

Assessment of Sediment Management Practices in Six High Priority Watersheds in San Mateo County



**San Mateo Countywide
Stormwater Pollution
Prevention Program**

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Assessment of Sediment Management Practices in Six High Priority Watersheds in San Mateo County

1.0 INTRODUCTION

On June 27, 2002, the San Mateo Countywide Stormwater Pollution Prevention Program (STOPPP) submitted a Sediment Management Practices Assessment Work Plan (Work Plan) (STOPPP 2002b) to the San Francisco Regional Water Quality Control Board (Regional Board) to help comply with Provision C.2 of the STOPPP municipal stormwater NPDES Permit (Order No. 99-059). STOPPP prepared this assessment in accordance with the Work Plan and to complete the sediment management-related tasks in STOPPP's Pollutant Prevention and Control Measures Plan (STOPPP 2001).

The specific objectives of this assessment were to:

- Summarize existing watershed assessment information relevant to sediment issues in six high priority watersheds in San Mateo County, including potential anthropogenic-related sediment sources.
- Document existing sediment management practices in the high priority watersheds.
- Identify data needed to allow evaluation of existing sediment management practices.
- Summarize recommendations for addressing sediment issues from previous studies on the high priority watersheds.

This assessment relied on readily available information about existing sediment issues and sediment management practices and policies implemented by STOPPP municipalities and other agencies that have jurisdiction within the six high priority watersheds.

2.0 BACKGROUND

2.1 Selection of high priority watersheds

Watersheds in San Mateo County were prioritized for assessment of sediment management practices in the Work Plan. The Work Plan designated the following watersheds as high priority due to the potential susceptibility of creeks to impacts of excessive sediment production:

- San Francisquito Creek watershed
- Pescadero Creek watershed
- Butano Creek watershed
- San Gregorio Creek watershed
- Pilarcitos Creek watershed
- San Pedro Creek watershed
- San Mateo Creek watershed

During prioritization, consideration was given to watersheds with:

- Existing beneficial uses listed in the Regional Board Basin Plan (SFRWQCB 1995) that are impacted by excessive sediment;
- Streams that support or potentially support anadromous salmonid communities;
- Streams listed as impaired by sedimentation/siltation on the Clean Water Act Section 303(d) list (i.e., San Francisquito, Butano, Pescadero, and San Gregorio Creeks) or threatened by sedimentation/siltation on the State Water Resources Control Board Monitoring List (i.e., Pilarcitos Creek below the Pilarcitos reservoir);
- Urban land uses; and
- Existing or proposed watershed assessment studies.

The San Francisquito Creek watershed was excluded from this assessment because there are already extensive efforts underway to assess and improve sediment management practices in this watershed. For more detailed information on the methodology used to prioritize watersheds, refer to the Work Plan (STOPPP 2002b).

2.2 Study Area

2.2.1 Description of watershed areas

Pescadero/Butano Creeks

The Pescadero and Butano Creeks watersheds (60 and 22 square miles, respectively) are both coastal drainages in western San Mateo County. Both creeks start in the Santa Cruz Mountains and converge in Pescadero Marsh before flowing to the Pacific Ocean at the Monterey Bay National Marine Sanctuary (SFRWQCB 2001a). The area that drains to Pescadero and Butano Creeks is the largest coastal watershed in San Mateo County. The tributaries to these creeks are located within deep, heavily wooded canyons; however, a large amount of the forest cover was removed in the middle of the 20th century (ESA et al. 2004). The tributaries flowing into Pescadero Creek include Honsinger, Hoffman, McCormick, Lambert, Slate, and Oil Creeks. The tributaries into Butano Creek include Little Butano and South Fork Butano Creeks (SFRWQCB 2001a). The total stream length for the combined Pescadero/Butano Creek watershed is approximately 70 linear miles, with 26 miles from the main stem of Pescadero Creek. There are about 21 miles of stream that provide potentially viable Coho rearing habitat within the main stem Pescadero Creek and Peters, Slate, Oil, and Butano Creeks (PWA 2003). Much of the main channel of Pescadero Creek is flanked by agriculture and urban areas associated with the town of Pescadero, located near the mouth of the creek (Table 1 and Figure 1) (SFRWQCB 2001a).

Table 1. Areal extent of land use/land cover types in the six high priority watersheds in San Mateo County.

Watershed	Land Use/Cover Type	Acres	Square Miles	Percent Total
Butano Creek	Forest	8664.27	13.54	62.9
	Rangeland	3452.55	5.39	25.1
	Agriculture	1287.44	2.01	9.3
	Wetlands	146.08	0.23	1.1
	Moderate-Density Residential	74.18	0.12	0.5
	Unknown	71.71	0.11	0.5
	Commercial	41.75	0.07	0.3
	Water	18.03	0.03	0.1
	Other	12.36	0.02	0.1
	Low-Density Residential	9.89	0.02	0.1
	Transportation	2.47	< 0.01	< 0.1
	High-Density Residential	0.54	< 0.01	< 0.1
	Utilities	0.16	< 0.01	< 0.1
	Pescadero Creek	Forest	22473.75	35.12
Rangeland		9887.75	15.45	28.6
Agriculture		1287.14	2.01	3.7
Moderate-Density Residential		621.68	0.97	1.8
Wetlands		73.71	0.12	0.2
High-Density Residential		48.92	0.08	0.1
Water		45.82	0.07	0.1
Commercial		39.84	0.06	0.1
Public, Quasi-Public		39.56	0.06	0.1
Unknown		34.62	0.05	0.1
Other		20.87	0.03	0.1
Low-Density Residential		2.47	< 0.01	< 0.1
Pilarcitos Creek		Rangeland	12294.76	19.21
	Forest	3753.42	5.86	20.5
	Agriculture	1362.10	2.13	7.4
	High-Density Residential	341.65	0.53	1.9
	Water	135.99	0.21	0.7
	Public, Quasi-Public	116.86	0.18	0.6
	Commercial	113.87	0.18	0.6
	Moderate-Density Residential	103.56	0.16	0.6
	Other	59.79	0.09	0.3
	Transportation	28.73	0.04	0.2
	Low-Density Residential	17.31	0.03	0.1
	Vacant, Undeveloped	9.02	0.01	< 0.1
	Recreation	4.95	0.01	< 0.1
	Utilities	4.94	0.01	< 0.1

Table 1 (cont.). Areal extent of land use/land cover types in the six high priority watersheds in San Mateo County.

Watershed	Land Use/Cover Type	Acres	Square Miles	Percent Total
San Gregorio Creek	Forest	16261.41	25.41	48.8
	Rangeland	15275.20	23.87	45.8
	Agriculture	973.30	1.52	2.9
	Moderate-Density Residential	600.95	0.94	1.8
	Industrial	51.92	0.08	0.2
	Commercial	39.56	0.06	0.1
	Public, Quasi-Public	32.15	0.05	0.1
	Water	24.73	0.04	0.1
	Unknown	17.31	0.03	0.1
	Vacant, Undeveloped	15.61	0.02	< 0.1
	Other	10.96	0.02	< 0.1
	Transportation	9.89	0.02	< 0.1
	High-Density Residential	7.42	0.01	< 0.1
San Mateo Creek (below dam)	Moderate-Density Residential	879.98	1.37	30.4
	High-Density Residential	729.20	1.14	25.2
	Forest	600.51	0.94	20.7
	Rangeland	349.15	0.55	12.1
	Commercial	104.25	0.16	3.6
	Public, Quasi-Public	100.56	0.16	3.5
	Vacant, Undeveloped	79.12	0.12	2.7
	Transportation	53.13	0.08	1.8
	Recreation	0.00	< 0.01	< 0.1
San Pedro Creek	Rangeland	3623.29	5.66	70.1
	High-Density Residential	905.54	1.41	17.5
	Forest	300.96	0.47	5.8
	Public, Quasi-Public	103.22	0.16	2.0
	Commercial	52.94	0.08	1.0
	Vacant, Undeveloped	46.98	0.07	0.9
	Moderate-Density Residential	45.71	0.07	0.9
	Agriculture	27.20	0.04	0.5
	Recreation	24.72	0.04	0.5
	Transportation	17.86	0.03	0.3
	Other	9.53	0.01	0.2
	Low-Density Residential	4.95	0.01	0.1
	Water	4.76	0.01	0.1
	Utilities	2.47	< 0.01	< 0.1

Source: ABAG (1996)

San Gregorio Creek

San Gregorio Creek drains an approximately 52 square mile watershed in western San Mateo County that begins in the Santa Cruz Mountains and discharges into the Pacific Ocean. The tributaries that join San Gregorio Creek include El Corte de Madera, Clear, Coyote, Bogess, Harrington, La Honda, Woodruff, Alpine, and Mindego Creeks. There are a number of water diversions in San Gregorio Creek that reduce the flows to “potentially detrimental levels” (SFRWQCB 2001a). Agriculture is a significant land use

in the watershed, concentrated along the floodplains and main channel of San Gregorio Creek. On the main stem of San Gregorio and along Corte de Madera and La Honda Creeks approximately 720 acres of farmland are irrigated. The watershed is mostly rural with the largest urban center in the town of La Honda (Table 1 and Figure 1) (SFRWQCB 2001a).

Pilarcitos Creek

Pilarcitos Creek originates at an elevation of 1,875 feet in the Santa Cruz Mountains and flows on the eastern side of Montara Mountain through a narrow gap in the range. It eventually flows into the Pacific Ocean at Half Moon Bay (SFPUC 2004). There are two major dams in the watershed. Pilarcitos Dam, located in the upper watershed area, creates a water supply reservoir and Stone Dam, located two miles downstream, diverts water via Lock's Creek Line to San Andreas Reservoir to provide water to San Francisco. The Stone Dam reservoir has a capacity of five million gallons (15.4 acre feet) (SFPUC 2004).

San Pedro Creek

The San Pedro Creek watershed has a drainage area of 8.2 square miles and drains into the Pacific Ocean in Pacifica (Davis 2004). About one-fifth of the total watershed area is urbanized with the remainder consisting mainly of open space and recreational areas (Table 1 and Figure 1). The overall imperviousness of the watershed is approximately 15 percent with 64 percent of the creek channel unmodified (STOPPP 2002a). In the main drainage area there are 14 distinct subwatersheds including: "the North, Middle, south, combined Middle/South, Sanchez, Shamrock, Crespi (labeled Hinton), Pedro Point I and II, and five groups of subwatersheds collectively titled unnamed 1-5" (Sims 2004). The remainder of the area is the approximately one square mile urbanized valley floor that drains runoff through storm drains and channels (Sims 2004).

San Mateo Creek

The San Mateo Creek watershed drains about 32.8 square miles that flows to San Francisco Bay at Ryder Park, which is just south of Coyote Point (SFRWQCB 2002). This study focuses on the watershed area below the Lower Crystal Springs Reservoir, which is approximately 4.5 square miles with a stream reach of approximately 5.5 linear miles. San Mateo Creek flows through a narrow valley that is moderately urbanized until it reaches the Mills Culvert 4.1 miles downstream of the dam (City of San Mateo, 1988). The lower areas of the watershed are primarily urban (Table 1 and Figure 1). The overall imperviousness of the watershed is approximately 38 percent with 51 percent of the creek channel unmodified in the watershed below the dam (STOPPP 2002a).

2.2.2 Municipal and agency jurisdictional areas

Several agencies manage land use and development within the six high priority watersheds (Table 2 and Figure 2). The Pescadero, Butano and San Gregorio Creek watersheds are entirely within the unincorporated area of San Mateo County. The town of Pescadero is a small urban area at the mouth of Pescadero and Butano Creeks. Other public lands in these watersheds include Pescadero Creek County Park, which is operated by the County of San Mateo and Pescadero and San Gregorio State Beaches,

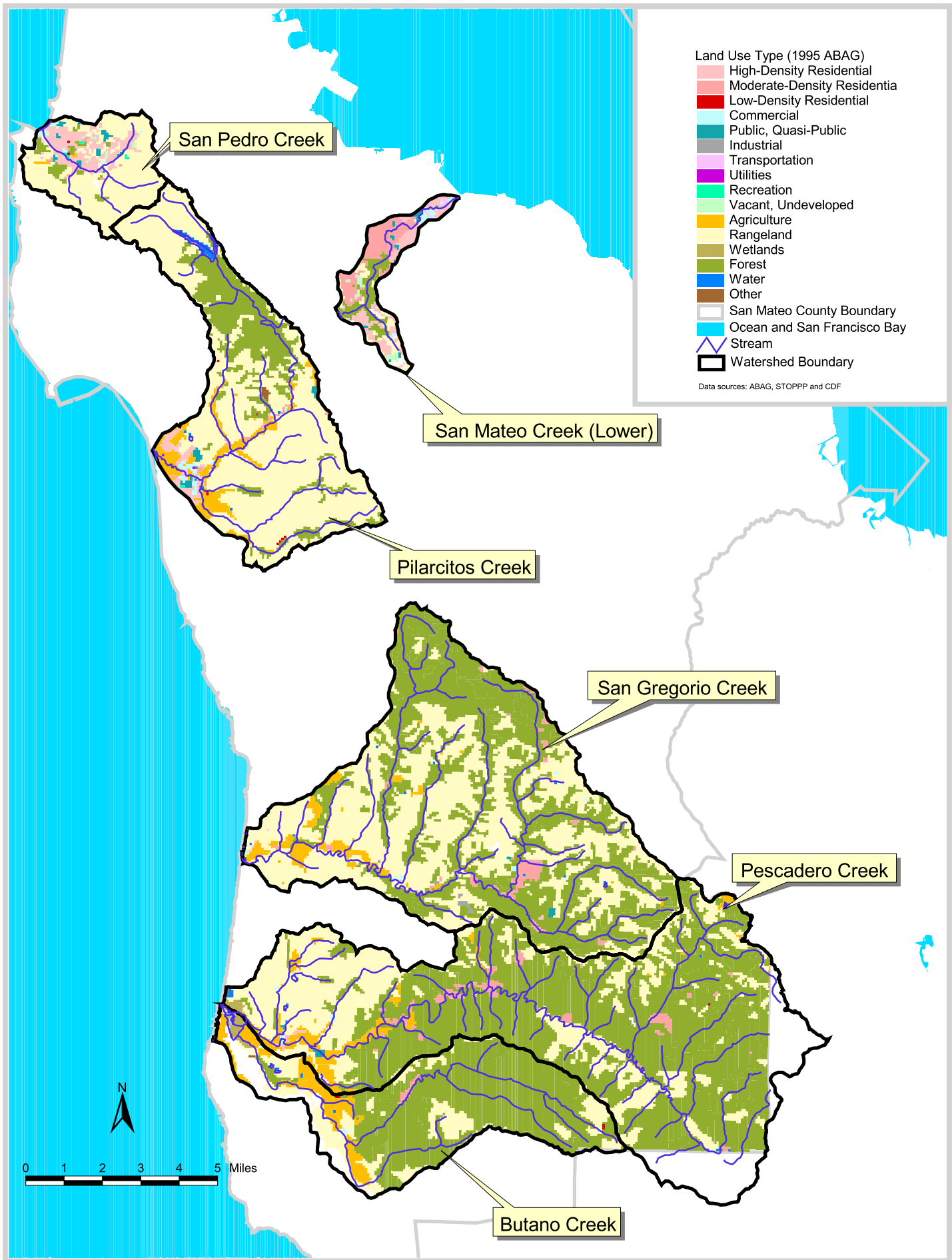


Figure 1. Land use type for six high priority watersheds in San Mateo County.

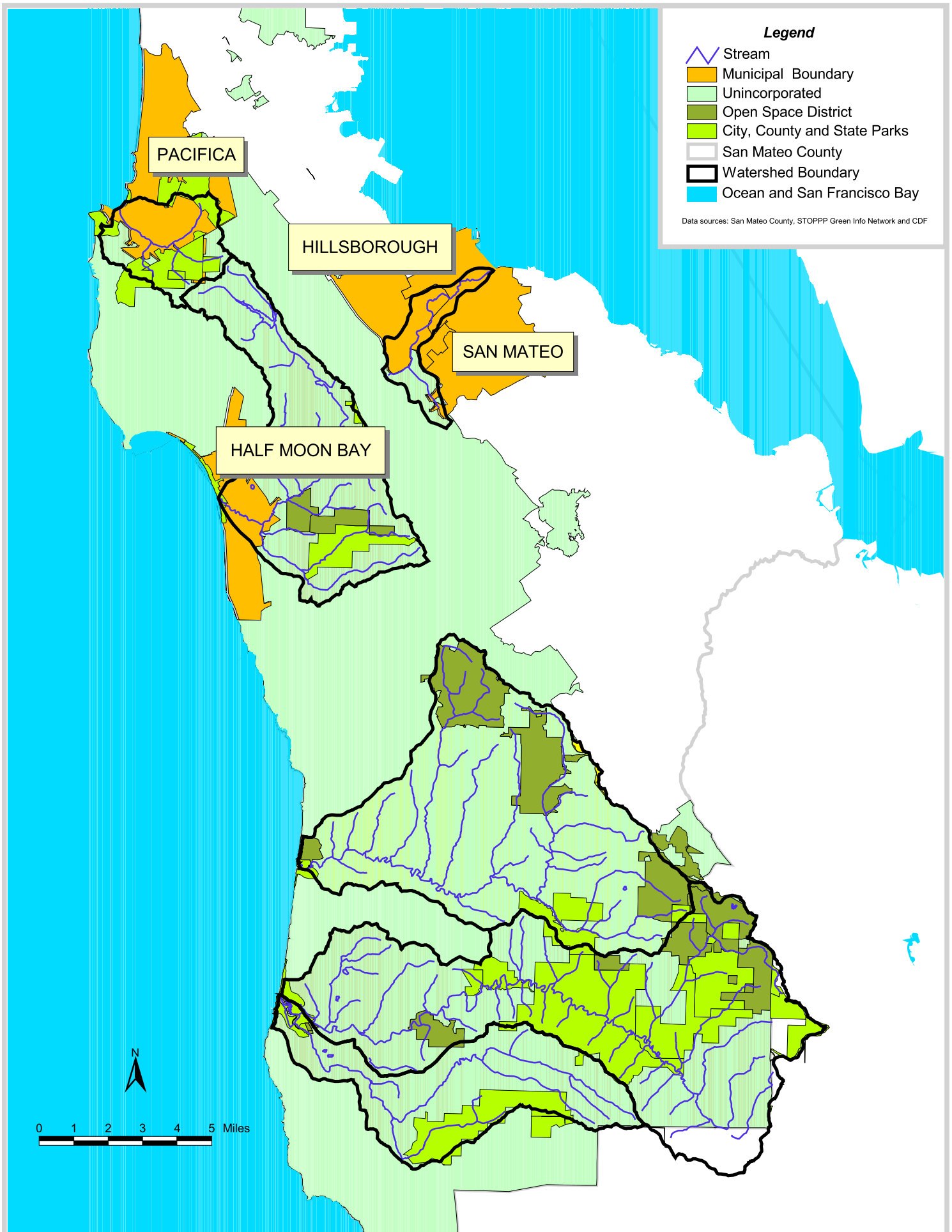


Figure 2. Jurisdictional and protected land boundaries in the six high priority watersheds in San Mateo County.

which are both managed by the California Department of Parks and Recreation.

Table 2. Total jurisdictional area for six high priority watersheds in San Mateo County.

Jurisdiction	Acres	Mi²	Total (%)
<i>Butano Creek</i>			
Unincorporated	13857	21.7	100
<i>Pescadero Creek</i>			
Unincorporated	34643	54.1	100
<i>Pilarcitos Creek</i>			
Unincorporated	17044	26.6	92.9
Half Moon Bay	1299	2.0	7.1
Pacifica	4	< 0.1	< 0.1
<i>San Gregorio Creek</i>			
Unincorporated	33191	51.9	100
<i>San Mateo Creek (below dam)</i>			
Hillsborough	1222	1.9	42.2
Unincorporated	977	1.5	33.8
City of San Mateo	696	1.1	24.0
<i>San Pedro Creek</i>			
Pacifica	2966	4.6	57.6
Unincorporated	2180	3.4	42.4

The Pilarcitos Creek watershed is mostly within the rural unincorporated areas of San Mateo County, with a small urban portion within the Town of Half Moon Bay. Approximately half of the San Pedro Creek watershed is located in Pacifica and the remaining areas are in unincorporated San Mateo County. The San Mateo Creek watershed area below the dam is primarily within the Town of Hillsborough, the City of San Mateo and unincorporated San Mateo County (Table 2 and Figure 2).

Figure 2 shows all City, County and State Parks located in the six high priority watersheds. Open space preserves managed by the Mid-peninsula Regional Open Space District and Peninsula Open Space Trust are also shown in Figure 2.

3.0 PREVIOUS WATERSHED ASSESSMENT STUDIES

3.1 Pescadero/Butano Creeks

3.1.1 Sediment Assessment of the Road and Trail Network within the Pescadero/Memorial/Sam McDonald County Park Complex

Pacific Watershed Associates (PWA) conducted a sediment assessment in the Pescadero/Memorial/Sam McDonald County Park Complex (PMSMPC), located within the headwater areas of both the Pescadero and Butano Creek watersheds, for the San Mateo County Parks and Recreation Department and the California Department of Fish and Game. The assessment “was specifically aimed at identifying future erosion sources impacting fish bearing streams and to develop prescriptions aimed at reducing

sediment input to the watershed” (PWA 2003). The erosion processes that do not deliver sediment to the stream network were not considered.

Major goals in recovery of salmonid populations include controlling existing erosional areas and preventing future erosion in other areas. The study developed an erosion and sediment inventory that covers about 74 miles of roads and trails within PMSMPC. The study also developed a prioritized erosion prevention plan. The assessment approach included ranking and prioritizing roads and trails based on their potential to impact downstream resources and their importance to the overall transportation system and management needs. Roads and trails were assessed within each sub-watershed and within each land management agency’s jurisdiction.

PWA concluded that the trail networks were significantly less likely to create erosion impacts on aquatic resources compared to road networks in the study area. The estimated sediment contribution to the stream network from untreated roads is more than 15 times greater than sediment from trails. The study determined that future projects to control erosion on road and trail systems for the benefit of anadromous fisheries should focus on treatment options for roads.

Of 137 road sites analyzed, 89 percent were recommended for treatment or control of erosion. An area that was determined to be a significant source of sediment was 5.7 miles of the Old Haul Road. PWA reports “...the 1998 winter storms caused approximately 17,370 yds³ of erosion and sediment delivery to Pescadero Creek and its tributaries from four sites located along the Old Haul Road. The four sites include two landslides and two large log and fill stream crossings.”

“Stream crossings, ditch relief culverts and potential landslide sites were inventoried, as well as other sites including road reaches, springs, and gullies. Implementation of erosion controls or BMPs was recommended for 71 of the 73 documented road-related stream crossings. PWA indicates that “The most common problems which lead to erosion at stream crossings include: 1) crossings with undersized culverts, 2) crossings with culverts that are likely to plug, 3) stream crossings with a diversion potential and 4) crossings with gully erosion at the culvert outlet. The sediment delivery from stream crossing sites is always classified as 100% because any sediment eroded at the crossing site is then delivered to the channel.”

Sixty-eight trail sites were identified as having the potential to deliver sediment to streams and 82 percent were recommended for treatment or control of erosion. Trails include single treed, horse, foot and bike trails which have the same types of erosional sites as roads, but on a smaller scale (i.e., less sediment contributed to the stream system).

3.1.2 Pescadero/Butano Watershed Assessment

The Pescadero/Butano Watershed Assessment (ESA et al. 2004) was prepared for the Monterey Bay National Marine Sanctuary Foundation. This document includes a geomorphic study that assesses sediment sources and erosion rates since 1937 and the current geomorphology of stream channels.

The objectives of the assessment included:

- Characterize the watershed and identify the areas of remaining high quality salmonid habitat that should receive high priority for conservation and restoration treatments;
- Identify the factors and anthropogenic processes limiting the quality of salmonid habitats in the watershed, and water quality generally.
- Identify the most cost-effective treatments for improving salmonid habitat, and the areas where these should be employed.

The approach to the sediment study included extensive field inventory and aerial photographic analysis. The fieldwork included an inventory of roads and trails and a stratified random sampling (STRS) scheme (used by USEPA in the Van Duzen River watershed Total Maximum Daily Load (TMDL)) to determine the total erosion and sediment delivery over the past 65 years. Findings from this study indicate the anthropogenic sources of sediment include:

- Clear cut and tractor logging,
- A period of intensive, mechanized agriculture on steep, unstable hill slopes, followed by abandonment of agriculture in these areas,
- Road construction and other grading activities;
- Disturbances within and along the stream channels themselves, including removal of riparian vegetation, manipulation of stream beds, stream banks, and stream courses, and construction within or adjacent to stream banks.

This study determined “the most broadly observed impediments to a productive fishery include a lack of cover, related to the infrequency of large woody debris; abundant fines, observed as deposits in streambeds, but which also are likely to impair water quality during higher flows; and shallow pools.”

3.2 San Gregorio Creek

3.2.1 Draft Report on Fluvial Geomorphology, Hydrology, and Riparian Habitat of La Honda Creek along the Highway 84 Transportation Corridor, San Mateo County, California

La Honda Creek is a third order tributary of San Gregorio Creek. Over the past 100 years, the land use within the San Gregorio Creek watershed has been greatly altered by anthropogenic activities such as logging, grazing, and rural residential development. A recent Caltrans study (Brady et al. 2003) focused on the lower 5 km (3.1 mi) of La Honda Creek, from the confluence with San Gregorio Creek upstream to Weeks Creek, which is in close proximity to Highway 84.

The study adopted a “corridor-based approach” to assess both transportation needs and environmental considerations. The approach was developed to protect the environment of the entire stream corridor through “more effective, economical, and ecologically sustainable designs” of engineering structures and necessary channel modifications.

The objectives of the project included:

1. Review existing information on the physical and biological conditions of the watershed,
2. Collect and interpret new data pertinent to designing sustainable and ecologically sensitive road maintenance projects,
3. Work with public groups to help them understand the project and gain access to the creek, and
4. Strengthen the working relationship and trust between Caltrans, the Department of Fish and Game, and the local community.

The study concludes that a significant part of the channel is susceptible to bank erosion and bed scour. Major channel modifications have occurred in the lower reaches of the channel from the construction of Highway 84 and private developments in the area. Channel alterations can cause accelerated bank erosion and sedimentation within the channel as well as scouring at modifications that may lead to failure. However, “the main source of sediment supplied to the creek is from land sliding.”

3.2.2 Road and Trail Erosion Inventory: El Corte de Madera Creek Open Space Preserve Draft Report

The El Corte de Madera Creek Open Space Preserve is owned and managed by the Mid-peninsula Regional Open Space District (MROSD). El Corte de Madera Creek is located within this 2,788-acre preserve and is a tributary to San Gregorio Creek. The mission of MROSD is to “acquire and preserve a regional greenbelt of open space land in perpetuity; protect and restore the natural environment; and provide opportunities for ecologically sensitive public enjoyment and education.”

The National Marine Fisheries Service and the Regional Board “have determined that erosion originating from the Preserve’s road and trail network may be delivering sediment to the aquatic system,” potentially impacting steelhead. A road and trail erosion inventory (Best 2002) was conducted to assist MROSD’s efforts to manage sediment sources within the Preserve. The objectives of the study were to:

1. Systematically inventory the condition and erosion potential along approximately 35 miles of roads and designated trails and approximately 15 miles of undesignated trails in the Preserve. The road inventory was designed to determine and rank the risks to both the road prism and stream channel from all sources of road and trail-related erosion, and to assess the long-term stability and maintenance requirements of the road and trail network.
2. Develop appropriate and feasible treatment prescriptions to repair damaged segments of roads and trails, and to control erosion at priority sites throughout the Preserve.
3. Analyze the erosional effects of past and current land management practices and recommend possible changes in management and maintenance techniques to improve the Preserve’s roads and trails and reduce sediment delivery to the aquatic system.
4. Develop a conceptual implementation schedule for the proposed road/trail repairs.
5. Develop a monitoring program to evaluate the effectiveness of the prescribed erosion control methods.

The inventory used a phased approach that included: 1) identification and inventory of specific sites and segments of road capable of delivering sediment to creeks; 2) site ranking to determine the relative priorities for treatment; 3) development of site or segment-specific treatments to eliminate or reduce sedimentation; and 4) evaluation of Preserve-wide use and management activities associated with sedimentation. The findings of this report are summarized below:

- Erosion of the road surface and gulying below the road are the most significant causes of road related erosion and road damage that currently occurs within the Preserve.
- The high use of the Preserve by mountain bicycles has contributed to the physical breakdown and infilling of water bars and dips which in combination with concentrated road runoff has resulted in locally significant damage to trails and/or chronic sediment delivery to the stream channel.
- A second leading cause of sediment is episodic erosion at stream crossings.
- Road-related landslides comprise a relatively small fraction of those sites needing corrective work because many of the roads have already been storm tested and no longer have the same risk of failure.

3.3 Pilarcitos Creek

3.3.1 Pilarcitos Creek Restoration Plan

The Pilarcitos Creek Restoration Plan (PWAL 1996) “takes a watershed approach toward developing alternatives to reduce sedimentation in the creeks, enhance fish migration and rearing and riparian habitat, and ways to provide educational resources.” Long-term restoration goals are presented.

The study found that the existing conditions in Pilarcitos Creek are as follows:

- Stream flow in Pilarcitos Creek is reduced by dams, water diversions, and groundwater pumping from the aquifer adjacent to the creek.
- Erosion is accelerated when vegetation is disturbed on steep hill slopes or on the channel banks.
- Most of the tributaries and the main channel of Pilarcitos Creek show evidence of channel incision.
- Bank erosion is pervasive throughout the Pilarcitos Creek watershed.
- The main source of water pollution in Pilarcitos Creek is the fine sediment eroded in the watershed.
- Stream substrate throughout the Pilarcitos Creek watershed is dominated by sand.
- Barriers to adult migration and to out-migrating smolt degrade fish habitat in the Pilarcitos Creek watershed.
- Stream habitat and fish abundance are generally the greatest in the upper reaches of Pilarcitos Creek.
- In most years Pilarcitos Creek is dry near the mouth and no summer lagoon forms.
- Riparian habitat has been disturbed and reduced in extent by urban and agricultural activities.

Balance Hydrologics, with funding from the U.S. Environmental Protection Agency, is developing a screening sediment budget for the Pilarcitos Creek watershed by identifying the tributaries contributing debris to this sediment-impaired system (Balanced Hydrologics 2004). The study involves monitoring of both suspended and bed load sediment near the mouths of seven major subwatersheds. The subwatersheds are affected by a variety of land uses and in diverse geologic settings. Subwatersheds will be compared based on the sediment loads conveyed at a given stream flow (sediment-rating curves), with adjustments for drainage area. Results will be used to select pilot subwatersheds for detailed on-the-ground inventories of sediment sources in this basin.

3.4 San Pedro Creek

3.4.1 San Pedro Creek Watershed Assessment and Enhancement Plan

The San Pedro Creek Watershed Assessment and Enhancement Plan (Plan) (SPCWC 2002) was prepared by the San Pedro Creek Watershed Coalition, which is a non-profit organization comprised of concerned citizens interested in restoring this 8.2 square mile watershed. The coalition works with public and private sectors to promote and facilitate watershed protection measures, and to educate the community - especially creekside residents - about how they can help.

The Plan uses the San Francisco Estuary Institute's (SFEI) Watershed Science approach to assess this watershed. The Plan evaluated information about historic and current conditions as a basis for supporting and directing future San Pedro Creek restoration activities. The Plan's sections cover geomorphic, biological and ecological assessments; water quality assessment and mitigation; information compilation, analysis and planning; restoration program; and education and outreach. Also included in this document are summaries of three additional studies: 1) Longitudinal Profile and Rosgen Classification of Reaches; 2) Storm Response of Water and Turbidity Levels in two Tributaries of San Pedro Creek; and 3) Optical Brighteners Sewage-Source Study.

The study of the longitudinal profile of the elevation of San Pedro Creek's thalweg (deepest part of the channel) and other channel features was conducted along the main stem of the creek from the Peralta Bridge to San Pedro Valley County Park. The creek's profile revealed important changes to the channel bed elevation resulting from historical channel modifications. The biggest change was observed at the Capistrano Bridge following the construction of a grade control structure and subsequent hardening of the channel segment upstream in the 1950's. These channel modifications resulted in 15 feet of vertical incision of the creek bed downstream of the grade control structure. This has created a serious barrier to fish migration and contributed to the loss of backyard property along this section of the creek. There are also many other grade control structures located at the Adobe, Linda Mar, and Oddstad Bridges that have created similar fish passage barriers.

The creek bed's gradient downstream of the grade control structure has decreased from historic levels because of the more frequent peak flows from paved areas associated with urbanization. The Plan speculates that the creek is still not in dynamic equilibrium with the flashy urban runoff it receives and will likely continue to erode unless "something is done to decrease the flashiness of the runoff." The Plan also concludes that off-road vehicle use in the 1960's and 1970's caused significant sediment inputs and

debris flow production from areas with very thin sandy soils along the middle slopes of Montara Mountain. The results of the geomorphological analyses of this watershed assessment are described below.

3.4.2 San Pedro Creek Geomorphic Analysis

Collins et al. (2001) assessed the current physical conditions of San Pedro Creek and the anthropogenic impacts on the watershed in order to create a scientifically based approach for future restoration and management of the creek. Major changes that have occurred to the creek include: loss of access to former wetlands, loss of flow into a former freshwater lake, entrenchment of the creek with up to 16 feet of incising in some areas in part due to the lost access to its historic floodplain, and placement of more than four miles of the North Fork's tributary creeks into underground culverts.

This assessment focuses on a 2.6-mile stretch of lower San Pedro Creek referred to as the study site. This study site extends from the Highway 1 Bridge through primarily suburban development of Pacifica to the confluence of the Middle and South Forks. Over one mile of bank length along the study site has artificial revetment (concrete, riprap, and sackcrete) and over 1.9 miles of the bank is eroding. Based on the Rosgen Stream Classification system, 27% of this section was classified as unstable due to down cutting and another 2% was unstable due to creek widening. The unstable sections of the creek are interspersed with more stable sections characterized as having moderate entrenchment and stable banks, plan form and profile.

The amount of sediment supplied by bank erosion and bed incision is believed to have accelerated greatly with modern settlement. About 60 percent of the sediment supply is estimated conservatively to be related to anthropogenic activities. Sand and finer-sized materials on the bed surface make up about 22% of the sediment, which is believed to be a greater percentage than what occurred historically.

Changes in land use have resulted in increased runoff and flood magnitude and frequency. Lowering of the water table elevation beneath the valley floor resulted from draw down along the entrenched channel bed and from construction of a drainage ditch. Generally large woody debris is removed or modified for flood passage in the channel. Steelhead migration has been deterred by structures creating impassable barriers under certain flow conditions. For example, there are at least ten remnant dam or weir structures in the channel in this stretch.

3.4.3 San Pedro Creek Watershed Sediment Source Analysis

San Francisco State University produced this four-volume compilation of sediment source reports for the San Pedro Creek Watershed Coalition. Volume I introduces the study area and discusses the studies for the subsequent volumes as well as findings from past reports on the main stem (also discussed below). Hill slope sources are addressed in Volume II, which focuses on gullies and landslides. Volume III analyzes sources of sediment from tributary channels. Volume IV is a table and map of the main stem treatment options that was unavailable for this assessment.

Volume II

Ten subwatersheds within the San Pedro Creek watershed are the focal point of this

study (Sims 2004) and include the North, Middle, South, combined Middle/South, Sanchez, Shamrock, Crespi (labeled Hinton), Pedro Point I and II and five groups of subwatersheds collectively titled unnamed 1-5. Land use in these subwatersheds varies greatly. The North Fork drainage is primarily urbanized and this tributary flows through underground channels. Conversely, both the South and Middle forks drainages are heavily vegetated open space with minimal current land use impacts. The existing land uses and conditions, including steep hill slopes, make the San Pedro Creek watershed extremely susceptible to erosion and landslides.

Hill slopes are affected by “slope washing, rilling, gullying, and an array of mass movements (landslides and other down slope gravitational movements) that are intensified where there is connectivity with a stream channel.” The results from this study show that “Channels erode beds and banks, and may also consume older terrace deposits where exposed by excessive bed incision and resultant over-steepened banks. Channel erosion has increased dramatically in the watershed, resulting largely from a dramatic increase in effective drainage density in some subwatersheds, ranging from approximately 6 km/km² in the subwatersheds of minimal impact (South and Middle Forks)... to nearly 17 km/km² at Pedro Point (while more significant due to its total area and headward position in the watershed is the 11 km/km² of the North Fork).”

The results of the sediment analysis indicated that human-related sediment sources within San Pedro Creek subwatersheds include:

- Sanchez subwatershed contributed a significant quantity of sediment due to an impervious road that has caused many slides and gullies.
- Middle subwatershed also had a significant contribution from past farming practices along the lower hill slopes causing many slides and gullies.
- Crespi, North, Middle, and the unnamed 5 subwatersheds have compacted hill slopes from previous farming and possibly grazing practices.
- Sanchez and Shamrock subwatersheds have been impacted by new roads associated with urban development causing gullies to form followed by increased surface erosion.
- North subwatershed has drainage terraces that protect houses on unstable hill slopes. The terraces are a direct sediment source from surface erosion and occasional landslides.
- Pedro Point II and Crespi, small intermittent drainages, contribute a substantial amount of sediment from recreational and farming practices.

The study analyzed natural and anthropogenic sources of sediment into the San Pedro Creek watershed and provided baseline data that would be useful to an analysis of long-term trends. The study states, however, “for a sediment source analysis of the San Pedro Creek watershed to be complete, a channel bank assessment is needed.”

Volume III

Pearce et al. (2004) conducted a sediment source assessment in tributaries of San Pedro Creek. The study found that three tributaries, Sanchez Fork, South Fork, and Middle Fork are a much greater source of sediment than the main stem of San Pedro Creek. The methodology used in the study is based on the method used for the geomorphic study performed on the main stem portion of the creek with modifications to

fit the project scope and budget.

The study findings include:

- Landslide/slump and terrace erosion are the dominant source of sediment.
- Bed incision occurs in the tributaries in response to incision of the mainstem.
- Sanchez Fork has the greatest percentage of bank revetment from residential land use.
- Bank and terrace erosion in the South Fork occurs because the channel had been relocated in the past.
- The best steelhead habitat can be found in the Middle Fork because there is “greater channel stability, larger mean grain size, abundance of pools, wood and riparian vegetation, and low-intensity surrounding land use.”

3.5 San Mateo Creek

3.5.1 Surface Water Ambient Monitoring Program (SWAMP)

The goal of the Regional Board’s implementation of the statewide SWAMP program is to monitor and assess all water bodies in the San Francisco Bay Area (SFRWQCB 2001a). Monitoring parameters include environmental indicators of stressors (e.g., pollutants or other water quality parameters), laboratory exposure/effects measurements (e.g., toxicity tests), and ecological response (e.g., benthic macroinvertebrate community analyses). Chemical analysis data are typically collected in three different seasons (summer, winter and spring) and biological and physical habitat data are generally collected during the spring.

The SWAMP program collected physical, chemical, and biological data at six sampling locations within the San Mateo Creek watershed January through June 2003. Four locations were sampled in urban areas below the Crystal Springs dam and two locations (reference sites) were sampled in tributary creeks draining into Crystal Springs Reservoir. STOPPP continued to monitor these locations for a second year during FY 2003/04. The results of the monitoring by the SWAMP program and STOPPP are not available yet.

The San Mateo Creek watershed area below the dam consists of primarily residential and commercial land uses that result in an estimated 38% cumulative watershed imperviousness. Forty-nine percent of the San Mateo Creek channel below the dam has been modified (STOPPP 2002a). The section of San Mateo Creek between North El Camino Real to North Railroad Avenue was converted into an underground culvert.

3.6 San Mateo County Assessment

3.6.1 Effects of County Land Use Policies and Management Practices on Anadromous Salmonids and their Habitats

Existing management practices were assessed in five Central California Coastal Counties, including San Mateo County, as part of the Fishnet 4C Program. The goal was to evaluate county land management practices and policies relative to protecting salmonid populations and to make recommendations for improving those practices and

policies (Harris et al. 2001). Existing management of erosion and bank protection was one component of the assessment.

Findings of the assessment included that there was a lack of riparian buffer policies or floodplain setback requirements in San Mateo County to protect streams. In addition, implementation and effectiveness of erosion controls used for development projects and bank protection structures were inconsistent, particularly during the rainy season. Another limitation identified in the assessment was a lack of standards for rural road and culvert maintenance.

Important sediment sources identified in the study were persistent road failures and landslides at certain locations and erosion from stored landslide debris, road spoils and other stored materials. Sheet wash erosion from unpaved roads and trails and ditch erosion associated with paved roads were identified as important sediment sources that were not directly addressed by existing policies.

Channel and levee maintenance, including woody debris removal from streams, was identified as an important concern for salmonid habitat quality. The study also identified stream crossings, including culvert replacements and repairs, and bank stabilization structures, especially where construction occurs along unstable banks near stream banks, as areas of concern for sediment impacts to salmonid habitat.

4.0 ANTHROPOGENIC ACTIVITIES AFFECTING SEDIMENT PRODUCTION IN STREAMS

Sediment production is a natural watershed process, however the rate of erosion, transport and deposition of sediment are greatly affected by anthropogenic activities. Land use conversion and urban development can affect erosion and sediment transport and deposition in many ways. The following sections provide a general description of erosion and sediment transport processes and the types of anthropogenic activities that might affect sediment production.

4.1 Erosion

Brief descriptions of three types of erosion processes and human activities that may impact erosion are discussed in this section. These include landslides or slope failures, and stream and surface erosion.

4.1.1 Landslide Erosion

The Northern California Landslide Working Group (NCLWG) identifies the three most common types of landslide erosion as deep-seated landslides, rock-fall and debris flows (NHC 2004). Deep-seated landslides are primarily earth flows and slumps that are grouped by their ability to transport sediment intermittently over periods of months to centuries (Reid et al. 1996) and generally move in pulses during or following wet periods. This type of landslide process is dormant during dry periods.

Debris flows, rockslides, and rock falls are rapid failures that usually move only once (Reid et al. 1996). Debris slides and flows occur episodically and are typically triggered by intense storms that follow seasonal precipitation that saturates the soil profile (NHC 2004). Landslides were identified as the dominant erosion process in the Santa Cruz

Mountains (NHC 2004). Abundant landslides occur about every five to ten years, usually during severe storms or infrequent large earthquakes.

Human activities can significantly affect landslide erosion processes. “Vegetation removal and soil disturbance directly affect rates of shallow land sliding.....road construction, use and maintenance are particular significant activities, as they may cause shallow or deep-seated landslides through failure of the road prism, contribute to down slope instability by re-distributing surface and groundwater flows....” (NHC 2004).

4.1.2 Stream Erosion

The natural process that creates stream channels is erosion, and the rate at which it occurs is determined by the slope of the channel and the resistance of the streambed material. Obstructions in the channel can increase erosion by accelerating and redirecting the flow of water (CDFG 1998). Bank erosion typically occurs during high flows and is greatest on river bends where high flows are directed at a bank (NHC 2004). Erosion of the streambed, or incision, refers to the removal of sediment on the bottom of a channel resulting in a lowering of streambed elevation (NHC 2004). Bed incision is often indicated by “knick points” or steps in the channel profile representing the upstream limit of streambed lowering.

Urban developments that increase impervious surface area will typically increase the frequency of the small and moderate peak flows (i.e., hydromodification). This can result in channel incision and bank erosion. Vegetation removal, road construction and soil compaction can also increase peak flows. Stream erosion can also be affected by human impacts that occur directly in the stream, including development in the riparian zone, straightening and hardening of the channel, and the construction of instream structures, bridges and culverts. These channel alterations often result in higher stream velocities and increased shear stress and bank erosion in reaches below the modified section. Removal of vegetation and large woody debris in stream channels can also result in bank erosion due to reduced vegetative bank protection and absence of instream structures (e.g., log jams) that help dissipate flow velocity and trap sediment.

Large dams and reservoirs trap bed load sediment, which may lead to the release of sediment-starved water to downstream reaches (Kondolf 1995). This “hungry water” can cause bed and bank erosion and channel incision. Instream gravel mining also disrupts geomorphic processes. Instream gravel extraction reduces sediment transport to downstream reaches and changes channel slope resulting in channel incision, both above and below gravel pits.

4.1.3 Surface Erosion

Sheet wash or surface erosion is caused by overland flow, which is common in areas where infiltration rates are lower than maximum rain intensities (e.g., roads and other compacted surfaces). Another type of overland flow occurs when the soil is saturated and cannot absorb any more water (Reid et al. 1996). Surface erosion is a chronic sediment source that is accelerated with storm events (CDFG 2004). The California Department of Fish and Game (1998) “has determined that the majority, in some case as much as 70 percent, of eroded sediment is caused by watershed road systems.” Surface erosion is also intensified with increased overland flows from urban development.

Anthropogenic activities that cause surface disturbances and lead to no or little vegetation to cover and hold together the mineral soils intensify surface erosion. Locations where this is likely to occur include roads and trails, construction or development sites, farms and fields (e.g., heavy grazing areas), landslide scars, bank erosion sites and sites where fire has occurred (NHC 2004, CDFG 1998).

Surface erosion from roads and trails can be a significant issue, resulting “in chronic delivery of fine-grain sediment into creeks... typically caused by lack of effective drainage structures, poor out sloping, steep gradient, and/or close proximity to stream” (Best 2002). The most significant sources are often from native or gravel surfaced roads; “their yield depend on road slope, road and drainage design road maintenance practices and traffic volumes.” Road and trail erosion in open space preserves and other parks can be intensified in areas with heavy recreational traffic, especially mountain bicycling. Poor road drainage often leads to road erosion problems because many drainage structures are undersized or inadequate (Best 2002).

Construction sites have the potential to contribute large quantities of sediment due to the grading and exposure of soil. However, erosion control management practices have greatly reduced sediment supply from developments (NHC 2004). Agricultural lands can also contribute fine sediment to streams. Erosion from croplands depends on the rainfall characteristics, topography, soil characteristics, vegetation, and surface armoring of the field (Reid et al. 1996). Landslides and fire scars leave behind areas of exposed soil that can provide “a small but consistent volume of sediment to streams each year” (NHC 2004).

4.2 Transport

Sediment can be transported two ways through the stream channel, either suspended or as bed load. Suspended sediment usually consists of clay and silt, and includes sand during high flows when turbulence is greatest. Bed load is bed material that is mobilized by rolling or sliding during flows and generally consists of coarser particles. The particle size for sediment that is moved in suspension versus bed load varies by flow magnitude; larger flows will cause coarser sediment to be transported and suspended by turbulence (NHC 2004).

Bed load materials comprise a significant quantity of the particles in the stream bed and mix with the bed material during transport. The fine sediments, usually clay and silt that are constantly suspended by turbulent flow, are considered the wash load (NHC 2004). Transport of bed material is variable based on the hydraulic aspects related to water discharge. The upstream supply of bed material affects the quantity of sediment in the wash load, which may be independent of hydraulic characteristics and is usually calculated as part of a suspended-sediment gauging program (NHC 2004).

Sediment transport can be significantly affected by anthropogenic activities such as channel modifications and hydromodification, both factors typically associated with urbanization. Another significant impact to sediment transport in some watersheds is the construction of dams to create reservoirs. A dam can effectively blocks all coarse sediment supply from the upper watershed drainage area. The lack of transport of coarse sediment to the downstream reaches of a creek can significantly affect channel stability.

4.3 Deposition

Sedimentation or sediment deposition is the process where the suspended or bed load is deposited in an area such as a streambed, floodplain, lake, reservoir, or estuary. When the sediment transport capacity is less than the volume of material supplied, deposition occurs. Temporary sediment storage occurs along the streambed between floods and long-term deposition occurs in lakes or reservoirs (NHC 2004).

Anthropogenic activities affecting deposition in the stream channel include construction of road crossings (e.g., bridges and culverts) and other grade control structures, and widening of the channel to increase flood conveyance capacities. These actions result in lowering the stream gradient and reducing stream velocities, which result in sediment deposition on the stream bed. Other structures can effectively block sediment transport, such as dams, weirs and fish ladders.

5.0 EXISTING SEDIMENT MANAGEMENT POLICIES AND PRACTICES

This section documents existing management practices and policies related to erosion control and sediment management in the six high priority watersheds in San Mateo County. Lead agencies, relevant regulatory/management driver, purpose and scope and applicable locations for each of the management practices that were identified to be relevant to protecting streams from excess sedimentation are shown in Table 3.

Existing information on development policies relevant to sedimentation of streams was compiled and summarized from various resources including an analysis of land use policies and management practices prepared for FishNet 4C (Harris et al. 2001) and STOPPP's Stormwater Management Plan (SWMP) (STOPPP 1998). Other resources include the studies on individual watersheds described previously in Section 3.0. Information relevant to municipal maintenance activities was compiled from STOPPP Annual Reports.

Information relevant to channel maintenance and bank protection maintenance activities was compiled and summarized from the STOPPP SWMP (STOPPP 1998). Information relevant to rural public works was found in the revised SWMP (STOPPP 2003) which has not been adopted by the Regional Board. Information from MROSD's (2003) El Corte de Madera Creek Open Space Preserve Draft Watershed Program was included because of its location in the San Gregorio Creek watershed and also to serve as an example of the types of programs that are implemented when the MROSD acquires land and performs maintenance. Other information relevant to management practices in rural areas was obtained from management plans developed for San Mateo County Parks and open space preserves. State beaches managed by the California Department of Parks and Recreation were not relevant to this analysis.

5.1 New Development

5.1.1 Stream buffers

Stream buffer ordinances, regulations and guidelines for restricting development in sensitive areas have been developed for areas in unincorporated San Mateo County. Harris et al. (2001) reports "San Mateo County's General Plan directs the County to

Table 3. Existing municipal/agency sediment management policies and practices in six high priority San Mateo County watersheds.

Type of Management Practice	Lead Agency	Regulatory/ Management Driver	Purpose and Scope	Location and Extent	Time Period of Projects	Reference
NEW DEVELOPMENT						
Stream Buffers and Setbacks						
Riparian Buffers	San Mateo County	San Mateo County's General Plan	Establishes buffer zones with restricted uses adjacent to sensitive habitats.	Unincorporated San Mateo County	Ongoing	Harris et al. (2001)
Riparian Buffers for Coastal Areas	San Mateo County	State Coastal Zone Protection Act	Restricts most new development within a defined riparian corridor. Exceptions provided for road maintenance and repair, placement of wells and utilities, and maintenance of existing flood control structures.	Coastal zones	Ongoing	Harris et al. (2001)
Hydromodification						
Hydromodification Management	STOPPP	STOPPP NPDES Permit	Requires that a hydrograph modification management plan be created to manage the impacts from changes to the volume and velocity of stormwater runoff from new development and significant redevelopment projects, where these changes can cause excessive erosion damage to downstream watercourses.	Countywide	To be implemented	STOPPP NPDES Permit
Outreach	STOPPP	STOPPP NPDES Permit	This outreach piece recommends site designs that minimize directly connected impervious areas without filtration. It also recommends using drainage as a design element (e.g., vegetated swales as street buffers and retention basins in play areas).	Countywide	Ongoing	STOPPP Conceptual Review Checklist for Stormwater Considerations
Construction BMPs						
Grading	San Mateo County Municipalities	STOPPP NPDES Permit/SWMP	Any grading projects shall include an effective erosion and/or sediment control plan... For development projects with significant erosion potential and planned construction activity during the wet season, each municipality will require, through a construction inspection process, that erosion and/or sediment control measures are implemented.... Prior to beginning of wet season, each municipality will require that each active construction site be stabilized to minimize erosion and discharges of sediment from disturbed areas and oversee the inspection of these sites to make sure these requirements are being met.	Countywide	Ongoing	STOPPP SWMP (1998)

Table 3. Existing municipal/agency sediment management policies and practices in six high priority San Mateo County watersheds.

Type of Management Practice	Lead Agency	Regulatory/ Management Driver	Purpose and Scope	Location and Extent	Time Period of Projects	Reference
EXISTING DEVELOPMENT						
Municipal Maintenance						
Street Sweeping	San Mateo County Municipalities	STOPPP NPDES Permit/SWMP	Municipalities perform street sweeping to remove as much material as possible and dispose of it properly. Wash down of streets is allowed only if runoff is controlled or contained. Residents are also encouraged to collect and compost leaves or schedule removal of bagged leaves.	Countywide	Ongoing	STOPPP SWMP (1998)
Road and Bridge Repair	San Mateo County Municipalities	STOPPP NPDES Permit/SWMP	Measures to reduce erosion and sediment include scheduling excavation and road maintenance activities for dry weather (if feasible), minimizing runoff, and protecting storm drain inlets. See STOPPP's Stormwater Management Plan for more specific requirements.	Countywide	Ongoing	STOPPP SWMP (1998)
Storm Drain Facility Maintenance	San Mateo County Municipalities	STOPPP NPDES Permit/SWMP	Municipalities inspect, and clean as necessary, storm drainage facilities (including inlets, culverts, V-ditches, and pump stations), at least once per year on average. When cleaning storm drain inlets and lines, the SWMP specifies removing the maximum amount of material at the nearest access point to minimize discharges to watercourses.	Countywide	Ongoing	STOPPP SWMP (1998)
Stream Maintenance						
Vegetation Management	San Mateo County	San Mateo County's General Plan	Guidelines for vegetation and debris control in riparian corridors.	Unincorporated San Mateo County	Ongoing	Harris et al. (2001)
Outreach	STOPPP	STOPPP NPDES Permit/SWMP	This outreach piece on erosion and sediment controls in riparian areas (Best Management Practices for Streamside Residences) includes information on streambank stabilization methods including revegetation, armoring, and deflection.	Countywide	Ongoing	STOPPP Erosion and Sediment Controls for Riparian Areas (DRAFT)
Streambank Alteration Management	USACE	Section 404 of Clean Water Act	Requires municipalities or any other parties performing streambank alteration work (e.g., bridge repairs, culvert replacement, flood control, etc.) to obtain a Section 404 permit. Permit requirements typically help minimize erosion due to the work.	Any "waters of the United States"	Ongoing	www.epa.gov/owow

Table 3. Existing municipal/agency sediment management policies and practices in six high priority San Mateo County watersheds.

Type of Management Practice	Lead Agency	Regulatory/ Management Driver	Purpose and Scope	Location and Extent	Time Period of Projects	Reference
Stream Maintenance (cont.)						
Erosion and Sediment Controls	MROSD	Section 303(d) of the Clean Water Act; Endangered Species Act enforced by CDFG and NMFS	Corrective measures to reduce erosion include: 1) Use of Best Management Practices to control erosion by directing storm water runoff off the trail network quickly and without creating large concentrations of water. 2) Reducing sediment reaching the aquatic environment as a result of trails located adjacent or close to streams by hardening the trail surface. 3) Preventing episodic erosion of stream crossings by installing larger culverts, rocking stream fords, or constructing footbridges. 4) Modifying the design of steep trails (over 15%) to help reduce the speed of mountain bicyclists, which will prevent or reduce erosion created when brakes are locked up.	Various areas within the El Corte de Madera Creek watershed (part of the San Gregorio Creek watershed)	Work will take place between June 15 to October 15 each year up until 2006.	MROSD 2003
Stream Restoration at Road Crossing	San Pedro Creek Watershed Coalition	Community based initiative	Bridge replacement project will include stabilizing and repairing creek banks, recontouring slopes, planting native vegetation to reduce soil erosion, and improve wildlife habitat and fish passages.	Weiler Ranch Road crossing of San Pedro Creek	Started July 29, 2001	SPCWC 2002
Flood Control	San Mateo County Department of Public Works	State legislation	Develop a flood control zone for an entire watershed before any flood protection project can be completed within that watershed including, channel, culvert and drainage improvements and silt and vegetation removal.	Active Flood Control Districts	Ongoing	SMC 2004
Unincorporated County Rural Road and Trails						
Trail Preservation and Realignment	MROSD	Section 303(d) of the Clean Water Act; Endangered Species Act enforced by CDFG and NMFS	MROSD is performing trail preservation and realignment projects. A number of locations present particularly difficult design challenges that require more than simple upgrades or Best Management Practices to reduce erosion. These locations are typically the steepest trails, the closest to streams, or the most difficult or costly to maintain. These trail segments will require extensive repairs or realignment. Where trail segments cannot be reconstructed in place, they will be closed and restored. New trail segments will be built that provide an equivalent or better trail experience in a less erosion prone location. See MROSD 2003 for more details.	Blue Blossom, Virginia Mill, Crossover, Fiant Salamander, Leaf, and Fir Trails (San Gregorio Creek watershed)	Various projects are ongoing	MROSD 2003

Table 3. Existing municipal/agency sediment management policies and practices in six high priority San Mateo County watersheds.

Type of Management Practice	Lead Agency	Regulatory/ Management Driver	Purpose and Scope	Location and Extent	Time Period of Projects	Reference
Road Width Minimization	MROSD	Section 303(d) of the Clean Water Act; Endangered Species Act enforced by CDFG and NMFS	MSROD will narrow road widths to the minimum necessary for patrol, emergency response, and maintenance activities, thus reducing the overall surface area exposed to the weathering and erosive effects of rainfall. Roads will typically be reduced to 4-foot width to accommodate All Terrain Vehicles (ATVs) for patrol, maintenance, and emergency access.	San Gregorio Creek watershed	June 15 – October 15, 2004 through 2006	MROSD 2003
Open Space Preserves						
Road and Trail Maintenance	MROSD	CDFG, SFRWQCB, USACE	MROSD generally repairs roads and culverts after acquiring new property in accordance with the Handbook for Forest and Ranch Roads (PWA 1994).	Open Space Preserves	Ongoing	Freeman, personal communication 2004
Riparian Corridor Setbacks	POST		POST leases land to farmers and requires their tenants to maintain 35-foot setbacks from riparian corridors.	Open Space Preserves	Ongoing	STOPPP 2002b
Agriculture						
Agricultural Practices	Coalition of Central Coast County Farm Bureaus	Voluntary farmer-led program	Farmers and ranchers are requested to protect water quality through practices such as improved tailwater retention systems, vegetative waterways or roadways, irrigation and/or tail water quality testing, and irrigation efficiency improvement projects.	Agricultural areas in San Mateo County (and five other counties)	Ongoing	SWRCB 2004

establish buffer zones adjacent to sensitive habitats with restricted uses, however, buffer zones are currently applied on a case by case basis.” Within these buffer areas, a zoning ordinance sets forth performance criteria and development standards. Also, the State Coastal Zone Protection Act requires special protection for streamside management areas to protect riparian vegetation. These management areas require a discretionary permit for new development when there is no other feasible alternative onsite. Although development is permitted, it “must maintain the functional capacity of the habitat and developers may be required to replant riparian vegetation” (Harris et al. 2001).

5.1.2 Hydromodification

All STOPPP municipalities are required, under Provision C.3 of the STOPPP NPDES permit (2003 amendment), to manage increases in peak runoff flow and increased runoff volume from certain new development and redevelopment projects. The permit requires that post-project runoff does not exceed pre-project rates and durations where the increased runoff from the project will result in increased potential for erosion or other adverse impacts to beneficial uses, attributable to changes in the amount and timing of runoff. The provision requires STOPPP to develop a Hydromodification Management Plan (HMP) to govern where and how runoff controls should be implemented. STOPPP anticipates completing a draft HMP by October 2004.

5.1.3 Outreach

STOPPP assists San Mateo County municipalities comply with the requirements of their municipal stormwater NPDES permit. STOPPP provides outreach and guidance materials to municipalities to distribute to developers, contractors and landowners in order to inform the public about permit requirements and assist with their implementation. One existing outreach piece encourages limiting site impervious area for development projects in an effort to reduce potential impacts of hydromodification to creeks and waterways. The outreach document suggests considering several options as part of new development site plans including: paving with permeable materials, cluster buildings or shared driveways, multi-story buildings to reduce land coverage, and installing parking bays or pull outs.

5.1.4 Construction

The statewide General NPDES Permit for construction activity disturbing one acre or more requires the development and implementation of a Stormwater Pollution Prevention Plan (SWPPP). The SWPPP must specify Best Management Practices (BMPs) that prevent grading and other construction activities from causing the off-site release of sediment and other pollutants during storms. In addition, most cities restrict grading during the rainy season and all active construction sites must be stabilized to minimize erosion and discharges of sediment from disturbed areas. Each SWPPP is customized to a particular construction site and the management practices specified vary greatly.

5.2 Existing Development

5.2.1 Municipal maintenance

Municipal maintenance activities related to sediment control include street sweeping, road and bridge maintenance, storm drain facility maintenance, road removal, stream restoration and vegetation and fire management. Municipalities conduct activities such as street sweeping and storm drain cleanouts at varying frequencies, depending on factors such as land use type. STOPPP's annual reports document relevant information such as the number of street miles swept and number of storm drain facilities (e.g., catch basins, storm drains and ditches, pump stations) cleaned each year.

Municipalities and other parties performing stream bank alteration (e.g., bridge repair, culvert replacement, flood control projects) must obtain a Clean Water Act Section 401 certification that water quality standards will not be violated and a Section 404 permit. The United States Army Corp of Engineers (USACE) is the primary federal agency with regulatory control and issues Section 404 permits, pursuant to USEPA guidelines and approval, for dredge and fill activities in "waters of the United States". The Section 404 permit helps regulate and minimize disturbances in the stream, limiting the amount of erosion occurring from stream alteration.

Examples of stream bank maintenance designed to reduce erosion includes management practices in the San Pedro Creek watershed. These practices include bridge replacement that stabilizes and repairs creek banks and planting native vegetation to reduce erosion (SPCWC 2002).

5.2.2 San Mateo County Flood Control District

The San Mateo Flood Control District is a district of San Mateo County's Public Works Department. The district is required to develop a flood control zone for an entire watershed before any flood protection project can be completed within that watershed. Three areas currently include active flood control zones: San Bruno Creek, Colma Creek and San Francisquito Creek. Currently there are no flood control zones within the six high priority watersheds selected for this assessment. Flood control management practices associated with flood control zones in other watersheds have included channel construction and improvements, culvert and drainage improvements, and silt and vegetation removal from open channels (SMC 2004). The six high priority watersheds currently do not have flood control zones.

5.2.3 Unincorporated San Mateo County

San Mateo County is responsible for much of the maintenance of rural roads and trails. STOPPP's new SWMP (STOPPP 2003) contains Rural Public Works Maintenance Performance Standards that apply to rural public works maintenance and support

activities related to:

- management and/or removal of large woody debris and live vegetation from stream channels;
- stream bank stabilization projects;
- road construction, maintenance, and repairs in rural areas to prevent and control road-related erosion;
- and environmental permitting for rural public works activities.

Although the Regional Board has not adopted the new SWMP, San Mateo County and other individual municipalities may already implement aspects of the Rural Public Works Maintenance Performance Standards.

San Mateo County also submitted a Coastal Watershed Erosion Control and Prevention Strategy (STOPPP 2001) to the Regional Board in fulfillment of Provision C.11 of STOPPP's municipal NPDES permit. The report summarizes progress made by the San Mateo County in the areas of erosion prevention, restoration, monitoring and education for the Gazos Creek, Pescadero Creek and San Gregorio Creek basins.

In addition, San Mateo County recently completed revised Maintenance Standards that supersede the Endangered Species Watershed Protection Program (ESWPP) Volume I Maintenance Standards discussed in the work plan for this project (STOPPP 2002b). The revised standards include the four areas covered in the original ESWPP (i.e., bank stabilization, slide debris, berms, and large woody debris management/removal) and are expanded to include new areas. They will be available on the County of San Mateo County website (www.co.sanmateo.ca.us) in the near future. The standards are specific to unincorporated San Mateo County; however, some San Mateo County cities have or plan to adopt them (Eckers 2004, personal communication).

5.2.4 Open Space Preserves

Peninsula Open Space Trust (POST) uses private and public funds to purchase land for protection from development. The goal of POST is to secure the open space in and surrounding the Santa Cruz Mountains, from the San Mateo County Coast to San Francisco Bay. POST policy is for acquisitions to remain closed to the public until an agency such as the MROSD, County Parks, or California Parks System has the resources to manage the lands. POST also leases land in San Mateo County to farmers and requires their tenants to maintain 35-foot setbacks from riparian corridors to protect water quality and habitat. POST currently manages agricultural land adjacent to fish bearing streams and non-fish bearing streams in San Mateo County (STOPPP 2002b).

The MROSD manages many of the open space lands within San Mateo County and maintains roads and trails within these preserves. Much work may be necessary upon acquiring new land; the MROSD repairs degraded roads and culverts before opening parks for public recreation. There are no formal policies that the MROSD follows when doing work; however, each site is analyzed before work is performed and a work plan is created on a site-by-site basis. The MROSD uses Pacific Watersheds Associates' "Handbook for Forest and Ranch Roads" (1994) as guidelines for roadwork within the open space preserves (Freeman 2004, personal communication). The MROSD also follows the policies in their Resource Management Five-Year Strategic Plan - overall

policies are to protect natural ecosystems and restore disturbed or degraded sites NHC 2004a.

5.2.5 Agriculture

The Coalition of Central Coast County Farm Bureaus is comprised of six counties (including San Mateo County) and is focused on “development and implementation of voluntary, cost effective, producer-directed programs to protect water quality.” Farmers and ranchers are requested to voluntarily protect water quality through practices such as “...improved tail water retention systems, vegetative waterways or roadways, irrigation and/or tail water quality testing, irrigation efficiency improvement projects...” (SWRCB 2004).

6.0 FINDINGS

This assessment uses available existing information to summarize anthropogenic activities that may be important sources of sediment production in six high priority watersheds in San Mateo County. Existing management practices and/or policies that may help address these sources were discussed earlier. An evaluation of the effectiveness of existing management practices in the high priority watersheds was not conducted at this time. In many cases, additional studies would be required to provide all of the data needed for such evaluations. This section summarizes pertinent available information on each high priority watershed, organized into the following categories:

- *Regulatory Status.* The regulatory status with regard to sediment issues (e.g., 303(d) listing and TMDL status) is briefly described.
- *Anthropogenic Sources.* The types of anthropogenic activities that may be important sources of sediment production are summarized.
- *Data Gaps.* Data gaps and information needs for evaluating effectiveness of existing management practices to control sediment production from anthropogenic activities are identified.
- *Recommendations from Previous Studies.* Recommendations from previous studies for controlling sediment sources are summarized.

6.1 Pescadero/Butano Creeks

6.1.1 Regulatory Status

Pescadero and Butano Creeks are currently listed by the State Water Resources Control Board as impaired by sediment under Section 303(d) of the Clean Water Act. A TMDL addressing sediment is underway for these watersheds with a projected completion date of June 2006 (Napolitano et al. 2003). The listing and TMDL are primarily a result of increased sediment delivery from historical and present-day land use practices having adversely impacted salmon and steelhead habitat in Pescadero and Butano Creeks.

6.1.2 Anthropogenic Sources

ESA et al. (2004) indicated that anthropogenic sources of sediment in the Pescadero/Butano Creeks watershed include:

- Clear cut and tractor logging,
- A period of intensive, mechanized agriculture on steep, unstable hill slopes, followed by abandonment of agriculture in these areas,
- Road construction and other grading activities,
- Disturbances within and along stream channels, including removal of riparian vegetation, manipulation of stream beds, stream banks, and stream courses, and construction within or adjacent to stream banks.

Significant landslides have occurred along Old Haul Road in the Pescadero Creek watershed and also make up about 10% of the inventoried sites in the PMSMCP assessment area (PWA 2003). ESA et al. (2004) noted that in 1982, a large storm caused many landslides in the San Francisco Bay region causing major damage. Many debris flows were found “in several areas of the Pescadero/Butano watershed: in the area between Bradley Creek and Honsinger Creek...; in the Butano basin, centered upstream of the confluence of South Fork Butano and Butano Creek...; and in the area west of the lower course of Butano Creek” and a large landslide occurred in the upper tributaries of Fall Creek, in Pescadero Creek County Park. These “debris slides comprise 20% of the total number of erosional features... but account for 56% of the measured erosion and 46% of the total sediment delivery.”

Ditch relief culverts in the County parks in the Pescadero/Butano Creeks watershed that potentially cause instream erosion “account for approximately 30% of the inventoried sites in the PMSMCP assessment area. Gully erosion can occur below ditch relief culvert outlets due to excessive road and/or ditch contribution to the inlet. Gully erosion can also occur as a result of poor installation techniques such as shot gunned outlets or the culvert being placed too high in the fill without functional downspouts” (PWA 2003). ESA et al. (2004) found that “bank erosion and channel incision sites each account for 30% of the total number of erosional features in the plots, but only approximately 17% and 23%, respectively, of the total sediment delivery.”

PWA (2003) indicated that the PMSMCP contains “approximately 13.3 miles of road surface and/or road ditch which currently drain directly to streams, and delivers ditch and road runoff and sediment to stream channels.” This study also indicated that “The most common problems which lead to erosion at stream crossings include: 1) crossings with undersized culverts, 2) crossings with culverts that are likely to plug, 3) stream crossings with a diversion potential and 4) crossings with gully erosion at the culvert outlet.”

6.1.3 Data Gaps

The data collected from previous studies included an aquatic habitat assessment and limiting factors analysis, and a sediment source analysis for the entire watershed. As a result, no data gaps were identified.

6.1.4 Recommendations from Previous Studies

The following sections summarize recommendations from two studies on the Pescadero/Butano Creeks watersheds.

Sediment Assessment of the Road and Trail Network within the Pescadero/Memorial/Sam McDonald County Park Complex

The sediment assessment on the roads and trails in the PMSMCPC (PWA 2003) stated “Road and trail upgrading consists of a variety of techniques employed to “erosion-proof” and to “storm proof” a road or trail and prevent unnecessary future erosion and sediment delivery. Erosion-proofing and storm-proofing typically consist of stabilizing slopes and upgrading drainage structures so that the road or trail is capable of withstanding both annual winter rainfall and runoff, as well as a large storm event without failing or delivering excessive sediment to the stream system. Most all the roads and trails in the PMSMCPC have been prescribed for upgrading.”

This study also states “Treatment priorities are evaluated on the basis of several factors and conditions associated with each potential erosion site. These include:

1. the expected volume of sediment to be delivered to streams (future delivery – cubic yards),
2. the potential or “likelihood” for future erosion (erosion potential - high, moderate, low),
3. the “urgency” of treating the site (treatment immediacy - high, moderate, low),
4. the ease and cost of accessing the site for treatments, and
5. recommended treatments, logistics and costs.”

Based on these treatment priorities PWA concluded that following sites need to be treated within the PMSMCPC (excluding the Old Haul Road) with erosion and sediment controls:

- 7 high priority sites, all at stream crossings.
- 21 high moderate priority sites including 16 stream crossings, 2 landslides, and 3 ditch relief culverts.
- 31 moderate priority sites including 21 stream crossings, 1 landslide, 8 ditch relief culverts, and 3 others.
- 37 moderate low priority sites including 16 stream crossings, 5 landslides, 13 ditch relief culverts, and 3 others.
- 21 low priority sites including 11 stream crossings, 11 ditch relief culverts, and 2 others.

Pescadero/Butano Watershed Assessment

Recommendations from ESA's Pescadero/Butano Watershed Assessment (ESA et al. 2004) include:

- Active road networks for timber companies have been upgraded in recent years; however, areas that need further management include the "secondary, infrequently used and abandoned logging roads and skid trails on both private timberlands and public parklands that constitute an important source of both chronic and episodic sediment delivery to streams. These roads should be inventoried and treated, with greater emphasis placed on roads in high and moderate priority basins...
- Upgrade of both forest and ranch roads (where most of the commercial timberlands and many park and open space lands are located), would go far in cost-effectively reducing anthropogenic sediment sources...
- Low-order stream channels store large quantities of sediment from previous land management practices... in some instances (particularly in high priority sub-basins) sediment may be removed or stabilized...
- To minimize gully erosion, both cultivation and grazing should be kept at relatively low intensities on the steeper slopes."

6.2 San Gregorio Creek

6.2.1 Regulatory Status

San Gregorio Creek is currently listed by as impaired by sedimentation under Section 303(d) of the Clean Water Act. A TMDL addressing sediment is underway for this watershed with a projected completion date of June 2007 (Napolitano et al. 2003). The listing and TMDL are primarily a result of increased sediment delivery from historical and present-day land use practices having adversely impacted salmon and steelhead habitat in San Gregorio Creek.

6.2.3 Anthropogenic Sources

Land use within the San Gregorio Creek watershed has been greatly altered by anthropogenic activities including logging, grazing, and rural residential development. Brady et al. (2003) concludes that a significant part of the La Honda Creek channel is susceptible to bank erosion and bed scour. Major channel modifications have occurred in the lower reaches of the channel from the construction of Highway 84 and private developments in the area. Channel alterations can cause accelerated bank erosion and sedimentation within the channel as well as scouring at modifications that may lead to failure. The study notes that the main sources of fine sediment in La Honda Creek are "1) conveyance of sediment by landslides; 2) off-channel, human activities such as construction of houses, roads, and driveways; poorly designed drainage; and agricultural tilling and irrigation runoff; 3) breakdown of mudstone in the channel; 4) entrainment of soil; 5) input from tributaries, and 6) drainage from Highway 84."

El Corte de Madera Creek is a tributary to San Gregorio Creek located within the El Corte de Madera Creek Open Space Preserve. Best (2002) states that surface erosion

is “the most significant causes of road/trail-related erosion and road damage that currently occur within the Preserve... The road inventory identified 49 separate road/trail reaches (totaling roughly 6.8 miles) where there is 1) a potential for future sediment delivery to streams or 2) where there is existing or potential road damage.” Best (2002) concludes:

- Erosion of the road surface and gulying below the road are the most significant causes of road related erosion and road damage that currently occurs within the Preserve.
- The high use of the Preserve by mountain bicycles has contributed to the physical breakdown and infilling of water bars and dips which in combination with concentrated road runoff has resulted in locally significant damage to trails and/or chronic sediment delivery to the stream channel.
- A second leading cause of sediment is episodic erosion at stream crossings.
- Road-related landslides comprise a relatively small fraction of those sites needing corrective work because many of the roads have already been storm tested and no longer have the same risk of failure.

6.2.3 Data Gaps

Potential information needs in the San Gregorio Creek watershed include the following:

- Aquatic habitat assessment and limiting factors analysis to identify the location and type of critical steelhead and coho salmon habitat and extent to which excess fine sediment is limiting production of anadromous fishes.
- Sediment source analysis to identify relative contributions of natural and anthropogenic sediment sources from landslide, channel and surface erosion that is occurring in the watershed.

6.2.4 Recommendations from Previous Studies

The following sections summarize recommendations from two studies on the San Gregorio Creek watershed.

Draft Report on Fluvial Geomorphology, Hydrology, and Riparian Habitat of La Honda Creek along the Highway 84 Transportation Corridor, San Mateo County, California

Recommendations by Brady et al. (2003) for future activities in La Honda Creek in the San Gregorio Creek watershed include the following:

- Develop a detailed sediment budget to identify the amount of fine sediment input.
- Develop an inventory of culvert location, exposed length, condition, and hydraulic effects. In addition, traps should be installed to determine the type and volume of sediment discharged through the culverts.
- Benthic macroinvertebrate monitoring should be continued to investigate spatial and temporal trends of BMI community and watershed health over time.
- Perform detailed slope stability mapping to locate areas of potential instability above the roadbed.
- Conduct additional stage-discharge measurements for stages higher than 2.5 feet to strengthen the stage-discharge relationship.

Road and Trail Erosion Inventory: El Corte de Madera Creek Open Space Preserve Draft Report

The following excerpt from the Road and Trail Erosion Inventory in El Corte de Madera Creek Open Space Preserve (Best 2002) provides sediment management recommendations:

“To correct existing erosion problems and to significantly reduce the potential for future sedimentation from problem sites, there are a number of actions the MROSD can take:

1. Treat all high and moderate sediment priority sites... Detailed treatment prescriptions for each of these sites are outlined... Proposed road/trail repairs should be generally consistent with Best Management Practices (BMPs) outlined by current Forest Practice Rules, International Mountain Biking Association... and Handbook for Forest and Ranch Roads... Treatments will require the following:
 - a. Upgrade road drainage by installing larger and more frequent cross drains (e.g., rolling dips, nicks, water bars, etc). Specific problem reaches have been identified in the road inventory but most roads and trails would benefit from upgrades.
 - b. Apply base rock to roads and trails within 50 to 75 feet of streams to harden their surface; and abandon and/or reroute problem trail segments that are too steep or located too close to a watercourse. These locations have been specifically identified in the inventory.
 - c. Modify trail design to prevent mountain bicyclists from aggressive braking. Aggressive braking of mountain bicyclists is a notable factor in the break down of drainage structures. To achieve this goal the trails will need to be designed to have tighter turns with more frequent reverse...
 - d. Replace rusted and damaged culverts at stream crossings. Upgrade culverts to pass a 100 year flood flow. Install rock fords or bridges at unculverted stream crossings.
2. To the extent possible, limit vehicle access to avoid driving patrol and maintenance vehicles on former skid trails, and avoid driving on other roads and trails during winter months. Some steep gradient multi use trails may also need to be closed to mountain bicycles during the wet winter months.
3. Increase post-storm and annual maintenance efforts to prevent new problems from emerging in response to storm events and heavy visitor use.

In addition to specific recommendations for treating areas, the Road and Trail Inventory also provides a section on maintenance recommendations “essential to protect the road and to minimize erosion and sedimentation... Roads and drainage structures will need to be inspected annually prior to the beginning of winter. Inspections should address culvert inlets and outlets on stream crossings and ditch relief culverts, road surface drainage such as water bars, out sloping and ditches, as well as road fills. In addition to annual, pre-winter drainage structure inspections, crews must inspect and perform emergency maintenance during and following winter storms. Often, nothing more than shovel work at problem spots will be required to solve most problems.”

6.3 Pilarcitos Creek

6.3.1 Regulatory Status

Pilarcitos Creek (below the Pilarcitos reservoir) is listed as threatened by sedimentation/siltation on the State Water Resources Control Board Monitoring List. A status of threatened impairment was identified because while there is evidence of sediment impairment, there is insufficient evidence that sediment sources are related to anthropogenic activities.

6.3.2 Anthropogenic Sources

The Pilarcitos Restoration Plan (PWAL 1996) notes erosion is accelerated when vegetation is disturbed on steep hill slopes and incision and bank erosion occur throughout the watershed. The plan reports “bank erosion rates were accelerated from disturbance to vegetation, channel incision, or straightening of meanders. Structural approaches to bank stabilization fix the channel in one location and do not allow the natural process of meander migration to occur. The disruption of this process causes other adjustments that accelerate bank erosion upstream of the hard structure.”

In the headwaters of Pilarcitos Creek upstream of Highway 92 landslides are common. One of these landslides “in Albert Canyon may be the result of concentrated runoff from an unpaved road above the slide or artificial steepening of the slope related to the Highway 92 road cut” (PWAL, et al. 1996).

6.3.3 Data Gaps

Potential information needs in the Pilarcitos Creek watershed include the following:

- Aquatic habitat assessment and limiting factors analysis to identify the location and type of critical steelhead habitat and extent to which excess fine sediment is limiting production of anadromous fishes.
- Sediment source analysis to identify relative contributions of natural and anthropogenic sediment sources from landslide, channel and surface erosion that is occurring in the watershed.

6.3.4 Recommendations from Previous Studies

The Pilarcitos Restoration Plan (PWAL 1996) recommends the following projects in order of priority that “are most likely to significantly enhance fish habitat within the existing funding.

- Modification of the fish barrier at the Historic Bridge crossing in the State Park in Mills Creek;
- Modifications of a small barrier about 2 miles upstream of the Historic Bridge on Mills Creek;
- Construction of off-channel irrigation ponds near Higgins Canyon Road on Arroyo Leon;

- Modification of the fish barrier at the private culver crossing on Arroyo Leon upstream of the confluence with Mills Creek.
- Modification of the lower, middle, and upper fish barrier on Apanplio Creek;
- Funding educational resources for landowners;
- Conducting a pilot project of vortex weir installation in Pilarcitos Creek (downstream of Highway 92) and monitoring to determine the extent of pool development and gravel entrapment;
- Installing staff gages on ponds and bridges. Determine stage-discharge relationships and purchase temperature recorders to allow volunteers to monitor pond levels, stream flow, and water temperatures;
- Removing Eucalyptus at sites where the value of the removed wood will pay for removal and revegetation of the sites.”

Bank erosion and non-native species are also concerns throughout the entire watershed but were not given high priority due to the cost of addressing these watershed-wide problems.

6.4 San Pedro Creek

6.4.1 Regulatory Status

The Regional Board reviewed existing information on San Pedro Creek regarding potential impairment due to sediment, but concluded that there is insufficient evidence to warrant listing (SFRWQCB 2001b).

6.4.2 Anthropogenic Sources

Bed and bank erosion are a significant source of sediment in the North and South Forks of San Pedro Creek and their tributaries. Urban development has likely resulted in hydromodification, including increased instream erosion, but further analysis is needed regarding the role of anthropogenic activities. Davis (2004) states “One hypothesis is an ongoing response of the fluvial system to a history of accelerated deposition from the farming and ranching periods. Other fluvial adjustments related to purposeful alteration of drainage systems: evidence can be seen in both forks of a history of ditching of smaller tributaries, commonly done by farmers to drain wetlands and increase areas for field cultivation... The ongoing instability of the stream system can be seen in the increased significance of streamside landslides in these tributaries as compared to downstream main-stem reaches. It may be some time before the effects, including elevated sediment yield, to decrease in significance for these two forks.”

Sims (2004) indicates that sediment production from hill slopes in the San Pedro Creek watershed was most significant in the Middle and Sanchez subwatersheds “largely because of an impervious road constructed along the slide-prone hill slopes of the Sanchez subwatershed... triggered many slides and subsequent gullying while past farming practices along the lower hill slopes generated the same response in the Middle subwatershed. Past farming and possibly grazing practices have also compacted hill slopes in Crespi, North, Middle, and unnamed five subwatersheds. As urban development expanded, new roads that triggered many gullies and subsequent surface erosion were created in Sanchez and Shamrock subwatersheds. Drainage terraces constructed in the North subwatershed to protect residential development from unstable

hill slopes provide direct delivery of sediment from surface erosion and in some cases triggered landslides.”

SPCWC (2002) noted that off-road vehicle use in the 1960's and 1970's caused significant sediment inputs and debris flow production from areas with very thin sandy soils along the middle slopes of Montara Mountain. Pearce et al. (2004) indicate that bank and terrace erosion in the South Fork occurs because the channel had been relocated in the past.

6.4.3 Data Gaps

The data collected from previous studies included an aquatic habitat assessment, geomorphic assessment of the main stem channel and an analysis of natural versus anthropogenic sediment sources that occur on hill slopes and tributaries. As a result, no data gaps were identified.

6.4.4 Recommendations from Previous Studies

San Pedro Creek Geomorphic Analysis

A geomorphic analysis of San Pedro Creek performed by Collins et al. (2001) contains an extensive list of recommendations, including:

- Where possible, reduce accelerated rates of bank erosion and bed incision to reduce property loss and input of fine sediment to the channel, but minimize the use of unnatural instream structures for stabilization. Instead, consider reshaping the channel cross section to a stable form, use biotechnical stabilization methods, or use boulder veins to direct flow away from eroding banks.
- Increase the width of the riparian buffer along the channel, especially where vegetation is presently missing. Promote the replacement of non-native invasive vegetation with native species to improve riparian habitat.
- The longitudinal profile of the main stem channel should be surveyed to establish future monitoring stations that will show changes in bed elevation and correctly define the terrace heights and stream gradient. The profile should be detailed enough to define pool/riffle morphology.
- The rest of the San Pedro Creek watershed should be assessed for sources of sediment resulting from land use and instream activities upstream of the main stem. The quality of water and habitat in main stem and tributary reaches should be assessed. It is important that the remaining high quality fragments be maintained into the future.

San Pedro Creek Watershed Sediment Source Analysis

A sediment source analysis in the San Pedro Creek Watershed conducted by Davis (2004) recommends treatments ranging from “easy to accomplish to much more difficult tasks. In San Pedro Valley County Park, the extensive network of trails that contribute minor amounts of sediment to the creek can be maintained via water-bar installations to limit the potential for connectivity to stream channels. Gullies created on private land will be more difficult, especially those resulting from the former Coastside Boulevard passing

through upslope areas of Sanchez subwatershed. Treatment may require replacement of paved remnants with alternative materials, and it will likely be difficult or expensive to maintain this road in such a way as to prevent gully erosion; on the other hand, the need is urgent both in terms of sediment yield and the future usability of the road, which is likely to be washed out in a short period of time.”

The study also discusses policy issues related to protecting streams in the San Pedro Creek watershed including the following:

“Many of the erosion problems identified in this report can be attributed to policy failures from the past, though most predate the incorporation of the City of Pacifica in 1957 and the activity of other land management agencies such as County Parks in the 1970s. We cannot reverse the effect of most of these decisions, but we can seek ways to avoid exacerbating the problem in the future. San Pedro Creek exists as a Steelhead stream due to the fact that a major part of its watershed – 2/3 – has remained undeveloped. The tenuous nature of its health suggests that this may be a highly critical proportion. Any significant increase in impervious surfaces and other characteristics leading to habitat degradation may cause this system to fail. Thus we must consider our actions very carefully.

While extensive development projects are no longer pursued in this watershed, we must carefully consider the effects of even “infill” projects. Many infill projects will have little to no effect, though any increase in impervious runoff adds to the problem of stream bank erosion, which not only degrades habitat but endangers homes. For the same reason, development of any sites on the floodplain or terraces close to the creek should also be avoided. Development of moderate to steep sites should especially be avoided, as these either feed runoff too rapidly to storm drains and the creek, or create substantial landslide hazards in down-slope areas to which they drain.”

6.5 San Mateo Creek

6.5.1 Regulatory Status

San Mateo Creek is not listed for impairment by sedimentation on the Clean Water Act 303(d) list or potential impairment on the State Water Resources Control Board Monitoring List.

6.5.2 Anthropogenic Sources

Studies addressing sediment and erosion processes in the San Mateo Creek watershed were not found during this assessment. However, since this watershed is highly urbanized, there is the potential that development and associated anthropogenic activities have led to increased erosion and sediment supply. In particular, stream erosion (i.e., channel incision and bank erosion) potentially occurs due to hydromodification. Stream erosion can also be caused by human impacts directly in the stream found in some urban areas, including development in the riparian zone, straightening and hardening of the channel, and the construction of instream structures, bridges and culverts. In addition, sediment production and erosion impacts in this watershed are potentially associated with the Crystal Springs reservoir dam.

6.5.3 Data Gaps

There is the potential for elevated sediment supply associated with urban development and anthropogenic activities in the San Mateo Creek watershed. However, studies addressing sediment in this watershed were not found during this assessment. In addition, although San Mateo Creek potentially supports anadromous fishes, further data would be needed to determine whether sediment potentially impairs fish spawning and rearing habitat.

6.5.4 Recommendations from Previous Studies

Studies addressing sediment in the San Mateo Creek watershed were not found during this assessment.

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