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Use of Tracers to Identify Sources of Contamination in Dry Weather Flow

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For watershed managers, the location of potential sources of bacterial contamination is an important step in addressing urban water quality concerns. Inappropriate or illicit discharges may account for a significant amount of the pollutants discharged from storm sewerage systems (Pitt and McLean, 1986), including wastewater that can be an important source of fecal coliforms and pathogens. The development of screening techniques to detect these discharges is a valuable tool in the management of urban watersheds and in achieving water quality goals in receiving waters.

Urban stormwater runoff is often made up of not just the traditional precipitation that drains from city surfaces, but also waters from many other sources, including illicit and/or inappropriate flows into the storm drainage system. The EPA's Nationwide Urban Runoff Program (NURP) recognized the significance of the impacts of pollutants from inappropriate entries into urban storm sewerage (USEPA, 1983). The final NURP report concluded that the costs and complications involved with locating and eliminating such connections might pose a substantial problem in urban areas, but provides opportunities for dramatic improvement in the quality of urban stormwater discharges.

The following article contains a description of the procedures developed during research conducted on locating inappropriate discharges, especially the factors in selecting tracer indicators and identifying source waters. These methods can be used in any urban watershed, although the selection of specific tracers would vary depending on the likely source flows. An important premise for the development of this methodology was that the initial field screening effort would require minimal effort and expense, but would have little chance of missing a seriously contaminated outfall. This screening program would then be followed by a more in-depth investigation to better determine the significance and source of the non-stormwater pollutant discharges.

The screening approach is based on the identification and quantification of clean baseflow and the contaminated components during dry weather flows. If the relative amounts of potential components are known, then the importance of the dry weather discharge can be determined. As an example, if a dry weather flow is mostly uncontaminated groundwater, but contains 5% raw sanitary wastewater, it could still be an important source of pathogenic bacteria.

Tracers can be used to identify relatively low concentrations of important source flows in dry weather flows in storm drains. An ideal tracer should have the following characteristics:

- Significant difference in pollutant concentrations between possible source waters.
- Small variations in pollutant concentrations within each likely source water.
- Conservative behavior (i.e., concentrations do not change due to physical, chemical or biological processes).
- Ease of measurement with adequate detection limits, good sensitivity and repeatability.

Selection of Possible Tracers of Flow Sources

Table 1 compares the usefulness of candidate tracers to identify different potential non-stormwater flow sources. Generally speaking, natural and domestic waters should be uncontaminated. Sanitary sewage, septage, and industrial source waters can produce toxic or pathogenic conditions. Other source flows, such as wash and rinse waters and irrigation return flows, may cause nuisance conditions, or critically affect aquatic life. Field traces marked by a black circle can probably be used to identify the specific source flows by their presence. White circles indicate that the potential source flow probably will not contain the field tracer, and may help confirm the presence of the source by its absence.

Readers will note that bacteria, specifically the fecal coliform to fecal strep. bacteria ratio (FC/FS), has not been included as a candidate field tracer. Geldreich (1965) proposed this measures as a potential way to identify if a contamination source is human or nonhuman in origin (FC/FS > 4 = Human; <0.7 = Non-human). Die-off rates of the component bacteria, however, were found to vary over time and space, making this measure too undependable as tracer for sanitary sewage contamination (see Table 2). There may be some value in investigating specific bacteria types, biotypes or markers, but much care needs to be taken in the analysis and interpretation of the results.