**Evaluation of Variation in Nitrate Concentration Levels in the Raccoon River Watershed in Iowa**

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The Raccoon River Watershed in Iowa has received considerable attention in recent years due to concerns regarding excessive nitrate (NO$_3^-$) concentrations in the Raccoon River. Recent detections of NO$_3^-$ concentrations above the federal drinking water standard of 10 mg L$^{-1}$ have raised questions about the sources of NO$_3^-$ in the Raccoon River and, more specifically, about the effect of agricultural practices in the watershed on in-stream NO$_3^-$ concentrations. Also, some sections of the Raccoon River have recently been identified in Iowa’s Federal Clean Water Act 303(d) as completely or partially impaired waters because of these elevated NO$_3^-$ levels. The Federal Water Pollution Control Act Amendments of 1972 is generally called the Clean Water Act. Its objective is to restore and maintain the chemical, physical, and biological integrity of the Nation’s waters. The Iowa Department of Natural Resources is the state agency responsible for water quality management in the state of Iowa (see http://www.iowadnr.gov/water/standards/index.html for more details).

The RRW is a part of the Mississippi River drainage basin, and nutrient runoff that is carried by the river system has been cited as a contributing factor to the hypoxic conditions that exist in the Gulf of Mexico (Rabalais et al., 2002). Kalkoff et al. (2000) reported that NO$_3^-$ concentrations from several Iowa watersheds are among the highest observed in the Corn Belt. Agricultural production is a predominant use of a significant portion of the land in the RRW and is a primary driver of the local economy within the watershed. More than half of the crop acres in the watershed are typically planted to corn, which is associated with annual applications of commercial fertilizers and manure. Intensive agriculture is often reported as the primary source of water quality degradation in the river despite the significant increases in nutrient utilization efficiency that have been achieved for corn production (Burkart and James, 1999). Nutrient outputs from animal agriculture have also been reported as a significant source of nutrient impairment of the Raccoon River (Keeney and DeLuca, 1993).

In recent years, agricultural researchers have developed theoretical and empirical tools designed to evaluate the effects of