The Effects of Columbia River Stage on Contaminant U Concentrations and Groundwater Compositions at the 300 Area IFRC

Hanford IFRC (Principal Investigator: John Zachara)

James P. McKinley (PI), Thomas C. Resch, Micah D. Miller, Rachael M. Lund, Vince R. Vermeul, Christopher J. Murray, and John M. Zachara – PNNL

Seasonal variations in contaminant uranium concentrations have long been observed at the Hanford site's 300 Area. A significant pool of uranium persists in the vadose zone; of particular interest is the uranium within the smear zone, the area traversed by the water table. The springtime snowmelt and the resultant long and short-term rise and fall in river stage drives a coupled undulation in the elevation of the water table along the river shoreline to a distance from the river of more than 250 m. Our objective was to determine whether groundwater captured uranium from the smear zone during water table rises, and whether the groundwater composition was affected by infiltration of river water during high-stage events. Because the timing and magnitude of river stage variations is dependent upon the accumulation of snow in the Columbia River catchment and the rapidity with which it is melted during the spring thaw, understanding the potential for U contributions to the local aquifer from the vadose zone required a multi-year sampling effort. To date, our efforts included sampling during the spring thaw for the years 2009-2011. Groundwater was sampled by pumping from the center of the well screen and by bailing from the top of the aquifer (sampling in 2011 was by pumping only) across the IFRC, and analyzed for major dissolved components and uranium.

Uranium concentrations prior to the seasonal groundwater rise were 30 -50 $\mu g\ U\ L^{-1}$ across the site each year. In each year, the water table rose abruptly, but the date and magnitude varied significantly. In 2010, the advent of spring was relatively late, and the maximum elevation occurred in late June; in 2011, the maximum was three weeks earlier. The magnitude of the rise varied also, with maximum elevations of approximately 106.3, 106.8, and 107.9 m in 2009, 2010, and 2011, respectively. In each year, the uranium concentration increased differentially across the site, with the largest contributions occurring proximal to the south-most cluster of nested wells. For example, in 2010, the uranium concentration increased from 50 $\mu g\ L^{-1}$ to 330 $\mu g\ L^{-1}$ over the course of 4 days at the south end of the site. Uranium concentrations decreased as the water table crested. The uranium concentration across the site – the 'background' concentration – increased broadly to 60 – 70 $\mu g\ L^{-1}$ over the course of the tests. Anion concentrations were used to assess the impact of river water infiltration. In 2009, no river water intrusion was detected; in 2010 river water comprised a maximum of approximately 80% of the groundwater at the eastern IFRC boundary, and was >90% in 2011. The groundwater impact was less toward the west, with the river water invading across the site to the northwest, and comprising less than 25% of the total at the western site boundary. The results demonstrated that the smear zone represented a significant source of uranium to groundwater, and that river water imposed significant compositional variation to the aquifer over the course of the test.