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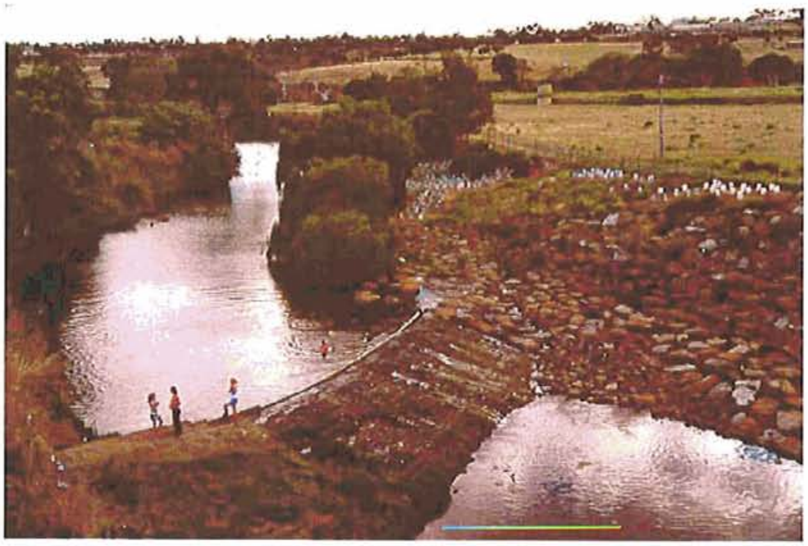
Geomorphology of the Maribyrnong River, Victoria



A report prepared for

Melbourne Water

By

Fluvial Systems Pty Ltd

ABN 71 085 579 095

July 2000

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Arundel Street Weir with recently installed fishway (C. Gippel, 1999).

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Executive summary

Introduction

Fluvial Systems Pty Ltd was commissioned by Melbourne Water to undertake a study of the fluvial geomorphology of the Maribyrnong River and to report on options for future management. This study is part of Melbourne Water's approach top strategic planning for the management of streams in Port Phillip and Western Port catchments.

In 1989 Melbourne Water commissioned Camp Scott Furphy Pty Ltd to undertake an assessment of the erosion occurring along the floodplain reach near Keilor. This study identified high priority sites between Arundel Weir and the Calder Freeway, which were subsequently stabilised. The purpose of the current study is to review this work in the context of current geomorphic processes, and make appropriate recommendations regarding management of the river, principally in the area from the Trestle Bridge to the junction of Jacksons and Deep Creeks.

Hydraulics and stream power

The mean stream power of the river varied spatially, and as a function of discharge. The channel mean stream power exceeded 50 Wm^{-2} over about half of the reach length for the 1:2 yr ARI flood event. The stream power did not increase very much beyond that experienced for the 1:5 yr ARI event, because higher discharges spilled onto the floodplain. However, these floods produced high stream powers exceeding 100 Wm^{-2} at a few locations.

The Maribyrnong River varies considerably in cross-section size and shape, and slope, over the study area, and this gives rise to considerable spatial variation in stream power.

Channel geomorphic processes

The Maribyrnong River is an actively eroding stream, and the most severe erosion would be expected on the outside bends of relatively tight meanders in alluvial bank material. Thus it is not surprising that the survey of Camp Scott and Furphy (1990) reported the most severe erosion in these locations. Despite rating many sites as having "severe" erosion, this cannot be interpreted as relating to a particular erosion *rate*. The survey of Camp Scott Furphy (1990) was based entirely on subjective visual inspection, and no erosion rate data were presented. Comparison of 1931 and 1993 aerial photographs revealed bend migration of 10-20 m at three locations only, but photographic distortion made the comparison difficult. There was no strong evidence available to suggest that erosion rates have increased in recent times.

The morphology of the channel was found to be variable throughout the study area, with some sections being more susceptible to erosion because of high stream power, high and steep banks, low width/depth ratio, confinement of floods, and poor riparian vegetation cover. Rock beaching conducted in response to the survey of Camp Scott Furphy (1990) was done at sites showing "severe" erosion, and these sites also had hydraulic and geomorphic characteristics that rendered them more susceptible to erosion. The visual assessment of the channel conducted in mid-1999 as part of this study did not attempt to rate erosion sites. However, the channel had a relatively stable appearance, with even vertical banks showing signs of recent vegetative colonisation, no doubt associated with the recent long period of drought.

The bed of the Maribyrnong River is stable, being controlled by a series of artificial weirs, rock grade control structures and natural rock bars.

The sediment supply, catchment hydrology and channel hydraulics may have altered slightly in historical times. Such subtle changes usually have no significance for channel erosion rates. However, if a small change caused the channel to cross a geomorphic threshold, then rejuvenation (incision, widening, or accelerated rate of bend migration) could occur. This process cannot be modelled with any level of certainty. In high-energy systems like the Maribyrnong River, it is known that poor riparian vegetation cover is conducive to ongoing bank erosion. Removal of the native riparian vegetation cover was probably the biggest single disruption to the geomorphology of the stream system during historical times. The vegetation of the riparian zone is currently more intact than it was in 1931, but much of it is composed of alien or weed species.

There is evidence of a massive slump failure on the left side-slope at chainage 14.8-15.0 km. This failure pre-dates the 1931 aerial photograph. Such failures probably occur during large rainfall and flood events, when high velocity overbank flows erode the saturated soils of the toe of the side-slope or terrace. Although infrequent and difficult to predict, these failures are catastrophic, and likely to occur again in the future.

Review of 1990 erosion study

The erosion survey conducted in 1990 by Camp Scott Furphy (1990) used a subjective visual assessment technique that incorporated non-geomorphic variables such as the perceived cost of stabilisation, or potential loss of assets if the site was not stabilised. However, there is no way of knowing how these factors were incorporated into the operators' judgements, nor how influential they were in determining the final rating. Camp Scott Furphy (1990) did not measure variables that might act as surrogates for erosion, such as channel morphology, or stream power. It is important to note that the erosion severity ratings were in no way connected to actual erosion rates, as such data were unavailable.

Analysis of a sample of 62 cross-sections, from the Trestle Bridge to the junction of Deep and Jacksons Creeks (21.7 km of river, and 43.3 km of bank), revealed that 13% of the banks were rated as having severe erosion. This equates to 5.6 km of severely eroded bank, an estimate that includes left and right banks. Of this total, 2.6 km was located in the Keilor reach from Calder Freeway to Browns Road (4.8 km of river, and 9.7 km of bank).

Not unexpectedly, the majority of sampled sites (64%) that were rated as having severe or moderate erosion were located on concave (outside) bends in alluvial material. Sites that were rated as having severe or moderate erosion that occurred within this type of channel morphology were associated with high bankfull stream power and steep bank angle. Steep bank angle is commonly thought (sometimes incorrectly) to be a good indicator of active bank erosion, and it is one of the indicators used in the Index of Stream Condition. Steep bank angle is a dramatic feature that is likely to make a strong visual impression when undertaking erosion assessments. Stream power at bankfull discharge is known to be a predictor of bank erosion potential, but it cannot be directly visually assessed during a low flow channel survey. It appears that the surveyors were responding to a combination of some artefact of high stream power, and steep bank angle. Bank angle was not this artefact, as bank angle and stream power were not correlated.

The distribution of erosion sites identified by Camp Scott Furphy (1990) was as expected, with most sites located on the outside (erosional) bend of meanders, and the more severely eroded sites being associated with steep bank angles and high stream power. This distribution would be found on any alluvial river, because it is natural for alluvial rivers to erode their banks as part of the meander migration process.

Camp Scott Furphy (1990) recommended stabilisation of the sites rated as severely eroded, even though they produced no data on actual erosion *rates*. Thus, it is possible that sites that were rated "severely eroded", were stable at the time of the survey. Similarly, it is possible that sites rated as having no erosion could have become unstable since the time of the survey. Camp Scott Furphy (1990) did not do a cost-benefit analysis of conducting the proposed bank stabilisation works.

It is difficult to identify active erosion using rapid visual assessment. This technique can identify sites of past erosion, which is probably a reasonable guide to sites of likely future erosion. The biggest problem is that the technique does not provide data on erosion rates, so it is difficult to predict the consequences of future erosion.

The Maribyrnong River is an actively eroding river. However, the rates of bend migration are relatively low by world standards, with only three bends showing measurable migration from a comparison of 1931 and 1993 aerial photographs. Distortion of the images, and poor quality of the earlier images compromised measurement of erosion rates from available photographs, so changes in the order of ± 10 m could not be detected by this method. The Camp Scott Furphy (1990) study recommended channel stability works at several high priority sites. Melbourne Water at a cost of about $1million subsequently undertook a programme of works. Decisions regarding erosion control works are driven partly by geomorphic considerations, but also by concerns about asset protection, and social factors (some of these were subjectively incorporated into the erosion severity rating scheme used in the survey). Thus, while the

Maribyrnong River is not a highly active river by world standards, the decision to conduct the post-survey stability works was justified at the time in terms of local social, economic and physical factors, and was consistent with the dominant Australian stream management paradigm that values absolute (in management time-scales) stability. This conventional paradigm is now falling out of favour in some circles, where it is recognised that a level of channel instability is desirable from an ecological perspective, and that channel stability is difficult and expensive to attain. The stability works done on the Maribyrnong River during the 1990s addressed sites where assets were threatened, and/or where there was an apparent risk of catastrophic channel change.

Ecological considerations

Based on macroinvertebrate community composition, the lowland Maribyrnong River is in relatively good condition for an urban lowland river, certainly relative to the Yarra River, which is severely degraded by the time it reaches its estuary. Relatively undisturbed lowland river communities in urban settings are quite rare. The Maribyrnong River is also one of the few large basaltic plain streams in Victoria. Thus the Maribyrnong is a valuable scientific resource, in addition to its obvious values as a community resource.

The Maribyrnong River is not pristine, but in terms of hydrological modification and water quality impacts, the river is less disturbed than most other large lowland rivers in the Melbourne Water area. The condition of the riparian vegetation appears to be better now than it was in the 1930s. Because the biotic communities of the Maribyrnong River are not severely disturbed, local-scale improvements to habitat and water quality are more likely to have measurable results in community recovery than in severely degraded systems. In severely degraded streams, multiple disturbances acting synergistically are likely to confound the potential success of local-scale restoration efforts.

Three major groups of disturbance have been identified as potential degrading processes to the Maribyrnong River ecosystem: 1) Land uses leading to bank and channel instability, and poor quality runoff in the Keilor floodplain area, 2) High nutrient loads, 3) Freeway runoff and general urban stormwater pollution.

Suggested management priorities

Bank erosion is a problem in two respects: landowners are concerned about loss of productive land, and the entrained sediment enters the fluvial system causing degraded water quality and deposition of sediment on habitats. The impact of bank erosion on substrate habitat quality is probably minor, as the macroinvertebrate community is in a fairly healthy condition despite bank erosion being a characteristic of this river for many years.

Water quality records suggest that the Maribyrnong River does not export an exceptionally high load of suspended sediment compared with some other rivers in the Melbourne Water area. Continued bank stabilisation works may be justifiable in terms of protection of private land or assets, but this can only be established through a cost-benefit analysis.

The weight of evidence gathered during the course of this study points to the conclusion that a large investment in further bank stabilisation works would represent poor value for money in terms of expected waterway health benefits.

The small weirs located on the river were constructed to create pools that were once used for pumping irrigation water in dry periods. It is recommended that Melbourne Water negotiate with landholders to repair or remove these weirs where necessary. This process will ensure that fish passage is maintained. Disused weirs do not require any treatment. The weirs help to stabilise the bed, but Milburns, Koroneos and McNabs Weirs may interfere with fish passage. Reconstruction of these weirs is recommended. The grade control structures appeared to be in good condition and do not require attention at this time.

The riparian vegetation is in poor to very poor condition in the areas that are used for intensive agriculture. Landholders have historically shown a reluctance to support re-establishment of the riparian zone. It is recommended that Melbourne Water continue to work with landholders to improve riparian vegetation, as this will bring environmental benefits, and should improve bank stability. The margins of the side-slopes and terraces (sometimes distant from the