HIGH RESOLUTION TURBIDITY DATA FOR EVALUATING MAINS FLUSHING WITHIN DISTRIBUTION SYSTEMS

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41st Annual WIOA
Queensland Water Industry Operations Conference and Exhibition
Central Queensland University Sports Centre,
Rockhampton
1 & 2 June, 2016

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ABSTRACT

Over the past months and years, an increase in monitoring of water quality using sensing, logging and telemetry technology within potable water distribution systems was much talked about, but why?
Compliance to ADWG (Australian Drinking Water Guidelines), public health, greater community awareness and expectation, intelligent/smarter networks.

Here we present an application of high resolution turbidity data toward assessing and streamlining the technique of mains flushing; a method for reducing the risk of discoloration in distribution systems.

It is shown that by appropriate deployment of sensors before, during, and after flushing the collected data can be used to assess the effectiveness of the flush at different points in the system. Going forward, it is also shown that it can be used in assessing return rate of material within the system. Quantitative metrics to reach these conclusions included turbidity event size and frequency and duration analysis on data collected periodically over a two year window.

KEYWORDS

Water quality, monitoring, discolouration, distribution systems

1.0 INTRODUCTION

The ADWG has 12 elements listed as the foundations of the Framework for Management of Drinking Water Quality. This paper will relate to three of them, namely:

1. Element 4: Operational procedures and process control in regards to Operational monitoring
2. Element 5: Verification of drinking water quality in regards to Drinking Water Quality monitoring.
3. Discuss chapter 9 of the ADWG with the reference to section 9.4.6 Chlorination as a Critical Control Point.

Discolouration of water supply is the most common form of quality related complaints that water companies receive from their customers (Vreeburg and Boxall, 2007). Current methods for managing discolouration in potable water distribution systems include flushing, scouring, re-lining, or replacing of mains to remove the causal material which has either built up over time within the system, or is a product of deterioration in condition and release from the pipe-wall itself (Smith et al., 1999). Currently there is little data available to accurately determine the varying condition of the infrastructure surrounding discolouration hotspots, due to its underground nature, and as a consequence maintenance tends to be employed across the entire surrounding area and is re-employed at a frequency determined by contact data collected from the end-users themselves following future grievances. This methodology is reactive in nature and the data type used is subjective and of low spatial and temporal resolution.

These factors indicate that there is a high potential for inefficient targeting of the maintenance strategies aimed at controlling the incidence of discolouration; leading to sub optimum budgeting associated with discolouration management.

With the advent of technologies that can collect turbidity data from within distribution systems at high resolution in both time and space, and where there is no available power and telemetry, it may be possible to streamline these types of maintenance strategies and employ them in a more targeted and proactive manner. To investigate this, turbidity monitors were deployed at high density points in a section of distribution already earmarked for mains flushing, to both assess the effectiveness of the technique itself, and also to assess the rate at which material might build up within such systems following this type of maintenance. The ultimate goal is to use this type of data as a guide for optimizing flushing maintenance schedules.

The revolution of intelligent water networks started with the integration of mobile telephony technology as a communications platform for analytical equipment, the first of which started with battery powered pressure and flow monitoring devices. These pressure and flow monitoring data loggers were used to great effect to reduce non-revenue water loss during the millennium drought in Australia. The loggers had general packet radio service (GPRS) communications so that they could be deployed in remote areas, with the data being transmitted back to a central location for analysis.

With the internet of things (IOT), today's technology is growing at a rapid pace. While pressure and flow monitoring is still a very current issue, the need to understand and manage more water quality parameters has seen the development of analytical sensors using GPRS/GSM technologies.

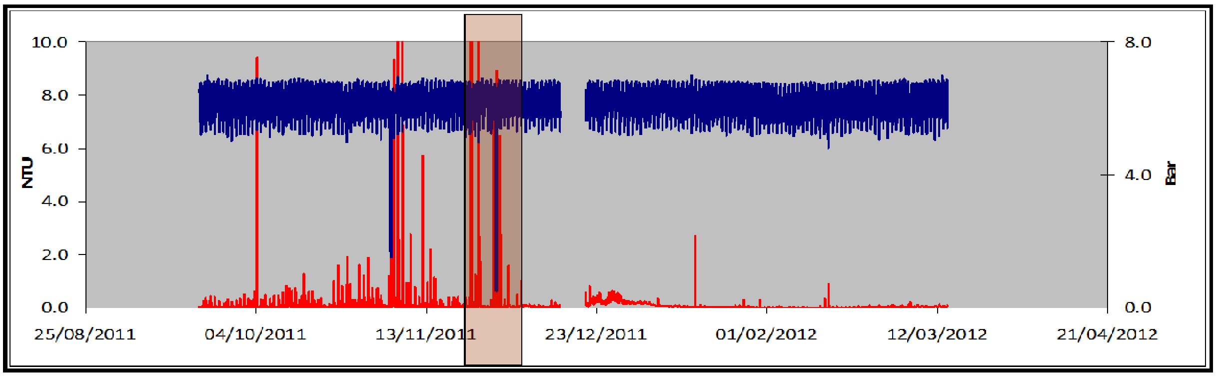
Evoqua Water Technologies is offering to address this need with sensors providing high-resolution monitoring of critical water quality parameters, as well as pressure and turbidity monitoring – all accessible in near real time for web hosted or SCADA visibility.

2.0 METHODS

The Hydraclam® water quality monitor (Wallace &Tiernan® products, Evoqua Water Technologies UK) was deployed at 6 sites within a single district metering area (DMA), for a 6 month period before, during and after mains flushing was employed in order to assess how successful the intervention technique was at improving water quality. All instrumentation was calibrated before deployment and configured to log turbidity data at 15 minute intervals during the 6 month timeframe. Following this deployment data was converted into turbidity size, frequency, and duration charts on a month by month basis. A single Hydraclam® monitor was then periodically deployed for 2-3 month periods over the following two years, with the intention of determining whether turbidity data can act as an indicator of whether material is building up within the system.

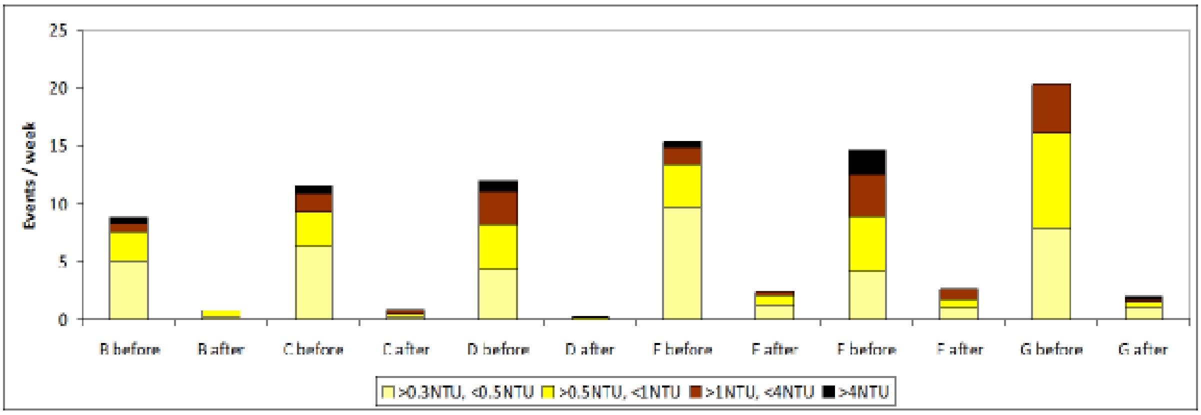
3.0 RESULTS AND DISCUSSION

Time series turbidity data (Figure 1) showed that by observation only, mains flushing was successful at reducing the amount of turbidity occurring within the system.



<u>Figure 1:</u> ***15 minute time-series data from site D, for 6 month timeframe, before, during and after flushing was employed. Highlighted box indicating the period during which flushing took place.***

Furthermore, metrics of turbidity event size and frequency showed that this was the case across all 6 sites monitored (Figure 2). However, the extent to which turbidity activity was reduced was found to be variable across each of the sites (Figure 2), indicating variable success in terms of removing sediment from within the system.

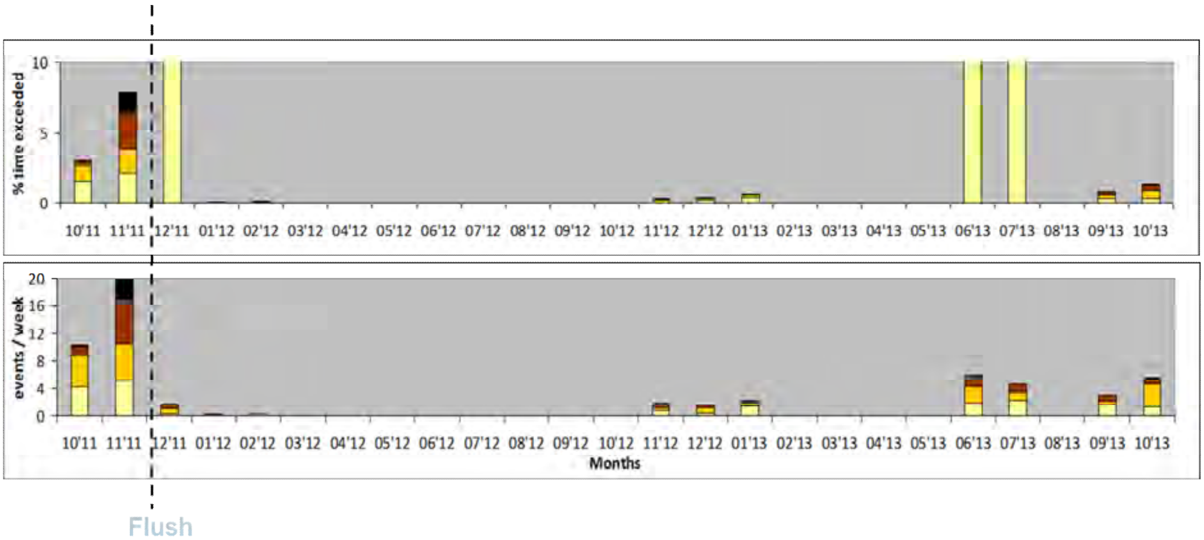


<u>Figure 2:</u> ***Event size and frequency data from all sites monitored for 6 months, before and after flushing, and figure extended from that presented in Mounce et al., 2015.***

When monitoring was continued beyond the initial 6 month study at site D at periodic intervals during the next 2 years, metrics of turbidity event size, frequency, and duration (Figure 3) showed some evidence that turbidity response was increasing over time (Figure 3).

Moreover, monitoring during the summer months showed turbidity was slightly elevated to between 0.3 and 1NTU for prolonged periods of time within the system (Figure 3), indicating some chronic movement through the system of poorer quality water.

By the end of the monitoring period, turbidity activity, measured by size, frequency, and duration, was at approximately 50% of the level that it was prior to flushing, indicating that material may be building up to a level within the system that might suggest re-flushing sooner rather than later to avoid customer complaints.



<u>Figure 3:</u> ***TOP - % time certain turbidities are exceeded within any particular month before, during, and after flushing at site D.***
BOTTOM – frequency of turbidity events before, during, and after flushing D.

4.0 CONCLUSIONS

- High resolution turbidity data was successful at showing that incidence of turbidity was reduced at all sites as a consequence of flushing, but that the effectiveness varied to different degrees across the sites.
- High resolution turbidity data, converted into size, frequency, and duration distributions may be useful for inferring the rate of return of material within sections of distribution system, with some indication of build-up of material over time.
- High resolution turbidity data, converted into size, frequency, and duration distributions may be useful for inferring the mode by which material is delivered to and transported through district metering areas (DMA).
- High resolution turbidity data can be utilized to work towards streamlining existing discolouration management activities by better targeting where and when to employ such techniques in the future.

Hydraclam® Water Turbidity and Pressure Monitor

The battery-powered Hydraclam monitor has the ability to measure pressure, low-range turbidity and electrical conductivity. The Hydraclam monitor measures water quality parameters to help customers to calibrate hydraulic water models, understand the flow patterns of mixed water sources and predict water discolouration events in the network, among many other applications.

The Chloroclam and Hydraclam monitors communicate via a secure web portal. The web portal incorporates Google Maps for device visualisation and network location. The web portal enables alarm functionality for user-defined alarms that can be sent via SMS or email. The web portal also offers a data analysis tool to understand the data that is being transmitted from the devices. The sampling frequency and data upload times can be adjusted by the customer to suit their data requirements. The Chloroclam and Hydraclam monitors are highly mobile and portable loggers. They connect to existing fire hydrant points in the reticulation network, so no mains tappings are required.

Evoqua Water Technologies also provides mechanical protection (enclosure) options for both sensors, fast and safe connection, fittings and instructions. The high mobility of the loggers enables customers to rapidly deploy the loggers across their network zones.

In which way do the Clams actually help?

Our customers who are currently using the Chloroclam and Hydraclam are doing so to improve and understand operational performance.
Some of the applications that the clam are being used for are:

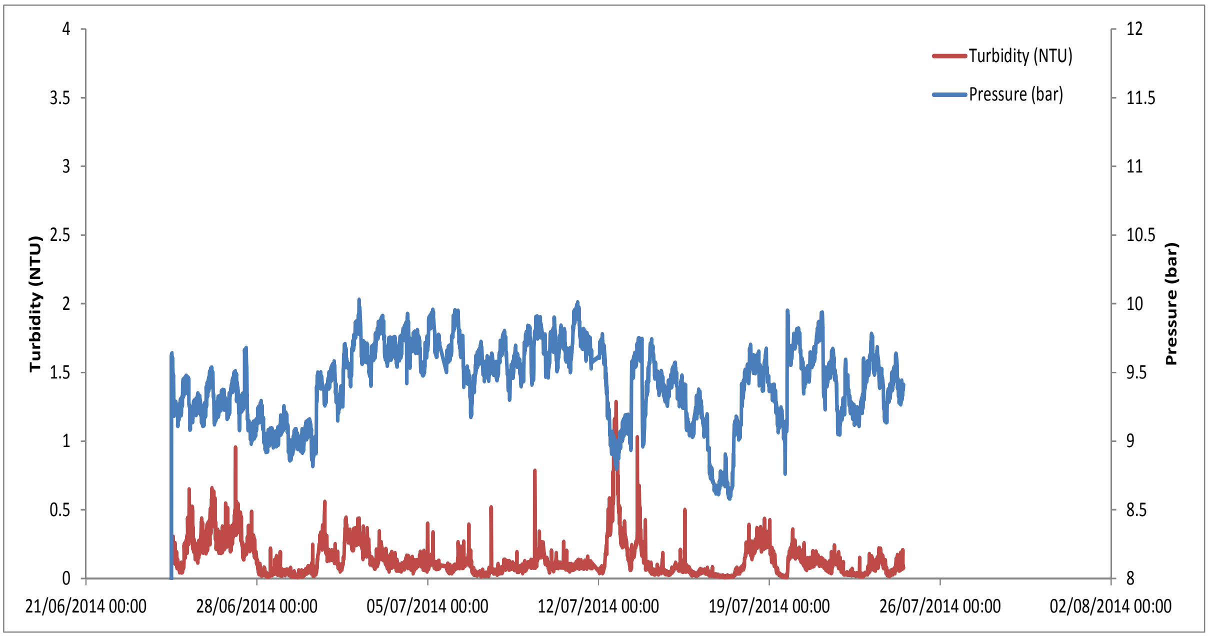
1. Pre and post residual monitoring after ice pigging, swabbing or mains flushing.
2. Chemical optimisation of manual chlorine dosing.
3. Understanding water age.
4. Detecting nitrification issues by monitoring free and total chlorine.
5. Critical control point monitoring.
6. Network pressure reduction and the effect on chlorine residuals.
7. Remote network chlorine monitoring.

What did we find?

- Demonstrated that flushing is successful in the short term.
- Data can be used to determine when flushing should be undertaken again – optimise when to flush.
- Data can be used to determine which parts of the DMA to focus flushing on – optimise where to flush.

What are the benefits to asset management?

- Allocate resources for maintenance more effectively – optimise resource.
- Be proactive in reducing customer complains – improve customer confidence.
- Improve OPEX allocation where it is needed
- Monitor changing condition of mains over time to guide business decisions.



<u>Figure 4:</u> ***Hydraclam field data for turbidity and pressure correlation.***

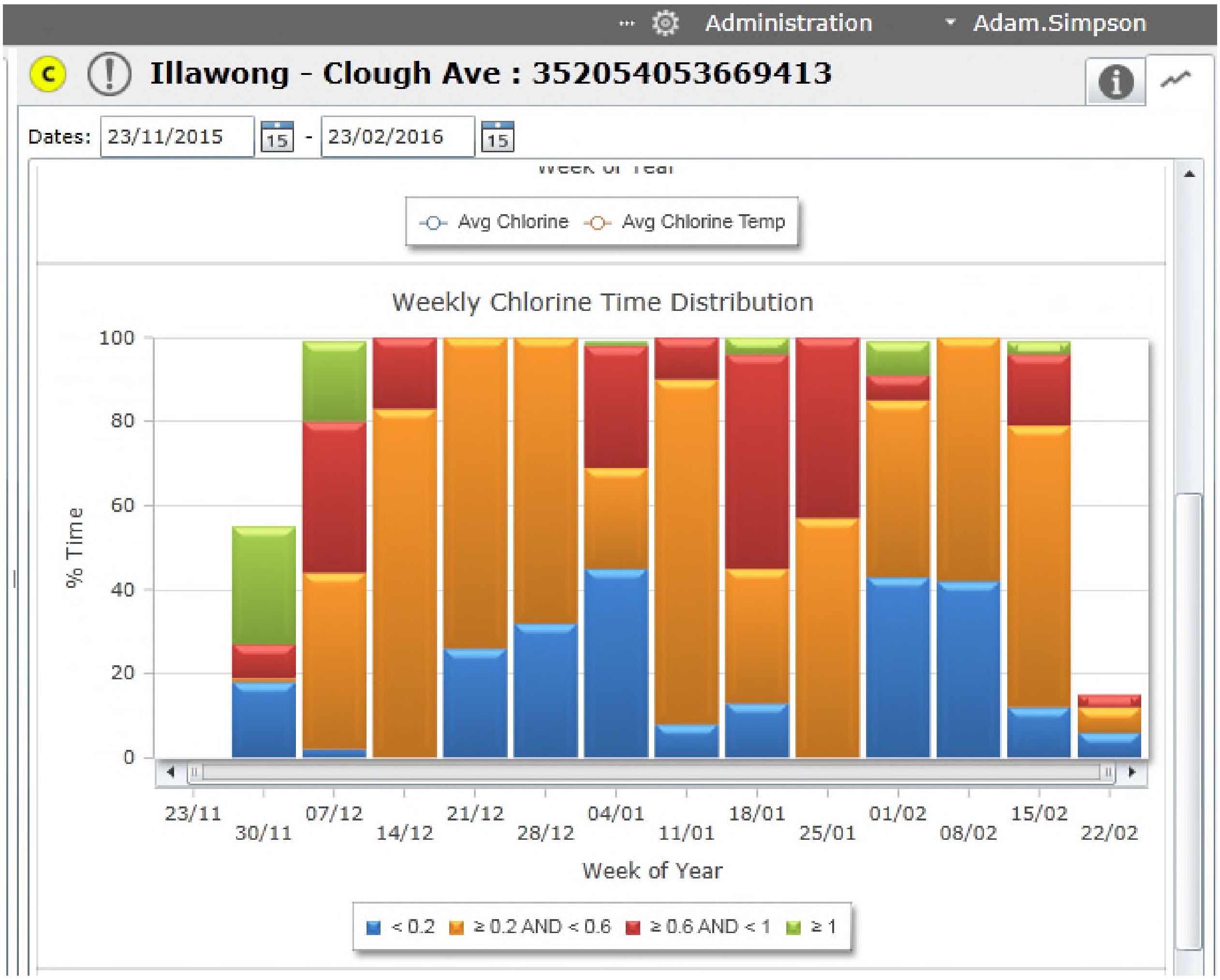


Figure 5: ***Chloroclam summarisation and weekly visualisation delivering information and not just data.***

5.0 REFERENCES

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