USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: ASSESSMENT OF THE EFFECT BIOTURBATION ON ADVECTIVE CONTAMINANT EXCHANGE AT THE SEDIMENT-STREAM INTERFACE

Duration: September 1, 1996 to August 31, 1998

Combined FY 1997 & FY 1998 Federal funds:

$ 92,239(Total) $ 92,239(Direct) $0 (Indirect)

Combined FY 1997 & FY 1998 Non-federal funds allocated:

$185,784(Total) $101,649(Direct) $ 84,135(Indirect)

Principal Investigators:

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Congressional District: 3rd District of South Carolina

Critical Regional Water Problems:

Analysis of surface water contamination is a concern of many regions, including the State of South Carolina and the Southeastern U.S. The combination of threats to the quality of the riparian environment includes the discharge of industrial and municipal wastewater, agricultural runoff, and non-point source pollutants. Analysis techniques have progressed from examining the transport of contaminants in the free surface water (water column) to examination of the concentrations of the transported contaminants in the benthic zone (stream bed). As indicated in the Request For Proposals. additional study of water quality problems is a research priority in the Southeast & Islands (SE& I region).

The development of numerical models to assess the transport of contaminants in the water column has benefited from a growing knowledge of the interaction of prevalent physical and chemical processes. An expanding knowledge of the relevant chemical processes has made way for the extension of these models to encompass contaminant flux and storage within the benthic zone. This has been demonstrated in the work of Farley (1992) and Farley and Elzerman (1993). However. knowledge of the physical mechanisms which dominate this flux for a given type of streambed material is still lacking. Modelers have been forced to base exchange coefficients upon a limited number

of empirical values. which are then used to estimate conditions at sites with widely differing physical and chemical characteristics. For example. the OTIS model by Runkel and Broshears (1991) does perform the representation of contaminant storage within a reach, but accomplishes this by the use of an empirical coefficient which aggregates flux to and from a hypothetical "dead zone". Assessment of contaminants in the surface waters of the Southeast and Island region can be improved with additional information in this area.

On a national level, the U.S. Environmental Protection Agency is just beginning to develop sediment quality criteria. Interim criteria are based on a conservative translation of water quality criteria. The translation is conservative because benthic exchange processes are ignored.. Unfortunately, the American economy does not support trial and error or overly conservative water quality management approaches. American industry needs finely tuned guidance and regulations to remain globally competitive. These guiding regulations must be firmly based on scientific knowledge and validation data. Such advances will therefore assist in managing toxic hot spots in the Great Lakes, critical estuaries in Florida and along the Atlantic and Gulf coasts, San Francisco Bay, Puget Sound, Chesapeake Bay, and in major rivers like the Mississippi, Columbia. and Hudson. The 1993 Mid-West flood yielded elevated levels of pesticides and nutrients that contaminated sediments throughout the Mississippi and into the Gulf of Mexico. Unfortunately, neither the magnitude or location of sediment contamination could be predicted.

Water quality problems within South Carolina include dioxin in waste discharges which can seep into the sediments of the Sampit River and Winyah Bay (McCutcheon, 1994). Hot spots of phosphorous are leaching into Charleston Harbor at unknown rates, potentially contributing to future eutrophication. Spills or low level releases of radioactive elements into the Savannah River from the Savannah River Site will likely continue. Therefore, the rate of contaminant transport into and out of river sediments must be understood to protect drinking water, biota, and recreational benefits.

Results and Benefits

The advection of porewater through sediment material, due to pressure gradients from the surface water flowing above, contributes to the flux of contaminants into and out of a stream bed. The goal of this project is to assess the effect that bioturbation has upon that advective contaminant exchange mechanism. The exchange of contaminants with the sediment plays an important role in the transport and fate of pollutants in river systems. Several tracer studies at Little Lost Man Creek in California by Bencala and Kennedy (1984) have shown this. The modeling of mechanisms that drive this exchange of solutes and water in the stream-catchment continuum is an emerging area of research (Bencala et al.. 1993). Advances in our understanding of these phenomena will benefit the development of analytical and numerical solutions to the contaminant transport problem. Knowledge gained from this study will help engineers and scientists in their current attempts to assemble models which describe contaminant transport across and within stream beds. As these solutions develop, proper management of water quality will be

accomplished more reliably. Better stream and sediment quality criteria can be developed nationally, and critical SE&I regional problems can be addressed.