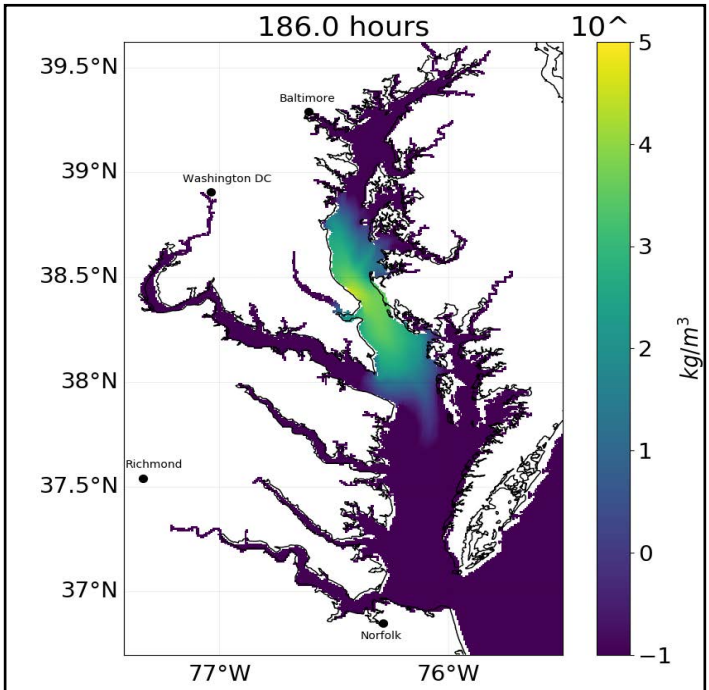
Hydrology and Surface Water Modeling Program

The Savannah River National Laboratory (SRNL) applies computer models developed by SRNL scientists, the U.S. Environmental Protection Agency (EPA), and the U.S. Army Corps of Engineers (CoE) to predict surface water hydraulics and the transport and dispersion of thermal and chemical/radiological contaminants discharged into streams, rivers, ponds, lakes, bays and/or coastal estuaries. This unique collection of modeling resources enables SRNL to support U.S. government agencies in a variety of areas including emergency response, water quality impact assessments, design safety for dam breaks or flooding, and contaminant source attribution.

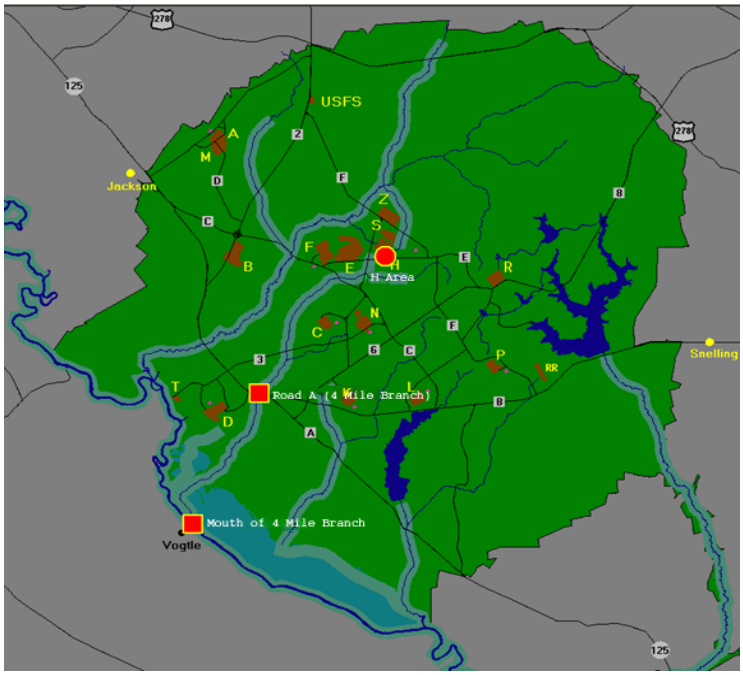
Advanced Modeling

SRNL's **ALGE3D** model provides a unique capability for predicting the transport and dispersion of contaminants released in complex hydrodynamic environments, such as rivers, lakes, bays, and/or tidal estuaries. This model solves the conservation equations for momentum, energy, and mass in three dimensions based on input of water body bathymetry, concurrent hourly meteorological conditions, and time dependent sea surface heights for tidal forcing (as applicable). Contaminants can consist of thermal, dissolved chemical, or particulate discharges. ALGE3D was recently adapted to support near real-time or post event emergency response and has frequently been used to perform source attribution assessments (i.e., origin, amount) for numerous U. S. Government customers.

ALGE3D has been benchmarked using simulations of Delaware Bay (estuarine tidal predictions), SRS's L-Lake and the Squaw Creek Reservoir in Texas (cooling ponds), and the Savannah River. Following a train derailment in 2005 near Graniteville, SC, ALGE3D was used to calculate the absorption of an airborne chlorine release adjacent to a nearby creek and the resultant downstream concentrations to assess potential violations of the U. S. Clean Water Act.



ALGE-3D Simulation of contaminant concentration in the Chesapeake Bay following a discharge near Calvert Beach, MD

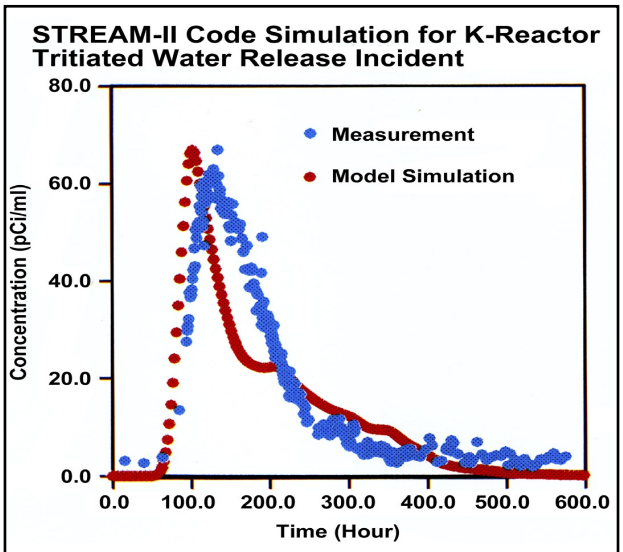


SRS streams (light blue shading) available for Stream-II modeling

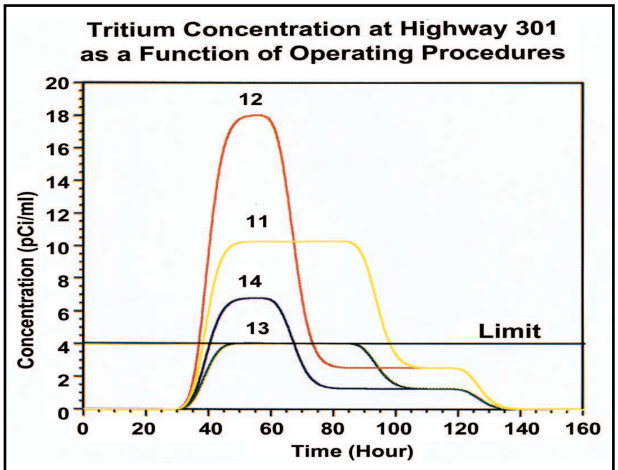
Emergency Response

The Stream-II code is a simple dilution and one-dimensional advective transport model used to predict travel times and concentration of aqueous releases for emergency response at the Department of Energy's Savannah River Site. Given a release location and time, transport and concentration calculations are performed for an appropriate sequence of predefined segments along SRS streams and the Savannah River based on average flows. Although the model assumes horizontal and vertical homogeneity of the contaminant, sedimentation of plutonium and cesium releases are calculated within a limited number of vertical segments near stream bottom. If rainfall has occurred, the CoE's HEC RMS and HEC RAS codes are used to compute water shed runoff and the resultant change in stream volume using gridded output from National Weather Service radar to define basin-averaged precipitation. **Steam-II** model results are used to assess the potential health effects at points of public access and drinking water plant intakes. ALGE3D is used to perform similar assessment for more complex water systems.

The **Stream-II** code performance has been benchmarked using the results of several tracer studies, including releases of rhodamine dye in SRS streams and the Savannah River and a 1991 tritium release from SRS K-Reactor complex.



Validation of Stream-II predictions against tracer releases data.



Predictions of tritium concentration to assess regulatory limit compliance

Safety / Hazards Analysis

DOE Order 420.1 establishes design criteria for nuclear facilities subject to flooding. Flood hazard curves must be defined which express water level as a function of either the annual probability of occurrence or the return period, in years. SRNL has developed a method of combining the Corps of Engineers HEC-HMS precipitation runoff model with a U.S. Geological Survey Water Surface Profile (WSPRO) hydraulic model to calculate facility specific probabilistic flood hazard curves. Flood hazard analyses have been performed for SRS nuclear facilities to demonstrate O420.1 design requirements for inclusion in documented safety analysis (DSA) reports.

Water Quality Studies

To ensure regulatory compliance, ATG has applied aquatic modeling to assess the downstream pollutant concentrations for proposed facility scenarios. For example, WASP5 was used to examine four scenarios involving a discharge of tritium into SRS streams. The results were used to determine one scenario in which downstream concentrations were in compliance with state and Federal limits.

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