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The Tritium Underflow Study at the Savannah River Site

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INTRODUCTION

An issue of concern at the Savannah River Site (SRS) over the past 20 years is whether tritiated groundwater originating at SRS might be the cause of low levels of tritium measured in certain domestic wells in Georgia. Tritium activity levels in several domestic wells have been observed to occur at levels comparable to what is measured in rainfall in areas surrounding SRS. Since 1988, there has been speculation that tritiated groundwater from SRS could flow under the river and find its way into Georgia wells.

A considerable effort was directed at assessing the likelihood of trans-river flow, and 44 wells have been drilled by the USGS and the Georgia Department of Natural Resources. Also, as part of the data collection and analysis, the USGS developed a numerical model during 1997–98 (Ref. 1) to assess the possibility for such trans-river flow to occur. The model represented the regional groundwater flow system surrounding the Savannah River Site (SRS) in seven layers corresponding to the underlying hydrostratigraphic units, which was regarded as sufficiently detailed to evaluate whether groundwater originating at SRS could possibly flow beneath the Savannah River into Georgia. The model was calibrated against a large database of water-level measurements obtained from wells on both sides of the Savannah River and screened in each of the hydrostratigraphic units represented within the model. The model results verified that the groundwater movement in all hydrostratigraphic units proceeds laterally toward the Savannah River from both South Carolina and Georgia, and discharges into the river.

Once the model was calibrated, a particle-track analysis was conducted to delineate areas of potential trans-river flow. Trans-river flow can occur in either an eastward or westward direction. The model indicated that all locations of trans-river flow are restricted to the Savannah River's floodplain, where groundwater passes immediately prior to discharging into the river. Whether the trans-river flow is eastward or westward depends primarily on the position of the Savannah River as it meanders back and forth within the floodplain and is limited to narrow sections of land adjacent to the river.

With respect to "westward" trans-river flow, the model indicates that it primarily occurs in locations south of SRS and within the deeper aquifers (Crouch Branch and McQueen Branch). Particle-tracking analysis of westward trans-river flow in these aquifers indicates that the groundwater crossing from South Carolina into Georgia originates as recharge in upland areas well to the east and south of SRS. The model identified one location (an area of less than one square mile) where westward trans-river flow originating as recharge within the boundaries of SRS and which could conceivably receive tritium or other contaminants from SRS as a result. The one-square-mile area occurs immediately adjacent to the Savannah River, where groundwater within the Gordon Aquifer flows immediately prior to discharging into the river and is indicated in Figure 1.

Reverse particle tracking indicates that recharge zones associated with the one square mile are located in the upland areas between D-Area and K-Area. There is no known subsurface contamination at these recharge zones. The travel times associated with the particles were calculated to range from 90 to 820 years, although these estimates are shorter than actual travel times since no accounting of groundwater transit time across the uppermost aquifer was included in the model. It is important to note that the range of travel times represents seven to 66 half-lives of tritium (12.33 years), suggesting that even if tritium contamination existed at the recharge areas, it likely would decay away prior to discharging into the Savannah River.

EVALUATION OF GROUNDWATER EXTRACTION SCENARIOS

A Peer Review Panel established at the request of the State of Georgia in 2000 evaluated the results of this investigation and recommended that several groundwater extraction scenarios be evaluated to determine if there were any plausible way that groundwater flow paths previously established could be influenced so as to increase the likelihood that tritiated groundwater might flow beneath the Savannah River and find its way into domestic wells in Georgia. In response to this, the USGS, in consultation with the DOE and the States of Georgia and South Carolina, updated the earlier model, formulated plausible groundwater extraction scenarios and evaluated those scenarios with the groundwater flow model. This work was completed in 2006 (Ref. 2).

This work included an update to the original groundwater model which included incorporation of boundary conditions representative of 2002, which was a time of severe drought in the SRS vicinity, as well as conditions projected to occur in 2020. The numerical model was then utilized to evaluate several hypothetical groundwater extraction scenarios to determine their impact upon westward trans-river flow that originates at SRS. Scenarios included groundwater extraction rates realized during times of drought (increased groundwater extraction) as well as one in which groundwater extraction at SRS was discontinued while groundwater extraction continued in Georgia.

RESULTS AND CONCLUSIONS

With respect to the only location of westward trans-river flow that has a recharge area within the SRS, the new evaluations of hypothetical pumping scenarios indicated that only a very slight impact is incurred, even under the most extreme groundwater extraction scenario. The updated model did not result in a significant change in the location of the recharge areas at SRS and the only impact was measured in slight changes in the travel times associated with the travel path. Figure 1 illustrates the location of recharge areas within SRS for westward trans-river flow and indicates the travel times associated with each to the discharge location under dry 2002 conditions (Ref. 2). The median groundwater travel times for particles released under each of the 4 groundwater extraction scenarios ranged from 366 to 507 years while. Under the most extreme scenario, that under which SRS groundwater extraction is discontinued, the shortest travel time was reduced from 90 to 79 years. It should be emphasized that the groundwater transit times reported in Figure 1 (Ref. 2) do not include the time required for groundwater to migrate vertically downward across the uppermost aquifer (i.e. at the recharge area), thus the actual groundwater travel times could be up to several decades longer than what was calculated in the model.

The exhaustive evaluations that have been conducted indicates that it is highly unlikely that tritiated groundwater originating at the SRS could migrate into Georgia and explain the low tritium activity levels that were originally observed in certain domestic water supply wells. Considering that those wells were located at some distance (several km) from the Savannah River, a far more likely explanation is that tritiated rainfall infiltrated the subsurface and recharged the shallow aquifer within which the well was finished.

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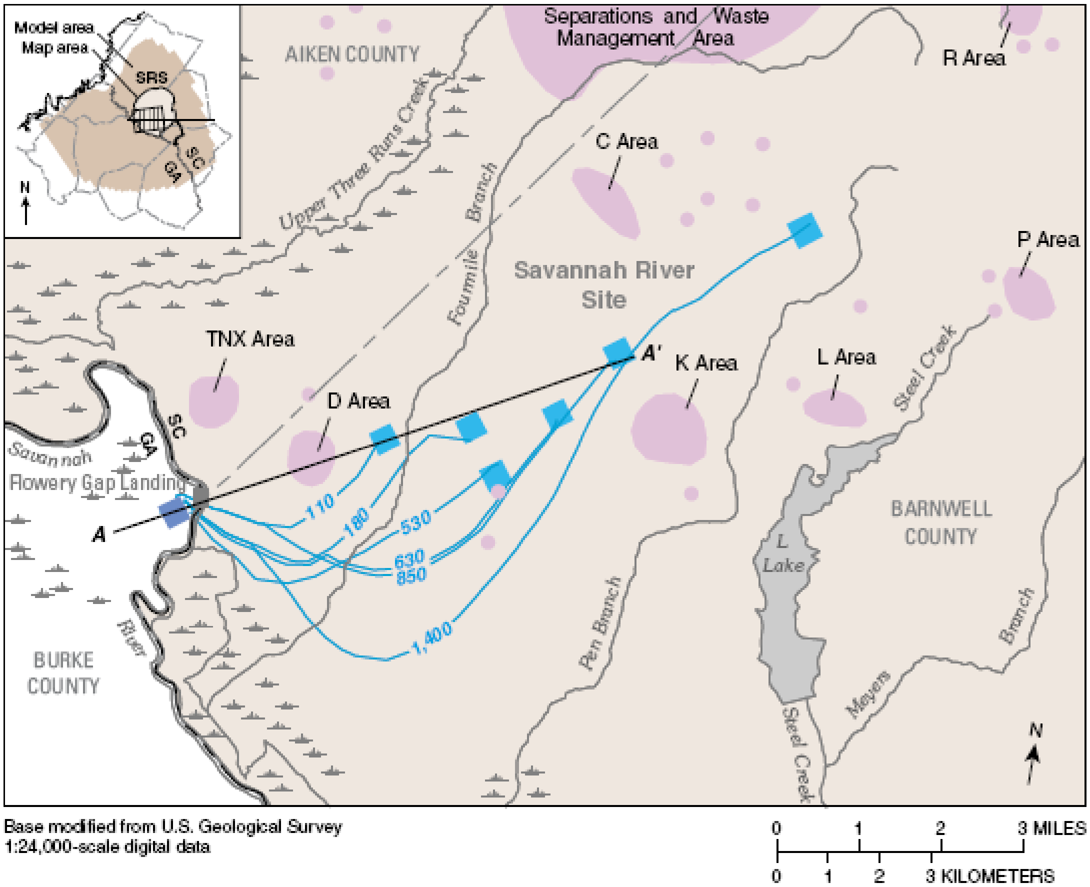

Figure 1. **Westward trans-river flow originating at the SRS**