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Summary

In 1990, a USDA Water Quality Demonstration Project was initiated in the Herrings Marsh Run (HMR) watershed in Duplin County, North Carolina. The HMR watershed is representative of an eastern Coastal Plain watershed with intensive agricultural practices. Ninety-six monitoring wells were installed on 21 farms throughout the watershed to evaluate the influences of agricultural practices on groundwater quality. Nitrate-N concentrations were below 10 ppm on 78% of the farms. Mean nitrate-N concentrations in groundwater at 5 farms exceeded 10 ppm. One farm with an undersized spray field for swine lagoon effluent had nitrate-N concentrations that
were greater than 50 ppm. The spray field was expanded and changes are being monitored. Immunoassay results revealed that the majority of the wells (98%) had <0.2 ppb of triazines, alachlor, and metolachlor, which were well below the maximum contaminant level for safe drinking water. Alachlor was the most frequently detected herbicide. Simultaneously, private residential wells in the watershed were sampled annually for nitrate and selected pesticides. Information on well construction and proximity to potential contamination sources was also collected for more than 100 domestic wells. Nitrate-N levels exceeded 10 ppm in about 25% of the domestic wells. Immunoassay screens for alachlor, triazines, and metolachlor indicated detections in 50% of the domestic wells with most detects <1 ppb. Alachlor was the most frequently detected pesticide in the domestic wells. Well depth and construction appear to be the major factors in determining the potential for nitrate and pesticide contamination. All of the high-nitrate wells and the majority of the wells with pesticide detections were less than 100 feet deep. Other factors contributing to contamination are proximity to cropland and to septic systems.

Project Description

In 1990, a five-year water quality demonstration project involving private industry, local landowners, federal, state, and local agencies was initiated on the 5059-acre Herrings Marsh Run (HMR) watershed in Duplin County, North Carolina. Duplin County has the highest agricultural revenue of any county in North Carolina and had the highest population of turkeys and the fourth highest population of swine of any county in the United States in 1990 (North Carolina Dept. of Agriculture, 1990). Agricultural management practices on the watershed are typical for the eastern Coastal Plain. Major crops on the watershed include tobacco, corn, soybeans, wheat, and vegetables. Fields may be double- or triple-cropped with crops, which may require numerous applications of nutrients and pesticides as part of annual management practices. High rainfall, shallow water tables, sandy soils, and low soil organic matter contribute to a high-risk potential of nutrient and pesticide leaching.

Groundwater monitoring wells were established on 21 farms in the HMR watershed. The farms were selected to represent the watershed both on a geographical basis and the farming practices on the watershed (row crops, effluent spray fields, etc.). Groundwater monitoring wells were sampled monthly and analyzed according to EPA methods and screened for pesticides using immunoassay techniques. Pesticide detects were confirmed by gas chromatography/mass spectroscopy (GC/MS).

Additionally, a residential well water quality education program was conducted on the watershed. During this program over 100 residential wells were sampled, public meetings were held to discuss water quality protection, and land use impacts on private well contamination were evaluated. Residential water supply wells were sampled initially in September 1990 for nitrate, chloride, conductivity, pH, and pesticides. Since 1990, selected wells have been sampled for nitrate and pesticides annually in September-October. A comprehensive questionnaire was compiled by Cooperative Extension Service (CES) specialists to obtain information on well characteristics.

The objective of the initial phase of this project was to evaluate the current water quality status of the groundwater in both agricultural fields and in residential water supply wells. Additionally, the effect of current and improved agricultural management practices on groundwater quality within the watershed was investigated.

Results

Mean nitrate-N concentrations in groundwater monitoring wells were less than 10 ppm on 78% of the farms. Nitrate-N concentrations at 5 farms exceeded 10 ppm, with concentrations ranging from 10 to 18 ppm. Nitrate-N concentrations in groundwater at one farm consistently exceeded 50 ppm. (Stream grab samples at this farm had mean nitrate-N and ammonium-N concentrations of 8 and 4 ppm, respectively). These elevated nitrate-N concentrations were believed to be directly related to the land application of swine wastewater that had been an ongoing operation

since 1986. The spray field for the waste application lacked a permanent grass cover and was undersized because of expansion of the swine operation. The spray field has been expanded and a permanent grass cover has been established. Changes in groundwater concentrations are continuing to be monitored. Elevated nitrate-N concentrations at other farms in the watershed are likely related to nonpoint sources of nitrogen caused by overapplication of fertilizer and animal waste.

Immunoassay techniques have shown that, throughout 1993 and 1994, alachlor, atrazine, and metolachlor were not detected in the majority (98% < 0.2 ppb) of the groundwater monitoring wells. Among the detections, alachlor was most frequently detected (14%). Most of the monitoring wells with detections had alachlor concentrations much less than the maximum contaminant level (MCL) of 2 ppb. The high percentage of alachlor detections was partly caused by 8 wells that had consistent near-monthly positive detections. Alachlor was confirmed by GC/MS analysis in selected wells. Despite the high atrazine usage in the watershed, only a small fraction of the wells (5%) had positive immunoassay detections. Only 2 wells were found to have consistent monthly atrazine detections, and the concentrations were always less than the MCL of 3 ppb. Atrazine was confirmed by GC/MS analysis in selected positive immunoassay detections. The total positive immunoassay detections for metolachlor were low (5%); no metolachlor was confirmed in these samples using GC/MS analysis. Positive immunoassay detections not confirmed by GC/MS analysis may be caused by immunoassay cross reactions with chemically similar herbicides or with herbicide metabolites. Collectively, the data indicates that, despite the heavy usage of herbicides in the HMR watershed, current pesticide BMPs (best management practices) used by local farmers and applicators are successful in maintaining groundwater quality.

Private residential wells in the watershed have been sampled annually for nitrate and selected pesticides. Information on well construction and proximity to potential contamination sources was also collected. Nitrate-N levels exceeded 10 ppm in about 25% of the residential well samples, with annual results indicating approximately the same levels since 1990. Twenty-seven percent of shallow residential wells (<100 feet) had nitrate-N concentrations greater than 10 ppm while none of the deeper wells (>100 feet) had concentrations greater than 10 ppm. Proximity of residential wells to cropland, septic tanks, and lawn and garden chemical application areas were factors contributing to possible elevated nitrate-N concentrations.

Immunoassay screens for alachlor, triazines, and metolachlor have shown detections in up to 50% of the wells. Most detections have been < 1 ppb, although concentrations over the MCL were confirmed in two wells. Frequency of positive responses was in the order alachlor > triazines > metolachlor. Alachlor was detected (>0.1 ppb) in 21% of the residential wells with 3% greater than 1 ppb. Triazines were detected (>0.05 ppb) in 21% of residential wells with 2% greater than 1 ppb. Metolachlor was detected (>0.05 ppb) in 4% of the residential wells with 1% greater than 1 ppb. Results from 1990 indicated that 39% of the shallow wells had pesticide detections, compared to 10% of the deep wells. Residential wells located adjacent to cropland had 48% detections compared to 26% of residential wells located farther from cropland.

In both residential and monitoring wells, approximately 25% of the wells had nitrate-N

concentrations exceeding 10 ppm. Pesticides were detected (at low levels) more frequently in residential wells than in monitoring wells indicating that well construction and use (possible chemical mixing) could contribute to increased possibility of contamination.

Technology Transfer

These results can be used by action agencies, farmers, and agricultural industries to better comply with state and federal water quality requirements. They can be used to provide guidance on activities that are likely to cause environmental problems. This information is being transferred in scientific journals, scientific meetings, extension publications, special topic workshops, public meetings, field days, and media presentations.

Public Affairs Activities

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