

Technical Documentation of the Regional Manure Management Model for the Chesapeake Bay Watershed

Model version used for the ERS Project “Manure Management for Improved Water Quality”

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Introduction

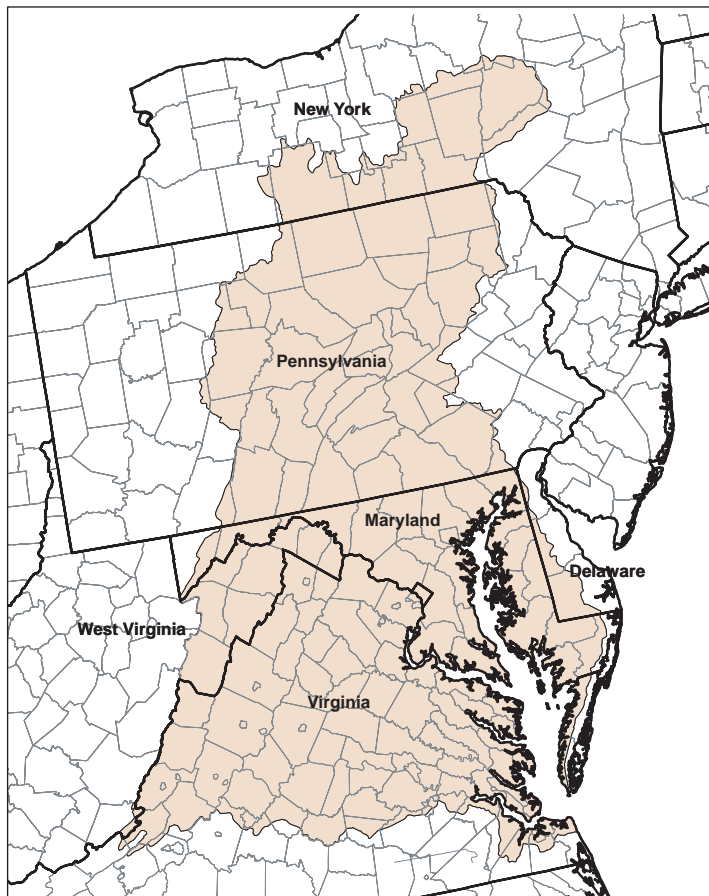
This report presents a discussion of the Chesapeake Bay Regional Manure Management Model, developed for use in the U.S. Department of Agriculture’s (USDA) Economic Research Service (ERS) project on “Manure Management for Improved Water Quality.” The report is intended to document the modeling framework, addressing model purpose and scope, model structure, parameter assumptions, data sources, and output generation. The model is designed to capture the spatial relationship between manure-nutrient production and land available for manure spreading, and implications for manure-hauling costs under Federal guidelines for animal waste management. The discussion highlights the use of farm-level survey data and cropland coverages from national databases within a regional optimization framework. Discussion of the modeling framework draws on empirical findings and visual presentations from the ERS analysis of costs of manure-nutrient management (Ribaudo et al., 2003).

In 1999, the Environmental Protection Agency (EPA) and USDA issued joint guidelines for regulatory and voluntary measures to protect water quality and public health from animal-waste pollution. In 2003, EPA published new regulations affecting an estimated 15,500 concentrated animal-feeding operations (CAFOs) (U.S. EPA, 2003). Meanwhile, USDA has a stated goal that all animal-feeding operations (AFOs) develop and implement comprehensive nutrient management plans (CNMPs) to minimize potential pollutant loadings from confined animal facilities and manure land application (USDA, NRCS, 2000). Nutrient standards that cap total applied nutrients—including manure nutrients—based on crop need (crop-based rates) provide the basis for manure application rates under both the USDA policies and EPA regulations. Implementation of nutrient standards will likely impose additional manure-hauling requirements in regions with concentrations of confined animal production. With limits on applied manure per acre, more land is required for manure spreading than is often available on animal-feeding operations and nearby farms, resulting in increased competition for available acreage and greater hauling distances.

As part of the Manure Management for Improved Water Quality Project at ERS, a regional modeling framework was developed to evaluate the effect of crop-based nutrient application rates (reflected in Federal guidelines and regulations) on costs of manure hauling and land application. Information developed by USDA indicates that many confined animal operations have insufficient land on the farm to spread all of their manure at crop-based rates (Kellogg et al., 2000). The effect of nutrient standards for land application will require that much of the manure be moved off the confined animal farms. Where animal production is concentrated, manure-handling costs faced by producers are determined largely by the spatial distribution of land area available for manure application and the level of competition among animal farms for available land; those two factors together determine the hauling distance required to access available land. An accurate assessment of the costs of manure hauling and land application argued for a regional perspective that considers spatial interactions across animal operations and agricultural land resources, and the effect of limited land resources in areas where confined animal production is concentrated.

The modeling framework was applied to the Chesapeake Bay watershed (fig. 1). The Chesapeake Bay is among the largest and most biologically rich estuaries in the world. However, excessive nutrient loads from various

Figure 1
Chesapeake Bay watershed



Source: Ribaldo et al., 2003.

sources—including wastewater treatment plants, urban runoff, fertilizer applications, animal waste, and atmospheric deposition—have resulted in eutrophication and related ecological shifts that adversely affect wildlife and aquatic resources (Preston and Brakebill, 1999). The declining health of the Bay ecosystem in recent decades has prompted a major Federal/State initiative to reduce excessive nutrient loading to the Bay and tributary streams. Animal agriculture is potentially a major source of nitrogen and phosphorus loadings due to concentrations of large confined animal feeding operations in some areas of the watershed. The Chesapeake Bay watershed encompasses several multi-county areas where the volume of manure-nutrient production from confined animal operations exceeds the capacity of area cropland when manure nutrients are applied at crop-based rates (Gollehon et al., 2001). Federal guidelines and regulations using crop-based nutrient rates are likely to have significant cost effects in areas of the Chesapeake Bay watershed where competition exists for land on which to apply manure.