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20 Years Later: Reexamining Oilfield Brine Contamination Plumes in the Prairie Pothole Region of Sheridan County, Montana

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The Prairie Pothole Region of Montana contains thousands of wetlands that provide critical habitat to numerous grassland and wetland bird species and also recharge shallow groundwater resources used for irrigation, drinking, and stock water purposes. Co-produced waters from oilfield activities in Sheridan County have contaminated many of these wetlands and water resources. Hydrological investigations beginning in the 1970s documented brine contamination to surface and groundwater resources in T36N, R58N Sec 27 (referred to hereafter as the Rabenberg site because the Rabenberg Waterfowl Production Area comprises the southern half section) within the Goose Lake Oilfield. This investigation will reevaluate the Rabenberg site to determine temporal changes of impacted water resources and rates of brine migration.

The Rabenberg site is underlain by coarse-grained partially-saturated glacial outwash deposits that are up to 30 feet thick, which overlay poorly-sorted clay-rich glacial tills. Groundwater in the outwash is unconfined, with groundwater flow direction and decreasing topographic relief to the southeast towards West Goose Lake. Potential sources of contamination at the Rabenberg site are from a storage tank battery to the west and oil well and injection well sites to the north and within the square mile section. Improper disposal methods, pipeline breaks, and leachates generated from reserve pits excavated at these sites are likely the primary sources of brine contamination. The higher hydraulic conductivities of the outwash deposits control the lateral transport of brine contamination.

A detailed hydrological investigation of the area was conducted in 1989 on wells and wetlands within the Rabenberg site and included major-ion chemistry, specific conductance and pH. Co-produced waters from this oilfield are characterized by high specific conductance (~291,000 us/cm in 2009), elevated chloride levels, and slightly acidic pH values. Uncontaminated shallow groundwater may have high specific conductance but lacks elevated chloride levels and is slightly basic. To determine the presence of brine contamination in the field, Jon Reiten of the Montana Bureau of Mines and Geology developed a contamination index (CI) defined as the ratio of chloride concentration to specific conductance. Reiten determined that waters with a CI greater than 0.035 have likely been impacted by oilfield brines. Results from the 1989 study delineated groundwater contamination nearly one mile downgradient from their potential sources based on CI values.

In May of 2009 water from wells and wetlands in the Rabenberg site were resampled and compared to the 1989 values. Initial 2009 field data shows a decrease in specific conductance and an increase in pH in several wells and wetlands near potential contamination sources and specific conductance increases and pH decreases in sites downgradient. This is interpreted as illustrating the movement of the contaminated groundwater towards West Goose Lake.

Electromagnetic data was collected in 1989 to determine the lateral extent of shallow groundwater contamination using an EM-31. Areas of high apparent conductivity were found at several locations associated with oilfield activities within the Rabenberg site. Repeat electromagnetic surveys are planned for September 2009 using an EM-34 which, unlike the EM-31, can determine contamination at various depths up to 60 meters.