COMMISSIONING OF A 180 ML/DAY ACTIVATED SLUDGE PLANT AT THE WESTERN TREATMENT PLANT, WERRIBEE

Paper Presented by :

Domenica De Maria

Authors:

Domenica De Maria, *Process Engineer,*
Jenelle Watson, *Senior Process Engineer*,
Robbert van Oorschot, *Manager Water Technology Group,*
GHD Pty. Ltd.

Trevor Gulovsen, *Senior Process Engineer, Operations WTP,*
Melbourne Water

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Jenelle Watson, *Senior Process Engineer* GHD Pty Ltd
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Trevor Gulovsen, *Senior Process Engineer, Operations WTP* Melbourne Water

ABSTRACT

The Western Treatment Plant treats more than half of Melbourne's sewage. The plant comprises a number of large lagoon systems. Two of these lagoon systems were augmented and upgraded as part of an Environmental Improvement Project to reduce nitrogen loads on Port Phillip Bay. The most recent upgrade was on the 25 West Lagoon system and involved the construction of a 180 ML/day activated sludge plant within the lagoon system.

This paper discusses the start-up, commissioning and performance in the first year of operation for the 25 West lagoon and 25 West activated sludge nitrogen removal plant upgrade.

KEY WORDS

Wastewater treatment, activated sludge plant, commissioning, nitrogen removal.

1.0 INTRODUCTION

The Western Treatment Plant (WTP) located near Werribee, Victoria, treats about 500 ML/d. This is more than half of Melbourne's sewage. The plant comprises a number of large lagoon systems known as the 25 West (25W), 55 East (55E), 115 East (115E) and "Old Lagoons" sewage treatment systems (refer Figure 1).

A study conducted by the CSIRO during the 90's into the health of Port Phillip Bay recommended reducing the nitrogen load into Port Phillip Bay. This triggered a major Environmental Improvement Project by Melbourne Water which led to the augmentation and upgrade of the 55E and 25W lagoon systems, with the objective of decreasing total nitrogen loads discharged to Port Phillip Bay.

In addition to reducing nitrogen loads to Port Phillip Bay other key objectives of the Environmental Improvement Project for WTP are to mitigate odours and increase production of treated effluent suitable for water recycling.

Figure 1: ***The Western Treatment Plant, Werribee***

The 55E lagoon system upgrade was commissioned in April 2001, and the 25W lagoon upgrade was commissioned in September 2004.

The project was completed in an Alliance comprising Melbourne Water (owner, operators), GHD (process designers and responsible for commissioning and operations), SKM (detail designers), John Holland Group (constructor) and Connell Wagner (project management).

This paper discusses the start-up, commissioning and performance in the first year of operation for the 25 West Activated Sludge Plant (ASP) upgrade.

2.0 PLANT DESCRIPTION

The 25W Lagoon system prior to upgrade comprised of 10 ponds in series. The first pond comprised two sections. A deep covered anaerobic reactor and a shallow aerated section. The remaining ponds were facultative/maturation ponds.

The recent upgrade and augmentation of the 25W lagoon series involved upgrading the 25W lagoon from a capacity of 100ML/day to treat 280 ML/day of sewage in the anaerobic reactor and the construction of a 180 ML/day activated sludge plant (ASP) in one of the ponds to achieve nitrogen reduction.

The plant key design targets, some of which are more stringent than the EPA licence parameters, are listed in Table 1.

The anaerobic reactor and Pond 1 upgrade involved an extension to the existing anaerobic reactor cover to capture the increased amount of odorous gases expected as the lagoon loading was increased from 100 Ml/d to 280 Ml/d. 180 ML/day is pumped from the anaerobic reactor outlet to the 25W ASP which is located in the original Pond 4.

The remaining 100 ML/d plus waste activated sludge from the 25W ASP pass through the remainder of Pond 1, where it is aerated for odour control and is then diverted for treatment in the Old Lagoons.

Wet weather flows in excess of plant capacity will bypass the ASP and be discharged directly into Pond 2 via a storm bypass located at the end of the aerated section of Pond 1.

Table 1: ***Key Design Effluent Quality Targets***

Parameter	Average	Median	80%-ile	90%ile	Max
Ammonia as N, mg/L		≤ 3		≤ 5	≤ 20
Total Nitrogen as N, mg/L	≤ 15				
E.coli, orgs/100ml		≤ 1000	< 2500		
BOD_5, mg/L		≤ 20		≤ 40	-
Total Suspended Solids, mg/L		≤ 30		≤ 60	

The ASP process is configured in the Modified Ludzack Ettinger (MLE) format for nitrogen removal. It comprises a 70 ML anoxic zone configured in a "race-track configuration and a 130 ML aerated zone. The aerated basin consists of five aeration zones each with floating air supply headers. In total 3424 No. tubular EDI diffusers on 428 No. liftable racks are installed. Installed aeration power comprises 3 No. 750 kW blowers.

Mixed liquor is settled in 5 No. 45 m diameter clarifiers with energy dissipating stilling wells. The effluent from the clarifiers is discharged to Pond 2 from where it passes through a series of ponds providing about 25 days maturation time for disinfection. The principal design parameters for the 25W ASP are listed in Table 2.

Table 2: ***Principal Design Parameters of the 25W ASP***

Parameter		Range	Typical
ASP design flow range, ML/day		50 - 205	180
Total ASP Load, tCOD/day		76 – 85	85
Total Basin Volume, ML			200
Aerobic Section Volume, ML			130
Anoxic Section Volume, ML			70
a-recycle, ML/day		540 – 720	720
MLSS, mg/L		3300 – 3500	3500
WAS ML/day		6 – 20	8
Clarifiers	Number		5
	Diameter		45
	RAS rate per clarifier, ML/d	18 - 54	36

The clarifiers discharge effluent to Pond 2 for maturation through Ponds 2, 3, and Ponds 5 to 10. Sludge is wasted from the ASP to the aerated section of Pond 1. Refer Figure 2.

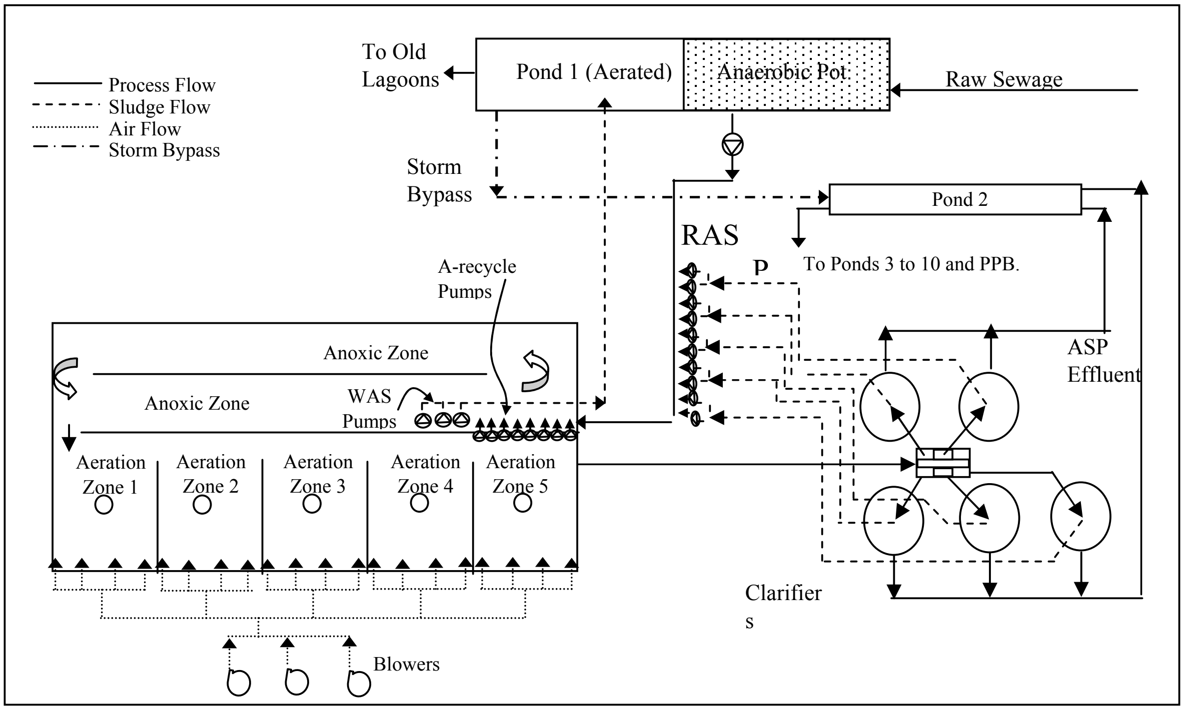

Figure 2: *The 25 West Lagoon System and ASP*

3.0 COMMISSIONING & FIRST YEAR OF OPERATION

Commissioning of the 25W ASP commenced on the 12 September 2004. The plant was filled with reclaimed water from adjacent ponds. The ASP was than seeded with WAS from the adjacent 55E lagoon system ASP. A temporary pipeline was constructed to transfer WAS from the 55E ASP to the 25W ASP. The transfer pipeline from the 55E ASP was selected as the most cost and time effective method of seeding the plant.

Influent primary treated wastewater from the anaerobic pot was initially fed to the ASP at a low rate and was gradually stepped up to the nominal feed rate of 180 ML/day. The gradual increase in feed rate during process commissioning was undertaken not only to avoid the risk of shock-loading the growing biomass, but also to mitigate the risk of inadequate treatment due to the concurrent commissioning of the aeration system. Commissioning of the aeration system necessitated frequent interruptions and shut downs of the aeration system during process commissioning. This was successfully managed and resulted in minimal impact on the process, and the commissioning was completed within a two-month period.

The commissioning period concluded November 2004, at which time, the mixed liquor suspended solids (MLSS) concentration was 3000 mg/L and the plant was successfully treating the design flow of 180 ML/day. At the conclusion of process commissioning, the plant was switched to a "follow-the-flow" mode. This mode of operation permits the flow to the ASP to vary with incoming raw sewage flows to the 25W lagoon. Flows to the ASP are permitted to vary between 50 ML/day and a maximum peak flow of 205 ML/day Throughout the first year of operation, in general, daily flows to the 25W ASP totaled approximately 180 ML/day. The average COD load was 223,000 kg/d.

Table 4 summarises the performance of the 25W W ASP and 25W Lagoon system in the first year of operation (November 2004 – November 2005).
The annual average power demand for the 25W ASP was 1790 kW.

Table 4: ***Summary of Performance for the 25W ASP and 25W Lagoon System in the First Year of Operation***

Parameter	ASP/ Pond 10	Average	Median	80%ile	90%ile	Max
Ammonia as N, mg/L	*P10-Limit*		*≤ 3*		*≤ 5*	*≤ 20*
	ASP	2				
	P10	3	2		6.8	13
Total Nitrogen as N, mg/L	*P10-Limit*	*≤ 15*				
	ASP	18-20				
	P10	10.5				
E.coli, orgs/100ml	*P10-Limit*		*1000*	*2500*		
	ASP					
	P10		18	71		
COD, mg/L	*P10-Limit*					
	ASP	50				
	P10	22				
BOD_5, mg/L	*P10-Limit*		*20*		*40*	
	ASP		6		20	
	P10		5		18	
Total Suspended Solids, mg/L	*P10-Limit*		*30*		*60*	
	ASP		9		17	
	P10		9		31	

4.0 DISCUSSION

During the first year of operation all EPA licence limits were met. A number of issues, which impacted on plant performance, were however encountered and resolved. Key issues included:

- Reduced aeration system efficiency
- Unreliable aeration system control
- Aeration system outages
- Lower than expected COD strength from the anaerobic pond

The key issues were in relation to the aeration system. The Alliance Team investigated and resolved the issues with the aeration system as the contractor responsible for design and supply of the aeration system went into liquidation before operation and control of the aeration system was completed and optimised.

Issues with the aeration system control mainly resulted in poor load sharing between the 3 blowers causing the third blower to be used when the other two blowers were not being utilized at their full capacity. This was also exacerbated by the reduced aeration efficiency, which requires additional blower output.

In addition problems with calibration of dissolved oxygen probes and drift of probe readings were encountered which caused lower than intended dissolved oxygen levels in some zones and subsequent intermittent nitrification issues. This contributed to the ammonia 90th percentile performance exceeding the design target.

There were aeration system outages throughout the commissioning and proof-of-performance periods. Issues with the aeration system which resulted in interruption of air supply to the aeration basin included:

- Aeration system control investigations and rectification
- Major and minor gaskets replacement in air supply pipes
- Blower vibration testing
- Off-gas testing – conducted to determine the oxygen transfer efficiency of the diffuser system.

The aeration system outages were up to 8 hours per day and were scheduled on alternate days to minimise impact to the biomass.

In the first year of operation the COD strength of the anaerobic pot feeding the ASP was less than expected resulting in a TKN:COD ratio of 0.15 versus a design TKN:COD ratio of 0.12. This resulted in a reduced denitrification capacity. It is expected that the COD strength from the anaerobic pot effluent will increase as the anaerobic pot matures, and thereby improve the denitrification capacity of the plant.

All of the issues were successfully overcome and resolved by the Alliance team and the plant demonstrated capable of achieving and or exceeding its design requirements with appropriate management of the aeration system. In the medium term an additional aeration blower is being installed to ensure adequate aeration capacity with the reduced aeration efficiency.

5.0 ACKNOWLEDGEMENTS

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