MID-TERM REVIEW

Understanding the impact of litter, including microplastics, on the social and ecological values of waterways and bays

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

Melbourne Water

RMIT UNIVERSITY A3P

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.

RPO 26: Methods are in place to assess volume and source of litter to inform and promote litter reduction programs.

RPO 27: Incidence of littering and illegal dumping is reduced through raised community awareness and knowledge, infrastructure and enforcement.

Key Research Areas

Water quality: Developing improved water quality indicators and monitoring methods to better understand the impacts of pollutants on waterway health.

Water Quality: Developing tools and approaches to assist in strategic planning of pollution management to protect biodiversity, amenity and recreation in waterways across the region.

Summary

With litter often the most visible pollutant in the environment (coming from littering along waterways but also from transportation via wind or through stormwater), relative to other pollutants, there is a broad public awareness of the prevalence and magnitude of litter in and along waterways. Litter reduces aesthetic values, impacts water quality, and potentially harms aquatic life such as platypus or waterbirds.

Melbourne Water (MW), together with Parks Victoria and local councils are the main agencies with responsibility for litter removal from waterways and beaches. Current management is based on a combination of prevention and clean-up activities, with key objectives of the Healthy Waterways Strategy (HWS) to decrease litter and illegal dumping and develop methods to assess the volume and source of litter to inform and promote litter reduction strategies.

To work towards the HWS objectives and effectively manage, and mitigate litter impacts, we need to understand the types, sources and quantities of litter entering waterways and their relative impacts. To achieve this relevant and robust data needed to be available that allows analysis of the nature and sources of litter, and provide an understanding of changes in litter over time – particularly in response to management interventions. While some litter data along waterways was collected prior to the development of the Healthy Waterways Strategy (e.g., volumes of litter cleaned out during routine litter trap maintenance), region-wide litter condition ratings and management targets were not able to be developed, nor was guidance on litter hotspots or the major sources of litter to help prioritise management efforts available.

To address these gaps this project emerged to create a standardized sampling framework to supports these different aspects of litter management.

In working to achieve this, the project identified the various purposes for litter assessments and reviewed existing survey methods for these purposes. The project has then validated potential methods through field case studies and developed a set of guidelines for surveying and monitoring litter that can be applied in a litter program framework.

Recommendations

- Upgrade the "Hot Spots Spatial Tool" developed by MW by the incorporation of the layers from the "hot spot prediction" method being trialled in the current project which uses human movement, drainage and land use data to predict litter hot spots.
- Develop a Litter Prioritisation Framework to assist MW in determining priority sites for investment in litter activities across the region.
- Adopt the standard methods provided through this project in all litter programs to allow comparison between litter loads and intervention effectiveness across waterways and programs

What did we do?

Literature review and stakeholder workshop

In 2019, a multi-stakeholder workshop was held to capture the purpose of litter monitoring and assessments undertaken by stakeholders in the region. This included the types of data needed, key criteria for surveys, existing methods and data management. A literature review was subsequently conducted to assess litter monitoring methods used locally, nationally and internationally.

Table 1. Litter program needs across Melbourne Water

Proposed Program	1. Litter Hotspots and Maintenance Program (LHM)	2. Litter Source Investigations (LSI)	3.HWS Monitoring Evaluation Reporting Improving (MERI) for litter
Description	Broad scale surveillance using rapid assessments to identify and confirm "hot spots" to inform management regime. Investigations may be ongoing or targeted at set points in time	Detailed assessments of litter volume and type at sites along a waterbody or drainage network strategically placed to determine litter sources. Investigations undertaken at set points in time as one-off studies	Detailed assessments of long-term changes in litter types and volumes across catchments. Sites provide a wide spatial coverage and assessments undertaken on a routine basis (e.g. biannually) to assess temporal trends
Objectives	Identify litter hotspots	Further identify key litter types	Identify trends in litter volumes and types at priority sites
	Determine locations and frequency of programmed maintenance for asset management framework	Track major sources of litter within the catchment	Track progress against HWS/ Waterway Delivery Investment Plan litter targets
	Inform initiation of Litter Source Investigations	Inform litter source management actions	Potentially lead to initiation of Litter Source Investigations and adaptive management approaches
	Assess effectiveness of litter reduction activities		
	Track progress against the Waterway Delivery Investment Plan Litter Key Performance Indicator target		
	Identify sites for MERI program		

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Bank and drain survey methods

In 2021, field assessments of potential quantitative and qualitative monitoring methods for assessing litter on banks and in stormwater drains were completed. These method trials were undertaken across sites representing different stream sizes, stream-side conditions and in wetlands. A rapid litter condition rating method was also trialled by MW teams at sites selected by MW.

HWS MERI for Litter Program

In 2021, a pilot study was initiated to trial a broad-scale monitoring program to understand the principal types, sources and quantities of litter entering waterways in key catchments and to provide baseline information to develop catchment litter condition ratings. The pilot study monitored litter at 26 sites from 6 urban sub-catchments (see Figure 2) and assessed changes in litter quantities and types through quantitative and qualitative monitoring methods applied biannually in 2021 and quarterly in 2022. Both qualitative and quantitative methods were used to determine if the quicker and simpler qualitative method could provide adequate information compared to the more intensive quantitative method.

Litter for Amenity program trials

The qualitative method was further validated and optimised into a rapid condition rating for MW's Litter for Amenity program. The objective of the program is to create a safe, aesthetically pleasing space that adds to the community's enjoyment of waterway environments. Commencing in May 2021, this condition rating tool was trialled by MW crews at a number of wetlands. Data collected will be incorporated with an amenity rating assessment of a site to provide an analysis of the risk of litter impacting the Amenity service along waterways. It's intended that this will enable a risk-based maintenance approach for litter across MW. The condition rating data is also key for the program's performance target setting and investment planning. Trials were completed in September 2022 with progression on roll out across sites in the Litter for Amenity program in 2023.

Stony Creek Litter Source Investigation

A case study using the litter source investigation method proposed by this research project was completed in Stony Creek, (Inner West of Melbourne). The project aimed to identify litter

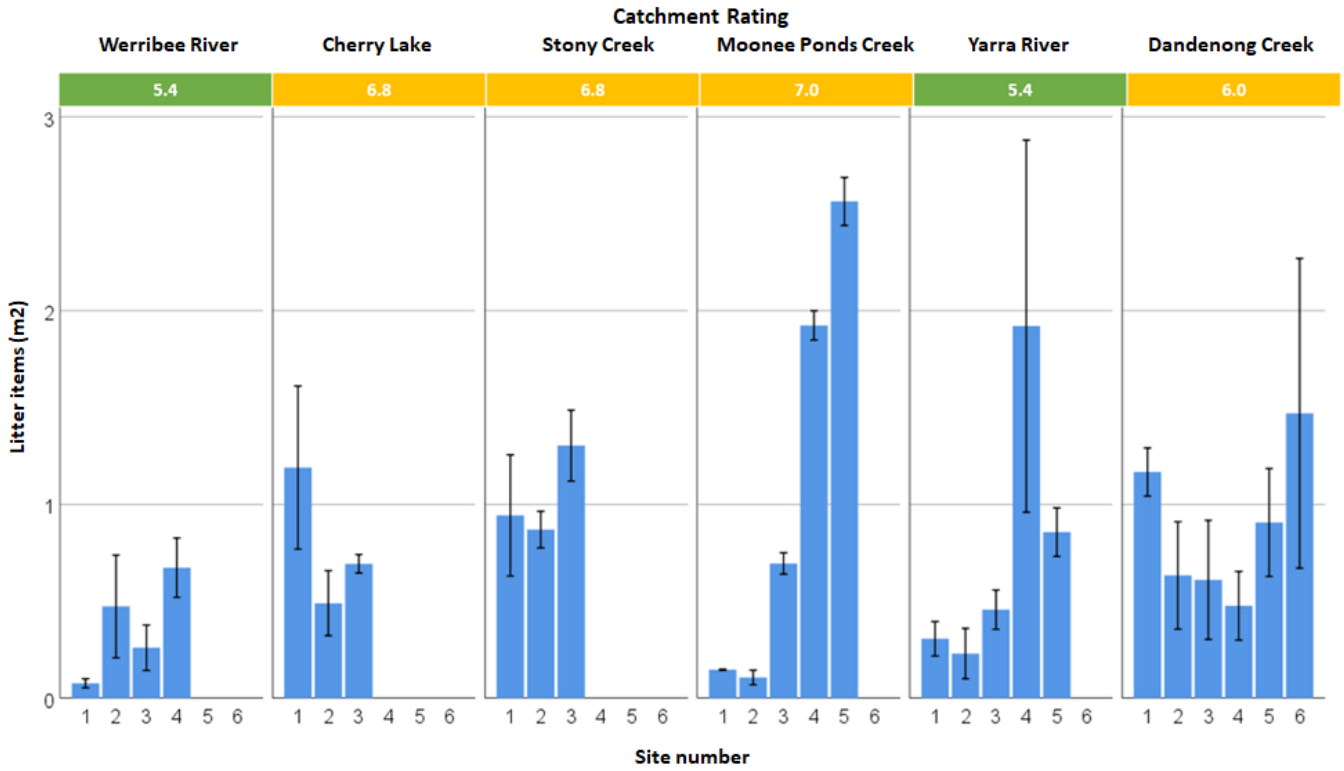

Figure 2. Quantitative catchment ratings and survey results for 26 sites across 6 sub-catchments

hotspots and major litter types and sources, as well as how to effectively target litter management based on different stakeholder needs. Initially, a desktop assessment described the current state of litter in the catchment (see Technical Report No. 31). Targeted litter surveys were then conducted to assess the contribution of litter from urban runoff through the stormwater system and from more localised catchment activities through bank surveys (see Technical Report No. 56). Finally, an assessment of the risks litter poses to Stony Creek's social and environmental values and identification of actions to manage litter across the catchment was undertaken.

What did we find?

Literature Review and Stakeholder Workshop

Workshop participants identified 158 different questions around litter monitoring and assessment. Questions identified specifically for Melbourne Water mostly related to the Healthy Waterways Strategy 2018 (HWS) indicators and targets. Overall, the questions raised by participants could be grouped into four monitoring purposes: 'surveillance', 'implementation', 'effectiveness' and 'ecological monitoring'. These purposes formed the basis for directing the development of standardised protocols and were considered in reviewing monitoring and assessment methods and prioritising standard methods to be assessed for application across the Melbourne Water business.

Following this, the core litter related works implemented across MW were identified and grouped into three main program types: 1) Litter Hotspots and Maintenance programs, 2) Litter Source Investigations, and 3) HWS MERI for litter programs (See Table 1).

Bank and drain survey methods

This part of the research identified, developed and validated litter monitoring methods relevant to litter survey needs. Subsequently, standardised approaches have been proposed for litter monitoring, including:

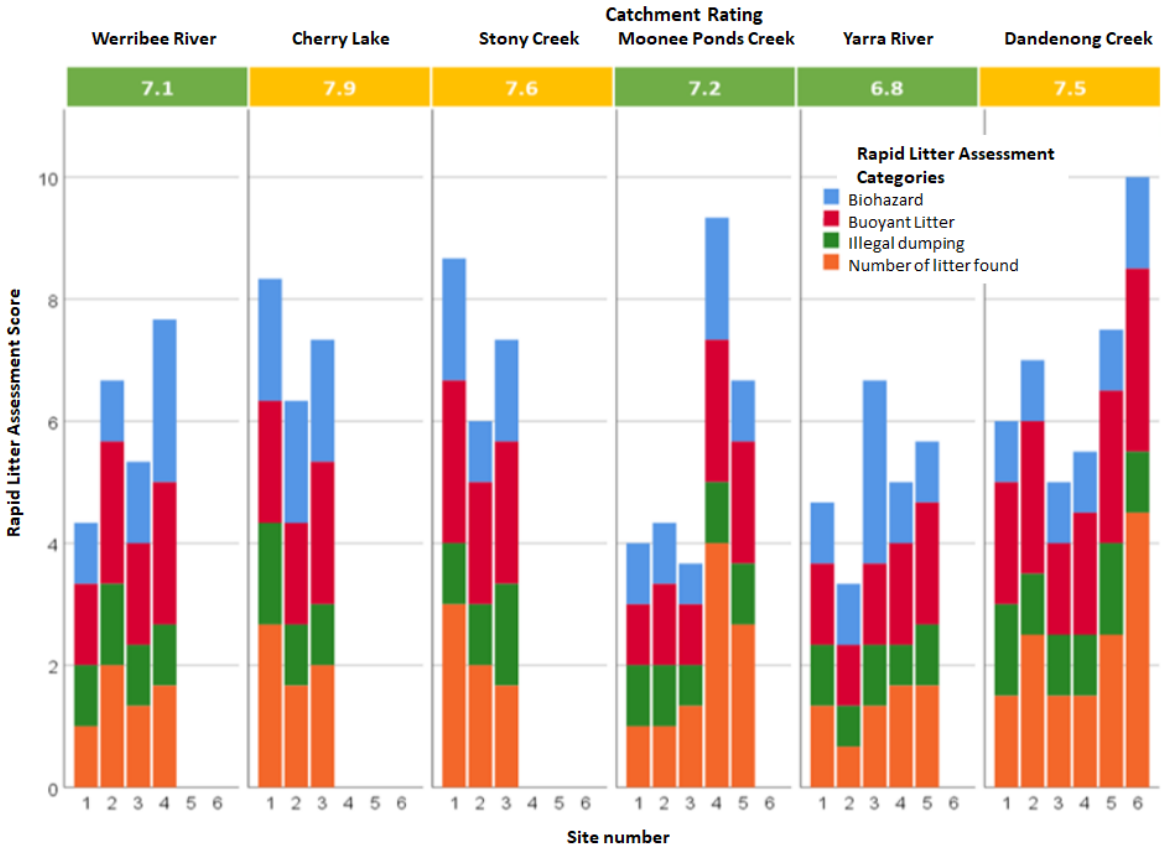

Figure 3. Qualitative catchment ratings and survey results for 26 sites across 6 sub-catchments.

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Standard methods for quantitatively monitoring litter on banks of inland waterbodies (rivers, creeks, wetlands, lakes) available via the A3P website: https://www.rmit.edu.au/about/schools-colleges/science/research/research-centres-groups/aquatic-environmental-stress/projects/litter-framework

- Melbourne Water Litter Standard Operating Procedure (SOP): Bank Surveys Comprehensive Method. September 2020.
- Melbourne Water Litter Standard Operating Procedure (SOP): Bank Surveys Rapid Method. September 2020.
- Instructional video: "Litter Monitoring: Bank Surveys". September 2020
- A standardised method for quantitatively monitoring litter from stormwater drains
- A standardised method for qualitatively assessing litter condition along waterways.

Lastly the program has been implementing trials that demonstrated the application of different approaches under the three programs outlined in Table 1. Summary findings from these are outlined in Figures 2 and 3.

HWS MERI for Litter Program

Since 2021, a broad-scale monitoring trial to understand the principal types, sources and quantities of litter entering waterways has been undertaken at 26 sites from 6 MW sub-catchments. Sites were surveyed biannually in 2021, then quarterly. Results are being used to assess differences in litter type and quantity occurring at sites within each sub-catchment and between sub catchments. Preliminary results (three rounds) from quantitative surveys show that Dandenong Creek and Moonee Ponds Creek have consistently higher litter loads, while Werribee River has the lowest (See Figure 2). Key litter types contributing to litter loads include food related packaging, expanded polystyrene and soft plastics, while at select sites cigarettes, hard plastics and paper items are also significant contributors. Qualitative assessments were conducted in parallel, and preliminary results indicate that most catchments are in “good” to “very good” condition with select sites in “fair” condition (See Figure 3). Data has been used to develop catchment ratings which are shown in Figure 2.

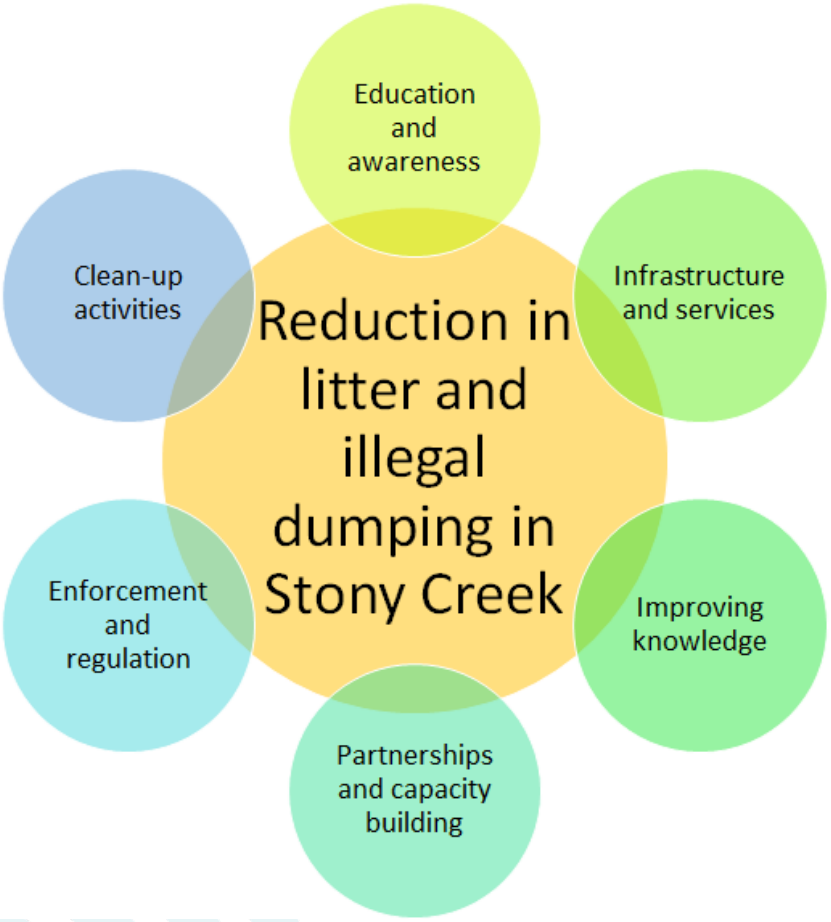

Figure 4. Mechanism of delivering litter management

Litter for Amenity program trials

The project made key contributions to MW programs through the co-development of litter condition rating methods which were trialled at sites in the Litter for Amenity program. These data will provide a Performance Measure with associated Performance Targets to ensure MW can successfully and cost-effectively manage litter for amenity along waterways. A3P have assisted with validation and refinement of the rating rubric and on-site review of the crew protocol and development of a Standard Operating Procedure for undertaking the condition assessment. This is important as it is intended to be implemented at all sites in the Litter for Amenity program across the MW region via the Survey123 app.

Stony Creek Litter Source Investigation

From 68 site visits, a total of 3019 litter items were collected, 1988 from along creek banks and 1031 from the stormwater network predominantly consisting of soft plastics, food related packaging, expanded polystyrene and cigarette related items (See Figures 5). Direct and indirect littering or dumping, and downstream transport and accumulation were identified as the main mechanisms responsible for litter in Stony Creek. Littering and dumping was associated with dry weather conditions and soft and hard plastics and food related packaging, while downstream transport and accumulation was associated with rainfall and distinctly related to the occurrence of cigarettes, polystyrene, and organic matter.

While litter occurred across the whole catchment, several locations had significantly greater accumulation, including Thomas Street and Yarraville Main Drain (MD) and Mathews Hill Reserve, followed by Paramount Road, Sara Grove and Tottenham MD, and Benbow St and the Francis St MD (See Figures 6a and b). Items posing greatest risk to values and assets of Stony Creek include soft plastics, expanded polystyrene, organic matter, and food wrappers.

Twenty-nine options for improving the litter situation in Stony Creek were proposed for further consideration and feasibility assessments and were based on 1) Targeting key litter types occurring across the catchment 2) Managing litter at hot spot sites and 3) Targeting those items posing greatest risk to values and assets of Stony Creek. Options fall into categories shown in Figure 4.

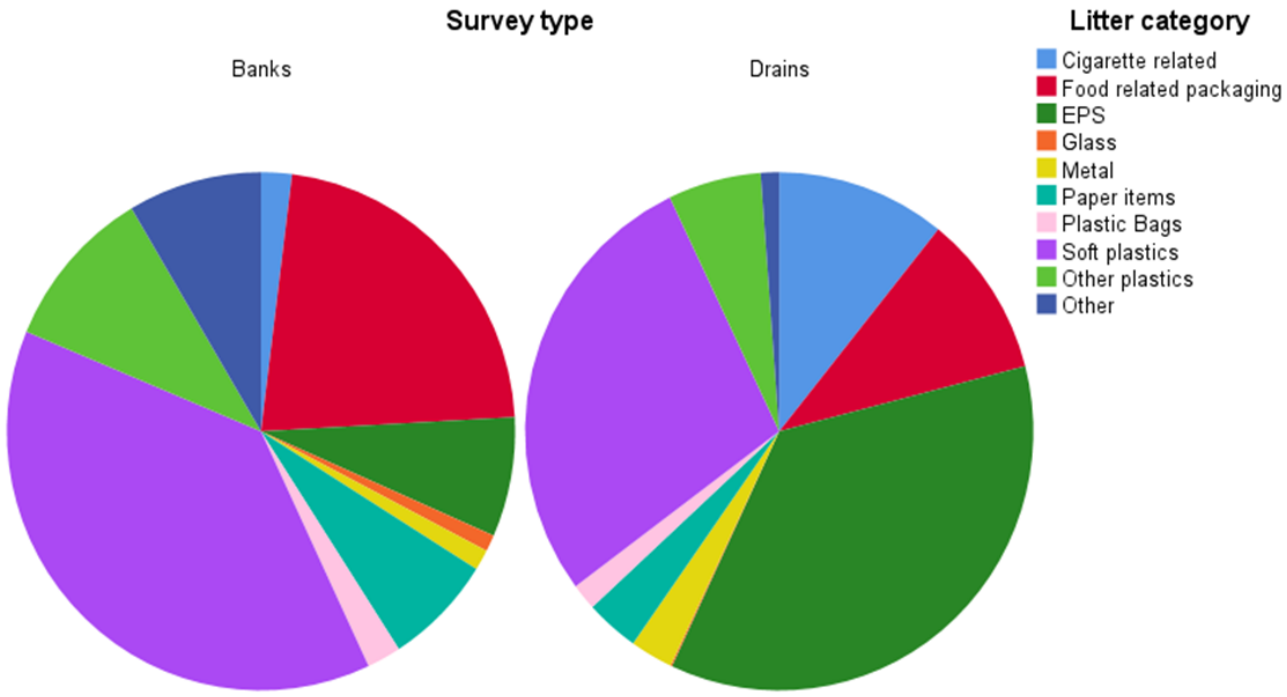

Figure 5. Contributions of different litter types in bank and stormwater drain surveys at Stony Creek. Drains n=1031; Banks n=1899.

Future direction and knowledge gaps

Litter monitoring using Artificial Intelligence (AI)

The project contributes to a collaborative trial between the Melbourne Water IT Innovation team and the Applied Research team to investigate the potential to apply Artificial Intelligence (AI) approaches to monitor litter in waterways (e.g., litter counts and broad characterisation of litter types). The first camera was in- stalled in 2022 along Moonee Ponds Creek and additional cameras will be installed in 2023 along Gardiners Creek, Dandenong Creek, Stony Creek and on the outlet of the Prahran Main Drain. Following an initial period of image collection and litter characterisation, AI algorithm development and testing will be possible. It is hoped that these litter cameras will enable continuous monitoring of litter types and volumes (during both dry and wet weather) at key locations across the region, that could be useful to complement other litter survey methods and enable reporting of long-term trends in litter e.g. public reporting of 'litter cam' data or assessing reductions in litter fol- lowing management interventions.
DEECA & Federal Uni are incorporating the Melbourne Water qualitative and quantitative tools into Litter Watch with the aim of them being available to all in mid 2023. This means that members of the general public will be able to contribute directly to litter data collection and feed into the HWS.

Reports

Mondschein, G., Clark, M. and Myers, JH. (2020) Melbourne Water Litter Standard Operating Procedure Litter Survey Riverbank Comprehensive, Aquatic Pollution Prevention Partnership, Technical Report No. 48a, RMIT University, Victoria, Australia.

Myers, J., Long, S., Tewman, M., & Pettigrove, V (2019), Workshop Summary Report: Operational Guidelines for Litter Monitoring and Assessment: A summary of workshop session outcomes for participant review. Technical Report No: 25, RMIT University, Victoria, Australia.

Myers, JH., Richardson, K., Long, S., Tewman, M. and Pettigrove, V. (2020), Year 1 Summary Report: Melbourne Water business purposes for the monitoring and assessment of litter, Aquatic Pollution Prevention Partnership, Technical Report No. 27, RMIT University, Victoria, Australia.

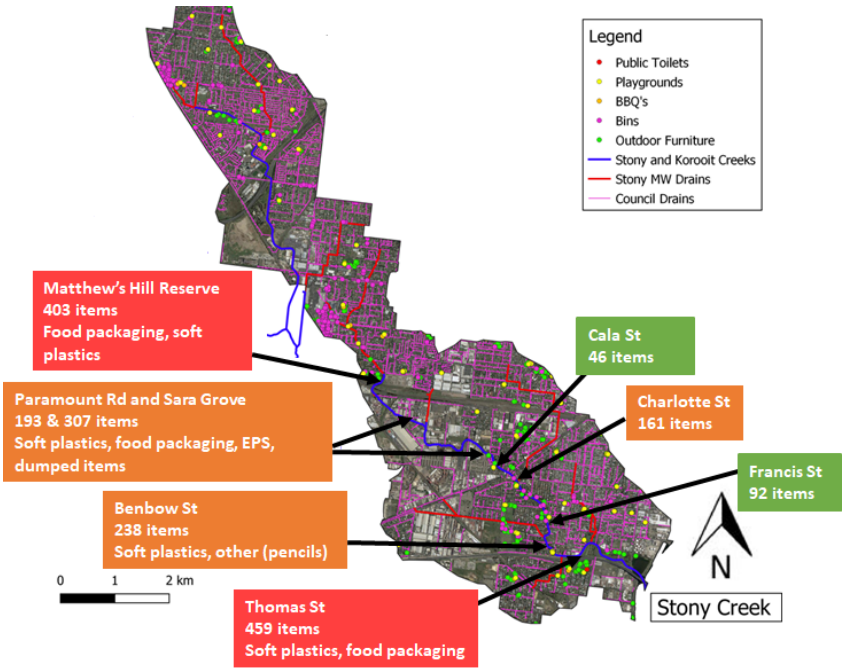

Figure 6a. Litter hot spots within Stony Creek catchment, green= low litter levels, orange = medium and red = high (by bank survey).

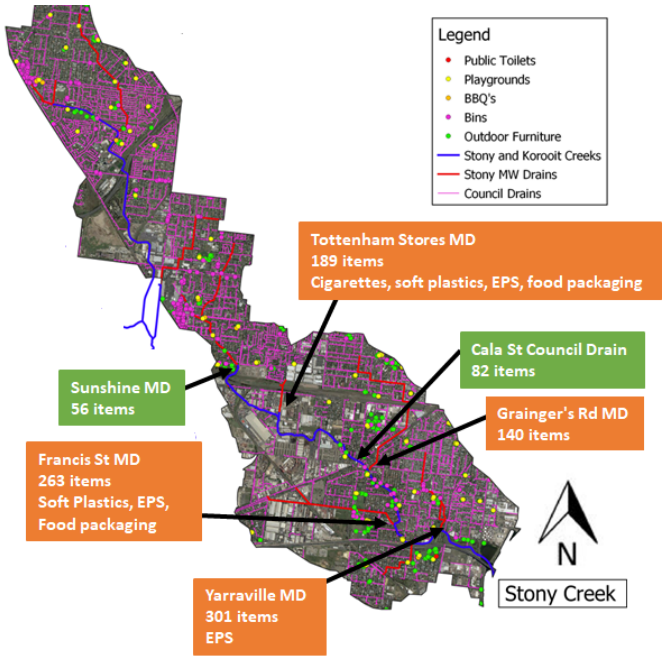

Figure 6b. Litter hot spots within Stony Creek catchment, green= low litter levels, orange = medium and red = high (by stormwater drain survey).

Myers, J., Mondschein, G., Clark, M., & Pettigrove, V (2021), Aquatic Pollution Prevention Partnership Project: Stony Creek whole of system litter investigation & management prioritisation Target Litter Survey Summary Report, Aquatic Environmental Stress Research Group, Technical Report No. 56, RMIT University, Victoria, Australia.

Myers, J.H., Mondschein, G., Clark, M., MacMahon, D., Walpitagama, M., Long, S., and Pettigrove, V. (2023), Summary Report: Field evaluation of litter monitoring methods for inland waterways, Technical Report No.72, Aquatic Pollution Prevention Partnership, RMIT University, Victoria, Australia.

Myers, J.H. and Slater, M. (2022), Standard Operating Procedure for conducting Qualitative Litter Assessments in inland waterways and wetlands, Technical Report No. 85, Aquatic Environmental Stress Research Group, RMIT University, Victoria, Australia.

Richardson, K., Myers, J.H., Long, S., and Pettigrove, V. (2020), A framework for litter monitoring and assessment: A comparison of existing riverine and litter trap litter survey and monitoring methods, Aquatic Pollution Prevention Partnership, Technical Report No. 30, RMIT University, Victoria, Australia.

Trestrail, C, Myers, J, MacMahon, D & Pettigrove, V (2020), Aquatic Pollution Prevention Partnership Project: Stony Creek whole of system litter investigation & management prioritisation Catchment background report, Aquatic Environmental Stress Research Group, Technical Report No. 31, RMIT University, Victoria, Australia.

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