Technical Note:
Dilution of Bacteria between the Storm Drain and Wave Wash

Two local studies have examined dilution between the storm drain and wave wash during dry weather, though no similar studies have been conducted during wet weather (Taggart, 2001; City of Los Angeles 2001). In the two studies conducted at storm drains discharging to Santa Monica Bay, researchers have observed a high degree of variability in the amount of dilution with dilution between the storm drain and wave wash spanning the gamut from 100% to negative values. In Taggart study, the researchers reported variability in the percent dilutions observed was large (see attached), with standard deviations nearly as high or higher than the average percent dilutions of the log densities of the bacteria indicators.

There are several potential explanations for the observance of "negative dilution". Negative dilution values indicate a higher indicator density was observed in the wave wash than in the storm drain discharge. First, in the study conducted by Taggart, initial analysis suggests that measurement error, as estimated from duplicate samples, is able to account for some, but not all, of negative dilution values observed. Second, there may be a source of bacteria in the surf zone other than the storm drain such as birds or bathers. Third, the apparent "negative dilution" observations may be due to the large amount of variability in the bacteria densities observed in the shoreline and in the discharge since the samples from the storm drain and shoreline were not collected from the same parcel of water.

1. Taggart Study

1.1. Methodology

The overall methodology used in this research was to repeatedly measure bacteria densities at one shoreline station located at the point where a stormdrain discharges urban runoff over the course of the dry, summer season. Simultaneous measurements of the bacteria densities and flow rate of storm drain discharge were collected along with data on the ocean and surfzone conditions that existed during the sampling. This research was a collaborative effort by the Southern California Coastal Water Research Project (SCCWRP), Heal the Bay, the Santa Monica Bay Restoration Project, the City of Los Angeles, and the Los Angeles Regional Water Quality Control Board.

The storm drain investigated for this research is the Santa Monica Canyon storm drain located in central portion of the Santa Monica Bay. Throughout the dry season, 32 sampling events were conducted at the Santa Monica Canyon storm drain. The sampling events were scheduled to capture a range of discharge and ocean conditions. Each sampling event consisted of one grab sample at the shoreline discharge point where the storm drain discharge enters the surfzone and a grab sample from the storm drain discharge above the tidal prism. In addition, the flow rate of the storm drain discharge was measured and data on various ocean parameters that potentially affect dispersion of bacteria within the surfzone were collected from available online databases. These parameters included wave height, swell direction and frequency, wind direction and speed, and tide conditions. Longshore velocity in the surfzone was measured at each sampling event by releasing discrete dye loads into the surfzone and then timing the dye movement along the shoreline.

Sampling was conducted from late March through September, 2000. None of the sampling events were conducted during rain-influenced days, assumed to be during any rainfall event over 0.1 inch in the watershed and the following three days.

Three fecal bacteria indicators were measured in each sample collected: Total coliform, E. coli, and enterococcus. The standard monitoring protocols and laboratory methods used by the local health agencies and POTWs in Southern California were followed in this study. Laboratory analyses were initiated within 6 hours of collection time. Samples were analyzed by the City of Los Angeles' microbiology laboratory using the defined substrate methodology. Enterococcus was quantified by the Enterolert system and total coliform and E. coli were quantified using Colilert by Idexx Corporation.

1.2. Summary of Results

In the dilution study by Taggart, researchers concluded that ocean conditions that significantly affect dilution are site-specific and that the scale of the variability observed in dilution was likely on the order of hours. Their study found that factors affecting dilution at the Santa Monica Canyon storm drain included tide height, and to a lesser extent, wind speed, wave height and longshore current. The effect these parameters have on dilution is likely site-specific. For example, the effect of tide height on dilution may be impacted by the slope and configuration of the storm drain channel. It is likely that more dilution would occur at channels with a shallow slope and a discharge point that easily allows ocean water to enter as the tide height increases. The impact of wind speed, wave height and longshore current on dilution will depend on the local beach topology and the general orientation of the beach to the predominant incoming swell and wind direction. The parameters found to affect dilution at Santa Monica Canyon can vary on time-scale of hours. For example, tide height fluctuates in a semi-diurnal manner in S. California and wind speed was correlated with time of day.

Lastly, the researchers point out that few significant relationships between dilution and the storm drain discharge parameters or ocean conditions in the surfzone were observed, indicating much of the variability observed in dilution was not explained. They conclude that the reason more of the variability could not be explained may be because additional factors not considered in their research are important and/or the relationships between dilution in the surfzone and the various ocean parameters studied are more complex than the relationships examined in their study.