

CHAPTER 1 – INTRODUCTION

Stream processes are strongly related to the physical conditions of the watershed from which they flow. Alterations to physical conditions of a watershed manifest themselves through measurable responses of stream flow, sediment transport, channel erosion and aggradation, water quality, and the health of dependant flora and fauna. Human settlement has often led to an evolution of the landscape from undeveloped to agricultural to urban land use. This evolution has a significant influence on the physical conditions of a watershed and can be clearly linked to stream channel responses. Human alteration of the landscape in the form of urbanization increases impervious surface area and drainage channel networks, causing alterations in the response of stream flow and sediment dynamics. The intent of this study is to characterize and compare two sub-watersheds of a Central California coastal stream, one partly urbanized and the other dedicated open space, and to identify, measure, and quantify differences in stream flow, turbidity, and bank erosion attributable to urbanization.

San Pedro Creek watershed is located in the City of Pacifica, California approximately 20 miles (32.2 km) south of San Francisco (Figure 1). The steep headwater tributaries begin in the northern Santa Cruz Mountains forming the main stem that flows west across San Pedro Valley and into the Pacific Ocean.

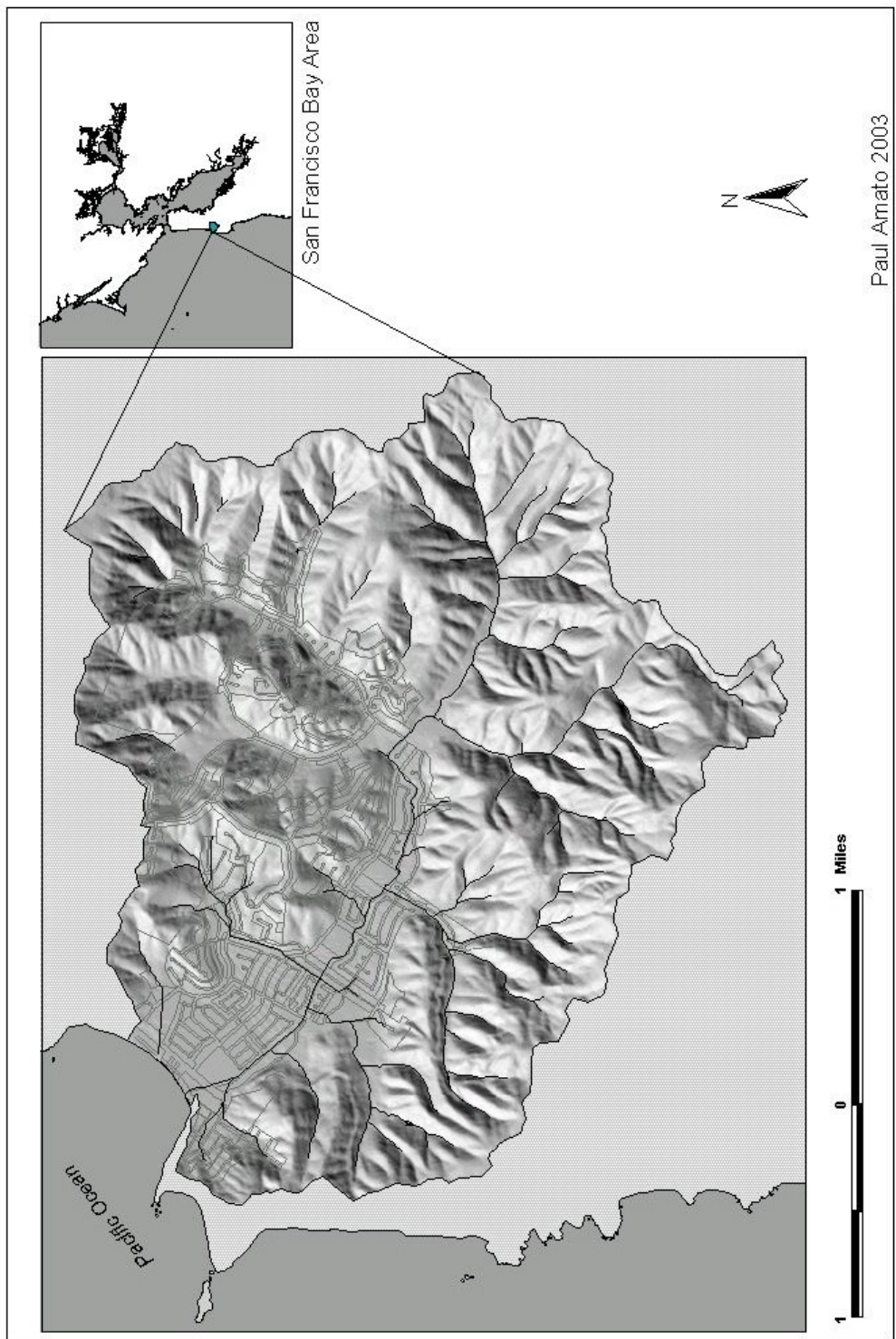


Figure 1. Location Map of San Pedro Creek Watershed

The entire watershed is approximately 8 square miles (20.7 km²) and composed of 5 main tributaries. Residential development dominates the lower and middle

watershed with light commercial and industrial facilities interspersed throughout the valley bottom. Headwater drainage areas are primarily dedicated open space.

The San Pedro Creek watershed was selected as the study site due to the potential to demonstrate contrasting stream responses in two neighboring sub-watersheds that are characterized by different land uses. San Pedro Creek is an especially interesting study location because it supports the central California coast evolutionarily significant unit, steelhead (*Oncorhynchus mykiss*), a state and federally listed threatened species. In addition, the highly developed steep slopes in the North Fork tributary represent the ever-increasing land use practice of hillside development that threatens to continue throughout the California coast.

This investigation considers land use change throughout the watershed but limits measured stream response to the two largest tributaries, the Middle Fork and the North Fork. The main stem of San Pedro Creek begins at the confluence of these tributaries near the geographic center of the watershed. The Middle Fork watershed is about 2.39 square miles (6.19 km²) and is composed primarily of undeveloped dedicated open space with the exception of some residential and commercial development at the downstream end. The Middle Fork channel is open and unlined with the exception of two box culverts and some revetment in the residential area. A riparian canopy is present along most of the channel length. The North Fork watershed is 2.37 square miles (6.13 km²) with residential and light commercial facilities in the valley and open space in the

headwaters. The North Fork channel is contained in a concrete pipe for most of its length with the exception of steep headward first and second order channels. The drainage area, topography, and vegetation of the tributary watersheds are similar, with notable variation in geology, and rainfall.

A properly functioning stream can be described as one that is in a state of equilibrium: it has “developed equilibrium size and shapes appropriate to the available discharge and character and quantity of sediment supplied” (Leopold et al. 1964). A stream that is neither aggrading nor eroding in excess is capable of adjusting to variations of discharge and sediment supply. When influences within the system alter the stream’s ability to transport water and sediment efficiently, excess erosion and aggradation occur. This condition has been referred to as disequilibrium. Landscape changes resulting from human activities often cause streams to enter a state of disequilibrium. A stream can move back and forth between these two states in response to changes to the physical setting. When changes cease or stabilize, the stream can eventually adjust to a state of quasi-equilibrium where erosion and aggradation rates re-stabilize. Though significant isolated erosion is still occurring, the main stem of San Pedro Creek appears to be capable of transporting its sediment load and may be in a state of quasi-equilibrium (Collins et al. 2001).

Prior to urbanization, the ground surface throughout the watershed was pervious, allowing infiltration of precipitation. When the natural surfaces were hardened with buildings and pavement, water infiltration potential was

significantly reduced and runoff rate and volume to the stream increased. As is typical with urbanization, road gutters, stormdrain facilities, and hillside drainage ditches were constructed to convey the increased runoff, resulting in more frequent and greater flood peaks in the stream channel. Hardening watershed surfaces also reduced the amount of sediment available for transport by the stream, which increased the amount of energy sediment-free water could exert on the stream channel boundaries. Channel incision, already initiated by earlier cattle grazing and farming practices, increased vertical separation of the channel from its floodplain, further increasing energy directed at the channel banks during frequent high flow events. Stream banks were destabilized as the bed degraded and the channel was subjected to more erosive flows at a greater frequency. Human landscape modifications altered natural surfaces and hydrologic response of the watershed, disrupting conditions that previously formed the equilibrium channel size and shape.

Today, these changes are especially evident in the main stem of San Pedro Creek below the North and Middle Fork confluence. Here, creek side residents have responded to erosion of their property with a variety of bank revetments ranging from yard debris to concrete. This alteration to the channel has in many cases resulted in erosion of the channel bed and adjacent unprotected banks, leading to a perceived need for more revetments. As a result, channel morphology and ecology are degraded from urban landscape change as well as by the response of the urban creek side dwellers.

Water quality has also been impaired due to urban runoff pollutants, increased fine sediment from localized in-stream erosion, increased temperature and decreased dissolved oxygen due to loss of riparian canopy, yard and pet waste, and failing sewer lines (Matuk 2001).

Evidence from seminal works on the influence of urbanization on watershed processes (Wolman 1967; Leopold 1973; and Morisawa 1979) and visual field reconnaissance led to the assumption that the Middle and North Fork drainages would respond differently to storms and that the resulting influence on stream processes and channel characteristics would be evident. To quantify these differences, gaging stations and continuous data logging systems were installed near the downstream ends of both drainages to measure values of turbidity and discharge (derived from stage) during storms. Physical characteristics of the drainages and temporal change were measured using ancillary data, and established field techniques. Influence of urbanization on bank erosion was measured using a survey method that was developed and used in several San Francisco Bay Area streams (Collins et al. 2001).