

## **GOSFORD'S EXPERIENCE IN MANAGING IRON AND MANGANESE**



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## ABSTRACT

The Gosford water supply has been subject to severe restriction since 2002, as a result of a long term drought. The total storage available had dropped to 12.8% in early 2007, with the prospect of a long hot summer ahead. Under this extreme environment, long established operational procedures were necessarily modified to focus on water conservation. The urgent need for the development of alternative sources removed the focus from operation, to capital works. One of the outcomes of the changed environment was the development of widespread discoloured water issues.

## 1.0 INTRODUCTION

Iron and manganese within urban water supply systems can have serious impacts, even at low levels. Lower demands associated with severe water restrictions can contribute to the problem, due to less natural flushing of the pipe network normally associated with summer demands. The long standing drought has impacted further, through a reduction in routine mains flushing programs in an effort to publicly demonstrate our commitment to saving water. Lower storage levels, as a result of the drought, impact on our ability to selectively isolate poorer quality sources. Unlined pipes and fittings are causing local discoloured water issues.

All-in-all, local conditions have compounded into the perfect opportunity for iron and manganese to proliferate within the distribution system, until levels are sufficiently high and widespread to cause endemic discoloured water problems.

## 2.0 DISCUSSION

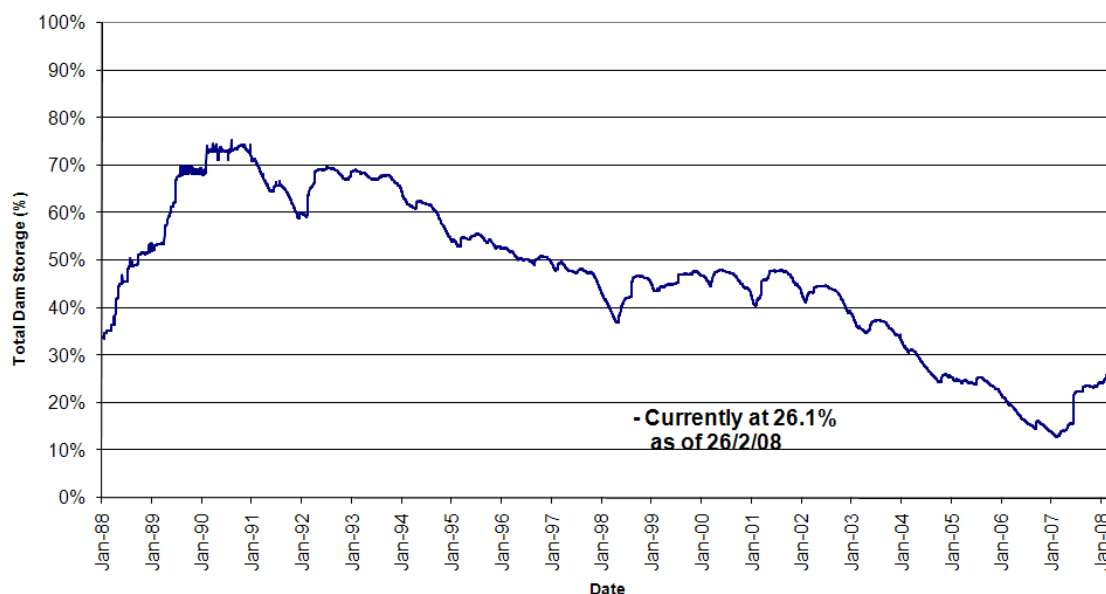
### 2.1 Water Supply System Overview

The Gosford Water Supply system is served by two significant water storages. Mooney Dam was commissioned in 1962, located within a rural catchment approximately 5 km west of Gosford, and is heavily influenced by surrounding agricultural activities. Mangrove Creek Dam was commissioned in 1982, and is located within a totally closed catchment, approximately 30 km west of Gosford. In 2007, several bore fields were commissioned as a result of low storage levels due to the drought. The Woy Woy borefield is located directly below the Woy Woy township. This supply has significant levels of iron and manganese.

Gosford and Wyong Councils share water supply headworks and distribution infrastructure, resulting in access to significant transfers of treated water between the two authorities. This provides additional opportunity to selectively isolate poorer quality sources if required.

The distribution system comprises 9390 km mains, 20 pumping stations, 34 reservoirs and 64,300 connections. Pre-drought demands ranged from 35 to 110 Ml per day.

Existing (restricted) demands range from 30 to 37 ML per day. The extreme reduction in peak demands has removed the natural flushing of the reticulation system which would normally occur during peak summer demands. Figure 1 details a history of the system storage levels over time.



**Figure 1:** Gosford Wyong Council's water supply system – total storage level (since 1988)

## 2.2 Water Storages

Mooney Dam suffers from an extremely high oxygen demand, resulting in the development of anoxic conditions throughout the storage. The presence of iron and manganese oxides within the sediments of the dam combined with the anoxic conditions, results in elevated levels of both elements within the water body.

Following a number of years of investigation and trials, a submerged mixer was deployed in 2000 to destratify the storage. Within a short time, the storage was totally destratified. However, dissolved oxygen levels throughout the storage did not respond. Dissolved oxygen dosing equipment was installed, providing a very good response in dissolved oxygen levels. Experience indicated that a minimum of 2.5mg/L of dissolved oxygen was a good operational target for good water quality, which was easily met with the combined mixing and oxygen injection systems.

Mangrove Creek Dam has been provided with a totally closed, essentially pristine catchment. Water quality was not perceived to be a problem from this type of catchment. However, investigations revealed significant levels of both iron and manganese within the storage. Implementation of destratification was successful in increasing dissolved oxygen levels and reducing both iron and manganese levels. Destratification also avoided the annual turnover of the storage, resulting in poor quality water for a number of months.

Current water restrictions prohibit the use of potable water for use outside the house. A “Water Banking” scheme was developed, whereby consumers can purchase vouchers for use of potable water for the garden, which has been replaced with water from alternate sources at approximately \$5/kL.

The quality of the alternate sources being delivered to the water treatment plant is almost invariably of less quality than that of the surface water storages.

### **3.0 EXISTING CONTROL MEASURES**

#### **3.1 Catchment Management**

The entire Mangrove Creek Dam catchment is owned by Council. It is pristine natural bushland. The Mangrove Creek weir catchment includes only one small private rural holding. Both areas are well managed, with minimal public access.

The Mooney Dam catchment includes a significant level of agricultural development, including piggeries, chicken farms and mixed horticultural. Much of the direct catchment is State Forest. Council is working with the Dept of Agriculture on a range of farming practice improvement initiatives within the wider catchment.

The Woy Woy bore field is shallow, and is located directly below the Woy Woy township comprising 40,000 people. The stratum is sand based, with a number of former tip-sites present. Management of this catchment is heavily reliant on existing Local Government development controls. A significant number of properties have a private spear point or bore, which extract from the same aquifer.

#### **3.2 Treatment**

The Mangrove Creek Dam storage has an aeration system providing effective destratification and oxygen transfer, resulting in good quality water year round.

The Mooney Dam storage has a submerged mixer which provides effective destratification of the storage. Oxygen transfer was found to be inadequate to control uptake of iron and manganese from the sediments within the storage. Oxygen injection has proved successful in maintaining appropriate dissolved oxygen levels. Both the destratification and oxygen injection systems suffered from extended failures over the previous twelve months.

The key surface water treatment plant is a conventional plant, last augmented in 1985, to 140 ML/day capacity. It comprises flash mixing, flocculation, horizontal flow sedimentation and single media sand filtration. There is no provision for iron or manganese removal.

The Woy Woy (bore field) water treatment plant incorporates aeration for oxidation of iron, potassium permanganate dosing for oxidation of manganese, flocculation and ultra filtration.

#### **3.3 Source Selection**

Raw water sources normally available include Mangrove Creek Dam, Mangrove Creek Weir, Mooney Dam and more recently, Woy Woy bore field. Council also has treated water sources available from Wyong Shire Council, through a long standing Joint Water Supply Agreement.

The continuing drought has resulted in minimal opportunity to avoid poorer quality sources. Over the previous five years, all efforts were directed toward maximising yield from available resources, often at the expense of quality.

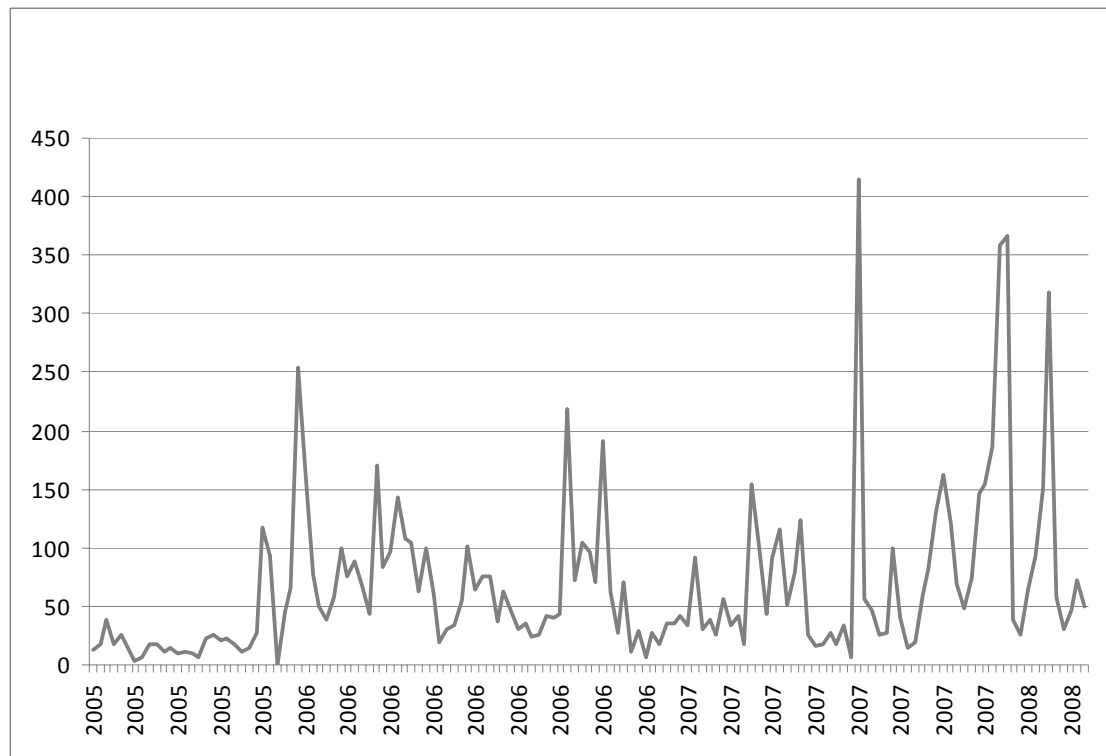
### 3.4 Operation and Maintenance

Prior to the drought, flushing programs existed to manage iron and manganese deposits within the reticulation system. These programs were severely curtailed following the introduction of level 2 restrictions in July 2002.

Restricted flushing was implemented during 2007, using tankers to collect the waste which was returned to the Somersby water treatment plant as a water conservation measure.

### 4.0 MODIFIED OPERATION & MAINTENANCE STRATEGIES IMPLICATIONS

Reduced storage levels due to the long standing drought resulted in a range of modified strategies, aimed at maximising yield in preference to optimising system performance and water quality. These modified strategies have combined to result in a significant discoloured water problem within Gosford. Figure 2 details a history of the complaints received.



**Figure 2:** *Weekly discoloured water complaints*

Since July 2005, Council has received 9550 complaints and delivered over 5,000 sachets of stain removing powder for customers suffering from staining of washing. A large number of claims have been received for the replacement of clothing damaged beyond

repair.

#### **4.1 Improvement Program**

A range of initiatives have been developed to provide a sustainable improvement in water quality within Gosford. Medium to long term initiatives have been developed under a program titled “Water Quality 2010”. This program of work includes a range of process improvements and replacement programs for unlined fittings and valves. System improvements have also been provided for, enabling the implementation of swabbing programs for key distribution mains. This program attracted Federal funding prior to the last election, on a dollar for dollar basis. The program of work is in the order of \$10M.

In the short-term, following significant rainfall during late 2007 and early 2008, an aggressive flushing program has been implemented. The program is generally being delivered overnight to minimise impacts on the customers. This program has delivered good results, with a significant drop on customer complaints, but has placed a considerable strain on resources, with night crews not being available for normal day time work.

Specific initiatives under “Water Quality 2010” include:

- Provision of permanganate dosing at Somersby Surface Water treatment plant, supported by lime and carbon dioxide dosing
- Provision of pre-chlorination of the filter influent at Somersby Water Treatment Plant
- Pipework modifications to provide for swabbing of key trunk mains
- Distribution system improvements to ensure minimum velocities can be maintained under lower (restricted) demands
- Unlined fittings replacement program
- Investigation into the pre treatment of supernatant from the sludge drying beds prior to returning to inlet works.
- Implementation of the Australian Drinking Water Guidelines 2004

#### **5.0 CONCLUSION**

The Gosford Water Supply is relatively typical of supply systems throughout NSW. Scheme development peaked in the 1970’s with major augmentations in the mid 1980’s. The treatment plant is similar to many plants throughout NSW, providing basic treatment capabilities, including flocculation, sedimentation, sand filtration, chlorination and pH correction. The reticulation system comprises a mix of cast and ductile iron, upvc and steel mains, some of which are unlined. Many of the valves and hydrant tops are unlined, as are some of the fittings

A detailed review of the wider risks to potable water quality existing within the supply system has been valuable in the development of a water quality improvement strategy targeting the widespread discoloured water issues within the Gosford Water Supply. The wider risks included the impact of reduced demands on pipe velocities, the impact of the drought on our ability to avoid poorer quality sources and the identification of key infrastructure. The identification of critical control points has re-established the importance of each of the more important infrastructure items and processes within the system.

The Australian Drinking Water Guidelines 2004 provide the framework necessary to develop a risk based, catchment to tap approach to water quality management. Without a structured approach to the identification of risks and the development of documented management strategies, individual risks can be easily overlooked with the passage of time. When a number of key risks are inadvertently overlooked, the water supply can be at significant risk.

Our urban water supplies deserve the risk-based, multi-barrier approach to ensure our systems are robust enough to perform, under even extreme circumstances.

## **6.0 ACKNOWLEDGEMENTS**

To the dedicated water operations staff who have responded to the current challenges with distinction.