Title: **A Simple Stochastic Model Predicting Conservative Mass Transport Through the Unsaturated Zone Into Groundwater (Study No. 1)**

Investigators:

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Objectives: To compare the transport of aldicarb to potassium bromide through the unsaturated zone and into groundwater, test predictions of bromide transport to the water table and the assumptions of the Randomized Plug Flow (RPF) model and show the utility of the proposed method in determining groundwater pollution potential under a particular set of circumstances.

Background/Need: Large spatial variability exists in parameters which measure transport in the unsaturated zone. The model developed in this study incorporates this variability in computing the transport of contaminants through this zone.

Methods: Five experiments were conducted in the Central Sands region of Wisconsin at a research station. The first experiment compared the movement of bromide as a tracer with aldicarb applied in the same manner, by extracting soil water samples at various depths. The second experiment tested the accuracy of a transfer function model (TFM) by comparing its predictions with soil water samples at various depths and samples from wells. Experiment three compared mass transport to the water table under three methods of potato cultivation. The fourth experiment compared the effects of over-irrigation on the three methods of potato cultivation. Experiment five compared in-furrow placement of tracer to tracer incorporated into hills.

Results: Experiment one showed that bromide moved through the soil at a similar rate to aldicarb. The second experiment showed good agreement of TFM with the percent of mass transported to the water table determined from well samples. Results of experiment three were inconclusive due to the large natural soil variability and problems with the sample apparatus. The fourth experiment showed that excess irrigation had minimal impact on the transport rates of bromide under the two hilled cultivation methods; however, transport rates under bed cultivation were much greater when more water was added. Experiment five showed that three times more tracer reached the water table under the in-furrow placement application than for hill incorporation.

Conclusions: Investigators conclude that bromide is an accurate tracer of aldicarb in the unsaturated zone. Rapid movement of substances due to soil property variability is much more important in determining groundwater pollution potential than the average rate of transport beneath a field. TFM may be a

useful tool to predict mass transport to the water table. Excess water runs off the hill treatments but infiltrates through the beds, resulting in an accelerated transport of tracer to depths. In-furrow placement of tracer causes the greatest groundwater pollution potential. RPF may provide good estimates of conservative mass transport to groundwater in sandy soils.

Recommendations/ Implications:

Further study of TFM is recommended to include shorter sample intervals, the use of more replicates to include all the natural variability in the field and an addition of vertical structure to the model. It is also suggested to introduce a retardation factor into the RPF model to test its applicability to less conservative solutes.

Availability of Report:

This report is available for viewing and loan at:

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