Full Paper

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Maribyrnong River Erosion Control Project – Floating Boom Trial

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Key Points

- Bank protection project trialing an innovative solution to control erosion
- The use of a floating boom to promote vegetation establishment
- 38,000 nursery grown semi-aquatic species planted behind boom
- If successful, the floating boom can be reused at other locations for erosion protection

Abstract

Traditional 'hard' engineering solutions to address channel stability are no longer the preferred option in contemporary waterway management. Where public assets are threatened and intervention is required 'soft' solutions including the establishment of vegetation to provide long-term stability and habitat can be a more cost-effective use of public funds that provides multiple benefits. However, in urban catchments, limited available space can make vegetation establishment, particularly on steep banks, difficult to achieve. In recognition of this issue, Melbourne Water has commenced a bank protection project trialling an innovative solution to stabilise a sheer, eroding bank of the Maribyrnong River in Melbourne's west.

The erosion of the bank in question is threatening a Parks Victoria owned pathway located less than 1m from the top of bank. A lack of riparian and aquatic vegetation means that the bank is vulnerable to erosive forces exerted by fluvial, tidal and wave action. To mitigate these forces this project uses a floating boom to promote sediment accretion and the establishment of riparian and semi-aquatic vegetation. Critical to the success of this approach is the fast establishment and colonisation of semi-aquatic vegetation. To facilitate this, 38,000 nursery grown emergent semi-aquatic species (macrophytes) are being installed to the river bench behind the boom. The floating boom methodology has not been used by Melbourne Water previously.

Keywords

Erosion, asset protection, floating boom, innovation, semi-aquatic vegetation, vegetation establishment

Introduction

Melbourne Water is trialing an innovative solution to stabilise a sheer, eroding bank of the Maribyrnong River in Melbourne's west at Avondale Heights. The left bank of the River is experiencing on-going erosion for an approximately 840m length, with bank retreat threatening a popular Parks Victoria owned public pathway.

Over the last eight years three projects have aimed to reduce the erosion by establishing riparian vegetation. Although plantings on the upper bank have established, efforts to establish semi-aquatic vegetation along the toe of the bank have largely failed. Due to the continual undercutting of the bank the previously planted trees and shrubs are now toppling into the waterway.

Alluvium Consulting was engaged to identify both the active erosion processes and potential alternative vegetation stabilisation techniques for the site.

Figure 1. Maribyrnong River, Avondale Heights –location of subject reach

The Issues

The Maribyrnong River is estuarine at the subject reach. It is tidally affected and therefore subject to bi-directional flow associated with rising and ebbing tides, as well as regular fluctuations in water level. The higher salinity of the water also limits the range of aquatic and riparian species able to be established.

Geotechnical conditions

A geotechnical investigation identified weak alluvial soils forming the bed and bank. Further, that the soils on the embankment will have limited capacity to support heavy loads.

Erosion mechanisms

The left bank of the Maribyrnong River is sheer, and has been eroding over a long period of time. Active erosion is occurring for approximately 840m.

The bank is actively retreating in the study reach, with isolated pockets of retreat observed throughout the reach (refer Figure 2). Tension cracks were observed at several locations, indicating mass failure of the steep bank is a primary cause of bank erosion and retreat.

It was determined that the principal erosion mechanisms were (i) cracking associated with wetting/drying and (ii) undercutting from wave action.

Figure 2. Example of mass failure and bank retreat at subject reach

Sources of erosion

Erosion has resulted mainly from

- Fluvial action (erosion during higher flow events);
- Tidal action (wetting and drying during tidal cycles);
- Anthropogenic action;

- Boat wash; and
- Human and domestic dog impacts in accessing the water via the bank.

Traditional Responses

Historically, there has been an emphasis on hard engineering solutions to protect and armour river banks and provide hydraulic capacity and flood protection. The lower Maribyrnong River is evidence of this, it has been extensively modified over the last century through straightening, widening, filling, deepening and rock beaching. Both banks of the lower 9km of the river from Footscray Road to immediately south of the subject reach have been continuously rock lined.

In recent decades a fundamental shift has occurred in the way waterway management agencies have approached erosion and the management of hydraulic capacity. Where possible, Melbourne Water now has a preference for 'soft' vegetative solutions to stabilize eroding banks and provide greater habitat and amenity outcomes (Healthy Waterways Strategy 2013).

Proposed Strategy

A number of approaches were considered to address the erosion at the subject reach. Doing nothing and allowing the bank to retreat was not considered an option due to the threat to the well-used public pathway. Continuing the traditional approach of rock armoring was also not preferred at this site as the bank is predominantly natural and the project is located in the lower Maribyrnong Valley Public Parklands, a reserve which is highly valued by the community as a place to recreate and connect to nature.

Timber pile fields

Timber pile fields are a common approach to achieve bank stabilisation in rivers that are experiencing bank erosion due to fluvial processes. The pile fields are installed perpendicular to the flow providing resistance to flow and deflecting the faster flow towards the middle of the waterway. The reduction in flow velocity at the pile field allows sediment to be deposited along the bank, thereby reversing the erosion trend, and facilitating vegetation establishment.

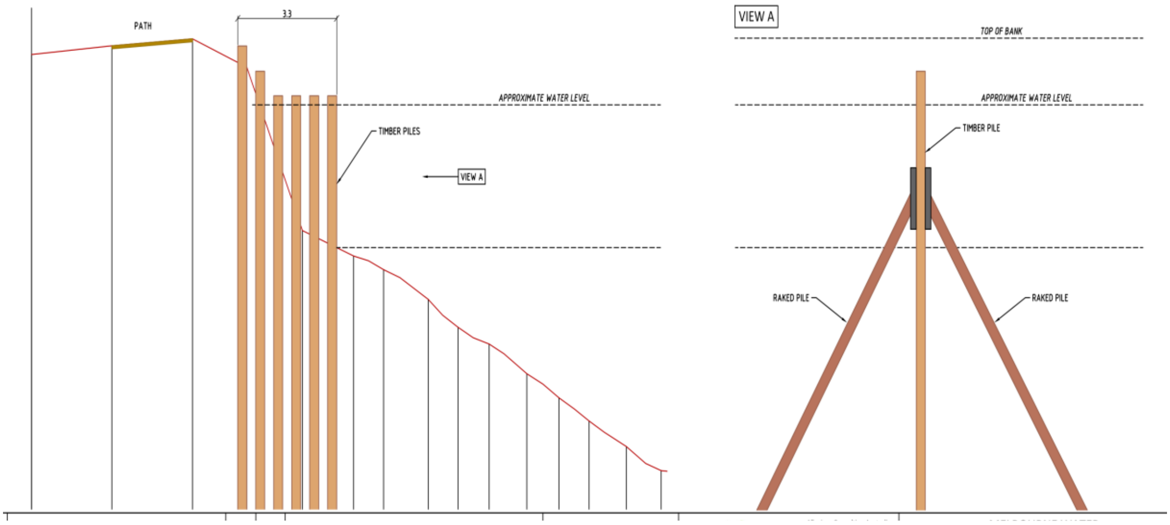

Figure 3. Example of a pile field design

This approach was not favoured for this project because:

- The sediment supply is generally low, except during flood events in the Maribyrnong River. Therefore, the rate of accumulation of sediment by the pile fields may not be sufficient to offset the on-going erosion.

- The weak alluvial soils mean pile fields would not be feasible to establish. Raking piles would likely be required to support the piles in place. This would result in a complex and costly installation.

Floating wetlands

Floating wetlands have previously been used for water quality treatment in lakes, ponds, and wetlands. However, they also have potential at this site for the purpose of bank protection.

They are made up of a multi-layered low density base that floats on the water surface. Plants are introduced to the upper part of the base with their roots growing down through the base and into the water column.

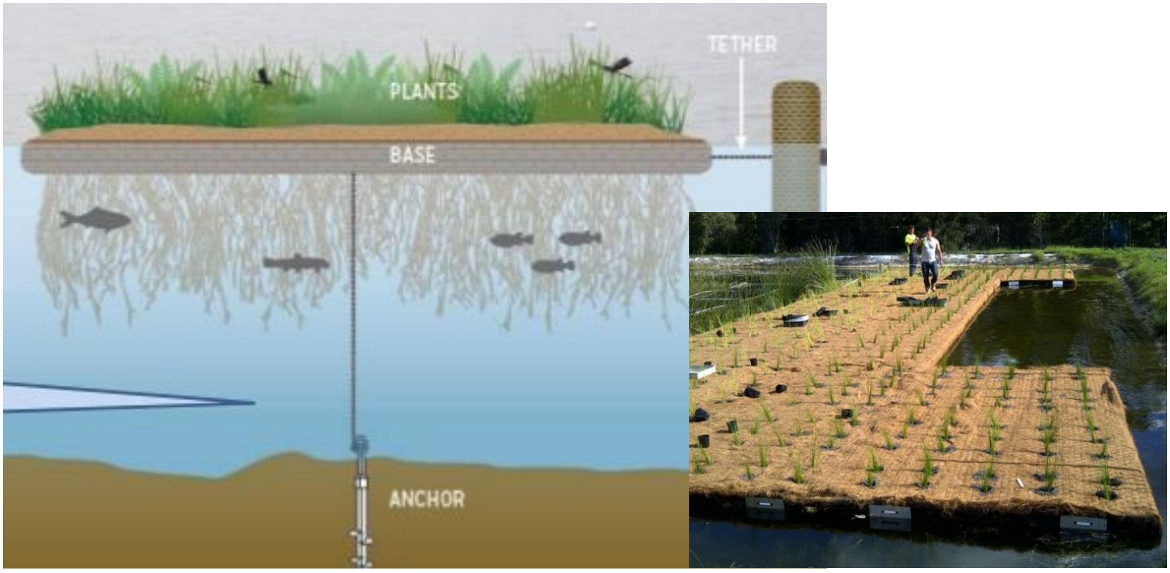

Figure 4. Example of a floating wetland design

The floating wetlands would be tethered to the bed of the River, near the bank. At normal and low water levels, the wetland is able to have move towards, or away, from the bank to the extent of the tether cable. Similarly, it could move upstream or downstream in response to flows and tidal movements. The floating wetlands can be installed from a barge on the River, without any need for machinery on the weak soils of the bank or pedestrian path.

The suite of vegetation selected for growing on the wetlands need to be chosen to suit the conditions, especially regarding the estuarine water quality. Bank vegetation would be installed next to the bank (behind the floating wetlands) which would ultimately merge with the floating wetlands, and provide long-term protection.

Advantages

- They accommodate the changing river levels;
- The wetlands and the tethering system encourages sediment deposition;
- It will be somewhat effective at mitigating boat wake;
- Aesthetically favourable treatment; and
- Modules can be launched from the bank and manoeuvred into position with a vessel on the River.

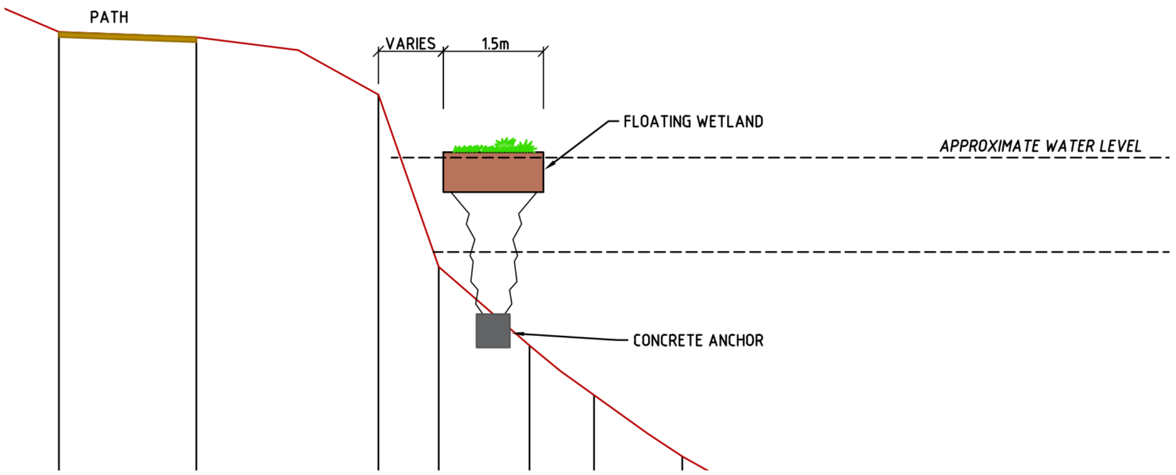

Figure 5. Example of floating wetland design

Concerns

- To reduce the potential cross flow currents, eddies and waves from boat wash an open mesh skirt would need to be installed on the underside of the base. This can be complex to achieve and potentially destabilising for the floating wetland.
- Floating wetlands may also represent a hazard where a person or animal try to access the wetland from the bank.

The potential safety hazard and cost meant that this was not the favoured approach for this project.

Floating boom

This option is similar to that of the floating wetlands, except that it uses a pipe boom instead of the wetland. The boom is laid out parallel to the bank and anchored to the bed with a slack tether cable. It has a geotextile skirt attached to it that is weighted to hang vertically in the water column.

The floating boom provides an isolated area of less turbulent water near the bank where vegetation can be established. Semi-aquatic vegetation is placed against the bank, behind the boom. The vegetation should quickly establish roots in the soft alluvial materials at the base of the embankment.

Advantages

- Accommodates the changing river levels.
- The boom and skirt help to mitigate impact on the bank from waves from boat wake.
- Once established the bank vegetation is a permanent solution that is a good aesthetic and ecological outcome (e.g. provides fish foraging habitat).
- The established vegetation helps to accumulate sediment through increasing bank roughness.
- The floating booms can be removed once vegetation is successfully established. They may then be deployed elsewhere. In this way the reach in question could be undertaken in stages reusing the same boom components.
- The floating booms can be launched from the bank and manoeuvred into position with a vessel on the River.

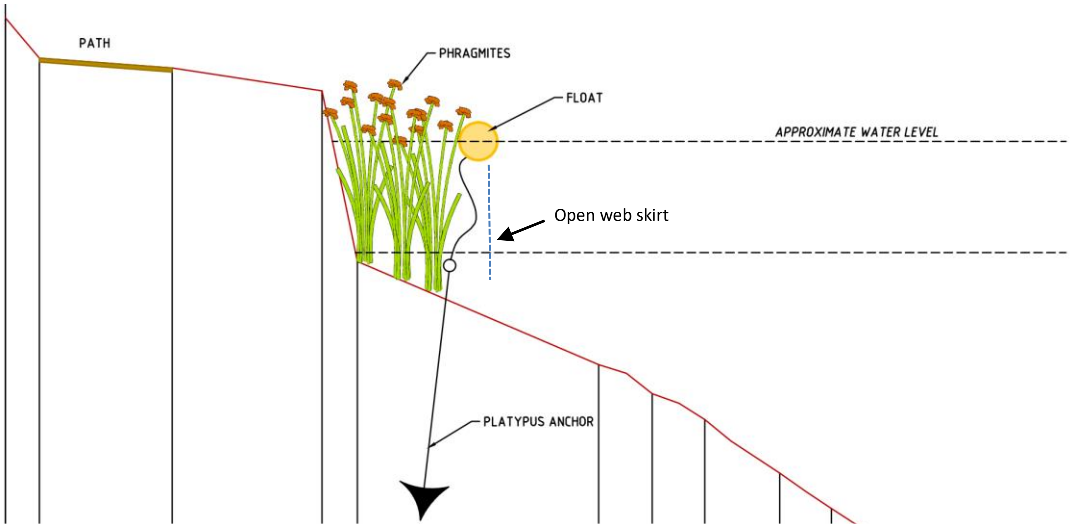

Figure 6. Floating boom cross-section

Concerns

- Designing the anchorage system in the soft alluvial soils; and
- Sourcing and/or propagating viable semi-aquatic species and installing them successfully against the bank.

The floating boom approach was favoured for this project as it provides a flexible, comparatively low cost method of stabilising the bank utilising vegetation. As this approach has not been utilised by Melbourne Water previously, only 420m of the bank will be treated as part of this project (stage one). This significantly lowers the capital cost of the project and enables it to act as a trial. Should the project be successful, the remaining 420m stretch will also be treated (stage two).

Design Challenges

Fluctuating River levels

The floating boom is a sealed HDPE pipe, made up of 6 metre lengths with hinged joints, aligned adjacent to the left bank. It is anchored to the river bed via a tether allowing it to move up and down with the water level in the river.

This means that the lateral position of the boom is not fixed. It will be vertically above the anchor point when the water level is high enough to put the tether into tension, but can move laterally at lower water levels due to slackness in the tether. The risk of the boom moving into the vegetation and tangling or damaging it had to be considered.

Also the anchor and boom system had to be designed for flood events when the boom was held below the surface of the water with high buoyancy forces, in addition to the fluvial loads.

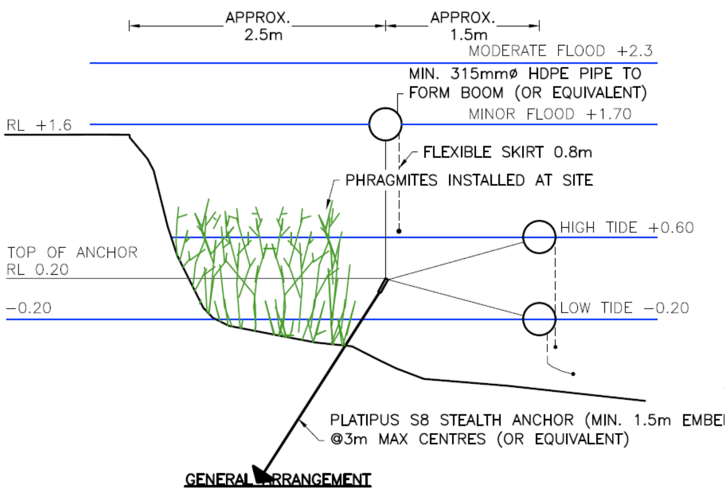

Figure 7. Floating boom general arrangement

Anchor design

The anchors needed to be simple to install underwater, but be able to sustain the maximum uplift forces in the weak alluvial soils. We elected to use a platipus anchor system that has been developed for this type of application. The anchors needed to be installed at 3 metre intervals to ensure the load capacity was not exceeded while maintaining an adequate factor of safety.

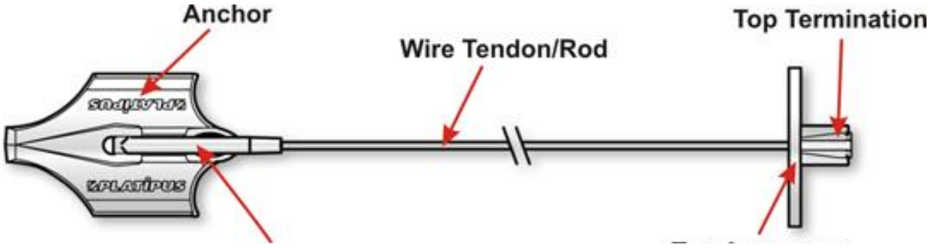

Figure 8. Platipus anchor design

There is a risk with these types of systems that if one anchor fails the load is shed onto the next anchor which may them be overloaded and fail itself, leading to a cascade failure of the whole system. This is addressed by using a large safety factor of greater than 2, but also by installing large concrete mass anchor blocks in the bank at each end of the floating boom. These blocks are designed to resist the total drag from the whole length of the pipe. Thus, in the case where all the platipus anchors fail, the system cannot be carried away down river.

Flexible skirt

Each floating boom segment is fitted with a flexible skirt, 0.8m long. The skirt is a woven geofabric material that has a high tensile strength. It is weighted to hang vertically in the water column, but can lie on the river bed when water levels are low. The weight in the skirt also sets the float height in the water which is set to have about two-thirds of the float above the water level.

Semi-aquatic plants

Plants chosen had to be robust and able to survive estuarine conditions and fluctuating water levels. A limited palette of five semi-aquatic species was selected based on their tolerance to the expected water depth and salinity levels in the river. Refer Table 1 below for species lists and numbers.

In order to prepare the plants for delivery directly to the riverbed the plants were grown as 'slabs' in plastic multipack trays (refer Figure 8 below). The aim was to have the trays filled with dense active roots that would hold together once the tray was removed at planting. Each plant slab was staked into the river bed with a single hardwood stake. A 1.5m gap was maintained between each slab to allow sufficient space for the vegetation to expand and colonise the site.

To reduce the risk of transplant shock the plants were irrigated with brackish water whilst being grown in the nursery. The salt content in the water was adjusted to produce a similar electrical conductivity as that found on the site.

Figure 9: Multipack tray format proposed for seedlings

Table 1: Plant species

Species	Density	Number of multipack trays	Number of plants
Phragmites australis	18 per tray	560	10,080
Juncus krausii		600	10,800
Bolboschoenus caldwellii		300	5,400
Schoenoplectus tabernaemontani		300	5,400
Cladium procerum		400	7,200
Total		**2,160**	**38,880**

Installation challenges

The installation of the floating boom was completed in March 2018. The materials, including the floating boom, brackets, ties and anchors were all made by different contractors. Under the contractual model used for this project the installation contractor was not responsible for procurement or coordination of materials and delivery. This presented logistical challenges and delays due to the coordination of material fabrication and delivery. For future projects utilising the floating boom the supply and installation of the boom and associated materials should be packaged together to be delivered by the installation contractor.

Allowing sufficient time to source sufficient number of the desired species of plants is critical to the success of a project of this nature. The semi-aquatics for this project were ordered in September 2017 and planted in March 2018. As a result, not all of the 38,000 plants were sufficiently established for planting within the desired growing season. Around half of the plants were installed in April, with a second planting scheduled for October 2018.

Conclusions

Using this novel approach for bank stabilisation is expected to result in lower overall cost than other comparable treatments while also providing greater amenity and habitat outcomes than traditional approaches.

A key advantage of this approach is that the same floating boom can then be remobilised allowing the bank stabilisation work to be staged, achieving reduced cost and risk.

This project represents stage one of erosion control works in this reach of the Maribyrnong River. Once the plants have established successfully, it is expected that the floating boom can be moved upstream to facilitate stage two. Any learnings, particularly around plant species selection, growth and establishment can be applied to stage two.

Following the successful completion of the Maribyrnong reach, this approach can be repeated at other locations to address bank stability and asset protection.

References

Melbourne Water, 2013, Healthy Waterways Strategy 2013/14 – 2017/18.