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Wet and Dry Weather Natural Background Concentrations of Fecal Indicator Bacteria in San Diego, Orange, and Ventura County, California Streams

Liesl Tiefenthaler[1], Martha Sutula[1], Yiping Cao[1], John Griffth[1], Meredith Raith[1], Carly Beck[1], Roshan Christoph[2], and Jay Shrake[2]

[1]Southern California Coastal Water Research Project Authority, Costa Mesa, CA, US

[2]AMEC, Inc.

EXECUTIVE SUMMARY

Elevated levels of fecal indicator bacteria (FIB) are a common problem in urban surface water and may lead to impairment of beneficial uses, such as swimming or other contact recreation. Once impaired, common regulatory solutions include establishing Total Maximum Daily Loads (TMDLs), incorporating those TMDLs into National Pollutant Discharge Elimination System (NPDES) permits, and other water quality management plans. A reference system approach is a critical element of these TMDLs where natural sources are documented, and a number of exceedance days are allocated based on the frequency at which "reference" sites with natural sources of bacteria exceed established FIB water quality standards. The goal of this study was to characterize the natural background concentrations of bacteria, nutrients, heavy metals and conventional constituents in undeveloped catchments during wet weather (storm), the three days following a storm, and dry weather (non-storm) conditions, and to categorize FIB water quality objective (WQO) exceedance frequency by geomorphologic, hydrologic, biotic and abiotic factors. This report focuses on presenting the findings for FIB, specifically *Escherichia coli* (*E. coli*; EC), enterococcus (ENT), total coliforms (TC) and fecal coliforms (FC).

Specific questions addressed in the study were:

1. How does the WQO exceedance frequency for FIB vary between wet weather, summer dry weather and winter dry weather?

2. How does FIB vary by stream landscape and site-specific factors, including:

- Catchment size and geology?

- Wet weather parameters such as size, timing of storm, and number of antecedent dry days? And

- Dry weather factors such as flow, stream physiochemical parameters (temperature, conductivity, and turbidity), chemical parameters (nutrients, organic carbon, metals, and conventional constituents) and trophic status, as measured by algal abundance?

Flow-weighted sampling of FIB was conducted during a total of eight storm events at 5 sites, for a total of 118 FIB samples over the period of January 2012 to May 2015. In addition, 427 FIB samples were collected during weekly dry weather sampling in 10 intermittent stream sites in 10 watersheds located in San Diego, Orange and Ventura Counties from January 2012 to August 2014. Nutrients, trace metals and other conventional constituents were collected biweekly; while these data will be presented in a separate report, they are used here as supporting data. Sites were selected to meet reference screening criteria and to represent a mix of watershed size (varying from <33 km^2 to > 66 km^2) and sedimentary versus igneous/metamorphic geology. The humanassociated fecal microbial source marker HF183 was used to eliminate sites or samples with potential human contamination. FIB concentrations and fluxes from this study were compared with data from previous studies in the region.

The study had five major findings:

1) FIB exceedances occurred in natural sites and were highest in summer dry weather. (April –August). Exceedances of single sample WQOs occurred at annual frequencies ranging from 1.4 to 3% for TC and EC, and up to 30% for ENT. No exceedances of FC single sample WQOs were observed. Annual frequencies of 30-day geomean WQO exceedances were 0% for EC and FC, but 48 and 30% for ENT and TC, respectively. Exceedance frequencies were highest in the summer, spiking up to 40% for ENT single sample WQO and 68% for the 30-day geomean WQO. Exceedance frequencies were 15- 20% higher then rolling-versus monthly 30-mean is used.

2) Storm EMC exceedances were low except for ENT. Based on seven storms, EMC exceedances of single sample WQOs were 0% for EC, FC and TC. For ENT, exceedances on the day of storm was 87% for ENT and 37% for the three "grab" days following the end of the storm. This frequency increased for EC and TC to 29% if the pollutograph maximum is used. The number of storm events captured was not sufficient to investigate the effect of geology or watershed size on storm EMCs.

3) The HF183 human-associated fecal microbial source marker was successfully used to exclude sites and samples with potential human fecal contamination, ensuring that the documented exceedance rates are attributable to non-human sources. FIB levels in natural streams likely result from a combination of natural inputs, such as wildlife, birds, and soil erosion and instream bacterial growth facilitated by high summer temperatures, availability of nutrients and presence of decaying organic matter.

4) Temperature, and to a lesser extent, nutrients and organic carbon, were the major factors associated with higher summer dry weather FIB concentrations and exceedance frequencies. No significant relationships were found with either watershed size or geology during dry weather. Water column FIB concentrations could not be attributed directly to

instream benthic algal biomass as a measure of stream trophic status, which was low and showed no distinct seasonal variation. In contrast, FIB, temperature, organic carbon and nitrogen spiked at the end of the season, coincident with the end of stream flow. This is a naturally-occurring cycle where organic carbon and nutrients are increasingly recycled from organic matter as flow diminishes and temperature increases, conditions which coincide with increased FIB concentrations.

5) Storm EMC fluxes were 2-3 times higher than dry weather FIB fluxes documented during this study. Wet and dry weather fluxes were comparable to those documented in previous southern California regional studies. This comparability of the study data to previous results suggests that data from this study can be used, in addition to other regional datasets, for regulatory applications of reference study results in the greater southern California region.

Full text: **862_StreamFIBs.pdf**