APPENDICES

Species Status of Las Virgenes Watershed

		FED	STATE	DFG	NATIVE PS
INVERTEBRATES					
Danaus plexippus	Monarch butterfly		SA		
Proceratium californicum	Valley oak ant	SC			
Euphydryas editha quino	Quino checkerspot butterfly	E			
Lycaena arota nubila	clouded tailed copper butterfly				
Neduba longipennis	Santa Monica shieldback katydid	SC			
Satyrium auretorum fumosum	Santa Monica Mtns. Hairstreak	SC			
Speveria callippe callippe	Callippe silverspot butterfly	E			
FISH					
Oncorhynchus mykiss	southern steelhead	E		SC	
VERTEBRATES					
Amphibians and Reptiles					
Anniella pulchra p.	Silvery legless lizard	SC		SC	
Bufo microscaphus californicus	Arroyo toad	E		SC	
Clemmys marmorata pallida	Southwestern pond turtle	SC		SC	
Cnemidophorus tigris multiscutatus	Coastal western whiptail	SC			
Coluber constructor mormon	Western yellow bellied racer	D			
Diadophis punctatus modesto	San Bernardino ringneck snake	SC			
Lampropeltis zonata pulchra	San Diego mountain kingsnake	SC		SC	
Leptotyphlops humilis	Western blind snake	D			
Lichanura trivirgata roseofusca	Coastal rosy boa	SC			
Masticophis flagellum piceus	Red coachwhip	D		SC	
Phrynosoma coronatum blainvillei	San Diego coast horned lizard	SC		SC	
Phrynosoma coronausm frontale	California coast horned lizard	SC		SC	
Rana aurora draytoni	California red-legged frog	T		SC	
Salvadora hexalepis virgultea	Coast western patch-nosed snake	SC		SC	
Thamnophis hammondii	Two striped garter snake	SC		SC	
Thamnophis sirtalis infernalis	California red sided garter snake	D			
Mammals					
Antrozous pallidus	Pallid bat			SC	
Bassariscus astutus	Ringtail		CP		
Eumops perotis californicus	California mastiff bat	SC		SC	
Euderma masulatum	spotted bat			SC	
Lepus californicus bennettii	San Diego Black-tailed Jackrabbit	SC		SC	
Felis concolor	Mountain lion	U			
Lepus californicus bennettii	San Diego Black-tailed Jackrabbit	SC		SC	
Macrotis californicus	California leaf-nosed bat	F2		SC	
Mustela frenata	Long-tailed weasel	SC		SC	
Myotis lucifugus occultus	Occult little brown bat	C2		SC	
Plecotus townsendi pallescens	Pale big-eared bat			SC	
Plecotus townsendii townsendii	Pacific western big-eared bat	C2		SC	
Taxidea taxus	Badger			SC	
Plants					
Astragalus brauntonii	Braunton's milk vetch	C1			1B
Berberis nevinii	Nevin's barberry	C1			1B
Chorizanthe parryi var. fernandina	San Fernando Valley spineflower	F1			
Dudley abramsii spp. parva	Conejo dudleya	SC			1B
Dudleya multicaulis	Many-stemmed dudleya	SC	R		1B
Eriogonum crocatum	Conejo buckwheat	SC	R		1B
Hemizonia minthornii	Santa Susana tarplant	E	E		1B
Pentachaeta lyonii	Lyon's pentachaeta	F1	CE		1B

Sources: Ahmanson Ranch EIR (1992), Malibu Creek Watershed Natural Resources Plan (NRCS, 1995), Survey at the RCD Restoration Site on Las Virgenes Creek (1995), and the National Diversity Database.

Table A–1. Listings and Status of Species Found in the Las Virgenes Creek Watershed.

Species Status of Las Virgenes Watershed

Species Status of Las Virgenes Watershed		FED	STATE	DFG	NATIVE PS
Birds					
Accipiter cooperi	Cooper's hawk			SC	
Accipiter straitus	Sharp shinned hawk			SC	
Agelaius tricolor	Tricolored blackbird	SC		SC	
Aimophila ruficeps canescens	Southern California rufous-crowned sparrow	SC		SC	
Amphispiza belli belli	Bell's sage sparrow	SC		SC	
Aquila chrysaetos	Golden eagle			SC	
Ardea herodias	Great blue heron		SA		
Asio flammeus	Short eared owl	SC (FWS)		SC	
Asio otus	Long eared owl			SC	
Athene cunicularia	Burrowing owl	SC		SC	
Buteo lineatus	Red shouldered hawk	B			
Buteo swainsoni	Swainson's hawk	C3	T		
Campylorhynchus brunneica pillus	Coastal cactus wren	F2		SC	
Circus cyaneus	Northern harrier	B			
Coccyzus americanus occidentalis	Western yellow-billed cuckoo	SC (FWS)	E		
Cypseloides niger	Black swift			SC	
Dendroica petechia brewsteri	Yellow warbler			SC	
Elanus laecurus	White-tailed Kite	SC (FWS)	SA	CP	
Elanus caerulea	Black shouldered kite		SA	CP	
Empidonax traillii extimus	Southwestern willow flycatcher	E			
Empidonax traillii	Willow flycatcher	E			
Eremophila alpestris actia	California horned lark	C2			
Falco columbarius	Merlin			SC	
Falco mexicanus	Prairie falcon			SC	
Falco peregrinus anatum	American peregrine falcon	E	E	P	
Icteria virens	Yellow-breasted chat			SC	
Ixobryehus exilis	Least bittern	SC		SC	
Lanius ludovicianus	Loggerhead shrike	SC		SC	
Melanerptes lewis	Lewis woodpecker			SC	
Nycticorax nycticorax	Black crowned night heron		SA		
Passerculus sandwichensis beldingi	Belding's savannah sparrow	SC	E		
Piranga flava	Hepatic tanager			SC	
Piranga rubra	Summer tanager			SC	
Polioptila califomica	California gnatcatcher	T		SC	
Polioptila melanura californica	Black-tailed gnatcatcher	F2		SC	
Progne subis	Purple martin			SC	
Pyrocephalus rubinus	Vermilion flycatcher			SC	
Riparia riparia	Bank swallow	CT	T		
Sialia mexicana	Western bluebird		T	SC	
Tyto alba	Barn owl			SC	
Vermivora virginiae	Virginia's warbler			SC	
Vireo belli pusillus	Least bell's vireo	E	E		

Legend

CE = California Endangered -- A California native species or subspecies which is in serious danger of becoming extinct (CDFG, 1988).

CT = California Threatened -- A California native species or subspecies although not presently threatened with extinction, is likely to become an endangered species in the near future (CDPG, 1988).

CP = California Fully Protected -- California native species or subspecies that may not be taken or possessed at any time (CDFG, 1988).

CR = California Rare -- Although not presently threatened with extinction, may become endangered if environment worsens

FE = Federally Endangered -- A species or subspecies which is in serious danger of becoming extinct.

FT = Federally Threatened -- A species or subspecies although not presently threatened by extinction, is likely to become an endangered species.

Fl = Federal Candidate Category 1 -- Sufficient biological information to support a proposal to list as threatened or endangered.

F2 = Federal Candidate Category 2 -- May warrant listing but sufficient biological information to support a proposal rule is lacking.

CSC = California Special Concern -- California native species or subspecies that are possibly declining or are vulnerable to extirpation and may be considered for listing or for special management and protection measures.

SA = Special Animal -- Native species or subspecies of special concern regardless of their legal protection status (CDFG, 1988).

SC = Special Concern -- Species or subspecies considered to be of special concern due to their existence at the limit or beyond their normal range.

B = National Audubon Society Blue List.

D, U = Uncommon -- A species or subspecies with a limited distribution and their vulnerability to threat is low at this time. These species are uncommon enough that their status should be monitored regularly.

S = Sensitive -- Native species or subspecies known or highly suspected to occur that are considered viable candidates for federal threatened or endangered classification (USFWS, 1986).

1B= California Native Plant Society— Priority List 1B; plant rare, threatened, or endangered in California and elsewhere; eligible for state listing.

PREDATOR—PREY RELATIONSHIPS

The table shows how the map was created based on relationships between wildlife and vegetation (Table B-1) and thenby identifying the vegetation cover containing the predator and its primary prey. In this case, bobcat and rabbit were paired to see which vegetation supported both species; the data was then graphically represented in the map showing bobcat territory in the vicinity of Las Virgenes waterhsed (Figure B-1).

	Predator				Prey	
Veg Description	lion	bobcat	coyote	badger	deer	rabbit
riparian (Sycamore-Oak-Willow)	1	1	1	0	1	1
coastal sage scrub	1	0	1	0	1	1
northern mixed chaparral	1	1	1	1	1	1
coastal sage scrub-chaparral transition	1	1	1	0	1	1
non-native grassland/herbaceous	0	0	1	0	1	1
valley oak	0	1	1	1	0	1
walnut	0	0	1	0	1	1
coast live oak	0	1	1	0	1	1
rock outcrops (barren inland)	1	1	1	0	0	0
chamise chaparral	1	1	1	1	1	1
red shank chaparral	1	1	1	0	1	1
non-native conifer/hardwood	0	0	1	0	0	1
coastal cactus scrub	0	0	1	0	0	1
coastal strand	0	0	1	0	0	0
water	1	1	1	1	1	1
coastal dune/bluff scrub	0	0	1	0	0	0
salt marsh	0	0	1	0	0	0
agriculture	0	0	1	0	0	0
development	0	0	1	0	0	0
Range (max) [acre]	38400	32000	256	1280	640	160

Table B-1. Predator–Prey Relationships Based on Vegetation Cover.

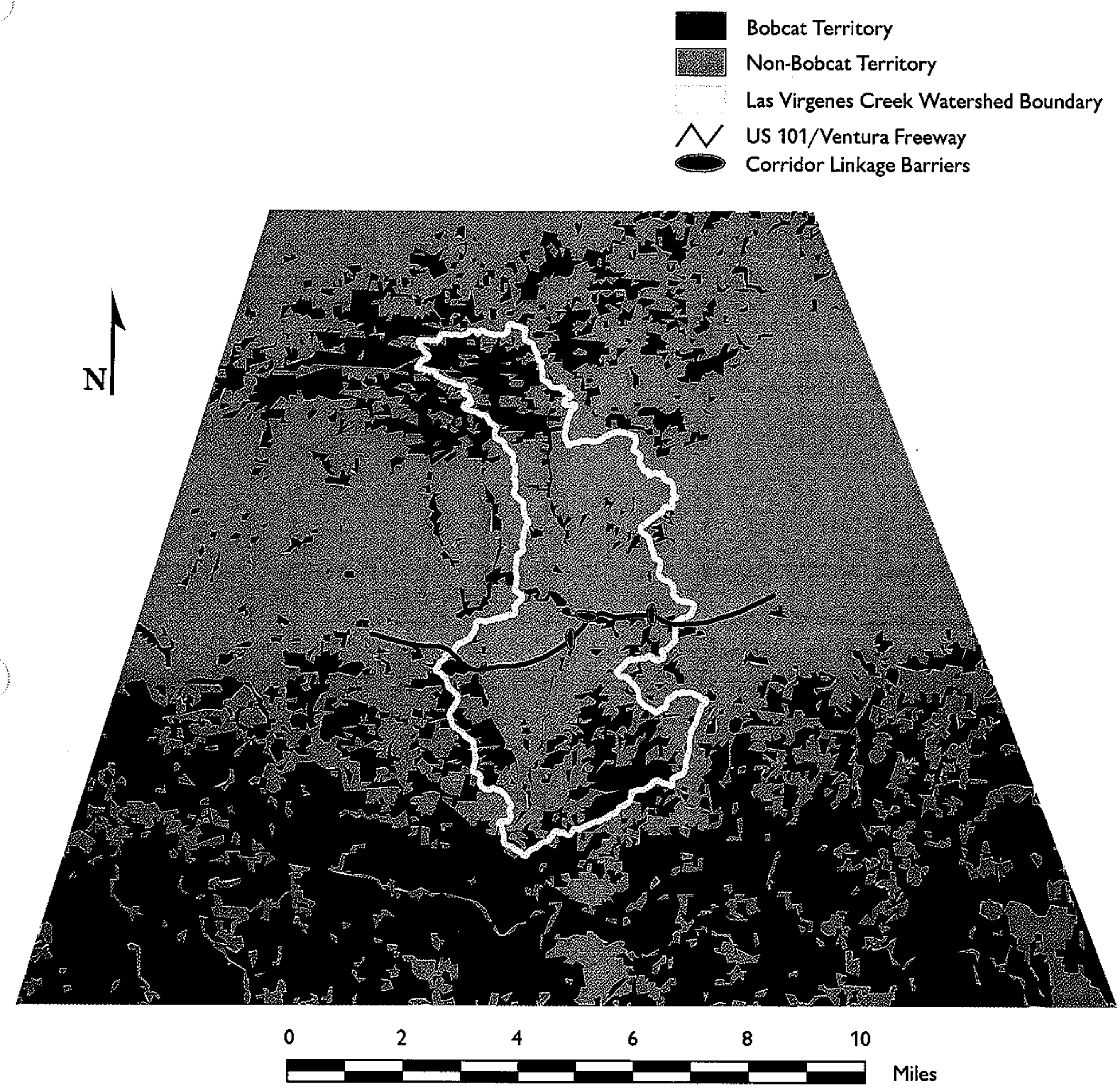

Figure B–1. Bobcat Territory Map in the Las Virgenes Vicinity.

DAILY NEWS / SUNDAY, MARCH 28, 1999 / NEWS — 3

Creek fans seek to build banks' value

Group tours site with eye for future preservation

By Douglas Haberman
Daily News Staff Writer

CALABASAS — Plastic bags and other trash clung to willow trees along the banks of Las Virgenes Creek on Saturday as a group took a tour. Mud-like mortar from a nearby housing construction site seeped into the water.

At the same time, lizards did their little push-ups here and there, a lone rabbit popped up and disappeared back into the brush, and ground squirrels darted across the trails at San Juan Bautista De Anza Park. Creek water burbled over rocks on its way to the Pacific Ocean.

The tour group — about 16 people — was part of a city-sponsored workshop to create a plan meant to return the creek to as natural a state as can be done then preserve it for future generations.

Participants spent the morning observing the creek environment, jotting down their perceptions and recommendations then sharing their thoughts with each other in a meeting room at the park.

"The goal should be to restore the creek as much as possible to a fully functioning riparian habitat," Paul Avery, an avid fly fisherman from Agoura Hills, told the group. The group as a whole seemed to share this sentiment.

Calabasas Mayor Pro Tem Dennis Washburn, Councilwoman Lesley Devine and Planning Commissioner Dave Brown were among the participants. Leading the endeavor was Bradley Owens, a graduate student in landscape architecture at California Polytechnic State University, Pomona, whose master's degree project involves writing the Las Virgenes Creek Watershed Management Plan for the city.

Washburn said he expects the document to come before the City Council in May or June. The council may well vote on aspects of the plan that can be acted on, he said, but it is mainly meant to be advisory.

Owens said his plan will focus on three goals: creek protection from storm water and sediment discharges, preserving linkages among undeveloped wildlife habitats, and providing community access for recreation and appreciation of nature.

"They want to create a town that attracts people because of the natural resources," Owens said of Calabasas officials.

One of those resources is Las Virgenes Creek, which starts in the Simi Hills and winds its way down through Calabasas, emptying into Malibu Creek, which itself spills into Santa Monica Bay.

Devine, the councilwoman, said one of the biggest threats to the creek is the proposed Ahmanson Ranch project, which calls for 3,050 homes and commercial development just across the Ventura County border to the north of Calabasas.

"You're going to put a city 40 percent the size of Calabasas on top of the watershed," she said.

Preserving a balance between development and nature is one of the city's toughest fights, workshop participants said.

As he hiked down from the park to the creek bank, Calabasas resident Dee Clayton Jr. momentarily ignored the trash strewn about and took in the wider view of the creek and surrounding green hillsides dotted with oaks.

"My hope is that 1,000 years from now, people will be able to stand here," he said, "and see the same thing."

AGENDA

Introduction

Collect Into Groups

Creek Walk

City Survey

Reconvene into Groups to Share Perceptions

- Categorize, Rank, etc.
- Share with entire workshop

Reconvene into Groups to Make Recommendations

- Generate Ideas, Categorize, Rank, etc.
- Share with entire workshop

Reconvene into Groups to Design

- Draw, list, define, etc.
- Share with entire workshop

Wrap Up

Workshop Walk Perceptions

Your Age:
Male/Female:

Map Location #1
Question: What would you enjoy doing here? Why?
Question: What was it like for you to reach this spot?

Map Location #2
Question: What would you enjoy doing here? Why?
Question: What do you want this place to be like in 100 years? What activities will be going on here?

Map Location #3
Question: What would you enjoy doing here? Why?
Question: Pretend that you're 5 years old; what would you learn here?

Map Location #4
Question: What would you enjoy doing here? Why?
Question: What three things here do you know nothing about?

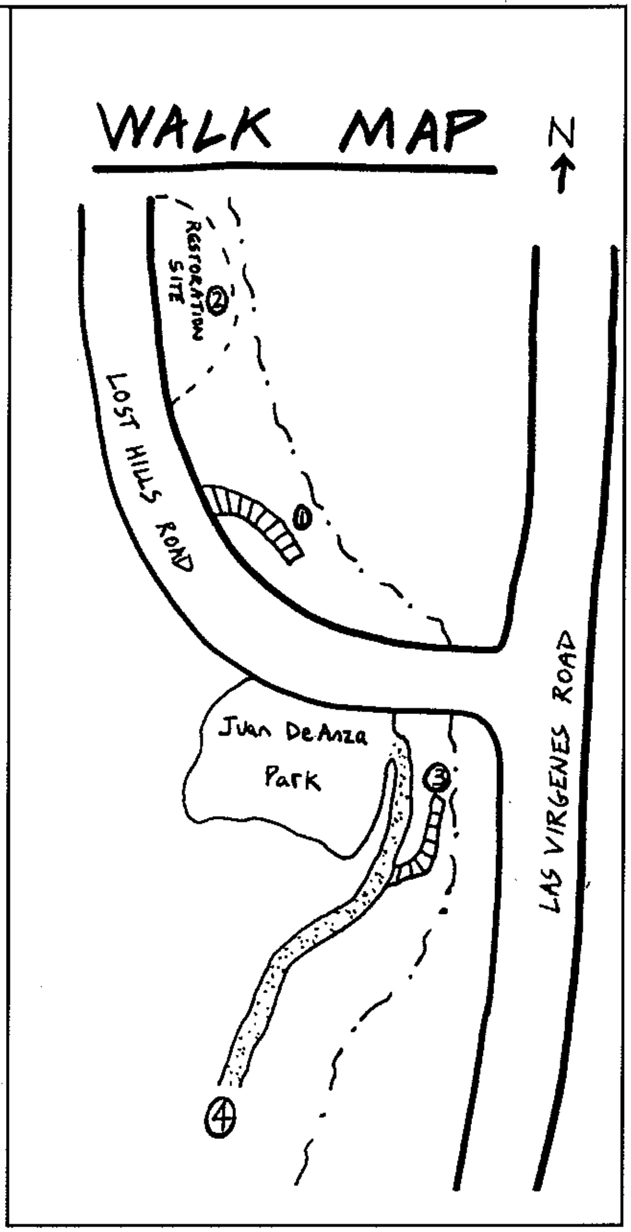

Figure C–1. Information Used to Conduct the Workshop.

Workshop and Survey

Workshop

A workshop was held at Juan Batista de Anza Park Community Center on March 27, 1999 in order to gain insight into the desires of local citizens for Las Virgenes Creek. This location is adjacent to the creek, so it was convenient to arrange a walk along the creek and ask questions first hand.

The workshop was designed using "Take Part" techniques (Halprin, 1972) and with guidance from Dr. Sharon Stine of Cal Poly, Pomona. The City of Calabasas sponsored the workshop, and Heather Merenda (the city Stormwater Program Manager) made many of the arrangements including publicizing the meeting. Also helping were Aerin Martin from the Landscape Architecture Graduate Program, and her husband Mike.

First off the agenda was shared, then it was off to the creek to walk, talk, and write, write, write. A questionnaire was distributed, along with a map of four locations, in order for the participants to gain insight in an orderly manner and facilitate later discussion (Figure C-1).

After the walk we reconvened in the Center so that people could work in groups to further elaborate on their perceptions and desires for the creek. Refreshments were served to help "facilitate" this process, as well.

Once these groups had a chance to formulate their ideas, each group had a member stand up and verbalize their vision for the creek at each location on the map; Aerin dutifully noted these expressions on a large yellow tablet. These were posted around the room so the groups could peruse them.

The final stage was to be a reconvening of the groups in order to take the information that had been share and attempt a design process in response to the notations. This would have been an interesting exercise, though perhaps another time, as time came to and end for the workshop.

Habitat preservation, walking/jogging, and education were the re-occurring themes voiced and written as priorities for Las Virgenes Creek by the workshop participants.

The survey— which was later distributed by the City of Calabasas to its citizens— was handed out to each participant in order to see how the responses would compare with the returns from the general population (Table C-1). The survey size, 13, is too small to draw any definite conclusions, but the results seem to show a somewhat different demographic between the two sets of respondents, and the workshop respondents more strongly favor habitat preservation and community activism; this would be expected of people who took the time to show up and participate in the workshop.

Survey

The survey was designed to gather popular sentiment and attitudes regarding Las Virgenes Creek. The survey was included in the city's quarterly newsletter sent out to each residence, and 344 people responded to the 15,000 survey's that were sent (Table C-1). The lack of responses may be the greatest piece of information to be derived, however, those that did respond showed a clear preference for the environmental stewardship that was a central objective of the city's formation.

The questions were designed in such a way that the survey could be statistically analyzed to draw conclusions between demographics (question #7) and responses to other question. For instance, it would be interesting to know which group was more likely to visit Las Virgenes Creek, or be in favor of habitat preservation. Unfortunately, the

Results from 344 Respondents

Summary

(1) WHAT WOULD YOU USE A GREENWAY FOR?
(A greenway is an open space bounded by urban development, optimally a place of refuge for people and wildlife.)
(PLEASE SHADE ALL THAT APPLY)

86.9%	Walking/jogging	11.3%	Weddings/celebrations
61.6%	Relaxation/meditation	8.4%	Other
48.8%	Picnicking	1.2%	No Answer
46.5%	Observation/education		

(2) WHAT DO YOU SEE AS THE GREATEST POTENTIAL USE OF LAS VIRGENES CREEK?
(PLEASE SHADE IN ONE)

32.6%	Habitat preservation/ Improvement
14.5%	Recreation
9.0%	Drainage
6.7%	Visual Amenity
0.6%	Education
2.0%	Other
34.6%	No Answer

(3) IS LAS VIRGENES CREEK A PLACE TO VISIT?

65.7%	Yes	10.8%	No Answer
23.5%	No		

(4) HOW MANY TIMES HAVE YOU VISITED LAS VIRGENES CREEK IN THE PAST YEAR?
(PLEASE SHADE IN ONE)

56.2%	0-1	7.8%	4-6
19.5%	2-3	4.4%	7-10
9.6%	11 or more	3.5%	No Answer

(5) HOW MUCH DO YOU FAVOR COMMUNITY ENVIRONMENTAL ENDEAVORS?
(PLEASE SHADE IN ONE, 1=LEAST, 5=MOST)

62.8%	5	3.8%	1
17.4%	4	2.6%	2
11.3%	3	2.0%	No Answer

(6) HOW IMPORTANT IS CLEAN AIR AND WATER IN YOUR DAILY LIFE?
(PLEASE SHADE IN ONE, 1=LEAST, 5=MOST)

84.9%	5	1.2%	2
10.5%	4	1.2%	3
2.0%	1	0.3%	No Answer

(7) WHAT IS YOUR HOUSEHOLD MAKEUP?
(PLEASE SHADE IN ONE) (OPTIONAL)

41.6%	Household with children
30.5%	Married, no children, age 41 and over
13.1%	Single
6.7%	Shared living
5.8%	Married, no children, age 40 and under
2.3%	No Answer

Results from 13Workshop Respondents

Question #	%
#1	
Walking/jogging	84.6
Observation/education	76.9
Relaxation/meditation	69.2
Picnicking	30.8
Other	23.1
Weddings/celebrations	15.4
#2	
Habitat preservation/improvement	61.5
Multiple answers	23.1
#3	
Yes	76.9
No	23.1
#4	
11 or more	30.8
0-1	30.8
2-3	23.1
4-6	15.4
#5	
5	92.3
4	7.7
#6	
5	84.6
4	7.7
#7	
Household with children	46.2
Single	23.1
Shared living	15.4
Married, no children (age 41 and over)	7.7
Married, no children (age 40 and under)	7.7

Table C–1. Survey Results Compared.

survey was analyzed without this level of detail (the surveys were analyzed by a third-party using machine readable techniques) and the responses are no longer available.

Summary

Overall, the workshop was a great opportunity to mix with locals sharing interest in the creek, as well as a chance to create ideas that could be "owned" by the community. The amphitheater design was one such outcome. The surveys are valuable to have the pulse of the community, as well as provide data that can be used as a basis for further survey comparisons.

References:

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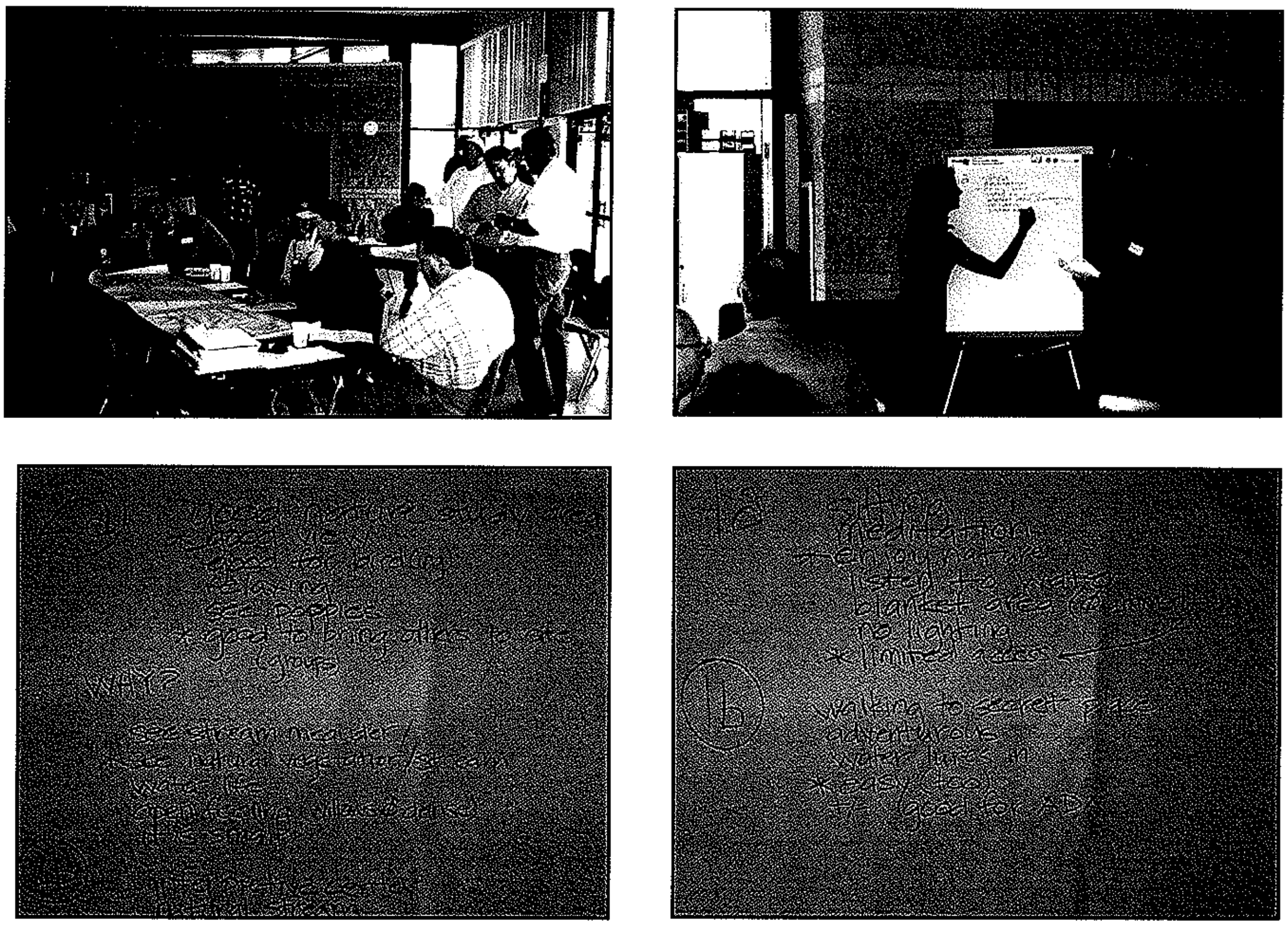
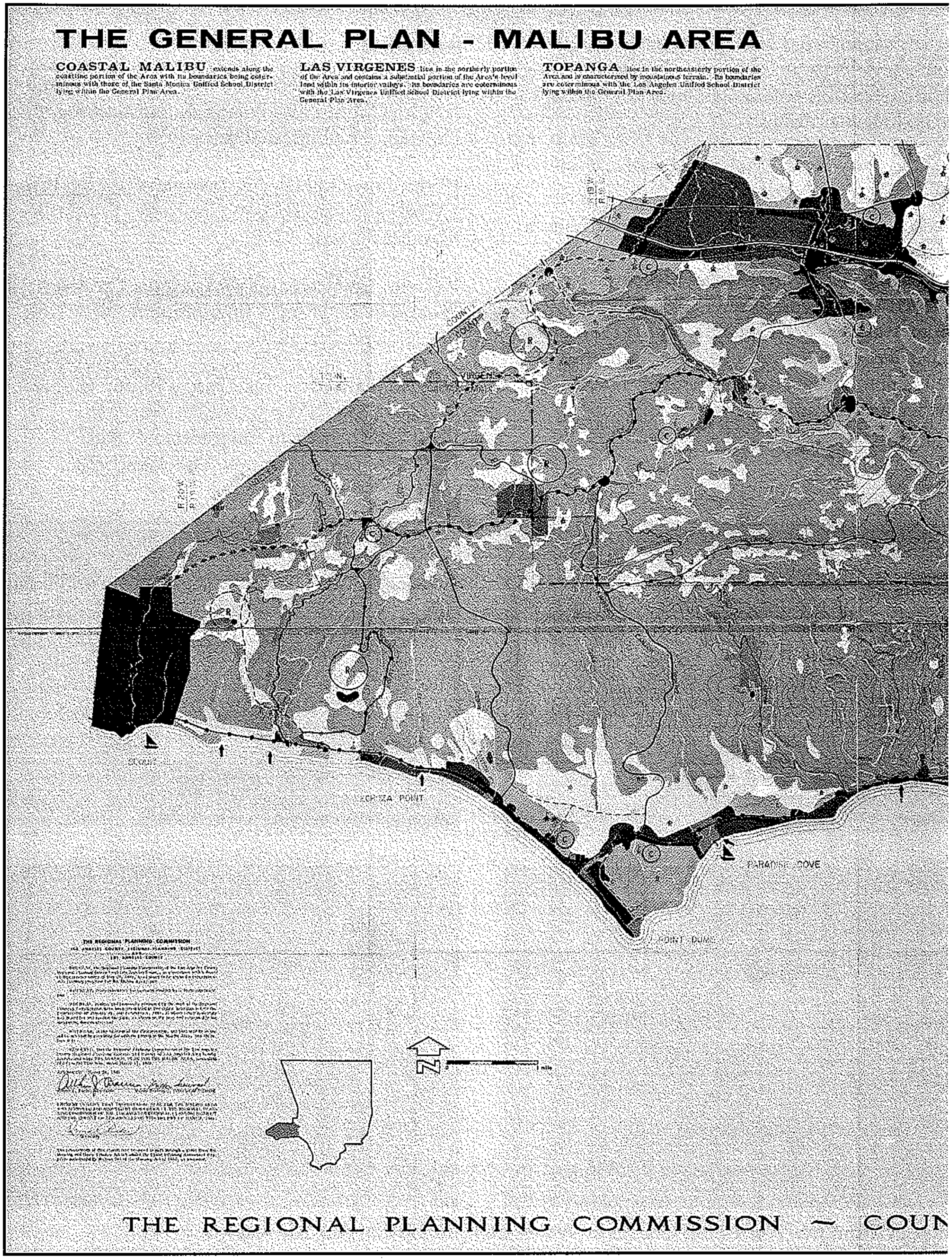
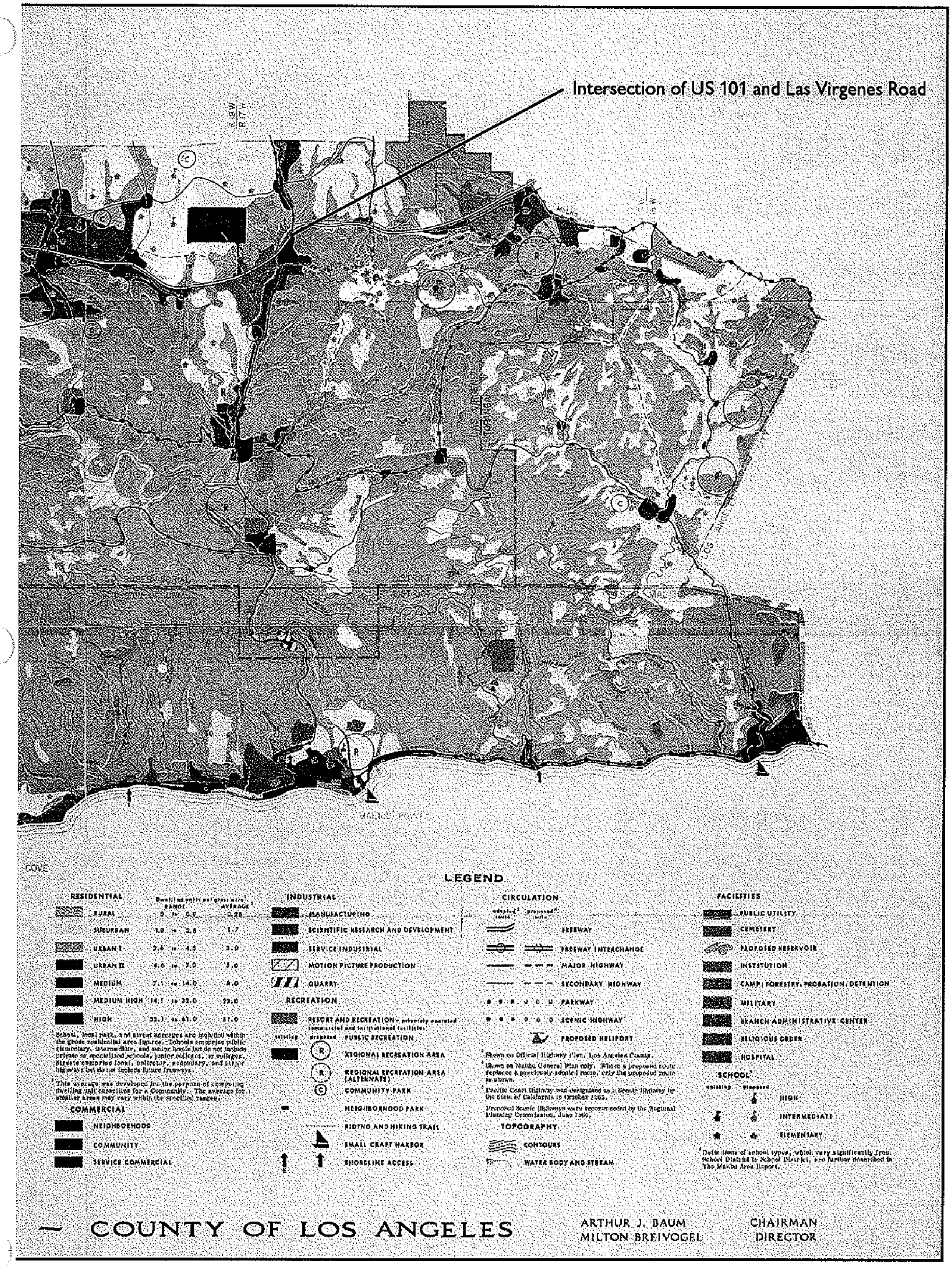


Images From the Workshop. Groups at Work, and Compilation of Their Ideas.


THE GENERAL PLAN - MALIBU AREA
COASTAL MALIBU extends along the coastline portion of the Area with its boundaries being coterminous with those of the Santa Monica Unified School District lying within the General Plan Area.
LAS VIRGENES lies in the northerly portion of the Area and contains a substantial portion of the Area's level land within its interior valleys. Its boundaries are coterminous with the Las Virgenes Unified School District lying within the General Plan Area.
TOPANGA lies in the northeasterly portion of the Area and is characterized by mountainous terrain. Its boundaries are coterminous with the Los Angeles Unified School District lying within the General Plan Area.
PARADISE COVE
THE REGIONAL PLANNING COMMISSION — COUN


Intersection of US 101 and Las Virgenes Road
COVE
LEGEND
RESIDENTIAL
RURAL
SUBURBAN
URBAN I
URBAN II
MEDIUM
MEDIUM HIGH
HIGH
COMMERCIAL
NEIGHBORHOOD
COMMUNITY
SERVICE COMMERCIAL
INDUSTRIAL
MANUFACTURING
SCIENTIFIC RESEARCH AND DEVELOPMENT
SERVICE INDUSTRIAL
MOTION PICTURE PRODUCTION
QUARRY
RECREATION
RESORT AND RECREATION
PUBLIC RECREATION
REGIONAL RECREATION AREA
REGIONAL RECREATION AREA (ALTERNATE)
COMMUNITY PARK
NEIGHBORHOOD PARK
RIDING AND HIKING TRAIL
SMALL CRAFT HARBOR
SHORELINE ACCESS
CIRCULATION
FREEWAY
FREEWAY INTERCHANGE
MAJOR HIGHWAY
SECONDARY HIGHWAY
PARKWAY
SCENIC HIGHWAY
PROPOSED HELIPORT
TOPOGRAPHY
CONTOURS
WATER BODY AND STREAM
FACILITIES
PUBLIC UTILITY
CEMETERY
PROPOSED RESERVOIR
INSTITUTION
CAMP: FORESTRY, PROBATION, DETENTION
MILITARY
BRANCH ADMINISTRATIVE CENTER
RELIGIOUS ORDER
HOSPITAL
SCHOOL
HIGH
INTERMEDIATE
ELEMENTARY
COUNTY OF LOS ANGELES
ARTHUR J. BAUM
CHAIRMAN
MILTON BREIVOGEL
DIRECTOR

Runoff Analysis for the Malibu Creek Watershed

- Introduction
- Background
- Model Inputs and Methods
- Assumptions, Limitations
- Results
- Conclusions
- References

Introduction

This analysis was undertaken in the spring, 1998, as part of a water quality monitoring program of Heal the Bay, funded by the California Coastal Conservancy, and created by the 606 Studio as a degree fulfillment masters project for the Graduate Program in Landscape Architecture at California Polytechnic State University, Pomona.

This document was originally prepared as an appendix to the Cal Poly Masters Project called "The Malibu Creek Watershed: A Framework for Monitoring, Enhancement and Action" completed in 1998.

Timothy Kovacs, Lance Nielsen, and Christopher Smemoe of EMRL have been instrumental in the development of this analysis, as well as Mark Abramson of Heal the Bay. Their willingness to help, and attention to detail is greatly appreciated.

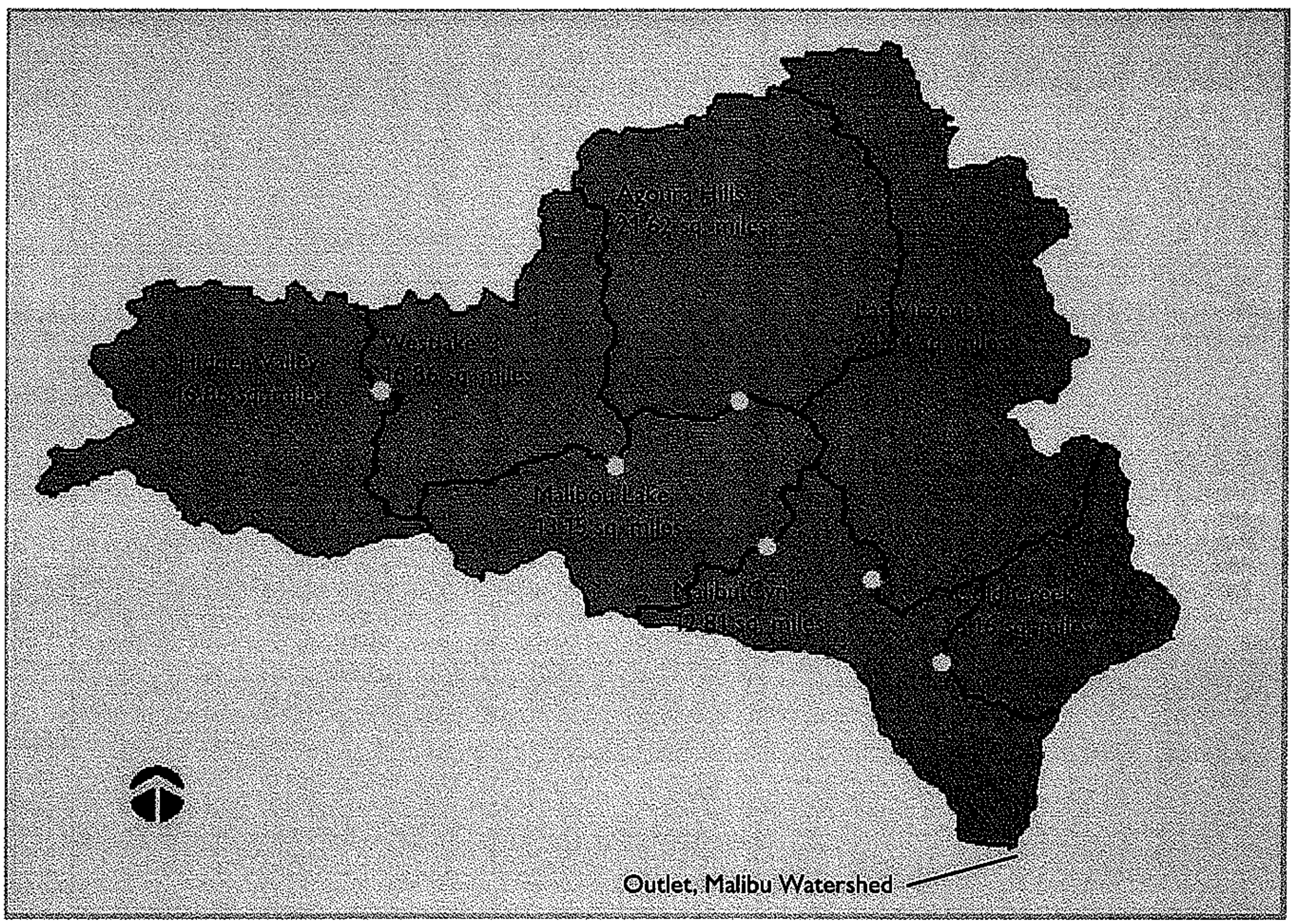


Figure 1. Malibu Creek Watershed Boundaries and Subsheds.

Primary Data	Source	Notes
Rainfall	NOAA	24hr, 2-5-10-25-50-100 year storms
Soils	Los Angeles County	Department of Public Works
Land Use	Los Angeles County	Department of Public Works
Watershed, Subshed Boundary's	Los Angeles County	Department of Public Works
Vegetation, Current Condition	Los Angeles County	Modified and updated by Cal Poly 606 Studio team
Vegetation, Pre-developed Condition	USFS	Survey by A.E. Wieslander
Elevation	Cal St. Northridge	Digitial Elevation Models (DEM)

Table 1. Model Data Sources.

Software used for modeling the watershed is called Watershed Modeling System (WMS) created by Environmental Modeling Research Laboratory (EMRL) of Brigham Young University. With this model, runoff was estimated utilizing data supplied by Los Angeles County and digital elevation data from DEM's. The watershed was modeled for two conditions, pre-development and current developed conditions. Results show approximately a 100% increase in runoff from the pre-developed condition to the current developed condition.

Background

The Malibu Creek watershed is located in Los Angeles and Ventura counties in southern California. The creek drains approximately 109 square miles and empties into Santa Monica Bay at Malibu Lagoon; elevations range from sea level to greater than 3,000 feet. The watershed has seven main subsheds (see Figure 1) and each has varying degrees of development ranging from rural low density to urban medium density. Also included in the watershed are many industrial, agricultural, and recreational developments.

Increasing the amount of impervious surfaces in a watershed can result in increased runoff and increased stream discharge; this can have a deleterious effect on habitats in the watershed and at the outflow, as well as on downstream development due to flooding and erosion.

A working model of runoff in the watershed is helpful in evaluating the impact of development on Santa Monica Bay, as well as for identifying suitable locations for future development. The runoff model is also used predictively when analyzing impact of potential development in the watershed.

The modeling tool chosen for this task is a modeling software called Watershed Modeling System (WMS) developed by Environmental Modeling Research Laboratory (EMRL) of Brigham Young University in Provo, Utah.

WMS provides a graphical interface for standard computer models such as HEC-1 and TR-20; HEC was developed by the United States Army Corps of Engineers, and TR-20 was developed by the Soil Conservation Service (SCS, now the National Resource Conservation Service or NRCS). In addition to the graphical interface, WMS provides many utilities for computing and converting data inputs required for the standard models. When using this software program, the model can be updated and refined as new information becomes available, thus adding to the effectiveness with which analyzing and predicting changes in the watershed can occur.

Storm Interval	Malibu Creek Outlet	Malibu Cyn	Cold Creek	Malibou Lake	Las Virgenes	Agoura Hills	Westlake	Hidden Valley
2yr/24hr	1,601	229	97	260	248	278	159	340
5yr/24hr	5,247	635	483	522	1,702	856	901	1,175
10yr/24hr	8,663	964	681	841	2,762	1,856	1,001	1,768
25yr/24hr	13,130	1,829	1,177	1,285	4,064	2,109	1,308	2,965
50yr/24hr	15,427	2,393	1,289	1,533	4,581	2,652	1,761	3,284
100yr/24hr	23,056	3,398	1,908	2,545	6,463	4,175	2,498	4,631

Table 2. Runoff Data of Malibu Creek Wastershed Outlet and Subsheds, Pre-Development Conditions [cfs].

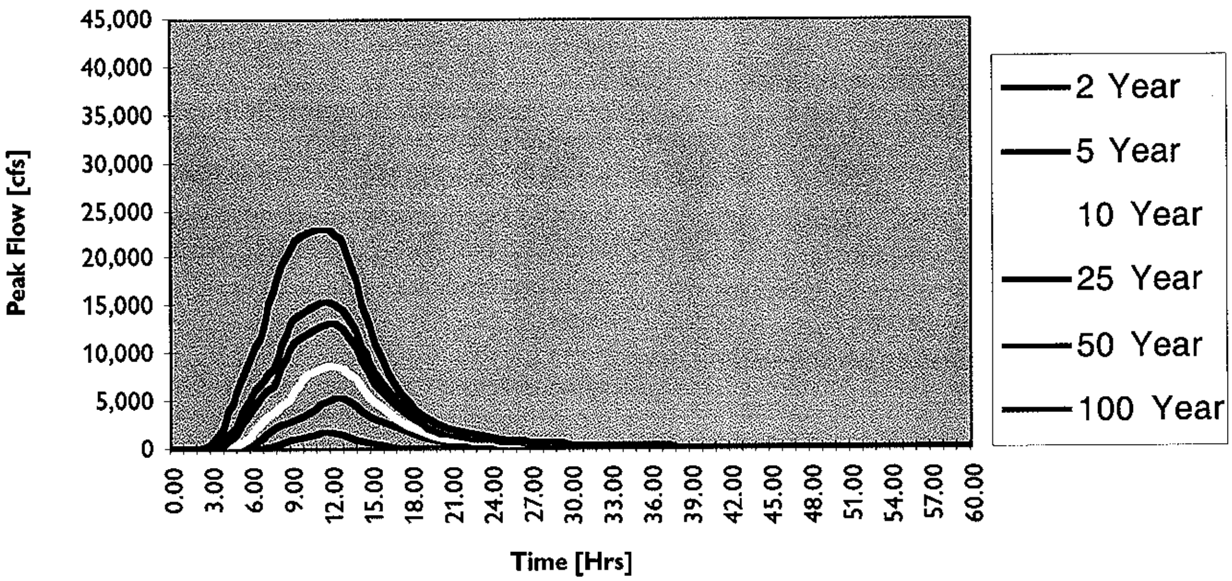


Figure 2. Hydrograph of Malibu Creek Watershed Outflow, Pre-Development Conditions [cfs].

Model Inputs and Methods

The WMS software requires that certain data sets are available depending on the model type and accuracy desired. A typical model would be developed based on Digital Elevation Models (DEM's) that are readily available on the World Wide Web. A DEM is spatial data that provides gridded elevation for a given land area and usually corresponds to a USGS quad map.

For this model, data was provided by LA County Dept. of Public Works; this included land use, soil types, vegetation, and watershed and subshed boundaries. This data was modified by the Cal Poly team to reflect the latest conditions using digital aerial photography and 3D modeling and input into the model in GIS shapefile format (except for the vegetation data, which is not used directly by the model; this will be discussed later in this document). In addition to the shapefiles,

Storm Interval	Malibu Creek Outlet	Malibu Canyon	Cold Creek	Malibou Lake	Las Virgenes	Agoura Hills	Westlake	Hidden Valley
2yr/24hr	3,766	573	270	702	693	921	1,307	939
5yr/24hr	13,255	1,365	1,074	1,265	3,646	2,311	3,162	2,668
10yr/24hr	19,821	1,950	1,432	1,888	5,454	4,305	3,907	3,738
25yr/24hr	26,616	3,342	2,249	2,682	7,469	4,784	3,982	5,708
50yr/24hr	30,161	3,735	2,433	3,109	8,762	5,751	4,814	6,189
100yr/24hr	42,090	5,596	3,356	4,699	10,948	8,221	6,559	8,146

Table 3. Runoff Data of Malibu Creek Wastershed Outlet and Subsheds, Existing Conditions, 1998 [cfs].

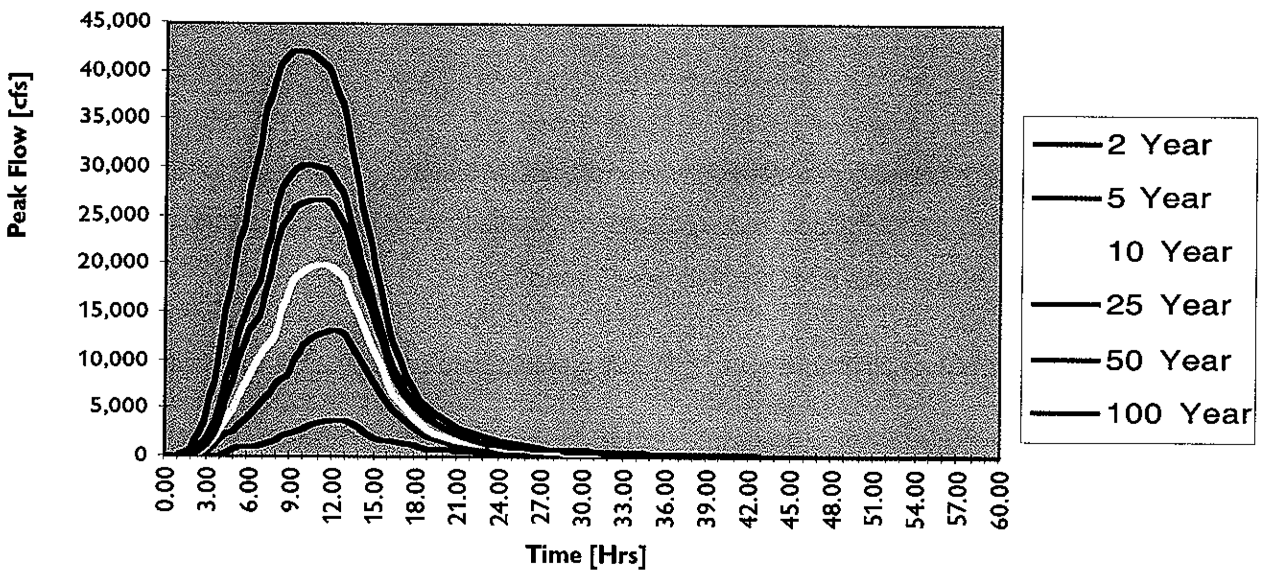


Figure 3. Hydrograph of Malibu Creek Watershed Outflow, Existing Conditions, 1998 [cfs].

DEM's were also utilized in the model for elevation dependent computations such as slope and subshed curve number averaging.

There are several dams within the Malibu watershed. Of these, four were used in the model due to their size and/or location within the watershed. Information about the dams is available on the World Wide Web (see references), and the dams used for this model (with the DWR number) are Lake Sherwood (765-000) in Hidden Valley, Westlake Lake (786-000) in Westlake, Lindero Lake (785-000) in Agoura Hills, and Malibou Lake (771-000) in the Malibou Lake subshed.

HEC-1 was chosen as the hydrograph method within WMS due to its ability to utilize the landuse and soils data, thus providing more precision than other models such as TR-20; within HEC-1, the SCS curve number method was chosen to compute losses (runoff) for the

Category	Malibu Canyon	Cold Creek	Malibou Lake	Las Virgenes	Agoura Hills	Westlake	Hidden Valley
Total Area [mi²]	12.81	8.16	13.15	24.34	21.62	12.99	16.86
Mapped Impervious (current) [mi²]	0.48	0.16	0.44	1.73	3.98	2.97	0.94
Percent Impervious (PreDev)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Percent Increased Impervious (Current)	3.71	2.01	3.38	7.11	18.39	22.89	5.56
PreDev Runoff (2yr/24hr) [cfs]	229	97	248	260	278	159	340
Current Dev. Runoff (2yr/24hr) [cfs]	573	270	693	702	921	1,307	939
Percent Increased Runoff	150	178	179	170	231	722	176

Table 4. Impervious Area Comparison, Pre-development vs. Current Development (1998).

Category	Malibu Canyon	Cold Creek	Malibou Lake	Las Virgenes	Agoura Hills	Westlake	Hidden Valley
Percent Increased Impervious (Current)	3.71	2.01	3.38	7.11	18.39	22.89	5.56
Percent Increased Runoff	150.22	178.35	179.44	170.00	231.29	722.01	176.18

Table 5. Percent Increase, Impervious Area and Increased Runoff.

same reason. The curve number method was developed by the SCS (now NRCS) as a way to index various surface runoff conditions based on land use conditions and soil characteristics.

A hydrograph is a representation of a volume surface flow in a given time period (cubic feet per second). For this model, a 24 hour storm was used as the time period. After the initial infiltration of rain into the topsoil, overland flow, or runoff, will occur and a peak will also occur at some point when the flows are greatest due to factors such as subshed geometry (area, slope), soil types, cover (land use, vegetation), and storm pattern. The hydrograph is a graphical representation of the collection of runoff at a common point (such as at a stream gage).

The model was run for intervals of 2-5-20-25-50-100 year storms based on rain data available from the National Oceanic Atmospheric Agency (NOAA) and applied to two conditions- current developed conditions, and pre-development conditions based on a vegetation survey from 1930-1934 by AE Wieslander of the United States Forestry Service. For pre-development land use conditions, the Wieslander survey was area averaged visually in order to input subshed curve numbers into the model

Table 1 lists the primary data sets used for the model and the source for the information. Additional source information is available in the reference section at the end of this document.

Assumptions, Limitations

This model is dependent on the available primary data; it is assumed that this was the best available at the time. It is known that the soil survey on which the GIS shapefile was based is an interim survey by the NRCS and is currently being updated for official release due in year 2001 (personal communication, Al Wasner, NRCS). In

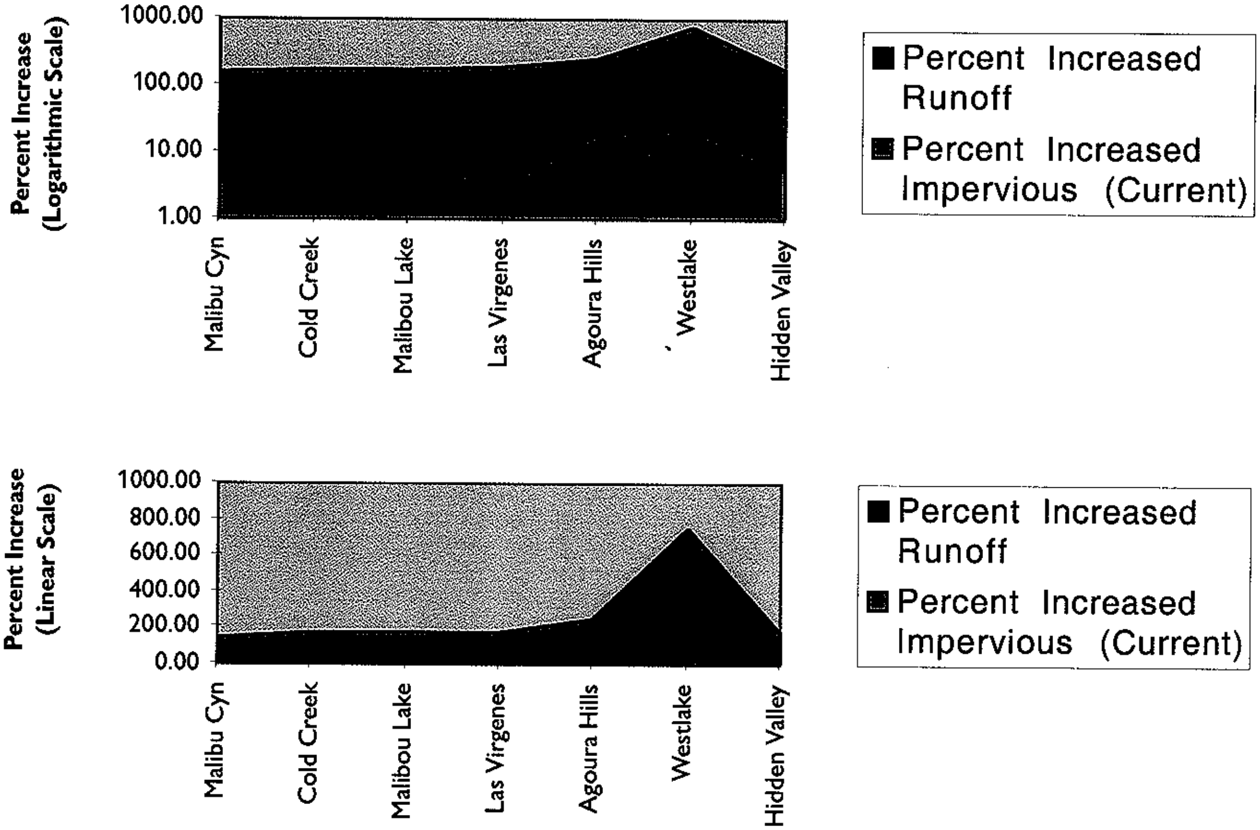


Figure 4. Relationship between Runoff and Impervious Surfaces in each Subshed.

addition, the land use categories supplied did not have direct correlation to the SCS curve number table so this was manually interpolated.

As stated previously, this model has many inputs so modification and refinement over a long period of time will return the best results. Additional information to add would be channel geometry, reservoir geometry and conditions, and more exact soils data. Hydrologic modeling is both art and science so the results are assumed to be estimates and will differ from actual conditions.

Results

The runoff analysis resulted in two primary results, pre-development and current developed conditions with modeled estimates of peak runoff (cubic feet per second) for each subshed and a total at the ocean outlet for each storm interval.

The data is presented in tabular form (see Tables 2 and 3) with a hydrograph representing the outlet (see Figures 2 and 3).

Conclusions

The modeling has shown that the watershed is yielding a large increase in runoff since pre-development conditions have changed into the current state of development. Increases greater than 100% are seen in every subshed, most approaching 200% for a two year storm, and the Westlake subshed showing an over 700% increase. Not only is the increase dramatic, but the relationship between the increase in mapped impervious surface and the runoff increase is interesting as well because of the logarithmic relationship borne out by the data.

Table 4 shows that the increase in impervious surface area in each subshed has dramatically increased the runoff into Malibu Creek (with the assumption being that the predeveloped condition had zero impervious surface). The clearest example is in the Westlake_subshed where a 22.89% increase in impervious surface has led to a 722.01% increase in runoff.

The graphs (See Figure 4)demonstrate that a small increase in impervious area within a watershed will result in large increases in runoff; two scales, logarithmic and linear, are shown in order to bring out the relationship visually. For instance, the linear graph (second graph) shows that the increase has a logarithmic relationship; small incremental increases of impervious surface leads to greater and greater amounts of runoff.

Although typical (and costly) structural devices such as dams and weirs can be used to control runoff, it is clear that this watershed will yield extreme amounts of runoff as impervious surfaces increase and, due to the erosive nature of the soils, will render these devices largely ineffective in relatively short periods of time as seen with Rindge Dam which has completely filled with sediment. It would seem that a more comprehensive management of the watershed resources will result in a cost effective and habitat conserving condition.

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Long Profile of Las Virgenes Creek

The long profile represents the elevational change along a stream course from the beginning to the end of the tributary. This is basic information used in river morphology in order to establish a baseline of information that can be used to determine changes that may take place, or vulnerability to change in hydrology.

This is a typical profile— steep in the headwaters, and flattening out towards its terminus.

Noteworthy in this profile, however, is the location of the concrete channel because it is located in a transfer point between the upper watershed and the lower watershed; this means that the energy normally received at this section will be transferred downstream during high flow events, and downcutting should be expected below the concrete section without measures taken to absorb this fluvial energy.

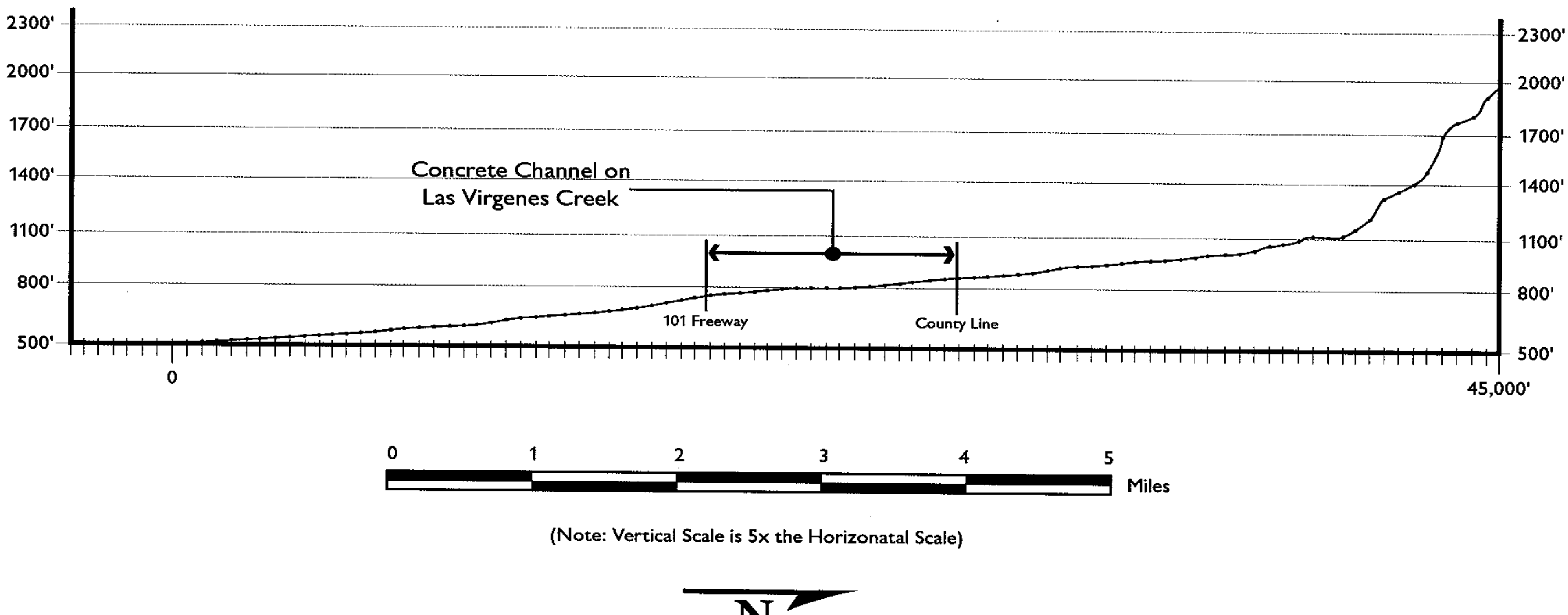

Figure F–1. Long Profile of Las Virgenes Creek.