Request for Proposals

Pharmaceuticals, Consumer Product, and Wastewater Contaminant Chemicals in Surface Water, Ground Water, and Drinking Water

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Notice to Prospective Bidders

Recent studies by the U.S. Geological Survey (USGS) (Kolpin *et al*., 2002; Barber *et al*., 1995) and others (Daughton and Jones-Lepp, 2001; Kümmerer, 2001) have indicated that chemicals associated with pharmaceuticals and personal care products (PPCPs) are widely present at low concentrations in the surface waters of the United States and Europe. In addition, recent sampling studies by the U.S. Centers for Disease Control (CDC) have shown a subset of these and similar chemicals present in source waters survive drinking-water treatment processes and remain present in delivered drinking water. The purpose of this project is to evaluate the presence and behavior of these compounds in drinking water treatment, riverine systems, and ground water.

The anticipated effort will require 800 to 2000 hours of technical effort (2 to 5 MEng students), leading to a draft final report on April 19, 2004. Assuming a one-week review by sponsors, a final report is due on Friday, May 7, 2004. In addition, the successful team will be expected to make one or more oral presentations to the client and the public.

To be considered, prospective bidders are asked to forward a letter of intent (LOI) with team qualifications to the above address by 5:00 pm, October 2003. The LOI should be no longer than 2 pages, exclusive of resumes, and should outline the team's preliminary plans for the project. Bidders will be notified by October 10 if they have made the short list, and successful bidders will be asked to submit a full technical plus cost proposal by December 5, 2003.

Background

An increasing number of published reports are documenting the widespread presence in surface water of organic chemicals originating from municipal wastewater. Chemicals commonly found in the surface waters of the U.S. include caffeine, estrogen derivatives,

antibiotics, antibacterials, fragrances, detergents, and pharmaceuticals. Environmental engineers and scientists are just beginning to evaluate the implications of these findings. Although the chemicals are present at low levels, the effects to aquatic organisms of constant exposure, long-term exposure, and exposure to a mix of chemicals are unknown. Also troubling is the discovery that many of these chemicals are not removed by conventional drinking-water treatment and are present in the drinking water supplied to some communities.

This study, conducted in cooperation with the Centers for Disease Control (CDC) in Atlanta, Georgia, seeks to evaluate the behavior of such chemicals as revealed by an extensive data collected by the CDC. The CDC has collected water samples of source water and at several points in a water treatment plant and analyzed those samples for an extensive set of organic chemicals. They have requested additional analysis of these data sets from an environmental engineering perspective to understand better the determinants of chemical behavior during wastewater treatment. CDC has also collected an extensive set of chemical analyses of private drinking-water wells in the Midwestern United States. They have requested additional analysis of this dataset in light of land use and other environmental factors using GIS or related analytical tools. An additional potential component of this project is an evaluation of the prevalence and concentration levels of these types of organic chemicals in Massachusetts in two river systems of similar size but differing character. The Assabet River, particularly at low flow, is an effluent-dominated stream. At the once-in-ten-years seven-day-average low flow (7Q10), 80 percent of the river flow originates from wastewater discharged by four municipal wastewater treatment plants along the river. In contrast, the Ipswich River receives no major municipal wastewater discharges and most wastewater is either disposed to ground water via on-site septic systems or exported from the basin. The degree to which organic chemicals in wastewaters from on-site systems can migrate via ground water to the river system is unknown. The comparison of the two rivers is expected to shed light on this question.

Proposed Study

The specific topics to be addressed in this study are flexible and should reflect the interests and talents of the project team.

One potential component of the study is the analysis of the CDC drinking-water treatment data set. A variety of analytical approaches are viable for this part of the study including:

- statistical analysis of the data to identify significant trends and correlations between chemical response to water treatment and chemical properties (e.g., by principal component analysis)
- development of a simulation model of organic chemical fate in one or more water-treatment unit processes.

Other analytical techniques are applicable to the CDC ground-water quality data. Specifically, land-use and other geographically-based factors are expected to be an important determinant of the presence of certain organic chemicals in well water but have

not yet been analyzed. GIS data for land use, geology, hydrogeology, soils, and other physiographic features are available for at least a subset of the study area. Analysis of relationships between these geographic features and the observed presence and concentrations of well-water contaminants is desired, with the goal to determine land-use and other factors that indicate a likelihood of ground-water contamination.

Some of the data provided by CDC may be confidential and will require special consideration. These data should not be distributed without written permission by the CDC and publication of the data must be cleared by CDC.

The Massachusetts river component of this study requires at least one and preferably two participants with a background in chemistry. The study will entail the analysis of low concentrations of organic chemicals in river water samples using novel analytical techniques and equipment (liquid chromatography to identify the compounds coupled with UV fluorescence and/or mass spectrometry in order to quantify the concentrations—LC/UV/MS). Another essential part of the proposed study is field data collection. The team will need to monitor streamflow to identify periods of low flow and then mobilize to collect river water-quality samples during low flow. Proper sample collection techniques and sample preservation procedures should be researched prior to the sampling program and followed during the program. The project sponsors also welcome proposals for analysis and assessment of the field and laboratory data that result from this project. Possible activities may include:

- statistical analyses of field data and comparison with data from other studies including the USGS national reconnaissance (Kolpin *et al*., 2002);
- analysis of field data for selected chemicals to determine fate and transport rate constants; and
- development of stream water-quality models to predict the fate and transport of PPCPs in the Assabet River.

Information for modeling the Assabet River is available in a prior M.Eng. project report (Savineau *et al.*, 1999).

Cited References

Daughton, C. G., and T. L. Jones-Lepp, Editors, 2001. *Pharmaceuticals and Personal Care Products in the Environment*. American Chemical Society, Washington, D.C.

Kolpin, D.W., *et al*., 2002. Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999-2000: A National Reconnaissance. Environmental Science & Technology, Volume 36, Number 6, Pages 1202-1211. (http://pubs.acs.org/hotartcl/est/es011055j_rev.html)

Barber, Larry B., II, Jerry A. Leenheer, Wilfred E. Pereira, Ted I. Noyes, Greg K. Brown, Charles F. Tabor, and Jeff H. Writer, 1995. Fate and Transport, Mississippi River Contaminants: Organic Contamination of the Mississippi River from Municipal and Industrial Wastewater. In: Robert H. Meade, Ed. Contaminants in the Mississippi River. Circular 1133. U.S. Geological Survey, Reston, Virginia. (http://water.usgs.gov/pubs/circ/circ1133)

Kümmerer, K., 2001. *Pharmaceuticals in the Environment: Sources, fates, effects and risks*. Springer-Verlag, New York, NY.

Savineau, A., Y. Sumi, T. Raine, and S. McGinnis, 1999. Control of Point and Nonpoint Sources of Phosphorus in Acton, Massachusetts. Master of Engineering Program, Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts. May 1999.

Management, Personnel, Schedule and Budget

The full proposal should include a breakdown of responsibilities by staff member, including the name of a project manager; a schedule for completion including project milestones and progress reports; and details regarding cost, expressed in terms of hours of effort by job classification (staff engineer, project manager).

Basis for selection

The project will be evaluated on a competitive basis using the following criteria:

- does the proposal address the client's needs?
- originality
- likelihood of success
- cost (expressed in terms of people-hours)