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Benchmarking WASP5 with Data from the 1991 K-Reactor Tritiated Aqueous Release Incident(U)

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DISCLAIMER

Benchmarking WASP5 with Data from the 1991 K-Reactor Tritiated Aqueous Release Incident

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The Savannah River Site (SRS) has upgraded its aqueous emergency response capability to model the transport of pollutants released from SRS facilities during normal operation or accidents through onsite streams to the Savannah River. The transport and dispersion modules from the U. S. Environmental Protection Agency (EPA) WASP5[1] model were incorporated into the SRS emergency response system, called the Weather INformation and Display (WIND) System. WASP5 is a water quality analysis program that simulates surface water pollutant transport, using a finite difference method to solve the advective transport equation.

Observed tritium concentrations in the SRS streams and the Savannah River from an accidental release from K-Reactor, one of the SRS nuclear material production reactors, were used to benchmark the new model. Although all SRS reactors have since been deactivated, this release of tritiated water occurred between December 22 and 25, 1991, through the K-Reactor secondary cooling water discharge[2]. Analyses of reactor discharge water suggested the leak began sometime during December 22. The leak was positively identified and isolated on December 25.

Following the release, tritium concentrations were tracked and measured as the tritiated water flowed from the K-Area outfall into Indian Grave Branch and Pen Branch, through the Savannah River swamp, past the mouth of Steel Creek, and down the Savannah River. The measured tritium concentrations at Steel Creek, Highway 301, Becks Ferry and Abercorn Creek were used for benchmarking. Figure 1 depicts the route traveled by the tritiated water.

The river system model includes Indian Grave Branch, part of Pen Branch, part of Steel Creek, and the Savannah River, as shown in Figure 1. The reach

from Point 1 to Point 2 in Figure 1 was divided into 38 segments, each with a cross-sectional area of 11.33 m^2. The reach from Point 2 to Point 3 is in the swamp area and was divided into 22 segments, each with a cross-sectional area of 197.14 m^2. The Savannah River from 30.5 km downstream from the New Savannah Bluff Lock and Dam to 14.5 km upstream from Fort Pulaski was divided into 489 segments, each with a cross-sectional area of 278 m^2. All model segments are 500 m in length. The cross-sectional areas of the reaches were estimated from the Manning Equation using the measured flows and the elevations obtained from the topographic maps. Figure 2 shows the schematic for the finite difference model.

The required inlet conditions are the Savannah River flow at Segment 1, the Pen Branch flow at Segment 54, and the Steel Creek flow at Segment 551. Daily averaged flows from December 22, 1991, to January 22, 1992, for the Savannah River, Pen Branch and Steel Creek were obtained from the U.S. Geological Survey Water Resources Data in South Carolina[3].

It was estimated that 5,700 Curies of tritium were released between December 22 and 25, 1991[2]. The model assumed that the release started at 12:00 noon on December 22, 1991 and was isolated at 12:00 noon on December 25, 1991 with a release rate of 1,900 Curies per day. This corresponds to a total release of 5,700 Curies of tritium in three days. The tritium was released at Segment 72.

A comparison of the model results with measured concentrations shows that the model overestimates the peak concentrations at Steel Creek, Highway 301, Becks Ferry and Abercorn Creek by 3, 3, 9 and 15%, respectively, and underestimates the transport times of the concentration peak at Steel Creek, Highway 301, Becks Ferry and Abercorn Creek by 37, 25, 18 and 20%, respectively (Figure 3). The discrepancies in the travel time could result from uncertainties in the initial release time. The oscillations in measured tritium concentrations at Abercorn Creek shown in Figure 3.D are caused by tidal cycles, which were not modeled in this study but will be included in future models.

The new SRS aqueous emergency response model (incorporating the WASP5 components) accurately simulates both the timing and the magnitude of the maximum tritium concentration. This demonstrates that the code can perform well both for emergency response and other engineering or safety analyses.

REFERENCES

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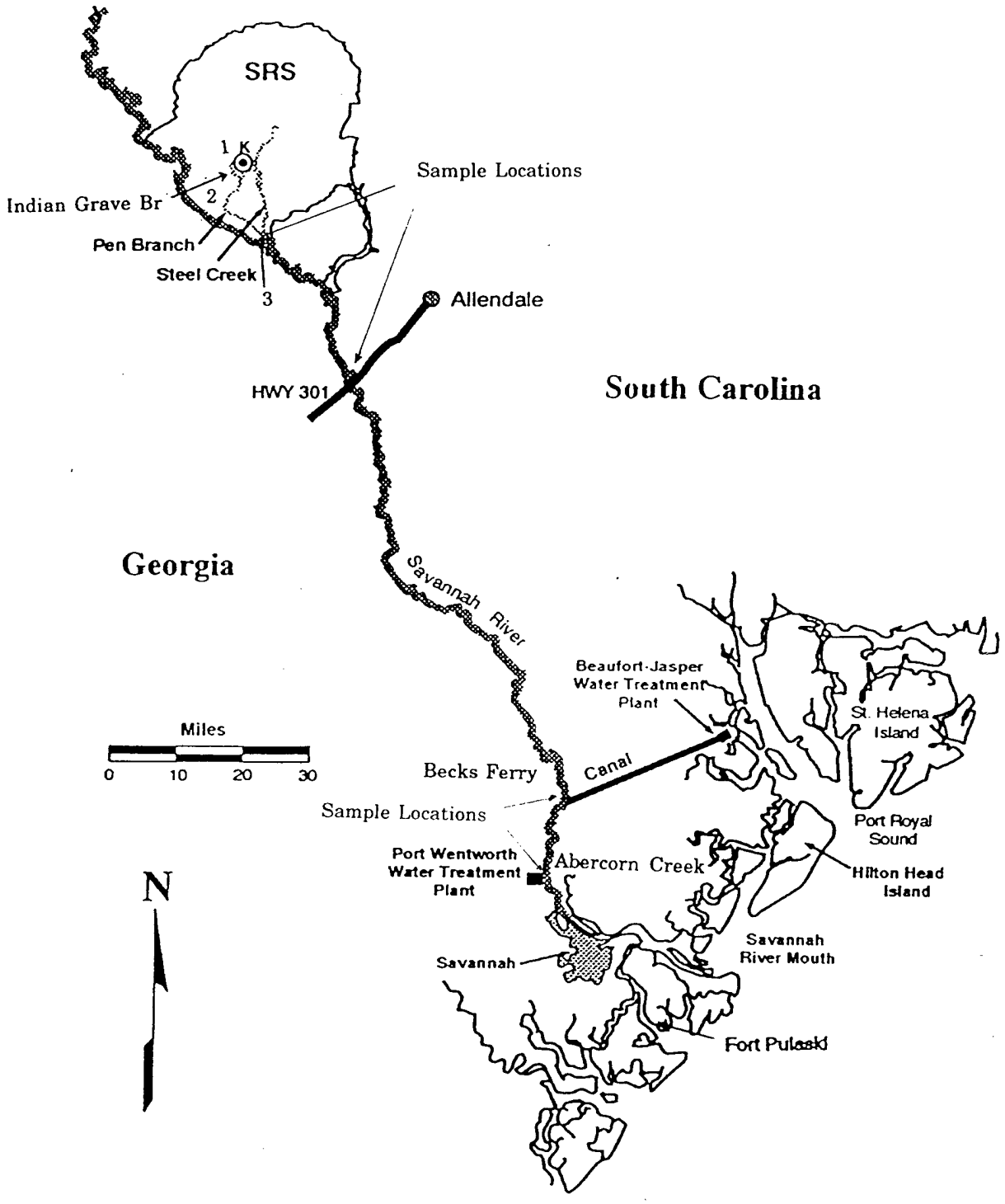


Fig. 1 Map shows path followed by tritium from K Area to Savannah River estuary after December 1991 release

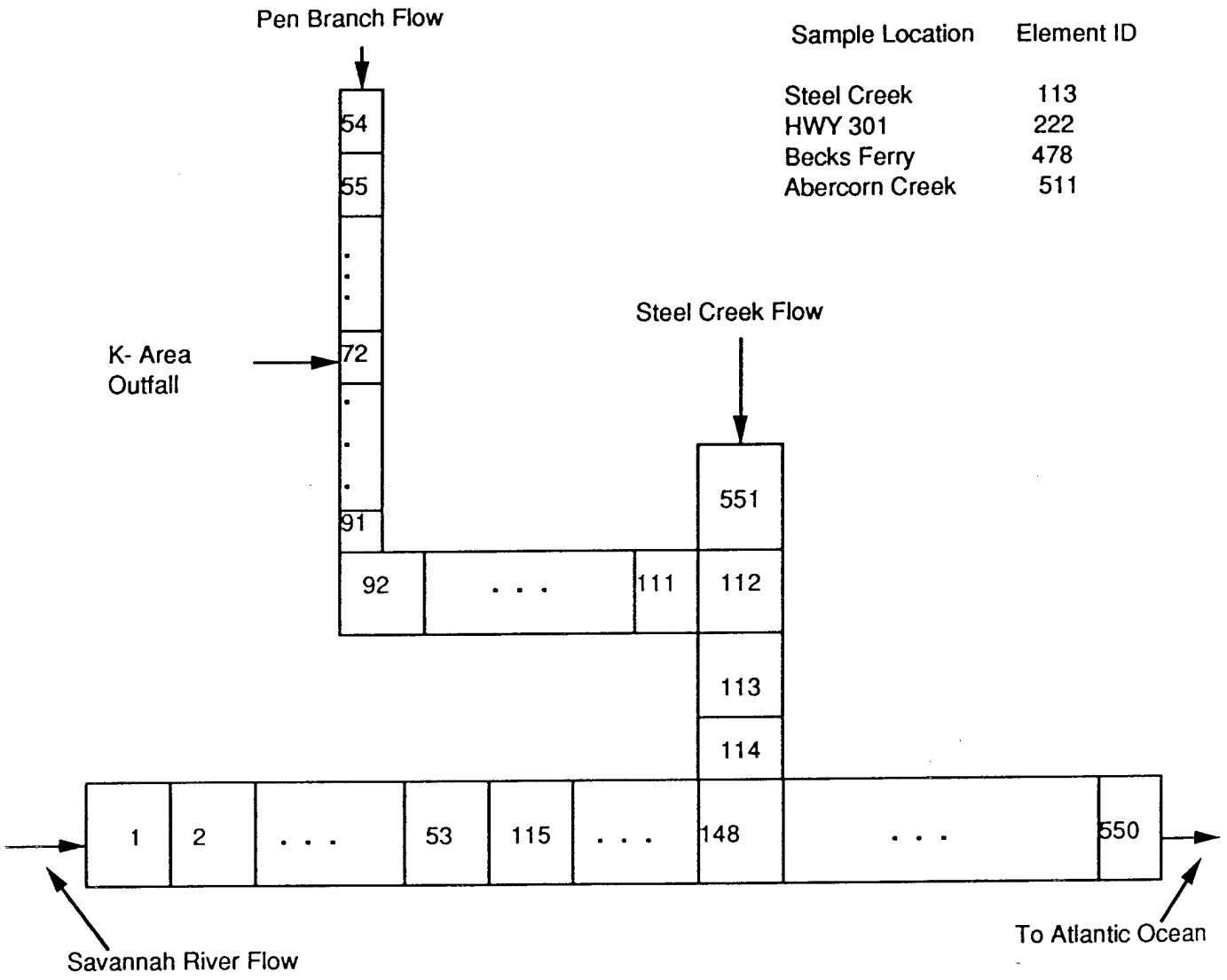
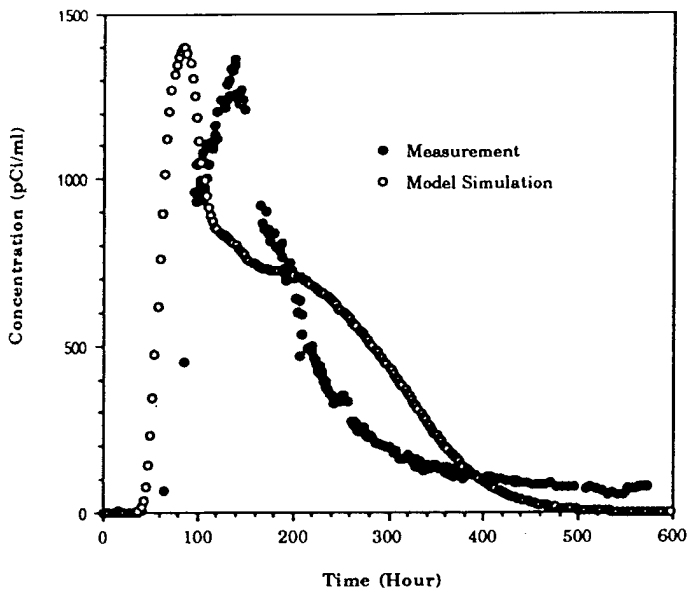
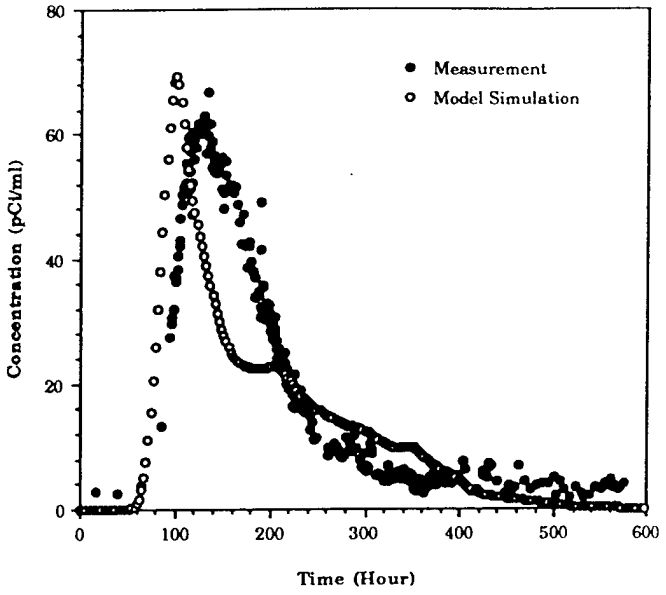


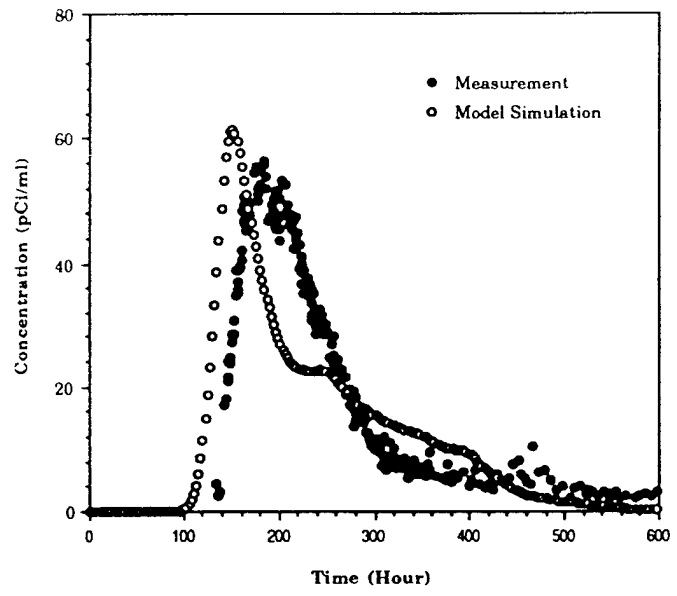
Fig. 2 Model Schematics (Not to Scale)



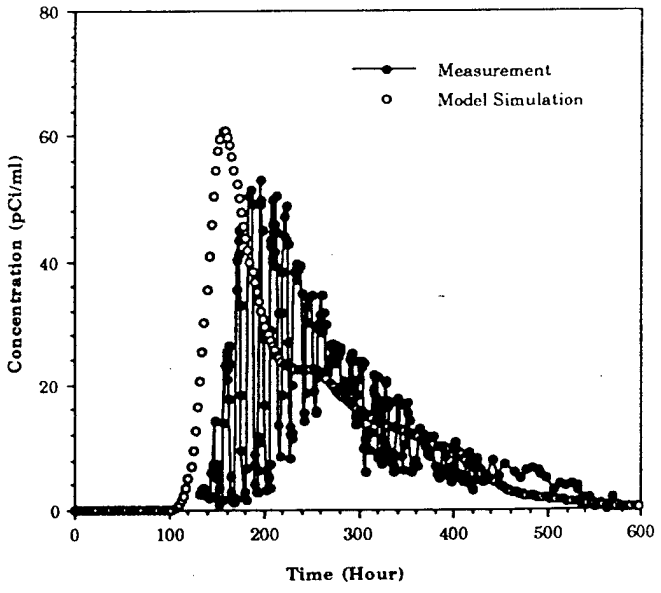
A. Tritium Concentration at Steel Creek



B. Tritium Concentration at Highway 301



C. Tritium Concentration at Becks Ferry



D. Tritium Concentration at Abercorn Creek

Fig. 3 Model Results

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