Success Story

Lake Ontario Collaborative Project uses 3D Hydrodynamic and Water Quality Modelling to Identify Potential Threats to Drinking Water Intakes[1]

The availability of clean, potable water from the Great Lakes is a crucial factor in the social and economic growth of this region of North America, and in fact, most of Ontario's 13 million residents receives drinking water from the one of the Great Lakes. As part of Ontario's Source Water Protection program, a group called the "Lake Ontario Collaborative" was formed to study the potential threats to this source of drinking water for Lake Ontario. The study used an events-based approach to evaluate potential large releases of contaminants associated with existing activities on land. A number of spill scenario events were identified and modelled to determine if these activities could result in deterioration of water quality at the location of the drinking water intakes to the point that it is unsuitable for use.

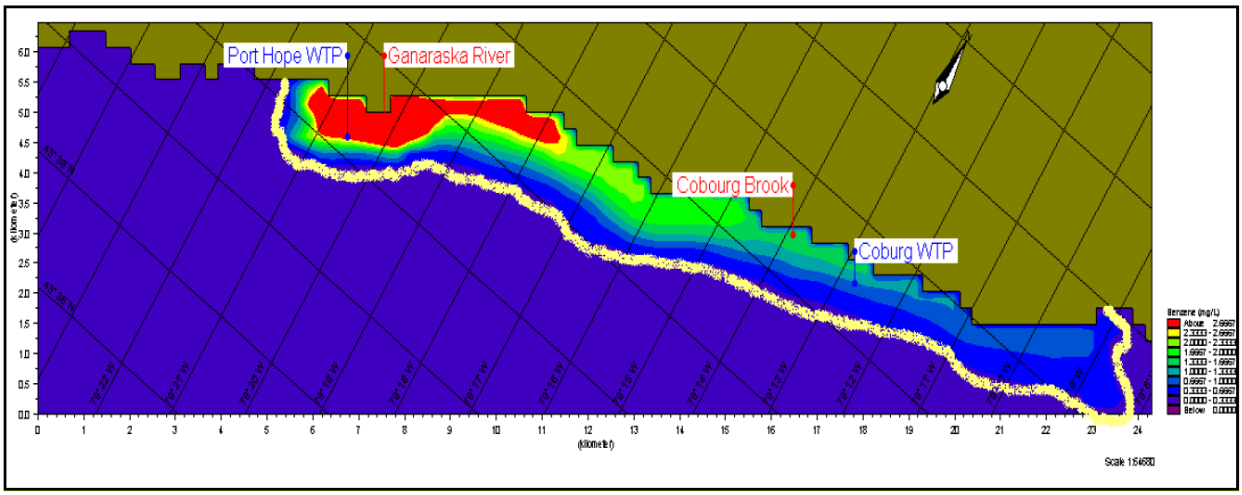
The scenarios that were selected for evaluation included:

- disinfection failures at each municipal waste water treatment plant;
- accidental release of tritium contaminated water from nuclear power plants;
- product of waste spills from industrial facilities; and
- spills from a petroleum pipeline as it crosses major tributaries.

For most spill sources, a series of events were modeled, because this method provides a typical lake response, rather than relying on specific directional events. A typical lake response could involve anyone of a spectrum of current directions and speeds that could occur at the specific time that a spill occurs.

The impacts of the spill scenarios on the water quality at the intake locations in Lake Ontario were modeled using DHI's MIKE 3 software for calculating three-dimensional hydrodynamics (e.g. water level, current speed and direction), and water quality (e.g. dissolved concentrations, bacterial densities, and radiological activity). MIKE-3 uses the full three dimensional representation of water motion, including thermodynamics. It accurately simulates the seasonal thermal conditions and summer stratification that affects the circulation pattern in Lake Ontario, which is required for accurate predictions of water currents.

The study used a whole lake model of Lake Ontario (Dewey, 2011) to predict the water currents in the nearshore area of interest, (i.e. the coastal zone of Lake Ontario). The ability of the model to forecast lake physics (currents; thermal character) was evaluated based on an extensive calibration effort. This involved comparing model calculations with observations for nearshore current meters located off sites between Darlington and Halton, ambient temperature profiles in the main lake, and temperature data from drinking water plant intakes. The calibrated model was then used to assess selected spill scenarios during selected events to determine the potential adverse impacts to the drinking water quality at the source water intakes.



[1] This document was prepared using excerpts and images from the Draft Proposed Assessment Report for Central Lake Ontario Source Protection Area – Appendix I – Threats from Activities in Intake Protection Zone-3 (June, 2011)

Chemical concentrations / radiological activity/ E. coli density levels at each intake were used in the initial screening to determine potential intakes impacted by the spill (release) from each specific source. Results from the simulations were graphed as a time trend of concentrations for a season at each intake, and tabulated as peak concentrations calculated for each intake. These results were then used to delineate intake protection zones for scenarios where adverse impacts were observed. The intake protections zones are used to help raise the awareness of the potential environmental and health risks posed by the spill scenarios, they help to communicate the importance of safe handling of hazardous substances, and they help to guide the preparation of emergency response planning in the event of a spill.

This study represents a first step in a systematic consideration of how a major spill or event from an activity which could reach Lake Ontario might impact specific drinking water intakes. The development of a calibrated and validated three-dimensional model with which to do the events based scenario modeling also provides a tool that can be used in future to expand this type of analysis to update the respective assessment reports.

For more information on MIKE 3 please visit the MIKE by DHI website at www.mikebydhi.com or contact DHI by calling 1-888-344-9233 or sending an email to dhi-ca@dhigroup.com. For more information about the Lake Ontario Collaborative Project please refer to the following website http://www.ctcswp.ca/Lake-Ontario-Collaborative/lake-ontario-collaborative.html.