OPTIMISATION OF A WATER TREATMENT PLANT FOR FLOOD CONDITIONS

Paper Presented by:

John Granzien
Gene Heffernan

Authors:

John Granzien, *Team Leader,*
Gene Heffernan, *Operator*

Seqwater

38th Annual WIOA Qld Water Industry Operations Conference
Parklands, Gold Coast
4 June to 6 June, 2013

OPTIMISATION OF A WATER TREATMENT PLANT FOR FLOOD CONDITIONS

John Granzien, *Team Leader,* Seqwater
Gene Heffernan, *Operator,* Seqwater

ABSTRACT

The January 2011 Flood event devastated the Local Somerset Regional Council area. This led to a lot of rectification works that had to be done and along with these works, some flood resilience projects to be undertaken. The flood resilience work program was instigated by State Government to ensure that future events like 2011 have a reduced impact on drinking water production operations. Although Seqwater Water Treatment Operations as a whole performed reasonably well under such trying conditions, there was a need for improvement across the board.

The purpose of this paper is to create within the readers mind an insight into what we had as far as appropriate process technology available to us before and during 2011, and what was achieved with a lot work, time and money to prepare us for the subsequent 2013 flood event. Upgrades to the Lowood Water Treatment Plant after the 2011 floods resulted in the plant managing raw water turbidity levels in excess of 9,000 ntu. This contributed to Seqwater's overall operational resilience in its ability to effectively manage extreme weather events

1.0 INTRODUCTION

During the droughts of the late 1970's and early 1980's, thought was given to how and if the Shires of Esk, Gatton and Laidley would be able to cater for a reliable potable water supply for the future growth of the region. With Lowood just having a new plant built in the early 80's to supply water for the area at that time, Gatton and Laidley Shires were suffering hardship with trying to obtain adequate supply for their growing areas. So a body was formed called The Esk, Gatton, and Laidley Water Board. Thus planning and construction was underway to create a Treatment Facility that would serve the 3 Shires water supply and put in place the needs of the ever growing communities.

The Treatment Facility was commissioned in 1989 and now supplies water from Fernvale through to the southern parts of the Somerset Regional Council area (Lowood, Tarampa Minden etc.) through to Laidley, Gatton, Forest Hill, and Helidon and up to Withcott at the foot of the Toowoomba Range. Along with this, the new correctional centre near Gatton also relies on the water supply to cater for their needs.

The Plant was originally designed to produce up to 16 ML/day with a raw water turbidity range from 5-300 ntu, and produce water within ADWG of 0.5-1 ntu. Now with changes ushered in by State Governments Water Supply Safety Reliability Legislation on Drinking Water supplies the bar has been lifted high and requires much greater levels of operator diligence to meet those standards. In particular the filtered water turbidity target has been tightened to 0.1 ntu, with a HACCP action trigger limit set at 0.2 ntu. This is to combat against the potential risk of Giardia and Cryptosporidium impacting the drinking water supply.

Hence after 2011, the treatment plant needed some minor and major overhauls and upgrades to ensure the continuity of a safe and reliable drinking water supply for the communities to which it serves.

Some of the topics in this paper were originally flagged for future Fiscal Year replacements and refurbishments, however they were fast tracked as the need became greater.

Keeping in mind that during the 2011 flood event, raw water turbidity levels reached in excess of 4000 ntu and during January 2013, it peaked in excess of 9000 ntu.

Upgrades completed and underway at present.

- Access road into the treatment plant, as this was significantly damaged during January 2011 by the heavy vehicles that were used to carry in water to supplement supply.
- Replacement of existing Potassium Permanganate dosing unit to better control manganese.
- Installation of a permanent polymer dosing unit
- Replacement of Lime dosing pumps and upgrades to the Lime Silo and batching unit
- Installation of a static mixer for coagulation, along with a new dosing pit
- Filter Media replacement
- Rectification of the clarifier flocculator and reactivator
- Replacement of filter inlet and washout valves
- Installation of a new raw water pump for the dry well
- Installation of new water quality instruments along with improved alarming and interlocks
- Upgrades to solids handling, with installation of geotubes to assist with increased Alum sludge production.

2.0 DISCUSSION

With predictions of higher than average rainfall forecast again for the coming wet season, it was decided by Management, Maintenance and Process Teams to look at addressing outstanding infrastructure improvements to deal with issues at Lowood WTP.

Planning commenced in May 2012, with subsequent approval in June 2012. August 2012 saw the commencement of projects which were then completed by early December 2012.

With a combined effort by Projects, Operations, Process Engineers and Maintenance team members, the project went through without any major problems or incidents. Of course there is always a curve ball in any project, but overall our expectations were met.

Consultation was ongoing with Queensland Urban Utilities during all of these projects and a strong relationship was again paramount to achieve and meet water quality and demand for the extensive reticulation network to which it supplies.

2.1 Access Roads

The road into the plant grounds was severely ripped up during the 2011 flood by the water trucks carting to site to try and supplement water supply. The bitumen road was replaced with a heavy duty concrete access road and will no doubt survive the ages. The access road to the raw water pump station was also destroyed in some parts due to the flood waters, but also by the cranes and excavators that were used to manoeuvre the temporary diesel pump to maintain water production.

2.2 Polymer and Potassium dosing units upgraded

During the flood of 2011 a quick temporary set-up of polymer coagulation and flocculation aids were introduced to help treat the muddy waters that came with this wild event. I might add that we thought these setups were looking like they were going to be ‘temporary permanent’ solutions which can often be the case. Not on this occasion however, as we were able to deliver these works as part of the flood resilience project. We now have a more up to date and aesthetically pleasing looking dosing unit for both chemicals.

2.3 Filter Media Replacement

The filter media had served the treatment plant for over 20 years but was starting to fail. With longer ripening times, the effective size of the sand particles were growing bigger and putting the plant at risk of not being able to meet the new (tighter) required WQ objectives.
The existing media consisted of mono-media type with 3 support layers of gravel.

Media	Depth (mm)	Effective Size (ES) (mm)	Uniformity Coefficient (UC)
Filter Sand	850	0.60 ± 0.05	≤ 1.35
Coarse Sand	100	1.5 – 3.0	
Fine Gravel	75	3 - 6	
Medium Gravel	75	6 – 12	
Coarse Gravel	75	12 - 25	

This job was a fairly extensive one as access to change out the media was limited due to no roof access to remove or replace the media. Vacuum trucks were used to remove the media through doors on the northern and southern sides of the building, and disposed of in one of the drying beds for storage and then removed to a local landfill for final disposal.

Each filter was cleaned out and the internal structure was inspected along with the filter nozzles which were damaged. The new media was then loaded to the filter via the roof, through a specially made chute which was attached to the 1 tonne media bag. One filter was completed at a time with the plant producing water through 2 filters at a reduced raw water flow rate to meet demand.

Each filter took 4 days to bring back online, and with using the weekends to prove its performance all went well. For each filter to be worked on, the need for double isolation from incoming water and any valve power source had to be done. The filter backwash panel and actuating valves were locked and tagged out and the filter inlet valve closed and locked, and a specially made weir plate was fitted to the filter inlet weir to stop ingress of water.

The current plant flow rate through the 3 filters is 180 L/sec and a backwash flow rate of 400 L/sec. At the time when the new media was in place, each filter was washed and then the fines were scraped off the top of the media and then washed and soaked with a high chlorine solution for a period of 24 hrs to ensure a solid bacteria kill. With limited storage in the backwash recovery tank, care was taken not to overflow this tank to the environment.

See the table below to show performance of new media against the old.

Elapsed time (min)	Filter 1 turbidity (NTU)	Filter 2 turbidity (NTU)
0	0.031	0.036
15	0.044	0.078
25	0.049	0.195
30	0.044	0.364

Results to prove the new media against old media with Filter 1 having the new media.

2.4 Static Mixer, Dose Pit installation and Direct Filtration Trials

There was no real mixing device in place when the plant was commissioned, and was solely relying on the flocculator reactivator to produce desired flocculation. The reactivator failed twice from 1993 and 1996 and was not in use until these upgrades. The refurbishment of the clarifier required it to be isolated and offline for up to a week and the plant would need to maintain production during this time. This would occur by using an existing bypass around the clarifier to the settled water channel. Therefore it was decided to install a static mixing device and relocate the dosing points of alum, lime and polymer to a new position further upstream from the clarifier, before the bypass.

The direct filtration process was trialled before the scheduled works using alum (coagulant) and polyDADMAC (coag aid), and alternatively, a Nalco blended product (ACH + polyDADMAC). The trials were carried out during good raw water quality conditions, that is turbidity < 10NTU and true colour < 10PCU. It was quickly realised that alum was not effective. The amount of sludge onto the filters quickly (within 30mins) caused turbidity breakthrough. The ACH/polyDADMAC blend however worked well. Dose rate was approximately 15mg/L as product. A fine floc was formed and filtered well.

Direct Filtration was in place for approximately 5 days while the clarifier drives and shafts were refurbished. The filters were required to be backwashed approximately every 12 hours. After 12 hours the filters were close to terminal head loss at approximately 1.8m.

It is important to note that the DF operation is only effective under favourable raw water quality conditions. Our assessment at the time of trialling was raw water turbidity above 10-11NTU would result in early breakthrough of the filters.

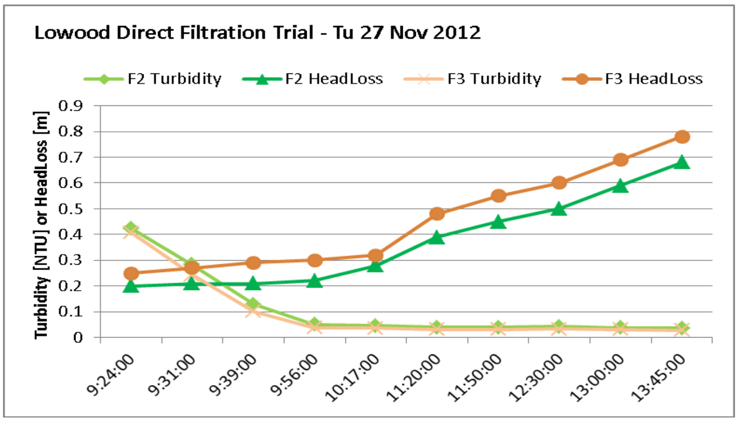

Figure 1: ***Graph showing filtered turbidity and head loss during DF trial***

2.5 Filter Inlet and Washout Valve Replacement

These valves were really at their use-by-date, and with spare parts hard to get, they were replaced. The issue with them was they were very slow to open and close and they did not seal properly which in turn placed an unwanted burden on the sludge dewatering process due to extra water involved. Once again all care was taken to perform the valve replacement in regards to safe work practice and also bearing water quality in mind, extreme hygiene commitments were paramount.

2.6 Refurbishment of Flocculator and reactivator

The flocculator and scraper vertical shafts are powered by a combined drive unit. Each shaft has its own gearbox and motor. The bridge drive shaft rotates within the flocculator shaft. The flocculator drive had been removed from the drive unit, due to failure of the drive gears. This was thought to be caused by an imbalanced flocculator shaft, probably as a result of the in-flow to the flocculator drum being directed onto the vertical shafts, causing the shaft(s) to bend over time.

The project included the provision of clarifier replacement drive assembly including gearbox, motors, flocculator mixer shaft and scraper top shaft and flange. Additionally, modifications to the clarifier bridge and walkway to suit the new drive assembly and provision of flow deflector baffle for inlet pipe to central flocculation chamber.

2.7 Projects underway or near completion

Sludge handling has been a bottle neck at this plant for the last few years and with the introduction of geo tubes for a quick temporary solution in late 2011 we survived problems with sludge handling. But now there is further need to come up with another way of handling waste until a further study which is being projected for the future and beyond. The next interim phase will be to install 3 x larger geo tubes in a specifically designed bunded area that will handle flood situations in the future. All of the leachate from the tubes will be captured and returned to the head of the plant for re-processing.

The installation of a fourth raw water pump is currently in the design stages and should be introduced this year. This hopefully will alleviate the stress placed on the three older pumps that have had their life time reduced due to the aggressive muddy water that they have had to deal with and transport over the years.

The installation of more water quality analysers on the raw, dosed, settled and pre-reservoir water will give a better understanding of how and when water quality barriers are pushed, and the operators will be able to further quantify the need for them to meet HACCP requirements.

3.0 CONCLUSION

Upgrades to the Lowood Water Treatment Plant after the 2011 floods resulted in the plant managing raw water turbidity levels in excess of 9,000 ntu. This contributed to Seqwater's overall operational resilience in its ability to effectively manage extreme weather events

Water Treatment Plant Operators in conjunction with support personnel can provide valuable input into organisational decision making.
We function at the pointy end where the rubber meets the road and often have to live with decisions made by other teams within an organisation.

In this particular example operational employees were able to assist and influence changes required at the coalface to help ensure the potable water provision to this local community was more resilient and capable of meeting the tighter standards of service associated with new legislation.

Everyone has a role to play - Operators, Process Engineers and Management at various levels and if we work together we can influence decisions and achieve necessary improvements.

4.0 ACKNOWLEDGEMENTS

Mike Burns - Senior Process Engineer, WTP Operations North, Seqwater
John Granzien - Acting Coordinator, WTP Operations Somerset Region, Seqwater
Gene Heffernan – WTP Operator, WTP Operations Somerset Region, Seqwater
Stan Stevenson – Manager, WTP Operations North, Seqwater