Baralaba WTP

Planning Report

May 2010

Banana Shire Council
Baralaba WTP Planning Report
May 2010

CITY WATER TECHNOLOGY Pty Ltd
ABN 92 052 448 094
Email: contact@citywater.com.au
Web page: www.citywater.com.au
Suite 26, 924 Pacific Hwy,
GORDON, NSW 2072
Phone (02) 9498 1444
Fax (02) 9498 1666

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Overview

This report outlines the investigations undertaken by City Water Technology on the Baralaba WTP. Issues and outcomes from the study are summarised below.

Water Demands and Required WTP Production

Historical water demands and expected WTP production capacities are shown in the table below. It is understood that Council do not expect significant increases in demand in future.

WTP Demands and Flow Requirements Summary

Flow Parameter	Typical	Worst Case
Historical Demands kL/day	100 - 600	882
Estimated Plant Treated Water Production Capacity kL/day		
Water Losses Through Process:	5 - 10% Losses	20% Losses
Reduced flow rate - 13 L/s	840 - 890	750
Typical flow rate - 15 L/s	970 - 1025	860

Treated water production capacity calculated using 20 hours operation per day, as detailed in section 2.3.2

As all town demands are met under typical flow rates and operating conditions, augmentation of the WTP capacity is not considered a priority at this stage, although it is noted that there may be a production shortfall under worst case demand and production conditions.

Water Quality Issues

A review of the raw water and WTP treated water quality found that:

- Raw water issues include turbidity and colour from river flow events, moderate levels of manganese and the presence of herbicides;
- Turbidity in WTP treated water has been periodically elevated to levels > 1 NTU which may compromise disinfection;
- Chlorine residuals achieved in the treated water have been highly variable and there may have been periods of very low readings and/ or incorrect monitoring of this parameter;
- *Coliforms* and *E.Coli* have been present in a number of treated water samples. Significant levels in late 2009 led to a 'boil water' alert being issued by the Regulator;
- From modelling of corrosivity potentials, the water is likely to be mildly corrosive under typical conditions.

WTP Process, Chemical Systems and Operational Issues

A review of the WTP treatment processes and chemical dosing systems found that:

- Most of the plant components are matched well in terms of achieving a 15 L/s plant flow rate, with the most limiting plant components being the clear water tank detention time (with current arrangement), the sludge lagoons and the clear water pumps;
- Most components would not be suitable for flowrates higher than the design flow rate of 15 L/s. Higher flow rates would require duplication of the major plant components or provision of a new separate process;

- Chemical dosing systems are sized to easily meet expected duties at a plant flow rate of 15 L/s and most would be adequate for an increased plant flow rate up to 30 L/s;
- Plant control and automation, safety and maintenance issues were also reviewed, with recommendations developed as outlined below.
- Online monitoring of filtered water turbidity and chlorine residuals with operator callout and plant auto shutdown alarms are priority issues associated with improving treated water quality performance.

Recommended Actions

The recommended high priority actions are listed in the following table, with indicative budget costs given where appropriate. Refer to Section 7 of this report for further details.

High Priority Actions and Indicative Budget Costs

Action	Indicative Cost
Online filtered water turbidimeter	$8,000
Online chlorine residual meter	$10,000
Improved process operation and control to achieve stable removal of turbidity	Operational action
Improved control of post-chlorine dosing via manual control, operator training	Operational action
Automatic control of chlorine system	$10,000
Clear water tanks reconfiguration	Council works underway
Raw water weir water level sensor system	$10,000
Replace Raw Water Pump No.1	$15,000
Pesticide/herbicide incident management plan	$10,000
Mains cleaning	Council works underway
Optimal operation of the town reservoir to maintain chlorine residuals	Operational action

Further recommended medium and lower priority actions are outlined in Section 7 of this report. It is recommended that Council pursue at least the high priority, short timeframe actions immediately or as soon as possible.

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1. INTRODUCTION AND OBJECTIVES

Banana Shire Council engaged City Water Technology (CWT) to conduct a detailed review of the Shire's water treatment plants (WTPs), reviewing the treatment plant capacity and addressing planning issues for current and future upgrade requirements. Plant capacity was then compared to future demands and other requirements, determined with the assistance of Council.

It is noted that an Upgrade Audit Report on Baralaba WTP was prepared by Hunter Water Australia in May 2005. A further report on the Baralaba water supply system was prepared by CWT in March 2010 in response to a 'boil water' alert in Baralaba.

This planning report outlines the findings from the above investigations for the Baralaba WTP and sets out options for addressing the upgrade requirements.

The objectives of the review and planning report for each WTP are to:

- Review treatment requirements based on raw water quality and treated water requirements;
- Review the capacity of each plant and each unit process, identifying capacity restraints or any available excess capacity;
- Identify issues and process upgrade requirements for current and future demand scenarios;
- Identify options to achieve the required upgrades and improvements.

2. PLANT FLOW RATE AND WATER DEMAND ISSUES

2.1 Annual Water Allocations

Baralaba's water supply is drawn from the impoundment of the Neville Hewitt Weir on the Dawson River. The water allocation is 182 ML/year.

The Neville Hewitt Weir was completed in 1976 and provides water storage of approx. 11300 ML. Banana Shire Council has no control of the town's water source as the Neville Hewitt Weir forms part of the regulated section of the Dawson River which is managed by Sunwater.

Water Source Allocation

Water Source	Allocation (ML/yr)
Dawson River	182

2.2 WTP Flow Rates

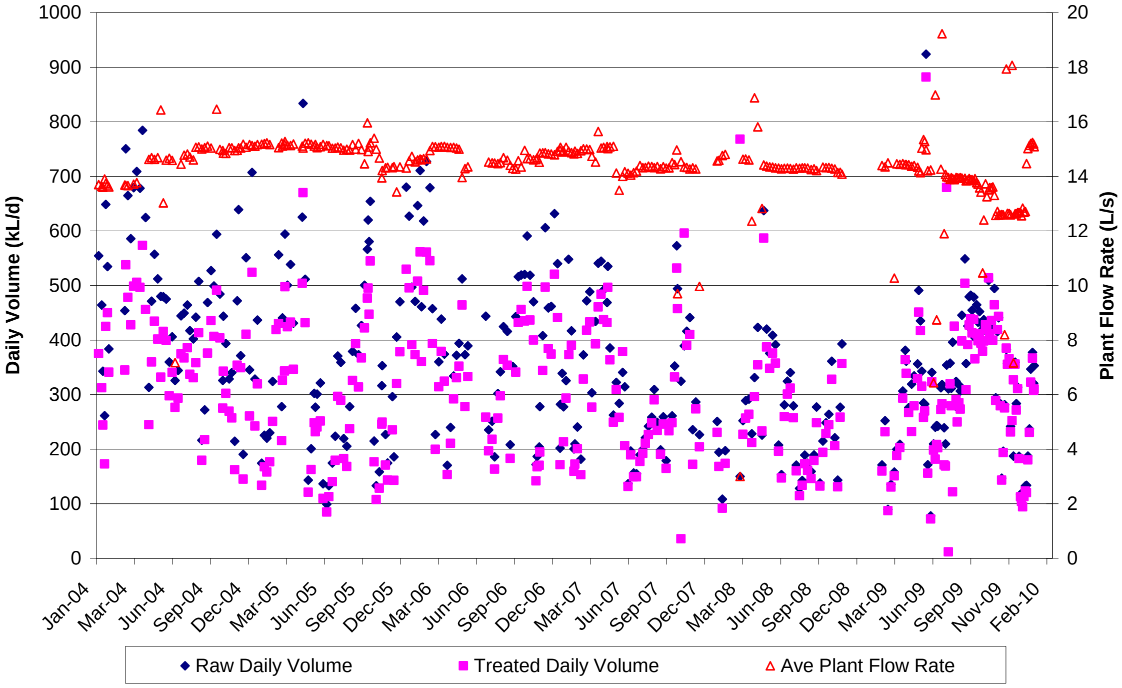
2.2.1 Plant Design Flow Rate

The Baralaba WTP is an Aquagenics package water treatment plant designed to treat 15 L/s. However the operators report that it initially took a few years of adjustments and improvements to allow the process to achieve this rate.

During episodes of particularly poor raw water quality, the operators sometimes down-rate the plant flow rate to 12-13L/s to achieve acceptable settling in the clarifier.

2.2.2 Plant Production and Flow Rate Data

Plant data from 2004 to 2009 was used to prepare the graph below, showing raw and treated flows in addition to backwash consumption. Daily volumes are calculated from water meter totaliser readings and as readings are only taken every few days, based on the average over periods between measurements. The average plant flow rate values are calculated based on the daily volume and the hours run. It is noted that the raw water flow meter totaliser head was replaced in February/ March 2005.



Graph of WTP Daily Volumes Treated and Flow Rates

The plant flow rate has generally been 14-15 L/s between April 2004 and September 2009. The lower flow rate previous to April 2004 was due to the use of raw water Pump No.1, which has a lower capacity. Raw Water Pump No.2 has predominantly been used since April 2004. The flow rate dropped to 12-13 L/s during late 2009 due to low river levels.

The highest calculated average daily water volume from totaliser records was 924 kL/day raw water, corresponding to 882 kL/day treated water, for a period in May 2009, associated with 17 hours per day pumping. Most data reflects daily raw water volumes in the range 100 – 800 kL/day and daily treated water volumes in the range 100 – 600 kL/day. No clear seasonal pattern in volumes treated was shown. Overall plant flow volumes appear to have fallen slightly between 2004 and 2008 and then increased again during 2009.

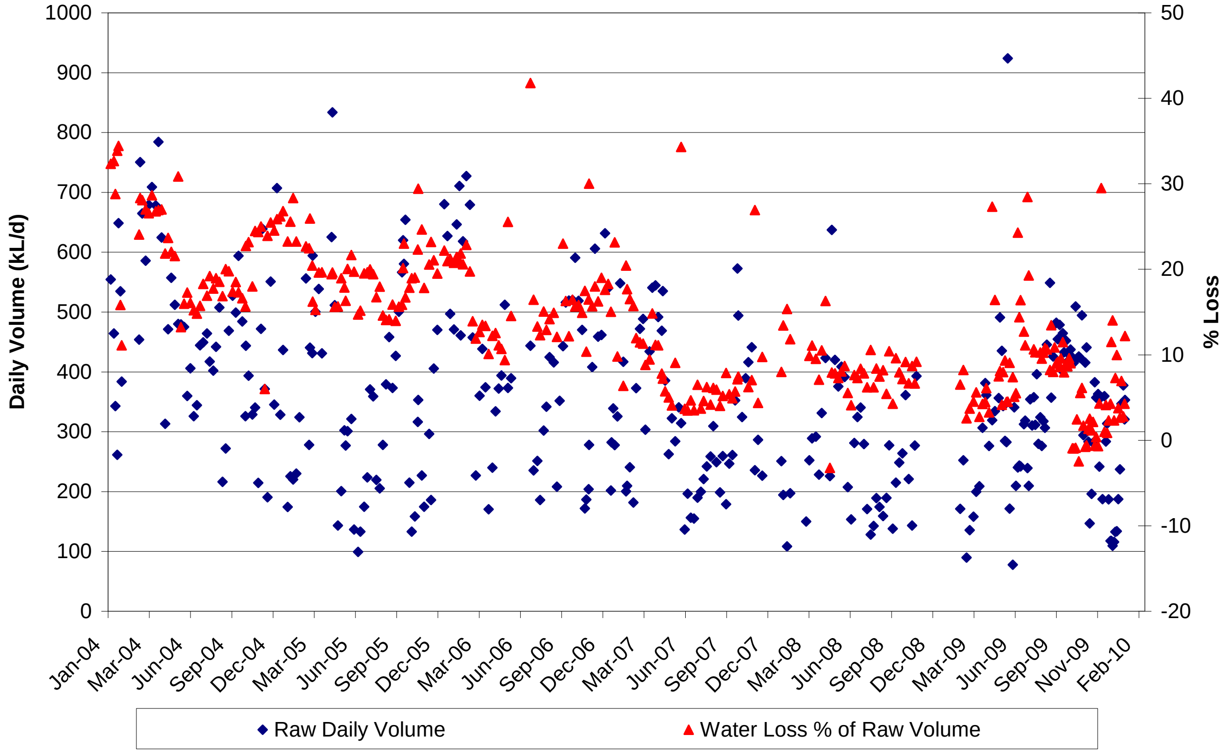
Plant run hours calculated from pump hour meter data showed that run hours varied between 1 and 17 hours per day, with the plant generally operating between 3 and 12 hours per day. The plant may have various starts and stops over the day based on tank levels and backwashing needs (because there is a single filter, the plant needs to be stopped to backwash the filter). It is expected that at maximum output the plant could be run for a maximum of 20 hours per day. Any improvement on this effective run time would depend significantly on filter run times and backwashing needs.

2.3 WTP Treated Water Production Capacity

2.3.1 Flow Rate Variation through WTP Process

Water is lost through the process via the clarifier desludges and filter backwashes. The wastewater volumes produced are discussed later in this report under the section on the Wastewater System.

The difference between the raw and treated daily volumes, in terms of the percentage or raw water 'lost' to the wastewater systems, is shown in the graph below. It is noted that the data below is based on the assumption that both the raw water and treated water flow meter totalisers are reading correctly.



Graph of Percentage Water Losses

As shown in the graph, the calculated losses were approximately 10 - 30% prior to 2007 and appear to have reduced to typically 2 - 15% since March 2007. The reason for the reduction in water losses since 2007 is not clear, but may be due to either operational changes or calibration of the flow totalisers.

Process losses of 5 – 10% are reasonable for a conventional treatment plant. Higher losses may be expected during period of dirty raw water due to increased desludge and backwashing.

If required, the percentage of water lost to waste could be reduced by further optimisation of sludge withdrawal and backwashing. Recycle of supernatant from the lagoons has been used in the past but was found to add extra flow rate into the process, causing process issues so has been discontinued.

2.3.2 Estimated Water Production Capacity

The table below summarises the estimated daily water output for the typical plant inlet flow rate of 15 L/s and a down-rated flow rate of 13 L/s. Figures are also included for a duplicated plant capacity of 30 L/s, as this is considered a feasible upgrade option if a higher water output was required to supply Baralaba and the surrounding facilities.

Calculations are based on up to 20 hours WTP operation per day and process water losses of 10% and 20%. Based on data reviewed above, losses of up to 10% may be expected under typical conditions, however higher losses of 20% or more may occur due to poor water quality or inefficient operation.

Estimated Water Production at Various WTP Flow Rates

WTP Inlet Flow Rate (L/s)	Estimated Treated Water Output (kL/d) with 20 h/day Operation	
	5 - 10% Water Loss	20% Water Loss
13	840 - 890	750
15	970 - 1025	860
30	1940 - 2050	1730

2.4 Current and Future Water Demand

Historically, as seen in data reviewed above, the WTP has typically produced 100 – 600kL/day to meet town demand. The highest recorded treated water demand period required a daily production of 882 kL/day.

Issues which impact on the future demand for treated water from the Baralaba WTP include the following:

- Council management have recently approved budget for an irrigation system for the Baralaba recreation ground, show grounds, hospital grounds and the school grounds which will use untreated water from the river. This separate water supply will reduce demand on the treated water system.
- Extension of the Baralaba water supply system to supply Woorabinda Aboriginal settlement has been considered in the past, however it is understood to be unlikely in the near future. Demands from the Woorabinda settlement have not been reviewed as part of this report.
- Further expansion of mining in the area is proposed, however it is understood that mine developments would not be serviced by Baralaba WTP as they would provide their own treated water source.
- No significant increases in the population of Baralaba are planned in the near future.

Based on the above points, significant increases in water demand from Baralaba WTP are not expected in the near future, in fact demand may be reduced by the introduction of the separate raw water supply for irrigation. Permanent water restrictions may also reduce WTP demands, although the effect of potential water restrictions has not yet been quantified.

3. WATER QUALITY ISSUES

3.1 River Source and Catchment Land Uses

Baralaba WTP draws water from the Dawson River, which also feeds the Moura and Theodore WTPs although Baralaba is many kilometres downstream of the Moura and Theodore draw-off points. The Baralaba WTP raw water draw-off is at the Neville Hewitt Weir a short distance from the WTP site.

The Dawson River catchment contains industries such as agriculture (cotton, sorghum, cattle) and mining. Irrigated crops are required to have catch ponds to take runoff from the irrigated area, i.e. to have zero runoff back to the river, however it is expected that this regulation may not always be adhered to and/ or catch dams may overflow in times of heavy rains. The water-borne protozoan parasites *Giardia* and *Cryptosporidium* may be present in the faeces of cattle and other livestock. Because of the surrounding agricultural areas, the raw water is likely to contain some of these protozoan parasites in addition to pesticides/ herbicides.

The river source is usually high in turbidity due to suspended sediment, especially in times of fast flow. During low rainfall conditions the river stops flowing and can become stagnant, reportedly associated with high levels of iron and manganese in the raw water which may be associated with stratification in the raw water body. During low river flow periods, blue green algae and taste and odour problems may also be problematic.

3.2 Raw Water Quality Monitoring Data

Water quality monitoring is currently performed around once per week at the WTP, when the operators visit the site. Operator readings of water quality parameters have not always been recorded regularly, however logging has been improved since late 2009 when there were ongoing issues with water quality in Baralaba. Results of operator testing are recorded on an electronic spreadsheet, similar to that used for the other plants.

Raw and treated water quality have been measured several times by external laboratories. The available external analysis results are tabulated in Appendix A.

It is noted that data logged on the Council database is sometimes incomplete, for example some samples are simply labelled “Baralaba WTP” with no indication whether they are raw or treated. **This data logging system would be more useful for managers and operators if data records were recorded more clearly.**

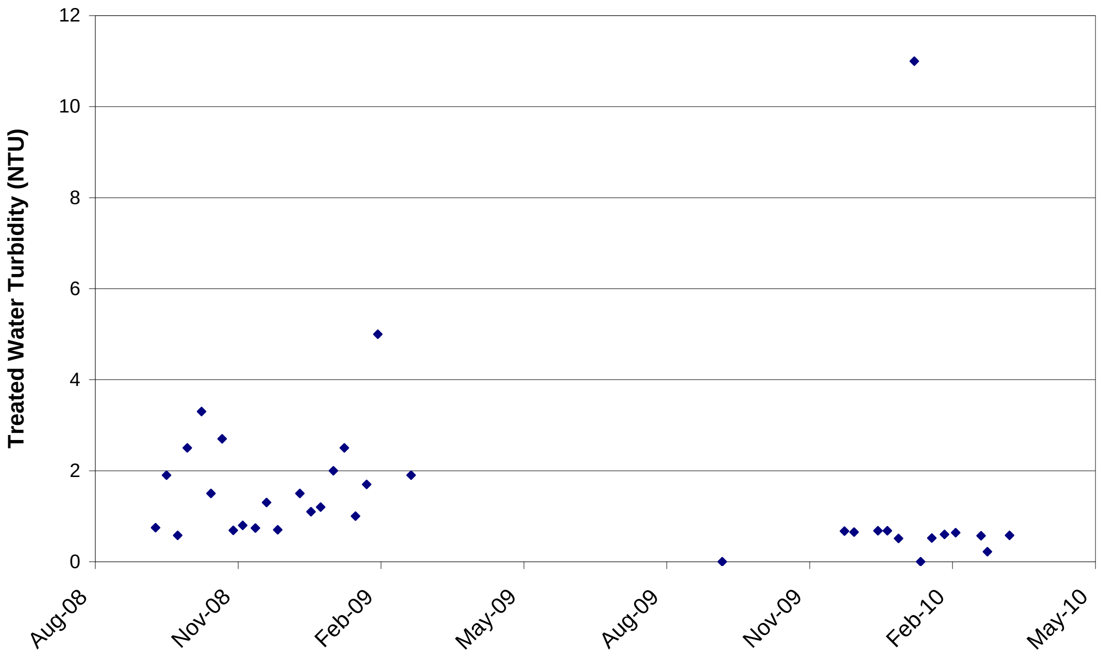
3.3 WTP Raw and Treated Water Quality

3.3.1 Turbidity

Although raw water turbidity is not monitored regularly at the WTP, data from Theodore and Moura (both of whom source their raw water from the Dawson River) indicate a seasonal variation, with turbidity tailing off towards the winter months. The turbidity peaks are reportedly associated with river flow conditions, with the main river flows occurring over the summer months.

It is noted that the significant and sometimes rapid changes in turbidity will sometimes require the re-optimisation of the coagulant dose, which is not easily achieved due to the lack of full time manning at the plant. Remotely viewable online indicators of process performance would assist in informing the operators when attendance at the plant is required to adjust process parameters. **An accurate level measuring system should be employed in the weir and transmitted to the WTP control system, raising an operator call out alarm if the weir level increases significantly** (say > 5%). In addition, a higher level change may be employed to shut down the WTP. The operator would then be alerted to attend site and optimise the treatment for that particular water.

The treated water turbidity data available from WTP monitoring during 2008-10 is shown in the graph below. It is understood that treated water turbidity was not regularly monitored between April and December 2009, possibly due to equipment failure.



Graph of Treated Water Turbidity

The treated water turbidity data shown above and other data available from external laboratory tests shows that turbidity levels have often been above the ADWG recommended level of 1 NTU. High treated water turbidities are generally associated with poor coagulation and/or poor filter performance. The turbidity of the water can be further increased after filtration by impurities in post-filtration lime dosing, however post-lime dosing is not normally used at the plant, therefore all turbidity measured is likely to be particles which have passed through the filter.

Disinfection is compromised at turbidities above 1 NTU. **Turbidities of at least < 1 NTU and preferably < 0.3 NTU should be targeted to minimise potential pathogen breakthrough.**

Raw and treated water turbidity should ideally continue to be measured at least once a week at the WTP.

3.3.2 Colour

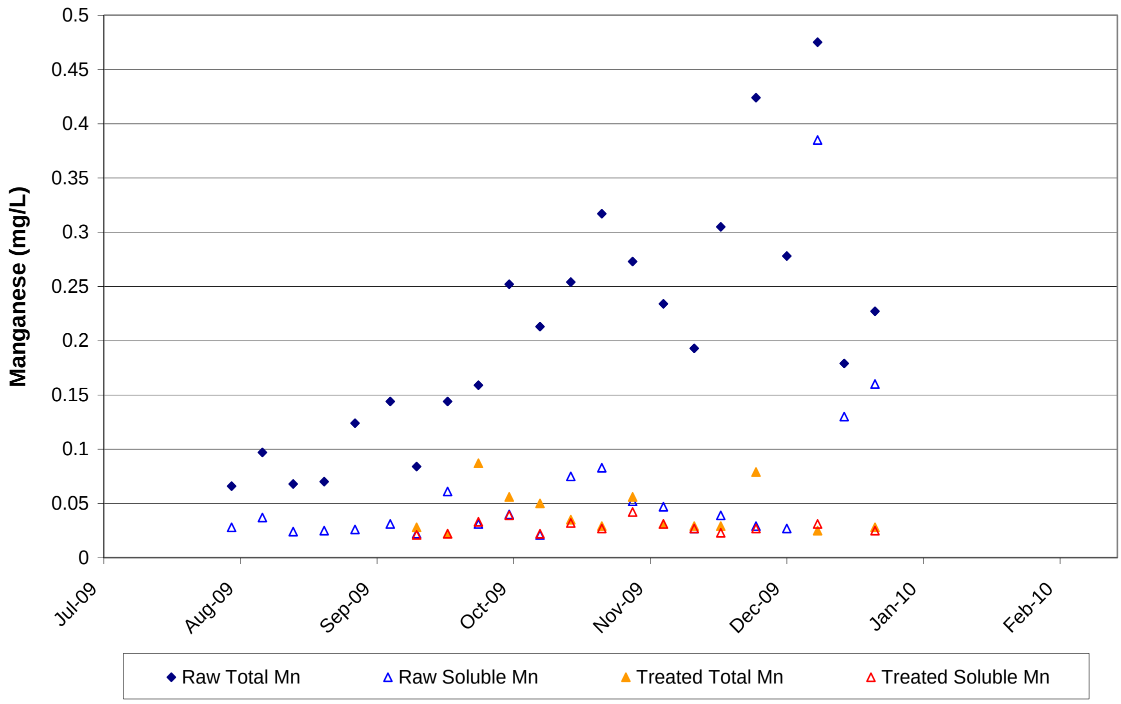
It is expected that raw water true colour fluctuates seasonally like turbidity, however more data is needed to confirm this. Raw water 'true colour' should ideally be measured at least once a week at the WTP.

Treated water true colour has been measured at up to 12 HU, which is just below the ADWG level of 15 HU, however the other values were lower. Higher colour levels usually indicate less than optimum coagulation.

3.3.3 Manganese

Manganese is an issue which affects many water treatment plants within Australia, including the Moura WTP. At Baralaba WTP, raw and treated water manganese was below detectable limits of 0.03 mg/L in the external laboratory results, however elevated levels have been reported on the plant log sheets in December 2004 and October 2009 – January 1020. The operators report that high raw water manganese levels are generally associated with stagnant conditions in the river.

Raw and treated water manganese results from available plant log sheet records for 2009 - 2010 are shown in the following graph.



As seen in the graph, raw water to manganese levels of up to 0.475 mg/L have been measured in recent plant testing. Soluble manganese levels are normally lower, up to 0.16 mg/L in the data shown above. Treated water total manganese levels for the period shown were typically 0.02 – 0.03 mg/L but there were two spikes in the range 0.075 – 0.10 mg/L which are in the range which may cause water quality complaints.

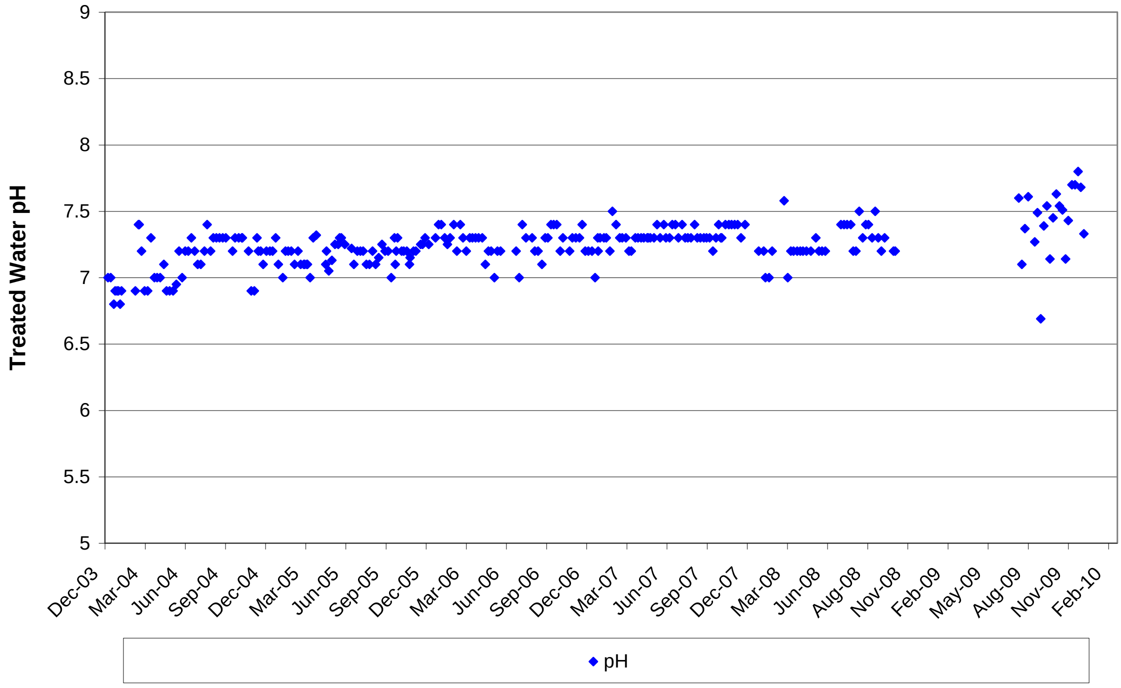
Raw water total and soluble manganese levels should continue to be measured at least once a week at the WTP.

3.3.4 Iron

Iron levels have occasionally been elevated in the raw water, with the maximum level of 3.96 mg/L recorded. Most of the iron is expected to be in particulate form or readily oxidisable to particulate form and easily removed by treatment. Iron levels in the treated water are typically around 0.02 mg/L and have measured up to 0.12 mg/L.

3.3.5 pH and Alkalinity

Raw water pH levels have ranged from 6.5 – 8.0. Treated water pH levels are shown in the trend below.



Graph of Treated Water pH

As shown in the graph above, the treated water pH has varied between 6.8 and 7.6 and is typically around 7.2. The operators report that a pH around 7.2 to 7.5 is generally targeted because at this level there is generally no requirement for post-filtration lime dosing (to minimise operational issues associated with lime dosing). This pH target is lower than the usual range adopted to minimise water corrosivity, as discussed under Water Corrosivity Issues below.

Reported raw and treated water alkalinity levels varied within the range 30 to 80 mg/L. Alkalinity levels below 40 mg/L can be associated with a tendency for the water to be corrosive, as discussed further below.

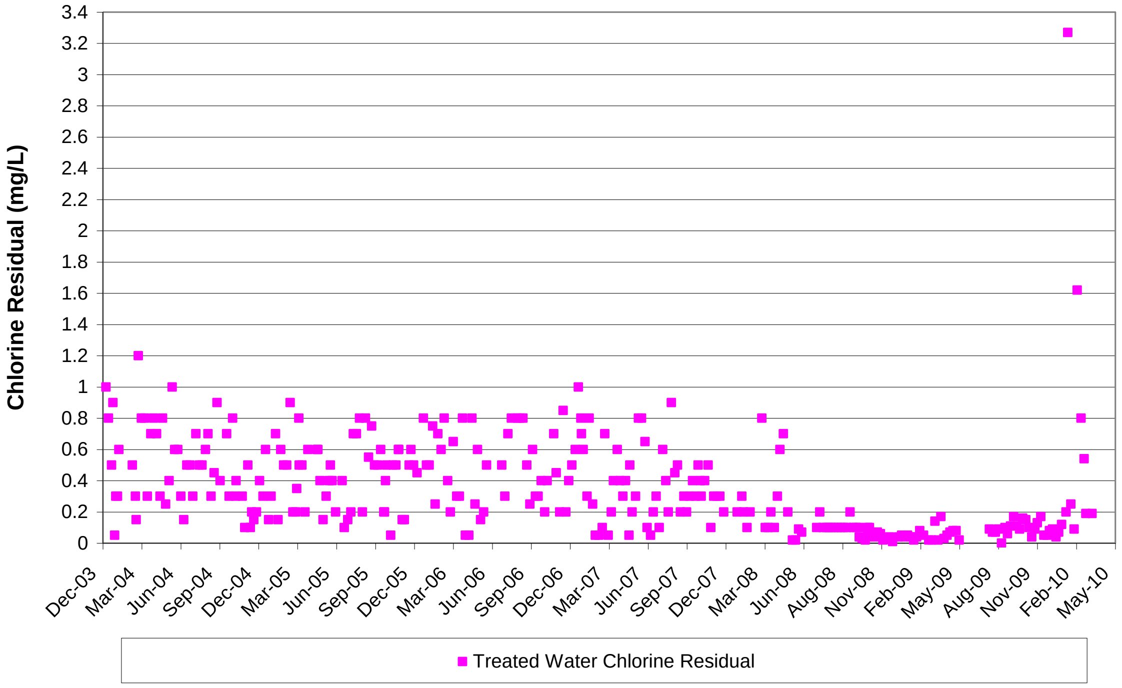
3.3.6 Fluoride

From the external laboratory results, it was noted that fluoride levels were measured at up to 0.22 mg/L occurring naturally in the raw water. These levels are well the ADWG guideline health concern level of 1.5 mg/L and below Queensland fluoridation targets of 0.6 – 0.8 mg/L.

Because of the low population of Baralaba, the state government does not require fluoridation dosing to this water supply. However if this were required and/or implemented in future, the background raw water fluoride levels would need to be taken into account in system design and operational monitoring.

3.3.7 Chlorine Residual

Operator reported data on chlorine residual was used to prepare the trend below.



Graph of Treated Water Chlorine Residual

As seen above, chlorine residuals between 0.02 and 3.27 mg/L have been recorded in weekly grab sample monitoring. Up to late 2008, the measured chlorine residual averaged around 0.4 mg/L but oscillated significantly. Between late 2008 and early 2010, the measured residual was significantly lower, and it is understood that during this period an incorrect sampling analysis procedure was followed with samples being transported offsite before analysis which would lead to readings much lower than the actual chlorine level. A different procedure appears to have been commenced in February-March 2010, with much higher readings reported.

Council should ensure that the correct chlorine residual sampling and analysis procedure is followed. It is understood that Council have a draft written procedure for this task. The procedure should be implemented as soon as possible.

Post-chlorine dosing control should be improved to meet the residual target more reliably. It is noted that online chlorine residual monitoring, potentially with automatic dose control, may assist in controlling the chlorine residual to meet target levels. Provision of this online monitoring is discussed later in this report.

3.3.8 Pesticides and Herbicides

The data available on raw water pesticide and herbicide analyses is shown in the table below.

Pesticide and Herbicide Analysis Results for Raw Water

Parameter	Units	2002		2004	2005	2006			2007		2009	
		18/9	7/11	24/2	27/9	16/5	WTP 11/7	Weir 28/11	Weir 16/5	Weir 12/11	Weir 28/1	Weir 21/12
OC Pesticides	µg/L	< 0.1	< 0.1	ND	"All pass"	ND	<0.3	<0.3	<0.3	<0.3	ND	ND
OP Pesticides	µg/L	< 0.1	< 0.1	ND	<0.01	ND	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Parameter	Units	2002		2004	2005	2006			2007		2009	
		18/9	7/11	24/2	27/9	16/5	WTP 11/7	Weir 28/11	Weir 16/5	Weir 12/11	Weir 28/1	Weir 21/12
Herbicides:												
Atrazine	µg/L	**0.08**	**0.07**	**0.04**	**0.03**	**0.03**	**0.05**	**0.02**	**0.20**	**0.05**	**0.06**	**0.12**
Desethyl Arazine	µg/L	-	-	-	-	-	**0.04**	**0.01**	**0.03**	**0.03**	**0.02**	**0.04**
Desisopropyl Atrazine	µg/L	-	-	-	-	-	**0.02**	<0.01	**0.01**	**0.02**	<0.01	<0.01
Diuron	µg/L	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Hexazinone	µg/L	**0.1**	**0.1**	**0.02**	**0.01**	**0.02**	**0.01**	**0.02**	**0.02**	<0.01	**0.01**	**0.01**
Simazine	µg/L	**0.11**	**0.11**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tebuthiuron	µg/L	**0.03**	**0.02**	**0.03**	**0.47**	**0.40**	**0.35**	**0.31**	**0.44**	**0.20**	**0.31**	**0.21**
Fluometuron	µg/L	-	-	<0.01	**0.02**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

ND: Not Detected

Treated water herbicide and pesticide analyses available are shown in the table below.

Pesticide and Herbicide Analysis Results for Treated Water

Parameter	Units	ADWG Value	Health Value	WTP 11/9/02	WTP 7/11/02	WTP 24/2/04
OC Pesticides	µg/L	-	-	< 0.10	< 0.10	Not detected
OP Pesticides	µg/L	-	-	< 0.1	< 0.1	Not detected
Herbicide Atrazine	µg/L	0.1	40	**0.07**	**0.09**	**0.03**
Herbicide Diuron	µg/L	-	30	< 0.01	< 0.01	0.01
Herbicide Hexazinone	µg/L	2	300	**0.1**	**0.13**	**0.01**
Herbicide Simazine	µg/L	0.5	20	**0.1**	**0.15**	<0.01
Herbicide Tebuthiuron	µg/L	-	-	**0.02**	**0.03**	**0.02**
Herbicide Fluometuron	µg/L	-	50	-	-	<0.01

As seen in the table above, pesticides were below the detectable levels in the samples taken, however a number of herbicides were found to be present and are indicated in bold. Specifically, the herbicides Atrazine, Hexazinone, Simazine, Tebuthiuron and Fluometuron have been detected. All herbicides levels are lower than ADWG guideline values except the Atrazine level in the raw water sample on 21/12/2009 which was higher than the ADWG recommended value of 0.1 µg/L but below the level of 40 µg/L where health effects are expected.

The presence of herbicides in the raw water is a concern as the current plant process cannot be expected to effectively remove these organic contaminants. **The operation and/ or design of the WTP treatment system should potentially be improved with the aim of effectively removing pesticides and herbicides from the water. PAC dosing or ozone/ BAC are commonly employed treatment systems**.

As herbicides have been detected, pesticides and herbicides should continue to be monitored regularly in the raw water and **an incident management plan prepared, including trigger levels for action**.

3.3.9 Algal Blooms and Taste and Odour Compounds

Blue green algal blooms have been reported to occur in the Dawson River from time to time, especially when the river level is low and the water becomes stagnant. No data was available on algae types and levels.

Taste and odour compounds are also reported to occur when the water becomes stagnant and/or there is a significant build up of sediments behind the weir, although analyses were not available. The operators reported that taste and odour problems in the raw water have been partially reduced in the past by having Sunwater open the scour valve on the river weir to release stagnant water and sediments from the weir. Manual PAC dosing has also been carried out at the WTP.

Algae and taste and odour compound analyses should be carried out when these contaminants are detected in the river water.

3.3.10 Microbiological Parameters

Data on the microbiological parameters total coliforms and *E.Coli* for samples taken in the distribution system (at Baralaba WTP, Baralaba Hospital and Baralaba Park) showed that both were detected on multiple occasions, as summarised in the table below.

Microbiological Analysis Results for Treated Water

Location	Date	*E.Coli* MPN/ 100 ml	*Coliforms* MPN/ 100 ml
Baralaba WTP	02/11/05	ND	**2**
	29/11/05	ND	ND
	10/01/06	ND	ND
	03/03/08	ND	ND
	31/03/08	ND	ND
	28/04/08	ND	ND
	26/05/08	ND	ND
	23/06/08	ND	ND
	21/07/08	ND	**110**
	18/08/08	ND	**>200**
	29/09/08	ND	ND
	18/11/08	ND	ND
	2/12/2009	ND	**22**
	7/12/2009	**1**	**56**
	15/12/2009	**2**	**200**
	11/01/2010	ND	**14**
	19/01/2010	ND	**200**
	01/02/2010	ND	**22**
	02/02/2010	ND	ND
	03/02/2010	ND	ND

Location	Date	***E.Coli*** MPN/ 100 ml	***Coliforms*** MPN/ 100 ml
	08/02/2010	ND	ND
	10/02/2010	ND	200
Baralaba Hospital	27/09/05	ND	ND
	02/11/05	**2**	**43**
	29/11/05	ND	**4**
	10/01/06	ND	ND
	03/03/08	ND	ND
	31/03/08	ND	**1**
	28/04/08	ND	ND
	26/05/08	ND	ND
	23/06/08	ND	ND
	21/07/08	ND	**>200**
	18/08/08	ND	**>200**
	29/09/08	ND	**4**
	18/11/08	ND	ND
	16/12/08	ND	ND
Baralaba Park	2/12/2009	**3**	**32**
	7/12/2009	ND	**36**
	15/12/2009	**5**	**48**
	11/01/2010	**18**	**62**
	19/01/2010	**1**	**200**
	01/02/2010	**15**	**38**
	02/02/2010	**9**	**41**
	03/02/2010	**10**	**45**
	08/02/2010	**2**	**74**
	10/02/2010	ND	**200**

There is no ADWG for total coliforms and they are not considered useful as an indicator of the presence of faecal coliforms and enteric pathogens. They may, however, indicate inadequate treatment, breakdowns in system integrity, or the presence of biofilms in the reticulation.

The ADWGs state that *E.Coli* should not be detected in drinking water (although they acknowledge that this will be difficult to achieve for 100% of sample taken). The Guidelines recommend the following action if *E.Coli* is detected in any sample:

- Take a repeat sample from the same location and from the supply source and analyse for *E.Coli*;

- Increase disinfection and/ or investigate the source of contamination.

Because of the multiple detections of *E.Coli* in the treated water in late 2009 and early 2010, the Department of Health required Council to issue a 'boil water' alert in Baralaba. The investigations into this incident are covered in a separate report by CWT and followed up in Council's 2010 risk assessment of the water supply. The steps identified in the CWT report "Baralaba WTP Performance Review" (March 2010) for enhancing performance in terms of disinfection and *E.Coli* levels include:

1. Provide weir level measurement at Neville Hewitt weir with an operator call out alarm if a rapid increase is detected;
2. Install online filtered water turbidimeter with WTP shut down and call out alarm;
3. Install a chlorine residual analyser to use for chlorine dosing control and to alarm if outside the set range;
4. Improve clear water tank inlet outlet arrangement;
5. Cover clear water tanks to minimise heating;
6. Ensure reticulation mains and tanks are satisfactorily clean;
7. Increase operating storage range in water tower.

The above findings relating to the WTP are included and addressed further in this report.

Microbiological parameters should continue to be monitored regularly, as required by the state government regulator. It is noted that, because of the surrounding catchment, **the raw and treated water should be analysed periodically for *Cryptosporidium* and *Giardia***.

3.3.11 Other Water Quality Issues

The levels of TDS, hardness, metals and other ions analysed by external laboratories are in the typical range expected for raw water.

It appears that trihalomethanes (THMs) or other chlorination by-products are not monitored regularly in the treated water. As pre-chlorination is undertaken at the plant, **the level of THMs should be checked by regular analysis**.

3.3.12 Raw and Treated Water Quality Summary

The range and typical values for significant water quality parameters in the WTP raw and treated waters are summarised in the table below.

WTP Raw and Treated Water Quality Parameters Summary

Parameter	Units	WTP Raw Water		WTP Treated Water	
		Range	Typical	Range	Typical
Turbidity	NTU	<1 - 885	300	0 - 11	1
True Colour	Pt-Co	0 - 179	30	0 - 13	5
pH	-	6.5 – 8.0	7.5	6.7 – 7.8	7.3
Alkalinity	mg/L $CaCO_3$	39 - 92	60	36 - 76	50
Manganese (total)	mg/L	< 0.01 – 0.475	0.150	0.022 – 0.087	0.025
Manganese (soluble)	mg/L	0.021 – 0.385	0.030	0.021 – 0.042	0.025

Parameter	Units	WTP Raw Water		WTP Treated Water	
		Range	Typical	Range	Typical
Iron (total)	mg/L	< 0.01 – 3.96	0.10	<0.01 – 0.12	0.02
Fluoride	mg/L	<0.01 – 0.18	0.15	<0.1 – 0.22	0.15
Free Chlorine	mg/L	-	-	0.02 – 3.27	0.4 up to 2009 0.1 Late 2009*
Total coliforms		Not tested		Detected in some samples	
E.coli	MPN/100ml	Not tested		Detected in some samples	
Pesticides	-	Not detected		Not detected	
Herbicides	-	Detected		Detected	
Blue Green Algae	-	Occasional occurrence		-	
Taste and odour compounds	-	Occasional occurrence		Occasional occurrence	
B-G Algal Toxins	-	Not tested		Not tested	

* Chlorine results for late 2009 may be lower than actual levels due to incorrect sampling and analysis technique

3.4 Water Corrosivity Issues

3.4.1 Problems Typically Associated with Corrosive Waters

Waters may be potentially corrosive due to various combinations of parameters such as low pH, low alkalinity, or low hardness. Problems commonly experienced in a water supply as a result of aggressive water include:

- reduced disinfection efficiency at elevated pH levels;
- pitting corrosion, high copper levels and blue water in copper pipes within buildings;
- elevated iron levels associated with iron or steel pipes;
- meringue dezincification of brass fittings at pHs of 8.5 or higher;
- high pH values throughout the reticulation due to the dissolution of various compounds from concrete and cement within the system.

These problems can lead to increased health risk to consumers and deterioration of service pipes and fittings in water supply schemes.

Water quality is considered the main contributing factor to corrosion of infrastructure in water supply systems. Other factors contributing to corrosion may include micro-organisms on pipe walls; reticulation design and layout; materials used; and water use characteristics.

3.4.2 Corrosivity Indices

Indices which reflect the corrosion potential or “aggressiveness” of water can be modelled using water quality data. These indices are useful in estimating the likely corrosion potential of waters, although they do not necessarily apply to all types of waters. They include:

- the Calcium Carbonate Precipitation Potential (CCPP); and
- the Langelier Index; and

- the Larson Index.

The CCPP and Langelier Index are indicators of whether a water is likely to be aggressive or scale forming. Negative values indicate that waters are likely to be corrosive while positive values indicate the water is likely to form calcium carbonate scale.

If the CCPP is zero then the water is saturated in terms of calcium carbonate. If the CCPP is positive then the water is over-saturated and likely to precipitate a film, predominantly of $CaCO_3$, onto pipes and other water supply infrastructure in contact with the water. If the CCPP is negative then the water is under-saturated and is likely to be corrosive. Various studies have shown CCPP to be an accurate indicator of corrosiveness of concrete and cement linings.

The Langelier Index (LI) has also been found to be an accurate indicator of water scaling and hence corrosivity under most circumstances. It is the difference between the saturated pH and the water's actual pH, and is therefore on a logarithmic scale. Again a negative value indicates that the water is likely to be corrosive and a positive value shows it to be over-saturated and therefore likely to be scale forming.

The Larson Index is an indicator of the potential aggressiveness of water in relation to the effect on oxide film formation on metals such as iron or mild steel. The Larson index is calculated as the ratio of chlorides and sulphides to alkalinity with all levels expressed in equivalents per million.

3.4.3 Water Quality Targets for the Prevention of Corrosion

The water quality targets outlined in the table below are generally recommended to minimise potential corrosivity in treated waters, based on industry experience. Given the scarcity of available water quality data, these calculations should only be used as a preliminary indicator of corrosion potential.

Typical Target Water Quality Parameters for Corrosion Control

Parameter	Units	Target	Guideline Range
pH	pH units	7.8 to 8	7.6 to 8.2
Alkalinity	mg/L as $CaCO_3$	45 to 55	> 40
Ca Hardness	mg/L as $CaCO_3$	> 40	> 40
CCPP	mg/L	- 3	- 6 to 0
Langelier Index	pH units	- 0.3	- 0.6 to 0
Larson Index	ratio	< 0.8	< 1.2

The pH of the water should be above 7.6 for waters leaving the WTP but should not exceed 8.3 as dezincification can occur at pHs of around 8.5 and above. At pHs above 7.0, the effectiveness of chlorine disinfection is reduced.

A free chlorine residual of around 0.2 mg/L in the extremities of the reticulation system is usually recommended to minimise the possibility of microbiologically-induced corrosion.

3.4.4 Baralaba Corrosion Indicators

Corrosivity indices were modelled for Baralaba WTP raw and treated water and are set out in the table below with the data used as input to calculations included.

The temperature of the water leaving the WTP was assumed to be 20 ^{o}C for all 3 cases.

Corrosivity Indices for Baralaba Raw and Treated Water

Parameter	Units	Raw Water Typical	Treated Water Typical	Treated Water Worst Case
Temperature	^oC	20	20	20
TDS	mg/L	90	110	100
Alkalinity	mg/L as $CaCO_3$	60	50	36.5
Calcium hardness	mg/L as $CaCO_3$	22	25	22
pH	-	7.5	7.3	6.7
Chloride	mg/L	7.3	16	24.5
Sulphate	mg/L	2.2	3	5.5
CCPP	**mg/L**	**-9.1**	**-11.9**	**-33.4**
LI	**-**	**-0.9**	**-1.1**	**-0.4**
Larson Index	**-**	**0.21**	**0.51**	**1.10**

The results of the modelling show that the raw water is likely to be mildly corrosive in terms of CCPP and LI but not in terms of the Larson Index. The operators report that corrosion of mild steel components on the raw water delivery path has been known to occur.

The results for the typical treated water show that the water is potentially corrosive in terms of the CCPP and LI and more likely to be corrosive than the raw water in terms of the Larson Index. The typical pH achieved is also lower than the recommended level of 7.6. The worst case treated water quality is likely to be corrosive in terms of all three indices, however it is noted that this type of quality would occur rarely and for short periods of time.

No corrosion problems were reported for the Baralaba water supply reticulation.

3.5 Treated Water Quality Targets

The treated water quality target levels recommended in the Australian Drinking Water Quality Guidelines (NHMRC, 2004) are shown in the table, with common targets based on industry experience and other water treatment plants around Australia and the current targets used at the Baralaba WTP.

Treated Water Quality Targets & Guideline Values

Parameter	Units	ADWG		Common Industry Treated Water Targets	Current Biloela Treated Water Target
		Health	Aesthetic		
Turbidity	NTU	1	5	< 0.1	< 0.3
Colour	HU		15	≤ 5	≤ 10
pH			6.5 – 8.5	7.5 – 8.3	7.2 – 7.5
Chlorine	mg/L	5		Depends on system	0.6 – 0.8
Total Aluminium	mg/L	0.2		≤ 0.2	-
Total Manganese	mg/L		0.1	≤ 0.05	-
Total Iron	mg/L		0.3	≤ 0.3	-
Total Alkalinity	mg/L as $CaCO_3$			≥ 40	-
Total Dissolved Solids (TDS)	mg/L		< 500	< 500	-
CCPP				-1 to -5	-
Total Trihalomethanes	mg/L	0.25		≤ 0.15	-

The targets adopted at the WTP are reasonable compared to the ADWG and industry values, although it is noted that:

- The pH target is slightly lower than the ADWG values, which would tend to make the water slightly more corrosive;
- Modern WTPs aim for <0.1 NTU turbidity for greater protection against *Giardia* and *Cryptosporidium*, however 0.3 NTU is considered a reasonable target for the Baralaba WTP in the short term at least.

It is noted from the analysis of water quality above that several of the existing water quality targets are not always met.

4. WTP PROCESS DESCRIPTION AND CAPACITIES

4.1 Process Overview

The Baralaba WTP is a conventional process package water treatment plant, constructed in 1998. Council advises that the plant has been changed in several ways since it was built, and that it took many months for the plant to be adequately commissioned and optimized. Council officers report that alternative chemicals and improvements continue to be trialed to reduce operating costs.

The conventional treatment process comprises the following main unit processes:

- Coagulation
- Flocculation and settling
- Filtration
- Disinfection
- pH adjustment (when required)

A diagram of the plant process is shown below.

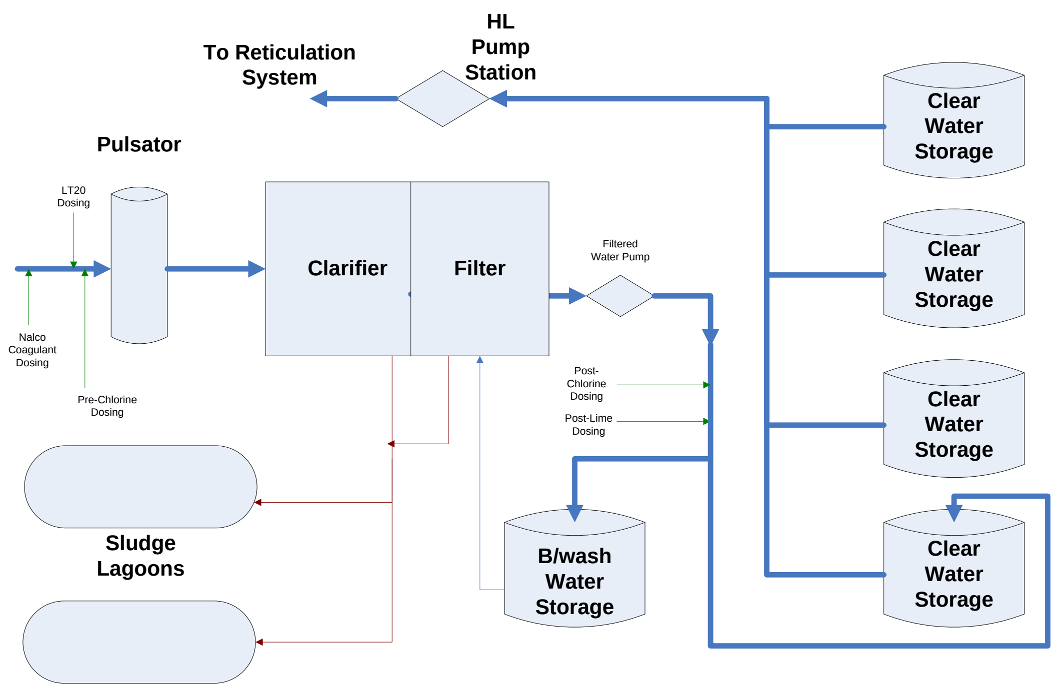


Diagram of Baralaba WTP Treatment Process

4.2 Raw Water Pumps and Plant Inlet

The raw water is drawn from the Neville Hewitt weir on the Dawson River by two submersible bore-type pumps. The two pumps are used as duty/ standby, although they are reportedly different types of pumps and of different capacity. Pump No.1 has limited flow of 12-13 L/s. Pump No.2 gives a flow of up to 18 L/s, which can then be throttled back to the required plant flow using a valve on the raw water inlet main, and is used in preference. From available data on pump run hours, it would appear that Pump No.1 has rarely been used for plant supply since April 2004, although the total number of pump hours was significantly greater for Pump No.1 at this time, possibly indicating that this pump is older than Pump No.2. Because Pump No.1 does not give the full flow rate of the WTP, it does not give full standby capacity. **Pump No.1 should be replaced with a suitable pump as soon as possible to provide a standby which can supply the full plant flow rate.**

The pumps are located in a pump well by the river. Raw water enters the pump well via the weir outlet structure which consists of concrete drop boards and screens located at levels controlled by Sunwater staff. The raw water quality received at the pumps is primarily determined by the weir outlet screen level and is thus impacted by Sunwater's operations of the screens. The level of the intake of the pumps reportedly has little effect on raw water quality received at the plant.

Photo of Raw Water Pump Pit and Pump Isolation Valves

The intake level of the raw water pumps can be altered by adding or removing pipe pieces. At low water levels in the weir impoundment, however, the length of the pumps causes problems with accessing all the water available as the pumps are around 2m high and the pump intake is in the middle of that length. A different type of pump would be required in order to more effectively remove water under low river levels. **When Pump No.1 is replaced, the type of new pump selected should allow water to be drawn from a lower level in the pump well if possible.**

The main parameters of the raw water pumps are given in the table below.

Raw Water Pumps and Plant Inlet

Component	Parameter (Units)	Design Criteria	Comments
Dawson River Pumps	Intake type	Pump well by weir on river	Via weir outlet structure
	No. and type of pumps	2 x borehole type pumps	2m long with intake near middle
	Capacity each (L/s)	Pump 1: 12 – 13 L/s Pump 2: 18 L/s	
	Mains diameter (mm)	150 / 100 mm	
	Mains maximum flow rate (ML/d, L/s)	At least 15 L/s	Designed for plant 15 L/s flow rate
Plant Inlet	Max hydraulic capacity	15 L/s	Plant max design flow rate

The raw water delivery main travels underground from the river into the plant intake area. The coagulant dosing line joins the main while it is still underground. The mains pipe then emerges above ground, where it has an isolation valve, extended contact time section, the raw water flow meter and other dosing points before it reaches the pulsator tank. The isolation valve on the inlet mains is adjusted to throttle back the raw water flow rate supplied by the pumps when required.

The inlet section of the raw water mains is shown in the figure below.

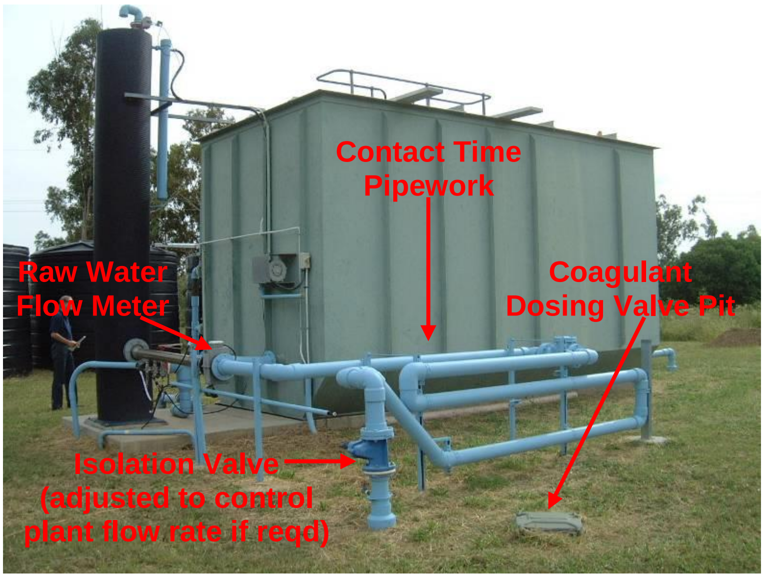


Photo of Plant Inlet Pipework and Flow Meter

4.3 Pre-Filtration Chemical Dosing

4.3.1 Chemical Dosing Locations

The chemicals currently dosed for pre-treatment and coagulation are:

- Nalco coagulant (primary coagulant), also called D245, dosed into the main at the plant inlet;
- Pre-coagulation chlorine (oxidant) dosed into the main at the plant inlet;
- Polyacrylamide (flocculant aid), product name Magnafloc LT20 dosed into the pipe between the flash mixer and the clarifier.

The locations of these dosing points on the raw water mains before the pulsator tank are shown in the figures below.

Photo of Coagulant Dosing Valve Pit at Dosing Point

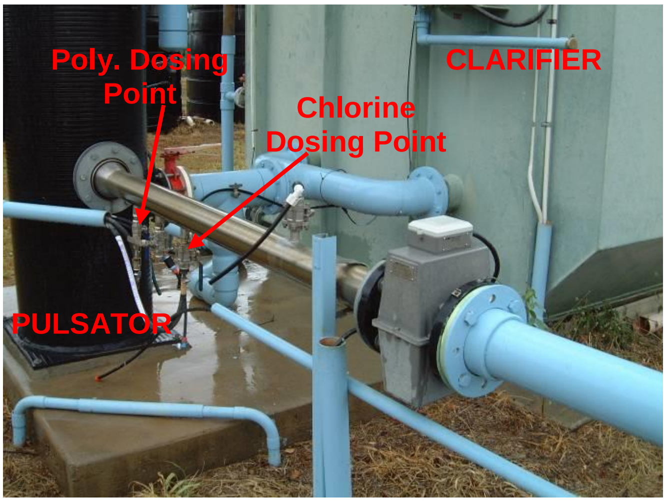


Photo of Chlorine and Polyacrylamide Dosing Points

4.3.2 Coagulant Dosing

The proprietary coagulant produced by Nalco, product number DVS1 C001-D245, is dosed as the primary coagulant. It was noted during discussions with Nalco, that the last part of the product number usually used on site to name the product, D245, is in fact a reference to the container size and is common to many other Nalco chemicals. **The Nalco coagulant product should therefore more correctly be referred to using the first part of the number, DVS C001, in discussions with Nalco at least.** As no other Nalco coagulants are currently used at the Banana Shire plants, the chemical is referred to as 'Nalco coagulant' in this report.

The Nalco coagulant is understood to be a polymerised aluminium chemical product, of the type often called aluminium chlorohydrate (ACH) or polyaluminium chloride (PACl), although the actual chemical composition of the product is protected by Nalco as proprietary information. Such products can be effective at lower doses than alum and generally cause less of a drop in pH, therefore reducing the need for pre-coagulation alkali dosing.

It is understood that the use of the Nalco coagulant was implemented in the last 12 months or so to replace another Nalco polyaluminium chloride (PACl) product called Ultrion 8588.

The coagulant is dosed into the raw water pipeline prior to a loop in the raw water main, installed subsequent to the original design to give extended contact time for the chemical. The operators report that pipework loop design was selected over a static mixer as the most economical option.

Chemical doses used and coagulant storage and dosing system capacities are discussed in the next chapter of this report.

4.3.3 Pre-Filtration Chlorine Dosing

Chlorine is dosed in to the raw water main after the coagulant and the contact time pipe coils, just prior to the pulsator vessel. Thus the dosing is after the start of coagulation but before flocculation and clarification. Pre-filtration chlorine is usually either dosed prior to coagulant, or just prior to the filters. The current dosing point, a short distance before the polyacrylamide dosing point is also not ideal as high levels of chlorine can damage the polymer chains, therefore it is generally better to separate the chlorine and polyacrylamide dosing points.

Pre-coagulation chlorination should use a dosing point upstream from the coagulant dosing point, and would generally be used to oxidise soluble metals and organic compounds (including taste and odour compounds). Pre-coagulation chlorine dosing can also assist by enhancing the coagulation process. One of the risks with pre-coagulation chlorination is that there is more chance that chlorine will react with the high levels of organic substances in the water to produce undesirable by-products such as trihalomethanes (THMs). If blue-green algal cells are present, chlorination may also lyse the cells, potentially releasing any algal toxins into the water.

Pre-filtration chlorination would involve dosing chlorine to the clarified water, just before the filter. This option is usually used in conjunction with manganese oxide coated media, as an additional treatment for removal of dissolved metals such as iron and manganese. From the review of the raw water data it is not clear that such a treatment step would be required, especially if most of the iron and manganese is present in the raw water in particulate form.

The pre-chlorine dose is reportedly adjusted to achieve a residual of around 0.1 mg/L (measured by grab sample from the water surface of the clarifier). The actual dose required depends on the raw water quality parameters, particularly turbidity and colour.

Chemical doses used and chlorine storage and dosing system capacities are discussed in the next chapter of this report.

4.3.4 Flocculant Aid Polyacrylamide (LT20) Dosing

The polyacrylamide, Ciba product Magnafloc LT20, is dosed as a coagulant/flocculant aid into the raw water main after coagulant and chlorine and just prior to the pulsator tank. Magnafloc LT20 is a non-ionic polyacrylamide. Based on the original operating manual, it appears that polyacrylamide dosing was not included in the original design of the plant.

Anionic or nonionic polyacrylamides (also known as polyelectrolytes) are used as flocculation aids to assist in binding particles together during coagulation and flocculation. These long-chain polymers influence the bonding between floc particles and help to form larger and/or denser floc.

It is noted that the effectiveness of polyacrylamides can be reduced by contact with chlorine, which damages the polymer chains. Ideally, **the polyacrylamide dosing point should be located further from the pre-chlorine dosing point**, another advantage of moving the chlorine dosing point as mentioned above.

Chemical doses used and polyacrylamide storage and dosing system capacities are discussed in the next chapter of this report.

4.3.5 Pre-Coagulation Alkali Dosing

Pre-coagulation alkali dosing is not currently used at the plant, however a dosing point and a spare dosing pump were provided in the initial plant design.

If pre-coagulation lime (‘pre-lime’) needed to be dosed, the operators report that there is a spare dosing pump available. The pre lime should ideally be dosed prior to the coagulant, therefore the coagulant dosing point may need to be moved to allow this.

As there is no alternative water supply, **provision should be made for pre-coagulation lime dosing** so that the WTP can effectively treat all likely raw water conditions.

4.3.6 Powdered Activated Carbon (PAC) Dosing

PAC dosing facilities are not currently available at the plant. **A PAC dosing system should be considered** as a method of addressing potential organic contamination, such as algal toxins, taste and odour compounds and pesticides/ herbicides.

4.4 Pulsator Tank

The pulsator tank pulses the flow by using the vacuum pump to lift and drop the column of water in this vessel. The purpose of the pulsator, according to the original operating manual, is to create flow of changing velocity into the clarifier. Periodic short high flow periods provide turbulence for:

- flocculation and
- sludge blanket expansion.

Between pulses, longer periods of a lower, stable flow rate entering the clarifier allow the sludge blanket to settle.

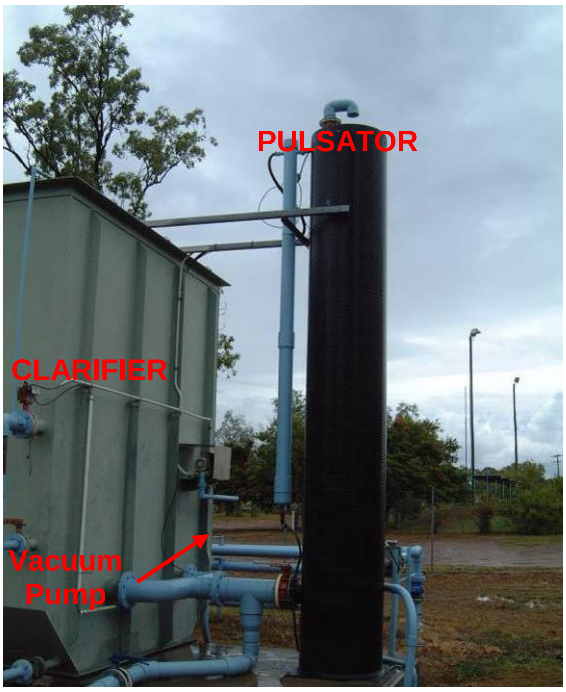


Photo Showing Pulsator and Vacuum Pump

The pulsed flow process is a proprietary system used mainly in package plant sized treatment processes. It does appear to be effective enough to form floc, however mixing energy throughout the whole process could be further investigated to ensure conditions are optimised.

4.5 Clarifier

The raw water flows into the base of the clarifier through a series of pipes which distribute the water over the floor of the clarifier. Floc particles are removed by both settling and interception in the sludge blanket. The settling tubes assist with settling by agglomerating floc particles into larger masses for faster settling.

Clarified water is collected through orifices in three launder pipes at the top of the clarifier.

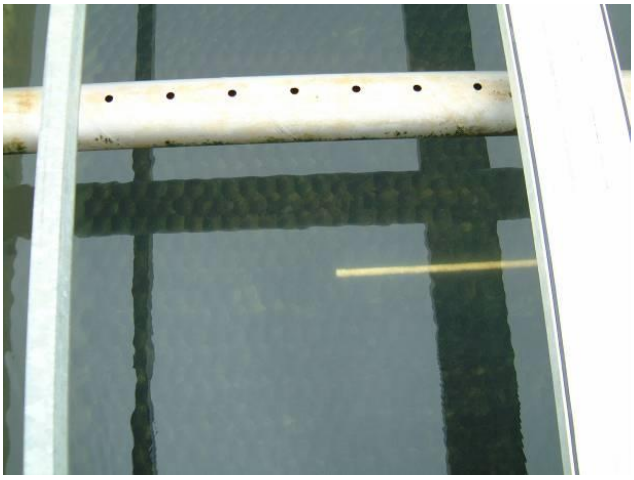


Photo of Clarifier Showing Settling Tubes and Supernatant Collection Pipe

The clarifier has a flat bottom. Sludge is withdrawn via a sludge weir, which runs along the full width of the inlet wall of the clarifier. There is both an automatic and a manual valve for withdrawing sludge from the drawoff weir. There is also a scour pipe from the base of the clarifier. A sight glass on the automatic sludge drawoff line allows the operator to view the sludge as it drawn off.

The sludge drawoff weir is above the floor of the clarifier rather than sludge being withdrawn from the base of the clarifier as is typical design. This design is supposed to ensure that there is always adequate sludge to form a suitable sludge blanket, even with excessive automatic desludging. However the operators report that the automatic desludging does not draw out enough sludge and some can turn anoxic causing taste and odour problems. Extra manual desludging is required twice per week, performed by shutting down the plant to let the sludge fully settle then running the 50 and 100 mm scour valves at the bottom of the tank.

The sludge is reportedly automatically blown down on average for around 2.4 minutes every 10 minutes, which is a high level of deludging. The operators adjust the blowdown settings in response to major changes in raw water or plant operation, based on observation of sludge volumes in the clarifier but usually set at a conservative level to avoid process problems during the periods of unmanned operation. Further optimisation of the sludge blowdown frequency and duration could potentially reduce the volume of sludge produced and therefore reduce the load on the sludge lagoons and the ‘wastage’ of water.

It is also reported that the automatic desludge system has been known to fail, with the operator not aware that sludge was not being drawn out of the clarifier. In general, **the operation and design of the clarifier desludge system could potentially be improved. Improvement options should be further investigated.**

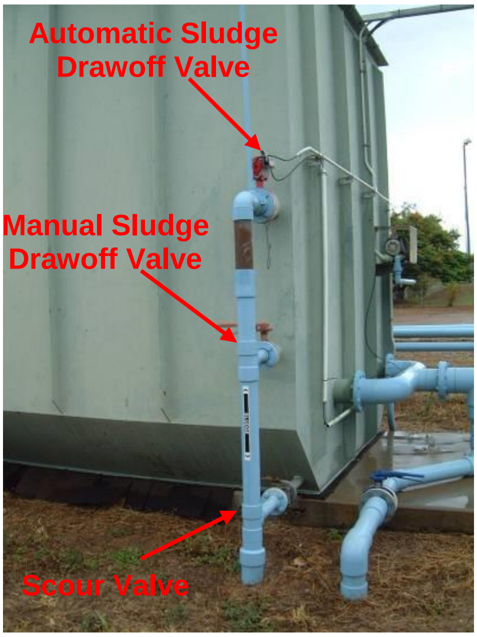


Photo of Clarifier Sludge Drawoff Arrangement

Despite the additional manual desludging, not all of the sludge can be removed from the bottom of the tank, and. The clarifier needs to be drained and cleaned out every 3 – 4 years to remove the buildup of sludge.

The main parameters for the clarifier are given in the table below.

Clarifier (Flocculation and Settling Zones)

Component	Parameter (Units)	Design Criteria	Comments
Flocculation	Type	Flocculation occurs in bottom zone of clarifier	
	Flocculation time (min)	Approx. 20 min	Estimated based on flocculation occurring in bottom 1.5 m of clarifier vessel
	Flocculation mixing	Hydraulic only	Turbulence created by pulsed flow
Clarification	Type	Up-flow sludge blanket with tube settlers	
	Depth (m)	Approx 4 m	Estimated height
	Settling zone surface area (m^2)	11.9 (nominal) 10.8 (effective)	As given in original operating manual
	Surface rating (m/h)	4.5 m/h 4.2 m/h reduced rating at 11-13 L/s (during high turbidity)	As given in original operating manual
	Sludge scraping	n/a	
	Sludge drawoff system	Sludge weir along one end of clarifier with actuated butterfly valve	

Component	Parameter (Units)	Design Criteria	Comments
	Typical sludge removal frequency and duration (min)	Frequency: Approx 10 min Duration: Approx 2.4 min	Controlled by timers for ON time and OFF time. Both timers have max (100%) setting = 8 minutes
	Sludge hoppers	n/a	
	Tank drainage facilities	Manual scour valve	

The loading rate of 4.5 m/h is at the high end of the range normally quoted for tube and plate settlers. The operators report that the clarifier performs acceptably under normal raw water conditions, however that the plant may be downrated when poor raw water quality is experienced.

A roof has been added to the clarifier in recent years to shield it from the sun, due to ongoing problems with algal growth.

4.6 Filtration and Backwashing

4.6.1 Filter Design

There is a single, sand media filter attached to the clarifier structure. Clarified water passes from the clarifier into the filter to flow through the media bed. The filter media is a dual-size silica sand media with a gravel support layer.

Filtered water is collected in the filter underdrains and then pumped to the clear water tanks by the filtered water pump. Due to site hydraulics, the plant will not function without the filtered water pump to transfer water from the underdrains to the clear water storages. It is noted that there is no installed standby for this pump, although a suitable replacement pump is kept on site ready to be installed if needed. **An installed standby filtered water pump could be fitted to minimise the risk of delays after failure of the duty pump.**

Because there is only one filter, the plant shuts down to perform a backwash. The plant's daily water production capacity is therefore significantly affected by the filter run times achieved.

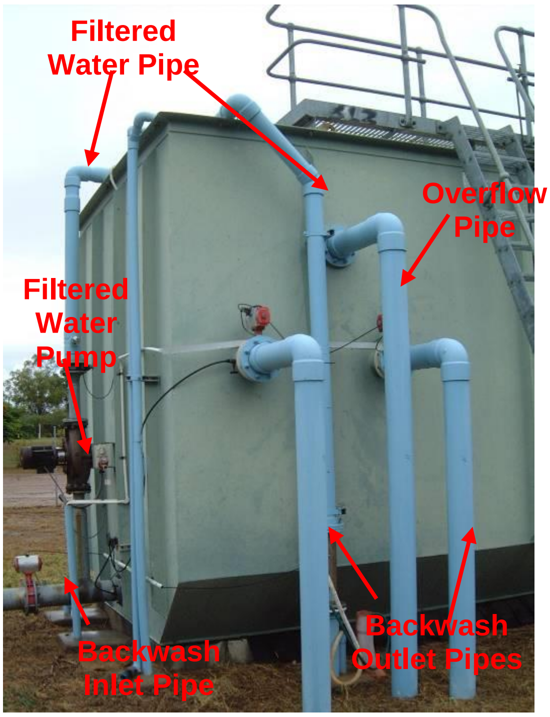


Photo of Filter Vessel and Pipes

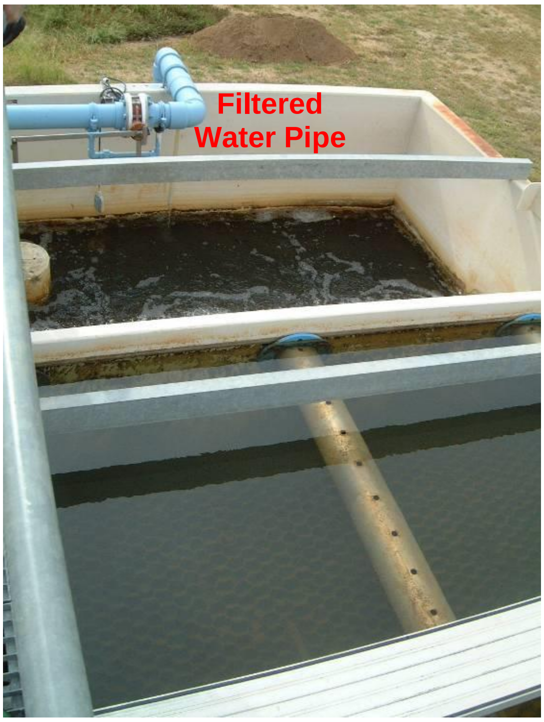


Photo of Filter and Clarifier (Top View)

The main parameters for the filter are given in the table below.

Filter

Component	Parameter (Units)	Design Criteria	Comments
Filter Beds	Type	Open, rapid sand filter	
	Number of filters	1 only	Backwashing performed when plant not running
	Area per Filter (m^2)	6 m^2	As given in original operating manual
	Total Filter Area (m^2)	6 m^2	
	Filtration Rate (m/h)	9 m/h at 15 L/s	As given in original operating manual
	Available headloss (m)	not known	Headloss meter provided with plant reportedly never worked correctly
Filter Media	Filter sand: effective size (mm), U.C., depth (mm)	0.9 mm, < 1.4, 900 mm deep	Silica sand used
	Coarse sand: effective size (mm), depth (mm)	1 – 3 mm, 80 mm deep	Silica sand used
	Filter gravel	Graded gravels	As given in original operating manual
Underdrains	Underdrain type	Pipe laterals	
Filtered Water Pump	Capacity (L/s)	16 L/s at 5.5m	As given in original operating manual

The filtration rate of 9 m/h is typical of rates for sand media filters. The achievable filter run times are not clear as the filter is normally backwashed every 10-11 hours based on a timer. These run times have been selected by the operators to ensure that reasonable filtered water quality is maintained and to match the expected plant daily operating hours so that generally one backwash is undertaken each day. Much longer run times would generally be expected in a typical filter design with an optimised system. It is noted that optimisation of the run times and reduction of backwashing frequency could potentially reduce the volume of sludge produced and reduce the proportion of water 'wasted' to the sludge lagoons. **Filter performance and run times should be investigated further.**

It is understood that tappings are available for a differential pressure headloss meter, as the original plant included a DP cell, but this never functioned effectively and has been removed. **A new DP cell should be fitted and connected to the SCADA system or an alternative logging system so that the headloss across the filter can be monitored.**

Online monitoring of the filtered water quality would also be beneficial, particularly because the plant is often unattended. This could be implemented if the online turbidimeter (described under the Online Monitoring section later in this report) was installed. It was noted that the operators have noted that algal growth in the turbidimeter cell may be a concern and system design should aim to minimise this risk. **The new online turbidimeter should be installed as soon as possible and connected to the SCADA system. An automatic shutdown alarm should be set up so that if the turbidity exceeds the operator adjustable high high setpoint (e.g. 1 NTU) for 5 minutes (fixed), the plant will shut down automatically and raise a call out alarm**.

The filtered water turbidity and headloss trends, once available, should be used to **optimise the filter run time and investigate the effectiveness of backwashing.**

The condition of the filter media and effectiveness of backwashing was reviewed by Hunter Water Australia in 2005, who reported that the media was analysed to be 0.9 mm effective size, as per the original specification and that the filter bed was generally in good condition but showed some mudballing near the walls of the filter. Mudballs (accumulations of media and floc) can indicate poor backwashing and/or overdosing of polyacrylamide.

4.6.2 Filter Backwashing

Backwashing is currently performed based on a timer. Backwashes can also be triggered by the water level in the filter (measured by a level switch). The filter also has capacity for backwashing triggered on differential pressure; however a new DP cell would need to be fitted. Ideally, **the filter should also trigger a backwash if the filtered water turbidity reached an unacceptable level,** based on the yet-to-be-installed online turbidimeter.

Backwashing water is drawn from the original concrete clear water storage tank by a single backwash pump. It is understood that one of the existing high lift pumps can be used as a standby backwashing pump if required. This requires an adjustment of the valves at the pumps and at the backwash tank and uses backpressure from the high level reservoir as well as the pump rate.

It was reported that the backwash launders and pipework are just adequate to drain away the water during backwashing and are likely to flood if the water rate increases above normal levels. Poor backwash water drainage and/or valve failure will retard the effective wash rate and can lead to poor washing in the filter. **The hydraulic requirements for drainage of the backwash water should be investigated and the backwash outlet pipework enlarged if necessary**.

Filter backwashing component capacities and settings are outlined in the table below.

Filter Backwashing

Component	Parameter (Units)	Design Criteria	Comments
Backwashing Parameters	Backwash control	Automatic operation	Provision for manual backwashing
	Backwash phases and typical duration (min)	Procedure: • Air scour, 1.5 min • Combined air and water, 3 min • Water wash, 4 min	
	Backwash triggers	Auto backwash performed when: • Run time > pre-set time (10 – 11 hrs) • Filter level > level switch trigger	
	Backwash frequency (hours)	Typically every 10 – 11 hrs (on timer)	
	Air Scour blower capacity (m^3/h)	130 m3/h at 280 mbar(g)	Based on original operating manual
	Air scour rate (m/h, m^3/h)	21.7 m/h at 100%	
	Backwash pump: No. of, capacity (L/s)	1 x 30 L/s at 8m	One duty pump. High lift pump can be used for backwashing
	Water scour rate (m/h, L/s)	18 m/h (nominal), 30 L/s	Based on original operating manual

The operators report that the automatic backwash settings have remained the same since commissioning, with 1.5 minutes air scour, 3 minutes combined air and water and 4 minutes water wash. The wash phase times are fairly typical, although it is noted that the combined phase would generally be shorter to prevent media carryover into the troughs (with the aim of stopping the combined phase before the water level reaches the top of the troughs, and therefore dependent on the height of the troughs). The operators report that there has not been a significant problem with media loss and that any media in the backwash troughs is shovelled back into the filter every 12 months or so.

The air flow rate of approximately 22 m/h is significantly lower than typical air scour rates.

It is understood that the backwash water pumping rate, 18 m/h, is maintained during the combined air and water phase as well as during the water wash. The rate is generally too high for the combined wash, as intermixing of the gravel layer with the sand media layer has been reported (based on Hunter Water's 2005 report). However this rate is very low compared to typical water washing rates and is unlikely to be achieving an optimal clean. The operators note that some algae and solids can generally be seen swirling above the surface of the sand, unable to be washed into the trough by the backwash water flow. Raising the backwash flow rate would require an upgrade of the backwash pump and is likely to require modifications to the backwash outlet launders and pipework to cope with the additional flow rate.

The air scour combined and water washing regimes should be further investigated to find out if they can be made more effective and more energy and water efficient.

Photo of Backwash Water Supply System

4.7 Post-Filtration Chemical Dosing

4.7.1 Chlorination

Post-filtration chlorine is dosed into the filtered water pipe after the filtered water pump (just before the pipe goes underground to the clear water storage tanks. The purpose of post-chlorine is for disinfection of the water leaving the plant, and to contribute a residual chlorine concentration to prevent the regrowth of biofilms in the reticulation pipes.

The chlorine dose is adjusted to achieve the chlorine residual of 0.6 – 0.7 mg/L.

Mixing at the chlorine dosing point is only from hydraulic turbulence.

Chemical doses used and chlorine storage and dosing system capacities are discussed in the next chapter of this report.

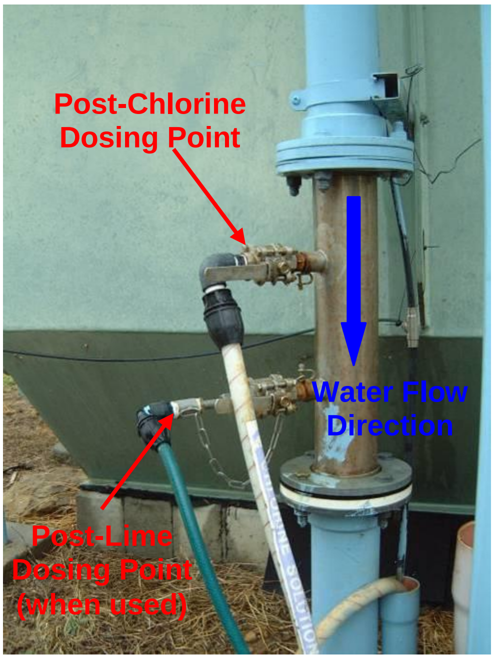


Photo of Post-Filtration Dosing Points

4.7.2 Post-Filtration Lime Dosing

Post-filtration lime is not required under normal conditions, and was reportedly last used in 2004 or early 2005. Post-lime dosing has been reported to be required mostly at times when the river is stagnant due to the application of higher pre-filtration chlorine doses (for manganese/ organics), which results in a lower filtered water pH.

Lime storage and dosing system capacities are discussed in the next chapter of this report.

4.8 Clear Water Storage and Pumping

Four 20 kL black polyethylene tank serve as the clear water reservoirs. The treated water pipe runs into the top of the first poly tank and out via a 150 mm PVC line (underground), with tees to inlet/outlet pipes on the other tanks. The 150 mm treated water pipe connects the tanks to the high lift pumps situated in the chemical dosing shed. The effective total storage is around 80 kL for all four tanks.

It is noted that the arrangement of all except the first of the poly tanks means that one tapping functions as both inlet and outlet from 150 mm treated water line, i.e. the tanks function as off-line storages. This arrangement has a high risk of short circuiting through the treated water line when the high lift pump is running, therefore the full detention time in the tanks is unlikely to be realised under such conditions.

There have reportedly been problems with poly tanks failing due to splits or leaks. The quality of these tanks for such an application is therefore questionable and **another type of tank should be considered if replacement tanks are provided**.

The original concrete clear water tank is generally isolated from the high lift pumps to be used as an off-line storage of backwash water. It can also be used to supply water to the high lift pumps when required by opening the isolation valve on the outlet pipe to the high lift pumps.

The high lift pumps act as duty standby. Based on the operator’s advice and limited data on flow rates and run hours, it is understood that the clear water pumps operate at around 9 L/s, at a setting of 40 Hz. This setting reportedly gives the preferred start/stop regime for the plant. It is understood that the pumps could supply a higher capacity if operated at 50 Hz, although the flow rate at maximum capacity is not known. Based simply on the frequency ratio of 50 – 40 Hz, it is estimated that the pumps may achieve around 11 L/s at maximum capacity.

Photo of Clear Water Storage Vessels

Photo of High Lift Pumps

The main parameters of the clear water system are shown in the table below.

Treated Water Systems

Component	Parameter (Units)	Design Criteria	Comments
Clear Water Storage Tanks	Number, type, location	4 x Black polyethylene tanks at WTP site	Poly tanks have problems with cracking and splitting. Original concrete tank used as backwash storage
	Capacity each (kL)	4 x 20 kL	
	Total Capacity (kL)	80 kL	
	Detention time (h)	148 min at 9 L/s, if flow passes through all 80 kL of storage 37 min at 9 L/s, if only 20kL effective detention	Short circuiting is likely as 3 of the tanks act as offline storages
Clear Water (High Lift) Pumps	No. and Capacity each (L/s)	2 x approx 9 L/s (when run at 40 Hz)	Pumps can supply higher capacity, but generally run at this setting

Detention time is critical to allow the post-chlorine to adequately disinfect the water. It is noted that the town system is fed directly from the WTP, with the town reservoir providing only back-pressure and extra storage rather than further detention time. The clear water tanks therefore need to provide adequate detention time for effective chlorine disinfection before the first customer. Depending on the path of water through the offline clear water tanks, the detention time may vary between around 37 min (20 kL detention) and around 150 min (80 kL detention) at the estimated clear water pump flow of 9 L/s. If short circuiting occurs between the inlet and the outlet in the first clear water tank, the minimum detention time will be even less. The standard minimum requirement for chlorine disinfection is 30 minutes detention at a residual of at least 0.5 mg/L, giving a C.t value of

15 mg.min/L. This minimum requirement would be exceeded if the target of 0.7 mg/L chlorine residual and the detention time of 37 minutes (C.t value of 26) were achieved at all times, however the chlorine residual is known to vary (as discussed previously) and short circuiting may reduce the detention time. **In order to minimise short-circuiting, the inlet-outlet arrangement through the clear water tanks should be altered so that the full 80kL storage volume is utilised for disinfection detention time.** It is understood that Council are currently (May 2010) taking steps towards achieving this task.

The loss of free chlorine residual due to water heating in the black poly clear water tanks is another issue which may affect the maintenance of an adequate residual. **Ideally the reservoirs should be covered to minimise heating effects**.

4.9 Town Reservoir and Reticulation

Baralaba is served by a single service reservoir with a total capacity of 450 kL. The reservoir is a standpipe design of 6 m diameter and 17.7 m high. The town system is fed directly from the WTP clear water tanks, with the town reservoir providing back-pressure and extra storage.

The Baralaba reticulation system, laid in the mid 1940's, is predominantly 100 mm nominal diameter Asbestos Cement (AC) Class C mains and 20mm polyethylene Class 12 material service pipes.

Town Reservoir

Component	Parameter (Units)	Design Criteria	Comments
Elevated Reservoir	Dimensions (m)	6 m diameter, 17.7 m high	
	Capacity (kL)	450 kL	

It is noted that the reservoir size of 450 kL, if operated full, will store approximately one day's water supply at typical demand levels.

Mains cleaning and the optimal operation of the town reservoir to maintain chlorine residuals are reticulation issues which were noted as actions in the CWT report "Baralaba WTP Performance Review" (March 2010) to address issues associated with the 'boil water' alert in early 2010.

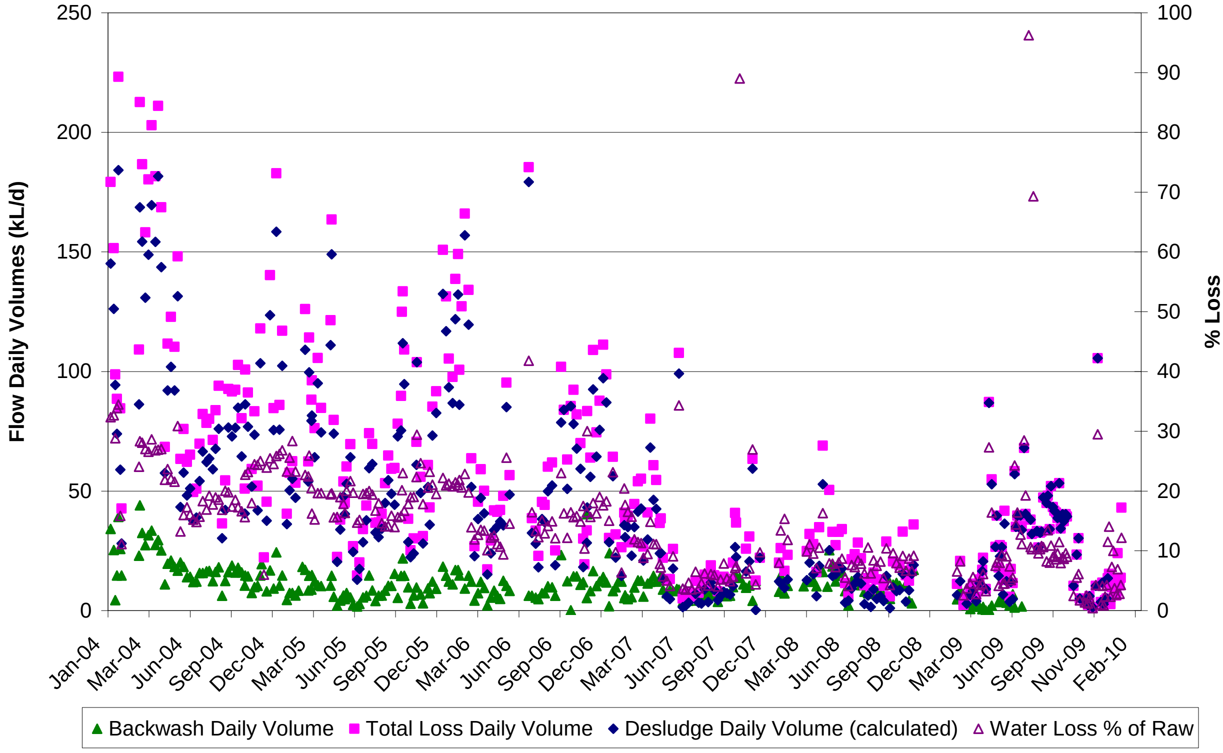
4.10 Wastewater System

4.10.1 Estimated Wastewater Production

The following notes are made regarding wastewater production at Baralaba WTP:

- Total water losses through the plant can be calculated based on raw water inflow minus treated water outflow (assuming both flow meters are accurate);
- Backwash volumes are metered by an online totaliser, with readings recorded when operators visit the plant;
- Clarifier desludge volumes are not metered, but it is assumed these can be estimated based on total water losses minus backwash volumes;

Available data for backwash, raw water and treated water volumes (averaged between days on which totaliser readings were recorded) was used to prepare the graph below showing backwash and clarifier blow down volumes.



Graph of Backwash and Desludge Volumes

It is noted that, assuming the flow meter readings are correct, the clarifier desludge volumes are the most significant wastewater component.

Based on the data shown in the graph above, the following approximate ranges and typical values were estimated for wastewater volumes produced under existing and historic plant conditions.

Estimated Current Wastewater Production Volumes

Wastewater Type	Daily Volume (kL/d)		Percentage of Raw Water Flow
	Expected Range	Typical	
Clarifier Sludge Blowdown	20 - 185	80	5 – 30 %
Waste Backwash Water	2 - 45	15	1 – 7 %
Total Wastewater	**20 - 230**	**95**	**5 – 35 %**

Based on a typical daily wastewater output of approximately 100 kL/day, a weekly wastewater volume of 700 m^3 and an annual volume of 36,500 m^3/yr would need to be processed by the sludge system.

4.10.2 Sludge Lagoons

Wastewater from the clarifier sludge blowdown and the filter backwash goes directly to the sludge lagoons. There are two lagoons, the second pond having been added to give extra storage when it was found that the original lagoon was overloaded. The lagoons are simple pits, with no lining, underdrains or supernatant collection facilities.

A submersible pump is sometimes used to pump some of the supernatant out of the lagoons to aid drying using. The supernatant is pumped onto the ground surface around the WTP grounds, from where it eventually infiltrates, evaporates or re-enters the Dawson

River. Various types of sump pumps have been used for this purpose, with on/off operation controlled by a float switch.

The operators report that the lagoons do not have enough capacity to allow the off-line lagoon to dry adequately. The operators excavate the sludge while it is still the consistency of sticky mud and place it in piles for further drying.

Wastewater System

Component	Parameter (Units)	Design Criteria	Comments
Sludge Lagoons	No. of, Dimensions (m)	Pond 1: 9 x 22 m Pond 2: 21 x 26 m	Operator advised dimensions Pond 1 built originally, pond 2 added subsequently
	Typical maximum fill level	Pond 1: 1.5 - 2.0 m Pond 2: 2.0 - 2.5 m	
	Capacity total (m^3)	Pond 1: 297 – 396 m^3 Pond 2: 1092 – 1365 m^3	
	Drainage system	No underdrains	
Supernatant Return	Supernatant pumps: No. of, Capacity (L/s)	1 x 30 L/s portable submersible pump	Supernatant pumped onto surrounding ground

Photo of Sludge Pond 1

Photo of Sludge Pond 2

The management of sludge is a significant issue at the plant. Compared to the expected wastewater production of 700 m^3 per week, the capacity of the lagoons is inadequate.

The optimisation of sludge blowdown and backwashing to produce less wastewater has been addressed above. If the sludge lagoons are still overloaded after optimisation of the processes producing wastewater, **the following options should be investigated:**

- **The use of a holding tank or thickener to thicken the sludge before the lagoons;**
- **The addition of underdrains or other additional drainage in the lagoons;**
- **The implementation of supernatant recycle from the lagoons and/or any new holding tanks to the head of the plant.**

The operators reported that in previous times the supernatant from the lagoons has been pumped into the top of the clarifier/filter to recycle some of the water. This arrangement is not ideal as the flow was not passed through the coagulation and flocculation stages. There were also problems with algae from the lagoons blocking the filter.

The use of supernatant recycling to the head of the plant would be beneficial to minimise the water lost to 'waste', however it would be important to control the return rate and the design must consider additional water quality problems related to the quality of the recycled supernatant, such as algae and taste and odour compounds. The raw water flow rate may need to be throttled back so the overall flow rate with the additional supernatant recycle stream is suitable for each process component. Ideally, the lagoons would be improved to allow the supernatant to be decanted to a pump well, and the supernatant recycle pumps should provide a constant flow in a given ratio to the overall plant flow and be controlled to start and stop with the plant.

4.11 Plant Components Capacity Summary

The current capacities of the main WTP unit processes were estimated, based on the review of components outlined above. These values are shown in the table below, along with notes on the main capacity-limiting factor for each unit process, and options which could be undertaken to increase the capacity of that unit process, if required.

Chemical system capacities are addressed in the next chapter of the report.

Process Components Capacity Summary

Component	Main Limiting Factor(s)	Estimated Maximum Capacity	Options to Increase Capacity (if Required)
Raw Water Pumps	Pump condition/ capacity, river level	15 L/s	Refurbish/ upgrade pumps, add more pumps
Plant Inlet and Pulsator	Hydraulic design	15 L/s	Upgrade design
Clarifier	Flocculation time, surface loading rate	15 L/s	Increase surface loading rating, add another clarifier
Filters	Filtration rate	15 L/s	Add more filters
	Filtered water pump	16 L/s	Upgrade pump
Clear Water Tanks	Detention time	May not be adequate due to short circuiting	Prevent short circuiting, add more tanks
Clear Water (High Lift) Pumps	Pump capacity	Expected up to 11 L/s	Upgrade, add more pumps
Sludge Lagoons	Lagoon volume and drying time required	Undersized for current sludge production	Refurbish, add pre-treatment and/or supernatant recycling

From the summary above, it appears that **the most limiting factors for the overall plant capacity are:**

- Clear water tank detention time limitations due to short circuiting;
- Sludge lagoon capacity.

Most of the other components of the plant appear to be effectively limited to around the design flow of 15 L/s. Duplication of the components or addition of another separate process stream would be required to increase the plant flow output.

The clear water pump capacity may be a limiting factor in how much water can be transported away to the town reservoir per day, depending on the treated water flow rate after WTP process losses.

5. CHEMICAL SYSTEM DESCRIPTIONS, DOSES AND CAPACITIES

5.1 Chemical System Descriptions

5.1.1 Nalco Coagulant

The Nalco coagulant is supplied as a liquid in 1000L bulky boxes. The product is usually delivered to Biloela WTP, where a bulky box is loaded onto a ute with a forklift and transported to Baralaba WTP by the operators. The chemical is decanted into the main 500L storage/ dosing tank and two additional 200L storage drums using a transfer pump. Such manual handling and the risk of contact with the chemical during transfer is not ideal, and **any upgrades to the system or changes to operations procedures should consider how to make chemical delivery easier and safer for the operators,** for example delivery of bulky box by truck with a lifting mechanism and dosing directly from the bulky box.

The chemical is metered to the dosing point by a single dosing pump, with a dilution/ carry water stream assisting in the transport and mixing of the chemical.

The main details for the coagulant storage and dosing system are given in the table below.

Coagulant System

Component	Parameter (Units)	Design Criteria	Comments
Nalco Coagulant System	Chemical product and Strength (%)	Nalco DVS1 C001-D245	Chemical composition is proprietary information
	Batching concentration (g/L)	Dosed undiluted	
	Storage tanks: No. of, capacity each (L)	2 x 200 L drums	Decanted from bulky box using transfer pump
	Dosing tank: No. of, capacity each (L)	1 x 500 L tank	
	Dosing pumps: No. of, Capacity (L/h)	1 x 9.5 L/h	Premia 75 Mega-P75ME10MHVV531XX, Max Press: 10 Bar Pump calibration checked with calibration tube
	Dilution water flow rate (L/h)	250	Set on rotameter (opened to max setting)

It is noted that there is not a standby coagulant dosing pump. However it was reported that suitable spare pumps are kept in storage. **An installed standby dosing pump, possibly with automatic changeover in the event of a pump failure,** would improve process reliability by allowing plant operation to continue with minimal interruption on the event of pump failure.

Council reported that the coagulant pump and/or the coagulant dosing line had found to have been problematic on two occasions in late 2005, possibly associated with dirty water complaints in town (although treated water was found to be of suitable quality when analysed after the complaint). The loss of coagulant dosing for any amount of time is a critical failure in the treatment process and should be treated with concern. The operators report that the plant PLC is set up to stop the plant and show an alarm if there is an electrical fault with the pump, however this system will not detect dosing failure due to line blockage etc. Because of the plant's remoteness, **a flow switch alarm should be considered for this dosing system** to alert operators to dosing failures related to factors other than electrical faults. It is noted that an online filtered water turbidimeter signal (as mentioned in the previous section of this report) would also give useful indication of major plant problems such as failure of the coagulant dosing system.

The dilution water flow will assist in dispersion of the coagulant at the dosing point, however as noted previously in this report, a static mixer at the dosing point should also be considered for optimum coagulation.

Photo of Coagulant Dosing Pump

Photo of Coagulant Storage/ Dosing Tank and Drums

5.1.2 Polyacrylamide (LT20)

The polyacrylamide LT20 is supplied as a powder and batched manually in a combined batching/ dosing tank. A funnel fed eductor is used to wet up the polymer powder as it is added to the water during batching.

The main details for the polyacrylamide makeup and dosing system are given in the table below.

Polyacrylamide System

Component	Parameter (Units)	Design Criteria	Comments
Polyacrylamide System	Chemical product and Strength (%)	Ciba Magnafloc LT20, supplied as powder	
	Storage space (bags)	Several bags stored in chemical dosing shed	
	Batching system	Manual feed into mixing/ dosing tank via eductor	
	Batching concentration (g/L)	2 g/L	2 kg into 1000 L
	Mixing/dosing tank size	1000 L	
	Dosing pumps: No. of, Capacity (L/h)	1x 29.4 L/h	Acromet pump model 2000-005. Pump calibration checked with calibration tube
	Dilution water flow rate (L/h)	250	Set on rotameter (opened to max setting)

Photo of Polyacrylamide Mixing/Dosing Tank

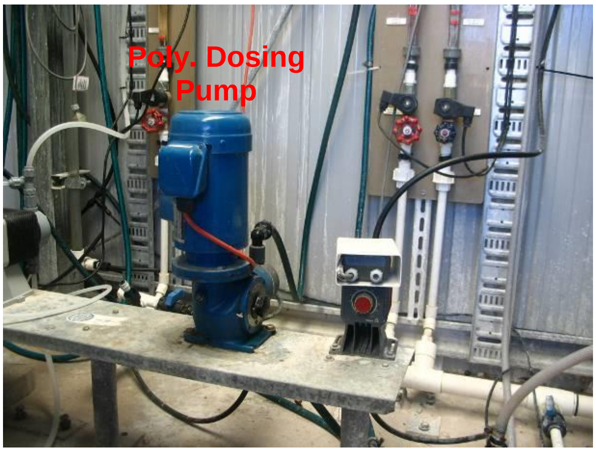


Photo of Polyacrylamide Dosing Pump

No problems were reported with the polyacrylamide makeup and dosing system. A future upgrade to an **automatic polyacrylamide makeup batching system** could be considered.

5.1.3 Chlorine

The chlorine dosing system is installed in part of the shed next to the chemical dosing room. The chlorine room normally houses two cylinders (one on-line cylinder plus standby cylinder) and the pre-chlorine and post-chlorine chlorinators.

Photos of Chlorine System Installation

The chlorine booster pump is housed inside the chemical dosing shed, next to the polyacrylamide batching tank.

Normal practise is to feed both the pre- and post-chlorinators from one duty cylinder, with pressure switches giving automatic changeover to the standby cylinder.

The chlorine cylinders are sometimes required to be delivered to site by the operators. Even though a forklift can be hired for the purpose, this operation can involve excessive manual handling and risks damage to the chlorine cylinders, and ideally **an easier and safer way of delivering the cylinders to site should be found.**

The main details for the pre- and post-chlorine dosing systems are given in the table below.

Chlorine Systems

Component	**Parameter (Units)**	**Design Criteria**	**Comments**
Chlorine System	Chemical product	Chlorine gas (70 kg cylinders)	
	Chlorine room capacity (cylinders)	4 to 6 x 70 kg cylinders	2 duty (1 x pre and 1 x post), remaining cylinders unconnected standbys
	Ejectors: No. of, Type, Capacity (g/h)	2 (1 x pre and 1 x post dosing), S10k Rotameters, Capacity: Pre: 200 g/h Post: 200 g/h	Ejector capacity advised by operator
	Booster water pumps: No. of, Capacity (L/s)	1 x 30.6 L/s	Davey model 09501-0 Type 666; 50 hz, 7.2 amps, 1.1 kw No installed standby
	Load cells capacity	No load cells	Pressure switches show when empty and give auto changeover
	Service water supply	Supplied from town delivery line	
	Chlorine leak detector: Type	Acutec 35	

It is noted that there is only one chlorine booster pump, common to both the chlorine systems. A standby pump should at least be kept in stock in case the booster pump fails. **Ideally, an installed standby chlorine booster pump should be provided to lessen the potential down time of the critical post-chlorine dosing system.**

The continued dosing of post-chlorine is critical for disinfection of the final water. Although there is auto-changeover if the duty cylinder runs out, other problems, such as booster pump failure or blockage, could interrupt dosing. It is understood that the installation of an online chlorine residual meter is planned. **The online residual meter should be installed as soon as possible and should be connected to the SCADA system, with an associated dial out alarm.**

Once online monitoring is available, **the control of the chlorine system could be upgraded to automatically adjust the dose in response to the measured value.**

Photo of Chlorine Booster Pump

Photo of Chlorine Leak Alarm Panel

The design of the chlorine systems and the chlorine room is compared to some of the requirements of the Australian Standard for chlorine installations (AS/NZS 2927: 2001) in the table below.

It was reported that when a chlorine leak did occur, the chlorine leaked into the chemical dosing shed and affected the electrical switchboard in the shed. The operators report that openings into the shed from the chlorine store have now been effectively sealed.

Relevant requirements of the Australian Standards for storage and handling of chlorine gas (AS/NZS 2927:2001) are shown in the table below and compared to the system used.

Australian Standard Requirements for Chlorine Installations

Clause	Requirements	Reqts Met?	Comments
1.8	Site secured against unauthorised persons	Y	Fence and locked gate
3.3.1	Chlorine installation at least 15 away from protected place (e.g. public building) and 8 m away from public place	Y	Estimated distance to nearest building
3.5.1	Cladding or lining of any indoor installation shall be incombustible. Floor shall be of concrete	Y	Colourbond lining, concrete slab
3.5.1	At least one sign prominently displayed at eye level, visible when door is open	Y	Sign on front of building
3.5.1	Pits, sumps and machinery wells enclosed or below the level of the chlorine installation shall have no unsealed openings into the chlorine storage or chlorinator areas or areas traversed by pipes carrying chlorine	Y	Sealed since a previous chlorine leak damaged electrical equipment inside shed
3.5.3	Natural or mechanical ventilation required. Natural ventilation requires at least 0.1 m^2 for each 2 m of external wall, near to floor level in opposite walls to create a cross-draught	N	Not strictly met (ventilation along one wall only), however significant ventilation below and above doors
4.2.1	Cylinders shall be kept upright and securely restrained	Y	Cylinders chained to wall. Check that chains fastened securely at all times

Clause	Requirements	Reqts Met?	Comments
4.3	Design, materials and pressure relief of S10k chlorinators not reviewed in detail. Proprietary product assumed to meet standards	Check	Check that installation of any pressure relief meets requirements
4.5, 4.6, 4.7	Design and materials of pipework, valves, joints and fittings not reviewed in detail	Check	Check that installation and materials meet requirements
4.8.1	Leak detectors shall be installed where chlorine is stored in tanks or where liquid chlorine is withdrawn. Leak detectors shall be tested each week	N	Leak detector installed. Assumed Acutec35 unit meets requirements Not tested weekly
5.3, 5.4	Staff medical testing and training levels not reviewed in detail. Assumed Council complies to requirements	Check	Check that testing and training meet requirements
5.7	Movement of cylinders shall be with a suitable trolley designed to hold cylinders in place by chain or clamp or crane/ hoist with proper cradle	N	Cylinder movement method may not comply. Trolley should be used
5.9	Weekly and monthly test procedures and records not reviewed in detail. Assumed Council complies to requirements	Check	Check that inspection and records meet requirements. Noted that general maint. records kept in daily diary
5.8, 5.10, 5.11	Cylinder connection procedures, PPE, maintenance procedures and work permits system not reviewed in detail. Assumed Council complies to requirements	Check	Check that connection procedures meet requirements
5.12	First aid station, safety shower and eyewash shall be provided	Y	
6.2	An emergency plan should be prepared and regularly reviewed and revised	Y	Existing emergency plans to be reviewed and revised as required
6.4	Signage shall include “No Smoking” and “Restricted Area” signs as per requirements	Y	

As seen above, the installation does not meet some of the requirements of the Standards. A number of requirements are assumed to be met but should be checked in detail by Council. **Ideally, the chlorine installation should be improved to meet the Australian Standards as required.**

5.1.4 Lime

Lime is not currently dosed at the plant at all as it is not required under usual conditions. However the original plant design allowed for both pre and post lime dosing. Post-lime dosing is occasionally used at the plant, under certain raw water conditions.

When used, lime is supplied in 20 kg bags. It is batched manually into a standard concentration dosing solution in the lime dosing tank. The dosing solution is delivered to the post-lime dosing point by a single metering pump.

It was noted that the original lime system had a bag cabinet and splitter suspended above the tank. This system was abandoned as the rising water level in the tank tended to wet the bag and make it difficult to unload.

The main details for the lime makeup and dosing system are given in the table below.

Lime System

Component	Parameter (Units)	Design Criteria	Comments
Lime System	Chemical product and strength (%)	Hydrated lime. Various suppliers. Varying purity	Poor quality lime implicated in pump and line blockages
	Makeup and dosing system components	Solution mixing tank Dosing pump	Manual loading into tank
	Number of makeup systems	1	
	Storage capacity	Lime in 20 kg bags	
	Bag unloading arrangement	Bags manually unloaded into solution tank	No dust extraction system
	Batching concentration (g/L)	Approx 35.3 g/L	3 bags (60 kg) into 1700 L
	Solution tank capacity (L)	1700	
	Dosing pumps: No. of, Capacity (L/h)	1 x 25.2 L/h	Pump calibration checked with calibration tube
	Dilution water flow rate (L/h)	250	Set on rotameter (opened to max setting)
	Flushing system	Flush on shutdown: • Pump 30 seconds • Delivery line extended flushing	

Photo of Lime Dosing Tank

Photo of Lime Dosing Pump

It is understood that the lime mixer operates continuously when the lime system is running. This is important as lime has limited solubility and will otherwise tend to settle out.

The operators report that there have been problems with blockages in the lime system and dosing lines, even though the lime solution is carried to the dosing point by dilution water and the system is set up to flush the lines with service water on plant shut down.

To reduce blockage problems, the system could be programmed to also flush periodically during operation. A further measure may be to periodically flush the system with an acid solution as part of a maintenance routine. **These additional flushing options, or others, should be investigated to reduce the occurrence of blockages in the lime system.**

As noted for other WTPs, the operators report that lime blockages are much less frequent when good quality lime is used. Good quality lime products should therefore be specified when chemicals are purchased.

The manual loading of the lime tank requires the lifting of 20 kg bags and potential contact with lime dust during bag unloading. **Manual handling and the risk of contact with the chemical would ideally be minimised in any planned lime system improvements.**

5.2 Chemical Doses Used

5.2.1 Nalco Coagulant

Data on coagulant doses is logged on plant record sheets at the WTP site, however was not available in electronic format for the preparation of trends. Based on operator advice, the doses used with the latest Nalco coagulant product (DVS1 C001-D245) range from around 20 mg/L to 80 mg/L. Typical doses are in the range 30 – 35 mg/L.

All chemical doses are summarised in the table at the end of this chapter.

5.2.2 Polyacrylamide (LT20)

The operators report that the dose of polyacrylamide applied is generally around 0.2 mg/L, and not normally varied.

5.2.3 Chlorine

The operators report that typical chlorinator settings are around 70 g/h for pre-filtration chlorination and 60 g/h for post-filtration chlorination. These dose rates correspond to dose rates of 1.3 and 1.1 mg/L respectively at the design flow rate of 15 L/s.

The pre-filtration chlorine dose may reportedly be raised to a maximum of 90 g/h (1.7mg/L) if high levels of metals are measured in the raw water.

The post-filtration chlorine dose reportedly has little variation, although it is adjusted in order to achieve a suitable chlorine residual.

All chemical doses are summarised in the table at the end of this chapter.

5.2.4 Lime

Post-filtration lime is reportedly used rarely and if required is needed at relatively low doses, say around 1 – 5 mg/L.

5.2.5 Powdered Activated Carbon

There is not powdered activated carbon (PAC) dosing facility at the plant. However, during periods where tastes and odours were a problem, weekly or daily dosing of PAC to the filter by hand has been undertaken in the past. The remote operation of the plant is not suitable for manual PAC dosing and **an automatic PAC system or another suitable technology for treating organic contamination (such as taste and odour compounds and algal toxins) would reduce the risk of producing treated water of unacceptable quality**.

5.3 Chemical Dose and System Capacity Summary

5.3.1 Calculated System Dosing Capacities

The current capacities of the chemical systems in mg/L for various plant flow rates were calculated, based on the review of systems outlined above and data shown in the following table. The capacity values are shown in the table, along with options for increasing the capacity of each system.

Chemical Dosing Capacities (Calculated from Available Data)

Chemical	System Parameters		Calculated Dose Capacity (mg/L)		Batch Tank/ Cylinder Usage Time		Options to Increase Capacity (if Required)
	Dosing capacty (L/h)	Dosing Soln (g/L)	15 L/s Plant Flow	30 L/s Plant Flow	Vessel Volume (L)	Time to Empty* (h)	
Nalco coagulant	9.5	1260 (s.g. 1.26)	**220**	**110**	500	53	Larger pump
Polyacr-ylamide (LT20)	29.4	2	**1.1**	**0.55**	1000	34	Stronger solution, larger pump
Pre-chlorine	200 g/h	n/a	**3.7**	**1.9**	70 kg	350	Upgrade dosing system
Post-chlorine	200 g/h	n/a	**3.7**	**1.9**	70 kg	350	Upgrade dosing system
Post-lime	25.2	35.3	**16.5**	**8.25**	1700	67.5	Stronger solution, larger pump

* At maximum dosing rate

5.3.2 Chemical Dose Summary and Comparison with Capacities

The actual chemical doses, as discussed above, are summarised in the table below, with the estimated system capacity for a 15 L/s plant flow repeated for comparison purposes.

Actual Doses Used (Estimated from Available Data)

Chemical	Actual Doses Used (mg/L)		Capacity at 15 L/s Plant Flow (mg/L)
	Range	Typical	
Nalco Coagulant (DVS1)	20 - 80	30 - 35	220
Polyacrylamide (LT20)	Little variation	0.2	1.1
Pre-chlorine	1.1 – 1.7	1.3	3.7
Post-chlorine	Little variation	1.1	3.7
Post-lime	Low doses used occasionally	2	16.5
Powdered activated carbon (PAC)	Dosed to filters in past to treat taste and odour compounds		No dosing system available

From the above comparison of actual doses with the capacity of each chemical system, the following comments are made:

- All chemical dosing systems comfortably meet the rates required for the expected range of chemical doses at a plant flow of 15 L/s;
- All chemical dosing systems would also achieve the expected dose rates if the plant was upgraded to give a flow rate of 30 L/s, although the chemical/ solution tanks may need to be topped up more than once per week under maximum dosing conditions.

6. WTP OPERATIONAL ISSUES

6.1 Plant Control and Operational Issues

6.1.1 General Observations

Baralaba is located by road approx. 100 km north-west of Biloela. Because of its small size and distance from the other three WTPs, Baralaba WTP is not staffed full-time. Operators from Biloela usually make the trip to Baralaba once a week in order to verify the status of the plant and restock chemicals.

The plant control system includes automatic backwashing but generally has a low level of automation, with no flow pacing or automatic dose adjustment and backwashing triggered either by a timer or a float switch. It is understood that Council plan to upgrade the plant PLC and general control system in the future and that there may be scope to achieve operational improvements as part of this process.

The existing system functions with little operator input. Water quality and other performance indicators are usually monitored only once per week at the WTP. There are few alarms available to alert the operator to plant process failures.

6.1.2 SCADA System

A RADTEL brand SCADA system common to all Council WTPs has been implemented over recent years. The Baralaba SCADA page currently shows the raw and treated water pumps, and the levels in the clear water tanks and the town reservoir. The SCADA system will potentially be useful in terms of adjusting setpoints, logging online data, remote plant observation/ operation and callout alarms, especially when online water quality monitoring is implemented.

6.1.3 Control of Plant Startup and Shutdown

The plant is automatically started and stopped based on water demand via the following control loops:

- High Lift Pump Control: The elevated town reservoir level signal is used to generate a start/stop signal to the WTP high lift (treated water) pumps. The start/stop signals can be set on the SCADA system;
- Raw Water Pump Control: The WTP clear water tank level signal is used to generate a starts/stop signal to the raw water pumps;
- Chemical Dosing Systems Control: The plant PLC controls the startup and shutdown of the chemical dosing systems to coincide with the raw water pump operation;
- Backwash Initiated Plant Stop: If a filter backwash is triggered, the plant PLC shuts down the raw water pumps, chemical dosing systems (if the plant is running) and high lift pumps, and then runs through the automatic backwash procedure.

It is noted that all valves on the flow path through the WTP remain open when the plant is off. The filter inlet and outlet valves are manually operated only and are usually left open.

It is noted that the raw water pump and the high lift (clear water) pump duties are changed over manually, but this can be done remotely by selecting the required duty pump on the SCADA screen.

6.1.4 Online Monitoring

The existing and planned online monitoring facilities for the WTP are summarised in the table below.

Online Monitoring Meters Summary

Component	Parameter (Units)	Design Criteria	Comments
Turbidity	Type	HACH – **Purchased but not yet installed**	To be logged to SCADA
	Sampling location	Filtered water - - **Not yet installed**	
pH	Type	**Planned, but not yet installed**	To be logged to SCADA
	Sampling location	Final water - **Not yet installed**	
Chlorine Residual	Type	**Planned, but not yet installed**	To be logged to SCADA
	Sampling location	Final water - **Not yet installed**	
Raw Water Flow	Type	Magmaster Magflow meter	Logged to SCADA
	Sensor location	Raw water main at plant inlet	
Treated Water Flow	Type	Magflow meter	
	Sensor location		
Clear Water Tank Level	Type	'Platypus' pressure sensor plus multi-trode	Level sensor logged to SCADA Multi-trode controls raw water pumps
	Sensor location	Second-on-line clear water tank	Sensor was moved from first clear water tank to give better flow control
Elevated (Town) Reservoir Level	Type	'Platypus' pressure sensor plus Hi/ Lo level float switches	Level sensor logged to SCADA
	Sensor location	Reservoir	

There is currently no online water quality monitoring. An online turbidimeter has been purchased but not installed. Online chlorine and pH meters are reportedly budgeted for the near future.

Online monitoring of turbidity, chlorine and pH should be implemented as soon as possible. Such remote monitoring is important for this mostly unmanned plant and should be developed as a priority to reduce the risk of unnoticed process failures.

An online raw water turbidimeter could be considered to provide advance warning of poor river quality, although the operators are usually aware of general river conditions from analysis at the other WTPs drawing from the same river.

The sample transport and sensor location of each online monitoring system should be designed carefully to maximise reliability. For example:

- The on-line turbidity system should be set up to minimise algal growth in the sample line and analyser with careful selection of siting, sample line flow rates and maintenance procedures;
- The on-line chlorine residual system should be set up to measure the residual at a constant contact time after chlorine dosing, which can be achieved by arrangement of the sample line to give a suitable contact time before the analyser (assuming that the chemical is fully mixed into the water before the sample line tapping).

The online parameters should be logged to the SCADA to allow the operator to view plant performance trends remotely.

6.1.5 Laboratory Equipment

The accuracy of laboratory equipment was not reviewed as part of this study. However it was noted that the Upgrade Audit report by Hunter Water Australia (May 2005) it was recommended that the Lovibond bench-top turbidimeter used at the plant be replaced with a more accurate bench-top model. **All laboratory equipment available at the plant should be checked to confirm it is accurate and reliable**.

6.1.6 SCADA Callout Alarms

There are a number of alarms which register on the main control panel for the plant. Some of these alarms are also connected to the SCADA system. It is understood that alarms are gradually being connected to the SCADA system and the SCADA callout alarms list.

The alarms for the plant process operation which are considered critical enough to be on the SCADA callout list (when available) include:

- Filtered water turbidity high;
- Treated water chlorine residual low/ high;
- Power outage;
- Treated water pH low/ high.

The turbidity and chlorine SCADA callout alarms should be developed and implemented as soon as possible, as noted in previous sections of this report. The pH and power outage alarms should also be set up when practical.

6.1.7 Power Failure Protection

It is understood that there is no backup power supply for the plant in case of power failure. Considering the storage volume and the size of the town, there is a risk that a protracted power failure could lead to low storage levels. **Provision of a backup power supply system should be considered.**

It is noted that the raw water pumps are supplied with power through the WTP power box, therefore the raw water pumps will not function if there is a power outage at the WTP, reducing the risk that raw water will be accidentally pumped through the WTP when it is offline due to power falure.

6.2 Safety and Environmental Issues

The following safety and environmental issues were noted during CWT's WTP inspection, however this is not intended to be a full and exhaustive OH&S audit.

It is understood that improvements since the draft version of this report was prepared include:

- Addition of roof and walkways over clarifier and filter;
- Provision of laboratory facilities and on-site toilet.

6.2.1 General Observations

6.2.2 Chemical Bunding

It is noted that none of the chemical solution tanks or dosing pumps in the chemical shed are separately bunded. Chemical spills would tend to leak onto the floor of the chemical shed. Chemical spills on the shed floor would be a health hazard, and it is likely that large spills would find their way outside the shed and potentially enter the environment.

Photo of Chemical Tanks in Storage Shed

All chemical storage and batching/ dosing tanks and all chemical dosing pumps should be bunded to prevent the spillage of chemicals. Bunds should be built to conform with standards on design and materials.

It was noted that a spill kit for cleaning up and isolating chemical spills is provided at the plant.

6.2.3 Manual Handling

Nalco coagulant is delivered in various sized containers by ute and is required to be decanted into the dosing tank by transfer (air operated diaphragm) pump. Chlorine cylinders are required to be lifted from the ute. There is no forklift available on site for lifting, although one can be hired when required.

As noted previously, upgrades of the chemical systems and changes in operational procedures should be developed to further minimise manual handling requirements for the operators.

6.2.4 Contact with Chemicals

Because chemicals are batched manually, there is some potential for the operators to come in contact with the chemicals such as lime and polymer powders. The manual unloading of the Nalco coagulant also gives potential for contact with the chemical. **Any upgrades of the chemical systems should consider ways to further minimise the risk of operator contact with chemicals.**

7. WTP AND SYSTEM UPGRADE REQUIREMENTS

7.1 Identified Potentials for WTP Improvement

The issues identified for potential improvement of the WTP are tabulated below according to the area of the WTP assessed. Time frame and priority levels have been developed for each issue, based on the consideration of current priorities and requirements of Council.

7.1.1 Water Quality Monitoring

System	Issue/ Requirement	Refer Section No.	Time Frame	Priority
General	Label data records more clearly in water quality database	3.2	Short	Low
Raw water quality	Prepare pesticide/herbicide incident management plan, including trigger levels for action	3.3.8	Medium	**High**
Raw water quality	Analyse water for algal toxins and taste and odour compounds when these contaminants are detected in the river water	3.3.9	Medium	Medium
Raw and Treated water quality	Monitor *Cryptosporidium* and *Giardia* in raw and treated water	3.3.10	Short	Medium
Treated water quality	Ensure that correct chlorine residual sampling and analysis procedure is followed	3.3.7	Short	**High**
Treated water quality	Monitor for THM levels regularly	3.3.10	Short	Medium
General	Check all laboratory equipment available at the plant to confirm it is accurate and reliable	6.1.5	Short	Medium

7.1.2 Online Instruments

System	Issue/ Requirement	Refer Section No.	Time Frame	Priority
At Neville Hewitt weir	Install accurate water level measuring system in the weir, transmitting signal to the WTP control system and raising an operator call out alarm if the weir level increases significantly	3.1.3	Medium	**High**
Filtered water	Install online filtered water turbidimeter and connect to SCADA system. Set up shutdown and operator callout alarms.	6.1.4, 4.6.1	Short	**High**
Treated water	Install online chlorine residual meter and connect to SCADA system, with associated callout alarms and possible auto control	5.1.3, 6.1.4	Short	**High**
Raw water	Install online monitoring of raw water turbidity and connect to SCADA system	6.1.4	Long	Low

System	Issue/ Requirement	Refer Section No.	Time Frame	Priority
Treated water	Install online treated water pH meter and connect to SCADA system	6.1.4	Short	Low
SCADA alarms	Implement SCADA pH and power outage callout alarms	6.1.6	Short	Low

7.1.3 Treatment Process Upgrades

System	Issue/ Requirement	Refer Section No.	Time Frame	Priority
Turbidity removal	Improve treatment process to achieve stable removal of turbidity to at least < 1 NTU and preferably < 0.3 NTU to minimise potential pathogen breakthrough	3.3.1	Short	**High**
Disinfection	Improve post-chlorine dosing control to meet the residual target more reliably – Either by manual or automatic control improvements	3.3.7	Short	**High**
Disinfection	Minimise short-circuiting through the clear water tanks so that the full 80kL storage volume is utilised for disinfection detention time	4.8	Short	**High**
Disinfection	Cover clear water tanks to minimise heating	4.8	Short	Medium
Removal of organic compounds	If required, add PAC dosing system or alternative process to remove organics from the raw water	3.3.9, 4.3.6, 5.2.5	Medium to long	Medium
Pre-coagln pH adjustmt	Make provision for pre-coagulation lime dosing	4.3.5	Medium	Low
Pre-filtration dosing	Investigate changing the order of dosing for the pre-filtration chemicals to: pre-chlorine, coagulant, then polyacrylamide	4.3.3, 4.3.4	Medium	Low

7.1.4 Chemical Dosing

System	Issue/ Requirement	Refer Section No.	Time Frame	Priority
Coagulant	Consider how to make chemical delivery easier and safer for the operators	5.1.1	Medium	Medium
Coagulant	Install standby coagulant dosing pump	5.1.1	Medium	Medium
Coagulant	Install automatic changeover system	5.1.1	Medium	Low
Coagulant	Install flow switch alarm	5.1.1	Medium	Medium
Polyacryl-amide	Install automatic polyacrylamide makeup batching system	5.1.2	Long	Low
Chlorine	Find easier and safer way of delivering cylinders to site	5.1.3	Medium	Medium

System	Issue/ Requirement	Refer Section No.	Time Frame	Priority
Chlorine	Improve chlorine installation to meet Australian Standards	5.1.3	Medium	Medium
Chlorine	Install standby chlorine booster pump	5.1.3	Medium	Medium
Lime	Minimise manual handling and the risk of contact with the chemical in any planned lime system improvements	5.1.4	Long	Low
Lime	Investigate additional flushing or other options to reduce the occurrence of blockages in the lime system	5.1.4	Medium	Low
General	Upgrades of the chemical systems should consider ways to further minimise the risk of operator contact with chemicals	6.2.3	Long	Medium
Bunding	Bund all chemical storage and batching/ dosing tanks and all chemical dosing pumps	6.2.1	Long	Medium
Nalco coagulant name	Refer to the Nalco coagulant product using the first part of the number, DVS C001, rather than D245	4.3.2	Short	Low

7.1.5 Clarifier

System	Issue/ Requirement	Refer Section No.	Time Frame	Priority
Clarifer	Investigate options to improve operation and design of the clarifier desludge system	4.5	Medium	Medium

7.1.6 Filter

System	Issue/ Requirement	Refer Section No.	Time Frame	Priority
Filter	Investigate filter performance and optimise run times	4.6.1	Medium	Medium
Filter	Investigate backwashing effectiveness using turbidity and headloss trends when available	4.6.1	Medium	Medium
Filter	Investigate air scour, combined and water washing regimes and hydraulic requirements for drainage of backwash water to make backwashing more effective if required	4.6.2	Medium	Medium
Filter	Install standby filtered water pump	4.6.1	Long	Low
Filter	Fit new DP cell and connect to logging system	4.6.1	Medium	Low

7.1.7 Wastewater System

System	Issue/ Requirement	Refer Section No.	Time Frame	Priority
Sludge treatment	Investigate options to overcome current sludge system capacity limitations.	4.10.2	Medium to Long	Medium

7.1.8 General

System	Issue/ Requirement	Refer Section No.	Time Frame	Priority
Raw water pumps	Replace Pump No.1 with a pump suitable to provide full plant flow rate.	4.2	Medium	**High**
Reticulation	Mains cleaning and optimal operation of the town reservoir to maintain chlorine residuals	4.9	Short	**High**
Power supply	Consider provision of backup power supply system for WTP	6.1.7	Medium	Medium
Clear water tanks	Consider using another type of tank if replacement tanks are needed, due to poly tank failures	4.8	Medium	Low

7.2 Recommended High Priority Actions

7.2.1 High Priority, Short Timeframe Actions

The following improvement works are high priority and should be carried out as soon as possible:

- Online filtered water turbidimeter – Install meter (already purchased) to measure turbidity of filtered water. Connect to SCADA system and set up high and high high turbidity alarms with appropriate controls e.g. High alarm to trigger a filter backwash. High high alarm to trigger automatic plant shutdown and operator callout.
- Online chlorine residual meter – Purchase and install meter to measure treated water chlorine residual at a suitable point. Connect to SCADA system and set up low, low low and high high alarms with appropriate controls e.g. Low alarm to trigger operator callout. Meter should produce suitable signal for automatic feedback control of chlorine dosing system.
- Clear water tank reconfiguration – Alter inlet and outlet of tanks to achieve flow in series and minimise short-circuiting so that the full 80kL storage volume is utilised for disinfection detention time. Noted that Council has commenced work to this effect.
- Mains cleaning and the optimal operation of the town reservoir to maintain chlorine residuals – These issues in the reticulation should be investigated as addressed in the CWT report “Baralaba WTP Performance Review” (March 2010). It is understood that Council are taking steps to organise mains cleaning in Baralaba.

The following operational actions are high priority and should be carried out as soon as possible:

- Establish correct chlorine residual sampling and analysis procedure – Council to implement draft procedure.
- Improve post-chlorine dosing control to meet the residual target more reliably – This may include improved manual control of dose assisted by online monitoring system and operator training or the design and implementation of automatic control of chlorine dosing from the online meter signal.
- Improve treatment process operation and control to achieve stable removal of turbidity to at least < 1 NTU and preferably < 0.3 NTU to minimise potential pathogen breakthrough – Manual optimisation of plant when required, assisted by online monitoring.

7.2.2 High Priority, Medium Timeframe Actions

The following actions are high priority actions which should be carried out in the medium term timeframe:

- Water level measuring system in the weir – Install accurate level sensor, transmitting signal to the WTP control system and raising an operator call out alarm if the weir level increases significantly.
- Pesticide/herbicide incident management plan - Prepare pesticide/herbicide incident management plan, including trigger levels for action.
- Replace Raw Water Pump No.1 – Replace with a pump suitable to provide full 15 L/s plant flow rate at all possible river levels, so that adequate standby is available to achieve full plant flow rate if Pump No.2 fails. If possible select a replacement pump which can draw from the lowest level in the pump well to minimise the effect of low weir levels on achievable WTP flow rate.
- Automatic control of chlorine dosing - Possible implementation of automatic control of chlorine dosing from the online meter signal.

7.3 Recommended Medium Priority Actions

7.3.1 Medium Priority, Short Timeframe Actions

The following actions are medium priority actions which should be carried out in the short term timeframe:

- Lab equipment review - Check all laboratory equipment available at the WTP to confirm it is accurate, reliable and calibrated. Confirm that all operators are proficient in using the equipment.
- Clear water tanks shade covers - Cover clear water tanks to minimise the effect of water heating on chlorine residuals levels.
- *Cryptosporidium* and *Giardia* monitoring – Background and event based monitoring in raw and treated water.
- Chlorine disinfection byproducts (THMs) monitoring – Regular monitoring in treated water.

7.3.2 Medium Priority, Medium to Long Timeframe Actions

The following actions are medium priority actions which should be carried out in the medium to long term timeframe:

- Algal toxin/ taste and odour compound analysis and treatment – Take samples for analysis if these contaminants are detected or likely to be in the river water. If required over the longer term, add PAC dosing system or alternative process to remove organics from the raw water.

- Power supply backup - Consider provision of backup power supply system for WTP in case of extended power failures.
- General chemical dosing improvements - Bund all chemical storage and batching/ dosing tanks and all chemical dosing pumps. Design any system improvements to make chemical delivery easier and safer for the operators and minimise the risk of operator contact with chemicals.
- Coagulant system improvements - Install flow switch on coagulant dosing line and connect to SCADA to trigger callout/ shutdown alarm if coagulant pump fails. Install standby coagulant dosing pump.
- Chlorine system improvements – Improve method of delivering cylinders to site. Find easier and safer way of delivering cylinders to site. Improve chlorine installation to meet Australian Standards. Install standby booster water pump.
- Clarifier desludge system improvements - Investigate options to improve operation and design of the clarifier desludge system. Noted that Council currently working on some modifications to this system.
- Filter performance investigation and improvement - Investigate filter performance and optimise run times. Investigate backwashing effectiveness using online turbidity and headloss trends when available. Investigate air scour, combined and water washing regimes and hydraulic requirements for drainage of backwash water to make backwashing more effective if required.
- Sludge system upgrade - Investigate options to overcome current sludge system capacity limitations. These could include:
    - Holding tank or thickener to thicken the sludge before the lagoons
    - Underdrains or other additional drainage in the lagoons
    - Supernatant recycle from the lagoons and/or any new holding tanks to the head of the plant

7.4 Recommended Low Priority Actions

The following actions are recommended actions, considered lower priority than those actions listed above but nevertheless expected to bring benefits in terms of performance or operability of the WTP. Although listed as low priority under the current climate, some of these issues may become higher priority if conditions or concerns change in future:

- Data labelling - Label data records more clearly in water quality database.
- Coagulant reference name - Refer to the Nalco coagulant product using the first part of the number, DVS C001, rather than D245.
- Use of poly tanks - Consider using another type of tank if replacement clear water tanks are needed, due to poly tank failures.
- Online monitoring of raw water turbidity - Install online monitoring of raw water turbidity and connect to SCADA system.
- Online treated water pH - Install online treated water pH meter and connect to SCADA system.
- SCADA alarms - Implement SCADA pH and power outage callout alarms

- Process improvements - Investigate changing the order of dosing for the pre-filtration chemicals to: pre-chlorine, coagulant, then polyacrylamide.
- Pre-coagulation lime dosing - Make provision for pre-coagulation lime dosing.
- Coagulant pump auto-changeover - Install coagulant dosing pump automatic changeover system (once installed standby pump available).
- Polyacrylamide auto batching system - Install automatic polyacrylamide makeup batching system.
- Lime system improvements - Minimise manual handling and the risk of contact with the chemical in any planned lime system improvements. Investigate additional flushing or other options to reduce the occurrence of blockages in the lime system.
- Filtered water pump standby - Install standby filtered water pump.
- Filter DP (headloss) meter - Fit new DP cell to filter and connect to SCADA logging system.

7.5 Budget Costs for High Priority Actions

Indicative budget cost costs for the recommended high priority works are given for reference in the following table.

Estimated Budget Costs

Action	Budget Cost	Notes
Online filtered water turbidimeter installation (already purchased), connection to SCADA system, commissioning and set up of alarms.	$8,000	Estimate
Online chlorine residual meter purchase, installation, connection to SCADA system, commissioning and set up of alarms	$10,000	Estimate
Chlorine system automatic control components purchase, installation, link to online chlorine residual meter signal and commissioning	$10,000	Estimate
Clear water tanks reconfiguration	Council works underway	-
Raw water weir water level sensor system purchase, installation, connection to SCADA system and set up of alarms	$10,000	Estimate
New Raw Water Pump No.1 approx. 15L/s duty submersible bore pump purchase, installation and commissioning	$15,000	Estimate
Pesticide/herbicide incident management plan	$10,000	Estimate
Mains cleaning	Council works underway	-

8. FINDINGS AND RECOMMENDATIONS

8.1 Findings

8.1.1 WTP Flow Rate and Demand Issues

The current capacity of the WTP is normally 15 L/s but may drop to 13 L/s or lower due to low river levels, use of the smaller raw water pump No.1, or if the plant is down-rated in poor raw water quality periods.

Historical water demands and expected WTP production capacities are shown in the table below.

WTP Demands and Flow Requirements Summary

Flow Parameter	Typical	Worst Case
Historical Demands kL/day	100 - 600	882
Estimated Plant Treated Water Production Capacity kL/day		
Water Losses Through Process:	5 - 10% Losses	20% Losses
Reduced flow rate - 13 L/s	840 - 890	750
Typical flow rate - 15 L/s	970 - 1025	860

Treated water production capacity calculated using 20 hours operation per day, as detailed in section 2.3.2

As seen in the table above, all typical town demands would be expected to be met with the WTP operating at 13 to 15 L/s. Maximum historical demand has been met by the plant operating at 15 L/s with typical process losses but there may be a shortfall under reduced WTP flow rates or increased process water loss conditions.

As town demands are met under typical operating conditions and treated water demands may be reduced in future due to the planned introduction of a separate raw water irrigation system, augmentation of the WTP capacity is not considered a priority at this stage.

8.1.2 Water Quality Issues

A review of the raw water and WTP treated water quality found that:

- Raw water issues include turbidity and colour from river flow events, moderate levels of manganese and the presence of herbicides;
- Turbidity in WTP treated water has been periodically elevated to levels > 1 NTU which may compromise disinfection;
- Chlorine residuals achieved in the treated water have been highly variable and there may have been periods of very low readings and/ or incorrect monitoring of this parameter;
- *Coliforms* and *E.Coli* have been present in a number of treated water samples. Significant levels in late 2009 led to a ‘boil water’ alert being issued by the Regulator;
- From modelling of corrosivity potentials, the water is likely to be mildly corrosive under typical conditions.

There have been ongoing treated water microbiological issues during early 2010, and separate investigations are still being undertaken to solve these problems. Improvements to achieve suitable and stable treated water quality from the WTP and within the reticulation are therefore a high priority issue.

8.1.3 WTP Process, Chemical Systems and Operational Issues

A review of the WTP treatment processes and chemical dosing systems found that:

- Most of the plant components are matched well in terms of achieving a 15 L/s plant flow rate, with the most limiting plant components being the clear water tank detention time (with current arrangement), the sludge lagoons and the clear water pumps;
- Most components would not be suitable for flowrates higher than the design flow rate of 15 L/s. Higher flow rates would require duplication of the major plant components or provision of a new separate process;
- Chemical dosing systems are sized to easily meet expected duties at a plant flow rate of 15 L/s and most would be adequate for an increased plant flow rate up to 30 L/s;
- Plant control and automation, safety and maintenance issues were also reviewed, with recommendations developed as outlined below.
- Online monitoring of filtered water turbidity and chlorine residuals with operator callout and plant auto shutdown alarms are priority issues associated with improving treated water quality performance.

8.2 Recommendations

The recommended high priority actions are listed in the following table, with indicative budget costs given where appropriate. Refer to Section 7 of this report for further details.

High Priority Actions and Indicative Budget Costs

Action	Indicative Cost
Online filtered water turbidimeter	$8,000
Online chlorine residual meter	$10,000
Improved process operation and control to achieve stable removal of turbidity	Operational action
Improved control of post-chlorine dosing via manual control, operator training	Operational action
Automatic control of chlorine system	$10,000
Clear water tanks reconfiguration	Council works underway
Raw water weir water level sensor system	$10,000
Replace Raw Water Pump No.1	$15,000
Pesticide/herbicide incident management plan	$10,000
Mains cleaning	Council works underway
Optimal operation of the town reservoir to maintain chlorine residuals	Operational action

Further recommended medium and lower priority actions are outlined in Section 7 of this report. It is recommended that Council pursue at least the high priority, short timeframe actions immediately or as soon as possible.

9. REFERENCES

- US EPA, Disinfection Benchmarking and Profiling Guidance Manual, EPA 815-R-99-013, US EPA Office of Water, August 1999.
- Hunter Water Australia/ Maunsell Australia, Baralaba WTP Upgrade Audit, May 2005.
- City Water Technology, Baralaba WTP Performance Review issues paper, March 2010.

10. APPENDICES

APPENDIX A –WATER QUALITY - EXTERNAL LABORATORY ANALYSIS RESULTS

General Analysis Results for WTP Raw Water

Parameter	Units	2002	2005	2006		2007					2008			ADWG
		Weir	WTP	WTP	WTP	Weir	WTP	Weir	Weir	Weir	Weir	Weir	Weir	
		15/10	29/11	10/1	28/11	19/2	16/5	21/8	17/9	12/11	18/2	26/5	18/8	
Turbidity	NTU	350	146	549	568	112	1	104	62	3	205	11	51	< 1
True Colour	HU	10	87	5	58	8	6	24	6	4	84	5	15	< 15
pH	-	7.3	7.18	6.53	7.3	7.2	7.36	7.97	7.27	6.87	7.27	7.02	7.81	6.5 – 8.5
Conductivity	µs/cm	115	153	163	171	178	205	207	234	237	125	172	195	-
Total Dissolved Solids (TDS)	mg/L	72	95	100	102	110	119	118	130	139	75	98	105	< 500
Total Dissolved Ions	mg/L	86	118	119	127	142	154	158	177	188	85	121	132	-
Total Hardness	mg/L $CaCO_3$	27.5	41	37	46	52	58	59	68	75	27	42	48	< 60 Soft, may be corrosive
Temp Hardness	mg/L $CaCO_3$	27.5	41	37	46	52	58	59	68	75	27	42	48	-
Alkalinity	mg/L $CaCO_3$	42	63	57	66	75	81	81	92	98	39	56	66	-
Silica	mg/L	11	16	16	16	15	14	9	10	12	14	12	13	-
Sodium	mg/L	10.5	12	14	12	14	15	17	16	16	10	14	14	< 180
Potassium	mg/L	4.7	5.5	6.2	5.7	6.2	6.4	6.4	6.6	7.6	5.2	5.9	6.2	-
Calcium	mg/L	6.7	9.6	8.7	11	12	14	14	16	18	6.8	11	12	-
Magnesium	mg/L	2.6	4.3	3.6	4.6	5.2	5.7	5.9	6.7	7.5	2.4	3.8	4.3	-
Hydrogen	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	-
Bicarbonate	mg/L	51	77	69	80	92	98	97	112	120	48	69	79	-
Carbonate	mg/L	0.1	0.1	0	0.1	0.1	0.1	0.6	0.2	0	0	0	0.3	-
Hydroxide	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	-
Chloride	mg/L	7.3	6.8	7.5	7.4	7.4	11	12	13	13	10	14	13	< 250
Fluoride	mg/L	0.1	0.1	<0.1	0.15	0.18	0.16	0.18	0.15	0.09	0.06	0.08	0.09	< 1.5
Nitrate	mg/L	1.5	0.6	7.3	2.2	1.1	<0.5	<0.5	1.9	2.5	0.8	2.0	<0.5	< 50
Sulphate	mg/L	2.2	1.4	3.3	4.3	4.4	3.7	4.9	5.1	5	<1	2.7	2.2	< 250
Iron	mg/L	0.05	0.16	<0.01	0.09	<0.01	<0.01	0.08	<0.01	<0.01	0.54	<0.01	0.14	< 0.3
Manganese	mg/L	<0.03	<0.03	<0.03	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	< 0.1
Zinc	mg/L	0.02	0.06	0.13	<0.01	0.04	0.04	<0.01	0.05	0.08	<0.01	0.20	<0.01	< 3

Parameter	Units	2002	2005	2006		2007					2008			ADWG
		Weir 15/10	WTP 29/11	WTP 10/1	WTP 28/11	Weir 19/2	WTP 16/5	Weir 21/8	Weir 17/9	Weir 12/11	Weir 18/2	Weir 26/5	Weir 18/8	
Aluminium	mg/L	0.05	0.09	<0.05	0.05	<0.05	<0.05	0.12	<0.05	<0.05	0.64	<0.05	0.14	< 0.2
Boron	mg/L	0.02	0.06	0.08	0.05	0.05	0.06	0.09	0.06	0.06	0.03	0.15	0.04	< 4
Copper	mg/L	<0.03	<0.03	<0.03	<0.03	0.06	0.1	<0.03	0.04	0.05	<0.03	0.03	<0.03	< 1

General Analysis Results for Treated Water

Parameter	Units	2002	2005	2006		2007				2008			ADWG
		15/10	1/11	10/1	28/11	19/2	16/5	21/8	12/11	18/2	26/5	18/8	
Turbidity	NTU	3	1	2	1	1	1	<1	<1	4	1	2	< 1
True Colour	HU	3	12	4	9	5	7	5	1	4	6	<1	< 15
pH	-	7.55	7.02	7.31	7.33	7.44	7.51	7.78	7.35	7.39	7.36	7.77	6.5 – 8.5
Conductivity	µs/cm	175	150	179	182	189	210	212	227	168	196	202	-
Total Dissolved Solids	mg/L	97	88	103	106	115	120	119	124	95	110	106	< 500
Total Dissolved Ions	mg/L	110	100	121	127	143	153	156	160	111	132	133	-
Total Hardness	mg/L $CaCO_3$	48.5	38	38	48	54	59	60	63	39	48	48	< 60 Soft, maybe corrosive
Temp Hardness	mg/L $CaCO_3$	36.5	38	38	48	54	59	60	63	39	48	48	-
Alkalinity	mg/L $CaCO_3$	36.5	45	53	59	71	76	74	70	50	58	63	-
Silica	mg/L	10	16	14	15	16	14	9	8	15	14	12	-
Sodium	mg/L	11	11	15	12	14	15	16	16	12	15	14	< 180
Potassium	mg/L	4.9	5.4	6.3	5.4	6.2	6.3	6.5	6.7	6.6	6.5	6.3	-
Calcium	mg/L	14.5	8.9	10	12	13	14	14	15	10	12	12	-
Magnesium	mg/L	3	3.8	3.1	4.6	5.3	5.8	5.9	6.6	3.3	4.4	4.3	-
Hydrogen	mg/L	0	0	0	0	0	0	0	0	0	0	0	-

Parameter	Units	2002	2005	2006		2007				2008			ADWG
		15/10	1/11	10/1	28/11	19/2	16/5	21/8	12/11	18/2	26/5	18/8	
Bicarbonate	mg/L	44.5	54	64	72	86	93	90	85	61	71	77	-
Carbonate	mg/L	0.1	0	0.1	0.1	0.1	0.2	0.3	0.1	0.1	0.1	0.2	-
Hydroxide	mg/L	0	0	0	0	0	0	0	0	0	0	0	-
Chloride	mg/L	24.5	14	17	15	14	15	17	24	16	20	16	< 250
Fluoride	mg/L	<0.1	0.1	0.1	0.14	0.22	0.18	0.17	0.16	0.09	0.08	0.09	< 1.5
Nitrate	mg/L	1.4	1	1.7	2.3	0.7	<0.5	0.5	1	0.8	0.5	<0.5	< 50
Sulphate	mg/L	5.5	1.4	2.9	4.2	4.4	3.7	5	5.5	1.2	2.4	2.3	< 250
Iron	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	< 0.3
Manganese	mg/L	<0.03	<0.03	<0.03	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	< 0.1
Zinc	mg/L	<0.01	0.09	0.03	0.05	0.13	0.43	0.03	0.06	<0.01	0.01	<0.01	< 3
Aluminium	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	< 0.2
Boron	mg/L	<0.02	0.05	0.06	0.05	0.06	0.06	0.09	0.06	0.03	0.05	0.04	< 4
Copper	mg/L	<0.03	0.04	0.04	<0.03	0.41	0.8	0.03	0.1	<0.03	0.03	<0.03	< 1