MID-TERM REVIEW

Effectiveness of rural land interventions to improve stream flows and water quality

Strategic alignment

Regional Performance Objectives (RPOs):

- RPO25: Programs, standards, tools and guidelines are in place to manage nutrients, sediments and other pollutants from rural land in priority areas.

Key Research Areas:

- Streamside vegetation and instream habitat: Developing decision support tools to support improved investment in riparian and instream habitat activities and locations
- 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.
- Water Quality: Quantifying ecosystem services in waterways for improving water quality to better account for the benefits of healthy waterways.

Summary

Melbourne Water makes major investments, in partnership with stakeholders, in mitigating the impacts of rural runoff on waterway health. The effectiveness of this investment is constrained by limited information on (i) where the pollutants are coming from (i.e. the location and type of sources) and (ii) the effectiveness of runoff control measures. The overall objective of this project was development of a framework for the Rural Land Management Program (RLMP) to prioritise locations for investment and identifying the most appropriate rural runoff treatment measures, incorporating two primary components (i) a pollutant source-prioritisation framework and a (ii) prediction of treatment performance, combining data from both field monitoring and from other studies. This follows work undertaken prior to 2018, where monitoring constructed swales and wetlands within agricultural land in Beenak were shown to be effective in reducing concentrations and loads of pollutants.

Recommendations

Microbial and chemical levels and source-tracking

- It is recommended that Melbourne Water undertake source-tracking investigations in catchments, before investing in water quality improvement works. Source-tracking is an affordable and effective way to prioritise actions based on their likely contribution to addressing potential sources of pollution (e.g. animal waste, septic tanks, wildlife).
- As well as septic tanks and cattle, Melbourne Water should prioritise actions to reduce the impacts of deer (see Project D2: Deer, which investigates priority areas for deer control), which were shown to be a significant contributor to stream water quality pollution in the study area.

Performance of revegetated gullies for treating rural runoff

- It is recommended that Melbourne Water review the metrics (e.g. nitrogen and sediment reduction estimates) used to evaluate the likely benefits of proposed projects through the RLMP to take into account the results of this study, as presented in Figure 1.
- Install fencing along gullies in rural areas to provide water quality benefits irrespective of buffer widths, by excluding cattle from the stream bed and adjacent banks.
- Where stock exclusion is not possible, rotational grazing management can improve sediment, nutrient and microbial water quality.
- Address concentrated surface flow pathways by changing buffer shape (making the buffer strip wider where flows converge) and diverting track drains.
- Avoid drainage or channelization of wetland areas, to ensure flow stays diffuse.
- Expand the buffer area to surround natural topographic depressions, avoiding concentrated flow from paddock to stream (see Fig. 2).
- Divert discharge from track drains over a broader area of enclosed buffer zone before it reaches the stream.
- Maintain dense ground cover vegetation to reduce streamside erosion and improve flow interception
- Maintain the greatest possible surface vegetation cover in riparian areas, through permanent stock exclusion if possible, followed by either active or passive vegetation establishment.
- Monitor surface vegetation density within buffers, particularly in established buffers where canopy shading may reduce surface vegetation density, or where concentrated flow is likely to occur.
- Consider re-planting low-density surface vegetation areas, with shade-tolerant species if under canopies.
- Employ fit-for-purpose pollutant control methods. Buffers must be sized so they have capacity for water treatment. Buffers should be wider in areas where higher flows are expected, e.g. where flows are concentrated by convergent topography (see Fig. 2).

- In steep areas with narrow buffers, pollutants borne by groundwater are unlikely to be significantly mitigated by buffers.

What did we do?

Component 1: Microbial and chemical levels and sources

Understanding levels and sources of pollutants (microbial and chemical) is a prerequisite to developing a spatially relevant prioritisation tool for mitigation efforts. Without understanding the most influential sources of pollution management efforts may be ineffective. In this project a novel bacterial source tracking method was used to understand the sources of bacterial pollution in forested and agricultural areas in the upper Tarago River system within the Westernport catchment. Effort was also put toward understanding potential pollutant sources (e.g. dairy sheds, farm operations sites, residences, municipal operations, commercial areas) within the catchment, delivering a proof of concept that this type of tracking can support the identification of management priorities.

Our source-tracking used the concept of 'fingerprinting' for source identification; we obtained a fingerprint for a particular source (e.g. cow, deer) and used this to determine the major sources of pollution. The concept utilises fingerprinting methods for chemicals, bacteria, protozoa and viruses. Bayesian models were then used to compare the chemical and microbial profiles obtained from the sources to the sink (i.e. the receiving waters). The output of the model is the percentage of each source which is predicted to contribute to a particular sink. These outputs are then directly used to prioritise mitigation.

Component 2: Performance of revegetated gullies for treating rural runoff

To address the capacity of buffers to reduce the export of sediment, nutrient and faecal pollutants, monitoring of concentrations and loads was undertaken in catchments where buffers were established, and those where cattle were allowed to freely graze the riparian area. Selection of monitoring sites was undertaken to minimise differences in catchment characteristics other than the presence or absence of buffers. Six study catchments were selected (three buffered catchments and three unbuffered catchments). Catchments were selected that contain both recently established vegetation (5 years since stock exclusion and planting) and more mature woody vegetation (15 years since stock exclusion and planting) to allow monitoring of a more representative range of buffers. The monitoring regime included both monthly dry weather sampling and wet weather sampling, with flows measured automatically via self-cleaning v-notch weirs at each site.

To better understand the impact of cattle exclusion, a field experiment was conducted which coupled high frequency turbidity measurements with cattle behaviour monitoring. This was a specific, intensive study, using camera traps to quantify

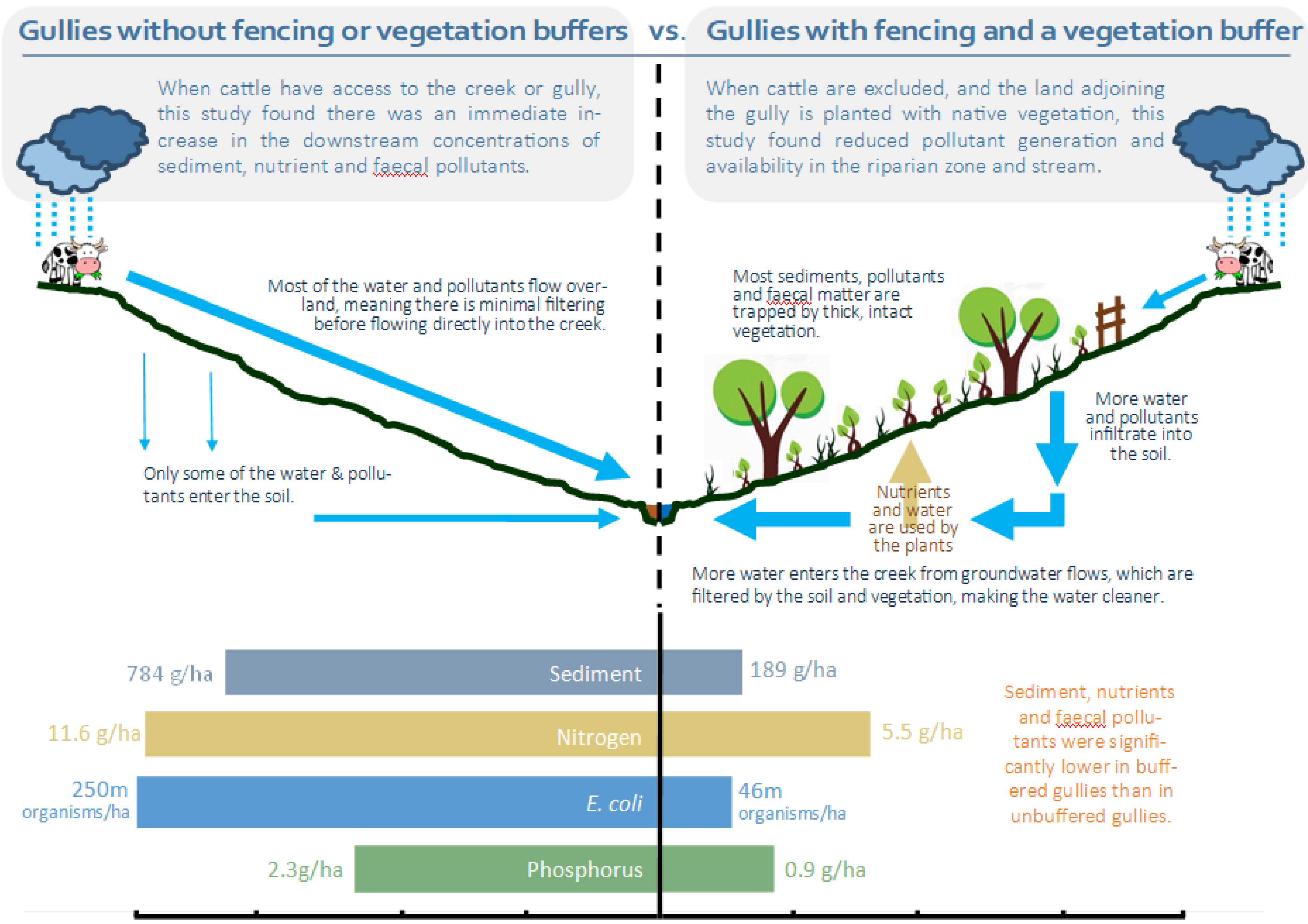

Figure 1: Comparison of the pollutant loads recorded by this research in streams and gullies fenced and vegetated, compared to stream and gullies in which stock had free access. The geometric mean of loads exported during rainfall events is reported.

cow movements and presence and to compare this to continuously-measured turbidity (NTU) and) triggered autosampling to record Total Suspended Solids (TSS).

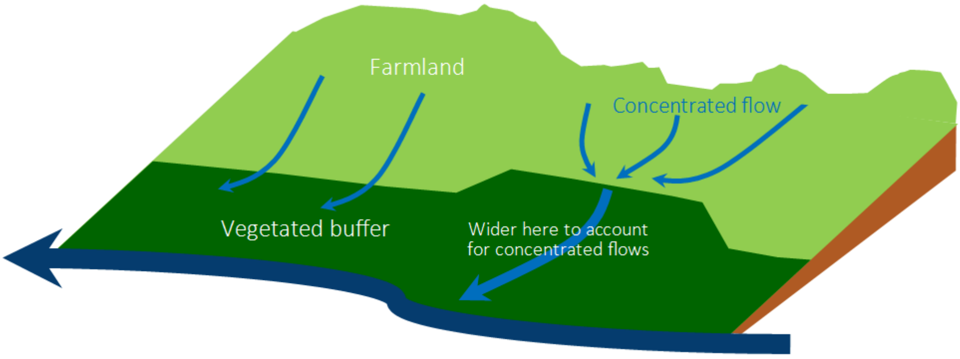

Figure 2: Buffers should be wider where surface and inground flows are concentrated,

What did we find?

Microbial and chemical levels and source-tracking

- Overall, contamination from faecal matter represented a low proportion of the total microbial community in water samples collected in receiving waters.
- The proportional contribution of cattle to the total faecal community in water samples was very low, with wild animals dominating waters across the study area. Notably, it was found that there was a substantial contribution of E. coli from waterbirds.
- Cattle faeces comprised a small proportion of the faecal community, and did not differ significantly between unbuffered and buffered catchments. Under the conditions within the study area, cattle were excluded from riparian paddocks for long periods of time, so a continuously high contribution to the faecal community might not be expected.
- However, buffers do appear to reduce the frequency of cattle material detections in the waterways.
- Source-tracking demonstrated the value of buffer strips, with cattle faecal contributions to E. coli levels being much lower in buffered streams than those that were unbuffered.
- Human wastewater contribution was predicted to represent a substantial proportion of the total faecal community in some catchments with the highest wastewater contribution predicted in buffered catchments. Contributions from wastewater were predicted to increase during dry weather conditions within both small agricultural catchments. The source of this wastewater signature may be seepage to groundwater from septic systems at the catchment margins.

Performance of revegetated gullies for treating rural runoff

- Buffers at the study sites reduced pollutant generation and availability of nitrogen, phosphorus, TSS and E. coli in the riparian zone by approximately 53%, 69%, 76% and 88%, respectively (Fig. 3).
- Cattle activity in the stream channel caused immediate increases in the downstream concentrations of sediment, nutrient and faecal pollutants, as shown in Fig. 3.
- Cattle were found to have a distinct preference for some areas of the stream channel, which may have ramifications for water quality management.
- Buffers can also reduce the contribution of cattle faeces to the microbial community of agricultural streams.
- Stream buffers can achieve an immediate improvement in water quality following the establishment of stock exclusion fencing.
- It is recommended that Melbourne Water review the project benefits assessment metrics used by the RLMP to take into account the results of this study, as presented in Figure 1.

Future direction and Knowledge gaps

Future research in this area includes methods for the monitoring and management of deer in Melbourne Water's water supply catchments. Future work could investigate the design of other water quality improvement practices to improve water quality in

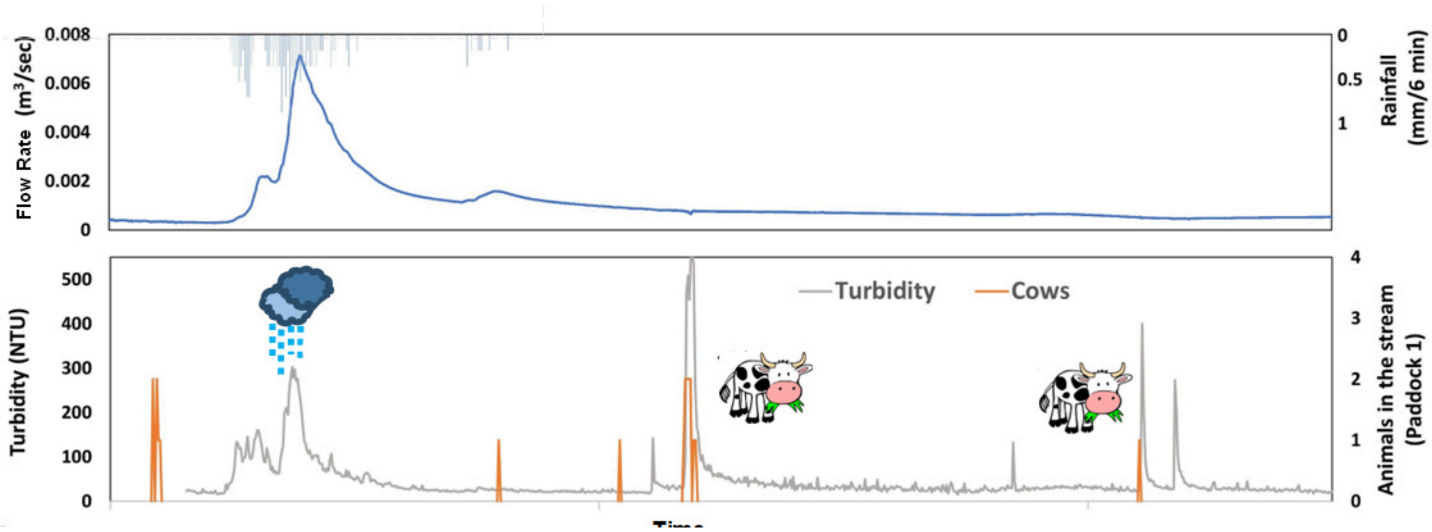

Figure 3: A time series of high-frequency turbidity (grey line), flow rate (blue line), rainfall and a record of cattle access to the stream. Turbidity was found to increase in response to both a rainfall event (as indicated by the rain cloud) and direct stream access by stock animals (indicated by cows).

agricultural catchments.

How are we sharing this information?

- Lim, T. J., Sargent, R., Henry, R., Fletcher, T. D., Coleman, R. A., McCarthy, D. T., & Lintern, A. (2022). Riparian buffers: Disrupting the transport of E. coli from rural catchments to streams. Water Research, 222.
- Research Practice Note 16.2: *Vegetated swales for the treatment of rural runoff*. 2016. Tim Fletcher, Rob James & Hugh Duncan.

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

Rhys Coleman
Waterways & Wetlands Research Manager (Applied Research)
rhys.coleman@melbournewater.com.au

Slobodanka Stojkovic
Knowledge Broker, Waterways & Wetlands Research
slobodanka.stojkovic@melbournewater.com.au