Title

Post Project Analysis of a Restored Reach of Redwood Creek

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Abstract

Redwood Creek is located in Sonoma County, California. Redwood Creek is a tributary of Maacama Creek, a tributary to the Russian River. The reach of Redwood Creek addressed in this study is on an alluvial fan. In summer of 2001 the California Department of Fish and Game conducted a stream inventory to determine the presence of anadromous fish in the watershed and recommended Rewood Creek be managed as an anadromous, natural production stream. Two restoration projects have been completed in recent years, the first in 2005 and the second in 2010. In this study we investigated the newly constructed reach to determine how the channel morphology has responded after the first water year. We conducted cross-sectional surveys at 4 locations along the restoration project. Survey results show that vertical channel adjustment is occurring, and that the channel is still in the process of finding geomorphic equilibrium. It is likely that the channel will continue to adjust in future storm events. Cross-section monitoring should proceed into the future to determine whether channel adjustments continue, and as a basis to determine the need for adaptive management.

Introduction

Redwood Creek is located in Sonoma County, California. Redwood Creek is a tributary to Maacama Creek, a tributary of the Russian River (figure 1 and 2). Redwood Creek's major tributaries include Foote Creek, Kellog Creek and Yellowjacket Creek. Redwood Creek drains a basin approximately 13.5 square miles in size. Elevations range from about 213 feet at the mouth of the creek to 4331 feet in the headwaters (CDFG, 2006). Redwood Creek is a forth order stream and has approximately 4.5 miles of ephemeral stream (CDFG, 2006). The upper watershed begins by Mount St. Helena and enters the Russian River near Healdsburg, CA. The watershed is approximately 80% privately owned and 20% state owned (CDFG, 2006). Portions of Redwood Creek are situated on an alluvial fan.

Redwood Creek is located on a young geologic formation with unconsolidated parent materials and easy erodible soils. The principal soils around Redwood Creek are: Entisols, Millisols and Alfisols (figure 3). Such soils are characteristic of alluvial fan areas.

The upper watershed contains chaparral, oak woodlands and some conifers. The creek then enters Knights Valley, an area dominated by vineyards, with some areas of oak woodlands and grasslands with cattle grazing (CDFG, 2006). The riparian vegetation in this reach is sparse, though some oaks are present and willow samplings have been recently planted (CDFG, 2006). The creek then enters a canyon with a developed canopy, comprised of bay, alder, buckeye, willow and redwood (CDFG, 2006). Several sensitive plants and wildlife have been found in the Redwood Creek watershed (CDFG, 2006).

The reach investigated in this study is on a portion of the channel located on an alluvial fan. Schumm, Mosley and Weaver (1987) describe alluvial fans as

> "An alluvial fan is an accumulation of sediment that has been deposited where a debris-laden stream emerges from the confined valley of an upland area onto the piedmont, where it is free to spread laterally and deposit its load. The ideal form of an alluvial fan is semicircular in plan. Because of their excellent exposure and ease of investigation, alluvial fans in arid and semiarid areas have received the greatest attention in recent scientific literature. However, fans are also common features in more humid regions..."

In the Russian River watershed many tributary creeks have formed alluvial fans where they exit the mountain canyon and spill out onto the river valley floor. The physical processes governing alluvial fans are distinct from other types of channels (figure 4). Alluvial fan channels are highly dynamic systems and are difficult to control. When restoration or flood management is applied to alluvial fan channels it is often done through the creation of a single thread channel, stabilized with large rocks. These types of projects tend to require frequent maintenance to prevent the channel from filling in with rock deposits.

Project Background

In the mid – 1980's a Fish and Game warden reported seeing coho salmon in Maacama Creek (CDFG, 2006). In November of 1993 a fisheries consultant seine netted Redwood Creek and found both coho and steelhead (CDFG, 2006). In the summer of 2001 a stream inventory was conducted by the California Department of Fish and Game. The objective of the stream inventory was to document the amount and condition of available habitat for fish and other aquatic species, with a focus on anadromous fish populations. The inventory was comprised of two site locations.

Site 1 started at the mouth of the Maacama and ended approximately 5000 feet upstream. Site 2 started near the confluence of La Franchi Creek and Redwood Creek and ended approximately 2000 feet downstream. The inventory of Site 1 found seven steelhead, along with at least 46 roach, 16 stickleback, 23 suckers, 18 crayfish, 35 sculpin, nine yellow-legged frogs, and one lamprey larva. The inventory of Site 2 found 4 steelhead and two coho salmon, along with at least 25 three-spine stickleback, 50 California roach, 46 sculpin, 30 Sacramento sucker, 12 crayfish, and two lamprey larvae. As a result of the stream inventory the California Department of Fish and Game recommended that: "Redwood Creek should be managed as an anadromous, natural production stream".

Following the stream inventory two restoration projects have been completed on Redwood Creek, along the reaches owned and managed by the Beringer Winery. In 2005 the first restoration project was conducted by the California Department of Fish and Game. This project was comprised of interventions such as: J hooks, boulder deflectors, riprap, instream boulder clusters, and weirs. In 2010 a second restoration project was conducted which comprised of a removal of a fjord, and the placement of boulder deflectors, riprap, instream boulder clusters, and weirs.

Post project photo-monitoring was conducted for the 2005 restoration project in August of 2011. On October 28th and November 3rd of 2011 Rune Storesund, D. Eng. P.E., G.E. surveyed the 2010 project using a Real Time Kinematic Geographical Positioning System (RTK GPS).

Purpose

The purpose of this study is to determine how channel morphology in the newly constructed reach has changed since the post construction monitoring conducted in October and November of 2011.

Research Methods

Existing Data Analysis

We gathered existing construction plans, reports, and monitoring data from The California Land Stewardship Institute and the California Fish and Wildlife Agency to determine the baseline conditions against which to compare our data (figures 5, 6 &7). This included longitudinal profile and cross-section data completed by Rune Storesund, D. Eng. P.E., G.E on October 28th and November 3rd of 2011.

Reconnaissance-Level Assessment

We initiated our field research with a reconnaissance-level site visit on April 13, 2012 to determine the data required to answer our research questions. During this site visit, we flagged high water marks (HWM) from the April 19th event for future surveying. We created a reach scale site conditions map to demonstrate geomorphic features, areas of instability, design elements such as grade control and bank protection. We also completed photo-documentation of points of interest.

Hydrology

No gage data was available for this site. As an alternative we obtained precipitation data from National Oceanic and Atmospheric Administration National Weather Service. We compared the recent water year precipitation volumes with precipitation volumes over the past ten years to assess the likelihood of a major storm event occurring since the 2011 topographic surveys.

Topographic Survey

We resurveyed 4 cross-sections using an auto-level, rod, and tape, in order to compare the results to the previous survey. Figure 12 shows the cross-section locations. We were unable to locate all the monuments associated with the historic data. We tied all elevations into the North American Vertical Datum of 1988 using benchmarks located at each cross section.

Results

Reconnaissance-Level Assessment

We observed high water marks from the April 19th, 2012 flow, which included debris deposits around mid-bank (figure 10). High water marks and the presence of wetted bed material show that several sub-channels of this braided channel were occupied during the recent rain event and are in the process of drying out. Overbank flow did not occur in this portion of the reach.

A visual assessment of the reach showed no evidence of later erosion. The majority of the channel is comprised of gravel, cobles and small boulders. Gravel bars, riffles and pools were evident in several locations through out the reach. Large wood was absent from the channel in all but one location, along the outer left bank.

Hydrology

The precipitation data shows that the rainfall magnitude since project construction was less-than-average to average (figure 8 & 9). Without gage data it is difficult to evaluate how the stream responds to a storm event. However, what we can extrapolate from the available data is that it is unlikely that channel experienced a storm event large enough to cause significant changes to the channel morphology.

Topographic Survey

The four cross sections surveyed subsequent to the April 19th storm are plotted against the October/November cross-sections. This comparison shows up to 2 ft. of aggradation in cross section one (figure 13). Cross-section three shows less than a ft. of erosion near top of bank, and relatively no changes near bottom of back (figure 14). Cross section 8 shows up to 2t of incision to the left sub channel and relatively no changes in the main channel (figure 15). Cross section 10 shows up to 2.5 ft. of aggradation in the gravel bar and relatively no changes to the main channel (figure 16).

Discussion

Although we were unable to obtain the design bank full discharge, a discharge often used as a benchmark for stream restoration projects (Dunne & Leopold 1978), the reconnaissance-level-assessment shows that the existing channel banks did not overtop during the April 19th storm event. Precipitation data shows that in the water year post construction it is unlikely that flows reached rates high enough to cause significant channel alterations. The four cross-section conducted show up to 2 feet of aggradation in the upper portion of the reach, up to 2ft of incision in the left sub-channel in the middle portion of the reach, and up to 2 ft. of aggradation in the lower portion of the reach. In cross sections 3 and 10 the majority of the channel showed little to no changes. Overall, it appears the restored reach channel is still in the process of finding geomorphic equilibrium. The channel has likely not had enough time to fully adjust to the construction, and more morphological changes are expected to occur with future large storm events.

Conclusion

The available existing design plans are vague and provide little guidance to the actual site design. This makes it difficult to determine if the channel morphology has deviated from the original design. The principal data available are channel cross sections preformed after construction. Judging from our site surveys and analysis, the morphology of the reach is still in the process of finding geomorphic equilibrium. Alluvial fans are dynamic systems and are known to change frequently. The restoration design interventions applied to the restored site do not appear to take into consideration the geomorphology of the site. The armored banks and boulder j hocks attempt to preserve the channel at a constant steady state. These types of interventions are inappropriate for alluvial fan channels. The six months, one-water year, since the last surveys were conducted is not enough time for the channel to fully adjust to construction. Cross-section monitoring should proceed into the future to determine whether channel adjustments continue, and as a basis to determine the need for adaptive management.

References Cited:

Dunne T, Leopold LB. 1978. Water in Environmental Planning. San Francisco: W. H. Freeman and Co.

California Department of Fish and Game, 2006. Stream Inventory Report of Redwood Creek

Post Project Assessment of Redwood Creek

Figures

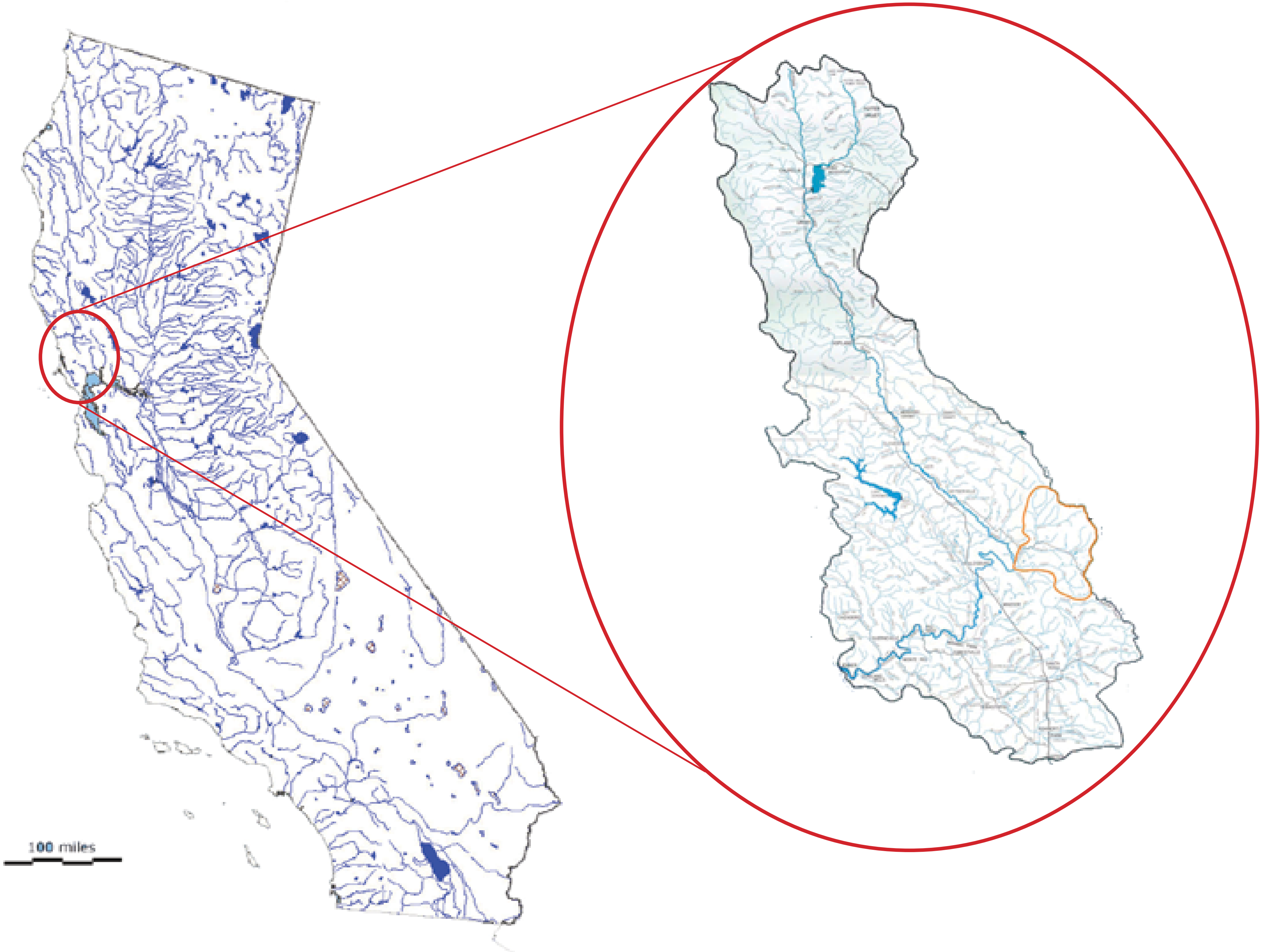

Figure 1. Watershed Map

Figure 2. Site Location

Entisols

Entisols are soils of recent origin. The central concept is soils developed in unconsolidated parent material with usually no genetic horizons except an A horizon.

Inceptisols

Inceptisols nevertheless are widely distributed.Often found on fairly steep slopes, young geomorphic surfaces, and on resistant parent materials.

Mollisols

Mollisols are soils of grassland ecosystems. Results from the long-term addition of organic materials. Some of the most important and productive agricultural soils in the world.

Ultisols

Ultisols are strongly leached, acid forest soils with relatively low native fertility.

Alfisols

Alfisols are moderately leached soils with high native fertility. Formed under forest and have a subsurface horizon in which clays have accumulated. Primarily found in temperate humid

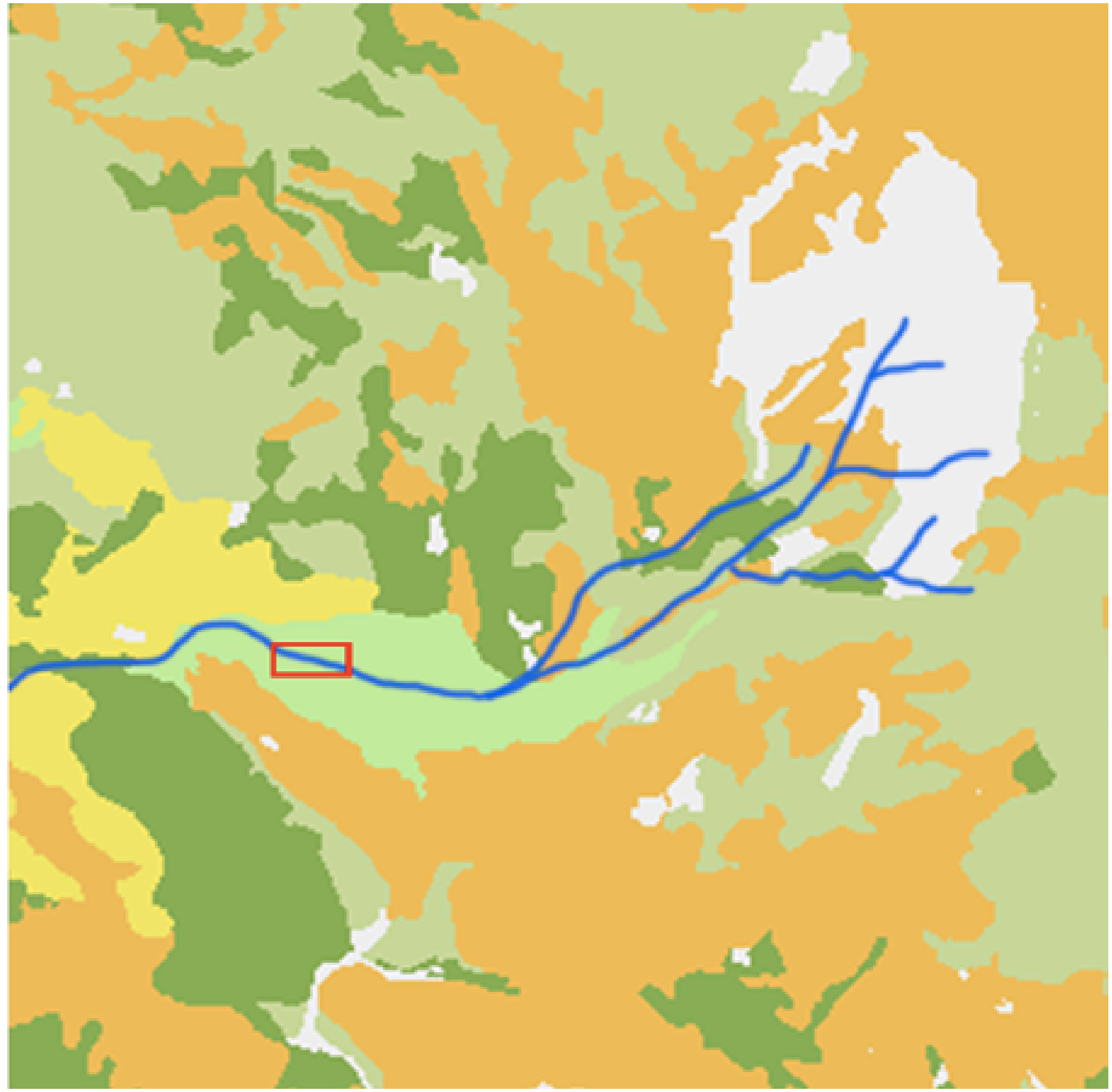

Figure 3. Soil Map

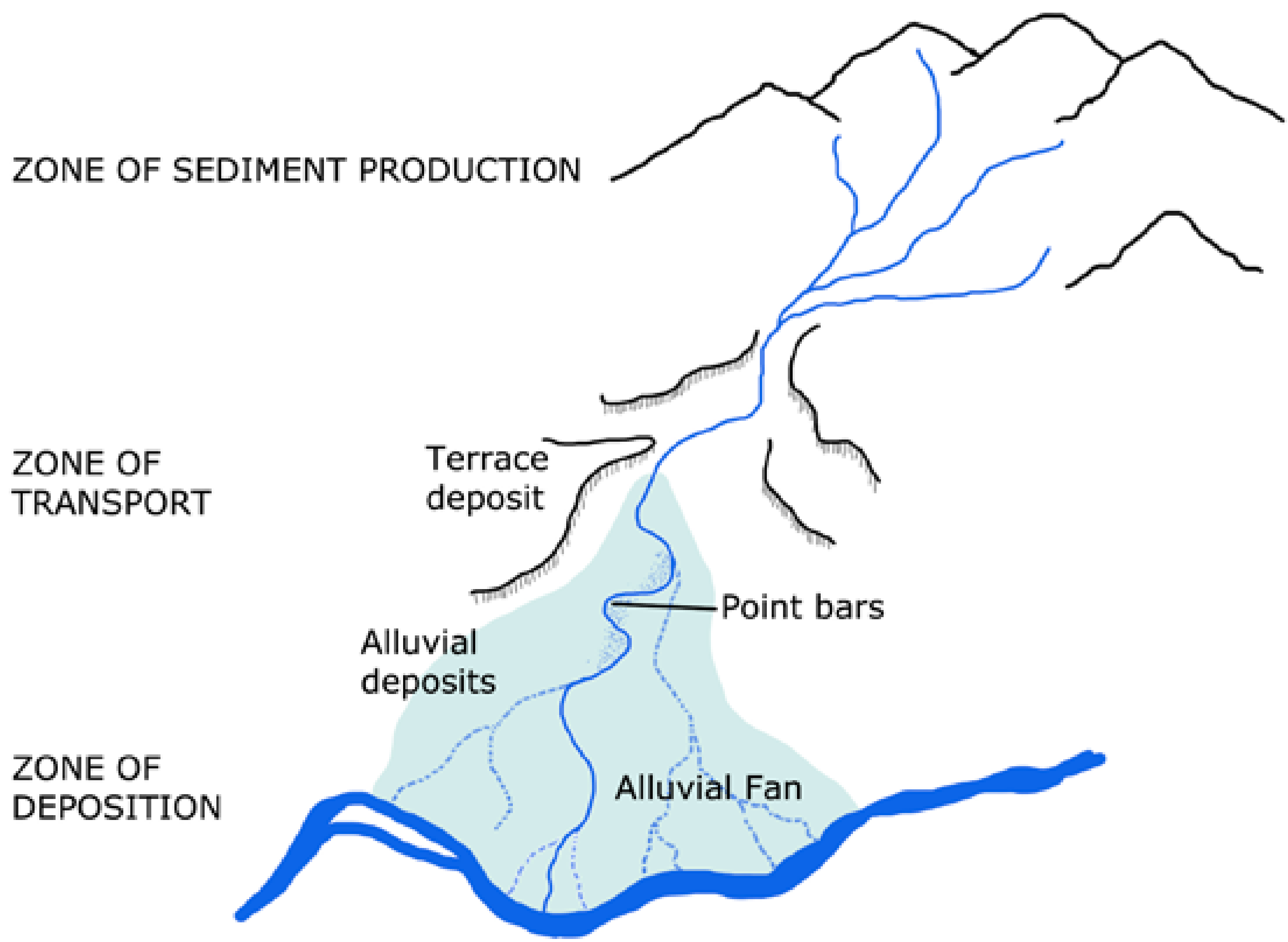

Figure 4. Alluvial Fan Conceptual Model

Redwood Creek Stream Crossing Removal

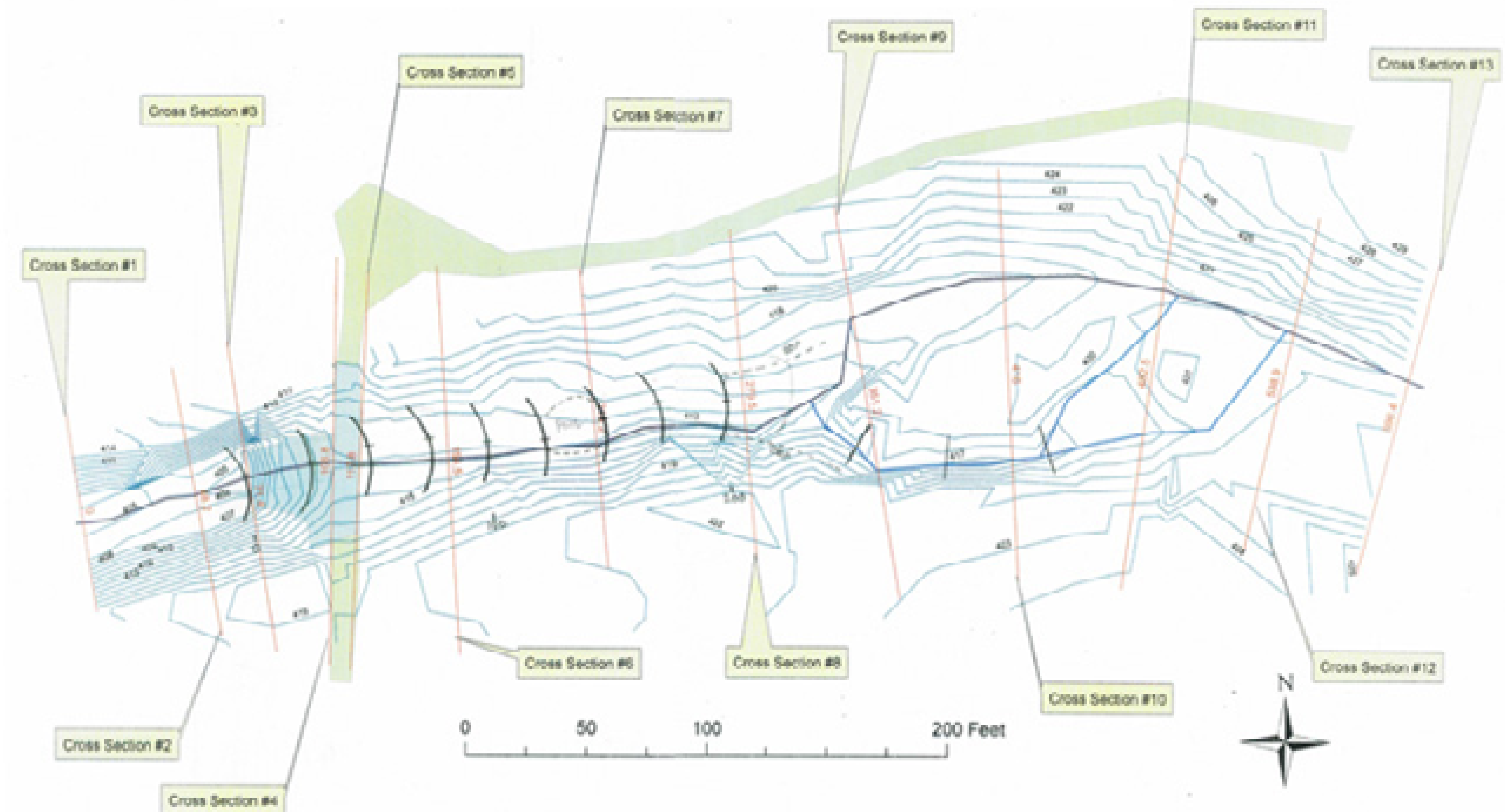

Figure 5. Construction Drawings

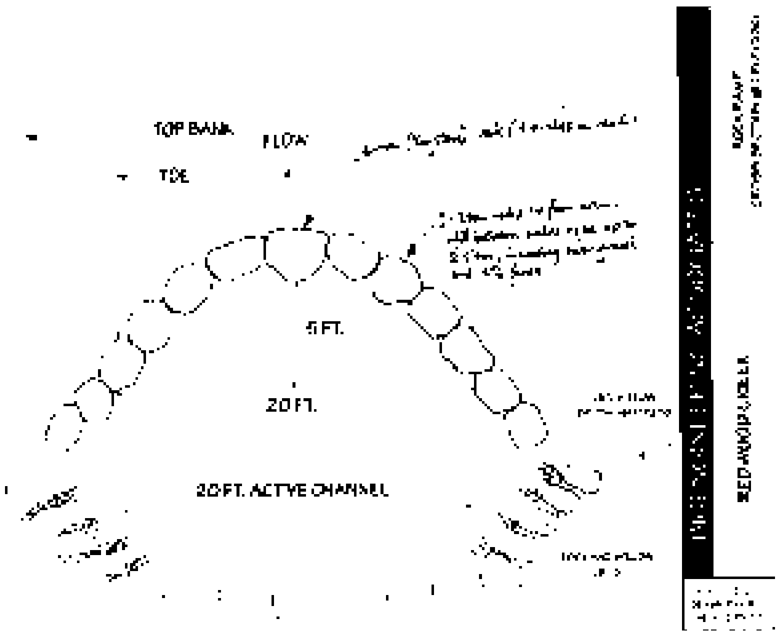

Figure 6. Rock Ramp Construction

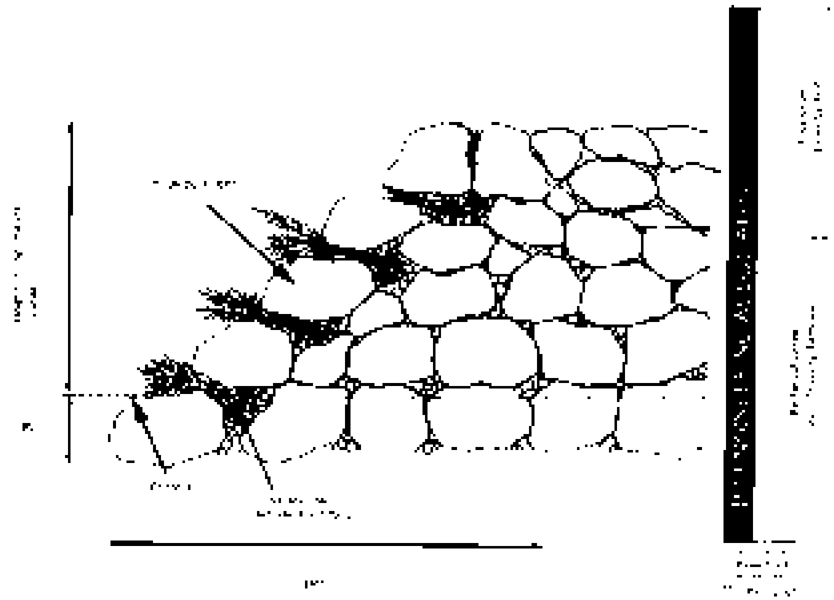

Figure 7. Rock Groin Construction

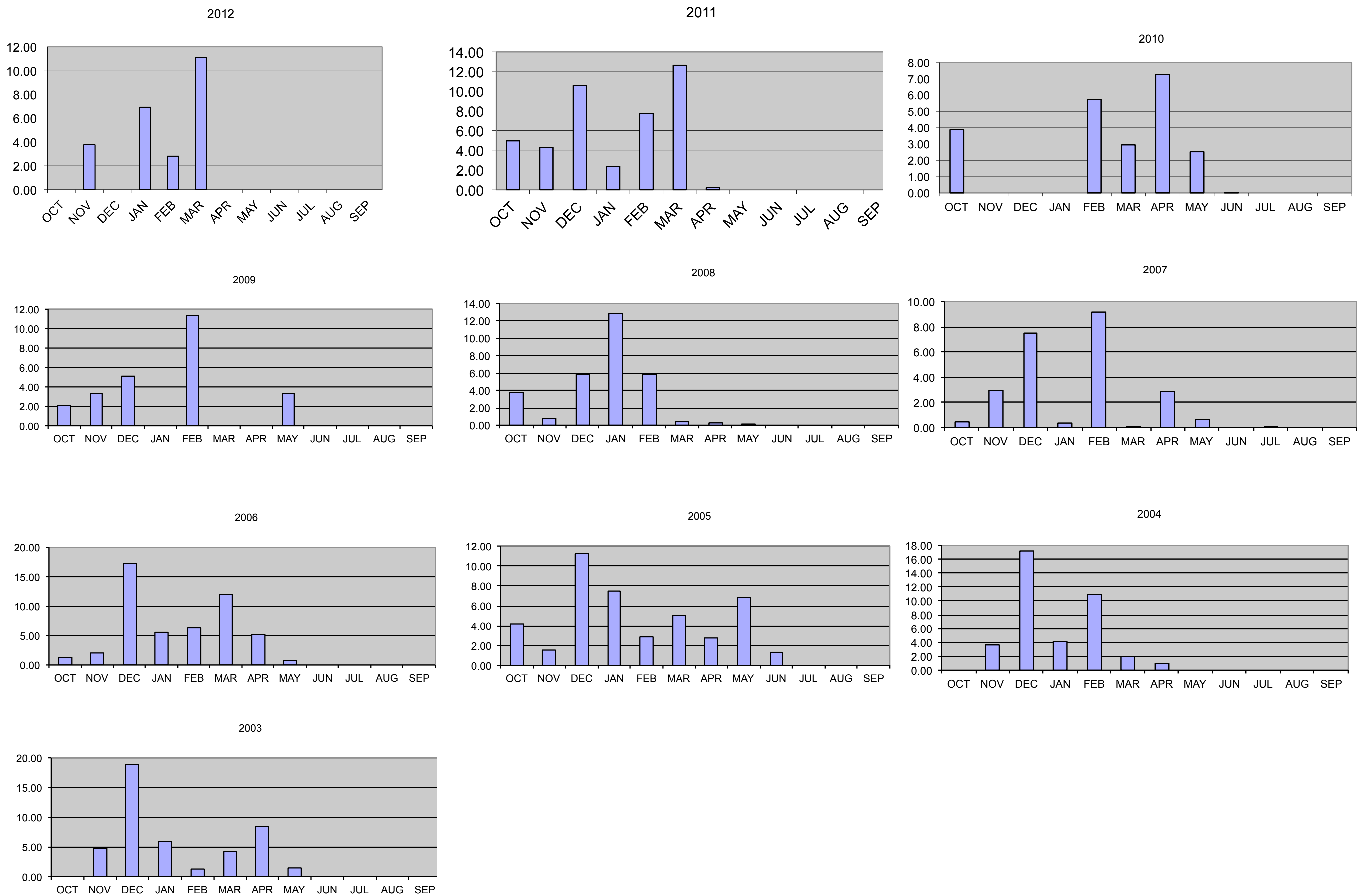

Figure 8. Montly Preciptation

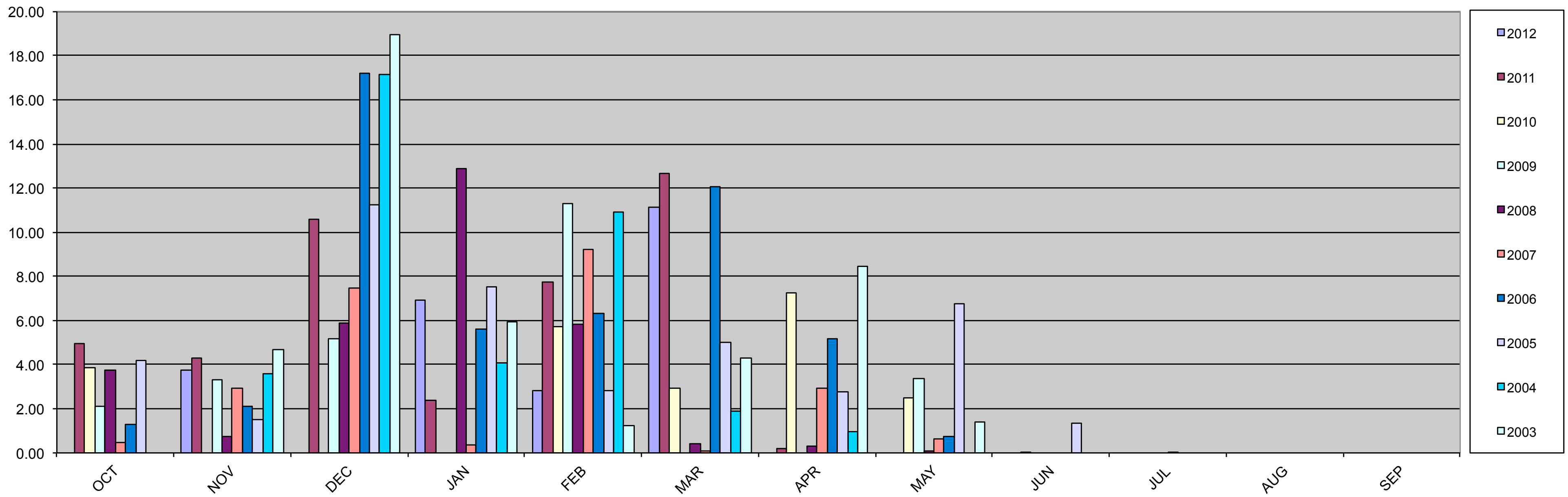

Figure 9. Montly Precipitation

Figure 10. Photo

Figure 11. Photo of Rock Groin

Figure 12. Cross Section Locations

Cross Section 1

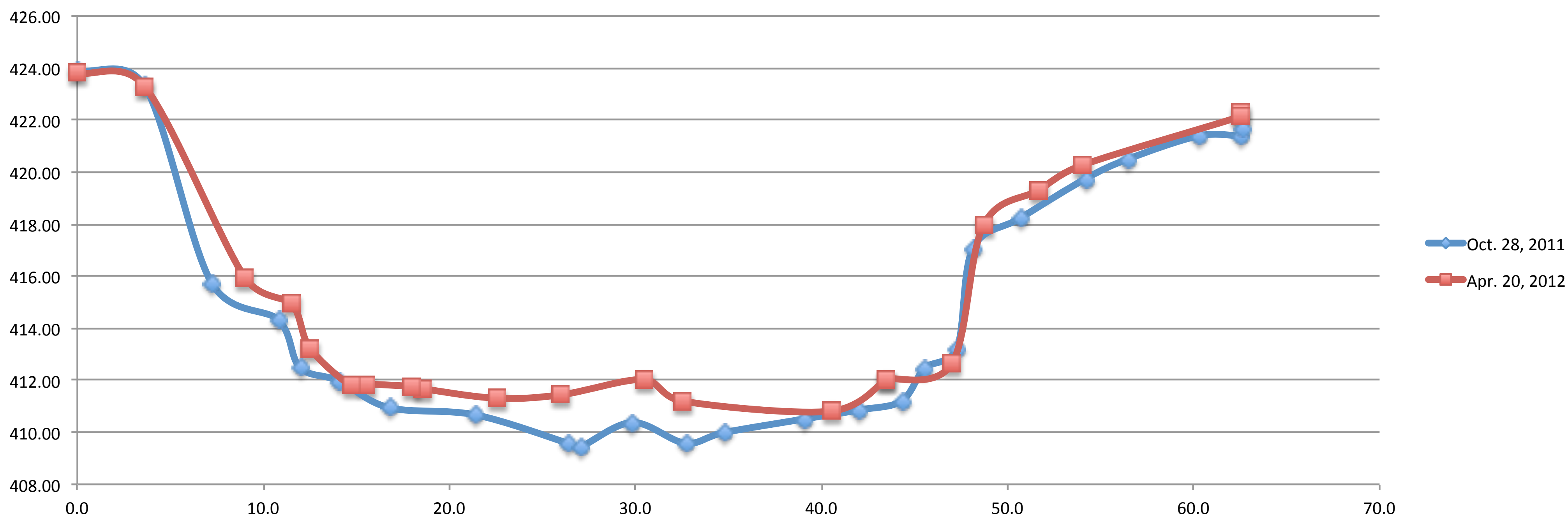

Figure 13. Cross Section Locations

Cross Section 3

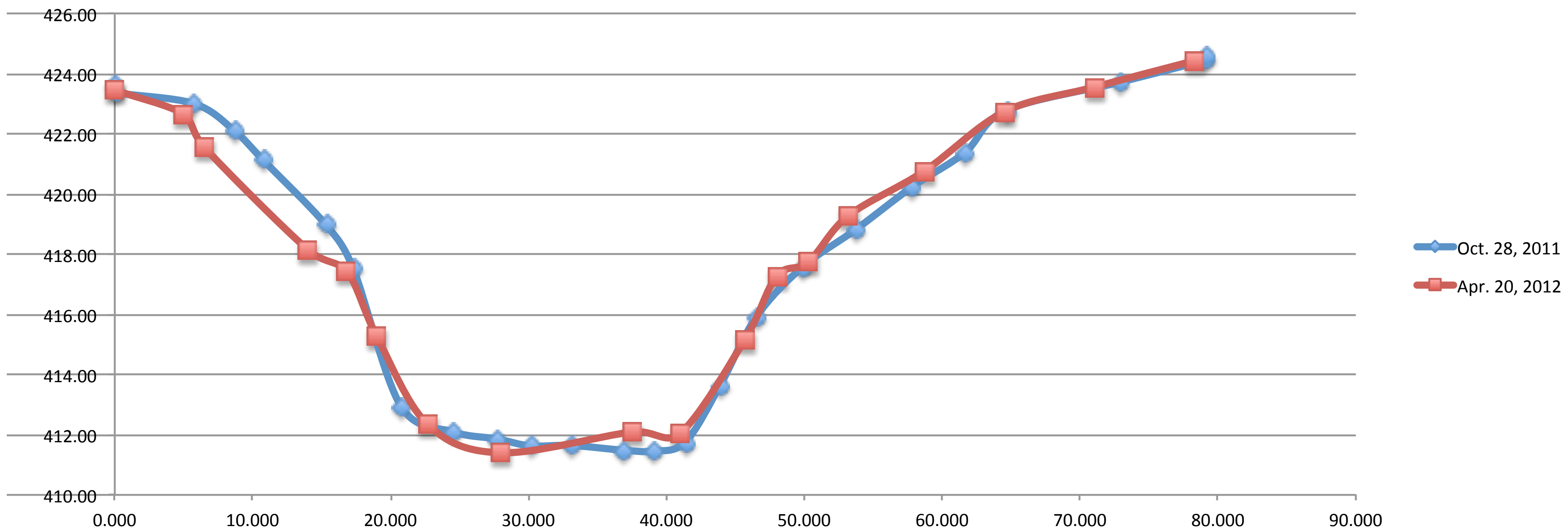

Figure 14. Cross Section Locations

Cross Section 8

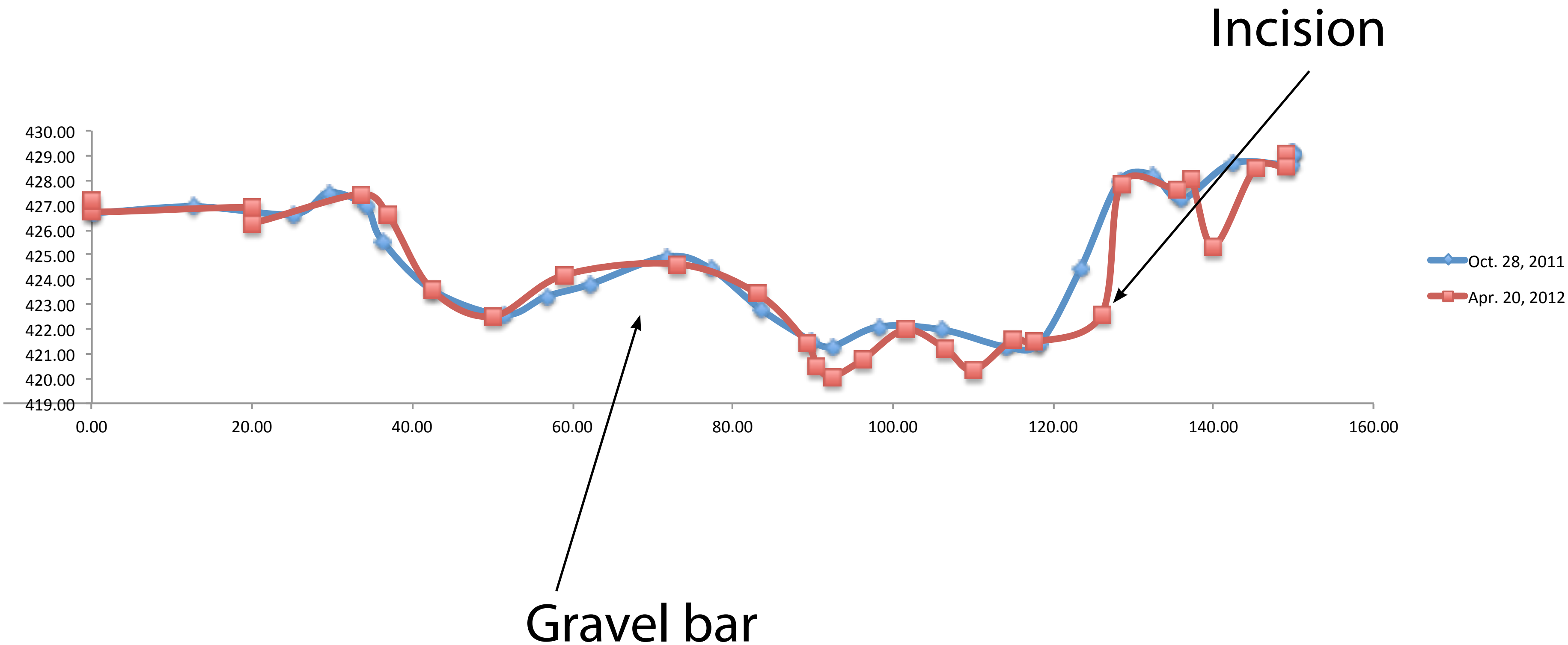

Figure 15. Cross Section Locations

Cross Section 10

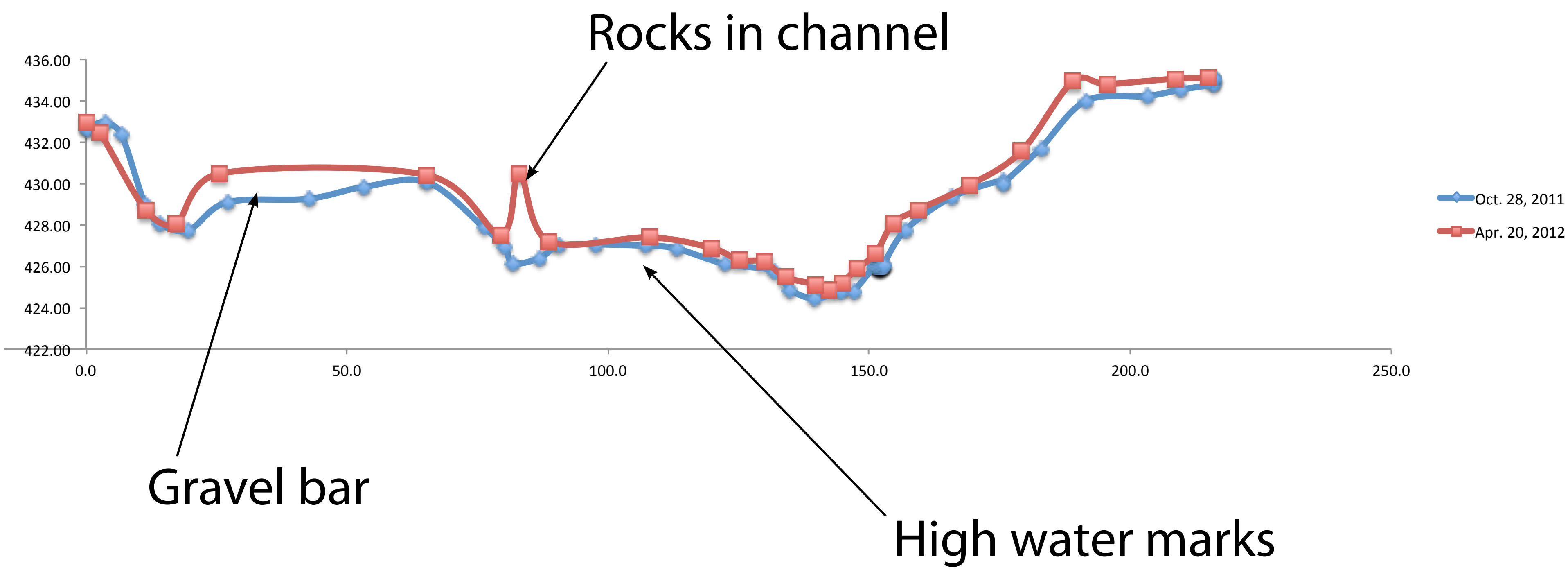

Figure 16. Cross Section Locations