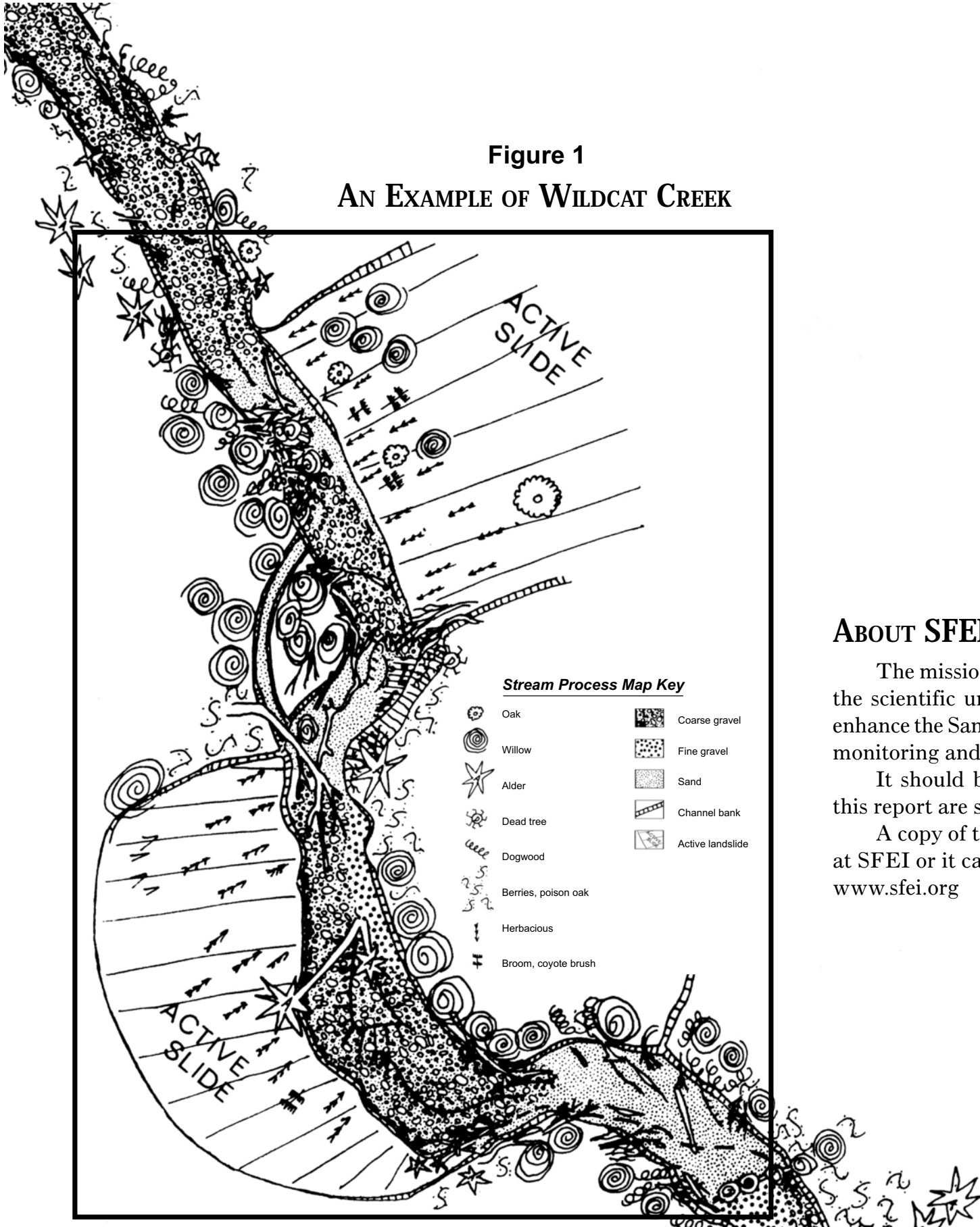


WILDCAT CREEK WATERSHED



A Scientific Study of Physical Processes and Land Use Effects

June 2001



ABOUT SFEI

The mission of SFEI is to foster development of the scientific understanding needed to protect and enhance the San Francisco Estuary through research, monitoring and communication.

It should be acknowledged that all aspects of this report are scientific and not political.

A copy of this report is available as a CD ROM at SFEI or it can be viewed on the SFEI website at www.sfei.org

Table 1

WILDCAT CREEK FACT SHEET

Mainstem	Total
Length of mainstem channel (mi) from upstream extent of tidal influence to headwater	13.8
Drainage area to tidal influence (sq mi)	8.8
Drainage area to flood control project	8.7
Mainstem flow regime - Alluvial Plain	Intermittent
Flow regime - Canyon	Intermittent/perennial
Mean annual precipitation (in)	23
Average annual maximum temperature (F)	64.7
Average annual minimum temperature (F)	49.6
Highest point in watershed (<i>Volmer Peak</i>) (ft)	1,905
Impoundments in Canyon	Jewel Lake, Lake Anza
Sediment basins in Alluvial Plain and Canyon	Flood Control Project, Tilden Golf Course
USGS gage station # (Richmond)	11181400
Drainage area (sq mi)	8.7
Years of record	1965-1975
Elevation at gage (ft)	20.6
USGS gage station # (Vale Rd)	11181390
Drainage area (sq mi)	7.8
Years of record	1976-1997
Elevation at gage (ft)	65.6
Record high flow year	1982
Record high flow (cfs) (Vale gage)	2050
Record low flow year	1976
Record low flow (cfs) (Vale gage)	26
Bankfull discharge (1.5 recurrence interval) from combined records for Vale site (cfs)	300
Bankfull discharge from Regional Curves (cfs)**	380
Effective discharge for sediment basin at Flood Control Project (cfs)*	500
Mean annual discharge (2.3 recurrence interval) from combined records for Vale site (cfs)	530

* WES USACE 1999

** Leopold 2000

Table of Contents

Preamble	1	Fluvial and Geomorphic Processes	28	Volume of Streamside Erosion	57
Executive Summary	2	Some Basic Watershed Concepts	28	Average Size of Bed Material	58
Wildcat Study Approach	5	Surface Erosion	28	Average Size of Bed Material by Reach	59
Regional Setting	6	Mass Wasting	29	Size and Abundance of Pools by Reach	60
Tide and Sea Level	7	Interactions of Streams and Landslides	30	Causes, Volumes and Depths of Pools	61
Wind	8	Geomorphic Importance of Vegetation	30	Distribution and Type of	
Rain	9	Hydrography	31	Large Woody Debris	63
Local Setting	10	Hydrology	31	How Wood Enters Channels	64
Watershed Topography	12	Geology	34	Flood Control Channel	66
Sections, Segments, and Reaches	14	Landslides	38	Tidal Baylands	67
Land Use History	16	Erosion That Could Not be Measured	41	Plan View Changes of the Mainstem	68
Land Use History 1750-1800:		Local Short-term Channel Channel Changes	41	Channel Aggradation and Degradation	69
Native Landscape	18	Hillslopes and Tributaries of the Lower Canyon Segment ..	42	Mainstem Channel Condition Summaries	72
Land Use History 1800-1850:		Example Subwatersheds	44	Long-Term Sediment Supply	74
Ranchero Landscape	20	The Mainstem Channel	46	Conceptual Models	76
Land Use History 1850-1900:		Mainstem Reservoirs, Upper and Middle		Expected Trends	79
Agricultural Landscape	22	Canyon Segments	49	Final Note	81
Land Use History 1900-1950:		Lower Canyon and Upper Alluvial Plain Segments and		Glossary	82
Urban Landscape	24	Reaches	51	References	83
Land Use History 1950–2000:		Bank and Terrace Condition by Reach	52	Map Sources	85
Modern Landscape	26	Left and Right Bank Conditions by Segment	53	Appendix A	86
		Types of Revetment by Reach	54	Jurisdictions Map	
		Condition of Revetment by Reach	55	Streamline Graph Key	
		Forms and Lengths of Streamside Erosion	56	Station and Reach Locations Map	
				Streamline Graphs	

List of Figures

Figure 1. An Example of Wildcat Creek	i	Figure 32. Watershed View 2000	27	Figure 57. Percent Length Right and Left Bank Conditions, Alluvial Plain Segment	53
Figure 2. Three Aspects of Watershed Health	1	Figure 33. Wildcat Hydrography Map	32	Figure 58. Percent Length Right and Left Bank Conditions, Lower Canyon Segment	53
Figure 3. Golden Gate Watershed	6	Figure 34. Flood Frequency from Peak Annual Flows	33	Figure 59a. Length of Different Revetment Types per Reach, Upper Alluvial Plain Segment	54
Figure 4. Bay Subregions	6	Figure 35. Wildcat Creek Geology Map	34	Figure 59b. Length of Different Revetment Types and Percent of Total Length of All Types for Entire Upper Alluvial Plain Segment.....	54
Figure 5. Daily Tide Pattern Relative to Bayland Surfaces.....	7	Figure 36. Geologic Cross-Section.....	34	Figure 60a. Length of Different Revetment Types per Reach, Lower Canyon Segment	54
Figure 6. Fort Point Sea Level Record	7	Figure 37. Wildcat Seismicity Map	36	Figure 60b. Length of Different Revetment Types and Percent of Total Length of All Types for Entire Lower Canyon Segment ...	54
Figure 7. Tidal Statistics for Wildcat Marsh	7	Figure 38. Wildcat Alluvial Plain Map.....	37	Figure 61. Revetment Conditions per Reach, Upper Alluvial Plain Segment.....	55
Figure 8. Long-term Rates of Sea Level Change	7	Figure 39. Wildcat Landslides Map	39	Figure 62. Revetment Conditions per Reach, Lower Canyon Segment.....	55
Figure 9. Calm Day Wind Pattern	8	Figure 40. Landslide Comparison Locator Map.....	40	Figure 63a. Length of Bank Erosion per Reach, Upper Alluvial Plain Segment.....	56
Figure 10. Diablo Wind Pattern	8	Figure 41. Landslide Comparisons.....	40	Figure 63b. Percent of Adjacent Bank and Terrace Erosion for Entire Upper Alluvial Plain Segment	56
Figure 11. Passing Winter Storm Wind Pattern	8	Figure 42. Tributary and Hillslope Sediment Source Decision Tree	43	Figure 64a. Length of Bank Erosion per Reach, Lower Canyon Segment.....	56
Figure 12. Spatial Pattern of Average Annual Rainfall in the Bay Area	9	Figure 43. Wildcat Subwatershed Map	44	Figure 64b. Percent of Canyon Slope, Landslide, Terrace and Adjacent Bank Erosion for Entire Lower Canyon Segment	56
Figure 13. Historical Precipitation Record based on Tree-Ring Data	9	Figure 44. Subwatershed Slope Classes	44	Figure 65a. Bank Erosion Volume per Reach, Upper Alluvial Plain Segment.....	57
Figure 14. Long-term Record of Droughts for the American River Watershed	9	Figure 45. Percent Increase in Subwatershed Drainage Density	45	Figure 65b. Bank Erosion Volume per Foot of Channel for Entire Upper Alluvial Plain Segment	57
Figure 15. Local Precipitation Record	9	Figure 46. Percent of Field and Map Measured Sediment from Different Sources in Grassland Subwatersheds	45	Figure 66a. Bank Erosion Volume per Reach, Lower Canyon Segment.....	57
Figure 16. Wildcat Watershed Map	11	Figure 47. Long-term Sediment Yield from Subwatersheds, ~1830-1999	45	Figure 66b. Bank Erosion Volume per Foot of Channel for Entire Lower Canyon Segment	57
Figure 17. Wildcat Alluvial Plain and Canyon Map	13	Figure 48. Cross-Section Locator Map	47	Figure 67. Geomorphic Map Detail of Wildcat Creek	58
Figure 18. Schematic of Sections, Segments, and Reaches	14	Figure 49. Wildcat Cross-Sections	47	Figure 68a. Sediment D50 Size Classes and Bed Material for Different Reaches, Upper Alluvial Plain Segment	59
Figure 19. Longitudinal Profile of USGS 7.5’ Quadrangle	14	Figure 50. Reservoir Locator Map	48		
Figure 20. Wildcat Sections, Segments, and Reaches Map	15	Figure 51. Historical and Modern Reservoir Contours	48		
Figure 21. 1830 Diseño	17	Figure 52. Jewel Lake and Lake Anza Sedimentation	49		
Figure 22. Eventline	18	Figure 53. Wildcat Reaches Map	50		
Figure 23. Impacts Map pre-1800	18	Figure 54. Mainstem Sediment-source Decision Tree	51		
Figure 24. Watershed View Circa 1800	19	Figure 55a. Percent Length of Bank Condition per Reach, Upper Alluvial Plain Segment	52		
Figure 25. Impacts Map 1800-1850.....	20	Figure 55b. Total Percent Length of Bank Condition for Entire Upper Alluvial Plain Segment	52		
Figure 26. Watershed View Circa 1850	21	Figure 56a. Percent Length of Bank Condition per Reach, Lower Canyon Segment	52		
Figure 27. Impacts Map 1850-1900.....	22	Figure 56b. Total Percent Length of Different Bank Conditions for Entire Lower Canyon Segment	52		
Figure 28. Watershed View Circa 1900	23				
Figure 29. Impacts Map 1900-1950.....	24				
Figure 30. Watershed View 1950	25				
Figure 31. Impacts Map 1950-2000	26				

List of Tables

Figure 68b. Upper Alluvial Plain, Percent of Sediment D50 Size Classes and Bed Material 59

Figure 69a. Sediment D50 Size Classes and Bed Material for Different Reaches, Lower Canyon Segment 59

Figure 69b. Lower Canyon Segment, Percent of Sediment D50 Size Classes and Bed Material 59

Figure 70a. Number of Pools per Volume Class per Reach, Upper Alluvial Plain Segment 60

Figure 70b. Upper Alluvial Plain Segment, Number and Percent of Different Pool Volume Classes 60

Figure 71a. Number of Pools per Volume Class per Reach, Lower Canyon Segment 60

Figure 71b. Lower Canyon Segment, Number and Percent of Different Pool Volume Classes 60

Figure 72. Number of Pools per Volume Class and Their Associated Causes, Upper Alluvial Plain Segment 61

Figure 73. Number of Pools per Volume Class and Their Associated Causes, Lower Canyon Segment 61

Figure 74a. Number of LWD Types per Reach, Upper Alluvial Plain Segment 62

Figure 74b. Number and Percent of Different LWD Types, Upper Alluvial Plain Segment 62

Figure 75a. Number of LWD Types per Reach, Lower Canyon Segment 63

Figure 75b. Number and Percent of Different LWD Types, Lower Canyon Segment 63

Figure 76. Debris Jam Characteristics, Combined Upper Alluvial Plain and Lower Canyon Segments 63

Figure 77a. Number of LWD Types per Recruitment Process, Upper Alluvial Plain Segment 64

Figure 77b. Percent of Different LWD Recruitment Processes, Upper Alluvial Plain Segment 64

Figure 78a. Number of LWD Types per Recruitment Process, Lower Canyon Segment 65

Figure 78b. Percent of Different LWD Recruitment Processes, Lower Canyon Segment 65

Figure 79. Change in Large Woody Debris over Time 65

Figure 80. Flood Control Basin Locator Map 66

Figure 81. Tidal Marsh Locator Map 67

Figure 82. Detail of Wildcat Marsh 67

Figure 83. Lower Wildcat 1827-28 68

Figure 84. Lower Wildcat 1830 68

Figure 85. Lower Wildcat 1856 68

Figure 86. Lower Wildcat 1893 68

Figure 87. Lower Wildcat 1898 68

Figure 88. Longitudinal Profile of Tidal, Flood Control, and Upper Alluvial Plain Segments 69

Figure 89. Wildcat Thalweg Profile at Railroad Trestle 70

Figure 90. Thalweg Profile and Reaches for Lower Canyon Segment 71

Figure 91. Wildcat Thalweg Profile at Alvarado Park 71

Figure 92. Wildcat Thalweg Profile at 117 Site 71

Figure 93. Wildcat Thalweg Profile 0.3 mi Downstream of Jewel Lake 71

Figure 94. Wildcat Thalweg Profile at Jewel Lake 71

Figure 95. Bank Conditions from the Upstream Extent of Maximum Tides to Jewel Lake Dam 73

Figure 96. Percent Length of Segments and Fish Barrier Locations 73

Figure 97. Measured and Calculated Sediment Supply Rate for Each Segment 74

Figure 98. Measured Sediment Yield for each Segment 74

Figure 99. Sediment Yield for Selected California Watersheds .. 75

Figure 100. Percent of Measured Sediment from Different Processes, Flood Control Channel to Jewel Lake 75

Figure 101. Percent of Measured Sediment Caused by Land Use Processes, Flood Control Channel to Jewel Lake 75

Figure 102. Detail of Geologic Cross-Section 76

Figure 103. 1927 Bridge Crossing on Wildcat 78

Figure 104. 1898 Detail of Wildcat Marsh 78

Table 1. Wildcat Creek Fact Sheet i

Table 2. Area and Length of Wildcat Creek by Segment 14

Table 3. Hydrography Table 31

Table 4. Wildcat Creek Rainfall and Runoff Volumes by Storms 32

Table 5. Percent Area of Slides 38

Table 6. Percent of Total Length of Tributaries Measured in Lower Canyon Segment 42

Table 7. Calculated and Measured Rates of Sediment Supply from Hillslope and Tributary Sources, Lower Canyon Segment Applicable to the Last 167 Years 42

Table 8. Wildcat Creek Cross Sections 46

Table 9. Lake Anza History 48

Table 10. Jewel Lake History 49

Table 11. Long-Term Average Rates of Sedimentation 49

Table 12. Length of Wildcat Creek by Reach 50

Table 13. Calculated and Measured Rates of Sediment Supply from Mainstem Bed Incision and Adjacent Bank Sources Along the Alluvial Plain and Lower Canyon Segments, Applicable to the Last 167 Years 51

Table 14. Pool Depth Classes per Reach 61

Table 15. Records for Sediment Basin at Flood Control Channel 66

Table 16. Facts Table for Reaches 72

Table 17. Facts Table for Segments 73

Table 18. Army Corps of Engineers Estimate of Total Annual Load of Wildcat Creek 1989 – 1996 74

Table 19. Estimates of Sediment Supply and Annual Load to Flood Control Segment 76

Acknowledgments

A Report by the San Francisco Estuary Institute (SFEI)

We wish to thank the following people for their scientific advice and review for this project: William Dietrich, Ph.D, Department of Geology and Geophysics, University of California at Berkeley; Russ Graymer, Ph.D., United States Geological Survey, Menlo Park, California; David Jones, Ph.D., Department of Geology and Geophysics (Emeritus), University of California at Berkeley; Luna Leopold, Ph.D., Department of Geology and Geophysics (Emeritus), University of California at Berkeley; Robert Uhrhammer, Ph.D., Seismology Laboratory, University of California at Berkeley.

For volunteering their time and expertise as field assistants, we wish to thank Ed Bowman, Steve Cochrane, Leslie Ferguson, Bret Harvey, Dale Hopkins, Hal MacClean, Jill Marshall, Lisa Michaeli, Mike Rigney, and Martin Trso. We especially wish to thank Paul Amato for his generous assistance during long stretches of difficult work.

Our understanding of land use and human history would not be possible without the materials and assistance provided by many volunteers, including: Joan Connolly, Shelby Sampson and Kathleen Ripley at Richmond Museum; the extensive archeological and historical research of Robert Orlins, Peter Banks, and Randy Miliken; John Holson of Pacific Legacy; Brad Barter and Tony Norris of City of Richmond; Scott Christie, Beth Hanson, and Adele Ho of the City of San Pablo; Zenobia Barlow, Sashia Swenson, Laurette Rodgers, and Sandy Neuman of the Center for Ecoliteracy; Noah Booker, Paul Grundland, Diane Altaugh, Pete Alexander, Beth Stone, Jerry Kent, Tim Gordon, Gary Santos, Renee Crowley, and all those who met with us at the East Bay regional Park District; Barbara Erder of the Jepson Herbarium; Sunnie Price, Take Ellis, Alithia Murray, and Steve Cochrane of the Richmond High Creekkeepers; Canterbury Graphics in Berkeley; Sandy Figuers; the staff of the Bancroft Library; Robert Leidy of the United States Environmental Protection Agency; Malcolm Margolin of Heyday Books; David Rogers; Lisa Viani; Barbara Vincent; Robert Coates; and Stephanie Manning. We especially wish to thank our interns, Emily Cheng and Julie Ekstrom, who collected many historical materials, and John Creaser at the Earth Sciences and Map Library, University of California at Berkeley, for his encouragement, generosity, and knowledge of maps.

The field and office equipment that was loaned to this project by Alan LaPoint, and Luna Leopold is greatly appreciated.

SFEI thanks the East Bay Regional Park District for providing access to Wildcat Canyon and Tilden Regional Parks.

Contributing Authors

TEXT

Josh Collins:

Preamble; Executive Summary; Study Approach; Regional Setting; Local Setting; Final Note; Glossary

Laurel Collins:

Preamble; Executive Summary; Study Approach; Local Setting; Fluvial and Geomorphic Processes (all sections); Summary of Watershed Processes; Conceptual Models; Expected Trends; Final Note; Glossary

Robin Grossinger:

Land Use History

Lester McKee:

Glossary

Ann Riley (Waterways Restoration Institute)

Flood Control Channel

CARTOGRAPHY

Elise Brewster

Zoltan Der

Robin Grossinger

Donna Morton

Christina Wong

DESIGN ART

Elise Brewster

DATA MANAGEMENT

Laurel Collins

Jeremy Thomas

FIELD WORK

Laurel Collins

Donna Morton

Jeremy Thomas

GRAPHIC DESIGN

Patricia Chambers

Adrienne Yang

GEOGRAPHIC INFORMATION SYSTEM

Zoltan Der

Christina Wong

HISTORICAL MAP RESEARCH

Elise Brewster

Robin Grossinger

PHOTOGRAPHY (UNLESS OTHERWISE NOTED) AND LANDSLIDE AND CHANNEL NETWORK STEREO PHOTO ANALYSIS

Laurel Collins

SYSTEMS ADMINISTRATION AND COMPUTER PROGRAM

Scott Campbell

Todd Featherston

Eric Witner

TABLES AND GRAPHS

Laurel Collins

Donna Morton

Jeremy Thomas

Final edits were produced by Laurel Collins who is responsible for any errors or omissions.

Funding Sources

This report was created with funds from the Lucille and David Packard Foundation; the Contra Costa Clean Water Program, California; and the San Francisco Estuary Institute.