Review of Historic and Recent Water Quality in Stony Creek

Overview of the research and results

Stony Creek is a small, heavily urbanised sub-catchment in the Maribyrnong Catchment Region of Melbourne. Due to a long history of various industrial activities, Stony Creek has been significantly affected by different types of pollution, and ranks very low for several key values and waterway conditions identified in the Melbourne Water Healthy Waterways Strategy (Melbourne Water, 2018). However, the creek does support some native frog and fish species; and amenity, community and recreation values in Stony Creek are rated high, with a target trajectory of becoming very high. These ranks are based on the high value the local community places on the catchment, and in particular large open reserves such as Cruickshank Park (Yarraville) (Maribyrnong City Council, 2014).

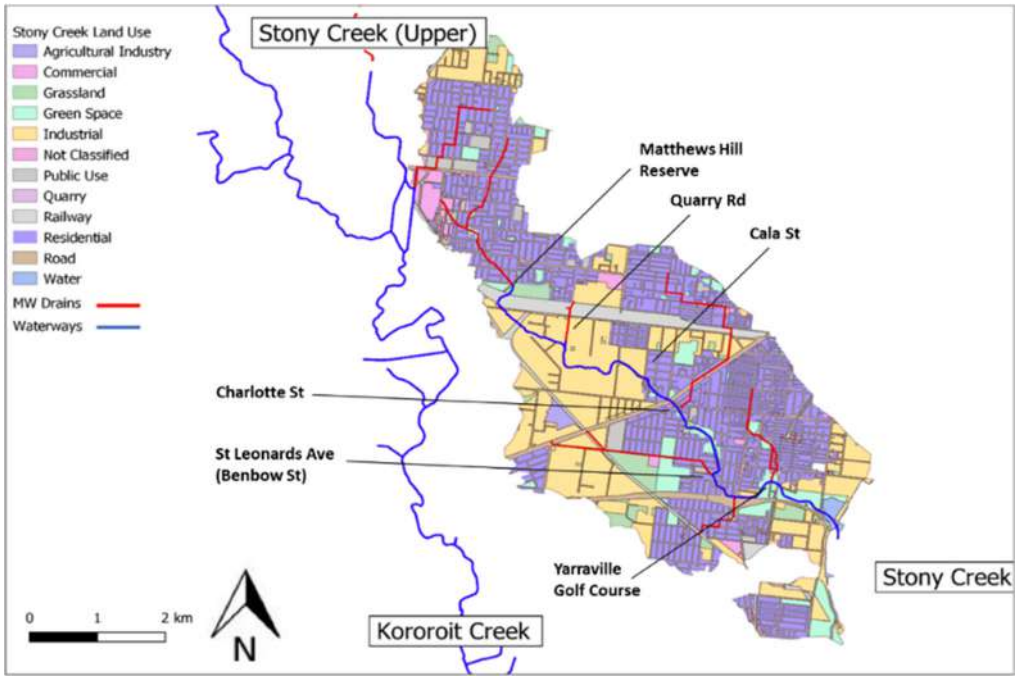

Figure 1. The Stony Creek Catchment, south west of Melbourne is dominated by Industrial and Residential landuses.

In this study, we have collated all available information to provide a review of historical and recent water quality and ecological monitoring data and any relevant ecotoxicological studies throughout the Stony Creek catchment. The review has identified several contaminants that are present in Stony Creek at concentrations that exceed water and sediment ecological objectives or guideline values and are thus likely to cause adverse ecological impacts (ANZECC&ARMCANZ, 2000; ANZG, 2018; EPA Victoria, 2021).

Water Quality

The predominant water quality issues at all sites are **dissolved oxygen** and regular exceedances of guideline values for **nutrients (phosphorus and nitrogen)** and **ammonia**. From the limited microbial indicator and toxicant data available, 16% of measurements of ***E. coli*** exceeded guideline values with some *E. coli* counts being especially high (e.g. 2,500,000 orgs/100 ml, which greatly exceed the guideline value of 5,500 orgs/100 ml). Metal concentrations in water at most Stony Creek sampling sites were also highly elevated, especially **zinc** and **copper** which exceeded guideline values on all occasions at all sites, and **chromium, nickel, lead, cadmium and arsenic** that exceeded guideline values on some occasions.

Water quality measurements were also summarised for the three major stormwater drains that enter Stony Creek, namely Tottenham Stores Main Drain (MD) (Quarry Rd), Graingers Rd MD (Charlotte St) and Francis St MD (St Leonards Ave). At all three sites **phosphorus and nitrogen** regularly exceeded guideline values (80-100% exceedances) and all **zinc and copper** concentrations exceeded guideline values. **Lead** also exceeded guidelines at all three sites (10-20% exceedance), and at Francis St MD, **cadmium, chromium and nickel** concentrations exceeded guidelines (10-20% exceedances). The microbial indicators ***E. coli*** **and** ***Enterococci*** showed exceedances in all three drains, but the highest concentrations observed were in Graingers Rd MD and Francis St MD.

A recent monitoring program by AQUEST in 2021 used passive samplers to detect several organic compounds (pesticides and pharmaceuticals) within the water column of Stony Creek. Passive samplers are devices that can provide a time-integrated measurement of micropollutants in water (Figure 2). For this study we used Polar Organic Chemical Integrative Sampler (POCIS) passive samplers to measure organic chemicals and pharmaceuticals (including antibiotics, antidepressants, beta blockers, analgesics) in water. The samplers were deployed instream for up to 4 weeks at all Stony Creek sites (but not deployed in stormwater drains).

A total of 20 different chemicals were detected in the passive samplers, including 7 herbicides, 6 fungicides, 2 insecticides and 5 pharmaceuticals and antimicrobials (Table 1). The major herbicides detected were **atrazine, metolachlor, simazine and diuron**, with a frequency of detection ranging from 81.3-100% of samples. Herbicides were observed throughout the entire catchment. The fungicides **propiconazole, tebuconazole and carbendazim** were the most frequently detected fungicides (>93% detection frequency), and they were also detected throughout the entire catchment. Only two insecticides were detected: **imidacloprid** which was present throughout the catchment and detected in 93.8% of samples; and **carbaryl**, which was only detected at Stony Creek downstream of Cala St drain, on one sampling occasion. A total of five pharmaceuticals and antimicrobial chemicals were detected, with **paracetamol** being the most frequently detected, occurring in 100% samples. **Carbamazepine, tilmicosin, sulphapyridine and thiabendazole** were also detected, but at lower frequencies (6.25-43.8%) and only at some sites.

Figure 2. Polar Organic Chemical Integrative Sampler (POCIS) passive sampler and stainless steel cage. Passive samplers are used to measure water soluble contaminants, and are deployed instream, attached to a steel picket.

Table 1. List of chemicals detected in passive samplers deployed at 8 locations within Stony Creek.

Group	Compound Name	Frequency of Detection (%)
Herbicides	Diuron	100
	Simazine	100
	Metolachlor	93.8
	Atrazine	81.3
	Ethofumesate	68.8
	Metribuzin	37.5
	Dimethomorph	6.25
Fungicides	Propiconazole	100
	Tebuconazole	100
	Carbendazim	93.8
	Pyrimethanil	68.8
	Myclobutanil	62.5
	Paclobutrazol	18.8
Insecticides	Imidacloprid	93.8
	Carbaryl	6.25
Pharmaceuticals and Antimicrobials	Paracetamol	100
	Thiabendazole	43.8
	Sulphapyridine	25.0
	Carbamazepine	12.5
	Tilmicosin	6.25

Sediment Quality

Sediment quality was also observed to be consistently poor throughout the Stony Creek catchment. **Zinc** (100% exceedance), and to a lesser extent **nickel, lead and copper** (2-100% exceedance) exceeded upper guideline values (GV-high), whereby high toxicity is expected. Similarly, **total petroleum hydrocarbons** (>95% exceedance) also greatly exceeded the upper guideline values,

indicating that high toxicity is expected in biota in contact with the sediments. The poor sediment quality is reflective of the long history of industrial activities within the catchment, as well as the increasing influence of urban development and stormwater runoff (Figure 3).

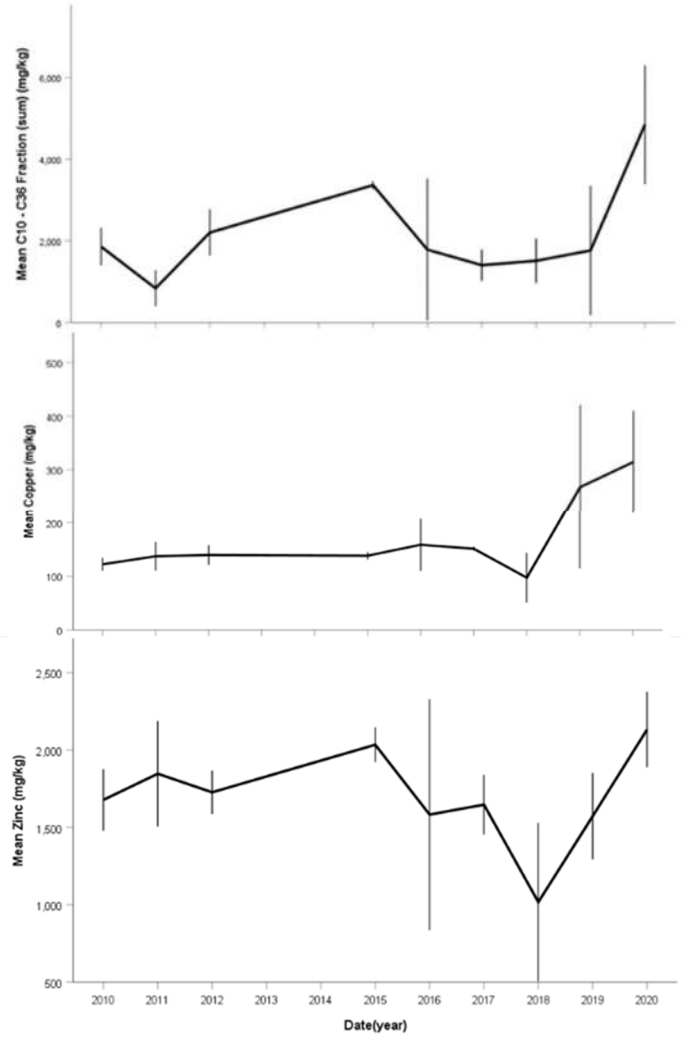

Figure 3. Trends in mean (±95% CI) metal and TPH concentrations in sediments collected from Stony Creek @Adaleigh St 2010-2020 (source: Melbourne Water/AQUEST). Concentrations show a sharp increase following the Tottenham warehouse fire in August 2018.

The AQUEST sampling program in 2021 utilised sediment bags that were deployed in stormwater drains to trap sediment particles from stormwater (Figure 4). Using this approach, several contaminants were detected at high frequency and/or concentration in sediments derived from stormwater, including **metals, pesticides** and TPH (Table 2). **Total petroleum hydrocarbons** were consistently detected in sediments throughout the catchment, whilst the metal concentrations tended to be higher in sites between Tottenham Stores MD and Francis St MD, rather than at Sunshine MD (top of catchment), or the Yarraville MD (bottom of catchment). Pesticide presence throughout the Stony Creek catchment was much lower and patchier than metals presence, and often only one site displayed detectable concentrations. **This work demonstrates that stormwater drains are an important source of contaminants to the catchment.**

Figure 4. Sediment bag deployed in Graingers Rd Main Drain (Charlotte St). Sediment bags are tethered to structures in stormwater drains using wire cables and trap sediment particles from stormwater.

Table 2. List of key chemicals detected in sediment bags deployed throughout Stony Creek.

Group	Compound Name	Frequency of Detection (%)
Metals	Copper	100.0
	Lead	100.0
	Nickel	100.0
	Zinc	100.0
	Cadmium	45.5
	Mercury	45.5
Pesticides	Bifenthrin	68.2
	Permethrin	45.5
	Dieldrin	13.6
	Chlorpyrifos	4.5
	Tebuconazole	4.5
TPH	C10-C36 Fraction (Sum)	81.8

In August 2018, a large warehouse fire in Tottenham caused Stony Creek to be contaminated with industrial chemicals and firefighting foams. After the fire, the air quality in West Footscray (1-hour and 24-hour PM2.5, ug/m^3) was very poor on late 31st August and early 1st September (EPA Victoria 2018b). The key chemicals detected in Stony Creek water and sediments were phenol (an industrial chemical and cleaning product), PAHs (fire and soot by-products), BTEX, PFAS and industrial solvents such as acetone and butanone. The incident has been described as 'the worst pollution event to a Melbourne waterway in almost 30 years' (Melbourne Water, 2019), and the contamination caused widespread fish kills and mortality to other aquatic biota in the days following the incident.

On-going remediation works are currently in place, and to date, Melbourne Water and EPA Victoria have facilitated the removal of millions of litres of contaminated water and several hundred cubic metres of contaminated sediment. Sediments collected upstream and downstream of the fire site have been screened for various chemicals, and showed high level contamination with chemicals including BTEX, TPH and PAHs, as well as concentrations of several metals that exceeded sediment quality guidelines. In addition, ecotoxicological studies done by the AQUEST research group (RMIT University) reported that sediments were toxic to laboratory-cultured invertebrates, but that toxicity was observed both upstream and downstream of the fire site, indicating that whilst the fire has certainly impacted Stony Creek, other sources of toxicity are also present in the creek upstream of where the fire occurred (Hassell et al., 2019).

Key Issues and Priority Contaminants in Stony Creek

The review has identified several contaminants that are present in Stony Creek including some that are likely to cause adverse ecological effects. For both water and sediment, several ecological objectives or guideline values were regularly exceeded. To maintain the current high condition of amenity, community and recreation values in Stony Creek, especially for Cruickshank Park, effort needs to go towards developing a better understanding of the sources of key contaminants to Stony Creek and how they can be effectively managed to protect and improve the condition of the Stony Creek catchment.

The priority contaminants in Stony Creek sediments are metals and TPH, whilst in water, the key issues are dissolved oxygen, nutrients, metals, and pesticides (Table 3). Stormwater drains are a likely source of nutrients, metals and *E. coli*, and more thorough monitoring is recommended to better elucidate the contribution stormwater drains have to pollution issues in Stony Creek (Table 4).

Since the catchment is severely impacted by pollution throughout the entire industrial area (from Quarry Rd and downstream), regular monitoring work to identify if the pollution persists upstream, north of Sunshine Rd would be of benefit. Furthermore, the development of options to intercept any pollution events before they contaminate Stony Creek, as well as the development of online treatment options for polluted waters and targeted pollution sourcing programs to identify and address the major pollution sources in the catchment should also be considered (Table 4).

Table 3. List of key contaminants in Stony Creek, associated land uses or industrial activities and likely sources to the catchment (if known).

Water quality parameter/contaminant	Compartment	Presence in catchment	Associated activities/industries	Potential sources to the Stony Creek catchment
Dissolved oxygen (<60%Saturation or >130%Saturation)	Water	Entire catchment	Eutrophication, excessive plant growth	Dissolved oxygen levels influenced by oxygen demand within the waterway. High levels of nutrients stimulate plant growth and subsequent decomposition, leading to fluctuations in DO levels. Management of excessive nutrients should help control DO fluctuations.
Nutrients (N and P)	Water	Entire catchment	Stormwater, agriculture/green space	Primarily stormwater runoff, secondarily fertilisers and runoff from green spaces
Microbial indicators (E.coli and Enterococci)	Water	Entire catchment, predominantly stormwater drains	Stormwater, sewage	Stormwater drains, stormwater-sewage cross connections, runoff from green spaces (i.e. dog and other animal faeces)
Pharmaceuticals	Water	Entire catchment, but patchy	Sewage	Stormwater-sewage cross connections, sewage overflows directly into Stony Creek
Metals (esp. copper, lead, nickel and zinc)	Water and sediments	Entire catchment	Urban development, various industrial activities	Stormwater drains, runoff from impervious surfaces throughout catchment (i.e. roads and roofs)
Pesticides - herbicides	Water and sediments	Entire catchment	Agriculture/green space, golf courses, domestic use	Stormwater drains, runoff from green spaces and domestic properties
Pesticides - fungicides	Water and sediments	Entire catchment	Agriculture/green space, golf courses, domestic use	Stormwater drains, runoff from green spaces and domestic properties
Pesticides – insecticides (esp. bifenthrin)	Water and sediments	Entire catchment	Agriculture/green space, golf courses, domestic use	Stormwater drains, runoff from green spaces and domestic properties and building sites
Petroleum hydrocarbons	Sediments	Entire catchment	Industrial activities, road runoff, stormwater	Stormwater drains, runoff from impervious surfaces throughout catchment such as roads

Table 4. Recommendations for managing key contaminants in Stony Creek.

Recommendation	#	Description	Expense	Management Implications
Development of options to intercept any pollution events before they contaminate Stony Creek	1	Prevent industrial area runoff by ensuring properties are correctly connected to sewer	low	Requires engagement with businesses, site inspections and potential plumbing/drainage works. On-going inspections may be required to ensure compliance
	2	Ensure construction sites have adequate bunding and temporary sediment ponds in place to prevent construction runoff entering Stony Creek	low	Requires engagement with businesses. On-going inspections may be required to ensure compliance
	3	Biofiltration systems (vegetated strips, buffer strips and rain gardens) to mitigate flows into Stony Creek	medium	Some maintenance required. Excellent opportunity for community engagement
Development of online treatment options for polluted waters	4	Filtration material installed within stormwater drains to absorb contaminants before they can enter Stony Creek	medium	Regular maintenance, cleaning and replacement of filter materials required. Risk of clogging and impeding stormwater flows/not functioning properly. Target industrial areas
	5	Construction of treatment wetlands to remove contaminants from Stony Creek	high	On-going maintenance and cleaning required. Risk of treatment wetlands becoming contaminant sinks with expensive costs for desilting due to reaching prescribed waste levels for some contaminants such as metals Limited space within catchment to build new wetlands. Consider In-stream wetlands (such as Cala St ponds).
Targeted pollution sourcing programs to identify and address the major pollution sources in the catchment	6	Community awareness program/workshop. Educate community about correct chemical disposal, implications of domestic pesticide use and contamination impacts on Stony Creek catchment	low	Excellent opportunity for community engagement
	7	Whole-of-catchment monitoring, and targeted stormwater drain monitoring program to identify key drains responsible for introducing pollution. Follow on from AQUEST 2021 study	medium	Produce empirical data and better understanding of pollution input patterns
Regulation, enforcement and behaviour change	8	Education and incentives: Best management practice guidelines, tools and information to be provided to businesses within the catchment (including capacity building/training opportunities)	medium	Incentives (positive recognition, assistance) should be offered to high risk businesses, particularly medium to small businesses
	9	Behaviour Change: On-ground enforcement/compliance officers to monitor business activities and ensure proper waste management	medium	Site inspections, evaluations to each business and on-going inspections to ensure compliance. Penalties to be applied to businesses that don't comply

References

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FULL REPORT CITATION:
Hassell, K., Leigh, C., Myers, J., Tewman, M., Vu, H., Pettigrove, V. (2021) Review of Historic and Recent Water Quality in Stony Creek. Technical Report No. 38. Aquatic Environmental Stress Research Group, RMIT University, Victoria, Australia.

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