WHAT WATER TREATMENT OPERATORS NEED TO KNOW ABOUT HEALTH BASED TARGETS

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ABSTRACT

The greatest risk to public health from drinking water, are microbial pathogens. To manage this risk, water businesses test drinking water for *Escherichia coli* to see if there is an indication that the water may be contaminated. However, the absence of this bacterium may not mean the water is free of pathogens. Other microbes that cause illness, such as protozoa and viruses may be present.

To better manage risk from all pathogens, the Australian Drinking Water Guidelines are likely to adopt the Health Based Targets (HBT) approach for microbial risks.

This will allow water businesses to manage microbial risk by assessing appropriate treatment technologies and the critical limits needed to control pathogens in source waters. For Water Treatment Operators it will underpin optimal performance of all barriers in treatment plants under all conditions.

This paper describes two case studies that demonstrate the application of HBT objectives in order to improve the management of microbial hazards in drinking water.

KEY WORDS
Drinking water, risk management, Health Based Targets.

1.0 INTRODUCTION

Health Based Targets (HBT) is a generic term that applies to activities that aim to protect public health. They have been used for many years in a range of circumstances. Air quality standards and road speed limits are examples of HBT. In the context of drinking water, water quality standards described in the Australian Drinking Water Guidelines and the Safe Drinking Water Regulations are HBT.

Modern laws now expect a risk management approach to protect public health. As there is no such thing as zero risk a HBT is needed to define the level of risk acceptable to the community. The World Health Organization (WHO) has determined this to be 1micro DALY. The soon to be revised Safe Drinking Water Regulations in Victoria may require water businesses to adopt a HBT that fulfils the expectation of the WHO approach.

This means that water businesses need to incorporate water quality targets and treatment goals in their design and management of drinking water supply systems.

HBT objectives provide a catchment to tap approach. Table 1 lists the different HBT objectives that operators need to be familiar with. System performance requires knowledge of hazards in the catchment and is used to determine the type and level of treatment required. Treatment standards define the performance parameters to ensure control of treatment barriers. Water quality standards are used to verify preventive measures have worked and that drinking water supplied is safe.

Table 1: ***Health Based Targets Types***

HBT Objectives	Nature of Target	Application
System Performance	Quantified removal of hazards	Log_{10} Reduction
Treatment Standard	Defines performance parameters	Critical Control Points(CCP) Critical Limits (CL)
Water Quality	Guideline Values	Endpoint testing

2.0 CASE STUDIES

The following case studies present circumstances where current practices in certain situations identified potential risk to public health.

2.1 Case study 1- Raw water source change

Background

A small rural town has a raw water storage that serves a number of purposes. It ensures a water supply during periods of high demand; it provides sufficient detention time to improve water quality; and it allows selective seasonal harvesting.

The Event

The failure of the transfer pump from the raw water storage to the treatment plant meant that water needed to be harvested prior to the raw water storage to maintain the drinking water supply.

The treatment plant usually operated with a stable turbidity around 5 NTU. The change in source location resulted in raw water turbidity to increase up to 50 NTU. The higher turbidity challenged the plants' coagulation and filtration processes. The filter runtime decreased rapidly resulting in the filters being unable to remove the formed flocs and achieving 16 NTU in the finished water.

A boil water notice was required to protect public health during the period of poor filtration.

During the boil water period the coagulation process was optimised to improved filter performance. Once the transfer pump was repaired and filter media was re-established the boil water notice was lifted.

Discussion

Filtration is a critical step in the removal of protozoa. Not having optimised filter performance limited the effectiveness of water treatment and increased the risk to public health.

The response undertaken was appropriate. However, the process was reactive and resulted in delayed actions. By quantifying system performance to establish treatment standards (HBT) the necessary critical limits would have been in place to alert operators that the usual treatment process would not be able to manage the changed conditions.

Preventive actions need to include discussions about optimisation processes to produce safe drinking water from different sources and during different conditions. Planning should not be limited to unusual events but also during normal operations. Operator knowledge is an important element for this activity.

2.2 Case study 2 - Water treatment during extreme events

Background

A water business undertook a risk assessment exercise using the Quantitative Microbial Risk Assessment (QMRA) methodology outlined in the Australian Guidelines for Water Recycling (NRMMC, EPHC, AHMC 2008) to review the performance of their treatment plants when challenged by extreme weather events.

The assessment revealed that all treatment plants performed within the acceptable or tolerable risk targets during normal conditions. However, calculations indicated that treatment of bacteria and viruses would be compromised in some systems during extreme weather conditions.

Discussion

This investigation resulted in a review of treatment processes and identified that it would be difficult in their chloramination systems to achieve the long contact time (Ct) needed when water quality was poor. Longer contact time is needed to reduce the amount of bacteria and viruses to a tolerable level using chloramination, as it is less reactive than free chlorine (Table 2). However, for long distribution systems chloramination is beneficial as it provides longer lasting residuals.

Table 2: ***Critical control point***

Turbidity (NTU)	**Temperature critical limit**	**pH critical limit**	Virus log_{10} reduction credit	**Free chlorine** CT critical limit (mg.min/L)	**Mono-chloramine** CT critical limit (mg.min/L)	**Ratio (chlorine equivalent)**
≤ 2.0	≥ 10˚C	≤ 9.0	1	≥ 10	≥ 3154	214.5
			2	≥ 16	≥ 4393	186.7
			3	≥ 21	≥ 5631	182.2
			4	≥ 27	≥ 6870	173.0

Adapted from Guidelines for validating treatment processes for pathogen reduction (Victorian Department of Health, 2013)

Both the Australian Drinking Water Guidelines and WHO guidelines clearly state that disinfection should not be compromised in order to manage risk.

To better manage risk during all conditions as well as maintaining disinfection in the distribution system the water business decided to modify its chloramination treatment method. This involved initially using free chlorine to meet the required disinfection. After achieving disinfection, ammonia could be added to improve chlorine residual throughout the network.

3.0 DISCUSSION

3.1 Health Based Target – *System Performance*

In drinking water, microbial pathogens attribute the greatest burden of disease, they are dispersed unevenly and occur in very low concentrations (NHMRC, 2013). This makes detection through sampling difficult and expensive.

When as little as one protozoa or virus can cause illness (Smeets, 2011), a risk management approach that quantifies the hazard in the catchment is critical to know how much treatment performance is required across the system to achieve an acceptable level of public health protection.

Treatment performance is about reduction of pathogens to a tolerable level. It is commonly represented as a $\log_{10}$ value (Table 3) and is applied to treatment technology targets to quantify controls. Case study 2 utilised this step to understand the source water quality during extreme events. From this information and linking it to the system performance objectives the business could optimise its treatment to address this.

Table 3: ***Log_{10} Reduction compared to percentage removed***

Log_{10} Value	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Reduction Percentage (%)	0	90	99	99.9	99.99	99.999	99.9999

3.2 Health Based Target – *Treatment Standards*

Treatment aims to control pathogens in one of two ways; removal by passing the water through a filter medium or membrane; and disinfection where the pathogens remain in the water but the infectivity of the pathogens is removed. The method used to treat pathogens is a Critical Control Point (CCP). The number of CCPs required is dependent on the type and quantity of pathogens likely to be in the source water. For individual treatment technologies, critical limits (CL) such as maximum flow, turbidity, etc. can be established to ensure the performance objectives are being met. For many water treatment plants, this would mean optimisation of filter performance and disinfection methods. Case study 1 could have utilised this step to set critical limits on turbidity performance, this may have highlighted earlier that there may have been a risk to public health.

3.3 Health Based Targets – *Water Quality*

By sampling water after treatment and through the network provides evidence that the overall system is performing appropriately and that there is no ingress within the network. This step is critical as it forms part of the catchment to tap approach and is used to verify delivery of safe water.

4.0 CONCLUSION

In Victoria, the implementation of the *Safe Drinking Water Act 2003* has created a high level of confidence that drinking water is safe. This requires water businesses to provide safe drinking water at all times.

Parts of the HBT approach to ensure drinking water treatment for all microbial pathogens is currently undertaken. Improvements as demonstrated in this paper can drive better performance of treatment plants.

Case study 1 highlights how a change in water source affects specific water treatment technology targets, in this situation it was filter performance. Establishing water treatment targets allows for a quicker response to operational changes that improve the management of the system. Case study 2 indicates how the HBT approach is used to emphasise where the greatest operational performance improvements can be made. These case studies show that HBT approaches provide a greater focus on individual water treatment technologies that enable businesses to consider how to maximise existing treatment measures. This provides greater clarity on how to control and manage risks in various conditions and provides confidence that the final product is safe.

5.0 ACKNOWLEDGEMENTS

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