Title: **Barnyard Management Practices: Effect on Movement of Nitrogen through Soils and Impact on Groundwater Quality (Study No. 10)**

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Period of Contract: August 25, 1988 through September 30, 1990

Objectives: To determine whether barnyards in the sand plain of Central Wisconsin are contributing nitrate-nitrogen to groundwater.

Background/Need: The primary aquifer of the Central Sands region of Wisconsin consists of highly permeable soils with a shallow depth to groundwater, which makes it vulnerable to contamination. Past research has shown extensive nitrogen groundwater contamination resulting from farming. Agricultural census data indicates significant increases in number of cattle per farm and manure production since 1950, while confined to smaller plots of land. This research investigates the impact of the additional nitrogen loading from animal wastes on farms due to this increase in cattle concentration.

Methods:

Five barnyard locations were selected for soil sampling based on preliminary testing for various nitrogen compounds in the fall of 1985 and spring of 1986. The barnyards were sampled seven times between May and September of 1986, and analyzed for NH_4-N, NO_3-N + NO_2-N and water content. Selection of sampling sites accounted for a range of barnyard management conditions which determine the variability of nitrogen movement and transformations in surface and subsurface soils based partly on moisture relationships and soil compaction.

Water analysis took place simultaneously with soil investigations. Three single depth piezometer wells were initially installed at each farm, followed by multilevel monitoring wells along the determined flow path under each designated study area. Groundwater elevation determinations were made throughout the study period and water samples taken monthly, and biweekly during spring snow melt and fall wet periods. Analysis of samples included NO_3-N, NH_4-N, K+, Cl- and electrical conductivity.

Results:

Three of the five barnyards manifested considerable quantities of accumulated organic carbon (O.C.) in the upper foot of soil in response to manure loading. Lower animal density and mechanical removal of manure account for less abundant quantities in the remaining two barnyards. Field moisture capacities (F.M.C.) ranged from 7-45%, varying as a response to accumulation of organic matter. Soil compaction, though detected at all barnyards, increased with animal density. Finely divided organic matter and hoof compaction prevent water migration and accumulation of soil NO_3-N due to anaerobic conditions.

Organic carbon accumulation and compaction lead to a high water-holding capacity and a protective seal, reducing leaching of nitrate to groundwater. Subsurface nitrate occurred in highest concentrations with well-drained surfaces and insufficient surface seals. Aerated, permeable soil conditions contribute significantly to groundwater contamination, even in areas of limited usage. Variability in chemical consistencies of downgradient water indicate point sources of contamination, which are driven by precipitation runoff and infiltration.

Conclusions:

Investigators concluded that in high-use areas where manure remains intact, hoof-compacted soil forms an organic seal which limits direct chemical leaching and nitrification, though runoff and infiltration do occur at fence lines and depressions receiving runoff from the barnyard. The ammonium buildup poses a potential nitrate problem upon abandonment through drying of the soil leading to aeration, nitrification and leaching. Low use yards and those with regular manure removal lack an effective barrier to nitrification, infiltration, and subsequent leaching.

K is found in higher concentrations than other mineral elements in manure and appears to move similarly to NH_4-N in sandy soils, which may qualify it as a tracer of animal waste in groundwater. Downgradient wells manifested high concentrations of K in the wells receiving leachate from animal waste.

Recommendations/ Implications:

Investigators feel an effective surface seal and containment of runoff may eliminate much of the groundwater contamination associated with confined cattle facilities. Clean water diversions, including rain gutters and sealed, curbed perimeters, and elimination of oversized exercise lots may decrease groundwater nitrate contamination. A concrete curbed surface with manure

removal, runoff containment and land spreading of waste at appropriate rates would provide the most contaminant prevention, and reduce long-term costs through reduced fertilizer requirements and improved cattle health with a drier habitat.

Further study is suggested in the following areas: To monitor and analyze nitrification indicators which could follow dynamics of nitrogen in groundwater, to assess impacts of runoff on uncompacted soil areas along barnyard edges and fence lines, to use potassium as a soil parameter to measure the degree of manure loading a soil profile has received from the presence of a barnyard and to better define a low stock density where NO_3-N leaching would not be a concern to groundwater.

Availability of Report: This report is available for viewing and loan at:

The Water Resources Center
1975 Willow Drive
Madison, WI 53706
(608) 262-3069
Publication 050842

Related References:

Bowen, Bryan Daniel, 1987. Potential for Nitrogen Groundwater Contamination from Animal Confinement Areas in Central Wisconsin. Unpubl. M.S. Thesis, Univ. of Wisc.-Stevens Point, Stevens Point, Wisc., 170 pp.

Travis, Michael J., 1988. Nitrogen Contamination of Groundwater from Barnyards in the Central Sand Plain Aquifer of Wisconsin. Unpubl. M.S. Thesis, Univ. of Wisc.-Stevens Point, Stevens Point, Wisc., 127 pp.

Key Words: Ammonium-nitrogen, barnyard runoff, Central Sands, nitrate-nitrogen, organic carbon, potassium

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