EXECUTIVE SUMMARY

The purpose of the Topanga Source Identification Study was to examine the various locations where bacterial exceedances of fecal indicator bacteria (FIB) are occurring and to use state-of-the-art methods to identify the possible sources of fecal contamination (human, gull, dog, horse) in lower Topanga Creek and at Topanga Beach. Based on the information gathered, we have identified and suggest some Best Management Practices that could potentially reduce, mitigate or eliminate these inputs and thus improve water quality at Topanga Beach.

Topanga Beach received poor wet weather water quality ratings between 2006 and 2014. The beach exceeded the water quality objectives set for Fecal Indicator Bacteria (FIB) from the Ocean Standards (AB411) based on weekly samples collected by the City of Los Angeles Environmental Monitoring Division. This happened frequently enough for Topanga Beach to be identified by Heal the Bay as the 4th most polluted beach in the state for the 2010-2011 season and as the 10th most polluted in 2011-2012. From 2012-2014, overall precipitation levels were very low, and water quality throughout the Santa Monica Bay was excellent. However, Topanga Beach was listed as “B” for summer dry (April – October 2012), “C” for winter dry (Nov 2012–Mar 2013), and “F” for wet weather year-round (Heal the Bay 2013). In 2014, summer dry was "A", winter dry "B", and "C" for wet weather year-round (Heal the Bay 2014). One of the goals of the Ocean Standards water quality objectives was to reduce the number of exceedances during the recreational season (April 1- October 31). In 2013 there were 17 exceedances and thus far in 2014 there have been four confirmed exceedances.

The information provided in this report includes all data collected from December 2012 through August 2014. Input from the Technical Advisory Committee throughout the study (2012-2014) helped identify data gaps, as well as refined and focused the sampling efforts.

Hypotheses and Results

At the start of the study, we identified the following hypotheses to test.

HYPOTHESIS 1. ***Upper watershed sources of FIB are not conveyed to the beach via the creek.***

Result: The upper watershed is not contributing to the exceedances observed at Topanga Beach. Based on the data collected thus far, FIB levels in the creek upstream of the lagoon do not appear to correlate with exceedances observed at Topanga Beach.

Data indicated that except for a few occasions, mainly associated with either rain events or observed transient activity, fecal indicator bacteria levels from the creek were unlikely to affect surfzone and lagoon water quality. Samples collected from the Pacific Coast Highway (PCH) Bridge, within the lagoon and along the beach in the ocean had clearly different patterns than those observed upstream within Topanga Creek.

HYPOTHESIS 2. ***Concentrations of FIB and/or markers and nutrients decrease as the creek flows downstream from town through the Narrows. Benthic macro-invertebrate community species diversity, sensitivity, and abundance increases as the creek flows downstream.***

Result: Concentrations of FIB and nutrients decrease as the creek flows downstream from town through the Narrows.

Conditions of FIB in the creek in the Narrows section, located between Owl Falls (6500 m) and Scratchy Trail (4800 m) appear conducive to a decrease in EC and ENT levels and observed levels of human- and dog-associated marker.

Nutrient levels in Topanga Creek and Lagoon are low overall, and despite the very low flow conditions in 2012-2014, the pattern of decreasing levels of nutrients as the creek flows downstream are consistent with those observed in previous studies (Dagit et al. 2004). Exceptions to this pattern were observed during rain events and associated with transient activities.

Result: From Owl Falls to Scratchy Trail and Topanga Bridge, benthic macroinvertebrate species diversity increases as the creek flows downstream. However, overall SCC-IBI scores are low throughout Topanga Creek.

The biotic integrity of benthic macroinvertebrate communities in Topanga Creek, as measured by Simpson's Diversity Index and Southern California Coastal Index of Biological Intergrity (SCC-IBI), was highest at Scratchy Trail and Topanga Bridge. Lower downstream, Brookside Drive showed significant disturbance, as this site ran dry twice throughout the course of the study. Throughout the watershed, both low and high flow conditions resulted in decreased IBI scores. Average total coliform in 2014 was also significantly correlated to low SCC-IBI total and EPT taxa scores. Only 16 of a total of 35 samples analyzed (2003-2014) had 500 or more individuals, which limited the ability to apply the SCC-IBI metric. A regional comparison of Topanga Creek to other Santa Monica Mountain sites (Malibu, Cold Creek, Arroyo Sequit, Solstice) revealed that since 2003 Topanga has had very low scores, second only to Malibu. The onset of drought in 2002 has had significant impacts on Topanga Creek, in terms of both SCC-IBI scores and species composition. In spite of low SCC-IBI scores, Topanga remains an important reference creek for the region, as it continues to flow throughout most of the reaches where others run dry.

HYPOTHESIS 3. ***FIB and/or pathogens are not leaking from faulty septic systems in the lower watershed, from septic systems along Pacific Coast Highway in Topanga State Park or from the County Lifeguard facility.***

Result: Testing of the septic systems along PCH indicated that the system at the Ranger residence at the Topanga Ranch Motel was possibly leaking, so repairs were completed in summer 2013. It is no longer leaking. The system at the Feed Bin was also a potential source of leachate and requires repair and further testing to evaluate the input potential into Topanga Creek. The other systems within Topanga State Park do not appear to be leaking, nor does the County Lifeguard facility.

No direct connection between septic systems and FIB at Topanga Beach was found. Although testing in Summer 2013 indicated that the majority of septic systems in the area adjacent to Topanga Lagoon are not likely to be actively contributing any leachate at this time, there are several studies that suggest that there can be a long lag time between input into the ground water table and emergence in either the ocean or a lagoon (Stone Environmental 2004). Since most of these systems have only been capped since 2008, additional testing in the future may be required in order to conclusively document any potential inputs.

HYPOTHESIS 4. ***Lower watershed and/or lagoon sources of FIB (human and non-human inputs such as gull, dog, etc.) are correlated with exceedances at Topanga Beach.***

Result: Contributions from Topanga Lagoon are correlated with FIB levels in the ocean during rain events and when the lagoon is connected to the ocean directly.

FIB levels are significantly increased when the lagoon is breached and connected to the ocean regardless of winter or recreational season.

Result: Dogs and gulls are a significant source of fecal contamination to the lagoon and ocean and likely contribute to exceedances of ENT state water quality standards at the ocean and lagoon sites.

Gull levels were detected 94% of the time in lagoon samples and 80% of the time in ocean samples, indicating that gulls are an important and chronic source of fecal contamination to Topanga Lagoon and ocean sites. Dog marker levels in Topanga waters were similar to those measured at Rosie's Dog Beach in Long Beach, CA and were detected on average 71% of the time at ocean sites and 64% of the time at lagoon sites. This confirms that dog waste is also a significant source of fecal contamination to Topanga Lagoon and ocean.

Result: Human marker was detected infrequently in the creek, lagoon and ocean.

In Topanga, continued sampling for human-associated marker is recommended. During Year 1 (July 2012 to June 2013), human-associated marker was detected in the ocean on five sampling dates, including first flush, and also on four dates in the lagoon, one of which was first flush. There was a total of seven dates with either ocean or lagoon detection. Results from Year 2 (July 2013 – June 2014) are encouraging, as human marker was detected in the ocean on just two days, one of which was first flush. A total of 376 samples were tested. For the lagoon, human hits were observed only during the first flush event of Year 2. Further sampling is needed to determine if this trend continues and if it will continue to occur under non-drought conditions.

Summary of Results

This FINAL report for the Topanga Source Identification Study includes extensive discussion of the following specific efforts in accordance with the deliverables required by the grant, however a summary of the most important results is included here for ease of use.

1. **Present physical and chemical water quality conditions in the main stem of Topanga Creek, and along Topanga Beach and Lagoon.** (See Chapters 6-7)

    - Rainfall was below normal for both years the study took place, and significant rain events were few and far between. Therefore, flow was consistently low throughout the study period as well.
    - The average wetted width of the creek remained fairly constant throughout the study but average depths decreased in some locations in 2014.
    - Water temperature, pH, and specific conductivity were relatively stable and consistent with previous data collected (Dagit et al 2004, 2000-2012 RCDSMM unpublished data).
    - Habitat types remained consistent during the course of the study with riffles, runs and glides dominant in the lower reach of the creek (below 3600 m) and a more complex mix of flow habitats (cascade/fall, riffle, run, glide and pool) found upstream.
    - Geomorphology and gradient affect the types of flow habitats present, with the lower gradient reach below 3600 m (<3%) being dominated by run-riffle complexes and the upper gradient (3-6%) being pool dominated.
    - Smaller substrates such as fines and gravel were more frequent in the lower reach, whereas larger substrate such as cobbles, boulder, and bedrock were more frequent in the upper reach, which has a higher gradient (> 3%).
    - Instream habitat complexity includes abundance levels of filamentous algae, aquatic macrophytes, boulders, woody debris, undercut banks, overhanging vegetation, living tree roots and artificial structures. In 2014, both the lower and upper reaches had greater habitat complexities than in 2013 despite the low flows.
    - The proportions of cover values for several riparian vegetation types were also estimated for the lower and upper reaches. Trees and saplings > 5m had the highest proportion of sparse cover in both the lower and upper reaches.
    - Overall, both reaches of Topanga Creek have relatively stable banks that can support a complex assemblage of aquatic organisms. The higher level of fines and gravel in the lower reach are highly mobile. Snorkel survey and habitat typing focused on habitat for endangered steelhead trout documented the pulses of sediment moving downstream with storm events over time (Dagit and Krug 2011). While the specific location of the sediment slugs varies over time, and results in decreased pool habitat in certain reaches, the overall amount of pool habitat and refugia for fish remained fairly constant, despite a

very wet year in 2005. Overall, channel morphology has also remained fairly constant over time (Dagit and Krug 2011).

- In-situ parameters (water temperature, dissolved oxygen, pH, conductivity, salinity) were, in general, within the standard tolerance ranges for wildlife.
- Nutrient and algae levels were, in general, low throughout the study period, with only occasional exceedances.
- On average, nitrate and orthophosphate levels decrease from Owl Falls (OF, 6500 m; the site closest to town) downstream to the lagoon but this decline is more pronounced between OF and Scratchy Trail (4800 m)
- On average, Brookside Drive (BR, 1700 m) had the highest levels of Ammonia.
- Owl Falls had the highest nutrient levels and Scratchy Trail has the lowest nutrient levels on average.

2. Microbial source tracking results. (See Chapter 3)

- Topanga Lagoon is a source of FIB to the ocean. FIB levels are significantly increased when the lagoon is breached.
- Levels of FIB and all markers increase from the most downstream creek site (SP) to the lagoon. The lagoon may serve either as a location where microbial levels may be increasing due to growth (FIB) or to the presence of new inputs (FIB and markers).
- FIB in the surfzone do not appear to originate from an upstream creek source, except on days when both flow and FIB levels in the upper watershed are elevated. Days where creek input had potential to significantly impact downstream levels occurred on two sampling dates during this study, including the first flush event during year two of the study.
- Winter samples (n=176) were four to eight times higher than samples for the recreational season (n=199) for the dog and gull marker, indicating that these markers follow a seasonal trend and may have more of an impact to water quality during the winter.
- Dog and gull marker levels indicate a significant source of fecal contamination to the lagoon and ocean, and both dog and gull sources are likely contributing to exceedances of ENT and EC state water quality standards at the ocean sites. When ENT levels were in exceedance, gull marker levels were higher than when ENT levels were in compliance at BO, and TL. When dog marker levels in Topanga water samples were compared to levels at two reference beaches and one dog beach, dog marker levels at Topanga were similar to levels at the dog beach. No dog marker was detected at the two reference beaches sampled (Dockweiler and Malibu).
- Human marker was detected infrequently in the lagoon and ocean (13%, n=376). Average human marker values were higher at ocean sites when ENT levels were in exceedance vs. in compliance of state water quality standards. During Year 1 (July 2012 to June 2013), human-associated marker was detected in the ocean on five sampling dates, including first flush, and also on four dates in the lagoon, one of which was first flush. There was a total of seven dates with either ocean or lagoon detection. Results from Year 2 (July

2013 – June 2014) are encouraging, as human marker was detected in the ocean on just two days, one of which was first flush. For the lagoon, human hits were observed only during the first flush event of Year 2.

3. **Description of human health risk associated with human and non-human sources of fecal contamination. (**See Chapter 4)

- Previous studies have well established that there is a correlation between the levels of FIB in recreational waters and incidence of illness when the likely source of fecal contamination is human.
- The risks associated with exposure to non-human sources of fecal matter in recreational water are still not well characterized, as epidemiological data on this topic are insufficient. However, there is some evidence in the literature for greatly reduced risk in water polluted by nonhuman fecal matter.
- Interest is growing in quantitative microbial risk assessment (QMRA) as a framework for understanding risk of illness in recreational water exposure.
- Ongoing research is required to fill data gaps before QMRA can be applied as an effective approach for predicting risk in recreational coastal waters. While US EPA has opened a door, site-specific water quality criteria (as would be derived from QMRA) are still not accepted under California regulations.
- For Topanga to be a candidate for QMRA in the future, testing for host-specific markers and pathogens (viruses) must be continued to assess the downward trend observed in human-associated marker and to monitor reductions in dog and gull pollution as sources. These measurements must continue as the drought ends so the role of the creek can be fully assessed. Depending on those results, it may be possible to conduct a thorough risk assessment and move towards site specific objectives.

4. **Examination of changes in macro-invertebrates, aquatic species of special concern and endangered fishes in relation to water quality conditions.** (See Chapters 8-11)

- Benthic macroinvertebrate Southern California Coastal Index of Biotic Integrity (SCC-IBI) scores increase from upstream to downstream. The lower scores in the downstream sites appears related to lack of flow.
- Both the high and low flow conditions resulted in decreased SCC-IBI scores.
- Although the SCC-IBI score for Topanga Creek was initially documented as Good (46) in 2001, analysis of the samples collected between 2003 -2014 range from Fair to Very Poor, and in fact 19 of 35 samples had too few individuals to apply the metrics.
- Average Total Coliform per site in 2014 (excluding first flush) was significantly and negatively correlated to EPT taxa, and also to total SCC-IBI scores ($F<0.05$, $R2=0.88$, $R2=0.64$). Average nutrient levels did not seem to be correlated with SCC-IBI scores.
- Drought conditions have reduced IBI scores throughout the region
- Crayfish removal had no effect on water quality or nutrient levels.

- Crayfish removal improved BMI community compositions while on-going but the effect was not observed two months after removal ceased.
- Crayfish removal could be beneficial in improving ecosystem health and nutrient cycling within the creek.
- Examination of diatom and soft-bodied algae communities can provide secondary indicators and multiple lines of evidence to better characterize the responses of southern California creeks to both natural (floods, wildfire) and anthropogenic inputs will allow for better understanding of the dynamics of aquatic systems.
- Diatom data from Topanga 2013-2014 provides a baseline snapshot of low flow conditions.
- A total of 125 diatom species were observed in Topanga Creek in 2013-2014. 46 species, many of them of cosmopolitan distribution, were common to both years, with 40 different species found only in 2013 and 39 species found only in 2014.
- *Cladophora glomorata* is the most common algal taxa found throughout southern California. It appears to be a reliable indicator of high total Nitrogen (3.5 mg l-1) (Stancheva et al. 2012) and was also the dominant species observed in both Topanga and Malibu Creeks despite their different nutrient levels. This could possibly be a result of inability to differentiate between species in the same genus that appear taxonomically similar, but in fact represent different species with different tolerance preferences. It could also mean that further refinement of the tolerance limits and preferences is needed.
- Applications of three different indices of biologic integrity showed a consistent picture between sites and creeks for the soft body algae only (S2), diatoms only (D18) and combination of both (H20). These metrics from the Southern California Index of Biotic Integrity (Fetscher et al. 2014) are only recently available, so it is not yet possible to compare the snapshot of conditions in Topanga and Malibu Creeks in 2013 to other sites regionally.

Identification of potential remedial actions and BMP's. (See Chapter 12 and 13)

We recommend that the following potential actions are considered for implementation in order to reduce exceedances at Topanga Beach and improve the water quality and habitat in the upper watershed. Additional recommendations for further studies to continue the investigation of sources of bacteria and other pollutants are detailed in Chapter 13.

Recommended BMP's for Topanga Beach:

1) Restore Topanga Lagoon and Lower Topanga Creek State Park. This is a longer-term project, but by restoring natural function to Topanga Lagoon, it would be possible to not only reduce the bacterial sources but also improve habitat for a variety of endangered species, especially tidewater gobies and southern steelhead trout.
2) Continued enforcement of the County code and additional signage may reduce impact and presence of dog feces. The marker data documents a rise in dog associated markers in the winter months when lifeguard supervision and peer-pressure from beach visitors are reduced. During the study, dogs and dog feces, were routinely observed on the beach. The winning student posters from the poster contest have been affixed to the lifeguard station to assist with public outreach.
3) Continue coordinated enforcement to reduce the number of homeless and transients camping in and around the beach and under the PCH underpass. A mass balance calculation of input of one direct deposit to the lagoon (~200g of human feces) was calculated to result in an exceedance of ENT (Riedel et al. 2014 submitted). Direct deposits were observed at both the lagoon and beach on multiple occasions during the study. Direct deposits associated with the transient population is again an enforcement issue but one that could potentially reduce exceedances.
4) Continued maintenance and monitoring of the Lifeguard Station shower and restrooms. Some drainage from the showers directly to the beach was observed on several occasions. When tides are high or storm events shift the lagoon mouth downcoast in front of the building, there is potential for this to become a source.
5) Investigate possible installation and maintenance of culvert filters along Pacific Coast Highway at Topanga Beach to prevent direct road surface run-off spills into Topanga Lagoon.
6) Upgrade the septic systems at the Topanga State Park along PCH as conditions change and opportunities arise. As the lagoon park plan evolves, incorporating state of the art septic systems into any visitor serving facilities is recommended.
7) Increase outreach to commercial facilities that are on septic systems along the beach. The Feed Bin has the last remaining septic system that is connected to a seepage pit. Upgrading that system should be a priority.
8) Additional patrolling of the state park for transient and RV dumping activity could help with any exceedances in the creek, similarly, further enforcement of the no-dogs-allowed-on-beach rule would probably help with the FIB issues at the beach/lagoon.
9) Increase public outreach concerning the problem with dog feces pollution. While changing behaviors is difficult, peer pressure to pick up after your dog, as well as to reduce the number of dogs visiting the beaches could help.
10) Participate in future monitoring and develop funding to initiate a quantitative microbial source identification study to evaluate the potential for developing appropriate site specific objectives.

Recommended BMP's for the Topanga Creek Watershed:

Although it does not appear that inputs into the upper watershed are associated with the exceedances at Topanga Beach, there are some indications that they negatively impact the creek's ecosystem overall. A number of BMP's could be implemented throughout the watershed in order to reduce inputs to the creek and possibly improve overall conditions in Topanga Creek.

1) Establish a community outreach program to inform residents of potential septic system impacts to the creek and encourage them to upgrade their existing septic systems by installation of effluent-filters in septic tank outlets to reduce particulates into leach fields or seepage pits, thus reducing bacterial and nutrient contamination potential. The community outreach program should include identifying funding sources to assist property owners in upgrading their septic systems.
2) Establish a community outreach program to inform residents of potential impacts to the creek from sub-surface and surface graywater discharges.
3) Through community outreach, encourage the installation of additional trash receptacles behind Topanga Market and Abuelita's.
4) Through community outreach, encourage the availability of public restrooms in Topanga Center.
5) Continue coordinated efforts to remove transient encampments and illegal marijuana farms located adjacent to the creek.
6) Implement the Santa Monica Mountains Local Coastal Program policy for existing equestrian facilities to encourage such facilities to come into compliance with all of the LCP policies and regulations as soon as possible.

Additional recommendations for future research are included in Chapter 13.