REMOVAL OF SOLUBLE IRON AND MANGANESE FROM BORE WATER AT CASTERTON WTP

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ABSTRACT

The Casterton Water Treatment Plant (WTP) is a combination pressure and gravity filtration system. Raw water is drawn from the Tullich bore field some 14 kms away from the WTP. The original treatment and supply system to Casterton consisted of filtration and sodium hypochlorite dosing to maintain water quality. Once this water is treated it is stored in a combination of clear water storages (CWS) to service Casterton and the surrounding towns of Sandford, Merino and Coleraine.

Adding to the demand of the original plant is the supply to the other towns. This has created several treatment issues, including increased water demand, seasonally fluctuating raw water quality, increased chlorination requirements to maintain chlorine residual over longer distances, chlorine residual causing oxidisation and fall-out of Iron and Manganese in the reticulation, high numbers of colored water complaints and issues maintaining chlorine residuals in the retic.

KEY WORDS

Iron, Manganese, Colour, Soluble, Bore, Bore Water

1.0 INTRODUCTION

1.1 Casterton WTP Supply and Demand

The Casterton WTP was originally designed to supply water to the towns of Casterton and Sandford through a system of onsite CWS and a covered storage basin, with the raw water supply coming from the Tullich bore field via a 14km supply main.

The original treatment plant was a pair of pressure filters dating back to the 1970s, with an upgrade of two supplemental gravity filters undertaken in 2006. The treated water passes through an onsite CWS and gravity-feeds to a covered reservoir.

With South West Victoria experiencing persistent drought conditions over the previous decade, the Tullich/Casterton system was expanded to supply two further town sites.

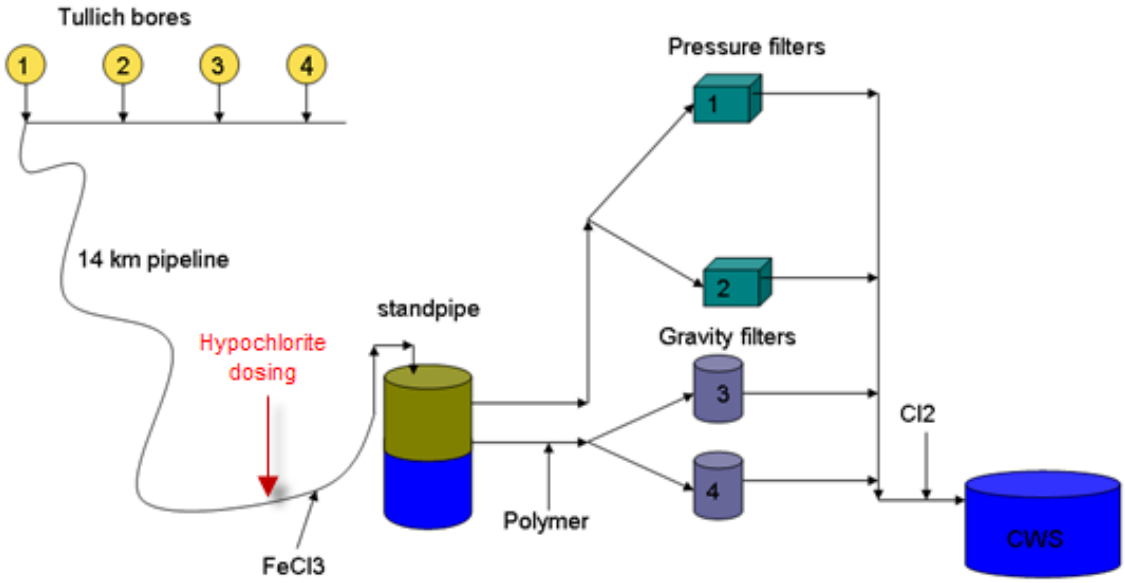

Figure 1: ***Casterton Water Treatment Plant process outline***

The addition of Merino and Coleraine to the system also required an expansion to the Tullich bore field and a fourth bore was equipped. This increased the theoretical WTP production to 5.5ML/day – 60 l/sec. However, pressure limitations and requirements for filter backwashing reduce that to the current operation of 4.3 ML/day – 50ltr/ sec.

1.2 Treatment and Quality Issues

The original treatment, consisting of filtration and dosing of sodium hypochlorite into the CWS, was augmented with Ferric chloride dosing to the raw water inlet and polymer as a flocking aid prior the gravity filters. These two chemical additions, combined with the catalytic activity of both the pressurised sand and anthracite over sand gravity filters, struggled to cope with the increased production/flow requirements.

Pre-chlorine dosing in the form of sodium hypochlorite to assist in the oxidisation of soluble manganese and iron prior to filtration was added to the plant in 2009. This showed improvement to the filtered water. However, process control and maintaining water quality in the CWS and reticulation was difficult due to the following issues.

The raw water drawn from the four bores in varying sequences and run times to satisfy production and licence requirements creates a changing blend of soluble metals, turbidity and colour.

The 14km distance of the bore supply main creates a six hour lag time from production to delivery, exacerbating the change of raw water quality at the head of the plant. In cooler months the plant may be idle for 18 to 20 hours, allowing some oxidisation of the raw water stored in the supply main.

The highly fluctuating values of turbidity, colour and soluble metals exposed the limitations on a fixed dose system, with an average filtered water quality achieved over required run times. This is most apparent in the chlorine demand or loss of Cl_2 residual in the supply/reticulation system and a high number of recorded dirty water complaints.

The extended supply system required higher Cl_2 residual to be maintained and this had the undesired effect of oxidisation of soluble manganese within the supply system. This ongoing reaction created poor aesthetic quality and customer complaints.

The lack of onsite manganese testing capability was a major hindrance to the treatment staff as the filtration process could not be adjusted to account for the soluble iron and manganese levels in the raw water.

2.0 DISCUSSION

2.1 In-House Optimisation of Treatment Process

With the treatment issue and knock-on effect recognised by the treatment staff, a working group was formed within Wannon Water to address the problem of residual manganese levels. With Wannon Treatment Response group meeting on site with the plant operators, all the relevant information and experience was collated to form a multi-prong approach to the issue.

Firstly, the Treatment Response group set about acquiring a licence to purchase and store a Manganese reagent test kit. This involved Department of Health Victoria as the reagents contain trace levels of Cyanide. A special storage system for the reagent and waste was installed as the lab was upgraded with new bench top equipment and fume extractor.

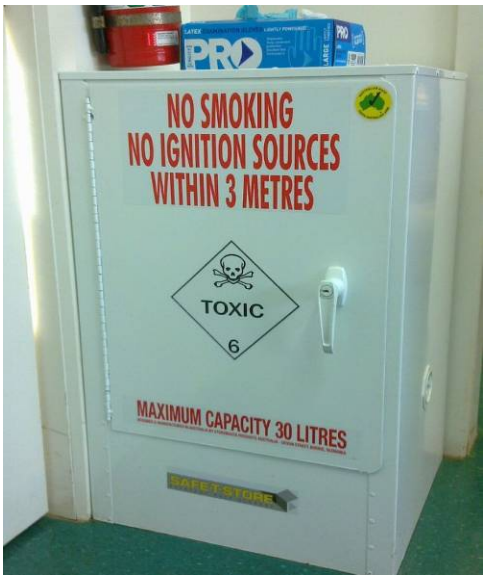

Figure 2: ***Storage vessel and containment for manganese reagent and waste***

In consultation with Treatment Services the plant's HACCP / testing routine was altered to reflect the increased lab tests required. While the operators' hazard analyses indicated the introduction of a hazardous chemical and controlled waste required changes to our lab procedures, reporting results and PPE.

Previously, in an effort to remove the built-up layers of oxidised particulates in the bore supply main, contractors where engaged annually to swab/pig the 14km length of main. The treatment staff responsible for Casterton WTP decided that this same task could be performed quarterly with some slight changes to the infrastructure and method. This was approved and to date Wannon Water has swabbed four times, greatly improving the raw water quality at the head of the plant.

Raw water data collated to indicate load on filtration process is included in Table1.

Table 1: ***Raw water data***

Ave turbidity range	5 – 19 NTU
Peak turbidity	105 NTU (10 to 30 min inflows)
Iron	2.00 – 4.20 mg/L
Manganese sol	0.070 – 0.120 mg/L
Colour	7 – 50 Pt-Co
pH	7.20 – 7.50
Ave flow	22 -32 l/sec
Peak flow	32 -50 l/esc

2.2 Process Changes and Results

The premise of removing soluble Fe/Mn by oxidisation prior to flocculation and filtration is greatly assisted by the ability to quantify their levels both prior and post the treatment presses. In-house testing for Manganese began in June 2010 combined with daily lab/jar testing. This has established a trend in raw water quality, enabling the treatment staff to pre-empt the demand for oxidisation.

Examples from plant process control log:

04-11-2010			
Bores operational	1, 2, 3.		
Raw flow inlet	50 l/sec		
pH	7.41		
Turbidity	5.57 NTU		
True colour	7 Pt –co		
Iron	2.49 mg/L		
Soluble Manganese	0.090 mg/L		
Sodium Hypochlorite pre dose		@ 12% = 5.2 l/h	
Ferric chloride		@ 42% = 5.5 mg/l	#w/v
Polyelectrolyte		@ 0.08 = 0.02 mg/l	#w/v
Filtered water outlet:			
pH	7.52		
Turbidity	0.09 NTU		
True colour	0.00 Pt-co		
Iron	0.02 mg/L		
Soluble Manganese	0.023 mg/L		
Free Chlorine	0.22 ppm		

With daily process monitoring and adjustments to compensate for sodium hypochlorite degradation in active strength, Wannon Water has successfully reduced the soluble manganese throughout the distribution water system.

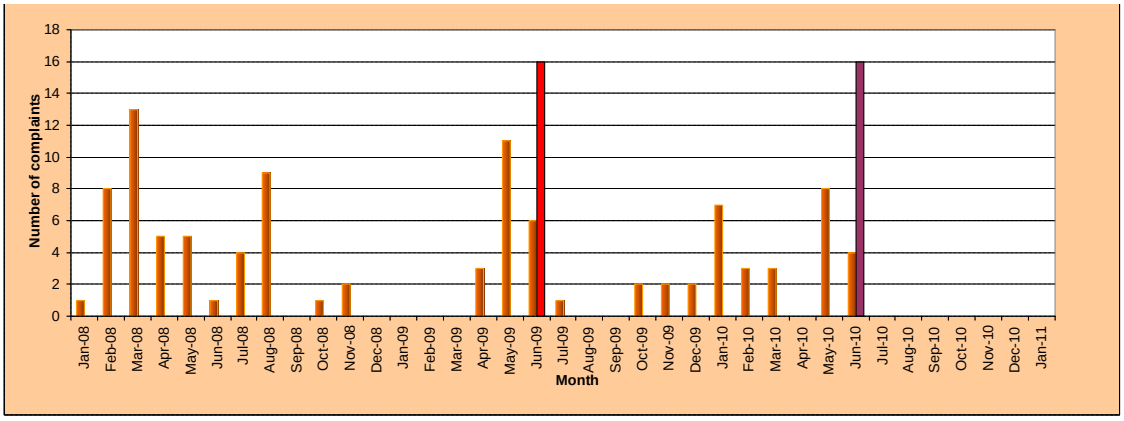

Figure 3: ***Illustrates the reduction of dirty water complaints throughout the Tullich - Casterton system.***

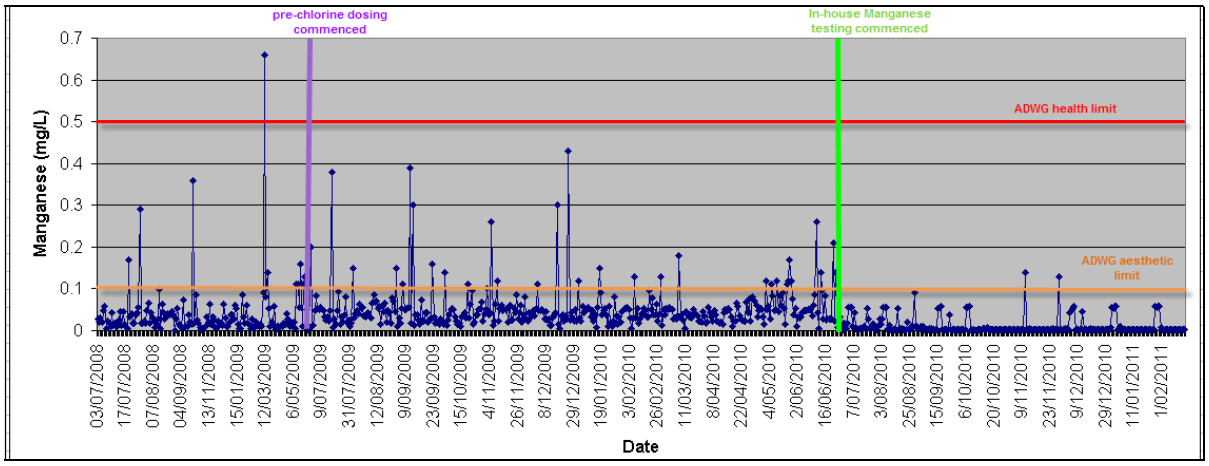

Figure 4: ***Illustrates the impact of plant optimisation to regulatory compliance for manganese in the Tullich - Casterton system.***

3.0 CONCLUSION

The optimisation of the Casterton filtration plant is still an ongoing process. Wannon Water aims to further improve the treated water quality through trial then implementation of innovative and cost effective treatment methods.

4.0 ACKNOWLEDGEMENTS

Wannon Water Western Treatment Team
Wannon Water Treatment Services