FEATURE | INNOVATION

Effects Of Algae Blooms On A Water Treatment Plant

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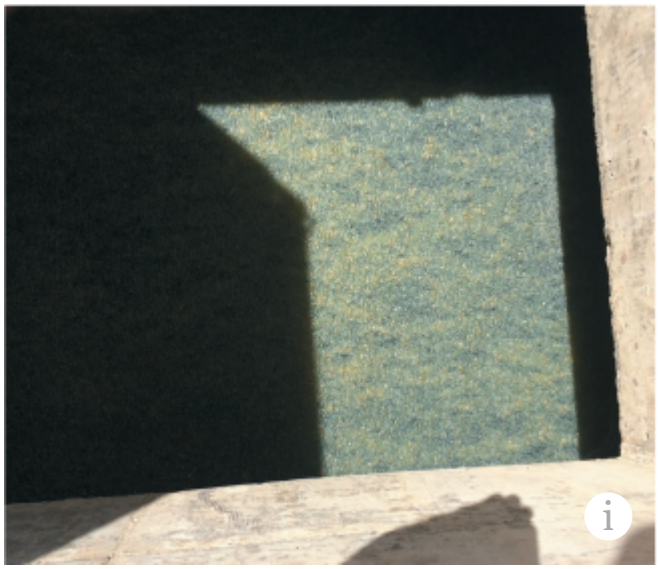
Located within the shores of Lake Ontario in Mississauga, the Arthur P. Kennedy Water Treatment Plant (formerly Lakeview Water Treatment Plant) is recognized as one of the most advanced Class IV Water treatment facilities in the world, providing safe drinking water throughout the communities served. The facility is owned by the Region of Peel and operated by the Ontario Clean Water Agency in a long-term partnership contract. At a rated capacity of 1,200 megalitres per day, the plant is divided into three separate treatment trains consisting of Conventional Filtration, Ozonation, Biological Carbon Filtration, Ultraviolet, and Ultrafiltration Membrane technologies. The raw water is drawn from Lake Ontario into an intake structure that is located two kilometres offshore at an approximated depth of 12 metres from the water surface and transferred through a 2,550 millimetre diameter concrete pressure pipe into the facility. Raw water is monitored regularly for chemical and biological parameters.

As source water for the plant, Lake Ontario consists of hundreds of kilometres of shoreline within southern Ontario. In recent years it has been challenged by growth of

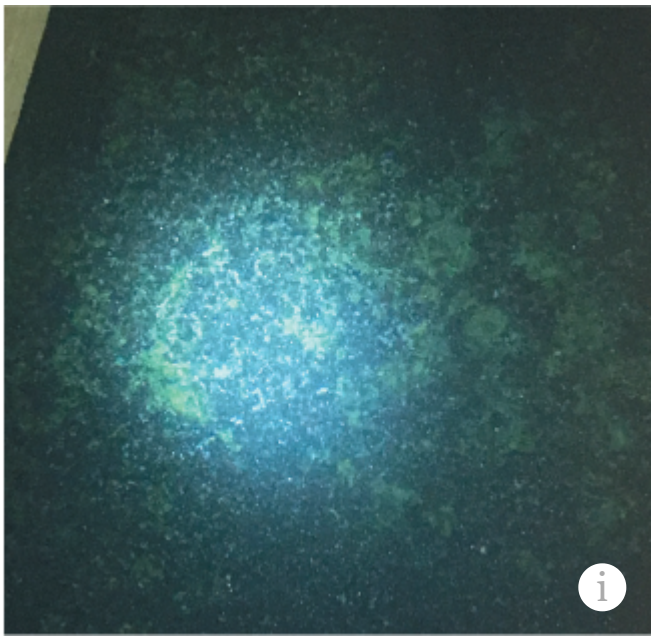
cyanobacteria, also called blue-green algae, which is natural, but its growth of large blooms is a well-researched and documented threat to drinking water intakes, aquatic life, and human health. The toxin that is produced by cyanobacteria impacting human health is known as microcystin. It is known that the toxin is released when the cells rupture or die off. Based on scientific research, the toxins in cyanobacteria can irritate the skin and, if swallowed, cause diarrhea and vomiting. There are a significant number of algae species and not all algae species are toxic to human health and instead are filter-clogging, impacting treatment facilities. The blue-green algae have a number of colours including green, orange, red, or brown. A *bloom* is a large mass that the algae grow into rapidly and which continues to change. These blooms will make the source water appear bluish-green or turquoise colour. Following the disappearance of blooms, toxins may persist in the water for a period of time depending on the overall conditions. Blue-green algae blooms are connected to an influx of nutrients such as phosphorus from runoff and/or by-pass events entering the lake during heavy rainfall. A range of factors including water depth, sunlight, temperature, and wind direction affects the potential for harmful algae bloom events and makes it hard to see, depending on the location of the bloom in the water. There are a number of strategies in place within the water treatment facilities and at the Arthur P. Kennedy Water Treatment Plant to proactively sample, monitor, and make process adjustments based on findings to protect treated water quality.



Proactive Sampling Strategy and Knowledge Sharing

As a municipal drinking water system with direction from Ministry of the Environment Conservation and Parks (MECP), the plant starts a proactive sampling schedule during and outside of the algae bloom season. The samples are sent to a certified laboratory for analysis. Analysis includes:

- MECP weekly raw water algae nutrient sampling
- MECP weekly raw water low level Total Phosphorous
- Weekly raw water sampling for algae speciation from June to October. Through this testing, the species and quantities of algae present in the sample (if any) is determined
- Weekly raw water samples for enzyme linked immunosorbent assay (ELISA) test for total microcystin from June – October
- In any event where the microcystin in the sample is greater than current regulatory limit of 1.5 ug/L the lab is required to provide the samples to the MECP lab for analysis of Microcystin-LR being the most common type of microcystins. The Ministry's lab is the only laboratory licenced to perform the analysis of microcystin-LR. Communication is then sent regarding findings by the ministry.



In addition to the above proactive sampling strategy, the team will collect samples for speciation and initiate process adjustments if at any given time algae is found on the intake screens and or surface of the filters.

A number of factors are an input into the annual sampling period such as: raw water temperature, any information received from MECP and or other municipalities of bloom events (which at our source typically starts in June through October of each year). Another important strategy is knowledge sharing and communication of important raw water quality observations and sample results amongst the neighbouring municipalities drawing water from Lake Ontario. For example, during 2018 the water systems were in communication regarding sampling results and algae speciation. Depending on the information received, the water system management team formulates the best treatment strategy to protect water quality. To date, non-toxic filter-clogging species of algae are detected at the Arthur P. Kennedy WTP during the bloom events.

Operational Rounds and Monitoring

As a 24/7 Class IV operated facility, the plant is operated by certified staff. Daily physical checks and plant rounds are conducted that are essential to overall performance monitoring of the facility. During an algae event, some of the process areas of importance include continuous monitoring of the raw water screens, and media filtration beds for presence of algae.

Process Adjustment and Control Based on Findings

Physical and Supervisory Control and Data Acquisition (SCADA) performance monitoring of the conventional and biological contactor filtration are essential to proactively increase the frequency of backwashes and optimize the backwash flow required for operating a conventional and biological filter during a raw water quality event. Adjustments to upstream coagulation are also made to maintain performance within the settling and flocculation tanks. The plant is designed based on the multi-barrier approach, leveraging various treatment technologies and treatment trains. Based on the findings, various tools are leveraged to protect water quality including further leveraging and increasing production output through process treatment technologies such as Ozonation to mitigate water quality impacts.

Examples of the Events

During the week of July 11, 2018, members of the public called regarding an algae bloom in Humber Bay Park (Mimico Creek), which is a nutrient-rich section as the creek is fed via a number of upstream sources. Water system compliance teams were notified by MECP regarding the bloom (Figure 1). During the same time, the Arthur P. Kenney operation team also noted algae at the raw water screens and within the media filters.

One of the direct impacts of the algae within the filters was reduced biological and conventional filter production, run hours, and requirement for increased frequency of backwashes. Presence of algae was noted upstream and also within the filters (Figures 2 and 3). The operations team followed the established contingency plan procedure for algae events to take samples for speciation and also conducted manual backwashes adjusting low and high filter backwash parameters. A persistent flow of algae was present at the intake screens however the plant did not experience severe filter clogging. A consistent and proactive response by operations staff to conduct backwashes on all media beds further assisted in reducing the impact of the filter clogging algae.

Raw water quality events can have a cascading effect on various parts of the plant that may not be directly linked to water treatment thus requiring flexibly in increasing frequency of inspection and cleaning. An example of this was the incoming algae plugging the raw water strainers within the low lift building (Figure 4). The Administration and Maintenance Building located on the grounds of the plant also uses raw water for facility systems cooling and we were unable to direct water to this building. During this event, the strainers were removed and cleaned once per shift until the incoming algae content decreased over a span of approximately one week. The intake screens were also manually operated at higher frequency and duration to reduce algae clogging.

Raw water quality events such as algae blooms have a range of negative impacts on treatment plants. However, through risk assessment and mitigation in operational

planning, established procedures, 24/7 physical and SCADA monitoring, and leveraging the multi-barrier treatment technologies, we are able to protect treated water quality.

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