



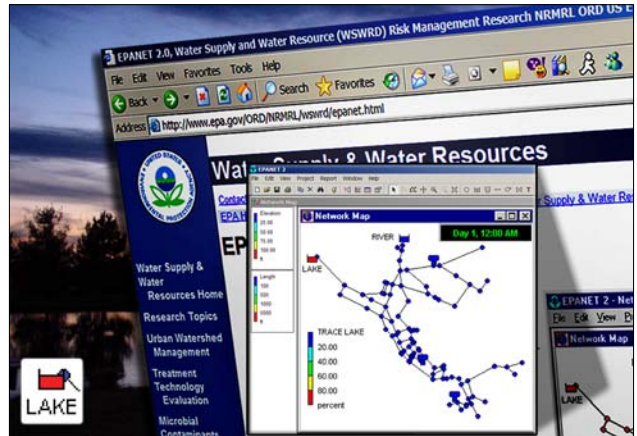
www.epa.gov/nhsrc

# technical BRIEF

## EPANET Extended to Include Multi-Species Modeling

### Background

The U.S. EPA's National Homeland Security Research Center (NHSRC) Water Infrastructure Protection Division (WIPD), headquartered in Cincinnati, Ohio, conducts and coordinates research to improve the security of drinking water and wastewater treatment, distribution, and sources. To counter threats against water systems, the NHSRC is developing the Threat Ensemble Vulnerability Assessment (TEVA) Program, a computer program that models and evaluates water system threats and vulnerabilities. TEVA relies on the EPA's EPANET hydraulic and water quality software package. EPANET has been extended to support homeland security research efforts.



### EPANET-MSX

EPANET is used in homeland security research to model contamination threats to water systems. Historically, EPANET has been limited to tracking the dynamics of a single chemical transported through a network of pipes and storage tanks, such as a fluoride used in a tracer study or free chlorine used in a disinfection decay study.

Recently, the NHSRC released a new extension to EPANET called EPANET-MSX (Multi-Species eXtension) that allows for the consideration of multiple interacting species in the bulk flow and on the pipe walls. This capability has been incorporated into both a stand-alone executable program as well as a toolkit library of functions that programmers can use to build customized applications.

The multi-species modeling extension to EPANET requires a new MSX input file in which the user specifies the mathematical expressions governing the reaction dynamics. EPANET-MSX parses the input file and stores and structures the data for efficient evaluation. Newton-Raphson and Runge-Kutta algorithms into the water quality modules are used to solve the differential-algebraic equations that specify the reaction dynamics.

This structure allows users the flexibility to model a wide range of chemical reactions of interest to water utilities, consultants, and researchers. EPANET-MSX enables users to model free chlorine loss, the formation of disinfection byproducts, nitrification dynamics, disinfectant residuals, and adsorption on pipe walls. Homeland security researchers are particularly interested in modeling the fate and transport of contaminant threats in drinking water distribution systems.

### MS-EPANET Software and User's Manual

The EPANET-MSX software and User's Manual is now available by following the link at: <http://www.epa.gov/nhsrc/water/teva.html>.

EPANET-MSX is distributed in a compressed zip file that contains a command line executable, several libraries of functions, and a User's Manual. The executable can be used to run water quality analyses without any additional programming effort. The function library can be used in conjunction with the existing EPANET Programmer's Toolkit to develop customized applications. At this point in time, the software has not been integrated into a Windows interface, but this is expected to happen at some point in the future.

(more)

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For more information, visit the NHSRC Web site at [www.epa.gov/nhsrc](http://www.epa.gov/nhsrc), and the TEVA Research Program site at <http://www.epa.gov/nhsrc/water/teva.html>.

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