Factsheet

Global Water Research Coalition

Effect Based Monitoring in Water Safety Planning

Applicability of effect-based methods in Sanitation Safety Planning and water reuse

Previous factsheets highlighted how and where effect-based methods (EBM) might support a more thorough approach to Water Safety Plans (WSP) for drinking water (Neale et al. 2022). In this brief factsheet, we look at the application of EBM in a broader wastewater and recycled water context

Sanitation Safety Planning (SSP) is a risk management tool for the safe use and disposal of wastewater, grey water and excreta (WHO, 2015) and was developed based on the WSP framework for managing drinking water quality. There are several similarities between WSP and SSP, including having the same core components of system assessment, monitoring and management. The application of EBM is well established in wastewater and water reuse contexts (e.g., Bain et al., 2014; Leusch et al., 2014; Jia et al., 2015). Therefore, similar to WSP, the integration of EBM into SSP is the next logical step to assess risks associated with chemical hazards.

WSP consist of eleven modules that cover preparation, system assessment, management and communication, and feedback and improvement (Figure 1) (Bartram et al., 2009).

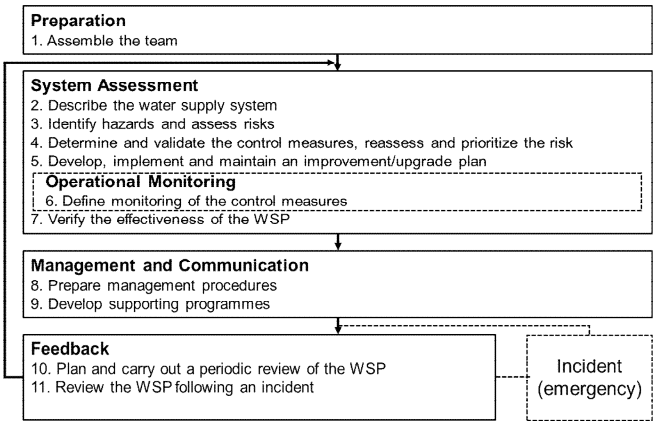

Figure 1: Overview of modules in the Water Safety Plan framework (adapted from Bartram et al. (2009)).

SSP for the safe use of wastewater consists of six modules (Figure 2), with a number of sub-modules within each module (WHO, 2015). The overlap between WSP and SSP is highlighted in Table 1, along with where EBM can be applied.

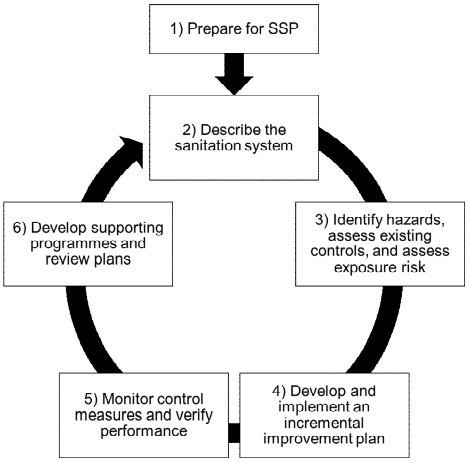

Figure 2: Sanitation Safety Planning modules (adapted from WHO (2015))

There are some key differences between WSP and SSP. SSP considers multiple exposure groups (humans, environment, crops) and addresses both the use and discharge of wastewater and sludge in the environment. Compared to wastewater, few studies have applied EBM to sludge and biosolids (e.g., Papa et al. 2020). In addition, regulatory frameworks are less clear and roles and responsibilities are shared over different sectors and levels.

The application of EBM in SSP does require some adaptation of the EBM protocols developed for drinking water. Issues to consider are:

- Differences in water matrices
- Other endpoints besides human health, including crop health and environmental health
- Interests of the various stakeholders and implementing agencies
- Lack of effect-based trigger values for various uses and disposal scenarios (e.g., sludge or biosolids) and lack of regulatory frameworks

To date, there is no World Health Organization (WHO) Water Reuse Safety Plan (WRSP). Goodwin et al. (2015) found that a WRSP could be based on the current WSP framework, but with increased emphasis on communication and engagement, along with improved mechanisms to account for uncertainty, risk interaction and risk prioritization.

Global Water Research Coalition

Effect Based Monitoring in Water Safety Planning

Applicability of effect-based methods in Sanitation Safety Planning and water reuse

The Australian Guidelines for Water Recycling developed a risk management framework for the management of recycled water quality and use (Figure 3) (NRMMC & EPHC & AHMC, 2006). This framework is based on the twelve elements considered good practice for the management of drinking water in Australia (NHMRC & NRMMC, 2011), a common approach to water management in Australia irrespective of source. The twelve elements in the framework share many similarities with the modules in the WSP framework, demonstrating that EBM can also be applied in the risk management framework.

Figure 3: Overview of the framework for the management of recycled water quality and use (taken from NRMMC & EPHC & AHMC (2006)).

Table 1: Similarities between Water Safety Plan (WSP) and Sanitation Safety Planning (SSP) modules and where effect-based methods (EBM) can be applied. Italics in the second column indicate sub-modules within the SSP modules.

Water Safety Plan (WSP)	Sanitation Safety Planning (SSP)	Application of EBM
1) Assemble the WSP team	1) Prepare for SSP *1.4) Assemble the team*	n/a
2) Describe the water supply system	2) Describe the sanitation system	EBM used to characterise water quality
	3) Identify hazards, assess existing controls, and assess exposure risk	
3) Identify hazards and hazardous events and assess the risks*	*3.1) Identify hazards and hazardous events*[†]	EBM used to identify chemical hazards
4) Determine and validate the control measures, reassess and prioritize the risk	*3.3) Identify and assess existing control measures* *3.4) Assess and prioritize the exposure risk*	EBM used to assess the efficacy of existing control measures
5) Develop, implement and maintain an improvement/upgrade plan	4) Develop and implement an incremental improvement plan	EBM used to confirm whether improved measures are effective and no new risks are introduced
	5) Monitor control measures and verify performance	
6) Define monitoring of the control measures	*5.1) Define and implement operational monitoring*	EBM used to ensure control measures are operating correctly
7) Verify the effectiveness of the WSP	*5.2) Verify system performance*	EBM used to verify control measures to confirm the quality of produced water
	6) Develop supporting programmes and review plans	
8) Prepare management procedures 9) Develop supporting programmes	*6.1) Identify and implement supporting programmes and management procedures*	n/a
10) Plan and carry out a periodic review of the WSP 11) Review the WSP following an incident	*6.2 Periodically review and update the SSP outputs*	EBM used to describe water quality after new control measures are implemented or any new or emerging hazards

*for human health through drinking water consumption; [†]for various uses and exposure groups (environment, crops, humans)

Global Water Research Coalition

Effect Based Monitoring in Water Safety Planning

Applicability of effect-based methods in Sanitation Safety Planning and water reuse

Further, the EU Project DEMOWARE proposed a WRSP that distinguishes between the planning and operating of water reuse schemes (Figure 4) (Hochstrat et al., 2017). Again, the framework shares many of the same modules as the WSP framework.

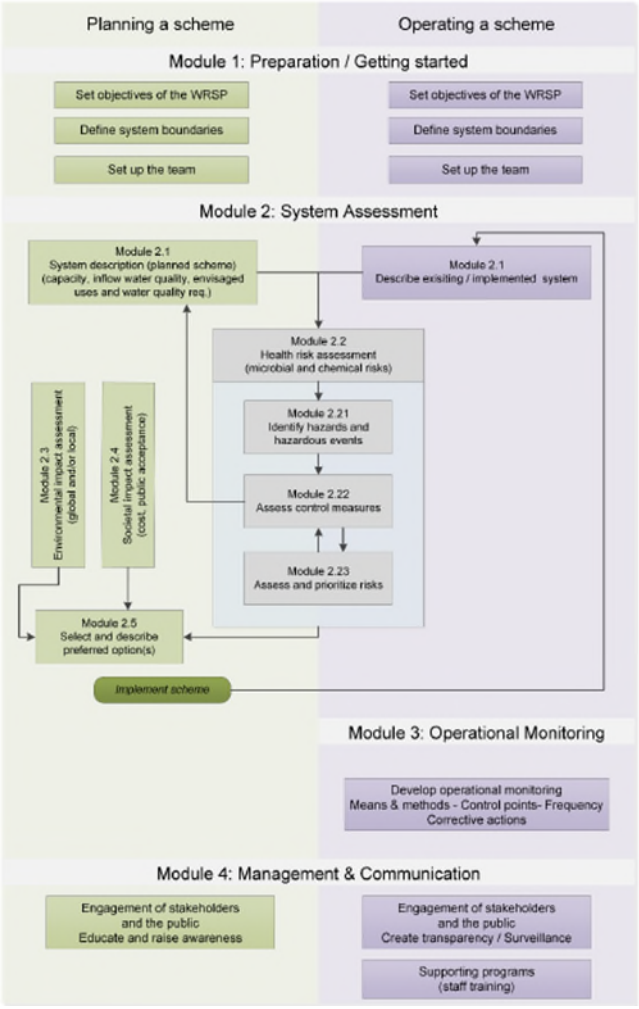

Figure 4: Overview of the Water Reuse Safety Plan proposed by the DEMOWARE project (taken from Hochstrat et al. (2017))

Adapting EBM to these different matrices and water uses thus would require only minor modifications from the one developed based on the classical WSP. This underlines the applicability of the presently available methods in frameworks for wastewater treatment, reuse for irrigation and (in)direct potable reuse.

Acknowledgements

This project was funded by PUB – Public Utilities Board, Stowa- Foundation for Applied Water Research, Water Research Australia, the Water Research Commission and the Water Services Association of Australia. In-kind support was kindly provided by Veolia Research and Innovation (VERI), SUEZ, and KWR Water Research Insititute.

References

Bain, P.A., Williams, M., Kumar, A. 2014. Assessment of multiple hormonal activities in wastewater at different stages of treatment. Environ. Toxicol. Chem. 33(10): 2297-2307.

Bartram, J. et al. 2009. Water safety plan manual: Step-by-step risk management for drinking-water suppliers. World Health Organization. Geneva.

Goodwin, D. et al. 2015. Applying the water safety plan to water reuse: Towards a conceptual risk management framework. Environ. Sci.: Water Res. Technol. 1: 709–722.

Hochstrat, R. et al. 2017. D3.4 Water Reuse Safety Plans: a manual for practitioners.

Jia, A. et al. 2015. *In vitro* bioassays to evaluate complex chemical mixtures in recycled water. Water Res. 80: 1-11.

Leusch, F.D.L. et al. 2014. Assessment of wastewater and recycled water quality: A comparison of lines of evidence from *in vitro*, *in vivo* and chemical analyses. Water Res. 50: 420-431.

Neale, P.A. et al. 2022. Effect-based monitoring to integrate the mixture hazards of chemicals into Water Safety Plans. J Water Health. Submitted 9th June 2022.

NHMRC & NRMMC 2011. Australian Drinking Water Guidelines 6, Version 3.7, National Water Quality Management Strategy. Canberra, Australia.

NRMMC & EPHC & AHMC 2006. Australian Guidelines for Water Recycling: Managing Health and Environmental

Global Water Research Coalition

Effect Based Monitoring in Water Safety Planning

Applicability of effect-based methods in Sanitation Safety Planning and water reuse

Risks (Phase 1). N. R. M. M. C. National Water Quality Management Strategy (NWQMS), Environment Protection and Heritage Council, and Australian Health Minister's Conference. Canberra, Australia.

Papa, M. et al. 2020. Anaerobic digestion of sewage sludge has no effect on glucocorticoid and anti-progestagenic activity but increases estrogenicity three-fold. Chemosphere. 286: 131753

WHO 2015. Sanitation safety planning: Manual for safe use and disposal of wastewater, greywater and excreta. World Health Organization, Geneva.