Cedar Grove Commissioning from An Operators Point of View

William Smith, *Supervisor Treatment Operation,* Logan city Council

Michael Gow, *Process Engineer,* Logan City Council

ABSTRACT

Commissioning Cedar grove was a fun and a great opportunity for an operator as most are aware about how important it is to have someone from treatment operation imbedded into the project of a new treatment plant and have a team involved in the design meeting to add input to the project. As we went through each phase of this project –we thoroughly discussed each section of the plant and breaking it down to get the right equipment to do the right job. One difficulty that we faced in this time is that it was hard to have the right people in the room at the right time as we still had treatment plants to run. We worked around this by having a team of people at each design phase. These were Supervisor of Treatment, Process engineer, Maintenance Engineer and Maintenance Supervisor.

During the construction, it was important to have someone involved and informing the rest of the team the progression of the construction and any changes to the layout or any impacts to the process.

Cedar Grove has a tight EA permit to comply by which was developed by the Department Environmental Science. In order to meet these conditions, we had to construct a MBR plant and constructed wetland for effluent polishing.

Commissioned in June 2020, the wastewater treatment at Logan City's Cedar Grove Environmental Centre has been achieving some great results in its first few weeks of testing. Wet weather operation has created some issues due to the large length of rising mains leading to the plant.

To commission Cedar we needed to shut down Flagstone WWTP which was a 4000ep MBR plant, receiving at the time 610KL/day nearing its capacity of 680KL/day. With the growth of the area increasing, Council decided to construct a centralised plant for the area.

Seeding the new plant was a great opportunity for value to be added by the operations team during the commissioning phase. The original plan by the design team was to tanker seed sludge from the Loganholme plant which had a large associated cost. The operations team was able to offer a much cheaper alternative, using the existing network to pump sludge from Flagstone WWTP using the effluent lagoon water to chase it through.

Everything on the Cedar Grove site started up ok and was ready to receive the flow. The plant was tested using water to check all equipment prior to receiving flows.

During design, we decided to move to the 2018 SCADA version. This version removes a lot of the excess colours and background noise which allows the operators to focus in more quickly on key information and alarms. There was a steep learning curve between the versions and a significant amount of missing information on SCADA during commissioning, however overall the layout has made it far easier to fault find and operate the plant.

The SCADA system is still being developed and improved and was missing some critical features on commissioning. This made commissioning and operation of the plant more difficult.

As a result of integrating operational knowledge into the design and commissioning phase of the project we were able to achieve significant cost savings and well as improved operability of the final plant.

INTRODUCTION

Logan City Council (LCC) has developed the Cedar Grove Waste Water Treatment Plant (WWTP) and Environmental Centre, located at Cedar Grove.

The Cedar Grove Environmental Centre (CGEC) site encompasses the Cedar Grove WWTP with wetlands. The Cedar Grove WWTP is designed to treat 20,000 Equivalent Persons (EP) in Stage 1 of operations, that is approximately 3.3ML/d of average dry weather flows (ADWF). This new plant is constructed to take the place of Flagstone WWTP which had a capacity of 4000ep and was at capacity at the time of transfer. This plant has also been made with the intent to service the Jimboomba, Greater Flagstone Area and parts of Greenbank.

Cedar Grove has a tight licence to meet this why we have designed a plant with Wetland polishing.

The challenging limits on the DA licence are a long term 50 percentile limit of 1mg/L total nitrogen, and 0.5mg/L total phosphorous, as well as a stipulation that 100% of nutrient mass loads from the plant must be offset by nutrient offset projects in the river catchment.

The Cedar Grove WWTP is located along Cedar Grove Road in Cedar Grove, beside the Logan river. The total area is approximately of 203.9 hectares (ha)

Process Description

The Cedar Grove WWTP receives raw sewage from the Logan South catchment and uses a Membrane Bioreactor (MBR) process. The treatment design capacity of the Cedar Grove WWTP is 20 000 EP that is approximately 3.3ML/day Average Dry Weather F lows (ADWF) for Stage 1.

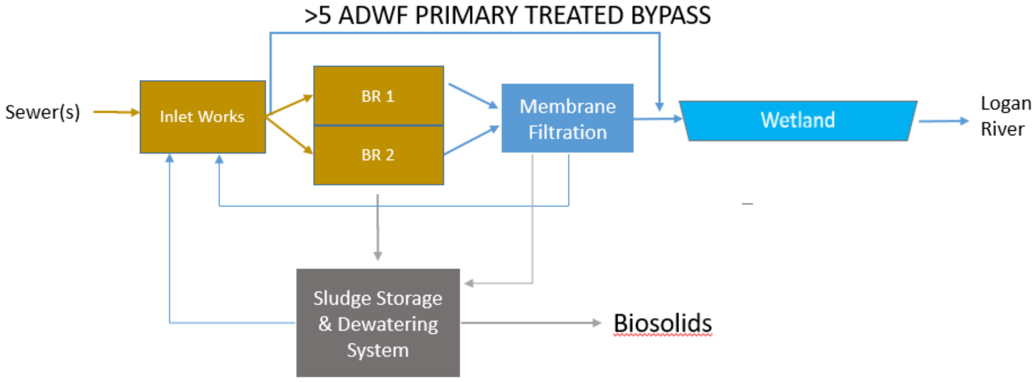

Figure 1: Block flow diagram of the Cedar Grove treatment process

The Cedar Grove WWTP comprises the following infrastructure:

- Control room
- An inlet works, including coarse screening, fine screening and grit removal
- A bypass system which will divert flows above 5 x ADWF to the wetlands, after screening
- A two-basin bioreactor with an integrated four membrane train MBR system
- chemical storage and dosing facility for alum, sodium hypochlorite, caustic soda, citric acid, and liquid sugar
- Bioreactor and membrane aeration blowers
- Aerobic Digester
- A biosolids dewatering facility comprising a centrifuge and polymer batching
- A dewatered biosolids temporary storage and load-out facility consisting of screw conveyers and 2 sealed spirotainers
- An odour control system capturing odours from the inlet works and flow splitter structures, and treating them through a bio-trickling filter with activated carbon polishing
- A generator unit providing backup power for the whole site

All flows received at the treatment plant will be discharged to a constructed wetland system. The constructed wetland system which totals 10 hectares, and provides further polishing of nutrients in the plant effluent in order to achieve the extremely low TN limit required by the licence. It is designed to accommodate peak wet weather flows of up to 6.5 x design ADWF.

Inlet Works

Screenings and grit removal of raw sewerage is provided prior to treatment in the MBR system. Influent then passes through two sets of horizontal drum screens; one for coarse material, one for fine material. In the event of a failure in the coarse screens the flow will divert through manually raked bar screens. This is followed by a vortex grit separator. After the grit vortex the flow passes down a channel into a splitter box at the beginning of the bio-reactors. If flows greater than 5 x ADWF occur for sustained periods and exceed the MBR design maximum then the bioreactor levels will rise above the splitter weir and will permit a bypass to the wetland system.


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The issue we found in this area are some of the auger motors was impacting the maintenance capability where they are located.

A few examples of defects found during the commissioning phase are overleaf:

Inlet Work	Access	There is not much room for accessing and inspecting through the man holes on the trickling filter
		Cannot open the hatch covers of the bar screen from the outside of the hand rail
	Maintenance	The oil drainage plugs of the gear box of the fine screen augers is located below the deck. The drained oil can pass into the waste water flow
		The brush opening for the drop boards can be a trip hazard
	Walkways	There are gaps in between walkways and other area of the top floor of the inlet. It leads to trip hazard
		The 90 degree bend joints used to join the handrail are not secured
		The Aluminium kick plates are joined with SS connecters at some places and Galvanized connecter at other places. It is not consistent & different material joint can lead to galvanizing action and corrosion
	Main Screens	Service water lines to the water spray at some places are not braced properly
		There is a gap in between the fine screen chute and the screw conveyer. Something can drop into the conveyer mistakenly
	Manual Screen	the gap around the davit bases. It leads to trip hazard
		The lifting handles of the hatch covers are sitting on the top of the covers. It leads to trip hazard

Defects are a normal thing to manage after construction and during operation of a new site, but it is important to make sure issues are fixed as soon as possible as it will get harder to get contractors back to repair these issues.

Bioreactors/Membranes

The plant consists of two parallel bioreactors linked to four independent membrane tanks. The bioreactors provide biological treatment of the screened and de-gritted sewage for BOD, TSS, nitrogen and phosphorus removal and consist of four key reaction zones:

- The Bio-selector zone
- The Anaerobic zone
- The Anoxic/swing zone
- The Aerobic zone.
- 4 Membrane chambers

To provide dissolved oxygen and mixing for biological treatment blowers push air through grids of diffusers on the bottom of the Aerobic zones, as well as the Anoxic/swing zone if required, which produces fine bubble aeration with high oxygen transfer. Mixers are also located within the Anoxic/swing tanks which operate when no aeration is provided. Air is provided intermittently on a timer basis to the bio-selectors to assist with scum removal on the surface. A scum harvester is also installed on the side of the membrane feed tank. A Return Activated Sludge (RAS) flow is pumped from the Recycle Chamber and split and returned to the Anoxic/swing zones, bio-selectors, and mixed with the raw sewage flow at the inlet works.

This process works well most of the time. During wet weather, we found that the ammonia levels would start to increase during the event. When investigating this issue we found that due to the length of rising mains leading the plant, at the start of wet weather event, a large slug of raw sewage would be pushed through at wet weather flow rates, which overwhelmed the aeration systems. To fix this we came up with a semi automated wet weather procedure. There were a couple key factors considered in developing this procedure:

1. Trigger point to engage the wet weather mode. We settled on a two point trigger flow, or ammonia, or both.
2. The balance of additional aeration and denitrification capacity. We settled on erring on the side of additional aeration as the wetlands system is better able to treat nitrate and nitrite loading than ammonia.

We have installed the code to see how it works and included changeable set points on SCADA for the operators. The next wet weather should show how this goes and what improvements can be done.

We also had other issues like short circuiting of ammonia across the bio-reactor 1 due to high return rate and a high peaking factor for the influent sewage. This didn't have a major impact on effluent quality as it was only an issue for short periods of time. To correct this issue we are turning off membranes trains as only 2 are required for 1 bioreactor.

There is a total of four membrane trains at the Cedar Grove WWTP with each membrane tank containing 3 but designed to hold up to 4 membrane modules. Each module has 1,900m^2 of active membrane area (total 22,800m^2). The membranes have various modes of operation. Normal operation is to have the membranes automatically cycling between productions and suspend mode based on the bioreactor level. While running, the membranes use coarse bubble aeration to clear suspended biomass from the membrane surface. In production mode, flow and aeration is either optimised in **Fopt** mode, which is the most efficient mode for the pumps and aerators, or the more intensive **Fmax** mode for wet weather, in which the permeate pumps run forward to permeate and backwards to backwash. In suspend mode membranes are not permeating, intermittent aeration is supplied for mixing.

This equipment worked well during commissioning, however later it was found that during construction that end plates were not added to the pipe work on the empty membrane cell slot. This caused an issue where MLSS was able to enter the permeate tank when valves were opened for a system test. This was detected quickly And fixed with minimal impact to the wetlands and microbiology tests.

The Cedar Grove WWTP stores several chemicals for the treatment process:
Alum is dosed for the precipitation of phosphorus. Phosphorus is largely removed biologically in the bioreactors which are equipped with anaerobic selectors, however allowance is made to polish phosphorus to below the target effluent level in the bioreactor using chemical dosing.
Carbon dosing in the form of liquid sugar is provided as a safeguard, particularly during low loads during commissioning to achieve the effluent total nitrogen target (3mg/L TN) from the MBR.
Sodium hydroxide solution dosing to the exit chamber of the inlet works can facilitate the adjustment of process alkalinity levels. The caustic is supplied to counter the effects of chemical coagulant dosing (alum) and net alkalinity consumption through nitrification.
Sodium hypochlorite and citric acid are kept onsite for membrane cleans. Sodium Hypochlorite is also dosed into the sites recycled water system

Commissioning of the plant.

The plant was commissioned in June 2020 and has been achieving great nutrient removal results during dry weather, with some issues during wet weather relating to the wastewater network layout.

There were 3 key operational obstacles during the commissioning process for Cedar Grove:

1. Getting seed sludge to the new plant.
2. Safely decommissioning the Flagstone WWTP
3. Preparing Cedar Grove to receive sewage flows

In planning the transfer of seed sludge to the Cedar Grove WWTP there were two options initially assessed:

1. Tanker SEED sludge from Loganholme WWTP
2. Tanker SEED sludge from Flagstone WWTP

When costing these options, it was found that both were extremely expensive due to the number of tanker trips required. This led the commissioning and operations teams to look for a new option.

Another answer was to transfer sludge from Flagstone, using the wastewater network to deliver the seed. This process would take a long time due to the length of the network and volume of the pump stations. It would take days to get the seed to site, at which point the sludge would be septic and the microbiology compromised. The idea was much more cost effective, but how could we shorten the time to get the seed sludge to the site? We came up with the idea to transfer the seed sludge through the network and chase it with the effluent stored in the 28ML lagoon which at this time had 22ML in storage. This had the added benefit of draining the effluent storage lagoon at Flagstone which made decommissioning much easier.

With the MLSS and effluent lagoon sent to Cedar Grove WWTP, the next steps in fully decommissioning the Flagstone WWTP were as follows:

1. Divert all influent flow from Flagstone to Cedar Grove
2. Empty all process tanks
3. Cover all defuses with clean water in each process tank.
4. Cover all membrane cells with clean water
5. Shutdown all other equipment
6. Shutdown all process control on SCADA and disconnect SCADA phone so alarms don’t come to the on-call operator afterhours.

After the plant items were shutdown, most equipment was deenergised, however site power was kept on as some equipment, such as CCTV, was still required.

To prepare Cedar Grove WWTP to receive sewage flows, the following actions were taken:

1. Commission all equipment onsite at Cedar Grove and test all pumpstation in the network
   - 1.1. The Partnership tested all equipment across the site making sure it runs in the field and on SCADA. The plant was initially filled with clean water to test pumps, blowers, and diffusers
   - 1.2. Partnership tested the network to make sure all pumpstation and raising mains are ready to receive flows
2. Test SCADA to make sure the new control system is ready to control the process

   While testing the new SCADA system, it was found that the new SCADA system was lacking some equipment information, and that sone of the pages were not ready and were missing important details and controls.

   Operators found it hard to run the plant for the first few months due to the lack of info on SCADA. With the help of contactors and partnership staff they were able to improve each page as the plant continued to run.

3. Bring Bio-reactors and Membranes on line

   Only 1 membrane tank was required initially, due to low initial flows. The second membrane tank will be brought online ones the plant reaches 1.5ML ADWF

4. Open the wetlands valves and adjust outlet pipes to accept MBR flow for polishing

Once the plant and wetlands were ready to receive flows, the process of transferring the seed sludge from Flagstone was started. The process vessels were emptied into the sewer network, and the effluent lagoon was pumped in behind it to chase it to the plant.

We monitored the arrival of the MLSS/Seed sludge to site, which did take some time to receive. Once it started to arrive at site we started the aeration system, then the rest of the process.

The MLSS levels were checked the next day, and were found to be low, but adequate for the low plant load at this time. No sludge was wasted for a period while the biomass built up, and liquid sugar was added to help the rate of solids build up and improve nutrient removal.

The trends below show the performance of the plant from commissioning thorough to now.

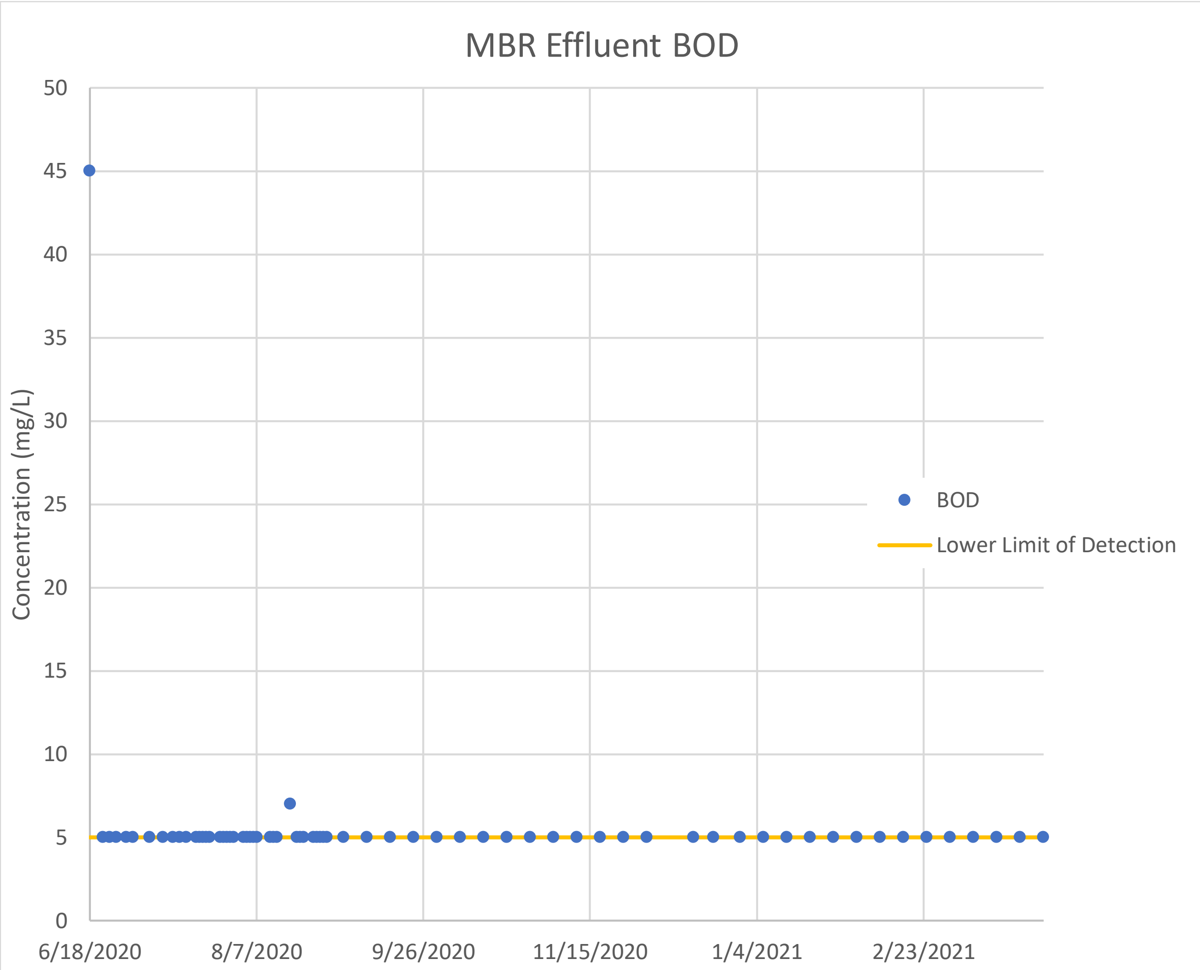

Figure 2: MBR Effluent BOD. During the initial commissioning there was BOD breakthrough due to low solids volume, however within several days there was sufficient solids to resolve this. Current MLSS is 4500mg/L which is working well while the plant is underloaded

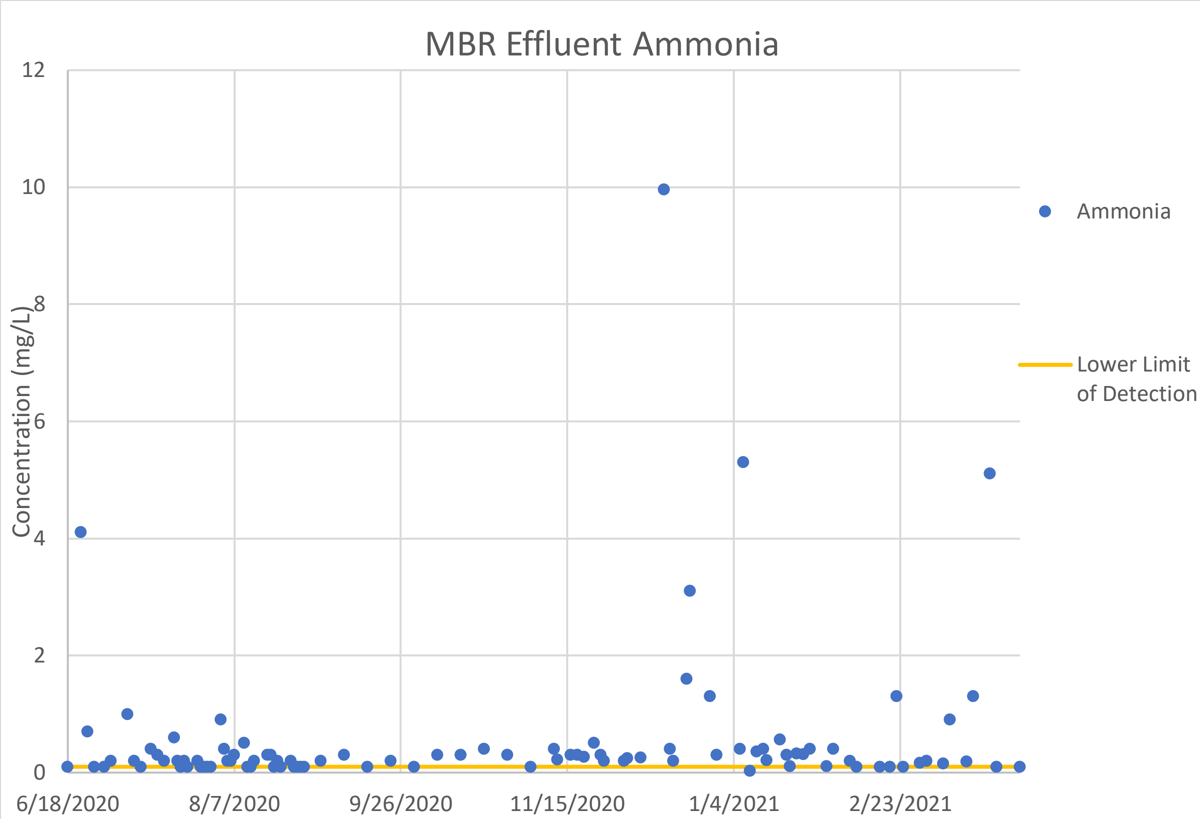

Figure 3: MBR effluent ammonia. This parameter is heavily influenced by wet weather. Dry weather performance has been good, and a wet weather aeration mode has recently been implemented to improve wet weather performance.

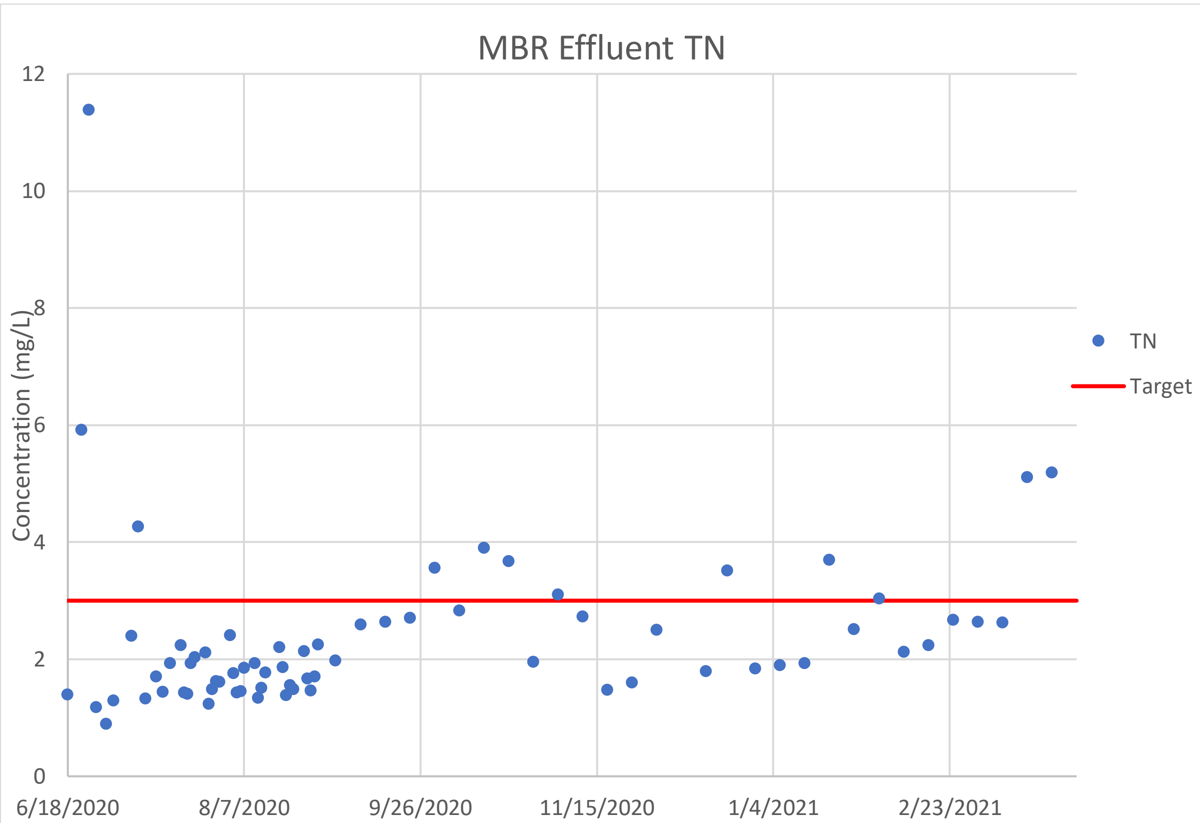

Figure 4: MBR Effluent total nitrogen. Total nitrogen is the most difficult licence parameter for the plant. Despite some wet weather issues, the target discharge to the wetlands is being achieved most weeks.

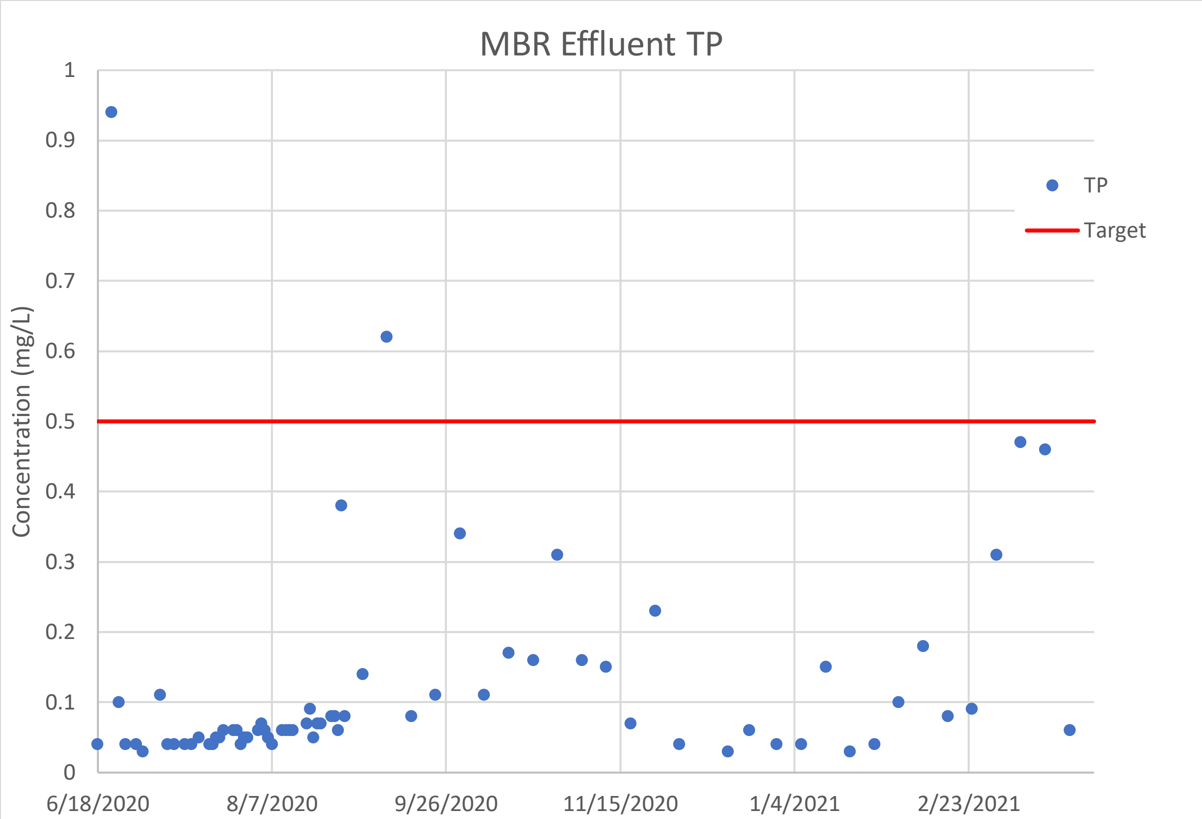

Figure 5: MBR effluent total phosphorous. The biological phosphorous removal in the MBR has been extremely successful, with a bare minimum of alum dosing.

Wetlands Commissioning and Performance

Due to the extremely low TN limit in the plants discharge licence, the performance of the wetlands is critical to the successful operation of the plant. There was some difficulty in achieving the target TN of 1mg/L on a consistent basis during commissioning. The issues identified when commissioning and operating the wetlands were as follows:

- Planting and watering the wetland batters.

  There were two elements to this issue. Firstly, the wetland batters were seeded using a hydro-mulch mixture of grasses, as well as native bushes and shrubs. After planting, the grass did not grow in all areas of the batters, and the bushes and shrubs grew in very few. This left areas of bare soil which were washed into the wetlands in wet weather.

  The second issue was watering the batters to encourage plant growth. Initially water was pumped from the end of the wetland cells onto the batters, however this seemed to create both a short-circuiting effect, as well as stirring up sediment in the wetlands which increased TSS and TN readings.

- Transpiration of water from the wetland cells.

  The wetland had very good performance in the removal of residual ammonia and nitrates, however it has almost no removal of other organic nitrogen. Transpiration of water from the wetland cells was, and still is, highly significant, with over 30% of dry weather flows evaporating in the wetlands. This concentrated residual organic nitrogen nearly to the TN limit.

- Weed management

  Weed species are a significant threat to wetland performance in the long term. Several weed species were found growing the wetland cells, requiring a variety corrective measures. Managing wetlands is a very new skill for the plant operators to learn, so teaching weed identification has been a priority.

- MBR performance

  Poor wet weather performance in the MBR has cause some spikes of nutrients from the wetland cells. This was more pronounced during the early establishment phase, and has reduced dramatically as the wetlands became more established.

Once this issues (excluding the transpiration issue) were addressed, performance stabilised to a level within, albeit barely, the long term TN target. Performance trends are show below.

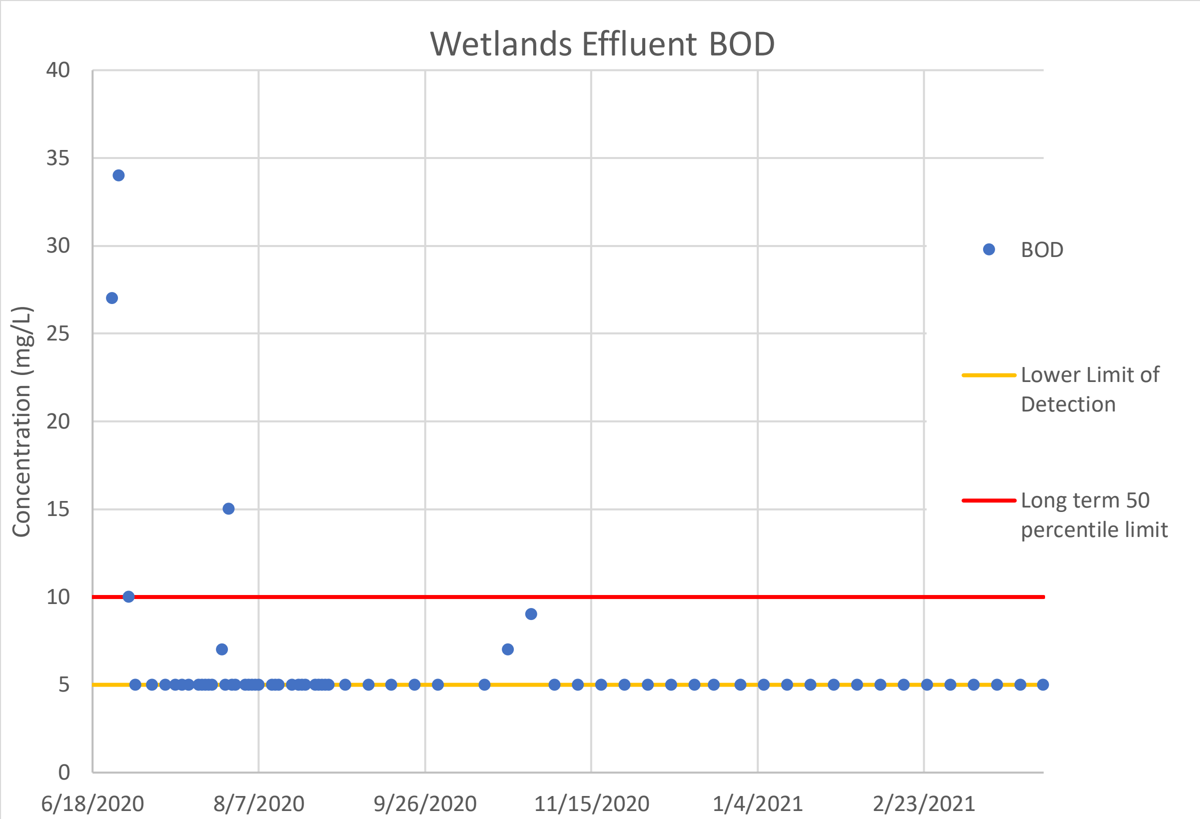

Figure 6: Wetlands effluent BOD. There were some early issues with batters erosion, however none have cause non-conformance with licence conditions after the initial commissioning and establishment phase.

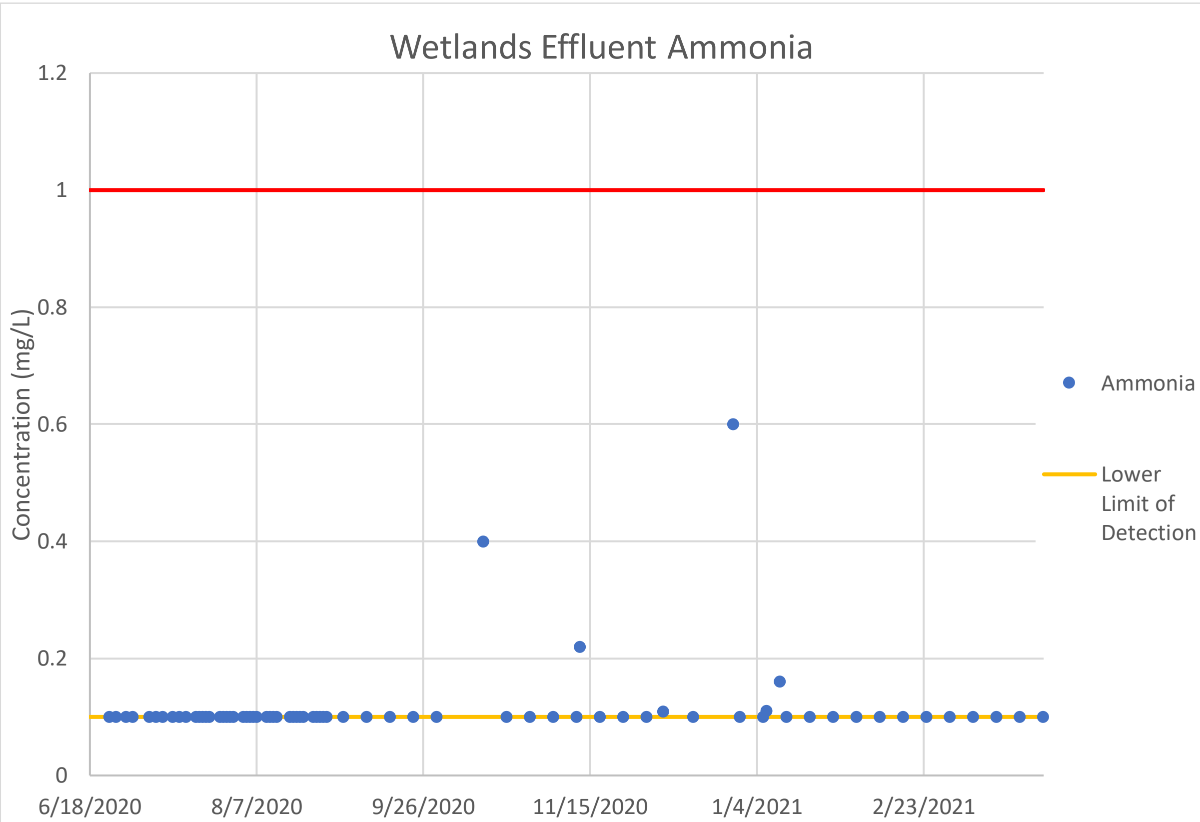

Figure 7: Wetlands effluent ammonia. A couple of peaks were observed as a result of wet weather issues in the plant; however most values have been at the lower limit of detection of the lab test.

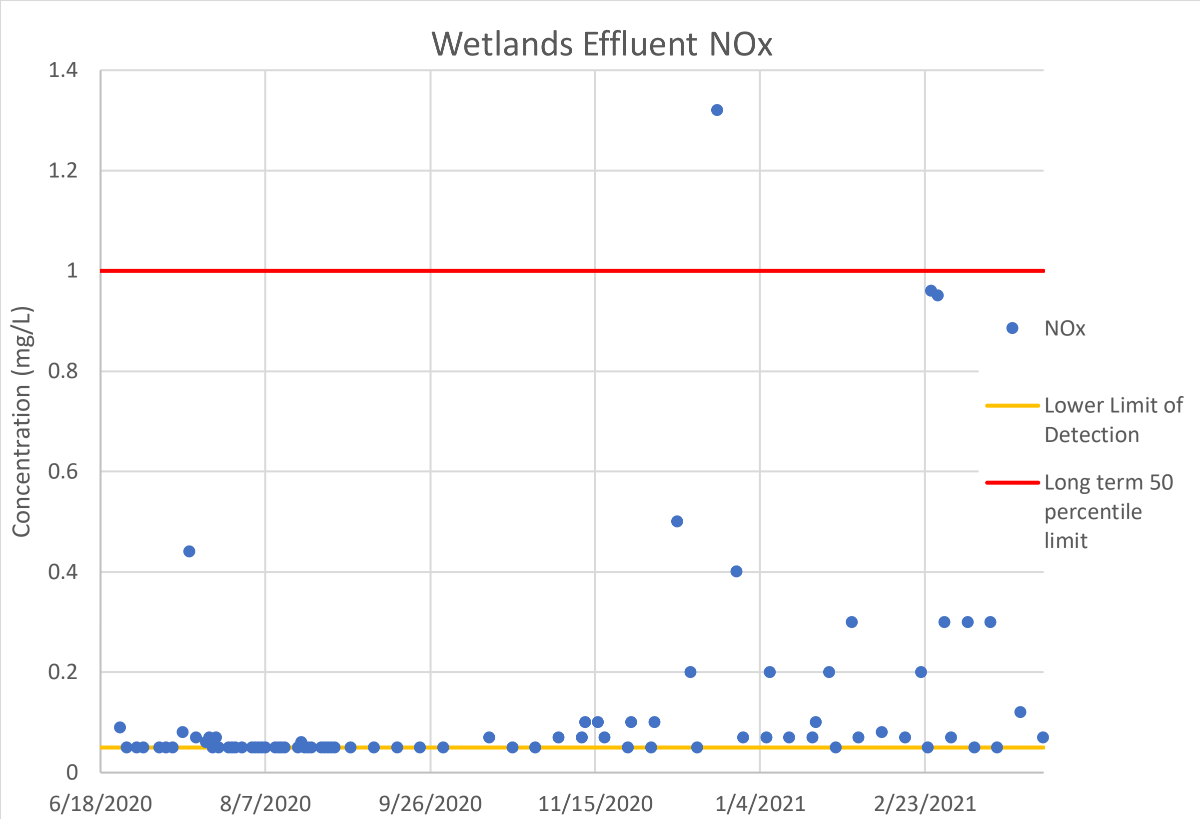

Figure 8: Wetlands effluent NOx. This parameter is affected significantly by wet weather, but during dry weather sits well below the compliance limit.

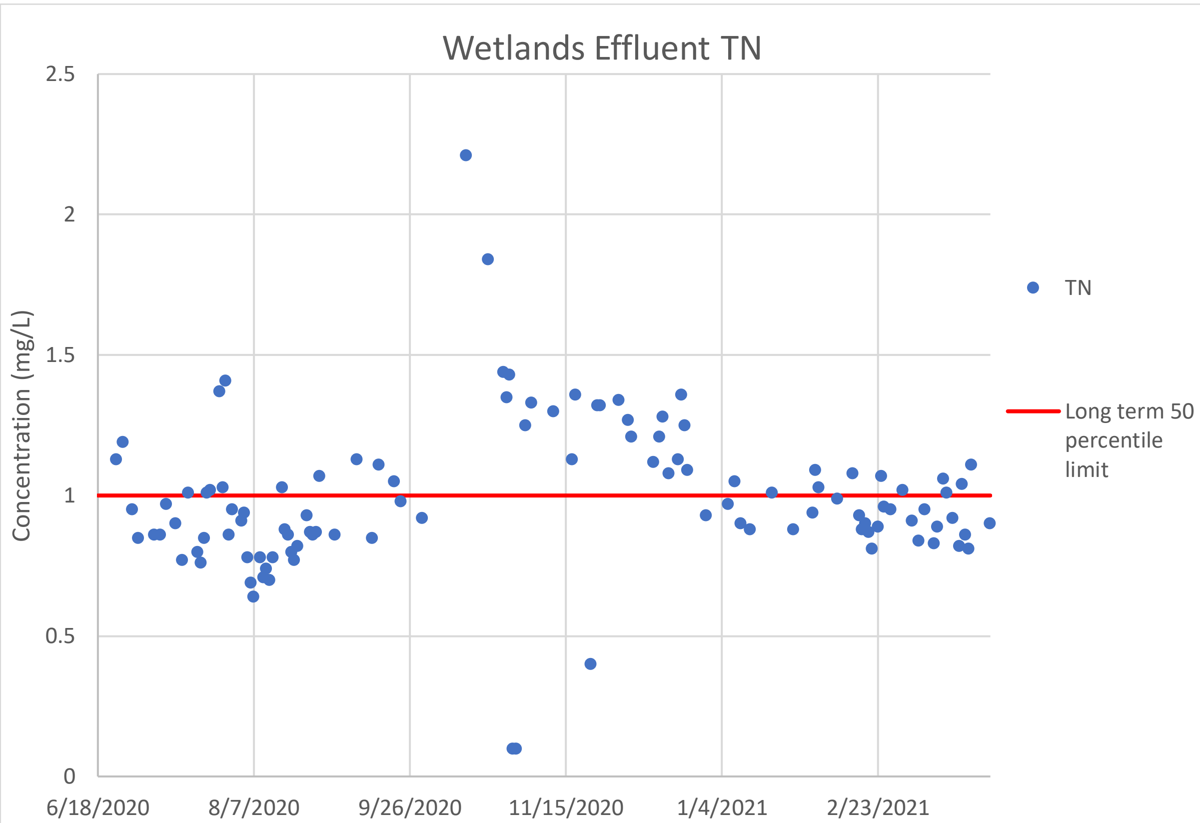

Figure 9: Wetlands effluent total nitrogen. Several issues have affected this parameter which are discussed above, however after corrective action the results are within long term targets.

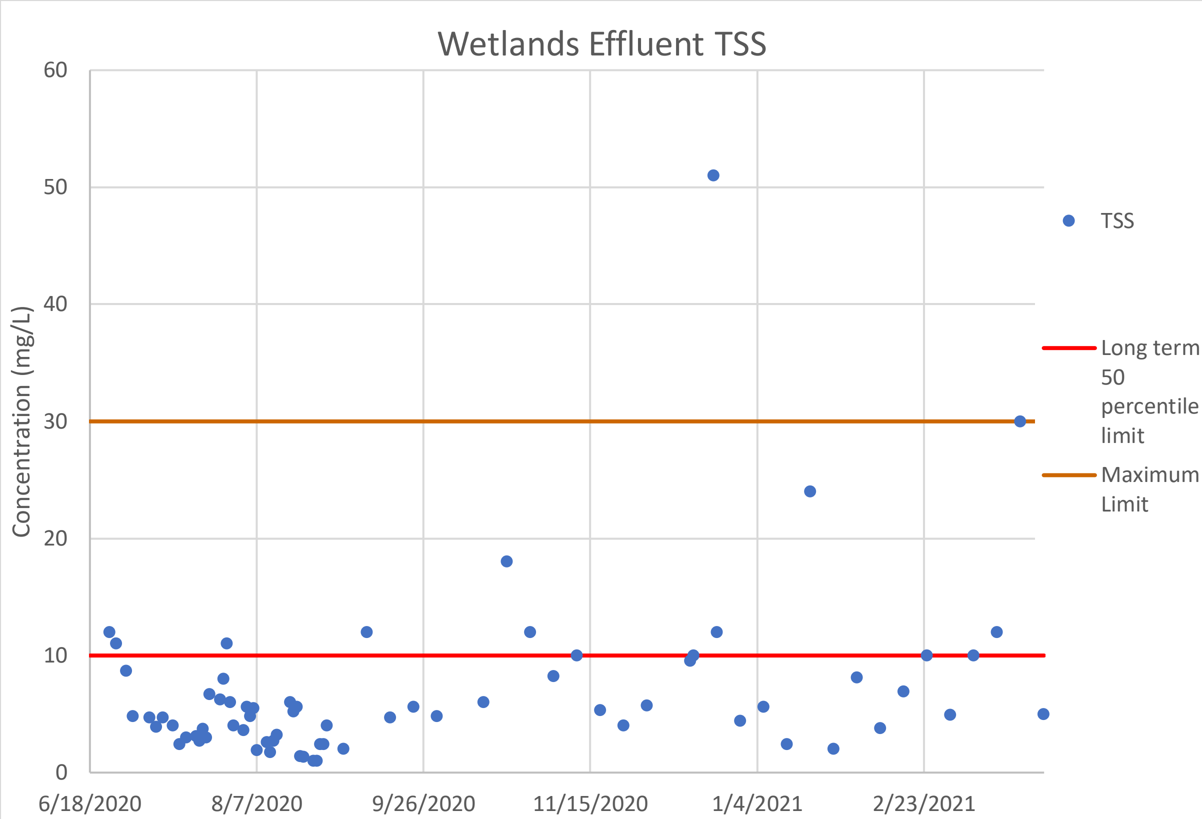

Figure 10: Wetlands effluent total suspended solids. This parameter is heavily affected in wet weather due to erosion of the batters. This should improve as plants and grass better establish in these areas.

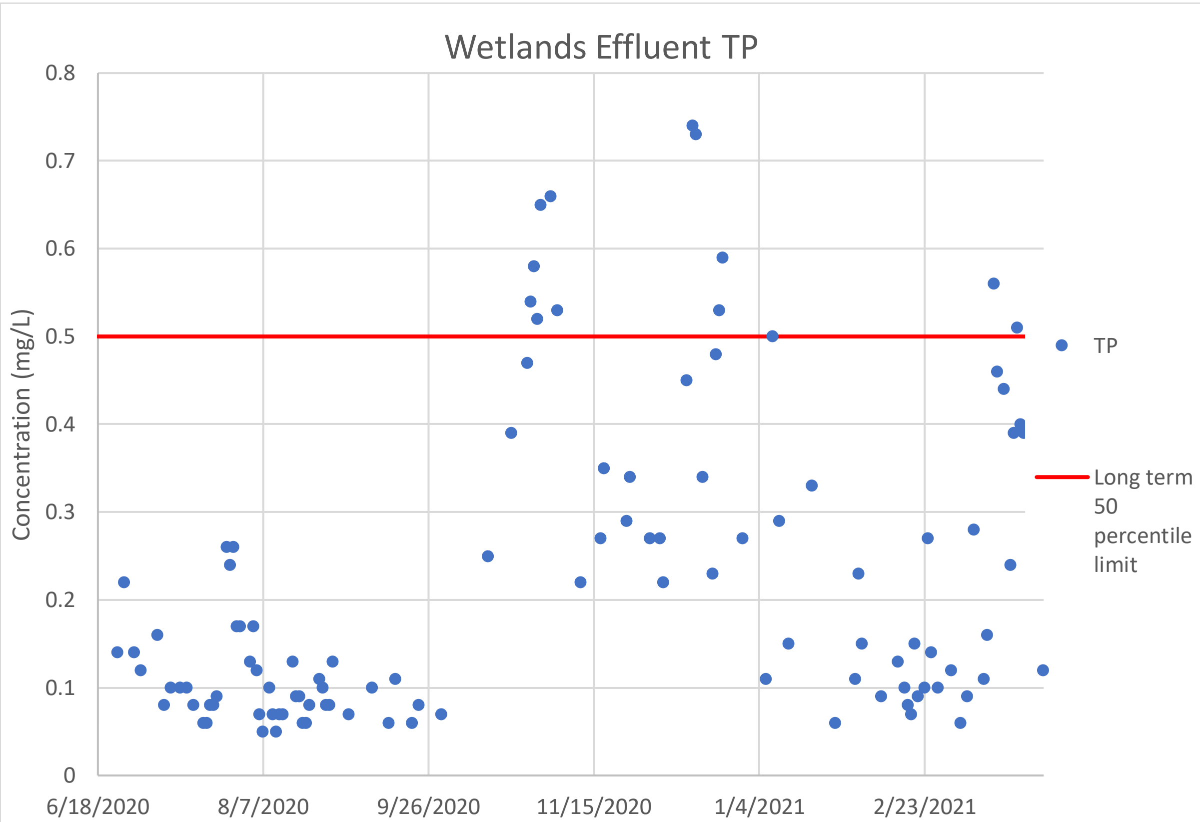

Figure 11: Wetlands total phosphorous. This parameter is affected by wet weather due to erosion of the batters and stirring up of sediment in the cells. Due to extremely good TP removal in the MBR there is no compliance issue with TP however.

Conclusion

The commissioning of Cedar Grove wastewater treatment plant was an overall success, with a number of learning experiences along the way. Involvement of the operation teams in the process has yielded good results in solving issues, creating opportunities along the way, and improving operability of the final asset.

The plants performance is overall quite good. The effluent is meeting the extremely strict nutrient requirements of its EA permit, however careful management of the wetlands is critical to its ongoing success.