INVESTIGATING THE ROLE OF SURFACE-GROUNDWATER INTERACTIONS ON SURFACE WATER QUALITY

by

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Identification and statement of the major regional water problem:

In the state of Alabama, most of the population obtains their water supply from surface water (USGS, 1987) and therefore it is important to identify and solve the problems that affect surface water quality. There has been a growing interest in understanding the mechanisms involved in surface water/groundwater interactions since these interactions play a crucial role in the behavior of contaminant transport both in streams and groundwater. Surface/groundwater interactions influence downstream water quality significantly since the concentration distribution both in a stream and in groundwater changes due to this exchange and the biogeochemical reactions occur between the minerals in the subsurface and the minerals in the streams. Furthermore, the interaction has an important impact on estimated total maximum daily loads (TMDL). TMDL is defined as a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources (EPA, 2005). According to the section 303(d) of the 1972 Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters (EPA, 2005). In the Section 303(d) list of the Clean Water Act (CWA) of the State of Alabama, there are over 100 surface waters including Three Mile Branch and Catoma Creek in Montgomery and Pepperell Branch and Moores Mill Creek in Lee County that do not meet applicable water quality standards (impaired waters) (ADEM, 2002).

The Weeks Bay watershed of Baldwin County in South Alabama is affected by high mercury contamination (USGS, 2004). Current research shows that there is a strong influence of groundwater inflow into the surface water and therefore the mercury concentration of surface water may be greatly affected by the chemistry of groundwater. In order to determine the groundwater inflow in this river basin, temperature measurements are taken in Fish River and Magnolia River. Harvey et al (2002) reported that the surface and groundwater interactions have an important effect on mercury transport in the North-central Everglades. Consequently, in order to have accurate information about the amount of pollutants in the surface water bodies one has to account for the surface/groundwater interactions. The aim of this proposal is to identify and quantify the interactions between surface water and groundwater and investigate the model performance by conducting well-controlled laboratory experiments. These models will be especially useful for solving practical water quality problems in small-scale Alabama watersheds, where the interaction between surface water and groundwater is particularly important in controlling surface water quality.

Statement of results, benefits, and/or information:

In this project, we will use two types of experiments to analyze the contaminant exchange between surface water and groundwater. The first experiment is designed to measure the lateral path of a contaminant plume as it interacts between surface water and groundwater along the flow path. The second experiment is designed to predict the vertical path of a contaminant plume as it interacts between surface water and the subsurface water beneath it. The experimental results will enhance physical-chemical understanding of the concentration distribution in surface water and groundwater. The outcome of this project will help understand the transient behavior of contaminants in
zones between the open channel and the aquifer and therefore the change in pollutant loads in surface waters that will affect the water quality in river basins.

The outcomes of this project serve as the foundation for a large grant proposal, which will focus on enhancing usefulness of existing models and developing improved models that can be incorporated into well-known hydrodynamic and water quality models. Our focus will be to develop a large proposal that can be submitted to the United States Department of Agriculture (USDA)-Cooperative State Research, Education, and Extension Service (CSREES) for the National Integrated Water Quality Program (NIWQP). The goal of this program is to contribute to the improvement of the quality of U.S. surface water and groundwater resources through research, education, and extension activities. A good example for a water quality model is EPD-RIV1. EPD-RIV1 (Martin and Wool, 2002) is a one-dimensional hydrodynamic and water quality model which consists of two parts: EPD-RIV1H (hydrodynamic) and EPD-RIV1Q (water quality). EPD-RIV1H predicts flows, depths, velocities, and water surface elevations. EPD-RIV1Q predicts the change in sixteen different state variables including carbonaceous biochemical oxygen demand, organic nitrogen, ammonia nitrogen, nitrate + nitrite nitrogen, dissolved oxygen, organic phosphorus, phosphates, algae, and coliform bacteria. The enhancement of such a model by modifying it to interact with groundwater models would allow us to better predict the water quality and allow us to more accurately estimate the TMDL for various water bodies.