Title: **Fate and Mobility of Radium-226 in Municipal Wastewater Sludge Following Agricultural Landspreading (Study No. 22)**

Investigators:

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Objectives: To provide background information and potential impacts of radium-226 in municipal wastewater.

Background/Need: Radium-226 and its decay product, radon gas, is found in soils, rock formations and groundwater. Certain rocks leach radium to groundwater. Radium in wastewater tends to be adsorbed by wastewater sludge. Past sampling has shown that of 1,300 communities in Wisconsin, 44 had radium levels in drinking water above the state and federal drinking water standard of 5 picocuries per liter (pCi/l). Radium-226 presents a potential health hazard when ingested. This study looks at the threat to food chain crops and groundwater.

Methods: Six sludge land disposal sites were selected for study in areas with high radium levels in the water supply. To obtain background radium activity levels in the soil, control sites were selected which had not received sludge containing radium. All control sites were of the same soil series, general locality and land use history. Soils were sampled at land application and control sites. To determine the percentage of radium removed in sludge, influent and effluent samples were taken at the wastewater treatment plants. Samples were initially analyzed for radium-226 activity and later for pH, organic matter, cation exchange capacity (CEC), particle size, nitrogen, phosphorus, potassium, calcium and magnesium.

Results: Radium-226 activities found in influent, wastewater sludge and effluent for sampled communities are lower than shown in previous testing. The application of sludge containing radium resulted in no apparent change in the site radium activity level. The hazard associated with emanation of radon gases produced during radium decay was not exceeded in any of the soil/sludge mixtures.

Radium activity levels may result in more rapidly increasing radium content from the application of sludge-bearing radium, though farmland application is quite variable in Wisconsin. Drinking water does not carry a significant health hazard of radon gas emanating from soils. Downward migration of radium in soil was not expected from the literature. Radium is more slowly released from clay soils than other similar alkaline cations. Sludge adsorbs

radium more readily due to the presence of organic matter and the affinity of radium for organic matter. Calcium is a likely control of radon activity due to like charges and valence bonds. No pH effect on plant uptake of radium is readily discernible. Radium activity in plants generally can be expected to increase with increasing substrate radium activity.

Conclusions:

Investigators conclude that sludge radium-226 activity is somewhat related to radium activity in treatment plant influent and sludge's capacity to adsorb and retain radium. Organic matter displays a great capacity to adsorb and retain radium. No hazard from radon gas is expected on agricultural sites used for disposal of sewage sludge containing radium because well ventilated conditions are expected. The DNR requires that soil radium activity limits not exceed 2 picocuries per gram dry weight. This level in soil is within the range of native background soil level. Soil radium activity is not affected by the land spreading of wastewater sludge containing radium. Plant radium activity was most concentrated in the roots and extended up to the fruit, though levels rarely exceeded background. The most likely threat to the environment as a result of the application of sludge containing radium in Wisconsin would be associated with soil erosion at sludge application sites resulting in sedimentation. This threat is controlled by management practices in NR 204 designed to control erosion.

Recommendations/ Implications:

Investigators discourage the disruption of land spreading of wastewater sludge containing radium, though suggest increased monitoring in areas where the sludge radium-226 activity exceeds 2 pCi/l. Efforts should be made to minimize the threat to receiving waters due to surface erosion of the soil/sludge mixture. A strategy for controlling the entrance of radium into the food chain should be established and implemented. Sites selected for the application of radium-containing sewage sludge should possess as much clay as possible, balanced with the need to maintain adequate infiltration capacity. Follow up studies are recommended with an emphasis on plant levels as controlled by soil factors, leaching under various conditions and the potential for quickened transport of radium with soil colloids to groundwater.

Availability of Report:

This report is available for viewing and loan at:

The Water Resources Center
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Publication 050854

Key Words:

Radium-226, radon, wastewater

Funding:

The Wisconsin Department of Natural Resources provided funding for this project through the Groundwater Management Practice Monitoring Program which receives appropriations from the Groundwater Account.