SAFE AND HEALTHY DRINKING WATER IN INDIGENOUS LOCAL GOVERNMENT AREAS PROGRAM

ABSTRACT

A program to enhance the infrastructure and management of drinking water treatment systems was piloted in Australia's remote Torres Strait Islands by the Queensland State Government, with close involvement of Torres Strait Islander local government officers and water operators. Data collection and analysis was undertaken by University of Queensland researchers to assess the effectiveness of the pilot, drawing on both quantitative and qualitative sources, including field visits to the two Torres Strait locations (Hammond and Warraber Islands). The findings identified five prerequisites for success for an effective program of safe water delivery: appropriate infrastructure that is 'fit for purpose, place and people'; mentoring and technical support for remotely-located water operators; co-operation across relevant state and local government agencies; tailored design for each community and ongoing mentoring and support. The pilot initiative has adaptive potential for other remote communities, and for other basic services, including wastewater treatment and solid waste management..

INTRODUCTION

1.1 The safe drinking water challenge in remote Indigenous communities.

Providing safe drinking water in remote Australian Indigenous communities can raise many challenges. Source waters may be seasonally or consistently of low quality; annual water shortages can impact the quality and quantity of water available; water treatment infrastructure may be inadequate; and local water treatment operators may lack site-specific training, sufficient support or ongoing professional development opportunities (Kizito, Thorne et al. 2013, Murphy, Corston-Pine et al. 2015).

A key example of these challenges to producing safe drinking water is in Australia's remote Torres Strait Islands.

The Torres Strait Islands Regional Council (TSIRC) is one of 16 Indigenous councils within Queensland (LGAQ 2015). TSIRC operates 15 drinking water treatment plants (WTPs), located across 14 islands serving approximately 5,000 people (TSIRC 2018). TSIRC is subject to the same drinking water regulatory framework employed throughout Queensland. This includes compliance with the requirements of the *Water Supply (Safety and Reliability) Act 2008*, administered by the Queensland Department of Natural Resources, Mines and Energy (DNRME), and the *Public Health Act 2005* and the Public Health Regulation 2018, administered by Queensland Health. These regulatory requirements are based on the framework for management of drinking water contained within the Australian Drinking Water Guidelines (NHMRC 2011).

During the period 2009 to 2016, TSIRC reported 48 drinking water quality incidents to DNRME (TPHS 2017). Incidents primarily concerned the detection of *Escherichia coli* (*E. coli*) in routine treated drinking water samples - an indicator of potential bacterial contamination of the water. When *E. coli* incidents occur the drinking water service provider must report the incident to regulators and commence an investigation and, in many circumstances, a boil water alert (BWA) will be issued. Upon review, in late 2016, the Queensland Health Department's Tropical Public Health Services (TPHS), located in Cairns in Far North Queensland, (Queensland Health) expressed concern at the number and duration of BWAs instituted for drinking water services operated by TSIRC. Some alerts had remained in place for over one year (Mosse 2016, Mosse 2016a). That review revealed contributors to the water contamination included infrastructure-associated challenges; water operators not having site-specific training and knowledge; and limited funding for capital upgrades, maintenance and repairs to equipment (Mosse 2016, Mosse 2016a).

1.2 The co-designed safe drinking water pilot.

A pilot drinking water initiative was developed in response to Queensland Health concerns. The 'Safe and Healthy Drinking Water in Indigenous Local Government Areas' pilot ("the safe drinking water pilot") was developed in close consultation with TSIRC engineering staff and the island-based, Indigenous water operators (TPHS 2017). This co-design approach has similarities to efforts in other Indigenous communities (Bradford, Vogel et al. 2018). It involved two key elements: Firstly, to build water operator skills, knowledge and capacity by providing support through training and follow-up mentoring of water operators to ensure they understood the importance of their role and the public health ramifications of poor operations. Secondly, to facilitate the installation of appropriate water treatment technology that was specifically suited to the location and source water quality.

The initiative was led by TPHS and primarily funded by Queensland Health's Health Protection Branch. TPHS has extensive experience in the provision of health services and health promotion within remote Indigenous communities. The foundation for the project was full engagement and co-design with both TSIRC management and the water operators on-island: existing infrastructure was reviewed to consider its suitability for the social location and purpose; minor infrastructure improvements were

implemented; and water operators were supported through mentoring to increase their confidence in decision-making and to solve challenges that arose (TPHS 2017). The pilot was conducted in consultation with other state government agencies, namely the Department of Local Government, Racing and Multicultural Affairs (DLGRMA, formerly the Department of Local Government and Planning - DILGP) and DNRME.

The initiative was trialled on Hammond Island (also known as Kirriri) and Warraber Island (see Figure 1) from January to June 2017. Hammond Island was selected as a trial location as there had been a BWA in place for over ten months (14 January 2016 to 21 November 2016). Warraber Island was selected due to on-going public health risks posed by the lack of continuous supply: the desalinated drinking water was only supplied three days per week and the stored water in covered onshore lagoons was contaminated by large numbers of migratory shore birds and waders (TPHS 2017).

METHODS

In late 2017, the University of Queensland was commissioned to evaluation the achievements of the safe drinking water pilot.

The evaluation methodology was based on an 'outcome evaluation' form of program logic, one that seeks to verify a link between explicit project activities and the effectiveness or impact of those activities, based on emerging results. Such an evaluation examines the changes created as a result of the project, the beneficiaries of the project, and consequences for participants and stakeholders (NSW DPC 2016).

Key aspects of the evaluation concerned assessment of progress against the primary objective of reducing the occurrence *E. coli* detections (an indicator of potential faecal contamination) in drinking water supplies serving participating communities. In addition, data was captured to assess the potential impact of the pilot on overall water quality, community health, knowledge of operational staff and legislative compliance.

To evaluate changes in *E. coli* detections levels in participating water supplies water monitoring data from the TSIRC Drinking Water Quality Monitoring Plans were obtained for Hammond and Warraber Islands for the period from September 2016 until December 2017, to cover the period six months prior to the initiative being implemented as well as the time subsequent to the initiative (TSIRC 2016, TSIRC 2016a). Additional information was provided by DNRME and from the water industry's State-wide Water Information Management (SWIM) database, which is administered by the Queensland Water Directorate (Queensland's local government water advisory and advocacy body). Data were collated into Microsoft Excel and then uploaded to SPSS v24 for analysis, and descriptive analyses were undertaken to identify trends and compliance.

To determine the key features that contributed to water quality improvements, interviews were conducted with key project stakeholders between October and December 2017. Seven interviews were undertaken with representatives from four Queensland Government agencies (Queensland Health's Water Unit, TPHS, DNRME, and DLGRMA -the main funder of local government infrastructure in Queensland), TSIRC, the Queensland Water Directorate, and water treatment technology supplier, Austek. The interview questions covered the history and practice of service delivery and long-term sustainability of water treatment on the islands. The open-ended interviews lasted for around one hour and were recorded by both voice recorder and handwritten notes. These notes were analysed for emerging themes and against relevant pilot objectives, using NVivo qualitative analytical computer software (QSR International).

To understand the on-island context of drinking water management and to evaluate the impacts of the pilot project, field visits were undertaken to Hammond Island (5 December 2017) and Warraber Island (6 and 7 December 2017). During the visits, TSIRC water operators provided their views on the project via a yarning circle.

To validate the outcomes of the evaluation with participants, particularly the Torres Strait Islander water operators, a second yarning circle was held for island-based TSIRC staff on February 22, 2018 on Thursday Island.

RESULTS AND DISCUSSION

This section presents the results of the pilot project evaluation, contextualised within a wider discussion.

Quantitative analysis of water quality monitoring data revealed that no *E. coli* detections had occurred since pilot implementation in either community. Examination of monitoring results for chlorine residual levels in samples from both Hammond and Warraber Islands showed improvements over time, suggesting that the pilot improved both water treatment and testing practices in both communities. Reductions in HPC (heterotrophic plate counts – a broad measure of microbial activity in water samples) levels are likely to have resulted from increased chlorine residuals following implementation of the pilot.

Analysis of the qualitative data, collected to inform evaluation of the pilot project, identified five key features that are crucial in effective delivery of safe drinking water:

- Appropriate infrastructure for water treatment and monitoring;
- Support for water operations staff;
- Co-operation across relevant state and local government agencies;
- Tailored design for each community to address specific needs; and
- Ongoing mentoring and support.

The sub-sections below provide details on these key features.

Feature 1: Appropriate infrastructure. Although drinking water treatment infrastructure was not the focus of the pilot, it became apparent through the interviews, yarning circles and field visits that some minor, but important changes were required to improve drinking water treatment and monitoring of water quality. For drinking water treatment, interviewees commented that the existing water treatment technology did not comply with the emerging approach of 'fit for purpose, place and people''. Instead, limited funding sometimes resulted in inappropriate infrastructure and inadequate maintenance. For example, the previous chlorine dosing pumps were low quality and too small for the required task, resulting in pump failures, running dry, and not providing accurate feedback to enable monitoring of chlorine dosing.

The pilot addressed infrastructure deficiencies by upgrading water treatment technology, which included new chlorine pumps and installing supervisory control and data acquisition (SCADA) telemetry. New duty and standby chlorine dosing pumps were installed with automatic dosing at the required rate. A Human Machine Interface (HMI) was installed to display real-time data regarding reservoir volume, pump dosing, chlorine levels, and to enable remote operation of the pump from engineers and management staff (SCADA 2018). Since installation of the SCADA system, there has been a shift from a pattern of peaks and troughs in chlorine levels to a more consistent and effective range, with correct chlorine dosing for 100 percent of the water leaving the Hammond Island WTPs and 98 percent of the water leaving the Warraber Island WTP.

The outcome of these improvements, in addition to the provision of tablets preloaded with the SWIM database portal, was found to have facilitated more timely and accurate recording of both operational and verification data.

Feature 2: Support for staff and culture. Supporting staff and culture emerged as a 'people-centric' element that ensured the successful implementation of the pilot and that could provide support for the long-term sustainability of safe drinking water delivery. Four aspects were noted from the interviews and initial yarning circle.

Firstly, cultural competency was the foundation of the model used by TPHS to ensure that all non-Indigenous and non-community staff demonstrated appropriate cultural engagement and respect when visiting community and engaging in project activities. Cultural competency has been defined as a set of behaviours, attitudes, and policies in combination that enable effective and respectful cross-cultural engagement between people from different cultural backgrounds (Vic Govt 2008, WA Govt 2016). Specific advice for effective health communication involves building trust; displaying humility and willingness to learn; and understanding that, as a visitor, one has outsider status and lacks expertise in community issues (Hampton 2013, Bamblett 2015). The need for individual cultural competence includes responding to different ways of seeing and doing when immersed in Indigenous settings.

Secondly, the pilot project was co-designed with TSIRC's Cairns and island-based staff. It was implemented with regular, close and often in-person communication. TPHS initially engaged with both Cairns and island-based TSIRC staff to collaboratively determine their priorities to improve water management. The pilot co-design was then shared with the TSIRC Councillors, who approved and then promoted it throughout their communities. This approach corresponds to published guidelines that advise early engagement of Indigenous stakeholders, ongoing engagement rather than one-off consultant visits, and fostering of long-term ownership within the community (Hunt 2013).

TPHS staff described their approach on-island as aiming to be humble, to avoid presenting as the 'expert', and to learn from their mentee while also being available to mentor. TSIRC water operators reflected there was an understanding and respect for Torres Strait Islander culture expressed by the TPHS staff. This included accepting changes to the island-based schedules due to staff being involved in family and cultural business. This awareness had been developed over time through guidance from TSIRC management and previous experience on the Torres Strait Islands and mainland communities. This collegiate working relationship with TSIRC water operators and colleagues was summarised as a practice bounded by mutual respect.

Feature 3: Cross agency collaboration. The interviews revealed, that in many instances, it was felt that there was insufficient water management capability when full responsibility for water infrastructure was transferred to Queensland Indigenous councils (including TSIRC) as part of local government reforms in the 1990s and 2000s. This process was considered to have prevented many of the Indigenous councils from gaining sufficient skills and capacity to manage their technology-based, legacy assets.

The interviews identified that it could be difficult for Queensland Indigenous Councils to engage with the range of government stakeholders, each playing

different role in attempting to ensure the ongoing operation, maintenance, funding and regulatory compliance of drinking water service provision. The number of stakeholders involved, and their lack of collaborative approach was seen as contributing to non-compliant water treatment on some islands as well as idle infrastructure. Given the above, the interviewees from the three Queensland Government agencies described the pilot project approach to fostering legislative compliance through education, support and guidance as positive.

Cross- agency collaboration was identified as a key feature of the pilot project. It was clear that this pilot enhanced the working relationships between stakeholder agencies at state and local levels of government. All of the various stakeholders involved reported very positive outcomes from this interagency partnership: both Queensland Health and DNRME built their confidence in TSIRC's ability to deliver and maintain safe drinking water; DLGRMA increased its awareness and focus on the Torres Strait islands; and TSIRC displayed a willingness to work with the regulatory and funding agencies towards long-term, positive outcomes for drinking water.

When reflecting on their newly-established interagency collaboration, those involved identified that for adequate drinking water management in the Torres Strait islands, one agency 'cannot do it alone', and establishing a common vision and maintaining an information exchange is crucial. This approach is consistent with a recent guidance document that described the risks of non-collaboration between agencies (Hunt 2013).

Feature 4: Tailored design for each community. Under the pilot project, tailored training for water operators working on the Torres Strait Islands was developed. An earlier assessment identified that water operators, while holding relevant and certified qualifications (Certificate III in Water Industry Operations), did not demonstrate sufficient knowledge of the public health aspects of drinking water service provision. In addition, most had failed to receive appropriate training following infrastructure upgrades to ensure skilled operation of the specific treatment equipment on their island.

Results of a pre-training assessment of core knowledge, undertaken in both pilot communities, elicited correct response rates of 18 per cent (two staff), 31 per cent (one staff) and 43 per cent (four staff). To address these gaps in the operators' knowledge TPHS collaborated with TSIRC water operators to design and deliver standard operating procedures that would be usable and effective for current and incoming water operators. The water operators put forward their preference to create their own 'YouTube'-style video clips that demonstrated correct procedures for using their own water treatment and monitoring equipment, and image-based posters with clear step-by-step instructions placed at each equipment location. After the training, video clip production and poster design, the skills and knowledge of all seven water operators was re-assessed and all scored 100%. Beyond assessment scores, a number of other changes were observed in the months following the training. This included a shift in language to use industry-standard water terminology such as 'turbidity' and 'disinfection', and a shift in discussion to reflect an understanding of the purpose of processes such as chlorine dosing. Observations from TSIRC senior staff noted improved handling of the water treatment equipment and improved submission of accurate log sheets. Notably, there was a willingness by TSIRC staff to train their counterparts to pass on acquired skills without requiring TPHS involvement.

Feature 5: Ongoing mentoring and support. Following the installation of new equipment and the tailored training on public health, the intensive delivery phase of the pilot focused on a series of mentoring visits by TPHS staff. This on-site support was intended to build the water operators' confidence and reinforce their operational competence. Initially mentoring visits occurred every weekday for six weeks. This was later revised to a less intensive engagement involving one week on/one week off for a duration of approximately six months. The mentoring model received very favourable comments from the water operators. They found it to be an effective means of upskilling. TPHS noted that the mentoring appeared to initiate an increase in operator competence and knowledge.

Wider-ranging benefits were identified as outcomes of mentoring visits delivery model. These included a perceived increase in support for island-based water operators from TSIRC's Cairns-based staff and from TPHS; an increase in trust in government agencies by TSIRC's Cairns and island-based staff; and desire for water operators involved in the project to become in involved in mentoring their fellow treatment plant operators on other islands, as well as on mainland Indigenous communities

Despite the success of this mentoring approach, it was noted by interviewees that a sustainable budget is required to support this in the long-term due to the high cost of travel to the outer islands and the demand on staff time.

CONCLUSIONS

The pilot initiative for drinking water treatment in the Torres Strait demonstrated that improvements in water quality, operator competence and regulatory compliance can be achieved within a short time period. Post-pilot, water operators appear to apply enhanced skills and knowledge when performing operational tasks and when sampling water to ensure that no disinfection or sampling failures occur.

To ensure a sustainable service delivery model ensuring equitable access to safe drinking water, five 'prerequisites for success' were identified:

1.Water treatment infrastructure that is 'fit for purpose, place and people': The technology, delivery timeline, and training provided should ideally be tailored to the needs of each community so that they are 'fit for purpose, place and people'. Water operators benefit from appropriate water treatment infrastructure, on-site training and communications technology in order to do their job effectively.

2. Support for staff and culture: Support is ideally be based on mutual respect and sufficiently funded for both the delivery phase and future years. This recognises that, in a challenging physical and social environment, water operators will require periodic visits to maintain their skills and adapt to new infrastructure and treatment methods.

3.Cross-agency collaboration: This has proved essential for the success of the initiative. Furthermore, support staff from government agencies require competency in relation to the culture of the local Indigenous community and be flexible and willing to learn from the communities.

4.Tailored design for each community: Every community is different with respect to its people, culture, environment, water sources, water quality hazards and water treatment infrastructure. Therefore, program delivery and training needs to be flexible and adaptable to address the specific needs of that community.

5.Ongoing mentoring and support: On-site support builds the water operators' confidence and reinforces operational competence. Mentoring and ongoing support allow for the water operators competence, operating and monitoring knowledge to grow progressively in an environment and on equipment familiar to the water operator.

Many of the prerequisites for success displayed in this initiative are transferable to other indigenous communities as well as being applicable to other basic service delivery in these communities, including wastewater treatment and solid waste management.