From scouring reeds to cleaning cobbles: adaptive management of environmental water in action

Andrew Sharpe[1], Peter Sandercock[2], Simon Treadwell[1] and Bill Moulden[3]

1. Jacobs, 452 Flinders Street, Melbourne, VIC 3000. Email: mailto:Andrew.Sharpe2@jacobs.com

2. Jacobs, 80A Mitchell Street, Bendigo, VIC 3550

3. Melbourne Water, 990 La Trobe Street, Docklands VIC 3008

Key Points

- Monitoring of environmental flows is needed to revise and improve environmental flow objectives and flow recommendations

Keywords

Coimadai Creek, Environmental Flows, monitoring, sediment, macrophytes

Introduction

In 2012 and 2013, Melbourne Water made several trial flow releases from Merrimu Reservoir into Coimadai Creek. They engaged Jacobs to help monitor the effect of those releases to determine whether they were meeting their intended ecological objectives and the effects predicted by Ecological Associates (2005), who developed the current environmental flow recommendations for Coimadai Creek. This paper describes the results of those trials and describes how the results are being used to manage environmental flows in Coimadai Creek.

Coimadai Creek

Coimadai Creek is a tributary of the Werribee River that flows to the west of Melbourne (see Figure 1). The upper reaches of Coimadai Creek are unregulated, but Merrimu Reservoir, which was built in the middle of the catchment between 1969 and 1986, controls flow in the reach between Merrimu and Melton Reservoir. Prior to the construction of Merrimu Reservoir, Coimadai Creek had an ephemeral flow regime that was punctuated by infrequent high magnitude flow events. The reservoir has effectively eliminated all large flows in the downstream reaches. The first few kilometers of river channel downstream of Merrimu Reservoir is permanently wet due to a constant leak that is needed to maintain the structural integrity of the dam wall. Common Reed *Phragmites australis* and Cumbungi *Typha spp.* have formed dense stands that now choke much of the channel in this permanently wet section. Further downstream, the stream is ephemeral, but still lacks large flow events. Woody shrubs such as Woolly Tea Tree *Leptospermum lanigerum*, River Tea Tree *L. obovatum*, and River Bottlebrush *Callistemon sieberi* have encroached into the channel. Much of the streambed is frequently smothered with fine sediment and mats of filamentous algae, which can reduce the quality, quantity and diversity of food and habitat for macroinvertebrates and other aquatic biota (see Gregory 1983; Lamberti 1996; Hart *et al.* 2013).

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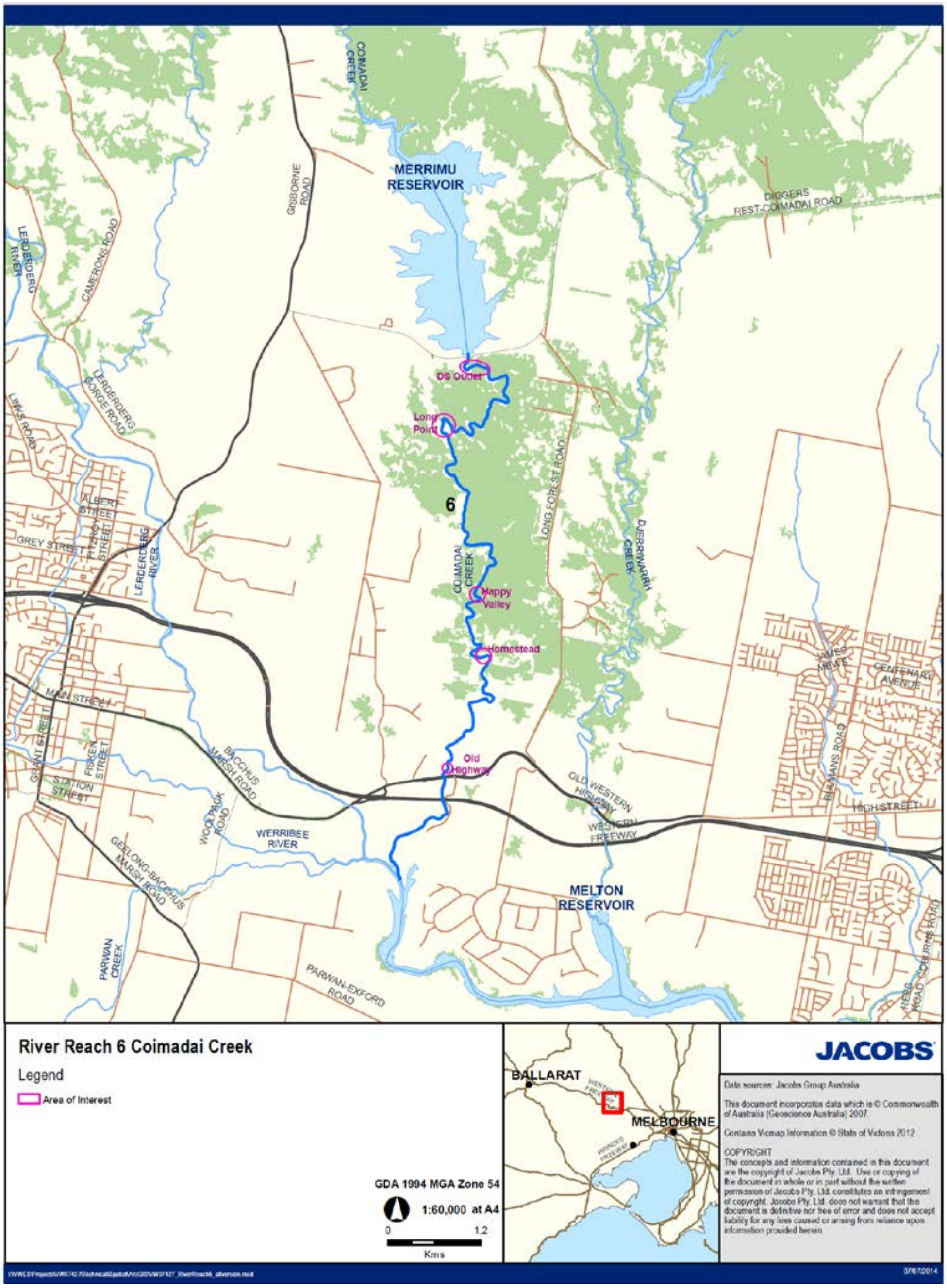

Figure 1: Map of Coimadai Creek showing monitoring sites.

Current environmental flow recommendations and predictions

Ecological Associates (2005) used the FLOWS method (DNRE 2002) to recommend an environmental flow regime for Coimadai Creek that would aim to remove much of the established in-channel vegetation and restore many of the environmental values that have been lost since the construction of Merrimu Reservoir. Their specific recommendations included overbank flows to disturb shrubby vegetation, bankfull flows to maintain channel dimensions, large freshes to disturb macrophytes in the channel, small freshes to flush sand and silt from the streambed and no flow in summer and autumn to allow the channel to dry (see Table 1). Bankfull and overbank flows cannot be delivered in Coimadai Creek and have not occurred since Merrimu Reservoir was completed. The most recent flow event that was large enough to disturb instream habitats was in November 1995, when approximately 7,000 ML was released over 12 days to mitigate flood risk and maintain the integrity of the dam spillway. Since then, the only flows in Coimadai Creek downstream of

Merrimu Reservoir have been small releases (generally less than 10 ML/day) from the reservoir and local catchment runoff. Larger transfer flows of around 100 ML/day are sometimes made through Coimadai Creek to top up water levels in Melton Reservoir to meet downstream irrigation demand. Such transfers are rare and haven't been made since 1997. The environmental flow trials in 2012 and 2013 were some of the largest flows in Coimadai Creek for more than a decade (see Figure 2).

The 2012 and 2013 flow trials had slightly different objectives. The 2012 trial aimed to determine whether the recommended large freshes of 93 ML/day were sufficient to disturb established macrophytes including *Phragmites* and *Typha*. The 2013 trial aimed to determine the flow required to clean biofilms, sediment and filamentous algae from the streambed in relatively open riffle and run habitats. The methods and results for each trial are discussed separately below.

Table 1: Existing environmental flow recommendations for Coimadai Creek including rationale. (reproduced and modified from Ecological Associates 2005).

Flow					Rationale
Season	Component	Magnitude	Frequency	Duration	
Dec-Feb	Cease-to-flow	0 ML/day	annual	1 month or natural	Curtail growth of emergent macrophytes
Mar-Jun	Cease-to-flow	0 ML/day	annual	1 month or natural	Curtail growth of emergent macrophytes
Dec-Jun	Fresh	5 ML/day	≥ 4 per year	3 days	Maintain pool habitat
Jul-Dec	Low flow	0.5 ML/day	Not in dry years	Commence after first winter runoff event	Maintain pool habitat
Jul-Nov	Small Fresh	10 ML/day	Up to 10 per year	5 days	Promote growth of aquatic vegetation Allow Pygmy Perch to access habitat Mobilise silt from pools and sand from riffles
Jul-Nov	Large fresh	93 ML/day	2 per year	2 days	Disturb macrophytes from riffle/run habitats
Anytime	Bankfull flow	1900 ML/day	1 in 5 years	1 day	Maintain channel dimensions Disturb macrophytes from all habitats (note – expect to achieve with flows greater than 217 ML/day).
Anytime	Overbank Flow	3000 ML/day	1 in 10 years	1 day	Disturb shrubby vegetation

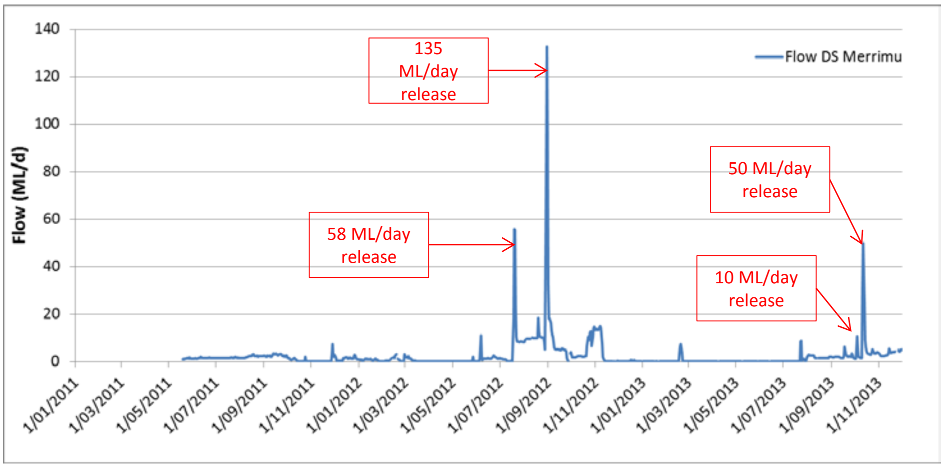

Figure 2: Hydrograph from Gauge 231223 showing flow in Coimadai Creek downstream of Merrimu Reservoir from May 2011 to December 2013. Trial flow releases are highlighted.

2012 flow trials

Methods used in 2012 trial

Melbourne Water made two high flow releases in July and August 2012 to try and disturb some of the established macrophytes and mobilise sand and fine gravel on the streambed. Based on the 2005 environmental flows assessment, we predicted that flows greater than 93 ML/day would be sufficient to disturb macrophytes from riffle and run habitats and flows greater than 217 ML/day would disturb macrophytes from all habitats. The first flow peaked at 58 ML/day for two days on 17-18 July 2012, and the second flow peaked at 135 ML/day for three days between 27-29 August 2012 (see Figure 2). It was not practical to make larger releases with the existing infrastructure. A constant flow of 10 ML/day was released during the intervening period, which we predicted would be sufficient to clean silt and fine sand from the streambed.

We took photographs from fixed photo points on 12 July 2012 (prior to the 58 ML/day flow release), on 25 July 2012 (between the two flow releases) and on 25 September 2012 (after the 135 ML/day flow release) to determine whether the two flow releases caused gross changes to the distribution and cover of established macrophytes or changed the amount of sediment and organic material on the streambed. We established macrophyte monitoring photo points on the bank at five sites from the Merrimu Reservoir Dam Wall to the Western Highway; a distance of approximately 9 km (see Figure 1). The number of fixed photo points at each site varied between two and five depending on the number of different habitats present. We also established two fixed 0.5 x 0.5 m quadrat locations on the streambed at Long Point and three fixed quadrat locations at Happy Valley to monitor changes in sediment cover. Quadrat photographs were not taken at the other three sites because they had limited areas of open water with cobble substrates.

We used qualitative rather than quantitative sampling methods because the trial is preliminary and Melbourne Water wants to determine whether the flow releases have had a marked effect. Those marked effects can be readily determined at low cost using repeat photographs.

Results and discussion of 2012 trial

The high flow releases in July and August 2012 did not result in any broad scale changes in the morphology and distribution of channel forms and associated vegetation. The response of the channel and vegetation did however vary across the five monitoring sites.

Little change was evident in the reach immediately downstream of the reservoir, which had the greatest density of in-channel vegetation. The flow releases (particularly the higher flow of 135 ML/day) flattened some macrophytes (see Figure 3), but they did not have any lasting effect and the stems 'stood up' again within a few weeks.

Further downstream where the channel was more open the two flows scoured algae and fine sediment from the streambed and removed some *Triglochin* sp., but again failed to disturb established reeds. The 135 ML/day flow also turned over gravels and flushed accumulated leaf litter from gravel bars beside the stream.

The released flows were close to the maximum that can be released from Merrimu Reservoir with the existing environmental water entitlement and based on the results of the 2012 monitoring we concluded that it would not be possible to use environmental flows to remove established macrophytes and reed beds in Coimadai Creek. The flows that were released, were sufficient to flush substrates and modify habitat conditions in open riffle and pool habitats that were not choked with vegetation.

Figure 3: Photographs showing reed beds before (left) and after (right) 135 ML/day flow release. Reed beds were temporarily flattened, but stood up again after several weeks.

2013 flow trials

Methods used in 2013 trial

Melbourne Water made two lower flow releases in 2013 to determine the flow magnitude required to clean substrates in open riffle and run habitats to improve conditions for macroinvertebrates. The first release of 10 ML/day commenced on 3rd October and followed a period of more than two months where flow was consistently less than 4 ML/day (see Figure 2). The second release of 50 ML/day commenced on 11th October and lasted for two days. Flows then dropped to around 2-4 ML/day for the next seven weeks (see Figure 2).

We qualitatively assessed the effect of these two flow releases by taking repeat photographs at fixed 0.5x0.5 m quadrats at the Happy Valley Site. For this trial we established six quadrats two rows across the width of the channel in three riffle/run habitats (see Figure 4) to compare differences in sediment scour in different habitats and between the middle and edge of the channel. We only assessed responses at the Happy Valley site because it had the most diverse range of cobble riffle and run habitats and deep pools. We photographed the streambed in each quadrat on 26 September 2013 (before the 10 ML/day flow release), 4 October (between the 10 ML/day and 50 ML/day release), 14 October 2013 (immediately after the 50 ML/day release) and 25 November 2013 (six weeks after the 50 ML/day release).

Results and discussion of 2013 trial

Prior to the first flow release the cobbles were coated in a thin film of fine sediment and biofilms. Some filamentous algae were also present (see Figure 5). The flow release of 10 ML/day slightly reduced the amount of sediment and algae on some cobbles in the fastest flowing parts of the channel, but had little effect elsewhere. The second flow release of 50 ML/day, cleared fine sediment and filamentous algae from the substrate across most of the channel (see Figure 5). After six weeks of flow less than 4 ML/day the substrates that had been cleaned by the 50 ML/day flow were heavily coated with filamentous algae, biofilms and fine sediment (see Figure 5).

From these results we conclude that biofilm and filamentous algae develop quickly during low flow conditions in warm months, but are not very prolific under similar flow conditions in cooler months. Flows of 40-50 ML/day are likely to be competent to scour filamentous algae, biofilms and fine sediment from the substrate surface across the whole channel and may be needed every 1-2 months during spring and summer low flow periods to clean the substrates and maintain habitat quality for macroinvertebrates.

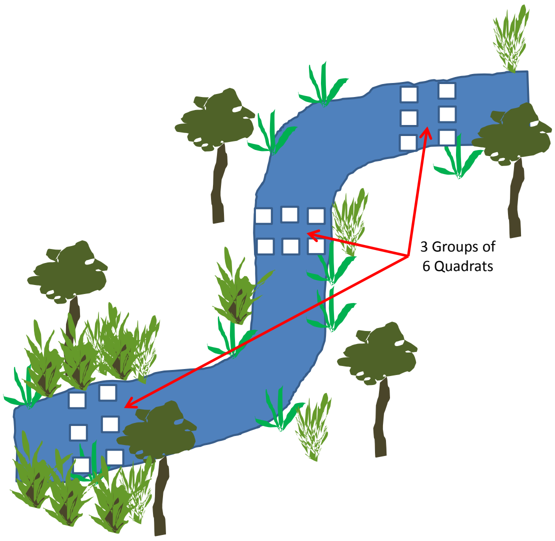

Figure 4: Schematic view of Happy Valley site showing layout of substrate quadrats across the width of the channel in three riffle/run habitats.

26 September 2013 Prior to flow release	4 October 2013 After 10 ML/day flow	14 October 2013 After 50 ML/day flow	25 November 2013 6 weeks after 50 ML/day flow

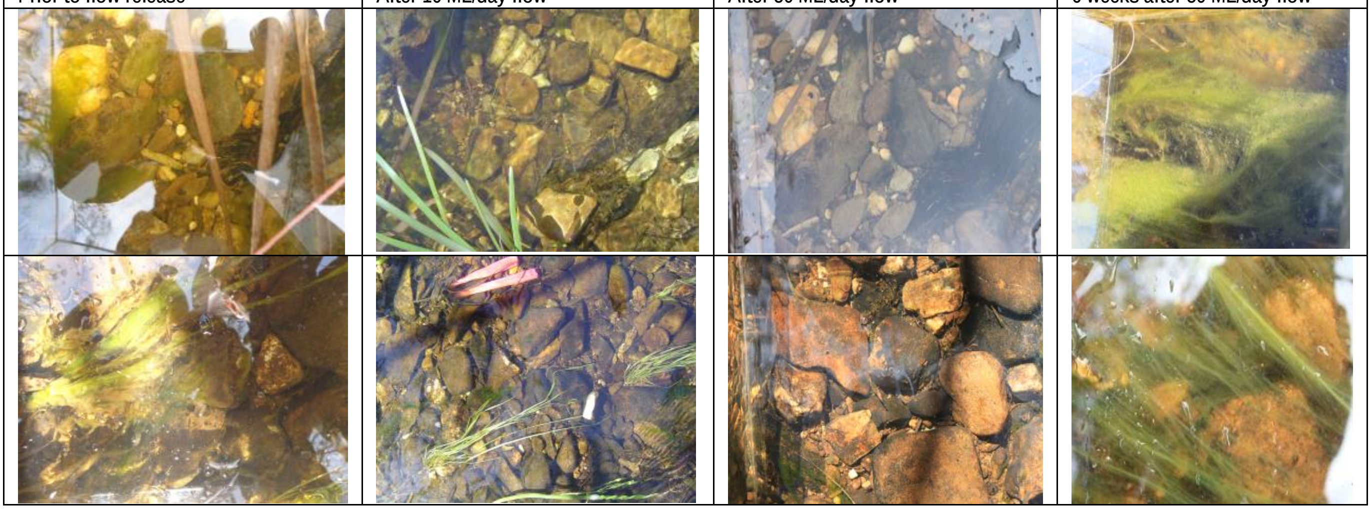

Figure 5: Repeat photographs cobble substrates before and after 10 Ml/day and 50 ML/day flow releases.

Conclusions

Our trial flow releases and associated monitoring has demonstrated that the current environmental flow objectives of removing established vegetation cannot be met because the largest flows that can be released from Merrimu Reservoir are too small. We expect that regular bankfull and overbank flows, such as still occur in the unregulated reach upstream of Merrimu Reservoir will be needed to reduce or remove established vegetation. Regular floods will not occur in the reach downstream of Merrimu Reservoir and therefore new environmental flow objectives are needed.

Melbourne Water is currently revising the environmental flow recommendations for several reaches in the Werribee River including Coimadai Creek. The updated flow recommendations will focus on preventing excessive accumulation of filamentous algae and fine sediment in open riffle and run habitats to provide suitable conditions for macroinvertebrates, providing enough flow to maintain permanent refuge pools throughout summer and providing sufficiently high flows to promote diverse riparian vegetation on benches and bars near the channel and to periodically flush leaf litter and other material from those benches. To achieve these outcomes, it will be necessary to deliver flows of approximately 130-140 ML/day at least once or twice a year in winter or early spring and several freshes around 40-50 ML/day from late spring to early summer when biofilm production and algal growth rates are high.

Acknowledgments

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