San Pedro Creek

Floodplain Monitoring and Assessment Project

Spring 2003

Conducted by

Joe Farrow

Matt Ward

Simion Jim Bulldis

GEOLOGIC SETTING

Regional Geology

San Pedro Creek is within the Coast Range Geomorphic Province of California. This region comprises a series of mountain ranges and valleys that generally trend northwest, sub-parallel to the San Andreas Fault system. Cenozoic and Mesozoic strata dip beneath the Great Valley Sequence to the east, while to the west the Pacific Ocean coastline is uplifted and terraced by benches that represent ancient, tectonically uplifted wave-cut platforms. The San Pedro Creek watershed lies within the central portion of the province, at the north end of the Santa Cruz Mountains. The Santa Cruz Mountains have been uplifted as a result of compression caused by local San Andreas Fault tectonics and regional transpression along the Pacific-North American Plate boundary since at least the Pliocene. The San Francisco Bay to the east is a structural depression formed between two major faults of the San Andreas fault system.

Lithologic associations may be divided into assemblages, large, fault - bounded blocks that contain a unique stratigraphic sequence. Different assemblages represent changes in depositional conditions in one or more large depositional basins. In the San Pedro Creek area the different assemblages reflect the juxtaposition of different basins or parts of basins by large offsets along the faults that bound the assemblages.

In the region (Early Cenozoic) strata generally rest with angular unconformity on three complexly deformed Mesozoic rock complexes that represent oceanic sediments and volcanic island arcs accreted on the North American Plate during Jurassic to Cretaceous subduction of the Pacific Plate.

The Coast Range ophiolite complex includes serpentinite, gabbro, diabase, and basalt; keratophyre; and overlying Great Valley sequence. This complex represents the accreted and deformed remnants of Jurassic oceanic crust, overlying arc volcanic rocks, and a thick sequence of turbidites. The Franciscan complex is composed of weakly to strongly metamorphosed graywacke, argillite, limestone, basalt, serpentinite, chert, and other rocks. The rocks of the Franciscan complex were probably Jurassic oceanic crust and pelagic deposits, overlain by Late Jurassic to Late Cretaceous turbidites subducted beneath the Coast Range ophiolite during Late Cretaceous or Early Tertiary time. The Salinian complex is composed of granitic plutonic rocks, and inferred gabbroic plutonic rocks at depth, overlain in places by Cretaceous strata. Small outcrops of pre-plutonic rocks are also preserved in places, including the Montara Mountain Assemblage. These plutonic rocks are part of a batholith that has been displaced northward by offset along the San Andreas fault system.

History of San Pedro Valley

The San Pedro Valley riverine system has been an integral part of the region- long before it was known as San Pedro Creek and well before Pacifica was known as a unique coastal getaway along the San Mateo County Coast. San Pedro Creek is located along the San Mateo County Coastline- a region whose geology and geography are dictated by the static properties of the San Andreas Fault Zone. The natural landscape has been created through tectonic processes directly related to the subduction of the Pacific Plate beneath the North

American Plate and includes a plethora of complex geologic process that include uplift, subduction and the ever persistent aspects of weathering and erosion.

The native Ohlone/Costanoan people of the area (whose traditions may have dated back 30,000+ years in the region) had an intimate relationship with San Pedro Creek. Upon investigation of the historical aspects of San Pedro Creek, it is realized that the area is a unique part of modern California history. In October 1769, Juan Gaspar De Portola, in his quest to locate Monterey Bay, disembarked (a bit north of Monterey) in what is now known as Linda Mar Bay in Pacifica. Spanish conquistadors were quick to realize the resourceful value of this valley and were swift in establishing outposts in the area- the most notable being the Sanchez Adobe slightly north of San Pedro Creek.

We now jump to the 20th century, and are faced with a new set of issues regarding San Pedro Creek and emerging urbanization issues. In 1957, nine communities in Pacifica incorporated to become The City of Pacifica. Pacifica is a unique city in that its neighborhoods are separated by natural barriers that have been formed by earth processes that include natural drainage patterns. In an effort to control flooding and ensure urban development, the westernmost reach and mouth of San Pedro Creek had been channelized in a concrete channel to control runoff. It became evident that the concrete runoff channel was not sufficient to control and contain heavy rain and flood-stage events. The most recent and damaging floods occurred along San Pedro Creek during the winter of 1982, wherein 182 residences and 10 commercial properties suffered upwards of 4,000,000 dollars in damage. While it was evident in the mid-1970's that a flood control plan was needed to address the issue of San Pedro Creek, funds were not available until the mid 1990's. The United States Army Corps of Engineers orchestrated the project that involved removing the concrete drainage and establishing a natural stream channel and a riparian corridor suitable for the propagation of wildlife.

Local Geology and Faulting

San Pedro Creek watershed is situated in a basin underlain by a sliver of Franciscan Complex Rocks west of the San Andreas fault. Rocks of the San Pedro Point Complex and Montara Mountain Pluton predominate to the south. This area contains fault-bounded elements of both the Franciscan and Salininan complexes. Rocks underlying the southern portion of the study area within the Point San Pedro Assemblage do not contain any of the Mesozoic basement rocks. Tertiary (Cenozoic) rocks are bounded at the base by a fault. However, large blocks of granitic rock as clasts in the Tertiary strata suggest that the original basement was granitic and probably related to the Salinian Complex.

Local faults are characterized by both strike-slip and dip-slip components of displacement. Offset is distributed on the various faults in the zones, and the locus of fault movement associated with a fault zone has changed through geologic time in fault shear zones as broad as 10 kilometers. The three major fault systems that display large right-lateral offsets are the San Andreas, the Pilarcitos, and the San Gregorio fault zones. The San Pedro Creek watershed lies between the San Andreas and San Gregorio faults. Both the San Andreas and San Gregorio fault zones have strands which display Holocene offset.

The San Andreas fault zone was displaced up to several meters in the area during the 1906 earthquake. Current estimates of total offset since 8 Ma are about 35 km for the San

Andreas fault zone in San Mateo County, 120 km for the Pilarcitos fault zone, and 155 km for the San Gregorio fault zone (Clark and others, 1984, McLaughlin and others, 1996, Dickinson, 1997).

In addition to strike-slip faults, a major component of reverse or thrust offset has contributed to regional uplift in the area, as previously mentioned. These structures run generally sub-parallel to the strike-slip faults, and reflect a component of stress perpendicular to the trend of the faults. Part of the offset on some of these reverse and thrust faults has taken place during Quaternary time, as shown by faulting of QTsc west of Crystal Springs Reservoir.

Geologic Units within the Watershed

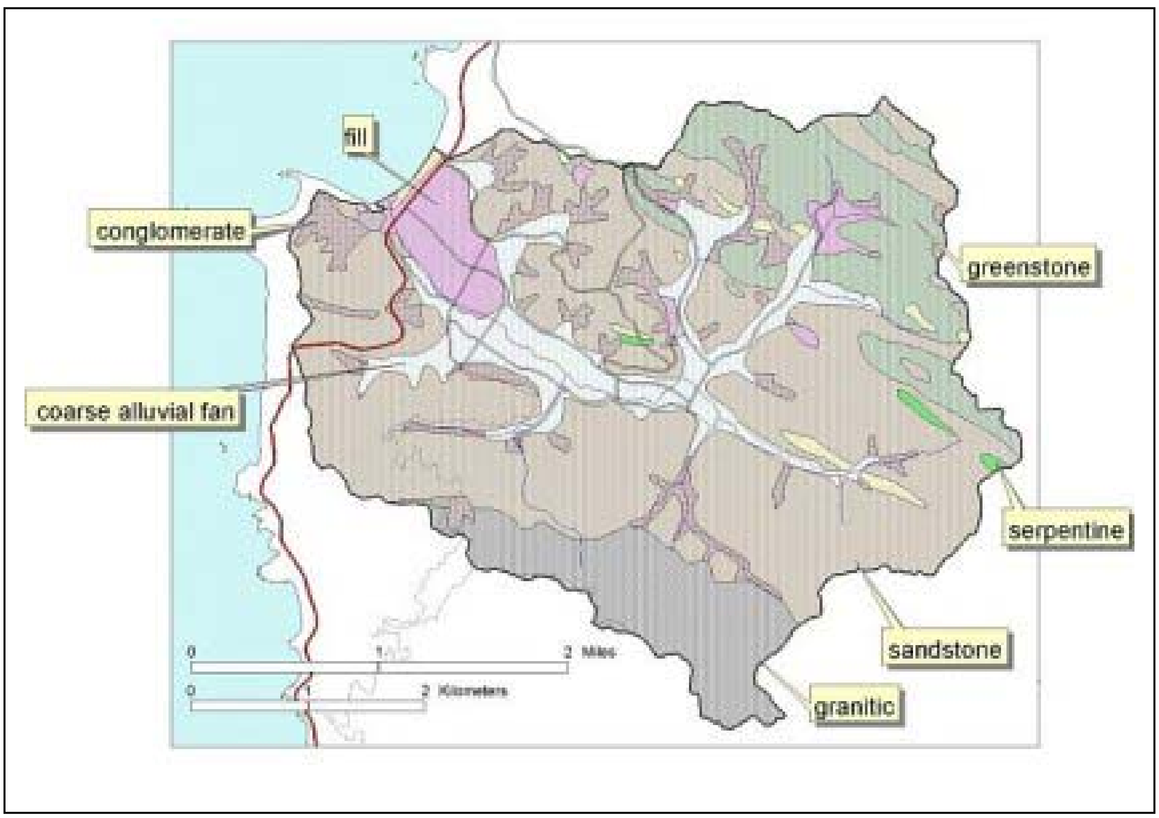
Local geology is shown on **Figure 1**.

1) Sandstone and sandstone-dominated melange. This is the most common upland rock type. Slopes are typically steep, and soils are well drained.
2) Montara Mountain granitics, which have been classified as tonalite. Characteristic soil development is thin, well-drained soils with outcrops on slope convexities. Slopes are typically quite steep, since this is all on Montara Mountain, extending to the west to San Pedro Mountain.
3) Greenstone. Quite in contrast to the above, greenstone doesn't tend to produce significant outcrops. This rock is common in the northeast part of the watershed, and is drained by the North Fork.

4) Alluvium. Flat valley bottoms are predominantly underlain by gravelly alluvial deposits. Most of these areas are covered by residential development.

5) “Conglomerate". Most of the areas mapped as "conglomerate" by the USGS appear to be unconsolidated colloidal deposits from debris flows and other slope movements.

6) Miscellaneous. There are scattered outcrops of serpentinite and limestone. Lower parts of San Pedro valley are mapped as fill, including the lower reach of San Pedro Creek, where the longitudinal profile was completed for this study.



(Davis, Jerry. 2002)

entire watershed
2127 ha (5257 acres)
21.27 km^2. (8.2 mi^2)

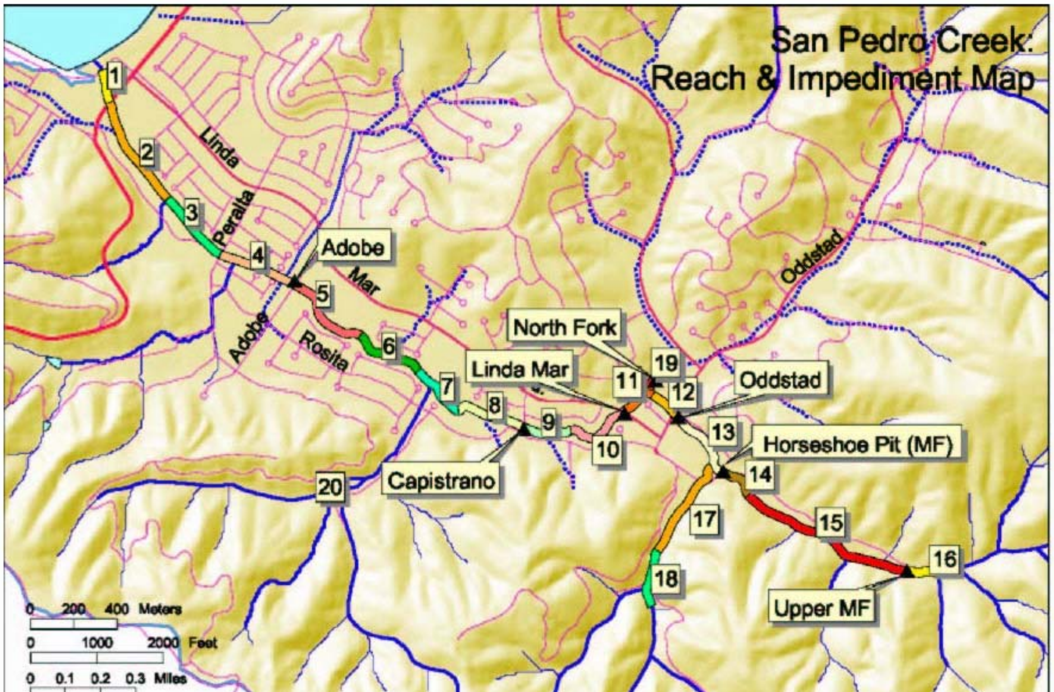


Figure 2 shows important reaches along San Pedro Creek. The longitudinal profile was completed along Reach 2. (Davis et al. 2002)

WATERSHED BACKGROUND

San Pedro Creek is a perennial stream that drains a 5,114 acre basin (8 square miles) composed of 5 main tributaries that define seven subwatersheds. The upper reaches of the watershed are formed by the north, middle, and south forks of San Pedro Creek and stream flows are maintained by springs in the south and middle forks of the basin. After their convergence at the head of the valley floor, the main stem flows northwesterly toward the Pacific Ocean. The Creek provides an excellent habitat for steelhead trout and is the only creek within 30 miles of San Francisco providing this type of habitat. The location of the longitudinal profile, reach 2, is shown on **Figure 2**.

LONGITUDINAL PROFILE

The profile was surveyed on April 6th and 19th, 2003 using an automatic level and standard survey rod. The Peralta Road Bridge was used as the initial benchmark. Elevations were transferred downstream to the Highway 1 bridge crossing of San Pedro Creek, where the longitudinal profile began. Our goal was to initiate the monitoring of the restoration project through the establishment of elevation measurements of the water-surface and streambed, field sketches of stream features, some sediment types on some of the reaches.

Just upstream of the San Pedro Creek corridor at the Highway 1 bridge on the beginning of the meander, the streambed had gravels as the predominating makeup. A survey was completed on April 19th. There was a bar on the south-side that was primarily cobbles and fines. At the 100 foot mark, there were cobbles on the south side and gravels on the north side of the streambed. At the end of the meander, the streambed was primarily sand with some cobbles and consisted of a narrower channel. There was pampas grass at this part of the reach. The soil that consisted of the northern floodplain was primarily organic that was black in color with some gritty fine sand consistency.

At the 178 foot station of the reach was a cobble bar. There was a standpipe at the 232 foot station on the southern side of the corridor. At the 242 foot station was a run that consisted primarily of fines and gravels. At the 264 foot was a riffle that consisted of gravels and fines and this streambed sediment continues. At the 293 foot, a run begins through the 343 foot station. At the 313 foot station, a log revetment begins on the south-side of the corridor and continues until the beginning of the run at 531 feet. There is flotsam on the north side and the inner edge of the stream at 435 feet is a sand bar with organic soil on the terrace/floodplain. The primary tree types are alder saplings. From station 377-490 feet are pools with a water surface elevation from 8.02 to 8.335 feet.

The next longitudinal survey was conducted on April 19th and begins at TP2 at station 610 feet. At this 610 feet station, a run begins. From station 668 through 767 feet, there is a sand bar in the middle of the stream. The leveler is set up on the north side of the creek on the terrace at approximately station 755 feet. We did not record any other sedimentation types until station 1057 feet. At this station, the left bank is sand and the thalweg is cobbles and gravels. The right bank is sandy. There are alders on the floodplain. At station 1089 feet, at the log revetment, the sediment type is primarily cobbles that are 6 inches across four feet across the reach as its width. At station 1130 feet, the stream bed is gravelly in this run. At station 1241, at the bottom of a highly eroded run is a scoured section that is the top of the run and the beginning a pool. It is at this point that major changes in the sediment makeup of the streambed and creek begin. The middle of the pool at station 1245 feet is bedrock that is scoured claystone with a depth of 1.24 feet. At the top of this pool at station 1256 feet is the same with a depth of 1.19 feet.

At this point, we have the beginning of a knick-point at station 1319 feet that is clay bedrock. This is also the top of the riffle that consists of gravels. At station 1339 feet is the knick-point that consists of eroded clay. At the top of the knick-point, station 1367 feet, is a depth of only 0.55 feet and consists of clay on the left bank and cobbles on the right bank. This is also the beginning of a riffle. At 1391 feet is the bottom of a deep pool and the beginning of a run. The depth of this is 1.21 feet. At station 1467 feet is the top of a run that consists of gravel at a depth of 0.80 feet and is also the bottom of a riffle. At station 1503 feet is the top of a riffle and the bottom of a run. At the middle of the run at station 1538 feet is a depth of 1.34 feet and the top of the run at station1563 feet at a depth of 0.86 feet is also a tule vegetation obstruction on the left bank. There is a gravel bar on the right side of this part of the corridor as well.

At the station 1603 feet is the bottom of a large pool on the right bank with log revetment protecting the bank. The depth at this part of the pool is 1.45 feet. The middle part of the pool is 2.17 feet deep. At the top of the pool and the beginning of a run is at station 1567 at 1.05 feet deep. There are sands and cobbles at this location. At station 1755 feet is the bottom of a riffle that continues until station 1788 feet and consists of grave. It is only 0.4 feet deep. At station 1755 feet is the bottom of a run that turns into a pool at 1908 feet. The right bank consists of clay. This large pool has many scour pools that are the deepest in this reach. At this station, the depth is 2 feet deep. At that middle of the pool is at a depth of 3.7 feet deep at station 1924 feet; and at the top of the pool at station 1931 feet at a depth of 1.15 feet deep. It is at this station that the bottom of a riffle begins. The top of the riffle is at station 2040 feet at the shallow depth of 0.55 feet.

This is where we ended the longitudinal profile of San Pedro Creek's flood control project on April 19, 2003. A densely vegetated riparian corridor was just a short distance upstream from station 2040 feet. Results were tabulated in an Excel Spreadsheet and are shown plotted on **Figure 3**.

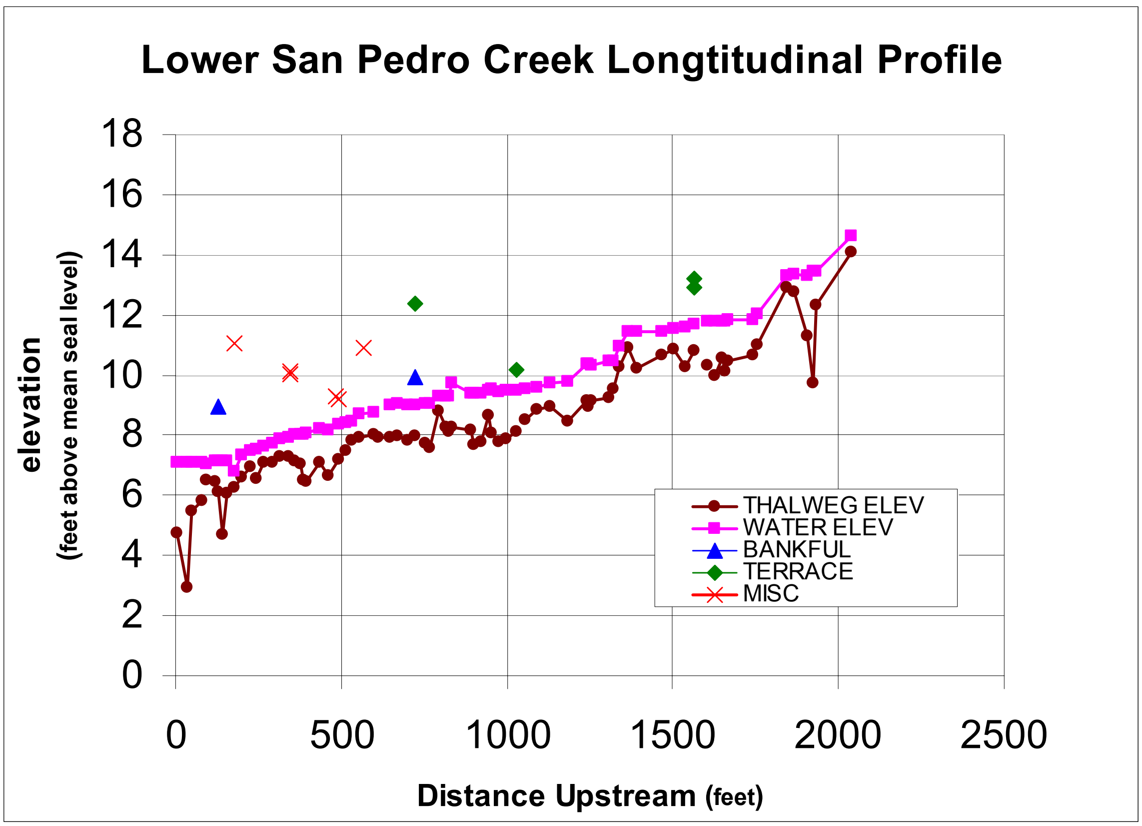


Figure 3 shows the longitudinal profile. At least two water surface elevations were in error, but overall results were consistent and correct. The survey was closed with precision of less than one-hundredth of an inch.

Longitudinal Studies were previously completed by the USGS, Jerry Davis, and the San Pedro Creek Watershed Coalition and are summarized on **Figure 4**.

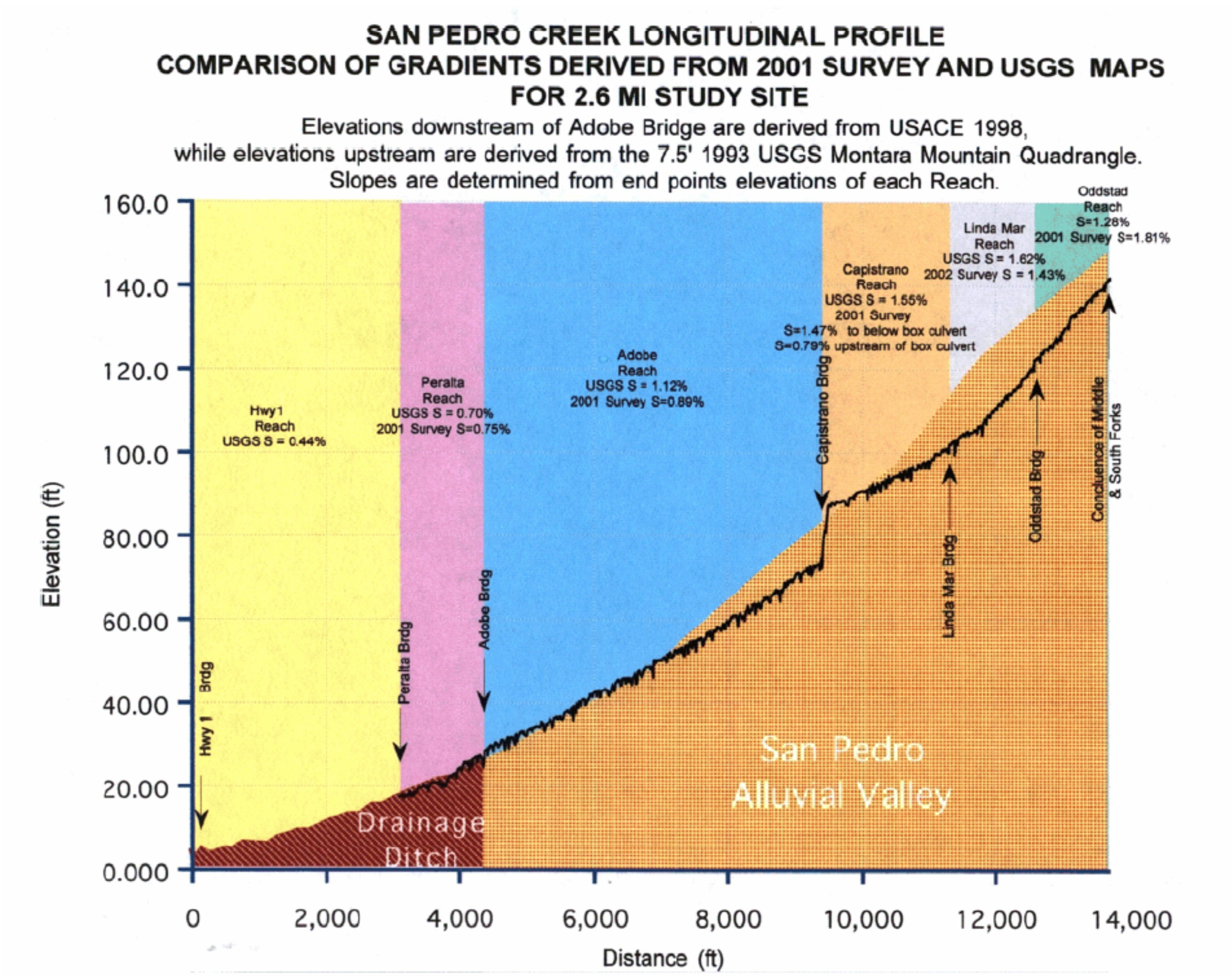


Figure 4 summarizes the longitudinal profile. Our study shows the initial 2000 feet in far greater detail. (Davis *et al.* 2002).

Stream Analysis

The longitudinal profile for reach 2 was divided into four segments of roughly equal length to allow for comparison of the gradient (water slope). The results of the analysis are presented in **Table 1**.

Station	Distance	Water Elev.	Slope	Percent Slope
3		7.07		
512	509	8.39	0.002593	0.26
512		8.39		
1030	518	9.5	0.002143	0.21
1030		9.5		
1538	508	11.61	0.004154	0.42
1538		11.61		
2040	502	14.64	0.006036	0.60

Table 1. Comparison of quarterly gradients.

Results show that the gradient steepened upstream, with most of the elevation difference occurring at four distinct steps in the upper half of the reach. When adding the slopes of these four stations, the average slope for our study is 37.25%. Comparing this slope to the USGS original slope average of 44% for the reach extending from the Peralta Bridge to Highway 1 bridge, there may have been some degradation that has occurred. However, since this survey did not include going all of the way up the corridor to the Peralta Bridge, but rather up to the origination of the USACE project. It is postulated that further surveying up to the Peralta Bridge would be necessary in order to ascertain whether a 6.75% degradation of the channel slope has occurred. The Rosgen Classification of this reach of the stream appears to have remained as a G4 type. This is due to the floodplain of San Pedro Creek and its characteristics similar to a single thread channel with a lot of gravels for streambed materials where the channel is entrenched. There are numerous scour pools and various locations wherein the stream has incised down to Quaternary clays. Sandstone bedrock is present in some parts of the reach and may be indicative of high stream velocities during storm events with high runoff. Part of this may be due to urbanization issues related to runoff and the short lag time of largely impervious surfaces. Also a conversation with a long-time resident had commented that a property owner had been dumping massive amounts of dirt on the other side of the paved road on the left bank of the reach several hundred feet way may be contributing to high runoff over the road and into the floodplain that he has observed. The depth of the thalweg is well below 12 feet, further lending to the notion of the G4 Rosgen classification. In order to establish the sinuosity of the stream, measurements of the valley length are needed and should be conducted in further studies.

The native riparian vegetation planted as part of the project appears to be flourishing. The willow stakes were budding with some leaves blossoming at the time of our study in April. This success should prevent extensive erosion of both right and left banks. . One of the species that appears to have become re-established is the red-legged frog- a threatened species. Many red-winged blackbirds and other avian species that include killdeer and migratory birds such as Mallard's ducks were observed during the survey. Steelhead trout fingerlings were observed throughout the reach in sufficient numbers to conclude that water quality (though turbidity and other water analyses were not part of this particular survey) are sufficient to support native species. Water quality sampling might be considered to establish turbidity and other water concerns.

The extensive log revetments appear to be preventing erosion at this time. April of 2003 was one of the wettest Aprils in years, so we had an opportunity to see the stream during both lower levels on April 6th and much higher runoff levels during the April 19th survey. I might note that the revetment on the right bank near the upper part of the reach has extensive scour pools as did many other revetment embankments. Periodic depth measurements of these scour pools and other pools near the revetments should be taken to determine whether this aspect of the restoration project is successful.

REFERENCES

Davis, Jerry (Editor). San Pedro Creek Watershed Assessment & Enhancement Plan. Prepared by San Pedro Creek Watershed Coalition. March 2002. [Accessed On-Line 5/10/03]. www.bss.sfsu.edu/jdavis/pedrocreek/publications.html.

US Army Corps of Engineers. San Pedro Creek Map. [Accessed On-Line on 5/6/03]. www.spn.usace.army.mil/projects/sanpedrocreekmap.pdf.