Understanding contaminant risk to environmentally sensitive areas

Strategic alignment

Regional Performance Objectives

RPO 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.

Key Research Areas

Other Aquatic Biodiversity:
Understanding areas of high biodiversity significance (e.g., Melbourne Water's Sites of Biodiversity Significance, Ramsar) and appropriate management responses to manage key threats to environmental values

Summary

Melbourne Water (MW) owns and manages over 40 sites classified as Sites of Biodiversity Significance (SoBS) and is committed to protecting the biodiversity values of these sites. Management plans for these sites exist and every five years assessments of condition are conducted to assess whether values are being adequately protected. However, pollution as a threat to site values has not historically been considered. This project assesses the likely risk of pollution impact at each site, prioritizes the need for on ground assessment and then provides information about the actual levels of pollution and the need to further investigate or manage specific contaminants (see Figure 1).

Across this program, different survey methods have been used to detect different types of pollutants- e.g., some pesticides are detected in sediment, but a different suite are detected in passive samplers (a device which is deployed for 2-4 weeks and can accumulate trace or micropollutants), in water. In addition, site surveys were undertaken to check that the framework used initially to determine risk at sites was valid. It was determined to be conservative, meaning that 75% of sites were in better condition than initially determined. Contaminants that were consistently present and a potential risk across the region include for Sediments- Zinc and Synthetic pyrethroid (Bifenthrin & Permethrin) and in water Aluminium, Copper, Zinc & Lead. Sources include road and roof top runoff, manufacturing and household use.

Recommendations

- Communicate this framework to other agencies, e.g., councils and Parks Victoria, who may want to adopt a similar approach for sites of high ecological value under their management
- Create a Performance Objective in the Healthy Waterways Strategy for Eel Race Creek to reduce excess lead concentrations
- Monbulk Creek (PPCP present) deployment of passive samplers to identify the source of PPCP contamination
- Spadonis Reserve (low risk) annual sampling recommended so any issues can be detected at an early stage and management actions can be put in place to avoid contamination risks at this site.

Once management interventions are enacted at any of these sites, an assessment of effectiveness in reducing pollution levels is recommended.

What did we do?

Risk assessment

A desktop ecological risk assessment to identify priority sites for contaminant screening was conducted, with risk ratings assigned using:

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- Land use near the site and upstream of any stormwater, river or stream inputs (Kellar et al. 2020)
- Likely classes of contaminants present in each land use (for example insecticides in residential areas, hydrocarbons and metals in industrial areas)
- Likelihood of toxicity to the environmental values
- Number of classes of environmental values which require protection (fish, frogs, macroinvertebrates and birds)
- Whether contaminant risks had previously been detected or suggested (Long et al. 2019)

Site Assessments

Site assessments (sediment, water and passive sampling devices that can detect the presence of pesticides and pharmaceuticals in waterways) were carried out at sites ranked as being highest priority in the ecological risk assessment. Local knowledge including flow regimes, legacy surrounding land use and non- Melbourne Water reports were sought from Waterway Land Officers, council and stakeholders as available. Depending on the initial screening results, an update to the site risk assessment score was made or follow up investigations to understand major pollution sources were instigated.

Follow Up Investigations

Follow up investigations, such as repeat sampling, ecotoxicity testing or pollutant source investigations, occurred at sites where results exceeded ecological water and/or sediment quality guidelines.

Examples of sites where further investigations have occurred or are recommended include:

- Eel Race Creek (lead in sediment) to identify the source, and determine the extent and magnitude, of lead contamination within Eel Race Creek through additional sediment sampling.
- Banyan Waterhole (lead in sediment) –assess the risk of elevated lead concentrations to aquatic life through standard sediment toxicity tests.

What did we find?

For each site, the tables below indicate where in the process the site currently sits.

- Desktop Risk Assessment: all sites have undergone a desktop risk assessment.
- Site Assessment: sites prioritised by the working group including non-SoBS have had an initial survey with sediment, surface water and passive sampling devices deployed, with results displayed and a revised risk assessment score suggested (Table 1 and 2),
- Follow up investigations: sites that require follow up investigations have been identified and the types of investigations have been agreed by the working group e.g., additional sediment and water sampling to understand the magnitude and extent of contamination, toxicity tests to understand if the concentrations present are likely to have an impact on aquatic life (incorporated into Table 1 and 2).

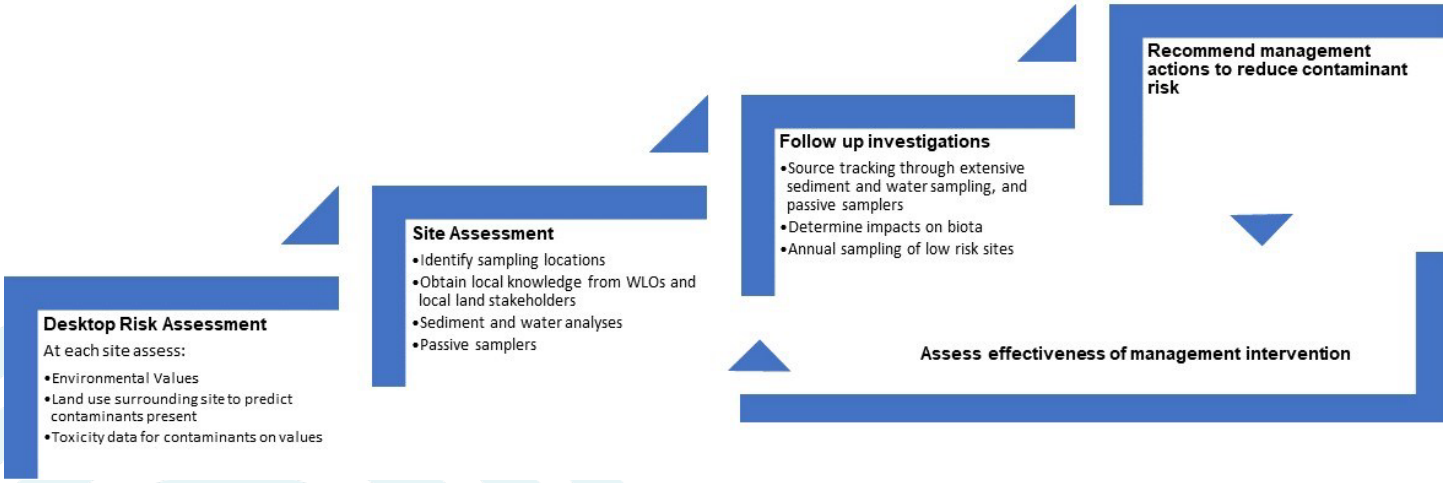

Figure 1. Representation of the environmentally sensitive areas (Sites of Biodiversity Significance- SoBS) project cycle

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Risk Assessment

Risk assessments were carried out for all SoBS and some additional sites of interest. We found that the risk scores range from low-risk sites with Wannarkladdin-Chelsea Heights Wetlands being assessed as the lowest risk (with a score of 6) to the Western Treatment Plant (WTP) being identified as the most at risk site (with a score of 32).

Site Assessments

Site assessments were carried out at prioritised sites according to risk ratings and the needs of the project team. This was an iterative annual process. Sediment and surface water samples were collected, and passive sampling devices were deployed for 4 weeks. Sediment samples were analysed for metals, total petroleum hydrocarbons (TPH) and over 100 pesticides. Surface water samples were analysed for metals, TPH, nutrients and, at some sites, Per– and Polyfluorinated Substances (PFAS). Passive sampling devices were analysed for over 100 pesticides and pharmaceutical and personal care products (PPCPs).

Table 1 . Site Assessment results showing chemicals detected at each Melbourne Water Sites of Biodiversity Significance (SOBs)

Site vs. Contaminants found	Banyan Waterhole	Eel Race Creek (ext. of Banyan Waterhole)	PARCS Wetland	Boggy Creek Waterway Reserve	Little Boggy Creek Retarding Basin	Tamarisk Waterway Reserve	Cherry Lake	Truganina Swamp	The Tarmuk	Jacana Wetlands	Galada Tamboore	Tirhatuan Wetlands	Dwarf Galaxias Conservation Wetlands	Hallam Valley Floodplain	Skeleton Creek Saltmarsh	Old Joes Creek Retarding Basin	Sugarloaf Reservoir Reserve	Monbulk Creek Retarding Basin	Seaford Wetlands	Edithvale Wetlands	Dunnetts Road Swamp
Aluminium																					
Arsenic																					
Cadmium																					
Chromium																					
Copper																					
Lead																					
Nickel																					
Zinc																					
Mercury																					
TPH																					
Pesticides number *	8	9		7	4	7	12	7	5	4	11	0	0		10	9		6	8	2	0
Bifenthrin																					
Permethrin																					
Dieldrin																					
Propiconazole II																					
Tebuconazole																					
Atrazine																					
Chlorantraniliprole																					
Diuron																					
Hexazinone																					
Imidacloprid																					
Metolachlor																					
Simazine																					
Pharmaceuticals number *															1	6		2	1	0	1
Carbamazepine																					
Paracetamol																					
Erythromycin																					
PFAS	1S 10W	13S 10W	10W						11 W	10W	11W										
Toxicity	AC																				
Risk score	17		20	13	14	14	19	18	19	19	19	18	19	15	17	14	14	12	11	10	8

Legend:
*Only the major Pesticides and Pharmaceuticals detected are listed.
Broadly: white - not tested, green—below trigger value, yellow - intermediate trigger value, red – above high trigger value, grey– analyte present, concentration unknown.
PFAS: S -Sediment W– Water.
Toxicity: A– Amphipod C- Chironomid
Risk Score - Based on risk analysis, number denotes initial score, colour denoted revised risk status; green– as expected, yellow– lower and red– higher than expected

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Summary of findings

Metals were present in the sediment and water at most sites, but some were at concentrations below guideline values and are therefore, not considered to pose a risk.

- The type of metals detected varied with site; with copper, lead, nickel and zinc being the most common metals present in sediment above guideline values.
- Aluminium was present in the water above guideline levels at 85% of sites. Copper and zinc were also present in water at concentrations above guideline values at some sites.
- Only three pesticides (out of over 100) were found in sediment – bifenthrin, permethrin (both synthetic pyrethroid insecticides) and dieldrin (organochlorine insecticide).
- Bifenthrin was detected at 70% of the sites and at 36% of these sites, bifenthrin was present at concentrations likely to have adverse impacts on aquatic life. Dieldrin was detected at two sites, and this was an unexpected result as dieldrin has been banned in Australia since the 1990s.
- Pesticides were detected in passive sampling devices at most sites and Pharmaceutical & Personal Care Products (PPCPs) were detected at some sites.

Site vs. Contaminants found	Jack Roper Reserve	Spadonis Reserve	Laverton RAAF Swamp, Williams Landing	Belgrave Lake	Tootgarook Wetlands	Lynbie Court @ Colchester Road Industrial Estate	Truemans Road Recreation Reserve	Chinaman's Creek @ Capel Sound
Aluminium								
Arsenic								
Cadmium								
Chromium								
Copper								
Lead								
Nickel								
Zinc								
Mercury								
TPH								
Pesticides number*	12	4		1	0	4	3	8
Bifenthrin								
Permethrin								
Dieldrin								
Propiconazole II								
Tebuconazole								
Atrazine								
Chlorantraniliprole								
Diuron								
Hexazinone								
Imidacloprid								
Metolachlor								
Simazine								
Pharmaceuticals number*	3	0		2	1	1	3	1
Carbamazepine								
Paracetamol								
Erythromycin								
PFAS			11					

Table 2 . Site Assessment results showing chemicals detected at other areas of interest.

Legend:
*Only the major Pesticides and Pharmaceuticals detected are listed.
Broadly: white - not tested, green—below trigger value, yellow - intermediate trigger value, red – above high trigger value, grey– analyte present, concentration unknown.
PFAS: S -Sediment W– Water.
Toxicity: A– Amphipod C- Chironomid
Risk Score - Based on risk analysis, number denotes initial score, colour denoted revised risk status; green– as expected, yellow– lower and red– higher than expected

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- Herbicides were the type of pesticide detected most frequently in passive sampling devices across the sites.
- The insecticides chlorantraniliprole and imidacloprid were detected in passive samplers at 38% and 58% of the sites respectively.
- The main PPCPs detected were carbamazepine and paracetamol, with detects at 46% and 77% of the sites sampled respectively.

Results show that the high value, low risk sites identified in the risk assessment were a low contaminant risk, which helps validate the risk assessment.

In 45% of the SoBS, contaminants had been over-estimated in the risk assessment i.e., some contaminant classes that had been expected to be present, based on land use, were not pre- sent. These were mainly petroleum hydrocarbons and nutrients.

In 50% of the SoBS sites, additional contaminants were found that had not been identified in the risk assessment, including PFAS, fungicides, herbicides and dieldrin.

Depending on the initial results, an update to the risk assessment was made and/or follow up investigations were instigated.

When the risk scores were reassessed following collection of data (Table 1 and 2), the revised risk scores showed:

- 15% of sites scored as expected.
- 25% of sites had a higher score (worse than initially expected).
- 60% of sites had a lower score (better than initially expected).

Follow Up Investigations

Sites fall into four categories:

1. Contaminants were detected and altered site management action is required, e.g., Eel Race Creek- see Long & MacMahon 2021. Our work at this site is now complete with our results forming the basis of next steps taken by the Melbourne Water.
2. Contaminants were detected and follow up investigations are in progress to determine the source and recommend changes in site management actions.
3. Contaminants were not detected at concentrations likely to pose a risk to aquatic life and alteration to site management is not required, e.g., Dunnetts Rd Swamp- confirming validity of risk assessment process.
4. Contaminants were not detected, but routine monitoring is recommended, as site conditions are identified as potentially changeable e.g., Spadonis Reserve.

Future directions and knowledge gaps

Adopt and embed this systematic approach for management of SoBS and sites of interest, incorporating multiple types of assessments to ensure all contaminant risks are considered and assessed and consequently, management actions can be put for-ward to sustain and improve the condition of these sites.

Communicate the outcomes and approaches with other agencies, e.g., councils and PV who manage priority wetlands so that sites are assessed and managed in a similar way across Melbourne.

Continue this program with the remaining SoBS that have not yet been investigated and other sites of interest, following working group recommendations Recommend site specific management actions to be incorporated into plans or HWS Performance Objectives as relevant.

Additional research to assess the risks of bifenthrin. Bifenthrin was the pesticide found at most of the sites and at some sites was present at concentrations likely to have an adverse impact on biota. This links with the A3P project: Impacts of sediments from urban stormwater on stream health led by Dr Claudette Kellar.

References/ Reports

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Appendix 1 – Prominent Land use for sites where assessments have occurred.

Site vs. Prominent Land-use	Banyan Waterhole	Eel Race Creek (ext. of Banyan Waterhole)	PARCS Wetland	Boggy Creek Waterway Reserve	Little Boggy Creek Retarding Basin	Tamarisk Waterway Reserve	Cherry Lake	Truganina Swamp	The Tarnuk	Jacana Wetlands	Galada Tamboore	Tirhatuan Wetlands	Dwarf Galaxias Conservation Wetlands	Hallam Valley Floodplain	Skeleton Creek Saltmarsh	Old Joes Creek Retarding Basin	Sugarloaf Reservoir Reserve	Monbulk Creek Retarding Basin	Seaford Wetlands	Edithvale Wetlands	Dunnetts Road Swamp	Spoadonis Reserve
Industrial *including Quarry*	■	■	■	■	■	■	■	■	■		■		■	■	■					■		
Commercial																						
Residential				■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Grassland			■		■		■	■	■	■	■	■	■	■		■	■	■			■	
Road, *Rail & Air*	■	■	■	■	■	■			■	■	■		■	■	■	■			■			■
Forest			■		■	■											■					
Greenspace				■	■	■	■	■		■	■	■			■	■			■	■		■
Horticulture	■	■	■														■		■			■
Grazing and Cropping	■	■	■														■	■				
Treated Wastewater Discharges			■																			
Untreated Wastewater Discharges			■																			

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