Griffin Ballard
Senior Seminar
Jeff Baldwin

Establishing a Longitudinal Study for Sediment Input in the Copeland Creek Headwaters

Abstract

Mass movements play a significant role in the deposition of sediment into creeks. Copeland Creek is a nine-mile perennial creek located on Sonoma Mountain in Sonoma County, California. Copeland Creek produces significant amounts of sediment that is being deposited along the alluvial fan, which comes into contact with Sonoma State University. Once reaching the valley floor, Copeland Creek bisects Sonoma State campus on its course to discharge into the Laguna de Santa Rosa. This generates concern because the accumulation of sediment is clogging the channel and filling the Laguna de Santa Rosa, leading to flood control and drainage issues along the stream. Copeland Creek Restoration Project, founded by Sonoma County Water Agency, was created help the flow of the stream, decrease sediment buildup and reduce the habitat problem existing along the creek. Establishing this study for sediment input along Copeland Creek headwaters creates a longitudinal study for future characterization and analysis of mass movements and sediment deposition along Copeland Creek in Fairfield Osborn Preserve. Several locations have been monumented for future observation, photo surveillance, and measurements of these mass movements and their contribution to sediment deposition. The potential information is important to Sonoma County Water Agency with regards to flood control, stream channelization, and accumulation of sediment.

Introduction

Mass movements are a powerful geomorphic process that have shaped the way Copeland Creek looks, works and operates. Mass movements can be caused many different things ranging from development of water in the ground to human modification to the landscape making the earth particularly unstable along a slope. Earthquakes and volcanic activity can also cause mass movements such as the Rodgers Creek fault, which runs through the base of Sonoma Mountain. The main contribution to the amount of movement that is occurring along Copeland creek comes from heavy precipitation leading to rapidly saturated sediment, which loosens because of gravity and slides into the creek. The problem is that these movements are depositing significant amounts of sediment and the Sonoma County Water Agency is curious as to how much sediment is being deposited, which served as the catalyst for this project. The Fairfield Osborn Preserve is a preserve maintained and owned by Sonoma State University and is not open to the public. The preserve is there for academic research and as well as preserve land for the local flora and fauna. Sonoma County Water Agency have established projects to determine how much sediment is being deposited along the Copeland Creek and would like to characterize the movements that are contributing as well as measure the sediment that is transported downstream.

This study sets base line markers to allow more accurate estimates and expected inputs of sediment being deposited in the creek. This study is important because it establishes locations for people further characterize and survey these mass movements along Copeland Creek as well as the sediment deposit along the creek in upper reaches of the Fairfield Osborn Preserve. The information that is being obtained is of importance to the Sonoma County Water Agency with regards to flood control, stream channelization, and accumulation of sediment.

This paper will be describing, in detail, several sites in which mass movements have been documented and surveyed. Each site will have a certain method of surveillance of the movement and will show visual evidence of substantial contribution of sediment input. GPS coordinates will be given to locations that can access satellites, as well as a sketch map of certain areas, so, re-finding each site is not a difficult task in itself. The idea is that in the future, people will be able to come back to each site, easily, with a description of each location and will be able to re-measure, re-photo and resurvey these movements. The locations that have been established are monitoring the larger movements, which are displaying the largest sediment input in the headwaters of Copeland Creek. This research paper will include maps, diagrams and cross sections in which the profile of the creek will be defined at a certain location as well as definitions and descriptions of each type of movement will be defined.

Literature Review

Large amounts of sediment are being deposited into the Copeland Creek by the processes of mass movements. These movements have contributed to deposition of sediment for a long time and the issue is that channel sedimentation is increasing. The triggers of mass movements along creeks can be a variety of things including tectonic activity, heavy precipitation, ground water accumulation, and human modification to land increase the chances of a landslide.

Due to the fact that FOP is a preserve, there is no human development occurring, so agricultural and architectural influences are not a factor. Mass movements in many other places occur because of things that humans do to weaken the slope itself. Vineyards and other agricultural development are big triggers for types of landslides in hillside areas. FOP is located on Sonoma Mountain, which has constant tectonic activity due to the Rogers Creek Fault, which the foot of Sonoma Mountain runs over. Because of this, constant movement occurs along these slopes but the movement minimal because of the weakness of the tectonic activity.

The accumulation of ground water plays a huge role because of the fact that Copeland Creek is a perennial creek and it continuously eats away at the base of the slope. Sonoma is located in a Mediterranean climate, thus the region experiences mild temperatures with moderate amounts of winter rainfall and very dry summers. During these winter rains, Sonoma Mountain experiences rather large storms that dump sizable amounts of precipitation. Because of these rains, a lot of activity occurs along the creek in the headwaters of FOP. The moisture in the soil causes slope instability, leading it to slip and slide away from the stable, more secure part of the slope (Harden, Deborah R, 1995)

The major movements that are occurring along Copeland Creek in the headwaters include debris flows and mudflows. Each movement has different material and different shape due its content. Debris flow content is characterized by a combination of loose soil, rock, organic matter, air and water. Debris flows are caused by intense surface water flow, due to heavy precipitation that erodes and destabilizes steep slopes. A mudflow is an earthflow containing material that is wet enough to flow rapidly and contains a substantial amount of sand, silt, and clay-sized particles and other organic material (Harden, Deborah R, 1995)

These movements have dumped so much sediment into that creek that projects have been established along to creek to help the flow by protecting and monitoring bank stabilization of Copeland Creek as well as to restore fish and wildlife habitat along the creek. Restoration was essential to decrease creek disturbance due to past land use practices and return the site to more natural conditions. Historic livestock grazing along the creek damaged aquatic habitat, diminished most of the bank vegetation, enhanced stream bank erosion, and increased channel sedimentation (Cook, David, 2001). The goal of the Copeland Creek Restoration Project Monitoring Plan was to restore the natural structure and function of the reach so it more closely resembled its pre-grazing conditions. The project objectives are to; improve aquatic habitat and water quality through decreasing sediment, nutrient loads and water temperature; decrease erosion through development of more stable channel banks and channel courses; and to increase the abundance of fish and wildlife diversity (Cook, David, 2001).

Along with the Copeland Creek Restoration Project Monitoring Plan, there is the Copeland Creek Master Plan, which has a similar objective. This project focuses on the development and preservation of the Copeland Creek Buffer Zone located on the Sonoma State University campus. The Buffer Zone, which originates at the top of the creek bank and extends laterally along the creek, has been designated to 150 feet on the north side of the creek and to include the Native Plant Garden on the south side of the creek. The master plan is comprised of policies and improvements to monitor restoration, recreation and opportunities for the creek to be utilized for its valued uses as well as its beauty (DuVall, Deborah G, 2001).

These projects are the motive behind this research and are the reason this longitudinal study is being created. The projects that are being conducted along Copeland Creek are in need of locations in which people can continuously re-measure and resurvey active sediment deposition. These locations will be set up in places where active movements are occurring and are easily locatable.

Methods

Two stream channel cross-sectional surveys were conducted, several locations in which people are able to take photo surveys of active movements have been positioned, and several head scarp surveillance locations have been established.

Head scarp surveillance is a very important tool to survey mass movements and sediment displacement from an escarpment. An escarpment is a steep slope, caused by erosion and is located at the top of the slope. There is mineral exposure at the base of the scarp and will display evidence of active sediment input. Rebar monuments were used to set up sites so that people can come every five to ten years and re-measure the distance between the two bars and the bars and scarp. These monuments and the collected measurements will illustrate how much movement has taken place at the head scarp and will give an idea of active that debris flow is.

A stream channel cross-sectional survey is were you locate two points on opposite sides of the creek and measure the distance as well as the depth of the creek and the changes within those two points. You have two measuring points at which you start and end, and in between those two points, you take down distance and depth until you go from one end to another. The importance of a setting up stream channel cross-sectional survey locations which people can re-measure and re-profile areas is so that they can get a new profile of the creek and see the changes in composition. Re-surveying a cross section can tell you whether the creek size has increased and erosion is causing the creek channel to widen. These surveys also tell you whether the creek has gotten deeper and whether there is more accumulation of debris along the bed.

Another method that will be used to in order to get my information across will be photo surveillance monumented locations. Photo surveillance of the major movements and setting up locations where it will be ideal to get a good view of the movements and help people examine and study the movements in the future.

Tools
Canon Rebel XTI (Pictures)
CTS/Berger Auto level
CTS Berger Measuremark F/G Stadial Rod
Trimble handheld GPS Unit
165Ft Keson Measurement Tape
2 Foot long Rebar
Orange flag dividers
Orange and pink tree ribbon
Orange Spray Paint
Compass/Inclinometer

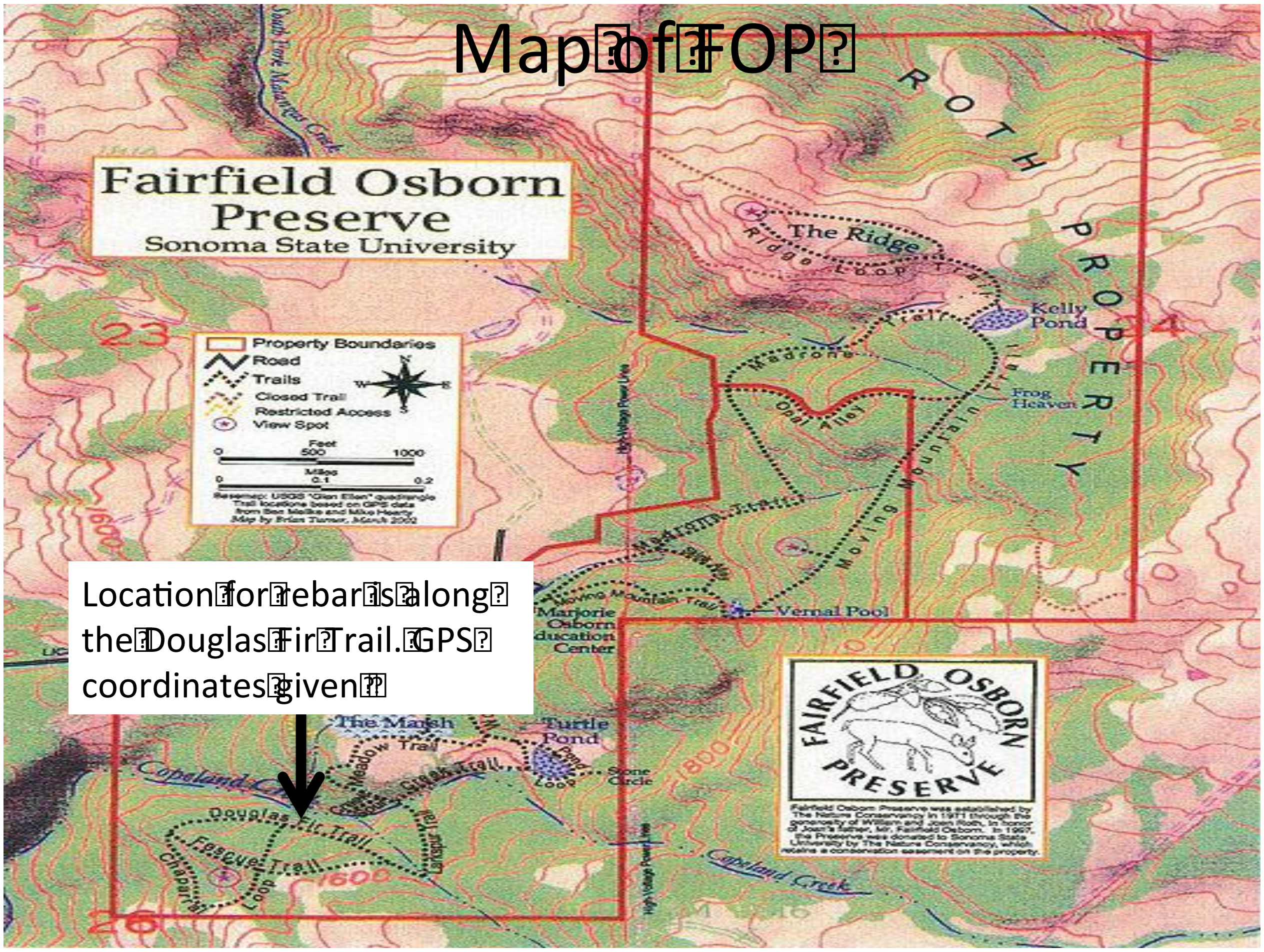
Locations

Site 1

The first site in which research has been conducted is located on top of an escarpment located on the south side of the stream, marked by an active debris flow. Rebar monuments were placed in two separate locations perpendicular to the creek in order to see the transformation that has taken place and to see how much sediment has been dislodged from the Scarp. The first bar was placed 1 meter away from soil exposure and the second bar was located 5 meters away from the first bar, 6 meters from soil exposure. These monuments are placed along the Douglas Fir trail which runs throughout the preserve so locating the monuments will not be an issue.

Rebar placed 1 meter behind scarp indicated by blue arrow. Brown boarder indicates scarp/slope edge.

Rebar placed 6 meters behind scarp, 5 meters behind fist rebar



Here is a trail map of FOP and the Black arrow above indicates where the site is along the Douglas Fir Trail. Acquired from Sonoma State Universities website.

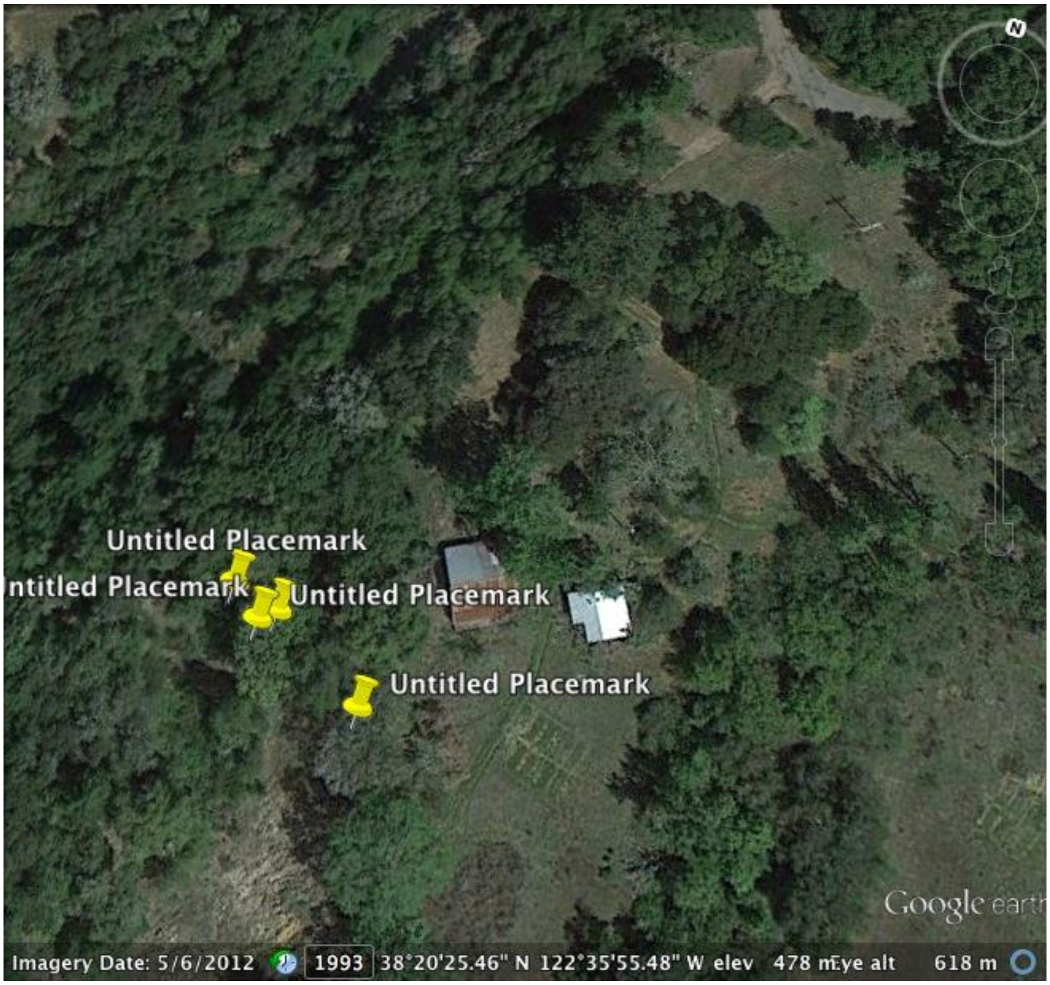
Site 2

The second site established was used for a stream channel cross sectional survey. Cross-section profiles of Copeland Creek will be used to monitor long-term trends in fluvial and geomorphic conditions of the stream channel and adjacent flood plain. These transects will provide an elevational profile of the creek and will indicate changes over time. The collected data will be used to evaluate changes in stream bank stability, channel migration, stream scouring, and substrate deposition. GPS coordinates are as follows:

North Bank Rebar: 38 20' 19.6" N, 122 35' 57" W, South Bank Rebar: 38 20' 19.56" N, 122 35' 56.75

Site 3

Located on the north bank of the creek, more head scarp measurements have been established here. The base of the scarp, where a debris flow is located, is distinctly displaying active sediment deposition. Rebar and flags have been placed on top of this slope to measure the size of displacement of sediment from the slope. I chose this location because it is one of the larger movements that have developed along the creek and I feel it contributes significant amounts of sediment input. The rebar and flags are posted along the head scarp located near the barn, close to the first driving entrance into FOP. GPS coordinates are as follows: 38 20' 24.49" N, 122 35' 57.31 W



This picture image from Google earth shows where the site location is as well as indicators of how to locate the site. The barn and the road are in very close proximity to the rebar and flags placed all along the scarp. The entrance to the barn is off the main road, Lichau road.

Site 4

This site is a location for photo surveillance. It is located in the middle of the creek and was created in order to Survey different locations that are actively contributing to sediment deposition. This location was chosen for its close proximity to base of the debris flow of site 1 and other active movements with large inputs. A spray Painted "X" was labeled on the largest rock located in the middle of the creek. The rock is very stable and shows no signs of movement regardless of heavy flow occurrences.

To the left is the spray painted X

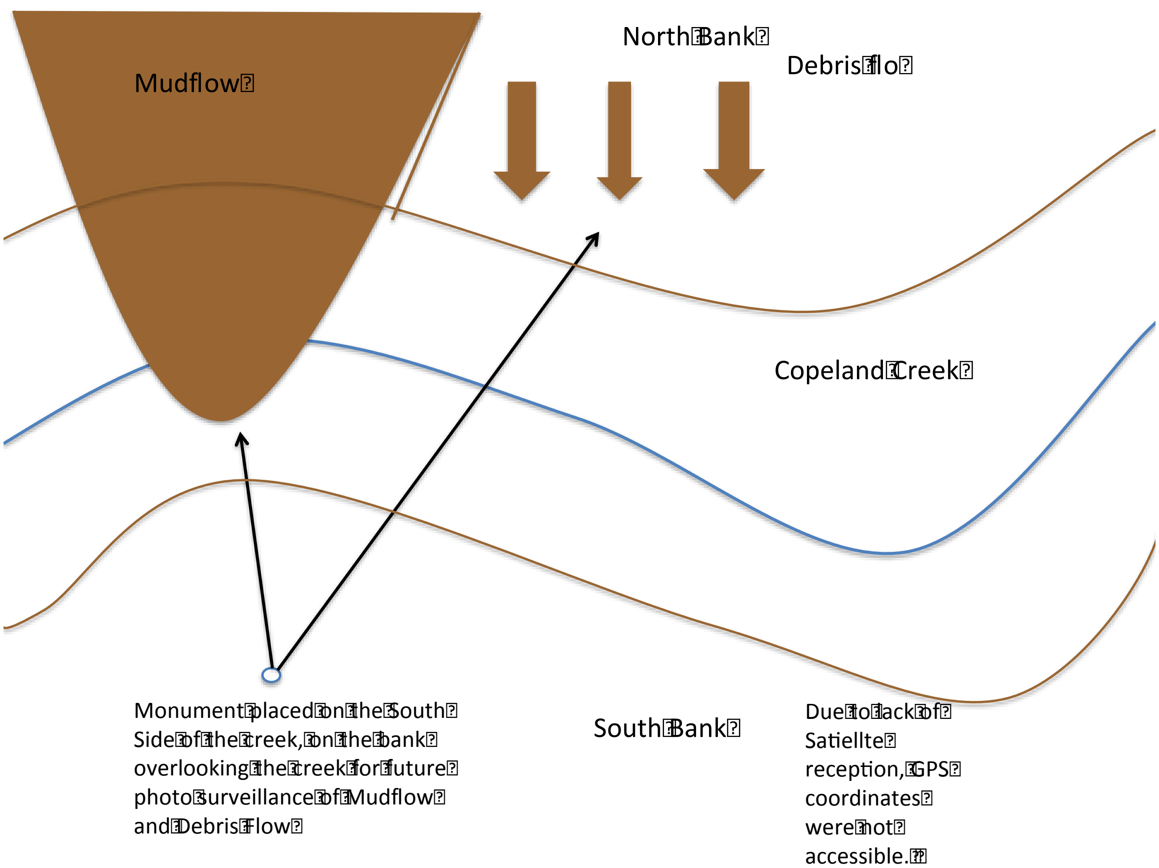
The base of site 1, debris flow

This image shows the spray painted X as well as other areas around it

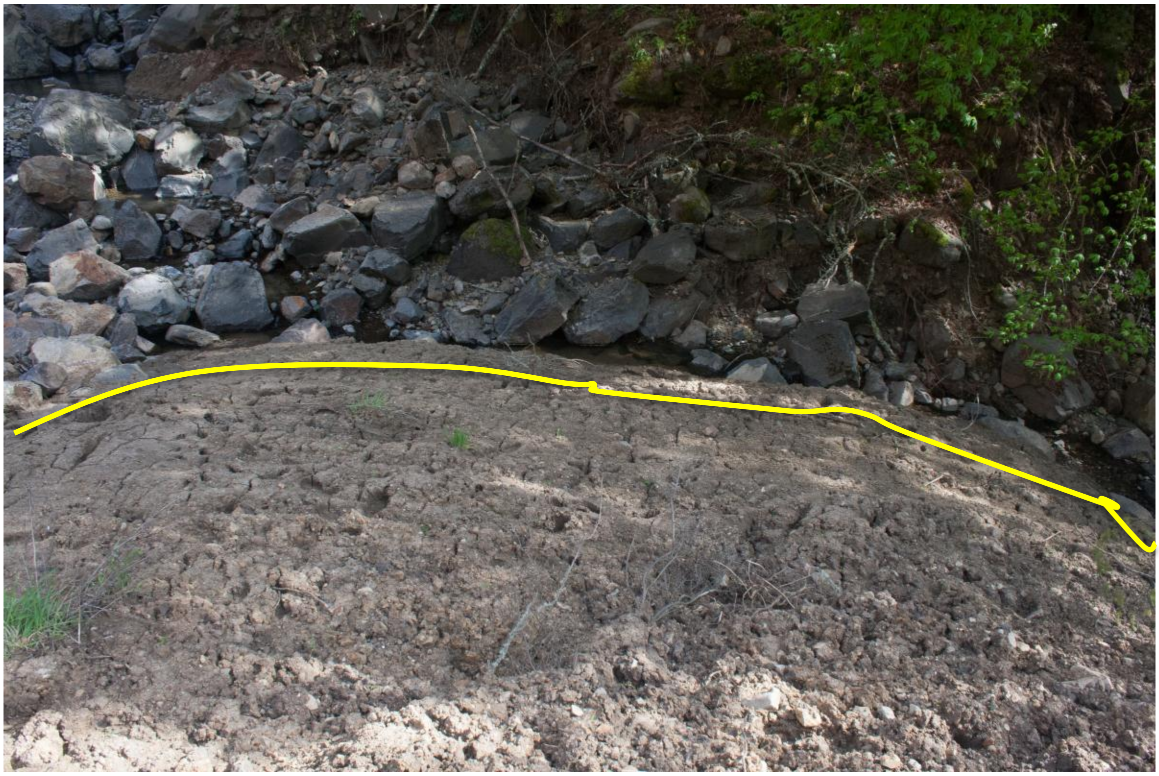
Site 5

This site is another location for photo surveillance. It is located at the base of a major mudflow also at the base of site 3's debris flow. The mudflow exhibits the most significant amount of sediment being deposited along Copeland Creek. This mudflow made such an impact that it altered the course of the creek and impeded the flow of the creek until natural channelization occurred and a new current had been established. The area in which this mudflow will be observed from is located on the south side of the creek, on a little bluff overlooking the creek. It is a good location to view both movements and is a location that will be there for future observation.

Rebar was placed along this bluff that is located along the creek. Has a great viewpoint of both mudflow and debris flow.



Above is a sketch map of the mudflow area. It gives indicators of where you should be looking and where the monument is located. As stated on the map, satellite reception was very poor resulting in no GPS accessibility.



Here is a picture of the base or toe of the mudflow. The picture was taken on top of the mudflow to show the impact of input. The yellow line shows the reach of the flow and shows how much it has altered the flow of the creek.

Site 6

This is the second stream channel cross-sectional survey. It is located near the main path on the north bank and is a very active area in terms of sediment transportation. This site will give ample opportunities for people to re-survey and re-measure this part of the creek and will give an indication on how much profile change can occur during a certain timeframe. The GPS coordinates are as follows: 1st Bar (North side of the creek): 38 20' 18.147" N, 122 28' 50.148"

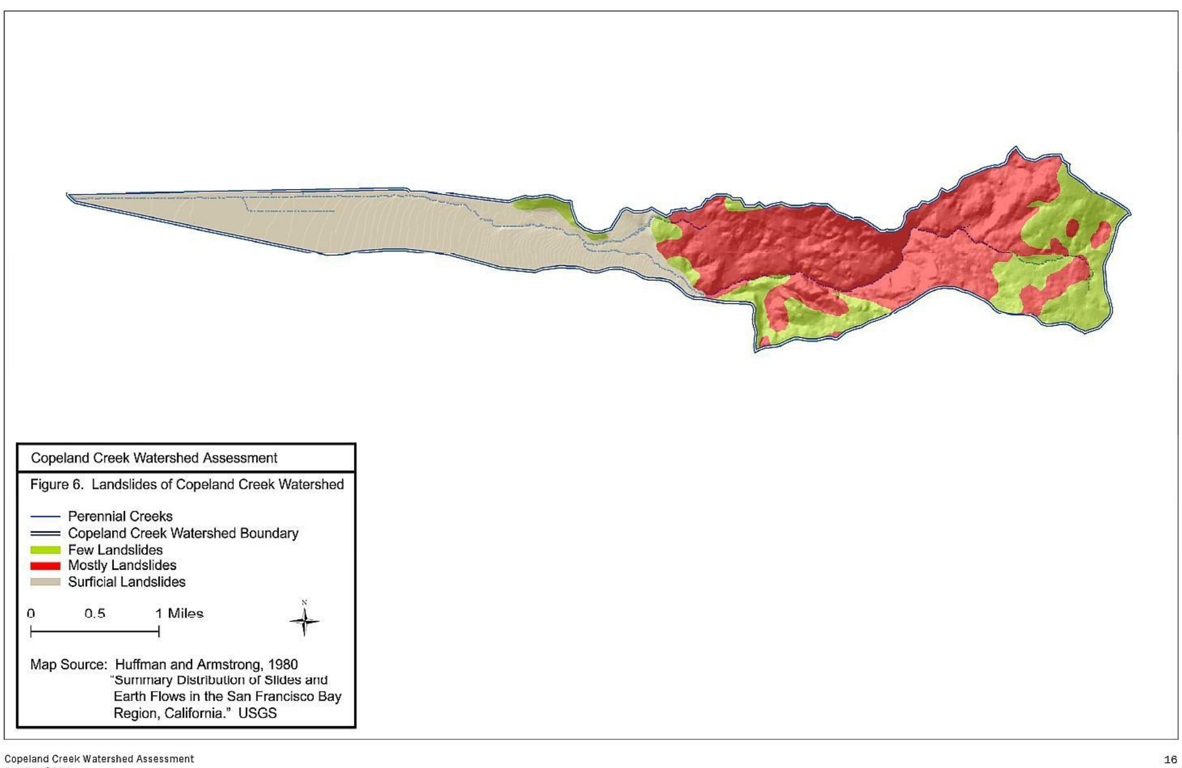
W, 2nd Bar (South side of the creek): 38 20' 17.530" N, 122 35' 49.652" W. It is located along the main path so located these monuments should not be a problem.

As the creek flows west and downhill, along the edge about 20 meters away from the cross section is a location at which landslides in that area will be monitored by photo surveillance. The GPS coordinates are as follows: 38 20' 18.351" N, 122 35' 51.295" W

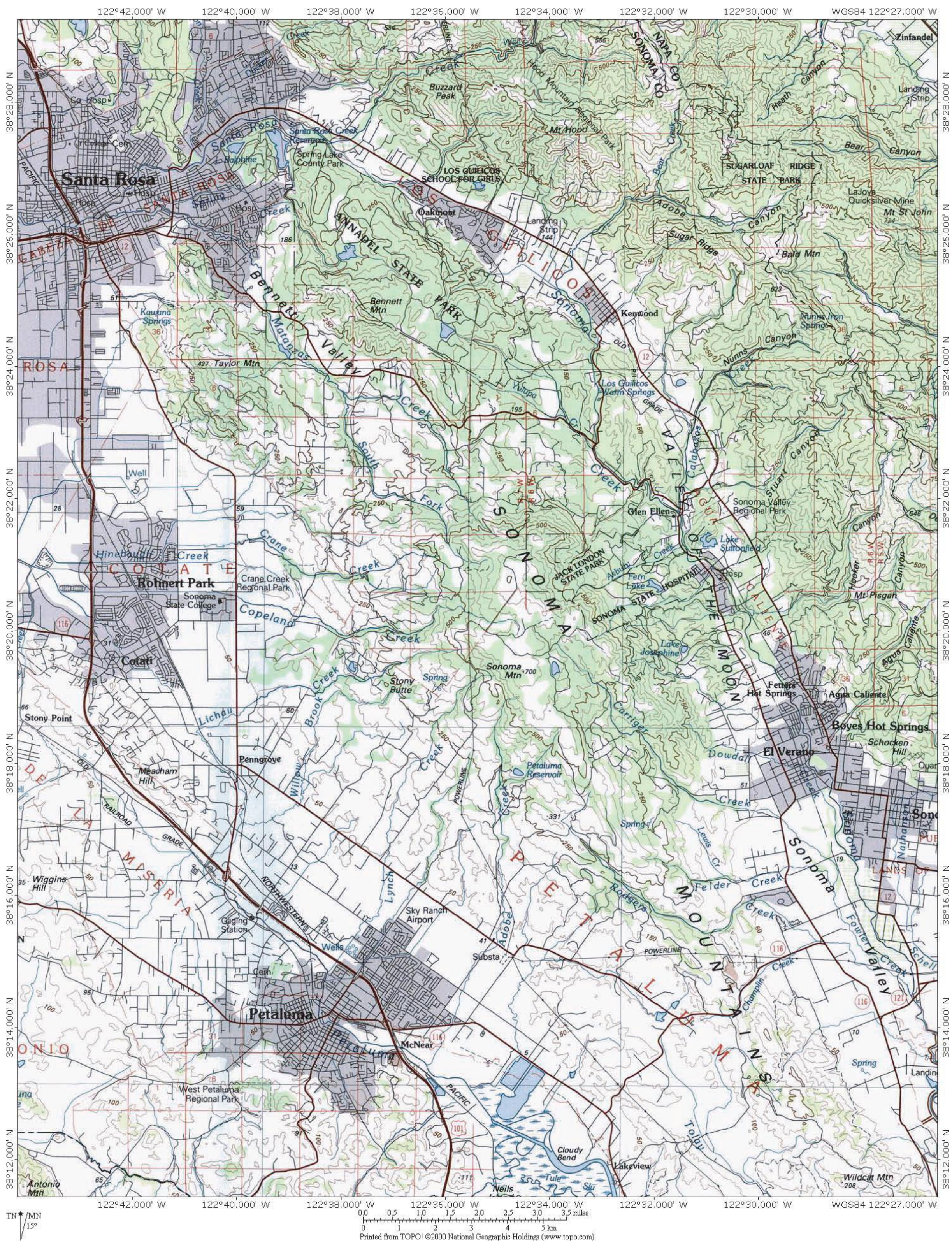
Picture of Jeff Baldwin, Kirstie Watkins, and Laura Schulte doing a cross section

Results

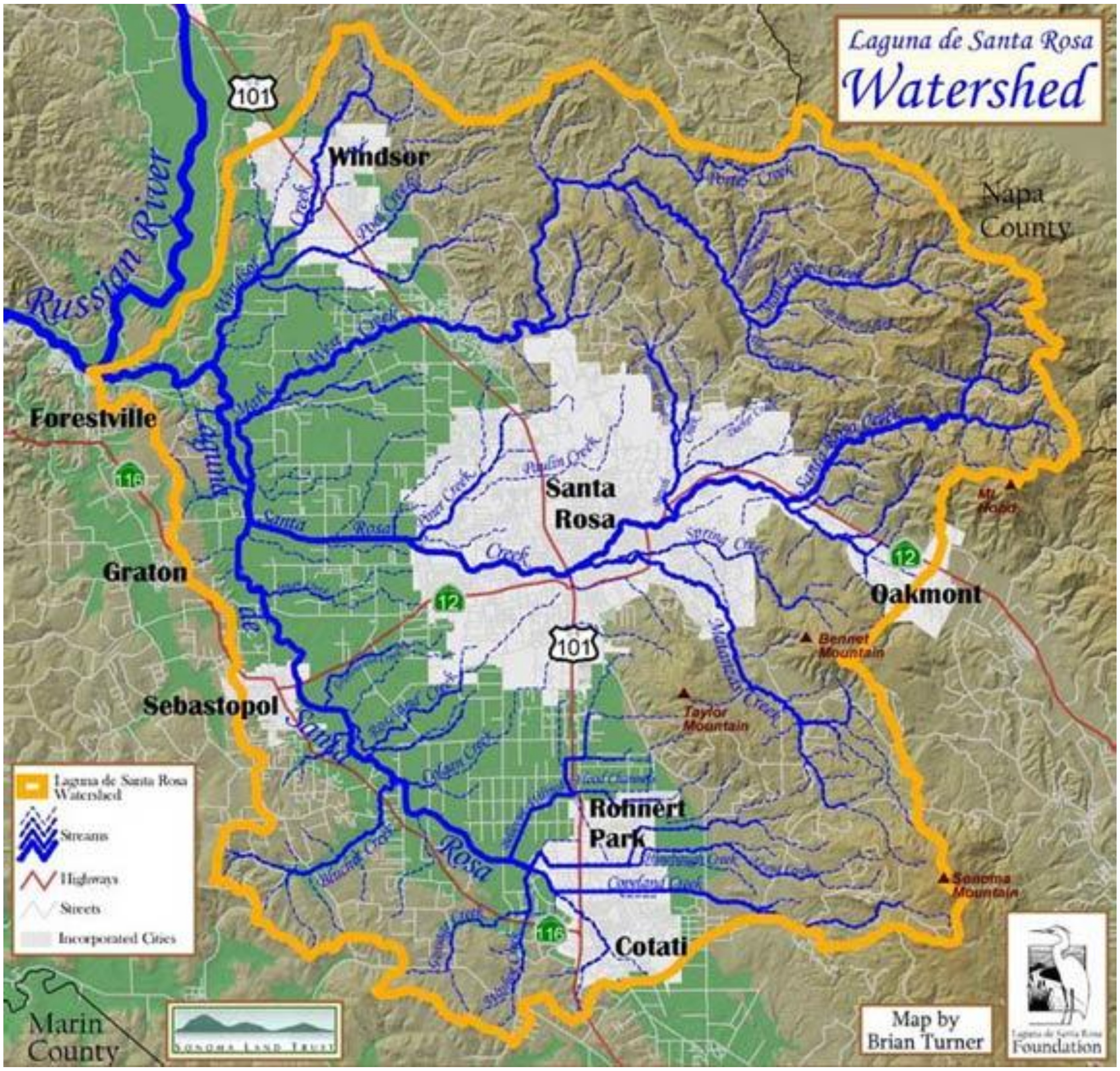
This project has ended up with multiple locations in which mass movements can be monitored and surveyed using different techniques. Each location that has been established is placed in their specific location due to their proximity to these active processes and the input they produce. Each site will be easily accessible for future surveillance and will provide the Sonoma County Water Agency with starting points at which they will be able to describe and locate active sedimentation input. The head scarp measurements will be able to measure and survey scarp displacement along active slopes. The stream channel cross-sectional surveys will be able to re-profile the stream and get a good understanding of how they creek has altered. The photo surveillance locations are important because they illustrate and show visual evidence of how impactful these movements can be and display the large amounts of sediment input produced by these movements. All these techniques and locations have been done in order to aid the Sonoma County Water Agency and their study of Sedimentation along Copeland Creek.



Map of Copeland Creek Watershed and Landslides along creek. The landslides are highlighted in color (Allen, James, 2009).



The previous shows a topographic map of Sonoma Mountain and in the middle of the map shows Copeland creek and the direction it goes and where it goes through. The blue line traces Copeland Creek as it travels through Rohnert Park and down Sonoma Mountain.



A map of the Laguna de Santa Rosa watershed and its tributaries including Copeland Creek

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Fairfield Osborn Preserve Map
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Map of Landslides in Fairfield Osborn Preserve
http://www.sonoma.edu/preserves/waters/projects/sediment/index.html

Map of Lagune de Santa Rosa watershed
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