Appendix: Animal Waste and Water Quality

A U.S. Geological Survey study of nitrogen loadings in 16 watersheds found that manure was the largest source in 6, located primarily in the Southeast and Mid-Atlantic States (Puckett, 1994). In the Mississippi drainage basin, animal waste is estimated to contribute 15 percent of the nitrogen load entering the Gulf of Mexico (Goolsby *et al*., 1999). Nitrogen (from all sources) transported by the Mississippi River is believed to be largely responsible for the large zone of hypoxic waters in the Gulf of Mexico. A study in the Upper Midwest found that the level of nitrate contamination in surface water is most strongly related to streamflow, acreage in corn and soybean production, the density of cattle, and population density (Mueller *et al*., 1993). The 1996 Water Quality Inventory contains a summary of State water quality assessments, which reports that animal operations (feedlots, confined facilities, and animal holding areas) were contributing sources of pollutants in 20 percent of impaired rivers and streams (U.S. EPA, 1998).[1]

Besides harming aquatic ecosystems, nitrate pollution also has potential human health concerns. The EPA has established a maximum contaminant level (MCL, a legal maximum exposure) of 10 mg/l for nitrate in drinking water. Nitrate can be converted to nitrite in the gastrointestinal tract. In infants, nitrite may cause methemoglobinemia, known as "blue-baby syndrome," which prevents the transport of sufficient oxygen in the bloodstream. Public water systems that violate the MCL must use additional treatment to bring the water into compliance, though exemptions are specified.

The most recent nationwide pollutant loading estimates indicated that in the 1980s, the largest manmade sources of phosphorus to the environment were fertilizer and manure applications (Litke, 1999). The phosphorus content of soils has shown increases in recent years, especially in areas of high manure application rates (Beauchemin *et al*., 1998). High phosphorus concentrations in streams and in soil-drainage water have been linked to areas with high soil phosphorus content (Litke, 1999). Of particular concern is phosphorus from manure, which is more mobile through soil than phosphorus from commercial fertilizer (Eghball *et al*., 1996).

Improved management of manure nutrients will also reduce the likelihood of pathogen contamination of water supplies—an issue attracting increased attention (NRAES, 1996; Olson, 1995). Bacteria are the third leading source of impairment of rivers and the second leading cause in estuaries (U.S. EPA, 1998). Potential sources include inadequately treated human waste, wildlife, and animal operations. Microorganisms in livestock waste can cause several diseases through direct contact with contaminated water, consumption of contaminated drinking water, or consumption of contaminated shellfish. Bacterial, rickettsial, viral, fungal, and parasitic diseases are potentially transmissible from livestock to humans (CAST, 1996). Fortunately, proper animal management practices and water treatment minimize the risk to human health posed by most of these pathogens. However, protozoan parasites, especially *Cryptosporidia* and *Giardia*, are important etiologic agents of waterborne disease outbreaks (CDC, 1996). *Cryptosporidia* and *Giardia* may cause gastrointestinal illness, and *Cryptosporidia* may lead to death in immunocompromised persons. These parasites have been commonly found in beef herds, and *Cryptosporidia* in dairy operations (USDA, 1994; Juranek, 1995).

Outbreaks of waterborne diseases are a growing concern. EPA estimates the cost to drinking water utilities for improved microbial treatment to be about $20 billion over the next 20 years, with about half of that needed immediately (U.S. EPA, 1997a). The health cost of *Giardia* alone is estimated to be $1.2-$1.5 billion per year (U.S. EPA, 1997b). *Cryptosporidia* are a more recently identified threat, with oocysts present in 65-97 percent of surface water sampled in the United States (CDC, 1996). The organism has been implicated in gastroenteritis outbreaks in Milwaukee, Wisconsin (400,000 cases and 100 deaths in 1993), and in Carrollton, Georgia (13,000 cases in 1987). The cost of the Milwaukee outbreak is estimated to have exceeded $54 million (*Health and Environment Digest*, 1994). While the source of the organism in these outbreaks was never determined, its occurrence in livestock herds has brought some attention to this sector, especially given the proximity of cattle and slaughterhouses to Milwaukee (MacKenzie *et al*., 1994).

[1] U.S. EPA's assessment relies on State self-reporting, which is incomplete and inconsistent among States (U.S. GAO, 2000). The Clean Water Act requires that such a report be submitted to Congress every 2 years.