A systematic literature review of the enabling environment elements to improve implementation of water safety plans in high-income countries

Rachel Baum and Jamie Bartram

ABSTRACT

Effective risk management helps ensure safe drinking water and protect public health. Even in high-income countries, risk management sometimes fails and waterborne disease, including outbreaks, occur. To help reduce waterborne disease, the WHO Guidelines for Drinking Water Quality recommend water safety plans (WSPs), a systematic preventive risk management strategy applied from catchment to consumer. Since the introduction of WSPs, international guidelines, national and state legislation, and local practices have facilitated their implementation. While various high-income OECD countries have documented successes in improving drinking water safety through implementing WSPs, others have little experience. This review synthesizes the elements of the enabling environment that promoted the implementation of WSPs in high-income countries. We show that guidelines, regulations, tools and resources, public health support, and context-specific evidence of the feasibility and benefits of WSPs are elements of the enabling environment that encourage adoption and implementation of WSPs in high-income countries. These findings contribute to understanding the ways in which to increase the uptake and extent of WSPs throughout high-income countries to help improve public health.

Key words | drinking water, enabling environment, risk management, water safety plan

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INTRODUCTION

Safe drinking water is consistently expected in high-income countries. However, waterborne disease and outbreaks still occur (Hrudey & Hrudey 2004, 2014). To reduce the incidence of waterborne disease, enhanced risk management practices, such as water safety plans (WSPs) can be implemented. WSPs are a systematic, preventive risk management approach that is applied from catchment to tap to ensure safe drinking water (Davison *et al.* 2005; Bartram *et al.* 2009). WSPs have been implemented in the following high-income countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Iceland, Ireland, Italy, Japan, Portugal, The Netherlands, New Zealand, Norway, Slovakia, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom (Davison *et al.* 2005; Martel *et al.* 2006; Japan Ministry of Health Labour & Welfare 2008; Malzer *et al.* 2010; Gunnarsdottir *et al.* 2012b; Brauer & Sturm 2014; Davidovits 2014; Reid *et al.* 2014; Rinehold *et al.* 2017). WSPs provide benefits in improving control of hazards, regulatory compliance, microbiological water quality, asset management, communication, staff knowledge of water supplies, and public health outcomes (Gunnarsdottir *et al.* 2012a; Loret *et al.* 2016; Rinehold *et al.* 2017; Setty *et al.* 2017).

While WSPs have grown from individual water system practices to national guidelines and regulatory requirements in some high-income countries, Canada, Chile, Israel, and the United States have limited experience with WSPs (Hamilton *et al.* 2006; Martel *et al.* 2006). Although these

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countries have drinking water quality regulations and require specific treatment processes and management practices, water contamination events still occur, contributing to waterborne diseases and outbreaks. Many drinking water quality regulations in these countries align with the components of a WSP, however gaps exist, indicating that potential benefits could be realized through improved preventive risk management (Chile Ministry of the Environment, 2012; Martel *et al.* 2006; Israel Ministry of Health Public Health Regulations 2013; Baum *et al.* 2015).

While formal rules (regulations or guidelines) promote the uptake of risk management practices such as WSPs, other conditions, such as cultures and norms, also influence risk management practices. Formal rules together with the conditions that affect the achievement of objectives are considered the enabling environment (Amjad *et al.* 2015; Ojomo 2016). To improve drinking water safety, an enabling environment can be created that supports that goal.

The objective of this systematic literature review was to assess the enabling environment by regulations, institutional arrangements, and/or conditions that promoted the adoption and implementation of WSPs in drinking water systems in high-income countries (defined as high-income Organisation for Economic Co-operation and Development (OECD) member states as classified by the World Bank). Understanding the ways in which WSPs were adopted and implemented in other OECD high-income countries illustrates the enabling environment that could help to close these gaps between current policies and WSPs in countries with less experience.

METHODS

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used (Moher *et al.* 2009). Study articles were identified from: Web of Science, ScienceDirect, Water Safety Portal, and the drinking water quality agency website of each high-income OECD country and states. Bibliographies from these articles were searched to identify other relevant studies or grey literature that were not found through the search. This search was conducted between June 1, 2017 and July 20, 2017.

Search terms were chosen to include articles that discussed any experiences related to WSPs or other risk management plans for water systems. Only articles in English were included. Since many water systems used hazard analysis and critical control points (HACCP) as a risk management practice similar to WSPs, HACCP was used as a synonym for WSP when searching. The search terms used were: 'drinking water' AND regulat* OR legislat* OR adopt* OR implement* OR experience* (included in the article) AND 'water safety plan*' OR 'HACCP' OR 'risk management' OR 'safety plan*' AND water (included in the title).

RESULTS

The literature search yielded 158 unique results (Figure 1). These 158 articles were screened by title and abstract to determine which were eligible for inclusion. Inclusion criteria were that the articles must be: about high income OECD countries, related to water systems serving communities, and about implementation or experiences with WSP or HACCP. Articles about evaluation frameworks for risk management, technologies to assist risk management, or articles on only other (low and middle income) countries were excluded. This led to the inclusion of 88 articles that

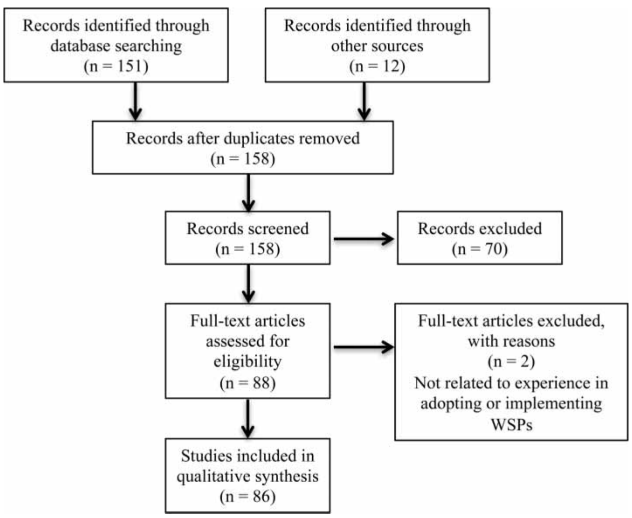

Figure 1 | PRISMA systematic literature review articles on enabling-environment elements for drinking water risk management plans in high-income OECD countries.

discussed the enabling environment through regulations, institutional arrangements, or experiences of a water system or set of water systems that led to the adoption of a WSP or similar risk management practice in a high-income OECD country. Two articles were excluded based upon full text review, in which it was revealed that the content was unrelated to the implementation or experience of a WSP or HACCP, leaving 86 articles in the synthesis of the literature review (see Appendix for full list of included articles, available with the online version of this paper).

Qualitative synthesis

The literature review revealed many case studies of WSP experiences. However, few articles compared different drinking water safety approaches. We synthesized the regulations, institutions, and conditions of the enabling environment across all WSP experiences at international, national, state and local levels that led to the adoption and implementation of WSPs.

Included studies suggest that the enabling environment for adoption and implementation of WSPs includes guidelines, regulations, tools and resources, public health support, and context-specific evidence of the feasibility and benefits of WSPs. Each of these components of the enabling environment influences others between international, national and state, and local levels (Figure 2).

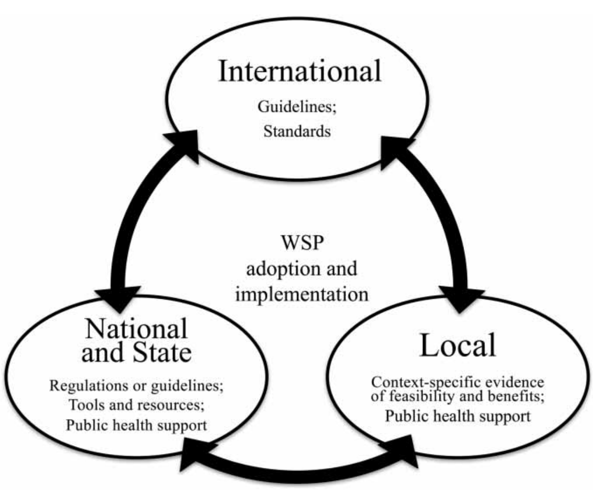

Figure 2 | Influence of enabling-environment elements across international, national, and local boundaries.

International-scale promotion and adoption of WSPs

On an international scale, guidelines and standards promote WSP adoption and implementation. Many systematic risk management practices for water systems in high-income countries began as a related international practice, HACCP, that was first used in the food industry to assure food safety (Havelaar 1994). HACCP practices for the food industry began in the late 1960s in the USA, and the US Food and Drug Administration conducted a pilot program of HACCP audits in 1973 (Ropkins & Beck 2000). By the 1990s, HACCP was practiced widely to improve food safety (Mortimore & Wallace 2013). Havelaar first noted the potential application of HACCP practices to drinking water systems in 1994 (Havelaar 1994). Since then, some countries, such as Switzerland, Iceland, France, and Slovenia have held water systems to the same standards as food processing centers, requiring water systems to institute HACCP (Beir *et al.* 2003; Bosshart 2003).

International Standards, including ISO 9001 and ISO 14001, have served as stepping stones towards WSPs as they include some of the components of a WSP. ISO 9001 addresses quality management systems, however it focuses on end product testing and continual improvement rather than preventive risk management (Australia National Health and Medical Research Council, 2004). ISO 14001 focuses on environmental management, but emphasizes environmental protection rather than public health (Martel *et al.* 2006). A case study of five water utilities in Australia showed that at each utility, ISO 9001 and ISO 14001 had been implemented prior to implementing HACCP, which both helped in minimizing additional documentation and additional management practices of HACCP (Martel *et al.* 2006).

Even though HACCP was an initial driver for improved risk management of drinking water systems, widespread application of HACCP for drinking water safety did not occur. Between 1994 and 2004, the World Health Organization (WHO) developed international guidelines for a systematic risk assessment and management plan for drinking water systems through an extensive design and consultation process. Throughout this period, WHO worked to promote a culture of improving drinking water safety through widely publicizing and promoting the use of what became known as WSPs through conferences, engagements, and discussions that led to the codification of WSPs as a component of a framework for safe drinking water in the 2004 Guidelines for Drinking Water Quality 3rd Edition (WHO Guidelines; WHO 2014); and in IWA; 2004 Bonn Charter for Safe Drinking Water (Bonn Charter) (IWA 2004). The WHO Guidelines added to the enabling environment by promoting similarly aligned national and state guidelines and regulations requiring systematic risk management (Hamilton *et al.* 2006; Martel *et al.* 2006). The WHO Guidelines and the Bonn Charter suggest that not only are hazard analysis and controls needed (like HACCP), but that risk assessment of the entire water system is necessary to set priorities for ensuring the safety of drinking water (IWA 2004; WHO 2004).

National- and state-scale promotion and adoption of WSPs

While HACCP was widespread in the food industry in many countries, the consideration of water as a food and the subsequent introduction of HACCP to water systems in some countries was often driven by a country's or state's public health agency, as they are frequently charged with creating regulations to protect and improve public health (Hamilton *et al.* 2006; Jayaratne 2008). These national public health agencies contributed to driving the wider policy context promoting WSPs, as they both participated in and were influenced by international and national discussions and guidelines that recognized that end-point testing was insufficient to guarantee safe drinking water (Hamilton *et al.* 2006; Martel *et al.* 2006; Jayaratne 2008; Brauer & Sturm 2014). In some instances, HACCP practices were initiated out of concern for public health following threats of waterborne disease outbreaks from drinking water (Hamilton *et al.* 2006; Jayaratne 2008; WHO 2014). For example, in Australia, Sydney endured a *Cryptosporidium* scare (but no disease outbreak) in 1998 that led to the discussion of HACCP practices being beneficial and ultimately required (Hamilton *et al.* 2006). Similarly, water quality incidents in northern Belgium led to the implementation of WSPs (WHO 2014). Water system managers began to implement HACCP risk management practices in Switzerland (1995), Iceland (1997), France (2001), and Slovenia (2004). In these countries, regulatory requirements for HACCP for all water systems were influenced by international discussions and promotion before formal international guidelines endorsed the adoption of WSPs (Brauer & Sturm 2014). Similarly, the Australian Drinking Water Guidelines were published in 2004, indicating that these guidelines were in development in parallel with the WHO Guidelines, and therefore both influenced and were influenced by these international discussions.

While some countries amended their risk management guidelines before formal international guidelines, following the publication of the WHO Guidelines and the Bonn Charter, many more countries amended their drinking water quality guidelines and regulations to include specific risk assessment components of WSPs in addition to hazard analysis (Martel *et al.* 2006; Brauer & Sturm 2014). In many countries, national or state agencies first introduced WSPs as pilot projects in a few utilities before creating national guidelines and regulations that led to large-scale implementation of WSPs or similar risk management practices (Table 1). In other cases, such as the Australian state of Victoria, individual water utilities implemented WSPs before national or state agencies introduced WSP pilot projects, guidelines, or regulations (Mullenger *et al.* 2002; Jayaratne 2008). While guidelines are not directly legally enforceable, like regulations, they provide standards for due diligence and help to create an enabling environment that supports the scale up of WSPs.

International, national, and state guidelines and regulations together helped in forming the enabling environment that led to an increased uptake of HACCP or WSPs for drinking water systems. According to a European workshop on WSPs in 2014, 'the most effective way to ensure broad implementation of WSP-type approaches is certainly a regulatory push' (WHO 2014). Smaller water systems especially benefited from a regulatory push, as it was often necessary for them to receive external support to implement a WSP (Schmoll *et al.* 2011). Where regulations changed, regulators themselves had to change, as they were charged with ensuring the effectiveness of WSPs. For these regulators, audits became a new part of their responsibilities (Rinehold *et al.* 2017). However, regulations are not *necessary* to cultivate the national enabling environment. For example, national-level tools and training resources can instead contribute to the enabling environment for the

Table 1 | High-income OECD country guidelines and regulations promoting the adoption of systematic risk management practices for drinking water quality

COUNTRY	REGULATIONS	GUIDELINES	SOURCES
Australia	By state (all six states require risk management plans): Drinking water quality management plan (Queensland 2008); Public Health Regulation (New South Wales 2012); Safe Drinking Water Act (Victoria 2003); SA Safe Drinking Water Act (South Australia 2011); Risk-based framework of NHWRC (Western Australia 2017); Drinking water quality management plan (Tasmania 2015)	National Health and Medical Research Council, Natural Resource Management Ministerial Council Australia National Health and Medical Research Council, 2004 promoting WSPs	Queensland Parliamentary Counsel (2008); New South Wales Government (2012); Victoria Government (2003); South Australia Government (2011); Western Australia Government (2017); Tasmania Public Health Services (2015)
Canada	By province: Drinking water safety plans required only in Alberta	Health Canada (2010) – Drinking water guidelines promoting multi-barrier approach	Martel *et al.* (2006); Perrier *et al.* (2014); Health Canada (2010); Reid *et al.* (2014)
Chile		Ministry of the Environment – no guidelines on risk management procedures	Chile Ministry of the Environment, Ch. 5 (2012)
European Union[1]		Commission Directive 2015/1787 amending Annex II to Council Directive 98/83/EC – grants ability to deviate from the Drinking Water Directive if the steps of a WSP are carried out	Commission Directive 2015/1787 amending Annex II to Council Directive 98/83/EC (EC 2015)
Iceland[2]	HACCP – regulated as food in The Foodstuff Act No. 93 (1995)		Gunnarsdottir & Gissurarson (2008); Gunnarsdottir *et al.* (2012b); Brauer & Sturm*et al.* (2014)
Israel		Ministry of Health – annual preventive sanitary surveys but no requirement for a systematic risk management plan	Israel Ministry of Health Public Health Regulations (2013); (Winston *et al.* 2003)
Japan		Ministry of Health, Labour and Welfare – Guidelines for WSP development	Japan Ministry of Health Labour & Welfare (2008)
Republic of Korea	Water Supply and Waterworks Installation Act (2010) has water quality standards but lacks a preventive risk management approach		Water Supply and Waterworks Installation Act (2010)
New Zealand	Health Amendment Act (2007) requiring Public Health Risk Management Plans for drinking water		Health Amendment Act (2007); NZ Ministry of Health (2014); Martel *et al.* (2006)
Norway[2]	Optimal disinfection program in Drinking Water Regulations No. 1372, Sec. 10 (Ministry of Health & Social Affairs 2001)		Drinking Water Regulations No. 1372 (Ministry of Health & Social Affairs 2001)
Switzerland	HACCP – regulated as food; Hygiene Ordinance (SR 817.051 HyV, Article 11) (1995)		Hygiene Ordinance 817.051 (1995); Brauer & Sturm (2014); Martel *et al.* (2006)
United States	Safe Drinking Water Act (1996) has many components similar to a WSP		Code of Federal Regulations Title 40, Parts 141–143

Notes: [1]High-income OECD European Union countries: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom. [2]European Free Trade Association member countries that are also required to implement EU directives into national legislation.

implementation of WSPs (WHO 2014). In Finland and Ireland, online tools helped the implementation of WSPs (Rickert *et al.* 2016). In other countries, such as Austria and Germany, manuals with examples (in their respective languages) were created, which eased the implementation of WSPs (Rickert *et al.* 2016). Such manuals and tools assisted in training water utility leaders in the implementation of WSPs without national regulations. The development of financial mechanisms and incentives also supports the enabling environment, especially for smaller systems that may be more financially limited (WHO 2014). For example, in Scotland, improvement grants for private suppliers are only available to those who have carried out a risk assessment (WHO 2014). Offering financial resources to water systems to develop and/or maintain their WSP reduces one of the greatest challenges (i.e. financial barriers) to implementation (Loret *et al.* 2016).

Iceland and Switzerland instituted regulatory requirements for HACCP for water systems, adding formal rules to their enabling environments (Table 1). The WHO's promotion of WSPs through the open process of development of its Guidelines for Drinking Water Quality over the period from 1994–2004 contributed to establishing an enabling environment that increased adoption of WSPs. Several countries that are members of the European Union (France, Portugal, Slovenia, England, Wales, Scotland, and Hungary) implemented WSPs through national regulations and international guidelines prior to the European Union's (EU) Annex II of the Commission Directive 2015/1787 (Beir *et al.* 2003; Metge *et al.* 2003; Brauer & Sturm 2014; Vierira 2007; May 2010; England and Wales Statutory Instruments No. 2734, 2007; Davidovits 2014; The Private Water Supplies (Scotland) Regulations, 2006).

The EU established the Drinking Water Directive (DWD) in 1998, which provides the minimum requirements for each country's national legislation. In 2015, the EU passed Annex II of the Commission Directive 2015/1787, which introduced the option for each country to adapt their national legislation to allow for monitoring based upon a systematic risk assessment (EU 2015/1787, 2015). While the EU already had a strict set of drinking water quality monitoring requirements, this legislation acknowledged the merit of WSPs, and enhanced the enabling environment for WSPs through formal regulations. Each EU member state had until 2017 to ensure that its regulations complied with the DWD legislation.

In Norway, national regulations led to the scale up of WSPs in 2001. Drinking Water Regulations No. 1372, Sec. 10 (Ministry of Health & Social Affairs 2001) requires water systems to submit recommendations for water sampling and analysis based upon a risk assessment of the water system. While a WSP is not specifically required, hazard analysis, risk assessment, and continued development are.

In New Zealand, the Ministry of Health implemented formal rules requiring all water systems to develop a WSP (previously known as Public Health Risk Management Plans) (Martel *et al.* 2006; Health Amendment Act 2007; New Zealand Ministry of Health 2014). New Zealand's Ministry of Health has published various documents to help both large and small water systems adopt WSPs (New Zealand Ministry of Health 2014).

In both Australia and Canada, national health departments created guidelines for drinking water facilitating the adoption of WSPs, however it is each state or province's responsibility to create their own regulations, if they want to require WSPs (Martel *et al.* 2006; Health Canada 2010; Perrier *et al.* 2014). Through the creation of these guidelines, national and state health departments added to the enabling environment, facilitating the adoption of WSPs in each state or province. In Australia, all six states require drinking water risk management plans; and in Canada, Alberta requires WSPs. In both Australia and Canada, utility leaders that were early adopters of WSPs assessed the applicability, feasibility, and benefits of WSPs prior to regulatory requirements (Jayaratne 2008; Perrier *et al.* 2014; Reid *et al.* 2014).

In the Republic of Korea, the Water Supply and Waterworks Installation Act requires that each water provider carry out its own safety management (Water Supply and Waterworks Installation Act 2010). It requires many practices similar to WSPs, but it does not specify the use of a systematic risk assessment. However, since 2012, the government-run water provider, K-Water, began to implement WSPs in various water systems around the country (K-Water 2013). While there are not formal regulations or guidelines in place, K-Water has developed a checklist of potential hazards and hazardous events, a Water Safety Index, and a group of 35 experts to assist water systems with their risk assessments (K-Water 2013). The national government created an enabling environment through providing tools and resources to assist in developing a WSP and through providing examples of WSPs throughout the country.

In Japan, the Ministry of Health, Labor and Welfare issued guidelines on the use of a systematic risk management approach to promote the implementation of WSPs (Kunikane 2009; Rinehold *et al.* 2017). While formal regulations (the Waterworks Act) do not specify the use of WSPs, the guidelines and tools from the Ministry of Health, Labor, and Welfare and the Japan Water Works Association have helped in the implementation of WSPs. The leaders of these organizations have also created a software program with a list of potential hazardous events that can help water system managers in the risk assessment process (Kunikane 2009).

In Israel and Chile, the Ministry of Health creates both conditions (guidelines) and formal rules (regulations) for enhanced water system risk management (Chile Ministry of the Environment, 2012; Israel Ministry of Health Public Health Regulations 2013). In Israel, preventive sanitary surveys are required annually at each water system, however the annual nature of these surveys mean that they are not part of the daily culture of the risk management of the water system, as WSPs are (Israel Ministry of Health Public Health Regulations 2013). They are used to identify hazards and risks throughout the drinking water system, but a team of water utility personnel to frequently assess and manage these risks is not required. In Chile, the Ministry of Health creates water quality regulations, however there are no regulations or guidelines for risk management plans for water systems (Chile Ministry of the Environment, 2012).

In the United States, there are substantive commonalities between existing national regulations and WSPs (Baum *et al.* 2015). However, WSPs have not been implemented and are not included in any national guidelines or regulations.

Local promotion and adoption of WSPs

Prior to creating national legislation, some countries, such as Australia and Portugal, chose to pilot WSPs (Vierira 2007; Jayaratne 2008). In 1998, at Yarra Valley Water, in Australia, water utility managers realized that its end-point testing was insufficient to ensure water safety (Jayaratne 2008). Its implementation of HACCP and then a WSP led to operational improvements and estimated cost savings from reduced operational expenses of $7,500 to $38,000 per incident (Jayaratne 2008). In southern Portugal, a public water supplier implemented a WSP and reduced the frequency of laboratory testing based upon the risk assessment, reducing laboratory testing and operating costs by 56% (Jayaratne 2008). In other countries, such as Germany and Greece, national institutions chose water systems in which to pilot WSPs to determine their feasibility and costs and benefits as a basis for informed discussion on whether to implement specific national regulations requiring WSPs (Damikouka *et al.* 2007; Schmoll *et al.* 2011). In Germany, the Federal Ministry of Health, the Federal Environment Agency, and the Association for Gas and Water led the effort to pilot WSP implementation in selected water systems to assess the applicability, feasibility, and costs and benefits of WSPs. Water system managers realized that at least 70% of their current practices corresponded with WSPs, so large-scale changes would not be needed (Schmoll *et al.* 2011). Many small water system managers in Germany saw the benefits of formal rules requiring WSPs, to garner resources and support from stakeholders (Schmoll *et al.* 2011). While Germany has not implemented regulations requiring WSPs, water system managers increasingly recognize the potential benefits of WSPs and implement them (Schmoll *et al.* 2011).

In these countries, local implementation of WSPs provided context-specific evidence of the feasibility and benefits of WSP implementation. This evidence helped to influence national guidelines and policies, as well as international guidelines. Collectively, these elements added to the enabling environment to promote the implementation and sustainability of WSPs.

DISCUSSION

The demonstrated benefits of WSPs justify an analysis of the conditions that would lead to their wider, faster, and easier adoption (Gunnarsdottir *et al.* 2012a; Loret *et al.* 2016; Rinehold *et al.* 2017; Setty *et al.* 2017). Our findings highlight the ways in which an enabling environment could be created to lead to greater uptake of WSPs and enhanced drinking water safety in other high-income countries through: crafting guidelines, regulations, tools and resources, public health support, and context-specific evidence of the feasibility and benefits of WSPs.

While the majority of the high-income OECD countries have experience with implementing WSPs, Canada, Chile, Israel, and the USA have little or no experience with WSPs. In these four countries, there are substantive commonalities between existing national regulations and WSPs. Similar to German water system operators, water system operators in these four countries would likely also recognize the similarities between their current practices and WSPs, making the adoption of WSPs less daunting. Additionally, with institutional support, the tools and resources to smoothly implement a WSP could make water system managers more willing and able to do so (Schmoll *et al.* 2011). In Alberta, Canada, the Alberta Environment and Parks group created a template with notes to assist water system managers in implementing their WSPs, which is an approach that could be taken to apply to the other states throughout Canada as well as other high-income countries' water systems (Reid *et al.* 2014). Similarly, the WHO has published step-by-step guides for WSP development and implementation for both large and small water systems (Bartram *et al.* 2009; WHO 2012) as well as a quality assurance tool (WHO/IWA 2013). For systems with financial barriers to implementation, grants could be offered to systems preparing to implement WSPs or to those that have already implemented WSPs, similar to Scotland's incentive approach (WHO 2014).

While there were 86 studies included in this systematic review that provided information on the enabling environment for WSP implementation, there may be other experiences with WSP development and implementation in high-income countries that have not been as well documented and reported. This evidence could provide even more detail into the components of an enabling environment and data on the costs and benefits of WSPs, if made publicly available. Additionally, there may be other contextual factors in these countries that influence the composition of an enabling environment for WSP implementation that should be taken into consideration.

This systematic review could assist policymakers, public health leaders, and water utility managers in Canada, Chile, Israel, and the USA, where there has been little experience with WSPs, to make informed decisions about WSP implementation. There are clear potential benefits for waterborne disease prevention in water systems in these countries, (Tulchinsky *et al.* 2000; Pino *et al.* 2015; Murphy *et al.* 2016) and dedicating the resources to help create the formal rules and conditions of an enabling environment could help to realize those benefits. It is through an enabling environment that scaling up WSP implementation could occur.

CONCLUSION

International, national, and local rules and conditions interact to create the enabling environment composed of regulations, guidelines, tools and resources, public health support, and context-specific evidence of the feasibility and benefits of WSPs for drinking water safety. International guidelines promote the creation of national regulations that depend on local implementation and cooperation to show evidence of the benefits of WSPs in improving drinking water safety. These elements collectively lead to the scale up and implementation of WSPs and promote their sustainability.

Since the implementation of regulations requiring WSPs, many high-income countries have shown evidence of the beneficial results from WSP implementation in enhanced water system management and water safety. Canada, Chile, Israel, and the USA might also be able to realize similar benefits if an enabling environment were created to promote the widespread implementation and development of WSPs.

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