GEOSPATIAL ESTIMATES OF PRODUCED WATER CONTAMINATION NEAR SKIATOOK LAKE, NORTHEASTERN OKLAHOMA USING DISSOLVED CL CONCENTRATIONS IN TRIBUTARY STREAMS

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Saline water produced from oil and gas wells can impact lakes, streams, and rivers. Reliable and cost-effective methods of evaluating produced water contributions to these bodies of water are needed for viable risk assessments. This study estimated the contribution of produced water to Skiatook Lake in Osage County, Oklahoma by using measurements of chloride concentrations in contributing streams and the lake and combining this data with geospatial analysis of stream courses and well locations. About 6,715 oil and gas wells are located in the entire 350 mi2 drainage basin of the lake. The 10,500 acres of land flooded by the lake (flooding began 1984) has approximately 215 plugged wells. The risk of contamination of the lake by produced saline water (total dissolved solids >100,000 mg/L) was evaluated using a mass balance of concentrations of Cl in the inflowing streams draining into Skiatook Lake and comparing that with well densities and proximities of producing wells to streams in the various contributing drainages.

To provide a snapshot of current surface water inputs of chloride to Skiatook Lake, discharge volume was measureds at the mouths of 18 streams draining into the lake, as well as the lake outfall. Chloride concentrations measured at these sites and along the reaches of two of the streams ranged from 5.8 to 2,260 mg/L. Water in the lake has an estimated residence time of 18 months and an average Cl value of 36 mg/L (n=6). Hominy Creek provides 63 percent of the surface water entering the lake, but a higher proportion (80 percent) of the Cl load (13.1 tons/day). Streams with higher measured Cl concentrations are generally in subdrainages with higher oil and gas well densities, but the load from these streams is relatively small compared to Hominy Creek because discharges from these streams are low in comparison. Geospatial analysis of well proximities to streams and discharges in subdrainages indicates that streams with more wells in close proximity (200 m) and low discharges have the highest measured Cl concentrations. The relationship between higher Cl concentrations and well proximity and discharge reflects the shorter transport distances for solutes as well as the effect of dilution.

Results indicate that a mass balance approach utilizing Cl concentrations coupled with geospatial analysis of well densities and proximities is useful for assessing risk of contamination by saline production waters to surface-water bodies.