

## The South Australian Safe Drinking Water Act: summary of the first year of operation

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### ABSTRACT

The *Safe Drinking Water Act 2011* was introduced in South Australia to provide clear direction to drinking water providers on how to achieve water safety. The Act requires drinking water providers to register with SA Health and develop a risk management plan (RMP) for their water supply that includes operational and verification monitoring plans and an incident notification and communication protocol. During the first year of operation, 212 drinking water providers registered under the Act, including one major water utility and a range of small to medium sized providers in regional and remote areas of the State. Information was captured on water source(s) used and water treatment. Rainwater was the most frequently reported drinking water source (66%), followed by bore water (13%), on-supply or carting of mains water (13%), mixed source (rainwater with bore water backup) (6%) and surface water (3%). The majority of providers (91%) treated the water supply, 87% used disinfection. During the first year of operation, 16 water quality incidents were formally reported to SA Health. These included both microbial and chemical incidents. Case studies presented highlight how the RMPs are assisting drinking water providers to identify incidents of potential health concern and implement corrective actions.

**Key words** | health, legislation, risk management, water quality

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### INTRODUCTION

The provision of safe drinking water is a fundamental requirement for community health and well-being. A range of microbial and chemical constituents in drinking water have the potential to affect human health. Rather than relying on end-point testing of water quality, it is widely recognised that a preventative risk management approach is a reliable way of achieving a safe drinking water supply and protecting public health.

The Australian Drinking Water Guidelines (ADWG) (NHMRC & NRMCC 2011) incorporate a framework for management of drinking water quality, providing national guidance on how to achieve a safe water supply through implementation of a risk management system. The ADWG take a similar approach to the World Health Organization's *Guidelines for Drinking-Water Quality* (WHO 2011) which

detail the use of water safety plans as an integral part of the framework for safe drinking water.

While the ADWG provide national guidance for drinking water quality in Australia, the responsibility for introducing drinking water legislation is with individual States and Territories. Introduction of legislation in Australia has occurred over the past 10 years, addressing a prior lack of regulatory oversight and prompted by a number of factors including a changing water industry and the need for enhanced direction to drinking water suppliers. In particular, climate variability, highlighted by the drought experienced by South Eastern Australia, coupled with population growth, has resulted in diversification of drinking water supplies, with a greater number of independent water supplies and innovative water solutions being

proposed to meet demand. Furthermore, the Sydney Water *Cryptosporidium* incident in 1998 (NSW Health 1998) and the waterborne disease outbreak in Walkerton, Canada, in 2000 (Hrudey & Hrudey 2014) demonstrated the risks and cost of failure to the water industry – both in monetary terms and health impact of lives lost or community illness.

Legislation in Australia now includes the *Safe Drinking Water Act 2003* in Victoria, the *Water Industry Competition Act 2005* in New South Wales, the *Water Supply (Safety and Reliability) Act 2008* in Queensland, and most recently, the *Safe Drinking Water Act 2011* in South Australia. Other States and Territories have introduced direction via the development of ancillary documents and regulatory support through public health legislation. State Drinking Water Quality Guidelines (2005) were developed in Tasmania with regulatory support through the *Public Health Act 1997*, while the Australian Capital Territory (ACT) provides direction to drinking water providers under the Public Health Drinking Water Code of Practice (2007) and regulatory support through the *Public Health Act 1997*.

While some differences exist in different jurisdictions, such as the scope of drinking water providers captured under each Act or auditing requirements, common to all legislation is the requirement for a risk management approach to the supply of drinking water based on ADWG.

In South Australia, the *Safe Drinking Water Act 2011* (the Act) and the *Safe Drinking Water Regulations 2012* were introduced to provide clear direction to drinking water providers on how to achieve water safety. Prior to the Act, drinking water safety had been regulated under the *Food Act 2001*, which included the requirement that drinking water was ‘fit for purpose’ but did not provide direction on how to achieve this goal. The intent of the Act in South Australia was to capture all drinking water providers that supply water to the public under one piece of legislation, from large water utilities to the small providers in regulated premises (vulnerable populations) that were previously captured under the *Food Act 2001*. This approach was taken rather than to introduce an Act for selected drinking water providers while regulating smaller supplies through separate legislation such as general Public Health legislation. Some jurisdictions have taken the latter approach, for example the *Safe Drinking Water Act 2003* in Victoria applies to designated water businesses (water

suppliers and water storage managers) and statutory authorities that publicly supply water (Parks Victoria and Alpine resorts). Regulation of water quality at prescribed accommodation premises, such as hotels, then falls under the *Public Health and Wellbeing Act 2008*.

By including all public water supplies under the Act it was realised a broad range of drinking water providers would be captured from water utilities, operators of independent town supplies, providers in rural and remote communities, hospitals, childcare and aged care centres, food and accommodation premises and water carters – and that most of these independent supplies would be very small. From a public health perspective, small water supplies are known to represent the greatest challenge and cause a disproportionate number of drinking water outbreaks (Hrudey & Hrudey 2004). Waterborne outbreaks in Australia have been associated with small facilities not serviced by a town supply (Cowie & Byleveld 2003) and studies have shown that smaller supply systems are significantly more likely to have high detection rates for faecal indicator bacteria (Cretikos et al. 2010).

Given the scope, a degree of flexibility was required under the Act to ensure that the risk management approach taken for each provider was consistent with the size of supply, complexity and nature of the water source. Although the Act includes a general obligation for drinking water providers to observe the principles of the ADWG, monitoring for specific microbial or chemical parameters to ADWG health guideline values was not defined, rather to be considered on a case by case basis. The option to use either a standard risk management plan (RMP) prepared by SA Health or develop a custom RMP provided the flexibility required to tailor monitoring plans and incident identification protocols based on the risks and hazards of each supply.

Consideration was also given to the high rate of rainwater use in South Australia. Provisions were made under the Act to allow exemptions in low risk settings where rainwater is provided. The consumption of rainwater is considered to be low risk for most people provided the infrastructure (rainwater tank, gutters and pipework) is adequately maintained (enHealth 2010). This is supported by studies carried out in Adelaide, South Australia, showing that for the general population, consumption of untreated rainwater does not contribute appreciably to community

gastroenteritis (Rodrigo *et al.* 2011). Where disease outbreaks associated with rainwater consumption have occurred, poor maintenance of infrastructure has been implicated as the cause (Merritt *et al.* 1999; OzFoodNet 2005; Franklin *et al.* 2009).

The exemption for rainwater in low risk premises covers short-term accommodation settings such as bed and breakfast operators or caravan parks, providing the supply is labelled rainwater to notify users of the source of drinking water. Informing consumers of the source allows them to exercise personal choice about consumption. The exemption does not apply to regulated premises such as hospitals, residential aged care facilities, schools, kindergartens and childcare centres that can provide services to potentially vulnerable populations. Private domestic rainwater or bore water supplies are exempt from the Act.

In this paper we report on the Safe Drinking Water Act in South Australia during its first year of implementation, summarise the range of drinking water providers captured following registration, the water sources and treatment processes used, and outline the water quality incidents reported to SA Health to date. A number of case studies are also provided.

## SAFE DRINKING WATER ACT 2011

The *Safe Drinking Water Act 2011* (the Act) and *Safe Drinking Water Regulations 2012* became effective in South Australia from 1 March 2013 with a 12 month transitional period. Full operation of the Act commenced from 1 March 2014. Consultation with stakeholders occurred prior to commencement, informing drinking water providers of requirements under the new legislation, and providing guidance on how to achieve this. Fact sheets and guidance documents were made available by SA Health, in addition to provision of information sessions and face to face meetings.

Key components of the Act require drinking water providers to:

- register with SA Health;
- implement a RMP for the water supply;
- provide water quality results to consumers on request;

- ensure audits or inspections are carried out.

On registration with SA Health, providers were asked for information about their water supply, treatment and monitoring.

As described by the Act, RMPs were required to have a detailed description of the system of supply, an outline of the risks to the quality of the water, an assessment of risks and the steps required to manage these risks, a monitoring programme covering both operational and verification monitoring and an incident identification and notification protocol. Standard RMPs were available from SA Health for adoption by small providers with low risk supplies, for example, small rainwater supplies or water carters. For supplies with complex treatment, such as a surface water supply or bore water in remote locations using reverse osmosis, a custom RMP was required to be developed by the provider. The Community Water Planner, a web-based tool developed by the National Health and Medical Research Council (NHMRC) and the National Water Commission (NHMRC 2011), was used by some providers to generate an RMP for their supply while other providers developed their own custom RMP based on existing documentation (such as standard operating procedures) in line with the principles of the ADWG.

SA Health reviewed custom RMPs submitted to ensure monitoring programmes and incident identification and notification protocols were appropriate for a given supply, and provided guidance where required. The operational monitoring programmes were reviewed to ensure inclusion of preventative measures for protection of the water supply, including items such as inspection of catchment area (dam, fencing), integrity of infrastructure (borehead protection zone, storage tanks) and criteria for items such as turbidity and UV operation. The verification monitoring programmes were reviewed to ensure key characteristics of the water supply were tested including microbial indicator organisms (*Escherichia coli* as an indicator of faecal contamination), disinfectant residuals, disinfectant byproducts, and health-related characteristics with potential to exceed the ADWG guideline levels as appropriate for a given supply. The testing frequency for water quality parameters was based on a number of factors including size of supply, the water source, disinfectant used and population supplied (general population vs vulnerable population). Consideration was

also given to the location of the drinking water provider, and the feasibility of obtaining meaningful test results when in remote locations. Finally, the incident identification and notification protocols were reviewed to ensure that the appropriate water quality incidents were defined, the inclusion of a list of personnel who should be notified of the incident and the time frame for this to occur. Reporting the incident to SA Health (required) allows the water quality provider to be guided through the appropriate responses for incidents which may have public health concern.

Once approved, drinking water providers were notified of the audit or inspection frequency (yearly or every 2 years) for their supply in line with that prescribed under the Act.

### Drinking water providers registered under the Act in South Australia

In the first year of operation a total of 212 drinking water providers registered under the Act. This includes the major water utility in South Australia, the SA Water Corporation, along with a range of small to medium sized drinking water providers in regional, rural and remote areas of the State.

The SA Water Corporation manages a large number of drinking water supplies and provides the majority of South Australia's drinking water supply, with approximately 1.5 million customers. SA Water has a well-established incident notification and communication protocol with SA Health. Quarterly water quality reports are provided to SA Health and an annual water quality report is published on the SA

Water website. Both provide performance analysis against the ADWG. Analysis of SA Water's water supplies are not included in this paper.

A breakdown of water sources, type of premises and treatment trends is given below for providers captured under the Act excluding SA Water.

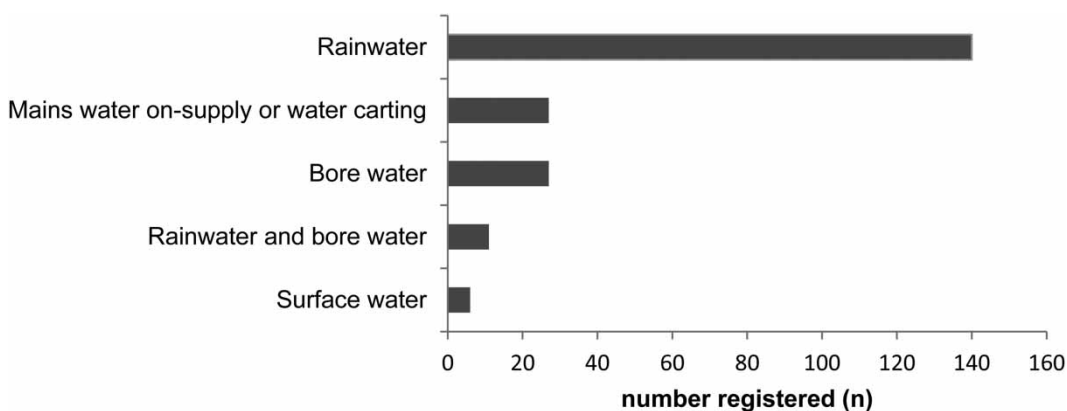
### Water source

The majority of drinking water providers that registered under the Act sourced drinking water from rainwater (66%,  $n = 140$ ), see [Figure 1](#). On-supply or carting of mains water accounted for 13% ( $n = 27$ ) of the providers, while a further 13% ( $n = 27$ ) were supplied by bore water. A number of providers used multiple sources of drinking water, predominantly rainwater with bore-water backup (5%,  $n = 11$ ). Finally, 3% ( $n = 6$ ) of providers used a surface water supply, from either a dam or the River Murray.

On-supplies are only captured under the Act where the mains water is considered to be materially altered. This may occur by either treatment of the water, such as chemical disinfection on site prior to distribution, or where providers stored mains water for extended periods with limited turnover, for example, storage of mains water for holiday accommodation where only seasonal use of the water occurs.

### Treatment

Water treatment processes used by drinking water providers included reverse osmosis, clarification (filtration, sedimentation,



**Figure 1** | Water sources used by drinking water providers (excluding SA Water Corporation) registered under the *Safe Drinking Water Act 2011*.

coagulation, flocculation), disinfection (UV treatment, chlorination, chlorine dioxide) or other adjustments including pH adjustment or water softening. The majority of providers (91%) treated water using at least one of the treatment processes, 87% used some form of disinfection. Supplies that registered without disinfection included small rainwater supplies ( $n=25$ ) and small bore water supplies ( $n=7$ ). Further information on treatment trends is given below, discussed by category of drinking water provider.

### Drinking water providers – type, water source and treatment trends

The type of premises that registered ranged across community supplies, mining accommodation, water carters, hospitals and aged care facilities, education premises, wineries, dairy product manufacturers, and food and accommodation premises. A breakdown of number of providers by type is given in Figure 2 with a summary of the typical water sources and treatment for the different categories of provider type given below.

Community supplies ( $n=17$ ) included both privately operated and local government operated drinking water supplies. This category included two town supplies of  $>2,000$  population, with the majority of other supplies servicing a population of approximately 200. The water sources used included surface water ( $n=3$ ), bore water ( $n=4$ ), on-supply of mains water ( $n=9$ ) and one rainwater supply. Treatment of surface water (River Murray or dam) was undertaken using conventional processes including coagulation, flocculation, filtration and disinfection. One of the community supplies using bore water was located in a coastal region of South Australia and accessed seawater via an underground bore. Treatment was by reverse osmosis followed by chlorination for disinfection.

Mining sites ( $n=11$ ) providing accommodation to workers were typically located in remote areas of the State (north to far north South Australia). All sourced bore water for drinking water and other purposes on site. In most cases, the bore water was treated by reverse osmosis due to the high total dissolved solids content of the ground water supplies in these areas.

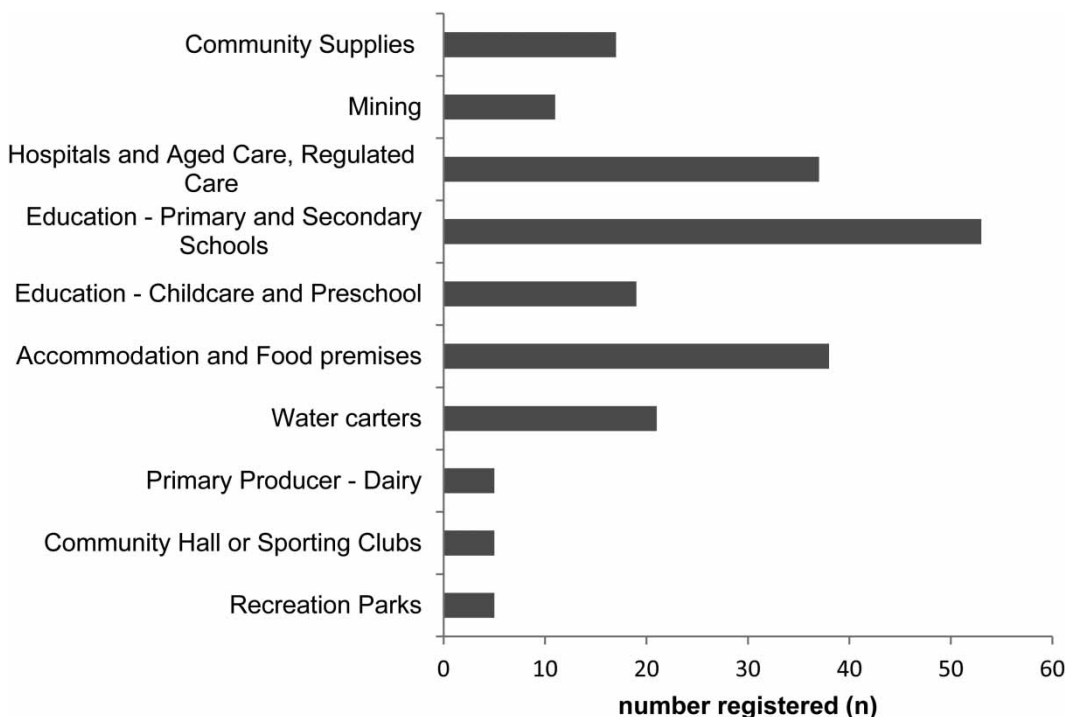


Figure 2 | Drinking water providers, by type, registered under the *Safe Drinking Water Act 2011*.

As shown in Figure 2, schools accounted for 25% (n = 53) of the total drinking water providers registered and included school premises, both public and privately owned, and school camp facilities located in regional areas of the State. All schools used rainwater as the source of drinking water and UV treatment was widely used. For public schools, the policy is to install a UV unit where rainwater is used. For private schools, UV disinfection or routine chlorination was also used for treatment of rainwater. Two of the private schools did not treat the rainwater. A further 18 preschool facilities also registered using rainwater, with UV treatment. One private childcare facility registered using rainwater where a boiled water procedure had been implemented.

There are 37 hospitals, aged care or other regulated care facilities registered under the Act, located in regional areas of the State. One hospital used a mains on-supply with further treatment. The remaining 36 hospitals and care facilities sourced drinking water from rainwater. UV treatment was widely used (n = 29). Three of the registered hospital or aged care providers did not treat the rainwater. A point-of-use media filter (validated for bacteria, virus and protozoa removal) was used at two of the facilities and a further two premises routinely chlorinated the rainwater tank.

Accommodation and food premises (n = 38) located throughout rural areas included hotels, motels, cafes, wineries, restaurants and breweries. The majority of providers used rainwater, while bore water was also used, on some occasions as backup to the rainwater supply. Two of the providers sourced drinking water from a surface water supply, one located on the River Murray and the second using creek water in a remote area of the State. Treatment of the surface water was by conventional water treatment processes for the River Murray water, and ultrafiltration of the creek water.

Water carters (n = 21) typically cart mains water to outer metropolitan regions or to mining camps. Four drinking water providers carted bore water, including businesses marketing bulk spring water in the Adelaide Hills districts. Treatment occurred by chlorination or UV disinfection.

Other drinking water providers included dairy product manufacturers (n = 5), small sporting clubs or community

halls (n = 5) and National Parks (n = 5). One surface water supply was included in the latter group.

### Water quality incidents reported to SA health

During the first 12 months of operation of the Act (1 March 2015 until 28 February 2015), 16 water quality incidents were formally reported to SA Health as per the incident identification and notification protocols included in RMPs (excludes incidents from SA Water supplies). Of these, 11 incident notifications were due to the detection of *E. coli* (Table 1) while the remaining five incident notifications were due to chemical exceedances above ADWG levels or parameters outside physical and chemical limits outlined in RMPs (Table 2).

As shown in Table 1, the majority of *E. coli* detections were reported from providers using rainwater, only one incident reported the detection of *E. coli* in a water sample from a storage tank of treated bore water (treated by reverse osmosis). Of the 11 microbial incidents reported, five can be attributed to one premises using rainwater without further treatment. The RMP for this provider required monthly *E. coli* testing, and detection of *E. coli* was reported on five separate occasions. Other providers using rainwater reported *E. coli* detections despite the presence of UV treatment on site. Most of these were low numbers of *E. coli* although one incident reported >100 *E. coli*/100 mL with a UV unit installed (refer to case study 1 below). A more detailed description of some of these failures is provided below.

The chemical water quality incidents reported (Table 2) included overdosing of chlorine, low chlorine residual and exceedances of chemicals above ADWG health guideline values including chlorite (a by-product of disinfection with chlorine dioxide) and nickel. Two of the incidents proved to be ongoing issues for the drinking water providers and are described in more detail below (case studies 2 and 3).

### Water quality incidents – case studies

Three water quality incidents reported to SA Health are described in detail below.

**Table 1** | Microbial incidents reported under the *Safe Drinking Water Act 2011* during the first year of operation

ID	Drinking water provider by type	Source water/Treatment	Microbial <i>E. coli</i> /100 mL			Remedial action
			0–10	10–100	> 100	
02	Education – primary and secondary	Rainwater (no treatment)		+		Chlorination of tank
04	Education – primary and secondary	Rainwater (no treatment)	+			Chlorination of tank
06	Hospitals and aged care	Rainwater + UV			+	Multiple tanks, chlorination, resampled, replaced UV
07	Hospitals and aged care	Rainwater (no treatment)		+		Multiple tanks, chlorination, resampled
08	Education – primary and secondary	Rainwater (no treatment)		+		Chlorination of tank
10	Education – primary and secondary	Rainwater (no treatment)		+		Chlorination of tank
11	Education – primary and secondary	Rainwater + UV	+			Chlorination of tank
12	Accommodation and food premises	Rainwater + UV	+			Chlorination of tank
13	Accommodation and food premises	Rainwater + UV		+		Chlorination. Replaced UV lamp, cleaned sleeve
15	Mining accommodation	Bore water + RO	Presence only			Tank cleaned, pipework flushed, chlorination
16	Education – primary and secondary	Rainwater (no treatment)		+		Chlorination of tank

**Table 2** | Chemical incidents reported under the *Safe Drinking Water Act 2011* during the first year of operation

ID	Drinking water provider by type	Source water/treatment	Chemical	Remedial action
01	Regulated care premises	Rainwater, chlorination	Chlorine overdose	Ongoing issue, installed UV treatment
03	Food premises	Bore water + chlorination	Chlorine overdose	Resample
05	Mining accommodation	Bore water + RO	Low chlorine residual, low pH	Resample
09	Community – on supply	Mains water, chlorine dioxide	Chlorite >ADWG 0.8 mg/L	Ongoing issue, implemented bottled water notice
14	Mining accommodation	Bore water + RO	Nickel >ADWG 0.02 mg/L	Resample, filter change

### Case study 1 – *E. coli* detections

A hospital in regional South Australia registered as a drinking water provider with SA Health and adopted a standard RMP for rainwater in regulated premises. The water supply consisted of two rainwater tanks where the pipework combined prior to passing through a UV unit. Routine sampling for *E. coli* every 6 months was included as part of the RMP. An incident was reported when sample results detected 140 *E. coli*/100 mL at one location in the hospital and 10 *E. coli*/100 mL at a second location onsite. The

hospital maintenance staff reported that the UV lamp had been operational at the time of the incident (via daily visual checks of lamp operation), and that the water sample had been taken after a rain event. Chlorination of the tanks occurred and the pipework was flushed. Repeat samples the following week reported 0 *E. coli*/100 mL and 69 *E. coli*/100 mL at the same two locations, respectively. Further chlorination of the tanks occurred. The UV lamp was also replaced, approximately 3 months prior to the scheduled replacement (every 12 months under the operational monitoring plan). After a third set of sampling, the

rainwater supply test results were free from *E. coli*. Historical data over the past 5 years showed that the routine sample results had been consistently free from *E. coli*. The most likely cause of the failure of disinfection was thought to be reduced UV lamp intensity, although this could not be confirmed. As part of the hospital investigations, additional pipework was installed to allow bypass of the rainwater system with mains water. This has been left in place in the case of future incidents. There was no report of gastrointestinal illness from this incident.

### Case study 2 – chlorine overdosing

A regulated care premises in the Adelaide Hills accommodating residents for extended stays and registered under the Act reported a number of chlorine overdosing incidents. Rainwater was used as the potable water supply. The facility adopted a standard RMP which was modified to suit the specific characteristics of their supply in consultation with SA Health. The facility infrastructure included five rainwater tanks supplying the drinking water to five buildings. A routine water quality testing programme had been implemented on site prior to the introduction of the Act. Both *E. coli* and coliform testing was carried out every 3 months. Water samples were taken from the kitchen tap in each of the buildings. The site had a known history of intermittent detections of *E. coli* in the water samples. A review of the previous 12 months of water quality data showed that *E. coli* detections were generally 1–10 *E. coli*/100 mL, however detection of >1,000 *E. coli*/100 mL had been reported on one occasion. The *E. coli* detections were being addressed by facility managers by routine disinfection. Manual chlorination of the rainwater tanks occurred every 2 weeks, and a boiled water policy had also been implemented on-site for residents as a standard protocol. The maintenance procedure also included repeat sampling following *E. coli* detection. The chlorine residual in the water samples was also determined.

Review of the chlorine residual results also indicated that overdose of chlorine had occurred on two occasions in the past 12 months; 8 mg/L and 44 mg/L chlorine residual were recorded in samples taken from kitchen taps compared to the ADWG health guideline of 5 mg/L chlorine. The standard chlorine dosing procedure forwarded by

the drinking water provider indicated that a maximum chlorine dose of 2.5 mg/L would have been expected in the rainwater tanks where adjustment of dose for the level of water in the tank occurred.

A further routine water quality sample taken resulted in a water quality incident being raised due to chlorine overdose at four locations on site (6–8 mg/L chlorine) – as per incident notification protocol in the recently implemented RMP. Following this incident, the decision was made to install UV disinfection onsite, which SA Health supported. UV units were installed on each rainwater tank supply, both alleviating the need for the boiled water protocol and avoiding potential errors with manual chlorination of tanks.

### Case study 3 – chlorite exceedances

A community supply using an on-supply of mains water as drinking water with further treatment of the water occurring on-site reported chlorite exceedances. In this facility, chlorine dioxide was used for disinfection prior to distribution to a number of buildings including a residential site. The drinking water provider consulted with SA Health during the development of their custom RMP which included monitoring for the disinfection by-product chlorite. An incident criteria of 0.8 mg/L chlorite based on the ADWG health guideline level was implemented where any exceedances of the guideline level were to be reported to SA Health for guidance on remedial action.

As a result of the establishment of the incident identification and notification protocol, ongoing chlorite levels >0.8 mg/L were reported to SA Health by the drinking water provider. Levels of chlorite ranged from 1.2 to 7.1 mg/L (1.5–9 times the ADWG health guideline level) at six locations across the facilities' distribution network. Repeat sampling showed similar high chlorite results across the network on a number of occasions despite a reduction in chlorine dioxide dosing. Supply of bottled water to the residents onsite occurred for approximately 3 weeks while the situation was investigated. Flushing of the water supply network was undertaken. Investigation revealed that the water supply was recirculating past the chlorine dioxide dosing point, resulting in the high levels of chlorite formation. Remedial action was taken to correct the recirculation and chlorite levels were restored to below



ADWG health levels. No further exceedances of chlorite have been reported to SA Health to date.

## DISCUSSION

The *Safe Drinking Water Act 2011* was introduced into South Australian law to help drinking water providers achieve a safe water supply based on a risk management approach, manifesting as an RMP. Both microbial and chemical contaminants may be present in water, with microbial contamination of a water supply having the potential to lead to outbreaks of acute gastrointestinal illness and other acute diseases. The protocols included in the RMPs are intended to reduce the risk of illness through early identification and correction of problems.

The first year of operation of the Act has provided a synopsis of the range of drinking water providers captured under the Act in South Australia. Facilitated by the registration process under the Act, information has been captured on the number of drinking water providers, the water source(s) used, along with existing treatment practices. While the total number of drinking water providers registered (212) was greater than expected, the range of drinking water providers captured in terms of size and complexity was as anticipated, with the vast majority of supplies being small providers. Aside from the major utility, SA Water Corporation, there were only two community supplies servicing a population >2,000, the remaining drinking water providers that registered were small supplies serving <200 population. Some of the providers that registered, particularly in remote locations, were known to be extremely small. The water supply and treatment used by a drinking water provider was typically governed by the available water source in the area, the water quality and the volume of water required to be supplied. Consistent with high rainwater use in South Australia – 46% of households have a rainwater tank in the Adelaide area and up to 86% of households outside of the Adelaide metropolitan area (ABS 2013) – the majority of providers sourced drinking water from rainwater. Rainwater was used by small providers in areas likely to receive greater amounts of rainfall, such as food and accommodation premises in the Adelaide Hills districts, but was also used by schools and regulated

care premises in regional locations. Disinfection was common, but not always used. Bore water was the predominant water source in remote areas of the State where rainfall is limited, with treatment by reverse osmosis often necessary due to the high salt content of the water supply. The broad nature of the Act has also ensured the drinking water providers servicing the most vulnerable populations in regulated care premises have been captured.

The implementation of the RMP, with monitoring plans and incident notification protocols, forms the basis of the risk management approach. While some drinking water providers had existing monitoring and maintenance schedules in place (for example, at regulated premises), for other providers the testing and maintenance requirements were new. It was noted that larger providers, including mining sites, often had existing documentation such as standard operating procedures and water quality testing programmes which could be transitioned into custom RMPs. At this stage, compliance with the monitoring requirements in RMPs cannot be assessed, but is expected to be addressed in future years through the audit and inspection programme.

The number of water quality incidents reported during the first year of operation of the Act was lower than expected. This may be due to in part to the lead time in implementing the operational (maintenance) and verification monitoring (water quality testing) required by the RMP. In particular, the number of microbial water quality incidents reported appeared low. The presence of the faecal indicator bacteria *E. coli* was reported on 11 occasions, with 10 incidents from providers sourcing rainwater. Multiple incidents were from one provider with an untreated rainwater supply. Untreated rainwater supplies have a higher *E. coli* testing frequency defined in RMPs than those with disinfection (chlorination or UV treatment); up to monthly for those supplying a vulnerable population such as in a regulated care premises. Survey data have previously reported a prevalence of 30% for *E. coli* detection in untreated rainwater samples collected in South Australia (Rodrigo *et al.* 2011). It is possible that the limited number of rain events recorded in South Australia in recent months has limited the amount of faecal contamination from birds, reptiles or small mammals washed into tanks from roof runoff. The latter 6 months of the reporting period was a particularly dry period in South Australia (BOM 2015).

It was also noted that four of the water quality incidents caused by *E. coli* detection in rainwater supplies were reported when UV units were installed. In at least one case the incident resolved following replacement of the UV lamp, suggesting that ineffective disinfection may have arisen from inadequate UV lamp intensity. While some studies have shown that UV disinfection alone is the least effective disinfection method – with rates of *E. coli* detection three times higher when compared with a chlorinated system (Cretikos et al. 2010), these reports have been from surface water supplies. Review of the chemical water quality incidents reported to date demonstrated how the implementation of an RMP has served to provide additional information and guidance to the drinking water providers. For some existing providers, maintenance and water quality testing had been carried out for a number of years prior to the Act, however the identification of incidents of potential health concern was not necessarily recognised. In the case study cited of chlorine overdosing, introduction of the RMP raised awareness of ADWG health guideline levels for chlorine residual and highlighted inherent problems with manual chlorine dosing. Similarly for the case study of chlorite exceedances, the relevance of the ADWG level for chlorite was not recognised until incorporated into the incident identification and notification protocol included in the RMP.

To date, the review of monitoring programmes and incident identification and notification protocols incorporated into a drinking water provider's RMP has been demonstrated to be an effective short-term measure for identifying existing water quality issues. In the long term, the audit process under the Act will assess compliance with the RMP, and provide a process for identifying any emerging problems or opportunities for improvement.

## CONCLUSIONS

The *Safe Drinking Water Act 2011* has captured a broad range of drinking water providers of varied size, water source(s) used and treatment practices. The range of providers captured is distinctive to the South Australian legislation, as it includes small drinking water providers

and the vulnerable populations which are potentially the most susceptible to waterborne disease outbreak.

To date, implementation of an RMP as required under the Act has facilitated improvements for many drinking water providers in supplying safe drinking water by commencing monitoring and maintenance not previously carried out. It has been demonstrated to assist drinking water providers in identifying incidents of potential health concern that were not previously recognised, and assist providers in seeking guidance from SA Health to resolve issues. It is intended that in the future, benefits will continue to be early identification and correction of problems consistent with the risk management approach.

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