SENTRY™

Addition of Dairy Wastewater Improves Biological Nutrient Removal at Summerside WWTP

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April 2020

The Sentry team was asked to profile the performance of microbial activity and carbon consumption rates in key process locations during a 12-month period at the Summerside Biological nutrient removal (BNR) wastewater treatment facility.

The study clearly outlines the events that triggered process imbalance and provided operators key insights into the local dairy wastewater contributions. The organic carbon from the dairy offsets supplemental carbon requirements at a cost savings of $35,000 – 70,000 USD/annum.

Figure1: Sensors installed at primary inflluent

Problem Statement

The Summerside Wastewater Treatment Plant utilizes a modified Johannesburg process for BNR. The facility is state-of-the-art and was commissioned in 2008. Over the past 12 years, the performance of the facility has dependably met high effluent standards for the removal of Nitrogen and Phosphorous. However, there have been imbalance events that resulted in periodic spikes of Nitrogen and Phosphorous in the effluent, and operators have been unable to diagnose the cause of the biological upsets. One of the operators' theories was that it was related to changes in wastewater from the local dairy processing facility. The treatment facility does not use supplemental carbon for BNR, relying on the wastewater to provide sufficient organic carbon.

Conclusions

- **Of the 37 imbalance events detected for the facility the majority were caused by heavy rain and inflow and infiltration.**

- **The local dairy processing facility has a critical role in providing bio-available carbon for BNR. High N and P effluent concentrations aligned with periods of dairy operation shutdown. When directly compared to the addition of supplemental carbon (i.e. MicroC or Acetic Acid) the addition of dairy wastewater resulted in an estimated annual cost savings of $35,000 – 70,000 USD.**

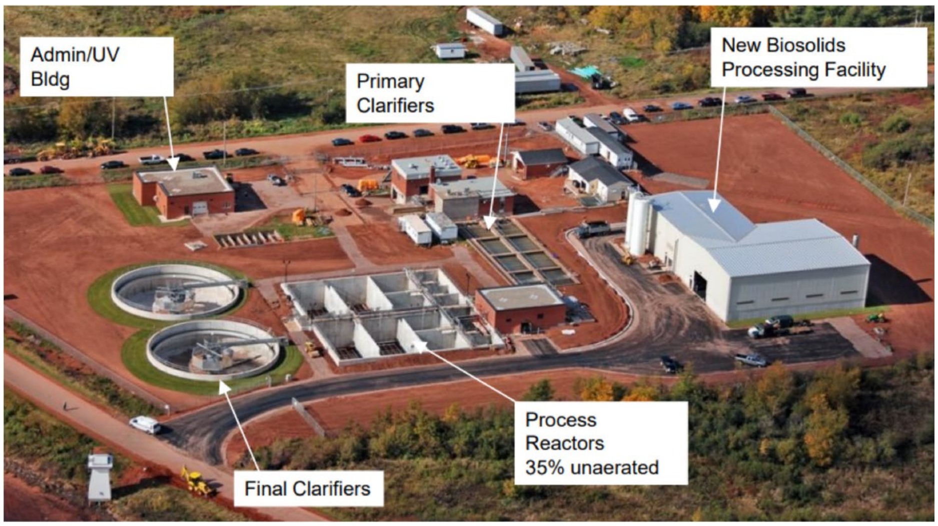
- **The weekly trend highlights a change in influent quality and/or operations on Thursday results in biological instability. On Thursdays the influent is the most variable and the sludge inventory is also the lowest. Both of these factors are likely contributing to the biological instability and result in imbalance events occurring more often Thursday/Friday.**

Introduction

The Summerside WWTP treats wastewater for approximately 18,175 people with an average daily flow of 3 MGD. The treatment process is a modified Johannesburg BNR process that is different to the typical Johannesburg because the influent enters

into a pre-anoxic tank instead of the anaerobic.
To achieve efficient Nitrogen and Phosphorus removal bio-available carbon must be available to key microbial communities. For example, to achieve low total nitrogen effluent standard readily biodegradable carbon is required in the anoxic zone for denitrification. Effective denitrification can require supplemental carbon addition because influent carbon quantities are insufficient to drive the denitrification process. Supplemental carbon sources can be purchased in various bio-available forms: acetic acid, methanol, or Micro-C. Sometimes industrial sources, such as brewery waste or digestate from an anaerobic digester can be utilized as a bio-available carbon source.

Three SENTRY probes were installed into the treatment facility: in the primary effluent, anaerobic cell (cell 2), and anoxic cell (cell 4). Sensors provided novel insight into the plant's nutrient removal performance.



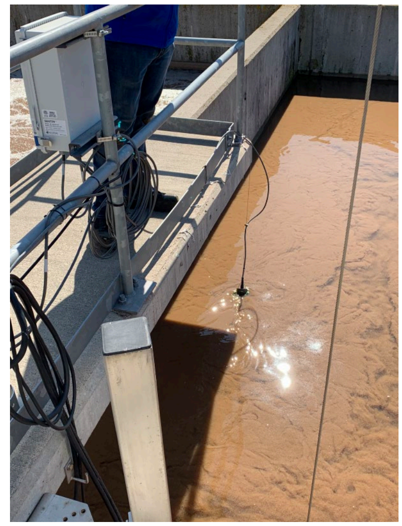


Figure 2: Summerside biological nutrient removal wastewater treatment facility.

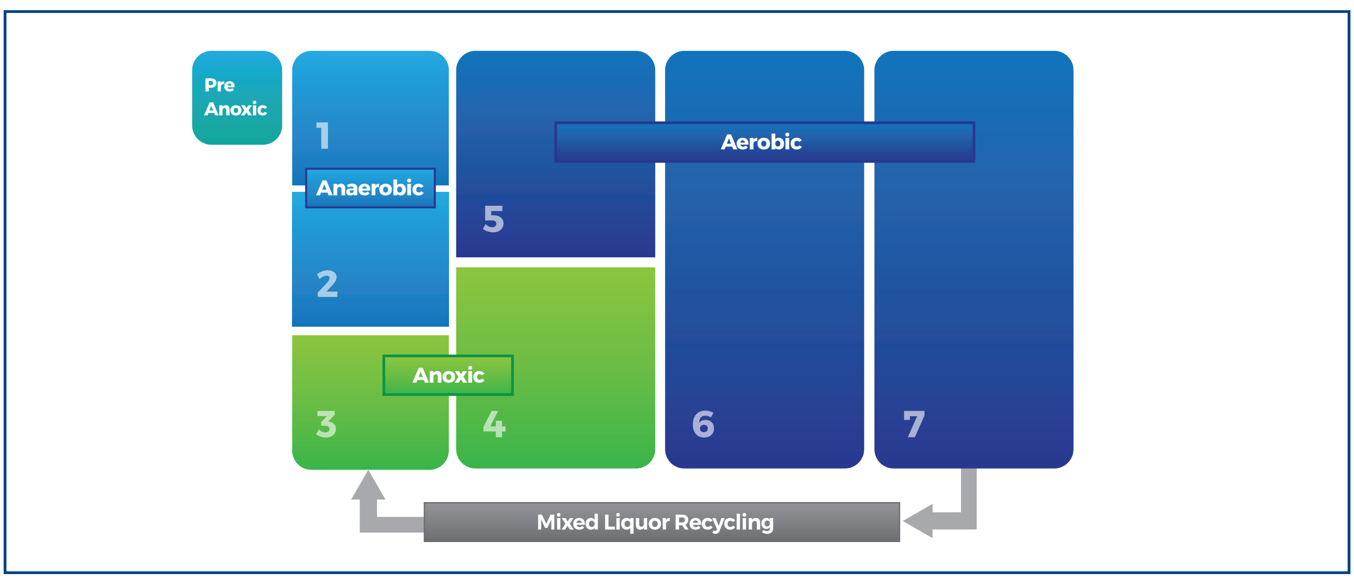


Figure 3: Summerside cell layout. Sensors are in the primary clarifier, Cell 2 (Anaerobic) and Cell 4 (Anoxic)

Project Objectives

- **Monitor incoming wastewater conditions and identify key biological imbalance triggers over 12 months.**
- **Develop historical data sets that show the weekly and daily biological activity trends for influent wastewater.**
- **Understand the impact of industrial discharge on wastewater treatment plant performance.**
- **Use the generated microbial activity data to suggest improved operational strategies for stable nutrient removal.**

SENTRY Solution

1. Biological imbalance events

There were a total of 37 biological imbalance events identified through the year, and the majority of these were caused by heavy rain resulting in inflow and infiltration. The next largest group of imbalances had unknown causes but are suspected to be caused by industrial discharge. Imbalance events that followed notification of wastewater discharge by industry are highlighted and key for understanding how large operators impact the BNR process.

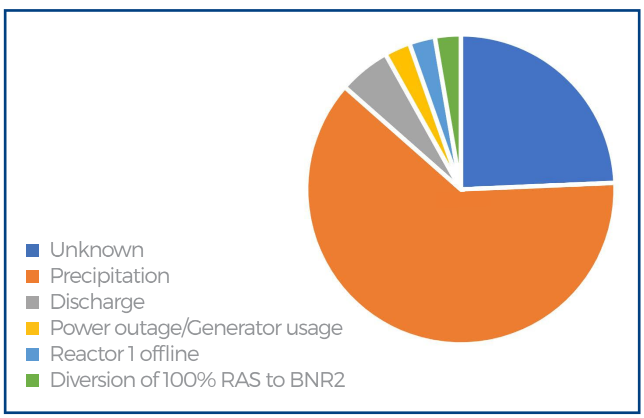


Figure 4: Summary of biological Imbalance events over a 12 month period

2. Weekly patterns of MET

The weekly trending information was generated from 12 months of data and provides clarity regarding microbial process stability and variability. The sensor located in the anoxic zone of the process seemed to provide the most sensitivity to detecting nutrient imbalance events. The stand-out day of the week at the facility is Thursday. SENTRY data shows us that the wastewater quality is least consistent on this day. In terms of plant operation, this is the day the plant has the lowest sludge inventory.

A suggested operational improvement is to uncouple the influent variability and sludge inventory impacts by changing wasting schedules to allow the process to better ride-out the changes in influent conditions. The facility sees the majority of their disruption in effluent Thursday/Friday and careful management on Thursdays likely will reduce these events.

3. Impact of dairy discharge - supplemental carbon

The WWTP is accustomed to receiving higher levels of carbon from the local dairy processing facility. One such example is noted in Figure 6 where the Dairy plant stopped discharging between Oct 22nd and 24th. During this period the MET values (rate of carbon consumption) was shown to drop by about 50% and effluent NO3 concentrations were shown to increase from ~ 2 mg/L to over 8 mg/L. There was a rapid increase in bio-available carbon consumption on October 24th as soon as the dairy facility resumed operations and discharging into the collection system. Higher PO4 concentration in the effluent was also observed on OCT 25th.

Domestic/municipal wastewater streams can be carbon deficient for complete phosphorous and nitrogen removal, but sometimes local industry can fill the need. This is a great reminder to municipalities of the opportunity for positive interaction with local industry. This can be leveraged to reduce the BNR supplemental carbon costs.

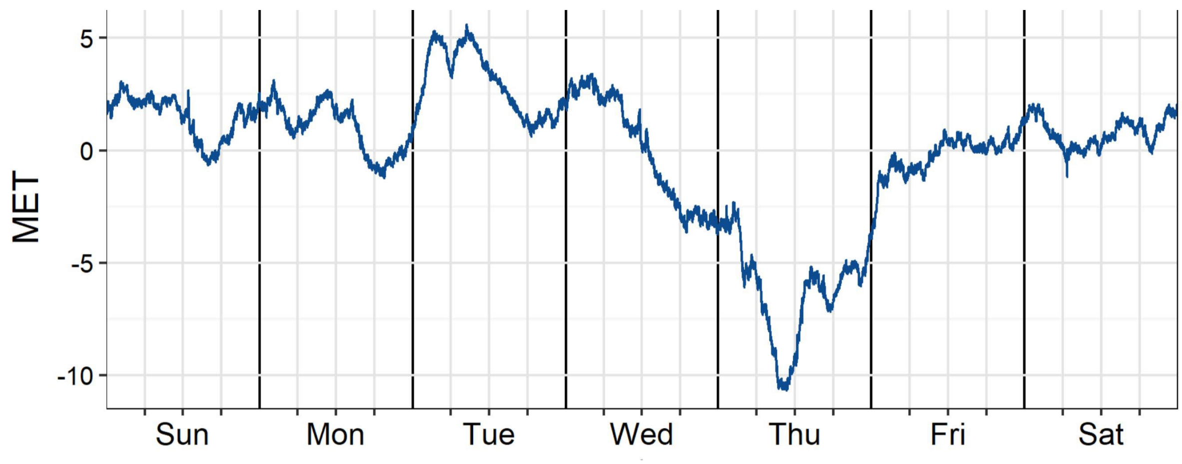


Figure 5: Weekly pattern of MET at anoxic zone. MET of anoxic zone is stable over the course of week except on thursday when MET declines significantly. The lower biological activity on this day usually corresponds to higher NO3 concentration at effluent.

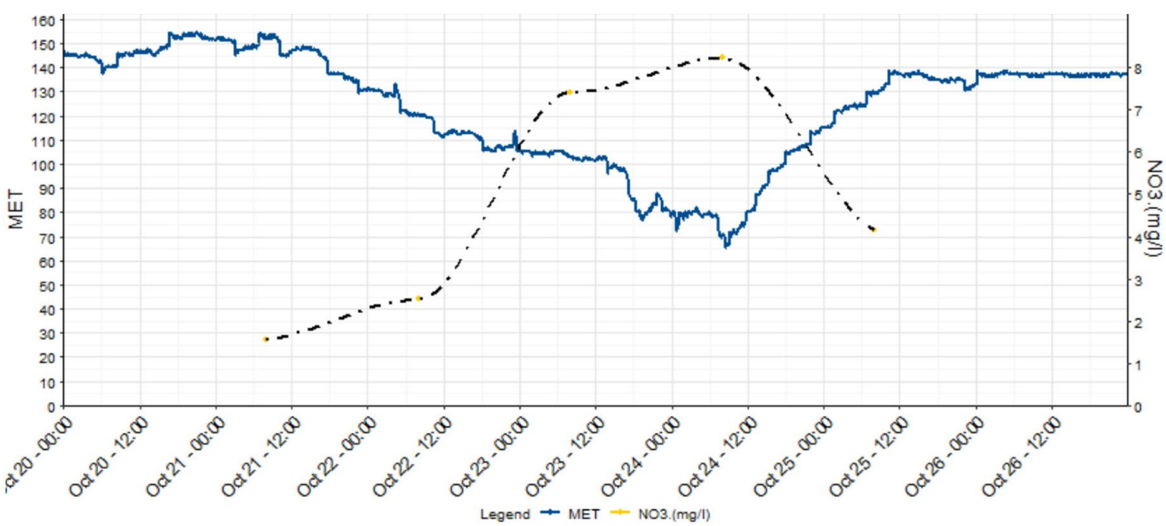


Figure 6: Monitoring microbial activity / consumption of bio-available carbon in the anoxic region of the BNR facility over a period of time that aligns with the shut-down in operations of the local dairy processing facility.

Economic Impact

A supplemental, external carbon source can be required for BNR treatment facilities. Supplemental carbon sources can be in various forms (e.g. acetic acid, methanol, ethanol, glycerol, Micro C) with industrial sources (e.g. brewery waste) also shown to be beneficial as additional carbon sources. These supplemental carbon sources can be a significant operational cost to BNR facilities. Wastewater treatment facilities can typically expect to spend $1.5 - $3 / gallon of supplemental carbon. For the Summerside facility with an average flow of 3 MGD, and an assumed cost of $2.7 / gallon of Micro C as the supplemental carbon source the facility could be considering an expected annual cost for supplemental carbon of $35,000 – 70,000 USD. Larger facilities can expect annual carbon costs ranging from $100,000 upwards of $1,000,000 per annum. The key indication from this study is the presence of the local dairy processing facility and the fact that it is providing additional carbon to the influent wastewater stream is providing a clear economic benefit to the facility.

There is a key opportunity for stakeholder engagement with local industry (e.g. dairy processing, breweries, food processing). Opportunities for open communication where these industries could discharge on a specific coordinated schedule during specific carbon light times would be a win-win for both parties. Also municipalities that do rely on these carbon supplies should become aware of key industry shut-down events so they can be proactive in mitigating carbon limited periods in advance. Having a clear understanding of organic carbon availability and the presence of sufficient carbon in key anaerobic and anoxic steps is central to cost effective BNR treatment.

The SENTRY™ platform is a low-cost, robust monitoring platform that provides operators this key insight and allows for significant savings for the operation of BNR facilities.

Contact

www.SentryWaterTech.com
www.IslandWaterTech.com

Dr Patrick Kiely
pkiely@SentryWaterTech.com
(+1) 902 361-2085

SENTRY Water Technologies Inc
65 Watts Avenue, Unit 9
Charlottetown, PE, C1E 2B7
Canada