Applying knowledge to improve water quality
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Analysis of the first-flush phenomenon and pollutant relationships within stormwater runoff

Nonpoint stormwater runoff remains a leading threat to surface water quality in the U.S. To better design more effective BMPs by understanding the nature of pollutant runoff loads with respect to the hydrograph, many studies have been performed on the first flush phenomenon (the assumption that the initial portion of a rainfall-runoff event is more polluted than the later portions). However, controversy still remains on whether or not the first flush truly exists, which factors influence a first flush, and how best to define the first flush phenomenon. The objectives of this study were to evaluate the first flush occurrence in two small urban watersheds using multiple definitions previously published in the literature, analyze for site-specific correlations between first flush strength and rainfall characteristics (i.e. peak flow rate, runoff volume, peak rainfall intensity, rainfall duration, antecedent dry period, etc.), and determine correlations among various pollutants in stormwater runoff. A year-long study captured stormwater samples from over 30 storm events and analyzed for TSS, turbidity, nutrients and heavy metals. Samples were collected using flow-based sampling frequencies which follow the hydrograph and yield a more accurate quantification of pollutant mass transport throughout the storm event than time-paced sampling used in previous first flush studies. For each collected storm, normalized cumulative pollutant load and runoff volume curves were generated for each pollutant with a minimum of seven discrete curve points to quantify the first flush effect and evaluate for first flush occurrence based on the published definitions (i.e. 80% of total load runoff in first 30% of total runoff volume). Linear regression analyses were performed to determine the first flush coefficients (b) for the power function L' = V'b to analyze for relationships between the first flush strength and rainfall characteristics. Funding partners include: USDA-CSREES, N.C. Dept. of the Environment and Natural Resources-Division of Water Quality, US EPA (319 Program), and North Carolina State University.

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