# Design of Airborne Electromagnetic Surveys for Ecosystem Assessment in the Williston Basin based on Geological, Geochemical, Hydrologic, and Geographic Information System Data

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Subsurface mapping of electrical conductivity by airborne electromagnetic (AEM) surveys aids in understanding hydrogeology frameworks and in mapping both naturally occurring saline waters and those co-produced from energy development (brine). The Williston Basin in the Northern Great Plains has been a leading source of domestic oil for over 50 years, with rapid new development occurring in the Bakken and Three Forks Formations. The basin is overlain by the Prairie Pothole Region (PPR), an area of abundant wetlands that provides critical habitat for waterfowl and other wildlife. Energy development methods have resulted in the release of brine. In the PPR, brine contamination poses a serious risk to wildlife, agricultural lands, and groundwater resources.

An AEM survey of the East Poplar oil field in the western Williston Basin mapped hydrologic features to depths of 40 – 50 meters, greatly aiding groundwater models and identifying: 1) glacial features such as shallow lake sediments, buried glacial valleys, and shallow gravel units, 2) subsurface brine plumes, and 3) shallow point sources of brine associated with oil production, brine disposal, and infrastructure failures.

The U.S. Geological Survey is studying potential environmental effects using a risk assessment of energy development to aquatic resources. The extent of contamination in the Williston Basin is unknown, requiring spatial data on energy infrastructure and aquatic resources. In addition, water chemistry analyses and geophysical surveys quantified the extent of contamination and brine movement in the most common geologic deposits in the PPR (till, outwash, and lacustrine). We characterized and mapped contaminated groundwater at least 0.8 km and up to 1.6 km from the likely sources. The spatial analysis identified 292,745 wetlands and 7,147 km of streams within 1.6 km of petroleum related wells. We also are using decision analysis methods based on communication with stakeholders to establish a framework to evaluate potential effects of energy development on environmental resources. This approach can prioritize AEM survey areas to examine possible risks to ecosystems and groundwater resources. This study will assist Federal and State resource managers make science-based decisions to allocate limited resources to areas of greatest need.