PERFORMANCE REVIEW OF DUAL MEDIA FILTERS TO EVALUATE THE POTENTIAL LOG REMOVAL CREDITS FOR MICROBIAL PATHOGENS

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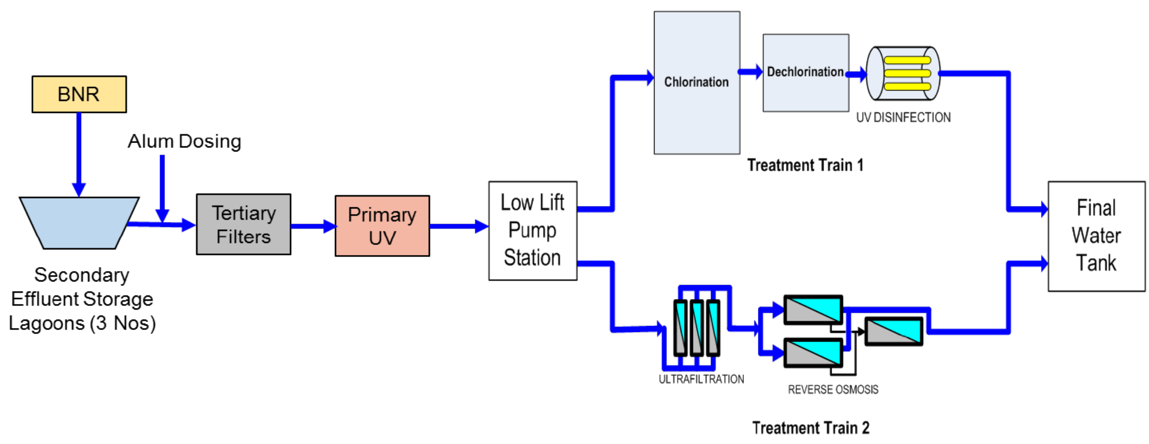
ABSTRACT

The Bendigo Recycled Water Factory (BRWF) treats secondary-treated effluent from the Bendigo Water Reclamation Plant (BWRP) to a Class A standard using a range of processes, including tertiary filtration, through dual media filters. The BRWF was commissioned in 2008, prior to the introduction of the then Department of Health's 2013 Guidelines for Validating Treatment Processes for Pathogen Reduction (the new Guidelines). Coliban Water has completed a detailed gap analysis to identify potential gaps in meeting the requirements of the new Guidelines. The gap analysis identified a shortfall in pathogen Log Reduction Values (LRVs) to meet the new Guidelines. Coliban Water has implemented some upgrades and operational modifications to assess whether it can claim the required LRVs through the dual media filters. This paper discusses the outcomes of this performance review.

1.0 INTRODUCTION

1.1 Background

The Bendigo Recycled Water Factory (BRWF) was designed and constructed to produce Class A recycled water. The recycled water is used for municipal irrigation, agricultural irrigation, as well as dual reticulation. The RWF process flow diagram is shown in Figure 1 below.



<u>Figure 1:</u> ***Rcycled Water Factory Process Flow Diagram***

The plant was commissioned in 2008 prior to the introduction of new Guidelines for Validating Treatment Processes for Pathogen Reduction, in 2013 (Department of Health, 2013) (the new Guidelines). Consequently, Coliban Water (CW) completed a detailed gap analysis to identify potential gaps in meeting the requirements of the new Guidelines, with the assistance of CH2M Hill, in 2011.

The assessment identified a shortfall in virus and protozoan log reduction values (LRVs) necessary to meet the new Guidelines. Table 1 below shows the claimed or claimable LRVs prior and after the introduction of the Guidelines.

<u>Table 1</u>: ***Claimed or Claimable LRVs Prior to and after the New Guidelines***

Process	**Viruses**		**Protozoa**	
	Train 1	**Train 2**	**Train 1**	**Train 2**
Activated Sludge	2.2/0.5		0.8/0.5	
Dual Media Filtration	0.0/0.8*		0.0/1.5*	
Primary UV Disinfection	0.3/0.0		3.0/0.0	
Chlorination	4.0/4.0	-	0.0/0.0	-
Secondary UV disinfection	0.7/0.7	-	3.0/3.0	-
Ultrafiltration	-	3.0/3.0	-	3.0/3.0
Reverse Osmosis	-	1.7/1.7	-	1.7/1.7
Total	**7.2/6.0**	**7.2/6.0**	**6.8/5.0**	**8.5/6.7**

*Note for Table 1 * - represents the minimum LRV required to claim for filtration in order to meet the log reduction requirements of the new Guidelines*

As per the new Guidelines, log reductions for multiple equivalent disinfection processes cannot be added together. Therefore, log reduction from one of the UV disinfection processes cannot be claimed. Additionally, the default LRV claimable from the activated sludge processes is 0.5 for both viruses and protozoa, which is lower than the previously claimed values.

Upgrading the existing filtration process and validating the claimable LRVs to compensate for the log reduction shortfalls was identified as a preferred option. Since the existing filters were traditionally operated for polishing purposes, there is uncertainty as to whether the filter performance to achieve the low turbidity target required to claim the required log reduction can be achieved. Therefore, the upgrade to the filters is being implemented in two stages.

- **Stage 1** – Operational and functional modifications, which included the installation of filter-to-waste functionality, optimisation of the backwash process, and a detailed investigation of the condition and performance of the filters to assess whether or not they could achive the required performance target.
- **Stage 2** - As per the outcomes of Stage 1 investigation, implement additional improvements and assess the performance of the filters to ensure that they achieve the desired performance target before undertaking validation.

Most of the Stage 1 works have been completed. The performance of the filters was evaluated against the default LRVs claimable for direct filtration detailed in the *Drinking Water Source Assessment and Treatment Requirements - Manual for Application of Health-Based Treatment Targets Release No. 1, 2014 (WSAA 2014).* The default values provided in the manual are tabulated in Table 2.

Table 2: ***Default Recommended LRVs for Direct Filtration Water Treatment (WSAA, 2014)***

Log Reduction Value		Process Critical Limits
Protozoa	**Viruses**	
2.5	1.0	Individual filter turbidity ≤ 0.3 NTU for 95% of month and not > 0.5 NTU for ≥ 15 consecutive minutes. Combined filtrate turbidity < 0.2 NTU for 95% of the month and not > 0.5 NTU for 15 consecutive minutes.
3.0	1.0	Individual filter turbidity ≤ 0.2 NTU for 95% of month and not > 0.5 NTU for ≥ 15 consecutive minutes.
3.5	1.0	Individual filter turbidity ≤ 0.15 NTU for 95% of month and not > 0.3 NTU for ≥ 15 consecutive minutes.

The assessment of the performance of the tertiary filters was undertaken as part of Stage 1, in light of the claimable LRVs for microbial pathogens.

2.0 DISCUSSION

2.1 Brief Detail of Works Implemented

There are four filters in the tertiary treatment plant. Turbidity meters were installed at the outlets of each filter cell in September 2014. The backwash sequence of the filters was modified to improve effluent quality in December 2014. The filter walls and media surfaces were cleaned to improve the performance, and extend the life of the filter media between 18 and 27 March 2015. During this period, media samples were collected for laboratory analysis to evaluate the properties of the media, to see if it needed to be changed. The turbidity instruments were calibrated and added to the maintenance schedule in April 2015. A filter-to-waste arrangement was also installed in April 2015 and commissioned in July 2015.

2.2 Feed Water Quality

Feed water quality from the lagoons that supply the filters varies, sometimes significantly. Lagoons 2 and 3 are shallow, compared to Lagoon 1. The effluent drawing depth is low and the hydraulic retention time is low in Lagoons 2 and 3, compared to Lagoon 1. Wind and frost conditions disturb the water column. Algal blooms in summer are likely to vary the feed water pH significantly. The feed water pH and turbidity were analysed by hand held portable instruments in a few grab samples during the period under review. The pH and turbidity were between 7 and 8.5, and 1 and 9 NTU, respectively. The phosphorus concentration was not monitored; however, it typically varies between 0.5 and 1.5 mg/L, as total phosphorus.

2.3 Performance of Filters

Individual filter performance was assessed using the data from the newly installed turbidity meters. Figure 2 below shows the typical performance of one of the filters (i.e. Filter 1) for a day.

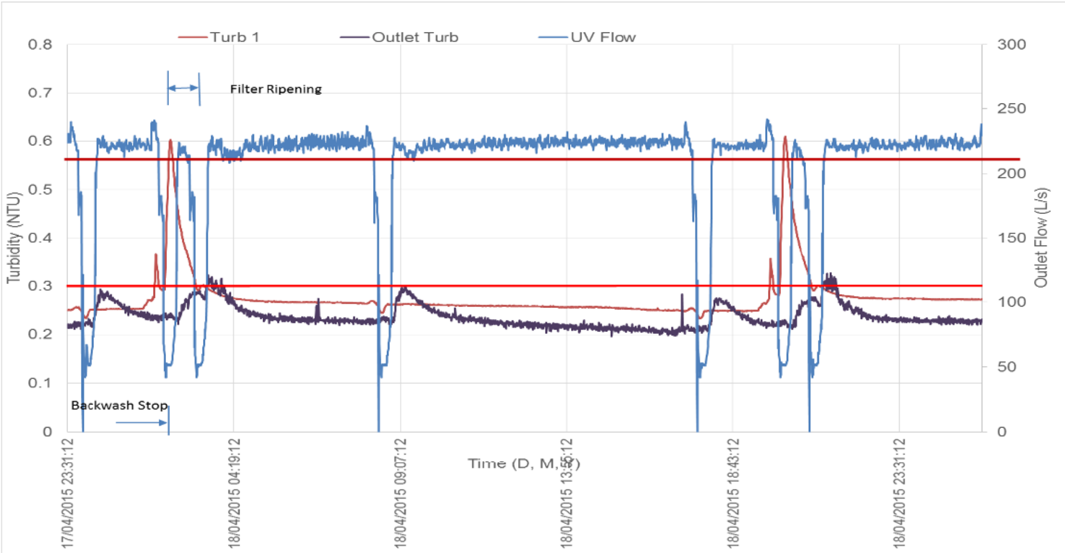


Figure 2: ***Typical Filter Performances***

Figure 2 shows that the filter did not achieve the post filter target turbidity of 0.3 NTU all of the time, especially during the filter ripening period, where the tubidity was above 0.3 NTU for approximately one hour. About 200kL of water needs to be recirculted through the lagoons via filter-to-waste system to produce turbidity of less than 0.3 NTU. This might cause lagoon overflow as there is limited volumetric capacity in the lagoon system.

Figure 3 shows the filter performance for a one week period. An increase in turbidity during the week was observed. This may be due to the slime build up on turbidity meters. Since the feed water is secondary treated sewage effluent, bioflim builds up quickly, requiring frequent cleaning of the meters, filter walls and media surface.

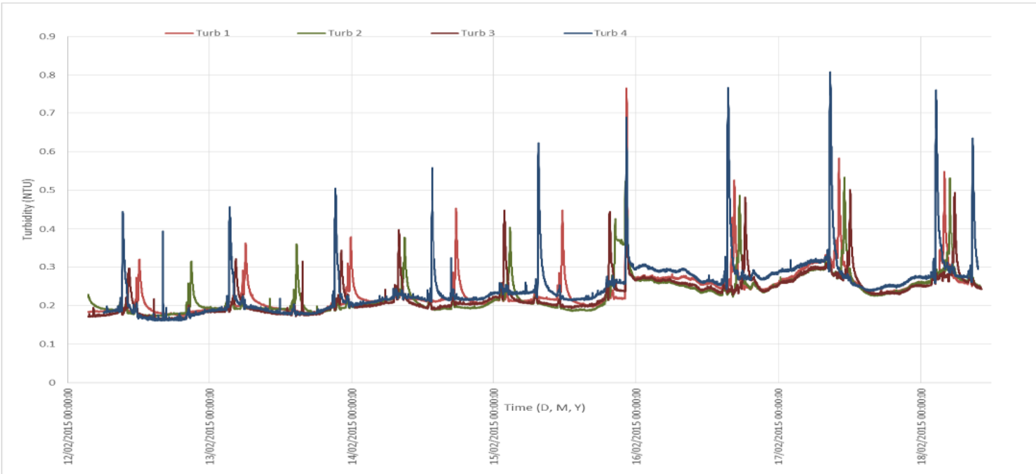


Figure 3: ***Filter Performance Over a One Week Period***

After the filter media and the filter walls were cleaned, the filter performance was assessed again. Data was analysed using the WTP filter analyser tool prepared by Australian Water Treatment Alliance for the following scenarios:

- Performance of filters one week prior to cleaning (12-2-15 to 18-2-15) –Scenario 1
- Performance of filters one week post cleaning (17-4-15 to 23-4-15) – Scenario 2

A summary of performance assessment using the WTP filter analyser tool obtained from these scenarios is tabulated in Table 3.

Table 3: ***Summary of Filter Performance***

	Filter 1	Filter 2	Filter 3	Filter 4
Percentage of the Time Individual Filter Turbidity < 0.3 NTU (Scenario 1)	79%	85%	75%	71%
Percentage of the Time Combined Filter Turbidity < 0.2 NTU (Scenario 1)	56%			
Percentage of the Time Individual Filter Turbidity < 0.3 NTU (Scenario 2)	45%	72%	26%	32%
Percentage of the Time Combined Filter Turbidity< 0.2 NTU (Scenario 2)	0%			

The ripening period for all filters appears to be about one hour. Occasionally, turbidity prior to backwash was above 0.3 NTU. In terms of turbidity, the performance of Filters 3 and 4 was poorer than Filters 1 and 2. As per the above analysis and historical performance data,the performance of Filter 4 was the worst of all the filters. Filter 4 turbidity was above 0.3 NTU most of the time after media cleaning.

Filter performance has deteriorated since the cleaning of the filters. This observation is consistent with the hypothesis that much of the filtration is ocurring within the surface sludge that builds up on the filters.

Better performance was also observed in the period after the cleaning of the turbidity meters. This indicates that the build-up of biofilm on the turbidity meters is leading to the meters giving higher results. This observation will mean that the turbidity meters will have to be cleaned at a greater frequency in order to maintain reliable results.

It should also be noted that the results of media sample analysis showed that the effective size of the media (mm d10) and its uniformity coefficient (d60/d10) had not change significantly from the original design values. This indicates that the filter media is in reasonably good condition and does not need to be changed in the short- to medium-term.

3.0 CONCLUSION

The results of the filter analysis show that tertiary filters at the Bendigo Recycled Water Factory are not achieving the target turbidity values to claim the required log reduction values using the current operation and maintenance conditions. Once the new filter-to-waste system is online, the filter outlet turbidity is likely to improve. However, it is not possible to achieve the target turbidity reliably and consistently to be able to move into a validation phase, without further process improvements. Therefore, the next step is to undertake the following activities to achieve the target performance:

1. Improve and optimise the operation of the tertiary filters by:
    a) Improving feed water monitoring in order to better understand the feed water characteristics
    b) Regular jar testing to optimise the coagulant dose, in order to achieve a target turbidity of 0.1 NTU
    c) Improve the maintenance of the filters, by carrying out regular cleaning of filter walls and media surface, and by undertaking more frequent cleaning of online instruments.

2. Improvements to the coagulation process to achieve floc formation, such as modification to the chemical injection (i.e. improved injection point, introduction of carrier water), and the installation of pH correction to the feed water pH to optimise the coagulation and flocculation process

3. Close monitoring of the performance of the filters.

4.0 ACKNOWLEDGEMENTS

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5.0 REFERENCES

Department of Health, *Guidelines for validating treatment processes for pathogen reduction, Supporting Class A recycled water schemes in Victoria* (February 2013) www.health.vic.gov.au/water/alternative/recycling

CH2MHILL, *Bendigo Recycled Water Scheme – Potential Implications of Department of Health Validation Guidelines,* report prepared for Coliban Water (October 2011)

Mosse, P *Operational Review of the Bendigo WRP with Particular Reference to the Condition and Operation of the Media Filters,* report prepared for Coliban Water *(June 2015)*

Mosse, P & Murray B (2009), *Practical Guide to the Operation and Optimisation of Media Filters* Industry Operators Association of Australia (WIOA), Shepparton, Australia

Water Services Association of Australia (WSAA), *Drinking Water Source Assessment and Treatment Requirements, Manual for Application of Health-Based Treatment Targets* Release No 1 (August 2014)