Title: **Hydrogeologic and Land-use Controls on Atrazine Detections in Dane County, Wisconsin**

Project I.D.: DNR Project No. 99

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Period of Contract: August 5, 1991 through June 30, 1993

Background/Need: Atrazine, a popular and inexpensive herbicide, has been used extensively during the past 30 years in the corn-producing regions of the Upper Midwest. Concern over the possible movement of atrazine to groundwater led to statewide sampling programs, site-specific investigations of atrazine movement, and approval of the 1991 Atrazine Rule which established atrazine management areas where the use of atrazine is restricted and prohibition areas.

The Rural Well Survey (LeMasters, 1990) indicated that 50% of the rural wells in Dane County, an area of dairy livestock agriculture with high corn production, contained detectable levels of triazine-based compounds.

There was interest in trying to relate atrazine detections to land-use and hydrogeologic characteristics at a regional scale. Previous statewide investigations that attempted to correlate atrazine sampling results with patterns of soils or geologic materials were unsuccessful and limited in approach. To better analyze the physical factors that might affect the distribution of atrazine detections, it was decided to look at a smaller area, specifically Dane County.

Objectives: The primary objective of this project is to determine the soils, geologic, and hydrogeologic factors that affect atrazine contamination of domestic wells.

Methods: In order to examine the physical controls on the distribution of atrazine detections, the land area that contributes water to the sampled wells was determined and land-use practices within those areas was accounted for. The project was conducted in four phases: 1) development of GIS coverages of available soils, geologic, and hydrogeologic information; 2) determination of the zones of contribution (ZOCS) of wells sampled for atrazine; 3) estimation of atrazine application rates within the ZOCs and 4) statistical analysis to examine the relationships among the hydrogeologic factors, land-use patterns, and the detections of atrazine.

Results and Discussion: Compilation of hydrogeologic data suggested the following results: 1) Compiling domestic well construction report information in a relational database and integrating the database with a GIS allow this information to be applied to a variety of problems. 2) PRETRAC, a pcarcplot application developed for this project, greatly facilitated the development of input files for particle tracking models as well as provided a powerful and flexible data exploration tool.

The relationships between atrazine detections and the variables describing physical and land-use factors were difficult to identify and quantify. Nonparametric techniques

such as cross tabulation of categorical data and logistic regression for multivariate analysis proved to be the most useful. Variables of primary importance in predicting whether a given domestic well would have an atrazine detection include 1) atrazine use, 2) presence of shale, 3) presence of Sinnipee Group dolomite as the uppermost bedrock unit over the majority of the ZOC, and 4) location in discharge area. Soil thickness, unlithified materials, and depth to bedrock data all suggest that thin, fine-grained soils may be attenuating atrazine.

Recommendations/ Implications: Soil characterization, geology, and an understanding of the groundwater flow system are important for prediction of atrazine detections. Land-use, presence of shale, and presence of Sinnipee Group dolomite are particularly important. Flow system position, especially location in a discharge area also appears to be important. Fine-grained units, either shale, clay layers in the Sinnipee, or thin fine-grained soils all appear to attenuate atrazine.

The statistical model developed to predict atrazine detection using the detailed soils, geologic, and hydrogeologic data for all 325 wells had overall predictive accuracy of 66%. Stratification of the data and development of separate models for the glaciated and unglaciated portions of the county led to improved overall predictive accuracy. This suggests that prediction of the distribution of atrazine detections is complicated by the variability of natural settings and that predictive models developed for smaller areas, with more consistent soils, geologic, and hydrogeologic characteristics are more likely to be accurate.

Related Publications: Bohn, M.F., and Muldoon, M.A., 1993. Integrating Hydrogeologic Data and Models with a Geographic Information System: Applications from a Regional Pesticide Study. (Abstract) 1993 Environmental Systems Research Inc. User Conference.

Muldoon, M.A. and Bohn, M.F., 1993. Integrating Hydrogeologic Data from Well Construction Reports with a Geographic Information System: Applications from a Regional Pesticide Study. Proceedings of International Association of Hydrogeologists Workshop on the Development of Water Related Information Systems, Washington D.C., May 1920, 1993, 9 p.

Bohn, M., Madison, F.W., Muldoon, M.A., and Connors, K. 1993. Dane County Atrazine Project Database and Documentation: Programs, Data Sources and Methods. Open file report, WOFR 9401, available on diskette from WGNHS.

Key Words: atrazine, land-use, geographic information system (GIS)

Funding: DNR, DATCP, Dane County Land Conservation Department and WGNHS.

Final Report: A final report containing more detailed information on this project is available for loan from Wisconsin's Water Library, University of Wisconsin - Madison, 1975 Willow Drive, Madison, Wisconsin 53706 (608) 262-3069.