Memo

Subject	Cooks River Waterway Asset Condition Assessment – Foreshore Public Safety Assessment
Project	0621090
Distribution	Claire Wheeler, Cooks River Alliance
Date	26 August 2022

1 Summary

The Cooks River Alliance (CRA) engaged Alluvium Consulting Pty. Ltd. (Alluvium) to assess the current condition of waterway assets in the Cooks River catchment. The assessment supports the development of the Coastal Management Program (CMP) and identifies key future management needs and options. During the assessment, the CRA and representatives from the NSW Department of Planning and Environment (DPE) who co-fund the CMP, found that a portion of waterway assets that are constructed of steel sheet piles are in very poor condition and present an immediate hazard to public safety. The CRA and DPE concluded that the public hazard of the sheet piles should be addressed as a matter of urgency. In response, the CRA requested a modification to Alluvium's scope to perform an urgent assessment of the public safety hazard associated with the sheet pile assets. It should be noted that the management options proposed in this memorandum are temporary solutions intended to reduce the current public safety hazard while more permanent and comprehensive management options are developed as part of the CMP.

The purpose of the study was to characterise and map the public safety hazard resulting from the sheet pile waterway assets and propose immediate measures to address this hazard. The study area includes the reaches of the Cooks River with steel sheet pile bank protection, which includes 1.95 km of the left bank and 2.18 km of the right bank of the river. The assets are located in parts of the Inner West and Canterbury Bankstown Council Local Government Areas (LGAs). The method for assessment of the public safety hazard was a site inspection of the full extent of the sheet pile assets, during which data regarding the condition of the assets, plus other factors contributing to the resulting hazard, such as the presence of physical barriers, were recorded. During this process, the sheet pile assets were delineated into 'reaches' of similar characteristics. The data were then used in a risk assessment calculation, which classified the public safety hazard as either low, medium or high.

The results were that 1.57 km of the shoreline assets are rated as a low public safety hazard, of which 1.20 km is within Canterbury-Bankstown Council and 0.38 km is within Inner West Council. 1.13 km of the shoreline assets are rated as a medium public safety hazard, of which 0.91 km is Canterbury-Bankstown Council and 0.22 km is within Inner West Council. 1.43 km of the shoreline assets are rated as a high public safety hazard, of which 0.61 km is within Canterbury-Bankstown Council and 0.81 km is within Inner West Council.

The study also included a review of potential management options for mitigation of the public safety hazard. On a balance of cost, sustainable material selection, visual appearance, resistance to flood flows and a low chance of blocking flood debris, the assessment recommends the installation of a timber fence to exclude the public from the sheet pile edges. The estimated cost to install fencing along the high hazard reaches is $93,000, and to install it along the medium hazard reaches would be another $73,000. The distribution of these between the Councils is as follows:

- Canterbury-Bankstown Council: High hazard reaches = $40,000, medium hazard reaches = $59,000.
- Inner West Council: High hazard reaches = $53,000, medium hazard reaches = $14,000.

This memorandum documents the method of assessment, the hazard classification results and presents a series of management options. Also included is a map of the assets, classified by the calculated hazard (Figure 6).

2 Method

The study was conducted through a four-step process as described in the following sections.

2.1 Step 1: Desktop assessment

A preliminary desktop analysis of the study area was performed based on the Cooks River Draft Waterway Asset Database, as provided by the CRA in September 2021. The mapping indicated where the project team should expect to find the sheet pile assets and along with an inspection of aerial imagery gave an initial understanding of the adjacent land use. Maps of the study area were prepared and used to record data during the field assessment.

2.2 Step 2: Field assessment

On the 8th of June 2022, Oliver Light (Alluvium) and Katherin Angelin (Alluvium) conducted a field assessment of the sheet pile shoreline identified in the Draft Waterway Asset Database. The sheet pile was assessed from the top of the bank. It is important to note that the assessment focused solely on the public safety hazard associated with the exposed edge of the sheet pile and land subsidence occurring immediately landward of the sheet pile edges. The scope of the assessment did not include a comprehensive structural assessment of the sheet pile assets.

The shoreline was delineated into reaches during the field assessment. The term 'reach' has been used to describe a length of shoreline asset with similar characteristics. A total of 41 reaches were delineated across both banks of the river.

The extent and condition of each reach were recorded using GPS and georeferenced photos. The following observations were recorded:

- The drop height from the edge of the sheet piles to the bank
- The exposed height of the sheet piles
- The distance from the walkway to the sheet pile assets
- The type and extent of vegetation on the channel banks, i.e seaward of the sheet piling
- The type and extent of vegetation in the riparian zone, i.e. landward of the sheet piling
- The condition of the top of the sheet piles
- The presence and extent of sinkholes near sheet pile assets
- The presence, type, and condition of existing barriers such as fences excluding people from the sheet pile edges.

The exposed sheet pile condition ranged from poor to moderate. The extent of sheet piling didn't exactly match that of the earlier mapping, with several reaches mapped as sheet piling found to be a natural bank, and vice versa. The full extent of the shoreline between the most upstream and downstream mapped sheet pile was assessed.

A range of conditions relating to the likelihood of public safety hazard attributed to the sheet pile was observed. The most critical element in the assessment appeared to be the presence of formal or informal barriers discouraging the public from accessing the sheet pile edges. The results are presented in more detail in the following sections.

2.3 Step 3: Public safety hazard assessment

The next task in the study was to develop and perform an assessment of the public safety hazard associated with the sheet pile edges. A hazard assessment method using a high-level Multi-Criteria Analysis (MCA) was developed to process the data collected during the field assessment. The purpose of the MCA was to categorise the public safety hazard of each reach, which would later be used to recommend where immediate works should be implemented to address the hazard.

Weightings are applied to the score of each criterion, as some criteria are deemed to be a greater contributor to public safety hazard than others. Each criterion was assigned a weighting from 1 to 5 based on the perceived relevance of that criterion to the assessment of public safety. It should be noted that the assignment of weightings also considered the range of scores that were assigned within each criterion, and the impact they have on results. For example, some criteria had scores from zero to two, while others had scores from zero to seven, and the weightings assigned took this into account.

Table 1 presents the categories used in the MCA, along with the weightings applied to each. Where a score fell on the margin between two categories, the more conservative value was selected.

Table 1. MCA categories

Criterion	Description	Category/score	Weighting
Drop height	Height from the top edge of the sheet piles to the current toe	(1) 0.5 - 1m (2) 1 - 1.5m (3) 1.5m - 2m (4) >2m	1
Exposed height	Height of the sheet piles that are exposed	(1) <0.05m (2) 0.05-0.1m (3) 0.1-0.2m (4) 0.2-0.3m (5) >0.3m	3
Distance to walkway	Distance from the walkway to the sheet pile assets	(0) No walkway (1) >10m (2) 7-10m (3) 5-7m (4) 3-5m (5) 2-3m (6) 1-2m (7) <1m	3
Riparian vegetation	The type and density of vegetation within riparian zones.	(1) Heavy trees (2) Light trees (3) Grass	3
Instream vegetation	The type and density of vegetation on the banks.	(1) Thick mangroves (2) Sparse mangroves (3) None	2
Pile top conditions	Conditions of the top of the sheet piles. Whether they are corroded, jagged, breaking apart, etc.	(1) Very good (2) Good (3) Moderate (4) Bad (5) Very bad	1
Sinkholes	The location of sinkholes relative to sheet pile assets. Major and minor sinkholes are determined by the depth and width of the sinkholes, as well as the number of sinkholes near the sheet pile assets.	(0) No sinkholes (1) Minor sinkholes (2) Major sinkholes	2
Existing barrier	The presence, type, and condition of existing barriers	(0) Good condition (1) Bad condition (2) No barrier	5

The results presented a distribution of weighted scores for each reach, as shown in Figure 1. This distribution allowed for an initial delineation of three categories, as shown in Figure 1. The MCA results were individually reviewed. Following the review, some modifications were made to the reach category scores to represent the hazard to public safety more accurately (Figure 2), as determined by our professional judgement and through discussions with the CRA and DPE.

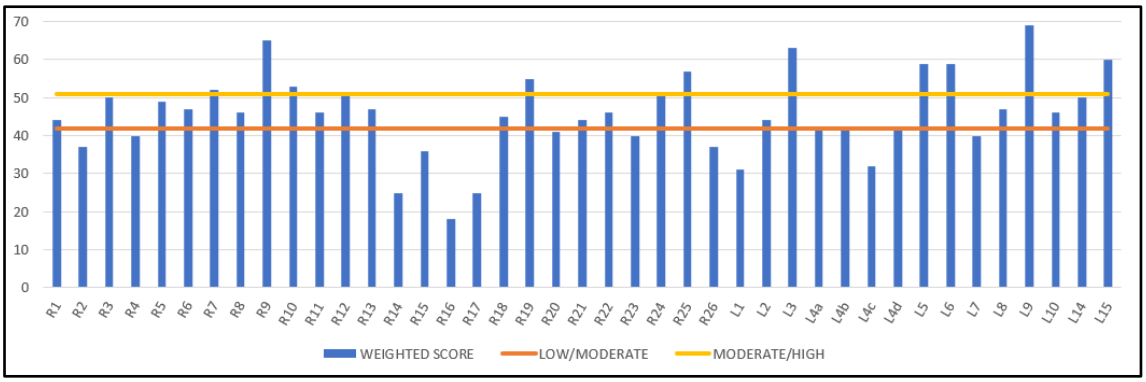

Figure 1. *Distribution of weighted results*

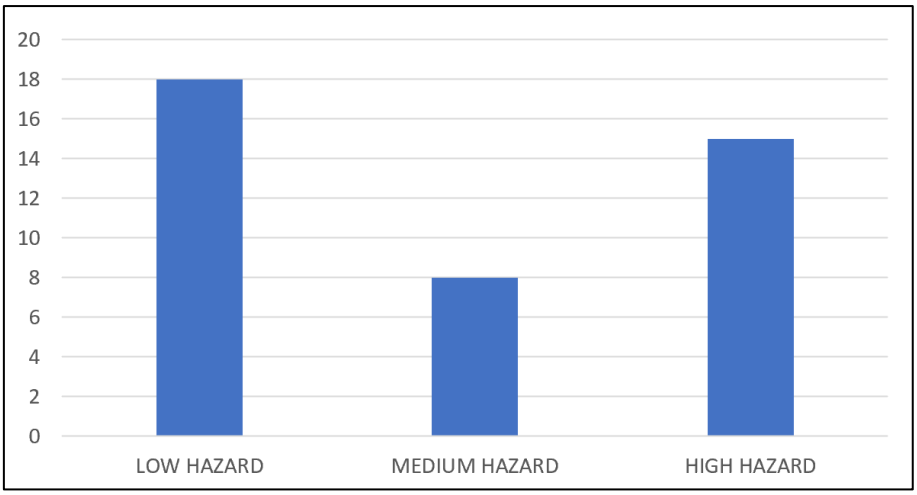

Figure 2. Final distribution *of hazard category scores*

A total of 18 reaches scored very well (numerical score under 42) indicating that there is currently a negligible to low safety hazard. A total of 8 reaches scored moderately (score between 42 and 51), which was interpreted as indicating there is some safety hazard, though not necessarily requiring urgent attention. A total of 15 reaches scored poorly (score greater than 51) and have been proposed as the reaches requiring urgent attention.

Examples of low hazard reaches are shown in Figure 3, including those where there is an existing fence or tree barrier or where there is no public pathway in the riparian corridor.

Figure 3: *Photographic examples of low hazard reaches*

The reaches scoring as medium hazard (shown in Figure 4) generally exhibited moderate to poor condition of the sheet piling. however, it is unlikely that people will access the sheet pile edges due to a moderate vegetation cover or a constructed barrier though in poor condition.

Figure 4: *Photographic examples of medium hazard reaches*

A common characteristic of the high hazard reaches (shown in Figure 5) is poor sheet pile condition, the lack of any barrier (be it natural or constructed), and regular public use of the land immediately adjacent.

Figure 5: *Photographic examples of high hazard reaches*

The modified MCA results were used to create a shapefile indicating the hazard rating for the different reaches of shoreline within the study, which is shown in Figure 6. These results are summarised in Table 2.

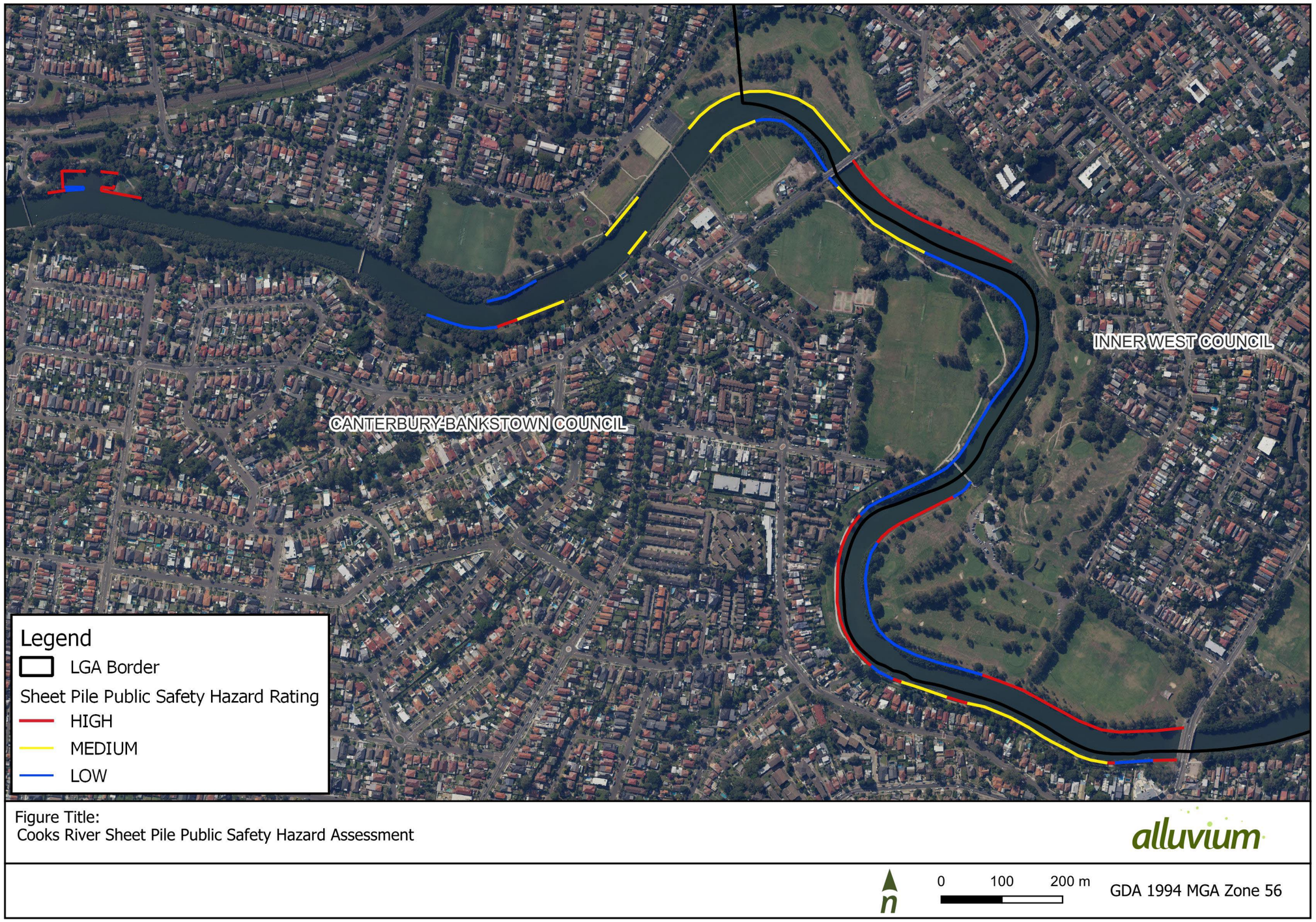

Figure 6. *Results of sheet pile public safety hazard assessment*

Table 2. MCA Results

Hazard rating	Left bank length	Right bank length	Total length
High	1.02 km	0.41km	1.43 km
Medium	0.40 km	0.73 km	1.13 km
Low	0.53 km	1.05 km	1.57 km

2.4 Step 4: Management recommendations

The modified MCA results were used to determine the shoreline areas requiring urgent management action and appropriate management options. It must be noted again that the proposed management actions were devised to address the public safety hazard associated with the sheet piles only. They are not intended to present a comprehensive and long-term bank management solution. Long-term solutions will be developed as part of the main Waterway Asset Condition Assessment scope of works.

Locations requiring urgent management

We recommend that urgent management measures are implemented at all shorelines scored as high hazard in the MCA. The reaches that scored a high hazard category were those with little or no barrier excluding people and an exposed edge of the sheet pile. The reaches receiving a score of low or medium, generally have an existing constructed barrier such as a fence, sheet pile capping, and/or natural barriers such as trees or wide-open space zones. These barriers mean that public access is not easy nor evident and as a result works are not perceived to be urgent. The high hazard shoreline reaches amount to a total of 1.43 km of shoreline in a total of 15 reaches, as shown in Figure 6.

Management Options

A variety of management measure types were considered including fencing, installation of rock to deter people from the shoreline edge and planting of a vegetation buffer to exclude people from the shoreline edging. A fence was determined to be the most appropriate option for providing an immediate measure to discourage people from accessing the sheet pile. Fences are also a relatively low-cost option that can be easily removed when a permanent bank management strategy is implemented. Table 3 highlights the length of high hazard reaches in each of the two LGAs and the related cost to install fencing (assuming timber post fencing with a cost of $65/m).

Table 3. Distribution of high hazard reaches and management costs by LGA

LGA	*Left bank length*	*Right bank length*	*Total length*	*Cost*
Canterbury Bankstown Council	0.21 km	0.41 km	0.61 km	$40,000
Inner West Council	0.81 km	0.*00* km	0.81 km	$53,000

Additionally, fences can also help to create a vegetated barrier by providing an unmown strip between the fence and the sheet pile. The strip could be planted out, or simply left for the existing groundcover species to establish. An example of where this has been done was observed on the upstream most part of Marrickville Golf Course (Figure 7).

Figure 7: *Example of a vegetated barrier*

The other options were deemed less appropriate for the following reasons:

- Significant engineering works such as the installation of rock would require a structural and geotechnical investigation of the site, which would delay the ability to implement the urgent works.
- Solely planting vegetation buffers would take time and require an establishment period, with a risk of failure.

3 Details of proposed management measure

The proposed method to urgently address the public safety issue is to install a fence that deters people from accessing the exposed sheet piling. Installation of signage should be included to communicate that the fencing is to ensure public safety and is a temporary solution. It is recommended that the fence is installed a minimum of one metre away from the sheet pile edge to achieve an appropriate offset, or such that they exclude people from the subsidence holes (whichever is greater), and to provide a safe working environment for the fence installers. There are several options for the type of fence. Table 4 provides a summary of the different fence types, including a cost comparison based on unit rate estimates which were obtained from Rawlinsons Australian Construction Handbook (2022).

Table 4. Summary of fence type alternatives

Fence type (1.2m height)	**Approximate cost to install at all high hazard reaches**
Stud framed – Chainwire clad 	$30/m
Barrier mesh with pickets at 3000mm centres 	$20/m
Galvanised welded mesh roll with tubular posts 	$105/m
Tubular steel landscape fence, pre-painted, posts set in concrete	$120/m

	
Geofabric fence, 300mm depth in trench, includes timber pickets at 3000mm centres 	$50/m
Timber post fence (half logs) 	$65/m

A key consideration when selecting a fence to be installed next to a river is its capacity to resist shear stresses associated with flood flows. Whilst harder engineering solutions such as steel fences have better structural resistance to failure in a flood than a timber picket fence, they would also potentially obstruct flood flows, which could have a negative impact on flood hydraulics.

On a balance of cost, sustainable material selection, visual appearance, resistance to flood flows and a low chance of blocking flood debris, we propose a timber post fence be installed. The estimated installation cost to install these at all high-risk shoreline is approximately $93,000. This does not include any contingency. A concept sketch of the proposed mitigation measure is shown in Figure 8.

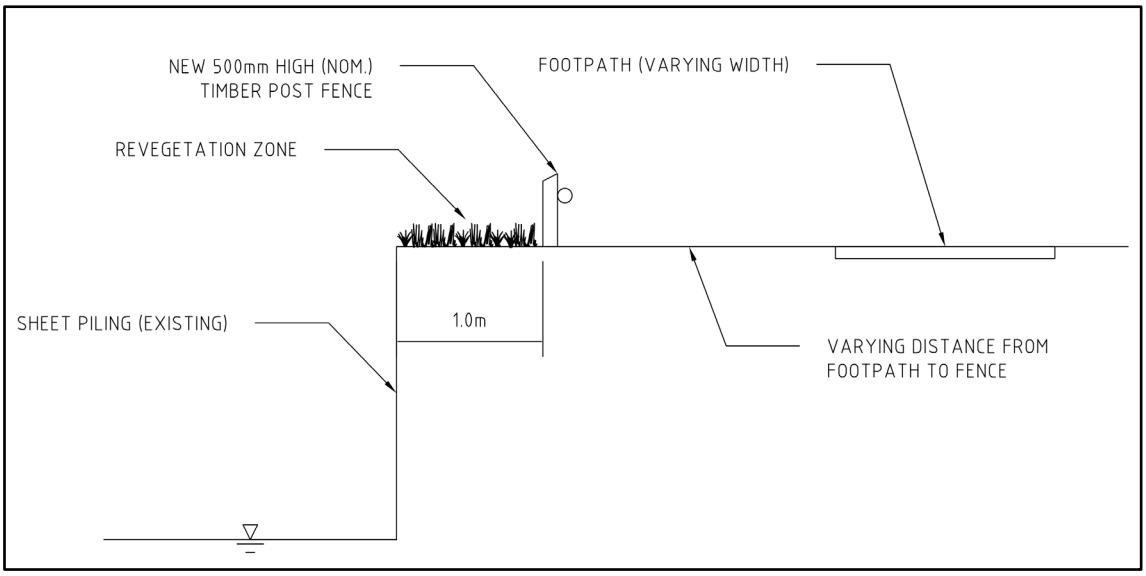

Figure 8. *Sketch of potential fence layout*