

CHLORINATION INCIDENT AT GLOUCESTER WTP



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ABSTRACT

Gloucester Water Treatment Plant (WTP) is a conventional filtration plant extracting raw water from the Barrington River in NSW. The WTP was transferred to MidCoast Water (MCW) in 2011 from Gloucester Shire Council along with the remaining water and sewer assets. In 2012, MCW identified key areas where upgrades were required however these were delayed. Only minor works were carried out at the time including the upgrade of the sodium hypochlorite system, which was replicated from another MCW plant. On 24th March 2015, an over chlorination event occurred which took six days to rectify. An independent review was undertaken on the incident which identified syphoning as the root cause. As a result of the event, it was evident the WTP required significant improvements and MCW water lacked many internal management systems and quality control.

1.0 INTRODUCTION

Gloucester WTP, transferred from Gloucester Shire Council to MCW in 2011, is situated in the north-eastern section of the Hunter Region of NSW, approximately 2.5hrs north of Sydney and 1hr west of Taree. The WTP services approximately 4000 people in 1900 homes with water extracted from the Barrington River. The current WTP, commissioned in 1979, is a conventional filtration water treatment plant comprising of coagulation, flocculation, clarification, media filtration, chlorine disinfection and fluoride dosing. The plant has a design capacity of 4.5MLD with an average daily supply of 0.9MLD. The water reticulation system comprises of 3 service reservoirs, 6 booster pump stations, 1 transfer pump station and approximately 30km water main.

Prior to the March 2015 incident, the WTP had seen minimal improvements since its inception. The plant remained a basic laborious process which lacked automation and monitoring. The plant utilised a radio telemetry system to initiate plant production based on reservoir and clear water tank levels, and recorded simple plant information such as raw water and clear water pump starts and run times only.

In 2012, MCW identified that the plant had significant operational and WHS issues and was internally reviewed for a significant upgrade in 2014. The 4 main areas where upgrades were required included:

1. Sludge pond upgrade with associated backwash balance tank, supernatant pump station and pipework.
2. Building upgrade including amenities and switchroom.
3. Roof over existing treatment tanks, and
4. Automation upgrade including switchboard, instrumentation upgrade, SCADA integration, new function specification and P&ID.

However, these upgrades were put on hold to enable an assessment of a longer term solution to be investigated. It was also determined that any significant augmentation was outside the capacity of the Long Term Financial Plan for the next 5-10 years.

In 2013, MCW aimed to improve the chemical storage areas by relocating the sodium hypochlorite and ACH into designated bunded areas, which were formally non-existent.

The sodium hypochlorite system also received an upgrade in the way of new dosing pumps, associated plumbing, and the dosing point was relocated from the rising main to the clear water chamber; with an aim of improving contact time. However, whilst the intention was constructive, the design and implementation was undertaken internally, replicating similar MCW WTP's. With this, it was assumed the new system was fit for purpose and ideally suited to its new application.

2.0 DISCUSSION

2.1 The Incident

On Tuesday 24th March 2015, the early signs of a chlorine incident were beginning to immerge. Upon arrival at the WTP at 6:00am, the operator later commented that he had noticed an unusual smell, however proceeded with the daily routine. At approximately 7:30am, the operator was notified by the routine reticulation sampler that chlorine levels were higher than normal in the rising main with a value of 3.7mg/L. With this, the operator tested the clear water well and recorded a result of 3.8mg/L. As a result, at 9am the operator reduced the dosage. At this point, the operator believed the increase in chlorine residual was a result of increasing the dose rate on Saturday 21st March to accommodate the increased turbidity in the river; which at this point was normal practice. The reticulation run continued throughout the morning with results normal for the reservoirs and only a slight increase in the designated reticulation sample. Based on these results and the operator tests, alongside the change in chlorine dosage, the recorded high chlorine was seen as a minor incident and within the ADWG, thus fit for consumption.

Later in the day, at 12:04pm, MCW customer service received the first customer complaint for this incident commenting their water tasted like 'sulphur and was bitter'. In response, customer service raised a work order, and the reticulation crew undertook mains flushing in the area. Between 2:00pm and 3:00pm two more calls were received, one of those from the Gloucester Hospital. These were recorded and further work orders raised. At 3pm, the high chlorine issue was passed onto the Catchment and Treatment (CAT) Manager and Area Coordinator for the first time. As initial testing indicated there was a higher than normal chlorine residual, however within the guidelines, it was decided to not utilise on-call staff and further investigations would continue the following day. At the time of the incident, MCW was embarking on an exercise to reduce overtime, thus any after-hours work was scrutinised. Additional calls were received throughout the afternoon by customer service, who advised customers that the elevated chlorine levels were a result of the 'fresh' in the river.

On Wednesday 25th March, MCW received a significant increase in customer calls and a media enquiry. After being delayed for various reasons, and oblivious to the significance of the crisis, chlorine sampling began at 10:30am starting with the two main reservoirs, Tyrell St and Ravenshaw St. Both reservoirs read over-range for the instrument which is a figure of 8.8mg/L and well above the ADWG; at which point the drain valves were opened and discharged to park land. At 11:20 the incident was notified to the executive and an incident management team was assembled, and by 12:00pm NSW Health and the EPA were notified.

At 12:20 Ravenshaw reservoir flushing was reduced as water quality had improved and back within the ADWG, local staff then focused on responding to customer complaints by flushing affected areas. Whilst the incident was developing, Telstra planned a shutdown of the mobile service between approximately 11:00am and 3:00pm making communications difficult. Additional crews from Taree and Forster were called upon to assist with reticulation flushing and water quality monitoring where water was discharged to the environment. An emphasis was placed upon flushing mains to areas that would have a minimal impact to the environment, such as open parklands where chlorine would have an opportunity to dissipate, and avoiding areas adjacent to rivers, creeks and nearby catchments for the protection of aquatic life. Bottled water was purchased and delivered to the schools, hospital and to those customers that had requested water via customer service. Flushing and sampling continued to approximately 9:00pm at which point signs were emerging that the situation was improving.

However, tests early the following morning indicated that the chlorine residual was back to its previous high throughout the reticulation, and this trend continued for the following four days; that is, an improvement in water quality by days end, however back to its former state the following morning. It was becoming obvious that the reticulation system had received a large slug of Sodium Hypochlorite, and flushing and usage were dragging this slug throughout different areas of the system. By Friday morning, approximately 1.5ML of water had been used to flush mains. Whilst field staff prioritised removing non-compliance water from the system, the emergency response team engaged an independent engineering consultant, Hunter H₂O, to investigate the incident to find the root cause.

Friday 27th March saw an announcement of a \$50 rebate to customers of the affected area and a visit to Gloucester from the MidCoast Water Executive to speak to the community. The community engagement occurred in the main street of Gloucester and was open to the public. The morning's forum allowed concerned rate payers to air their concerns and have their questions answered; feedback indicated this was a positive exercise. Flushing and sampling of the reticulation system continued until Monday 30th March at which point the chlorine residual has returned to normal.

2.2 The Investigation

At 1:00pm on Friday 27th March, the independent consultants, Hunter H₂O, arrived at the Gloucester WTP to begin their assessment. The evening involved two Hunter H₂O consultants, the WTP operator and the area Coordinator, where the plant and its operation were introduced, followed by a verbal risk assessment to pin-point how the incident may have occurred. By the end of the initial site review, Hunter H₂O concluded that there were five likely causes for the high chlorine incident, and these included:

1. The chlorine dosing system could have continued to operate after the plant had shut down, due to a stuck or faulty inlet control float valve, which is the chemical dosing trigger. However this was deemed unlikely as the flocculate hour meters would have shown a longer run time, and the other chemical dosing systems would have affected pH and aluminium residual.
2. The dosing pump could have been left in test/prime mode, which operates at maximum dosage. However this was also unlikely due to the requirement for an operator to manually and continuously hold this function locally.

3. The speed of the pump may have been set to maximum, which would have resulted in a dose rate of between 21-25mg/L of chlorine. Whilst this is possible it is unlikely as both operator and reticulation sampler collected samples from the plant and rising main with much lower results. These samples would have been similar to that of the reticulation if this had occurred.
4. Sabotage was also considered. The chlorine system is located outside the main plant and only protected by a chain wire fence. A person entering the plant could manually operate or adjust the pump as outlined in point 2 and 3, or physically dose into the clear water well via the external inspection. Again, results would have been higher in the plant and rising main samples. Further, the plant has a CCTV system, where the history was viewed with no signs of un-authorised entry, and with no drain valve on the tank would have required bringing a bulk supply with them.
5. And the final, was that the chlorine system had continued to syphon either during normal pump operation and or after the plant had shut down. Whilst efforts were made to replicate this cause during the visit, a syphon did not occur in any way.

At this point Hunter H₂O was confident that syphoning was the cause. They backed this theory with the following comments:

1. The dosing pumps were rated to 2 Bar maximum pressure only, minimising the ability to load the system to prevent a syphon,
2. The loading valve showed signs of leaking backwards due to being incorrectly seated,
3. The discharge point for the chlorine into the clear water well was below the base of the bulk storage tank, which would allow a syphon to occur.

With this, it was advised that the plant be manually operated only and manned during this period until the cause was identified and corrected, and the valves of the chlorine system be manually closed when not operated.

A return visit on the 31st of March by Hunter H₂O involved focusing on testing the sodium hypochlorite system. The visit also coincided with a delivery of chlorine that morning resulting in a near full tank. As the system utilised carrier water, the initial tests focused on stopping and starting the water whilst the pumps were running. It was observed that there was a sharp increase in the amount of chlorine dosed, though the continued operation of the dosing pump was enough to slow and break the syphon; eliminating an intermittent supply of carrier water as the cause. However, when the carrier water and the dosing pump were turned off simultaneously, a syphon occurred instantly and continued on well after the dosing system had stopped. Checks were then undertaken on both the loading valves which were found to be only finger tight; thus the loading valves were not being utilised. Therefore, a syphon on the initial visit failed to be replicated due to a lower level, head, on chlorine in the tank.

3.0 CONCLUSION

3.1 Hindsight

After concluding on the cause, there were numerous factors visible that either contributed to the incident, or should have triggered an investigation. Firstly, two weeks prior to the incident, chlorine dosing pump 1 had been put into service due to a leak on pump 2.

This was the first time it was used since its installation, 2 years prior; and with no record of commissioning. As previously stated, the chlorine system was installed based on other MCW systems, with no P&ID or risk assessment undertaken, and by MCW staff.

Reviewing the WTP chlorine monitoring data showed the chlorination system which was installed in November 2013 had a history of elevated chlorine levels which should have indicated a system problem. It appeared the syphoning had been occurring for quite some time though unacknowledged. Regular monitoring of the results and plotting trends would have highlighted the issue earlier.

It took 20 hours from the first complaint before an incident was recognised, with one of those complaints from the hospital, a critical customer. It was stated by MCW that the increase in chlorine residual was a results of dealing with the fresh in the river, however there had only been a total of five complaints regarding water quality in the past two years. The sheer volume of calls should have warranted a quicker response, and alerted management to a potentially more significant issue.

Finally, sampling of the water quality was limited to a portable chlorine test kit, with a limit of 8.8mg/L. Whilst this was an indicator of high chlorine and a further need to flush, no formal testing was done and analysed; thus the true levels in the reticulation were not actually quantified. It was not until a sample was provided by a customer taken on Tuesday night, and submitted to the MCW laboratory several days later that an understanding of the quantity of chlorine dosed in the system could be established.

Whilst the sample was not formal, it could not be ignored; the sample had a total and free chlorine reading of 140mg/L. Formal sampling would have also allowed a more detailed assessment of other analyte's. It must also be noted that a number of customers in Gloucester receive water directly off the rising main to the reservoirs, thus they would have received a highly concentrated slug of chlorine straight from the plant.

3.2 What Was Done Right?

Cue the crickets...

As outlined by Hunter H₂O in their 'Gloucester Water Quality Incident Review', the following were considered positive actions taken by MCW:

1. Once the incident was declared, management were quick to act not only advising residents through the different forms of media but also contacting schools, the hospital and nursing home. Bottled water was also supplied to those.
2. The regulators were notified within 45 minutes of the declaration and given regular updates as available.
3. Extra MCW staff was called upon from nearby areas to assist with flushing and monitoring.
4. MCW requested that the community assist by flushing household mains to rid the high chlorine and to speed the recovery. This request came with a \$50 dollar rebate.
5. The community engagement in the main street of Gloucester.
6. An apology letter to the community from MCW published in the Gloucester Advocate

7. And the engagement of an independent consultant to review not only the cause of the incident but how MCW responded, and provide recommendations for any improvement.

3.3 Post Incident

As expected, the incident triggered immediate response and concern for the entire plant. The review identified 60 actions to be addressed, with the most critical being the sodium hypochlorite system. Within a short period the system was completely replaced, based on Hunter H₂O's P&ID and risk assessment, including automation, online instruments and analysers. To date, the plant has received a considerable amount of required works given the timeframe and resources available, in areas of both engineering and process. It is scheduled that the programmed works will be completed within the next twelve months, at a cost of approximately \$1M, and the plant's proficiency be re-evaluated within 5-10 years.

From a business perspective, this incident also highlighted a number of weaknesses in MCW's systems such as incomplete overarching business management frameworks and integrated management systems, lack of quality systems and internal control, a lack of system knowledge management, inadequate training of staff, incomplete implementation of the drinking water quality management plan, assets not up to current design standards and no overall disaster recovery plan. Due to budget restraints, MCW had also developed a reactive culture as opposed to proactive planning. This incident is an example of learning lessons and finding deficiencies the hard way!

4.0 ACKNOWLEDGEMENTS

Hunter H₂O, Graeme Watkins, and the MidCoast Water Executive for their support and lack of finger pointing.

5.0 REFERENCES

Hunter H₂O, 'Gloucester Water Quality Incident Review', 2015.