

**SALT REMOVAL BY NATURAL ATTENUATION:
RESULTS FROM OSPER "A" SITE, OSAGE COUNTY, OKLAHOMA**

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For the last six years, we have been investigating the transport, fate, natural attenuation and ecosystem impacts of inorganic and organic compounds in releases of produced water and associated hydrocarbons at the Osage-Skiatook Petroleum Environmental Research (OSPER) site "A", located in NE Oklahoma. Approximately 1.2 ha of land at this inactive site, is visibly affected by salt scarring, tree kills, soil salinization, and brine and oil contamination. Geochemical data from nearby oil wells show that the produced water source is a Na-Ca-Cl brine (~150,000 mg/L TDS), with low concentrations of SO₄. Groundwater and surface water impacts are being investigated using a variety of methodologies, including detailed chemical and isotope analyses of water from repeated sampling of 44 boreholes, 1–36 m deep. Results show a plume of high salinity water (2,000-30,000 mg/L TDS) that intersects Skiatook Lake and extends beyond the visibly impacted areas. No significant amount of liquid petroleum was observed in this plume, but organic acid anions, BTEX and other VOCs were present.

The rate of salt removal from this site by surface runoff following precipitation is being determined by measuring the volume and chemical composition of water flowing over weir I that captures most of the surface and 'base' flow from this site. Results show that the initial runoff that leaches the previously precipitated surficial salts can have a relatively high salinity (up to 3,000 mg/L TDS), but that only small amounts of total salts (~500 kg per year) are removed by this process. During March, 2007, additional discharge and chemical data were obtained not only from our usual weir I, but also from a newly installed weir II, situated ~75 m downslope from weir I and ~3 m below (vertical), and draining an area that is normally covered by lake water, but was exposed because of the prolonged draught in this region. Results show that overland transport of salt at weir II is 3-5 times higher than that from weir I.

Slug tests on selected wells indicate the hydraulic conductivity of the permeable sandstone units is only about 1 cm/day, indicating that brine flow in the confined sandstones is low. These results support the conclusion that large amounts of salts from produced-water and petroleum releases still remain in the rocks of the impacted area after more than 70 years of natural attenuation. These results also indicate that 'pump and treat' would not be an effective option for remediation of the groundwater at this site.

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