THE WEARS RESMIX400 EXPERIENCE IN COWRA, NSW AND THE UK

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1.0 INTRODUCTION

In the developed world, one of the critical factors is safe and sustainable drinking water; sometimes this is the best definition which defines the developed world. For those of us who have had the opportunity to travel, a question which is always relevant is; "do we drink the water". While there are now alternatives and most carry with them drinking water from a bottles, in Australia, because of the hard work of a lot of Councils across this Country, we have the luxury of being able to drink the water from any tap, even garden taps in most parts of the country. With this expectation however comes the responsibility that the water being made safe for drinking is always safe. Failure here would mean that unsafe drinking water could become a public health issue which has many impacts; sickness, penalties, embarrassment, paper-work, increased regulation etc. It's something which none of us want to happen and there is no reason why it should. Following processes and procedures, proper and timely monitoring, proper maintenance and attention to detail will, in most cases, ensure that good quality water is always available to our communities.

Most water utilities, like in Cowra in NSW and in the UK have adequate Water Treatment Plants (WTP), and by a number of available processes, remove the sediment, change the pH, disinfect and clean the water making it suitable for drinking. The usual last step in most treatment processes is the addition of chlorine in some form, which provides disinfection of the water, killing bacteria that can cause health issues. Most Water Utilities add sufficient chlorine at their WTP to ensure that at the most remote end of their reticulation there is enough chlorine still available to make sure the water is still safe. But chlorine if added in very high quantities can smell like swimming pool water which isn't desirable. Alternatively, chlorine in dirty reservoirs or if the water is stored for too long, will oxidise and can reduce to a level which can be deemed unsafe. So the actions at the WTP need to be finely balanced to maintain enough chlorine, but then, not too much, in the drinking water to ensure its suitability.

Adding enough chlorine so that there is enough at the point of consumption is somewhat unscientific so what can be done to make this more predictable and give WTP operators the confidence they need to ensure their public health issues are fully met on behalf of their communities. Or what did Cowra Council do, based on the research done in the UK by an Australian Company, WEARS Australia, to give their operators this confidence??

Figure 1: ***The ResMix400 Prior to Installation***

2.0 DISCUSSION

2.1 Source Water Management

WEARS Australia (Water Engineering and Research Solutions) is an Australian company and has been in the business of improving water quality for over 20 years. Their work in this area commenced as a research project looking at low cost solutions for mixing water storages, such as dams and reservoirs. In dams, their work looked at taking the oxygen-rich top water layers and pumping this water to the bottom of the dam and thus mixing the whole water body so that this water had a consistent DO level from top to bottom. This also implied that the water temperature was likewise almost the same from top to bottom. DO is a measure of water quality so water quality was improved for drinking, the environment and fish-habitats, and consistent temperatures meant that autumn dam-turnover then didn't occur improving water quality during these times. Higher oxygen levels in the water body allowed Manganese (Mn) and Iron (Fe) to precipitate out of solution and fall to the dam floor such that these chemicals did not have to be removed during the water treatment process. Also cooler, moving water did not allow algal growths to flourish. This technology, developed almost 20 years ago, was soon seen as the replacement for the old, expensive bubble plumes that had been installed until that time. The WEARS system is now is accepted as best practice with installation costs of about one third of that of a bubble plume, and operation costs of about one eighth. The WEARS ResMix system pumps water downwards, rather than suck water upwards which is now seen as its most logical advancement over other mixers.

With this technology fine-tuned for dams of all sizes; Cotter Dam (Canberra)of 90GL, Chifley Dam (Bathurst) of 30GL and Suma Dam (Orange) of 20GL to name a few, WEARS turned its attention to a series of units for even smaller dams and has now developed a unit suitable for town reservoirs, namely the WEARS ResMix400.

2.2 What's the Problem?

The issue that was faced in Cowra's water supply was that their WTP could produce good quality water but the configuration of their reservoirs meant that water in the tanks sometimes remained in the tank long enough for the available chlorine to be oxidised. As a result, they were unable to always guarantee the required chlorine residual at the extremities of their reticulation. Water quality standards were sometimes difficult to meet and this had impacts on their Drinking Water Management Strategy. Cowra to their credit at least knew they had a problem and were therefore able to address it. Their situation is duplicated in most water supply systems however.

Their reservoirs fill and empty via a common pipeline as most do. When demand is high, water comes in and goes out continuously as the system operates itself. Depended upon the demand, the size of the reservoir and the settings of the clear water pumps, the water towards the top in larger tanks can stay in the reservoir and become 'aged'. Chlorine has time to oxidise and as a result, chlorine level is reduced. The chlorine residual continues to drop over time and in the worst case, can drop to zero. Alternatively, in winter when demand is lower, the treated water can sit in the tank for extended periods with the same effect.

Chlorine in reservoirs can degrade in two ways; firstly by oxidisation as described above. Secondly, by doing its job, making the water safe. As the clean water sits in the reservoir, the small amounts of sediment settles onto the floor of the reservoir and forms a silt layer

there. This silt layer consumes chlorine. Other carbonaceous material can also cling to the walls and begins to grow in the still water adjacent. And. if structures like ladders and columns exist in the reservoirs, dead zones develop which also allows water to age in the tank. These areas present water quality issues and the available chlorine in the water has to work hard on these surfaces to address the water quality issues that they produce, reducing the available chlorine.

The solution becomes clearer as the issues are unpacked in this way. By continuously mixing the water in the reservoir, and forcing this mixed water onto the reservoir surfaces where the chlorine is being consumed, settlement of the sediment can't occur, water weeds can't grow on the walls and dead spots are removed completely. The fresh water coming into a reservoir is mixed with the older water and the net chlorine residual increases. As this chlorine rich water is then pumped onto the surfaces by the WEARS' mixer, these issues are treated by this available chlorine. Over time, after only about a day, water quality improves and the chlorine residual increases.

There are other reservoir mixers. Those that mix from the bottom of the tank miss these advantages. Further, nozzles installed on the inlet have a place; however these are only useful when water is entering the tank. When the tank is full and the pumps are off, they are unable to provide any mixing.

2.3 What Information Did Cowra Base Their Decision On?

The WEARS ResMix400 stands about 1.8m high and can be folded down to fit through a 650mm x 650mm reservoir hatch. Once it enters the water, the floats unfold to support the unit in the water at the right depth. The unit is driven by a 0.5kW electric motor, and is tethered by two stainless steel cables. The preferred location of the unit in the reservoir is in the centre of the tank. The unit is manufactured from Grade 316 Stainless Steel and food grade plastics. The unit costs about $3/day to run continuously and installation takes about 4 hours on average if power is available at the site. The unit, as with all of WEARS' solutions, was developed in Australia.

The ResMix400 is not an aerator. It pumps water continuously but slowly at a rate of about 70L/sec. In a large say 4ML tank, each drop of water will go through the mixer about every 15hrs or 1.6 times per day, but importantly, the whole tank is moving and being refreshed. Water is being moved by the mixer, but the water is moving by the convection currents the mixer develops.

Once the concept and prototypes were developed, WEARS searched the world for a water supply where this could be proven and came across a small town in the UK which met their needs. The water supply in this village is fully treated and pumped to two reservoirs situated on an adjacent hill. The reservoirs are of equal size, filled by the same rising main from the WTP and both feed a common trunk main to service the village. Adopting well known research protocols and in consultation with the Water Utility there, WEARS installed a ResMix400 in just one reservoir and used the unmixed reservoir as process control. As WEARS predicted, the chlorine residual improved by between 10% and 45%. This is the chlorine available in the tank at any time increase by this amount as shown by the attached graphs.

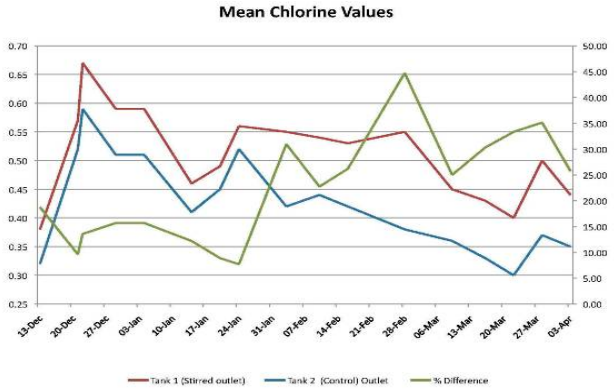

Figure 2: ***Chlorine Residuals in the Mixed and Unmixed Tanks in the UK Village***

That's a great outcome on its own. It means that the water quality provided by this level of chlorine is greatly increased and the Operator can be assured that any monitoring of outlying reticulation points will reflect this higher chlorine level. It also means that, if chlorine levels at remote points are being maintained, then chlorine dosing levels at the WTP can then be reduced to achieve the same outcome. An increase in chlorine residual of between 10% and 45% is likely to equate to a reduction in chlorine usage at the WTP of between 10% and 20% which:

- Reduces water treatment costs
- Reduces the negative impacts of disinfection inherent in using chlorine; smell, taste, longer-term residual effects.

In summary, chlorine residual as a reflection of water quality is improved by mixing the water.

But what happened to water quality? Does this simply stay the same and chlorine usage can be reduced?

This water supply has a safe water supply. The disinfection provided at the WTP is effective and reduces bacteria levels to below regulated levels. There are no issues with water quality or public health. Bacterial contamination is at very low levels in the two tanks and well below the accepted standard. Water borne bacteria in water supplies respond at two different water temperatures; those that exist at about the temperature of piped water (about 22^0C) and die at higher temperatures, and those that can live in humans (about 36^0C). Plate testing of the water from both tanks at these two temperatures was therefore undertaken.. In the unmixed tank, these bacteria were evident at the accepted levels, however in the mixed tank, they were all but non-existent as shown in the graphs below.

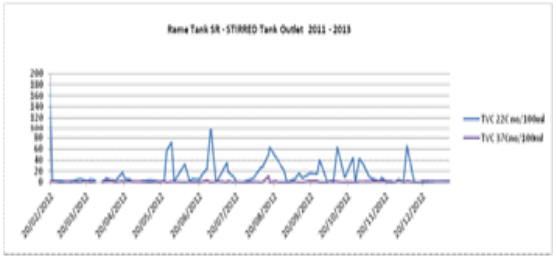

Figure 3: ***Comparison of Bacteria Levels at 22C***

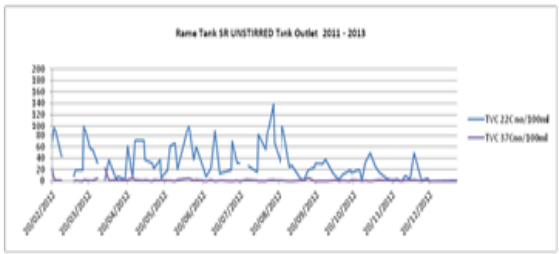

Figure 4: ***Comparison of Bacteria Levels at 36C***

What does this mean? It means that not only did the chlorine residual levels increase, but at the same time, the small amounts of bacteria present in the water, decreased. The chlorine consumed in the tank was being used more effectively making the water safer, but also simultaneously further reducing the bacterial counts. This outcome proved conclusively the effectiveness of applying the WEARS' technology in this application.

As a side benefit, but one of great importance, sediment in town reservoirs will only fall to the reservoir floor if the water is still. The WEARS mixer continuously mixes the water in the tank and therefore most of these small amounts of sediment remain suspended; only a small fraction make their way onto the reservoir floor. This sediment is gently rolled to the floor/wall joint and collects there by the moving water. While the periods between reservoir cleaning are thereby reduced, the cleaning process only then requires removing the sediment from around the perimeter of the tank floor.

WEARS has installed a unit into the North Cowra No. 7 reservoir which is 34m diameter and has a volume of 9ML. This reservoir operates in parallel with their North Cowra No. 8 reservoir which has a volume of 4.4ML which they do not mix. Measuring results from these two tanks is difficult because the tanks act in parallel however, chlorine residual will be increased by between 10% and 45% and bacteria counts reduced by the installation of this mixer.

2.4 Where to From Here?

A mixed reservoir will clearly improve chlorine residuals in a tank, and in most circumstances this might be enough to improve the water quality parameters to address water security, but what if there is no chlorine left or the residual levels are very low when it gets to the reservoir. This might be the case in long pipelines for example. After mixing in this circumstance, an improvement in chlorine residual levels of between 10% and 45% might still not be enough to maintain good water quality. The ResMix400 doesn't produce chlorine; it works with what it has available. Simply mixing alone will not address this issue. So what can?

Post-dosing with chlorine is not a new concept but in most applications already in place, little science has been available to do this in an intelligent way. Many have installations involve floating cages into which added chlorine pucks. As the chlorine puck dissolves, chlorine is added to the water in a random, arbitrary way. In others, chlorine is dosed as the water leaves the tank. To complement their offering in this area, WEARS has developed a small dosing pump which doses chlorine into the throat of the ResMix400. Chlorine can be in the form of sodium hypochlorite or even chlorine gas; sodium hypo is preferred. This chlorine, when it enters the mixer throat, is pumped throughout the tank almost instantly so that the chorine can go to work at once. A installed sensor in the tank tells the dosing pump when to turn on and off, so that a desired chlorine level in the reservoir can be set and maintained. The dosing system can be linked to Council's SCADA system and monitored to provide real-time feedback to the Operator on chlorine levels in the tank. This data can be logged and recorded if Council's SCADA system has this capacity. Apart from refilling the chlorine source, it is almost a set-and-forget solution. This is the next step for Cowra and can only be achieved once chlorine levels can be achieved in all the reservoirs in a water supply network. This dosing system can be added to the ResMix installation.

The following step in this process is still being developed by WEARS, but the process thinking is well researched. Once the chlorine level can be assured in each reservoir in a network by mixing and post-dosing if required, then, by working backwards, the chlorine dosing at the WTP can be reduced, or possibly even deleted. This is particularly relevant where the clear water pumps at the WTP pumps directly into the reticulation; those living on these rising mains sometimes suffer from high chlorine levels. If the desired chlorine level is say 0.5PPM, and this level can be achieved by mixing and dosing at the reservoir, then the dosing level at the WTP can be reduced from say 0.7PPM to also 0.5PPM for example, a further reduction in chlorination costs and a safer water supply will result.

The ResMix400 has been installed in the UK, Middle East, Australia and now in the US. The water supply in Trangie will be the next reservoir in Australia where a unit will be installed. The Cowra installation of the ResMix400 unit was completed in under a day, and involved a small crane to lift the unit into the tank and through the reservoir hatch. The unit was floated into position and tethered in place using certified divers engaged by WEARS. This was achieved by drilling a small plug into the wall above the TWL. In steel tanks, tethering is achieved by drilling a small hole into the roof purlins. The unit is designed to float up and down with the operating levels within the tank and the unit is simply turned off when the tank needs to be drained and the unit simply hangs on the anchor cables until it is again floated by the rising water. In Cowra, the operating levels were between 30% and 100% of its full capacity. The power had been made available at the reservoir by Council's electrician and the installation simply included running the power via a conduit down the tank to the control box adjacent to the power supply. The control box includes a variable control switch and can provide a 4-20mA signal suitable for most SCADA systems. The speed of the unit is infinitely variable and can therefore be run at any speed. Once set though, WEARS recommends that the unit be left to do its job; a unit is usually set at about 75% of its nominal maximum power rating of the motor.

3.0 CONCLUSION

In conclusion, the installation of a WEARS ResMix400 into the Cowra reservoir is a work in progress in achieving a reliable and scientific way of achieving residual chlorine levels in water supply networks and by doing this, provide safer, potable water to the Cowra Community. By mixing the water using the WEARS system, Cowra has achieved an improvement in chlorine residual of between 10% and 45% and further development of the system over time will see greater improvements. Installation of the ResMix400 is likely to be a required addition to all reservoirs in the future to ensure water quality meets the requirements of the Drinking Water Guidelines.