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Peninsula Open Space Trust

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UNIT CONVERSION TABLE

Measurement	English Unit	Multiplication	Metric Unit
Area	ft^2	0.0929	m^2
	yd^2	0.8361	m^2
	mi^2	2.59	km^2
Length	ft	0.3048	m
	in	25.4	mm
	mi	1.6093	km
	yd	0.9144	m
Volume	ft^3	0.0283	m^3
	gal	3.785	L
	fl oz	29.574	mL
	yd^3	0.7646	m^3
	acreft	1233.49	m^3
Discharge	cfs	0.0283	cms
Mass	oz	28.35	g
	lb	0.4536	kg
	kip	0.4536	tonne
	short ton	907.2	kg
	short ton	0.9072	tonne
Density	lb/yd^3	0.5933	kg/m^3
	lb/ft^3	16.0185	kg/m^3
Pressure	psi	6894.8	Pa
	ksi	6.8948	Mpa
	lbf/ft^2	47.88	Pa
Velocity	ft/s	0.3048	m/s
	mph	0.447	m/s
	mph	1.6093	km/h
Temperature	F	(F-32)/1.8	C

PREFACE

The need for highway maintenance in coastal California watersheds is complicated by active continental-margin geology, seasonally intense rainfall, and changing land uses that modify the local hydrology. These conditions typically accelerate landsliding, hillslope erosion, and stream channel erosion that damage or threaten the transportation infrastructure.

Repairing and maintaining roadways located along stream corridors, and the State and Federal review and permitting required for such projects are typically done as needed on a site-by-site basis. This approach has proven to be unsatisfactory for three reasons:

1) Repairs introduce engineered structures or channel modifications that can alter the course or function of the stream and create new instabilities that may threaten the roadway or adjacent property downstream,

2) This approach is expensive because once a roadside failure occurs or is about to occur, the emergency situation often precludes the design and use of more permanent or ecologically sustainable effective solutions.

3) The modifications can degrade the riparian and aquatic habitat because they are often made without adequate knowledge as to how they will affect the overall physical and biological function of the stream.

Developing projects that satisfy both transportation and environmental goals requires changing the present "site-by-site approach" to a "corridor-based approach" in which engineered structures and modifications are designed at the outset with the intent of meeting the needs of the transportation engineer (or traveling public) while protecting the environment of the stream corridor. Adopting this approach will lead to more effective, economical, and ecologically sustainable designs. However, doing this requires:

1) Documenting and understanding the biological conditions and physical processes operating within the stream corridor,

2) Identifying specific sites within the corridor where the roadway is potentially threatened and characterizing the processes at that location, and

3) Making this information available in a manner usable to transportation engineers and resource managers in time to develop ecologically sensitive designs before emergencies arise.

The Highway 84 corridor along San Gregorio and La Honda Creeks between Highway 1 and Highway 35 in San Mateo County exemplifies the maintenance challenge described above. The *Draft Strategic Plan for Restoration of Endangered Coho Salmon South of San Francisco Bay (1998)* identified San Gregorio Creek as one of nine creeks in which recovery of Coho salmon is a priority. The Plan listed potential and suspected factors limiting recovery of salmonids, but because the San Gregorio Watershed did not receive the level of analysis given to other priority watersheds, the status of salmonids in this watershed and the factors limiting their success are not

well documented. Therefore, the Strategic Plan provided little specifically applicable guidance for those working in the watershed.

By providing corridor-based information on physical and biological conditions in the La Honda watershed, this project integrates the needs of transportation engineers with those of natural resource managers, balancing the goal of preserving or enhancing the riparian and aquatic ecosystem along a transportation corridor with that of protecting the welfare and safety of the traveling public. Throughout the report, preliminary information and preliminary conclusions are offered, pending further data collection and analyses in the San Gregorio Creek Watershed / Highway 84 corridor.

Orientation and Structure of this report

This report, which documents the habitat and physical setting of La Honda Creek, is written for two differing audiences: civil engineers and aquatic ecologists. After reading this work, engineers will better understand the effects that modifications to the transportation corridor along a stream bank can have on the riparian and aquatic habitat, and ecologists will gain insight into the engineering challenges of maintaining safe and ecologically sustainable roadways.

The report is made up of nine sections; each describes key aspects of the social, physical, and biological environment relevant to Caltrans and DFG, whose collective objective is to manage the La Honda Creek Highway 84 transportation corridor.

Section 1 provides background information and describes the role of the local community in making this study both possible and successful.

Section 2 describes the physical and biological aspects of the watershed as well as key historical land use patterns. La Honda Creek is located in a geologically active and climatically variable section of California's coastline. Rich, deep soils and abundant moisture support native stands of redwood and historically abundant salmonid populations. These factors have made the watershed an attractive place to live and to exploit local natural resources, which in turn, have profoundly affected the watershed.

Section 3 describes the geology, soils and surficial processes. La Honda Creek crosses a number of geological formations that have been intermingled by faulting. Active tectonics and climate have sculpted the landscape, and caused widespread landsliding which has shaped the watershed. The stability of Highway 84 along La Honda Creek varies greatly depending on the underlying geological materials and processes occurring on adjacent slopes and within the stream channel.

Section 4 examines hydrological features and processes that affect transportation engineering and habitat for key endangered species, particularly the salmonids. Although the U.S. Geological Survey maintains a discharge gauge on San Gregorio Creek near Highway 1, Section 4 provides the only hydrologic information for La Honda Creek. These temperature and discharge data are useful for preliminary habitat and transportation modeling and design. Additional site specific information, alternative detailed analytical techniques, and considerations of other resource agency design objectives may be required for final designs.

Section 5 is the first baseline study of benthic macroinvertebrates in the watershed. These insects are sensitive indicators of watershed disturbances, and indicate the feeding resources available for salmonid rearing.

Section 6 examines the potential of La Honda Creek as habitat for anadromous salmonids (coho salmon and steelhead trout). This section assesses the current condition of salmonid habitat in La Honda Creek, focusing on the physical and fluvial processes that supply the habitat requirements.

Section 7 reviews engineering considerations based on the synthesis of new and existing data. This section locates and describes the most critical areas where Highway 84 threatens the stream channel or where processes in the channel threaten the stability of the road or its structures (Plates 1A-C).

Section 8 describes recommendations for future studies, based upon data gaps identified during the course of this study.

Section 9 lists references pertinent to this study.

The appendices compile the raw data collected during the project.

EXECUTIVE SUMMARY

This project is intended to assist the California Departments of Transportation (Caltrans) and Fish and Game (DFG) in designing repairs and maintenance along the La Honda Creek-Highway 84 corridor that are the most effective, economical, and environmentally sustainable possible. To do so, this project documents the geological, hydrological, and ecological conditions of La Honda Creek that most affect the stability of Highway 84, or that would be most impacted by transportation engineering activities along the corridor, particularly as related to native salmonids.

La Honda Creek is located in the Santa Cruz Mountains of San Mateo County, California. It is a third order tributary to San Gregorio Creek which flows into the Pacific Ocean approximately 19 km (11.8 mi) to the west of the confluence. The watershed is well vegetated in redwoods and deciduous trees, shrubs, and grass reflecting the moist and cool climate. Land use has changed dramatically during the last 100 years, from logging to grazing to rural residential. This project examined the lower 5 km (3.1 mi) of La Honda Creek from the confluence with San Gregorio Creek upstream to Weeks Creek. Highway 84 closely follows the creek throughout this area.

The following outlines the findings and conclusions of this report:

Geology

The slopes underlying the watershed are primarily sedimentary and volcanic units that readily weather into clay-rich soils that are particularly prone to erosion and landsliding. The area is also seismically active; earthquakes cause significant shaking and exacerbate landsliding, especially during the wet season. Landsliding is the primary source for sediment into La Honda Creek.

Fluvial Geomorphology

The La Honda Creek channel is mainly controlled by bedrock but is alluvial in certain areas, especially immediately downstream from active landslides where sediment input is abundant. Water flows year around, but during the late summer, low flow in certain parts of the channel may limit fish passage, as well as production and downstream transport of food resources.

Downcutting is occurring throughout most of the channel, eroding the banks and scouring the bed. Early and on-going modifications made to accommodate Highway 84 and to protect private property have significantly modified the lower reaches of the channel, causing accelerated bank erosion and the release of sediment into the channel. Many of these modifications are being scoured and are unstable or failing.

Hydrology

The 25-year, average annual precipitation in the La Honda Creek watershed is 794 mm (31.3 in), varying from 356 to 1205 mm (14.0-47.4 in). The amount of slope runoff depends on antecedent soil moisture and rainfall intensity, duration and total on the scale of days. Slope instability is also dependant upon antecedent rainfall, but the intensity and duration of hourly rainfall is more important than daily rainfall. The intensity and duration of precipitation events is capable of exceeding the infiltration capacity of the thick soils, causing the hillslopes to become unstable. Runoff into La Honda Creek causes the stream to rise rapidly, and floods are common.

Water velocity during high flow events was measured at Delay's bridge. Measurements covering stages of 0.24 – 0.76 m (0.78 to 2.50 ft) were recorded, corresponding to discharges of 1.86 – 33.0 m^3/s (20 to 355 cfs). Estimated discharge corresponding to a 2.2 m (9-ft) stage is 251 m^3/s (2,700 cfs). These flows could significantly change the channel cross-sectional shape, undermine streamside structures, and destabilize the banks. The recurrence intervals of discharges of 280 and 370 m^3/s (3,000 and 4,000 cfs) are estimated to be 50 and 100 years, respectively.

Water temperature, recorded in a pool near Delay's bridge for the period December 2002 to October 2003, varied between 4 and 20° C (40 - 68° F). Water and air temperature appear to correlate well, allowing seven-day water temperature predictions to be made in the absence of water temperature monitoring.

Three locations between Weeks Creek and the confluence with San Gregorio Creek were sampled to assess water turbidity. The data indicate that turbidity could reach levels > 10,000 NTU in large floods, potentially having detrimental effects on salmonid populations. However, the data show that for similar stages, turbidity decreased downstream from Weeks Creek; there is no evidence that runoff from Highway 84 appreciably increases the turbidity of La Honda Creek.

The main source of sediment supplied to the creek is from landsliding. High flows winnow out the finer fraction, and transport boulders and cobbles downstream as discrete pulses. The present distribution of the larger bars and terraces is due to the periodic reworking of these sediment pulses.

Benthic Macroinvertebrates

Changes in the number and diversity of benthic macroinvertebrates (BMIs), reflect the relative "health" of a watershed. The response of BMIs to watershed conditions will have an effect up the food chain. A reduced BMI population will affect the summer growth of rearing salmonids, because BMIs are the primary food source. A total of 65 taxa were identified in two sampling events. Although La Honda Creek is relatively pristine compared to other more urbanized or intensely agriculturalized Bay Area watersheds, the number and diversity of BMIs show signs of degradation due to a long history of human occupation. Based upon BMI data, the watershed is presently in "marginal" health.

Based upon the diversity of taxa in the samples, it appears that the benthic community is being somewhat affected by fine sediment deposition in the substrate of the creek. However, the watershed does not appear to be affected by significant organic enrichment. When compared to the Russian River Index of Biotic Index (IBI), the BMI population is classified as fair to poor. These conclusions are drawn from only two sets of samples, making trend detection and statistical analysis difficult and much less robust. Additional data should be collected in La Honda Creek to gain a better understanding of the status of the benthic community.

Salmonid Habitat

The salmonid population in La Honda Creek has been decreasing, but the precise cause is uncertain. Fieldwork completed during the course of this study was focused upon constraining the factors that may be limiting the successful recovery of salmonids, especially those that could be related to maintenance or repair of Highway 84.

Although many aspects of the habitat provided in La Honda Creek appear adequate for supporting salmonids, substrate embeddedness is the likely limiting factor for spawning success. The spawning gravels are notably embedded with fine sediment, possibly making it difficult for salmonids to excavate redds and reducing the free flow of water across the eggs, thus limiting their survival. Although the settling of fine sediment from the water column (turbidity) is the most common cause of embeddedness, in this case it appears to be due more to the in-situ breakdown of gravels within the streambed during wetting and drying that occurs during fluctuations in flow. In addition to the embeddedness, fluctuating flows and decreases in water quality may also be limiting the recovery of salmonids in La Honda Creek.

Locally, runoff and construction on Highway 84 have been suspected of releasing fine, suspended sediment to the water. This material has been linked to declines in salmonid populations, elsewhere. However, neither the condition of the channel substrate nor the pilot turbidity study done herein show an appreciable relationship between Highway 84 and increased fine sediment contamination as compared to the "natural" streamside processes operating within the watershed.

Other critical habitat factors in La Honda Creek appear to be satisfactory for the successful access, spawning, and rearing of salmonids including: 1) volume, seasonal distribution, and depth of flow (except for one area near Delay's bridge); 2) water temperature; 3) amount, distribution, and recruitment of large, woody debris (LWD); 4) type, complexity, depth and spacing of pools and refugia; 5) location, distribution, grainsize and size distribution of spawning gravels; 6) effective passage through the channel during all life stages.

Although measuring water quality was beyond the scope of this project, local degraded water conditions may negatively impact salmonid viability. Potential sources of contamination include household and commercial trash thrown into the creek, dumped liquids, septic, detergents, and possible hillslope runoff from cattle grazing.

Engineering Considerations

Downcutting is occurring throughout most of the channel, eroding the banks and scouring the bed. Early and on-going modifications made to accommodate Highway 84 and to protect private property have significantly modified the lower reaches of the channel, causing accelerated bank erosion. Many of these modifications are being scoured and are unstable or failing.

Drainage from Highway 84 contributes fine sediment to La Honda Creek. However, substrate conditions, a pilot turbidity study, and estimated current velocities indicate that fine sediment does not accumulate on the channel bottom in a way that would significantly impact salmonids.

Along the study reach, there are six areas in which the relationship between La Honda Creek and Highway 84 is critical due to structural stability or impact to the habitat. These areas, referred to herein as "pressure points" are mapped, and the materials and processes operating there are described in detail. Accelerated bank erosion is occurring at all of the pressure points, in places causing the riprap armor to fail. To determine and monitor the erosion rate, the bank was surveyed and reference pins were installed in the bank and riprap. Because slope failures are a common problem along the roadway, in-situ shear strength was measured to locate areas of weak soil.