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## Revision History

<table>
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<tr>
<th>Rev. No.</th>
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<td>1</td>
<td>2013</td>
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1 INTRODUCTION

This document focuses upon estuarine creek areas of Lake Macquarie and is intended to assist landowners and managers to determine which bank stabilisation treatment and construction techniques suit their situation. The Guidelines are a support document to Council’s Local Environmental Plan (LEP) and Council’s Development Control Plan (DCP).

Council’s DCP defines creekbank stabilisation treatments as Lakefront Area Development and a development application is required before undertaking any works associated with this form of development.

Lakefront Area Development means development which is carried out within 6 metres of the deed high water mark of Lake Macquarie, its tributaries and estuaries and includes a jetty, slipway, boat ramp, pontoon, wharf, groyne or similar structure that may extend over or under the water and includes bank stabilisation treatments.

Lake Macquarie is a large coastal estuarine lake with an overall length of some 22 kilometres in the north-south direction and 10 kilometres in width. The lake covers an area of approximately 110 square kilometres and has a catchment area of 605 square kilometres.

The lake contains 12 major, and many more minor, estuarine creek zones where freshwater tributaries interface with the saline body of the main lake. These include Cockle Creek, North Creek, South Creek, Shepherds Creek, Cold Tea Creek, Pourmalong Creek, Dora Creek, Wangi Wangi Creek, Stockyard Creek, Stony Creek, Mud Creek and L.T. Creek.

These areas support a wide range of habitats and uses including recreation, nature conservation, residential and commercial development and rural activities. As a direct result of many of these uses the ecology of these areas has been highly modified through vegetation clearance, reclamation, earthworks and construction.

Bank erosion and the loss of fringing riparian vegetation along estuarine creeks within Lake Macquarie is a major concern for the community and Council. With funding from Office of the Lake Macquarie & Catchment Coordinator a number of creekbank stabilisation initiatives were developed and trialed. These included:

- examination of best practice stabilisation designs from other estuarine areas
- consultation with the local community and government agencies
- the design and implementation of a bank management demonstration site
- open days at the demonstration site to gather community feedback and
- the preparation of four standard creekbank stabilisation designs

The Guidelines use the designs as a basis to provide general information for typical situations where stabilisation and rehabilitation is required. The general aim is to re-establish ‘stable’, and preferably natural, creekbanks along the lakes tributaries.
2 EROSION PROCESSES AND PROBLEMS

The erosion processes that are likely to affect a particular site will depend on prevailing conditions. There can be considerable variation in the type and extent of erosion within relatively short distances along the creekbank.

Bank erosion in tributaries usually occurs through a combination of vegetation clearing, current scour, wind generated waves and boat waves.

In some localised situations, dredging of creek and drain outlets may also contribute to bank erosion. Modifying the natural creekbank can amplify these processes.

The key factors that affect the rate or severity of erosion are:

- wave height-due to wind speed, duration, fetch length, wind direction;
- creekbank and bed slope,
- water depth,
- creekbank material-grain size, material type (granular, clay, rock),
- presence of vegetation or structural elements,
- activities associated with the use of the area.

Creekbank erosion can result from the removal of native vegetation including aquatic species such as mangroves and seagrass, development or construction activities or built elements, such as retaining walls, boat ramps and slipways.

Creekbank erosion needs to be considered in the context of the estuary as a dynamic system. Increased erosion often occurs during storm events or where some disturbance, usually human induced, has caused instability to the creekbank. Following such events the stream will reestablish equilibrium and may result in further erosion. While creekbank erosion rates have not been quantified, it is possible that at some locations the creekbank has retreated substantially.

The consequences of creekbank erosion are:

- adverse aquatic ecological impacts, such as smothering of near shore habitats,
- fragmentation and reduction of creekbank habitats,
- localised degradation of water quality,
- reduction of tree cover and creekbank vegetation communities.
- loss or reduced access along the creekbank for recreational uses,
- potential loss of public and private land,
- increased maintenance and stabilisation costs,
- reduced aesthetics especially due to ad hoc erosion protection works and a reduction in the natural character of the site.
3 WATER LEVELS IN LAKE MACQUARIE

Water level changes in the lake and tributaries occur as a result of tidal movement and major storm events. Tidal movement in the lake and tributaries is restricted due to the narrow ocean entrance at Swansea. The maximum tidal range in the lake and tributaries is approximately 0.2 metres. Flood inundation of estuarine creek areas may occur during major storm events. The 1% AEP design water level for the lake is 1.38 metres AHD with an extreme design water level of 2.63 metres AHD. The actual levels reached during any particular storm event are influenced by a combination of prevailing ocean levels, atmospheric pressure, catchment rainfall and rain falling directly on the surface of the lake and its tributaries.
4 SELECTING A SUITABLE TREATMENT

The following steps should be considered when intending to undertake bank stabilisation works in estuarine creek zones.

STEP ONE
Carry out a Site Analysis (Refer to Note below)

STEP TWO
Seek advice from a Qualified Engineer/Designer

STEP THREE
Discuss your proposal with Council

STEP FOUR
Select a suitable Creekbank Stabilisation Treatment

STEP FIVE
Lodge a Development Application with Council
Note - A sample site analysis sheet is contained in Appendix D. This will assist in identifying matters that may be relevant to the decision making process.

Consultation with the land owner, Crown Lands, is recommended prior to design works commencing. Creekbank stabilisation activities will require approval from the following state and local authorities:

- Department of Planning and Infrastructure
- NSW Department of Primary Industries (Fisheries)
- Lake Macquarie City Council (LMCC).
CREEKBANK STABILISATION TREATMENTS

Creekbank stabilisation treatments can take several forms depending on the situation and purpose.

Soft engineering approaches that protect or enhance the natural state of the creekbank are preferred. Heavily engineered systems may be required where exceptional circumstances have resulted in active erosion. These treatments are typically used as a last resort.

Generally, 'soft' treatments include the rehabilitation or re-establishment of native vegetation to stabilise creekbank material.

'Hard' treatments include the use of revetments and seawalls to retain and armour the creekbank. Seawalls are unlikely to be approved as a stabilisation option on private properties.

The spectrum of stabilisation techniques available is shown in Appendix A.

5.1 DESIGN PHILOSOPHY

Three (3) standard designs for creekbank rehabilitation have been developed for a range of estuarine creek property types including: shallow creek frontage, deep creek frontage and seawall replacement/modification. Copies of the standard designs are shown in Appendix E.

The design approach adopted has been to consider not only the creekbank stability itself, but also the native revegetation areas, recreational access and runoff control. These factors are all significant to creekbank rehabilitation, managing both environmental and recreational considerations.

Creekbank stability for all designs has been based on stream flow and scour velocities as well as the likelihood of wave action to occur at the frontage. Wave action can be generated from wind, storm events or boat wash, depending on the site location. Wave action from all sources is more prominent in the lake and deep creek areas than the shallow creek areas that are generally more protected. The level of wave action and its frequency are directly related to the level of creekbank stability required.

Stability in the standard designs has been typically achieved over a short distance between the water frontage and the yard. This is to encourage the standard design to be adopted by landowners without significant impact on the useable yard area. Dissipation of wave energy is achieved through the use of rock, vegetation and appropriate creekbank alignment, depending on the likelihood of wave action at the frontage.

The overall layout of the stabilisation work has been designed to cater for both environmental and recreational considerations. Native revegetation areas have been maximised and recreational access, if warranted, has been located adjacent to the boundary. This is intended to separate recreational access to the creek from the native revegetation area. By locating the access adjacent to a boundary, vegetation continuity is provided along the frontage. This also minimises disturbance to the native vegetation area.

The optional recreational access area consists of either a stabilized ramp or cantilevered landing platform.

The stabilised ramp is designed for small boat launching and retrieval. The access is stabilised using an interlocking synthetic cell to allow for vegetation establishment.

The landing platform is designed to be a low profile, minimal structure designed to allow safe access/egress from a boat to the property. The platform is 2.4 metres by 2.4 metres in size, the maximum permissible under Council regulations. The landing platform design is cantilevered so that no piers are required within the creek bed. The final design should be completed in consultation with a Structural Engineer. If recreational access is not required, the full extent of the creek bank can be revegetated as shown.

A filter strip is provided to control runoff from the yard area in each standard design. The filter strip consists of an excavated garden bed, immediately upslope of the native revegetation areas. All stormwater runoff from the yard is to be drained to the garden bed and will flow through the native vegetation area prior to discharging to the creek. This promotes water harvesting, limits first flush runoff entering the waterway and minimises the erosion potential from regular runoff scouring the overbank area.

The garden bed can also be planted out with native vegetation. This practice should be encouraged to provide additional habitat but is not considered essential to the overall functioning of the rehabilitation works. The garden bed provides separation between grassed areas of the yard and the native vegetation.
area. The separation minimises the potential for grass growth within the native vegetation area that would require mowing. The garden bed also provides some flexibility to the landowner, acting as a transition between the essential environmental requirements of the creekbank and the recreational uses of the yard area.

In the standard creekbank designs, a balance has been reached between providing environmental best practice, consisting of a stabilised bank with native revegetation and minimising impact on the yard area of the property. The stabilised bank has generally been fitted within a width of one (1) to two (2) metres. The excavated garden bed has a dual function being part of the runoff control and bank stability, but also a recognisable part of the yard. The garden bed and native revegetation area have been fitted within a minimum width of four (4) metres from the top of bank. A range of designs have been provided that should be widely applicable around Lake Macquarie and its creek systems.

The actual design of the required stabilisation can be complex and each design is usually site specific. Consequently, some judgement is required to meet specific site objectives and the physical site constraints. Contact the Council to discuss your proposal. The following is an overview of each of the treatments.

5.2 SOFT TREATMENTS

5.2.1 SHALLOW CREEK FRONTAGES

The shallow creek frontage design is directly applicable to frontages in the upper reaches of creeks where there is very limited boat access and the frontage is protected from storm wave action. A typical application of this design would be for properties with frontages to Mud Creek where wave action is minimal and remnant vegetation is growing up to the creek edge in undisturbed areas. Frontages are typically less than 300mm above the creek bed. These frontages can be stabilised with native vegetation. The design consists of a jute mesh covering for plant establishment and a 1v: 3h batter for long term stability.

Figure 1 - Shallow creek frontage at Mudd Creek

a. Reinstatement or rehabilitation of creekbank vegetation is highly encouraged

b. Removal of native creekbank vegetation is highly discouraged.

The establishment of vegetation on a site is the most effective means of preventing soil erosion. A good cover of vegetation protects the soil surface by:

- reducing the erosive forces of water,
- reinforcing the soil with plant roots,
- reducing the velocity of surface runoff, and
- catching dislodged soil particles before they move from the eroded site.

Littoral and riparian vegetation also acts as a habitat corridor and creates aesthetically pleasing areas that encourage recreation and use.
Many areas now support highly modified vegetation communities with scattered native trees and exotic grass understorey.

Naturalised environments can provide longterm benefits including reduced maintenance costs, energy savings and increased areas of riparian habitat. However, returning the creekbank to a more natural state takes time to properly establish and can initially be a more expensive option.

Establishing a naturalised creekbank is facilitated through two main processes.

**Passive Naturalisation**

Passive naturalisation occurs when mowing ceases and the area is allowed to naturally regenerate. The process works best where there is an existing source of native seed. Some limited intervention may be required to control excessive weed growth until a native understorey establishes.

**Active Naturalisation**

Is required where there are no native species present. The area to be naturalised needs to be prepared, planted, mulched and maintained until healthy establishment of native species occurs.

Matters to consider when revegetating include:

- species selection,
- planting densities,
- site preparation,
- maintenance,
- adjacent land uses, and
- views and aesthetics.

**Appendix B** provides a discussion and recommendations for sites where revegetation works are an integral part of the project. A plant list for suitable creekbank species is shown in **Appendix C**.

### 5.3 HARD TREATMENTS

Hard creekbank stabilisation treatments can be either 'rigid’ or ‘flexible’. The materials used in the structure will be dictated by the site and the nature of its use.

#### 5.3.1 REVETMENTS

Revetments are designed to dissipate wave energy and protect the creekbank from currents and smaller wave conditions.

They can be constructed using 'flexible' articulated treatments such as rock rubble. An advantage of the flexible revetment treatment is that it can tolerate settlement or movement without failing.

Sloped rock rubble revetments are an effective way of absorbing and dissipating wave energy, reducing wave run-up, overtopping and scour.

Revetment treatments will suit most needs on Lake Macquarie creekbanks.
Deep Creek Frontages

The deep creek frontage standard design is to be applied to those creeks that are large enough for boat access. This design can be used for frontages with an elevation range of 0.5 metres to 1 metre between the yard level and creek bed. Frontages in excess of 1 metre deep will require structural design. This design consists of large rock, 0.5 metres diameter to be placed and stacked for bank stability. This will provide protection from wave action. The design has been coupled with native vegetation on the upper banks. This vegetation can be used to screen the rock, but will also provide for additional bank stability and habitat for wildlife.

5.3.2 SEAWALLS

Vertical or near vertical faces are generally less effective against wave attack as severe scour can occur at the base of the wall through water turbulence. Vertical surfaces also reflect wave energy off shore causing increased wave turbulence that may lead to bed profile changes. Problems can also occur adjacent to these structures.

Many sea walls are constructed from reinforced concrete such as the photo opposite. Seawalls can be modified to provide bank stabilisation with better environmental outcomes.

It is unlikely that seawalls, would be required or approved to address erosion problems associated with individual private properties.

Modification to Seawall

This standard design is to be applied where a landowner is seeking to replace a seawall through an elevation range of 0.5 metres to 1 metre. Seawalls offer bank stability, however the smooth vertical surface of a seawall offers no ecological value and reflects wave energy. Reflected wave energy has the potential to be destructive elsewhere within the waterway.

During replacement of the seawall, there may be an opportunity to retain the existing footing and base block and construct the rock wall above the footing. Advice from a Structural Engineer will be required to assess the stability, longevity and suitability of retaining the existing footing. The rock wall will not be concrete grouted. The rock wall will offer wave impact dissipation through the crevices between the rocks and the 1v:2h batter. The increased number of crevices in comparison to the seawall offers multiple sites for aquatic inhabitants.
6 APPENDICES

6.1 APPENDIX 1 - SPECTRUM OF STABILISATION TECHNIQUES
6.2 APPENDIX B – VEGETATION RECOMMENDATIONS

Discussion/recommendations:
The following discussion is provided as recommendations for rehabilitation of native vegetation associated creekbanks.

Plant Selection and Installation
Plant selection and installation is very important for successful rehabilitation of creekbanks. Planting at higher densities and with a broader range of species will:

- enhance plant survival,
- increase the root mass and depth, and
- allow a more diverse ecosystem to develop.

Increased planting densities will improve the chance of establishment and to allow the new plants to out-compete weeds and provide each other with some support and shelter. For example, ground covers/grasses should be planted in the order of 100 plants per square metre.

Ensuring that proper site preparation and use of appropriate fertilisers, soil modifiers, water absorbing materials, mulch (not deeper than 200mm) and in some cases shelter will also enhance the chances of plant establishment.

One of the aspects that has been highlighted as a contributing factor in the poor establishment is the use of non endemic species and plants grown outside the local area, away from a coastal environment. It is suggested that endemic species, many of which are identified in Appendix C, be used in creekbank planting.

The wholesale removal of existing vegetation, which is often introduced grasses, to plant native species may not be warranted in every situation. Introduced grasses can provide a stable transition from a beach to the land. Where an erosion scarp of up to 200mm has formed, grasses assist in holding the bank in place and may be adequate in limiting further erosion.

Where scarps are higher, such as greater than 250mm the shallower root depth and/or root mass of the grass does not hold the bank, undermining by wave action may continue and the bank collapses taking the grass cover with it. In this instance, native species with a longer root base may be more suitable.

Planting should occur as soon as possible after the construction of the creekbank stabilisation treatment. Delaying the planting leaves the creekbank vulnerable to erosion.

Planting in areas used for private land/water based recreation will require greater consideration to ensure damage through trampling does not result. Grouping or limiting planting areas and improving the growth of the grass component in active area will provide a better overall result.

Maintenance
Ongoing care of the plants, including replanting, watering, weed control, shelter control, restricting pedestrian access, are essential factors in plant establishment.

Where vegetation, especially native species is used as a major component of the creekbank stabilisation treatment, it is vital that the planting succeeds. Follow up maintenance is necessary to limit costs associated with repeated planting.
### 6.3 APPENDIX C – NATIVE SPECIES FOR CREEKBANK AREAS

#### 6.3.1 LOCAL NATIVE SPECIES SUITABLE FOR CREEKBANK PLANTING

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Botanical Name</th>
<th>Growth Form</th>
<th>Conditions</th>
<th>Position</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Plantain</td>
<td>Alisma plantago-aquatica</td>
<td>Erect, emergent herb to 1m tall</td>
<td>Wet-damp</td>
<td>In water – waters edge</td>
<td>Tubers are edible</td>
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<tr>
<td>Swamp Lily</td>
<td>Ottelia ovalifolia</td>
<td>Submerged plant with floating leaves</td>
<td>Wet, ponds and slow moving water</td>
<td>In water</td>
<td>Attractive white flowers</td>
</tr>
<tr>
<td>Water Ribbons</td>
<td>Triglochin procerum</td>
<td>Submerged, tufted herb</td>
<td>Wet, permanent creeks</td>
<td>In water</td>
<td>Widespread and common; small, green fruits are edible</td>
</tr>
<tr>
<td>Leafy Twig-rush</td>
<td>Cladium procerum</td>
<td>Erect, leafy sedge 1-1.5m high</td>
<td>Edge of freshwater swamps on the coast</td>
<td>In water</td>
<td></td>
</tr>
<tr>
<td>Jointed Twig-rush</td>
<td>Baumea articulate</td>
<td>Sedge 1-2m tall</td>
<td>Swamps</td>
<td>In water</td>
<td>Attractive plant with large, drooping inflorescence</td>
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<tr>
<td>Native Violet</td>
<td>Viola hederacea</td>
<td>Creeping herb forming carpets</td>
<td>Moist and shady</td>
<td>Bank slope to floodplain</td>
<td></td>
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<tr>
<td>River Buttercup</td>
<td>Ranunculus inundatus</td>
<td>Small herb</td>
<td>Marshy, periodically inundated</td>
<td>Waters edge</td>
<td></td>
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<tr>
<td>Swamp Pennywort</td>
<td>Centella asiatica</td>
<td>Creeping herb</td>
<td>Marshy, clay or sandy soils</td>
<td>Top of bank to floodplain</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydrocotyle peduncularis</td>
<td>Creeping herb</td>
<td>Moist, shady</td>
<td>Top of bank to floodplain</td>
<td></td>
</tr>
<tr>
<td>Swamp Goodenia</td>
<td>Goodenia paniculata</td>
<td>Small, tufted herb to 30cm</td>
<td>Marshy conditions</td>
<td>Top of bank to floodplain</td>
<td></td>
</tr>
<tr>
<td>Common Name</td>
<td>Botanical Name</td>
<td>Growth Form</td>
<td>Conditions</td>
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<tr>
<td>Prickly-leaved Paperbark</td>
<td>Melaleuca styphelioides</td>
<td>Tree 6-15m</td>
<td>Swampy places, fresh and brackish</td>
<td>Top of bank to floodplain</td>
<td>Lower catchment</td>
</tr>
<tr>
<td>Narrow-leaf Paperbark</td>
<td>Melaleuca Linariifolia</td>
<td>Small tree to 8m</td>
<td>Marshy ground</td>
<td>Top of bank to floodplain</td>
<td>Lower catchment</td>
</tr>
<tr>
<td>Node-fruit Paperbark</td>
<td>Melaleuca nodosa</td>
<td>Shrub or small tree to 6m</td>
<td>Marshy ground</td>
<td>Top of bank to floodplain</td>
<td>Lower catchment</td>
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<tr>
<td>Broad-leaved Paperbark</td>
<td>Melaleuca quinquenervia</td>
<td>Tree 8-12m</td>
<td>Marshes</td>
<td>Top of bank to floodplain</td>
<td>Lower catchment</td>
</tr>
<tr>
<td>Willow Bottlebrush</td>
<td>Callistemon salignus</td>
<td>Shrub 3-4m</td>
<td>Moist and swampy ground</td>
<td>Top of bank to floodplain</td>
<td>Lower catchment</td>
</tr>
<tr>
<td>Cabbage Tree Palm</td>
<td>Livistona australis</td>
<td>Tall palm</td>
<td>Rainforest gullies</td>
<td>Top of bank to floodplain</td>
<td></td>
</tr>
<tr>
<td>Water Gum</td>
<td>Tristaniopsis laurina</td>
<td>Small, spreading tree 4-10m</td>
<td>Moist</td>
<td>Top of bank to floodplain</td>
<td>Upper catchment</td>
</tr>
<tr>
<td>Grey Myrtle</td>
<td>Backhousia myrtifolia</td>
<td>Spreading shrub 3-4m</td>
<td>Sheltered gullies</td>
<td>Top of bank to floodplain</td>
<td>Upper catchment</td>
</tr>
<tr>
<td>Lilly Pilly</td>
<td>Acmena smithii</td>
<td>Shrub or tree</td>
<td>Moist</td>
<td>Top of bank to floodplain</td>
<td>Upper catchment</td>
</tr>
<tr>
<td>Sandpaper Fig</td>
<td>Ficus coronata</td>
<td>Small tree 3-4m</td>
<td>Moist</td>
<td>Top of bank to floodplain</td>
<td>Upper catchment</td>
</tr>
<tr>
<td>Black Wattle</td>
<td>Callicoma serratifolia</td>
<td>Large shrub usually 4-5m</td>
<td>Moist</td>
<td>Top of bank to floodplain</td>
<td>Upper catchment</td>
</tr>
<tr>
<td>Cheese Tree</td>
<td>Glochidion ferdinandi</td>
<td>Shrub or tree usually 4-8m</td>
<td>Moist</td>
<td>Top of bank to floodplain</td>
<td>Upper catchment</td>
</tr>
<tr>
<td>Common Name</td>
<td>Botanical Name</td>
<td>Growth Form</td>
<td>Conditions</td>
<td>Position</td>
<td>Notes</td>
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</tr>
<tr>
<td>Rough-barked Apple</td>
<td>Angophora floribunda</td>
<td>Small to medium tree</td>
<td>Moist valleys with deep, alluvial soils</td>
<td>Top of bank to floodplain</td>
<td>Upper western parts of catchment in valleys of Watagan mountains</td>
</tr>
<tr>
<td>Sydney Blue Gum</td>
<td>Eucalyptus saligna</td>
<td>Tall tree 30-50m</td>
<td>Moist</td>
<td>Top of bank</td>
<td>Upper catchment</td>
</tr>
<tr>
<td>Swamp Mahogany</td>
<td>Eucalyptus robusta</td>
<td>Tree 20-30m</td>
<td>Swampy ground, fresh and brackish</td>
<td>Floodplain (and steep creekbank land)</td>
<td>Lower catchment</td>
</tr>
<tr>
<td>Swamp Oak</td>
<td>Casuarina glauca</td>
<td>Tree to 20m</td>
<td>Along boundary between fresh and brackish waters</td>
<td>Top of bank to floodplain</td>
<td>Lower Catchment</td>
</tr>
<tr>
<td>River Oak</td>
<td>Casuarina cunninghamii</td>
<td>Tall tree to 20-35m</td>
<td>Fresh water</td>
<td>Top of bank</td>
<td>Larger creeks in middle to upper catchment</td>
</tr>
<tr>
<td>Swamp Water Fern</td>
<td>Blechnum indicum</td>
<td>Erect fern 50-150cm</td>
<td>Swamy ground near the coast</td>
<td>Floodplain</td>
<td></td>
</tr>
<tr>
<td>Common Maidenhair Fern</td>
<td>Adiantum aethiopicum</td>
<td>Delicate fern 15-40cm</td>
<td>Damp, shady places</td>
<td>Bank to floodplain</td>
<td>Occurs in dense colonies</td>
</tr>
<tr>
<td>False Bracken Fern</td>
<td>Calochlaena dubia</td>
<td>Soft fern to 1.5m</td>
<td>Moist, shady conditions on sandy soils</td>
<td>Top of bank to floodplain</td>
<td>Forms dense colonies</td>
</tr>
<tr>
<td>Spiny Mat-rush</td>
<td>Lomandra longifolia</td>
<td>Grass-like herb to 1m</td>
<td>Wide range of habitats</td>
<td>Bank slope to floodplain (above high tide on creekbanks)</td>
<td>Flowers/bases of new leaves are edible</td>
</tr>
<tr>
<td>Tussock Rush</td>
<td>Juncus usitatus</td>
<td>Forms dense clumps to 1m</td>
<td>Range of soils from moist to swampy sites</td>
<td>Bank slope and waters edge</td>
<td></td>
</tr>
<tr>
<td>Saw-edge</td>
<td>Gahnia clarkei</td>
<td>Forms dense thickets to 2.5m</td>
<td>Damp and marshy sites</td>
<td>Bank slopes to floodplain</td>
<td></td>
</tr>
<tr>
<td>Common Name</td>
<td>Botanical Name</td>
<td>Growth Form</td>
<td>Conditions</td>
<td>Position</td>
<td>Notes</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------------------------</td>
<td>------------------------------</td>
<td>---------------</td>
<td>-------------</td>
<td>--------</td>
</tr>
<tr>
<td>Club-rush</td>
<td>Bolboshoenus caldwellii</td>
<td>Erect sede 50-100cm tall</td>
<td>Brackish water</td>
<td>Waters edge</td>
<td></td>
</tr>
<tr>
<td>Marsh Club-rush</td>
<td>B. fluviatilis</td>
<td>See above</td>
<td>Freshwater</td>
<td>Waters edge</td>
<td></td>
</tr>
<tr>
<td>River Club-rush</td>
<td>Schoenoplectus validus</td>
<td>Forms dense stand to 1.5m or more</td>
<td>Freshwater</td>
<td>Waters edge</td>
<td></td>
</tr>
</tbody>
</table>
6.4 APPENDIX D – SITE ASSESSMENT PROFORMA

To be used as a guide with carrying out site inspection before design, development application, construction or maintenance activities take place.

GENERAL
Assessment Undertaken by: ................................................................. Site Sketch: (plan view)
Date: .................................................................
Street Address / Location: ........................................................................
Suburb: .................................................................
Weather Conditions: (on the day of inspection)
........................................................................................................
........................................................................................................

SITE CONDITIONS
Infrastructure (eg. Sewerage, stormwater). Identify on Location Sketch.
........................................................................................................

Structures: (eg. Sea wall, boat sheds, boat ramp, jetty, play equipment and garden shed).
Identify on Location Sketch
........................................................................................................

Recreation Uses:
Land Based: (eg. Type, frequency of use)
........................................................................................................

Water Based: (Type, frequency of use)
........................................................................................................
CREEKBANK CONDITIONS

General description: Including adjacent areas:

Profile Sketch: (Cross section)

Details: (e.g. bank-width, slope, material, scarpe height, any constructed elements, length of Eroded creekbank, length of unaffected creekbank).

Orientation:

Prominent Wind Patterns Affecting the Site: (consider seasonal changes)
Identify on Site Sketch:

Prominent Wave Patterns Affecting the Site: (consider seasonal changes & water uses)
Identify on Site Sketch:

Soils: (eg. Type, natural, fill, acid sulfate soils).
Soil testing by qualified person may be required. Attach Geotech Report if necessary.

Visual Aspects:
Consider views from the water, land and adjoining properties. Photographs are useful.

Vegetation Types: (include predominant Species, Significant Species or Habitats)
Onshore: .................................................................
Offshore: .................................................................
Condition (eg presence of weeds, tree health, maintenance impacts)
6.5 APPENDIX E – CREEKBANK STABILISATION – STANDARD DESIGNS

Notes
1. Standard Design – Shallow Creek Frontage. This design is applicable to Shallow Creek Frontages with bank 0.2 metres to 0.5 metres above creek bed.
2. Landing Platform to be designed by a Structural Engineer and cantilevered (no piles) to water edge.
3. Site design to retain existing native vegetation.
4. Discuss your proposal with Council.

STANDARD DESIGN
Shallow Creek Frontage

Section A-A Shallow Creek Frontage
(0.2 - 0.5m High Bank, Low Wave Action)

Adjoining Property or Reserve

Filter Strip 4m (min.)

Native Landscaped Area
Refer to Plant Schedule

Garden Bed

Shallow Creek Frontage

Yard

Adjoining Property or Reserve

Plan View

Fill with topsoil and mulch 200mm high above existing ground level

Existing Ground level

Provide Drainage Gravel Layer 60mm thick

Native Landscaped area to be planted

M.H.W.L

Pin Jute Mesh into existing ground level for Native Plant Establishment

Creek Bed

1

or flatter

REV. C

NTS

Ref No: R02_V1/1768_045.dgn
Section A-A Rock Stabilised Bank
(0.5-1.0m High Bank, Moderate Wave Action)

Notes
1. Standard Design—Deep Creek Frontage. This design is applicable to Deep Creek Frontages with banks 0.5 metres to 1 metre above creek bed.
2. Flood Platform: to be designed by a Structural Engineer and cantilevered (no piles) to water edge over rock.
3. Site design to retain existing native vegetation.
4. Discuss your proposal with Council.

Umwels (Australia) Pty Limited

STANDARD DESIGN
Deep Creek Frontage

NTS
Ref No.:PM2_V1/1785_041.dgn
Adjoining Property or Reserve

Filter Strip 4m (min.)

Base Block of Existing Seawall

Creek Foreshore

Landing Platform Max. Dimensions 2.4m x 2.4m under Stabilised Access (if desired). See Note 2 & Refer to landing platform and stabilised creek access sheets.

Yard

Adjoining Property or Reserve

2m min.

2m min.

Notes:
1. Standard Design – Modification to Seawall. This design is applicable to Creek Frontages with bank 0.5 metres to 1 metre above creek bed. Works in excess of 1 metre high require design by a Structural Engineer.
2. Landing Platform to be designed by a Structural Engineer and cantilevered (no piles) to water edge over rock.
3. Footing and base block of existing seawall (up to M.H.W.L.) may remain if stable and in "good condition". "Condition" to be assessed by a Structural Engineer and key in rock as required.
4. Site design to retain existing native vegetation.
5. Discuss your proposal with Council.

NSW (Australia) Pty Limited

STANDARD DESIGN Modification to Seawall

Ref No.: Rev 02\_YV1766_042.dgn

Adopted by Council 11 June 2013
Section A-A Landing Platform

Notes
1. Landing Platform to be designed by a Structural Engineer. The design is to be cantilevered with no piers into water.
2. Drainage to discharge yard stormwater to garden in filter strip. Drainage can be grassed open channel (100mm deep) or a grated drainage pit and 90mm PVC pipe connected to garden bed (alternatively to suit design requirements).
3. Low key or minimal structure permitted to an elevation of 1.2m, such as handrail, if desired.
4. Site design to retain existing native vegetation.
5. Discuss your proposal with Council.

STANDARD DESIGN
Landing Platform

Umwelt (Australia) Pty Limited

REV. C

NTS

Ref No.: RO2_V176S_041.dgn
**Estuarine Creekbank Stabilisation & Rehabilitation Guideline**

**STANDARD DESIGN**

Stabilised Creek Access

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**Notes**

1. Drainage to discharge yard stormwater to garden in filter strip. Drainage can be grassed open channel (100mm deep) or a grased drainage pit and 900mm PVC pipes connected to garden bed (alternatively to suit design requirements).
2. Site design to retain existing native vegetation.
3. Discuss your proposal with Council.

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**Umweld (Australia) Pty Limited**

NTS

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Adopted by Council 11 June 2013