

The Simultaneous Application of Chemical and Biological Markers to Identify Reliable Indicators of Untreated Human Waste and Fecal Pollution in Urban Philadelphia Source Waters

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Abstract : This paper publishes the results of the first known study conducted in urban Philadelphia waterways that simultaneously utilized anthropogenic chemical and biological markers to identify suitable indicators of untreated human waste and fecal pollution. A total of 13 outfall samples, 30 surface water samples, and 2 groundwater samples were analyzed for fecal contamination and untreated human waste using a suite of 25 chemical markers and 5 bio-markers. Pearson rank correlation tests were conducted to establish associations between the abundances of bio-markers and the concentrations of chemical markers. Results show that 16S rRNA gene of human-associated Bacteroidales (BacH) was very strongly correlated (0.76 - 0.97, $p < 0.05$) with labile chemical markers acetaminophen, cotinine, estriol, and urobilin. Likewise, human-specific F- RNA coliphages (F-RNA-II) and labile chemical markers, urobilin, ibuprofen, cotinine and estriol, were significantly correlated (0.77 - 0.95, $p < 0.05$). Similarly, a strong positive correlation (0.67 - 0.91, $p < 0.05$) was evident between the abundances of bio-markers BacH and F-RNA-II, and the concentrations of the conservative markers, trimethoprim, meprobamate, diltiazem, triclocarban, metformin, sucralose, gemfibrozil, sulfamethoxazole, and carbamazepine. Human mitochondrial DNA (MitoH) correlated moderately with labile markers nicotine and salicylic acid as well as with conservative markers metformin and triclocarban (0.31 - 0.47, $p < 0.05$). This study showed that by associating chemical and biological markers, a robust technique was developed for fingerprinting source-specific untreated waste and fecal contamination in source waters.

Keywords : anthropogenic markers, bacteroidales, fecal pollution, source waters, wastewater

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