

**TO: Chair and Members of the Source Protection Committee
Meeting #2/24, March 20, 2024**

**FROM: Behnam Doulatyari, Senior Manager, Watershed Plans and
Source Water Protection**

RE: Phase 2 of the CTC Water Quality Assessment

RECOMMENDATION

THAT the CTC Source Protection Committee receive the staff report Phase 2 of the CTC Water Quality Assessment and attachments for information.

EXECUTIVE SUMMARY

In response to concerns raised by the CTC Source Protection Committee (SPC) after reviewing the 2022 Annual Progress Report, staff initiated a multiphase investigation of water quality trends across the CTC Region. Here we present the updated *Issue* identification methods and draft delisting criterion. A decision tree for water quality sampling frequency is provided to refine the additional water quality sampling recommended in the previous phase of the project, discussed in meeting #3/23. The need for additional policies for addressing existing *issues* has been considered with several recommendations.

Report

Task 12, 13, and 14 under the s. 36 workplan identifies the need to review current drinking water *Issues* in the CTC Source Protection Region (SPR) based on the latest water quality monitoring data and statistical trend analysis methods. Furthermore, the CTC SPC reiterated their concern at meeting #1/23 around water quality *Issues* at municipal production wells and the need for further investigation. Accordingly, a multi phase investigation was initiated which includes the following:

- (i) Phase 1: Review and update the statistical trend analysis method employed for identifying drinking water *Issues*, establish water quality data management standards, and sampling frequency recommendations.
- (ii) Phase 2: Review and update *Issue* identification methods and develop a delisting criterion.
- (iii) Phase 3: Review existing drinking water *Issues* and conduct a hydrogeological assessment as to the likely cause of the observed statistical trend based on all available data.

- (iv) Phase 4: Develop an automated water quality reporting tool in collaboration with ORMGP platform.

[Phase 1](#) was completed and presented to the Committee during meeting #3/23. A series of recommendations were provided, including increased water quality sampling frequency at municipal drinking water systems to allow for the use of the new trend analysis methodology. Implementing municipalities raised concerns regarding the additional resources required for the increased sampling frequency. Staff are currently undertaking a high-level financial impact analysis and will bring the results to the Committee at a later date.

Given the limitation on resources, further refinement of sampling frequency recommendation based on existing vulnerability assessment and quality of available data was recommended. The decision tree in **Attachment 1** shows the first draft of this analysis. The decision tree is currently only concerned with raw water samples at municipal production wells. It is anticipated that discussions on increased sampling in monitoring wells will continue during the anticipated guideline development on delineation of Issue Contributing Areas. SPA and municipal staff from CTC will contribute to the guideline.

Work on Phase 2 has been ongoing and the memo in **Attachment 2** outlines the current *issue* identification method, provides an updated one, as well as a draft delisting criterion. Both items were presented to the CTC Implementation Working Group on February 6, 2024 and will be further discussed with the group in upcoming meetings.

Task 9 under the s. 36 workplan asks for the consideration of additional policies to address *drinking water "issues" identified in the inaugural Source Protection Plan, 2015*. The discussion paper in **Attachment 3** provides an overview of 2021 Technical Rules under the *Clean Water Act, 2006* associated with the identification of an *issue*, the delineation of issue contributing areas (ICAs), and monitoring and reporting requirements and the policies designed to eliminate the *issue*. It describes the ICAs in the CTC and the reasons for the identification of this policy review in the CTC's S. 36 workplan. Finally, it seeks to provide decision-making support information to determine if the current ICA policies are adequate, whether the current policies need to be revised and whether additional policies are needed to eliminate the *issue* and provides a series of recommendations.

This discussion paper was first presented to the Implementation Working Group on September 26, 2023. At the time the discussion report was intended to include proposed updated SAL and SNO policies for compliance with 2021 Technical Rules. The proposed policies were instead considered under Agenda Item 7.1b. This approach was chosen to allow completion of "mandatory" elements of the s.36 workplan to meet our delivery timeline, while allowing sufficient time for fulsome engagement with our implementing municipalities on *issues*, ICAs and water quality monitoring.

Next Steps

Staff will continue engagement with the Implementation Working Group on the Phase 2 results, while commencing Phase 3 of the project. Work on Phase 4 is ongoing with results anticipated in Q2 2024.

Similarly on Task 9, engagement with the Implementation Working Group will continue to further consider draft policies.

Report prepared by:

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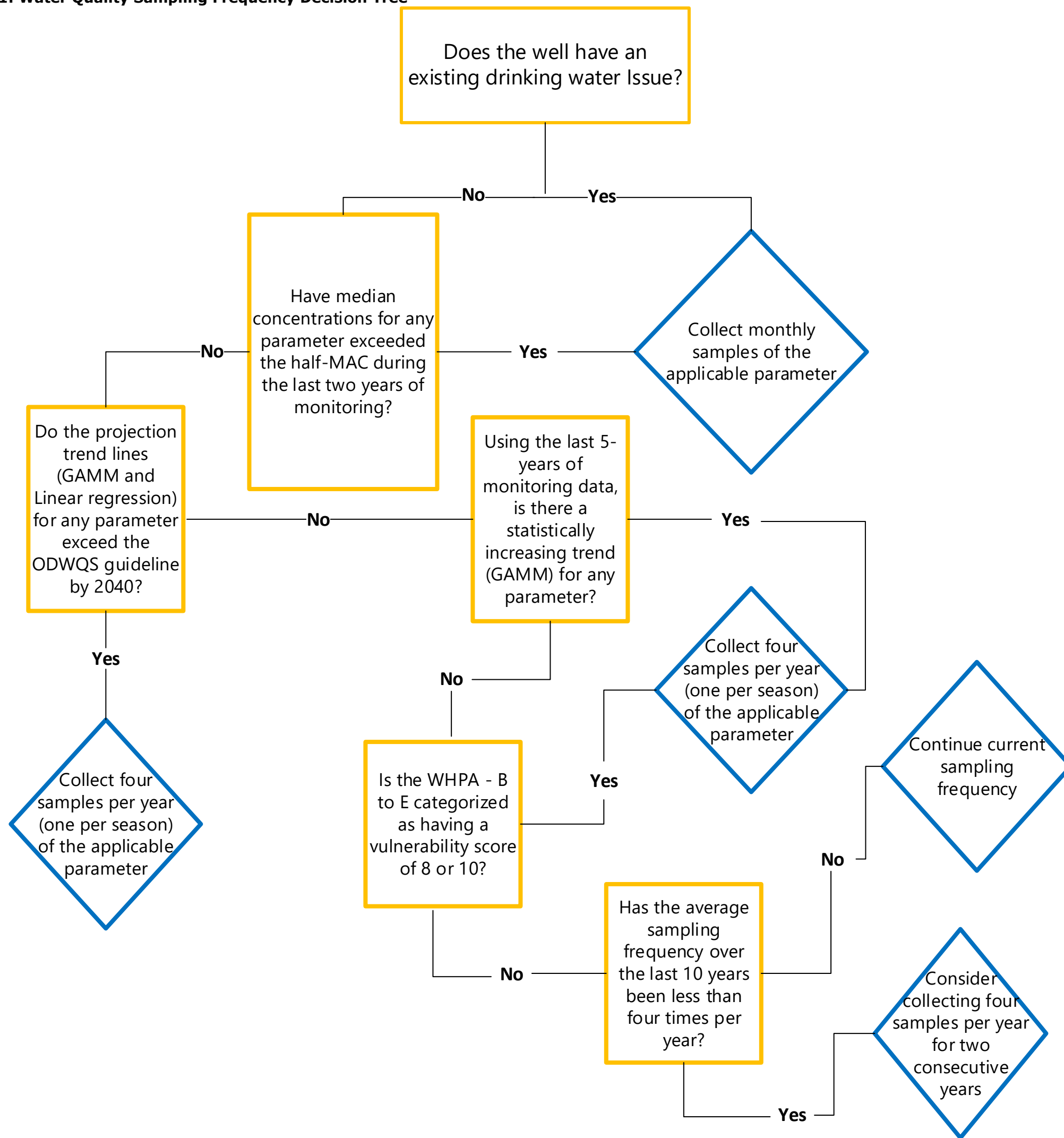
Attachments (3)

Attachment 1: Water Quality Sampling Frequency Decision Tree

Attachment 2: CTC Source Protection Region Water Quality Assessment Phase 2 Memo

Attachment 3: Discussion Paper: Consideration of additional policies to address Drinking Water Issues identified in the inaugural CTC Source Protection Plan

Attachment 1: Water Quality Sampling Frequency Decision Tree



CTC Source Protection Region Water Quality Sampling Frequency Decision Tree

The purpose of the water quality sampling frequency decision tree is to identify the minimum sampling frequency required to effectively utilize the preferred statistical method (i.e., General Additive Model) to analyze municipal production well raw water quality data.

The decision tree presents a risk-based approach that helps identify municipal production wells that are more vulnerable to an activity or condition that adversely affects or has the potential to adversely impact the quality of drinking water sources and would benefit from an increased sampling frequency.



Memo

To: Behnam Doulatyari, Senior Manager, Watershed Plans & Source Protection

From: Hailey Ashworth, Specialist, Hydrogeology and Kata Bavrlic, Program Manager, Watershed Plans and Analytics

Date: February 14, 2024

Re: CTC Source Protection Region Water Quality Assessment Study Phase 2 - review and revise the Issue identification methods and develop delisting criterion

Purpose

Task 12, 13, and 14 under the s. 36 workplan identifies the need to review current drinking water Issues in the CTC Source Protection Region (SPR) based on the latest water quality monitoring data and statistical trend analysis methods. Furthermore, the CTC Source Protection Committee reiterated their concern about water quality Issues at municipal production wells and the need for further investigation. Accordingly, a multi-phase investigation was initiated. Phase 2 is tasked with reviewing and updating the drinking water Issue identification methods and develop a delisting criterion for wells with current drinking water Issue(s).

The purpose of this memo is to revise the drinking water Issue identification methods by using advanced analytical approaches that are more appropriate for the data set and study objectives (i.e., using Generalized Additive Mixed Models: GAMM). The memo will also present delisting criterion to remove a current drinking water Issue(s).

Context

A drinking water Issue as defined by the 2021 Technical Rules under the Clean Water Act, 2006 includes:

The presence of a parameter in water at a surface water intake or in a well, including a monitoring location related to a drinking water system to which clause 15(2)(e) of the Act applies, if the parameter is listed in Schedule 1, 2 or 3 of the Ontario Drinking Water Quality Standards or Table 4 of the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines and,

a. The parameter is present at a concentration that may result in the deterioration of the quality of the water for use as a source of drinking water, or

b. There is a trend of increasing concentrations of the parameter at the surface water intake, well or monitoring location and a continuation of that trend would result in the deterioration of the quality of the water for use as a source of drinking water.

The 2021 Technical Rules are not explicit on the guidelines used to define an Issue and leave a fair amount to professional judgment. This has led to a variety of methods being used by Source Protection Regions to identify an Issue.

The identification of a drinking water Issue in the CTC SPR was based on an assessment of sodium, chloride, and nitrate concentrations in the raw water of municipal wells. These parameters are evaluated based on the Ontario Drinking Water Quality Standards (ODWQS; MOE, 2006). ODWQS has defined an aesthetic objective for chloride of 250 mg/L, sodium of 200 mg/L and a maximum acceptable concentration for nitrite + nitrate (i.e., nitrate) of 10 mg/L. Regarding municipal drinking water wells, the Local Medical Officer of Health is notified when sodium concentrations exceed 20 mg/L so that information may be communicated to local physicians for use with patients on sodium reduced diets.

The focus on sodium, chloride, and nitrate is to identify and differentiate natural versus anthropogenic impacts on groundwater quality. An increasing trend over time in these parameters shows an anthropogenic impact. These parameters are not removed through typical municipal drinking water treatment processes, although concentrations of parameters of concern can be reduced at the point of use through blending (Regional Municipality of Halton 2013). In addition, these three parameters have been identified as existing drinking water Issues in the CTC SPR.

Current Issue identification method

Parameter concentrations in each municipal production well were assessed against prescribed ODWQS concentration limits set for each parameter. To determine if concentrations exceed the objective limits, the data were analyzed in the most recent year and with projections to 2043. A thirty-year time horizon projection (i.e., 2043) was proposed by CVC staff in 2013 (CTC SPC 2013), as this is generally the planning horizon under the Growth Management Plan for the Greater Golden Horseshoe. This Plan applies to most municipalities in the Credit Valley Source Protection Area (CVSPA).

In the determination of an Issue, consideration was also given to the frequency with which the half concentration of the ODWQS (half-Maximum Allowable Concentration) was met or exceeded (CTC SPC 2019). The half-Maximum Allowable Concentration is a commonly used trigger for enhanced vigilance.

For the most recent year of data, analysis was performed by reporting whether:

1. the mean concentration values for that year exceeded the applicable ODWQS parameter concentration limits; and
2. the mean concentration values for that year exceeded the applicable half concentration of the ODWQS (half-Maximum Allowable Concentration).

Projections to 2043 of the mean concentration values were performed using XLSTAT® software to determine an average time within which the ODWQS could potentially be met. Th XLSTAT® software included the Mann-Kendall trend test. The projection of the confidence limits of 95% were chosen to provide an indication of the earliest and latest expected time within which the ODWQS could potentially be exceeded, given the statistical properties of the datasets. Projections to 2043 were performed by extending the trend lines into the future using slope estimates from the Mann-Kendall trend test. Detected exceedances of the half-Maximum Allowable Concentration were also considered in the analysis, particularly for wells with uncertain trends or predicted exceedances of the ODWQS close to 2043.

An Issue was confirmed if the mean concentration was expected to exceed the applicable ODWQS prior to 2043, and if there were recorded exceedances of the half-Maximum Allowable Concentration during the monitoring period.

Revised drinking water Issue identification methods

To identify a drinking water Issue(s), the following revised Issue identification statistical methods are proposed:

1. Do concentrations exceed the applicable ODWQS concentration limits?

- a) Current period of record: Calculate the **median*** parameter concentration based on the last year of monitoring data and determine if it exceeds or is below the applicable ODWQS concentration limits. If it exceeds the concentration limits, the parameter is considered an Issue. Ideally, the last year of data should have twelve samples (i.e., one per month), but no fewer than four (i.e., one sample per season). If fewer than four samples are available, the previous two years can be combined to achieve the minimum four sample threshold.

*Generally, when working with non-normally distributed data, reporting mean values can be misleading. Groundwater monitoring datasets are often non-normal and skewed to one end of the distribution with many low or high values. Mean values are especially sensitive to skewed data and outliers, so the preferred approach to describe central tendency with these types of datasets is to report median values (Sainani, 2012).

- b) Future (year 2040): Determine if the projected trend lines (i.e., GAMM and linear regression) meet or exceed the applicable ODWQS concentration limits.

If both the linear regression and GAMM trend lines meet or exceed the applicable concentration limits by 2040, the parameter is considered an Issue.

Because GAMMs are less familiar than the other tests, a hybrid approach has been developed that considers the results from both the linear regression and GAMM. Specifically, the certainty of exceeding a concentration limit is described as follows:

- when forecasts from both statistical tests show an exceedance, an Issue is considered highly likely.
- when only one test shows an exceedance, an Issue is somewhat likely.
- if neither trend lines exceeds, or shows a decreasing trend, an Issue is not likely.

2. Do concentrations exceed the half-Maximum Allowable Concentration (MAC) of the applicable ODWQS concentrations limits and is there a statistically increasing trend?

a) Current period of record: Calculate the **median** parameter concentrations based on the last year of monitoring data and determine if it exceeds or is below the half-MAC of the applicable ODWQS concentration limits. If it does exceed the half-MAC*, and there is a statistically significant increasing trend over the last 5-years of monitoring data, this can be considered a potential Issue. Ideally, the last year of data should have twelve samples (i.e., one per month), but no fewer than four (i.e., one sample per season). If fewer than four samples are available, the previous two years can be combined to achieve the minimum four sample threshold.

*If the median parameter concentration does exceed the half-MAC, and there is a statistically increasing trend, sample collection frequency should increase to monthly sampling, if not already doing so. If there is no trend or a statistically significant decreasing trend, consider increasing sampling frequency to twelve times per year (i.e., one sample per month).

b) Future (year 2040): Determine if the projected trend lines (i.e., GAMM and linear regression) exceed the half-MAC of the applicable ODWQS concentration limits by 2040. If the trend lines exceed the half-MAC, and there is a statistically increasing trend between the current and future period, this can be considered a potential Issue, and an increase in sampling frequency to monthly is suggested. Importantly, the projection period should not exceed the length of the data record used to estimate a statistical trend or baseline period (e.g., if a 20-year monitoring period is available, the projections should not extend more than 20 years into the future). Where the existing data record is shorter than how far into the future the projections are made, it is assigned a 'low confidence'. When the existing data record is as long or

exceeds how far into the future the projections are made, this is assigned a 'moderate confidence'.

Proposed delisting criterion

The criterion proposed for delisting a parameter associated with a current drinking water Issue includes:

1. Concentrations of the applicable parameter associated with a current drinking water Issue have not exceeded the half-MAC and/ or the ODWQS in the last 5-years of monitoring. Over this monitoring period, a minimum sample size of 10 samples collected per year is required to perform this analysis.
2. Has there been a sustained decrease in concentrations of the applicable parameter. Using the GAMM statistical analysis method, a statistically significant decreasing trend in concentrations of the applicable parameter associated with a current drinking water Issue should be present in the last 5-years of monitoring. Over this monitoring period, a minimum sample size of 10 samples collected per year is required to perform this analysis.
3. Implementation of each of the policies identified in the CTC Source Protection Plan (SPP) related to the applicable threat activity taking place in the Issue Contributing Area for the parameter associated with a current drinking water Issue must have happened and are continuously being addressed.
4. Does the implementation of the applicable CTC SPP policies represent an important step towards the reduction or elimination of the parameter of concern? Has action been taken to reduce the occurrence of the parameter of concern within the drinking water source?

It is recognized that it may not be possible to fully remove the parameter of concern from the drinking water source, due to natural processes and social and economic factors. However, best efforts should be demonstrated that effort has been made to reduce the occurrence and likelihood of the parameter contaminating the drinking water source.

If each of the four-criterion listed above have been met, and the parameter associated with a current drinking water Issue is identified as a candidate to be delisted, it is recommended that monthly sampling of the parameter be performed for two consecutive years to evaluate the status and trend of the parameter concentrations and ensure that they are still meeting the delisting criterion.

It is also recognized that there will be a need to revise the delisting criterion in the future because of anticipated amendments to the Technical Rules, revisions to SPP policies, and updated guidelines from the Ministry.

Additional Information Sources and References

CTC Source Protection Region. (2013). *Issue Determination, Halton Region Wells*. April 2013. Toronto, ON: Toronto and Region Conservation.

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Credit Valley Source Protection Authority (CVSPA). (2023). *CTC Source Protection Region Water Quality Assessment Technical Report*. October 25, 2023.

Ministry of Environment (MOE). (2006). *Technical support document for Ontario drinking water standards, objectives, and guidelines*. http://cvc.ca/wp-content/uploads/2011/03/std01_079707.pdf

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Sainani, K. L. (2012). Dealing with non-normal data. *Pm&r*, 4(12), 1001-1005.