USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title:Filter-Adsorbers and Watershed Management for Herbicide Control in Drinking Water: Addressing Small Utilities With Impounded Water Supplies in Midwest Farmlands

Duration:2 years, beginning September 1, 1996 and ending August 31, 1998.

Funding:

	Federal	University	State and Local	Total
Year 1	$24,999	$27,856	$24,840	$77,695
Year 2	$24,994	$27,001	$25,675	$77,670
Project Total	$49,993	$54,857	$50,515	$155,365

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Statement of Research Need:

Pollution of drinking water supplies by agricultural herbicides is a critical state and regional concern. The widespread application of pre-emergent herbicides to row crops in the Midwest states, including Missouri, has resulted in elevated levels of s-triazines (atrazine, cyanazine, simazine, etc.) in seasonal runoff. In north-central Missouri, many rural communities obtain their drinking water from reservoirs that collect agricultural runoff and its associated herbicide residues. These contaminants are suspected human carcinogens and the USEPA has set drinking water maximum contaminant limits (MCL's) in the low micro grams per liter range to minimize adverse health effects, Agriculture-based rural communities and small towns that use impoundments for their water supply are the most adversely impacted health-wise by herbicide use. A conflict exists because substantial economic benefits are obtained with herbicide use in the form of lower net crop production costs. Balancing of adverse health impacts and economic benefits is achieved through control of herbicides levels in the drinking water by a variety of means.

A large number of impounded water supplies in. rural Missouri have excessive levels of atrazine and ten such utilities violated drinking water standards in 1994. As a corrective action, several utilities implemented continuous addition of powdered activated carbon (PAC) in their treatment process. PAC has been effective for the removal of the herbicides; however, it is expensive and presents handling and disposal problems. PAC does not completely remove the contaminants, but removes enough to meet the MCL's. Granular activated carbon (GAC) is known to be an effective alternative to PAC and may be used in filter-adsorbers for the control of highly-adsorbed synthetic organic compounds (SOC's), which include most herbicides. Historically, water utilities in Missouri have not used GAC in their filters and regional studies on the effectiveness of filter-adsorbers for herbicide removal do not exist. Although GAC filter-adsorbers are used in some mid-western utilities, their performance has not been scientifically documented and little is known about their behavior under diverse water quality conditions or when it is advantageous to use GAC versus PAC.

Several important and unresolved issues surround the engineered application of GAC filter-adsorbers. The main question is determining the breakthrough profile of the herbicides since the GAC must be replaced when the effluent herbicide concentration exceeds acceptable levels. Filter-adsorbers may have premature breakthrough due to their frequent backwashing, which turns the bed over. Laboratory batch isotherm studies can give a good indication of GAC adsorptive capacity, but the results are difficult to extend to full-scale processes when several adsorbing contaminants are present. Also, natural organic matter (NOM), which typically occurs at levels of several mg/L in Midwest surface waters, fouls the carbon and interferes with herbicide adsorption. The long-term effect of NOM on herbicide breakthrough cannot be ascertained in bench-scale studies and no field-scale engineering research studies have examined the adsorptive interaction of multiple herbicide contaminants and NOM. Existing models for predicting multi-component breakthrough require calibration with pilot-scale breakthrough curve data. Pilot studies are recommended for systems without operating data from nearby similar plants and waters. For small community water systems, piloting can be prohibitively expensive and the economic risk of implementing full-scale GAC filter-adsorbers too great without such data. Thus, PAC application is the only feasible option at the present. However, if more were known and documented about the performance of GAC filter-adsorbers, another and perhaps better option would be available.

Accumulation of adsorbed NOM, which serves as a food source for heterotrophic organisms. This biological growth presents several potential problems including release of microorganisms into treated water, increased GAC fouling and capacity reduction, production of byproducts leading to taste and odor problems, and release of herbicide metabolites not presently regulated but considered to be as harmful as the parent compounds. The potential for problems increases in small utilities where the water plant operation is intermittent, i.e., the filters are idled overnight. Therefore, assessment of the effects of biological activity is needed to ensure that GAC is a desirable filter medium for small utilities.

In some situations, watershed management may be sufficient to control the release of herbicides to water supplies; thus, treatment may be avoided altogether. The Public Drinking Water Program of the Missouri Department of Natural Resources (MDNR) has initiated and funded studies to determine the identifying features of watersheds, farming practices, and impoundments that result in high levels of herbicides in the water supplies. The purpose of those studies is to direct watershed management efforts to where they provide the greatest benefit. If the contamination level in runoff can not be sufficiently or reliably controlled by management practices or implementation is simply too expensive, then treatment is the preferred alternative and a selection must be made between the use of PAC or GAC. A rationale for this selection process, which may be based on temporal loading characteristics and the organic composition of the water, has yet to be described. A study of the filtration and adsorption performance of filter-adsorbers will provide data on the GAC option.

The city of Higginsville, Missouri has been selected in this proposal for a close examination of the relationship between watershed, reservoir, herbicide levels, and treatment technique. A watershed management plan is being formulated by the USDA-NRCS and data exists on herbicide application rates and resulting runoff levels. Such data needs to be evaluated to determine the effectiveness of watershed management and its impact on raw water quality. Higginsville will be the first utility in Missouri to cease using PAC and install GAC in their filter basins for herbicide control. Two of their four filters will be retrofitted with GAC and a blended finished water will be produced. Thus, the Higginsville plant constitutes the ideal situation for an in-depth study of herbicide control in drinking water through watershed management and the use of filter-adsorbers.

Statement of Benefit:

This project addresses an important need of the North Central Region where each member state has numerous small communities that lack the financial resources to evaluate the performance and benefits of GAC filter/adsorbers and watershed management for herbicide control. Specifically, the following four priority research areas listed in the RFA are addressed: Watershed Processes and Management; Drinking Water Quality, Availability, and Source Protection; Treatment for Small Communities; and, Surface Water Quality. This project is unique because it addresses the effectiveness and connectivity of two control approaches - watershed management to minimize the magnitude of the problem; the resulting accumulation, attenuation, and removal of the herbicides in the reservoir system; and the performance of the ultimate barrier, a GAC filter-adsorber, to prevent the ingestion of these contaminants by the rural population. No published study exists similar to the proposed study. The results of this proposed research wiII include the following:

An assessment of the long-term GAC filter-adsorber performance in regard to filtration and herbicide adsorption, secondary adverse effects and benefits, and cost-effectiveness compared to PAC.

Development of competitive adsorption isotherms for atrazine, cyanazine, and NOM through laboratory batch studies with analysis that compares isotherm predicted filter-absorber breakthrough to the observed breakthrough of herbicides and NM in the Higginsville plant.

Integration of the MDNR watershed data for the HigginsviIle site into a simple lake mass balance model to determine the fraction of applied herbicides entering the water supply and the effect of the impoundment on raw water quality over time. The effect of raw water quality variation on control method selection will be assessed.