Title: **Urban Stormwater Infiltration: Assessment and Enhancement of Pollutant Removal**

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Background/Need: Urban stormwater contains a variety of pollutants that may make discharge to surface waters unacceptable. However, common stormwater management practices have limitations. Treatment in municipal wastewater facilities may overload the plant's capacity. Practices involving infiltration through soil and subsoil to remove or attenuate contaminants vary in their effectiveness. The transport of contaminants in saturated soil is commonly described by the "retardation equation." This study assesses the retardation equation for predicting potential contaminant transport and groundwater contamination from stormwater infiltration sites.

Objectives: To determine the extent of contaminant attenuation of atrazine, selected PAHs and metals by specific soils and whether the retardation equation can successfully predict contaminant transport in packed soil columns.

Methods: Batch experiments were conducted to obtain equilibrium soil-water partition coefficients (K_d) using three different soils. A simplified simulated stormwater matrix was created to represent typical stormwater. Packed soil column experiments were conducted to assess predictive capabilities of the retardation equation.

Results and Conclusions: The retardation equation provides a useful framework for comparative assessments of mobility during infiltration by predicting contaminant migration using easily measured soil properties (density, porosity, texture, organic matter content) and estimated or measured contaminant sorption (K_d). However, the retardation model should not be used for simulation of actual transport at a field site because the model does not account for several important factors and processes important in contaminant transport. The model does not account for dispersion, removal and/or permanent retention (degradation, irreversible sorption or precipitation) reactions and non-equilibrium conditions. Also, the model is applicable only to systems where contaminant sorption is reversible.

Contaminant retardation may be substantially different than predicted by the retardation equation. While agreement between observed and predicted mobility was fair for a moderately sorbed organic compound (atrazine), no mobility assessment could be made for more highly sorbed chemicals (phenanthrene and fluoranthene) since they were undetected in soil columns.

The K_d value for the specific soil contaminant system is the largest source of error in the retardation model. Several interrelated factors contribute to uncertainty in the K_d: 1) the assumption of equilibrium for the contaminant-soil adsorption-desorption reactions as the contaminant migrates through the soil may be invalid; 2) slow desorption rates may cause the contaminant to migrate more slowly than expected; 3)

K_d values measured in batch equilibrium systems may differ from actual K_d in soil columns due to differences in soil dispersion, particle size distribution, surface area, and available sorption site density.

Stormwater matrix compositions (major anions and cations; DOC) is highly variable and can have an important influence on contaminant mobility. The simulated stormwater used in this study does not reflect variability in composition and associated contaminant behavior encountered at field sites.

Organic contaminant predictive equations adapted from published information did not adequately predict K_d for PAHs in soils with low fractions of organic carbon. This is an important limitation of these equations.

All assumptions of the retardation must be met before using the equation as a predictive tool. It is unlikely that all the assumptions will be met at an actual field setting.

Recommendations/ Implications: Appropriate field studies should be conducted to fully characterize stormwater matrix constituents, especially DOC and colloid concentrations. Bacteria and virus abundance, viable lifespan and potential to transport contaminants should also be measured in future field studies. Laboratory methods other than the standard batch technique should be developed to measure more realistic K_d values.

The retardation equation may be more useful (qualitatively) if expanded to account for partitioning in soils with low organic carbon or decreasing organic carbon with depth. Equation expansion could also include the effects of DOC and colloids on transport. At minimum an equation which includes the effects of dispersion should be used for predictive modeling.

Key Words: Atrazine, PAH, Phenanthrene, Fluoranthene, Zinc, Copper, Packed Soil Column

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Final Report: A final report containing more detailed information on this project is available for loan from Wisconsin's Water Library, University of Wisconsin - Madison, 1975 Willow Drive, Madison, Wisconsin 53706 (608) 262-3069.