Evaluation of Wastewater Chemicals as Indicators of Human Fecal Contamination

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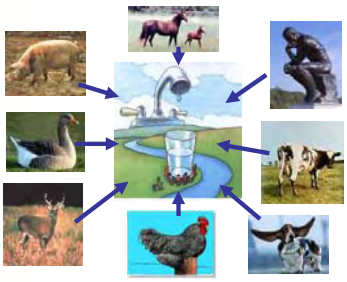
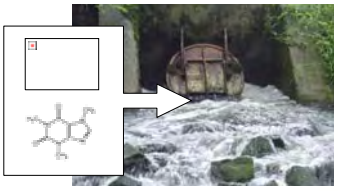
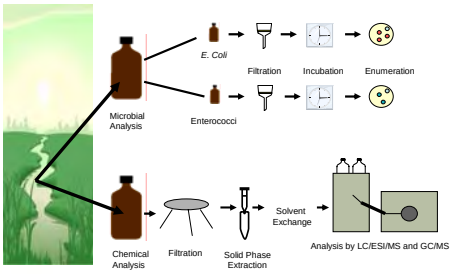


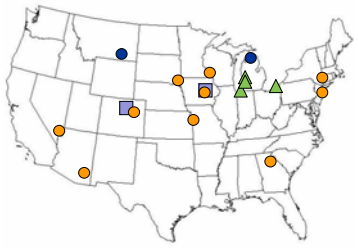
The quality of drinking and recreational water is currently ascertained using indicator bacteria. The traditional tests that analyze for these bacteria require approximately 24 hours to complete and do not discriminate between human and animal sources. One potential solution is to use human wastewater chemicals (such as pharmaceuticals, personal care products, surfactants, and fragrances), which would require shorter analysis times and are human specific. Numerous questions about the presence, persistence, fate and transport of wastewater compounds must be answered before their ability to serve as indicators of human fecal contaminations can be determined. This information was gathered through a series of projects in collaboration with the USGS, each designed to further the understanding of the behavior of the chemicals.



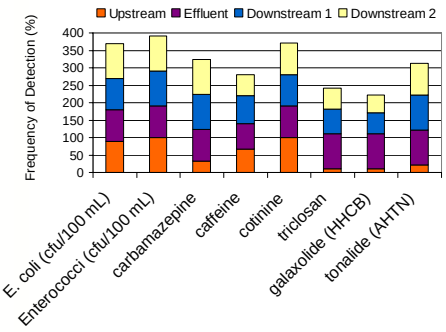


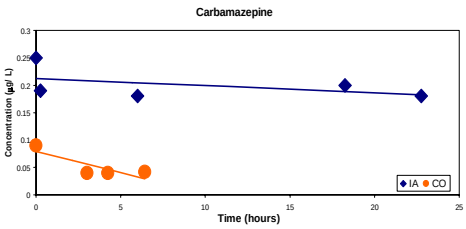
Experimental protocol used for this project.

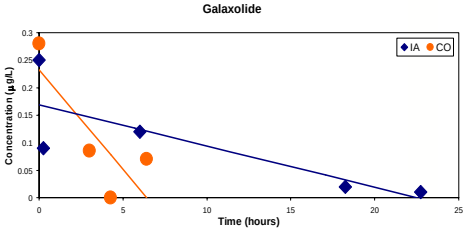
- The first step was to determine which chemicals survive wastewater treatment, and obtain information about their environmental persistence. An effluent sample and water samples were collected up- and downstream from ten wastewater treatment plants. The samples were analyzed for pharmaceuticals using liquid chromatography mass spectrometry (LC/MS) and gas chromatography mass spectrometry (GC/MS) for the bulk of the wastewater chemicals.
- To further refine the information gathered in the first step, a dye tracer study was performed at two locations to determine the time it takes for a given parcel of water to travel from a wastewater treatment plant to successive downstream sampling points; this is known as a Lagrangian study. By knowing the time of travel, the kinetics of the changes in concentration can be calculated, which can be used to better quantify persistence.
- Knowing the environmental occurrence and persistence, the third step was to conduct an epidemiological study (the National Epidemiological and Environmental Assessment of Recreational (NEEAR) Water Study) to determine if there is a link between these chemicals and negative health impacts.



Sampling locations:
- Wastewater treatment plant (WWTP) study
- Background locations sampled with the WWTP
- Lagrangian study
- Epidemiological study







The above graphs illustrate the results from the first two phases of the chemical indicator evaluation project.

- The six chemicals in the left graph are representative of the persistence patterns of 110 chemicals analyzed in the project. Caffeine and cotinine show nearly equal frequencies of detection in all of the sample types and are the most persistent; this was similar to the persistence of the indicator bacteria *E. coli* and enterococci. Triclosan, galaxolide and tonalide exhibit low frequencies of detection upstream and markedly decreasing frequencies of detection downstream, and can be classsified as ephemeral. Carbamazepine shows a persistence between the two extremes. The compounds in the latter two groups would be useful to determine temporal or spatial distance from the contamination source.
- The two graphs on the right were generated as part of the Lagrangian study in Fall 2003. The difference in the persistence of carbamazepine and galaxolide can clearly be seen. A second round of sampling occurred in Spring 2005. The results from both sampling periods will be used to calculate pseudo first-order rate constants to quantify the decrease in concentration.
- The true utility of these wastewater chemicals to serve as indicators of human fecal contamination is currently being evaluated in an epidemiological study.