UPGRADE AND COMMISSIONING OF JOHN GILBERT WATER TREATMENT PLANT - DUBBO

Paper Presented by:

Peter Catelotti

Authors:

Peter Catelotti, *Water Treatment Plant Supervisor,*
Dinesh Manivannan, *Treatment Technician,*

Dubbo City Council

2nd Annual WIOA NSW Water Industry Engineers & Operators Conference
Jockey Club - Newcastle
8 to 10 April, 2008

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Peter Catelotti, *Water Treatment Plant Supervisor,* Dubbo City Council
Dinesh Manivannan, *Treatment Technician,* Dubbo City Council

ABSTRACT

Dubbo is a city in the Central West Region of New South Wales, Australia. It is known as a defacto regional/country capital city for NSW. It is the largest population centre in the Central West/Orana Region and serves a catchment of 130,000. It is located at the intersection of the Mitchell, Newell and Golden Highways. Dubbo serves as a major road and rail freight link to other parts of New South Wales. To meet the population growth and the standards for drinking water supply, Dubbo City Council decided that a major upgrade of the existing water softening plant was necessary. The John Gilbert Water Plant is now the largest water softening plant in NSW.

KEY WORDS
Statistical local area (SLA), Megalitres (ML), Microsiemens, Powdered Activated Carbon, Salinity, Hardness in terms of $CaCO_3$, Water Treatment Plant (WTP).

1.0 INTRODUCTION

1.1 History of Water Supply to Dubbo:

The water supply in 1938 was sourced from a well in the Macquarie River and a number of wells in a gravel drift about half a kilometer back from the river. The water was filtered from the drift, but was hard water; the two supplies were mixed to yield good water. In 1940 a water treatment plant was commissioned and treated water was supplied to consumers for the first time. In 1981 Council replaced the existing treatment plant with the John Gilbert Water Treatment Plant of 30 ML/day capacity. The plant was named in honour of the City Engineer of the day, Mr John B Gilbert. In 1999 Dubbo City Council planned for a major upgrade of the plant for the following reasons.

1.2 Reasons for the Upgrade of John Gilbert Water Treatment Plant

To cope with the continuing growth of the city, as the increasing importance of Dubbo is reflected in its population growth. In 1971 the population was 20,629; at June 1999 the Statistical Local Area (SLA) of Dubbo had an estimated resident population of 37,500 and was predicted to reach 40,000 by 2007.

Council commissioned a study into its water treatment capacity in 1994 by the NSW Department of Commerce. Their “Report on Long Term Augmentation Options for Dubbo Water Treatment Plant”, November 1994, outlined a proposal for the augmentation of the plant. The authors were “surprised” at the hardness of the Macquarie River water and attributed this to hard water from the Bell River entering the system.

The source of water supply to the water treatment plant depends on the Mid Macquarie catchment region. The Mid Macquarie region is in the central west of New South Wales between Burrendong Dam and Dubbo. It comprises the Talbragar, Bell and Little River catchment between Wellington and Dubbo.

A 1994 rapid stream survey also showed that streams in parts of the catchment were highly saline, with some sites exceeding 10,000 MicroSiemens/cm, (about one fifth of sea water salinity). The old filters were not capable of handling the increased turbidity in river water after high rainfall. After high rainfall, the storm runoff into the river results in high turbidity and colour in the raw water to the plant. This is illustrated by the turbidity figures before the upgrade and after the upgrade as shown in Figure 1. The peaks in the graph occur during and after rainfall.

In addition to increasing the production rate we were also looking to produce water of total hardness 60-80mg/L, improve the taste of the water and algae toxin removal, and to reduce odour.

Previously the bore water was not treated and had been mixed with the treated river water in the chlorine detention tank. This resulted in increased hardness of the water supplied to town. So the upgrade was focussed to combine river water and bore water prior to softening. The report also recommended a second raw water pump station and a bank of up to six (6) new filters to replace the existing bank of four (4) filters.

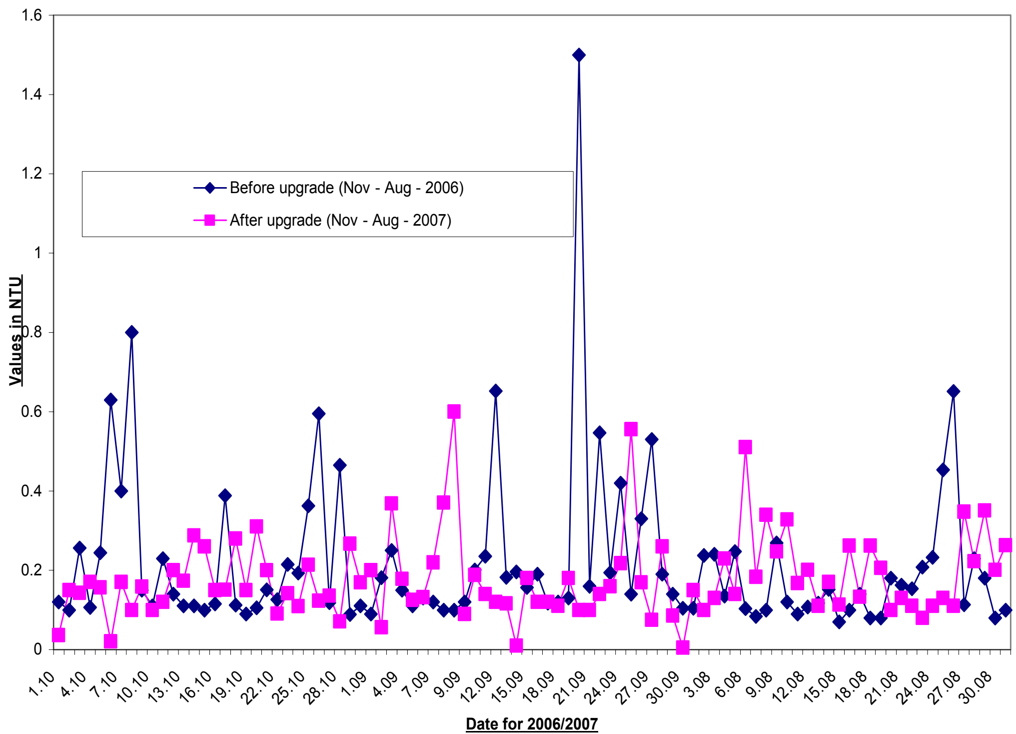

Figure 1: ***Comparison of turbidity of water in same months of 2006 and 2007***

2.0 DISCUSSION

2.1 Options

Options for the upgrade included four source water and treatment options and three different service level options:

- ***Option A*** – River water would be used for the bulk supply and bore water would be used for recarbonation and to supply peak demands. The river water would be softened. The portion of bore water not used for recarbonation would be aerated to remove carbon dioxide only. The water hardness would remain about the same.

- ***Option B*** – River water would be used to supply all the raw water, Carbon Dioxide (CO_2) would be required for recarbonation. The hardness of water produced would be lower than that of Option A
- ***Option C*** – This option is essentially the same as Option A although the bore water would be softened along with the river water, except for that used for recarbonation.

The hardness of water produced would be lower than that of Option A.

- ***Option D*** – River water would be used for the raw water supply, bore water would be used solely for recarbonation. The hardness of water produced would be lower than that of Option A. This option was discarded because it would not be possible to meet the current licence limit for maximum river water extraction of 8,300 ML per year. It would also reduce the security of supply by limiting the water source to the Macquarie River water only.

2.2 The Water Service Level Options Identified

Following consideration of the preliminary Options Report and community consultation, Dubbo City Council resolved to proceed with the following:

Water Source – Water Source Option C was adopted. In this option all bore water was to be aerated to remove Carbon Dioxide and then softened along with the river water. Carbon Dioxide gas was to be used for recarbonation.

Service Level - A dedicated PAC contact tank would be provided to give improved removal of algal toxins and improved taste and odour reduction. Council would retain the option of a future addition of ozone/BAC, to achieve lower usage of chlorine in the water.

2.3 The Major Elements of the Upgrade

a) since the 1980's. The works included the construction of a new river water intake structure with Johnston Screens that can be periodically cleaned with compressed air backflow.

b) Construction of a powdered activated carbon (PAC) contact tank of effective capacity of 39 megalitres. The tank receives water from all sources,being two river pump stations and two different borefields. The tank is fitted with two floor mounted mixers that ensure thorough mixing of the waters with each other and with the PAC.

Figure 2: ***New filters***

Figure 3: ***New clarifier***

c) Construction of a new clarifier of diameter 33 metres and a depth of 6.4 metres. The clarifier has a flow capacity of 55 megalitres per day and is designed to operate in parallel with the existing 32 megalitre per day capacity clarifier. The existing clarifier has a diameter of 26.5 metres and a depth of 5.9 metres.

d) Construction of six (6) new filters to filter the water from both clarifiers. Each filter is a rectangular box, 12.6 metres long, and 4.8 metres wide with a water depth of 3.9 metres. Each filter has an effective volume of 235 cubic metres, or 0.24 megalitres. On the bottom of each filter are 2016 nozzles used to collect the filtered water. On top of this is a depth of 300mm gravel, then 300mm of sand, and finally 1000mm of crushed coal.

e) Construction of a new tank that combines both a chlorine detention function and a clear water storage tank. Clear water pumps mounted on top of the new tank pump water into the distribution network.

f) Construction of two new water treatment solids drying beds. Water treatment solids is the name given to matter suspended in the untreated water, which is removed by the treatment process as concentrated slurry. The slurry is pumped into the drying beds for natural processing to dry the nutrient further, to the point where it can be collected by earth moving machinery. The material has a high concentration of lime, typically more than 70%, and is applied to nearby agricultural soils to improve their quality after analysing for the heavy metals by registered EPA testing labs.

Figure 4: ***New Ferric Chloride, carbon dioxide and fluoride dosing system***

Figure 5: ***Old and New clearwater holding tanks***

2.4 Difficulties in the Project Implementation Stage

The major challenge in implementation of the new project was to continue water supply to the city during construction, demonstration and commissioning. All the upgrades included in the project were constructed to the final stage and then connected to the existing system in a 24 hours shut down period of the existing system so as to provide as little disruption to the water supply as possible. We had to overcome these Critical changeovers where there was no turning back once the implementation had commenced. Maximum offline time available was 24 hours.

Tasks performed in different 24 hour shut down periods of the existing system were:

- Raw water cut-in involved removing part of the rising main to connect the existing Raw water pump station (RWPS 1), the refurbished pump station (RWPS 2) and the bores to the new PAC contact tank.
- Disconnecting the old filters from the existing system and connecting the new filters to the new system. Converting the old filters to a filters-to-waste tank for the new filters. Consequently, the new filters-to-waste tank pumps could not be tested prior to demonstration due to the need to decommission the existing filters. However, decommissioning of the existing filters could not occur until after the new filters had been completely tested.

- Converting the old recarbonation tank to a service water tank, as carbon dioxide dosing could not be stopped to maintain the pH of the water to town, so the new carbon dioxide system was built and connected during the decommissioning of the old recarbonation tank.

Partly because of the challenges listed above, the project timeframe was extended so as to undertake critical works during the winter period.

Figure 6: ***Aerial view of WTP before upgrade***

Figure 7: ***Aerial view of upgraded Dubbo WTP during construction.***

2.5 Technical challenges

Technical challenges were faced in order to maintain the standards of drinking water required by ADWG during the implementation stage:

- The quick lime dosing system initially gave some unforeseen difficulties, such as unreliable feed rates, flooding and hang-ups. This required all staff and operators involved during the operation of the plant to utilize their skills and knowledge in solving the issues. The operators had to keep track of the lime dosing system every day, particularly in the early implementation stage. After a number of modifications it worked well.

- When the new clarifier was brought online we experienced a critical challenge of high pH. After the initial dosing, the pH was very high. To overcome the pH, the water from the new clarifier was mixed with the water from the old clarifier and aerated using bore water until we were able to get the pH balanced.

2.6 Training and Up-skilling Operators

As the old system was also a water softening plant, staff were experienced in tackling the sort of problems expected in running the new plant. They were actively involved in the pre-commissioning testing to gain experience with the new system.

Operational staff input at the planning stage alleviated a number of problems at commissioning time, as they were able to forecast a number of process problems at that time. This resulted in significantly less "hair pulling" later on.

3.0 CONCLUSIONS

There were some foreseen and unforeseen challenges during the upgrade of the John Gilbert Water Plant from 30 ML/d to 80 Ml/d. However, by planning it well the implementation of the new system in parallel with the existing system had only minimal impact on the town water supply. The Whole process was checked by operators in person to rule out errors, even though some of the dosing systems are automated.

Currently the John Gilbert Water Treatment Plant is the largest lime/soda ash softening plant in Australia and will be capable of meeting the water quality standards and meet the demands of the town water supply for next 30 yrs. Since the implementation of the project we have experienced problems with the mechanical & electrical systems which have given the operators a chance to display their operational skills. We have all added new tricks to our basket.

4.0 ACKNOWLEDGEMENTS

Thanks to Council for allowing me the opportunity to present this paper and the team from the Dept of Commerce who worked closely with us during the commissioning stage. Thanks to Geoff Bellingham Manager, Mike Wilson the Operations Engineer for providing some valuable information in preparing the paper. Thanks to the Treatment Technicians Glenn Clifford, Malcolm George, Patrick Geeves and councils Mech/Elec Team for discussing the problems they faced during the implementation of the upgrade.

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