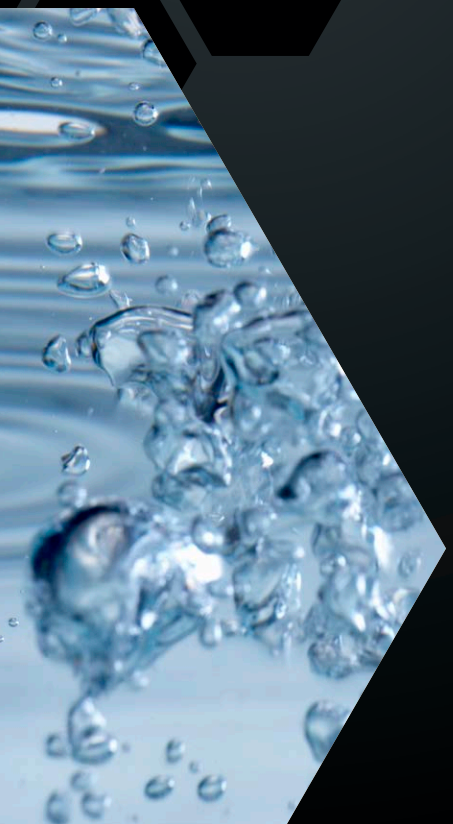
An Effective Tool for Drinking Water Protection

Contact Information

William B. Samuels, PhD
Center for Water Science and Engineering
Leidos, Inc.
703 253 8872
william.b.samuels@leidos.com

James C. Springer, PE
Greater Cincinnati Water Works
513 624 5624
James.Springer@gcww.cincinnati-oh.gov

Richard Fry
Defense Threat Reduction Agency
703 767 3193
rick.fry@dtra.mil



After a release of hazardous materials into a river or stream environment, drinking water protection and contamination risk mitigation require that information on the fate of waterborne contaminants be made available quickly to decision makers. The Defense Threat Reduction Agency (DTRA) has identified the Incident Command Tool for Drinking Water Protection (ICWater) as a forecasting tool that can be used to predict the consequences of a chemical, biological, or radiological (CBR) materials release within river or stream systems.

ICWater was designed to answer four critical questions:

(1) Where is the contaminant going?
(2) Is there a drinking water intake in its path?
(3) When will it reach drinking water?
(4) Is its level high enough to be a human threat?

The tool interfaces with the US Geological Survey (USGS) real-time stream gauging network. Contaminant travel time and concentration can be estimated at locations downstream based on conditions at the time of the spill. Several other relevant geographic databases are combined within the tool to provide information that incident commanders require. Information includes the location and contact information for all public drinking water intakes, dams, hazardous material sites, pipelines, bridges, and locations of critical infrastructure such as hospitals and fire and police stations. ICWater also contains a reference database that identifies the concentrations of CBR contaminants, which are a concern for human health if consumed in drinking water. River networks have also been developed for basins outside the contiguous United States, in Asia, Africa, and Europe. Upstream tracing of the river network can be used to identify sources of contaminants.

ICWater Interface Showing Spill Site, Charleston Intake, and Real-Time USGS Gauge

In addition to ICWater, models of water distribution (PipelineNet) and wastewater collection systems (SewerNet) have been developed for emergency management of CBR events. The tools have demonstrated usefulness for spill response and homeland security through their application in national and international events such as the West Virginia chemical spill and the Fukushima Daiichi Nuclear Power Plant incident. ICWater was developed by Leidos, Inc. (carrying on the legacy of SAIC), with funding from several government agencies, most notably the US Forest Service and DTRA. DTRA currently maintains, trains, and distributes the software to federal, state, and local users.

The Challenge

On January 9, 2014, an estimated 10,000 gallons of 4-methylcyclohexanemethanol (MCHM), an organic solvent used in coal processing, leaked from a ruptured container into the Elk River near Charleston, West Virginia. The spill, just one mile upstream from a water treatment plant, forced officials to ban residents and businesses in nine West Virginia counties from using the water for anything other than flushing toilets or fighting fires. An estimated 300,000 West Virginia residents were affected by the spill. ICWater model runs were initiated by DTRA, Leidos, and Greater Cincinnati Water Works (GCWW) to estimate the travel time and concentration of the spill.

ICWater Downstream Trace (120 hours travel time) Showing Drinking Water Intakes

The Solution

ICWater, an Esri® ArcGIS® extension, uses the National Hydrography Dataset Plus (NHDPlus) river network for downstream and upstream tracing of contaminants. The NHDPlus contains more than three million stream and river reaches, all hydrologically connected. Mean flow volume and velocity are attributes of each reach in the network.

USGS real-time stream flow gauges are linked to the network to update the mean flows and velocities to reflect actual conditions. The difference between the updated mean velocity in ICWater and the measured velocity on the Kanawha River (just downstream of the spill and the Charleston, West Virginia, intake) was less than three percent. The system also contains locations of industrial and municipal dischargers such as the spill site on the Elk River. It is also linked to the Environmental Protection Agency Safe Drinking Water Information System to provide data on populations served by each water utility downstream of the spill.

Tracing was initiated at the spill site to forecast the location of the leading edge, peak concentration, and trailing edge of the plume for drinking water intakes as far downstream as 200 miles. Model runs were updated based on MCHM measurements at downstream locations on the Ohio River to provide accurate forecasts to nearby water intakes.

The Results

GCWW, a large water utility on the Ohio River, used ICWater and National Oceanic and Atmospheric Administration velocity estimations, along with river grab samples, to determine when to close its intake to allow the spill to pass by. Data for Cincinnati showed good agreement (within several hours) between the observed peak time of arrival and the model's estimated peak time. The leading-edge predictions were also close to the observations.

According to GCWW, "The model was very useful in preparing for the arrival of the spill. It assisted in narrowing down an expected time of arrival and was especially useful in predicting the peak concentration. In spills such as the Elk River spill, GCWW normally closes the raw water intakes to allow the spill to pass."

esri®

Understanding our world.

G63334
ESRI6/14ft