WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: TN4041

Title: Investigation of Factors Controlling Transport of Microbial Pathogens in Saprolite Soils

Focus Categories: Groundwater, Non Point Pollution

Keywords: groundwater quality, contaminant transport, wastewater, public health, septic tanks, bacteria, viruses, infiltration

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Congressional District: Tennessee, 2nd

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Abstract

Recent field and laboratory tracer experiments in the fine-grained saprolite that mantles much of the bedrock of the southern Appalachians and the Valley and Ridge physiographic regions indicate that colloids (microorganisms and other suspended particles) can travel very rapidly through these relatively low hydraulic conductivity soils (McKay et al., 2000; Cumbie and McKay, 1999; Harton, 1996; Cumbie, 1997; Haun, 1998). This phenomenon has been attributed to flow through fractures and root-holes in the saprolite, which act as fast-flow pathways in an otherwise low permeability material. This suggests that microbial pathogens may also be highly mobile in saprolite and could result in contamination of wells or springs used for water supply. The first hypothesis for this study is that bacteria-sized pathogens will have greater mobility in saprolite than larger (Protozoa), or smaller (Viruses) pathogens. This is what was observed in experiments using latex microspheres in saprolite (Haun, 1998; Cumbie and McKay, 1999), where the larger particles experienced greater losses due to settling and the smaller particles experienced greater losses due to attachment to fracture walls. The second hypothesis is that chemical composition of the effluent will have a major influence on pathogen attachment and retention in saprolite, with greater retention occurring in more concentrated solutions. This can help immobilize pathogens near the septic field, but may become less effective during seasonally wet periods when the effluent is rapidly diluted by infiltration. The objectives of the study outlined in this proposal are to test these two hypotheses under controlled laboratory conditions, using 1-2 undisturbed, representative samples of typical East Tennessee saprolite, and geochemical conditions typically found near a septic system, and in the zone of dilution downgradient of the system. The saprolite columns have been collected from an existing field research site in Eastern Tennessee (Smith et al., 2000). The transport experiments will utilize microorganisms that are representative of each of the three main types of pathogens: protozoa, bacteria and viruses. The

microorganisms chosen for the experiments are the protozoa Cryptosporidium, and Giardia, gram-positive Coccus bacterial strain and an Escherichia coli bacterial strain, and the viruses MS-2 and PRD1. The chosen microorganisms cover a wide range of sizes and are either completely non-pathogenic or have a very low potential for infection, but have transport characteristics that are similar to important pathogens. The influence of groundwater geochemistry will be evaluated by repeating the transport experiments using influent solutions that are representative of conditions both near a septic field (high ionic strength, high dissolved organic carbon, etc.), and further downgradient, where the contaminants are much more dilute. This study will help assess the susceptibility of fractured saprolite to contamination by pathogens and will be of interest to a wide variety of researchers, consultants and regulators. It will also provide the scientific basis for larger-scale studies.