the edges of Oliva park and Juilliard park. Therefore, the highest density of crime incidents happened around parks' borders around creek reach 4.

2. Crime data and Bike trails

Bike trails in Santa Rosa are main transportation. They connected to the bay trails to the whole Bay Area. the analysis on the crime and bike trail focuses on questions such as where are the crime clusters locating? Are there intersections? If so, what are those bike trails intersecting with? With close observation in the Data Analysis 2: Crime data + Bike trails (shown in Appendix D), there are three main crime clusters along the reach 4 area. There is all the intersections area, and those bike trails intersect with creek. It means there is the higher crime incidents happened on the bridges across on the Santa Rosa Creek.

3. Crime data and population density.

According to the demographic survey on census 2010, the population and the block are recorded by the nation. The research focuses on finding the relationship between population density and crime data, and If the number of crime points increased by the population density. After observation in the Data Analysis 2: Crime data + Population density (shown in Appendix D), there are five main crime clusters around the region. as the red color shown on the legend, all of five clusters are in the higher population density blocks(darker red) comparing their closing blocks. Therefore, surrounding the Santa Rosa Creek reach 4, crime clusters more appear at the higher population density blocks.

Chapter 4. Discussion

Flora and Fauna Identification

The Santa Rosa Citywide Creek Master Plan stated that there were particular native plants typically planted in urban environment river restorations as shown in Figure 4.1. Comparing the plants recorded in Table 4.1 with those listed in Figure 4.1, it was found that nearly 79% of the suggested plant species from the Santa Rosa Creek Restoration guidelines (The City of Santa Rosa, et al., 2013) were present in Santa Rosa creek. Plants not observed in the creek were the California rose, blackberry, and grape, bur reeds, and bay trees. In addition, several invasive species were found including the common fig, ivy, the himalayan blackberry, and watercress. Of these, ivy was noted to be most invasive, stretching along all parts of reach four. Even though

there were some non-native species, roughly 16%, mixed within the native species, the amount of native species present, nearly 84%, remains relatively high in number. With this, the flora of the creek can be said to be moderately successful, where removal of invasive species should be considered.

Table 3.2 which exhibits the fauna observed. Though few metrics were outlined in the project proposals to analyze fauna success, it can be said that there were a significant variety of observable forms of life along reach four of Santa Rosa creek, and thus it can be deemed as a healthy and successful ecosystem.

Stream Composition

Maintaining a varying pebble count throughout the stream creates an improved habitat for the flora and fauna thriving after the river restoration was completed. Since no area is sediment rich in this reach, this can also serve as an indicator that fish are habitable in this section of the Santa Rosa Creek since many freshwater fish require gravel prevalent sediment conditions to successfully complete their life cycles throughout a stream. This also indicates there is no strong indicator of large sediment transport or build up in certain areas of the reach (Kondolf, 2000).

Community Interaction

The interviews show that mostly adults visit the creek by foot on a weekly basis and live less than five or ten minutes from the creek. Most visitors do not have an animal companion and a

slight majority of visitors have one or more human companions. Also, many interviewees who noted they visit the creek daily live at the creek as they are homeless. The biggest concerns more people have with the creek is the amount of litter surrounding the creek and crime that happens around the creek. The concern about litter was unsurprising as it is in a very urban area. The concerns about crime are interesting so we investigated crime rates in the area around the creek. Figure 3.6 shows a map of crime data in Santa Rosa for 2017-2018. There is no correlation between increased crime and proximity to the creek. There are crimes that happen along the creek but no more than what occur in the city at large. However, when people refer to crime, it was our sense during the interview they were implying the presence of a homeless population. It is true there were many homeless people along the creek, some were interviewed during this study. The bay area has a large homeless population for reasons outside the scope of this study.

Recreational activities, open spaces, and educational opportunities were all noted to have positive correlations with the previous creek restoration that occurred. Many community members were witnessed to be happy with the new developments that occurred in the creek and often interacted with it, where all of these listed aspects were deemed to be successfully implemented.

Multiple photos were taken at all five locations along the creek which can be viewed in Appendix C. Some of the photos taken along the creek pathway are indicative of supporting

cultural heritage in the community which is also a positive indicator for the objectives of the previous creek restorations.

GIS Data Application

After community survey, the gis data application gives a in-deep thinking on community safety.

The government should think about the crime points, crime clusters with more social-related factors. According to the crime and factors geographical result, the police department could go on patrol around those locations.

The precision of the data needs to improve. In this research, the city provides limit data and there are some more data from Sonoma County where have not precisely located gis information, and the information such as crime types are not fully clear.

Chapter 5. Conclusion and Recommendations

Overall, when holistically viewing the Santa Rosa Creek restorations, it can be said that the restorations were successful in meeting their objectives: there are the recommended number of native species present, the pebble count does not show signs of sediment build up or transport, and community interaction is thriving. Looking back on the eleven goals set in Santa Rosa Citywide Creek Master Plan, as shown in Table 1.1, almost all of those goals have been met. The flora and fauna evaluation show the habitat is healthy. The pebble count does not indicate

stormwater issues. Walking along the creek there are many paths and spaces for recreation and many signs informing pedestrians about the wildlife at the creek fulfilling the open space, recreation, and education goals. There was observed nutrient build up at location 4 so other metrics (such as dissolved oxygen) could indicate a water quality issue in the future. The goal of having a healthy and safe community however was not met. Residents have an obvious issue with crime in the area as described in Figure 3.6 and in the interview data collected.

Recommendations

We recommend a community clean up of the river: a day in which the community volunteers to pick up litter and learn about the wildlife at the creek. A further water quality analysis is also recommended because of the nutrient build up at location 4 (shown in Photo 5 of Appendix C). Dissolved oxygen, pH, biological oxygen demand, and turbidity should be measured. As mentioned earlier, the main goal that is not met is the health and safety goal. In the past year there have been reported incidents of vandalism, disorderly conduct, and assault along the creek (the crime data is in Figure 3.6). More surveillance should be added along the creek. Another important social issue involves the high numbers of homeless individuals which frequent the area or claim spots along the creek as their residence. To maintain important health and safety standards, it is critical this population is educated in necessary and proper procedures.

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Tables

Table 1.1

Goal	Description
Habitat	<i>Local creeks and riparian corridors are preserved, enhanced, and restored as habitat for fish, birds, mammals, and other wildlife.</i>
Storm Water	<i>The ability of waterways to carry stormwater runoff and surface drainage is protected and improved to alleviate flood risk.</i>
Economic	<i>The economic value of areas adjacent to creeks is enhanced.</i>
Open Space	<i>The urban environment is enhanced with natural and open space features.</i>
Recreation	<i>Trail corridors and other recreational opportunities are provided along some waterways.</i>
Education	<i>Educational opportunities are provided along some waterways.</i>
Aesthetics	<i>Aesthetic qualities of creeks are enhanced.</i>
Water Quality	<i>Water quality of creeks is protected and enhanced.</i>
Private Property	<i>Private property rights are respected.</i>
Health and Safety	<i>Public health and safety is protected.</i>
Cultural Resources	<i>Cultural and archaeological resources are protected.</i>

Table 3.1

Section 1-2		Section 2-3		Section 3-4		Section 4-5	
Species	Name	Species	Name	Species	Name	Species	Name
<i>Platanus occidentalis</i>	American Sycamore	<i>Quercus geminata</i>	Live Oak	<i>Quercus geminata</i>	Live Oak	<i>Acer macrophyllum</i>	Big leaf Maple
<i>Ficus carica</i>	Common Fig	<i>Quercus lobata</i>	Valley Oak	<i>Quercus lobata</i>	Valley Oak	<i>Quercus lobata</i>	Valley Oak
<i>Typha domingensis</i>	Cattails	<i>Foeniculum vulgare</i>	Fennel	<i>Typha domingensis</i>	Cattails	<i>Salix lucida ssp lansianandra</i>	Shining Willow
<i>Rubus armeniacus</i>	Himalayan Blackberry	<i>Salix lucida ssp lansianandra</i>	Shining Willow	<i>Rubus armeniacus</i>	Himalayan Blackberry	<i>Salix lasio</i>	Arroyo willow
<i>Alnus rhombifolia</i>	White Alder	<i>Acer macrophyllum</i>	Big Leaf Maple	<i>Cornus Sericea ssp sericea</i>	Red stem dogwood	<i>Fraxinus latifolia</i>	Oregon ash
<i>Pyracantha crenatoserrata</i>	Chinese Firethorn	<i>Typha domingensis</i>	Cattails	<i>Rhus typhina</i>	Staghorn Sumac	<i>Aesculus californica</i>	Buckeye

<i>Foeniculum vulgare</i>	Fennel	<i>Digitaria</i>	Crabgrass	<i>Digitaria</i>	Crabgrass	<i>Typha domingensis</i>	Cattails
<i>Salix lucida ssp lansianandra</i>	Shining Willow	<i>Symphoricarpos albus var levigatus</i>	Snowberry	<i>Populus</i>	Cottonwood	<i>Platanus occidentalis</i>	American Sycamore
<i>Acer macrophyllum</i>	Big Leaf Maple	<i>Arbutus menziesii</i>	Madrone	<i>Foeniculum vulgare</i>	Fennel	<i>Arctostaphylos</i>	Manzanita
<i>Lygodium japonicum</i>	Common Fern	<i>Quercus Kelloggii</i>	Black Oak	<i>Arbutus menziesii</i>	Madrone	<i>Acer Negundo</i>	Boxelder
<i>Hedera</i>	Ivy	<i>Hedera</i>	Ivy	<i>Sambucus</i>	Elderberry	<i>Juncus effusus</i>	Rush
<i>Juglans hindsii</i>	Northern California Black walnut	<i>Juncus effusus</i>	Rush	<i>Hedera</i>	Ivy	<i>Ludwigia peploides</i>	Water Primrose
<i>Juncus effusus</i>	Rush	<i>Schoenoplectus acutus</i>	Tule	<i>Schoenoplectus acutus</i>	Tule	<i>Nasturtium officinale</i>	Watercress
<i>Nasturtium officinale</i>	Watercress	<i>Nasturtium officinale</i>	Watercress	<i>Juncus effusus</i>	Rush		

Table 3.2

Section 1-2	Section 2-3	Section 3-4	Section 4-5
Name	Name	Name	Name
Finches	Egret	Finches	Finches
Mallard Ducks	Finches	Mallard Ducks	Fish larvae/fry
	Fish larvae/fry	(Reported Otter)	

Table 3.3

Population of Section 1				
Size Class (mm)	Number of Rocks	%	Cumulative %	Finer than (mm)
256	8	32	100	360
180	6	24	68	256
128	5	20	44	180
80	0	0	24	128
64	1	4	24	80
45	1	4	20	64
32	0	4	16	45
22.6	0	4	12	32
16	1	4	8	22.6
11.3	0	0	4	16
8	0	0	4	11.3

<8	1	4	4	8
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*Total embedded rocks is equal to 20 which is 80% of the total measured, where all were ≥ 64 mm

Table 3.4

Population of Section 2				
Size Class (mm)	Number of Rocks	%	Cumulative %	Finer than (mm)
256	0	0	100	360
180	0	0	100	256
128	0	0	100	180
80	1	4	100	128
64	4	16	96	80
45	1	4	80	64
32	9	36	76	45
22.6	5	20	40	32
16	4	16	20	22.6
11.3	1	4	4	16
8	0	0	0	11.3
<8	0	0	0	8

Table 3.5

Population of Section 3				
Size Class (mm)	Number of Rocks	%	Cumulative %	Finer than (mm)
256	0	0	100	360
180	0	0	100	256
128	1	4	100	180
80	6	24	96	128
64	3	12	72	80
45	9	36	60	64
32	1	4	24	45
22.6	2	8	20	32
16	2	8	12	22.6
11.3	0	0	4	16
8	1	4	4	11.3
<8	0	0	0	8

Table 3.6

Population of Section 4				
Size Class (mm)	Number of Rocks	%	Cumulative %	Finer than (mm)
256	0	0	100	360
180	0	0	100	256
128	0	0	100	180
80	3	12	100	128
64	5	20	88	80
45	9	36	68	64
32	5	20	32	45
22.6	1	4	12	32
16	1	4	8	22.6
11.3	0	0	4	16
8	1	4	4	11.3
<8	0	0	0	8

Table 3.7

Population of Section 5				
Size Class (mm)	Number of Rocks	%	Cumulative %	Finer than (mm)
256	0	0	100	360
180	0	0	100	256
128	0	0	100	180
80	0	0	100	128
64	1	4	100	80
45	2	8	96	64
32	5	20	88	45
22.6	3	12	68	32
16	9	36	56	22.6
11.3	2	8	20	16
8	2	8	12	11.3
<8	1	4	4	8

Figures

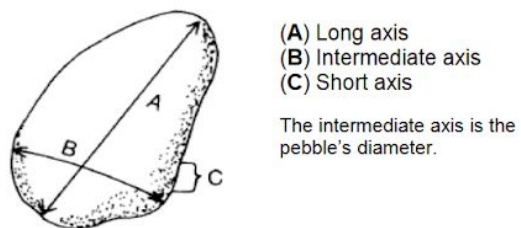


Figure 2.1 (Harrelson, et al, 1994)

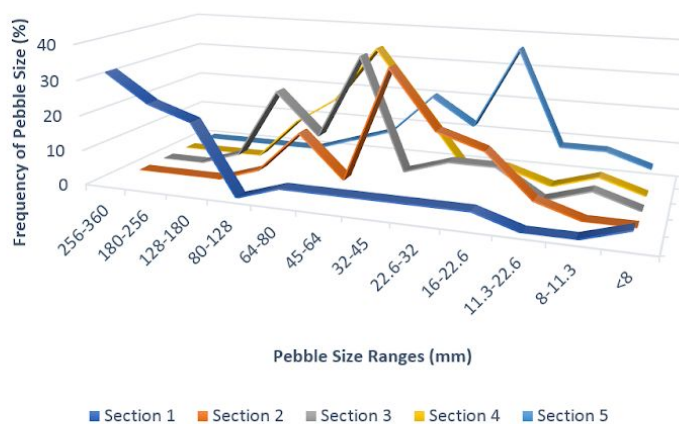


Figure 3.1

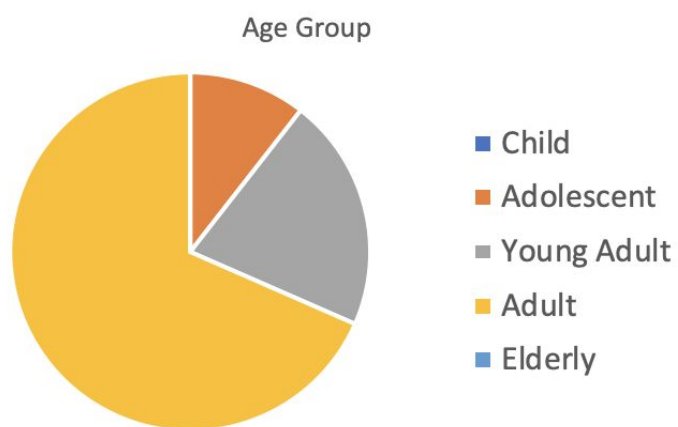


Figure 3.2

How far do you live from the creek?

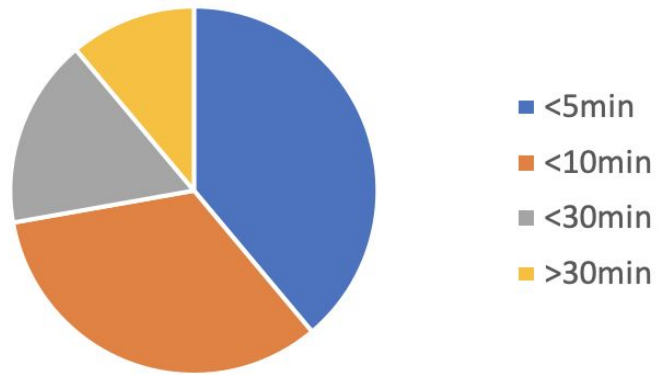


Figure 3.3

How often do you visit the creek

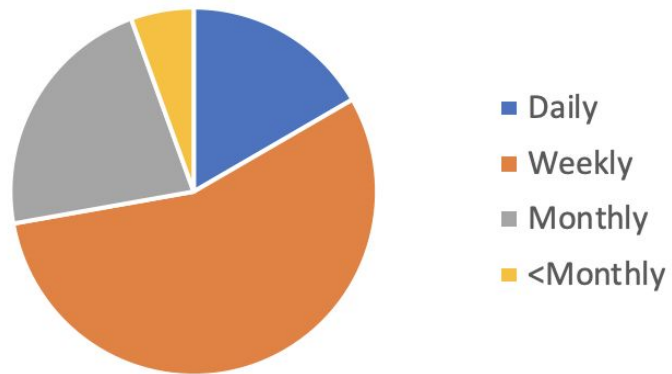


Figure 3.4

How do you travel to the creek?

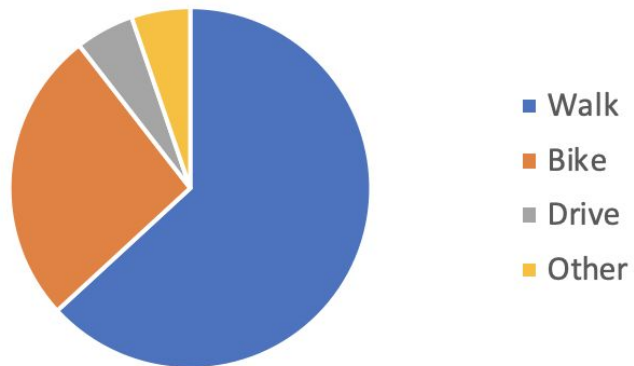


Figure 3.5

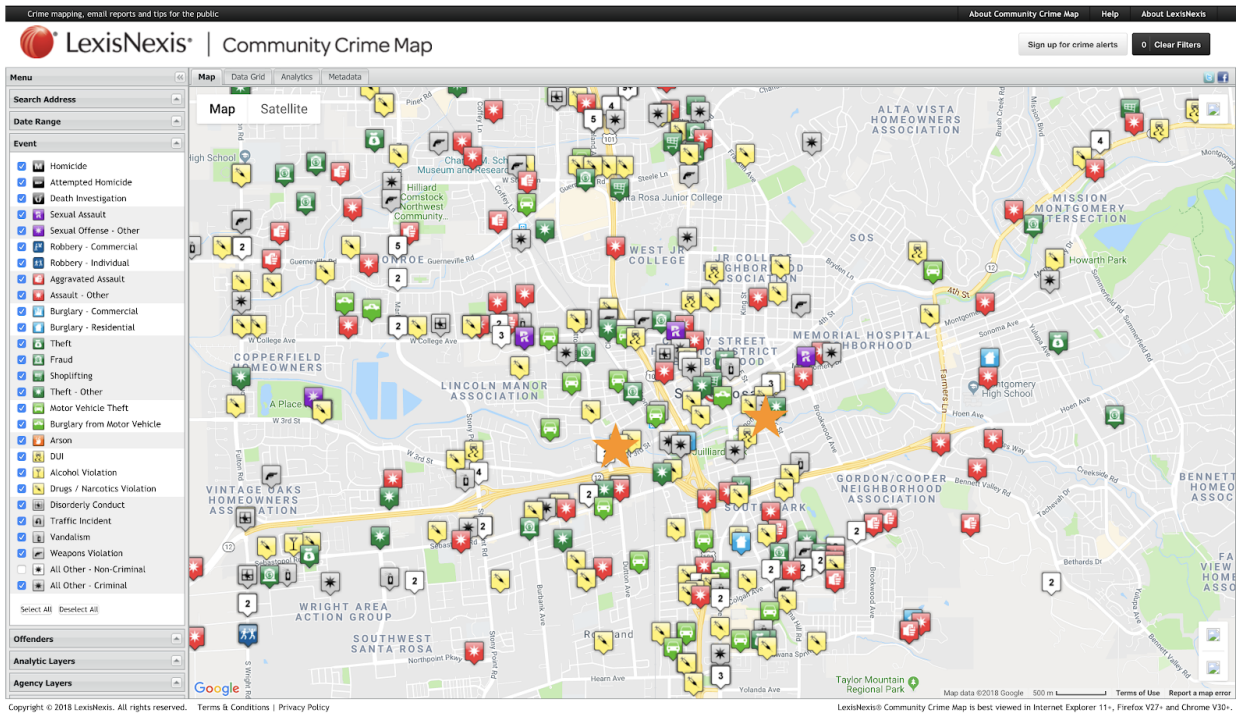
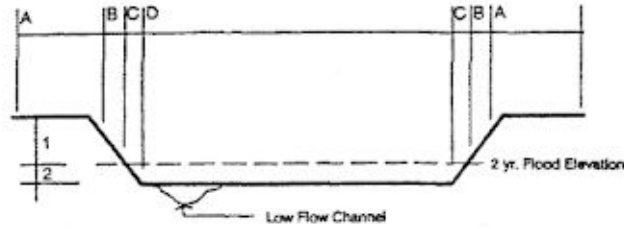


Figure 3.6 (“LexisNexis® Community Crime Map”, 2018)

Typical Revegetation Scheme for Urban Reaches “C”, “D”, and “E”

Figure 26



PLANTING ZONES		MOISTURE REGIME	PRINCIPAL PLANT SPECIES
A	Top of Bank	Xeric (dry)	Live Oak, Valley Oak, Madrone, Bay, Manzanita, Cenothus, Native Bunch Grasses and Wildflowers
B	Mid-Bank	Mesic (intermediate)	Valley Oak, Black Oak, Buckeye, Maple, Elderberry, California Rose, California Blackberry, California Grape, Snowberry, Native Grasses and Wildflowers
C	Lower-Bank	Hydric (seasonally wet)	Alder, Cottonwood, Willow, Ash, Boxelder, Elderberry, Maple, Snowberry, California Rose, California Blackberry, California Grape, Native Herbs
D	Channel Bottom	Hydric (perennially wet)	Elderberry, California Blackberry, California Grape, California Rose, Snowberry, Sapping Willows, Native Wetland Grasses, Sedges, Tules, Rushes, Cattails, and Bur reed
HYDRAULIC PLANTING ZONES			PRINCIPAL PLANT SPECIES
1	Above 2 yr. Floodplain		Elderberry, California Blackberry, California Grape, California Rose, Snowberry
2	Below 2 yr. Floodplain		Grasses, Tules, Cattails, Snowberry, California Rose, California Blackberry, and Fishery Enhancement

Figure 4.1 (The City of Santa Rosa, et al., 2013)

Table Captions

Table 1.1. The eleven goals set by the Santa Rosa Citywide Creek Master Plan

Table 3.1. List of identified plant species in studied reach of Santa Rosa Creek

Table 3.2. List of identified animal species in studied reach of Santa Rosa Creek

Table 3.3. Pebble count tabulated for section 1 of the studied reach of Santa Rosa Creek

Table 3.4. Pebble count tabulated for section 2 of the studied reach of Santa Rosa Creek

Table 3.5. Pebble count tabulated for section 3 of the studied reach of Santa Rosa Creek

Table 3.6. Pebble count tabulated for section 4 of the studied reach of Santa Rosa Creek

Table 3.7. Pebble count tabulated for section 5 of the studied reach of Santa Rosa Creek

Figure Captions

Figure 2.1. Pebble count measurement breakdown

Figure 3.1. Pebble count distribution in each section of the reach

Figure 3.2. The age group of interviewees broken into five categories

Figure 3.3. The travel time for the interviewee to travel to the creek from their home.

Figure 3.4. The frequency at which an interviewee visits the creek.

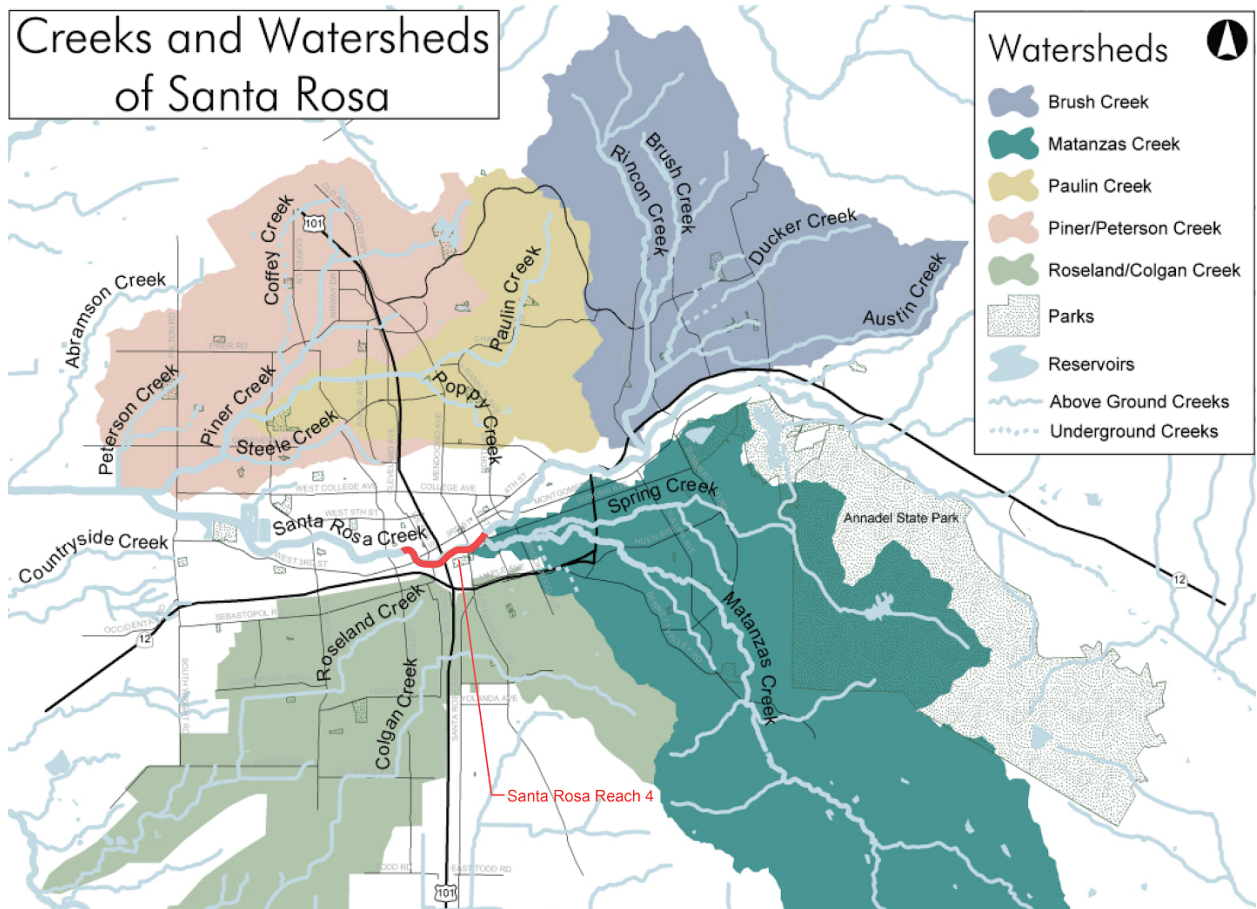
Figure 3.5. The method of transportation the interviewee uses to travel to the creek.

Figure 3.6: A map of crime in Santa Rosa with orange stars marking the start and finish off Region 4 of the creek.

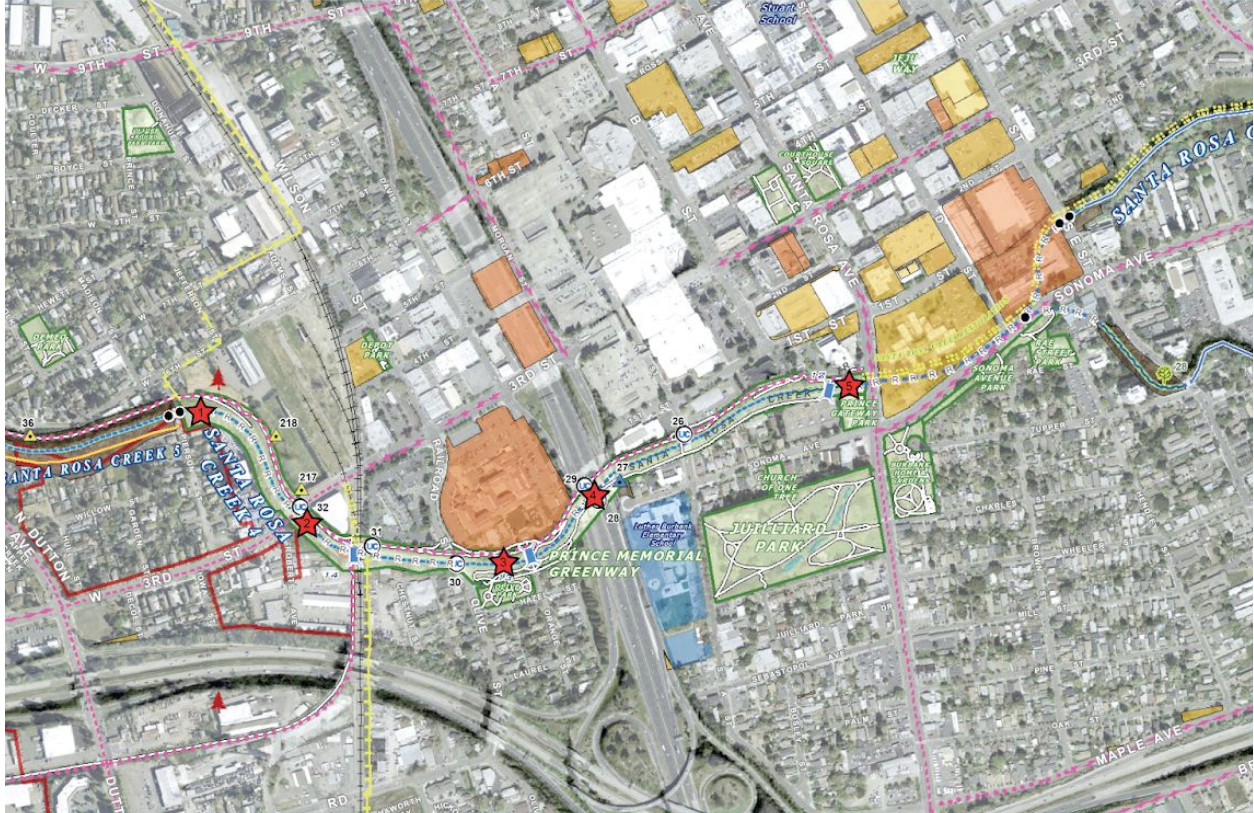
Figure 4.1. Typical revegetation scheme for urban reaches as stated in the Santa Rosa Creek Design Manual (The City of Santa Rosa, et. al)

Appendices

Appendix A: Maps



[Map of Creeks and Watersheds of Santa Rosa]



[Map of Pierson Reach from Pierson Street to E Street. The five red stars indicate the different locations the reach was analyzed at in the post-restoration study]

Appendix B: Survey

Santa Rosa Creek Restoration Analysis Project
 Santa Rosa, Sonoma County, CA
 Interview Field Data Sheet



Date Collected		Collection Number	
Interviewer			
Location		Time	
General Information			
Age Group	<i>Child / Adolescent / Young Adult / Adult / Elderly</i>		
Human Companions	<i>Yes / No</i>	Details	
Animal Companions	<i>Yes / No</i>	Details	
Interview Questions			
1. How far do you live from the creek?	<i><5 Min</i>	<i><10 Min</i>	<i><30 Min</i> <i>>30Min</i>
2. How do you travel to the creek?	<i>Walk</i>	<i>Drive</i>	<i>Bike</i> <i>Other</i>
3. How often do you visit the creek?	<i>>Weekly</i>	<i>Weekly</i>	<i>Monthly</i> <i><Monthly</i>
4. Do you have any comments or concerns about the creek?			
Comments/Other Notes			

Appendix C: Photos



Photo 1: Relevant cultural mural along Santa Rosa Creek's Prince Memorial Greenway



Photo 2: Example of one of the several educational boards erected along the creek



Photo 3: Location 1, evidence of only embedded rock and shallow creek.



Photo 4: Location 2, evidence of large embedded rock



Photo 5: Location 4, indicates unhealthy water quality.

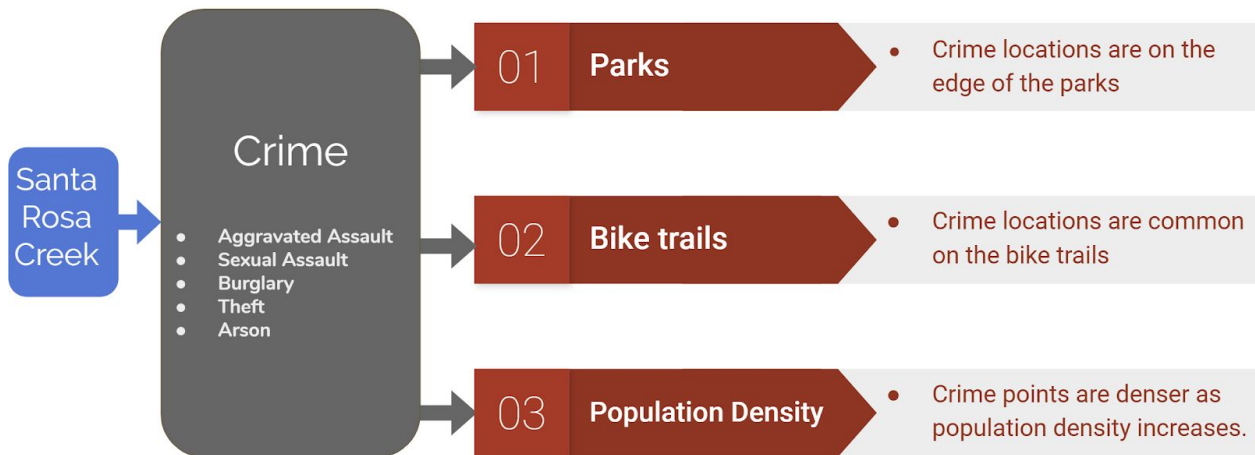


Photo 6: Location 4, shows shallow water flowing over sidewalk underneath Santa Ana Ave.

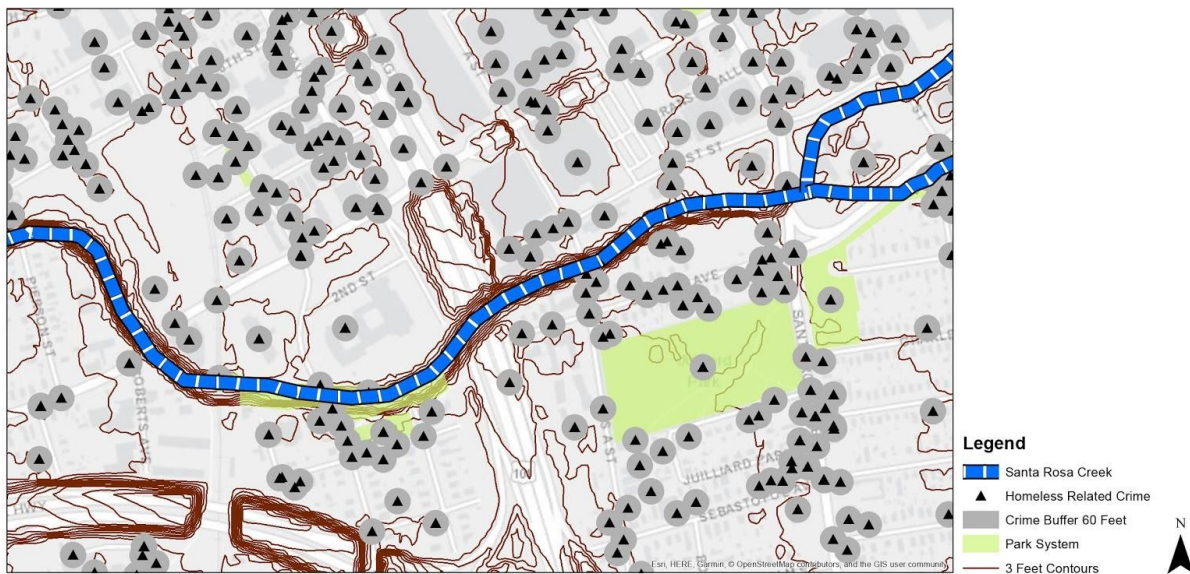


Photo 7: Location 5, lots of vegetation and large walls on either side of creek.

Appendix D: Data Analysis



Flow chart for crime data analysis



Data Analysis 1 : Crime data + Park System

Resource: USGS, Sonoma County, The City of Santa Rosa



Data Analysis 2 : Crime data + Bike Trails
 Resource: USGS, Sonoma County, The City of Santa Rosa



Data Analysis 3 : Crime data + Population density
 Resource: USGS, Census 2010, Sonoma County, The City of Santa Rosa