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Technical Memorandum

DATE: September 20, 2024

TO: Jesse Waldorf
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CC: Codi Abbott, Paul Sheridan, Ashley Gray

FROM: Shona Robinson, PhD, PEng

RE: **EGMONT WATER TREATMENT PLANT**
Disinfection Byproduct Review
Our File 0724.035-300

Background

System Summary

This memorandum presents advice from Kerr Wood Leidal Associates Ltd. (KWL) relating to trihalomethane (THM) and haloacetic acid (HAA) occurrence in the Egmont water system within the Sunshine Coast Regional District (SCRD). Our understanding of the system is as follows:

- The water source is Waugh Lake;
- Water is filtered through a 5 micron and then 1 micron spun poly filters, UV and then chlorinated via sodium hypochlorite;
- Water is then pumped to a reservoir that feeds the area;
- The water is potable (treated for bacteria and viruses) but the maximum acceptable concentrations (MACs), based on the Guidelines for Canadian Drinking Water Quality (Guidelines), are regularly exceeded for THMs and HAAs;
- Peak water use is typically in July, in the range of 50-60 m^3/d;
- The treatment plant site location is relatively space constrained and does not have sewer access; and
- The water intake currently consists of a perforated pipe a few inches above the lake bottom; as of June 2024, SCRD had plans to replace the intake with a screened intake, slightly higher off the lake bottom.

Disinfection Byproducts

Disinfection byproducts (DBPs) can form when chlorine used to disinfect drinking water reacts with organic matter in the water. Two groups of DBPs with maximum allowable concentrations (MACs) in the Guidelines Canadian for Canadian Drinking Water Quality (Guidelines) are THMs and HAAs. These two groups are used as indicators for all chlorinated DBPs in drinking water; though they have potential longer term health effects, primary disinfection should never be compromised to manage DBPs, as this could lead to non-potable water that in the worst-case scenario could be fatal for water users.

Both THMs and HAAs form via organics' reaction with chlorine over time, causing them to be higher in the distribution system than immediately after treatment. Means of reducing THMs and HAAs noted in the Guidelines are:

- Remove/reduce organic matter before chlorination;
- Optimize the primary disinfection process (without ever compromising disinfection to have potable water);
- Use alternative disinfection methods; or
- Use a different water source.

To select the best strategies for the Egmont water system, a good understanding of existing source water characteristics and DBP formation is crucial.

Historical Data

Organics

Total organic carbon (TOC) is typically determined using a specialized analyzer in a commercial lab. The SCRD is coordinating with a lab for future samples; however, historical TOC concentrations have been measured in-house by SCRD staff using a Hach analyzer. This in-house analyzer may be a useful means of monitoring TOC; however, a comparison with TOC measured by an accredited lab would provide quality assurance.

TOC has been reported for several locations since 2021. Raw water (squares), reservoir or treated water (triangles), and unknown (circle) concentrations are plotted in Figure 1.

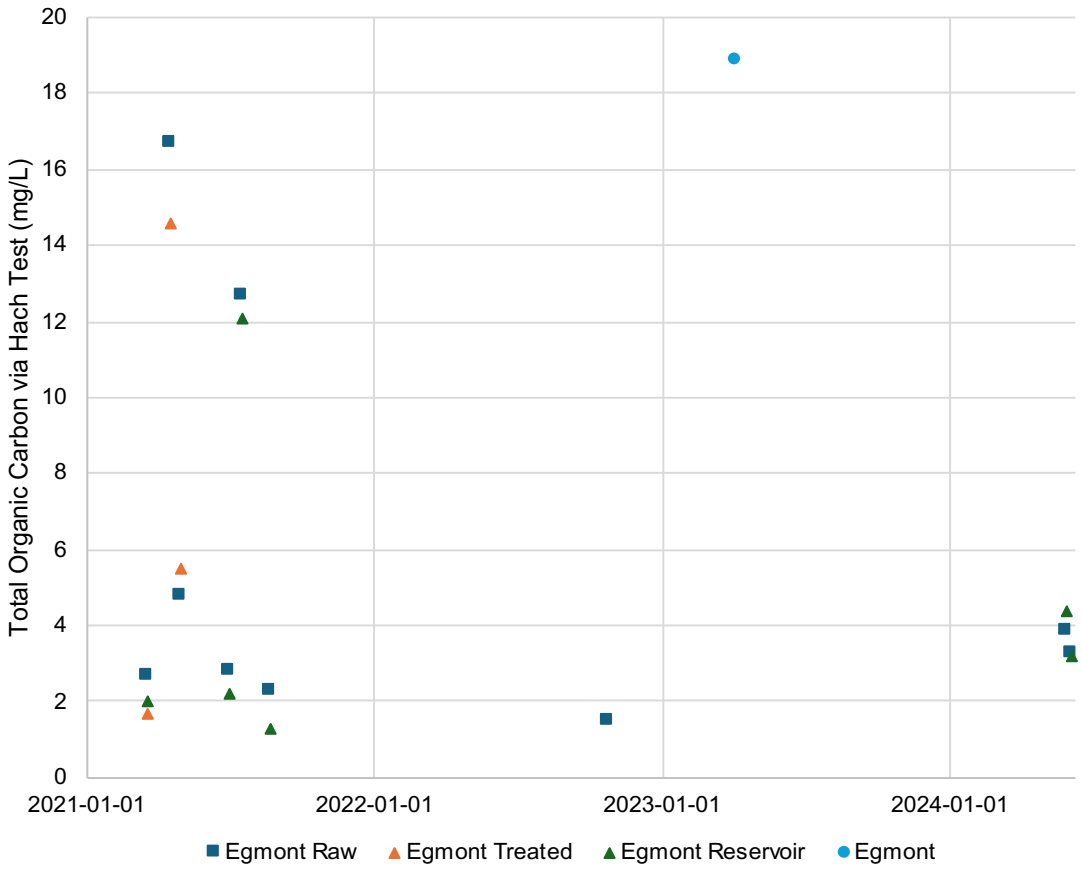

Figure 1: Total Organic Carbon Reported by SCRD

This data led to the following observations:

- TOC concentrations range from 1.3 mg/L to 18.9 mg/L;
- There is insufficient data to assess seasonal patterns; and
- Treated/reservoir and raw TOC concentrations collected at the same time were usually similar, suggesting that existing treatment has minimal impact on TOC.

TOC concentrations below 2.5-3.0 mg/L typically result in acceptable DBP formation; this is an estimate as DBP formation potential depends on the character of the TOC. As several samples exceed this concentration, TOC treatment could be a strategy to reduce DBPs.

Dissolved organic carbon (DOC) was reported for only four samples but may be more relevant to DBP formation than TOC, as filters remove the particulate (i.e., non-dissolved) component of TOC. Follow-up TOC and DOC sampling should be completed to understand:

- TOC and DOC concentration at the new intake, as the proximity to the lake bottom can impact organics;
- The performance of the in-house Hach analyzer; and
- The seasonality of organics in Waugh Lake.

Colour can often act as a proxy for organics, as many sources of TOC are coloured, such as decaying leaves and vegetation. Other colour contributors can be metals such as iron and manganese. Simultaneous colour and TOC measurements were available for 7 samples (some raw, some treated), and are plotted in Figure 2.

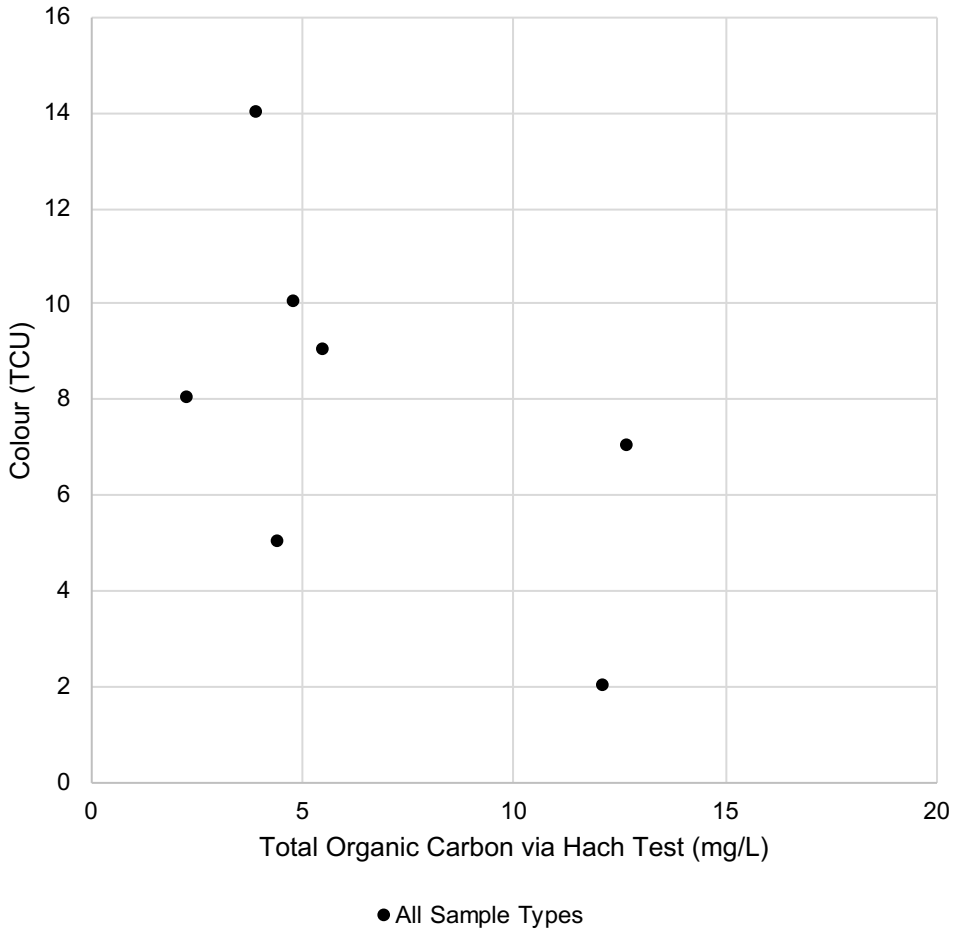

Figure 2: Relationship Between Colour and Total Organic Carbon

This data led to the following observations:

- There is no obvious correlation between colour and TOC; and
- There is too little data to know whether colour is a useful indicator of TOC.

Colour greater than 15 TCU fails to meet the Guidelines' aesthetic objective. That is not the case for the Waugh lake samples reported.

Chlorine

Chlorine concentrations are measured regularly at the storage reservoir and several locations throughout the distribution system. The measured residual at the WTP (blue triangles), reservoir residual (green triangles), and distribution system concentrations (circles) are plotted in Figure 3.

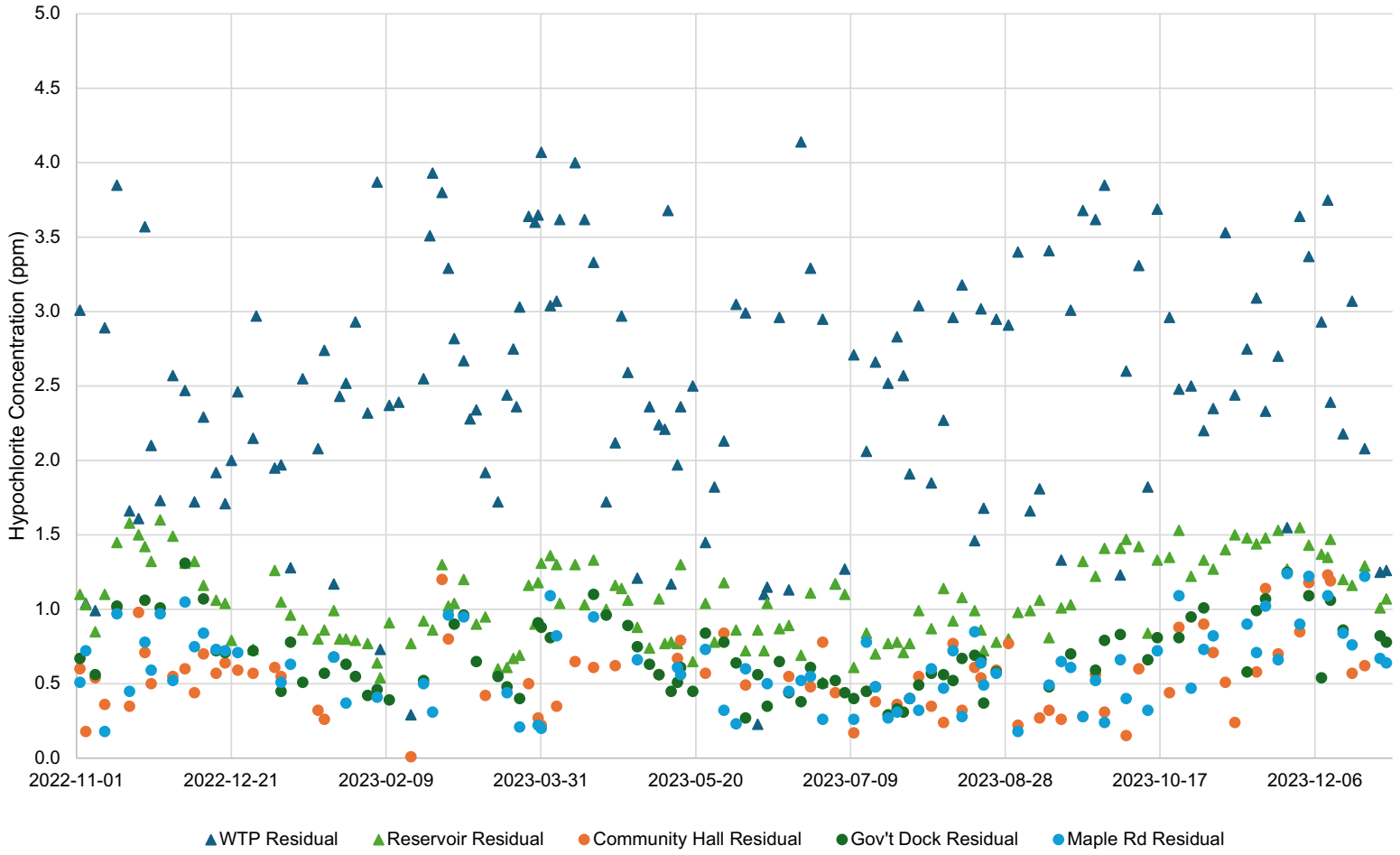

Figure 3: Chlorine Dose and Residual Concentrations

This data led to the following observations:

- The chlorine residual drops following dosing, with an average of:
  - 2.5 ppm in the plant;
  - 1.1 ppm in the reservoir; and
  - 0.6 ppm across the 3 distribution system sampling points.

The drop in chlorine residual indicates that components of Waugh Lake's water are reacting with (and consuming) the chlorine. The organics are contributing to the chlorine demand and resulting in disinfection byproducts.

A distribution system residual (to prevent regrowth and monitor the system) is usually in the range of 0.2 to 1.0 mg/L. Some typical information is included in the Guidelines:

> "Data provided by six provinces and territories indicate that typical levels of free chlorine in Canadian drinking water systems range from 0.4 to 2.0 mg/L leaving the treatment plant, from 0.4 to1.2 mg/L at intermediate points in the distribution system, and from 0.04 to 0.8 mg/L at the far end of the distribution system." (Health Canada)

Thus, the residual leaving the WTP is a little high, but levels within the Egmont distribution system are in a typical range. There may be some room for reduction in hypochlorite dose, provided distribution system residual can be maintained at an adequate level.

Disinfection Byproducts

The above data indicate that both high organics and high chlorine residual are sometimes present in Egmont water supply, and these are contributing to disinfection byproducts. The levels of THMs and HAAs are measured quarterly at two locations, described as "treatment source" and "end of system", as plotted in Figure 4. "Treatment source" indicates the beginning of the distribution system, though it is unclear if this is at the WTP or the reservoir.

Figure 4: THM and HAA Concentrations in Egmont Water System

This data led to the following observations:

- THM and HAA concentrations increase through the distribution system, as chlorine reacts with organics, as the “treatment source” data are always below corresponding “end of system” data;
- All THM and HAA measurements at the end of the system are above the Guideline maximum allowable concentrations (MACs), indicated by the dotted lines; and
- THM and HAA concentrations at the “treatment source” are lowest in the summer sampling events, but higher at other times of year.

If “treatment source” refers to reservoir concentrations, the relatively low concentrations here during the summer are likely due to higher water demand, causing faster reservoir turnover. This would give DBPs less time to form in the reservoir, though they appear to have formed by the end of the system in all cases.

Direct measurement of THMs and HAAs can be variable due to fluctuations in system conditions (e.g., demands, chlorine dose). As well as measuring THMs and HAAs directly, there is a standardized method of assessing THM and HAA formation potential of source water; this has not been reported by SCRD but could help provide a consistent benchmark to assess the issue.

DBP Treatment Next Steps

As discussed in the above sections, additional data is needed to better characterize the source water and understand the contributors to high THM and HAA formation. Further, for a new water intake, historical water quality data and DBP formation may no longer be relevant.

Sampling Plan

The proposed sampling plan should be carried out when the new intake is in use. This plan includes a full year of data collection, as surface water quality changes seasonally. Both in-house and external lab analyses are included to manage costs and to characterize in-house techniques. The analytes were selected in order to:

- Predict DBP formation potential & determine causes of DBP formation; and
- Understand water characteristics, so that a treatment system can be designed, if needed.

The recommended sampling plan is provided in Table 1:

Table 1: Recommended Sampling Plan

Analyte	Location				Frequency				Lab Type		Notes
	Raw Water	WTP Treated	Reservoir	Distribution System	Weekly	Bi-Weekly	Monthly	Quarterly	In-House	Commercial	
Organics & Organic Proxies											
TOC	X					X	X		X	X	Instruct lab NOT to filter TOC samples. It is suggested to complete the first 4 samples with both in-house and commercial analysis. If the two correlate well, commercial analysis can be reduced to monthly, with in-house analysis continuing bi-weekly.
DOC	X					X	X		X	X	
UV – unfiltered	X					X			X		
UV – filtered	X					X			X		
Colour – unfiltered	X					X			X		Could be completed by commercial lab if desired, or lab data could be requested for some samples for QA.
Colour – filtered	X					X			X		
Metals (or do full metals scan if same cost)											
Total Iron	X							X		X	Metals characterization is useful in determining treatment requirements.
Total Manganese	X							X		X	
Disinfection Byproducts											
Formation Potential											Not suggested, as expensive / cumbersome & can assess treatment requirements based on the raw water profile.
THMs			X	X				X		X	
HAAs			X	X				X		X	
Miscellaneous											
Chlorine Residual		X	X	X	X				X		Current chlorine measurements are sufficient.
Dissolved Oxygen	X					X			X		Include to help understand lake turnover.
pH	X					X			X		Field pH should be reported to lab on COC.
Temperature	X					X			X		Field temperature should be reported to lab on COC.

Recommendations

It is recommended to address the Egmont water system DBP concerns by:

1. Replacing the raw water intake, as intended in June 2024.
2. Completing the above sampling plan.
3. Determining the best combination of strategies to address THMs and HAAs.
4. Modifying operations or adding treatment, as required.

Following sample collection, KWL would be pleased to provide the SCRD with advice on items 3 and 4.

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Revision History

Revision #	Date	Status	Revision Description	Author
0	September 20, 2024	Final		SJR