Topanga Creek Watershed
Water Quality Study
Final Report

October 2003-2004

Submitted by:

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EXECUTIVE SUMMARY

Water quality concerns in Topanga Creek and the Santa Monica Bay initiated a cooperative effort between the Resource Conservation District of the Santa Monica Mountains and the Los Angeles County Department of Public Works, Watershed Planning Division to document conditions in the Topanga Creek Watershed. This study was funded by a grant from the NOAA Coastal Impact Assistance Program. Topanga Creek is the third largest watershed draining into the Bay, and one of the least altered. Despite a population of approximately 12,000 humans, and impacts from Topanga Canyon Blvd. (State Highway 27), Topanga Creek retains much of its biological diversity. Since 2001, reproducing populations of endangered steelhead trout and tidewater gobies have been monitored. Seven of nine potential amphibian species, including several species of special concern, are also well documented. Topanga Creek covers approximately 18 square miles, of which approximately 12% is developed. Over 75% of the watershed is in public ownership.

From October 2003 - 2004, ten sites were monitored monthly, with three of those sites monitored weekly. Sites were selected to capture representative areas of the upper watershed, as well as be accessible, and located on public lands. Several locations were monitored based on results of the Topanga Creek Water Quality Study Final Report 1999-2001 (Dagit, 2001), which indicated that these locations were experiencing higher than targeted levels of nutrients, and frequently exceeded water quality objective targets for total coliform, fecal coliform and *E. coli* bacterias.

Topanga Creek Water Quality Sampling Sites 2003-2004

Total and fecal coliform bacteria counts documented during this study are high overall, and exceeded standards in both in wet and dry conditions, as summarized in Table 1. Site 1 Topanga Lagoon had 71% total coliform, 43% fecal coliform and 71% enterococcus exceedences. Bacteria levels at Site 2. Bridge (located mid-way between the town of Topanga and Topanga Beach) never exceeded the standard for total coliform, and only exceeded that for fecal coliform (21%) and enterococcus (50%) during rain events.

In the upper watershed, Site 3. Entrado Rd., Site 5. Falls Dr., Site 6. Behind Abuelita's, Site 7. Backbone Trail and Site 8. Highvale Rd. experienced exceedences for all parameters. These sites had over 60% exceedence for enterococcus, between 14-29% exceedence for fecal coliform, and between 17-71% exceedence for total coliform bacteria. All sites exceeded all parameters during the first flush rain event in October 2004, and during much of the rainy season.

This suggests that the "hot spots" in the upper watershed are serious, but the creek is still able to cleanse itself, except during storms. The high levels of fecal and enterococcus bacterias in the upper watershed 'hot spots' appear to be mostly related to non-human inputs (based on the fact that enterovirus RNA was not commonly detected), although faulty septic systems, and daylighting greywater can not be ignored as potential additional sources.

High levels of total coliform and enterococcus bacteria were noted in both control locations, indicating that conditions in these locations fostered bacterial growth, especially when flow was restricted and the water ponded. The high level of fecal coliform and the detection of human enterovirus RNA during the first flush at Site 10. Zuniga Rd. is curious, as there is no possible source of human contamination at this location. The high concentrations of native pond turtles using this pool as a refugia may be the source of these bacteria. Both total and enterococcus bacteria are known to reproduce successfully in conditions like those found in the study sites, especially when the water is ponded, which may account for the high levels observed in sites with no possible human inputs.

The sources of bacterial contamination were identified as a major question in the previous study. Therefore, this study utilized both standard laboratory testing for total, fecal coliform bacteria and enterococcus, as well as subjecting 6 of 14 possible sample sets (including first flush) to Real Time Quantitative Reverse Transcriptase Polymerase Chain Reaction (PCR) tests. One test uses enterovirus RNA in a water sample as an indicator for the recent or current presence of active viruses. This test targets a whole family of enteroviruses, including poliovirus, Coxsackievirus and Echoviruses**.** These viruses are known to only infect humans and not other animals. Therefore presence/absence is an indication of pathogenicity and identifies if the source is human or non-human. Numerous sites (Site 1, Site 2, Site 5, Site 6, Site 7, Site 8) had positive results for enterovirus presence in December 2003, February 2004, April 2004 and/or August 2004. Only Site 2. Bridge and Site 6. Behind Abuelita's had detectable levels on more than one occasion. Given the small number of sampling events, and the fact that only a small sub-set of the population (infected people) shed the enteroviruses, it is cause for concern that they were present in at least one location in 4 of 6 months tested.

It was interesting to compare these data to the standard test results for enterococcus, which indicate that every site had at least one sample exceeding the saltwater enterococcus target of 104 MPN/ 100ml. The overall average of enterococcus bacteria at all sites, including the control sites, exceeded this limit. While no target is set for freshwater enterococcus levels, we used the target of 61MPN/100ml (CDHS). The presence of pathogenic enterovirus combined with high enterococcus levels are problematic and need additional study.

Additionally, we used PCR to look for Bacteriodes/ Prevotella bacteria thought to be present only in human feces (Boehm, Fuhrman, Mrse and Grant, 2003). Results were also reported as presence/absence. No evidence of human specific Bacteriodes was found in any samples. It may be that the test is not sufficiently sensitive to detect the levels of human bacteroides present.

Another major question of this study was to continue to explore the relationship between water quality at Topanga Beach and lagoon, with inputs from the upper watershed. As was the case in the previous study, it appears that bacterial contamination and higher phosphate levels documented in Topanga lagoon are a result of local impacts associated with the businesses, residences, and parking lots along Pacific Coast Highway immediately adjacent to the lagoon. Human enterovirus was only detected in December 2003. Total and fecal coliform levels, as well as enterococcus levels compared to those upstream at Site 2 Bridge indicate that local wildlife and anthropogenic sources are more dominant than those coming from upper watershed sources. This information is summarized in Table 21 (pg 39).

Efforts are currently underway to determine suitable levels of pollutants through development of Total Maximum Daily Loads (TMDL's) for the creeks draining into the Santa Monica Bay. Topanga Creek is listed for lead in the upper watershed, and for bacteria at Topanga Beach. Numerous planning efforts are addressing the requirements of on-site septic management and its relationship to overall water quality in the Bay. Topanga Creek residents rely entirely on septic systems, and there are no storm water conveyance systems per se, but in fact stormwater is "conveyed" and enters the creek in a variety of ways.

An additional recommendation from the previous study was to use more sensitive tests for nutrients. Thus we switched from the LaMotte test kits that are standard for citizen water quality monitoring programs to a more sensitive Smart2 Colorimeter test process. When samples were tested by both methods, the colorimeter consistently was more sensitive and provided a better way to document nutrient levels. Even with this increased sensitivity, only phosphates emerged as a nutrient of concern. Levels for both nitrate-N and ammonia-N were well below the targets and Basin Plan objectives.

Maintaining water quality that can support sensitive aquatic species as well as prevent human health impacts is a stated goal of the Topanga Creek Watershed Management Plan (2003). Providing residents of the watershed with practical, economically viable ways to ensure that their septic systems are functioning properly, that greywater is adequately filtered and properly discharged, and reduce impacts from domestic animal waste are essential. The most critical next step will be a targeted outreach to the residents with steps they can take to prevent further water quality degradation and improve water quality at locations where problems have been observed.

Table 2 summarizes the average levels of all parameters measured during the 2003-2004 Study. The Water Quality Objective/Target/Guidelines listed are found in either the Los Angeles Regional Water Quality Control Board Basin Plan, or in the EPA standards. In some cases (nitrogen-N), there is no legal Water Quality Objective at this time, but rather a target or guideline recommended by the State Water Resources Control Board for effluent discharge from Tapia Sewage Treatment Plan in Malibu Creek.

Enterococcus was selected for monitoring in this study, even though there is only a WQO for saltwater, because it is frequently used as an indicator bacteria (EPA 1986). The freshwater

Enterococcus target of 61 MPN/100 ml is a recommendation of the CA Department of Health Services Draft Guidelines for Freshwater Beaches.

Table 3 summarizes the problems identified at each sampling location and provides suggested Best Management Practices that could improve water quality.

Table 1. Summary of Exceedences Topanga Creek Watershed 2003-2004

Site	Total coliform <10,000MPN/100ml	Fecal coliform <400MPN/100ml	Enterococcus <104MPN/100ml salt <61 MPN/100ml fresh
Site 1. Topanga Lagoon	1/14 71%	6/14 43%	10/14 71%
Site 2. TC Blvd Bridge	0/14 0%	3/14 21%	7/14 50%
Site 3. Entrado Rd	5/14 36%	4/14 29%	12/14 86%
Site 4. Rodeo Grounds Rd	0/5 0%	0/5 0%	2/5 40%
Site 5. Falls Dr.	1/14 71%	2/14 14%	13/14 93%
Site 6. Behind Abuelita's	3/14 21%	4/14 29%	14/14 100%
Site 7. Backbone Tr.	2/7 29%	2/7 29%	5/7 71%
Site 8. Highvale Rd.	2/12 17%	2/12 17%	8/12 67%
Site 9. Paradise Rd. (control)	2/5 40%	1/5 20%	4/5 80%
Site 10. Zuniga Rd. (control)	1/14 71%	4/14 29%	7/14 50%

Table 2. Summary of Topanga Creek Water Quality Site Averages, 2003-2004

Site	Average Entro-coccus MPN/100ml	Average Total Coliform MPN/100ml	Average pH	Average Nitrogen-N ppm	Average Ammonia-N ppm	Average Phosphates ppm
Water Quality Guidelines	<104 MPN/100ml	<10,000 MPN/ 100ml	6.5-8.5	<3.5 ppm	2.5-10.5 ppm (pH adjusted)	<0.10 ppm
Site 1. Topanga Lagoon	**931** **931 -ff**	5,183 4,970-ff	7.6	0.14	0.11	**0.11**
Site 2. TC Blvd Bridge	**140** **180-ff**	712 1,304-ff	7.8	0.15	0.11	0.10
Site 3. Entrado Rd	**1,037** **125,378-ff**	**11,946** **125,379-ff**	7.4	0.66	0.17	**0.23**
Site 4. Rodeo Grounds Rd	**106** **No ff**	1,980 No ff	7.7	0.12	0.23	**0.11**
Site 5. Falls Dr.	**420** **936-ff**	1,198 2,326-ff	7.9	0.35	0.17	**0.30**
Site 6. Behind Abuelita's	**420** **3,962-ff**	6,413 **70,240-ff**	7.3	0.32	0.4	**0.21**
Site 7. Backbone Tr.	**1,035** **3,315-ff**	4,117 **232,100-ff**	7.8	0.36	0.26	**0.19**
Site 8. Highvale Rd.	**462** **20,429-ff**	**146,776** **267,878-ff**	7.2	0.26	0.16	**1.53**
Site 9. Paradise Rd. (control)	**543** **320,108-ff**	**13,585** **330,868-ff**	7.5	0.52	0.45	**0.12**
Site 10. Zuniga Rd. (control)	**209** **885-ff**	2,125 **23,401-ff**	7	0.10	0.12	0.05

Note that averages that exceed Water Quality Objectives (WQO) or guidelines are in bold type.
ff= First flush event samples collected 19 October 2004

Table 3. Summary of Suggested Best Management Practice Recommendations for Problem Sites in the Topanga Creek Watershed 2003-2004

Site	Pollutant Problem	Best Management Practice (BMP) Recommendation
Site 1. Topanga Lagoon	Total and Fecal coliform Bacteria, Enterococcus	-Install filters on culverts draining into the lagoon. -Monitor and maintain septic systems adjacent to the lagoon. -Restore historic lagoon to provide opportunity for natural cleansing processes -Investigate growth conditions for bacteria in sediments. -Continue water quality monitoring to document improvements following implementation of BMP's.
Site 1. Topanga Lagoon	phosphates	-Require adjacent restaurants, businesses and other facilities to use biodegradable soaps. -Require proper disposal of soapy water into a septic system or filtered greywater system.
Site 3. Entrado Rd.	Total and Fecal coliform Bacteria, Enterococcus	-Monitor and maintain septic and greywater systems at the private residences draining into this culvert. Investigate contribution of domestic animal wastes to bacteria counts.
Site 3. Entrado Rd.	phosphates	-Provide educational information to local residents about biodegradable soaps. -Require proper disposal of greywater.
Site 5. Falls Dr	Fecal coliform bacteria, Enterococcus	-Monitor and maintain septic and greywater systems at the private residences draining into this culvert.
Site 5. Falls Dr.	phosphates	-Provide educational information to local residents about biodegradable soaps. -Require proper disposal of greywater.
Site 6. Behind Abuelitas	Fecal coliform bacteria, Enterococcus	-Monitor and maintain septic and greywater systems at the businesses draining into this reach. -Provide additional toilet facilities to transients. -Remove transient encampments.
Site 6. Behind Abuelitas	phosphates	-Require adjacent restaurants, businesses and other facilities to use biodegradable soaps. -Require proper disposal of soapy water into a septic system or filtered greywater system
Site 7. Backbone Trail	phosphates	-Provide educational information to local residents about biodegradable soaps. -Require proper disposal of greywater.
Site 8. Highvale Rd.	Total and Fecal coliform Bacteria, Enterococcus	-Monitor and maintain septic and greywater systems at the private residences draining into this culvert. -Investigate contribution of domestic animal wastes to bacteria counts.
Site 8. Highvale Rd.	phosphates	-Provide educational information to local residents about biodegradable soaps. -Require proper disposal of greywater.

Recommendations Summary:

Detailed recommendations are provided in Section 5 (pg 51). The following summarization provides a quick glimpse of these suggestions.

1. Continued Monitoring

   With increasingly sophisticated tools to identify sources of bacteria and pathogens (and decreasing costs of these tests), additional sampling that captures more seasonal and temporal changes is possible. Identification of DNA markers for horses, dogs and birds is also in progress, and use of these tests to further identify contributions from these sources is recommended.
2. Implement Best Management Practices (BMP's)

   A number of BMP's could be implemented throughout the watershed to help reduce the problems of pollution. These include, but are not limited to, regular maintenance and monitoring of septic systems, implementation of low cost, effective alternative greywater systems, installation of green berms and manure composting at corralled animal facilities, additional public restrooms in Topanga Center, installation of culvert filters adjacent to Topanga Lagoon and Beach.
3. Education Efforts

   The process of educating property owners and residents about ways to reduce the impacts of their run-off on the creek is a never ending process. Yearly meetings and implementation of demonstration greywater and septic systems are recommended.
4. Continued Participation in Regional Water Quality Control and Planning Efforts.

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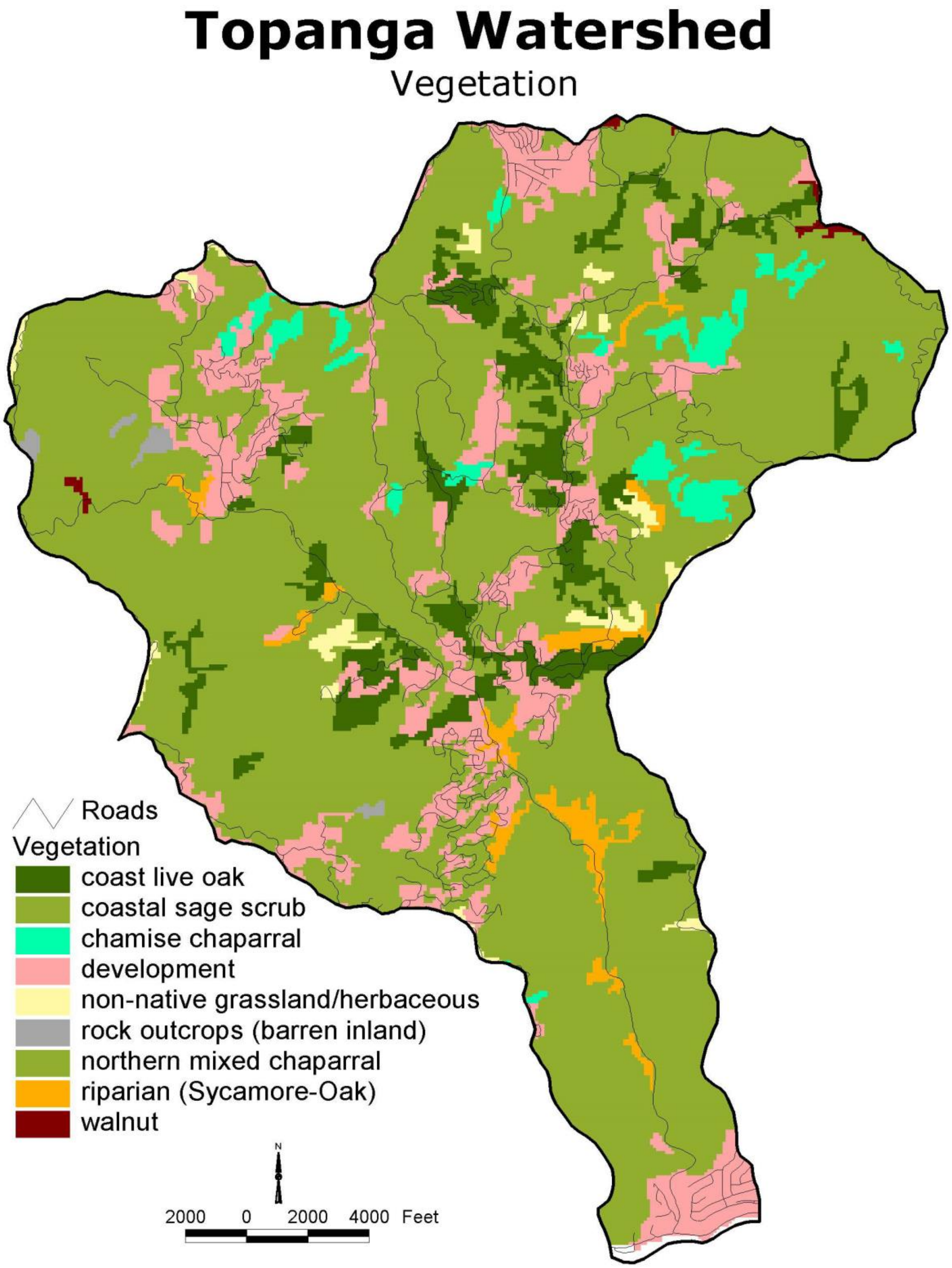
Figure 1. Map of Vegetation and Topanga Creek Watershed Boundaries



1. TOPANGA CREEK WATERSHED CONDITIONS AND BACKGROUND

1.1 Watershed Description:

The Topanga Creek Watershed covers eighteen square miles, and is the third largest watershed draining into the Santa Monica Bay. The watershed is oriented from north to south, starting at the Top of Topanga where Topanga Canyon Blvd. crosses the hill into the San Fernando Valley, and extending to the ocean at Pacific Coast Highway. Within the watershed, the creek is divided into two main sub-drainages in the northern section, with the Old Topanga creek drainage to the west and the Summit Valley, Santa Maria and Garapito sub-drainages merging on the east. The Garapito subdrainage has been identified as the main eastern headwaters of the creek, although the other smaller drainages are also important sources of flow, especially during storms. Both of these reaches of creek are tightly constrained along much of their length by main roads, utilities and homes.

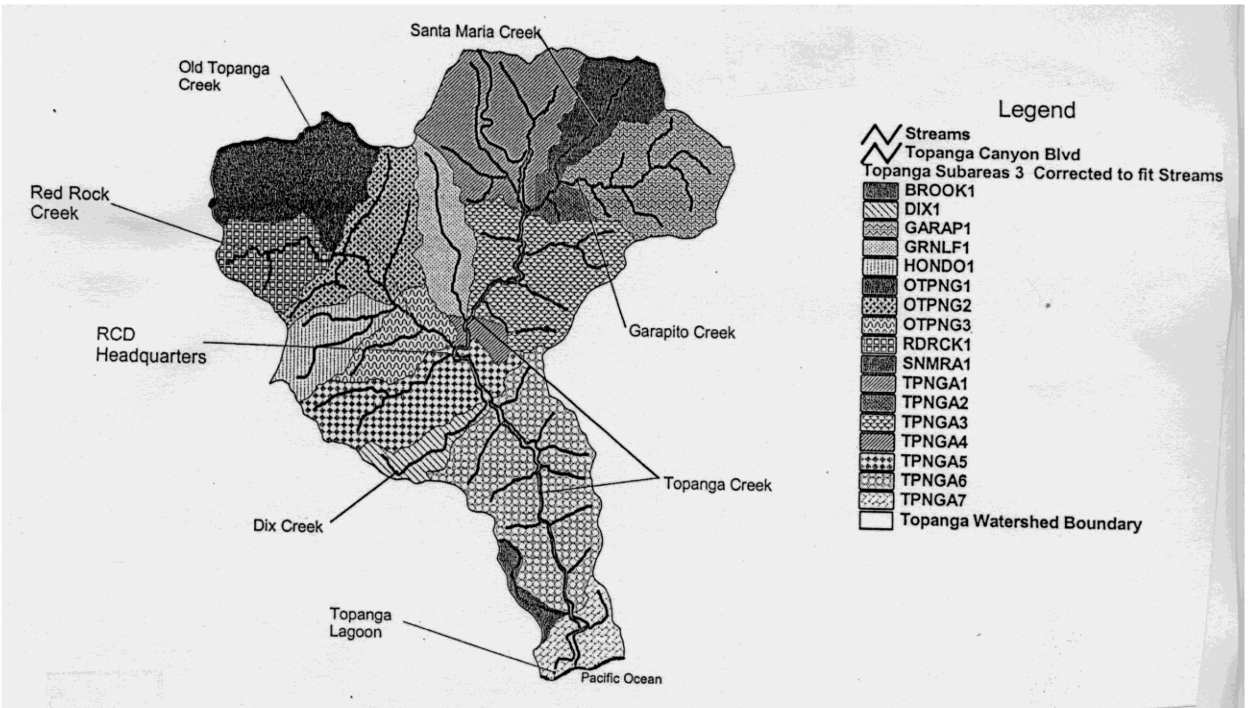
There are approximately 200 residences located immediately adjacent to the creek, with a population of approximately 12, 000 residents within the entire watershed. There are no storm drain collection systems or other point sources of storm water collection or dispersal systems. Although there is some imported water for use by the single-family homes and small businesses, there are no substantial agricultural or industrial uses within the watershed. To date, the overall extent of impervious surfaces associated with developed areas within the Topanga Creek Watershed is estimated to average 12% throughout the watershed (Riley, et all, in press). Riley, et. al. also found that in reviewing the relationship between percent of development, (including all roads, pavement, houses, etc.) and both abundance and presence of sensitive amphibian species in the Santa Monica Mountains, the threshold level is around 8%, above which species begin to drop out. Topanga is a rather unique exception at present, retaining all the sensitive indicator species as of the spring 2004 survey. This is probably due to the fact that over 8,000 of the 12,400 acres of the watershed are public open space and development is concentrated in the upper section of the watershed surrounded by fragmented native vegetation.

The confluence of the two main sub-drainages of the creek is located in the town of Topanga, at an elevation of roughly 700 feet. From the confluence down to the ocean, the creek maintains a single dominant channel, with storm events causing ephemeral flow in side channels. The narrow, steep canyon topography in this reach provides a significant geomorphologic constraint. Below the town of Topanga, the creek flows through Topanga State Park and human impacts are restricted to road runoff, impacts from road maintenance practices related to sediment inputs, and location and maintenance of utilities. This section of creek is host to a wide variety of sensitive aquatic species including a reproducing population of endangered Steelhead Trout, and CA Species of Special Concern like CA Newts, CA Tree Frogs, Western Toads, Pacific Tree Frogs, and Two-striped Garter Snakes.

At the mouth of Topanga Creek, a remnant lagoon of approximately 2 acres remains on the south side of Pacific Coast Highway (PCH). The creek channel is constrained in the lower 1,000 meters by an illegal berm installed by tenants in the rental units following the 1980 flood, and by the narrow opening of the bridge under PCH (82’ wide), which concentrates storm flows as they pass under the bridge, through the lagoon, and into the ocean at Topanga Beach. Much of the lower elevation floodplain has been altered by sediment accumulation upstream of the berm.

The historic 30 acre lagoon was filled in with 35 vertical feet of fill material in the 1930's when PCH was relocated inland from it's original alignment. At that time, the original bridge, which spanned over 250 feet, was removed and the smaller bridge installed. Efforts are underway to develop a restoration for the lagoon.

Figure 2. Subdrainage Areas within the Topanga Creek Watershed (taken from the Topanga Creek Watershed and Lagoon Feasibility Study, 2002)



The facilities associated with Topanga Beach located on the south side of PCH are under the supervision of Los Angeles County Department of Beaches and Harbors. The houses and businesses on the north side of PCH are now part of Topanga State Park. While many of the structures have been removed or retired since the property was acquired in August 2001, water quality problems in the lagoon and along the beach have persisted during this study. A restoration plan is being developed that will be incorporated into a revision of the Topanga State Park General Plan. At that time, the extent of restoration and configuration of the restored lagoon will be defined. To date, the preliminary efforts to secure funding to replace the existing bridge with a wider span to accommodate eventual lagoon restoration is underway with Caltrans. In addition to restoring the historic lagoon, the plan will also include a variety of Best Management Practices designed to help reduce non-point source pollution at this location.

1.2 303(d) Listing

Topanga Beach is listed by the Los Angeles Regional Water Quality Control Board (LARWQCB) as impaired for bacteria, and the upper watershed is listed as impaired for lead (303d listing). These listings are based on daily bacteria data collected by Hyperion Sewage

Treatment Plant at ankle depth off the lifeguard station at Topanga Beach, and a few samples collected by the LARWQCB in the 1980’s in the upper watershed.

The establishment of Total Maximum Daily Loads (TMDL’s) for Topanga Beach and upper watershed are in process. Los Angeles County has inaugurated the North Santa Monica Bay Watershed Committee to address these issues in a more regional context. Data from this and previous studies are being used to assist in the process of developing the standards and limits for the TMDL in Topanga.

1.3 Previous Water Quality Studies

Between July 1999 and June 2001, a study of water quality was undertaken by the Resource Conservation District of the Santa Monica Mountains (RCDSMM) at 5 sites weekly and an additional 10 sites monthly. The goal of that study was to identify the relationship of upper watershed inputs to the poor water quality at Topanga Beach, and to identify any relationships between water quality throughout the Topanga Creek Watershed and septic systems, sensitive species distribution, implementation of Best Management Practices, and land use.

The summary report released in July 2001 found that although there were several locations in the upper watershed where bacteria levels exceeded standards on a fairly regular basis, by the time the water flowed through the steep, narrow reach below town and was sampled at the bridge located 2 miles upstream from the ocean, it was within standards except during rain events. A comparison of the data from the bridge site to that collected at Topanga Beach and lagoon indicated that the upper watershed was not usually the main source of bacterial exceedences at the ocean. Comparisons indicated that when the berm at the mouth of the creek was closed, water quality at the beach was usually within standards, but that when the berm was breached, allowing direct flow to the ocean, exceedences took place. This suggested that the source of the bacterial contamination was from the area surrounding the lagoon, including the rental houses, Topanga Ranch Motel, businesses, road run-off from the LA County Department of Beaches and Harbors parking lot and PCH, and potentially septic influences from houses on the beach directly up coast.

One major question was how much of the bacterial contamination might be coming from bird use in the lagoon, rather from human sources. In an attempt to answer this, the current study looked at DNA to identify if bacterial samples were from human or non-human sources, and also to search for the presence of viral pathogens.

Another major question related to how close Topanga Creek was to losing sensitive aquatic species. It is extremely difficult to predict when a creek will reach its capacity for natural cleansing actions, utilizing biological and chemical mechanisms to recycle nutrients. Clearly the presence of a reproducing population of endangered steelhead trout warranted continued monitoring of the water quality issues, in addition to the need to meet the TMDL standards.

Data for bacteria, nutrients, dissolved oxygen, turbidity, temperature and pH were also collected as part of a statewide synoptic California Coast Wide Snapshot Day on 17 May 2003. Citizen monitors representing 69 individual watershed and citizen monitoring groups participated in collecting samples at 564 sites along the entire length of the CA coast. Santa Monica BayKeeper coordinated the sample collection in the Santa Monica Bay, and the samples from Topanga Creek were included in this data set.

Another snapshot sampling event was conducted by CH2M-Hill on 28 August 2004 at 5 randomly selected locations within the upper watershed and at the lagoon/ocean outlet (Bullard, pers. correspondence). None of these locations correspond to those in the study, but the high levels of fecal coliform and Enterococcus detected at a pool downstream of Topanga School Rd., as well as at the confluence of Old Topanga Creek subdrainage indicate that bacterial contamination is a real concern. This data is consistent with sampling done by this study on 10 August 2004, when not only high levels of fecal coliform and Enterococcus were detected in the upper watershed, but several sites tested positive for presence of human specific enterovirus DNA.

Concern about water quality has been an on-going issue with the Topanga Creek Watershed Committee. They host yearly meetings providing educational workshops on the care of septic systems, greywater systems and encourage the use of least toxic household products. They have also been involved in testing alternative methods for controlling invasive *Arundo donax*, in an attempt to reduce the amount of herbicide used in the watershed. LA County Road Maintenance has a no-herbicide policy for maintaining road shoulders in the watershed, as does Caltrans. Slope mowing and hand cutting are used to reduce roadside vegetation.

1.4 Creek Clean Up Events

The Topanga Creek Stream Team has organized 2 Creek Clean Up events each year since 1998, in September to coincide with the statewide Coastal Clean Up day, and in April to celebrate Earth Day. At each event, between 2 and 8 tons of trash, including transient encampments, and hazardous materials have been removed. Keeping up with the education of the community regarding closing trash can lids to reduce the spread of trash by ravens and coyotes, as well as continued monitoring for roadside dumping is an on-going effort.

Figure 3. Sampling Site Locations in the Topanga Creek Watershed, 2003-04

<u>1.5 Rainfall</u>
Rain data was collected in numerous locations throughout the Topanga Creek Watershed by volunteers and at the continuously recording station maintained by LA County at Fire Station 69 (LA Station 6). We are still waiting for that data to become available. The volunteer locations summarized are located in upper Fernwood, above the Fire Station, and in the north east ridge of the watershed at Viewridge. As most volunteer gages are measured in inches, the data is reported as inches and converted to millimeters for the total only.

Table 4. Wet Spells in Topanga Creek Watershed Water Year 2003-04

Wet Spell	**Fernwood**		**Viewridge**	
2003	**Event**	**Cumulative**	**Event**	**Cumulative**
1. Nov 1-3	0.8	0.8	0.55	0.55
2. Nov 9	0.0	0.8	0.03	0.58
3. Nov 15-16	0.2	1.0	0.07	0.65
4. Dec 7	0.2	1.2	0.06	0.71
5. Dec 14	0.0	1.2	0.17	0.88
6. Dec 23-25	3.10	4.30	2.26	3.14
2004				
7. Jan 2-4	1.01	5.31	0.51	3.65
8. Feb 3	1.3	6.61	0.8	4.45
9. Feb 18-23	4.63	11.24	2.4	6.85
10. Feb 26	6.37	17.61	4.0	10.85
11. Mar 2	1.1	18.71	0.75	11.6
12. Apr 17	0.0	18.71	0.03	11.63
TOTAL Inches		18.71		11.63
TOTAL mm		*467.75*		*290.75*

An unusual storm event occurred between 17-20 October 2004, dropping 5.6 inches (140 mm) of rain and allowed sampling for the first flush rainstorm. The first flush of 2003 took place on Christmas Day when all labs were closed, so no sampling was done.

2. WATER QUALITY SAMPLING METHODS

Table 5. GPS Location Data for Topanga Creek Watershed Sampling Sites 2003-04

Site Name	Northing	Easting	Elevation (ft)
1. Topanga Lagoon	3767444.99	353943.86	0
2. TC Blvd. Bridge MM2.02	3770186.511	353615.330	300
3. Entrado Rd	3776915.558	352404.126	1200
4. Rodeo Grounds Rd	3767672.78	354258.01	0
5. Falls Dr	3772058.316	352638.922	800
6. Behind Abuelita's	3772890.667	352128.236	700
7. Backbone Trail	3773438.802	351570.056	800
8. Highvale Rd.	3774002.020	352529.961	800
9. Paradise Rd (control)	3776082.677	355021.999	1000
10. Zuniga Rd. (control)	3775667.89	348687.34	1000

(Datum: UTM 11, NAD 27)

2.1 Site Selection Criteria

The locations selected for sampling for this study were chosen as a result of the information gathered in the 1999-2001 study. The three locations monitored weekly included:
Site 1-Topanga Lagoon knee deep off the east wing wall,
Site 2- the mile marker 2.02 Bridge on Topanga Canyon Blvd.
Site 3 - at the junction of the culverts draining from the west and north on Entrado Rd.

Water quality in the lagoon is of great concern as it relates to water quality in the beach surf zone. The bridge location is representative of overall upper watershed water quality, as it collects everything from the upper watershed and is located halfway between the town of Topanga and the ocean. The site at Entrado Road was chosen since it was identified as a "hot spot", with bacteria counts and nutrient levels that routinely exceeded standards in the 1999-2001 Study.

An additional 7 locations were selected to capture water quality monthly in the following sections of the watershed:

- Control sites in the headwaters upstream of any development impacts (Site 9 – Paradise Rd at the headwaters of Garapito creek, Site 10- Zuniga Rd. at the headwaters of a small creek draining into the Old Topanga sub-drainage).

- Site 8 at the culvert located at the intersection of Highvale Rd and Topanga Canyon Blvd. along the main stem of Topanga Creek, upstream of the confluence with Old Topanga. This site was identified as a "hot spot" in the previous study, with high nutrient levels and bacteria counts that indicated problems.

- Site 7 at the Backbone Trail crossing on Old Topanga Rd, which is downstream of known transient encampments, and receives heavy pedestrian and horse traffic.

- Site 6 is just downstream of the confluence of the 2 main sub-drainages in the upper watershed, in a small pool behind Abuelita's restaurant. This reach of creek also has heavy impact from transient encampments and was a "hot spot" identified in the previous study.

- Site 5 was just above the culvert under Falls Rd. This drainage captures most of the run-of from a large section of the Fernwood area. It has routinely had high nutrient levels and bacteria levels exceeding standards.

- Site 4 at Rodeo Grounds Road was a new site in this study, selected in order to further identify potential sources of pollution into the lagoon. It is located 400 meters upstream from the lagoon and is surrounded by rental properties inherited by Topanga State Park when the property was acquired.

2.2 Water Quality Parameters Tested

Data collection for this study included physical, chemical and biological parameters that influence water quality. Additionally, photographs were taken each week at Topanga Lagoon, from a location on the east side of the PCH bridge, looking south towards the ocean. Photographs of site conditions were also taken at the monthly sampling events at all sites with water. The parameters measured are consistent with those of the EPA Volunteer Water Quality Monitoring Protocol, as well as the protocols of other local citizen monitoring groups, including the City of Calabasas and the Heal the Bay Stream Team. Coordination of supervisor training, comparisons of standards and QA/QC protocols took place throughout the study. A copy of sample weekly and monthly data sheets, as well the site conditions data sheet are included in Appendix A.

2.2 a Physical Parameters:

1. Site Conditions: Air temperature, weather conditions, substrate, flow condition, water color, water odor, presence of oil, foam, alga type and amount, debris and trash type and amount, notes on any other pertinent information.

2. Water Temperature: At each location, water temperature was taken using the YSI Model 55 Dissolved Oxygen meter probe, which was given time to equilibrate before reading. At 8 other locations, Onset Stowaway recording thermometer probes were installed to collect continuous air and water temperatures in sections of the creek inhabited by steelhead trout. These probes were set to record at 30 minute intervals and were in the creek between June and September 2004. Data was downloaded in the field in August, and again when the probes were removed at the end of September prior to the start of winter rains. Measurements were recorded to the nearest tenth place.

2.2 b Chemical Parameters:

3. Salinity: Salinity was tested at each location by using a Vista Model A366ATC refractometer (0-10% salinity), which was calibrated prior to each sampling event by

rinsing the lens with distilled water and adjusting the scale to 0. Measurements were recorded to the nearest whole number in parts per thousand (ppt).

4. Dissolved Oxygen: The YSI Model 55 Dissolved Oxygen probe was calibrated prior to each sampling event by setting the altitude and salinity for the RCDSMM office and ensuring that it matched the requisite 97.5% expected using distilled water at 700 feet. The probe membrane was kept moist between sampling events, and the membrane changed as needed. The meter was kept on during the entire sampling event, thus preventing the need for re-calibration. The elevation for each sampling site was noted on the data sheets for quick reference. Both salinity and altitude were entered at each location, and then the probe was gently swirled at approximately mid-depth until the reading stabilized for both water temperature and dissolved oxygen. Values were recorded in mg/l, to the nearest hundredth place.

5. pH: An Oakton Waterproof pH Testr2 was used to collect pH data at each location. Prior to each sampling event, the probe was calibrated to a neutral 7 solution, and either a 10 or 4 solution. Adjustments were made for calibration as necessary. Batteries and electrodes were checked regularly to ensure freshness and function. Measurements were recorded to the nearest tenth place.

6. Conductivity: A WP Oakton ECTestr probe was used to collect conductivity data which is measured in microseimens (uS). Conductivity is the ability of water to conduct an electric current, and is related to salinity and amount of dissolved ions. We eventually needed to obtain both a high (0-19.90mS) and low range probe (200uS to 1990 uS), in order to adequately measure the conditions. Each probe was calibrated prior to the sampling event by immersion in a solution of known conductivity and making any necessary adjustments to the probe. At each sampling location, the probe was immersed in the water, allowed to stabilize, and readings recorded to the nearest hundredth place in uS.

7. Nitrate- Nitrogen: The cadmium reduction method was used to determine levels of low range (0.00 – 3.00 ppm) Nitrate –N in each sample. Samples were collected in each site by immersing a collection bottle under the surface, opening the lid, filling the container, closing the lid and immediately recording the bottle number and placing in a cooler with ice. Upon return to the RCDSMM office, all samples were tested within 4 hours of collection. The sample was transferred to a testing bottle, treated according to the protocol in the Smart 2 Colorimeter procedure manual using reagents from the appropriate test kit. A blank was tested for each sample, and split samples were done several times, or if the readings seemed off. Measurements were recorded to the nearest hundredth part per million (ppm)

8. Ammonia – Nitrogen: For the low range (0.00-1.00 ppm) Ammonia-N test, the saliccylate method for freshwater was used. If a sample was higher than 1ppm, then the sample was tested again using the high range (0.00-4.00 ppm) Nesslerization method. Samples were collected in each site by immersing a collection bottle under the surface, opening the lid, filling the container, closing the lid and immediately recording the bottle

number and placing in a cooler with ice. Upon return to the RCDSMM office, all samples were tested within 4 hours of collection. The sample was transferred to a testing bottle, treated according to the protocol in the Smart 2 Colorimeter procedure manual using reagents from the appropriate test kit. A blank was tested for each sample, and split samples were done several times, or if the readings seemed off. Measurements were recorded to the nearest hundredth part per million (ppm)

9. Phosphates (orthophosphates): The low range (0.00-3.00ppm) Orthophasphate ascorbic acid reduction method was used. Samples were collected in each site by immersing a collection bottle under the surface, opening the lid, filling the container, closing the lid and immediately recording the bottle number and placing in a cooler with ice. Upon return to the RCDSMM office, all samples were tested within 4 hours of collection. The sample was transferred to a testing bottle, treated according to the protocol in the Smart 2 Colorimeter procedure manual using reagents from the appropriate test kit. A blank was tested for each sample, and split samples were done several times, or if the readings seemed off. Measurements were recorded to the nearest hundredth part per million (ppm).

10. Turbidity: A LaMotte Model 2008 Turbidity Meter was used to measure the samples. Calibration of the meter was completed prior to each testing session by using both a 5.0 NTU and 0.5 NTU calibration solution. Samples were poured into the test bottles and placed into the meter. Once the reading stabilized, the measurement was recorded to the nearest hundredth NTU.

2.2 c Biological Parameters:

11. Algae: The type (floating on surface, floating in water column, attached) and percent cover of the sampling pool was recorded by visual estimation at each location. Note was also made of algae condition (dead, alive, decomposing). The presence of diatom films on the bottom were included as part of the overall cover estimate. In most cases, the species of algae was identified as well. Algae coverage was recorded by code: 0= none, 1=light(<5%), 2=moderate (5-25%), 3= high (25-50%), and 4= dense (>50%).

12. Total and Fecal Coliform Bacteria and Enterococcus: Sample bottles provided by MWH Laboratories contained specific fixatives for the coliform and enterococcus tests. At each location, one of each type of bottle was submerged, opened sub-surface, filled and closed before breaking the surface. Samples were labeled and immediately stored in an ice chest. Samples were transported by messenger service to the lab within the 6 hour holding period. Samples were tested there according to the following standard tests: ML/SM9221B – total coliform bacteria, ML/SM9221C – fecal coliform bacteria, and ML/SM9230B – Enterococci analysis. Results were reported in Most Probable Number (MPN)/100 mls.

13. Bacterial DNA and Viral Pathogens: To better understand the sources of bacteria, additional 1 gallon samples were collected for testing on 6 occassions by Dr. Jed Fuhrman's lab at USC. Real Time Quantitative Reverse Transcriptase Polymerase Chain Reaction (PCR) tests use the enterovirus RNA in a water sample as an indicator for the

recent or current presence of active viruses. It targets a whole family of enteroviruses, including poliovirus, Coxsackievirus and Echoviruses. These viruses are known to only infect humans and not other animals, allowing presence/absence (with a detection limit of about 1 plaque forming unit/sample) as an indication of pathogenicity and source. Additionally, the test uses PCR to look for Bacteriodes/Prevotella bacteria thought to be present only in human feces. Results were also reported as presence/absence, with a detection limit of approximately 1 microgram of feces per sample volume. These bacteria are typically the most common type in human feces, but are strict anaerobes and generally do not grow after being released into aerobic environments outside the human body – hence they make good markers.

2.3 Data Collection Issues

For the majority of the study, all equipment functioned properly, with the exception of the conductivity and turbidity meters at the start of the study. It took over a month to get them repaired and back on line. Each piece of equipment was calibrated immediately prior to data sampling according to their individual protocols. Because we had 2 teams collecting monthly data, it was possible to check samples randomly with probes from each test kit to be sure they were reading accurately.

Flow was not measured, as most sites were too shallow to allow the Marsh-McBurney Flow Meter to function accurately.

Photographs were not taken at sites that were dry at monthly sampling dates. The digital camera broke in July, was repaired and broke again in September, causing us to miss a few weekly shots of the lagoon condition.

Levels of sediment input into the creek were measured indirectly via turbidity. In addition, a concurrent study focused on monitoring steelhead trout has conducted yearly instream mapping. Results of these surveys allow tracking of sediment slugs moving downstream through the creek in pulses related to storm events (Dagit, et al 2004). Issues related to overal sediment movement were discussed in detail in the *Topanga Creek Erosion and Sediment Transport Study*, conducted by Orme and Orme, 2002.

This study did not include sampling for heavy metals, pesticides, total suspended solids or any other potential pollutants. The previous study in 1999-2001 did not suggest that any of these parameters were a problem, so the funds were allocated to those parameters related to the 303(d) listing, TMDL's and previously identified problems.

The first flush rain event occurred on 25 December 2003, and since all the labs were closed for the holidays, no samples were collected. A large storm event took place between 17-20 October 2004, and although it was not the true first flush, (which occurred during the night) flow was sufficient at most sites to warrant sampling on the morning of 19 October.

2.4 QA/QC Protocol

As part of the organization for this study, Quality Assurance objectives were defined as per those used by other local citizen monitoring groups. These objectives are consistent with those in the *EPA Environmental Monitoring and Assessment Program: Integrated Quality Assurance Project Plan for Surface Waters Research Activities*. We also relied upon the formal QA/QC Plan developed for the 1999-2001 study that included the specific QA/QC plans from MWH Laboratories for bacteria.

A critical element of any water quality monitoring plan is the protocol for sample collection. In the Topanga Creek study, samples were collected at close to the same location relative to established landmarks at each sampling event. For parameters measured on site, the meters were immersed into the creek, allowed to stabilize, and then the information recorded. Water was also collected in numbered Nalgene 500ml bottles so that nutrients and turbidity could be tested back at the RCDSMM. With the lid on, the bottle was submerged below the surface approximately 5 cm. When the depth was shallow, the deepest area of the sampling location was used and the bottle submerged as deeply as possible. Once filled, the lid was affixed before lifting the bottle out of the water. Every attempt was made to avoid collecting algae, sediments or insects. The bottle number was recorded and the bottle immediately stored in a cooler with ice.

Water temperature was measured using the YSI Model 55 Dissolved Oxygen meter, which has a sensitivity of 0.1^0C, an accuracy of approximately 1^0C and a precision of approximately 3^0C. The variability of temperature related to water depth (in the rare cases when there was stratification), and in relation to normal daily and seasonal fluctuations seemed to be adequately represented by attempting to sample at each location within approximately the same time frame at each sampling event, allowing for reasonable comparisons over time.

Dissolved oxygen was also measured using the YSI Model 55 meter, and had a sensitivity of 0.1 mg/l. Accuracy and precision were not specifically tested for this instrument. Dissolved oxygen levels are subject to high variability during the day, and seasonally related to water temperature, amount of biological activity, wind, and flow. Attention to time of sampling and sampling procedure (calibration prior to each use, input of accurate altitude and salinity at each site, keeping the probe submerged approximately 5 cm, swirling gently, allowing the reading to stabilize, etc.) appear to have provided sufficient reliability for this type of monitoring.

The Oakton pH Testr2 meter has a sensitivity of 0.1pH, and an accuracy of approximately 0.1pH following calibration. Standard solution testing prior to every sampling event with both a neutral (7) and either acidic (4) or basic (10) standard assured reasonable accuracy and precision.

Conductivity was also tested by meter. Both the low and high range meters were calibrated prior to each sampling event using standard solutions that provided sensitivity to 0.01uS or 0.01mS, respectively. Accuracy and precision for these instruments were not specifically tested.

In order to assure the most accurate and complete data collection, both staff and volunteers used a consistent sampling protocol at each sampling event. The project supervisors participated in training sessions with other local citizen monitoring groups, and tested both equipment and standards to ensure that they were functioning properly. All equipment was calibrated prior to each sampling event. The nutrient tests using the colorimeter were performed by the same 2 project supervisors, using the same protocols. Accuracy was thus measured based on both the calibration of equipment to known standards, and the degree to which results agreed based on more than one test of the same sample assisted in our evaluation of precision.

Completeness of data reflects the number of possible sampling events actually captured, as well as the acquisition of data for each identified parameter at each sampling event. Overall, the completeness for the Topanga Water Quality Study was high (over 99%). A summary of completeness for each site follows. Completeness was effected by equipment failure (conductivity and turbidity meters) as well as readings for ammonia that were >1 ppm, before we purchased the high range test kit.

Table 6. Summary of Sampling Site Completeness

Site	Total Possible Sampling Dates	Total Dates Collected	Total Dates Dry	Missing data points out of a possible 17 at each sampling event	% Completeness
Weekly				(935 possible data points)	
Site 1. Topanga Lagoon	55	55	0	21	99.97
Site 2. TC Blvd. Bridge MM2.02	55	55	0	15	99.98
Site 3. Entrado Rd	55	55	0	21	99.97
Monthly				(maximum of 238 possible data points)	
Site 4. Rodeo Grounds Road	14	5	9	5 (68 possible)	99.92
Site 5. Falls Drive	14	14	0	5 (238 possible)	99.97
Site 6. Abuelita’s	14	14	0	4 (238 possible)	99.98
Site 7. Backbone Tr	14	8	6	2 (102 possible)	99.98
Site 8. Highvale Rd	14	12	2	8 (204 possible)	99.96
Site 9. Paradise Ln	14	5	9	1 (85 possible)	99.98
Site 10. Zuniga Rd	14	14	0	4 (238 possible)	99.98

NOTE: Dates that were dry were not included in the calculation of completeness. Only problems with missing data when there was water were included.

2.5 Role of Volunteers,

As with most Volunteer Water Quality Monitoring programs, sampling is dependent on the dedication of a core group of concerned stakeholders who volunteer to become trained observers. In the Topanga study, volunteers were a valuable addition to the sample collection process, especially during the monthly sampling events when collection of all 10 samples within the time frame needed to get bacteria samples to the lab was quite a challenge.

Two training sessions were conducted, one on 1 November 2003 and another on 8 May 2004. A total of 30 volunteers participated in the training. Several of these volunteers went on to collect samples in the Dry Creek/Cold Canyon Watershed.

During the course of the study, volunteers contributed 95 hours to collecting samples. A few individuals participated in the testing process for nutrients and turbidity as well. We were extremely lucky to have such strong support from so many interested stakeholders.

On 1 November 2004, a total of 68 4th and 5th graders at Topanga Elementary School participated in a water quality and watershed class. This hands-on class allowed students to test for pH, as well as experience making the watershed work, using a model provided by the RCDSMM. Students learned why the physical, chemical and biological parameters studied are important, and how they impact the aquatic species living in Topanga Creek.

Figure 4. Water Quality Volunteer Robert Moulton at Site 6

3. RESULTS

Physical Parameters

3. 1. Site Conditions
Observations of site conditions at each sampling event included weather, air temperature, substrate, flow conditions, water color, odor, presence of oil or foam, debris, and trash. While several of these parameters were quite variable (air temperature, flow, amount of trash), substrate remained stable at all locations. Clear water color, no discernable odor, lack of surface oil and foams were considered compliant. Brownish water was noted in the control sites but appeared a normal result of tannins from oak leaves and other natural vegetation. Color changed according to rainfall, or input from anthropogenic sources. Sewage or rotten egg odors were not compliant and considered indicative of input from either greywater or septic systems nearby. Oils and foams were rarely noted, but when present considered cause for concern. The possible source of some of the foams in the control sites might be *Ceanothus sp*. These shrubs are known to produce a soapy substance when branches and leaves are crushed and may be a contributor to foam observed during high storm events that wash decaying leaves and twigs into the creek.

Table 7. Summary of Observations on Water Color, Odor, Oil and Foam 2003-04

		Number of Observations not Compliant				
Site	**Total Dates Sampled**	**Water Color**	**Water Odor**	**Surface Oil**	**Foam**	**% Not Compliant**
1. Topanga Lagoon	55	6	0	0	6	5.45
2. Bridge MM 2.02	55	2	1	0	1	1.8
3. Entrado Rd.	55	8	38	8	4	**26.4**
4. Rodeo Grounds Rd.	5	0	0	0	0	0
5. Falls Dr.	14	0	0	0	0	0
6. Behind Abuelita's	14	3	2	5	0	**17.8**
7. Backbone Trail	8	1	0	0	0	3.1
8. Highvale Rd.	12	7	9	3	1	**41.6**
9. Paradise Rd. (control)	5	2*	1	0	0	15
10. Zuniga Rd. (control)	14	8*	0	2*	0	0

*Note at Site 10, the surface oils were associated with bait from turtle traps, and the brownish color at both Site 9 and 10 are characteristic of all pools in those drainages and appear normal.

The sites with the most numerous problems with water color, odor, surface oil and foam were Site 3. Entrado Rd., Site 6. Behind Abuelita's, and Site 8. Highvale Rd. At two of these locations, the sample collection area is either in a culvert or in a small pool just below a culvert outfall. Behind Abuelita's, the problems appeared associated with heavy use by transients, and stagnant pooling in the late summer. No direct outfalls have been observed. The surface oil noted on 2 occasions at Zuniga were directly related to baiting the pool with sardines to capture native pond turtles, and therefore not any real concern.

The 2 occasions (out of 55 sample dates) when color changes or foam were noted at Site 2 TC Blvd. Bridge were associated with storm events. The same is true at Site 1. Topanga Lagoon.

3. 2. Water Temperature

Water temperature was measured in two ways for this study. At each sampling event, water temperature was recorded using the YSI Model 55 Dissolved Oxygen meter. Additionally, Onset Stowaway recording thermometers were placed in 8 pools containing steelhead trout in June 2004 and recorded water temperature every 30 minutes until they were retrieved at the end of September 2004, just prior to the rainy season. The pools were selected to represent a variety of depths, percent canopy cover, and substrate characteristics. While no steelhead trout have yet been observed in Topanga Lagoon, there is a reproducing population of endangered Tidewater gobies at that location. Since water temperature is such a critical parameter for fishes, this data will assist in the restoration planning process for the lagoon. Appendix C contains graphs illustrating temperature changes at each location over the course of the study.

Table 8. Summary of Site 1.Topanga Lagoon
Maximum, Minimum and Average Water Temperatures by month 2003-04

Month	**Maximum ^{0}C**	**Minimum ^{0}C**	**Average ^{0}C**
October 2003	23.2	17	19.62
November 2003	17.4	14	15.1
December 2003	15.6	11.3	12.9
January 2004	13.5	12.2	12.95
February 2004	15.6	13.4	14.35
March 2004	18.2	12.1	15.76
April 2004	24	15	18.1
May 2004	22.5	18.3	21.1
June 2004	22.6	20.6	21.78
July 2004	25.5	23.4	24.27
August 2004	27	21.6	23.72
September 2004	23.8	20.8	21.95
October 2004	20.8	18	19.53
Yearly Average	**20.7**	**16.75**	**18.55**

Table 9. Summary of Site 2. Topanga Canyon Blvd Bridge MM 2.02
Maximum, Minimum and Average Water Temperatures by month 2003-04

Month	**Maximum ^{0}C**	**Minimum ^{0}C**	**Average ^{0}C**
October 2003	18.1	15.2	17.38
November 2003	13.8	11.3	12.63
December 2003	10.3	8.4	9.32
January 2004	10.7	8.7	9.6
February 2004	10.7	7.9	9.85
March 2004	15.6	11	14
April 2004	18.4	11.7	14.7
May 2004	20.6	15.7	17.88
June 2004	18.7	18	18.44
July 2004	20.3	19.2	19.83
August 2004	20.5	17.9	19
September 2004	20.2	16.9	18.23
October 2004	16.3	15.9	16.06
Yearly Average	**16.47**	**13.68**	**15.14**

It was interesting to see that the range of temperatures in the main body of Topanga Lagoon, south of the PCH bridge stayed relatively warm overall, with a low of 11^{0}C in December 2003, to a high of 23.8^{0}C in September 2004, with a yearly average of 18.55^{0}C. This reflects the almost complete lack of vegetative canopy, the consistently shallow but variable depths, and present conditions that are critical limiting factors for fishes. This could explain why the majority of gobies are found upstream of the bridge, where the riparian cover begins.

By contrast, the locations where steelhead trout are found throughout the lower section of Topanga Creek remain cooler, with average temperatures at the Site 2. Bridge hovering around 15.14^{0}C, with a high of 20.5^{0}C to a low of 7.9^{0}C. At both locations the seasonal changes were just over 12^{0}C. The continuously recording thermometers were all placed in locations supporting steelhead, and the table below summarizes the range of temperatures related to depth and canopy cover. It appeared that at some of these locations, the influence of year round groundwater input from seeps and springs was a major factor. All distances were measured starting from the north side of the PCH bridge over Topanga Lagoon moving upstream. Graphs of all data are included in Appendix C and D.

Water temperature at the upper watershed locations averaged a high of 18.36^{0}C, which is between the average highs at the Bridge and Lagoon. The upper watershed sites did experience lower temperatures, with an average of 7.96^{0}C. The range of maximum to minimum temperatures in the upper watershed varied by site, and was least at Site 9. Paradise (5.6^{0}C), and most at Sites 5 Falls Dr.(14^{0}C) and Site 6. Behind Abuelita's (14.4^{0}C). Microclimates, amount of canopy cover, and water depth were all important influencing factors in the upper watershed locations.

Table 10. Summary of Onset Recording Thermometer Data, July – September 2004

Site	**Canopy Cover %**	**Average Depth cm**	**Maximum ^{0}C**	**Minimum ^{0}C**	**Average ^{0}C**
Topanga Lagoon (3m)	25	80	30.06	11.99	18.6
2000 m Ski Pole Pool	10	50	29.55	10.86	19.54
2600 m Ken^2 Pool	75	25	26.31	16	18.32
3500 m Alder Grove	90	30	26.27	15.03	19.25
3800 m Sycamore Tree	75	30	29.71	14.57	20.16
4000 m Noel Pool	0	75	31.65	14.42	19.88
4389 m Josh Pool	50	200	25.21	15.51	19.54
4500 m Cascade Pool	75	40	24.87	15.04	19.77

Seasonal variation was apparent at all locations, with the coldest temperatures being recorded in December through February, and the warmest in August through October. This is consistent with the seasonal trends documented in the 1999-2001 study.

3.3 Water Depth

This was one of the most variable parameters measured. We noted a few discrepancies in depths between observers, which appears related to exactly where in the pool they measured. Maximum depths were measured at Site 10. Zuniga Rd., which is a bedrock scour pool where depth is limited by the lower ledge of the rocks, and at Site 1. Topanga Lagoon, which was deepest when the berm was closed but flow from storm events was still coming down the creek, especially in the spring months. Depths at all other locations were directly related to rainfall. Average depths are for dates when water was present.

Table 11. Summary of Water Depth, Topanga Creek 2003-04

Site	**Total Dates**	**Maximum Depth cm**	**Minimum Depth cm**	**Average Depth cm**
1. Topanga Lagoon	55	90	25	50.50
2. Bridge MM 2.02	55	70	10	40
3. Entrado Rd.	55	21	5	10
4. Rodeo Grounds Rd.	5	20	0	17.1
5. Falls Dr.	14	39	14	30
6. Behind Abuelita's	14	110	5	31.5
7. Backbone Trail	8	16.5	0	15
8. Highvale Rd.	12	50	0	31.5
9. Paradise Rd. (control)	5	35	0	29
10. Zuniga Rd. (control)	14	100	30	77

Chemical Parameters:

3.4. Salinity

Salinity levels in Topanga Creek remained between 1-7 ppt in the upper watershed throughout the study. Samples were collected on the surface at Topanga Lagoon, and spiked to 13 ppt on one occasion, remaining quite fresh for most of the year. There did not appear to be much salt intrusion in the lagoon, except during high tides following storm events, when the ocean waves entered the lagoon. It is a dominantly fresh water system.

Table 12. Summary of Salinity Ranges by Site 2003-04

Site	**Total Dates Sampled**	**Maximum Salinity ppt**	**Minimum Salinity ppt**	**Average Salinity ppt**
1. Topanga Lagoon	55	13	0	3.2
2. Bridge MM 2.02	55	3	0	1.4
3. Entrado Rd.	55	5	0	3.38
4. Rodeo Grounds Rd.	5	2	1	1.4
5. Falls Dr.	14	3	0	1.64
6. Behind Abuelita's	14	7	2	2.6
7. Backbone Trail	8	3	0	1.6
8. Highvale Rd.	12	7	0	4.2
9. Paradise Rd. (control)	5	4	1	2.75
10. Zuniga Rd. (control)	14	4	0	1.5

3.5 Dissolved Oxygen

Observations of dissolved oxygen levels were graphed for each site in Appendix C. Knowing that DO levels naturally vary during the day, every attempt was made to collect samples within the same time frame at each sampling event, thus reducing the variability related to normal temporal fluctuations. During the summer and fall months when water levels receded and pools at several sites became isolated and stagnant, dissolved oxygen levels were quite low. Overall, decline of dissolved oxygen levels was related to increased water temperatures and increased algal cover. In general, when flow in the creek was constant, dissolved oxygen levels are well within the ranges needed to support a wide variety of aquatic species from 3 mg/l in summer/fall to over 11 mg/l in winter/spring. Steelhead trout prefer between 5-10 mg/l. (McEwan and Jackson 1996). The lowest readings were obtained in small stagnant pools with no inflow during the summer months. The Water Quality Control Plan Los Angeles Region has a target of greater than 5 mg/l for any single determination in cold water, and greater than 7 mg/l for all waters, except where natural conditions cause lesser concentrations.

Dissolved oxygen levels below this limit were detected at all upper watershed locations, except Site 3. Entrado Rd. during the summer and fall, when pools were stagnant and no flow occurred. It was interesting to note that frequent observations of western pond turtles and other aquatic species were found utilizing the Zuniga Rd site, even when DO levels were low. No aquatic species were observed at the other locations under these conditions.

Table 13. Summary of Dissolved Oxygen Ranges by Site 2003-04

Site	**Total Dates Sampled**	**Maximum DO mg/l**	**Minimum DO mg/l**	**Average DO mg/l**
1. Topanga Lagoon	55	19.65	5.55	11.07
2. Bridge MM 2.02	55	14.77	7.34	9.65
3. Entrado Rd.	55	11.35	4.1	8.0
4. Rodeo Grounds Rd.	5	7.93	7.63	7.77
5. Falls Dr.	14	10.95	8.34	9.55
6. Behind Abuelita's	14	10.72	1.15	5.7
7. Backbone Trail	8	14.9	2.92	9.64
8. Highvale Rd.	12	8.58	0.18	2.57
9. Paradise Rd. (control)	5	9.45	0.57	6.4
10. Zuniga Rd. (control)	14	12.75	2.62	7.86

WQO is >5 mg/l

3.5. pH

The acceptable range of pH for most aquatic species is between 6.5- 8.5 in freshwater systems. The pH at most locations in Topanga were within this acceptable range. Graphs of pH at each location are included in Appendix C. Site 5. Falls Dr., had a high of 8.6, and also had the highest average pH for all sites. It also recorded the lowest pH of 5.6 and was most variable of all sites observed. Site 3. Entrado Rd. also had a high degree of variability that seem related to the flow levels in the culvert. Interestingly, the control site at Site 10. Zuniga Rd. had the highest pH level recorded (8.7) in July 2004.

Table 14. Summary of pH Ranges by Site 2003-04

Site	Total Dates Sampled	Maximum pH	Minimum pH	Average pH
1. Topanga Lagoon	55	8.3	7	7.67
2. Bridge MM 2.02	55	8.3	6.9	7.86
3. Entrado Rd.	55	8.2	6.5	7.42
4. Rodeo Grounds Rd.	5	7.8	7.6	7.7
5. Falls Dr.	14	8.6	5.6	7.92
6. Behind Abuelita's	14	8.5	6.7	7.3
7. Backbone Trail	8	8.3	7.6	7.8
8. Highvale Rd.	12	7.7	6.7	7.2
9. Paradise Rd. (control)	5	7.8	7.3	7.5
10. Zuniga Rd. (control)	14	8.7	7.9	7

WQO is 6.5-8.5

3.6. Conductivity

At standard temperatures, conductivity is an indicative measure of the number of dissolved ions in the water, and is recorded as uS (microseimens). Ranges are usually from 0.5-3.0 uS for distilled water, with potable water ranging from 30-1500 uS and seawater up to 53,000 uS. No specific target range is included in the Water Quality Control Plan Los Angeles Region. This measurement is an indirect way to evaluate the amount of dissolved salts in the water that are conductors. In conjunction with pH and salinity, conductivity is used to evaluate inputs from groundwater sources or sewage. The higher averages at Site 1, 3 and 8 may be indicative of pollutant inputs

Table 15. Summary of Conductivity Ranges by Site 2003-04

Site	Total Dates Sampled	Maximum Conductivity uS	Minimum Conductivity uS	Average Conductivity uS
1. Topanga Lagoon	55	9200	1180	**2417**
2. Bridge MM 2.02	55	1420	340	1008
3. Entrado Rd.	55	3300	1990	**2292**
4. Rodeo Grounds Rd.	5	1490	1250	1332
5. Falls Dr.	14	1130	900	969
6. Behind Abuelita's	14	2400	1480	1810
7. Backbone Trail	8	1840	300	1212
8. Highvale Rd.	12	4200	270	**2494**
9. Paradise Rd. (control)	5	1700	820	1276
10. Zuniga Rd. (control)	14	900	270	597

3. 8. Nitrate-Nitrogen

Nutrient levels were measured with much greater precision and accuracy for this study due to the use of the colorimeter testing methodology. While there are no target levels of nitrate-N based on criteria needed to support aquatic life, that standard for drinking water is <10 ppm. Levels of nitrates greater than 3.5 ppm are thought to contribute to increased algal production and eutrophication in Southern California streams (Abramson, per. Communication). Natural background readings vary depending on underlying geologic conditions, but can range from 0.0-0.08 ppm. A pending TMDL limit for Malibu Creek is <1 ppm. Graphs of nitrate levels at all sites are included in Appendix C.

In both the 1999-2001 and present study, Site 3. Entrado Road consistently showed the highest levels of nitrates with an average of 0.66 ppm. Sites 5, 6 and 7 also averaged over 0.32 ppm. An interesting trend was repeated with the control site (9. Paradise Rd.) which continued to have higher than expected nitrate levels as well. We really don't understand what the source of nitrates is at Site 9. Perhaps it is related to historic use of the property, or it may indicate a geological source in that section of the watershed. The other control site (10) is also a bedrock scour pool, but did not have any nitrates to speak of. All sites experienced a spike in nitrate levels in March 2004, following a fairly strong rainstorm, which dropped over 2.5 cm (1 inch) of rain a week before the sampling event.

Nitrate-N is often a by-product of septic system or greywater system effluent and can also be released into the creek from corralled animal manure. When evaluating the level of input, we looked at the entire suite of nutrients, as well as bacteria to determine which sites appeared to have direct human related inputs as opposed to either corralled animals or natural background levels.

Table 16. Summary of Nitrate-Nitrogen Ranges by Site 2003-04

Site	**Total Dates Sampled**	**Maximum Nitrate ppm**	**Minimum Nitrate ppm**	**Average Nitrate ppm**
1. Topanga Lagoon	55	0.87	0	0.14
2. Bridge MM 2.02	55	0.84	0	0.15
3. Entrado Rd.	55	1.35	0	**0.66**
4. Rodeo Grounds Rd.	5	0.14	0.05	0.12
5. Falls Dr.	14	0.87	0	**0.35**
6. Behind Abuelita's	14	1.71	0	**0.32**
7. Backbone Trail	8	1.87	0	**0.36**
8. Highvale Rd.	12	0.89	0	0.26
9. Paradise Rd. (control)	5	1.75	0.07	**0.52**
10. Zuniga Rd. (control)	14	0.35	0	0.10

Pending WQO is <1 ppm

3.9. Ammonia – Nitrogen: The most common source of Ammonia –nitrogen in freshwater systems are human effluent and animal wastes. Most aquatic species are quite sensitive to increased levels of ammonia, with toxicity occurring between 1-25 ppm. The target for freshwater systems is not to exceed 0.4 mg/l (ppm). The Water Quality Control Plan Los Angeles Region utilizes the EPA pH adjusted range of 2.5 – 10.5 ppm. Although every site in the watershed experienced a maximum reading of over 1 ppm, averages for all sites were well below 0.5 ppm.

As was observed with Nitrate-N, levels of Ammonia-N spiked in most locations in March 2004. We did not get a high range test kit for the colorimeter until spring 2004, so we are not certain about the absolute range of ammonia levels. The highest averages were at Site 6. Behind Abuelita's and at Site 7. Backbone Trail. Both of these locations have had a documented problem with transient encampments during the course of the study. Additionally, horses are frequently ridden across the creek at Site 7 and could be adding the higher levels observed here. It was interesting to find that high ammonia levels were also observed at Site 4., Rodeo Grounds Rd. At this location, septic systems associated with the rental homes are a more likely source than transients or animal wastes, although these are also potential contributors. The high average observed at Site 9 control are not clear, since there are no possible sources of contamination, other than visits by local dogs and wildlife.

Table 17. Summary of Ammonia-Nitrogen Ranges by Site 2003-04

Site	**Total Dates**	**Maximum Ammonia ppm**	**Minimum Ammonia ppm**	**Average Ammonia ppm**
1. Topanga Lagoon	55	>1	0	0.11
2. Bridge MM 2.02	55	>1	0	0.11
3. Entrado Rd.	55	>1	0	0.17
4. Rodeo Grounds Rd.	5	>1	0.04	**0.23**
5. Falls Dr.	14	>1	0	0.17
6. Behind Abuelita's	14	3.5	0	**0.40**
7. Backbone Trail	8	>1	0.02	**0.26**
8. Highvale Rd.	12	>1	0	0.16
9. Paradise Rd. (control)	5	1.5	0	**0.45**
10. Zuniga Rd. (control)	14	>1	0	0.12

WQO is <0.4 ppm

3.10. Phosphates (Ortho-phosphates)

In the previous study, several locations (Falls Dr., Highvale Rd. and Entrado Rd) had frequently detectable low levels of phosphates. Common sources of levels exceeding 0.65 ppm in fresh water include organic elements from septic systems, greywater systems and inorganic sources like fertilizers and soaps from detergents. Natural readings range from 0.0-0.65 ppm. The accuracy of our detection increased with the implementation of the colorimeter tests in this study. The target limit for EPA is 0.10 ppm.

Sites 3. Entrado Rd, Site 5. Falls Dr., Site 6. Behind Abuelita's and Site 8. Highvale Rd. again consistently had the highest levels. Site 8 Highvale Rd. had a high of 3 ppm, and an average over 1.53 ppm. While Site 3. Entrado also had a high reading of 0.95 ppm, the average was only 0.23 ppm. Sites 5 and 6 also had a fairly constant level of 0.30 ppm and 0.21 ppm respectively. Spikes of phosphate levels were more erratic than those for either nitrates or ammonia. Each site spiked at a different time, although the first flush readings in October 2004 tended to be higher for all sites. Greywater lines have been observed flowing near both Site 5. Falls Dr. and Site 8. Highvale Rd. and could be a significant contributor to the high levels at these locations. Although no direct greywater flows have been observed at Site 3. Entrado Rd., the consistent odors at the site, as well as overall poor water quality levels are a cause for concern. Only the control Site10. Zuniga Rd. maintained an average below the target of 0.10 ppm, and even this was exceeded on one occasion associated with rain. There are no anthropogenic sources known to impact this site.

Table 18. Summary of Ortho-phosphates Ranges by Site 2003-04

Site	**Total Dates Sampled**	**Maximum Phosphates ppm**	**Minimum Phosphates ppm**	**Average Phosphates ppm**
1. Topanga Lagoon	55	0.37	0	0.11
2. Bridge MM 2.02	55	0.47	0	0.10
3. Entrado Rd.	55	0.95	0	**0.23**
4. Rodeo Grounds Rd.	5	0.19	0.05	0.11
5. Falls Dr.	14	0.46	0.2	**0.30**
6. Behind Abuelita's	14	0.46	0	**0.21**
7. Backbone Trail	8	0.57	0.04	0.19
8. Highvale Rd.	12	3	0.18	**1.53**
9. Paradise Rd. (control)	5	0.38	0	0.12
10. Zuniga Rd. (control)	14	0.14	0	0.05

WQ target is <0.10 ppm

3.11. Turbidity

The amount of suspended particles, phytoplankton, pollutants, and other materials is measured as turbidity. Not only does turbidity affect water clarity, it can also increase heat absorbtion and impair breathing and foraging of aquatic animal species. Los Angeles has no standards for receiving waters, but discharge from sewage is limited to 20-30 NTU. The Basin Plan objective ofr turbidity is a mix of numeric and narrative: "The secondary drinking water standard for turbidity is 5 NTU. Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increses in natural turbidity attributable to controllable water quality factors shall not exceed the following: where natural turbidity is between 0 and 50 NTU, increases shall not exceed 20%; where natural turbidity is greater than 50 NTU, increases shall not exceed 10%".

Table 19. Summary of Turbidity Ranges by Site 2003-04

Site	Total Dates Sampled	Maximum Turbidity NTU	Minimum Turbidity NTU	Average Turbidity NTU
1. Topanga Lagoon	55	44.7	0.55	2.53
2. Bridge MM 2.02	55	35.6	0.12	1.53
3. Entrado Rd.	55	14.14	0.34	2.42
4. Rodeo Grounds Rd.	5	7.4	0.98	3.3
5. Falls Dr.	14	1.65	0.08	0.74
6. Behind Abuelita's	14	3.95	0.4	1.66
7. Backbone Trail	8	3.55	0.31	1.10
8. Highvale Rd.	12	44.8	0.57	**6.27**
9. Paradise Rd. (control)	5	6.89	0.8	2.43
10. Zuniga Rd. (control)	14	19.72	0.79	3.4

WQO is <5 NTU

The highest reading for turbidity (44.7 NTU) was noted at Site 1. Topanga Lagoon in March 2004 following a major rain storm. Overall, turbidity was variable in the lagoon and appeared related to flow and algal levels. At Site 8. Highvale Rd., levels were consistently high, which is indicative of greater input, potentially related to greywater discharge. Highvale Rd. exceeded the Basin Plan secondary drinking water standard of <5 NTU on average. The average levels at the control sites were relatively high, and appeared related to input of natural leaf materials and soil debris.

Biological Parameters:

3.12. Algae

Only a few species of algae were commonly observed in Topanga Creek. Floating algae included dense mats of *Azolla sp*., *Enteromorpha sp*., and green diatom films. The benthic algae species commonly seen included brown diatom films, *Chara sp*., *Spyrogira sp*., *Cladophora sp*., and *Rhizoclonium sp*. These were all primarily attached to the substrate, and sometimes floated into the water column. The area of cover was defined either as the discrete sampling pool, or in the case of a wider creek reach, the area within 10m up and downstream of the sampling point. For Topanga Lagoon, algae cover was recorded for the lagoon as a whole, with the observations generally made from the bank above, which provided a good view of the whole lagoon area south of the PCH bridge.

As can be seen by examining the graphs in Appendix C, algal cover typically increased during the warm spring and summer, peaking between March and May, and was scoured out during rain events in the winter. The growth of algae appears to be more related to seasonal weather trends and amount of canopy cover at a give location rather than to nutrient availability. The trends in algal levels observed during this study are consistent with observations from the 1999-2001 study.

Table 20. Summary of Algal Cover by Site 2003-04

Site	Total Dates Sampled	0= No Algae	1= Light <5%	2= Moderate 5-25%	3= High 25-50%	4= Dense >50%	Average Density
1. Topanga Lagoon	55	18	10	7	17	3	1.55
2. Bridge MM 2.02	55	22	10	8	9	6	1.4
3. Entrado Rd.	55	8	1	3	6	30	2.78
4. Rodeo Grounds Rd.	5	3	2	0	0	0	1
5. Falls Dr.	14	11	0	2	0	1	0.57
6. Behind Abuelita's	14	3	0	2	1	8	2.7
7. Backbone Trail	8	2	3	3	0	0	1.1
8. Highvale Rd.	12	8	2	0	0	0	0.16
9. Paradise Rd. (control)	5	3	1	1	0	0	0
10. Zuniga Rd. (control)	14	8	3	0	0	0	0.8

Site 3. Entrado Rd. had the most consistently high levels of algae, with approximately 50% canopy cover, along with chronic input of nitrates, ammonia and phosphates. Site 6. Behind Abuelita's also had a moderate level of cover during the entire year, and also is one of the sites with less than 50% canopy cover, providing optimal conditions for algal growth. By contrast, Site 5. Falls Dr. and Site 8 Highvale Rd. have almost 100% canopy cover, and despite chronic inputs of nutrients, little algal growth was observed at these locations.

The dominant species of algae observed were those found attached to the substrate. Only at Site 1, 3 and 6 was there an even split between attached and surface floating species. Algal mats are suspected of being suitable sites for bacterial reproduction, and high levels of bacteria are often found associated with over 25% algal cover. The combination of inputs of nutrients, especially nitrogen and phosphates with algal cover may be a factor in encouraging total bacterial growth.

3.13. Total and Fecal Coliform Bacteria and Enterococcus

During the 2003-2004 study, total and fecal coliform bacteria samples were collected at each monthly sampling event. Six of the 10 sites had water for each event, and the other 4 sites were more variable depending on rainfall. In reviewing the data summarized and graphed in Appendix C for each site, a few trends became clear. As might be expected, the highest bacteria counts occurred following or during the first rainfall events of the water year, in November and December 2003, and October 2004. The highest levels previously recorded were also associated with the first large storm events in 1999, 2000 and 2001. No data was collected in 2002.

It is interesting to compare the bacteria levels at Site 1. Topanga Lagoon with Site 2. TC Blvd Bridge MM 2.02, since that site collects all sources in the upper watershed after it has passed through over 2 miles of undeveloped stream corridor. In the 1999-2001 study, *E. coli* was tested rather than Enterococcus, making direct comparisons difficult. (During that study, results for fecal coliform and E. coli matched closely, so we decided to use Enterococcus to get a more clear idea of contamination levels.) However, there was only 1 event during that sampling period when the fecal coliform levels were higher at the Bridge (MM 2.02) than they were in Topanga Lagoon. In the 2003-2004 study, there were 4 months (June-September 2004) when the total coliform counts were higher at the Bridge. The fecal coliform counts were higher at the bridge than the lagoon only in May 2004 and during the first flush. This suggests that natural recovery and cleansing is still taking place during most of the year in the natural section of creek between town and the bridge.

The results for Enterococcus are also interesting to compare between these sites. Both locations experienced exceedences, at the lagoon 71% (10 events) and at the bridge 50% (7 events), including the first flush data. Of these, the level of Enterococcus at the bridge was higher than that in the lagoon only in October 2003 and September 2004. The levels were the same in May and June 2004. The rest of the time the levels at the lagoon were notably higher than at the bridge upstream.

In the upper watershed, the results were also interesting. The control sites at Zuniga Rd and Paradise Rd. did not exceed the levels for total coliform except during the first flush, but despite being well above any influence from septic systems or greywater, it did exceed the fecal coliform standards in August, September and October 2004. Zuniga Rd. also exceeded the Enterococcus target of 61 MPN/100ml, which is interesting since there are no sources of human fecal materials for this location. The RNA testing for human enteroviruses was negative, indicating that the sole source of entrococcus was other animals, except during the first flush storm in October 2004, when human specific enteroviruses were detected. This is a confusing result. This site receives heavy use from turtles, and the surrounding trails are used by horses and dogs. It may be that turtles and domestic animals do share some enterovirus strains, as has been observed with bacteriodes, and that the current assay is not as human specific as we thought. It may also be that there is an encampment located upstream that we are unaware of.

During the 1999-2001 study, Entrado Rd was identified as a significant “hot spot” for bacterial contamination, with consistently high levels and numerous exceedences. The results of this study indicate that this trend continues, with 12 out of 14 sampling events exceeding the target for enterococcus. Synoptic RNA testing did not find evidence of either human bacteriodes or human enteroviruses. This site is downstream of Summit Valley Park and numerous corralled animal facilities that might also be contributing to these high levels.

Site 5. Falls Dr. and Site 6. Behind Abuelita’s were also noted as problem sites in the earlier study. This trend appears to be continuing with both sites exceeding all standards on several occasions, with enterococcus levels consistently above 61 MPN/ 100ml. At both these locations, presence of human enteroviruses were detected as well. This would seem to indicate that the human sources are more common, although animal sources are also present.

The same trend was observed at Site 8. Highvale Rd., although not as frequently. Again, the RNA testing indicated presence of human specific enteroviruses.

The Backbone Trail location had an occasional exceedence in the previous study, but was usually within standards. By contrast, the 2003-2004 results revealed not only 5 occasions when the standard for enterococcus was exceeded (no flow conditions), but also found evidence of human enteroviruses. This is a cause for concern, since the sources could be related to either transient encampments upstream of the sampling location, or input of septic and greywater systems from some other locations upstream.

As might be expected due to dilution influences, only the lagoon and Site 2 Bridge remained under the total coliform and fecal coliform exceedence limits during the first flush sampling of 19 October 2004, although enterococcus levels were above standard only at the Site 2. Bridge. All other sites showed extremely high numbers, with control Site 9. Paradise Rd. exceeding the highest detection level of greater than 1.6 million MPN/ 100 ml for all 3 bacteria parameters.

Table 21. Number of Exceedences for Bacteria, Topanga Creek 2003-04

Site	**Total Dates Sampled**	**No. Total Coliform >10,000**	**No. Fecal Coliform > 400**	**No. Entero >106**	**Human Bacteriodes Present**	**Human Enterovirus Present**
1. Topanga Lagoon	14	1	6*	10	0	1
2. TC Blvd. Bridge MM 2.02	14	0	3*	7*	0	2
3. Entrado Rd.	14	5*	4*	12*	0	0
4. Rodeo Grounds Rd.	5	0	0	2*	0	0
5. Falls Dr.	14	1*	2*	13*	0	1
6. Behind Abuelita's	14	3*	4*	14*	0	2,
7. Backbone Trail	7	2*	2*	5*	0	1
8. Highvale Rd.	12	2*	2*	8*	0	1,
9. Paradise Rd. (control)	5	2*	1*	4	0	0
10. Zuniga Rd. (control)	14	1*	4*	7*	0	1

*= exceedence at first flush 19 October 2004

Table 22. Comparison of Bacteria Levels at Topanga Beach, Topanga Lagoon and Site 2. Bridge

	Total Coliform			Fecal Coliform			Enterococcus			HTB Rating	
Date	Beach	Lagoon	Bridge	Beach	Lagoon	Bridge	Lagoon	Bridge	Berm condition	Dry	Wet
10/14/03	20	500	220	10	300	70	30	**130**	closed	A	ns
11/11/03	30	5000	900	10	**1300**	23	**300**	**240**	closed	A	C
12/9/03	320	**50000**	220	250	**5000**	23	**11000**	**70**	closed	C	D
1/13/04	20	3000	1600	10	**2400**	**1600**	**2200**	30	closed	C	F
2/10/04	480	1700	170	74	130	2	**130**	50	open	D	A+
3/9/04	340	700	330	51	240	13	90	50	open	A	F
4/13/04	10	300	80	10	80	0	**130**	**80**	closed	B	ns
5/11/04	71	2400	1100	10	130	1100	**240**	**240**	closed	A+	ns
6/8/04	67	1400	1700	67	**500**	23	**110**	**110**	closed	A	ns
7/13/04	67	1100	1300	67	**800**	30	**300**	**500**	closed	A	ns
8/10/04	67	70	240	67	2	34	4	30	closed	A+	ns
9/14/04	67	110	900	67	17	0	**300**	**240**	closed	A	ns
10/12/04	210	1100	500	67	50	2	0	50	closed	B	ns
10/19/04	6800	2200	9000	210	**880**	**1400**	50	**700**	First Flush	F	F

Total coliform standard: 10,000 MPN/100ml
Fecal coliform standard: 400 MPN/100ml
Entercoccus saltwater standard: 104 MPN/100ml
Entercoccus freshwater guideline: 61 MPN/100ml

Presence of Human Enterovirus RNA

Date	**Site 1. Lagoon**	**Site 2 Bridge**
12/9/03	**positive**	**positive**
2/10/04	negative	negative
4/13/04	negative	negative
5/11/04	negative	negative
8/10/04	inconclusive	**positive**
10/19/04	negative	negative

Table 23. Summary of Bacteria Data for Topanga Lagoon and Topanga Creek

Figure 5. Total Coliform Bacteria from all Topanga Creek Watershed Sites, 2003-04

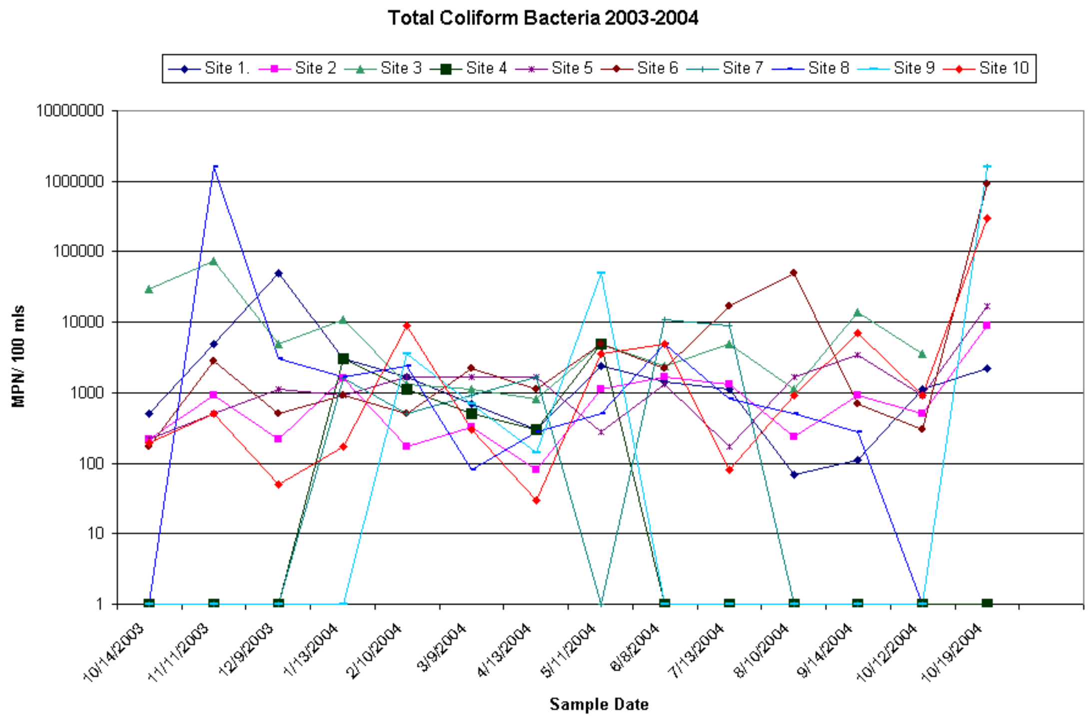


Figure 6. Fecal Coliform Bacteria from all Topanga Creek Watershed Sites, 2003-04

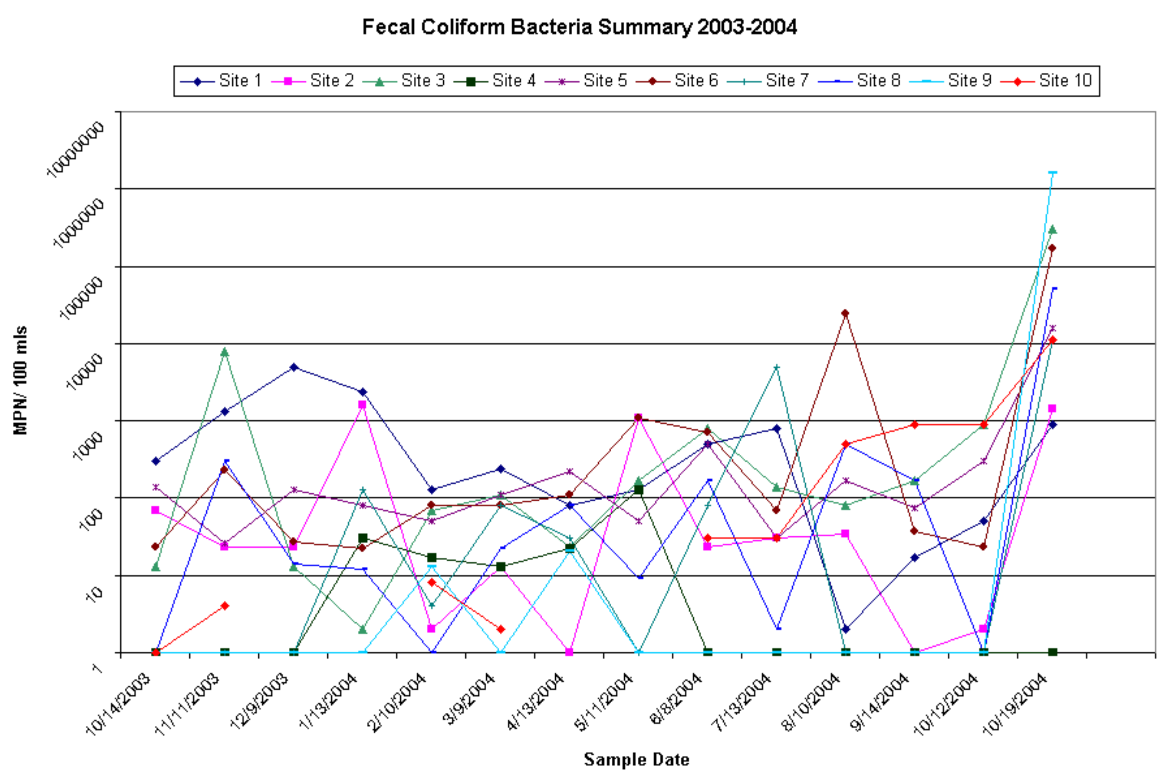
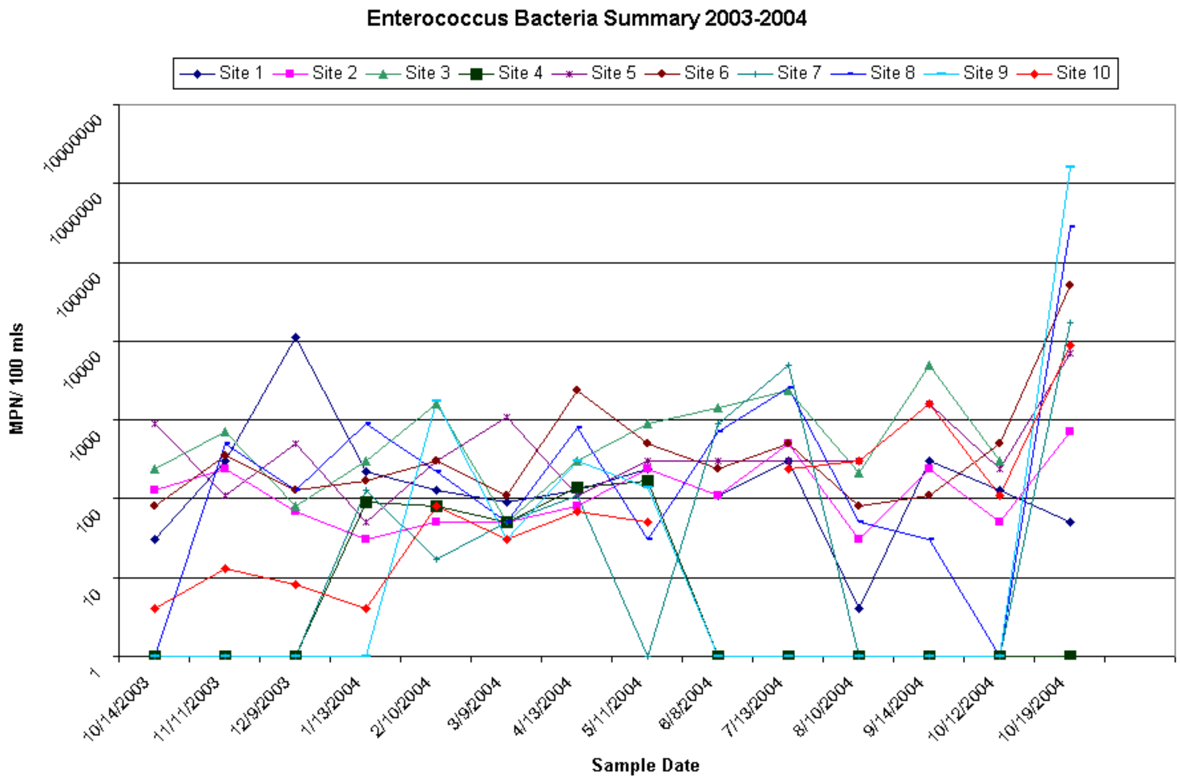


Figure 7. Enterococcus Bacteria from all Topanga Creek Watershed Sites, 2003-04



3.14. Bacterial DNA and Viral Pathogens

Samples collected at the same time as the total and fecal coliform and enterococcus tests were tested at USC using Real Time Quantitative Reverse Transriptase PCR analysis to determine the presence or absence of human bacteriodes and human enteroviruses. These tests were conducted to allow us to further identify the possible sources of bacteria and evaluate if indeed they represent a human health threat associated with increased pathogenicity.

It was interesting to note that even when the total and fecal coliform counts were quite high, as related to storm events, no human bacteriodes were detected at any location in the watershed. One reason for this may be that this assay has less sensitivity than the more standard bacteria tests, and any human contamination was below the detection limit. Because previous tests with this method in Topanga and similar watersheds have sometimes been positive, it suggests that human fecal bacterial contamination is not high in relation to animal fecal contamination, which is detectable in the standard bacterial indicator tests. Future refinement of these tests is needed to determine if the additional sources are birds, corralled, domestic or wild mammals. At this point, it is only possible to determine if they are specifically human, and above the current detection limit.

The assay for human enteroviruses is considered to be human specific, although it is not possible to prove that there are no animal enteroviruses that cross-react with this assay. There is little information about the type and abundance of enteroviruses in wild animal populations.

Therefore, positive detection of human enteroviruses is a strong indication of human source contamination. That being said, we have no idea why the only location tested during the first flush that had showed presence of human enteroviruses was at the Zuniga Rd. control site. There are no human sources in that area, and that result is quite confusing.

There were several samples that tested positive for human enterococcus bacteria (Site 1. Topanga Lagoon, Site 2. Bridge) in December 2003. In February 2004 when it was raining, only Site 6. Behind Abuelita's tested positive. Interestingly, in April 2004, Site 5. Falls Dr. and Site 7. Backbone Trail also tested positive. There does not seem to be a clear pattern of impact based on this data. Something was going on in August 2004 when Site 2, Site 6 and Site 8 all tested positive, but we have no information on specific septic releases, greywater problems or other actions that might be related to these exceedences that are in the upper watershed.

Table 24. Summary of Human Enterovirus Detection 2003-04

Site	**Months with Positive Detection of Human Enterococcus**
Site 1. Topanga Lagoon	December 2003
Site 2. TC Blvd. Bridge MM 2.02	December 2003, August 2004
Site 3. Entrado Rd	
Site 4. Rodeo Grounds Rd.	
Site 5. Falls Rd	April 2004
6. Behind Abuelita's	February 2004, August 2004
7. Backbone Trail	April 2004
8. Highvale Rd.	August 2004
9. Paradise Rd (control)	
10. Zuniga Rd. (control)	October 2004, (first flush)

4. DISCUSSION

4.1 Beneficial Uses and Water Quality Objectives

Standards set by the federal Clean Water Act and the state of California regarding beneficial uses provide the required regulatory goals for achieving the highest possible water quality. Beneficial Uses for Topanga Creek, as the third largest watershed draining into the Santa Monica Bay, are defined in the 1994 Water Quality Control Plan Los Angeles Region (Basin Plan) by the Los Angeles Regional Water Quality Control Board.

Table 25. Beneficial Uses and Water Quality Objectives Summary for Topanga Creek and Lagoon

Parameter	**Beneficial Use Water Quality Objective or Definition**	**Topanga Creek Results**	**Topanga Lagoon Results**
Navigation		NA	NA
REC 1 (Water contact recreation)	Fecal coliform shall not exceed a single sample limit of 400 MPN/ 100 ml	Exceedences at several sites in the upper watershed during 2003-2004	Exceedences in 6 months (Nov 03, Dec 03, Jan 04, June 04, July 04, First Flush Oct 04)
REC 2 (Non-water contact recreation)	Fecal coliform shall not exceed a single sample limit of 400 MPN/ 100 ml	Exceedences at several sites in the upper watershed during 2003-2004	Exceedences in 6 months (Nov 03, Dec 03, Jan 04, June 04, July 04, First Flush Oct 04)
Warm Water	Remain < 80^0F, raise no more than 5^0F above normal	Exceedence on a few dates	NA
Cold Water	Not be altered more than 5^0F above normal	No exceedences	NA
Estuary	Uses of water that support, preserve or enhance estuarine habitats	NA	Limited function
Rare	Uses that support habitats necessary for state or federally listed species	Functions in several reaches of the creek, but limited in upper watershed	Limited function
Migratory	Uses supporting anadromous fish	Limited function	Limited function, Passage opportunities limited
Spawning	Uses supporting high quality habitat for reproduction and early development of fish	Functional areas limited in lower reach of creek	Passage opportunities limited
Wetlands	Uses that support preservation, enhancement of wetland habitats	NA	Limited function

4.2 Santa Monica Bay Pollutants of Concern

Standards for pollutants of concern have also been established in the Basin Plan and through the California Toxics Rule (CTR), with the goal of ultimately setting Total Maximum Daily Loads (TMDL's) for each of these parameters in order to achieve compliance to all standards. The Basin Plan generally establishes a numeric and/or narrative objective for conventional pollutants and minerals, while the CTR has objectives for metals and organics. The 303(d) list identifies the parameters for which each watershed is impaired. Topanga Creek has been listed for lead in the upper watershed and bacteria at Topanga Beach. No other pollutants of concern have been listed for the watershed.

However, levels of nutrients, pathogens, sediments, trash and heavy metals are all potential problems in every watershed. The studies in Topanga Creek have directed sampling to identify if any of these parameters are currently a concern and if so, to identify potential sources and trends of exceedence.

4.3 Bacterial and Viral Contamination

Total and fecal coliform bacteria and Enterococcus are commonly measured indicators of water quality. Total coliform counts include bacteria from numerous sources, including soil, plants, and animals, including humans. These bacteria are important decomposers, contributing greatly to maintaining healthy natural systems. In Southern California where rainfall is limited for as long as 6 months each year, high levels can build up in the soil, along riparian corridors and within pooled systems with little to no flow. When the rains arrive, spikes of total bacteria are associated with the first flush. Subsequent levels decrease as the bacteria are diluted by the higher creek volume, as well as by reduced reproduction related to cooler temperatures and shorter day length. Under ideal conditions, coliform bacteria can reproduce exponentially, generating enormous numbers in a very short time frame. Present standards limit the number of total coliform bacteria to 10,000 MPN/ 100 ml before exceedence causing beach closure.

Fecal coliform bacteria originate in the guts of mammals and birds. Therefore, presence of these bacteria is a good indicator of contamination from sewage, septic systems, greywater systems, wild populations of birds and mammals, domestic and corralled animals. While these bacteria are not necessarily pathogenic, they are readily measured, and have become the standard for evaluating the role of fecal contamination in receiving waters. Fecal coliform contamination has also been associated with impacts to nearshore shellfish. Studies used by the EPA to evaluate different indicator bacteria found that levels of fecal coliform were not as reliable in predicting rates of illness in swimmers as enterococcus (EPA 1986). However, standards for beach closure are still using fecal coliform limits of 400 MPN/ 100 ml.

Enterococcus are found in human feces, as well as that of other warm-blooded animals. It appears to be a more conclusive measure of potential pathogenicity. Comprised of several different species, enterococcus have been found to cause a variety of illnesses in swimmers, including nausea, vomiting, abdominal cramps, and fever. A number of these species include anti-biotic resistant strains, and are a real cause for public health concern. Presently the limit for Enterococcus is 104 MPN/ 100ml before exceedence in marine waters, and a target of <61 MPN/ 100 ml in freshwater.

High levels of fecal coliform bacteria and Enterococcus in particular have been related to increased disease risk for swimmers in the Santa Monica Bay (Haile, et al 1999). Levels of these bacteria typically increase following storm events carrying run-off into the creeks and ocean, and near point source outfalls like those associated with storm drains and sewage treatment plants. Further studies at Avalon Bay, Catalina Island (Boehm, et al. 2003) found contamination results from leaky sewer lines consistent with this problem, as did Taggert (2002) in examining two locations near outfalls at beaches in Santa Monica.

Based on the results of this study, it appears that several locations in the watershed remain problematic for bacterial contamination.

4.4 Locations of "Hot Spots"

It appears from the results of this study that the "hot spots" identified in the previous study remain problematic. Exceedences of fecal coliform and Enterococcus standards at Topanga Lagoon (Site 1), in the lower reach of Topanga Creek (Site 2) during storm events, and at several locations in the upper watershed (Sites 5, 6, 7, 8) indicate that contamination is still occurring. The real issue concerns the sources of the fecal bacteria and phosphates. The synoptic DNA testing did not find evidence of human specific fecal Bacteriodes in any sample. This may be an artifact of the testing process, which perhaps needs further refinement in order to sensitively detect presence of these Bacteriodes. The presence of human specific enteroviruses was more frequent, and was a greater cause for concern since these viruseshave known pathogenicity and are thought to be specific to human contamination.

While these tests were not able to conclusively identify the sources of microbial contamination, they do suggest that septic system, greywater system, contributions of transient encampments, domestic and corralled animals could all make a significant contribution of contaminants to Topanga Creek. Each of the "hot spots" identified, with the exception of Site 2 at the bridge, are located immediately adjacent to one or more of these potential sources.

A real issue of concern is the increase in exceedences of Enterococcus at Site 2. TC Blvd. Bridge. During the 1999-2001 study there were 5 (17%) exceedences for *E. coli*. By contrast, during the 2003-2004 study, 6 (43%) of the samples exceeded saltwater Enterococcus standards. There were no exceedences for total coliform counts during either study, and the percentage of exceedences for fecal coliform remained relatively constant with 13% in 1999-2001 and 14% in 2003-2004. One contributing factor may be the more numerous transient encampments located upstream and the documented problem of human feces being directly deposited immediately on the stream banks at several locations. It may also be related to potentially higher inputs from other upstream sources like septic and greywater systems, and corralled animals. However, the presence of detectable levels of human specific enteroviruses in December 2003 and August 2004, both unrelated to rain events, indicates that humans, rather than animals, may be the more worrisome contributor to the contamination problems.

4.5 Role of Septic Systems and Greywater Systems

The pattern of bacterial contamination, nutrient levels, as well as the positive results for human specific enterovirus DNA at several locations in the upper watershed strongly suggest that septic and greywater systems are indeed contributors to these exceedences. This study was not designed to single out specific sources, but proximity of observed and reported greywater lines at Site 3. Entrado Rd., Site 5. Falls Rd., and Site 8. Highvale Rd. are suspected sources and need to be addressed.

The exceedences observed at Site 6. Behind Abuelita's could be a combination of input from the septic systems of the restaurant and market complex, but there is also direct evidence (observed feces) of impacts from transients. The challenges at this site will require cooperative effort from the adjacent landowners, the Sheriff's Dept. and the County. Topanga Canyon Town Council has installed and maintained two port-o-potties in the parking lot behind the market for several years. While this clearly helps, it has not been enough to off-set the level of contamination at this location.

The picture at Site 7. Backbone Trail is not clear. It is a matter of concern that the site tested positive for human specific enterovirus DNA in April 2004. Given the low levels of flow during most of the year at this location, it would suggest that the sources are fairly close to the sampling location. If this is the case, then transient encampments just upstream are a probable source of human fecal contamination. Removal of the transients and monitoring to ensure that new camps are not established is the responsibility of the landowner, CA Department of Parks and Recreation. Other possible sources include the septic and greywater systems further upstream in the sub-drainage.

The identification of human specific enterovirus at Site 1. Topanga Lagoon and Site 2. TC Blvd. Bridge in December 2003 and/or August 2004 is puzzling. Detection at both these sampling events was also noted at Site 6. and Site 8 in the upper watershed. While there was some rain (0.2 inches) a few days before the sampling, it was not a strong storm. It is not clear if this is related to a specific contamination event that was widespread, or from a series of possible spot sources.

4.6 Role of Domestic, Corralled Animals and Birds

The high levels of fecal and enterococcus bacteria found in the control samples on several occasions, and in Topanga Lagoon suggest that input of fecal coliform bacteria from both natural animal sources and domestic or corralled animals is a contributing factor to exceedences. At both control sites (9 and 10), high levels of enterococcus did not show any evidence of human specific enterovirus RNA, with the exception of the first flush event, when human enterovirus was detected at Site 10. The other sites (5, 6, 7, 8) all tested positive for human specific enterococcus at some time when exceedences occurred, which points more towards septic and greywater as the more probable sources.

The tests for human specific Bacteriodes did not test positive in any sample. It is not clear if this is an artifact of the testing procedure, which is unable to detect levels as well as the standard tests, or possibly related to dilution. It could also indicate that the fecal contamination was primarily from animal sources, except when enteroviral RNA was present, which more directly correlates with human inputs.

In either case, levels of bacterial contamination throughout the watershed remain a pollutant of concern. Development of a suitable TMDL and implementation of strategies to reduce the inputs of bacteria into the upper watershed in particular will require cooperative effort of all residents in the watershed.

4.7 Water Temperature

Most aquatic species have a specific preference for a range of water temperatures. Southern steelhead trout and arroyo chub are the two fish species found in Topanga Creek. Both of these fishes are fairly tolerant of water temperature variations, but prefer a range from 8-16^{0}C

(McEwan and Jackson 1996). The locations where steelhead are found typically remain between 8^0C and 25^0C. In the upper watershed, temperature may be a limiting factor in the distribution of arroyo chub. Chub are the only fish documented in the main stem of Topanga Creek and the Old Topanga Creek sub-drainage upstream of the confluence.

4.8 Nutrients and Algae

Nitrogen-N, Ammonia-N, Ortho-phosphates are all generally associated with anthropogenic inputs into aquatic systems and are directly related to amount of algal growth and potential eutrophication cycles. Results of this study indicate that while levels of phosphates are a concern in the upper watershed, overall nutrient loading does not appear to have exceeded the natural capacity of the creek to absorb and utilize these inputs. Algal growth patterns appear more related to seasonal variation than to nutrient loading.

4.9 Relationship of Water Quality and Sensitive Species Distribution

In addition to the documentation of water quality parameters and endangered fishes, surveys of amphibian and aquatic macro-invertebrates have also been conducted each spring since 2000. Four sample sites are located in the main stem of Topanga Creek, from Greenleaf Rd upstream, in Old Topanga Creek upstream starting at the Backbone Trail crossing, and in lower Topanga Creek from 3200 – 3700m, and from 4550m – 5000m.

While the ubiquitous Pacific Tree Frog (*Hyla regilla*) was found at all locations, more sensitive species such as the CA Tree Frog (*Hyla cadaverina*), CA Newt (*Taricha tarosa*) and Two-striped Garter snake (*Thamnophis hammondi hammondi*) were not present in the upper watershed locations. Western Toads (*Bufo borealis*) were an exception, and were observed in both the lower and upper watershed.

To date, no exotic fish species have been observed in any reach of Topanga Creek, however Red Swamp Crayfish (*Procambarus clarkii*) have been found between Highvale Rd. and the bridge below Abuelita's in the main stem of the creek.

A review of the distribution and diversity of macro-invertebrate species indicates that the most numerous species in the upper watershed are high tolerance level organisms, able to handle sedimentation, low dissolved oxygen levels, and wide temperature ranges. Sensitive macro-invertebrate species have only been observed in the lower watershed where flow is more consistent and other water quality parameters are more suitable.

4.10 Land Use Concerns

The proximity of development to Topanga Creek in the upper watershed and the direct inputs associated with both dry and wet weather exposure has long been a source of concern. With the majority of the watershed in public ownership, only 4,000 acres of private lands, in addition to impacts associated with the roads, are the primary potential sources of contaminants. Using mapping tools like GIS, the amount of development in the watershed as a whole is approximately 12%. According to a recent study of amphibian distribution in the Santa Monica Mountains

National Recreation Area, the threshold of watershed development associated with loss of sensitive amphibian species is about 8% (Riley, et al, in press). Studies of urban impacts on other stream systems shows a range of between 10-15% (Paul and Meyer, 2001). It could be that the more limited rainfall in the Mediterranean climate of Southern California, combined with the non-seasonal flows associated with urban runoff are factors in the greater sensitivity of Santa Monica Mountains streams to development impacts. Given the level of cumulative development in the Topanga Creek watershed, it is remarkable that so many amphibian and aquatic species are still present with relatively high populations.

Previous studies of erosion and sediment transport found that sediment levels in the upper watershed are fairly high as a result of erosion from many anthropogenic sources. This sediment appears to travel in plugs, pulsing down the creek with storm events (Orme, et al 2002). Road maintenance practices, improper fire road cuts and rainy season grading and construction all contribute to this problem.

The problems associated with septic systems located too close to ground water tables have also been previously suspected. It appears from this study that there is some septic and greywater influence on bacterial contamination, but it is not possible given the construct of our sampling locations to point fingers at specific sources.

4.11 Best Management Practices Implications

Several Best Management Practices (BMP's) jump out as important potential ways to improve water quality in Topanga Creek overall, and specifically address the problems with nutrient and bacterial contamination. These include careful placement, maintenance and monitoring of septic systems, providing opportunities to develop affordable, low-tech greywater systems that do not daylight, provide monetary assistance to residents wanting to implement upgrades to their systems, and step up control of transient encampments in the creek.

Additional opportunities include greater effort to compost manures from corralled animals, install green berms and other filtration devices around corrals, and continue efforts to have dog owners pick up after their pets both at home and on park lands.

Most critical will be the continued effort to provide homeowners in areas adjacent to the hot spots at Falls Dr., Behind Abuelita's, along Highvale Rd. and in the Entrado Rd area with information so that they can prevent or correct current inputs into the creek.

4.12 Water Quality in Topanga Creek within a Regional Context

Topanga Creek is the third largest watershed draining into the Santa Monica Bay, after Malibu Creek Watershed and Ballona Creek Watershed, both of which have well documented water quality problems related to intense urban development, increased flows from reclaimed water and urban runoff, and reduced or compromised function of the wetlands/estuary at their mouths. Topanga Creek Watershed is fortunate in that although there is a fairly high overall level of watershed development (12%), imported water is not a significant problem. Topanga benefits from the protection of the entire lower reach of the creek from the town downstream almost 4 miles until it is again constrained by development at Topanga Beach.

To get a sense of how Topanga rates in relation to other local streams, data collected by Heal the Bay's Stream Team from reference sites at HTB-19 Arroyo Sequit (3.38% development cover in 10.96 sq miles), HTB-14 Solstice Creek (2.07% development cover in 4.43 sq miles), and HTB-3 Cold Creek (2.55 % development cover in 0.7 sq miles) were reviewed for 2003. An additional impaired site at Malibu Creek/lagoon having almost 15% development cover in 109 sq miles was also included for comparison.

Table 26. Comparison of Water Quality Parameters from Creeks in the North Santa Monica Bay 2003-04

Site	Average Entro-Coccus	Average Total Coliform	Average pH	Average Nitrogen-N ppm	Average Ammonia-N ppm	Average Phosphates ppm
Target or WQ Guideline	**<104 MPN/100ml (saltwater) <61 MPN/100ml (freshwater)**	**<10,000 MPN/ 100ml**	**6.5-8.5**	**<3.5 ppm**	**2.5-10.5 ppm (pH adjusted)**	**<0.10 ppm**
Topanga Lagoon Site 1	**931**	4970	7.6	0.14	0.11	**0.11**
Topanga Creek – Site 2	**180**	1304	7.8	0.15	0.11	0.10
Arroyo Sequit (HTB-19)	30	2037	7.6	0.65	0.036	**0.14**
Solstice Creek (HTB-14)	56.3	1529	7.6	0.05	0.023	0.06
Cold Creek (HTB-3)	27.3	1040	7.7	0.01	0.035	0.06
Malibu Creek (HTB-1)	75.6	6439	7.9	2.78	0.064	**2.17**

Numbers in bold indicate exceedence of targets or WQO. First flush rain events excluded.

The levels of enterococcus and total coliform bacteria at both Site 1 and 2 in Topanga are significantly higher than not only the reference creeks, but also the identified impaired location at the mouth of Malibu Creek (HTB-1). This was a somewhat surprising result and the sources of the bacterial contamination in Topanga are not entirely clear. In the Lower Rincon Creek Watershed in Santa Barbara County, ducks, domestic animals and human sources were equally identified as responsible sources for high fecal coliform and entero levels (Environmental Health Services, 1999). Detection of human specific enteroviruses at both locations during this study indicate that both human and wild sources are contributing to the problem.

Human enteroviruses were found in samples at one or both locations (Site 1 and 2) in December 2003 and August 2004. Both these locations have significant documented use by a variety of waterbirds, as well as several additional mammal species at Site 2. Bridge. The relationship of input from these potential wild sources to the high values observed in Topanga, as compared to that found in Malibu Creek HTB-1, which experiences even greater inputs from both human and wild sources, is not clear.

The levels of nutrients measured in Topanga Creek are consistent with those found in the other reference streams identified by Heal the Bay, and significantly lower than those found at the mouth of Malibu Creek.

Based on this comparison, it would appear that Topanga Creek and Lagoon do not meet the standards for a reference stream as established by Heal the Bay (Abramson, et al 1998), but rather are representative of a degrading stream that is potentially on its way to impairment. The difficulty is to identify how close the creek is to exceeding the threshold for natural recovery.

Figure 8. Topanga Lagoon

5. RECOMMENDATIONS FOR FUTURE STUDY

5.1 Continued Monitoring

Additional effort is needed to definitively ascertain the sources of fecal coliform and enterococcus contamination in the upper watershed and Topanga Lagoon. Further synoptic sampling with both traditional and DNA testing targeting human specific bacteria and enteroviral pathogens is needed. Additional DNA testing targeting dog, horse and bird fecal signatures would also be a significant addition to the information base. One limitation of this study was that we could only afford to do both sets of tests on 6 out of a possible 14 sampling events. Another limitation was that identification of bacterial sources was limited to human or not human. It would be useful to increase the number of sampling events to capture a broader range of conditions, as well as to more specifically identify bacterial sources. New and more sensitive DNA tests to make such measurements are currently under development and should be available very soon.

The nutrient levels in the upper watershed and at Topanga Lagoon are also worthy of continued monitoring. Although only phosphate levels exceeded the target levels, the chronic input of even low levels of nutrients at so many upper watershed locations suggests that inputs from greywater and septic systems are a real threat. It will not be possible to determine if implementation of recommended BMP's are successful without continued monitoring.

This study did not evaluate current levels of heavy metal, DDT, herbicides, pesticides, or other identified pollutants of concern for the Santa Monica Bay, which is being undertaken by the Los Angeles Regional Water Quality Control Board. Since the upper watershed of Topanga Creek is listed for a TMDL for lead, even though it did not appear to be problematic based on the 1999-2001 study, it would be worthwhile to include testing for levels of lead in future studies.

5.2 Implementation of BMP's

A number of BMP's could be implemented throughout the watershed in order to address the identified problems. Funding sources to assist property owners in implementing these recommendations should be identified and made available to all watershed residents. These include, but are not limited to:

- Installation of bio-filters in septic system outlets to reduce particulates into leach fields or seepage pits, thus reducing bacterial and nutrient contamination potential.
- Installation of a variety of filters to capture sub-surface greywater discharges.
- Installation of additional trash receptacles behind Topanga Market.
- Increased availability of public restrooms in Topanga Center.
- Consistent removal of transient encampments located adjacent to the creek.
- Installation of green berm filter strips on the downslope edges of corrals to prevent manure spills and contaminated stormwater run-off.
- Use of manure composting with runoff control.
- Installation of culvert filters along PCH at Topanga Beach to prevent direct road surface run-off spills into Topanga Lagoon.

- Investigation and upgrade as needed of the septic system at the Topanga Ranch Motel and other commercial and residential structures along PCH.

5.3 Education Efforts

In order to be successful in reducing pollutants into Topanga Creek, Lagoon and Beach, an on-going education program is needed. Funding support for these efforts should be identified and grants sought. Outreach to the students within the watershed through watershed classes such as those conducted yearly at Topange Elementary School for 4th and 5th graders is a great way to teach about the conections between what goes down the kitchen sink and pollution in the creek. Providing workshop opportunities for property owners, including visits to existing septic and greywater systems with innovative ways of reducing contamination has been successful in the past and should be continued on a yearly basis.

Most difficult is to reach out at the neighborhood level to property owners adjacent to identigfied "hot spots". Using the model of neighborhood commitees established by the Topanga Coaliton for Emergency Preparedness (T-CEP), inviting neighbors to gather at a social event, and then providing both a clear picture of the problem and some suggested solutions could help reach those who are not inclined to attend community workshop events.

Additional reporting about water quality concerns in the local paper and web site are also recommended.

5.4 Continued Participation in Regional Water Quality Control and Planning Efforts

With the establishment of TMDL's and septic regulations looming in the near future, it will be critical for representatives of the Topanga Creek Watershed to participate in the process of determining acceptable procedures for maintenance, monitoring and implementation of BMP's. The North Santa Monica Bay Watersheds Committee, Heal the Bay and the Los Angeles Regional Water Quality Control Board will all weigh in on these matters. Topanga has the advantage of still supporting a healthy, diverse environment, and as such, levels in Topanga can be used to develop realistic standards for coastal streams.

6. REFERENCES

Abramson, M. et al. 1998. A Framework for Monitoring, Enhancement and Action. Thesis for 606 Studio, Cal Poly Pomonona

Boehm, A.B., J. A. Fuhrman, R. D. Mrse and S. B. Grant. 2003. Tiered Approach for Identification of Human Fecal Pollution Source at a Recreational Beach: Case Study at Avalon Bay, Catalina Island, California. Environmental Science and Technology, Vol 37(4): 673-680.

CA Dep. of Health Services. Draft Guidelines for Freshwater Beaches. Appendix A. www.dhs.cahwnet.gov/ps/ddwem/beaches

Dagit, R. K. Reagan and C. Swift. 2004. Topanga Creek Watershed Southern Steelhead Trout Monitoring March 2003-2004. Prepared for Pacific States marine Fisheries Commission Contract No. P00110543. Resource Conservation District of the Santa Monica, Topanga, CA

Dagit, R. K. Reagan and C. Swift. 2003. Topanga Creek Watershed Southern Steelhead Trout Preliminary Watershed Assessment and Restoration Plan Report. Prepared for CA Department of Fish and Game Contract No. P0050014. Resource Conservation District of the Santa Monica, Topanga, CA

Dagit, R. 2001. Topanga Creek Watershed Water Quality Study Final Report July 1999-June 2001. Resource Conservation District of the Santa Monica Mountains. Prepared for State Water Resources Control Board 205j Contract #09-070-250-0

Dagit, R. and C. Webb. 2002. Topanga Creek Watershed and Lagoon Restoration Feasibility Study. Prepared for the Southern CA Wetlands Recovery Project Contract No. 00-062. Resource Conservation District of the Santa Monica Mountains

Doan, Tamara, B. Hoover and R. Clark. 2003. California Coast Wide Snapshot Day Report 2003. State Water Resources Control Board, Sacramento, CA

Environmental Health Services. 1999. Lower Rincon Creek Watershed Study: A Field Investigation into the Source of Fecal Contamination in the Lower Rincon Creek Watershed and Ocean Interface (Surfzone). Prepared for the Santa Barbara County Public Health Department, Santa Barbara County Water Agency and Heal the Ocean. Santa Barbara, CA

EPA. (United States Environmental Protection Agency) 1986. Ambient Water Quality Criteria for Bacteria. Office of Research and Development Microbiology and Toxicology Division, Washington, DC

EPA. (United States Environmental Protection Agency) 1983a. EPA Environmental Monitoring and Assessment Program: Integrated Quality Assurance Project Plan for Surface Waters Research Activities. Washington, DC.

EPA. (United States Environmental Protection Agency) 2002. Implementation Guidance for Ambient Water Quality Criteria for Bacteria. Washington, DC.

EPA. (United States Environmental Protection Agency) 1993. Volunteer Estuary Monitoring: A Methods Manual. Washington, DC.

Haile, R.W., et al. 1999. The Health Effects of Swimming in Ocean Water Contaminated by Storm Drain Runoff. Epidemiology 10(4):355-363.

Heal the Bay. 2004. Heal the Bay Stream Team Monitoring website. www.healthebay.org

Los Angeles Regional Water Quality Control Board. 1994. Water Quality Control Plan Los Angeles Region.

McEwan, D. and T. Jackson. 1996. Steelhead Restoration and Management Plan for California. Inland Fisheries Division, California Department of Fish and Game, the Resources Agency, Sacramento, CA.

Orme, A., A. Orme and K. Saunders. 2002. Topanga Creek Watershed Erosion and Sediment Transport Study. Prepared for the Santa Monica Bay Restoration Project Contract No. FC-00-04. Resource Conservation District of the Santa Monica Mountains.

Paul, Michael J and Judy L. Meyer. 2001. Streams in the Urban Landscape. Annual Reviews of Ecological Systems, 32:333-65.

Riley, S. et al. (in press) Effects of urbanization on the distribution and abundance of amphibians and invasive species in southern California streams. IN PRESS Conservation Biology

Rigney, Theresa E. 1993. Citizen Water Quality Monitoring of Urban Creeks. Masters Thesis. University of San Francisco.

Taggart, Mitzy. 2002. Factors affecting Shoreline Fecal Bacteria Densities around Freshwater Outlets at Two Marine Beaches. Dissertation. UCLA School of Public Health, Los Angeles, CA.

Topanga Creek Watershed Committee. 2003. Topanga Creek Watershed Management Plan. Topanga, CA