

## Appendix E. U.S. Geological Survey 2008 Publication Abstracts

### ***An update of hydrologic conditions and distribution of selected constituents in water, Snake River Plain aquifer and perched-water zones, Idaho National Laboratory, Idaho, emphasis 2002-05 (Linda Davis)***

Radiochemical and chemical wastewater discharged since 1952 to infiltration ponds, evaporation ponds, and disposal wells at the Idaho National Laboratory (INL) has affected water quality in the Snake River Plain aquifer and perched-water zones underlying the INL. The U.S. Geological Survey, in cooperation with the U.S. Department of Energy, maintains ground-water monitoring networks at the INL to determine hydrologic trends, and to delineate the movement of radiochemical and chemical wastes in the aquifer and in perched-water zones. This report presents an analysis of water-level and water-quality data collected from aquifer and perched-water wells in the USGS ground-water monitoring networks during 2002–05.

Water in the Snake River Plain aquifer primarily moves through fractures and interflow zones in basalt, generally flows southwestward, and eventually discharges at springs along the Snake River. The aquifer is recharged primarily from infiltration of irrigation water, infiltration of streamflow, ground-water inflow from adjoining mountain drainage basins, and infiltration of precipitation.

From March–May 2001 to March–May 2005, water levels in wells declined throughout the INL area. The declines ranged from about 3 to 8 feet in the southwestern part of the INL, about 10 to 15 feet in the west central part of the INL, and about 6 to 11 feet in the northern part of the INL. Water levels in perched water wells declined also, with the water level dropping below the bottom of the pump in many wells during 2002–05.

For radionuclides, concentrations that equal  $3s$ , where  $s$  is the sample standard deviation, represent a measurement at the minimum detectable concentration, or “reporting level.” Detectable concentrations of radiochemical constituents in water samples from wells in the Snake River Plain aquifer at the INL generally decreased or remained constant during 2002–05. Decreases in concentrations were attributed to decreased rates of radioactive-waste disposal, radioactive decay, changes in waste-disposal methods, and dilution from recharge and underflow. In October 2005, reportable concentrations of tritium in ground water ranged from  $0.51 \pm 0.12$  to  $11.5 \pm 0.6$  picocuries per milliliter and the tritium plume extended south-southwestward in the general direction of ground-water flow. Tritium concentrations in water from several wells southwest of the Idaho Nuclear Technology and Engineering Center (INTEC) decreased or remained constant as they had during 1998–2001, with the exception of well USGS 47, which increased a few picocuries per milliliter. Most wells completed in shallow perched water at the Reactor Technology Complex (RTC) were dry during 2002–05. Tritium concentrations in deep perched water exceeded the reporting level in nine wells at the RTC. The tritium concentration in water from one deep perched water well exceeded the reporting level at the INTEC. Concentrations of strontium-90 in water from 14 of 34 wells sampled during October 2005 exceeded the reporting level. Concentrations ranged from  $2.2 \pm 0.7$  to  $33.1 \pm 1.2$  picocuries per liter. However, concentrations from most wells remained relatively constant or decreased since 1989. Strontium-90 has not been detected within the eastern Snake River Plain



aquifer beneath the RTC partly because of the exclusive use of waste-disposal ponds and lined evaporation ponds rather than the disposal well for radioactive-wastewater disposal at RTC. At the RTC, strontium-90 concentrations in water from six wells completed in deep perched ground water exceeded the reporting level during 2002–05. At the INTEC, the reporting level was exceeded in water from three wells completed in deep perched ground water. During 2002–05, concentrations of plutonium-238, and plutonium-239, -240 (undivided), and americium-241 were less than the reporting level in water samples from all wells sampled at the INL. During 2002–05, concentrations of cesium-137 in water from all wells sampled by the USGS at the INL were less than the reporting level.

Changes in detectable concentrations of nonradioactive chemical constituents in water from the Snake River Plain aquifer at the INL varied during 2002–05. In April 2005, water from well USGS 65, south of the Reactor Technology Complex (RTC) [formerly known as the Test Reactor Area (TRA)], contained 100 micrograms per liter ( $\mu\text{g/L}$ ) of chromium, a decrease from the concentration of 139  $\mu\text{g/L}$  detected in October 2001. Other water samples contained from less than 1.7 to 30.3  $\mu\text{g/L}$  of chromium. Chromium was detected in water from 2 wells completed in shallow perched ground water, and in 17 wells completed in deep perched water. During 2002–05, the largest concentration of sodium in water samples from aquifer wells at the INL was 76 milligrams per liter ( $\text{mg/L}$ ) in a sample from well USGS 113, south of INTEC. During April–October 2005, dissolved sodium concentrations in deep perched water at the RTC ranged from 6 to 27  $\text{mg/L}$  in all wells except well USGS 68 (370  $\text{mg/L}$ ). No analyses were made for sodium in shallow perched ground water at the RTC during 2002–05. Dissolved sodium concentrations in water from 16 wells completed in deep perched water at the RTC were determined. At the INTEC, sodium concentrations were determined from one well completed in shallow perched ground water, and from two wells completed in deep perched ground water. In 2005, chloride concentrations in most water samples from the INTEC and the Central Facilities Area (CFA) exceeded ambient concentrations of 10 and 20  $\text{mg/L}$ , respectively. Chloride concentrations in water from wells near the RTC were less than 20  $\text{mg/L}$ . At the Radioactive Waste Management Complex (RWMC), chloride concentrations in water from wells USGS 88, 89, and 120 were 86, 41, and 20  $\text{mg/L}$ , respectively, nearly the same as the 1999–2001 reporting period. Concentrations of chloride in all other wells near the RWMC were less than 13  $\text{mg/L}$ . During April to October 2005, chloride concentrations in shallow perched ground water from three wells at the RTC ranged from 10 to 32  $\text{mg/L}$  and from 3 to 35  $\text{mg/L}$  in deep perched ground water. At the INTEC, dissolved chloride concentrations in deep perched ground water in wells closest to the percolation ponds ranged from 118 to 332  $\text{mg/L}$ . In 2005, sulfate concentrations in water from aquifer wells USGS 34, 35, and 39, southwest of INTEC, were 42, 46, and 46  $\text{mg/L}$ , respectively. Historically, concentrations in these wells have been at or just below 40  $\text{mg/L}$ , the estimated background concentration of sulfate in the Snake River Plain aquifer at the INL. The maximum sulfate concentration in water from wells completed in shallow perched ground water at the RTC was 396  $\text{mg/L}$ . During April to October 2005, concentrations of dissolved sulfate in water from wells completed in deep perched ground water at the RTC ranged from 66 to 276  $\text{mg/L}$ . Concentrations of dissolved sulfate in water from two wells completed in deep perched ground water at the INTEC were 35  $\text{mg/L}$ .



In October 2005, concentrations of nitrate in water from wells USGS 41, 43, 45, 47, 52, 57, 67, 77, 112, 114, and 115 near the INTEC, exceeded the regional background of 5 mg/L (as nitrate) and concentrations ranged from 6 mg/L in well USGS 45 to 34 mg/L in well USGS 43. However, since 1981, nitrate concentrations have decreased overall in water from these wells.

During April to October 2005, water samples from five aquifer wells were analyzed for fluoride; detected concentrations ranged from 0.2 to 0.3 mg/L. These concentrations are similar to the background concentrations, which indicate that wastewater disposal has not had an appreciable affect on fluoride concentrations in the Snake River Plain aquifer near the INTEC.

During 2002–05, 12 volatile organic compounds (VOCs) were detected in water from aquifer wells at the INL. Concentrations of from 1 to 9 VOCs were detected in water samples from 13 wells. Primary VOCs detected included carbon tetrachloride, chloroform, 1,1-dichloroethane, 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene.

During 2002–05, attempts were made each year to sample well USGS 92, completed in perched water at the RWMC; however, lack of water in the well precluded obtaining an adequate sample during most sampling events. Most of the same VOCs except chloroethane that were detected during 1999–2001 were detected during 2002–03; additionally, bromodichloromethane was detected. Concentrations of 16 VOCs were detected during 2002–03. Most VOCs fluctuated through time and show no distinct trend.

***Field methods and quality-assurance plan for quality-of-water activities, U.S. Geological Survey, Idaho National Laboratory, Idaho (LeRoy L. Knobel, Betty J. Tucker, and Joseph P. Rousseau)***

No abstract was written for this report. The report summarizes the field methods and quality assurance performed as part of the USGS INL Project Office water quality sampling activities.

***Construction diagrams, geophysical logs, and lithologic descriptions for boreholes USGS 126a, 126b, 127, 128, 129, 130, 131, 132, 133, and 134, Idaho National Laboratory, Idaho (Brian V. Twining, Mary K. Hodges, and Stephanie Orr)***

This report summarizes construction, geophysical, and lithologic data collected from ten U.S. Geological Survey (USGS) boreholes completed between 1999 and 2006 at the Idaho National Laboratory (INL): USGS 126a, 126b, 127, 128, 129, 130, 131, 132, 133, and 134. Nine boreholes were continuously cored; USGS 126b had 5 ft of core. Completion depths range from 472 to 1,238 ft. Geophysical data were collected for each borehole, and those data are summarized in this report. Cores were photographed and digitally logged using commercially available software. Digital core logs are in appendixes A through J. Borehole descriptions summarize location, completion date, and amount and type of core recovered. This report was prepared by the USGS in cooperation with the U.S. Department of Energy (DOE).



***Statistical stationarity of sediment interbed thicknesses in a basalt aquifer, Idaho National Laboratory, Eastern Snake River Plain, Idaho (Caleb N. Stroup, John A. Welhan, and Linda C. Davis)***

The statistical stationarity of distributions of sedimentary interbed thicknesses within the southwestern part of the Idaho National Laboratory (INL) was evaluated within the stratigraphic framework of Quaternary sediments and basalts at the INL site, eastern Snake River Plain, Idaho. The thicknesses of 122 sedimentary interbeds observed in 11 coreholes were documented from lithologic logs and independently inferred from natural-gamma logs. Lithologic information was grouped into composite time-stratigraphic units based on correlations with existing composite-unit stratigraphy near these holes. The assignment of lithologic units to an existing chronostratigraphy on the basis of nearby composite stratigraphic units may introduce error where correlations with nearby holes are ambiguous or the distance between holes is great, but we consider this the best technique for grouping stratigraphic information in this geologic environment at this time.

Nonparametric tests of similarity were used to evaluate temporal and spatial stationarity in the distributions of sediment thickness. The following statistical tests were applied to the data: (1) the Kolmogorov-Smirnov (K-S) two-sample test to compare distribution shape, (2) the Mann-Whitney (M-W) test for similarity of two medians, (3) the Kruskal-Wallis (K-W) test for similarity of multiple medians, and (4) Levene's (L) test for the similarity of two variances.

Results of these analyses corroborate previous work that concluded the thickness distributions of Quaternary sedimentary interbeds are locally stationary in space and time. The data set used in this study was relatively small, so the results presented should be considered preliminary, pending incorporation of data from more coreholes.

Statistical tests also demonstrated that natural-gamma logs consistently fail to detect interbeds less than about 2–3 ft thick, although these interbeds are observable in lithologic logs. This should be taken into consideration when modeling aquifer lithology or hydraulic properties based on lithology.

***Laboratory-measured and property-transfer modeled saturated hydraulic conductivity of Snake River Plain aquifer sediments at the Idaho National Laboratory, Idaho (Kim S. Perkins)***

Sediments are believed to comprise as much as 50 percent of the Snake River Plain aquifer thickness in some locations within the Idaho National Laboratory. However, the hydraulic properties of these deep sediments have not been well characterized and they are not represented explicitly in the current conceptual model of subregional scale ground-water flow. The purpose of this study is to evaluate the nature of the sedimentary material within the aquifer and to test the applicability of a site-specific property-transfer model developed for the sedimentary interbeds of the unsaturated zone. Saturated hydraulic conductivity ( $K_{sat}$ ) was measured for 10 core samples from sedimentary interbeds within the Snake River Plain aquifer and also estimated using the property-transfer model. The property-transfer model for predicting



$K_{\text{sat}}$  was previously developed using a multiple linear-regression technique with bulk physical-property measurements (bulk density [ $\rho_{\text{bulk}}$ ], the median particle diameter, and the uniformity coefficient) as the explanatory variables. The model systematically underestimates  $K_{\text{sat}}$ , typically by about a factor of 10, which likely is due to higher bulk-density values for the aquifer samples compared to the samples from the unsaturated zone upon which the model was developed. Linear relations between the logarithm of  $K_{\text{sat}}$  and  $\rho_{\text{bulk}}$  also were explored for comparison.

## REFERENCES

- Davis, L.C., 2008, An update of hydrologic conditions and distribution of selected constituents in water, Snake River Plain aquifer and perched-water zones, Idaho National Laboratory, Idaho, emphasis 2002-2005: U.S. Geological Survey Scientific Investigations Report 2008-5089 (DOE/ID-22203), 74 p.
- Knobel, L.L., Tucker, B.J., and Rousseau, J.P., 2008, Field methods and quality-assurance plan for quality-of-water activities, U.S. Geological Survey, Idaho National Laboratory, Idaho: U.S. Geological Survey Open-File Report 2008-1165 (DOE/ID-22206), 36 p.
- Perkins, K.S., 2008, Laboratory-measured and property-transfer modeled saturated hydraulic conductivity of Snake River Plain aquifer sediments at the Idaho National Laboratory, Idaho: U.S. Geological Survey Scientific Investigations Report 2008-5169 (DOE/ID-22207), 14 p.
- Stroup, C.N., Welhan, J.A., Davis, L.C., 2008, Statistical stationarity of sediment interbed thicknesses in a basalt aquifer, Idaho National Laboratory, Eastern Snake River Plain, Idaho: U.S. Geological Survey Scientific Investigations Report 2008-5167 (DOE/ID-22204), 20 p.
- Twining, B.V., Hodges, M.K.V., and Orr, Stephanie, 2008, Construction diagrams, geophysical logs, and lithologic descriptions for boreholes USGS 126a, 126b, 127, 128, 129, 130, 131, 132, 133, and 134, Idaho National Laboratory, Idaho: U.S. Geological Survey Data Series 350, (DOE/ID-22205), 27 p.



*Stage Coach Stop*