MID-TERM REVIEW

What are the effects of chemicals frequently used by Melbourne Water on or near waterways on aquatic ecosystems and human health?

Healthy Waterways Strategy 2018-2028
Port Phillip & Westernport, Victoria

Melbourne Water

RMIT UNIVERSITY A3P

Strategic alignment

Regional performance Objectives

PRO 23: The potential impacts of emerging contaminants of concern such as microplastics, pesticides and pharmaceuticals, and toxic chemicals are better understood and mechanisms to respond collaboratively developed.

RPO 24: Risk-based programs are in place to mitigate sources of urban pollution (licenced and unlicensed discharges) to protect bays and waterways.

Key Research Areas

Water quality: Understanding the environmental impacts of pollutants, including contaminants of concern, to inform risk-based management of waterways across the region.

Other aquatic biodiversity: Understanding the unintended consequences of our management activities on aquatic biodiversity to inform works planning and programming to reduce impact on environmental values.

Summary

Consistent with Melbourne Water's (MW) desire for best practice and continuous improvement in human health and environmental protection, this project seeks to review the public health and environmental risks of chemicals used by MW on or near waterways and, in particular, understand whether there are more friendly alternative approaches. This project also contributes towards MW's approach to the general environmental duty as part of the *Environment Protection Act 2017.*

Melbourne Water uses various chemicals as part of their business operations (e.g., herbicides for vegetation control; briquettes to control mosquito larvae). To continue to reduce the environmental and human health risks from chemicals used on or near waterways, there is a need to consider the chemicals used in MW business operations and understand how and where they are applied. Further more, there is a need to understand whether the use of chemicals in MW operations could result in chemicals being transported from the site of application into adjacent waterways and whether there is a subsequent impact on waterway values. To inform improved chemical use policies and practices, this project undertook a stocktake of chemicals used by MW in and around waterways, whether they could be impacting on aquatic ecosystems, and through a risk assessment approach identified activities considered to be the greatest risk to environment and public health. Following the initial stocktake and assessment of chemical use across the business, the focus of the project has been on understanding potential alternative chemicals or practices to the herbicide glyphosate for vegetation management.

This direction of research came from herbicide use being identified as the greatest risk to waterways and glyphosate being the most widely used herbicide in Melbourne Water. In parallel, the business was interested in glyphosate following local and international concerns with glyphosate use.

Recommendations

- Advocate for best practice around vegetation management and communicate information and learnings to stakeholders and the broader community to empower change externally
- Trial the development of an integrated vegetation management plan for Melbourne Water which incorporates current research findings on alternative vegetation management approaches including:
- Implement operational trails of imazapyr and possibly bromacil at sites with low risk of non-target impacts to residential gardens
- Further assess the viability of heatweed in combination with herbicides at larger operational sites.

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What did we do?

Chemical Stocktake

A stocktake of the chemicals used across the Melbourne Water business was undertaken to identify chemicals used in Melbourne Water operations in and around waterways or that have potential to impact on waterway health. Information on the chemical types, volumes and sites of storage and areas of business use was collected. Chemicals were identified through review of ChemAlert stock holdings, business area specific surveys, and by reviewing available reports and investigation of specific chemical product uses.

Environmental and Human Health risk assessment

The assessment followed the basic principles of risk assessment to determine the potential hazard chemicals pose to surface and ground waters, associated wildlife and operator health. The risk assessment was informed by business specific surveys, direct requests for information, ChemAlert, product safety data sheets (SDS), available toxicological data and scientific studies. Operator health and environmental risk ratings were determined for each product and their labeled chemical
components.

Alternatives to Herbicide Use

With herbicide application on or near waterways identified as posing the greatest risk to waterway and operator health, a review examining Melbourne Water's current weed management practices and assessing alternative approaches was undertaken. The costs and benefits of different approaches in MW vegetation management practices were assessed in terms of human health and environmental risks, cost, and efficacy. The approaches examined included chemical control with herbicides and alternative products, thermal weeding, biological control, and physical control, with final recommendations for suitable lower-risk alternatives.

Assessing alternatives to glyphosate for vegetation management

Following the herbicide alternatives review, this research project focused on the use of glyphosate. The glyphosate program involved a) desktop review of the worldwide use of glyphosate and available alternative control methods and b) field trials for alternative approaches (mechanical and herbicide alternatives). Mechanical field trials included sites along fence lines and pipe tracks using brush cutting, edge mowing and heatweeding at Kilsyth,

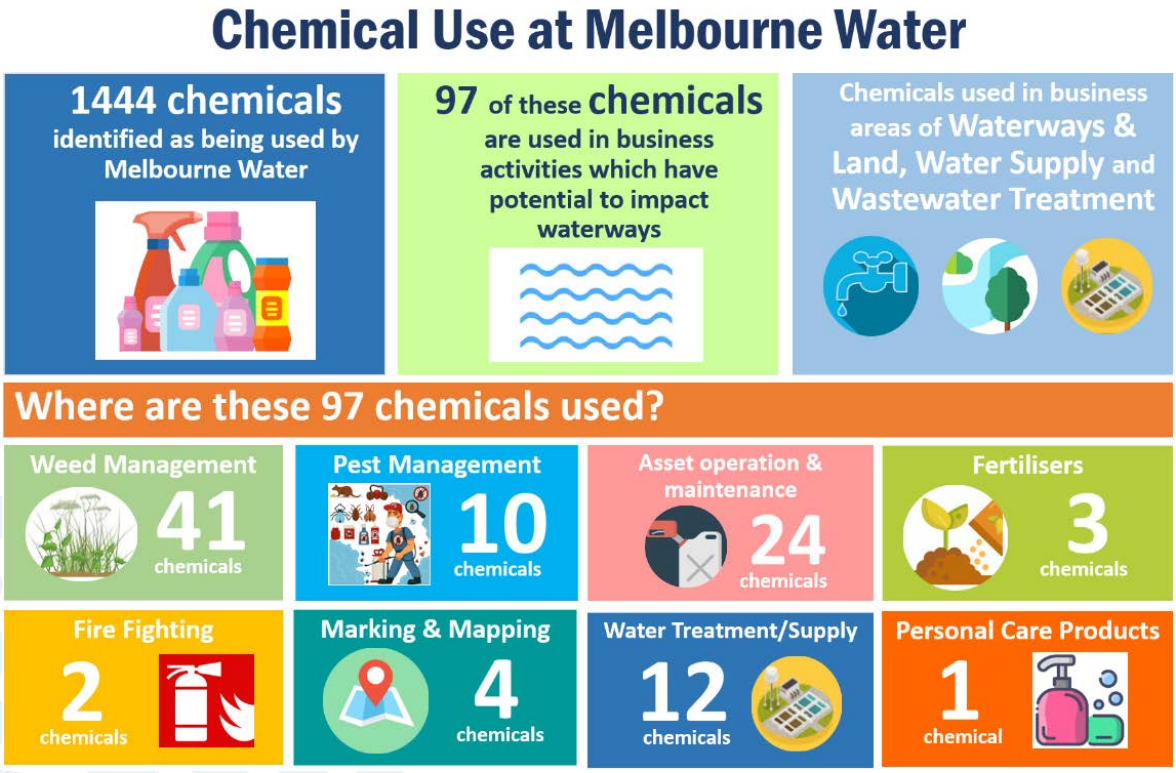

Figure 1. Summary of chemical use across the Melbourne Water business.

Nunawading, Ashwood, Langwarrin, East Keilor, Avondale Heights and St Albans. Herbicide alternative assessment included trials of four herbicides (bromacil, impazapyr, imazamox, imazapic) and glyphosate at four MW operational sites (Devilbend, Eastern Treatment Plant, Western Treatment Plant and Notting Hill) and assessments of effectiveness and non-target impacts were made over 180 days post application.

Herbicide toxicity to frogs

The toxicity of glyphosate, imazapyr and two other herbicides (diuron and simazine) to the southern brown tree frog (*Litoria ewingii)* tadpoles was tested over a period of 48 hours. Tadpoles were exposed to low (environmentally relevant), medium and high concentrations. We recorded both morphological (e.g., weight and snout to vent length) and physiological responses (e.g., biological responses).

What did we find?

Chemical Stocktake

Out of 1400 chemicals used by Melbourne Water, 97 chemicals were identified as having a potential impact on waterways (Fig. 1). These chemicals are mainly used across Waterways and Land Operations, Water Supply and Wastewater Treatment parts of MW business. Most chemicals (51) are used in pest and vegetation management, followed by 24 chemicals used in asset operation and management and 22 chemicals used across water treatment and supply (for marking, mapping, as fertilisers or bioremediators, in firefighting and as personal care products (Fig 1).

Environmental and Human Health risk assessment

The risk assessment found, of the 97 products used as part of Melbourne Water business activities in and around waterways, 51 chemicals were found to be potentially hazardous to aquatic environments and 52 potentially hazardous for human health (Table 1). Highest risk ratings were determined to be moderate to high, with no product, or its constituent chemicals identified as posing a potential extreme risk, as risks associated with products with more toxic compounds have limited use.

Overall, the greatest number of products posing a moderate to high risk to both environmental and operator health, were products used in weed and pest management, particularly herbicides and insecticides. Other products identified as posing moderate to high risks included products used for asset operation and maintenance including a truck wash (PhytoClean Sanitiser) and other cleaning products along with unleaded petrol and a fire retardant. For chemicals identified as high risk, lower risk substitutions from within Melbourne Water's existing inventory of approved products were suggested.

Alternatives to Herbicide Use

The review assessed 19 alternative methods of weed control including chemical approaches such as alternative herbicides and alternative products (i.e. acetic acid, pelargonic acid, plant oils and extracts, sodium chloride); thermal methods such as steam, flame, electrothermal, hot water and foam; biological controls including invertebrates, pathogens and grazing animals; and physical controls including mowing, slashing, brush cutting, cultivation and tilling, ringbarking, flooding, hand weeding, mulching and solarisation.

Table 1. Summary of risk assessment outcomes of chemical use across the Melbourne Water business. Twenty-three products had no human health or environmental warnings; however, this does not mean these products are necessarily harmless. Warnings are o ten not able to be assigned where data is insufficient to make a determination. L= Low, M= Medium, H=High Risk

Business Area	Aquatic Environment			Operator Health			Total		
	L	M	H	L	M	H	L	M	H
Pest management	5	28	1	21	10	0	9	33	3
Asset operation and management	7	6	0	10	5	0	9	10	0
Water treatment	0	4	0	6	0	0	3	4	0
All	12	38	1	37	15	0	20	46	3
Total	51			52			71		

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The main findings from the review were:

- There are trade-offs between choosing more effective control options that may impose relatively greater environmental and human health risks versus less effective control strategies that are safer to the environment and human health.
- An integrated strategy combining chemical and nonchemical control methods may be optimal for reducing herbicide use while achieving suitable control outcomes but is not necessarily superior to a chemical-dominant strategy in all cases.
- Physical control methods, such as slashing or hand weeding, may be useful as a pre-treatment to reduce the quantity or application volume of herbicides needed to control weeds.
- Similarly, modifying application volumes and regimes may yield equally effective results with overall less herbicide use or minimal loss to the environment.

Findings from this review were used to design alternative methods for vegetation control trials.

Assessing alternatives to glyphosate for vegetation management

Glyphosate discussion paper

Glyphosate is currently restricted for use in 34 countries. Even though it is not formally banned in Australia, over 27 local government areas are independently reviewing its use and assessing alternatives.
Common alternatives to glyphosate include other synthetic or organic herbicides, physical controls (e.g. thermal, mechanical methods) and biological controls, but consideration must be given to efficacy, cost and relative human and ecological risk.

Mechanical alternatives assessment
Alternate management options to glyphosate tested included brush cutting, edge mowing and heat-weeding. Glyphosate application was the most effective and cheapest method to control **v**egetation, producing the most consistent outcomes. Brush cutting and edge mowing did not yield long- term results, with Heatweed the most effective alternative strategy trialed, but seasonal variation existed.

Human risk was also assessed from an ergonomic perspective to operators and it was found that alternative methods of vegetation control carry similar or lower musculoskeletal risks compared to glyphosate spraying, except for the hand-held walk-behind brush cutter which may increase the risk of injury to operators' arms.

Figure 2. Pictogram of alternatives to glyphosate treatment for herbicide management investigated in this project.

Herbicide alternatives assessment

Preliminary results from field trials suggest two alternative herbicides, imazapyr and bromacil, show potential promise for use in vegetation control in substitution of glyphosate.

A second round of treatment will provide an understanding of risks repeated applications pose to non-target vegetation and further confidence in initial findings.

Herbicide toxicity to frogs

Our experiments did not find any statistically significant impacts of the herbicides at environmentally relevant concentrations in tadpoles of the Southern brown tree frog. However, general stress response trends were observed that will be further investigated in follow up tests.

Future direction and knowledge gaps

Project outcomes to date have provided Melbourne Water with a deeper understanding of the risks chemicals used in the delivery of services pose to waterway and operator health. The research will continue to generate multiple lines of evidence and improved confidence to support any recommendations for operational change.

Upcoming research will focus on several key activities including a continuation of the glyphosate alternatives assessment program, an assessment of the impacts direct herbicide spraying in drains has on waterway health, and ongoing research into the impacts of pesticides on frogs.

References/ Reports

Boyle, R., Odell, E., Pettigrove, V. & Myers, J. (2020), Melbourne Water Weed Control: A Review of Current and Alternative Approaches, Aquatic Environmental Stress Research Group, Technical Report No. 37, RMIT University, Victoria, Australia.

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