

2

PILOT OF PREDICTIVE MODELING TO MONITOR PUBLIC BEACH WATER QUALITY

The Community and Health Services Committee recommends the adoption of the recommendation contained in the following report dated March 26, 2012, from the Commissioner of Community and Health Services and Medical Officer of Health.

1. RECOMMENDATION

It is recommended that:

1. The Regional Clerk circulate this report to the Town of Georgina and the Town of Whitchurch-Stouffville.

2. PURPOSE

This report is prepared for Council in order for it to carry out its legislative duties and responsibilities as the board of health under the *Health Protection and Promotion Act*. It describes a predictive system for monitoring recreational beach water quality, which can more accurately identify days with high *E. coli* levels than the water sampling method currently used. The Public Health Branch will pilot a predictive model in selected local beaches as part of its 2012 beach surveillance program.

3. BACKGROUND

The Public Health Branch monitors public beach water quality as mandated by the Province to reduce the risk of waterborne illness

The goal of the York Region Beach Surveillance Program is to protect residents and visitors by monitoring water quality at public beaches. The Ontario Public Health Standards mandate the beach surveillance activities to be conducted by health units:

- **Routine surveillance of public beaches during the swimming season**
Beach surveillance consists of collecting water samples and recording sampling conditions such as water clarity, temperature, presence of wildlife, and beach use. Weekly sampling is the minimum, but sampling frequency depends on historical water results. Currently, surveillance of York Region beaches occurs on a weekly basis from mid-June to September.

- **Annual pre-season assessments of public beaches**

Pre-season assessments guide health units in developing site-specific surveillance plans appropriate to the risk posed by each beach. These assessments are to include analysis of previous years' data on water conditions, as well as an environmental survey to identify beach features that may influence recreational water quality, such as:

- shoreline materials
- lakebed conditions
- culverts
- boat activity
- currents

Water quality is monitored at 14 public beaches in the Region. These are along the south shores of Lake Simcoe in the Town of Georgina and on Musselman's Lake in the Town of Whitchurch-Stouffville (*Attachment 1*).

A beach "posting" is a notification to the public of increased risk associated with beach use, while a beach "closure" indicates a health hazard

The Ontario Public Health Standards require that health units inform the public, by posting signs in prominent locations on the beach, when there is evidence that beach water quality could present an increased risk to the health of bathers. Presently, York Region beach postings occur when bacterial testing of the water shows results exceeding the provincial standard of 100 *E.coli* per 100mL of water. This level of bacteria represents an increased risk of illnesses such as skin, ear, eye, nose and throat infections as well as gastrointestinal illness.

In contrast, beaches are closed in the case of an immediate health hazard, such as a sewage spill or blue-green algae bloom.

A 24-hour delay in posting beaches with poor water quality significantly affects the program's accuracy

Water samples collected during beach surveillance are sent to the provincial laboratory for bacterial analysis to determine the *E.coli* count. Since this analysis requires at least 21 hours, water sample results are received by York Region 24 to 30 hours after submission. If *E.coli* results exceed the provincial limit, a beach posting occurs. Community notification of postings is also facilitated through the Regional website and the Health Connection public health telephone information line. The posted beaches are then re-inspected daily until the beach water quality is within the provincial standard. If posted on a Friday, the beach remains posted over the weekend until re-inspected on Monday.

Although York Region Public Health follows the industry standard, the delay required for water testing can be problematic. Following the 24-hour delay in analysis, it is possible for the beach water quality to have changed. In 2011, the Public Health Branch conducted an increased monitoring program. It found that two thirds of *E.coli* peaks lasted less than 24 hours. The result was inaccurate public notifications: the beaches remained open on a day of increased risk (during which water samples are processed) and the following day the beaches were posted on a day of minimal risk (once the previous day's lab results were received). The current beach surveillance system does not have the timeliness to respond to fluctuations in water quality.

4. ANALYSIS AND OPTIONS

Predictive modeling can estimate water quality immediately, based on current environmental conditions and trends derived from historical data

Predictive modeling is a technique of basing beach posting decisions on environmental conditions. By using current data, a predictive model has the potential to be superior to the industry standard of bacterial analysis. Predictive systems have been successfully implemented in U.S. beaches.

Predictive modeling uses a statistical technique called multiple linear regression to determine which factors best predict current *E. coli* levels in the water. Common predictors include water clarity, average air temperatures, wind direction, and amount of rainfall. Historical data is evaluated to identify trends between possible predictors and water quality for each beach, and a site-specific model equation is created for each beach that accounts for the particular geography and water conditions of the location.

A predictive beach surveillance program can more accurately identify unsafe bathing days than the existing system

For the 2012 swimming season, predictive models will be piloted as part of the beach surveillance program for three beaches on the shore of Lake Simcoe, while the existing monitoring system will continue for the remaining beaches. The three beaches were chosen to optimize improvement over the current monitoring program.

For each beach in York Region, a predictive model has been created and compared with the existing water quality monitoring system. Simulations were run using data from 2008 to 2011 to evaluate the two methods. It was found that, under our existing program, only 30% of unsafe swimming days resulted in postings for the three pilot beaches. Using the predictive models, this average was 57%. Although simulations can never fully replicate real-life validation, the results are clear: the predictive models were approximately two times better than the existing system.

Surveillance of pilot beaches will occur five days a week, with immediate posting

In practice, the predictive system is very similar to the existing beach surveillance program. The surveillance and sampling procedures remains unchanged. The decision to post beach signage, however, will not depend on waiting for laboratory results. Instead, current beach conditions will be inputted into the beach's model equation to predict the current *E.coli* count. If the predicted count is above the provincial limit, then the beach will be posted immediately.

Beach surveillance will take place five days a week, to provide the public with up-to-date information on beach water quality. Sampling will be performed at all beach surveillance visits, to validate this pilot program. In the long term, water sampling will still be required weekly, at a minimum, for ongoing monitoring of predictive model performance.

The predictive models will be updated yearly, as part of the pre-season analysis for each beach. In general, the larger the data set used, the more reliable the predictive model will be. The accuracy of the predictive models will improve as additional data is collected by the beach surveillance program.

Assessment of pilot results will guide program expansion across York Region's public beaches

Based on the results from the 2012 pilot program, the predictive model can be assessed for full implementation at all public beaches in York Region. It is important to note that beaches with consistently excellent water quality may not benefit from a predictive model. At these beaches, postings are so rare that the predictive system would not provide a practical improvement over weekly sampling. However, it would be appropriate to implement predictive modeling for the majority of York Region beaches, as a predictive model would perform better than the existing surveillance system.

As the Public Health Branch expands this program, staff will explore the use of technology to automate beach surveillance, such as water monitoring buoys and simple weather stations. Automation would allow more frequent updates on water quality, and allow for updates over weekends.

Predictive modeling is an opportunity for York Region to be a public health leader

A brief environmental scan of Ontario public health units found that predictive models have yet to be implemented in the province. However, three other health units are planning on piloting a predictive beach surveillance program similar to York Region's in 2012: Niagara Region, the City of Toronto, and Eastern Ontario Health Unit. By

implementing predictive models in the 2012 swimming season, York Region will be part of a group providing leadership on this issue.

The Public Health Branch will continue to keep up-to-date with any developments that could increase effectiveness and efficiency. For example, new and faster techniques of testing for *E.coli* are under development. If this results in a superior process for monitoring beach water quality in the future, staff will re-visit the program as necessary.

Link to key Council–approved plans

The pilot of predictive modeling to improve the accuracy and timeliness of beach water postings reduces health risks to the public associated with waterborne illness. This aligns with the action area “A Place Where People Achieve Optimal Health” in *Vision 2051*.

5. FINANCIAL IMPLICATIONS

There are no additional financial implications associated with the predictive modeling pilot. Beach water surveillance program expenditures of \$104,000 are accommodated within the approved 2012 Public Health Branch Business Plan and Budget. This will be offset by 75% provincial subsidy, for a net tax levy of \$26,000.

6. LOCAL MUNICIPAL IMPACT

A public health initiative to strengthen the beach surveillance program will optimize the well being of York Region residents and visitors who use local beaches. The Public Health Branch has engaged in discussions with staff from the Town of Georgina, where the three pilot beaches are located.

7. CONCLUSION

Beach water quality predictive modeling is an example of evidence-based public health policy. The predictive modeling offers significant improvement over the existing beach water monitoring program in terms of accurately identifying days with increased risk to bathers. For the public, the new predictive system will reduce the risk of adverse health effects related to the use of the public beaches within York Region.

For more information on this report, please contact Dr. Karim Kurji, Medical Officer of Health at Ext. 4012.

The Senior Management Group has reviewed this report.

(The attachment referred to in this clause was included in the agenda for the April 11, 2012 Committee meeting.)

York Region Beaches

Lake Simcoe

Georgina
Island

Town of Georgina

Town of East Gwillimbury

Durham Region

LEGEND

-  Provincial Highway
 Road
 Proposed Road
 Railway
 Municipal Boundary
 Regional Boundary
 Lake *
 River *
 Town or Village
 Urban Area

 **York Region** **Geomatics**

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ATTACHMENT 1