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Special Session May 16, 2007

Protecting Lake Ontario Drinking Water

Hosted by the Collaborative Study to Protect Lake Ontario Drinking Water
Moderator: Larry Moore, Ontario Clean Water Agency

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Speakers

Larry Moore	***Ontario Clean Water Agency***
Ron Motum	***Regional Municipality of Durham***
Ram Yerubandi	***National Water Research Institute, Environment Canada***
Susan Watson	***Environment Canada – Canadian Centre for Inland Waters***
Gary Bowen	***Toronto Region Conservation Authority***
John Langan	***Stantec ConsultingLtd.***

Proceedings prepared by Pam Maloney, *St. Lawrence River Institute of Environmental Sciences, Cornwall, Ontario, Canada*

Larry Moore - *Ontario Clean Water Agency*

The Collaborative – Purpose, Structure, and Objectives

Lake Ontario has 33 intakes from the Niagara River to the Bay of Quinte. Approximately six million people depend on these water systems for drinking water in residential areas, businesses, and institutions. When the Clean Water Act was passed in 2006, the Ontario Ministry of the Environment provided funds for technical studies to develop source water protection plans in support of the new legislation.

The Collaborative Study to Protect Lake Ontario Drinking Water was established to identify and evaluate local and lake-wide hazards. The Collaborative includes the municipalities from Niagara Region to Prince Edward County, provincial ministries, Environment Canada, and the Ontario Clean Water Agency, as well as conservation authorities, research organizations, and consultants. The mission of the Collaborative is "To ensure the long-term, pro-active and strategic protection of Lake Ontario-based drinking water supplies."

Historically, water utilities have not focused on source water protection. However, the Clean Water Act requires protection of water intake zones, which directly affects all

utilities. In addition to the monitoring and research funded by the Ontario Ministry of the Environment and Environment Canada, the utilities fund research through the Ontario Water Works Research Consortium (OWWRC), an organization that links the utilities with research agencies. The OWWRC was established in 2000 to study parameters in Western Lake Ontario that affect taste and odour in drinking water. Studies have included the physical, chemical, and biological dynamics of the lake, and the identification of algae and other potential sources of taste and odour compounds. Studies have not examined benthic species, pathogens, or chemical hazards.

The Ontario Drinking Water Quality Management Standard (October 2006) identified threats to Lake Ontario drinking water, including potential inputs from rivers, streams, storm water, sewage overflows, and other discharges into the lake. It is evident that the dynamics in Lake Ontario are diverse and variable throughout the seasons, and that more work needs to be done to characterize the intake zones and potential threats.

Through the Collaborative Study to Protect Lake Ontario Drinking Water, powerful information will be provided to local source committees and to laypeople. Phase 1 of the Collaborative Study is focused on identifying intake protection zones (IPZ). Phase 2 will be focused on identification of threats along the lakeshore, watersheds, and intake zones. The Collaborative will also be involved in new challenges such as pathogen identification and monitoring - this process will be data intensive. A public consultation is being held on June 13 - invitations are available on the website, www.owwrc.com.

Ron Motum – ***Regional Municipality of Durham Technical Support Division, Works Department***

Lake Ontario Water Utilities – Understanding the Source

Since the Clean Water Act, water utilities in the Western Lake Ontario basin have redefined the existing Ontario Water Works Research Consortium (OWWRC) into the Collaborative Study to Protect Lake Ontario Drinking Water. The Source Protection Plan is the first line of defense for protection of the municipal water supply - it is intended to minimize human impacts by providing physical data (i.e. temp, bacteria, turbidity, conductivity), information on operational events (i.e. intake and wastewater, study reports, sewer use), and recommendations to manage the impacts of harmful activities.

The Regional Municipality of Durham owns and operates 14 water supply systems: 5 water supply plants are located on the lakeshore, and some on Lake Simcoe; other systems utilize groundwater sources. All of these water supply systems operate a direct filtration system; some have additional treatment regiments such as GAC, superchlorination, and UV treatments. Taste and odour problems were first identified in 1993, and have recurred in 1994, 1998, and 1999 on Lake Ontario. Episodes continue to be reported, but with less severity. On Lake Simcoe, taste and odour problems occur regularly. The cause and source of taste and odour in these areas remain unknown.

The occurrence of excess or nuisance algae in source water has been a problem since 2003, and water restrictions have been imposed as a result. Source water protection legislation and the Clean Water Act have led to the implementation and growth of wellhead protection studies in Durham. The Ontario Water Works Research Consortium (OWWRC) was created in 2000 to address taste, odour, and algae problems. The intent of the Collaborative Study is to understand the source.

The primary benefits of the Collaborative include its mandate to bring all interest groups together, and reduce costs by sharing resources. It allows for collaborations and partnerships that are of great value to utilities. It avoids duplication of research, and enables more extensive projects. By including 3 levels of government, the Collaborative allows for a unified approach.

Combining historical data with new measurements will develop a powerful data set that will allow for useful modeling opportunities. The Collaborative will also focus on impacted intakes, build on research, and meet the requirements of the MOE Source Protection Program. This will help utilities establish a common approach to meeting the drinking water standards and source water standards.

Overall, the Collaborative Study will provide a better understanding of source water, and enable us to be better prepared. This will give utilities the ability to plan ahead, devise new technologies, and be proactive.

Discussion

Q: How will modeling taste and odour data help to protect against health hazards? Can algae and contaminant occurrence predict health occurrences?
A: The Collaborative study provides useful data for the identification of health hazards. The public will benefit from the support of the scientific community. This data will allow the utilities to give the public reassurance.

Q: What are the mechanisms behind the Collaborative Study?
A: Sue Watson's presentation will address this.

Ram Yerubandi *Water Science and Technology, National Water Research Institute, Environment Canada*

Physical processes for Source Water Protection in Lake Ontario

The intake protection zones (IPZs) in western Lake Ontario are highly variable. This variability is due to parameters such as intake depth, source inputs, and offshore and episodic events such as accidental spills, industrial accidents, etc. Lake physics parameters such as circulation and mixing, transport of materials from sources to intakes, meteorology, topography, seasonal stratification, plumes, currents, and waves are criteria that characterize the complexity of the IPZs.

The National Water Research Institute of Environment Canada performs systematic monitoring and modeling studies to develop science-based integrated management of Lake Ontario source waters. The focus of the research is to describe patterns of circulation, temperature, current, and mixing during different seasons.

Using computer models, lake water temperature changes are demonstrated over the years – these models also show mean flows within the lake, circulation trends, and thermal stratification through water depths. The creation of thermal bars in the lake are brought about by the influence of warm rivers throughout the seasons. In the summer, wind has a primary effect on circulation, stratification, waves, coastal jets, currents, and turbulence. Wind driven circulation is important in deep water areas, as upwelling or downwelling occurs along shorelines depending on the wind direction. Trends and observations during the winter are limited, due to the reduced ability to sample and observe trends.

Currently, different modeling techniques such as the ELCOM and POM models are being examined. Computer simulations of current trends and wind speed have been created to demonstrate how they affect one another. These models can be used to predict discharge movement based on water movement trends. Unfortunately, models do not give complete information on all parameters. Other modeling techniques must be utilized for different data.

In summary, the data collected and the modeling methods show the effects of circulation and mixing on the delivery of water masses to drinking water intakes. However, coastal physical processes are very complicated – additional experimental data and modeling is required to continue this work. Furthermore, to predict trends and use these results to advise others, winter observations, as well as extensive calibration and validation of prediction models are needed.

Discussion

Q: With respect to Lake Ontario data modeling for municipal IPZ delineations, how will you interface with source water protection groups to provide advice?

A: Environment Canada is providing the data for modeling. Other partnerships with Queen's University, consulting firms, etc. will provide scientific advice to the source water protection committees to help define and answer questions. Most consultants are using the same models.

Susan Watson *Aquatic Ecosystem Management Research, National Water Research Institute, Canadian Centre of Inland Waters (CCIW)*

Lake Ontario - Chemical and Biological Threats to Drinking Water

Historically, drinking water sources, inputs, and watersheds have been inadequately characterized, with a small amount of monitoring or management. Over time, we have become reliant on treatment rather than protection. However, this type of band-aid approach is not sustainable - upgrades and maintenance are costly, and operators lack adequate training to keep up with the changing times. In addition, consumers are more educated and concerned about their drinking water. There is a general mistrust of municipal supplies that has led a trend toward alternatives such as bottled water.
The Collaborative Study to Protect Lake Ontario Drinking Water outlines an integrated system from source to tap. The working model involves multi-group involvement toward a safe drinking water supply, utilizing public involvement, guidelines, legislation, etc.

Over the years, the Great Lakes have experienced a number of problems including eutrophication, blooms, and contamination. In 1994, the Remedial Action Plan of the International Joint Commission identified 43 areas of concern in the Great Lakes Basin. Each Area of Concern showed beneficial use impairments based on a number of criteria; however drinking water assessment was not a priority. Despite remediation efforts, impacts such as bacteria, toxins, algal growth, and taste and odour are still increasing. .

The goals of the Collaborative Study to Protect Lake Ontario Drinking Water are to identify known and emerging threats to drinking water and to assess their occurrence, monitoring, and management. Some of the knowledge gaps include: seasonal spatial levels of chemical hazards, toxin-producing cyanobacteria, and pathogens; winter conditions; shoreline storm runoff; plume tracking; inshore processes such as algal mats; and thermal bar analyses. New research is required in all of these areas.

The working plan of the Collaborative involves creating an inventory of existing data, performing the necessary fieldwork to fill information gaps, providing new data; modeling the trends at intake protection zones; and creating a management framework.

In 2007, research will focus on the Credit River area. This region is representative of other lakefront areas and provides parameters for study, including sewage treatment plants, river discharge, water outfalls and urban shoreline impacts. Sampling will be performed at regular intervals, and throughout the winter. A number of sampling sites for new data have been identified around the Credit River output, water treatment plants, and sewage treatment plants. The data from water and sewage treatment plants will be examined, as well as moorings data, physical profiling, and analyses of water quality, nutrients, plankton, and pathogens such as *E.coli* and other bacteria, protozoans Cryptosporidium, Giardia, and enteric viruses. Cyanobacterial impairments such as taste/odour and toxins, and chemical faecal impacts will also be studied.

In 2008, the scope of the assessment will be broadened, and research will be coordinated and combined with other research agencies.

Current knowledge on pathogens is based on historical data of outbreaks in drinking water. Historical data on *E. coli* occurrence is available - sporadic high levels have occurred, however, the trends are not well understood. Some cyanobacteria produce neurotoxins. Although these have been observed with large variability from year to year, they occur at the same time every year. Taste and odour compounds present aesthetic concerns, due to terpenoids, produced by some algae and actonomycetes, which give an earthy-musty odour to drinking water. Other compounds such as pigment derivatives and sulphur have also been linked to taste and odour; however, these compounds have been identified in trace amounts, and no guidelines exist for their control. Work done with the St. Lawrence River Institute has identified that inshore sources of these compounds in the St. Lawrence River contribute to taste and odour occurrences.

Knowledge gaps occur in the areas of pathogens, winter sampling data, and comparisons of water supplies and intakes around the lake. More information is needed on pathogens, taste and odour compounds, and toxins. Current modeling techniques may not be accurately predicting trends of toxic chemicals.

Discussion

Moderator asked to hold questions until after the other speakers.

Gary Bowen ***Toronto and Region Conservation Authority***

Lake Ontario Tributaries - Loadings and Hazards

Phase 1 of the Collaborative Study involves identification of all intake zones, watersheds, and other parameters for study. Subsequent phases will study the loadings from streams and tributaries for incorporation into models for IPZ control and management.

In order to calculate tributary and stream loads, extensive information and monitoring data is needed throughout the year. Currently, the Conservation Authorities are not collecting an adequate number of samples to provide accurate load estimates. Event mean concentrations are used to calculate loads and stream flow information, and water quality models are being created to compare with real data and with previously collected data. Sampling priorities are being assigned to key watershed input sources.

To estimate pollutant loads near drinking water intakes, a variety of procedures were employed in a study that was co-authored by collaborators from the Toronto and Region Conservation Authority, Environment Canada and the University of Guelph. Loadings for nutrients and suspended solids were determined from methods such as: event mean concentrations coupled with runoff volumes for daily, monthly, and annual time steps; unit area loadings on watershed and sub-watershed bases; calculated loads using combined stream and flow chemistry; and non-point source model-estimated peak loads for major storm events. With this data, annual loads were profiled from tributaries around the lake. Modeling was used to examine loading trends after extreme events such as precipitation, storms, etc.. Effects from climate change scenarios were predicted, as well as other extreme events. These loading calculations help inform other studies with respect to water quality, and not just drinking water.

Phase 2 of the Collaborative Study will involve identifying priority watersheds for monitoring, and threats to drinking water.

Discussion

Q: How are land-based observations for loading linked to other sites such as Lake Erie?
A: The study has not got to the point where the data can be used to estimate loading trends in other lakes. However, one option is to compare land uses, i.e. if 75% of land use is agricultural, how much phosphorus loading would be expected.

John Langan ***Stantec Consulting Ltd.***

Stantac Consulting Ltd. is the primary consulting team for the Collaborative Study's Phase 1 analyses of surface water vulnerability studies in nine Lake Ontario

municipalities with 20 municipal drinking water plants. The intake assessment analyses and guidance modules involve a series of studies on source water inputs and effects: Module 1 involves watershed characterization; Module 2 involves a long term municipal supply strategy; Module 3 involves groundwater vulnerability analysis; Module 4 concentrates on surface water vulnerability analysis; Module 5 includes an issues, evaluation, and threats inventory; Module 6 involves water quality risk assessment; and Module 7 is a water budget/water quantity risk assessment

Module 4 involves surface water vulnerability, with key elements that include intake and setting characterization, IPZ delineation, vulnerability score determination, vulnerability score determinations, uncertainty levels assessments, and applications to a geo-referenced database. Critical data for these assessments include intake specifications, raw water quality at intake, pathogens, turbidity, temperature, and chemistry. Local shoreline information and tributary watercourse information from Module 1 is also required for generic regulation mapping of outfalls in each area, as well as local pathways mapping and lake current information.

Intake Protection Zone characterization involves measurements of intake length, depth, setting, local lake processes, and other influences. IPZ delineation encompasses a study range of 1 km radius at a minimum. Further characterization includes modeling local water movement vectors, and measuring the extent of movement inland and upstream. The purpose of zone delineation is to identify threats, land uses, and ultimate protection strategies. The process for these Module 4 assessments include owner operator interviews to obtain information about perceived threats and concerns, and to understand the operations of water treatment plants, i.e. anecdotal info about storms, past occurrences, time to shutdown intake, and area information.

Vulnerability scores are formula driven, based on the model used. Calculated scores will be used later in Module 6 for risk assessment. The uncertainty level assessments provide a measurement of the confidence in IPZ and vulnerability score. These assessments take into account the quality, quantity, and distribution of the available data, and will also influence water quality risk assessment scores determined in Module 6.

For the Collaborative Study, Stantec Consulting and other firms will be involved in in-water and alongshore delineation and water quality analyses. Preliminary modeling is already occurring in Western Lake Ontario where good data is already available. Complex areas will require more detailed and overlapping modeling methods – this will likely be a priority for future work.

The status of the Collaborative study is as follows:

Phase 1: Preliminary Vulnerability Assessment (Module 4) will be complete at the end of July 2007.

Phase 2: Scoping level issues and threats (Module 5) and risk assessment (Module 6) - initiation July 2007; completion June 2008

Phase 3: Follow up detailed work at priority locations identified in Phase 2 - initiation July 2008; completion December 2008

No further discussion or questions.

Conclusion

The Collaborative Study to Protect Lake Ontario Drinking Water will identify and evaluate local and lake-wide hazards, with the end objective of ensuring long-term, pro-active, and strategic protection of Lake Ontario-based drinking water supplies. This will be done through identification of threats along the lakeshore, watersheds and intake zones and the source of the threats. The research/monitoring/data analysis/modeling will result in a better understanding of source water, and is expected to result in a management framework that includes Source Protection Plans for all Intake Protection Zones. The Collaborative Study enables partnerships and collaborations in a source-to-tap approach toward a safe drinking water supply. The expected completion date for this initiative is December, 2008.