Major sources and fate of sediments in streams, wetlands, estuaries and bays to inform management opportunities

Strategic alignment

Regional Performance Objectives (RPOs):

- RPO 15: Victoria's planning system is used effectively to protect and enhance waterway values.
- RPO 17: Water quality in waterways and bays is improved by reducing inputs of sediment and other pollutants from urban construction and development.
- RPO 25: Programs, standards, tools and guidelines are in place to manage nutrients, sediments and other pollutants from rural land in priority areas.

Key Research Areas:

- Port Phillip Bay and Westernport: Undertaking priority research projects identified in the Western Port Environment Science Review and synthesis Report.
- Stormwater management and flooding: Developing decision support tools to inform the most effective stormwater treatment systems and locations to protect waterway biodiversity, amenity and recreation.
- Water quality: Developing improved water quality indicators and monitoring methods to better understand the impacts of pollutants on waterway health.

Summary

This research program aimed to improve models of urban, periurban and rural sediment budgets, to inform plans and strategies to decrease sediment loads to receiving waters. Waterways, estuaries and bays are sensitive to changes in sediment load, due to sedimentation and light attenuation, as well as nutrients and toxicants that attach to sediment particles. With a focus on the Westernport catchment, this project has investigated aspects of the sediment budget that are currently poorly understood.

Western Port is particularly sensitive to sediment inputs, containing seagrass beds that are under threat from light attenuation, due to fine sediment inputs from the catchment and coast. It is understood that fine sediment is slowly flushing from the seagrass areas of the bay and should continue to do so, given catchment sediment loads remain at or below current levels (Melbourne Water, 2018). A sediment load target has been specified in the State Environment Protection Policy (Waters)(now the Environmental Reference Standards) to allow flushing to occur. DEECA, in collaboration with Melbourne Water, recently led the review of strategic actions proposed for the Westernport catchment to reduced sediments loads and





whether those actions were likely sufficient to achieve the sediment loads target in the face of future urban growth and climate change (Jacobs 2023).

Sediment loads from rural lands and channel erosion are reasonably well-understood as a result of sediment budgeting work undertaken for Melbourne Water by CSIRO in the Westernport catchment since the early 2000s. Most recently, a Westernport dSedNet model was developed to identify priority management actions to achieve the sediment loads target (Cuddy et al. 2019). However, several uncertainties remain, including a knowledge gap around sediment liberated by different stages of urban development in the catchment. There is also a need to better quantify aspects such as gully erosion, bank erosion (identified as the major contributor to sediment loads in the dSedNet model), and sediment deposition/resuspension.

Recommendations:

- Policies to reduce sediment loads to streams and receiving waters should place greater priority on improving construction erosion and sediment control in growth areas and should target both development-scale and lot-scale activities, with a focus on minimising exposed soil extent and duration, and connection between sources and drains.
- Continue to place high priority on protecting natural wetlands from development, including avoiding constructed waterways where they could affect wetland functioning.
- Review the gully erosion module in dSedNet model, in particular, consider revising the gully size parameter and gully activity in certain landscapes.

What did we do?

Central to this research was the installation of pairs of suspended-sediment monitoring stations upstream and downstream of targeted land uses (i.e. construction areas at different phases of development). This catchment-scale sediment load monitoring has been completed by annual monitoring of channel cross-section change between the paired stations (to estimate channel erosion contributions) and annual monitoring of sediment build-up in wetlands and sediment ponds by bathymetric survey (to estimate treatment effectiveness).

The project also has initiated three sub-projects:

1. Disentangling variability of sediment sources within the catchments (PhD project, commenced Nov 2021). Two main questions are being addressed via this project: what are the spatio-temporal dynamics of soil erosion in relation to land



Figure 1: Outputs of channel dimension tool.

use; and where is sediment supply coming from in the urban context? This project is developing and implementing low cost turbidity sensing methods within the catchments to quantify relative contributions from different sources.

- 2. The problem of sediment transfer in peri-urban streams and its interaction with riverbed morphology (PhD project, commenced January 2022), with the following key research questions: what are the dynamics of sediment transfer in the river network (deposition and remobilisation) during a flow event and over multiple events? Do the riverbed or riverbanks represent an important sediment source to the global sediment budget?
- 3. The activity level and evolution of gullies in the southeastern Westernport catchment: A field validation campaign sampled sites from across the region and assessed the level of gully activity at each site based on evidence of vertical banks, headcuts and vegetation cover. These data were used to validate estimates of gully activity in the Westernport sediment budget model (dSedNet).

What did we find?

- Our results provide additional motivation for increased stormwater harvesting, in particular our sediment monitoring shows that increased flow is a key driver of increased sediment loads.
- Our observations indicate that natural wetlands play a role in buffering catchment sediment inputs, and that common urban waterway treatments that degrade that function (e.g. constructed waterways) risk further increasing sediment loads.
- GIS-based time-series land cover mapping has provided a conceptual understanding of the relative sediment load contribution of different urban development stages compared to mature estates (developed urban areas). This work has been published (Figure 1; Russell 2021). The conceptual model predicted that potential sediment supply peaks with bare soil cover early in the construction process, but then remains high during subsequent road and house

construction as imperviousness and drainage connection increase. Total sediment supply potential from a site depends greatly on the duration of soil exposure and disturbance. This model is now being validated with field data.

- Sediment monitoring and surveys indicate that sediment concentrations from urban sources are not necessarily higher than from upstream (rural) sources, but sediment loads are much higher due to increased flows.
- Overall gully activity in the Westernport catchment was found to be reasonably consistent with previous mapping for the dSedNet model, but gully size was likely overestimated, and gullies in certain landscapes tended to be mis-classified (e.g. mapped gullies in the lowlands around Dalmore were all found to be inactive).
- We expect the development of low-cost monitoring systems to increase the coverage and resolution of data and to provide tools to further assist with adaptive management (e.g. construction sediment control, compliance monitoring, sediment pond maintenance).
- We expect to be able to further resolve the contributions of different construction phases and activities with long-term monitoring and application of new monitoring systems at finer scales.
- The validation of key parameters and processes in the Westernport sediment budget model will contribute to development of plans to meet the SEPP sediment target.

How are we sharing findings?

Technical Reports

- Technical Report: "Sediment budgets: major sources and fate of sediments in streams, wetlands, estuaries and bays to inform management opportunities", 2019, MWRPP Report 19.1. Kathryn Russell & Geoff Veitz
- Technical Report: "Sediment load monitoring of urbanizing areas in Westernport catchment", 2023, MWRPP Report 23.10. Kathryn Russell

• Technical Report: "Field validation of dSedNET gully mapping for the Westernport catchment", 2022, MWRPP Report 22.6. Mike Sammonds & Kathryn Russell

Journal Articles

- Russell, K. (2021) Potential sediment supply fluxes associated with greenfield residential construction. Anthropocene, 35. 100300.
- Hawley, R. J., Russell, K., & Taniguchi-Quan, K. (2021). Restoring Geomorphic Integrity in Urban Streams via Mechanistically Based Stormwater Management: Minimizing Excess Sediment Transport Capacity. Urban Ecosystems.

For more details on the research outcomes of this project, or other projects of the MWRPP, please contact:

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



