

**QUEENSLAND HEALTH**

**POPULATION HEALTH QUEENSLAND**

**INVESTIGATORS REPORT**

**WATER FLUORIDATION INCIDENT**

**NORTH PINE WATER TREATMENT PLANT**

**June 2009**

## **1.0 INTRODUCTION**

On 13 May 2009 Seqwater advised Queensland Health that they had received notification of a water sample result for fluoride well in excess of the 1.5mg/L standard set for fluoridated water. The sample was taken by LinkWater (the entity that operates the trunk water mains as part of the SEQ Water Grid) of treated water from the North Pine Water Treatment Plant.

This report provides a summary of the legislative requirements for water fluoridation and an explanation of the alleged breaches associated with the incident. The evidence obtained by Queensland Health during the course of its public health investigation into the incident is summarised and an analysis of this evidence provided to support the conclusions of the report.

## **2.0 LEGISLATIVE REQUIREMENTS**

The safety of water fluoridation is managed under the provisions of the *Water Fluoridation Act 2008* and the *Public Health Act 2005*. The Water Fluoridation Act and Regulation provide guidance on the prescribed levels of fluoride in drinking water supplies required to achieve an oral health benefit, the commencement dates for water fluoridation throughout Queensland and requirements for reporting, recording, sampling and operator competency. The *Public Health Regulation 2005* sets a standard for fluoride added to drinking water which is protective of public health and reflects national standards.

Queensland Health has also published a Water Fluoridation Code of Practice (2008) that details best practice solutions for ensuring the safe operation of water fluoridation plants. The Code of Practice also provides additional information to assist with ensuring compliance with legislative requirements.

The prescribed fluoride concentration for fluoridated water from North Pine Water Treatment Plant is 0.8mg/L. In terms of public health protection, the fluoride concentration should not exceed 1.5mg/L.

## **3.0 SUMMARY OF THE INCIDENT**

Shortly prior to midnight on 27 April 2009 the North Pine treated water pumps were shut down to allow for scheduled maintenance work to commence the following day. During this time treated water was still available for use at the water treatment plant, some nearby residents as well as the YMCA Camp Warrawee by virtue of a positive return pressure in the Aspley main that allowed water to be drawn from the treated water delivery main.

With the water treatment plant and treated water pumps off line and essentially no water flowing through the delivery main, there should have been no signal from the main delivery flow meter linked to the dosing unit to initiate fluoride dosing. A review of control system records shows that erroneous flow signals from the flow meter began to appear almost 19 hours after treated water pumps were shut down, thus sending a false water flow signal to the fluoride dosing facility. Fluoride dosing

occurred at this time. More erroneous flow spikes several hours later intermittently continued the fluoride dosing until the online analyser registered a fluoride level of 1.2mg/L and initiated a “high high” fluoride alarm resulting in an automated shutdown of the fluoride dosing facility. This disabled the fluoride dosing facility at approximately 12:35 am on 29 April 2009 and no further fluoride entered the water delivery main. By this time, approximately 13,000 litres of concentrated fluoride solution had been dosed into the main and had slowly migrated to the online analyser sample point which registered the fluoride concentration above 1.2mg/L.

## **4.0 ALLEGED LEGISLATIVE BREACHES**

The Public Health Act requires that a drinking water service provider must not supply drinking water that the provider knows, or reasonably ought to know, is unsafe. Queensland Health considers non-compliance with this provision as a serious offence, which is reflected in the penalties attached to the offence, including a maximum of 2 years imprisonment.

The Water Fluoridation Act requires that a public potable water supplier must add the fluoride to the supply in a form prescribed under a regulation and comply with the requirements prescribed under the regulation.

Whilst non-compliance with these provisions is not considered to be of the same magnitude as the unsafe water provision under the Public Health Act, compliance with the requirements of the Regulation demonstrates a well managed fluoride dosing program for day to day water fluoridation activities.

Seqwater meets the definition of a drinking water service provider and a public potable water supplier.

An investigation has been undertaken by Queensland Health to obtain evidence of whether or not there was compliance with the provisions of the Public Health Act and Water Fluoridation Act.

## **5.0 EVIDENCE**

### **Fluoride concentration**

Under the provisions of S6 of the Water Fluoridation Regulation a prescribed fluoride concentration of 0.8mg/L must be maintained in the water supply, with compliance being established if the fluoride concentration in the water supply, averaged over a quarter, is within 0.1mg/L of 0.8mg/L. The maximum standard set for fluoridated water under the Public Health Regulation is 1.5mg/L.

- A water sample analysis result indicated a fluoride concentration of 31mg/L. The sample was taken by LinkWater on 29 April 2009 at a site approximately 150 metres from the fluoride injection point. LinkWater is the owner of the delivery water main and the treated water pump station. The sample analysis result was received by LinkWater on 12 May 2009. Subsequent validation of

the sample analysis found an error had occurred and the concentration was actually 17mg/L rather than the 31mg/L first reported. The sample was then sent to an external laboratory which returned a value of 19.6mg/L which was adopted as the most accurate sample analysis result.

- The on-line fluoride analyser located at the treatment plant is only capable of measuring a maximum of 3mg/L and it has been demonstrated that the fluoride concentration exceeded this maximum level for over 27 hours during the incident.

### **Public exposure to over- fluoridated water**

Under S57E of the Public Health Act a water provider must not supply drinking water that the provider knows, or reasonably ought to know, is unsafe.

- On 30 April 2009 two filter back washing operations were undertaken at the water treatment plant prior to bringing the water treatment plant on line. The backwashing required approximately 800 kilolitres of water. An investigation commissioned by Seqwater, and undertaken by the independent engineering consultants Cardno Pty Ltd, determined that the vast majority, if not all, of the over-fluoridated water was used for backwashing. However it was also concluded that some of the water was potentially supplied to consumers, including 4 houses located adjacent to the water treatment plant and YMCA Camp Warrawee, which is also located in close proximity to the water treatment plant. The Cardno investigation also concluded that the water was likely to have been significantly diluted in terms of fluoride concentration.

### **Engineering**

Under the provisions of S7(2) of the Water Fluoridation Regulation the water supplier must use automatic, interlocked fluoride dosing equipment that has the rate of feed of the fluoride compound paced to the flow of the water and which also has water flow measuring devices, one of which is a flow meter. In this clause 'interlocked' means that if part of the dosing equipment fails the entire dosing system shuts down.

- Two key pieces of the fluoride dosing control system that are required to be interlocked with the fluoride dosing facility were shown to be malfunctioning or disabled. These safety features were the water flow meter and the flow switch.
- The flow meter provides water flow rates to the fluoride dosing facility which prompts the dosing facility to add fluoride to the water supply at a rate consistent with the rate of water flow. The flow meter was found to be malfunctioning and sending false flow signals to the dosing unit, causing the dosing unit to add fluoride when there was no water being supplied.
- The flow switch signals either 'on' or 'off' to indicate water flow or no flow respectively. If the flow switch is signalling 'off' the fluoride dosing plant will not dose. The flow switch had been operating erratically and was disconnected for repair on 24 April 2009 which effectively removed one of the required control mechanisms. When the flow switch was repaired on 29 April 2009, it was not calibrated as there was no flow through the treatment plant at

that time. This resulted in the signal being set to 'on', thereby allowing the fluoride dosing facility to dose.

- The control system is designed such that dosing stops when there is a difference detected between the main delivery flow meter and the flow switch, for example, when the flow meter was reading 'no flow' and the flow switch was set to 'on'.
- The alarm system is connected to various pieces of equipment within the treatment plant to alert operators when equipment is operating outside of acceptable parameters. The on-line fluoride analyser is connected to this alarm system. This analyser measures the concentration of fluoride in the water supply a short distance (approximately 50 metres) from the injection point and is designed to trigger an alarm to alert operators when fluoride concentrations exceed 1.0mg/L. Around the time of the incident the alarm function had been disabled by Seqwater staff due to problems with false alarms frequently triggering.
- There is an additional automated safety feature which triggers an alarm and stops fluoride dosing when fluoride concentrations exceed 1.2mg/L. This feature functioned as required.

### **Water system management**

- Due to the reconfiguration of water supply systems within South East Queensland different water supply entities own different infrastructure. Seqwater own and are responsible for the fluoride dosing facility, while LinkWater own and maintain the flow meter which is one of the primary mechanisms for commencing, stopping and pacing fluoride dosing. There is evidence available that staff at Seqwater were aware that the delivery flow meter was malfunctioning prior to the incident and had requested LinkWater to investigate.

### **Operational plans and Operator competency**

Under the provisions of S10 of the Water Fluoridation Regulation it is a requirement that before the end of each day recordings must be made, in the approved form, of the volume of water to which fluoride has been added, the amount of fluoride added, the calculated fluoride concentration and the analysed fluoride concentration. Further, under the provisions of S12 of the Water Fluoridation Regulation the water provider must ensure that each operator has the necessary training, knowledge and experience in relation to fluoride.

- There was evidence of inappropriate operational responses shown by staff, demonstrated by responses to the alarms generally, inadequate record keeping and, when records were completed, an inadequate response to anomalies noted within these records.
- There was a lack of understanding within Seqwater of the operation and functioning of the fluoride dosing facility demonstrated by their belief that the treated water pumps were interlocked with the fluoride dosing pumps and that the fluoride dosing was fully automated, therefore the fluoride dosing facility would not/could not work while treated water pumps were shut down.

- There was lack of understanding of the need to complete the required recording forms on a daily basis irrespective of whether the water treatment plant was shut down and the significance of the information recorded. For example, there is evidence that the required recording forms were not completed daily and that when they were completed, the figures demonstrated that 16kg of fluoride powder had been used over the period when there was no water flow. This information appears to have not been correctly communicated, leading to no further action being taken.
- Shutdown operating procedures and certain operational functions within Seqwater were demonstrated to have not been updated to consider the fluoride dosing facility. This contributed to a lack of coordinated response by staff to various pieces of information therefore decisions were made based on incorrect or incomplete assessments. This is evidenced by the lack of operating procedures for shutting down the fluoride dosing plant or for responding to alarms triggered by equipment within the treatment plant.

## 6.0 ANALYSIS

This analysis will examine the evidence found from two perspectives:

1. Whether unsafe drinking water was supplied
2. Whether there were non-compliances with the provisions of the Water Fluoridation Regulation and hence the requirement for providers to comply with the Water Fluoridation Act.

This analysis will inform the conclusions of the report.

### **The supply of unsafe drinking water**

There is no doubt that the fluoride concentration, demonstrated by the water sample analysis result, significantly exceeded the public health standard. It is difficult to determine whether this sample result represented the highest actual fluoride concentration as a result of this incident or whether the actual fluoride concentration may have been higher or lower for a period of time. There is little evidence to confirm that the water was supplied to the community and whether any water supplied was consumed by community members or used for other purposes. Consequently, it is difficult to confirm a level of public exposure, although it should be noted that investigations by Queensland Health did not identify evidence of community harm as a result of this incident.

The ‘supply of unsafe water’ offence within the Public Health Act implies a degree of negligence or wilful disregard which is reflected in the high level penalties and possibility of custodial sentencing. Interviews with plant operators did not demonstrate any deliberate negligence in their actions, but rather a lack of knowledge and expertise regarding the design and functioning of the fluoride dosing facility. Examples include: knowledge of how the fluoride equipment was interlocked; the significance of daily recording activities in terms of public health protection; and inappropriate operational responses including non-response to alarms. These factors contributed to the incident unfolding without timely intervention from the operators.

## **Non-compliance with the requirements of the Water Fluoridation Regulation**

The fluoride dosing equipment, as originally designed and installed, complied with requirements of Section 7(2) of the Regulation. However there is evidence of a breach of Section 7(2)(b) which states that ‘automatic fluoride dosing equipment must have water flow measuring devices’. Around the time of the incident the flow switch had been disabled leaving a single remaining flow device in place.

A reasonable person would expect that the equipment was not only installed, but was also functioning properly, and that an alarm indicating equipment malfunction would be responded to appropriately. The water flow measuring devices (eg: flow meter and flow switch) were both shown to be not operating properly prior to the incident. It is also reasonable to expect that an alarm alerting to higher than normal fluoride concentrations would not be disabled and the alarm that was functioning would be appropriately responded to by operators. Whilst these issues are not definitive non-compliances with the legislation, they clearly contributed to the incident. Given the (incorrect) belief by the operators that certain functions of the fluoride dosing facility were interlocked, their actions are understandable, however this provides evidence of the lack of operator knowledge and expertise.

There are also breaches of the recording requirements, in that the approved recording form was not completed before the end of each day, as required by Section 10(2)(b) of the Regulation. This issue was further compounded by that fact that when the approved form was completed, there was a lack of communication and follow up review of the recorded figures. It is acknowledged that even if the form had been completed before the end of the relevant day this would not have prevented the incident, but would have allowed an earlier response. Given that the treatment plant was shut down and therefore there was no water flowing through the plant, there should be no volume of water to record and no amount of fluoride being added, however there was actually an amount of 16kg of fluoride recorded for the period of time over which the incident occurred. Therefore the operator should have been aware at this point that the fluoride dosing facility or equipment was malfunctioning.

Additionally, the calculated fluoride dose required to be recorded should be approximately the same as the fluoride concentration provided by undertaking the prescribed analysis. Again, because the treatment plant was shut down, the on-line fluoride analyser was not checked or fluoride levels recorded daily, even though it was later demonstrated the analyser was showing high fluoride concentrations and alarms were triggered advising of the high level. While these matters could not have prevented the incident, they should have resulted in early detection of the problem and allowed appropriate mitigation measures to be implemented in a timely manner.

Section 12 of the Water Fluoridation Regulation requires that operators have the necessary training, knowledge and experience to operate a fluoride dosing facility. Whilst the operators have completed an appropriate formal competency training unit and onsite training with the fluoride equipment design contractor, the underlying reasons for the requirements of the regulatory framework did not appear to be clearly understood. This would include the reasoning behind daily recording of fluoride chemical used as a cross check against the results of the daily fluoride analysis.

Also, there appears to be a lack of understanding as to the design features of the dosing facility, which led to a mistaken belief that the fluoride dosing unit could not operate when the water treatment plant was not supplying water. Even though the operators had successfully achieved the recommended training competency, the above actions demonstrate inadequate knowledge and experience. This can be remedied by the implementation of improved systems for the reinforcement of operator learning and skill development through mentoring, improved training content and provision of operational manuals.

## **7.0 CONCLUSIONS**

There is inadequate evidence to consider prosecution under the 'supply of unsafe water' offence. However, there are breaches of the requirement under the *Water Fluoridation Act 2008* to comply with the provisions of the *Water Fluoridation Regulation 2008* which support the issue of a remedial notice to Seqwater.