

AGRICULTURAL drains in Ontario often have high bacterial, nitrogen, and phosphorus concentrations. The Ausable Bayfield Conservation Authority (1) and the Ontario Ministry of the Environment (5) have established that in some cases land application of liquid manure causes bacterial and chemical contamination of field tile drains. That contamination may result in beach closures due to elevated bacterial concentrations and excessive algal growth.

In a field study by Patni and Hore (6), tile drainage generally was unaffected by manure spreading on fields, except when a heavy rainfall occurred. On the other hand, Evans and Owens (2) found a 30 to 900 fold increase in fecal bacteria concentration in the tile effluent from a sandy clay loam pasture field within two hours of spreading liquid manure. A one-time observation by Patterson and associates (7) found the water from five-foot deep drains in a plowed field to be cloudy and foul smelling within 30 minutes after a 0.2-inch application of liquid manure. Smith and associates (8) stated that macropore flow significantly reduces the soil's ability to retain bacteria and viruses.

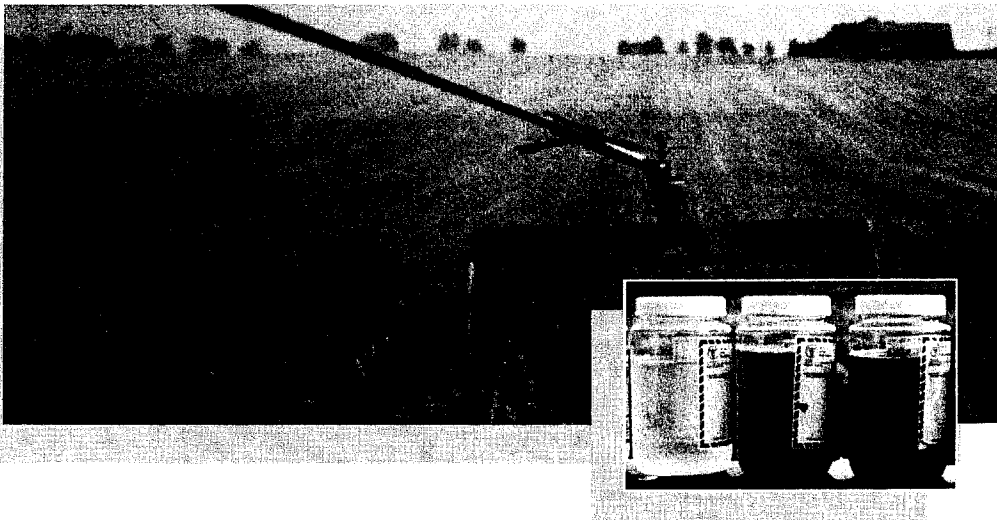
The conservation authority has now monitored 12 liquid manure spreading events under a variety of field conditions on a total of five soil types in Huron and Perth Counties, Ontario. Participating farm operators

and/or custom applicators were asked to spread the liquid manure as they would normally. Eleven of the applications used the irrigation method of spreading, while a tank spreader with manure broadcast on the ground was used for the remaining one. The drainage tile spacing in the field site was systematic at 50-foot intervals, except for two sites (numbers 3 and 8) that were random. Changes in the concentrations of bacteria and nutrients in the soil underlying the area of manure application were monitored, in addition to changes in the tile drain water quality. For nine of the manure spreading events the biotracers—nalidixic acid resistant *Escherichia coli* [EC (NA)] and rifampicin resistant *s. faecalis* [FS (RIF)]—were introduced with the liquid manure to trace the manure's movement through the soil and into the water. These biotracers are readily detected in both soil and water, are not normally present in the natural environment, and are nonpathogenic.

Eight of the 12 manure spreading events resulted in water quality degradation within 20 minutes to six hours following the manure application. Tile flow increased at two sites in response to the liquid manure application. For two of the spreading events that did not result in water quality degradation there was no tile drain flow at the time of manure application. For one other spreading

The effect of farm liquid waste application on tile drainage

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Using an irrigator gun to spread liquids on winter wheat residue. The inset shows drain water samples taken during half hour intervals. One and a half hours after spraying began, the samples were contaminated.

event at which there was no significant contamination, the ground had been tilled just prior to manure application. This may have impeded movement of the manure components by shearing the macropores at the soil surface. For the final spreading event at which there was no significant contamination the soil structure was platy. This perhaps impeded the downward movement of the manure components. A 0.6-inch rainfall the day following manure application resulted in tile drain contamination by the manure components.

For each spreading event, soil bacterial levels including the biotracers were measured at three depths in the soil before and after manure application. Previous research on bacterial movement through soil columns (3, 4, 8) indicated that soil was an efficient filter for bacteria. The concentration of fecal coliform at various depths in the soil, before and after spreading, expressed as number of bacteria per 100 grams of soil is typical of the other spreading events monitored, with the exception of the event where the soil surface had been tilled just prior to manure application. For that particular event fewer bacteria were detected at the lower depths in the soil column.

Based on the 12 monitored events, farm liquid waste applied to land can rapidly

penetrate the soil and contaminate field tile water. An acceptable rate of application was difficult to determine. Further research should be conducted on the impact of farm liquid waste applications on tile drain water and on finding economical methods to reduce the impact and on the water quality.

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Summary of manure application runs

Event No.	Date	Soil Type	Crop Rotation*	Ground Cover and Residue Cover†	Tile Flow	Application Rate (gallons/acre)	Bacterial Increase and Timing
1	5/89	Perth cl	C/S/W	Fall plowed 6%	Yes	8,200	3,400 fold within 2 hours
2	8/89	Perth cl	C/S/W	Wheat residue 95%	No	15,000	Small when flow resumed
3	9/89	Perth cl	C/B/H	Corn silage residue, 57%	Yes	10,000	1,600 fold within 4 hours
4	10/89	Brookston cl	S/C	Soybean residue 76%	No	6,000	Small when flow resumed
5	11/89	Wauseon sl	S/C	Soybean residue 78%	Yes	5,700	1,000 fold within 6 hours
6	5/90	Listowel sil	S/C	Fall plowed 6%	Yes	3,800	200 fold within 5 hours
7	6/90	Perth cl	C/S/W	Seed bed 1%	Yes low	11,900	Small, within 3 hours
8	7/90	Perth cl	H/C/G	Hay 93%	Yes high	10,700	30 fold within 20 minutes
9	8/90	Perth cl	C/S/W	Wheat residue 94%	Yes low	11,300	45,000 fold within 2.5 hours
10	9/90	Listowel sil	C/S/W	Wheat residue 94%	Yes low	4,700	30,000 fold within 2.5 hours
11	9/90	Huron cl	C/S/W	Wheat residue 96%	Yes low	7,700	725,000 fold within 2 hours
12	11/90	Perth cl	C/S/W	Fall plowed 3%	Yes	17,000	290 fold within 2 hours

* C=corn, S=soybeans, W=wheat, H=hay, B=barley, G=grain.

† A 100-foot rope with markings every foot was laid diagonally to the direction of cultivation. The percent residue was determined by counting the number of times that residue was present at the foot markings. Minimum residue size was 1.5 x 0.125 inches.