Mar 2nd, 1:00 PM

Session 2A: Nonpoint Source

Kentucky Water Resources Research Institute, University of Kentucky

LITTLE RIVER WATERSHED DELINEATION AND "MISBEHAVED" KARST DRAINAGE

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Abstract: Groundwater hydrology of the southwestern two thirds of the Little River basin, in southwestern Kentucky, is dominated by well-developed karst in a sinkhole-plain. Previous groundwater-tracer investigations (1987 and 1994) documented karst underflow of topographic watershed boundaries of the Little River (Figure A). This Nonpoint Source (NPS) project expanded on these earlier dye tests and a previous NPS groundwater investigation by Ray and others (2005).

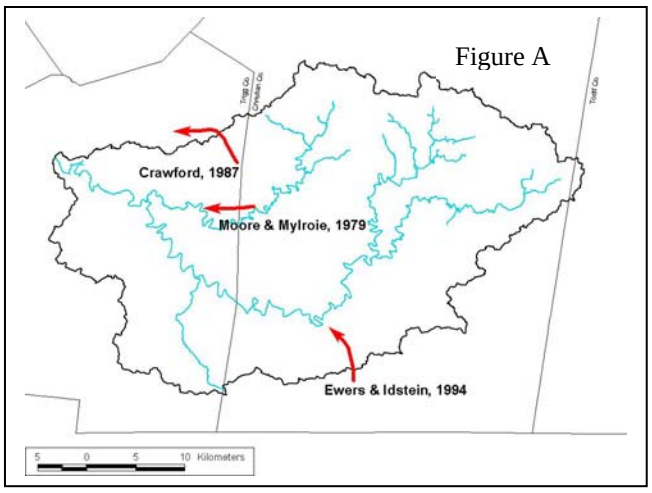

Figure A

Accurate karst watershed information is vital for effective emergency response to spills and for reliable monitoring of waste and industrial sites. Likewise, karst groundwater data are important for assessment and abatement of NPS pollution from agriculture, transportation, and urban settings, and for evaluation of Total Maximum Daily Loadings (TMDL's) of pollution for regional streams. Hydrologic Unit Code (HUC) watershed delineations mapped by the U.S. Geological Survey (USGS) comprise the existing watershed-boundary data-set to be tested by additional groundwater tracing. These digital HUC boundaries were mapped entirely from topographic divides, which often vary significantly from actual groundwater divides in karst regions.

Forty-nine tracer tests were conducted to map spring basins and test the established HUC boundaries. Forty dye injections were successfully detected in 17 spring basins and two sub-basins, for an 82% test-recovery rate. Interpreted groundwater flow paths averaged 5.3 km, but extended up to 15 km. Groundwater velocities averaged greater than 30 m per hour. The highest documented velocity exceeded 130 m per hour. Rapid velocities within these lengthy groundwater flow paths demonstrate the sensitivity of karst terrane to spills and ambient pollution and highlight the importance of their identification.

The minimum annual discharge of study-area springs ranges from 1.7-169.9 L/s. Groundwater basin and sub-basin areas, based on tracer tests and topographic divides, range from 2.0-186.6 km^2. Unit base flow (UBF), or the ratio of discharge to basin area,

ranges from 0.44-14.54 L/s/km^2. Most spring basins in the well-developed karst of the sinkhole plain yield a UBF of 2.0-2.75 L/s/km^2. UBF deficits at some springs suggest unmeasured sub-fluvial springs. Bordering the sinkhole plain to the northeast, a moderately-developed shallow karst setting has been identified that yields about half the UBF of the sinkhole plain. In contrast, Murphy Spring yields 7 times the typical UBF because of unaccounted cutoff diversions from Montgomery Creek.

Karst groundwater drainage that is incongruous with topographic basins is termed "misbehaved". For the purposes of this study, misbehaved karst drainage is defined as *verified conduit flow passing beneath a delineated 14-digit or lower HUC boundary*. As shown by successful tracer tests, **39%** of 17 karst basins contain misbehaved drainage, ranging from 10-99% of individual basin areas. Of the entire 638 km^2 of karst-basin area in which tracer tests were conducted, **48%** exhibited misbehaved drainage. These data demonstrate that identified karst drainage basins, rather than HUC delineations alone, comprise the most accurate and appropriate watershed research and management units in karst areas.

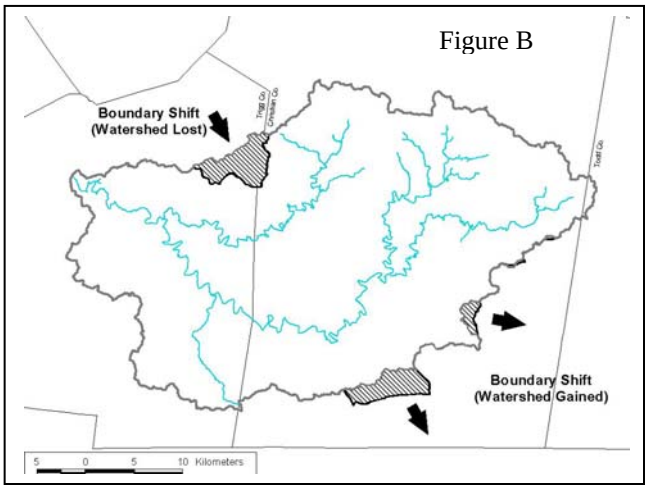

Figure B

This study supported previous work and concluded that Little River basin enlargement occurs in the southeast, with watershed gains from West Fork Red River of about 23 km^2. Equivalent basin reduction occurs in the northwest with watershed losses to Muddy Fork (Figure B). Unusual karst drainage documented in the region includes intermittent karst windows and lakes, seasonal overflow distributaries up to 5.6 km wide, a 2.2 km-wide perennial distributary, audible subterranean waterfalls, conduit flow beneath a perched aquifer, and conduit underflow of the bedrock channels of West Fork Red River, Montgomery Creek, and Little River.

Karst groundwater basins and conduit flow routes mapped during this NPS study will contribute significantly to a future issue of the Kentucky Geological Survey's Map and Chart Series entitled *Mapped Karst Groundwater Basins in the Hopkinsville 30 x 60 Minute Quadrangle*. Acquisition of these karst data is an efficient use of 319h Nonpoint Source funding and provides vital information for future studies and response to environmental emergencies.

Crawford, N.C., 1987, Groundwater flow in the vicinity of a gasoline spill near Gracey, Trigg County, Kentucky, Consultant's Report.

Ewers, R.O., and Idstein, P.J., 1994, Quarles Spring groundwater basin analysis, Fort Campbell, Kentucky: EWC Final Report.

Ray, J.A., O'dell, P.W., Moody, J.R., Blanset, J.M., and Blair, R.J., 2005, Identification and prioritization of karst groundwater basins in Kentucky for targeting resources for nonpoint source pollution prevention and abatement: Kentucky Division of Water, 136 p.

COMPREHENSIVE COMMONWEALTH WATER EDUCATION PROJECT

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This presentation will focus on the products, progress, difficulties, and successes of the Comprehensive Commonwealth Water Education Project. The Comprehensive Commonwealth Water Education Project ("CWEP") is a statewide, federally funded project designed to educate adult Kentuckians about the impact of nonpoint source water pollution. Through surveys of Kentucky citizens, water pollution was identified as the number one environmental problem in the state. However, few Kentuckians understand the sources of water pollution or how to prevent the impact of water pollution. The goal of CWEP is to use the talents, resources, and knowledge of the project partners to provide Kentuckians with the knowledge of the cause and effects of water pollution. To achieve this goal there are several components to CWEP including professional development for educators; a Kentucky State Standards aligned curriculum for grades K-8 based on the "Living Stream" at the Salato Wildlife Education Center; a documentary and virtual field trip produced by Kentucky Educational Television; the Kentucky Growth Readiness Project; and a media campaign produced by Western Kentucky University, WKYU-PBS. The Kentucky Environmental Education Council will assess all products, including the educator professional development workshops.

The educator professional development project is designed to educate formal and non-formal teachers about the impacts of nonpoint source water pollution. The project is a standards-based program wherein the regional universities will implement the program in their basins and will serve as the project basin contact to assist with disseminating information to citizens of the universities' basins. The Salato Wildlife Education Center and the participating universities are each developing a Kentucky standards aligned curriculum.

Kentucky Educational Television created a water documentary explaining sources of nonpoint water pollution and the ways to address the problems. The documentary is divided into segments so that it can be used in a classroom setting. The virtual field trip will also be a tool that teachers can use in the classroom.

The Kentucky Growth Readiness Project curriculum is based on the University of Connecticut Nonpoint Source Education for Municipal Officials (NEMO) curriculum that has been adapted for use in other states. With the assistance of the Tennessee Valley Authority, the Kentucky Division of Water developed the program to educate public officials, developers, farmers, builders, and consumers. There are presentations directed to specific audiences that the trainers can adjust depending on their audience. The

trainers are able to communicate through the internet and the tools for the project are available through the CWEP website and the Kentucky Growth Readiness Handbook.

The media campaign includes television, radio, and print public service announcements. In addition, there is a website that incorporates all elements of CWEP, including the water documentary, the virtual field trip, public service announcements, the Kentucky Growth Readiness Project, and the Educator Professional Development Project. These tools will be made available to the public through the grant partners and CWEP basin contacts.

The Kentucky Environmental Education Council is developing assessment tools to measure the accomplishments of CWEP. This will include pre- and post- test scores for the participants of the workshops and the professional development programs. Furthermore, the Kentucky Environmental Education Council will include several nonpoint source questions in the environmental literacy survey it commissions every five years. KEEC will also conduct focus groups with citizens and then assess impact of CWEP within Kentucky communities. Project partners will continue to improve the project through the continuing assessment of CWEP.

The CWEP partnership includes: Kentucky Educational Television Foundation, Inc.; Western Kentucky University, Center for Water Resource Studies; Kentucky Division of Water, Watershed Management Branch; Kentucky Waterways Alliance; Kentucky Department for Fish and Wildlife Resources; University of Kentucky, Tracy Farmer Center; Kentucky Geographic Alliance; Kentucky Environmental Education Council; Kentucky Division of Conservation; University of Kentucky Cooperative Extension; Northern Kentucky University, College of Education; University of Louisville, Center for Environmental Education; University of Louisville, Department of Geography and Geosciences; Western Kentucky University, Center for Math, Science, and Environmental Education; and Murray State University, Center for Environmental Education; University of Kentucky Water Resource Institute; Kentucky Association of Counties; Kentucky League of Cities; and Western Kentucky University WKYU-PBS. The wealth of expertise that these partners bring to the project will make it possible to deliver to Kentuckians effective and accurate information regarding nonpoint source water pollution.

ASSESSMENT OF WATER QUALITY TRENDS IN THE UPPER CUMBERLAND RIVER BASIN: FOCUS ON PATHOGEN IMPAIRMENT

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The upper Cumberland River Basin (8-digit HUC 05030101) has continued to be significantly impacted by pathogen problems for several years. These impacts are due to various causes including the improper operation of wastewater treatment plants, straight pipes and failing onsite treatment systems, and other non-point sources. The Kentucky Division of Water began an extensive sampling effort in 1993 that has continued up to the present. In 1998, a formal TMDL (Total Maximum Daily Load) for the entire region was developed that focused on eliminating point sources primarily associated with improperly operated wastewater treatment plants within the basin. Subsequent to the development of the TMDL, several million dollars of wastewater projects have been implemented in the region as a result of funding provided through EPA, Eastern Kentucky PRIDE, and the Army Corps of Engineers.

In order to assess the potential impacts of these projects, a 319 project was implemented for the purposes of collecting and assessing water quality data in the region for the last 10 years. The analyzed data were obtained from the Kentucky Division of Water (both ambient and focused sampling) and from PRIDE (both synoptic and focused sampling). The data were evaluated using both deterministic and statistical measures at four different levels: regional, county, station, and project sites. In general, the analyses indicated measurable improvements in the majority of data sets, however several sites in Harlan County still appear to exhibit problems associated with high fecal coliform concentrations.

NOTES

WATERSHED & LAND USE PLANNING: A BMP TECHNOLOGY TRANSFER PROJECT

A Case Study of the Dry Run Watershed Basin

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The Georgetown-Scott County Planning Commission, working with CDP Engineers, Inc., is conducting a pilot project for watershed planning that will encompass properties within the City of Georgetown and Scott County. The plan was submitted and approved by the Kentucky Division of Water – Non-Point Source Section, as a Section 319(h) grant for FFY 2004. The study area is defined as the "Dry Run Watershed Basin" that incorporates approximately 8000 acres (12.5 sq.mi.). The basin is generally located north of downtown Georgetown at the confluence of Dry Run Creek and N. Elkhorn Creek (i.e., Moss Park and Bi-Water Farm), extending north towards and including approximately one-half of the Toyota Motor Manufacturing of Kentucky (TMMK) property, Anne Mason School, Derby Estates, Scott County Fire Station #1 and Harbor Village. Approximately one-third of the proposed study area is currently located within the current Urban Service Boundary (USB) with the potential growth area per the Comprehensive Plan process to increase to over one-half of the study area within a minimum of ten years.

Based on development projections, the Dry Run Basin is the area identified for future growth and urban development within the community. There are several factors that will guide growth into this basin including the construction (completion) of Champion Way, construction of Anne Mason Elementary School, installation of a sanitary sewer trunk line and related infrastructure, construction of the proposed northwest bypass connecting U.S 460 at Western Elementary/Canewood to Cherry Blossom Way/Delaplain Road at I-75 (exit 129). This area was also identified as a growth corridor during the 1991 Comprehensive Plan review.

Once completed, the watershed plan would provide a long range plan for development within this area. The Watershed Plan will be a proactive measure to guide development, storm water and establishing water quality features (BMP's) including open space,

riparian areas, trail linkages, etc. This plan will also provide the baseline elements for a drainage study that would be used by the design and development community as they propose various developments within the basin area.

This project will be a proactive step in watershed planning, including developing a land use plan and storm water model for this basin and for the entire community. This plan has the potential of being an innovative approach to land use planning, storm water planning, and environmental assessment and planning. It is our goal, upon completion of the plan, to present this to various local, state and potentially national organizations, including publication in national journals.