FLOATING THE POTENTIAL OF DIRECT FILTRATION TO REDUCE OPERATIONAL COSTS

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ABSTRACT

Like many other Victorian water businesses, East Gippsland Water (EGW) has a strong focus on reducing operational costs and over the years and has implemented a number of programs to reduce electricity consumption, after-hours operator response and chemical usage. One idea that was floated (pun intended) was that in times of good raw water quality we would run our Dissolved Air Floatation (DAF) and Filtration plants in a Direct Filtration (DF) mode. This involves turning off the DAF system and relying on Coagulation, Flocculation and Media Filtration for solids removal. A single day trial was undertaken to see how the plant would handle this mode of operation. The plant performance during this trial was good enough to enact a further three day trial and a week-long trial which both showed even more promising results.

The main components of this trial were:

- Will the plant perform?
- Will the savings justify the change?
- What is the operator time required?
- What other benefits or drawbacks are we missing?

The trial showed that there is a strong potential for significant cost savings that can be made at minimal interruption to normal operations. During DF mode the overall power demand is expected to reduce between 15-50% depending on the flow of the plant. There were also a number of other benefits including the potential to reduce sludge production and decrease machine wear that were not initially realised.

1.0 INTRODUCTION

Direct Filtration (DF) refers to the idea of removing the clarification process and simply running with coagulation, flocculation and filtration as the main principles of solids removal. Given the good water quality (low turbidity, low colour and minimal microbiological contamination) produced from the Mitchell Catchment, the ability to operate in DF mode was considered to be an acceptable option. The Mitchell River catchment supplies East Gippsland Water's (EGW) largest water treatment plant (WTP), Woodglen WTP. Woodglen was commissioned in 2009 and has been designed to run primarily as a Dissolved Air Floatation and Filtration (DAFF) plant. This being said there is reference within the operations manual and the design documents that it has been constructed in a way that allows for DF to be possible.

The significant driver of operating in DF mode is the potential to operate without areas of the plant that draw significant amounts of power. This trial was initially met with some concerns due to the idea that the plant was already operating at extremely high levels of performance and it was believed that the trial would negatively impact this, as well as increase operator time and callouts. This concern was the reason behind the multiple trials at varying lengths. Overall it was found that DF is definitely an option from an operations perspective as well as from a financial and environmentally beneficial viewpoint.

2.0 DISCUSSION

2.1 The Site

A summary of EGW's Woodglen Water Treatment Plant (WTP) which is the site where the trial was undertaken is included in Table 1. This table allows a comparison to be drawn between the plant which was used for the trial and others that may be considered appropriate for a trial similar to this.

Table 1: ***Summary of East Gippsland Water's Woodglen Water Treatment Plant***

Flow	Water Treatment Process	Added Chemicals
125 – 255 L/sec	Coagulation, flocculation Dissolved air flotation (normal operating conditions) Filtration (granular media) Disinfection Fluoridation NOTE: 2 Cells = 2 filters (monitored individually)	Caustic soda Poly aluminium chlorohydrate (PAC 23) Chlorine gas Fluoride (FSA)

2.2 The Approach

This trial has been attempted on 3 separate occasions all with slightly different approaches. A summary of each trial is found in Table 2; single day trial and the extended trials.

Table 2: ***Overview of the Multiple Trials Attempted by EGW***

Trial Number	Length of Trial (Days)	Operating Method
1	1	Turned off recycled water (DAF) flow to one of the 2 cells. This allowed visibility of how DAFF and DF work under the same raw water conditions. This was completed during one work day to see how the filter responded.
2	3	Same process as Trial number 1 but given the extended time it also allowed the ability to shut down the DF if it failed overnight but still produce water at half capacity.
3	7	Complete isolation of recycled flow from plant.

2.3 The Analysis

To determine the effectiveness of the trial there were several key items that required analysis. The summary of the four main areas and brief outline of what was to be analysed as part of each is shown below.

- *Power Usage:* The main driving force behind this project was the potential to run

without areas of the plant that were responsible for a significant portion of the plants power usage. This was measured initially by a local power analysis display that allowed basic results such as amps and power factor to be recorded. For the latest trial some more advanced power monitoring equipment (contractor supplied) was used to get a better picture over time.

- *Filter Performance:* By operating in DF mode, the clarification barrier of treatment has been removed. This results in a much larger reliance on the media filtration as the major solids removal process. There was initial concerns about how the filter would manage and how this would affect other areas of the plant such as the washwater system. One of the keys to determining the filter performance was the flow rate or solids loading.
- *Washwater Sustainability:* Woodglen WTP has its own limitations with the washwater system that relies heavily on good raw water quality and good plant performance to maintain minimal levels of washwater. During this trial it was expected that there would be a significant reduction in filter run times and therefore more backwash water to deal with. There was some uncertainty about how the system would handle this change.
- *Operator Involvement:* As with all trials and proposed plant changes, the key factor is that this does not make the operator's job harder. As well as this, we did not want to generate unnecessary out of hours callouts or issues, as ultimately this is an extra cost and a health and safety concern.

2.4 The Results

The nature of this trial resulted in most of the results requiring assumptions to be made. Over time and with future extended periods of DF, these figures will be clearer and a greater understanding of the impacts will be documented. Thea summary of the results from the most recent trial (longest duration) is shown below.

Filter Performance:

As mentioned in the analysis section, filter performance was key factor in determining the effectiveness of this trial. The measurement used to measure the performance was both the run time and the filtered water turbidity compared to that in DAFF mode. Figure 1 below shows a trend from Trial 2 which allows a visible comparison of the headloss trends between DAFF (lighter) and DF (darker).

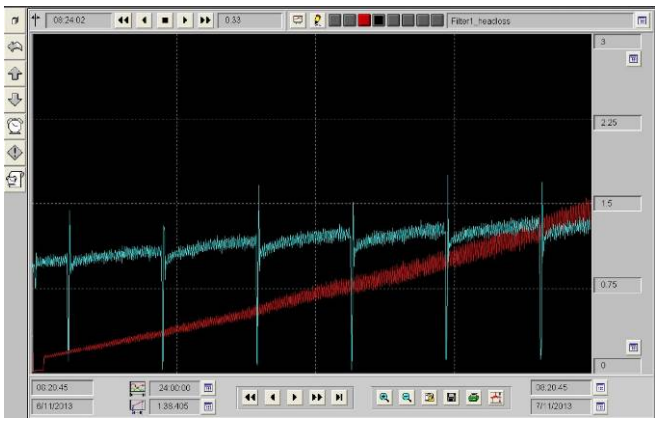

Figure 1: ***Comparison of Headloss Trends during Trial 2 showing DAFF (lighter) vs DF (darker)***

It is obvious that the DF headloss is increasing at a significantly quicker rate compared to

the DAFF, due to the increased solids load on the filter.

Filter run time varied depending on what flow was attempted during the trial. Table 3 below shows the difference between DAFF run times compared to DF run times and also the cause of the backwash. There was no doubt that the frequency of backwashes had increased in the DF mode. The impact of this changed is discussed in the "Washwater Sustainability" section below.

Table 3: ***Summary of Filter Performance Changes Under Different Modes and Flow Conditions***

Mode	Plant Flow (L/sec)	Filter Run Time (hours)	Reason For backwashing
Direct Filtration	200	12	Increase in Filtered Water turbidity
	160	30	Increased Headloss or Increase in Filtered Water turbidity
DAFF	200	130	Increased Headloss
	160	160	Timer Clock limited to 160 hours

Washwater Sustainability:
Overall the washwater system coped with the load under these conditions but it did take some optimisation to achieve this. It will be noted that in future, if DF mode is chosen, there will be roughly a week of increased work to ensure the plant can operate effectively in all areas.

The main optimisation is related to the change in washwater composition in the washwater storage tank. The change in plant operation means the washwater is now solely backwash water and no float off, the solid composition of the washwater was more consistent but different. This resulted in some changes to the lamella clarifier operation during this time but in the future this may be a set and forget change during the DF periods.

The flow to the washwater system was similar for both modes because the increased backwash frequency associated with DF was balanced slightly by the removal of float offs (not required in DF mode due to no float). Once again this change will be investigated further during even more extended periods of DF operations.

Power Usage:
As expected the level of power savings is significantly influenced by the flow rate of the plant. As the plant flow increases, the speed and number of recycled water pumps must increase and therefore so does the power consumption. Figure 2 below shows the percentage of savings that were expected to see if this becomes a mode of operation. The top line shows the instantaneous power savings that were recorded at the time of the trial.

The bottom line shows the savings adjusted to account for the following assumptions:

- Plant flow rate not always able to meet required demand

- Potentially an increase in washwater pumping costs
- Compressor run hour reductions.

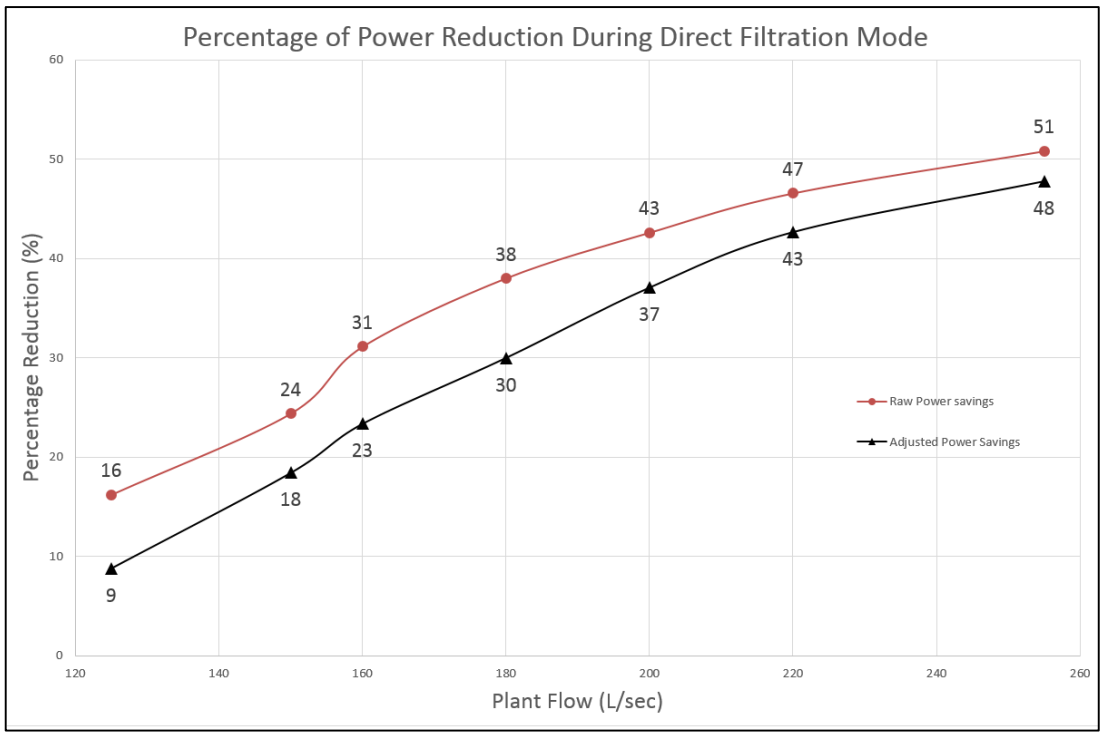

Figure 2: ***High Quality Clarified Water can Reduce the Risk of Poor Filter Performance***

Operator Involvement

The results from the operators involvement analysis is simply anecdotal evidence from the operators themselves and also an analysis on the number of alarms received over the period of the trial. From the operators there was little involvement other than the changeover from DAFF to DF and vice versa. The change in plant operation did not impact day to day tasks and only resulted in a slight increase in time spent optimising the washwater system. As for alarms there was only one alarm received over this week that was related to this change in modes. The alarm was caused due to increased pressure on the filters resulting in 2 backwashes occurring within a short period. This caused an increase in the filtered water.

General Comments

This trial is effective at Woodglen WTP but each site will have varying aspects that influence how effective it could be there. Some factors that may impact other plants ability to see the significant power reductions that were seen in this trial are:

- Raw Water Source – quality and delivery method (pumped or gravity)
- Makeup and design of filter bed
- Age of infrastructure

As an extra benefit to this trial, this gives us the confidence that if the DAF system were to fail for some reason, we have the ability to produce safe drinking water.

3.0 CONCLUSION

The initial concerns that were shown prior to this trial were soon overshadowed by the great potential witnessed during the trial. The results shown above suggest that there is potential for this to become a long term solution that will allow for a reduction in operational costs as well as a reduced environmental impact. This trial was simple and required little operator time.

There are several components of this DF that have not been investigated at this stage including the potential to reduce the coagulant dose or possible implement polymer dosing as a filter aid. Over the next 12 months there should be more in depth studies completed on this mode and more detail provided to the industry to assist other corporations who may want to attempt something similar. The next steps of this trial for EGW are to implement PLC coding changes that allow this as an operational mode and work towards longer periods of operation. These longer periods will allow us to further investigate and become more aware of the benefits or negative impacts of DF.

4.0 ACKNOWLEDGEMENTS

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