STARTUP & COMMISSIONING OF A LOW LOADED WASTEWATER TREATMENT PLANT

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ABSTRACT

The Pimpama Treatment Plant was built as part of Gold Coast Water's Pimpama-Coomera Waterfuture Master Plan to provide Class A+ recycled water to the surrounding community. The plant consists of a wastewater treatment plant which was commissioned late 2008 followed by a recycled water treatment plant that is now at the final stages of commissioning. Included in this paper is a discussion of various challenges encountered during the startup and commissioning phases of the wastewater treatment plant. Throughout this period the operations team benefited by gaining expanded knowledge and experience in addressing issues that would otherwise rarely be encountered during typical daily plant operation.

KEYWORDS

Wastewater, recycled water, commissioning.

1.0 INTRODUCTION

As the keystone in Gold Coast City Council's award winning Pimpama Coomera Waterfuture Master Plan, the Pimpama Treatment Plant has been designed to provide Class A+ recycled water through a separate network for toilet flushing and external use via purple taps.

Figure 1: ***Purple water fittings designated for recycled water use***

The Pimpama Treatment Plant is located in a rapidly developing area between Brisbane and the centre of the Gold Coast. The plant combines a wastewater treatment process based around a 5-stage Bardenpho compartmentalised bioreactor, with a recycled water treatment plant incorporating ultra-filtration and ultra-violet disinfection, as represented by the process flow diagram.

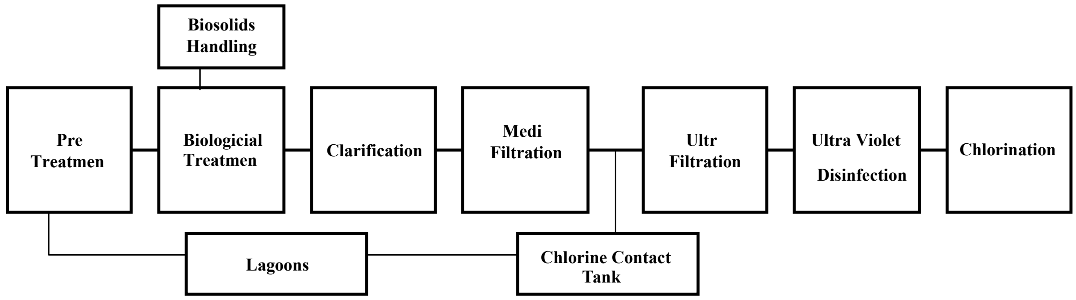

Figure 2: ***Pimpama process flow diagram***

Stage 1 of the wastewater treatment plant was commissioned in late 2008 with a nominal design capacity of 17 ML/d. The plant currently receives approximately 4.2 ML/d ADWF – one quarter of the design flow.

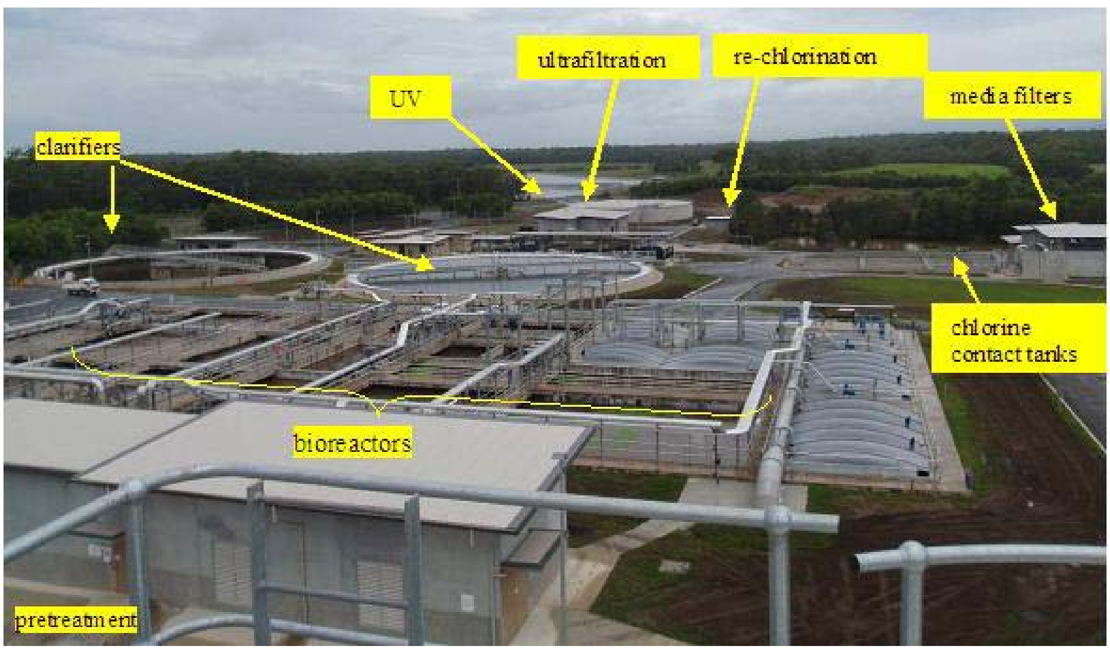

Figure 3: ***Pimpama treatment plant layout***

Operating the plant with this low load presented a number of operational challenges in addition to the challenges that could usually be expected from commissioning a new treatment plant. This paper will generally focus on discussing experiences associated with the wastewater plant only, in particular, the biosolids handling, biological treatment and secondary clarification.

Confronting and overcoming these challenges has proved a rewarding experience for the operational staff.

2.0 DISCUSSION

2.1 Seeding the Bioreactor

The process of initiating/inoculating the bioreactor at start-up was the subject of much discussion with a number of methods considered, each requiring pre-filling of the bioreactor with water to approximately 30% of tank depth. These included the following:

- Addition of MLSS from local source followed by feeding of biomass with manufactured food substrate before introducing raw sewage.
  Pro: Saving on cost of transporting entire required biomass.
  Con: Risk developing biomass unaccustomed to raw sewage characteristic.
- Introduction of raw sewage then allowing biomass to develop naturally.
  Pro: Cheapest option, with added benefit of developing a well adapted biomass.
  Con: Time required to develop biomass, also likelihood of odour, foaming, sludge bulking.
- Addition of MLSS from local source followed by introduction of raw sewage.
  Pro: Fastest method to achieve BNR.
  Con: Logistically impractical to transport approx 200 tanker loads.
- Addition of dewatered sludge from local source before introduction of raw sewage.
  Pro: Saving over cost of transporting MLSS.
  Con: Less viable biomass compared to MLSS due to extensive endogenous decay.

Given that the plant was a greenfield construction site, bioreactor seed sludge would have to be sourced from another plant. Gold Coast Water's (GCW) Coombabah and Merrimac WWTPs were the two most logical choices, producing significant quantities of dewatered sludge daily with the added advantage that Merrimac would also provide sludge containing extra phosphorous accumulating bacteria.

The bioreactor was first filled with Class B effluent pumped from the Coombabah WWTP effluent lagoons to a level sufficiently above all submersible mixers, A-recycle pumps and OKI aerators. To avoid the possibility of creating a septic environment and the associated odour issues, raw sewage was introduced one day after seeding had taken place.

A temporary concrete bund was constructed beside the bioreactor swing zone where seed sludge could be delivered by GCW's bio-solids transporting contractor before being applied directly to the aerated swing zone by front-end loader.

To ensure even distribution of sludge was occurring throughout the bioreactor, MLSS concentrations were tested regularly at various locations until 1200mg/L was achieved. This took 5 days. During the seeding process and the following 2 weeks, the Specific Oxygen Uptake Rate (SOUR) was monitored closely to assess microbial activity. Initially, SOUR results were very low even into the second day of introducing seed sludge. Before the seeding process started, SOUR trials had shown that biomass within the dewatered sludge had a significantly reduced viability in comparison to that of a healthy mixed liquor and further mortality was expected to occur during handling and transport. As the SOUR results began to increase, so did the rates of nitrification, so rapidly in fact that complete nitrification was being achieved within 3 weeks from the day raw sewage was introduced to the bioreactor.

Focus was directed to improving denitrification earlier than expected. At this stage, the rates of enhanced biological phosphorus removal were still not of primary concern.

2.2 Excessive Aeration Capacity

While the plant is receiving such low loading rates, the use of an air relief blow-off valve has been employed to avoid over pressurisation of the aeration header piping and over aeration within the bioreactor. Rather than exhausting direct to atmosphere, possibly causing noise pollution, a section of 300mm header pipe has been submerged below the bioreactor surface at aerobic zone 3 where excess air is released through perforations.

Figure 4: ***Aeration Blow-Off***

Although the oxygen transfer efficiency of this excess air is relatively low compared to what would be delivered to this zone via the OKI aerator, the DO concentration does still increase as a result, so the aeration control valve for this zone is left manually closed for typical ADWF. The blow-off valve's automatic actuator modulates to maintain the aeration header pressure set-point.

The current low oxygen demands in the bioreactor combined with the relatively large sizing of the aeration control butterfly valves to each zone makes operating at ranges near the closed position very finicky. Considerable effort was spent during commissioning to tune out the resulting sporadic DO fluctuations from the PID control loops and through continued experimentation a much smoother DO profile across all zones has been developed.

2.3 Managing the Sludge Age

Maintaining a solids inventory in a 16.85 ML bioreactor to suit an average daily domestic sewage inflow of 4.2 ML and BOD of 250 mg/L would seem quite easy, however, regular interruptions to the sludge dewatering process due to various commissioning events saw the sludge age reach up to 60 days at times, double the target.

Aside from being able to test the belt filter presses at a higher solids loading rate and seeing the improved dewatering performance offered by a sludge with very low volatile suspended solids, the general result of running up the solids inventory was negative and became a high priority to rectify.

As the MLSS concentration increased up to 3000-4000 mg/L from a typical 2400 mg/L, sludge settling characteristics would change and often a pin-floc would develop. The resulting increase in clarifier effluent turbidity would then threaten to jeopardise commissioning plans further downstream at the media filters.

The dewatering process incorporates two gravity drainage deck (GDD) belt filter presses that each have a feed capacity of 80m^3/hr, which when operated without interruption are able to reduce the solids inventory very quickly, however, experience to date has shown that the sludge settling characteristics will normally take approximately 1 sludge age to recover back to optimum. These events are expected to become less frequent now that commissioning of the WWTP has finalised.

2.4 Chemical Dosing

Turn down capacity of methanol, alum and hypochlorite dosing systems continues to be a limitation. Methanol is dosed into the post anoxic zone of the bioreactor as a carbon supplement for denitrifying bacteria. Although further improvements to de-nitrification are expected to be achieved via continued fine tuning of aeration patterns, methanol dosing will still be required. Current dosing set points already have the pumps operating at minimum speeds with low flow failures a regular occurrence, making it necessary to explore other options that will allow further turn down as the process is optimised.

Alum and hypochlorite dosing issues are related to the media filtration section of the RWTP. Alum is dosed at a flash mixer upstream of a series of four single media filters but the raw water quality coming from the secondary clarifier is such that very little alum is required, currently up to 6.5mg/L, causing low flow failures similar to that of the methanol dosing system.

The media filtration section of the plant has provision for three different hypo dosing points. First being at a flash mixer for manganese oxidation upstream of the filters, second for ultra filtration feed water post media filters and third at the entry to chlorine contact tanks (CCTs) also post media filters. The easiest solution to this problem was to increase the dose rate upstream of the media filters so that a adequate chlorine residual would be maintained throughout and allow both downstream pumps to be switched off. Recent alterations to HACCP parameter values, however, have since rendered this operational method inadequate and alternative approaches are now being trialled.

2.5 Control system

During the wastewater plant startup process, supervisory control and data acquisition (SCADA) software programmers were required to continually change and add new sections to the control system as other parts of the plant became available. This made it imperative to establish a high level of communication between the operations team and commissioning staff associated with SCADA system development. Each series of developments would mean losing SCADA control of some or all of the plant for the time it took to download the upgraded software.

With cooperation between both parties, any unwanted software glitches that arose from these upgrades, which happened almost every time, were dealt with promptly and systematically by the programmers.

A Profibus digital network has been installed throughout both the wastewater and recycled water treatment plants rather than a typical 4-20mA communication system to provide easy access to device alarming and equipment diagnostics information. Given that most electrical staff and contractors have had limited experience using Profibus, familiarisation with the system is ongoing.

Due to the demands of meeting commissioning milestones during plant startup, much of the Profibus network was installed without earthing to structures such as cable trunking and hand-railing with VSD and Profibus cables also unshielded. Not only was the entire system vulnerable without earthing but most instruments on the network became affected by signal interference due to the absence of cable shielding, causing loss of plant control during worst cases. Much time and effort has since been directed at eliminating interference with only intermittent events still occurring in isolated sections of the plant.

3.0 CONCLUSIONS

A variety of operational challenges, some foreseen and others unforeseen, have occurred during the commissioning of the Pimpama Wastewater and Recycled Water Treatment Plant. These challenges have been overcome using both technical knowledge and effective and consistent communication. As a result, the operations team has benefited by gaining expanded knowledge and experience in addressing various issues that would otherwise rarely be encountered during typical daily plant operation.

Although the ultimate goal with any new treatment plant is to construct a perfect example of the latest technology that operates flawlessly from the day it is started, it is important to realise that this has probably never happened. By appreciating that defects are inevitable, and cannot always be rectified overnight, and adopting a positive approach towards cooperating with commissioning staff, GCW's operations and maintenance personnel have shown that startup problems can still be corrected to the desired standard at the end of the day.

4.0 ACKNOWLEDGEMENTS

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