THE IMPACT OF A UNIQUE CATCHMENT ON URIARRA SEWAGE TREATMENT PLANT

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ABSTRACT

The existing forestry settlement at Uriarra in rural ACT was destroyed in the 2003 Canberra bushfires. The ACT Government committed to rebuilding and a new village containing 100 homes is nearing completion. Sewerage services to Uriarra Village consist of a pressurised sewer network and a membrane bioreactor treatment plant, which are owned and operated by ACTEW Water.

During the first year of plant operation, there has been a much larger than expected deviation in sewage composition and flows from the original design assumptions. The general effects on effluent quality and the wastewater treatment processes within the plant are discussed, which highlight the importance of inflow balancing for activated sludge plants.

KEY WORDS – Sewage characterisation, inflow equalisation, balancing, pressurised sewers.

1.0 INTRODUCTION

The 2003 Canberra bushfires resulted in widespread destruction, particularly in the western areas of the ACT. The former forestry settlement of Uriarra, located 18.5 km west of the Canberra CBD was heavily impacted, with 16 of its 22 houses destroyed. In 2007, the ACT Government announced that the site would be redeveloped into a rural village of 100 houses. Uriarra Village was gazetted as a Canberra suburb on 1 May 2012 (Gallagher, 2012).

The new Uriarra Village has a water supply and sewerage network that is unique within Canberra. It is entirely owned and operated by ACTEW Water and built by the AAT Alliance, an alliance between ACTEW Water and Tenix. Residents are reliant on rainwater tanks for their domestic water supplies, with pressurised non-potable water from the Bendora Gravity Main (which connects Bendora Dam with Mount Stromlo Water Treatment Plant) for fire fighting purposes. The sewerage system was based on the Tenix-designed Bega Valley Sewerage Project (BVSP).

Sewage from Uriarra Village is conveyed by a low pressure pumped sewerage network. Each domestic dwelling has its own 1100 L "pod", containing a macerating pump and stand-alone electronic control system. Wastewater is then conveyed to Uriarra Sewage Treatment Plant (USTP). USTP is a purpose-built membrane bioreactor (MBR) treatment plant that was designed to treat an average dry weather flow (ADWF) of 66 kL/d from 102 "pods" in the Village.

The raw wastewater undergoes grit and screenings removal prior to nutrient removal via a single tank, semi-continuous biological process with sodium hydroxide and ferric chloride utilised for alkalinity control and phosphorous precipitation, respectively. The recycled water is then microfiltered using submerged membranes and disinfected with ultraviolet (UV) light prior to discharge into Tarpaulin Creek. Effluent reuse for farm irrigated has yet to commence and may require a modification to the existing Environmental Authorisation.

In addition, the plant has a 66 kL influent balance tank between the gross solids removal and biological treatment and a "Bioselector" zone to facilitate enhanced biological phosphorous removal (EBPR) and simultaneous nitrification and denitrification (SND).

USTP commenced treating wastewater from Uriarra Village in July 2011. After an initial period of commissioning and biological process conditioning, the plant completed a 28 day performance proving period in November 2011 and has been treating all sewage from Uriarra Village from this time.

The design influent flows and plant mass loadings were assumed based on typical concentrations experienced for similar Tenix-designed MBRs in the BVSP. The assumed ultimate ADWF once Uriarra Village was completed (100 houses) was 66 kL/d. The corresponding process loadings are summarised in Table 1.

Table 1: ***Assumed process loadings at USTP used as the basis for design.***

Parameter	Design Influent Concentration (mg/L)		Design Influent Loading at Ultimate Design ADWF (kg/d)	
	50th Percentile	*90th Percentile*	*50th Percentile*	*90th Percentile*
Alkalinity	300	350	19.8	23.1
BOD	350	450	23.1	29.7
COD	750	1000	49.5	66.0
TSS	300	400	19.8	26.4
VSS	260	340	17.2	22.4
Ammonia	50	65	3.30	4.29
TKN	70	90	4.62	5.94
Total P	12	15	0.79	0.99
Ortho P	8.5	10	0.56	0.66

During the commissioning period, it became evident that the nature of the influent differed greatly from these design assumptions. These deviations should be responsible for a greater impact on effluent quality and process performance than has currently been experienced.

2.0 DISCUSSION

2.1 Plant Inflow Volumes

The mean daily inflow to USTP since November 2011 was compared to the mean number of household sewer "pods" commissioned (which may not correspond with the number of premises occupied) in Uriarra Village during that month and the corresponding assumed ADWF from design. The results are shown in Table 2. Note that March 2012 was a period of extremely wet weather and significant flooding in the ACT region.

The flow data indicates the plant will treat a much lesser volume of wastewater than originally designed. This has been attributed to low per capita water use due to the residents being reliant on their own rainwater tanks for domestic water supplies. This reduced flow has resulted in several key items of equipment (specifically rotary lobe pumps and aeration blowers) operating at near their turndown limits for extended periods. It is unknown at this stage whether this may alter their expected operating lives.

Table 2: ***Current mean daily inflows and assumed inflows to USTP, based on the number of sewerage 'pods' commissioned.***

Month	Mean Daily Inflow (kL/d)	Number of 'Pods' Commissioned at Month End	Estimated Mean Daily Inflow Based on Design Ultimate ADWF (kL/d)	Difference Between Actual and Estimated Inflows (%)
November 2011	25.6	77	49.8	-48.6%
December 2011	27.4	77	49.8	-45.0%
January 2012	25.1	78	50.5	-50.3%
February 2012	28.1	80	51.8	-45.8%
March 2012	34.2	82	53.1	-35.6%
April 2012	27.1	82	53.1	-49.0%
May 2012	27.6	82	53.1	-48.0%
June 2012	29.4	84	54.4	-46.0%
July 2012	28.7	84	54.4	-47.2%
August 2012	29.8	87	56.3	-47.1%
September 2012	31.2	87	56.3	-44.6%
October 2012	32.2	89	57.6	-44.1%
November 2012	29.6	89	57.6	-48.6%
December 2012	30.0	89	57.6	-47.9%
January 2013	29.5	90	58.2	-49.3%
Mean Values	*29.0*			-46.5%

The pressurised sewer network is subject to less infiltration than the gravity network in Canberra. During extreme wet weather in March 2012 (a conservative 1:20 year event), the increase in inflows at both the Lower Molonglo Water Quality Control Centre (LMWQCC, Canberra's primary wastewater treatment plant) and USTP was compared. The results are shown in Figure 1. It shows that the pressurised system was subject to infiltration but not to the same extent as the entire Canberra network. The primary reason for wet weather infiltration is due to the non-watertight lockable lids used on the "pods" in Uriarra Village.

The daily inflow variation was also determined and compared with LMWQCC over the same period and displayed in Figure 2. On average, USTP receives a 23 percent higher mean daily inflow on a Saturday or Sunday than a traditional working day. By contrast, LMWQCC has a negligible change in total flow on a weekend. This high variance in hydraulic load is attenuated in the influent balancing tank such that biological process sees very little difference in daily flow (see Figure 3).

2.2 Process Loadings

Table 1 highlighted the design process loadings for USTP and Table 2 demonstrated that the plant is receiving 44 percent of the design ADWF (currently 29 kL/d). Consequently, it should also be processing 44 percent of its design influent mass loadings. The actual plant loadings from November 2011 to January 2013, based on mean daily inflow, are shown in Table 3. Volatile suspended solids (VSS) were measured as percentage of total suspended solids (TSS), which averaged 92 percent over the period.

Figure 1: ***Ratio of Actual Daily Inflow to ADWF for both LMWQCC (100 ML/d) and USTP (assumed to be 29.0 kL/d) during the March 2012 wet weather event.***

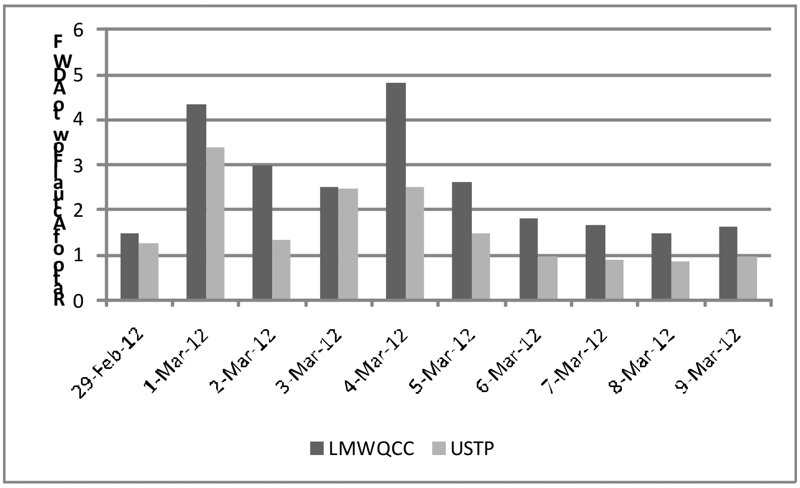


Figure 2: ***Mean daily inflow to USTP based on the day of the week.***

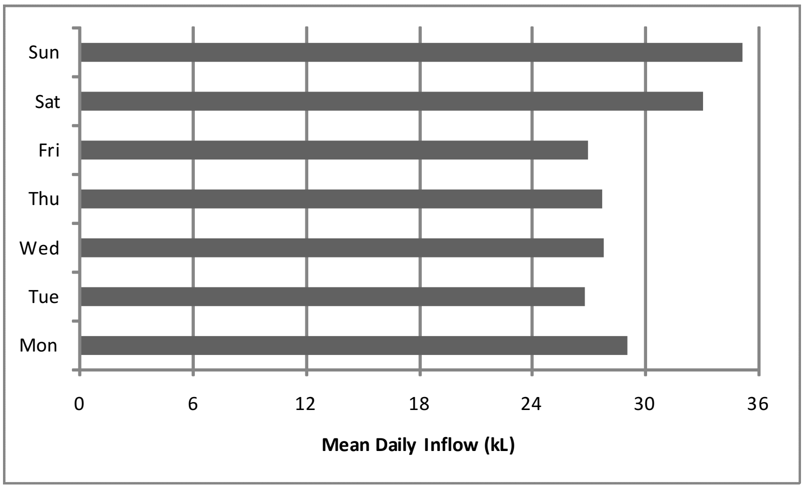
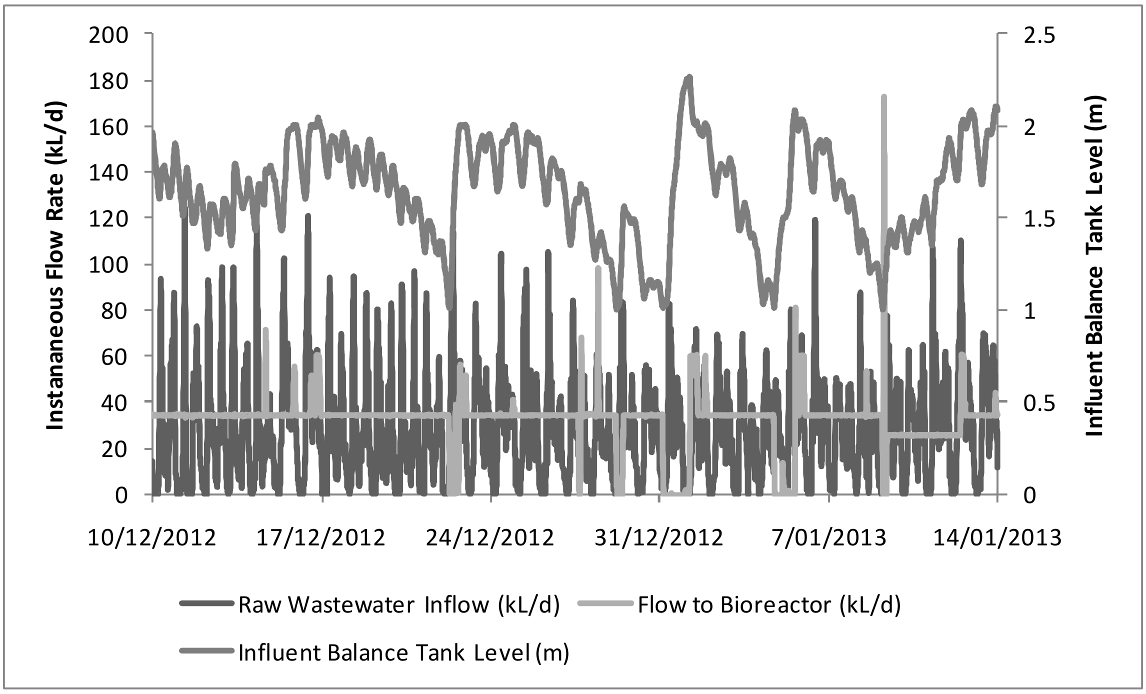


Table 3: ***Actual influent process loadings for USTP from November 2011 to January 2013.***

Parameter	Actual Influent Concentration (mg/L)		Actual Influent Loading at Mean Daily Inflow (kg/d)		Percentage of Design ADWF Loading at Mean Daily Inflow	
	50th Percentile	*90th Percentile*	*50th Percentile*	*90th Percentile*	*50th Percentile*	*90th Percentile*
BOD	355	440	10.3	12.8	45%	43%
COD	690	810	20.0	23.5	40%	36%
TSS	230	336	6.7	9.8	34%	37%
VSS	219	266	6.4	7.7	37%	34%
Ammonia	70	76	2.0	2.2	62%	51%
TKN	87	96	2.5	2.8	55%	47%
Total Phosphorous	15	16	0.4	0.5	55%	47%

Figure 3: ***Comparison between raw wastewater and biological inflows, along with***

Influent Balance Tank levels, at USTP over a 5 week period.



Analysis indicates the composition of the actual influent is heavily overweight with respect to ammonia (particularly at the 50th percentile), overweight with total nitrogen and total phosphorous (particularly at 50th percentile) and underweight with COD (particularly at 90th percentile), VSS and TSS (at both 50th and 90th percentiles). It is likely some COD and suspended solids have been removed during the screenings and grit removal stages, as this sample is post-inlet works. However, this portion would have little value as substrate as it is not readily biodegradable. As a result of higher nutrient loads relative to the amount of biodegradable material in the influent, further studies are required to determine if this may place future limitations on denitrification and, consequently, any EBPR.

Given the wide variation in the hydraulic loads in the process, particularly on weekends, the biological process should be subject to highly variable process loadings. However, as demonstrated in Figure 3, the influent balance tank is highly effective at attenuating the inflow such that the impact on the biological process is minimal. Qualitative evidence suggests that nutrient loadings in the Bioreactor, particularly phosphorous, are higher on weekends although not in proportion with the increase in hydraulic flows.

The plant has consistently met the nutrient effluent parameters in its Environmental Authorisation, despite these drastic swings in raw wastewater characteristics. Any non-compliances have coincided with either power or equipment failure.

2.3 Advantages of Inflow Equalisation

The advantages of inflow equalisation in activated sludge processes have been well proven (Dold *et.al.*, 1984; Henze *et.al.*, 2008). An inflow regulation facility was built at LMWQCC in the late 1990s, which resulted in much greater control of nutrient removal within the process (in particular, ammonia).

As demonstrated in Figure 1, catchments serviced by pressurised sewerage networks typically produce highly variable inflows to receiving sewage treatment plants. The traditional approach to aeration control taken by Tenix-designed plants in the BVSP has been to allow for programming of independent aeration cycles at each hour of the day. This requires operators to enter up to 48 separate aeration parameters per day.

The Influent Balance Tank has allowed ACTEW Water to heavily simplify this approach, given that significant dampening of nutrient and substrate loading occurs. The number of aeration programmes has been reduced from 24 to 2; a default programme and an alternate programme for unusual events. This makes implementing minor changes straightforward and does not require operators to have a detailed understanding of the wastewater-generation patterns of inhabitants of the Uriarra Village.

The consistency of process loading also results in consistent biomass growth kinetics and a reduction in the “lag” phase of their growth cycle. The end result is a consistent rate of biosolid production over a 24 hour period. This has allowed ACTEW Water simplify the existing sludge wasting strategy by implementing hydraulic sludge age control, which allows greater process scrutiny by operators (the wasting process occurs during the day when an operator is on site).

3.0 CONCLUSIONS

- Pressurised sewerage networks are likely to induce highly cyclical hydraulic and process loads on receiving sewage treatment plants.
- Care needs to be taken when considering the sewage characterisation from a pressurised sewerage system, particularly if the population is not serviced by mains water.
- Influent balancing is a highly effective approach in optimising and simplifying the operation of the activated sludge process.

4.0 ACKNOWLEDGEMENTS

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5.0 REFERENCES

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